ONTARIO POWER GENERATION

Environmental Emissions Data for Nuclear Waste Management – Bruce Site

Q4 2022

OVERVIEW

This report summarizes the environmental emissions data for Q4 2022 for OPG's Nuclear Waste Management operations located at the Bruce Nuclear Power Development site in Bruce County. OPG's Western Waste Management Facility (WWMF) stores low and intermediate level radioactive waste from the operation of OPG and Bruce Power nuclear reactors. The low level waste is stored as is, compacted or incinerated. The facility also provides used fuel dry storage for the Bruce Power reactors. OPG's Radioactive Waste Operations Site 1 (RWOS 1) stores low and intermediate level radioactive waste.

This report includes:

- Radioactive Effluents: Releases to air and water remained well below the regulatory limits.
- Groundwater Monitoring: OPG continued to analyze groundwater results to examine trends.
- Waste Incinerator: Emissions testing results confirmed compliance with air quality standards.
- Spills to the Environment: There were no spills to the environment that were reportable to a regulatory authority.

Note: The contents of this report are consistent with environmental data OPG is required to provide to the Canadian Nuclear Safety Commission (CNSC) on a quarterly basis. These reporting requirements are periodically revised.

ENVIRONMENTAL EMISSIONS MANAGEMENT

OPG has an environmental management program to ensure its activities are conducted in a manner that minimizes any adverse impact on the public and the environment. OPG's environmental program conforms to CNSC requirements for environmental protection and the International Organization for Standardization (ISO) standard for environmental management systems. The quality assurance programs for OPG's chemistry and health physics laboratories conform to the requirements of national and international standards.

As part of OPG's environmental management program, OPG has established an effluent monitoring and control program that is based on the "ALARA" principle. That is, measures are in place to ensure emissions to the environment are kept As Low As Reasonably Achievable while taking social and economic factors into account.

Public Radiation Dose Data

Annual environmental monitoring program results for Nuclear Waste Management site, including an assessment of radiation dose to the public and protection of the environment, are available at: *www.opg.com/news-and-media/Pages/reports.aspx*

Annual assessments of environmental radiological data for the Bruce Nuclear Power Development site, including OPG's waste facilities, are available at: *www.brucepower.com/resources-and-publications/reports*

MONITORING OF RADIOACTIVE EFFLUENTS

Release Limits & Action Levels

OPG uses radiation dose limits specified in federal legislation to derive Release Limits for the radionuclides that may be released to air and water from its nuclear facilities. OPG's WWMF must maintain its radiological emissions well below these limits to meet the terms of its operating licence. OPG also sets Action Levels that are much lower than the Release Limits to identify and control emissions before a limit can be reached.

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AIR EMISSIONS

Emissions from the WWMF are monitored to track performance. For Q4 2022, radiological emissions to air remained well below the Release Limits and no Action Levels were exceeded (Appendix A, Table A.1).

WATER EMISSIONS

Water removed from the WWMF storage structures and building sumps is transferred to Bruce Power Active Liquid Waste (ALW) system, and is accounted for in that station's emissions.

GROUNDWATER MONITORING

Groundwater monitoring wells are sampled semi-annually in Q2 and Q4 of every year, and the subsurface drainage is monitored monthly. The monitoring data of these sampling locations are available in the environmental emissions data reports (Appendix A, Tables A.2, A.3 and A.4).

WASTE INCINERATOR EMISSIONS TESTING

The results of annual emissions testing performed at the Waste Volume Reduction Facility in 2022 indicated the facility is in compliance with Ontario air quality standards. (Appendix A, Table A.5)

SPILLS TO THE ENVIRONMENT

OPG has extensive programs to ensure the risk of spills to the environment is effectively assessed and managed. All spills are reported by OPG to the appropriate federal, provincial and municipal authorities as required.

There were no reportable spills at the Nuclear Waste Management site in Q4 2022.

APPENDIX A

ENVIRONMENTAL EMISSIONS DATA

Environmental Emissions Data for Nuclear Waste Management – Bruce Site

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Table A.1: WWMF Airborne Radionuclide Releases[a]

	Tritium Oxide (Bq)	Particulate (Bq)	Iodine-131 (Bq)	Carbon-14[b] (Bq)
SUMMARY: ANNUAL				
Release Limit (Bq/year)[c]	3.45×10^{17}	6.65×10^{11}	1.99×10^{12}	2.41×10^{15}
Total Releases As of Q4 2022	1.4×10^{13}	0	5.3×10^{3}	5.2×10^{9}
DETAILS: QUARTERLY[d]				
Action Level (Bq/week)[e]	6.91×10^{14}	1.33×10^{9}	3.98×10^{9}	4.82×10^{12}
Q1	3.0×10^{12}	0	1.9×10^{3}	8.0×10^{8}
Q2	3.4×10^{12}	0	2.1×10^{3}	5.6×10^{8}
Q3	3.3×10^{12}	0	5.5×10^{2}	1.8×10^{9}
Q4	4.5×10^{12}	0	7.2×10^{2}	2.0×10^{9}

(a) The Waste Volume Reduction Building radioactive waste incinerator stack and ventilation exhaust stack are monitored for tritium, particulate, and iodine-131 emissions. The incinerator stack is also monitored for carbon-14 emissions. The Transportation Package Maintenance Building ventilation stack is monitored for tritium and particulate emissions. The Used Fuel Dry Storage Facility ventilation stack is monitored for particulate emissions.

(b) Carbon-14 emissions are impacted by the in-service time of the incinerator. OPG has completed the effluent monitoring assessment of C-14 emissions waste storage and is in the process of reviewing the impact on C-14 emission data.

(c) The derived Release Limit for a given radionuclide is the release rate of that radionuclide to air during normal operation of a nuclear facility over the period of a calendar year, which would result in an individual receiving a dose equal to the regulatory annual dose limit for a member of the public.

(d) Releases have been summarized by quarter for this report.

(e) Exceedances of Action Levels must be reported by OPG to the CNSC. To prevent an Action Level from being reached, OPG has set Internal Investigation Levels that require emissions to be reviewed when they reach the high end of the normal range. Corrective actions are taken if necessary. There were no CNSC Action Level exceedance events in the fourth quarter of 2022.

A becquerel (Bq) is the standard international unit for measuring radioactive decay or radioactivity. One becquerel is the decay of one atom of a radioisotope per second, and is an extremely small amount of radioactivity. Becquerel is a measure of the rate (not energy) of radiation emission from a source.

Another unit of measuring radioactivity is the curie (Ci). 1 Ci = 3.7×10^{10} Bq.

Table A.2: Radioactive Waste Operations Site 1 Groundwater Monitoring Results

		Tritium (Bq/L)	Gross Beta (Bq/L)
WSH 122	Q2	2.28×10^{2}	N/A
	Q4	1.22×10^{2}	N/A
WSH 123	Q2	6.98×10^{2}	N/A
	Q4	1.43×10^{3}	N/A
WSH 124	Q2	1.60×10^{2}	N/A
	Q4	1.71×10^{2}	N/A
WSH 125	Q2	1.34×10^{2}	N/A
	Q4	1.33×10^{2}	N/A
WSH 126	Q2	1.38×10^{2}	N/A
	Q4	1.49×10^{2}	N/A
DD (N)[(b)]	January	1.82×10^{2}	1.38×10^{-1}
	February	1.93×10^{2}	1.29×10^{-1}
	March	1.93×10^{2}	7.52×10^{-2}
	April	1.87×10^{2}	1.42×10^{-1}
	May	2.38×10^{2}	8.77×10^{-2}
	June	2.32×10^{2}	8.91×10^{-2}
	July	2.43×10^{2}	1.88×10^{-1}
	August	2.21×10^{2}	8.17×10^{-2}
	September	2.19×10^{2}	1.25×10^{-1}
	October	2.41×10^{2}	1.14×10^{-1}
	November	2.17×10^{2}	1.51×10^{-1}
	December	2.63×10^{2}	1.62×10^{-1}
DD (S)[(b)]	January	2.24×10^{2}	7.05×10^{-2}
	February	1.65×10^{2}	1.12×10^{-1}
	March	1.98×10^{2}	6.61×10^{-2}
	April	2.02×10^{2}	1.29×10^{-1}
	May	2.77×10^{2}	7.55×10^{-2}
	June	2.54×10^{2}	5.28×10^{-2}
	July	2.61×10^{2}	1.14×10^{-1}
	August	2.50×10^{2}	8.81×10^{-2}
	September	No Sample – Ditch was dry	No Sample – Ditch was dry
	October	2.59×10^{2}	1.01×10^{-1}
	November	2.03×10^{2}	1.39×10^{-1}
	December	2.03×10^{2}	4.42×10^{-2}

(a) Values prefixed by an "<" indicate that reported results were less than the minimum detectable limit.

(b) Discharge Ditches (DD) are surface water sampling points and are sampled monthly.

Table A.3: WWMF Groundwater Monitoring Results

As per regulatory requirements, Section 4 of CNSC REGDOCS-3.1.3, *Reporting Requirements for Waste Nuclear Substance Licensees, Class II Nuclear Facilities and Users of Prescribed Equipment, Nuclear Substances and Radiation Devices,* RWOS-1 data will now be reported annually in Q4 in the Annual Compliance Monitoring Report.

	Tritium (Bq/L)	
	Q2	Q4
WSH 224	N/A	5.22×10^{1}
WSH 226	9.13×10^{0}	9.67×10^{0}
WSH 228	1.59×10^{2}	1.56×10^{2}
WSH 229	1.29×10^{3}	8.78×10^{2}
WSH 230	6.56×10^{2}	6.78×10^{2}
WSH 231	9.26×10^{3}	9.39×10^{3}
WSH 232	N/A	8.40×10^{0}
WSH 237	N/A	1.07×10^{1}
WSH 238	N/A	1.06×10^{0}
WSH 239	N/A	1.05×10^{1}
WSH 240	1.02×10^{1}	1.03×10^{1}
WSH 242	4.85×10^{1}	3.90×10^{1}
WSH 243	2.70×10^{2}	2.80×10^{2}
WSH 244	N/A	4.14×10^{1}
WSH 245	N/A	8.34×10^{0}
WSH 249	N/A	8.29×10^{0}
WSH 251	N/A	1.68×10^{3}
WSH 252	N/A	1.76×10^{4}
WSH 253	2.11×10^{4}	2.33×10^{4}
WSH 255	3.11×10^{3}	2.49×10^{3}
WSH 256	N/A	2.79×10^{3}
WSH 257	N/A	3.49×10^{3}
WSH 259	N/A	1.11×10^{3}
WSH 260	N/A	1.67×10^{1}
WSH 263	N/A	5.62×10^{1}
WSH 264	N/A	5.36×10^{1}
WSH 265	4.28×10^{2}	5.03×10^{2}
WSH 267	N/A	8.21×10^{0}
WSH 268	N/A	9.98×10^{0}
WSH 269	5.44×10^{2}	4.53×10^{2}
WSH 270	N/A	8.48×10^{0}
WSH 272	N/A	2.95×10^{2}
WSH 275	N/A	8.40×10^{0}
WSH 276	2.36×10^{1}	1.13×10^{1}
WSH 277	N/A	3.11×10^{2}
WSH 278	N/A	3.62×10^{1}

	Tritium (Bq/L)	
	Q2	Q4
WSH 279		1.74×10^2
WSH 282	6.93×10^2	6.00×10^2
WSH 283	1.12×10^2	1.20×10^2
WSH 284	3.39×10^2	3.58×10^2
WSH 285	2.99×10^2	4.23×10^2
WSH 286	2.69×10^2	3.16×10^2
WSH 287	2.87×10^2	3.16×10^2
WSH 301	N/A	9.62×10^0
WSH 302	N/A	9.88×10^0
WSH 307	N/A	9.58×10^0
DGRB12	N/A	1.10×10^2
DGRB12A	N/A	9.41×10^0
DGRB14	N/A	4.86×10^1

Table A.4: WWMF Subsurface Monitoring Results

Month	Tritium (Bq/L)				
	WWMF SS1	WWMF SS2	WWMF SS3	WWMF SS4B	WWMF SS6
January	1.26×10^3	1.09×10^3	1.42×10^3	1.74×10^4	4.33×10^3
February	1.29×10^3	1.01×10^3	1.41×10^3	2.44×10^4	1.27×10^3
March	7.94×10^2	1.09×10^3	1.83×10^3	2.28×10^4	3.69×10^3
April	1.76×10^3	1.95×10^3	1.38×10^4	5.17×10^3	1.76×10^3
May	1.14×10^3	1.98×10^3	1.15×10^4	6.73×10^3	1.14×10^3
June	1.13×10^3	4.63×10^3	1.57×10^4	5.66×10^3	1.13×10^3
July	1.35×10^3	1.53×10^3	1.82×10^3	1.50×10^4	4.06×10^3
August	1.32×10^3	1.33×10^3	4.90×10^2	1.16×10^4	6.11×10^3
September	1.32×10^3	1.05×10^3	7.72×10^2	1.56×10^4	5.20×10^3
October	1.28×10^3	1.04×10^3	9.75×10^2	1.51×10^4	4.09×10^3
November	1.28×10^3	1.10×10^3	2.26×10^3	1.53×10^4	4.53×10^3
December	1.35×10^3	1.12×10^3	2.04×10^3	1.39×10^4	5.55×10^3

Table A.5: Nuclear Sustainability Services - Western Incinerator Facility Point of Impingement (POI) Assessment Summary [(a)]

Compound of Concern	Emission Rate	Calculated POI Concentration	Applicable POI Standard	Compliance Assessment
		24 hour basis (except where noted)	24 hour basis (except where noted)	% of Limit
	g/s	µg/m³	µg/m³	
PM	2.87E-04	1.74E-02	120	1E-2
Carbon Monoxide	8.8E-04	1.61E-01 (1/2-hour)	6,000 (1/2-hour)	3E-03 (1/2-hour)

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Compound of Concern	Emission Rate	Calculated POI Concentration	Applicable POI Standard	Compliance Assessment
		24 hour basis (except where noted)	24 hour basis (except where noted)	% of Limit
	g/s	µg/m³	µg/m³	
Sulphur Dioxide	0.0	0	275	0
		0 (1-hour)	690 (1-hour)	0 (1-hour)
Nitrogen Oxides	5.71E-02	3.45E0	200	1.72
		8.77E0 (1-hour)	400 (1-hour)	2.19 (1-hour)
HCl	4.24E-03	0.26	20	1.29
D&F (TEQ)	8.16E-12	4.93E-10	1.00E-07	4.9E-01
		1.50E-09 (1/2-hour)	**15 (1/2-hour)**	1E-08 (1/2-hour)
Total PCB's	1.38E-08	8.32E-07	*0.15*	*5.55E-04*
Naphthalene	4.05E-07	2.44E-05	*22.5*	*1.09E-04*
		7.46E-05 (1/2 -hr)	**36 (1/2-hour)**	2.07E-04 (1/2-hr)
Benzo(a)pyrene	*4.32E-08*	4.70E-07 (annual)	0.00001 (annual)	*4.7* (annual)
		2.61E-06	0.005	5.2E-2
Acetaldehyde	*1.28E-04*	7.73E-03	500	*2E-03*
		2.36E-02 (1/2-hour)	500 (1/2-hour)	*5E-03* (1/2-hour)
Formaldehyde	*1.28E-04*	7.73E-03	65	1E-02
Phenol	*2.43E-04*	1.47E-02	30	*5E-02*
Acrolein	*1.28E-04*	7.73E-03	0.4	*2.0*
		1.97E-02 (1-hour)	4.5 (1-hour)	*4E-01* (1-hour)
Benzene	6.23E-06	6.78E-05 (annual)	0.45 (annual)	2E-02
Methyl Ethyl Ketone (2-Butanone)	*1.86E-06*	*6.87E-05*	1,000	*1E-05*
Vinyl Chloride (chloroethene)	*1.87E-06*	*1.13E-04*	1	*1.13E-02*
Ethylbenzene	1.86E-06	1.12E-04	1,000	1E-05
Styrene	1.86E-06	1.12E-04	400	*3E-05*
Tetrachloro-ethylene	1.86E-06	1.12E-04	360	*9E-04*
Toluene	1.86E-06	1.12E-04	*2,000*	*6E-06*
Trichloroethane, 1,1,1	1.86E-06	1.12E-04	115,000	1E-07
Trichloroethene (trichloroethylene)	1.86E-06	1.12E-04	12	*9E-04*
Xylene [b]	3.72E-06	2.55E-04	730 (sum of all xylenes)	3E-05
Arsenic	*1.46E-07*	*8.84E-06*	*0.3*	*3E-03*
Barium	7.87E-06	4.75E-04	*10*	*5E-03*
Beryllium	*3.29E-08*	*1.99E-06*	0.01	2E-02
Cadmium	1.04E-06	6.27E-05	0.025	2.5E-01
Chromium	7.53E-07	4.55E-04	0.5	9E-03
Copper	6.24E-07	3.77E-04	50	1E-04
Lead	1.78E-07	1.08E-05	0.5	2E-03

Compound of Concern	Emission Rate	Calculated POI Concentration	Applicable POI Standard	Compliance Assessment
		24 hour basis (except where noted)	24 hour basis (except where noted)	% of Limit
	g/s	µg/m³	µg/m³	
Manganese	5.74E-06	3.47E-04	0.4	9E-02
Mercury	*1.99E-07*	1.20E-05	2	6E-04
Nickel	4.10E-07	4.46E-06 (annual)	0.04 (annual)	1E-02 (annual)
Silver	*4.39E-08*	2.65E-06	1	*3E-04*
Zinc	5.62E-06	3.4E-04	120	3E-04

***Bold text indicates ECA prescribed limits*.**

Underlined italics indicate compound emissions less than reporting limits.

Shaded italics indicate **Guideline** POI concentrations.

(a) The results of an emission testing program performed in October 2022 indicated the Nuclear Sustainability Services - Western Waste Volume Reduction Facility was operating well within compliance for all Ontario Environmental Protection Act, Ontario Regulation 419/05 standards and point of impingement guidelines based on ground level point of impingement concentrations. This testing is required annually to meet Ontario Ministry of the Environment, Conservation and Parks Environmental Compliance Approval requirements.

(b) Only m/p-Xylene was detected in the samples and it was used in this table (o-Xylene was below the detection limit).