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 2016, BNL facilities released a total of 10,426 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.

To accrue savings from fuel purchases, BNL's Central Steam Facility drew down existing supplies of residual fuel oil in the Major Petroleum Facility storage tanks by burning 804,380 gallons of residual fuel to meet 21 percent of the heating and cooling needs of the Laboratory's major facilities in 2016. As a result, emissions of particulates, oxides of nitrogen, and sulfur dioxide increased from 2015 levels.

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 two facilities, the Brookhaven Linac Isotope Producer (BLIP) and the Target Processing Laboratory (TPL), that are continuously monitored with inline detection systems, and one inactive facility, the High Flux Beam Reactor (HFBR), where periodic monitoring is conducted. Figure 4-1 provides the locations of these monitored facilities, and Table 4-1 presents airborne release data from 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.

4.2 FACILITY MONITORING

Radioactive emissions are monitored at the HFBR, BLIP and TPL. The samplers in the exhaust stack for BLIP and the TPL exhaust duct 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 2016 are reported in Table 4-2. The average gross alpha and beta airborne activity levels for samples collected from the BLIP exhaust stack were 0.0004 and 0.0119 pCi/m^3, respectively. Annual average gross alpha and beta airborne activity levels for samples collected from the TPL were 0.0008 and 0.0125 pCi/m^3, respectively.

4.2.1 High Flux Beam Reactor

In 1997, a plume of tritiated groundwater

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

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

4.2.2 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 2016, BLIP operated over a period of 30.4 weeks, during which 3,475 Ci of C-11 and 6,950 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, 4.46 E-1 Ci. Combined emissions of C-11 and O-15 were 10,425 Ci, 2.29 times higher than the combined emissions of 4,551 Ci in 2015. This increase is primarily due to operation at higher average current levels for short periods, and occasional increased water gaps for Thorium targets in 2016. The Thorium target irradiations are in support of future actinium-225 production programs.

4.2.3 Target Processing Laboratory

As mentioned in Section 4.2.2, 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.

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

Facility	Nuclide	Half-Life	Ci Released
HFBR	Tritium	12.3 years	2.45E-01
BLIP	Carbon-11	20.4 minutes	3.48E+03
	Oxygen-15	122 seconds	6.95E+03
	Tritium	12.3 years	4.46E-01
Total			**1.04E+04**

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

4.2.4 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, 348, 463, 480, 490, 490A, 510A, 535, 555, 725, 734, 735, 745, 801, and 815, 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 8-5 in Chapter 8 for the calculated dose from these facility emissions.

4.2.5 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. Evaluations determine 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 2016.

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

Facility Monitor		Gross Alpha (pCi/m³)	Gross Beta
BLIP	N	52	52
	Max.	0.0042 ± 0.0009	0.0357 ± 0.0019
	Avg.	0.0004 ± 0.0004	0.0119 ± 0.0012
	MDL	0.0006*	0.0009*
TPL - Bldg. 801	N	52	52
	Max.	0.0067 ± 0.0013	0.0596 ± 0.0028
	Avg.	0.0008 ± 0.0005	0.0125 ± 0.0013
	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

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 adsorbent material for processing by liquid scintillation analysis. In 2016, 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 0.0011 and 0.0128 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 4-3. Gross Activity Detected in Ambient Air Monitoring Particulate Filters.

Sample Station		Gross Alpha (pCi/m³)	Gross Beta
P2	N	49	49
	Max	0.0028 ± 0.0007	0.0206 ± 0.0014
	Avg.	0.0012 ± 0.0005	0.0139 ± 0.0011
	MDL	0.0005*	0.0006*
P4	N	51	51
	Max	0.0022 ± 0.0006	0.0218 ± 0.0013
	Avg.	0.0009 ± 0.0003	0.0095 ± 0.0007
	MDL	0.0003*	0.0004*
P7	N	50	50
	Max	0.0021 ± 0.0006	0.0201 ± 0.0015
	Avg.	0.0011 ± 0.0004	0.0131 ± 0.0010
	MDL	0.0004*	0.0006*
P9	N	45	45
	Max	0.0036 ± 0.0017	0.0266 ± 0.0031
	Avg.	0.0014 ± 0.0005	0.0151 ± 0.0013
	MDL	0.0006*	0.0007*
Grand Average		**0.0011 ± 0.0004**	**0.0128 ± 0.0010**

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

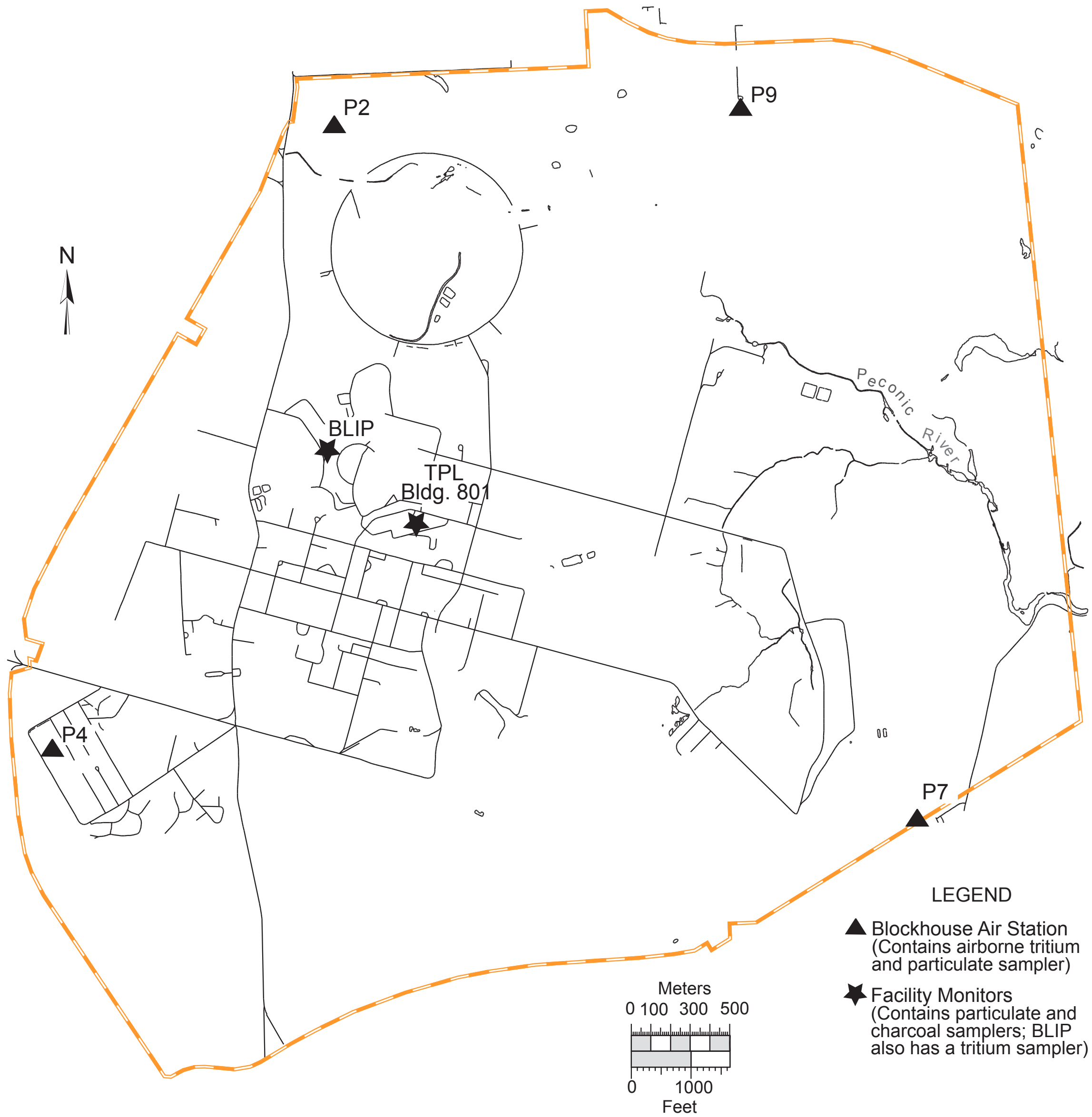


Figure 4-2. BNL On-Site Ambient Air Monitoring Stations.

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 0.0013 and 0.0163 pCi/m^3, with an average concentration of 0.0085 pCi/m^3. BNL results ranged from 0.0033 to 0.0134 pCi/m^3, with an average concentration of 0.0131 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 2016, NYSDOH reported that airborne gross beta activity at that location varied between 0.0029 and 0.0203 pCi/m^3, and had an average concentration of 0.0106 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 2016, tritium samples were collected from Stations P2, P4, P7, and P9 to assess the potential impacts from the Laboratory's two 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 two weeks from each sampling station during 2016; however, one sample could not be analyzed because the amount of moisture captured on the 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 9.9 pCi/m^3.

4.4 NONRADIOLOGICAL AIRBORNE EMISSIONS

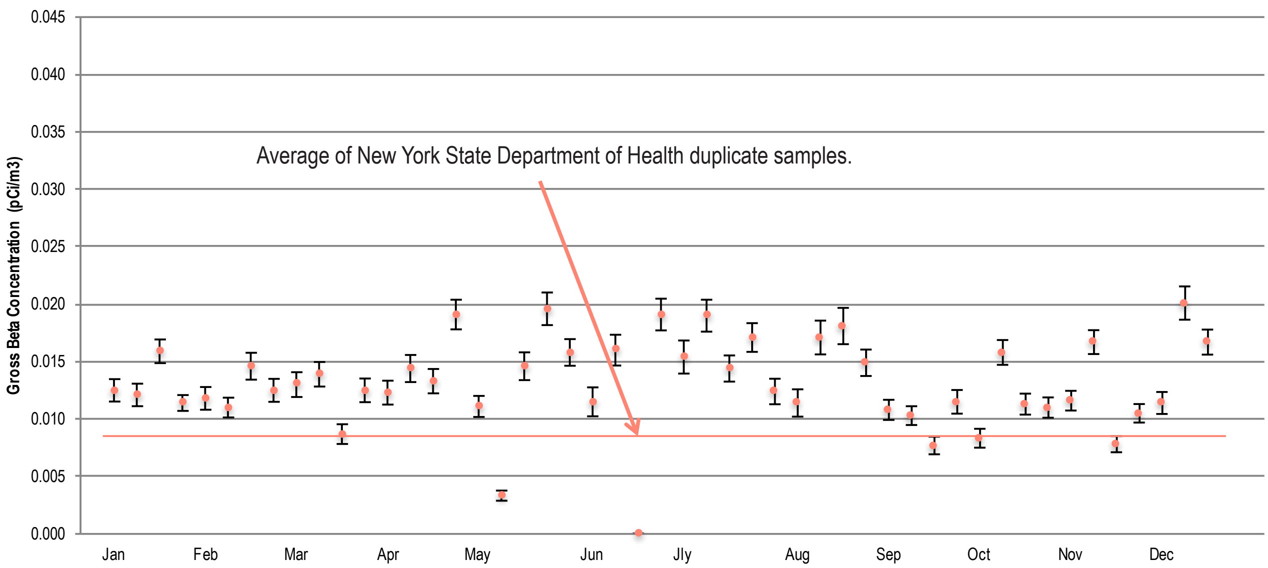
Various state and federal regulations governing nonradiological releases require facilities to conduct periodic or continuous emission monitoring to demonstrate compliance with emission limits. The Central Steam Facility (CSF) is the only BNL facility that requires monitoring for nonradiological emissions. 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 MMB-tu/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 of each year, the peak ozone period, owners and operators of boilers equipped with CEMS must 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



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

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

emission rate is used to establish compliance. Owners and operators of 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 an approved 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 0.121, 0.120, 0.103, and 0.101 lbs/MMBtu, while the corresponding permissible weighted average emissions rates each quarter were 0.158, 0.165, 0.160, and 0.152 lbs/MMBtu.

In 2016, 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 CO_2 was conducted in December 2016. 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.

Table 4-4. Ambient Airborne Tritium Measurements in 2016.

Sample Station	Wind Sector	Validated Samples	Maximum (pCi/m^3)	Average (pCi/m^3)
P2	NNW	26	23.6 ± 3.4	4.5 ± 3.5
P4	WSW	24	11.7 ± 5.3	3.2 ± 3.7
P7	ESE	25	5.8 ± 4.0	1.1 ± 1.4
P9	NE	26	27.3 ± 19.0	2.3 ± 4.5
Grand Average				**2.5 ± 3.3**

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 1.1 and 9.9 pCi/m^3.

To achieve savings on fuel purchases, existing supplies of residual fuel at the Major Petroleum Facility were used to supply 21.0 percent of the heating and cooling needs of BNL's major facilities in 2016. By comparison in 2015, natural gas satisfied more than 99.8 percent of the heating and cooling needs. Consequently, 2016 emissions of particulates, NOx, and sulfur dioxide (SO_2) were 1.3, 3.3, and 18.6 tons, respectively, and higher than the respective totals for 2015. 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 2007.

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 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 (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 2016). BNL's SSP identifies a number of actions that have or will be taken to help the Laboratory progress towards meeting 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. The LISF is expected to deliver an annual average of 44 million kilowatt-hours (kWh) per year of solar energy into the local utility grid over a 20 year period. In 2016, the LISF provided 52.4 million kilowatt-hours of solar energy to Long Island. This equates to a 33,949 $MtCO_2e$ GHG offset or reduction. Even though the power from the LISF is purchased by the local utility, the Laboratory receives GHG reduction credits by purchasing an equivalent amount of Renewable Energy Credits (RECs) each year. In March 2011, BNL began receiving 15 megawatts per hour of hydropower from the New York Power Authority. In 2016, BNL consumed 118,729 megawatts of hydropower, providing a net combined GHG reduction of 98,901 $MtCO_2e$ from the LISF and hydropower. Furthermore, in 2016 BNL completed an expansion of the Northeast Solar Energy Research Center (NSERC). The NSERC is a solar photovoltaic facility that now has a capacity of 816 kW. In 2016, it provided 553,715 kWh and offset 359 $MtCO_2e$.

In October 2013, DOE awarded BNL a Utility Energy Service Contract (UESC). This project called for the implementation of energy savings measures to reduce Scope 1 and 2 GHG levels by approximately 7,000 $MtCO_2e$. In May of 2015, the Laboratory completed Phase I energy conservation measures that included:

- The installation of a 1,250 ton high-efficiency chiller to increase the efficiency of supplied chilled water
- Upgraded lighting systems in 18 buildings
- Enhanced building control upgrades and additions to provide for heating, ventilation, and air conditioning temperature setbacks in nine buildings

Other planned energy savings initiatives from Phase II UESC projects set to begin in FY 2018 will include additional lighting and building control upgrades, and chilled water storage improvements. BNL will periodically evaluate the potential to install a combined heat and power

Table 4-5. Central Steam Facility Fuel Use and Emissions (2007–2016).

	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)
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
2016	804.38	120,712	0.00	0	441.98	453,348	3.7	33.6	19.0	1.7
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

(CHP) plant and will recommend going forward if a business case develops to make installation a viable alternative.

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 2,395 $MtCO_2e$, up 11.6 percent from FY 2015, and 14.7 percent higher than the FY 2008 baseline value of 20,136 $MtCO_2e$. GHG emissions from electrical transmission and distribution losses rose 1,784 $MtCO_2e$, accounting for most of the increase. Transmission and distribution GHG emissions increased despite a 5.2 percent drop in use of purchased electricity, because the e-Grid distribution loss adjustment factor used to calculate local grid and hydropower transmission and distribution electrical losses jumped from 6.59 percent in FY 2015 to 9.09 percent in FY 2016.

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 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 included:

- In April, a survey was performed using traffic counters to aggregate and distinguish the types of vehicles entering the site from 7 am to 9 am for five days to obtain better metrics to estimate commuting GHG emissions. The survey results were combined with tallies of the number and types of multi-occupant vehicles each day to estimate commuting GHG emissions for FY 2016.
- A mass email was distributed 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 were 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 June, the Laboratory Protection Division canvased Bike Program past and current users for feedback to make the program more convenient and efficient. Based on responses, program enhancements include the issuance of reflective decals to bikes to make it easier for gate officers to identify authorized bicyclists. Another enhancement is the amendment of the re-registration period from annually to every five years. 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 bicyclists 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.
- During the Laboratory's promotion of its participation in Car Free Day Long Island held on September 22, a Ride Green poster and a Monday Memo segment were used to emphasize that ridesharing can be as simple as two people carpooling once a week. The poster and the Monday Memo segment focused on the 88 percent of BNL employees who reside in one of the 69 "carpool clusters" (areas where seven or more fellow employees live). Employees residing in 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 2017 plans to survey past cloud-based video teleconferencing service users on the merits of using teleconferencing services and to convey the survey results to employees via BNL media services. Actions that should help to reduce employee GHG emissions include Human Resources plans to amend its telework and compressed work schedule policy to require initial and reauthorization requests to be routed to a centralized approval system. Schedules described in request forms will be used to determine the number of days employees requesting telework or compressed work schedules are not commuting. BNL will also seek DOE Sustainability Office approval to use a modified approach to more accurately estimate its commuter GHG emissions. The approach uses a set of emission factors based on EPA Tier 2 methane and nitrous oxide emission standards and average fleet-wide CO_2 emission targets established by EPA for 2012–2025 passenger cars and light duty trucks.

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