



NUCLEAR WASTE
MANAGEMENT
ORGANIZATION

SOCIÉTÉ DE GESTION
DES DÉCHETS
NUCLÉAIRES

Safe and Secure Transportation of Canada's Used Nuclear Fuel

Questions and Answers

MAY 2015

The Nuclear Waste Management Organization (NWMO) was established in 2002 by Canada's nuclear energy producers in accordance with the *Nuclear Fuel Waste Act*. 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 NWMO's responsibility includes the design and development of a transportation system for the safe, secure delivery of used nuclear fuel from current interim storage locations to a centralized deep geological repository.

In May 2010, the NWMO initiated a site selection process to identify a suitable location for that repository. The process involves extensive community engagement and technical assessments before a site can be selected. It is expected to take several more years to complete the necessary studies to identify a preferred site and an informed and willing host.

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 and Transport Canada. Used nuclear fuel shipments will meet the International Atomic Energy Agency's 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.

For more information about safe, secure transportation of Canada's used nuclear fuel, refer to *Safe and Secure Transportation of Canada's Used Nuclear Fuel* at www.nwmo.ca/brochures. For a video overview, go to www.nwmo.ca/videos.

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Public Safety

Highlights

- » Safety is built into every element of the system for transporting used nuclear fuel, beginning with the design of the transportation package.
- » Packages are engineered to withstand extreme conditions without releasing their contents.
- » Transportation of used nuclear fuel is jointly regulated by the Canadian Nuclear Safety Commission (CNSC) and Transport Canada, and regulations reflect stringent standards set by the International Atomic Energy Agency (IAEA).

Questions and Answers

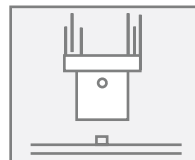
How durable is the package that is used to transport used nuclear fuel?

Used nuclear fuel transportation packages are designed and tested to ensure protection of the public during normal operations, as well as during accident conditions. 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, and must withstand severe impact, fire and immersion.

A free-drop test from nine metres onto an unyielding surface, such as a thick concrete pad



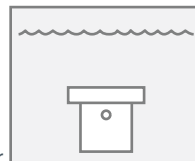
A puncture test onto a steel bar from a height of one metre



A thermal test at 800 degrees Celsius for 30 minutes

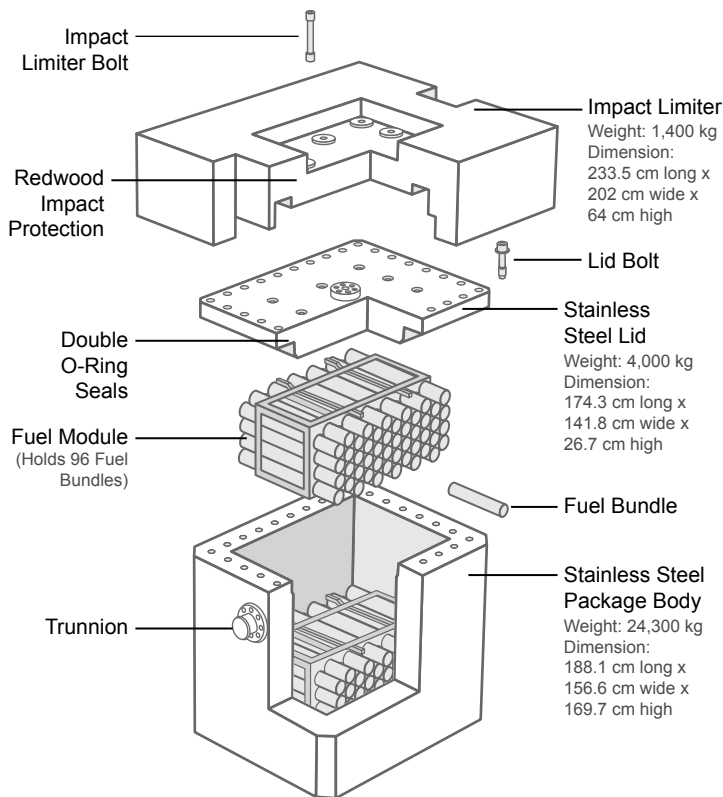


An immersion test equivalent to a depth of 15 metres of water for eight hours and 200 metres of water for one hour



Each test is designed to demonstrate the package's ability to withstand accident conditions without releasing its contents. To gauge the cumulative effects on the transportation package design, the first two tests are conducted in the sequence that will result in the most damage to the package, followed by the thermal test. The immersion test is conducted independently and is designed to evaluate the integrity of the package under pressure. The order and type of tests are considered to correspond to real transport accident scenarios.

The NWMO is assessing the transportation of used nuclear fuel using two package designs: the Used Fuel Transportation Package (UFTP) and the Dry Storage Container Transportation Package (DSC-TP).



Cutaway View of Used Fuel Transportation Package

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.

Dry Storage Container Transportation Package

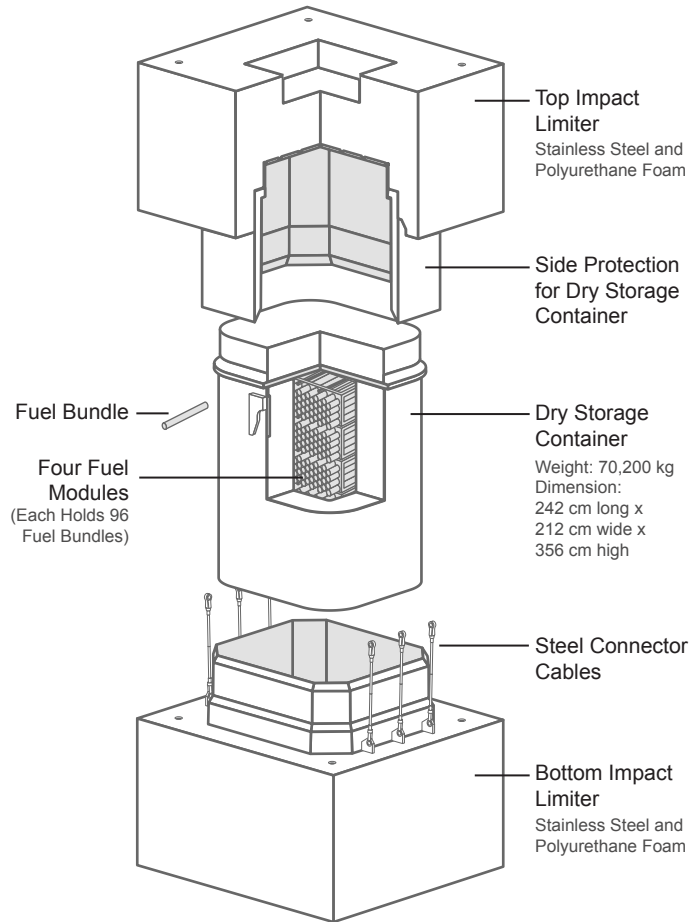
Weight: 100,300 kg

Dimension:

367 cm long x

337 cm wide x

595 cm high



Cutaway View of Dry Storage Container Transportation Package

Will people be exposed to radiation when you transport used nuclear fuel? How much?

The CNSC regulates the use of nuclear energy and radioactive materials to protect the health, safety and security of people and the environment, including setting regulatory limits on radiation exposures. The regulatory limit for a member of the public is 1 milliSievert (1 mSv) per year.

The average natural

background radiation dose received by Canadians is about 1.8 mSv per year.

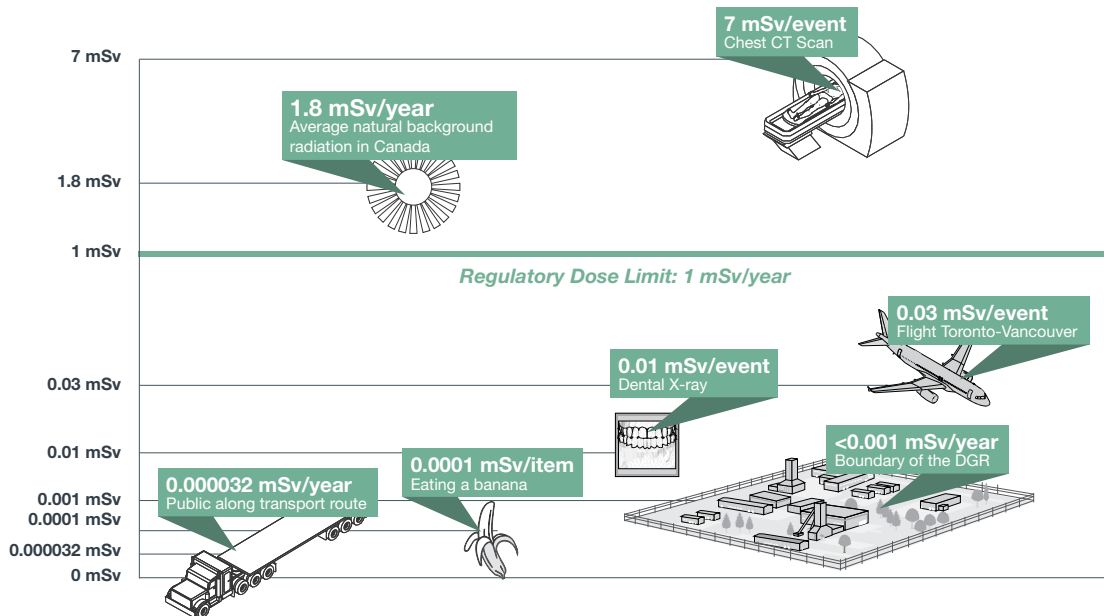
A recent generic study was conducted to determine the potential exposure to individuals along transportation routes using the UFTP. The study considered individuals including residents living along or in the vicinity of the transport route, people sharing the transport route, and people at rest stops along the route.

The annual dose to these people is expected to be lower than the regulatory public dose limit.

As part of the package and transportation certification and licensing process, and before any shipment of used nuclear fuel is authorized by the regulator, the NWMO will have to demonstrate that radiation levels from the package will be below the regulatory limit for transport packages.

Comparison of Sources of Radiation

The graphic below compares dose rates from common sources of radiation to what members of the public would encounter if they were located 30 metres from a transportation route for used nuclear fuel and experienced all 620 truck shipments or 62 train shipments. Based on a generic dose study, the annual dose would be 0.000032 mSv, which is significantly lower than the public dose limit of 1 mSv set by the regulator.



If an accident occurs on a road or railway, will people or the environment be harmed? Would the used nuclear fuel explode or catch on fire?

Given the robust transport package that will be used, transportation incidents are expected to be conventional in nature (e.g. fender-benders). Safety is built into every element of the system for transporting used nuclear fuel, beginning with the transportation package design. The package is engineered to withstand accident conditions without releasing its contents (see page 5 for information about testing).

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

Is used nuclear fuel currently transported in Canada or other countries? How much? What is the safety track record?

Canada has proven and continues to demonstrate its ability to transport used nuclear fuel with hundreds of shipments made since the 1960s. In Canada, three to five shipments of used nuclear fuel are transported by road each year. 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.

Internationally and in Canada, there have been no serious injuries, health effects, fatalities, or environmental consequences attributable to the radioactive nature of the used nuclear fuel being transported.

Who is responsible for the safety of transporting used nuclear fuel? What are the roles of the federal, provincial and local governments in overseeing the transportation of used nuclear fuel?

The NWMO will have overall responsibility for the safe transportation of used nuclear fuel from nuclear reactor sites where it is currently stored to a deep geological repository, once it is constructed.

In Canada, the safe, secure movement of radioactive materials for all modes of transport is jointly regulated by the CNSC and Transport Canada. The CNSC regulates the transport of nuclear materials through the *Packaging and Transport of Nuclear Substances Regulations*. Transport Canada administers the *Transportation of Dangerous Goods Act* and provides operating and safety oversight of railways. Together, their regulations cover the certification of the transportation package design, the licence to transport, security planning, emergency response planning, training, and communication arrangements.

Provincial governments are responsible for developing, maintaining and operating road infrastructure, for conducting safety inspections of the commercial vehicles and their drivers, and for law enforcement.

Local governments are responsible for enforcing local and provincial ordinances governing safety and commercial vehicle operation. They are responsible for developing, operating, and maintaining local streets and roadways, and in some instances, designated portions of highways. They also provide first responders in the event of a transportation incident.

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.

Who can answer questions and concerns from communities along potential transportation routes?

As the multi-year site selection process continues to advance, the NWMO will welcome communities as a group along the transportation route to raise questions or concerns to be addressed in the process.

Security and Emergency Management

Highlights

- » The NWMO will co-ordinate its emergency planning with the provinces, provide training of workers and emergency responders, and conduct drills and exercises along routes.
- » The NWMO will provide an emergency response plan to the Canadian Nuclear Safety Commission (CNSC), Transport Canada and the provinces to demonstrate that appropriate emergency measures are in place and that information is available to relevant public emergency response agencies.
- » Shipments of used nuclear fuel will be continuously monitored by the NWMO's transportation command centre and will have a security escort.

Questions and Answers

What sort of planning will there be for security?

The NWMO will develop and submit a transportation security plan to the CNSC as part of the application for a licence to transport used nuclear fuel. The plan's primary purpose is to ensure used nuclear fuel will receive adequate physical protection against any credible threat that may arise during transport. Risks are continually reassessed to ensure that security measures are appropriate for specific circumstances. The transportation security plan must meet the requirements of the *Nuclear Security Regulations*.

What sorts of security measures will be in place during shipments?

Security measures are put in place to assure the used nuclear fuel to be transported will receive adequate physical protection against any credible threats. These measures include agreements with different levels of law enforcement. Shipments of used nuclear fuel will be continuously monitored by a transportation command centre and will have a security escort.

What are the procedures if there is an accident?

In Canada, the emergency management community has adopted a standard approach for responding to accidents, regulated under the *Transportation of Dangerous Goods Act*. Federal, provincial and local governments use a comprehensive approach to emergency management, which includes having in place measures for prevention, mitigation, preparedness, and response and restoration activities for all modes of transportation. The NWMO will follow this process.

Who is involved to ensure a plan is in place for transportation incidents?

The purpose of the emergency response plan is to ensure co-ordination among the NWMO, provincial and local first responders, leaders of affected communities, and federal agencies. Provincial governments, and local administrations and authorities are responsible for response services. Federal organizations may provide additional resources at the request of the province or municipality.

A safe and secure transportation program has many elements, including training and joint drills and exercises with

provincial and local emergency responders. In the interest of ensuring maximum safety, the NWMO is committed to robust emergency preparedness. Response plans and procedures are rigorously tested through multi-layered training, inter-agency communications, process and joint exercises.

What if a community on the transportation route does not have a fire station, police station or other emergency responders?

The NWMO will provide an emergency response plan to the CNSC, Transport Canada and the provinces. The NWMO will co-ordinate its planning with the provinces to provide training and conduct exercises along the designated routes.

Who will bear financial liability for cleanup or damages if an accident occurs during transportation?

Under the *Nuclear Liability Act*, the NWMO would be liable up to a prescribed limit, regardless of fault, for damage or injury resulting from the unlikely event of a release of radioactivity during transportation. The Act requires the NWMO to carry a prescribed amount of insurance to ensure that compensation is available.

Modes of Transportation

Highlights

- » Around the world, used nuclear fuel has been transported safely for more than 50 years by road, rail and water.
- » Regardless of the mode used to transport used nuclear fuel, there has never been a serious injury, health impact, fatality, or environmental consequence attributable to the radioactive nature of the material being transported in this type of package.
- » The NWMO has not yet determined the mode of transportation, as this will depend in part on the location of the site that is ultimately selected to host a repository for Canada's used nuclear fuel.
- » Actual shipments to a used nuclear fuel repository are not planned to begin before 2035 at the earliest. Once started, it is estimated it will take approximately 38 years to complete the transfer of used nuclear fuel from interim storage sites to the repository.

Questions and Answers

How is used fuel transported?

Used nuclear fuel can be transported by road, rail or water. All three modes provide for safe and secure transportation around the world.

It is expected to take several more years to complete the necessary studies to identify a preferred site and an informed and willing host for Canada's used fuel repository. At this early stage of assessment, the NWMO is looking at road and rail access from the interim storage sites to communities that are engaged in the site selection process.

As the site selection process advances, the NWMO will identify preferred transportation modes and potential routes with each potential site under consideration. The mode of used fuel transport, potential routes, and the safety and social acceptability of the transportation system will be fully addressed through engagement during the siting process and through the environmental assessment and licensing process for the long-term management facility.



How will transportation be considered within the federal environmental assessment process?

It is expected that the environmental assessment will review all activities related to the project, including transportation.

Are upgrades required to transportation infrastructure, and if so, who pays?

Any requirement for infrastructure improvements can only be confirmed once a potential site for a repository is identified.

For a potential site to be considered technically feasible for a repository site, safe,

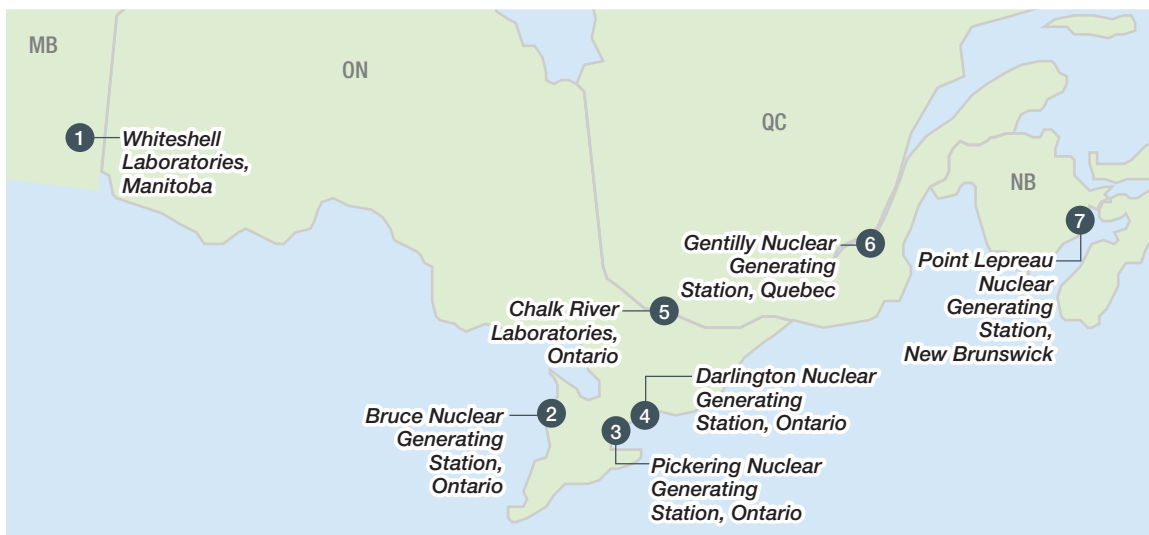
secure routes for transporting used nuclear fuel from interim storage facilities in Canada to the repository site are a requirement. Transportation infrastructure must already exist or be possible to develop. The NWMO will need to demonstrate to regulatory authorities the safety and security of the transportation system before the shipments of used fuel can begin.

The NWMO would fund local infrastructure improvements needed to assure safety. Any such improvements would need to be undertaken before the NWMO could proceed with transportation activities. Any infrastructure improvements

would be subject to discussion and negotiation with the appropriate agencies.

Are transportation routes the subject of their own assessment by the NWMO?

Yes. The NWMO has begun a process for evaluating the suitability of potential repository sites. This process includes assessing the transportation infrastructure and road and rail routes associated with moving used nuclear fuel from interim storage sites to any potential site for a future repository. Communities will be involved in this assessment.



Canada's Seven Interim Storage Sites for Used Nuclear Fuel

How many shipments would there be per day, and for how long?

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. The number of shipments per year would be approximately 620 by road, averaging less than two a day. If rail is used, there would be approximately 62 shipments per year of about 10 packages per train, averaging one shipment every six days. Options for shipments that use a combination of transportation modes may also be considered depending on the site selected to host the repository.

Regardless of the mode(s) used to transport used nuclear fuel, it is expected to take approximately 38 years to move all Canada's used nuclear fuel. This estimate assumes 4.6 million fuel bundles will need to be moved to the repository, based on current anticipated volumes from existing nuclear facilities. In the future, decisions regarding nuclear power generation made by provincial governments and nuclear plant operators may result in a larger volume of used nuclear fuel that would need to be managed.

How are radioactive materials being transported now in Canada? How is used fuel transported in other countries?

On a yearly basis, approximately one million packages of radioactive materials are transported in Canada. Most shipments are by road, including about three to five shipments of used fuel per year. The used fuel is shipped from a nuclear generating station to Atomic Energy of Canada Limited's Chalk River Laboratories for research and post-irradiation examination.

In the United States, nearly 3,000 shipments of commercial used fuel have been moved more than 2.5 million kilometres during the last 40 years, most 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.

Does transportation of used nuclear fuel require a dedicated road or rail line? Does it require road closure to the public during transport?

No. Neither a dedicated road nor railway is needed, and there is no need to close the transit route to the public.

What type of vehicles will be needed?

The vehicles used will be designed to carry certified transportation packages. Preliminary studies show that transporting used nuclear fuel in the Used Fuel Transportation Package (UFTP) (by road and rail) and the Dry Storage Container Transportation Package (by rail) can be designed to meet current weight and size standards.

Will health and safety of truck drivers or rail workers be at risk?

To ensure worker health and safety, the Canadian *Radiation Protection Regulations* set limits on the amount of radiation a nuclear energy worker can receive. These regulations set an annual dose limit of 50 mSv per year to a maximum of 100 mSv over a five-year period. Before any transportation of used nuclear fuel can begin,

the NWMO will be required to demonstrate its operations will not result in any worker or member of the public being exposed to radiation that would result in exceeding regulatory limits.

A generic study was completed 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.

Drivers and train crews would receive training that meets the *Transportation of Dangerous Goods Regulations* for ensuring safety and security. Shipments of used nuclear fuel will be continuously monitored by a transportation command centre and will have a security escort.

Public Involvement in Transportation Planning

Highlights

- » Decisions regarding the most appropriate routes and modes will require engagement from those who are potentially affected by future transportation decisions and who may have questions or concerns to be addressed in the process.
- » The NWMO will demonstrate the safety and security of any transportation system to regulatory authorities and citizens before transportation of used nuclear fuel to the repository can begin.
- » The NWMO will welcome communities as a group along the transportation route to raise questions or concerns to be addressed in the process.

Questions and Answers

How much information will be provided to communities along the transportation route? Will communities along the chosen transportation route have a voice?

The NWMO will demonstrate the safety and security of any transportation system to regulatory authorities and citizens before transportation of used nuclear fuel to the repository can begin.

By the time a specific site has been identified and evaluated for a repository, the NWMO will also have identified preferred transportation modes and potential routes. By then, the NWMO will have welcomed communities along the transportation route to raise questions or concerns to be addressed in the process, including through a regional study whose outcome will help shape any path forward.

Would a community be able to direct the route of the shipment through their community?

A shipment route is an important element in planning for transportation security. As part of the site selection process for the used fuel repository, the NWMO will identify preferred transportation modes and potential routes associated with each interested community under

consideration. This process will include engagement and input from groups that are potentially affected by future transportation and that have questions or concerns to be addressed.

In general terms, a municipality can regulate transportation from a traffic perspective as long as it does not have an impact on meeting regulatory requirements for safe and secure transportation. For example, if a certain route is identified to meet aspects of regulatory requirements, it would not be possible for a municipality to change the route. On the other hand, a municipality could impose safety restrictions, for example weight limitations, on all traffic to protect road integrity during the spring thaw, even if this had the effect of temporarily preventing used fuel shipments.

Would communities be notified of transportation schedules and routes?

Based on current regulatory requirements, 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. Relevant information would be provided only to persons or agencies with a valid need to know, such as emergency responders.

For more information, please contact:

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