Safe and Secure Transportation of Canada's Used Nuclear Fuel

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nwmo
NUCLEAR WASTE MANAGEMENT ORGANIZATION
SOCIÉTÉ DE GESTION DES DÉCHETS NUCLÉAIRES

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Highlights

SAFE AND SECURE TRANSPORTATION OF USED NUCLEAR FUEL IS A PRIORITY

The transportation system is an important component of Canada's plan for the long-term management of used nuclear fuel. For a potential site for Canada's used fuel repository to be considered technically feasible, it must be accessible by safe and secure routes for the transportation of used nuclear fuel from interim storage facilities in Canada.

TRANSPORTATION IS SUBJECT TO ROBUST REGULATION AND OVERSIGHT

Stringent regulatory requirements must be met before used nuclear fuel is transported. Transportation of used nuclear fuel is regulated by the Canadian Nuclear Safety Commission (CNSC) and Transport Canada. Used nuclear fuel shipments will meet the International Atomic Energy Agency's (IAEA) safeguard requirements to ensure they are secure. Transportation operations will meet federal, provincial, and local safety legal requirements, and will be inspected for compliance. The Nuclear Waste Management Organization (NWMO) will need to demonstrate to regulatory authorities the safety and security of a transportation system before the shipments of used fuel can begin.

TRANSPORTATION PLANS WILL BE DESIGNED TO REFLECT THE INTERESTS OF CITIZENS

As part of the site selection process for the used nuclear fuel repository, the NWMO will identify preferred transportation modes and potential routes associated with each site under consideration. Decisions regarding the appropriate transportation routes and modes will require engagement and input in the planning process from all groups that are potentially affected by future transportation and have questions or concerns to be addressed in the process.

THERE IS A STRONG INTERNATIONAL TRACK RECORD IN TRANSPORTING USED NUCLEAR FUEL SAFELY

Transportation of radioactive material is a well-established practice. Over 50 years, there have been more than 20,000 shipments worldwide of used nuclear fuel, using road, rail and water transport. Canada has proven, and continues to demonstrate, its ability to safely transport used fuel, with hundreds of shipments made since the 1960s. Internationally and in Canada, there have been no serious injuries, health impacts, fatalities or environmental consequences attributable to the radiological nature of used nuclear fuel shipments.

1 Introduction

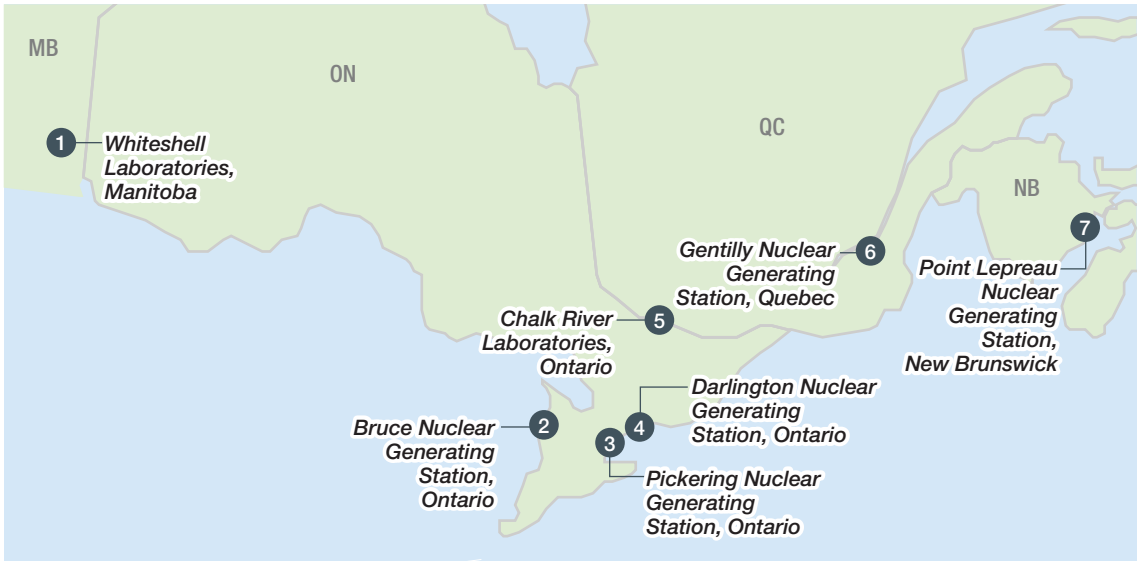
This brochure provides an overview of the transportation activities associated with Canada's plan to manage the used nuclear fuel that is created through electricity generation.

The Nuclear Waste Management Organization (NWMO) was established in 2002 by Canada's nuclear electricity producers in accordance with the *Nuclear Fuel Waste Act* (*NFWA*). Its mandate is to develop and implement collaboratively with Canadians an approach for the long-term management of Canada's used nuclear fuel that is socially acceptable, technically sound, environmentally responsible and economically feasible.

The *NFWA* requires nuclear fuel waste producers to establish trust funds to finance the long-term management of used nuclear fuel. In accordance with the legislation, Ontario Power Generation, Hydro-Québec, New Brunswick Power Corporation, and Atomic Energy of Canada Limited (AECL) established trust funds in 2002, and began making annual contributions to those funds. These funds will be used to cover all aspects of Canada's plan, including transportation of the used nuclear fuel.

Canada's used nuclear fuel is now safely stored on an interim basis in licensed facilities at reactor sites. These sites are located in Ontario, Quebec and New Brunswick, as well as at AECL's nuclear research facilities in Ontario and Manitoba.

The NWMO's responsibility includes designing and developing a transportation system for the safe, secure delivery of used nuclear fuel from current interim storage locations to a centralized deep geological repository.



Canada's seven nuclear sites

2 Working Together to Ensure Safe Transportation of Used Nuclear Fuel

The long-term management of used nuclear fuel is a responsibility we all share. Canada's plan for the long-term management of used nuclear fuel involves transporting used fuel from current storage facilities to a centralized site. Plans for transporting used nuclear fuel need to ensure people and the environment are safe at all times. The Nuclear Waste Management Organization (NWMO) transportation program includes technical aspects to meet regulatory requirements, as well as public engagement to understand and address public priorities, questions and concerns. We invite you to be involved.

The site for a deep geological repository has not yet been selected, and used fuel transportation will not begin for several decades. Nonetheless, conversations are beginning on how we should plan for used fuel transportation. With the help of this document to begin this conversation, we want to:

- Provide you with information regarding the safe and secure transportation of used nuclear fuel in Canada;
- Address questions we are hearing about the future transportation of used nuclear fuel required by Canada's plan; and
- Involve you in the conversation.

Join us at an open house or workshop in your area, visit NWMO specialists at an NWMO community office in your area, or visit the NWMO website to learn more or share your perspective.

3 What Is Canada's Plan?

Canada's plan for the long-term management of used nuclear fuel is known as Adaptive Phased Management (APM). This plan emerged from a three-year dialogue with Canadians between 2002 and 2005, and reflects best international practice and features considered important by citizens. The federal government selected APM as Canada's plan in June 2007.

The Nuclear Waste Management Organization's (NWMO) primary goal is safety – to protect people and the environment from highly radioactive used nuclear fuel. Used fuel will need to be contained and isolated from people and the environment essentially indefinitely. Planning is underway to provide safe, centralized containment and isolation of Canada's used nuclear fuel in a deep geological repository located in a suitable rock formation.

This facility will include the repository and a Centre of Expertise that will be a hub for national and international scientific collaboration.

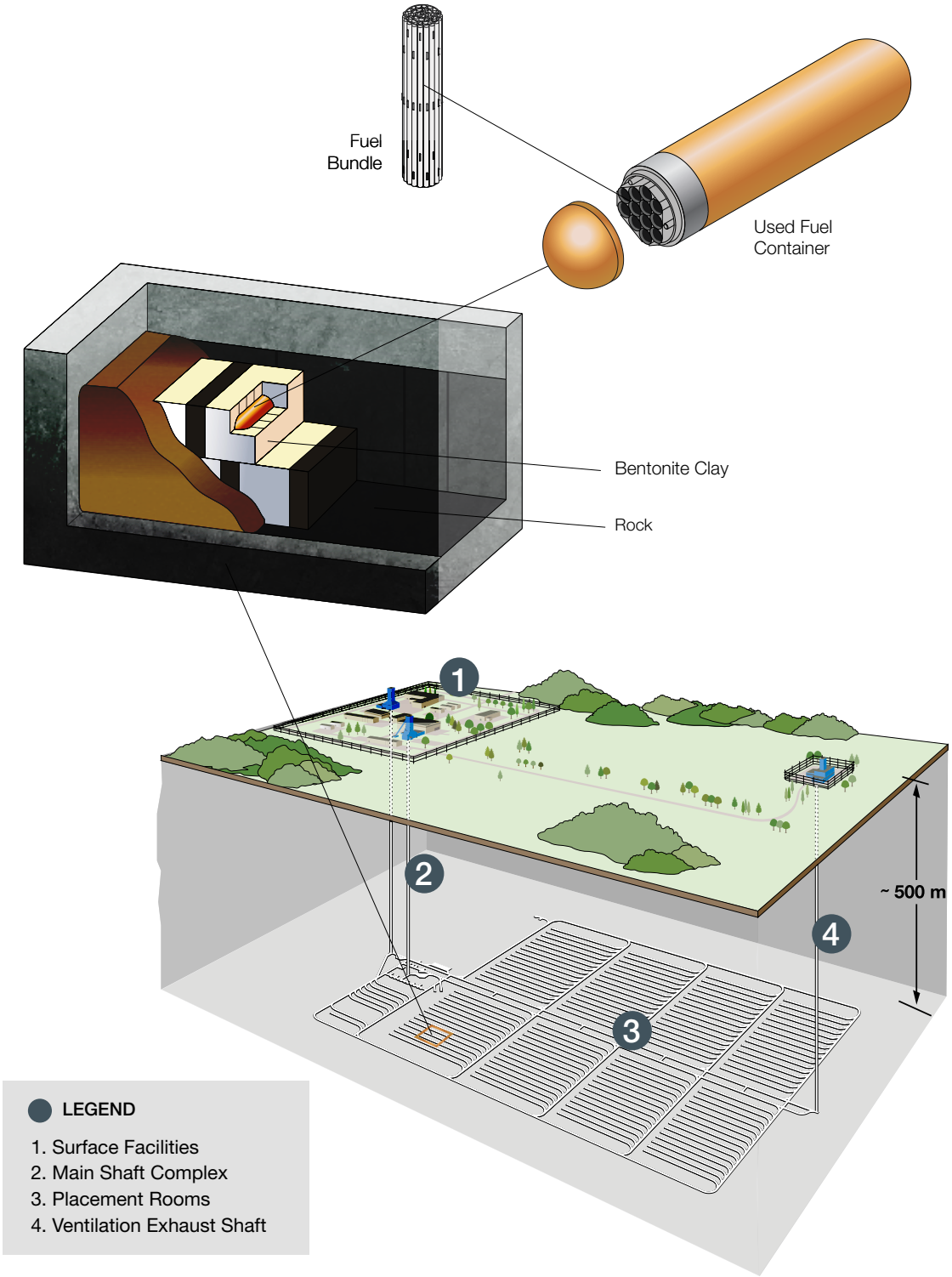
In accordance with Canada's plan, the NWMO is seeking an informed and willing host for the facility. The NWMO initiated a site selection process in May 2010 to identify a suitable location for the repository. The siting process requires a long process of learning and dialogue with communities and extensive technical assessments before a preferred site can be identified.

This large national infrastructure project will bring significant economic benefits to the area and province where it is implemented. The plan is designed to be implemented collaboratively with an area that has a suitable rock. The project will only proceed with the interested community, affected First Nation and Métis communities in the area, and surrounding communities working in partnership to implement it.

The NWMO is committed to meeting or exceeding all applicable regulatory standards and requirements for protecting the health, safety and security of people and the environment.

Transportation of used fuel is a regulated activity. Transportation of used fuel from seven interim storage facilities to the repository will require the Canadian Nuclear Safety Commission to issue a licence to transport used nuclear fuel and to operate the facility. For more information about APM and the project, please visit www.nwmo.ca.

Example of a Deep Geological Repository



4 Transportation Planning

The Nuclear Waste Management Organization (NWMO) will need to demonstrate to regulatory authorities and citizens the safety and security of a transportation system before the shipments of used nuclear fuel can begin.

For a potential site to be considered technically feasible for a repository site, a transportation route must be identified or be capable of development for transporting used nuclear fuel from interim storage facilities in Canada to the repository site.

If Canada's existing reactors operate to the end of their planned lives, including the planned refurbishment, the inventory of used fuel that will need to be shipped to the repository could be about 4.6 million bundles, depending on future operating experience. Canada's plan was developed for managing Canada's used nuclear fuel. No used fuel from outside Canada will be placed in the Adaptive Phased Management (APM) repository.

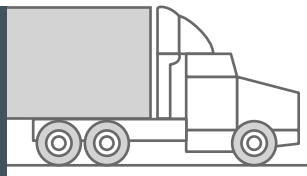
The NWMO has established a process for evaluating suitability of potential siting areas. This process includes assessing the transportation infrastructure associated with a siting area, including routes, connections and intermodal transfer points. The NWMO has begun the evaluation process for these areas, including the communities that expressed interest in learning more and other communities in the area. The first step is to use existing information sources to determine if the necessary transportation infrastructure exists or if that infrastructure can be developed. Subsequent evaluation steps will include more detailed exploration, and mode, route and logistics studies.

Over 50 years, there have been more than 20,000 shipments worldwide of used nuclear fuel, using road, rail and water transport. The NWMO is looking at road and railroad access from the interim storage sites to each of the potential host communities. Preliminary assessments suggest one or both of these modes appear to be potential options for used fuel transport in each of the areas involved in the site selection process.

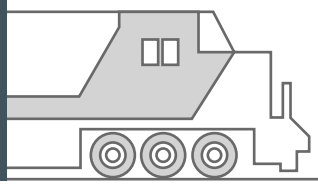
As part of the site selection process, the NWMO will identify preferred transportation modes and potential routes associated with each siting area under consideration. The process will include engagement with and input from communities and individuals with a shared interest in future transportation and that have questions or concerns to be addressed.

Average Number of Shipments per Year

The transportation program is expected to extend over approximately 38 years, based on current anticipated volumes from existing nuclear facilities.



620 shipments/year » 1 or 2 shipments/day » 1 container/truck



62 shipments/year » 1 shipment/6 days » 10 packages/train

Once the repository begins operation many years from now, used nuclear fuel will be delivered to the repository site at a rate that allows for emplacement in the repository as it is received. Options for shipments that use a combination of transportation modes may also be considered depending on the site selected to host the repository.

Once a site is selected, the NWMO will need to demonstrate the preferred mode and route will meet all regulatory requirements. The NWMO is committed to implementing a safe and secure transportation system and effective emergency preparedness in the event of an accident. The primary objective is to protect the public and environment, and to address the questions and concerns of citizens. This will include demonstrating:

A robust, tested and certified transportation package

Requirements are met for commercial vehicle and railroad safety and security

A Transportation Security Plan is in place

An Emergency Response Plan is in place

Requirements are met to obtain a licence to transport

Periodic reviews and audits are planned

To inform the planning process, Canada follows the International Atomic Energy Agency's guidance and standards, and monitors transportation programs for radioactive materials in the United Kingdom, Sweden, Germany, France, and the United States.

Following these international standards, the Canadian Nuclear Safety Commission (CNSC) and Transport Canada require the NWMO to demonstrate it has met all safety and security regulations before the CNSC will issue a licence for the shipment of used nuclear fuel to a repository (see Section 9, *Transportation Regulation and Oversight*). In addition to meeting the regulatory requirements noted above, the NWMO will also need to present its plans for safety practices, training and emergency response.

The NWMO recognizes that a safe and secure transportation program has many elements, including (in addition to the ones above):

High-quality and well-trained workers and vehicle operators

Safe operating practices, including protocols for bad weather and road conditions, safe parking, and route control

Training and joint exercises with provincial and community emergency responders

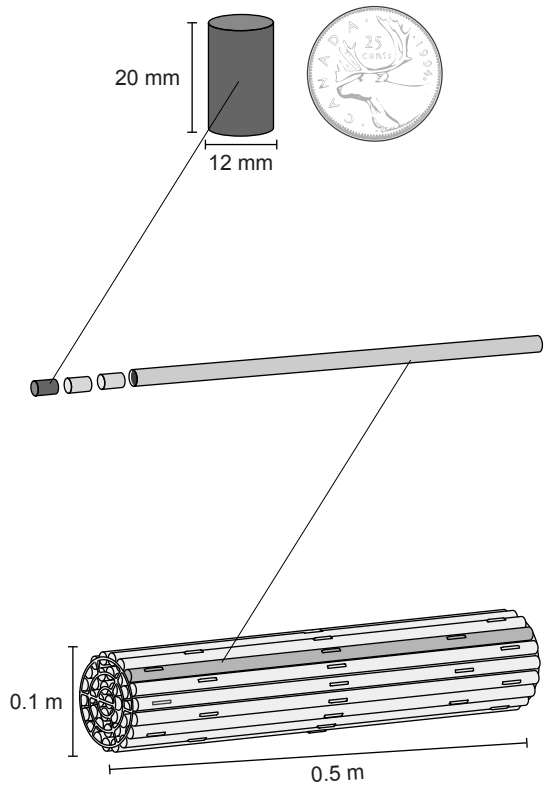
Informed and engaged public during planning and operating phases

APM program evaluation and improvement process

5 What Is Used Nuclear Fuel?

Used nuclear fuel is a by-product created when nuclear power plants generate electricity. It remains radioactive for a long period of time, and must be contained and isolated from people and the environment essentially indefinitely. Although its initial radioactivity level decreases rapidly with time, residual radioactivity (together with chemical toxicity) persists, and the used fuel will remain a potential hazard for a very long time. For this reason, used fuel requires careful management essentially indefinitely.

Used CANDU nuclear fuel is not a liquid or a gas – it is a stable solid. Under Canadian and international regulations, it is not classified as flammable, explosive or fissile material.



The Nuclear Fuel Pellet

Fuel pellets are made from uranium dioxide powder, baked in a furnace to produce a hard, high-density ceramic. Ceramics do not readily dissolve in water and are resistant to wear and high temperatures.

The Fuel Pencil

Fuel pellets are contained in sealed zircaloy metal tubes, called pencils. These are welded together into a cylindrical fuel bundle.

The Fuel Bundle

Each bundle is composed of fuel pencils and is made of a strong, corrosion-resistant metal, called zircaloy. Fuel bundles are roughly the size of a fire log and weigh approximately 24 kilograms. Before being loaded into a reactor, the radiation hazards associated with unirradiated fuel bundles are relatively low. Radiation dose from unirradiated fuel bundles is in the order of 0.05 mSv/h. When operational in a nuclear reactor, each fuel bundle can generate enough electricity to power up to 100 homes for a year.

For more information about this subject, please visit the Canadian Nuclear Safety Commission website at: www.nuclearsafety.gc.ca/eng/resources/radiation/index.cfm. The purpose of this section is to provide information on the basics of ionizing radiation.

Safely Managing the Hazard During All Phases of the Nuclear Fuel Cycle

When used nuclear fuel is removed from a reactor, it is highly radioactive. Although the radioactivity decreases with time, used fuel will remain a potential health risk for many hundreds of thousands of years. This hazard needs to be appropriately managed.

The radioactivity of used fuel initially drops quickly once it is removed from the reactor. More than 99 per cent of the radioactivity decays after 10 years. It continues to decay with time.

Canada has a robust regulatory framework that governs the handling of used nuclear fuel. Used nuclear fuel is carefully managed and shielded at all times to ensure no one is exposed to an unshielded bundle. In Canada, used fuel has been safely managed for several decades in many types of nuclear facilities. At the reactor sites, fuel is safely cooled, contained and shielded in storage pools. At the interim waste management facilities, this containment and shielding is achieved using large storage containers made of concrete and steel. Both water and concrete are effective barriers to radiation. In transit, the robust transport package is designed to contain and shield the used fuel. And eventually, it will be safely contained and isolated in a deep geological repository with multiple natural and engineered barriers.

The measures used to protect people and the environment from radiation hazards are to limit exposure time, maximize distance and provide adequate shielding. These measures are incorporated into all stages of the management of used fuel, including transportation.

6 How Is It Currently Stored?

Used nuclear fuel is stored on an interim basis in either wet storage in pools or in dry storage containers at reactor sites.

When used nuclear fuel is removed from a reactor, it is considered a waste product. It is radioactive and requires careful management. The used fuel is first placed in a specially designed water-filled pool at the reactor site where its heat and radioactivity decrease. After seven to 10 years, it can either remain in wet storage, or in some locations, it is moved to and safely managed in dry storage facilities licensed for interim use at each reactor site. Each nuclear power reactor site has a Canadian Nuclear Safety Commission-licensed radioactive waste management facility for the safe dry storage of used nuclear fuel. These facilities are monitored to ensure no impact on the public and environmental safety, and to confirm they meet all requirements for national and international security agreements.

Currently in Canada, there are approximately 2.5 million used fuel bundles being safely stored in water-filled pools or dry storage concrete containers, silos or vaults.

Used nuclear fuel storage in wet bay – the water keeps fuel bundles cool and provides an effective radiation shield.

Ontario Power Generation used nuclear fuel dry storage facility

Point Lepreau dry storage silos

Gentilly-2 dry storage vaults

7 The Key to Ensuring Safety: Used Fuel Transportation Packages

Safety is built into every element of the nuclear transport system, beginning with the transportation package design. Used nuclear fuel transportation packages are designed and tested to ensure protection of the public during normal operations, as well as during accident conditions. The Canadian Nuclear Safety Commission (CNSC), using internationally tested standards, has the responsibility for evaluating the transportation package and certifying its design, the registration of the use of individual packages, and monitoring the package maintenance process.

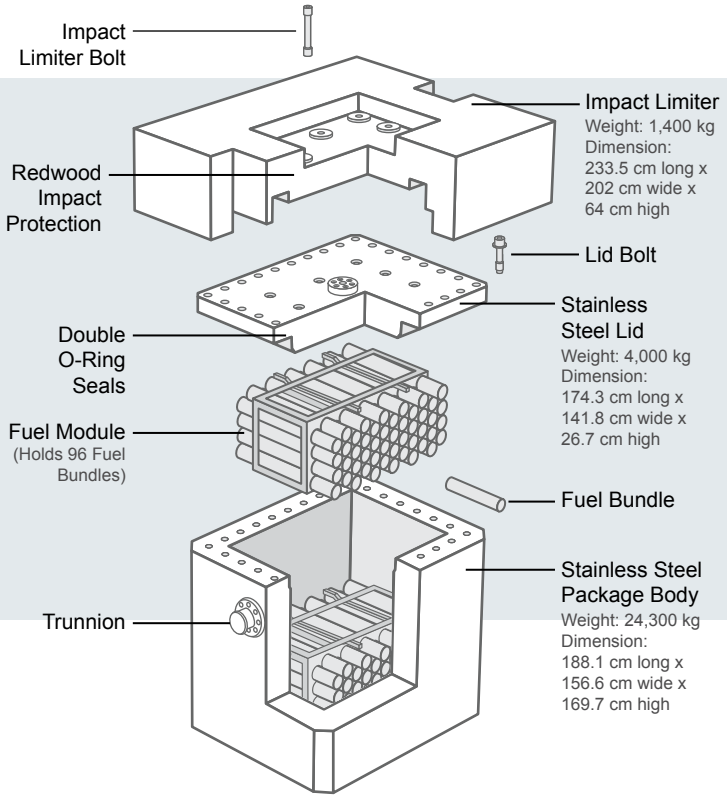
There are several used nuclear fuel transportation packages certified for use in Canada, including the Used Fuel Transportation Package (UFTP) and the Dry Storage Container Transportation Package (DSC-TP), shown in the figures on page 15. Before a transportation package can be used in Canada, the design must be certified by the CNSC to meet regulatory requirements, which incorporate international safety standards. The requirements include tests designed to demonstrate the ability of the package to withstand severe impact, fire and immersion.

When all the requirements for design and testing are met, the CNSC issues a certificate for the package design. The certificate specifies procedures for the manufacture, operation and maintenance of the transportation package. It also defines the authorized contents that may be carried in the package. The certificate is valid for five years. At the end of this period, the Nuclear Waste Management Organization (NWMO) will have to apply for recertification and renewal of the package's certification.

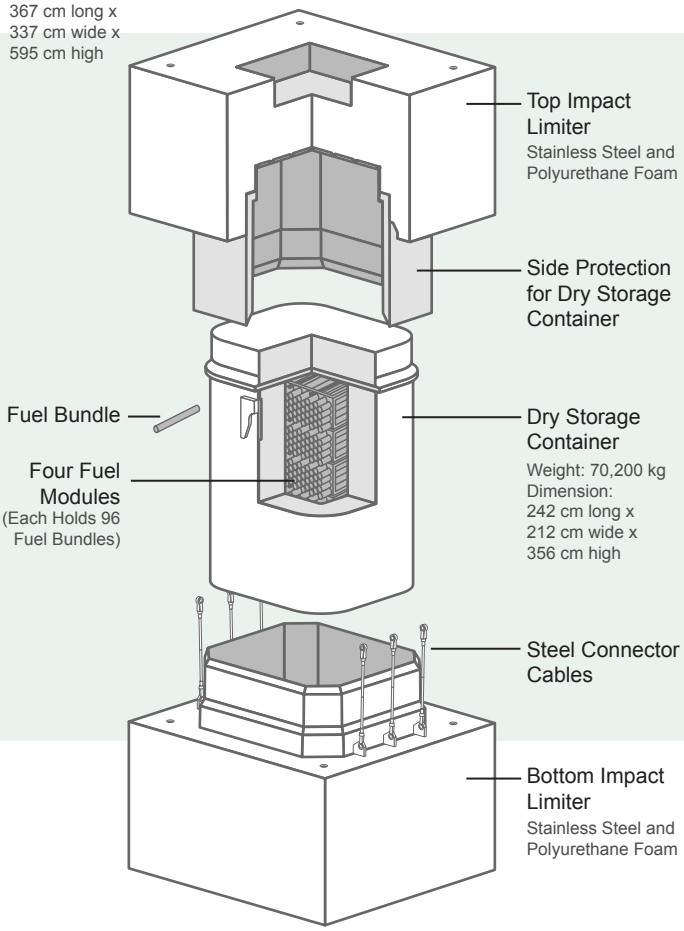
The NWMO is assessing the transportation of used fuel using the certified UFTP and DSC-TP designs.

Used Fuel Transportation Package

The UFTP consists of three main components: the body, lid and impact limiter. The body and lid are made of solid stainless steel with walls nearly 30 centimetres thick. The lid is attached to the body by 32 bolts. The impact limiter consists of a redwood core encased in a stainless steel skin. The stainless steel body and lid provide containment, shielding and impact resistance. The impact limiter is designed to protect the body and lid closure in the event of an accident. The reusable package can carry 192 used fuel bundles and weighs almost 35 tonnes when loaded.



Dry Storage Container Transportation Package
Weight: 100,300 kg
Dimension:
367 cm long x
337 cm wide x
595 cm high



Dry Storage Container Transportation Package

Used nuclear fuel is currently stored on an interim basis in dry storage containers (DSC) at Ontario Power Generation Waste Management Facilities. The DSC-TP consists of a DSC fitted with impact limiters on each end.

The DSC consists of a body and lid made of high-density concrete encased in a carbon steel skin. The DSC body and lid are welded closed after being filled with used fuel. The reusable impact limiters consist of stainless steel shells filled with rigid polyurethane foam. The impact limiters are fastened together using steel cables. The DSC provides containment and shielding, and the impact limiters are designed to protect the DSC in the event of an accident. The DSC can carry 384 used fuel bundles and weighs approximately 100 tonnes when loaded.

The UFTP and DSC-TP are designed, tested and certified to retain their contents during normal operations and in the event of an accident.

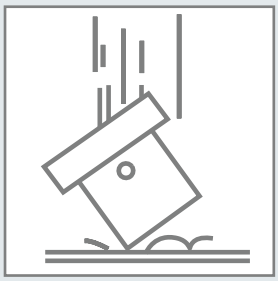
The CNSC uses a three-part process for ensuring safe and secure transportation of used nuclear fuel.

1. The CNSC issues a certificate for the design.
2. The CNSC registers users for the package.
3. The CNSC issues a licence to transport.

The certificate for the package design is based on it meeting a number of requirements, including demonstrating its ability to withstand accident conditions without releasing its contents. The regulations (*Packaging and Transport of Nuclear Substances Regulations* and International Atomic Energy Agency (IAEA) *Regulations for the Safe Transport of Radioactive Material*) allow computer-simulated, scale-model or full-scale–model testing to demonstrate a transportation package's suitability for certification. A combination of scale-model and computer-simulated tests were used for the UFTP and DSC-TP.

To gauge the cumulative effects on the transportation package design, the first two tests described below are conducted in the sequence that will result in the most damage to the package, followed by the thermal test.

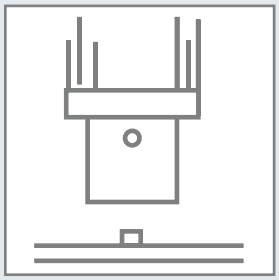
Free-Drop Test



The package is dropped from nine metres (30 feet) onto a flat, unyielding surface (such as a steel-reinforced concrete pad), striking the surface in the orientation that will result in the most damage to the package.

This test determines the performance of the package when it experiences loads comparable to the most severe potential transportation collision. The loads associated with this test are many times higher than those experienced when a train travelling at 160 kilometres an hour collides with the transportation package. A detailed analysis is available in the NWMO technical report: *Why the Nine Metre Drop Test Bounds the Impacts from Most Severe Accidents* (NWMO TR-2014-04).

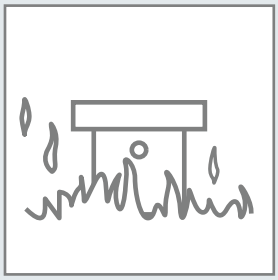
Puncture Test



After the drop test, the same package is subjected to a one-metre (40-inch) free drop onto a 15-centimetre (six-inch) diameter steel bar at least 20 centimetres (eight inches) long.

While the free-drop test simulates an impact that is spread over a larger area, this test looks at what would happen in a collision with a sharp object. The test demonstrates that the container will not puncture.

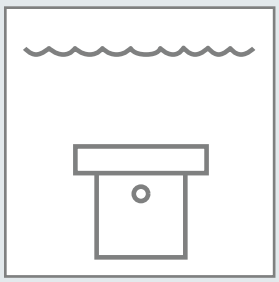
Thermal Test



The same package used in the drop and puncture tests is then subjected to a fully engulfing petroleum fire. The fire temperature must reach 800 degrees Celsius (1,475 degrees Fahrenheit) for 30 minutes.

This test mimics the conditions of a potential severe accident involving flammable liquids near a package. The fire must fully engulf the package for the entire test. The flame must reach 800 degrees Celsius, which is typical of a hydrocarbon fire. In real accidents, fires involving flammable liquids generally do not burn for 30 minutes because the supply of fuel dwindles and the fire location shifts.

Immersion Test



Using either computer analysis or physical testing methods, the package is subjected to external pressure that is the same as if it were immersed under 15 metres (50 feet) of water for at least eight hours to test for leakage. The package is also subjected to an enhanced water immersion test at 200 metres (650 feet) to test its ability to withstand extreme external pressures.

Water bodies near most bridges, roadways or harbours are less than 15 metres deep. The eight-hour period is sufficient to allow the submerged package to come to a state where its conditions will not change, regardless of the length of time required to remove it. The enhanced immersion test (200 metres) considers the unlikely possibility of a package sinking at particularly deep locations, such as some points on the continental shelf. It subjects the package to maximum pressure.

Demonstration Trials Over the Years

Well beyond the scope of these regulatory requirements, over the years, used nuclear fuel transportation packages that meet the same requirements as the UFTP and DSC-TP have been subjected to extreme demonstration trials.

For example:

- An independent, full-scale test with working rail cars in 1984 by the United Kingdom's Central Electricity Generating Board showed that a package designed to meet IAEA requirements could successfully withstand being rammed by a train travelling at 160 kilometres an hour.

- In 1999, the German Federal Institute for Materials Research and Testing exploded a propane-filled rail tank car next to a nuclear waste transportation cask. The exploding rail car directly hit and overturned the cask, which embedded itself into the ground about 10 metres away. The contents were fully contained with only superficial scarring of the package.

In all tests, the transportation packages survived the demonstration intact without releasing its contents.

Ongoing NWMO Activities

The NWMO will continue to test package performance under multiple conditions and research evolving technologies to optimize package design and performance.

8 Managing Risks

The Nuclear Waste Management Organization (NWMO) must demonstrate that transportation of used nuclear fuel from interim storage locations to the final repository site will be safe and that the public and the environment will be protected at all times.

Radiation is found in many forms. People are exposed to natural background radiation every day from the ground, building materials, air, food, outer space (cosmic rays), and even from elements occurring naturally in the body.

The amount of radiation to which an individual is exposed is commonly referred to as a radiation dose. The Canadian Nuclear Safety Commission (CNSC) *Radiation Protection Regulations* have set an annual radiation dose limit of 1 milliSievert (mSv) per year for members of the public to limit exposure from nuclear-related activities. This radiation dose is about half of the average background radiation dose received by Canadians (1.8 mSv per year).

The CNSC *Radiation Protection Regulations* also establish effective dose limits for nuclear energy workers. These regulations set an annual dose limit of 50 mSv per year and a maximum of 100 mSv over a five-year period.

The CNSC uses epidemiology studies and international understanding of radiation to ensure its regulations appropriately protect Canadians. The CNSC and other regulatory bodies set dose limits and regulations that limit exposure.

The following table shows limits and possible health effects from radiation.

What Is a mSv?

A milliSievert is one thousandth of a Sievert, a unit of dose that reflects the relative biological effects of various types of radiation.

Dose	Limit or Health Effect
More than 5,000 mSv	Dose which may lead to death when received all at once
1,000 mSv	Dose which may cause symptoms of radiation sickness (e.g. tiredness and nausea) if received within 24 hours
100 mSv	Lowest acute dose known to cause cancer
30–100 mSv	Radiation dose from a full-body computed axial tomography (CAT) scan
50 mSv	Annual radiation dose limit for nuclear energy workers
1.8 mSv	Average annual Canadian background dose
1 mSv	Annual public radiation dose limit
0.1–0.12 mSv	Dose from lung X-ray
0.01 mSv	Dose from dental X-ray
0.01 mSv	Average annual dose due to air travel

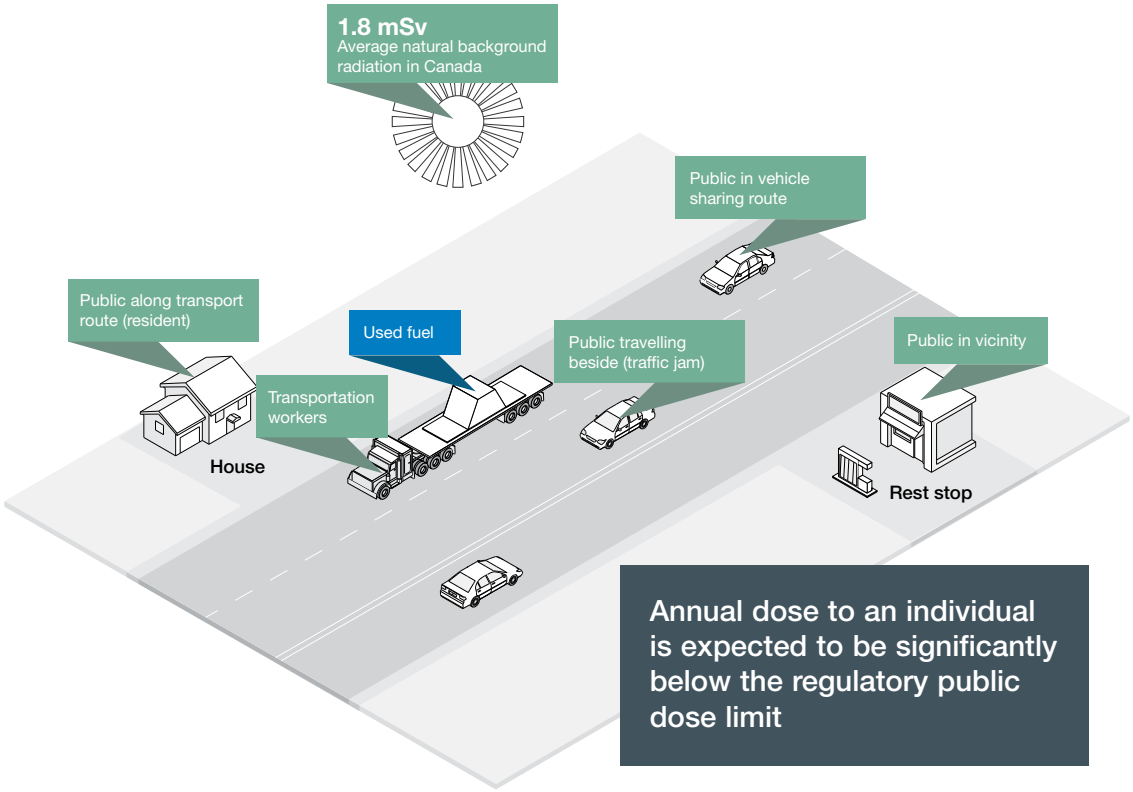
Source: CNSC website – Radiation Health Effects
www.nuclearsafety.gc.ca/eng/resources/radiation/introduction-to-radiation/radiation-health-effects.cfm

Radiation Dose to the Public During Transportation

Before any shipment of used fuel is authorized by the regulatory authorities for either the Used Fuel Transportation Package (UFTP) or the Dry Storage Container Transportation Package, the NWMO will have to demonstrate that potential exposure to members of the public along the transportation routes is below the regulatory limit (1 mSv per year).

Considering the annual number of shipments that are planned and the current design of the UFTP, potential exposure to individuals along the transportation routes is expected to be lower than the regulatory limit.

A recent generic study was conducted to determine the potential exposure to individuals along transportation routes using the UFTP. The study considered individuals including residents living along or in the vicinity of the transport route, people sharing the transport route, and people at rest stops along the route. The annual dose to these people is expected to be lower than the regulatory public dose limit.



Radiation Dose to Transportation Workers

Building on the public dose assessment, a further study provided a generic assessment of the potential occupational dose to transportation workers involved in used fuel transportation using the UFTP.

Transportation activities assessed in this study focused on worker activities from the time a used nuclear fuel shipment leaves the interim storage facilities to its arrival at the repository site. The study showed doses to workers would be lower than the regulatory public dose limit of 1 mSv per year.

9 Transportation Regulation and Oversight

In Canada, the safe, secure movement of radioactive materials is jointly regulated by the Canadian Nuclear Safety Commission (CNSC) and Transport Canada.

The CNSC regulates the transport of radioactive material through the *Packaging and Transport of Nuclear Substances Regulations* (*PTNSR*).

The *PTNSR* include a series of safety-based regulatory requirements covering the entire journey of a shipment, from the time it is initially packaged to arrival at its destination. Regulatory control of packaging and transport of used nuclear fuel is managed by:

- Setting transportation package performance requirements;
- Certifying transportation package designs;
- Registering all users of certified transportation packages;
- Establishing and enforcing the radiation protection program for the carriers;
- Issuing a Licence to Transport used nuclear fuel only when the Emergency Response Plan and Transportation Security Plan have been established and approved;
- Providing duty officers 24-7 for any emergency;
- Investigating accordingly in the event of an incident or emergency;
- Overseeing all aspects of physical security measures; and
- Performing compliance inspection.

Prior to transporting used fuel in Canada, the CNSC's comprehensive regulatory framework requires a certificate for the transport package and a licence to transport. The CNSC evaluates applications to ensure that safety and security measures are technically and scientifically sound, that all requirements are met, and that the appropriate safety provisions are in place to protect people and the environment. Elements of a transportation program covered in this evaluation include:

- Training of workers and emergency responders;
- Maintenance of a radiation protection program;
- Management of an emergency response plan;
- Maintenance of security measures;
- Maintenance of records; and
- Adherence to all regulatory requirements.

A CNSC fact sheet called *Regulating the Packaging and Transport of Nuclear Substances in Canada* is available at www.nuclearsafety.gc.ca.

The CNSC also provides frequently asked questions about the transportation of used nuclear fuel on its website.

The *PTNSR* are derived from the standards published by the International Atomic Energy Agency (IAEA). More information on the IAEA is available at www.iaea.org.

Transport Canada's *Transportation of Dangerous Goods Regulations* establish requirements for training, emergency planning, safety marks, and documentation.

Transport Canada's responsibilities for the shipment of radioactive materials include:

- Establishing and enforcing transportation requirements for the consignors and carriers;
- Establishing requirements and undertaking compliance inspections for areas such as training and documentation; and
- Setting and enforcing requirements for Emergency Response Assistance Plans.

Transport Canada's Canadian Transport Emergency Centre (CANUTEC) is a national advisory service that assists emergency response personnel in handling dangerous goods emergencies on a 24-7 basis. The emergency centre is staffed by bilingual scientists specializing in chemistry or a related field and trained in emergency response. The emergency response advisors are experienced in interpreting technical information from various scientific sources including Material Safety Data Sheets (MSDS) in order to provide pertinent and timely advice.

Transport Canada's regulations for the transportation of dangerous goods have been adopted at the provincial and territorial levels through agreements.

Provincial governments/regulators/ministries are responsible for enforcing provincial statutes and inspection, or responding to a transportation incident involving radioactive material.

Regulatory Framework

Transport Canada / Transports Canada

Provincial / Territorial Dangerous Goods Transportation Acts

Transportation of Dangerous Goods Act

Transportation of Dangerous Goods Administrative Agreements Province/Territory – Canada

Transportation of Dangerous Goods Regulations

Canadian Nuclear Safety Commission / Commission canadienne de surete nucleaire

Nuclear Safety and Control Act

General Nuclear Safety and Control Regulations

Nuclear Security Regulations

Packaging and Transport of Nuclear Substances Regulations

Regulations for the Safe Transport of Radioactive Material (TS-R-1)

IAEA International Atomic Energy Agency

10 The NWMO's Roles and Responsibilities

The Nuclear Waste Management Organization (NWMO) will have overall responsibility for the safe transportation of used nuclear fuel from the current interim storage locations to the deep geological repository. The Canadian Nuclear Safety Commission (CNSC) and Transport Canada are responsible to ensure regulations are followed.

Communication

The NWMO will operate a central command centre that will provide a single point of contact for all agencies involved in transportation-related communications. The centre will allow for quick access to shipment information, including vehicle driver location, weather, traffic, and routing, and will enable communication with the driver, security personnel, and if needed, regulatory agencies and emergency responders, including Transport Canada, CANUTEC (Transport Canada's Canadian Transport Emergency Centre) and the CNSC.

Communication will be in place throughout the transport of the used fuel in accordance with the Transportation Security Plan. This includes communication among the:

- Transportation command centre;
- Security escort accompanying the used fuel;
- Sites from which the shipment originated;
- Repository site; and
- All emergency response command centres of provinces through which the shipments will transit.

In the event of an incident, the transport command centre would be notified. Upon notification, the transport leader on duty would contact the emergency response command centre of the province in which the incident took place. The provincial emergency response command centres would communicate with emergency response teams along the transportation route.

Emergency Response

The NWMO will provide an emergency response plan to the CNSC, Transport Canada and the provinces, ensuring that information is correct and available to relevant public emergency response agencies. The NWMO will also assist response agencies with developing their emergency plans for used nuclear fuel, as required.

The purpose of the emergency response plan is to enhance the co-ordination among the NWMO, provincial and local first responders, leaders of affected communities, and federal agencies. According to the Emergency Management Framework for Canada (2nd edition – January 2011), all levels of government may be asked to participate in emergency management. Provincial governments and local administrations and authorities will be responsible for the response services. Federal organizations may provide additional resources at the request of the province/municipality.

In collaboration with the provinces, the NWMO will co-ordinate its planning, provide used fuel specific training, and conduct exercises along the designated routes. Exercises are a tool to train, enhance communications, and co-ordinate, as well as improve, emergency response programs. Exercises may include full-scale, as well as desktop exercises, to evaluate the integrated performance of the system. In the interest of ensuring maximum safety in transportation incident conditions, the NWMO is committed to robust emergency preparedness with response plans and procedures being rigorously tested through multi-layered training, inter-agency communications, and process and joint exercises.

In Canada, the emergency management community has adopted an all-hazards approach for responding to major disasters or emergencies, regardless of cause. Federal, provincial and local governments have adopted a comprehensive approach to emergency management, which includes balanced efforts across prevention, mitigation, preparedness, response and restoration activities. The NWMO will work in collaboration with provincial and local governments to ensure training and equipment for first responders meet required standards along the transportation route. The NWMO will follow this process as it plans and prepares along routes for the shipment of used nuclear fuel.

Security Considerations

The NWMO is responsible for the development of the transportation security plan. The primary purpose of the plan is to ensure that the used nuclear fuel will receive adequate physical protection against any credible threats that may arise during transport. Risks will be continually reassessed to ensure security measures are appropriate for specific circumstances.

Security measures are aimed at preventing diversion or sabotage of the transportation package, and include a combination of engineered, physical and monitoring measures to protect the cargo, and provide for detection, alarm, recording, and communication, in the event of an occurrence. Security provisions during transportation are designed to ensure that used fuel will receive adequate protection against credible threats and will comply with Section 5 of the *Nuclear Security Regulations* as prescribed by the CNSC.

Transportation Security Plans will be maintained current and may be subject to periodic review by the CNSC to ensure they address current threat levels.

CNSC regulations require that specific security measures be addressed for the transport of used fuel, including:

- Shipments must have a security escort and constant surveillance;
- A Transportation Security Plan for shipments of used fuel must be submitted. A plan is prepared to detail proposed security measures and arrangements for the shipment;
- Security measures such as escort personnel, communication arrangements to contact response services, safety inspections prior to shipment, contingency arrangements in case of delay or mechanical breakdown, and procedures to be followed during scheduled stops or unscheduled delays must be included;
- A safety, threat and risk assessment must be carried out by competent public and private organizations in order to identify potential risks and areas for improvement, as well as possible mitigation measures, and in order to identify any credible risks; and
- The CNSC has provided guidance related to what information is to be safeguarded for the security and safety of shipments. All information pertaining to security measures and arrangements for this type of shipment is considered sensitive information and would not be disclosed to the public. Prescribed information would be provided only to persons or agencies with a valid need to know, such as police response forces.

11 International Experience

Many countries are developing plans for or proceeding with programs for the long-term management of used nuclear fuel or other radioactive materials. There is a great deal of experience in their safe movement, both in Canada and around the world.

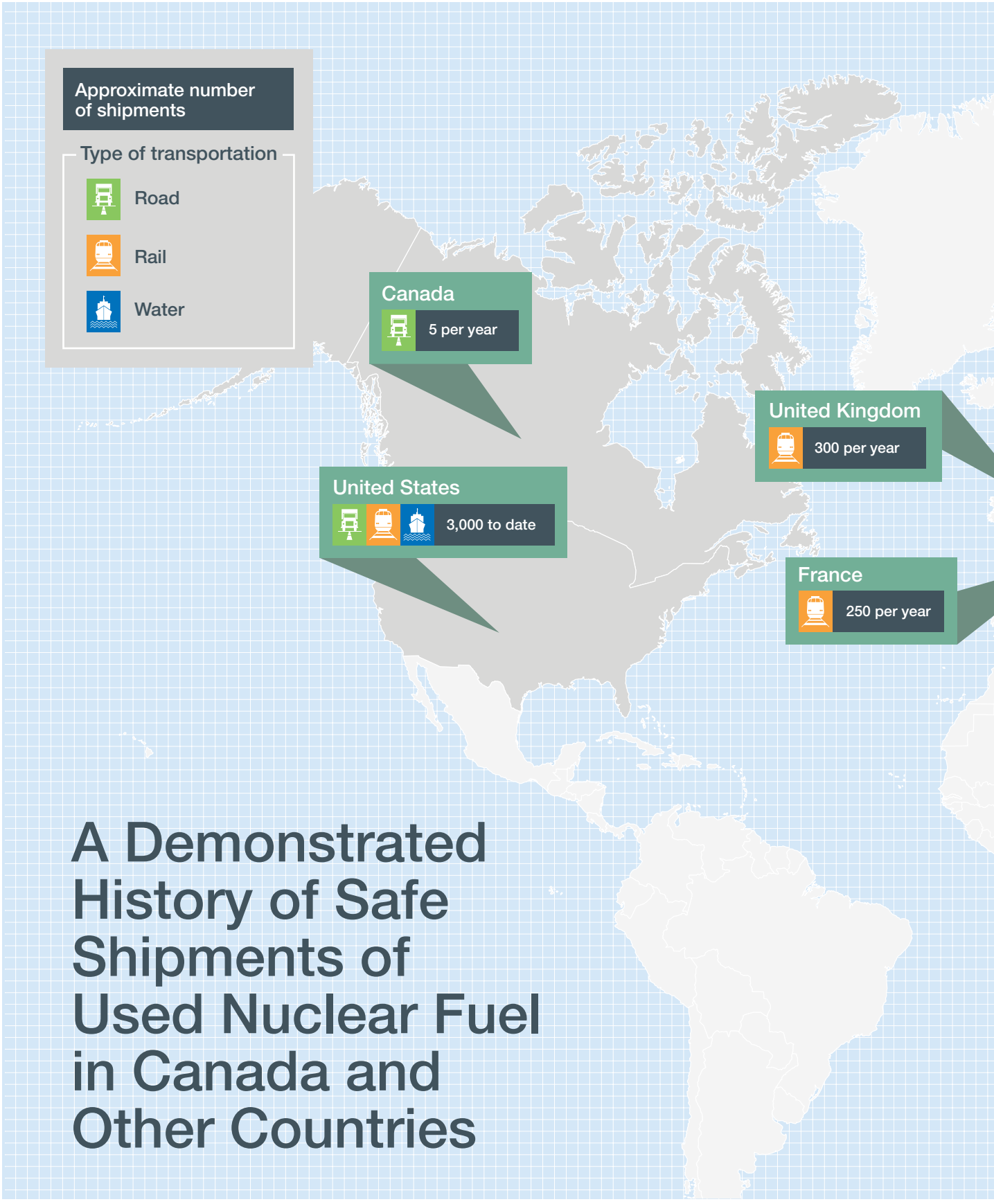
In over 50 years, internationally and in Canada, there have been no serious injuries, health impacts, fatalities or environmental consequences attributable to the radiological nature of used nuclear fuel shipments.

Governments, regulators and commercial organizations in Canada and around the world have extensive experience in the safe, secure transportation of radioactive materials. Canada transports about one million packages of radioactive materials each year. Since the 1970s, Canada has transported approximately five used fuel shipments annually from nuclear generating stations to Atomic Energy of Canada Limited's Chalk River Laboratories for research and post-irradiation examination.

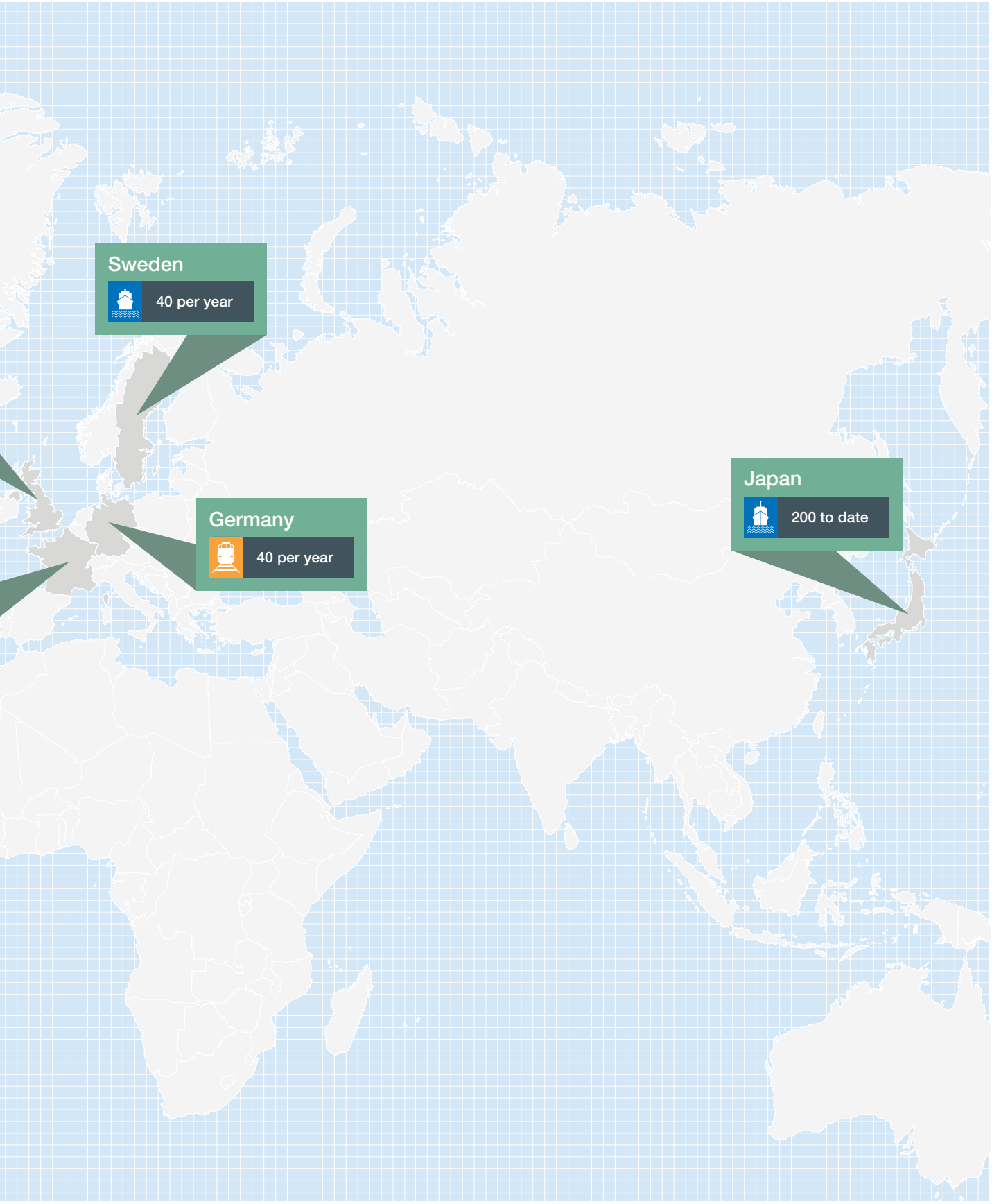
The International Atomic Energy Agency, government agencies, and independent experts in many countries, most notably the United States, the United Kingdom, Europe, and Japan, have regularly examined and researched safety issues related to radioactive substance transport.

In the United States, nearly 3,000 shipments of commercial used fuel have been moved over 2.5 million kilometres in the last 40 years, mostly over roads and some by rail. The United Kingdom and France transport a combined average of 550 shipments of high-level radioactive waste every year, primarily by rail. Sweden makes approximately 40 shipments per year by water, while Japan has made approximately 200 shipments by water.

Courtesy of World Nuclear Transport Institute



A Demonstrated History of Safe Shipments of Used Nuclear Fuel in Canada and Other Countries


Sweden
40 per year
Germany
40 per year
Japan
200 to date

12 Resources

Relevant publications, websites and videos

Nuclear Waste Management Organization: www.nwmo.ca

- Transporting Canada's Used Nuclear Fuel
- Implementing Adaptive Phased Management
- One-stop access to annual reports, videos, brochures and more
- Safely Managing Used Nuclear Fuel in Canada
- Generic Public Dose Assesment
- Worker Dose Assessment
- Step 3, Phase 1 Preliminary Assessments: Chapter 6 – Preliminary Assessment of Transportation

Canadian Nuclear Safety Commission: www.nuclearsafety.gc.ca

- Radiation Health Effects
- Regulating the Packaging and Transport of Nuclear Substances in Canada
- Frequently asked questions on the transportation of used nuclear fuel
- Regulatory Guide on Transportation Security Plans for Category I, II or III Nuclear Material (G-208)

Transport Canada: www.tc.gc.ca

- Emergency Preparedness

International Atomic Energy Agency: www.iaea.org

- Transport of radioactive material

World Nuclear Transport Institute: www.wnti.co.uk

For more information, please contact:

Nuclear Waste Management Organization (NWMO)

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NUCLEAR WASTE MANAGEMENT ORGANIZATION

SOCIÉTÉ DE GESTION DES DÉCHETS NUCLÉAIRES