Pre-WIPP In-Situ Experiments in Salt
Part I - Executive Summary
Part II - Program Description

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PRE-WIPP IN-SITU EXPERIMENTS IN SALT

PART I
EXECUTIVE SUMMARY

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FOREWORD

(note added during review)

The following document presents plans for in-situ experiments in a geothermal system in southeastern New Mexico. Schedule and facility design are based on features of a representative local potash mine and on consultation with mine owners. Subsequent WIPP program uncertainties have to do with the implementation of the activities discussed here; therefore, the relative schedule for various activities are appropriate for planning only. The document represents a matrix of in-situ activities to address technical issues prior to the availability of a detailed site description.

PROGRAM OBJECTIVES

This document presents a systematic and interrelated matrix of the field experiments to be performed in salt. Most of these experiments will be performed in a specially excavated area of a southeastern New Mexico potash mine. The goals of the program are to obtain scientific and engineering data applicable to the design of emplacement and containment systems for radioactive waste disposal in bedded salt formations in southeastern New Mexico and to acquire information to resolve generic technical issues relating to the disposal of high-level waste in salt formations. The relative importance of the experiments and the entire WIPP experimental program is shown in Figure 14. A description of the experimental program is given in the FY81 DOE Laboratory Program Plan (SAND79-0098).

The general objectives of many of these experiments are:

1. To evaluate the thermochemical/mechanical response of the bedded salt to emplaced heat sources in a relatively site-specific geological and geologic situation.
2. To determine, and if present, evaluate unusual or unexpected responses of the salt response to a simulated canister heat load.
3. To evaluate the predictive capability of the numerical and analytical processes for the WIPP facility.

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- * While real waste will not be utilized in the mine dedicated area, heaters will be used to simulate the heat field corrosion, and leaching studies will be initiated to simulate canister host-rock interaction. Stable isotopes will be used to obtain preliminary data on waste host-rock interaction and corrosion. Gas generation issues for non-heat bearing waste will be investigated. Simulated waste handling and retrieval will be initiated. The performance of geotexts and other engineered barriers will be evaluated.

4. To develop a (framework of fundamental information and aspects of instrumentation) for the design and installation of in-situ experiments in the WIPP facility.

In addition to experiments which support the development of the technological bases for waste isolation, other activities related to facility preparation and design will be addressed. Their general objectives are:

1. Evaluation of techniques and equipment for drilling large-diameter, transfer emplacement holes.
2. Evaluation and development of techniques and procedures for the incorporation and emplacement of radioactive waste in a facility-scale disposal room.
3. Evaluation of techniques and equipment for retrieval of waste canisters from a heated and/or salt backfilled disposal room.
4. Evaluation of techniques and methods for scanning, locating, and identifying fugation and location of gas and/or brine migration.
5. Assessment of techniques, materials, and procedures for enhanced monitoring in support of the overall planning program.
6. Collection of ventilation air, particulate, and humidity data for application to filtration and weather-related design requirements.

The specific objectives of each category of these in-situ experiments are presented in Table 1. The results of the experiments will be important to the development of safety-and-consequence analyses, Title III design, and licensing. For certain experiments, the importance is more directly aligned with operational safety and in-situ experiments in the WIPP facility. Many of the experimental results will address issues on which the public, including the technical community, will want assurances before proceeding with waste disposal operations.

The impact of the mine dedicated area experiments on the WIPP design and operation are summarized in Table II. Almost all planned activities will impact some aspects of design and operation.

MINE DEDICATED AREA FACILITY

The mine dedicated area facility in which most of the experiments will be performed is a specially excavated, two-level experimental area in a salt layer whose gross properties resemble those of the proposed WIPP horizons. Space has been allocated to experimental activities, instrumentation allowed, management center, and storage. This dedicated facility in the mine is separated, as far as is practicable, from existing mine workings. The layout for the facility is shown schematically in Figure 2. The schedule for development of this facility during fiscal 1979 is shown in Figure 3.

EXPERIMENTAL ACTIVITIES

The experimental activities are broken down into three groups:

1. Experiments which are in process or planned prior to entrance of mine dedicated area (including work planned at Avery Island with the assent and cooperation of ONWI).
2. Experiments which will commence during and are associated with excavation.
3. Experiments which will commence in the mine dedicated area after it has been completed.

Tables III, IV, and V indicate the anticipated start date, the impact on WIPP operation, and design or WIPP experimental area development for each of the activities. The associated Figures 4, 5, and 6 show the schedules of each of the three groups with relevant WIPP milestones superimposed. A detailed description of these experiments is given in Part II of this document.

IN-SITU EXPERIMENTS IN SALT

PROGRAM MANAGER

— 313 —

FIGURE I -1

EXPERIMENTAL PROGRAM MANAGEMENT MATRIX

	MODELING	LABORATORY	BENCH SCALE	PRE WIPP INSITU	WIPP
TRU CHARACTERIZATION				*	
HLW INTERACTIONS				*	
THERMAL/STRUCTURAL INTERACTION					
NUCLIDE MIGRATION				*	
PERMEABILITY					
BRINE MIGRATION					
BOREHOLE PLUGGING					
OPERATION & DESIGN SUPPORT					
INSTRUMENTATION DEVELOPMENT

NO RADIOACTIVITY IN MINE DEDICATED AREA.

TABLE I
OBJECTIVES OF IN-SITU (MINE) EXPERIMENTS

<u>EXPERIMENTAL</u> <u>ACTIVITIES</u>	<u>OBJECTIVE</u>
Thermal/Structural Effects	<ol style="list-style-type: none"> 1. To obtain experience in simulating thermal effects of canisters containing heat producing waste by using electrical heaters. 2. To collect corrosion data. 3. To simulate thermal field that would be induced as a consequence of high-level waste emplacement. 4. To evaluate the applicability of commercial and specially-designed instrumentation to the measurement of stresses and deformation on a salt under conditions of elevated temperature. 5. To obtain structural stress and deformation data under controlled field scale conditions and elevated temperatures for validation of predictive computational models. 6. To examine compaction, recrystallization, and permeability change of salt backfill in holes in drifts as a function of time and temperature.
Brine Migration	To determine the influence of a heat field on the motion of brine in salt (and, if possible, determine the movement of appropriate non-radioactive tracers in brine); to determine relevant salt-brine material interaction.
Permeability	To measure gas and liquid permeabilities of rock salt in a mine.
Hole Plugging and Sealing	To support, in a fully controlled manner, field demonstrations of borehole plugging and sealing.

TABLE I (Cont.)
OBJECTIVES OF IN-SITU (MINE) EXPERIMENTS

EXPERIMENTAL ACTIVITIES	OBJECTIVE
Operation and Design Activities	<p>The objectives of these tasks are to develop and demonstrate waste handling procedures and to obtain applicable WIPP design data relevant to:</p> <ol style="list-style-type: none"> 1. Emplacement and retrieval of TRU and chemically handled waste 2. Drilling of waste emplacement holes 3. Particulate and humidity measurements for air and ventilation design 4. Identifying inclusions and structural discontinuities within intact salt prior to excavation or emplacement of waste 5. Perfecting a radiation monitoring system that accurately measuring all isotopes and directions to background radiation in a mine
Instrumentation Development	<p>To support the above activities in the design of instrumentation systems to accomplish objectives stated above when commercially available systems are inadequate or unavailable</p>

TABLE II
IMPACT OF IN-SITU (MINE) EXPERIMENTS ON WIPP DESIGN AND OPERATION

EXPERIMENTAL ACTIVITIES	IMPACT ON WIPP DESIGN	IMPACT ON WIPP OPERATION
<u>Thermal/Structural Effects</u>		
In-Situ Determination of Rock Thermal Properties	Improved reliability of calculational results during the design process	Reassessment of WIPP canistered hole design and spacing and related room design considerations in light of experimental data
Evaluation of Limiting Canistered Power Level	Selection of gross thermal loading that is compatible with near field thermal/rock mechanics constraints	
Near-Field Rock Mass Structural Behavior	Selection of emplacement hole depth, diameter and spacing and need for hole sleeving; selection of monitoring instrumentation and procedures	Installation of monitoring equipment WIPP experimental data
Room Closure	Selection of disposal room- and-pillar geometry and dimensions for required stability; monitoring instrumentation, and procedures	Installation of monitoring equipment WIPP experimental data
Heated Pillar Performance	Selection of disposal room- and-pillar geometry and dimensions for required stability; monitoring instrumentation, and procedures	Installation of monitoring equipment WIPP experimental data
Borehole Closure	Validation of calculational procedures--waste container hole sizing	Waste container provisions
In-Situ Stress Changes	Validation of calculational procedures, and monitoring instrumentation and procedures	Installation of monitoring equipment WIPP experimental data
Backfill Consolidation	Backfill/sealing	Retention of backfill

*Many of these activities will also enable assessment of near- and mid-term performance.

TABLE II (Cont.)
IMPACT OF IN-SITU (MINE) EXPERIMENTS ON WIPP DESIGN AND OPERATION

EXPERIMENTAL ACTIVITIES	IMPACT ON WIPP DESIGN	IMPACT ON WIPP OPERATION
Excavation and deposition of backfilling and backfilling methods	Equipment selection and production backfilling; backfill mining procedures	Production operation procedures, operation in experimental area
Excavation and decontam- ination monitoring, also drilling and special rock	Equipment selection and drilling techniques and procedures	Monitoring and operation procedures, operation in experimental area
Analysis of past failures and safety levels	Ventilation circuits, and selection of ventilation and filter equipment	Operational ventilation procedures
Analysis of energy profile	Equipment selection and production	Operational procedures
<u>Instrumentation</u> <u>Development</u>	Impact instrumentation designed for WIPP experimental area and for repository monitoring	Instrumentation design and system and monitor- ing of WIPP experiments

PROJECT STONE CHART

1979

SEPT OCT NOV DEC JAN FEB MAR APR MAY JUNE JUL AUG SEPT OCT

• ISSUE REQ

[] EVALUATE QUOTES

[] NEGOTIATE CONTRACT

[] OFFICIAL APPROVAL

[] EXCAVATION

[] PRE-DEDICATED AREA EXPERIMENTS

EXCAVATION ASSOCIATED EXPERIMENTS

POST-DEDICATED AREA DEC 1

TABLE III
 PREDEDICATED AREA EXPERIMENTS

Experiment	Start Date (1979)	Relevance to WIPP		
		WIPP Operation	WIPP Design	WIPP Exp.
<u>Operation and Design</u>				
Modeling Exchange of Mine Ventilation System and Fresh Air	January		Yes	Yes
Modeling Simulation				
Modeling	February	Yes	Yes	
Modeling	February	Yes	Yes	
Modeling Exchange of Mine Ventilation System	May	Yes		
<u>Instrumentation Development</u>				
Instrument Development Experiment	April			Yes

PROBABILITY

PROBABILITY

PROBABILITY

PROBABILITY

PROBABILITY

PROBABILITY

PROBABILITY

TABLE IV
EXPERIMENTS TO COMMENCE WITH AND FOLLOW EXCAVATION
OF MINE DEDICATED AREA

	Start Date	Relevance to WIPP		
		WIPP Operation	WIPP Design	WIPP Expos
<u>Thermal/Structural</u>				
Subsident Structural Deformation	June	Yes	Yes	Yes
Subsidence At Sylvite Level (if appropriate)	June			
<u>Permeability</u>				
"Nitrogen Pocket" Gas Analysis	June	Yes	Yes	
<u>Operation and Design</u>				
Micro Seismic	June	Yes		
Mine Face Scanning				
Rain	June	Yes	Yes	
Resistivity	June	Yes	Yes	
Particulate Measurements	June		Yes	
Moisture Exchange between Dedicated Area and Mine	June		Yes	
Study of Excavation Technology and History of Excavation	June		Yes	

EXPERIMENTS TO FOLLOWS EXCAVATION FOR MINE DEDICATED AREA

SCHEDULE BASIS

EXCAVATION BEGINS

AMBIENT STRUCTURAL DEFORMATION

////// NITROGEN GAS POCKET ANALYSIS

////// SH:SPIC

////// SCANNING

////// FLUORULATES

////// GASE EXCHANGE

////// EXCAVATION TECHNOLOGY

EXCAVATION

TABLE V
MINE DEDICATED AREA EXPERIMENTS

	Start Date	Relevance to WIPP		
		WIPP Oper	WIPP Design	WIPP Expts
<u>TRU Characterization</u>				
Incorporated into O/D demonstrations				
<u>HLW Interactions</u>				
Corrosion material				
Grouped in heater fields	In heater exps			Yes
Waste forms in heater fields	In heater exps			Yes
<u>Thermal/Structural</u>				
done closures - ambient and heated	11/79		Yes	Yes
single heater experiments	11/79			Yes
Nested heater array	9/80			Yes
Heated room	8/80			Yes
Heated pillar	10/80			Yes
<u>Nuclide Migration</u>				
None (stable isotopes possible in heater fields)	In heater exps			
Tracer experiments	In heater exps			Yes
<u>Permeability</u>				
In situ permeability in mine floor/ceiling	1/80	Yes	Yes	
<u>Brine Migration</u>				
In-Situ Heater Experiments	11/79			Yes
<u>Borehole Plugging</u>				
Salt plug tests at mine level	11/79		Yes	
Media quantification	11/79		Yes	
<u>Operation and Design</u>				
Drilling studies	11/79	Yes		
Storage and retrieval of TRU	11/79	Yes		
TRU operation demonstration	6/80	Yes		
Simulated retrieval of HLW Forms	1981			
Communication system	9/80	Yes	Yes	
Radiation background	11/79	Yes		
Mine Ventilation Studies	5/80	Yes	Yes	
<u>Instrumentation Development</u>				
Borehole closure devices	In hole closure			
Thermal probe	8/79			
Stress and deformation sensors	8/79			

MINE DEDICATED AREA EXPERIMENTS (THERMAL/STRUCTURAL AND BRINE MIGRATION)

SCHEDULE BASIS

MINE DEDICATED AREA EXPERIMENTS
(OPERATION AND DESIGN, AND BOREHOLE PLUGGING)

SCHEDULE BASIS

FIGURE 6B

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PRE-WIPP IN-SITU EXPERIMENTS IN SALT

PART II
PROGRAM DESCRIPTION

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PART II - PROGRAM DESCRIPTION

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FOREWORD

The following document presents plans for in-situ experiments in a specific location in southeastern New Mexico. Schedule and facility design were based on features of a representative local potash mine and on contract negotiations with mine owners. Subsequent WIPP program uncertainties have required changes in the implementation of the activities discussed here; however, the general schedule for various activities is appropriate for future planning. This document represents a matrix of in-situ activities to address relevant technical issues prior to the availability of a bedded salt repository.

This document is a program description for a comprehensive suite of in-situ (field) non-radioactive experiments to be performed in bedded salt. These experiments are responsive to both scientific and engineering issues that relate to the geologic disposal of radioactive waste in bedded salt formations in southeastern New Mexico. Most of the activities enumerated here will be completed prior to the underground development of the WIPP facility, and will thereby support extensive radioactive waste experiments which will be performed in the WIPP.

In-situ activities are described which will be performed before, during the excavation of, and within an underground facility in which various phases of the pre-WIPP experimental program can be performed.

The first section of this document gives the relationship of these specific activities to the overall WIPP experimental program at Sandia Laboratory and correlates each activity to specific waste-isolation issues.

The second section gives a brief description of the mine dedicated to the salt, which is to be developed for experiments.

Sections III, IV, and V enumerate experiments in three specific categories:

1. Experiments being conducted in southeast New Mexico and Avery Island prior to the availability of this dedicated area.
2. Experiments beginning during the excavation phase of the mine dedicated area.
3. Experiments which will commence in the dedicated area after it is excavated and ready for occupation.

The experiments underway or now in planning are described in some detail. Longer-range experiments not initiated in FY79 are given in less detail.

Section VI includes a brief comparison of these experiments with those performed previously in Project Salt Vault, and currently in the Avery Island and Asse salt mines. Section VII outlines the program management.

The contents of this program plan reflect plans developed in FY75 and FY78 and previous discussions with the former Office of Waste Isolation (OWI). Coordination and discussion with the Office of Nuclear Waste Isolation, ONWI, and the USGS is also reflected. The experience gained with the GSF program at the Asse Mine in West Germany by A. R. Sattler was also quite beneficial in the development of relevant in-situ experiments. The present and planned experiments in the Avery Island salt mine are also recognized in the development of this plan. This program description represented the plan as of April 1, 1979.

 

Don't miss: The 2016-2017 season will feature a variety of new shows, including "The Great British Bake Off," "The Great British Sewing Bee," and "The Great British Garden." These shows are all set to premiere in the autumn months.

Area: _____

WIPP:

[illegible]

FIGURE I-1

EXPERIMENTAL PROGRAM MANAGEMENT MATRIX

	MODELING	LABORATORY	BENCH SCALE	PRE WIPP INSITU	WIPP
TRU CHARACTERIZATION				✱	
HLW INTERACTIONS				✱	
THERMAL/STRUCTURAL INTERACTION					
NUCLIDE MIGRATION				✱	
PERMEABILITY					
BRINE MIGRATION					
BOREHOLE PLUGGING					
OPERATION & DESIGN SUPPORT					
INSTRUMENTATION DEVELOPMENT					

BENCH SCALE &
INSITU PROGRAM

NO RADIOACTIVITY IN MINE DEDICATED AREA.

 

DESCRIPTION OF OVERALL EXPERIMENTAL PROGRAM

The remainder of this section gives the overall experimental program and the key concepts for each program area, with special emphasis on the WIPR program area.

Thermal Structural Interaction

The thermal structural interaction is one of the experimental program areas in which WIPR is involved.

1. To provide predictions of elastic-plastic behavior of materials.
2. To establish the constitutive model for the material.
3. To determine the mechanical properties of the material.
4. To determine the thermophysical properties of the material.
5. To determine the mechanical properties of the material.
6. To determine the thermophysical properties of the material.
7. To determine the mechanical properties of the material.
8. To determine the mechanical properties of the material.

The purpose of the thermal structural interaction is to provide a comprehensive view of the material properties from a practical viewpoint.

1. To evaluate the performance of the material properties of the material under the conditions of the material properties of the material.
2. To evaluate the performance of the material properties of the material under the conditions of the material properties of the material.
3. To evaluate the performance of the material properties of the material under the conditions of the material properties of the material.
4. To develop a framework for the material properties of the material under the conditions of the material properties of the material.

1.1.1. Description:

The purpose of the thermal structural interaction is to provide a comprehensive view of the material properties from a practical viewpoint.

temperature, stress, and deformation fields. The technique has been developed to incorporate both ambient and thermally induced forces. Supporting calculations are performed to define commensurate deformation and temperature experiments. Interaction between these experiments and modeling for the model's capability is validated.

parameters which characterize the thermophysical properties of a material. Measuring thermal conductivity, thermal expansion, porosity, and thermal transmittivity, are being performed. Triaxial tests and creep tests both uniaxial and thermal creep behavior are performed on pressure-bearing creep apparatus. Data are obtained for both salt and aqueous surrounding media.

1. The first stage included a series of field tests in southern Russia with pit-layers. Measurements of structural deformation of pit-layers were made under conditions of various combinations of heater exposure, as well as of soil relative deformation is monitored.

Permeability

Agitation:

1. To estimate the permeability of SENNM rockbit sealant plugs as a function of temperature, confining pressure, and time.
2. To estimate the radial borehole permeability of the SENNM sealant plug.
3. To estimate the radial permeability in the sandstone.
4. To derive models for assessing the impact of sealant plug permeability integrity.
5. To quantify consolidation and permeability changes.

Notes:

[illegible]

General description:

Laboratory studies on the pyrolysis (argon, hydrogen, nitrogen) of polymers have been completed and summarized [Suharsana et al., 1992; SAMD-2001]. Field tests have been conducted on core with a high rate of burial, threat to the previous lithostatic stress state. Burial is inevitable, will include in-situ confirmation of laboratory results. The field will be the borehole plugging task.

Brine Migration

Objectives:

1. To determine brine migration rates and mechanisms under applied thermal gradients for salt and other appropriate compounds;
2. To determine the dependence of brine migration on temperature and stress states;
3. To determine the sensitivity of brine migration to the local and regional geochemistry of halite and other compounds;
4. To evaluate engineered barriers to the consequences of brine migration if it occurs.

Notes:

An understanding of the phenomena of brine migration is essential for the performance of heat production within a natural geologic repository. Laboratory data on brine migration exist for KCl crystals, natural rock, and a "model Salt Vault" and WIPP indicate "migration" of liquid brine from the vault, and a "maximum brine inflow" for a WIPP cavern has been estimated. However, the knowledge of phenomenological details of brine migration is highly fragmented. The issues surrounding brine migration are characterized by controversy because of the lack of an agreed definition. Only when sufficient data are obtained will it be possible to determine whether brine migration is a significant hazard.

General Descriptions:

Both qualitative examination of KClM crystals and quantitative measurements of migration, content, and macroscopic behavior in thermally stressed systems will be performed. Measurement of rates of movement of macroscopic quantities of water through salts and characterization of other calculated properties of rocks subject to a thermal gradient will also be done. An additional objective includes analysis of the movement of individual ions established in the migration experiments. The results of the latter experiments will be used to determine what brine migration will be performed to assess the possible consequences of brine migration and associated effects.

Borehole Plugging

Objectives:

1. To develop, test, and evaluate candidate cementitious and non-cementitious materials for use in a field experiment, the laboratory and field tests testing program;
2. To integrate plug design into the development and implementation of the geochemical program to ascertain and verify the importance, timing, and suitability of cementitious and other materials in well bore plugging materials;

3. To assess, develop, and modify appropriate instrumentation techniques to obtain the data required to verify plug performance;
4. To provide an in-situ environment for emplacing and evaluating potential plug designs.

Needs:

1. **Materials.** The identification and evaluation of cementitious materials for use as well-bore plugs is required to support the demonstration of a feasible isolation technology to preclude the leakage of fluids to the WIPP facility and the egress of water-borne radionuclides from the facility via man-made penetrations. Failure to demonstrate a satisfactory WBP technology could cast doubt on the long-term isolation of the repository from the biosphere. Selection of grouts as initial plugging candidates is appropriate since a well-developed emplacement technology exists. However, long-term suitability must be assured, and this requires the application of geochemical and rock mechanics principles. Demonstration of grout suitability will be pursued in concert with evaluations of alternative plugging materials. The latter include natural materials and synthetic salts and clays which may be tailored to match the stratigraphies encountered by shafts or boreholes.

The development and assessment of these various plugging materials focus for near term effects (operation periods) with field test and demonstrations and for longer term compatibility (repository lifetime) with laboratory studies and theoretical analyses will provide candidate plugging materials which provide an additional measure of isolation through the sealing of repository penetration.

2. **Instrumentation.** This program supports the field-test and laboratory programs to obtain data required to evaluate plug performance.
3. **Field Tests.** This program provides an in-situ experimental environment. The proof that materials can be identified and emplaced, restricting fluid migration along a well bore, must be produced and quantified, and provided as evidence that the public health and environment being considered. Failure to demonstrate this technology could jeopardize the construction authorization for the WIPP facility.

General Description:

This task will identify, test, and select appropriate materials for plugging boreholes and shafts in and near a waste repository. Criteria for candidate materials include emplaceability, permeability, bond strength, durability, geochemical, thermal and mechanical stability. Initial studies focus on cementitious grouts; later investigations will examine natural materials. Evaluation of cured grout specimens by petrography and electron probe microanalysis will determine mineral phase assemblages. Determination of required thermodynamic properties of grout minerals coupled with thermodynamic evaluation of reactions between grout and rock minerals will be performed to determine the potential for grout degradation.

This subtask will also identify instrumentation requirements for quantifying in-place plug performance with regard to seepage, cure strength and other aspects of plug adequacy and will lead to the design and development of the required instrumentation. Both short-term, readily available instrumentation and long-term development of instrumentation systems which will survive for very long lifetimes will be assessed and addressed within the program. In addition to laboratory studies, field tests will be performed to provide in-situ evaluation of material properties and emplaced candidate plug designs. The proposed test matrix will be directed initially toward assessing potential plug design adequacy, strength, durability, and host rock bond with the long-term goal of developing and testing alternative plug materials identified during the course of the program development.

Operation and Design

Objectives:

1. To obtain a suitable salt horizon in an active path near to, but not the in-situ, non-nuclear waste simulation phase of the overall experimental programs leading to the WIPP experimental facility;
2. To design, excavate, and prepare the pre-WIPP test chamber to carry out the planned scientific experiments and evaluation of engineering, operation and design assumptions;
3. To implement phases of the experimental program which address the operation and design issues pertaining to operational safety, risk assessment modeling, and salt interactions.

Needs:

This subtask is an integral part of a phased experimental program leading to development of the WIPP experimental facility in about 1986. The fundamental goal of this subtask is to obtain scientific and engineering data that address the design aspects applicable to emplacement and containment systems, facility design, and operation of the WIPP. In general, the results of the experiments will be important to safety-and-consequence analyses, Title II design, and other licensing-related activities should WIPP be licensed. For certain experiments, the importance is more directly aligned with assurance of performance operational safety and in-situ experiments planned for the WIPP facility.

The WIPP Waste Acceptance Criteria Steering Committee has pointed out a need for simulated full-scale waste handling demonstrations. Experience gained in field operations with salt at elevated temperatures. Operational problems relating to ventilation, drilling emplacement holes, underground communications, and safety will be addressed. Methods of remote handling, control, contact salt must be evaluated and adapted to WIPP. Related engineering and background questions need to be addressed prior to WIPP operation.

General Description:

The principal activities in this subtask include the design and facility support for the experimental program and the definition and implementation of experiments which will serve to support the development of operating procedures and verification of design assumptions.

These latter activities include some preliminary activities in a mine as well as those in the pre-WIPP dedicated area. Task activities include work in areas of simulated waste handling and retrieval, operational issues (emplacement hole drilling, ventilation, mine safety communications), work on intact salt, scanning intact salt for anomalies (brine, gas pockets), and questions related to radiation background.

Instrumentation Development

Objectives:

1. To support WIPP mine experiments by providing appropriate instrumentation to achieve experimental objectives;
2. To assure that the best methods available will be used in the direct monitoring programs of the WIPP facility.

Needs:

Several borehole closure measurement requirements to accompany heater experiments (on-line devices) have been identified. A suitable way to monitor stress in salt is a well-recognized need. Methods to determine exact locations of measuring devices in heater experiments must be established. The standard heater-thermocouple method of measuring thermal conductivities is cumbersome; a simpler method (e.g., a probe) is desirable. The need for long-term monitoring has been identified and will be addressed as specific requirements are developed.

General Description:

The philosophy of the instrumentation development is simple. When an instrumentation need arises it will be filled if possible by an off-the-shelf instrument. If this is not appropriate, an attempt will be made to modify existing instrumentation. If that is not possible and the need is critical for a given WIPP task, then a development program will be undertaken.

Development work will be continued on transducer systems for in-situ stress, borehole closure, and extensometers. The thermal probe for determination of in-situ thermal properties will be completed and field certified. Borehole survey devices will be adapted for use in supporting field programs appropriate signal conditioning, and fieldable recording systems will be integrated into each instrumentation package.

SECTION II

DESCRIPTION OF DEDICATED AREA MINE FACILITY

The planned facility for the mine dedicated area is shown in Figure II-1. General space allocations for the various experiments are indicated on the drawing. Recording alcoves, storage areas, and operations management areas are also shown.

Preliminary distribution of power has been made and will be detailed in the operations plan (SAND79-0623) along with a more detailed facility description.

The facility has two levels to best utilize a layer of salt 15-20 feet thick which is accessible to the horizons already mined by ramping. This salt has gross chemical and physical properties similar to the WIPP CH and RH horizons, although the detailed geochemistry may have differences with the two WIPP horizons. A comparison of some specific properties is shown in Table II-1. Preliminary analysis of the salt proposed for the dedicated area was taken from the same layer of salt at the appropriate location in ERDA 3. The regional characteristics of the salt were assumed to be generally uniform in this preliminary work. The correspondence with the WIPP horizon is shown in Figure II-2. The salt above and below this seam, though thin, will be adequate for some experiments and is an adequate bounding material for the team in which most of the activities will be conducted. The geographic relationship between the WIPP site and the mine dedicated area is shown in Figure II-3.

The upper level access, on top of the salt seam, will utilize the salt directly, drilling into it (heater experiments, hole closures, etc.), whereas the lower level is centered in this 15-20 foot salt seam for ambient and heated plume experiments, etc. This arrangement also provides an option for experiments in salt with higher impurity and brine contents.

The primary experiment horizon is close to existing mine work and is accessible by ramping down some 10-15 feet as shown in Figure II-1. This layer was chosen both for its accessibility and gross resemblance to WIPP salt.

The design is to provide the minimum development required to establish two-level experiment facility while providing adequate ventilation and independent escapeways. Large pillars are left on each of the two working levels, and additional entries can be excavated into those pillars to provide chambers for further experiments. The three entryways into this mine chambered area will remain relatively clear to provide easy access to all experiment chambers as well as potential escapeways.

The entries have been standardized to cross-sections of 8 x 21 feet. This size is optimum for mining and compatibility with the excavation of the capacity of the experimenters. An exception is the Heated Room experiment. Additional headroom is desired in that area to accommodate the lowering of heated canisters. Also, since much of the upper level is used for drilling into the salt seam in the floor, additional headroom--10 feet--is planned for the entire upper level to facilitate this drilling.

Figure II-1. Schematic of Mine-Dedicated Area

[illegible]

FIGURE 10-1. GEOLOGIC CROSS SECTION

DEDICATED AREA
LOCATION

1
2
LONGITUDE 110° 15' W

110° 15' W

TABLE II-1

GROSS COMPARISON OF PHYSICAL PROPERTIES OF RH, CH, HORIZONS
WITH SALT AT DUVAL MINE

	<u>WIPP SITE</u>		<u>DEDICATED AREA</u>
	<u>CH</u>	<u>RH</u>	
MEAN DEPTH, ft	2125	2675	1080
DENSITY	2.12	2.11	2.11
P WAVE, micro sec/ft	59	69	60
S WAVE, micro sec/ft	121	120	120
YOUNGS MODULUS, psi $\times 10^6$	4.9	4.9	4.95
POISSON RATIO	0.25	0.25	0.25

MINERALOGY

	<u>TYPICAL ESTIMATES-WIPP SITE</u>		<u>THEORETICAL-DEDICATED AREA</u>
	<u>CH</u>	<u>RH</u>	
HALITE, %	92	97	91.6
ANHYDRITE, %	--	2.1	--
DOLYHALITE, %	2	--	1.7
CLAYS, %	2	1.5	2.0-2.5
KALINITE, %	1	--	1.7
GYALITE, %	1	--	1.7

WIPP Site mineralogical quantities typical estimate. More being done for geochemical properties for WIPP horizons are being tabulated.

Physical properties from ERDA-9 geophysical logging program.

Properties for prospective dedicated area taken for equivalent lithology horizon. Theoretical calculations were made from the ERDA 1980 logging data for minerals and estimates in dedicated land.

Geochemical properties from logs of ABC No. 3 for equivalent horizons of CH and RH.

The schematic plan layout of the three entries and cross-cuts are shown in Figure II-4. The upper and lower levels have identical shape. Each is developed by three parallel entries. Cross-cuts are placed at the beginning and end of each level. The unexcavated pillar sizes are a combination of 51 x 41 and 123 x 141 feet. Additional excavation of these pillars is visualized, but obtaining in excess of 60 percent extraction will be permitted.

The three main entries coincide with extensions of existing headings on the lower level of the host mine. The length of the unexcavated pillar has been reduced to accommodate two additional cross-cuts measuring 9 x 21 feet supported by 33-foot pillars. Such development results in an eventual extraction ratio of 56.7 percent.

Figure II-4 also shows relationship with existing mine workings. Note that the facility will be away from the existing workings. No mining has taken place below the dedicated area. There is a sylvite level approximately 10 feet above the dedicated area; however, little development has been accomplished in the portion of the sylvite level above the dedicated area. This should provide a relatively virgin, i.e., unstressed area, which should be ideal for many of the experiments.

The schedule for acquisition and development of the dedicated area is shown in Figure II-5.

Figure 11-5. MILESTONE CHART

SECTION III

PRE-MINE DEDICATED AREA EXPERIMENTS

A limited suite of experiments in preash mines is already underway or in the advanced planning stage. Most of these experiments are being performed at the Duval Nash Draw mine and are listed by experiment category. One experiment performed at Mississippi Chemical Company is being conducted; it is deferred until late but is not included in the planning summaries. These experiments, then, are being done in advance of the availability of the mine dedicated area, and a schedule is shown in Figure III-1. In the following paragraphs the experiments, with their identification number, are listed under the appropriate program area.

Thermal Structural Experiments

Pillar Failure Experiment at Ambient Temperatures (Exp. 3-4a). A joint effort between Sandia and Mississippi Chemical Company is being completed to conduct a pillar failure at ambient temperature conditions in an ongoing mine operation. The mining system employed by Mississippi Chemical Company involves 90 percent extraction of the ore (80 percent NaCl, 20 percent KCl). The remaining 10 percent is left in the form of a symmetrical array of pillars in which undergo severe deformation over relatively short periods of time. This mining approach provides an unique opportunity to monitor pillar failure, to document the failure mechanisms, and to compare measurements with calculations.

The problems associated with this monitoring activity involved both instrumentation of an experimental area, a proximity to an active mining operation and various aspects of mine safety. In order to conduct this experiment at a distance of approximately 1000 feet from the instrumented pillars, long cable runs, cable jumpers, and junction boxes were necessary. The design recording mitigates problems associated with an ongoing mining operation. Automated readouts, using potentiometers (vs. dial gauges), were necessary for personnel safety.

The work underground is complete, a laboratory program for determining material constants to use in the pillar calculations is underway, and the experimental data analysed will commence upon completion of the instrumentation program. A schematic of instrumentation plans for the pillar and adjacent areas is shown in Figure III-2.

In all requirements for an ongoing mining operation, safety must be considered. The experimental areas after gage installation lie in the banked area. Fireways or radiation potential, are anticipated in WIPP. Experiments in this nature will ensure that similar experiments will be carried out in the WIPP facility in an efficient and safe manner.

Figure III-1PPF DEDICATED AREA EXPERIMENT

SCHEDULE BASIS

SEAL AND BRINE MIGRATION TECHNIQUE DEVELOPMENT

MOISTURE EXCHANGE OF MINE VENTILATION SYSTEM WITH OUTSIDE AIR

MINE FACE SCANNING (RESISTIVITY)

MINE FACE SCANNING (RADAR)

RADIATION BACKGROUND

Operation and Design Activities

Moisture Exchange Between Mine Ventilation System and Outside Air (Exp. 8-10). Measurements of moisture exchange in the mine ventilation system with the outside air and the drift surfaces is continuing in FY79. These data will be used in considering the backfill of rooms, corrosion, brine production, and ventilation design. Measurements of air pressure, relative humidity, and temperature are made at the intake and exhaust shafts of a mine, on the surface and, where possible, in newly mined and older areas of a mine. The object is to determine the moisture exchange balance between the mine and the atmosphere and to note any seasonal variations.

Moisture content of intake and exhaust air is monitored with dew point hydrometers (B3G Model 880) equipped with a filter system to minimize effects of mine particulates on the instrumentation. Data from the hydrometers is recorded at 20-minute intervals.

Temperature and pressure measurements are required with each hydrometer. A battery-operated psychrometer (Bendix Model 566) is used in conjunction with the dew point hydrometers, and the humidity is also measured with this psychrometer.

Background Radiation in a Mine (Exp. 8-13). This series of measurements will provide data required as input to a radiation safety system design for accurately measuring all isotropic contributions to background radiation in a mine. This radiation safety system will be developed before the operational phase of the WIPP facility. The system will be sufficiently sensitive to detect any changes in the background radiation due to possible contamination. It will be the first step in the design of a radiation safety monitoring system which will detect small levels of contamination and identify the isotope causing the contamination. Spectroscopy systems relying on solid state detectors are planned. The naturally existing background (principally ^{40}K) in salt/potash mines will be carefully monitored. Sensitive spectroscopy systems will detect small amounts of contaminants or other background components superimposed on the background. This activity, initiated in FY78, will continue through FY80.

Mine Face Scanning (Exp. 8-16). The mine face scanning activity will reactively identify brine or gas inclusions within salt prior to excavation. These techniques have been developed and applied in salt/potash mines in West Germany. These are not entirely developmental techniques, although they have not been utilized in this country.

Basically the techniques involve (a) radar, using reflected radiation; (b) RP, using transmitted waves; and (c) electrical, involving resistivity measurements. These techniques could be used in the WIPP mining phases (operational safety), the waste emplacement phases (operational safety), and, in cases of retrieval, to accurately locate canisters. It may be possible to map approximately 100 meters above, below, and around the WIPP facility for any detectable anomalies and to map the relative electrical resistance of each pillar for relative moisture content. Electrical methods (resistivity) can also be used to determine whether brine pools are connected and to estimate the relative water content in salt and significant changes in water content of a given salt mass; e.g., any variation of water content of a pillar.

Brine pools, gas pockets and very wet salt all give characteristic responses to electromagnetic radiation when they are found in dielectric properties. Brine pools produce reflections to radar signals, and salt with a very high brine content rapidly attenuates incoming electromagnetic radiation.

Study is being made in an operating potash/salt mine for the initial use of these techniques in order to develop proficiency in experimental techniques. For the radar and RF devices, a sequenced measurement program will be undertaken to develop proficiency in using these instruments and at a validation of their capability. The first measurements with radar and electrical resistivity equipment have been initiated in FY79 (February)* and will continue in FY80. Schematically the use of this technique is displayed in Figure III-3. A resistivity probe developed for use in salt is shown in Figure III-4.

Instrumentation Development Experiments

Pre-dedicated Heater Experiment (Technique Development) (Exp. 9-9). An agreement has been reached with the Duval Chemical Company for a heater technique development experiment. While the primary purpose of the activity is to develop and prove out a new heater concept (quartz lamp), a strong secondary objective is technique development for in-situ investigation of brine migration phenomena. Other issues, insofar as possible, will be addressed with the deployment of this developmental heater. A description of the entire system follows.

Being both before and after heater turn-on is planned, an area will be analyzed for free water, chemical and physical changes. Ground measurements (resistivity) to determine shifts of brine in salt will be investigated.

Heater turn-on will occur in mid-FY79. Maximum salt temperatures will be in the neighborhood of 200°C. Radiant quartz lamps will be used to heat a stand-off section of a 5-inch diameter hole drilled into a salt formation. Forced flow of dry nitrogen gas will flow into the base of the heated section to carry off any moisture released. The humidified nitrogen will flow through special desiccants that cumulatively have been shown to absorb over 99 percent of the moisture they contact. The weight gain of the desiccant is the measure of the moisture released from the heater cavity in the salt and will provide a measure of any moisture migrating into the heater cavity.

- * The first resistivity tests for mine face geology were made (2/8, 1979). Although the data have yet to be reduced and analyzed, there are indications that this method has potential for determining relative water (brine) content in salt, whether two brine pools have a water connection, etc. The first radar experiments for mine face also been conducted (1/27-3/1). Although the data have yet to be reduced, brine and voids behind intact material have been detected.

Figure III-3

Concept of Mine Pillar Scanner and Electrical Resistance method of Pillars to Determine Anomalous Features.

FIGURE III-4
RESISTIVITY PROBE DEVELOPED FOR USE IN SALT

The dessicant assembly has been calibrated by measuring the flow of dry nitrogen through a closed glass system containing a measured amount of water. The humidified nitrogen passes through the three measurement dessicant cartridges and then through the overflow cartridge. The measurement cartridges have a combined capacity of about 15 grams of water, and the overflow cartridge will absorb an additional 120 grams.

The overflow cartridge will also absorb many off gas products which can be baked off and analyzed by gas chromatography. Future provisions for sampling the off gas stream will be incorporated if deemed appropriate. A schematic of this experiment is shown in Figure III-5 and III-6.

Experiments to be Performed at Avery Island

A number of experiments will be performed at Avery Island with the cooperation of UNWI. These experiments, to be performed also in the mine dedicated area, have been described in greater detail in appropriate sections of this report.

Borehole Closure Device (Exp. 9-1,2 Instrument Development). An already developed mechanical device is being tested at Avery Island. The original hole size is 8".

Strain Gage Stress Meter (Exp. 9-6 Instrument Development). At UNWI's request, Sandia will utilize some strain gage stressmeters to measure ambient lithostatic stresses in the Avery Island mine.

Thermal Probe Instrumentation Development (Exp. 9-3,4 Instrument Development). The thermal probe developed at Sandia will be utilized at the Avery Island mine. The thermal conductivities measured will be compared with those measured by the heater experiments at Avery Island.

Moisture Exchange (Exp. 8-10 Operation and Design). A data point in the moisture exchange at the Avery Island mine with the relatively damp Louisiana climate will be compared with results from one or more southeastern New Mexico mines.

FIGURE 111-6. SCHEMATIC OF HEATER (AND SPIN MIGRATION TECHNIQUE) DEVELOPMENT EXPERIMENT

SECTION IV

EXPERIMENTS TO COMMENCE WITH AND FOLLOW ONGOING EXCAVATION

The excavation of the mine dedicated area is an integral portion of the mine dedicated area activities. Opportunities exist to test remote scanning methods on salt (mine face scanning), moisture exchange, measurement when newly mined salt faces exist, and particulate measurements in the air and ventilation associated with an active mining machine. Early time structural deformations will be measured, and mine ventilation studies will be made. Analysis can also be made of gas pockets in the mine which may be encountered during the excavation process. These activities will start during excavation and in many cases will continue in the dedicated area. A schedule of these activities is shown in Figure IV-1.

Thermal Structural Interaction Experiments

Structural Deformation Measurements to Follow Excavation of Mine Dedicated Area (Exp. 3-4b). The purpose of instrumenting the pre-WTEP dedicated area for excavation is to obtain data concerning rock responses induced by the excavation. Such data will not only provide information necessary to understand the characteristics of the salt horizon, but will also provide information to be used to amplify particular experimental designs. Types of data which will be gathered include:

1. Roof-to-floor closure
2. Rib-to-rib closure
3. Internal pillar deformation
4. Differential roof sag
5. Differential floor heave
6. Stress changes induced by mining and in situ stresses

These data will not only be gathered during the excavation, but will continue, but will also be gathered through the life of the mine dedicated area to assess long term rock response. Of the suite of experimental work to follow excavation, this will be the most substantial in terms of instrumentation and man hours committed.

Instrumentation and analysis requirements are:

1. Installation of two orthogonal instrumentation lines for determination of vertical closure rates of the roof and floor. One of the lines of measurement will extend the entire length of the face of the dedicated ramps; while the other line(s) of measurement (one or more, depending on levels) would extend across the widest portion of each level.
2. Calculation of intersection closure as a function of time after extraction by measurement of roof-to-floor closure at the center of each intersection.
3. Determination of the volumetric strain of different sized pillars utilizing roof-to-floor closure, internal pillar displacement, and rib-to-rib closure data.

4. Observation of possible differential displacement of the pillars and members caused by roof-fall or other disturbance during the excavation process.
5. Assessment of the pillar loading history by the use of strain gauges in every pillar. Stressmeters will be installed before the pillar is formed by excavation to obtain an empirical loading history.
6. Monitoring of the "crown" stress and deformation history of the roof on one pillar on each level through extensive use of strain gauges in the pillar.

Figures 1 and 2 show preliminary layouts for the various instrumentation systems. Figures IV-2a, IV-2b, and IV-2c for the upper and lower levels show the location of the instrumentation, by type, of the number of installations, and the recording device, sensitivity, and range of the instrumentation. Figure IV-2d is a summary on proposed for use has been provided by the contractor. Other fluid or the associated contractors, therefore, for various reasons, a complete list is not included. A representative example of the instrumentation for the differential roof sag/floor heave instrumentation is also included in Figure IV-3.

A prediction of inherent deformation for the position of the pillars in the 10 percent extraction ratio is obtained in Figure IV-4. The predicted roof-floor closure as a function of localized extraction is provided as a guide for such interpretation. The localized extraction is defined as the percentage of rock extracted in a given area around and about the intersection. The radius used for the localized extraction; however, it will be used constant for all intersections and for the total extraction in the entire intersection area.

Permeability

"Nitrogen Pocket" or Clay Seam Fluid Analysis (Exp. 8-1). As the excavation proceeds, the mine operator will observe the conditions in the ceiling to relieve fluid pressure that may exist. A sample will be taken during this process, or it is planned to take a sample from the fluid in the occurrences and sample these gases. The gas sample will be taken from a gas pocket in salt, as well as the gas sample from the fluid. This will provide useful information of permeability in the floor and roof.

Operation and Design

Mine Particulates (Exp. 8-11). The main purpose of the particulate measurements is to obtain the salt particulate load, however, the measurements of the salt loading in the mine ventilation system will be used in planning and timing support activities. Another important activity is to establish the ability of ventilation systems to remove the particulate transport particulates for the purpose of bounding the dispersion of particulates which may enter the ventilation system and cause health problems.

- The layout of the Upper Level is shown in the diagram above.
- The layout of the Lower Level is shown in the diagram below.

FIGURE IV-2a

TABLE IV-1

MEASUREMENTS OF GROUNDWATER LEVELS IN THE FLOOD EXPOSURE
DURING FLOODING AREA

MEASUREMENT POINT	ELEVATION		MEASUREMENT METHOD	MEASUREMENT DEVICE	MEASUREMENT FREQUENCY	COMMENTS
	1974 LEVEL	1975 LEVEL				
POINT 1 (FLOOD EXPOSURE)	10	10	AUTOMATIC	PRESSURE METER	DAILY	DRAINAGE TO BE DETERMINED DURING MINING
POINT 2 (FLOOD EXPOSURE)	24	24	MANUAL	FEED TUBE EXTENSOMETER	MONTHLY*	
POINT 3 (FLOOD EXPOSURE)	200	200	MANUAL	DATA EXTENSOMETER	MONTHLY*	
POINT 4 (FLOOD EXPOSURE)	1	1	MANUAL	PRESSURE GAUGE	MONTHLY*	
POINT 5 (FLOOD EXPOSURE)	10	10	AUTOMATIC	PRESSURE METER	DAILY	
POINT 6 (FLOOD EXPOSURE)	1	1	MANUAL	FEED TUBE	DAILY	
POINT 7 (FLOOD EXPOSURE)	4	4	AUTOMATIC	FEED TUBE EXTENSOMETER	DAILY	
POINT 8 (FLOOD EXPOSURE)	10	10	AUTOMATIC	FEED TUBE EXTENSOMETER	DAILY	

* Measurements are taken daily, weekly, and monthly as response to flooding.

CORE AND BOREHOLES (SELECT ANCHOR DEPTHS
FROM CORE LOGS)

FIGURE IV-3

Differential Post Supports (Core Logs)

FIGURE IV-4. Asymptotic Roof-to-Floor Closure as a Function of Extraction Ratio From a Viscoelastic Analysis with a Transient Creep Law.

During the excavation of the mine dedicated area, samples from the airstream returning from the area where the miner machine is working will be taken. These samples will be taken at various distances from the mining face. The samples will be analyzed to establish the size distribution of salt particulates in the airstream as a function of distance from the generation point.

Tests will be conducted later to establish the threshold velocities at which the ventilation airstreams will pick up and transverse (by carrying or sweeping) different sizes of particles. Results will relate airstream velocity with particle size and density for particles motivated. Particles of known size and density and of a material foreign to that in the mine will be injected into the ventilation stream, and travel distances of the particles will be measured. These data will allow a systematic prediction of the extent to which particulates introduced into vent streams by fire or accidents will be dispersed.

Microseismic Measurements (Exp. 8-20). Microseismic (geophone) monitoring as a potential mine safety device will commence sometime during excavation and continue after excavation. The Bureau of Mines and the German Geological Survey (ASAG) are using this method as a back up to structural deformation work for mine stability monitoring.

Mine Face Scanning, Radar and Resistivity (Exp. 8-16a, b). The excavation of this facility will provide a unique and ample opportunity to test the available methods for scanning intact salt. These activities have been described in Section III.

Moisture Exchange Between Mine Dedicated Area and the Rest of the Mine (Exp. 8-10). A moisture exchange measurement will be made between the new excavations for the mined area and the rest of the mine. This measurement, described in detail in Section III, will more nearly approximate early WIPP conditions than measurements made at the intake and exhaust shafts in the existing mine. Information on hygroscopic effects of new mine faces as a function of time will be obtained.

Later, a controlled moisture exchange experiment on a room-size scale is planned to determine and demonstrate the rate and amount of moisture absorbed versus the humidity, the effect of relative humidity on corrosion, and the behavior of oxidized salt versus humidity.

Assembly of a Gas Detection System for Use in a Mine (Activity 8-18). A system to detect gases is being assembled in FY79 for use in a mine. This is primarily for industrial and mine safety and will be used in any excavation and drilling connected with pre-WIPP (mine) activities.

Gas pockets can be encountered in excavation in the mines of southeast New Mexico. As previously discussed, in some mines drilling is done into the ceiling to relieve gas pressures during the development of new areas. In drilling holes to install rock mechanics gages in our mine dedicated area as well as during excavation of the mine dedicated area, it is possible that gas pockets can be encountered.

Excavation Technology (Exp. 8-21). A history of excavation, power used by the mining machine, and the duty cycle of the mining machine will be maintained. An accurate time history of excavation, at the very least, is essential for the rock mechanics activities to follow the ongoing excavation. These data will be very useful in making projections for WIPP itself as the excavation of the mine dedicated area is made in salt (not potash) and must be done to a higher degree of precision (as would be characteristic of WIPP) than for simple extraction of ore.

SECTION V

MINE DEDICATED AREA EXPERIMENTS

The mine dedicated area will provide a facility for pre-WTPP in-situ experiments. Thermal/structural experiments, borehole plugging activities at the mine level, operation and design activities, and instrumentation development activities will be implemented. High-level waste interaction and uranide migration will be simulated with heaters and stable isotopes. A schedule of these activities is shown in Figure V-1a and V-1b.

Thermal Structural Interactions

Hole Closure Measurements (Exp. 3-5). Hole closure measurements will commence as soon as there is an area dedicated to the pre-WTPP in-situ experiments. Hole closure measurements in orthogonal directions will be made at ambient and elevated temperatures in the study area to obtain data on existing stress fields and the effect of heat on the stress fields.

This experiment is being coordinated with the experiment to obtain preliminary drilling data, and hole sizes of 1-1/8", 4", and 8" will be used initially. Holes will be drilled to about a depth of 20 feet in the rib and floor. The data will provide hole closure as a function of depth and orientation using special sandia-designed hole-closure devices (see instrument development).

Thermal Field Experiments

Initial Heater Experiments (Exp. 3-6). The objectives of the thermal field experiments are:

1. To obtain experience in simulating thermal effects of canisters containing heat producing waste by using electrical heaters;
2. To determine the influence of a heat field on the motion of brine in salt and possibly determine the movement of appropriate non-radioactive tracers in brine; to determine relevant salt-brine material interaction;
3. To collect corrosion and leaching data by recovery of stacks of various types of coupons buried in the heated salt as well as examination of instrumentation components recovered from the salt after termination of the heating phase;
4. To simulate thermal fields related to design loadings up to 150 kw/acre or greater on a local basis. A small portion of the heated area of salt will be subjected to temperature rises in excess of 200°C in order to assess whether thresholds for other phenomena are reached;
5. To monitor structural effects in heated salt.

MINI DEDICATED AREA EXPERIMENTS
THERMAL, STRUCTURAL AND BRINE MIGRATION

SCHEDULE BASIS

FIGURE V-16. MINE DETECTION AREA DEVELOPMENT
OPERATION AND DESIGN AREA DEVELOPMENT

SOUTHERN PACIFIC

Three heater experiments will be installed and turned on as soon as the dedicated area in a suitable salt region is available. One heater (Exp. 1, in more detail later) will be primarily for brine migration and structural effects described here, will concentrate on structural effects. The instrumentation associated with these heaters to measure thermal, chemical, and structural changes, and problems characteristic of long-term operation will be reconciled with these first heaters. More heaters will be installed. Single heaters would be used for such short-term projects as:

1. Retrieval procedures--one of the two heaters will be removed and the other unsleeved.
2. Monitoring on line and/or by caliper, the brine migration in the unsleeved situation, as well as pressure in the brine region and the backfill in the sleeved situation.
3. Determining if microcracks in salt are formed upon heating.

The heater for the experiment concentrating on brine migration will be a metal canister with a 4 foot heated length inside of a 6 foot long sleeve. Steel has been chosen for the heater canister material. Maximum temperatures of approximately 200°C are planned. Structural and chemical effects will be emphasized.

Instrumentation will include stress gage extensions, thermocouples, an on-line hole-closure device. A strain gage array will be used to measure the deformations in the sleeve and the heater. A pressure transducer will measure the pressure. The canister design will incorporate provisions for monitoring early corrosion and leaching. Efforts will be directed toward measuring this structural effects activity in addition to the brine migration before and after heating. Brine migration will be monitored by caliper and integrated as they address more than just the migration of brine.

It is anticipated that a fourth long-term experiment will be installed. Evaluation of getters will be designed and will be turned on about 12 months after the mine dedicated area is turned over to the experiment. Getters are important for the evaluation of backfill and the brine migration. They could provide another barrier for rad. products migration and for the migration of brine. The experiment will measure thermal, chemical, and structural changes, brine uptake and/or transmission of brine, and the chemical and physical properties. Ultimately three or four such experiments will be installed. Various getter-crushed salt temperature variations will be used. The heater used for these studies will be approximately 4 feet long and 6 inches in diameter, 4 feet long.

Nested (Multiple) Heater Array (Exp. 3-7). Sometime after the first two initial heater experiments, a more extensive heater array will be installed to address the question of brine migration (including the migration of dissolved tracers). An attempt will be made to collect and analyze the off-gas products will be analyzed in a mine. The array will be used for bench-scale experiments. The nested array will be composed of a number of heaters at different temperatures and different volumes of brine. The heaters will be

and the in-situ properties of salt around approximately 200 μ g. Sufficiently steep temperature gradients would be provided to measure properties thought to be gradient dependent, e.g. brine migration. Corrosion coupons will be inserted.

Thermal deformation about the heaters due to the impression of the heat shield will be measured both vertically and radially, and measurements to predict the stress changes will be attempted. Measurements of transfer heat fluxes between heated salt and mine air will be made.

Exp. 3-7 will be one of the main heater experiments in the dedicated area. Since this activity is to be preceded by at least two heater experiments in the dedicated area as well as one outside the dedicated area, it is unlikely that this experiment will start in FY79. Clearly this Activity will be an integrated experiment addressing more than a single technical issue.

Heated Room (Exp. 3-8). A demonstration to investigate water-vapor transport in a heated room is planned. Deformation measurements will be made during the heating phase. The measurements of room pressure during the heating will be used to develop predictive capabilities for appropriate design decisions concerning the HLX experimental area. Comparison of ground-based data will be a consideration in designing this activity. A comparison of ground-based and more early scaling calculations are shown in Figure V-2. Some of the primary work is scheduled in FY79, i.e., dimensioning of the room and determination of power requirements.

Dimensioning of the predicted roof-to-floor closure, and the size of the room in the dedicated area, with 20 kw meter is shown in Figure V-3. This activity is to be coordinated with the HLX experimental area to support the design activities in the construction of the HLX experimental area. In this heated room is water vapor, and the water vapor will be measured prior to retrieval. The activity, described here, is the design of the vent thermal/structural system but is a part of the design of the HLX experimental area demonstration.

Heated Pillar (Exp. 3-9). A heated pillar test represents a technical issue in the HLX experimental area activities (see Table). Excavation of the pillar test area will precede the major undertaking of the HLX experimental area. The heater emplacements in the pillar are presently being designed. The measurements of the heated pillar will be used to develop predictive capabilities, verify the creep law for SEMI data, and to support the preparation of necessary safety reports. Due to the timing of the present design of the HLX area, carrying a heated pillar experiment to failure, the heated pillar will be turned off at some pre-determined pillar failure. The activity will be scheduled in final design effort of WIPP for final construction of the HLX experimental area. Preliminary planning of the heated pillar is shown in Figure V-4. A schematic of the heated pillar is shown in Figure V-4. The heated pillar is located in the center of the room next to the heated room. The heated pillar is shown in Figure V-3, Model 11-1. The heated pillar is 14-ft wide, approximately 60-ft long, and will be located in the layout of the mine dedicated area, Figure V-3.

FIGURE 10-41. Relationship between normalized stress and normalized strain for different concrete strengths.

FIGURE 10-1. PRE-MIX ENVIRONMENTAL TEST ANALYSIS

W-4. 11

In-Situ Permeability

This activity is an additional effort to measure gas permeability in actual rock salt geologies. A significant concern in repository design and waste acceptance criteria is potential gas generation, its rate of permeation through rock salt, and its effects or consequences on long-term repository integrity. Gas production can result from degradation of wastes and waste containers (via radiolytic, thermal or pyrolytic, chemical-corrosion, or possibly bacterial mechanisms), or waste-geology interactions (e.g., radiolysis of brine).

The laboratory measurements have been made on borehole cores for nitrogen and hydrogen at various confining pressures and temperatures. These results allow reasonable estimates to be made of the in-situ permeabilities, especially at temperatures not easily available in the field.

The first field measurements will concentrate initially on borehole measurements (Exp. 5-2a) at depths of 1500 to 3000 feet, incorporating a typical repository section. This will allow, via a guarded packer arrangement, establishing the overall formation permeability of gases for the bedded salt at depths envisioned for the WIPP. These tests are part of the borehole plugging program and are more fully described in the Salt Plugging Plan (SAND79-0739). Early in FY80, the mine experiments (Exp. 5-2b) will allow more finely (spatially) spaced measurement. An experimental scheme shown in Figure V-5. This may be coupled with a second-phase borehole measurement of crosshole permeability. Some simpler permeability measurements may be done in conjunction with heater experiments to determine if microfractures are formed upon heating as is indicated by work at Avery Island.

The modeling will use the above measurements for assessing the possibility of mine inflation and long-term repository integrity. More detailed models will include the effect of induced fractures and creep interaction with the surrounding media.

Borehole Plugging (Mine) Activities

Salt Plug Experiments (SPE) (Exp. 7-3b). This experiment is designed to provide in-situ testing of materials for potential application to BHP. Techniques for emplacing and evaluating these materials will be emphasized both in the field and laboratory programs.

The development of plugging materials and emplacement techniques is a long-term goal of the BHP. This experiment provides the initial opportunity to develop this capability with anticipated extension to a future well bore plugging test.

These tests will provide an evaluation of techniques for plug materials and will incorporate native materials which may represent a viable solution to the effects of man-made penetrations since the salt horizon provides the most protection from the standpoint of repository integrity. Suitable techniques for emplacing salt or salt-like grouts will be investigated. Existing laboratory analysis indicates that suitable materials and techniques may be available. This experiment will provide for development and validation testing in situ.

ELECTRONIC
HELIUM SNIFFER

EVACUATION
AND SAMPLING
TUBE

TO HELIUM
RESERVOIR

10
cm.

d
cm.

BOREHOLE
PACKER

BOREHOLE
PLUG

Media Qualification Experiment (Exp. 7-3e). Determination of the plug environment will be required to permit development of the plug design models and realistic consequences analysis scenarios. Site-specific data must be obtained as the first step in this process, supported by mine experiments.

The mine-dedicated area will provide facilities for investigations including the determination of in-situ permeability, local stress stages, and chemical and thermal reactions between the media and the plug. Additionally the disturbance of the media by the drilling operation can be investigated. Fluid parameters can be investigated over a larger range not possible in a well bore. The resulting data will be used to calibrate and judge the adequacy of similar data obtained from boreholes.

Advanced Instrumentation Development (Exp. 7-2). Instrumentation development for borehole plugging is recognized as a necessary part of field testing, and provision for advanced techniques is included in the program to permit development as required. Space provided within the in-situ mine environment for present testing and development of advanced instrumentation systems for possible future application to the long-term monitoring of borehole integrity.

Brine Migration

First In-Situ Experiment on Migration of Brine in Mine Dedicated Area (Exp. 6-6). The first in-situ fluid migration experiments will, in part, resemble the earlier in-situ heater development experiment mentioned in Section III, just as a heater in an open hole, flushing at the heater cavity with dry nitrogen and measurement of water and other off-gas products with careful analysis of core samples both before heater turn on and upon cessation of heating. As important as water collection, however, will be the effort to capture a brine sample which may form in the heater cavity. This experiment is still in the design phase, but emphasis will be given to brine capture.

Scenarios involving physical, chemical, and material interactions of salt brines would be investigated as an integral part of the brine heater experiment. Cooperation with other appropriate agencies concerned with brine migration, especially the USGS, has been established. The water content of the salt in proposed pre-WIPP horizons (approx. 1/2 percent) is ideal for this work. Coring will be done both before and after the experiment. Maximum salt temperatures in the neighborhood of 200°C are planned.

Subsequent In-Situ Brine Migration Experiments (Exp. 6-6). At this time subsequent experiments in brine migration are planned for implementation, partially encompassing a closed hole experiment where there is no flushing at the heater cavity. The heater may be at some nominal pressure. This configuration more closely approximates anticipated repository conditions. The correlation between brine presence and the migration of (stable) nuclides will also be investigated. Additional information on brine migration is gained in the thermal/structural heater experiments because the heater experiments are integrated and also address issues which include brine migration, structural effects, corrosion, leaching, and stable nuclide migration. The heated heater array described earlier will also address issues mentioned here.

Operation and Design Activities

Preliminary Drilling Experiment (Exp. 8-6). The objective of this activity is to gather data on salt drilling for application in the design of the drilling systems for WIPP. Data collected will be used to size drill drives, to optimize drill cutter configurations and cutter materials, and to predict drilling accuracy. Another important purpose of this work is to provide the drilled holes required for experiment emplacement, instrument emplacement, and experiment sampling.

Measurements will be made to determine the power required to drill different holes in salt using a variety of cutter types. The drill used is a standard long-stroke drill which has been modified by the addition of instrumentation to record turning rate, drive torque, pull-down force or thrust, and rate of penetration. Test will eventually be conducted in hot (T approximately 100°F) as well as cold salt. In the drilling tests, cuttings will be analyzed to determine size spectrum. This data will subsequently be used to design the cutting collectors for the WIPP drills. Standard commercial collector systems will be tried and evaluated. Air requirements for efficient cutting removal will be determined.

Targeting tests will be conducted to assess drilling accuracies. Emphasis will be on optimizing techniques and equipment to enhance accuracy. A secondary part of this task will be the selection, mounting, and testing of targeted systems.

Power requirements for drilling in hot and cold salt will be measured. Systems designed to expedite core breakoff and capture will be tested. The goal of these tests will be to gain insight for the design of the long-reach drilling systems envisioned for retrieval of radioactive WIPP experiments.

Other drilling-related tests will eventually be conducted. The following are planned tests:

1. Drilling methods other than rotary, such as rotary percussion, percussion, grit blast, electrical discharge, and high-temperature jet.
2. Development tests on drill-bit high blow-out prevention for use in tapping in pockets or pressurized experiment cavities.

Storage of Simulated TRU Waste (Exp. 8-7). The TRU waste operation in the pre-WIPP program will include a storage demonstration of PCU containers under the following environmental conditions: (a) dry salt, (b) dry air, (c) wet salt, (d) humid air, and (e) brine. In all of these cases, the TRU containers in storage will be planned in realistic configuration, except that they will contain no radioactivity. A schematic of this activity is shown in Figure 8-10. In addition, compaction, recrystallization, and permeability of waste in salt will be measured when subjected to lithostatic pressure. Implementation of this activity will start in FY79 and monitoring will continue for several years.

The capability of the TRU waste container to resist corrosion will be investigated under the five environmental conditions depicted. After a period of time, containers will be recovered and an assessment of corrosion made.

FIGURE V-6. Environmental Conditions for Assessment of Corrosion of TRU Waste Containers.

Thirty uncoated drums from the same manufacturer that provides the Rocky Plate drums are being ordered. A dozen acrylic enamel lacquer-coated drums from Rocky Plate are being obtained. Other coatings will be applied to the additional drums (a coal tar epoxy and a chlorinated rubber coating and a phenolic mastic). There will be two drums with each coating stored in conditions (a) - (c) above.

Supporting measurements will include: (1) humidity near brine pool-brine salt; (2) resistivity measurements in vicinity of brine pool; (3) monitoring conductivity of brine; (4) analysis of brine; and (5) quarterly sampling or "snorking" of drums for corrosion, etc.

Simulated TRU Operations Demonstration (Exp. 8-8). TRU waste handling procedures will be tested and demonstrated. The demonstration will include:

1. storage for a period of time;
2. backfilling of the access;
3. breakthrough of the backfill to gain retrieval access; and
4. retrieval of the TRU containers.

In many of the above steps, an underground leasable cavern will provide the facility for operational procedures in the WIPP facility safety reports and to involve the public that retrievability is practical. Preliminary planning for this work will be initiated in FY79.

Demonstration of Retrieval of Simulated Remotely-Handled Waste (Exp. 8-9).

One of the largest WIPP operation and design tasks is concerned with remotely-handled waste operations; specifically, to demonstrate emplacement of remotely-handled waste on a production basis and to demonstrate its retrieval. This is to be accomplished after going through a backfill. While these tasks are being performed to demonstrate capabilities of the HW experimental area at WIPP, these demonstrations will also have relevance to any wastes at WIPP which involve a heat load. The earlier mentioned heated coon experiment will constitute the first part of this activity.

The demonstration of waste emplacement will involve drilling, and emplacement of heater canisters, backfilling, and in some cases, blind hole measurements. Collection of data on possible decrepitation of salt and on cavern (structural measurements) will be made. Overcoming operational problems such as recovering of canister remnants and surrounding simulated emplaced salt, will be tested and evaluated. Tests will utilize equipment similar to that to be produced and used in WIPP. Early planning for this activity will begin in FY79. A concept of this experiment is shown in Figure 1-7.

Communications System (Exp. 8-19). The goal of this activity is to demonstrate the communications required for handling and retrieval of equipment in the WIPP facility and to evaluate the performance of various models of the WIPP facility. A system assessment will first be made with subsequent testing in FY80 to be carried out in the mine isolated area.

FIGURE V-7. 10' x 10' HANDOVER AREA

Mine Ventilation Studies (Exp. 8-22). The objectives of this study are:

1. To evaluate those coefficients required to design and predict the performance of the ventilation systems (such as film coefficients, flow fraction coefficients, and shock factors) and coefficients for convective heat transfer.
2. To establish velocity profiles across ventways for the purpose of systematically identifying those avenues in which air quality and airborne radioactivity monitors should be placed to minimize the time required for detection.
3. To evaluate designs of structures used for control of ventilation.

Precise pressure, velocity, and temperature measurements throughout the vent far or corridor in the mine dedicated area will be made. A dependence of ventilation coefficients, shock factors, and convective heat transfer coefficients. Transit times of toxic and flammable gases and smoke in ventfar or streams will be determined by use of minute amounts of radioactive tracer in helium or freon. Ventilation stoppings which will accommodate a possible time closure without loss of sealing or integrity will be tested.

Instrumentation Development

Borehole Closure (Mechanical) (Exp. 9-1). A prototype mechanical borehole closure device has been developed for use in a mine. This device provides borehole closure and orientation; it is to be tested at the Avery Island mine, FY79. An improved mechanical device will also be ready in FY79. The device is composed of a spring-loaded mechanical device that monitors three axes, X, Y, Z, and θ with an electrical readout comparable with data from a strain gage. The unit will be used to measure borehole diameter and the change in borehole before and after heating, of the boreholes. A capacitive device, presently attached to the heater will monitor the convergence during heating. A schematic of a closure device is shown in Figure 4-3.

Stress Deformation Sensors (Exp. 9-6). Two gages are being developed for the stress measurements in salt--a Sandia developed FRAC gage and a fully-developed strain gage stressmeter. Additional calibration of these gages is being undertaken in FY79, and it is believed that they will be available for use before FY80.

The viscoplastic behavior of salt may prohibit totally uniaxial stress measurements, but information related to absolute stresses and strains in salt will be obtained that could not be obtained previously. Development of this gage. These gages will be used in the mine dedicated area, for example of the initial disposition of these gages will be in Rooms IV-2a and IV-2b. Further application will be to fix these gages in the floor and pillars at fixed intervals to determine the changes in the stress field moving away from a mined out face.

Borehole (Capacitive) (Exp. 9-2). A capacitive borehole closure device is being developed for use on line on experiment with an inner borehole in a specimen of salt. The principle is the same as that used in the Sandia

FIGURE 1-8

CONVECTION BARRIER, THERMISTOR, AND STABILIZER

the Avey mine. The gage will be designed to be independent of the equipment, but rather will be based on application to a variety of equipments.

Thermal Probe (Mine) (Exp. 9-3). A thermal probe is being developed to give a very direct reading of the in-situ thermal conductivity of rock. Thermal conductivity will be measured throughout the WIPP facility and different horizons surrounding the WIPP horizons. This will be done by replacing the long replaced heater arrays to measure in-situ thermal conductivities, and the potential is being investigated.

The theory and technique for thermal probes have been developed in the laboratory. Basically, a slender heater rod, or fine streamer, is inserted into a medium in which is large in the sense that boundary effects are negligible. The medium with the rod are not seen for some time. The temperature of the rod and response of the rod imbedded in salt can be reduced to a constant thermal conductivity value. Thermocouples attached to the rod measure the temperature response.

Field-scale work is complete, and the first in-situ check-out will be accomplished in southeast New Mexico and Avery Island in 1979. A final report on this device will be written in FY79.

Thermal Probe (Borehole) (Exp. 9-4). The thermal conductivity of the in-situ candidate WIPP horizons will be measured by use of an appropriately designed thermal probe inserted in a deep borehole. This device will provide access to measurement of in-situ thermal conductivities of horizons which will not be accessible until the WIPP horizons are reached during the mining operation and to neighboring horizons which will never be accessed. The development and performance testing would be carried out both in laboratory and in-mine situations before use in deep boreholes.

Videllaneous Instrumentation Development (Activity 9-7). This activity is based on the fact that within the in-situ (and laboratory) problems before instrumentation problems inevitably occur. An attempt is made to anticipate problems to address these contingencies. This activity includes development of sensors in our pre-WIPP mine delineated areas. Such development now includes a level gage that provides an absolute level reference for the mine, and a sensor that differentiates floor levels from top of the back.

SECTION VI

COMPARISON OF THE PRE-WIPP, PROJECT SALT VAULT, AVERY ISLAND, AND ASSE MINE EXPERIMENTS

Project Salt Vault experiments were performed in bedded salt at the Asse Mine near Angoulême, France (ORNL-4555), and the Avery Island experiments were performed in non-bedded salt at the International Salt Company Mine near New Iberia, Louisiana. The principal differences between bedded salt and dome salt are water content, porosity, and structural features and non-NaCl constituents. The Project Salt Vault experiments were designed and performed with four specific objectives:

1. To determine waste handling methodology;
2. To determine effects of radiation on salt to determine maximum salt temperature;
3. To determine the possibility of radiolytic production of hydrogen gas;
4. To collect design-related information on creep and plasticity of salt at elevated temperature.

Use was made of both electrical heaters and spent-fuel assemblies emplaced in vertical drillholes.

The main objectives of the Avery Island experiments can be summarized as follows:

1. To evaluate the in-situ thermomechanical response of dome salt to an emplaced heat source for comparison with Project Salt Vault results for bedded salt;
2. To evaluate emplacement hole closure and salt loading on emplacement hole sleeves at various levels of simulated waste canister power;
3. To evaluate the capability of calculational procedures for prediction of thermomechanical response.

Use was made of electrical heaters emplaced in vertical drillholes with sleeve sleeves, with and without crushed salt backfill between the walls of the drillhole and sleeve.

In both sets of experiments, the simulated disposal rooms were open to ventilation, and such phenomena as permeability perturbation and brine or nuclide migration were not part of the test program. The appearance of brine in the emplacement holes during the Project Salt Vault experiment was an unexpected observation. Due to the low water content in the Avery Island dome salt, significant brine migration was not anticipated.

These previous experiments duplicate the proposed mine dedicated area pre-WIPP experiments only in the sense that electrical heaters will be used in conjunction with sleeved and unsleeved simulated emplacement holes, and that

[illegible]

the results of the experiment (example 1) and the results of the control experiment (example 2) are indicated in Table 1. The results of the control experiment are in good agreement with the results of the experiment with the addition of the inhibitor. The results of the experiment with the addition of the inhibitor are in good agreement with the results of the experiment with the addition of the inhibitor.

On June 1, 1964, the station of 114 E. Fifth, Ave. & Lincoln, was visited. The station was located on the bottom of a pile of debris, approximately 100 feet from the shore. The debris was composed of a variety of materials, including wood, metal, and plastic. The debris was piled up in a large area, and the station was located in the center of this area. The debris was piled up in a large area, and the station was located in the center of this area. The debris was piled up in a large area, and the station was located in the center of this area.

[illegible]

currently scheduled Standard-OMWV discussions permit an exchange of information on important data as well as other areas of mutual interest. Both agencies intend to continue the exchange of information with the IIR, and are planning that special AECW information-exchange proceedings will be held on a semi-regular basis, and a more personal contact with West German officials will follow in their program.

TABLE VI-1

YARDSTICKS FOR IN-SITU ACTIVITY EFFORT IN SALT

ROOMS	Instrumented Pillars	Area for Floor Space (ft ²)	Total Area (ft ²)
Ship's Cabin	5	3+	2.7×10^4
Aviation Island	1	--	3×10^4
1000 Deck Cabined Area (WIPP)	11+	9+	1×10^5
WIPP Experiments			2×10^5

SECTION VII

PROGRAM MANAGEMENT

1. General ALSEP Experiment Program Management and Program Area Functions

The field site is assigned responsibilities for the management of the program area(s). The individual(s) assigned to the management of the program area(s) associated with each area, function, and/or experiment must also be responsible for communication and coordination of the program area(s) with other areas, both on program and non-program, and for providing the field site with knowledge and information on the status of each area. These individuals, generally the area managers, must provide their mode(s) of, time(s), length(s), and location(s).

- a. Individuals who give implementation tasks. These individuals collect the information and needs of various program areas and synthesize them into a single program management plan, and coordinate the testing program.

The structure of the program matrix (with program and implementer initials) has been shown in Figure I-1. The program area and implementer initials are shown in Figure VII-1. This section deals primarily with the organization of the field site tasks and responsibilities in Figure VII-1.

- a. The field site is responsible for the overall experimental program as approved by A.W. Seilly #4641, in many of the engagements reported. As discussed above, individuals in the nine program area of the program must ultimately approve program documentation in their areas, and submit program network charts.

H. G. Walker is in charge of negotiations with the mine for institute activities. He is also in charge of the management functions of the mine, restricted area and for any institute activities in any of the nonbearing areas. He is in charge.

- a. W. Seilly, in charge of technical aspects of the testing program, initiates appropriate programmatic needs into institute activities and initiates experiment implementation. He works with the individuals in the program area in maintaining the network charts for the program area and contributed to and channels experiment reports to the appropriate individuals in these areas. Supporting analytical work is arranged and coordinated by him and the corresponding program area manager. A.W. Seilly assists H. G. Walker as necessary in maintaining proper interface with the mine.

The field activity does not correspond identically to the nine program areas, at the time, interests of some program areas may be more important than others. While experiments are not appropriate in the mine and the bearing areas, support is supportive to all areas.

FIGURE 1-1-1

FIGURE VII - 2 ORGANIZATION OF IN SITU PROGRAMS

The project leaders identified in Figure VII-2 define and implement experimental activities, help maintain program networks, and initiate experiment reports. The program is thus integrated, with sufficient overlap to allow for nine basic program areas.

Sanita staff and contractor personnel design hardware, procure equipment, conduct experiments, and provide documentation as appropriate. Most of the equipment comes from Sanita project or field test groups and the hardware comes from contractor personnel. Most instrumentation and test support is provided by Sanita field test personnel, and the remaining is provided by various contractors as needed. Recording and data management is done by Sanita.

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