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EFFECTIVE DATE IS
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.UCLEAR WASTE MANAGEMENT PROGRAM

CONTROLLED COPY NO. 83

No.:	033-NNWSI-P 11.19
Revision:	0
Date:	February 25, 1988
Page:	1 of 10

Subject:	Approved:
(See Below)	(See Page 2)

TECHNICAL PROCEDURE

Air Permeability Measurements

8808310012 880826
PDR WASTE
WM-11 PDC

102.7
WM-11
NH03

ROUTING AND TRANSMITTAL SLIP

Date 8/26/88

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2. J. Blanton P137		
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8-18-88
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J. Kennedy (Name)	John Dronkers (Name)
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ITEM	REV.	DATE
033-NNWSI-P 11.19 Air Permeability Measurements	0	2/25/88
033-NNWSI-P 11.22 Operation of the Data Acquistion System	0	5/24/88

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INSTRUCTIONS/REMARKS

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102.7

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(See Below)	(See Page 2)

TECHNICAL PROCEDURE

Air Permeability Measurements

8808310012

NNØ31
102.7
WM-11

LL 5497 (Rev. 11/86)

Originated by: Kenrick H. Lee 7/22/88
Kenrick H. Lee Date

Reviewed by: Dale G. Wilder 7/21/88
Dale G. Wilder Date
Key Reviewer

Reviewed by: John J. Bronkers 7/29/88
John J. Bronkers Date
Deputy Project Leader
for Quality Assurance

Reviewed by: David W. Short 8/4/88
David W. Short Date
Deputy Project Leader
for NNWSI Project

11.19.1 PURPOSE

This procedure describes the testing program for in situ air permeability measurements in welded tuff, as discussed in 033-NNWSI-P 11.10 "Test Plan: Prototype Engineered Barrier Design Testing". The procedure covers all field and laboratory work related to in situ air permeability measurements performed in support of "Prototype Engineered Barrier Design Testing" - WBS 1.2.6.9.4.5. This procedure supports activity S-20-1, "Evaluate Test Components in Support of Component Selection". The intended use of this procedure is to evaluate its adequacy as applied to field practices and to revise it as needed. The purpose of the final field-tested procedure is to provide guidelines so that other equally trained and qualified personnel can understand how the work is performed or how to repeat the work if necessary. For both this initial procedure and the final version, the work will be documented by the use of scientific notebooks as discussed in 033-NWMP-R 11.0 Rev. 1. (revision pending). The field validated procedure will provide a set of guidelines which the scientist will take into account in conducting the measurement. The scientist is allowed the flexibility of making changes to this procedure if the changes made are approved and documented as described in the "Records" section. The use of the term procedure does not imply that this is repetitive work that does not require professional judgement.

11.19.2 SCOPE

This procedure applies to all field and laboratory work related to in situ air permeability measurements performed in support of "Prototype Engineered Barrier Design Testing" WBS 1.2.6.9.4.5. Changes to this procedure are allowed. Any changes are recorded in the test logbook and on the procedure itself. The recording and authorization for these changes are described in the "Records" section of this procedure.

11.19.3 RESPONSIBILITIES

The Task Leader for "In Situ Engineered Barrier Design Testing" is responsible for assuring that this procedure is used. The Task Leader is also responsible for assuring that any changes to this procedure are reviewed and incorporated into the next revision.

11.19.4 SUMMARY

Air permeability measurements will be made along sections of the heater emplacement borehole. Thermal effects on the rock permeability will be observed by conducting tests prior to heating, and then repeating the tests immediately after the heater is deenergized and removed from the borehole. During the post-heating series of tests, temperatures of the cooling rock are expected to remain a number of degrees above the ambient value.

The testing method requires injection of compressed air into the fractured tuff, through the heater emplacement borehole, and measurement of the air flow rates and borehole pressures. Measurements will be conducted under steady state conditions to facilitate easy interpretation of the test data. However, some transient state data will be collected for use in the design of future experiments. Permeability will be computed from the steady state injection pressure and flow rate. Through the use of inflatable packers, preselected sections of the borehole will be isolated and tested to obtain permeability values at different locations.

The permeability of the rock mass is believed to be dominated by fractures, therefore many of the field measurements will be used to determine permeabilities and equivalent hydraulic apertures of fractures intersecting the test zones. Apertures will be computed assuming validity of the cubic law for gas flow through natural fractures. A test zone length of about 46 cm (1.5 ft) will be tested so as to minimize the number of discrete fractures intersecting the zone. Before making the first series of permeability measurements, fracture locations and orientations will be estimated from borescope or borehole television surveys conducted in the borehole. Longer sections of the borehole will also be tested to measure bulk permeability values.

A downhole straddle packer assembly, coupled to a compressed air flow and monitoring system located in the rock mechanics incline, will be used to inject air into sections of the borehole (Figure 1). Air will be supplied from the G-Tunnel compressed air line at a pressure of up to 862 kPa (125 psi). The packer assembly, comprising three pneumatic packers, will isolate three borehole zones, including the zone behind the deepest packer (the lower zone). The zones straddled by the packers are referred to as the upper zone (between the central packer and the packer nearest the borehole collar) and the central zone, and will each have a fixed length of about 46 cm (1.5 ft). The length of the lower zone will vary as the assembly is relocated within the borehole. A pressure transducer and a thermocouple will measure the pressure and temperature in each zone. Only the central and lower zones will be directly pressurized. When a test zone is pressurized the remaining two zones will serve as observation zones in which pressure and temperature changes are also measured. Pressures and temperatures monitored in observation zones may give additional information on fracture orientation, or warn of air leakage around the packer assembly.

Permeability measurements will commence with the deepest packer positioned at the back end of the borehole, and all three packers inflated. The central zone will be tested, followed by the lower zone, before the assembly is withdrawn a distance of about 20 to 40 cm (7.9 to 15.7 in.) and the central and lower zones tested again. This sequence will be repeated until the entire borehole length behind the "shear zone" is completed. Steady state injection pressures will be limited to a maximum value of about 207 kPa (30 psi), so as to minimize the effects of fracture deformation and turbulence. At higher pressures, fracture deformation and turbulence can cause significant data interpretation concerns.

In an attempt to observe the effect of injection pressure on measured air permeability values, borehole sections will be tested at up to six different steady state pressures. In addition to fracture deformation and turbulence, changes (or apparent changes) in air permeability with pressure may be caused by leakage around packers or through connections, Klinkenberg slip effects, or increased moisture displacement at higher pressures. Injection testing at different pressures will permit identification of some of these effects so that appropriate adjustments can be made in the data analysis.

Air temperatures and pressures in the borehole and manifold will be recorded by a computerized Data Acquisition System (DAS). Pressures will also be displayed on gages located outside of the borehole collar. Air flow rates will be recorded manually.

11.19.5 APPARATUS

The measurement apparatus will consist of a downhole straddle packer assembly, comprising three pneumatic packers, coupled to a compressed air flow and monitoring system located in the rock mechanics incline. A schematic of the equipment is shown in Figure 1.

Compressed air supplied from the G-Tunnel line will travel through a filter and a pressure regulator before entering a three-branch manifold, with each branch containing a flow meter capable of measuring a different range of flowrate. The manifold will be capable of supplying controlled flows in the range of 0.5 to 600 SLM (0.02 to 21 SCFM). If necessary, the upper flow limit may be extended to about 2800 SLM (100 SCFM) by simply changing to a higher capacity flow meter in one of the branches. In addition to the flow meters, the manifold will contain flow and pressure regulating devices for control of the test zone pressure. To determine the mass flow rate of a highly compressible fluid such as air, the thermodynamic character of the fluid expansion must be considered. The temperature and pressure of air leaving the manifold will therefore be measured by an in-line thermocouple and pressure transducer. Manifold and borehole pressures will be displayed on pressure gages and recorded by the DAS. All temperatures measured will also be recorded by the DAS. Flow meters will be read manually and the data entered into the logbook.

The packer assembly will be fitted to a 51-mm (2-in) I.D. aluminum pipe, supplied in 2.4-m (8-ft) lengths. Each packer will have a seal length of 48 cm (18 in). A longer packer would have offered better sealing against leakage by providing a larger contact area between the wall and packer, and by increasing the length of any flow paths around the packer through interconnecting joints. However, the packer lengths were limited to 48 cm so as to minimize the weight of the assembly for handling in the emplacement borehole, while still providing an adequate seal. Air will be injected into the lower and central borehole zones through separate 2.54-cm (1-in) lines. A single 6.35-mm (1/4 in) line will be used to inflate all three packers with nitrogen supplied from bottles. Each of the three borehole zones will be fitted with a Type E thermocouple for temperature measurement.

Zone pressures will be transmitted to three pressure transducers, located outside of the borehole collar, through plastic tubing. Placing the transducers outside of the borehole is expected to delay transmission of the pressure by only a few tens of milliseconds. Therefore, this delay will not affect the results for steady state testing.

An air tugger winch, driven by compressed air, will be used for packer assembly installation and relocation within the borehole. The winch will be positioned in the incline, close to the borehole collar, and operated with a pulley system attached to rock bolts. The winch rope will be tied to the length of aluminum pipe protruding from the borehole. This system for installing and repositioning the packer assembly will be selected by REECo or F&S in consultation with LLNL representatives.

Permeability test instrumentation and equipment are listed in Table 1.

11.19.6 CALIBRATION

Flow meters, Pressure transducers, and thermocouples will be calibrated in the laboratory prior to field application. Flow meters will be calibrated and certified to NBS traceability by the manufacturer, Brooks Instrument Division. Pressure transducers and thermocouples will be calibrated in the Instrument Calibration Laboratory of the Mechanical Engineering Department at LLNL. The calibration procedures and results will be documented in memoranda prepared by the Instrument Calibration Laboratory.

11.19.7 TEST PROCEDURE

The following procedures will be followed for each series of permeability tests:

a) The borehole is cleaned by using compressed air to remove rock fragments. To avoid the possibility of injury from rock projectiles, personnel will not stand directly in front of the borehole during cleaning.

b) The packer assembly is pushed to the back of the borehole and restrained (by tying to the rock bolts), then all three packers inflated to a pressure of about 690 kPa (100 psi), effectively isolating three borehole zones. The distance from the collar to the outer packer is recorded in the logbook.

c) The DAS is turned on to record borehole and manifold temperatures and pressures about one minute before flow is opened into the central borehole zone. Note that temperatures and pressures are monitored in all three borehole zones. Flow rates are manually recorded at about one-minute intervals. A flow rate is selected to give a stable test zone pressure between 14 and 207 kPa (2 and 30 psi). Air injection must continue until no fluctuation in either pressure or flow rate is observed for a period of at least 10 minutes.

d) Once the steady-state flow rate and pressure are established, the flow valve is shut off while the DAS continues to record borehole pressures and temperatures as the zone pressures decay. The DAS is turned off when zone pressures and temperatures return to ambient values.

e) Steps (c) and (d) are repeated, up to five times, using different zone pressures within the range 14 to 207 kPa.

f) The tests are repeated (steps (c) through (e)), except air is now injected into the lower zone instead of the central zone.

g) The packers are deflated and the assembly withdrawn a distance of 20 to 40 cm (7.9 to 15.7 in.). Tests on the central and lower borehole zones are now performed at the new assembly location. This cycle of testing in the central and lower zones, deflating and withdrawing the packer assembly to a new location then testing again, is repeated until the entire length of borehole behind the shear zone (about 4.5 m) is completed.

Each of the two series of tests, before heating and following the heating cycle, is expected to take about seven to ten days.

11.19.8 SAFETY

There are potential hazards associated with the use of compressed air in permeability testing. A packer blowout can cause dangerous rifling of the tubing and packer hardware out of the borehole. A "whipping line" can also present a safety hazard.

Although the packer inflation pressure will be limited to a maximum of only 690 kPa (100 psi), precautionary measures will be taken to protect personnel from the hazards associated with compressed gases. Prior to bladder inflation, the packer assembly will be restrained to prevent rifling in the event of a packer blowout. This will be achieved by tying the aluminum center pipe to rock bolts anchored adjacent to the borehole collar. In the 30.5-cm (12-in) diameter borehole, a packer blowout at 690 kPa will generate a maximum force of about 50 kN (11,300 lb). The restraining system will be designed by REECo or F&S to take this maximum load, using a factor of safety of at least 1.5. The packer assembly will always be secured before the packers are inflated, and will only be untied for packer relocation. To prevent whipping line accidents, the hose conducting pressurized air will be carefully secured to the rock surface using rock bolts. Moreover, a short chain will be attached across a coupling where the pressurized hose is joined to another line. This will prevent whipping if the coupling separates.

11.19.9 RECORDS

Borehole and manifold pressures and temperatures will be recorded by the DAS while air flow rates will be recorded manually in a logbook. The logbook data will also include the location of each test zone, measured from the borehole collar. The records will identify the time, date, and persons conducting the measurements. The annotated procedure itself will be a record. The permeability test data, recorded in the logbook and by the DAS, will be archived in the Records Management System (RMS) of the Nuclear Waste Management Project.

The process to change a procedure is dependent upon the section of the procedure which has to be changed. Changes to procedure sections titled: "PURPOSE", "SCOPE", "RESPONSIBILITIES", "RECORDS", "PERSONNEL QUALIFICATIONS", and "SAFETY" are described using carbon copy memorandum forms. The review and approval process for these changes begins when the initiator of the changes writes the proposed changes on the memorandum form. The memorandum identifies the initiator of the proposed changes. The Principal Investigator responsible for the activity will review the proposed change and authorize it by signing the memorandum. The original sheet of the form will be attached to the field copy of the technical procedure and a notation made on the margin of the procedure referring the reader to the memorandum. One of the carbon copies will be pasted in the scientific notebook and the third copy will be returned to the Subtask Leader and filed.

Documentation of the methods or procedure used to perform the test/activity will be provided by the Scientific Notebook approach. In contrast to the requirement for documentation of changes to other sections of this procedure, there is no requirement to note deviations from the approach in those sections of this procedure that address methods or procedures only. Rather the documentation will be provided in the Scientific Notebook in accordance with 033-NWMP-R 11.0, Revision 1 (approval pending.) As such, deviations from the suggested or typical judgement of the scientist responsible for this activity. Revised procedures will then be prepared upon completion of the test using the original technical procedures, changes specified in the scientific notebook in accordance with revision procedures outlined in Section 8.2.

11.19.10 PERSONNEL QUALIFICATIONS

This procedure will be carried out by a hydrologist, or someone with equivalent training and background.

Table I. Equipment and Instrumentation for Air Permeability Measurements

Item	Quantity	Remarks
Straddle packer system (components a. through c.)	1	
a. High temperature packer with radiation guard, 11 in. O.D.	1	Also used for moisture collection
b. Nitrile packer, 11 in. O.D.	2	
c. 8 ft. aluminum pipe, 2 in. ID	4	Push rods
Pressure gage, ±0.5% F.S. accuracy	4	For borehole and manifold
Pressure gage, ±1% F.S. accuracy	1	Supply pressure
Pressure regulator, 2-100 psig	1	Control supply pressure
Metering valve, 0-100 psig	3	Manifold
Flow meter, 0.5-5 SLM	1	
Flow meter, 6-60 SLM	1	Manifold
Flow meter, 60-600	1	Manifold
Thermocouple, with 200 ft. extension wire, (type E) ±1°C precision	4	Borehole and manifold air temperatures.
Air filter	1	At supply line
On/off valve	4	
1 1/2 in. hose	100 ft.	Main air line
Air tugger (with steel rope)	1	Relocation of packer assembly
Rock bolts	4	Restrain packer assembly
Nitrogen bottle	1	Inflate packers

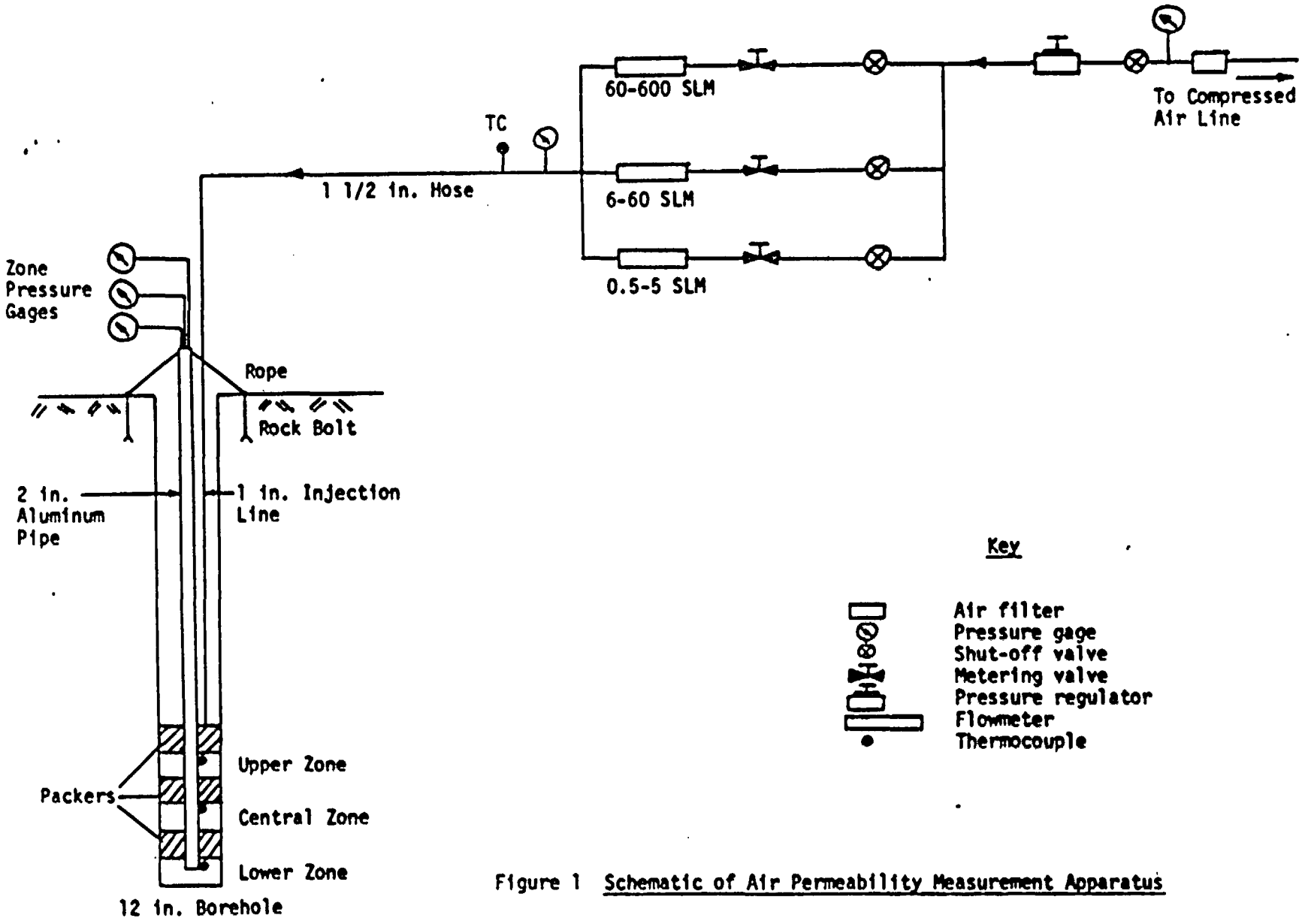

Figure 1 Schematic of Air Permeability Measurement Apparatus

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Page:	1 of 10

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Approved: (See Page 2)

TECHNICAL PROCEDURE

Operation of the Data Acquisition System

Originated by: Donald B. Watwood 7/21/88
Donald B. Watwood Date

Reviewed by: J. A. Beatty 7/21/88
Jane A. Beatty Date
Key Reviewer
DBW 7/27/88

Reviewed by: John J. Dronkers 8/4/88
John J. Dronkers Date
Deputy Project Leader for
Quality Assurance

Reviewed by: David W. Short 8/9/88
David W. Short Date
Deputy Project Leader for
NNWSI Project

11.22.1 PURPOSE

This procedure describes the operation of the Data Acquisition System as discussed in 033-NNWSI-P 11.10, "Test Plan: Prototype Engineered Barrier Design Testing". This procedure applies to all automated data acquisition in support of "Prototype Engineered Barrier Design Testing", WBS 1.2.6.9.4.5. This procedure supports activity S-20-1, "Evaluate Test Components in Support of Component Selection." The intended use of this procedure is to evaluate its adequacy as applied to field practices and to revise it as needed. The purpose of the final field-tested procedure is to provide guidelines so that other equally trained and qualified personnel can understand how the work is performed or how to repeat the work if needed. For both this initial procedure and the final procedure, the work will be documented by the use of scientific notebooks as discussed in 033-NWMP-R 11.0, Rev.1 (approval pending). The field validated procedure will provide a set of guidelines which the scientist will take into account in conducting the measurement. The scientist is allowed the flexibility of making changes to this procedure if the changes made are approved and documented as described in the "Records" section. The use of the term procedure does not imply this is repetitive work that does not require professional judgement.

11.22.2 SCOPE

This procedure applies to automated data acquisition performed in support of the "Prototype Engineered Barrier Design Testing" WBS 1.2.6.9.4.5. Changes to this procedure are allowed. Any changes are recorded in scientific notebooks and on the procedure itself. The recording and authorization for these changes are described in the "Records" section of this procedure.

11.22.3 RESPONSIBILITIES

The Task Leader for In Situ Engineered Barrier Design Testing is responsible for assuring that this procedure is used. The Task Leader is also responsible for assuring that any changes to this procedure are reviewed and incorporated into the next revision.

11.22.4 PROCEDURES

11.22.4.1 System Description

The Data Acquisition System (DAS) is comprised of a model HP9816, series 200 computer system with the appropriate software to acquire, control, and archive data from a data acquisition/control unit models HP3497A/HP3498A. This system is designed to accommodate several types of sensors and each type will be discussed.

11.22.4.2 Thermocouples

Data from the thermocouples are routed through one of three zone boxes where they are connected to isothermal blocks which provide a reference junction. The temperature of the isothermal blocks is read each time data are taken and this temperature reading along with thermocouple data is routed via shielded twisted pairs of wires into the data input channels of the HP3497A/3498A Data Acquisition/Control Units. The HP3498A also outputs a constant current excitation to the resistance thermal devices (RTDS) used to monitor temperatures of the isothermal blocks.

11.22.4.3 Pressure Transducers, Liquid Level Sensor, Watt Transducers, and Barometer

These devices all require power supplies which are provided by units in the DAS rack. Sensor output is routed via shielded twisted pairs to the HP3497A/3498A Data Acquisition/Control Units. The hardware descriptions are shown in appendix B. The HP3497A/3498A Data Acquisition/Control Units reads each input channel and transmits these raw data to the HP9816 CPU via the HPIB bus where they are archived both as raw and processed data. The primary storage medium is a HP9153, 16MBYTE hard disk. The data is backed up on three floppy disks. One floppy disk is contained in a disk drive in the HP9153 chassis and two others are contained in a HP9122 dual disk drive. Additional backup will be provided by a hard copy output of a HP82906A line printer.

11.22.4.4 Software

Software for the DAS is comprised of HP BASIC 4.1 operating system, and routines written to integrate features of a HP DACQ/300 Data Acquisition Manager Software Package.

11.22.4.5 Calibration

The digital multimeter portion of the HP3497A will be calibrated and certified to NBS traceability by the Electronic Engineering Department's LLNL Instrument Services Facility or by the manufacturer, Hewlett Packard Inc. Calibration and certification to NBS traceability of the RTDS will be accomplished according to "Calibration of the Thermocouples", 033-NNWSI-P 12.5. The calibration procedures and results will be documented in memoranda prepared by the appropriate calibration facility.

11.22.4.6 Operation

Operation instructions of the DAS are provided (see Appendix A) (by G WHIZ), for long term data acquisition and (Appendix C) (GASP) for the air permeability measurements.

11.22.5 RECORDS

The data collected during the Prototype Engineered Barrier Design Testing will be archived by the DAS on a hard disk, floppy disks, and hard copy output of a line printer. When a floppy disk is changed, a label will be affixed showing the date installed, the date removed, and the person changing the disk. The same information will be entered in the DAS scientific notebook. The data collected during this test and the revised procedure itself will be archived in the Records Management System (RMS) of the Nuclear Waste Management Project. The process to change a procedure is dependent upon the section of the procedure which has to be changed. Changes to procedure sections titled: "PURPOSE", "SCOPE", "RESPONSIBILITIES", "RECORDS", "PERSONNEL QUALIFICATIONS", and "SAFETY" are described using carbon copy memorandum forms. The review and approval process for these changes begins when the initiator of the changes writes the proposed changes on the memorandum form. The memorandum identifies the initiator of the proposed changes. The principal investigator responsible for the activity will review the proposed change and authorize it by signing the memorandum. The original sheet of the form will be attached to the field copy of the technical procedure and a notation made on the margin of the procedure referring the reader to the memorandum. One of the carbon copies will be pasted in the scientific notebooks and the third copy will be returned to the Subtask Leader and filed.

Documentation of the methods and procedures used to perform the test/activity will be provided by the scientific notebook approach. In contrast to the requirement for documentation of changes to other sections of this procedure, there is no requirement to note deviations from the typical approach outlined in those sections of this procedure that address methods or procedures only. Rather, the method or approach used will be determined by the principal investigator or the person assigned by the principal investigator to do the work, and the documentation will be provided in the scientific notebook in accordance with 033-NWMP-R 11.0, Revision 1 (approval pending) as such, deviations from the suggested or typical approaches outlined in this procedure are allowed based on the technical judgement of the scientists responsible for this activity. Revised procedures will then be prepared upon completion of the test using the original technical procedures, changes specified in the scientific notebooks in accordance with revision procedures outlined in section 8.2.

11.22.6 PERSONNEL QUALIFICATIONS

This procedure will be carried out by an engineer, technician, scientist, or someone trained in the operation of the DAS.

11.22.7 SAFETY

Standard LLNL electrical safety procedures will be adhered to during operation of the DAS.

Appendix A

Taking Data Using G_whiz

Computer Set-up: Attach the 9133 disk drive to the HP computer using the HPIB address 703. The 9122 dual floppy drive should have address 700. The HP 3497 should be at address 709. The line printer should be at 701.

Booting the System: Turn on the computer and all the disk drives. After the BASIC system is completely loaded the message BASIC READY 4.03 will appear at the bottom of the screen. Then type LOAD "LBINS" and wait for that program to load. Press the RUN key to execute this program. It loads in all the system binary files needed for the data acquisition codes.

Creating the Archive: This is only done the first time you use the system. Skip this step if the archive already exists. Type LOAD "NOAH" and wait for the program to load. Then type LOADSUB ALL FROM "SYSTEM". After that type LOADSUB ALL FROM "DATA_STORE". If the error message Cannot build COM at this time appears, press the SCRATCH softkey, and reload "NOAH", "SYSTEM", and "DATA_STORE". After all this, press the RUN key to execute NOAH. The program will display the message Creating the G_data archive. It will also send a description of the archive's book structure to the line printer.

Starting the Data Taking Program: Type LOAD "G_whiz" and wait for the program to load. Then type LOADSUB ALL FROM "SYSTEM". After that type LOADSUB ALL FROM "DATA_STORE". Next type LOADSUB ALL FROM "TEMP_LIB". The final command to type is LOADSUB ALL FROM "GRAPHICS". If the error message Cannot build COM at this time appears, press the SCRATCH softkey, and reload "G_whiz, "SYSTEM", "DATA_STORE", "TEMP_LIB", and "GRAPHICS". After all this, press the RUN key to execute G_whiz.

The program first asks you for the date. This is entered in the format DD MMM YYYY. For April Fool's Day you would type 01 APR 1988. Then the program wants to know the current time. This is in the format HH:MM:SS. For noon you would type 12:00:00 or just 12:00.

While G_whiz is running, the softkeys on the HP are defined to handle different functions that someone might want to do between data readings. A diagram of the keys with their labels appears at the bottom of the screen. When data is being read, the message Taking data. Don't use softkeys appears and the softkeys are disabled.

Taking another data set: If you want to take a data set between two of the hourly readings, press the softkey labeled "Take data". This will take a full data set, write it to both the archive and the floppies, and print out the readings. Using this option does not affect the scheduling of the next data reading, but it does change the variables the other subroutines check to make sure there is enough time to perform printing and/or plotting.

Plotting out the data: Press the softkey labeled "Plot data" to plot up to four traces of data on the screen. The program will tell you how many minutes are left until the next data reading. If there are less than 10 minutes, it won't allow you to plot. It will then ask Thermocouple or other data? (T or E). Respond by typing a T or E. Then it will ask # of lines on this plot? (<= 4). This is the number of thermocouples or transducers you will plot out on one plot.

Appendix A

Taking Data Using G_whiz
(con't.)

Then for each line on the plot the program will ask Which thermocouple # (<= 132) or Which data # (<= 20) to find out which data elements correspond to each line on the plot. Then the program will tell you There are nn sets of readings. Then it will ask you for the range of readings you want the plot to cover. This plot will be printed on the screen. It can be sent to the printer by hitting the DUMP GRAPHICS key on the HP. When you're done looking at the plot, use the "Clear screen" softkey to erase the plot.

Printing out old data: Press the softkey labeled "Print data" to print out previous data readings. This is useful if the printer had previously run out of paper and some printouts were missed. The program will tell you how many minutes are left until the next data readings. If there are less than 10 minutes, it won't allow you to print. Then the program will tell you There are nn sets of readings and ask you for the range of readings you want to print out. These data sets will be printed out using the same formats that are used when the data is taken.

Changing the time increment between readings: To increase or decrease the number of minutes between data readings, press the softkey labeled "Change delay." It will ask you what value you want as the new time increment and reset the cycling of the program. It will not allow you to set a time increment less than 10 minutes. If you try, it will set the delay value to 10 minutes.

Changing floppies: The floppies need to be changed about every ten days. If the new floppy has already been initialized, just press the eject button on the drive and insert the new one. If it needs to be initialized, follow the directions under Floppy operations.

Floppy operations: To initialize a floppy, get a floppy directory, or move data files from the hard disk to a floppy, press the softkey labeled "Flop ops." The computer will ask you which operation you want. Then it will ask you which floppy drive you want to use. Before initializing a floppy, the program will ask "Are you sure you want to initialize it? (y/N)." You must respond with a lower case y to initialize the floppy. When moving files from the hard disk to a floppy, you are asked for the file number range you want to move. After the files are written to the floppy, they are erased from the hard disk to free up space.

Finding out how much space is left in the archive: Press the softkey labeled "Arch space". It will tell you Available percentage = xx%. Available records = xx. Space for nn more readings. This last number is an approximation, but the percentage and # readings are exact.

How much time until the next data reading?: Press the softkey labeled "Time left". The computer responds with the current date and time, tells you when the last reading was taken, and how many minutes there are until the next scheduled reading. It also prints out the note This number will be wrong if the Take data softkey has been used since the last hourly read. If the "Take_data" softkey has been used, the next scheduled reading is sooner than reported by the "Time left" softkey.

Appendix A

Taking Data Using G_whiz
(con't.)

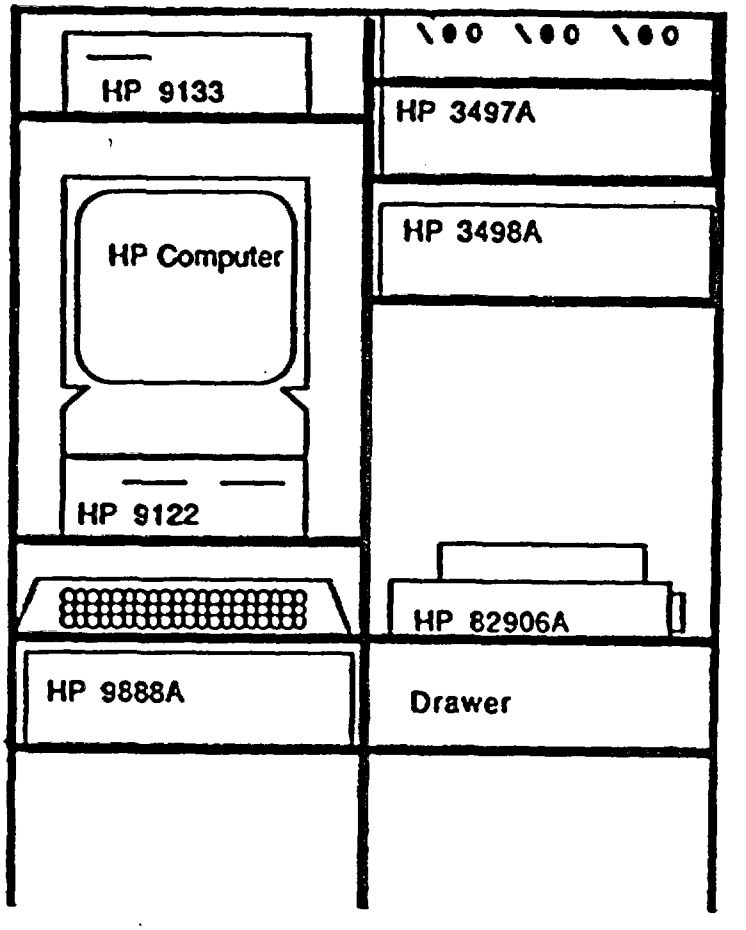
What time was a specific reading taken?: The program looks at all the data sets in terms of what # reading they were. To find out what time corresponds to a certain set of readings press the softkey labeled "Time list". The program will tell you how many minutes are left until the next data reading. If there are less than 5 minutes, it won't allow you to look at the times. Then the program will ask for the reading range whose times you want and whether you want them printed on the screen or the printer.

Clearing the screen: Press the "Clear screen" softkey to erase whatever is on the screen. This is very useful for getting rid of old plots.

Stopping the program: Press the softkey labeled "Quit". The program will ask Are you absolutely sure? (y/N). You must respond with a lower case y for the program to stop. The program will send a form feed to the line printer and write Goodbye! to the screen.

Appendix B

Hardware Description



HP 9133A -	Hard disk and floppy drive Hard disk address is :,703,0. Floppy address is :,703,1.
HP 9122 -	Dual floppy drives Left-hand floppy address is :,700,0. Right-hand floppy address is :,700,1.
HP 9188A -	Bus expander
HP 3497A -	Data Acquisition/Control Unit
HP 3498A -	Extender for HP 3497A
HP 82906A -	Line Printer Address is 701.

Appendix C

Taking Data Using Gasp

Booting the System: Turn on the computer and all the disk drives. The system will automatically boot. After the BASIC system is completely loaded the message BASIC READY 4.03 will appear at the bottom of the screen. Now type LOAD "LBINS" and wait for that program to load. (The asterisk in the bottom-right corner of the screen will disappear.) Press the RUN key to execute this program. It loads in all the system binary files needed for the data acquisition codes. It will type LBINS finished when it's done running.

Starting the Data Taking Program: Type LOAD "Gasp" and wait for the program to load. Then type LOADSUB ALL FROM "SYSTEM". After that type LOADSUB ALL FROM "DATA_STORE". Next type LOADSUB ALL FROM "TEMP_LIB". If the error message Cannot build COM at this time appears, press the SCRATCH softkey, and reload "Gasp", "SYSTEM", "DATA_STORE", and "TEMP_LIB". After all this, press the RUN key to execute Gasp.

The program first asks you for the date. This is entered in the format DD MMM YYYY. For April Fool's Day you would type 01 APR 1988. Then the program wants to know the current time. This is in the format HH:MM:SS. For noon you would type 12:00:00 or just 12:00.

Then the program asks for information about the test. Just type in the answers to the questions it asks. The last thing it asks for is the delay value. This is the increment of time between data readings.

While Gasp is running, the softkeys on the HP are defined to handle different functions that someone might want to do between data readings. A diagram of the keys with their labels appears at the bottom of the screen. When data is read, the message Taking data. Don't use softkeys appears and the softkeys are disabled.

Taking another data set: If you want to take a data set between scheduled readings, press the softkey labeled "Take data". This will take a data set and print out the readings. Using this option, does not affect the scheduling of the next data reading.

Cataloging or initializing floppies: This can be done using the softkey labeled "Flop ops" and answering the questions it asks.

Starting another test series: Use the softkey labeled "New test" and answer the questions it asks.

Changing the time between readings: Use the softkey labeled "Change delay" and it will ask you for the new time increment in minutes.

Stopping the program: Press the softkey labeled "Quit". The program will ask Are you absolutely sure? (y/N). You must respond with a lower case y for the program to stop. The program will send a form feed to the line printer and write Goodbye! to the screen.