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 facility emission monitoring, environmental air sampling is conducted to verify local air quality. Information regarding radiological and regulated, nonradiological air releases for 1999 is presented in this chapter. Ambient radiological air quality data collected at various onsite locations are also discussed.

In 1999, the Brookhaven Medical Research Reactor, the High Flux Beam Reactor, and the Brookhaven Linac Isotope Producer were the most significant contributors to the site's radiological air emissions. Total radionuclide emissions were consistent with those of recent years. Over the course of 1999, a total of 1,672 Ci (62 TBq) of airborne radioactive material was released from these facilities. Gaseous argon-41 (a short-lived radionuclide) from the Brookhaven Medical Research Reactor accounted for 98 percent of this total.

Natural gas has been the predominant fuel burned at the Central Steam Facility since three boilers were converted to dual-fuel (oil/natural gas) firing capability in 1997. As a result of the conversion, facility emissions of particulate matter, nitrogen oxides (NO_x), and sulfur dioxide (SO_2) have declined by 8.9 tons, 51.4 tons, and 92.3 tons, respectively, relative to 1996 levels.

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 (the National Air Emission Standards for Hazardous Air Pollutants or NESHAPs), and DOE Orders 5400.1, *General Environmental Protection Program* (1989) and 5400.5, *Radiation Protection of the Public and the Environment* (1990). Under NESHAPs Subpart H, a section of the federal Clean Air Act (CAA), facilities whose emissions 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. There are five facilities that fall into this category (see sections 4.1.1-4.1.5 below). Figure 4-1 indicates the location of each of the monitored facilities within the BNL site. Facilities which 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 (BMRR)

The BMRR is fueled with enriched uranium, moderated and cooled by light water, and is operated intermittently at power levels up to 3 megawatts (MW) (thermal). To cool the neutron reflector surrounding the core of the BMRR reactor vessel, air from the interior of the containment building is used. When air is drawn through the reflector, it is exposed to a neutron field that causes the argon component

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

of the air to become radioactive. This radioactive form is known as argon-41. It is a chemically inert gas with a short half-life ($t_{½}$) of 1.8 hours. After passage through the reflector, the air is routed through a roughing filter and a high efficiency particulate air (HEPA) filter to remove any particulate matter, and finally, a charcoal filter for the removal of radioiodines produced by the fissioning of fuel. Following filtration, the air is exhausted to a 150-foot stack adjacent to the reactor containment building.

A real-time monitor is in place to track argon-41 air emissions, while passive filter media are 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 contribute less than 10 percent of the total public dose resulting from the BMRR's air emissions. In accordance with NESHAPs, these radionuclides are sampled on a periodic basis to confirm that their concentrations remain consistent with expected levels.

In 1999 the BMRR released 1,640 Ci (61 TBq) of argon-41 to the atmosphere. This value is consistent with this facility's emissions totals for previous years. Argon-41 consistently constitutes the greatest fraction of all radionuclide activity released from the BNL site.

4.1.2 HIGH FLUX BEAM REACTOR (HFBR)

Following the discovery of an underground plume of tritium emanating from the spent fuel storage pool, the HFBR was 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 ($t_{½}$ = 12.3 years). In a shut-down 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

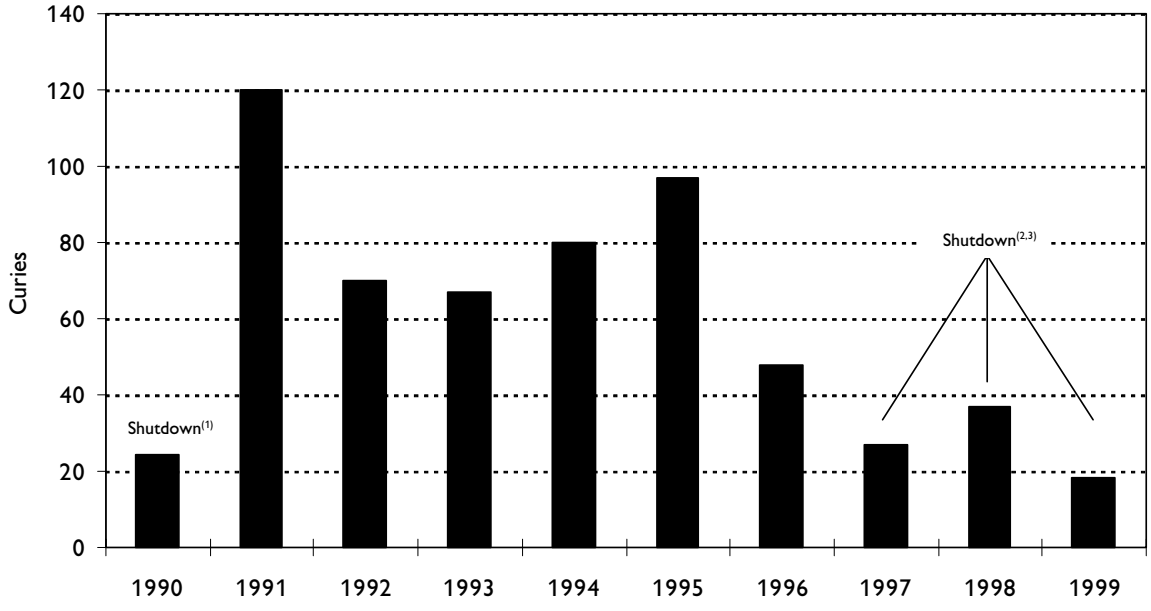

Figure 4-2. HFBR Airborne Tritium Emissions, Ten Year Trend.

to building air where it is routed to the facility's 320-ft stack. Concentrations of HTO in air emissions are determined by the use of an integrating silica gel absorbent. In 1999, 18 Ci (0.7 TBq) of airborne HTO were released from the HFBR (see trend plot shown in Figure 4-2).

4.1.3 BROOKHAVEN LINAC ISOTOPE PRODUCER (BLIP)

Protons from the Linear Accelerator (LINAC) are sent via an underground beam tunnel to the BLIP where they strike various target metals (see Figure 4-3). These metals, which become activated by the proton beam, are then transferred to the Building 801 Target Processing Laboratory for later use in radiopharmaceutical production. 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 oxygen-15, a radionuclide with a very short half-life of 123 seconds. This isotope is released as an airborne emission.

In 1999, the operation of the BLIP was limited to the months of January and December. During this period, a total of 12 Ci (0.5 TBq) of oxygen-15 was released as an airborne emission. Other radionuclides such as tritium and beryllium-7 were released in much smaller quantities. See Table 4-1 for a complete listing.

4.1.4 EVAPORATOR FACILITY

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

Figure 4-3. Brookhaven LINAC Isotope Producer (BLIP).

Table 4-1. Airborne Radionuclide Releases from Monitored Facilities in 1999.

Facility	Nuclide	Half-life	Ci Released
BMRR	Ar-41[1]	1.8 h	1.64E+03
Bldg. 801 Target Processing Laboratory	Co-60	5.2 y	8.90E-07
	Rb-86	18.6 d	1.38E-05
	Se-75	120 d	1.93E-05
	Ti-44	62.2 y	3.97E-07
	Zn-65	244 d	1.67E-06
HFBR	Cs-137	30 y	3.37E-08
	H-3	12.3 y	1.81E+01
BLIP	O-15	2 m	1.23E+01
	H-3	12.3 y	4.31E-02
	Be-7	53 d	5.49E-06
Evaporator Facility	Be-7	53 d	4.76E-04
	Co-56	79 d	2.99E-06
	Co-57	271 d	3.01E-05
	Co-58	71 d	1.81E-05
	Co-60	5.2 y	2.41E-05
	Cs-137	30 y	5.31E-05
	H-3	12.3 y	1.98E+00
	Mn-54	312 d	1.91E-05
	Na-22	15 d	1.35E-06
	Rb-86	18.6 d	8.57E-05
	Se-75	120 d	2.13E-06
	Zn-65	244 d	4.44E-04

Notes:
See Figure 4-1for facility locations
Half-life abbreviations: m = minutes h = hours d = days y = years
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 contribute > 10% of the total public dose due to BMRR air emissions. See text for discussion.

Liquid waste generated onsite that contains residual radiological material is accumulated at the Building 811 Waste Concentration Facility (WCF). At the WCF, suspended solids and a high percentage of radionuclides are removed from the liquid using a reverse osmosis process. However, because of its chemical properties, tritium is not removed. The tritiated water which remains following waste concentration is delivered to the Evaporator Facility in Building 802b where it is converted to steam and released as an airborne emission. This method is preferable to release via surface water because (1) there is virtually no potential to influence the groundwater aquifer, and (2) the potential for this tritium to contribute to an offsite dose is minimized by atmospheric dispersion. The emission is directed to the same stack used by the HFBR for building air exhaust.

In 1999, 2 Ci (73 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 are released at much lower activity levels (see Table 4-1 for a listing). The activity values listed in the table are estimated since facility emissions are tracked using an inventory system. Liquid shipments to the Evaporator Facility are sampled and analyzed prior to delivery to determine actual radionuclide concentrations. The total emissions for a water tanker delivery are 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 BUILDING 801 TARGET PROCESSING LABORATORY

Target metals irradiated at the BLIP facility are transported to the Building 801 Target Processing Laboratory 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 Building 801 operations are not significant contributors to the site perimeter dose via the airborne pathway (less than one percent).

4.1.6 ADDITIONAL MINOR SOURCES

There are several research departments within BNL conducting work which 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 release of any environmentally significant quantity of radioactive material. Compliance with NESHAPs is demonstrated through the use of an inventory system that allows an upper estimate of potential releases to be calculated. Facilities which demonstrate compliance in this way include buildings 463, 555, 318, 490, 490A, 703W and 830. A wide range of research operations are hosted in these buildings including work in the fields of biology, chemistry, medicine, applied science, and advanced technology.

4.1.7 PREVIOUSLY UNCHARACTERIZED RADIOLOGICAL AIR EMISSION SOURCES EVALUATED IN 1999

A number of new Environmental Restoration Program operations and other key facility processes which produce radiological air emissions were evaluated in 1999. Since all environmental restoration activities covered under CERCLA must conform to the substantive requirements of NESHAPS Subpart H, those activities with the potential to emit radiological emissions were assessed for dose potential. The CAP88-PC dose modeling program was used to estimate the maximum public dose which could be associated with these activities (see Chapter 8 for more information on this program). This modeling program is explicitly designed to model continuous airborne radiological emissions which 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 treat these 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 BUILDING 811 TANK REMEDIATION

This environmental restoration activity included the removal, processing, packaging, transportation, and disposal of radioactively contaminated sludge from underground storage tanks and diatomaceous earth lab pack waste from Building 811. The effective dose equivalent to the maximally exposed individual was estimated at 4.09E-2 millirem per year by the CAP88-PC modeling program.

During the operation, a localized ambient air sampling program was instituted to quantify

actual rather than estimated emissions. The results of this sampling program consistently reported the activity from gamma-emitting isotopes as much lower than the conservatively estimated source terms used in the CAP-88 modeling program. Gross alpha and gross beta activities are not used by the CAP88-PC program in estimating effective dose equivalent, however, they were used in this instance as part of a screening mechanism to demonstrate that the concentrations near a potential receptor would not be detectable.

Air sampling within the tent (a HEPA ventilated enclosure erected above the work area) showed average gross alpha and beta activity concentrations of 2.6 and 114 pCi/m^3, respectively. Background concentrations of airborne gross alpha activity are usually less than 0.002 pCi/m^3 (7.4 E-5 Bq/m^3), while airborne beta activity from naturally-occurring radionuclides is typically between 0.005 and 0.02 pCi/m^3. When the particulate removal efficiency of the HEPA filters (99.99 percent) is taken into consideration, the gross activity concentrations outside of the tent due to the tank removal work would be measurably lower than the monitoring system's minimum detection limit (MDL), confirming that this work did not constitute a source of public exposure approaching the NESHAPs Subpart H limit.

4.1.7.2 BUILDING 830 RADIOACTIVE TANK SIZING OPERATION

Sludge from two tanks previously used for radioactive waste storage was removed and the tanks were cut into pieces small enough to fit within waste shipment containers. Since the cutting operations had the potential to generate airborne radionuclides, this work was performed within a tent enclosure. The tent was serviced by two HEPA filtration units, which exhausted external to the enclosure to minimize airborne radioactivity within the work area. It was estimated that 0.07 pounds of the total 3.5 pounds of residual sludge was available for release in each tank. Analysis of the sludge reported strontium-90, thorium-228 and 230, cesium-137, cobalt-60, and americium-241 in the microcurie per gram range. The effective dose equivalent to the maximally exposed individual resulting from this waste tank sizing operation was estimated at 9.15E-9 millirem per year by the CAP88-PC modeling program. This is a statistically insignificant value.

4.1.7.3 POSITRON EMISSION TOMOGRAPHY (PET) CARBON-11 RELEASE

Positron Emission Tomography (PET) is a technology that measures metabolism in the brain, thereby providing images that reflect the functioning of a subject's brain. To visually document changes in the brain, a PET research subject is injected with a short-lived radioactive isotope that is attached to one of a number of compounds that bind to specific brain sites. The amount of radiotracer is similar to that administered in nuclear medicine procedures. The radiotracer emits energy that is recorded by detectors in the PET instrument, which signal the location and concentration to a computer. The computer translates these data into an image of brain activity as the brain actually functions.

In 1999, a one-time-only release of carbon-11, resulting from the synthesis of 10 millicuries of carbon-11 methyl iodine in preparation of positron emission tomography, was evaluated for compliance with the NESHAP air emission standards prior to release. These emissions were released from the Building 491 (BMRR) stack. Under conservative assumptions, the effective dose equivalent to the maximally exposed individual was estimated at 4.0 E-7 millirem per year by the CAP88-PC modeling program, which is a statistically insignificant value.

4.1.7.4 CHEMICAL/ANIMAL AND GLASS HOLES PIT REMEDIATION

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. Debris recovered from these areas after the environmental restoration contractors completed excavation activities included numerous plastic, metal, glass, and wood items. During 1999, a hopper conveyor system that fed into a shredder was used to further characterize the debris, reduce the volume of debris, package the debris, and to ensure that processed materials transported for offsite disposal met the disposal facility's acceptance criteria. Potential radiological contaminants in the debris included americium-241, cesium-137, and europium isotopes 152, 154, and 155. This operation did not have a dedicated ventilation system, precluding applicability of the CAP88-PC modeling program.

During the operation, a localized ambient air sampling program was instituted to quantify actual rather than estimated emissions. The results of this sampling program consistently showed activity from gamma-emitting isotopes in concentrations of pico-curies per cubic meter. At these levels, the dose was negligible in comparison to the dose limit of 10 millirem per year established under NESHAPs.

Gross alpha and gross beta measurements were used in this instance as part of a screening mechanism to demonstrate that the concentrations near a potential receptor would not be detectable. Ambient air sampling from the immediate work area showed average gross alpha and beta activity concentrations of 0.075 and 0.86 pCi/m^3, respectively. Background concentrations of airborne gross alpha activity are usually less than 0.002 pCi/m^3 (7.4 E-5 Bq/m^3), while airborne beta activity from naturally occurring radionuclides is typically between 0.005 and 0.02 pCi/m^3. Average gross alpha and gross beta activity concentrations were measurably lower than the monitoring system's MDLs but still higher than typical background concentrations.

4.1.7.5 BGRR PILE FAN SUMP REMOVAL AND FAN HOUSE DECONTAMINATION

The BGRR operated from 1950 to 1969 producing neutrons for scientific research. The BGRR decommissioning project, which commenced in 1999, is removing or isolating areas of the BGRR facility that contain hazardous materials and/or radioactive contamination to reduce any potential risk to public health, workers, and the environment. BGRR environmental restoration activities in 1999 included the removal of a concrete sump and its associated piping, and the remediation of the surrounding soils. Primary cooling fans numbers 1 through 5 and secondary and auxiliary fans were also removed. In addition, related remediation work inside the reactor building was initiated.

Radionuclides present in the source term inventory included tritium; cobalt-60; europium-152, 154, and 155; yttrium-90; strontium-90; cesium-137; uranium-233, 234, 235, and 238; neptunium-237; plutonium-238, 239, 240, and 241; americium-241. The CAP88-PC model was used, and it was determined that this remedial action project would result in a hypothetical maximally exposed individual receiving less than 3.0 E -04 millirem per year from these activities.

Actual airborne emissions were quantified through a localized air sampling program during the course of the operations. The results of this sampling program consistently reported the activity from gamma-emitting isotopes as much lower than the conservatively estimated source terms used in the CAP88-PC modeling program.

Gross alpha and gross beta activities are not used by the CAP88-PC program in estimating effective dose equivalent, however, they were used in this instance as part of a screening mechanism to demonstrate that the concentration near a potential receptor would not be detectable.

The ambient air sampling from the immediate work area reported an average gross alpha activity concentration of 0.034 pCi/m^3 (1.26 E-3 Bq/m^3) and an average gross beta activity concentration of 0.078 pCi/m^3 (2.89E-3 Bq/m^3). These results are slightly higher than the respective average MDLs of 7.12E-3 pCi/m^3 (2.63E-4 Bq/m^3) for gross alpha and 2.50E-2 pCi/m^3 (9.25E-5 Bq/m^3) for gross beta. According to 40 CFR 61 Appendix D methods for estimating radionuclide emissions to the atmosphere, a release fraction of 1E-3 may be applied to particulates released through a dedicated exhaust system. Applying this factor, the estimated gross alpha and gross beta activity concentrations to the atmosphere were 3.4.E-5 pCi/m^3 (1.2 E-6 Bq/m^3) and 7.8 E-5 pCi/m^3 (2.8E-6 Bq/m^3), respectively, or well below the MDLs.

4.1.7.6 HIGH VACUUM THERMAL DESORPTION FOR CHEMICAL HOLES PROJECT

This project involved processing mercury contaminated mixed waste recovered from the chemical holes area. The isotopes contained in the radiological component of the waste were identified as cesium-137; europium-152 and 154; plutonium-238 and 239; radium-226; thorium-232; uranium-234, 235, and 238; and americium-241. Under the most conservative assumptions, the effective dose equivalent to the maximally exposed individual was estimated at 6.54 millirem per year by the CAP88-PC modeling program. Exhaust from the thermal desorption chamber passes through a series of engineering controls before they are released to the ambient air. The controls include two water cooled impingers (two 30-gallon carbon steel vessels filled with water chilled to 35 - 45°F) to condense out mercury vapors, two in-series carbon beds to recover any residual mercury vapors, and finally, two HEPA filters to trap any

particulate matter. Since the CAP88-PC modeling did not take into account the effectiveness of the engineering controls in reducing particulate emissions, environmental restoration personnel will collect ambient air samples using a continuous flow portable sampler equipped with a radionuclide filter. The samples are to be collected and analyzed for alpha, beta, and gamma radiation after the unit commences operation in January 2000.

4.1.7.7 WASTE MANAGEMENT RECLAMATION BUILDING

The Reclamation Building (Building 865) is the primary facility for handling radioactive waste materials. 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 wastes for shipment offsite. The following is a brief description of six areas or pieces of equipment that were installed to meet 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 placed into operation since its installation. When fully operational, molten slag which contains the bulk of contamination will be skimmed off, and the molten lead will be recast in molds for reuse as shielding blocks, provided acceptable radiation levels are achieved through the decontamination process.
- *Equipment Decon Bath*. When operational, the surfaces of contaminated materials will be cleaned in the bath using non-hazardous cleaning agents. After the materials are cleaned, they will be dried and stored.
- *Fume Hood*. Radioactive wastes are inspected, sorted and repacked in a room. 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 placed into operation since its installation
- *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 has not been placed into operation since its installation.

Since each of these waste-handling activities has the potential for generating 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 40 CFR 61 Appendix D methods through knowledge of the radionuclides in the waste and their quantities. However, exact source terms for the types of wastes processed in the Reclamation Building are often not readily available, making such an estimate difficult. Therefore, sampling systems were designed for each exhaust stack to directly and continuously monitor radioactive 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 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 is expected to be completed by March 2000.

4.1.8 STATUS OF RADIOLOGICAL AIR EMISSION SOURCES EVALUATED IN 1998

4.1.8.1 LINEAR ACCELERATOR (LINAC)

Due to the energy of the protons accelerated by the LINAC, the production of airborne radionuclides through air activation and/or spallation interactions is possible. The most significant production point of airborne radionuclides inside the tunnel occurs where the beam crosses an air gap as it enters the BLIP vacuum system. Radioactive products were available for atmospheric release prior to 1999 via the tunnel ventilation exhaust stack, located adjacent to the BLIP building. Although identified as a source of airborne radionuclides in 1998, the exhaust system servicing the LINAC tunnel has since been removed from service. The LINAC tunnel emissions are no longer

vented at any stack point and the radionuclides now decay in place inside the tunnel.

4.1.8.2 AGS COOLING TOWER #2

Magnets used to steer the AGS particle beam experience significant heating and are cooled via a recirculating, non-contact water loop. Under certain conditions, such as high energy proton operations, low concentrations of radioactive elements may be produced in the cooling water when it circulates in the vicinity of the beam line. Radioisotopes which exist as gases may be liberated from the water when exposed to air during circulation in the outdoor cooling tower. These gaseous isotopes can constitute an airborne emission. The radionuclides which are likely to be released via this mechanism include oxygen-14 ($t_{1/2}$ = 1.2 min.), oxygen-15 ($t_{1/2}$ = 2.1 min.), nitrogen-13 ($t_{1/2}$ = 10 min.), and carbon-11 ($t_{1/2}$ = 20 min.). Tritium is also present and may be emitted from the tower as water vapor in microcurie quantities per year. Cooling Tower #2 processes activated cooling water from the AGS C-line. The C-line is one of several beam lines (labeled alphabetically) that branch off from the AGS ring. This beam line received no beam and did not operate in 1999. Therefore, there were no emissions from this cooling tower in 1999.

4.2 AIR MONITORING FOR RADIONUCLIDES

As part of the environmental monitoring program, an array of stations is in place around the BNL site to collect air samples which are

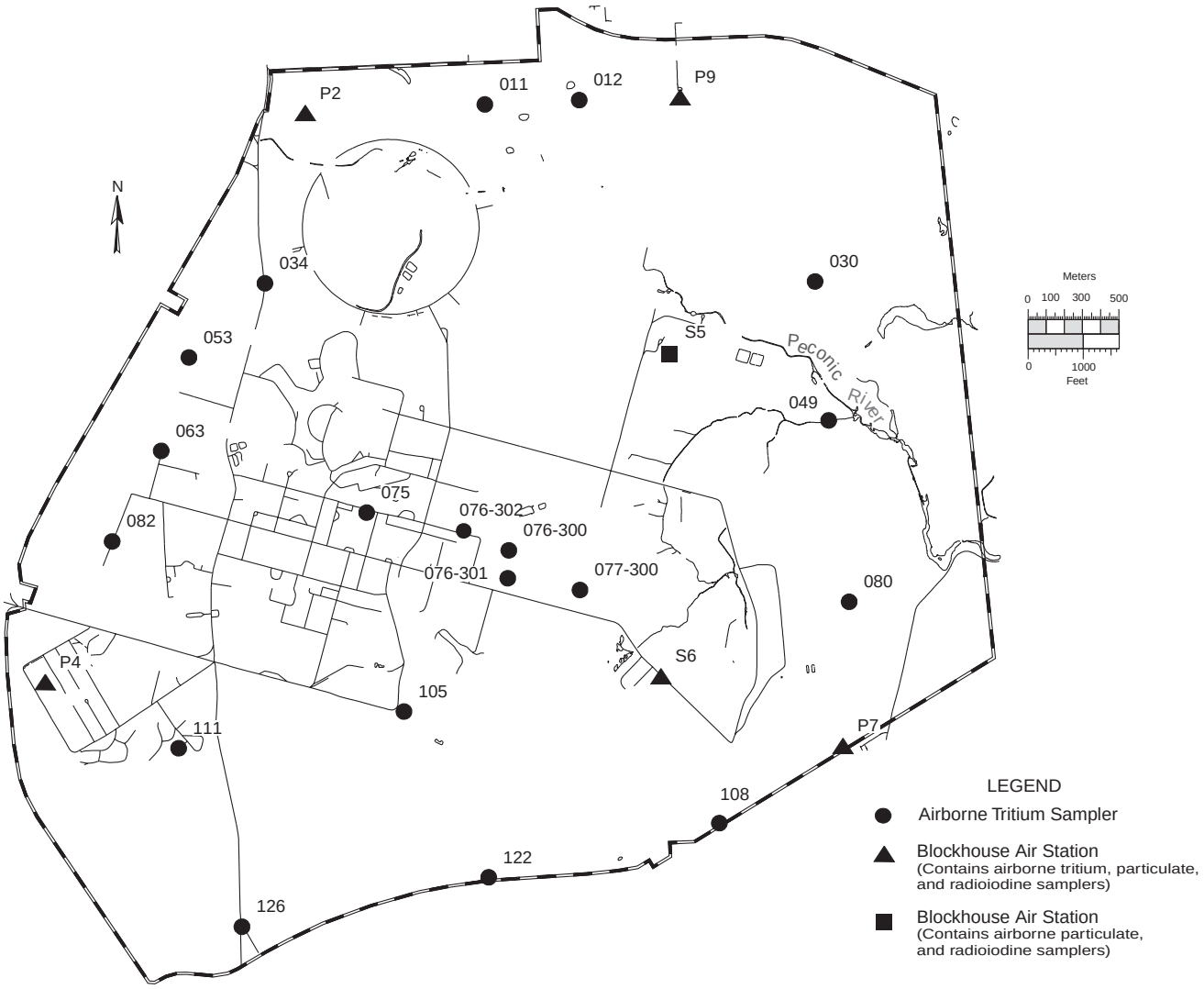

Figure 4-4. Onsite Air Monitoring Stations.

used to determine radiological air quality. Six samplers are located in 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 potential radioiodines (none were detected in 1999), 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. 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 MDL were the basis for reducing sampling frequency. Charcoal cartridges were collected monthly and analyzed by gamma spectroscopy. 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.

In addition to these samples, the New York State Department of Health (NYSDOH) received duplicate filter samples that were collected at Station P7, located at the southeast boundary. These samples were collected on a weekly basis and analyzed by an independent NYSDOH Laboratory for gross beta activity. Analytical results were comparable to those collected by BNL and were reported in the document called *Environmental Radiation In New York State* (NYSDOH 1993). Analytical results for gross beta reported by the NYSDOH were between 0.005 and 0.02 pCi/m^3, while Station P7 results averaged 0.0178 pCi/m^3 (see Table 4-2).

Table 4-2. Gross Activity Detected in Air Particulate Filters in 1999.

Sample Station		Gross Alpha (pCi/m^3)	Gross Beta (pCi/m^3)
P2	N	51	51
	Max.	0.0127 ± 0.0015	0.0403 ± 0.0027
	Avg.	0.0007 ± 0.0005	0.0139± 0.0017
	NAD	4	51
P4	N	51	51
	Max.	0.0253 ± 0.0028	0.0544 ± 0.0039
	Avg.	0.0013 ± 0.0005	0.0166 ± 0.0025
	NAD	5	51
P7	N	51	51
	Max.	0.0287 ± 0.0022	0.0512 ± 0.0027
	Avg.	0.0010 ± 0.0011	0.0178± 0.0028
	NAD	5	51
P9	N	52	52
	Max.	0.0127 ± 0.0015	0.0317 ± 0.0023
	Avg.	0.0008 ± 0.0005	0.0134 ± 0.0014
	NAD	3	52
S5	N	52	52
	Max.	0.0139 ± 0.0017	0.0340± 0.0025
	Avg.	0.0007 ± 0.0005	0.0139± 0.0018
	NAD	5	52
S6	N	52	52
	Max.	0.0170 ± 0.0017	0.0360 ± 0.0024
	Avg.	0.0009 ± 0.0006	0.0147 ± 0.0017
	NAD	6	52

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

4.2.1 GROSS ALPHA AND BETA ACTIVITY

Particulate filter analytical results are reported in Table 4-2. Annual average gross alpha and beta airborne activity levels were equal to 0.001 pCi/m^3 (0.04 mBq/m^3) and 0.015 pCi/m^3 (0.6 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. Note however that 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.

As part of a state-wide 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 reports that typical airborne gross beta activity at that location varies between 0.005 and 0.025 pCi/m^3 (0.2 to 0.9 mBq/m^3). Sample results measured at BNL generally fall well within this range, demonstrating that onsite radiological air quality is consistent with that observed in 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. Nineteen

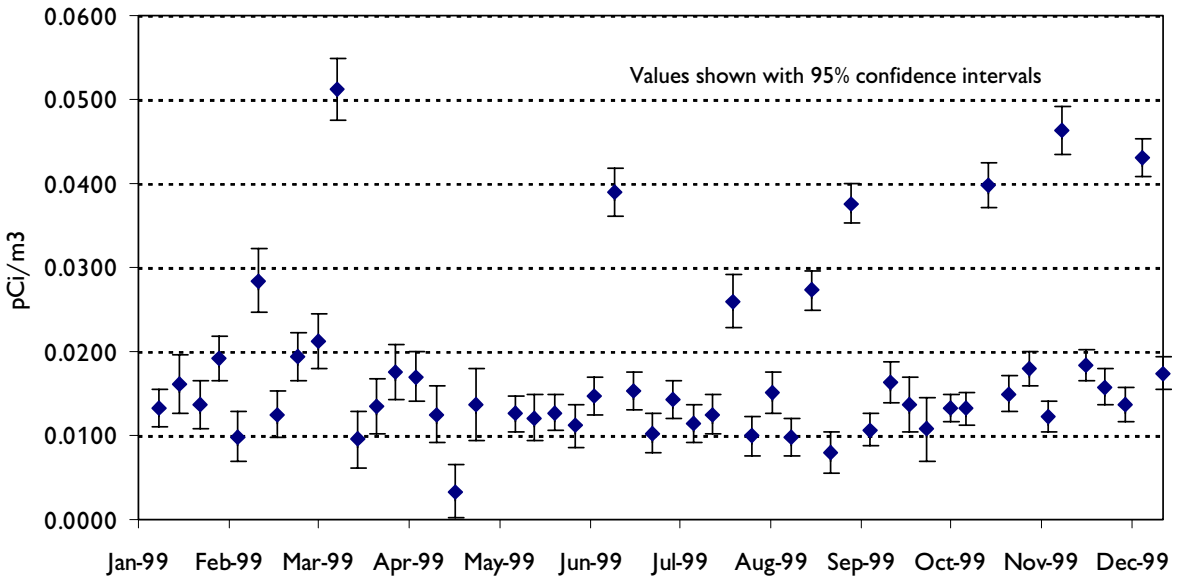

Figure 4-5. Airborne Gross Beta Concentration Trend Recorded at Station P7.

monitors (not including those which monitor the Removal Action V ([RA V]) recharge basin – see section 4.2.2.1 below) are located at or near the property boundary (see Figure 4-4 for locations). 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 in the BNL Analytical Services Laboratory 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 which were 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). In 1999 the frequency of airborne tritium sampling was reduced from a weekly basis to a monthly basis. This reduction in sampling frequency was based on results from many successive years where the air sampling stations showed no detectable evidence of tritium. While one location (S6) showed a maximum value which was above the typical detection limit of about 4 pCi/m^3 (0.15 Bq/m^3), the remainder of the sample results were below the MDL. These data demonstrated that there was no significant difference in ambient tritium concentrations onsite or at the site boundary.

Table 4-3. 1999 Ambient Airborne Tritium Measurements.

Sample Station	Wind Sector	Validated Samples	Maximum (pCi/m^3)	Average (pCi/m^3)
P9	NE	20	2.9 ± 2.2	0.1 ± 0.5
011	NNE	21	<3.7	-0.1 ± 0.5
012	NNE	19	<1.5	-0.1 ± 0.3
P2	NNW	21	<1.5	-0.2 ± 0.3
030	ENE	20	<3.9	-0.3 ± 0.5
034	NNW	20	<5.6	0.0 ± 0.5
049	E	17	<3.2	-0.1 ± 0.6
053	NW	20	<6.7	0.0 ± 0.7
063	W	21	<3.8	0.1 ± 0.4
075	SW	18	<5.0	0.1 ± 0.5
076-302	ESE	11	<3.7	0.6 ± 0.4
080	ESE	16	<2.1	-0.3 ± 0.4
082	W	18	<4.2	0.3 ± 0.7
S6	SE	21	70.3 ± 5.2	16.0 ± 5.9
P7	ESE	22	<4.4	0.3 ± 0.4
105	S	17	<4.5	-0.1 ± 0.5
108	SE	19	<2.4	0.2 ± 0.4
P4	WSW	21	<3.9	0.0 ± 0.3
111	SW	18	<3.9	-0.1 ± 0.4
122	SSE	21	<4.2	-0.2 ± 0.4
126	SSW	17	<7.4	-0.3 ± 0.4
Grand Average				0.7 ± 0.3

Notes:
See Figure 4-4 for station locations.
All values reported with a 95% confidence interval.
Typical detection limit for tritium is 1- 5 pCi/m^3.
DOE Order 5400.5 air Derived Concentration Guide: 100,000 pCi/m^3.

Table 4-4. 1999 Ambient Tritium Monitoring Results at RA V Recharge Basin.

Location	Validated Samples	Detections	Maximum (pCi/m^3)	Average (pCi/m^3)
Northeast corner of basin (076-300)	20	1	2.8 ± 3.1	0.5 ± 0.5
Southeast corner of basin (076-301)	12	0	< 3.9	-0.2 ± 1.5
National Weather Service Building (077-300)	22	0	< 6.9	0.1 ± 0.7

Notes:
See Figure 4-4 for locations of recharge basins.
Typical minmum detection limit for tritium is between 1 and 5 pci/m^3.

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 MDL. The maximum concentration recorded at Station S6 was 70 pCi/m^3 (2.6 Bq/m^3). The higher values observed at this station may have been due to its proximity to the former Hazardous Waste Management Facility. By comparison, 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 exposed individual.

As compared with 1998, observed concentrations of tritium at the sampling stations were consistently lower in 1999. This is probably explained by the fact that releases of HTO from the HFBR dropped by more than fifty percent from 37 Ci (1.4 TBq) in 1998 to 18 Ci (0.7 TBq) in 1999.

4.2.2.1 REMOVAL ACTION V (RA 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 below ground surface to carbon filtration units, and ultimately to the RA V recharge basin, located 3,000 feet 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 which later proved to be very conservative, the recharge basin was evaluated as a potential air emission source for NESHAPs compliance prior to the start of pumping operations (see the section 5.1.6.1 of the BNL *Site Environmental Report for Calendar Year 1997* [BNL 1999] for a discussion of that evaluation).

Airborne HTO monitoring in the vicinity of the RA V recharge basin continued in 1999. Two monitors are installed immediately adjacent to the basin at the northeast and southeast corners, the downwind directions of the predominant winds on site (see BNL wind rose in Figure 1-10). An additional station was placed near the National Weather Service building, approximately 0.2 mile to the east of the basin. As can be seen in Table 4-4, only one of 54 validated samples showed results greater than the MDL, but at a value consistent with what was observed throughout the site. This is as expected since direct analysis of the basin water showed tritium values which were rarely above the MDL of about 350 pCi/L (13 Bq/L). Since the recharge basin airborne tritium surveillance began in 1997, the majority of tritium samples obtained at the recharge basins were reported below the MDL. Consequently, in calendar year 1999, the frequency of sampling was reduced from a weekly basis to once per month.

4.3 NONRADIOLOGICAL AIRBORNE EMISSIONS

Various state and federal regulations covering 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 have heat inputs 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 of Rules and Regulations (NYCRR) Part 227-2, and the New Source Performance Standard, 40 CFR 60 Subpart Db. As such, these boilers are equipped with continuous emissions monitors for nitrogen oxides (NO_X). Boiler No. 7 emissions are also continuously monitored for opacity. To measure combustion efficiency, Boiler Nos. 6 and 7 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.

During the summer of 1999, a new Continuous Emission Monitoring System (CEMS) was installed for Boiler No. 6. Before the installation of the new system, emissions from Boiler No. 6 were monitored by a time-share system that electronically switched between stacks to continuously monitor flue gas concentrations of CO_2 and NO_X in Boilers 6 and 7. The original CEMS is now dedicated to Boiler No. 7. Components of the new system include new analyzers for carbon monoxide (CO), CO_2 and NO_X emissions and a new data acquisition system. The three new analyzers and the data acquisition system are mounted in a temperature-controlled cabinet outside the CSF control room (see Figure 4-6). After installation of the new system was completed, the performance of the analyzers was tested in accordance with 40 CFR 60 Appendix B specifications. The new dedicated system ensures greater operational flexibility to the CSF in the event of a CEMS malfunction.

From May 1 to September 15 (the peak ozone period), compliance with the 0.30 lbs/MMBtu NOx emissions standard is demonstrated by calculating the 24-hour average emission rate from CEMS readings and comparing the value to the emission standard. The remainder of the year, the calculated 30-day rolling average CEMS emissions rate is used to establish compliance. In 1999 there were no measured exceedances of the NO_X emission standard for either boiler.

Figure 4-6. Central Steam Facility Continuous Emission Monitoring Analyzers.

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.

Due to the use of natural gas as the primary fuel, annual particulate, NO_X, and SO_2 emissions at the CSF have dropped significantly from totals in 1996, when natural gas was not yet available for burning (see Table 4-5). In

Table 4-5. Central Steam Facility Fuel Use and Emissions.

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

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

1999, emissions of particulates, NO_X, and SO_2 were 8.9 tons, 51.4 tons, and 92.3 tons lower than the respective totals recorded in 1996. Meanwhile, since volatile organic compound (VOC) emissions produced by natural gas combustion are higher than those from burning residual oil (i.e., #6 oil), VOC emissions rose by 0.9 tons from 1996 to 1999. On an equivalent-heat input basis, particulate emissions at the CSF have fallen by 9.2 tons, NO_X emissions have dropped by 53.6 tons, and SO_2 emissions are down by 94.7 tons over the same period.

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