INDEPENDENT MONITORING OF THE WASTE ISOLATION PILOT PLANT

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Prior to the start of waste disposal operations, the Carlsbad Environmental Monitoring and Research Center, CEMRC, was established to provide independent monitoring of the potential radiological and chemical environmental impacts of the Waste Isolation Pilot Plant (WIPP), a deep geological repository for transuranic, defense-related, radioactive wastes. CEMRC makes public its analytical findings. The sampling program is extensive and includes WIPP exhaust air, ambient air, surface water, sediment, vegetation, soil, and humans (whole body counting). After almost fifteen years of successful waste disposal operations, the first accidental airborne radiation release from WIPP was detected above ground on February 14, 2014. The highest activity detected offsite was 115.2 μ Bq/m^3 for ^{241}Am and 10.2 μ Bq/m^3 for $^{239+240}$ Pu. The Am/Pu ratios in the detected releases were compatible with the known inventory of a specific waste stream in the repository from which at least one container is known to have breached due to chemical reactions that occurred inside that container. The concentrations detected in outside air were very small, localized, and well below any level of public-health or environmental concern. Prior to the release event the actinide sampling results were largely compatible with a weapons-testing origin, not significantly different from the levels found prior to the start of waste disposal operations. After the release event, externally detected actinide levels returned to those same pre-disposal ambient levels. WIPP has served the nation in the clean-up of its radioactive waste generated during the decades of weapons production and will continue to do so. CEMRC provides an important service as an independent monitor of WIPP's environmental impacts.

I.INTRODUCTION

The Waste Isolation Pilot Plant (WIPP) is a U.S. Department of Energy (DOE) transuranic waste repository for the permanent disposal of defense transuranic (TRU) waste from the nation's defense program. The repository is mined in the Salado Formation, a bedded salt formation of the Permian era, approximately 655 m (2150 ft.) below land surface. Located in southeast New Mexico about 26 miles from Carlsbad, the WIPP facility is the nation's first deep underground repository licensed to accept TRU waste, with activity concentrations of alpha-emitting isotopes >3700 Bq/g (> 100 nCi/g) and half-life >20 years. The repository, which opened in March 1999, has since disposed of more than 86,000 m^3 of TRU waste in more than 165,000 containers, cleaning up 22 generator sites nationwide. The WIPP is about half- full in terms of its legally defined capacity .

As shown in Figure 1, the WIPP repository layout currently has eight panels planned, each consisting of seven waste disposal rooms approximately 300 feet (91 meters) long and 33 feet (10 meters) wide. Seven of the panels have been excavated; and the first five have been closed and sealed from ventilation air. Panel 6 is full, but has not yet been sealed. Panel 7 is the current active waste disposal area. The underground area of the repository is strongly ventilated by drawing outside air through air intake shaft and then exhausting out to the environment through a exhaust shaft by exhaust fans located on the surface. Continuous Air Monitors (CAMs) underground are used to control whether or not the ventilation returning to the surface is passed through these large filter systems before it is released to the atmosphere. When the air monitors sense any contamination, the ventilation system is automatically switched to the filtration mode allowing air stream to pass through HEPA (High

Efficiency Particulate Absorption) filters bank before being put back into the environment.

From the standpoint of addressing operational and environmental risk, as well as public concerns, WIPP has extensive human health and environmental monitoring. In addition to the regulatory compliance monitoring, carried out by the Department of Energy's contractor, Nuclear Waste Partnership, (NWP, LLC), the facility is also monitored by an independent oversight organization, the Carlsbad Environmental Monitoring & Research Center (CEMRC), which is associated with the New Mexico State University. The CEMRC has been conducting independent health and environmental monitoring in the vicinity of WIPP since 1995. The primary goal of CEMRC is to develop and implement an independent health and environmental monitoring program in the vicinity of WIPP and make the results easily accessible to all interested parties. CEMRC is funded by DOE through a grant process that respects its independence in carrying out and reporting the results of environmental monitoring at and near the WIPP site. Under the CEMRC monitoring program, air, drinking water, surface water, soil, sediments, vegetation and the local population around the WIPP facility as well as air entering and exiting the WIPP underground, are regularly analyzed. Public access to the monitoring data and their ability to directly participate in CEMRC's whole body counting program provides a key element of trust and transparency for the public. The CEMRC program has capabilities to detect radionuclides rapidly in case of accidental releases from the repository or other portions of the facility during operations.

I.A. Radiation Release Event at the WIPP

The WIPP repository was sited successfully and had been operating safely and efficiently for nearly 15 years when there was an airborne radiation accidentally release from the repository on February 14, 2014. It was the first reported release at the WIPP, and it was first reported by CEMRC. The accident released moderate levels of radioactivity into the repository. The dominant radionuclides were americium and plutonium. A small, but measurable amount of radioactivity also escaped to the surface and was detected approximately 0.6 miles away from the facility. The release was detected by an underground CAM located near panel 7 where waste was being emplaced. As soon as CAM alarmed on the night of February 14 went off, the WIPP's ventilation system automatically switched to the filtration mode, reduced the flow, and directed the exhaust air stream through HEPA filter banks. This is intended to prevent any discharge into the atmosphere in the event of an accident involving waste underground. The ventilation system appeared, at the time, to be functioning as designed, so there was no reason to suspect any substantial release to the environment. Since this incident occurred during the night, only a few employees were at the WIPP site and no employees were in the underground. Personnel were frisked and none were reported to have external contamination; however, 21 personnel were found to have positive bioassay results for ^{241}Am. Follow-up testing results were below the detectable limits of the laboratory analysis, indicating that the radioactive isotopes were excreted from the body. No long-term adverse health effects are expected for these employees.

The radiation release was likely caused by a chemical reaction inside a TRU waste drum, which overheated, and ruptures underground, spilling radioactive materials into the repository. The drum that ruptured contains a mixture of nitrate salts and cellulose in the form of a wheat-based commercial litter used to absorb liquid waste and may have contributed to the chemical reaction that caused the radiation release at WIPP [1].

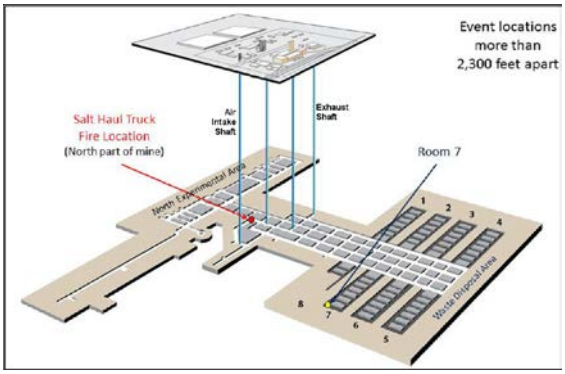


Fig. 1. WIPP Layout

Following the announcement of the underground radiation detection event by DOE, CEMRC used its fixed ambient air radiation monitors located at (1) Onsite, which is about 0.1 km northwest of the WIPP exhaust shaft, (2) Near Field, about 1 km northwest of the facility; and (3) Cactus Flats, about 19 km southeast of the WIPP site to ascertain whether or not there were releases to the ground surface [2]. An accelerated analysis of the underground air both before and after HEPA filters, from samplers at

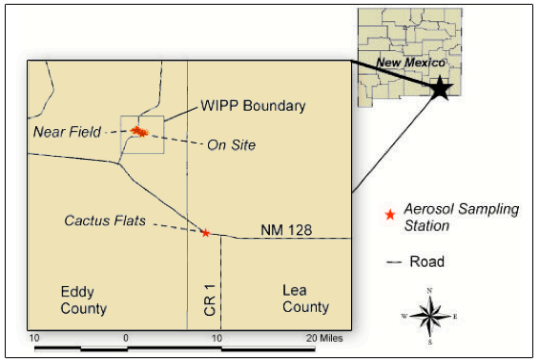


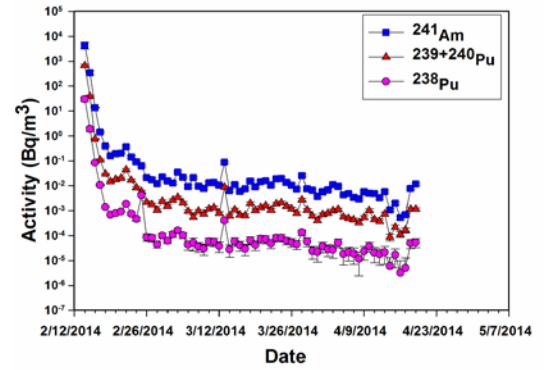
Fig. 2. Ambient Aerosol Sampling Locations

Station A (Pre-HEPA) and Station B (Post-HEPA) were also performed in order to determine the amount and type of radionuclides that were ultimately released into the environment.

Independent analytical results of air filters from sampling stations on and near the WIPP facility released by CEMRC on February 19, 2014 confirmed brief detection of trace amounts of ^{241}Am and $^{239+240}$ Pu at two sampling locations (Onsite and Near Field). The filters that were analyzed had been installed at these stations prior to the event, on February 11, 2014 and were removed on February 16, 2014. The Onsite filter was removed on February 18, 2014 because the site was not accessible until then. A third ambient air- filter station at Cactus Flats showed no detectable americium or plutonium.

The highest concentrations detected were 10.2 µBq/m^3 for $^{239+240}$Pu and 115.2 µBq/m^3 for ^{241}Am at the Onsite sampling Station, and 81.4 µBq/m^3 for ^{241}Am and 5.78 µBq/m^3 for $^{239+240}$Pu at the Near Field Station. The levels detected were very low, well below any level of public health or environmental contamination concern. There is no risk to anyone from contamination levels that were only detectable because of the sensitivity of modern radiation monitoring equipment. A week after the event, the radiation at these stations had decreased by a hundred times, and two weeks later the radiation levels at these stations were back to the pre-release levels and sometimes not even detectable, demonstrating no continuing or long-term environmental contamination.

Air concentration data collected during the first week of the accident were utilized to estimate the potential dose receive by the worker and public. The particles were conservatively assumed to be in the respirable range of 0.1 to 10 microns. Although the



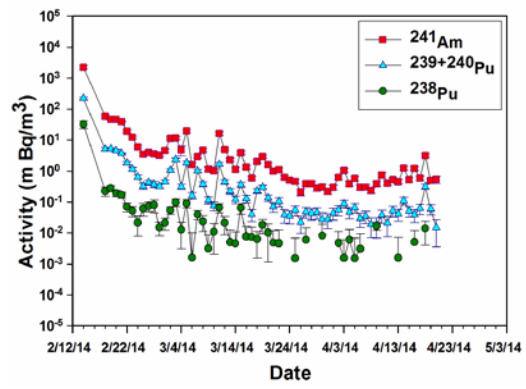


Fig. 3. The daily ^{241}Am, $^{239+240}$Pu and ^{238}Pu concentrations in Station A (Pre-HEPA, Top) and Station B (Post-HEPA, Bottom) filters following the February 14, radiation release event at the WIPP.

release was determined to be mostly Am and some Pu, 100% Pu was assumed because it has a higher ICRP 60 dose conversion factor and would result in a more conservative dose estimate. Dose assessment modeling from the release data showed a potential dose of less than one millirem at each of the environmental sampling locations (Hayes, 2014). A person receives about 10 millirems from a single chest x-ray procedure. The average person living in the United States receives an annual dose of about 620 millirem from exposure to naturally occurring and medical sources of radiation.

CEMRC also intensified analyses of the WIPP underground air, both just before and just after the HEPA filters, called Station A and Station B, respectively to show just how much radiation escaped the underground and how well the HEPA filters worked to prevent the underground radiation from reaching outside. As expected, the filter removed the morning after the event at Station A (before filtration) showed high levels of radioactivity, about 4337 Bq/m^3 of air for ^{241}Am and 671 Bq/m^3 of air for

$^{239+240}$Pu (Figure 2, left). The filter collected the very next day showed about 342 Bq/m^3 of air for ^{241}Am and 38.8 Bq/m^3 of air for $^{239+240}$Pu. By the morning of February 21, these levels had dropped to 0.2 Bq/m^3 of air for combined Pu and Am.

The amount of radiation measured on Station B (Post -HEPA filtration) were much lower, about 2.3 Bq/m^3 of for ^{241}Am and 0.22 Bq/m^3 for $^{239+240}$Pu (Figure 2, right) when it was collected on February 18, almost four days after the release. Given that this particular filter remained in the sampler from the time of the underground radiation detection event until four days after the event, this filter was representative of the total amount of ^{241}Am and $^{239+240}$Pu, and ^{238}Pu that may have been released into the environment. By February 21, a Station B sample had only about 0.43 Bq/m^3 of combined Pu and Am.

Based on the CEMRC analyses of the Station B samples measured over the first week of the event, and accounting for the total air flow, the source term of contamination defined as the amount of airborne radioactivity that ultimately escaped from the repository was calculated as 2.53×10^7 Bq of ^{241}Am and 2.48 $\times10^6$ Bq of $^{239+240}$Pu. In terms of radiological risk at or in the vicinity of the WIPP site, the increased risk from the WIPP releases is exceedingly small, approaching zero.

In addition, other environmental samples such as soil, sediment and surface water samples were also collected from within a 100-mile radius of WIPP to assess the regional impact of the February 14 radiation release event to the local environment, if any. The $^{239+240}$Pu concentrations in the soil samples measured ranged from 0.04 to 0.28 Bq/kg, while for ^{241}Am the range was from 0.06 to 0.14 Bq/kg. No detectable concentrations of ^{238}Pu were observed in any of the soil samples analyzed. The concentrations of these nuclides are comparable to the historical data recorded for these areas prior to arrival of TRU wastes in the WIPP and are typical "background soil" values. As in the case of soil, levels of radionuclides in sediment samples from the three reservoirs in the vicinity of the WIPP site following the February 14 radiation release event showed no detectable increases above those typical of previously measured natural variation. The concentrations range of $^{239+240}$Pu (0.14-0.27 Bq/kg) and ^{241}Am (0.09-0.18 Bq/kg) fell within the range of the baseline phase data for the sediment samples.

As expected, none of these radionuclides were detected in the surface water samples taken from these same three reservoirs. These results were reported to the public by CEMRC as they were obtained through analyses.

II.CONCLUSIONS

The accelerated air monitoring campaign, which began on February 14, 2014 shows that except for the brief detection of americium and plutonium in the nearby ambient air samples, there is no increase in radiological contaminants that could be attributed to the recent radiation release from the WIPP in the wider region. The radiation levels detected in the ambient air samples in the vicinity of the WIPP site were very small. In terms of radiological risk at or in the vicinity of the WIPP site, the increased risk from the WIPP releases is exceedingly small, approaching zero. The release of any radioactivity has the potential to alarm portions of the general population who do not understand the difference between actual risk and perceived risk. CEMRC's independence and its extensive monitoring program and constant public engagement provide confidence to the local public in the aftermath of the WIPP release event. As an independent monitoring organization CEMRC proved its value in terms of providing independent monitoring results to the local and wider populations, and in terms of interpreting the detected values and assuring these populations there would be no harmful effect on their health or their environment. The CEMRC independent monitoring and communications model perhaps ought to be considered as part of the consent-based siting process for new nuclear facilities, especially nuclear waste repositories, elsewhere in the nation and world.

ACKNOWLEDGEMENTS

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