企画セッション | 部会・連絡会セッション：海外情報連絡会

2019年3月21日(木) 13:00 ~ 14:30 | B会場 共通教育棟2号館 1F 10番

[2B_PL] カナダの原子力事情

座長:橘 幸男(JAEA)

[2B_PL01] カナダの原子力事情

概要

*Jean-Philippe Davignon[1] (1. カナダ大使館)

[2B_PL02] カナダの原子力事情

放射性廃棄物処分技術

*Roman Bilak[1] (1. Terralog Tech.)

International Nuclear Information Network Session

Nuclear Energy in Canada
(1) An Overview

*Jean-Philippe Davignon[1]
[1] Embassy of Canada to Japan

1. Introduction

Canada sees nuclear energy as a strategic asset, a driver of innovation, a source of good jobs, and a key part of its growing non-emitting energy mix. Nuclear energy is considered reliable, safe, and environmentally responsible as long as it is developed in a robust regulatory framework to address safety, security, and waste management concerns. It has a role to play, alongside renewables, in bolstering economic growth, energy security and access, and environmental stewardship in support of clean energy goals.

This is why Canada joined the U.S. and Japan to launch a new nuclear energy initiative at the Ninth Clean Energy Ministerial (CEM9) on May 24, 2018 in Copenhagen, Denmark. The “Nuclear Innovation: Clean Energy Future” (NICE Future) initiative aims to promote and accelerate the use of nuclear energy as an important part of the global clean energy transition by ensuring that nuclear energy receives appropriate representation in high-level discussions about clean energy. Nuclear energy plays an important role in Canada’s energy mix, and will contribute to Canada’s overall strategy to combat climate change.

2. Canada’s Policy Regarding Climate Change

Canada’s plan to fight climate change at home – The Pan-Canadian Framework on Clean Growth and Climate Change – is effective: we are phasing out coal, putting a price on carbon emissions, making historic investments in public transit, green infrastructure and clean technologies, promoting energy efficiency, and protecting more of our nature for our children and grandchildren. Furthermore, Canada’s national “Generation Energy” consultations in 2017, in which over 380,000 Canadians participated, emphasized that our population wants to move toward a low-carbon economy. Four identified pathways to that clean energy future to mitigate climate change are: using more renewable fuels; switching to clean power; increasing energy efficiency; and, producing cleaner oil and gas. Canada will continue to reinforce its commitment to meet its obligations under the Paris Agreement through the ongoing implementation of this plan, including investing in innovation, clean tech and in the resilience of our communities.

Canada is also working together with its international partners to fight climate change on a global scale, including helping developing countries gain increased access to financing in their transition to low-carbon and climate-resilient economies. In November 2015, in support of the Paris Agreement, Canada’s Prime Minister pledged $2.65B over five years to advance international climate change objectives. This support is being delivered through a variety of channels, including through the United Nations Framework Convention on Climate Change (UNFCCC) financial mechanism – the Green Climate Fund – as well as through a number of multilateral and bilateral initiatives.

Canada and the UK co-launched the Powering Past Coal Alliance on the margins of the UNFCCC’s COP23. The Alliance is a voluntary coalition of governments, businesses and organizations, established to help lead global efforts to end the use of unabated coal power – power generated by plants without technology to capture and store carbon emissions. As of December 2018, a total of 80 members have joined the Powering Past Coal Alliance, comprising 30 national governments, 22 sub-national governments, and 28 businesses or organisations. Eliminating coal power and shifting to less-polluting energy is essential for clean air and healthy communities, a safe climate and cleaner economic growth.

3. Overview of Canada's Nuclear Sector

Nuclear energy plays an important part in Canada's energy mix and assists in meeting greenhouse gas emission targets (Canada has committed to have 90% of its electricity coming from non-emitting sources by 2030, up from 80% now). It is the second-largest source of non-emitting electricity generation in Canada, after hydropower, with 19 CANDU reactors located in two Canadian provinces producing 15% of Canada's electricity. Furthermore, Canada is the second largest exporter of uranium in the world, with uranium mining, milling, and processing operations concentrated mainly in the province of Saskatchewan. Canada's nuclear sector also includes research facilities, medical facilities, irradiation facilities, isotope producers and processing and fuel fabrication facilities. In total, the nuclear sector contributes $6 billion annually to Canada's economy, and accounts for 30,000 direct jobs.

In Canada, nuclear energy falls within the jurisdiction of the federal government, whose role encompasses Research and Development (R&D), non-proliferation and nuclear security, and international engagement and collaboration, as well as the regulation of all nuclear materials and activities in Canada. The government places top priority on health, safety, security and the environment in relation to nuclear activities in Canada. While the federal government has important responsibilities relating to nuclear energy, the decision to invest in electric generation rests with the provinces. It is up to the provinces, in concert with the relevant provincial energy organizations/power utilities, to determine whether or not new nuclear power plants should be built.

4. Canada's Small Modular Reactor Roadmap

A stakeholder-driven roadmap identifying the opportunities for on and off-grid applications of Small Modular Reactors (SMRs) in Canada was published on November 7, 2018. It takes a pan-Canadian approach towards nuclear energy, which may help to guide important decisions on existing and emerging nuclear energy technologies. Canada has a promising domestic market for SMRs. Conservative estimates place the potential value for SMRs in Canada at $5.3B between 2025 and 2040. Globally, the SMR market has an estimated value of $150B annually in 2040. This represents a large potential market for Canada, which has already exported nuclear reactor technology to six countries.

Canada has a window of opportunity to lead as it has all the necessary elements:

- A strong international brand and flexible and performance based regulator,
- World class nuclear laboratories and demonstration sites—with a federal investment of $1.2 billion to revitalize infrastructure at Canada's national nuclear laboratories in Chalk River
- Mature supply chain and domestic uranium mining industry—leveraging $26 billion in investments to refurbish 10 nuclear reactors in the Canadian province of Ontario,
- Extensive nuclear operating experience, and strong science and technology in related areas (materials science, medicine, irradiation/sterilization, food safety).

The roadmap is a "call to action" for all key enablers in Canada. It includes 53 recommendations for action by governments, industry, and stakeholders. The roadmap proposes that these enablers respond to its recommendations with concrete commitments for action to seize Canada's SMR opportunity.

5. Conclusion

Canada will host the next Clean Energy Ministerial ("CEM 10") and the Fourth Mission Innovation Ministerial from May 26 to the 29th, 2019 in Vancouver, and looks forward to working closely with member countries to accelerate progress towards a clean energy future. With respect to nuclear energy development and innovation, strategic partnerships will be key to success—both across the sector and internationally. Through the "NICE Future" initiative under the Clean Energy Ministerial, Canada is partnering with leading global economies to ensure appropriate representation of nuclear energy in broader clean energy discussions—including the role that SMRs could play in meeting climate change and clean energy goals.

2019年春の年会

International Nuclear Information Network Session

Nuclear Energy in Canada

(2) Technology for Radioactive Waste Disposal: Slurry Fracture Injection (SFI) Zero Discharge Deep Well Disposal - Considerations for the Fukushima Daiichi Nuclear Power Plant Site Clean-up -

*Roman Bilak[1]

[1]Terralog Technologies Inc.

1. Introduction

Slurry Fracture Injection (SFI) is an environmentally sustainable and advanced deep well disposal technology. SFI is used to dispose of large volumes of various waste streams including: contaminated soil, sludge, slurry, tank bottoms, and contaminated water. Such waste streams may also be low-level radioactive wastes or Naturally Occurring Radioactive Material (NORM). SFI disposal has been used extensively as a secure and permanent solution to achieve a Zero-Discharge Waste Management Strategy.

2. Advanced Deep Well Disposal

The SFI technology is an advanced deep well disposal process with Process Control. Deep geological sequestration has been proven as a viable solution for the permanent disposal of waste streams such as contaminated soil, sludge, and slurry. Large volumes of these waste streams, including NORM, (10,000+ m^3/month) have been successfully disposed by using the SFI process. The same approach has potential viability for large volumes of such waste streams that are contaminated with low-level radioactivity. However, additional HSE controls need to be implemented to ensure safe handling and slurry preparation of these radioactive waste streams. Implementation of the SFI process results in significant environmental advantages including elimination of run-off & contamination risks to surface and groundwater; elimination of surface land use impairment; elimination of landfills and surface storage; and elimination of long-distance transport risks & costs.

3. SFI Process

To describe the SFI process in its basic terms, waste material is screened to specified injection criteria (if required), then slurried in a stream of waste-water. Slurry is made with as high a waste concentration as possible and pumped down a waste disposal well at in situ fracturing pressures into a suitable deep geologic formation. SFI disposal occurs into thick, porous, permeable geologic formations of intermediate depth (350 to 2000+ m). Special emphasis is placed on the use of industry Best Practices and Process Control features to mitigate risks and achieve Zero-Discharge waste disposal.

SFI is an innovative, sustainable, cyclic hydraulic fracturing process using lower injection rates and pressures (versus conventional hydraulic fracturing methods). The SFI process has been applied to unconsolidated sand formations. The formation geomechanics induced by the SFI process cause the development of a uniform, expansive stimulated rock volume around the disposal well, with significant formation storage capacity. SFI mechanics mitigate development of induced seismicity or fault reactivation.

Extensive process monitoring must be utilized during SFI operations in order to ensure effective Process Control (i.e. ensure in situ containment, optimization of disposal formation response, maximize formation storage capacity, and mitigate wellbore integrity risks). Monitoring techniques include: well logging, formation testing, bottomhole pressure monitoring and engineering analyses (indicator pressure analyses, pressure fall-off analyses, injection pressure analyses, etc.). This data is continuously used to modify and optimize the slurry design and injection strategies to ensure Process Control during active SFI disposal operations.

Figure 1: Schematic of SFI Facility

4. Conclusion

The SFI technology is being used as an advanced deep well disposal process for many waste streams in different countries, including NORM.

This workshop will review:

- Best Practices (geological, technical, regulatory, and environmental aspects) for the use of SFI technology.
- Geology and technical considerations for assessing the SFI process for the Zero Discharge Deep Well Disposal of certain waste streams generated from the decommissioning of the Fukushima Daiichi Nuclear Power Plant.
- SFI field cases, comprehensive risk assessments, and regulatory issues for deep well disposal.