MOUND FACILITY ENVIRONMENTAL MONITORING SUMMARY 1977

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Environmental Monitoring Summary: 1977

Issued: June 9, 1978

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MOUND FACILITY

Miamisburg, Ohio 45342

operated by

MONSANTO RESEARCH CORPORATION

a subsidiary of Monsanto Company

for the

U. S. DEPARTMENT OF ENERGY

Contract No. EY-76-C-04-0053

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1977 highlights

Effluent reduction

Radioactive emissions from Mound Facility were reduced in 1977. Mound has, for the last eight years, consistently reduced the total radioactive emissions in effluents. This reduction results from the combined efforts of the effluent reduction program, the recently initiated "as low as practicable" (ALAP) concept, and active management support.

Sediment stability

In 1974, concentrations of plutonium-238 were found to be above baseline levels in the sediment of the abandoned Miami-Erie Canal adjacent to Mound. An extensive Environmental Plutonium Study evaluated the situation. The study concluded that the contaminated sediments did not present a hazard to people living in the area or to the public at large. After several years of monitoring the area, the situation was reevaluated to determine the stability of the contaminated sediments in the Miami-Erie Canal area. It was concluded that the contaminated sediment present in the abandoned Miami-Erie Canal is quite stable, even though it is not covered with water and has been disturbed by construction activities, and further action such as removal or burial is not necessary.

Soil inventory

In order to provide further assurance of the effectiveness of Mound's stack emission monitoring and to provide a means of evaluating the potential impact on the environment from deposition of plutonium-238 stack emissions, a soil inventory was completed. The soil inventory estimated the quantity of plutonium-238 deposited in the

environment from past Mound Facility stack emissions to be 360 mCi of plutonium-238 distributed over 800 km² (309 mi²). The radiation dose from any resuspension of the deposited plutonium is in compliance with proposed EPA guidance for transuranics in the environment.

EPA drinking water standard

The U.S. EPA has adopted new drinking water standards for radiological, biological, and chemical elements in water. The new highly conservative radiation standards, which became effective in June, 1977, although not based upon new toxicological or epidemiological information, reduced the previous federal standard by a factor of approximately 50. Since water from nine local wells exceeded the new standard as a result of past Mound Facility tritium effluents, Mound implemented a forced water-turnover program for the aquifer in the spring of 1977. Two high capacity wells were pumped continuously for the last eight months of the year. Increased infiltration to and discharge from the aquifer have brought some of the wells into compliance with the new EPA standard. It is anticipated that the forced water-turnover program will result in all private wells achieving compliance during 1978. There is no health problem associated with the very low levels of tritium in the local water wells although they exceed the EPA standard.

I. Introduction

Monsanto Research Corporation operates Mound Facility, a government-owned facility of the U.S. Department of Energy (DOE) in Miamisburg, Ohio. Mound Facility is an integrated research, development, and production facility performing work in support of DOE weapon and nonweapon programs with emphasis on explosive and nuclear technology.

Mound Facility originated as a technical organization in 1943 when Monsanto Chemical Company was requested by the Manhattan Engineering District to accept responsibility for determining the chemical and metallurgical properties of polonium*. Originally, Monsanto's Central Research Department and several satellite units in the Dayton, Ohio area were used for this project. Late in 1945, the Manhattan Engineering District determined that the research, development, and production organization established by Monsanto at Dayton should become a permanent facility. A search for a suitable location in early 1946 led to the selection of an 180-acre tract adjacent to Miamisburg, about ten miles (16 km) south of Dayton.

Construction of Mound Facility, which was named after the Miamisburg Indian Mound adjacent to the site, began in February 1947 and was completed in 1948. The new laboratory was the first permanent facility of the Atomic Energy Commission, successor to the Manhattan Engineering District.

*Polonium and other technical terms are defined in the Glossary.

All programs at that time were concerned with polonium-210 and its applications. Additional assignments soon led to a wide variety of technical activities, and during the last 29 years many diversified capabilities have been developed for highly specialized research, development, and production operations.

Mound Facility from the air.

Separation of the stable isotopes of noble gases began as an expansion of research beginning in 1954 on thermal diffusion columns. Today, Mound Facility is recognized worldwide for thermal diffusion research and stable isotope separation processes which provide a large number of nonradioactive isotopes for sale throughout the free world. These isotopes find use in cyogenics, nuclear physics research, geochemistry, agriculture, chemistry research, and medicine.

Indian Mound adjacent to Mound Facility

In 1954 the thermoelectric generator utilizing heat from radioactive decay was invented at Mound Facility. This invention utilized heat from the radioactive decay of polonium-210. The first SNAP generator, SNAP-3, fueled with polonium-210, was demonstrated at the White House in 1959. Since that time numerous heat sources fueled with plutonium-238 have been developed and fabricated for use in thermoelectric generators and heat sources for lunar experiments, weather satellites, navigational satellites, spacecraft, life support systems, swimsuit heaters, artificial hearts, and cardiac pacemakers.

Mound continues to diversify its activities and today receives funding from nine DOE divisions as well as support of such other federal agencies as the Environmental Protection Agency and the Nuclear Regulatory Commission.

In 1949, the year in which the Facility began operations, the foresight was there to establish not only health and safety precautions for Mound's employees but also for the control of these possibly hazardous materials to ensure the public safety and integrity of the environment. The formal Environmental Control and Monitoring program, continually being altered to reflect current public and environmental needs, exemplifies concern for the well-being of the communities surrounding the facility.

II. Applicable standards

Radioactivity concentration guide

DOE radiation protection regulations are based principally on the Radioactivity Concentration Guide (RCG)

levels that were recommended by the former Federal Radiation Council and approved by the President as guidance for all federal agencies.

The recommended levels are developed with the assistance of appropriate federal agencies, the National Academy of Sciences, the National Committee on Radiation Protection and Measurements, and the International Commission on Radiological Protection. In addition to

A fisheye view of a system designed to control alpha or beta radiation

their own expertise, the members of these groups seek the advice of other highly qualified scientists with specialized knowledge of the many factors that determine the effects of radioactivity on man. The results of the extensive experimental programs on the behavior and effect of radioactive material in the environment and in living tissue are also carefully considered in developing the RCG levels. These levels are reviewed as new research information becomes avail-

A system designed to work with alpha, beta, gamma, and neutron emitters.

able or as new problems arise to determine whether changes in these standards are needed.

The RCG that has been established for each specific type of radioactive material is the concentration of radioactivity in the environment that should not be exceeded without careful consideration. The radiation dose received from radioactive materials at the RCG level is less than the radiation dose received routinely by the general population from such sources as cosmic rays, naturally occurring radioactive materials, and medical diagnostic x-rays. The levels of radioactive materials documented in this report are small fractions of the RCG.

Nonradioactive standards

Both the U. S. EPA and the Ohio EPA have established standards for ambient levels of pollutants in the environment. The more restrictive of these standards serve as the criteria for this report. In addition, the U.S. EPA has issued a discharge permit for each Mound effluent stream effective June 30, 1975. The permit specifies concentration limits for various pollutants.

III. Effluent monitoring

History

An important concept in pollution control is control at the source. Mound has established an effluent monitoring system which utilizes this concept. Most effluents are monitored at least twice before being discharged to the environment. This system allows almost immediate notification of problem areas in effluents so that corrective action can be taken to prevent significant emissions to the environment.

A concept receiving recent emphasis in control of radioactive emissions is the "as low as practicable" (ALAP) concept. ALAP emphasizes the control of effluent emissions, which are already well within standards, to levels that are as low as practicable. Before this concept was initiated by DOE, Mound had established a similar administrative control program. This program involved setting effluent goals which were less than the standards. This program's success is demonstrated in the following graphs.

Air - radioactive

Current operations at Mound primarily involve two radionuclides. These radionuclides are tritium and plutonium-238. The following graphs illustrate the continuing progress Mound has made in control of airborne releases of tritium and plutonium over the past few years.

Air - Nonradioactive

The Mound steam boilers are presently fired with natural gas and fuel oil. During cold weather, natural gas supply to Mound is interrupted, and fuel oil with less than 1% sulfur content is burned. During 1977 Mound's steam boilers were fired almost equally by fuel oil and natural gas.

Emissions from all Mound sources that are registered with the Regional Air Pollution Control Agency (RAPCA) and the Ohio EPA and that have applicable emission standards were estimated using USEPA techniques. All nonradioactive airborne emissions at Mound Facility were in compliance with applicable standards and had minimal impact on ambient air quality. This was

Annual quantities of tritium in airborne effluents

Annual quantities of plutonium-238 in airborne emissions

further demonstrated by particulate concentration data collected at Mound air-sampling stations. These data indicate that Mound operations do not have a measurable effect on the ambient particulate level of the region.

Water - radioactive

Tritium and plutonium-238 are also the radionuclides of interest in Mound's water effluents. The following graphs demonstrate the continuing decrease in water effluent releases within the last few years.

Water - nonradioactive

The quality of water discharged to the Great Miami River from Mound Facility is subject to a U.S. EPA National Pollutant Discharge Elimination System (NPDES) permit. The permit limitations apply to nonradioactive water quality parameters only. During 1977 only two minor exceptions occurred. These exceptions were slightly elevated suspended solids originating from the storm sewer system during July. Analyses of the data indicate that pollutants in Mound's water effluents are so minimal that they have no significant effect on the Miami River into which the water effluents are discharged.

IV. Offsite environmental monitoring

History

In order to further verify the integrity of Mound onsite effluent controls, air, water, foodstuffs, and soil samples are collected in the offsite environment. These samples are then carefully analyzed for any minute trace of tritium or plutonium-238. The monitoring survey is conducted by a staff of professionally trained personnel. A detailed technical re-

Annual quantities of tritium in water effluent streams

Annual quantities of plutonium-238 in water effluent streams

port documenting the survey results has been issued on a regular basis since 1959 to the Atomic Energy Commission and its successors, the Energy Research and Development Administration and the Department of Energy, and to local, state, and federal agencies, such as the Miami Conservancy District, the Montgomery County Health Department, State of Ohio Department of Health, the Ohio Environmental Protection Agency, and the Federal Environmental Protection Agency. The data in this report are essentially a summary of the detailed technical report.

Air

During 1977 an offsite air sampling network consisting of 14 continuously operating air sampling stations collected samples for both tritium oxide and plutonium analyses, and a fifteenth sampler collected only plutonium samples. Averages of sampling data for CY-1977 are shown in the following table along with data from five onsite continuous air samplers.

AVERAGE AIRBORNE CONCENTRATIONS OF RADIONUCLIDES

	Range (% of RCG)	Grand Average (% of RCG)
Offsite Pu-238	<0.01 -0.15	<0.037
Offsite Tritium	<0.005-0.018	<0.009
Onsite Pu-238	0.02 -0.12	0.057
Onsite Tritium	<0.008-0.015	<0.01

Water

Since treated waste-water is discharged from Mound to the Great Miami River, water samples are collected in the Great Miami River. Samples are also collected from the abandoned Miami-Erie Canal and adjacent ponds, surface water locations (ponds), municipal drinking

Offsite air sampling stations.

water, and private wells. Most of these samples are analyzed for both tritium and plutonium. The average of the sampling analyses for CY-1977 are shown in the following table.

The average concentration of tritium in all public drinking water was 5.5% of the new drinking water standard which was adopted by the U.S. EPA in 1977.

A Mound air sampling station.

Average Radionuclide Concentrations at Various
Water Sampling Locations

	Plutonium-238 (% of RCG)		Tritium (% of RCG)	
	Range	Grand Average	Range	Grand Average
River	<0.0005-<0.0040	<0.0014	<0.10 -<0.19	<0.14
Miami-Erie Canal & Ponds	- -	0.18	0.52 - 2.4	1.3
Surface Water Locations	<0.0005 <0.0006	<0.0005	<0.05 -<0.11	<0.10
Municipal Drinking Water	- -	<0.0005*	2.5**-14**	5.5**
Private Wells	- -	<0.0028	149**-233**	180**

*Includes Miamisburg only.

**These drinking water values are now controlled by the new EPA standard. Based on the latest information, all private wells are approaching compliance with the new EPA standard.

Although the privately operated wells had always been in compliance with the prevailing AEC and ERDA standard for tritium effluent and drinking water, the new U.S. EPA drinking water standards for radiological, biological, and chemical elements in water, which became effective in June 1977, placed nine wells in a non-compliance status for tritium because the new standard for radioactivity is 50 times less than the old standard. The average concentration for 1977 exceeds the

Great Miami River adjacent to Mound Facility

Offsite water sampling locations.

new standard by a factor of 1.8. There is no health problem associated with the levels of tritium in these local wells although they exceed the new EPA standard. The EPA regulations for tritium are essentially a non-degradation standard and are not based on new toxicological or epidemiological evidence of deleterious health effects and do not condemn water supplies that exceed the new standards.

This tritium concentration resulted from Mound Facility releasing tritiated waste water, which was always within then current standards, to the Great Miami River via the site drainage ditch and Miami-Erie Canal over a period of years prior to 1970. Some of the water migrated into the aquifer adjacent to Mound Facility and increased the concentration of tritium in the aquifer.

Since 1970, changes in operating procedures reduced the Mound Facility tritium effluent concentration by a factor of almost 50 and resulted in a continuing decrease of tritium in the private wells. In order to accelerate the rate at which tritium was being dissipated from the aquifer and to achieve compliance of the private wells with the new EPA standard at the earliest possible time, Mound initiated a forced water-turnover program for the aquifer using a high-capacity well at the Mound site and an old well no longer used by the City of Miamisburg. These wells were pumped continuously from spring of 1977 for the remainder of the year. Increased infiltration into and discharge from the aquifer have brought some of the wells into compliance with the EPA standard and significantly reduced levels in the remaining wells.

It is anticipated that the forced water-turnover program will result in all private wells achieving compliance during 1978. This program has been approved by the Ohio EPA and U.S. EPA. Mound has a continuing commitment to keep these agencies apprised of the progress in bringing the affected wells into compliance.

Foodstuff

Various samples of foodstuffs were collected and analyzed during CY-1977 for tritium and plutonium.

There are no RCG's for foodstuffs; therefore, a direct comparison with the RCG cannot be made. The tritium and plutonium-238 content of the foodstuffs, however, are within the range of that found in water.

Soil

In order to provide additional assurance of the effectiveness of the Mound monitoring program and past environmental evaluations, two major projects were undertaken during 1977, Soil Inventory and Stability of Plutonium Contaminated Sediments in the Miami-Erie Canal.

The Soil Inventory involved collection of soil core samples to determine the total quantity of plutonium that has been deposited in the surrounding environment from Mound airborne emissions. The total inventory of plutonium-238 was estimated to be 360 mCi distributed over 800 km². Radiation dose to the public from these plutonium levels or any resuspended plutonium, even from the areas of maximum concentration, is in compliance with the proposed EPA standard for transuranic elements in soil.

The study of the stability of plutonium contaminated sediments in the Miami-Erie Canal was conducted to determine the magnitude of airborne plutonium-238 that may be released from this sediment and the impact on the population of this airborne plutonium.

The study indicated that, although the contaminated sediments in the canal and pond area appear to con-

Pulse height analyses system to analyze for specific alpha emitting radionuclides.

tribute to airborne plutonium-238, the observed maximum monthly concentration of plutonium-238 in air is a small fraction of the DOE RCG. Dose equivalents, conservatively calculated from these actual data, are well within existing DOE Standards and proposed EPA Guidance.

Computer system to differentiate spectra in environmental sample analyses.

Summary

In 1977 Mound Facility operated well within DOE Guidelines and Standards. Mound continued to reduce total radioactive emissions in 1977 which demonstrates the effectiveness of such programs as the effluent reduction program and ALAP, as well as active management support.

Two major projects were undertaken to provide further assurance of Mound's monitoring program and to verify earlier evaluations. These projects were a determination of the stability of plutonium in the abandoned Miami-Erie Canal and a soil inventory. In both cases the conclusions from these projects verify earlier evaluations and demonstrate that the monitoring program is providing valid information.

All municipal drinking water supplies are in compliance with the new EPA drinking water standard. Some private wells have been brought into compliance, and it is anticipated that the forced water-turnover program will result in all private wells achieving compliance during 1978.

The effectiveness of our environmental program, as documented in this report, demonstrates Monsanto's corporate Environmental Protection Policy. This policy states that Monsanto will endeavor to protect the environment by: "establishing and maintaining discharge standards designed to protect the environment at all locations where Monsanto has operating control, and establishing and maintaining an environmental assessment at each plant site, measuring the effects of our presence on the surrounding environment."

Glossary

- Alpha Particles - A positively charged particle having the least penetrating power of emitted particles.
- Ambient - Surrounding environment.
- Background levels - The concentration of both radioactive and nonradioactive elements as they naturally occur in the environment.
- Beta Particles - A negatively charged particle more penetrating than alpha particles but less than gamma photons or neutron particles.
- Curie - A quantity of radioactivity equal to 3.7×10^{10} disintegrations per second.
- Effluent - The route by which pollutants flow into the environment (e.g., via water or stack discharges).
- ERDA - The U. S. Energy Research and Development Administration (formerly the Atomic Energy Commission).
- Gamma Rays - Electromagnetic radiation similar to ordinary radiowaves and visible light waves except frequencies are higher and they are not visible to the human eye.

Isotope

- One of two or more atoms with the same atomic number but with different atomic weights. For example, there are three isotopes of hydrogen (hydrogen, deuterium, and tritium). All act chemically like hydrogen, but have somewhat different physical properties.

Monitoring

- The observation of the amounts of material in a specific medium (e.g., air, water, or soil) involving the use of highly sophisticated instruments to find parts per billion, trillion, or even smaller traces.

Neutrons

- Neutral or uncharged particles.

Plutonium

- A radioactive man-made metallic element which emits alpha particles.

Relative penetration powers of alpha and beta particles, gamma rays, and neutrons through paper, aluminum, steel and lead.

- Polonium - A radioactive metallic element.
- Radioactivity - The spontaneous emission of particles or energy from an unstable atom.
- Radioactivity Concentration Guide - (RCG) Guidelines established by DOE for the maximum allowable concentration of a material in a given environment. The RCG is an extremely conservative guide to maintain the integrity of the environment.
- Radionuclide - A radioactive element.
- Radionuclide Concentration - The quantity of a radioactive element in the environment, either naturally existing or man contributed.
- Tritium - A radioactive isotope of hydrogen which emits beta particles.
- X-Rays - Same as gamma rays.