4 Air Quality

Brookhaven National Laboratory monitors both radioactive and nonradioactive emissions at several facilities on site to ensure compliance with the requirements of the Clean Air Act. In addition, BNL conducts ambient air monitoring to verify local air quality and assess possible environmental impacts from Laboratory operations.

During 2006, BNL facilities released a total of 4,410 curies of short-lived radioactive gases. Oxygen-15 and carbon-11 emitted from the Brookhaven Linac Isotope Producer constituted more than 99.9 percent of the site's radiological air emissions.

Since natural gas prices were comparatively lower than residual fuel prices from June through October in 2006, the Central Steam Facility used natural gas to meet most of the heating and cooling needs of the Laboratory's major facilities during this period. As a result, annual facility emissions of particulate matter, nitrogen oxides, and sulfur dioxide were considerably lower in 2006 than in the prior two years, when residual fuel satisfied more than 99.9 percent of BNL major facility heating and cooling needs.

4.1 RADIOLOGICAL EMISSIONS

Federal air quality laws and DOE regulations that govern the release of airborne radioactive material include 40 CFR 61 Subpart H: National Emission Standards for Hazardous Air Pollutants (NESHAPs)—part of the Clean Air Act, and DOE Order 5400.5, Radiation Protection of the Public and the Environment. Under NESHAPs Subpart H, facilities that have the potential to deliver an annual radiation dose of greater than 0.1 mrem (1 μSv) to a member of the public must be continuously monitored for emissions. Facilities capable of delivering radiation doses below that limit require periodic, confirmatory monitoring. Although not required, BNL has one facility that is continuously monitored, the Brookhaven Linac Isotope Producer (BLIP). Periodic monitoring is conducted at one active facility, the Target Processing Laboratory (TPL), and one inactive facility, the High Flux Beam Reactor (HFBR). Figure 4-1 indicates the locations of these monitored facilities, and Table 4-1 presents the airborne release data from each of these facilities during 2006. Annual emissions from monitored facilities are discussed in the following sections of this chapter. Also discussed is a fourth inactive facility, the Evaporator Facility, which was periodically monitored in past years. The associated radiation dose estimates are presented in Chapter 8, Table 8-4.

4.1.1 Brookhaven Medical Research Reactor

In August 2000, DOE announced that the Brookhaven Medical Research Reactor (BMRR) would be permanently shut down due to a reduction of research funding. Until it stopped operating in late December 2000, the BMRR was fueled with enriched uranium, moderated and cooled by "light" (ordinary) water, and was operated intermittently at power levels up to 3 MW, thermal. Air from the interior of the containment building was used to cool the neutron reflector surrounding the core of the reactor vessel. As air was drawn through the reflector, it was exposed to a neutron field, resulting in activation of the argon fraction of the air. This produced argon-41 (Ar-41), an inert, radioactive gas (half-life 1.8 hours). After passage through the reflector, the air was routed through a roughing filter and a high-efficiency

Figure 4-1. Air Emission Release Points Subject to Monitoring.

particulate air (HEPA) filter to remove any particulate matter. Charcoal filters were also used to remove radioiodines produced during the fission process. Following filtration, the air was exhausted to the atmosphere through a 150-ft stack adjacent to the reactor containment building. This air was continuously monitored for Ar-41 emissions.

After the BMRR stopped operating, continuous Ar-41 monitoring was reduced to periodic, semi-annual monitoring to confirm that radionuclide concentrations remained below detection limits. In January 2003, the remaining fuel was removed from the BMRR reactor vessel, eliminating the last significant source for radionuclide emissions. The sole remaining BMRR emission source was evaporation of the cooling water, which contained the radioactive isotope tritium (H-3, half-life 12.3 years) produced by neutron activation when the BMRR operated. In January 2005, EPA approved BNL's petition to discontinue emissions monitoring at the BMRR. As a result, samples are no longer collected.

In 2006, the facility was managed as a radiological facility. During the year, all removable radioactive equipment in the reactor vessel was retrieved and shipped to a DOE-approved disposal facility.

4.1.2 High Flux Beam Reactor

When the HFBR operated, "heavy" water was used as a neutron moderator and fuel coolant. Heavy water, or D_2O, is water composed of a nonradioactive isotope of hydrogen known as deuterium. When exposed to neutron fields generated inside a reactor vessel, deuterium becomes activated and produces radioactive tritium. As a result of the transfer of fuel elements from the reactor, tritiated heavy water (HTO) from the HFBR system was contained in the spent fuel storage pool. In 1997, a leak in the pool was discovered when a plume of tritiated groundwater was traced back to it. The HFBR was put in standby mode, the pool was pumped out, and the HTO from the pool was properly disposed of as radioactive waste. The pool was then repaired and double lined, in accordance with Suffolk County Article 12 regulations (SCDHS 1993) and remained empty while the facility was in a standby mode.

The HFBR continued in standby mode until November 1999, when DOE declared that it was to be permanently shut down. Residual tritium in water in the reactor vessel and piping systems continues to diffuse into the building's air through valve seals and other system penetrations, though emission rates are much lower than during the years of operation (Figure 4-2).

Table 4-1. Airborne Radionuclide Releases from Monitored Facilities.

Facility	Nuclide	Half-Life	Ci Released
HFBR	Tritium	12.3 years	4.03E+0
BLIP	Carbon-11	20.4 minutes	1.28E+3
	Oxygen-15	122 seconds	3.12E+3
	Tritium	12.3 years	6.78E-2
TPL - Bldg. 801	Germanium-68	270.8 days	3.47E-9
Total			**4.41E+3**

Notes:
Ci = 3.7E+10 Bq
BLIP = Brookhaven Linac Isotope Producer
HFBR = High Flux Beam Reactor (operations were terminated in November 1999)
TPL = Target Processing Laboratory

The increase in emissions in 2003 was attributed to evaporative losses when HTO remaining in the reactor core was pumped out for approved disposal. In 2004, the downward trend in emissions resumed: the level dropped from 9.0 Ci (the 2003 value) to 3.94 Ci. In 2005, tritium emissions climbed to 17.9 Ci, apparently due to evaporation of residual heavy water through an open drain-tank vent line. In 2006, tritium emissions dropped to 4.03 Ci, a level consistent with 2004 emissions. The air emissions from the HFBR facility have been

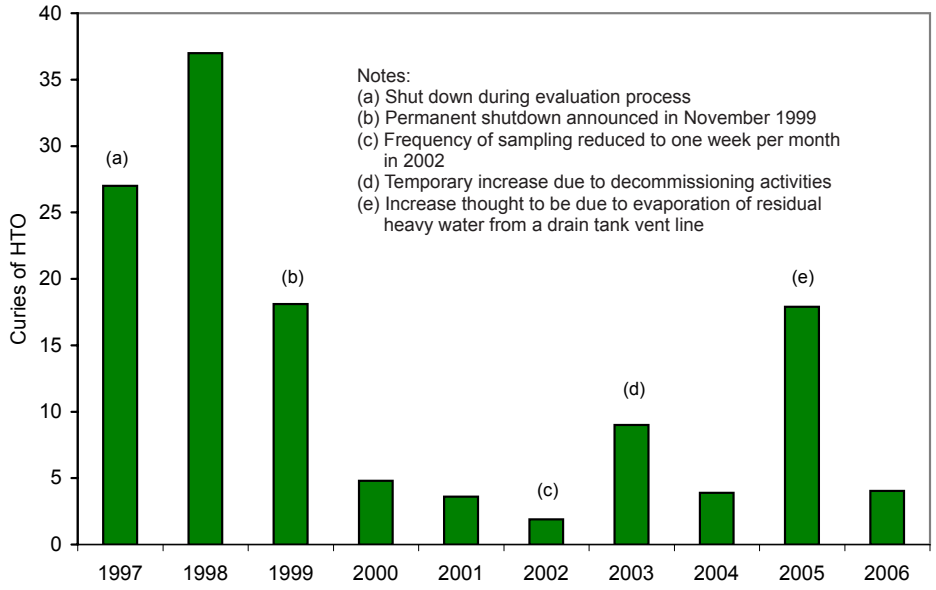

Figure 4-2. High Flux Beam Reactor Tritium Emissions, Ten-Year Trend (1997–2006).

monitored since 2002 via air sampling of the building at a frequency of one week per month.

4.1.3 Brookhaven Linac Isotope Producer

Protons from the Linear Accelerator (Linac) are sent via an underground beam tunnel to the BLIP, where they strike various metal targets to produce new radionuclides for medical diagnostics. The activated metal targets are transferred to the TPL in Building 801 for separation and shipment to various radiopharmaceutical research laboratories. During irradiation, the targets become hot and are cooled by a continuously recirculating water system. The cooling water also becomes activated during the process, producing secondary radionuclides. The most significant of these radionuclides are oxygen-15 (O-15, half-life 122 seconds) and carbon-11 (C-11, half-life 20.48 minutes). Both of these isotopes are released as gaseous, airborne emissions through the facility's 33-ft stack. Emissions of these radionuclides are dependent upon the current and energy of the proton beam used to manufacture the radioisotopes.

In 2006, BLIP operated over a period of 22 weeks. During this period, 1,284 Ci of C-11 and 3,122 Ci of O-15 were released. Tritium produced from activation of the target cooling water was also released, but in a much smaller quantity, 6.78E-02 Ci. Combined emissions of C-11 and O-15 were roughly 35 percent higher than in 2005, primarily due to five additional weeks of operation. The combined emissions, normalized to the same number of micro-amp-hours of production, were 31 percent lower than the total in 2003. This drop in emissions was facilitated by the installation of a lucite enclosure over the continuously recirculating water system. Section 8.4.1 provides more details on the enclosure's effectiveness.

4.1.4 Evaporator Facility

In the past, liquid waste generated on site that contained residual radioactivity was accumulated at the Waste Concentration Facility (WCF) in Building 811. At this facility, reverse osmosis was used to remove suspended solids and a high percentage of radionuclides from the liquid. Because tritium is an isotope of hydrogen, it could not be removed from aqueous wastes. The tritiated water that remained following waste concentration was transferred to the Evaporator Facility in Building 802B, where it was converted to steam and released as an airborne emission. The Evaporator Facility was constructed primarily to reduce the amount of tritiated water released to the Peconic River through the BNL Sewage Treatment Plant. Emissions from the Evaporator Facility were previously directed to the same stack used by the HFBR to exhaust building air. This method was preferable to releases to surface water because there was virtually no potential for the airborne emissions to influence groundwater (the primary drinking water source on Long Island), and the potential for the released tritium to contribute to an off-site dose was minimized by atmospheric dispersion.

No aqueous waste has been processed at the WCF since 2001. As a result, the Evaporator Facility has not been used and has produced no emissions of tritiated water vapor. Because generation rates of aqueous wastes containing residual radioactivity are expected to remain low, it is no longer cost effective to process the waste in the same manner. Wastes are now processed through solidification and disposed of off site. As a result, planning is underway to decommission the Evaporator Facility. Subject to funding availability, the plans also call for demolishing the Building 802B stack and decontaminating the WCF.

4.1.5 Target Processing Laboratory

As mentioned in Section 4.1.3, the metal targets irradiated at the BLIP are transported to the TPL in Building 801, where isotopes are chemically extracted for radiopharmaceutical production. Airborne radionuclides released during the extraction process are drawn through multistage HEPA and activated charcoal filters and then vented to the HFBR stack. The types of radionuclides that are released depend on the isotopes chemically extracted from the irradiated metal targets, which may change from year to year. Annual radionuclide quantities released from this facility are very small,

typically in the µCi to mCi range. In 2006, the total release from the TPL was 0.0035 µCi. See Table 4-1 for details of the radionuclides released in 2006.

4.1.6 Additional Minor Sources

Several research departments at BNL use designated fume hoods for work that involves small quantities of radioactive materials (in the µCi to mCi range). The work typically involves labeling chemical compounds and transferring material between containers using pipettes. Due to the use of HEPA filters and activated charcoal filters, the nature of the work conducted, and the small quantities involved, these operations have a very low potential for atmospheric releases of any significant quantities of radioactive materials. Compliance with NESHAPs Subpart H is demonstrated through the use of an inventory system that allows an upper estimate of potential releases to be calculated. Facilities that demonstrate compliance in this way include Buildings 463, 490, 490A, 510, 535, 555, 725, and 801, where research is conducted in the fields of biology, medicine, high energy physics, chemistry, applied and materials science, and advanced technology. See Table 8-4 in Chapter 8 for the calculated dose from these facility emissions.

4.1.7 Nonpoint Radiological Emission Sources

Nonpoint radiological emissions from a variety of diffuse sources were evaluated in 2006 for compliance with NESHAPs Subpart H. Diffuse sources evaluated included planned research, environmental restoration, and waste management activities. The EPA-approved CAP88-PC dose modeling computer program was used to calculate the possible dose to members of the public from each of the planned activities. The evaluations determined whether NESHAPs permitting and continuous monitoring requirements were applicable, or whether periodic confirmatory sampling was needed to ensure compliance with Subpart H standards for radionuclide emissions. Chapter 8 discusses the NESHAPs evaluations of the research, environmental restoration, and waste management activities that occurred in 2006.

4.2 FACILITY MONITORING

In the past, potential sources of radioactive emissions have been monitored at the BMRR, HFBR, Evaporator Facility, TPL, and BLIP. Because the BMRR and HFBR are permanently shut down and the Evaporator Facility has not processed any aqueous wastes since 2001, no particulate sampling was conducted at these facilities in 2006.

The samplers in the TPL exhaust duct and the exhaust stack for BLIP are equipped with glass-fiber filters that capture samples of airborne particulate matter generated at these facilities (see Figure 4-3 for locations). The filters are collected and analyzed weekly for gross alpha and beta activity. Particulate filter analytical results for gross alpha and beta activity are reported in Table 4-2. The average gross alpha and beta airborne activity levels for samples collected from the BLIP exhaust stack were 0.1320 and 1.2226 pCi/m^3, respectively. Annual average gross alpha and beta airborne activity levels for samples collected from the TPL were 0.0053 and 0.0451 pCi/m^3, respectively.

4.3 AMBIENT AIR MONITORING

As part of the Environmental Monitoring Program, air monitoring stations are in place around the perimeter of the BNL site. Samples are collected using sampling equipment at six blockhouse stations and three pole-mounted samplers (see Figure 4-3 for locations). The blockhouses are fenced to control access and protect costly sampling equipment. In 2003, the number of pole-mounted, battery-powered silica-gel samplers used for airborne tritium monitoring was reduced from 16 to 3. The elimination of redundant samplers was justified on the basis that historical air surveillance data after the shutdown of the HFBR and the BMRR revealed that, at most of the sampling stations, the tritium concentrations were below minimum detection limits (MDL) obtained on the day of analysis.

At each blockhouse, vacuum pumps draw air through columns, where particulate matter is captured on a glass-fiber filter and water vapor for tritium analysis is collected on silica-gel absorbent material. Particulate filters are col-

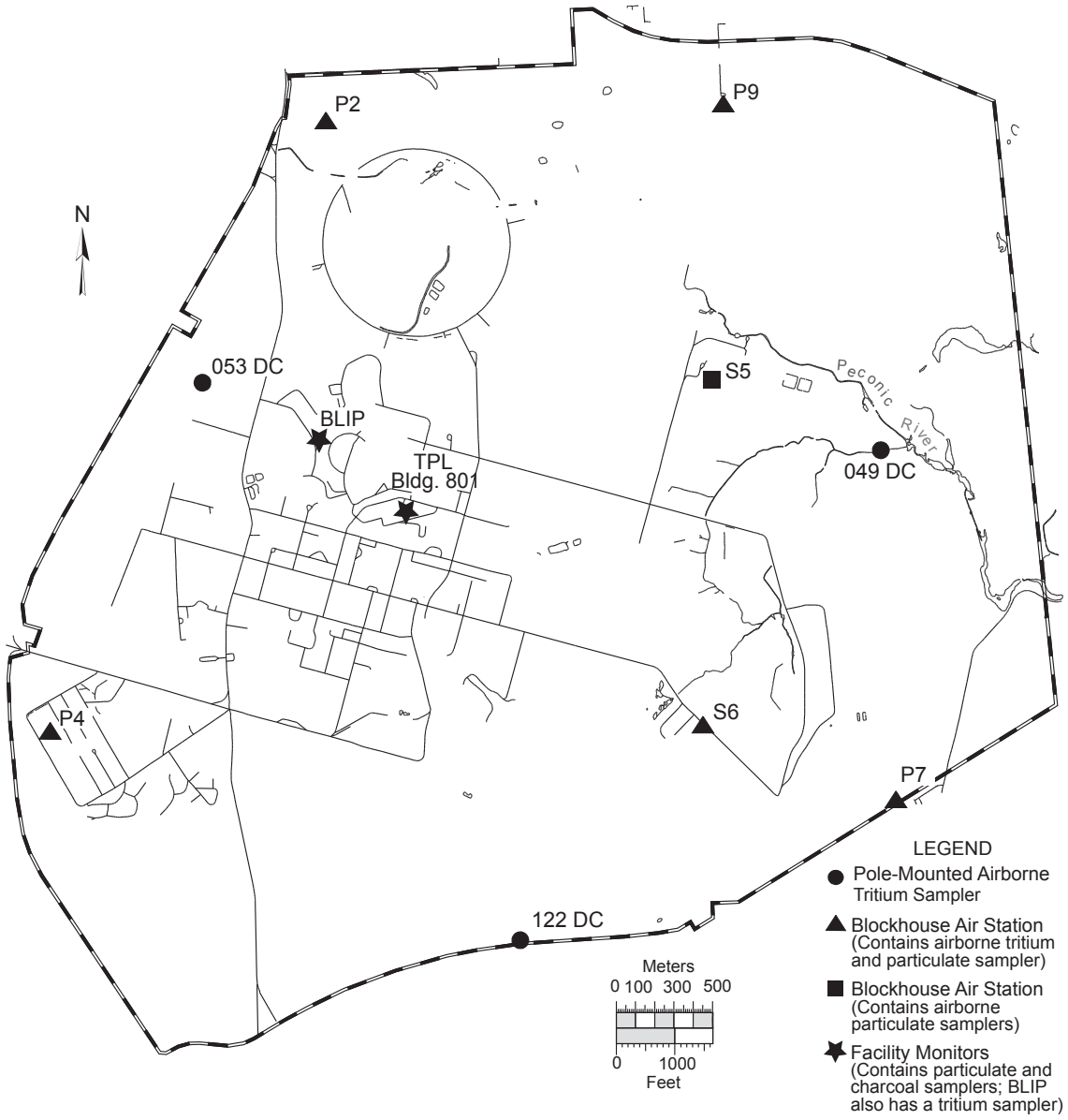

Figure 4-3. BNL On-Site Ambient Air Monitoring Stations.

lected weekly and are analyzed for gross alpha and beta activity using a gas-flow proportional counter. In 2006, silica-gel samples were collected every two weeks for processing by liquid scintillation analysis.

4.3.1 Gross Alpha and Beta Airborne Activity

Particulate filter analytical results for gross alpha and beta airborne activity are reported in Table 4-3. Validated samples are those not rejected due to equipment malfunction or other factors (e.g., sample air volumes were not acceptable). The annual average gross alpha and beta airborne activity levels for the six monitoring stations were 0.0016 and 0.0147 pCi/m^3, respectively. Annual gross beta activity trends recorded at Station P7 are plotted in Figure 4-4. The results for this location are typical for the site. The trend shows seasonal variation in activity within a range that is representative of natural background levels. The New York State Department of Health (NYSDOH) received duplicate filter samples that were collected at Station P7 using a sampler they provided. These samples were collected weekly and analyzed by the NYSDOH laboratory for gross beta activ-

Table 4-2. Gross Activity in Facility Air Particulate Filters.

Facility Monitor		Gross Alpha (pCi/m³)	Gross Beta (pCi/m³)
BLIP	N	51	51
	Max.	0.5080 ± 0.2050	2.6100 ± 0.3650
	Avg.	0.1320 ± 0.1167	1.2226 ± 0.2485
	MDL	0.1823*	0.3046*
TPL - Bldg. 801	N	50	50
	Max.	0.0279 ± 0.0145	0.2110 ± 0.0291
	Avg.	0.0053 ± 0.0030	0.0451 ± 0.0064
	MDL	0.0040*	0.0067*

Notes:
See Figure 4-3 for sampling station locations.
All values shown with a 95% confidence interval.
BLIP = Brookhaven Linac Isotope Producer
MDL = Minimum Detection Limit
N = Number of validated samples collected
TPL = Target Processing Laboratory
*Average MDL for all samples taken at this location

Table 4-3. Gross Activity Detected in Ambient Air Monitoring Particulate Filters.

Sample Station		Gross Alpha (pCi/m³)	Gross Beta (pCi/m³)
P2	N	46	46
	Max	0.0030 ± 0.0008	0.0241 ± 0.0019
	Avg.	0.0012 ± 0.0005	0.0119 ± 0.0012
	MDL	0.0005*	0.0009*
P4	N	39	39
	Max	0.0133 ± 0.0019	0.0256 ± 0.0016
	Avg.	0.0019 ± 0.0007	0.0150 ± 0.0014
	MDL	0.0006*	0.0010*
P7	N	46	46
	Max	0.0045 ± 0.0009	0.0248 ± 0.0018
	Avg.	0.0016 ± 0.0006	0.0141 ± 0.0013
	MDL	0.0006*	0.0010*
P9	N	46	46
	Max	0.0038 ± 0.0009	0.0287 ± 0.0028
	Avg.	0.0012 ± 0.0006	0.0125 ± 0.0013
	MDL	0.0006*	0.0011*
S5	N	46	46
	Max	0.0034 ± 0.0009	0.0294 ± 0.00223
	Avg.	0.0016 ± 0.0006	0.0161 ± 0.0015
	MDL	0.0006*	0.0010*
S6	N	48	48
	Max	0.0170 ± 0.0062	0.1200 ± 0.0124
	Avg.	0.0019 ± 0.0008	0.0184 ± 0.0017
	MDL	0.0008*	0.0013*
Grand Average		**0.0016 ± 0.0002**	**0.0147 ± 0.0010**

Notes:
See Figure 4-3 for sampling station locations.
All values shown with a 95% confidence interval.
MDL = Minimum Detection Limit
N = Number of validated samples collected
*Average MDL for all samples taken at this location

ity only. The analytical results NYSDOH found were comparable to the Station P7 samples analyzed by GEL Laboratories, an analytical laboratory contracted by BNL. New York State's analytical results for gross beta activity at BNL were between 0.0028 and 0.0232 pCi/m^3, with an average concentration of 0.0100 pCi/m^3. BNL results ranged from 0.0002 to 0.0248 pCi/m^3, with an average concentration of 0.0141 pCi/m^3. As part of a statewide monitoring program, NYSDOH also collects air samples in Albany, New York, a control location with no potential to be influenced by nuclear facility emissions. In 2006, NYSDOH reported that airborne gross beta activity at that location varied between 0.0030 and 0.0157 pCi/m^3, and the average concentration was 0.0089 pCi/m^3. Sample results measured at the Laboratory generally fell within this range, demonstrating that on-site radiological air quality was consistent with that observed at locations in New York State not located near radiological facilities.

4.3.2 Airborne Tritium

Airborne tritium in the form of HTO is monitored throughout the BNL site. In addition to the five blockhouses containing tritium samplers, three pole-mounted monitors used for tritium sampling are located at or near the property boundary (see Figure 4-3 for locations). Observed concentrations of tritium at the sampling stations in 2006 were comparable to concentrations observed in 2005. Table 4-4 lists the number of validated samples collected at each location, the maximum value observed, and the annual average concentration. Validated samples are those not rejected due to equipment malfunction or other factors (e.g., a battery failure in the sampler, frozen or supersaturated silica gel, insufficient sample volumes, or the

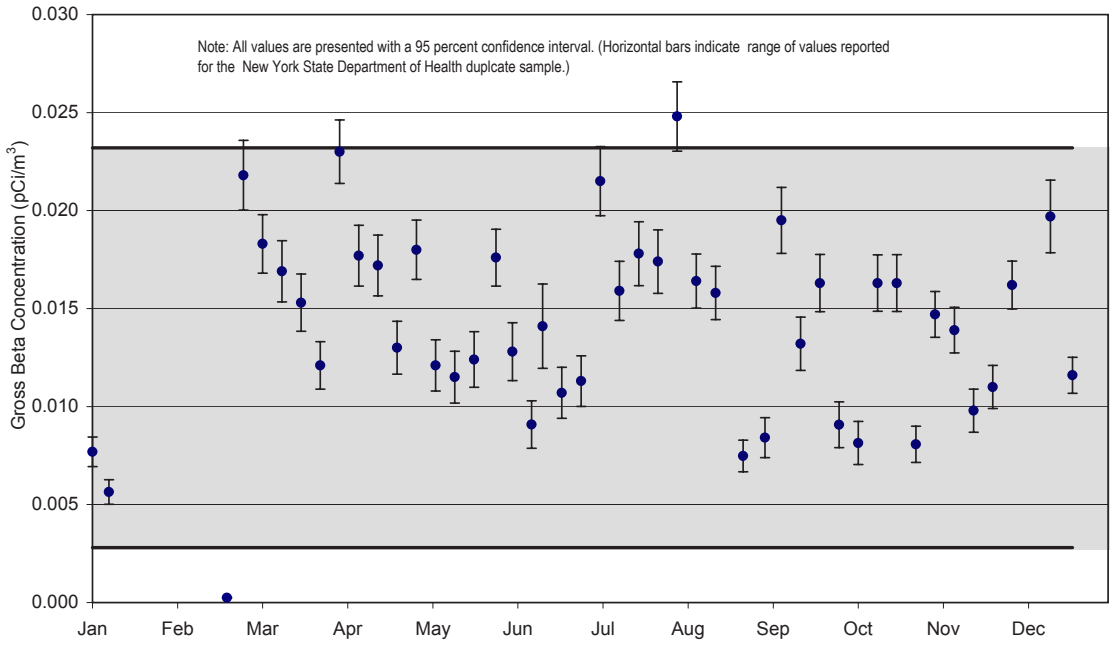

Figure 4-4. Airborne Gross Beta Concentration Trend Recorded at Station P7.

loss of sample during preparation at the contract analytical laboratory). Airborne tritium samples were collected every two weeks from each sampling station during 2006. The average tritium concentrations at all of the sampling locations were less than the typical MDL, which ranged from 1.0 to 9.0 pCi/m^3. The collected data demonstrate that there were no significant differences in ambient tritium concentrations on site or at the site boundary.

4.4 NONRADIOLOGICAL AIRBORNE EMISSIONS

Various state and federal regulations governing nonradiological releases require facilities to conduct periodic or continuous emission monitoring to demonstrate compliance with emission limits. The Central Steam Facility (CSF) is the only BNL facility that requires monitoring for nonradiological emissions. The Laboratory has several other emission sources subject to state and federal regulatory requirements that do not require emission monitoring (see Chapter 3 for more details). The CSF supplies steam for heating and cooling to major BNL facilities through an underground steam distribution and condensate grid. The location of the CSF is shown in Figure 4-1. The combustion units at the CSF are designated as Boilers 1A, 5, 6, and 7. Boiler 1A, which was installed in 1962, has a heat input of 16.4 MW (56.7 million British thermal units [MMBtu] per hour). Boiler 5, installed in 1965, has a heat input of 65.3 MW (225 MMBtu/hr). The newest units, Boilers 6 and 7, were installed in 1984 and 1996, and each has a heat input of

Table 4-4. Ambient Airborne Tritium Measurements in 2006.

Sample Station	Wind Sector	Validated Samples	Maximum (pCi/m^3)	Average (pCi/m^3)
049	E	21	59.9 ± 7.1	3.1 ± 6.1
053	NW	18	10.3 ± 6.5	1.3 ± 1.7
122	SSE	20	4.1 ± 4.6	-0.7 ± 1.4
P2	NNW	22	12.3 ± 3.5	0.7 ± 1.7
P4	WSW	21	11.4 ± 3.9	-0.4 ± 2.0
P7	ESE	22	14.4 ± 2.8	0.9 ± 1.7
P9	NE	21	27.8 ± 5.9	2.0 ± 2.7
S6	SE	23	10.5 ± 3.3	0.6 ± 1.5
Grand Average				**0.9 ± 1.0**

Notes:
See Figure 4-3 for sampling station locations.
Wind sector is the downwind direction of the sample station from the HFBR stack.
All values reported with a 95% confidence interval.
Typical minimum detection limit for tritium is between 1.0 and 9.0 pCi/m^3.
DOE Order 5400.5 Air Derived Concentration Guide is 100,000 pCi/m^3.

42.6 MW (147 MMBtu/hr). For perspective, Keyspan's Northport, New York power station has four utility-sized turbine/generator boilers, each with a maximum rated heat input of 1,082 MW (3,695 MMBtu/hr).

Because of their design, heat inputs, and dates of installation, Boilers 6 and 7 are subject to Title 6 of the New York Code, Rules, and Regulations (NYCRR) Part 227-2, and the Federal New Source Performance Standard (40 CFR 60 Subpart Db: Standards of Performance for Industrial-Commercial-Institutional Steam Boilers). Therefore, these boilers are equipped with continuous emission monitors to measure nitrogen oxides (NO_x). Boiler 7 was already equipped with a continuous opacity monitor to comply with Subpart Db opacity monitoring requirements, and after a new continuous opacity monitor for Boiler 6 was voluntarily brought online in 2004, emissions on both boilers are now continuously monitored for opacity. To measure combustion efficiency, the boilers are also monitored for carbon dioxide (CO_2). Continuous emission monitoring results from the two boilers are reported quarterly to EPA and the New York State Department of Environmental Conservation.

From May 1 to September 15 (the peak ozone period), compliance with the 0.30 lbs/MMBtu (129 ng/J) NO_x emission standard for No. 6 oil and the 0.20 lbs/MMBtu (86 ng/J) NO_x emission standard for No. 2 oil and natural gas is demonstrated by calculating the 24-hour average emission rate from continuous emission monitoring system readings and comparing the value to the emission standard. The remainder of the year, the calculated 30-day rolling average emission rate is used to establish compliance. Boiler 7 opacity levels are recorded as 6-minute averages. Measured opacity levels cannot exceed 20 percent opacity, except for one 6-minute period per hour of not more than 27 percent opacity. In 2006, there were no measured exceedances of the NO_x emission standards for either boiler. During the year, all of the Boiler 6 and Boiler 7 opacity measurements that exceeded the opacity limit occurred during boiler startups or shutdowns, or during necessary calibrations of the monitoring system. Changes in the sequence of the soot blowing cycle for Boiler 6 that were

Table 4-5. Central Steam Facility Fuel Use and Emissions (1996 – 2006).

	Annual Fuel Use and Fuel Heating Values						Emissions			
Year	No. 6 Oil (103 gals)	Heating Value (MMBtu)	No. 2 Oil (103 gals)	Heating Value (MMBtu)	Natural Gas ($106 ft^3$)	Heating Value (MMBtu)	TSP (tons)	NO_x (tons)	SO_2 (tons)	VOCs (tons)
1996	4,782.55	703,991	52.77	7,388	0.00	0	14.0	104.9	109.0	0.7
1997	3,303.43	484,613	10.23	1,432	190.65	194,463	13.7	83.5	75.1	1.0
1998	354.28	52,283	9.44	1,322	596.17	608,093	2.7	75.1	8.9	1.7
1999	682.76	78,335	2.77	388	614.98	627,280	5.1	53.5	16.7	1.8
2000	2,097.32	309,317	0.82	115	342.40	349,248	9.5	81.6	45.0	1.2
2001	3,645.10	538,847	3.40	476	103.96	106,039	17.5	80.4	77.8	0.8
2002	2,785.04	407,518	0.29	41	220.62	225,030	15.4	62.4	53.8	1.0
2003	4,290.94	628,765	402.06	56,288	0.98	1,000	22.8	75.3	107.1	0.6
2004	4,288.76	628,063	2.45	343	0.11	109	16.4	81.9	104.7	2.4
2005	4,206.12	618,590	0.87	122	0.00	0	15.2	80.4	93.1	2.4
2006	2,933.00	432,430	0.22	30	191.35	195,177	11.8	66.9	66.3	2.2
Permit Limit (in tons)							113.3	159.0	445.0	39.7

Notes:
NO_x = Oxides of Nitrogen
SO_2 = Sulfur Dioxide
TSP = Total Suspended Particulates
VOCs = Volatile Organic Compounds

made in August 2005 have proven effective in eliminating opacity exceedances due to soot blowing. Similar changes made to the soot blowing cycle on Boiler 7 after the installation of a new soot blowing controller in March 2006 have been successful in eliminating soot blowing opacity exceedances on that boiler, as well. While there are no regulatory requirements to continuously monitor opacity for Boilers 1A and 5, surveillance monitoring of visible stack emissions is a condition of BNL's Title V operating permit. Daily observations of stack gases recorded by CSF personnel throughout the year showed no visible emissions with opacity levels exceeding the regulatory limits established for these boilers.

To satisfy periodic testing requirements of the Laboratory's Title V operating permit, emission tests of Boilers 1A, 6, and 7 were completed in October 2006, and required emission tests of Boiler 5 were conducted in December 2006. The purpose of the tests was to certify compliance of Boilers 1A and 5 with Part 227-2 emission standards for NO_x and to certify compliance of all four boilers with Part 227.2(b)(1) emission standards for particulates. Results of the NO_x emission tests of Boiler 1A and 5 demonstrated that flue gas emissions of NO_x from both boilers while combusting residual fuel at low, moderate, and high load conditions were well below the Part 227-2 NO_x standard of 0.3 lbs/MMBtu. Similarly, results of separate tests of Boiler 5 while burning natural gas at low, medium, and high operating loads showed flue gas emissions of NO_x to be less than the corresponding Part 227-2 emission standard of 0.2 lbs/MMBtu. Meanwhile, the average particulate emissions from three test runs of Boilers 1A, 5, 6, and 7 at low, medium, and high operating loads while burning residual fuel were 0.063, 0.084, 0.026, and 0.051 lbs/MMBtu, respectively; all readings are less than the emission standard of 0.1 lbs/MMBtu.

In 2006, residual fuel prices from June to October exceeded those of natural gas. As a result, natural gas was used to supply more than 84 percent of the heating and cooling needs of BNL's major facilities during these months. Throughout the year, natural gas supplied approximately 31 percent of major facility heating and cooling needs. By comparison, in 2004 and 2005, residual fuel satisfied more than 99.9 percent of the major facility heating and cooling needs. Consequently, 2006 emissions of particulates, NO_x, and sulfur dioxide (SO_2) were 3.4, 13.5, and 26.8 tons less than the respective totals for 2005. All emissions were well below the respective permit limits of 113.3, 159, and 445 tons. Table 4-5 shows fuel use and emissions since 1996.

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