RADIOLOGICAL SAFETY AT A TRU REPOSITORY

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ABSTRACT

The Waste Isolation Pilot Plant (WIPP), located in Carlsbad, New Mexico, USA, is a deep geologic repository for (TRU) wastes. Although the TRU waste shipping, handling, and disposal processes do not involve significant levels of radiation exposure, protecting workers, the public, and the environment from radiological harms has always been a high priority at WIPP. "Start Clean and Stay Clean" is the operational philosophy of the repository. Before the repository was opened for waste disposal, extensive environmental measurements were performed to characterize the radiation background of the disposal site and its surrounding areas. Radiobioassay analyses were also conducted to determine the baseline radioactivity in WIPP workers and random samples of the general population in Carlsbad. ALARA (maintaining radiation doses at levels that are as low as reasonably achievable) has been an integral part of WIPP facility design and operational processes. The repository is continuously striving for radiation exposure minimization. This paper describes the safety measures of the TRU waste transportation process, baseline radiobioassay and environmental background measurements. It also discusses the radiological control and environmental protection programs during operational phase. The effectiveness of these programs is evaluated, based on the radiological safety results since the WIPP began its disposal operations in March 1999.
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INTRODUCTION

The Waste Isolation Pilot Plant, or WIPP, is designed to dispose of TRU waste left from the research and production of nuclear weapons. Located in southeastern New Mexico, 42 km east of Carlsbad, project facilities include disposal rooms excavated in an ancient, stable salt formation 650 m underground.

TRU waste is defined as "waste containing more than 100 nCi of alpha-emitting TRU isotopes per gram of waste, with half-lives greater than 20 years." TRU waste is produced during nuclear fuel assembly; nuclear weapons research, production, and cleanup; and reprocessing of spent nuclear fuel. It has been estimated that approximately 60% TRU wastes are mixed wastes, since they contain both radioactive components and chemically hazardous materials. Currently the WIPP facility is designed to dispose of approximately 1.75×10^5 m^3 of TRU waste in its 35 years of operations that began in March 1999.

The majority of the wastes to be disposed of at the WIPP are contact-handled (CH) TRU wastes. Dose rates on the surface of CH TRU waste containers are limited to 200 mrem/hr. Although some remote-handled (RH) TRU waste containers may have a surface dose rate of as high as 1000 rem/hr, the WIPP can accept no more than 5 % by volume of RH TRU waste with a surface dose rate above 100 rem/hr. Despite the fact that the transportation, handling, and disposal

processes of TRU wastes do not involve possibilities for significant radiation exposure, extensive precautions and effective safety measures are taken to ensure radiological safety to workers, the public, and the environment(1).

Safety Measures for TRU Waste Transportation

To track and communicate with vehicles transporting radioactive and certain other types of hazardous wastes, DOE has developed the Transportation Tracking and Communication System, known as TRANSCOM. All TRU waste shipments to the WIPP site are to be tracked through this system. TRANSCOM uses satellite communications and computer networks to track shipments from start to end.

TRU waste shipments are continuously tracked by two satellites. The vehicle position is transmitted to a satellite receiving station and relayed to the TRANSCOM control center, where the information is displayed on computer-generated maps. The control center is to house and maintain a database containing scheduling, routing, shipment content, and emergency response information about each shipment to the WIPP. Federal, state, and tribal officials are to have access to this database. If the truck gets off the designated route or stops moving without explanation, control center operators would follow up to identify and solve the problem as necessary.

Drivers and others with access to the system can communicate with one another through the TRANSCOM central operator. State police, for example, can transmit a message to drivers through the TRANSCOM central operator about driving conditions along a route, and drivers, in turn, can respond through the operator.

The DOE Albuquerque Field Office Emergency Operations Center is to be in charge of any incident involving a shipment of TRU waste, regardless of where the incident occurs. The initial response to an incident would most likely come from local "first responders," such as state or local police departments, fire departments, and other emergency response personnel. First responders are trained in material identification, regulations, response procedures, and personal protection. In the event of an incident, local responders would usually contact state public health agencies, and, if necessary, the first response team would be followed by the appropriate DOE Radiological Assistance Team and eventually augmented by the DOE Carlsbad Area Office's Incident/Accident Response Team. The States and Tribal Education Program (STEP), which began in 1988, offers courses on responding to potential incidents involving shipments of waste to the WIPP. In 1993, the Occupational Safety and Health Administration reviewed and certified the STEP courses. Through STEP, DOE has trained more than 11,000 emergency response personnel.

WIPP Radiobioassay Program

Radiological control policy at the WIPP emphasizes the prevention of radioactive contamination and airborne radioactivity. No workers are expected to receive internal exposure during normal operations(1). External doses to workers, although expected to be minimal, are routinely

measured with thermoluminescent dosimeters that have been accredited by the DOE Laboratory Accreditation Program.

Internal exposure is only possible in the event of a contamination incident. If contamination is found above pre-established levels or if a release of radioactive material is known or suspected radiological work is immediately secured until an assessment of the situation is made.
In order to ensure removable contamination is detected in a timely manner, monitoring is done at key points during work processes. To verify the absence of airborne radioactivity, workplace air monitoring is performed using three types of monitoring devices: process air samples, fixed air samplers, and continuous air monitors.

For the purpose of dosimetry monitoring, WIPP site employees are assigned to exposure group classifications based on their potential for exposure to radioactive materials. Radiobioassay monitoring is a key element in an internal dosimetry program. Baseline radiobioassay measurements are conducted to detect and document the amounts of radioactivity inside the body of workers prior to performing TRU waste handling and disposal activities. *In vivo* radiobioassay measurements (whole-body counting and lung counting) and *in vitro* (urine analysis) must be completed prior to performing radiation work(2).

The WIPP has also established a confirmatory radiobioassay monitoring program to assess the effectiveness of the radiological control program. The confirmatory program involves sampling a small fraction of a worker group at a relatively constant rate over a one-year period.
The program includes in vivo and in radiobioassay measurements and are primarily designed to detect isotopes such as ^{238}Pu, ^{239}Pu, ^{241}Am, ^{90}Sr, and ^{137}Cs that are expected in the TRU wastes. The frequency and types of radiobioassay measurements for radiation workers are conducted according to a schedule determined by the potential of exposure(3).

If an incident results in the release of radioactive material, those workers who are suspected of having an intake will have samples collected. Sample types may include urine, feces, or other sample types as directed by the WIPP Radiological Control manager. *In vivo* counting may also be requested. The action levels for incident sampling are as follows(4):

- Suspected exposure to airborne radioactivity potentially in excess of the DAC.
- Any facial contamination or contamination around skin break, abrasions, burns, or on nasal wipe will be monitored for internal exposure as directed by the Radiological Control Manager.
- Members of the general public, minors and/or declared pregnant workers who are in the vicinity of any incident where an intake of radioactive material may have been possible will be monitored for internal exposure as directed by the Radiological Control Manager.
- Any other situation in which internal exposure is possible as determined by the Radiological Control Manager.

Environmental Monitoring

The WIPP Environmental Monitoring Program has been established to comply with applicable environmental protection regulations(5,6). The WIPP initiated environmental baseline

measurements in 1975. Prior to the beginning of operational phase environmental monitoring in March 1999, extensive measurements had been completed and valuable data obtained during the baseline environmental monitoring period of over a decade(7,8).

The WIPP Environmental Monitoring Plan(9) and the Environmental Protection Implementation Plan(10) provide schedules and guidelines for monitoring a comprehensive set of parameters to detect and quantify present or potential environmental impacts. Radiological surveillance covers an extensive geographic area that includes nearby ranches, villages, and cities.

The radionuclides present in the environment can give both internal and external doses. Internal dose is caused by the intake of radionuclides in humans. The only radiation dose received by the general public living in the vicinity of the WIPP site has been that associated with background radiation. The major routes of intake of radionuclides in the general public are ingestion and inhalation. Ingestion includes the intake of the radionuclides from drinking milk and water and consuming agricultural and meat products. Inhalation includes the intake of radionuclides through breathing dust particles.

Seven locations around the WIPP site: Southeast Control (SEC), Carlsbad (CBD), Mills Ranch (MLR), Smith Ranch (SMR), WIPP East (WEE), WIPP South (WSS), and WIPP Far Field (WFF) for airborne particulate sampling. Weekly samples are collected on three Whatman micro fiberglass filters of 4.7 cm diameter. The samples were collected at a height of 1.5 to 2 m. Filters were counted for gross alpha and beta after being stored for five to seven days in the laboratory to allow the short-lived radon daughters to decay.

Representative groundwater samples are collected twice a year from seven wells located around the WIPP site. Approximately 4000 L of water is pumped out of these wells before 40 L water samples are collected at depths ranging from 180 to 270 m from six wells (WQSP-1 to WQSP-6), and from a depth of approximately 70 m from well WQSP-6A. Approximately 8 L of water of each sample is used for the determination of radionuclides of interest. The rest is used for determining non-radiological analyses.

Surface water sampling occurs at 11 locations. Samples are collected annually. Polyethylene containers are rinsed several times with the water of the sampling location before approximately 4 L water samples are collected for analysis. The samples are labeled and acidified with concentrated nitric acid to a pH value of 2 immediately after collection.

Soil samples are collected from six locations: MLR, SEC, SMR, WEE, WFF, and WSS. Samples from each location are taken at three depths: 0-2 cm (surface soil), 2-5 cm (intermediate soil), and 5-10 cm (deep soil). Measurements of radionuclides at various depths provide information the vertical distribution profile of radioactivity in the soil system.

Sediment samples are taken from 12 locations, mostly from the same water bodies where surface water samples are taken. Samples are collected in certified-clean containers from the top 15 cm of the sediment of each water body for radionuclide analysis.

The uptake of radionuclides by plants and vegetation is an important factor in estimating the intake of individual radionuclides in humans through ingestion. Vegetation samples are collected for radionuclide analysis from the same locations for soil sampling.

Soft tissues of game animals (deer, quail, rabbits, etc.) are periodically sampled and analyzed for information pertaining to the food chain pathway. Fish samples from three locations of the Pecos River are collected and analyzed annually.

All laboratory results are verified and validated before they are accepted and used for Environmental Monitoring evaluation and reports.

Operational Phase Radiological Safety

The WIPP radiological safety programs had successfully passed the scrutiny during a series of internal and external Operational Readiness Reviews. The project had successfully completed the shipping, handling, and disposal of 44 TRU waste shipments (17 from Los Alamos National Laboratory, 23 from Rocky Flats Environmental Technology Site, and four from Idaho National Engineering & Environmental Laboratories) during 1999. Shipment tracking was effective and safety records excellent. This demonstrates that the safety measures have worked. Emergency response to transportation incidents was not needed but the project has been conducting refresher training and drills to ensure competence of the responders.

Effectiveness the WIPP site radiological control program is substantiated by the fact that, during the TRU waste handling and disposal processes: a) no contamination incidents, b) worker radiobioassay results do not indicate any intake, and c) environmental monitoring results are statistically indifferent from baseline data.

As the WIPP proceeds further into its operational phase, project workers are gaining more experience in all aspects of waste transportation, handling, and disposal activities. The valuable experience will be very useful to the project's efforts in continuous safety improvement. Lessons learned from TRU waste operations will also help other programs in the design or fine-tuning of waste management facilities and processes.

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