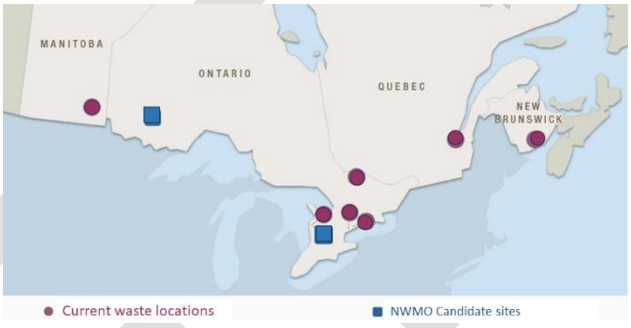
Nuclear Waste, Transportation, Transportation Accidents and Accident Risk

The Nuclear Waste Management Organizations and the Canadian Nuclear Safety Commission promote the notion that the transportation of high-level nuclear waste is safe, suggesting that the public should not be concerned. In reality, there is very little experience with nuclear fuel waste transportation in Canada, international experience has a mixed record, and there are serious gaps in the testing of the transportation containers and training for emergency responders. It is appropriate to be concerned.

The Nuclear Waste Management Organization is proposing to construct a centralized site for the processing, burial and eventual abandonment of all of Canada's highly radioactive nuclear fuel waste. Since 2020 the NWMO has focused its siting efforts on two sites, one in southwestern \Ontario and one in Northwestern Ontario, and it intends to select a site in 2024. Transportation planning is still preliminary, despite the site selection being imminent, but will involve an estimated 2-3 trucks per day for a period of fifty years or longer.



Both the Nuclear Waste Management Organization and the Canadian Nuclear Safety Commission describe what they consider to be a successful track record for radioactive waste shipments, pointing to the large number of shipments which they claim have been carried out internationally without serious injury, fatalities or environmental consequences or pointing to the one million packages of radioactive materials that are transported each year in Canada. And while those statements may not be blatantly untrue, they do not tell the whole story.

First, it's important to note that the "one million packages of radioactive materials" the NWMO and CNSC frequently refer to as evidence of Canada's excellent transportation record are mostly packages of single isotopes being shipped for medical or industrial uses. These shipments are not radioactive waste, and they are certainly not high-level radioactive waste.

Experience in Canada with the long-distance shipment of high-level waste has been very limited. The NWMO touts that there have been "hundreds of shipments since the 1960s"[1], but place this in context: the NWMO is suggesting that the shipment of a single fuel bundle or fuel rod for research purposes (the primary purpose of fuel waste shipments to date, averaging three to five shipments per year) is comparable to the routine shipment of hundreds of irradiated fuel bundles per shipment, averaging five shipments every two days. Do the math: five bundles per year vs more than 120,000 fuel bundles per year.[2]

Second, while having had no major accidents resulting in radiological contamination to date is certainly a positive – that is the essence of the assuring statements from the NWMO and the CNSC – it is not an assurance of future success. Each shipment is unique, and the past may not be a predictor of the future, particularly since the volume and the type of shipments increase and change dramatically.

Third, it would not be factually correct to say that there have been no accidents or releases of radioactive material during transportation of radioactive goods or waste to date. Nor would it be reasonable to not acknowledge that there are significant risk factors.

Accidents

The following are road transportation accidents that took place in Canada between 2016 and 2018 and were publicly disclosed by the Canadian Nuclear Safety Commission:

- In January 2018 a tractor trailer hauling uranium concentrate to Cameco's Blind River refinery was in an accident on Highway 17 between Wawa and Sault Ste. Marie, ON.
- In May 2017 there were two separate transport incidents involving the shipment of low-level radioactive loads from the Bruce Nuclear Generating Station hauling waste to an unidentified off-site facility.

- In December 2016 there was a transport trailer accident just west of North Bay involving a truck hauling uranium concentrate from Montréal to Cameco's uranium refinery in Blind River
- In April 2016 a tractor trailer hauling uranium concentrate from Cameco's Blind River refinery to its Port Hope conversion facility was in an accident on Highway 17 near Massey
- In January 2016 a truck hauling uranium on Highway 4 near Swift Current Saskatchewan was in an accident, the container was breached, and there was a spill of uranium yellowcake onsite, resulting in the highway being closed for the cleanup[3]

The CNSC has also disclosed two marine shipping accidents. In 2011 a sea shipment containing uranium yellowcake was returned to Canada after encountering rough seas enroute from Canada to China that resulted in a loss of containment. Cleanup took from January to May 2011, but the ship remained in dry dock for much longer due to legal disputes between the carrier and Cameco, who was the shipper, with both parties arguing that the other was at fault.

In a second marine accident in 2014 a flat rack containing four cylinders of Uranium Hexafluoride (UF6) composed of low-enriched uranium, each weighing 4.5 tonnes was accidently dropped back into the ship's cargo hold from an elevation of about 7 metres (23ft) when two connectors on the crane let go and the container then swung down and snapped off, dropping back into the hold.[4,5]

Two additional incidents had their origin in Canada, but occurred in the U.S. In 2013, a truck hauling uranium hexafluoride caught fire near Troy, Ohio. The driver – recognizing the danger of exposing the UF6 to fire - managed to disconnect the rig from the trailer and drove the truck two miles down the road, leaving the load of uranium hexafluoride unattended but avoiding the trailer being engulfed in the fire. There was no requirement to report the incident to either Canadian or American nuclear regulators.[6]

In 2017, one of the first shipments of high-level liquid radioactive waste from Chalk River in Canada to Savannah River Site (SRS) in South Carolina was found to be "hot" upon arrival at SRS, meaning that it was above allowable radiation limits due to a failure in the packaging.[7] In a potentially related earlier incident the bottom of a "caddy" manufactured by the same company (and which are part of the equipment that goes with the NAC-LWT cask) had unexpectedly failed, dropping highly radioactive spent nuclear fuel rods to the bottom of a storage pool at Chalk River. The failure of the caddy was caused by poor welds, a manufacturing defect that was also evident on a number of other caddies designed to serve the same purpose.[8]

International Experience

A historical review of the transport of spent nuclear fuel prepared for the U.S. Department of Energy found that spent nuclear fuel (SNF) and high-level waste (HLW) transportation incidents can be divided into three general categories. The first and most common category involves radioactive contamination on the surface of SNF casks and/or the vehicles on which they are transported. Instances of contamination have occurred in many countries where SNF and HLW have been transported. The second category involves transportation accidents, and the review indicates that to date "while it may be impossible to completely prevent transportation accidents ….no injury has ever been caused by the radiological nature of SNF or HLW in a transportation accident". The third category is public demonstrations and protests that have led to the disruption of shipments.[9]

A report prepared by Public Health England reviewing transport of radioactive materials in the U.K identified 16 accidents and incidents in the UK in 2012, and 182 accidents or incidents between 2007 and 2012. There are 1,034 events that are known to have occurred since 1958. [10] An international report identified a fatality associated with the transport of radioactive materials in the United States between 1997 and 2011 and indicated that there were 128 accidents with cargoes of radioactive materials including the one death. No details or references were provided.[11]

Reporting in Canada

Canada has no registry or publicly accessible database of radioactive shipments, or of accidents or incidents involving the shipment of radioactive wastes and other materials.

Transport Canada does provide summary statistics of emergencies, which they describe as an incident in which "the release or anticipated release (e.g. spills, accidents), loss or theft of dangerous goods that is or could be in excess of a quantity or concentration specified by regulation from the means of containment if it endangers, or could endanger, public

safety". A Class 7 emergency is one in which there is a "level of ionizing radiation greater than the level established in section 39 of the "Packaging and Transport of Nuclear Substances Regulations, 2015".[12]

The following transport-related radiological emergencies were reported by Transport Canada:[13]

Year	2022	2021	2020	2019	2018	2017	2016	2015
# of Incidents	2	7	14	5	5	8	13	11

Risk Factors

Risk is a calculation of probability x consequence. Factors which increase "probability" of accident include volume or number of shipments, conditions of transport, security of the containers, and security / reliability of the transportation mode. One of the most important factors in calculating transportation risk is how dangerous or hazardous is the material being transported. In the case of high level nuclear waste, the material being transported is VERY hazardous.

Two important risk factors related to the road transport of radioactive waste are 1) vehicle safety and maintenance, and b) frequency of truck collisions and accidents.

Between 2010 and 2013, more than one truck in seven carrying radioactive material was pulled off the road by Ontario ministry of transportation inspectors for failing safety or other requirements. During this period, inspectors examined 102 trucks carrying "Class 7 Dangerous Goods (Radioactive material.)" Of those, 16 were placed "out-of-service," which means the vehicle "must be repaired or the violation corrected before it is allowed to proceed." Violations included faulty brake lights; "load security" problems; flat tires; false log; damaged air lines; and a driver with no dangerous goods training. Others had enforcement actions related to hours of service; annual inspection requirement; missing placards; exceed gross weight limit; speed limiter; overlength combination; over-height vehicle; and vehicle registration / insurance. According to reports, an additional nine vehicles fell into this category, and were in violation but were not prohibited from proceeding. In total, 25 of the 102 inspections − nearly one in four − resulted in the vehicle being place out-of-service and / or enforcement action taken against the operator of the vehicle.[14]

More recently, the Ontario Provincial Police have released statistics on the involvement of transport trucks in highway traffic accidents. Reportedly, during the first half of 2018 the OPP has investigated more than **3,600** transport truck-related collisions, which represent **11** per cent of the total number of collisions **(34,461)** and in the course of those investigations the OPP has laid more than **1,615** speeding charges, **354** distracted driving charges and **963** defective equipment-related charges against transport truck drivers.[15]

Statistics for the entire year of 2018 are equally sobering. OPP statistics show that among the thousands of crashes in 2018 involving transport trucks, almost half – 40 per cent – involved a truck that was either following too closely or had made an improper lane change. The OPP said it responded to 7,674 transport truck collisions last year. These crashes claimed 63 lives and caused 1,142 injuries. Close to 80 per cent of last year's transport truck-related collisions were multi-vehicle crashes, making this a significant road safety issue, OPP said.[16] Northeastern Ontario is reported as seeing the largest increase, with an 800% increase in fatalities and 3,600 transportation accidents involving transport trucks (approximately half of the provincial total. Accidents were largely attributed to driver distraction and faulty equipment.[17]

With the data available, it was not possible to determine the percentage of vehicles represented in the 2018 statistics of accidents involving transport trucks were Class 7 vehicles transporting Dangerous Goods (Radioactive Material), but there is presumably a correlation between the MOT statistics from 2013 which showed a 25% incidence of faulty maintenance and the OPP observations in 2018 that accidents were largely attributed to driver distraction and faulty equipment.

Container Testing

According to the Canadian Nuclear Safety Commission "packages requiring certification have to undergo stringent testing since improper packaging can give rise to severe consequences. Testing must simulate both normal and accident conditions of transport. The tests can include free-drop testing, puncture testing, thermal testing and aircraft accident simulations."[18] Similarly, the NWMO assures the public that "transportation packages are designed and tested to ensure protection of the public".[19]

CNSC and NWMO presentations and publications about the transportation of radioactive waste almost without exception include a presentation on the international Atomic Energy Agency container safety tests. Members of the public have questioned the degree to which tests actually represent real world accident scenarios. For example, if a container was involved in a fiery transport accident, can we reasonably expect that the fire would be extinguished within 30 minutes? Similarly, is it reasonable to expect that a container submerged in water – a river, or lake en route – would be retrieved within eight hours? Note also that the "impact tests" are for a nine metre drop, but not for containers being crushed.

At least equally problematic is that there is no evidence that the one certified container for used fuel transport in Canada has been subject to the frequently referred to tests.

It took two years, but the Canadian Nuclear Safety Commission responded to a 2021 Access to Information (ATI) request about "safety testing" of the NWMO's Used Fuel Transportation Package in mid-2023. The CNSC provided 838 of the 3464 pages identified as being relevant to the request while the remaining pages were withheld following a review by Ontario Power Generation and the NWMO.

The ATI response confirmed there have been no full-scale tests of the Used Fuel Transportation Package, that the only tests were done in 1980s and were of 1/7th scale or ½ scale containers, and that the tests were only partially completed and only partially successful.[20]

A half-scale model of the predecessor package had been the subject of a set of drop tests at the Chalk River Nuclear Laboratory in the 1980s, and to a "seventh-scale" set of tests that were not described. No documentation was included that suggested that the previous or current design had been subject to the IAEA style tests to determine how the package would respond in water submersion or fire tests, at full scale or even half-scale.

The response also confirmed that the water immersion and fires tests often described by the NWMO as part of the international standards for "testing" the transportation package are calculations, not actual tests.

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NOTES

[1] Safe and Secure Transportation of Canada's Used Nuclear Fuel Questions and Answers, NWMO May 2015, page 3

[2] NWMO's "Deep Geological Repository Transportation System Conceptual Design Report (September 2021) estimates 5,500,000 fuel bundles over 45 years; see page 16, as posted at https://www.nwmo.ca/-/media/Reports---Reports/APMREP004400209.ashx?sc_lang=en

[3] As posted June 2021 at https://nuclearsafety.gc.ca/eng/acts-and-regulations/event-reports-for-major-nuclear-facilities/event-reporting/transport-intransit-events.cfm?pedisable=true

[4] CNSC's Regulatory Efforts for Improvement in Response to Transport Events E-DOCS-#5728486 2019-09-03 1:06 PM, as found at https://resources.inmm.org/system/files/patram_proceedings/2019/a1148_3.pdf

[5] UF6 Drop at https://atlantic.ctvnews.ca/container-in-radioactive-scare-was-improperly-secured-nuclear-safety-agency-1.1748578

[66] https://www.thestar.com/business/2013/10/31/burning_truck_hauling_nuclear_load_flies_under_radar.html

[7]www.dnfsb.gov/sites/default/files/document/11571/Savannah%20River%20Week%20Ending%20April%2021%202017.pdf

[8] https://mailchi.mp/17d0e40b7103/nsr

[9] A Historical Review of the Safe Transport of Spent Nuclear Fuel Prepared for US Department of Energy Nuclear Fuels Storage and Transportation Planning Project Oak Ridge National Laboratory, Argonne National Laboratory, August 31, 2016 FCRD-NFST-2016-000474, Rev. 1 ORNL/SR-2016/261, Rev. 1, page 65

[10] Radiological Consequences Resulting from Accidents and Incidents Involving the Transport of Radioactive Materials in the UK – 2012 Review, A L Jones and M P Harvey, Public Health England

[11] Risk Assessment of Accidents During the Transportation of Liquid Radioactive Waste in Multimodal Transport, A Tumanov 2019 IOP Conf. Ser.: Earth Environ. Sci. 272 032078

[12] https://tc.canada.ca/en/dangerous-goods/canutec/annual-statistics/

[13] https://tc.canada.ca/en/dangerous-goods/canutec/annual-statistics

[14] 'Trucks with radioactive cargo fail inspections', John Spears, 15 Nov 2013, Toronto Star, https://www.thestar.com/business/2013/11/15/trucks_with_radioactive_cargo_fail_inspections.html ,Ministry of Transportation – Undertaking #61: www.ceaa-acee.gc.ca/050/documents/p17520/95562E.pdf

[15] OPP FATAL TRANSPORT TRUCK COLLISIONS UP 38 PER CENT, 2018-7-12, www.opp.ca/index.php?lng=en&id=115&entryid=5b4887f9af4f935dc5554413

[16] Transport truck crashes claimed 63 lives in 2018, OPP says, https://www.northernontariobusiness.com/industry-news/transportation/transport-truck-crashes-claimed-63-lives-in-2018-opp-says-1504688

[17] https://northernontario.ctvnews.ca/video?clipId=1438878

[18] http://nuclearsafety.gc.ca/eng/nuclear-substances/packaging-and-transport-of-nuclear-substances/certification-process-for-transport-packages/index.cfm

[19] See, for example, page 18 of the NWMO's "Preliminary Transportation Plan", December 2021

[20] Look for online posting of ATI responses