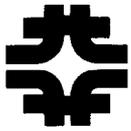


I. SEMIANNUAL ENVIRONMENTAL MONITORING REPORT  
January 1, 1971 to June 30, 1971

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November 29, 1971



## II. Introduction.

The National Accelerator Laboratory facility is a 200 GeV proton synchrotron. The primary purpose of the installation is fundamental research in high-energy physics. Most of the radioactivity produced as a result of accelerator operation is contained in insoluble shields and beam dumps.

During this reporting period, the pre-accelerator components (Cockroft-Walton, 200 MeV Linac, 8 GeV Booster synchrotron) were operated to design energy but at reduced current. The main accelerator was operated only with coasting beam (no acceleration). No extraction from the main accelerator to the targeting areas was attempted. Therefore, accelerator produced radiation and radioactivity during this reporting period is negligible with respect to applicable environmental protection standards and the data recorded can be regarded as indicative of normal background levels.

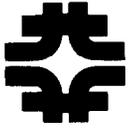
Only three types of accelerator produced radiation merit monitoring for environmental purposes:

### A. Penetrating Radiation.

Operation of the accelerator at full design energy and intensity will inevitably result in production of some penetrating radiation (primarily neutrons and muons) outside the shielding. Although the shielding has been designed to be adequate for foreseeable circumstances, monitoring for purposes of determining actual radiation levels both on and off site is necessary.

### B. Air-borne Radioactivity.

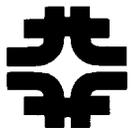
Under normal operation of certain of the beam dumps and target boxes, radioactivation of air may occur. Monitoring of



such activation will be carried out for purposes of personnel exposure control. Under no circumstances is the off-site concentration of air-borne radioactivity expected to approach the limits set forth in the appropriate guidelines.

C. Water-borne Radioactivity.

During accelerator operations, some radioactivation of the soil will occur. Leaching of these radionuclides into the ground water provides a possible mechanism for transport of NAL produced radionuclides into surface run-off waters. Also, a very small fraction of these radionuclides may reach the aquifer.



III. Applicable Standards.

All of the standards pertinent to the operation of this facility are contained in the AEC Manual, Chapter 0524, Standards for Radiation Protection, Part II, Individuals and Population Groups in Uncontrolled Areas.

A. Penetrating Radiation.

The appropriate standard is taken from the AEC Manual, Chapter 0524, Paragraph II.A, applied to populations\*:

0.17 rem/year (exposure to whole body, gonads or bone marrow).

B. Air-borne Radioactivity.

The concentration guides are taken from the AEC Manual Appendix 0524, Annex A, Table II, Column 1, Concentrations in Air in Uncontrolled Areas, and divided by a factor of three for application to samples of the population\* (0524, Par. II.C.1.)

C. Water-borne Radioactivity.

The concentration guides are taken from the AEC Manual, Chapter 0524, Annex A, Table II, Column 2, Concentrations in Water in Uncontrolled Areas, and divided by a factor of three for application to populations\* (0524, Par. II.C.1.)

\* Based on an average dose to a suitable sample of the exposed population.



IV. Sample Collection and Analysis Summary.

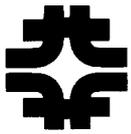
A. Penetrating Radiation.

A central monitoring station is maintained in the NAL site "village". The monitoring equipment consists of four major components:

1. Aluminum-Argon ionization chamber. This chamber is mostly sensitive to muons and gammas, and much less sensitive to neutrons. The data is recorded as daily integrals of the ionization current. During the latter part of the recording period, a continuous strip-chart record of ionization current was also made.
2. Tissue-equivalent ionization chamber. This chamber is sensitive to neutrons as well as gammas and directly ionizing radiations. The data is again recorded as daily integrals of the ionization current.
3. 3 in x 3 in NaI(Tl) spectrometer. This device is sensitive primarily to gamma radiation above 100 keV. The data is recorded as daily integrals of the counts.
4. Bonner spectrometer. This device is an array of moderating hydrogenous spheres with thermal-neutron sensitive  $\text{Li}^6\text{I}(\text{Eu})$  scintillators located at the center of each sphere. The data is recorded as the daily integral of counts in each detector and unfolded by a computer program to obtain the neutron flux and dose.

B. Air-borne Radioactivity.

Operations during this reporting period could not produce measurable quantities of air-borne radioactivity. Hence, no air-monitoring was performed.



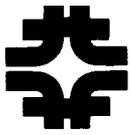
C. Water-borne Radioactivity.

Monthly water samples were taken at various locations on the site and analyzed for the presence of those radionuclides which have been experimentally determined to be produced and leachable from NAL soils in measurable quantities.

The water sampling locations were chosen to sample two ground water systems:

1. Surface and near-surface waters. These samples were taken from sumps which collect water in the vicinity of accelerator components.
2. Silurian Aquifer. These samples were taken from farm wells which tap the 70 foot Silurian Dolomite Aquifer which is a prime water supply for many private residences in the area.

The sample analysis service was contracted to U.S. Testing Company (Richland Laboratory, Richland, Washington). Each monthly sample shipment contained one unidentified sample to which known concentrations of radionuclides had been added. The agreement of the reported concentrations to the known concentrations for these control samples provided verification of compliance with the analysis specifications. The specifications for these analyses are summarized in Table 1.



V. Monitoring Data.

A. Penetrating Radiation.

The location of the central monitoring station is shown in Figure 1. No evidence of accelerator induced radiation was seen by any detector. The three gamma sensitive monitors (aluminum-argon ion chamber, tissue-equivalent ion chamber, NaI crystal) have consistently indicated natural-background-level exposures of approximately .007 milliRoentgens/hour. Neutron dose rates monitored have indicated an average neutron component not exceeding approximately .0006 millirem/hour which is again completely consistent with the expected cosmic-ray neutron background.

In summary, all data indicates that operation of the NAL facility during this reporting period did not measurably increase the ambient radiation at the monitoring station.

B. Air-borne Radioactivity.

No data was taken.

C. Water-borne Radioactivity.

The locations of the sampling points are shown in Figure 1 and further described in Table 2. The analysis results are tabulated in Table 3. No measurable concentrations of accelerator produced radionuclides were found in any of the water systems.



VI. Interpretation and Summary.

The monitoring data give no evidence that the operations of the NAL facility during this reporting period have in any way increased the environmental radiation levels in the vicinity of the site.

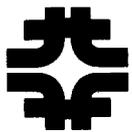


Table 1  
Specifications for the Analyses  
of Radionuclides in Water

<u>Radionuclide</u>	<u>Concentration Guide*</u> <u>μCi/ml</u>	<u>Specified**</u> <u>Sensitivity</u> <u>μCi/ml</u>	<u>Specified***</u> <u>Precision</u> <u>μCi/ml</u>
Na <sup>22</sup>	1 x 10 <sup>-5</sup>	1.3 x 10 <sup>-6</sup>	5 x 10 <sup>-7</sup>
Ca <sup>45</sup>	3 x 10 <sup>-6</sup>	3 x 10 <sup>-7</sup>	3 x 10 <sup>-7</sup>
Mn <sup>54</sup>	3.3 x 10 <sup>-5</sup>	3.3 x 10 <sup>-6</sup>	1 x 10 <sup>-6</sup>
H <sup>3</sup>	1 x 10 <sup>-3</sup>	1 x 10 <sup>-4</sup>	2.5x10 <sup>-5</sup>
Be <sup>7</sup>	6.7 x 10 <sup>-4</sup>	3 x 10 <sup>-5</sup>	1 x 10 <sup>-5</sup>

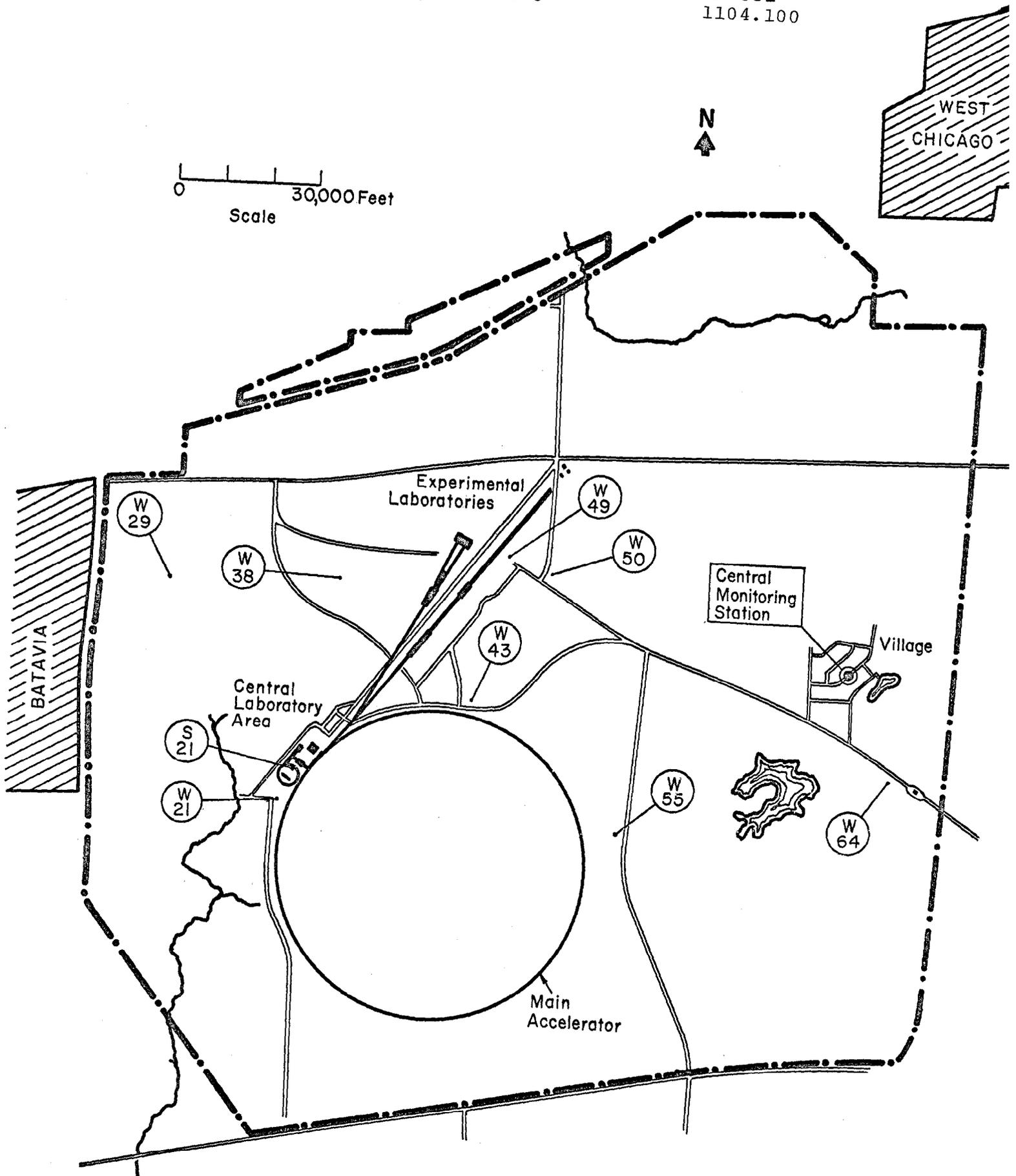
\* The concentration guides are taken from the AEC Manual, Chapter 0524, Annex A, Table II, Column 2 (Water in Uncontrolled Areas) and reduced by a factor of three as appropriate for a suitable sample of exposed population. The smaller of the values given for soluble and insoluble forms has been used in each case.

\*\* For most radionuclides the actual analysis sensitivity was found to be considerably better than that specified in the contract with U.S. Testing Company. Therefore, these sensitivities should be considered as an upper limit to the detectable concentrations.

\*\*\* The precision is stated for the 95% confidence level (two standard deviations).

Figure 1 - Map of Sampling Locations

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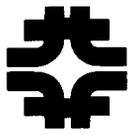


Table 2  
Description of Sampling Locations

<u>Designation</u>	<u>Description</u>	<u>Water System Sampled</u>
S 21	Sump in vicinity of 200 MeV transport (Booster enclosure)	Shallow ground water
W 21	Farm well	Silurian aquifer
W 29	Farm well	Silurian aquifer
W 38	Farm well	Silurian aquifer
W 43	Farm well	Silurian aquifer
W 49	Farm well	Silurian aquifer
W 50	Farm well	Silurian aquifer
W 55	Farm well	Silurian aquifer
W 64	Farm well	Silurian aquifer

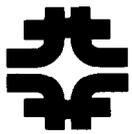


Table 3  
Results of Water Sample Analyses

<u>Sample Number</u>	<u>Month</u>	<u>Sample Location*</u>	<u>Detectable** Activities</u>
8-B	January	S 21	None
8-C	January	W 43	None
9-A	February	S 21	None
9-B	February	W 43	None
10-A	March	S 21	None
10-D	March	W 43	None
11-A	April	W 38	See Note 1
11-B	April	W 43	None
11-D	April	S 21	None
11-E	April	W 21	None
13-A	May	W 50	None
13-B	May	W 55	None
13-C	May	W 21	None
13-H	May	W 43	None
13-I	May	S 21	None
14-A	June	W 21	None
14-B	June	W 43	None
14-C	June	W 64	None
14-E	June	W 50	None
14-G	June	S 21	None
14-H	June	W 29	None
14-I	June	W 49	None

Note 1  $(3 \pm 3) \times 10^{-7}$   $\mu\text{Ci/ml}$  of  $\text{Ca}^{45}$  was reported. This result is at the threshold of sensitivity for the analysis, and should be regarded as a 'null' result. None of the other radionuclides were detected.

\* Sampling locations are shown on Figure 1 and described in Table 2.

\*\* "None" means that none of the five radionuclides tested for was observed. Refer to Table 1 for the applicable sensitivities.