Canada's Nuclear Regulator

Radioactive Release Data from Canadian Nuclear Power Plants 1999–2008

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Radioactive Release Data from Canadian Nuclear Power Plants 1999-2008

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Cover images
Nuclear power plants from left to right: Gentilly-2, Point Lepreau, Pickering A and B, Bruce A and B, and Darlington

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INFO-0210/Rev. 13

Compiled by Environmental Compliance and Laboratory Services Division
Directorate of Environmental and Radiation Protection and Assessment
Canadian Nuclear Safety Commission
Ottawa, Canada

September 2009

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Summary

CNSC regulations require that each licensee take all reasonable precautions to protect the environment and the health and safety of persons, including identifying, controlling and monitoring releases of nuclear substances to the environment.

CNSC staff verifies that licensees have programs in place to identify, control and monitor gaseous and aqueous releases of nuclear substances to the environment. CNSC staff assesses environmental performance by reviewing, among other indicators, release monitoring data and public radiation doses.

This document presents the results of the licensee effluent monitoring programs over a ten year period, from 1999 to 2008. The levels of radioactive materials releases in the environment from all the nuclear power plants are far below both the derived release limits (DRLs) and the regulatory dose limits to the members of the public.

Introduction

Nuclear power plants, also called nuclear generating stations, release small quantities of radioactive materials, in a controlled manner into both the atmosphere (as gaseous effluents) and adjoining water bodies (as liquid effluents). The purpose of this document is to report the levels of these releases for each operating nuclear generating station in Canada. The report also indicates how these releases compare with the limitations imposed by the Canadian Nuclear Safety Commission (CNSC), as part of its regulatory program. The data shows that the levels of gaseous and liquid effluents from all operating nuclear generating stations are well below the values authorized by the CNSC.

This 13th revision of INFO-0210 presents data for the ten year period from 1999 to 2008.

The report incorporates graphs for each nuclear generating station, displaying annual gaseous releases containing tritium in the form of tritium oxide, iodine-131, noble gases, radioactive particulate and carbon-14, as well as the annual liquid releases containing tritium in the form of tritium oxide, gross beta-gamma activity and carbon-14. In the case of Darlington nuclear power plant, airborne releases of elemental tritium are also given, because the plant includes a tritium removal facility.

In each case, the release data are compared to the derived release limits (see below for an explanation of this term), in order for the data to be placed in perspective.

Each facility is unique in regards to the type of work performed, as well its current lifecycle stage (i.e., operating at reduced or full capacity, or in a phase of refurbishment). Therefore, direct comparisons between facilities are not possible, since one facility may have different release quantities of radioactive materials than any other.

Derived release limits

The doses received by members of the public from routine releases at nuclear power plants are too low to be measured directly. Therefore DRLs are calculated.

DRl’s are required, as radioactive materials released into the environment, through gaseous and liquid effluents from power plants, can result in low radiation doses to members of the public being acquired through external and internal exposure. External exposure occurs by direct contact with radionuclide-contaminated ground surfaces, or by immersion into contaminated water and air clouds, while internal exposure occurs through the intake of radionuclides by inhalation (breathing) and/or intake of contaminated foods. Such doses are subject to statutory limits for members of the public, which are set out in sections 13 and 14 of the *Radiation Protection Regulations*. On May 31, 2000, the *Nuclear Safety and Control Act* (NSCA) and its associated Regulations came into force in Canada, to replace the *Atomic Energy Control Act* and its Regulations. The *Radiation Protection Regulations* introduced new dose limits to protect the public and environment, which reflect the recommendations of the International Commission on Radiation Protection (ICRP 60). In

May 2000, the annual public dose limit was reduced from 5 mSv to 1 mSv for a whole body dose.

Furthermore, the CNSC requires - as per General Nuclear Safety and Control Regulation sections 12 (1) c) and (1) f) - that every licensee shall take all reasonable precautions to protect the environment and the health and safety of people. Every licensee shall also take all reasonable precautions to control the release of radioactive nuclear substances into the environment, as a result of the licensed activity. The doses received by members of the public from routine releases at nuclear generating stations are too low to be measured directly.

Table 1
Derived release limits (DRLs) for gaseous effluents

Nuclear generating station	**Tritium*** (TBq)	**Iodine-131** (TBq)	**Noble gases** (TBq-MeV**)	**Particulates** (TBq)	**Carbon-14** (TBq)
Point Lepreau	4.3×10^5	22	7.3×10^4	5.4	3.3×10^3
Bruce-A	8.8×10^4	1.2	5.0×10^4	2.1	5.7×10^2
Bruce-B	9.3×10^4	1.3	1.2×10^5	2.5	6.0×10^2
Darlington	4.3×10^4 (HTO) 8.1×10^5 (HT)***	4.7	3.9×10^4	2.4	1.8×10^3
Pickering-A	5.5×10^4	9.7	2.9×10^4	2.1	6.3×10^3
Pickering-B	5.5×10^4	9.7	2.9×10^4	2.1	6.3×10^3
Gentilly-2	4.4×10^5	1.3	1.7×10^5	1.9	8.8×10^2

* Tritium oxide (HTO)
** TBq-MeV (terabecquerel-million electron volts)
*** Derived release limit for elemental tritium (HT) resulting from the tritium removal facility at Darlington nuclear generating station

Methodology for establishing derived release limits

When the CNSC approved the DRLs for each nuclear generating station, it took into consideration the environmental pathways through which radioactive material could reach the most exposed members of the public after being released from the facility. The most exposed members of the public are known as the *critical group*. They are defined as those individuals who are expected to receive the highest dose of radiation because of considerations such as their age, diet, lifestyle and location relative to the station.

Since 1987, DRL calculations have been based on a method recommended by the Canadian Standards Association (document CAN/CSA-N288.1-M87). This approach takes into account many more environmental pathways than the previous calculating methods, and it allows for the use of more site-specific data. More realistic assumptions were incorporated into the method - for example, the use of shielding factors (shelter, clothing etc) and occupancy times (time spent in a dwelling or area) - and the environmental transfer values for individual radionuclides were also updated. In addition using this standard, the CNSC may place additional requirements on the calculation of DRLs, such as the use of certain site-specific information, which enable better estimates of environmental transfer processes (the movement of radionuclides from one media to another).

As the methods of calculating DRLs become more advanced, it may become necessary for licensees to revise their release limits. Licensees may also have to review the assumptions affecting the exposure of critical groups, and adjust them where necessary, in order to make them more representative, by including, for example, factors such as location and lifestyle habits of critical groups, as well as the location of farms. In addition to these, licensees may use more of the site-specific data obtained from their routine environmental monitoring programs, such as liquid dispersion factors or surveys of the local population.

The net effect of changes associated with the methodology for calculating DRLs has been that some limits increased while others have decreased, over time, depending on the relative importance of the various pathways. As new information on dose calculation methods or parameters becomes available, the DRLs may require subsequent revisions. The current DRLs for all nuclear generating stations are listed in Tables 1 and 2, and were revised to take into consideration the change in public dose limit established in 2000, except in the case of Gentilly-2 – where the DRLs are being currently revised.

The heavy horizontal lines at the top of the graphs in this report show the DRL for the elements in question.

Table 2
Derived release limits for liquid effluents

Nuclear generating station	**Tritium*** (TBq)	**Gross beta-gamma activity** (TBq)	**Carbon-14** (TBq)
Point Lepreau	1.6×10^{7}	1.6×10^{1}	3.0×10^{2}
Bruce-A**	4.5×10^{4}	5.8×10^{-1}	1.1×10^{1}
Bruce-B	6.0×10^{5}	4.9	9.1×10^{1}
Darlington	4.3×10^{6}	7.1×10^{1}	9.7×10^{2}
Pickering-A	5.1×10^{5}	4.7	6.4×10^{1}
Pickering-B	5.1×10^{5}	4.7	6.4×10^{1}
Gentilly-2	1.2×10^{6}	5.3	1.0×10^{2}

* Tritium oxide (HTO)
** The liquid DRLs for Bruce A provided here are based on one condenser cooling water pump operating. Other liquid DRLs are available for 2, 3 or 12 pumps operating.

Internal operating targets

Nuclear generating stations maintain their own internal operating targets, which equate to approximately 1% of the specified DRLs. Although DRLs are expressed as an annual release limit, the weekly and monthly rates of release are further controlled. For gaseous releases, the maintained limit is the annual DRL divided by 52 weeks, while liquid release limits represent the annual DRL divided by 12 months. Weekly airborne releases and monthly liquid releases at each nuclear generating station are compared to the respective weekly and monthly limits, and are reported to the CNSC on a quarterly basis. Also, nuclear generating stations use environmental action levels developed based on the CNSC Regulatory Guide G-228, Developing and Using Action Levels.

Release data

Licensees measure and report their releases in different ways. Most of these report the radionuclides representing major contributing factors to public dose - such as airborne releases of tritium, iodine-131, noble gases, particulate and carbon-14, and liquid releases of tritium, gross beta-gamma and carbon-14. As particulate and gross beta-gamma consist of mixtures of radionuclides, the most dose-restrictive radionuclide is chosen to represent the mixture as the basis for comparison with the DRL.

Annual releases of radionuclides are presented in graphs and tables for each nuclear generating station. The bars of the graphs depict the amount of radionuclide released each year, in units of terabecquerels (TBq) or, in the case of noble gases, terabecquerel-million electron volts (TBq-MeV). Logarithmic scales are used, to allow comparisons between annual radioactive releases and the DRL for each radionuclide.

The “ND” mention in the following graphs and tables indicates that radioactive releases were not detected in that particular year.

Interim DRLs

The DRLs used at the Bruce nuclear generating stations were last revised and implemented in 2001, to reflect the annual statutory public dose limit of 1 mSv, and to incorporate more recently accepted values for factors such as the breathing and ingestion rates used in the calculations. These most recent DRLs are referred to as “interim”, as they are expected to be replaced by a more comprehensive revision in the future. The Darlington nuclear generating station implemented new DRLs in 2005, to replace the “interim” DRLs of 2001. Also, Pickering A and B implemented new DRLs in 2007. The DRLs for Point Lepreau nuclear generating station were last revised in 1996, and were based on a public dose limit of 1 mSv, as recommended by the ICRP in 1990. The DRLs for the Gentilly-2 nuclear generating station were last revised in 1992, and take into account the previous annual statutory public dose limit of 5 mSv. However, the internal administrative targets are set at 1% of the DRL, and the requirements to maintain the dose as low as reasonably achievable (ALARA) are equivalent to those at other nuclear generating stations.

Terminology

A brief glossary is provided at the end of this report, to enable all the readers to understand specific terms and expressions that relate to radioactive release data.

Scientific notation

Due to the magnitude of the numbers used in this report, it is often more convenient to express them in scientific notation. In most cases, the numbers in this report are rounded to two significant figures. Examples follow:

100,000	$= 10^5$
1,260,000	$= 1.3 \times 10^6$ (two significant figures)
0.003473	$= 3.5 \times 10^{-3}$ (two significant figures)

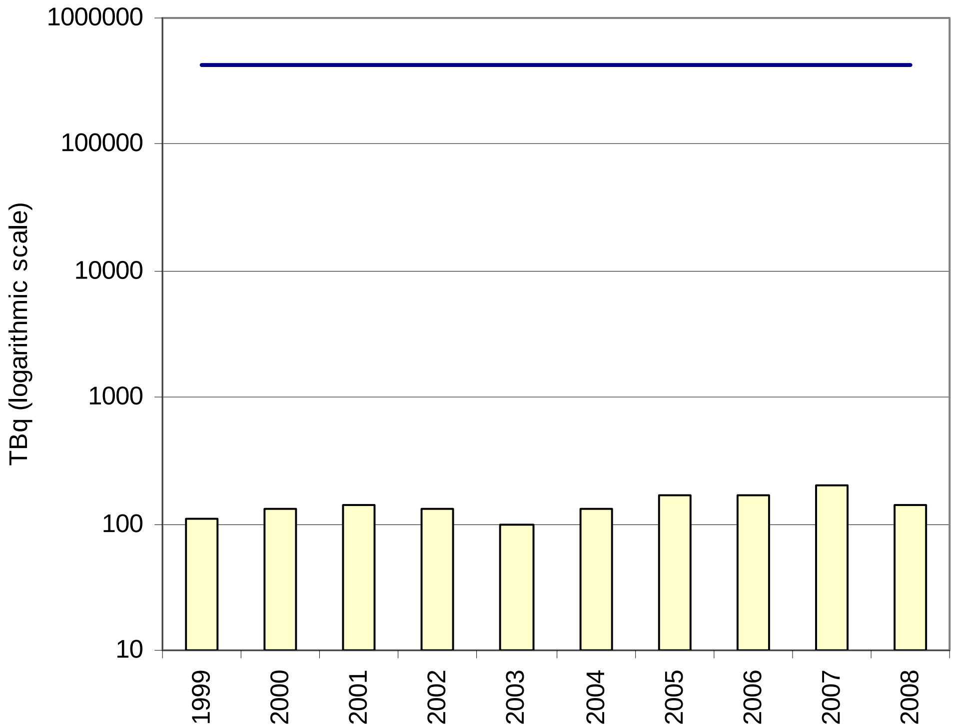
Point Lepreau Nuclear Generating Station

The Point Lepreau nuclear generating station consists of one nuclear reactor, which began operation in 1982. It is located in New Brunswick on Point Lepreau, which extends into the Bay of Fundy.

The data for radioactive gaseous and liquid effluents released here between 1999 and 2008 is presented in the following graphs. The major radionuclides in gaseous effluents are tritium, in the form of tritium oxide (Figure 1.1), iodine-131 (Figure 1.2), noble gases (Figure 1.3), radioactive particulate (Figure 1.4) and carbon-14 (Figure 1.5). Those in liquid effluents are tritium in the form of tritium oxide (Figure 1.6), gross beta-gamma activity (Figure 1.7), and carbon-14 (Figure 1.8).

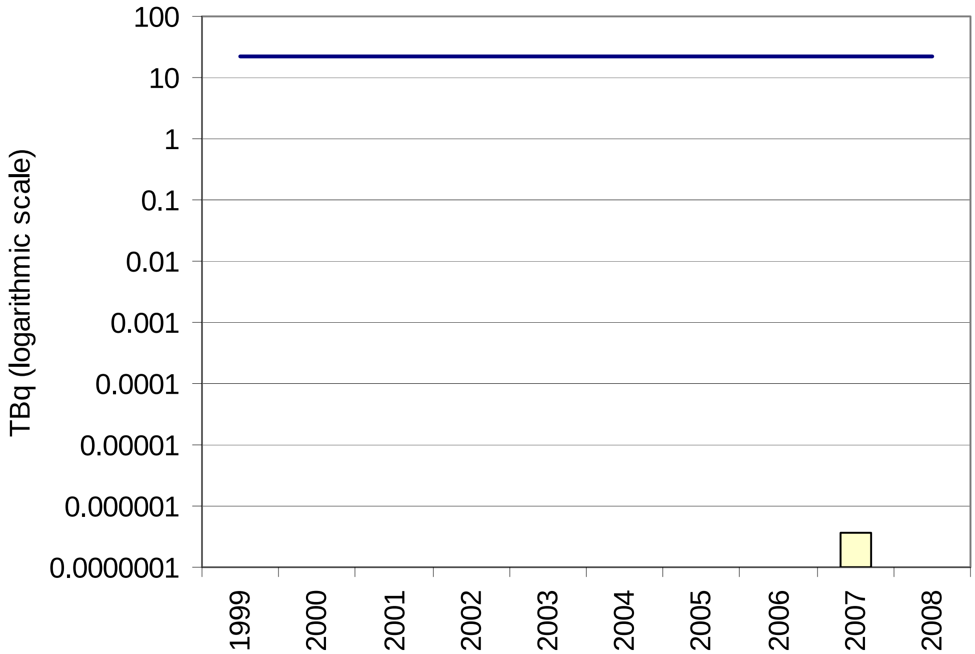
The Point Lepreau nuclear generating station began reporting carbon-14 in liquid releases in 1997. The nuclear generating station was shutdown for refurbishment in 2008.

Figure 1.1
Tritium oxide in gaseous effluent from the Point Lepreau nuclear generating station (1999-2008)
DRL since 1996: 4.3 x 10^5 TBq



Year	TBq
1999	1.1 x 10^2
2000	1.3 x 10^2
2001	1.4 x 10^2
2002	1.3 x 10^2
2003	1.0 x 10^2
2004	1.3 x 10^2
2005	1.7 x 10^2
2006	1.7 x 10^2
2007	2.0 x 10^2
2008	1.4 x 10^2

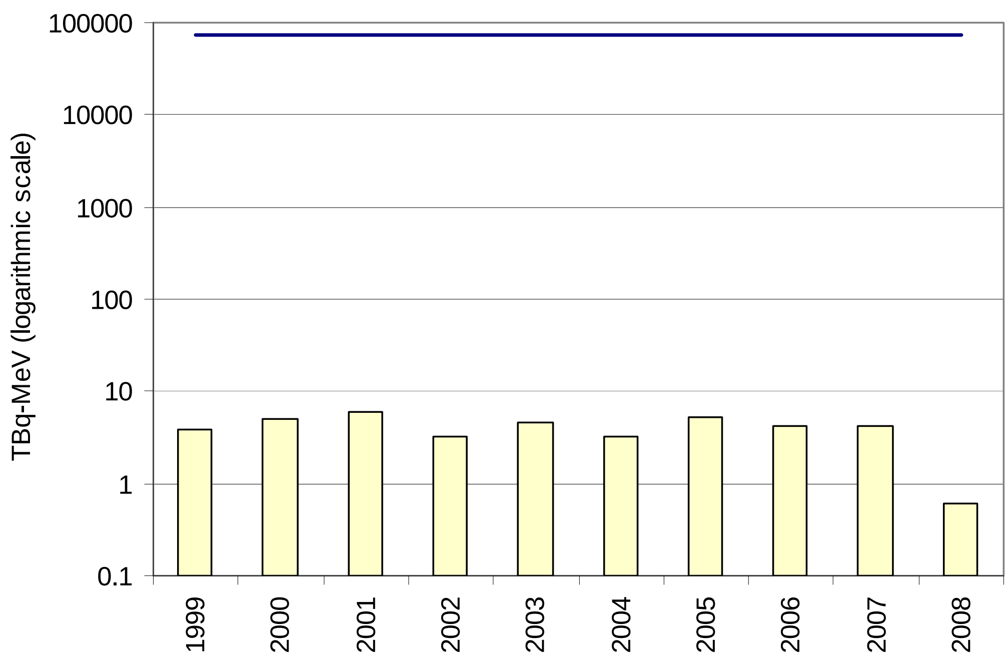
Figure 1.2
Iodine-131 in gaseous effluent from the Point Lepreau nuclear generating station (1999-2008)
DRL since 1996: 22 TBq



Year	TBq
1999	ND
2000	ND
2001	ND
2002	ND
2003	ND
2004	ND
2005	ND
2006	ND
2007	3.7×10^{-7}
2008	ND

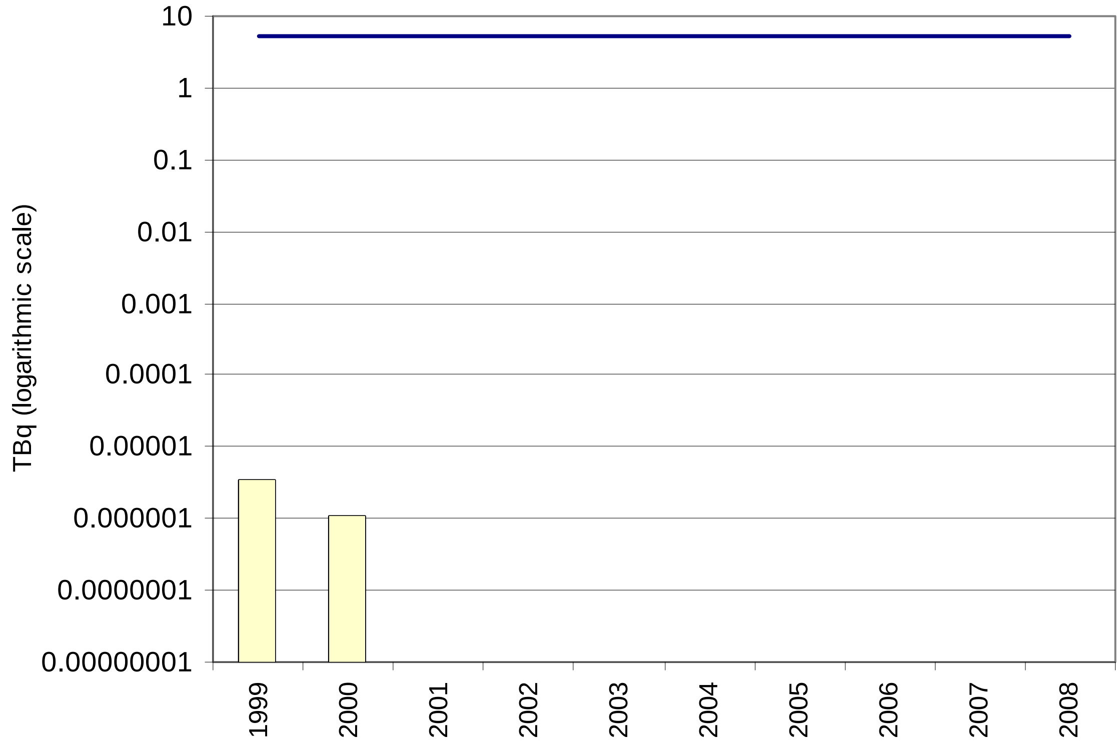
ND=Not Detected

Figure 1.3
Noble gas in gaseous effluent from the Point Lepreau nuclear generating station (1999-2008)
DRL since 1996: 7.3×10^{4} TBq-MeV



Year	TBq-MeV
1999	3.8
2000	5.0
2001	5.9
2002	3.2
2003	4.6
2004	3.3
2005	5.3
2006	4.3
2007	4.2
2008	0.62

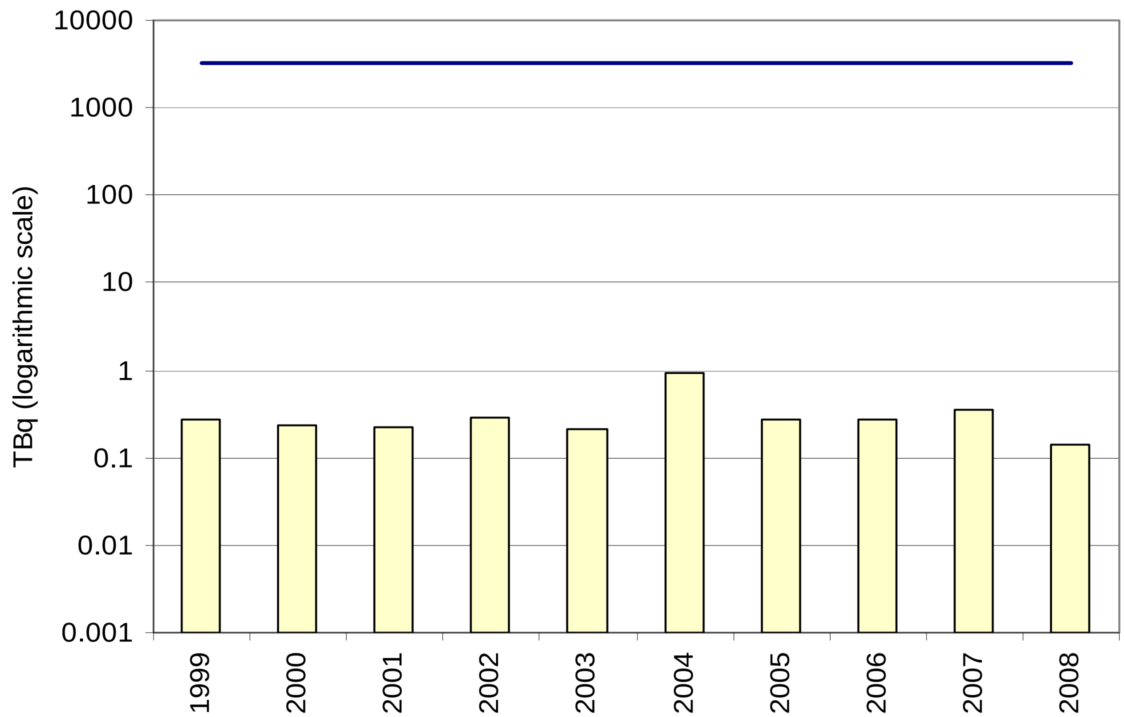
Figure 1.4
Radioactive particulate in gaseous effluent from the Point Lepreau nuclear generating station (1999-2008)
DRL since 1996: 5.2 TBq



Year	TBq
1999	3.5×10^{-6}
2000	1.1×10^{-6}
2001	ND
2002	ND
2003	ND
2004	ND
2005	ND
2006	ND
2007	ND
2008	ND

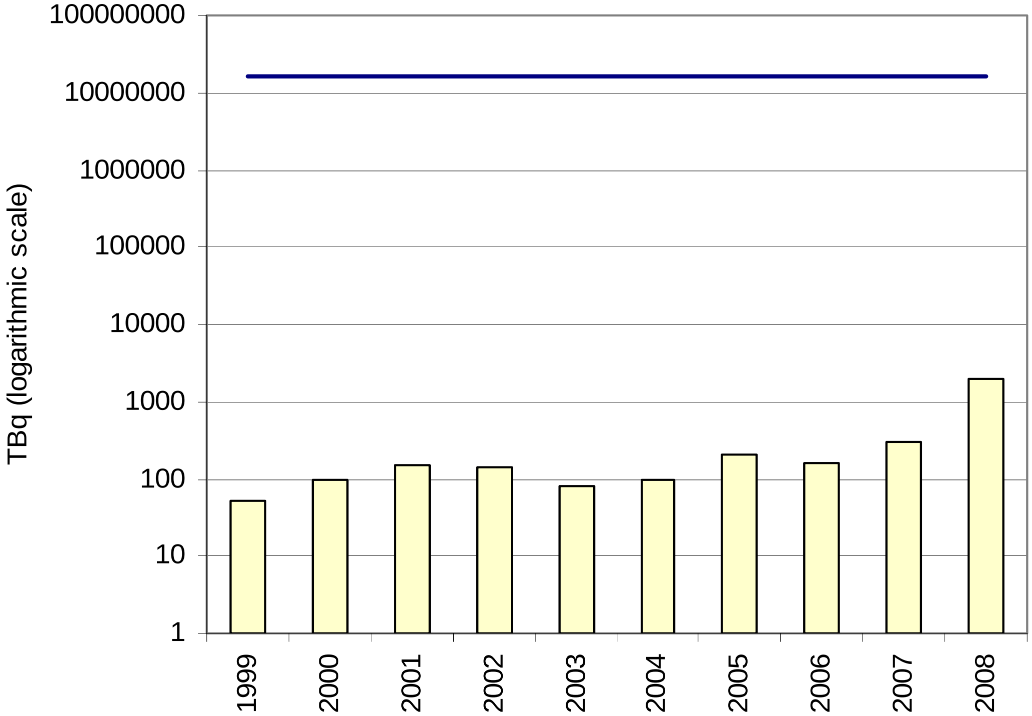
ND=Not Detected

Figure 1.5
Carbon-14 in gaseous effluent from the Point Lepreau nuclear generating station (1999-2008)
DRL since 1996: 3.3×10^{3} Bq



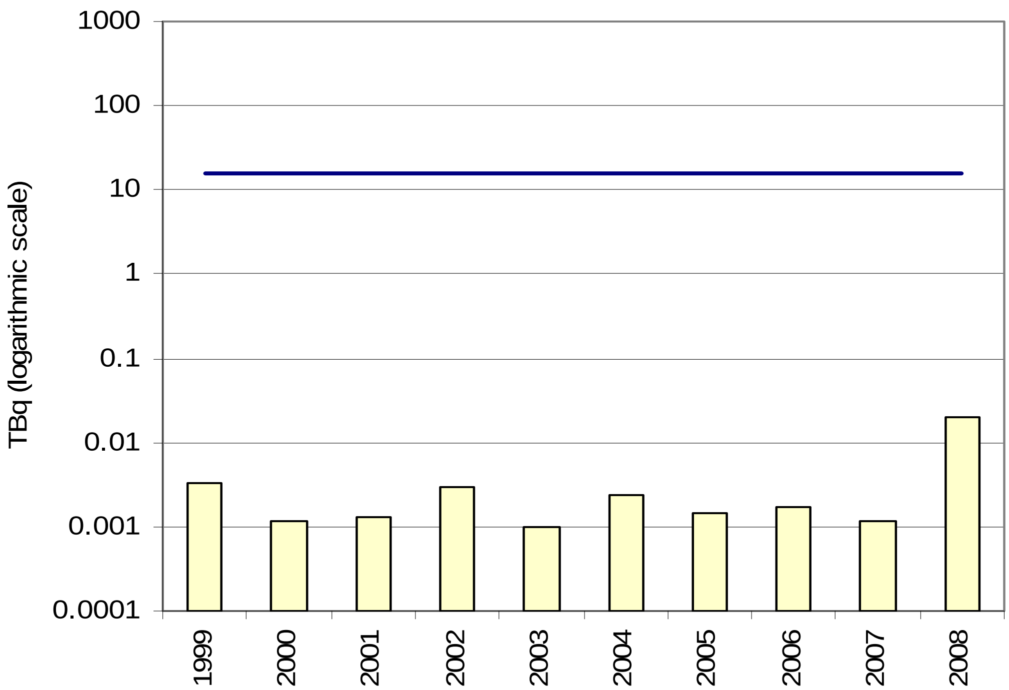
Year	TBq
1999	0.28
2000	0.23
2001	0.22
2002	0.29
2003	0.21
2004	0.91
2005	0.28
2006	0.28
2007	0.36
2008	0.14

Figure 1.6
Tritium oxide in liquid effluent from the Point Lepreau nuclear generating station (1999-2008)
DRL since 1996: 1.6×10^{7} TBq



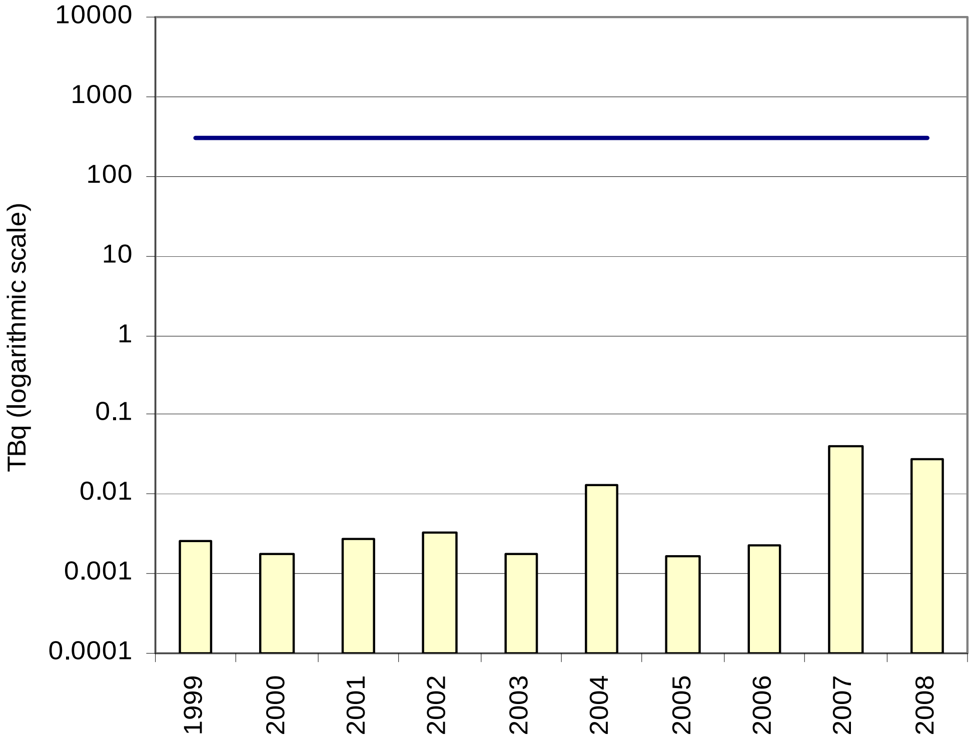
Year	TBq
1999	5.3×10^{1}
2000	9.6×10^{1}
2001	1.5×10^{2}
2002	1.4×10^{2}
2003	8.1×10^{1}
2004	9.6×10^{1}
2005	2.1×10^{2}
2006	1.6×10^{2}
2007	3.0×10^{2}
2008	2.0×10^{3}

Figure 1.7
Gross beta-gamma activity in liquid effluent from the Point Lepreau nuclear generating station (1999-2008)
DRL since 1996: 1.6×10^{1} TBq



Year	TBq
1999	3.3×10^{-3}
2000	1.2×10^{-3}
2001	1.3×10^{-3}
2002	3.0×10^{-3}
2003	1.0×10^{-3}
2004	2.4×10^{-3}
2005	1.4×10^{-3}
2006	1.7×10^{-3}
2007	1.2×10^{-3}
2008	2.0×10^{-2}

Figure 1.8
Carbon-14 in liquid effluent from the Point Lepreau nuclear generating station (1999-2008)
DRL since 1996: 3.0×10^2 TBq



Year	TBq
1999	2.6×10^{-3}
2000	1.8×10^{-3}
2001	2.8×10^{-3}
2002	3.4×10^{-3}
2003	1.8×10^{-3}
2004	1.3×10^{-2}
2005	1.7×10^{-3}
2006	2.3×10^{-3}
2007	4.0×10^{-2}
2008	2.7×10^{-2}

Bruce-A Nuclear Generating Station

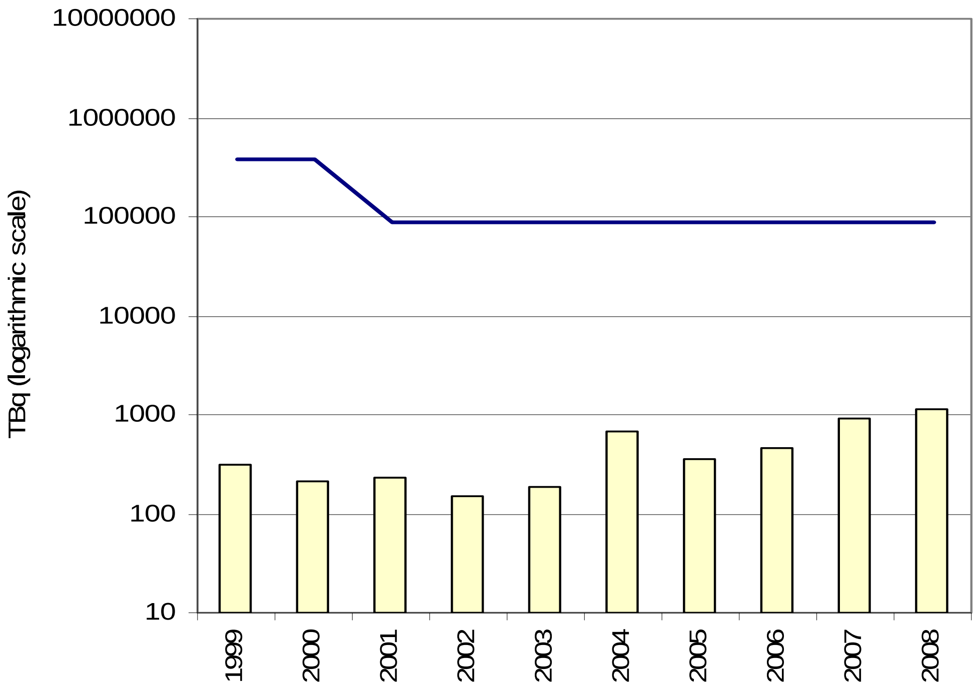
The Bruce-A nuclear generating station consists of four nuclear reactors (units 1-4), which began operating in 1976. It is located in Ontario, on the shore of Lake Huron, near the town of Kincardine.

In 1997, as part of its extensive recovery program, Ontario Hydro (now Ontario Power Generation) temporarily shut down the Bruce-A reactors, and all the units were maintained in a guaranteed shut down state. Units 3 and 4 were recently returned to service; Unit 4 was restarted in October 2003, while Unit 3 was restarted in January 2004. The Bruce nuclear generating station is currently operated by Bruce Power.

Data for radioactive gaseous and liquid effluents released between 1999 and 2008 from the Bruce-A nuclear generating station are presented in the following graphs. The pertinent items in the gaseous effluents are tritium, in the form of tritium oxide (Figure 2.1), iodine-131 (Figure 2.2), noble gases (Figure 2.3), radioactive particulates (Figure 2.4) and carbon-14 (Figure 2.5); those in the liquid effluents are tritium, in the form of tritium oxide (Figure 2.6), gross beta-gamma activity (Figure 2.7) and carbon-14 (Figure 2.8).

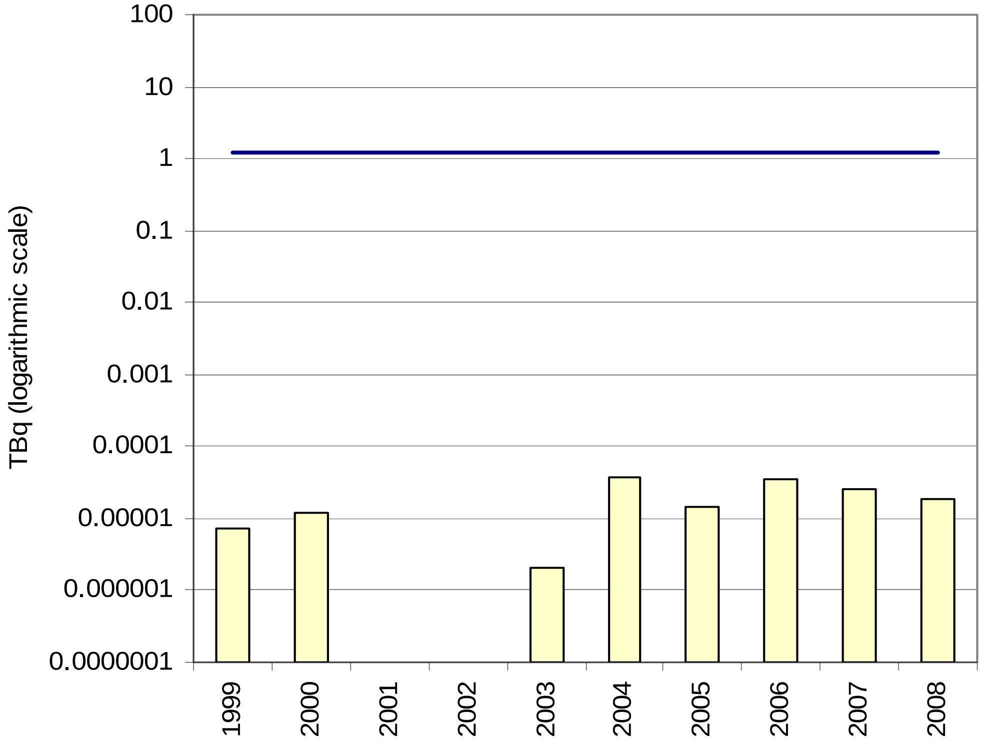
Bruce-A began reporting carbon-14 releases in gaseous and liquid effluents in 1999.

Figure 2.1
Tritium oxide in gaseous effluent from the Bruce-A nuclear generating station (1999-2008)
DRL from 1990 to 2000: 3.8 x10^5 TBq; DRL since 2001: 8.8 x 10^4 TBq



Year	TBq
1999	3.1 x 10^2
2000	2.1 x 10^2
2001	2.3 x 10^2
2002	1.5 x 10^2
2003	1.9 x 10^2
2004	6.7 x 10^2
2005	3.6 x10^2
2006	4.5 x 10^2
2007	9.3 x 10^2
2008	1.2 x 10^3

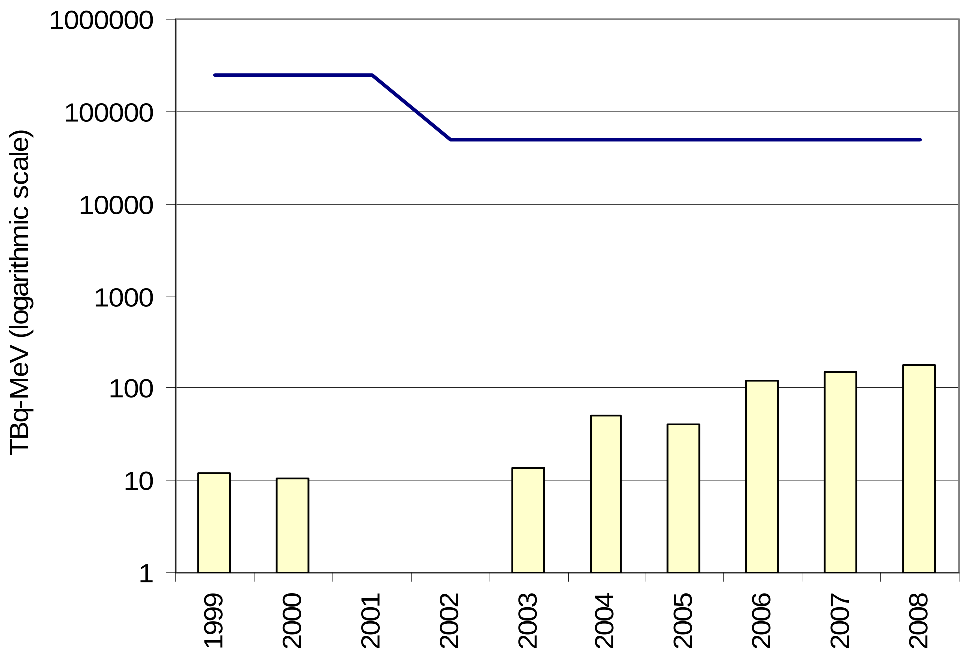
Figure 2.2
Iodine-131 in gaseous effluent from the Bruce-A nuclear generating station (1999-2008)*
DRL since 1990: 1.2 TBq



Year	TBq
1999	7.2×10^{-6}
2000	1.2×10^{-5}
2001	NA
2002	NA
2003	2.1×10^{-6}
2004	3.8×10^{-5}
2005	1.4×10^{-5}
2006	3.4×10^{-5}
2007	2.6×10^{-5}
2008	1.8×10^{-5}

*NA= Not Applicable

Figure 2.3
Noble gas in gaseous effluent from the Bruce-A nuclear generating station (1999-2008)*
DRL from 1990 to 2000: 2.5×10^5 TBq-MeV; DRL since 2001: 5.0×10^4 TBq-MeV

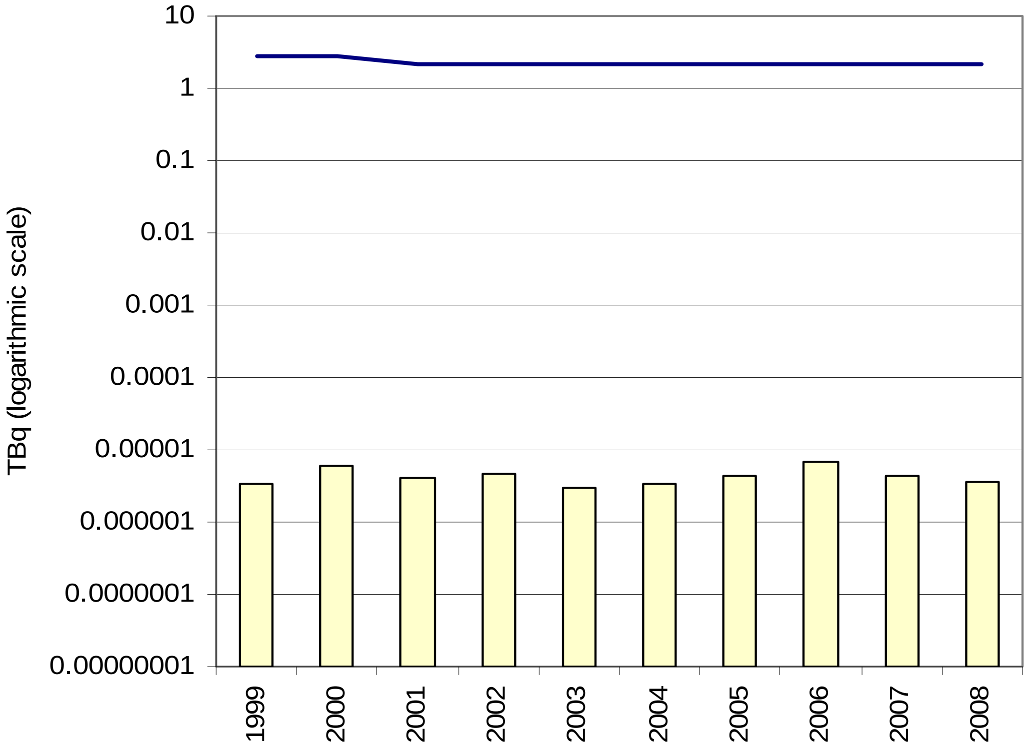


Year	TBq-MeV
1999	1.2×10^1
2000	1.1×10^1
2001	NA
2002	NA
2003	1.4×10^1
2004	5.0×10^1
2005	4.1×10^1
2006	1.2×10^2
2007	1.5×10^2
2008	1.8×10^2

*NA= Not Applicable

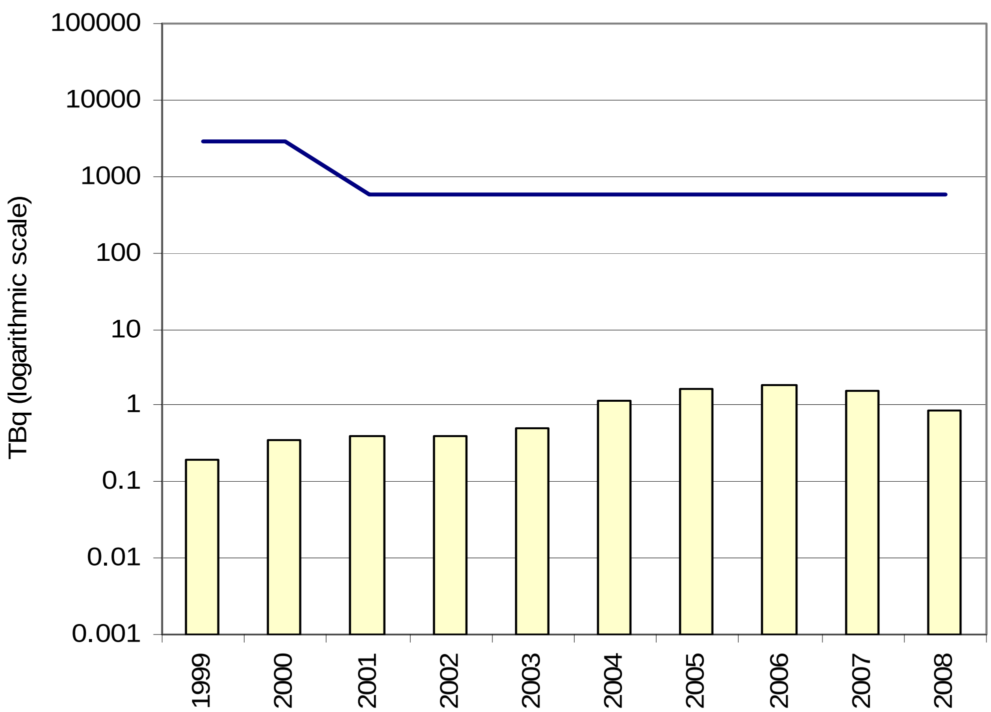
*In 2000, OPG shut down all noncontaminated stack monitors and all contaminated stack noble gas and iodine monitors at Bruce A, for two years.

Figure 2.4
Radioactive particulate in gaseous effluent from the Bruce-A nuclear generating station (1999-2008)
DRL from 1990 to 2000: 2.7 TBq; DRL since 2001: 2.1 TBq



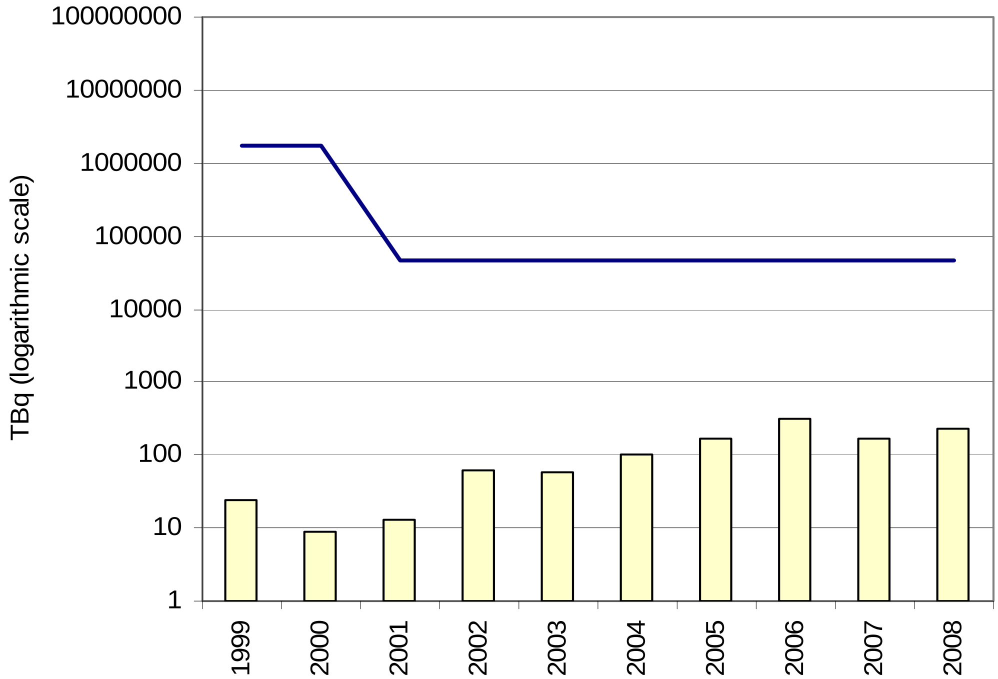
Year	TBq
1999	3.4×10^{-6}
2000	6.1×10^{-6}
2001	4.1×10^{-6}
2002	4.7×10^{-6}
2003	2.9×10^{-6}
2004	3.5×10^{-6}
2005	4.5×10^{-6}
2006	6.7×10^{-6}
2007	4.4×10^{-6}
2008	3.5×10^{-6}

Figure 2.5
Carbon-14 in gaseous effluent from the Bruce-A nuclear generating station (1999-2008)
DRL from 1990 to 2000: 2.8×10^3 TBq; DRL since 2001: 5.7×10^2 TBq



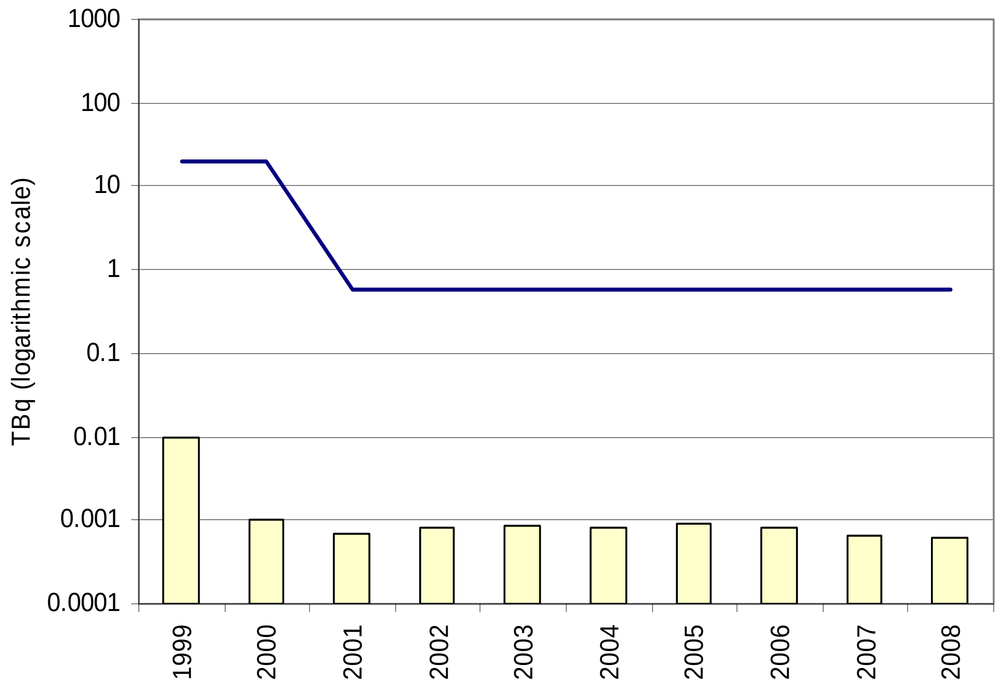
Year	TBq
1999	0.20
2000	0.35
2001	0.39
2002	0.39
2003	0.51
2004	1.2
2005	1.7
2006	1.9
2007	1.5
2008	0.87

Figure 2.6
Tritium oxide in liquid effluent from the Bruce-A nuclear generating station (1999-2008)
DRL from 1990 to 2000: 1.7×10^{6} TBq; DRL since 2001: 4.5×10^{4} TBq



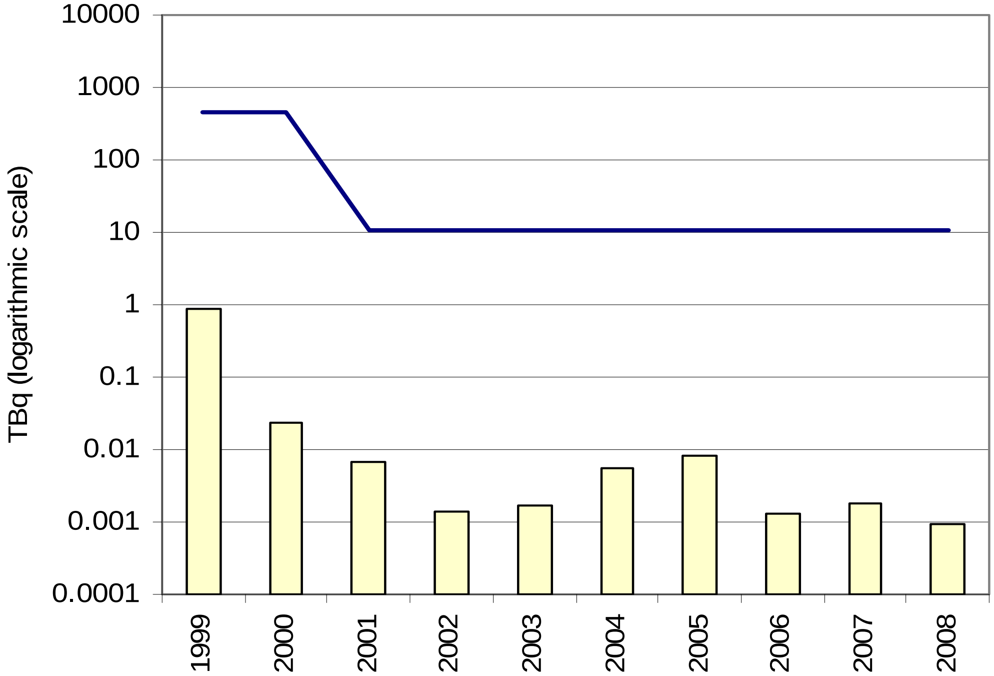
Year	TBq
1999	2.4×10^{1}
2000	9.0×10^{0}
2001	1.3×10^{1}
2002	6.4×10^{1}
2003	6.0×10^{1}
2004	9.9×10^{1}
2005	1.7×10^{2}
2006	3.0×10^{2}
2007	1.7×10^{2}
2008	2.4×10^{2}

Figure 2.7
Gross beta-gamma activity in liquid effluent from the Bruce-A nuclear generating station (1999-2008)
DRL from 1990 to 2000: 2.0×10^{1} TBq; DRL since 2001: 5.8×10^{-1} TBq



Year	TBq
1999	9.7×10^{-3}
2000	1.0×10^{-3}
2001	7.0×10^{-4}
2002	8.1×10^{-4}
2003	8.8×10^{-4}
2004	8.1×10^{-4}
2005	9.0×10^{-4}
2006	8.3×10^{-4}
2007	6.7×10^{-4}
2008	6.2×10^{-4}

Figure 2.8
Carbon-14 in liquid effluent from the Bruce-A nuclear generating station (1999-2008)
DRL from 1990 to 2000: 4.5×10^{2} TBq; DRL since 2001: 1.1×10^{1} TBq



Year	TBq
1999	8.6×10^{-1}
2000	2.4×10^{-2}
2001	6.4×10^{-3}
2002	1.4×10^{-3}
2003	1.7×10^{-3}
2004	5.7×10^{-3}
2005	8.2×10^{-3}
2006	1.3×10^{-3}
2007	1.8×10^{-3}
2008	9.2×10^{-4}

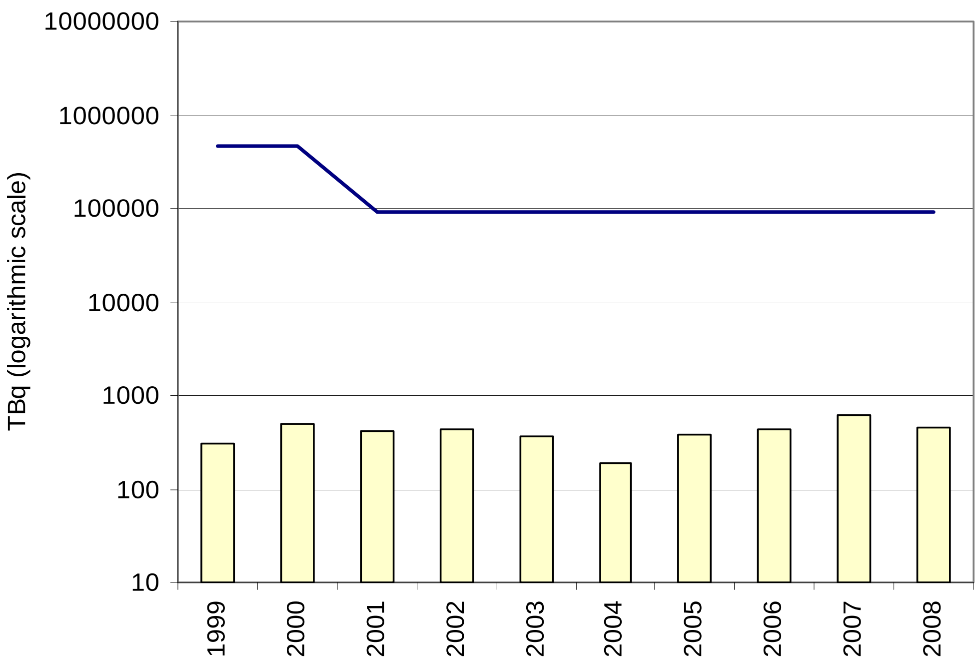
Bruce-B Nuclear Generating Station

The Bruce-B nuclear generating station consists of four nuclear reactors (units 5-8), which began operation in 1984. It is located in Ontario, on the shore of Lake Huron, near the town of Kincardine. The Bruce nuclear generating station is currently operated by Bruce Power Inc.

Radioactive gaseous and liquid effluents released between 1999 and 2008 from the Bruce-B nuclear generating station are represented in the following graphs. The pertinent items in the gaseous effluents are tritium, in the form of tritium oxide (Figure 3.1), iodine-131 (Figure 3.2), noble gases (Figure 3.3), radioactive particulates (Figure 3.4) and carbon-14 (Figure 3.5), while those in the liquid effluents are tritium, in the form of tritium oxide (Figure 3.6), gross beta-gamma activity (Figure 3.7) and carbon-14 (Figure 3.7).

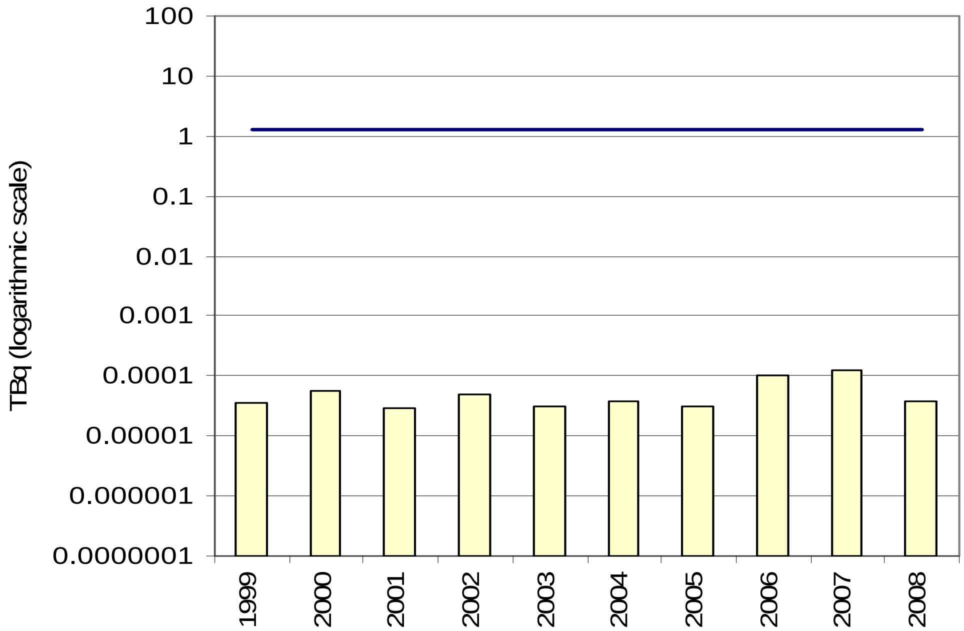
Bruce-B began reporting carbon-14 releases in liquid effluents in 1999, and carbon-14 releases in gaseous effluents starting in 2000.

Figure 3.1
Tritium oxide in gaseous effluent from the Bruce-B nuclear generating station (1999-2008)
DRL from1990 to 2000: 4.7 x 10^5 TBq; DRL since 2001: 9.3 x 10^4 TBq



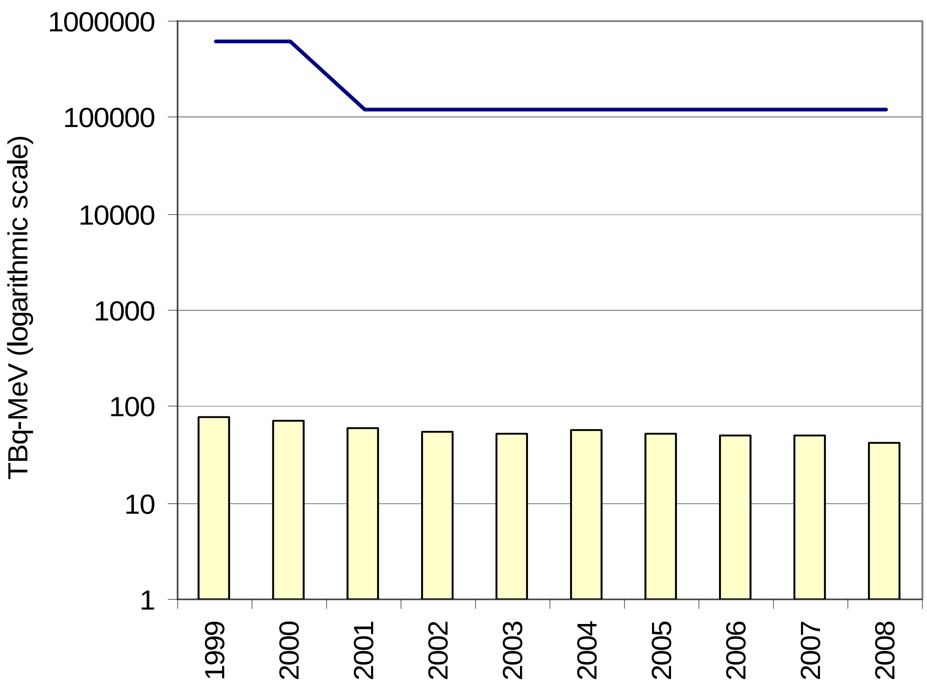
Year	TBq
1999	3.1 x 10^2
2000	4.9 x 10^2
2001	4.2 x 10^2
2002	4.3 x 10^2
2003	3.7 x 10^2
2004	1.9 x 10^2
2005	3.8 x 10^2
2006	4.4 x 10^2
2007	6.3 x 10^2
2008	4.5 x 10^2

Figure 3.2
Iodine-131 in gaseous effluent from the Bruce-B nuclear generating station (1999-2008)
DRL since 1990: 1.3 TBq



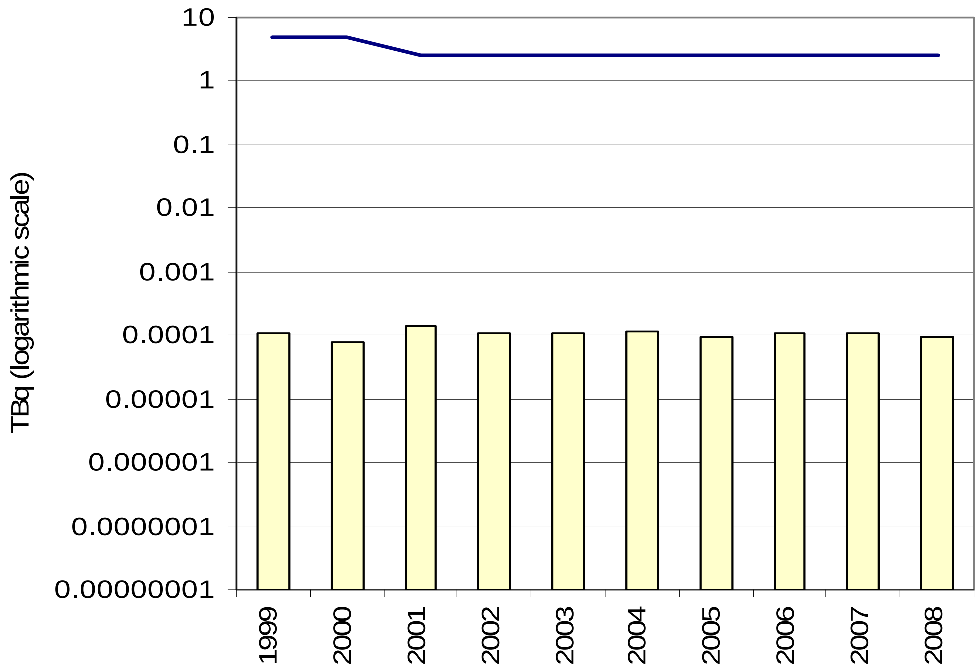
Year	TBq
1999	3.5×10^{-5}
2000	5.5×10^{-5}
2001	2.8×10^{-5}
2002	4.9×10^{-5}
2003	3.2×10^{-5}
2004	3.9×10^{-5}
2005	3.2×10^{-5}
2006	1.0×10^{-4}
2007	1.2×10^{-4}
2008	3.8×10^{-5}

Figure 3.3
Noble gas in gaseous effluent from the Bruce-B nuclear generating station (1999-2008)
DRL from 1990 to 2000: 6.1×10^{5} TBq-MeV; DRL since 2001: 1.2×10^{5} TBq-MeV



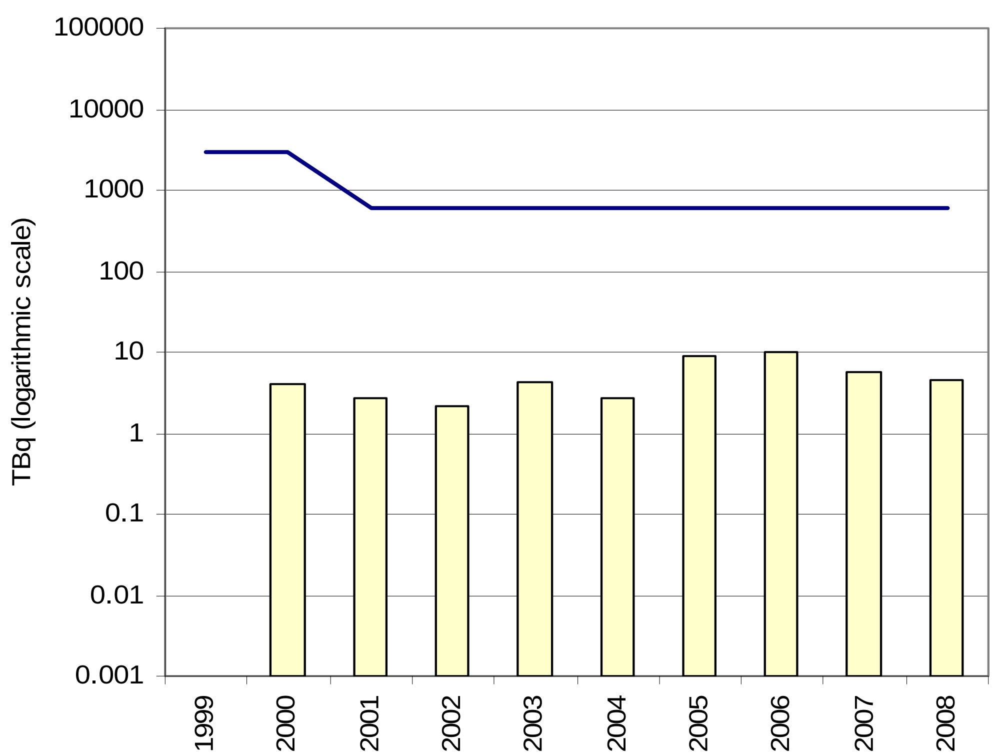
Year	TBq-MeV
1999	79
2000	72
2001	61
2002	56
2003	51
2004	56
2005	53
2006	51
2007	50
2008	43

Figure 3.4
Radioactive particulate in gaseous effluent from the Bruce-B nuclear generating station (1999-2008)
DRL from 1990 to 2000: 4.8 TBq; DRL since 2001: 2.5 TBq



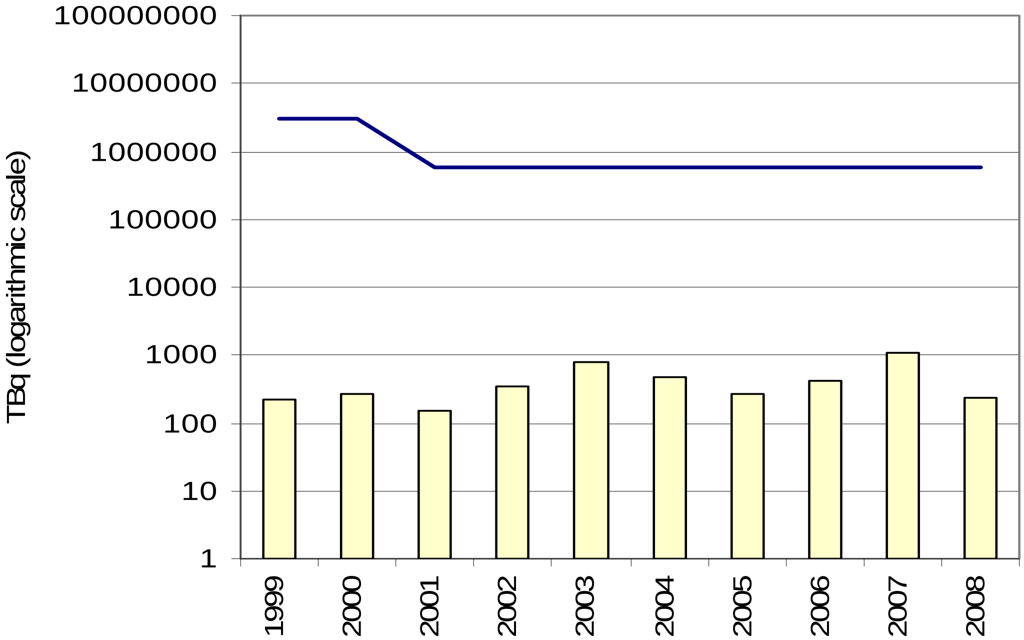
Year	TBq
1999	1.1×10^{-4}
2000	7.9×10^{-5}
2001	1.4×10^{-4}
2002	1.1×10^{-4}
2003	1.1×10^{-4}
2004	1.1×10^{-4}
2005	9.8×10^{-5}
2006	1.1×10^{-4}
2007	1.1×10^{-4}
2008	9.6×10^{-5}

Figure 3.5
Carbon-14 in gaseous effluent from the Bruce-B nuclear generating station (1999-2008)
DRL from 1990 to 2000: 3.0×10^{3} TBq; DRL since 2001: 6.0×10^{2} TBq



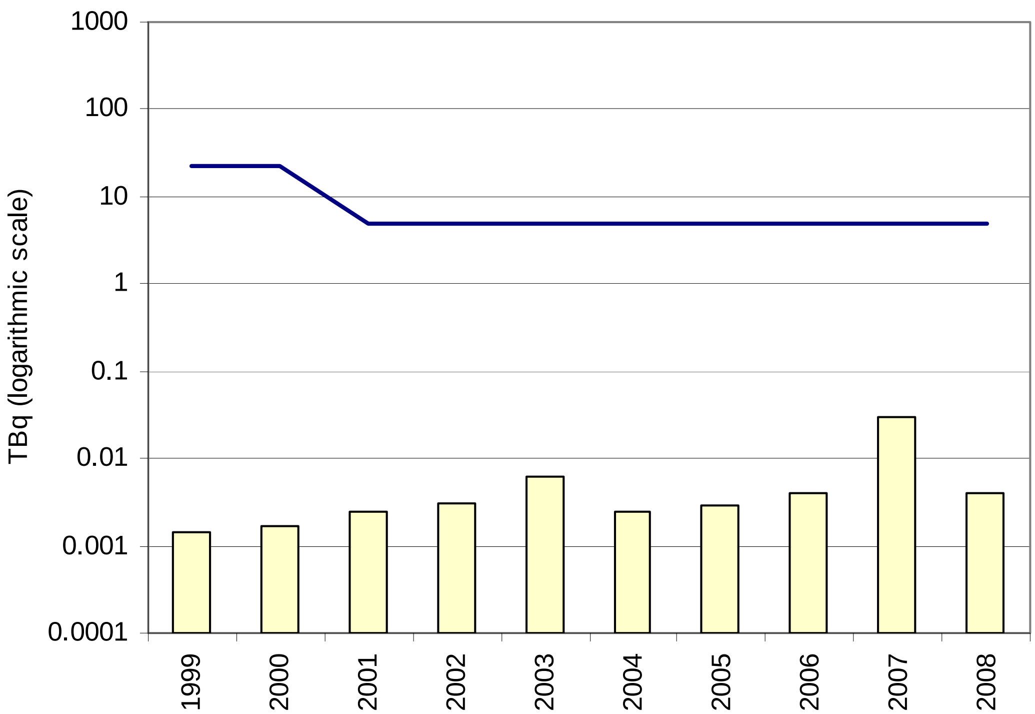
Year	TBq
1999	Not Monitored
2000	4.1
2001	2.7
2002	2.1
2003	4.3
2004	2.6
2005	8.8
2006	10
2007	5.7
2008	4.5

Figure 3.6
Tritium oxide in liquid effluent from the Bruce-B nuclear generating station (1999-2008)
DRL from 1990 to 2000: 3.0 x 10^6 DRL since 2001: 6.0 x 10^5 TBq



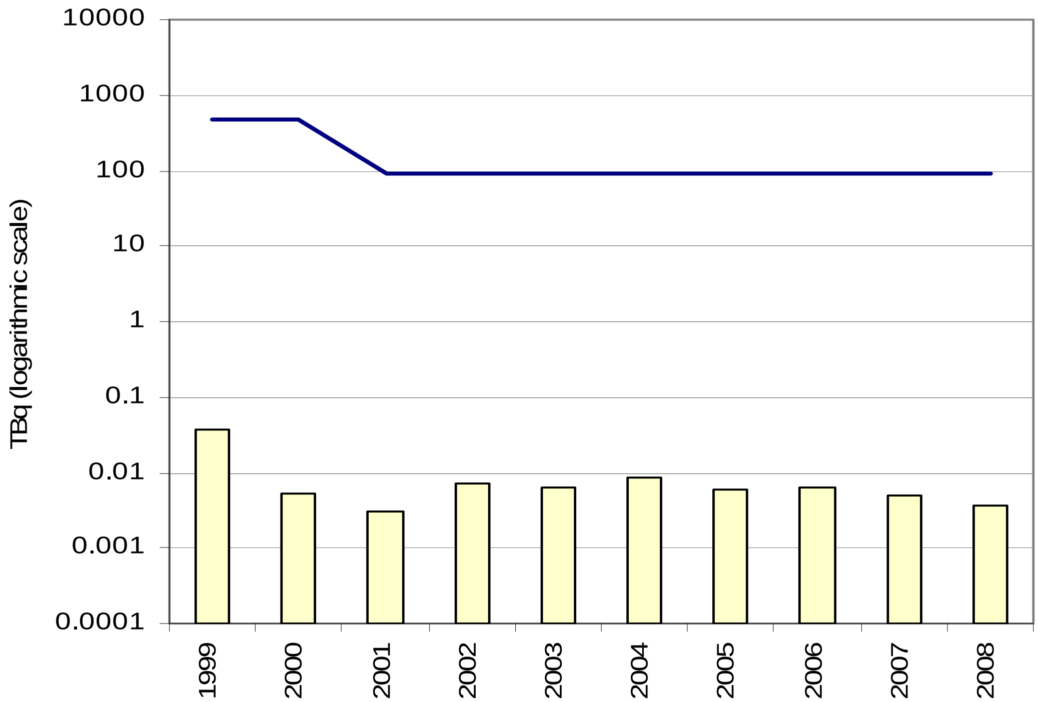
Year	TBq
1999	2.2 x 10^2
2000	2.7 x 10^2
2001	1.5 x 10^2
2002	3.5 x 10^2
2003	8.0 x 10^2
2004	4.9 x 10^2
2005	2.6 x 10^2
2006	4.3 x 10^2
2007	1.1 x 10^3
2008	2.3 x 10^2

Figure 3.7
Gross beta-gamma activity in liquid effluent from the Bruce-B nuclear generating station (1999-2008)
DRL from 1990 to 2000: 2.3 x 10^1 TBq; DRL since 2001: 4.9 TBq



Year	TBq
1999	1.4 x 10^{-3}
2000	1.7 x 10^{-3}
2001	2.4 x 10^{-3}
2002	3.0 x 10^{-3}
2003	6.1 x 10^{-3}
2004	2.5 x 10^{-3}
2005	2.9 x 10^{-3}
2006	3.9 x 10^{-3}
2007	2.9 x 10^{-2}
2008	4.1 x 10^{-3}

Figure 3.8
Carbon-14 in liquid effluent from the Bruce-B nuclear generating station (1999-2008)
DRL from 1990 to 2000: 4.8×10^{2} TBq; DRL since 2001: 9.1×10^{1} TBq



Year	TBq
1999	3.6×10^{-2}
2000	5.2×10^{-3}
2001	3.1×10^{-3}
2002	7.1×10^{-3}
2003	6.5×10^{-3}
2004	8.5×10^{-3}
2005	6.0×10^{-3}
2006	6.3×10^{-3}
2007	5.1×10^{-3}
2008	3.6×10^{-3}

Darlington Nuclear Generating Station

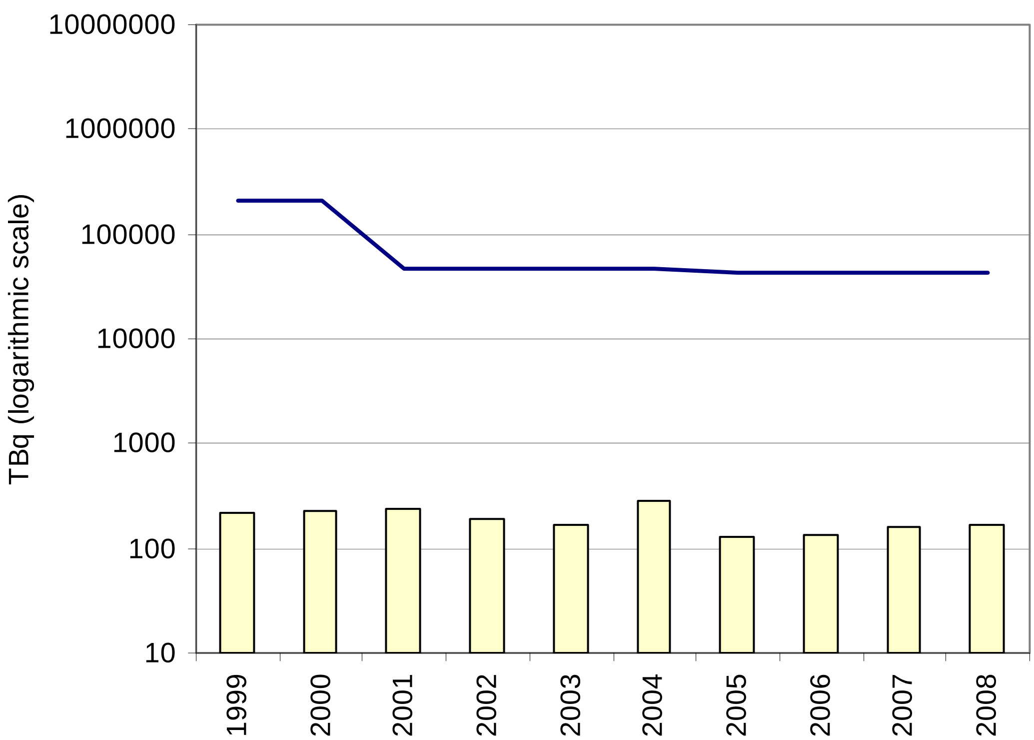
The Darlington nuclear generating station consists of four nuclear reactors (the first of which started up in 1989), and a tritium removal facility, which started operations in 1988. Both facilities are located in Ontario, on the shore of Lake Ontario, near the town of Bowmanville.

Data for radioactive gaseous and liquid effluents released between 1999 and 2008 from the Darlington nuclear generating station are presented in the following graphs. The pertinent items in the gaseous effluents are tritium, in the form of tritium oxide (Figure 4.1) and elemental tritium (Figure 4.2), iodine-131 (Figure 4.3), noble gases (Figure 4.4), radioactive particulates (Figure 4.5) and carbon-14 (Figure 4.6); those in the liquid effluents are tritium, in the form of tritium oxide (Figure 4.7), gross beta-gamma activity (Figure 4.8) and carbon-14 (Figure 4.9).

Gaseous effluent releases of tritium in elemental form occur due to the operation of the tritium removal facility.

Darlington began reporting carbon-14 releases in gaseous and liquid effluents in 1999.

Figure 4.1
Tritium oxide in gaseous effluent from the Darlington nuclear generating station (1999-2008)
DRL from 1989 to 2000: 2.1×10^5 TBq; DRL from 2001 to 2004: 4.6×10^4 TBq; DRL since 2005: 4.3×10^4 TBq

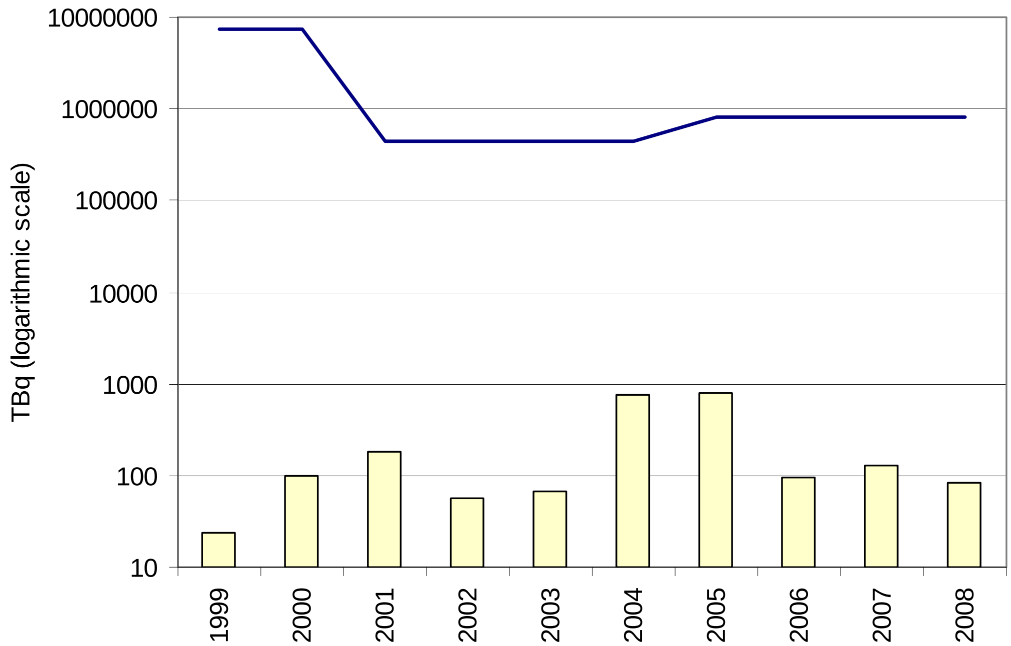


Year	TBq
1999	2.2×10^2
2000	2.3×10^2
2001	2.4×10^2
2002	1.9×10^2
2003	1.7×10^2
2004	2.8×10^2
2005	1.3×10^2
2006	1.3×10^2
2007	1.6×10^2
2008	1.7×10^2

Figure 4.2

Elemental tritium in gaseous effluent from the Darlington nuclear generating station (1999-2008)

DRL from 1993 to 2000: 7.3 x 10^6 TBq; DRL from 2001 to 2004: 4.5 x 10^5 TBq; DRL since 2005: 8.1 x 10^5 TBq

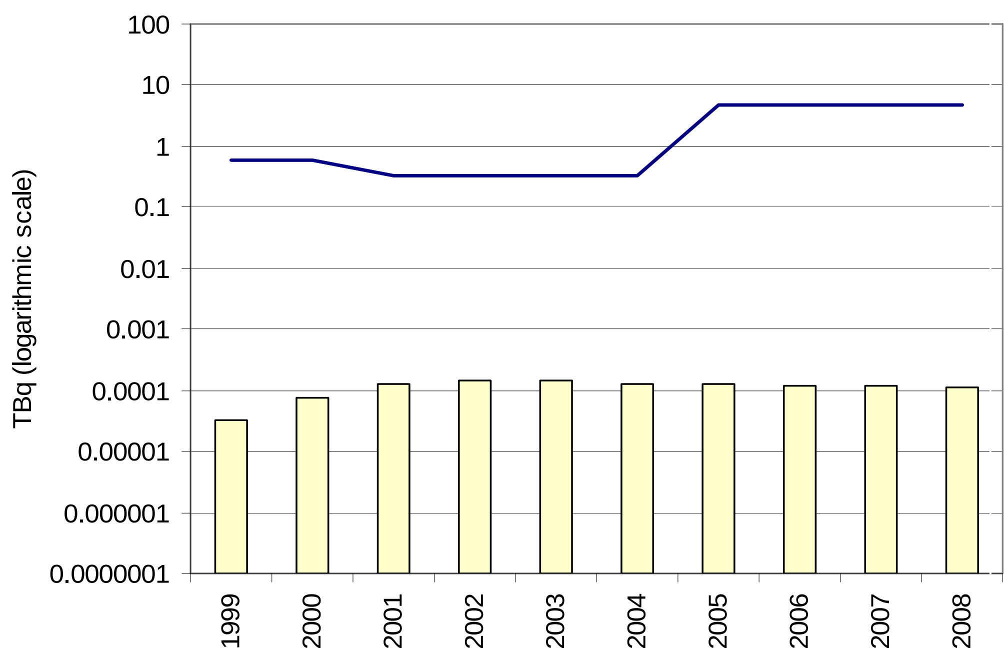


Year	TBq
1999	2.4 x 10^1
2000	1.0 x 10^2
2001	1.8 x 10^2
2002	5.6 x 10^1
2003	6.6 x 10^1
2004	7.5 x 10^2
2005	7.9 x 10^2
2006	9.5 x 10^1
2007	1.3 x 10^2
2008	8.3 x 10^1

Figure 4.3

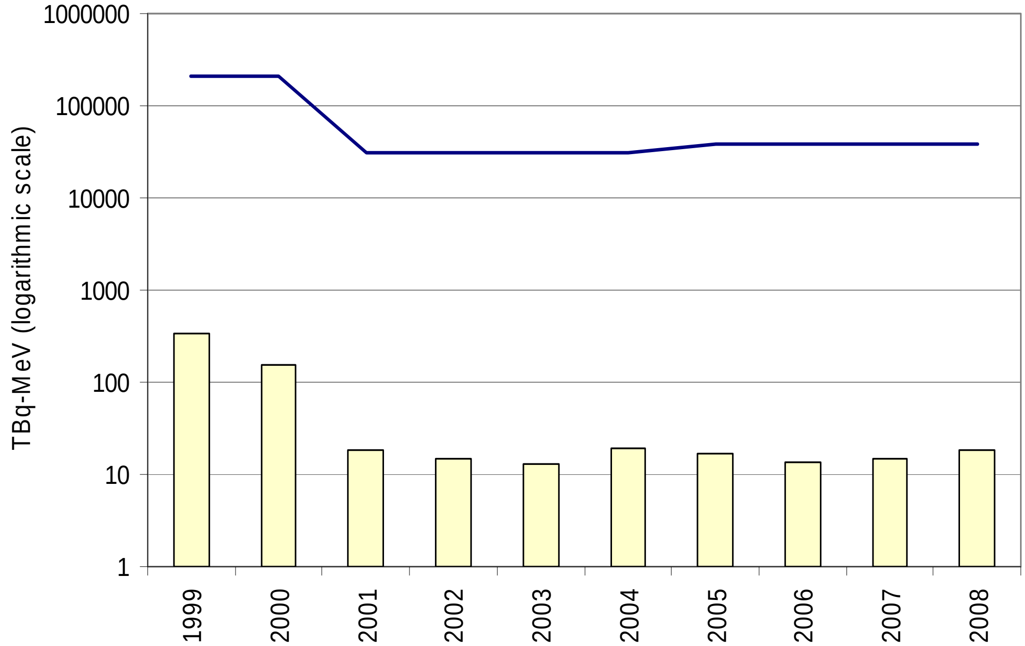
Iodine-131 in gaseous effluent from the Darlington nuclear generating station (1999-2008)

DRL from 1989 to 2000: 6.0 x 10^{-1} TBq; DRL from 2001 to 2004: 3.3 x 10^{-1} TBq; DRL since 2005: 4.7 TBq



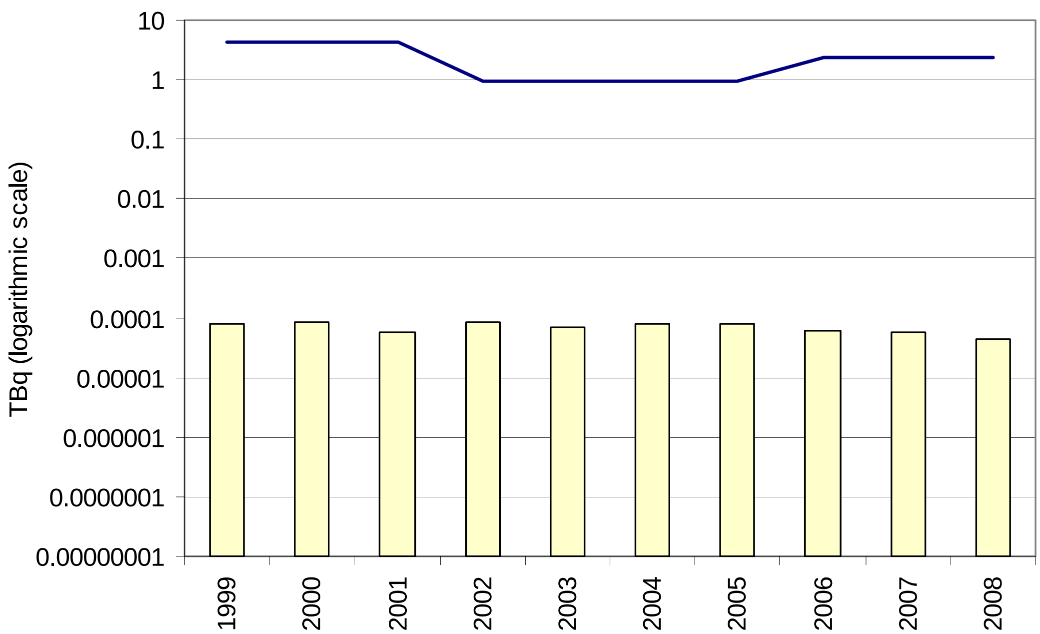
Year	TBq
1999	3.2 x 10^{-5}
2000	7.5 x 10^{-5}
2001	1.3 x 10^{-4}
2002	1.5 x 10^{-4}
2003	1.4 x 10^{-4}
2004	1.3 x 10^{-4}
2005	1.3 x 10^{-4}
2006	1.2 x 10^{-4}
2007	1.2 x 10^{-4}
2008	1.1 x 10^{-4}

Figure 4.4
Noble gas in effluent from the Darlington nuclear generating station (1999-2008)
DRL from 1989 to 2000: 2.1×10^5 TBq-MeV; DRL from 2001 to 2004: 3.1×10^4 TBq-MeV; DRL since 2005: 3.9×10^4 TBq-MeV



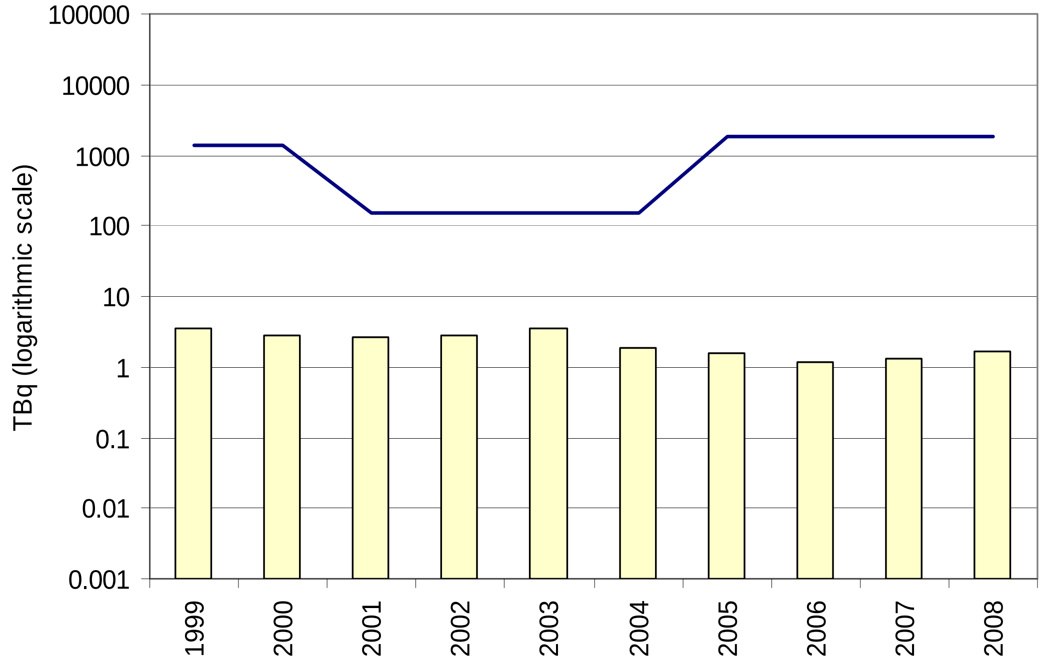
Year	TBq-MeV
1999	3.4×10^2
2000	1.5×10^2
2001	1.8×10^1
2002	1.5×10^1
2003	1.3×10^1
2004	1.9×10^1
2005	1.7×10^1
2006	1.4×10^1
2007	1.5×10^1
2008	1.8×10^1

Figure 4.5
Radioactive particulate in gaseous effluent from the Darlington nuclear generating station (1999-2008)
DRL from 1989 to 2000: 4.4 TBq; DRL from 2001 to 2004: 9.4×10^{-1} TBq; DRL since 2005: 2.4 TBq



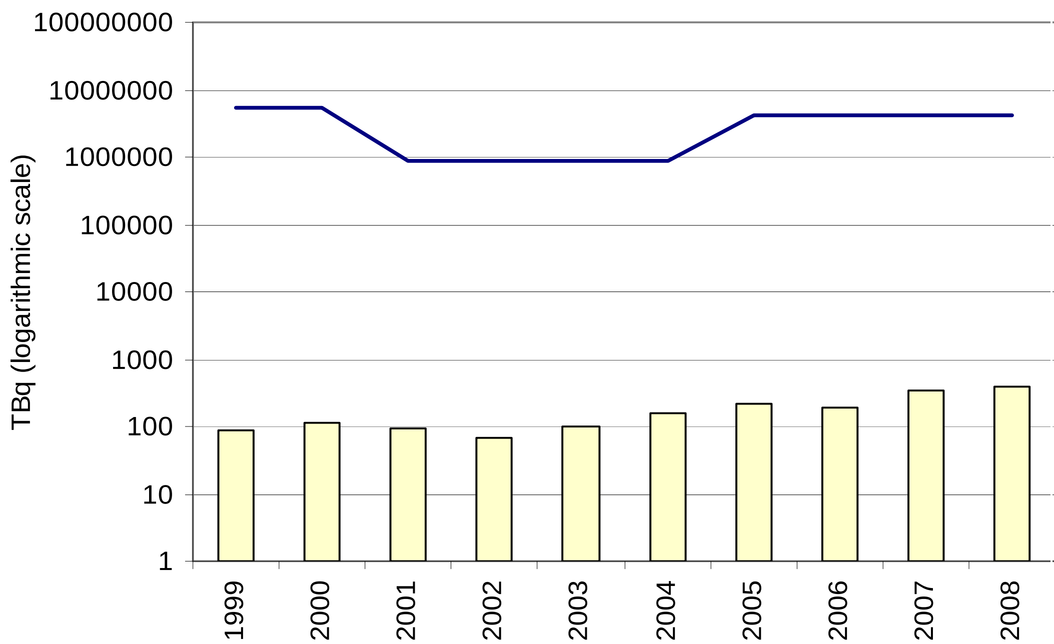
Year	TBq
1999	8.2×10^{-5}
2000	8.6×10^{-5}
2001	5.6×10^{-5}
2002	8.7×10^{-5}
2003	6.9×10^{-5}
2004	8.0×10^{-5}
2005	7.8×10^{-5}
2006	6.3×10^{-5}
2007	5.9×10^{-5}
2008	4.3×10^{-5}

Figure 4.6
Carbon-14 in gaseous effluent from the Darlington nuclear generating station (1999-2008)
DRL from 1989 to 2000: 1.4 x 10^3 TBq; DRL from 2001 to 2004: 1.5 x 10^2 TBq; DRL since 2005: 1.8 x 10^3 TBq



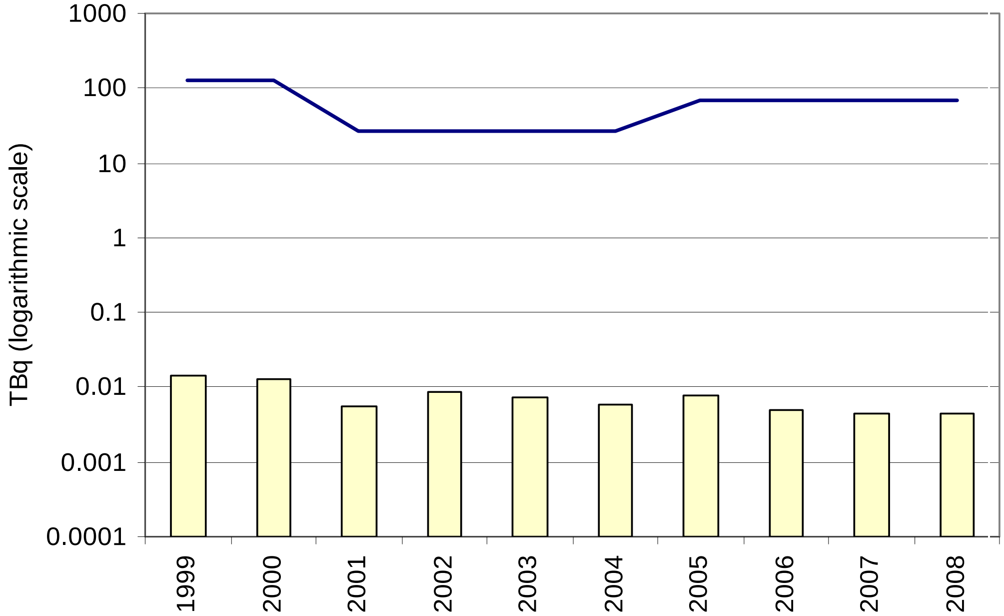
Year	TBq
1999	3.5
2000	2.8
2001	2.6
2002	2.8
2003	3.5
2004	1.9
2005	1.6
2006	1.2
2007	1.3
2008	1.7

Figure 4.7
Tritium oxide in liquid effluent from the Darlington nuclear generating station (1999-2008)
DRL from 1989 to 2000: 5.3 x10^6 TBq; DRL from 2001 to 2004: 8.8 x 10^5 TBq; DRL since 2005: 4.3 x 10^6 TBq



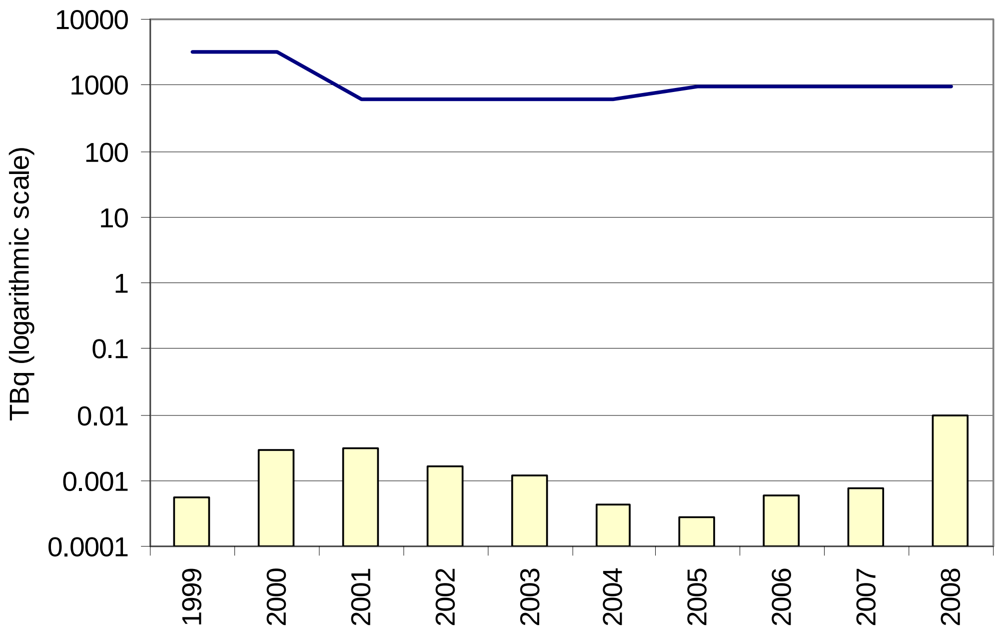
Year	TBq
1999	8.9 x 10^1
2000	1.1 x 10^2
2001	9.4 x 10^1
2002	6.9 x 10^1
2003	1.0 x 10^2
2004	1.6 x 10^2
2005	2.2 x 10^2
2006	1.9 x 10^2
2007	3.5 x 10^2
2008	3.9 x 10^2

Figure 4.8
Gross beta-gamma activity in liquid effluent from the Darlington nuclear generating station (1999-2008)
DRL from 1989 to 2000: 1.3×10^{2} TBq; DRL from 2001 to 2004: 2.6×10^{1} TBq; DRL since 2005: 7.1×10^{1} TBq



Year	TBq
1999	1.4×10^{-2}
2000	1.3×10^{-2}
2001	5.6×10^{-3}
2002	8.5×10^{-3}
2003	7.3×10^{-3}
2004	5.7×10^{-3}
2005	7.8×10^{-3}
2006	4.8×10^{-3}
2007	4.5×10^{-3}
2008	4.5×10^{-3}

Figure 4.9
Carbon-14 in liquid effluent from the Darlington nuclear generating station (1999-2008)
DRL from 1989 to 2000: 3.2×10^{3} TBq; DRL from 2001 to 2004: 6.0×10^{2} TBq; DRL since 2005: 9.7×10^{2} TBq



Year	TBq
1999	5.7×10^{-4}
2000	2.8×10^{-3}
2001	3.0×10^{-3}
2002	1.7×10^{-3}
2003	1.2×10^{-3}
2004	4.3×10^{-4}
2005	2.8×10^{-4}
2006	5.9×10^{-4}
2007	7.6×10^{-4}
2008	9.5×10^{-3}

Pickering-A Nuclear Generating Station

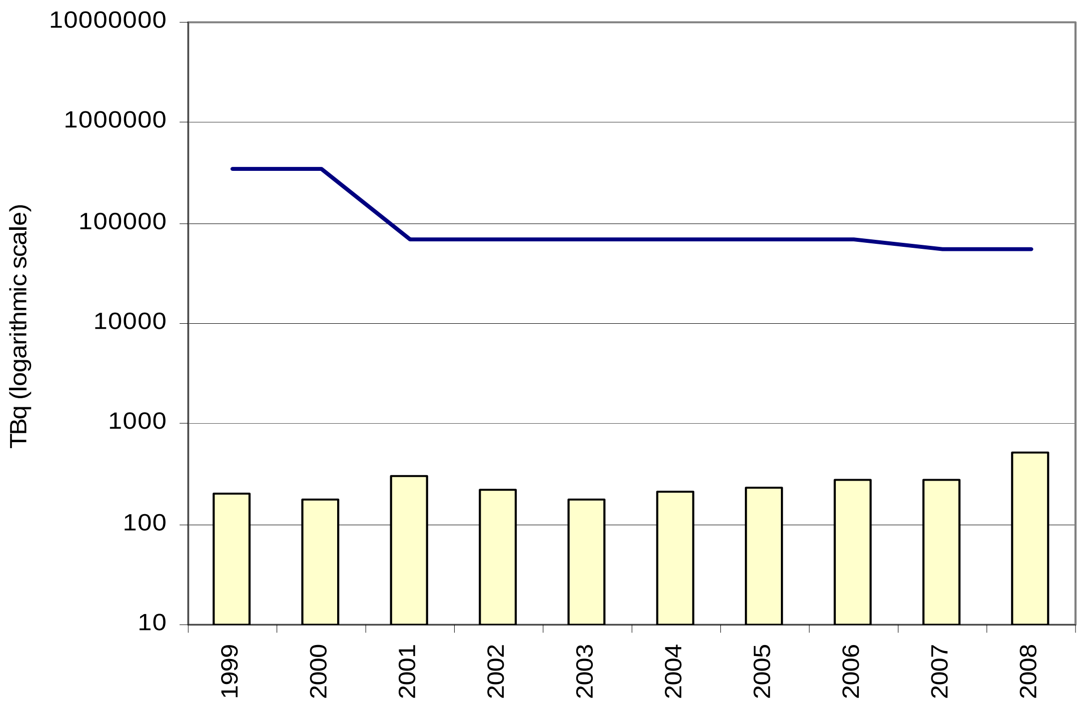
The Pickering-A nuclear generating station consists of four nuclear reactors (units 1-4), which began operation in 1971. It is located in Ontario, on the shores of Lake Ontario, near the town of Pickering.

In 1997, as part of its extensive recovery program, Ontario Hydro (now Ontario Power Generation) temporarily shut down all Pickering-A reactors, and the reactors were maintained in a guaranteed shut-down state. Unit 4 was restarted in September 2003, and Unit 1 was returned to service in 2005.

Data for radioactive gaseous and liquid effluents released between 1999 and 2008 from the Pickering-A nuclear generating station are presented in the following graphs. The pertinent items in the gaseous effluents are tritium, in the form of tritium oxide (Figure 5.1), iodine-131 (Figure 5.2), noble gases (Figure 5.3), radioactive particulates (Figure 5.4) and carbon-14 (Figure 5.5); those in the liquid effluents are tritium, in the form of tritium oxide (Figure 5.6) and gross beta-gamma activity (Figure 5.7).

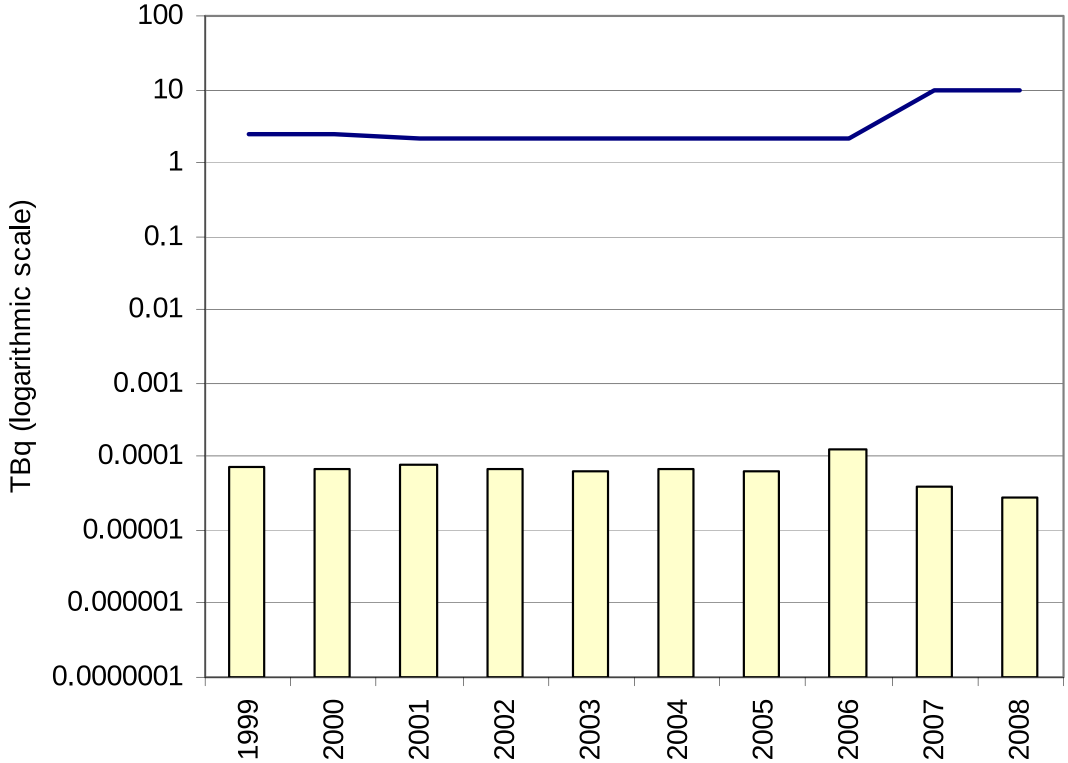
Since 1999, carbon-14 releases in liquid effluent from Pickering A have been reported in the carbon-14 liquid release data for Pickering B.

Figure 5.1
Tritium oxide in gaseous effluent from the Pickering-A nuclear generating station (1999-2008)
DRL from 1992 to 2000: 3.4×10^5 TBq; DRL from 2001 to 2006: 7.0×10^4 TBq; DRL since 2007: 5.5×10^4 TBq



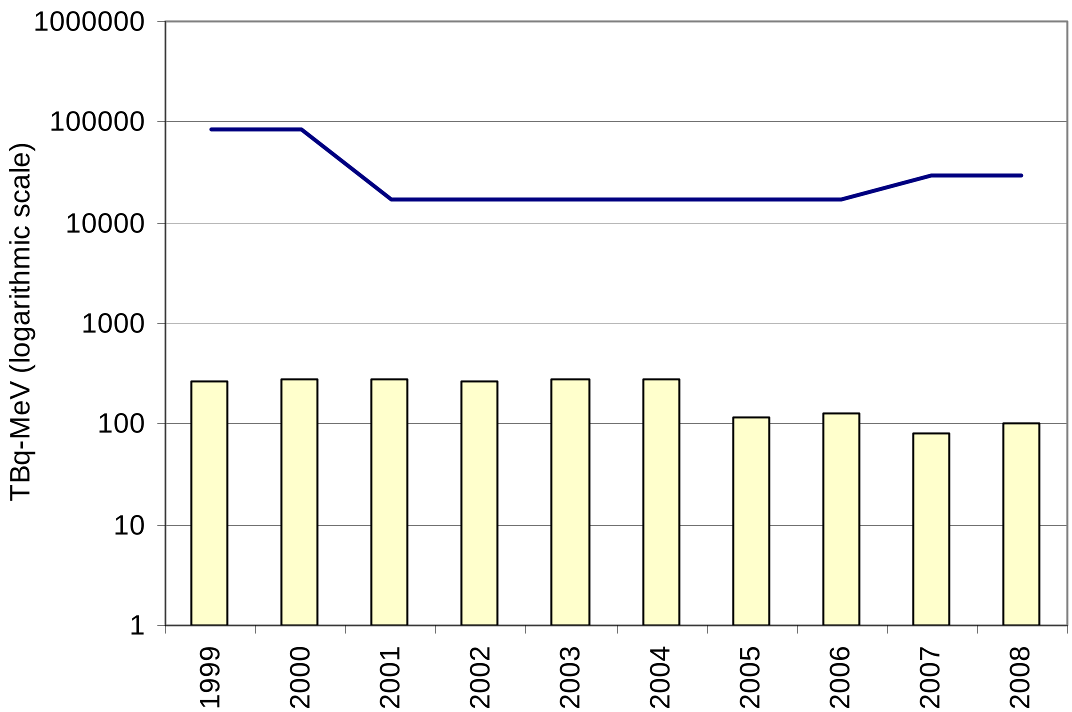
Year	TBq
1999	2.0×10^2
2000	1.8×10^2
2001	3.1×10^2
2002	2.3×10^2
2003	1.7×10^2
2004	2.1×10^2
2005	2.4×10^2
2006	2.7×10^2
2007	2.8×10^2
2008	5.2×10^2

Figure 5.2
Iodine-131 in gaseous effluent from the Pickering-A nuclear generating station (1999-2008)
DRL from 1992 to 2000: 2.4 TBq; DRL from 2001 to 2006: 2.2 TBq; DRL since 2007: 9.7 TBq



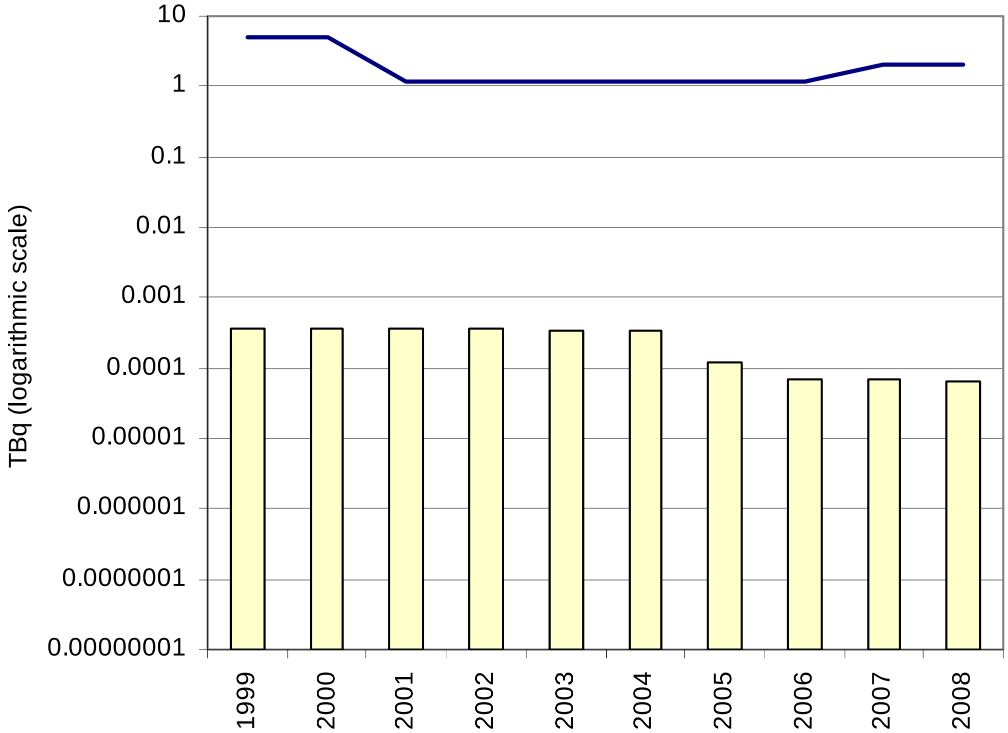
Year	TBq
1999	7.2×10^{-5}
2000	6.7×10^{-5}
2001	7.8×10^{-5}
2002	6.7×10^{-5}
2003	6.4×10^{-5}
2004	6.9×10^{-5}
2005	6.1×10^{-5}
2006	1.2×10^{-4}
2007	3.9×10^{-5}
2008	2.8×10^{-5}

Figure 5.3
Noble gas in gaseous effluent from the Pickering-A nuclear generating station (1999-2008)
DRL from 1992 to 2000: 8.3×10^4 TBq-MeV; DRL from 2001 to 2006: 1.7×10^4 TBq-MeV; DRL since 2007: 2.9×10^4 TBq-MeV



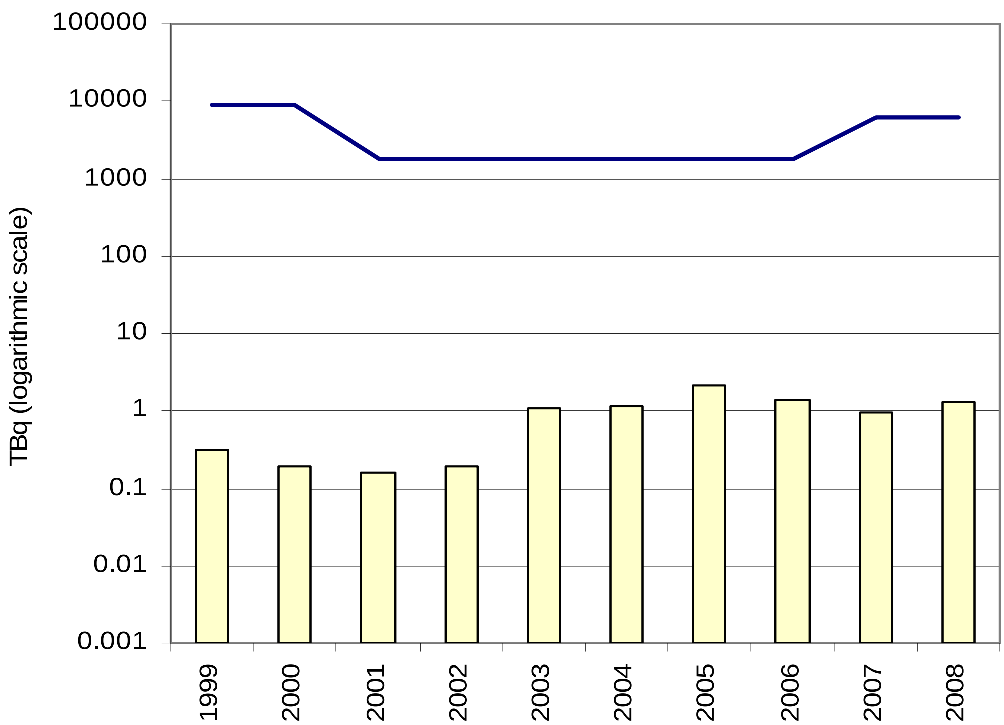
Year	TBq-MeV
1999	2.6×10^{2}
2000	2.7×10^{2}
2001	2.8×10^{2}
2002	2.7×10^{2}
2003	2.8×10^{2}
2004	2.8×10^{2}
2005	1.2×10^{2}
2006	1.3×10^{2}
2007	8.2×10^{1}
2008	1.0×10^{2}

Figure 5.4
Radioactive particulate in gaseous effluent from the Pickering-A nuclear generating station (1999-2008)
DRL from 1992 to 2000: 5.0 TBq; DRL from 2001 to 2006: 1.2 TBq; DRL since 2007: 2.1 TBq



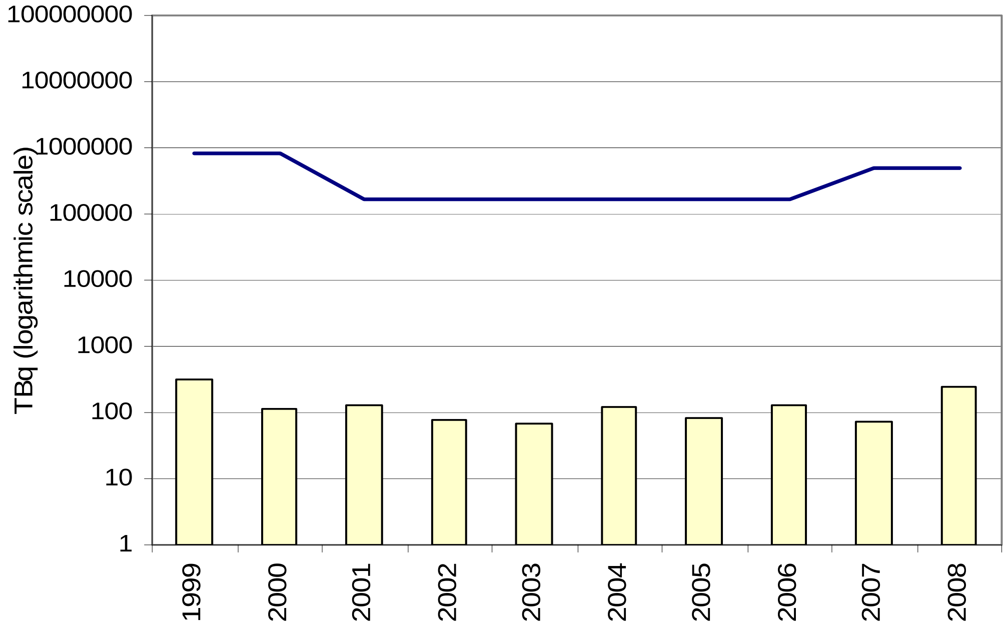
Year	TBq
1999	3.6×10^{-4}
2000	3.5×10^{-4}
2001	3.5×10^{-4}
2002	3.6×10^{-4}
2003	3.4×10^{-4}
2004	3.5×10^{-4}
2005	1.2×10^{-4}
2006	6.7×10^{-4}
2007	7.0×10^{-5}
2008	6.6×10^{-5}

Figure 5.5
Carbon-14 in gaseous effluent from the Pickering-A nuclear generating station (1999-2008)
DRL from 1992 to 2000: 8.8×10^3 TBq; DRL from 2001 to 2006: 1.8×10^3 TBq; DRL since 2007: 6.3×10^3 TBq



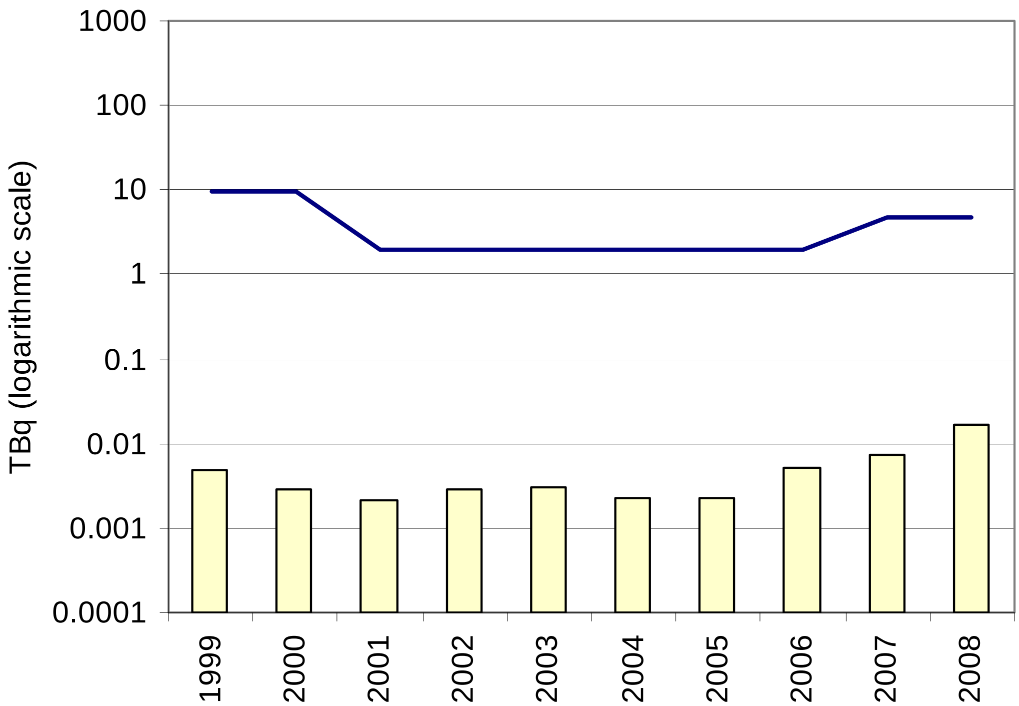
Year	TBq
1999	0.32
2000	0.19
2001	0.16
2002	0.19
2003	1.1
2004	1.2
2005	2.1
2006	1.4
2007	0.94
2008	1.3

Figure 5.6
Tritium oxide in liquid effluent from the Pickering-A nuclear generating station (1999-2008)
DRL from 1992 to 2000: 8.3 x 10^5 TBq; DRL from 2001 to 2006: 1.7 x 10^5 TBq; DRL since 2007: 5.1 x 10^5 TBq



Year	TBq
1999	3.2 x 10^2
2000	1.2 x 10^2
2001	1.3 x 10^2
2002	7.7 x 10^1
2003	6.8 x 10^1
2004	1.2 x 10^2
2005	8.2 x 10^1
2006	1.3 x 10^2
2007	7.1 x 10^1
2008	2.5 x 10^2

Figure 5.7
Gross beta-gamma activity in liquid effluent from the Pickering-A nuclear generating station (1999-2008)
DRL from 1992 to 2000: 9.7 TBq; DRL from 2001 to 2006: 2.0 TBq; DRL since 2007: 4.7 TBq



Year	TBq
1999	4.8 x 10^{-3}
2000	2.9 x 10^{-3}
2001	2.1 x 10^{-3}
2002	2.9 x 10^{-3}
2003	3.1 x 10^{-3}
2004	2.3 x 10^{-3}
2005	2.2 x 10^{-3}
2006	5.0 x 10^{-3}
2007	7.2 x 10^{-3}
2008	1.7 x 10^{-2}

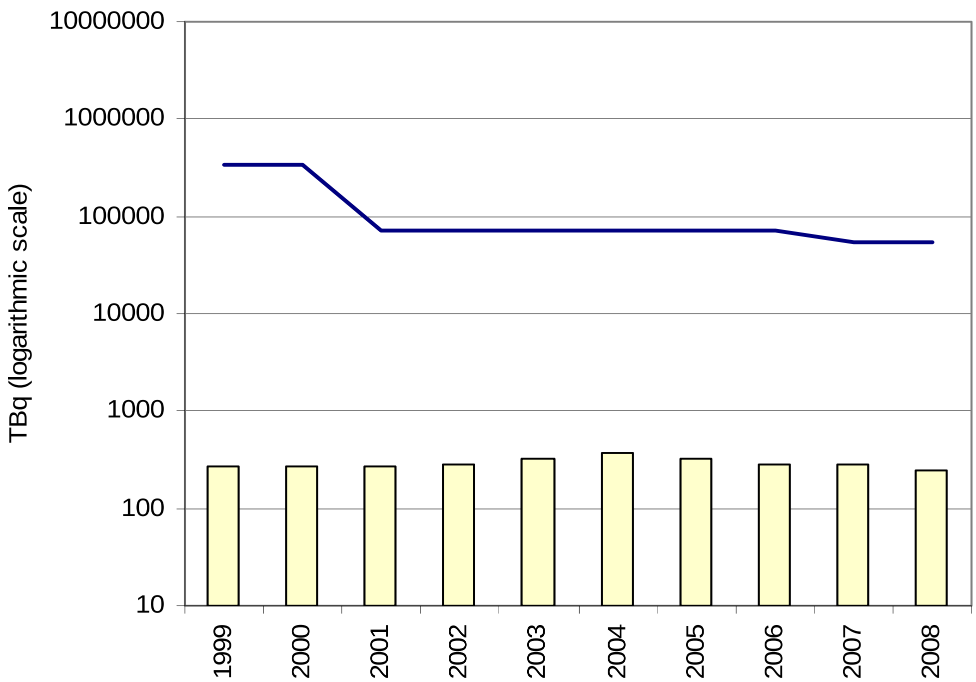
Pickering-B Nuclear Generating Station

The Pickering-B nuclear generating station consists of four nuclear reactors (units 5-8), which began operation in 1982. It is located in Ontario, on the shore of Lake Ontario, near the town of Pickering.

Data for radioactive gaseous and liquid effluents released between 1999 and 2008 from the Pickering-B nuclear generating station are presented in the following graphs. The pertinent items in the gaseous effluents are tritium, in the form of tritium oxide (Figure 6.1), iodine-131 (Figure 6.2), noble gases (Figure 6.3), radioactive particulates (Figure 6.4) and carbon-14 (Figure 6.5); those in the liquid effluents are tritium, in the form of tritium oxide (Figure 6.6), gross beta-gamma activity (Figure 6.7) and carbon-14 (Figure 6.8).

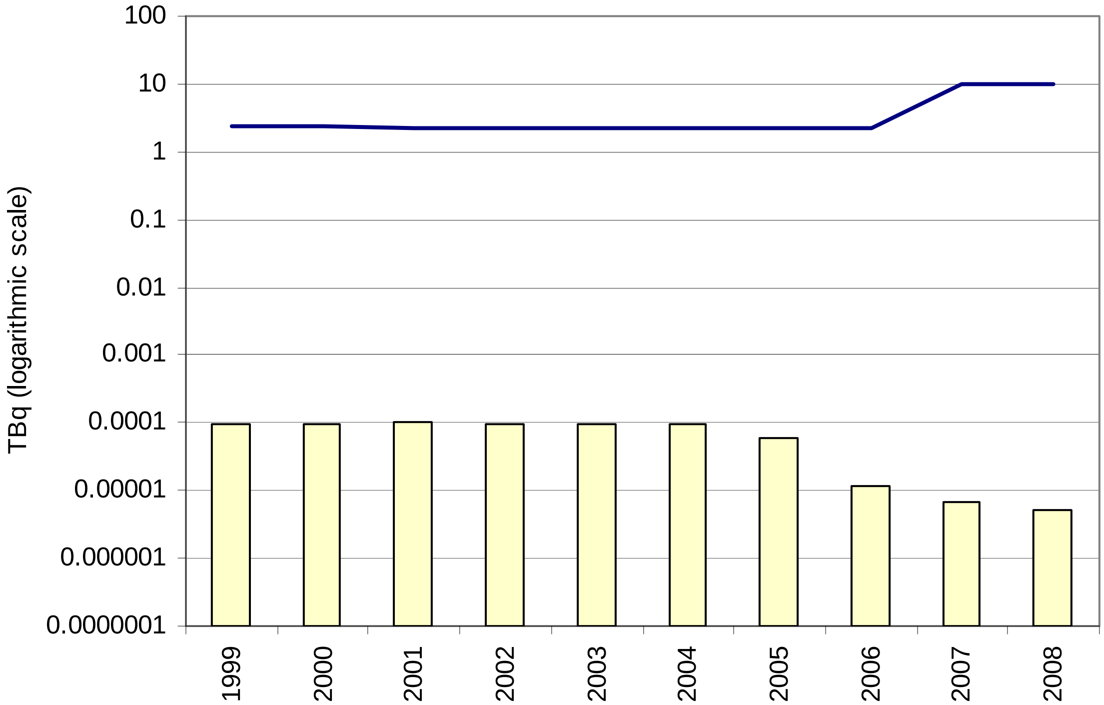
Pickering-B began reporting carbon-14 in liquid releases in 1999 (including Pickering A releases), and reporting carbon-14 in gaseous releases in 2000.

Figure 6.1
Tritium oxide in gaseous effluent from the Pickering-B nuclear generating station (1999-2008)
DRL from 1992 to 2000: 3.4×10^5 TBq; DRL from 2001 to 2006: 7.0×10^4 TBq; DRL since 2007: 5.5×10^4 TBq



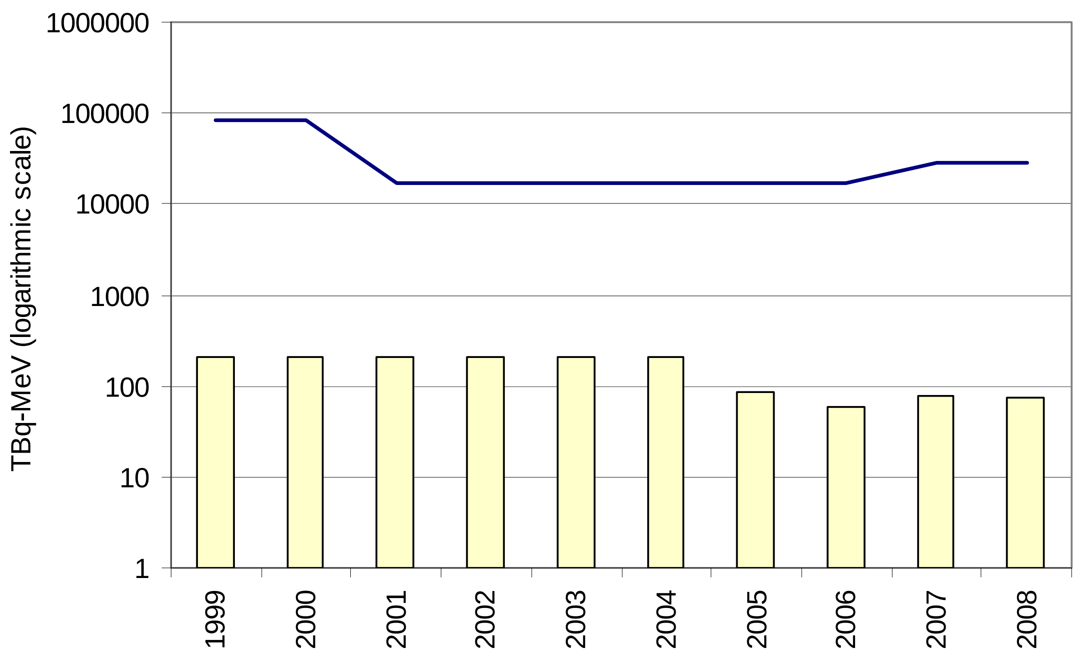
Year	TBq
1999	2.7×10^2
2000	2.7×10^2
2001	2.7×10^2
2002	2.8×10^2
2003	3.3×10^2
2004	3.8×10^2
2005	3.3×10^2
2006	2.9×10^2
2007	2.8×10^2
2008	2.4×10^2

Figure 6.2
Iodine-131 in gaseous effluent from the Pickering-B nuclear generating station (1999-2008)
DRL from 1992 to 2000: 2.4 TBq; DRL from 2001 to 2006: 2.2 TBq; DRL since 2007: 9.7 TBq



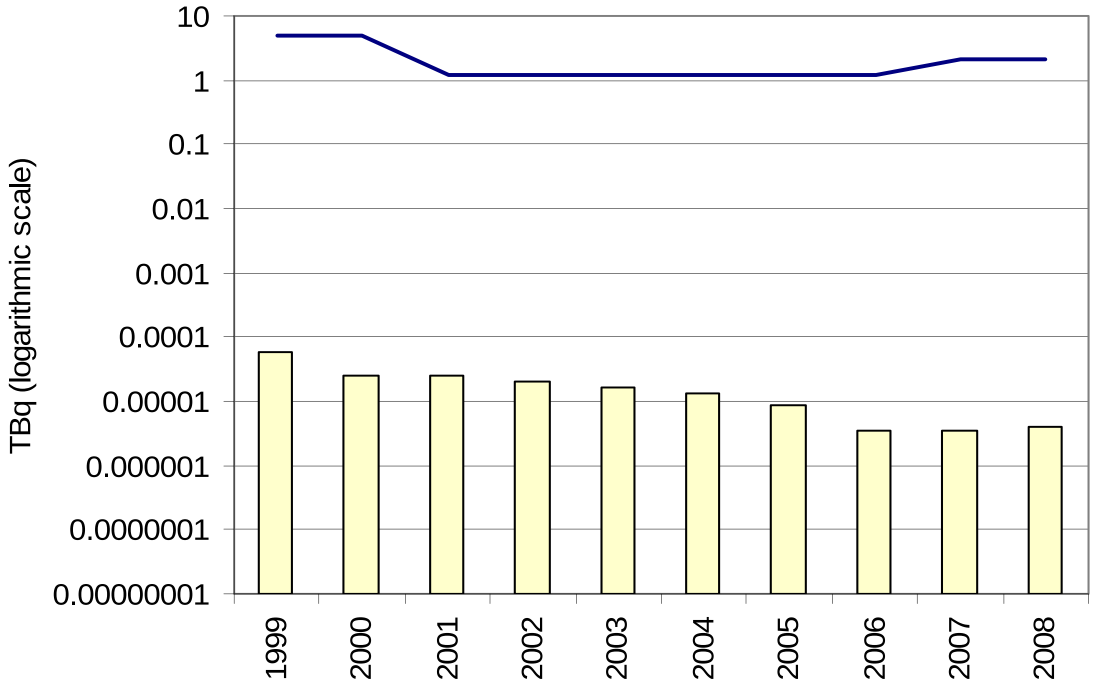
Year	TBq
1999	9.6×10^{-5}
2000	9.8×10^{-5}
2001	1.0×10^{-4}
2002	9.8×10^{-5}
2003	9.7×10^{-5}
2004	9.7×10^{-5}
2005	6.0×10^{-5}
2006	1.2×10^{-5}
2007	6.8×10^{-6}
2008	5.1×10^{-6}

Figure 6.3
Noble gas in gaseous effluent from the Pickering-B nuclear generating station (1999-2008)
DRL from 1992 to 2000: 8.3×10^4 TBq-MeV; DRL from 2001 to 2006: 1.7×10^4 TBq-MeV; DRL since 2007: 2.9×10^4 TBq-MeV



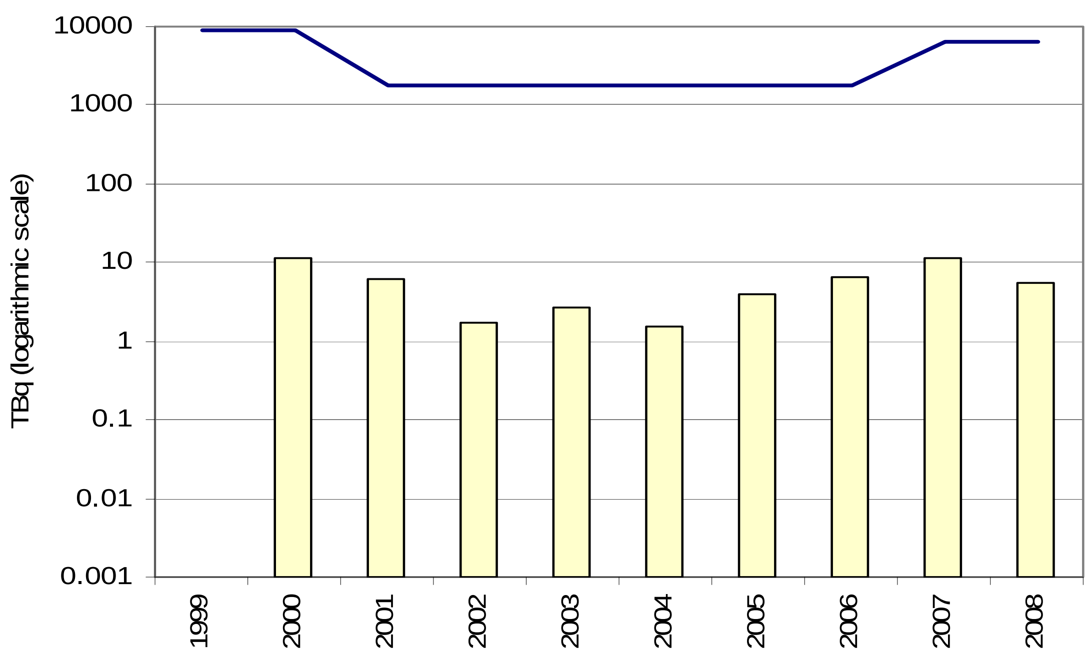
Year	TBq-MeV
1999	2.1×10^{2}
2000	2.1×10^{2}
2001	2.1×10^{2}
2002	2.0×10^{2}
2003	2.0×10^{2}
2004	2.1×10^{2}
2005	8.7×10^{1}
2006	5.8×10^{1}
2007	7.7×10^{1}
2008	7.4×10^{1}

Figure 6.4
Radioactive particulate in gaseous effluent from the Pickering-B nuclear generating station (1999-2008)
DRL from 1992 to 2000: 5.0 TBq; DRL from 2001 to 2006: 1.2 TBq; DRL since 2007: 2.1 TBq



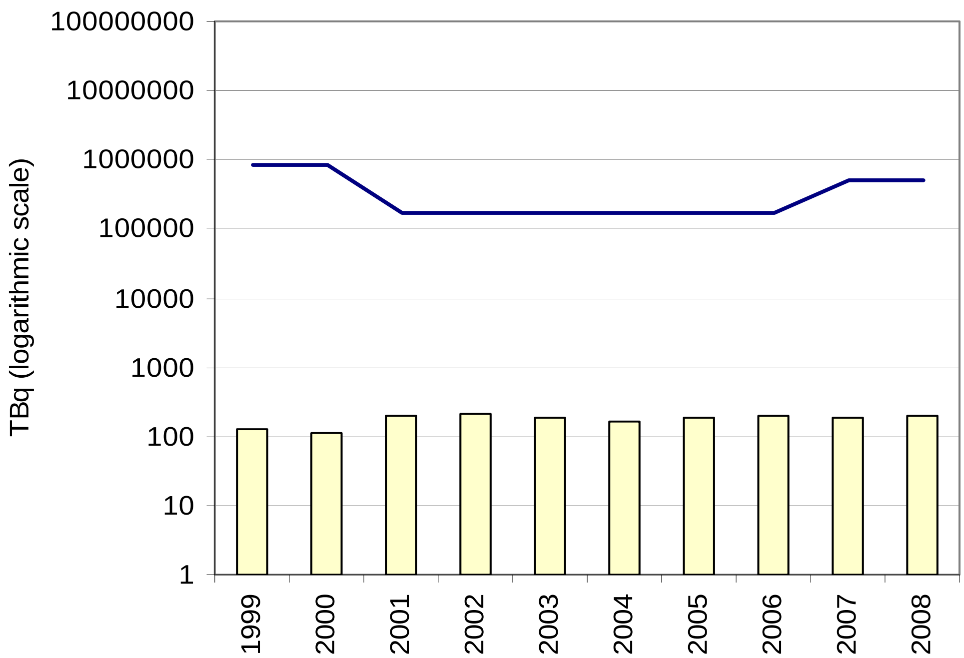
Year	TBq
1999	5.7×10^{-5}
2000	2.4×10^{-5}
2001	2.6×10^{-5}
2002	2.0×10^{-5}
2003	1.6×10^{-5}
2004	1.3×10^{-5}
2005	9.0×10^{-6}
2006	3.4×10^{-6}
2007	3.5×10^{-6}
2008	4.0×10^{-6}

Figure 6.5
Carbon-14 in gaseous effluent from the Pickering-B nuclear generating station (1999-2008)
DRL from 1992-2000: 8.8×10^3 TBq; DRL from 2001 to 2006: 1.8×10^3 TBq; DRL since 2007: 6.3×10^3 TBq



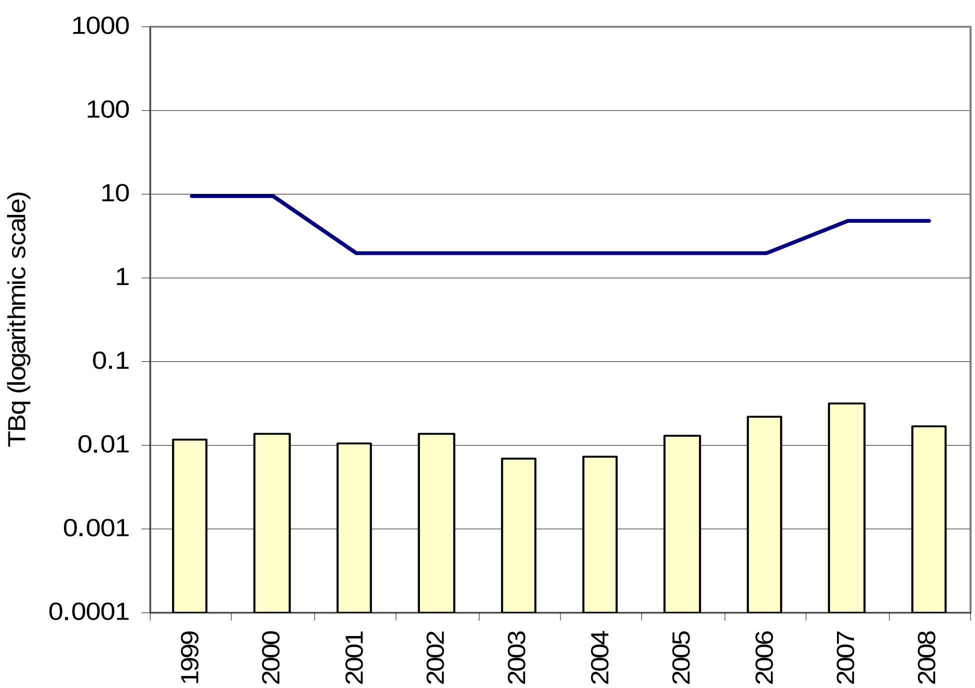
Year	TBq
1999	Not Monitored
2000	11
2001	6.3
2002	1.8
2003	2.6
2004	1.6
2005	3.9
2006	6.7
2007	11
2008	5.4

Figure 6.6
Tritium oxide in liquid effluent from the Pickering-B nuclear generating station (1999-2008)
DRL from 1992 to 2000: 8.3 x 10^5 TBq; DRL from 2001 to 2006: 1.7 x 10^5 TBq; DRL since 2007: 5.1 x 10^5 TBq



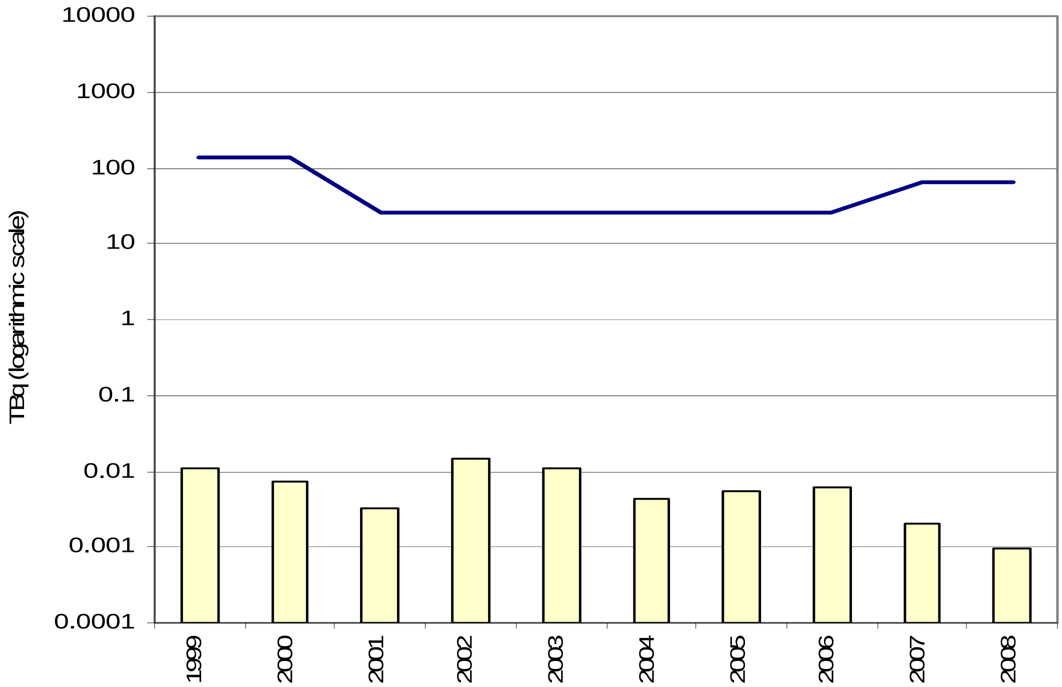
Year	TBq
1999	1.3 x 10^2
2000	1.1 x 10^2
2001	2.0 x 10^2
2002	2.1 x 10^2
2003	1.9 x 10^2
2004	1.7 x 10^2
2005	1.8 x 10^2
2006	2.0 x 10^2
2007	1.8 x 10^2
2008	2.0 x 10^2

Figure 6.7
Gross beta-gamma activity in liquid effluent from the Pickering-B nuclear generating station (1999-2008)
DRL from 1992 to 2000: 9.7 TBq; DRL from 2001 to 2006: 2.0 TBq; DRL since 2007: 4.7 TBq



Year	TBq
1999	1.2 x 10^{-2}
2000	1.3 x 10^{-2}
2001	1.1 x 10^{-2}
2002	1.4 x10^{-2}
2003	7.0 x 10^{-3}
2004	7.2 x 10^{-3}
2005	1.3 x 10^{-2}
2006	2.2 x 10^{-2}
2007	3.2 x 10^{-2}
2008	1.7 x 10^{-2}

Figure 6.8
Carbon-14 in liquid effluent from the Pickering-B including Pickering A nuclear generating station (1999-2008)
DRL from 1992 to 2000: 1.4×10^{2} TBq; DRL from 2001 to 2006: 2.6×10^{1} TBq; DRL since 2007: 6.4×10^{1} TBq



Year	TBq
1999	1.1×10^{-2}
2000	7.3×10^{-3}
2001	3.3×10^{-3}
2002	1.5×10^{-2}
2003	1.1×10^{-2}
2004	4.4×10^{-3}
2005	5.5×10^{-3}
2006	6.2×10^{-3}
2007	2.0×10^{-3}
2008	9.9×10^{-4}

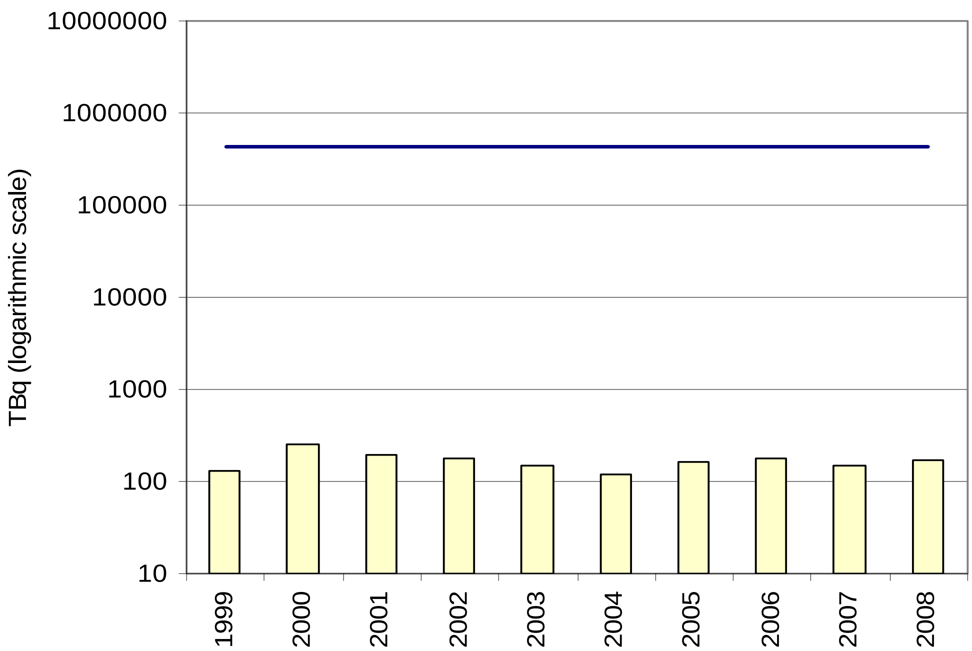
Gentilly-2 Nuclear Generating Station

The Gentilly-2 nuclear generating station consists of one nuclear reactor which became operational in 1982. It is located in Québec, on the Saint Lawrence River, near the city of Trois-Rivières.

Data for radioactive gaseous and liquid effluents released between 1999 and 2008 from the Gentilly-2 nuclear generating station are presented in the following graphs. The pertinent items in the gaseous effluents are tritium, in the form of tritium oxide (Figure 7.1), iodine-131 (Figure 7.2), noble gases (Figure 7.3), radioactive particulate (Figure 7.4) and carbon-14 (Figure 7.5); those in the liquid effluents are tritium, in the form of tritium oxide (Figure 7.6), gross beta-gamma activity (Figure 7.7) and carbon-14 (Figure 7.8).

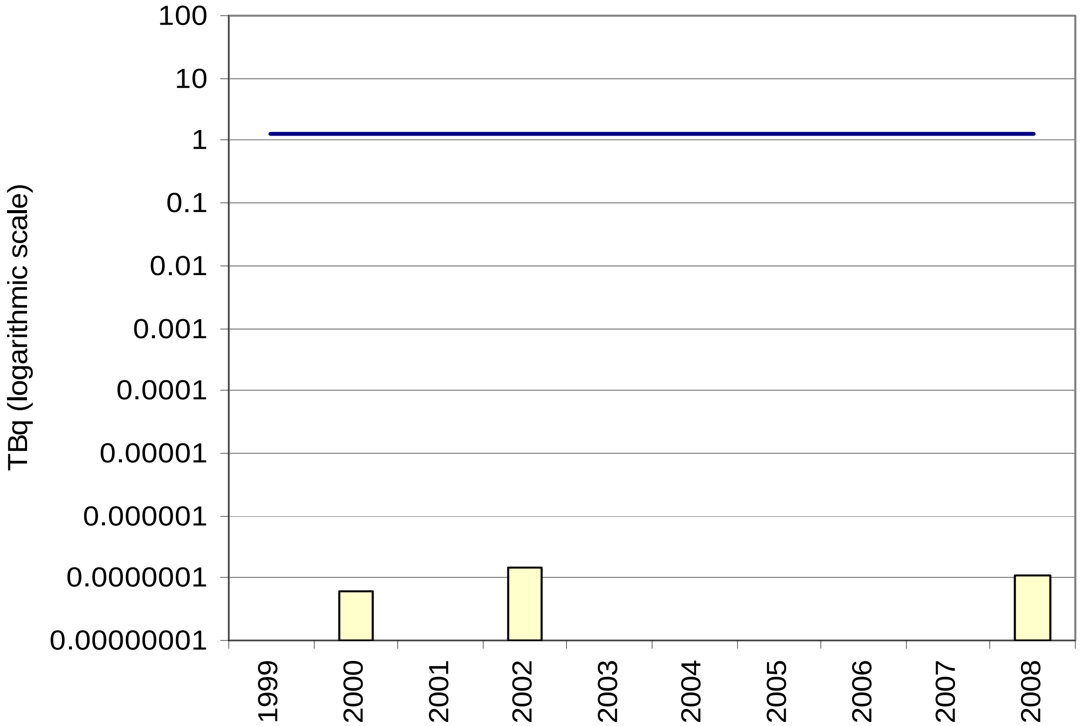
DRLs for carbon-14 in gaseous and liquid effluents were introduced in 1992, and are based on a public dose limit of 5 mSv.

Figure 7.1
Tritium oxide in gaseous effluent from the Gentilly-2 nuclear generating station (1999-2008)
DRL since 1992: 4.4×10^5 TBq



Year	TBq
1999	1.3×10^2
2000	2.5×10^2
2001	1.9×10^2
2002	1.8×10^2
2003	1.5×10^2
2004	1.2×10^2
2005	1.6×10^2
2006	1.8×10^2
2007	1.5×10^2
2008	1.7×10^2

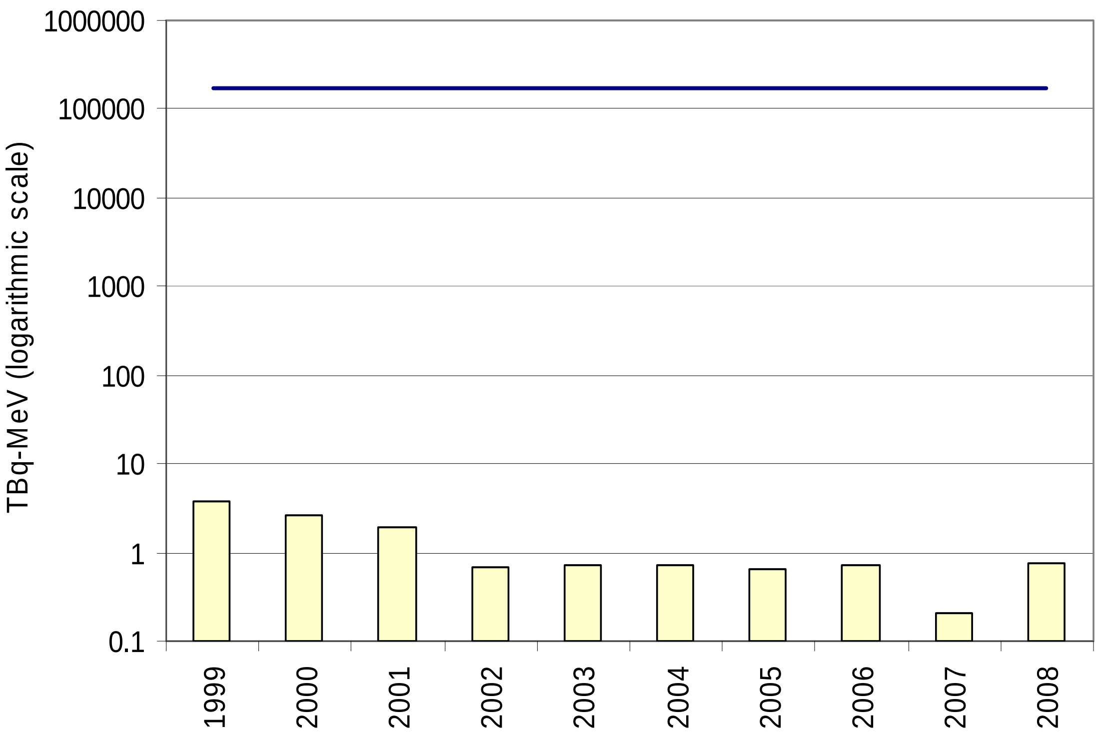
Figure 7.2
Iodine-131 in gaseous effluent from the Gentilly-2 nuclear generating station (1999-2008)
DRL since 1992: 1.3 TBq



Year	TBq
1999	ND
2000	6.4×10^{-8}
2001	ND
2002	1.4×10^{-7}
2003	ND
2004	ND
2005	ND
2006	ND
2007	ND
2008	1.1×10^{-7}

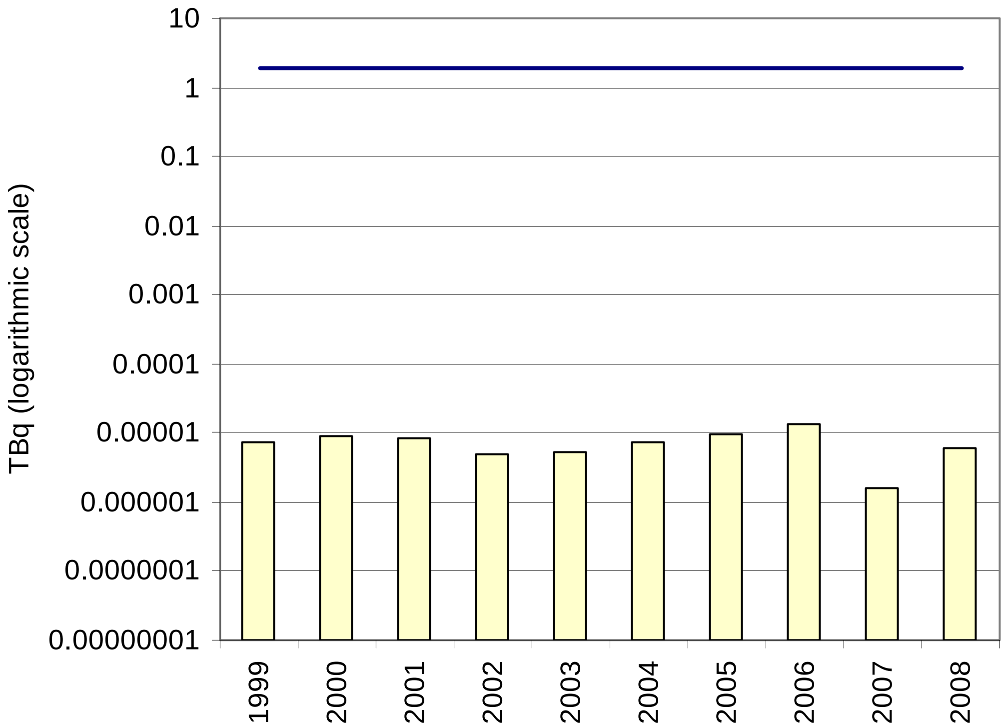
ND=Not Detected

Figure 7.3
Noble gas in gaseous effluent from the Gentilly-2 nuclear generating station (1999-2008)
DRL since 1992: 1.7×10^5 TBq-MeV



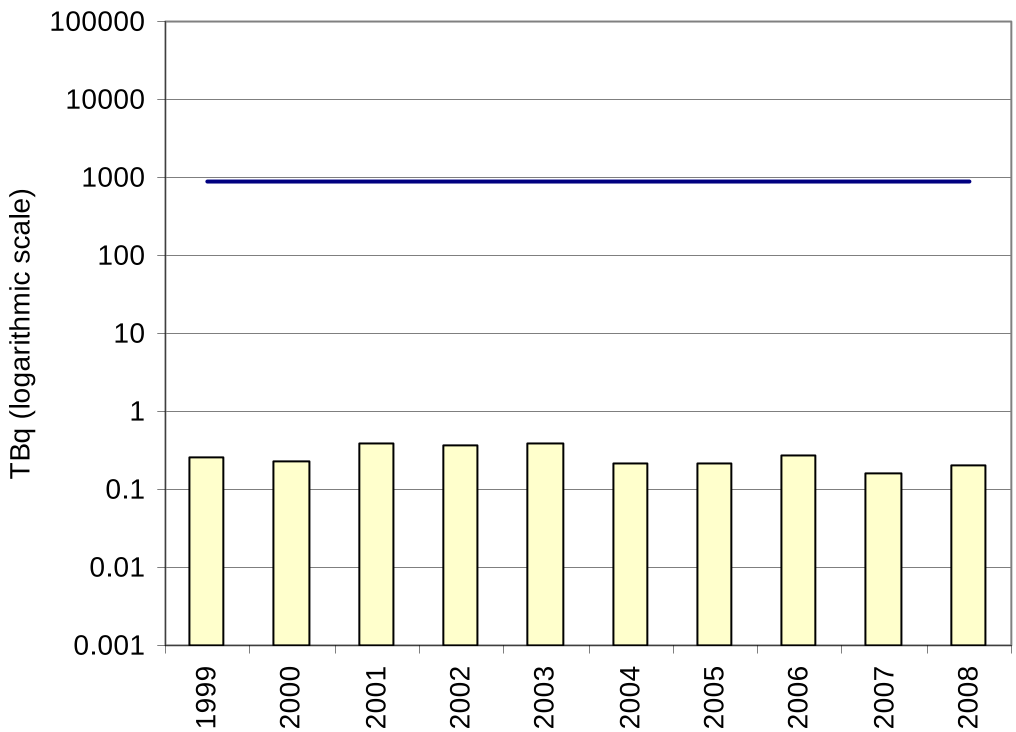
Year	TBq-MeV
1999	3.8
2000	2.6
2001	1.9
2002	0.69
2003	0.71
2004	0.71
2005	0.66
2006	0.72
2007	0.20
2008	0.74

Figure 7.4
Radioactive particulate in gaseous effluent from the Gentilly-2 nuclear generating station (1999-2008)
DRL since 1992: 1.9 TBq



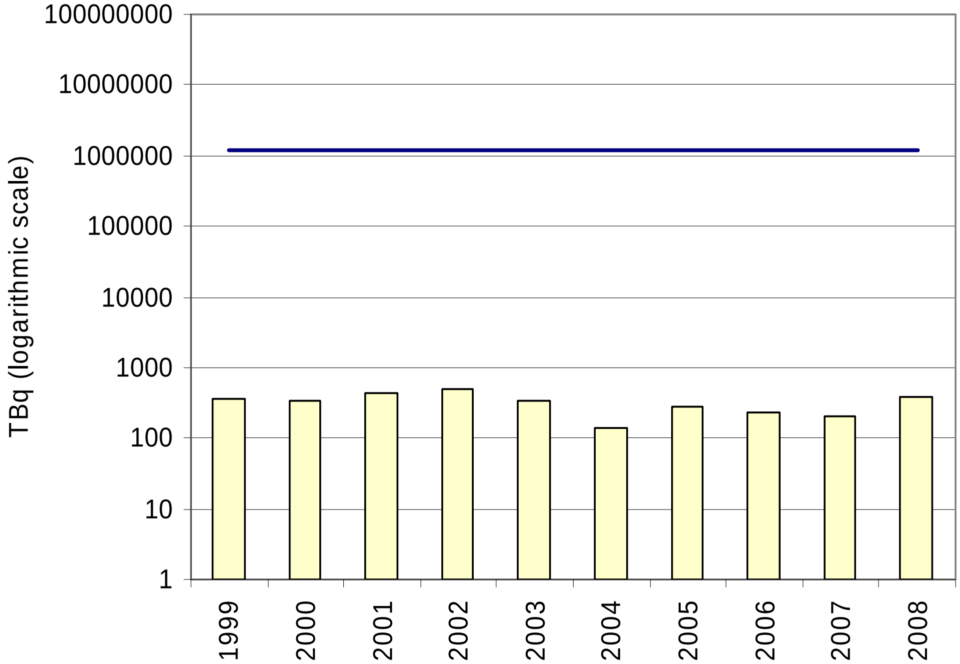
Year	TBq
1999	7.4×10^{-6}
2000	9.0×10^{-6}
2001	8.3×10^{-6}
2002	5.0×10^{-6}
2003	5.4×10^{-6}
2004	7.4×10^{-6}
2005	9.4×10^{-6}
2006	1.3×10^{-5}
2007	1.6×10^{-6}
2008	5.9×10^{-6}

Figure 7.5
Carbon-14 in gaseous effluent from the Gentilly-2 nuclear generating station (1999-2008)
DRL from 1992 to 2003: 9.1 x 102, DRL since 2003: 8.8×10^{2} TBq,



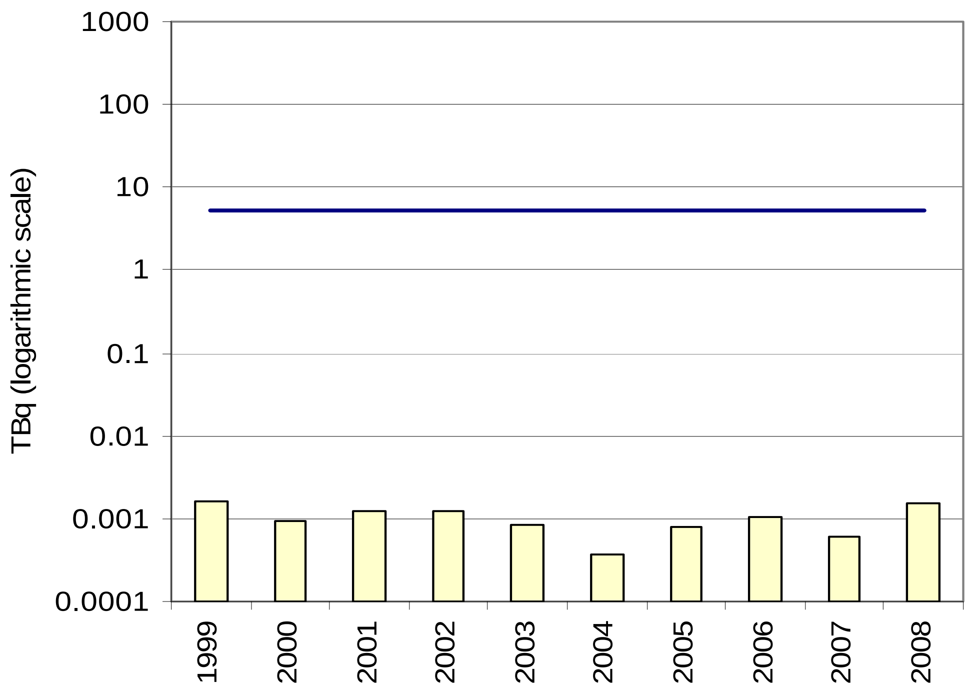
Year	TBq
1999	0.25
2000	0.23
2001	0.40
2002	0.37
2003	0.39
2004	0.22
2005	0.22
2006	0.28
2007	0.16
2008	0.21

Figure 7.6
Tritium oxide in liquid effluent from the Gentilly-2 nuclear generating station (1999-2008)
DRL since 1992: 1.2 x 10^6 TBq



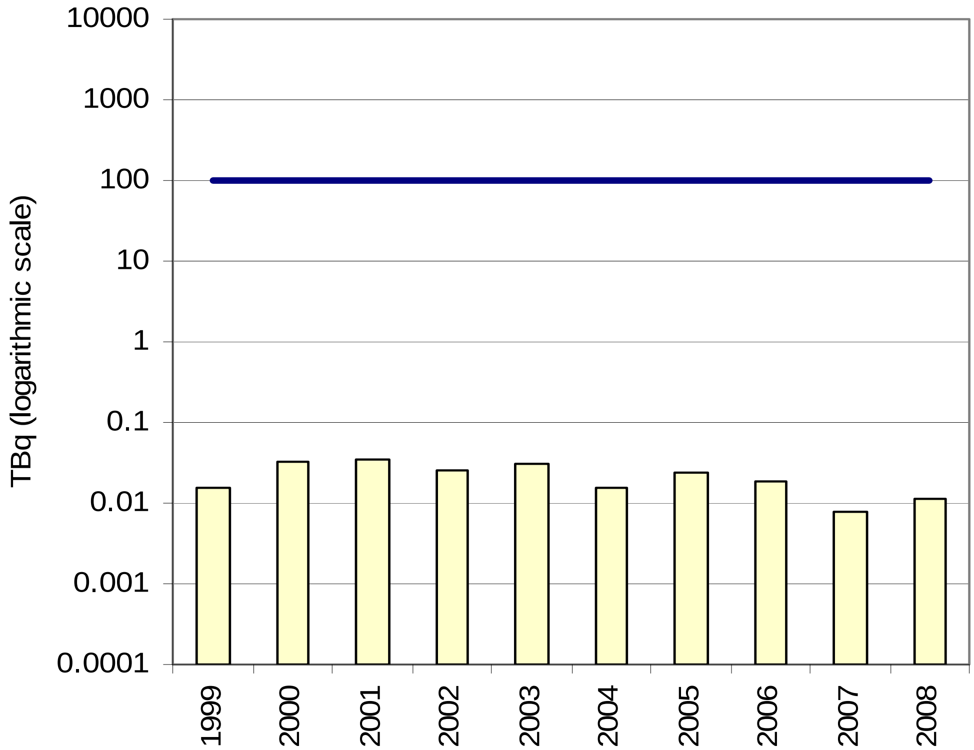
Year	TBq
1999	3.6 x 10^2
2000	3.4 x 10^2
2001	4.5 x 10^2
2002	5.0 x 10^2
2003	3.5 x 10^2
2004	1.4 x 10^2
2005	2.7 x 10^2
2006	2.3 x 10^2
2007	2.0 x 10^2
2008	3.7 x 10^2

Figure 7.7
Gross beta-gamma activity in liquid effluent from the Gentilly-2 nuclear generating station (1999-2008)
DRL since 1992: 5.3 TBq



Year	TBq
1999	1.6 x 10^{-3}
2000	9.4 x 10^{-4}
2001	1.2 x 10^{-3}
2002	1.3 x 10^{-3}
2003	8.6 x 10^{-4}
2004	3.8 x 10^{-4}
2005	7.8 x 10^{-4}
2006	1.0 x 10^{-3}
2007	6.1 x 10^{-4}
2008	1.6x 10^{-3}

Figure 7.8
Carbon-14 in liquid effluent from the Gentilly-2 nuclear generating station (1999-2008)
DRL since 1992: 1.0×10^{2} TBq



Year	TBq
1999	1.5×10^{-2}
2000	3.2×10^{-2}
2001	3.4×10^{-2}
2002	2.6×10^{-2}
2003	3.0×10^{-2}
2004	1.6×10^{-2}
2005	2.3×10^{-2}
2006	1.9×10^{-2}
2007	8.0×10^{-3}
2008	1.1×10^{-2}

Glossary

action level: in this document, action level refers to a specific quantity of radionuclide (released as effluent) which, if reached, may indicate a loss of control in part of a licensee's environmental protection program, and triggers a requirement for specific action to be taken.

Becquerel (Bq): the unit of activity under the SI system. It is equivalent to 1 disintegration per second, or 2.7×10^{-11} Ci.

critical group: a homogeneous group of members of the public, identified as being those individuals which are most likely to receive the highest doses from exposure to radioactive materials released by CNSC licensees. While the concept of critical group is the same for all nuclear generating stations in Canada, the description of the critical group for each station is unique. It is based on analysis of site-specific radionuclide releases and exposure pathways.

derived release limit (DRL): a limit on the release of a radioactive substance from a licensed nuclear facility, insofar as compliance with the DRL gives reasonable assurance that the regulatory public dose limit is not exceeded.

dose limit: a limit on the radiation dose, specified in the CNSC *Radiation Protection Regulations.*

Iodine-131: radioactive isotope of iodine. There are several radioisotopes of iodine produced during the normal operation of a nuclear reactor; I-131 is one of them.

Carbon-14: radioactive isotope of carbon. Carbon-14 is produced during normal operation of Canadian nuclear reactors (based on CANDU technology).

gross beta-gamma: this is a measurement of all beta and gamma activity present, regardless of their specific radionuclide source. Gross measurements are used as a method to screen samples for relative levels of radioactivity.

ionizing radiation: any atomic or subatomic particle, or electromagnetic wave, having sufficient energy to produce ions (atoms which have become charged due to the loss or gain of electrons) in the material in which it is absorbed. Ionizing radiation includes alpha and beta particles and gamma radiation, as well as neutrons and some other particles.

irradiation: exposure to radiation.

logarithmic scale: an exponential scale in which the distances separating each value from the reference point are proportional with their exponents, rather than their linear relationship to each other. The presentation of data on a logarithmic scale is helpful when the data covers a large range of values.

noble gases: xenon, argon, krypton, neon, helium. They are chemically inert gases. Radioisotopes of the noble gases are created during the operation of a nuclear reactor.

radionuclide: a material with an unstable atomic nucleus that spontaneously decays or disintegrates, producing radiation.

radioactivity: the spontaneous disintegration of the nucleus of an atom by expulsion of particles. It can be accompanied by electromagnetic radiation. Solids, liquids or gases can be radioactive.

Sievert (Sv): the SI unit of dose, corresponding to the rem (1 Sv = 100 rem). It is the product of absorbed dose in grays and the radiation weighting factor.

tritium: a radioactive form of hydrogen, having an atomic mass number of three. Tritium is produced during the normal operation of Canadian nuclear reactors (CANDU technology). Elemental tritium refers to the form HT, and tritium oxide to the form HTO.