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# Brookhaven National Laboratory
# Brookhaven Medical Research Reactor Facility

## Facility Environmental Monitoring Report

## Calendar Year 2001

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April 15, 2002

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**GW62ER.02**

**Brookhaven National Laboratory**
**Brookhaven Medical Research Reactor**
**Facility Environmental Monitoring Report**
**Calendar Year 2001**

***Summary of Results:***

*Although the BMRR was shutdown in December 2000, BNL has maintained the established air monitoring program to verify that the radionuclide emissions would diminish as anticipated. Monitoring of BMRR air emissions during 2001 did not detect any reactor-derived radionuclides.*

*Analysis of groundwater samples collected from BMRR monitoring wells during CY 2001 indicate that engineered and operation controls have been effective in protecting groundwater quality. Groundwater monitoring results indicate that tritium concentrations continue to be well below the 20,000 pCi/L drinking water standard.*

*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.[1]

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 μCi/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. When the BMRR was operational, excess heat was transferred by means of heat exchangers with once through (secondary) cooling water which was obtained from process supply well 105 or the BNL Chilled Water System. This secondary water was discharged to recharge basin HP

[1] All spent fuel is scheduled to be removed from the BMRR by the summer of 2002. Drainage of the primary cooling water is scheduled to be completed by the end of CY 2002.

located 800 feet to the south of the Medical Department complex, and was 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 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, which is a chemically inert gas with a half-life of only 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, and finally, a charcoal filter for the removal of radioiodines produced by the fissioning of fuel. Following filtration, the air was exhausted to a 150-foot stack adjacent to the reactor containment building. Although the facility is inactive, a real-time monitor continues to track potential remnant 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. When BMRR was operational, it was major point source of airborne radioactive effluent released from the

BNL site, with argon-41 consistently contributing the largest fraction of all radionuclide activity released.

Although the BMRR was shutdown in December 2000, BNL has maintained the established air monitoring program to verify that the emission levels would diminish as anticipated. Following the termination of reactor operations, there is little potential for air emissions of particulates and radioiodines, and argon-41 emissions should be greatly reduced. Historically, argon-41 was the only radionuclide that had the potential to contribute a small fraction of dose to the members of public. (Note: Argon-41 has a half-life of 1.8 hours.) As anticipated, monitoring of BMRR air emissions during 2001 did not detect any reactor-derived radionuclides.

### 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 2001 indicates that tritium concentrations continued to be well 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 1,550 pCi/L in Well 084-27 (Table 1). As in past years, no other reactor-related radionuclides were detected in the groundwater (Tables 2 and 3).

### 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 the first five months of 2001 during which discharges to Outfall 004 occurred. Discharges ceased as of June 2001 and a SPDES permit modification has been submitted to the NYSDEC to remove this discharge from BNL's SPDES permit.

## Future Monitoring Actions

The following actions are recommended for the CY 2002 monitoring period:

- The monitoring wells shall continue to be sampled on a semiannual basis.

- No changes in air monitoring program are recommended until all remaining fuel has been removed and the BMRR facility has been fully decontaminated.

## 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).

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**Brookhaven Medical Research Reactor**
**Groundwater Monitoring -Tritium Results**
**Calendar Year 2001**

## Table 1

| Well | Location | Collection Date | Tritium Result (pCi/L) | Tritium MDL (pCi/L) |
|---|---|---|---|---|
| 84-28 | Upgradient of BMRR | 03-12-01 | <374 | 374 |
| | | 09-12-01 | <331 | 331 |
| | | | | |
| | | | | |
| 84-12 | Downgradient of BMRR | 03-12-01 | <347 | 347 |
| | | 09-12-01 | 347 +/- 207 | 331 |
| | | | | |
| | | | | |
| 84-13 | Downgradient of BMRR | 03-12-01 | <347 | 347 |
| | | 09-12-01 | 507 +/- 214 | 331 |
| | | | | |
| | | | | |
| 84-27 | Downgradient of BMRR | 03-12-01 | 1,550 +/- 295 | 347 |
| | | 09-12-01 | 1,230 +/- 246 | 331 |
| | | | | |
| | | | | |
| Drinking Water Standard | | | 20,000 | |

MDL = Minimum Detection Limit

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**
**Calendar Year 2001**

**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 | 03-12-01 | 0.85 +/-0.4 | 0.63 | 4.38 +/-1.4 | 2.2 |
| | | 09-12-01 | 3.25 +/- 0.6 | 0.79 | 3.29 +/- 1.5 | 2.3 |
| | | | | | | |
| | | | | | | |
| 84-12 | Downgradient of BMRR | 03-12-01 | <0.63 | 0.63 | 3.41 +/-1.4 | 2.2 |
| | | 09-12-01 | <0.79 | 0.79 | 4.87 +/-1.5 | 2.3 |
| | | | | | | |
| | | | | | | |
| 84-13 | Downgradient of BMRR | 03-12-01 | 3.36 +/- 0.6 | 0.63 | 11.1 +/-1.7 | 2.2 |
| | | 09-12-01 | 1.14 +/- 0.5 | 0.79 | 5.17 +/-1.5 | 2.3 |
| | | | | | | |
| | | | | | | |
| 84-27 | Downgradient of BMRR | 03-12-01 | <0.63 | 0.63 | 6.88 +/- 1.6 | 2.2 |
| | | 09-12-01 | 2.88 +/- 0.7 | 0.79 | 4.13 +/-1.5 | 2.3 |
| | | | | | | |
| | | | | | | |
| NYSAWQS | | | 15 (a) | | 1,000 | |

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

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**Groundwater Monitoring - Gamma Spectroscopy Results**
**Calendar Year 2001**

**Table 3**

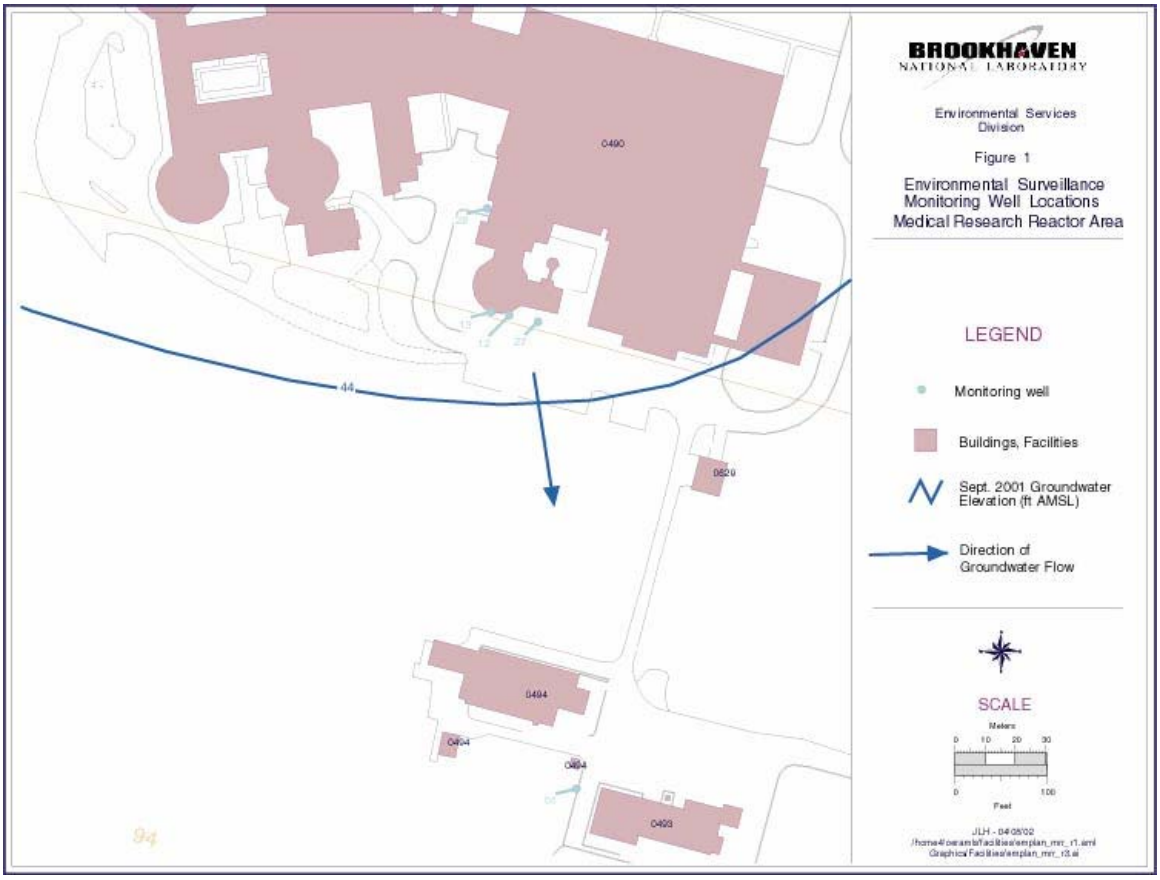
| Well | Location | Collection Date | Gamma Result (pCi/L) |
|---|---|---|---|
| 84-28 | Upgradient of BMRR | 03-12-01 | Bi-214 = 97.1 +/- 7.8; Pb-214 = 86 +/- 9.6 |
| | | 09-12-01 | Bi-211 = 18.6 +/-10.6 |
| | | | |
| | | | |
| 84-12 | Downgradient of BMRR | 03-12-01 | K-40 = 35.8 +/- 25.9; Bi-212 = 17.6 +/- 9.6; Bi-214 = 79.2 +/- 6.1; Pb-214 = 75.7 +/-5.8 |
| | | 09-12-01 | ND |
| | | | |
| | | | |
| 84-13 | Downgradient of BMRR | 03-12-01 | K-40 = 33.1 +/-4.2; Pb-214 = 30 +/- 4.0 |
| | | 09-12-01 | ND |
| | | | |
| | | | |
| 84-27 | Downgradient of BMRR | 03-12-01 | Bi-214 = 59.4 +/- 4.7; Pb-214 = 55.9 +/-6.3 |
| | | 09-12-01 | Pb-214 = 7 +/- 3.3; Ra-226 = 62.3 +/- 50(Note 3) |
| | | | |

ND = Radionuclide not detected.

Note 1: K-40, Bi-211, Bi-214, and Pb-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. The drinking water standard for Ra-226 is 3 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.

Note 3: Ra-226 detected in the September sample from Well 084-27 is likely to be associated with natural uranium.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Division
Figure 1
Environmental Surveillance
Monitoring Well Locations
Medical Research Reactor Area
LEGEND
Monitoring well
Buildings, Facilities
Sept. 2001 Groundwater
Elevation (ft AMSL)
Direction of
Groundwater Flow
SCALE
Meters
0 10 20 30
0 100
Feet
JLH - 04/26/02
0490
44
0820
0494
0494
0494
0493
94