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ATT. 3: NOVEMBER 1985 BENDIX REPORT
ENTITLED "DOWNHOLE INSTRUMENTATION AND PORE-GAS-SAMPLING/DATA-COLLECTION PROCEDURES"

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VADOSE ZONE CHARACTERIZATION OF TECHNICAL AREA 54, WASTE DISPOSAL AREAS G AND L, LOS ALAMOS NATIONAL LABORATORY, NEW MEXICO

REPORT 2: DOWNHOLE INSTRUMENTATION AND PORE-GAS-SAMPLING/DATA-COLLECTION PROCEDURES

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November 1985

Prepared for
U.S. Department of Energy
Los Alamos National Laboratory
Los Alamos, New Mexico
in Conjunction with
U.S. Department of Energy
Grand Junction Projects Office
Grand Junction, Colorado
Under Contract No. DE-AC07-76GJ01664

11216

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1.0 PURPOSE AND SCOPE

This report describes the instrument installations and procedures for sample and data collection conducted in support of the vadose zone characterization of Waste Disposal Areas G and L, Technical Area 54, Los Alamos National Laboratory, New Mexico. The study was initiated in response to a Resource Conservation and Recovery Act (RCRA) Compliance Order/Schedule (Docket Number 001007) issued to the Laboratory by the Environmental Improvement Division of the State of New Mexico. The Compliance Order/Schedule, dated 7 May 1985, specifies acquisition of certain geotechnical information. The instrument installations described in this report were designed and emplaced by Bendix Field Engineering Corporation/Grand Junction Operations (Bendix) in accord with a Statement of Work issued by Los Alamos National Laboratory. Bendix is the Operating Contractor for the Department of Energy (DOE) Grand Junction, Colorado, Projects Office.

This report is the second in a series of reports documenting the vadose zone characterization of the study area. The first report (Rush and Dexter, 1985) presented preliminary lithologic and geophysical data obtained via drilling and logging operations conducted over the period 30 July to 22 August 1985. This second report presents the instrument-completion diagrams for the nine boreholes in which instruments were installed and describes the procedures to be used in the collection of samples and other data.

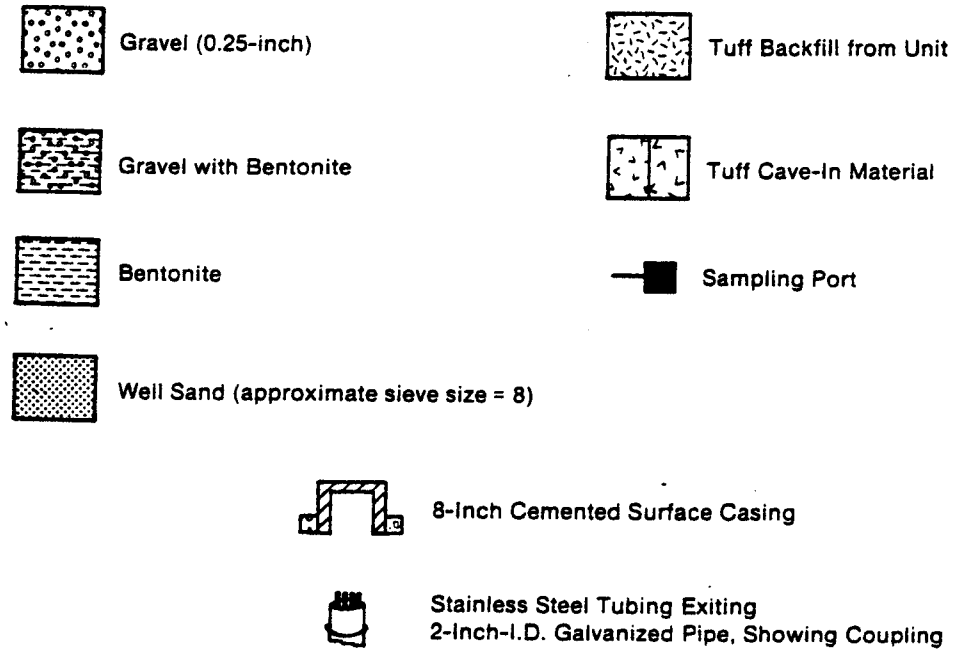
2.0 INSTRUMENT INSTALLATIONS

2.1 PORE-GAS SAMPLING PORTS

A total of 23 sampling ports were installed in seven boreholes in the study area in order to collect samples of pore gas at various locations in the boreholes. The sampling ports were constructed using low-pressure mobile-phase filters which were welded to standard 2-inch-I.D. galvanized pipe (see Figure 2-1). The filters consist of 2-micrometer, porous, stainless steel elements. Uphole access is provided via connection to 1/4-inch stainless steel tubing and stainless steel compression fittings.

Installation was accomplished by carefully lowering the string of galvanized pipe downhole. The annuli surrounding the pore-gas sampling ports were then filled with a fine-grained (sieve size of 80) silica sand, and isolated from upper and lower zones using powdered bentonite. (One zone in Hole LGC-85-09 was packed in tuff backfill due to cave-in of the hole.) Figure 2-2 presents the legend for the sampling-port installations; completion diagrams are shown in Figures 2-3 through 2-9 for the seven boreholes.

LEGEND FOR PORE-GAS SAMPLING-PORT INSTALLATIONS



LEGEND FOR PSYCHROMETER AND TRANSDUCER INSTALLATIONS

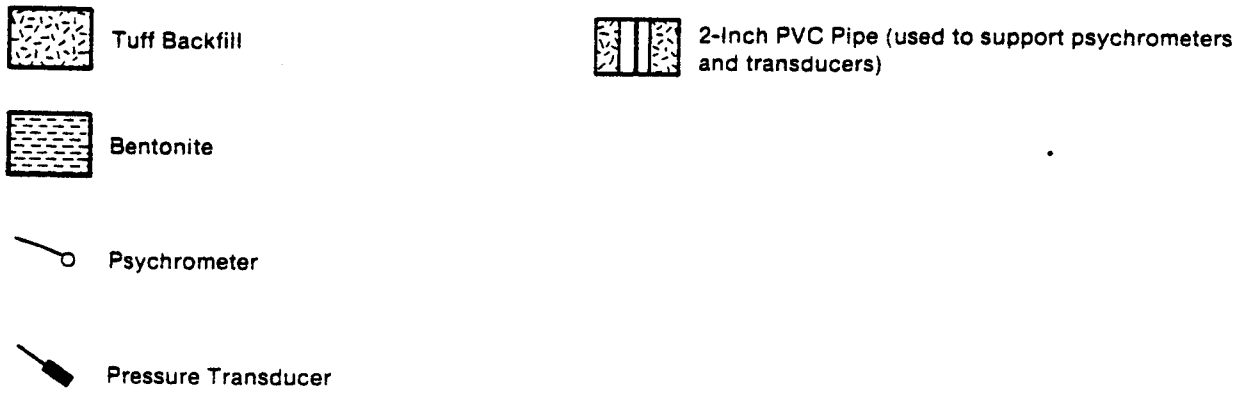


Figure 2-2. Legends for the Instrument Installations

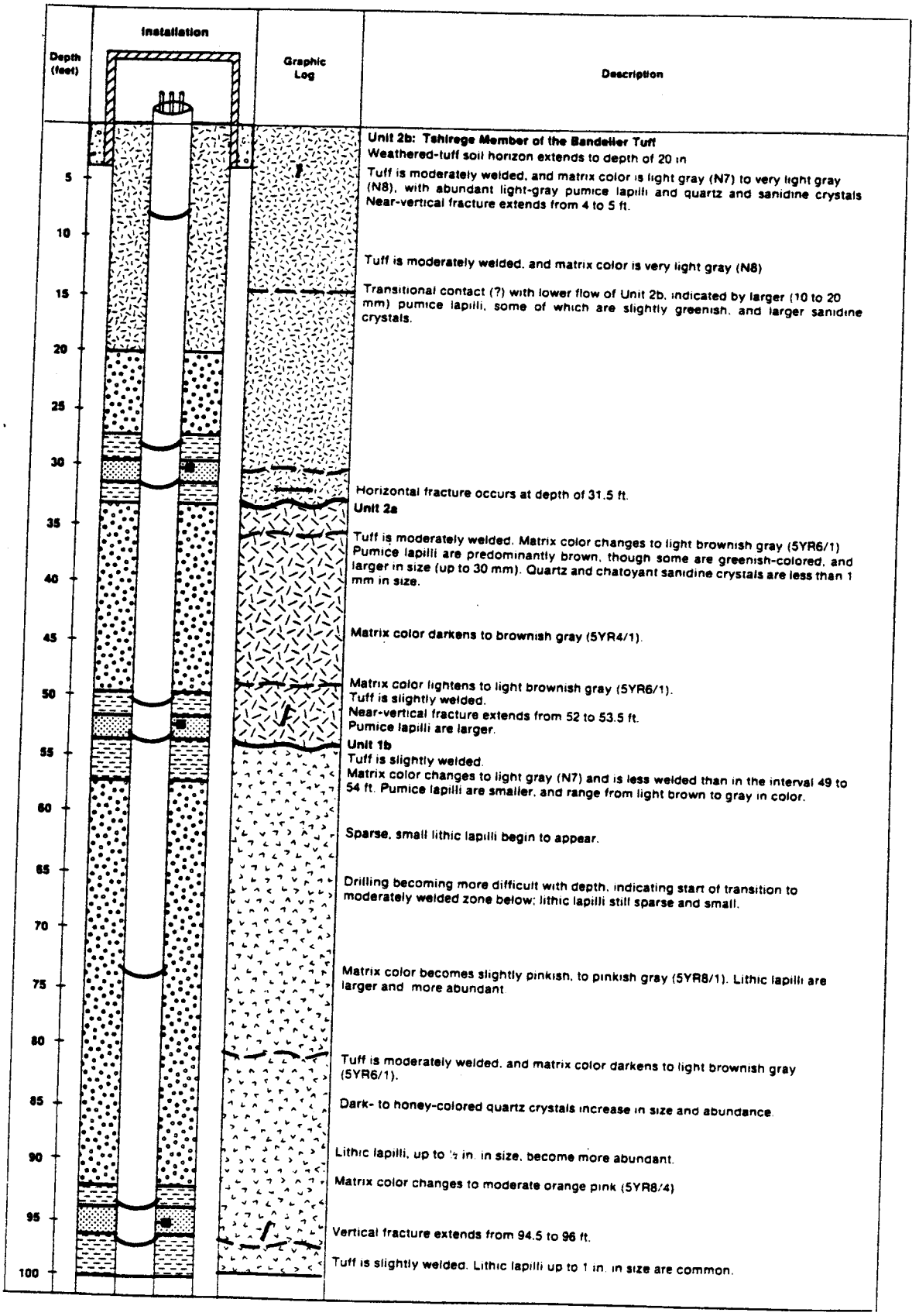


Figure 2-4. Pore-Gas Sampling Port Installation for Hole-LGC-85-10

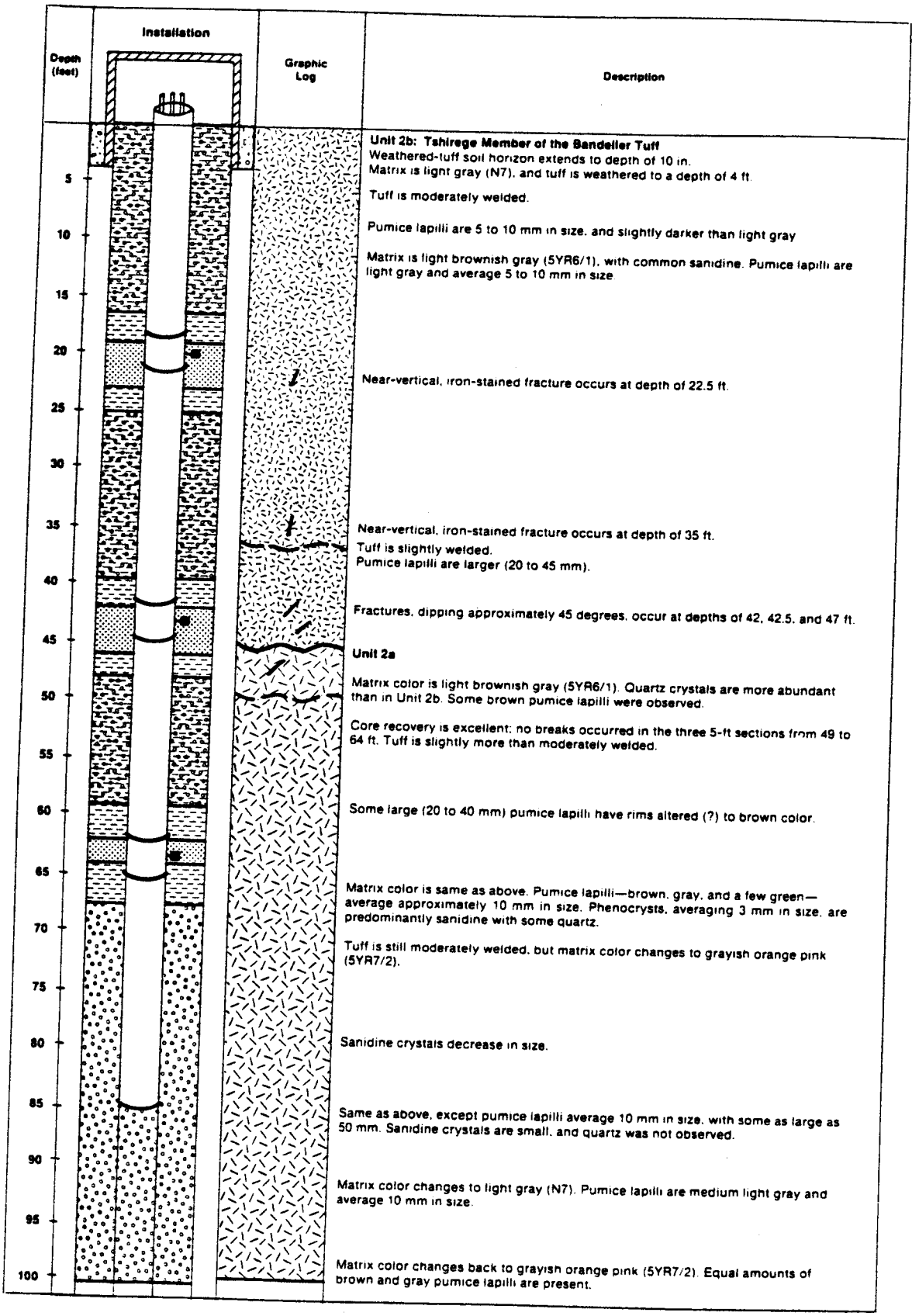


Figure 2-6. Pore-Gas Sampling Port Installation for Hole LLC-85-13

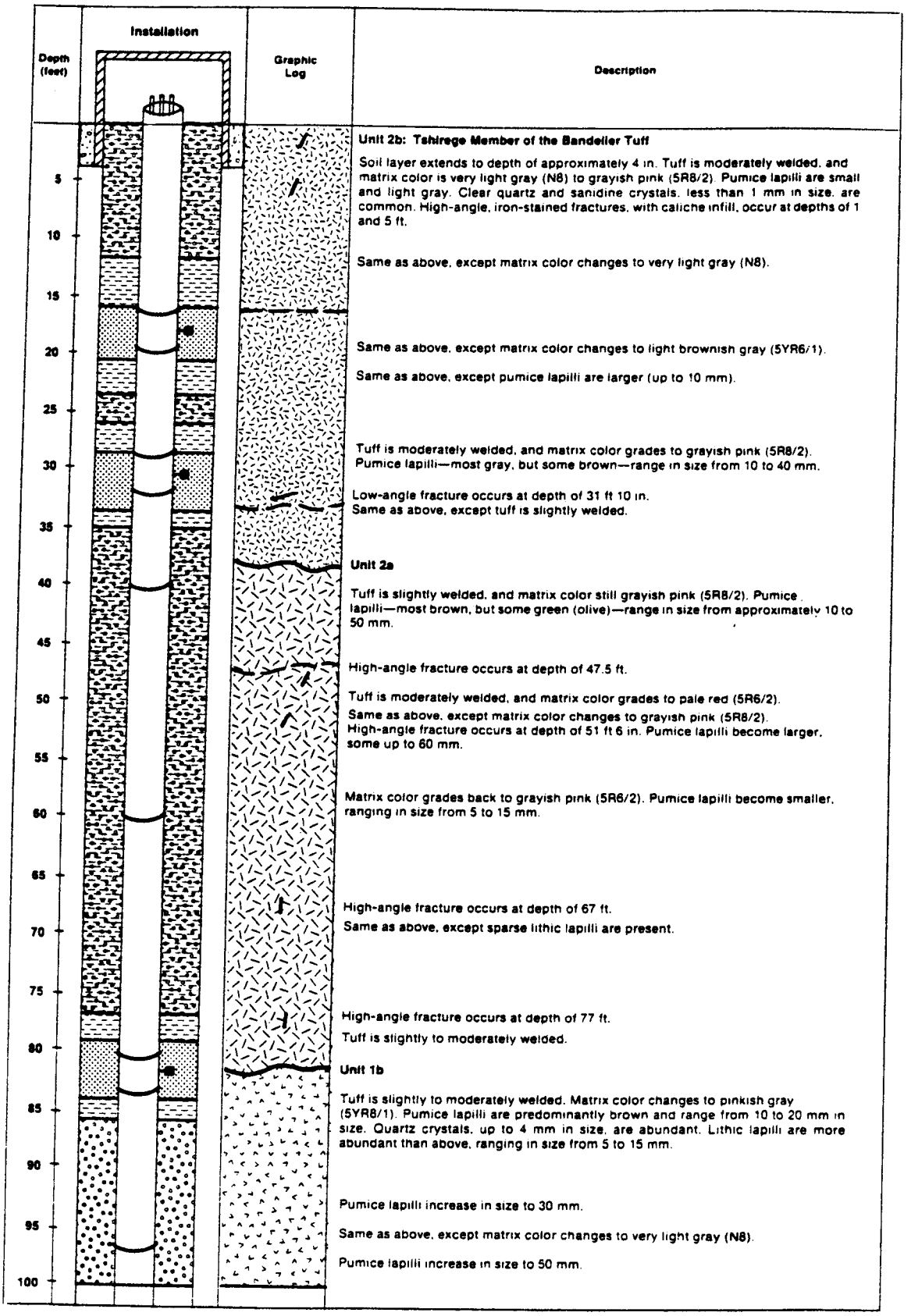
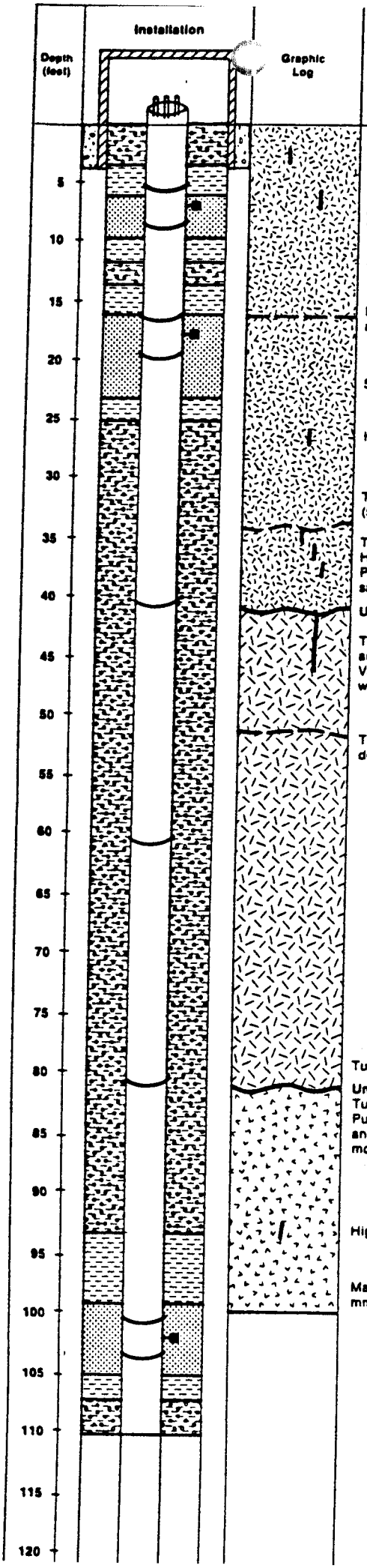


Figure 2-8. Pore-Gas Sampling Port Installation for Hole LLC-85-15



Unit 2b: Tshirege Member of the Bandelier Tuff
Soil and weathered tuff extend to depth of 16 in.

Tuff is moderately welded, and matrix color is grayish pink (5R8/2). Pumice lapilli are light gray and range up to 10 mm in size. Quartz and sanidine crystals range up to 4 mm in size. Near-vertical fractures occur at 3 ft and from 6 to 7 ft.

Same as above.

Reworked ash (crossbedding) occurs at depth of 15 ft 5 in. The material is orange and represents the contact between the upper and lower flows in Unit 2b.

Still moderately welded, grayish-pink (5R8/2) tuff.

High-angle fracture, with iron alteration, occurs at depth of 25 ft 10 in.

Tuff is still moderately welded, but matrix color changes to grayish orange pink (5YR7/2).

Tuff is slightly welded, and drilling becomes easier at depth of 34 ft.
High-angle fractures (one continuous fracture?) occur at depths of 34, 36, and 37 ft. Pumice lapilli are gray and brown, and range in size from 10 to 20 mm. Quartz and sanidine crystals are less than 1 mm in size.

Unit 2a

Tuff is slightly welded, and matrix color is light gray (N7). Pumice lapilli are brown, gray, and green. Sanidine and quartz crystals are larger, up to 3 mm. Vertical fracture with silt infill extends from 41.5 to 45.6 ft; it was probably filled in with reworked ash prior to deposition of Unit 2b.

Tuff is moderately welded, and matrix color changes to grayish pink (5R8/2), at depth of approximately 46 ft. Pumice lapilli are brown and green.

Tuff is slightly less welded than above, and rare lithic lapilli are present.

Unit 1b
Tuff is slightly to moderately welded. Matrix color changes to light gray (N7). Pumice lapilli are predominantly brown and range in size from 20 to 40 mm. Quartz and sanidine crystals are still common. Lithic lapilli are larger (up to 30 mm) and more abundant.

High-angle fracture occurs at depth of 92.5 ft.

Matrix color lightens to very light gray (N8). Pumice lapilli are larger (up to 50 mm). Lithic lapilli are common.

Figure 2-9. Pore-Gas Sampling Port Installation for Hole LLC-85-16

2.2 THERMOCOUPLE PSYCHROMETERS AND PRESSURE TRANSDUCERS

Thermocouple psychrometers and pressure transducers were installed at the study area in order to measure temperature, water potential, and pressure at various depths in selected boreholes. A total of 38 psychrometers were installed, 23 in Hole LLP-85-03 and 15 in Hole LGP-85-07. Because of the presence of surface casing in Hole LLP-85-03, a shallow boring was drilled adjacent to the main hole and five psychrometers were installed in this second hole close to the ground surface (depicted in the completion diagram as being in Hole LLP-85-03). A total of four pressure transducers were installed, three in Hole LLP-85-03 and one at ground surface near this hole.

Installations were accomplished by taping the instruments to a string of Schedule 40, 2-inch-I.D., polyvinylchloride (PVC) pipe and carefully lowering the string into the hole. The annulus surrounding the PVC pipe was then backfilled with auger cuttings from that drill hole. It was assumed that the density of this backfill material was similar to the in-situ density of the Bandelier Tuff, and that the relative humidity of the backfill material, as sensed by the instruments, would equilibrate with the relative humidity of the tuff. Fractured zones in Hole LLP-85-03 were isolated using powdered bentonite at selected intervals.

Installation depths, cooling coefficients, and scanner/channel identifications for the psychrometers in Holes LLP-85-03 and LGP-85-07 are presented in Tables 2-1 and 2-2, respectively. Completion diagrams of the psychrometer and transducer installations are shown in Figures 2-10 and 2-11; refer to Figure 2-2 for legend information for these installations. Calibration information will be presented in a subsequent report.

Table 2-2. Installation Depths and Cooling Coefficients for Psychrometers in Hole LGP-85-07

Psychrometer Serial Number	Scanner/Channel	Cooling Coefficient (microvolts)	Installation Depth (feet)
29415	III/1	59	4.5
29459	III/2	56	6.5
29410	III/3	60	8.5
29461	III/4	56	10
29411	III/5	57	12
29463	III/6	56	14
29417	III/7	57	17
29466	III/8	56	19
29403	III/9	61	22
29467	III/10	58	27
29407	III/11	57	32
29465	III/12	59	37
29464	III/13	57	42
29404	III/14	52	47
29468	III/15	57	52

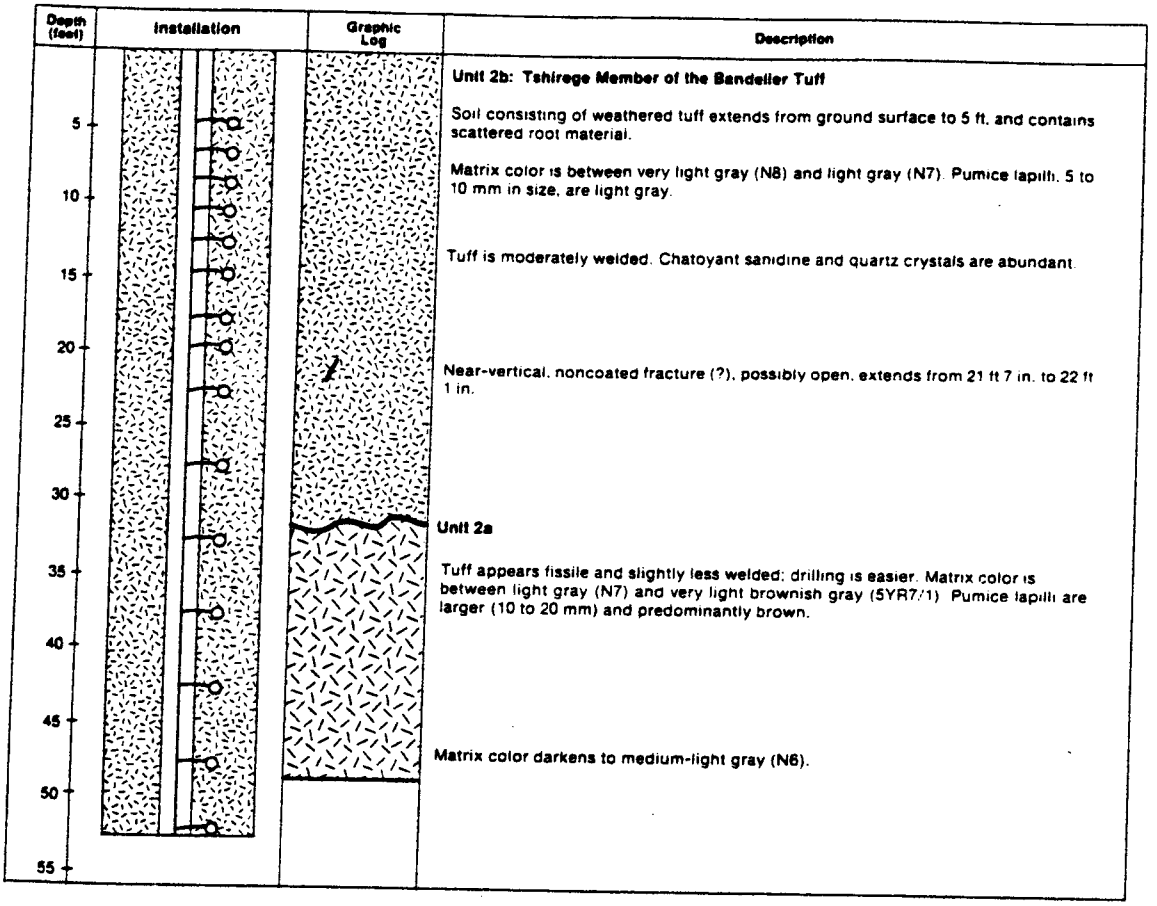
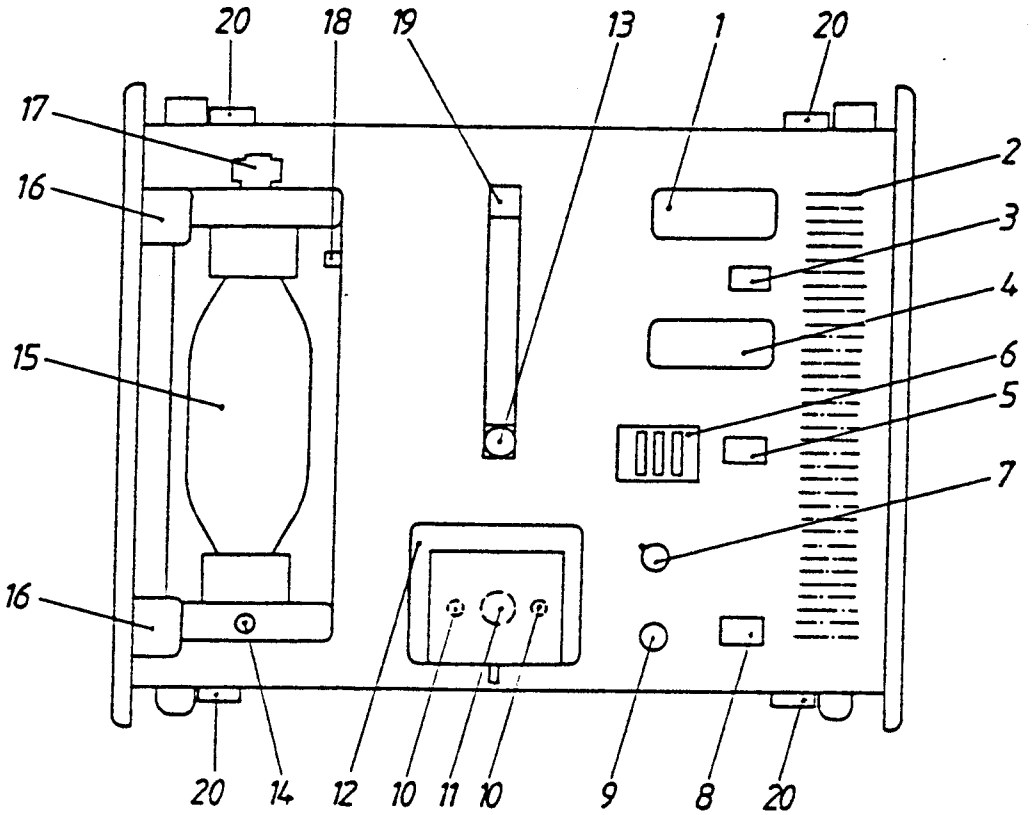


Figure 2-11. Installation of Thermocouple Psychrometers in Hole LGP-85-07



1 Temperature display (with GS 312 only)
2 Venting slits
3 Key for activating a temperature measurement (with GS 312 only)
4 Digital volume counter and state indicator
5 Key for starting and stopping a measurement cycle
6 Preset switches for the gas volume
7 Mode switch "Continuous" or "Preset"
8 Main switch
9 Socket for external control
10 DC power connection
11 DC fuse
12 Power adapter GN 220/12 (with GS 312 only)
13 Fine regulation valve for flow rate
14 Inlet
15 Absorber vessel
16 Mounts for stand rod
17 Lock for the absorber vessel
18 Outlet
19 Float-type flow meter
20 Lock for cover

Figure 3-1. Schematic of the DESAGA Gas Sampler

- Sample Volume
- Flow Rate
- Temperature and Barometric Pressure at Time of Sampling (The volume displayed by the pump meter is at ambient conditions. Temperature and pressure measurements are therefore required in order to correct this volume to standard conditions.)
- Sampler's Signature

3. The sampling ports may eventually become clogged. As a preventive measure, the parts should be periodically "blown out" with compressed nitrogen.

3.2 COLLECTION OF WATER-POTENTIAL DATA

3.2.1 Introduction

These procedures were developed to collect water-potential data from boreholes located in Waste Disposal Areas G and L, Technical Area 54, Los Alamos National Laboratory, New Mexico.

3.2.2 Equipment

The psychrometers installed in Holes LLP-85-03 and LGP-85-07 may be read using an automated scanner. The scanner chosen for this study is the microprocessor-controlled HP-115 Water Potential Data System manufactured by Wescor. The HP-115 is a battery-powered scanning device, capable of determining water potential using either the dew-point (hygrometric) or the wet-bulb (psychrometric) method. The equipment descriptions and operating procedures presented herein were taken from the Instruction Manual for the HP-115 (Wescor, undated).

A maximum of 15 psychrometer leads can be plugged directly into the rear of the scanner, resulting in a 15-channel scanning capability. Measurements of temperature, zero offset, and psychrometer/hygrometer output are read from the psychrometer probes and automatically stored in memory for each scan. Time is also stored in memory at the beginning of each scanning cycle. A liquid crystal display (LCD) window located at the top of the instrument provides a means of monitoring the data-collecting operation. Data that have been stored in memory are then recovered via the RS-232C port located on the back panel of the instrument. Using this port, the memory contents may be transferred to a printer, a cassette, a telephone modem, or directly to a computer.

An internal rechargeable battery allows the HP-115 to run unattended for up to 60 days, or until the memory is filled. If desirable, an external battery can be connected to the rear panel of the instrument to permit longer periods of operation. The internal battery can be recharged from a wall socket by plugging the charging unit into the battery port located on the back of the instrument.

Since the scanner's memory limits the length of uninterrupted operating time, an equation is used to predict the time required to fill the memory. The maximum operating time of the scanner is given as

5. MODES 04 and 05 - Cooling Coefficients. These modes refer to the cooling coefficients of the psychrometer probes. Since cooling coefficient settings are independent of the psychrometric (wet-bulb) mode of operation, they need not be set for the psychrometer probes at Los Alamos.

6. MODE 06 - Number of Sensors. Rotating the MODE dial to 06 causes the number of sensors being scanned to be displayed. This number may be changed by rotating the two rightmost digits of the SET dial to the appropriate number of sensors and pressing the ENTER button. Assuming that 15 psychrometer probes are to be scanned, the number of sensors should be set to 15.

7. MODE 07 - Scan Interval. Rotating the MODE dial to 07 causes the scan interval to be displayed. The scan interval is the elapsed time between successive scanning cycles. If the psychrometer probes are to be scanned twice daily, the scan interval (MODE 07) should be set to 1200 using the SET dial, and then the ENTER button should be pressed.

8. MODE 08 - Wet-Bulb Run. Rotating the MODE dial to 08 causes the SET time to be displayed until the first scanning cycle is complete. The initial scanning cycle is begun by pressing ENTER while in MODE 08. This initiates a primary scan of all the channels, after which the liquid crystal display (LCD) window will go blank. The LCD window will remain blank until the time in the scanner equals the start time designated in MODE 01. At this point, the LCD window will display time for approximately 14 seconds, and a new scanning cycle will begin.

   During any scan, the temperature, offset, and wet-bulb readings will be displayed sequentially for each channel. All temperature readings are prefixed with a 4, followed by the value in tenths of a degree Celcius. Zero offset and wet-bulb readings, prefixed with a 5 and a 6, respectively, are displayed in tenths of microvolts. An example of the scanner readings is given below:

Temperature:	4205 = 20.5° Celcius
Zero Offset:	5010 = 1.0 microvolt
Wet Bulb:	6155 = 15.5 microvolts

9. MODE 13 - Data to RS-232C Port. Using Mode 13, data stored in the scanner's microprocessor may be transferred to a cassette tape while the scanner remains in the field. Wescor's CI-30 audio cassette interface is designed to interface the RS-232C port with the cassette recorder in this manner. The operating procedures for the CI-30 audio cassette interface are discussed below, and are based on the CI-30 Operating Manual (Wescor, 1982).

   The CI-30 is equipped with an audio cable (Q4-275) and an RS-232C cable. The audio cable is simply a cord with a 1/8-inch phone jack on both ends. The RS-232C cable contains one end labeled INPUT and the other end labeled OUTPUT. Pinouts for the INPUT and OUTPUT ends of the RS-232C cable and their respective connections to the sending and receiving devices are shown in Figures 3-2 and 3-3. Data transfer via the RS-232C port is accomplished in the manner described below. Steps a through d

describe the transfer of data from the HP-115 scanner to the cassette recorder; Steps e through j describe data transfer from the cassette recorder to any computer.

a. Referring to Figure 3-2, connect the INPUT end of the RS-232C cable to the RS-232C port on the HP-115 scanner. Connect the OUTPUT end of the same cable to the RS-232C port on the CI-30 cassette interface.

b. Connect the audio cable (Q4-275) between the microphone jack on the CI-30 and the microphone jack on the cassette recorder. Advance the cassette tape until the clear leader is past the recording heads.

c. Switch the HP-115 to Mode 13. Turn on the CI-30 interface. Start the cassette recorder in RECORD mode and allow 10 seconds to pass. Initiate data transmission at the HP-115 by pressing the ENTER switch for 1 full second. This will cause the LCD window on the HP-115 to display four ones, i.e., 1111, indicating that data are being transmitted.

d. The data will continue to be transmitted to the cassette tape recorder until the HP-115 displays real time. Data transmissions can take anywhere from a few seconds to several minutes depending on the volume of data stored in the microprocessor. Upon completion of data transmission, turn the CI-30 interface off, stop the cassette recorder, rewind the tape, and disconnect both cables. Then set the MODE switch on the HP-115 to 08 and press the ENTER button to begin storing new data. The CI-30 and the cassette recorder can now be taken to the computer to enter the data.

e. The cable connections between the CI-30 and the computer are shown in Figure 3-3. Connect the INPUT end of the RS-232C cable to the RS-232C port on the CI-30. Connect the OUTPUT end to the RS-232C port on the computer.

f. Start the cassette recorder in the PLAY mode. When a high tone is heard, stop the recorder and connect the Q4-275 audio cable between the earphone jack on the cassette recorder and the earphone jack on the CI-30.

g. Prepare the computer to receive data. The parameters of the computer must match those of the sending device, i.e., the HP-115 scanner. Therefore, set the baud rate to 300, parity to none, and character length to 10 bits, which includes one start bit and one stop bit.

h. Adjust the volume control on the cassette recorder to between two-thirds and three-fourths of full volume, and start the cassette recorder in the PLAY mode. Allow the recorder to run in PLAY mode for 2 seconds prior to starting the computer and turning on the CI-30. It is important that the CI-30 be turned on last to prevent garbling of the data. The data are now being transmitted from the cassette recorder to the computer.

i. Upon completion of transmission, turn the CI-30 and the cassette recorder off and disconnect all cables. The wet-bulb and temperature data are now ready to be viewed at the computer terminal.

removed from the scanner input port, checked, cleaned, and reattached. The system is then rechecked to ensure that a proper electrical connection has been achieved.

The channel numbers corresponding to the four transducers are as follows:

- CH00 - Surface Transducer
- CH01 - Transducer Buried at 26 Feet Below Ground Level
- CH02 - Transducer Buried at 54 Feet Below Ground Level
- CH03 - Transducer Buried at 90 Feet Below Ground Level

Channel 00 is the barometric pressure calibrated at sea level.

4.0 REFERENCES

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