

# THE HERFA-NEURODE HAZARDOUS WASTE REPOSITORY IN BEDDED SALT AS AN OPERATING MODEL FOR SAFE MIXED WASTE DISPOSAL\*

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## ABSTRACT

For 18 years, the Herfa-Neurode underground repository has demonstrated the environmentally sound disposal of hazardous waste in a former potash mine. Its principal characteristics make it an excellent analogue to the Waste Isolation Pilot Plant (WIPP). The Environmental Protection Agency has ruled in its first conditional no-migration determination that it is reasonably certain that no hazardous constituents of the mixed waste, destined for the WIPP during its test phase, will migrate from the site for up to ten years. Knowledge of and reference to the Herfa-Neurode operating model may substantially improve the no-migration variance petition for the WIPP's disposal phase and thereby expedite its approval.

## INTRODUCTION

Before any category of hazardous materials is disposed of permanently in a mined geologic repository, a reasonable degree of certainty needs to be established that these materials will not return to and contaminate the biosphere. To achieve this degree of confidence, theoretical calculations are performed, expected repository performance is modeled on computers, and experiments are conducted by practicing with scaled-down versions of the full size repository.

An experimental or test phase to validate the assumptions, calculations, and models needs to precede full-scale operations. During this test phase, waste is not yet disposed of in a permanent configuration; rather, it is stored in a retrievable manner. Valuable additional validation may be obtained by comparing the features of a planned repository to those of an already existing and successfully operating analogue. The first geologic repository for transuranic mixed waste, just about to enter its test phase, may thus be compared with the only operating hazardous waste repository in bedded salt, the Herfa-Neurode disposal facility in Germany.

## MIXED WASTE STORAGE AT THE WIPP

In this discussion, the mined geologic repository during its test phase is the Waste Isolation Pilot Plant (WIPP). The WIPP, near Carlsbad, New Mexico, is a congressionally mandated research and development facility, chartered to demonstrate the safe disposal of radioactive wastes resulting from the defense activities and programs of the United States. The WIPP will serve as a pilot plant for approximately the first five years of its operation, i.e., the test phase. The wastes to be emplaced during that time will be stored

and therefore will be fully retrievable, pending a decision whether to proceed with permanent disposal operations.

Most of the wastes to be shipped to the WIPP will be radioactive-mixed wastes, composed of mixtures of transuranic isotopes and of chemical constituents which are listed or otherwise identified as hazardous in the Resource Conservation and Recovery Act (RCRA). The requirements of this act also apply to radioactive mixed wastes and therefore to the WIPP. The RCRA prohibits the land disposal of untreated hazardous waste unless it is first demonstrated to a "reasonable degree of certainty that there will be no migration of hazardous constituents from the disposal unit as long as the waste remains hazardous." If this can indeed be demonstrated to the satisfaction of the Environmental Protection Agency (EPA), this agency, upon examination and approval of a properly prepared and submitted petition, may issue a no-migration determination.

The conditional no-migration determination issued to the WIPP allows just the test phase to proceed. It is valid for up to ten years. That amount of time will accommodate the planned experiments and the retrieval of the waste if the results of the test phase are unfavorable. To obtain the conditional no-migration determination, the WIPP had to demonstrate with a reasonable degree of certainty that no hazardous constituents will migrate from its confines for at least ten years. This demonstration fills eight volumes, occupying 330 mm (13 inches) of shelf space.

## HAZARDOUS WASTE DISPOSAL AT HERFA-NEURODE IN COMPARISON

An alternate but far less cumbersome path might have led to the same result. It would be based on reference to an analogue which closely resembles the WIPP during its test phase. Fortunately, such an analogue exists. It is the underground waste disposal facility - in German: Untertage

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Deponie (UTD) - located at Herfa-Neurode near Bad Hersfeld in the Federal Republic of Germany. The UTD was established in 1972 by the Kali & Salz AG, the preeminent German potash producer which is principally owned and controlled by the multi-national chemical concern BASF. The repository consists of a mined-out section of a potash mine, separated by a distance of about 10 km from present mining operations. It is located in rocks of the same type (bedded salt) and of the same geologic age (late Permian) as the WIPP, and it lies at a comparable depth (705m v. 655m). Figure 1 shows the comparative stratigraphy of both facilities. Other similarities include regional mining history and experience, general geological structure, and distance from the nearest subsidence zone. Dissimilarities weigh, almost without exception, in favor of the WIPP: salt overburden (175m v. 400m), age of igneous intrusives in the vicinity (15m.y. v. 35m.y.), total salt thickness (270 m v. 600m), and engineering design (potash mining v. dedicated, specifically engineered facility). These and other characteristic attributes are compared in Table I.

**SIGNIFICANT DISSIMILARITIES**

A few dissimilarities require additional comment.

1. Pockets of interstitial gas under high pressure have been encountered in the vicinity of both repositories. Near the UTD, the gas, mostly CO<sub>2</sub>, is thought to de-

rive from 15 million year-old basaltic intrusives. The salt has, therefore, been impermeable even to gas for at least 15 million years. The gas encountered in the WIPP and in neighboring potash mines consists mostly of N<sub>2</sub>. It is thought to be the remnant either of the Permian atmosphere or of organic material trapped during deposition of the enclosing salt. The WIPP salt has, therefore, been impermeable even to gas for possibly up to 225 million years.

2. The potash mineralization at the UTD consists of hartsalz, i.e., a mixture of kieserite, sylvite, and halite with some anhydrite. Convergence rates in hartsalz are slower than in the comparatively pure and mineralogically simple halite at the WIPP. As a result of this difference, disposal rooms at the UTD have stayed open for 30 to 60 years, and complete closure is expected over geologic time. Waste at the WIPP needs to remain retrievable for up to ten years. The WIPP is designed for a total operational life of about 25 years. Complete closure and waste encapsulation is expected within 75 to 150 years. Thus, the waste will be permanently removed from the biosphere much earlier than at the UTD.

3. A large portion of the waste destined for the WIPP contains organic polymers such as polyethylene and polyvinyl chloride. Although these materials are not

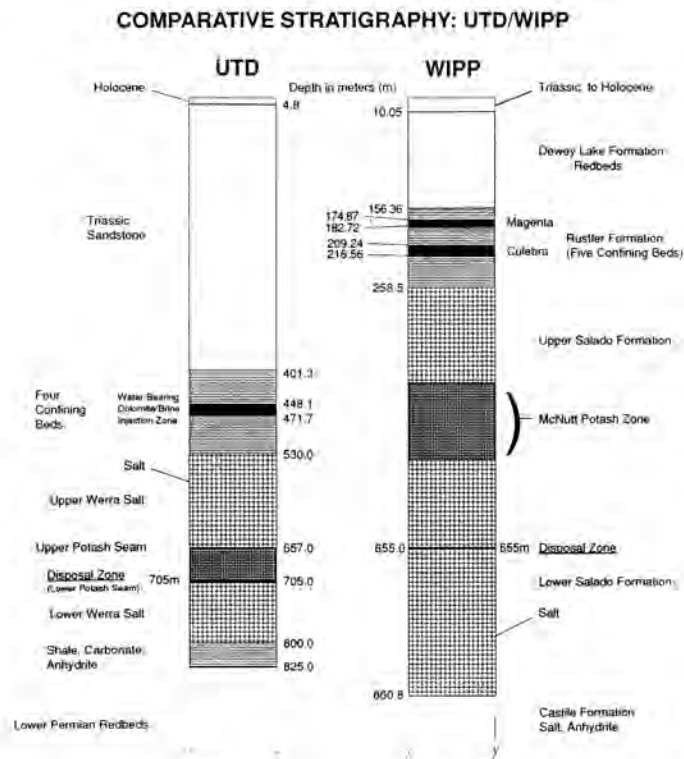


Fig. 1. Comparative stratigraphy UTD/WIPP.

TABLE I

Comparative Characteristics:

	UTD	WIPP
Repository Medium	bedded Salt	bedded Salt
Age of Geologic Formation	late Permian	late Permian
Regional Mining History	90 y.	60 y.
Total Salt Thickness	270 m.	600 m.
Depth to Repository Horizon	705 m.	655 m.
Salt Overburden	175 m.	400 m.
Mine Temperature	25-30°C	23-31°C
Distance from Subrosion Zone	4 km	4 km
Age of Gas Inclusions	≥15 m.y.	≤ 225 m.y.
Regional Dip	2-3°	2-3°
Mineralogy	complicated	simple
Known Geologic Discontinuities	yes	no
Room Height	2.5-3.5 m.	4 m.
Room Width	14 m.	10 m.
Engineering Design	former mine	designed repository
Waste Category	hazardous only	mixed
Organic Waste Component	negligible	significant
Time to Room Closure	geologic	75 - 150 y.
Minimum Time for Retrieval	≥100 y.	10 y.
Expected Operating Life	> 50 y.	25 y.
Successful Disposal Record	18 y.	to be established

normally readily biodegradable, radiolytic processes may increase their rate of degradation. Microbes in the WIPP environment will also cause some biodegradation of waste containers, backfill, and waste, altering the chemistry of the repository.

In contrast, the UTD accepts almost exclusively inorganic water-soluble wastes. In the long term, no waste that could be incinerated will be allowed to be disposed of underground. Thus, the UTD does not have to face the issue of gas generation and of potential overpressurization of the repository. This issue does not affect the test phase of the WIPP either, but it needs to be resolved before disposal operations commence.

- The UTD has successfully disposed of hazardous waste (a total of approximately 1 million tons) for 18 years. No migration away from the repository has been detected during this time, and none is expected in the future. All of the UTD's waste, however, will retain its hazardous properties. Waste destined for the WIPP, in contrast, will lose a significant portion of its

hazardous characteristics as the radioactive component decays and eventually becomes harmless.

## CONCLUSION

No hazardous waste constituents have migrated from the UTD Herfa-Neurode for 18 years. No migration from the WIPP is conceivable during its test phase. The Herfa-Neurode hazardous waste repository presents an excellent analogue for mixed waste storage and disposal at the WIPP.

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