Air Quality 4

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 2014, BNL facilities released a total of 7,535 curies of short-lived radioactive gases. Oxygen-15 and carbon-11 emitted from the Brookhaven Linac Isotope Producer constituted more than 99.99 percent of the site's radiological air emissions.

Because natural gas prices were comparatively lower than residual fuel prices throughout the year, BNL's Central Steam Facility used natural gas to meet 99.3 percent of the heating and cooling needs of the Laboratory's major facilities in 2014. As a result, emissions of particulates, oxides of nitrogen, sulfur dioxide, and volatile organic compounds were well below the respective regulatory permit criteria pollutant limits.

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 (CAA), and DOE Order 458.1 Chg. 3, *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. BNL has one facility that is continuously monitored with an in-line detection system, the Brookhaven Linac Isotope Producer (BLIP). During 2014, periodic monitoring was conducted at one active facility, the Target Processing Laboratory (TPL), and one inactive facility, the High Flux Beam Reactor (HFBR). Figure 4-1 provides the locations of these monitored facilities, and Table 4-1 presents the airborne release data for each of these facilities. Annual emissions from monitored facilities are discussed in the following sections of this chapter. The associated radiation dose estimates are presented in Chapter 8, Table 8-4.

4.1.1 High Flux Beam Reactor

In 1997, a plume of tritiated groundwater was traced back to a leak in the HFBR spent fuel storage pool. Consequently, the HFBR was put 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 continued to diffuse into the building's air through valve seals and other system penetrations, though emission rates were much lower than during the years of operation.

In 2010, the HFBR was disconnected from the 100-meter stack, and a new HFBR exhaust system was installed in 2011. As part of the HFBR Long-Term Surveillance Program (BNL 2012) air samples are now collected from outside the HFBR confinement using a permanently installed sample port. Samples are analyzed for tritium to evaluate facility emissions and to ensure that air quality within the building is acceptable to permit staff entry. Additionally,

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

samples are collected one week per month from the HFBR exhaust system using a standard desiccant sampling system for tritium analysis. Desiccant samples are analyzed by an off-site contract laboratory.

4.1.2 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 re-circulating 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: 20.4 minutes). Both of these isotopes are released as gaseous, airborne emissions through the facility's 33-foot stack. Emissions of these radionuclides are dependent on the current and energy of the proton beam used to manufacture the radioisotopes.

In 2014, BLIP operated over a period of 32 weeks, during which 2,511 Ci of C-11 and 5,023 Ci of O-15 were released. Tritium produced from activation of the target cooling water was also released, but in a much smaller quantity, 3.25 E-2 Ci. Combined emissions of C-11 and O-15 were 7,534 Ci, 53 percent higher than the combined emission of 4,918 Ci in 2013. This increase is primarily due to operation at higher energy levels in 2014.

4.1.3 Target Processing Laboratory

As mentioned in Section 4.1.2, 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 charcoal filters and the filtered air is then vented to the atmosphere. The types of radionuclides that are processed 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. Gamma analysis of monthly composite samples was discontinued in 2013. This decision was based on historical analytical results of TPL particulate filters that showed gross alpha/beta levels to be very low, and consistent with background concentrations. As a result, there are no reported radionuclide emissions from the TPL in Table 4-1. Should future gross beta analyses of TPL emissions show the potential for other radionuclide emissions, gamma analyses will be conducted.

4.1.4 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. 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 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.

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

Facility	Nuclide	Half-Life	Ci Released
HFBR	Tritium	12.3 years	4.87E-01
BLIP	Carbon-11	20.4 minutes	2.51E+03
	Oxygen-15	122 seconds	5.02E+03
	Tritium	12.3 years	3.25E-02
Total			**7.535E+03**

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

Facilities that demonstrate compliance in this way include Buildings 197, 197B, 463, 480, 490, 490A, 510A, 725, 801, 815, 865, and 901, where research is conducted in the fields of nuclear safety, biology, high energy physics, medicine, medical therapy, photon science, advanced technology, environmental chemistry, and synthetic biology. See Table 8-4 in Chapter 8 for the calculated dose from these facility emissions.

4.1.5 Nonpoint Radiological Emission Sources

Nonpoint radiological emissions from a variety of diffuse sources may be evaluated for compliance with NESHAPs Subpart H. Diffuse sources evaluated often include planned research, planned waste management activities, and planned D&D activities. In 2014, the only diffuse source evaluated was for planned soil remediation work at the Former Hazardous Waste Management Facility. The EPA-approved CAP88-PC dose modeling computer program was used to calculate the possible dose to members of the public from the planned activities. Evaluations determined whether NESHAPs permitting and continuous monitoring requirements are applicable, or whether periodic confirmatory sampling is needed to ensure compliance with Subpart H standards for radionuclide emissions. Chapter 8 discusses the NESHAPs evaluations of environmental restoration activities that occurred in 2014.

4.2 FACILITY MONITORING

Radioactive emissions are monitored at the TPL, BLIP, and HFBR. 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 4-1 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 in 2014 are reported in Table 4-2. The average gross alpha and beta airborne activity levels for samples collected from the BLIP exhaust stack were 0.0003 and 0.0097 pCi/m^3, respectively. Annual average gross alpha and beta airborne activity levels for samples collected from the TPL were 0.0007 and 0.0106 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 (see Figure 4-2 for locations). There are six blockhouse stations and three pole-mounted, battery-powered silica-gel samplers equipped for collecting samples.

At each blockhouse, vacuum pumps draw air through columns where particulate matter is captured on a glass-fiber filter. Particulate filters are collected weekly, and are analyzed for gross alpha and beta activity using a gas-flow proportional counter. Also, water vapor for tritium analysis is collected on silica-gel absorbent material for processing by liquid scintillation analysis. In 2014, silica-gel samples were collected every two weeks.

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. Ambient air samples are collected weekly from site perimeter monitoring stations P2, P4, P7, and P9. 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 four monitoring stations were 0.0016 and 0.0146 pCi/m^3, respectively. Annual gross beta activity trends recorded at Station P7 are plotted in Figure 4-3. The results for this location are typical for the site, and show 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 activity. The analytical results were comparable to the Station P7 samples analyzed by General Engineering Lab, an analytical laboratory contracted by BNL. New York State's analytical results for gross beta activity at the Laboratory were between 0.0021 and 0.0200 pCi/m^3, with an average concentration of 0.0088 pCi/m^3. BNL results ranged from 0.0035 to 0.0451 pCi/m^3, with an average concentration of 0.0104 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 2014, NYSDOH reported that airborne gross beta activity at that location varied between 0.0007 and 0.1180 pCi/m^3, and had an average concentration of 0.0133 pCi/m^3. All of the sample results measured at BNL 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 (tritiated water) is monitored throughout the BNL site. In addition to the five blockhouses containing tritium samplers, three pole-mounted monitors that may be used for tritium sampling are located at or near the Laboratory's property boundary (see Figure 4-2 for sample locations). Tritium sampling in 2014 was limited to Stations P2, P4, P7, and P9 on the basis that they are adequately located around the site's perimeter to monitor potential impacts from BNL's three tritium sources. 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 loss of sample during preparation at the contract analytical

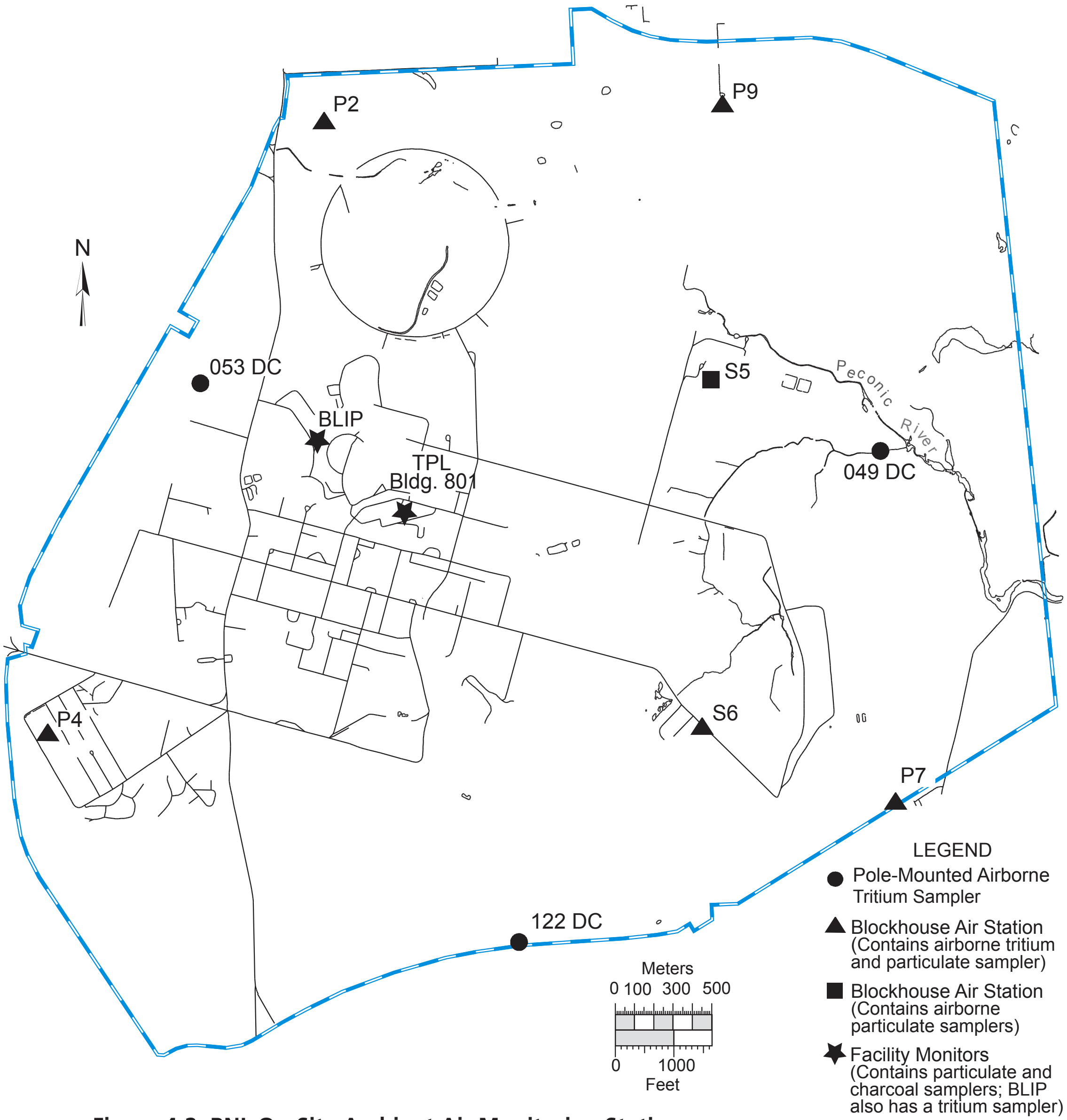


Figure 4-2. BNL On-Site Ambient Air Monitoring Stations.

laboratory). Airborne tritium samples were collected every two weeks from each sampling station during 2014; however, 25 samples could not be analyzed because moisture captured on silica gel was insufficient for analysis. The average tritium concentrations at all of the sampling locations were less than the typical minimum detection limits (MDLs), which ranged from 1.3 to 6.2 pCi/m^3.

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

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

Facility Monitor		Gross Alpha (pCi/m³)	Gross Beta
BLIP	N	51	51
	Max.	0.0022 ± 0.0010	0.1330 ± 0.0050
	Avg.	0.0003 ± 0.0004	0.0097 ± 0.0011
	MDL	0.0007*	0.0008*
TPL - Bldg. 801	N	51	51
	Max.	0.0029 ± 0.0007	0.0586 ± 0.0021
	Avg.	0.0007 ± 0.0004	0.0106 ± 0.0010
	MDL	0.0005*	0.0006*

Notes:
See Figure 4-2 for sample 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 validated samples taken at this location

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 42.6 MW (147 MMBtu/hr). For perspective, National Grid'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 the CSF boilers have the potential to emit more than 100 tons per year of oxides of nitrogen (NOx), the CSF is considered a major facility, and all four of its boilers are subject to the Reasonably Available Control Technology (RACT) requirements of Title 6 of the New York Code, Rules, and Regulations (NYCRR) Part 227-2. Because of their design, heat inputs, and dates of installation, Boilers 6 and 7 are also subject to the Federal New Source Performance Standard (40 CFR 60 Subpart Db: Standards of Performance for Industrial-Commercial-Institutional Steam Boilers). Both boilers are equipped with continuous emission monitoring systems (CEMS) to show compliance with NOx standards of Part 227-2 and Subpart Db, and with continuous opacity monitors to demonstrate

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

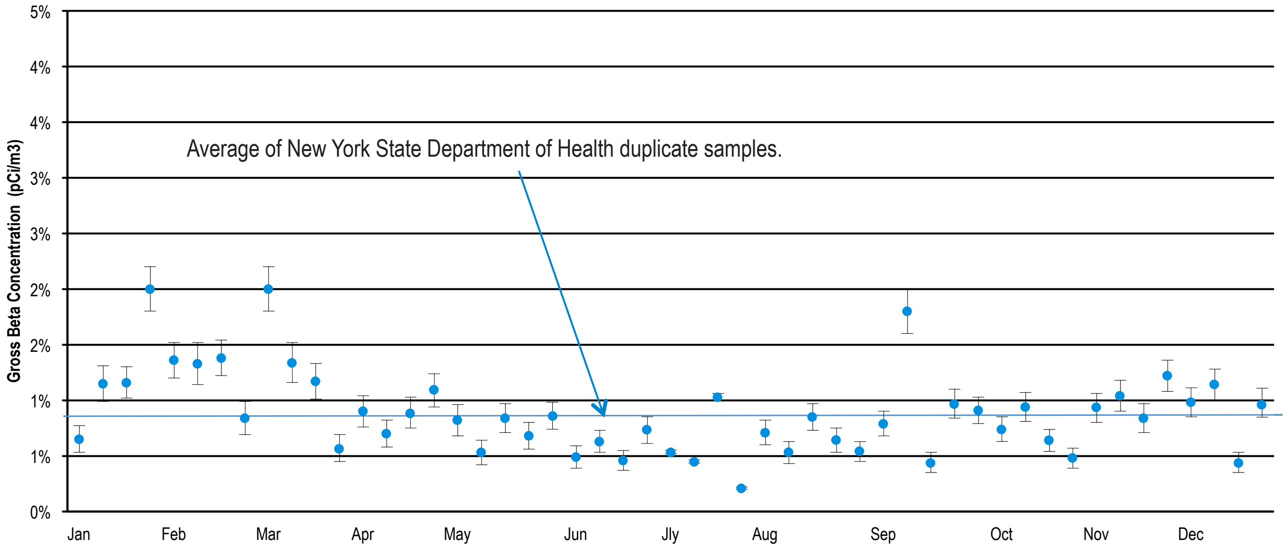
Sample Station		Gross Alpha (pCi/m³)	Gross Beta
P2	N	51	51
	Max	0.0031 ± 0.0008	0.0240 ± 0.0018
	Avg.	0.0015 ± 0.0005	0.0119 ± 0.0010
	MDL	0.0005*	0.0006*
P4	N	50	50
	Max	0.0068 ± 0.0034	0.0493 ± 0.0060
	Avg.	0.0025 ± 0.0011	0.0204 ± 0.0022
	MDL	0.0011*	0.0015*
P7	N	52	52
	Max	0.0088 ± 0.0021	0.0451 ± 0.0033
	Avg.	0.0011 ± 0.0005	0.0104 ± 0.0010
	MDL	0.0005*	0.0006*
P9	N	52	52
	Max	0.0034 ± 0.0012	0.0263 ± 0.0019
	Avg.	0.0015 ± 0.0007	0.0158 ± 0.0015
	MDL	0.0007*	0.0009*
Grand Average		**0.0016 ± 0.0007**	**0.0146 ± 0.0014**

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

compliance with Subpart Db opacity monitoring requirements. To measure combustion efficiency, the boilers are also monitored for carbon monoxide (CO). Continuous emission monitoring results from the two boilers are reported quarterly to EPA and the New York State Department of Environmental Conservation (NYSDEC).

On July 1, 2014, new Part 227-2 lower reasonable available control limits (RACT) for NOx emissions became effective. The respective NOx RACT emission limits of 0.20 lbs/MMBtu for the combustion of natural gas and 0.30 lbs/MMBtu for the combustion of No. 6 oil burned in the CSF three large boilers dropped to 0.15 lbs/MMBtu for both fuels. Meanwhile, the NOx RACT emission limit for the CSF's one mid-size boiler (Boiler 1A) dropped from 0.30 lbs/MMBtu to 0.20 lbs/MMBtu.

From May 1 to September 15, the peak



Note: All values are presented with a 95 percent confidence interval.

Figure 4-3. Airborne Gross Beta Concentration Trend Recorded at Station P7.

ozone period, owners and operators of boilers equipped with CEMS demonstrate compliance with Part 227-2 NOx RACT limits by calculating the 24-hour average emission rate from CEMS readings and comparing the value to the emission limit. During the remainder of the year, the calculated 30-day rolling average emission rate is used to establish compliance. Boilers not equipped with CEMS must demonstrate compliance with NOx RACT limits via periodic emissions testing. Following the end of each calendar quarter, facilities with boilers equipped with CEMS must tabulate and summarize applicable emissions, monitoring, and operating parameter measurements recorded during the preceding three months. Measured opacity levels cannot exceed 20 percent opacity, except for one 6-minute period per hour of not more than 27 percent opacity.

Because past emissions testing and CEMS results when No. 6 oil was burned have shown that all four CSF boilers cannot meet the new lower NOx RACT standards, BNL is using a system averaging plan to demonstrate compliance in quarterly reports submitted to NYSDEC. This is accomplished with a NOx ledger, where NOx emission rate credits accumulated during quarterly periods when natural gas is burned at levels below the NOx RACT limits offset ledger debits that occur when any of the four boilers burn oil. The ledger must show that the actual NOx weighted average emission rate of operating boilers is less than the Part 227-2 permissible NOx weighted average rate for the quarter. For the third and fourth calendar quarters of 2014, the respective actual weighted average emission rates for operating boilers were 0.087 and 0.090 lbs/MMBtu, while the respective permissible weighted average emissions rates were 0.121 and 0.150 lb/MMBtu.

On July 17, 2014, Boiler 6 exceeded the new NOx RACT limit of 0.15 lbs/MMBtu with a 24-hour average emission rate of 0.21 lbs/MMBtu while firing No. 6 oil. The exceedance occurred after natural gas service was interrupted to the CSF to permit modifications of utility natural gas line services. Natural gas service to the CSF was restored later that day after service line modifications were completed. As noted in Chapter 3, this exceedance was documented in the quarterly Site-Wide Air Emissions and Monitoring Systems Performance Report submitted to NYSDEC. Despite the exceedance, the actual weighted average emission rate for operating boilers that day was 0.123 lbs/MMBtu, which was less than the permissible weighted average emissions rate of 0.150 lbs/MMBtu.

In 2014, there was one excess opacity measurement recorded by Boiler 6 on November 25

Table 4-4. Ambient Airborne Tritium Measurements in 2013.

Sample Station	Wind Sector	Validated Samples	Maximum (pCi/m³)	Average (pCi/m³)
P2	NNW	24	16.5 ± 6.3	3.7 ± 3.7
P4	WSW	25	18.0 ± 6.4	3.4 ± 3.6
P7	ESE	7	10.1 ± 4.4	3.9 ± 2.6
P9	NE	21	17.4 ± 6.9	4.0 ± 3.9
Grand Average				**3.7 ± 4.2**

Notes:
See Figure 4-3 for station locations.
Wind sector is the downwind direction of the sample station from the High Flux Beam Reactor (HFBR) stack.
All values reported with a 95% confidence interval.
Typical minimum detection limit for tritium is between 2.0 and 10.0 pCi/m³.
DOE Order 5400.5 Air Derived Concentration Guide is 100,000 pCi/m³.

during scheduled service work on the continuous opacity system, and five excess opacity measurements recorded by Boiler 7. Two of the Boiler 7 excess opacity readings that occurred on October 8 during boiler startup were due to unknown causes, while the two excess readings recorded on November 24 were the result of a blower motor failure. The final excess opacity reading occurred during startup of Boiler 7 after the blower motor was replaced on November 25. During quarterly quality assurance tests of the opacity monitors for Boilers 6 and 7, multiple 6-minute periods greater than 20 percent opacity were also recorded. As noted in Chapter 3, all of the excursions were documented in quarterly Site-Wide Air Emissions and Monitoring Systems Performance Reports submitted to NYSDEC. 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 on days when the boilers were operated.

To satisfy quality assurance requirements for the continuous emissions monitoring system of the Laboratory's Title V operating permit, a relative accuracy test audit (RATA) of the Boilers 6 and 7 continuous emissions monitoring systems for NOx and CO2 was conducted in December 2014. The results of the RATA demonstrated that the Boiler 6 and 7 NOx and CO_2 continuous emissions monitoring systems met RATA acceptance criteria, which are defined in 40 CFR 60, Appendix B, Specifications 2 and 3.

In 2014, residual fuel prices exceeded those of natural gas for most of the year. As a result, natural gas was used to supply more than 99.3 percent of the heating and cooling needs of BNL's major facilities. By comparison, in 2005, residual fuel satisfied 99.9 percent of the major facility heating and cooling needs. Consequently, 2014 emissions of particulates, NOx, and sulfur dioxide (SO2) were 12.6, 49.5, and 92.1 tons less than the respective totals for 2005, when No. 6 oil was the predominant fuel. 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 2005.

4.5 GREENHOUSE GAS EMISSIONS

One of the overarching goals of Executive Order (EO) 13514, *Federal Leadership in Environmental, Energy, and Economic Performance,* is for federal agencies to establish agency-wide greenhouse gas (GHG) reduction targets for their combined Scope 1 and 2 greenhouse gas emissions and for their Scope 3 greenhouse gas emissions (see Appendix A for definitions). DOE has set the following GHG emission reduction goals for fiscal year 2020: reduce Scope 1 and 2 GHG emissions by 28 percent relative to their fiscal year (FY) 2008 baseline and reduce Scope 3 GHG emissions by 13 percent relative to their FY 2008 baseline.

BNL includes these same goals in its annual Site Sustainability Plan (SSP), which is submitted to DOE in December of each year (BNL 2014). Due to planned programmatic growth with the addition of the Laboratory's National Synchrotron Light Source II (NSLS-II) and other programs, Scope 1 and 2 emissions are projected to increase to 297,000 metric tons carbon dioxide equivalent ($MtCO_2e$) by 2020, a 44 percent increase from the FY 2008 baseline of 205,628 $MtCO_2e$. Due to the projected increase, meeting the Scope 1 and 2 reduction goal will be difficult. BNL's SSP identifies a number of actions that have or will be taken to help the Laboratory move towards this goal.

In November 2011, the Long Island Solar Farm (LISF), a large array of more than 164,000

Table 4-5. Central Steam Facility Fuel Use and Emissions (2005–2014).

Annual Fuel Use and Fuel Heating Values							Emissions			
Year	No. 6 Oil (10^3 gals)	Heating Value (MMBtu)	No. 2 Oil (10^3 gals)	Heating Value (MMBtu)	Natural Gas (10^6 ft^3)	Heating Value (MMBtu)	TSP (tons)	NO_x (tons)	SO_2 (tons)	VOCs (tons)
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
2007	2,542.85	374,432	0.00	0	263.04	268,301	9.7	77.3	59.3	2.2
2008	1,007.49	148,939	0.10	14	496.48	506,406	5.7	46.7	23.0	1.9
2009	1,904.32	283,734	0.00	0	375.03	382,529	9.0	53.4	44.9	2.1
2010	447.47	66,591	0.00	0	561.42	568,939	3.4	41.5	10.0	1.8
2011	31.49	4,726	0.01	2	657.06	668,564	2.6	30.4	0.9	1.8
2012	43.44	6,519	0.00	0	613.44	630,616	2.5	29.1	1.2	1.7
2013	117.21	17,590	0.00	0	631.95	649,645	2.9	30.7	2.9	1.8
2014	34.03	5,107	0.00	0	673.80	690,584	2.6	30.9	1.0	1.9
Permit Limit (in tons)							113.3	159.0	445.0	39.7

Notes:
NOx = oxides of nitrogen
SO2 = sulfur dioxide
TSP = total suspended particulates
VOCs = volatile organic compounds

solar photovoltaic panels constructed on site began producing solar power. Annually, the LISF is expected to deliver 44 million kilowatt-hours of solar energy into the local utility grid. This equates to 28,000 $MtCO_2e$ that the Laboratory can count on as GHG offsets or reductions. In March 2011, BNL began receiving 15 megawatts per hour of hydropower from the New York Power Authority. In 2014, BNL consumed 120,555 megawatts of hydropower, providing a net GHG reduction of 73,538 $MtCO_2e$.

In October 2013, DOE awarded a Utility Energy Service Contract. This project allows for the implementation of energy savings measures and is scheduled for completion by late 2015. In addition to energy savings, it will reduce Scope 1 and 2 GHG levels by approximately 7,000 $MtCO_2e$. By the end of 2014, BNL was nearly 50 % complete with Phase I energy conservation measures that included:

- Improvements that will increase the efficiency of supplying chilled water
- Upgraded lighting throughout the site
- Computerized building control upgrades and additions to provide for heating, ventilation, and air conditioning temperature setbacks

Other planned energy savings initiatives include improvements at the CSF and in the steam distribution system, and the construction of a combined heat and power plant.

To meet the 2020 Scope 3 GHG emissions reduction goal, Scope 3 emissions must be lowered by 2,618 $MtCO_2e$ from the FY 2008 baseline of 20,136 $MtCO_2e$. A secondary Scope 3 goal set by DOE is to reduce GHG emissions from employee business travel by 12 percent from the FY 2008 baseline or 1,056 $MtCO_2e$. Overall, Scope 3 GHG emissions have dropped by 2,735 $MtCO_2e$ or 13.6 percent from FY 2008 to FY 2014, despite a 995 $MtCO_2e$ or 2.2 percent increase in employee business travel GHG emissions over the same period. This reduction was a direct result of the purchase and use of 120,555 megawatt-hours of hydropower from the New York Power Authority in 2014. Hydropower purchased in 2014 accounted for 41.5 percent of all BNL power purchases. As a result, GHG emissions from transmission and distribution losses dropped 2,898 $MtCO_2e$, or 26.1 percent.

To achieve the employee travel reduction goal, BNL must reduce its employee travel GHGs by 1,056 $MtCO_2e$. Reaching this goal is complicated by a growing employee population that rose 5.2 percent from 2,669 full-time employees at the end of FY 2008 to 2,808 as of September in 2014. Further increases are projected due to programmatic growth. Actions taken in 2014 and others planned in 2015 that will help BNL move forward in meeting the employee business travel GHG reduction goals included:

- BNL staff continued to work with administrators of MetroPool, the New York State Department of Transportation regional commuting services contractor, to review the scope of customized rideshare portal options intended to enhance employee interest and participation in ridesharing. After the meeting, BNL staff reconsidered planned rideshare website improvements, choosing instead to work with the Web Services Group to convert the current rideshare website to a Commuter Choice website. The new website will stress both the environmental and work/life balance benefits of more sustainable commuting options, as well as the resources available to enable employees to rideshare, commute by bicycle, use mass transit, and establish compressed work or telework schedules. BNL Environmental Protection Division staff subsequently met with the Web Services Group to review the current rideshare website and to discuss desired elements for the new Commuter Choice website.
- A working group led by BNL Human Resources developed two new procedures that will be added to the the Laboratory's Standards-Based Management System (SBMS) Flexible Work Arrangements Subject Area. These new procedures expand flexible workweek and compressed workweek schedules for non-bargaining non-exempt employees and non-bargaining employees, respectively.
- BNL's Badging Office amended forms used to register employee vehicles and provide stickers for site entrance purposes. The form now includes the vehicle model, in addition to the model year and make that was previously recorded. These records will serve as an improved metric for estimating the average mileage of vehicles used in vehicle commuting and for measuring reductions in commuter GHG emissions over time as employees replace older less fuel efficient models with vehicles meeting the progressively higher corporate average fuel economy standards that became effective with 2011 model year light duty vehicles.

Future actions that should help to reduce business travel GHG emissions include plans to expand user teleconferencing capabilities through the deployment of enhanced communications technologies in FY 2015 as part of BNL's sitewide telephone replacement project. In addition to providing users with the ability to rapidly schedule and conduct ad-hoc audio teleconferences, the new technologies will enable users to integrate desktop video teleconferencing capabilities with larger room-based sessions and mobile devices. This allows teleconferencing sessions to be scheduled by any individual user, and spans the use of previously disparate technologies. As such, the need to travel for traditional face-to-face meetings is expected to decrease.

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