ONTARIO POWER GENERATION

Environmental Emissions Data for Nuclear Waste Management - Bruce Site

Q3 2017

OVERVIEW

This report summarizes the environmental emissions data for Q3 2017 for OPG's Nuclear Waste Management operations located at the Bruce Nuclear Power Development site in Bruce County. OPG's Western Waste Management Facility 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 stores low and intermediate level radioactive waste.

This report includes:

- Radioactive Effluents: Releases to air and water were less than one per cent of the regulatory limits.
- Perimeter Dose Rate Monitoring: Results demonstrate radiation exposures were within the regulatory limit.
- 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 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 Western Waste Management Facility 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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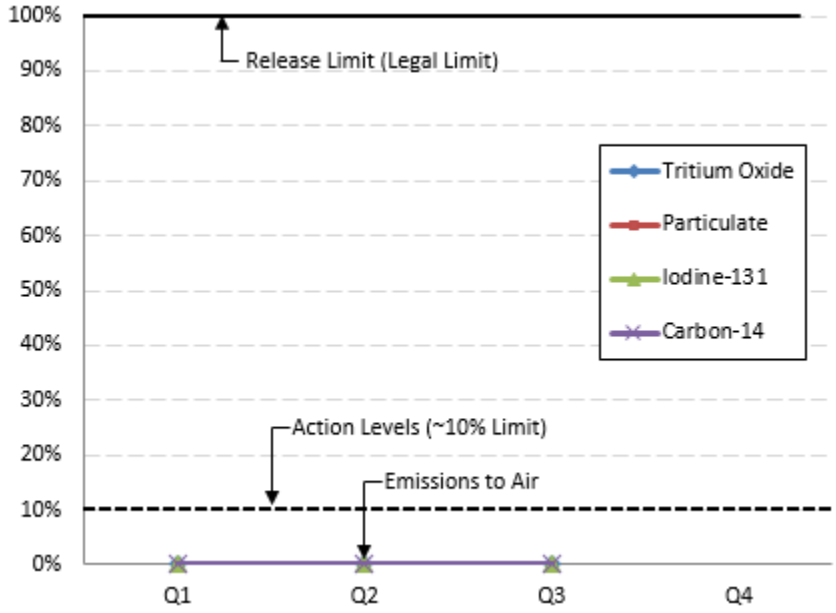
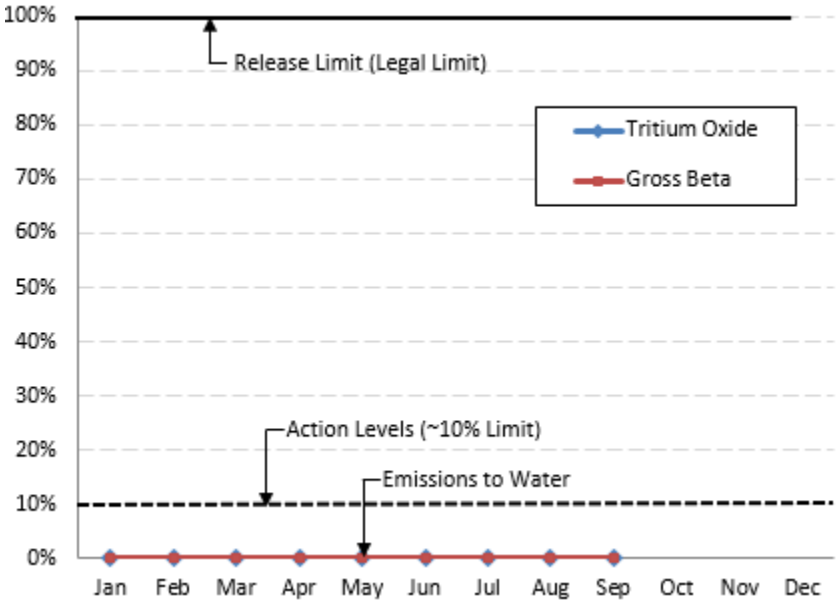
Performance Results

Emissions from the Western Waste Management Facility are monitored to track performance. For Q3 2017, radiological emissions to air and water remained less than one per cent of the Release Limits and no Action Levels were exceeded. (Appendix A, Tables A.1 and A.2) The following graphs show radiological emissions for the year to date as a percentage of the Release Limits.

Air Emissions as a Per Cent of Release Limits



Water Emissions as a Per Cent of Release Limits



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PERIMETER DOSE RATE MONITORING

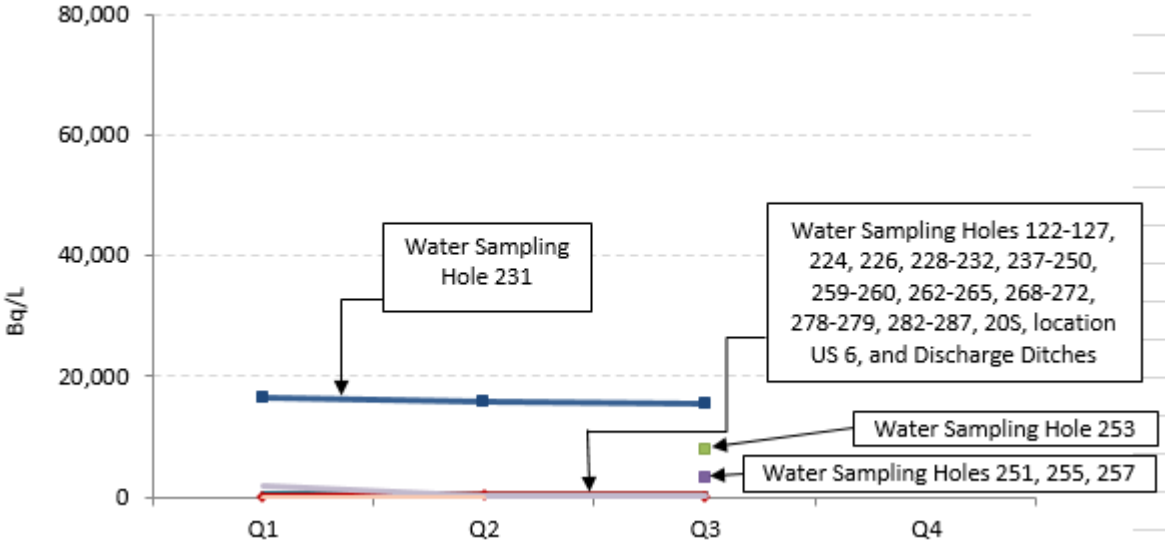
Average ambient dose rates are measured at perimeter fences by Thermoluminescent Dosimeters to demonstrate that radiation exposures to non-Nuclear Energy Workers and members of the public are as low as reasonably achievable. (Appendix A, Table A.3)

GROUNDWATER MONITORING

Groundwater monitoring is conducted in and around the Western Waste Management Facility and the Radioactive Waste Operations Site 1 waste storage structures to analyze water quality. Recommendations to the Western Waste Management Facility groundwater sampling and analytical program have been implemented in this quarter. Additional groundwater sampling locations, monitoring results and change of sampling frequency have been reflected. (Appendix A, Tables A.4, A.5 and A.6) The following graph shows average quarterly and annual tritium concentration results for the year to date. Tritium concentrations at Water Sampling Hole (WSH) 231 remain elevated but show a decreasing trend since 2010, with seasonal variation.

There are no regulatory limits associated with the concentrations of radionuclides in industrial groundwater monitoring wells. Water from OPG's monitoring wells is not used for drinking water purposes.

Groundwater Monitoring Tritium Concentration Results



WASTE INCINERATOR EMISSIONS TESTING

The results of annual emissions testing performed at the Waste Volume Reduction Facility in 2016 indicated the facility is in compliance with Ontario air quality standards. (Appendix A, Table A.7)

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.

OPG classifies its reportable spills as Category A, B or C spills based on the actual or potential impacts. Category A spills are considered very serious due to the scale of injury or damage, health effects, or safety impairment.

Category B spills are considered serious due to localized injury or impacts to property. Category C spills are all other reportable spills that are less serious than Category A and B spills.

There were no reportable spills at the Nuclear Waste Management site in Q3 2017.

APPENDIX A

ENVIRONMENTAL EMISSIONS DATA

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Table A.1: Airborne Radionuclide Releases[a]

	Tritium Oxide (Bq)	Particulate (Bq)	Iodine-131 (Bq)	Carbon-14[b] (Bq)
SUMMARY: ANNUAL				
Release Limit (Bq/year)[c]	2.96×10^{17}	2.34×10^{12}	1.90×10^{12}	1.09×10^{15}
Total Releases As of Q3 2017	1.06×10^{13}	4.52×10^{3}	1.04×10^{5}	2.70×10^{9}
DETAILS: QUARTERLY[d]				
Action Level (Bq/week)[e]	5.9×10^{14}	4.7×10^{9}	3.79×10^{9}	2.17×10^{12}
Q1[f]	6.11×10^{12}	0	3.79×10^{4}	1.63×10^{9}
Q2[f]	2.97×10^{12}	0	3.29×10^{4}	8.07×10^{8}
Q3	1.55×10^{12}	4.52×10^{3}	3.29×10^{4}	2.58×10^{8}

(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.

(c) The derived Release Limit for a given radionuclide is the release rate of that radionuclide to air or surface water 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 third quarter of 2017.

(f) Particulate emissions were zero for the quarter as only naturally occurring radionuclide material was detected.

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: Waterborne Radionuclide Releases[a]

	Tritium Oxide (Bq)	Gross Beta-Gamma (Bq)[b]
SUMMARY: ANNUAL		
Release Limit (Bq/year)[c]	7.70×10^{15}	4.56×10^{11}
Total Releases as of Q3 2017	2.10×10^{11}	2.63×10^{8}
DETAILS: MONTHLY		
Action Level (Bq/month)[d]	6.2×10^{13}	3.6×10^{9}
January	3.11×10^{10}	1.02×10^{8}
February	2.57×10^{10}	1.09×10^{8}
March	2.15×10^{10}	2.72×10^{7}
April	2.20×10^{10}	7.28×10^{6}
May	1.93×10^{10}	4.61×10^{6}
June	1.97×10^{10}	3.43×10^{6}
July	2.69×10^{10}	2.38×10^{6}
August	2.70×10^{10}	3.61×10^{6}
September	1.70×10^{10}	3.20×10^{6}

(a) Various surface and sub-surface water drainage systems service the Western Waste Management Facility. Water is collected at sample stations and is monitored for radioactivity before the water is released to surface water drainage. The weekly samples taken from each sample station are analyzed for tritium and gross beta activity. The results of the individual sample stations are combined and reported as a total emission from the Western Waste Management Facility.
(b) Monthly release data is gross beta.
(c) The derived Release Limit for a given radionuclide is the release rate of that radionuclide to air or surface water 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) 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 third quarter of 2017.

Table A.3: Perimeter Fence Dose Rates

		Average Air Kerma Rate (µGy/hour)[a]
Location		**Q3**
Radioactive Waste Operations Site 1	1	0.050
	1A	0.053
	2	0.051
	2A	0.050
	3	0.048
	4	0.049

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Location		Average Air Kerma Rate (µGy/hour)[a] Q3
	4A	0.052
Western Low and Intermediate Level Waste Storage Facility	5	0.044
	8	0.059
	10	0.045
	11	0.043
	12	0.050
	15	0.057
	16	0.060
	17	0.058
	18	0.057
	19	0.056
	20	0.057
	21	0.056
	22	0.053
	23	0.058
	24	0.056
	25	0.056
	26	0.069
	27	0.071
	28	0.092
	29	0.063
Western Used Fuel Dry Storage Facility	DFSN-1	0.077
	DFSN-2	0.084
	DFSN-3	0.079
	DFSN-4	0.057
	DFSS-1	0.062
	DFSS-2	0.064
	DFSS-3	0.067
	DFSS-4	0.062
	DFSE-1	0.061
	DFSE-2	0.082
	DFSE-3	0.080
	DFSE-4	0.028
	DFSW-1	0.086
	DFSW-2	0.076
	DFSW-3	0.076
	DFSW-4	0.054

(a) Average ambient dose rates are measured at perimeter fences by Thermoluminescent Dosimeters to demonstrate that potential doses due to radiation fields from waste management facility operations are well within allowable limits and pose a negligible risk for the public, the workers and the environment. Dose rate monitoring results are compared to an internal target dose rate standard of 0.5 µGy/hour. This target is derived from the 1 mSv/year dose limit specified in federal legislation for a member of the public and assumes exposure for a working year (2,000 hours).

Table A.4: Radioactive Waste Operations Site 1 Groundwater Monitoring Results

		Tritium (Bq/L)	Gross Beta (Bq/L)	Carbon 14 (Bq/L) [a]
		Q3	Q3	Q3
WSH 122		197	0.12	<0.1
WSH 123		566	0.10	<0.1
WSH 20S		300	0.11	<0.1
WSH 124		147	0.13	<0.1
WSH 125		151	0.14	<0.1
WSH 126		140	0.14	<0.1
WSH 127		114	0.10	<0.1
DD (N)[b]	July	191	0.11	N/A
	August	185	0.17	N/A
	September	254	0.18	N/A
DD (S)[b]	July	143	0.13	N/A
	August	180	0.16	N/A
	September	184	0.20	N/A

(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.5: Western Waste Management Facility Groundwater Monitoring Results

		Tritium (Bq/L)	Gross Beta (Bq/L)	Carbon 14 (Bq/L)[a]
		Q3	Q3	Q3
WSH 226		21.3	0.17	<0.1
WSH 228		102	0.13	<0.1
WSH 229		570	0.14	<0.1
WSH 230		424	0.14	<0.1
WSH 231[b]	July	1.55×10^4	0.11	N/A
		1.55×10^4	0.16	N/A
	August	1.56×10^4	0.20	N/A
	September	1.53×10^4	0.18	N/A
WSH 240		21.3	0.17	<0.1
WSH 242		33	0.15	N/A
WSH 243		282	0.18	<0.1
WSH 253[b]		8330	0.33	N/A
WSH 255[b]		3360	0.18	N/A
WSH 264		29.5	0.16	<0.1
WSH 265		575	0.33	<0.1
WSH 269		325	6.23	N/A
WSH 282		615	0.74	<0.1
WSH 283		130	0.70	<0.1

	Tritium (Bq/L)	Gross Beta (Bq/L)	Carbon 14 (Bq/L)[a]
	Q3	Q3	Q3
WSH 284	416	0.58	<0.1
WSH 285	281	0.27	0.27
WSH 286	275	0.97	<0.1
WSH 287	21.3	0.12	<0.1

(a) Values prefixed by an "<" indicate that reported results were less than the minimum detectable limit.
(b) Water Sampling Holes are sampled on a quarterly basis, except for WSH 231 which is sampled bi-weekly and monthly starting in August 2017. It has been determined the source of the tritium at WSH 231 is evaporated water from waste in the Low Level Storage Buildings, which has likely migrated as condensate via underground electrical infrastructure. Various mitigating measures have been taken and the tritium concentration at WSH 231 shows a decreasing trend, with seasonal variations. WSH 251, WSH 253, WSH 255 and WSH 257 were incorporated into the groundwater monitoring program in 2017 and are used to monitor the extent of the tritium migration. The tritium is unlikely to have a measurable impact on the water quality of Lake Huron.

Table A.6: Western Waste Management Facility Annual Groundwater Monitoring Results[a]

	Tritium (Bq/L)	Gross Beta (Bq/L)	Carbon 14 (Bq/L)[b]
WSH 224	32.5	0.15	<0.1
WSH 232	22.4	0.13	<0.1
WSH 237	21.8	0.53	<0.1
WSH 238	21.8	0.53	<0.1
WSH 239	163	0.16	<0.1
WSH 244	20.7	0.16	N/A
WSH 245	21.3	0.14	N/A
WSH 247	21.3	0.37	N/A
WSH 249	20.7	0.23	N/A
WSH 250	179	0.17	<0.1
WSH 251[c]	3490	0.17	N/A
WSH 257[c]	2670	0.22	N/A
WSH 259	808	0.25	N/A
WSH 260	116	0.15	N/A
WSH 262	26.5	0.14	<0.1
WSH 263	243	0.65	N/A
WSH 268	21.8	0.10	N/A
WSH 270	21.8	0.11	N/A
WSH 271	21.8	0.30	N/A
WSH 272	242	0.13	N/A
WSH 278	28.5	0.16	N/A
WSH 279	198	0.13	N/A

(a) Annual samples were taken in Q3 of 2017.
(b) Values prefixed by an "<" indicate that reported results were less than the minimum detectable limit.
(c) Refer to footnote (b) in Table A.5.

Table A.7: Annual Waste Incinerator Emission Test Results and Emission Criteria[(a)]

Stack Gas Concentration Criterion	Allowable Value	2016 Test Average Value
Particulate Matter	maximum 14 mg/Rm^3	0.50 mg/Rm^3
Mercury	maximum 20 µg/Rm^3	1.52 µg/Rm^3
Dioxin and Furan Toxic Equivalents (TEQ)	maximum 80 pg TEQ/Rm^3	3.15 pg TEQ/Rm^3
Total Hydrocarbons	maximum 50 ppm	2.4 ppm

(a) The results of an emission testing program performed in June 2016 indicated the Western Waste Management Facility 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 and Climate Change Environmental Compliance Approval requirements.