Uranium Regulation: Mining, Transportation, Trade and Control

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Introduction and terminology
Regulating mines – old vs. new
Environmental impact assessment
Licensing and corporate social responsibility
Safety and radiation protection
Transportation of uranium
Uranium trade and supply
Non-proliferation, export control
Conclusions
Some Terminology

- **uranium**: natural element, common in most of the Earth’s rock, soils, rivers, oceans – it is a factor of its concentration in natural deposits, as well as the price of uranium, that determines whether it is feasible to extract
  - average-grade ore – from 0.1% uranium, fairly common today
  - very high-grade ore – up to 20% uranium, Athabasca basin, Canada
- Uranium is of regulatory interest and importance once it is part of the nuclear fuel cycle – which is to say, once it is to be extracted, as its potential to generate energy is its major use
- **radon**: radon is produced by the decay of uranium; radon gas is released into the air when uranium ore is mined and, to a lesser extent, during the production of uranium reactor fuel
- uranium that has been mined and milled is **uranium concentrate** (U₃O₈) or **yellowcake**; several further steps are required before uranium may be used in a reactor as nuclear fuel
Uranium in the “Front End” of the Fuel Cycle

Mining

Rock containing on average 0.1–19% uranium (uranium ore) is extracted from the ground. The ore is transported to a regional mill.

Milling

Uranium ore is ground and the uranium (U₃O₈) is chemically separated from most other constituents. The uranium concentrate, containing approximately 98% uranium (yellowcake) is shipped to a refinery.

Refining

The remaining contaminants in the uranium concentrate are chemically separated from the uranium. The purified uranium (UO₂) is shipped to a uranium conversion facility.

Conversion

The chemical form of uranium is converted to UO₂ (for CANDU reactor fuel) or to UF₆ (for enrichment).

Enrichment

The fuel bundles are shipped to a nuclear generating station.

Fuel assembly

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Uranium Market Info and Data

- Resources, production, demand – the “Red Book”
- Uranium supply for energy security – statistical profile of the world uranium industry
- Identified resources are sufficient for “over 120 years of supply” for global nuclear power fleet… but still depends on “timely investment”
- Production in 21 countries – current leading producers:
  - Kazakhstan (36%)
  - Canada (15%)
  - Australia (12%)
  - Niger (8%)
  - Namibia (8%)
- Demand growth is subject to uncertainty

Current Red Book Stats and Information

- Identified resources up over 7%, adds 8-10 years of reactor requirements to resource base
- Mine production increased by 7.6% - lower growth rate than prior period: the increase is a result mainly of Kazakhstan
- Identified resources 7.6M tonnes of uranium metal, recoverable at costs up to $260/kg
- Environmental and social aspects of uranium production – looking for “leading practice operations”, especially in new host countries
- Uranium requirements projected to rise from about 62K tonnes of uranium metal (2012, 437 operating reactors) to between 72K and 122K tonnes by 2035 – subject to lots of uncertainty

“The currently defined resource base is more than adequate to meet high-case uranium demand through 2035… Other concerns in mine development include geopolitical factors, technical challenges, increasing expectations of governments hosting uranium mining and other issues facing producers in specific cases.”
Uranium Mining Regulation: Part of Nuclear Law

Commonalities with other aspects of nuclear law:

- Worker safety and radiation protection
- National interest in control over the resource
- Non-proliferation and export control
- Radioactive waste – low-activity, high-volume, long-lived
- Environmental protection
- Social acceptance
Old Uranium Mining vs. New Uranium Mines

• Legacy sites: old mining practices, Cold War secrecy, lack of remediation, no closure plans, worker exposures

• New sites: environmental stewardship, site rehabilitation, social responsibility, financial guarantees, internationalized standards, prevention and mitigation of risks to health, environment – highly regulated

• Canadian example:
  Rio Algom v. Canada, 2012 ONSC 550
  (Jan 4, 2012 decision of Ontario Superior Court)
Rio Algom v. Canada, 2012 ONSC 550 – not the law that’s interesting, but the facts

- **1954-1972**: Rio Algom sold >65M pounds of uranium oxide to a Canadian government-owned (Crown) corporation, which in turn (and for no profit), sold the uranium to the U.S. Atomic Energy Commission to build nuclear arsenal in the Cold War – the “Cold War contracts”

- Rio Algom made >$72M on the contracts based on a formula that was meant to incentivize the industry and turn a profit for them – to create a uranium mining industry in Canada

- Price formula included cost of tailings management, but such management was rudimentary at the time

- **1990s**: new regulations – to remedy environmental harm caused by the radioactive waste, ineffectively treated mine tailings – Rio Algom complied

- **2000**: *Nuclear Safety and Control Act* – licence to decommission required, new standards for mine rehabilitation

- Rio Algom sues Canada – Canada indemnifying company as an implied term of Cold War contracts?

- Legal arguments fail – Rio Algom must hew to new environmental standards for mine rehabilitation, Canada is not required to indemnify it

- Rio Algom’s costs of managing tailings will continue in perpetuity – current estimate of future cost is approx. $100M
Decommissioning and Restoration

- Legacy sites needing remediation are all over the world, a remnant of past inappropriate or nonexistent standards.
- Governments are financing necessary cleanup – e.g., European Bank for Reconstruction and Development fund for Central Asia sites, set up in 2015 at request of European Commission.
- Remediating former sites can be more technically challenging than new sites.
- Acceptability of new mines is judged against how governments are perceived to have dealt with legacy sites.
- These photos show a fairly modern decommissioning project.

Cluff Lake, 1999

Cluff Lake, 2005
Licensing Uranium Projects in Canada – Lifecycle Approach

Licence application
- Prepare site
- Construct
- Operate
- Decommission
- Release from licence/abandon

Environmental assessment (as applicable)

Public hearing

Licence

Regulatory oversight
- Licence conditions
- Inspections
- Compliance assurance

Licensee obligations
- Health and safety
- Environmental protection
- Security
- Monitoring
- Reporting
- Financial guarantee
Environmental Impact Assessment

- International conventions:
  - *Aarhus Convention* (access, public participation)
  - *Espoo Convention* (environmental assessment (EA) in transboundary context); *Kiev Protocol*

- Environmental protection: a tenet of nuclear law

- Environmental impact assessment (EIA) is a process to predict the environmental effects of proposals:
  - assessing whether proposal would cause adverse effects - physical, biological, human environment
  - ensuring public discourse on a project
  - crafting monitoring programs, mitigation measures, remediation plans – lifecycle

- International Environmental Standards - ISO 14001: environmental management system, to measure and improve environmental impact
EIA Components for Uranium Production

- Baseline data – topography, hydrogeology, flora, fauna, local air, water, soils, biota
- Detail of ore body, mining method proposed, milling process, transportation
- Socio-economic issues – need to include potential impacts on culture, potential positive economic effects, long-term plan for land
- Cumulative impacts
- EIA is a planning tool, with procedural and substantive elements
Uranium Production EIAs – Some Interesting Points

• Social impact (political) and environmental protection (scientific) – EIA recognizes the link
• ‘Social acceptability’ of uranium mining –
  - Ranger Inquiry (Australia):
    1975-77 Fox Report - ethics of mining, social and Aboriginal opposition
  - Matoush Project (Canada):
    2013 Quebec government decision: inadequate social acceptability
  - Bureau des audiences publiques sur l’environnement (BAPE) on uranium mining in Quebec (Canada): 2015 report
• Changes to EIA process: timing, sophistication, scope, formality, participation
• Nuclear regulatory role in EIA
• Participant funding
  – encouraging public involvement
• UN Declaration on the Rights of Indigenous Peoples, article 29:

1. Indigenous peoples have the right to the conservation and protection of the environment and the productive capacity of their lands or territories and resources. States shall establish and implement assistance programmes for indigenous peoples for such conservation and protection, without discrimination.

2. States shall take effective measures to ensure that no storage or disposal of hazardous materials shall take place in the lands or territories of indigenous peoples without their free, prior and informed consent.

3. States shall also take effective measures to ensure, as needed, that programmes for monitoring, maintaining and restoring the health of indigenous peoples, as developed and implemented by the peoples affected by such materials, are duly implemented.

Fond du Lac Denesuline First Nation et al. v. Canada (Attorney General) 2012 FCA 73
March 2012 Federal Court of Appeal (see NLB 2012/1, No. 89)
Licensing a New Mine or Mill

Factors to be considered would include:

• Application – *Uranium Mines and Mills Regulations*
• The EIA process and results: impacts, follow up
• Safety issues – radiation protection, worker safety, transport, emergency preparedness/planning
• Public and Aboriginal consultation
• Tailings management, rehabilitation plan
• Disclosure/reporting requirements
• Financial security/guarantee for site closure
• Long-term plan for institutional control

*Social responsibility is important*
Ownership of Uranium Resources, Mining Operations

• Often complex ownership structures for mines
• Countries may impose foreign ownership limits for national security, national interest (Canada: 49%)
  – limits may be waived: Canada waived the policy requirement for Paladin Energy Ltd. on the Michelin project (Labrador, Canada) in June 2015
• Of note:
  – 10 largest uranium producers responsible for about 90 percent of global production (2009): Areva, Cameco, Rio Tinto, Kazatomprom, Rosatom subsidiary ARMZ, BHP Billiton, Navoi, Uranium One, Paladin, General Atomics/Heathgate
Corporate Social Responsibility and Accountability

**Equator principles**
- “Environmental and social risk management for project finance”
- 80 banks, covering more than 70% of project financing in emerging markets;
- includes such things as human rights due diligence, Greenhouse gas emissions tracking

- *So, mining companies may have financing that is tied to corporate social responsibility (CSR)*

**Canada’s Office of the Extractive Sector CSR Counsellor**
- promotes the International Finance Corporation (IFC) performance standards,
- the Voluntary Principles on Human Rights and Security and the non-financial reporting frameworks of the Global Reporting Initiative
- labour and working conditions, pollution prevention, indigenous peoples, sustainable development, community health and security, land acquisition, etc.

- *So, voluntary standards find their way into contracts and trade.*
Corporate Social Responsibility and Accountability

- Canada’s *Corruption of Foreign Public Officials Act*
- Bilateral trade treaties may refer to the promotion and enforcement of internationally recognized CSR standards as an exception to trade liberalization (e.g., *Canada-Peru Free Trade Agreement*).
- U.S.: *Alien Tort Claims Act; Foreign Corrupt Practices Act*
  - Does a Canadian mining company owe a duty of care to protect Guatemalan Mayan Q’eqchi from human rights abuses by the company’s subsidiaries in Guatemala?
  - June 2015 motion decision ordering production of documents – on security at other mine projects; community relations activities; corporate control documents.
- Canada’s *Extractive Sector Transparency Measures Act*
  - requires reporting of payments in Canada and abroad on commercial development of oil, gas and minerals;
  - to deter corruption in the global extractive sector by making government revenues from natural resources transparent to the public; meant to ensure citizens benefit from natural resources.
Construction – Cigar Lake Mine
Operation – McArthur River Mine
Operation – Key Lake Mill
Operation – McClean Lake Mine and Mill
What Waste Do Uranium Mines and Mills Produce?

**Remember: high volume, low activity**

- **Clean waste rock and waste rock:** Mining produces both clean waste rock and waste rock that must be removed to retrieve the uranium ore. Clean waste rock is not harmful to the environment and is placed in surface rock piles for future use. Waste rock is usually found close to the ore body and contains low concentrations of radionuclides or heavy metals (mineralized waste). These must be managed during operations and properly disposed of so that contaminants are not released to the environment.

- **Tailings:** Milling uranium ore produces tailings. Tailings are what is left over once the uranium has been removed from the ground rock – they resemble fine sand. They contain long-lived radionuclides (such as thorium-230 and radium-226) produced from the decay of uranium, as well as trace metals like arsenic and nickel. They also contain chemical residues from the milling process.
Mine Waste Management

In-pit tailings management

- Water to mill for treatment
- Tailings from mill
- Overburden
- Sandstone
- Basement rock
- Sand and gravel
- Waste rock
- Pump
Waste Management for Mines/Mills

- Article 3(2) notes the Convention does not apply to “naturally occurring radioactive material … that does not originate from the nuclear fuel cycle unless … declared as radioactive waste … by the contracting party”. Contracting parties have agreed to include mine/mill waste in reporting.
Protecting the Environment

• Control releases
  – To the air
  – To surface water
  – To ground water

• Measure/monitor
  – Releases
  – Effects

• Take action, when required
Radiation Protection: the Workers

- Management
- Control of radioactive materials
- Control of worker doses
- Measurement of radiation
Radiation Protection: the Public

- Measure radiation in the environment
- Calculate potential dose to members of the public
Packaging and Transport
Transportation

Producing vs using countries + complexity of fuel cycle = lots of shipments, different stages

- IAEA regulations
- Packaging requirements
- Security requirements, physical protection
- Use of reliable carrier
- Secure storage in transit
- Driver communications
- Emergency planning
- Security response
- Shipment notification
Transportation of Uranium

• Real-life examples of transport issues involving uranium:
  1. at sea – MCP Altona incident (January 2011)
  2. on land – yellowcake spill at Blind River Canada from containers travelling from Wyoming, U.S. (June 2012)
Uranium Mining and Safeguards

Treaty on the Non-proliferation of Nuclear Weapons (NPT):
• NNWS forego nuclear weapons, accept safeguards;
• nuclear trade – for peaceful purposes – is done under safeguards

Starting point for safeguards (INFCIRC/153):
• “nuclear material of a composition and purity suitable for fuel fabrication or for being isotopically enriched” (art.34)
• so not naturally occurring uranium ore

• Safeguards procedures for mining/milling: export and import reporting, but no nuclear material accountancy and verification
• Accountancy and verification procedures apply to nuclear material at the next stage of the fuel cycle – ore concentrate for nuclear purposes, conversion, enrichment, fuel fabrication
• Additional Protocol (INFCIRC/540) obligations include providing information on mining activities, stocks of source material, concentration plants, import/export, research and development
Non-Proliferation and Uranium Trade

- Peaceful purposes nuclear trade under safeguards
- Government policies respecting non-proliferation determine when/how a State puts ‘obligations’ on its trade (beyond NPT requirements)
- Nuclear cooperation agreements – treaty-level assurance that nuclear material, equipment and technology will be used only for civilian, peaceful applications – include obligations:
  - exports only for peaceful, non-explosive end-uses
  - control over items subject to the nuclear cooperation agreement that are re-transferred
  - control over the reprocessing of any obligated spent nuclear fuel
  - control over the storage/use of any separated plutonium
  - control over high enrichment / its subsequent storage and use
  - bilateral safeguards if IAEA safeguards are unable to be applied
  - assurances of adequate physical protection – Convention on the Physical Protection of Nuclear Material
- Nuclear Suppliers Group Guidelines – INFCIRC/254
Uranium Trade – Fuel Supply

• Fuel supply: mining, conversion, enrichment, fuel fabrication – all are required to guarantee supply of fuel

• NPT article IV:
  – “inalienable right of all the Parties …to develop research, production and use of nuclear energy for peaceful purposes” and
  – “right to participate in, the fullest possible exchange of equipment, materials and scientific and technological information for the peaceful uses of nuclear energy”

• BUT: the relevant technology, materials and know-how for civilian nuclear energy production are all dual-use

• Proliferation risk – enrichment technologies
Fuel Supply – Enrichment Technology

How to achieve assurance of supply and ensure non-proliferation?

• Fuel Bank – international body (IAEA) stockpiling fuel
• Ensuring commercial competitiveness and avoiding monopolistic conditions – challenging
• May 2015 – IAEA Board of Governors approved host state agreement for Kazakhstan to host Low Enriched Uranium (LEU) Fuel Bank (2017 start?)

LEU from the bank will only be supplied to a Member State (MS) which fulfills the following eligibility criteria:

• MS experiencing supply disruption of LEU to a nuclear power plant and is unable to secure LEU from the commercial market, through State-to-State arrangements, or by any other such means
• The IAEA has made a conclusion that there has been no diversion of declared nuclear material and no issues relating to safeguards implementation in the requesting State are under consideration by the IAEA Board of Governors
• MS has brought into force a comprehensive safeguards agreement requiring the application of IAEA safeguards to all its peaceful nuclear activities
• LEU from the IAEA LEU bank, as a mechanism of last resort, can only be supplied to a MS upon advance payment, when the Director General concludes that these three criteria are fully met
Some General Takeaways

• As a strategic resource that is important for energy security, uranium is of both national and global importance.

• For health and safety, radiation protection, environmental stewardship and non-proliferation, control of uranium production and trade is an important part of national and international nuclear law.

• Evolution of environmental standards distinguishes current mining from legacy practices, but the perception of environmental damage and unsafe practices must still be addressed. Lifecycle management is key to current regulatory schemes.

• Mine operators need to be aware of CSR imperatives and social acceptability issues for projects – transparency is key.

• The internationalization of the fuel cycle has potential for non-proliferation gains and security of supply, but must also ensure competition and show respect of the NPT bargain.
We will never compromise safety.