

Environmental Emissions Data for Darlington Nuclear

Q4 2023

OVERVIEW

This report summarizes Darlington Nuclear's environmental emissions data for Q4 2023. Darlington Nuclear Generating Station has four reactor units and a total generation capacity of 3,512 megawatts. The station is located in the Municipality of Clarington in Durham Region. Darlington Unit 3 was shut down in 2020 for refurbishment and it has returned to service in Q3 2023. Darlington Unit 1 was shut down in Q1 2022 and Unit 4 was shut down in Q3 2023 for refurbishment.

This report includes:

- Radioactive Effluents: Releases to air and water remained well below the regulatory limits.
- Darlington Waste Management Facility: Monitoring results for air emissions.
- Groundwater Monitoring: OPG continued to analyze groundwater results to examine trends.
- 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 that 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.

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. Darlington Nuclear 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.

Public Radiation Dose Data

The radiation dose to the public resulting from the operation of Darlington Nuclear is a very small fraction of the estimated annual average background radiation dose around the station.

Annual environmental monitoring program results for Darlington Nuclear, including an assessment of radiation dose to the public, are available at:

www.opg.com/news-and-media/Pages/reports.aspx

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Performance Results

Darlington Nuclear's emissions are monitored to track performance. For Q4 2023, Darlington Nuclear's radiological emissions to air and water remained well below the Release Limits and no Action Levels were exceeded. (Appendix A, Tables A.1 and A.2)

DARLINGTON WASTE MANAGEMENT FACILITY

Radiological air emissions, storm water, and radiation dose monitoring requirements for the Darlington Waste Management Facility (DWMF) were met in Q4 2023 and no issues were identified (Appendix A, Tables A.3).

Past monitoring results from the radiological particulate emissions monitoring of the ventilation system at the Dry Storage Container (DSC) Processing Building at the DWMF have consistently demonstrated negligible particulate emissions from this building. As approved by the CNSC, this particulate emissions monitoring will be discontinued in 2024.

GROUNDWATER MONITORING

Groundwater monitoring is conducted at monitoring wells around the Darlington site perimeter, including along the Lake Ontario shoreline, to confirm that there are no adverse off-site impacts from tritium in groundwater. The Annual Groundwater Monitoring Report is available at: <https://www.opg.com/reporting/regulatory-reporting/>

RELEASES OF HAZARDOUS SUBSTANCES (NON-RADIOACTIVE)

Darlington Nuclear complies with numerous regulatory requirements for controlling and monitoring releases of hazardous substances to the environment. Darlington Nuclear reports releases of hazardous substances to Environment Canada's National Pollutant Release Inventory (NPRI). Tools and resources for accessing, analyzing and interpreting NPRI data are available on the [NPRI website](#). Darlington Nuclear's carbon dioxide emissions are well below the threshold for mandatory reporting to federal and provincial authorities. Greenhouse gas data and information for reporting facilities are available on the [Greenhouse Gas Emissions Reporting Program \(GHGRP\) website](#).

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 in Q4 2023.

APPENDIX A

ENVIRONMENTAL EMISSIONS DATA

Environmental Emissions Data for Darlington Nuclear

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Table A.1: Airborne Radionuclide Releases

		Elemental Tritium (Bq)	Tritium Oxide (Bq)	Carbon-14 (Bq)	Noble Gas (Bq-MeV)	Iodine-131 (Bq)	Particulate (Bq)	Gross Alpha (Bq)
SUMMARY: ANNUAL								
Release Limit (Bq/year)^(a)		8.23 x 10 ¹⁷	4.94 x 10 ¹⁶	1.21 x 10 ¹⁵	3.80 x 10 ¹⁶	1.77 x 10 ¹²	6.06 x 10 ¹¹	1.08 x 10 ¹¹
Total Releases as of Q4 2023		1.8 x 10 ¹⁵	5.3 x 10 ¹⁴	1.3 x 10 ¹²	2.2 x 10 ¹³	1.2 x 10 ⁸	5.1 x 10 ⁶	5.2 x 10 ⁶
DETAILS: WEEKLY^(b)								
Action Level (Bq/week)^(c)		1.65 x 10 ¹⁵	9.88 x 10 ¹³	2.42 x 10 ¹²	7.60 x 10 ¹³	3.53 x 10 ⁹	1.21 x 10 ⁹	Not specified ^(d)
Jan.	Week 1	8.4 x 10 ¹⁰	3.7 x 10 ¹²	2.7 x 10 ¹⁰	6.0 x 10 ¹¹	2.8 x 10 ⁶	5.5 x 10 ⁵	1 x 10 ⁵
	Week 2	1.1 x 10 ¹¹	2.4 x 10 ¹²	1.4 x 10 ¹⁰	3.4 x 10 ¹¹	2.8 x 10 ⁶	4.1 x 10 ⁵	1 x 10 ⁵
	Week 3	4.6 x 10 ⁹	4.2 x 10 ¹²	1.3 x 10 ¹⁰	2.3 x 10 ¹¹	2.6 x 10 ⁶	3.6 x 10 ⁵	1 x 10 ⁵
	Week 4	1.1 x 10 ¹²	3.3 x 10 ¹²	1.4 x 10 ¹⁰	3.6 x 10 ¹¹	2.3 x 10 ⁶	3.0 x 10 ⁵	1 x 10 ⁵
	Week 5	8.0 x 10 ¹²	2.8 x 10 ¹²	1.3 x 10 ¹⁰	3.3 x 10 ¹¹	2.5 x 10 ⁶	2.7 x 10 ⁵	1 x 10 ⁵
Feb.	Week 6	8.2 x 10 ¹²	3.5 x 10 ¹²	1.3 x 10 ¹⁰	8.7 x 10 ¹¹	2.5 x 10 ⁶	4.0 x 10 ⁵	1 x 10 ⁵
	Week 7	1.0 x 10 ¹³	3.3 x 10 ¹²	1.5 x 10 ¹⁰	3.3 x 10 ¹¹	2.5 x 10 ⁶	4.7 x 10 ⁵	1 x 10 ⁵
	Week 8	9.9 x 10 ¹²	3.1 x 10 ¹²	1.3 x 10 ¹⁰	2.6 x 10 ¹¹	2.4 x 10 ⁶	4.1 x 10 ⁵	9 x 10 ⁴
	Week 9	1.1 x 10 ¹³	3.7 x 10 ¹²	1.2 x 10 ¹⁰	3.9 x 10 ¹¹	2.4 x 10 ⁶	3.2 x 10 ⁵	1 x 10 ⁵
Mar.	Week 10	1.4 x 10 ¹³	5.6 x 10 ¹²	1.1 x 10 ¹⁰	2.6 x 10 ¹¹	2.3 x 10 ⁶	3.1 x 10 ⁵	1 x 10 ⁵
	Week 11	1.6 x 10 ¹³	3.4 x 10 ¹²	1.2 x 10 ¹⁰	1.4 x 10 ¹¹	2.4 x 10 ⁶	2.2 x 10 ⁵	1 x 10 ⁵
	Week 12	1.6 x 10 ¹³	3.6 x 10 ¹²	1.2 x 10 ¹⁰	1.9 x 10 ¹¹	2.3 x 10 ⁶	5.2 x 10 ⁵	1 x 10 ⁵
	Week 13	1.6 x 10 ¹³	4.7 x 10 ¹²	1.8 x 10 ¹⁰	7.2 x 10 ¹¹	2.4 x 10 ⁶	4.3 x 10 ⁵	1 x 10 ⁵
Apr.	Week 14	1.7 x 10 ¹³	4.3 x 10 ¹²	1.2 x 10 ¹⁰	3.8 x 10 ¹¹	2.5 x 10 ⁶	5.7 x 10 ⁵	1 x 10 ⁵
	Week 15	2.2 x 10 ¹³	6.4 x 10 ¹²	1.1 x 10 ¹⁰	4.2 x 10 ¹¹	2.4 x 10 ⁶	5.3 x 10 ⁵	1 x 10 ⁵
	Week 16	2.5 x 10 ¹³	3.7 x 10 ¹²	1.8 x 10 ¹⁰	4.4 x 10 ¹¹	2.3 x 10 ⁶	5.5 x 10 ⁵	1 x 10 ⁵
	Week 17	1.5 x 10 ¹³	2.6 x 10 ¹²	1.9 x 10 ¹⁰	3.8 x 10 ¹¹	2.5 x 10 ⁶	2.0 x 10 ⁵	1 x 10 ⁵
	Week 18	2.5 x 10 ¹³	3.1 x 10 ¹²	3.3 x 10 ¹⁰	1.7 x 10 ¹¹	2.3 x 10 ⁶	1.6 x 10 ⁵	1 x 10 ⁵
May.	Week 19	3.8 x 10 ¹³	3.0 x 10 ¹²	1.5 x 10 ¹⁰	1.1 x 10 ¹¹	2.1 x 10 ⁶	3.1 x 10 ⁵	1 x 10 ⁵
	Week 20	2.8 x 10 ¹³	3.2 x 10 ¹²	1.6 x 10 ¹⁰	1.5 x 10 ¹¹	2.2 x 10 ⁶	9.0 x 10 ⁵	1 x 10 ⁵
	Week 21	2.9 x 10 ¹³	3.1 x 10 ¹²	2.1 x 10 ¹⁰	5.1 x 10 ¹¹	2.2 x 10 ⁶	3.9 x 10 ⁵	9 x 10 ⁴
	Week 22	4.8 x 10 ¹³	3.7 x 10 ¹²	3.5 x 10 ¹⁰	6.2 x 10 ¹¹	2.2 x 10 ⁶	7.9 x 10 ⁵	1 x 10 ⁵
Jun.	Week 23	2.3 x 10 ¹³	3.7 x 10 ¹²	5.2 x 10 ¹⁰	8.1 x 10 ¹¹	2.1 x 10 ⁶	8.3 x 10 ⁵	1 x 10 ⁵
	Week 24	3.2 x 10 ¹³	3.1 x 10 ¹²	1.7 x 10 ¹⁰	3.8 x 10 ¹¹	2.3 x 10 ⁶	3.6 x 10 ⁵	1 x 10 ⁵
	Week 25	2.8 x 10 ¹³	3.2 x 10 ¹²	4.6 x 10 ¹⁰	2.9 x 10 ¹¹	2.1 x 10 ⁶	5.3 x 10 ⁵	9 x 10 ⁴
	Week 26	2.4 x 10 ¹³	2.3 x 10 ¹²	3.1 x 10 ¹⁰	3.6 x 10 ¹¹	2.3 x 10 ⁶	1.6 x 10 ⁵	1 x 10 ⁵
Jul.	Week 27	3.2 x 10 ¹³	3.0 x 10 ¹²	2.1 x 10 ¹⁰	3.1 x 10 ¹¹	2.2 x 10 ⁶	6.0 x 10 ⁵	1 x 10 ⁵
	Week 28	2.8 x 10 ¹³	3.1 x 10 ¹²	4.8 x 10 ¹⁰	1.5 x 10 ¹¹	2.3 x 10 ⁶	3.4 x 10 ⁵	1 x 10 ⁵
	Week 29	3.6 x 10 ¹³	3.3 x 10 ¹²	3.8 x 10 ¹⁰	2.7 x 10 ¹¹	2.2 x 10 ⁶	2.3 x 10 ⁵	1 x 10 ⁵
	Week 30	2.8 x 10 ¹³	2.7 x 10 ¹²	1.7 x 10 ¹⁰	4.8 x 10 ¹¹	2.4 x 10 ⁶	8.9 x 10 ⁵	1 x 10 ⁵
	Week 31	2.0 x 10 ¹²	3.2 x 10 ¹²	4.7 x 10 ¹⁰	8.4 x 10 ¹⁰	2.4 x 10 ⁶	6.1 x 10 ⁵	1 x 10 ⁵
Aug.	Week 32	2.3 x 10 ¹¹	2.4 x 10 ¹²	3.5 x 10 ¹⁰	2.7 x 10 ¹¹	2.3 x 10 ⁶	4.1 x 10 ⁵	1 x 10 ⁵

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		Elemental Tritium (Bq)	Tritium Oxide (Bq)	Carbon-14 (Bq)	Noble Gas (Bq-MeV)	Iodine-131 (Bq)	Particulate (Bq)	Gross Alpha (Bq)
	Week 33	9.4×10^{10}	2.5×10^{12}	2.7×10^{10}	5.2×10^{11}	2.3×10^6	5.5×10^5	1×10^5
	Week 34	7.5×10^{11}	2.6×10^{12}	1.4×10^{10}	6.1×10^{11}	2.1×10^6	6.6×10^5	1×10^5
	Week 35	9.7×10^{11}	4.4×10^{12}	2.4×10^{10}	5.8×10^{11}	2.1×10^6	5.9×10^5	1×10^5
Sept.	Week 36	4.4×10^{14}	2.4×10^{14}	1.9×10^{10}	4.4×10^{11}	2.1×10^6	1.2×10^6	1×10^5
	Week 37	2.2×10^{13}	1.8×10^{13}	1.6×10^{10}	1.6×10^{11}	2.2×10^6	2.1×10^6	1×10^5
	Week 38	5.5×10^{12}	4.5×10^{12}	1.6×10^{10}	1.6×10^{11}	2.2×10^6	1.3×10^6	1×10^5
	Week 39	3.9×10^{12}	7.5×10^{12}	1.8×10^{10}	3.2×10^{11}	2.3×10^6	9.1×10^5	1×10^5
Oct.	Week 40	2.2×10^{11}	5.0×10^{12}	1.8×10^{10}	5.9×10^{11}	2.2×10^6	3.9×10^5	1×10^5
	Week 41	2.3×10^{13}	7.6×10^{12}	1.7×10^{10}	1.5×10^{11}	2.2×10^6	4.5×10^5	1×10^5
	Week 42	6.1×10^{13}	4.7×10^{12}	6.3×10^{10}	3.0×10^{11}	2.3×10^6	2.6×10^5	1×10^5
	Week 43	1.4×10^{13}	4.8×10^{12}	2.0×10^{10}	2.8×10^{11}	2.3×10^6	2.5×10^5	1×10^5
	Week 44	6.4×10^{12}	1.1×10^{13}	2.1×10^{10}	1.9×10^{11}	2.3×10^6	3.3×10^5	1×10^5
Nov.	Week 45	5.2×10^{12}	5.1×10^{12}	2.0×10^{10}	7.5×10^{11}	2.4×10^6	7.1×10^5	1×10^5
	Week 46	3.2×10^{12}	6.2×10^{12}	1.7×10^{10}	6.9×10^{11}	2.4×10^6	2.5×10^5	1×10^5
	Week 47	1.6×10^{14}	7.5×10^{12}	1.5×10^{10}	6.0×10^{11}	2.4×10^6	6.9×10^5	1×10^5
	Week 48	4.5×10^{14}	6.5×10^{13}	1.6×10^{10}	8.7×10^{11}	2.4×10^6	4.7×10^5	1×10^5
Dec.	Week 49	2.0×10^{13}	5.6×10^{12}	1.2×10^{10}	1.2×10^{12}	2.3×10^6	3.6×10^5	1×10^5
	Week 50	6.4×10^{12}	4.1×10^{12}	1.8×10^{10}	8.3×10^{11}	2.3×10^6	4.9×10^5	1×10^5
	Week 51	6.5×10^{11}	6.2×10^{12}	1.5×10^{10}	8.8×10^{11}	2.3×10^6	6.0×10^5	1×10^5
	Week 52	0.00E+00	4.9×10^{12}	1.8×10^{10}	1.4×10^{12}	3.1×10^6	8.3×10^5	1×10^5

- (a) 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.
- (b) Analysis of air emissions is conducted weekly to monitor against internal performance targets. Emissions are reported using the fiscal calendar and months contain either four or five weeks. Values prefixed by an "<" indicate that reported results were less than the instrument detection limits.
- (c) 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 2023.
- (d) Action Level for gross alpha is not specified because it is not a routinely monitored radionuclide group at Darlington Nuclear as the activity is below the threshold value for monitoring.
- (e) The weekly Tritium Oxide emissions at the Station exceeded the Action Level during Week 36. The recorded tritium oxide release of 2.4×10^{14} Bq/week surpasses the station's Action Level of 9.88×10^{13} Bq/ week.

Table A.2: Waterborne Radionuclide Releases

	Tritium Oxide (Bq)	Gross Beta-Gamma (Bq)	Carbon-14 (Bq)	Gross Alpha (Bq)
SUMMARY: ANNUAL				
Release Limit (Bq/year)^(a)	6.43×10^{18}	3.47×10^{13}	6.97×10^{14}	4.39×10^{11}

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	Tritium Oxide (Bq)	Gross Beta-Gamma (Bq)	Carbon-14 (Bq)	Gross Alpha (Bq)
Total Releases as of Q4 2023	2.7×10^{14}	1.7×10^{10}	2.2×10^8	8.5×10^5
DETAILS: MONTHLY^(b)				
Action Level (Bq/month)^(c)	5.14×10^{16}	2.77×10^{11}	5.58×10^{12}	Not specified ^(d)
January	1.9×10^{13}	1.3×10^9	9.5×10^6	9×10^4
February	1.3×10^{13}	9.1×10^8	5.2×10^6	7×10^4
March	1.8×10^{13}	9.7×10^8	1.7×10^7	7×10^4
April	2.0×10^{13}	2.1×10^9	1.9×10^7	9×10^4
May	1.7×10^{13}	1.2×10^9	1.1×10^7	7×10^4
June	2.3×10^{13}	1.7×10^9	1.2×10^7	5×10^4
July	3.4×10^{13}	1.9×10^9	2.6×10^7	7×10^4
August	3.8×10^{13}	1.6×10^9	2.7×10^7	6×10^4
September	2.3×10^{13}	1.4×10^9	2.2×10^7	7×10^4
October	2.8×10^{13}	1.6×10^9	1.3×10^7	8×10^4
November	2.0×10^{13}	1.2×10^9	1.0×10^7	7×10^4
December	1.3×10^{13}	1.3×10^9	4.5×10^7	6×10^4

- (a) 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.
- (b) Analysis of water emissions is conducted monthly to monitor against internal performance targets. Monthly emissions are reported using the fiscal calendar and months contain either four or five weeks. Months with five weeks typically report higher releases relative to months with four weeks. For 2023, January, April, July, and October have five weeks.
- (c) 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 2023.
- (d) Action Level for gross alpha is not specified because it is not a routinely monitored radionuclide group at Darlington Nuclear as the activity is below the threshold value for monitoring.

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). $1 \text{ Ci} = 3.7 \times 10^{10} \text{ Bq}$.

While station emissions typically remain at consistently low levels, small fluctuations do occur because of changing operating conditions (e.g. unit outages), work activities, and equipment issues.

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Table A.3: Darlington Waste Management Facility Emissions

		Air - Particulate (Bq) ^(a)
January	Week 1	≤74
	Week 2	≤74
	Week 3	≤74
	Week 4	≤74
	Week 5	≤37
February	Week 6	≤37
	Week 7	≤37
	Week 8	≤37
	Week 9	≤74
March	Week 10	≤37
	Week 11	≤37
	Week 12	≤37
	Week 13	≤74
April	Week 14	≤37
	Week 15	≤74
	Week 16	110
	Week 17	≤37
	Week 18	≤37
May	Week 19	≤37
	Week 20	≤37
	Week 21	≤74
	Week 22	≤74
June	Week 23	≤37
	Week 24	≤74
	Week 25	≤37
	Week 26	≤37
July	Week 27	≤74
	Week 28	≤37
	Week 29	≤37
	Week 30	110
	Week 31	≤37
August	Week 32	≤37
	Week 33	≤74
	Week 34	≤37
	Week 35	≤37
September	Week 36	≤74
	Week 37	≤74
	Week 38	≤37
	Week 39	≤74

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		Air - Particulate (Bq) ^(a)
Oct.	Week 40	≤74
	Week 41	≤74
	Week 42	≤74
	Week 43	≤37
	Week 44	≤74
Nov.	Week 45	≤74
	Week 46	≤74
	Week 47	≤37
	Week 48	≤74
Dec.	Week 49	≤74
	Week 50	≤37
	Week 51	≤37
	Week 52	≤74

(a) Values prefixed by an “≤” indicate that reported results were less than or equal to the instrument detection limits. All weekly results were below the Action Level of 1.21×10^9 Bq.