WIPP R&D IN SITU TEST PROGRAM*

L. D. Tyler
Experimental Programs Division 6332
Sandia National Laboratories**
Albuquerque, New Mexico 87185

ABSTRACT

The Waste Isolation Pilot Plant (WIPP) is a Department of Energy (DOE) R&D Facility for the purpose of developing the technology needed for the safe disposal of the United States' defense-related radioactive waste. The in situ test program focus is to provide the models and data to demonstrate the facility performance for isolation of waste at WIPP. The program is defined for the WIPP sealing system, thermal-structural interactions and waste package performance. A number of integrated large-scale underground tests have been operational since 1983 and are ongoing. The tests address the issues of both systems design and long-term isolation performance of the WIPP repository.

INTRODUCTION

The Waste Isolation Pilot Plant (WIPP) has been authorized by the U.S. Congress as a facility with a mission "for the express purpose of providing a research and development facility to demonstrate the safe disposal of radioactive waste resulting from the defense activities and programs of the United States exempted from regulation by the Nuclear Regulatory Commission" (1). The WIPP is under construction in the salt beds of the Salado formation in southeast New Mexico. The facility is to be used to permanently isolate transuranic (TRU) waste generated by the U.S. Defense program, and to provide an "underground laboratory" in which the concepts for safe disposal of defense high level waste (DHLW) and TRU waste in salt are being demonstrated. The construction at WIPP began in July 1981, and presently consists of an extensive underground test facility and the beginning of the first storage panel. The facility horizon is located in a very thick evaporative sequence of the Salado Formation. This paper provides an overview of the in situ test activities of the WIPP R&D Program.

WIPP R&D PROGRAM

The WIPP R&D Program provides the technical basis for systems design and performance assessment for the WIPP and safe disposal of defense waste at other repositories (2). The major focus of the R&D activities addresses the isolation capabilities of the WIPP facility and entombment of the TRU waste. Research on the disposal and isolation of DHLW is also underway. The DHLW waste will not be disposed of at WIPP, but will be removed at the end of the experimental program. All of the research of the R&D Program is aimed at demonstration of the safe disposal of defense waste. The sealing system used at the WIPP is intended to be one of the major barriers for isolation of TRU waste. The seal barrier system can be divided into three categories: Shaft seals, panel seals, and room isolation. Common to each of these categories are a number of issues which require investigation. What is the seal design and what materials are to be used? How does the salt formation load the seal, and how does the salt creep to entomb the waste in the storage rooms? How much water moves into the shafts and rooms from the surrounding salt? How does the crushed salt backfill used in the storage rooms and shafts reconsolidate and at what rates? Do fractures heal and what are the flow paths caused by the possible disturbed areas around the shafts and storage rooms? The disturbed areas may be caused by construction-induced damage and subsequent deformations of the salt. The WIPP R&D Program was organized to address these technical issues. Because of the long-time nature of the performance of the disposal and seal systems, the focus of the program is to develop models of the system based on the observations and data from laboratory and field tests. The initial phase of the technical development in the WIPP Program involved laboratory testing and small-scale field testing in commercial salt and potash mines. The WIPP R&D Program is now conducting a number of realistic-scale in situ tests in the underground salt research area at a depth of 659 m in the WIPP facility (Fig. 1). These large-scale in situ tests provide the basis for validation of models, codes, and designs and confirm laboratory experiments. The program is divided into three technical areas: Plugging and Sealing (P&S), Thermal/Structural Interactions (TSI), and Waste Package Performance Experiments (WPP). The in situ test planning was developed to integrate the many activities and tasks in such a way to ensure that the technical issues are investigated with the appropriate emphasis and timing. The in situ testing is a major phase in the demonstration of the safe isolation of nuclear waste as illustrated in Fig. 2. The in situ tests for each of the technical areas are described in the following paragraphs. The location of the in situ tests in the research area of the WIPP underground is illustrated in Fig. 3.

PLUGGING AND SEALING

The WIPP Seal System is composed of the exploratory borehole plugs, shaft seals, storage panel seals, and storage room and drift backfill. The evaluation of the total seal system concerns: The existing rock formation; the disturbed zone immediately surrounding the opening; the interface between the seal and host rock; and the seal material emplaced as the plug. The P&S Program is organized into seal testing, formation characterization, material evaluation, model development, design analysis, and evaluation of engineering requirements (3). The shaft seal concept is illustrated in Fig. 4, and the storage panel seal concept

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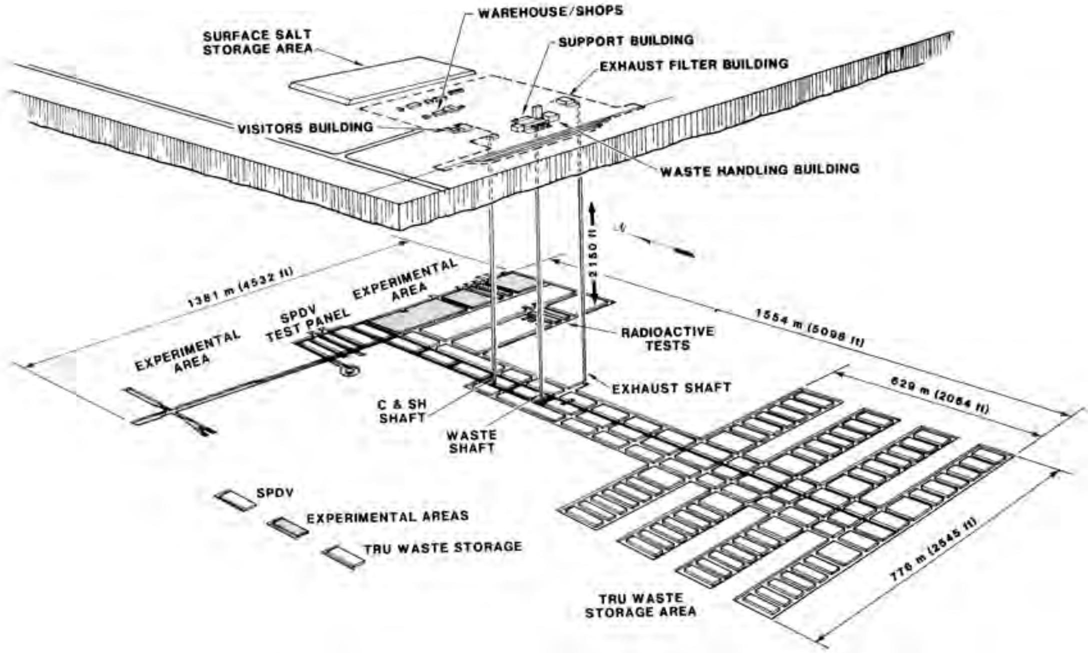

Fig. 1. WIPP Site Layout.

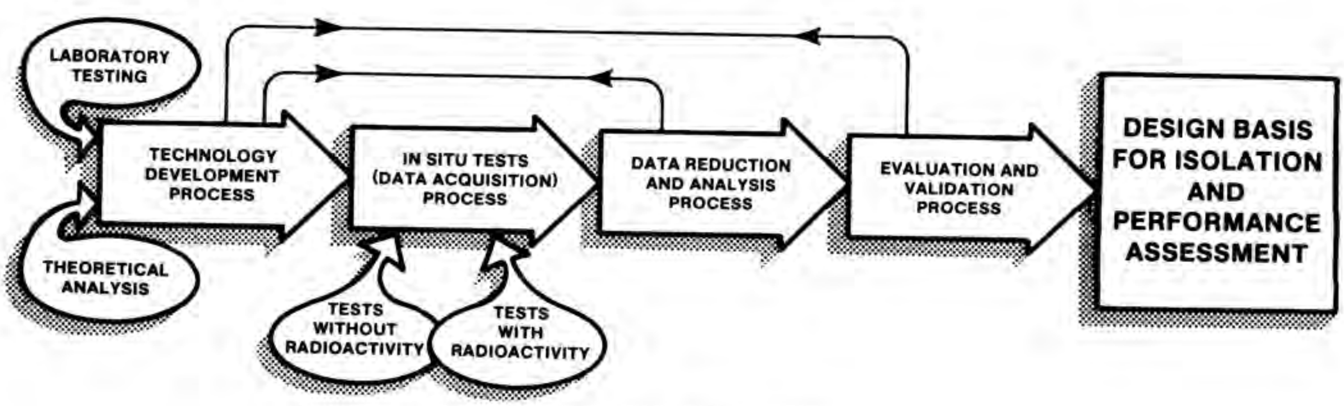

Fig. 2. WIPP R&D Process.

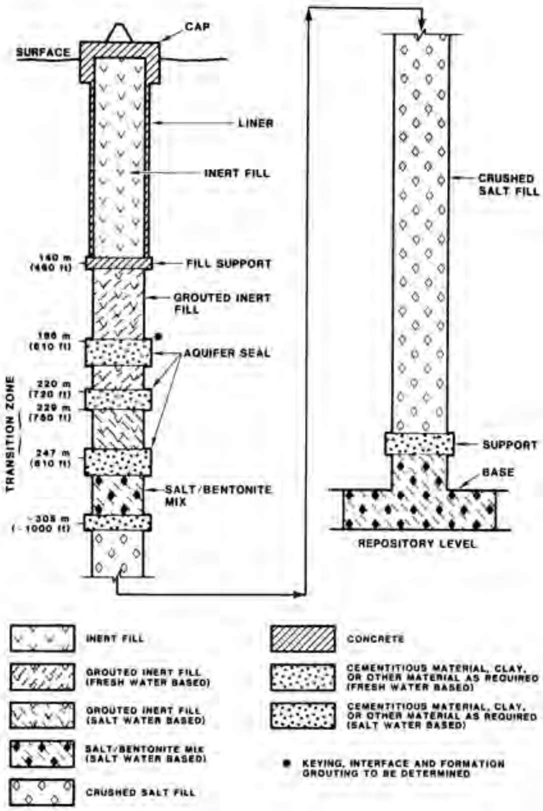

Fig. 3. Experimental Area Layout.

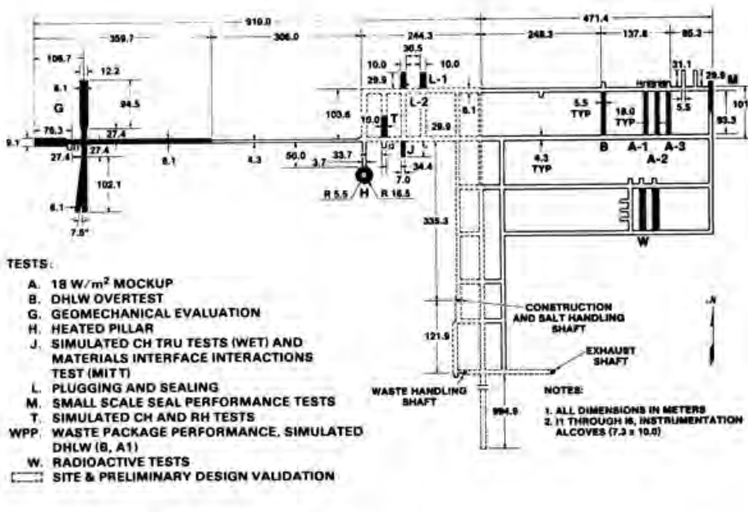

Fig. 4. WIPP Shaft Seal Concept.

is illustrated in Fig. 5. The P&S in situ tests provide measurements of the material performance for sealing man-made openings in layered halite; the characteristics of formation fluid flow; and the effect of disturbed areas on the seal system performance evaluation. The data and information from these tests are fundamental in achieving confidence that the information obtained from the theoretical and laboratory studies is consistent with the real disposal environment, and will be used to validate the models and predictive techniques required for predicting the long-term performance of the WIPP seal system.

The P&S in situ tests include:

- Small-Scale Seal Performance Tests
- Borehole Plug Tests
- Large-Scale Seal Performance Tests
- Permeability Measurements
- Moisture Transport and Release Tests
- Plug Test Matrix

The following sections describe the status of each test, including the issues being addressed and the test objectives.

Small-Scale Seal Performance Tests

These tests are a series between lab-scale and full-scale test experiments to evaluate the seal components of the seal system in the sealing environment of the facility. The size of the tests are intermediate. The objectives of the Small-Scale Seal Performance Tests are as follows:

* Evaluate in situ performance of candidate seal materials and emplacement techniques.
* Obtain permeability measurements through the seal system.
* Evaluate the structural behavior and geochemical interactions of the seal materials and the host rock.
* Evaluate the time-dependent and scaling effects of the seal/host rock interactions.
* Obtain data for the development and validation of predictive techniques and models.

The test series addresses the technical issues of the thermal, mechanical, and hydrologic (flow restriction) performance of seal systems in the host-rock environment. The specific technical issues for each experiment series are as follows:

Series	Issue	Configuration/Materials
A	Shaft seal	Salt-based concrete, vertical holes.
B	Panel Seal	Salt-based concrete, horizontal holes.
C	Panel Seal	Salt and bentonite block, mortar barriers, and horizontal openings.
D	Room Isolation	Various salt and bentonite backfill materials.
E	Panel & Shaft Seal	Concrete seal, fractured anhydrite zone, vertical holes.

These seal experiments evaluate the seal system performance by measuring fluid flow rates through the seal system that might occur along the several combinations of flow paths. Holes for seal implacement are

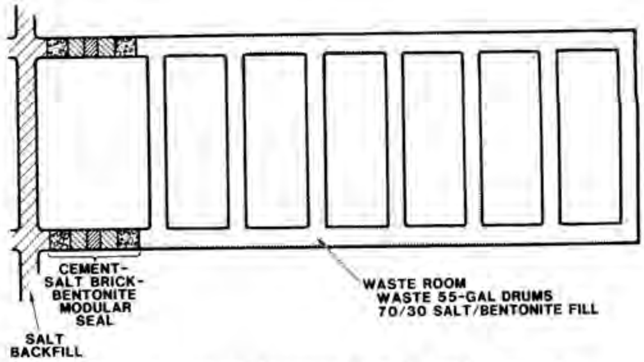

Fig. 5. WIPP Storage Panel Seal Concept.

are to be drilled vertically and horizontally to a nominal depth of 5 m, in a designated Test Room M area. The holes range from .15 to .92 m in diameter. The seals are emplaced in each hole with lengths that range from .30 to .92 m long. Permeability tests with both gas and brine as the working fluid range up to 14 MPa. The vertical concrete seal experiments of series A were initiated in July 1985 (4). The horizontal concrete seal experiments of series B were initiated in February 1986 (5). The structural and permeability data collected to date for the two series show sound, tight seals. Both gas and brine flow tests initially indicate tight seal systems with less than microdarcy permeabilities. The Series C tests are just starting. These experiments are the evaluation of the salt and sald/bentonite block seal component to be used in the shafts and panel entry. To date, the viability of the production and emplacement of these blocks have been demonstrated. The Series D and E experiments are scheduled later this year and early next year and are, respectively, for the evaluation of backfill materials and sealing across clay and anhydrite beds of the WIPP.

Borehole Plug Tests

These tests address the type of material and emplacement technique appropriate for plugging deep boreholes in salt and nonsalt at WIPP. The boreholes to be plugged are primarily from the WIPP site characterization program. Tests will demonstrate and verify the techniques developed for installing, testing, and monitoring the performance of borehole plugs. Test objectives are as follows:

* Determine the sealing performance of plugs in deep boreholes.
* Determine the emplacement techniques for deep boreholes.
* Evaluate the long-term stability and durability of plug materials.

Plug material emplaced in a borehole will be sampled to evaluate the interactions between the grout and formation materials. One 20 cm diameter, 2 m long, freshwater grout plug has been tested in an anhydrite formation 1,370 m from the surface (6). This plug was very effective in reducing flow. Another plug is planned to be emplaced in the salt formation, and its in situ time-dependent performance will be monitored.

Large-Scale Seal Performance Test

This test is referred to as the bulkhead test because it will evaluate the performance of a full-sized seal emplaced in a drift configuration underground at WIPP. The bulkhead seal will be designed as a prototype of the storage panel seals and will be based on the integration of data acquired from laboratory studies, seal performance analysis, and in situ test data. The bulkhead seal tests will be coupled with the large-scale room performance tests, which will examine the full scale performance of backfill behavior with the synergetic effects of moisture inflow, room closure, and backfill consolidation. The test objectives are as follows:

* Demonstrate full-scale emplacement and seal performance in the host rock environment.
* Demonstrate large-scale performance behavior of backfill engineered barriers for disposal rooms.
* Validate seal flow and structural computer models.
* Develop the data base for WIPP underground seal design.

Detail test design will begin for the large-scale test in 1987. The test design will focus on the flow and structural measurements that will allow the evaluation of the multiple component seal configuration and backfill consolidation. The large-scale test will examine the effectiveness of backfilling storage rooms due to the backfill/room interactions. The composite panel seal and its interaction with the formation will provide the data to determine the validation of the seal design.

Permeability Measurements

The permeability tests are being carried out in both the Salado and Rustler formations, and are important in establishing the capability of the WIPP geologic formations to isolate radioactive waste. The permeability tests provide a measure of formation damage and identification of potential leak paths due to the disturbed area around the facility openings. The permeability values will be incorporated into the WIPP seal design and the performance assessment studies that describe the potential flow through the repository. The permeability measurements are also important to the evaluation of the potential buildup and dissipation of waste-generated gas in the repository storage area. The test objectives are as follows:

* Determine the permeability and effective porosity of the in situ competent salt.
* Determine permeability variations with distance from the mined face (disturbed zone).
* Evaluate the influence of the interspersed clay and anhydrite seams on permeability values.
* Determine the permeability of the Rustler formation in the facility shafts.

The technical issues for the permeability tests are to address the fluid flow characteristics of the WIPP host rock at the repository horizon. To date, permeability measurements have been made in more than 50, 12 cm diameter gas permeability holes drilled at various depths from the underground facility (7). The holes drilled into the host rock intercepted clay seams; anhydrite stringers and marker beds; and other anomalous interbeds or halitic discontinuities. The flow tests were conducted in a dual-packer system that isolated regions of interest in the test holes. Both injection and pressure decay tests were done using nitrogen gas. Some brine and tracer gas tests were also done. The test results were interpreted from flow rates, downhole pressures, temperature, and packer pressure. The results show the formation to be very tight away from the excavations. The initial results indicate that competent salt has a permeability to gas less than 10^{-8} darcy. Preliminary results show free-field clay and anhydrite seams have gas permeabilities comparable to those of the competent salt. The permeabilities near the excavations are a function of the opening size, location from the room centerline, and geometry of the opening (8). Flow tests around excavations indicate that near the drift centerlines at the excavation surface permeabilities are greater than a microdarcy with the permeabilities at the room edges less than a microdarcy. Flow tests at drift intersections indicate fracture flow occurs in the intersection floor and ceiling with effective permeabilities of the order of a darcy. More testing is planned, including the periodic measurements of permeability that will be made to determine the time dependence as the formation deforms.

Moisture Transport and Release Tests

Although the bedded salt at WIPP does not contain circulating groundwater, it does contain up to 0.5 wt% water. The construction of an underground opening causes the formation moisture to migrate to the opening and be released into the room or shaft. The amount of moisture released may not be large, but could be significant for the consolidation of crushed salt used as a shaft seal, panel seal, or room backfill. The amount of moisture present in a storage room may also be important in the generation of gas from the organic content of the waste. These tests are designed to evaluate the moisture release rates and provide data for the development of predictive models for moisture transport, release, and accumulation in a repository system. The test objectives are as follows:

* Develop and validate a model for the movement of naturally occurring moisture in the WIPP host rock.
* Evaluate the quantity, rates, and characteristics of moisture release to openings in the storage horizon.

Currently, experiments are underway to quantify brine movement to both unheated and heated WIPP test boreholes. These experiments are part of the full-scale simulated DHLW near-field effects/waste package performance tests. The thermal release data are being accumulated for reference simulation with 470 W heaters in Room A1, and for an overtest condition with 1,500 W heaters in Room B. Water vapor released from entering brine is swept from the holes by flowing nitrogen (9). Water inflow to each of the holes, 36 inches in diameter, during a week of unheated operation was 5 to 15 g/day. Water inflow rates initially rose rapidly and remained constant after heating was initiated. Cumulative quantities of water were 35 kg in approximately 600 days for each of the 1,500 W holes and 4 kg in approximately 400 days for each of the 470 W holes. A darcy flow model shows promise for modeling the results. The data are consistent with a closed domain of interconnected porosity as the source of the brine. Additional tests are planned to determine the flow rates and humidity in an isolated void and formation pore pressure.

Plug Test Matrix

These tests address the long-term stability of seal materials for the WIPP seal system. The tests provide an in situ environment in the WIPP salt for seal material samples to be exposed for up to five years. The recovered samples will allow analysis of the stability of the seal materials and the interactions between the materials and the host rock. Test objectives are as follows:

* Determine the interactions and long-term geochemical stability of seal materials in various salt conditions.
* Provide in situ cured samples for laboratory investigations.

Each selected plug material will be emplaced in 12, and in some cases up to 24, holes underground in Rooms L1 (ambient) and L2 (heated). Plug materials will be subjected to ambient, wet, and heated conditions. Grouts, concretes, and salt mixtures are planned as candidate materials. To date, samples of candidate salt-based grout and concrete have been emplaced.

THERMAL/STRUCTURAL INTERACTIONS (TSI)

The TSI in situ tests provide the important data and models for the applied structural loads of the formation on the storage rooms and facility seal system. The tests are focused on determining the underground stability and rock deformation of the salt for long-term waste isolation. These in situ tests have been designed to address the development of a predictive model for both TRU and DHLW disposal in salt. The heated salt tests also provide accelerated response data for the ambient predictive code validation. The TSI in situ tests are designed to address the technical issues by large scale simulations, large formation material response tests, formation in situ stress tests, and salt yield and failure tests.

The major goal of the TSI Program is to develop the capability to predict drift response at a given site without a prior knowledge of the actual drift response. To date, the predictive model, which is based on a secondary creep law and reference stratigraphy (10), has been compared with drift closure data for the first drift constructed in the southern part of WIPP (South Drift) (11). The comparison shows that the model underpredicts the drift closure by up to a factor of five. Normally, the comparison predictions and field data are a factor of three. The same model has been used to compare with the data collected from the construction of Room D in the experimental area with similar results (12). Because of the importance of the rock mechanics model prediction for waste entombment and seal system performance, there is a continuing model development effort. A more complete constitutive model is being investigated, which incorporates both transient and steady-state-creep and quasi-steady-state plasticity. This material model has been used for some preliminary comparisons with data from the south drift. The comparison shows considerable improvement in the predicted drift response (13). As the new model is developed, it will be validated with the large-scale TSI experiments.

The TSI in situ tests are:

Large-Scale Simulations
- $18 W/m^2$ DHLW Mock-up
- DHLW Overtest

Formation Material Response Tests
- Geomechanical Evaluation
- Heated Pillar

Formation In Situ Stress

Yielding and Failure Tests
- Clay Seam Shear
- Acoustic Emissions Monitoring

The following sections provide the TSI test objectives and descriptions

Large-Scale Simulations

Both of the large-scale simulation tests provide ambient and high temperature data for validation of rock mechanics predictive models for salt deformation. The $18 W/m^2$ test is a reference condition for disposal of DHLW and the Overtest provides approximately three times as much thermal power as the reference case. Both tests had at least six months of ambient temperature data collected before the heated phase was initiated. The test objectives are as follows:

* Determine structural stability from salt creep and room closure rates for both ambient and elevated temperatures.
* Determine the validity of predictive models for TRU and DHLW storage room closure and facility seal loads.

The $18 W/m^2$ test is located in room A2 with parallel Rooms A1 and A3 considered as "guard" heated rooms. The salt pillars between the rooms are 18 m thick and the rooms are 5.5 x 5.5 m in cross-sectional dimensions. The canisters contain heating elements to simulate the waste and are emplaced in 5 m deep holes in the floor. Ambient-temperature data collection started in September 1984 with a mining sequence experiment. The heated phase was initiated in October 1985. The heaters are operated at the reference power of 470 W each. In Room A2 the salt temperature next to the heaters is currently 58°C with a drift floor temperature of 39°C. The Overtest is located in Room B, which is the same size as Room A2. The canisters are simulated heated packages in the floor but operated at a power level of 1.5 kW each. This test began ambient temperature operation in June 1984, and the heated phase was initiated in April 1985. Currently, in Room B the salt temperature next to the heaters is 137°C with a drift floor temperature of 63°C. Both of these tests are scheduled to operate for three years. Currently, the test data are being reduced and comparisons with model predictions are being made.

Formation Material Response Tests

The constitutive models developed from laboratory tests require confirmation with large-scale material in situ tests. The current predictive model uses a creep model based on laboratory data. The Geomechanical Evaluation Test and Heated Pillar Test provide the in situ material tests needed to identify the response of the salt in the WIPP facility. The test objectives are as follows:

* Determine the validity of the constitutive models used in the predictive computer codes for room closure and seal loading.
* Determine the behavior of room and pillar as a result of salt deformation.
* Determine the mechanical properties and failure modes of in situ salt.

The Geomechanical Evaluation Test is located in Room G and consists of the phased mining of a long, isolated drift that represents 2D geometry drift intersection, and a tapered (wedge-shaped) salt pillar. All the long drifts are of the same 3 m height but are of varying widths (6.1, 9.2, and 12.2 m). The different drift sizes and geometries provide data for comparison with the short- and long-term model predictions. The wedge pillar is designed to ensure failure of the salt to allow a study and definition of the mode of failure. The data will be an in situ basis for developing failure criteria for underground design and correlation with laboratory data and failure mechanism studies. The first phase of this test began in January 1985 with the later phases scheduled for 1988. The Heated Pillar Test is a large heated axisymmetric thermomechanical salt pillar test in Room H. The 11 m-diameter salt pillar is surrounded by a heater blanket for uniform heating. The pillar is located in the center of a 3 m-high and 11 m-wide excavated annulus. The geometry is simplified to allow better evaluation of the salt material model without the complications of geometry in computer code predictions. The initial phase of the Heated Pillar Test was a one-year ambient temperature test with the heating initiated February 1986.

Formation In Situ Stress

The formation in situ stress is important as a boundary condition for any predictions for waste isolation in salt. The stress field in salt has been assumed to be hydrostatic because of the plastic nature of the salt. The formation stress was measured using the hydraulic fracturing technique. The test objective is to:

* Determine the in situ stress state of the WIPP salt at the facility horizon.

This test consists of a series of long boreholes drilled horizontally along the axis of drifts that will later be excavated. The first borehole was a 10 cm hole drilled westward to a 125 m depth along the access drift to Test Room G. Hydraulic fracture (hydrofrac) tests were conducted at different depths with a fluorescent dye in the fracture fluid. The dyed fractures were mapped during the drift excavation using a blacklight source (14). The orientation of the major fractures provided a definition of the minor principal stress direction. This test showed the feasibility of using the hydrofrac technique for in situ stress measurements in a salt formation. More recently, the hydrofrac technique has been used to measure the in situ stress in the pillar between Rooms 4 and 3, and in a northward hole drilled at the north-south intersections in Room G. The pressure records from all of the tests infer the stress magnitudes with the stress directions defined by the fracture maps obtained during excavation.

Yielding and Failure Tests

This set of TSI tests are needed to define material response that could not easily or reliably be obtained in the laboratory and are required for the development of the predictive rock mechanics model. Shear displacement along clay seams has been observed in the test rooms and along the excavated drifts in the WIPP. Therefore, a knowledge of the contribution of the shear of clay seams to the room closure and seal loading is needed. This knowledge will be formulated into a model that will be incorporated into the predictive model for the formation structure.

The technical issue for the shear test is to examine the in situ clay seam properties which will be used in a model for the clay seam behavior. The test objectives are as follows:

* Determine the effective friction coefficient of clay seams, which will be compared with laboratory results.
* Evaluate calculated displacements along the clay seams with in situ data.

This test is currently being planned. The test concept consists of imposing a direct shear stress on selected, existing clay seams within excavated openings underground. Several techniques are under consideration for applying a shear force across a clay seam, including rotational force and direct shear force on the sliding surface. Clay seams in the salt away from excavations can be reached by over-core drilling techniques. The clay seams near an excavated surface can be accessed by saw cuts along the surface containing the seams.

The Acoustic Emission Monitoring is a nondestructive technique to obtain data on salt fracture initiation and the progressive failure of a salt pillar. This data is an important input to the development of a salt fracture model for the TSI predictive model. The acoustic emission data coupled with mapping of fractures will allow a good in situ picture of the failure of salt as it fractures. The test objectives are as follows:

* Determine the onset of yielding and fracturing of a salt pillar.
* Evaluate the progressive failure of a salt pillar.
* Correlate acoustic-emission data with pillar deformation and fracture progression.

The plans for the acoustic emission monitoring is to instrument the Wedge Pillar of the Geomechanical Evaluation Test in Room G. A total of 24 sensors will be located within the wedge and in its surfa-e. The acoustic velocity will be used to detect the onset and location of yielding and fracturing in the stressed pillar. This testing will occur in the late phases of the Geomechanical Evaluation Tests.

WASTE PACKAGE PERFORMANCE (WPP)

The waste package performance task for the WIPP addresses the near-field environment effects on the waste container for disposal of defense waste, both DHLW and TRU. The results of these investigations are the basis for development of a model to predict the moderate to long-term performance of the waste containers. The in situ tests for this program provide a confirmation of the laboratory and modeling results and the integration of these results in an actual emplacement environment (15). Specifically, the in situ tests address the durability and containment integrity of the waste packages in the highly corrosive salt environment. The tests include the waste-form, container, and engineered barrier materials applicable for a TRU and DHLW repository in salt. The first phase of testing for both types of wastes simulates the waste package emplacement without radioactivity. The heat effects of DHLW and RH (Remote Handled) TRU are simulated using electrical heaters inside the waste containers. The synergistic effects of radiation and the behavior of radioactive waste in the in situ salt environment will be evaluated using radioactive waste or encapsulated radioactive sources.

The WPP in situ test program is organized into three parts as defined by:

* Simulated DHLW Technology Experiments.
  Full-Scale DHLW Canister Tests
  Materials Interface Interactions Tests (MIIT).
* Simulated Contact Handled (CH) and Remote Handled (RH) TRU Technology Experiments.
* WIPP Radioactive Tests (WRT).

The primary objectives of the WPP program are to provide the baseline data and models for defining a source term for the performance assessment of the TRU disposal at WIPP and the demonstration that all types of defense waste can be safely disposed in a salt repository. Each of the WPP tests are briefly described in the following sections.

Simulated DHLW Technology

The full-scale DHLW canister tests address the issue of the performance of DHLW waste package (canister and backfills) in a salt environment (16). These tests will also provide baseline data needed to demonstrate safe disposal of DHLW. The test objectives are as follows:

* Evaluate the containment integrity of DHLW packages in a nonradioactive environment.
* Evaluate interactions of the waste canisters, backfill materials, and host rock at near-reference and overtest thermal conditions.
* Develop a technical basis for validating the concept of safe disposal of high-level waste in salt.

These tests involve the emplacement of 18 full size simulated DHLW packages in vertical holes in two underground test rooms. Six of the test packages were emplaced in Test Room A1 in a near-reference repository condition of 18 W/m^2 area thermal load (17). The packages contained electrical heaters that are operated at the reference condition of 470 W per canister. The package design tested is a stainless steel can with a thin Ticode 12 overpack wrap for corrosion resistance. The Room A1 waste package tests were installed and initiated in October 1985. The current mid-package surface temperatures of the waste packages in Room A1 are 65°C.

Twelve waste packages are tested in Test Room B, where an overtest thermal condition exists (about three times the area thermal loading of Room A1). Eight of the test packages contain internal electric heaters; the remaining four contain nonradioactive DHLW glass provided by the Savannah River Plant and Laboratory. Some of the Room B canisters were intentionally defected with artificially produced slots and holes to simulate cracks and pits in the material. The package materials being evaluated include 304L stainless steel canisters with mild steel overpacks and Ticode 12 canisters. A number of the waste packages include backfill barrier materials for evaluation. These backfill materials are crushed salt and low-density bentonite/sand mixtures. The evaluation of the canister and backfill materials are further accelerated by the controlled injection of quantities of brine into the backfill around the packages. The heated phase in Room B started in April 1985, which was the initiation of the waste package tests except for two glass-filled Ticode 12 canisters, scheduled to be emplaced in March 1987. The mid-package surface temperatures for the internally heated Ticode 12 packages in Room B are 178°C.

The evaluation of the materials from both test Rooms A1 and B will be done by periodic sampling of the backfills and removal of the waste packages for laboratory analysis of the canister, overpack, and backfill materials. The performance of the different different material samples will be determined by the laboratory analysis correlated with the near-field environmental data as a function of time. The resulting performance model will allow the long-term evaluation of the package systems performance.

The MIIT Test is a set of in situ test samples of various nonradioactive waste forms and package materials as they interact in a relevant brine and thermal environment. These tests are a part of a larger test program for obtaining a good statistical data base on waste-form and canister-material performance. The waste-form materials were supplied by the Savannah River Laboratory and represent materials from the U.S. and seven foreign-country participants (Germany, France, Canada, Belgium, Japan, the United Kingdom, and Sweden). The technical issue addressed by this test is the evaluation of various waste forms and canister material and their interaction in a saturated, hot in situ environment. The test objectives are as follows.

* Evaluate the performance of nonradioactive glass waste forms under anticipated and accelerated geochemical conditions.
* Determine the effects of waste package components and backfills on waste glass durability.

The MIIT Test in Room J involves the evaluation of samples of long-term in situ leaching and surface interactions in drilled boreholes containing WIPP brine at 90°C. The boreholes drilled vertically into the floor are 8.3 cm in diameter to depths of 1.2 and 2.1 m. The test assemblies consist of multiple material components cut into annular rings and supported together by Teflon disks, threaded rods, and nuts. An electrical heater rod is inserted through the center of the assembly. Fifty assemblies are being tested for up to five years with periodic sampling during the test period. The installation of the MIIT Test was completed and the test initiated in September 1986. The six-month test samples were removed in February 1987 for analysis.

Simulated Contact Handled (CH) and Remote Handled (RH) TRU Technology Experiments

Tests using simulated CH and RH TRU wastes are being conducted in the WIPP underground facility to provide data for demonstrating the safe disposal and isolation of the TRU waste to be stored in the WIPP facility. In determining the room storage and isolation behavior as a part of the performance assessment, a definition of the source term is required. An integral part of this definition is the behavior of the waste containers and backfill material. These large-scale tests focus on evaluating the durability and corrosion behavior of the waste containers as well as their interaction with backfill materials. The technical issues addressed by these tests are the performance of the TRU containers in nominal and overtest environments, and the collection of in situ data on the performance of various backfill barrier materials. The test objectives are as follows:

* Evaluate the corrosion and durability of CH TRU containers in both nominal and accelerated in situ environments.

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