DIIS REPORT

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Cindy Vestergaard

Governing Uranium in Canada

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Contents

Abbreviation

AA	administrative arrangement
AEC	Atomic Energy Commission (USA)
AECB	Atomic Energy Control Board
AECL	Atomic Energy of Canada Limited
AONM	Australian Obligated Nuclear Material
AP	Additional Protocol
BAPE	Bureau d'audiences publiques sur l'environnement
BTC	Board of Transport Commissioners
CA	Complementary Access
CAEA	China Atomic Energy Authority
CDA	Combined Development Agency
CDT	Combined Development Trust
CGNPC	China General Nuclear Power Corporation
CNSC	Canadian Nuclear Safety Commission
CPC	Combined Policy Committee
CSSP	Canadian Safeguards Support Program
DTMF	Deilman Tailings Management Facility
EIS	Environmental Impact Statement
ENL	Eldorado Nuclear Limited
ESEC	Earth Sciences Extraction Company
IAEA	International Atomic Energy Agency
ICD	inventory change documents
ICRP	International Commission on Radiological Protection
INFCE	International Nuclear Fuel Cycle Evaluation
JBACE	James Bay Advisory Committee on the Environment
JCU	Japan-Canada Uranium Co. Ltd
KAEC	Kativik Environmental Advisory Committee
LSA	Low Specific Activity
MBA	Material Balance Area
MUG	McClean Lake Underground

NCA	Nuclear Cooperation Agreement
NIRB	Nunavut Impact Review Board
NMAS	Nuclear Material Accounting System
NNWS	Non-Nuclear Weapons State
NPP	nuclear power plant
NPT	Treaty on the Non-Proliferation of Nuclear Weapons
NRC	Nuclear Regulatory Commission (USA)
NRCan	Natural Resources Canada
NROP	Non-Resident Ownership Policy (Canada)
NSCA	Nuclear Safety and Control Act
NSG	Nuclear Suppliers Group
NUTP	National Uranium Tailings Program
NWS	Nuclear Weapons State
OPG	Ontario Power Generation
OURD	Overseas Uranium Resources Development Co. Ltd.
PIV	Physical Inventory Verification
PP18	Policy Paper 18
PP21	Policy Paper 21
ppm	parts per million
PTNSR	Packaging and Transport of Nuclear Substances Regulations, 2015
RAPP	Rajasthan Atomic Power Station
SABRE	Surface Access Borehole Resource Extraction
SMDC	Saskatchewan Mining Development Corporation
SRC	Saskatchewan Research Council
SSAC	State System for Accounting and Control
TMF	tailings management facility
tU	tonnes of uranium
UG	Urangesellschaft Canada Ltd.
UOC	uranium ore concentrates
WNA	World Nuclear Association
WNTI	World Nuclear Transport Institute

Acknowledgements

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1. Introduction

Canada has produced more uranium than any other country in the world, close to 500,000 tonnes of uranium since 1942. It hosts the world's largest operating mine, mill and refinery and is home to Saskatchewan's Athabasca Basin, where the world's largest high-grade uranium deposits are located. Given its high concentrations upwards of 20 per cent uranium, or 200,000 parts per million (ppm), Canada is the only producer that has to 'water down' its rock.

While Canada maintains high rankings, its overall share of global production has dropped from 32 per cent in 2002[1] to approximately 15 per cent today. For decades until 2009 it was ranked as the world's top annual producer, when it was surpassed by Kazakhstan and dropped to second place. Canada consumes approximately 15 per cent of its own production, fuelling 19 CANDU reactors at three separate locations in Ontario and one in New Brunswick. The rest, nearly 85 per cent of Canada's total uranium production, is exported.

This study analyses the Canadian uranium supply industry, the evolution of its development and the legal framework that regulates uranium production and trade. It is part of the larger *Governing Uranium* project being led by the Danish Institute for International Studies (DIIS), which explores the dimensions of the security of natural uranium in a changing global market.

It should be noted that there were some challenges in historical documents regarding the reporting of volumes, specifically of 'tonnes' and 'tons' of U_3O_8 and of 'tonnes uranium' (tU). Canada began transitioning from the imperial system of measuring to the metric system in 1970 which could explain a number of the variations. When used in this report, they are reflective of the sources used in obtaining the information. Where the term 'uranium' is used, it refers to uranium in the form of UOC unless otherwise stated.

[1] Parliament of the Commonwealth of Australia, Standing Committee on Industry and Resources, 'Australia's uranium: greenhouse friendly fuel for an energy hungry world,' Canberra, November 2006, p. 58.

2. Domestic Demand for Canada's NPPs

In the late 1950s, Canadian industry and Atomic Energy of Canada Limited (AECL) began developing a Canadian line of nuclear power plants (NPPs): the CANDU (Canada Deuterium Uranium) reactor. The CANDU uses heavy water (deuterium oxide) as a moderator and coolant and is fuelled by natural uranium (as distinct from enriched uranium). The first prototype (22 MWe) went operational in 1962 at Rolphton, Ontario, 30 kilometres from the Chalk River facilities, with the second, larger prototype (200 MWe) beginning to generate power at Douglas Point, Ontario, in 1967. Commercial reactors began operating in Pickering, Ontario, in 1971.[2] Today, 22 CANDU reactors (19 operational) are located at five plants in three provinces. The Gentilly-2 Nuclear Generating Station, located near Trois-Rivières, Québec, was permanently shut down in December 2012, leaving Ontario and New Brunswick as the only provinces with operating plants.[3] In Ontario, nuclear power generates more than 50 percent of the province's electricity.[4] As a whole, Canada's total generating capacity is 13,553 MWe, or about 15 percent of the country's electricity. The nineteen power reactors currently operating are listed in Figure 1.

Given that a nuclear power plant of 1,000 MW requires around 200 tU per year, the annual demand for natural uranium generated by Canada's nuclear power reactors can be estimated currently at approximately 2,600 tU. For the foreseeable future, Canada's demand for natural uranium will remain the same, as proposals to build several nuclear reactors have been deferred,[5] lapsed[6] or terminated, prompting, in the case of Ontario, refurbishment and life extensions instead.[7]

[2] World Nuclear Association, 'Nuclear Power in Canada,' http://www.world-nuclear.org/info/Country-Profiles/Countries-A-F/Canada--Nuclear-Power/. Accessed 5 November 2015.

[3] Hydro-Québec operated one reactor with an installed capacity of 675 MWe until December 2012, when it was closed. The co-located Gentilly-1 Nuclear Power Station, which operated intermittently from 1972 to 1978, was shut down in 1984. It has been partially decommissioned and is now in a storage-with-surveillance mode and is licensed as a waste facility.

[4] Ontario Power Generation, 'Nuclear Power,' http://www.opg.com/generating-power/nuclear/Pages/nuclear.aspx. Accessed 5 November 2015.

[5] In August 2012, the CNSC issued OPG with a license to prepare the Darlington site for the construction of four nuclear power reactors. In May 2014 the licence was revoked by a federal court due to concerns about nuclear waste, hazardous emissions and accidents. The CNSC is appealing the decision. In November 2013, the Ontario government deferred plans for the construction of two new nuclear reactors at Darlington to be operated by OPG.

[6] A proposal for a feasibility study on building a second reactor at the Point Lepreau site, initiated by the New Brunswick provincial government in 2007, has lapsed.

[7] OPG proposed to refurbish four Darlington and four Bruce B reactors to extend reactor lifetimes, instead of building new reactors of up to 4800 MWe at Darlington.

Figure 1. Nuclear Power Plants in Canada

Sites	*Owner/ Operator*	*No. of Units*	*Installed Capacity (MWe)*	*Start of Commercial Operation*	*Planned Closure*	*Current Status*
Bruce A & B Nuclear Generating Stations, Kincardine, Ontario	Bruce Power	8	6,232 (Bruce A & B combined)	Bruce A 1977-1979 Bruce B 1984-1987	Refurbish-ment planned in 2016[8]	All units operating
Darlington Nuclear Generating Station, Clarington, Ontario	Ontario Power Generation (OPG)	4	3,512	1990-1993	Until 2055 (beginning of shutdown state 2048 and final shutdown in 2085)[9]	All four reactors operating
Pickering Nuclear Generating Station, Pickering Ontario	OPG	8	3,100	1971-1973 for units 1 to 4 1983-1986 for units 5 to 8	Until 2020[10]	Six operating; two in safe storage
Point Lepreau Generating Station, New Brunswick)	New Brunswick Power Nuclear (NBPM)	1	705	February 1, 1983	Until 2036[11]	Operating
Gentilly-2 Nuclear Generating Station, Bécancour, Québec	Hydro-Québec	1	675	October 1, 1983	-	Closed December 2012
Total		22	*14,224 (13,553 operating)*			*19 operating*

8 Achieving Balance: Ontario's Long-Term Energy Plan, 2013, p. 5: http://www.energy.gov.on.ca/en/files/2014/10/LTEP_2013_English_WEB.pdf

9 OPG website, CNSC Draft Screening Report, 2012, pp. 6-7. - http://www.opg.com/generating-power/nuclear/stations/darlington-nuclear/darlington-refurbishment/Pages/reports.aspx

10 Achieving Balance: Ontario's Long-Term Energy Plan, 2013, p. 5: http://www.energy.gov.on.ca/en/files/2014/10/LTEP_2013_English_WEB.pdf

11 Decommissioning Cost Study for the Point Lepreau Generating Station, Document N29-1632-002, Rev. 0, 2010, p. 13 (Adobe – search "March"): file:///C:/Users/mmhe/Downloads/30.52.pdf or file:///C:/Users/mmhe/Downloads/30.52%20(1).pdf

3. Uranium Production in Canada

Canada has the world's fourth largest known uranium resources. As of 1 January 2013, Canada's total identified conventional uranium resources recoverable at a cost of <USD 80/kgU amounted to 418,300, with identified resources recoverable at <USD 130/kgU amounting to 493,900 tU.[12] The Athabasca Basin in northern Saskatchewan hosts the world's highest grade unconformity-related uranium deposits. From 1953 until the end of 2013 the area produced a total of 356,523 tU_3O_8 (approximately 786 million pounds),[13] accounting for the majority (over 70%) of Canada's total uranium production. For the past twenty years, all uranium production in Canada has come from this area.

In 2015, three uranium mines are operating: McArthur River, Rabbit Lake (Eagle Point) and Cigar Lake. All three are mined by underground methods and produced a total of 9,134 tU (10,771 tU_3O_8) in 2014, ranking Canada as the world's second largest producer after Kazakhstan. Three mills are also operating at McClean Lake, Rabbit Lake and Key Lake. All mills in Canada produce U_3O_8, both calcined and non-calcined.

Operating Mines

McArthur River / Key Lake

Discovered in 1988, McArthur River is the world's largest high-grade uranium deposit, located approximately 620 kilometres north of Saskatoon, Saskatchewan. As of December 31, 2013, proven and probable ore reserves were 1,037,400 tonnes at a grade of 15.76% U_3O_8 for a total of approximately 163,500 tU_3O_8.[14] Ore grades within the deposit are 100 times the world average, which means the operation can produce over 18 million pounds of uranium annually by mining only 150 to 200 tonnes of ore per day. Mining commenced in December 1999, with commercial production achieved on November 1, 2000.[15]

[12] Red Book, 2014, p. 175.

[13] Saskatchewan Ministry of Economy, 'Saskatchewan Ministry of the Economy Uranium Mining Supply Chain Requirement Guide,' March 2014, p. 2.

[14] Canadian Nuclear Safety Commission, 'CNSC Staff Report on the Performance of Uranium Mine and Mill Facilities: 2013,' Ottawa, Canada, p. 48.

[15] Cameco, 'McArthur River Operation Northern Saskatchewan, Canada' National Instrument 43-101, Technical Report, 2 November 2012, p. 38.

McArthur River is currently the world's largest uranium mine in operation (based on annual production), producing 9,135 tU_3O_8 in 2013 and 8,675 tU_3O_8 in 2014.[16] Total production from when it began operations in 1999 until the end of 2014 was 122,333 tU_3O_8.[17] These figures place McArthur as the world's fourth largest uranium mine of all time, after the Wismuth (Bismuth) uranium mine in East Germany (which produced 216,000 tU from 1946 to 1990), Russia's Priargunsky Mining and Chemical Combine (140,000 tU since 1968) and Namibia's Rössing mine (127,405 tU U_3O_8 since 1976).[18] McArthur is on track to surpass Rössing in 2015 to become the third largest all-time producing uranium mine (and likely to pass Priargunsky in 2016).[19]

Uranium is mined 600 metres underground, then crushed and mixed with water in a ball mill to form slurry which is pumped to the surface. The ore slurry is loaded into specially designed containers and transported by road to the Key Lake Operation, 80 kilometres southwest, for further processing into U_3O_8. The Key Lake site includes two mined-out ore bodies, Gaertner and Deilmann, which were discovered in the mid-1970s. Mining ended there in 1983 and 1997 respectively, with production from stockpiles ending in 2002. Milling began in 1983, and since 1999 the mill processes uranium from the McArthur River Mine. Mineralised waste rock is also transported to Key Lake in covered haul trucks, where it is blended with the high-grade ore slurry to create the mill ore feed of about 3.4% U.[20] Tailings are deposited in the mined-out Deilmann pit (known as the Deilman Tailings Management Facility, DTMF).

Key Lake is the world's largest high-grade mill, producing 8,867 tU_3O_8 in 2012 and 9,132 tU_3O_8 in 2013.[21] According to Cameco, Key Lake has delivered over 208,652

[16] World Nuclear Association, 'Uranium in Canada,' http://www.world-nuclear.org/info/country-profiles/countries-a-f/canada--uranium/. Accessed 20 October 2015.

[17] Cameco, 'McArthur River Mine / Key Lake Mill,' 2*014 Annual Report,* 11 March 2015. See also IAEA and NEA, *Uranium 2014: Resources, Production and Demand*, p. 126; and the World Nuclear Association, 'Uranium in Canada,' http://www.world-nuclear.org/info/Country-Profiles/Countries-A-F/Canada--Uranium/#Notes. Accessed 20 October 2015.

[18] Cindy Vestergaard, *Governing Uranium Globally*, DIIS Report 2015: 09, pp. 31-32.

[19] In 2014, Rössing produced 1,308 tU; 2,043 tU in 2013; and 2,289 tU in 2012. See: World Nuclear Association, 'Uranium in Namibia,' http://www.world-nuclear.org/info/Country-Profiles/Countries-G-N/Namibia/. Accessed 20 October 2015.

[20] International Atomic Energy Agency and the OECD Nuclear Energy Agency, *Uranium 2014: Resources, Production and Demand*, 2014, p. 176.

[21] CNSC, 'CNSC Staff Report on the Performance of Uranium Mine and Mill Facilities: 2013,' Ottawa, Canada, p. 75.

tU_3O_8 (460 million lbs) to world markets since 1983.[22] Cameco envisages the Key Lake Operation as a future 'regional mill', offering milling services for a number of regional ore deposits, including from the proposed Millennium project (see next section). In July 2014, the CNSC approved an increase in mill production to 11,360 tU_3O_8 per year.[23]

McArthur River mine is a joint venture between Cameco (70%) and AREVA Canada Resources Inc. (30%), a subsidiary of France's AREVA Group. The Key Lake mill is also a joint venture between the two, with Cameco holding 83 per cent interest and AREVA 17 per cent.[24] Cameco is the operator of both the MacArthur River mine and Key Lake mill. In October 2013, the Canadian Nuclear and Safety Commission (CNSC) issued a ten-year licence following a public hearing in La Ronge, Saskatchewan. Cameco's licence for the McArthur River Operation and Key Lake mill expires on October 31, 2023.

Rabbit Lake

Rabbit Lake opened in 1975 in the Athabasca Basin, making it the oldest operating uranium production facility in North America. Its deposits include the mined-out original Rabbit Lake open pit, Collins Bay A, B and D zones, and the currently operating Eagle Point underground mine. Following completion of mining at the Rabbit Lake pit in 1984, open pit mining of the Collins Bay B zone took place from 1985 to 1991. Wholly owned and operated by Cameco, Rabbit Lake was the first mine in Canada to introduce a seven days in/seven days out commuter system.[25]

Rabbit Lake (Eagle Point) produced 1,559 tU_3O_8 in 2013[26] and 1,900 tU_3O_8 in 2014.[27] Total production from 1975 to 2014 amounted to 198.2 million pounds (90,000

[22] Cameco, 'McArthur River/Key Lake,' http://www.cameco.com/businesses/uranium-operations/canada/mcarthur-river-key-lake. Accessed 20 October 2015.

[23] Cameco, 'McArthur River Mine / Key Lake Mill,' Annual Report 2014, http://www.cameco.com/annual_report/2014/mda/our-operations-and-projects/uranium-operating-properties/mcarthur-river-mine-key-lake-mill/. Accessed 3 November 2015.

[24] Cameco, 'McArthur/Key Lake' http://www.cameco.com/businesses/uranium-operations/canada/mcarthur-river-key-lake. Accessed 30 October 2015.

[25] Cameco, 'McArthur River/Key Lake,' http://www.cameco.com/businesses/uranium-operations/canada/mcarthur-river-key-lake. Accessed 20 October 2015.

[26] CNSC, 'CNSC Staff Report on the Performance of Uranium Mine and Mill Facilities: 2013,' Ottawa, Canada, p. 59.

[27] Cameco Northern Saskatchewan, 'Operations and Major Projects,' http://camecomicrosites.zu.com/northernsk/cameco_in_north/operation_major_projects/rabbit_lake/. Accessed 1 November 2015.

tonnes) of U_3O_8. As of December 31, 2013, the proven ore reserves remaining at Rabbit Lake were 92,000 tU_3O_8. Cameco expects the Eagle Point mine to operate at current rates of production until at least 2018.[28]

Ore from Eagle Point is trucked 13 km north to the Rabbit Lake mill and processed into U_3O_8. Similar to the Key Lake mill, Rabbit Lake also processes stockpiled material with newly mined ore. For several years, ore from the Eagle Point mine has been blended at the Rabbit Lake mill with previously mined low-grade material to supplement uranium concentrate production. In 2014, the mill produced 1,872 tU_3O_8.[29]

Waste rock storage and tailing management facilities are also located at the site. Rabbit Lake designed, installed and commissioned the world's first pervious surround in-pit tailings management facility (TMF). Raise water, essentially water drained and squeezed from the consolidating tailings, is collected and returned to the mill for reuse or treatment.[30] Current decommissioning and reclamation activities at Rabbit Lake are ongoing. In October 2013, the Commission issued a ten-year licence following a public hearing in La Ronge, Saskatchewan. Cameco's licence for the Rabbit Lake Operation expires on October 31, 2023.[31]

Cigar Lake

Cigar Lake is Canada's newest mine and is the world's second largest high-grade uranium deposit (after McArthur River) with an estimated 537,100 tU uranium reserves, including proven reserves of 233,600 tU (at 24% U_3O_8) and probable reserves of more than 303,500 tU (at 17.84% U_3O_8).[32] It was discovered in 1981, and construction began in December 2004, with production initially anticipated to begin in 2007. As a result of flooding in October 2006 and again in 2008,[33] construction and operation were pushed back while remedial measures were undertaken. Cameco obtained an operating license in June 2013. The first transports of ore from the mine

[28] CNSC, 'CNSC Staff Report on the Performance of Uranium Mine and Mill Facilities: 2013,' Ottawa, Canada, p. 60.

[29] CNSC, 'CNSC Staff Report on the Performance of Uranium Mine and Mill Facilities: 2013,' Ottawa, Canada, p. 60.

[30] Saskatchewan Ministry of Economy, 'Saskatchewan Ministry of the Economy Uranium Mining Supply Chain Requirement Guide,' March 2014, p. 4.

[31] CNSC, 'CNSC Staff Report on the Performance of Uranium Mine and Mill Facilities: 2013,' Ottawa, Canada, p. 60.

[32] 'Cigar Lake Uranium Mine, Saskatchewan Canada,' *Mining-Technology.com*, http://www.mining-technology.com/projects/cigar-lake-uranium-mine-canada/. Accessed 1 December 2015.

[33] 'Cameco tackles Cigar Lake flooding again,' *World Nuclear News*, 26 October 2009.

to MacLean mill took place in March 2014. By October, the mill was producing concentrate to yield 156 tU_3O_8 for the year.[34]

Commercial production was declared on 1 May 2015, and on 27 September 2015 the senior management of Cameco and AREVA cut the ribbon on the mine, commemorating the official start to production.[35] On 16 December 2015, Cameco announced that production at Cigar Lake had surpassed 10 million pounds (3,846 tU) of U_3O_8.[36] Total production for the year will be reported in Cameco's fourth quarter results, due to be released in February 2016.

Cameco uses a unique jet-boring system adapted for the deposit. The process involves a non-entry mining method which freezes the ore and surrounding rock by circulating brine chilled to -40C through large pipes underground (this freezing takes about one year). A mining machine then bores through the frozen rock to create the production tunnel. High pressure water jets are then used to cut cavities out of the frozen ore to collect slurry which in turn is pumped to storage (sump storage) where it settles. The slurry then moves underground to the grinding and processing circuit and is eventually pumped to the surface where it is loaded onto a tanker truck and transported to the McClean mill. When mining is complete, each cavity in the ore body is filled with concrete before repeating the process with the next cavity.[37]

Cameco owns 50.25 per cent of Cigar Lake, with AREVA holding 37.1 per cent, Idemitsu Canada Resources 7.85 per cent and TEPCO Resources 5 per cent. Cameco is the operator. Operations at the underground mine are permitted for eight years until June 2021[38] and are licensed for up to 10,908 tU_3O_8 annually.[39] Cameco plans to ramp up to this target by 2018.[40]

McClean Lake Mill

Located seventy kilometres northeast from Cigar Lake in the Athabasca Basin, the McClean Lake mill is currently being expanded from its current capacity of 13 mil-

[34] World Nuclear Association, 'Uranium in Canada,' http://www.world-nuclear.org/info/country-profiles/countries-a-f/canada--uranium/#Notes. Accessed 1 November 2015.

[35] 'Cigar Lake mine officially starts production,' *Mining.com*, 27 September 2015.

[36] 'Production Milestone for Cigar Lake,' *World Nuclear News*, 16 December 2015.

[37] Cameco, 'Cigar Lake,' *2014 Annual Report*, 11 March 2015.

[38] CNSC, 'CNSC Staff Report on the Performance of Uranium Mine and Mill Facilities: 2013,' Ottawa, Canada, p. 34.

[39] Ibid., p. 35.

[40] Cameco, 'Cigar Lake,' *2014 Annual Report*, 11 March 2015.

lion pounds (5,900 tU_30_8) to 24 million pounds (10,886 tU_3O_8) to meet Cameco's production target for Cigar Lake. Construction of the expansion is expected to be completed by the end of 2015.[41] Other infrastructure at the site includes a sulphuric acid plant, a ferric sulphate plant, an oxygen plant, warehouses, offices and living accommodation for site personnel.[42]

McClean Lake is a joint venture between AREVA Resources Canada (70%), Denison Mines Corporation (22.5%) and OURD (Canada) Ltd (7.5%). AREVA is the operator. McClean Lake also consists of nine known ore deposits, five of which have been mined out, with some ore stockpiled on the surface. The project includes the JEB, McClean, Sue and Caribou deposits. The first ore from the JEB deposit was fed into the mill in June 1999, with commercial production achieved on 1 November 1999.[43] JEB was mined out from 1997 to 1999 and ore stockpiled. The Sue C ore body was completed in February 2002 and ore stockpiled on the surface. Mining remained suspended until the last half of 2005, when operations began at the Sue A, Sue E and Sue B deposits. Sue E was mined out within six months, with Sue E and Sue B following in 2008. Waste from these mines was deposited in the mined-out Sue C pit, where special waste from Cigar Lake will also be deposited.[44] Conventional mining has not been carried out at the McClean Lake Operation since.

The McClean mill produced approximately 49.9 million pounds (over 22,000 tU_3O_8) from 1999 until it was placed on stand-by in June 2010.[45] In September 2014 the McClean Lake mill recommenced operations by processing a blend of Sue B and ore from the SABRE program, eventually blending in ore from Cigar Lake. Approximately 90,700 tonnes of Sue B and SABRE ore at an average grade of 0.38% U_3O_8 remain in the stockpile.[46] The McClean Lake mill is the only facility in North America capable of processing high-grade uranium ore (from less than 1% to 30% uranium) without diluting it.[47] In total, until mid-2014 more than 50

41 Denison Mines, 'Exploration & Development, http://www.denisonmines.com/s/McLean_Lake.asp. Accessed 2 November 2015.

42 Ibid.

43 Ibid.

44 Ibid.

45 The mill had been processing stockpiled ore from McClean North and Sue A, B and E deposits, production of which was declining.

46 Denison mines, 'McClean Lake,' http://www.denisonmines.com/s/McLean_Lake.asp. Accessed 12 December 2015.

47 AREVA, 'McClean Lake Operations site guide,' http://us.areva.com/home/liblocal/docs/Profile/Operations/Mining/2013%20McCleanLake%20Site%20Guide.pdf. Accessed 2 November 2015.

million pounds of uranium concentrate (22,700 tU_3O_8) had been produced at McClean Lake.[48]

Exploration activities for the expansion of known deposits and the identification of new projects are ongoing. The McClean Lake Underground (MUG) mine could have a life expectancy of six to ten years, and would feature ramp access starting at one of the former open-pit mines. The proposed Midwest Project (see next section) in the eastern Athabasca region received approval for its environmental assessment in August 2012. Ore from the proposed mine would be processed at the McClean Lake mill, seventeen kilometres east of the Midwest site.[49] Up to 75 per cent of the mill's expanded capacity of McClean Lake will be dedicated to processing Cigar Lake ore, with the remaining capacity reserved for processing other sources, such as Midwest. In 2012, McClean was also authorised to process ore slurry from the McArthur River mine.[50]

The JEB Tailings Management Facility (TMF) serves as the repository for all resulting tailings. Mining projections to 2038 indicate that the McClean Lake mill will produce tailings in excess of the existing capacity of the TMF. After evaluating a number of options, AREVA has decided to pursue an expansion of this facility.[51] The current licence, issued in July 2009, was amended on December 19, 2012 and expires on June 30, 2017. The amended licence authorises the operation of the ore slurry receiving circuit and high-grade milling circuits in the McClean Lake Operation mill, along with the processing of ore slurry from approved sources, including Cigar Lake Operation and McArthur River Operation at the McClean Lake Operation mill. It also allowed for an increase in maximum annual U_3O_8 production from 3,629 tonnes to 5,909 tonnes.[52]

Production figures for each mine (including McClean ore bodies) over the past decade are given in Figure 2.

48 AREVA, *Kiggavik Project Final Environmental Impact Statement*, Tier 1, Volume 1: Main Document, September 2014, p. 12.

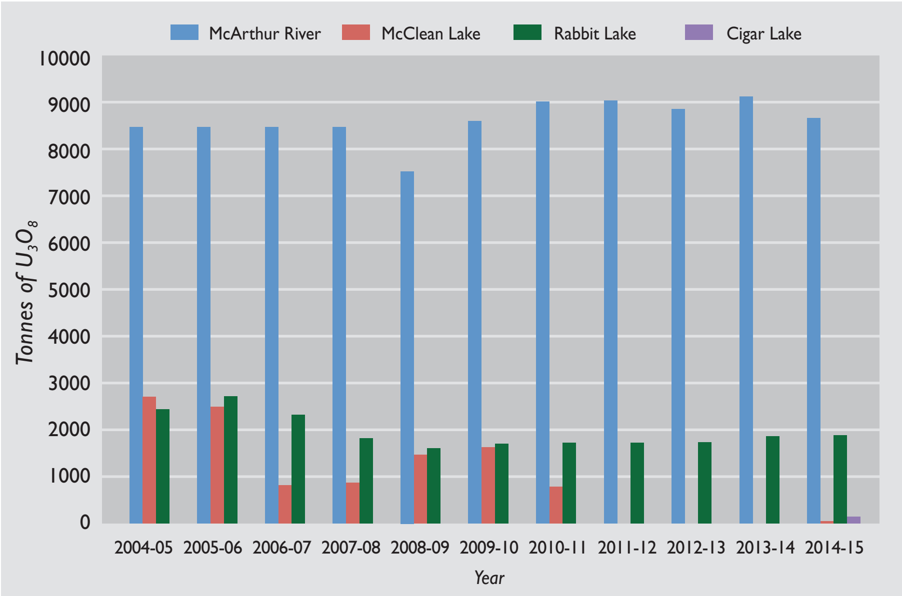
49 AREVA, 'McClean Lake Operations site guide,' http://us.areva.com/home/liblocal/docs/Profile/Operations/Mining/2013%20McCleanLake%20Site%20Guide.pdf. Accessed 2 November 2015.

50 CNSC, 'CNSC Staff Report on the Performance of Uranium Mine and Mill Facilities: 2013,' Ottawa, Canada, p. 91.

51 AREVA, 'McClean Lake Operations site guide,' http://us.areva.com/home/liblocal/docs/Profile/Operations/Mining/2013%20McCleanLake%20Site%20Guide.pdf. Accessed 2 November 2015.

52 CNSC, 'CNSC Staff Report on the Performance of Uranium Mine and Mill Facilities: 2013,' Ottawa, Canada, p. 91.

Figure 2. Recent production from individual mines in Canada



Source: World Nuclear Association[53]

Proposed Mines

Millennium

The Millennium deposit in the Athabasca Basin was discovered in 2000 and may hold as much as 46.8 million pounds (18,000 tU) at an average grade of 4.53% U_3O_8.[54] In 2012, Cameco acquired AREVA's 27.94 per cent interest in the project to bring its ownership to 69.9 per cent.[55] The rest (30.1%) is held by JCU Canada Exploration Ltd, a subsidiary of the Japan-Canada Uranium Co. Ltd (JCU). Cameco is the operator.

The deposit is located 35 kilometres north of the Key Lake mill, where all ore from the mine will be processed, so that no tailings or storage is anticipated at the mine.

[53] World Nuclear Association webpage, "Uranium in Canada": http://www.world-nuclear.org/info/Country-Profiles/Countries-A-F/Canada--Uranium/#a. Accessed 16 November 2015.

[54] See: J. Halaburda, 'The Milennium Uranium Deposit, Athabasca Basin, Saskatchewan, Canada: An Atypical Basement-Hosted Unconformity-Related Uranium Deposit, Economic Geology, 104(6), November 2009, pp. 815-840.

[55] Cameco, 'Milennium,' *2014 Annual Report*, 11 March 2015.

Saskatchewan Province issued environmental approval for the project in December 2013. In May 2014, Cameco requested the CNSC to postpone a June 2014 public hearing scheduled to conclude the environmental assessment. Due to poor economic conditions in the uranium market, Cameco withdrew its application for a ten-year licence to construct and operate the underground Millennium mine.[56]

Midwest

The Midwest project is also located in the Athabasca Basin, approximately fifteen kilometres from the McClean Lake mill, where extracted ore is planned to be processed. The project is owned by AREVA Resources Canada (69.16%), Denison Mines (25.71%) and OURD (5.67%) and includes two deposits: the Midwest deposit discovered in 1978, and the Midwest A deposit, discovered in 2004/2005.[57] AREVA is the operator. Mining at Midwest will be open-pit, and all resulting tailings will be disposed of in McClean Lake's tailings management facility (TMF). The final version of the project's Environmental Impact Statement (EIS) was submitted to the provincial and federal governments in September 2011 and approved the following September. The environmental assessment and engineering activities are still continuing to allow the project to proceed when market conditions improve.[58]

Kiggavik

AREVA's Kiggavik Project is located north of 60° in Nunavut, approximately 80 kilometres west of Baker Lake. The Project includes two sites, Kiggavik and Sissons, involving five proposed individual mines: three open-pit mines at Kiggavik (East Zone, Center Zone and Main Zone) and one open-pit (Andrew Lake) and one underground mine (End Grid) at Sissons. The mill will be located at Kiggavik to produce 3,200–3,800 tU_3O_8 per year. The mined-out open pits will serve as the tailings management facility. The total quantity of resources is estimated at approximately 51,000 tU (133 million pounds U_3O_8) at an average grade of 0.46% uranium. Based on studies to date, the mine's life is approximately twelve years of production and fourteen for the mill.[59]

[56] Cameco, 'Milennium,' *2014 Annual Report*, 11 March 2015.

[57] Denison Mines, 'Midwest Project,' http://www.denisonmines.com/s/Midwest.asp. Accessed 4 November 2015.

[58] AREVA, 'Midwest,' http://us.areva.com/EN/home-995/areva-resources-canada-midwest.html. Accessed 15 December 2015.

[59] AREVA, *Kiggavik Project Final Environmental Impact Statement*, Tier 1, Volume 1: Main Document, September 2014, p. 2.

Uranium was discovered in the area in 1974, and in 1989 the owner at the time, Urangesellschaft Canada Ltd. (UG), proposed a mine development for the Kiggavik Project. In 1993, AREVA (formerly COGEMA Resources Inc.) acquired UG and became the Project's operator. Exploration was carried out until a 1997 pre-feasibility study, which concluded that the deposits were not economically viable at the time, and the Project was put into care and maintenance from 1998 to 2002.[60]

Community outreach from 2003 onwards led eventually to drilling and fieldwork in the summer of 2007. The Kiggavik Project falls under the jurisdiction of the Nunavut Land Claims Agreement and is thus subject to the environmental assessment process of the Nunavut Impact Review Board (NIRB) rather than the Canadian Environmental Assessment Act. The environmental review process was formally initiated in November 2008, with the NIRB releasing the final guidelines for preparation of the Kiggavik Environmental Impact Statement (EIS) in May 2011.[61] The final EIS was submitted to the NIRB in October 2014. In May 2015, the NIRB issued a news release stating that it had completed its review and recommended to the federal Minister of Aboriginal Affairs and Northern Development that the Kiggavik Project not proceed at this time. Without a definite start date or development schedule included in the EIS, the Board found it could not provide confident assessments on the future ecosystemic and socio-economic effects.[62] In July 2015, AREVA asked the federal government to return the report to the NIRB to consider amending it to include the necessary terms and conditions so it can be approved.[63] The case is ongoing.

Today, Kiggavik is owned by AREVA and Urangesellschaft Canada Limited (collectively 'AREVA') and by the Japan-Canada Uranium Company Limited and Daewoo International Corporation.[64] AREVA's interest is 64.8%, followed by JCU with 33.5% and Daewoo 1.7%. AREVA is the operator.[65]

[60] Ibid.

[61] AREVA, *Kiggavik Project Final Environmental Impact Statement*, Tier 1, Volume 1: Main Document, September 2014, p. 8.

[62] NIRB, 'Nunavut Impact Review Board Issues Final Hearing Report Following Review of AREVA Resources Canada Incorporated's "Kiggavit Uranium Mine" Project,' *News Release*, Cambridge Bay, Nunavut, 8 May 2015. File No. 09MN003.

[63] World Nuclear News, 'Areva begs to differ on Kiggavik recommendation, 9 July 2015.

[64] AREVA, *Kiggavik Project Final Environmental Impact Statement*, Tier 1, Volume 1: Main Document, September 2014, p. v.

[65] AREVA, *Kiggavik Project Final Environmental Impact Statement*, Tier 1, Volume 1: Main Document, September 2014, p. 9.

Given the remoteness and climate of the area, it is proposed to construct and operate an airstrip at the site for the transport of personnel and UOC. Access to the site will be provided by a winter road between Baker Lake and Kiggavik. Mill reagents, fuel and other supplies will be transported by ship and barge to a dock facility (to be constructed) at Baker Lake during the summer season and then trucked to Kiggavik. The proposed project is the first in the world (since the 1940s) to propose transporting yellowcake by air. Uranium concentrate would be packaged into barrels at the Kiggavik site and transported via aircraft to Points North, Saskatchewan, and onward to ground transportation networks in southern Canada.[66]

[66] NIRB, 'Nunavut Impact Review Board Issues Final Hearing Report Following Review of AREVA Resources Canada Incorporated's "Kiggavit Uranium Mine" Project,' *News Release*, Cambridge Bay, Nunavut, 8 May 2015. File No. 09MN003.

4. Refining and Conversion

Although technically a single process, the refining and conversion of natural uranium in Canada takes place at two separate facilities: refining in Blind River and conversion in Port Hope, both located in the province of Ontario and both owned by Cameco Corporation. Blind River was built in 1983 and receives UOC from mines and mills in Canada and around the world, which it refines into uranium trioxide (UO_3). Most of this is sent directly to Cameco Port Hope, although some is exported. The capacity of Blind River is approximately 18,000 tU per year, making it the largest refinery in the world.

The conversion plant at Port Hope has a longer history, going back to 1935 as a radium extraction facility. Today, it converts UO_3 into either UF_6, which is exported for subsequent enrichment, or UO_2, which is primarily used for the domestic production of CANDU fuel. The throughput of the UF_6 plant is approximately 12,500 tU per year, while the UO_2 plant processes around 2,000 tU per year.[67]

A plant in Calgary, Alberta, owned by Earth Sciences Extraction Company (ESEC), has also been licensed to remove uranium from phosphate rock feed stock before conversion of the rock into fertilizer. The facility operated from the early 1980s[68] but was shut down for economic reasons in 1987. In 1996, the Atomic Energy Control Board (AECB) allowed ESEC to modify the facility to process phosphoric acid without recovering the contained uranium. The uranium recovery parts of the plant were then physically isolated.[69]

In February 2006, ESI Resources Ltd filed a licence renewal application for its uranium recovery facility. There were deficiencies in the application, and CNSC requested a revised submission in March 2006. Three months later a CNSC inspection at the facility revealed uranium contamination inside the dryer room and evaporation ponds. A month after the facility licence expired, along with ESI's authorisation to possess and store materials, the CNSC issued an Order that ESI take specified actions and measures to protect the environment from the continued

[67] Governing Uranium website: http://uranium.csis.org/pit_to_port/. Accessed 10 December 2015.
[68] Atomic Energy Control Board, *Annual Report 1979-80*, Ottawa, Canada, p. 6.
[69] AECB, *Annual Report 1997-98*, pp. 14 -15.

presence of uranium-contaminated material at the unlicensed site.[70] The site was fully reclaimed.

There are no enrichment facilities in Canada.

[70] CNSC, Canadian Nuclear Safety Commission Annual Report 2006-2007.

5. History of Uranium Production

Canada's first uranium mine was discovered in 1930 on the eastern shore of Great Bear Lake in the Northwest Territories. At the time radium was the target, used for its bright yellow pigment in colouring ceramics and its gamma rays in the treatment of cancer. It was even considered a miracle product used in a range of products from cosmetics to toothpaste and suppositories.[71] Uranium was considered an annoying and hefty waste product, taking as much as one short ton of uraninite (pitchblende) to yield one-seventh of a gram of radium.[72] But the rewards were financial; in the 1930s, radium had reached a price as high as $75,000 per ounce.[73]

Radium production began in 1932 at Port Radium, with uranium, silver and copper as by-products. The same year, Eldorado Gold Mines, the owner and operator, built a radium refinery in Port Hope, Ontario, approximately 5,000 km away.[74] Ore was initially transported down Canada's waterways, taking two months to reach the refinery, in rivers that were ice-free for only a few weeks of the year. As time went on, Eldorado acquired its own airplanes which were employed more often to transport ore to Waterways. Rail was also used.[75] Each ton of pitchblende concentrates required seven tons of chemicals for treatment, making it less costly to ship the concentrates than the chemicals. Eldorado produced radium until June 1940.

In 1942, Port Radium re-opened to fulfill its first uranium order, made in spring 1941 by the United States for eight tons of refined uranium oxide for preliminary experiments with an atomic pile.[76] Another wartime order was made in 1942 for 60 tons of uranium oxide from Eldorado's stockpile at Port Hope, which was used by Dr Enrico Fermi to create the world's first self-sustaining nuclear chain reaction at the University of Chicago.[77] While quantities of supply during the war from Port

[71] Susan Quinn, *Marie Curie—A Life* (New York: Simon & Schuster, 1995), 409-410. Quinn writes: "A 1929 pharmacopoeia listed 80 patent medicines whose ingredients were radioactive; they came in the form of bath salts, liniment, suppositories, toothpaste, and chocolate candies."

[72] Cindy Vestergaard, *Governing Uranium Globally,* DIIS Report 2015: 09, p. 26.

[73] Anna Tilman, 'On the Yellowcake Trail,' *Watershed Sentinel,* June/July 2009, p. 18.

[74] Ibid.

[75] Porthopehistory.com: http://www.porthopehistory.com/blindfaith/chapter_two.htm. Accessed 10 October 2015.

[76] The wartime order was made by Dr Lyman J. Briggs, chairman of Roosevelt's Advisory Committee on Uranium in the United States. See Sharon Squassoni et al., Governing Uranium in the United States, *CSIS Report*, March 2014, p. 8.

[77] Sharon Squassoni et al., *Governing Uranium in the United States*, p. 8.

Radium are unclear, estimates place the total amount at 1,000 tons of uranium concentrate.[78] Port Radium produced uranium until 1960 and again between 1964 and 1982, when the mine finally closed. In 2007, the federal government completed remediation of Port Radium.

In September 1943, Orders in Council reserved to the Crown all new discoveries of radioactive minerals in the Yukon and Northwest Territories and banned their staking by private interests, with provincial authorities adopting similar measures. The Canadian Government nationalised Eldorado in early 1944, and the name was changed to Eldorado Mining and Refining Limited.[79] During the war the acquisition and disposal of radium and uranium had been controlled to a limited extent under the Canadian War Orders and Regulations.

Believing uranium was in short supply, in 1943 the United States and United Kingdom established the Combined Development Trust (CDT) (later the Combined Development Agency, CDA) 'to secure control of uranium and thorium within the participants' own territories – the United Kingdom taking responsibility for the British Commonwealth (excluding Canada) and the Colonial Empire – and to seek to acquire control of uranium and thorium resources in third countries (known as 'CDT territories').'[80] Uranium was bought jointly by the CDT and was allocated to the two countries through the Combined Policy Committee (CPC). The allocations were determined keeping in mind 'supplies from other sources, such as indigenous supplies from the United States and supplies from Canada.'[81] The United States purchased all of Canada's uranium with documents from the 1940s, indicating that details of Canadian contracts were not known to the UK government at the time.[82]

On 30 December 1947, the government revoked the Orders in Council that prohibited private prospecting for uranium, and by 1955 there was active exploration of large ore-bodies by a growing private industry. A total of 502 properties or occurrences showing uranium or thorium in amounts of 0.05% had been reported, and permits to carry on exploration and development work had been issued in 93 cases, fifty being

[78] Earle Gray, *The Great Uranium Cartel* (Toronto: McClelland and Steward), 1982, p. 33.

[79] Eldorado operated the mine and refinery without any change of management at that time and, assisted by the Geological Survey of Canada, began active prospecting for uranium deposits.

[80] Molly Berkemeier, Wyn Q. Bowen, Christopher Hobbs and Matthew Moran, *Governing Uranium in the United Kingdom*, DIIS Report 2014: 02, p. 6.

[81] *Governing Uranium in the United Kingdom*, p. 7.

[82] Ibid, pp. 7-8.

issued in 1950.[83] By the end of 1952, 645 properties or unstaked occurrences were known, and 130 exploration permits were in effect.[84] By the end of March 1956, the number of exploration permits in force reached 432,[85] and it was estimated that Canada had reserves of 225,000 tU (237,000 tU_3O_8).[86] This was the first time that Canada (along with the United States and South Africa) made estimates of its ore reserves public.[87] Previous to this, data received from exploration permits were summarised annually and included in a confidential inventory of Canadian deposits of uranium and thorium.[88]

On 16 March 1948, Eldorado Mining and Refining Ltd became the sole buying agent for the federal government. Its mandate included negotiating contracts, procurement and re-sale to foreign countries of all radioactive ores, concentrates, precipitates and products produced in Canada. The contracts contained specifications for the product and method of payment, sampling and assaying procedures. Companies submitted reports and drawings of covering ore reserves and grades to the Board, along with information on ore impurities, the proposed method of recovery and processing, financial accounts, anticipated capital expenditures to bring properties to production and estimates of operating costs.[89]

Exploration led to the development of production centers in Saskatchewan, Ontario and Northwest Territories. From four mining permits in force in 1953-54[90] to six a year later (three in Ontario and three in Saskatchewan),[91] the number of operating mines reached nineteen in the year 1957-58, with a combined milling capacity of 40,000 tons of ore a day. Twelve mines, each with individual treatment plants, began milling operations that year alone, ten of them in Ontario.[92] Development was also spurred by Ottawa changing its approach in 1955 to a fixed pricing scheme it had established years previously. While the government raised the price, which had

83 Fifth Annual Repot of the Atomic Energy Control Board of Canada, 1950-51, Ottawa, Canada, p. 10.

84 Seventh Annual Report of the Atomic Energy Control Board of Canada 1952-53, Ottawa, Canada, p. 9.

85 Distributed as follows: Alberta, 4; British Columbia, 9; Northwest Territories, 33; Manitoba, 4; Saskatchewan, 131 ; Ontario, 212; Quebec, 36; New Brunswick, 3.

86 Eleventh Annual Report of the Atomic Energy Control Board 1956-57, Ottawa, Canada, p. 9.

87 W.D.G. Hunter, 'The Development of the Canadian Uranium Industry: An Experiment in Public Enterprise,' *Canadian Journal of Economies and Political Science*, Vol. 28 (3), August 1962, p. 341.

88 Seventh Annual Report of the Atomic Energy Control Board of Canada 1952-53, Ottawa, Canada, p. 10.

89 Hunter, 1962, p. 334.

90 Eighth Annual Report of the Atomic Energy Control Board of Canada 1953-54, p. 9.

91 Ninth Annual Report of the Atomic Energy Control Board of Canada, 1954-1955, Ottawa, Canada, p. 8.

92 Twelfth Annual Report of the Atomic Energy Control Board 1957-58, Ottawa, Canada, p. 9.

initially been fixed too low, and caused industry to lose money, it changed its policy with the goal of ending prospecting and putting known deposits into production.[93]

The nineteen mines operating during the 1950s are listed in Figure 3. All of them were developed during the 1950s, except for Port Radium, which had been operating since 1942.

Figure 3. Uranium mines in Canada operating during the 1950s

Mine	*Owner/Operator*	*Province*	*Duration of Operations*
Beaverlodge	Eldorado Mining and Refining Ltd	Saskatchewan	1952-1982
Bicroft	Bicroft Uranium Mines Ltd	Ontario	1956-1963
Buckles Mine	Rio Algom Ltd	Ontario	1956-1960
Can-Met Mine	Denison Mines Ltd	Ontario	1957-1960
Denison Mine	Denison Mines Ltd	Ontario	1957-1992
Dyno Mine	Canadian Dyno Mines Ltd	Ontario	1954-1960
Gunnar	Eldorado Mining and Refining Ltd	Saskatchewan	1955-1961 (open pit) 1957-1963 (underground)
Lacnor Mine ('Lake Nordic')	Rio Algom Ltd	Ontario	1956-1960
Madawaska Mine	Madawaska Mines Ltd	Ontario	1954-1964 1975-1982
Milliken Mine	Rio Algom Ltd	Ontario	1957-1964
Nordic Mine	Rio Algom Ltd	Ontario	1956-1970
Panel Mine	Rio Algom Ltd	Ontario	1958-1961 1978-1990
Port Radium	Eldorado Mining and Refining Ltd	Northwest Territories	1932-1940 (radium) 1942-1960 1964-1982
Pronto Mine	Rio Algom Ltd	Ontario	1955-1970
Quirke Mines	Rio Algom Ltd	Ontario	1956-1961 1965-1990
Rayrock Mine	Rayrock Mines Ltd	Northwest Territories	1957-1959
Spanish American Mine	Rio Algom Ltd	Ontario	1957-1959
Stanleigh Mine	Rio Algom Ltd	Ontario	1956-1961 1982-1997
Stanrock	Rio Algom Ltd	Ontario	1958-1960 1964-1985

93 Hunter, 1962, p. 336.

Canada also began to diversify its customer base in 1956-1957. Along with two contracts to deliver oxide to the United Kingdom, Canada also completed an agreement with West Germany in 1957 for 500 tU over a five-year period, the first sale of Canadian uranium strictly for non-military purposes and the first to a state other than the United States or United Kingdom.[94] In 1959, Canada signed a nuclear cooperation agreement with Euratom. The same year, Canadian producers made deliveries reaching a peak of 15,909 tU_3O_8 (12,200 tU), approximately 32% of total world production,[95] valued at CDN $333,577,990.[96]

By May 1958, the new government was permitting mines to find their own markets for output surplus to existing obligations, ending Eldorado's monopoly of buying and selling uranium in Canada. However, within a year, the United States Atomic Energy Commission (AEC) had ample supplies of uranium for the U.S. nuclear weapons program and began phasing out its foreign uranium purchases, eventually halting them altogether in 1966. With world production outstripping demand, Canadian producers entered agreements to 'stretch-out' deliveries with the United States and United Kingdom for existing contracts, leading to a decline in deliveries to 12,480 tU_3O_8 in 1960[97] and 9,630 tU_3O_8 in 1961.[98] The majority of Canadian mines then closed over the coming years, with only a handful operating in Ontario and production declining up to less than 3,000 tU in 1966.[99] As one researcher noted in 1963, the elimination of the military demand for uranium – the reason Canada's uranium mining industry was brought into being – led to a 'crisis of survival.'[100]

In 1969, four uranium producers, three of them in the Elliot Lake area of Ontario[101] and Beaverlodge in northern Saskatchewan, produced 4,457 tU, a figure which stayed steady through 1970 and 1971. The continuing oversupply of the global uranium market, however, meant that producers were only exporting around 25-35% of annual UOC production. Of the 4,578 tU_3O_8 produced in Canada in 1970, only 1,164

94 Gray, 1982, p. 71.

95 World Production in 1959 was around 50,000 short tons of uranium, of which the US produced 16,400, Canada 15,900, South Africa 6,400, the USSR and East Germany an estimated 6,000 and Belgian Congo, 2,300 tons. Consumption outside the Soviet bloc was approximately 30,000 tons in 1959. See Hunter 1962, p. 352.

96 Fourteenth Annual Report of the Atomic Energy Control Board of Canada, 1959-1960, p. 10. The 2014 Red Book gives a figure of 12,200 tU for 1959.

97 Fifteenth Annual Report of the Atomic Energy Control Board of Canada, 1960-1961, pp. 9-10.

98 Sixteenth Annual Report of the Atomic Energy Control Board of Canada, 1961-1962, p. 9.

99 Red Book, 2014, p. 176.

100 Hunter, 1962, p. 352.

101 The three in Elliot Lake were the Quirke Mines and the Stanrock Mine.

tonnes of natural uranium were exported (including re-exports).[102] The following year, 1,823 tU_3O_8 of the total 4,976 tU_3O_8 produced were exported.[103] In 1965, the government announced a stockpiling program which lasted until 1 July 1970, although it also entered into an agreement with Denison Mines Limited regarding a joint-venture stockpile to purchase 3,230 tU_3O_8 from Denison from January 1, 1971 to December 31, 1974.[104] By 1971, 80,000 tU were being held as stockpiles by the governments of Australia, Canada, France, South Africa, the United Kingdom and United States – four times as much as annual production in the west at the time.[105]

Exports began to increase (3,000 of the 5,200 tU_3O_8 produced) in 1972, although exploration continued to decline. By January 1972, Canadian uranium producers had long-term contracts with customers in Germany, Japan and the United Kingdom amounting to 51,700 tU_3O_8.[106] Fifty-nine exploration permits remained in force as of 31 March 1973.[107] During 1973, five active operations in Ontario and Saskatchewan produced approximately 4,800 tU_3O_8.[108] In the year 1974-75, three active mining permits were in force (two mines located at Elliot Lake and the other at Beaverlodge, Saskatchewan),[109] and in 1977 there were six operating mines and a number of potential new mines at various stages of development, with the AECB noting widespread exploration activity in all provinces and territories.[110]

The increase in the number of mines was spurred by an increase in prices and demand in the mid-1970s, as exemplified by the AECB's approval in 1975-76 of 23 uranium sales contracts totaling approximately 74,000 short tons of uranium ore concentrates.[111] The rise in prices was initially due to the establishment of a clandestine international uranium cartel to buoy prices in response to the U.S. AEC embargoing the enrichment of foreign uranium for use in U.S. reactors from the early 1960s to the mid-1970s, which effectively prohibited U.S. utilities from using foreign-origin uranium. The cartel involved the governments and mining companies of Canada,

[102] Twenty-Fifth Annual Report of the Atomic Energy Control Board of Canada, 1970-1971, p. 9.
[103] Twenty-Sixth Annual Report of the Atomic Energy Board of Canada, 1971-1972, Ottawa, Canada, p. 12.
[104] Twenty-Fifth Annual Report of the Atomic Energy Control Board of Canada, 1970-1971, p. 9.
[105] Gray, 1982, p. 95.
[106] Twenty-Sixth Annual Report of the Atomic Energy Board of Canada, 1971-1972, Ottawa, Canada, p. 12.
[107] Atomic Energy Control Board, *Annual Report 1972-1973*, Ottawa, Canada, p. 15.
[108] Atomic Energy Control Board, *Annual Report 1973-1974*, Ottawa, Canada, p. 25.
[109] Atomic Energy Control Board, *Annual Report 1974-1975*, Ottawa, Canada, p. 21.
[110] 'Brief to the Cluff Lake Board of Inquiry,' Presented by the Atomic Energy Control Board, AECB-1104, April 1977, p. 7.
[111] Atomic Energy Control Board, *Annual Report 1975-76*, Ottawa, Canada, p. 29.

Australia, France and South Africa, as well as the Rio Tinto-Zinc Corporation Ltd (RTZ), an international mining firm with headquarters in London. The cartel was set up in 1972, but came to public attention in 1976, when 200 pages of confidential documents were stolen from the files of Mary Kathleen Uranium Ltd, an Australian company.[112] A score of lawsuits were launched, while cartel countries took steps to protect uranium-producing companies from prosecution under US laws. Canada, for example, passed the Uranium Securities Information Regulations in 1976, making it illegal for anyone in Canada to reveal or even talk about cartel documents. The penalty was up to five years in jail.[113]

However, the cartel's effectiveness lasted less than two years. By the time the last price schedule was set by the group in January 1974, the cartel's prices had been overtaken by increasing prices caused by a number of factors such as delays in the construction of NPPs, increases in the costs of mining uranium, the OPEC oil embargo and cutbacks to production in Australia and South Africa.[114] When the cartel was formed in 1972, the price of non-American uranium was under US $5 per pound and the US price around $6. Two years later the market price was 60% more than the cartel's, and by 1975 the world price was about $25 and rising.[115] Another contributing factor was the recognition by the United States that its domestic mines and mills would be unable to fulfill U.S. demand, leading to the AEC embargo to be phased out from 1977, with 10 percent of U.S. utilities' enriched uranium allowed to be foreign origin. This was followed by an additional 20 percent in 1978, and additional annual 10 percent allowance until 1984.[116] In 1978, prices reached a high of approximately US $50 a lb. Consequently, the uranium cartel's ambitions were overshadowed by the unprecedented prices being offered on the open market, leading to its collapse before it ever really got going.[117]

As prices began to rise in the mid-1970s, so did Canada's uranium production and exports. Indeed, a number of mines which had been closed in the early 1960s (such as the Panel Mine and Stanleigh Mine) re-opened in 1978 and 1982 respectively,[118] along with new, large mines entering into production: Rabbit Lake in 1975, Cluff Lake in

[112] Gray, 1982, p. 7.
[113] Ibid., p. 200.
[114] Ibid., p. 164.
[115] Ibid., p. 152.
[116] Squassoni et al., *Governing Uranium in the United States*, p. 13.
[117] Cindy Vestergaard, *Governing Uranium Globally*, DIIS Report 2015: 09, p. 28.
[118] Panel then operated until 1990 and Stanleigh until 1997.

1980 and Key Lake in 1983. From 3,600 tU in 1975, Canadian uranium production more than doubled to 8,080 tU in 1982.[119] While global uranium production peaked at 68,000 tU the same year and continued to decline across suppliers for the rest of the decade,[120] Canada's uranium production would continue to increase until it reached its second peak in 1987 of 32.2 million pounds (14,605 tU_3O_8).[121] Canada's success was in part due to the existence of long-term purchasing contracts. At the time, eight mines were operating, five in Ontario and three in Saskatchewan.[122] In the 1989-90 reporting year, Canadian exports reached 9,398 tonnes of natural uranium to eleven countries: Federal Republic of Germany, France, Finland, Indonesia, Italy, Japan, South Korea, Spain, Sweden, United Kingdom and United States.[123]

During the 1980s, Canada's refining and conversion capacity was also modernised and expanded. Eldorado Resources Limited (previously Eldorado Nuclear Limited) constructed a refinery for converting yellowcake into uranium trioxide ($U0_3$) at Blind River, Ontario, in 1982-83 and the AECB approved construction of a second plant in Port Hope for the conversion of $U0_3$ into UF_6.[124] Canada's uranium industry also experienced a wave of consolidation and mergers. In 1988, the Saskatchewan Mining Development Corporation, a provincial Crown corporation, merged with Eldorado to form Cameco Corporation. In 1991 Cameco made its first public share issue and was fully privatised in 2002.[125]

By the end of the 1980s, the price of uranium was stagnating below US $20, leading Amok Ltd (a French-owned company which later became Cogema Resources and is now AREVA) and Cameco to temporarily shut down Cluff Lake and Rabbit Lake respectively, while Rio Algom Ltd announced it would shut down its Quirke and Panel mines in the Elliot Lake area no later than the summer of 1991. Denison Mines Inc. also announced that it would reduce its workforce at Elliot Lake by 28% by August 1990.[126] Rio Algom and Denison Mines began decommissioning

119 Stephen Salaff, 'The Prospects of Canadian Uranium,' Centre for Resource Studies, Queen's University, *Working Paper No. 27*, July 1983, p. 2.

120 Cindy Vestergaard, *Governing Uranium Globally*, pp. 30-31.

121 'Annual Uranium Review,' *Northern Miner*, 1 November 1988.

122 Atomic Energy Control Board, *Annual Report 1987-88*, Ottawa, Canada, p. 5.

123 Atomic Energy Control Board, *Annual Report 1989-90*, Ottawa, Canada, p. 27.

124 Atomic Energy Control Board, *Annual Report 1982-83*, Ottawa, Canada, p. 5.

125 World Nuclear Association, 'Brief History of Uranium Mining in Canada,' http://www.world-nuclear.org/info/Country-Profiles/Countries-A-F/Appendices/Uranium-in-Canada-Appendix-1--Brief-History-of-Uranium-Mining-in-Canada/. Accessed 23 November 2015.

126 Atomic Energy Control Board, Annual Report 1988-89, p. 4.

in 1992, which lasted for a decade. According to the CNSC, 'All of the sites have now been substantially decommissioned, with all mine features capped or blocked, all facility structures demolished and all sites landscaped and revegetated (active decommissioning).'[127]

For the next few years, Canada's total exports of natural uranium declined to 7,810 tonnes in 1991,[128] but then increased again through the mid-1990s, with exports reaching 10,506 tonnes in 1994.[129] The following year, exports dipped back down to 8,179 tonnes.[130] Overall, from production figures of around 9,000 tU in the early 1990s, Canada would reach its third peak of 12,920 tU in 1998.[131]

Since the closing of Elliot Lake's last uranium mines in mid-1996,[132] the Athabasca Basin has been the only source of uranium in Canada. Annual production in the 2000s has ranged from 12,333 tU_3O_8 in 2003 to a height (and Canada's fourth peak) of 13,713 tU_3O_8 in 2005. Since then production has declined by 10%, but is still in the range between 10,600 and 12,000 tU_3O_8.[133] Canada held its number one producer ranking throughout the 1980s and into the 2000s until 2009, when Kazakhstan overtook it as the world's top producer. Today, Kazakhstan produces over 20,000 tU, or 38 per cent of the world total, more than Canada and Australia (the third largest producer) combined.[134]

The figure below charts Canada's uranium production from 1945 to the end of 2014. With the introduction of operations at Cigar Lake in 2014, Canada's uranium production is on track to reach its fifth peak within the next decade.

[127] Canadian Nuclear Safety Commission, 'Uranium Mines and Mill Waste,' http://nuclearsafety.gc.ca/eng/waste/uranium-mines-and-millswaste/index.cfm#Ontario. Accessed 20 October 2015.

[128] Atomic Energy Control Board, Annual Report, 1991-92, Ottawa, Canada, p. 25.

[129] Atomic Energy Control Board, Annual Report, 1994-95, Ottawa, Canada, p. 31.

[130] Atomic Energy Control Board, *Annual Report, 1995-96*, Ottawa, Canada, p. 33.

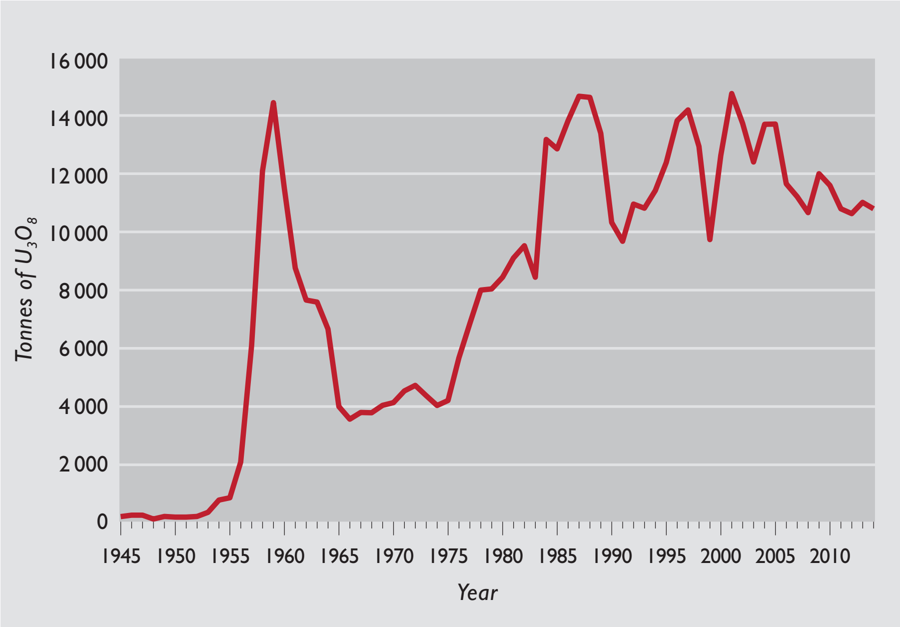
[131] Natural Resources Canada, 'About Uranium,' http://www.nrcan.gc.ca/energy/uranium-nuclear/7695. Accessed 23 November 2015.

[132] IAEA/NEA, Red Book, 2014, p. 176.

[133] 'Uranium in Canada,' World Nuclear Association, http://www.world-nuclear.org/info/country-profiles/countries-a-f/canada--uranium/. Accessed 23 November 2015.

[134] Cindy Vestergaard, *Governing Uranium Globally*, p. 22.

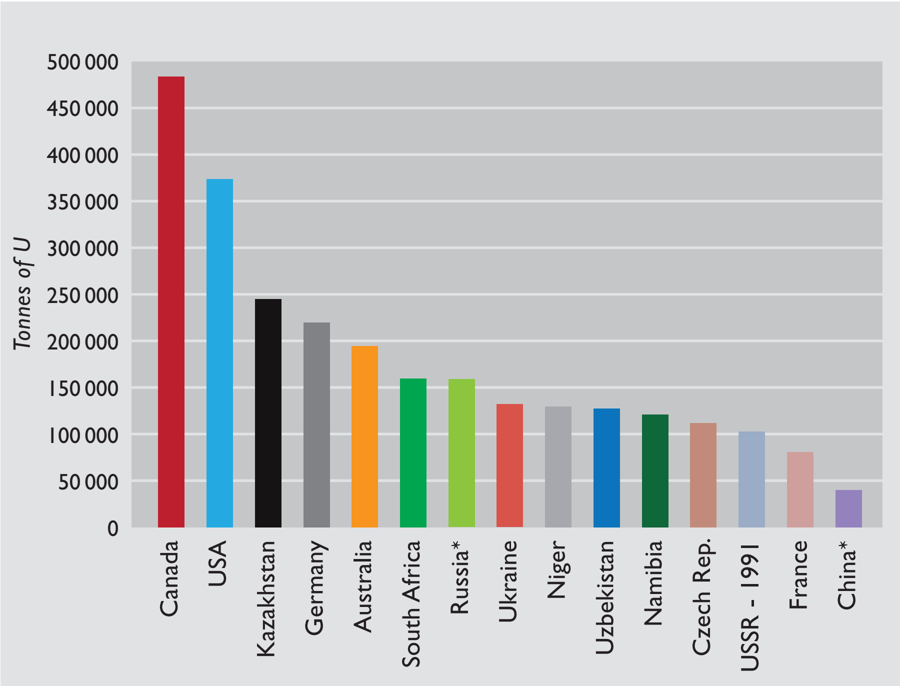
Figure 4. Canadian Uranium Production 1945–2014



Sources: 'Forty Years of Uranium Resources, Production and Demand in Perspective the Red Book Retrospective', OECD 2006, NEA No. 6096, Nuclear Energy Agency Organisation for Economic Co-operation and Development, pp. 255-258, WNA World Uranium Mining Production: http://www.world-nuclear.org/info/Nuclear-Fuel-Cycle/Mining-of-Uranium/World-Uranium-Mining-Production/, the Standing Committee on Industry and Resources (AUS), Australia's uranium: greenhouse friendly fuel for an energy hungry world, p. 91. Unit conversion formula from tU to tonnes of U_3O_8: 5 · 10-6 = 5e-6.

It should also be noted that Canada's Non-Resident Ownership Policy (NROP) for uranium projects has, since 1987, restricted foreign ownership of uranium mines to a maximum of 49%. The ownership structures in place at the time were 'grandfathered' from the new policy and were permitted to continue. The policy provided for exemptions in situations where Canadian partners cannot be found, and it applies to uranium production only (uranium exploration is not subject). In June 2015, Aurora Energy Ltd, a wholly-owned subsidiary of Australia's Paladin Energy Ltd, was granted an exemption from NROP to allow it to become the majority owner of the Michelin Project, which includes 91,500 hectares in the Central Mineral Belt (CMB) of Labrador, Canada, approximately 140 kilometres north of Happy Valley-Goose Bay and 40 kilometres southwest of the Postville community. The exemption was granted after no Canadian partner came forward.

Figure 5. Total World Production by Country 1945–2014



* Estimated by Secretariat of OECD/WNA

Exploration drilling at the Michelin deposit and in the area immediately surrounding Michelin is ongoing.[135]

In terms of total world production of conventional resources of uranium from 1945 to 2014, thirty countries are estimated to have produced 2,769,107 tU, with Canada (474,820 tU) topping the list, followed by the United States (371,941 tU), Kazakhstan (221,864 tU), Germany (219,652 tU) and Australia (189,589 tU).[136] The top fifteen all-time producers are charted in Figure 5.

[135] Aurora acquired the rights to Michelin in 2011. On 26 June 2014, Paladin announced a revised mineral resource estimate for Michelin, which measured and indicated mineral resources totaling 84.1 million pounds of U_3O_8, with an additional 22.9 million pounds remaining in the inferred category. Paladin Energy Ltd, Michelin Project Geology and Resources, http://www.paladinenergy.com.au/default.aspx?MenuID=201. Accessed 5 November 2015.

[136] Cindy Vestergaard, *Governing Uranium Globally*, DIIS Report 2015: 09, p. 21.

6. History of Uranium Regulation: The Path to Responsible Supplier

During WWII, Orders in Council issued September 1943 reserved to the Crown all new discoveries of radioactive minerals in the Yukon and Northwest Territories and banned staking by private interests. Provincial authorities adopted similar measures at the request of the Dominion. In January 1944, the government nationalised the Eldorado Company and turned it into a Crown corporation, with sole responsibility for increasing the output of uranium and for directing work in exploration and research. The state exercised full and direct control over production, prospecting and marketing.[138]

Following the war, uranium was classified as a 'prescribed substance', and nuclear energy became a matter of 'national interest' under the Atomic Energy Control Act of 1946. The Act established the Atomic Energy Control Board (AECB) to advise the federal government and exercise control over the administrative agencies concerned with nuclear energy. The AECB was empowered to make Regulations, which were first issued in 1947 and were concerned mainly with matters of security and strategic control over the movement of uranium and other radioactive materials.[139]

Prospectors required a provincial licence to stake claims and were required to report to the Geological Survey before making a discovery public if the deposit contained more than 0.05% of uranium or thorium. The AECB then issued exploration and mining permits giving rights to drill, remove samples and dispose of ores and concentrates. Operators were required to provide periodic reporting on progress and allow AECB inspectors access to the property for inspection. Sales could only be made to persons authorised by the Board to receive such materials.[140]

In these early years, information related to uranium supply and production remained classified. The AECB's first annual report, issued in 1947, included a section on

[137] Please note that this chart is an updated of version of the one used in the reports on *Governing Uranium Globally* and *Governing Uranium in Australia*. In those two reports, the quantities were mistakenly measured in tU_3O_8 when they are instead, as noted in the chart here, in tonnes of uranium (tU).

[138] Hunter, 'The Development of the Canadian Uranium Industry: An Experiment in Public Enterprise,' *Canadian Journal of Economies and Political Science*, Vol. 28 (3), August 1962, p. 330.

[139] Hunter, p. 335.

[140] H.A. Rose and H.D. Smythe, 'A Safeguards System Analysis of the Canadian Nuclear Complex,' Presentation at the Panel on Safeguards Systems Analysis of Nuclear Fuel Cycles,' IAEA Headquarters Vienna, August 25–29, 1969. AECB-1041, p. 9.

'uranium supply and production.' It stated that 'for obvious reasons, it is not in the public interest that specific information in this field should be published at this time.'[141] After the privatisation of uranium production, AECB reports would be more open in reporting on exploration and licensing. By the end of 1956, information on production and ore reserves was no longer classified,[142] and in 1959 the AECB published information on exports, noting total deliveries of 13,537 tU_3O_8 valued at $275 million.[143] In January 1980, the Board announced that documentation related to and included in licence applications would be made publicly available. In addition, 'details of any significant occurrences at nuclear facilities that resulted in corrective measures being ordered or taken or whenever the Board was aware of an actual or potential hazard of significance to the public or the environment, would be announced by a press release.'[144]

The AECB's Regulations were revised from time to time, notably in 1960, when the regulatory scope of the AECB was extended to include matters of health and safety. The 1960 Regulations included a section on 'Health and Safety Precautions' and included compliance with mine safety laws in AECB exploration and mining licenses, while the Board also appointed provincial Department of Mines inspectors.[145] Dose limits were also defined for the first time, establishing standards for the maximum permissible doses of radiation for workers (50 millisieverts per year) and the general public (5 msV per year) as recommended by the International Commission on Radiological Protection (ICRP).

In 1974, another revision of the Regulations gave the AECB responsibility for regulating the health, safety and security aspects of prescribed substances (uranium and thorium) and nuclear facilities.[146] This was accompanied by a comprehensive licensing system, which included the submission and evaluation of applications, issuance of licences and compliance inspection.[147] The Regulations required that no

[141] Atomic Energy Control Board, Annual Report to the Committee of the Privy Council on Scientific and Industrial Research for the period ending 31 March 1947, p. 4.

[142] Hunter, p. 335.

[143] Thirteenth Annual Report of the Atomic Energy Control Board of Canada, 1958-1959, p. 10.

[144] The policy became effective on 1 May 1980. See Atomic Energy Control Board, *Annual Report 1979-80*, Ottawa, Canada, p. 1.

[145] A. T. Prince, 'The Role of the Atomic Energy Control Board in Uranium Exploration and Mining,' AEBC, Presented to the Canadian Nuclear Association, Toronto: Ontario, 16 November 1976, p. 2, AECB-1098.

[146] Nuclear facilities included research and power reactors, nuclear fuel processing and fabrication plants, heavy water plants, particle accelerators and radioactive waste-management facilities.

[147] A. T. Prince, 'The Role of the Atomic Energy Control Board in Uranium Exploration and Mining,' AEBC, Presented to the Canadian Nuclear Association, Toronto: Ontario, 16 November 1976, p. 2, AECB-1098.

person could prospect, mine, refine, use, sell or possess prescribed substances unless licensed by the Board. Specific exemptions were made for prospecting, provided this did not involve the annual removal of more than ten kilograms of uranium or thorium from each deposit, and for substances containing less than 0.05 weight per cent of uranium and thorium involving not more than ten kilograms of uranium or thorium per calendar year. Before authorisation to allow construction and development, assessments on the potential impact of the mine and its associated mills and waste management (tailing disposal) facilities on their surroundings were required, as well as a preliminary review of the occupational health and safety aspects of the facility designs.[148]

In addition, the Mine Safety Advisory Committee was established in 1974 to evaluate and make recommendations on applications for mining licences, as well as advise on radiological health and safety standards for uranium and thorium mine and mill workers. The Committee met quarterly and included experts from federal government agencies[149] and provincial agencies in Ontario (Ministries of Health, Environment and Natural Resources) and Saskatchewan (Departments of Labour and Natural Resources). The Board also established a Radioactive Waste Safety Advisory Committee to provide advice on the waste management aspects of uranium mining and milling, specifically the mill tailings.[150]

In 1976 a Joint Panel on Occupational and Environmental Research for Uranium Production in Canada was formed as a voluntary organisation composed of federal and provincial departments and agencies, uranium mining companies, labour unions and non-profit research institutions. The purpose was to share information regarding proposed, ongoing and completed research with regard to the effects of uranium (and thorium) production on the health and safety of workers and the environment.[151] Up to that point, the regulation of uranium mining had primarily been left in provincial hands, but it was being given renewed attention by the federal government in light of the findings made by the 1974 Commission on the Health and Safety of Workers in Mines in Ontario along with those from a number of epidemiological

[148] Ibid., p. 4.

[149] These included the Departments of the Environment, Health and Welfare, Energy, Mines and Resources, Indian and Northern Affairs, and Labour, as well as Atomic Energy of Canada Limited and the Atomic Energy Control Board.

[150] A. T. Prince, 1976, p. 6.

[151] H. Stocker, P. J. Duport and L. D. Brown, Directorate of Research and Safeguards, Atomic Energy Control Board, 'Operation of the Joint Panel on Occupational and Environmental Research for Uranium Production in Canada,' Saskatchewan Human Resources, Labour and Employment, Regina, July 1993, INFO-4446.

studies demonstrating detrimental effects to health arising from the inhalation of radon daughter products by both uranium and other miners.[152] Administrative arrangements were also agreed with provincial agencies in Ontario and Saskatchewan in 1976, to the effect that they would take over the responsibility for the safety of the mines and for the health of mine and mill workers.[153]

In September 1982, the government launched a research and development program into the long-term effects of uranium mill tailings on the environment. CDN $7.7 million was allocated to the five-year National Uranium Tailings Program (NUTP). A small team was set up within the federal Department of Energy, Mines and Resources. The research led to the development of a probabilistic predictive mathematical model which would compare the long-term implications for various close-out strategies for the tailings waste.[154] Reference sites for the modelling were the Lacnor and Rabbit Lake tailings sites.[155]

In November 1977, Bill C-14, proposing the Nuclear Control and Administration Act, was tabled in Parliament. The Bill expanded the AECB's regulatory powers to cover environmental aspects and proposed to replace the AECB with a 'Nuclear Control Board' to regulate all the health, safety, security and environmental aspects of the nuclear field. The new Board was to be more independent of involvement in the promotional and commercial aspects of the nuclear industry. The Bill also increased public participation, making it mandatory for public hearings to be held before issuing a licence to construct a major nuclear facility including uranium mines, mills or processing plant, along with a nuclear reactor (greater than 1 MW), a spent-fuel reprocessing plant, a radioactive waste management facility, an enrichment plant, or a heavy water plant.[156] While Bill C-14 failed to pass in 1978, the Board did issue amendments to its Regulations that year relating to maximum permissible exposures of uranium mine and mill workers to radon daughters. This amendment

[152] H. Stocker, P. J. Duport and L. D. Brown, Directorate of Research and Safeguards, Atomic Energy Control Board, 'Operation of the Joint Panel on Occupational and Environmental Research for Uranium Production in Canada,' Saskatchewan Human Resources, Labour and Employment, Regina, July 1993, INFO-4446.

[153] A. T. Prince, 'The Role of the Atomic Energy Control Board in Uranium Exploration and Mining,' AEBC, Paper presented to the Canadian Nuclear Association, Toronto: Ontario, 16 November 1976, p. 2, AECB-1098.

[154] Atomic Energy of Canada Limited, *Canada Enters the Nuclear Age: A Technical History of the Atomic Energy of Canada Limited as seen from its Research Laboratories* (Montreal: McGill Queens University Press), 1997, p. 388.

[155] W. Whitehead, 'Decommissioning of Uranium Mines and Mills: Canadian Regulatory Approach and Experience,' Presented to the Canadian Nuclear Society International Conference on Radioactive Waste Management, September 1986, p. 2. INFO-0219.

[156] AECB, *Annual Report 1977-78*.

also included uranium and thorium mines and mills in the definition of nuclear facilities for the first time.[157]

Bill C-14 failed to pass due mainly to disagreements over provincial and federal jurisdiction. A number of provinces had established a series of provincial commissions on uranium regulation during the 1970s, namely Ontario (1974), Saskatchewan (1977), British Columbia and Nova Scotia (1981). In these commissions, the provinces argued that AECB jurisdiction was limited to issues related to national security and foreign policy, and they expressed concern about the lack of clarity regarding the boundaries between provincial and AECB environmental legislation.[158] In the case of Ontario and Saskatchewan uranium exploration and production would continue, whereas moratoriums on uranium exploration and mining were introduced in British Columbia and Nova Scotia (see section on Provincial Moratoriums).

In terms of staffing at the AECB, the scientific advisory staff was initially small, with an establishment of only eleven persons until 1962. With limited resources, the Board's efforts were focused on licensing reactors, heavy water plants and radioisotopes, mining operations and waste disposal being left to the Provincial regulatory agencies acting under AECB's Regulations. The regulatory revisions of 1974 gave the AECB new initiative in the licensing of uranium mines and their associated mills and waste management facilities, prompting further increases in staff to pay greater attention to front-end licensing.[159] By 31 March 1977, the AECB was being supported by a total staff of 116 persons, including scientists, engineers, administrative officers, secretaries and clerks to monitor Canada's nuclear activities.[160] Eleven years later, the number had more than doubled to a staff of 261 persons, 215 of which were located in Ottawa, 45 based at regional offices and one seconded overseas.[161] In 1988, however, the President of the AECB stressed that the Board was 'not in a position to meet the public's expectations concerning nuclear safety due to the meager resources available to the agency compared to the extent of its responsibilities.'[162] The government responded favourably a year

[157] Ibid.

[158] Ibid.

[159] 'Brief to the Cluff Lake Board of Inquiry,' presented by the Atomic Energy Control Board, April 1977, p. 7, AECB-1104.

[160] Atomic Energy Control Board, *Annual Report 1977-78*, Ottawa, Canada, p. 3.

[161] Atomic Energy Control Board, *Annual Report 1988-89*, p. 4.

[162] President's Message, Atomic Energy Control Board, *Annual Report, 1987-88*.

later.[163] Staff numbers then continued to rise to 316 in March 1991,[164] 357 five years later[165] and 380 in March 1998.[166]

The AECB continued its discussions with several provinces to clarify and define major problem areas, which would eventually be resolved with the tabling of the Nuclear Safety and Control Act (NSCA). On 20 March 1997, the Act received Royal Assent and entered into force on 31 May 2000, when revised regulations were approved. Uranium and Thorium Mining Regulations were issued in 1988 and were replaced by the Uranium Mine and Mill Regulations when the NSCA came into force. The NSCA established the Canadian Nuclear Safety Commission (CNSC) to regulate the development, production and use of nuclear energy and the production, possession and use of nuclear substances, prescribed equipment and information. It also clarified federal and provincial jurisdiction, empowering the CNSC to establish administrative agreements with provincial departments or agencies to complement (not duplicate) regulation.

From Military to Civilian Purposes

With negotiations on the IAEA Statute finished in October 1956, it became official policy in February 1957 that Canada would negotiate agreements with countries for cooperation in peaceful applications of atomic energy. Under the policy, export permits by the AECB and the Department of Trade and Commerce could be issued for individual sales of up to 250 lbs of uranium for use in testing and research, with a maximum for any one country of 2,500 lbs unless a cooperation agreement existed between Canada and that country, in which case sales of greater amounts were allowed.[167]

A 1957 agreement with West Germany for 500 tU over a five-year period represented the first sale of Canadian uranium strictly for non-military purposes.[168] The agreement included a 'provision for adequate safeguards to ensure that materials such as

163 President's Message, Atomic Energy Control Board, *Annual Report 1989-90*.

164 259 in Ottawa, 54 at site and regional offices, and three on secondment abroad. See AECB, *Annual Report 1991-92*, p. 5.

165 Atomic Energy Control Board, Annual Report 1995-1996, Ottawa, Canada, p. 6.

166 319 in Ottawa and 61 at site and regional offices. See: Atomic Energy Control Board, *Annual Report 1997-98*, Ottawa, Canada, p. 4.

167 Hunter, p. 338.

168 Gray, p. 71.

uranium…shall not be diverted to any military use.'[169] Safeguards were modeled on IAEA first-generation safeguards, and the agreement called for Canadian inspectors to visit West Germany to ensure that uranium was not being diverted from peaceful purposes. Agreements for uranium exports were also made with Switzerland (in 1958), Euratom (1959), Japan (1959)[170] and Sweden (1962), with peaceful use clauses and bilateral verification measures by Canada, or increasingly through IAEA safeguards. Canada also concluded agreements to supply research reactors with India in 1956 and Pakistan in 1959.[171]

Canada's new policy was tested in 1957, and again in 1965, when Paris negotiated to buy Canadian uranium but failed to secure a contract for a renewable delivery of 1,000 tonnes.[172] Canada would not sell 'free of use' uranium, even at a high price, to France. Ottawa was prepared to sell safeguarded Canadian uranium for civilian purposes, but would not sell at the price requested by the French (who sought a discount since the price asked by the Canadians was the same as that for the unsafeguarded uranium sold to the United States).[173]

On 3 June 1965, Prime Minister Lester B. Pearson announced in the House of Commons that Canadian uranium would only be exported only for peaceful purposes:

> As one part of its policy to promote the use of Canadian uranium for peaceful purposes the government has decided that export permits will be granted … with respect to sales of uranium covered by contracts entered into from now on, only if the uranium is to be used for peaceful purposes. Before such sales to any destination are authorised the government will require an agreement with the government of the importing country to ensure with appropriate verification and control that the uranium is to be used for peaceful purposes only.[174]

[169] Gray, pp. 71-72.

[170] The agreement with Japan was for the donation by Canada of three tons of uranium metal to the IAEA, for onward sale by the latter to Japan. See Thirteenth Annual Report of the Atomic Energy Control Board of Canada, 1958-1959, p. 8.

[171] Maria Sultan, Zafar Nawaz Jaspal, Mohmmad Riaz, Jamshed Hashmi, Jawad Hashmi and Asra Hassan, edited by Malik A. Ellahi, *Governing Uranium in Pakistan*, DIIS Report 2015: 08, p. 13.

[172] Cécile Padova and Bruno Tertrais, *Governing Uranium in France*, DIIS Report 2014: 17, p. 18.

[173] Ibid., p. 13.

[174] Gray, pp. 76-77.

Canada would thereafter no longer sell uranium for military purposes, including to the United States and United Kingdom (for new sales, the small amount left on existing U.S. and UK contracts would still be delivered).[175]

A number of agreements were then negotiated in 1966. In June, a Safeguard Transfer Agreement between the IAEA, Canada and Japan entered into force, which outlined terms for the Agency to assume responsibility for applying safeguards to nuclear transfers between Canada and Japan. In October, Canada and the United Kingdom agreed upon safeguards arrangements that applied to UOC supplied under a contract concluded with Rio Algom Mines Limited and the United Kingdom Atomic Energy Authority. And, in December, Canada and India ratified an agreement providing for the expansion of the Rajasthan Atomic Power Station, which included a provision for the later assumption of safeguards responsibilities by the IAEA.[176] Canada also carried outs its own safeguards inspections by AECB officers to verify that materials of Canadian origin supplied abroad were used for peaceful purposes only. In the late 1960s, the Board carried out inspections in France, the Federal Republic of Germany, India, Japan, Pakistan, Switzerland, the United States and the United Kingdom.[177]

Canada's non-proliferation policy was reinforced in 1968, when Canada signed the Treaty on the Non-Proliferation of Nuclear Weapons (NPT). After the entry into force of the NPT in 1970, Canada officially opened negotiations on a safeguards agreement with the IAEA on 26 August 1971 under which the Canadian nuclear program would be subject to IAEA inspection. The agreement (INFCIRC/164) was signed in Vienna on 21 February 1972 and entered into force on that date.[178] Canada was among the first countries to bring a comprehensive safeguards agreement with the IAEA into force. By 1976, Canada's 22 operating nuclear facilities were safeguarded under INFCIRC/164.[179]

[175] Gray, p. 77.

[176] Twenty-First Annual Report of the Atomic Energy Control Board of Canada, 1966-67, Ottawa, Canada, p. 8.

[177] See the Twenty-Fourth Annual Report of the Atomic Energy Control Board of Canada, 1969-70, Ottawa, Canada, p. 8; and the Twenty-Third Annual Report of the Atomic Energy Control Board of Canada 1968-1969, Ottawa, Canada, p. 8.

[178] Agreement between the Government of Canada and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons, INFCIRC/164, 21 February 1972.

[179] Atomic Energy Control Board, *Annual Report 1975-76*, Ottawa, Canada, p. 37.

In May 1974 India tested a nuclear device, which led Canada (and a number of other suppliers) to review its non-proliferation and export policy. In December 1974 and again in December 1976, the government announced stricter controls. Taken together, these two announcements framed Canada's policy, which stated specifically that nuclear cooperation would only be concluded with non-nuclear weapon states (NNWS) that had either ratified the NPT or accepted IAEA full-scope safeguards. The policy was specific to cooperation agreements entered into after 31 December 1976 and did not affect commercial contracts already in place.[180] Nuclear exports, whether new or old ones, would also only be permitted to both NNWS and nuclear weapons states (NWS) after assurances that Canadian-supplied nuclear items (including uranium ore concentrates, heavy water, equipment and technology) would not be used in the production of a nuclear explosive device. These assurances required control over the re-transfer of Canadian-supplied items, the reprocessing of spent fuel and the subsequent storage of separated plutonium and enrichment beyond 20 percent U235 of Canadian-origin uranium, along with a provision for fallback safeguards in the event that the IAEA was unable to perform its safeguards functions. Assurances were also required for adequate physical protection.[181] Contracts were limited to a maximum of ten years, with a provision for an additional five.[182]

Canada terminated its nuclear relationship with India in May 1976. The two reactors Canada provided to the Rajasthan Atomic Power Plant (RAPP) continued to be subject to IAEA safeguards, whereas the CIRUS reactor continued to operate without them. In December 1976 the nuclear relationship with Pakistan also ended. Pakistan replaced Canadian fuel to the KANUPP reactor with locally manufactured fuel that replaced the Canadian nuclear fuel bundles.[183] The KANUPP reactor continued to be safeguarded by the IAEA.[184]

The revised policy required the renegotiation of existing bilateral nuclear cooperation agreements (NCAs) for supplies which had been committed prior to the first

[180] J.H. F. Jennekens, Director of Licensing, AECB, 'NPT Safeguards: Progress and Practice Summary,' presented to the Annual Winter Meeting of the American Nuclear Society, San Francisco, USA, 27 November–2 December 1977, p. 7, AECB-1118.

[181] Government of Canada, 'Canada's Nuclear Non-Proliferation Policy,' published by Authority of the Right Honourable Joe Clark, Secretary of State for External Affairs, 1985, pp. 13-14.

[182] J. F. D. MacIsaac, 'The Effect of Safeguards on the Contractual Relations of Nuclear Suppliers,' Atomic Energy Control Board, Ottawa, Canada, pp. 2-3.

[183] Maria Sultan et al., *Governing Uranium in Pakistan*, p. 47.

[184] Government of Canada, 'Canada's Nuclear Non-Proliferation Policy,' published by Authority of the Right Honourable Joe Clark, Secretary of State for External Affairs, 1985, p. 19.

policy statement of 1974. The government allowed for renegotiations over a period of one year, which was twice extended for six months. On 1 January 1977, the government ceased permitting the export of nuclear material, equipment or technology to states that were unable to conclude an agreement consistent with Canada's new export policy.[185] At the time, Canada had 'old' nuclear cooperation agreements with Argentina, Finland, South Korea and Spain.[186] New agreements were concluded with South Korea (in force from January 1976) and Finland (August 1976). Spain and Argentina, however, were not party to the NPT, and therefore 'new' cooperation was precluded until they ratified it.[187]

However, exports to Japan and Euratom were suspended, as neither initially accepted Canada's new requirements related to reprocessing. Negotiations throughout 1977 led to a renegotiated bilateral agreement with Japan, and uranium shipments proceeded after its ratification in September 1980.[188] Discussions with Euratom led in January 1978 to an Interim Arrangement to delay the issue of reprocessing until the International Nuclear Fuel Cycle Evaluation (INFCE) had been completed. The INFCE was a multilateral technical evaluation carried out between October 1977 and February 1980. Its reports and overview recognised the general principle that assurances of supply and non-proliferation were complementary. Its conclusions were transmitted to governments for consideration, but were not binding.[189] In December 1981, Canada agreed that nuclear material subject to the Canada-Euratom Agreement could be reprocessed and plutonium stored within the framework of the European's current and planned nuclear energy program, which had been described (and as updated) by Euratom.[190]

Canada noted that its suspension policy, particularly as applied to Euratom and Japan, which were major uranium markets, demonstrated 'Canada's commitment

[185] J.H. F. Jennekens, Director of Licensing, AECB, 'NPT Safeguards: Progress and Practice Summary,' presented to the Annual Winter Meeting of the American Nuclear Society, San Francisco, USA, 27 November–2 December 1977, p. 7, AECB-1118.

[186] Atomic Energy Control Board, Annual Report 1975-76, Ottawa, Canada, p. 37.

[187] Government of Canada, 'Canada's Nuclear Non-Proliferation Policy,' published by Authority of the Right Honourable Joe Clark, Secretary of State for External Affairs, 1985, p. 17.

[188] Government of Canada, 'Canada's Nuclear Non-Proliferation Policy,' published by Authority of the Right Honourable Joe Clark, Secretary of State for External Affairs, 1985, p. 17.

[189] For information on the INFCE, see R. Skjoldebrand, 'The International Nuclear Fuel Cycle Evaluation – INFCE,' *IAEA Bulletin* Vol. 22 (2), pp. 30–33.

[190] Government of Canada, 'Canada's Nuclear Non-Proliferation Policy,' published by Authority of the Right Honourable Joe Clark, Secretary of State for External Affairs, 1985, p. 18.

to non-proliferation and…its willingness to accept the commercial consequences of its non-proliferation policy.'[191] A presentation by AECB in 1977 noted:

> A price has of course been paid for Canada's determination to act in the interest of reducing the possibility of weapons proliferation. The uranium producing industry, an important sector of Canada's economy, has been unable to export uranium to its major customers throughout the current year. This embargo has resulted in significant strain on Canada. It is, however, an acceptable price to pay if the desired results can be achieved.[192]

By 1990, Canada had seventeen bilateral agreements covering nuclear co-operation with 28 countries.[193] A new NCA with China took effect in November 1994, bringing the number to eighteen, covering 29 countries. In 1994 and 1995, bilateral negotiations were held to update NCAs with Mexico, Lithuania and the Czech Republic. Negotiations for a new agreement were also successfully concluded with Argentina, which acceded to the NPT in 1995.[194]

Canada also became active in developing international safeguards, particularly related to CANDU-type power reactors. In the summer of 1968, Canada and the United States began cooperating to design, build, install and test a prototype of an unattended, tamper-resistant, tamper-indicating, safeguards instrumentation system for CANDU-type reactors.[195] In the 1970s, work on the instrumentation required to facilitate safeguards inspections continued jointly between the two countries and the IAEA, being carried out at the Pickering Generating Station. In addition, Canada implemented a program at the Douglas Point reactor for the development of safeguards instrumentation and techniques for the CANDU reactor. [196]

[191] Government of Canada, 'Canada's Nuclear Non-Proliferation Policy,' published by Authority of the Right Honourable Joe Clark, Secretary of State for External Affairs, 1985, p. 18.

[192] J.H. F. Jennekens, Director of Licensing, AECB, 'NPT Safeguards: Progress and Practice Summary,' presented to the Annual Winter Meeting of the American Nuclear Society, San Francisco, USA, 27 November–2 December 1977, p. 8, AECB-1118.

[193] Atomic Energy Control Board, *Annual Report, 1989-90*, Ottawa, Canada, p. 26.

[194] Atomic Energy Control Board, *Annual Report, 1994-95*, Ottawa, Canada, p. 31.

[195] The responsible agencies directly involved in the program are the Arms Control and Disarmament Agency and the Atomic Energy Commission in the United States of America and Atomic Energy of Canada Limited and the Atomic Energy Control Board of Canada. See J.G. McManus, Assistant Scientific Adviser-Safeguards Atomic Energy Control Board, 'The Joint Canada United States of America Development Program in Safeguards Instrumentation,' prepared for presentation to the United States Atomic Energy Commission's 'Workshop on Safeguards,' Argonne National Laboratory, Chicago, May 5-9, 1969.

[196] 'Brief to the Cluff Lake Board of Inquiry,' presented by the Atomic Energy Control Board, April 1977, p. 7, AECB-1104.

In 1978 the government initiated the Canadian Safeguards Support Program (CSSP) to supplement IAEA resources on safeguards research and development. The program's first phase concentrated on safeguards approaches for on-load fuelled reactors. In 1983 the scope was expanded to include bulk handling facilities, future CANDU fuel cycles, storage facilities and more general tasks.[197] The CSSP was guided by the Interdepartmental Committee on Safeguards (ICS), which was made up of senior staff working in the safeguards and non-proliferation areas from both the AECB and the Department of External Affairs. The Committee provided advice on priorities, costs and technical details to ensure consistency with Canada's non-proliferation policy.[198]

[197] AECB Staff, 'Canadian Safeguards Support Program, Annual Report for Fiscal Year 91/92,' January 1993, p. 1, INFO-0438.
[198] Ibid., p. 2.

7. Uranium Regulation in Canada Today

The Nuclear Safety and Control Act (NSCA) provides for: a) limiting the risks to national security and to the health and safety of persons and the environment that are associated with the development, production and use of nuclear energy, and the production, possession and use of nuclear substances, prescribed equipment and prescribed information; and (b) the implementation in Canada of measures to which Canada has agreed respecting international control of the development, production and use of nuclear energy, including the non-proliferation of nuclear weapons and nuclear explosive devices.[199] Uranium, thorium and deuterium are classified as 'nuclear substances' under the NSCA, and uranium or thorium mines and mills are included in the definition of a 'nuclear facility.'[200]

Section 26 of the Nuclear Safety and Control Act states that:

> … no person shall, except in accordance with a licence, (a) possess, transfer, import, export, use or abandon a nuclear substance, prescribed equipment or prescribed information; (b) mine, produce, refine, convert, enrich, process, reprocess, package, transport, manage, store or dispose of a nuclear substance; (c) produce or service prescribed equipment; (d) operate a dosimetry service for the purposes of this Act; (e) prepare a site for, construct, operate, modify, decommission or abandon a nuclear facility; or (f) construct, operate, decommission or abandon a nuclear-powered vehicle or bring a nuclear-powered vehicle into Canada.

The NSCA also included a requirement for financial guarantees, such as letters of credit, for uranium mines and mills to ensure the availability of funds for decommis-

199 Section 3, National Safety and Control Act, S.C. 1997, c. 9, Current to 16 November 2015.

200 Paragraph 2 of the NSCA defines a 'nuclear facility' as any of the following facilities: (a) a nuclear fission or fusion reactor or subcritical nuclear assembly, (b) a particle accelerator, (c) a uranium or thorium mine or mill, (d) a plant for the processing, reprocessing or separation of an isotope of uranium, thorium or plutonium, (e) a plant for the manufacture of a product from uranium, thorium or plutonium, (f) a plant for the processing or use, in a quantity greater than 1015 Bq per calendar year, of nuclear substances other than uranium, thorium or plutonium, (g) a facility for the disposal of a nuclear substance generated at another nuclear facility, (h) a vehicle that is equipped with a nuclear reactor, and (i) any other facility that is prescribed for the development, production or use of nuclear energy or the production, possession or use of a nuclear substance, prescribed equipment or prescribed information, and includes, where applicable, the land on which the facility is located, a building that forms part of, or equipment used in conjunction with, the facility and any system for the management, storage or disposal of a nuclear substance. See NSCA, p. 2.

sioning.[201] Total costs are estimated on the basis of a decommissioning plan submitted by the operator, which is reviewed and approved by the CNSC and the province every five years. In Saskatchewan and Ontario, the province is the recipient of financial guarantees. There is also a financial guarantee for the institutional control of funds to be transferred to the province when the mine is released back to provincial control and maintenance. No province has yet applied to this programme.

The NSCA established the quasi-judicial Canadian Nuclear and Safety Commission (CNSC) to regulate the use of nuclear energy and materials to protect the health, safety and security of Canadians and the environment, to implement Canada's international commitments regarding the peaceful use of nuclear energy and to disseminate scientific, technical and regulatory information to the public.[202] The CNSC is independent but not isolated from government. It reports to Parliament through the Minister of Natural Resources, and its decisions are reviewable only by the Federal Court of Canada, not the Minister. It has a staff of more than 800 employees, who review licence applications, enforce compliance with the NSCA, regulations and any licence conditions, as well as make recommendations to the Commission, which is made up of seven appointed permanent members.

The CNSC regulates the entire nuclear fuel cycle and its waste management, including mining, milling, conversion, fuel fabrication, reactors and import/export controls. Exploration remains the purview of the province, with the CNSC becoming involved in advanced exploration, that is, bulk sampling of ore during underground development or tunneling through orebody. The CNSC implements laws passed by Parliament and issues regulations, licences and documents to regulate the nuclear industry in Canada. It certifies operators and transporters and can issue orders to take action in serious cases, whether facility- or activity-specific. The CNSC also co-chairs the Federal-Provincial-Territorial Radiation Protection Committee, which provides a national forum on radiation protection issues and develops standards and practices to protect people from radiation exposure.

The CNSC also conducts environmental assessments under the 2012 Canadian Environmental Assessment Act. At Class I nuclear facilities (i.e. reactors) and uranium mines and mills, the CNSC sets out the environmental protection policies, programs

[201] Subsection 24(5) of the NSCA.

[202] Canadian Nuclear Safety Commission, 'The Commission': http://cnsc.gc.ca/eng/the-commission/index.cfm. Accessed 1 December 2015.

and procedures to be applied. Environmental impact assessments and mitigation measures are required under the NSCA as part of the CNSC's licence application. These assessments are used to predict the environmental effects of proposed activities before they are carried out and to provide opportunities for public participation.

The CNSC also reviews and updates its environmental provisions in response to events worldwide. For example, after the triple disaster (earthquake, tsunami, nuclear meltdown) at the Fukushima Daiichi nuclear power plant in March 2011 in Japan, the CNSC requested Class I nuclear facilities and uranium mines and mills to review initial lessons learned, particularly the underlying defence-in-depth concept, with a focus on external hazards such as seismic activity, flooding, fire and extreme weather events, measures for the prevention and mitigation of severe accidents, and emergency preparedness, as well as to report on implementation plans for short-term and long-term measures to address significant gaps.[203] Findings from the CNSC Fukushima Task Force Report noted that there was a need to ensure regulatory consistency among licensees, which up to that point had each operated with its own means and methods for complying with emergency preparedness and response expectations.

The Task Force report recommended converting guidance documents into regulatory documents with the addition of more detailed specifications. In response, the CNSC issued the REGDOC-2.9.1, Environmental Protection Policies, Programs and Procedures.[204] This document combined and updated two which were related to Class I facilities and uranium mines and mills, which the task force found lacking the 'detailed and specific requirements needed to strengthen and standardize emergency preparedness and response in Canada.'[205] It sets out the environmental management system (EMS), its scope and framework that operators are to implement. It applies a broader interpretation to the impact of pollution and included the concept of minimizing releases within the scope of the environmental management system.

The CNSC publishes a list of ongoing, completed and cancelled environmental assessments on its website. The environmental impact assessment is a major part of the licensing process and provides opportunities for public participation, including Aboriginal consultations.

[203] CNSC, 'CNSC Fukushima Task Force Report,' INFO-0824, October 2011, p. 10.

[204] REGDOC-2.9.1

[205] CNSC, 'CNSC Fukushima Task Force Report,' INFO-0824, October 2011, p. 40.

Canada's approach to uranium regulation also emphasizes the social and economic impacts of projects and the constitutional duty to consult with aboriginal peoples. Social acceptance is therefore an integral part of the permitting process, involving public and consultative exchanges with local communities continuously throughout the duration of a project. In Saskatchewan, for example, operators are required to report annually on their public involvement programmes, including on the employment and business opportunities for northerners. There is also the target for operators to obtain at least 35 per cent of all required goods and services from northern suppliers. Government agencies and departments similarly adopt human resource objectives that lead to an increase in northern participation in their staff.[206] These requirements and objectives stem from a panel that considered the potential impact of the development of the McArthur mine on Saskatchewan's aboriginal communities. Their 1997 report concluded: 'We are of the opinion that northern people, because they must bear the greatest environmental risk associated with this project and because of their traditional roots in this part of Canada, deserve to share more generously than other Canadians in the benefits produced by the McArthur River Project.'[207]

Non-proliferation and Export Controls

Canada's approach to non-proliferation and export policy has remained largely in place since the policy statements of the mid-1970s. The stated objectives of Canada's nuclear non-proliferation policy today are to 'assure Canadians and the international community that Canada's nuclear exports do not contribute to the development of nuclear weapons or other nuclear explosive devices' and to 'promote a more effective and comprehensive nuclear non-proliferation regime.'[208] The policy requires that Canadian-supplied nuclear material, equipment, non-nuclear material and technology may only be transferred to countries under a bilateral NCA. The CNSC implements these agreements through administrative arrangements (AAs) that it concludes with its counterpart in the partner country. Key provisions in Canada's NCAs include a peaceful, non-explosive end-use assurance; prior approval over retransfers to third parties of Canadian-obligated items and the reprocessing or enrichment of Canadian-obligated uranium; provisions for fall-back safeguards; and adequate

[206] Lisa Thiele, 'Uranium mining and production: A legal perspective on regulating an important resource,' *Nuclear Law Bulletin*, Vol 2013/2, No. 92, p. 17.

[207] Ibid.

[208] CNSC, 'Non-proliferation: import/export controls and safeguards,' http://nuclearsafety.gc.ca/eng/resources/non-proliferation/index.cfm. Accessed 2 December 2015.

physical protection of Canadian-obligated items.[209] These provisions are similar to those required from Australia, Euratom and the United States. Unlike Australia, however, Canada does not include the Additional Protocol as a condition of supply.

Licences must be obtained before nuclear items and materials are traded. The CNSC applies a risk-based approach to assessing applications for export and import licences on a case-by-case basis to ensure conformity with its membership in export control regimes such as the Nuclear Suppliers Group (NSG) and the Zangger Committee and that it is in line with IAEA guidelines, the NSCA and subsequent domestic regulations and guidance.[210] Regulatory document REGDOC-2.13.2, Import and Export, which sets out the CNSC's guidance for licensees, notes that applications are assessed on the non-proliferation credentials of the importing country (whether a member of the NPT and/or NSG); information available on the nuclear weapons-related activities in the end-user country, including any intermediaries; the risk of diversion posed by the transfer; the relevance of the items to any known procurement efforts; the utility of the items to a nuclear weapon or explosive device; any proliferation concerns regarding any parties involved in the transaction; the legitimacy of the end-use and end-user; and whether there have been any previous rejections. All exports and imports are also subject to the applicability of NCAs and must fulfil the assurances or guarantees provided/required.[211]

Section 3 of the Nuclear Non-Proliferation Import and Export Control Regulations stipulate that an application for an import/export licence must include the applicant's contact information; a description of the substance, equipment or information, together its quantity, country of origin and intended end-use; and end-user contact information. The Regulations also specify that controlled substances which fall under Category I, II or III nuclear material as defined in the Nuclear Security Regulations also require measures to be taken in accordance with the Convention on the Physical Protection of Nuclear Materials (CPPNM). While uranium ore concentrates are defined as source materials under the Act and the Import/Export Regulations and Security Regulations, it is not a Category I, II or III material (see section on 'Uranium Security'). Intangible transfers of controlled nuclear information are also subject to export controls. Intangible transfers include

[209] CNSC, 'Safeguards and Non-proliferation: Import and Export,' http://nuclearsafety.gc.ca/pubs_catalogue/uploads/REGDOC-2-13-2-Import-and-Export-eng.pdf

[210] Canada is a founding member of the NSG and Zangger Committee.

[211] Regulatory Document REGDOC-2.13.2, Import and Export, http://nuclearsafety.gc.ca/eng/acts-and-regulations/consultation/comment/regdoc2-13-2.cfm. Accessed 2 December 2015.

emails, downloads or other electronic file exchanges, face-to-face meetings and telephone conversations.[212]

The Commission delegated authority for import and export licencing to a designation officer, who makes decisions to issue, amend, replace, renew, transfer, suspend or revoke an import/export licence. Most licencing decisions are made on the basis of technical support and the recommendations of CNSC staff. NCAs then require appropriate notifications to be exchanged by the CNSC and its foreign counterpart before exports are authorised.

Canada–IAEA Safeguards

As noted previously, Canada signed the NPT on 23 July 1968 and ratified it on 8 January 1969. The Canada-IAEA Safeguards Agreement (INFCIRC/164) was signed in Vienna on 21 February, 1972 and entered into force on that date.[213] Article 34(c) of the agreement[214] requires that full-scope IAEA safeguards be applied to any nuclear material in Canada which has reached 'a composition and purity suitable for fuel fabrication or for isotopic enrichment…'. Full safeguards therefore begin when nuclear material pure enough to be fabricated or enriched 'leaves the plant or process stage', historically interpreted as the output of conversion plants (i.e., UO_2 or UF_6). The agreement requires Canada to report on its exports and imports of materials containing uranium and thorium (i.e. 'pre-34(c) material') to the IAEA (which it does semi-annually) and establish a state system of accountancy and control (see section on inventory controls).

Canada signed the Additional Protocol (AP) in September 1998. The AP gives the IAEA access to comprehensive and updated information related to Canada's uranium mines, mills and the Blind River refinery. It also expanded IAEA access under Complementary Access (CA) provisions. Since the Canadian AP entered into force in September 2000, the IAEA has undertaken six CA visits to Canadian mines and mills.[215]

212 Ibid.

213 Agreement between the Government of Canada and the International Atomic Energy Agency for the Application of Safeguards in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons, INFCIRC/164, 21 February 1972.

214 Which is identical to Paragraph 34(c) of the IAEA model CSA agreement (INFCIRC/153).

215 Farrukh Qureshi, Patrick Burton, Karen Owen-Whitred, Canadian Nuclear Safety Commission, 'Canadian Experience with the Implementation of Article 34 (c) of the Canada-IAEA Safeguards Agreement,' Paper presented to the 56th Annual Meeting of the Institute of Nuclear Materials Management (INMM), Indian Wells, California, USA, July 2015, p. 5.

In 2005, the IAEA drew a broad conclusion for Canada that all nuclear material declared by Canada was accounted for and being used solely for peaceful, non-explosive purposes, and that there was credible assurance of the absence of undeclared nuclear materials or activities. On the basis of this conclusion, the IAEA can fundamentally change safeguards implementation into what are known as 'integrated safeguards.' The main elements comprise implementation dependent on the activities of a particular state, which in Canada includes considerations that are non-technical (i.e. long-standing commitment to nuclear non-proliferation) as well as technical (i.e. natural uranium fuel cycle that stretches from mining to the storage of spent fuel and the presence of an IAEA regional office in Toronto). Regularly scheduled inspections by the IAEA are then replaced by a smaller number of unannounced or short-notice inspections, along with Canada providing material accountancy and operational information to the IAEA on a near-real time basis.[216]

In 2003, the IAEA introduced 'Policy Paper 18', which brought full safeguards forward to the production of uranyl nitrate or the first practical point before that. Given that uranyl nitrate is produced at the back half of the UOC refining process in Canada, the decision was made to move the starting point of full material accountancy to when drums of UOC are added to production lines, thereby also capturing the addition to the process of safeguarded uranium scrap recycled from conversion and fuel fabrication plants at Port Hope. This marked the first time that Agency safeguards captured a refinery plant in Canada (Cameco's Blind River refinery),[217] as well as applying safeguards to the entire Port Hope plant. The new starting point did not require Canada to report on the thousands of drums stored at the site because UOC remained a 'pre-34(c)' material and not subject to the full scope of IAEA accountancy and control provisions.[218]

Implementation of the PP18 was prioritised by the CNSC, as it was viewed as a prerequisite to attaining the broader safeguards conclusion Canada had been working towards since 2000. The process was launched in September 2003 with numerous meetings between CNSC and Cameco to obtain operator buy-in at all levels, especially at Blind River, which had no previous experience with safeguards except for

216 CNSC, 'The Canadian Nuclear Safety Commission Safeguards Program Annual Report 2006-2007,' May 2008, p. 11.

217 K.E. Owen, 'Implementation of IAEA Policy Paper 18 in Canada', in *Addressing Verification Challenges: Proceedings of an International Safeguards Symposium on Addressing Verification Challenges*, organised by the International Atomic Energy Agency (IAEA) in Cooperation with the Institute of Nuclear Materials Management and the European Safeguards Research and Development Association, 16-20 October 2006.

218 Cindy Vestergaard, *Governing Uranium Globally*, p. 46.

an occasional Complementary Access request under the Additional Protocol. At the same time, discussions between the CNSC and IAEA monitored progress, set implementation milestones and established the parameters of safeguards approaches to the two Cameco facilities.[219] The process took almost exactly two years, until July 2005, two months before the IAEA reached its broader conclusion for Canada.[220]

In 2013 the IAEA drafted Policy Paper 21, which further clarified the chemical forms of uranium that fall under paragraph 34(c), capturing the material product of uranium mills and concentration plants, that is, drums of 'pure' UOC suitable for fuel fabrication.[221] As Canada is both a large producer and an importer of UOC, there may be a possibility that PP21 will capture some source material in-country. Canada has agreed to treat UOC imported as safeguarded material if it is identified as safeguarded by the shipper at the time of shipment, and it may also perform independent analysis to confirm that the UOC received is subject to PP21. Canada is currently analysing and reviewing the impact of PP21 at Canadian mills, laboratories, universities and other institutions which possess any quantity of sufficiently pure UOC or natural uranium solutions resulting from the purification of UOC.[222]

Inventory Controls

In Canada, Group 1 material is material classified as subject to IAEA full-scope safeguards (which start with PP18 and the introduction of UOC feed to Cameco's Blind River until locations subject to PP21 are confirmed), and it requires detailed and regular nuclear material accounting and reporting to the CNSC.[223] Group 2 is source material excluding both ore residues and depleted uranium, and therefore is 'pre-34(c)' material. Although Group 2 is not subject to full material accountancy, the CNSC does require inventory change documents (ICD), which register increases and decreases in nuclear material. Licensees are required to report to the CNSC on

219 K.E. Owen, 2006, p. 157.

220 Ibid., p. 158.

221 *Governing Uranium Globally*, p. 48.

222 Farrukh Qureshi, Patrick Burton, Karen Owen-Whitred, Canadian Nuclear Safety Commission, 'Canadian Experience with the Implementation of Article 34 (c) of the Canada-IAEA Safeguards Agreement,' Paper presented to the 56th Annual Meeting of the Institute of Nuclear Materials Management (INMM), Indian Wells, California, USA, July 2015, p. 7.

223 There is a distinction between Group 1A and Group 1B material. Group 1B is material that has been temporarily exempted, although it is expected to be re-classified as Group 1A (reportable) material when conditions for Group 1B are no longer met.

the business day following the transaction.[224] Foreign-obligated Group 2 material also has to be reported annually on 31 January, as well as at the request of the CNSC. Nuclear material accounts are received from operators, inputted and reconciled in the CNSC's electronic national system known as the Nuclear Material Accounting System (NMAS) on a monthly basis. They are closed on an annual basis as part of the Physical Inventory Verification (PIV) exercises.

The introduction of Policy Paper 18 and the implementation of integrated safeguards have led to an increase in the provision of information, a requirement to submit information directly to the IAEA and a change in the timing of submissions.[225] In the past, the CNSC would receive ICDs in hard-copy format via courier, mail or fax in a variety of layouts, which were inputted into NMAS by two dedicated administrative clerks, who in turn put it into the format for IAEA reporting – an onerous and time-consuming process. In 2008, the CNSC introduced a dedicated email address to receive reporting digitally (with encryption). In modernising the system and moving towards an integrated electronic system, the CNSC adopted machine-readable electronic forms to permit facility operators to upload material reporting directly to NMAS easily and securely. The CNSC published new requirements and guidance documents which provide information on how the new reporting requirements are to be met.[226] They became effective on 1 January 2011. With standardised requirements in place, Canada becomes one of only a few states to provide the IAEA with near real-time accountancy data from approximately fifty different material balance areas, enabling the IAEA to be more effective in planning inspections and analysing declarations.[227]

Uranium Security

Canada is a party to the Convention on the Physical Protection of Nuclear Material (CPPNM),[228] which imposes specific requirements on the transport of natural

[224] Individual items are reported. If the number of items in inventory are very large, as is usually the case with UOC, the items can be grouped into a batch, and it is the number of items in the batch that is reported. The element and isotope weight of each item or batch on the List of Inventory Items is reported in unrounded numbers.

[225] Jennifer Sample, 'Establishing and Advancing Electronic Nuclear Material Accounting Capabilities,' Paper presented to the 2014 IAEA Safeguards Symposium, Vienna, Austria, October 2014.

[226] *Accounting and Reporting of Nuclear Material RD-336* and *Guidance for Accounting and Reporting of Nuclear material GD-336*.

[227] Vestergaard, Governing Uranium Globally, p. 93.

[228] The CPPNM entered into force on 8 February 1987. The Convention entered into force in Canada the same day.

uranium. Annex 1 of the Convention states that, 'for natural uranium other than in the form of ore or ore-residue, transportation protection for quantities exceeding 500 kilograms uranium shall include advance notification of shipment specifying mode of transport, expected time of arrival and confirmation of receipt of shipment.' However, as the CPPNM is specific to international transport, in 2005 it was amended to extend its provisions to the protection of nuclear material and facilities in domestic use, storage and transport. As of 1 December 2015, 153 states are party to the CPPNM. The 2005 Amendment will enter into force when two-thirds of States Parties have ratified it. Eighty-nine states, including Canada,[229] had ratified the Amendment as of 1 December 2015, or 58 per cent of total States Parties.

Under the Nuclear Safety and Control Act, licensees are required to 'make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations,' but it is not specific regarding what these provisions are.[230] Similarly, the CNSC does not prescribe security regulations specific to natural uranium under the Nuclear Security Regulations. It does state in a footnote that 'any quantities of natural uranium, depleted uranium and thorium should be protected at least in accordance with prudent security practice.'[231] This is similar language to the CPPNM, which states that natural uranium should be protected in accordance with 'prudent management practice,' though it does not describe what specific measures might be considered 'prudent'.

Although Canada does not take a prescriptive approach to nuclear security for natural uranium, the CNSC does require information on nuclear security to be included in license applications for uranium mines and mills in the newly updated 'Licensing Process for Class I Nuclear Facilities and Uranium Mines and Mills' issued in April 2015. Licences for mines and mills also require licensees to implement and maintain a security program, which generally includes assessments and measures to address risks identified for an industrial security threat, along with measures to prevent the loss of and unauthorised access to nuclear substances and to prevent facility sabotage.[232] As such, all mines and mill operators have their

[229] Canada ratified the 2005 CPPNM Amendment on 3 December 2013.

[230] Section 24, Paragraph 4(b), Nuclear Safety and Control Act, S.C. 1997, c. 9, current to 24 November 2015.

[231] CNSC, 'Information Dissemination: Licensing Process for Class I Nuclear Facilities and Uranium Mines and Mills,' REGDOC-3.5.1, April 2015, p. 46.

[232] Licence Condition Handbooks issued by the CNSC for each of the currently operating mines and mills in Canada list these principles in the section on 'Compliance Verification Criteria.'

own security plans in place, which are reviewed and approved by the CNSC and include procedures for emergency response.

For Blind River, there is a specific Facility Security Plan which Cameco must comply with. Cameco is required to update and re-submit its Plan to the CNSC whenever it proposes to amend or update the Plan. If the Vulnerability Threat Risk Assessment is greater than the Vulnerability Risk Assessment on file with the CNSC, then the Plan must be reviewed and updated.[233] Taken as a whole, Canada's approach is consultative rather than prescriptive, and it applies a graded approach to nuclear security for natural uranium.

Transport

The transport and handling of uranium has evolved greatly since the days of workers carrying bags of radioactive ore at Port Radium. Prior to the publication in 1949 of the first Board of Transport Commissioners (BTC) regulations for rail transport, the packaging and shipment of materials were not covered by detailed regulations. The promulgation of the Atomic Energy Control Board Shipping Containers Order in 1963 and the development of regulations for air and marine transport completed the Canadian regulations prior to the adoption of the IAEA Regulation for the Safe Transport of Radioactive Material in 1969.[234] All Canadian packaging and shipments of radioactive materials, as well as all foreign packaging and shipments entering Canada, were then required to comply with the IAEA standards and certified by the regulatory authority. At the time, the AECB worked actively with other federal and provincial government departments in establishing emergency procedures for transportation accidents involving radioactive material.[235]

The CNSC issues licences and certificates for certain kinds of packaging and transport of nuclear substances in accordance with the Packaging and Transport of Nuclear Substances Regulations of 2015 (PTNSR), which are based on the IAEA's Regulations for the Safe Transport of Radioactive Material, 2012 Edition. Uranium ore and UOC are classified as LSA-I materials. These classifications are primarily for safety

[233] CNSC, 'Licence Conditions Handbook: Cameco Blind River Refinery Fuel Facility Operating Licence,' LCH-CAMECO-BRRF-ROO2, Revision 2, 24 April 2015, p. 55.

[234] R.W. Blackburn, 'Transportation of Radioactive Material: Progress and Potential,' Paper presented to the 10th Annual International Conference of the Canadian Nuclear Association, Toronto, 24–27 May 1970, p. 3.

[235] Twenty-Third Annual Report of the Atomic Energy Control Board of Canada 1968-69, Ottawa, Canada, pp. 8-9.

and radiation purposes, particularly in the case of a spill. LSA-I material requires at a minimum an Industrial Packaging-1 (IP-1) standard quality container, which is the least rigorous of the industrial packaging classifications. This is because the amount of natural uranium that must be ingested to produce a significant dose of radiation is significantly greater than uranium in other forms (such as highly enriched uranium). This is consistent with IAEA industrial packaging requirements for LSA material.[236]

The final product, the ore concentrate, is packaged in 200-liter steel drums (400 kg), which is a Type A packaging, the most common used for UOC transport. Type A packages are designed to withstand normal handling and minor accidents. The drums are then typically loaded into approved cargo containers and transported from the concentration plant to conversion plants by ship, rail or truck. A container carries around 20-35 drums, or approximately 1-1.5 significant quantities.[237] In Canada transport security plans are not required for UOC, but transporters use GPS tracking and have two-driver rules.

[236] 'Regulations for the Safe Transport of Radioactive Material, 2005 Edition, Requirements and Controls for Transport, Table 4, Industrial Package Requirements for LSA Material and SCO,' International Atomic Energy Agency, p. 55.
[237] Vestergaard, *Governing Uranium Globally*, p. 79.

8. Recent Bilateral NCAs

Canada has 27 Nuclear Cooperation Agreements in force covering a total of 44 countries (including Euratom), which are reciprocal and provide a policy framework for imports and exports. These NCAs are all slightly different, but the provisions on notifications, reporting and requests for prior consent for retransfer, consultations and fall-back safeguards provisions are found in all of them. The most controversial of these agreements is that concluded with India in June 2010, given that India remains outside the NPT. The Canada–Kazakhstan NCA, while not as controversial, entered into force in 2014, but its AA negotiations are still ongoing, with some sticking points still to be worked through.

Canada–India Nuclear Cooperation

As noted earlier, Canada concluded an agreement with India to supply the CIRUS research reactor in 1956 and concluded another agreement in 1963 for the construction of the first unit of the nuclear power station at the Rajasthan Atomic Power Plant (RAPP I). Under the bilateral agreement, India committed itself to using the fissionable material produced in the RAPP 1 reactor 'only for peaceful purposes' and agreed to Canadian inspections to verify the provision. In 1966 a second CANDU unit (RAPP II) was sold to India. The two reactors were designed on the basis of the Douglas Point CANDU prototype.[238] Negotiations for RAPP II started differently than for CIRUS and RAPP I. India opened the negotiations by stating that it would only accept safeguards on the reactor core, uranium fuel and heavy water and would not allow restrictions on 'items and equipment' that were considered 'normal items of commerce.'[239] In the end, the safeguards agreement reached was identical to that for RAPP I.[240]

In 1965 British and American intelligence notified Canada that India was planning to develop a nuclear weapons programme using Canadian technology. At the time, Canadian technicians stationed at CIRUS in the 1960s were aware that plutonium was being removed from the plant, but accepted the explanation that fuel was being removed because of problems with the cladding (the aluminum covering the uran-

[238] World Nuclear Association, 'Nuclear Power in Canada,' http://www.world-nuclear.org/info/Country-Profiles/Countries-A-F/Canada--Nuclear-Power/. Accessed 5 November 2015.

[239] Duane Bratt, *The Politics of CANDU Exports*, Toronto: Toronto University Press, May 2006, p. 107.

[240] Bratt, p. 107.

ium fuel rods).[241] However, Canada was uneasy about the official explanation, and Prime Minister Pierre Trudeau expressed concern in a letter to Prime Minister Indira Ghandi in October 1971. He cautioned that 'the use of Canadian-supplied material, equipment and facilities in India, that is, at CIRUS, RAPP I or RAPP II, or fissile material from these reactors, for the development of a nuclear explosive device would inevitably call…for a reassessment of our nuclear co-operation arrangements with India.'[242] In response, Gandhi agreed that nuclear co-operation between Canada and India had been dedicated to 'the development and application of nuclear energy for peaceful purposes,' and added that 'it should not be necessary now in our view to interpret these agreements in a particular way based on the development of a hypothetical contingency.'[243]

In 1971, Canada, India and the IAEA concluded a 'Trilateral Safeguards Agreement.' Under the agreement, the IAEA assumed responsibility for applying safeguards at RAPP regarding nuclear material supplied by Canada and further processed in India. India's domestically produced uranium was also safeguarded in the Canadian reactors, except for CIRUS.[244] Under the agreement, the IAEA assumed the responsibility for applying safeguards at RAPP, thereby relieving the AECB from inspecting the reactors.[245]

The CIRUS reactor produced plutonium for India's first nuclear test on 18 May 1974. While India defined it as a 'peaceful nuclear explosion,' the Canadian government did not distinguish between nuclear weapons and other nuclear explosives and suspended its nuclear co-operation program with India. Later, India admitted that uranium fuel of non-Canadian origin had produced the plutonium in the CIRUS reactor that was used in the explosive device, but maintained that since the nuclear material was of non-Canadian origin there was no breach of its obligations to Canada.[246]

Discussions between Canada and India were then held over the next two years but were unsuccessful in resolving their differences. As a result of India's nuclear test Canada's non-proliferation policy had become stricter, and India was not willing

[241] Ibid, p. 108.

[242] Government of Canada, 'Canada's Nuclear Non-Proliferation Policy,' published by Authority of the Right Honourable Joe Clark, Secretary of State for External Affairs, 1985, p. 7.

[243] Ibid.

[244] Bratt, p. 109.

[245] Government of Canada, 'Canada's Nuclear Non-Proliferation Policy,' published by Authority of the Right Honourable Joe Clark, Secretary of State for External Affairs, 1985, p. 8.

[246] Ibid., p. 7.

to join the NPT or apply full-scope IAEA safeguards on its entire nuclear program. Consequently, there was no agreement to secure upgraded non-proliferation arrangements for Canadian-supplied nuclear items and facilities in India. In May 1976, Canada announced that it was terminating its nuclear relationship with India, except that directly related to medical isotopes.[247] The two RAPP reactors continued to be subject to IAEA safeguards, while the CIRUS reactor operated without them.

Canada's position on nuclear cooperation with India remained in place for thirty-four years. On 18 July 2005 a joint India–US statement proposed to separate India's nuclear facilities into civilian and military/strategic categories, placing more Indian facilities and materials under IAEA safeguards. A year later the joint agreement was finalised, and in September 2008 the Nuclear Suppliers Group (NSG) granted India an exemption from its rules requiring a comprehensive safeguards agreement as a condition of nuclear trade. The same year, India signed an umbrella safeguards agreement with the IAEA (INFCIRC/754), placing ten nuclear power reactors under safeguards (the list has since been added to and included 22 facilities as of February 2015).[248] It also provides that any nuclear (including source) material subject to IAEA or bilateral agreement may be further produced, processed, used or stored in a facility not listed on the IAEA's safeguards list provided the material is placed under temporary safeguards while it is present in the facility. The importation of uranium is to be notified within four weeks of its arrival, and India has to inform the IAEA of all facilities that use imported uranium and the precise amount in each facility. In short, this means that foreign-sourced uranium imported into India *must* be IAEA-safeguarded, but the IAEA does not consider the origin of the uranium subject to safeguards.[249]

In February 2006 Stephen Harper became Canada's 28th Prime Minister, and in the fall of 2008 he announced that he would be willing to discuss nuclear cooperation with India. Negotiations led to an agreement in 2010, while negotiations on an Administrative Arrangement (AA) continued until 2012, when the conditions for implementation were finalised. That November, Harper highlighted the economic opportunities the deal would provide, paying 'dividends in terms of jobs and growth for Canadians down the road.'[250] As the agreement entered into force, Canada's

[247] Atomic Energy Board of Canada, Annual Report 1975-76, Ottawa, Canada, p. 37.
[248] INFCIRC/754/Add.7, 5 February 2015.
[249] Cindy Vestergaard, *Governing Uranium Globally*, p. 53.
[250] 'India and Canada finalise conditions of nuclear deal,' *BBC News*, 7 November 2012.

Minister of Natural Resources and Minister of Foreign Affairs noted that it resulted 'from Canada's vigorous efforts to reach new markets for energy exports, creating opportunities for Canadian business.'[251] In March 2013, the CNSC and India's Department of Atomic Energy co-signed the AA, and the NCA entered into force in September 2013. According to Harper, the deal marked a break from the past, leaving the 1970s behind.[252]

One of the biggest challenges during negotiations over the AA was 'flagging.' Canada's agreements with other states that possess nuclear weapons and that are a party to the NPT include provisions for bilateral reporting requirements on the supplier's materials and equipment, obligating or 'flagging' the material as it moves through the importing country's fuel cycle. India, however, rejects flagging and argues that, because all imported uranium will be used in safeguarded facilities and will therefore be reported to the IAEA, there is no need for bilateral reporting.[253] In the end, the 2012 announcement of the conclusion of the AA spoke generally of 'discussions and information sharing', making no reference to the inventory reports and accounting processes that are included in other Canadian NCAs.[254]

The Canada's NCA with India therefore creates an 'India-specific' exemption to its long-standing non-proliferation policies for partners to be a party to the NPT. However, Canada, like Australia and the United States, which have also concluded NCAs with India, is confident that its AA and IAEA safeguards provide the peaceful assurances required. In April 2015, a contract between Cameco and India's Department of Atomic Energy was signed during an official visit to Canada by Indian Prime Minister Narendra Modi. The contract provides for the export of 7.1 million pounds (approximately 3,200 tonnes) of UOC to India over five years.[255] Eight months later on 4 December 2015, the first shipment of Canadian UOC arrived in India.[256]

[251] NRCan, 'Harper Government announces coming into force of Canada-India Nuclear Cooperation Agreement, 27 September 2013: https://www.nrcan.gc.ca/media-room/news-release/2013/11496. Accessed 10 December 2015.

[252] At the signing of the agreement, Harper called it a good agreement because 'we cannot live in the past of 1970s' [sic]. See: 'India, Canada sign civil nuclear deal,' *Times of India*, 28 June 2010.

[253] Vestergaard, *Governing Uranium Globally*, p. 62.

[254] Paul Meyer, 'India and the meltdown of Canada's nuclear non-proliferation policy', *The Star*, 15 November 2012.

[255] Cameco, 'Cameco Announces Contract with India to Provide Uranium for Electricity Generation,' 15 April 2015: https://www.cameco.com/media/news/cameco-announces-contract-with-india-to-provide-uranium-for-electricity-generation. Accessed 1 December 2015.

[256] World Nuclear News, 'India receives first uranium shipment from Canada,' 4 December 2015.

Canada–Kazakhstan Nuclear Cooperation

In August 2014, the Canada-Kazakhstan NCA entered into force. The AA is still being negotiated and is likely to be complicated by at least two factors, namely the implementation of Policy Paper 21, and the potential for a jointly-built refinery owned by Cameco and Kazatomprom. There is a possibility that PP21 will capture some mills in Kazakhstan that produce 'high-purity' UOC, meaning that Kazakhstan will require time to conduct its own reviews and analysis on whether PP21 impacts its domestic milling (and potential refining) facilities. The idea of a refinery in Kazakhstan, similar to Cameco's Blind River, is still at the design stage, but its potential requires Ottawa to include third-country reporting requirements in the AA currently being negotiated. Given that Kazakh material could pass through nuclear technology made in Canada, such materials would become 'Canadian-obligated' before heading to third countries such as China.[257] This would be a first for Kazakhstan. At the time of writing, the author understands that the negotiations between Kazakhstan and Canada on the AA are ongoing.

[257] Vestergaard, *Governing Uranium Globally*, p. 65.

9. Provincial Moratoriums

Provinces have the authority to make laws in relation to exploration for non-renewable natural resources (such as uranium). According to the 1982 Constitution Act, provinces can also legislate regarding exports of primary production from non-renewable natural resources to other provinces as long as they do not discriminate in prices or suppliers exported to another part of Canada.[258] Thus far only two provinces have formalised prohibitions on exploring and mining uranium, specifically British Columbia and Nova Scotia. Québec has recently imposed a temporary moratorium until the results of a government review are completed.

British Columbia

In March 1980 the Social Credit Government in British Columbia terminated the hearings of the Royal Commission of Inquiry into Uranium Mining and announced a seven-year moratorium on uranium mining in the province.[259] The moratorium lapsed in 1987 and was not updated by succeeding governments until 2008, when the Liberal Government under Premier Gordon Campbell made the informal ban formal. In April, the B.C. Minister of State for Mining, Kevin Krueger, announced the establishment of a 'no registration reserve' under the Mineral Tenure Act for uranium and thorium, thereby barring the rights to uranium in future claims.[260] A year later, the Chief Inspector of Mines stopped all work on existing claims, prompting Boss Power Corporation to launch a lawsuit that it had a Notice of Work that the mines inspector was legally obliged to consider. In 2011, the province, now under the New Democratic Party Government, reached a settlement of CDN $30 million for the mineral rights to the Blizzard uranium deposit located 48 kilometers southeast of Kelowna, plus legal costs.[261]

Nova Scotia

In Nova Scotia, a moratorium on new uranium exploration licences was announced in September 1981. Four months later, the re-elected Progressive Conservative Gov-

[258] Paragraph 92 A, of the 1982 Constitution Act.

[259] Atomic Energy Control Board, *Annual Report 1979-80*, Ottawa, Canada, p. 4.

[260] Province of British Columbia, Ministry of Energy, Mines and Petroleum Resources, 'Government Confirms Position on Uranium Development,' *News Release,* 24 April 2008.

[261] 'Uranium mine lawsuit costs B.C. $30M,' CBC News, 21 October 2011.

ernment under John Buchanan established an inquiry into the impact of uranium exploration and mining in Nova Scotia and a month later announced that no new exploration permits would be issued pending the findings of the inquiry.[262] The policy was continued by subsequent governments until November 2009, when the newly elected New Democratic government in the province passed the Uranium Exploration and Mining Prohibition Act, which prohibited exploration for or mining of uranium in the province. Mining of uranium as a by-product was allowed if the uranium content was less than 0.01 per cent by weight.[263]

Québec

More recently, in April 2013, Québec's environment minister requested the Bureau d'audiences publiques sur l'environnement *(*BAPE) to set up a year-long commission to study the environmental and social impacts of uranium exploration and mining in the province. Public consultations were to be held across Québec, including the territories covered by the James Bay and Northern Québec Agreement and the Northeastern Québec Agreement. The James Bay Advisory Committee on the Environment (JBACE) and Kativik Environmental Advisory Committee (KEAC) also set up their own commissions and accompanied BAPE at community consultations.[264]

The Minister's request was prompted by local opposition to exploration activities at the Matoush Underground Exploration Project, which were licensed by the CNSC in October 2012. Matoush is owned by Strateco Resources and is located 210 kilometers north of the Cree community of Mistissini. Strateco Resources suspended exploration work at Matoush after the provincial government denied it permission to conduct underground exploration. In April 2013 the environment minister also announced that no permits for uranium exploration or mining would be issued until BAPE had completed its study. BAPE set up the uranium commission in May 2014.

After one year of public consultations, the BAPE report was issued in May 2015.[265] It concluded that allowing uranium mining operations would be premature, given

[262] Nova Scotia Department of Mines and Energy, 'Uranium in Nova Scotia: A Background Summary for Uranium Inquiry Nova Scotia,' Report ME 1982-7 SC, Halifax, Nova Scotia, 1982, p. 13.

[263] Nova Scotia Department of Natural Resources, 'Uranium Ban to Become Law,' *News Release*, 14 October 2009.

[264] Bureau d'audiences publiques sur l'environnement, 'Uranium Industry Issues in Quebec,' Report 308, Joint Report, Cree/English version, May 2015.

[265] Ibid.

the large number of technological uncertainties and gaps in scientific knowledge with regard to the risks involved.[266] It also noted that Québec should further weigh the legal and economic impacts of establishing a temporary or permanent ban on uranium extraction. The President of the CNSC responded to the BAPE report, stating that some of its conclusions and recommendations are misleading, given their lack of scientific rigour. The response underscored the proven safe track record of modern uranium mining: 'To suggest that uranium mining is unsafe is to imply that the CNSC and the government of Saskatchewan have been irresponsible in their approval and oversight of the uranium mines of Canada for the last 30 years.'[267] The report and its recommendations are now being analysed by an inter-ministerial committee to assess its findings.[268] In the meantime, the moratorium remains in place.

According to the Ministère de l'Énergie et des Ressources Naturelles, approximately 8,800 tonnes of uranium have been identified so far in Québec. Reserves are situated mainly in James Bay and the Côte-Nord region, with Nunavik, Témiscamingue, Hautes-Laurentides and Outaouais also reporting uranium showings.[269] To date, no uranium mines have operated in Québec.

[266] Ibid., p. xii.

[267] 'Canadian regulator dismisses Québec uranium report,' *World Nuclear News*, 30 July 2015.

[268] 'Québec uranium commission makes recommendation,' *World Nuclear News*, 20 July 2015.

[269] Bureau d'audiences publiques sur l'environnement, 'Uranium Industry Issues in Quebec,' Report 308, Joint Report, Cree/English version, May 2015, p. viii.

10. Conclusion

Canada is both a producer and consumer of uranium. The majority of uranium produced, nearly eighty-five per cent, is exported abroad while the rest is processed to fuel Canada's domestic fleet of CANDU reactors. Although its total annual production figures were surpassed by Kazakhstan in 2009, Canada comfortably remains the largest uranium producer of all time. It also hosts the world's highest-grade uranium deposits and the world's largest producing uranium mine, mill and refinery. It is expected that annual production figures will increase in the years to come as the Cigar Lake mine reaches full capacity, but Canada is unlikely to resume the top annual spot anytime soon. Kazakhstan has been steadily increasing its uranium production over the past decade, more than doubling Canada's production per year since 2011.

Rankings aside, uranium production in Canada has evolved over seven decades from being dedicated to fulfilling military requirements to being focused on the environment, non-proliferation and safety. Initially a state secret, uranium mining and trade have become transparent, with a public hearing-based licensing process, regulatory oversight and annual reporting of operational safety and environmental performance. The case of the CNSC working with industry and the IAEA to fully safeguard uranyl nitrate for the first time demonstrates how Canada's consultative regulatory process is able to accommodate an expanding structure of international nuclear treaties and obligations. Moreover, a graded approach to nuclear security coupled with a risk-based approach to UOC exports (and imports) allows for flexible and tailored regulations in line with legislative and policy changes. This level of transparency and regulation is unparalleled by any other industry in Canada. It forms the basis of Canada's reputation as a solid and steady supplier.

The nuclear deal with India does challenge Canada's long-standing non-proliferation and nuclear supply policy by providing a country-specific exemption for India. It marks a new chapter in Canada's nuclear relations with India, but it does not signal a farewell to the 1970s. Canada's past continues to inform its regulatory present as the principles of peaceful use and international safeguards remain deeply grounded in Canada's nuclear regulatory structure. One of the greatest differences between then and now is that these principles are now agreed to by India with all of its imported UOC verified by the IAEA today. Canada applies the same risk-based approach to uranium exports destined for India as it does for all of its UOC export license applications.

During its seventy-four years of uranium experience, Canada's regulatory system has been continually-evaluated and updated to reflect domestic and international obligations. The Canadian case demonstrates that, even in the world's all-time largest uranium producer, support varies from province to province (or territory). It also underscores how a holistic, inclusive approach to stakeholders encourages continual dialogue, providing the foundation for Canada's nuclear policy and regulatory framework as it adapts to a changing global uranium market.