South Bruce Nuclear Exploration Project

NUCLEAR WASTE MANAGEMENT ORGANIZATION
SOCIÉTÉ DE GESTION DES DÉCHETS NUCLÉAIRES

Preliminary Radiological Safety Study – South Bruce

Presentation to the Community Liaison Committee

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Study objectives

To provide information on:

- Potential radiological effects of the Project on the safety of current and future South Bruce residents and those in proximity to the site
- A high-level description of safety features of the facility, including mitigation and/or follow-up measures, if needed

To provide important context and background information on:

- Radiation, radioactivity and their presence in the environment
- Relevant Canadian regulations pertaining to protection of people from radiation
- Emissions of radioactivity potentially associated with the Project

Agenda

1. Radiation and radioactivity
2. Project phases
3. Building confidence in safety

1

Radiation and radioactivity

Radiation

Radiation is energy in the form of moving waves or streams of particles.

Non-ionizing radiation

- Does not have enough energy to create ions

Examples: visible light, infrared, microwaves, radios

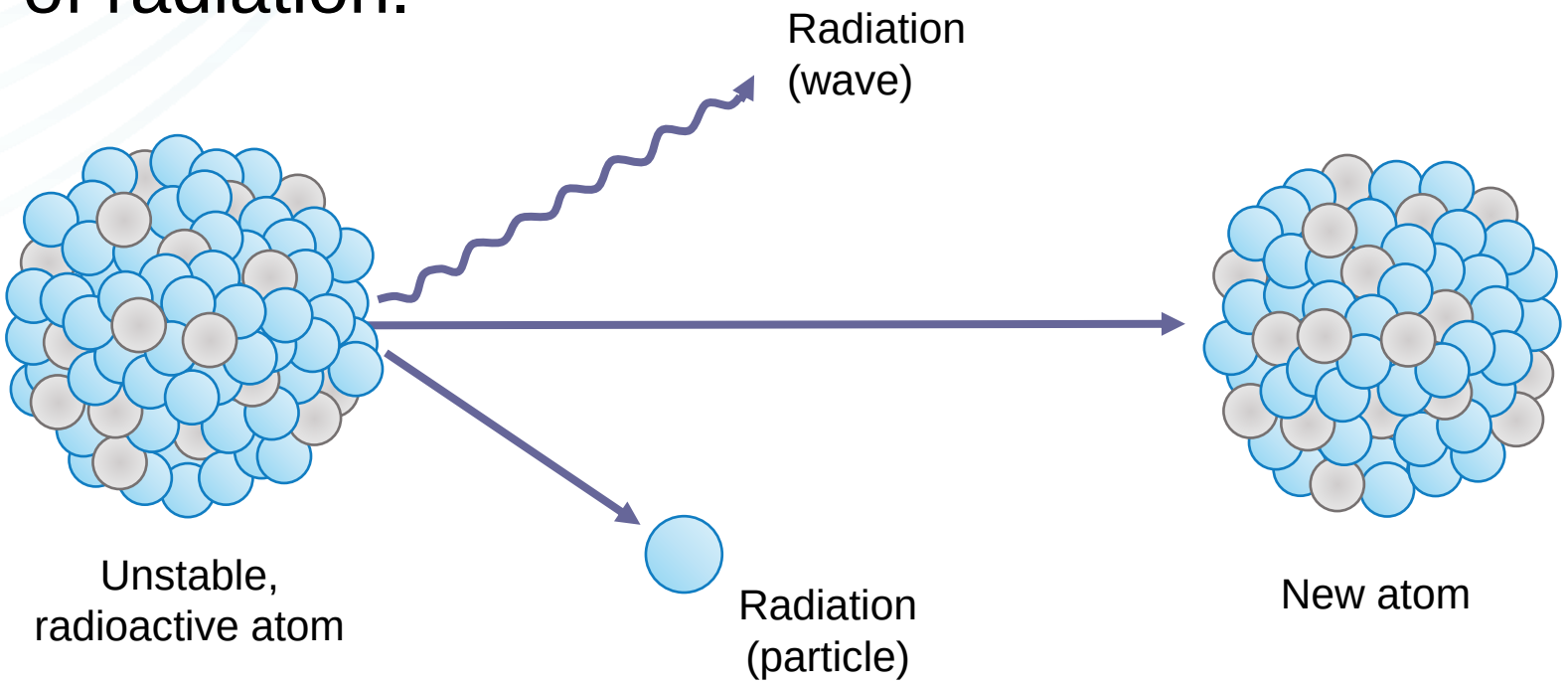
Ionizing radiation

- Has enough energy to create ions, which can be harmful to humans
- Has its place and purpose such as x-rays for medical diagnosis

Examples: cosmic, gamma, x-rays

Radioactivity

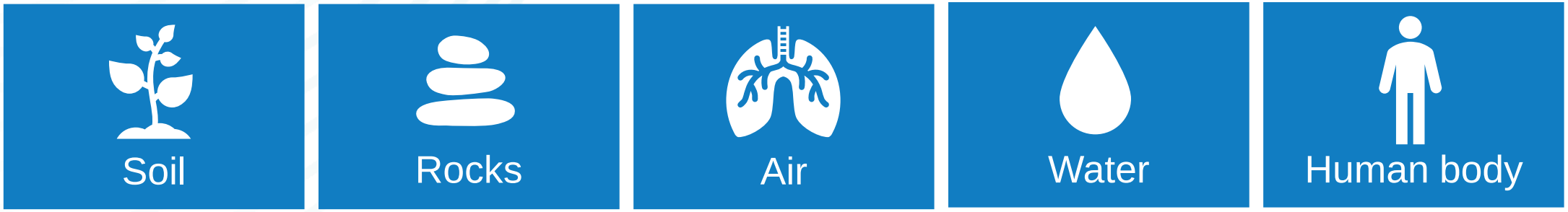
Radioactivity is the phenomenon whereby atoms undergo spontaneous random disintegration, usually accompanied by the emission of radiation.[1]



[1]International Atomic Energy Agency 2019

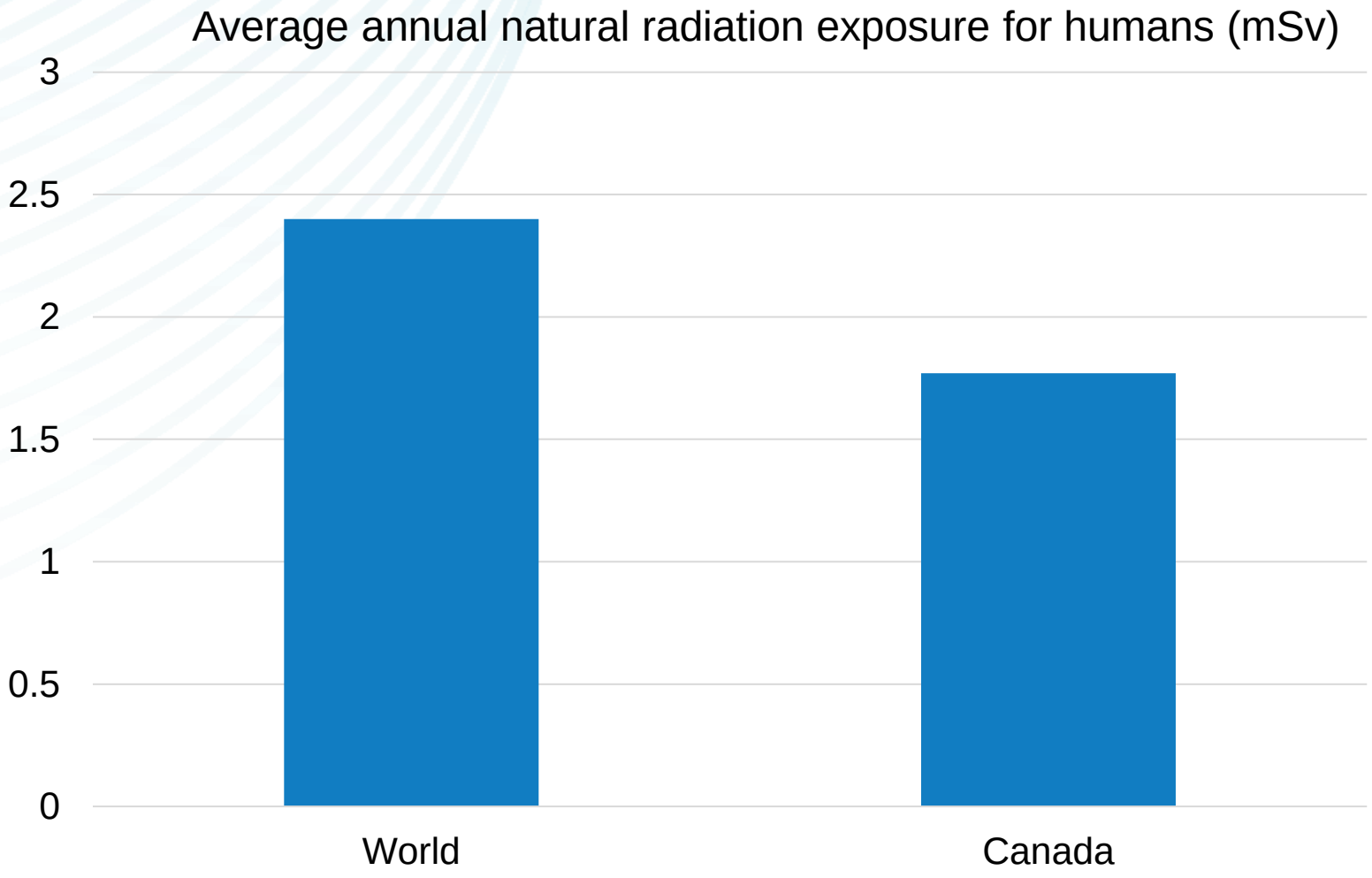
Radiation

Sources of **natural** radiation:



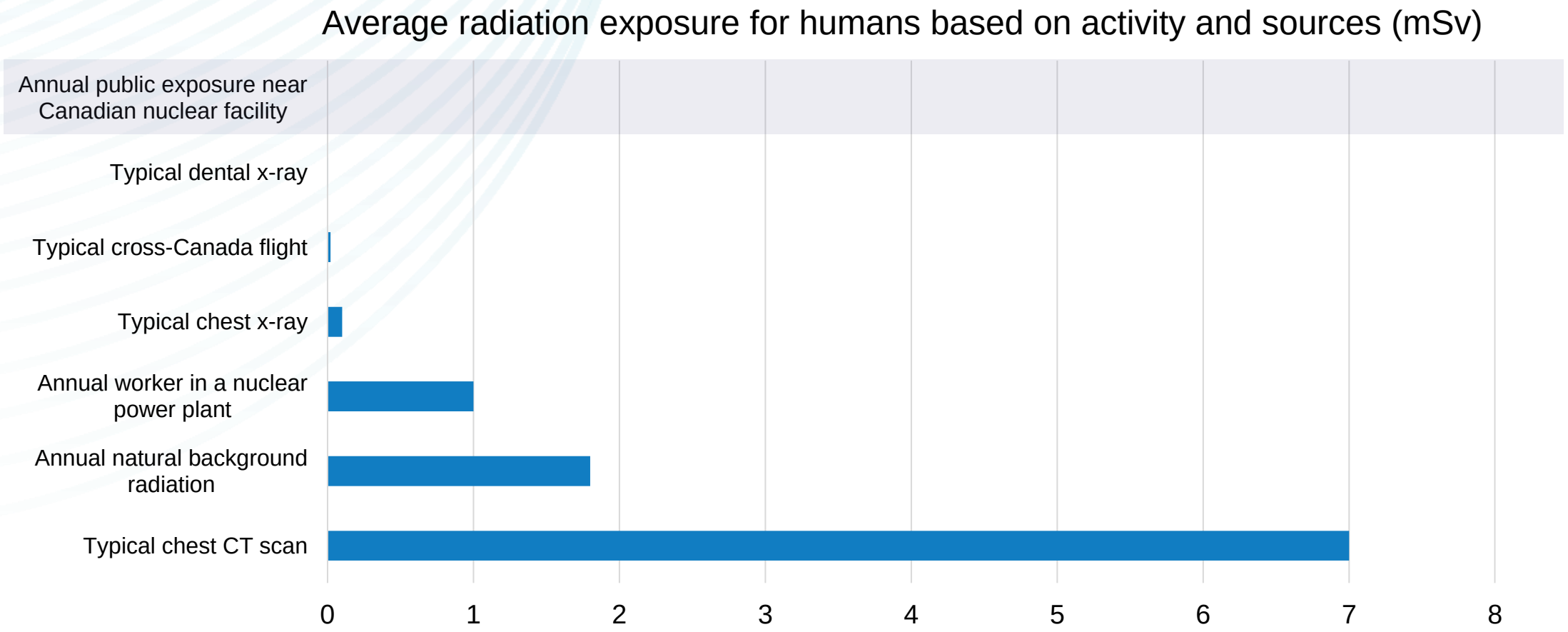
Sources of **manufactured** radiation:

Radiation exposure



Note: millisievert (mSv) is a unit of radiation exposure that is related to risk of harm

Examples of radiation exposure



Note: annual dose limit is one (1) millisievert (mSv)

Source: Typical Doses from Various Sources (CNSC 2020a)

Approving and regulating radiation

Radiation and related facilities are regulated at the federal level. The main agencies involved in regulation include:

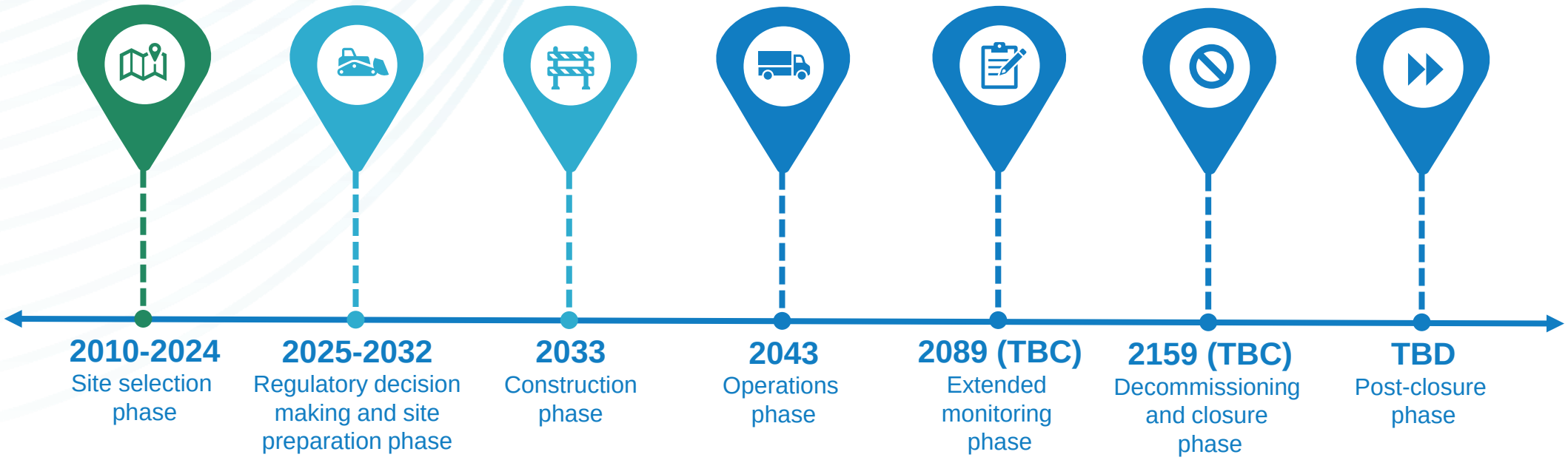
- **Canadian Nuclear Safety Commission** (CNSC)
  - Primary regulator for the use of nuclear energy and materials, and related facilities
  - Issues requirements that reflects international regulatory best practices and modern codes and standards
  - Generally aligned with safety concepts of international scientific organizations and agencies such as the IAEA, UNSCEAR and ICRP
  - Issues a licence for each phase of a project outlining what activities can take place
- **Health Canada**
  - Radiation Protection Bureau delivers Health Canada's environmental and occupational radiation protection program

In addition, the **Impact Assessment Agency of Canada**, which is accountable to the Minister of Environment and Climate Change is responsible for the assessment of the impacts of potential projects (both negative and positive) and thus contributes to informed decision making on major projects such as the proposed NWMO Project.

2

Project phases

Project phase timeline



Operations phase

- Phase anticipated to begin in 2043
- **Activities**
  - Receiving used nuclear fuel to the site
  - Repackaging, sealing and inspecting used nuclear fuel for safe storage
  - Transferring/dispatching used nuclear fuel into the underground facility
  - Storing used nuclear fuel in the underground repository
  - Sealing repository rooms once full

All above-ground activities involving handling of radioactive material will take place within the Used Fuel Packaging Plant.

Operations phase

Potential radiation sources

- Direct radiation from the fuel bundles
- Small amounts of gas or particulates that may be released from fuel during handling
  - Fuel handling accidents within the facility would be very unlikely based on safety measures

The objective is to

ensure community and worker safety, and infrastructure and environmental protections by preventing and minimizing releases and exposures.

Operations phase

Radiation exposure mitigation measures (design and engineering-based)

- Construct thick concrete walls in the fuel handling areas
- Use of automated fuel handling systems
- Seal used fuel containers
- Use of filtered and monitored air ventilation systems
- Use of dry decontamination and cleanup methods
- Use of process water treatment system
- Use of monitoring equipment and shutdown capability

Operations phase

Safety measures (procedural)

- Controlled site access
- Process and emissions controls
- Health and safety, and radiation protection programs
- Regular maintenance
- Emergency preparedness
- Monitoring systems and monitoring programs
- Initial and ongoing safety assessments
- Regulatory reviews and inspections
- Independent third-party monitoring

Post-closure phase

- Commences after the decommissioning and closure phase, start date is to be determined
- Phase monitoring will last as long as needed to verify the repository is operating safely
- Repository is designed such that there is no need for human intervention and maintenance
- Decision is informed by post-closure safety assessment

Post-closure Safety Assessment

- Considers a range of future scenarios to ensure design and mitigation measures are effective

Potential sources

- Fuel is held within containers

Post-closure phase: multi-barrier system

Each barrier acts as part of a system while also providing its own unique and stand-alone level of protection.

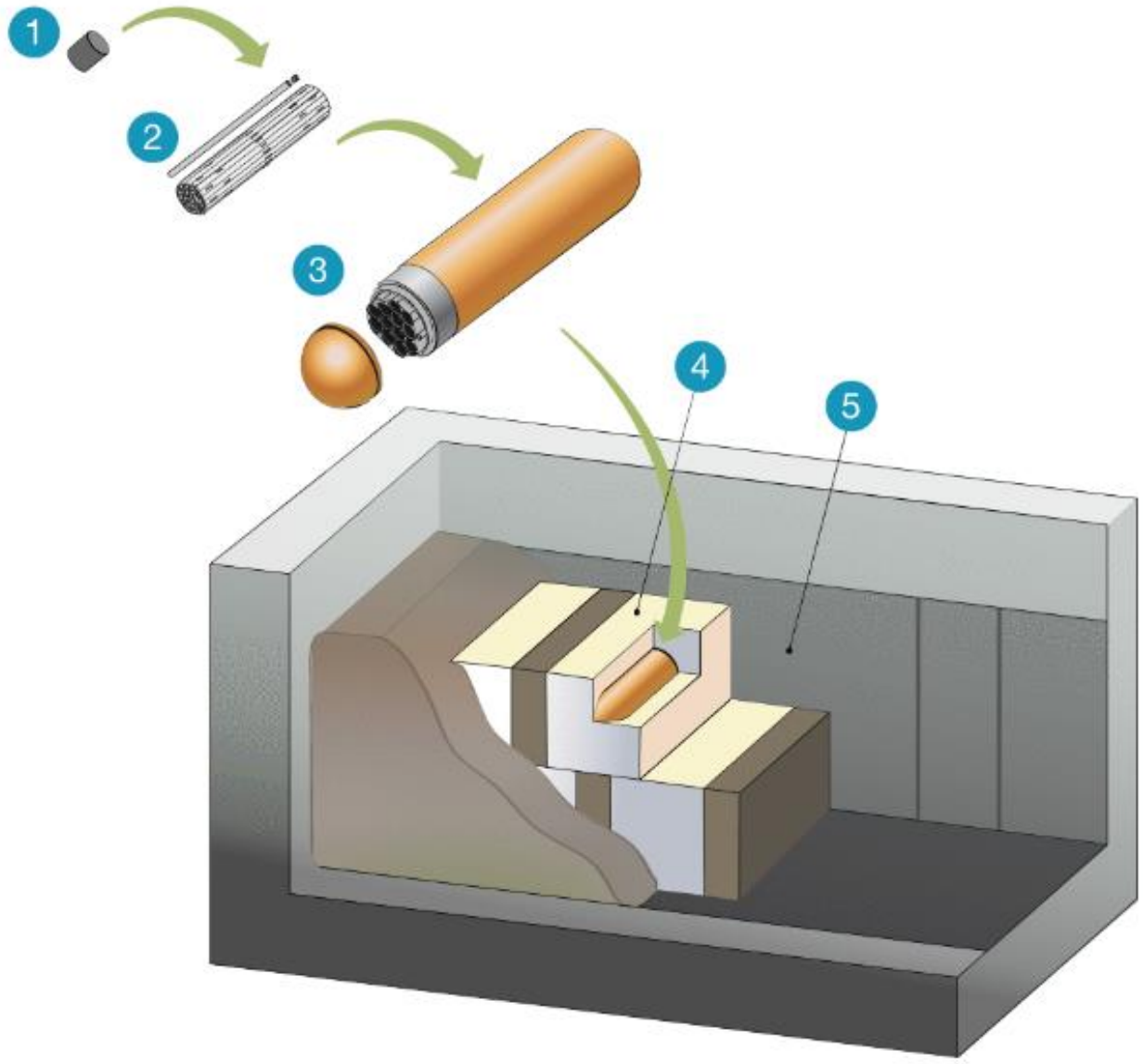
Barrier 1: Nuclear fuel pellet

Barrier 2: Fuel element and fuel bundle

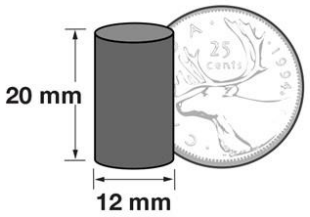
Barrier 3: Used nuclear fuel container

Barrier 4: Bentonite clay

Barrier 5: Geosphere



Post-closure phase: multi-barrier system

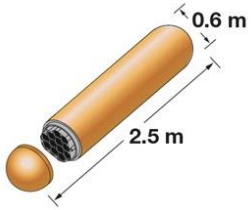


Barrier 1: Nuclear fuel pellet

- A ceramic material, made from uranium dioxide, which does not readily dissolve in water and is resistant to wear and high temperatures, and baked in a furnace to produce a hard, high-density pellet

Barrier 2: Fuel element and fuel bundle

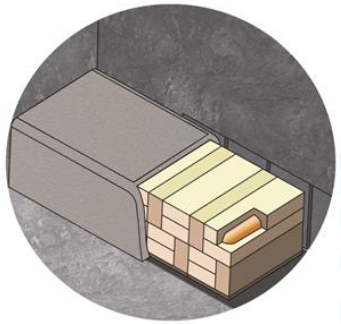
- Contained in a corrosion-resistant alloy called Zircaloy
- Function is to contain and isolate the fuel pellets



Barrier 3: Used nuclear fuel container

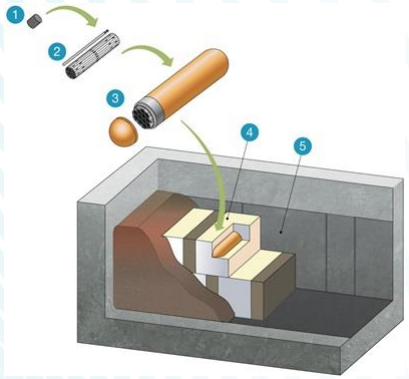
- Coated with copper to prevent corrosion
- Function is to prevent any water near the container from reaching the fuel

Post-closure phase: multi-barrier system



Barrier 4: Bentonite clay

- A natural material proven to be a powerful barrier to water flow, swelling (and sealing) when exposed to water
- Function is to help to isolate any radionuclides in the unlikely event they were to escape from the container
- Will be used to fill all open spaces in each underground chamber, seal the entrance to each placement room and backfill tunnels and shafts to further isolate the repository from the environment



Barrier 5: Geosphere

- Function is to form a natural barrier of rock, protecting the repository from disruptive natural events, water flow and human intrusion
- Will safely contain and isolate the used nuclear fuel, even under extreme scenarios
- The repository will be approximately 650 metres underground

Post-closure phase

Safety measures

Active

- Regulatory process (decision to enter post-closure phase)
- Monitoring
- On-site land use controls

Passive

- Depth of repository isolated from the surface
- Multi-barrier design (waste form, container, sealing materials, and host rock)
- Geology (rock stability, favourable underground conditions)
- Sealing of tunnels, boreholes and shafts at closure
- Radioactivity decreases with time

Conclusion

- Based on our assessment to date, NWMO is confident that a deep geological repository could be constructed at the South Bruce Site in a manner that would protect people and the environment, and provide safe long-term management for Canada’s used nuclear fuel.
- NWMO is continuing to improve and extend their understanding and therefore confidence in order to support first site selection and then regulatory decision.

3

Building confidence in safety

Peer Review findings

Building confidence in safety

Examples of studies to date

Preliminary Radiological Safety Study, August 2023

- Summarizes how to ensure safety and how radiological effects would be minimized

Confidence in Safety Report, March 2022

- Reviews the site characteristics contributing to safety

Deep Geological Repository Conceptual Design Report, September 2021

- Describes the facilities, controls and programs for operational and post-closure safety

Preliminary Radon Assessment for a Used Fuel Deep Geologic Repository, December 2020

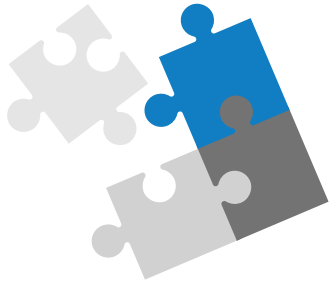
- Assesses the potential for hazards from radon gas for workers

Emergency Services Study Report, November 2022

- Assesses the capabilities of the local and regional emergency services to respond to radiation emergencies

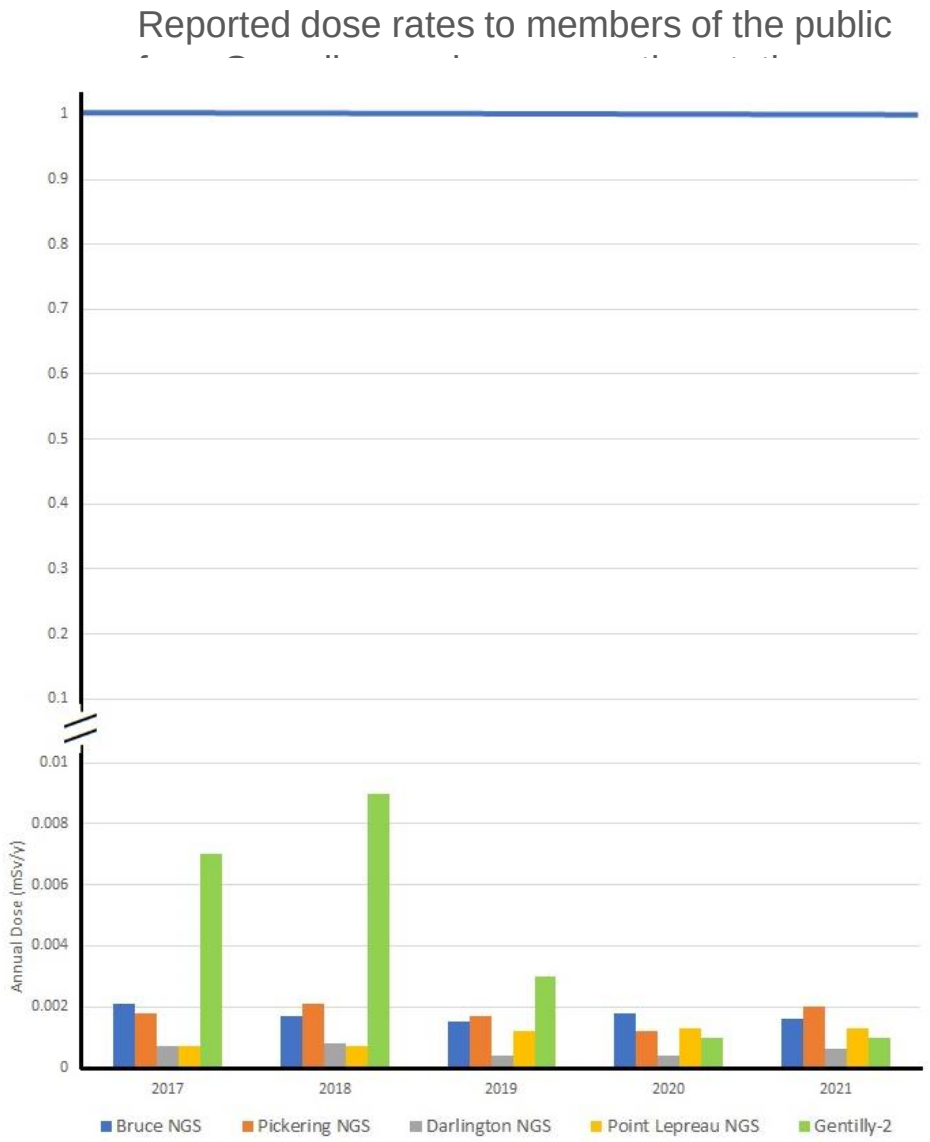
Community Health Programs and Infrastructure Report, April 2023

- Assesses the capabilities of local and regional health services to treat radiation exposure



Building confidence in safety

- Canada has a history of safe performance at its nuclear stations where used nuclear fuel is currently stored
- Dose rates and emissions from the processing areas have remained below regulatory limits



Technical Peer Review findings

- Agree the Study substantively complies with the approved Statement of Work providing the community with a good description of the basics of potential radiological impacts of the project.
- Report provides important information to address Guiding Principles #1 and#2
- Current conceptual design indicates that the radiological risk to the community is quite low and that doses to the public will be below regulatory dose limits, and likely to be negligible compared to the natural background radiation and to Canada's standards. However, an additional study will be needed once the site-specific conceptual design is complete to describe the mitigation and/or follow-up measures to be taken if an increase in risk is identified during any phase of the project.
- Additional information could be provided related to the status of international experiences with Deep Geological Disposal of Used Nuclear Waste.
- Radiation and radiological safety would also impact other community services such the emergency and health services. Additional studies will be needed to access the capabilities and capacity of the municipality to respond to radiation-related injuries and emergencies.

What we've learned

- The Project would be regulated by the robust regulatory frameworks and an Impact Assessment would be completed.
- NWMO is confident that a deep geological repository could be constructed at the South Bruce Site in a manner that would provide safe long-term management for Canada's used nuclear fuel.
- Safety assessment for the operations will be advanced along with the facility design
- It is expected that the potential radiological effects during post-closure would be less than during operations.

Questions?