Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

CMD 21-H107.1B

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Supplementary Information

Written submission from Ontario Power Generation Inc.

In the Matter of

Application for a licence amendment to authorize activities related to the production and possession of Molybdenum-99 (Mo-99) at the Darlington Nuclear Generating Station (NGS)

Public Hearing - Hearing in writing based on written submissions

September 2021

Renseignements supplémentaires

Mémoire de Ontario Power Generation Inc.

À l'égard de

Demande de modification de permis en vue d'obtenir l'autorisation de produire du molybdène 99 (Mo-99) à la centrale nucléaire de Darlington

Audience Publique - Audience fondée sur des mémoires

Septembre 2021

Canada

ONTARIO POWER GENERATION

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September 24, 2021

NK38-00531 P
NK38-CORR-00531-22780 P

Mr. M. Leblanc
Commission Secretary,
Canadian Nuclear Safety Commission
P.O. Box 1046
280 Slater Street
OTTAWA, Ontario
K1P 5S9

Dear Mr. Leblanc:

Darlington NGS – Response to the questions Commission Panel Members Addressed in CMD-H107Q Regarding the Application for PROL 13.02/2025 Amendment to Authorize Production and Possession of Molybdenum-99

The purpose of this letter is to provide the Canadian Nuclear Safety Commission, referred to as the "Commission", response to the questions Commission Panel members addressed to OPG in CMD-H107Q (References 1 and 2).

The supplemental CMD is in consideration of OPG request for an amendment of Darlington Nuclear Generating Station Power Reactor Operating Licence PROL 13.02/2025 to authorize the Molybdenum-99 (Mo-99) radioisotope production and possession.

Attachment 1 of this submission provides OPG responses to the questions from Table 2 of CMD-H107Q (References 1 and 2).

OPG follows robust, well established processes for the design, construction, installation and commissioning activities for Mo-99 IIS including OPG's Engineering Change Control Process. By adhering to these robust processes, OPG ensures that the Mo-99 IIS complies with industry codes and standards and can be safely operated.

OPG has concluded that the proposed activities to support production of Mo-99 in selected Darlington NGS CANDU reactors will not compromise continued safe reactor operation, nor impact on safe generation of electricity for the province of Ontario.

Should you have any questions, please contact Ms. Paulina Herrera, Manager, Darlington Regulatory Affairs, at (289) 387-0520.

Sincerely,

Steve Gregoris
Senior Vice President
Darlington Nuclear
Ontario Power Generation Inc.

Attach.

cc: Mr. J. Burta – CNSC (Ottawa)

CNSC Acting Site Supervisor
forms-formulaires@cnsc-ccsn.gc.ca

References:

1. Questions from Commission Panel Members, CMD 21-H107Q: Application for a licence amendment to authorize activities related to the production and possession of Molybdenum-99 (Mo-99) at the Darlington Nuclear Generating Station (NGS), September 9, 2021, e-Docs pdf: 6637962.

2. Questions from Commission Panel Members, CMD 21-H107Q – Erratum: Application for a licence amendment to authorize activities related to the production and possession of Molybdenum-99 (Mo-99) at the Darlington Nuclear Generating Station (NGS), September 22, 2021, e-Docs pdf: 6646318.

ATTACHMENT 1

OPG letter S. Gregoris to M. Leblanc, “Darlington NGS – Response to the questions Commission Panel Members Addressed in CMD-H107Q Regarding the Application for PROL 13.02/2025 Amendment to Authorize Production and Possession of Molybdenum-99” ”

CD# NK38-CORR-00531-22780

Response to Commission Panel Questions – Table 2 of CMD-21-H107Q

Prepared by: **I. Malek**

Checked by: **J. Chapin**

ATTACHMENT 1

Response to Commission Panel Questions – Table 2 of CMD-21-H107Q (References [1] and [2])

Commission Panel question#1

Some interveners have raised the point that this proposal (i.e. first-of-a-kind (FOAK) initiative), relatively speaking, is more technically complicated than other extant neutron irradiation (i.e. 98 Mo (n, gamma) 99 Mo) systems. The point has also been raised that there is no operational experience (i.e. OPEX) with this design. Why was a more technically complicated process with no OPEX chosen?

OPG response for question#1

Early in the Project, overall Operating Experience (OPEX) was obtained through interviews with Oak Ridge National Laboratory (ORNL) and TRI University Meson Facility (TRIUMPH).

The Molybdenum-99 Isotope Irradiation System (Mo-99 IIS) is no more complicated than many other systems in Darlington Nuclear Generating Station. The basic concept of irradiating material in a reactor is well understood. The system for moving targets into and out of the core is indeed First of a Kind, and though the assembled system configuration is somewhat unique, each component of the system is based on existing tried principles:

- The elevator and basket's basic functions are similar to the winch suspended adjuster it replaces.
- Once the basket docks in the elevator, the transfer of targets in and out of the basket follows known hydraulic propulsion methods.
- The airlock is a common feature in systems reviewed during the design concept stages.
- Common pneumatic propulsion methods are used to safely transfer capsules to the transport flask and introduce new targets.

Therefore, collectively the operational characteristics of individual processes comprising the system are well understood and appropriately engineered.

A further source of OPEX, in the above areas, are events documented by OPG in Station Condition Records database (SCRs), as described in OPG CMD-21-H107.1 Section 2.1.7 "OPEX". OPEX reviews were conducted during various stages of the Mo-99 IIS project to identify previous applicable experience and lessons learned. The external events are documented in the CANDU Owners Group (COG) database. The results of these OPEX reviews were documented in Conceptual Design Report and used as part of the design process.

As stated in OPG CMD 21-H107.1, Section 1.7, Page 9, OPG's top priority is safety. This is demonstrated through adherence to OPG's ECC process throughout the development of Mo-99 IIS. The Mo-99 IIS will also undergo extensive commissioning and testing prior to the introduction of targets to ensure safe, reliable operation.

Commission Panel question#2

An intervener (CMD 21-H107.2) raised the question of why an empiric, real-world demonstration of how the proposed target apparatus will respond to irradiation, e.g. in a research reactor setting, is not required versus a more theoretical "proof of principle"approach. Please respond.

OPG response for question#2

Demonstrations of target irradiation in the University of Missouri Research Reactor (MURR) were performed as an important and complimentary step to the activation analysis. MURR is a tank-type nuclear research reactor in the U.S. with 10 megawatt thermal output. The target irradiation in MURR provided confirmatory information to proceed to full production at Darlington NGS.

In addition to testing in a research reactor, the changes made at Darlington NGS to introduce Mo-99 IIS are subject to stringent safety analysis in accordance with CNSC regulatory requirements. OPG confirms that safety is not affected by the introduction of this system. The ability to control power, cool the fuel, and contain radioactivity remains unchanged. The introduction of Mo-99 IIS does not alter the safety case or result in any reduction of safety margin, as documented in OPG CMD-21-H107, Section 2.4, "Safety Analysis".

Commission Panel question#3

What is the ultimate fate of an irretrievable 98 Mo target and associated apparatus relative to the target itself and to operations of the involved unit?

OPG response for question#3

The potential pneumatic and hydraulic propulsion issues, such as position control, arrest at end of flight, target construction, stuck targets, and heat generation were incorporated in the design concept and improvements made.

The requirements for fail safe operation were defined and implemented in IIS software. For example, should the basket fail, the main control room interface would announce the condition.

A mispositioned target resulting from seeding or harvesting has no adverse operational consequence. For all stalls or breakdown of the Mo-99 IIS above or outboard of the RMD deck, there is no effect on the reactor.

Irretrievable targets in the core can be left in place and retrieved during a planned routine outage for reactor maintenance. Conservative analysis was performed for a target stuck in the core for up to 7 years. The reactivity of the targets slowly declines with irradiation, and the analysis showed that a target stuck in the core for 7 years will have no effect on reactor operation.

The ultimate fate of the target that has been inside the core for too long would be disposal as radioactive waste in accordance with waste handling procedures.

Commission Panel question#4

From CMD 21-H107, p.15: "During harvesting, the targets will be held for period of time under the RMD out of the flux fields of the reactor, a stage referred to as the dwell period, to allow for decay of some short-lived high energy activation products to reduce the radiation hazard."

Please clarify how long this dwell period storage will be and how much reactivity is expected to remain from non- 99 Mo sources after this period. What are the major remaining activation isotopes and what are their half-lives?

OPG response for question#4

The two isotopes affecting the chosen dwell time of 2 hours are:

- Mo101 (15 min half-life) from the targets and
- Mn56 (2.6 hr half-life) from the capsule.

After dwell, 95% of the shielded dose rate is due to Mo99 (66 hrs) and Mo101 (15 minutes) from target material while Mn56 (2.6 hrs), Zr97 (171 hrs) and Na24 (15 hrs) contribute from the zirconium sheath material.

70 Ci/capsule remain after dwell with contributions from non Mo99/Tc99 isotopes in the target and from the capsule material. OPG will follow established Radiation Protection procedures, including remote handling as required, to ensure personnel are always protected during these periods.

Commission Panel question#5

As BWXT is the shipper and transporter, if a transport accident, incident, were to occurwhile still on OPG property how would it be managed? Is there a protocol which clearly outlines roles and responsibility of the shipper and OPG while the product is still on site?

OPG response for question#5

The harvested irradiated targets will be loaded by OPG staff into a BWXT transportation package, a shielded flask and overpack, that is certified by the Commission. The flask will be loaded onto a truck for transport to BWXT Medical laboratory. BWXT staff will be responsible for transportation from Darlington station to BWXT-Medical in Kanata, Ontario. OPG, as the consignor, will be responsible for packaging the radioactive material and preparing the shipping documents.

BWXT-Medical, being the shipper, would be the primary contact in the event of a transportation accident off site. BWXT-Medical may request OPG's assistance, depending on the proximity of the accident to OPG's nuclear facilities. Both BWXT-Medical and OPG have emergency transportation response capability.

While the transportation vehicle is on site at Darlington NGS, responses to a potential vehicle accidents or incidents carrying radioactive material require adherence to OPG's Radiation Protection (RP) Program. Site qualified Radiation Protection personnel with support from Darlington NGS security would assess the situation and follow approved RP procedures in place, N-PROC-RA-0027, "*Radioactive Work Planning, Execution And Close Out"*. If applicable, the safe handling of the shipment on the vehicle would be in accordance with W-PROC-WM-0033: "*Radioactive Shipments*". W-PROC-WM-0033 would be followed if the shipment would need to be removed from truck and re-assembled and packaged onto different truck for any reason due to the accident.

If such an event were to occur while on site, the Class 7 Carrier of the shipment would notify the OPG Shift Manager/Mo-99 Project Front Line Manager, Transportation Officer, Class 7 shipper, and Security personnel to support resolution of the event. An SCR would be initiated to document the adverse conditions, issue resolutions and mitigation actions, and any lessons learned.

OPG has a long history of safe handling and shipments of radioactive packages/shipments. There have been 291 Class 7 radioactive shipments from Darlington NGS in 2021, year to date, and a total of 5,120 radioactive shipments originating from Darlington NGS, via all qualified Class 7 carriers since electronic records have been filed in 2002. There have been no accidents with respect to these radioactive shipments.

Commission Panel question#6

Please clarify, with specific examples, Indigenous engagement activities completed by OPG related to the transportation route between OPG and the BWXT Kanata facility.
As BWXT will, in essence, be the shipper, transporter and receiver for the neutron activated product, is OPG aware of specific engagement activities completed by BWXT Indigenous communities along the transportation route?

OPG response for question#6

OPG acknowledges the Aboriginal and Treaty Rights of Indigenous communities as recognized in the Constitution Act, 1982. Under its Indigenous Relations Policy, OPG regularly undertakes engagement with Indigenous communities with established or asserted rights and/or interests in any given project area.

In the case of the Mo-99 IIS project, it was key that Laurentis Energy Partners (LEP), wholly owned by OPG, and its business partner BWXT, engage with the Indigenous communities located proximate to the planned production of the isotope at Darlington NGS as well as the Mo-99 transportation route along highways 401, 416 and 417, which traverses the treaty and traditional territories of multiple communities.

The communities engaged were identified in co-operation with CNSC staff. These engagement activities were conducted jointly by OPG/LEP and BWXT. The table below provides examples:

Community	Date	Location	Comments
Metis Nation of Ontario Region 8	Jan 13, 2019	OPG 889 Brock Road	Presentation to local Council members and MNO HQ staff Toronto. OPG and BWXT gave joint presentation.
Williams Treaties First Nations	Jan 24, 2019	Darlington Energy Centre	Presentation to Scugog Island, Rama, Alderville. OPG and BWXT gave joint presentation.
Williams Treaties First Nations	March 13, 2019	BWXT Peterborough	Presentation to Hiawatha, Curve Lake done jointly by BWXT and OPG.
Metis Nation of Ontario Region 6 (includes Ottawa Council)	April 27, 2019	BWXT Peterborough	Presentation to local Council members and MNO HQ staff Toronto.
Mohawks of the Bay of Quinte	April 29, 2019	Tyendinaga	Presentation to Chief and Council. (BWXT and OPG/LEP co-presented to the Chief and council)
Algonquins of Ontario (AOO)	May 13, 2019	Pembroke	Presentation to AOO Council. (BWXT and OPG/LEP co-presented to the AOO council)
Pikwakanagan First Nation	May 14, 2019	Nordion site, Kanata	Presentation to First Nation staff. (BWXT and OPG/LEP co-presented to First nation staff)
Algonquin Anishinabeg Nation Tribal Council (Algonquin of Quebec).	Oct 18, 2019	OPG offices Ottawa.	Presentation to First Nation AANTC staff. (BWXT and OPG/LEP co-presented to the AANTC staff)
Williams Treaties First Nations	Feb 11, 2020	Darlington Energy Centre	OPG and BWXT gave joint Project update.
Mohawks of the Bay of Quinte	Feb 18, 2020	Darlington Energy Centre	OPG and BWXT gave joint Project update.
Pikwakanagan First Nation	Feb 28, 2020	At First Nation and on-line.	OPG and BWXT gave joint Project update.
COVID 19 Protocols: March 2020: All subsequent meetings below were on line or by E mail			
CNSC	April 29, 2020	On-line.	Project update call re: Indigenous engagement to date. OPG and BWXT Jointly presented.
All identified Indigenous communities.	June 5, 2020	Email.	Email contained latest project information with offer to meet virtually in order to answer any questions.

Metis Nation of Ontario Region 8	Sept 30, 2020	On-line.	Project update. OPG and BWXT gave joint presentation.
All identified Indigenous communities.	April 27, 2021	Email.	Email contained latest project information with offer to meet virtually in order to answer any questions.

OPG/LEP and BWXT engaged with the identified Indigenous communities together in order to provide them with information regarding the production and transportation of the medical isotope and to discuss any issues and concerns.

References:

[1] Questions from Commission Panel Members, CMD 21-H107Q: Application for a licence amendment to authorize activities related to the production and possession of Molybdenum-99 (Mo-99) at the Darlington Nuclear Generating Station (NGS), September 9, 2021, e-Docs pdf: 6637962.

[2] Questions from Commission Panel Members, CMD 21-H107Q – Erratum: Application for a licence amendment to authorize activities related to the production and possession of Molybdenum-99 (Mo-99) at the Darlington Nuclear Generating Station (NGS), September 22, 2021, e-Docs pdf: 6646318.

Summary of Regulatory Commitments, Regulatory Obligations and Regulatory Management Actions Made/Concurrence Requested

NK38-CORR-00531-22780

Submission Title: **Darlington NGS – Response to the questions Commission Panel Members Addressed in CMD-H107Q Regarding the Application for PROL 13.02/2025 Amendment to Authorize Production and Possession of Molybdenum-99**

Regulatory Commitments (REGC):

No.	Description	Date to be Completed
	None	

Regulatory Management Action (REGM):

No.	Description	Date to be Completed
	None	

Regulatory Obligation Action (REGO):

No.	Description	Date to be Completed
	None	

Concurrence Requested: None