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## The role of nuclear forensics in determining contamination sources

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The Waste Isolation Pilot Plant (WIPP) is a radioactive waste repository operated by the U.S. Department of Energy (DOE) for the permanent disposal of defense transuranic (TRU) and TRU-mixed wastes (wastes that also have hazardous chemical components). Located near Carlsbad, New Mexico, the WIPP facility is the world's first deep geological disposal facility licensed to accept TRU waste having alpha activity > 37000 Bq/g for radioactive isotopes with atomic numbers higher than uranium and half-life greater than 20 years. Since the facility opened for operations in March 1999, WIPP has disposed of more than 91,000 m<sup>3</sup> of TRU waste in more than 170,000 containers, allowing the remediation of 22 generator sites nationwide.

Four years ago, the WIPP experienced its first minor accident involving a radiological release. On February 14, 2014, a waste container in the repository underwent a chemical reaction that caused the container to over-heat and breach, releasing some of its contents into the underground. A small amount of radioactivity escaped through the ventilation system and was detected above ground. It was the first unambiguous release from the WIPP repository. Soon after the radiation release event, the Department of Energy-Office of Environmental Management appointed an Accident Investigation Board (AIB) to determine the cause of the radiation release. The AIB used both chemical and radiological forensic analyses of the materials ejected from the drum to pinpoint the exact location and cause of the drum breach. To complement the AIB investigation, the DOE also chartered a Technical Assessment Team (TAT) of specialists to perform a comprehensive, independent scientific review of the mechanisms and chemical reactions that may have resulted in the release of radioactivity. The Carlsbad Environmental Monitoring and Research Center (CEMRC), an independent radiological monitoring organization, also performed extensive monitoring of the above ground environmental samples. The CEMRC's environmental samples and the TAT samples from repository were examined to determine isotope ratios for comparison with what was known of the potential source materials in the drum believed to be the source of contamination. The TAT, the AIB, and CEMRC interpreted the isotope ratios found as providing forensic evidence of the contamination source. This paper discusses the difficulties and uncertainties inherent in making definitive forensic claims based on the variability in the key ratios of the breached drum and the sample media collected from the WIPP underground as well as those collected outside the repository. The TAT and AIB also relied on a photographic examination of the waste in the room where the release occurred. CEMRC's analytical results independently support the TAT and AIB conclusions. Following a lengthy recovery process the facility recently resumed waste disposal operations.

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