Chapter 4

Air Quality

Brookhaven National Laboratory performs continuous emissions sampling at several facilities to ensure compliance with requirements of the Clean Air Act. In addition to a facility emissions monitoring program, routine environmental air sampling is conducted to verify local air quality and environmental impacts.

In 2000, the Brookhaven Medical Research Reactor, the High Flux Beam Reactor, and the Brookhaven Linear Accelerator Isotope Producer were the most significant contributors to the site's radiological air emissions. Total radionuclide emissions were consistent with those of recent years. During 2000, a total of 3,265 Ci (121 TBq) of airborne radioactive material was released from these facilities. Gaseous argon-41 and oxygen-15 (both short-lived radionuclides with respective half-lives of 1.8 hours and 123 seconds) from the Brookhaven Medical Research Reactor and the Brookhaven Linear Accelerator Isotope Producer respectively accounted for more than 99% of this total.

Due to rising natural gas prices, the Central Steam Facility relied more on residual fuel to meet the heating and cooling needs of BNL's major facilities than in 1999. As a result, annual facility emissions of particulate matter, nitrogen oxides, and sulfur dioxide rose in 2000. Still these pollutant emissions were 32%, 22%, and 59% lower than respective totals in 1996.

4.1 RADIOLOGICAL AIRBORNE EMISSIONS

Federal air quality laws and U.S. DOE regulations governing the release of airborne radioactive material include 40 CFR 61 Subpart H (from the National Emission Standards for Hazardous Air Pollutants or NESHAPs), DOE Order 5400.1 (1990), *General Environmental Protection Program*, and DOE Order 5400.5 (1993), *Radiation Protection of the Public and the Environment*. Under NESHAPs Subpart H, a section of the federal Clean Air Act, facilities with emissions that have the potential to deliver a radiation dose of greater than 0.1 mrem/year (1 μSv/year) to a member of the public must be continuously monitored. BNL has five facilities that fall into this category. Figure 4-1 indicates the location of each of the monitored facilities, and Table 4-1 presents the airborne releases from each of these facilities during 2000. Facilities with emissions that fall below this value require only periodic, confirmatory monitoring. Annual emissions are discussed in the following sections. The associated dose calculations are presented in Chapter 8.

4.1.1 BROOKHAVEN MEDICAL RESEARCH REACTOR

In August 2000, DOE announced that the Brookhaven Medical Research Reactor (BMRR) would be permanently shut down. Until it stopped operating in late December 2000, the BMRR was fueled with enriched uranium, moderated and cooled by light water, and was operated intermittently at power levels up to 3 MW (thermal). To cool the neutron reflector surrounding the core of the BMRR reactor vessel, air from the interior of the containment building was used. When air was drawn through the reflector, it was exposed to a neutron field that caused the argon component of the air to become radioactive. This radioactive form is known as argon-41. It is an inert

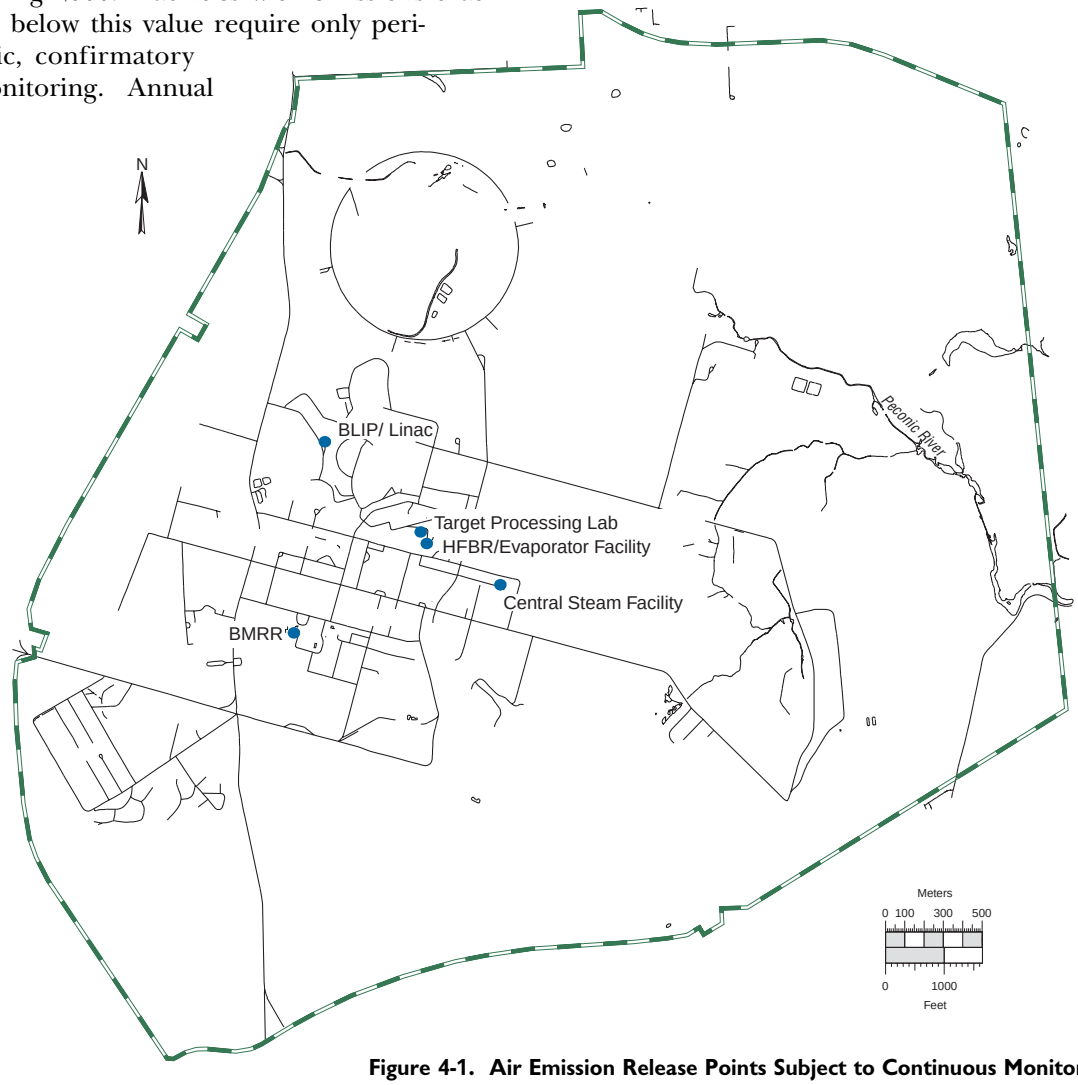

Figure 4-1. Air Emission Release Points Subject to Continuous Monitoring.

Table 4-1. Airborne Radionuclide Releases from Monitored Facilities (CY 2000).

Facility	Nuclide	Half-life	Ci Released
BMRR	Ar-41[1]	1.8 hours	2.19E+03
HFBR	Cs-137	30 years	1.30E-07
	H-3	12.3 years	4.80E+00
BLIP	O-15	122 seconds	1.07E+03
	H-3	12.3 years	2.46E-04
Evaporator	Be-7	53 days	7.81E-05
Facility	Co-56	79 days	4.91E-07
	Co-57	271 days	4.94E-06
	Co-58	71 days	2.97E-06
	Co-60	5.2 years	3.95E-06
	Cs-137	30 years	8.71E-06
	H-3	12.3 years	3.25E-01
	Mn-54	312 days	3.13E-06
	Na-22	2.6 years	2.21E-07
	Rb-86	18.6 days	1.44E-05
	Se-75	120 days	3.49E-07
	Zn-65	244 days	7.28E-05
Target	Cs-137	30 years	7.10E-10
Processing	I-126	13 days	1.17E-12
Laboratory	Se-75	120 days	8.97E-12
Total			3.265E+03

Notes:
Ci = 3.7E+10 Bq.
BMRR=Brookhaven Medical Research Reactor
HFBR=High Flux Beam Reactor
BLIP=Brookhaven LINAC Isotope Producer
[1] While other nuclides are released from the BMRR, none contributed >10% of the total public dose due to BMRR air emissions. See text for discussion.

gas with a short half-life of 1.8 hours. After passage through the reflector, the air was routed through a roughing filter and a high efficiency particulate air (HEPA) filter to remove any particulate matter. Charcoal filters were also used for the removal of radioiodines produced during the fission process. Following filtration, the air was exhausted to a 150-foot (46 meter) stack adjacent to the reactor containment building.

A real-time monitor was used to track argon-41 air emissions, while passive filter media were used to collect and quantify radioiodines and particulates. Because non-argon radionuclide concentrations in the air emissions are of a much lower concentration and total activity, they contributed less than 10% of the total public dose resulting from the BMRR's air emissions. In accordance with NESHAPs Subpart H requirements, these radionuclides were sampled on a periodic basis to confirm that their concentrations were within expected levels.

In 2000, the BMRR released 2,190 Ci (81 TBq) of argon-41 to the atmosphere. This value is consistent with previous years emission totals for this facility. Argon-41 has consistently constituted the largest fraction of all radionuclide activity released from the BNL site.

4.1.2 HIGH FLUX BEAM REACTOR

Following the discovery of an underground plume of tritium emanating from the spent fuel storage pool, the High Flux Beam Reactor (HFBR) was kept in a stand-by mode from January 1997 until November 1999, when DOE announced that it would be permanently shut down. The storage pool was drained in December 1997 to prevent additional leakage as well as to facilitate repairs. When the HFBR was operational, it used heavy water as a neutron moderator and fuel coolant. Heavy water, or D_2O, is water that is composed of a nonradioactive isotope of hydrogen known as deuterium. When exposed to the neutron fields generated inside the reactor vessel, the deuterium became activated, producing radioactive tritium (half-life = 12.3 years). In a shutdown mode, tritium continues to be released from the HFBR even though the reactor vessel has been de-fueled, because the vessel and associated cooling loops remain filled with heavy water. Tritiated water vapor (abbreviated HTO) is released from the vessel and associated piping systems (via diffusion at valve seals and other system penetrations) to building air, where it is routed to the facility's 328-foot (100-meter) stack. Concentrations of HTO in air emissions are determined by the use of an integrating silica gel absorbent. In 2000, 4.8 Ci (0.2 TBq) of airborne HTO were released from the HFBR. Figure 4-2 illustrates the declining trend of tritium emissions.

4.1.3 BROOKHAVEN LINAC ISOTOPE PRODUCER

Protons from the Linear Accelerator are sent via an underground beam tunnel to the Brookhaven Linac Isotope Producer (BLIP), where they strike various target metals. These metals, which become activated by the proton beam, are then transferred to the Target Processing Laboratory (Bldg. 801) for later use in radiopharmaceutical research. During irradiation, the targets are cooled by a continuously recirculating water system. Several radioisotopes are produced in the cooling water; the most significant of which is gaseous

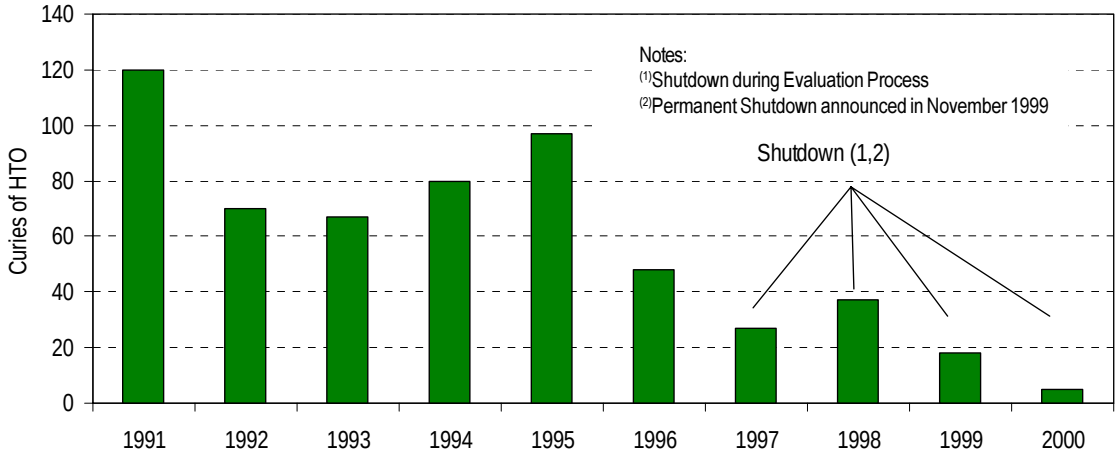

Figure 4-2. HFBR Airborne Tritium Emissions, Ten Year Trend (1991-2000).

oxygen-15, a radionuclide with a very short half-life of 122 seconds. This isotope is released as an airborne emission.

In 2000, the operation of the BLIP was limited to the months of January through March. Over this period, a total of 1,070 Ci (39.6 TBq) of oxygen-15 was released as an airborne emission. Tritium was also released, but in a much smaller quantity. See Table 4-1 for a complete listing.

4.1.4 EVAPORATOR FACILITY

The Evaporator Facility (Bldg. 802B) was constructed to reduce the total amount of tritiated water released to the Peconic River from BNL operations. Wastewater processing began in 1995.

Liquid waste generated onsite that contains residual radiological material is accumulated at the Waste Concentration Facility (WCF) in Building 811. At the WCF, suspended solids and a high percentage of radionuclides are removed from the liquid using reverse osmosis. However, because of its chemical properties, tritium cannot be removed. The tritiated water which remains following waste concentration is transferred to the Evaporator Facility in Building 802B, where it is converted to steam and released as an airborne emission. The emissions are directed to the same stack used by the HFBR for building air exhaust. This method is preferable to release via surface water because there is virtually no potential to influence groundwater, and the potential for this tritium to contribute to an offsite dose is minimized by atmospheric dispersion.

In 2000, 0.3 Ci (12 GBq) of HTO were released as an airborne emission from the Evaporator Facility. Since the waste concentration process does not remove all other radionuclides with complete efficiency, radionuclides other than tritium were released at much lower activity levels (see Table 4-1 for a listing). The activity values listed in the table were estimated, since emissions from this facility are tracked using an inventory system. Liquid shipments to the Evaporator Facility were sampled and analyzed prior to delivery to determine actual radionuclide concentrations. The total emissions for a water tanker delivery were calculated by computing the product of the radionuclide concentrations and the total volume of water evaporated. This method is very conservative since some fraction of the chemically reactive radionuclides bind to the interior surfaces of the boiler system; hence, airborne releases and projected doses from this facility are most likely overestimated.

4.1.5 TARGET PROCESSING LABORATORY

Target metals irradiated at the BLIP facility are transported to the Target Processing Laboratory (Building 801) where the useful isotopes are chemically extracted for radiopharmaceutical production. Airborne radionuclides released during the extraction process are drawn through multi-stage HEPA and charcoal filters and then vented to the HFBR stack (see Table 4-1 for isotopes and quantities). Radionuclide quantities released from this facility annually are small, typically in the microcurie range. Isotopes released to the atmosphere from the Target Processing

Laboratory operations are not significant contributors to the site perimeter dose via the airborne pathway (less than 1%).

4.1.6 ADDITIONAL MINOR SOURCES

There are several research departments within BNL conducting work that involves very small quantities of radioactive materials in the microcurie to millicurie range. Typically, fume hoods designated for use with radioactive materials are used. Operations such as transferring material between containers, pipetting, and chemical compound labeling are typical of the work conducted within the hoods. Due to the use of filters, the nature of the work conducted, and the small quantities involved, these operations have a very low potential for atmospheric releases of any environmentally significant quantities of radioactive materials. Compliance with NESHAPs is demonstrated through the use of an inventory system that allows an upper estimate of potential releases to be calculated. Facilities that demonstrate compliance in this way include Buildings 463, 555, 318, 490, 490A, 703W, and 830, where research in the fields of biology, chemistry, medicine, applied science, and advanced technology is conducted.

4.1.7 PREVIOUSLY UNCHARACTERIZED RADIOLOGICAL AIR EMISSION SOURCES EVALUATED IN 2000

A number of new environmental restoration operations and other key facility processes that produce radiological air emissions were evaluated in 2000. Since all environmental restoration activities covered under the Comprehensive Environmental Response, Compensation and Liability Act must conform to the substantive requirements of NESHAPs Subpart H, those activities with the potential to emit radiological emissions were assessed for dose. The CAP88-PC dose modeling program was used to estimate the maximum dose to members of the public that could be associated with these activities (see Chapter 8 for more information on this modeling program). This modeling program is explicitly designed to model continuous airborne radiological emissions that occur over the course of a single year, and is not well suited for estimating short-term or acute releases such as those found with the environmental restoration activities. Given this limitation, these evaluations tend to be very conservative and overestimate the effective dose equivalent to the maximally exposed individual, since they treat potential emission sources as if they were continuous annual sources that do not end with the cessation of environmental restoration activities. The conclusions of the assessments are discussed below.

4.1.7.1 CHEMICAL/ANIMAL AND GLASS HOLES PITS SOIL EXCAVATION

The chemical/animal pits were used for the disposal of chemical containers, glassware, and animal carcasses from the late 1950s to 1966, while the glass holes pit was used for the disposal of laboratory glassware and chemical containers from 1966 to 1981. The soil in stockpile #6B was generated during the pit excavation phase of the ongoing environmental restoration activities. Stockpile #6B contained approximately 440 cubic yards (336 cubic meters) of soil removed from the bottom of several pits located in the chemical/animal pit area. Because the potential existed for radiologically contaminated soil particles to become airborne during loading and shipping of contaminated soil, a NESHAPs evaluation was conducted.

Using site-specific meteorological data (temperature, precipitation, wind speed, and mixing height), the effective dose equivalent to the maximally exposed individual from these activities was estimated to be 6.07E-03 mrem/year (6.07E-02 μSv/yr) using the CAP88-PC model. This dose to the maximally exposed individual is below the 0.1 mrem/year (1 μSv/yr) threshold that triggers the NESHAPs permitting requirements. Therefore, this soil removal operation was exempt from permitting requirements.

4.1.7.2 WASTE CONCENTRATION FACILITY SOIL EXCAVATION

During the ongoing environmental restoration activities at the Waste Concentration Facility (Bldg. 811), approximately 700 cubic yards (535 cubic meters) of radiologically contaminated soil was excavated in the vicinity of the building. To help prevent soil particles from becoming airborne, water mist was applied to soils during excavation and backfill operations. Following the project health & safety plan, local meteorology was monitored, and work was suspended if

sustained winds exceeded 25 miles per hour (40 km per hour).

The probable release inventory of radionuclides in the soil consisted of cesium-137 (464 pCi/g) and strontium-90 (454 pCi/g). Using the CAP88-PC model, an effective dose equivalent of 8.52E-03 mrem/year (8.52E-02 μSv/yr) to the maximally exposed individual was estimated. This dose to the maximally exposed individual is below the 0.1 mrem/year (1 μSv/yr) threshold that triggers the NESHAPs permitting requirements. Therefore, this soil excavation activity was exempt from permitting requirements.

4.1.7.3 BROOKHAVEN GRAPHITE RESEARCH REACTOR DUCT REMOVAL

The Brookhaven Graphite Research Reactor (BGRR) operated from 1950 to 1969, producing neutrons for scientific research. The BGRR Decommissioning Project, which commenced in 1999, involves removing or isolating areas of the BGRR facility that contain hazardous materials and/or radioactive contamination to reduce any potential risk to the public, workers, and the environment. BGRR environmental restoration activities in 2000 included the partial removal of the aboveground primary air-cooling ductwork that was part of the pile primary air-cooling system. Pile cooling air was ducted towards the top of the fan house in Building 704, where the north and south air plenums joined to form a common header over the fan house. The common header ducted the air to the intake of five fans, which were removed in 1999. The fans discharged air into an underground duct that carried the air to the 328-foot (100-meter) main stack. The internal surfaces of the ductwork were contaminated.

Figure 4-3. Railcar Loading of Contaminated Landscape Soil.

Radiological samples were taken from the interior surface of the ductwork to determine the type and quantity of contamination present. A fixative was used to contain any loose contamination, and the duct opening was capped and sealed to prevent any spread of contamination.

Using site-specific meteorological data and current population data, the effective dose equivalent to the maximally exposed individual, estimated with the CAP88-PC model, was 1.5E-05 mrem/year (1.5E-04 μSv/yr). This dose is below the 0.1 mrem/year (1 μSv/yr) threshold that triggers the NESHAPs permitting requirements. Therefore, no permit application was required for this operation.

4.1.7.4 AREA OF CONCERN 16 SOIL REMOVAL ACTION

This environmental restoration removal action involved the excavation of landscape soil contaminated with low levels of cesium-137 in six areas of concern. Contaminated soil was excavated to a depth of 1 foot (0.30 meters). The soil was excavated using both conventional construction equipment and manual tools for narrow and restricted areas. Excavated soil was later packaged and transferred to railcars for offsite disposal (see Figure 4-3).

Using the CAP88-PC model along with site-specific meteorological data and current population data, the effective dose equivalent to the maximally exposed individual was estimated to be 3.66E-02 mrem/year (3.66E-01 μSv/yr). This dose to the maximally exposed individual is below the 0.1 mrem/year (1 μSv/yr) threshold that triggers the NESHAPs permitting requirements. Therefore, no permit application was required for this operation.

4.1.7.5 WASTE MANAGEMENT DIVISION RADIOACTIVE WASTEWATER PROCESSING OPERATIONS

During a process evaluation of radioactive wastewater processing operations associated with the Waste Concentration Facility in Building 811, waste transfer operations in Building 810, and the Evaporator Facility in Building 802B, a recommendation was made to conduct a NESHAPs evaluation of a number of sources that have the potential to

release small amounts of radiological emissions that are not directed to the HFBR stack. Included among the sources evaluated were vent pipes for the four aboveground wastewater storage tanks in Building 811, vent pipes for a 15-gallon (57-liter) condensate storage tank and a 5,000-gallon (18,925-liter) tritiated water tank in Building 802B, and potential fugitive emissions from leaks in pumps and pipe valves in the wastewater transfer lines connecting the three buildings. The potential airborne source term was estimated based on the information provided in the process evaluation and worst-case emission factors from 40 CFR 61, Appendix D.

The CAP88-PC model provided a conservative estimate of the effective dose equivalent to the maximally exposed individual. The 1.76E-03 mrem/year (1.76E-02 μSv/yr) effective dose equivalent from these operations is well under the 0.1 mrem/year (1 μSv/yr) threshold that triggers the NESHAPs permitting requirements.

4.1.7.6 SEWAGE TREATMENT PLANT SOIL AND SEDIMENT EXCAVATION

Since planned excavation of cesium-137 contaminated soil and sediment at the Sewage Treatment Plant would disturb and suspend soil and sediment particles, a NESHAPs evaluation was performed to estimate the potential dose to members of the public. During excavation activities, approximately 3,000 cubic yards (2,294 cubic meters) of soil were removed from the bottom of several filter beds at the Sewage Treatment Plant.

The CAP88-PC modeling program conservatively estimated the effective dose equivalent to the maximally exposed individual to be 5.96 E-02 mrem/year (5.96 E-01 μSv/yr). The effective dose equivalent from this source is well under the 0.1 mrem/year (1 μSv/yr) threshold that triggers NESHAPs Subpart H permitting requirements. Therefore, no NESHAPs permit application was required for this remedial action.

4.1.8 STATUS OF RADIOLOGICAL AIR EMISSION SOURCES EVALUATED IN 1999

4.1.8.1 WASTE MANAGEMENT RECLAMATION BUILDING

The Waste Management Reclamation Building (Building 865) is the primary facility for handling radioactive waste materials (See Figure 2-6 in Chapter 2). The building is designed to receive bulk radioactive waste of various sizes and configurations, and then to disassemble, decontaminate, reduce the volume, temporarily store, and properly package the waste for shipment offsite. The following is a brief description of six processing areas or equipment systems that were installed to conduct these functions.

- *Lead Melting Area.* A lead melter capable of melting contaminated lead shielding and components is located in this area. This unit has not been used since its installation. When the unit is placed in operation, molten slag that contains the bulk of contamination will be skimmed off, and the remaining molten lead will be recast in molds for reuse as shielding blocks, provided acceptable radiation levels are achieved through the decontamination process.
- *Equipment Decontamination Bath*. The surfaces of contaminated items, such as respirators, are cleaned in the bath using nonhazardous cleaning agents. After the materials are cleaned, they are dried and stored.
- *Fume Hood*. Radioactive wastes are inspected, sorted, and repacked. Any airborne emissions generated during the different handling steps are exhausted through a fume hood equipped with a HEPA filter.
- *Carbon Dioxide Blaster Room*. In this room frozen carbon dioxide pellets will be propelled under pressure to remove surface and fixed contamination from equipment and waste materials. This unit has not been operated to date.
- *Plasma Cutting Torch*. This torch will be used to cut metal waste of various geometries to reduce the volume of the waste and to ensure that it fits into standard radwaste shipping containers. This unit has not been placed into operation since its installation.
- *Waste Compactor*. The compactor uses a 500,000-pound hydraulic ram to reduce the volume of contaminated paper product and miscellaneous metal items. This unit is operational, however, it has not been used to date.

Since each of these waste handling activities has the potential to generate radioactive airborne emissions, the ventilation exhaust systems for each is equipped with a HEPA filter. Ordinarily, radionuclide emissions for these types of intermittent, low dose potential

(i.e., less than 0.1 mrem/year to the maximally exposed individual) operations are estimated using NESHAPs Appendix D methods through knowledge of the radionuclides in the waste and their quantities. Since exact source terms for the types of wastes processed in the Reclamation Building are often not readily available making such estimates difficult, sampling systems were designed for each exhaust stack to directly and continuously monitor radiological emissions during waste handling operations. This level of monitoring is greater than what is prescribed under NESHAPs Subpart H for these types of sources.

Each monitoring system was designed to comply with specific requirements of 40 CFR 61.93(b), particularly those for the periodic measurement of flow rate, monitoring of the effluent by direct extraction, and monitoring the effluent using representative samples that are withdrawn continuously when the waste handling equipment is operational. Installation of the stack monitoring systems commenced in 1999 and was completed in March 2000. Since the HEPA filter pumps were operated intermittently in 2000, no periodic samples were analyzed during the year.

4.1.8.2 HIGH VACUUM THERMAL DESORPTION FOR CHEMICAL HOLES PROJECT

During this project, mercury contaminated mixed waste recovered from the chemical holes area was processed in a high vacuum thermal desorption chamber. Exhaust air from the thermal desorption chamber passed through two HEPA filters to trap particulates before being released to the ambient air. Other controls included two water-cooled impingers (two 30-gallon carbon steel vessels filled with water chilled to 35 - 45°F) to condense out mercury vapors, and two in-series carbon beds to recover any residual mercury vapors. Using the CAP88-PC modeling program in 1999, the effective dose equivalent to the maximally

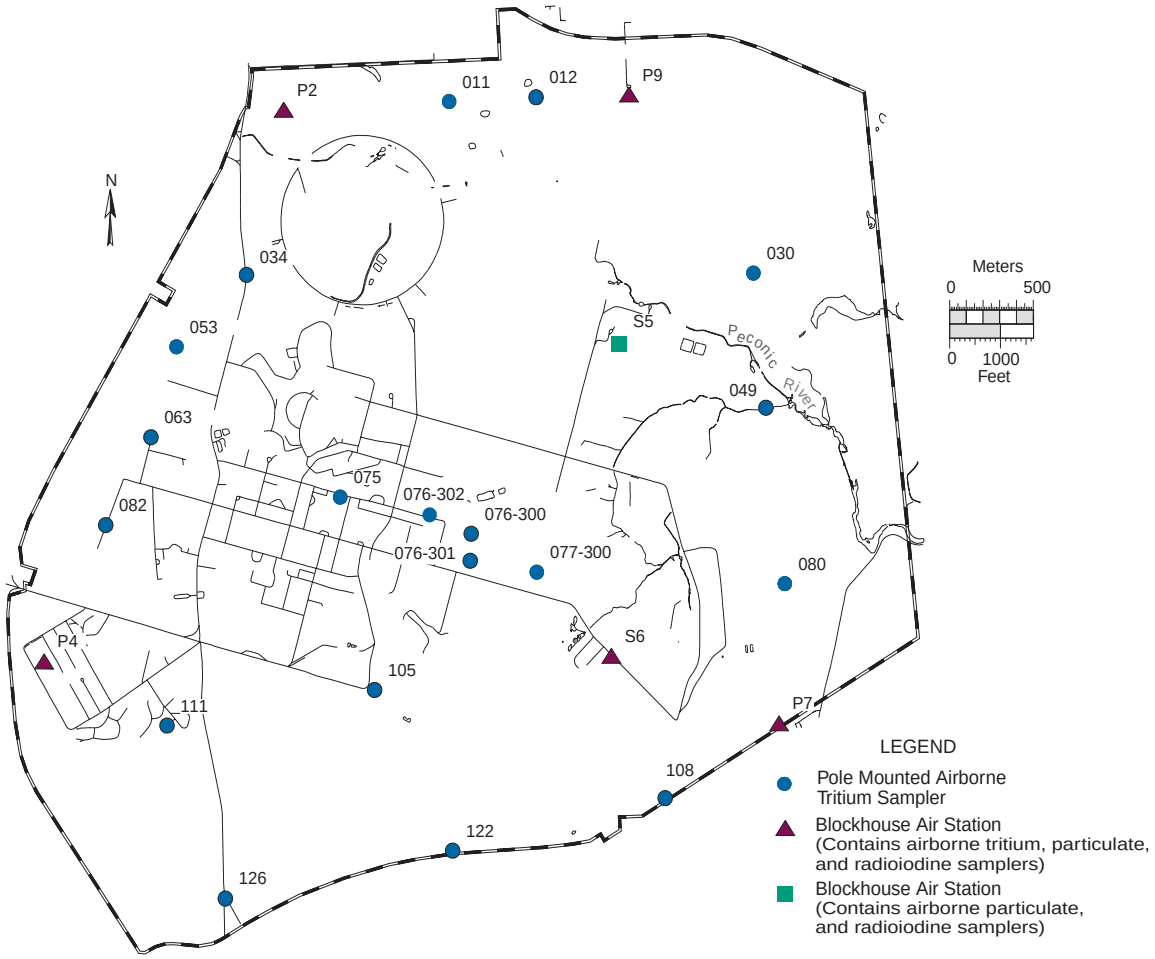

Figure 4-4. Onsite Ambient Air Monitoring Stations.

exposed individual was estimated at 6.54 mrem/year (65.4 μSv/yr) under the most conservative assumptions. Since the CAP88-PC modeling did not take into account the effectiveness of the engineering controls in reducing particulate emissions, follow-up air samples were collected as the wastes were processed (from January to June 2000) using a continuous flow portable sampler equipped with a radionuclide filter. The samples were analyzed for gamma emitters, and small quantities of americium-241, cesium-137, and zinc-65 were detected in the samples. Using the sample results, a second NESHAPs evaluation was performed with the CAP88-PC modeling program. The revised effective dose equivalent to the maximally exposed individual was 8.03E-08 mrem/yr (8.03E-07 μSv/yr) for this activity.

4.2 AMBIENT AIR MONITORING FOR RADIONUCLIDES

As part of the Environmental Monitoring Program, an array of monitoring stations is in place around the BNL site for collection of air samples to determine ambient radiological air quality. Samplers are located in six dedicated blockhouses (see Figure 4-4 for locations). The blockhouses are fenced for security purposes to control access and protect costly sampling equipment. At each blockhouse, glass-fiber filter paper is used to capture airborne particulate matter, charcoal cartridges are used to collect any potential radioiodines, and silica-gel tubes are used to collect water vapor for tritium analysis (with the exception of Station S5 which does not contain a tritium sampler). Filter paper is collected weekly and analyzed for gross alpha and beta activity using a gas-flow proportional counter. Charcoal cartridges are collected monthly and analyzed by gamma spectroscopy. Since April 1999, silica-gel samples have been collected one week a month for processing by liquid scintillation analysis. Before that, silica-gel samples were collected weekly. Multiple years worth of sampling data with results below the minimum detection limit (MDL) were the basis for reducing sampling frequency. In addition to the blockhouses, 19 pole-mounted, battery-powered silica-gel samplers (used for tritium analysis) are located throughout the site, primarily along the site boundary.

4.2.1 GROSS ALPHA AND BETA ACTIVITY

Particulate filter analytical results for gross alpha and beta activity are reported in Table 4-2. Annual average gross alpha and beta airborne activity levels for the six monitoring stations were equal to 0.0005 pCi/m^3 (0.02 mBq/m^3) and 0.0135 pCi/m^3 (0.52 mBq/m^3), respectively. Annual gross beta activity trends recorded at Station P7 are plotted in Figure 4-5. The results at this location are typical for the site. The trend shows seasonal variation of concentrations within a range that is representative of natural background levels. The gross alpha activity is not plotted because the vast majority of results were below the MDL. Measurable activity is primarily due to radionuclide decay products associated with natural uranium and thorium.

Table 4-2. Gross Activity Detected in Air Particulate Filters (CY 2000).

Sample Station		Gross Alpha (pCi/m^3)	Gross Beta (pCi/m^3)
P2	N	51	51
	Max.	0.0013 ± 0.0009	0.0352 ± 0.0024
	Avg.	0.0004 ± 0.0001	0.0123 ± 0.0014
	NBD	44	2
P4	N	52	52
	Max.	0.0018 ± 0.0007	0.0018 ± 0.0032
	Avg.	0.0005 ± 0.0001	0.0005 ± 0.0018
	NBD	43	0
P7	N	52	52
	Max.	0.0024 ± 0.0010	0.0336 ± 0.0027
	Avg.	0.0005 ± 0.0001	0.0134 ± 0.0017
	NBD	42	3
P9	N	52	52
	Max.	0.0021 ± 0.0008	0.0388 ± 0.0028
	Avg.	0.0006 ± 0.0001	0.0124 ± 0.0014
	NBD	36	1
S5	N	52	52
	Max.	0.0019 ± 0.0008	0.0298 ± 0.0023
	Avg.	0.0006 ± 0.0001	0.0143 ± 0.0016
	NBD	36	2
S6	N	50	50
	Max.	0.0031 ± 0.0025	0.0474 ± 0.0091
	Avg.	0.0005 ± 0.0001	0.0146 ± 0.0018
	NBD	41	1
Grand Average		0.0005 ± 0.0001	0.0135 ± 0.0009

Notes:
See Figure 4-4 for sample station locations.
All values shown with a 95% confidence interval.
N = Number of samples collected.
NBD = Number of samples with results below the minimum detection limit.

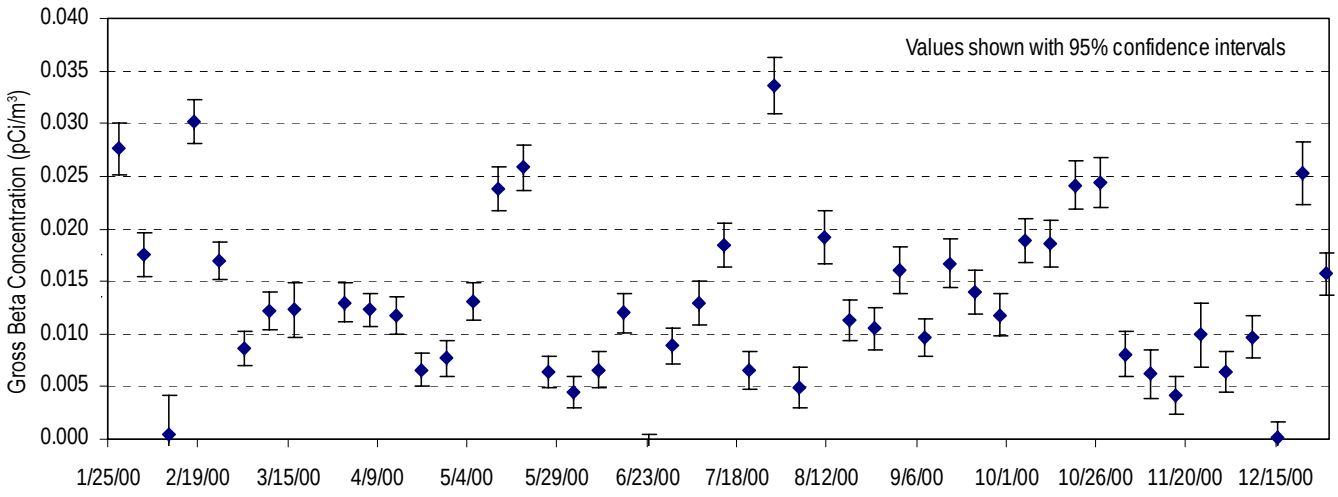

Figure 4-5. Airborne Gross Beta Concentrations Recorded at Station P7 (CY 2000).

The New York State Department of Health (NYSDOH) received duplicate filter samples that were collected at Station P7, located at the southeast site boundary. These samples were collected weekly and analyzed by an independent NYSDOH laboratory for gross beta activity. Preliminary analytical results received were comparable to the samples analyzed by the BNL Analytical Services Laboratory. Analytical results for gross beta reported by the NYSDOH laboratory were between 0.006 and 0.025 pCi/m^3 (0.22 and 0.93 mBq/m^3), while the BNL results ranged from 0.0001 to 0.034 pCi/m^3 (0.005 to 1.24 mBq/m^3).

As part of a statewide monitoring program, the NYSDOH also collects air samples in Albany, New York, a control location with no potential to be influenced by nuclear facility emissions. The NYSDOH reported in 2000 that airborne gross beta activity at that location varied between 0.0025 and 0.0260 pCi/m^3 (0.09 to 0.96 mBq/m^3). Sample results measured at BNL generally fall within this range, demonstrating that onsite radiological air quality is consistent with that observed at locations in New York State not located near radiological facilities.

4.2.2 AIRBORNE TRITIUM

Airborne tritium in the form of HTO is monitored throughout the BNL site. In addition to the five blockhouses containing tritium samplers, fourteen pole-mounted monitors (not including those which monitor the Removal Action V Recharge Basin – see Section 4.2.2.1 below) are located at or near the property boundary (see Figure 4-4 for locations). Two additional pole-mounted monitors are centrally located onsite. HTO is collected by using a pump that draws air through a column of silica gel, a water-absorbent medium. The absorbed water is recovered and analyzed using liquid scintillation counting techniques.

Table 4-3 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 super-saturated gel, or the loss of sample during laboratory preparation). Airborne tritium samples were collected from each sampling station once a month. While one location (S6) showed the maximum and average values to be above the typical minimum detection limit range from 1 to 5 pCi/m^3 (0.04 to 0.19 Bq/m^3), the remainder of the sample results were below the minimum detection limit. The collected data demonstrated that there was no significant difference in ambient tritium concentrations onsite or at the site boundary. With the exception of Station S6, which is located adjacent to the former Hazardous Waste Management Facility, all annual average concentrations were observed to be below the minimum detection limit. The maximum concentration recorded at Station S6 was 54.6 pCi/m^3 (2.0 Bq/m^3). The higher values observed at this station are most likely due to its proximity to the former Hazardous Waste Management Facility. By comparison,

Table 4-3. Ambient Airborne Tritium Measurements (CY 2000).

Sample Station	Wind Sector	Validated Samples	Maximum (pCi/m^3)	Average (pCi/m^3)
P9	NE	12	1.3 ± 0.7	0.2 ± 0.5
011	NNE	8	< 2.8	0.3 ± 0.5
012	NNE	8	2.2 ± 1.3	0.1 ± 0.8
P2	NNW	11	< 3.3	0.1 ± 0.4
030	ENE	10	< 1.7	-0.5 ± 0.5
034	NNW	10	< 3.4	0.4 ± 0.5
049	E	7	< 1.2	-0.6 ± 0.5
053	NW	9	< 3.3	-0.7 ± 1.2
063	W	12	< 5.3	-0.1 ± 0.9
075	SW	9	< 11.8	1.4 ± 1.4
076-302	ESE	8	< 4.7	0.7 ± 0.7
080	ESE	12	< 3.0	0.1 ± 0.5
082	W	11	< 6.0	0.7 ± 1.3
S6	SE	12	54.6 ± 4.7	19.8 ± 8.1
P7	ESE	11	< 1.8	0.0 ± 0.5
105	S	10	< 2.5	0.0 ± 0.7
108	SE	9	< 13.5	0.2 ± 1.0
P4	WSW	11	< 1.4	-0.2 ± 0.4
111	SW	8	< 4.4	-0.4 ± 1.6
122	SSE	8	< 2.8	0.2 ± 0.3
126	SSW	10	< 2.6	-0.3 ± 0.7
Grand Average				1.2 ± 0.8

Notes:
See Figure 4-4 for station locations.
Wind sector is the downwind direction of the sample station from the five BNL facilities noted in Section 4.1 that are subject to NESHAPs Subpart H continuous monitoring requirements.
All values reported with a 95% confidence interval.
Typical minimum detection limit for tritium is between 1 - 5 pCi/m^3.

the DOE Order 5400.5 derived concentration guide for tritium in air is 100,000 pCi/m^3 (3.7 kBq/m^3). The airborne derived concentration guide is the concentration of a radionuclide in air, which if inhaled at that level for one year, would result in an effective dose equivalent of 100 mrem (1 mSv) to the maximally exposed individual. Therefore, all BNL station measurements of ambient tritium are less than 0.1% of the DOE derived concentration guide value. Observed concentrations of tritium at the sampling stations in 2000 are comparable to concentrations observed in 1999, but are considerably lower than measured station concentrations in 1996 when the HFBR released 48 Ci of HTO to the atmosphere.

4.2.2.1 REMOVAL ACTION V RECHARGE BASIN

In 1997, an interim pump-and-recharge system was constructed to control the leading edge of the plume of tritium associated with the leakage of the spent-fuel storage pool at the HFBR. Three extraction wells are being used to pump groundwater containing both tritium and volatile organic compounds from approximately 150 feet (46 meters) below ground surface to carbon filtration units, and ultimately to the Removal Action (RA) V recharge basin, located 3,000 feet (914 meters) to the north of the plume edge. (The volatile organic compounds being treated by this system are from sources unrelated to the HFBR.) Using assumptions that later proved to be very conservative, the recharge basin was evaluated, prior to the start of pumping operations, as a potential air emission source for NESHAPs compliance. (See Section 5.1.6.1 of the *BNL Site Environmental Report for Calendar Year 1997* [BNL 1999] for a discussion of that evaluation.)

During 2000, airborne HTO monitoring in the vicinity of the RA V recharge basin continued. Two monitors are installed immediately adjacent to the basin at the northeast and southeast corners (Stations 076-300 and 076-301 on Figure 4-4), downwind of the predominant winds on site (see BNL wind rose in Chapter 1, Figure 1-10). An additional station was placed near the National Weather Service building (Station 077-300), approximately 0.2 mile (0.3 km) to the east of the basin. For the year 2000, none of the 32 validated samples exceeded the minimum detection limit (See

Table 4-4. Ambient Tritium Monitoring Results at RA V Recharge Basin (CY 2000).

Location	Validated Samples	Detections	Maximum (pCi/m^3)	Average (pCi/m^3)
Northeast corner of basin (076-300)	11	0	< 8.7	0.2 ± 0.8
Southeast corner of basin (076-301)	11	0	< 1.4	-0.4 ± 0.8
National Weather Service Building (077-300)	10	0	< 3.7	-0.1 ± 0.8

Notes:
See Figure 4-4 for sample station locations.
Typical minimum detection limit for tritium is between 1 and 5 pCi/m^3.

Table 4-4 for results). These results are consistent with prior findings, which show that the majority of tritium samples collected since the tritium surveillance began in 1997 were below the minimum detection limit.

4.3 NONRADIOLOGICAL AIRBORNE EMISSIONS

Various state and federal regulations governing nonradiological releases require facilities to conduct periodic or continuous emissions monitoring in order to demonstrate compliance with emission limits. BNL has several emission sources subject to state and/or federal regulatory requirements that do not require emissions monitoring (see Chapter 3 for more details). The Central Steam Facility (CSF) is the only BNL emission source required to monitor nonradiological emissions.

The CSF supplies steam for heating and cooling to BNL major 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 Boiler Nos. 1A, 5, 6, and 7. Boiler 1A, which was installed in 1962, has a heat input of 16.4 MW (56.7 MMBtu/hr). Boiler 5 was installed in 1965, and has a heat input of 65.3 MW (225 MMBtu/hr). The newest units, Boilers No. 6 and 7, were installed in 1984 and 1996, respectively. Each of these boilers has a heat input of 42.6 MW (147 MMBtu/hr).

Because of their design, heat inputs, and dates of installation, Boiler Nos. 6 and 7 are subject to Title 6 of the New York Code, Rules, and Regulations (NYCRR) Part 227-2, and the federal New Source Performance Standard, 40 CFR 60 Subpart Db. As such, these boilers are equipped with continuous emission monitors for nitrogen oxides (NO_X). Boiler No. 7 emissions are also continuously monitored for opacity. To measure combustion efficiency, both boilers are also monitored for carbon dioxide (CO_2). Continuous emissions monitoring results from the two boilers are reported on a quarterly basis to the U.S. Environmental Protection Agency and the New York State Department of Environmental Conservation.

From May 1 to September 15 (the peak ozone period), compliance with the 0.30 lbs/MMBtu (129 ng/J) NO_x emissions standard is demonstrated by calculating the 24-hour average emission rate from continuous emission monitoring system readings and comparing the value to the emission standard. The remainder of the year, the calculated 30-day rolling average continuous emission monitoring system emission rate is used to establish compliance. Boiler No. 7 opacity levels are recorded as 6-minute averages. Measured opacity levels cannot exceed 20% opacity, except for one 6-minute period per hour of not more than 27% opacity. In 2000, there were no measured exceedances of the NO_x emission standard for either boiler, or excess opacity measurements on Boiler No. 7.

In the spring of 1997, the Long Island Lighting Company completed work extending a natural gas main into the CSF. To accommodate the combustion of natural gas, new gas rings were added to the burners of Boiler No. 5, and natural gas trains were installed to connect the gas main to Boiler Nos. 5 and 7. In 1998, existing steam atomized oil burners on Boiler No. 6 were replaced with two dual-fuel low NO_x burners, and a natural gas train was added to connect the boiler to the gas main.

Table 4-5. Central Steam Facility Fuel Use and Emissions (1996 - 2000)

Year	Annual Fuel Use			Emissions			
	# 6 Oil (10^3 gals)	# 2 Oil (10^3 gals)	Natural Gas (10^6 ft^3)	TSP (tons)	NO_x (tons)	SO_2 (tons)	VOCs (tons)
1996	4,782.55	52.77	0.00	14.0	104.9	109.0	0.7
1997	3,303.43	10.23	190.65	13.7	83.5	75.1	1.0
1998	354.28	9.44	596.17	2.7	75.1	8.9	1.7
1999	682.76	2.77	614.98	5.1	53.5	16.7	1.8
2000	2,097.32	0.82	342.40	9.5	81.6	45.0	1.2

Notes:
TSP - Total Suspended Particulates
VOCs - Volatile Organic Compounds

In 2000, increased residential consumption of natural gas caused natural gas prices to rise substantially. As the price of natural gas fluctuated and exceeded that of residual fuel (No. 6 oil), the CSF burned residual fuel. The CSF used more than three times as much residual fuel in 2000 as it had in 1999, while total natural gas use declined by nearly 45% (see Table 4-5). Consequently, annual emissions of particulates, NO_x, and SO_2 were 4.4 tons, 28.1 tons, and 28.3 tons higher than the respective totals for 1999. Nonetheless, annual CSF emissions of these pollutants were 32%, 22%, and 59% lower than respective totals in 1996.

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