The Salt Defense Disposal Investigations (SDDI): Current Status and Future Plans – 14486

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ABSTRACT

Results are presented from simulations performed in support of the Salt Defense Disposal Investigations (SDDI), a field test designed to confirm the behavior of bedded salt as a geologic disposal medium for defense high-level waste (HLW) and DOE-managed spent nuclear fuel (SNF), emplaced on disposal room floors and shielded with run of mine salt. Recent activities in the following areas are summarized: radioactive waste inventory and heat load projections; potential repository design options; and current status of the field test project. We conclude that there is a continued need for research into the potential performance of a repository for heat-generating waste in bedded salt and a need to better understand the integrated response of the salt at the field scale. In particular, it is important to investigate the evolution of the small but non-negligible quantities of water within the salt as the heat from radioactive decay diffuses into the surrounding geologic medium. Recent coupled model developments illustrate the possibility of a heat pipe that redistributes brine away from waste packages, where vapor then condenses across the boiling front within the run-of-mine salt, dissolving the granular salt until once again saturated, resulting in redistribution of salt within the run-of-mine salt backfill. Detailed test planning for the field-scale heater test is underway using pre-test predictions to provide design information for heating canisters and instrumentation, as is the mining and characterization of a test bed in the underground at WIPP. The paper describes the test itself, along with the suite of physical measurements that are currently planned.

INTRODUCTION

Salt formations are an excellent candidate as a geologic repository because long term plastic deformation encapsulates the waste, thereby potentially relaxing the need for long-term integrity of the waste package. Salt also exhibits much higher thermal conductivity than other crustal rocks, in principle allowing more heat-generating waste emplacement for an equivalent peak formation temperature. For these reasons, the US

Department of Energy has embarked on a generic study to assess the efficacy of salt as a disposal medium for heat-generating nuclear waste [1]. The goal of the research effort is to identify potential gaps in knowledge that must be filled in order to build a credible safety case for the disposal of high-level waste in salt, generated either from civilian nuclear power generation or from nuclear weapons R&D and production activities. Previous studies have been conducted on the thermal effects with an emplacement concept using canisters in pre-drilled boreholes in intact salt (floors and walls). But few studies have been conducted with an emplacement concept of canisters within open disposal rooms (on the floor), using run of mine salt for operational radiation shielding, especially in an evaporate formation.

Among the research goals of the program is the investigation of the behavior of salt when subjected to thermal loads like those that would be present in a high-level waste repository. This research builds upon results of decades of previous salt repository program efforts in the US and Germany and the successful licensing and operation of a repository in salt for disposal of defense transuranic waste [2], [3], [4]. Laboratory tests being conducted to measure salt and brine properties across and beyond the range of possible repository conditions [5]. Coupled numerical models are being developed to describe phenomenology (thermal, mechanical, and hydrological) observed in the laboratory tests and at the field scale [6], [7].

Along with these studies, planning has begun for a field test to investigate many phenomena that have been variously cited as potential issues or uncertainties for disposal of thermally hot waste in salt. The field heater tests will be designed to confirm the technical basis for placing heat-generating radioactive waste in a salt repository, and the results will be shared with the scientific community and other interested parties in support of a consent-based process. The field test will provide answers to gaps in knowledge of salt performance at elevated temperatures.

The inventory of high-level radioactive waste currently in need of disposal in the U.S. comes from two origins: 1) defense-generated wastes, consisting of high level waste (HLW) and spent nuclear fuel (SNF) generated from the nation's nuclear weapons and naval propulsion programs; and 2) civilian waste consisting primarily of SNF from the nation's nuclear power reactors. Previous studies examined a disposal concept and field test suitable for managing the high heat loads expected from commercial SNF and/or future waste forms produced in a reprocessing scenario [2], [8], [9]. The focus of this paper is defense wastes, which in general emit lower heat loads per canister. For this reason, a modified disposal concept and field test in salt have been developed that specifically target the defense waste inventory [10].

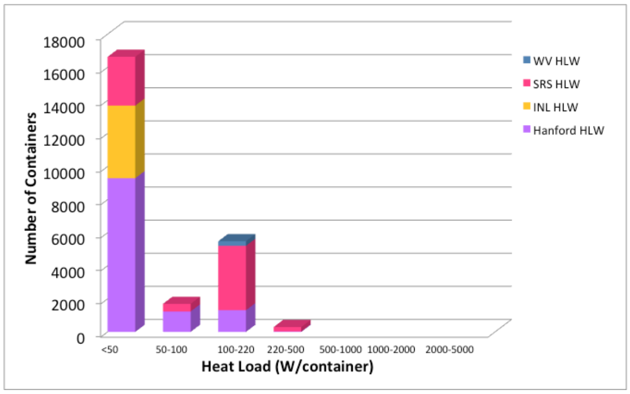
The paper summarizes information on the heat loads of the various waste streams, develops a disposal concept applicable to the defense waste inventory, and then describes a thermal test designed to confirm our understanding of the behavior of the system under conditions that would be experienced in an operating salt repository.

U.S. HIGH-LEVEL WASTE INVENTORY AND HEAT LOADS

A repository design concept depends on the physical, radiochemical, and thermal characteristics of the waste as prepared for disposal. This section provides a brief summary of the thermal characteristics of each type of waste for the purposes of framing the subsequent discussion on a salt repository design concept for these wastes. A more complete discussion is found in Reference [11].

Defense-Generated Wastes. DOE-EM currently manages the HLW generated from the reprocessing of nuclear fuel used for defense purposes as well as DOE-owned SNF, which includes fuel from reactors used for research and defense purposes, fuel from the U.S. Naval propulsion program, and some recovered damaged fuel from the Three Mile Island accident that the U.S. government manages in long-term storage. HLW in the form of borosilicate glass waste forms has already been prepared at the Savannah River Site (SRS) and is awaiting disposal in a high-level waste repository. Large quantities of high-level waste also exist in various liquid and solid forms at SRS, Hanford, and Idaho National Laboratory (INL). HLW resulting from reprocessing activities at West Valley, New York, also awaits disposal [12].

The heat loading varies over a significant range over the spectrum of defense-generated waste considered for disposal (see Figure 1 for DOE-owned HLW and Figure 2 for defense SNF). Thus, a repository disposal concept for these wastes must accommodate a range of waste package dimensions and heat loads, which places a premium of disposal methods that are adaptable to a diverse set of waste package properties. With respect to the range of thermal loads, the vast majority waste containers would emit heat of 1000 W/container or less, with a large portion of the inventory at 200 W/container or less.



Note: The term “container” refers to a single HLW canister.

Figure 1. Heat loads for the current and planned DOE-owned HLW inventories. Adapted from Reference [12].

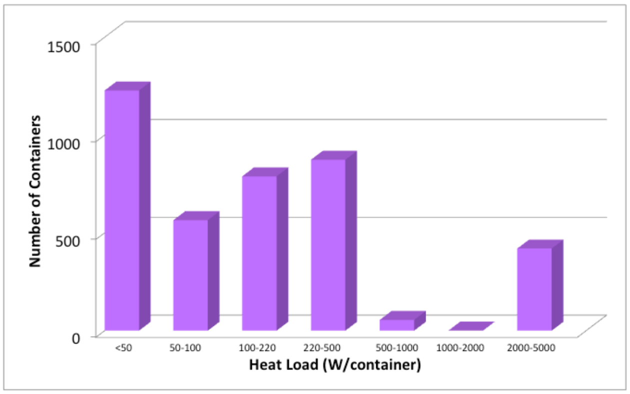


Figure 2. Heat loads for the defense SNF inventory Adapted from Reference [12].

Civilian Wastes. Civilian waste consists primarily of SNF from the nation’s nuclear power reactors, stored temporarily by the utilities at the site of currently or formerly operating nuclear power plants. The Yucca Mountain EIS [13] categorized the heat loads of disposal packages for the Yucca Mountain repository on the basis of average heat loads across a wide range of fuel burnups and ages. The analysis was designed to enable the average heat load across the repository to be represented, to specify the configuration of disposal packages to be disposed of in the repository, and to ensure that the heat loads were reasonably bounding. Given this purpose, the EIS specified a total of 4239 containers of PWR SNF with 21 fuel assemblies per container, and 2784 containers of BWR SNF with 44 fuel assemblies per container. The average heat loads were 8800 W/container for the PWR SNF, and 6200 W/container for the BWR SNF. However, there is broad variability in the heat content of the nation's spent fuel inventory, including lower burnup fuels for which these heat loads would be bounding. Furthermore, if a new repository program leads to a reconsideration of the number of fuel assemblies packaged in an individual disposal container, there is a possibility of even smaller numbers of fuel assemblies and lower per-package heat loads.

Thus, considering both defense-generated and civilian wastes, there is potentially a very broad range of heat loads per package, depending on the waste type and mode of packaging of the waste, especially if repackaging of commercial SNF is adopted. Nevertheless, there is a fairly distinct difference in heat loads of defense-generated versus civilian wastes, which argues for a staged approach in which salt R&D to investigate the impact of heat initially targets the lower heat loads representative of defense waste, with perhaps some applicability to civilian waste as well. Such a strategy also allows for a stepwise learning process in which field-scale investigations at intermediate heat loads, which are necessary to build confidence in our understanding and models of repository behavior, will be invaluable if subsequent high-heat-load experiments are performed. In the present study, we discuss a repository design and field thermal testing program to accomplish the first phase of this strategy, namely the intermediate heat load regime, nominally at per-package heat loads of about 1000 W/container or less.

THE IN-DRIFT SALT REPOSITORY DISPOSAL CONCEPT

Previously, the in-drift disposal method has been introduced in which the waste canisters are placed along the length of a drift, one at a time, and covered with salt backfill for shielding [11]. This efficient in-drift emplacement configuration will maximize the utilization of the valuable repository real estate, eliminating wasted or empty space. This section briefly summarizes this disposal concept.

The in-drift emplacement design concept is based on a disposal strategy in which a series of repository panels, each of which is a subsurface cell consisting of individual drifts, are constructed underground. As shown in Figure 3, a depiction of two drifts in such a system, mining advances one drift ahead of the drift where disposal operations are being conducted. Retreat waste emplacement is conducted in the open disposal drift by bringing in one canister at a time using a remotely operated vehicle (ROV) and placing it perpendicular to the drift, on the floor. The single canister (or multiple canisters) is covered with run-of-mine (ROM) salt backfill for shielding using freshly mined ROM salt from the next adjacent disposal drift. The backfill strategy and the target areal heat loading desired will dictate the location of the next canister (typically 1 – 5 foot spacing). The process is repeated until the entire drift is filled and the backfill is emplaced. This use of ROM salt for operational shielding minimizes the volume of waste rock that must be removed to the surface and subsequently managed as solid "waste".

Backfill placement can be adjusted such that the canister spacing could be varied to accommodate a variety of thermal areal densities (W/m^2). Although temperatures and average heat load will be design parameters, the relatively low wattage of the HLW and defense SNF renders this a relatively minor consideration.

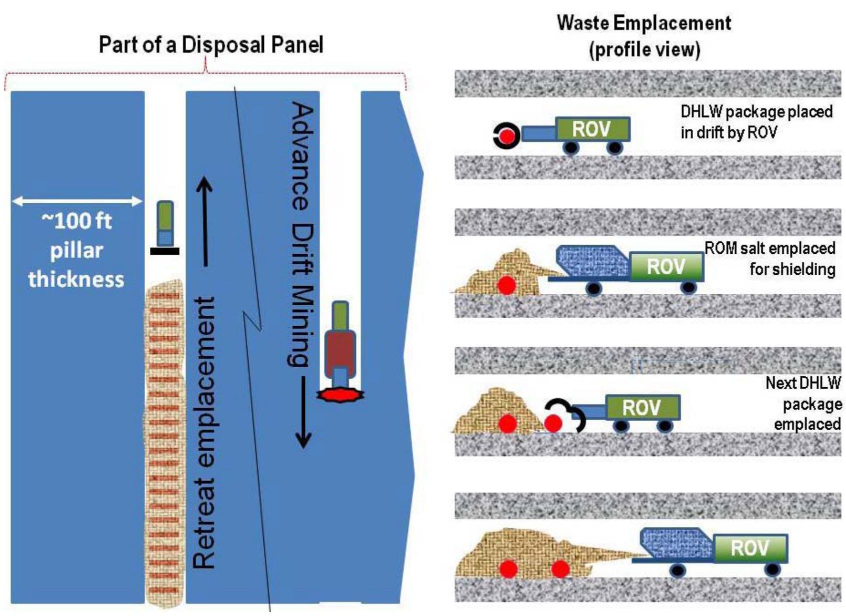


Figure 3. In-drift waste emplacement concept (not to scale)

There are several operational advantages to this disposal concept over traditional concepts such as the borehole emplacement method currently used for Remote Handled waste at WIPP, several of which would lead to tremendous advantages across the entire waste management system for defense wastes. In addition, the in-drift emplacement concept imposes few limits on disposal of a wide array of waste forms, container sizes, shapes and configurations. These operational advantages are:

- *No predrilled disposal holes are required, as in disposal concepts in which canisters are inserted in the wall or floor of a drift*
- *Rubber-tire disposal vehicles may be employed, instead of track-mounted vehicles, avoiding the need to construct an operationally onerous rail transport system in the repository.*
- *Emplacement of run of mine salt is an operationally simple method to provide radiation shielding for workers who must re-enter disposal rooms to inspect ground conditions as required by regulations*
- *Emplacement of waste containers on the floor enables narrow room width and height to be used*.
- *Emplacement on the floor leads to efficient, expedient, and safe operations when compared to insertion into holes in the wall or on the floor*.

Over time, depending on the physical dimensions and the temperature of the emplacement drift, the salt emplacement drift will slowly deform and surround the backfilled waste packages. The backfill will eventually be in contact with the drift roof, and any ventilation provided during the pre-closure period will pass through the salt. This disposal concept is likely to promote drying of the salt backfill and drift during the pre-closure ventilated period. The amount of moisture removed from the system, and any accumulation along the drift or near the canisters are important phenomena to examine in a field demonstration test. It is advantageous in any repository design that the waste packages not be subject to a large quantity of brine, thus limiting the potential for corrosion, at least during the pre-closure period when it might be required to retrieve, or in the case of salt, recover the waste packages. Over the longer term, salt disposal in general, and this concept in particular, promotes the complete isolation of waste from overlying or underlying water-bearing formations, thereby limiting the releases to the accessible environment.

RATIONALE FOR THE SDDI IN SITU THERMAL TEST

Past field heater tests, performed at WIPP, other U.S. salt sites, and worldwide, have provided significant benefit to our knowledge of salt behavior. Previous summaries of this work [3], [4] have synthesized the information from these tests to evaluate the completeness of our understanding, so that an accurate assessment of the need for future field testing could be evaluated. Despite the fact that significant thermal testing has been conducted in both bedded and domal salts both in the U.S. and Germany, there is a gap in our experience base regarding the way in which bedded salt such as that at the WIPP site would behave for the in-drift disposal concept, either for intermediate or high heat loads [11]. In short, borehole heater tests have been performed in bedded salt at WIPP, and in-drift heater tests have been performed in domal salt in the Asse mine in Germany, but knowledge of the behavior of bedded salt for the in-drift disposal concept is a gap that still exists. In this context, the principle technical uncertainty that would be addressed is the behavior of the small amounts of water contained in the salt upon heating. Because bedded salt may contain upwards of an order of magnitude more water than domal salt, either in the form of fluid inclusions or hydrous minerals, testing of the in-drift concept in domal salt is insufficient for understanding the behavior of water when subjected to decay heat.

Thus, a demonstration of a proof-of-principle in-drift disposal concept, focusing on water movement, would help to clarify our state of knowledge, in particular improving our understanding of the thermo-hydrologic behavior of heat-generating waste in a bedded salt medium. There remains uncertainty in brine and vapor transport due to the complexity of predicting the interplay of multiple processes, as well as issues of scale [2]. A definitive study on the suitability of salt as a disposal medium, performed in the underground in a controlled and cost effective manner at WIPP, the only permitted repository in the U.S., will provide valuable information on the suitability of bedded salt for a host of wastes in the U.S. inventory, including the defense waste managed by the DOE. Field-scale studies and demonstrations, in contrast to laboratory-scale studies and computer generated models, provide the scientific and engineering base of information necessary to produce the scientific basis necessary for legislators, regulators, or public stakeholders to make informed, confident decisions. Field testing and full-scale demonstrations are essential components of such a program.

There are several programmatic and scientific/technical goals of a field-scale thermal test at intermediate heat loads. Of the five goals described below, the first two are considered to be programmatic in the sense that they provide an advance in our ability to demonstrate the efficacy of a disposal concept or to exercise our capability to conduct high-quality repository science tests in the underground. The remaining three goals fulfill scientific objectives.

1. *Demonstrate a proof-of-principle concept for in-drift disposal in bedded salt*. The in-drift disposal concept is simple, safe, and expedient, but it has not been demonstrated in the field in bedded salt. The outcome of this proposed testing, in concert with the WIPP and analogue repository experience, would allow a more objective evaluation and optimization of proposed future repository designs. Additionally, the testing would enable us to explore the boundary between the thermal limits of an in-drift disposal concept and the alcove emplacement concept.

2. *Provide a test bed for developing instrumentation systems suitable for in situ salt repository experiments*. Past and current testing experience in the WIPP underground provides a strong experience base for designing and conducting subsurface tests in salt. The SDDI testing program will enable us to expand on this base through the development of new methods for monitoring the behavior of the medium. The transport of water as liquid and vapor and within the test region, including in the run-of-mine salt, is a prime example of a need that will be filled in this effort. The test bed will be the venue for demonstrating the usefulness and durability of instrumentation systems deployed in the harsh environment of a heated salt disposal system.
3. *Investigate the accessibility of brine, and the liberation and transport of water in situ*. Because the fate of brine is key to the evolution of any disposal setting in bedded salt, water migration in this testing milieu (in-drift disposal with a crushed salt backfill) needs to be examined and documented. The availability and movement of brine and water vapor, and the interaction with the salt medium under thermal loads remain uncertain despite some scientific investigation of these phenomena. The liberation of water from fluid inclusions, along grains, and from hydrous minerals must be understood, along with the potential precipitation/dissolution processes stemming from water transport.
4. *Critically evaluate our understanding of coupled thermal, hydrologic, and chemical (THC) processes*. Because the condition of the waste package and subsequent compaction of the run-of-mine salt over long time periods is affected by the early-time behavior of water in the salt, gaining an understanding of these processes is required to instill confidence in long-term projections of repository evolution. After the heating cycle is complete, the test will be allowed to cool sufficiently to allow for the performance of forensic studies of the test bed. These observations will be a primary data set that will establish a firm understanding of the coupled THC processes at full scale.
5. *Develop a validated coupled process model for disposal in salt for heat-generating wastes*. Iterative field observations and model development will lead to a validated coupled THC process model that can be used with confidence in establishing the early-time coupled behavior for a future repository design.

It is important to achieve a firm understanding of the prevailing hydrologic and chemical effects during a demonstration of an emplacement concept to provide a basis for potential future actions regarding disposal of defense wastes in a salt repository. The *in situ* demonstration test is the centerpiece of the SDDI project. It consists of a series of heaters in a pair of drifts, covered with run-of-mine salt, thereby representing a small section of a repository in salt employing the in-drift disposal concept. Our current conceptual model, which will be subjected to testing at the field scale, is that the crushed salt will remain in a relatively permeable and porous condition during the initial period after heating (or waste emplacement, in the case of an actual repository), leading to the mobilization of water as vapor within the pile of crushed salt. Brine entering the drift from the surrounding medium will be mobilized as vapor along with the previously trapped water in the crushed salt, leading to redistribution within the drift and an overall drying effect as water is removed in the ventilation air. Within the salt pile, there is the possibility of complex, coupled processes occurring that could influence the heat transfer in the vicinity of the heat source. Recent coupled model developments [6] illustrate the possibility of a heat pipe that redistributes brine away from waste packages, where vapor then condenses across the boiling front within the run-of-mine salt. The strength of these processes depends on the hydrologic properties of the salt pile, as well as the quantity and accessibility of previously trapped water present in the salt. If a strong heat pipe is established, significant deviations from thermal conduction behavior will be observed, and enhanced heat transport away from the source region will be seen. Thus, temperature within the salt pile should be a diagnostic that provides important evidence of the presence or absence of this process. In addition, the vaporization and condensation of water would lead to precipitation and dissolution of salt, respectively, in different regions of the salt pile, resulting in redistribution of salt and changes to the porosity and permeability. If these changes occur and are of sufficient magnitude, they should be observable either during the heating phase or during post-test forensic examination of the test bed.

The heat pipe and salt redistribution effects described above are based on known physico-chemical principles and basic heat and mass transport processes, and have been investigated at the laboratory scale [14]. The degree to which they occur *in situ* depends on the specific conditions of the field test. Regardless of whether the effects are strong or weak in the test, they should be predictable, that is, able to be represented in a coupled THC numerical model that reproduces the measured behavior. Likewise, accompanying thermal-mechanical (TM) modeling, augmented by extensive geomechanics experience and data at the WIPP site, should enable us to represent the relatively small amounts of drift closure expected during this test using TM models. The validated conceptual and numerical models resulting from the effort can then be used in future design calculations or performance assessment analyses.

PRELIMINARY DESIGN OF THE SDDI IN SITU THERMAL TEST

This section describes a preliminary, high-level plan (pre-detailed test planning) for the SDDI thermal test. Recalling that the motivation of the test is to evaluate its behavior under thermal loads representative of those that would be experienced if DOE-owned

HLW and defense SNF were disposed in salt, the test is designed provide the data to validate our understanding of the thermal, hydrologic, geochemical, and geomechanical behavior in the vicinity of heat-generating waste at intermediate heat loads.

The in-drift disposal concept to be tested will lead to the movement of water as vapor within and potentially out of the system, at least during the time period when the mine-run salt has sufficient permeability to support gas flow by forced or natural convection processes. Thus, a primary goal of a field-scale thermal test is to demonstrate this water movement, and to demonstrate a quantitative understanding through modeling of the moisture data. Although these are not planned to be very long term tests, it is expected that brine evolution from the salt under a pressure and temperature gradient is highest at earlier times and then diminishes with time.

To demonstrate the in-drift waste emplacement concept described above, two drifts (80 feet long each) of minimal cross-sectional dimensions (approximately 16 feet wide by 10 feet high) will be mined. The drifts are located in the WIPP salt disposal investigations (SDI) research area with the drifts being mined in the northeast section of the facility (Figure 4).

Figure 5 provides a general overview of the test drifts and the test layout. The dimensions and testing horizon are tentative and will be defined in detailed test planning and functional and operational requirements development.

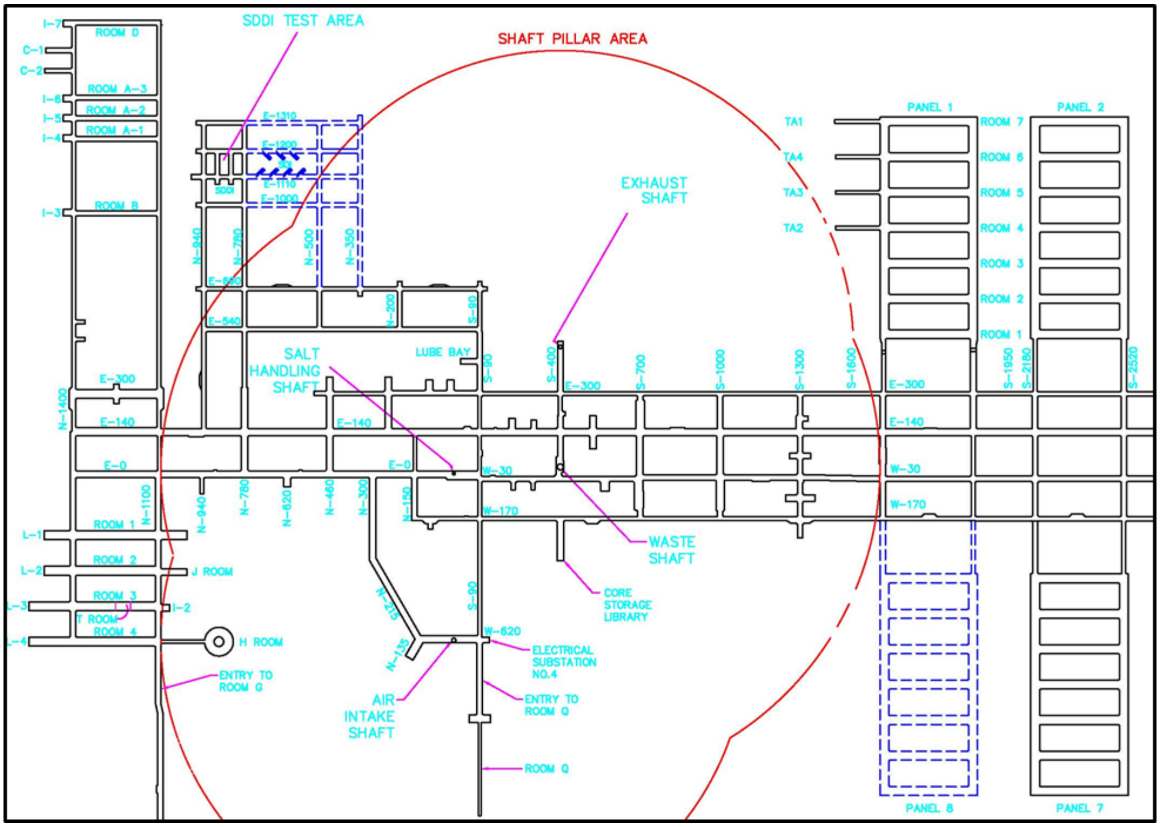


Figure 4. Area within the WIPP SDDI research area for the proposed thermal test

The test concept consists of two test drifts, each with five canister heaters of dimensions similar to that of a HLW disposal canister. Different heat loads will be applied in these two drifts: a cooler drift at sub-boiling conditions (heat load in the range of 200-300 W x 5, to be determined in the detailed test design) and a warmer drift with boiling conditions in at least part of the domain (heat load in the range of 750-1500 W x 5). These heat loads will comfortably cover the thermal range of the defense waste characteristics described earlier. The heaters will be spaced approximately 3 feet apart, center to center. The instrumentation and the heating system are being designed such that it can be adjusted to cover a wide range of temperature regimes as desired. The heaters will have sealed (welded) ends with high-temperature potted electrical leads, and the electrical controller will use a variable step-down transformer to regulate heater power.

In the test layout, both test drifts will be set-up identically, and run-of-mine salt backfill will be placed on top of the five canister heaters to a depth of approximately 6 feet, without compaction. This arrangement simulates the conditions an emplacement drift will experience immediately following emplacement in an operating salt repository. A bulkhead will be located at both ends of the drift to control air flow through the drift and allow for measurement of the air characteristics (humidity, temperature, pressure, flow). The drifts will be heated for approximately one year before a decision is made to either continue the heating or, if enough of the key phenomena, such as the movement and fate of water have been observed and understood, allowing the drift to cool and post-test forensics conducted.

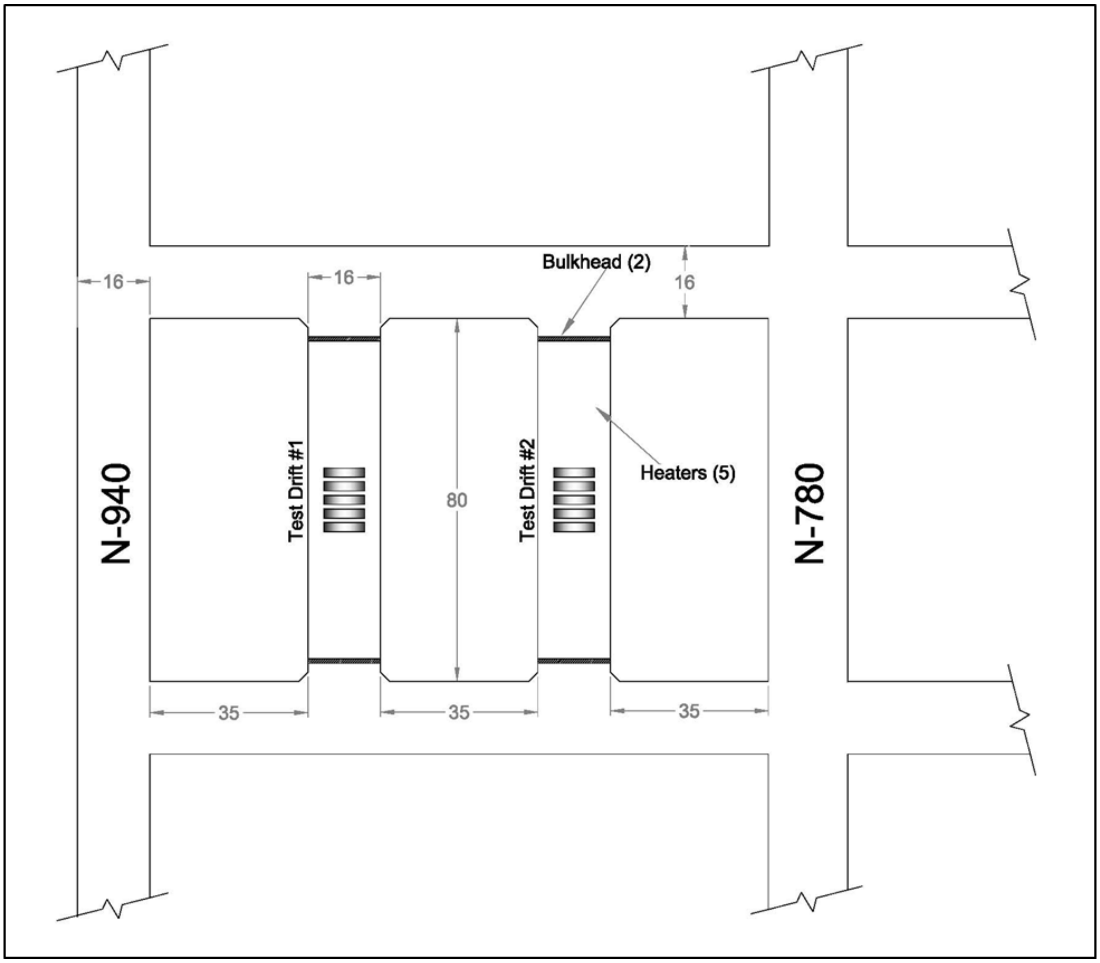


Figure 5. Plan view of the layout of the proposed field-scale thermal test

The movement of water and water vapor will be affected by the heat transport from the heater canisters through the crushed salt, and into the intact salt, which consists of a disturbed rock zone (DRZ), and an unperturbed zone of salt, along with other minerals and marker beds. Air will be mobile within the crushed salt and overlying air gap, transporting water as vapor, where it will perhaps condense ahead of the thermal front.

Alternatively, water may transport as vapor out of the drift and the repository through the ventilation system, leading to an overall drier condition in the vicinity of the heaters than existed initially. As described earlier, the vaporization and condensation of water may in turn lead to salt precipitation and dissolution. It is important to note that geomechanical effects are anticipated to be small in the short time the test is scheduled to run. However, these effects will also be monitored, as they are well known to play an important role in the ultimate reconsolidation of the crushed salt and the healing of the fractures in the DRZ.

Instrumentation of this test concept will focus on the behavior of the crushed salt in the drift and the surrounding disturbed rock zone (DRZ), measuring processes and parameters in the drift that provide evidence of water vapor and brine migration and physical and chemical property changes with time. Initially, the backfill properties will be those of a permeable, granular medium, making the backfilled test drifts quite accessible to measurements of a variety of parameters.

In this initial phase of the project, lasting for approximately one year, various measurement systems and diagnostic methods are being evaluated to assess their feasibility and likelihood of providing relevant information. A multi-institutional team of investigators with research and subsurface operational experience has been assembled to conduct the investigations. A brief description of each method is provided below, and the investigator's organization is listed parenthetically:

Thermal and mechanical measurements: spatially distributed measurements of temperature using resistance temperature detectors (RTDs) or thermocouples (TC) will be the primary method of monitoring temperature (Sandia National Laboratories – SNL). Fiber optic methods to monitor temperature are also being evaluated as a potentially new approach to provide more widespread coverage within the test bed (Lawrence Berkeley National Laboratory – LBNL). Geomechanical monitoring systems (SNL) such as multi-point borehole extensometers (MPBX) and cross-drift convergence measurements are being designed to observe the response of the drift during heating.

Hydrologic and geochemical measurements: Hydrologic parameters to be measured include 1) local gas permeability within the test bed in the salt pile and the DRZ (Los Alamos National Laboratory – LANL, and SNL); 2) local water content within the salt pile, potentially using a combination of moisture probes adapted for use in a salt environment, such as neutron probes and time domain reflectometry (TDR) methods (LANL); 3) gas and water vapor tracer methods to monitor vapor-phase transport within the salt pile and surrounding air gap and DRZ (LANL); 4) geochemical sampling to understand the evolution of chemical composition of the liquid and gas phases.

Geophysical Methods: Geophysical imaging methods with the potential to provide a three-dimensional, dynamic view of conditions within the test bed are being explored: 1)

Electrical resistance tomography (ERT) with the potential to image the location of liquid water within the test bed (LBNL); 2) passive seismic event monitoring or perhaps active time-lapse *in situ* seismic wave transmission measurements and monitoring are being considered that could be able to noninvasively detect thermal/mechanical changes and the presence of liquid water (LANL).

Along with these instrumentation development efforts aimed at monitoring the conditions during the test, basic characterization methods are being conducted (LANL) to identify the spatial distribution of hydrous minerals within the region affected by the thermal pulse, as well as in the run-of-mine salt. Additionally, studies are being performed to evaluate the geochemical conditions (aqueous chemistry and mineralogy) from the standpoint of understanding the durability of test equipment, as well as the long-term behavior of engineered materials under the aggressive chemical conditions present in a salt repository. Finally, to better understand the potential for coupled THC processes to occur, including heat pipe effects and salt redistribution, a series of laboratory experiments at intermediate scale (on the order of one meter in dimension) are being planned to investigate these processes under controlled conditions (LANL).

CONCLUSIONS

The US Department of Energy has embarked on a study to assess the efficacy of salt as a disposal medium for heat-generating nuclear waste. The goal of this phase of the research effort, known as the Salt Defense Disposal Investigations (SDDI), is to identify potential gaps in knowledge that must be filled in order to build a credible safety case for the disposal of defense high-level waste and DOE-managed spent nuclear fuel, generated from nuclear weapons R&D and production activities. Recent activities in the following areas are summarized: radioactive waste inventory and heat load projections; potential repository design options; and progress towards the SDDI field-scale heater test to demonstrate the preferred disposal concept.

The experience at WIPP, combined with evidence from studies performed in bedded salt and salt domes around the world, suggest that, given a properly selected site, salt is potentially an excellent medium for isolating heat-generating wastes from the environment. However, based on a review of the literature, we conclude that there is a continued need for research into the potential performance of a repository for heat-generating waste in bedded salt and a need to better understand the integrated response of the salt at the field scale. In particular, it will be important to investigate the evolution of the small but non-negligible quantities of water within the salt as the heat from radioactive decay diffuses into the surrounding geologic medium.

The proposed in-drift disposal concept is expected to demonstrate operational efficiency and the ability to handle various sizes and shapes of waste. The expectations for *in situ* behavior are informed by the extensive WIPP experience and knowledge of salt deformation. The demonstration of placing mine-run salt over the waste, which in actual disposal operations would provide radiation exposure protection for workers, is important for operational evaluation and performance objectives. The heat from the buried canisters will warm the salt mass and accessible moisture would be expected to transport with the airflow, and perhaps out of the repository. Measurement of the drying effect is one of the main goals of the field tests being considered. Recent coupled model developments illustrate the possibility of a heat pipe that redistributes brine away from waste packages, where vapor then condenses across the boiling front within the run-of-mine salt, dissolving the granular salt until once again saturated, resulting in redistribution of salt within the run-of-mine salt backfill. Testing our understanding of and ability to model these coupled thermal-hydrologic-chemical processes is another primary objective of the SDDI project.

Initial planning for a field-scale heater test has been conducted, and mining of a test bed in the underground at the WIPP site has begun. Currently, ongoing efforts are focused on preparing detailed test plans and developing the instrumentation systems and coupled process models.

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