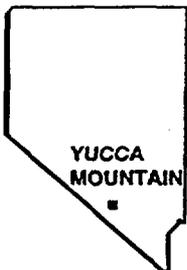


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U.S. DEPARTMENT OF ENERGY

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**YUCCA MOUNTAIN
SITE CHARACTERIZATION
PROJECT**

MOISTURE STUDIES IN THE ESF

REVISION 5

**FIELD WORK PACKAGE
FWP-ESF-96-004**



INFORMATION COPY

UNITED STATES DEPARTMENT OF ENERGY

**OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT
FWP/LWP APPROVAL**

QA: QA

SECTION I (Project Engineer completes)

FWP/LWP Title:

Moisture Studies in the ESF

FWP/LWP Identifier:

FWP-ESF-96-004

Assigned Project Engineer:

Alan J. Mitchell

Affected Organizations in FWP/LWP:

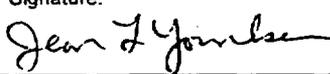
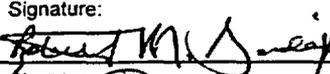
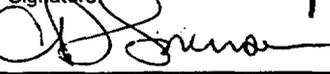
LANL, USGS, LBNL, MK, and SAIC

HISTORY OF REVISIONS

Revision Number	Effective Date	Reason for Change
0	07/23/96	Initial issue.
1	All	Inclusion of tracer gas injection tasks, additional affected organizations, and ES&H responsible. Various updates also included.
2	04/29/98	Update scope to include new moisture related tests and testing locations.
3	09/24/98	Update DIE references, controls, points of contact list, and ES&H review. Added attachment 12 and made various editorial changes.
4	04/07/99	Clarify organizational responsibilities and update scope of work.
5	02/08/00	Additional workscope.

SECTION II (Project Engineer obtains signatures) (N/A for expedited changes)

The following signatures authorize work to commence in accordance with this FWP/LWP and within the constraints identified in the Planning and Control System approved by the Office of Civilian Radioactive Waste Management.

Manager Name:	Organization:	Signature:	Date:
J. Younker	Applied Research & Testing Programs		2-7-00
Robert Sandifer	M&O Site Construction Dept.		2-7-00
Dennis Sorensen	M&O Environmental Safety & Health		2/7/00
Robert Clark	OQA		2/7/00
Manager Name:	Organization:	Signature:	Date:
Manager Name:	Organization:	Signature:	Date:

SECTION III (Project Engineer obtains signatures) (N/A for non-expedited changes)

Work approved in the previous revision of this FWP/LWP may continue with the expedited changes identified in this revision. A full review of this expedited change should be initiated within 3 working days of the effective date of this revision.

TCO Manager:	Signature:	Date:

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INTRODUCTION

This Field Work Package (FWP) developed in accordance with AP- 5.2Q provides both administrative guidance and instructions which implement the Quality Assurance Requirements and Description (QARD) DOE/RW-0333P, and Integrated Safety Management Program principles/functions related to Moisture Studies in the Exploratory Studies Facility (ESF).

Affected organizations are responsible for conducting field work in accordance with this controlled FWP. It is the affected organization's responsibility to determine the Quality Assurance (QA) program applicability for related activities in accordance with the Office of Civilian Radioactive Waste Management approved QA program. This FWP is neither a design document, nor a Yucca Mountain Site Characterization Project (YMP) baseline document.

1.0 SCOPE AND DESCRIPTION

1.1 GENERAL SCOPE DESCRIPTION

This FWP provides the process controls utilized by the Test Coordination Office (TCO) to manage and coordinate the activities for this study which include the configuration, installation, and implementation of Moisture Studies in the ESF. This testing FWP will address testing criteria, Project controls, Environmental, Safety, and Health (ES&H) requirements, and identify roles and responsibilities specific to this testing workscope. This FWP applies to Moisture Studies in underground excavations in the ESF, including but not limited to the ESF, Enhanced Characterization of the Repository Block (ECRB), and other locations as activities are budgeted and planned.

1.1.1 General Test Description and Objectives

This FWP describes the interfaces and controls used to coordinate Moisture Studies in the ESF. The objective of this task is to ensure information collected is suitable for use on the YMP. Moisture Studies in the ESF will consist of many different types of moisture measurements and moisture/water determinations which will be conducted throughout the ESF from the North Ramp portal along the Main Drift, continuing to the South Portal and throughout the entire ECRB Cross-Drift and extensions utilizing exposed ribs of alcoves as well as niches constructed specifically for this study.

The purpose of Moisture Studies in the ESF is to; (1) document tunnel baseline conditions and effects of various construction and operating activities; (2) conduct hydrologic testing, infiltration, percolation, and seepage flux measurements, and data collection of the unsaturated and saturated stratigraphic zones exposed in the ESF; (3) utilize the information gathered from these studies to continue the development of process models to support system performance, site recommendation, and license application; (4) determine a mass water balance for material excavated during construction; (5) provide information for hydrologic imbibition with consideration to airborne industrial hygiene issues; (6) fracture flow and transport; and (7) associate information and technical skills used for moisture studies to help correlate and bring together

additional information which could tie to the activities needed to provide data required for performance assessment.

The Site Facilities Office (SFO) implements ESF niche and alcove construction based on location criteria from the Principal Investigator (PI) transmitted through the TCO and design information from the Architect/Engineer (A&E).

Niche and alcove design and construction is the responsibility of the A&E and SFO.

Each niche will be constructed by the respective department within the SFO according to drawings and criteria. References to drawings may be called out for items including alteration of ground support utility requirements and construction configurations. The design process for these excavations will be coordinated by the TCO Design Coordinator. The design is concurrent with Repository Design planning in regards to the potential repository design. Prior to niche or alcove excavation, a series of boreholes may be drilled to allow for gaseous and/or aqueous tracer testing. During mechanical excavation processes, the PIs or their designees may collect bulk rock samples and map in-situ fractures. Upon completion of excavation, additional boreholes will be drilled laterally from each niche. These holes will be instrumented as quickly as possible, then bulkhead doors will be installed at each niche. Datalogging equipment will be set in or near the niches or alcoves. Opening of a niche bulkhead door must be coordinated by the TCO in order not to compromise the test and be concurrent with all access procedures.

Specific measurements planned may include: (1) the determinations of flux and humidity gradients across the boundary layers near the wall or invert surfaces; (2) installation of instrumentation into boreholes and or bench cuts to gain direct measurement of water potential, temperatures, rock permeability, and porosity; (3) determination of the air flow velocity, temperature, relative humidity, and barometric pressures within the various locations (approximately one sensor station every 500 meters to 1000 meters, and supplemented by mobile surveys along tunnel segments, and at major interfaces and fault intersections); and (4) the use of infrared imaging and other techniques to evaluate the evaporative processes near the ESF tunnel surfaces.

Measurements which are currently required by the Natural Environment Program Operations (NEPO) scientists are: (1) electrical power consumption (as available); (2) air flow measurements inside the ESF/ECRB; and (3) volumes of traced water used inside the ESF/ECRB, dust control, construction, drilling operations, and other construction/testing activities. This information shall be supplied by the departments within the SFO.

Globally, the objectives of Moisture Studies in the ESF are to provide determinations of moisture conditions in the tunnel rock as well as the excavated areas in order to supply information to supplement hydrologic modeling calculations for the entire Yucca Mountain area and provide input to effective hydrologic, transport, flow, and integrated site models.

1.1.2 Regulatory Basis for Moisture Studies in the ESF

The following are controlled or published YMP documents that describe Moisture Studies in the ESF. These documents, together with related plans, include:

- Site Characterization Plan (DOE/RW-0199), Date: December 1988
 - Section 8.3.1.2.2.8 Fluid Flow in Unsaturated Zone Fractured Rock
 - Section 8.3.1.2.2.9 Site Unsaturated Zone Modeling and Synthesis
 - Section 8.3.1.2.2.1.2 Unsaturated Zone Infiltration
 - Section 8.3.1.2.2.3.1 Percolation in the Unsaturated Zone
- Characterization of the Yucca Mountain Unsaturated Zone
- Aqueous-Phase Chemical Investigations Unsaturated Zone Hydrochemistry
- Multi-Year Planning System (MYPS) FY00 at <http://ympcs1.ymp.gov>

1.2 SPECIFIC SCOPE DESCRIPTION

1.2.1 Organizational Responsibilities

The organizations described in the following section provide services in support of Moisture Studies in the ESF. A brief scope of responsibilities for each organization is provided including interface responsibilities. Specific ES&H responsibilities, processes, and controls are included in Section 4.1. In general, the TCO acts as the interface and coordinator between the PI Organization(s) and all other organizations listed in the following paragraphs. The TCO monitors all test-related construction and testing activities associated with this activity, also ensures and enacts the appropriate controls, as necessary, through the relevant organization(s).

TEST COORDINATION OFFICE - The TCO is responsible for overall field management, coordination, and monitoring of test activities as defined in this FWP. Specific responsibilities will include: planning and coordination of field testing activities, specifically coordination between the PIs and Construction Management; preparation and maintenance of working schedules based on annual budget allocations; assignment of a FWP Records Coordinator (FWPRC) to monitor the FWP records, assignment of a Data Manager for the data management activities described in FWP-ESF-96-001, "Exploratory Studies Facility Data Collection Systems"; preparation of requests for field work scope modification for activities that fall within the approved scope of this activity; and preparation and control of changes to this FWP. These responsibilities, when shared with the supporting PIs, will ensure that data processes and information gathered from the test activities described herein will meet requirements. The TCO is on site whenever construction or test-related activities are occurring. The TCO will provide ESF access for scientific staff, support staff, and Data Collection Systems (DCS) support personnel as required. The TCO is responsible for coordinating all aspects of field test implementation. The TCO will coordinate all requests specific to testing that are included in this FWP, as well as additional requests when supplied to the Project Engineer (PE) assigned to the test or the Field Test Manager. Field activities that are not coordinated through the TCO may cause delays to field implementation or result in changes that may directly affect field test

objectives. The TCO has the responsibility of maintaining the anticipated work location of each PI or designee while working in the field.

PRINCIPAL INVESTIGATORS -The PIs will provide the scientific staff, instrumentation, and equipment necessary for maintaining and calibrating all required scientific equipment and instrumentation utilized for conducting Moisture Studies in the ESF. Moisture Studies activities include deployment of testing components, instrumentation, and interactions with the established data collection services in the ESF. The PIs are responsible for ensuring that the data and information collected during test activities associated with Moisture Studies in the ESF are acceptable to meet requirements for site characterization and are qualified in accordance with QA requirements. The PIs are responsible for ensuring that each of their field staff has been provided an opportunity to read and understand the contents of this FWP. It is the responsibility of each PI or designee performing work covered within this FWP to report to the assigned PE, as well as the Field Test Manager each time they plan to conduct field activities. Field activities that are not coordinated through the TCO may cause delays to field implementation or result in changes that may directly affect field test objectives.

The PI is responsible for ensuring that each of their field staff have been provided an opportunity to read and understand this FWP and associated Work Instructions.

SITE FACILITIES OFFICE (SFO) - The SFO Organization is comprised of multiple departments which provide overall management of all tunnel operations. These SFO departments include Craft Management Department (CRMD), Field Engineering Department (FED), and Construction Management Department (CMD). The SFO will provide an interface to the TCO. The SFO will ensure that criteria transmitted through design documents and FWPs will be adhered to, unless communicated to the TCO. The TCO will coordinate testing field activities with the SFO who will ensure departmental support in providing underground labor, materials, and equipment to facilitate testing activities as requested by the PIs, and transmitted through the TCO. This support for testing activities may, at a minimum, include drilling activities, survey support, and the transportation of equipment and samples inside the ESF and on the ESF Pad. The SFO has the responsibility of ensuring safe working conditions and safe constructor operated equipment. Personnel entering the ESF will comply with the M&O Safety and Health Plan.

WIRELINE MEASUREMENT SUPPORT (WMS) - WMS personnel will provide instrumentation and equipment, geophysical logging, and support for testing activities associated with this FWP. Call out for this support, as defined by the PI, will be coordinated through the responsible Moisture Studies TCO PE and TCO Field Test Manager (FTM). Work will be conducted for these activities through FWP-ESF-96-013, "Borehole Wireline Measurements for ESF Testing Activities."

SAMPLE MANAGEMENT AND DRILLING DEPARTMENT (SM&DD)
SM&DD will provide sample collection, handling, packaging, archiving, and shipping support for samples or core as requested by the TCO.

SUPPORT SERVICE & MAINTANCE MANAGEMENT DEPARTMENT

(SS&MMD) - SS&MMD personnel will provide photography and photography processing support including archiving and distribution. Call out for this support will be coordinated through the responsible Moisture Studies PE and Field Test Coordinator (FTC).

1.2.2 Field Testing Equipment

The PI testing organizations shall provide the test equipment required to field activities associated with Moisture Studies in the ESF. The PIs shall have approved procedures and/or scientific notebooks to follow when using this equipment. Field data collection equipment may be supplied by the PI testing organizations or provided to the PI testing organizations by the ESF DCS program. Currently identified PI provided instrumentation is outlined in Attachment 3.

1.2.3 Computer Software

Software (excluding that which is an integral part of measuring and test equipment) that uses numerical methods for complex scientific, engineering, or mathematical calculations will be controlled in accordance with appropriate QA procedures. The DCS use manufactured software in order to allow the devices to perform the functions required. No manipulation of raw data will occur in the field during data collection, unless performed by the PI under approved procedures or documented in the PI's scientific notebook. No data manipulation software is identified at this time.

Personnel who use electronic methods to control data, used as sources for Quality Affecting work, must determine if requirements from the QARD Supplement V apply.

1.3 IMPLEMENTING FIELD DOCUMENTS

FWP-ESF-96-001 will provide the process controls utilized by the TCO to manage the configuration, procurement, installation, calibration, operation, and maintenance of the DCS specific to site characterization activities conducted in the ESF. FWP-ESF-96-001 will implement the installation and operation of data collection equipment and instrumentation to meet the data requirements identified for Moisture Studies in the ESF requiring electronic data collection support.

The following procedures or equivalents will be utilized to conduct work within the scope of this FWP. The roles and responsibilities by which these procedures are applied in executing the work are presented in Section 3.0. The sequence in which these documents are applied in executing the work is presented in Section 3.0. The decision to implement these procedures or apply them to QA controlled activities is under the direction of the implementing organization. This list identifies procedures and processes currently planned to implement activities. Integrated Safety Management (ISM) principles and functions are administrative in nature and are implemented using the Work Instruction Process. This process is outlined in Attachment 15. These procedures may be revised, replaced, or added to, as needed, without revising this FWP.

Procedure Number	Title
AP-3.14Q	Transmittal of Input
AP-6.7	Authorization for the use of Radioactive Materials or Ionizing Radiation Producing Equipment
AP-17.1Q	Records Source Responsibilities for Inclusionary Records
AP-SIII.1Q	Scientific Notebooks
AP-SIII.3Q	Submittal and Incorporation of Data to the Technical Data Management System
LANL-EES-13-DP-612	Identification, Collection, and Handling of Non-Required Assigned Core in the ESF
LANL-EES-13-DP-613	Borehole Wireline Measurements
LANL-YMP-QP-03.5	Documenting Scientific Investigations
NWI-DS-001Q	Field Logging, Handling, and Documenting Borehole Samples
NWI-DS-002Q	Field Drilling Support Activities
NWI-DS-004Q	Logging, Handling, and Documenting Exploratory Studies Facility Non-Required Assigned Core Samples
NWI-ESF-007Q	Water Use and Control – Subsurface
NWI-ESF-008Q	Surveying
NWI-ESF-009Q	Control and Distribution of Survey Documents
NWI-ESF-016Q	Tracers, Fluids, and Materials Estimating, Accounting, and Reporting
NWI-ESF-030Q	Traced Water System
NWI-SPS-001Q	Use of a Tracer Gas for Determining Atmospheric Contamination of the Unsaturated Zone in a Dry-Drilled borehole
PRO-EP-001	Environmental Permit Compliance
PRO-EP-002	Non-Hazardous Waste Management
PRO-EP-004	Spill Management
PRO-IM-011	Lessons Learned Program
PRO-MG-004	Integrated Safety Management System
PRO-SH-001	Accident Investigation, Reporting and Recordkeeping
PRO-SH-003	Compliance with the Occupational Safety and Health Administration Hazard Communication Standard
PRO-SH-004	Hearing Conservation Program
PRO-SH-005	Emergency Management
PRO-SH-011	Conducting a Job Safety Analysis
PRO-SH-014	Silica Protection Program

PRO-SH-019	Airborne Radiation Protection Program for Naturally Occurring Radon
PRO-TS-007	Authorization to Purchase and Use Regulated Hazardous Materials
QAP-2-0	Conduct of Activities
USGS-YMP-HP 97	Measurement of Temperature and Relative Humidity Using a Temperature and Relative Humidity Probe
USGS-YMP-HP177	Operation of a Barometric Pressure Transducer.
YAP-2.8Q	Tracers, Fluids, and Materials Data Reporting and Management
YAP-12.3Q	Control of Measuring and Test Equipment and Calibration Standards
YAP-15.1Q	Control of Non-Conformances
YAP-30.2	Land Access and Environmental Compliance
YAP-30.10	Authorization to use Regulated Hazardous Substances and Materials
YAP-30.39	Exploratory Studies Facility Tunnel Access Approval Process
YAP-SII.1Q	Submittal, Review, and Approval of Requests for Yucca Mountain Site Characterization Project Geologic Specimens
YAP-SII.4Q	Collection, Submission, and Documentation of Non-Core and Non-Cuttings Samples to the Sample Management Facility for Site Characterization
YAP-SV.1Q	Control of the Electronic Management of Data
YMP-LBNL-QIP-5.2	Preparing Development Plans and Quality Technical Implementing Procedures
YMP-LBNL-TIP/TT-3.0	Calibration and Tuning of the Balzer's Mass Spectrometer for Tracer Tests in the DST Using Reference Calibration Bags
YMP-LBNLII-TIP/TT-5.0	Calibration of Inferred Camera
YMP-LBNL-QIP-4.3	Procurement Report Initiation and Acceptance of Quality Products and Services
YMP-LBNL-QIP-SII.0	Documenting Sample Control
YMP-LBNL-QIP-SV.0	Control of the Electronic Management of Data
YMP-LBNL-TIP/AFT-3.0	Preparation of Standards for Aqueous Tracer Concentration Measurements
YMP-LBNL.TIP/AFT-4.0	In Situ Constant Mass Flux air Permeability Testing Using Pneumatic Packers
YMP-LBNL-TIP/AFT-5.0	Borehole Scanner Survey
YMP-LBNL-TIP/AFT-6.0	Psychrometer Measurements
YMP-LBNL-TIP/AFT-7.0	Use of a Spectrometer or Fluorometer to Determine Aqueous Constituent
YMP-LBNL-TIP/AFT-8.0	Use of an Ion-Selective Electrode to Determine Ion Concentrations in Solution

YMP-LBNL-TIP/AFT-9.0	Chromatographic Determination of Aqueous Constituent Concentration
YMP-LBNL-TIP/AFT-10.0	Field Checks for the Mettler Toledo Model PG-s and SG Series Balances
YMP-LBNL-TIP/AFT-2.0	Drift Scale Test Gas Tracer Testing in Hydrology Boreholes using Balzer's Mass Spectrometer
YMP-LBNL-TIP/AFT-3.0	Calibration and Tuning of the Balzer's Mass Spectrometer for Tracer Tests Performed in the DST Using Reference Calibration Bags

1.4 DATA AND DELIVERABLES

Scientific and testing data and records related to the ESF are the result of the implementation of this FWP. The PIs have the responsibility for the collection, analysis, submittal, and reporting of data in compliance with Project and participant plans and procedures for their specific testing activities as described in this FWP. The ESF Data Manager manages and facilitates the flow of ESF test-related data. Data record responsibility is addressed in Section 6.0 of this FWP.

Information needs, specific parameters, and instrumentation type yielding data are listed in Attachment 3.

Deliverables:

Analysis and Modeling Report (AMR) "In situ field testing of processes"
 Process Modeling Report (PMR) "Unsaturated Zone Flow and Transport"

Data collected from Moisture Studies activities may feed the following models:

- Hydrogeologic Framework Model
- Infiltration Model
- Conceptual Numerical Model for UZ Flow and Transport
- Radionuclide Transport Model
- UZ Colloid Transport Model
- Analysis of Hydrologic Properties Data
- Abstract Drift Seepage and Scale Coupled Processes

1.5 PLANNED TFM USAGE

The use or removal of testing related Tracers, Fluids, and Materials (TFM) by affected organizations must be identified and reported to the TCO prior to use/removal. The TCO will report the use of test-related TFM in accordance with YAP-2.8Q. The FED is responsible for reporting construction-related TFM usage in accordance with YAP-2.8Q and NWI-ESF-016Q. The controls regarding the use of TFM are listed in the Determination of Importance Evaluations (DIE) specific to the field work which are implemented and controlled under this FWP (Attachment 12).

Below is a list of planned TFM, which has been transmitted to the Safety Assurance Department (SAD) and evaluated through a DIE. This list of tracers does not signify approval by M&O Environmental Programs Department (EPD) for the use of any of the tracers. Each individual tracer and associated tracer

test shall be identified and approved in the land access and environmental approval letter as required by YAP-30.2.

Planned TFM include:

Silica Flour	Sodium Tungstate Dihydrate
Polycell Expanding Foam	Sodium Molybdate Dihydrate
Overton Type Sand (Washed Sand)	Sodium Fluoride
Sodium Chloride	Potassium Fluoride
Lithium Bromide	Magnesium Fluoride
Fluorescent Polystyrene Microspheres	Magnesium Iodide
Sulfur Hexafluoride (gas)	Helium
Nitrogen	Neon
SUVA Cold -MP (tetrafluoroethane) gas	Krypton
2,4,6-Trifluorobenzoic Acid	Xenon
2,4,5-Trifluorobenzoic Acid	Argon
2,3,4-Trifluorobenzoic Acid	Sodium Iodide
2,3,6-Trifluorobenzoic Acid	Sodium Bromide
2,3,4,5-Tetrafluorobenzoic Acid	Calcium Iodide
2,3,5,6-Tetrafluorobenzoic Acid	Calcium Bromide
3,4,5-Trifluorobenzoic Acid	Potassium Iodide
2,3-Difluorobenzoic Acid	Potassium Bromide
2,4-Difluorobenzoic Acid	Sodium Hypochlorite
2,5-Difluorobenzoic Acid	Potato Starch (powdered)
2,6-Difluorobenzoic Acid	Pyranine
3,4-Difluorobenzoic Acid	Amino G Acid
3,5-Difluorobenzoic Acid	Rhodamine WT
Pentafluorobenzoic Acid	FD&C Blue No.1
Acid Yellow #7 (Lissamine FF)	FD&C Yellow No.5
Rhodamine B	FD&C Yellow No.6
Sulforhodamine B	Fluorescein
FD&C Red No. 40	

If additional TFM are required, separate requests for DIE evaluations and EPD approvals will be submitted by the TCO. Each tracer test must have appropriate EPD approvals prior to injection, except drilling using approved SF⁶.

Attachment 12 lists the EPD approved tracers as well as the approved/pending tracers submitted to EPD and DIE for approvals/evaluations for each specific location where testing activities will be conducted within the scope of this FWP.

Preliminary information specific to tracer usage and recovery shall be supplied to the TCO by the PIs, by the 5th day of each month.

2.0 SAMPLING PLAN

The PI or designee will select sample locations in the field. Samples shall be collected under the PI's scientific notebook as identified in Section 1.3 or other applicable procedures. Core samples shall be collected under the current version of NWI-DS-001Q, NWI-DS-002Q, NWI-DS-004Q, and/or YAP-SII.1Q. Core determinations will be made by the TCO and concurred with by management in accordance with LANL-EES-13-DP-612.

Bulk Rock samples (if required) shall be collected under the PI's scientific notebook as identified in Section 1.3. In addition, the current version of YAP-SII.4Q, shall be used to document collection and provide traceability of all underground bulk rock and water samples taken from the ESF. Particular samples collected in support of Moisture Studies in the ESF will be collected according to the sample collection criteria identified in, and under the control of Field Work Package FWP-ESF-96-009, Consolidated Sampling in the Exploratory Studies Facility. PI organizations will provide all non-standard sample packaging materials, transportation containers, and any associated equipment.

- All PIs who collect ESF samples shall coordinate underground access and sample collection support (including survey and photography) through the TCO.
- In instances where a sample location is identified, but the sample is not required immediately or sampling is constrained due to safety or construction considerations, the TCO may identify a construction or test exclusion zone to allow later sampling or testing.

3.0 WORK IMPLEMENTATION AND CONTROL

3.1 IMPLEMENTATION

The following list of activities provides instructions on how work associated with this testing will be conducted and controlled. The TCO generally acts as the interface and coordinator between the PI organization(s) and all other organizations involved in these activities. The TCO monitors all test-related construction and testing activities associated with construction monitoring to ensure the appropriate controls, as necessary, are implemented through the relevant organizations(s). All applicable DIE controls listed on Attachment 12 are incorporated into these instructions.

Safety requirements and procedures involved in these activities are addressed in Attachment 4.

The following list of activities includes both those that implement QARD requirements, and management guidance that does not implement QARD

requirements. Grading is accomplished by QAP-2-0 or equivalent procedure. Items flagged with a **QA** are recognized as being quality affecting unless specifically graded out and documented by the organization performing the task. Items identified with a **QA:N/A** do not affect the sequence of the quality affecting work and do not implement QARD requirements and are therefore considered administrative in scope. The sequence of **QA** activities may be modified by the TCO FTC based on conditions in the field, provided affected organizations concur and those modifications are documented.

3.1.1 GENERAL ITEMS

- 3.1.1.1** **AFFECTED ORGANIZATIONS** who perform ESF testing activities specific to this FWP shall coordinate field activities through the ESF TCO. **QA:N/A**
- 3.1.1.2** The **TCO** will serve as point-of-contact for all testing activities defined in this FWP including drilling/coring operations, test installation, and DCS interactions. **QA:N/A**
- 3.1.1.3** Throughout the implementation of this FWP, the **TCO** will provide regular written reports to the U.S. Department of Energy (DOE) and Management and Operating Contractor (M&O) Manager addressing test specific progress. **QA:N/A**
- 3.1.1.4** **PIs** will provide necessary information to support TCO planning, management, and reporting requirements. **QA:N/A**
- 3.1.1.5** **CRMD, FED, CMD** will provide construction support, test support facilities, and operational flexibility to instrument, maintain, operate, and monitor Moisture Studies in the ESF and conduct post construction activity moisture-related activities. **QA:N/A**
- 3.1.1.6** **CMD** will maintain the ability to access any identified sample location for re-sampling, if necessary, as directed by the TCO. **QA:N/A**
- 3.1.1.7** **CRMD, FED, CMD** will provide administrative construction-related documentation necessary to support testing to the TCO which may include information specific to air flow measurements and electrical usage in the ESF. **QA:N/A**
- 3.1.1.8** **SM&DD** will provide a list of sample numbers and corresponding accession numbers to the records center with a copy to the TCO PE. **QA:N/A**
- 3.1.1.9** **FED** will survey the sample locations of each bulk rock sample collected in accordance with NWI-ESF-008Q, as requested by the TCO and provide a list of accession or data tracking numbers. **QA**
- 3.1.1.10** The **PIs** and the **DATA MANAGER** will maintain the ability to tie into a centralized DCS when available and when necessary. **QA:N/A**
- 3.1.1.11** **SS&MMD** personnel will take photographs as directed by the TCO and provide a list of photograph identifiers. **QA:N/A**

- 3.1.1.12 PIs are responsible for collection, management, and submittal of data, in compliance with Project and applicable PI plans and procedures. **QA**
- 3.1.1.13 FED shall track, minimize, and report water use in accordance with NWI-ESF-007Q. **QA**
- 3.1.1.14 The TCO and CMD shall develop, with all affected organizations, Work Instructions for this particular work that specifically address detailed ES&H issues. All field work shall be done consistent with the activities described in the FWP and within the ES&H controls detailed in the Work Instruction(s). **QA:N/A**
- 3.1.1.15 The TCO, PI, and all scientific staff will participate in a daily Toolbox Safety Meeting that is held at YMP work sites at the start of each shift. **QA:N/A**
- 3.1.1.16 CRMD and FED shall provide labor, materials, and equipment necessary to construct or modify the sealed bulkhead doors at each location specific to this FWP, according to TCO instructions. **QA:N/A**
- 3.1.1.17 CRMD and A/E shall coordinate the application of shotcrete in test support areas with the TCO prior to application. **QA:N/A**
- 3.1.1.18 The TCO will seek concurrence with PIs prior to CRMD application of shotcrete, and will notify CRMD and A/E of their approval in writing. **QA**
- 3.1.1.19 CRMD and FED will minimize, to the extent practical, the quantity of fluids used in and around borehole collars at all test areas. Quantities will be documented in accordance with YAP-2.8Q. **QA**
- 3.1.1.20 CRMD will dry-drill rockbolt holes and shall not use Swellex type bolts for ground support in areas identified by the TCO through SFO or A/E consistent with applicable drawings and specifications. **QA**
- 3.1.1.21 The TCO shall monitor water used in testing niches in the Topopah Spring Loop to ensure the total used does not exceed approximately 19.5m³ (or about 5,150 gallons) per niche. Water use includes construction water in shotcrete, geologic mapping, and dyed testing water. Reporting will be done in accordance with YAP-2.8Q. **QA**
- 3.1.1.22 CRMD shall not use cementitious materials for niche excavation-related ground support until the TCO provides written notification/concurrence that testing activities within the niches or alcoves have been completed. **QA**
- 3.1.1.23 CRMD, FED, and PI Organizations shall limit the use of chlorides as practical. Only non-chloride-based ground enhancing materials may be used. Use of chlorides will be documented in accordance with YAP-2.8Q. **QA**
- 3.1.1.24 The TCO shall evaluate and document concurrence of the use of chloride for applications other than potable water. **QA**

- 3.1.1.25** The PIs and TCO shall ensure the emplacement of committed organic substances related to niche testing is minimized. Use of committed organics will be documented in accordance with YAP-2.8Q. QA
- 3.1.1.26** For the Alcove Slot Cut Testing, the PIs and TCO shall ensure the following tracers are limited as indicated unless an additional SAD evaluation is conducted. Organic tracers are limited to 6 grams, fluorinated tracers are limited to 18 grams, and non-fluorine halogenated salts are limited to 39 grams. TFM reporting will be done in accordance with YAP-2.8Q. QA
- 3.1.1.27** For the ECRB systematic testing, the PIs and TCO shall ensure that the total quantity of water emplaced during drilling and testing of the ECRB Systematic Drilling boreholes shall not exceed 90 percent of the DIE Requirement 3 water loss limit, when combined with all other water losses (e.g., construction, dust control, drilling, testing), in the 10 meter section of the ECRB Cross Drift in which it is used. TFM reporting will be done in accordance with YAP-2.8Q. QA
- 3.1.1.28** The TCO shall ensure that the quantity of water loss in the final 13 meters of Alcove 8 and all of Niche #3 (i.e., not subsequently recovered in the Niche #3 drip collection systems) shall not exceed a cumulative average of 3.785 m³/m (approximately 1000 gal/m) without further SAD Evaluation. This water loss includes all water lost during construction of and testing in that section of Alcove 8 and all of Niche #3. Furthermore, the testing water released shall not exceed 37.85 m³ (approximately 10,000 gallons) until an adequate recovery rate has been demonstrated and approved by SAD. TFM reporting will be done in accordance with YAP-2.8Q. QA
- 3.1.1.29** FED will ensure that water used for testing purposes in the Topopah Spring Loop and Cross Drift is traced in accordance with NWI-ESF-030Q. QA
- 3.1.1.30** The TCO and PIs shall ensure that specific TFM for the areas identified in Attachment 12 shall not exceed the specific concentrations and quantities without an additional SAD evaluation (Note: The maximum concentrations and quantities of all EPD approved/pending tracers for each specific test location is listed in Attachment 12). QA
- 3.1.1.31** The TCO will report the use of test-related TFM in accordance with YAP-2.8Q. QA

3.1.2 GENERAL GUIDELINES FOR DRILLING ACTIVITIES

- 3.1.2.1** The PIs will select and identify borehole locations and specify needs in writing to the TCO. Borehole locations shall include the North Ramp, South Ramp, Alcoves, and locations associated with Drift Scale niches along the ESF Main Drift, and ECRB. QA:N/A
- 3.1.2.2** The TCO shall identify, based on the PI's needs, the location of testing boreholes in the field prior to the installation of niche-related ground support. QA:N/A

- 3.1.2.3 **CRMD** will supply the personnel and equipment to drill and core boreholes at identified locations. Boreholes will nominally be NQ-3 or HQ-3 sized, drilled utilizing dry drilling techniques. Expected approximate borehole depths will be from 2 meters to 20 meters deep. **QA:N/A**
- 3.1.2.4 The **TCO** shall notify **SFO** to use only dry drilling techniques. This notification will be documented. **QA:N/A**
- 3.1.2.5 **CRMD** shall maintain a 300 mm distance between testing boreholes and niche-related ground support boreholes in the Topopah Spring Main Drift and ECRB consistent with applicable drawings and specifications. **QA**
- 3.1.2.6 **FED** will layout the collar locations and backsites (if necessary) for boreholes associated with the niches and alcoves. **QA:N/A**
- 3.1.2.7 The **TCO** will define and document the disposition of core generated from drilling/coring activities associated with this FWP as outlined in procedure LANL-EES-13-DP-612. **QA**
- 3.1.2.8 The **PI** may drill short boreholes, nominally 2 meters (6.2 feet) in length by 2.5 cm (1 inch) in diameter, for instrumentation including, but not limited to, heat dissipation probes and tensiometers. **QA:N/A**
- 3.1.2.9 **CRMD** shall monitor and document air pressure and flow rates during drilling operations. Any modifications to the compressed air supply lines shall be inspected and documented by the drilling foreman and a representative from **FED**. **QA:N/A**
- 3.1.2.10 **SM&DD** will support drilling operations by: (1) maintaining footage drilled per drill bit; and (2) noting who is the driller on site during coring operations. Reporting will be done in accordance with **NWI-DS-002Q**. **QA**
- 3.1.2.11 The **SM&DD** will support drilling operations by reporting line-of-sight measurements (as requested by the **TCO**) on the daily operations report in accordance with **NWI-DS-002Q**. **QA**
- 3.1.2.12 **SM&DD** or their designees will take custody of the core samples by operating the extruder to remove core from the core barrel, and processing the core in accordance with **NWI-DS-001Q** and/or **NWI-DS-004Q**. **QA**
- 3.1.2.13 The **SM&DD** will supply an administrative copy of all daily drilling reports to the **TCO** and submit a copy to the records center, in accordance with **AP-17.1Q**. **QA:N/A**
- 3.1.2.14 The **SM&DD** will collect core samples as requested by the **PI** in accordance with **YAP-SII.1Q**. **QA**
- 3.1.2.15 **FED** will survey and document the borehole collar locations and orientation plan view of opening, and profile of Niche excavations in accordance with **NWI-ESF-008Q** and **NWI-ESF-009Q**. **QA**

- 3.1.2.16 The FED shall put all test-related survey data into the TDMS according to AP-SIII.3Q, unless excluded by the TCO. **QA**
- 3.1.2.17 CRMD will maintain the ability to collect bulk rock samples, water samples, and core samples from all Drifts, Niches, and Alcoves in the ESF. **QA:N/A**
- 3.1.2.18 The PI will document acceptance of each borehole (drilled with a drill rig) or provide further direction to obtain a suitable hole. **QA**

3.1.3 GENERAL TEST INSTRUMENTATION GUIDELINES

- 3.1.3.1 The PI will install instrumentation in accordance with their QA technical procedures or scientific notebook identified in Section 1.3. **QA**
- 3.1.3.2 The TCO will coordinate the staging and installation of all test equipment with the PI. **QA:N/A**
- 3.1.3.3 The PI will maintain the ability to utilize or connect into a centralized DCS when applicable and where available. **QA:N/A**

3.1.4 GENERAL TESTING GUIDELINES

- 3.1.4.1 The PIs, TCO, and/or TECHNICAL SUPPORT personnel, shall collect acquired data in accordance with their scientific notebooks identified in Section 1.3 or other applicable QA procedures. **QA**
- 3.1.4.2 The PI will transmit initial and developed data in accordance with AP-SIII.3Q as identified in Section 6.1 of this FWP. **QA**
- 3.1.4.3 The PI, scientific staff, and/or WMS personnel will conduct borehole wireline measurements in accordance with FWP-ESF-96-013. **QA**

3.1.5 MOBILE MOISTURE MONITORING SURVEY

- 3.1.5.1 The TCO will coordinate through CMD, times and durations of any moisture monitoring surveys conducted in the ESF. **QA:N/A**
- 3.1.5.2 The PI will transmit in writing to the TCO, methodology pertaining to the mobile moisture monitoring cart. This methodology will, at a minimum, include weight of the entire cart fully loaded, equipment to be installed on the cart, electrical power requirements for the cart, and expected rate of travel of the cart. **QA:N/A**
- 3.1.5.3 The TCO will provide escorts front and rear of the moisture monitoring cart as it travels through the ESF. **QA:N/A**

3.1.6 LOCATION SPECIFIC GUIDELINES

3.1.6.1 Upper Tiva Canyon Alcove (Alcove 1)

- 3.1.6.1.1 The PI shall install and operate an infiltration system on the surface above Alcove 1, capable of providing 1 to 2 cm of water per day to an

area not to exceed 1.5 times the area of the bulkheaded alcove in accordance with their procedures identified in Section 1.3. **QA**

3.1.6.1.2 The PI will ensure that the surface infiltration system shall be covered with a cover, sealed on all edges with an appropriate material (I.E. sand bags), and maintained such that the liner is not impacted by weather conditions. **QA:N/A**

3.1.6.1.3 The PI will install moisture monitoring instrumentation which may include heat dissipation, tensiometers, temperature, humidity probes, psychrometers, Electrical Resistive Probes (ERT), and pneumatic packers in boreholes and/or on the exposed surfaces of the Alcove in accordance with approved procedures identified in Section 1.3. **QA**

3.1.6.1.4 The PI shall collect and dispose of all recoverable tracers in accordance with EPD guidelines. **QA:N/A**

3.1.6.2 Upper Paintbrush (non-welded) Contact Alcove (Alcove 3)

3.1.6.2.1 The PI will install moisture monitoring instrumentation which may include heat dissipation, tensiometers, temperature, humidity probes, psychrometers, ERT, and pneumatic packers in boreholes within the exposed surfaces of the alcove in accordance with approved procedures identified in Section 1.3. **QA**

3.1.6.3 Lower Paintbrush (non-welded) Contact Alcove (Alcove 4)

3.1.6.3.1 The PI will install moisture monitoring instrumentation which may include heat dissipation, tensiometers, temperature, humidity probes, psychrometers, ERT, and pneumatic packers in boreholes and/or on the exposed surfaces of the alcoves, in accordance with approved procedures identified in Section 1.3. **QA**

3.1.6.3.2 The PI will install moisture monitoring instrumentation which may include heat dissipation, tensiometers, temperature, humidity probes, psychrometers, ERT, and pneumatic packers in boreholes and/or on the exposed surfaces, including the slot cut at the terminal end of the drift in accordance with approved procedures identified in Section 1.3. **QA**

3.1.6.3.3 The PI will conduct water release experiments in boreholes, in the terminal face of the alcove. **QA**

3.1.6.3.4 The PI will drill additional short boreholes with hand held tools into the terminal face of the alcove. **QA:N/A**

3.1.6.4 Northern Ghost Dance Fault Access Drift (Alcove 6)

3.1.6.4.1 N/A.

3.1.6.5 Southern Ghost Dance Fault Access Drift (Alcove 7)

- 3.1.6.5.1** The TCO shall follow the requirements identified in PRO-SH-0019 prior to entering the areas behind the bulkheads or as identified by a potential airborne radioactive area. **QA:N/A**
- 3.1.6.5.2** CRMD or PI shall drill small diameter boreholes (approximately 1 3/8 inch diameter x 2.0 meters deep) at locations identified by the PI through the TCO. **QA:N/A**
- 3.1.6.5.3** The PI will install moisture monitoring instrumentation which may include heat dissipation, tensiometers, temperature, humidity probes, psychrometers, ERT, and pneumatic packers in boreholes and/or on the exposed surfaces of the Alcove in accordance with approved procedures identified in Section 1.3. **QA**
- 3.1.6.5.4** The PI shall inform the TCO, prior to the injection and report the use of tracers as identified in Section 1.5 of this FWP. The reporting shall be made by the PI on a monthly basis. If new tracers are identified, the request shall be made to the assigned PE for this FWP. **QA**

3.1.6.6 Niche 35+66 (Niche #1)

- 3.1.6.6.1** The PI may install and/or remove/monitor moisture monitoring instrumentation including heat dissipation, tensiometers, temperature, humidity probes, psychrometers, ERT, and pneumatic packers in boreholes and/or on the exposed surfaces of the Niche in accordance with approved procedures identified in Section 1.3. **QA**

3.1.6.7 Niche 36+50 (Niche #2)

- 3.1.6.7.1** The PI may install additional and/or remove/monitor moisture monitoring instrumentation including heat dissipation, tensiometers, temperature, humidity probes, psychrometers, ERT, and pneumatic packers in boreholes and/or on the exposed surfaces of the Niche in accordance with approved procedures identified in Section 1.3. **QA**

3.1.6.8 Niche 31+07 (Niche #3) [see also Alcove 8]

- 3.1.6.8.1** The PI will install additional and/or remove/monitor moisture monitoring instrumentation which may include heat dissipation, tensiometers, temperature, humidity probes, psychrometers, ERT, and pneumatic packers in boreholes and/or on the exposed surfaces of the Niche in accordance with approved procedures identified in Section 1.3. **QA**

3.1.6.9 Niche 47+88 (Niche #4)

- 3.1.6.9.1** The PI will install and monitor moisture monitoring instrumentation, which may include heat dissipation, tensiometers, temperature, humidity probes, psychrometers, ERT, and pneumatic packers in boreholes and/or on the exposed surfaces of the Niche in accordance with approved procedures identified in Section 1.3. **QA**

3.1.6.10 Ramps and Main Drift

3.1.6.10.1 The PI will install and monitor moisture monitoring instrumentation including heat dissipation, tensiometers, temperature, humidity probes, psychrometers, ERT, and pneumatic packers in boreholes and/or on the exposed surfaces in accordance with approved procedures identified in Section 1.3. **QA**

3.1.6.11 Enhanced Characterization of the Repository Block

3.1.6.11.1 The TCO will be on location at all times during the excavation of these two test areas to facilitate the hydrologic and air testing which will be conducted by the PI organizations. **QA:N/A**

3.1.6.11.2 **CRMD** shall dry drill holes (approximately 2 to 4 meters deep) into the rib of the ECRB Cross Drift as requested by the TCO. **QA:N/A**

3.1.6.11.3 **CRMD** shall supply individuals to assist in the collection of grab samples and the installation of scientific monitoring instrumentation. **QA:N/A**

3.1.6.11.4 Air sampling instrumentation shall be installed by PIs at locations identified in association with M&O Industrial Hygiene monitoring stations. The TCO will coordinate locations for these instruments with CMD. **QA:N/A**

3.1.6.11.5 **CRMD** and **FED** shall provide labor, materials, and equipment necessary to construct, or modify bulkheads at approximately CS 17+63, 25+03, and 26+00 specific to this FWP and according to TCO instructions.

3.1.6.12 Cross Drift Drainage Benches

3.1.6.12.1 **CRMD** shall supply individuals to excavate/construct approximately six 1 meter long by 1 meter wide by 0.5 meter high openings on the left rib. Each opening shall have a bottom surface of ± 1 inch smoothness from corner to corner. These openings can be line drilled and split or excavated with pneumatic tools. Minimized use of LiBr traced construction water may be used during excavation/construction of these benches. The preliminary locations for the benches are; 11+15, 13+00, 15+25, 17+35, 22+15, and 24+25. The final locations will be determined by the PI and transmitted to the **CRMD** by the TCO. **QA:N/A**

3.1.6.12.2 **CRMD** shall supply individuals to erect a small platform, at the same elevation as the bench, for testing equipment to be placed on. **QA:N/A**

3.1.6.12.3 **CRMD** will supply individuals to cut a kerf, the same diameter as the testing disk infiltrometer, (approximately 24" diameter) into the bench floor approximately 1 inch deep (depending on the flatness of the bench). **QA:N/A**

3.1.6.12.4 The TCO will post these locations as "Test Exclusion Areas" with signage. **QA:N/A**

3.1.6.13 ECRB Systematic Borehole Drilling

3.1.6.13.1 CRMD shall drill/core a series (approximately 19) of NQ3 size boreholes (approximately 20 meters deep) at locations in the crown and left rib. These boreholes will be used for air permeability and liquid release testing for percolation and seepage testing (Attachments 13 and 14). Phase 1 of this activity is from approximately CS 14+44 to approximately CS 17+63. Every 30 meters, one low angle (~15° from drift axis) shall be dry drilled into the crown. Every 90 meters, one near vertical (~75° from drift axis) will be dry drilled into the crown. Every 90 meters, one pair of horizontal to invert (2 to 3 meter separation) will be dry drilled into the left rib. **QA:N/A**

3.1.6.13.2 CRMD shall provide for the use of an elevated work platform that will be utilized by the PI for borehole testing for the boreholes drilled into the crown. Periodic movements of the work platform will be coordinated by the TCO at the request of the PI. **QA:N/A**

3.1.6.13.3 CRMD shall provide electrical power to these locations for temporary testing activities. **QA:N/A**

3.1.6.14 Niche 16+20 (Niche #5)

3.1.6.14.1 The PI will continue to test the three (approximately 20 meters) NQ3 size boreholes at locations identified in Attachments 5-6 throughout excavation of the niche. These boreholes will be used to conduct air permeability testing for pre and post excavation effects testing. **QA:N/A**

3.1.6.14.2 CRMD shall drill/core a series (approximately 7) of NQ3 size boreholes (approximately 20 meters deep) at locations identified by the PI after access drift excavation. These boreholes will be used for air permeability and liquid release testing for pre and post excavation effects testing (Attachments 7-9). **QA:N/A**

3.1.6.14.3 CRMD shall supply individuals to excavate the Niche as identified in approved drawings. If at all possible, the final 10 meters of excavation should be conducted without water application to the exposed surfaces of the niche and only to the muck that is generated and stacked on the invert. **QA:N/A**

3.1.6.14.4 Water use during excavation shall be kept to a minimum and reported by FED in accordance with NWI-ESF-007Q. **QA**

3.1.6.14.5 The PI will install moisture monitoring instrumentation, which may include heat dissipation, tensiometers, temperature, humidity probes, psychrometers, ERT, and pneumatic packers in boreholes and/or on the exposed surfaces of the Niche in accordance with approved procedures identified in Section 1.3. **QA**

- 3.1.6.14.6** CRMD shall drill/core a series (approximately 6) of NQ3 size boreholes (approximately 7 meters deep) at locations identified by the PI through the TCO and CMD (Attachments 10-12) QA:N/A
- 3.1.6.14.7** CRMD shall construct a bulkhead door at a location as identified by the PI and transmitted to CMD by the TCO. Sodium Silicate or paged grout may be used to ensure an air tight (as possible) seal around the bulkhead. QA:N/A
- 3.1.6.14.8** CRMD shall supply an uninterrupted source of tunnel air and LiBr traced construction water to the alcove at all times. During planned outages, alternate sources shall be made available. QA:N/A
- 3.1.6.15 Cross Over Alcove (Alcove 8) Niche 31+07 (#3)**
- 3.1.6.15.1** CRMD shall excavate the alcove, leaving the invert as smooth as possible. Upon completion of excavation, the invert shall be cleaned (using air and or air/mist) to allow for detailed Geologic Mapping to be conducted. QA:N/A
- 3.1.6.15.2** CRMD shall construct a bulkhead door at a location as identified by the PI and transmitted to CMD by the TCO. Sodium Silicate or parged grout may be used to ensure an air tight (as possible) seal around the bulkhead. QA:N/A
- 3.1.6.15.3** CRMD shall drill small diameter boreholes (approximately 1 3/4 inch diameter x 30 to 300 cm deep) at locations identified by the PI through the TCO and CMD (approximately 64 holes). QA:N/A
- 3.1.6.15.4** CRMD shall drill/core 2 HQ-3 size boreholes approximately 13 meters long from locations in the Alcove invert to be specified by the PI. QA:N/A
- 3.1.6.15.5** CRMD shall drill small diameter boreholes approximately 22 meters long from locations in the Alcove invert to the crown of Niche #3 for cable installation. The final location will be specified by the PI. QA:N/A
- 3.1.6.15.6** CRMD shall drill/core 6 HQ-3 size boreholes approximately 13 meters long from the intersection of the alcove invert and ribs at locations to be specified by the PI. QA:N/A
- 3.1.6.15.7** CRMD shall drill/core 4 HQ-3 size boreholes approximately 13 meters long from the intersection of the ribs and crown in Niche 31+07 (#3) at locations to be specified by the PI. QA:N/A
- 3.1.6.15.8** QA: The PI shall install an infiltration system on the invert of the Alcove in accordance with procedures identified in Section 1.3, capable of providing 1 to 2 cm of water per day, to an area not to exceed 1.5 times the area of the Niche 31+07. QA
- 3.1.6.15.9** CRMD shall provide craft support and material to construct an approximate 3 meter by 3 meter metal frame to contain the water/tracer as it is applied to the invert of the alcove. The frame

should be approximately 30 cm tall and coated with an approved rust inhibiting paint. The frame shall be anchored to the invert and sealed with grout. (if invert smoothness is adequate, kerfs may be cut into the invert to allow for the metal frame to be installed).

QA:N/A

- 3.1.6.15.10** CRMD shall provide craft support and material to construct a movable metal platform over the top of the infiltration plot on the invert of the alcove, to allow personnel access to the entire plot area. **QA:N/A**
- 3.1.6.15.11** FED shall provide approximately 50 cubic feet of well sorted, washed sand (Overton Type) and spread over the infiltration plot area. **QA:N/A**
- 3.1.6.15.12** The PI will ensure that the surface infiltration system shall be covered with a cover, sealed on all edges with appropriate material (i.e. sand bags), and maintained such that the liner is not impacted by tunnel conditions (i.e. ventilation, dust, and hydrocarbons). **QA:N/A**
- 3.1.6.15.13** The PI will install moisture monitoring instrumentation which may include heat dissipation, tensiometers, temperature, humidity probes, psychrometers, ERT, and pneumatic packers in boreholes and/or on the exposed surfaces of the Alcove in accordance with approved procedures identified in Section 1.3. **QA**
- 3.1.6.15.14** CRMD will provide a steel plate capable of supporting a load cell similar to the configuration in Alcove 1. **QA:N/A**
- 3.1.6.15.15** CRMD shall supply an uninterrupted source of tunnel air and LiBr traced construction water to the alcove at all times. During planned outages, alternate sources shall be made available. **QA:N/A**
- 3.1.6.15.16** CRMD will provide support to transport containers of collected tracers to the surface for evaporation or disposal. The schedule will be transmitted to the TCO by the PI, which will be conveyed to the CRMD. **QA:N/A**
- 3.1.6.15.17** The PI will coordinate with the TCO each deployment of Acoustic Tomography, Ground Penetrating Radar, neutron logging, and other similar technical support activities. **QA:N/A**
- 3.1.6.15.18** The PI will report TFM usage of all tracers for the previous month to the TCO by the 5th of each month. **QA:N/A**
- 3.1.6.15.19** The TCO shall follow the requirements identified in PRO-SH-0019 prior to entering the areas behind the bulkheads or as identified by a potential airborne radioactive area. **QA:N/A**
- 3.1.6.15.20** CRMD will provide support to install frame outside Niche 31+07 in the ESF Main Drift and move plastic trays in order to allow for sample collection. **QA:N/A**

3.1.6.15.21 CRMD shall provide and invert surface that is level and smooth to provide a stable surface for drip collection system installation.

3.1.6.16 Crest Alcove (Alcove 9)

3.1.6.16.1 CRMD shall construct bulkhead doors, to criteria identified by the TCO, at locations identified by the PI and transmitted to FED by the TCO. **QA:N/A**

3.1.6.16.2 CRMD shall drill approximately 50 small diameter boreholes (approximately 1 3/8 inch diameter x .75 meter deep) at locations identified by the PI through the TCO and CMD. **QA:N/A**

3.1.6.16.3 The PI will install moisture monitoring instrumentation which may include heat dissipation, tensiometers, temperature, humidity probes, psychrometers, ERT, and pneumatic packers in boreholes and/or on the exposed surfaces of the Alcove in accordance with approved procedures identified in Section 1.3. **QA**

3.1.6.16.4 The TCO shall follow the requirements identified in PRO-SH-0019 prior to entering the areas behind the bulkheads or as identified by a potential airborne radioactive area. **QA:N/A**

3.2 PREREQUISITES AND HOLD POINTS

The addition of new tracers or changes to tracer concentrations shall not be utilized until all DIE and EPD requirements have been resolved. The TCO is responsible for documenting and lifting this hold point.

3.3 STOP WORK

Affected organizations must inform the TCO if quality-related work elements cannot be conducted as described in this FWP. The TCO will, if applicable, issue a stop work on those elements. If FWP revisions are required, work on affected elements will be stopped until the modifications have been completed and controlled by the Project. The M&O Safety and Health Department, EPD, or any employee may stop work for ES&H related issues if an imminent danger exists to the workers, public or the environment. Employee's rights relating to Safety and Health (S&H) are described in the M&O Safety and Health Plan. Environmental conditions are described in the M&O Environmental Management Plan.

3.4 SPECIAL INSTRUCTIONS

None identified.

4.0 ADMINISTRATIVE (NON-QA) INSTRUCTIONS

4.1 ENVIRONMENTAL, SAFETY, AND HEALTH

4.1.1 Environmental

Site disturbing work requires Yucca Mountain Site Characterization Office (YMSCO)/Assistant Manager, Office of Project Execution

(AMOPE) approval transmitted by EPD. To establish and maintain a high degree of environmental awareness on the YMP, all organizations and employees involved with YMP activities must clearly understand their roles and responsibilities in maintaining compliance with all applicable environmental requirements. All work shall comply with environmental requirements as found in YAP-30.2 and associated approval letters. The TCO supplies said letters to the PI and ensures the PI works to requirements specified. In order to carry out and meet these environmental requirements plus fulfill this commitment, environmental requirements and stipulations will be presented in the initial EPD PRO-EP-001 meeting conducted in association with any field activity related to this FWP, and periodically presented in subsequent Safety Toolbox Meetings.

All work shall comply with applicable environmental stipulation letters as required by YAP-30.2 and PRO-EP-001. Use of Tracers, in excess of State approved levels, must be brought to the attention of the M&O EPD by the TCO within two working days.

All tracers must be approved through the EPD prior to use, including concentration limits for each tracer.

A preliminary set of information shall be transmitted to the TCO from each PI regarding tracer usage and recovery by the 5th of each month.

Radiological Requirements

All applicable items, equipment, and materials that have been in use on the NTS, or will be used by Affected Organizations, shall be surveyed by Radioactive Material Control prior to entering the YMP Site area. This is to identify potential radiological contamination and such shall not be used if the survey results indicate the presence of contamination greater than levels established by the NV/YMP Radiological Control Manual for release of material for unrestricted use. A report of the survey results shall be sent within 10 working days to the Affected Organizations and the YMSCO/AMOPE/Environmental Field Coordinator (EFC), with a copy to the M&O Radiological Control Manager and M&O EPD. All surveys shall be completed prior to moving an item onto the YMP Site area. An indication of clearance is to accompany each item moved onto the YMP Site area.

All conditions mandated in the M&O Radiation Protection Program and M&O-RI-001, an authorization for the Use of Radioactive Materials or Ionizing Radiation Producing Equipment must be met. Requests for use of radioactive materials, including sealed sources, shall be made to the M&O Radiological Control Manager.

4.1.2 Safety and Health

Specific ES&H requirements are implemented through work instructions particular to individual activities. The work instructions acknowledge a person-in-charge, identify work scope, equipment requirements, hazard identification, and task steps. These work instructions are maintained in the field TCO offices on the ESF pad.

Safety and Health Roles and Responsibilities: The TCO and the M&O SFO for the YMP regards the safety and health of all employees to be of paramount importance. To establish and maintain a high degree of safety and health awareness on the YMP, all organizations and employees involved with the scientific characterization activities must clearly understand their roles and responsibilities in maintaining a safe and healthful workplace.

The M&O strives to work within the ISM process implemented within the YMP. This process identifies five core functions. They are (1) define the scope of work, (2) analyze the hazards, (3) develop and implement hazard controls, (4) perform work within controls, and (5) provide feedback and continuous improvement. Roles and responsibilities are defined within this FWP and the attachments of this document.

The responsibility for safety and health on the YMP begins with the M&O Contractor, flows down through the SFO, then to the TCO and the Constructor. From these organizations, responsibility flows down to the respective organizations conducting work on the YMP, including scientific characterization organizations, through the umbrella of the M&O Safety and Health Plan. The M&O Safety and Health Plan establishes implementing guidance through written YMP safety and health programs and procedures. From the M&O, responsibility for the safety and health of YMP employees flows through M&O line management and each organization's supervision, then ultimately to individual employees.

An ES&H Review is an attachment to this FWP and has been compiled by the TCO S&H Specialist in order to evaluate and transmit information on the potential hazards that may be encountered while installing, operating and/or maintaining scientific investigation equipment or instrumentation on the YMP. In the event discrepancies are found between the ES&H Review and this FWP on roles and responsibilities, the FWP language prevails. Each organization's line management and supervision should read the ES&H Review and use it as a guideline for informing, educating, and implementing protective measures for the identified hazards.

Participants will report injury, illness, and property damage incidents in accordance with NAP-SH-001, FOI 55001, and DOE 0232.1, "Occurrence Reporting Processing System (ORPS)."

4.2 POINTS OF CONTACT

FOC Visitor Control	L. Camp	295-5915
TCO Project Engineer	A. Mitchell	295-6539
FWPRC	A. Mitchell	295-6539
ESF Testing TFM	A. Mitchell	295-6539
ESF Data Manager	F. Homuth	295-4900
Field Test Coordinator	R. Kovach	295-6180
TCO Manager	R. Oliver	295-3578
TCO Safety Coordinator	M. Taylor	295-3647
CMD	R. Law	295-3699
CRMD	M. Sparks	295-7560
FED	R. Dresel	295-4250
Borehole Wireline Measurement Support	D. Neubauer	295-5022

SM&DD	C. Lewis	295-6105
Safety Assurance Department	M. Sellers	295-3953
TEST Manager	M. Peters	295-3644
Photography Support	D. Unglesbee	295-5965
Environmental	T. Pysto	295-5082
M&O Applied Research & Testing Program Director	J. Younker	295-5497
LBNL Principal Co-Investigator	J. Wang	(510) 486-6753
LBNL Principal Co-Investigator	R. Trautz	(510) 486-7954
USGS Principal Co-Investigator	A. Flint	(916) 278-3221
USGS Principal Co-Investigator	L. Flint	(916) 278-3223
USGS Principal Co-Investigator	D. Hudson	295-5973
USGS Principal Co-Investigator	W. Guertal	295-5851

4.3 SCHEDULE

The working QA:N/A schedule, included as Attachment 1 is expressly limited to this FWP and record development for Yucca Mountain site field activities associated with this FWP. Task dates and estimated durations are based on construction schedules and current construction strategies. The tasks, dates, and durations are subject to change.

4.4 SUMMARY ACCOUNTS

A QA:N/A summary account associated with the activities described in this FWP and related information is included as Attachment 2.

5.0 FIELD VERIFICATIONS AND SCOPE COMPLETION

5.1 FIELD VERIFICATION

No field verifications have been identified at this point.

5.2 SCOPE COMPLETION

The scope of this FWP will be completed when each PI has notified the TCO in writing that all testing activities associated with this FWP have been completed and no further data will be collected. Scope completion will be documented by the PI. The PE for Moisture Studies in the ESF will forward a copy of the completion notification record to the FWPRC.

6.0 RECORDS

6.1 LIST OF RECORDS

PIs are responsible for collection, management, and submittal of data, in compliance with Project and applicable PI plans and procedures. All transfers of data between YMP Participants, submittal of data to the YMP database, and transfer of data to outside parties shall be conducted in accordance with AP-SIII.3Q, and other applicable plans and procedures.

All records shall be submitted to the Records Processing Center (RPC) within 60 days of their completion. Records will be submitted to a Project approved

records center. An information copy of any records submitted to the RPC should be sent to the TCO PE assigned to the activity.

The FWPRC will coordinate and monitor the development of the FWP records package. The records package shall contain documents that demonstrate compliance with YMP procedures. The completed records package for this test may contain (or reference) the following:

Record	Participant	QA Designator
Revisions/Changes to this FWP	TCO	QA:QA
DIEs related to the FWP	TCO	QA:QA
Regular Reports Addressing Test Status	TCO	QA:N/A
ES&H Review/Job Safety Analysis	TCO	QA:N/A
ESF Drilling Reports and Related Information	SM&DD	QA:QA
Photograph Negative Numbers Supporting Test Activities	TCO	QA:N/A
Sample Numbers, Corresponding Accession Numbers Supporting Test Activities	SM&DD	QA:QA
As-Builts Borehole and Sample Collection Survey Coordinates	FED	QA:QA
Construction/Testing Related Use of TFM	FED/TCO	QA:QA
Safety Assessment Reviews	TCO	QA:N/A
Instrumentation Locations	PI Organizations	QA:QA
Borehole Locations and Needs	PI Organizations	QA:N/A
Documentation Identifying Work as Complete	PI Organizations – TCO	QA:QA
Modifications to Quality-Related Work Sequence	TCO	QA:QA
Documentation of TCO Toolbox Meetings	TCO	QA:N/A
Borehole Wireline Measurements and Video	Wireline Support	QA:QA
TCO Concurrence Regarding the Use of Chlorides	TCO	QA:QA
TCO Notification/Concurrence to Constructor that Testing Activities in Niches are Complete	TCO	QA:QA
Mobile Moisture Monitoring Cart Methodology	PI Organizations	QA:N/A
Borehole Acceptance	PI Organizations	QA:QA
Monthly Information Specific to Tracer Usage and Recovery	PI Organizations	QA:N/A

Monthly and Quarterly Transmittal of UIC State Approved Tracers Used During Testing Activities Specific to this FWP	TCO	QA:N/A
Calibration Documentation	PI	QA:N/A
Lifting of Hold Points	TCO	QA:QA
Scientific Work Instructions	PI	QA:N/A
Documentation of Toolbox Meetings	PI/TCO	QA:N/A
TCO Notification to SFO to Use Dry Drilling	TCO	QA:QA

6.2 RECORDS GENERATION

Activities within the scope of this FWP will be documented in accordance with AP-17.1Q, see Section 6.1 above. All personnel associated with this testing activity are responsible for ensuring that documents associated with this FWP shall meet the legibility and indexing requirements established in AP-17.1Q. If a scientific notebook is utilized, it shall be stored in accordance with the procedures.

7.0 ATTACHMENTS

1. Summary Schedule Information (QA:N/A)
2. Summary Account Information (QA:N/A)
3. Expected Information Needs, Parameters, and Instrumentation (QA:N/A)
4. Environmental, Safety, and Health Review (QA:N/A)
5. Access Drift Boreholes (Niche 16+20) – End View Figure 3 (QA:N/A)
6. Access Drift Boreholes (Niche 16+20) – Plan View Figure 4 (QA:N/A)
7. Niche 16+20 – Borehole End View Figure 5 (QA:N/A)
8. Plan View – Niche 16+20 Layout of Pre-Niche Boreholes Figure 6 (QA:N/A)
9. Side View – Niche 16+20 Layout of Pre-Niche Boreholes Figure 7 (QA:N/A)
10. Post-Niche 16+20 Construction Radial Boreholes – End View Figure 8 (QA:N/A)
11. Plan View – Niche 16+20 Layout of Post-Niche Construction Radial Boreholes Figure 9 (QA:N/A)
12. Maximum Tracer Concentrations and Quantities (QA:N/A)
13. Borehole Layout of Systematic Characterization of Topopah Spring Lower Lithophysal Unit (QA:N/A)
14. Close Up View of Three Categories of Systematic Boreholes (QA:N/A)

8.0 REFERENCES

1. "Site Characterization Plan", 8.3.1.2.2.1.2, Evaluation of Natural Infiltration.
2. "Site Characterization Plan", 8.3.1.2.2.3.1, Matrix Hydrologic Properties Testing.
3. "Site Characterization Plan", 8.3.1.2.2.8, Fluid Flow in the Unsaturated Zone Fractured Rock.
4. "Site Characterization Plan", 8.3.1.2.2.9, Site Unsaturated-Zone Modeling and Synthesis.

Summary Account Information

	Moisture Studies in the ESF	WBS#	Lead Matrix Org.	Start Date	FY00 Work Package Number	FY00 WP Funding (\$K)
Field Implementation						
	Discrete					
	Moisture Studies in the ESF & Cross Drift	1.2.21.3.U	USGS	10/1/99	8191213UU5	390K
	Moisture Studies in the ESF & Cross Drift	1.2.21.5.T	M&O/LBNL	10/1/99	1401213UM5	400K
Field Support Implementation						
	Matrix Support					
	Test Coordination	1.2.21.5.T	M&O LANL	10/1/99	1701215TM1	\$1064K
	SMF Support	1.2.21.5.T	M&O/SAIC	10/1/99	1401215TM3	1172K
	ECRB Testing Support	1.2.21.5.T	TCO/MK	10/1/99	1701215TMT	154K
	Field Survey	1.2.21.5.T	MK	10/1/99	1701215SM7	378K
	Subtotal- Discrete					790K
	Subtotal-Matrix Support					2,768 K
	Totals					3,558K

**EXPECTED INFORMATION NEEDS,
 PARAMETERS, AND INSTRUMENTATION**

Data regarding the following parameters are expected to be collected as part of the Moisture Studies. This list is subject to change as Scientific Investigations Proceed.

Primary Technical Data Parameters

- Fracture Connectivity
- Fracture Frequency
- Water Content
- Saturation
- Temperature
- Rock Displacement
- Permeability

INFORMATION NEEDS	INSTRUMENTATION TYPES
Changes in Rock Saturation	<ul style="list-style-type: none"> • Humicaps • Electrical Resistivity Tomography (ERT) • High Frequency Electromagnetic Tomography (HFEM) • Tensiometers • Heat Dissipation Probes • Psychrometers
Water Chemistry	<ul style="list-style-type: none"> • Borehole Fluid Sampling & Monitoring
Drainage/Reflux of Liquid by Fracture Flow	<ul style="list-style-type: none"> • Infrared Imaging (IR Camera) • Detailed Fracture Mapping • Fluid Sampling
Bulk Rock Samples Core Samples	<ul style="list-style-type: none"> • Pore Water Extraction Matrix Properties Measurements
Rock-Mass and Fracture Permeability Changes	<ul style="list-style-type: none"> • Fluid Sampling • Mass Flow Controllers • Pressure Transducers

ENVIRONMENTAL, SAFETY, AND HEALTH REVIEW (QA:N/A)

1.0 INTRODUCTION

This Environmental, Safety, and Health (ES&H) Review of the Field Work Package (FWP) for Moisture Studies in the Exploratory Studies Facility (ESF) and the Enhanced Characterization of the Repository Block (ECRB) East-West Drift has been compiled by the Test Coordination Office (TCO) ES&H Specialist. This ES&H review strives to incorporate the seven guiding principles and five core functions of Integrated Safety Management (ISM).

This review has been conducted to ensure ES&H functions have been integrated into the activities described by the FWP. This ES&H Review does not address all environmental and permit compliance stipulations. Line Managers and supervisors should contact Environmental Programs Department (EPD) to ensure that the necessary environmental permits have been applied for and approved in accordance with Environmental Programs Department Procedure, **PRO-EP-001, Environmental Permit Compliance**. This includes compliance with YAP 30.2 Approval Letters, Air Permits, and UIC Permits.

The purpose of this ES&H Review is to: (1) provide a **Preliminary Hazard Analysis (PHA)** which identifies and lists the hazards; and (2) recommends engineering, administrative, personal protective equipment (PPE), and work practice control measures for coordinating and conducting Moisture Studies in the ESF and the ECRB.

This review has also been conducted to ensure that information about potential hazards and control measures will be transmitted to all affected organizations on the Yucca Mountain Site Characterization Project (YMP) in order to **integrate ES&H into all activities, processes, work instructions (WI), and operations** described by the FWP.

Line managers and supervisors should read/review this document and work with Safety and Health (S&H) and their employees in order to evaluate work processes and operations where written **WI** are required and a **Job Safety Analysis (JSA)** will need to be conducted and documented. See Section 4.2, Line Management and Supervision for a detail explanation of JSAs.

1.1 EQUIPMENT SCOPE AND DESCRIPTION

This revision of the FWP for conducting Moisture Studies in the ESF and the ECRB involves revising the wording to incorporate the most current ISM logic and a clear understanding of Nuclear Culture within the YMP.

A detailed description of the work activities can be found in the Field Work Package for Moisture Studies in the ESF FWP-ESF-96-004.

2.0 HAZARDS

2.1 PRELIMINARY HAZARD ANALYSIS (PHA):

Identified Hazards: Listing of activities/tasks and the potential hazards to scientific personnel conducting moisture studies activities:

Activity/Task:	Potential Hazards:
“Dry” mechanical excavation, underground construction, “dry” drilling and “dry” core drilling.	Exposure (E) to Respirable Silica Dust.
Working in inadequately ventilated drifts, alcoves, niches, and adits.	Exposure (E) to Radon, dust and diesel emissions.
Drilling and blasting (using explosives).	Exposure (E) to gases, noise being struck by (SB) premature detonation.
Working around electrical equipment & systems.	Contact with (CW) energized electrical systems & components.
Working in high noise levels.	Physical hazard; exposure (E) to high noise levels, hearing impairment, hearing loss.
Working around drilling, and heavy equipment.	Being struck (SB), contact with (CW) equipment, or equipment components.
Working with high pressure equipment.	Contact with (CW) or being struck by (SB) high equipment/components.
Working in hot/humid environments.	Exposure (E) to hot temperature extremes & high humidity.
Occupying/working in rodent and/or insect infested work areas. Random potential for scorpions, black widow spiders, and poisonous snakes.	Exposure (E) to Hantavirus, insect bites, spider, or snake bites.
Working with chemical/hazardous materials.	Exposure to (E) & contact with (CW) chemicals.
Working at a height greater than 6 feet.	Fall to below or fall to ground (FOL).
Working with flammable, combustible materials, working with cutting/welding equipment, & other sources of ignition.	Fire (CW).

Walking and working on uneven surfaces.	Slips, trips, and falls (FSL).
Neutron well logging.	Exposure (E) to ionizing Radiation.
Extended working hours, extended driving hours to remote/isolated areas.	Driving alone, falling asleep, vehicle accidents.
Working alone in a remote/hazardous location.	Isolated, limited communications.

3.0 HAZARD CONTROLS

“Dry” mechanical excavation, underground construction, “dry” drilling and “dry” core drilling: Moisture studies activities may require “dry” mechanical excavation, or underground construction using Alpine Miner or similar equipment. Boreholes will be “dry” drilled or “dry” core drilled using compressed air as the drilling fluid. Respirable dust containing crystalline silica could be produced as a result of these types of operations.

“Dry” mechanical excavation/construction, “dry” drilling and “dry” core drilling should only be conducted according to the Work Practices as outlined in Section 5.2 of the M&O Safety and Health Procedure **PRO-SH-014, “Silica Protection Program”**. **PRO-SH-014** requires line managers and supervisors to implement effective engineering controls, such as atomizing water spray, highly efficient particulates and Aerosols/Air (HEPA) filtration system, dust diverter, Torit dust collector and/or administrative controls (rotation of personnel), and work practices to control Silica dust.

The Management and Operating contractor (M&O) Silica Protection Program requires employees to attend a training course on the hazards and control measures for Silica exposure. **PRO-SH-014** recommends that workers exposed to high dust level work areas receive a chest x-ray and “uniforms” to wear. In addition, as part of this program, employees may be required to wear a respirator as a secondary line of defense.

Employees will follow the guidance/requirements that can be found in the M&O Safety & Health Procedure **PRO-SH-009 “Respiratory Protection Program”**, should respiratory protection be required as part of moisture studies activities. Supervisors and employees wearing respirators have several specific responsibilities/actions under this procedure. Employees must have completed a physical examination within the past year and have no facial hair that interferes with the sealing surface of the respirator. M&O Safety & Health Procedure **PRO-SH-007, “Health Surveillance Program”** describes how M&O employees can arrange for physical examinations, on site through Bechtel Nevada Medical. To schedule physical examinations call 5-2957.

Respiratory equipment, fit testing, and training for M&O Project and Scientific Characterization Personnel is supplied by M&O Industrial Hygiene (IH). Contact the IH Staff (day shift only) in Trailer #5 on the ESF Pad (5-6269) for respirator fit

testing, equipment issue, and training support. You must call and make a reservation/appointment in advance.

Currently, the employees are required to wear occupational respiratory protection, i.e., at a minimum, 1/2 mask HEPA Filtered Air Purifying Respirator whenever underground construction or drilling activities are being conducted and dust generation is above the Action Level (AL). Once the respirator has been donned, personnel may only lift the mask to take a short drink of water, spit, wipe their nose, and/or briefly communicate. Smoking and chewing of tobacco is not allowed in areas of the ESF or the ECRB where respirators are required. Approved respiratory protection shall be worn in posted areas and whenever so directed by supervision.

An ongoing IH sampling and monitoring program which includes both the sampling of employees' breathing zones and work areas is being conducted by M&O IH. Engineering controls are being constantly evaluated and additional engineering controls will be recommended when they are required.

Working in inadequately ventilated drifts, alcoves, niches, and adits:

Ventilation: Scientific Characterization Personnel conducting moisture studies activities should be aware that work is not allowed in drifts, alcoves, adits, or niches where ventilation has not been established or maintained. A minimum of 30 linear feet per minute (LPM) must be maintained in all areas underground. During daily operation in the ESF and ECRB, M&O IH will conduct air quality and air quantity inspections, and on an as needed basis. Test alcove, adits, and niches that have been closed will need to be monitored by IH and Health Physics (HP) personnel before anyone can reenter. Contact the TCO ES&H Specialist to arrange to provide IH and HP support. Exemptions may be granted through the TCO FTM on a case by case issue.

Radon: Working inside the ESF and the ECRB could also expose personnel to Radon. Radon is not toxic, however Radon and Radon Daughters (a decay product of Radon) are radioactive and emit radiation. Continued chronic exposure to high levels of these gases has been linked to the incidence of lung cancer. Radon is a colorless, odorless, tasteless gas. Radon daughters are of particular concern, because they adhere to respirable dust and once inhaled, they become deposited in the lungs where they continue to decay, giving off radiation and damaging the lung tissue.

For scientific characterization purposes and to preserve moisture content of the rock, some of the alcoves, niches, and adits in the ESF and the ECRB have been closed off, either with bulkhead doors or sealed with plastic. Other alcoves in the ESF and the ECRB will be protected with safety orange barricades. This is being done to prevent/control employee exposure to naturally occurring Radon. Re-entry/re-occupation of any closed, barricaded, or sealed alcove, niche, and/or adits in the ESF and the ECRB must be coordinated through the TCO and the Site Facilities Office (SFO) with the assistance of M&O IH and HP.

Please note, the SFO includes the Departments of Construction Management (CMD), Craft Management (CRMD), Field Engineering (FED), and Support Services & Maintenance Management (SS&MMD). (See Section 4.0 Roles and Responsibilities, SFO, and/or copy of latest organizational chart available on YMP Lotus Notes, Server YMNL1).

M&O Safety and Health Procedure, **PRO-SH-019, "Airborne Radiation Protection Program for Naturally Occurring Radon"** provides guidance/requirements to moisture studies personnel and other YMP personnel in order to limit exposure to Radon. A "Radon Threshold" of >7.5 pCi/L (over 40 hours is the OSHA action level) will be established as an "action level" for employee/worker exposure. **PRO-SH-019** requires the implementation of the following requirements:

Signs and Postings: Sections of the ESF and the ECRB, alcoves, niches, and adits are to be posted "Caution Airborne Radioactive Area – Naturally Occurring Radon".

Entry Permit: Entry into closed, sealed, or barricaded alcoves, niches, and/or adits will require an entry permit. In addition, a sign in/sign out-log will be kept and entry can only be done after Radon levels and air quality measurements have been made.

Training: An explanation of the Radon procedure/issues will be included in General Underground Training (GUT)

Ventilation Management Plan: Notification of TCO, SFO, CMD, CRMD, M&O IH, and M&O HP is required one day in advance when scientific characterization activities require reentry behind a barricade or closed bulkhead, alcove, adit or niche. This is to ensure that the fan(s) are operating and have been operating for an appropriate period of time prior to entry in accordance with the ESF Ventilation Management Plan. Exemptions may be granted by the TCO-FTM on a case by case reason to support testing activities.

Personal Protective Equipment: Respiratory protection for short-term entries will be the "field call" by HP personnel monitoring the situation.

Personal Monitoring Program: Currently the M&O is investigating a personal monitoring program for exposure to Radon for M&O Employees who routinely work underground. This pilot program uses both passive and air sampling technologies. Contact the M&O HP at 5-5969 for information on obtaining these personal monitors.

Radon Dose Calculations: ESF and the ECRB personnel will receive a "Dose Calculation" and will be notified through the IH "reporting system".

Drilling and Blasting (using explosives): Current plans may call for scientific alcoves and niches in the ESF and the ECRB to be excavated using drill and blast methods. All explosive loading and firing operations will be done under the direction and control of a certified blaster, usually a craft employee of CRMD. Scientific characterization personnel must receive permission from the certified blaster and check-in with the Person-In-Charge (PIC) before entering the area. (See Section 4.0 Roles and Responsibilities, Person-In-Charge). Smoking is not allowed in the areas where explosives are being handled and used. The immediate area is evacuated during blasting operations. During post-blasting operations, the mining personnel will monitor ground conditions and the M&O IH personnel will monitor air quality prior to re-entry/re-occupation of the area by scientific personnel. Do not attempt to re-occupy the area until it is cleared by the craft mining personnel from CRMD and the IH personnel.

Working around electrical equipment & systems: Personnel conducting moisture studies activities in the ESF and the ECRB will note that anytime scientific personnel are required to conduct work on electrical circuits or any form of equipment with stored energy, the system must be locked out and tagged out. The Lockout/Tagout program involves any type of electrical/mechanical system or component, and ensures that all electrical/mechanical systems and components are first de-energized, isolated, and rendered inoperative, before employees can begin work. This process of de-energizing, isolating, and rendering inoperative is known as Lockout/Tagout. Lockout/Tagout is an Occupational Safety and Health Administration (OSHA) program requirement that seeks to ensure that equipment needing maintenance, repair, or service has been locked out and tagged out (identified) in order to prevent injuries to employees by accidental activation. All Lockout/Tagout activities should be performed in accordance with M&O line procedure, LP-OM-001-M&O, "Lockout/Tagout Process".

Personnel conducting moisture studies activities in the ESF and the ECRB will note that "High Voltage" cable(s) will be lying on the ground around the drilling/mining equipment and diesel generators that may supply power to the drilling operation. Casual contact with these power cables is not a safety concern. However, if the nature of any moisture studies activity could possibly cause physical damage to the electrical cable jacket(s) or conductors, it is mandatory that contact be made with a TCO Field Test Representative (FTR) to arrange with CRMD for services of the craft electricians to move the cable(s).

Scientific personnel should not attempt to open or work on any electrical components, such as junction or panel boxes. Contact the TCO FTRs to arrange with CRMD for services of the craft electricians. All electrical systems must be locked and tagged out before any work can even be attempted.

All cord and plug connected equipment (i.e., electrical cords or multi-outlet devices) at sub-surface sites must be either part of an "Assured Grounding Program" or plugged into outlets that are Ground Fault Circuit Interrupt (GFCI) protected. Underground, panel boxes equipped with GFCI protected circuits can be identified by plug and cord connectors wrapped with blue tape. All scientific characterization personnel must ensure that any cord and plug connected equipment used underground and not connected to a GFCI device is entered into the "Assured Grounding Program". The "Assured Grounding Program" uses a "color coding" system on extension cords and equipment. Contact the TCO FTR to arrange with CRMD for the services of the craft electricians, who perform this service. Extension cords cannot be over 50 feet in length and no more than one extension cord can be used at any one outlet/location. Permanent or hard wired power drops should be used in place of extension cords whenever possible. All extension cords, or multi-outlet devices must be Underwriters Laboratory (UL) listed and be rated for heavy duty/outside use. Extension cords cannot be hung in the same rack/hook as the tunnel power cables and they must be designated for hard or extra hard use. Extension cords designated for hard or extra hard use will have the following letters written on the outside: S, ST, SO, STO, SJ, SJO, SJT, SJTO, etc. Guidance/requirements for extension cord use can be found in OSHA 29 CFR 1926.405 (a) (ii) (J) or the National Electrical Code (NEC), Table 400-4. Contact the TCO for assistance from the CRMD craft electricians for permanent power drops or rack/hook hardware installations.

Working in high noise levels: Personnel conducting moisture studies activities need to be aware that the core drill, drill jumbo, and related equipment that will be used, produce high noise levels. Hearing protection (ear plugs and/or earmuffs) must be used, during core drilling operations. The operation should be posted by IH at the request of CMD. Ear plugs and earmuffs are available from the portal shack at the entrance to ESF. Earmuffs are available from the Tool Crib located on the ESF Pad.

During certain operations, (i.e., drill jumbo, jack-leg drilling, or jack hammering operations), dual protection, both ear plugs and ear muffs, may be required. Contact the TCO S&H Specialist for information on moisture studies areas where dual protection may be required. Approved hearing protection shall be worn in posted areas and whenever so directed by supervision.

The M&O Safety and Health Procedure **PRO-SH-004 "Hearing Conservation Program"** specifies the requirements for employees working in high noise areas. All employees working in these areas must be in the hearing conservation program and, among other things, obtain a baseline and annual audiogram which is usually conducted during annual physical examinations.

Working around drilling and heavy equipment: When moisture studies activities require personnel to conduct work on electrical circuits or any form of equipment with stored energy (i.e., mechanical systems/components, drilling systems monitoring devices), the systems/components must first be de-energized, isolated, and rendered inoperative before employees can begin work. This process of de-energizing, isolating, and rendering inoperative is known as Lockout/Tagout. (See, **Working around high voltage electrical equipment & systems**).

The Lockout/Tagout program is not required for working around mobile in-use equipment (i.e., automobiles, pickup trucks, front-end loaders, forklifts). Scientific personnel conducting moisture studies activities where heavy equipment is being used, should check-in with the CRMD craft personnel (operating engineers) operating the equipment to ensure that the operators/miners/teamsters know of your presence. To become familiar with an operation where drilling and electrical equipment is being used, attend the beginning of each shift Toolbox Safety Meeting, and talk with CRMD and the craft personnel conducting the work.

Contact the ESF TCO FTR to arrange for Lockout/Tagout assistance through CRMD with craft electricians.

Working around heavy equipment can present health hazards of respirable dust, and safety hazards from contact with and being struck by moving equipment. For example, a "front end loader's" safety hazards would include both pinch points and being struck or run over by the equipment.

When scientific characterization activities require work in the same area as heavy equipment, personnel should be aware of the following:

Do not stand behind mobile equipment when it is running. (The operator may not be able to see or even hear you).

All mobile equipment i.e., front-end loaders, forklifts, are required by OSHA regulation to have warning systems installed on them that sound a loud alarm whenever the equipment/machine is placed in reverse. Pay attention to these alarms and watch for moving equipment.

Most mobile equipment is operated with a spotter (a driller and/or another operator), who watch the machine as it moves and warn the operator of foot travelers in the area. Pay attention to the commands of the operator and/or the spotter.

Whenever you are working around drilling and heavy equipment, **pay attention to your surroundings** and follow all directions of the CRMD craft personnel operating the equipment.

Working with high pressure equipment: Personnel conducting moisture studies activities could encounter air compressors, pneumatic equipment, and gas/air in bottles/cylinders. Never walk under or near any of this equipment while it is in operation or use.

Compressed air will be used as the "dry" drilling fluid on Moisture Studies Boreholes. Air compressors and air receivers (storage tanks) must be equipped with pressure relief valve/apparatus. Air hoses must be equipped with whip checks, to prevent accidentally separated hoses from thrashing about, injuring employees. Never attempt to tighten, remove, or adjust any compressed air or gas equipment, lines, or pipes while the components are pressurized.

Compressed air equipment, lines, or pipes must be equipped with bleed down valves and pressure indicating gauges to ensure that all air pressure is relieved before attempting to tighten, remove, or adjust any components.

Large K bottles or cylinders which contain 200 cubic feet of compressed gas may be used at moisture studies locations. These cylinders are used for operations such as oxygen/acetylene cutting and tracer gas injection. In general, any cylinder that is not being used must be stored in an upright position, secured to a rack with a chain, and have the protective cap on the cylinder valve. Cylinders should be transported using a cart that is designed for this purpose.

Working in hot/humid environments: Personnel conducting moisture studies activities could encounter certain areas of the tunnel (i.e., drilling equipment, Alcove 5 Heated Drift) where elevated temperatures and humidity are routinely found. The combination of wearing respiratory equipment and working in an environment with elevated temperatures and humidity could produce heat stress. In conditions such as these, three types of stress can occur, heat cramps, heat exhaustion, and heat stroke.

Personnel conducting moisture studies activities should be aware of the following symptoms of heat stress and the proper first aid treatments:

Heat Cramps

Symptoms

1. Muscle cramps in legs, hands, feet, or abdomen.
2. Pain accompanying cramps.
3. Profuse sweating.
4. Faintness.

First Aid Treatment

1. Move to cool (air conditioned) place.
2. Sip salted water (1 teaspoon of salt in 1 quart).
3. Massage cramped muscles.
4. Obtain medical treatment.

Heat Exhaustion

Symptoms

1. Profuse sweating.
2. Intense thirst from dehydration.
3. Cool, moist skin (clammy and pale).
4. Fatigue, weakness, dazed.
5. Dizziness.

First Aid Treatment

1. Move to cool (air conditioned place).
2. Loosen tight clothing and remove excess clothing.
3. If conscious, sip salted water.
4. Treat for shock, lay on back, and raise feet slightly.
5. Stay with the patient until medical aid arrives.

Heat Stroke

(Please note: Heat Stroke is a medical emergency)

Symptoms

(Can occur suddenly, with little warning.)

1. Dizziness, raging headache.
2. Hot, dry, flushed skin.
3. Full and fast pulse.
4. Breathing deep at first, later shallow breathing.
5. High temperature (106 degrees or higher).
6. Confused, delirious behavior.
7. Muscle twitching, growing into convulsions.
8. Loss of consciousness or coma.

Emergency Care

1. Heat Stroke is a true medical emergency, arrange transport to a medical facility without delay.
2. Move to cool (air conditioned) place.
3. Strip to underclothes.
4. Lay on back, head and shoulders raised slightly.
5. Assure breathing airway is open.
6. Put ice or cold wet cloth on head.
7. Cool body with water or wet cloth.
8. Do not give coffee, cigarettes, or a stimulant.

Controlling Heat Stress: Personnel conducting moisture studies activities should:

- Follow scheduled work/rest cycles. Requirements for work/rest regimens can be found in the latest **Threshold Limit Values Booklet for Chemical Substances and Physical Agents**, published by the American Conference of Governmental Industrial Hygienists (ACGIH).
- Workers should alternate between light and heavy work.
- Where possible, rotate duties among several workers.
- Drink plenty of water. Drink at least 16 ounces about an hour before work starts and then 5 to 7 ounces every 15 to 20 minutes during work. Some

people find electrolyte drinks (i.e., Gatorade) effective instead of, or in addition to water.

- Encourage workers to wear loose fitting, light clothes whenever possible.

Personnel conducting moisture studies activities should drink plenty of liquids and take frequent breaks. M&O Safety and Health Procedure, **PRO-SH-008, Occupational Heat Stress**, provides guidance/ requirements for dealing with potential heat stress conditions and establishes responsibilities within the M&O.

Occupying/working in rodent and/or insect infested work areas. Random potential for scorpions, black widow spiders, and poisonous snakes: An outbreak of a potentially fatal illness has occurred in the Southwest, primarily in New Mexico and Arizona, although three cases have been reported in Central Nevada.

The cause of the illness has been identified by the Center for Disease Control (CDC) as the Hantavirus. Rodents such as pocket mice, deer mice, canyon mice, and kangaroo rats are the primary carriers of the virus.

As a precaution, all scientific personnel working at moisture studies locations inside the ESF and the ECRB should be aware of the possibility of exposure to Hantavirus and follow this advice:

- Avoid human contact with rodents, rodent droppings, and rodent nesting materials. Infected rodents carry the virus in saliva, urine, and feces.
- The virus can infect humans through breathing the dust of dried out rodent feces and urine, and/or contact with rodent feces/urine through skin that is cut, dried, or broken. Avoid breathing dust from rodent infested areas, avoid skin contact with rodent infested areas.
- If a facility or job site in which scientific personnel are working has visible signs of "heavy" rodent infestations (i.e., rodent excreta, and/or rodent nests), the rodents should be trapped/removed and the facility cleaned and disinfected.
- Scientific personnel should make no attempt to remove or clean-up rodent infested areas. M&O IH personnel have trained CRMD craft personnel in pest control techniques. They have the expertise, equipment, and supplies to trap and clean-up heavy infestations.

Insects, scorpions, black widow spiders, and poisonous snakes:
Work areas that have signs of insect infestations should be sprayed with pesticides. Trained CRMD craft personnel will also conduct these types of pest control spraying operations. Do not bring your own insect spray onto the site.

Scientific testing personnel should be vigilant when walking near areas including stacked pipe, stored drilling equipment, or stored materials as these are favorite nesting places for spiders, scorpions, and poisonous snakes. Seek immediate medical attention if bitten.

Note: Medics are located in the Change House next to the North Portal on the ESF Pad.

Scientific personnel should contact R. Kovach, who will coordinate with IH and CRMD craft personnel. CRMD's craft personnel will perform pest control services.

Working with chemical/hazardous materials: A majority of the chemicals and materials used in Moisture studies activities will be provided by the Tool Crib.

Any other TFM that could be used as part of moisture studies activities, must be approved by the M&O Environmental Programs Department Procedure **PRO-TS-007, "Authorization to Purchase and Use Regulated Hazardous Materials"**. **PRO-TS-007** requires that a Material Request for Authorization (MRA) Form be submitted and approved before chemicals and materials can be transported and used on the Project.

A Determination of Importance Evaluation (DIE) has been completed in support of planned TFM usage. It captures any controls or constraints identified through the DIE process in the field implementing documentation.

The requirements for identifying, characterizing, tracking, and documenting the disposition, management, and disposal of non-hazardous waste (including empty and used containers and used lead acid batteries) generated during Moisture studies activities on the YMP shall be in accordance with Environmental Programs Department Procedure **PRO-EP-002, "Non-Hazardous Waste Management"**.

The Federal, State, and U.S. Department of Energy (DOE) requirements mandate that regulated and hazardous materials are managed to minimize the potential of their release during transport, storage, and use. Environmental Programs Department Procedure, **PRO-EP-004, "Spill Management"**, directs those who transport, store, and use regulated hazardous materials to use appropriate engineering practices, develop plans to be followed in the event of a release or spill, be capable of responding to such a release, and be able to notify appropriate authorities.

The use or removal of testing related TFM by affected organizations must be identified and reported to the TCO prior to such use or removal. The TCO ES&H Specialist coordinates the annual inventory of hazardous chemicals as required by OSHA regulation and the M&O Safety and Health Procedure **PRO-SH-003 "Compliance with the Occupational Safety and Health Administration (OSHA) Hazard Communication Standard"**. The affected organization must know the location of the Material Safety Data Sheets (MSDS), and the proper storage, use, transportation, and PPE requirements for all the hazardous chemicals they use. The MSDS should always be reviewed before using any product/material underground. Contact M. F. Taylor, ESF TCO ES&H Specialist, if there are questions regarding TFM usage in the ESF and/or ECRB.

Working at a height greater than 6 feet: Scientific personnel conducting moisture studies activities who have to work at a height greater than 6 feet off the ground, must either work behind scaffolding with guard rails (top rail minimum height 42 inches, mid rails, toeboards); or use OSHA approved fall protection equipment, including a **body harness, lifelines, Sala Block, and/or lanyards**.

OSHA approved ladders (set at an angle of between 75 and 90 degrees from vertical) must always be used. (NOTE: Metal ladders cannot be used around energized electrical equipment, only OSHA approved fiberglass ladders can be used where there is a danger from contact with energized electrical equipment.) A three point contact must be maintained by personnel using approved ladders. Approved fall protection equipment is available at the ESF Pad from the Tool Crib. Lifeline and lanyards must be attached to structural components that will support at least 5,000 lbs. Contact the TCO FTR to make arrangements for getting proper fall protection equipment.

Working with flammable, combustible materials, working with cutting/welding equipment, and other sources of ignition: While the likelihood of a fire inside the ESF or ECRB is remote, scientific characterization personnel should be aware of the following:

Whenever the CRMD craft personnel conduct cutting and/or welding operations, OSHA requires a fire watch (i.e., a person standing by with a fire extinguisher). Incipient Stage Fire Extinguisher Training is being offered by the M&O Training Department.

Spills or leaks of flammable or combustible material must be cleaned-up immediately and reported to the CRMD craft personnel and PIC. This is necessary for both employee safety and health and environmental reporting requirements.

Air purifying ½ mask or full face HEPA Filtered respirators for respirable silica dust will not filter out the carbon monoxide (CO) gas that is always produced by fire. In case of an underground emergency involving a fire, you must remove your air-purifying respirator and don your self-rescuer.

Fire hoses have been installed on the right rib of the ESF and fire extinguishers have been placed on the left rib in the ECRB. CRMD craft personnel are trained in the use of this equipment. Follow the direction of CRMD supervisory personnel or the PIC in the event of an underground fire emergency.

Smoke detection equipment has been installed in Alcove 5. These devices, which have audio and visual alarm system, will alert personnel to the presence of fire and/or smoke. Follow the directions of CRMD supervisory personnel or the PIC should these systems sound an alarm. Personnel should don their self-rescuers at the first indication of an emergency involving a fire.

Walking and working on uneven surfaces: In most cases, personnel conducting moisture studies activities in the ESF or the ECRB will be escorted by a fully underground trained and qualified TCO FTR, who is familiar with the underground operations, equipment, and construction process. Follow the direction of these TCO FTRs.

The Thermal Testing Facility (Alcove 5) sections of the access drifts, are at 14.61% and 11.5% down grades. Rubber tire equipment can slide when attempting to stop. Foot traffic should be limited when equipment of this type is in operation.

A pre-cast concrete invert section system has been chosen for installation in the ESF Tunnel. Railroad lines for the equipment and man-trains have been

attached/secured to these invert sections. The invert sections have gaps and irregularities on the walking surface. Slips, trips, and falls could be hazardous.

The ECRB has treated wood ties to which the railroad lines are attached/secured. These ties will have gaps and irregularities. A metal grate walkway has been installed in the ECRB for pedestrians.

When accessing the main drift in the ESF to conduct moisture studies activities, always walk on the rib that has the lights strung on it.

In the underground drifts, when a train approaches, the operator will sound the horn on the locomotive. In the ESF main drift, when pedestrians hear or see an approaching train, they must stop, move as far off the right rib and away from the track as possible, and stand with their backs to the rib while facing the oncoming equipment. Remain still until the equipment has passed. While the locomotive passes, they will keep their eyes on the operator/swapper but not shine their cap lamp in the operator/swapper's eyes. Pedestrians will proceed only after all the rail cars and equipment has cleared the area.

In the ECRB drift, when pedestrians encounter a train, the locomotive operator will stop and wait for personnel to move up onto the utility pipes on the left rib. Only after pedestrians have moved to the utility pipes, will the train continue. Remain still until the equipment has passed. While the locomotive passes, keep your eyes on the equipment and the operator, but do not shine your cap lamp in his/her eyes. Proceed only after all the rail cars and equipment have cleared the area. Reflective safety vests (red or orange) are required to be worn by all personnel working, walking, or visiting the ECRB East-West Cross Drift.

In the ESF main drift and at the ECRB "Y", do not stand on or near any of the "California Switches" while equipment is approaching or actually on the switch. Rail cars and equipment have a larger potential to "de-rail" in these areas. These switches have currently been installed at the 19+50 meters, the end of the first curve (Alcove 5) 28+00 meters, and at 45+00 meters.

Curves in the tunnel make it more difficult for the locomotive operator to see pedestrians. The locomotive operator will sound the horn when entering these areas. Pedestrian traffic needs to pay attention and watch for train traffic. If possible, limit foot traffic when train traffic is in these areas.

When moisture studies activities require personnel to access the ESF and the ECRB, and/or alcoves that are in an active mining stage, pedestrians should be aware of the following:

- Alcoves should be accessed on the right rib, just like the ESF main drift. Watch for mobile equipment and follow the directions of the mining personnel on where to walk and stand.
- Do not stand behind mobile equipment when it is running.

The locomotive operator, swapper, and miners communicate with a series of cap lamp/flashlight visual signals. Pedestrians should be aware of the following signals:

- Horizontal movement of the cap lamp/flashlight = Stop (freeze in place).

- Vertical movement of the cap lamp/flashlight = move away from the person giving the signal.
- Circular movement of cap lamp/flashlight = approach the person giving the signal.

Follow all directions of the TCO FTR, PIC, or CRMD personnel while accessing underground work areas.

Neutron well logging: As part of moisture studies activities, Neutron sources will be used to log boreholes in the ESF, the ECRB, and other scientific alcoves, adits, and niches. Authorization for the use of ionizing radiation producing materials will be through the M&O Radiation Control (RADCON) Manager, and will be in accordance with the NV/YMP RADCON Manual and the M&O Radiation Protection Program (RPP). All work involving wireline borehole measurements will be conducted under Field Work Package FWP-ESF-96-013, Borehole Wireline Measurements For Exploratory Studies Facility Testing Activities.

A Radiological Work Permit (RWP) will be issued before any activity involving the use of radioactive materials/tools is permitted. Radiological Health Surveys will be conducted during the use of these radioactive materials/tools. Radioactive Material Areas (RMA) with controlled access will be established during deployment. Signage, posting, and barricade requirements will be in effect. Foot traffic may be restricted or limited during calibration and insertion activities inside and around the RMA. Any employee required to be inside the RMA will, at a minimum, have General Employee Radiation Training (GERT) and Rad Worker I Training. Any employee inside the RMA will have the following personal monitoring devices: NTS Whole Body Thermoluminescent Dosimeter (TLD) and Neutron Dosimeter. Personnel handling the tool and related accessories will wear Finger TLDs.

Extended working hours, extended driving hours to remote/isolated areas: During some moisture studies scientific and construction activities, extended working and extended driving hours could be encountered. Personnel conducting field test coordination or oversight activities should utilize the "buddy system". Transportation, back and forth to remote/isolated sites should be done in pairs (or more) riding in a single vehicle. Find someone to ride with you who will stay awake, talk, and monitor your driving. Driving alone, back to town, after working at remote/isolated sites for more than 10 hours is not permitted.

Area 25 Vehicular Backup Awareness Warning: In all YMP Area 25 operating areas, it is required for drivers of light duty government vehicles not equipped with backup alarms to sound their horn twice prior to backing vehicles. This measure will increase your awareness and awareness of your fellow worker.

Radio Net and/or telephone check-in/check-out with Ranch Control for accountability is required on a daily basis. Personnel conducting field test coordination or oversight activities should never venture into the field without a radio (YMP Net #1), first aid kit, food, and water.

Any moisture studies activity in Alcove 1 or at remote surface-based locations on **weekends or during off normal hours** requires additional approval from the TCO. A "Safety and Emergency Procedure Description and Plan" must be

completed and approved by the TCO. This safety and emergency plan lists participants and emergency contacts and is distributed by e-mail to Project operations, construction, and craft management organizations.

Seat belts must be worn in all government vehicles and equipment where provided. Nevada State Law requires all YMP personnel to wear seat belts, and the DOE requires wearing seat belts while driving or riding in a government vehicle. Drivers are responsible for ensuring that passengers wear their seat belts.

To report life threatening injuries or medical emergencies call "911", on the NTS Radio Network call "Mayday, Mayday, Mayday", emergency services will answer, and will request information on the nature of your emergency and support/ assistance you may require. Ranch Control monitors "911" telephone calls and "Mayday" radio communications.

Working alone in a remote hazardous location: Scientific personnel conducting Moisture Studies in the ESF and the ECRB, particularly the scientific alcoves, should be aware that effective immediately, a Two Person rule is in effect in the ESF and the ECRB. This means, if you are going into an alcove to do work, **YOU CANNOT BE ALONE**. This rule applies if the individual is going beyond the location where you can be noticed at a glance from the Main Drift (such as up to the turnaround bay in some alcoves) approximately 10 to 20 meters into the alcove. It is each person's responsibility to make sure that you are not alone.

Any individual from SFO, the CMD, the CRMD, or the TCO can be the second person. Let this person know where you are going to be and ask them to check on you. If they leave, ask them to notify you, so you can also depart. This requirement does not apply when scientific personnel enter an alcove for a brief period of time, for the purpose of making an inspection, downloading data, or taking readings.

Coordination with TCO FTM (Dick Kovach) or an on-shift FTR needs to be established. Exemptions may be granted by the FTM. The TCO and FTRs can be reached at (702-295-6180/6189). The TCO and FTRs can call upon other organizations underground to help provide that second person, but only if given advanced notice.

4.0 ROLES AND RESPONSIBILITIES - SAFETY AND HEALTH

4.1 Safety and Health Roles and Responsibilities: The M&O is in charge of the YMP and has the responsibility for S&H for all teammate organizations, employees, visitors, and personnel from other organizations when they are on M&O controlled worksites. Clear roles and lines of responsibility, authority, and accountability are established at all levels of the organization to ensure protection of workers, the public, the environment, and property.

Therefore, in order to fully implement the principles of ISM, the M&O has appointed a PIC for each underground and surface-based work area or location where construction (testing support) and/or scientific testing activities are being conducted. (A description of the PIC's roles and responsibilities is provided below).

SFO, CRMD, CMD, and the TCO will discuss the daily construction (testing support) and/or scientific testing activities scheduled to be conducted and appoint a PIC for each specific work area or location from their line management and supervision staff. Depending on each specific work activity i.e., construction/testing support or scientific, the PIC may be any individual from SFO, CMD, CRMD, the TCO, or a scientific testing organization. The PIC will be identified in the Toolbox Safety Meeting prior to the start of daily activities.

4.2 Specific Group and Individual Safety and Health Roles and Responsibilities: The following groups and individuals are responsible for:

Site Facilities Office: The SFO includes the Departments of CMD, CRMD, FED, and SS&MMD. The SFO, primarily the CMD and the CRMD are responsible for jointly selecting (with the TCO) the PIC. The SFO is responsible for implementing the requirements of this FWP during the construction/test support and scientific testing processes. SFO provides construction/test support services to the organizations conducting scientific testing activities work on the YMP. SFO is responsible for oversight and management of all construction/test support activities on the YMP. CMD is responsible for integrating the requirements of the M&O Safety and Health Plan and M&O S&H policy and procedures into all construction/test support and scientific testing activities. SFO has S&H responsibility for all persons (employees and visitors) inside YMP construction/test support and scientific testing work areas and locations. SFO is responsible for maintaining YMP construction/test support and scientific testing work areas and locations in a safe and healthful condition, for maintaining mobile and stationary equipment, S&H training, and training in the safe operation of some pieces of equipment.

Test Coordination Office (TCO): is responsible for jointly, selecting (with the SFO, CMD, and CRMD) the PIC. The TCO is responsible for scientific testing activities on the YMP. The TCO is responsible for the implementation of the requirements of this FWP and for coordinating all scientific testing activities/requirements with construction/testing support activities. The TCO and other scientific organizations are responsible for the S&H of their employees and conducting scientific testing activities in compliance with the M&O Safety and Health Plan and M&O S&H policy and procedures.

Line Managers and Supervisors: M&O line management and supervision is responsible and accountable for the protection of workers, the public, the environment, and property. M&O Line managers and supervisors are responsible for evaluating their work operations, activities, or processes that present new or unusual hazards, then conducting and documenting a JSA. A JSA is a structured, step-wise method to identify discrete tasks in a job, recognize the hazard(s) involved in each task, and specify mitigations to eliminate or reduce the hazard(s) to an acceptable level (i.e., engineering, administrative, or PPE controls, employee S&H training). All JSAs must be conducted and documented in accordance with **M&O Safety & Health Procedure PRO-SH-011, "Conducting a Job Safety Analysis"**. All JSAs must be reviewed and approved by the M&O S&H. Contact the TCO ES&H Specialist for assistance in determining which scientific characterization activities require JSAs. Once the JSAs have been produced, reviewed, and approved, they will be used as a task guide for employee training purposes, and this training will be documented.

M&O Employees: M&O employees (once they have been trained and understand the requirements), regardless of their employer, are responsible for understanding and following the requirements of the ES&H programs of their employer and specific YMP ES&H programs. M&O employees are responsible for ensuring that the ES&H training they have received is followed and implemented, regardless of whether the training was received from their parent organization or on the YMP. M&O employees are responsible for knowing the identity of the PIC in their specific work area or location. M&O employees are responsible for immediately notifying the PIC and then their M&O organization supervisor of unsafe acts, conditions, and/or equipment.

Person-In-Charge (PIC): is responsible for ensuring the specific work (construction/ testing support or scientific testing) activity is conducted in accordance with M&O established S&H procedures. The PIC is responsible for ensuring that the Toolbox Safety Meeting is conducted at the beginning of each shift, on a daily basis. A PIC shall be present in the specific work area during all construction/ testing support or scientific testing activity, operation, or process. The PIC will determine if the workers present have the training, experience, knowledge, skills, and abilities needed to perform their work safely and competently. The PIC will be a point of contact for all visitors to the specific work area. i.e., all workers in the specific work area should be able to immediately identify the PIC. If the PIC needs to leave his/her assigned specific work area, a new PIC will be selected and the change will be communicated to all individual workers in the specific work area. If an issue arises, the PIC will be responsible for notifying the appropriate manager(s) within the SFO and TCO and serve as the focal point of contact of issue resolution.

4.3 Written Safety and Health Roles and Responsibilities - TCO ES&H Review

The ES&H Review is an attachment to this FWP and contains both a PHA and a section recommending control measures for all identified hazards. The ES&H Review is specific to the construction/testing support and scientific testing activities found in this FWP. Each organization's line management and supervision shall read the ES&H Review and use it as both guidelines and minimum requirements for informing, educating, and implementing protective measures, i.e., engineering, administrative, PPE controls, training to a JSA, or environmental controls, for the identified hazards. A JSA may be assigned by the TCO to be generated by another organization and will be incorporated in the work described in this FWP. A copy of the ES&H review will be available at the ESF TCO field office, the Las Vegas Office, and will be transmitted to test and SFO Departments **working on the YMP**.

M&O Teammate organizations and employees will still perform work that is authorized by their respective FWPs, work plans, work instructions, and/or work procedures. Teammate organizations perform their work as an "integrated group" to the ES&H polices and procedures as set forth by the M&O.

M&O Teammate organizations and employees will continue to conduct construction/testing support and scientific testing work on the YMP through the umbrella of the M&O Safety and Health Plan and the listed Environmental Plans that can be found in the FWP.

The “M&O Safety and Health Plan” (B00000000-01717-4600-00016), establishes implementing guidance/requirements through S&H procedures and applicable Environmental Plans that can be found in the FWP.

5.0 EMPLOYEE TRAINING

Visiting scientific characterization personnel requiring access to the YMP site must watch a short training video and be escorted by an individual with General Education Training (GET), General Underground Training and First Aid CPR Training. Scientific characterization personnel requiring routine access to work underground in the ESF and/or the ECRB must coordinate through the TCO in accordance with YAP-30.39, “Exploratory Studies Facility Access Approval Process” and be current in GET, GUT, First Aid/CPR, Respirator, and Hearing Conservation Training. In accordance with YAP-30.39 and as part of GUT, employees are issued an “A” or a “B” sticker for their hard hat, depending on their access requirements and worker category. Personnel entering the ECRB must have an “A” or “B” sticker, or be escorted by a worker with an “A” or “B” sticker.

PPE is required for all persons entering any construction site on the YMP. On the ESF Pad, other than during shift change or when walking to or from the buses or parking lots, all personnel are required to wear the following personal protective equipment:

- Approved safety shoes (ANSI Z41)
- Approved hard hat (ANSI Z89.1)
- Approved safety glasses (ANSI Z87.1)

Side shields are required on all safety and regular prescription glasses. (Procurement contracts require vendors to supply side shields for all prescription safety glasses ordered through the M&O prescription eyewear program). Dark sunglasses (safety or regular prescription) will not be worn inside buildings on the ESF Pad or in any areas underground. M&O Safety and Health Procedure PRO-SH-002, “Procurement of Required Personal Protective Equipment”, describes how M&O employees go about obtaining prescription ANSI approved safety glasses (with side shields) and footwear through the M&O purchasing system. Casual dress (i.e., no shirt, tank tops, cut-offs, shorts, and/or sandals are not allowed at YMP worksites). If you have any questions regarding PPE, contact your M&O Supervisor or an M&O S&H Representative.

All participants shall adhere to the M&O Safety and Health Procedure PRO-SH-001, “Accident Investigation, Reporting and Recordkeeping”, for instruction on reporting and processing of information on injuries, illnesses, and property damage.

5.1 OTHER TRAINING

All personnel entering the ESF and/or the ECRB, who have **not** received the shift toolbox briefing, are to ask the portal guard for current conditions in the tunnel before they enter. This is to ensure compliance with applicable OSHA Standards.

6.0 EMERGENCY RESOURCES LOCATION AND CONTACTS

6.1 EMERGENCY REPORTING

M&O Safety and Health Procedure PRO-SH-005, “Emergency Management”, was developed for supervisors who have responsibilities for a facility or worksite.

In an emergency, telephone 911. Over the Radio announce "Mayday, Mayday, Mayday", then give name and location. The Mercury Communications Information Center will get details of assistance required and dispatch the appropriate response organization.

6.2 NEAREST UNDERGROUND PHONE

Mine Phones are located at the entrance to alcoves and spaced approximately 500 meters apart, along the right rib of the ESF and the left rib of the ECRB. To use the mine phone, depress the black switch in the handset, and ask the portal guard to pick-up. State the location and nature of the emergency.

6.3 NEAREST HOSPITAL OR CLINIC

Mercury, Nevada (approximately 38 miles). The NTS paramedics and an ambulance are stationed at the ESF Pad in the Change House. Do not contact them directly. Always go through the Mercury Operator.

6.4 NEAREST FIRST AID STATION/PARAMEDIC

A First Aid Station is located on the ESF Pad at the Change House. The First Aid Station is manned by two paramedics, who work a ten (10) hour shift in order to ensure that medical coverage is provided during the underground shift.

Scientific characterization organizations, including line managers and supervisors performing work away from the ESF Pad should also be aware that a "Medical Needs Analysis" that is in accordance with M&O Safety and Health Procedure **PRO-SH-012, "Conducting a Medical Needs Analysis"** should be completed and on file with the TCO.

6.5 NEAREST FIRST AID KIT/EYE WASH STATION

First aid kits and eye wash stations are located in scientific alcoves and other work areas.

6.6 NEAREST POTABLE WATER

Orange "Gott" Drinking Water Coolers are located throughout the ESF and the ECRB.

6.7 SUGGESTED EMERGENCY EVACUATION ROUTE AND MEETING AREA(S)

Underground, situations may occur that will require immediate evacuation of an operation or area. These situations may include but are not limited to uncontrollable fire, explosions, collapse, hazardous chemical release, or chemical spill.

If such a situation(s) occurs, the Mine Service Phones are equipped with a speaker, which will serve as an underground paging system to announce any emergency condition. Follow the direction given by the announcement, the SFO Supervisor Personnel, or the PIC handling the emergency.

Should access to the portal be cut off or evacuation routes become questionable, all personnel in the tunnel should report to the SFO Supervisory Personnel or the

PIC in their work area and follow the instructions provided.

7.0 TCO PERSONNEL

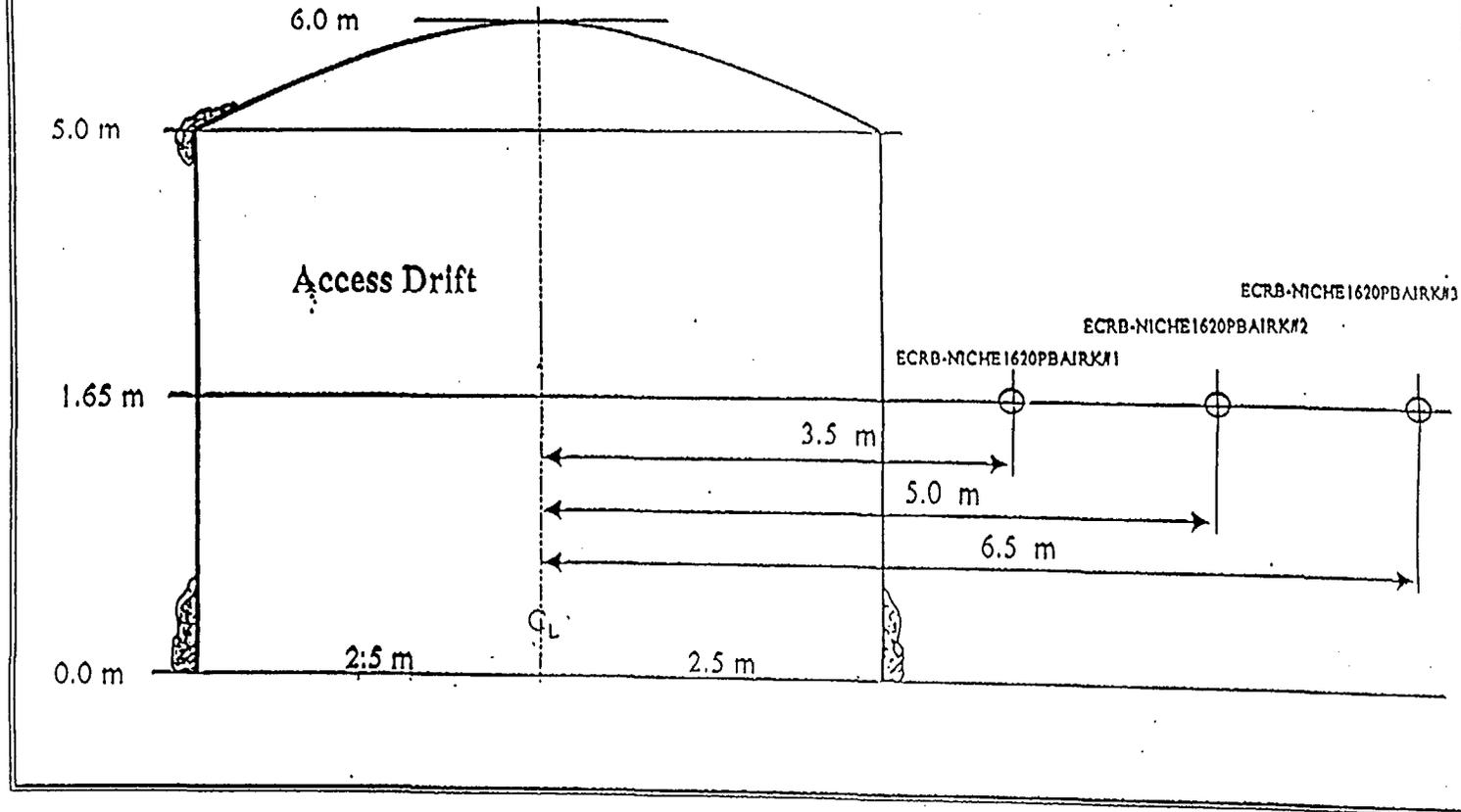
Some TCO Personnel carry hand held radios and are available on the surface through YMP NET #1.

7.1 TCO FIELD TEST COORDINATION PERSONNEL AND PHONE NUMBERS

Dick Kovach	FTM	295-6180
Kitty Longhouser	Secretary	295-3483
Gene Griego	FTR	295-1804
Joe Spoeneman	FTR	295-6189
Tom Brake	FTR	295-1804
John Dinsmoor	FTR	295-3727
Mike Taylor	ES&H Specialist	295-3647
	Beeper -	794-6676

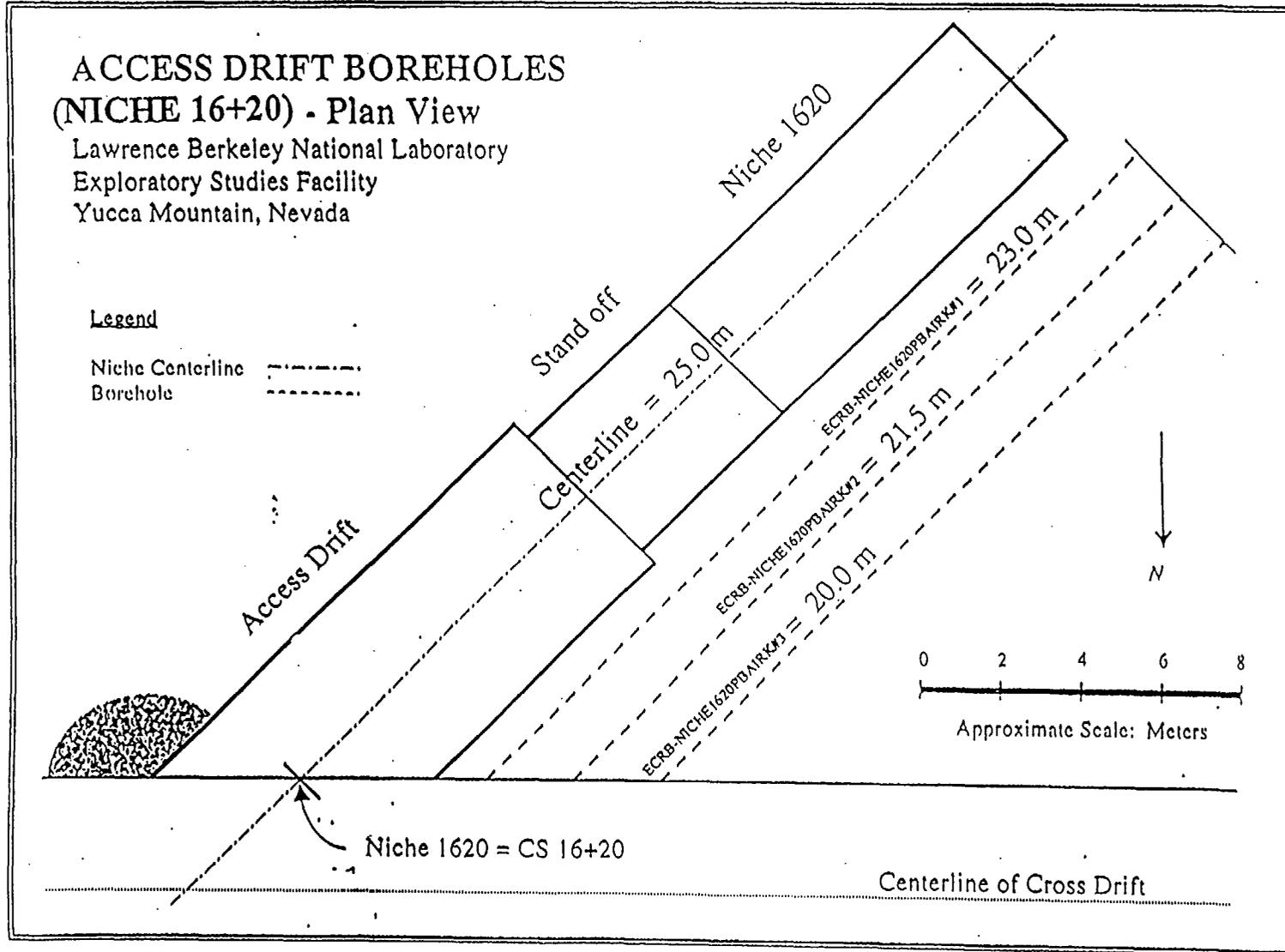
FIGURE 3

ACCESS DRIFT BOREHOLES (NICHE 16+20) - End View
Lawrence Berkeley National Laboratory
Exploratory Studies Facility
Yucca Mountain, Nevada



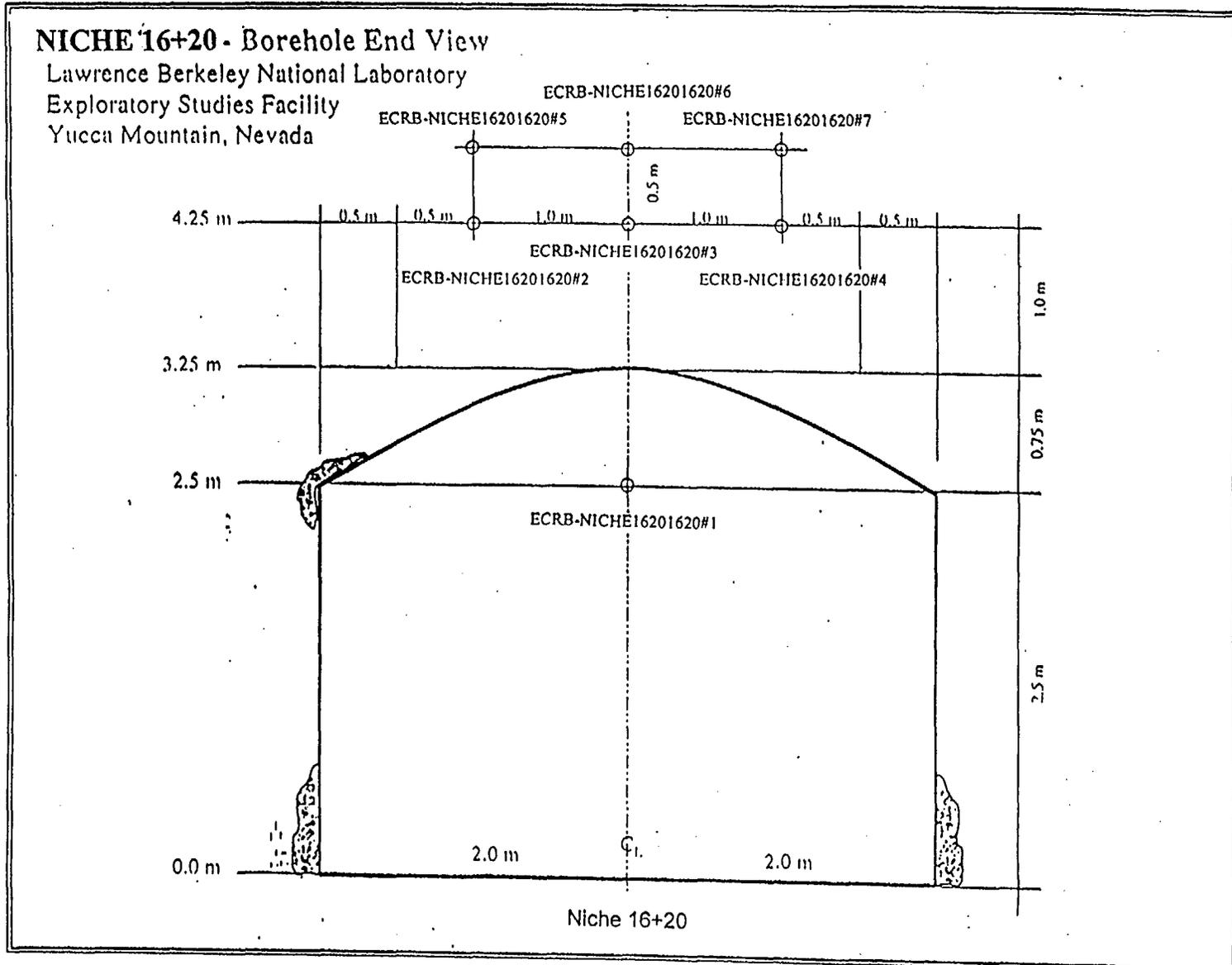
Access Drift Boreholes (Niche 1620) - End View Figure 3

FIGURE 4



Access Drift Boreholes (Niche 1620) - Plan View Figure 4

FIGURE 5



Niche 16+20 - Borehole End View Figure 5

Plan View - Niche 16+20 Layout of Pre-Niche Boreholes Figure 6

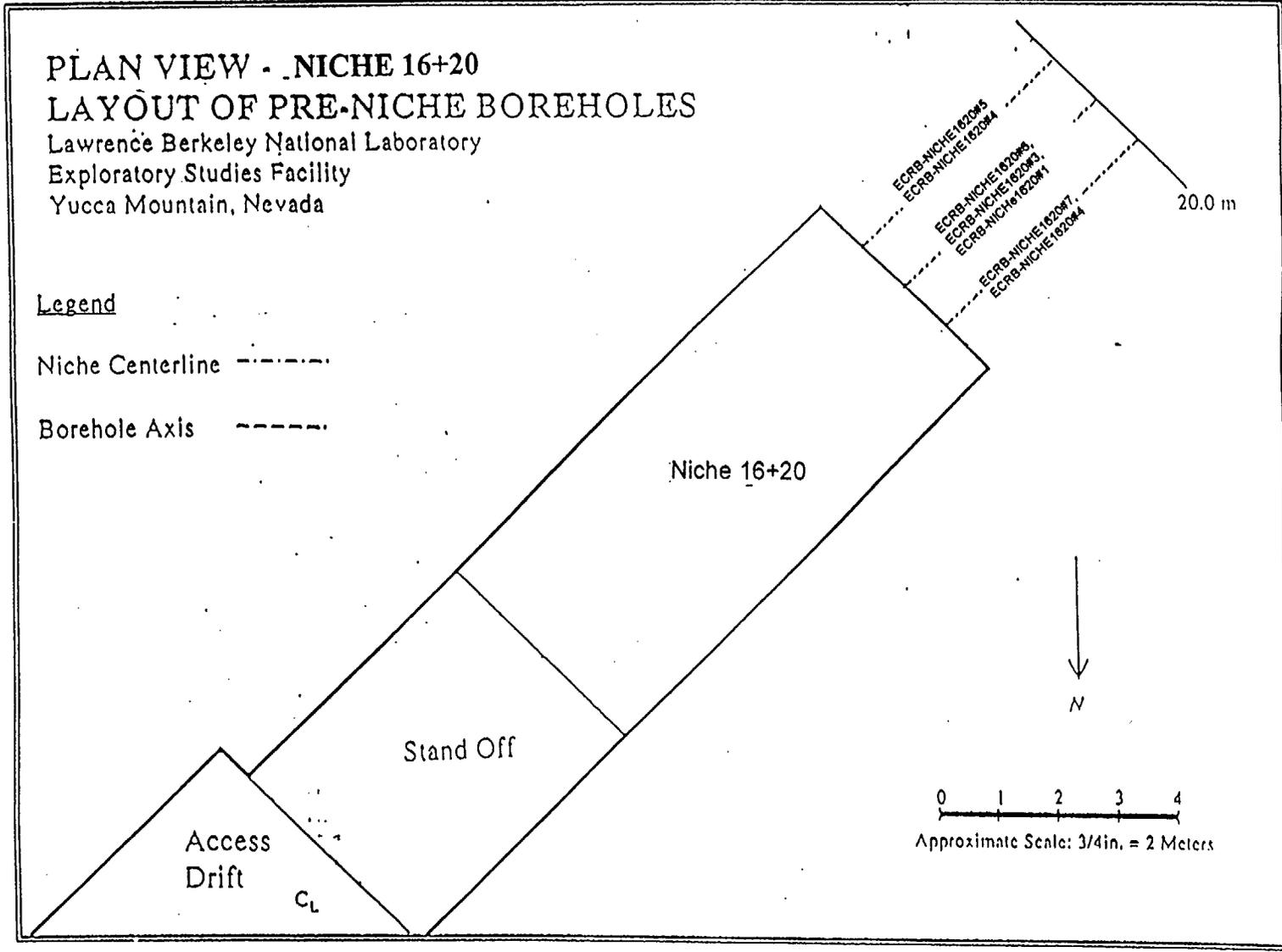


FIGURE 6

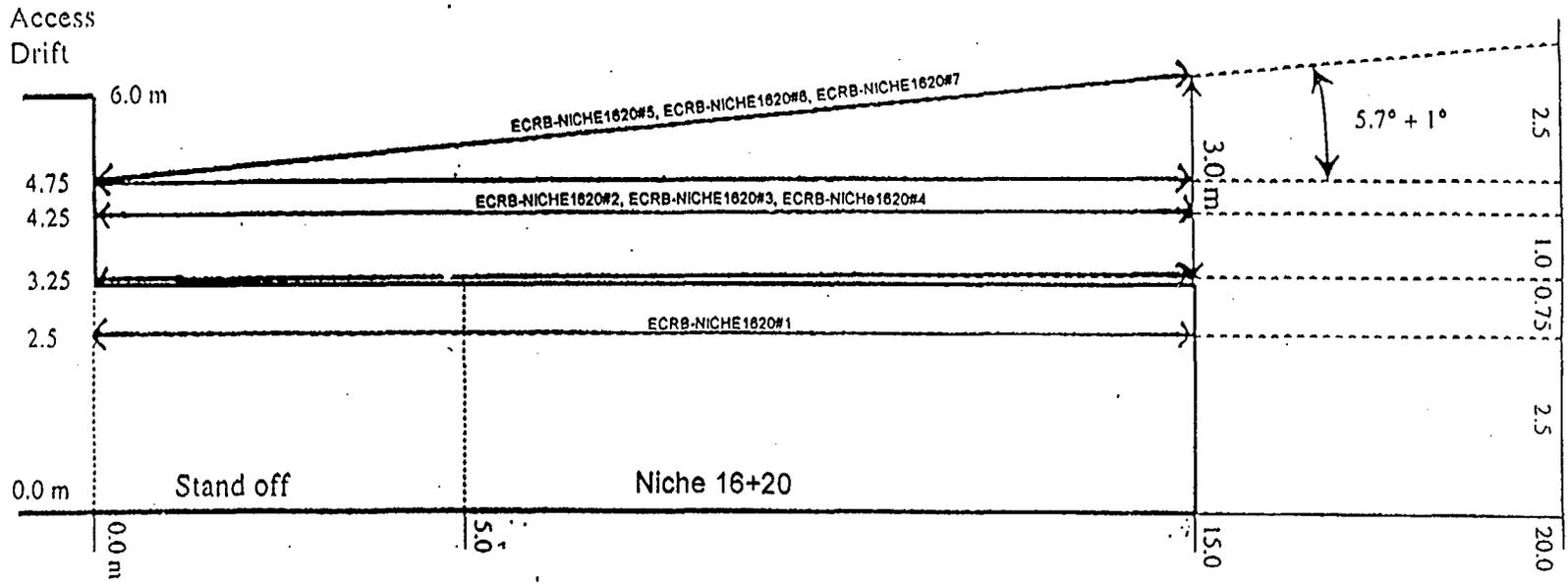
FIGURE 7

SIDE VIEW - NICHE 16+20
LAYOUT OF PRE-NICHE BOREHOLES

Lawrence Berkeley National Laboratory
 Exploratory Studies Facility
 Yucca Mountain, Nevada

Legend

Borehole Axis -----



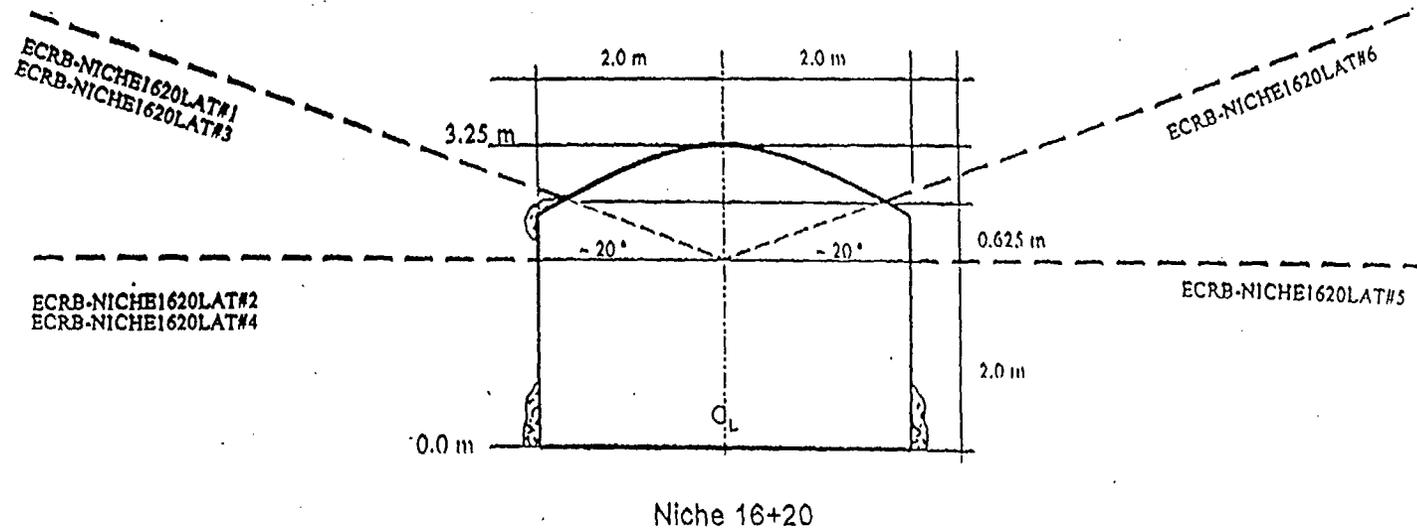
Side View - Niche 16+20 Layout of Pre-Niche Boreholes Figure 7

FIGURE 8

POST-NICHE16+20 CONSTRUCTION RADIAL BOREHOLES - END VIEW

Lawrence Berkeley National Laboratory
Exploratory Studies Facility
Yucca Mountain, Nevada

Note: A total of six boreholes will be drilled into the Left Rib (LR) and Right Rib (RR) of Niche 1620 as shown on the Plan View of Figure 9. Three of the 7.0-meter long boreholes (LR-B-1, LR-B-2, and RR-B) will be drilled along a near-horizontal plane located approximately 2.0 meters above the invert as shown in the diagram below. The remaining holes should be sloped upward about 20 degrees with a collar elevation of approximately 2.625 meters above the invert.



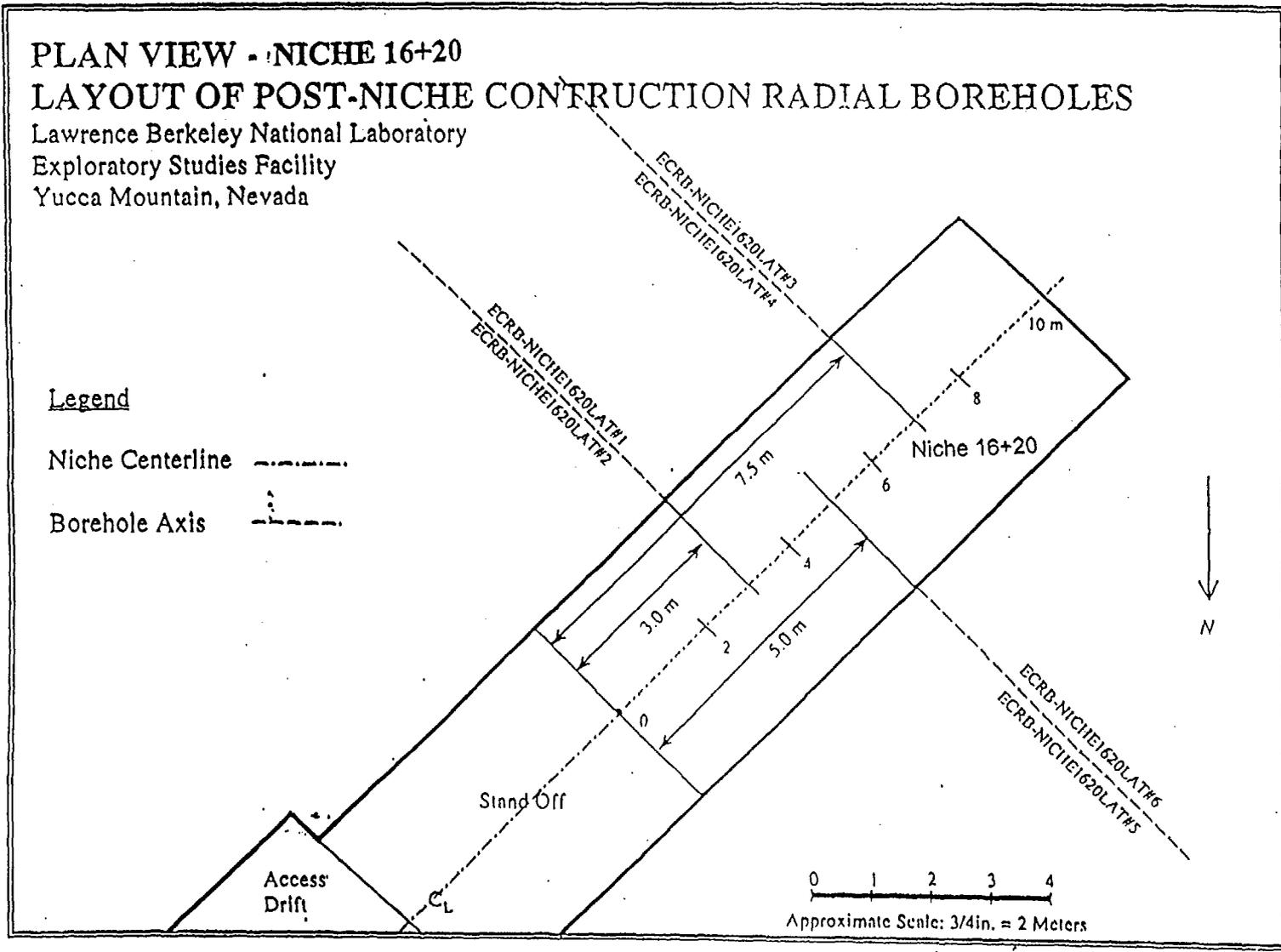
Post-Niche 16+20 Construction Radial Boreholes - End View Figure 8

FWP-ESF-96-004, R5
MOISTURE STUDIES IN THE ESF

Attachment 10
Page 1 of 1
QA:NA

FIGURE 9

Plan View - Niche 16+20 Layout of Post-Niche Construction Radial Boreholes Figure 9



Maximum Tracer Concentrations and Quantities

Alcove 1		
Tracer	Maximum Quantity (grams or liters)	Maximum Concentration (ppm)
Calcium Bromide	151.4 kg	500
Calcium Iodide	3.0 kg	10
Lithium Bromide	151.4 kg	600
Sodium Chloride	605.6 kg	2,000
Magnesium Fluoride	26.3 kg	87
Sodium Iodide	3.0 kg	10
Fluorescein	0.3 kg	1
Pyranine	0.3 kg	1
Rhodamine WT	0.3 kg	1
FD&C Blue No. 1	6.1 kg	20
Alcove 4		
Tracer	Maximum Quantity (grams or liters)	Maximum Concentration (ppm)
Sodium Chloride	60 g	3,000
Lithium Bromide	4,000 g	2,000
2,4,6-Trifluorobenzoic Acid	0.5 g	20
2,3,4-Trifluorobenzoic Acid	0.5 g	20
2,3,6-Trifluorobenzoic Acid	0.5 g	20
2,3,4,5-Tetrafluorobenzoic Acid	0.5 g	20
2,3,5,6-Tetrafluorobenzoic Acid	0.5 g	20
2,4,5-Trifluorobenzoic Acid	0.5 g	20
3,4,5-Trifluorobenzoic Acid	0.5 g	20
2,3-Difluorobenzoic Acid	0.5 g	20
2,4-Difluorobenzoic Acid	0.5 g	20
2,5-Difluorobenzoic Acid	0.5 g	20
2,6-Difluorobenzoic Acid	0.5 g	20
3,4-Difluorobenzoic Acid	0.5 g	20
3,5-Difluorobenzoic Acid	0.5 g	20
Pentafluorobenzoic Acid	0.5 g	20
Fluorescein	4 g	4,000
Acid Yellow #7 (Lissamine FF)	4 g	4,000
Pyranine	240 g	4,000
Amino G Acid	4 g	4,000
Rhodamine B	4 g	900
Rhodamine WT	420 g	4,000
Sulforhodamine B	4 g	4,000
FD&C Blue No. 1	516 g	10,000
FD&C Red No. 40	50 g	10,000
FD&C Yellow No. 5	50 g	10,000
FD&C Yellow No. 6	50 g	10,000
Sodium Tungstate Dihydrate	50 g	5,000

Sodium Molybdate Dihydrate	50 g	5,000
Sodium Fluoride	50 g	5,000
Potassium Fluoride	50 g	5,000
Magnesium Fluoride	50 g	5,000
Helium	1,440 L	1,000
Neon	1,440 L	1,000
Krypton	1,440 L	1,000
Xenon	1,440 L	1,000
Argon	1,440 L	1,000
Magnesium Iodide	50 g	5,000
Sodium Iodide	50 g	5,000
Sodium Bromide	50 g	5,000
Potassium Iodide	50 g	5,000
Potassium Bromide	50 g	5,000
Alcove 6		
Tracer	Maximum Quantity (grams or liters)	Maximum Concentration (ppm)
Sodium Chloride	60 g	3,000
Lithium Bromide	4,000 g	2,000
2,4,6-Trifluorobenzoic Acid	0.5 g	20
2,3,4-Trifluorobenzoic Acid	0.5 g	20
2,3,6-Trifluorobenzoic Acid	0.5 g	20
2,3,4,5-Tetrafluorobenzoic Acid	0.5 g	20
Sulfur Hexafluoride	0.5 cubic meters	104,000
Helium	0.5 cubic meters	104,000
2,3,5,6-Tetrafluorobenzoic Acid	0.5 g	20
2,4,5-Trifluorobenzoic Acid	0.5 g	20
3,4,5-Trifluorobenzoic Acid	0.5 g	20
2,3-Difluorobenzoic Acid	0.5 g	20
2,4-Difluorobenzoic Acid	0.5 g	20
2,5-Difluorobenzoic Acid	0.5 g	20
2,6-Difluorobenzoic Acid	0.5 g	20
3,4-Difluorobenzoic Acid	0.5 g	20
3,5-Difluorobenzoic Acid	0.5 g	20
Pentafluorobenzoic Acid	0.5 g	20
Fluorescein	64 g	4,000
Acid Yellow #7 (Lissamine FF)	64 g	4,000
Pyranine	240 g	4,000
Amino G Acid	64 g	4,000
Rhodamine B	64 g	900
Rhodamine WT	420 g	4,000
Sulforhodamine B	64 g	4,000
FD&C Blue No. 1	816 g	10,000
FD&C Red No. 40	160 g	10,000
FD&C Yellow No. 5	160 g	10,000
FD&C Yellow No. 6	160 g	10,000
Sodium Tungstate Dihydrate	80 g	5,000
Sodium Molybdate Dihydrate	80 g	5,000
Sodium Fluoride	80 g	5,000
Potassium Fluoride	80 g	5,000

Magnesium Fluoride	80 g	5,000
Helium	1,440 L	1,000
Neon	1,440 L	1,000
Krypton	1,440 L	1,000
Xenon	1,440 L	1,000
Argon	1,440 L	1,000
Magnesium Iodide	80 g	5,000
Sodium Iodide	80 g	5,000
Sodium Bromide	80 g	5,000
Potassium Iodide	80 g	5,000
Potassium Bromide	80 g	5,000
Alcove 8		
Tracer	Maximum Quantity (grams or liters)*	Maximum Concentration (ppm)
Calcium Bromide	140 g*	500
Calcium Iodide	2 g*	10
Lithium Bromide	140 *g	600
Sodium Chloride	550 g*	2000
Magnesium Fluoride	20 g*	87
Sodium Iodide	2 g*	10
Fluorescein	0.2 g*	1
Pyranine	0.2 g*	1
Rhodamine WT	0.2 g*	1

Niche #1		
Tracer	Maximum Quantity (grams or liters)	Maximum Concentration (ppm)
Sulfur Hexafluoride and Noble Gases (Helium, Neon, Krypton, Xenon, Argon)	Total of all Noble gases and SF6 not to exceed 1,000 L per tracer	1,000
Fluorescein	14 L**	2,000
Pyranine	14 L**	2,000
Acid Yellow #7 (Lissamine FF)	14 L**	2,000
Rhodamine WT	14 L**	2,000
Rhodamine B	14 L**	2,000
Sulforhodamine B	14 L**	2,000
FD&C Blue #1	14 L**	10,000
FD&C Red #40	14 L**	10,000
FD&C Yellow #5	14 L**	10,000
FD&C Yellow #6	14 L**	10,000
LiBr Water (tracer make-up water)	NA	30
Amino G Acid	14L**	2,000

Niche #2		
Tracer	Maximum Quantity (grams or liters)	Maximum Concentration (ppm)
Sulfur Hexafluoride and Noble Gases (Helium, Neon, Krypton, Xenon, Argon)	Total of all Noble gases and SF6 not to exceed 1,000 L per tracer	1,000
Fluorescein	84 L**	2,000
Pyranine	84 L**	2,000
Acid Yellow #7 (Lissamine FF)	84 L**	2,000
Rhodamine WT	84 L**	2,000
Rhodamine B	84 L**	2,000
Sulforhodamine B	42 L**	2,000
FD&C Blue #1	42 L**	10,000
FD&C Red #40	42 L**	10,000
FD&C Yellow #5	42 L**	10,000
FD&C Yellow #6	42 L**	10,000
2,3-Difluorobenzoic Acid	0.4 g	20
Pentafluorobenzoic Acid	0.4 g	20
Sodium Iodide	100 g	5,000
Calcium Bromide	100 g	5,000
Calcium Iodide	100 g	5,000
LiBr Water (tracer make-up water)	NA	30
Amino G Acid	84 L**	2,000
Niches 3 & 4		
Tracer	Maximum Quantity (grams or liters)	Maximum Concentration (ppm)
Nitrogen	20 L	20
SUVA Cold-MP	20 L	20
Sulfur Hexafluoride	1,000 L	1,000
Helium	1,000 L	1,000
Neon	1,000 L	1,000
Krypton	1,000 L	1,000
Xenon	1,000 L	1,000
Argon	1,000 L	1,000
Sodium Chloride	60 g	3,000
Lithium Bromide	40 g	2,000
Fluorescent Polystyrene Microspheres	40 g	--
2,4,6-Trifluorobenzoic Acid	0.5 g	20
2,3,4-Trifluorobenzoic Acid	0.5 g	20
2,3,6-Trifluorobenzoic Acid	0.5 g	20
2,3,4,5-Tetrafluorobenzoic Acid	0.5 g	20
2,3,5,6-Tetrafluorobenzoic Acid	0.5 g	20

2,4,5-Trifluorobenzoic Acid	0.5 g	20
3,4,5-Trifluorobenzoic Acid	0.5 g	20
2,3-Difluorobenzoic Acid	0.5 g	20
2,4-Difluorobenzoic Acid	0.5 g	20
2,5-Difluorobenzoic Acid	0.5 g	20
2,6-Difluorobenzoic Acid	0.5 g	20
3,4-Difluorobenzoic Acid	0.5 g	20
3,5-Difluorobenzoic Acid	0.5 g	20
Pentafluorobenzoic Acid	0.5 g	20
Fluorescein	4 g	4,000
Acid Yellow #7 (Lissamine FF)	8 g	4,000
Pyranine	20 g	4,000
Amino G Acid	4 g	4,000
Rhodamine B	1 g	900
Rhodamine WT	4 g	4,000
Sulforhodamine B	48 g	4,000
FD&C Blue No. 1	300 g	10,000
FD&C Red No. 40	160 g	10,000
FD&C Yellow #5	50 g	10,000
FD&C Yellow #6	50 g	10,000
Sodium Tungstate Dihydrate	50 g	5,000
Sodium Molybdate Dihydrate	50 g	5,000
Sodium Fluoride	50 g	5,000
Potassium Fluoride	50 g	5,000
Magnesium Fluoride	50 g	5,000
Magnesium Iodide	50 g	5,000
Sodium Iodide	25 g	5,000
Sodium Bromide	50 g	5,000
Potassium Iodide	50 g	5,000
Potassium Bromide	50 g	5,000
Potato Starch (powdered)	500 g	--
Sodium Hypochlorite	100 g	1,000
LiBr Water (tracer make-up water)	NA	30

Niche #5		
Tracer	Maximum Quantity (grams or liters)	Maximum Concentration (ppm)*
Sodium Chloride	60 g	3,000*
Lithium Bromide	40 g	2,000*
Fluorescent Microspheres	40 g	--
Polystyrene Microspheres	40 g	--
Sulfur Hexafluoride (gas)	1,000 L	1,000*
Nitrogen	20 L	20*
SUVA Cold - MP	20 L	20*

2,4,6-Trifluorobenzoic Acid	0.5 g	20*
2,3,4-Trifluorobenzoic Acid	0.5 g	20*
2,3,6-Trifluorobenzoic Acid	0.5 g	20*
2,3,4,5-Tetrafluorobenzoic Acid	0.5 g	20*
2,3,5,6-Tetrafluorobenzoic Acid	0.5 g	20*
2,4,5-Trifluorobenzoic Acid	0.5 g	20*
3,4,5-Trifluorobenzoic Acid	0.5 g	20*
2,3-Difluorobenzoic Acid	0.5 g	20*
2,4-Difluorobenzoic Acid	0.5 g	20*
2,5-Difluorobenzoic Acid	0.5 g	20*
2,6-Difluorobenzoic Acid	0.5 g	20*
3,4-Difluorobenzoic Acid	0.5 g	20*
3,5-Difluorobenzoic Acid	0.5 g	20*
Pentafluorobenzoic Acid	0.5 g	20*
Fluorescein	16 g	4,000*
Acid Yellow #7 (Lissamine FF)	16 g	4,000*
Pyranine	20 g	4,000*
Amino G Acid	4 g	4,000*
Helium	1,000 L	1,000*
Neon	1,000 L	1,000*
Krypton	1,000 L	1,000*
Xenon	1,000 L	1,000*
Argon	1,000 L	1,000*
Rhodamine B	4 g	900*
Rhodamine WT	4 g	4,000*
Sulforhodamine B	48 g	4,000*
FD&C Blue No. 1	280 g	10,000*
FD&C Red No. 40	160 g	10,000*
FD&C Yellow No. 5	50 g	10,000*
FD&C Yellow No. 6	50 g	10,000*
Sodium Tungstate Dihydrate	50 g	5,000*
Sodium Molybdate Dihydrate	50 g	5,000*
Sodium Fluoride	50 g	5,000*
Potassium Fluoride	50 g	5,000*
Magnesium Fluoride	50 g	5,000*
Magnesium Iodide	50 g	5,000*
Sodium Iodide	25 g	5,000*
Sodium Bromide	50 g	5,000*
Potassium Iodide	50 g	5,000*
Potassium Bromide	50 g	5,000*
Calcium Iodide	100 g	5,000*
Calcium Bromide	100 g	5,000*
Sodium Hypochlorite	100 g	1,000*
Potato Starch (powdered)	500 g	--

ECRB Systematic Drilling		
Tracer	Maximum Quantity Injected (grams or liters)	Maximum Concentration (ppm or mg/L)*
FD&C Blue No. 1	10 g***	2 mg/L
FD&C Red No. 40	100 g***	20 mg/L
FD&C Yellow No. 5	100 g***	20 mg/L
FD&C Yellow No. 6	100 g***	20 mg/L
FD&C Acid Yellow No. 7	1 g***	0.2 mg/L
Fluorecein	0.05 g***	0.01 mg/L
Pyramine	0.3 g***	0.06 mg/L
Sulfur Hexafluoride	540,000 L***	1000 ppm
Xenon	540,000 L***	1000 ppm
Neon	540,000 L***	1000 ppm
Krypton	540,000 L***	1000 ppm
2,4,6-Trifluorobenzoic Acid	100 g***	20 mg/L
2,3,4-Trifluorobenzoic Acid	100 g***	20 mg/L
2,3,5-Trifluorobenzoic Acid	100 g***	20 mg/L
2,3,4,5-Tetrafluorobenzoic Acid	100 g***	20 mg/L
2,3,5,6-Tetrafluorobenzoic Acid	100 g***	20 mg/L
2,3-Difluorobenzoic Acid	100 g***	20 mg/L
2,4-Difluorobenzoic Acid	100 g***	20 mg/L
2,5-Difluorobenzoic Acid	100 g***	20 mg/L
2,6-Difluorobenzoic Acid	100 g***	20 mg/L
3,4-Difluorobenzoic Acid	100 g***	20 mg/L
3,5-Difluorobenzoic Acid	100 g***	20 mg/L
Pentafluorobenzoic Acid	100 g***	20 mg/L
Sodium Iodide	25 g***	5 mg/L
Lithium Bromide	5000 g***	1000 mg/L
Sodium Chloride	2000 g***	400 mg/L
Sulforhodamine B	0.1 g***	0.02 mg/L
Amino G Acid	2 g***	0.4 mg/L

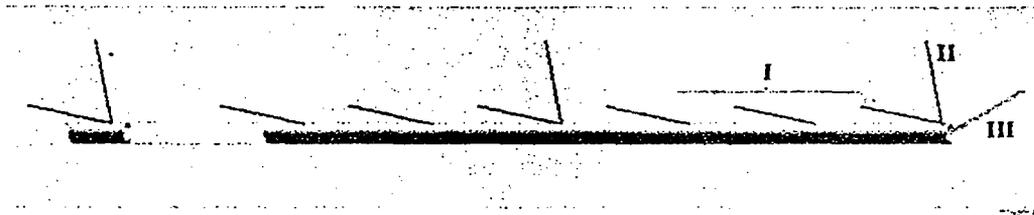
* The quantity of tracers (in excess of the 20+/-10 ppm of LiBr allowed for tracing of construction water) applied with the Alcove #8 water injection testing water shall not exceed the following limits without further SAD evaluation: Total quantity of halogenated salts (excluding LiBr and Fluorine) shall not exceed 2 g/m² of injection test area; total quantity of committed Fluorine shall not exceed 1 g/m² of injection test area; and total quantity of committed organics shall not exceed 0.3 g/m² of injection test area

** The maximum volumes of dyed water in Niches 1# & #2 testing activities shall not exceed 42 liters (11.1 gallons) for food color dyes and 84 liters (22.2 gallons) for fluorescent dyes.

*** Tracers and water loss (i.e., not subsequently recovered) during ECRB Systematic Drilling boreholes shall not exceed the following quantities, as averaged over the 10 m section of the ECRB Cross Drift in which they are released, without further evaluation by the SAD: The emplaced quantity of fluorinated tracers shall not exceed 7.6 grams per meter; the emplaced quantity of non-fluorine, halogenated salt tracers shall not exceed 16 grams per meter; the emplaced quantity of non-fluorescent, organic tracers shall not exceed 2.9 grams per meter; and the concentration of fluorescent tracers used shall not exceed 1 ppm (i.e, 0.001 gram per liter).

BOREHOLE LAYOUT OF SYSTEMATIC CHARACTERIZATION OF TOPOPAH SPRING LOWER LITHOPHYSAL UNIT

Three Categories of ~20 meter long boreholes for
performing air permeability, liquid seepage and gas tracer tests



- I One low angle (~15° from drift axis), every 30 meters along ECRB Cross Drift
- II One near vertical (~75° from drift axis), every 90 meters along Cross Drift
- III One horizontal pair (2 to 3 meter separation) collared on rib, every 90 meters along Cross Drift

Figure 1 Borehole configuration for systematic characterization of the East-West Cross Drift from station 14+44 m to 17+63 m.

CLOSE UP VIEW OF THREE CATEGORIES OF SYSTEMATIC BOREHOLES

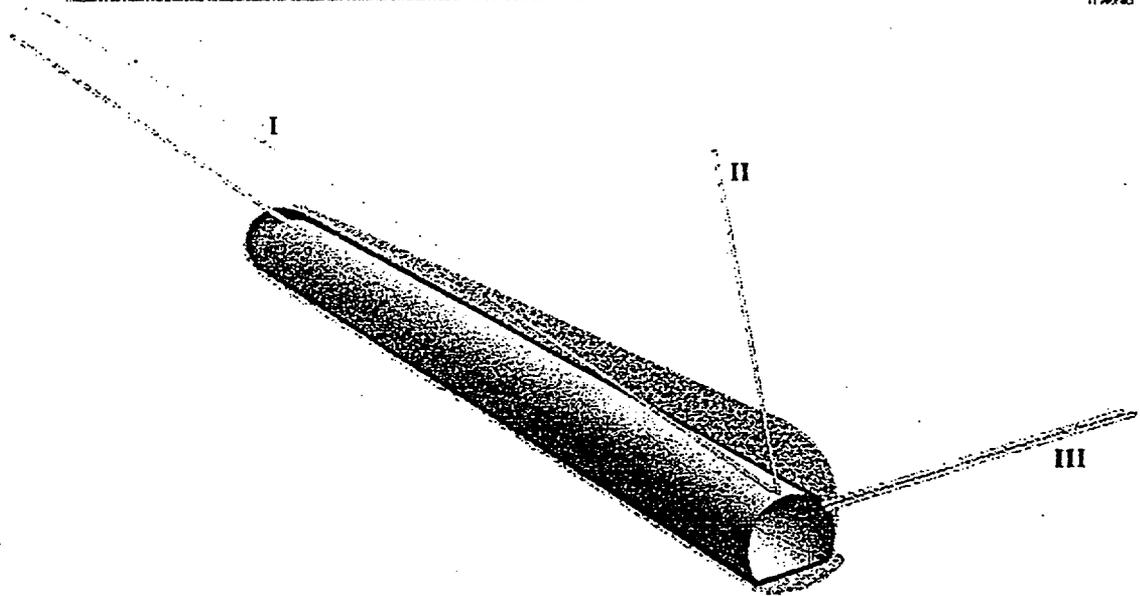
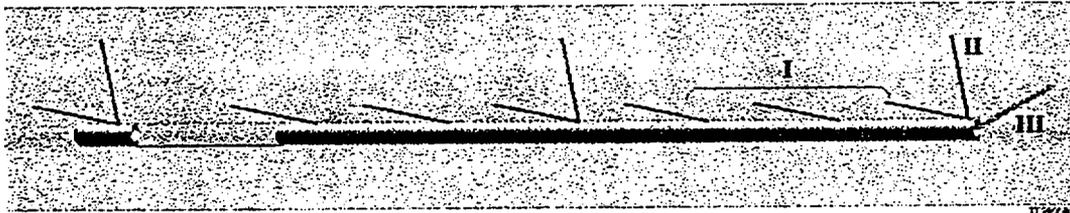


Figure 2 A close-up view of three categories of boreholes between stations 14+44 and 17+63 in the Cross Drift for systematic characterization of flow and transport properties of the lower lithophysal unit.

WORK INSTRUCTION OUTLINE (QA:N/A)

The following is a generic administrative outline used to integrate the controls established in the ES&H review and produce a Work Instruction specific to testing work elements.

1. General Information
 - Work Instruction Number
 - Title
 - Start and End Dates
 - Work Type
 - Location of Work
 - Planner
 - Requestor
 - Person In Charge
 - Work Package, Job, and Charge Numbers
- I. Review and Approval
- II. Risk Assessment Code (RAC)
 - ES&H Severity Category
 - Probability Category
- III. Work Scope
 - Requirements Source
 - Person In Charge
 - Equipment Requirements
 - Materials
 - Quantities
 - Work Location
 - Attachments
- IV. Hazard Identification and Mitigations
- V. Emphasis on Working Within Controls
 - Qualification and Training Requirements List
- VII. Task Steps
 - Work Instruction Acceptance Criteria
- VIII. Feedback and Comments
 - Completion Signatures