Title 40 CFR Part 191 Compliance Certification Application for the Waste Isolation Pilot Plant

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Appendix GTMP

United States Department of Energy
Waste Isolation Pilot Plant

Carlsbad Area Office
Carlsbad, New Mexico

Geotechnical Monitoring Plan

Waste Isolation Pilot Plant Geotechnical Engineering Quality Assurance Program

Cognizant Section: Geotechnical Engineering

Approved By: C E Cowley

WASTE ISOLATION PILOT PLANT

WIPP

WIPP GEOTECHNICAL ENGINEERING QA PROGRAM

WP 07-1, Rev. 1

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List of Acronyms

C&C - Consultation and Cooperation
DOE - Department of Energy
EES - Excavation Effects Survey
EPA - Environmental Protection Agency
LTCs - Local Termination Cabinets
MOC - Managing and Operating Contractor
QA - Quality Assurance
PRS - Project Records Storage
RIDS - Records Inventory and Disposition Schedule
SNL - Sandia National Laboratories
SPDV - Site Preliminary Design Validation
TDR - Time Domain Reflectometry
TRU - Transuranic
WID - Waste Isolation Division
WIPP - Waste Isolation Pilot Plant
WP - WIPP Procedure
WPSO - WIPP Project Site Office

WIPP GEOTECHNICAL ENGINEERING QA PROGRAM

WP 07-1, Rev. 1

<u>Change History</u>

Pages iv, vi, vii, viii, 4-8, Att. 1 (add information for RCRA required inspections of Room 1, Panel 1, roof support instrumentation) - 07/15/93; Pages i, ix, and x - 06/10/94

6-10-94

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WIPP GEOTECHNICAL ENGINEERING QA PROGRAM

WP 07-1, Rev. 1

FOREWORD

This document is a quality assurance project plan (QAPjP) applying to WID environmental data operations (EDOs). As such, its purpose is to define the applicability of the WID quality management system, as described in WP 13-1, to the specific technical activities described within the scope of this plan. Implementation of this plan shall be in accordance with, and subject to the requirements of the quality assurance requirements as prescribed in WP 13-1. Independent assessment of the effectiveness of the activities described in this plan shall be scheduled and performed by the WID Q&RA Department.

06-10-94

1.0 INTRODUCTION

The WIPP Geotechnical Engineering Program is designed to (1) provide geologic information necessary to establish a high level of understanding of site characteristics and (2) provide assessments of the stability and performance of underground openings. The Geotechnical Engineering Program currently consists of the following three activities:

1. Geomechanical Monitoring Program
2. Geology Program
3. Excavation Effects Program

These programs are implemented and controlled by individual program plans and operating procedures. The program plans are included in Sections 3 through 5.

1.1 Geomechanical Monitoring Program

The Geomechanical Monitoring Program monitors for geotechnical parameters with geomechanical instruments installed in the shafts and drifts of the WIPP facility. Geomechanical instrumentation found in the shafts and the underground presently includes: tape extensometer stations, convergence meters, borehole extensometers, piezometers, embedment strain gages, stress gages, inclinometers, load cells, and crackmeters.

The instrumentation system provides data on the WIPP geotechnical performance design for design validation, routine evaluation of the safety and stability of excavation, and of the short-term and long-term behavior of underground openings. Data on the stability and closure of underground excavations are used to identify areas of potential instability and allow for remedial action to be taken in a timely manner.

1.2 Geology Program

The activities associated with the Geology Program include geologic and fracture mapping, maintenance of a geologic (core) sample storage facility, seismic monitoring and evaluation, and other special activities that are performed on an as-needed basis. The purpose of the Geology Program is to provide input to help confirm the suitability of the site to contain and isolate TRU radioactive waste.

1.3 Excavation Effects Program

The Excavation Effects Program was initiated to gain a better understanding of fracture development around excavations in salt. The program consists of routine inspections of selected borehole arrays. These observations help to detect and quantify the occurrences of discontinuities such as fractures and bed separations, which result from the excavation of the underground openings.

Technical implementation of these programs is controlled by the Field Program Plans that are discussed in Sections 3 through 5 and the unique operating procedures listed in Table 1-1.

Table 1-1

WIPP GEOTECHNICAL AND GEOSCIENCES PROCEDURES MANUAL

Geomechanical Monitoring Program Plan WP 07-3

WP 07-301	Manually Acquired Geomechanical Instrument Data
WP 07-302	Automatically Acquired Geomechanical Instrument Data
WP 07-303	Geomechanical Instrument Data Processing
WP 07-304	Installing Convergence Reference Points
WP 07-305	Installing Multiposition Borehole Rod Extensometers
WP 07-306	Installing Rock Bolt Load Cells
WP 07-307	Installing Convergence Meters
WP 07-312	Manually Reading Wire Convergence Meters
WP 07-313	Operation of Gyra-Vib Separator Salt Screening Plant
WP 07-315	Data Collection from Boreholes for Excavation Effects Monitoring
WP 07-410	WIPP BSEP Collection and Inflow Measurements
WP 07-413	Brine Chemistry Sampling and Analyses

Geology Program Plan WP 07-5

WP 07-501	Geologic and Fracture Mapping of the Facility Horizon Drifts
WP 07-502	Geologic Rock Core Logging
WP 07-503	Geologic Mapping of Shafts
WP 07-504	WIPP Project Core Storage, Handling, and Distribution

Excavation Effects Program

WP 07-315	Data Collection from Boreholes for Excavation Effects Monitoring

2.0 QUALITY ASSURANCE REQUIREMENTS

The objective of Section 2.0, Quality Assurance Requirements, is to establish the specific quality assurance requirements associated with the Geotechnical Engineering QA Program. Those quality assurance requirements are driven by, and are supplemental to, WP 13-1, WID Quality Assurance Program Description, and implementing WIPP Quality Assurance procedures.

The basic 18 requirements that are defined in ASME NQA-1-1989, Quality Assurance Program Requirements for Nuclear Facilities, and their application to the Geotechnical Engineering QA Program are discussed in the following sections.

2.1 Organization

2.1.1 Organizational Structure

The organizational structure of the WID is described in Section 2.0 of WP 13-1. The Geotechnical Engineering Program is the responsibility of the Engineering department.

2.1.2 Quality Assurance Responsibilities for the Geotechnical Engineering QA Program

Quality Assurance provides independent oversight of the Geotechnical Engineering Program to verify that quality objectives are defined and achieved. The Quality Assurance Manager reports directly to the WID General Manager, and is therefore sufficiently removed from the cost and schedule concerns of Geotechnical Engineering. The Quality Assurance Manager has been delegated authority and given organizational freedom by the WID General Manager to access work areas, identify quality problems, initiate or recommend corrective actions, verify implementation of corrective actions, and to ensure that work is controlled or stopped until adequate disposition of an unsatisfactory condition has been implemented. The independence and delegated authority of the Quality Assurance Manager ensures that objective independent assessments of the quality of the performance of the Geotechnical Engineering Program can be achieved.

It is the responsibility of the Geotechnical Engineering Manager to ensure that basic qualifications for Geotechnical Engineering personnel are met. A spectrum of expertise ranging from basic qualifications to specialized knowledge in different areas of engineering would be expected among the Geotechnical Engineering staff. The essential levels of qualification required for Geotechnical Engineering personnel follows:

- Engineer (Sr. Level): The required technical capabilities are basic engineering skills and knowledge of project budgeting, scheduling and regulatory agreements, procurement, and dealing with subcontractors (B.S. degree in a technical field plus eight years experience). The person must demonstrate an ability to plan, coordinate, and manage a broad range of engineering activities given only general objectives and minimal direction and to coordinate engineering activities and designs with other site participants. The engineer should be innovative in dealing with constantly changing budgets, schedules, and priorities.

- Associate Engineer: The required technical capabilities are in areas of mechanical design and equipment maintenance (B.S. degree and two years experience preferred). The person must demonstrate good organizational abilities with the capability to develop and maintain an equipment control and maintenance program and an understanding of safety-related activities.

- Senior Technician: The required technical capabilities include an academic or high school diploma, and a minimum of four or five years technical experience, with a minimum of two years as an engineering technician. The person must be capable of providing guidance and work assignments to lower classified technicians and have the ability to exercise judgement, initiative, and interpretation to achieve desired results. This individual must also demonstrate the ability to work reliably and efficiently with little or no supervision after receiving training.

- Technician: The required technical capabilities include a high school diploma or equivalent. Two years of field experience is preferred. This individual must demonstrate the ability to learn a wide variety of tasks, work reliably and efficiently with little or no supervision after receiving training, and demonstrate manual dexterity applicable to handling various types of mechanical equipment.

The Geotechnical Engineering Manager ensures that position descriptions for assigned Geotechnical Engineering personnel are adequately prepared and shall include position purpose, principal responsibilities, nature of work, and scope.

The Geotechnical Engineering Manager conducts an annual performance review of personnel according to Westinghouse requirements for personnel review.

New Geotechnical Engineering personnel selected to perform geotechnical activities shall have experience or training that corresponds with the scope and complexity of the activities. Personnel shall be well informed of the technical objectives and requirements of applicable codes and Quality Assurance Program elements that are to be employed.

Formal training shall be conducted as required by a subject matter expert qualified under WP 14-TR3308 in geotechnical instrumentation. On-the-job training shall be included in the training to the extent necessary to gain first-hand experience and a qualification card. The qualification card shall be prepared by the subject matter expert or cognizant Geotechnical Engineering personnel responsible for new employee qualification. Qualification cards shall be retained in Technical Training department files.

NOTE: No employee shall be allowed to conduct an unsupervised specific Geotechnical Engineering activity without a qualification card on the specific activity by a subject matter expert in Geotechnical Engineering.

The performance of qualified personnel shall be evaluated and documented every three years. The Geotechnical Engineering Manager shall determine the need for retraining of Geotechnical Engineering personnel.

The need for retraining may be noted by Quality Assurance during any surveillance or audit or during a periodic review initiated by the cognizant professional or Geotechnical Engineering Manager.

The Geotechnical Engineering Manager ensures that documents detailing all staff training are up to date and properly filed. Copies of all training records shall be given to the Training department.

2.1.3 Engineering Responsibilities and Authorities

The Geotechnical Engineering Manager and staff are responsible for achieving and maintaining quality in the Geotechnical Engineering Program. Job descriptions shall be maintained for the Geotechnical Engineering Manager, professional, technical, and administrative staff positions. The Manager of Geotechnical Engineering reports to the Manager of Advanced Repository Technology and has responsibility for the design and implementation of the Geotechnical Engineering QA Program, including the following areas:

- Preparation and approval of technical plans and the Quality Assurance section and the technical sections of the Geotechnical Engineering QA Program
- Development and approval of specific WIPP procedures for the conduct of Geotechnical Engineering activities
- Establishment of minimum qualification criteria and training requirements for all program personnel
- Review and approval of programmatic reports and documents
- Preparation of the budget and schedules for the Geotechnical Engineering department
- Determination of the effect of, and the appropriateness of reporting nonconformances, and providing the appropriate documentation for any reporting
- Notification of Geotechnical Engineering and Quality Assurance personnel of nonconformances and changes that could affect the quality of work

Geotechnical Engineering shall review and approve all Geotechnical Engineering Program data prior to release.

For each technical program, the Geotechnical Engineering Manager may appoint a Geotechnical Engineering Cognizant Engineer, who will have the following responsibilities:

- Direction of the Geotechnical Engineering Program per written approved procedures
- Initiation and review of programmatic plans and procedures
- Review and evaluation of instrumentation data
- Preparation and review of programmatic reports
- Ensuring that appropriate readings are collected and analyzed
- Ensuring that adequate technical support is provided to the Quality Assurance department when required, during audits of vendor facilities

The Geotechnical Engineering Manager designates one or more associate engineers or technicians who will be responsible for the following items:

- Collecting instrumentation readings
- Assisting the cognizant engineer in the preparation and maintenance of appropriate data sheets and documentation
- Monitoring equipment operability status
- Reporting equipment malfunctions
- Reporting nonconformances to the cognizant engineer or Geotechnical Engineering Manager
- Initiating data checks
- Conducting field activities in accordance with written procedures

2.2 Quality Assurance Program

The WIPP Geotechnical Engineering QA Program is governed by WP 13-1. The Quality Assurance Program used by the WID is described in Section 2.0 of WP 13-1. Steps to ensure quality shall be incorporated, as needed, in the technical procedures used for Geotechnical Engineering activities. The Geotechnical Engineering Manager, or assigned designee, is responsible for developing and maintaining the Geotechnical Engineering QA Program and Geotechnical Engineering procedures. In accordance with the Sections 2.0 and 3.0 of WP 13-1, Geotechnical Monitoring is a Quality Code I activity.

2.3 Design Control

The Design Control requirements are described in Section 3.0 of WP 13-1. The Geotechnical Engineering Program will adhere to all applicable portions of these requirements when performing design activities.

2.4 Procurement Document Control

Procurement shall be carried out in accordance with the appropriate policies and procedures, as outlined in Section 4.0 of WP 13-1 and WP 15-609, Planning, *Preparation, and Processing of Purchase Requisitions and Purchase Requisition* Change Notices. WP 13-1 and WP 15-609 require specification of a quality code and design class, and concurrence by the Quality Assurance department with procurement documents. The requester shall also specify which Quality Assurance clauses, from the checklist in WP 15-609, are applicable to each Geotechnical Engineering procurement. Technical requirements for procured items and services shall be developed and specified in procurement documents. If deemed necessary, procurement documents shall require suppliers to have an adequate quality assurance program to ensure that required characteristics are attained.

2.5 Instructions, Procedures, and Drawings

Provisions and responsibilities for the preparation and use of instructions and procedures are outlined in the Section 5.0 of WP 13-1. Quality-affecting activities performed by, or on behalf of the Geotechnical Monitoring Program shall be performed in accordance with written plans or approved procedures. They shall contain the applicable provisions outlined in Section 9.0, paragraph 2.1.1, of WP 13-1. WIPP general procedures for procurement, document control, and Quality Assurance auditing currently exist and shall be utilized.

Technical procedures shall be developed for each quality-affecting function performed for Geotechnical Monitoring. The procedures shall include in-process and final quality controls and documentation requirements. The procedures shall be as detailed as required and include, when applicable, quantitative or qualitative acceptance criteria to determine that activities have been satisfactorily accomplished. Procedures shall be developed in accordance with existing WIPP procedures. The standard format used for procedure preparation is outlined in WP 15-101, Preparing, Revising, Reviewing, and Canceling Procedures.

2.6 Document Control

Requirements for the control of documents are outlined in Section 6.0 of WP 13-1. Controls ensure that the latest approved versions of procedures are used in performing geotechnical monitoring functions, and that obsolete materials are removed from work areas.

Geotechnical Engineering shall establish documented procedures that define the preparation, approval, and issue requirements for documents which are being used for Geotechnical Engineering activities. As a minimum, the procedures shall include:

- Identification of the required document format
- Identification of the individuals or organization responsible for the preparation, review, approval, and distribution of documents
- Provisions for documents to be reviewed by appropriate WID technical support departments
- Provisions for Quality Assurance review and approval of all quality-related documents
- Provisions for document changes other than obvious typographical errors to be controlled in the same manner as the original document

Geotechnical Engineering is responsible for documentation of the following:

- Engineering Calculations Briefs: Geotechnical Engineering data used in calculations is sometimes acquired from previous reports. The results of work must be completely documented to provide evidence of source, work performance, and quality.
- Field Investigations, Testing and Sampling: Geotechnical Engineering shall document project name, participating personnel, date, time, calibrated equipment used, activity location, and when necessary, unusual conditions encountered. As part of field investigations, photographs in color may be taken for documentation.
- Laboratory Testing: Geotechnical Engineering is responsible for documenting initial data, collected data, and the results of laboratory test plans. Each test document shall include:

- Project name
- Type of observation
- Identification of test personnel
- Testing date
- Identification of calibrated equipment used
- Identification and description of sample(s) tested
- Test data and any subsequent data reduction
- Test results in the form of tables and curves
- Action taken in connection with any deviation noted
- Person evaluating test results
- Results and acceptability

2.7 Control of Purchased Material, Equipment, and Services

Policy requirements and associated responsibilities for the control of purchased material, equipment, and services are outlined in Section 7.0 of WP 13-1. Measures shall be taken, in accordance with current WIPP procurement policies and procedures, to ensure that procured items and services shall conform to specified requirements. These measures will generally include one or more of the following:

- Evaluation of the supplier's capability to provide items or services in accordance with requirements, including the previous record in providing similar products or services satisfactorily

- Evaluation of objective evidence of conformance, such as supplier submittals

- *Examination and testing of items or services upon delivery*

These methods shall be adequate to ensure quality in the majority of procurements. *If it is determined that additional measures are required to ensure* quality in a specific procurement, additional steps may be provided for procurement documents and implemented by Geotechnical Engineering staff and/or the Quality Assurance department. These additional assurances may include source inspection and audits or surveillance at the supplier's facilities.

2.8 Identification and Control of Items

Measures used to ensure that only correct and accepted items are used at the WIPP are outlined in Section 8.0 of WP 13-1. All items that potentially affect the quality of the Geotechnical Engineering Program shall be identified and controlled to ensure that only accepted items are used.

Geotechnical Engineering is responsible for the identification and control of geologic samples stored in accordance with WP 07-504, WIPP Project Core Storage, Handling, and Distribution.

Engineering will be specifically responsible for the identification and control of geologic samples. The geologic samples will be stored in a secure facility and an up-to-date database will be maintained to identify and control the samples. Traceability will be maintained in accordance with ASME NQA-1-1989, 8S-1, Supplementary Requirements for Identification and Control of Items.

2.9 Control of Processes

Section 9.0 of WP 13-1 outlines the requirements and responsibilities for control processes. Measures employed to ensure that standard processes and special processes performed by the WID or their suppliers are accomplished under controlled conditions and in accordance with applicable safety analysis reports, regulations, codes, standards and specifications, as outlined in WP 13-1. The Geotechnical Engineering Manager, or designee, is responsible for maintaining a general schedule of geotechnical activities and for revising the schedule as needed to ensure that the program objectives are satisfied.

2.10 Inspection

An outline of the inspection program applied to the WIPP site is contained in Section 10 of WP 13-1. Inspections of geotechnical monitoring items shall be performed and documented as required and defined in implementing procedures, both upon receipt and while in service. The Quality Assurance department is responsible for the inspection of equipment upon receipt at the WIPP site.

Geotechnical Engineering may assist the Quality Assurance department during the inspection of equipment upon arrival at the WIPP site. Performance checks for the Geotechnical Engineering Program are designed to determine the acceptability of purchased items, and to assess degradation that occurs during use.

2.11 Test Control

Section 11.0 of WP 13-1 outlines the requirements and responsibilities for the control of tests. Testing or experimental/monitoring activities carried out for Geotechnical Engineering programs shall be performed in accordance with written plans or procedures which shall contain the following provisions, as applicable:

- Scope and/or definition or purpose
- Prerequisites such as calibrated instrumentation and supporting data; adequate test equipment and instrumentation, including accuracy requirements; completeness of item to be tested; suitable and controlled environmental conditions; and provisions for data collection and storage
- Instructions for performing the test
- Any mandatory inspection and/or hold points to be witnessed by the WID or other designated representatives
- Acceptance and rejection criteria
- Methods of documenting or recording test data
- Requirements for qualified personnel
- Evaluation of test results by authorized personnel

Test or experimental/monitoring procedures prepared by other project participants (e.g., Sandia National Laboratories) used as WID procurement documents will be reviewed to ensure that the documents are complete and the tests described by the documents are adequate to determine that the involved equipment, systems, or structures are operationally acceptable.

Computer program testing activities that effect quality-related activities performed by the WID or their suppliers shall be accomplished in accordance with written test plans or procedures. Examples of computer program testing are standard design analysis, sampling data reduction, Central Monitoring System, and experimental data processed by computer.

Test requirements and acceptance criteria shall be provided or approved by the organization responsible for the design or use of the program to be tested unless otherwise designated. Required tests, including (as appropriate) verification tests, hardware integration tests, and in-use tests, shall be controlled.

Test requirements and acceptance criteria shall be based upon applicable design or other pertinent technical documents.

Verification tests shall demonstrate the capability of the computer program to produce valid results for test problems encompassing the range of permitted usage defined by the program documentation. Acceptable test problems solutions are as follows:

- Hand calculations
- Calculations using comparable proven programs
- Empirical data and information from technical literature

For programs used for operational control, testing shall demonstrate required performance over the range of operation of the controlled function or process.

Depending on the complexity of the computer program being tested, testing may range from a single test of the completed computer program to a series of tests performed at various stages of computer program development to verify correct translation between stages and proper working of individual modules, followed by an overall computer program test.

Regardless of the number of stages of testing performed, verification testing shall be sufficient to establish that test requirements are satisfied and that the computer program produces a valid result for its intended function.

Test problems shall be developed and documented to permit confirmation of acceptable performance of the computer program in the operating system. Test problems shall be run whenever the computer program is installed on a different computer, or when significant hardware or operating system configuration changes are made. Periodic in-use manual or automatic self-check routines shall be prescribed and performed for those applications where computer failures or drift can affect required performance.

Test procedures or plans shall specify the following, as applicable:

- Required tests and test sequence
- Required ranges of input parameters
- Identification of the stages at which testing is required
- Criteria for establishing test cases

- Requirements for testing logic branches
- Requirements for hardware integration
- Anticipated output values
- Acceptance criteria
- Reports, records, standard formatting, and conventions
- Personnel qualification
- Changes to procedures require the same review and approval requirements as the initial release of the procedure

Verification test records shall identify the following:

- Computer program tested
- Computer hardware used
- Test equipment and calibrations, where applicable
- Date of test
- Tester of data recorder
- Simulation models used, where applicable
- Test problems
- Results and acceptability
- Action taken in connection with any deviations noted
- Person evaluating test results

In-use test results shall identify the following:

- Computer program tested
- Computer hardware used
- Test equipment and calibrations, where applicable
- Date of test
- Tester or data recorder
- Acceptability

Procurement documents shall specify the appropriate test requirements for WID suppliers and subcontractors. When specified in the procurement document, suppliers or subcontractors shall be required to submit test plans and/or procedures to the WID for review and approval. Geotechnical Engineering representatives shall, when specified in the procurement document, witness supplier/subcontractor test activities.

2.12 Control of Measuring and Test Equipment

Measuring and test equipment shall be controlled and calibrated to ensure continued accuracy of instrumentation data. Results of calibrations, maintenance, and repair shall be documented. Calibration records shall identify the reference standard and the relationship to national standards or nationally accepted measurement systems. Records shall be maintained to track uses of measuring and test equipment. If measuring and test equipment is found out of calibration tolerances, the equipment shall be tagged and its use ceased until corrections are made. An evaluation shall be made and the effects upon previous results shall be documented. The evaluation shall be approved by the Geotechnical Engineering Manager, and corrective measures shall be taken as needed.

It is the responsibility of the site calibration laboratory to maintain records of the calibration status of all geomechanical measuring and test equipment. Equipment is administered in accordance with applicable portions of WP 10-003, Instrumentation Control and Calibration. Calibration reports and operability test data are maintained by the WIPP Calibration Lab. Any out-of-tolerance condition is evaluated for potential impact on the validity of data. Impact evaluation and corrective actions are initiated per specific Geotechnical Engineering QA Program instructions. An out-of-tolerance condition may require a nonconformance report to be initiated according to Section 15.0 of WP 13-1.

2.13 Handling, Storage, and Shipping

Requirements necessary to ensure that the handling, storage, and shipping of waste material, equipment and components, including spare parts, are outlined in Section 13.0 of WP 13-1. Geotechnical Engineering is responsible for identifying critical, sensitive, perishable, or high-value items that require the preparation of detailed procedures to control the handling, cleaning, storage, preservation, and shipping of geomechanical materials, equipment, or spare parts.

It is the responsibility of Geotechnical Engineering to store, handle, and distribute geologic samples in accordance with WP 07-504.

2.14 Inspection, Test, and Operating Status

Measures to ensure that required inspections and tests are performed are outlined in Section 14.0 of WP 13-1. Controls shall be implemented in accordance with documented procedures to ensure that items are not used prior to passing required inspections and tests. The status shall be identified on the items or on documents traceable to the items. Items that have not been accepted shall be identified as such and stored separately from accepted items. The operational status of equipment shall be identified on the equipment or on the equipment list. Faulty equipment shall be tagged and, if practicable, physically segregated from the work area.

2.15 Control of Nonconforming Conditions/Items

Section 15.0 of WP 13-1 describes the system for ensuring that appropriate measures are established to control nonconforming conditions.

Nonconforming items/conditions connected to the Geotechnical Engineering Program can be identified by the following:

- Geotechnical Engineering personnel during the performance of field operations, supervision of subcontractors, and preparation and verification of data reduction processing and numerical analyses
- Laboratory personnel during the preparation for and performance of laboratory testing, calibration of equipment, and quality control activities
- Quality Assurance personnel during the performance of audits and other Quality Assurance activities

Equipment that does not conform to specified requirements shall be controlled to prevent its use. Faulty items shall be tagged and segregated. Repaired equipment shall be subject to the original acceptance inspections and tests prior to use.

The Geotechnical Engineering Manager is responsible for:

- Evaluation and documentation of a nonconformance
- Ensuring that nonconformances detected for items within Geotechnical Engineering are identified, tagged, segregated, reported, and processed, in accordance with established procedures
- Providing disposition for nonconforming conditions identified with Geotechnical Engineering
- Review and approval of proposed disposition of nonconformances, as required

2.16 Corrective Action

Requirements for the development and implementation of a system to determine, document, and initiate appropriate corrective actions after encountering conditions adverse to quality are outlined in Section 16.0 of WP 13-1. Conditions adverse to acceptable quality shall be documented and reported in accordance with corrective action procedures, and corrected as soon as practical. Immediate action shall be taken to control work performed under conditions adverse to acceptable quality, and its results, to prevent degradation in quality.

The Geotechnical Engineering Manager, or designee, shall investigate any deficiencies in Geotechnical Engineering activities to determine if there is an underlying root-cause and take corrective actions, if necessary. All such actions shall be documented and reported to the Quality Assurance department.

2.17 Quality Assurance Records

Section 17.0 of WP 13-1 outlines the policy regarding the identification, preparation, collection, storage, maintenance, disposition and permanent storage of Quality Assurance records. The Geotechnical Engineering Manager, or designee, is responsible for the preparation and distribution of Geotechnical Engineering reports in accordance with appropriate DOE orders, policies, and directives.

Records to be generated in the Geotechnical Engineering QA Program shall be specified by procedure. From this, a master list of records shall be developed and maintained. This master list of records shall identify those records determined to be Quality Assurance and shall be included on the Geotechnical Engineering RIDS. The Quality Assurance records shall document the results of the Geotechnical Engineering Program implementing procedures and shall be sufficient to demonstrate that all quality-related aspects are valid. The records shall be identifiable, legible, and retrievable in accordance with DOE/WIPP 89-013, WIPP Project Records Management Handbook, and Quality Assurance record procedures.

While in the custody of the Geotechnical Engineering department, the records shall be protected from loss and damage by procedures requiring backups of electronic records and multiple copy storage. Geotechnical Engineering will coordinate with Project Records Services (PRS) for both periodic and perpetual transfer of records to PRS. It shall also ensure that copy machine-readable

Quality Assurance records are transferred to more permanent media, either while in the custody of Geotechnical Engineering personnel or immediately upon accession by PRS.

Geotechnical Engineering is responsible for the core library in the core storage building. Records will be maintained of all core library activities. This includes additions to the core library, removal of any material from the core library, any tests performed on the core, a record of people who examine the core on site, and any other alterations made to the core.

Geotechnical Engineering Program procedures are administered by the Geotechnical Engineering Manager in accordance with guidance provided by WP 15-030, Records Management. Records will be transferred to PRS for permanent filing, as outlined in DOE/WIPP 89-013.

2.18 Audits and Independent Assessment

Provisions and responsibilities for quality assurance-type audits are outlined in Section 18.0 of WP 13-1. Periodic independent audits of the Geotechnical Engineering Program shall be scheduled, planned, and performed to verify that work is performed in accordance with specified requirements. The audits shall be administered and led by the Quality Assurance department. Audit teams shall not include members of the Geotechnical Engineering staff. The audits and independent assessments shall be performed in accordance with Quality Assurance auditing procedures.

3.0 TECHNICAL PROGRAMS

The Geotechnical Engineering Technical Programs define the investigations currently being carried out by Westinghouse Electric Corporation, MOC for the WIPP, to evaluate the geotechnical performance of the underground facility. The data from the program are needed to demonstrate the safe disposal of TRU waste both in the short-term (during the operational life of the facility) and in the long-term to demonstrate that the facility, following decommissioning, will satisfy the appropriate federal regulations governing isolation of the waste. The data are used to provide confidence in the operational effectiveness and safety of the underground operations, for design validation, to support site characterization and performance assessment activities, and to support activities required for research and technological development. The collection of the geotechnical data is also necessitated by the C&C Agreement with the state of New Mexico that stipulates continuing studies of the site geology, and the need to satisfy EPA regulations for repository performance (40 CFR 191).

Two main WIPP contractors, SNL and Westinghouse, share responsibility for performing activities at the WIPP site in the area of geotechnical engineering. The contractors perform their tasks under the direction of the DOE-WIPP Project for site characterization, performance assessment, and technology development. They plan and execute experiments that are carried out in the WIPP. Westinghouse carries out routine geotechnical monitoring to ensure that the facility operates safely and that data is available to make decisions for managing and performing engineering and operational activities. Additionally, Westinghouse assists SNL in the collection and analysis of certain geotechnical data and also provides engineering support for the SNL Experimental Program, when requested. Each contractor is responsible for particular tasks and has assembled a group or project team to perform the necessary work. The contractors subcontract some support services, such as drilling and hydrologic testing. The overall Geotechnical Engineering QA Program is complex and diverse, and requires that the two major contractors work closely together in order to define needs and to avoid duplications of effort.

Field activities have been organized into three programs that cover the following:

- Data collection from geomechanical instrumentation (rock mechanics)
- Data from surveys of fracture development
- Geology

Each field program is controlled by a program plan that describes the general scope of the investigation, its methodology, and Quality Assurance requirements. The technical programs are discussed in Chapter 4.0.

4.0 DESCRIPTIONS OF TECHNICAL PROGRAMS

4.1 Geology Program

4.1.1 Introduction

The Geology Program is one of three technical programs being carried out under the Geotechnical Engineering Program to collect data on the geotechnical performance of the underground facility. Information from the Geology Program is used to document the existing geology conditions and characteristics and to monitor for changes resulting from the excavations. Activities associated with this program include geologic and fracture mapping, the maintenance of a facility for the storage of geologic samples (Core Library), seismic monitoring and evaluation, and other special activities that are performed on an as-needed basis.

This program plan describes the general scope of the investigation, its methodology, and Quality Assurance requirements. The plan has been prepared in accordance with the requirements listed in Section 11.0 of WP 13-1. The plan will be updated periodically to reflect additions and changes to the program.

The data needs for the analyses performed in the different Geotechnical Engineering programs that comprise the overall program are interrelated. Therefore, data collected under one field program may be used for analyses associated with other programs.

4.1.2 Background

The Los Medanos area has been examined since 1974 to assess site capability for isolation of radioactive waste. The present site for the WIPP was selected in 1976 and has been under continuous investigation since that time as a site for containment and isolation of TRU radioactive waste. As the geology will form the principal barrier in the isolation of the waste from the accessible environment, the Geology Program has provided important data for site characterization and was integral to the decision to proceed with design and construction of the facility.

The site geology has been mainly characterized by subsurface investigations, and approximately 80 boreholes drilled specifically for the WIPP. Local to regional geology studies have used data from as many as 600 industry and WIPP boreholes.

Initially, detailed characterization of the geology within the site boundaries was hindered by the undesirability of drilling exploratory boreholes from the surface into the proposed disposal horizon in the salt beds, 2150 feet below the surface. The boreholes would intercept aquifers in the stratigraphic sequence overlying the salt deposit and could create open pathways from the surface. From these, water bearing units into future waste storage areas or into the buffer zone around the waste area. This initial characterization of the site geology relied heavily on the use of noninvasive geophysical techniques such as seismic reflection; gravity, magnetic, and resistivity surveys in conjunction with data correlated and interpreted from perimeter surface boreholes. In addition to field studies, and as samples have become available, laboratory studies of the geochemistry, physical properties, petrology and mineralogy of the local strata have been conducted. Site selection and preliminary geologic characterization are described in Geologic Characterization Report (Powers. et. al., 1978) and in the Final Environmental Impact Statement (DOE, 1980).

To provide actual data on underground conditions, the Site and Preliminary Design Validation Program was initiated. The program was completed in 1983 and provided extensive geologic characterization of drifts and shafts. The information from the program established confidence in site suitability and was the basis for the decision to proceed with construction of the WIPP facility.

4.1.3 Program Purpose

The purpose of the current Geology Program is to confirm the suitability of the site based on continuing field activities.

4.1.4 Program Scope

Specific activities associated with the Geology Program are designed to accomplish the following:

- Provide additional site geological characterization based on mapping excavations and logging of cores
- Develop and interpret a database on mineralogy, chemistry and textural features characteristic of dissolution residues and compare the data to regular and irregular depositional features and fabrics
- Develop and interpret a database on subsidence induced by mining and integrate the results with WIPP subsidence models
- Derive a model that describes the hydrogeology of the Rustler Formation based on geologic, hydrologic, and geochemical data
- Monitor the local seismicity using a series of surface based seismographs. As part of this activity, analyses will be performed to determine if any correlation of seismic events with mining or petroleum recovery operations can be established

4.1.5 Methodology

The methodology for performing the activities associated with the Geology Program is described in this section. Tasks performed on a routine basis are carried out according to the approved procedures detailed in the Geotechnical and Geosciences Procedures Manual. Tasks which are in development or are not expected to be performed routinely are performed in accordance with individual plant work requests which supplement this program plan. Plant work requests may also be used to coordinate interrelated or complex activities between the Geotechnical Engineering field programs.

4.1.5.1 Routine Activities

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The following activities of the Geology Program are performed on a routine basis:

- SEISMIC MONITORING - Seismic monitoring and evaluation is carried out by the New Mexico Institute of Mining and Technology, a subcontractor to Westinghouse
- GEOLOGIC MAPPING - Geologic mapping is performed in newly excavated areas and when the cognizant engineer or Geotechnical Engineering Manager deems it necessary. All geologic mapping is performed in

accordance with WP 07-501, Geologic and Fracture Mapping of the Facility Horizon Drift, or WP 07-503, Geologic Mapping of Shafts. The mapping results are documented in the annual Geotechnical Field Data and Analysis Reports and in appropriate topical reports.

All drifts and rooms in which geologic mapping was not conducted are visually inspected by the cognizant engineer, or designee, within three months of excavation to verify that the exposed rock units are laterally continuous and similar to those exposed in the mapped areas of the facility. These inspections are documented and maintained in the Geotechnical Engineering files. Any unusual features are reported in the annual Geotechnical Field Data and Analysis Reports.

- FRACTURE MAPPING - Fracture mapping is performed at locations selected by the cognizant engineer and/or Geotechnical Engineering Manager. Fracture mapping is carried out by the cognizant engineer, or designee, in accordance with appropriate sections of WP 07-501.

- CORE LIBRARY OPERATIONS - Geotechnical Engineering maintains a repository for geologic samples that have been determined necessary for long-term storage. Based on requirements for site characterization and evaluation, DOE-WPSO determines which geologic samples are to be retained. WP 07-504, WIPP Project Core Storage, Handling, and Distribution, defines the proper methods for maintaining the sample repository. The procedure includes methods for the submittal of core to the Core Library, maintenance of the core storage facility (inventory, handling, and distribution), authorization for access to view the core on site, and authorization to remove samples from the library.

  Records are maintained of all Core Library activities which include submittal of samples to the Core Library, removal of samples from the Core Library, type of testing performed on the core, a record of people who had access to the core on site, and any other alterations made to the core.

4.1.6 Other Activities of the Geology Program

4.1.6.1 Brine Sampling and Evaluation

Brine Sampling involves brine collection and analysis to monitor the origins, hydraulic characteristics, extent, and composition of brine occurrences at the WIPP.

Boreholes designated for brine sampling are located at various locations throughout the WIPP underground. Brine collection is carried out in accordance with approved procedures.

Data collected is issued annually in the Brine Sampling and Evaluation Report.

4.1.6.2 Plant work requests will be initiated for non-routine Geology Program activities to ensure that the activity will be completed as planned. These plant work requests will provide specific details to describe the activity and methods and equipment required to complete the activity.

Complete or ongoing activities that are not considered routine activities of the Geology Program include geologic mapping of the air intake, exhaust, and waste handling shafts. A test plan was developed for each of these activities to ensure that all the necessary steps to complete the activity were carried out. The test plans for each of these activities are included in the work plans referenced in Section 5.0 of this program plan.

4.1.7 Data Handling

Raw data, logs, and data records collected through the Geology Program are considered permanent records and shall be handled accordingly. QA Records generated as a result of Geology Program activities include: core logs, fracture maps, geologic maps, seismic reports. All raw data, logs, and data records will be transferred to PRS according to the requirements of WP 15-030.

Raw data collected for the Seismic Monitoring and Evaluation activity is directly transmitted to the New Mexico Institute of Mining and Technology. Quarterly data and analysis reports on the seismic data are prepared by the New Mexico Institute of Mining and Technology and submitted to Geotechnical Engineering. Copies of the quarterly seismic reports are transmitted to other project participants and to PRS in accordance with the RIDS for Geotechnical Engineering.

4.1.8 Quality Assurance

Policies and practices that apply to the Geology Program that will provide confidence in the quality of the data generated and samples collected are described in Section 2.0 of this program plan.

4.2 Geomechanical Monitoring Program

4.2.1 Introduction

The Geomechanical Monitoring Program consists of monitoring geomechanical instruments in the shafts and drifts of the WIPP facility. Geomechanical instrumentation presently installed in the shafts and underground includes tape extensometers points, convergence meters, borehole extensometers, piezometers, embedment strain gages, stress gages, inclinometers, load cells and crackmeters. The instrumentation is sufficiently sensitive that small changes in rock displacements and rock stresses can be detected.

The instrumentation system has provided data on the WIPP design for design validation, routine evaluation of safety and stability of excavations, and for developing initial interpretations of long-term behavior of underground openings. From an operational point of view, the data relating to the identification of areas of potential instability allow for remedial action to be taken in a timely manner. For long-term behavior, repository performance will rely heavily on the extrapolation of in-situ data, taken over a few years, to predict thousands of years of repository performance.

The information on the geomechanical monitoring is documented in the Geotechnical Field Data Reports prepared by Architect/Engineer, Bechtel, (DOE, 1986a) from 1982 to 1986 and by Westinghouse subsequent to 1987. Geotechnical data is also contained in the Design Validation Final Report (DOE, 1986b) which documents the performance of the facility during the Site and Preliminary Design Validation Program.

This program plan describes the general scope of the investigation, its methodology, and Quality Assurance requirements. The plan has been prepared in accordance with requirements listed in Section 11 of WP 13-1. Where tasks are performed on a routine basis, they are carried out according to approved procedures that are detailed in the Geotechnical and Geosciences Procedure Manual. Where tasks are in the development stage or are not expected to be performed routinely, the specific steps in the performance of the monitoring activity will be detailed in test plans.

Plant work requests may also be used to coordinate interrelated or complex activities from the field programs. The data needs for the analyses performed in the Geomechanical Monitoring Program are interrelated and data collected under one field program may be used for analyses associated with other programs.

4.2.2 Background

As site characterization progressed and design activities began, the engineering performance of the rocks at the WIPP became important for both the design of the operating facility and the assessment of its long-term performance. Of special significance are the time-dependent properties of the salt. SNL has carried out extensive experimental work to establish an appropriate, constitutive relationship for salt that can predict its in-situ, mechanical performance. Because these experiments were incomplete when design of the underground facility started, facility design was based on empirical information from potash mines, available rheological parameters derived from the laboratory testing of rock samples, engineering evaluations, and numerical analyses. To validate the design, field data from geomechanical instrumentation were used to determine actual mechanical performance of the shafts and excavations at the facility horizon.

4.2.3 Program Purpose

The purpose of the Geomechanical Monitoring Program is to determine the actual geomechanical performance of the underground excavations at the WIPP. Data on stability and closure are needed for operational considerations and for performance assessment.

4.2.4 Program Scope

The activities associated with the Geomechanical Monitoring Program are designed to:

- Maintain and augment the geomechanical instrumentation system in the WIPP underground and upgrade the automatic data acquisition system as necessary
- Monitor geomechanical instrumentation on a regular basis and maintain a current database of instrument readings
- Evaluate the geomechanical instrumentation data and prepare regular reports that document the data and analyses describing the stability and performance of underground openings
- Recommend corrective or preventative measures, if needed, to ensure excavation stability, safe operation of the facility, and an acceptable time frame for possible waste retrieval

- Provide predictions, as needed, of the performance of the underground excavations based on instrumentation data and supplemented by analytical studies

4.2.5 Methodology

The process by which geomechanical monitoring is initiated may vary. It may be part of operational excavation monitoring, research test support, or test termination. However, the process of proper documentation and analysis is common to all.

The installation and monitoring of the geomechanical instruments are governed by approved procedures detailed in the Geotechnical and Geosciences Procedure Manuals.

Instruments which have been installed underground are monitored automatically by a surface datalogger or read manually. The purpose of each type of instrument and monitoring technique is provided in Table 4-1.

4.2.5.1 Data Acquisition

Geomechanical instrumentation data is remotely acquired by the geomechanical datalogging system or manually by geotechnical engineering technicians. Manually acquired data is collected on a quarterly basis at minimum; however, more frequent readings may be collected as determined by the cognizant engineer or cognizant manager. Automatically acquired data is collected on a monthly basis, at minimum, although more frequent readings may be collected as necessary.

4.2.5.2 Geomechanical Datalogging System

The geomechanical datalogging system consists of a surface computer and LTCs located at various locations underground. The surface computer is used to access the LTCs by means of programs and polling devices installed in the LTCs. All data received is then stored in the Geomechanical Instrumentation System Database. Installation of LTCs is performed in accordance with Specification No. E-P-309, Instrument Cabinets and Panels.

4.2.5.3 Instrumentation

Geomechanical instruments are installed in accordance with approved procedures and the following specifications:

E-P-246	Pull Boxes and Terminal Boxes - Enclosures
E-Q-281	Instrumentation Cables
E-P-244	Cable Terminations
E-P-309	Instrument Cabinets and Panels

Instruments are installed at various locations based on specific monitoring requirements for various locations underground. The locations, monitoring required, and instruments used is provided in Table 4-1.

TABLE 4-1
GEOMECHANICAL MONITORING INSTRUMENTATION

LOCATION	INSTRUMENT USED	MONITORED
Salt Handling, Waste and Exhaust Shafts	Piezometers	Groundwater pressure behind the shaft liner and key at the waterbearing Magenta and Culebra Dolomite Members.
	Extensometers	The Unnamed Upper and McNutt members of the Salado Formation in the lower unlined portion of the shafts.
	Earth Pressure Cells and Strain Gages	Horizontal stress between the concrete key and the Salado Formation as the creep effects load on the concrete structure.
Salt Handling and Waste Shaft Stations	Tape Extensometer Points	Roof to floor closure and rib to rib closure.
	Multiple Point Borehole Extensometers	Fracture separation in the rock strata.
	Rockbolt Load Cells	*Tensile loads in rockbolts.*
Main Access Drifts	Tape Extensometer Points	Roof to floor and rib to rib closure rates in intersections and midpillar locations.
	Multiple Point Borehole Extensometers	Fracture of separation in the rock strata.
	Crackmeters	Fracture or separation in the rock.
Waste Storage Panel	Multiple Point Borehole Extensometers	Fracture of separation in the rock strata.
	Tape Extensometer Points, Wire Convergence Meters	Roof to floor and rib to rib closure rates. Where access is restricted remotely read convergence meters are installed.
	Rockbolt Load Cells	Tensile loads in rockbolts.
Site Preliminary Design Validation Test Rooms	Multiple Point Borehole Extensometers	Fracture separation in the rock strata.
	Tape Extensometer Points	Roof to floor and rib to rib closure rates.
	Stressmeters	Monitor stress changes from all directions in the anhydrite bed.
	Inclinometers	Monitor borehole movement in rock strata.
	Wire Convergence Meters	Roof to floor closure rates. Due to restricted access they are read remotely.

4.2.5.4 Data Analysis and Dissemination of Data

The frequency of data analysis on geomechanical data is based upon the requirements established in WP 02-9, Final Safety and Analysis Report. A completed data analysis is performed on an annual basis, at a minimum. The results of the analyses are published annually in the Geotechnical Field Data and Analysis Report.

An assessment of convergence measurements and geotechnical observations is made after each round of measurements. The results of this assessment are distributed to affected underground operations, engineering, and safety managers. Data analysis may be performed on a more frequent basis, as recommended by the cognizant engineer or cognizant manager.

Although geomechanical instrumentation data is published annually under an approved distribution list, data may be released to external sources with consent from the DOE-WPSO.

4.2.5.5 Calibration

Measuring equipment used to read geomechanical instruments are calibrated by Westinghouse Calibration Lab, in accordance with WP 10-003. Frequency of calibration is based on manufacturer recommendations upon receipt of the measuring device at the WIPP site. Calibration records are maintained by the Westinghouse Calibration Lab. Copies are kept on file in Geotechnical Engineering on an "information only" basis.

4.2.5.6 Routine Activities

Tasks that are in the development stage or are not expected to be performed routinely are detailed in plant work requests.

Maintenance is performed on an as-needed basis. When an instrument is damaged or erroneous readings are suspected, the instrument is physically inspected and evaluated for repairs or replacement. If repair efforts are unsuccessful, that instrument is documented as malfunctioning and monitoring is discontinued until the instrument has been replaced. If it is determined by Geotechnical Engineering that replacement is not necessary, the instrument is not replaced. 07-15-93

07-15-93

Monitoring and inspection of Room 1, Panel 1 is performed on a weekly basis by Geotechnical Engineering. Visual inspections are made during weekly data collection from manually read instrumentation. These inspections will check the physical condition of the instrumentation, junction boxes and cabling for damage, corrosion and loose parts. Any unusual observations or deterioration are documented on the GIS field data sheets and the cognizant engineer is notified of existing conditions.

The performance of the remotely read instrumentation in Room 1, Panel 1 is evaluated by the cognizant engineer on a weekly basis. The evaluation results are reported, on a weekly basis, to the Project Control Group set up to evaluate the performance of Room 1, Panel 1 and the supplemental roof support system. This evaluation is used to determine whether the geomechanical instrumentation and data acquisition system is performing as anticipated and is documented on a Room 1, Panel 1, Roof Support Instrumentation Inspection Data Sheet (Attachment 1).

Maintenance on borehole extensometers is performed during an annual resetting activity. Resetting increases the rod lengths of those extensometers that have had a displacement of more than two inches since the last reset. This extends the useful life of the instrument and enables maintenance to be performed as well. 07-16-93

The appropriate procedures for the installation, calibration, and monitoring of these instruments are presented in the Geotechnical and Geosciences Procedure Manuals. Additional instrumentation may be installed as needs arise. 07-15-93

4.2.5.7 Other Activities of the Geomechanical Monitoring Program

A test plan will be developed, for activities in a developmental stage, that will include or reference the appropriate procedures to ensure that all necessary steps to complete the activity are carried out. These test plans will detail specific plans which describe instrument characteristics, locations, procedures, etc.

4.2.6 Data Handling

Raw data, logs, and records collected from geomechanical instrumentation under the Geotechnical Engineering Program are considered permanent records. QA records generated as a result of Geomechanical Monitoring Program activities include: Field Data Sheets, Initial Data Sheets, and Extensometer Reset Data Sheets. Permanent records are transferred to PRS in accordance with the Geotechnical Engineering RIDS. All geomechanical instrumentation data collected are reported in the annual Geotechnical Field Data and Analysis Report.

A listing of each geomechanical instrument, its location, and its fieldtag identification is located in the Rock Mechanics Program File. This listing is updated on an annual basis, at a minimum. Also included in the list is the criteria under which each instrument was installed. Reference to specific instrumentation and instrument location, can be found on Drawing No. 74-V-001-W, Location of GIS Instrumentation, Termination Boxes and Termination Box LTC 17 Schematic. This drawing is updated whenever a new instrument has been added to the geomechanical instrumentation system.

4.2.7 Quality Assurance

All aspects of the Geomechanical Monitoring Program activities shall conform to the requirements described in Section 2.0, of this manual and the Geotechnical and Geosciences Procedure Manuals.

4.3 Excavation Effects Program

4.3.1 Introduction

The Excavation Effects Program is being conducted to provide necessary information on the structural behavior of the salt rock around the excavated openings. A variety of techniques are used at the WIPP to monitor fracturing. These include borehole surveys, geologic fracture mapping, resistivity surveys, ground-probing radar, and evaluation of geomechanical instrumentation.

Excavation effects data acquired from borehole surveys and nondestructive geophysical techniques are used to supplement geomechanical data and geological observations to detect and quantify the occurrences of discontinuities such as fractures and separations.

This program describes the scope of the investigation, the methodology, and Quality Assurance requirements. The plan has been prepared in accordance with Section 11.0 of WP 13-1.

4.3.2 Background

During the underground Site and Preliminary Design Validation Program, there were indications that fractures were developing in the floors of excavations. These observations resulted in the initiation of a survey of boreholes throughout the underground. This survey, together with visual observations of excavation surfaces, showed that fracturing was occurring throughout the facility both in the roof and floor, and to a lesser extent in the ribs. This behavior was not entirely unexpected and has been previously observed in evaporite mines (Baar, 1977). In general, the fracturing at the WIPP has been discovered in the floors of excavations before being discovered in the roofs.

Following development of the fractures at the WIPP, a maintenance program was put into effect in mid-1986 to study fracturing and separation in the roof and floor. In 1986, thirty borehole arrays were drilled for the specific purpose of determining the distribution of fracturing around the underground facility. These holes are inspected annually, when access is available. The annual inspection of these holes is referred to as the EES. Other open holes in the facility can also be inspected periodically, although not as part of the EES.

4.3.3 Program Purpose

Boreholes are inspected to assess the nature of fracturing surrounding excavations in the underground facility at the WIPP. An understanding of fracturing around excavations will aid in evaluating underground stability in the short-term during operations and, in the long-term, for the design and construction of permanent bulkhead seals.

4.3.4 Program Scope

The activities associated with the Excavation Effects Program include scheduled borehole inspections, geologic observations, and geophysical methods. The program is designed to:

- Perform regular surveys of observation boreholes in the underground to monitor the propagation and development of fractures

- Conduct regular fracture mapping of the underground to identify surface fracture features and their evolution over time. Fracture mapping is performed under the Geology Program; however, data collected is also used for the Excavation Effects Program

- Evaluate additional techniques for monitoring fracture development within the salt and implement them as required

- In association with other Geotechnical Engineering programs, evaluate data and proposed mechanisms to explain the development of fractures at the WIPP

4.3.5 Methodology

The methodology for performing the activities associated with the Excavation Effects Program is described in this section. Borehole fracture surveys and fracture mapping are performed on a routine basis and are carried out in accordance with approved procedures and detailed in the site Geotechnical and Geosciences Procedure Manuals. Other activities which are in the developmental stage or are not performed routinely are conducted in accordance with plant work requests.

4.3.5.1 Borehole Surveys

Thirty-six arrays of three to six boreholes were drilled for the EES at various locations in the underground (Excavation Effects Array Locations, Table 4-2). The arrays were laid out in similar configurations so that results from one location could be readily compared to results from other locations. The holes are an average of nine feet long. The center holes, at most arrays, were drilled to a 3 inch diameter to allow the use of borehole cameras. The majority of the holes were drilled to 1-7/8 inch diameter.

Open boreholes not specifically included in the EES are of varying diameter and depth. These holes are not inspected annually, but can be inspected when additional information is required in that area.

Boreholes are physically examined using a scratcher probe rod. The boreholes are initially drilled to depths between 6 feet and 12 feet and are inspected annually in accordance with WP 07-315.

4.3.5.2 Data Collection

Data is collected using an aluminum probe rod which consists of a flattened nail less than 1/16 inch wide attached at a right angle to one end. Fractures are identified by scratching the nail along the sides of the borehole while applying moderate pressure. Fractures are located where the nail catches at the same depth on all sides of the borehole wall.

4.3.5.3 Fracture Mapping

Fracture mapping is a routine activity performed under the Geology Program; however, collected data is also used under the Excavation Effects Program. Fracture mapping is described in detail in Section 4.1.5 of this manual.

4.3.5.4 Other Activities of the Excavation Effects Program

For each of these activities, a test plan is developed that will include or reference the appropriate procedures to ensure that all necessary steps to complete the activity are carried out.

4.3.5.4.1 Time Domain Reflectometry (TDR) Monitoring

TDR monitoring encompasses the installation of TDR cables and subsequent data collection and analysis. TDR methods supply information on subsurface fracture location and size.

TABLE 4-2
EXCAVATION EFFECTS ARRAY LOCATIONS

ARRAY	OPENING DIMENSIONS (HxW)(ft.)	EXCAVATION DATE	LOCATION	DATE DRILLED
1	13 x 33	04/83	Test Room 4, N1175	05/15/86
2	13 x 33	04/83	Test Room 4, N1264	05/16/86
3	13 x 33	04/83	Test Room 4, N1361	05/16/86
4	13 x 33	04/83	Test Room 3, N1198	05/15/86
5	13 x 33	04/83	Test Room 3, N1243	05/15/86
6	13 x 33	04/83	Test Room 3, N1312	05/15/86
7	13 x 33	03/83	Test Room 2, N1147	05/21/86
8	13 x 33	03/83	Test Room 2, N1231	05/21/86
9	13 x 33	04/83	Test Room 1, N1159	05/21/86
10	13 x 33	04/83	Test Room 1, N1275	05/21/86
11	12 x 25	(Floor Lowered 4 ft 12/83)	N1110, W02	05/30/86
12	12 x 14	02/83	N1430, E140	06/05/86
13	8 x 14	01/84	N1110, E439	06/20/86
14	12 x 14	02/84	N1430, E875	06/05/86
15	12 x 25	02/83	N626, W02	06/20/86
16	8 x 14	02/83	N305, E147	07/15/86
17	12 x 32	10/82	Salt Handling Shaft Station, N28	05/30/86
18	20 x 35	06/82 (Roof Raised 3 ft 08/87)	Salt Handling Shaft Station, S24	06/04/86
19	20 x 35	06/82 (Roof Raised 3 ft 08/87)	Salt Handling Shaft Station, S56	06/03/86
20	15 X 25	12/82 (Floor Lowered 5/84)	S592, E155	07/10/86
21	12 x 20	07/85	S700, E66	07/08/86
22	12 x 14	05/84,07/84	S700, E300	07/08/86
23	12 x 14	07/84	S1190, E229	07/09/86
24	15 x 25	12/84; 08/85; 06/84	S1300, E155	07/09/86

TABLE 4-2 Continued
EXCAVATION EFFECTS ARRAY LOCATIONS

ARRAY	OPENING DIMENSIONS (HxW)(ft.)	EXCAVATION DATE	LOCATION	DATE DRILLED
25	15 x 25	12/82 (Floor Lowered 5/84)	S1129, E155	07/09/86
26	08 x 25	01/83	S2205, E154	07/16/86
27	12 x 14	03/83	N1430, E1555	07/11/86
28	12 x 20	03/83 (Floor Lowered 4/83	N1110, W432	07/16/86
29	15 x 25	12/82 (Floor Lowered 11/85)	S1700, E155	07/10/86
30	8 x 14	02/84	N1110, E1303	07/11/86
31	12 x 14	03/84	N1420, E1375	03/08/91
32	12 x 14	03/84	N1420, E1470	03/07/91
33	13 x 33	03/84	N1420, E1110	03/06/91
34	13 x 33	02/87	E720, S1688	04/26/91
35	13 x 33	02/87	E720, S1775	04/26/91
36	13 x 33	02/87	E720, S1865	04/26/91

NOTES:

1. Nominal hole depth is 9 feet but some holes are shorter due to low drift roof or drilling difficulties.

2. One roof and one floor hole of each array were generally drilled 3 inches in diameter to accommodate use of the borehole camera if desired. Other holes were drilled 1-7/8 inches in diameter. Existing holes were used where possible.

3. Observations were made using a probe consisting of a nail attached perpendicular to the end of a rod.

4. Holes at Array 13 were drilled to only 6 to 6.5 feet depth due to low drift roof. No roof holes were drilled at Arrays 16 and 26 due to low drift roof.

TDR monitoring consists of rock mass movements which deform a grouted coaxial cable causing a change in cable capacitance and thereby, a reflected wave form occurs when voltage is applied to the cable via the Tektronix cable tester. By monitoring changes in the reflected waveforms, it is possible to monitor the rock mass deformation.

TDR installations are currently located only in the SPDV Test Rooms. No WIPP procedure has been developed, and until a procedure is deemed appropriate, work involving TDR monitoring will be governed by an approved test plan.

4.3.5.4.2 Resistivity Surveys

The resistivity technique currently used at WIPP by Geotechnical Engineering is a direct method which requires a series of lead electrodes to be installed in regular grids of shallow boreholes on the excavation surface being investigated. The electrodes are connected to a transmitting power supply. Current is applied to selected electrodes and the voltage drop is measured at other nearby electrodes. The spacing of electrodes and the selection of which electrodes are energized during a measurement depend on the location and the information desired. Data may be collected manually with a voltmeter or automatically with a computerized datalogger on a monthly basis.

4.3.5.4.3 Ground-Probing Radar Surveys

Ground-probing radar is a technique used at the WIPP to investigate fracturing within the salt rock. Contrasts in dielectric constant along the travel path of a transmitted electromagnetic signal produce reflections from subsurface interfaces. The length of the time between signal generation and receival of the reflected signal is used to provide images of fracturing within the rock mass. The depth of investigation depends upon the frequency of the electromagnetic signal and the conductivity of the salt rock.

4.3.6 Data Handling

Raw data, logs, and data records collected through the Excavation Effects Program are considered permanent records and are handled accordingly. QA records generates us a result of EEP activities include: Field Data Sheets. All raw data, logs, and data records will be documented in the Field Data and Analysis Reports and transferred to PRS in accordance with WP 13-030.

4.3.7 Quality Assurance

All aspects of the Excavation Effects Program activities shall conform to the requirements established in Section 2.0 of this manual.

5.0 REFERENCES

40 CFR 191, Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High Level and Transuranic Radioactive Wastes

ASME NQA-1-1989, Quality Assurance Program Requirements for Nuclear Facilities

Drawing No. 74-V-001-W, Location of GIS Instrumentation, Termination Boxes and Termination Box LTC 17 Schematic

DOE/WIPP 89-013, WIPP Project Records Management Handbook

Rock Mechanics Program File No. 78010

SAND 80-7096, Seismicity in the Area of the Waste Isolation Pilot Plant (WIPP)

Specification No. E-P-244, Cable Terminations

Specification No. E-P-246, Pull Boxes and Terminal Boxes - Enclosures

Specification No. E-P-309, Instrument Cabinets and Panels

Specification No. E-Q-281, Instrumentation Cables

Work Plan of Geotechnical Activities in the Waste and Exhaust Shafts at the WIPP Facility

Work Plan for the Geologic Mapping in the Air Intake Shaft at the WIPP Facility

WP 02-9, Final Safety Analysis Report

WP 07, Geotechnical and Geosciences Procedures Manuals

WP 07-501, Geologic and Fracture Mapping of the Facility Horizon Drifts

WP 07-503, Geologic Mapping of Shafts

WP 07-504, WIPP Project Core Storage, Handling, and Distribution

WP 10-003, Instrument Control and Calibration

WP 13-1, WID Quality Assurance Program Description

WP 14-TR3308, On-The-Job Training

WP 15-609, Planning, Preparation, and Processing of Purchase Requisitions and Purchase Requisition Change Notices

WP 15-030, Records Management

WP 15-101, Preparing, Revising, Reviewing, and Canceling Procedures

WP 15-103, Document Control

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