Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

CMD 25-H2.21A

Date: 2025-06-04

Supplementary Information

Presentation from Dr. Frank Greening

In the matter of the

Ontario Power Generation Inc.

Application to renew power reactor operating licence for the Darlington Nuclear Generating Station

Commission Public Hearing Part-2

June 24-26, 2025

Renseignements supplémentaires

Présentation de Dr. Frank Greening

À l'égard d'

Ontario Power Generation Inc.

Demande concernant le renouvellement du permis d'exploitation d'un réacteur de puissance pour la centrale nucléaire de Darlington

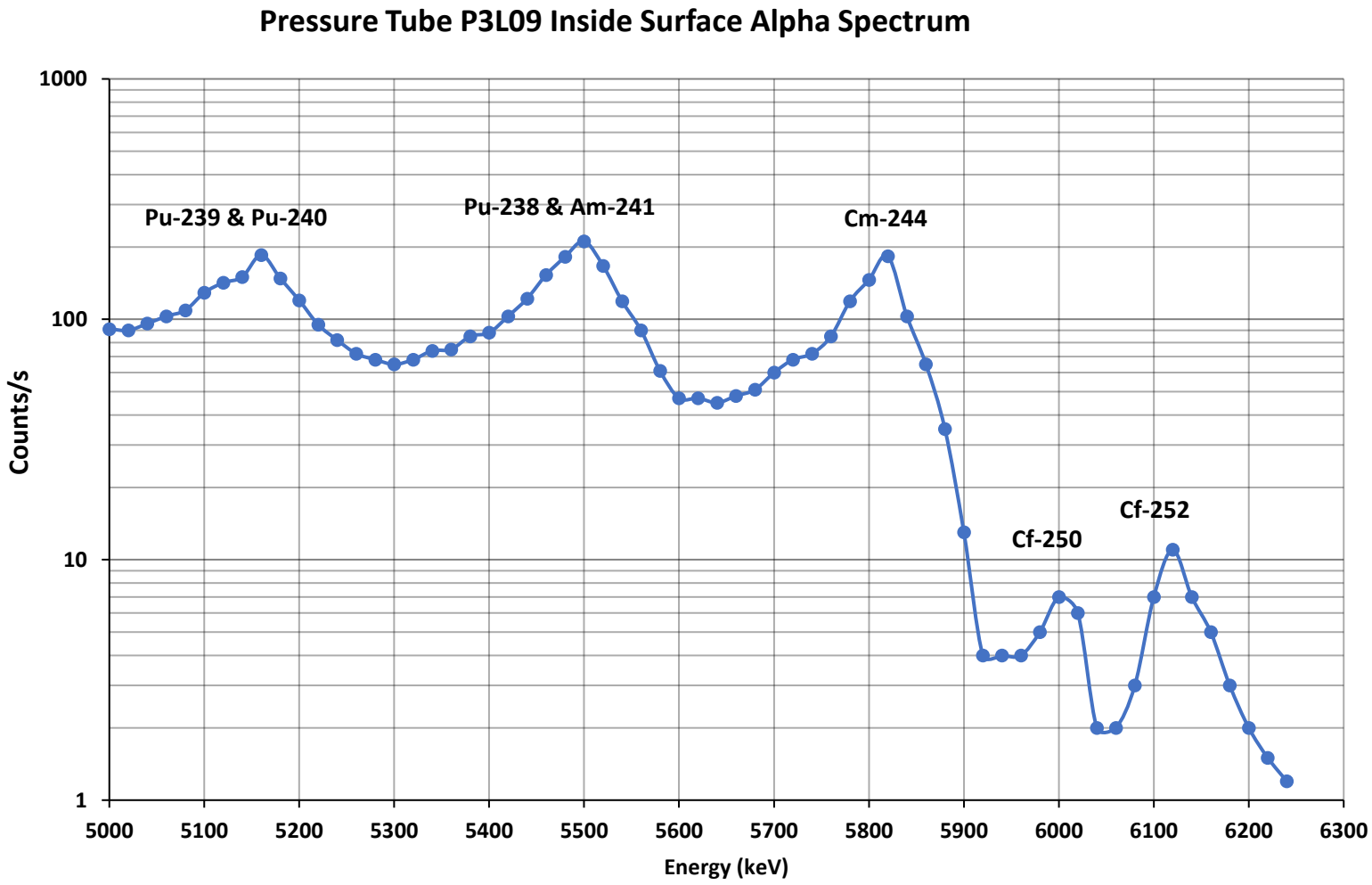
Audience publique de la Commission Partie-2

24-26 juin 2025

Canada

Neutron Emissions from Irradiated Pressure Tubes

F. R. Greening Ph.D.


Pressure Tube P3L09 Inside Surface Alpha Spectrum
1000
100
10
1
Counts/s
Pu-239 & Pu-240
Pu-238 & Am-241
Cm-244
Cf-250
Cf-252
5000
5100
5200
5300
5400
5500
5600
5700
5800
5900
6000
6100
6200
6300
Energy (keV)

Radionuclide	Half-Life	Alpha Energies (keV)	(%)	Decay Factor for 6 years
Cm-242 (α_1)	163 days	6113	74	0.000088
Cm-242 (α_2)		6069	26	
Cf-252 (α_1)	2.65 years	6118	82	0.2082415
Cf-252 (α_2)		6076	15	

Reactor Units	Date	Unmonitored Hazard
Pickering 1 & 2	1985	Carbon-14 Particulate
Point Lepreau	2008	Alpha Particulate
Bruce Unit 2	2009	Iron-55 Particulate
Bruce Unit 1	2010	Alpha Particulate
Darlington Unit 2	2018	Alpha Particulate

CARBON-14 detected on PRESSURE TUBES

*Analysis of **Pickering NGS "A"** Unit 4 N_2 Annulus Gas Filter Deposit.* OHRD Report C81-04-K, (January 1981).

IRON-55 detected on PRESSURE TUBES

*The Characterization of a **Bruce Unit 2** End Fitting Smear.* OHRD Report C92-10-K, (February 1992).

PLUTONIUM, AMERICIUM and CURIUM detected on PRESSURE TUBES

*Analysis of **Bruce NGS "A"** Particulate Samples Collected Nov/'79, Feb/'80 and April/'80.* OHRD Report 80-234-K, (June 1980).

NEUTRON EMITTERS detected on PRESSURE TUBES

*Cm-244 Contributions to the Alpha Source Term of **CANDU Reactors**.* Kerntechnik Volume 86, pages 106 – 115, (2021)

Canadian Nuclear Safety Commission | Commission canadienne de sûreté nucléaire

CMD 19-M7.1

Date: 2019-01-28
File / dossier : 6.02.04
Edocs pdf : 5772701

Submission from Ontario Power Generation

Mémoire d'Ontario Power Generation

In the Matter of

À l'égard de

Darlington Nuclear Generation Station: Update on Alpha Contamination Event

Centrale nucléaire de Darlington : Mise à jour sur l'événement de contamination alpha

Action Item from November 8, 2018 Commission Meeting

Mesure de suivi de la réunion de la Commission du 8 novembre 2018

Commission Meeting

Réunion de la Commission

Written Intervention for the 2015 Darlington Relicensing Public Hearings

(Ref: 2015-H-04) Submitted by: Dr. Frank Greening

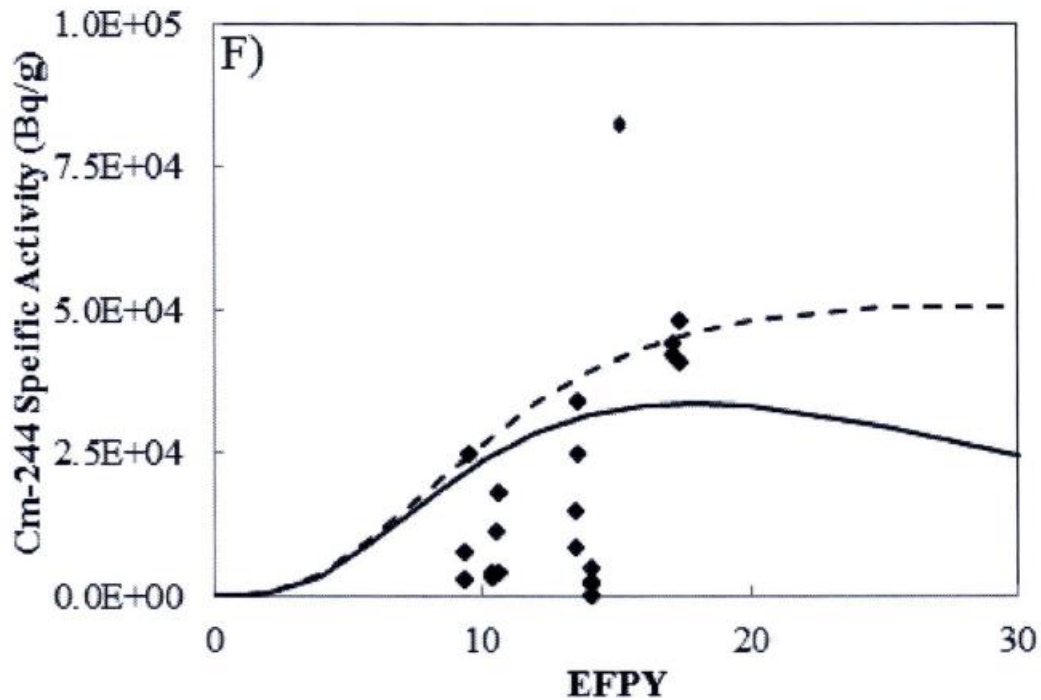
The CNSC needs to recognize that the refurbishment of a large CANDU reactor creates a heightened potential to expose workers to radiological hazards that are not present during the day-to-day operation of a reactor.

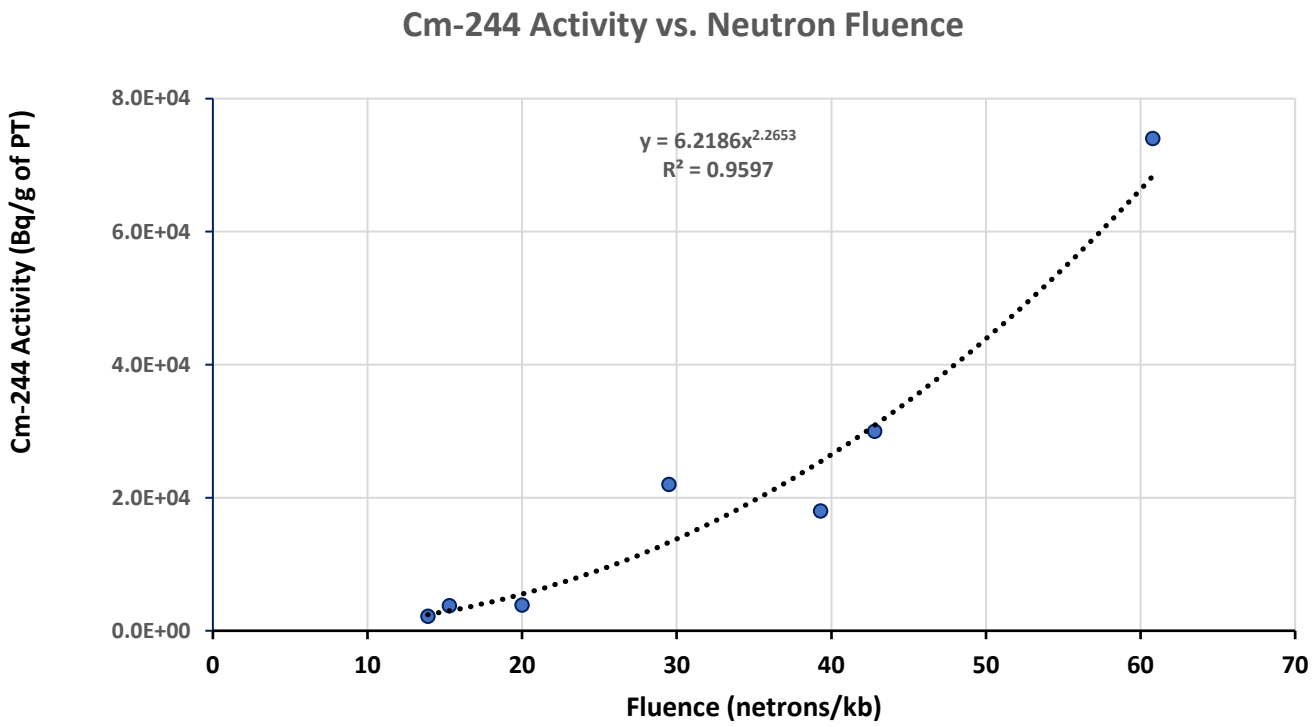
The CNSC needs to evaluate the following issues concerning the refurbishment of Darlington Units 1 to 4:

1. The alpha source term for all four Darlington Units

2. Radiation field data for all four Darlington Units

3. The training that will be given to Darlington refurbishment workers

(vi) Does OPG have reliable measurements of *the inventory of Cm-244* in its pressure tube wastes?	OPG has an active waste characterization program, including pressure tube measurements and Darlington End Fitting and Liner Tube data. A partial summary of the CANDU pressure tube data analysis was published (3rd Canadian Conference on Nuclear Waste Management, Decommissioning and Environmental Restoration Ottawa Marriott Hotel, Ottawa, ON, Canada, September 11-14, 2016. Measurements, from several CANDU units, indicate that Cm-244 is present in significant amounts in pressure tube material. OPG continues to conduct measurements to increase the extent of its waste characterization database. The included graphic shows a general distribution of Cm-244 specific activity vs Equivalent Full Power Years for various CANDU units. 


Cm-244 Activity vs. Neutron Fluence
y = 6.2186x^2.2653
R² = 0.9597
Cm-244 Activity (Bq/g of PT)
8.0E+04
6.0E+04
4.0E+04
2.0E+04
0.0E+00
0
10
20
30
40
50
60
70
Fluence (netrons/kb)

Bruce Unit 7 Neutron Shielding for Lu-177 Irradiations

Boron-Filled Polyethylene Neutron Shield

Container for transportation of 0.15g of californium-252

/r/ALL