Transportation of Radioactive Materials in Ontario

Information Package

Prepared by the Ministry of Transportation and Ministry of Community Safety and Correctional Services
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Introduction

- The Ministry of Transportation (MTO) and the Ministry of Community Safety and Correctional Services (MCSCS) have developed this *Transportation of Radioactive Materials in Ontario* Information Package to enhance first responder and emergency management stakeholders’ preparedness for an incident involving the transportation of radioactive materials.

- This information package aims to raise general awareness about the transportation of radioactive materials in Ontario, including [Highly Enriched Uranium (HEU)](https://www.ontario.ca/page/highly-enriched-uranium) / [Highly Enriched Uranyl Nitrate (HEUNL)](https://www.ontario.ca/page/highly-enriched-uranyl-nitrate).
Background

• Approximately 1 million packages containing radioactive materials are safely transported in Canada every year.

• Radioactive materials come in a variety of types, and when transported, are subject to stringent safety regulations to protect the public in the event of a transportation incident.

• The transportation of radioactive materials in Ontario poses minimal risk to public health and safety.
Objectives

The objective of this Information Package is to provide first responders and emergency management stakeholders with information on:

1) The regulatory requirements for the transportation of radioactive materials;
2) Basics of radiation and potential health consequences;
3) What types of radioactive materials are being transported in Ontario;
4) Available resources to inform first responders and emergency management stakeholders in the event of a transportation incident involving radioactive materials; and
5) Where to access additional resources.
Section 1: Regulatory Framework
Regulatory Framework

Overview

• Canada is one of many countries that regularly transport radioactive materials. As such, all regulations are based on international standards and best practices as defined by the International Atomic Energy Agency (IAEA).

• The federal government regulates the shipment of radioactive materials; the provincial and municipal governments have responsibilities regarding the response to a transportation incident and would receive support from the consignor and federal agencies.

• The regulatory framework for the transportation of radioactive material and the emergency response to a potential incident involving such transportation involves multiple stakeholders.
Federal Regulatory Framework

Transportation of radioactive material is jointly regulated by:

**Transport Canada**
- Sets transportation requirements for all nine classes of dangerous goods.

**Canadian Nuclear Safety Commission (CNSC)**
- Based on [International Atomic Energy Agency (IAEA) Standards](https://www.iaea.org).
- Sets transportation packaging and classification requirements.
Chart illustrates International and Federal Regulatory Frameworks

- Provincial / Territorial Dangerous Goods Transportation Acts
- Transportation of Dangerous Goods Act
- 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 (SSR-6)
- IAEA (International Atomic Energy Agency)
Consignors’ Roles and Responsibilities

Consignors

• If a consignor is transporting radioactive materials that meet the requirement for an Emergency Response Assistance Plan (ERAP) (see Part 7 and Column 7 of Schedule 1 of the TDG), that consignor must have an ERAP approved by Transport Canada.

• An ERAP describes what would be done in the event of a transportation incident. The plan is intended to assist local emergency responders by providing them with technical experts and specially trained/equipped emergency response personnel at the scene of an incident.

• Examples of consignors that transport radioactive material include nuclear electricity generating stations or hospitals shipping nuclear medicinal waste.
Municipal and Provincial Roles and Responsibilities

Municipalities

- Responsible for taking appropriate measures to protect public health and safety within their jurisdiction

Province of Ontario

- The *Provincial Nuclear Emergency Response Plan* provides the framework for the overarching nuclear emergency response for the Government of Ontario and governs the response to nuclear and radiological emergencies in the province.
- The Province can provide coordination and support for the emergency response to a transportation incident involving radioactive material.
- Various provincial ministries have responsibilities under Order in Council 1157/2009 to respond to radiological and/or transportation incidents.
Section 2: Radiation Basics
Radiation Basics

Overview

• There are some radioactive materials that pose minimal threat to public health and safety, while others should be handled with extreme caution.

• This section will identify what radiation is and identify methods to reduce the potential health consequences of radiation exposure or contamination.
What is Radiation?

• Radiation is energy in the form of high speed particles and electromagnetic waves that can be found everywhere (e.g. visible light, radio and television waves, microwaves, and cosmic rays).

• Non-Ionizing Radiation: Does not have enough energy to ionize* molecules but can damage cells and tissue. It represents a low risk to human health (e.g. sunlight, microwaves).

• Ionizing Radiation: Is radiation that carries enough energy to free electrons from atoms and molecules, thereby ionizing them. A potentially high risk to human health (e.g. x-rays, gamma radiation).

*Ionization refers to the action of creating ions by ejecting an electron from an atom or molecule.
Radiation Basics

Ionizing Radiation Types

The most common types of ionizing radiation are alpha (α), beta (β), and gamma (γ); neutrons are a fourth type. The image below shows the different types of radiation and the level of shielding required to reduce or eliminate the dose rate.

Source: Ministry of Health and Long Term Care, Radiation Health Response Plan
Radiation Basics

Dose Levels

• Exposure to radiation in low levels occurs on a daily basis through many natural and artificial sources and is not always harmful.

• When ionizing radiation penetrates the human body or an object, it deposits energy. The energy absorbed from exposure to radiation is called a dose.

Source: Canadian Nuclear Safety Commission
Radiation Basics

Exposure vs. Contamination

It is important to know the difference between radiation exposure and contamination.

Exposure

• The act or condition of being subject to irradiation (the process by which an organism or object is exposed to radiation) either externally or internally.
• The significance of radiation exposure to individuals depends on its duration, the nature of the source, the proximity to the source and the availability and nature of shielding.
• It is possible for a person to be exposed to radiation yet not be contaminated. People who have been exposed do not pose a risk to others interacting with them.
• Exposure takes place as long as radioactive atoms stay near, on, or in the body.
Radiation Basics
Reducing External Exposure

Reducing exposure to an external dose of radiation can be achieved by using the following principles:

1. **Time:** Minimize time spent in a radiation field. The dose received is directly proportional to time spent at that location.
2. **Distance:** Increase the distance from a radioactive source in order to decrease the dose rate.
3. **Shielding:** Provide a shield between the person and the radioactive source in order to reduce or eliminate the dose rate.
Internal exposure is only possible through ingestion, inhalation or absorption of a radioactive source. Reducing internal radiation exposure can be achieved through the following actions:

- Wear appropriate personal protective equipment;
- Control the spread of loose contamination;
- Decontaminate individuals and items in a timely manner; and,
- Get treatment with appropriate pharmaceuticals in a timely manner (e.g., potassium iodide, Prussian blue).
Radiation Basics

Exposure vs. Contamination

Contamination

- Contamination refers to when radioactive material is deposited in water or air, or on the surfaces of structures, areas, objects, or people. Contamination of humans can be internal or external.

- **External contamination** refers to materials containing radioactive isotopes that are deposited on the skin. This can usually be removed with soap and water.

- **Internal contamination** refers to radioactive material that is taken into the body through inhalation, ingestion, or absorbed through skin or wounds. This is more difficult to remove and requires sophisticated treatment.

- The effects of contamination are related to the amount of radiation to which an individual is exposed, the length of time of exposure, and the part(s) of the body affected. Human health impacts can range from very mild and self-limiting effects such as reddening of the skin to severe burns, organ failure, and death; these effects can occur days to months after a serious incident.
Radiation Basics

Contamination Control Practices

• In order to reduce the chances of becoming contaminated, individuals should:
  – Understand the principles of time, distance and shielding;
  – Wear personal protective equipment that provides the highest level of skin and respiratory protection; and,
  – Control the spread of loose contamination.

• If contamination does occur:
  – Decontaminate individuals and items in a timely manner; and,
  – Get treatment with appropriate pharmaceuticals in a timely manner.
Section 3: Transportation of Radioactive Materials
Transportation of Radioactive Materials Packaging

• All packages used for the transport of radioactive material must meet certain safety and performance requirements as stated in IAEA regulations.

• The objectives of the regulations are to protect the health and safety of persons and the environment.

• The greater the radioactivity, the more robust the package.

• Depending on the material to be transported, the following types of packages may be used to transport radioactive materials:

  - Excepted Packages
  - Industrial Type Packages
  - Type A package*
  - Type H package*
  - Type B Package*
  - Fissile Material packages

* The design of these package types must be certified by the Canadian Nuclear Safety Commission before they can be used.
Transportation of Radioactive Materials

Packaging: Excepted, Industrial, and Type A

- The contents of these packages pose minimal threat to public health and safety based on their radioactive levels.
- Industrial and Type A packages are designed to withstand a series of tests that simulate normal conditions of transport without loss of content and with limited increase to the dose rate on the exterior of package.
- Some of the tests these packages must be able to pass include:

  - **Drop test**: A 1.2-metre (47 in) drop test onto an unyielding surface
  - **Penetration test**: Dropping a metal bar onto the package
  - **Water spray test**: Simulating rain fall
  - **Stacking test**
## Transportation of Radioactive Materials

### Types of Packaging

<table>
<thead>
<tr>
<th>Type</th>
<th>Use</th>
<th>Example</th>
<th>Photo</th>
</tr>
</thead>
</table>
| **Excepted Package** | Transport very small quantities of radioactive materials          | • Empty packages previously containing radioactive material  
• Smoke detectors  
• Medical isotopes | ![Medical Isotopes Container](Uranium Ore Containers) |
| **Industrial Package** | Transport low specific activity (LSA) material and surface contaminated objects (SCO) | • Uranium ores and concentrates  
• Low-level radioactive waste (contaminated paper towels, gloves, etc.) | ![Uranium Ore Containers](Uranium Ore Containers) |
| **Type A Package**   | Transport quantities of radioactive materials that pose minimal risk to human health or safety or the environment | • Medical isotopes  
• Industrial devices (portable nuclear densometer gauges) | ![Type A package and label](Uranium Ore Containers) |
Transportation of Radioactive Materials

Packaging: Type H, Type B and Fissile Material

• Type B packages are very robust with radiation shielding, and remain intact even under accident conditions of transport.

• Type B packages must withstand the same normal transportation conditions as Type A packages, as well as testing to simulate accident conditions.

• Packages used to transport fissile material must remain sub-critical when subjected to the tests for Type B packages.

• Before these packages can be used in Canada they require certification by the CNSC by undergoing stringent testing, including:

FREE DROP
A 9-metre (30-foot) free-fall onto an unyielding surface

PUNCTURE
A 1-metre (40-inches) free-fall onto a steel rod

THERMAL
A 30-minute, fully-engulfing fire at 800° (1475°F)

IMMERSION
An 8-hour immersion under water
## Transportation of Radioactive Materials

### Types of Packaging

<table>
<thead>
<tr>
<th>Type</th>
<th>Use</th>
<th>Example</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type H</strong></td>
<td>Transport uranium hexafluoride (UF6)</td>
<td>• UF6 is a compound used in the uranium enrichment process that produces fuel for nuclear reactors</td>
<td><img src="image1" alt="Type H Package" /></td>
</tr>
<tr>
<td><strong>Type B</strong></td>
<td>Transport highly radioactive materials</td>
<td>• Cobalt sources &lt;br&gt; • Exposure devices &lt;br&gt; • Used nuclear fuel from CANDU reactors</td>
<td><img src="image2" alt="Type B Package (Exposure Device)" /></td>
</tr>
<tr>
<td><strong>Fissile Material</strong></td>
<td>Transport radioactive materials that are fissile</td>
<td>• Highly enriched uranium (HEU/HEUNL) &lt;br&gt; • High-level radioactive waste</td>
<td><img src="image3" alt="Type B Fissile Package" /></td>
</tr>
</tbody>
</table>
As a part of the Global Threat Reduction Initiative the Federal Government is shipping Highly Enriched Uranium (HEU and HEUNL) from Canadian Nuclear Laboratories’ (CNL) Chalk River facility by road to Savannah River, South Carolina.

- This initiative removes existing weapons-grade material from Canada and eliminates a nuclear liability for future generations of Canadians.

- HEU/HEUNL is transported via roadway in packages that are certified by both the Canadian Nuclear Safety Commission (CNSC) and its U.S. counterpart, the Nuclear Regulatory Commission, to meet international safety requirements.

- These packages are very robust, designed to withstand potential accidents and undergo strict testing for based on international standards.

- Transport of HEU/HEUNL is subject to the same regulatory packaging and transport requirements as all other radioactive materials.
Highly Enriched Uranium (HEU) is natural uranium that has been enriched to raise the proportion of Uranium-235 to exceed 20%, in contrast to natural uranium which has a proportion of Uranium-235 of less than 1%.

In Canada, HEU was used as fuel in research reactors and as target for the production of medical isotopes.

Enriched Uranyl Nitrate Liquid (HEUNL) is Highly Enriched Uranium in a liquid solution.
Transportation of Radioactive Materials
Transportation of HEU/HEUNL: Incident Response

• In the event of an incident involving packages containing HEU/HEUNL First Responders will follow the same procedures they would for other fissile radioactive material (See Emergency Response Guide 165).

• Note: An Emergency Response Assistance Plan (ERAP) is required for the transportation of HEU/HEUNL.

• For more information on Response Measures see Section 4.
Section 4: Response Measures
Response Measures

Placards

Vehicles transporting Class 7 Radioactive Materials must display placards if one of the following conditions is met:

• Packages display the III-Yellow labels
• An ERAP is required for the material (UN# also required)
• More than 500kg gross mass (total weight of material and package) is transported
Response Measures

Placards and UN Number

Example of a Placard for a Large Means of Containment
Radioactive Material, Type B Package, Fissile, UN 3328 Class 7

Placard Locations

Front of the truck or front of the cargo unit
Both sides of the cargo unit
Rear of the cargo unit
### Response Measures

#### Labels used on Radioactive Material Packages

Packages used to transport radioactive materials will display one of the following transport labels which will depend on the amount of radiation measured on the surface of the package.

<table>
<thead>
<tr>
<th>Label</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>I-White</td>
<td>Extremely low radiation levels</td>
</tr>
<tr>
<td>II-Yellow</td>
<td>Low radiation levels</td>
</tr>
<tr>
<td>III-Yellow</td>
<td>Higher radiation levels</td>
</tr>
<tr>
<td>Fissile</td>
<td>Fissile Materials</td>
</tr>
<tr>
<td>No Label</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Excepted packages</td>
</tr>
</tbody>
</table>
Response Measures

Emergency Response Guidebook

• Intended for use by first responders during a transportation incident involving dangerous goods.

• Aid in quickly identifying specific or generic hazards of the material(s) involved in an incident, and in protecting first responders and the general public during the initial response phase of an incident.

• **Guide 161 to 166** (pages 260 to 271) address Class 7 Radioactive Materials.

• It can be found online [here](#).
Response Measures
Public Safety Measures

Summary of Guides 161 to 166 of the Emergency Response Guidebook

- Priorities for rescue, life-saving, first aid, fire control and other hazards are higher than the priority for measuring radiation levels.
- As an immediate precautionary measure, isolate location at least 25 metres in all directions.
- Stay upwind, uphill and/or upstream.
- Keep unauthorized personnel away.
- Detain or isolate uninjured persons or equipment suspected to be contaminated.
- If there is a package breach, delay decontamination and cleanup until instructions are received from Radiation Authority, Canadian Nuclear Safety Commission.
Response Measures

Emergency Response Assistance Plan (ERAP)

What does it do?

• The plan is intended to assist local emergency responders by providing them with access to technical experts and specially trained and equipped emergency response personnel at the scene of an incident.

• Describes the specialized response capabilities, equipment and procedures that will be used to support a response to incidents involving high-risk dangerous goods.

ERAP and Radioactive Materials

• If a shipment of radioactive material requires an ERAP, it will be provided by the consignor.

Example: CNL has an ERAP in place and approved by Transport Canada which covers the transport of HEU in solid and liquid form.
Response Measures

Emergency Response Assistance Plan (ERAP)

Where do I find ERAP information?

- *Transportation of Dangerous Goods Regulations* requires that the ERAP reference number and activation telephone number be present on the shipping documents.

  Examples:
  
  - 2-2021 ERP: 613-123-4567
  - ERAP 2-2021: 316-123-4567
  - PIU 2-2021: 613-123-4567

- For a road vehicle, shipping documents should be within the driver’s reach or clearly visible when the vehicle is unattended.

- For more information on ERAPs [click here](#).
Response Measures

Emergency Response Assistance Plan (ERAP)

**First responders are reminded to only undertake actions consistent with their training and level of equipment.**

How is it activated?

When arriving at the scene of a transportation incident involving radioactive materials, the following steps are advised:

1. Consult the Emergency Response Guide and follow applicable guidelines
2. Locate the ERAP Number on shipping document
3. Call the ERAP activation telephone number
4. If the ERAP cannot be located, call CANUTEC
5. Call the Spills Action Centre to advise of incident

- In an emergency CANUTEC may be contacted 24/7 at **1-888-CANUTEC (226-8832) / 613-996-6666** or by dialing **666** on a cellular device within Canada.
- In an emergency, the CNSC can be contacted 24/7 at **1-844-879-0805** or **613-995-0479**
- The Spills Action Centre can be contacted 24/7 at **1-800-268-6060**.
Section 5: Additional Resources and Information
Additional Resources

Provincial Resources for Hazmat/CBRNE Incident Response and HUSAR
http://www.mcsss.jus.gov.on.ca/english/FireMarshal/FireServiceResources/Communiques/OFM_Com_2016-05.html

Transport Canada - CANUTEC
www.tc.gc.ca/eng/canutec/menu.htm

Canadian Nuclear Safety Commission – Highly enriched uranium in Canada

Canadian Nuclear Safety Commission – The Safe Transport of Highly Enriched Uranium
http://www.nuclearsafety.gc.ca/cnsconline/fl/index-eng.cfm

Canadian Nuclear Laboratories – “A commitment to global safety and security”

Ministry of Health and Long-Term Care – Radiation Health Response Plan

Health Canada’s online course METER: Basic Concepts of Radiation and Protection Principles(for first receivers in a health care setting):


Emergency Management and Nuclear Security - CNSA

If First Responders are interested in receiving training in emergency response involving radioactive material, they can communicate with CNSC at cnsc.information.ccsn@canada.ca.
Conclusion

• Reader should now have a basic understanding of:

  ✓ Regulatory requirements for the transportation of radioactive materials
  ✓ Basics of radiation and potential health consequences
  ✓ How radioactive materials are transported in Ontario
  ✓ First Responder resources available in the event of transportation incident involving radioactive materials
  ✓ Where to access further information

• If you have any questions or require further information please contact askofmem@ontario.ca.