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Supplementary Information

Written submission from Ontario Power Generation

In the Matter of

Ontario Power Generation

Ontario Power Generation – Licence amendment application for the Darlington Nuclear Generating Station regarding the commercial production of Cobalt-60

Public Hearing – Hearing in writing based on written submissions

Spring 2024

Renseignements supplémentaires

Mémoire d' Ontario Power Generation

À l'égard d'

Ontario Power Generation

Ontario Power Generation – Demande concernant la modification de son permis pour la centrale nucléaire de Darlington en vue de produire commercialement du Cobalt-60

Audience publique – Audience fondée sur des mémoires

Printemps 2024

Canada

ONTARIO POWER GENERATION

Richard Geofroy
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Darlington Nuclear

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December 22, 2023

CD# NK38-CORR-00531-25073 P

Ms. M. Bacon-Dussault
Acting Commission Registrar
Canadian Nuclear Safety Commission
P.O. Box 1046
280 Slater Street
OTTAWA, Ontario
K1P 5S9

Dear Ms. Bacon-Dussault:

Darlington NGS – Addendum to the Application for Darlington Nuclear Generating Station Power Reactor Operating Licence 13.03/2025 Amendment for Production of the Cobalt-60 Radioisotope

The purpose of this letter is to submit to the Canadian Nuclear Safety Commission, referred to as "the Commission", an addendum to the request for an amendment to Darlington Nuclear Generating Station (NGS) Power Reactor Operating Licence (PROL) 13.03/2025 to add, as a new activity, Cobalt-60 (Co-60) radioisotope production. As presented in References 1 and 2, OPG's request for an amendment to the Darlington PROL 13.03/2025 to add a new licensed activity to possess, transfer, produce, package, manage and store the Co-60 radioisotope, remains unchanged.

Co-60 is an essential radioisotope used in the medical and food industries. The primary application of Co-60 continues to be the sterilization of single-use medical devices, such as surgical gowns, latex gloves, catheters, scalpels, bandages, swabs for COVID-19 testing and implants. Certain foods and food ingredients are treated with gamma irradiation from Co-60 to make them safer, reduce spoilage and extend shelf life. Irradiation will kill parasites and microorganisms that cause foodborne illnesses.

OPG has been producing the Co-60 radioisotope in Pickering NGS's CANDU reactors for decades, providing a significant portion of worldwide production (15-20%). The Co-60 Production Modifications Project at Darlington NGS provides an opportunity for OPG and Canada to maintain long-term supply of Co-60 and continue to be a major contributor of the radioisotope with significant health, safety and social benefits.

The introduction of Co-60 radioisotope production at Darlington NGS is a continuation of OPG's practice, and OPG is confident in the proposed process and approach. OPG plans to utilize all four of Darlington NGS's reactors for the irradiation of Cobalt-59 (Co-59) rods to produce Co-60. Co-60 production will overlap with Molybdenum-99 (Mo-99) production in Darlington NGS Unit 2.

The Co-60 Production Modification Project construction window, presented in Reference 2, provides the schedule details for each unit modification installation between the time period of 2022 to 2027. All unit modification installations have been scheduled to be completed during refurbishment and planned outages with some online work for Unit 2.

OPG is committed to the safe and reliable operation of Darlington NGS. The design documents, engineering assessments and nuclear safety analyses completed for the modifications to Darlington NGS to produce Co-60 demonstrate that the addition of this new licensed activity can be carried out safely at Darlington NGS, and will not compromise continued safe reactor operation, nuclear safety, public safety, the environment or international agreements to which Canada is a signatory.

As part of this addendum, Attachment 1 provides updates to the proposed amendment to Darlington's PROL 13.03/2025, originally submitted as Attachment 1 of Reference 1.

Attachment 2 provides the compliance matrix for the *Nuclear Safety and Control Act*, and the associated regulations required for the amendment of the Darlington NGS PROL to add the proposed new licensed activity, that remains unchanged from the submission in Reference 1.

Attachment 3 provides updates to enhance the information provided in Reference 1 to the impact assessment of the proposed new licensed activity on Darlington's licensing bases for each of the 14 PROL Safety and Control Areas and Nuclear Facility Specific licence conditions, to support the application for PROL amendment.

OPG continues to regularly engage with Indigenous Nations and communities with established or asserted rights and/or interests in the areas surrounding OPG operations. As part of its engagement plan, OPG conducted and continues to conduct updates/meetings with the identified Indigenous Nations and communities, leading up to the licensing hearing to further discuss the project. Nordion will be responsible for the conveyance of Co-60 to their processing facility and for any engagement, with OPG's support, with the Indigenous Nations and communities along the transportation route. OPG is prepared to provide capacity support to the engaged Indigenous Nations and communities, in line with the Indigenous Relations Policy and the scope of the engagement required.

In summary, this submission provides supplemental information in support of the OPG request to the Commission to amend the Darlington PROL 13.03/2025 to add a new licensed activity to possess, transfer, produce, package and manage the Co-60 radioisotope. OPG remains committed to safe operation of the Darlington NGS units, and re-affirms that the Co-60 system can be implemented as presented in the robust safety case. Assessments completed conclude that the proposed activities to support production of Co-60 will not compromise continued safe reactor operation, environmental protection and public safety. OPG will continue to meet Canada's international obligations under the *Treaty on the Non-Proliferation of Nuclear Weapons*.

Should you have any questions, please contact Liliana Moraru, Manager – Strategic Projects, at (905) 260-4089 or Liliana.moraru@opg.com.

Sincerely,

Richard Geofroy
Senior Vice President
Darlington Nuclear
Ontario Power Generation Inc.

Attach.

cc: CNSC Site Supervisor – Darlington
forms-formulaires@cnsc-ccsn.gc.ca
A. Viktorov – Ottawa
A. Mathai – Ottawa
S. Baskey – Ottawa

References:

1. OPG letter, R. Geofroy to D. Saumure, “Darlington NGS – Application for Darlington Nuclear Generating Station Power Reactor Operating Licence 13.03/2025 Amendment for Production of the Cobalt-60 Radioisotope”, April 28, 2023, CD# NK38-CORR-00531-23462

2. OPG letter, R. Geofroy to D. Saumure, “Darlington NGS – Supplemental Submission to Application for Darlington Nuclear Generating Station Power Reactor Operating Licence 13.03/2025 Amendment for Production of the Cobalt-60 Radioisotope”, June 30, 2023, CD# NK38-CORR-00531-24619

ATTACHMENT 1

OPG letter R. Geofroy to M. Bacon-Dussault, “Darlington NGS – Addendum to the Application for Darlington Nuclear Generating Station Power Reactor Operating Licence 13.03/2025 Amendment for Production of the Cobalt-60 Radioisotope””

CD# NK38-CORR-00531-25073

Proposed Amendment to Darlington NGS PROL 13.03/2025

Prepared by: **S. Khan/A. McGee**

Checked by: **L. Moraru**

ATTACHMENT 1

Revise Proposed Amendment to Darlington NGS PROL 13.03/2025

Current PROL 13.03/2025	Requested Amendment to PROL 13.03/2025 (Revised proposed amendment in bold and italic)
IV) LICENSED ACTIVITIES:	**IV) LICENSED ACTIVITIES:**
This licence authorizes the licensee to:	This licence authorizes the licensee to:
(i) operate the Darlington Nuclear Generating Station which includes the Darlington Tritium Removal Facility housed within the Heavy Water Management Building (hereinafter "the nuclear facility") at a site located in the Municipality of Clarington, in the Regional Municipality of Durham, in the Province of Ontario;	(i) operate the Darlington Nuclear Generating Station ***and the authorized equipment for the production of equipment of medical radionuclides***, which includes the Darlington Tritium Removal Facility housed within the Heavy Water Management Building (hereinafter "the nuclear facility") at a site located in the Municipality of Clarington, in the Regional Municipality of Durham, in the Province of Ontario;
(ii) possess, transfer, use, package, manage and store the nuclear substances that are required for, associated with, or arise from the activities described in (i);	(ii) possess, transfer, use, package, manage and store the nuclear substances that are required for, associated with, or arise from the activities described in (i);
(iii) import and export nuclear substances, except controlled nuclear substances, that are required for, associated with, or arise from the activities described in (i);	(iii) import and export nuclear substances, except controlled nuclear substances, that are required for, associated with, or arise from the activities described in (i);
(iv) possess and use prescribed equipment and prescribed information that are required for, associated with, or arise from the activities described in (i);	(iv) possess and use prescribed equipment and prescribed information that are required for, associated with, or arise from the activities described in (i);
(v) possess, transfer, process, package, manage and store the nuclear substances associated with the operation of the Darlington Tritium Removal Facility;	(v) possess, transfer, process, package, manage and store the nuclear substances associated with the operation of the Darlington Tritium Removal Facility;
(vi) possess, transfer, process, package, manage and store Molybdenum-99 radioisotope and its associated decay isotopes.	(vi) ***possess, transfer, process, package, manage and store nuclear substances that are required for associated with, or arise from the activities associated with, described in operations of Darlington Nuclear Generating Station and activities described in (i) as OPG produces (1) Co-60; and (2) Mo-99 (including its decay isotopes).***

ATTACHMENT 2

OPG letter R. Geofroy to M. Bacon-Dussault, “Darlington NGS – Addendum to the Application for Darlington Nuclear Generating Station Power Reactor Operating Licence 13.03/2025 Amendment for Production of the Cobalt-60 Radioisotope””

CD# NK38-CORR-00531-25073

Licence Amendment Matrix – Nuclear Safety and Control Act and Applicable Regulations

Prepared by: **R. Kovinthan**

Checked by: **P. Le Dreff**

ATTACHMENT 2

Licence Amendment Matrix - Nuclear Safety and Control Act and Applicable Regulations

This Attachment, along with Attachment 3 of this submission, provide the information required by the *Nuclear Safety and Control Act* and the applicable Nuclear Regulations made pursuant to the Act, to support an application by OPG to amend the current Darlington NGS Power Reactor Operating Licence (PROL) 13.03/2025 to allow a new licensed activity to possess, transfer, produce, package, manage and store the Cobalt-60 (Co-60) radioisotope.

The tables below are divided by applicable regulation and demonstrate how OPG has addressed each of the applicable regulatory requirements of the subject regulation for its licence amendment request.

Nuclear Safety and Control Act		
Section	**Regulatory Requirement**	**OPG Response**
Licences		
24	***Licences*** (1) *The Commission may establish classes of licences authorizing the licensee to carry on any activity described in any of paragraphs 26(a) to (f) that is specified in the licence for the period that is specified in the licence.* ***Application*** *(2) The Commission may issue, renew, suspend in whole or in part, amend, revoke or replace a licence, or authorize its transfer, on receipt of an application* *(a) in the prescribed form;* *(b) containing the prescribed information and undertakings and accompanied by the prescribed documents; and* *(c) accompanied by the prescribed fee*	This submission requests the amendment of Darlington NGS PROL 13.03/2025 to add a new licensed activity to possess, transfer, produce, package, manage and store the Co-60 radioisotope. This Attachment, along with Attachment 3 of this submission, provide the information required by the *Nuclear Safety and Control Act* and the applicable Nuclear Regulations made pursuant to the Act, and provide supplemental information in support of OPG's application for PROL amendment. OPG is in good standing with respect to the provision of CNSC licensing fees and will provide any additional fees associated with this PROL amendment request, if requested.
	Conditions for issuance, etc. *(4) No licence shall be issued, renewed, amended or replaced —*	OPG understands that qualification will be determined through consideration by the Commission of this application for licence amendment and the associated

Nuclear Safety and Control Act		
Section	**Regulatory Requirement**	**OPG Response**
	and no authorization to transfer one given — unless, in the opinion of the Commission, the applicant or, in the case of an application for an authorization to transfer the licence, the transferee *(a) is qualified to carry on the activity that the licence will authorize the licensee to carry on; and* *(b) will, in carrying on that activity, make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.*	supporting material, as well as deliberation through the Commission decision-making process. OPG is qualified to safely undertake the additional activities associated with the production of Co-60 at Darlington NGS. Attachment 3 of this submission documents the assessments completed and provisions established in support of the licence amendment request. Specifically: - Section 3.4 documents the safety assessments. - Section 3.8 documents worker health and safety provisions. - Section 3.9 documents assessments and impact on environmental protection. - Section 3.12 documents the security considerations. - Section 3.13 documents the impact on Canada's international obligations related to safeguards and non-proliferation.
25	**Renewal, etc.** *The Commission may, on its own motion, renew, suspend in whole or in part, amend, revoke or replace a licence under the prescribed conditions.*	OPG understands this requirement and will continue to comply.
26	***Prohibitions*** *Subject to the regulations, no person shall, except in accordance with a licence,* *(a) possess, transfer, import, export, use or abandon a nuclear substance, prescribed equipment or prescribed information;*	OPG understands these requirements and will continue to comply. This licence amendment application and Attachment 3 of this submission provides the information required to accompany the request to licence Darlington NGS to perform the activities required to produce the Co-60 radioisotope.

Nuclear Safety and Control Act		
Section	**Regulatory Requirement**	**OPG Response**
	(b) mine, produce, refine, convert, enrich, process, reprocess, package, transport, manage, store or dispose of a nuclear substance; *(c) produce or service prescribed equipment;* *(d) operate a dosimetry service for the purposes of this Act;* *(e) prepare a site for, construct, operate, modify, decommission or abandon a nuclear facility; or* *(f) construct, operate, decommission or abandon a nuclear-powered vehicle or bring a nuclear-powered vehicle into Canada.*	
Records and Reports		
27	***Records and reports*** *Every licensee and every prescribed person shall* *(a) keep the prescribed records, including a record of the dose of radiation received by or committed to each person who performs duties in connection with any activity that is authorized by this Act or who is present at a place where that activity is carried on, retain those records for the prescribed time and disclose them under the prescribed circumstances; and* *(b) make the prescribed reports and file them in the prescribed manner, including a report on* *(i) any theft or loss of a nuclear substance, prescribed equipment or prescribed information that is used in carrying on any activity that is authorized by this Act, and*	OPG understands these requirements and will continue to comply in accordance with provisions/requirements stated in Darlington's Licence Conditions Handbook section A.5, *"Record Keeping"* and applied through OPG program N-PROG-AS-0001, *"Nuclear Management System Administration"*.

Nuclear Safety and Control Act		
Section	**Regulatory Requirement**	**OPG Response**
	(ii) any contravention of this Act in relation to an activity that is authorized by this Act and any measure that has been taken in respect of the contravention.	
Procedures for Decisions and Orders		
40	***Public hearings*** *(5) The Commission shall, subject to any by-laws made under section 15 and any regulations made under section 44, hold a public hearing with respect to* *(a) the proposed exercise by the Commission, or by a panel established under section 22, of the power under subsection 24(2) to issue, renew, suspend, amend, revoke or replace a licence; and* *(b) any other matter within its jurisdiction under this Act, if the Commission is satisfied that it would be in the public interest to do so.*	OPG is providing the Licensing Impact Assessment in Attachment 3 of this submission, in support of an application for the amendment to Darlington's PROL 13.03/2025 to add a new licensed activity to possess, transfer, produce, package, manage and store the Co-60 radioisotope.

General Nuclear Safety and Control Regulations		
Section	**Regulatory Requirement**	**OPG Response**
Licences – General Application Requirements		
3 (1)	*An application for a licence shall contain the following information:* *(a) the applicant's name and business address;*	Ontario Power Generation Inc. P.O. Box 4000, Bowmanville, Ontario L1C 3Z8 Contact person, signing authority and licence holder: Richard Geofroy Senior Vice President Darlington Nuclear, Ontario Power Generation Telephone: (289) 387-0016
	(b) the activity to be licensed and its purpose;	In this submission, OPG is requesting an amendment to the Darlington NGS PROL 13.03/2025 to add a new licensed activity to possess, transfer, produce, package, manage and store the Co-60 radioisotope.
	(c) the name, maximum quantity and form of any nuclear substance to be encompassed by the licence;	Maximum quantity and form of the Co-60 radioisotope as per Section 1.6 of Attachment 3 of this submission.
	(d) a description of any nuclear facility, prescribed equipment or prescribed information to be encompassed by the licence;	A description of the required reactor and facility modifications is provided in Section 1 of Attachment 3 of this submission.
	(e) the proposed measures to ensure compliance with the Radiation Protection Regulations, the Nuclear Security Regulations and the Packaging and Transport of Nuclear Substances Regulations, 2015;	OPG understands this requirement and will remain in compliance with the current licence conditions documented in PROL 13.03/2025, and with the *Radiation Protection Regulations*, the *Nuclear Security Regulations*, and the *Packaging and Transport of Nuclear Substances Regulations*. As described in Sections 3.7, 3.12 and 3.14 of Attachment 3 of this submission, and in accordance with provisions/requirements stated in Darlington's Licence

General Nuclear Safety and Control Regulations		
Section	**Regulatory Requirement**	**OPG Response**
		Conditions Handbook sections 7 *"Radiation Protection"*, 12 *"Security"* and 14 *"Packaging and Transport"* and applied through OPG programs N-PROG-RA-0013, *"Radiation Protection"*, N-PROG-RA-0011, *"Nuclear Security",* and W-PROG-WM-0002, *"Radioactive Material Transportation"*.
	(f) any proposed action level for the purpose of section 6 of the Radiation Protection Regulations;	This request for PROL amendment to add Co-60 production activities does not require a change to the radiation protection action levels.
	(g) the proposed measures to control access to the site of the activity to be licensed and the nuclear substance, prescribed equipment or prescribed information;	This request for PROL amendment to add Co-60 production activities does not require changes to the measures to control Darlington NGS site access, the nuclear substance, prescribed equipment or information.
	(h) the proposed measures to prevent loss or illegal use, possession or removal of the nuclear substance, prescribed equipment or prescribed information;	This request for PROL amendment to add Co-60 production activities will not require changes to the measures to prevent loss or illegal use, possession or removal of the nuclear substance, prescribed equipment or prescribed information.
	(i) a description and the results of any test, analysis or calculation performed to substantiate the information included in the application;	This request for PROL amendment to add Co-60 production activities is supported by a robust safety case that has been submitted to CNSC staff and is summarized in Attachment 3 of this submission.
	(j) the name, quantity, form, origin and volume of any radioactive waste or hazardous waste that may result from the activity to be licensed, including waste that may be stored, managed, processed or disposed of at the site of the activity to be licensed, and the proposed method for managing and disposing of that waste;	As documented in Section 3.11 of Attachment 3 of this submission, minimal volume of radioactive waste will be generated from Co-60 production operations. There are two waste streams generated as part of the Co-60 production operations: 1) Production scrap from harvesting activities, which will be managed in accordance with OPG's current programs and processes, and 2) Spent cobalt, which will be taken back by OPG and stored in a licenced facility. No hazardous waste will be generated from Co-60 productions.

General Nuclear Safety and Control Regulations		
Section	**Regulatory Requirement**	**OPG Response**
	(k) the applicant's organizational management structure insofar as it may bear on the applicant's compliance with the Act and the regulations made under the Act, including the internal allocation of functions, responsibilities and authority;	The organizational management structure will not change as a result of the requested licence amendment.
	(l) a description of any proposed financial guarantee relating to the activity to be licensed; and	OPG understands the regulatory requirements for a financial guarantee. The financial guarantee documented in Reference [1] will not change as a result of the licence amendment request.
	(m) any other information required by the Act or the regulations made under the Act for the activity to be licensed and the nuclear substance, nuclear facility, prescribed equipment or prescribed information to be encompassed by the licence.	OPG understands this requirement and will continue to comply.
(1.1)	*The Commission or a designated officer authorized under paragraph 37(2)(c) of the Act, may require any other information that is necessary to enable the Commission or the designated officer to determine whether the applicant* *(a) is qualified to carry on the activity to be licensed;* *or* *(b) will, in carrying on that activity, make adequate provision for the protection of the environment, the health and safety of persons and the maintenance of national security and measures required to implement international obligations to which Canada has agreed.*	OPG understands this requirement and will continue to comply.
Application for Amendment, Revocation or Replacement of Licence		
6	*An application for the amendment, revocation or replacement of a licence shall contain the following information:* *(a) a description of the amendment, revocation or replacement and of the measures that will be taken and the methods and procedures that will be used to implement it;*	Description of the requested PROL amendment is provided in this submission. Attachments 1 and 3 of this submission document the changes and measures that will be required to permit the Darlington NGS reactors to produce the Co-60 radioisotope, as well as the measures that will be taken and the methods and procedures that will be used to implement it.

General Nuclear Safety and Control Regulations		
Section	**Regulatory Requirement**	**OPG Response**
	(b) a statement identifying the changes in the information contained in the most recent application for the licence; *(c) a description of the nuclear substances, land, areas, buildings, structures, components, equipment and systems that will be affected by the amendment, revocation or replacement and of the manner in which they will be affected; and* *(d) the proposed starting date and the expected completion date of any modification encompassed by the application.*	
Incorporation of Material in Application		
7	*An application for a licence or for the renewal, suspension in whole or in part, amendment, revocation or replacement of a licence may incorporate by reference any information that is included in a valid, expired or revoked licence.*	OPG understands and has provided applicable references to information contained in the existing Darlington NGS PROL and Licence Conditions Handbook in Attachment 3 of this submission.
Obligations – Obligations of Licensees		
12(1)	*Every licensee shall* (*a) ensure the presence of a sufficient number of qualified workers to carry on the licensed activity safely and in accordance with the Act, the regulations made under the Act and the licence;*	The regulatory requirement of Darlington NGS minimum shift complement will not change as a result of this licence amendment request to produce Co-60, and in accordance with provisions/requirements stated in Darlington's Licence Conditions Handbook section 2, *"Human Performance Management"* and applied through D-PROC-OP-0009, *"Station Shift Complement"*. Refer to Section 3.2 of Attachment 3 of this submission for further details.
	(b) train the workers to carry on the licensed activity in accordance with the Act, the regulations made under the Act and the licence;	OPG staff will be trained on operation and maintenance activities associated with the licence amendment request in accordance with provisions/ requirements stated in Darlington's Licence Conditions Handbook section 2, *"Human Performance Management"* and applied through OPG program N-PROG-TR-0005, *"Training"*.

General Nuclear Safety and Control Regulations		
Section	**Regulatory Requirement**	**OPG Response**
		Refer to Section 3.2 of Attachment 3 of this submission for further details.
	(c) take all reasonable precautions to protect the environment and the health and safety of persons and to maintain the security of nuclear facilities and of nuclear substances;	OPG understands this requirement and will continue to comply in accordance with provisions/requirements stated in Darlington's Licence Conditions Handbook sections 9, *"Environmental Protection"* and 12, *"Security"* and applied though OPG programs OPG-PROG-0005, *"Environment Health and Safety Managed Systems"* and N-PROG-RA-0011, *"Nuclear Security"*, respectively. Refer to Section 3.9 of Attachment 3 of this submission for details on environmental protection. Refer to Section 3.12 of Attachment 3 of this submission for further details on the impact to security.
	(d) provide the devices required by the Act, the regulations made under the Act and the licence and maintain them within the manufacturer's specifications;	OPG understands this requirement and will continue to comply.
	(e) require that every person at the site of the licensed activity use equipment, devices, clothing and procedures in accordance with the Act, the regulations made under the Act and the licence	OPG understands this requirement and will continue to comply.
	(f) take all reasonable precautions to control the release of radioactive nuclear substances or hazardous substances within the site of the licensed activity and into the environment as a result of the licensed activity;	OPG understand this requirement and will continue to comply in accordance with provisions/requirements stated in Darlington's Licence Conditions Handbook sections 7, *"Radiation Protection"*, 8, *"Conventional Health and Safety"* and 9 *"Environmental Protection"* and applied though OPG programs N-PROG-RA-0013, *"Radiation Protection"* and OPG-PROG-0005, *"Environment Health and Safety Managed Systems"*, respectively. Refer to Sections 3.7, 3.8, and 3.9 of Attachment 3 of this submission for further details on radiation protection, conventional health and safety, and environmental protection.

General Nuclear Safety and Control Regulations		
Section	**Regulatory Requirement**	**OPG Response**
	g) implement measures for alerting the licensee to the illegal use or removal of a nuclear substance, prescribed equipment or prescribed information, or the illegal use of a nuclear facility;	OPG understands this requirement and will continue to comply in accordance with provisions/requirements stated in Darlington's Licence Conditions Handbook section 12, *"Security"* and applied through OPG program N-PROG-RA-0011, *"Nuclear Security"*. Refer to Section 3.12 of Attachment 3 of this submission for further details on security.
	h) implement measures for alerting the licensee to acts of sabotage or attempted sabotage anywhere at the site of the licensed activity;	OPG understands this requirement and will continue to comply in accordance with provisions/requirements stated in Darlington's Licence Conditions Handbook section 12, *"Security"* and applied through OPG program N-PROG-RA-0011, *"Nuclear Security"*. Refer to Section 3.12 of Attachment 3 of this submission for further details on security.
	i) take all necessary measures to facilitate Canada's compliance with any applicable safeguards agreement	OPG understands this requirement and will continue to comply in accordance with provisions/requirements stated in Darlington's Licence Conditions Handbook section 13, *"Safeguards and Non-Proliferation"* and applied through OPG program N-PROG-RA-0015, *"Safeguards and Nuclear Material Accountancy"*. Refer to Section 3.13 of Attachment 3 of this submission for further details on safeguards.
	(j) instruct the workers on the physical security program at the site of the licensed activity *and on their obligations under that program; and*	OPG understands this requirement and will continue to comply in accordance with provisions/requirements stated in Darlington's Licence Conditions Handbook section 12, *"Security"* and applied through OPG program N-PROG-RA-0011, *"Nuclear Security"*. Refer to Section 3.12 of Attachment 3 of this submission for further details on security.

General Nuclear Safety and Control Regulations		
Section	**Regulatory Requirement**	**OPG Response**
	(b) a statement identifying the changes in the information contained in the most recent application for the licence; *(c) a description of the nuclear substances, land, areas, buildings, structures, components, equipment and systems that will be affected by the amendment, revocation or replacement and of the manner in which they will be affected; and* *(d) the proposed starting date and the expected completion date of any modification encompassed by the application.*	
Incorporation of Material in Application		
7	*An application for a licence or for the renewal, suspension in whole or in part, amendment, revocation or replacement of a licence may incorporate by reference any information that is included in a valid, expired or revoked licence.*	OPG understands and has provided applicable references to information contained in the existing Darlington NGS PROL and Licence Conditions Handbook in Attachment 3 of this submission.
Obligations – Obligations of Licensees		
12(1)	*Every licensee shall* (*a) ensure the presence of a sufficient number of qualified workers to carry on the licensed activity safely and in accordance with the Act, the regulations made under the Act and the licence;*	The regulatory requirement of Darlington NGS minimum shift complement will not change as a result of this licence amendment request to produce Co-60, and in accordance with provisions/requirements stated in Darlington's Licence Conditions Handbook section 2, *"Human Performance Management"* and applied through D-PROC-OP-0009, *"Station Shift Complement"*. Refer to Section 3.2 of Attachment 3 of this submission for further details.
	(b) train the workers to carry on the licensed activity in accordance with the Act, the regulations made under the Act and the licence;	OPG staff will be trained on operation and maintenance activities associated with the licence amendment request in accordance with provisions/ requirements stated in Darlington's Licence Conditions Handbook section 2, *"Human Performance Management"* and applied through OPG program N-PROG-TR-0005, *"Training"*.

General Nuclear Safety and Control Regulations		
Section	**Regulatory Requirement**	**OPG Response**
		Refer to Section 3.2 of Attachment 3 of this submission for further details.
	(c) take all reasonable precautions to protect the environment and the health and safety of persons and to maintain the security of nuclear facilities and of nuclear substances;	OPG understands this requirement and will continue to comply in accordance with provisions/requirements stated in Darlington's Licence Conditions Handbook sections 9, *"Environmental Protection"* and 12, *"Security"* and applied though OPG programs OPG-PROG-0005, *"Environment Health and Safety Managed Systems"* and N-PROG-RA-0011, *"Nuclear Security"*, respectively. Refer to Section 3.9 of Attachment 3 of this submission for details on environmental protection. Refer to Section 3.12 of Attachment 3 of this submission for further details on the impact to security.
	(d) provide the devices required by the Act, the regulations made under the Act and the licence and maintain them within the manufacturer's specifications;	OPG understands this requirement and will continue to comply.
	(e) require that every person at the site of the licensed activity use equipment, devices, clothing and procedures in accordance with the Act, the regulations made under the Act and the licence	OPG understands this requirement and will continue to comply.
	(f) take all reasonable precautions to control the release of radioactive nuclear substances or hazardous substances within the site of the licensed activity and into the environment as a result of the licensed activity;	OPG understand this requirement and will continue to comply in accordance with provisions/requirements stated in Darlington's Licence Conditions Handbook sections 7, *"Radiation Protection"*, 8, *"Conventional Health and Safety"* and 9 *"Environmental Protection"* and applied though OPG programs N-PROG-RA-0013, *"Radiation Protection"* and OPG-PROG-0005, *"Environment Health and Safety Managed Systems"*, respectively. Refer to Sections 3.7, 3.8, and 3.9 of Attachment 3 of this submission for further details on radiation protection, conventional health and safety, and environmental protection.

General Nuclear Safety and Control Regulations		
Section	**Regulatory Requirement**	**OPG Response**
	g) implement measures for alerting the licensee to the illegal use or removal of a nuclear substance, prescribed equipment or prescribed information, or the illegal use of a nuclear facility;	OPG understands this requirement and will continue to comply in accordance with provisions/requirements stated in Darlington's Licence Conditions Handbook section 12, *"Security"* and applied through OPG program N-PROG-RA-0011, *"Nuclear Security"*. Refer to Section 3.12 of Attachment 3 of this submission for further details on security.
	h) implement measures for alerting the licensee to acts of sabotage or attempted sabotage anywhere at the site of the licensed activity;	OPG understands this requirement and will continue to comply in accordance with provisions/requirements stated in Darlington's Licence Conditions Handbook section 12, *"Security"* and applied through OPG program N-PROG-RA-0011, *"Nuclear Security"*. Refer to Section 3.12 of Attachment 3 of this submission for further details on security.
	i) take all necessary measures to facilitate Canada's compliance with any applicable safeguards agreement	OPG understands this requirement and will continue to comply in accordance with provisions/requirements stated in Darlington's Licence Conditions Handbook section 13, *"Safeguards and Non-Proliferation"* and applied through OPG program N-PROG-RA-0015, *"Safeguards and Nuclear Material Accountancy"*. Refer to Section 3.13 of Attachment 3 of this submission for further details on safeguards.
	(j) instruct the workers on the physical security program at the site of the licensed activity *and on their obligations under that program; and*	OPG understands this requirement and will continue to comply in accordance with provisions/requirements stated in Darlington's Licence Conditions Handbook section 12, *"Security"* and applied through OPG program N-PROG-RA-0011, *"Nuclear Security"*. Refer to Section 3.12 of Attachment 3 of this submission for further details on security.

General Nuclear Safety and Control Regulations		
Section	**Regulatory Requirement**	**OPG Response**
	(k) keep a copy of the Act and the regulations made under the Act that apply to the licensed activity readily available for consultation by the workers.	OPG understands this requirement and will continue to comply.
Transfers		
13	*No licensee shall transfer a nuclear substance, prescribed equipment or prescribed information to a person who does not hold the licence, if any, that is required to possess the nuclear substance, prescribed equipment or prescribed information by the Act and the regulations made under the Act.*	OPG understands this requirement and will continue to comply in accordance with provisions/requirements stated in Darlington's Licence Conditions Handbook section 14, *"Packaging and Transport"* and applied through OPG program W-PROG-WM-0002, *"Radioactive Material Transportation"*. The irradiated Co-60 will be transported in a Type B transportation package certified by the CNSC to Nordion's facility in Kanata, Ontario which is licensed to receive this nuclear substance. Refer to Section 3.14 of Attachment 3 of this submission for further details on Packaging and Transport.
Notice of Licence		
14	*(1) Every licensee other than a licensee who is conducting field operations shall post, at the location specified in the licence or, if no location is specified in the licence, in a conspicuous place at the site of the licensed activity,* *(a) a copy of the licence, with or without the licence number, and a notice indicating the place where any record referred to in the licence may be consulted; or* *(b) a notice containing* *(i) the name of the licensee,* *(ii) a description of the licensed activity,* *(iii) a description of the nuclear substance, nuclear facility or prescribed equipment encompassed by the licence, and*	OPG understands this requirement and will continue to comply.

General Nuclear Safety and Control Regulations		
Section	**Regulatory Requirement**	**OPG Response**
	(iv) a statement of the location of the licence and any record referred to in it. *(2) Every licensee who is conducting field operations shall keep a copy of the licence at the place where the field operations are being conducted.* *(3) Subsections (1) and (2) do not apply to a licensee in respect of* *(a) a licence to import or export a nuclear substance, prescribed equipment or prescribed information;* *(b) a licence to transport a nuclear substance; or* *(c) a licence to abandon a nuclear substance, a nuclear facility, prescribed equipment or prescribed information.*	

Class I Nuclear Facility Regulations
Applicable items in the Class I Nuclear Facility Regulations have been addressed in the above General Nuclear Safety and Control Regulations section.

Radiation Protection Regulations		
Section	**Regulatory Requirement**	**OPG Response**
Radiation Protection Program		
4	*Every licensee must implement a radiation protection program and must, as part of that program,* *(a) keep the effective dose and equivalent dose received by and committed to persons as low as reasonably achievable, taking into account social and economic factors, through the implementation of* *i. management control over work practices,* *ii. personnel qualification and training,* *iii. control of occupational and public exposure to radiation, and* *iv. planning for unusual situations; and* *(b) ascertain the quantity and concentration of any nuclear substance released as a result of the licensed activity* *i. by direct measurement as a result of monitoring, or* *ii. if the time and resources required for direct measurement as a result of monitoring outweigh the usefulness of ascertaining the quantity and concentration using that method, by estimating them.*	OPG has a well-established radiation protection program that complies with all elements of the *Radiation Protection Regulations* and in accordance with provisions/requirements stated in Darlington's Licence Conditions Handbook section 7, *"Radiation Protection"* and applied through OPG program N-PROG-RA-0013, *"Radiation Protection"*. Information on the radiation protection provisions and considerations during the design and operation of the Co-60 production system are documented in Section 3.7 of Attachment 3 of this submission. OPG staff operating the proposed Co-60 system receive training and will have the appropriate radiation protection qualification.

Nuclear Security Regulations
The production of Co-60 does not involve Category I, II or III Nuclear Material as defined in the *Nuclear Security Regulations*. No new or additional security requirements are required for Co-60 production operations at Darlington NGS. OPG understand the requirements of the *Nuclear Security Regulations* and will continue to comply in accordance with provisions/requirements stated in Darlington's Licence Conditions Handbook section 12, *"Security"* and applied through OPG program N-PROG-RA-0011, *"Nuclear Security"*. The security considerations for Co-60 production are documented in Section 3.12 of Attachment 3 of this submission.

Nuclear Substance and Radiation Device Regulations		
Section	**Regulatory Requirement**	**OPG Response**
Licence Applications – General Requirements		
3	***(1)*** *An application for a licence in respect of a nuclear substance or a radiation device, other than a licence to service a radiation device, shall contain the following information in addition to the information required by section 3 of the General Nuclear Safety and Control Regulations:* *(a) the methods, procedures and equipment that will be used to carry on the activity to be licensed;* *(b) the methods, procedures and equipment that will be used while carrying on the activity to be licensed, or during and following an accident, to* *(i) monitor the release of any radioactive nuclear substance from the site of the activity to be licensed,* *(ii) detect the presence of and record the radiation dose rate and quantity in Becquerel's of radioactive nuclear substances at the site of the activity to be licensed,* *(iii) limit the spread of radioactive contamination within and from the site of the activity to be licensed, and* *(iv) decontaminate any person, site or equipment contaminated as a result of the activity to be licensed;* *(c) a description of the circumstances in which the decontamination referred to in subparagraph (b)(iv) will be carried out;* *(d) the proposed location of the activity to be licensed, including a description of the site;* *(e) the roles, responsibilities, duties, qualifications and experience of workers;* *(f) the proposed training program for workers;* *(g) the proposed instructions for dealing with accidents, including fires and spills, in which the nuclear substance may be involved;* *(h) the proposed inspection program for the equipment and systems that will be used to carry on the activity to be licensed;* *(i) the methods, procedures and equipment that will be used to calibrate radiation survey meters in accordance with these Regulations;*	Procedures for operation and maintenance of the Co-60 production system are currently under development. As documented in section 3.3 of Attachment 3 of this submission, the addition of cobalt adjuster rods does not affect the Operator response to unit transients so it will not impact the current procedures or governance on the response to reactor unit transients. As documented in section 3.9 of Attachment 3 of this submission, emissions from operation of the Co-60 system will be monitored. OPG will follow established procedures for responding to elevated emissions and contamination. Refer to section 3.2 of Attachment 3 of this submission for further information of training. Refer to section 3.10 of Attachment 3 of this submission for further information on emergency response. Refer to section 3.7 of Attachment 3 of this submission for further information on radiation protection. The production of Co-60 does not involve category I, II, or III Nuclear Material as defined in the *Nuclear Security Regulations*.

Nuclear Substance and Radiation Device Regulations		
Section	**Regulatory Requirement**	**OPG Response**
	(j) the methods, procedures and equipment that will be used to calibrate and verify the calibration of dosimeters referred to in paragraphs 30(3)(d) and (e); *(k) the methods, procedures and equipment that will be used to conduct the leak tests and surveys required by these Regulations;* *(l) where the application is in respect of a nuclear substance that is an unsealed source and that is to be used in a room, the proposed design of the room;* *(m) if the application is in respect of a nuclear substance that is contained in a radiation device, the brand name and model number of the radiation device, and the quantity of the devices;* *(n) where the application is in respect of Category I, II or III nuclear material, as defined in section 1 of the Nuclear Security Regulations,* *(i) the measures that will be taken to prevent nuclear criticality, and* *(ii) the information required by section 3 or 4 of the Nuclear Security Regulations, as applicable;* *(o) if the applicant will be manufacturing or distributing radiation devices referred to in paragraph 5(1)(c) or section 6 or 7, or check sources mentioned in section 8.1, the proposed procedure for the disposal of each radiation device or check source or for its return to the manufacturer.*	

Packaging and Transport of Nuclear Substances Regulations, and Transportation of Dangerous Goods Regulations
Packaging and transportation considerations for Co-60 production are documented in Attachment 3, Section 3.14 of this submission. OPG understands the requirements of the *Packaging and Transport of Nuclear Substances Regulations*, and *Transportation of Dangerous Goods Regulations* and will continue to comply in accordance with provisions/requirements stated in Darlington's Licence Conditions Handbook section 14, *"Packaging and Transport"* and applied through OPG program W-PROG-WM-0002, *"Radioactive Material Transportation"*.

Reference:

[1]. “Record of Decision – OPG’s Consolidated Financial Guarantee – DEC 22-H104”, December 6, 2022, e-Doc# 6930798, CD# N-CORR-00531-23514.

ATTACHMENT 3

OPG letter R. Geofroy to M. Bacon-Dussault, “Darlington NGS – Addendum to the Application for Darlington Nuclear Generating Station Power Reactor Operating Licence 13.03/2025 Amendment for Production of the Cobalt-60 Radioisotope””

CD# NK38-CORR-00531-25073

Licensing Impact Assessment in Support of the Cobalt-60 Production Modifications Project at the Darlington Nuclear Generating Station

Prepared by: **R. Kovinthan**

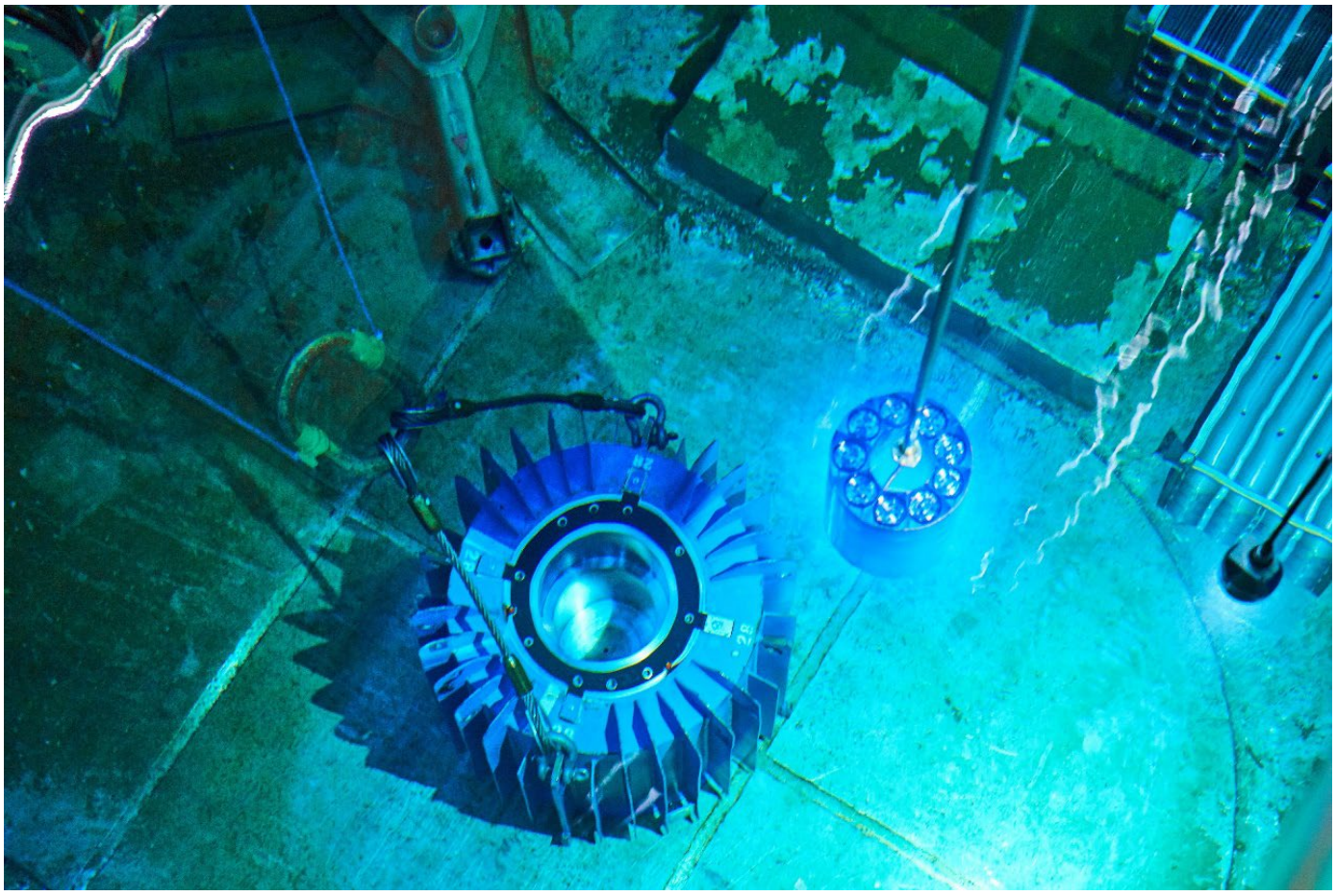
Checked by: **P. Le Dreff**

ATTACHMENT 3
CD# NK38-CORR-00531-25073

ONTARIO POWER GENERATION | Where a brighter tomorrow begins.

Licensing Impact Assessment in Support of the Cobalt-60 Production Modifications Project at the Darlington Nuclear Generating Station

R002



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Executive Summary

Ontario Power Generation Inc. (OPG) is applying to the Canadian Nuclear Safety Commission (CNSC), referred to as "the Commission", to amend the Darlington Nuclear Generating Station (NGS) Power Reactor Operating Licence (PROL) 13.03/2025 to add a new licensed activity to possess, transfer, produce, package, manage and store the Cobalt-60 (Co-60) radioisotope.

Co-60 is an essential radioisotope used in the medical and food industry. OPG has been producing the Co-60 radioisotope in Pickering NGS's reactors for decades, providing a significant portion of the worldwide production (15-20%). There will be a supply gap with Pickering NGS's eventual end of commercial operation, and the Co-60 Production Modifications Project at Darlington NGS provides an opportunity for OPG and Canada to maintain long-term supply of Co-60 and continue to be a major contributor of the radioisotope with health, safety and social benefits.

OPG plans to utilize all four of Darlington NGS's reactors for the irradiation of Cobalt-59 (Co-59) rods to produce Co-60, with a currently planned construction window between 2022 and 2027 during unit refurbishment and planned outages. Co-60 production is planned to overlap with Molybdenum-99 (Mo-99) production in Darlington NGS Unit 2.

The Co-60 radioisotope planned to be produced at Darlington NGS will be shipped to Nordion (Canada) Inc.'s (referred to hereafter as Nordion) facility in Kanata, Ontario where it is commercialized and sold to market, similar to the arrangement for Co-60 produced at Pickering NGS. Nordion operates its Class 1B facility in Kanata under Nuclear Substance Processing Facility Operating Licence NSPFOL-11A.01/2025, valid until October 31, 2025. OPG, Nordion and its predecessor companies have been collaborating to produce Co-60 at Pickering NGS, to varying amounts, since the 1970s.

Nordion will be responsible for the conveyance of Co-60 to their processing facility and all subsequent steps in the processing of Co-60 for end-users. Nordion will have responsibility for the ownership of the F231 Type B transportation package and be accountable for package certification and maintenance activities.

OPG is committed to the safe and reliable operation of Darlington NGS. This application provides a summary of the design documents, engineering assessments and nuclear safety analyses completed for the modifications to Darlington NGS to produce Co-60. These deliverables demonstrate that the addition of this new licensed activity can be carried out safely at Darlington NGS, and will not compromise continued safe reactor operation, nuclear safety, public safety, the environment or international agreements to which Canada is a signatory.

OPG has and will continue to follow its established Engineering Change Control process for ensuring the design complies with applicable regulatory requirements and that configuration management for the station will be maintained. The proposed modifications at Darlington NGS for Co-60 production on all four units include: conversion of non-cobalt adjuster rods to inactive Co-59 adjuster rods, addition of equipment and tooling to facilitate installation of Co-59 adjuster rods, safe removal of the irradiated Co-60 rods during planned outages, and modifications for discharging, storing and processing[1] adjuster rods in the Wet Cask Handling Bay of the Irradiated Fuel Bay (IFB) in the West

[1] Processing refers to the harvesting activities to prepare and package the Co-60 bundles in the Nordion supplied shipping packages for shipment to Nordion's processing facility in Kanata, Ontario. This word is used multiple times in the LIA with the above context and is not related to NSCA's prescribed term of 'processing'.

Fuelling Facilities Auxiliary Area. Operation of the Co-60 production system will have well established work processes. There are no programmatic changes required to the Nuclear Management System or any other programmatic changes to documents listed in the current Darlington NGS PROL 13.03/2025 and the associated Licence Conditions Handbook.

The safety analyses completed demonstrate that addition of this new licensed activity will have negligible effect on safe reactor operation, and on public safety. The assessment to evaluate the effects of having the Co-60 and Mo-99 production systems in the same operating unit at Darlington NGS has been completed. Due to both systems being spatially and temporally independent from each other, their combined effect is no greater than their individual effects. Both systems were analyzed individually from a reactor safety and operational standpoint, with necessary measures in place ensuring safe operation of both systems in one reactor.

A Predictive Effects Assessment (PEA), prepared in accordance with Canadian Standards Association (CSA) N288.6-12, “Environmental risk assessments at Class 1 nuclear facilities and uranium mines and mills”, concludes that operation of the Co-60 production system will not result in any unacceptable risks to human and ecological receptors residing in the vicinity of the Darlington NGS site. The PEA assessed the cumulative effects of the Co-60 production system and the Mo-99 Isotope Irradiation System operations, and the cumulative increase in public dose is estimated to be 0.004% of the regulatory public dose limit of 1 mSv/a, and 0.003% of the dose from background radiation in the vicinity of Darlington NGS. There are also no exceedances of the 2.4 mGy/d and 9.6 mGy/d radiation benchmarks for terrestrial and aquatic biota, respectively. The additional emissions of the Co-60 and Mo-99 production systems are a small fraction of existing Darlington NGS emissions and the predicted doses are well below regulatory limits.

Darlington NGS will continue to meet Canada’s international obligations under the Treaty on the Non-Proliferation of Nuclear Weapons. The production of Co-60 at Darlington NGS will interface with the normal operation of the IFB, but does not involve nuclear material that is subject to safeguard requirements pursuant to the Canada/International Atomic Energy Agency (IAEA) Safeguards Agreement (Uranium, Thorium or Plutonium) and as defined in REGDOC-2.13.1, *“Safeguards and Nuclear Material Accountancy”*.

OPG believes in timely, open and transparent communication to maintain positive and supportive relationships and the confidence of Indigenous Nations and communities and members of the public. Two-way dialogue takes place with Indigenous Nations and communities and members of the public through personal contact and meetings, community newsletters, speaking engagements, advertising and educational outreach. Through this regular outreach, OPG continues to provide Indigenous Nations and communities, members of the public and interested parties with information regarding the production and transportation of the Co-60 radioisotope.

As part of its engagement plan, OPG has planned updates/meetings with the identified Indigenous Nations and communities leading up to the licensing hearing to further discuss the project. Nordion will be responsible for the conveyance of Co-60 to their processing facility and for any engagement, with OPG’s support, with the Indigenous Nations and communities along the transportation route. OPG is prepared to provide capacity support to the engaged Indigenous Nations and communities, in line with the Indigenous Relations Policy and the scope of the engagement required.

OPG remains committed to safe operation of the Darlington NGS units and re-affirms that the Co-60 system can be implemented as presented in the robust safety case. Assessments completed

conclude that the proposed activities to support production of Co-60 will not compromise continued safe reactor operation, environmental protection and public safety.

Land Acknowledgement

The lands and waters on which the Darlington Nuclear Generating Station (NGS) is situated are within the traditional and treaty territory of the Williams Treaties First Nations, which includes Curve Lake First Nation, Hiawatha First Nation, Alderville First Nation, Chippewas of Beausoleil First Nation, Chippewas of Georgina Island First Nation, Chippewas of Rama First Nation, and the Mississaugas of Scugog Island First Nation.

The Darlington NGS is within the territory of the Gunshot Treaty and the Williams Treaties of 1923. The Gunshot Treaty Rights were reaffirmed in 2018 in a settlement with Canada and the Province of Ontario.

To acknowledge the treaty and traditional territories is to recognize the rights of the First Nations. It is to recognize the history of the land, predating the establishment of the earliest European colonies. It is also to acknowledge the significance for the Indigenous peoples who lived and continue to live upon it, to acknowledge the people whose practices and spiritualties are tied to the land and water and continue to develop in relation to the territory and its other inhabitants today.

1. Production of Cobalt-60 (Co-60)

Cobalt-60 (Co-60) is a high-intensity gamma ray emitter with a relatively long half-life and is the activation product when Cobalt-59 (Co-59) is bombarded with slow neutrons. Co-60 can be produced in nuclear reactors due to the presence of slow neutrons. Canada Deuterium Uranium (CANDU) reactors can be used to produce Co-60 by substituting the non-cobalt adjuster rods with adjuster rods containing inactive Co-59.

Co-60 is currently being produced and harvested at Bruce B Nuclear Generating Station (NGS) and Pickering NGS Units 6, 7 and 8. OPG has been producing Co-60 in CANDU reactors for over 50 years. The primary application of Co-60 continues to be the sterilization of single-use medical devices, such as surgical gowns, latex gloves, catheters, scalpels, bandages, swabs for COVID-19 testing and implants. These medical devices can be sterilized in their original packaging. The use of Co-60 in sterilization technology is an important part of healthcare manufacturing around the world.

Certain foods and food ingredients are treated with gamma irradiation from Co-60 to make them safer, reduce spoilage and extend shelf life. Irradiation can kill parasites and microorganisms that can lead to food poisoning and can prevent pests from developing in stored product, replacing the use of chemical preservatives and pesticides.

Ontario Power Generation Inc. (OPG) is committed to ensuring the long-term supply of Co-60 following the eventual end of commercial operation of Pickering NGS. In support of this commitment, OPG, in partnership with Nordion (Canada) Inc. (referred to hereafter as Nordion), is implementing a number of modifications and installing new equipment to facilitate Co-60 production and harvesting at Darlington NGS.

1.1. Adjuster Rods

OPG is proposing modifications at Darlington NGS to enable Co-60 production, which includes modifying the adjuster rods. The purpose of the adjuster rods is to act as part of the Reactor Regulating System (RRS) in maintaining control of reactor power. The adjusters' shape (flatten) the core power distribution both radially and axially during normal operation by absorbing neutrons. The adjuster rods can be withdrawn (in successive banks) to provide additional reactivity when required. Each reactor at Darlington NGS has 16 adjuster rods participating in reactor regulation.

Each adjuster rod is controlled by the RRS to lower the associated adjuster element into the core (to provide a negative reactivity effect) or raise it out of the core (to provide a positive reactivity effect), according to the requirements of the RRS to shape the neutron flux in the reactor during various modes of operation.

The adjuster rods are currently of a design that uses Stainless Steel (SS) tubing and a SS or titanium center rod for neutron absorption. They are commonly referred to as SS adjuster rods. These will be replaced by an adjuster rod design configured to house Co-59 pencils, which will similarly serve as the neutron absorbers, but will also be irradiated to produce Co-60. The adjuster rods will be replaced at regular intervals, during unit outages, and will be harvested to recover the Co-60.

The cobalt adjuster design will be dimensionally and operationally compatible with the requirements of the existing design and will be dimensionally compatible with the existing adjuster units. Production of Co-60 at Darlington NGS was anticipated during the original design and construction of the Darlington station. Therefore, some fundamental provisions for this changeover from SS rods to cobalt adjuster rods are already incorporated in the design of the reactor as well as structures, supporting elements, and shielding in the vicinity of the reactor. These provisions were assessed as part of the detailed design phase to ensure suitability and incorporated into the Co-60 Production Modifications Project design.

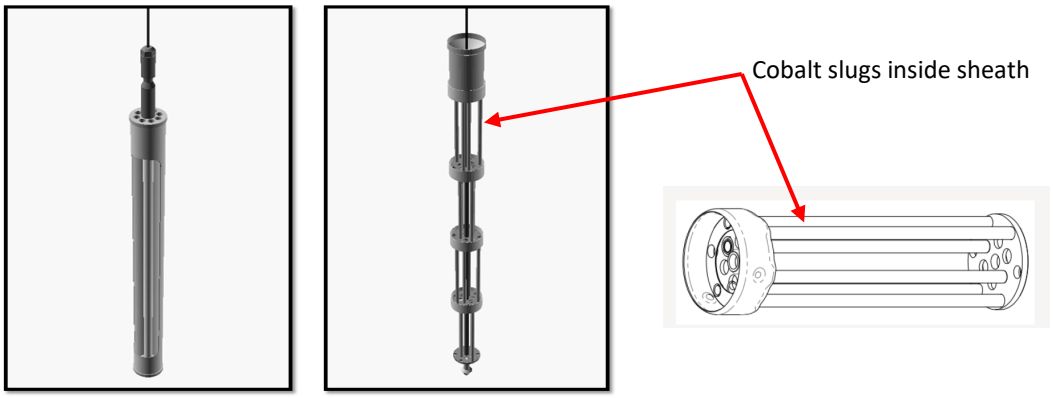
1.2. Design Changes

The Darlington NGS reactors each have 24 adjuster rods. Eight out of the 24 rods are permanently locked out of core. Changeover from non-cobalt (SS) adjuster rods to Co-59 adjuster rods will be completed only on the 16 adjuster rods participating in reactor regulation. An Operating Experience (OPEX) report, NK38-REP-31780-10009, "*OPEX Report – DN Cobalt-60 Production Modification"* (Reference [1]), was completed to capture OPEX related to cobalt production and conversion of stations to cobalt production, to inform cobalt modifications at Darlington NGS. See Section 3.1.6 for details on OPEX.

The proposed modifications at Darlington NGS for Co-60 production on all four units include: conversion of non-cobalt adjuster rods to inactive Co-59 adjuster rods, addition of equipment and tooling to facilitate installation of Co-59 adjuster rods, safe removal of the irradiated Co-60 rods during planned outages, and modifications for discharging, storing and processing adjuster rods in the Wet Cask Handling Bay (WCHB) of the Irradiated Fuel Bay (IFB) in the West Fuelling Facilities Auxiliary Area (WFFAA).

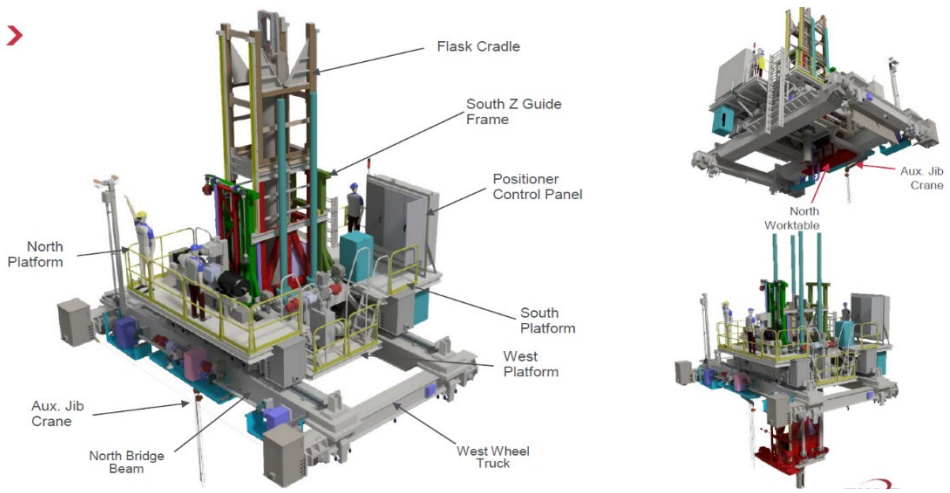
To implement Co-60 production at Darlington NGS, a number of modifications and new equipment are required. The Co-60 Production Modifications Project comprises the following major scope elements, each captured under a Master Engineering Change (MEC) (References [2] and [3]):

1. **MEC 142910: Cobalt Adjuster Rod Conversion and Adjuster Unit Modifications (Permanent Modifications to Adjuster Rods, Adjuster Units, and Associated Shielding)**: This design package addresses the adjuster rod, adjuster unit, and reactor physics design changes supporting conversion to cobalt adjuster rods at Darlington NGS. The design implements the design basis changes, regulatory approvals, equipment, and modifications that are required for initial installation and subsequent operation with Co-59 adjuster rods in the reactor, replacing the existing design of the adjuster rods.

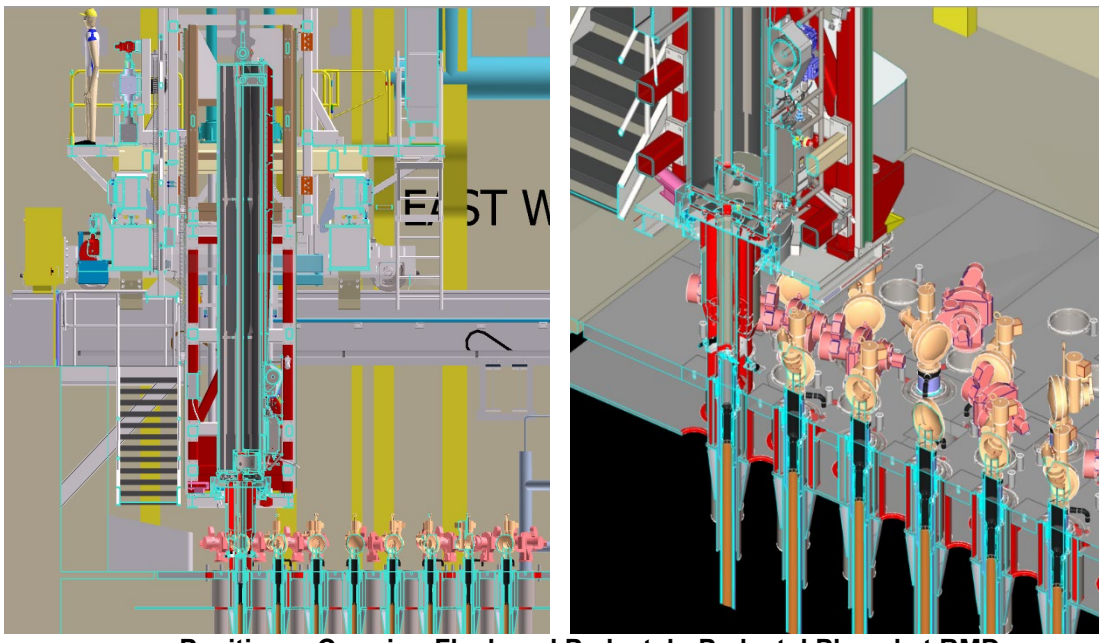


Adjuster Rods and Bundles

2. **MEC 142912: Modifications for Periodic Removal of Cobalt Adjuster Rods from the Reactor**: This design package addresses the periodic replacement of cobalt adjuster rods from the reactor at the Reactivity Mechanism Deck (RMD). The design implements the equipment, tooling, and modifications that are required for periodic replacement of irradiated cobalt rods. This MEC includes design of significant additional equipment including the cobalt positioner that allows for remote removal of the irradiated cobalt adjuster rods to ensure a controlled material handling process and radiation safety.

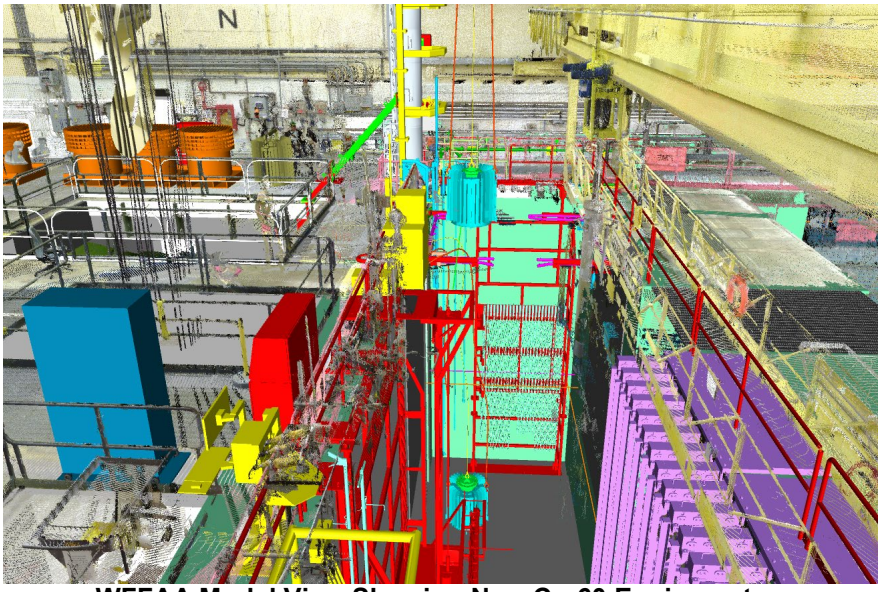


Cobalt Positioner Rendering



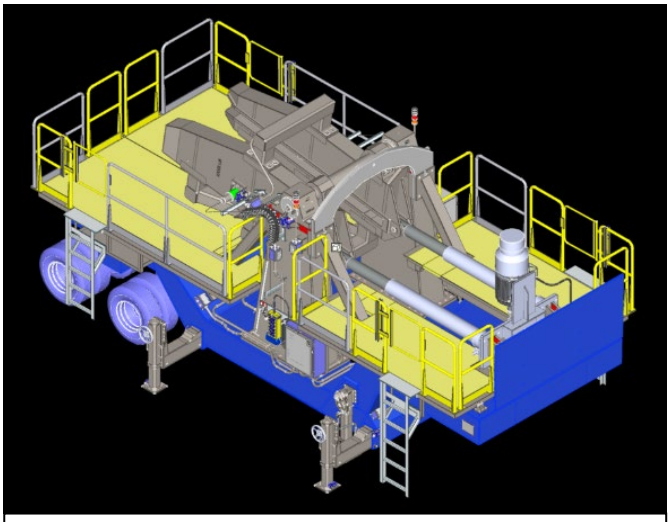
Positioner Carrying Flask and Pedestal - Pedestal Placed at RMD

3. **MEC 142913: Modifications for Discharge, Storage, Cobalt Adjuster Rod Processing, and Off-Site Transport of Cobalt (Modifications at the WFFAA):** This design package implements the equipment, tooling, and modifications that are required for discharge, temporary storage, cobalt adjuster rod processing, component handling, and off-site transport of Co-60 bundles. 'Off-site transport' denotes the functions at the WCHB that permit the irradiated rods to be loaded into the Nordion-provided flasks for actual off-site transportation, as well as the safe handling of Nordion flasks.

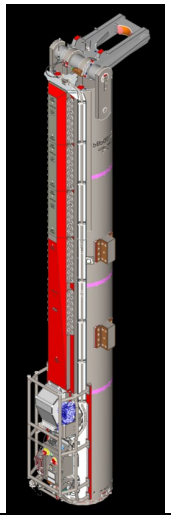


WFFAA Model View Showing New Co-60 Equipment

4. **MEC 142914: Modifications for On-Site Transport of Cobalt Adjuster Rods:** This design package implements the equipment and tooling that is required for on-site transfer of both the inactive and the active cobalt rods. This includes the design of the Flask, and the Transporter/Erector (T/E). This MEC also involves transportation equipment for handling of miscellaneous Co-60 tooling.



Transporter / Erector for DNGS



Cobalt Flask for DNGS

5. **MEC 142915: Modifications for Audio, Video, and Gamma Monitoring of Cobalt Production Operations:** This design package implements the equipment and modifications that are required for audio communications, video-monitoring, and gamma monitoring of cobalt harvesting operations.

6. **MEC 151468: Cobalt Cooling Circuit System Update Modification Design Requirements:** This document-only modification implements changes to the existing design requirements outlined in NK38-DR-31780-10001, "*Adjuster Units"* to allow cobalt adjuster rods to operate up to 3.5 Effective Full Power Years (EFPY) without cooling from the cobalt adjuster rod cooling system.

As cited from NK38-REP-34820-00001, "*Cobalt Adjuster Element Cooling Circuit Assessment*": In its original conception, cobalt cooling was required for the irradiated cobalt rods when in the "parked position" to limit oxide growth on the cobalt rod and to mitigate the potential for deflagration of H_2/D_2.

The Cobalt Cooling System is currently out-of-service due to various leaks and other legacy issues. However, it is still part of the design basis and is in a laid-up state. Periodically, the system is utilized as a flow path to the Moderator to assist with scheduled Moderator drains by utilizing re-occurring TMOD-108380. In addition, as part of the detritiation strategy for DNGS Refurbishment, the same flow path is utilized for flushing the Moderator system with demineralized water after the Moderator system has been drained of D_2O and laid up for Refurbishment.

To support the use of Cobalt adjusters at DNGS with an isolated Cobalt Cooling System (in addition to OPEX from Pickering/Bruce), Thermal Analysis NK38-REP-03500-0797058 (Reference [10]) of

the Cobalt Adjusters has been completed for DNGS. The analysis concluded that during a Loss of Moderator Inventory event, the rods (in core, or when in the parked position), after 3.5 years of irradiation, do not get hot enough to pose a deflagration risk. Furthermore, due to changes in the processing technique since the original conception, Nordion has informed OPG that oxide growth is no longer a concern.

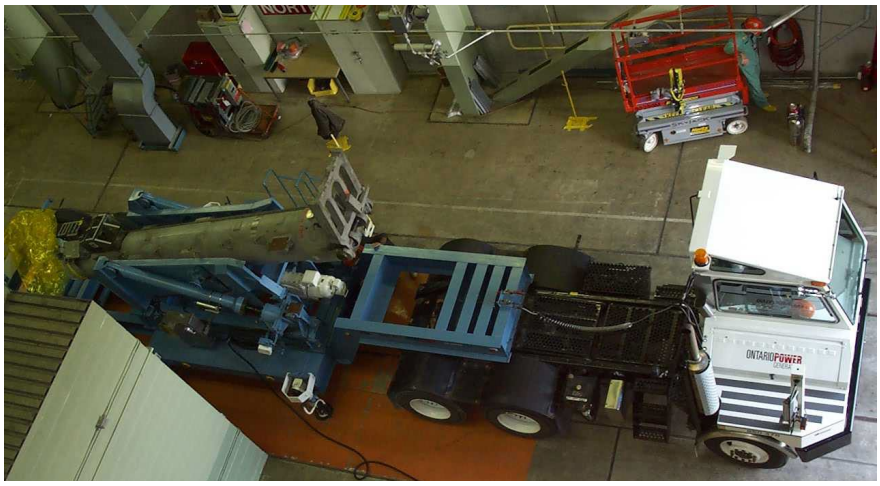
Currently, OPG's long term intention for the Cobalt cooling system is to leave the system 'as-is' as there are no significant disadvantages. The Cobalt-60 Project has updated existing station documentation to reflect the current configuration through the ECC process under MEC 151468 which is a 'paper modification' only.

1.3. Operational Changes for Production of Co-60

1.3.1. Adjuster Rod Removal and Transfer to the Fuel Bay

Co-60 implementation at Darlington NGS involves substituting the 16 SS adjuster rods that participate in reactor regulation for each unit with neutronically equivalent Co-59 adjuster rods. After approximately three years of irradiation in the reactor core (typical planned outage duration for Darlington NGS), up to a maximum of 3.5 years, the Co-60 rods will be harvested (i.e., removal of Co-60 rods from reactor core) and then disassembled, packaged and transported to Nordion, in Kanata, Ontario.

During planned maintenance outages, new Co-59 adjuster rods will be suspended vertically and lowered down into the reactor guide tubes from the RMD, where the adjuster rods will be converted to Co-60 by means of irradiation, for up to 3.5 equivalent full power years. Following the irradiation of cobalt adjuster rods in the reactor unit and prior to reaching the licensed limit for Co-60 activation, the Co-60 rods will be removed in the subsequent planned maintenance outage. To support removals, the unit will be shut down, allowed to cool and placed in a Guaranteed Shutdown State (GSS) suitable for cobalt harvesting operations. Following removal of the Co-60 rods from the reactor, the new Co-59 adjuster rods are installed. During reactor unit operation, the Co-60 adjuster rods are designed to perform similar to the existing SS adjuster rods. Therefore, during all modes of operation (except for the planned cobalt harvests), the use of Co-60 rods will be indistinguishable from SS rods. After rod removal from the reactor, Co-60 rods are then transported to the WCHB area of the WFFAA facility at Darlington NGS. Once discharge into the WCHB is complete, cobalt rods will be dismantled and packaged for shipment to Nordion’s facility in Kanata, Ontario, where they are commercialized and sold to market.



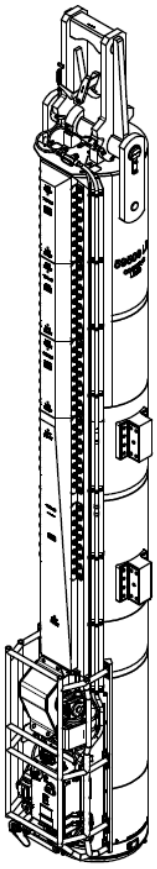
Transporter/Erector and truck at Pickering NGS

To facilitate Co-60 production at Darlington NGS, the Cobalt Adjuster Element Processing System (CAEPS), consisting of various equipment and tooling, is being developed to support the replacement of cobalt adjuster rods during routine reactor maintenance outages. The cobalt removal and transfer equipment is designed to be used intensively for relatively short periods of time, and to function reliably, and efficiently, so that the limited “window” of outage time available for the replacement process is not extended. The cobalt removal and transfer system is mechanized extensively to minimize labour and operator skills required. The system is designed for high productivity, to minimize the demands upon station staff during the critical maintenance interval.

The following CAEPS equipment will be used to safely unload the cobalt adjuster rods from the reactor, transport them to the fuel bay and process them in the fuel bay.

1. Flask and Pedestal

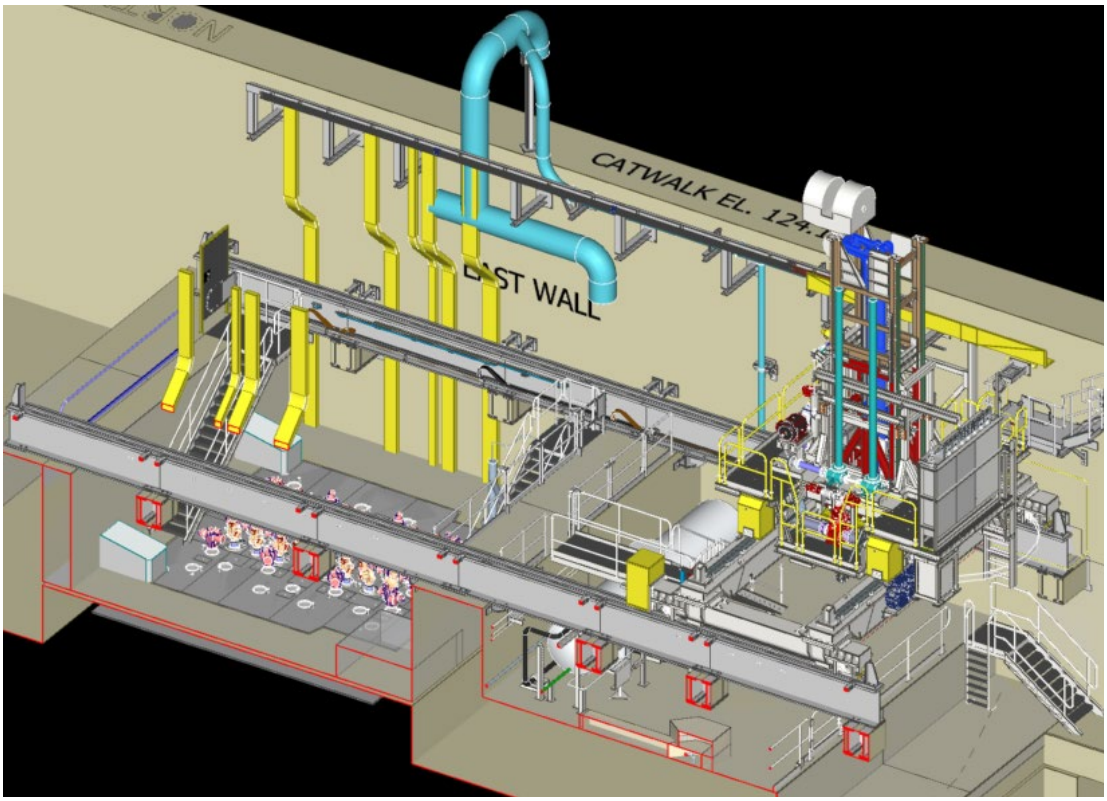
   The flask is designed to safely contain one irradiated cobalt adjuster rod. The flask shielding is designed to reduce the contact dose rate on the exterior of the flask to 50 mrem/h or less during normal cobalt harvest operations. The CAEPS pedestal is used along with the flask and flask positioner and is designed to bridge the gap between the bottom of the flask and the shielded RMD structure around the adjuster site of interest. The assembly of permanent and temporary shielding elements provides a heavily shielded passage for the cobalt adjuster rod during its removal from the reactor.



Cobalt Flask With Lead Shielding for Radiation Protection) – Design Concept

2. Flask Positioner

The CAEPS flask positioner is designed to accept and, carry the flask and pedestal, and to precisely position these devices at each of the converted adjuster unit positions at the RMD. The flask positioner is very similar to a crane and runs on a runway located approximately three meters above the RMD. The use of the positioner in the cobalt adjuster rod replacement process allows for activities to be completed over the RMD with the enhanced safety features of the flask positioner. The harvest operations rely on the overhead reactor deck area crane to deliver the flask between the flask positioner and the T/E.



Positioner Carrying Flask and Parked in Home Position Away from the RMD - 3D Model

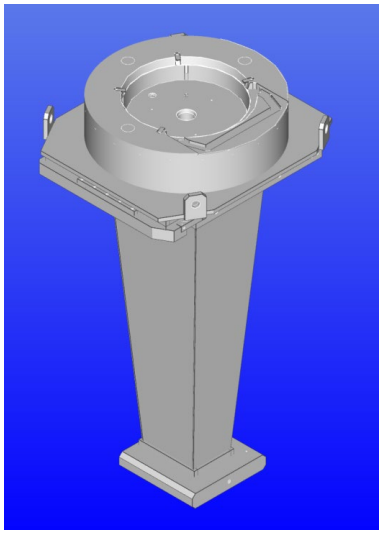
3. Transporter/Erector

After each irradiated cobalt adjuster rod is removed from the reactor and secured into the CAEPS flask, the reactor deck area crane is used to lift the flask from the flask positioner and lower it into the T/E. The T/E and tow-vehicle are used to safely transport the CAEPS flask, containing the cobalt adjuster rod, between the reactor auxiliary bay and the WFFAA facility. The T/E is required to park in the WFFAA truck bay, deploy stabilizers, and rotate the flask to vertical position such that it may be engaged by the WFFAA flask handling crane. The flask handling crane is then used to deliver the flask to the removable flask platform in the discharge area of the WCHB within the WFFAA. At this location, the crane supports the flask, and the flask is positioned for discharge.

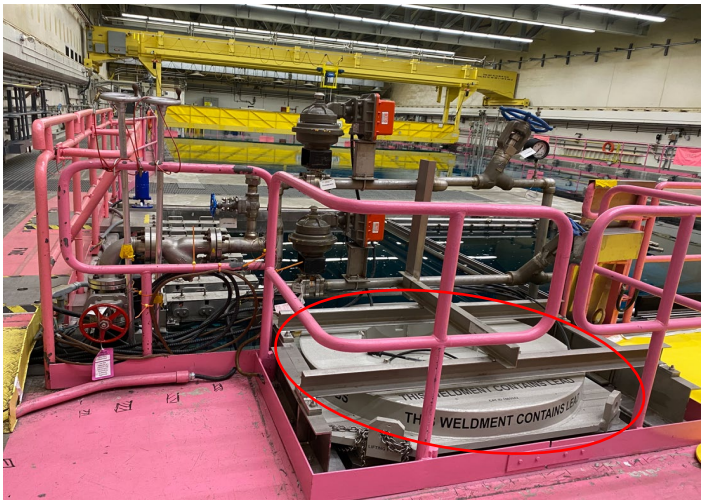
4. Discharge Equipment and Tooling

The discharge operation will be performed at the cut-out in the North-West area of the WCHB. The existing concrete structure, along with the discharge port and removable flask platform provide shielding for the transfer of the cobalt adjuster rod from the flask into the water shielding of the WCHB. A removable structural barrier will be installed for discharge operations, and prevent the Flask from travelling beyond its intended position. Additional tooling provides temporary support for the adjuster components during the discharge sequence. Submerged beneath the discharge port is the discharge trough which is used to accept the discharged adjuster rod and provide visual confirmation that the rod has been fully lowered into the WCHB. From the discharge trough, the cobalt adjuster rod is

transferred to the cobalt storage rack using hoists on the bridge crane and transfer tooling. Once stored, the adjuster rods await processing.



Co-60 Discharge Port (Lower) and Removable Flask Platform (Upper) -3D Model



Existing Discharge Equipment (Removable Flask Platform Shown in Red)

There are no changes to maintenance and inspection requirements of equipment that support online reactor operations due to the Co-60 Production Modifications Project. All of the Co-60 equipment and tools are used to support harvesting operations during a planned maintenance outage. Maintenance and inspections of these equipment and tools is expected to be performed prior to use in harvesting operations. Maintenance requirements and frequency for each piece of equipment will be based on the original equipment manufacturer's specifications. As governed by OPG's Engineering Change Control (ECC) process, N-PROC-MP-0090, "*Engineering Change Control Process"*, and N-PROC-MA-0034, "*Predictive Maintenance Program Requirements"*, maintenance tasks will be converted into model work orders or new procedures, informed by Pickering NGS and Bruce B NGS cobalt program best practices. These work orders will be scheduled at a pre-defined frequency through OPG work management processes.

1.3.2. Cobalt Processing and Handling in the Fuel Bay

The Cobalt Adjuster Processing Equipment is described in NK38-MDR-31935-10001 R002, *"Modification Design Requirements for Discharge, Storage, Processing and Off-Site Shipping of Cobalt"* (Reference [4]), and is comprised of the following items:

1. Inspection Table

   The inspection table provides an area for inspection of the cobalt bundles and temporary storage for individual bundles and bundle carriers. The table is restrained at the side of the bay and rests on the bottom of the WCHB.

2. Bundle Separator

   The bundle separator receives and rotates the cobalt adjuster rod to horizontal. This equipment grips the cobalt adjuster assembly head cup and lower cone, placing the

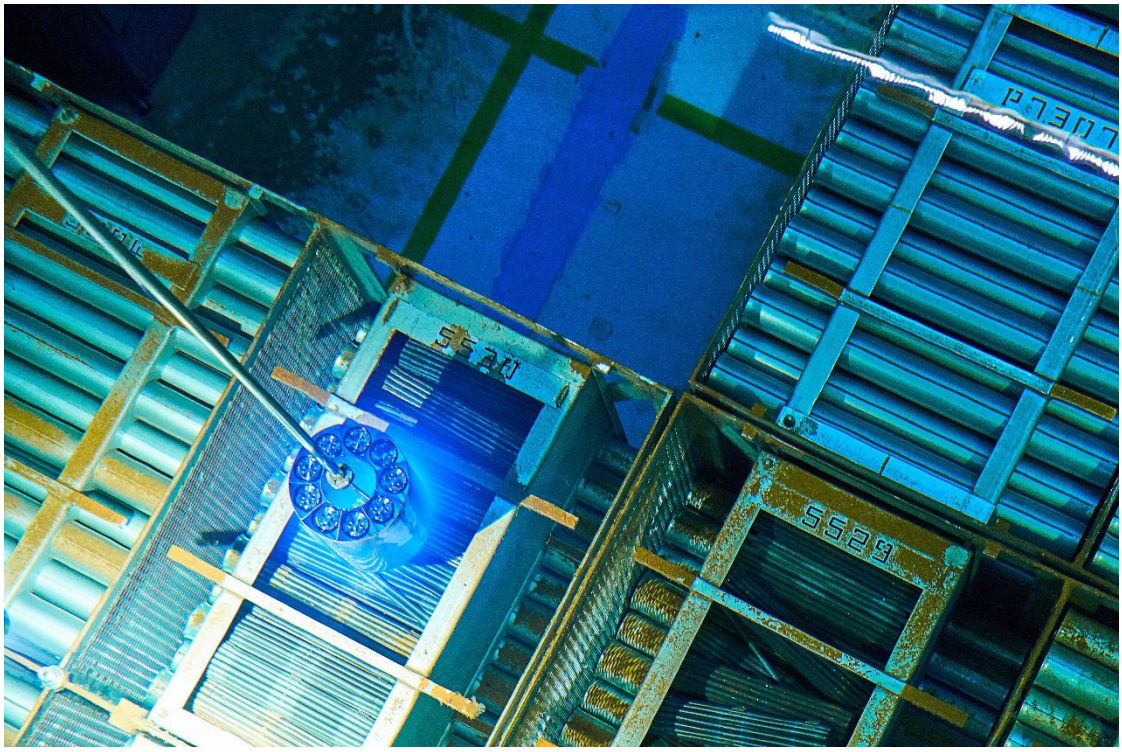
adjuster center rod in tension. The tensile force applied is sufficient to fracture the center rod at a designed weak point located at the lower cone area of the center rod. The fractured center rod allows the adjuster to be disassembled into cobalt bundles and adjuster waste components.

3. Center Rod Muncher and Storage Bin

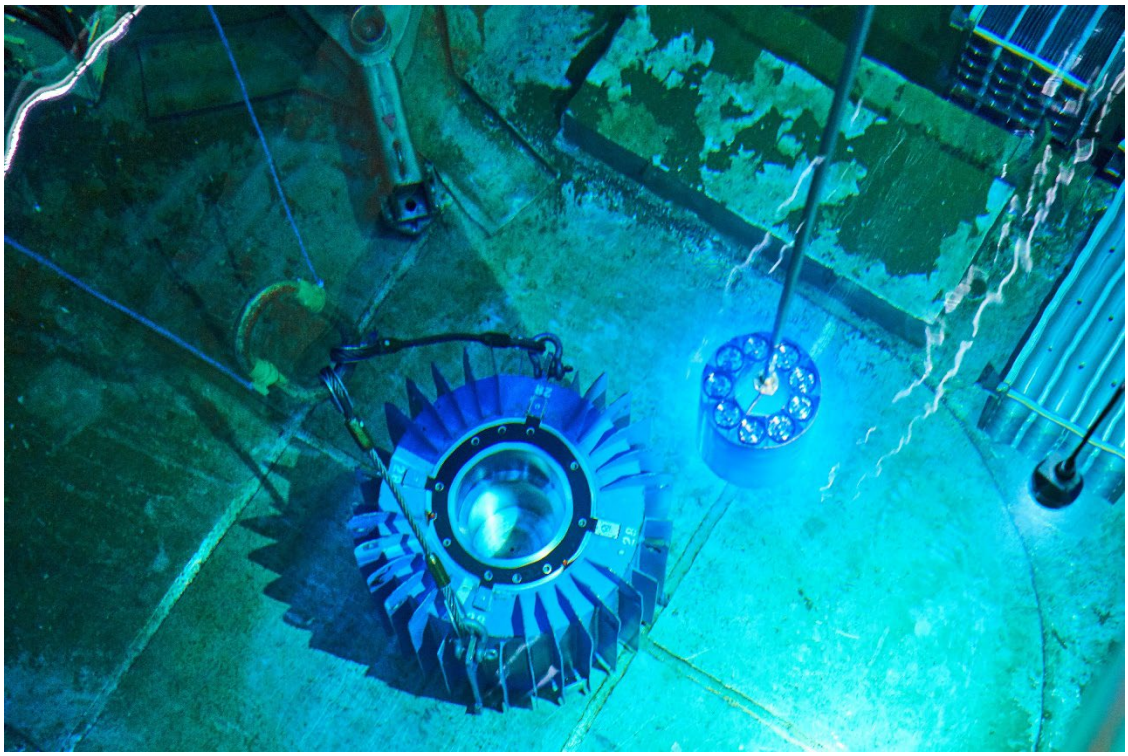
The muncher is supported from a bay-side frame and located at the bottom of the WCHB adjacent to the inspection table. This equipment consists of a pedestal, cutter assembly, storage bin, catenary hoses and control cables. The storage bin receives non-cobalt containing adjuster rod waste produces by the adjuster disassembly. The waste components from the bundle separator are discharged into the bin via a chute located at the end of the bundle separator and under the inspection table. See Section 3.11 for Waste Management.

4. Control Panel

The operation of the bundle separator and center rod muncher hydraulics are manually initiated from the control panel.



A Bundle Carrier Complete with Co-60 Isotope Being Prepared for Loading into the Nordion Shipping Package at Pickering NGS



Co-60 Bundle Carrier Being Placed into the Nordion Shipping Package at Pickering NGS

1.4. Co-60 Bundle Transportation

After the individual irradiated cobalt bundles have been removed from the adjuster rod assembly, inspected, and measured to quantify their radiological contents, they are placed in a cobalt carrier and loaded into Nordion's F231 Type B Transportation Package. The F231 is a Type B transportation package of CNSC certified design for transport of up to 400,000 curies of Co-60. Up to four F231 packages are loaded onto a transport vehicle by OPG's Transportation of Dangerous Goods (TDG) Class 7 qualified personnel.

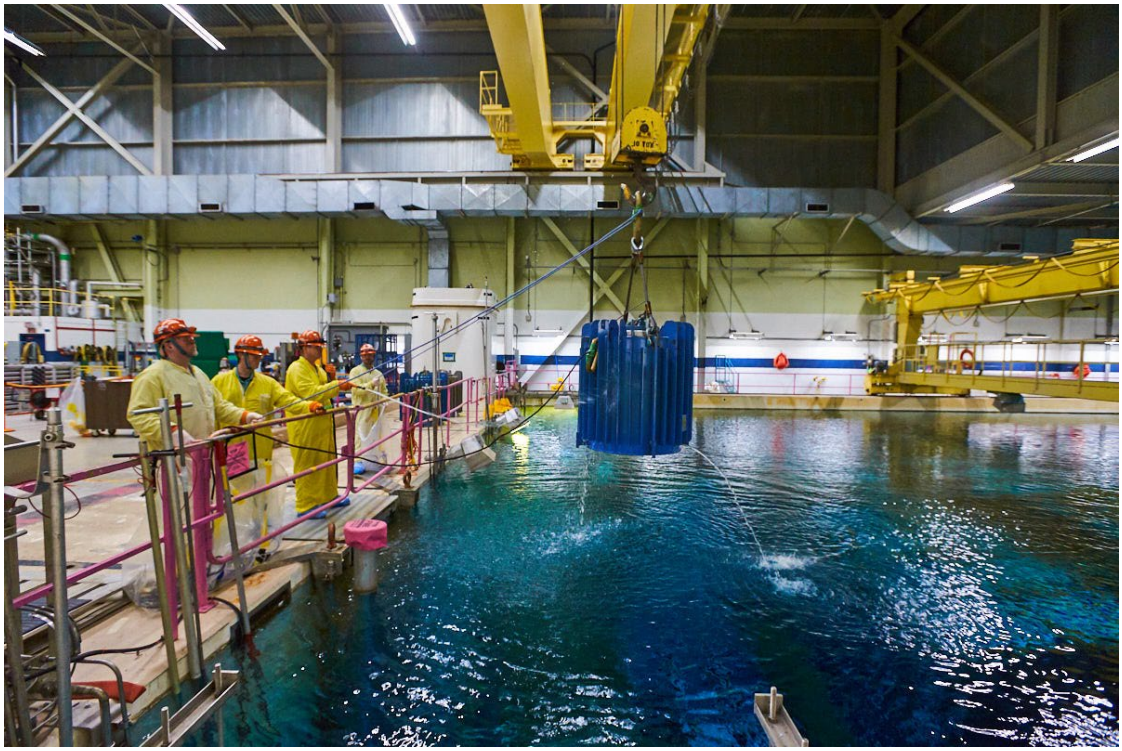
The F231 transportation package, containing irradiated Co-60 bundles, will be secured on a flatbed trailer for transport to Nordion for isotope processing. OPG's TDG Class 7 qualified personnel will be responsible for packaging the radioactive material, preparing the shipping documentation, completing the shipment notifications, and offering the radioactive material for transport. Nordion's staff will arrange a carrier to transport the shipment from Darlington NGS to the Nordion site in Kanata, Ontario. Nordion operates its Class 1B facility in Kanata under Nuclear Substance Processing Facility Operating Licence NSPFOL-11A.01/2025, valid until October 31, 2025. OPG, Nordion and its predecessor companies have been collaborating to produce cobalt at Pickering NGS, to varying amounts, since the 1970s.

As part of the transportation package design certification, the package undergoes enhanced mechanical and thermal testing, among other criteria, to demonstrate safety during both routine and accident conditions of transport in accordance with CNSC's *Packaging and Transport of Nuclear Substances Regulations*. These activities are the responsibility of Nordion as the owner of the packaging. Nordion, having ownership of the transportation packaging, will be responsible for the package design and maintenance. See Section 3.14 for more details.

Once irradiated, the Co-60 will be shipped from Darlington NGS to Nordion's facility in Kanata, Ontario. The incoming and outgoing Nordion transportation vehicles will be processed by Darlington security staff in accordance with N-INS-61400-10016, "*Security Process of Vehicle Ingress and Egress to the Controlled and Protected Areas*". Once the Co-60 shipments have been turned over to Nordion and leave OPG property, Nordion staff will be responsible for transportation and any associated security plan from Darlington NGS to the Nordion site. OPG staff will not accompany the shipment from Darlington NGS to Nordion's facility.

OPG being the consignor, does have ultimate responsibility for the Cobalt-60 shipment until it is received by Nordion (the consignee) at their facility in Kanata, ON. Acknowledging this responsibility, OPG has entered into a contractual agreement with Nordion, which requires Nordion to maintain the Transportation Security plan for these shipments to meet the requirements of REGDOC-2.12.3. Nordion's Transportation Security Plan will be revised for the transportation of Cobalt-60 from Darlington to Kanata, and will be submitted by Nordion to CNSC NSD within the timeline required by REGDOC 2.12.3. OPG will review Nordion's Transportation Security Plan on an annual basis to meet the requirements of REGDOC 2.12.3.

All Co-60 shipments will be in accordance with CNSC certificate CDN/2077/B(U)-96, for the Nordion (Canada) Inc. F-231, F-231-L, F-231-MK2, and F-231-MK2-L Serial Nos. 11 and up.



Co-60 Lifted from the IFB at Pickering NGS

Decontamination Prior to Shipment

F231 Transportation Package Loaded on Transport Vehicle for Shipment to Nordion

1.5. Audio, Video and Gamma Monitoring of Cobalt Operations

The Cobalt Remote Command Center for audio communication, video and radiation monitoring is designed to support a minimum of three staff (including a work supervisor, and Radiation Protection Coordinator for Radiation Protection (RP) oversight) to remotely direct the work and monitor the radiological exposures and dose rates present during key aspects of the cobalt adjuster rod removal/replacement work.

1.6. Maximum Quantity of Co-60

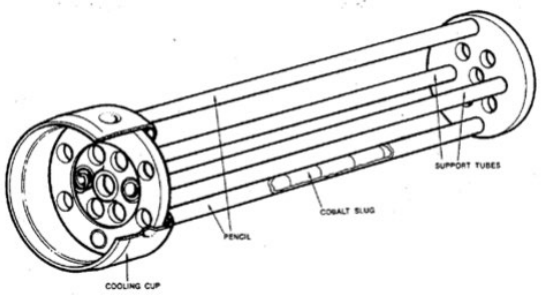
Table 1.6.1 represents the total predicted quantity of Co-60 in the 16 adjuster rods of each reactor unit based on the specified irradiation period. Reactor unit maintenance outages have a staggered schedule in order to perform a maintenance outage on each unit once every three years. An unplanned outage will have a minor impact on the effective irradiation time and will not affect the total Co-60 bundle yield significantly.

In addition, up to two full sets of irradiated cobalt rods (16 rods per set) can be temporarily stored in the WCHB of the IFB in the WFFAA. Both sets of rods may be stored in the cobalt adjuster rod storage rack.

An additional Co-60 bundle will be received from Nordion and placed into the IFB for calibration of the Cobalt Bundle Measurement System. These bundles will be replaced periodically to ensure accuracy of the calibration.

This bundle is an activated subassembly of an adjuster rod. It contains up to 6 pencils containing activated cobalt slugs, and these are held in place between two Zirconium end plates fixed by two zirconium support tubes. Each bundle is approximately 8.1 inches long and 2.4 inches in diameter.

Diagram below shows a bundle; however, a cooling cup would not be present on a calibration bundle.



There is a significant variation in bundle activity in part due degree of activation, number of cobalt slugs in the bundle and its subsequent decay after removal from the reactor. The expected range of initial activity is nominally 30KCi +/- 5KCi.

Nominal initial activity of bundle: 30KCi, 1110TBq
Initial range/tolerance: +/-5KCi, +/-185TBq
Expected lifetime range: 15KCi – 35KCi, 555 - 1295TBq

Dose rates associated with the calibration bundle are as follows: @30cm ~430,000 R/h, @1m – from side ~38,700 R/h, @1m from end ~35,000 R/h. Dose rates are in air. Note: A measured dose rate at contact is not available, but would be far in excess of 430,000 R/hr.

Loose surface contamination varies and is dependent on the moderator radionuclide burden during a given reactor operation cycle. Co-60 is the principal contaminant, followed by Zr-95/NB-95. These contaminants are found in levels ranging from 10's to 100's of µCi's.

The calibration bundle will be stored in the Irradiated Fuel Bay (IFB) at DNGS, with the bundle storage table. The calibration bundle is changed based on activity due to the half-life of Co-60 (5.27 years), and the bundle will be changed approximately every 5 years.

The calibration bundle will be returned to Nordion and made into C-188 source for irradiators, Zirconium waste will be disposed via Nordion Zirconium waste stream to CNL Chalk River.

The Cobalt-60 rack is designed to include storage for 32 Cobalt rods in the WCHB. This is a conservative provision as Cobalt-60 harvest initiation in each unit is naturally staggered and thus, it would be very rare (but predictable) if two harvests would occur within three weeks of one another. Note: Cobalt discharge to removal is typically completed in a 3-week period.

In the extremely unlikely event that three units worth of Cobalt are expected to be harvested concurrently, there would be ample lead time to perform further analysis to assess the bay's cooling capacity to safely store the third set of rods via a temporary rack (similar to the one which is being used to facilitate stainless steel rack relocation). If the assessment results are not favourable, OPG would have to wait until the first set of rods are removed from the bay before removing the third units' rods from the reactor. This could have critical path (commercial) implications to the respective unit's outage.

Nordion's capacity to remove Cobalt from OPG is not a concern, as they have indicated that they have dozens of Shipping Flasks at their facility and that the market demand for Cobalt remains very high. Furthermore, Nordion is financially incentivized to remove the Cobalt off-site immediately as it loses its efficacy over time and is sold by the curie.

Nordion supplies OPG with each new batch of Co-59 rods with the expectation the rods will be ready to harvest in 3-3.5 EFPY. This is in accordance with the OPG-Nordion Co-60 Irradiation agreement and Co-60 harvests are planned years in advance. Nordion would not supply rods for a harvest if they do not expect to have production capacity at the end of the irradiation period.

All Co-60 rods which are harvested are expected to be received by Nordion. Nordion plans Co-60 production several years in advance and there are provisions within the OPG-Nordion Co-60 Irradiation Services agreement for Nordion to decrease production of Co-60 based on sales volumes in preceding years. In the unlikely event that a batch is not shipped to Nordion due to a significant delay, OPG will handle this Co-60 batch in accordance with OPG approved standards and procedures, including OPG-STD-0156, "*Management of Waste and Other Environmentally Regulated Materials"*, which documents how waste is managed and the accountabilities for ensuring that all waste at Darlington NGS is processed in accordance with federal, provincial and municipal regulations, and N-PROC-RA-0017, "*Segregating and Handling of Radioactive Waste*", which includes strategies for waste minimization, waste characterization and waste management practices.

As cited from NK38-REP-31930-00001 (Reference [36]) "*Predictive Effects Assessment for the DN Co-60 Production System*": The additional emissions of the Co-60 and Mo-99 Production Systems are a small fraction of existing DNGS emissions. The cumulative increase in public dose for the critical group is estimated to be 0.004% of the regulatory public dose limit of 1 mSv/a, and 0.003% of the dose from background radiation in the vicinity of DNGS. Based on the results of the Predictive Effects Assessment (PEA), no needs for additional mitigation or environmental monitoring, as a result of the Co-60 Production System, were identified.

Additionally, radiological airborne emissions would not be impacted by delays in shipments to Nordion, as the primary contributor to airborne emissions are the operations at the RMD not the IFB (See Section 4.2 of NK38-REP-31930-00001 "*Predictive Effects Assessment for the DN Co-60 Production System*"). An airborne pathway is not anticipated for extended storage of Co-60 rods in the IFB since the fraction of airborne emissions stemming from the IFB come from purging activities only (See Section 4.2 of NK38-REP-31930-00001 "*Predictive Effects Assessment for the DN Co-60 Production System*") which are only completed when the Cobalt is ready to ship and thus, would be unchanged. Liquid emissions would not be impacted by prolonged Cobalt-60 storage in the WCHB as Cobalt decay does not result in additional neutron production, and thus, tritium cannot be produced in the IFB since it is a light water system.

The time evolution of estimated, bounding Co-60 yields per Unit with 16 AA's is presented in Table 1.6.1. These Co-60 yield values are obtained from the best estimate values (see Enclosure 4 of Reference [10]) with an additional two standard deviations (10% added at each time step in total). Assuming four units at Darlington NGS with 16 Co-60 AA rods, one at each irradiation step in Table 1.6.1 and two full Co-60 AA complements irradiated at 3.5 EFPY in spent fuel bays, the bounding value of the total amount of Co-60 in the Darlington NGS plant would be 79.3 MCi or 2.93E06 TBq.

Table 1.6.1: Bounding Co-60 Yields for 16 Adjuster Rods per Reactor

Irradiation Period	Total Bundle Yield (MCi)	Total Bundle Yield (TBq)
Yield 1.0 EFPY:	6.04	2.24E+05
Yield 2.0 EFPY:	10.81	4.00E+05
Yield 3.0 EFPY:	14.49	5.36E+05
Yield 3.5 EFPY:	15.99	5.92E+05

2. Project Intent

OPG notified CNSC staff in Reference [5] that the Co-60 Production Modifications Project include modification of all four reactor units to produce Co-60 at Darlington NGS.

OPG plans to utilize all four of Darlington NGS's reactors for the irradiation of Co-59 rods to produce Co-60. Co-60 isotope production will hence overlap in one unit with Molybdenum-99 (Mo-99) production. The effects of each system were assessed per NK38-REP-03500-0989867 R002, "*Cobalt Adjuster And Molybdenum Target Delivery System Interaction*" (Reference [6]), and it was found that there is negligible effect of each system on reactor safety and reactor operations. Due to

both systems being spatially and temporally independent from each other, their combined effect is no greater than their individual effects. Both systems were analyzed individually from a reactor safety and operational standpoint, with necessary measures in place ensuring safe operation of both systems in one reactor.

The Co-60 Production Modifications Project construction window is currently planned between 2022 and 2027, and all unit modification installation is during refurbishment or planned outages. The schedule details will be provided in a supplemental submission to this application in June 2023.

OPG and Nordion have established a planned division of scope, whereby OPG is responsible for the following site activities:

- Receipt and storage of Co-59 rods,
- Irradiation of Co-59 rods in Darlington NGS's reactors, and;
- Harvesting of the irradiated rods from the reactor core and on-site processing.

Nordion will be responsible for arranging a carrier to transport the shipment of Co-60 to their processing facility and all subsequent steps in the processing of Co-60 for end-users. Nordion operates its Class 1B facility in Kanata under Nuclear Substance Processing Facility Operating Licence NSPFOL-11A.01/2025, valid until October 31, 2025.

2.1. Submissions to CNSC

The design documentation and safety analyses competed in support of the Co-60 Production Modifications Project and provided for CNSC staff's review prior to the submission of the request for licence amendment are summarized in Section 3. Appendix A provides a consolidated list of OPG's pending regulatory commitments for the Co-60 Production Modifications Project.

2.2. Licensing Basis

There are no safety issues that result from the conversion of the Darlington NGS adjuster rods from SS to Co-59, and subsequent irradiation, to produce Co-60.

There are no programmatic changes required to the Nuclear Management System or any other programmatic changes to documents listed in the current Darlington Power Reactor Operating Licence (PROL) 13.03/2025 and the associated Licence Conditions Handbook (LCH). Any changes as a result of Co-60 production modifications installation to the OPG governance, programs and processes that form the licensing basis for each Darlington NGS Safety and Control Area (SCA) are identified in Section 3 of this document.

The proposed change to the licensing basis is (see Attachments 1 and 2 of this submission, and Section 3 below for details):

- Addition of a new licensed activity to possess, transfer, produce, package, manage and store the Co-60 radioisotope.

The systems and structures which were specifically built into the original Darlington plant to support harvesting of Cobalt-60 are:
1) The legacy Cobalt cooling circuit
2) The legacy CAEPS positioner rail supports and rails

Due to Nordion's ability to accept Cobalt-60 with oxide growth, and the confirmation that deflagration of H2/D2 would not occur with the cooling system out of service, the Cobalt-60 Cooling circuit is no longer deemed necessary and will not be utilized for future DNGS Cobalt Harvesting. Full details and history on the cooling circuit can be found in NK38-REP-34820-00001 "*Cobalt Adjuster Element Cooling Circuit Assessment*".

When DNGS was built, rail supports and rails were provided in anticipation that a CAEPS Positioner could one day be utilized for Cobalt-60 Flask Handling, and that it would be less costly to 'rough-in' the rail supports during original construction rather than install them after the fact. Since inception however, seismic requirements became more stringent and while the rail supports provided during original construction were deemed adequate to support the weight of the new CAEPS Positioners, the existing rail design did not have the track geometry needed to meet the current applicable crane code, nor did they have the lateral support strength needed to withstand a seismic event and thus the rails have been re-designed. The new rails designed for the CAEPS Positioner are of the correct geometry to meet the applicable requirements of CSA B167 and ASME NOG-1, and have lateral supports which are anchored into the adjacent concrete walls such that the assembly will stay intact during a siesmic event.

3. Safety Control Areas

The following sections describe how the conversion of adjuster rods from SS to cobalt, and the production, temporary storage, and preparation for transport of the Co-60 isotope will impact each of the 14 SCAs and the Nuclear Facility Specific licence conditions in the Darlington PROL 13.03/2025. Section 3 documents the impact of the Co-60 Production Modifications Project on Darlington NGS's governance, programs and processes.

The regulatory requirements and OPG governance, programs and processes that form the licensing basis for each of the 14 SCA's and the Nuclear Facility Specific licence conditions in Section 3 reflect what is in the current Darlington NGS LCH, LCH-PR-13.03/2025-R005. OPG confirms continued compliance with the applicable requirements/standards outlined in the current Darlington NGS LCH, and correspondence between OPG and CNSC staff regarding the listed regulatory requirements and OPG governance, programs and processes that form the licensing basis.

3.1. Management System

Darlington NGS remains in compliance with CSA N286-12, "Management system requirements for nuclear facilities"

- ✓ ***OPG's Engineering Change Control (ECC) process is applied to the Co-60 modification to ensure quality, design basis compliance and configuration management.***
- ✓ ***Safe reactor operation is the overriding priority.***
- ✓ ***Qualified vendors used for this modification follow their own quality assurance programs as approved by OPG and OPG confirms compliance through audits.***

OPG's Nuclear Management System provides a framework that establishes the processes and programs required to ensure OPG achieves its safety objectives, continuously monitoring their performance against these objectives, and fosters a healthy safety culture.

The entire lifecycle of the Co-60 Production Modifications Project implementation follows OPG's Nuclear Management System, which is in compliance with the requirements of CSA Standard N286-12. The Nuclear Management System will not change as a result of the proposed Co-60 modification on four Darlington NGS reactor units.

3.1.1. Regulatory Requirements Related to Management System

In addition to compliance with the "*Nuclear Safety and Control Act*" and the "*General Nuclear Safety and Control Regulations*", the regulatory requirements listed in Table 3.1.1 apply to the Management System SCA.

Table 3.1.1: List of Management System Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Co-60 Production Modifications Installation Impact
Safety Culture	CNSC REGDOC - 2.1.2 (2018)	No change. A healthy safety culture continues to remain OPG's highest priority.
Management system requirements for nuclear facilities	CSA N286 (2012)	No Change.

3.1.2. OPG Submissions to CNSC Staff Related to Management System

The Co-60 Production Modifications Project is in full compliance with N-PROC-MP-0090, "*Engineering Change Control Process"*, and N-GUID-00700-10000, "*Engineering Change Control Guide to Management Expectations*" and meets all the requirements of CSA N286-12. The ECC process, N-PROC-MP-0090, defines the process to be followed for all changes to the OPG Nuclear design basis, and ensures all design changes are planned, designed, installed, commissioned, placed into service, or removed from service within the Safe Operating Envelope or Safety Design Envelope, design basis, and licensing conditions. The process ensures that the physical configuration and the associated documentation is controlled (a match between the physical and paper configuration).

A Project Charter, NK38-PCH-31780-10001, *"Darlington Cobalt-60 Production Modifications"*, and Project Management Plan (PMP), NK38-PMP-00120-00022, *"Cobalt-60 Production Modification Project Management Plan"*, were completed for the Co-60 Production Modifications Project (Reference [7]). The PMP provides the project team, and interfacing organizations, a common understanding of the scope, assumptions, constraints, risks, and resources, and defines how project integration management will occur as processes interact. The Co-60 Project is operating primarily under the Engineering Procurement Construction (EPC) model with OPG's contract with E.S. Fox. E.S. Fox manages Tetra Tech (Design Service Provider (DSP)) and other Original Equipment Manufacturers for engineering and procurement, respectively. OPG has oversight on all activities and all design documents are accepted by OPG.

3.1.3. Safety Culture

OPG's highest priorities are the safety of its employees, the public, protection of the environment, adherence to international safeguards, and continued safe unit operation across OPG facilities. OPG's N-POL-0001, "*Nuclear Safety & Security Policy"* directs individuals at all levels of the organization to consider safety as the overriding priority.

3.1.4. Management of Contractors

OPG is utilizing the Engineering Procurement and Construction (EPC) contract model for Co-60 production implementation at Darlington NGS and has engaged a qualified vendor as the general contractor who will be providing EPC services, as per OPG-PROG-0038, "*Contract Management*".

The intent of OPG-PROG-0038 is not to describe specific EPC Services provided by vendors. It is the overarching Enterprise Projects document which governs OPG-wide contract management. OPG-PROG-0038 has six referenced lower tier documents which govern specific aspects of Nuclear contracts. Section 1.1 of lower tier document, N-INS-00120-10025, "*Extended Services Master Services Agreement Request for Work*", outlines the process for procuring EPC services under the Extended Services Master Services Agreement. The Cobalt-60 project engaged the EPC vendor and awarded the contract through this process.

OPG-PROG-0039, *"Project Management"* is applicable to the Cobalt-60 Project as it meets the applicability criteria defined in OPG-PROG-0039.

While project specific documents such as the Project Charter and PMP do not explicitly refer back to OPG-PROG-0039, NK38-PMP-00120-00022, "*Cobalt-60 Production Modification Project Management Plan*" does provide an indirect reference by referring to OPG-MAN-00120-0010 "*Project Integration Management*" which refers to OPG-STD-0148 "*Project Management*" which points back to OPG-PROG-0039 "*Project Management*".

The overall project is executed and managed under the EPC Vendor's CSA N286-12 approved quality program. It is the responsibility of the EPC Vendor and OPG, under their quality programs, to select appropriate quality program requirements for subcontracted items and services and ensure the sub-suppliers are approved accordingly. Therefore, by implementing the EPC Vendor's N286 program for the overall project management, activities and items associated with this project, including those provided by sub suppliers to the specified technical and quality requirements, meet the requirements of the N286-12.

The EPC contractor is responsible for ensuring all of the design, procurement, and construction is completed with required quality and safety. OPG is responsible for ensuring that all on-site contractor activities comply with OPG's safety requirements. OPG provides oversight of contractor employees who perform installation and testing work at Darlington NGS. The contractor used will be from OPG's Approved Supplier List.

Documented evidence of all EPC work and subsequent tests performed will be kept as part of OPG records as required by OPG's ECC process and CNSC regulations.

Additionally, OPG has implemented vendor and contractor oversight during on-site and off-site activities to ensure compliance with quality and safety requirements.

Specifically, OPG ensures:

- Strict traceability of all material used, strategic oversight of construction methods and commissioning tests performed.
- Early detection/documentation of potential issues so that corrective measures can be taken at the appropriate time.
- The approved design is constructible, operable and maintainable, safely without any adverse impact on the station's design basis, in accordance with OPG's ECC process.

3.1.5. Organization

During normal operation, the Co-60 project will not require any organizational changes or additional resources as changes to station operations are minimal. During planned unit maintenance outages with cobalt harvesting, additional support in staffing is required. However, this phase is temporary and can be fulfilled from the existing workforce. This does not impact the overall organizational structure.

All harvesting, maintenance and processing of Co-60 rods in the IFB will be performed by qualified personnel.

3.1.6. Operating Experience

An OPEX review was conducted during various stages of the Co-60 Production Modifications Project, particularly with respect to existing cobalt operations at Pickering NGS to identify previous applicable experience and lessons learned (NK38-REP-31780-10009, "*OPEX Report – DN Cobalt-60 Production Modification"* (Reference [1])). The OPEX review included ALARA/shielding, reactor regulating, lifting and transporting of cobalt equipment, and processing of cobalt at Pickering NGS, for example. OPG has also reviewed the Station Condition Records (SCRs) database and the CANDU Owners Group (COG) database for external events. In addition, experienced stakeholders from Pickering NGS were integrated into the project design team to facilitate equipment design to incorporate lessons learned and ensure tools are appropriate to facilitate safe Co-60 production. Finally, during operations, experience from Pickering NGS is planned to be integrated into Darlington NGS operations.

The results of the OPEX reviews were used to improve design and operational changes, for a positive impact on conventional safety, radiation safety, nuclear safety or overall dose impact.

3.1.7. Business Continuity

OPG's program document, OPG-PROG-0033, "*Business Continuity Program"* and guidance document, N-GUID-09100-10000, "*Contingency Guideline for Maintaining Staff in Key Positions When Normal Station Access Is Impeded"*, will not require changes for operation with Co-60 adjusters since there are minimal operational changes.

3.1.8. Impact of Co-60 System on OPG Governance, Programs, and Processes

There is no change to the OPG governance, programs and processes that form the licensing basis for Darlington NGS's Management System SCA as a result of Co-60 production modifications installation.

3.2. Human Performance Management

Systematic reduction of the potential for human errors and management of defences in pursuit of zero events of consequences were important considerations during the Co-60 design process.

- ✓ ***The Co-60 modification is in compliance with CNSC regulatory document REGDOC-2.2.1, "Human Factors".***
- ✓ ***Human Factors Engineering principles have been applied and workers have the necessary knowledge, skills and attributes, are fit for duty and sufficient in number to carry out Co-60 related work.***
- ✓ ***Systematic Approach to Training (SAT) based training will be completed prior to operation of the Co-60 system.***
- ✓ ***OPG has experience in handling the Co-60 system.***

3.2.1. Regulatory Requirements Related to Human Performance Management

In addition to compliance with the *"Nuclear Safety and Control Act"* and the *"General Nuclear Safety and Control Regulations"*, the regulatory requirements listed in Table 3.2.1 apply to the Human Performance Management SCA.

Table 3.2.1: List of Human Performance Management Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Co-60 Production Modifications Installation Impact
Personnel Training	CNSC REGDOC-2.2.2 (2014)	No change. There will be continued compliance.
Personnel Certification, Volume III: Certification of Persons Working at Nuclear Power Plants	CNSC REGDOC-2.2.3 (2019)	No change. There will be continued compliance.
Fitness for Duty: Managing Worker Fatigue	CNSC REGDOC-2.2.4 (2017)	No change. There will be continued compliance.
Fitness for Duty, Volume II: Managing Alcohol and Drug Use, Version 3	CNSC REGDOC-2.2.4 (2021)	No change. There will be continued compliance.
Fitness for Duty, Volume III Nuclear Security Officer Medical, Physical, Psychological Fitness	CNSC REGDOC-2.2.4 (2018)	No change. There will be continued compliance.

3.2.2. Human Performance Program Overview

The goal of the Human Performance (Hu) program is to continually reduce the frequency and severity of events through the systematic reduction of human error and the management of defenses in pursuit of zero events of consequence. As defined in program N-PROG-AS-0002, "*Human Performance",* human performance is the system of processes, values, job site conditions, behaviours, and their ultimate results that determine plant/facility performance.

The Hu program integrates site-wide proactive (prevention) and reactive (detection and correction) Hu initiatives, which includes the following:

- Providing oversight and mentoring of department Hu.
- Identifying emerging Hu issues, and determining strategies for related improvement.
- Approving site-wide Hu improvement initiatives and measures, and overseeing implementation progress.
- Use of the Hu toolbox, prevent event tools.
- Identifying and implementing Hu improvement communication, education, and training opportunities.

The site strategic plan provides guidance to the leadership team on the requirements for the development and implementation of an integrated site and department Hu strategic plan. Department managers and supervisors develop a Hu plan that sets clear direction and priorities to achieve the common goals.

Long-term Hu monitoring of Co-60 production will be completed through SCRs, per normal practices at OPG. Each facility has established monitoring and oversight forums which review and compare performance with standards of excellence to gauge the effectiveness of performance improvement efforts, as per N-PROG-AS-0002, including:

- Trending data in the aggregate to identify strengths as well as areas for improvement;
- Documenting improvement activities, clearly identifying timelines, accountabilities, targets and measures;
- Monitoring implementation of initiatives, corrective actions and hold line management accountable for results; and,
- Monitoring the use of the Accountability Analysis Model, as described in N-INS-09030-10001, "*Human Performance Event Communication and Analysis".*

3.2.3. Human Factors Engineering

Human Factors (HFs) are factors that influence Hu as it relates to the safety of a nuclear facility or activity over all design and operations phases. These factors may include the characteristics of the person, task, equipment, organization, environment, and training. The consideration of HFs in issues such as interface design, training, procedures, and organization and job design may affect the reliability of humans performing under various conditions. The goal of including HFs in design is to apply theory, principles, data and other methods to the design of structures, systems, and components (SSCs) to optimize human and system performance (as per CSA N290.12-14, *"Human factors in design for nuclear power plants"*).

A requirement of any modification to nuclear plants is to include adequate consideration of Human Factors Engineering (HFE), in compliance with CNSC regulatory document REGDOC-2.5.1, *"General Design Considerations: Human Factors".*

At OPG, HFE is considered in every modification having a Human System Interface following the ECC process under N-PROC-MP-0090. A graded approach is used to determine the level of HFE effort and rigor required in a modification, as specified in N-MAN-06700-10002, *"Guide for OPG Human Factors Engineering Process"*.

Following the OPG HFE process, the Co-60 Production Modifications Project was scoped as full level of effort, requiring a Human Factors Engineering Program Plan (HFEPP) and Human Factors Engineering Summary Report (HFESR). Consistent with the level of HF scoping, HFE analyses are being conducted and findings incorporated in the design for the Project to reduce the probability for human error. Oversight and guidance is being provided by OPG HFE Specialists.

At the time of submitting this letter, the HFE documents listed in Table 3.2.2 have been submitted to CNSC staff.

Table 3.2.2: List of Human Factors Engineering Documents Submitted to CNSC Staff

Title of Documents Submitted to CNSC Staff	Document Number
Human Factors Engineering Program Plan-Darlington Cobalt 60 Production Modification	NK38-PLAN-31935-00001-R000 (Reference [12])
Human Factors Engineering Verification and Validation Plan – Darlington Cobalt-60 Production Modification	NK38-PLAN-31935-00002-R000 (Reference [13])

The HFEPP produced for the Co-60 Production Modifications Project defines the scope of the planned HFE activities and the approach for the effective management of those activities, including timely integration of HFE into the design. The HFEPP addresses all elements described in CNSC regulatory document REGDOC-2.5.1 for HFEPPs, including, but not limited to:

- OPEX Review,
- Task Analysis,
- Staffing,
- Job Design, and
- Inputs to Training and Procedures.

Additionally, an HFE Verification and Validation (V&V) Plan was prepared, as planned in the HFEPP (Reference [13]). The purpose of the HFE V&V Plan was to describe the scope of the V&V activities and the planned approach for validation activities. The HFE V&V Plan addresses the elements outlined in CNSC regulatory document REGDOC-2.5.1 for V&V Plans.

The HFE analysis is on-going and will be documented in a HFESR once V&V activities are complete, as outlined in the HFEPP. The HFE analysis and issuance of the HFESR will be completed for a unit to return to service containing Co-59 adjuster rods, with the first unit being Unit 1 after DNRU1 completion. Submission of the HFESR to CNSC staff is tracked under Regulatory Management Action Request (REGM) 28247842 (References [12] and [14]) (Appendix A).

3.2.4. Personnel Training

As per OPG's training program (including N-PROC-TR-0008, "*Systematic Approach to Training"),* Darlington NGS staff will be qualified as required for the Co-60 related activities. Qualifications specific to Co-60 operations and management will be developed based on the Co-60 systems training program from Pickering NGS and will be updated for use at Darlington NGS. The Co-60 systems training at Pickering NGS, such as QUAL 11492, *Cobalt Processing Operator*, consists of training requirements for Non-Licensed Operators to harvest cobalt at Pickering NGS and the associated PELs are shown in Table 3.2.3, and this material will be updated for use at Darlington NGS. A Training Needs Analysis (TNA) will be tracked and completed in accordance with OPG's ECC Process.

Table 3.2.3: List of qualifications related to Cobalt operations developed for Pickering NGS

PEL ID	PEL Name
62512	NLO OJT: Load COCAL File and Disassemble Cobalt Rod
62513	NLO OJT: Load Cobalt Bundle Carriers Into The Bay
62514	NLO OJT: Perform Cobalt Bundle Measurements
62515	NLO OJT: Load Cobalt Flask And Purge
69881	Remove/Replace PNGS Cobalt Adjuster Rod - QC
79081	Pickering Wet Fuel FSOS Approval To Perform Cobalt Processing Operations

Department specific actions have been put in place to support a new training plan for Fuelling and Reactor Physics staff, particularly in relation to tracking of Cobalt adjuster irradiation and embedded Simulation of Reactor Operation (SORO) modelling. The Reactor Regulating System engineers will also be invited to attend specific presentations for awareness of minor differences in the rate of change in adjuster reactivity. Additionally, a new Training Needs Analysis (TNA) is also in progress for Authorized Nuclear Operators, Control Room Shift Supervisors and Shift Managers. Considering the similarity in adjuster rod reactivity worth, only minor revisions are expected to the relevant operating procedures. The following work groups will be involved in routine Cobalt harvesting and the corresponding TNAs have been completed:

- Non-Licensed Operations (Fuel Handling), Non-Licensed Operations (U0), Advanced Inspection and Maintenance (AIM), Mechanical Maintenance, Control Maintenance, Radiation Protection, Responsible Health Physics.

3.2.4.1. Cobalt Harvesting and Packaging

Qualified personnel will be responsible for the cobalt harvesting process at Darlington NGS. This will include experienced individuals from the Pickering NGS cobalt crew to transfer relevant OPEX from Pickering NGS. In addition, training specific to new Darlington NGS equipment will be provided for the cobalt harvesting crew to get a clear understanding of the operations and maintenance of the equipment. This may be completed via a combination of Computer Based Training and in-person training sessions, as required by OPG's training needs assessment and the training group's recommendations. This may be supplemented by On-the-Job Training /Evaluation. Vendor supplied documentation of the equipment in the form of operating manuals will be used for training development. In addition, a mock-up to aid in training will be set up to practice certain higher risk activities to minimize risks during cobalt harvesting, where practical.

Based on NK38-REP-31780-10009, "*Opex Report - Dn Cobalt-60 Production Modification*" (Enclosure 1 of Reference [1]), Darlington will not be designing and fabricating mock-up components for use in the station. Darlington Cobalt-60 does not have any mock shielding components (e.g., Pedestal, Shielding Ring, Lower Shield Plugs, etc.). For flask discharge training in the bay, an existing mock-stainless steel adjuster rod will be used which does not resemble a Cobalt rod and is therefore, not at risk of inadvertent use. When not in use, the mock-stainless steel adjuster rod is stored in a lay flat at the south end of the Dry Storage Container (DSC) decontamination pit. Furthermore, test rods which will be used for commissioning of equipment (and ultimately destroyed during testing of the center rod muncher) will come with the following features to differentiate them from actual rods:

1. Head cups will be anodized and labelled with "FOR TESTING ONLY" (this is the part that is normally labelled with the overall assembly label)
2. The bundle cups will be anodized (to differentiate them in colour)
3. The pencils will be anodized, and pencil serial no. will either be left "blank" or an "X", pencil anodizing may turn dark gray rather than blue per SS construction.

Harvesting, packaging and transporting cobalt within Darlington NGS will be performed by qualified personnel. This includes flask handling at the RMD, transport/erector operation, moving cobalt throughout to the IFB, and preparing and packaging the cobalt into the F231 Transportation Package, prior to shipment. Vendor Operating Manuals will be the basis for the training program for these activities, which is planned to be created by OPG, as per the OPG Training Program N-PROG-TR-0005, "*Training*" and N-PROC-TR-0008, "*Systematic Approach to Training*". Dummy rods will be available to perform practice training for removing and installing cobalt rods.

3.2.4.2. Cobalt Transport

All Co-60 (F231) transportation package receipt, handling and preparation for shipment activities will be completed by Transportation of Dangerous Goods (TDG) Class 7 qualified OPG personnel in accordance with OPG's existing procedure W-PROC-WM-0033, "*Radioactive Shipments*".

As outlined in Table 2 of NK38-REP-31780-10056 R001 "*Darlington Cobalt-60 Production Modification - ALARA Assessment"*, submitted as Enclosure 1 of Reference [43], estimated dose rates for the following on-site packaging and Cobalt-60 transport activities are:

- F231 Loading (Ambient dose rate at control panel): 0.5 mrem/hr
- F231 Raised above water and sprayed with a handheld spray nozzle: 2 mrem/hr
- F231 Decontamination (Worker is 1m from F231 surface): 10 mrem/hr
- Readiness for shipment/Class 7 checks: 1 mrem/hr
- Greater than 2m Trailer/Flask: 0.5 mrem/hr
- Driver/Cab: 0.5 mrem/hr
- F231 turnover for off-site shipment (Escorting and complete required checks): 0.2 mrem/hr

The internal dose target for Normal WFFAA Operations (at all worker locations) is less than 25mrem/h. Dose target for F231 handling (Contact) is less than 200 mrem/h and for F231 Handling (1m) is less than 10 mrem/h.

OPG's Radioactive Shipping program is more stringent than the federal requirements in the CNSC Packaging and Transport of Nuclear Substances Regulations (PTNSR) 2015. W-PROC-WM-0033, *"Radioactive Shipments"*, requires the outside surfaces of all packages to be free of loose

contamination. In contrast, the loose contamination requirements of the PTNSR adhere to a 4 Bq/cm^2 (~ 800 cpm on contamination survey meter) threshold as described in IAEA SSR-6, *"Regulation for the Safe Transport of Radioactive Material"*.

Additionally, the internal dose rate targets for contact and 1 meter dose rates are 200 mrem/h and 10 mrem/h, respectively. These are the lower bounds for "III – Yellow, Exclusive Use" category shipments in accordance with PTNSR/IAEA; the upper bound for contact dose rates is 1000 mrem/h.

Canadian Federal limits on radiation exposure are as follows:

- Nuclear Energy Worker: cannot exceed 5000 mrem in one year or 10,000 mrem in five years.
- Pregnant Nuclear Energy worker: cannot exceed 400 mrem starting on the date the licensee has been informed of the pregnancy
- Non-Nuclear Energy Worker: 100 mrem within a calendar year.

Comparatively, OPG limits for Nuclear Energy Workers are 2000 mrem in one year for OPG employees and 4000 mrem for contract workers, and 5000 mrem in five years for OPG employees and 9000 mrem for contract workers. Refer to N-PROC-RA-0019, "*Dose Limits and Exposure Control*" for more information.

3.2.4.3. Fuelling Operations

Fuel management changes due to the introduction of the Co-60 system will be included as part of relevant software updates to the fuel handling system and have been assessed and detailed in Enclosure 1 of Reference [11]. In addition, any operational restrictions due to the Co-60 system, e.g., limiting the irradiation period to less than 3.5 years, will be included in relevant operating procedures as per the ECC process.

3.2.5. Certification Personnel Training

3.2.5.1. Certified Operations Staff

OPG's initial training and requalification training for certified staff will include operation of the unit with Co-59 adjusters installed. A TNA will be completed as required for the engineering and operational change, and training is planned to be developed and delivered as per the processes in place, and in accordance with OPG's ECC process.

3.2.5.2. Certified Responsible Health Physicist

A TNA for the Responsible Health Physicist will be completed as required for the engineering and operational change, and training is planned to be developed and delivered as per the processes in place, and in accordance with OPG's ECC process.

3.2.6. Minimum Shift Complement

The Minimum Shift Complement (MSC) is the minimum number of qualified staff who are required to be present to ensure the continued safe operation of Darlington NGS, to respond to all credible postulated Design Basis Accidents (DBA) and to ensure adequate emergency response capability is available for the most resource intensive conditions.

Outages are a unique scenario where there are additional staff on site to support the outage schedule, which leads to a significant number of staff on site at all times. Cobalt harvesting, while performed during an outage, will have a dedicated crew that is in addition to the MSC resources already on site. Both the Operators and Maintainers in the Co-60 crew will be responsible for safe stating their cobalt work if an event were to occur, the cobalt crew will not have MSC response responsibilities and the MSC resources will not be responsible to support the cobalt equipment.

Minimum shift complement numbers are always met per OPG's licencing requirements. This does not change during an outage. If Co-60 harvesting is occurring during the outage, the dedicated Co-60 crew will be performing the necessary tasks. There will be no impact to the MSC staff as a result of the Co-60 operations.

The existing MSC, as specified in D-PROC-OP-0009, "*Station Shift Complement*" and N-INS-03490-10003 "Minimum Shift Complement Resources Qualifications and Procedures Required For Responding To Resource Limiting Events", remains valid and is not impacted by this project. The Co-60 crew is a dedicated crew for Co-60 operations and the staff on the crew are completely separate, additional staff to MSC staff. Co-60 staff will not be required as part of the station response to an event as they will be focusing on Co-60 operations. This is true for the entire dedicated Co-60 crew of Operators, Mechanical Maintainers and Control Technicians. Similarly, MSC staff will not be required for Co-60 operations.

The MSC for Darlington NGS, documented in D-PROC-OP-0009, "*Station Shift Complement*", documents the minimum staff numbers and their associated qualifications based on the following six DBAs:

1. Loss of Instrument Air
2. Main Steam Line Break
3. Common Mode – Design Basis Earthquake
4. Primary Heat Transport (PHT) Liquid Relief Valve Fail Open
5. PHT Pump Seal Failure (all seals) and Motor Fire
6. Loss of Coolant Accident with Failure of Emergency Coolant Injection System

Safety assessments of the impact of the Co-60 system on postulated DBAs in the Safety Report were completed and are documented in NK38-REP-03500-0774822 R01, *"Assessment of Impacts of Cobalt Adjusters on Safety Analysis"* (Enclosure 3 of Reference [10]). The assessment concludes that operation of the Co-60 system will have no material impacts on existing safety analyses with the presence of the system being bounded by existing analyses.

Over the course of the Co-60 design phase, HFE took a systematic approach to MSC impact assessments and considered inputs from the safety analysis, as well as physical design considerations, staffing decisions and procedure changes. There is no impact on MSC, and this will be further demonstrated by the completed HFE V&V activities (Reference [12]).

3.2.7. Fitness for Duty

As part of OPG's fitness for duty program, OPG has in place a Continuous Behaviour Observation Program which trains supervisors and managers to monitor workers for signs of fatigue or other factors which could adversely impact worker performance.

N-PROC-OP-0047, "*Hours of Work Limits and Managing Worker Fatigue"*, describes provincial and CNSC expectations to manage worker fatigue, applicable to all Nuclear Power Plants. The Cobalt-60 project shall be completed in accordance with this document.

Under this governance, supervisors are required to ensure that their employees are aware of their prescribed limits and are also responsible for monitoring their employees' hours of work. The process requires that employees are aware of their time limitations, track work hours and promptly notify the first line manager in advance of a potential violation.

OPG-PROC-0208, "*Fitness For Duty: Policy On Managing Alcohol And Drug Use*", sets out specific requirements for all workers to address alcohol and drug use and possession at all times while workers are engaged in company business, when on company premises and worksites, and/or when operating vehicles and equipment in the course of their duties for the company. The Policy includes alcohol and drug testing for certain categories of workers, including the regulatory requirements set out by the CNSC. This Policy forms one part of our overall approach to managing Fitness for Duty at company premises and worksites.

OPG Security monitors all personnel entering the protected area for indications of being unfit for duty or under the influence of intoxicants; if they suspect a worker is unfit they deny access to the facility. OPG is using periodic canine drug monitoring at security entry points as an additional barrier to ensure the fitness for duty of all staff entering the protected area.

3.2.8. Impact of Co-60 System on OPG Governance, Programs and Processes

There is no change to the OPG governance, programs and processes that form the licensing basis for Darlington NGS's Human Performance SCA as a result of Co-60 production modifications installation.

3.3. Operating Performance

Production of Co-60 will not adversely affect continued safe reactor operation

- ✓ ***Safe reactor operation is the overriding priority***
- ✓ ***The Safe Operating Envelope (SOE) and the licensing basis remains unchanged.***
- ✓ ***Co-60 operations will not impact safety limits, special safety system trip setpoints, or accident management.***
- ✓ ***OPG staff will follow approved procedures and will receive training prior to Co-60 isotope production.***

The Nuclear Operations Program, N-PROG-OP-0001, *"Nuclear Operations"*, implements a series of standards and procedures to ensure that the plant is operated safely and reliably. This program establishes safe, uniform, and efficient operating practices and processes within nuclear facilities that provide nuclear professionals the ability to ensure facilities are operated in such a manner that the PROL, Operating Policies and Principles (OP&P), and other applicable regulations and standards are followed. It also supports the alignment, prioritization and resolution of operational problems, keeping reactor safety as an overriding priority.

OPG does not anticipate any significant changes to the Nuclear Operations Program that implements the licence condition, or the OP&P, due to the production of Co-60 by changing the existing SS adjuster rods to Co-59 adjuster rods.

3.3.1. Regulatory Requirements Related to Operating Performance

In addition to compliance with the *"Nuclear Safety and Control Act"* and the *"General Nuclear Safety and Control Regulations"*, the regulatory requirements listed in Table 3.3.1 apply to the Operating Performance SCA.

Table 3.3.1: List of Operating Performance Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Co-60 Production Modifications Installation Impact
Accident Management: Severe Accident Management Programs for Nuclear Reactors	CNSC REGDOC-2.3.2 (2013)	Continued compliance, Co-60 production will have no adverse impact
Periodic Safety Reviews	CNSC REGDOC-2.3.3 (2015)	Given the Co-60 production modifications is a new design that satisfies all applicable regulatory requirements, this system will be factored into subsequent PSRs after the PSR that is currently under development for renewal of the Darlington PROL in 2025.
Reporting Requirements for Nuclear Power Plants	CNSC REGDOC-3.1.1 (2014)	Continued compliance, Co-60 production will follow CSNC REGDOC-3.1.1
Requirements for the safe operating envelope for nuclear power plants	CSA N290.15 (2010)	Continued compliance, Co-60 production will have no impact

The adjuster rods form part of the RRS and are withdrawn out of the core in specific (limited) circumstances to add reactivity. The nominal position of the 16 in-service adjuster rods during normal operation is "fully in core".

The predicted reactivity worth of cobalt adjusters was compared to the reactivity worth of non-cobalt adjusters in the reactor units at Darlington NGS. It was confirmed that the degree of similarity between the cobalt adjuster rod configuration and the non-cobalt adjuster rod configuration is such that no changes to the RRS control logic and parameters were required, as documented in NK38-CORR-31780- 0901715 R001, "*Analysis to Determine Effect of Cobalt Rod Design on Adjuster Unit Drive Controls and RRS Control Logic Reactivity Management"*.

The introduction of cobalt adjusters is associated with a small increase in the total adjuster reactivity worth, and the reactivity worth of each cobalt adjuster bank. A limited RRS assessment was performed and covered four time-average scores of varying cobalt adjuster irradiation time periods; namely 0.00 EFPY, 1.00 EFPY, 2.25 EFPY, and 3.50 EFPY. In each case the calculations of the reactivity insertion rate indicate that the liquid zone control system can compensate for the reactivity introduced by bank withdrawal. As a result, based on the assessment documented in NK38-REP-

03100-0936656, "*RRS Assessment of Reactivity Insertion Rates for Cobalt Adjusters"*, the RRS can accommodate each adjuster bank withdrawal with cobalt adjusters.

Table 0.2 lists any Operating Performance documents and the Reactor Safety supporting documents submitted to CNSC staff.

3.3.1.1. Validation of Rod Reactivity through Physics Commissioning

Darlington cobalt Adjuster Absorbers (AAs) are designed such that their individual reactivity worth after 3.5 EFPY irradiation cycle under core-equilibrium conditions, matches the corresponding SS AAs reactivity worth at the end of their service life. Simulations (i.e. benchmarking) of un-irradiated SS and cobalt AAs under pre-equilibrium core conditions confirmed that individual reactivity worth for these AA types is similar (Enclosure 2 of Reference [10]).

Validation of rod reactivity through physics commissioning at low power is important before operation at high power. The cobalt adjuster rods will either be commissioned in refurbishment units or outage units. Per current OPG plans, the first unit to commission cobalt AA's will be Unit 1 following its refurbishment outage. In this instance, the 16 un-irradiated Co-59 AA's will be commissioned under fresh core conditions. Prior to these measurements, the reactivity worth of cobalt AA's will be pre-simulated, to accurately reflect the Unit 1 core-configuration at that time.

It is expected that for subsequent units in refurbishment and outage, physics commissioning will be similar. Please see section 3.15.2 for further details.

3.3.2. Impact on Fuelling

The main requirements for fuelling are the maintenance of criticality and flux shape, as well as the optimization of fuel burnup. The computer code used for initial simulations with cobalt adjusters is the Reactor Fuelling Simulation Program – Industry Standard Toolset (RFSP-IST). Overall, the results from the stand-alone RFSP simulations have confirmed that no changes are required for fuelling practices with cobalt adjusters, during both the pre-equilibrium period and the regular equilibrium fuelling (Enclosure 2 of Reference [11]).

The fuel management code "Simulation of Reactor Operation" (SORO) is used at OPG sites for routine core monitoring, compliance and predictive fuelling simulations. While RFSP-IST is used primarily as a design and safety analysis tool, SORO is used as a production tool to simulate the operation of each of OPG's reactor units, accounting for the actual fuel burnup, refuelling and device movements that take place each day. A set of SORO models has been created for the purposes of cobalt support activities. It includes pre-equilibrium and equilibrium models suited for use as the basis for the predictive fuel management studies in later stages of this project. The current SORO model (using current adjusters) is largely consistent with the new SORO models for the future Darlington NGS cobalt adjusters which accommodate the pre-equilibrium core and an equilibrium core (Enclosure 2 of Reference [11]).

The SORO models for Darlington NGS are unit specific, and already contain the adjuster aging algorithm that will be updated for cobalt adjusters after installation in each unit. Any effects of cobalt adjusters will be transparent to the person using SORO code and the respective SORO model.

3.3.3. Response to Reactor Unit Transients

The adjuster rods form part of the RRS and are used in response to a unit transient.

The addition of cobalt adjuster rods does not affect the Operator response to unit transients, so it will not impact the current procedures or governance on the response to reactor unit transients (Enclosure 1 of Reference [10]).

3.3.4. Procedures Overview

OPG's "*Engineering Change Control Process*" (N-PROC-MP-0090) and process for "*Development, Review and Approval of Technical Procedures*" (N-PROC-AS-0028) has been used to generate a comprehensive list of documents (such as Operating procedures, Operating Manuals, Abnormal Incident Manuals) that need to be revised to acknowledge the substitution of existing SS rods with cobalt rods, and any new operator actions/considerations which may be required. The process ensures a comprehensive review of operating and maintenance manuals for engineering changes, which results in all applicable documents being updated and transferred to the relevant work groups through the Project Turnover process to Station. This process also assures configuration control such that "plant and paper" match and what is in the plant matches the records kept.

As part of the operation of the Co-60 production system at Darlington NGS, an operating manual and procedure will be developed, similar to those used at Pickering NGS (P-OM-018-31985-04.04.12, "*Cobalt Processing – Cobalt Handling*", and P-OP-31985-0001, "*Cobalt Processing Procedure*"), with changes adapted for use at Darlington NGS. Backout processes for cobalt adjuster rod removal during harvesting will be outlined in the cobalt operating procedures. REGM 28252894 tracks submission of the Darlington NGS Co-60 operating manual and procedure to CNSC staff by August 29, 2025 (Appendix A).

The comprehensive list of documents created/revised to support DNGS Cobalt-60 harvesting are listed below. Target issuance dates correspond to the planned equipment turnover date for the applicable Engineering Change related to the document and the first unit which is driving the procedure to be issued.

- I-MP-31780-00001 Adjuster Rod Drive Mechanism Removal (MEC 142910 (U1)),
- I-MP-31780-00003 Adjuster Rod Removal - All Types (MEC 142910 (U1)),
- I-MP-31780-00004 Adjuster Rod Discharge Into Wffaa Wchb (MEC 142913 (WFFAA)),
- I-MP-31780-00005 Adjuster Rod Drive Mechanism Installation (MEC 142910 (U1)),
- I-MP-31990-50008 Reactivity Mechanism Tooling Maintenance Procedure (MEC 142910 (U1)),
- NK38-CMP-76112-10001 CAEPS - Positioner - Laser Alignment Tool Calibration (MEC 142912 (U1)),
- NK38-CMP-76112-10002 Cobalt Equipment Preliminary Examination (MEC 142912 (U1)),
- NK38-CTP-31935-10001 CAEPS - Processing Equipment Preliminary Examination (MEC 142913 (WFFAA)),
- NK38-CTP-76112-10003 Positioner Service - Maintenance (MEC 142912 (U1)),
- NK38-MMP-31935-10001 CAEPS - Processing Separator Overhaul (MEC 142913 (WFFAA)),
- NK38-MMP-31935-10002 CAEPS - Processing Rod Muncher Overhaul (MEC 142913 (WFFAA)),

- NK38-MMP-31935-10003 CAEPS - Shipping Flask (MEC 142913 (WFFAA))
- NK38-MMP-31770-01 Remove Control Absorber Rod Drive Mechanism And Cable (MEC 142910 (U1)),
- NK38-MMP-31770-02 Control Absorber Rod Drive Mechanism And Cable Installation (MEC 142910 (U1)),
- NK38-MMP-31780-03 Installation Of Adjuster Rod Drive Mechanism (MEC 142910 (U1)),
- NK38-MMP-31780-07 Aa Thimble Gasket Leak Repair (MEC 142910 (U1)),
- NK38-MMP-31810-02 Shut Off Rod Drive Mechanism And Cable Removal (MEC 142910 (U1)),
- NK38-MMP-31810-03 Shut Off Rod Drive Mechanism And Cable Installation (MEC 142910 (U1)),
- NK38-CTP-31935-10001 CAEPS - Transporter / Erector - Maintenance (MEC 142914 (U1)),
- NK38-CTP-31935-10003 CAEPS - Transporter / Erector - Preliminary Examination (MEC 142914 (U1)),
- NK38-CTP-31935-10004 CAEPS - Flask - Maintenance, Repairs and Overhaul (MEC 142914 (U1)),
- NK38-OM-31935-10001 CAEPS - Positioner Operating Manual (MEC 142912 (U1)),
- NK38-OM-31935-10001 Cobalt Processing (MEC 142913 (WFFAA)),
- NK38-OM-63700-02 Reactor Regulating System (MEC 142910 (U1)),
- NK38-OM-37000-03 Reactor Physics, “Hazards and Practices” (MEC 142910 (U1)),

3.3.5. Reporting and Trending

Reporting will be performed in compliance with CNSC regulatory document REGDOC-3.1.1, “*Reporting Requirements for Nuclear Power Plants”* as applicable. There is no change required as a result of the Co-60 Production Modifications Project.

3.3.6. Outage Management Performance

During Darlington NGS planned unit maintenance outages, the Co-60 isotope will be harvested from the reactor before the irradiation period goes beyond 3.5 years. The Co-60 adjuster rods will be removed from the reactor and placed in the irradiated fuel bay for processing and new Co-59 adjuster rods will be installed. Normal routine reactivity worth tests will be planned and completed at the end of each outage, with the reactor critical at low power, i.e. before the unit reaches full power.

There is no impact on the management of outages, which are scheduled and planned in accordance with N-PROC-MA-0013, “*Planned Outage Management”*. New maintenance procedures will be prepared and approved per OPG’s *“Development, Review and Approval of Technical Procedures”*, N-PROC-AS-0028.

3.3.7. Guaranteed Shutdown States

There are three Guaranteed Shutdown States (GSSs) approved for use in Darlington NGS reactors: the Over-Poisoned GSS (OPGSS), the Drained GSS (DGSS) and the Rod-Based GSS (RBGSS). These GSSs are specified in Section 2.1.3 of NK38-OPP-03600, *“Operating Policies and Principles”* and are applied according to associated operating manuals. A brief description of the impact that cobalt AA implementation will have on each of the station’s GSSs is provided below, and the

requirements are reflected in GSS manual NK38-MAN-03677-10001, "*Guaranteed Shutdown State Manual"*:

- **OPGSS:** This GSS is based on maintaining a minimum concentration of gadolinium poison in the moderator, while complying with specified moderator chemistry, minimum moderator level and moderator temperature limits. Implementation of cobalt adjuster rods (AAs) does not challenge any of these requirements. The additional decay heat generation in cobalt AAs is negligible relative to the heat removal capacity of moderator cooling, so moderator temperature control will not be challenged, NK38-REP-31780-0865925 R002, "*Review of Applicability of Darlington Cobalt Adjuster Physics Analyses"* (Enclosure 1 of Reference [8]).

  All cobalt harvesting and replacement activities will be performed with the unit in the OPGSS; the new operating procedures are not expected to allow such activities while in the DGSS or the RBGSS.

- **DGSS:** This GSS is based on maintaining the calandria devoid of moderator, which alone precludes a critical assembly. All shut-off rods (SORs), control absorbers (CAs), and AAs (both in-service and out-of-service) are maintained in their fully inserted positions to eliminate the risk of a rod dropping into a dry calandria, and the associated risk of equipment damage that such a drop could cause.

  The DGSS will not be used for cobalt harvesting or replacement activities. Thermal analysis has been performed and documented in NK38-REP-03500-0797058 R02, "*Analysis Report for Physics/Thermal Analysis to Support Implementation of Cobalt in Darlington NGS*" (Enclosure 4 of Reference [10]). Prior to starting the transition to the DGSS, cobalt AAs will be harvested, as stated in NK38-MAN-03677-10001.

- **RBGSS:** This GSS is based on maintaining all SORs, CAs, and in-service AAs in their fully inserted positions. Cobalt AAs have been designed such that their bulk reactivity worth at the 3.5 EFPY irradiation limit (i.e., their minimum reactivity worth) is no less than the bulk reactivity worth of 16 in-service SS and titanium AAs at approximately 21 EFPY of irradiation, as per NK38-REP-03100-0688151 R02, "*DNGS Physics Analysis of Cobalt Adjuster Absorber Rods"* (Enclosure 1 of Reference [10]). Therefore, the RBGSS remains applicable throughout the maximum 3.5 EFPY irradiation cycle for cobalt AAs, and their reactivity contribution will not be less than that from the current 16 in-service AAs (stainless steel and titanium) at the end of their life.

  Cobalt AAs will be harvested and replaced during an outage while in the OPGSS, and after replacement, the reactivity worth of the new cobalt AAs will be confirmed after criticality is achieved. The transition from OPGSS to RBGSS will remain applicable at the end of regular outages (period between the new AA installation and the critical reactivity worth check), based on the following: (i) full insertion of the replaced AAs will be guaranteed; (ii) AA manufacturing and installation processes provide confidence that the new AAs will exhibit the reactivity worth expected; and (iii) previous RBGSS sensitivity analysis, NK38-CORR-03677-0374540, "*Determination of Subcriticality Margin for Darlington New RBGSS Sensitivity Cases (Withdrawal of Adjusters and Outage Period of 1 Year)"* (Enclosure 2 of Reference [15]), has demonstrated that sufficient sub-criticality margin is maintained even if adjuster rods are out of (withdrawn from) the reactor core.

  The RBGSS will not be used for cobalt harvesting or replacement activities.

3.3.8. Unit Installation Applicability

The installation of cobalt adjuster rods will be similar for each Darlington NGS unit and therefore, the amendment to allow for the production of Co-60 is generic to all four Darlington NGS units.

An assessment has been completed, NK38-REP-03500-0989867 R002 (Reference [6]), to evaluate the effects of having the cobalt adjuster assembly and the Mo-99 Isotope Irradiation System (IIS), also known as the Target Delivery System (TDS), in the same operating unit (Unit 2) at Darlington NGS. The effects of each system were assessed and it was found that there is negligible effect of each system on reactor safety and reactor operations. Due to both systems being spatially and temporally independent from each other, their combined effect is no greater than their individual effects. Both systems were analyzed individually from a reactor safety and operational standpoint, with necessary measures in place ensuring safe operation of both systems in one reactor.

Since the cobalt adjuster rods are designed to be similar to the original adjuster rods, OPG confirms that the Fuel and Reactor Physics practices will accommodate any unit with TDS (Moly-99) installed. Once both systems are commissioned on the same unit, the interaction between Cobalt Adjuster aging and operation of the Mo-99 TDS system will be managed by the Fuelling Engineers (FE) who have tools and processes at their disposal to ensure compliance with safety limits for core parameters.

Similar to the fuelling study for operation with Mo-99 IIS, the report NK38-REP-03100-0948159 "*Darlington Fuel Management Study for Cobalt Support Activities*", provided as Enclosure 2 of Reference [11], also used an automated method for channel selections for fuelling. In practice, the fuelling list is revised by FEs whenever a core parameter approaches an internal action limit in pre-simulations. Additionally, FEs can provide input to Operations delaying fuelling operations or/and delaying the TDS (Moly-99) seeding/harvesting operations, implicitly accounting for the very slow changes in Cobalt adjuster properties.

3.3.8.1. Severe Core Damage Considerations

The individual effects of the Molybdenum TDS and the Cobalt adjusters on the behaviour, evolution, and source term of corium and severe accidents are negligible. In addition to the small quantities of Molybdenum and Cobalt, neither metal has a high degree of volatility such that the releases from the core, if any, would be small in comparison with the other volatile and semi-volatile fission products that are available for release during a severe accident.

The assessment has been completed and is documented in NK38-REP-03500-0989867 R002 (Reference [6]).

3.3.9. Impact of Co-60 System Installation on Operating Performance

There is no change to the OPG governance, programs and processes that form the licensing basis for Darlington NGS's Operational Performance SCA as a result of Co-60 production modifications installation, except for those identified below in Table 3.3.2. Changes to the impacted documents are tracked through OPG's ECC process.

Table 3.3.2: Impact of Co-60 on Darlington NGS's Operational Performance Licensing Basis Documents

OPG Document Title	OPG Document Number	Co-60 Production Modifications Installation Impact
Operational Safety Requirements: Fuel and Reactor Physics	NK38-OSR-08131.02-10003	Change to include reference to Cobalt AA documentation, with no change to limits or compliance practices
Operational Safety Requirements: Moderator System	NK38-OSR-08131.02-10008	Change required based on cobalt adjuster rod interfacing with moderator
Operational Safety Requirements: Reactor Regulating System	NK38-OSR-08131.02-10010	Change required based on cobalt adjuster rod control by RRS
Operational Safety Requirements: Fuel Handling System and Irradiated Fuel Bays	NK38-OSR-08131.02-10018	Change required based on cobalt adjuster rod transportation, storage and processing
Operational Safety Requirements: Critical Safety Parameter Monitoring Instrumentation	NK38-OSR-08131.02-10021	Potential change to include reference to Cobalt AA documentation
Operational Safety Requirements: Shield Cooling System	NK38-OSR-08131.02-10022	Change required based on relevant analyses listed in Table 3.4.2 below

3.4. Safety Analysis

A comprehensive set of assessments were completed to demonstrate:
- ✓ ***Continued safe reactor operation.***
- ✓ ***No reduction in margins of safety.***
- ✓ ***No changes to safety system setpoints.***
- ✓ ***Public safety will be maintained.***

Specific new safety assessments for the Co-60 project are required to comply with CNSC regulatory documents REGDOC-2.4.1, "Deterministic Safety Analysis" and REGDOC-2.4.2, "Probabilistic Safety Assessment (PSA) for Nuclear Power Plants".

The Reactor Safety Program, N-PROG-MP-0014, *"Reactor Safety Program"*, establishes the requirements and processes for the management of issues relating to the following key components:
- Safety Analysis Basis
- SOE
- Severe Accident Management

The program and implementing procedures and standards govern management of issues related to Nuclear Safety Analysis and their impact on safe operation.

The Risk and Reliability Program, N-PROG-RA-0016, *"Risk and Reliability Program"*, establishes a framework for the development and use of probabilistic risk assessment as a means to manage radiological risks and to contribute to safe operation of nuclear reactors.

3.4.1. Regulatory Requirements Related to Safety Analysis

In addition to compliance with the "*Nuclear Safety and Control Act*" and the "*General Nuclear Safety Control and Regulations*", the regulatory requirements listed in Table 3.4.1 apply to the Safety Analysis SCA.

Table 3.4.1: List of Regulatory Requirements Related to Safety Analysis

Licensing Basis Document Title	Document Number	Co-60 Production Modifications Installation Impact
Deterministic Safety Analysis	CNSC REGDOC-2.4.1 (2014)	Co-60 system safety assessments were conducted in compliance with applicable requirements. Resolution of outstanding actions, communicated in Reference [16], has been provided as Enclosure 1 of Reference [42]. See footnote 2 on page 38.
Probabilistic Safety Assessment (PSA) for Nuclear Power Plants	CNSC REGDOC-2.4.2 (2014)	Co-60 system safety assessments were conducted in compliance with applicable requirements
Quality assurance of analytical, scientific and design computer programs for nuclear power plants	CSA N286.7 (1999, Reaffirmed 2012)	Co-60 system safety assessments were conducted in compliance with applicable requirements

3.4.2. OPG Submissions to CNSC Related to Co-60 Safety Analysis

The reactor safety supporting documents were provided to CNSC staff to facilitate review of the reactor safety analyses for the Co-60 Production Modifications Project. Two scenarios were identified where impact on existing safety cases were analyzed in further detail and the impacts are expected to be insignificant.

Enclosure 1 of Reference [44] provides N-REP-03500-1315507, "*Summary of Darlington Cobalt Adjuster Project Safety Analyses*" which summarize the process followed to identify operational physics and safety analyses potentially impacted by the replacement of currently used Stainless Steel/Titanium (SS/Ti) Adjuster Absorbers (AA) with cobalt AAs at DNGS and provides a summary of impact assessments on the Darlington safety case and assurances of safe operation with cobalt AAs within the current SOE limits.

Table 3.4.2 documents all the safety analysis submitted to CNSC staff.

Table 3.4.2: List of Reactor Safety Supporting Documents Submitted to CNSC Staff

Title of Documents Submitted to CNSC Staff	Document Number
DNGS Physics Analysis of Cobalt Adjuster Absorber Rods	NK38-REP-03100-0688151 R02 (Enclosure 1 of Reference [10])
Pre-equilibrium Core Simulation with DRAGON/RFSP for Cobalt Adjusters for Darlington Reactor	NK38-REP-03100-0766860 R01 (Enclosure 2 of Reference [10])
Assessment of Impacts of Cobalt Adjusters on Safety Analysis	NK38-REP-03500-0774822 R01 (Enclosure 3 of Reference [10])
Analysis Report for Physics/Thermal Analysis to Support Implementation of Cobalt in Darlington NGS	NK38-REP-03500-0797058 R02 (Enclosure 4 of Reference [10])
Strategy for Cobalt Absorber Rod Physics Commissioning and Test Pre-Simulations	Attachment 1 of Reference [11]
Darlington RFSP and DRAGON Physics Models for Cobalt Support Activities	NK38-REP-03100-0919101 R00 (Enclosure 1 of Reference [11])
Darlington Fuel Management Study for Cobalt Support Activities	NK38-REP-03100-0948159 R00 (Enclosure 2 of Reference [11])
Impact Of Cobalt Adjusters Implementation on Darlington Risk Assessment (DARA)	NK38-REP-31780-0854476 R000 (Enclosure 3 of Reference [11]) R001 was provided in Reference [17]
Review Of Applicability of Darlington Cobalt Adjuster Physics Analyses	NK38-REP-31780-0865925 R002 (Enclosure 1 of Reference [8])
Darlington Cobalt-60 Adjuster Assembly Design Report	NK38-DRT-31780-00006 R000 (Enclosure 2 of Reference [8]) R001 was provided in Enclosure 1 of Reference [27]
Cobalt Adjuster and Molybdenum Target Delivery System Interaction	NK38-REP-03500-0989867 R001 (Enclosure 1 of Reference [9]) R002 was provided in Reference [6]

Title of Documents Submitted to CNSC Staff	Document Number
GOTHIC Safety Analysis of the Darlington Irradiated Fuel Bay[2]	NK38-REP-34410-0973916 R01 (Enclosure 1 of Reference [42])
Evaluation of Limiting Safety Cases for GTE/Cobalt Adapter Thermal Analysis	NK38-REP-03500-10035 R01 (Enclosure 1 of Reference [18])
Assessment of Safety Cases Impact on the Cobalt Adjuster GTE/Adapter Interfaces	NK38-REP-31784-0907427 R000 (Enclosure 1 of Reference [19])

3.4.2.1. Scenario 1: Loss of Moderator Inventory Accident (LOMA)

Adjuster rod design in the Darlington NGS reactors consists of 16 adjuster rods which are normally fully inserted in the core during reactor operation. The adjusters are part of the RRS and can be withdrawn from the core in pre-defined groups (banks). The adjusters will remain in core in the event of a LOMA. It has been demonstrated that there is no safety concern related to deuterium deflagration following a LOMA (a bounding event) for the existing SS adjusters. The safety case related to the potential for deuterium deflagration was updated (Enclosure 4 of Reference [10]). Since cobalt adjusters generate more heat than SS adjusters, a LOMA was identified as the only DBA that can lead to deuterium deflagration in the core. A LOMA can lead to heat-up of the exposed in-core adjuster rods as the moderator drains. Uncovered in-core cobalt adjusters could become an ignition source if their surface temperature was higher than the minimum surface ignition temperature. Following a LOMA, the increase in the rate of transfer of deuterium from the moderator fluid to the cover gas could result in the formation of a flammable mixture.

Therefore, a nuclear safety analysis was performed to confirm that the use of cobalt adjusters in Darlington NGS as an ignition source did not pose a deflagration hazard following a LOMA (Enclosure 4 of Reference [10]). The predicted peak temperature of the adjuster rods remained below the acceptance criterion of the surface ignition temperature. The analysis accounted for irradiation periods of 3.0 and 3.5 EFPY for the cobalt adjusters, which bounds the planned irradiation time at Darlington NGS, and confirmed that the use of cobalt adjusters did not pose a deflagration hazard following a LOMA at Darlington NGS.

3.4.2.2. Scenario 2: Guide Tube Extension (GTE) Interference When Rods Parked Out of Core

During normal operation, the adjusters are located inside perforated guide tubes and are cooled by the moderator. As a means of controlling reactivity (i.e., during poison override after a turbine trip),

[2] OPG confirms full compliance to REGDOC-2.4.1 and the residual issues have been addressed in the revised analysis report.

The results of the confirmatory assessments were incorporated into R01 of the affected analysis report NK38-REP-34410-0973916 "*GOTHIC Safety Analysis of the Darlington Irradiated Fuel Bay"* (Enclosure 1 of Reference [42]).

the adjusters may be withdrawn from the moderator to their parked positions where they are enclosed in the extensions of the non-perforated GTEs above the core. Each GTE is surrounded by a thimble, which forms the boundary between the moderator cover gas and the shield tank coolant. Heat generated by the cobalt adjusters is removed primarily by convection and thermal radiation through the cover gas to the shield tank coolant. However, the temperature of an adjuster and its GTE will increase when an adjuster assembly is withdrawn from the core and exposed in cover gas.

As part of the overall design analysis, a need was identified for more detailed calculations (Reference [8]) because of the potential constrained axial expansion of the GTE due to nuclear heating while irradiated adjusters are parked out of core during poison prevent operation.

Enclosure 2 of Reference [8] confirms that the adjuster unit components (containment boundary, pressure boundary and non-pressure boundary) will satisfy all applicable code requirements for allowable stresses under the conditions analyzed. The analysis highlights that the effects of nuclear heating and associated differential thermal expansion between the adjuster GTE and thimble are acceptable, and there is no exceedance of code allowable stresses or unacceptable distortion resulting from this phenomenon. All pressure boundary components of the adjuster assembly meet the applicable code requirements and all non-pressure boundary components are within the allowable stresses for the material and containment boundary integrity is assured.

3.4.3. Deterministic Safety Analysis

The cobalt adjusters' reactivity worth and their ability to shape the neutron flux will decrease over time until the cobalt is harvested as a result of composition changes due to irradiation. Therefore, an assessment of the impact on the Darlington NGS safety analysis of the reduction of this reactivity worth and ability to shape the neutron flux is required and is addressed in NK38-REP-03500-0774822 R01, *"Assessment of Impacts of Cobalt Adjusters on Safety Analysis"* (Enclosure 3 of Reference [10]). In particular, a review of the Darlington Safety Report was conducted, as well as other recent safety analyses, in order to assess potential impacts on the safety case.

It was determined that for all events, the implementation of cobalt adjusters will have either no impact, or minimal/negligible impact on the analysis conclusions. As such, the impact of Co-60 production has no significant impact on the safety analysis, safety report and, by extension, public safety. Other than limits on cobalt irradiation and use of DGSS with irradiated cobalt rods, no other constraints, operational or otherwise, have been identified related to implementation of cobalt adjusters. SORO fuelling software was updated to capture cobalt irradiation as part of compliance with channel and power limits.

An assessment has been completed, NK38-REP-03500-0989867 R002 (Reference [6]), to evaluate the effects of having the cobalt adjuster assembly and the Mo-99 IIS, also known as the TDS, in the same operating unit (Unit 2) at Darlington NGS. The effects of each system were assessed and it was found that there is negligible effect of each system on reactor safety and reactor operations. Due to both systems being spatially and temporally independent from each other, their combined effect is no greater than their individual effects. Both systems were analyzed individually from a reactor safety and operational standpoint, with necessary measures in place ensuring safe operation of both systems in one reactor.

3.4.4. Probabilistic Safety Assessment

OPG's N-PROG-RA-0016, "*Risk and Reliability"* establishes the framework for the development and use of probabilistic risk assessment as a means to manage radiological risks and to contribute to safe reactor operation.

An assessment of the impacts on the existing Darlington Probabilistic Safety Assessment was completed to qualitatively assess the impact on Darlington Risk Assessment (DARA) Level 1 At-Power and Outage Analyses as a result of conversion to cobalt adjusters, NK38-REP-31780-0854476 R001, *"Impact of Cobalt Adjusters Implementation on Darlington Risk Assessment (DARA)"* (Reference [17]). The qualitative assessment showed that the impact of the changes from SS adjusters to cobalt adjusters on the DARA Level 1 At-Power and Outage analyses are negligible.

3.4.5. Severe Accident Analysis

OPG's operational procedures ensure that the operation of the facility can be returned to a safe and controlled state should operation deviate from normal. In addition to the operational guidance for abnormal and emergency states, OPG maintains a severe accident management program to address residual risks posed by severe accidents.

The safety case of the facility is not altered by the introduction of the cobalt adjuster rods, or by the production of Co-60. The replacement of the current adjuster rods with cobalt adjuster rods is transparent to reactor operation and to other station systems. The frequencies of the DBA and Beyond Design Basis Accident (Reference [18]) are not affected by the introduction of cobalt.

Potential Cobalt and Molybdenum TDS interactions have been documented in NK38-REP-03500-0989867 R002, "*Cobalt Adjuster and Molybdenum Target Delivery System Interaction"* (Reference [6]). This report includes a detailed review of the analyses impact (against each Appendix of DN Safety Report Part III: Accident Analysis), a qualitative review against the impact on PSA, and considerations for the additional Molybdenum and Cobalt to a Severe Core Damage corium pile. The report also includes an operational impact assessment and restrictions/conditions during guaranteed shutdown state (GSS).

The two systems will be used separately from each other, and therefore, no interactions that can affect nuclear safety analysis or operational analysis are expected. Any adjuster rod movement by an Authorized Nuclear Operator would require approval by Control Room Shift Supervisor and are only used per restrictions in OP&Ps. The operating procedures developed for Moly TDS contain restrictions on when harvesting/reseeding can occur. These would prevent operators from performing harvesting/reseeding during reactivity transients and provides harvesting permissive based on an acceptable range of individual and average zone levels.

NK38-REP-03500-0989867 R002, "*Cobalt Adjuster and Molybdenum Target Delivery System Interaction"* (Reference [6]) concludes that, "*As the two systems are significantly separated, both spatially and temporally, and as this survey of possible interactions with other systems has shown, their combined effect is no greater than their individual effects. Compliance with the requirements of each system is sufficient to comply with the requirements of both systems when they are installed in the same unit*."

The review documented in the Cobalt Molybdenum TDS interaction report does not identify an impact to Severe Accident Management Guidelines (SAMG) or Management of CANDU Safety Issues, since

the Moly TDS and the Cobalt adjuster rods do not participate, nor are they credited, in the mitigation of a severe accident sequence. The installation and operation of the Moly TDS and Cobalt adjusters do not have impact on the existing Accident Management and Severe Accident Management programs (covered under OPG's Emergency Preparedness program N-PROG-RA-0001, "*Consolidated Nuclear Emergency Plan*").

3.4.6. Hazard Analysis

A hazard analysis was performed to examine the consequences of postulated events to determine the nature of any release of radioactive materials and to confirm that the dose rate to the public at or beyond the site boundary is not affected, and is documented in NK38-REP-03200-00001 R001, "*Dose Rate Analysis of Darlington Co-60 Adjusters During Normal Operation and Flasking*" (Enclosure 5 of Reference [45]).

Co-60 harvesting operations at Darlington NGS will introduce specific hazards as identified in Enclosures 2, 3, 4 and 5 of Reference [12]. A systematic approach was taken to assess these hazards and appropriate actions were taken to minimize the effect on workers, public and the environment.

A hazard analysis was performed to cover all transfer stages from the reactor core to the IFB, to identify potential nuclear safety risks along the designated transfer route and is documented in NK38-REP-31935-10036 R000, "*Hazard Analysis for CAEPS Flask Transportation Between the RAB and WFFAA"* (Enclosure 3 of Reference [12]). The Co-60 adjuster rod flask will be lifted to a significant height, in order to maneuver it for transfer. The potential consequences of uncontrolled movement, or dropping the flask, were assessed and appropriate engineering and safety mitigating actions are put in place, as documented in NK38-REP-21190-10003 R002, "*Assessment of CAEPS Flask Drop at Reactor Building"* (Enclosure 2 of Reference [1]).

Flask Structural Analysis, NK38-REP-21540-10003 R001, "*Assessment of CAEPS Flask Drop at WFFAA*" (Enclosure 3 of Reference [1]), confirms that flask shielding will not be compromised from the bounding flask drop scenario. A combination of design and procedural-based preventative measures have been identified for all hazards associated with the transfer activities of the CAEPS Flask between the RAB and the IFB. Design-based preventative measures are the preferred solution with procedural preventative measures being used to mitigate risks where design-based solutions cannot be employed.

Table 3.4.3 below lists the documents related to the hazard analysis and assessments submitted to CNSC Staff.

Table 3.4.3: List of Hazard Analysis and Assessment Documents Submitted to CNSC Staff

Title of Documents Submitted to CNSC Staff	Document Number
Hazard Analysis for CAEPS Flask Handling at RMD & Hoistway	NK38-REP-31935-10034 R000 (Enclosure 2 of Reference [12])
Hazard Analysis for CAEPS Flask Transportation Between the RAB and WFFAA	NK38-REP-31935-10036 R000 (Enclosure 3 of Reference [12])

Hazard Analysis for CAEPS Flask and Nordion Shipping Flask Transportation Activities at the WFFAA	NK38-REP-31935-10035 R000 (Enclosure 4 of Reference [12]) R001 was provided in Reference [20]
Dose Rate Analysis of Darlington Co-60 Adjusters During Normal Operation and Flasking	NK38-REP-03200-00001 R001 (Enclosure 5 of Reference [45])
Assessment of CAEPS Flask Drop at Reactor Building	NK38-REP-21190-10003 R001 (Enclosure 8 of Reference [12]) R002 was provided in Enclosure 2 of Reference [1]
Assessment of CAEPS Flask Drop at WFFAA	NK38-REP-21540-10003 R000 (Enclosure 9 of Reference [12]) R001 was provided in Enclosure 3 of Reference [1]

3.4.7. Impact of Co-60 System on OPG Governance, Programs and Processes

There is no change to the OPG governance, programs and processes that form the licensing basis for Darlington NGS's Safety Analysis SCA as a result of Co-60 production modifications installation, except for those identified below in Table 3.4.4. Changes to the impacted documents are tracked through OPG's ECC process.

Table 3.4.4: Impact of Co-60 on Darlington NGS's Safety Analysis Licensing Basis Documents

OPG Safety Analysis Licensing Basis Document Title	OPG Document Number	Co-60 Production Modifications Installation Impact
Darlington Analysis of Record	NK38-REP-00531.7-10001	Co-60 Safety analyses is reflected in AoR
Safety Analysis Basis and Safety Report	N-PROC-MP-0086	Will be updated to include the Co-60 Safety analyses

In addition to list of impacted document changes in Table 3.4.4, OPG has committed (Reference [21]) to perform confirmatory activity of measurement and assessment of the Cobalt AA reactivity worth and incremental cross sections at the end of their first irradiation cycle at Darlington NGS. This activity is being tracked under REGM 28258842 (Appendix A).

3.5. Physical Design

Co-60 production modifications submitted design complies with all applicable regulatory requirements.

- ✓ ***Co-60 system design and operation is similar to that already performed at Pickering NGS***
- ✓ ***OPG staff provide oversight of vendors and follow the ECC process***

3.5.1. Regulatory Requirements Related to Human Performance Management

In addition to compliance with the "*Nuclear Safety and Control Act*" and the "*General Nuclear Safety and Control Regulations*", the regulatory requirements listed in Table 3.5.1 apply to the Physical Design SCA.

Table 3.5.1: List of Physical Design Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Co-60 Production Modifications Installation Impact
Requirements for safety related structures for CANDU nuclear power plants	CSA N291 (2008 and update no. 2, 2011)	Co-60 production design complies with the requirements in this CSA Standard
General requirements for safety systems of nuclear power plants	CSA N290.0 (2011)	Co-60 production design complies with the requirements in this CSA Standard
Human Factors in Design for Nuclear Power Plants Compliance Assessment Summary	CSA N290.12 (2014)	Co-60 production design complies with the requirements in this CSA Standard
General requirements for pressure-retaining systems and components in CANDU nuclear power plants	CSA N285.0 (2008 and update no. 2)	Co-60 production design complies with the requirements in this CSA Standard
Environmental qualification of equipment for CANDU nuclear power plants	CSA N290.13 (2005 and update no. 1, 2009)	Co-60 production design complies with the requirements in this CSA Standard
General requirements for seismic, design and qualification of CANDU nuclear power plants	CSA N289.1 (2008)	Co-60 production design complies with the requirements in this CSA Standard
Qualification of digital hardware and software for use in instrumentation and control applications for nuclear power plants	CSA N290.14-15 (R2020) Reference [22]	Co-60 production design complies with the requirements in this CSA Standard
Cyber security for nuclear power plants and small reactor facilities	CSA N290.7 (2014)	Co-60 system design complies with cyber security requirements
Requirements for electrical power and instrument air systems of CANDU nuclear power plants	CSA N290.5 (2016)	Co-60 production design complies with the requirements in this CSA Standard

3.5.2. OPG Submissions to CNSC Related to Physical Design

Design documents were submitted to CNSC staff to facilitate review of the design approach being taken for the Co-60 Production Modifications Project. The physical design documents listed in Table 3.5.2 have been submitted to CNSC staff.

Table 3.5.2: List of Physical Design Documents Submitted to CNSC Staff

Title of Documents Submitted to CNSC Staff	Document Number/Reference
Modification outline package for MEC 142910 R000, MOD-142910, "*DNGS Co-60 Production Modifications for Conversion to Cobalt Adjuster Rods"*	Enclosure 1 of Reference [2]
Modification outline package for MEC 142912 R000, MOD-142912, "*1 2 3 4-31780-master-modifications For Periodic Removal\ Replacement of Cobalt Adjuster Rods from Reactor (Reactivity Mechanism Desk)"*	Enclosure 2 of Reference [2]
Modification outline package for MEC 142913 R001, MOD-142913, "*012-31935 Master-DNGS Co-60 Production Discharge Storage Processing and Off-site Transport Modifications*"	Enclosure 3 of Reference [2]
Modification outline package for MEC 142914 R000, MOD-142914, "*014-31780-master-modification For On-site Transport of Cobalt Adjuster Rods and Additional Equipment*"	Enclosure 4 of Reference [2]
Modification outline package for MEC 142915 R000, MOD-142915, "*012 1 2 3 4-31780-master-modification For Audio Video and Gamma Monitoring of Cobalt-60 Adjuster Rod Operations*"	Enclosure 5 of Reference [2]
Modification outline package for MEC 151468 R000, *"1, 2, 3, 4-34820-Master-DNGS CO-60 Production: Cobalt Cooling Circuit System Update"*	Attachment 1 of Reference [3]
Co-60 Production Modification: RMD, Site Transportation and Monitoring	NK38-MDR-31780-10002 R000 (Enclosure 6 of Reference [2]) R001 was provided in Reference [23] R002 was provided in Reference [4]
Modification Design Requirements for Conversion to Cobalt Adjuster Rods	NK38-MDR-31780-10004 R000 (Enclosure 7 of Reference [2]) R001 was provided in Reference [24]

Title of Documents Submitted to CNSC Staff	Document Number/Reference
	R002 was provided in Reference [25] R003 was provided in Reference [26]
Modification Design Requirements for Discharge, Storage, Processing and Off-Site Shipping of Cobalt	NK38-MDR-31935-10001 R001 (Enclosure 8 of Reference [2]) R002 was provided in Reference [4]
MEC 151468 Cobalt Cooling Circuit System Update Modification Design Requirements	NK38-MDR-34820-00001 R000 (Enclosure 1 of Reference [3])
Adjuster Units Failure Modes and Effects Analysis (FMEA)	NK38-REP-31780-0940417 R000 (Enclosure 1 of Reference [12])
Hazard Analysis for CAEPS Flask Handling at RMD & Hoistway	NK38-REP-31935-10034 R000 (Enclosure 2 of Reference [12])
Hazard Analysis for CAEPS Flask Transportation Between the RAB and WFFAA	NK38-REP-31935-10036 R000 (Enclosure 3 of Reference [12])
Hazard Analysis for CAEPS Flask and Nordion Shipping Flask Transportation Activities at the WFFAA	NK38-REP-31935-10035 R000 (Enclosure 4 of Reference [12]) R001 was provided in (Reference [20])
Dose Rate Analysis of Darlington Co-60 Adjusters During Normal Operation and Flasking	NK38-REP-03200-00001 R000 (Enclosure 5 of Reference [12]) R001 was provided in Enclosure 5 of Reference [45]
Assessment of CAEPS Flask Drop at Reactor Building	NK38-REP-21190-10003 R001 (Enclosure 8 of Reference [12]) R002 was provided in Enclosure 2 of Reference [1]
Assessment of CAEPS Flask Drop at WFFAA	NK38-REP-21540-10003 R000 (Enclosure 9 of Reference [12]) R001 was provided in Enclosure 3 of Reference [1]
Darlington Cobalt-60 Adjuster Assembly Design Report	NK38-DRT-31780-00006 R000 (Enclosure 2 of Reference [8]) R001 was provided in Enclosure 1 of Reference [27]

Title of Documents Submitted to CNSC Staff	Document Number/Reference
Design Specification Adjuster Unit Thimble and Guide Tube Extension	NK38-DS-31780-00003 R000 Enclosure 3 of Reference [27]
RMD with Cobalt-60 Operations Supplemental Design Report	NK38-DRT-31710-00003 R000 (Enclosure 1 of Reference [28] R001 was provided in Enclosure 4 of Reference [45]

3.5.3. Design Governance

Darlington's PROL 13.03/2025 requires that design modifications be controlled such that the station is maintained and modified within the limits prescribed by the design and licensing basis. Design changes are performed in accordance with OPG's program N-PROG-MP-0001, *"Engineering Change Control"* to ensure design changes to each OPG Nuclear facility (including SSC, software, and engineered tooling) are planned, designed, installed, commissioned and placed into or removed from service such that the facility configuration is managed in accordance with the design and the licensing basis, and remains within the SOE.

OPG provided input and oversight of the Co-60 system design process to ensure compliance with N-PROG-MP-0001 and has confirmed all requirements have been met for the Co-60 Production Modifications Project.

3.5.4. Co-60 System Design

The Co-60 system design is described in Section 1.2. Some features of the Co-60 design are outlined below.

3.5.4.1. Site Characterizations

The Co-60 design will not change Darlington NGS site characterization.

3.5.4.2. Facility Design

The Co-60 design will not result in the installation of new facilities at Darlington NGS.

3.5.4.3. Failure Modes and Effects Analysis

A Failure Modes and Effects Analysis (FMEA) was performed as part of the engineering change for Co-60, NK38-REP-31780-0940417 R000, *"DNGS Cobalt-60 Modifications - Adjuster Units Failure Modes and Effects Analysis (FMEA)"* (Enclosure 1 of Reference [12]). Key failure modes and effects are identified for components affected by the design modifications to convert to the use of cobalt adjuster rods in the Darlington NGS reactors.

Review of the risks following implementation of the modifications, as well as the additional mitigation measures described in the FMEA document, show that the design and design analysis mitigations

for the adjuster rods, in addition to the recommended procedural mitigations, effectively reduce the risk of adjuster rod failures during installation/removal, normal operations and post-DBA/Common Mode Event, with the exception of multiple rod-drop into the core following a Design Basis Earthquake, for which the risk is considered to be unchanged.

3.5.4.4. Seismic Qualification

The cobalt project designs comply with seismic requirements in CSA Standards N289.1-08, *"General requirements for seismic, design and qualification of CANDU nuclear power plants"*, N289.3-10, *"Design procedures for seismic qualification of nuclear power plants"* and N291-08 and Update No. 2, *"Requirements for safety-related structures for CANDU nuclear power plants"*. A summary table identifying seismic categorization for major equipment was submitted to CNSC staff in Attachment 1 of Reference [12].

3.5.4.5. Environmental Qualification

The Environmental Qualification (EQ) program is defined in document N-PROG-RA-0006, *"Environmental Qualification"*.

The cobalt modification design complies with CSA Standard N290.13-05 and Update No. 1, "*Environmental qualification of equipment for CANDU nuclear power plants"*, as discussed in NK38-CORR-03200-0948917 R000, *"Assessment of Increased Normal Dose Rate on EQ Components from Operation of Co-60 Adjusters".* Equivalent EQ assessment documentation is under development for Unit 2.

3.5.4.6. Over-Pressure Protection

The Co-60 design complies with CSA Standard N285.0-08 and Update No. 2, "*General requirements for pressure-retaining systems and components in CANDU nuclear power plants"*.

- When the Co-60 adjusters are harvested, the moderator cover gas system is in a depressurized state and the calandria burst discs are available. There is no impact on the overpressure protection of the calandria and reactivity mechanism associated components, when the adjuster rod mechanism assembly is removed.

- As part of preparing the Nordion cobalt shipping flasks, the flasks are purged with argon. A portable arrangement with bottles will be used to provide argon supply to the flask prepping room.

3.5.4.7. Software

There is minimal software application in the Co-60 production modification. Any software included as part of the design adheres to the Software Qualification Requirements, as per N-PROC-MP-0090.

A relay-based system that does not include software is used for the majority of the control systems applied for the CAEPS. One key exception is a seismic sensor and switch used to detect seismic activity and disconnect power to the positioner. This sensor utilizes software and has been categorized accordingly.

3.5.4.8. Cyber Security

The Co-60 production modification design complies with OPG's cyber security requirements. Cyber Security is addressed during the design scoping phase of the modification process and issues are tracked through to the in-service declaration.

OPG's cyber security program is documented in OPG-PROG-0042, "*Cyber Security"*. The program defines organizational responsibilities, processes and overall requirements for an effective Cyber Security Program, the purpose of which is assurance of protection of the confidentiality, integrity, and availability of OPG's assets.

OPG's N-PROC-RA-0135, "*Cyber Security"* takes authority from OPG-PROG-0042 and defines processes for the identification, classification, and protection of Cyber Assets (CAs) in OPG Nuclear. This procedure also ensures those nuclear CAs that are cyber essential assets are protected and meet the requirements of CSA Standard N290.7-14, "*Cyber Security for nuclear power plants and small reactor facilities"*. These documents interface respectively.

3.5.4.9. Containment Integrity

The integrity of containment is not impacted during normal operation of the systems involved in the Co-60 production modification. During normal operations, the adjuster rod drive mechanism housing serves as a part of the reactor containment boundary. During a harvest each adjuster unit site will have its mechanism assembly removed to allow the Co-60 adjuster rod to be removed and replaced. The mechanism assembly is removed for a limited period of time when the reactor is in the shutdown state only. In the event this containment boundary needs to be restored temporarily, a Class 2 temporary maintenance covers will be available to serve as the alternate containment boundary to ensure defense in depth.

Equipment and components associated with the Co-60 production modification are designed to maintain the containment boundary under normal and abnormal circumstances. Credited containment boundary components and seals are required to maintain the containment boundary integrity for three months following credited accidents, as required, if exposed to harsh conditions expected during accident scenarios. No modifications were done to the existing credited containment boundary components and seals to facilitate the change to Cobalt Adjusters.

Refer to Section 3.4.2.2 for details on the analysis performed to address potential concerns due to potential interference of the GTE and cobalt cooling elements on the containment boundary when cobalt adjuster rods are parked out of core.

3.5.4.10. Electrical Power Systems

The electrical design associated with the equipment and components for Co-60 production modification are designed to meet CSA N290.5-16. New power supplies under the cobalt modifications consist of tie-ins to existing Class IV power supplies only and the routing of cables follows existing facility separation of divisions/groups. These loads are protected/isolated by breakers that are sized adequately and will trip during fault to prevent impact to upstream components in the facility.

The positioner electrification Requirements Traceability Matrix (RTM) is captured in NK38-REF-31780-0702607, *"Requirement Traceability Matrix MECs 142912 142914 142915"*, and the Transporter/Erector power supply RTM, which provide details on how the electrical requirement was satisfied in the design. The applicable design documents are in the table below:

Document Number/Reference	Title of Documents Related to Electrical Power Systems
600V Distribution System Class Iv Bus 5334-Bu27 Schematic (1-Line) Diagram	NK38-F0S-53340-0007-U3
600V Distribution Class IV-5334-27CbX Feeder Breaker Protection Elementary Wiring Diagram	NK38-D1S-65334-5208-U3
Cobalt-60 Voltage Drop Calculation for DEC 154557	NK38-CALC-76112-00002
Darlington NGS- Cobalt 60 Positioner U3 - ETAP Analysis	NK38-CALC-76112-00011-U3
Reactor Building and RAB 3-56100-LC4001 347V 600V AC Cl IV Lighting and 120V 208V AC Receptacle Wiring Connections	NK38-D0S-56000-0125
Cobalt-60 Voltage Drop Calculation for DEC 154561	NK38-CALC-56314-10001

3.5.4.11. Co-60 Code Classification

The Co-60 Production Modifications Project is compliant with OPG's procedure N-PROC-MP-0040, *"System and Item Classification"* defining the requirements and process to be followed for code classification of pressure retaining systems.

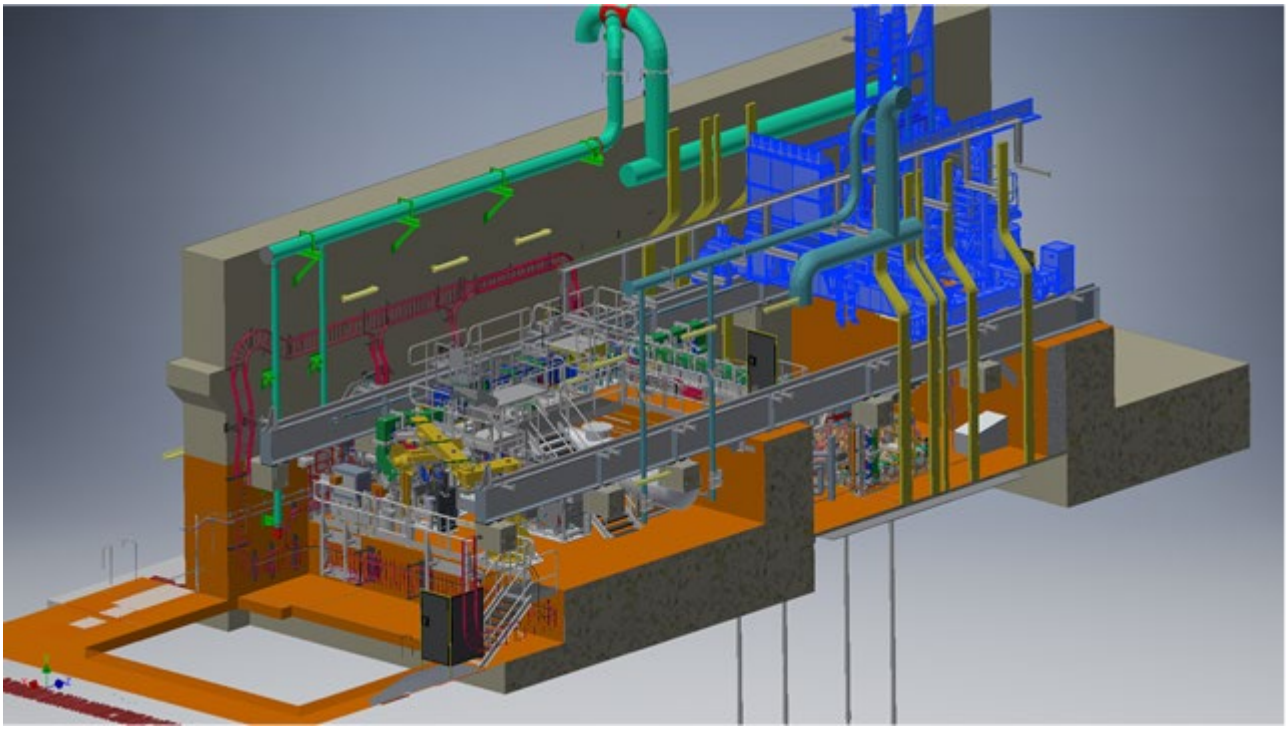
In accordance with Darlington's PROL 13.03/2025 and the requirements of CSA N285.0-08 and Update No. 2, the following requests for CNSC staff's code classification consent support the Co-60 Production Modifications Project:

- For modifications to the Adjuster Thimbles and the Adjuster Cobalt Adapter fittings (Reference [29]). CNSC staff provided consent in Reference [30].
- For modifications to the Units 1, 3, and 4 RMD due to design loads at the 16 adjuster port sites (Reference [31]). CNSC staff provided consent in Reference [32]. Submission for Unit 2 is documented in Reference [46].
- For Unit 2 modifications to reroute Mo-99 TDS interference lines (Reference [46]).

3.5.5. Considerations for Unit 2: Cobalt-60 CAEPS and the Mo-99 Target Delivery System

In addition to the production of Co-60 at Darlington NGS, a separate isotope production project is currently underway to install a Molybdenum-99 (Mo-99) Target Delivery System (TDS) in Unit 2. This modification allows for the commercial production of Technetium-99, a radioisotope which is of growing importance in 3-D medical imaging applications. The Mo-99 TDS is an electromechanical system which will be present beneath the Co-60 CAEPS flask positioner system once installed in Unit 2. The TDS system uses a combination of mechanical, pneumatic and hydraulic means to lower and retrieve isotope targets into and out of the reactor through four elevator ports. The elevator ports have replaced the guide tube assemblies of four adjuster sites that had adjuster elements permanently locked out of core to optimize reactor efficiency. In Unit 2, the TDS system is predominately located on the West side of station room U2-R302 and on the South end of the RMD.

Having been designed and built by the same vendor who are producing the Co-60 flask positioners, the two systems are designed to prevent unintended interactions. The flask positioner can be driven between R302 and the RMD and perform its function independently of the TDS, and the TDS can operate as usual while the Positioner is parked in its home position in R302.



3-D Model of R302 (left) and the RMD (right) in Unit 2 with both CAEPS and TDS Constructed

3.5.5.1. Design Considerations

While the TDS and CAEPS system are designed to operate in close proximity and avoid interactions, there are minor 'would-be' interferences which have been identified during constructability walkdowns throughout the Unit 2 Co-60 detailed design stage. The interferences and resolutions are as follows:

1. DRS Tubing: tubing to be re-routed as per Engineering Change 162864 and request for code classification submission (Reference 46)
2. TDS Double High Handrail: southern section removed to allow the Positioner to be in its "home" position. Other Handrails will be temporarily removed as required for harvests.
3. Positioner Runway Tie-Back: on the north side of South Shielding Wall, tie-back to be modified to account for TDS Baseplate interference.
4. TDS Maintenance Exhaust Ducting: ducting to be re-routed to provide clearance for the Positioner travel path.
5. TDS Tritium Line: tritium line re-route required.
6. TDS Contaminated Exhaust: ductwork to be re-routed.

These interferences are being addressed by the Co-60 project, with the TDS and flask positioner vendor's engagement. The interferences are to be addressed under Engineering Change (EC) 162864 and will be rectified during the D2421 outage in 2024.

Other factors differentiating the Unit 2 design from the other units include the following:
The flask positioner zoning limits switches, which are set more restrictively in the X-Y plane as required to eliminate the possibility of collisions with the TDS components. The Positioner runway tie-backs in unit 2 are shaped to eliminate additional interferences with the TDS. The Co-60 Operations Supplemental Design Specification, NK38-DS-31710-00003, and Co-60 Operations Supplemental Design Report, NK38-DRT-31710-00003, have been provided in Reference [45] which address the combined loading of Co-60 and TDS. Code classification consent has been requested under Reference [46] for Unit 2 RMD, which will now see loads from TDS and cobalt equipment simultaneously on the same unit. NK38-REP-31780-10056 R001, "*Darlington Cobalt 60 Production Modification- ALARA Assessment"* provided under Reference [43] concluded that no additional measures were taken for units where the Target Delivery System and Cobalt systems are installed as the collective measured implemented individually for each system was deemed sufficient. Additionally, Cobalt Harvesting Procedures, Training Manuals and HFE consideration will be updated to address newly installed TDS equipment at the Unit 2 RMD.

All design ECs associated with the Co-60 harvest infrastructure on Unit 2 have been approved for installation start in 2024. The remaining EC associated with Co-59 adjuster rod installation and integrated commissioning of the harvesting infrastructure has been completed supporting installation in the D2721 outage in 2027.

3.5.5.2. Safety Considerations

Safety analysis and operational assessments for the Mo-99 and Co-60 projects were performed independently of one another, meaning the Mo-99 TDS safety analyses and assessments were performed assuming that the Darlington core operated with standard, non-cobalt adjuster rods. The cobalt project's analyses did not consider the presence or operation of a TDS system. As the Co-60 Production Modifications Project was scoped in Unit 2, an evaluation was completed and report produced: NK38-REP-03500-0989867 R002 (Reference [6]), which demonstrates there are no adverse effects within the reactor caused by the proximity of both systems to each other.

3.5.5.3. Operational Considerations

During the standard Mo-99 irradiation period occurring while the unit is online, the TDS can lower and withdrawal targets into core while the positioner is parked above in R302. Since all moving target elevator components are contained within the TDS flight tubing envelope, there is no risk of interference. Standard Mo-99 harvesting operations such as lowering of the targets to the loading bay using the TDS jib crane can all be done without obstruction as approximately 3.6 m of headroom exists beneath the Co-60 positioner. For maintenance activities that require access to the top side of the TDS in R302, the positioner will be required to move from its home position to allow operator access. With respect to Co-60 harvesting during planned outages, Mo-99 harvesting does not occur during the outage period as target irradiated ceases when the unit is offline. This allows for Co-60 harvesting to occur during unit outages without interruption from standard Mo-99 harvesting operations.

3.5.6. Impact of Co-60 System on OPG Governance, Programs and Processes

There is no change to the OPG governance, programs and processes that form the licensing basis for Darlington NGS's Physical Design SCA as a result of Co-60 production modifications installation.

3.6. Fitness for Service

The Co-60 production modification was designed to allow removal of components for fitness forservice inspections and preventative maintenance.

- ✓ ***Preventative maintenance plans, testing and periodic inspections in accordance with OPG's governance are under development.***

3.6.1. Regulatory Requirements Related to Fitness for Service

In addition to compliance with the *"Nuclear Safety and Control Act"* and the *"General Nuclear Safety and Control Regulations"*, the regulatory requirements listed in Table 3.6.1 apply to the Fitness for Service SCA.

Table 3.6.1 List of Fitness for Service Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Co-60 Production Modifications Installation Impact
Periodic inspection of CANDU nuclear power plant components	CSA N285.4 (2014)	Co-60 production designs are in compliance
Periodic inspection of CANDU nuclear power plant containment components	CSA N285.5 (2018) (Reference [33])	Co-60 production designs are in compliance
Technical requirements for in-service inspection evaluation of zirconium alloy in pressure tubes in CANDU reactors	CSA N285.8 (2015)	Co-60 production designs are in compliance
In-service examination and testing requirements for concrete containment structures for CANDU nuclear power plant components	CSA N287.7 (2008)	Not applicable
Reliability Programs for Nuclear Power Plants	REGDOC 2.6.1 (2017)	Co-60 production designs are in compliance
Maintenance Programs for Nuclear Power Plants	REGDOC 2.6.2 (2017)	Co-60 production designs are in compliance
Aging Management	REGDOC 2.6.3 (2014)	The Co-60 system will be incorporated into the aging management program as applicable as part of the ECC process.

3.6.2. OPG Submissions to CNSC Related to Fitness for Service

There have been no submissions to CNSC staff for the Co-60 Production Modifications Project related to the Fitness for Service SCA.

3.6.3. Equipment Fitness for Service / Equipment Performance

OPG's program N-PROG-MA-0025, "*Major Components"* establishes a formal and systematic process in OPG Nuclear for managing information related to major component areas and reactor components and structures.

The Co-60 system will not impact the fitness for service and periodic inspections of the major components.

3.6.4. Maintenance

Maintenance activities for Co-60 will be scheduled and conducted in accordance with N-PROG-MA-0019, "*Production Work Management"*. This program specifies the requirements for identifying, prioritizing, planning, scheduling, and executing work in support of the operation, maintenance and modification of the station. The program also establishes safe, uniform and efficient station work control practices.

The objective of OPG's maintenance program, N-PROG-MA-0004, "*Conduct of Maintenance",* is to ensure that safety systems remain available to satisfy their design intent as described in the station's supporting safety analysis and minimize equipment failures. This is accomplished by completion of corrective and preventative maintenance activities along with routine inspections on system components to ensure that they remain in good operating condition.

3.6.5. Co-60 Preventative Maintenance, Testing and Periodic Inspections

The development of preventative maintenance, testing and periodic inspection plans are requirements of the ECC process. It is anticipated that the majority of critical equipment inspections will be performed when the cobalt equipment is not in use (i.e., no cobalt harvesting scheduled). Testing and inspections will be determined as per the ECC process and will be performed within planned unit outages. All these activities will be performed in accordance with OPG work management processes. The details of these plans will be similar to those performed at Pickering NGS. The development of these plans is tracked for completion prior to completing the Available for Service Declaration, in accordance with OPG's ECC process.

Creation of maintenance documents for new equipment is driven by the ECC Process to ensure compliance with OPG's existing maintenance, ageing management and fitness for service programs. Maintenance documents including Maintenance Manuals, Preventative Maintenance Plans, Periodic Inspection Plans, and Ageing Management Plans for the Flask, Flask Transporter, Positioner, and Processing Table will be issued aligned with the Project Turnover timeframes. This activity is being tracked under REGM 28263203 (Appendix A).

Projected Turnover timeframes for the major equipment is as follows:

- Flask: Quarter 3 2024; Flask Transporter: Quarter 3 2024; Positioner (U1): Quarter 3 2024; Processing Table: Quarter 3 2025

3.6.6. Aging Management

The objective of OPG's aging management program, N-PROG-MP-0008, "*Integrated Aging Management"*, is to ensure the condition of critical equipment is understood, and required activities are in place to ensure the health of these components and systems while the station ages. The Co-60 equipment will be incorporated into the aging management program, as applicable and as part of the ECC process.

3.6.7. Chemistry Control

The installation of cobalt adjuster rods will have negligible impact on moderator chemistry and IFB chemistry. There are no additional chemicals needed to support operation with cobalt adjuster rods. Assessment NK38-REP-34410-10025 R000, *"Assessment of Irradiated Fuel Bay Purification Circuits for Co-60 Production Modification"* was submitted to CNSC staff in Enclosure 1 of Reference [34], and documents that the IFB purification system is not adversely impacted by irradiated Co-60 rods.

3.6.8. Impact of Co-60 System on OPG Governance, Programs and Processes

There is no change to the OPG governance, programs and processes that form the licensing basis for Darlington NGS's Fitness for Service SCA as a result of Co-60 production modifications installation.

3.7. Radiation Protection

The Co-60 system design and operation will comply with OPG's Radiation Protection program.

- ✓ ***As Low as Reasonably Achievable (ALARA) principles were applied during Co-60 design to minimize worker and public dose during Co-60 operation.***
- ✓ ***Significant investment in shielding is incorporated into the design to reduce dose rates.***
- ✓ ***Best practices and OPEX is incorporated from the Pickering and Bruce stations to support ALARA principles.***

As per OPG's N-PROG-RA-0013, "*Radiation Protection"*, the overriding objective of the Radiation Protection (RP) Program at Darlington NGS is the control of occupational and public exposure to radiation. For the purposes of controlling radiation doses to workers and the public, this program has four implementing objectives:

- Keeping individual radiation doses below regulatory limits.
- Avoiding unplanned radiation exposures.
- Keeping individual risk from lifetime radiation exposure to an acceptable level.
- Keeping collective radiation doses ALARA, social and economic factors taken into account.

3.7.1. Regulatory Requirements Related to Radiation Protection

In addition to compliance with the *"Nuclear Safety and Control Act"* and the *"General Nuclear Safety and Control Regulations"*, the regulatory requirements listed in Table 3.7.1 apply to the Radiation Protection SCA.

Table 3.7.1: List of Radiation Protection Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Co-60 Production Modifications Installation Impact
Radiation Protection Regulations	SOR/2000-203	Continued compliance
Nuclear Substances and Radiation Devices Regulations	SOR/2000-207	Continued compliance

The RP Program is defined in N-PROG-RA-0013. Implementing procedures include, but are not limited to:

- N-PROC-RA-0014, *"Radiological Zoning, Personnel / Material Monitoring"*
- N-PROC-RA-0015, *"Contamination Control While Performing Work"*
- N-PROC-RA-0019, *"Dose Limits and Exposure Control"*
- N-PROC-RA-0025, *"Selection of Radiation Personal Protective Equipment"*
- N-PROC-RA-0027, *"Radioactive Work Planning, Execution and Close Out"*
- N-PROC-MA-0060, *"Control of Temporary Shielding"*

3.7.2. OPG Submissions to CNSC Staff Related to Radiation Protection and ALARA

The following RP and ALARA related documents listed in Table 3.7.2 were submitted to CNSC staff:

Table 3.7.2: List of Submitted Radiation Protection and ALARA Related Document*s*

Document Title	Document Number
Darlington Cobalt 60 Production Modification- ALARA Assessment	NK38-REP-31780-10056 R000 (Enclosure 6 of Reference [12]) R001 was provided in Enclosure 1 of Reference [43]
Design Radiation Protection Requirements and Design Targets	NK38-REP-31780-10055-000 (Enclosure 7 of Reference [12]) R001 was provided in Reference [35]
Dose Rate Analysis of Darlington Co-60 Adjusters During Normal Operation and Flasking	NK38-REP-03200-00001 R000 (Enclosure 5 of Reference [12]) R001 was provided in Enclosure 5 of Reference [45]
Modification Scope for ALARA Planning in Design	NK38-PLAN-31780-00006 R000 (Enclosure 4 of Reference [1])
Source Parameters for Darlington Cobalt Flask Design Assessment	NK38-REP-31780-0841462-001 (Enclosure 5 of Reference [1])

REGM 28255219 tracks submission of the engineering evaluation of a scenario that sees a rapid increase in gamma dose rate or transient conditions due to withdrawal of a cobalt adjuster absorber to CNSC staff by October 8, 2027 (Appendix A).

Control of personnel movement into areas which may have gamma dose rates in excess of 2.5 mrem/h (e.g., when 16 Cobalt adjust rods are in the parked position while unit is online) is conducted by designation of radioactive work areas and required radiological postings in accordance with Radiation Protection Regulations. The RMD area and portions of the catwalk (124.1m elevation) which could experience dose rates above 2 mRem/hr will be designated a radioactive work area during routine operations. This is documented in Appendix E of NK38-REP-31780-10056 R001, provided as Enclosure 1 of Reference [43], where it states that entry to the area will require applicable site RP qualifications, additional dosimetry (Electronic Personal Dosimeter), and if needed, portable RP instrumentation.

3.7.3. Application of ALARA

CNSC guidance document G-129, "*Keeping Radiation Exposures and Doses As Low-As-Reasonably-Achievable (ALARA)"* and OPEX from similar operations, was used as guidance during the Co-60 design process to ensure that radiation exposures to station personnel will be kept well within regulatory dose limits. The application of ALARA is aligned with REGDOC-2.7.1, *"Radiation Protection"*, and includes:

1. Identification of exposure situations during:
    a. Routine Online Operation
    b. Harvest and Discharge
    c. Upset conditions
2. Identification of RP options:
    a. Engineered controls
        i. Task specific equipment and tooling
        ii. Shielding material and geometry
        iii. Material selection impact on radiation source term and contamination
    b. Administrative controls
        i. Area restrictions
        ii. Personnel resource requirements
3. Quantified impact of radiation protection options
    a. Cost-benefit analysis
    b. Dose reduction factors
    c. Impact on other types of hazards (e.g., conventional)
    d. Achieving RP design goals and targets
4. Option comparison
5. Optimized approach
    a. Interfacing with applicable stakeholders, including subject matter experts and plant senior management
    b. Judgement of reasonableness based on good practice and feasibility

An example of incorporation of RP OPEX involves identification of a risk when the cable of the irradiated adjuster rod has been mechanically connected to the flask. The accident scenario involves failure of the flask winch controls, or accidental operation above and beyond the desired lift height such that the lower shield plug becomes unseated and the irradiated adjuster rod moves towards the thimble opening. In this situation), gamma radiation would be streaming from the thimble site in the absence of the appropriate shielding. This risk was mitigated in Darlington NGS design by use of a

control interlock to stop the raise winch command in unintended equipment configurations. OPEX highly relevant to shielding and ALARA has been summarized in Table 3-2 in NK38-REP-31780-10009.

3.7.3.1. Worker Dose Control and Distance

Individual worker radiation doses, including those for contractors and visitors, are managed to Exposure Control Levels that are below Administrative Dose Limits, which are in turn below the regulatory limits. As documented in the Co-60 ALARA assessment NK38-REP-31780-10056-R001, (Enclosure 1 of Reference [43]) the estimated accumulated whole body dose increase to station personnel will be maintained well below the Exposure Control Levels.

The Co-60 ALARA assessment report, NK38-REP-31780-10056 R001 (Enclosure 1 of Reference [43]), documents the design decisions that were made to ensure that worker safety is optimized and exposure levels are minimized during cobalt harvesting. The design includes mobile tritium and portable gamma monitoring instruments for use during harvesting, see Section 5.2.6 of NK38-REP-31780-10056 R001 (Enclosure 1 of Reference [43]).

Continuous monitoring of radiological fields will be performed at Darlington NGS when handling cobalt: rods, cables, bundles, carriers and flasks and observing all foreign material exclusion practices under N-PROC-MA-0018, *"Foreign Material Exclusion"*, similar to Pickering NGS procedure P-OP-31985-0001, *"Cobalt Processing Procedure"*, Section 2.2 (b), (c). Submission of the Co-60 production system operating manual and procedure to CNSC staff is tracked under REGM 28252894.

Furthermore, design has included safety provisions (MEC 142914, Design Engineering Change (DEC) 151682) such that cobalt harvest workers are able to maintain a safe distance from areas of elevated dose rates. For example, the flask design features a control pendant allowing workers to operate the equipment from room R302.

Personnel assigned to perform cobalt harvesting operations will be radiation protection qualified as per OPG training requirements, with working rights governed under N-PROC-RA-0010, *"Facility Access and Working Rights (Radiological)"*.

The physical areas impacted by the Co-60 system were evaluated and includes a temporary exclusion zone during harvest and permanent radioactive work areas during routine online operations. The purpose of the temporary exclusion zone is to limit the work area to authorized personnel only, while the permanent radioactive work area takes into account rod movement due to processes in the RRS.

During harvesting operations, all operation steps will be performed away from the RMD, all work will be executed as per an approved Radiological Exposure Permit (REP), and a qualified Radiation Protection assistance will be present to supervise the harvesting operations.

For non-outage situations when personnel need to enter the RMD, there is a risk of rods parked out of core causing a rise in dose rates in the area. As part of the Co-60 design modification, the RMD and surrounding areas will be classified as permanent radiological work areas as discussed above. The radiological controls for personnel entry will be listed in an approved REP. As a minimum, personnel will carry a gamma meter and wear an Electronic Personal Dosimeter set to alarm at a dose rate and dose.

These areas are documented in NK38-REP-31780-10056 R001 (Enclosure 1 of Reference [43]) and are shown in Figure 1.

3.7.4. Shielding

Gamma radiation from the irradiated adjuster components is the primary radiological hazard from Co-60 harvesting operations and requires innovative shielding.

Permanent and temporary shielding structures will be in place to reduce the radiological hazards. The permanent shielding structures are manufactured with a combination of tungsten, steel and lead, and are designed against target dose rates. A radiation shielding assessment was completed, NK38-REP-03200-00001 R001 (Enclosure 5 of Reference [45]), to understand the dose rate impact during harvesting operations. Temporary shielding structures allow harvesting operations to be conducted within a reasonable distance with consideration for the plant's current structural shielding.

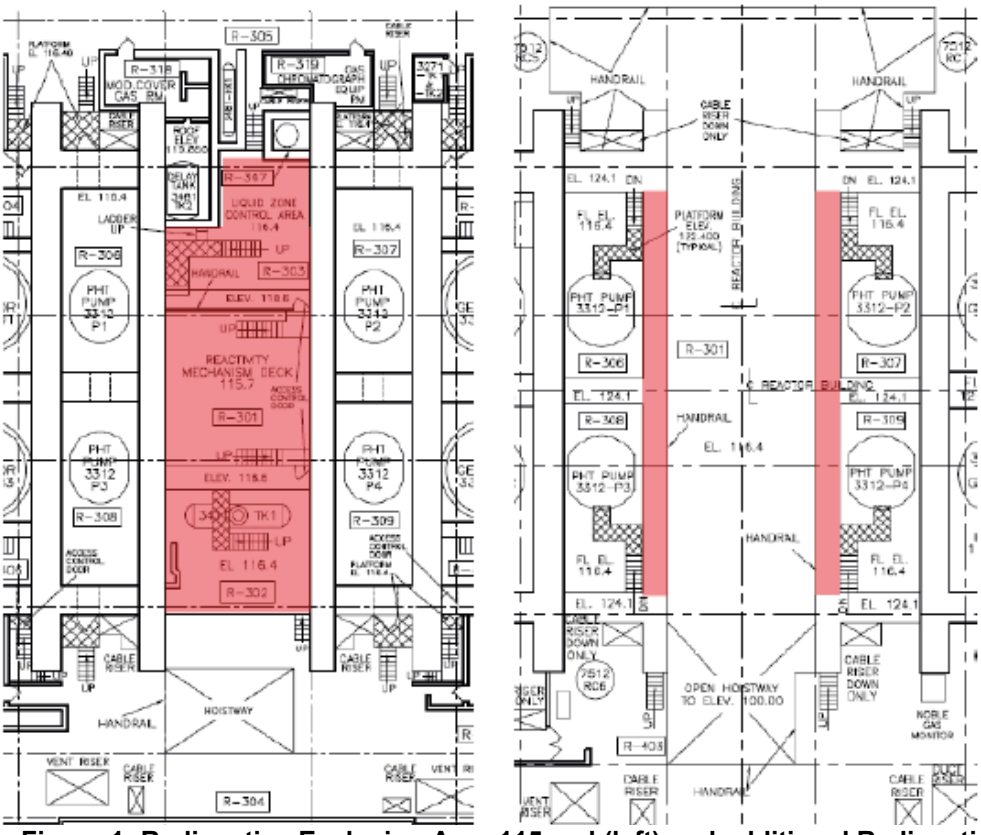


Figure 1: Radioactive Exclusion Area 115m el (left) and additional Radioactive Work Areas 124.1m el (right)

3.7.4.1. Summary of ALARA Design Measures

The following components will be modified as per OPG's ECC process to provide shielding per ALARA principles:

a. **Wedge-shaped block (permanent shielding block):** The design basis material of the wedge-shaped block is SS and the replacement material of Tungsten alloy has a minimum density of 18.5 g/cc. A radiation shielding assessment was completed, NK38-REP-03200-00001 R001 (Enclosure 5 of Reference [45]) and confirmed that the tungsten alloy would support the adjuster rod removal process. The material Tungsten, which was chosen instead of SS, improved geometry and provided tighter tolerances and covered a larger surface area, specifically around the Cobalt Cooling Line, in comparison to the current design.

b. **Pedestal:** As a primary design control, the pedestal and Pedestal-to-Flask interface has optimum Tungsten shielding material to reduce dose rate from the irradiated cobalt rod as it passes the interface into the flask. This modification is in response to the additional contingency scenario of a stuck rod condition.

c. **Sheave Modification:** This modification arose from the requirement to have the adjuster rod at a specific location within the core. The modification will include cutting three (3) slots in the sheave to allow for visual inspection and confirmation of the vertical position of the rod within the reactor core. This will eliminate the requirement for radiography, potential re-work, save critical time and minimize worker dose. This modification is similar to the ones implemented at Pickering NGS and Bruce NGS.

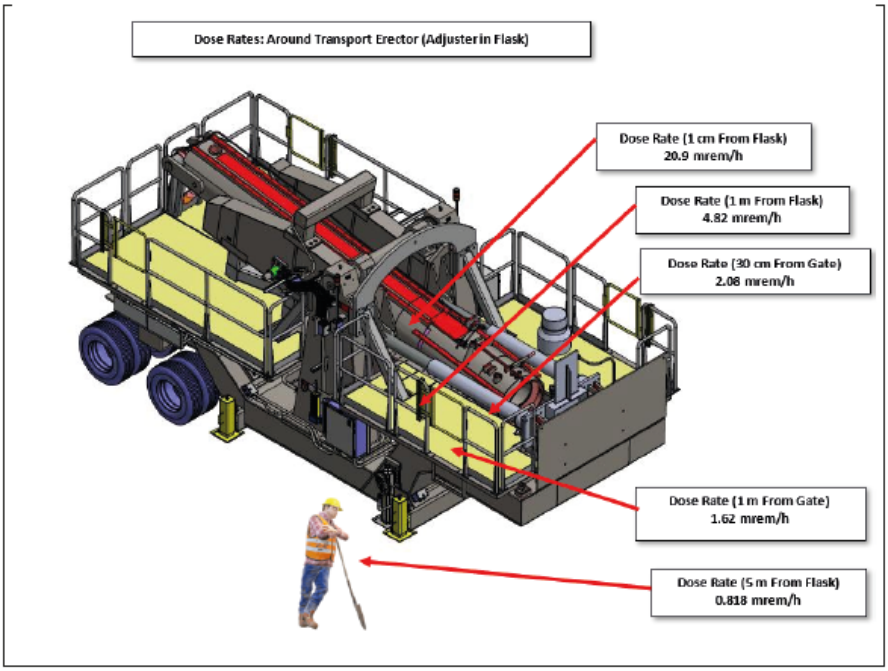
d. **Cobalt Flask:** Based on OPEX from Bruce NGS, the radial shield thickness on the flask was increased to maintain dose rate targets for the 3.5 EFPY cobalt adjuster rods and provide shielding support during the transfer process. The Darlington NGS flask design also changed the internal cable tube which was shielded by the flask body in the Bruce NGS design, to an external cable tube, reducing the air gaps within the flask and increasing the effective shielding distance of the lead material. The Upper Shield Plug and Sheave Split Mount Assembly of the flask material were changed to Tungsten to account for the increased activity of the cobalt rod (Enclosure 6 of Reference [12]).

e. **Transporter Erector:** The transporter erector is based on the Bruce NGS design with several improvements – see Figure 2 below. For example, the addition of a portable pendant which will allow workers to further distance themselves from the flask, thereby reducing dose rates. Another improvement includes the installation of a metal plate between the flask and the driver, which provides incremental dose rate reduction to personnel where possible.

f. **In-Bay Extended Reach and Long Handled Tooling:** The long-handled tools will be used as part of the bundle discharge and processing in the WFFAA, and will allow personnel to operate underwater equipment, keeping the rods at the same depth of water. The operators can remain at larger distances, thereby reducing dose rates. These tools are developed based on current Co-60 production operations at Bruce B NGS and Pickering NGS.

g. **Split Shielding Ring:** This modification includes increasing the thickness of the shielding ring to maintain dose rate targets from the increased activity of the Co-60 rods.

Three-dimensional models were used to understand the effectiveness of the shielding from the source term. This aids in positioning personnel at appropriate locations. This is documented in the Co-60 ALARA assessment report, NK38-REP-31780-10056 R001 (Enclosure 1 of Reference [43]).



3.7.5. Radiological Monitoring and Other Controls

Radiation instruments capable of monitoring the radiological hazards associated with Co-60 operations and maintenance are available. These instruments are strategically placed at various locations areas to ensure work is conducted in a controlled, predictable manner.

The Area Radiation Monitors (ARMs) which will be temporarily set up on the RMD prior to Cobalt-Harvesting will be selected in accordance with the latest revision of N-EL-03425.42-10001 "*List of RP instrumentation for Specialized Use in OPG Nuclear*", as directed by Section 4.1 and Appendix C of the new I-MP-31780-00001-R04 *"Adjuster Rod Drive Mechanism Removal"* procedure, which is under review for issuance prior to first harvest. Currently, the model which is used in similar applications is the Mirion Technologies RDS-31.

3.7.6. Estimated Dose to Public

Co-60 operations and maintenance will be conducted in accordance with OPG's RP program to prevent uncontrolled releases of contamination or radioactive materials through established controls and monitoring of people and materials leaving the station. To minimize tritium in the RMD areas, the escaped tritium vapours from the cover gas are removed by the intake vents on the east and west contaminated exhaust system via a tie-in to the existing ductwork that is subject to positive pressure from portable HEPA filter ventilation units. Please see Section 3.9 for the environmental monitoring process.

3.7.7. Impact of Co-60 Production Modifications Installation on OPG Governance, Programs and Processes

There is no change to the OPG governance, programs and processes that form the licensing basis for Darlington NGS's Radiation Protection SCA as a result of Co-60 production modifications installation.

Instructions on when and where temporary monitors will be set up (and which type) will be found in Section 4.1 and Appendix C of I-MP-31780-00001-R005 "Adjuster Rod Drive Mechanism Removal" procedure, currently prepared, under review and for issuance prior to first harvest.

3.8. Conventional Health and Safety

OPG staff remain committed to preventing workplace injuries and to continuous improvement in employee health and safety performance.

- ✓ ***Conventional safety principles were assessed during the design process to protect personnel from injury.***
- ✓ ***Measures will be implemented to help ensure that no worker is injured during installation operation of Co-60 production equipment by means of safe work planning following OPG standards and execution.***
- ✓ ***Fire protection will be through normal fire protection measures at Darlington NGS. No special provision is required for the Co-60 system as there is no increase in combustible material.***

The goal of OPG's Conventional Health and Safety Program is to ensure workers continue to work safely in a healthy and injury-free workplace by managing risks associated with activities, products and services of OPG's nuclear operations. Risk reduction is primarily achieved through compliance to operational controls, developed through risk assessment and safe work planning.

3.8.1. Regulatory Requirements Related to Conventional Health and Safety

OPG confirms continued compliance with the *"Nuclear Safety and Control Act"* and the *"General Nuclear Safety and Control Regulations"*.

3.8.2. OPG Submissions to CNSC Related to Conventional Safety

Personnel conventional safety principles are an integral part of OPG's ECC process and were assessed throughout the Co-60 design process to protect personnel from injury during Co-60 system installation and operation. In addition, all installation and operating activities will be performed in accordance with workplans and other safety related documents (e.g. appropriate Lift plans, etc.) that ensure safety during all phases of execution and operational activities.

Table 3.8.1: List of Submitted Conventional Safety Related Documents

Document Title	Document Number
Hazard Analysis for CAEPS Flask Handling at RMD & Hoistway	NK38-REP-31935-10034 R000 (Enclosure 2 of Reference [12])
Hazard Analysis for CAEPS Flask Transportation Between the RAB and WFFAA	NK38-REP-31935-10036 R000 (Enclosure 3 of Reference [12])
Hazard Analysis for CAEPS Flask and Nordion Shipping Flask Transportation Activities at the WFFAA	NK38-REP-31935-10035 R000 (Enclosure 4 of Reference [12]) R001 was provided in (Reference [20])

3.8.3. Ensuring Conventional Safety Performance

The foundation of OPG's Health and Safety Management System is OPG-POL-0001, "*Employee Health and Safety Policy"*, which describes the approach and commitments to conventional health and safety for the organization, and the requirements and accountabilities of all employees.

OPG's program document OPG-PROG-0005, "*Environment Health and Safety Managed Systems"* puts the Health and Safety Policy into action. The Health and Safety Managed System program and supporting governing documents establish process requirements that protect employees by ensuring they are working safely in a healthy and injury-free workplace. It also outlines the responsibilities of various levels in the organization to ensure activities are performed to meet the requirements of OPG's Health and Safety Policy.

Installation of the Co-60 modification will be performed by a general contractor, with OPG staff providing oversight as per the OPG ES MSA process. With respect to on-site contractors, OPG will assume the role of owner and constructor, as defined in the Ontario Occupational Health and Safety Act, and are governed by the requirements set therein. In accordance with OPG governance, all contractors are expected to comply with OPG's conventional health and safety protocols while on site.

3.8.4. Impact of Co-60 Production on OPG Governance, Programs and Processes

There is no change to the OPG governance, programs and processes that form the licensing basis for Darlington NGS's Conventional Health and Safety SCA as a result of Co-60 production modifications installation.

3.9. Environmental Protection

Installation and operation of the Co-60 system is predicted to cause no notable environmental impact:

- ✓ ***ALARA principles applied.***
- ✓ ***Public dose will remain well below 1% of the regulatory public dose limit.***
- ✓ ***Compliance with CSA Standard N288 series and applicable sections of REGDOC-2.9.1, "Environmental Protection: Environmental Principles, Assessments and Protection Measures"***

3.9.1. Regulatory Requirements Related to Environmental Protection

In addition to compliance with the *"Nuclear Safety and Control Act"* and the *"General Nuclear Safety and Control Regulations"*, the regulatory requirements listed in Table 3.9.1 apply to the Environmental Protection SCA.

Table 3.9.1: List of Environmental Protection Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Co-60 Production Modifications Installation Impact
Environmental management of nuclear facilities: Common requirements of the CSA N288 series of Standards	CSA N288.0 (2022)	Continued compliance, Co-60 production will have no adverse impact
Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities	CSA N288.1 (2014)	Continued compliance, Co-60 production will have no adverse impact
Environmental monitoring program at class I nuclear facilities and uranium mines and mills	CSA N288.4 (2010)	Continued compliance, Co-60 production will have no adverse impact
Effluent monitoring programs at class I nuclear facilities and uranium mines and mills	CSA N288.5 (2022)	Continued compliance, Co-60 production will have no adverse impact
Environmental risk assessments at class I nuclear facilities and uranium mines and mills	CSA N288.6 (2012)	Continued compliance, Co-60 production will have no adverse impact
Groundwater protection programs at Class I nuclear facilities and uranium mines and mills	CSA N288.7 (2015)	Continued compliance, Co-60 production will have no adverse impact
Performance Testing of Nuclear Air-Cleaning Systems at Nuclear Facilities	CSA N288.3.4 (2013)	Continued compliance, Co-60 production will have no adverse impact
Environmental Protection Environmental Principles, Assessments and Protection Measures	REGDOC-2.9.1 (Version 1.1 2017)	Continued compliance, Co-60 production will have no adverse impact

3.9.2. OPG Submissions to CNSC Staff Related to Environmental Protection

Table 3.9.2: List of Submitted Environmental Protection Documents Related to Co-60

Document Title	Document Number
Predictive Effects Assessment for the DN Co-60 Production System	NK38-REP-31930-00001 R000 (Reference [36])

3.9.3. Environmental Management System (EMS)

OPG's OPG-POL-0021, "*Environmental Policy"* requires that OPG maintain an Environmental Management System (EMS) consistent with the ISO 14001, "*Environmental Management System Standard"*.

Operation of Co-60 equipment will be in accordance with OPG's EMS as described in OPG- PROG-0005, "*Environmental Health and Safety Managed Systems"* and OPG-POL-0021. The EMS provides specific direction on how the Environmental Policy is implemented while meeting the expectations of OPG-POL-0032, "*Safe Operations Policy"*, N-POL-0001, "*Nuclear Safety & Security Policy"*, and N-CHAR-AS-0002, "*Nuclear Management System"*.

3.9.4. Predictive Effects Assessment

In support of the Co-60 Production Modifications Project at Darlington NGS, a Predictive Effects Assessment (PEA), NK38-REP-31930-00001 R000, *"Predictive Effects Assessment for the DN Co-60 Production System"* (Reference [36]) was completed and submitted to CNSC staff. The PEA is a predictive Environmental Risk Assessment (ERA) meeting the ERA requirements of CSA Standard N288.6-12 and CNSC regulatory document REGDOC-2.9.1, Version 1.1. The PEA will supplement the existing ERA for Darlington Nuclear, which has not so far considered the potential for effects from the Co-60 isotope production activity.

The PEA (Enclosure 1 of Reference [36]) identifies that the contaminant of potential concern expected to be emitted from the operation of the Cobalt-60 Production System is tritiated water vapour (HTO) released to air. No other radiological nor non-radiological contaminants of potential concern are expected to be released to the air nor water from the operation of the Cobalt-60 Production System.

A Human Health Risk Assessment and Ecological Risk Assessment were conducted as part of the PEA. The PEA also assessed the cumulative effects of the Cobalt-60 Production System and the Darlington NGS Mo-99 Isotope Irradiation System operations, which are both to be installed in the same operating unit (Unit 2). The cumulative increase in public dose is estimated to be 0.004% of the regulatory public dose limit of 1 mSv/a, and 0.003% of the dose from background radiation in the vicinity of Darlington NGS. There are also no exceedances of the 2.4 mGy/d and 9.6 mGy/d radiation benchmarks for terrestrial and aquatic biota, respectively.

Overall, the PEA concludes that operation of the Cobalt-60 Production System will not result in any unacceptable risks to human and ecological receptors residing in the vicinity of the Darlington NGS site. The additional emissions of the Cobalt-60 and Mo-99 Production Systems are a small fraction of existing Darlington NGS emissions and the predicted doses are well below regulatory limits. In

addition, based on the results of the PEA, additional mitigation or environmental monitoring as a result of the Cobalt-60 Production Modifications Project at Darlington NGS will not be required.

3.9.5. ALARA Principles Used in Design

Protecting the environment and ensuring that emissions from Darlington NGS remain well below the Derived Release Limits (DRL) was a consideration during the design of the Co-60 Production Modifications Project. All DRLs and Action Levels will be maintained as per the licensing basis throughout the operation of the Co-60 equipment. Details are provided in Section 3.7.

3.9.6. Effluent and Emissions Control (Releases)

OPG is committed to complying with the requirements of the CSA Standard N288 series documents.

Darlington NGS reports against approved DRLs, in accordance with CSA Standard N288.1-14, "*Guidelines for calculating derived release limits for radioactive material in airborne and liquid effluents for normal operation of nuclear facilities".* A DRL is defined as the release rate of a given radionuclide/radionuclide group to air or surface water during normal operation of a nuclear facility that would cause an individual of the most highly exposed group to receive a dose equal to the annual regulatory dose limit over the period of a calendar year.

The PEA concludes radiological releases from Co-60 production are negligible, in comparison with the DRLs and Environmental Action Levels (EAL), which are precautionary levels set far below the actual DRLs. Lower Internal Investigation Levels (IILs) will continue to be used to demonstrate and maintain adherence to the ALARA principle.

3.9.7. Monitoring Programs

The Darlington NGS Environmental Monitoring Program (EMP) complies with CSA Standard N288.4-10, "*Environmental monitoring programs at Class 1 nuclear facilities and uranium mines and mills"*, as per the Darlington NGS LCH.

The EMP also complies with any applicable statutes, regulations, licenses, or permits that govern the operation of the facility including, but not limited to, Section 3 (h) of CNSC's *Class I Nuclear Facilities Regulations* (SOR/2000-204) and Section 3.5 of REGDOC-3.1.1. The EMP is in place at Darlington NGS to monitor radioactive and non-radioactive contaminants, or physical stressors, within the environment in and surrounding the OPG site, inclusive of those resulting from the installation and operation of the Co-60 equipment. Additionally, environmental sampling and analyses for the EMPs support the calculation of annual public dose resulting from operation of Darlington NGS, as required by REGDOC-3.1.1. OPG submits the annual EMP report to CNSC staff as required by the Darlington PROL. The results are also made available to the public on the OPG website.

The Effluent Monitoring Program at Darlington NGS is implemented in accordance with N-STD-OP-0031, "*Monitoring of Nuclear and Hazardous Substances in Effluents"* and complies with CSA Standard N288.5-11, "*Effluent monitoring programs at Class I nuclear facilities and uranium mines and mills".* This monitoring program ensures that releases are below regulatory limits and complies with principles of ALARA. OPG provides the results of the airborne and waterborne radioactive

effluent monitoring program to CNSC staff quarterly and these results are also made available to the public on the OPG website.

3.9.8. Conventional Releases

Unit operation with the Co-60 equipment and rods will not result in any increase to non-radiological releases or emissions from Darlington NGS. There are no additional chemicals used. This is documented in the PEA report (Reference [36]).

3.9.9. Impact of Co-60 on OPG Governance, Programs and Processes

There is no change to the OPG governance, programs and processes that form the licensing basis for Darlington NGS's Environmental Protection SCA as a result of Co-60 production modifications installation.

3.10. Emergency Management and Fire Protection

Operation of the Co-60 processing system will have an acceptable impact on Darlington's Emergency Management and Fire Protection program, and will be confirmed by OPG's Engineering Change Control Process

- ✓ ***Co-60 design complies with CSA Standard N293-12, "Fire protection for CANDU nuclear power plants".***
- ✓ ***Co-60 does not introduce a new type of fire hazard.***
- ✓ ***No new operating limits or Operator actions within first eight hours.***

Under Darlington's PROL 13.03/2025, Darlington NGS is required to maintain an emergency preparedness program in accordance with CNSC regulatory documents REGDOC-2.10.1, *"Nuclear Emergency Preparedness and Response"* and REGDOC-2.3.2, "*Accident Management: Severe Accident Management Programs for Nuclear Reactors",* as well as a fire protection program in accordance with CSA Standard N293-12.

3.10.1. Regulatory Requirements Related to Emergency Management and Fire Protection

In addition to compliance with the *"Nuclear Safety and Control Act"* and the *"General Nuclear Safety and Control Regulations"*, the regulatory requirements listed in Table 3.10.1 apply to the Emergency Management and Fire Protection SCA.

Table 3.10.1: List of Emergency Management and Fire Protection Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Co-60 Production Modifications Installation Impact
Nuclear Emergency Preparedness and Response, Version 2	CNSC REGDOC-2.10.1 (2016)	Continued compliance, Co-60 production will have no impact
Fire protection for CANDU nuclear power plants	CSA N293-12	The Co-60 production design and operation complies with CSA Standard.

3.10.2. OPG Submissions to CNSC Related to Emergency Preparedness and Fire Protection

There were no specific submissions related to this topic, however, the modification is in accordance with OPG's Emergency Preparedness program N-PROG-RA-0001, *"Consolidated Nuclear Emergency Plan"*.

3.10.3. Nuclear Emergency Preparedness and Response

OPG's Emergency Preparedness program, N-PROG-RA-0001*,* requires OPG staff to implement and maintain its emergency response capability to protect the public, employees, and the environment in the event of a nuclear emergency.

In order to respond effectively to an emergency, the staff at Darlington NGS practice and conduct routine emergency preparedness drills and exercises in accordance with N-PROC-RA-0045, "*Emergency Preparedness Drills and Exercises"* through simulated events.

Reactor operation with the Co-60 system will not impact existing emergency preparedness programs or drills or exercises.

3.10.4. Conventional Emergency Preparedness and Response

The Co-60 system will not introduce new conventional emergency response requirements.

3.10.5. Fire Response

OPG's Fire Protection program, N-PROG-RA-0012, "*Fire Protection"* establishes provisions to prevent, mitigate and respond to fires such that fire risk to OPG Nuclear workers, public, environment, nuclear physical assets, and power generation, is acceptably low and controlled. There will be no changes to N-PROG-RA-0012 as a result of operation with Co-60 adjuster rods.

3.10.6. Co-60 Fire Protection and Compliance with CSA Standard N293-12

The Co-60 design and installation complies with CSA Standard N293-12. No new fire hazards have been introduced due to the Co-60 modification.

In addition, the conversion of the adjuster rods to cobalt will not require an update to the Darlington Fire Hazard Assessment, and Fire Safe Shutdown Assessment.

3.10.7. Impact of Co-60 System on Darlington's Emergency Management and Fire Protection Licensing Basis Documents

There is no change to the OPG governance, programs and processes that form the licensing basis for Darlington NGS's Emergency Management and Fire Protection SCA as a result of Co-60 production modifications installation.

3.11. Waste Management

A minimal amount of waste is expected to be generated from Co-60 production operation and maintenance.

- ✓ ***Waste generated will be managed in accordance with existing waste management processes.***
- ✓ ***Spent Co-60 will be shipped to and stored in a licensed facility.***
- ✓ ***Storage of Co-60 is not included in this licence application.***

3.11.1. Regulatory Requirements Related to Waste Management

In addition to compliance with the *"Nuclear Safety and Control Act"* and the *"General Nuclear Safety and Control Regulations"*, the regulatory requirements listed in Table 3.11.1 apply to the Waste Management SCA.

Table 3.11.1: List of Waste Management Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Co-60 Production Modifications Installation Impact
Management of low and intermediate-level radioactive waste	CSA N292.3 (2008)	Continued compliance, Co-60 production design and operation complies with the requirements in this CSA Standard
Decommissioning of facilities containing nuclear substances	CSA N294 (2019)	Continued compliance, Co-60 production design and operation complies with the requirements in this CSA Standard

3.11.2. OPG Submissions to CNSC Related to Waste Management

There were no Co-60 specific submissions made to CNSC staff related to this to SCA.

3.11.3. Management of Waste

Under the Darlington PROL 13.03/2025, OPG is required to have a program to manage in-plant radioactive or hazardous waste resulting from licensed activities. OPG's waste management

program is implemented and maintained through a suite of OPG Standards, Policies, Procedures and Guides, including OPG's waste management standard, OPG-STD-0156, "*Management of Waste and Other Environmentally Regulated Materials"*, which documents how waste is managed and the accountabilities for ensuring that all waste at Darlington NGS is processed in accordance with federal, provincial and municipal regulations, and OPG procedure N-PROC-RA-0017, "Segregating and Handling of Radioactive Waste", which includes strategies for waste minimization, waste characterization and waste management practices as per CSA N292.3-08, "*Management of low and intermediate-level radioactive waste*".

There are two radioactive waste streams generated as part of Co-60 operations:

(1) Production scrap from disassembly activities in the Irradiated Fuel Bay (IFB) that will remain on-site at Darlington NGS in a storage bin until facility end of life. The production scrap includes the broken-down adjuster rods.

(2) Spent cobalt, which refers to cobalt sources returned at the end of their commercial life. The spent cobalt will not be returned to Darlington NGS but will be taken back by OPG and stored in the Bruce 'B' IFB to cool for 25 to 30 years. It will then be transferred to dry storage at an OPG Waste Management Facility for an additional cooling period prior to long term waste management.

The OPG/Nordion irradiation agreement states the size and Co-60 activity prior to shipment to OPG. No individual pencil in a Spent Cobalt Bundle shall have a curie content exceeding 1800 curies at time of shipment, and Nordion will ensure that all reasonable tests for radioactive surface contamination are completed prior to shipment.

The production scrap and the spent cobalt (once received back from Bruce 'B' IFB) will be managed under OPG's waste management program for all nuclear substances which is implemented and maintained through a suite of OPG Standards, Policies, Procedures and Guides, including OPG's waste management standard, OPG-STD-0156, "*Management of Waste and Other Environmentally Regulated Materials*", which documents how waste is managed and the accountabilities for ensuring that all waste at Darlington NGS is processed in accordance with federal, provincial and municipal regulations, and OPG procedure N-PROC-RA-0017, *"Segregating and Handling of Radioactive Waste"*, which includes strategies for waste minimization, waste characterization and waste management practices as per CSA N292.3-08, "*Management of low and intermediate-level radioactive waste*".

30 Years of Co-60 processing is expected to produce up to 3 disposal bins worth of production scrap, with each disposal bin having a capacity of 1.37 m^3. The estimated mass for 30 years of production scrap based on the scrap material dimensions is 1493 kg.

3.11.4. Waste Management and Waste Minimization and Practices

Co-60 implementation will not impact OPG's waste management practices, and Darlington NGS will remain in compliance with CSA Standard N292.3-08, "*Management of low and intermediate-level radioactive waste"*, and OPG-STD-0156.

Low and Intermediate Level Radiation Waste (LILRW) will be handled in accordance with D-INS-79000-10001, "*Waste Disposal Guidelines for Oil and Chemical Waste at Darlington"* and D-INS-79000-10002, "*Waste Disposal Guideline for Solid and Waste Recycling at Darlington."*

3.11.5. Chemical and Hazardous Waste

Chemicals and hazardous waste will not be used or generated during Co-60 production. Therefore, Co-60 production will not generate chemical or hazardous waste.

3.11.6. Decommissioning Plans

The Darlington NGS preliminary decommissioning plan NK38-PLAN-00960-10001 (PDP), *"Preliminary Decommissioning Plan – Darlington Nuclear Generating Station"* describes the activities that will be required to decommission and restore the Darlington site for other OPG uses. The cobalt system will be added during the future review of PDP per the OPG ECC process.

The Cobalt-60 system, being a relatively small and removable system, and based on the Pickering NGS Preliminary Decommissioning Plan (P-PLAN-00960-10001), it is expected that Co-60 decommissioning can be managed with minor changes to the current decommissioning plans with no notable impact. OPEX will be implemented from the Pickering NGS Preliminary Decommissioning Plan as applicable.

3.11.7. Impact of Co-60 System on OPG Governance, Programs and Processes

There is no change to the OPG governance, programs and processes that form the licensing basis for Darlington NGS's Waste Management SCA as a result of Co-60 production modifications installation, except for those identified below in Table 3.11.2. Changes to the impacted documents are tracked through OPG's ECC process.

Table 3.11.2: Impact of Co-60 System on Darlington NGS's Waste Management Licensing Basis Documents

OPG Environmental Protection Licensing Basis Document Title	OPG Document Number	Co-60 Production Modifications Installation Impact
Preliminary Decommissioning Plan – Darlington Nuclear Generating Station	NK38-PLAN-00960-10001	The cobalt system will be added during the future review of PDP.

3.12. Security

Operation related to Co-60 will not require changes to OPG security provisions or processes.

- ✓ ***Incoming and outgoing shipments of Cobalt will follow existing security processes.***

The Co-59 adjuster rods will be received periodically at Darlington NGS. Once irradiated, the Co-60 will be shipped from Darlington NGS to Nordion's facility in Kanata, Ontario. Nordion staff will arrange for transportation from Darlington NGS to the Nordion site.

OPG's security program and processes at Darlington NGS will not need to be modified for Co-60 production.

3.12.1. Regulatory Requirements Related to Security

In addition to compliance with the *"Nuclear Safety and Control Act"* and the *"General Nuclear Safety and Control Regulations"*, the regulatory requirements listed in Table 3.12.1 apply to the Security SCA.

Table 3.12.1: List of Security Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Co-60 Production Modifications Installation Impact
Nuclear Security Regulations	SOR/2000-209	Continued compliance
Cyber security for nuclear power plants and small reactor facilities	CSA N290.7 (2014)	Co-60 system design complies with cyber security requirements
High Security Facilities, Volume I: Nuclear Response Force, Version 2	CNSC REGDOC-2.12.1 (2018)	Continued compliance, Co-60 production will have no impact
Site Access Security Clearance	CNSC REGDOC-2.12.2 (2013)	Continued compliance, Co-60 production will have no impact
Fitness for Duty, Volume III: Nuclear Security Officer Medical, Physical, and Psychological Fitness	CNSC REGDOC-2.2.4 (2018)	Continued compliance, Co-60 production will have no impact
Security of Nuclear Substances: Sealed Sources and Category I, II and III Nuclear Material, Version 2.1	CNSC REGDOC-2.12.3 (2020)	Continued compliance, Co-60 production will have no impact
Criteria for Physical Protection Systems and Devices at High Security Sites	CNSC RD-321 (2010)	Continued compliance, Co-60 production will have no impact RD-321 has been superseded by REGDOC-2.12.1, Volume II.
Criteria for Explosive Substance Detection, X-Ray Imaging and Metal Detection at High Security Sites	CNSC RD-361 (2010)	Continued compliance, Co-60 production will have no impact RD-361 has been superseded by REGDOC-2.12.1, Volume II.

3.12.2. OPG Submissions Related to Security

There were no Co-60 submissions made to CNSC staff related to the Security SCA.

3.12.3. Facilities and Equipment

The addition of cobalt adjuster rods will not require changes to security related facilities, equipment or staffing levels. The incoming and outgoing Nordion transportation vehicles will be processed by Darlington security staff in accordance with N-INS-61400-10016, "*Security Process of Vehicle Ingress and Egress to the Controlled and Protected Areas"*.

3.12.4. Response Arrangements

The installation of Co-59 adjuster rods and the processing of Co-60 adjuster rods will not require changes to security response arrangements or processes.

3.12.5. Impact of Cobalt on OPG Governance, Programs, and Processes

There is no change to the OPG governance, programs and processes that form the licensing basis for Darlington NGS's Security SCA as a result of Co-60 production modifications installation.

3.13. Safeguards and Non-Proliferation

Darlington will continue to meet Canada's international obligations under the Treaty on the Non-Proliferation of Nuclear Weapons.

- ✓ ***As a result of the Co-60 design descriptions provided to CNSC staff, no safeguard provisions have been identified by the International Atomic Energy Agency (IAEA).***
- ✓ ***OPG will comply with any changes or with IAEA requirements.***
- ✓ ***Newly installed Co-60 equipment will not interfere will IAEA safeguards requirements.***
- ✓ ***All reports and information necessary for safeguards implementation and compliance will continue to be provided on a timely basis.***

Darlington NGS will continue to meet Canada's international obligations under the "*Treaty on the Non-Proliferation of Nuclear Weapons*". The production of Co-60 will interface with the normal operation of the IFB, but does not involve nuclear material that is subject to safeguard requirements pursuant to the Canada/IAEA Safeguards Agreement (Uranium, Thorium or Plutonium) and as defined in REGDOC-2.13.1, "*Safeguards and Nuclear Material Accountancy*".

3.13.1. Regulatory Requirements Related to Safeguards and Non-Proliferation

In addition to compliance with the *"Nuclear Safety and Control Act"* and the *"General Nuclear Safety and Control Regulations"*, the regulatory requirements listed in Table 3.13.1 apply to the Safeguards and Non-Proliferation SCA.

Table 3.13.1: List of Safeguards and Non-Proliferation Related Regulatory Requirements

Licensing Basis Document Title	Document Number	Co-60 Production Modifications Installation Impact
Nuclear Non-proliferation Import and Export Control Regulations	SOR/2000-210	Continued compliance
Safeguards and Nuclear Material Accountancy	CNSC REGDOC-2.13.1 (2018)	Continued compliance

3.13.2. Submissions Related to Safeguards and Non-Proliferation

Nuclear standard N-STD-RA-0024, *"Safeguards and Nuclear Material Accountancy Implementation"* outlines the communication protocol between OPG, the CNSC and IAEA. A presentation titled "*Cobalt 60 Production at Darlington Nuclear – IAEA and Safeguards"* (February 2022) was provided to the CNSC to facilitate staff communication with the IAEA. The presentation material includes a summary of the impact of the Co-60 modification on IAEA activities.

3.13.3. Nuclear Material Accountancy and Control

All reports and information necessary for safeguards implementation and compliance will continue to be provided on a timely basis.

Darlington completes an annual Physical Inventory Taking (PIT) as part of Licence Condition 13.1. The Co-60 modification will not impact OPG's compliance with non-fuel reporting requirements documented in CNSC regulatory document REGDOC-2.13.1.

3.13.4. Safeguards Equipment, Containment and Surveillance

Canadian facilities are selected at random by the IAEA for physical inspections to confirm compliance with international non-proliferation requirements.

The Co-60 production modification will have minimal impact on IAEA inspections. A temporary partial obstruction of an IAEA camera and an increase in background radiation near fuel modules staged to IAEA verification, have been identified. OPG is in the process of resolving these items with the IAEA prior to starting Co-60 activities in the IFB.

3.13.5. Import and Export

Co-59 and Co-60 are not controlled nuclear substances under the Nuclear Non-Proliferation Import and Export Control Regulations. There will be no requirement to obtain a licence to import or export Co-60 by OPG. There will be no requirement to import nuclear material for Co-60 production modifications installation and operation. Nordion will be responsible for obtaining the required export licenses for exporting the processed Co-60 outside of Canada.

There are no plans to import or export cobalt as a nuclear substance at Darlington NGS. There will be no requirement to import nuclear material for Co-60 production modifications, installation, and operation. Nordion will be responsible to obtain the required export licenses for exporting the processed Co-60 outside of Canada.

Similar to the Pickering LCH, the new activity of production of Co-60 will be captured separately with a licence condition for the receipt of spent cobalt, which refers to cobalt sources returned at the end of their commercial life, that is taken back by OPG in form of a sealed source. This licence condition is not to be included in the import/export licence condition.

3.13.6. Co-60 Inventory Control

Inventory information will be recorded and kept per the cobalt harvesting procedures. Cobalt bundle information will be obtained and recorded, with COCAL files (or similar) uploaded for Wet Fuel Operations review. A mechanical maintenance procedure will be prepared for Darlington NGS, similar to P-B-MMP-31985.04, *"Cobalt Adjuster Rod Change Out"* used for cobalt adjuster rod replacements at Pickering NGS. Submission of the Co-60 production system operating manual and procedure to CNSC staff is tracked under REGM 28252894.

Form N-FORM-10730, *"Radioactive Shipment Permit"* will be filled out prior to shipment of F231 transportation package with irradiated cobalt bundles, per procedure W-PROC-WM-0033.

3.13.7. Impact of Co-60 on OPG Governance, Programs, and Processes

There is no change to the OPG governance, programs and processes that form the licensing basis for Darlington NGS's Safeguards and Non-Proliferation SCA as a result of Co-60 production modifications installation.

3.14. Packaging and Transport

OPG will comply with applicable transportation regulations:

- ✓ ***Co-60 bundles will be transported in radioactive material transportation packages of CNSC certified design.***
- ✓ ***OPG has a regulatory compliant radioactive material transportation program that includes qualified personnel for receipt, handling and shipment of irradiated material in support of Co-60 production.***
- ✓ ***Both OPG and Nordion have the capability and plans for responding to transportation accidents.***
- ✓ ***There is no change required to OPG's response to transportation accidents.***
- ✓ ***Irradiated Co-60 will be received by a licensed facility.***

3.14.1. Regulatory Requirements Related to Packaging and Transport

In addition to compliance with the "*Nuclear Safety and Control Act"* and the "*General Nuclear Safety and Control Regulations"*, the regulatory requirements listed in Table 3.14.1 apply to the Packaging and Transport of Co-60.

Table 3.14.1: Regulatory Requirements for Packaging and Transportation

Licensing Basis Document Title	Document Number	Co-60 Production Modifications Installation Impact
Transportation of Dangerous Goods Regulations	SOR/2001-286	Compliance with requirements.
Packaging and Transport of Nuclear Substances Regulations	SOR/2015-145(2015)	Compliance with requirements.

OPG will be responsible for packaging the Co-60, preparing the shipping documents, making applicable notifications and offering goods for transport. Nordion will arrange for the carrier and conveyance for transport of irradiated Co-60 from Darlington NGS to the Nordion site in Kanata, Ontario. Nordion has responsibility for the ownership of the F231 Type B certified transportation package and is accountable for package certification and maintenance activities. Nordion operates its Class 1B facility in Kanata, under Nuclear Substance Processing Facility Operating Licence NSPFOL-11A.01/2025, valid until October 31, 2025. OPG, Nordion and its predecessor companies have been collaborating to produce cobalt at Pickering NGS, to varying amounts, since the 1970s.

The selected carrier for Nordion is Jade Transport, where this carrier is qualified to access DNGS and the incoming and outgoing Nordion transportation vehicles will be processed by Darlington security staff in accordance with N-INS-61400-10016, "*Security Process of Vehicle Ingress and Egress to the Controlled and Protected Areas*". Jade Transport is Nordion's qualified carrier, providing the similar service for Pickering NGS, and OPG is satisfied that the package can be signed over.

3.14.2. Packaging and Transportation Governance and Overview

The program document, W-PROG-WM-0002, "*Radioactive Material Transportation"* (RMT), establishes the program and necessary controls for safe, regulatory compliant and efficient transportation of radioactive material at OPG. The RMT program establishes procedures for the handling, packaging, shipment, carriage and receipt of radioactive materials. The program also addresses emergency response to transportation accidents.

In accordance with W-PROG-WM-0002 and the regulatory requirements, OPG qualified staff will package the Co-60 for shipment in the CNSC Type B certified transportation packaging, and will prepare the shipping paperwork for transport and receipt at a facility licensed by the CNSC to receive the specific radioactive material.

OPG personnel, who are TDG Class 7 Qualified Handler/Receivers or are under the direct supervision of someone who is Class 7 qualified, will be responsible for transportation package handling, which includes package unloading / loading (disassembly / reassembly), package surveys etc.

- The irradiated Co-60 adjuster rods will be transferred into the shielded cobalt flask remotely using the CAEPS positioner, which is designed to withdraw the irradiated cobalt adjustor rods safely from each of the adjuster sites. The flask is then lifted from the positioner into the transporter/erector equipment, which is designed to transport the loaded cobalt flask from the

Unit 0 loading bay to the WFFAA (IFB) for discharge and placing into cobalt storage racks under water at WCHB.

- In the WCHB, under shielded conditions (under water) the cobalt rods are disassembled using the cobalt processing table into pencils, which are loaded in Nordion's F231 Type B Transportation Package (which is a Type B transportation package of CNSC certified design for transport of up to 400,000 curies of Co-60). Once the pencils are loaded into the Nordion's F231 Type B Transportation Package, the package is purged with Argon before loading onto a truck by OPG's TDG Class 7 qualified personnel.

The F231 Flask will remain suspended directly over the WCHB by the Flask Handling crane to allow excess water to drip back into the bay before the Flask is placed on the floor adjacent to the WCHB for further drying and preparation for shipping. Instructions for this sequence will be included in the Co-60 operating manual, NK38-OM-31935-04.03.08, "*Cobalt Processing - Purge A Flask*". REGM 28252894 tracks submission of the Darlington NGS Co-60 operating manual to CNSC staff.

Darlington NGS will be utilizing the new vacuum drying process that has been adopted by Pickering. Instructions on this segment of the process will be included in the new Co-60 Operating Manual NK38-OM-31935-04.03.08, "*Cobalt Processing - Purge A Flask*" tracked under REGM AR 28252894.

OPG will fulfill the role of consignor for the Type B(U) radioactive shipment of irradiated cobalt bundles from Darlington NGS to Nordion's facility in Kanata, Ontario. OPG's TDG Class 7 qualified personnel will be responsible for packing the radioactive material, preparing the shipping documents, and completing the shipment notifications, and offering the radioactive material for transport.

OPG resources from Radiation Protection, Health Physics, RMT (i.e., Transportation Officers), Operations, and Advanced Inspection and Maintenance will be required to perform the on-site activities.

The TDG Class 7 carrier who transports the shipment from Darlington NGS to the Nordion site in Kanata, Ontario will be arranged by Nordion.

This overall process will be similar to the Pickering NGS Co-60 production and transportation process and all OPEX will be incorporated into development of the final manuals. Submission of the Co-60 production system operating manual and procedure to CNSC staff is tracked under REGM 28252894.

The following personnel/groups will be performing the specific aspects of packaging and transportation:

- Experienced and qualified OPG personnel will perform cobalt harvesting and preparation for transport activities.
- OPG qualified personnel will transfer the irradiated cobalt bundles from the cobalt adjuster sites to the IFB.
- OPG Transportation Officers, who are TDG Class 7 qualified personnel, will provide oversight of the Type B(U) shipment.

- Unloading / loading transportation package, securing lid, and hoisting will be completed by OPG personnel who are TDG Class 7 qualified or under the direct supervision of a worker who is qualified.
- Receiving and shipping transportation packages will be completed by OPG qualified personnel in accordance with W-PROC-WM-0033. Checks and activities will be completed in accordance with W-PROC-WM-0033 and any transportation related issues identified will be addressed per W-PROC-WM-0033.
- OPG qualified personnel, who are TDG Class 7 qualified or under the direct supervision of a worker who is qualified, will perform loading to a conveyance at the loading dock activities.
- Nordion will be responsible for providing a qualified and knowledgeable third-party carrier, similar to the transportation carrier that carries Co-60 radioactive shipments from Pickering NGS. The third party Class 7 carrier will require access to Darlington NGS. The carrier will either be provided site access / NGET training by OPG for independent access or will be escorted by OPG personnel on-site.

OPG will provide CNSC notification of intent to transport Type B(U) packages containing cobalt activities greater than 1000 TBq, at least 7 days prior to shipment activities per W-PROC-WM-0033, and in accordance with the *"Packaging and Transport of Nuclear Substances Regulations, 2015"*, Section 25(2)(b), and IAEA's *"Regulations for the Safe Transport of Radioactive Material, 2018 Edition"*, No. SSR-6 (Rev. 1), paragraphs 558(b) and 559.

3.14.3. Co-60 Transportation Packaging Certification

As part of the transportation package design certification, the package undergoes enhanced mechanical and thermal testing, among other criteria, to prove safety during both routine and accidental conditions of transport in accordance with CNSC's *Packaging and Transport of Nuclear Substances Regulations*. These activities are the responsibility of Nordion as the owner of the packaging.

In accordance with the *Packaging and Transport of Nuclear Substances Regulations*, Nordion has previously submitted the required information to the CNSC and has obtained Type B certification for design of the F231 transportation package. OPG understands that the transportation packaging to be used at Darlington NGS for Co-60 shipments is Nordion's F231, which is the same packaging used for transport of Co-60 bundles on public roads from Pickering NGS to Nordion's facility for Co-60 processing.

OPG is a Registered User of the F231 Type B transportation package (Reference [37]), under CNSC certificate CDN/2077/B(U)-96 for the Nordion (Canada) Inc. F-231, F-231-L, F-231-MK2, and F-231-MK2-L Serial Nos. 11 and up Transportation Packages, which is currently valid until November 30, 2026. OPG procedure W-PROC-WM-0006, "*Radioactive Material Transportation Records"*, provides direction for maintaining records from package design, maintenance and transportation of radioactive materials created under W-PROG-WM-0002. There will be no changes as a result of the Co-60 Production Modifications Project.

3.14.4. Package Maintenance and Procedures

Nordion, having ownership of the transportation packaging, will be responsible for the package design and maintenance.

The Co-60 Operating Manual, tracked under REGM AR 28252894, will include requirements for inspections and checks prior to shipping to confirm the shipping package is in a suitable, safe condition for handling and loading. This will be similar to the requirements used at Pickering NGS (P-OP-31985-0001, "*Cobalt Processing Procedure*"), with changes adapted for use at Darlington NGS.

3.14.5. Response to Transportation Accidents

OPG's response in the event of transportation accidents involving radioactive material is documented in N-STD-RA-0036, "*Radioactive Material Transportation Emergency Response Plan*". There will be no change required to this plan as a result of the Co-60 project.

OPG, being the consignor, has a duty to respond in the event of a transportation accident, as described in N-STD-RA-0036, and would maintain communications with all required authorities. Nordion may request OPG's assistance, depending on the proximity of the accident to OPG's nuclear facilities. Both Nordion and OPG have emergency transportation response capability.

Every Class 7 shipment originating from an OPG facility has an ERAP (Emergency Response Assistance Plan) included with the shipping documentation and this will also be implemented for Co-60 shipments from Darlington NGS. In the event of a transportation accident, as per the ERAP, Darlington would utilize the Transportation Emergency Response Plan (TERP) response team to respond to the accident. In the event that additional assistance is required for managing the accident, CANUTEC, the Canadian Transport Emergency Centre, would be engaged for response. This is the same OPG strategy utilized for Pickering NGS for Co-60 shipments.

OPG's shipping documentation includes a reference to an ERAP number. Currently, the assigned ERAP number is ERP2-0121 as documented in N-STD-RA-0036, *"Radioactive Material Transportation Emergency Response Plan"*, which is the standard to ensure timely and appropriate response for responding to emergencies involving radioactive material transport. This standard receives authority from W-PROG-WM-0002, *"Radioactive Material Transport"*, which includes applicable governance that require other emergency response documents. W-PROC-WM-0033, *"Radioactive Shipments"*, requires the use of Radioactive (electronic) Shipment Advice Form (eSAF), W-FORM-10305. There is a section for emergency information on this form which documents the ERAP reference number, contact numbers, and an OPG Emergency Response form. The applicable OPG Emergency Response form for the Co-60 is W-FORM-10256, *"Emergency Response Information Class 7 Radioactive Material Type A or Type B"*.

3.14.6. Impact of Co-60 System on OPG Governance, Programs and Processes

There is no change to the OPG governance, programs and processes that form the licensing basis for Darlington NGS's Packaging and Transport SCA as a result of Co-60 production modifications installation.

3.15. Nuclear Facility Specific

OPG will comply with Nuclear Facility specific regulations:

- ✓ ***Minimal increase to tritium emission rates and no modifications / interface with Tritium Removal Facility (TRF) operation***
- ✓ ***Return to Service (RTS) for Refurbishment Units 1 and 4 will include Cobalt adjuster rods and commissioning of the adjuster rods will comply with OPG's Engineering and Nuclear Safety requirements and be integrated into existing Refurbishment regulatory hold points***
- ✓ ***No changes are expected to Integrated Implementation Plan***
- ✓ ***Cobalt-60 will only be transported to Nordion facility in Kanata from Darlington Nuclear Station***
- ✓ ***Cobalt-60 and Mo-99 isotopes will be generated in Unit 2 following implementation of Cobalt-60 project***

3.15.1. Tritium Removal Facility Operations

The program document, N-PROG-AS-0008, "*Heavy Water Management"*, establishes overall requirements for effective Heavy Water management within OPG, and ensures that there is a coordinated effort to achieve effective and efficient Heavy Water (HW) management. The HW program establishes procedures for the following:

a. HW demand supply planning which includes integrated strategic planning
b. HW asset management, which includes:
   i. HW inventory management,
   ii. tritium accounting,
   iii. life cycle/life extension management - Tritium Removal Facility (TRF), and
   iv. HW assets decommissioning planning.
c. HW logistics and integration

There is no impact to the Tritium Removal Facility (TRF) from Co-60 production activities. Any heavy water from the harvesting activities of the Cobalt adjuster rods will be handled per D-PROC-RA-0083, "*Radioactive Liquid Waste Handling*".

There is no change to the OPG governance, programs and processes that form the licensing basis for Darlington NGS's TRF Operations as a result of Co-60 production modifications installation.

3.15.2. Refurbishment – Return to Service

If the cobalt adjuster modification is installed in a refurbishment outage, then physics commissioning will be completed on Return to Service (RTS), and will validate the rod reactivity at low power before operation at high power. Per current OPG plans, the first unit to commission cobalt AA's will be Unit 1 following its refurbishment outage, DNRU1. In this instance, the 16 un-irradiated cobalt AA's will be commissioned under fresh core conditions, by measuring the reactivity worth of 16 individual AAs and 8 AA banks. Prior to these measurements, the reactivity worth of cobalt AA's will be pre-simulated, to accurately reflect the Unit 1 core-configuration at that time. The measurements will be compared to the pre-simulations for acceptance (Attachment 1 of Reference [11]). Physics commissioning of cobalt AAs is integrated into the current overall Darlington Unit 1 RTS plans, and

the Completion Assurance Document (CAD) will be submitted to CNSC staff per the existing protocol (Reference [38]). The CAD provides information that all pre-requisites, Co-59 adjuster modification commissioning, and testing activities have been completed. The same strategy is expected for Unit 4 (Darlington Unit 4 refurbishment RTS).

The out-of-service Adjuster Absorbers will not be converted to Cobalt adjusters in any Darlington unit. They are the original stainless steel/titanium rods and were not replaced during refurbishment. All such rods have remained locked out-of-core since 1996, the only exception being a few instances when moderator was drained during a long outage.

At present, OPG does not intend to remove the four remaining out-of-service AA rods in U2 and U4, nor the remaining 8 out-of-service AA rods in U1 and U3.

There is no change to the OPG governance, programs and processes that form the licensing basis for Darlington NGS's Refurbishment – Return to Service as a result of Co-60 production modifications installation.

3.15.3. Integrated Implementation Plan

The Integrated Implementation Plan (IIP) contains commitments and timeframes for implementation based on the results of the Environmental Assessment (EA) for Darlington Refurbishment and Continued Operations, as well as the Darlington Integrated Safety Review (ISR). The installation of Co-59 adjuster rods and the processing of Co-60 adjuster rods will not require changes to Integrated Implementation Plan (IIP), NK38-REP-03680-10185, *"Darlington NGS Integrated Implementation Plan (IIP)"*. Given that the Co-60 production modifications is a new design that satisfies all applicable regulatory requirements, this system will be factored into subsequent PSRs, after the PSR that is currently under development for renewal of the Darlington PROL in 2025.

There is no change to the OPG governance, programs and processes that form the licensing basis for Darlington NGS's IIP as a result of Co-60 production modifications installation.

3.15.4. Regulatory Hold Points for Return to Service and Continued Operations

Once Co-59 rods have been installed, commissioning will be performed to validate key parameters as described in Section 3.15.2 above. This will be integrated per the "*Ontario Power Generation Protocol with Canadian Nuclear Safety Commission for Darlington Nuclear Generating Station Unit 1 Return to Service*" (Reference [38]), for removal of Regulatory Hold Points (RHP). The same strategy is expected for Unit 4 (Darlington Unit 4 refurbishment RTS).

There is no change to the OPG governance, programs and processes that form the licensing basis for Darlington NGS's RHPs for Return to Service and Continued Operation as a result of Co-60 production modifications installation.

3.15.5. Import and Export of Nuclear Substances

Co-59 and Co-60 are not controlled nuclear substances under the *Nuclear Non-Proliferation Import and Export Control Regulations*. There will be no requirement to obtain a licence to import or export Co-60 by OPG. There will be no requirement to import nuclear material for Co-60 production

modifications installation and operation. Nordion will be responsible for obtaining the required import and export licenses for the importing and exporting the processed Co-60 outside of Canada.

There is no change to the OPG governance, programs and processes that form the licensing basis for Darlington NGS's Import and Export of Nuclear Substances as a result of Co-60 production modifications installation.

3.15.6. Molybdenum-99 Isotope Irradiation System

The CNSC, referred to as "the Commission", has considered OPG's application for a licence amendment to authorize the production of Mo-99 at Darlington NGS, and pursuant to section 24 of the *Nuclear Safety and Control Act*, amended the PROL issued to OPG for Darlington NGS in Record of Decision DEC 21-H107 (Reference [39]). The Commission included in the amended licence, PROL 13.03/2025, the condition and licensed activities as recommended by CNSC staff in CMD 21-H107 (Reference [40]). Licence Condition 15.6 includes two regulatory hold points (RHPs), related to the installation and commissioning of the Mo-99 IIS in Unit 2, which have been released upon verifying that the prerequisite steps for release have been taken by OPG as the licensee.

OPG notified CNSC staff in Reference [5] that the Co-60 Production Modifications Project will include modification of all four reactor units to produce Co-60 at Darlington NGS. Co-60 isotope production will hence overlap in one unit with Mo-99 production. The safety assessment completed for the production of Co-60 in all four reactor units, and at least one unit with both Co-60 and Mo-99 production, was submitted to CNSC staff in Reference [6]. The effects of each system were assessed and it was found that there is negligible effect of each system on reactor safety and reactor operations. Due to both systems being spatially and temporally independent from each other, their combined effect is no greater than their individual effects. Both systems were analyzed individually from a reactor safety and operational standpoint, with necessary measures in place ensuring safe operation of both systems in Unit 2.

There is no change to the OPG governance, programs and processes that form the licensing basis for Darlington NGS's Mo-99 Isotope Irradiation Program as a result of Co-60 production modifications installation.

4. Public Information and Engagement

OPG believes in timely, open and transparent communication to maintain positive and supportive relationships and confidence of key stakeholders. OPG's Stakeholder Relations organization adheres to the principles and process for external communications as governed by nuclear standard N-STD-AS-0013, "*Nuclear Public Information and Disclosure"*.

OPG provides responses to issues and questions raised by stakeholders and the public, and tracks issues and questions to identify trends in order to further refine proactive communications. Two-way dialogue with community stakeholders and residents is facilitated through personal contact, community newsletters, speaking engagements, advertising and educational outreach.

Through this regular outreach of an ongoing nature, OPG continues to provide members of the public and interested parties with information regarding the production and transportation of the isotope Co-60.

4.1. Community Committees

The Darlington Community Advisory Council (CAC) is made up of citizens, representatives of non-government organizations and members of local government staff who examine a number of issues associated with the existing and future activities of the Darlington Nuclear site. The CAC assists Darlington NGS in identifying and responding effectively to the concerns of the community. The Council's purpose is to identify community issues and concerns, and defines the actions members believe will be required to continuously improve operations at the site and promote the well-being of the community, among other purposes. The Council's advice focuses on, but is not limited to, the effects of Darlington NGS operations on the environmental, health, safety, social and economic interests of the community.

In addition to the CAC, OPG has a representative on the Durham Nuclear Health Committee (DNHC). DNHC is a committee of Durham Regional Council that is chaired by the Region's Commissioner and Medical Officer of Health. The DNHC is a forum for discussing and addressing potential radiation and environmental human health impacts. OPG Nuclear staff make regular presentations to the DNHC on a variety of environmental, community outreach and operational issues.

5. Indigenous Communications and Engagement

OPG believes in timely, open and transparent communication to maintain positive and supportive relationships and the confidence of key Indigenous Nations and communities. OPG's Stakeholder Relations organization adheres to the principles and process for external communications as governed by nuclear standard N-STD-AS-0013.

OPG provides responses to issues and questions raised by Indigenous Nation and community representatives, and tracks issues and questions to identify trends in order to further refine proactive communications. Two-way dialogue with Indigenous Nations and communities and residents is facilitated through personal contact and meetings, community newsletters, speaking engagements, advertising, and educational outreach.

Through this regular outreach, OPG continues to provide Indigenous Nations and communities, members of the public and interested parties with information regarding the production and transportation of the isotope Co-60.

5.1. Indigenous Nation and Community Communications

OPG acknowledges the Aboriginal and Treaty Rights of Indigenous people, Nations and communities as recognizedin the *Constitution Act, 1982*. Under its Indigenous Relations Policy, OPG regularly engages with Indigenous Nations and communities with established or asserted rights and/or interests in the areas surrounding OPG operations. In the case of the Co-60 project and its vendor partners, engagement is with the affected Indigenous Nations and communities listed below, some of which are treaty rights holders and some are interest holders:

- Williams Treaties First Nations
- Mohawks of the Bay of Quinte
- Metis Nation of Ontario, Region 8
- Six Nations of the Grand River

OPG began to engage with these Indigenous Nations and communities beginning in late 2021 and has continued to do so in 2022 in order to provide information regarding the production and transportation of the isotope, and to discuss any identified issues and concerns. Table 5.1.1 lists the engagement activities completed in support of the Co-60 Production Modifications Project. This is also in accordance with OPG's Reconciliation Action Plan. The Plan is aligned with the Truth and Reconciliation Commission's Call to Action #92, which urges corporate Canada to create a better future by applying a reconciliation framework to business activities.

As a part of its engagement plan for the Co-60 Production Modifications Project, NK38-PLAN-00120-00017, *"Darlington Cobalt-60 Production Modifications Indigenous Engagement Plan"* (Enclosure 1 of Reference [41]), OPG has planned ongoing updates/meetings with the identified Indigenous Nations and communities, leading up to the Licensing hearing to further discuss the project, and provide updates. OPG is prepared to provide capacity support to the engaged Indigenous Nations and communities, in line with the Indigenous Relations Policy and the scope of the engagement required.

Table 5.1.1: Completed Engagement with Indigenous Nations and Communities

Date	Community	Format	Comments
Oct 4, 2021	Curve Lake First Nation	Virtual introduction presentation	The Co-60 Project was presented in a forum with two other projects.
Oct 26, 2021	Six Nations of the Grand River	Virtual introduction presentation	The Co-60 Project was presented in a forum with two other projects.
Nov 18, 2021	Métis Nation of Ontario (MNO) 8	Virtual introduction presentation	The Co-60 Project was presented in a forum with two other projects.
Nov 30, 2021	Curve Lake First Nation	Virtual meeting	Cobalt technical presentation (with Nordion participation)
Jan 21, 2022	Williams Treaties First Nations	Virtual introduction presentation	The Co-60 Project was presented in a forum with two other projects.
Aug 19, 2022	MNO 8	Virtual presentation	Introduction Co-60 slide package presented again with project updates (MNO 8 staffing changes).

In preparation for hearings regarding the production Co-60, as well as the transportation of irradiated Co-60, OPG will proactively engage the identified Indigenous Nations and communities through various activities, such as staff briefings, community information sessions, written communication and/or workshops, etc. The specific objective is to ensure that Indigenous Nations and communities in the production area around Darlington NGS are provided with a forum to discuss key topics of Indigenous interest related to the licence amendment application.

6. Conclusion

OPG has been producing the Co-60 radioisotope in Pickering NGS's CANDU reactors for decades, providing a significant portion of the worldwide production (15-20%). With the station's upcoming end of commercial operations, expanding Co-60 production to Darlington NGS will help Ontario continue to meet the growing global demand for this essential radioisotope used in the medical and food industry.

OPG is requesting an amendment of the Darlington NGS PROL to add a new licensed activity to possess, transfer, produce, package, manage and store the Co-60 radioisotope.

OPG is committed to the safe and reliable operation of Darlington NGS. The introduction of Co-60 radioisotope production at Darlington NGS is a continuation of OPG's practice, and OPG is confident in the proposed process and approach. OPG plans to utilize all four of Darlington NGS's reactors for the irradiation of Cobalt-59 rods to produce Co-60. The design documents, engineering assessments and nuclear safety analyses completed for the modifications to Darlington NGS to produce Co-60 demonstrate that the addition of this new licensed activity can be carried out safely at Darlington NGS, and will not compromise continued safe reactor operation, nuclear safety, public safety, the environment or international agreements to which Canada is a signatory, as summarized below:

- **Design:** OPG has and will continue to follow its established ECC process for ensuring the design complies with applicable regulatory requirements and that configuration management for the station will be maintained.
- **Continued Safe Reactor Operation:** The safety analyses completed demonstrate that addition of this new licensed activity will have negligible effect on safe reactor operation, and on public safety.
- **Environmental Protection:** A PEA, prepared in accordance with CSA N288.6-12, concludes that operation of the Co-60 production system will not result in any unacceptable risks to human and ecological receptors residing in the vicinity of the Darlington NGS site. The additional emissions of the Co-60 and Mo-99 production systems are a small fraction of existing Darlington NGS emissions and the predicted doses are well below regulatory limits.
- **Licensing Basis:** Operation of the Co-60 production system will have well established programs and processes. There are no programmatic changes required to the Nuclear Management System or any other programmatic changes to documents listed in the current Darlington NGS PROL 13.03/2025 and the associated Licence Conditions Handbook.
- **Safeguards and Non-Proliferation:** Darlington NGS will continue to meet Canada's international obligations under the *Treaty on the Non-Proliferation of Nuclear Weapons*. The production of Co-60 will interface with the normal operation of the IFB, but does not involve nuclear material that is subject to safeguard requirements pursuant to the Canada/ IAEA Safeguards Agreement (Uranium, Thorium or Plutonium) and as defined in REGDOC-2.13.1.

OPG will continue to provide information to CNSC staff to assist in fulfillment of their regulatory role.

7. References[3]

[1]. OPG letter, R. Geofroy to J. Burta, “Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Response to CNSC Staff’s Review of the Detailed Engineering Design Documents (D03)”, October 31, 2022, CD# NK38-CORR-00531-23780.

[2]. OPG letter, S. Gregoris to J. Burta, “Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Submission of Preliminary Engineering Design Documents (D01-01 and D01-02)”, September 3, 2020, CD# NK38-CORR-00531-21872.

[3]. OPG letter, S. Gregoris to K. Hazelton, “Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Submission of Preliminary Engineering Design Documents (D02-01 and D02-02)”, March 5, 2021, CD# NK38-CORR-00531-22406.

[4]. OPG email, C. Axlet to A. Mathai, “Confidential – Darlington NGS – Cobalt-60 Production Modifications Project: CNSC Staff’s Notification of Document Changes – Co-60 Production Modification: RMD, Site Transportation and Monitoring, NK38-MDR-31780-10002 R002 and Modification Design Requirements for Discharge, Storage, Processing, and Off-Site Shipping of Cobalt, NK38-MDR-31935-10001 R002”, April 28, 2023, CD# NK38-CORR-00531-24235.

[5]. OPG letter, R. Geofroy to J. Burta, “Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Update on the Initiative to Produce Cobalt-60”, February 28, 2022, CD# NK38-CORR-00531-23192.

[6]. OPG email, C. Axler to A. Mathai, “Confidential – Darlington NGS – Cobalt-60 Production Modifications Project: CNSC Staff’s Notification of Document Changes – Cobalt Adjuster and Molybdenum Target Delivery System Interaction, NK38-REP-03500-0989867 R002”, April 12, 2023, CD# NK38-CORR-00531-24231.

[7]. OPG email, A. Bhardwaj to S. Baskey, “Confidential – Darlington NGS: Co-60@DNGS: CNSC staff requests for information supporting OPG Round 1 Dispositions to D03 – A9096”, February 15, 2023, CD# NK38-CORR-00531-24067.

[8]. OPG letter, R. Geofroy to J. Burta, “Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Submission of Safety Analysis Documentation for SA03”, March 14, 2022, CD# NK38-CORR-00531-23058.

[9]. OPG letter, R. Geofroy to J. Burta, “Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Submission of the Impact Assessment of Cobalt Absorber Rods and Molybdenum Isotope Irradiation System on the Same Unit (SA04)”, June 1, 2022, CD #NK38-CORR-00531-23379.

[3] Appendix B provides a brief summary of each OPG submitted confidential correspondence listed in section 7, ‘References’.

[10]. OPG letter, S. Gregoris to J. Burta, “Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Submission of Reactor Safety Documents (SA-01)”, September 18, 2020, CD# NK38-CORR-00531-21945.

[11]. OPG letter, S. Gregoris to J. Burta, “Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Submission of Reactor Safety Supporting Documents for SA02-01 and SA02-02”, September 30, 2021, CD# NK38-CORR-00531-22762.

[12]. OPG letter, S. Gregoris to J. Burta, “Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Submission of Detailed Engineering Design Documents (D03)”, November 12, 2021, CD# NK38-CORR-00531-22945.

[13]. OPG letter, R. Geofroy to J. Burta, “Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Submission of D03-01 and the Human Factors Verification and Validation Plan”, January 12, 2022, CD# NK38-CORR-00531-23083.

[14]. OPG email, A. Bhardwaj to J. Burta, “Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – CNSC Staff Notification of Regulatory Management Action Request Due Date Extension for HFESR”, October 13, 2022, CD# NK38-CORR-00531-23786.

[15]. OPG letter, B. Duncan to P.A. Webster, “Darlington NGS ‘A’ – Request for Approval of an OP&P Temporary Change for a Demonstration of the Rod-Based Guaranteed Shutdown State”, January 27, 2012, CD# NK38-CORR-00531-15754.

[16]. OPG letter, R. Geofroy to A. Mathai, “Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Plan to Address Residual CNSC Staff Comments on the Darlington Irradiated Fuel Bay Analysis”, April 21, 2023, CD# NK38-CORR-00531-24021.

[17]. OPG email, S. Chae to J. Burta, “Confidential – Darlington NGS – CNSC Staff’s Notification of Document Changes: Impact of Cobalt Adjusters Implementation on Darlington Risk Assessment (DARA), NK38-REP-31780-0854476 R001”, July 7, 2022, CD# NK38-CORR-00531-23578.

[18]. OPG letter, R. Geofroy to J. Burta, “Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Submission of the Evaluation of Limiting Safety Cases for Guide Tube Extension / Cobalt Adapter Thermal Analysis”, August 26, 2022, CD# NK38-CORR-00531-23649.

[19]. OPG letter, R. Geofroy to A. Mathai, “Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Response to CNSC Staff’s Review of the Evaluation of Limiting Safety Cases for Guide Tube Extension / Cobalt Adapter Thermal Analysis”, April 13, 2023, CD# NK38-CORR-00531-24010.

[20]. OPG email, A. Palladino to J. Burta, " Confidential – Darlington NGS – CNSC Staff’s Notification of Document Changes: Hazard Analysis for CAEPS Flask and Nordion Shipping Flask Transportation Activities at the WFFAA, NK38-REP-31935-10035 R001", March 28, 2022, CD#, NK38-CORR-00531-23372.

[21]. OPG letter, R. Geofroy to A. Mathai, “Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Response to CNSC Staff’s Round 2 Review of the Reactor Safety Supporting Documents for SA02-01 and SA02-02”, April 4, 2023, CD# NK38-CORR-00531-24060.

[22]. OPG letter, M.R. Knutson to V. Viktorov, “OPG Response – Pickering NGS and Darlington NGS – Implementation of CSA N290.14-15 (R2020), Qualification of Digital Hardware and Software for Use in Instrumentation and Control Applications for Nuclear Power Plants – Action Item 2022-OPG-24737”, November 22, 2022, CD# N-CORR-00531-23324.

[23]. OPG email, A. Palladino to J. Burta, “Confidential – Darlington NGS – CNSC Staff’s Notification of Document Changes: Co-60 Production Modification: RMD, Site Transportation and Monitoring, NK38-MDR-31780-10002 R001”, March 28, 2022, CD# NK38-CORR-00531-23371.

[24]. OPG email, A. Palladino to J. Burta, “Confidential – Darlington NGS – CNSC Staff’s Notification of Document Changes: Modification Design Requirements for Conversion to Cobalt Adjuster Rods, NK38-MDR-31780-10004 R001”, March 28, 2022, CD# NK38-CORR-00531-23373.

[25]. OPG email, V. Carter to J. Burta, “Confidential – Darlington NGS – CNSC Staff’s Notification of Document Changes: Modification Design Requirements for Conversion to Cobalt Adjuster Rods, NK38-MDR-31780-10004 R002”, April 24, 2022, CD# NK38-CORR-00531-23374.

[26]. OPG email, A. Bhardwaj to J. Burta, “Confidential – Darlington NGS – CNSC Staff’s Notification of Document Changes: Modification Design Requirements for Conversion to Cobalt Adjuster Rods, NK38-MDR-31780-10004 R003”, October 26, 2022, CD# NK38-CORR-00531-23803.

[27]. OPG email, A. Bhardwaj to S. Baskey, “Confidential – Darlington NGS – Co-60@DNGS: OPG's Response to CNSC Staff Requests for Information: SA03 – 189DF.2”, December 2, 2022, CD# NK38-CORR-00531-23918.

[28]. OPG email, A. Bhardwaj to S. Baskey, “Confidential – Darlington NGS – Co-60@DNGS: OPG Response to CNSC Staff Requests for Information: 2022 CODE CLASS REQUET - Modification to the Units 1, 3 and 4 Reactivity Mechanisms Deck Containment Boundary - 51E2C”, December 23, 2022, CD# NK38-CORR-00531-24002.

[29]. OPG letter, R. Geofroy to J. Burta, “Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Request for CNSC Staff's Code Classification Consent for Adjuster Thimbles and Adjuster Cobalt Adapter”, May 2, 2022 CD# NK38-CORR-00531-23248.

[30]. CNSC letter, A. Mathai to R. Geofroy, “Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – CNSC Staff Review of OPG Request for CNSC Staff's Code Classification Consent for Adjuster Thimbles and Adjuster Cobalt Adapter”, March 1, 2023, e-Doc# 6969708, CD# NK38-CORR-00531-24105.

[31]. OPG letter, R. Geofroy to J. Burta, “Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Request for CNSC Staff's Code Classification Consent for Modification to the Units 1, 3 and 4 Reactivity Mechanisms Deck Containment Boundary”, October 28, 2022, CD# NK38-CORR-00531-23745.

[32]. CNSC letter, A. Mathai to R. Geofroy, “Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – CNSC staff Review of OPG Request for CNSC Staff’s Code Classification Consent for Modification to the Units 1, 3 and 4 Reactivity Mechanisms Deck Containment Boundary”, March 1, 2023, e-Doc# 6969715, CD# NK38-CORR-00531-24104.

[33]. OPG letter, M.R. Knutson to J. Burta and R. Richardson, “OPG Notification of Compliance with the 2018 Edition of CSA Standard N285.5 – Periodic Inspection of CANDU Nuclear Power Plant Containment Components”, April 12, 2022, CD# N-CORR-00531-23054.

[34]. OPG letter, S. Gregoris to K. Hazelton, “Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Response to CNSC Staff’s Comments on the Preliminary Engineering Design Documents (D01-01 and D01-02)”, April 30, 2021, CD# NK38-CORR-00531-22516.

[35]. OPG email, A. Bhardwaj to S. Baskey, “Confidential – CNSC Staff Requests - Darlington NGS – Co-60@DNGS: Round 2 RP comments from D03 and D01 - A9100”, April 17, 2023, CD# NK38-CORR-00531-24234.

[36]. OPG letter, R. Geofroy to J. Burta, “Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Submission of the Predictive Effects Assessment”, April 27, 2022, CD# NK38-CORR-00531-23353.

[37]. CNSC email, C. Ouellette to D. Baker, “Confirmation of Registered User Registration for Certificate No. CDN/2077/B(U)/-96 (Rev. 7) for Nordion (Canada) Inc. F-231, F-231-L, F-231-MK2 and F-231-MK2-L, Serial Nos. 11 and up”, November 5, 2021, CD# TRAN-CORR-00531-00912.

[38]. CNSC letter, N. Abonasara to S. Gregoris and S. Sinnathamby, “Ontario Power Generation Protocol with the Canadian Nuclear Safety Commission for Darlington Nuclear Generating Station Unit 1 Return to Service -Revision 0”, December 17, 2021, e-Doc# 6703417, CD# NK38-CORR-00531-23046

[39]. CNSC email, J. Bouchard to J. Vecchiarelli, “Record of Decision and Licensing for Hearing in Writing - OPG - CMD 21-H107”, October 26, 2021, CD# NK38-CORR-00531- 23014.

[40]. CNSC email, J. Bouchard to R. Lahaye, “Submission from CNSC staff for the hearing in Writing and Participant Funding – Mo-99 – CMD 21-H107”, June 23, 2021, CD# NK38-CORR-00531-22663.

[41]. OPG email, A. Bhardwaj to S. Baskey, “Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Indigenous Engagement Plan”, November 9, 2022, CD# NK38-CORR-00531-23812.

[42]. OPG letter, R. Geofroy to A. Mathai, “Darlington NGS – Co-60 Production Modifications Project – Revision of Darlington Irradiated Fuel Bay Analysis Report”, November 28, 2023, CD# NK38-CORR-00531-25066

[43]. OPG email, L. Moraru to A. Mathai, “Darlington NGS - Response to CNSC Staff Review and Comments Regarding OPG Application for DNGS PROL 13.03/2025 Amendment for Production of the Cobalt-60 Radioisotope - 20A87”, November 9, 2023, CD# NK38-CORR-00531-24962

[44]. OPG email, L. Moraru to A. Mathai, “Darlington NGS – Response to CNSC Staff Review and Comments Regarding OPG Application for DNGS PROL 13.03/2025 Amendment for Production of the Cobalt-60 Radioisotope - Appendix B –20C88”, November 22, 2023, CD# NK38-CORR-00531-25065

[45]. OPG email, A. Bhardwaj to A. Mathai, “Darlington NGS - Response to CNSC Staff Review and Comments Regarding OPG Application for DNGS PROL 13.03/2025 Amendment for Production of the Cobalt-60 Radioisotope - 20A87”, October 26, 2023, CD# NK38-CORR-00531-24952

[46]. OPG letter, R. Geofroy to A. Mathai, “Darlington NGS – Cobalt-60 Production Modifications Project – Request for CNSC Staff’s Code Classification Consent for Modification to the Unit 2 Reactivity Mechanisms Deck Containment Boundary and to Re-route Target Delivery System Class 2 Tubing”, September 4, 2023, CD# NK38-CORR-00531-24571

APPENDIX A

Cobalt-60 Production Modifications Project Regulatory Commitments

The purpose of this appendix is to document a consolidated list (Table 1) of OPG's pending regulatory commitments for the Cobalt-60 Production Modifications Project. Some of the submissions and activities are scheduled to occur after the date of this application and, in some cases, after the licence amendment hearing. OPG has initiated Regulatory Management Action Requests (REGMs) for all regulatory commitments to track to completion the outstanding submissions and activities, in accordance with OPG's processes.

Should changes to the due date of these commitments be required, in recognition that there will be activities occurring over the course of the project, OPG will provide prior CNSC staff notification.

Table 1 – List of Cobalt-60 Production Modifications Project Regulatory Commitments

#	Description	REGM #	Target Completion Date
1.	Submit the Human Factors Engineering Summary Report for the Cobalt-60 Production Modifications Project at Darlington NGS to CNSC staff (Reference [A-1] and [A-2]).	28247842	July 31, 2024
2.	Provide all Maintenance Manuals, Preventative Maintenance Plans, Periodic Inspection Plans, and Ageing Management Plans for the Flask, Flask Transporter, Positioner, and Processing Table	28263203	July 30, 2025
3.	Submit the Darlington NGS Cobalt-60 production system operating manual and procedure to CNSC staff.	28252894	August 29, 2025
4.	Submit the engineering evaluation of a scenario that sees a rapid increase in gamma dose rate or transient conditions due to withdrawal of a cobalt adjuster absorber to CNSC staff (Reference [A-4]).	28255219	October 8, 2027
5.	Submit to CNSC staff the confirmatory activity of measurement and assessment of the Cobalt AA reactivity worth and incremental cross sections at the end of their first irradiation cycle at Darlington NGS (Reference [A-5]).	28258842	within 6 months of the start of the first outage involving Cobalt Adjuster Absorber harvesting
6.	Submit the request for CNSC staff's code classification consent for Unit 2 modifications to	28256375	COMPLETE

#	Description	REGM #	Target Completion Date
	reroute Molybdenum-99 (Mo-99) Target Delivery System (TDS) interference lines.		
7.	Submit the revision of the affected analysis report enclosed in *"Thermal Hydraulic Analysis for Storage and Processing of Cobalt Adjuster Elements in Darlington Wet Cask Handling Bay"* to CNSC staff to include results of the confirmatory assessments (Reference [A-3]).	28259126	COMPLETE
8.	Submit the request for CNSC staff's code classification consent for modifications to the Unit 2 Reactivity Mechanism Deck (RMD) due to additional design loads added by Cobalt-60 Production System and Mo-99 TDS equipment at the RMD.	28256376	COMPLETE

References

[A-1]. OPG letter, S. Gregoris to J. Burta, "Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Submission of Detailed Engineering Design Documents (D03)", November 12, 2021, CD# NK38-CORR-00531-22945.

[A-2]. OPG email, A. Bhardwaj to J. Burta, "Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – CNSC Staff Notification of Regulatory Management Action Request Due Date Extension for HFESR", October 13, 2022, CD# NK38-CORR-00531-23786.

[A-3]. OPG letter, R. Geofroy to A. Mathai, "Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Plan to Address Residual CNSC Staff Comments on the Darlington Irradiated Fuel Bay Analysis", April 21, 2023, CD# NK38-CORR-00531-24021.

[A-4]. OPG letter, R. Geofroy to J. Burta, "Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Response to CNSC Staff's Review of the Detailed Engineering Design Documents (D03)", October 31, 2022, CD# NK38-CORR-00531-23780.

[A-5]. OPG letter, R. Geofroy to A. Mathai, "Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Response to CNSC Staff's Round 2 Review of the Reactor Safety Supporting Documents for SA02-01 and SA02-02", April 4, 2023, CD# NK38-CORR-00531-24060.

APPENDIX B

Confidential Submission	Summary
[1]. OPG letter, R. Geofroy to J. Burta, "Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Response to CNSC Staff's Review of the Detailed Engineering Design Documents (D03)", October 31, 2022, CD# NK38-CORR-00531-23780.	This correspondence served to provide a response to CNSC staff's review of detailed engineering design documents as part of Design Submission #3. Supplementary documents, including forms, assessments, reports, and engineering input files, were provided as part of the response to CNSC requests. Additionally, in response to CNSC review of Radiation Protection requirements, a commitment was made to initiate an engineering evaluation for a scenario involving transient radiological conditions related to worker Radiation Protection. The correspondence concludes that no document updates are required.
[2]. OPG letter, S. Gregoris to J. Burta, "Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Submission of Preliminary Engineering Design Documents (D01-01 and D01-02)", September 3, 2020, CD# NK38-CORR-00531-21872.	This correspondence served to submit preliminary engineering documents for CNSC review for a portion of the Co-60 project scope. The submitted documents provide the preliminary risk evaluations, determination of the appropriate level of rigour to be applied in the design, and requirement definition for the applicable Co-60 project scopes. The documents provided are a standard set of documents produced in the preliminary engineering process according to the approved Engineering Change Control process. The correspondence indicates that future administrative revisions of the documents are expected and will be submitted for CNSC review.
[3]. OPG letter, S. Gregoris to K. Hazelton, "Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Submission of Preliminary Engineering Design Documents (D02-01 and D02-02)", March 5, 2021, CD# NK38-CORR-00531-22406.	This correspondence served to submit preliminary engineering documents for CNSC review for a portion of the Co-60 project scope. The submitted documents provide the preliminary risk evaluations, determination of the appropriate level of rigour to be applied in the design, and requirement definition for the applicable Co-60 project scopes. The documents provided are a standard set of documents produced in the preliminary engineering process according to the approved Engineering Change Control process. The correspondence indicates that future administrative revisions of the documents are expected and will be submitted for CNSC review.

[4]. OPG email, C. Axler to A. Mathai, “Confidential – Darlington NGS – Cobalt-60 Production Modifications Project: CNSC Staff’s Notification of Document Changes – Co-60 Production Modification: RMD, Site Transportation and Monitoring, NK38-MDR-31780-10002 R002 and Modification Design Requirements for Discharge, Storage, Processing, and Off-Site Shipping of Cobalt, NK38-MDR-31935-10001 R002”, April 28, 2023, CD# NK38-CORR-00531-24235.	This correspondence served to notify the CNSC of changes made to the Project’s Modification Design Requirements. The changes implemented in this revision will not result in any adverse impact on the health and safety of persons, security, environment or Canada's international obligations or limits stated in the Safety Report. These changes provide the project with flexibility to meet the intent of select requirements in a manner involving no permanent modifications to the plant. Particularly, this update allowed for portable vacuum ventilation, radiation monitoring, and video/audio monitoring equipment to be used at the Reactivity Maintenance Deck during a Cobalt harvest, as well as portable Argon purging and vacuum drying equipment to be used in the fuel bay during Cobalt flask preparation for transport.
[5]. OPG letter, R. Geofroy to J. Burta, “Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Update on the Initiative to Produce Cobalt-60”, February 28, 2022, CD# NK38-CORR-00531-23192.	The purpose of this correspondence was to notify CNSC staff that all four reactor units at Darlington NGS will be modified to produce Cobalt-60, after the initial intent of producing Cobalt-60 in only 3 reactor units. Cobalt-60 isotope production will hence overlap in one unit with Molybdenum-99 production. Therefore, Safety Analysis Submission #4 (SA04) documenting the safety case for the overlap in this unit will be submitted to CNSC staff per the OPG-CNSC Protocol for Cobalt-60.
[6]. OPG email, C. Axler to A. Mathai, “Confidential – Darlington NGS – Cobalt-60 Production Modifications Project: CNSC Staff’s Notification of Document Changes – Cobalt Adjuster and Molybdenum Target Delivery System Interaction, NK38-REP-03500-0989867 R002”, April 12, 2023, CD# NK38-CORR-00531-24231.	This correspondence served to notify the CNSC of an additional section which was added to Cobalt-Molybdenum interaction report covering severe core damage considerations. The added section demonstrates why the presence of Cobalt-60 and Molybdenum in the core would have a negligible contribution on such considerations, as these substances are inert to the physical and chemical properties of the overall reaction and make up only 0.02% of the reactor's mass.
[7]. OPG email, A. Bhardwaj to S. Baskey, “Confidential – Darlington NGS: Co-60@DNGS: CNSC staff requests for information supporting OPG Round 1 Dispositions to D03 – A9096”, February 15, 2023, CD# NK38-CORR-00531-24067.	This correspondence served to provide a response to CNSC staff’s request for additional information to support the review of OPG’s dispositions to CNSC staff inquiries regarding Design Submission #3. To fulfill CNSC’s request, OPG provided three documents as attachments. A shielding analysis plan was provided, which outlines the approach and methodology to be used for the analysis of the radiation and shielding in the vicinity of the Darlington reactors. The project charter and project

	management plan were also provided, which outlined the roles, responsibilities and planned oversight of the Co-60 project as requested by CNSC.
[8]. OPG letter, R. Geofroy to J. Burta, “Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Submission of Safety Analysis Documentation for SA03”, March 14, 2022, CD# NK38-CORR-00531-23058.	This correspondence provides analysis related to a Guide Tube Extension (GTE) and thimble thermal expansion, which warranted a more detailed assessment as part of detailed design. Enclosure 1 of the correspondence includes a report which confirms that the safety analysis documentation submitted for SA-01 is unaffected by detailed design developments for the new Darlington NGS cobalt adjusters. Enclosure 2 provides an additional report which confirms that the adjuster unit components (containment boundary, pressure boundary and non-pressure boundary) will satisfy all applicable code requirements for allowable stresses under the design basis conditions analyzed. The correspondence also notes that, at the time, additional assessments are in progress to evaluate the impacts of this nuclear heating phenomena under Beyond Design Basis Accident conditions.
[9]. OPG letter, R. Geofroy to J. Burta, “Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Submission of the Impact Assessment of Cobalt Absorber Rods and Molybdenum Isotope Irradiation System on the Same Unit (SA04)”, June 1, 2022, CD #NK38-CORR-00531-23379.	This letter encompasses an impact assessment for both Cobalt Absorber Rods and Molybdenum Isotope Irradiation System on operating in the same unit. A comprehensive safety analysis and operational assessment was performed for each system individually and combined in the same unit. The assessment concludes that the effect of each system is minimal with regards to reactor safety as well as reactor operations.
[10]. OPG letter, S. Gregoris to J. Burta, “Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Submission of Reactor Safety Documents (SA-01)”, September 18, 2020, CD# NK38-CORR-00531-21945.	This correspondence included the submission OPG's reactor safety analysis (SA-01), in support of the Cobalt-60 (Co-60) Production Modifications Project at Darlington Nuclear Generating Station (NGS). This submission included a physics analysis of cobalt adjuster rods, pre-equilibrium core simulations of how cobalt adjusters behave in the Darlington reactor, an analysis on if implementation of cobalt adjusters affect existing safety analysis, and a report on the physics/thermal analysis to support cobalt implementation at Darlington.

[11]. OPG letter, S. Gregoris to J. Burta, “Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Submission of Reactor Safety Supporting Documents for SA02-01 and SA02-02”, September 30, 2021, CD# NK38-CORR-00531-22762.	This correspondence included the submission of supporting documents for OPG's safety analysis submission #2 per the OPG-CNSC protocol. Included in this submission was the physics commissioning strategy for new cobalt adjuster rods, updated physics models for cobalt aging prediction, a fuel management study which impacts the impact of cobalt adjusters on reactor fuelling, and an assessment on how cobalt adjusters impact the existing Darlington Risk Assessment (DARA).
[12]. OPG letter, S. Gregoris to J. Burta, “Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Submission of Detailed Engineering Design Documents (D03)”, November 12, 2021, CD# NK38-CORR-00531-22945	This correspondence served to submit detailed engineering phase documents for CNSC review for a portion of the Co-60 project scope. Attachment 1 provides a summary of the seismic category for the major Co-60 equipment. Enclosure 1 provides the Adjuster Units Failure Modes and Effects Analysis (FMEA), which documents the key failure modes of adjuster unit components and their resulting effects, mitigation strategies for failure modes, and recommendations on how to address mitigation of failure modes in the station procedures. Enclosures 2, 3, and 4 provide hazard evaluations for heavy equipment handling processes at the station. These documents evaluate the hazards associated with handling and transportation of equipment, and identify preventative measures to mitigate the impacts of the hazards. Enclosure 5 provides a dose rate analysis in the vicinity of the reactor for operating with cobalt adjuster elements and removal of cobalt adjuster elements. It is concluded that there will be no significant impact to dose rates when the adjusters are in-core during normal operation and shutdown. Mitigations, including access control measures, are recommended for a limit set of reactor conditions and maintenance configurations. Enclosure 6 and 7 provide the radiological requirements, design targets, and the assessments. The requirements are set based on applicable standards, and assessments are performed to estimate dose uptake by workers in order to demonstrate that the requirements are met. It is concluded that design controls have reduced worker exposure as low as reasonably achievable, and recommendations are made to further enhance radiological safety. Enclosures 8 and 9 provide structural analyses of potential impact scenarios related to heavy load handling. These documents assess the impact scenarios at key locations within the station. It is concluded that the structures at these locations can

	withstand the specified impacts, and procedural measures are recommended to mitigate the likelihood and consequence of the evaluated scenarios. Enclosure 10 provides a planning document specific to Human Factors Engineering subject matter. The plan documents the scope of the human factors engineering activities and describes the planned approach on how these activities will be integrated into the design.
[13]. OPG letter, R. Geofroy to J. Burta, "Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Submission of D03-01 and the Human Factors Verification and Validation Plan", January 12, 2022, CD# NK38-CORR-00531-23083.	This correspondence served to submit detailed engineering phase documents for CNSC review for a portion of the Co-60 project scope. Enclosure 1 provides a thermal analysis of the fuel bay in the WFFAA area of the station. This analysis is a REGDOC-2.4.1 compliant Safety Analysis, using the Gothic software program to evaluate the thermal impact of new and existing heat sources in the Irradiated Fuel Bay. The analysis addresses a loss of cooling event in the Irradiated Fuel Bay with the Co-60 modifications implemented. It is concluded that the impact of the additional Co-60 and Stainless Steel AA heat loads on IFB time-to-boil is minor, and cooling can be established or restored within an acceptable time frame using existing alarms and emergency response procedures. Enclosure 2 provides the Human Factors Verification & Validation Plan, which describes the approach to and nature of validation activities to ensure human factors engineering guidelines and principles are adhered to during the project phases.
[14]. OPG email, A. Bhardwaj to J. Burta, "Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – CNSC Staff Notification of Regulatory Management Action Request Due Date Extension for HFESR", October 13, 2022, CD# NK38-CORR-00531-23786.	The purpose of this correspondence was to provide notification to CNSC staff for a due date extension Regulatory Management Action Request (REGM) which tracks submission of a Human Factors Engineering Summary Report (HFESR). This is due to the addition of the Cobalt-60 production in a unit which also produces Molybdenum-99, which triggered additional human factors engineering assessments due to the Molybdenum-99 equipment present at the Reactivity Mechanism Deck.
[15]. OPG letter, B. Duncan to P.A. Webster, "Darlington NGS 'A' – Request for Approval of an OP&P Temporary Change for a Demonstration of the Rod-Based Guaranteed	Enclosure 2 of this correspondence 'NK38-CORR-03677-0374540 – Determination of Subcriticality Margin for Darlington New RBGSS Sensitivity Cases' demonstrates that for the Rod Based Guaranteed Shutdown State (RBGSS), sufficient sub-criticality margin is maintained

Shutdown State", January 27, 2012, CD# NK38-CORR-00531-15754.	even if adjuster rods are withdrawn from the reactor core during accident conditions.
[16]. OPG letter, R. Geofroy to A. Mathai, "Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Plan to Address Residual CNSC Staff Comments on the Darlington Irradiated Fuel Bay Analysis", April 21, 2023, CD# NK38-CORR-00531-24021.	This correspondence served to document and provide the planned approach to CNSC for addressing open issues raised during CNSC staff's review of the GOTHIC analysis report for Loss of IFB Cooling. These issues are residual and can be resolved in parallel with the licence amendment process. The planned path forward involves additional assessments, which will be incorporated into a revision of the analysis report and re-submitted to CNSC.
[17]. OPG email, S. Chae to J. Burta, "Confidential – Darlington NGS – CNSC Staff's Notification of Document Changes: Impact of Cobalt Adjusters Implementation on Darlington Risk Assessment (DARA), NK38-REP-31780-0854476 R001", July 7, 2022, CD# NK38-CORR-00531-23578.	This correspondence provides a revision to NK38-REP-31780-0854476, "Impact of Cobalt Adjusters Implementation on Darlington Risk Assessment (DARA)". This revision shows that the assessment has no adverse impact on the health and safety of persons, security, the environment, or Canada's international obligations and has no adverse impact on the licensing basis and no impact on the limits stated in the Safety Report.
[18]. OPG letter, R. Geofroy to J. Burta, "Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Submission of the Evaluation of Limiting Safety Cases for Guide Tube Extension / Cobalt Adapter Thermal Analysis", August 26, 2022, CD# NK38-CORR-00531-23649.	This correspondence served to submit a detailed engineering phase document for CNSC review for a portion of the Co-60 project scope. Enclosure 1 provides an evaluation addressing the integrity of the reactivity mechanisms housing the cobalt adjuster elements, specifically related to the thermal expansion induced by nuclear heat generation under bounding reactor conditions. The assessment establishes the limiting scenarios and associated reactor conditions which could contribute to high thermal expansions and increase stresses on the reactivity mechanism components. With the limiting events determined, the conditions to prevent failure of components are specified, and it is concluded that the pressure boundary integrity is maintained under the required conditions.
[19]. OPG letter, R. Geofroy to A. Mathai, "Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Response to CNSC Staff's Review of the Evaluation of Limiting Safety Cases for Guide Tube	This letter includes OPG responses to CNSC staff's technical questions regarding the evaluation of limiting safety cases for guide tube extension / cobalt adaptor thermal analysis, and the assumptions/conservative approach used in the calculations.

Extension / Cobalt Adapter Thermal Analysis", April 13, 2023, CD# NK38-CORR-00531-24010.	
[20]. OPG email, A. Palladino to J. Burta, " Confidential – Darlington NGS – CNSC Staff's Notification of Document Changes: Hazard Analysis for CAEPS Flask and Nordion Shipping Flask Transportation Activities at the WFFAA, NK38-REP-31935-10035 R001", March 28, 2022, CD# NK38-CORR-00531-23372.	NK38-REP-31935-10035 "Hazard Analysis for CAEPS Flask and Nordion Shipping Flask Transportation Activities at the WFFAA" documents the hazards associated with equipment handling and transportation. The document was revised to clarify that the CAEPS flask is to follow the new travel pathway to meet station operational needs. The new travel pathway was confirmed to be adequate via structural evaluation. The revision has no adverse impact to the health, safety and security of persons, environment or the Darlington Nuclear Generating Station.
[21]. OPG letter, R. Geofroy to A. Mathai, "Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Response to CNSC Staff's Round 2 Review of the Reactor Safety Supporting Documents for SA02-01 and SA02-02", April 4, 2023, CD# NK38-CORR-00531-24060.	This letter includes OPG responses to the second round of CNSC technical comments on reactor safety supporting documents, and includes a commitment for OPG to provide the results of a confirmatory assessment which will validate the accuracy of the Cobalt rod aging algorithm in OPG's reactor modelling software, within 6 months of the first Cobalt harvest.
[22]. OPG letter, M.R. Knutson to V. Viktorov, "OPG Response – Pickering NGS and Darlington NGS – Implementation of CSA N290.14-15 (R2020), Qualification of Digital Hardware and Software for Use in Instrumentation and Control Applications for Nuclear Power Plants – Action Item 2022-OPG-24737", November 22, 2022, CD# N-CORR-00531-23324.	This correspondence was sent to notify the CNSC that DNGS is compliant with CSA N290.14-15 (R2020) Qualification of digital hardware and software for use in instrumentation and control applications for nuclear power plants, and that an implementation plan for CSA N290.14-15 (R2020) standard is not required as the gap analysis together with the appropriate OPG governance documents were revised to align with requirements of the CSA standard in support of Pickering's License Conditions Handbook (LCH).
[23]. OPG email, A. Palladino to J. Burta, "Confidential – Darlington NGS – CNSC Staff's Notification of Document Changes: Co-60 Production Modification: RMD, Site Transportation and Monitoring, NK38-MDR-31780-10002 R001", March 28, 2022, CD# NK38-CORR-00531-23371.	This correspondence served to notify the CNSC of the first revision made to the Project's Modification Design Requirements. The changes implemented in this revision are minor in nature and have no adverse impact on the health and safety of persons, security, environment or Canada's international obligations or limits stated in the Safety Report. Notable changes implemented in this revision were changes to shielding requirements in areas where operators are prohibited from entering,

	reduction in the number of phone lines required from 2 to 1, additional requirement for local tritium monitors, additional requirement for a camera in the hoist well, removal of requirement for manual movement of shielding box.
[24]. OPG email, A. Palladino to J. Burta, "Confidential – Darlington NGS – CNSC Staff's Notification of Document Changes: Modification Design Requirements for Conversion to Cobalt Adjuster Rods, NK38-MDR-31780-10004 R001", March 28, 2022, CD# NK38-CORR-00531-23373.	Modification Design Requirements for Co-60, NK38-MDR-31780-10004 "Modification Design Requirements for Conversion to Cobalt Adjuster Rods" documents the design requirements to be adhered to during detailed design of the project. The document was revised to revision number R001 to address various changes to requirements as part of the detailed design phase of the project as of October 2020. The changes include updates to requirements to address thermal and radiological conditions and oxide growth introduced by operation of cobalt adjuster rods, removal of integrity assembly requirements with no impact to safety and the present design for liquid sealant was maintained in lieu of a gasket. The revision has no adverse impact to the health, safety and security of persons, environment or the Darlington Nuclear Generating Station.
[25]. OPG email, V. Carter to J. Burta, "Confidential – Darlington NGS – CNSC Staff's Notification of Document Changes: Modification Design Requirements for Conversion to Cobalt Adjuster Rods, NK38-MDR-31780-10004 R002", April 24, 2022, CD# NK38-CORR-00531-23374.	Modification Design Requirements for Co-60, NK38-MDR-31780-10004 "Modification Design Requirements for Conversion to Cobalt Adjuster Rods" documents the design requirements to be adhered to during detailed design of the project. The document was revised to revision number R002 to address various changes to requirements as part of the detailed design phase of the project as of June 2021. The changes include: clarification regarding ability to perform power/reactivity maneuvers, updated adjuster element cable strength requirements, and allowing materials used in existing cobalt adjuster rod design at other nuclear generating station sites. The revision has no adverse impact to the health, safety and security of persons, environment or the Darlington Nuclear Generating Station.
[26]. OPG email, A. Bhardwaj to J. Burta, "Confidential – Darlington NGS – CNSC Staff's Notification of Document Changes: Modification Design Requirements for Conversion	Modification Design Requirements for Co-60, NK38-MDR-31780-10004 "Modification Design Requirements for Conversion to Cobalt Adjuster Rods" documents the design requirements to be adhered to during detailed design of the project. The document was revised to revision

to Cobalt Adjuster Rods, NK38-MDR-31780-10004 R003", October 26, 2022, CD# NK38-CORR-00531-23803.	number R003 to address various changes to requirements as part of the detailed design phase of the project as of June 2022. The changes include removal of select shielding based on radiological assessment, adjustment to shielding material specification, increasing allowable methods for shielding void testing, removal of requirement to support plant configuration for load cycling. The revision has no adverse impact to the health, safety and security of persons, environment or the Darlington Nuclear Generating Station.
[27]. OPG email, A. Bhardwaj to S. Baskey, "Confidential – Darlington NGS – Co-60@DNGS: OPG's Response to CNSC Staff Requests for Information: SA03 – 189DF.2", December 2, 2022, CD# NK38-CORR-00531-23918.	In this correspondence OPG provided responses to CNSC requests for additional information regarding OPG's SA03 submission, as well as additional documents to support the responses. Additional documents included a Cobalt-60 adjuster assembly design report, a design specification for vertical flux deterctor assemblies, design specification for adjuster unit thimble and guide tube extension, a report on the estimated frequency of adjuster rod use at Darlington, and a general arrangement drawing for Type 2 Adjuster rods.
[28]. OPG email, A. Bhardwaj to S. Baskey, "Confidential – Darlington NGS – Co-60@DNGS: OPG Response to CNSC Staff Requests for Information: 2022 CODE CLASS REQUET - Modification to the Units 1, 3 and 4 Reactivity Mechanisms Deck Containment Boundary - 51E2C", December 23, 2022, CD# NK38-CORR-00531-24002.	This correspondence served to provide a response to CNSC staff's request for additional information, in support of CNSC staff's review of the code classification for the Modification to the Units 1, 3 and 4 Reactivity Mechanisms Deck Containment Boundary. Supplemental documents, including a design report and code classification approval forms, were provided to support the code classification justification, as part of the response to CNSC requests.
[29]. OPG letter, R. Geofroy to J. Burta, "Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Request for CNSC Staff's Code Classification Consent for Adjuster Thimbles and Adjuster Cobalt Adapter", May 2, 2022 CD# NK38-CORR-00531-23248.	This correspondence served to request CNSC staff consent of the code classification regarding the Adjuster Cobalt Adapter and Adjuster Thimble. These components are proposed to be classified as "Class 2" per Canadian Standards Association (CSA) N285.0-08 and Update No.2, "General requirements for pressure-retaining systems and components in CANDU nuclear power plants". This code classification is the same as the original code classification of the Adjuster Cobalt Adapter and Adjuster Thimble, and has no impact on the original consequence of failure statement.

[31]. OPG letter, R. Geofroy to J. Burta, “Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Request for CNSC Staff's Code Classification Consent for Modification to the Units 1, 3 and 4 Reactivity Mechanisms Deck Containment Boundary”, October 28, 2022, CD# NK38-CORR-00531-23745.	This correspondence served to request CNSC staff consent of the code classification regarding the Modification to the Units 1, 3 and 4 Reactivity Mechanisms Deck Containment Boundary. These components are proposed to be classified as “Class 4” per Canadian Standards Association (CSA) N285.0-08 and Update No.2, “General requirements for pressure-retaining systems and components in CANDU nuclear power plants”. The classification is requested as there has been a change to loading, there is no physical modification to the containment boundary. This code classification has no impact on the original consequence of failure statement.
[33]. OPG letter, M.R. Knutson to J. Burta and R. Richardson, “OPG Notification of Compliance with the 2018 Edition of CSA Standard N285.5 – Periodic Inspection of CANDU Nuclear Power Plant Containment Components”, April 12, 2022, CD# NCORR-00531-23054.	The purpose of this letter was to notify the CNSC that Darlington Nuclear Generation Station will be compliant with the 2018 edition of CSA Standard N285.5, “Periodic Inspection of CANDU Nuclear Power Plant Containment Components,” by May 2, 2022, and to indicate that the Licence Condition Handbook (LCH) will be updated to reflect the compliance to the 2018 edition as of May 2, 2022.
[34]. OPG letter, S. Gregoris to K. Hazelton, “Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Response to CNSC Staff’s Comments on the Preliminary Engineering Design Documents (D01-01 and D01-02)”, April 30, 2021, CD# NK38-CORR-00531-22516.	This correspondence served to provide a response to CNSC staff’s review of the preliminary engineering design documents. Supplementary documents, including assessment of the Irradiated Fuel Bay Purification Circuit, input files and issue tracking files were provided as part of the response to CNSC requests where applicable. Revised human factors engineering level of effort forms were also provided. A number of the CNSC comments are addressed by documents which are provided separately to CNSC in future submissions.
[35]. OPG email, A. Bhardwaj to S. Baskey, “Confidential – CNSC Staff Requests - Darlington NGS – Co-60@DNGS: Round 2 RP comments from D03 and D01 - A9100”, April 17, 2023, CD# NK38-CORR-00531-24234.	The purpose of this reference was to demonstrate that revision 1 of the report ‘NK38-REP-31780-10055 - Design Radiation Protection Requirements and Design Targets’ was sent to the CNSC subsequent to the original report being sent as part of the Detailed Engineering Design Documents (D03) submission. Revision 1 was prompted by an increase to the size of the radiological control area required around the Reactivity Mechanism Deck during Cobalt Rod withdrawal.

[36]. OPG letter, R. Geofroy to J. Burta, "Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Submission of the Predictive Effects Assessment", April 27, 2022, CD# NK38-CORR-00531-23353.	The purpose of this letter is to submit for CNSC staff's review the Predictive Effects Assessment (PEA), in support of the Cobalt-60 Production Modifications Project at Darlington NGS. Enclosure 1 provides NK38-REP-31930-00001 R000, "Predictive Effects Assessment for the DN Co-60 Production System". The PEA is a predictive Environmental Risk Assessment (ERA) as defined in Canadian Standards Association (CSA) N288.6-12, "Environmental risk assessments at Class I nuclear facilities and uranium mines and mills", which estimates the effects of a contaminant or stressor on an existing environment (e.g. resulting from a new facility or process) prior to its release into the environment. The PEA will supplement the existing Darlington ERA, which has not thus far considered the potential for effects from Cobalt-60 production activity. Overall, the PEA concluded that operation of the Cobalt-60 Production System will not result in any unacceptable risks to human and ecological receptors residing in the vicinity of the Darlington NGS site. The additional emissions of the Cobalt-60 and Mo-99 Production Systems are a small fraction of existing Darlington NGS emissions, and the predicted doses are well below regulatory limits.
[41]. OPG email, A. Bhardwaj to S. Baskey, "Confidential – Darlington NGS – Cobalt-60 Production Modifications Project – Indigenous Engagement Plan", November 9, 2022, CD# NK38-CORR-00531-23812.	The purpose of this email is to provide CNSC staff with the Indigenous Engagement Plan in support of the Cobalt-60 Production Modifications Project at Darlington NGS. Enclosure 1 provides NK38-PLAN-00120-00017-000, "Darlington Cobalt-60 Production Modifications Indigenous Engagement Plan". Attachment 1 provides a copy of the presentation material OPG presented, with Nordion (Canada) Inc. participation, to Curve Lake First Nation in November 2021. Attachment 2 provides a copy of an example of presentation material OPG presented to the Metis Nation of Ontario 8 in August 2022.
[42]. OPG letter, R. Geofroy to A. Mathai, "Darlington NGS – Co-60 Production Modifications Project – Revision of Darlington Irradiated Fuel Bay Analysis Report", November 28, 2023, CD# NK38-CORR-00531-25066	The purpose of this letter is to provide CNSC staff with a revised Darlington Irradiated Fuel Bay (IFB) Analysis Report. The revised analysis report complies with the requirements of REGDOC-2.4.1, *"Deterministic Safety Analysis"* and documents the impact to the safety case for storage of the Co-60 rods in the IFB WCHB. The analysis results demonstrate there is sufficient time for operators to respond to a

	loss of IFB cooling event. The report also concludes that the predicted public airborne doses for all Loss of IFB Cooling events are well below the regulatory dose limits.
[43]. OPG email, L. Moraru to A. Mathai, "Darlington NGS - Response to CNSC Staff Review and Comments Regarding OPG Application for DNGS PROL 13.03/2025 Amendment for Production of the Cobalt-60 Radioisotope - 20A87", November 9, 2023, CD# NK38-CORR-00531-24962	The purpose of this submission is to provide CNSC staff the NK38-REP-31780-10056 R001, "*Darlington Cobalt 60 Production Modification-ALARA Assessment*" which document the results of the evaluation regarding "*Target Delivery System and Cobalt Interaction Radiological Hazard Assessment."* The report concludes that no additional measures were taken for units where the Target Delivery System and Cobalt systems are installed as the collective measured implemented individually for each system was deemed sufficient.
[44]. OPG email, L. Moraru to A. Mathai, "Darlington NGS – Response to CNSC Staff Review and Comments Regarding OPG Application for DNGS PROL 13.03/2025 Amendment for Production of the Cobalt-60 Radioisotope - Appendix B – 20C88", November 22, 2023, CD# NK38-CORR-00531-25065	The purpose of this submission is to provide CNSC staff N-REP-03500-1315507 "*Summary of Darlington Cobalt Adjustor Safety Analyses*" which summarize the process followed to identify operational physics and safety analyses potentially impacted by the replacement of currently used Stainless Steel/Titanium (SS/Ti) Adjuster Absorbers (AA) with cobalt AAs at Darlington Nuclear Generating Station (DNGS) and provides a summary of impact assessments on the Darlington safety case and assurances of safe operation with cobalt AAs within the current SOE limits.
[45]. OPG email, A. Bhardwaj to A. Mathai, "Darlington NGS - Response to CNSC Staff Review and Comments Regarding OPG Application for DNGS PROL 13.03/2025 Amendment for Production of the Cobalt-60 Radioisotope - 20A87", October 26, 2023, CD# NK38-CORR-00531-24952	The purpose of this submission is to provide CNSC staff the following documents: R001 of NK38-CORR-31780-0901715, "*Analysis to Determine Effect of Cobalt Rod Design on Adjuster Unit Drive Controls and RRS Control Logic";* NK38-REP-03100-0936656 R000, "*RRS Assessment of Reactivity Insertion Rates for Cobalt Adjusters";* R001 of NK38-DS-31710-00003, "*RMD with Co-60 Operations Modification Design Specification";* R001 of NK38-DRT-31710-00003, "*RMD with Co-60 Operations Supplemental Design Report";* R001 of NK38-REP-03200-00001, "*Dose Rate Analysis of Darlington Co-60 Adjusters During Normal Operation and Flasking"*.
[46]. OPG letter, R. Geofroy to A. Mathai, "Darlington NGS – Cobalt-60 Production Modifications Project – Request for CNSC Staff's Code Classification Consent for Modification to	The purpose of this letter is to request CNSC staff's code classification consent of the System Classification Lists for modification to the Darlington NGS Unit 2 Reactivity Mechanisms Deck (RMD) containment

the Unit 2 Reactivity Mechanisms Deck Containment Boundary and to Re-route Target Delivery System Class 2 Tubing", September 4, 2023, CD# NK38-CORR-00531-24571	boundary under Master Engineering Change (MEC) 142910 and for modification to re-route Target Delivery System (TDS) Class 2 tubing to avoid interferences under MEC 142912, in support of the Cobalt-60 Production Modifications Project at Darlington NGS. The modification to the Unit 2 RMD involves additional loading transferred to the deck from the TDS and Cobalt-60 shielding components.

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

CD# NK38-CORR-00531-25073

Submission Title: **Darlington NGS – Addendum to the Application for Darlington Nuclear Generating Station Power Reactor Operating Licence 13.03/2025 Amendment for Production of the Cobalt-60 Radioisotope**

Regulatory Commitments (REGC):

No.	Description	Date to be Completed

Regulatory Management Action (REGM): As per Appendix A, Attachment 3.

No.	Description	Date to be Completed
	Various - Appendix A	

Regulatory Obligation Action (REGO):

No.	Description	Date to be Completed
	None	

Concurrence Requested: None