

AN OVERVIEW OF OPG'S TRANSPORTATION PROGRAM

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Abstract

OPG has been safely transporting Low and Intermediate Level Radioactive Waste for over 40 years. A strong management system exists which supports the transportation program and helps ensure a robust safety record is maintained. The objective of this paper is to review the main components of OPG's Radioactive Materials Transportation (RMT) program, the history of the program, as well as highlights and benefits.

The transportation program is thorough and rigorous, and begins with the design of robust transportation packages. OPG owns and operates a fleet of RMT packages that include Type B packagings. This type of packaging requires approvals by the Canadian Nuclear Safety Commission (CNSC) in accordance with Packaging and Transport of Nuclear Substances Regulations (PTNSR). These approvals are in the form of certificates for transport package design, and, in certain cases, Licences to Transport.

A governance structure exists to ensure both programmatic and procedural compliance for all aspects of transportation and shipping – starting from waste preparation at the stations, to shipping, through to delivery and receipt at the Western Waste Management Facility (WWMF) in Tiverton, Ontario. OPG also has a rigorous driver training program and this will be discussed in the paper. A thorough and systematic maintenance program is in place for each transportation package.

Another important component of OPG's transportation program is its Transportation Emergency Response Plan which ensures timely and appropriate response is in place for responding to emergencies involving radioactive material transportation. Coupled with the emergency response plan is a public outreach program to maintain public trust and confidence in the transportation program.

Examples of implementation of the program will be provided and a review of the recently commissioned Multi-Purpose Transportation Package will be included.

Keywords: Transportation, safety, shipping

1. Introduction

OPG's Decommissioning and Nuclear Waste Management Division (DNWMD) is responsible for the implementation and management of a Radioactive Material Transportation (RMT) program for OPG. The objective of the program is to ensure safe, regulatory compliant, efficient and environmentally responsible transportation of radioactive material across OPG.

To accomplish the task of radioactive material transportation on behalf of OPG, the RMT department provides a fleet of tractors and trailers, specialized packaging for carrying radioactive material, Transportation of Dangerous Goods qualified carriers (drivers), and a managed system.

The managed system consists of:

- a) A set of handling and shipping procedures
- b) A set of package maintenance procedures
- c) A process for scheduling and tracking shipments
- d) Specialized training and qualification of staff
- e) Internal audit and assessment program
- f) Transportation Emergency Response outreach program
- g) Independent oversight of higher risk radioactive material shipments
- h) Supporting programs, including Transportation Emergency Response Plan, vehicle and package maintenance, package design and certification

The RMT program includes controls and governance for the handling, packaging, shipment, carriage and receipt of radioactive material, and verification that emergency response for transportation incidents is appropriately established. The program consists of multiple checks and balances, and includes a quality assurance program that is compliant with the quality assurance requirements of the Canadian Nuclear Safety Commission's (CNSC) Packaging and Transport of Nuclear Substances Regulations (PTNSR). The strong management system is the foundation for the transportation program and helps RMT maintain its robust safety record. Compliance with the program ensures safety of workers, the public and the environment from the transportation of radioactive material.

2. Performance

OPG typically performs over 700 radioactive shipments per year. OPG has been safely transporting radioactive materials from its nuclear generating stations and other licensed nuclear facilities for over 45 years, and has never had an accident resulting in a radioactive release or a serious personal injury. OPG has never had an accidental release, or imminent accidental releases reportable under the Transportation of Dangerous Goods (TDG) Regulations. OPG carriers transporting radioactive material are highly trained and skilled drivers who have an excellent safety record on the road. The driver training program will be discussed in further detail in section 6.

3. Transportation needs and assets

OPG transports radioactive material on public roads on an on-going basis to sustain its nuclear fleet operations. OPG transportation needs include transporting:

1. Low and Intermediate Level Radioactive Waste from the Pickering and Darlington Nuclear Generating Stations to the Western Waste Management Facility in Tiverton, Ontario, located on the Bruce Nuclear Generating Site;
2. Radioactive tooling, equipment, sources, and moderator heavy water between the Darlington, Pickering and Bruce Nuclear Generating Stations;
3. Reactor components and single bundles of irradiated fuel to Canadian Nuclear Laboratories-Chalk River for examination; and
4. Radioactive samples and heavy water to and from Kinectrics for analysis or clean-up.

The RMT program currently has a fleet of nine tractors, over a dozen conveyances, 14 OPG-owned Type B transportation packagings, a number of leased Type B packagings, a fleet of various Type A and less transportation packagings, and a group of highly skilled and experienced TDG Class 7 carriers to execute this specialized program. The fleet has grown substantially since its inception in 1970, and the program is in the process of procuring additional Type B and Type A transportation packagings, and replacing and refurbishing trailers in an effort support Darlington Refurbishment operations, replace aging equipment, and improve efficiencies. The equipment replacement program will be discussed further in section 11.

3.1 Low and Intermediate Level Waste shipments

A large portion of OPG's radioactive shipments involve shipping Low and Intermediate Level Radioactive Waste (L&ILW) generated at the Pickering and Darlington Generating Stations to the waste storage facility, namely the Western Waste Management Facility (WWMF), located on the Bruce Nuclear Generating Site. Radioactive waste is segregated at the generating stations into Low Level Waste (LLW) incinerable, LLW compactable, LLW non-processible, and Intermediate Level Waste (ILW) following nuclear station governance. Based on the waste stream, LLW is placed into appropriate reusable containers or totes, as specified in the WWMF Waste Acceptance Criteria procedure, and then loaded and secured in an RMT Type A, 40 foot freight container – See Figures 1 and 2. ILW is loaded into specialized Type B transportation packagings. The waste is then transported to the WWMF for unloading and storage. Radiological survey data for the L&ILW is recorded on a load form and used as input for completing the radioactive shipment. Requirements for accepting L&ILW at the WWMF fall under Decommissioning and Nuclear Waste Management governance, W-PROG-WM-0001 – See Figure 3.



Figure 1: ISO 40 - Outside View



Figure 2: ISO 40 loaded with re-usable totes – Inside view

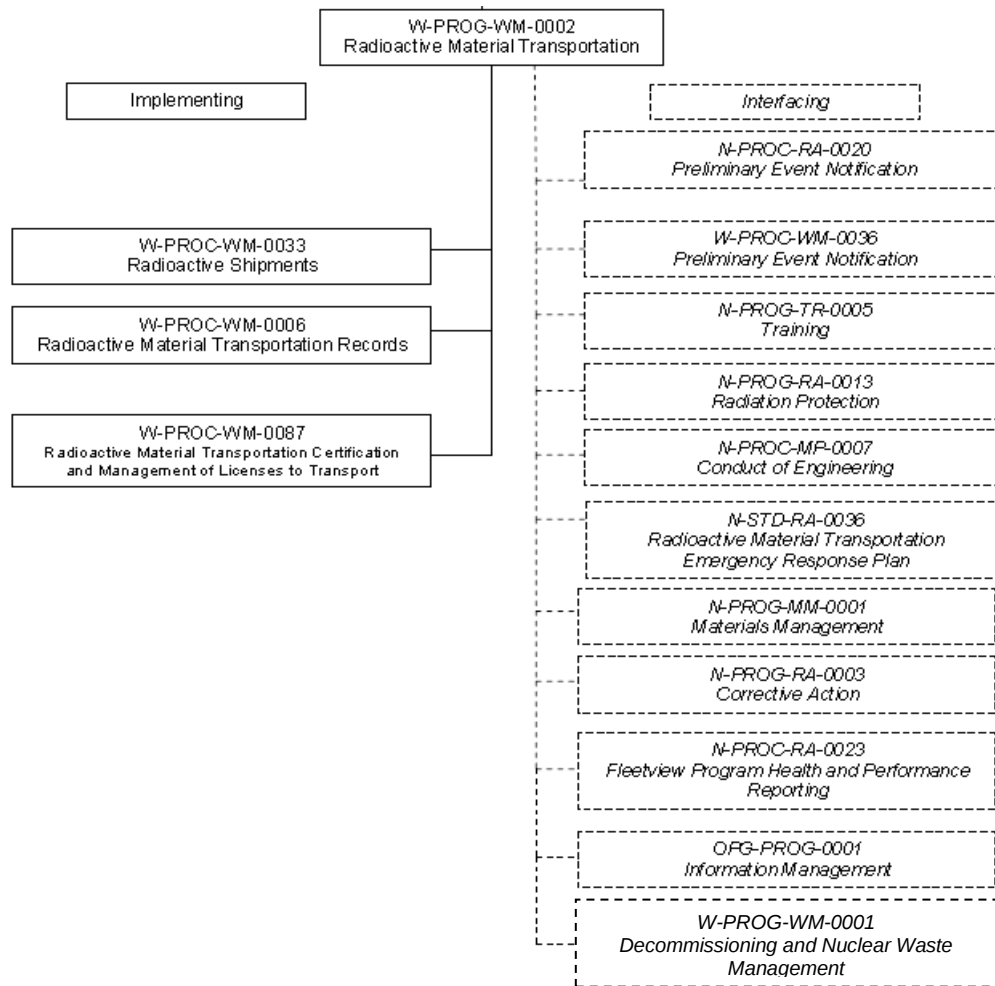


Figure 3: RMT program implementing and interfacing documentation

4. Radioactive Material Transportation governance

Figure 3: RMT program implementing and interfacing documentation, provides the hierarchy and structure of the documents that authorize, implement, and interface with the RMT program. RMT governance starts with a program document that identifies the program scope, roles and accountabilities, and governance structure (Document number: W-PROG-WM-0002). Implementation of the program is governed by a general radioactive material shipment procedure that specifies the requirements for the shipping, handling, and receiving radioactive material from OPG facilities licensed (Document number: W-PROC-WM-0033). This procedure ensures compliance with applicable regulatory requirements, OPG nuclear requirements, and RMT program requirements. There is also a records management procedure that establishes the requirements and controls for transportation packagings and shipments records, and a procedure that provides direction on obtaining and maintaining CNSC certificates for Type B transportation packages owned by OPG – See Figure 3.

4.1 Package handling, shipping and maintenance procedures

Instructions for both the use and maintenance of radioactive material (Class 7 material) packagings approved for use at OPG are contained in a series of technical procedures. These package handling and maintenance procedures are classified as “reference-use” and thus must be present and followed at the work site. The handling procedures provide instruction for receiving, handling and preparing the specific package for shipment. The maintenance procedures provide instruction on how to complete annual maintenance, inspection and testing of the specific package. The procedures ensure compliance with applicable regulations, OPG governance, and if applicable, CNSC certificates for transport package design. The procedures are regularly reviewed and updated as required.

Each Type B certificated packaging approved for use at OPG has its own procedure for packaging receipt, handling and shipping, and an associated verification sheet, as well as its own procedure for maintenance, inspection and testing, and an associated verification sheet. There is one receipt, handling and shipping procedure for all Type A and less packaging approved for use at OPG (Document number: W-PROC-WM-0040), and several packaging specific maintenance procedures.

Verification sheets consist of a checklist of essential steps that must be completed and signed-off by Class 7 qualified workers to ensure the packaging was handled, shipped, and/or received, or maintained in accordance with procedure. PTNSR requires verification of certain conditions of a transportation package at the time of loading and receipt of radioactive material. The RMT program uses verification sheets to meet and document completion of these requirements. All completed verification sheets are reviewed and signed-off by line supervision and, depending on the classification of the shipment, by a Transportation Officer prior to shipment.

4.2 Shipment documentation

In 2002, RMT implemented a computer program to generate the shipping document for each radioactive shipment at OPG. All Class 7 shipments are logged into this central computerized

database, called Electric Shipment Advice Form (ESAF), recording information about the type of material being transported, packaging, point of origin, destination, dose rates, and shipment classification and activity, etc. The program has some set logic that enables or disables appropriate fields, and automatically populates some fields. The program also has drop-down boxes for many fields which involve selecting the appropriate input from a list of options. There is an ESAF manual and procedure to assist the user with data input, and help ensure the shipping document is properly completed. The shipment document generated using the electronic program contains all information required by the regulations and additional information required by OPG governance. The computer program has many benefits over the old paper form method, including allowing users to easily pull-up past shipment information, gather historic shipping statistics, or easily call-up a shipping document during audits or inspections. The program is also a useful tool for forecasting future shipping needs.

5. Shipment management and tracking

RMT has many tools which are used to make transporting radioactive material safe and efficient for the company. Through the use of a web based GPS tracking system, RMT can instantly locate any tractor, trailer and/or package in the fleet. With an onboard navigation system in each highway tractor, RMT can instantaneously and continuously monitor a vehicle based on pre-defined conditions related to time, motion, geographic zones and other event combinations. The system is equipped with an emergency response alarm that when triggered by the carrier alerts the carriers' supervisor of the event and the need to respond. The program has the capability to provide historical electronic data reports on carrier performance, such as speed, hard breaking, and other driving efficiencies. These reports have consistently shown that RMT carrier performance is within or exceeds program expectations. Onboard linked navigation systems in the truck cabs allow direct communication between managers/dispatchers and carriers while a shipment is en-route, and provide the carrier with up-to-date weather and road conditions.

In addition to these electronic safety barriers, RMT has established a conservative adverse weather protocol, which is above industry standards and regulatory requirements. The program restricts use of RMT high-sided trailers during high wind conditions, or pulls trucks off the road before adverse weather affects a shipment's ability to be completed. The program also identifies safe locations for the carrier to stop along RMT transportation routes.

The GPS tracking system has many useful purposes that include time management, historical information on carrier performance, and shipment and carrier safety and security.

6. Class 7 shipping, handling/receiving, and carrier training

Transportation of Dangerous Goods Regulations require that anyone who handles (i.e. loading/unloading, packing/unpacking), offers for transport, or transports radioactive material (Class 7 material) be adequately trained and hold a training certificate, or be under the direct supervision of someone who does. Three Class 7 training qualifications are available, namely Class 7 shipper, Class 7 handler/receiver, and Class 7 carrier. Each qualification consists of completing a classroom course, and on-the-job training. The shipper course involves a three day classroom course, and the handler/receiver and carrier courses each involve a one day classroom course.

To be successful, trainees must obtain a minimum score of 80% on both the course written examination and on the ‘on-the-job training’ performance evaluation. Only workers who have successfully completed both the classroom course and on-the-job training will be issued a training certificate, and only those involved with a minimum number of shipments per year can remain certified.

OPG limits the number of employees qualified to ensure only those who possess the appropriate knowledge, skills and experience are involved with Class 7 transportation. OPG has developed a high quality training program in accordance with OPG Training governance, N-PROG-TR-0005 – See Figure 3. The training ensures personnel are adequately trained and the training is reviewed annually to ensure it remains up-to-date, effective, and timely. At the request of external companies, OPG also frequently delivers OPG Class 7 shipper training to personnel from external licensed facilities.

To meet facility responsibilities to the Radioactive Material Transportation program, each work group involved with radioactive material packaging and transportation, including mechanics, operators, health physics, radiation control technicians and civil maintainers, must maintain an adequate complement of trained Class 7 qualified shippers and handler/receivers, and provide line management oversight of their work to ensure compliance with the Radioactive Material Transportation program and procedures.

The Class 7 carrier training program is comprehensive and rigorous. OPG hires highly skilled and seasoned drivers, who are then extensively trained in radiation protection skills and practices, which is above industry standards. Class 7 carrier training takes about eight months to a year to complete and focuses on defensive driving, load securement, radiation protection, Class 7 Transportation of Dangerous Goods, and includes adverse weather road training by an industry leading third party specialist. In addition, a third party evaluation company assesses and grades all new hires, and regularly tests current carriers to identify areas of improvement.

7. Oversight and audits

The RMT program consists of multiple checks and balances, including Transportation Officer oversight of higher risk shipments, and internal and external audits.

OPG governance requires all higher risk, Type A and Type B radioactive shipments, where OPG is either the consignor and/or carrier or when using OPG owned packaging, be reviewed by a Radioactive Material Transportation Officer prior to being shipped as a final check before travelling on public roadways. Transportation Officer’s physically inspect each Type A and B shipment and review the shipping document and accompanying Radioactive Shipment Permit for regulatory and OPG procedural compliance. Transportation Officers check items such as safety markings, load securement, package configuration, package condition, shipment classification, and shipping documentation.

The RMT program and its supporting programs are both self and independently assessed on a routine basis to assure regulatory and OPG program compliance. Audits are planned, scheduled, and performed by qualified personnel to provide comprehensive, independent verification and

evaluation of the RMT program. Regulators, such as Transport Canada and the CNSC, also complete periodic inspections of the program and its performance. Assessment scope include aspects such as personnel training, documentation, records management, safety markings, transport procedures for shipping and receiving, package maintenance, and handling of in-house non-compliances, and transport related incidents. The assessments have not identified any regulatory infractions or significant findings, and the CNSC compliance inspections have repeatedly concluded that packaging and transportation of nuclear substances at OPG is satisfactory and acceptable. Some assessments have identified opportunities for improvement, and in response, RMT has dispositioned the recommendations, developed implementation plans and executed improvements.

8. Transportation Emergency Response Plan (TERP)

OPG has an emergency response plan for transportation incidents involving radioactive material called the Transportation Emergency Response Plan (TERP), N-STD-RA-0036 – See Figure 3. TERP is activated when there is an incident involving a radioactive material shipment by road resulting in the potential or actual release of radioactive material to the environment. Under TDG Regulations, the consignor is required to have emergency response capability and to file an emergency response plan with Transport Canada for transport of certain classifications and quantities of radioactive material. However, OPG's TERP is designed to respond to an incident involving transportation of any radioactive material, exceeding regulatory requirements. OPG's plan is registered with and has been accepted by Transport Canada.

The objective of the TERP program is to minimize radiation spread and exposure to the public, emergency responders and OPG personnel; in the event of a release of radioactive material, stop the leak, contain it, prevent loss to the environment and repack the radioactive material; and decontamination and remediation of the incident scene.

A governance structure exists for the TERP program. It includes:

- a) Documentation outlining the response and programmatic accountabilities to ensure the program is maintained and tested.
- b) Response equipment operation and maintenance procedures.
- c) A technical analysis of OPG shipment contents and packagings to identify the most credible transportation emergency incident requiring a TERP response, called the Design Basis Event Report.
- d) A TERP responder selection, training and qualification program. The training program follows the training governance framework, N-PROG-TR-0005 – See Figure 3.
- e) Activation protocols with a 24 hour OPG emergency contact number.
- f) Mutual aid assistance procedures including an external spills contractor service agreement, a mutual initial response assistance agreement with other radioactive material consignors in Ontario, Quebec and New Brunswick, and a mutual aid agreement for nuclear emergency support.

Radioactive material transportation emergency response capability is tested on an annual basis. TERP drills involve response to a simulated radioactive material transportation incident, and involve practicing and assessing the effectiveness of response materials, equipment and

personnel, and the interface with external stakeholders. The drills provide a means of validating the effectiveness of TERP's capability to ensure the safety of the public, the environment, and employee's in the event of a transportation emergency. All drills and real event responses are evaluated, and good practices and lessons learned are captured within a report so corrective actions are developed to ensure pragmatic improvements.

8.1 Emergency response community outreach program

The Radioactive Material Transportation program delivers emergency response orientation sessions in primary transportation route communities on an on-going basis. The objective of the sessions is to provide emergency responders and municipal officials with an overview of OPG's radioactive material shipping business and OPG's emergency response plan for transportation accidents. It includes information related to radiation and radioactivity, the type of packaging used, identifying typical OPG shipments by package type, and identifying requirements for hazard communication. In a typical year, about dozen orientation sessions are run.

9. Transportation packaging design

Radioactive material transportation packages are required by regulations to meet specific package design criteria and to pass tests to demonstrate they meet the criteria. All packages used by OPG are designed, tested, manufactured and used in compliance with the regulatory requirements, and in some cases, exceed regulatory requirements. Packages used to transport high risk levels of radioactive material, Type B packaging, require certification and registration by the CNSC. The RMT program tracks and maintains certificates and registrations for the thirteen Type B packaging currently used at OPG and one License to Transport Category III radioactive material. This process is governed by an internal procedure, W-PROC-WM-0087, Radioactive Materials Transportation Package Certification and Management of Licenses to Transport - See Figure 3. While packages designed for the transport of low risk levels of radioactive material do not require certification by the CNSC, these packages are still required to comply with the PTNSR. OPG retains compliance report documentation demonstrating that each of its transportation packagings are in compliance with the regulations. The RMT program implements design and configuration control measures to provide documented assurance that transport packages are in compliance with their certification.

10. Transportation packaging and vehicle maintenance

All Type B transportation packagings owned and operated by OPG as well as reusable Type A and less transportation packagings have a dedicated maintenance program developed by OPG's Transportation Engineering group. All of these packagings are maintained annually, and all chassis in the RMT fleet are maintained both quarterly and annually per the Highway Traffic Act. Chassis are also periodically refurbished, including sandblasting, repainting and weld inspection. All RMT vehicles are kept in top mechanical condition. They are frequently replaced, well before the industry end of life. All of RMT tractor-trailers are equipped with anti-rollover devices.

Annual transportation package maintenance involves replacing gaskets and fasteners, inspecting sealing surfaces and tiedown components, painting and sandblasting, decontaminating package internal surfaces as required, and where applicable, non-destructive examination of package welds and fastener threads for cracks and flaws, etc. All replacement parts (such as gaskets) used during maintenance must be the certified, approved replacement parts, which are specified in package maintenance governance, to ensure packages maintain their approved and tested design configuration, and in the case of Type B packagings, maintain compliance with their CNSC transport package design certificate.

Transportation packaging maintenance for all OPG owned and operated packaging is completed in-house by OPG employees at the WWMF. The RMT program maintains a minimum complement of specially trained, Class 7 qualified Mechanical Maintainers and only these workers are permitted to complete transportation package maintenance. These workers must successfully complete a specialized maintenance course for the Type B packagings they will complete maintenance on, in addition to holding the class 7 handler/receiver qualification discussed in section 6. As discussed in section 4.1, there is a set of procedures and verification sheets for all transportation packaging maintenance, testing and inspection. The procedures and verification sheets are followed and completed by qualified workers during all package maintenance. The completed verification sheets are conservatively retained as a record for life of the equipment plus five years.

All packaging and chassis maintenance is tracked and documented through a preventative maintenance planning system. The preventative maintenance program is a valuable tool for identifying upcoming maintenance, and ensuring all required maintenance is completed and executed in a timely manner. For example, the program automatically calls up packagings and trailers due for upcoming maintenance, alerting the OPG Scheduler that arrangements need to be made to complete the maintenance.

11. Equipment replacement

The RMT program includes a strategic equipment replacement plan to ensure that radioactive material transportation packages are replaced or supplemented as required. Aging management studies are conducted on the structures and components most vulnerable to aging to evaluate the equipment replacement plan on an ongoing basis.

RMT is in the process of replacing its older radioactive material transportation packages. The designs of the new packages incorporate improvements based on operating and maintenance experience, and utilize industry best-practices.

11.1 International Standards Organization (ISO) 20/40 packaging replacement

OPG has a fleet of eight Type A transportation freight containers, known as International Standard Organization (ISO) 20s and ISO 40s, which can function as both a conveyance and/or transportation packaging. Five of the ISOs are 40 feet long (ISO 40s) and three of them are 20 feet long (ISO 20s). The ISO 40s are used primarily to ship radioactive waste from the stations

to the WWMF – See Figures 1 and 2. The ISO 20s are primarily used to ship contaminated tools and equipment. The ISO fleet is now 15 years old and nearing the end of their reliable working life. Their very frequent use and essential role in the operation of OPG's nuclear fleet, means that the ISOs will need to be replaced in the near future. Furthermore, the upcoming Darlington Refurbishment project is expected to generate double the volume of LLW over a period of several years, which will increase demand for the ISO 40s. In order to meet the increased demand, not only will all eight ISOs be replaced, but the number of ISO 40s will increase from the current five to six.

11.2 Multi-Purpose Transportation Package

RMT currently operates six OPG Tritiated Heavy Water Transportation Packages (THWTPs), and three Radioactive Filter Transportation Packages (RFTPs), servicing Pickering, Darlington and Bruce Nuclear Generating Stations (NGS). The THWTPs are used to transport significant volumes of tritiated heavy water to and from Pickering or Bruce NGSs to the Darlington Tritium Removal Facility where tritium is removed from the heavy water and then “clean” heavy water is returned back to the stations. This activity is essential in meeting station limits for tritium content in moderator and primary heat transport systems to minimize employee dose, public dose and emission limits, and to meet Bruce Power contractual obligations. The RFTPs are used to transport ILW, such as contaminated filters, in a re-usable, shielded flask from Pickering or Darlington NGSs to the WWMF. At the WWMF, the waste is unloaded from an RFTP into an in-ground storage container. The RFTP is then shipped back with an empty shielded flask to the originating station. These transportation systems are in high demand and are critical to Ontario nuclear production.

The THWTPs and RFTPs are currently being used past their original 15 year design life. Packaging aging assessments were conducted and it was concluded that the service life could be extended from the originally estimated 15 years to 40 years. Periodic inspections of the critical components are routinely completed in order to detect any deterioration due to the aging process.

Due to the ages of the packages and their importance in the continued operation of the nuclear stations, there is a need to design and fabricate new transportation packages to eventually replace all existing THWTPs and RFTPs. The THWTP and RFTP replacement packaging is called the Multi-Purpose Transportation Package (MPTP). The MPTP has a universal design with two internal cavity configurations based on the type of payload the package will carry, i.e. tritiated heavy water, or radioactive solids in a shielded flask – See Figure 4. The MPTP design is a conservative evolution of the THWTP and RFTP designs. The MPTP design incorporates a number of improvements on the preceding designs while preserving the existing interface configurations with the intention of minimizing disruptions to established operating practices. Examples of improvements include use of double o-ring seals versus the single gasket seal, use of spring nut retention screws to replace swivel nuts facilitating easier inspection, and a reduction in the number of bolts for securing the outer packaging cover. These improvements reduce operation and maintenance efforts. As well, the outer packaging body design was changed slightly to improve resistance to shear forces in a side impact.



Figure 4: MPTP carrying tritiated heavy water

To date, two MPTPs configured to transport tritiated heavy water (two per trailer), have been successfully commissioned and in use since 2010. A third MPTP configured to carry solid ILW in a shielded flask was commissioned in 2014 and is in use for Darlington shipments. In addition, there are projects currently underway to procure and commission another set (two per trailer) of MPTP's to carry tritiated water, and another two MPTPs to carry solid ILW. These new transportation packagings are scheduled to be in-service in 2017.

12. Conclusion

In conclusion, OPG has a robust management system to support its Radioactive Material Transportation program and helps ensure a strong safety record is maintained. It is clear that the program's objective of safe, regulatory compliant, efficient and environmentally responsible transportation of radioactive material is of significant importance to OPG.

The rigorous Class 7 training program, well maintained and designed fleet of tractors, trailers, and packagings, and effective managed system allow OPG to set the industry standard for safe and reliable transportation of radioactive material in Ontario.

OPG will continue to upgrade its transportation program and assets to keep up with changing technology, operational needs, and regulatory standards to protect the public and the environment. With new large scale business opportunities like Darlington Refurbishment and the shutdown of the Pickering Nuclear Generating Station, transportation demand and public awareness of OPG's RMT program will be at an all time high.

The RMT program will continue with public outreach seminars to maintain transparency and continue its dedication to safe transportation of radioactive material in Ontario.