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 2015, BNL facilities released a total of 4,551 curies of short-lived radioactive gases. Oxygen-15 and carbon-11 emitted from the Brookhaven Linac Isotope Producer constituted more than 99.98 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 99.8 percent of the heating and cooling needs of the Laboratory's major facilities in 2015. 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 inline detection system, the Brookhaven Linac Isotope Producer (BLIP). During 2015, 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. Samples are

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

collected one week per month 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 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: 20.4 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 2015, BLIP operated over a period of 31 weeks, during which 1,517 Ci of C-11 and 3,034 Ci of O-15 were released (see Table 4-1). Tritium produced from activation of the target cooling water was also released, but in a much smaller quantity, 2.86 E-2 Ci. Combined emissions of C-11 and O-15 were 4,551 Ci, 40 percent lower than the combined emissions of 7,534 Ci in 2014. This decrease was primarily due to operation at lower energy levels in 2015.

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 resumed.

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. 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.

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

Facility	Nuclide	Half-Life	Ci Released
HFBR	Tritium	12.3 years	4.51E-01
BLIP	Carbon-11	20.4 minutes	1.52E+03
	Oxygen-15	122 seconds	3.03E+03
	Tritium	12.3 years	2.86E-02
Total			**4.55E+03**

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

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 decontamination and decommissioning (D&D) activities. In 2015, the only diffuse source evaluated was for planned decontamination and demolition of Building 811, the former Waste Concentration 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 2015.

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 2015 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 0.0115 pCi/m^3, respectively. Annual average gross alpha and beta airborne activity levels for samples collected from the TPL were 0.0012 and 0.0101 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 four blockhouse stations 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 2015, silica-gel samples were collected every 2 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 0.0013 and 0.0135 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

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

Facility Monitor		Gross Alpha (pCi/m^3)	Gross Beta
BLIP	N	52	52
	Max.	0.0014 ± 0.0006	0.0664 ± 0.0025
	Avg.	0.0003 ± 0.0004	0.0115 ± 0.0011
	MDL	0.0006*	0.0008*
TPL - Bldg. 801	N	51	51
	Max.	0.0143 ± 0.0018	0.0216 ± 0.0018
	Avg.	0.0012 ± 0.0006	0.0101 ± 0.0012
	MDL	0.0007*	0.0009*

Notes:
See Figure 4-1 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

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

Sample Station		Gross Alpha (pCi/m^3)	Gross Beta
P2	N	50	50
	Max	0.0068 ± 0.0022	0.0392 ± 0.0019
	Avg.	0.0014 ± 0.0006	0.0125 ± 0.0012
	MDL	0.0006*	0.0008*
P4	N	47	47
	Max	0.0089 ± 0.0049	0.0862 ± 0.0086
	Avg.	0.0013 ± 0.0006	0.0148 ± 0.0014
	MDL	0.0007*	0.0009*
P7	N	52	52
	Max	0.0052 ± 0.0015	0.0220 ± 0.0014
	Avg.	0.0011 ± 0.0005	0.0124 ± 0.0011
	MDL	0.0006*	0.0007*
P9	N	51	51
	Max	0.0032 ± 0.0007	0.0326 ± 0.0038
	Avg.	0.0014 ± 0.0006	0.0144 ± 0.0012
	MDL	0.0006*	0.0007*
Grand Average		**0.0013 ± 0.0006**	**0.0135 ± 0.0012**

Notes:
See Figure 4-2 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

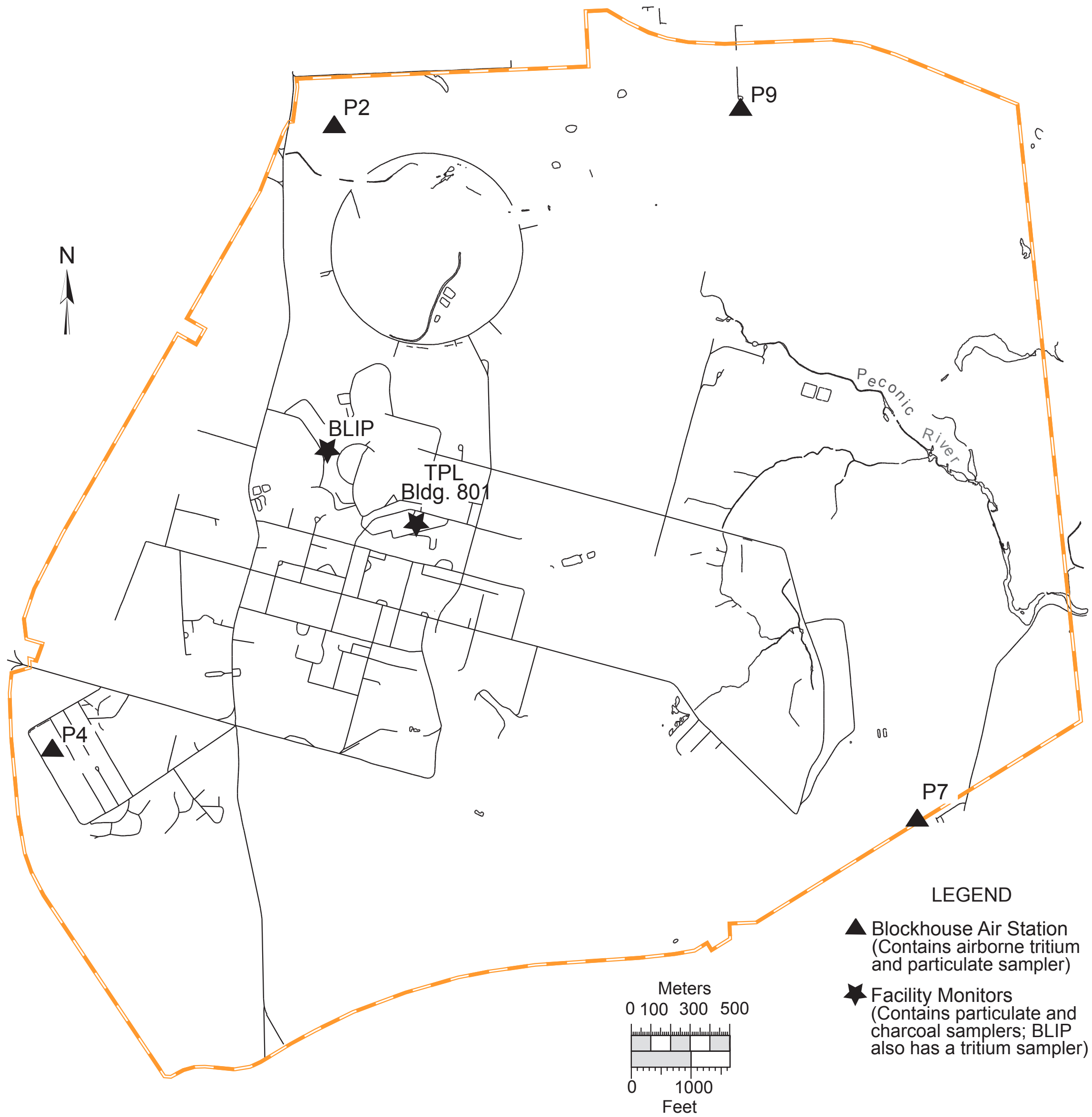


Figure 4-2. BNL On-Site Ambient Air Monitoring Stations.

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 0.0025 and 0.0260 pCi/m^3, with an average concentration of 0.0101 pCi/m^3. BNL results ranged from 0.0050 to 0.0220 pCi/m^3, with an average concentration of 0.0127 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 2015, NYSDOH reported that airborne gross beta activity at that location varied between 0.0043 and 0.0280 pCi/m^3, and had an average concentration of 0.0119 pCi/m^3. All 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 2015, tritium samples were collected from Stations P2, P4, P7, and P9 to assess the potential impacts from the Laboratory'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 laboratory). Airborne tritium samples were collected every 2 weeks from each sampling station during 2015; however, eight 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 1.1 to 9.2 pCi/m^3.

4.4 NONRADIOLOGICAL AIRBORNE EMISSIONS

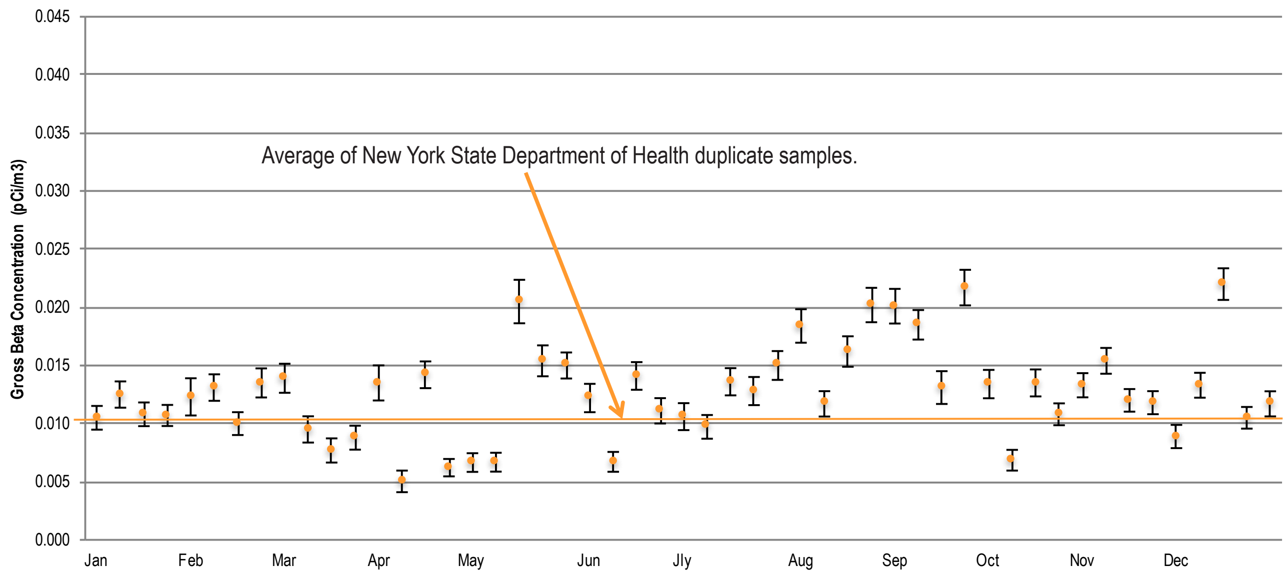
Various state and federal regulations governing nonradiological releases require facilities to conduct periodic or continuous emission monitoring to demonstrate compliance with emission limits. The Central Steam Facility (CSF) is the only BNL facility that requires monitoring for nonradiological emissions. 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 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 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. 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 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.



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

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

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 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. The actual weighted average emission rates for operating boilers in the first, second, third, and fourth quarters, respectively, were 0.090, 0.088, 0.087 and 0.086 lbs/MMBtu, while the permissible weighted average emissions rate each quarter was 0.150 lbs/MMBtu.

In 2015, the only excess opacity measurements recorded by Boiler 6 and Boiler 7 continuous opacity systems occurred during scheduled quality assurance calibration error tests of the opacity monitors. 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 2015. The results of the RATA demonstrated that the Boiler 6 and 7 NOx and CO2 continuous emissions monitoring systems met RATA acceptance criteria, which are defined in 40 CFR 60, Appendix B, Specifications 2 and 3.

In 2015, residual fuel prices exceeded those of natural gas for most of the year. As a result, natural gas was used to supply more than 99.8

Table 4-4. Ambient Airborne Tritium Measurements in 2015.

Sample Station	Wind Sector	Validated Samples	Maximum (pCi/m^3)	Average (pCi/m^3)
P2	NNW	25	41.7 ± 10.7	3.7 ± 3.4
P4	WSW	26	9.6 ± 3.5	1.3 ± 3.4
P7	ESE	18	3.9 ± 1.0	0.4 ± 0.7
P9	NE	24	13.8 ± 3.5	2.6 ± 3.7
Grand Average				**2.1 ± 3.0**

Notes:
See Figure 4-2 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/m^3.

percent of the heating and cooling needs of BNL's major facilities. By comparison, in 2006, residual fuel satisfied 68.9 percent of the major facility heating and cooling needs. Consequently, 2015 emissions of particulates, NOx, and sulfur dioxide (SO2) were 9.4, 36.6, and 65.9 tons, respectively, and less than the respective totals for 2006 when No. 6 oil was the predominant fuel used. 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 2006.

4.5 GREENHOUSE GAS EMISSIONS

One of the overarching goals of Executive Order (EO) 13693, *Planning for Federal Sustainability in the Next Decade*, is for federal agencies to establish agency-wide greenhouse gas (GHG) reduction targets for their combined Scope 1 and 2 emissions and for their Scope 3 emissions (see Appendix A for definitions). DOE has set the following GHG emission reduction goals for fiscal year (FY) 2025: reduce Scope 1 and 2 GHG emissions by 50 percent relative to their FY 2008 baseline and reduce Scope 3 GHG emissions by 25 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 2015). BNL's SSP identifies a number of actions that have or will be taken to help the Laboratory move towards the Scope 1 and 2 GHG emissions reduction goal.

In November 2011, the Long Island Solar Farm (LISF), a large array of more than 164,000 solar photovoltaic panels constructed on the BNL site began producing solar power. Annually, the LISF is expected to deliver 44 million kilowatt-hours of solar energy into the local utility grid. In 2015, the LISF provided 51.4 million kilowatt-hours of solar energy to Long Island. This equates to a 28,119 MtCO_2e GHG offset or reduction for the Laboratory. In March 2011, BNL began receiving 15 megawatts per hour of hydropower from the New York Power Authority. In 2015, the Laboratory consumed 121,682 megawatts of hydropower, providing a net combined GHG reduction of 108,058 MtCO_2e from the LISF and hydropower.

In October 2013, DOE awarded a Utility Energy Service Contract (UESC). This project allows for the implementation of energy savings measures that will reduce Scope 1 and 2 GHG levels by approximately 7,000 MtCO_2e. In May of 2015, the Laboratory had completed 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 a potential Phase II UESC project, lighting upgrades, and improvements at the CSF in the steam distribution system. BNL continues to evaluate the potential to install a combined heat and power (CHP) plant and will recommend going forward if a business case can be developed.

To meet the 2025 Scope 3 GHG emissions reduction goal, Scope 3 emissions must be lowered by 5,034 MtCO_2e from the FY 2008 baseline of 20,136 MtCO_2e. Overall, Scope 3 GHG emissions rose by 3,079 MtCO_2, up 18.0 percent from FY 2014 and 0.4 percent higher than the FY 2008 baseline value of 20,136 MtCO_2. GHG emissions from electrical transmission and distribution losses rose 2,984 MtCO_2, accounting for most of the increase. Transmission and distribution GHG emissions increased despite a 3.0 percent drop in use of purchased electricity, because the regional transmission and distribution loss factor used to calculate transmission and distribution electrical losses

Table 4-5. Central Steam Facility Fuel Use and Emissions (2006–2015).

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)
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
2015	9.66	1,449	0.00	0	619.98	638,209	2.4	30.3	0.4	1.7
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

jumped from 6.18 percent in FY 2014 to 10.10 percent in FY 2015.

Unless projected drops in purchased electricity and transmission and distribution loss GHG emissions from the implementation of planned UESC Phase II energy conservation measures and construction of a combined heat and power plant are significant, BNL will need to focus its efforts on reducing GHG emissions from employee business air travel and employee commuting.

Actions taken in 2015 and others planned in 2016 that will help BNL to reduce GHG emissions from air travel and employee commuting and move forward in achieving the Scope 3 GHG reduction goal include:

- Fiscal Services and Human Resources identified a method to use the Laboratory's current time-keeping system in PeopleSoft to accurately record the number of days and hours of employee teleworking under BNL's Flexible Work Arrangement procedures.
- The distribution of a mass email to 1,288 active employees, guests, and contractors requesting that they update their current stickered vehicle database records. As a result, stickered vehicle database records for more than 3,500 individuals covering just over 5,000 vehicles from model year 1984 to 2016 are recorded in the database. Since the records now include the vehicle make, model, and model year, they were used in conjunction with EPA's combined mileage ratings from the US DOE fuel economy website to conclude that the average fuel economy of employee vehicles used in commuting had increased from 23.2 miles per gallon in FY 2014 to 23.8 miles per gallon in FY 2015. The database statistics will enable the Laboratory to show how fuel economy improvements made as employees gradually replace older vehicles with newer models that reflect higher Corporate Average Fuel Economy (CAFE) Standards established for vehicle manufacturers by the National Highway Traffic Safety Administration (NHTSA) help to reduce employee commuting GHG emissions.
- In May, the Laboratory announced that it had extended its pilot program to expand the number of site access points to BNL bicycle commuters for an additional year. The program, initiated in April 2014, provides bicycle commuters residing south and east of the Laboratory with more direct access via a gate at the southeast corner of the site. The program also allows registered bicy-

clists entering the site via the Main Gate from the west and the North Gate to pass through without having to slow down and present their badge.

- The introduction of a new carpooling initiative called "Two for Tuesdays" during the Lab's promotion of its participation in Car Free Day Long Island held on September 22. The initiative emphasizes that ridesharing can be as simple as two people carpooling once a week. Promotional efforts included a feature article on BNL's homepage, email messages, and posters that focused on the 89 percent of BNL employees who reside in "car-pool clusters" (areas where 10 or more fellow employees live). Employees residing in each of the 39 carpool clusters were also encouraged to use the 511NYRideshare ride-match tool to reach out to employees residing nearby who were also interested in carpooling.

Future actions that should help to reduce business travel GHG emissions include FY 2016 plans to demonstrate Blue Jeans teleconferencing capabilities at an information table on Earth Day, the rollout of amended Standards-Based Management System Flexible Work Arrangements Subject Area procedures that enable employees to record telework and compressed work schedule days using PeopleSoft HR time reporting records, and coordinated efforts with the Laboratory's Web Service group to convert the current rideshare website to a Commuter Choice website.

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