

EXPLORING EARTH'S MYSTERIES
...PROTECTING ITS FUTURE

Brookhaven National Laboratory Brookhaven Medical Research Reactor Facility

Facility Environmental Monitoring Report

Calendar Year 2000



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**Brookhaven National Laboratory
Brookhaven Medical Research Reactor
Facility Environmental Monitoring Report
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Summary of Results: Analysis of groundwater samples collected at the BMRR during CY 2000 indicate that engineered and operation controls have been effective in protecting groundwater quality. Groundwater monitoring results indicate that tritium concentrations continue to be below the 20,000-pCi/L drinking water standard.

Periodic air monitoring of BMRR emissions indicated that the concentrations of normally measured short-lived radionuclides on the filter and charcoal canister were very low quantities. Real time air monitoring measurements indicated an emission rate for argon-41 of 2,189 Ci. This emission rate is consistent with those of 1998 (2,360 Ci) and 1999 (1,640 Ci).

During the monitoring period, there were no SPDES permit excursions at BMRR designated outfalls.

Background

The BMRR is a 3 MW light water reactor that was used for biomedical research. Research operations at the BMRR stopped in December 2000, and BNL is preparing plans to permanently decommission the facility.

The BMRR's primary cooling water system consists of a recirculation piping system that contains 2,550 gallons of water. The tritium concentration in the primary water is currently 465 $\mu\text{Ci/L}$, for a total tritium content of 4.5 Ci. Unlike the High Flux Beam Reactor, the BMRR does not have a spent fuel storage canal or pressurized imbedded piping systems that contain radioactive liquids. Historically, fuel elements that required storage are either stored within the reactor vessel, or were transferred to the HFBR spent fuel canal. The primary system's piping is fully exposed within the containment structure, and is accessible for routine visual inspections. Excess heat is transferred by means of heat exchangers with once through (secondary) cooling water which is obtained from process supply well 105 or the BNL Chilled Water System. This secondary water is discharged to recharge basin HP located 800 feet to the south of the Medical Department complex. This discharge is monitored as part of the State Pollutant Discharge Elimination System (SPDES) program.

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 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 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.

In 1997, tritium was detected in wells installed directly downgradient (within 30 feet) of the BMRR. The maximum tritium concentration during 1998 was 11,800 pCi/L, almost one-half of the drinking water standard of 20,000 pCi/L. The tritium is believed to have originated from the historical discharge of small amounts of BMRR primary cooling water to a basement floor drain and sump system that may have leaked. Although the last discharge of primary cooling water to the floor drain system occurred in 1987, the floor drains continued to be used for secondary (non-radioactive) cooling water until 1997. The infiltration of this water may have promoted the movement of residual tritium from the soils surrounding the floor drain piping system to the groundwater. The floor drains were permanently sealed in 1998 to prevent any accidental future releases to the underlying soils.

Environmental Monitoring Program

The environmental monitoring program for the BMRR is described in the BNL Environmental Monitoring Plan (Daum *et al.* 2000; BNL, 2001). The BMRR monitoring programs are summarized below.

Monitoring Results

Air Monitoring:

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. In accordance with NESHAP requirements, these nuclides are sampled only on a periodic basis to confirm that their concentrations remain consistent with expected levels. The BMRR generates the largest quantity of airborne radioactive effluent released from the BNL site with argon-41 consistently contributing the greatest fraction of all radionuclide activity released.

During CY 2000, the contribution from particulates and radioiodines to the total dose to the members of the public was less than 1 percent of the 10 mrem dose limit from air

pathway. Therefore, only periodic sampling was done to confirm low levels of emissions. Periodic air monitoring of BMRR emissions indicated that the concentrations of normally measured short-lived radionuclides on the filter (e.g., Sr-91, Sr-92, Cs-138 and Ba-135) and charcoal canister (e.g., Kr-87, Xe-133, Xe-135, and Xe-135m) were very low quantities. Real time monitoring measurements of air emissions indicated a release of 2,189 Ci of argon-41 during CY 2000. This emission rate is consistent with those of 1998 (2,360 Ci) and 1999 (1,640 Ci). Argon-41 was the only radionuclide that has the potential to contribute small fraction of dose to the members of public. (Note: Argon-41 has a half-life of 1.8 hours.)

Groundwater

Samples collected from four groundwater monitoring wells are used to verify that the engineered and administrative controls described above are effective in preventing additional impacts to groundwater quality (Figure 1).

Monitoring results for sampling conducted during 2000 indicates that tritium concentrations continued to be below the drinking water standard of 20,000 pCi/L. Detectable levels of tritium were observed in all three downgradient wells, with the maximum value of 7,870 pCi/L in Well 084-27 (Table 1). Slightly elevated gross beta concentrations (up to 38.6 pCi/L) were detected in several samples from downgradient Well 084-13 (Table 2). As in past years, no other reactor-related radionuclides, including strontium-90, were detected during 2000 (Tables 3 and 4). The elevated gross beta values are probably due to naturally occurring potassium-40, which was detected in BMRR groundwater samples at concentrations up to 105 pCi/L.

SPDES Monitoring

Once through cooling water was used to cool the research reactor in 2000. Water was supplied through a dedicated well (Process Well 105). The discharge from this system is a SPDES permitted release and is designated Outfall 004 (Figure 2). As required under SPDES permit monitoring requirements, the outfall is monitored monthly for pH and flow and quarterly for organic compounds. Additionally the water supply and the discharge are also monitored under the BNL surveillance program quarterly for organics. The outfall is also monitored quarterly for inorganics, and radiological parameters. All concentrations were less than regulatory limits during 2000.

Future Monitoring Actions

The following actions are recommended for the CY 2001 monitoring period:

- The monitoring well sampling schedule will be reduced from quarterly to semiannual.

- No changes in air monitoring program are recommended until the BMRR is fully decommissioned.

References

BNL, 2001. Brookhaven National Laboratory Environmental Monitoring Plan, CY 2001 Update (January 2001). BNL-52584 (Update).

Daum, M., Dorsch, W., Fry, J., Green, T., Lee, R., Naidu, J., Paquette, D., Scarpitta, S., and Schroeder, G., 2000. Brookhaven National Laboratory, Environmental Monitoring Plan 2000 (March 31, 2000).

**BNL Facility Environmental Monitoring Report
Brookhaven Medical Research Reactor
Groundwater Monitoring -Tritium Results
Calendar Year 2000**

Table 1

Well	Location	Collection Date	Tritium Result (pCi/L)	Tritium MDL (pCi/L)
84-28	Upgradient of BMRR	01-11-00	<343	343
		03-06-00	<306	306
		06-06-00	299 +/- 205	295
		09-18-00	338 +/- 191	298
		12-06-00	<320	320
84-12	Downgradient of BMRR	01-11-00	<343	343
		03-06-00	1,180 +/-236	306
		06-07-00	<295	295
		09-18-00	642 +/- 211	298
		12-06-00	326 +/- 218	320
84-13	Downgradient of BMRR	01-11-00	1,777 +/-283	343
		03-06-00	1,360 +/-245	306
		06-06-00	<295	295
		09-18-00	<298	298
		12-06-00	<320	320
84-27	Downgradient of BMRR	00-11-00	7,870 +/-433	343
		03-06-00	4,120 +/- 348	306
		06-07-00	1,600 +/- 382	295
		09-18-00	NS	
		12-06-00	827 +/- 249	320
Drinking Water Standard			20,000	

MDL = Minimum Detection Limit

NS: Well not sampled due to pump failure.

Note: "<" symbols preceding a value (e.g., <307) indicates that the measure value was less than the stated Minimum Detection Limit.

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Groundwater Monitoring - Gross Alpha/Gross Beta Analytical Results
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Table 2

Well	Location	Collection Date	Gross Alpha Result (pCi/L)	Gross Alpha MDL (pCi/L)	Gross Beta Result (pCi/L)	Gross Beta MDL (pCi/L)
84-28	Upgradient of BMRR	01-11-00	1.44 +/-0.5	0.75	6.8 +/-1.4	2.0
		03-06-00	<0.97	0.97	9.2 +/- 1.5	2.1
		06-06-00	<1.02	1.02	4.4 +/- 1.3	2.0
		09-18-00	3.8 +/- 0.6	0.89	14.3 +/- 1.7	2.1
		12-06-00	<0.79	0.79	<2.5	2.5
84-12	Downgradient of BMRR	01-11-00	1.2 +/-0.5	0.75	8.2 +/-1.5	2.0
		03-06-00	<0.97	0.97	3.8 +/-1.4	2.1
		06-07-00	<1.02	1.02	4.9 +/- 1.4	2.0
		09-18-00	2.4 +/- 0.6	0.89	10.8 +/- 1.6	2.1
		12-06-00	<0.79	0.79	<2.5	2.5
84-13	Downgradient of BMRR	01-11-00	<0.75	0.75	8.6 +/-1.5	2.0
		03-06-00	<0.97	0.97	35.8 +/-2.2 (c)	2.1
		06-06-00	<1.02	1.02	38.6 +/- 2.3	2.0
		09-18-00	6.3 +/- 0.8	0.89	10.6 +/- 1.6	2.1
		12-06-00	<0.79	0.79	<2.5	2.5
84-27	Downgradient of BMRR	01-11-00	1.3 +/-0.5	0.75	6.9 +/- 1.4	2.0
		03-06-00	<0.97	0.97	7.2 +/-1.5	2.1
		06-07-00	<1.02	1.02	12.1 +/- 1.6	2.0
		09-18-00	NS	--	--	--
		12-06-00	<0.79	0.79	1.7 +/- 1.5	2.5
Drinking Water Standard			15 (a)		50 (b)	

MDL = Minimum Detection Limit

a: Excluding radon and uranium.

b: Screening level above which analysis for individual radionuclides is required.

c: Elevated gross beta result likely due to high potassium-40 level, detected at 105 pCi/L

Note: "<" symbols preceding a value (e.g., <0.97) indicates that the measure value was less than the stated Minimum Detection Limit.

NS: Well not sampled due to pump failure.

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Groundwater Monitoring - Gamma Spectroscopy Results
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Table 3

Well	Location	Collection Date	Gamma Result (pCi/L)
84-28	Upgradient of BMRR	01-11-00	ND
		03-06-00	K-40 = 39.6 +/-23.4
		06-06-00	Tl-208=4.2 +/- 1.6; Bi-214=23.5+/-4.7; Pb-214=18.0+/-4.3
		09-18-00	ND
		12-06-00	ND
84-12	Downgradient of BMRR	01-11-00	ND
		03-06-00	K-40 = 21.7 +/-21.2
		06-07-00	Pb-214=7.9+/-2.7
		09-18-00	Pb-214=34.8+/-3.2; Bi-214=35.0+/-4.9
		12-06-00	ND
84-13	Downgradient of BMRR	01-11-00	K-40 = 34 +/-24.2
		03-06-00	K-40=105+/-19.6; Tl-208=3.3+/-1.7 Pb-214 = 5.9+/-2.1
		06-06-00	Pb-214 =5.8+/-3.2
		09-18-00	Pb-212=4.9+/-3.2; Pb-214=12.2+/-3.6; Bi-214=15.8+/-4.0
		12-06-00	ND
84-27	Downgradient of BMRR	01-11-00	Pb-214 = 6.3 +/-3.2
		03-06-00	K-40 = 27 +/-26.5
		06-07-00	K-40=28.7+/-25.1; Pb-214=13.3+/-3.5
		09-18-00	NS
		12-06-00	Pb-214=17.3+/-3.8

ND = Radionuclide not detected.

NS: Well not sampled due to pump failure.

Note 1: Potassium-40 and Lead-214 are naturally occurring radionuclides.

Note 2: Safe Drinking Water Act limit for K-40 = 280 pCi/L and for Pb-214 = 8,000 pCi/L. Limit is calculated as 4% of the DOE Derived Concentration Guide to obtain a concentration that would produce a 4 mrem committed effective dose equivalent.

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 Groundwater Monitoring - Strontium-90 Results
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Table 4

Well	Location	Collection Date	Gross Beta Result (pCi/L)	Sr-90 Result (pCi/L)	Sr-90 MDL (pCi/L)
84-28	Upgradient of BMRR	09-18-00	14.3 +/- 1.7	<0.6	0.6
84-12	Downgradient of BMRR	09-18-00	10.8 +/- 1.6	<0.8	0.8
84-13	Downgradient of BMRR	09-18-00	38.6 +/- 2.3	<0.6	0.6
84-27	Downgradient of BMRR	09-18-00	NS	NS	--
Drinking Water Standard			50	8	

MDL: Minimum Detection Limit

NS: Well not sampled due to pump failure.

Note: "<" symbols preceding a value (e.g., <1.0) indicates that the measure value was less than the stated Minimum Detection Limit.

