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Room Q Data Report Test Borehole Data from April 1989 through November 1991

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ABSTRACT

Pore-pressure and fluid-flow tests were performed in 15 boreholes drilled into the bedded evaporites of the Salado Formation from within the Waste Isolation Pilot Plant (WIPP). The tests measured fluid flow and pore pressure within the Salado. The boreholes were drilled into the previously undisturbed host rock around a proposed cylindrical test room, Room Q, located on the west side of the facility about 655 m below ground surface. The boreholes were about 23 m deep and ranged over 27.5 m of stratigraphy. They were completed and instrumented before excavation of Room Q. Tests were conducted in isolated zones at the end of each borehole. Three groups of 5 isolated zones extend above, below, and to the north of Room Q at increasing distances from the room axis. Measurements recorded before, during, and after the mining of the circular test room provided data about borehole closure, pressure, temperature, and brine seepage into the isolated zones. The effects of the circular excavation were recorded. This data report presents the data collected from the borehole test zones between April 25, 1989 and November 25, 1991. The report also describes test development, test equipment, and borehole drilling operations.

MASTER *JP*

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PREFACE

Preliminary data from in and around Room Q may have appeared in technical papers, memoranda, and presentation materials by S. Howarth, E. Peterson, S. Finley, and J. Nowak. This report is considered the definitive data report for the Room Q experiments.

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1.0 INTRODUCTION

This report presents the data from a series of hydrologic tests conducted at the Waste Isolation Pilot Plant (WIPP) in southeastern New Mexico. The WIPP is a US Department of Energy (DOE) research and development facility designed to examine methods for safe long-term storage of transuranic (TRU) radioactive wastes generated by United States defense programs. The WIPP disposal horizon is located 655 meters below ground in the Permian Salado Formation. The tests described in this data report were designed to provide information on fluid flow and formation pore pressure in the Salado.

The tests were conducted in 15 boreholes drilled from within the WIPP facility. The collars of the boreholes are located just outside a recently excavated test room (Room Q) in the west section of the facility. The boreholes were drilled and instrumented before the mining of Room Q. They formed isolated test zones above, below, and beside the room for gathering data regarding pressure, temperature, closure, and brine inflow. The isolated test zones lie within 27.5 m of local stratigraphy.

In addition to the test data from the boreholes, this report describes test development, testing tools and procedures, as-built information, and borehole-drilling techniques.

Data from other measurements taken from inside Room Q—such as resistivity, brine inflow, closure, barometric pressure, humidity, and air temperature—will be addressed in a companion report.

1.1 Background

The WIPP repository horizon is located 655 m underground in the Salado Formation, a 600-m-thick layer of bedded salt. One major advantage of salt as a host for radioactive waste isolation is its ability to creep and enclose the waste within the formation. However, testing in the underground has shown that the salt contains pockets of brine that could have potentially deleterious effects on the repository. 1) The brine may become entrapped in the repository, preventing creep closure of the formation. 2) Brine entrapment in pockets may degrade the crushed salt seal material (Nowak and Stormont, 1987). 3) The presence of brine and high relative humidity may increase pressurized gas generation (Lappin et al., 1989), in turn increasing mechanical loads on seal structures. However, some reports show that a moderate rate of brine inflow could speed the desired reconsolidation of crushed salt seal components and backfills that will be used to fill voids in repository waste panels (Holcomb and Shields, 1987).

The tests conducted in the boreholes around Room Q were designed to help reduce uncertainties about brine inflow.

1.2 General Description of the Tests

The tests performed in the boreholes around Room Q were intended to provide data from which permeability, flow potential, and pore pressure of the host rock could be inferred. These parameters are needed to formulate a model of brine seepage into Room Q. Test measurements were made with tools installed approximately 23 m into previously undisturbed rock. Fifteen test boreholes were drilled at several different angles relative to the proposed entrance of Room Q so that test intervals could be placed at specific radial distances from the centerline of the room. The borehole-drilling procedure is described in Section 3.2. Drilling was completed and tools were installed before Room Q was excavated. The circular cross-sectional shape chosen for Room Q provides a uniform stress field around the excavation.

Data were acquired before, during, and after excavation. These data will be used to understand brine seepage rates into Room Q, and that understanding will be used to estimate the rate of brine seepage into the repository, a factor that will ultimately affect the repository consolidation process. Analysis of the data provided by these tests will thus reduce the level of uncertainty in hydrologic parameters used in performance assessment calculations for the WIPP repository.

1.3 Test Objectives

The borehole hydrologic tests around Room Q were designed to provide information on the formation pore pressure, permeability, and flow potential of the Salado Formation both within the zone of influence of the WIPP excavations and in the undisturbed "far field" parts of the Salado. The immediate test objectives were to create a comprehensive data set to determine formation permeability, pore pressure, and fluid flow before and after Room Q mine-by. Additional data about permeability measurements and/or gas-flow testing of the Salado at and near the underground-facility horizon can be found in Peterson et al. (1987), Stormont et al. (1987), Stormont (1990), Beauheim et al. (1991), and Saulnier et al. (1991).

Data were collected to measure pressures in the host rock surrounding Room Q before, during, and after excavation in order to characterize the pore-pressure gradient as it developed in response to mining and to subsequent brine inflow. Data from testing activities were acquired from two distinct types of tests: 1) constant-pressure flow tests, and 2) long-term

pressure-buildup tests. While both activities can be analyzed using the same numerical model, they require the use of different analytical solutions. The current analysis of flow testing is accomplished by using the Graph Theoretic Field Model (GTFM) as the numerical model (Pickens et al., 1987) and comparing the results with Doe fractional-dimension type curves (Doe, 1991), an analytical method. The current analysis of the long-term pressure buildup is accomplished using GTFM as the numerical model and comparing the results with the analytical solution of Gringarten (1979) included in the Interpret/2 well-test-interpretation code developed by Scientific Software-Intercomp. Comparisons of the numerical models with the analytical solutions provide confidence in the results. From these analytical results, values for formation pressure, permeability, transmissivity, and diffusivity can be assigned to the formation around Room Q. The first analytical evaluation of these data is currently in the report preparation stage.

The local pore-pressure gradients induced by the excavation of the WIPP test rooms are predicted to extend only a few meters into the surrounding host rock, so hydrologic understanding of the region is limited. A locally bounded region of interconnected porosity in the Salado Formation might account for current inflow data, and pore pressure may still be nearly equal to pre-excavation values within a few meters of WIPP excavations (Nowak, 1990; Finley et al., 1992). If the local pore system is saturated and isolated from overlying aquifers, the pre-excavation value should be close to lithostatic pressure (approximately 14.8 MPa, or 2150 psi). If, on the other hand, the pore system is globally interconnected and saturated, the pre-excavation value could be closer to hydrostatic pressure (approximately 6.9 MPa, or 1000 psi).

Design calculations support the notion that pore-pressure measurements in boreholes of moderate lengths can be used to determine formation pressure (Nowak et al., 1988). Data from these measurements can be used to quantify the pore-pressure gradient near an excavation for comparison with model predictions. The data can also be used to determine far-field pore pressure as an approximation of the pre-excavation value. Inferences about the size of the flow regime (locally limited or global) could also be made from the estimated pre-excavation pore pressure. Integrated brine-inflow and pore-pressure measurements for the same excavation are essential for understanding the mechanistic relationships in the region.

A detailed description of the measurement system appears in Section 5.

2.0 WIPP UNDERGROUND DEVELOPMENT

The WIPP is a DOE facility built for the permanent disposal of TRU waste from defense-related activities. The WIPP is located in the northern part of the Delaware Basin in southeast New Mexico. Figure 2-1 is a three-dimensional representation of the facility currently under construction. The disposal areas are situated about 655 m below ground surface within the Salado geologic formation—a bedded evaporite sequence consisting primarily of halite.

2.1 Large-Scale Stratigraphy

The WIPP repository is situated in the middle of the 250-million-year-old Salado Formation, a salt bed that extends from 250 to 850 meters below the land surface. The Salado is bounded by the Rustler Formation above and the Castile Formation below. The Salado is intact in the WIPP area, and brine flow within it is exceptionally slow because primary porosity is low and open fractures are absent in the pliant salt. Low effective porosity allows for very little brine movement.

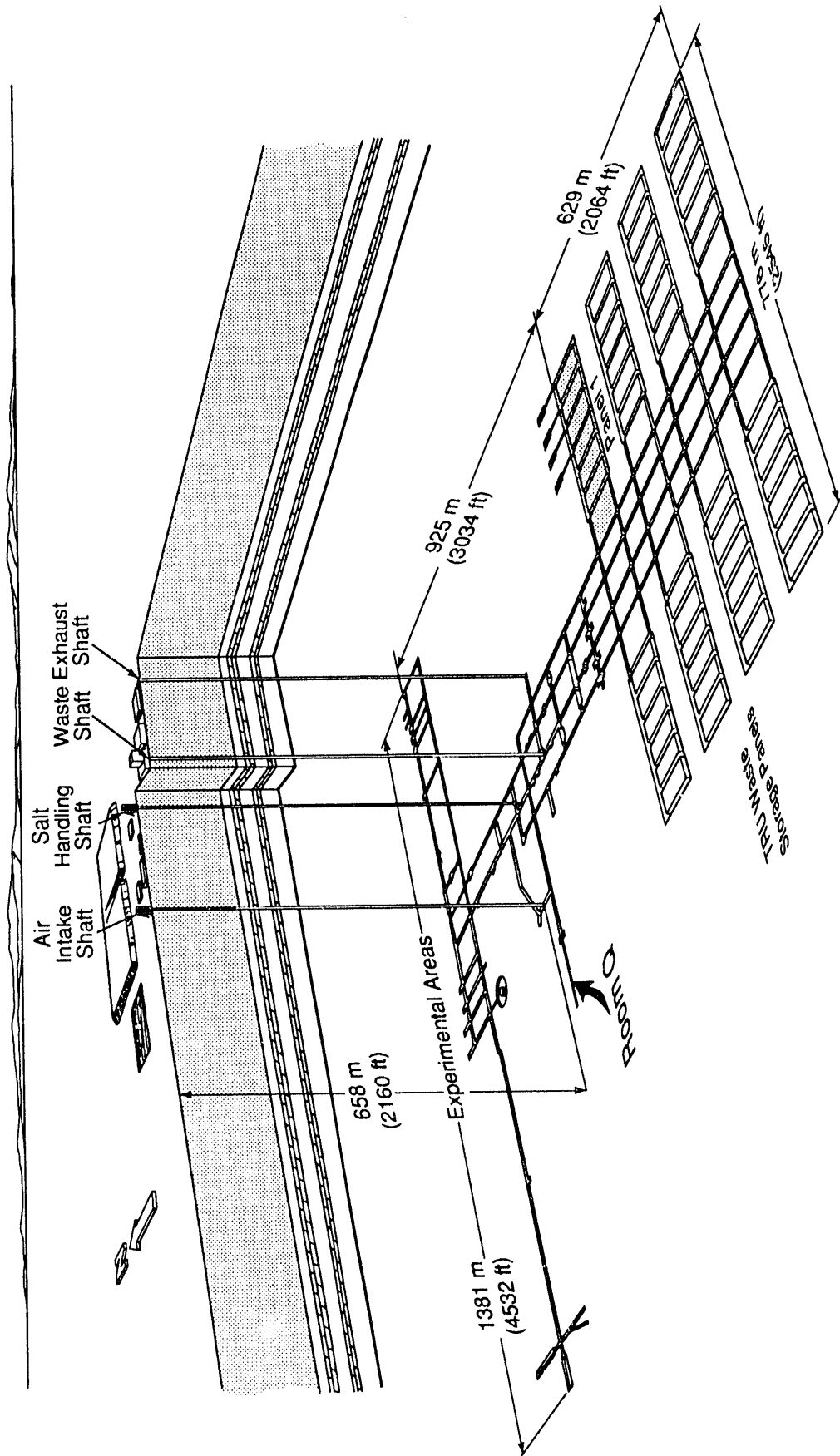
The Salado consists of three informal members: an upper member of halite interbedded with polyhalite, anhydrite, and sandstone; a middle member, the McNutt Potash Zone, composed of halite, sylvite, and langbeinite; and a lower member of halite with lesser amounts of anhydrite, polyhalite, and glauberite. The repository is located in this last and lowest member, 655 m below the land surface and about one meter above an anhydritic bed known as Marker Bed 139.

The lithologic layers that make up the Salado are nearly horizontal at the WIPP, having a regional dip of less than one degree.

2.2 Underground Facility Construction

Construction of the underground facility began in July 1981 when the first of four existing shafts was mined. Excavation with continuous miners then proceeded off and on for two years until the underground facility approached the size and shape shown in Figure 2-1. Of the eight storage panels shown, only Panel 1 has been mined to date; the other seven panels of the repository area are planned.

The underground rooms and drifts of the WIPP facility were excavated with continuous-mining machinery. Blasting techniques were not used. Creep



TRI-6346-59-18

Figure 2-1. The WIPP facility.

closure of the rooms began immediately after excavation, with early closure rates of several centimeters per year. Closure effects are discussed in Munson et al. (1989). Current plans call for each disposal room to be filled with up to 6,800 55-gallon steel drums of contact-handled (CH) TRU waste.

2.3 Room Q Development

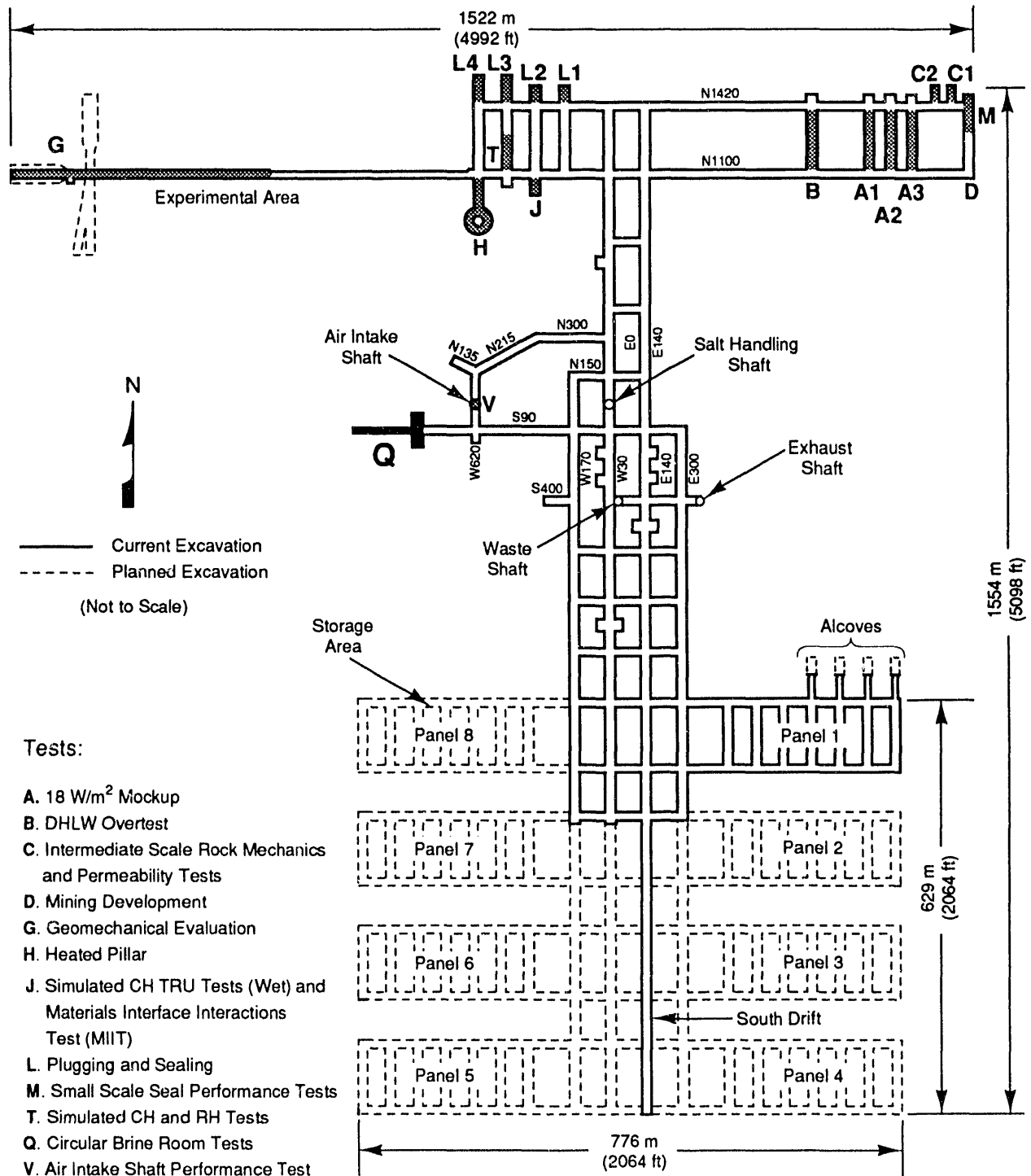
The focus of this report, Room Q, is one of several rooms developed for Sandia National Laboratories (SNL) tests. All such test rooms are identified with an alphabetic character. Figure 2-2 highlights these test rooms, situated mostly in the northern extent of the underground facility. Room Q is a recent (1989) excavation located approximately 92 m west-southwest of the Air Intake Shaft. Access to the room required construction of a drift extending westward from the existing ventilation airway.

2.3.1 Room Location Relative to Stratigraphy

Room Q was located in the upper host rock strata of the planned waste disposal stratigraphic interval--the same stratigraphy found in the repository rooms to the southeast--so that tests could be conducted in an isolated, undisturbed area where baseline (pre-mining) values for pressure and fluid flow could be established in a far-field location. The crown of Room Q was designed to peak at 2.1 m above the orange marker band (OMB), a thin layer of polyhalite and halite. The OMB is a distinctive reference stratum routinely used to establish grade for mining operations at the WIPP. Current design specifies that the roof of each waste disposal room should be approximately 2.1 m above the OMB and the floor of each disposal room should be 1.8 m below the OMB. The OMB was also used to guide excavation of the access drift and instrument area. Underground surveys indicate that the OMB drops about 1.5 m between Room Q and Panel 1, resulting in a slight negative grade to the southeast of less than 1/2%.

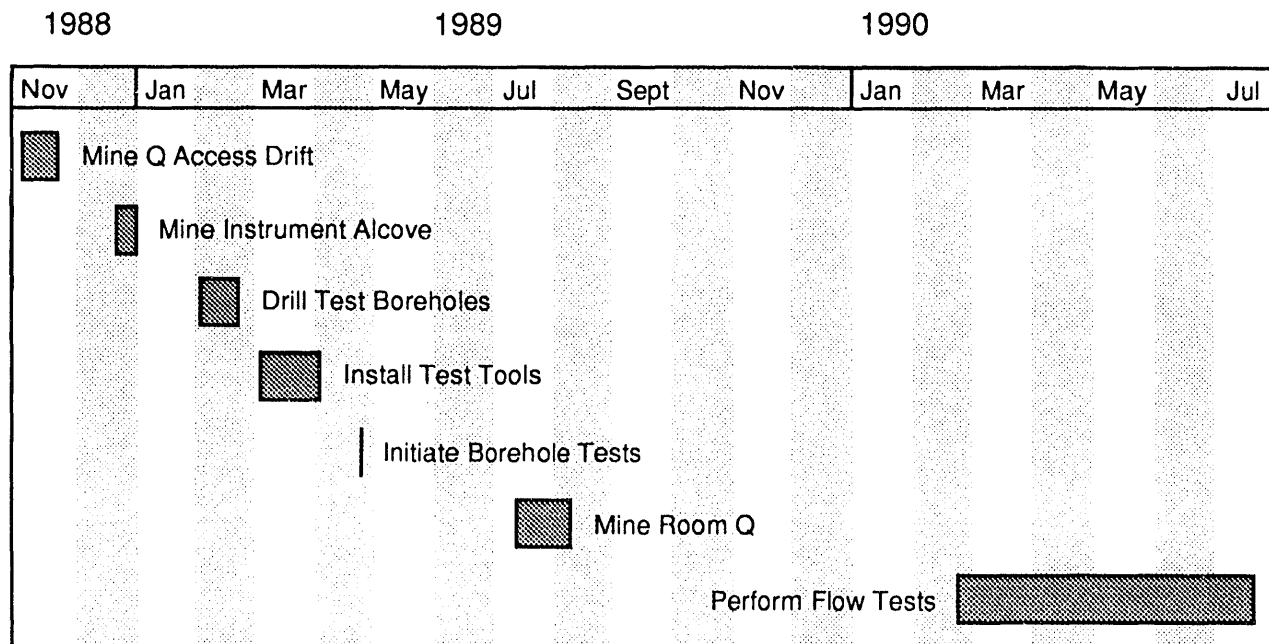
2.3.2 Access Drift and Instrument Alcove Mining

In November 1988 the Q access drift was completed to final length. The S90 drift was extended 91.4 m beyond the Air Intake Shaft. One month later the Room Q Instrument Alcove was mined. Figure 2-3 presents the development schedule for all Room Q activities beginning with the mining of the Room Q access drift in November 1988 and ending with the excavation of Room Q in August 1989.



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Figure 2-2. Location of Room Q.



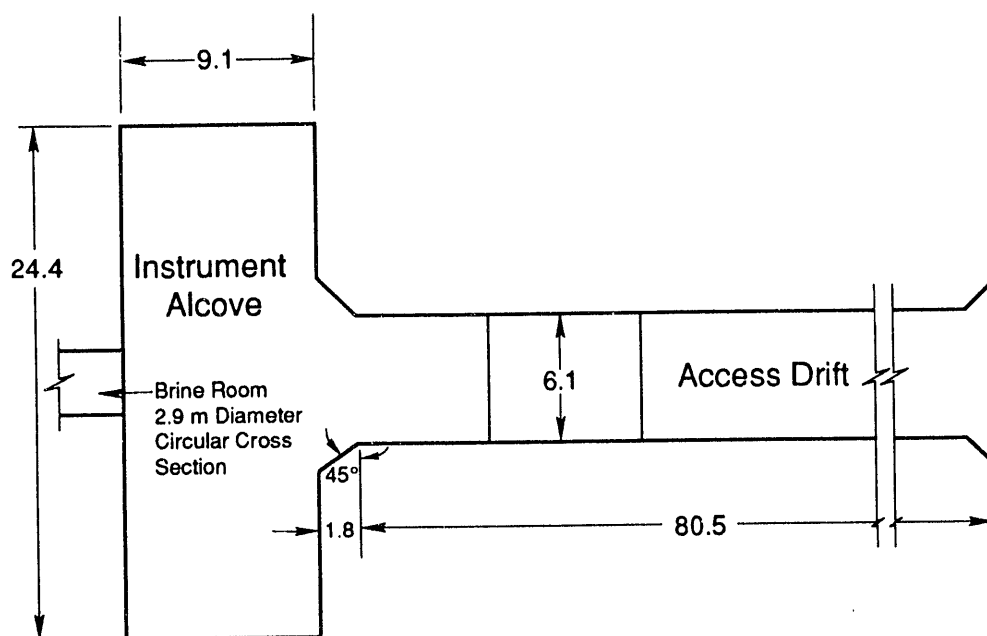
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Figure 2-3. Development schedule for Room Q activities.

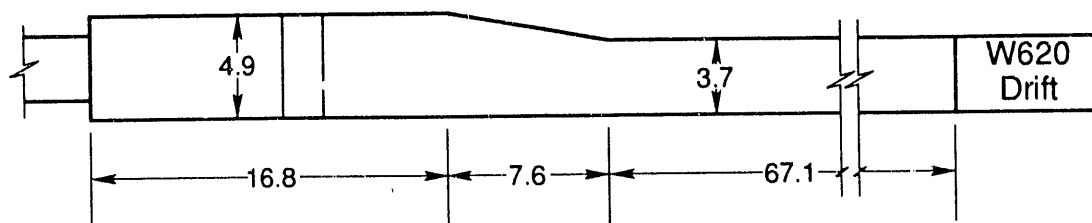
In December 1988, the west end of the Q access drift was enlarged to form a 24.4 x 9.1-m Room Q Instrument Alcove—a large area for housing instrument panels and data-acquisition equipment. The Instrument Alcove became the staging area for the borehole pressure tests.

Excavation of the Instrument Alcove involved mining a rectangular opening 4.9-m high by 9.1-m wide by 24.4-m long. Since the Room Q access drift was only 3.7 m high and did not provide enough clearance for tunnel boring and drilling operations, the roof height was increased to 4.9 m by angle cutting an additional 1.2 m over a horizontal distance of 7.6 m to form an inverted ramp at the entry to the Instrument Alcove. The Alcove then provided both an undisturbed wall to drill the test boreholes and ample space for instrument panels, a data-acquisition shed, tool maintenance, and equipment storage. The Instrument Alcove was also an ideal area for assembling and operating the tunnel-boring machine used to mine Room Q. Plan and elevation views of the access drift and the Instrument Alcove are presented in Figure 2-4.

Plan



Elevation



Note: All Dimensions in Meters

TRI-6119-4-0

Figure 2-4. Plan and elevation of the Instrument Alcove.

3.0 TEST BOREHOLES

The tests that are the focus of this data report were conducted in 15 boreholes drilled into the west face of the Room Q Instrument Alcove after the Alcove was mined. Because these boreholes were vital to the generation of an integrated data set, accurate drilling for test-region placement was crucial. The test boreholes were drilled and completed between February 15 and March 23, 1989. All but three holes were lined and grouted to isolate a test region deep within the formation. The three holes farthest from the intended location of Room Q were left unlined to accommodate the three 8.9-cm tools left from previous testing.

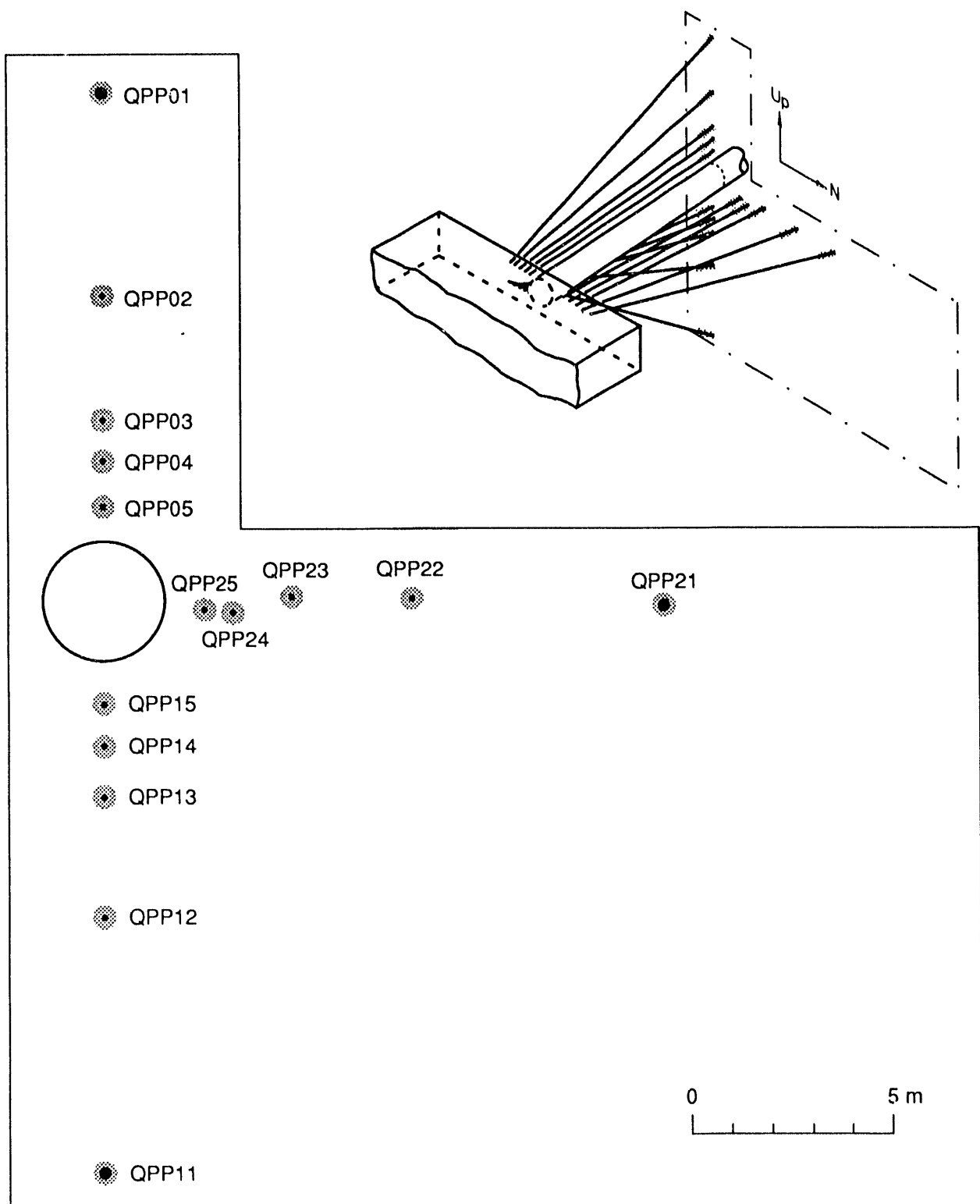
3.1 Borehole Locations

Figure 3-1 shows the final location of the test boreholes relative to the Instrument Alcove. The Alcove and the boreholes are represented in both two- and three-dimensional perspectives. The plane circumscribed by the phantom lines in the three-dimensional drawing corresponds to the border around the figure and represents a slice of the stratigraphy 23 m west of the Instrument Alcove. Note that test holes QPP01 through QPP05 slope up at oblique angles relative to the Instrument Alcove and terminate in a vertical plane above Room Q. Holes QPP11 through QPP15 slope down at oblique angles from the Alcove and terminate in a vertical plane below Room Q. Holes QPP21 through QPP25 fan out from the Alcove and terminate in a horizontal plane north of the center of Room Q.

As shown in Figure 3-1, all test zones lie in a plane that extends radially outward from the proposed cylindrical brine room. One group of test zones extends vertically upward, another vertically downward, and another horizontally northward. The collars of the boreholes are located at the Instrument Alcove west face. All of the test boreholes extend approximately 23 m west from the collars, forming test regions of approximately 2 m in length. The test regions include both the test zones and guard zones. The test zones are the deepest zones in the test regions.

3.2 Drilling

As shown in Figure 3-1, the Room Q tests required a complex array of holes drilled into the west wall of the Instrument Alcove. The boreholes were drilled with a Diamec 230 dual-column mounted rotary drill. All test boreholes began with a 10.2-cm-diameter opening until they reached the approximate length designated for the test region. Holes QPP01, QPP11, and



TRI-6119-233-0

Figure 3-1. Final location of test boreholes.

QPP21 (holes farthest from Room Q) were intended to contain 8.9-cm-diameter tools, so they were drilled at 10.2 cm to the end of the test region and were not cased and grouted. The remaining holes were designated to hold 3.5-cm tools, so drilling with the 10.2-cm bit was stopped short of the test region. The 3.8-cm slim hole test regions were drilled later. First a 6.0-cm outside diameter steel casing was inserted in the hole and grouted. Then a tapered centering plug on the end of the casing was used to guide the drill for later drilling of the slim hole test regions.

The drilling plan called for 15 holes with endpoints placed at precise locations deep within the salt. Three groups of five holes were planned to terminate in a plane intersecting the +30.5-m station point of Room Q: 5 above, 5 below, and 5 horizontal. These skewed boreholes presented a challenge to surveyors and drillers, since they had to be drilled at different oblique angles and to different depths in order to terminate in the same plane. The challenge was overcome by first marking and drilling a set of practice holes in the N1420 drift between Rooms 2 and 3 in the north end of the Experimental Area. These practice holes were successfully completed, and they provided the setup procedures used to drill the test holes in the Instrument Alcove. First, computations were made to determine angles, total depths, collar locations, and corresponding backsights for each hole. Then surveyors located and marked foresights, backsights, and hole labels on the Instrument Alcove ribs. (The holes for these tests were labeled "QPP": "Q" indicates the test room and "PP" identifies the pore pressure tests.) The final step involved setting up and properly aligning the drill, which was accomplished by chaining a section of drill rod to the marked collar location (foresight), then aligning the drill with a stringline stretched tightly through the hollow rod towards the backsight mark. The drill-rig frame was carefully adjusted using come-alongs and clamps until the stringline and drill rod axis were concentric.

All QPP holes were started with a 10.2-cm-diameter diamond plug bit, except QPP05. This last hole was cored with a 10.2-cm-diameter diamond core bit so that a core sample could be obtained. Unfortunately, none of the retrieved core was acceptable for logging purposes: the sample fractured into small grains that were impossible to recover as a core.

For the initial stage of drilling, the 10.2-cm-diameter bits were used instead of the smaller diameter bits because large holes provide more control when drilling a straight line. Holes QPP01, QPP11, and QPP21 were all drilled to total depth with the 10.2-cm-diameter bit. The remaining twelve test holes were stopped about 2 m short of total planned distance and then fitted with steel casing, a PVC cap, and grout. The as-built length, diameter, collar coordinates, angle, and drill dates for the initial drilling

of each borehole are presented in Table 3-1. Table 3-1 was created from actual survey results. Underground surveys at the WIPP utilize a local rectangular coordinate system established by WIPP engineers, as described in Gonzales (1989). Under this system, coordinates are based on a marker located at the corner common to sections 20, 21, 28, and 29 in Township 22S, Range 31E. The WIPP engineers modified the state-plane coordinates of this marker by subtracting 66,000 ft from the east coordinate and 49,000 ft from the north coordinate. The resulting numbers have fewer digits and are thus easier to use. They also are more appropriate to the scale of the WIPP underground. Table 3-1 was developed from survey results reported in U.S. units of feet and inches. For this report, the units were metricized for consistency.

Note that the total depths of QPP01, QPP11, and QPP21 (the 10.2-cm holes located farthest from Room Q) are greater than the depths of the other 12 holes because they were drilled to total depth during the initial drilling stage.

Table 3-1. As-built Data for Test Boreholes (Initial Drilling Stage)

Hole Number	Collar Coord. North (m)	Collar Coord. East (m)	Collar Coord. Elev. (m)	Drill Date(s)	Depth of Hole (m)	Diam. of Hole (cm)	Vert. Drill Angle (deg.)	Horiz. Drill Angle (deg.)
QPP01	2918.23	1816.52	388.61	3-7-89 to 3-8-89	26.37	10.16	27.426	12.832
QPP02	2918.82	1816.53	388.59	3-6-89	22.65	10.16	14.599	10.755
QPP03	2919.42	1816.58	388.56	3-4-89 to 3-5-89	21.40	10.16	6.920	9.174
QPP04	2920.05	1816.60	388.57	3-3-89 to 3-4-89	23.13	10.16	4.111	7.976
QPP05	2920.65	1816.63	388.61	2-27-89 to 3-3-89	21.03	10.16	1.925	5.922
QPP11	2918.19	1816.60	386.17	2-21-89 to 2-22-89	26.64	10.16	-29.017	12.095
QPP12	2918.81	1816.60	386.18	2-18-89 to 2-20-89	22.80	10.16	-16.298	11.153
QPP13	2919.43	1816.61	386.18	2-17-89 to 2-18-89	21.52	10.16	-9.522	9.315
QPP14	2920.04	1816.62	386.17	2-15-89	21.79	10.16	-6.577	7.735
QPP15	2920.64	1816.65	386.16	2-7-89 to 2-9-89	21.09	10.16	-3.870	6.126
QPP21	2927.92	1816.65	387.88	3-13-89 to 3-15-89	24.54	10.16	-2.250	20.599
QPP22	2927.32	1816.64	387.87	3-11-89 to 3-13-89	21.70	10.16	-2.001	8.651
QPP23	2926.71	1816.69	387.89	3-11-89	20.94	10.16	-1.929	2.213
QPP24	2926.08	1816.67	387.85	3-10-89	21.49	10.16	-2.839	0.135
QPP25	2925.50	1816.67	387.88	3-10-89	20.91	10.16	-2.726	0.000

3.3 Borehole Completion

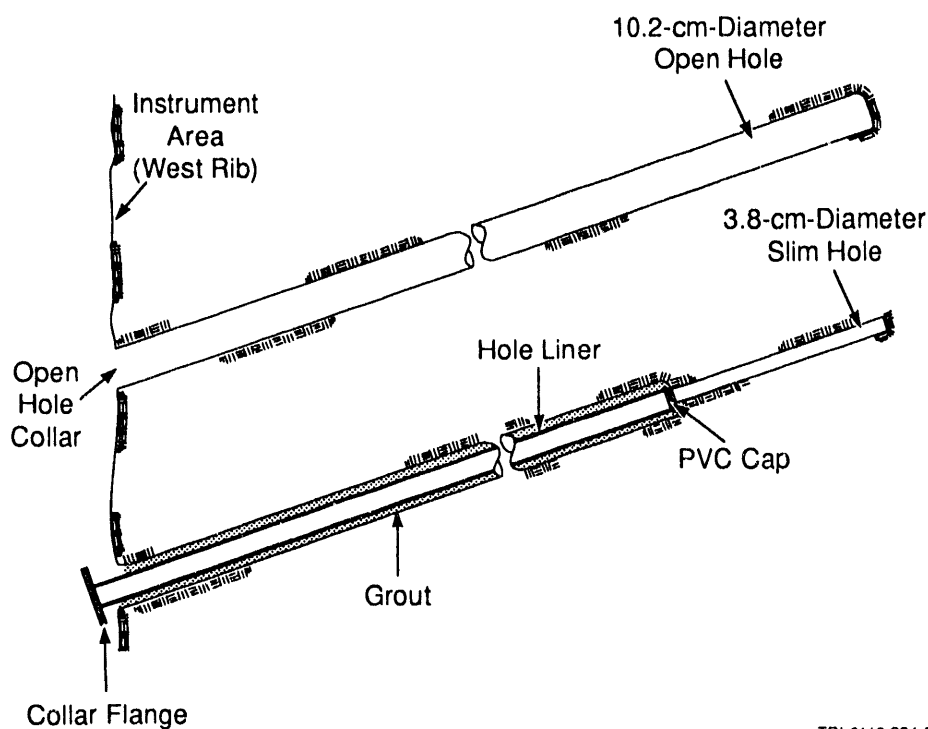
After all 15 boreholes were drilled, the 12 shorter holes were "completed" by the insertion of a steel pipe into the borehole. Figure 3-2 shows the two variations of holes created for the tests. The first variation is an open hole with no casing or grouting requirements, measuring 10.2 cm from end to end, and ready for tool emplacement as drilled. The second variation is a cased hole with a narrower, slim hole test region. The casing used to line the finished holes was made of schedule 60 wrought steel. Each pipe was cut to fit the specific length of each cased hole and fitted with a welded flange collar. A polyvinyl chloride cap was permanently attached to the casing end to serve as a centering device and to prevent grout and debris from filling the pipe during insertion and later grouting of the pipe in the hole.

An annulus of approximately 2.1 cm was formed between the wall of the borehole and the outer wall of the pipe. Grout was injected to completely fill the annulus and secure the pipe. Lining the 12 holes with casing and grout provided several advantages over unlined or open holes. First, the lining limited deformation and fracturing along the entire borehole length. Second, only brine from a defined interval in the last 2 m of the hole could enter the hole. Third, the casing and cap acted as a guide for the final slim hole drilling operations and tool installation.

After a curing period of at least 7 days, the drill was set up to re-enter the lined holes with a smaller-diameter bit and rod. A solid-faced, 3.8-cm diamond plug bit penetrated the PVC cap at the back of the hole to complete the final 2 m of drilling, finishing the slim hole test region. These regions were subsequently divided into test and guard zones after installation of the test equipment.

The final drilling results are presented in Table 3-2. Final depth coordinates in this table are based on the same coordinate system as described for Table 3-1. Note, for example, that hole QPP02 was initially drilled at 10.2 cm to a length of 22.6 m on March 6 (see Table 3-1). The hole was cased and grouted and allowed to cure until March 23, when it was drilled to total depth of 24 m with the 3.8-cm plug bit. Detailed drilling logs for all test boreholes are provided in Appendix B. The as-built coordinates given in Tables 3-1 and 3-2 were derived from the field survey notes, drill logs, laser alignment data, and hole deviation data that is also listed in Appendix B.

Drilling operations were successful, with all holes terminating within one degree of the theoretical locations specified in the Test Plan.



TRI-6119-234-0

Figure 3-2. Open and cased boreholes.

Table 3-2. Final Drilling Results

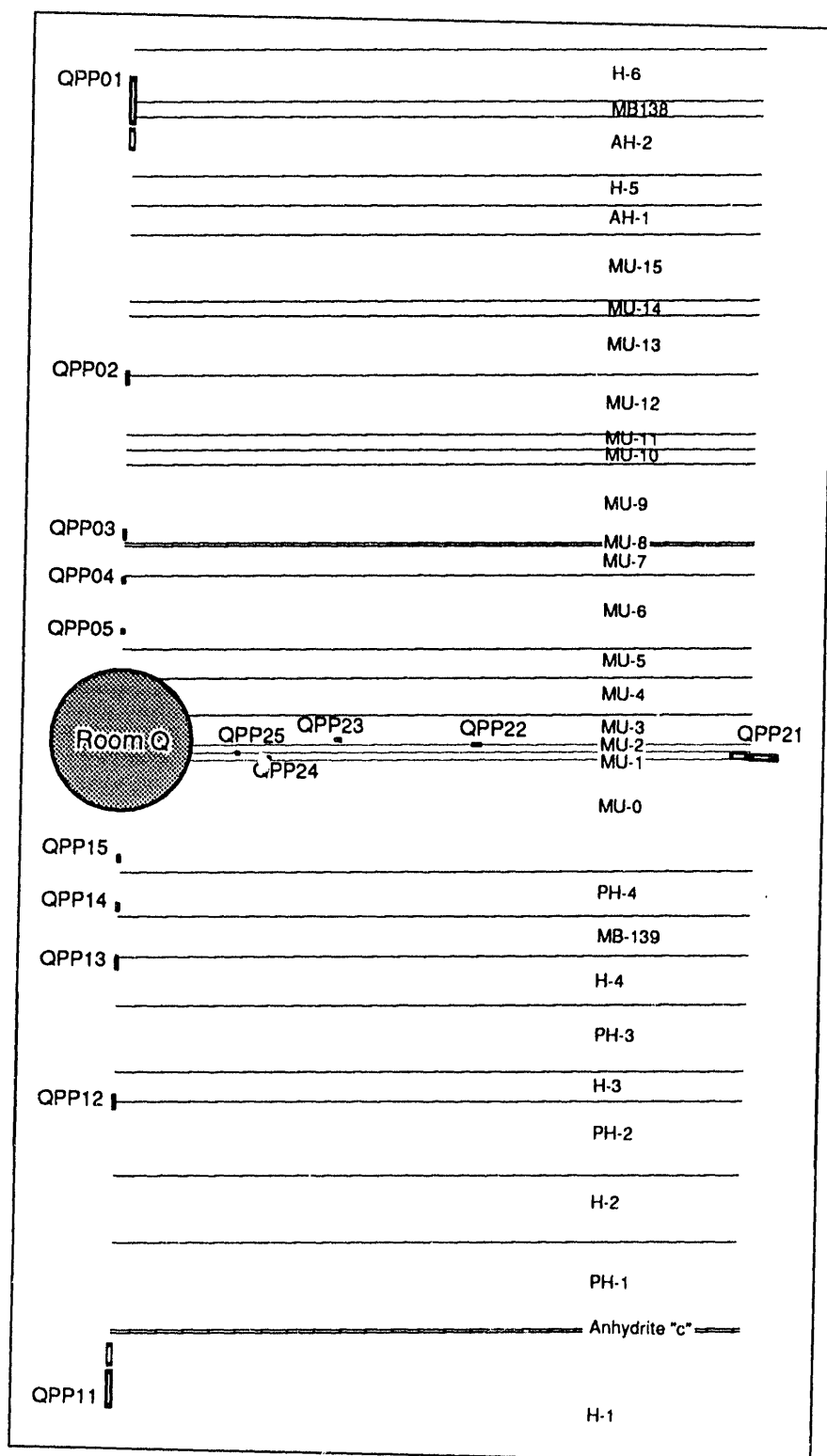
Hole Number	Final Depth Coord. North (m)	Final Depth Coord. East (m)	Final Depth Coord. Elev. (m)	Drill Date (s)	Total Depth of Hole (m)	Diam. of Hole (cm)
QPP01	2923.43	1793.71	400.75	3-7-89 to 3-8-89	26.37	10.16
QPP02	2923.16	1793.67	394.65	3-23-89	24.05	3.81
QPP03	2923.09	1793.70	391.38	3-23-89	23.35	3.81
QPP04	2923.45	1792.37	390.38	3-23-89	24.54	3.81
QPP05	2923.04	1793.90	389.30	3-23-89	22.98	3.81
QPP11	2923.08	1793.82	373.25	2-21-89 to 2-22-89	26.64	10.16
QPP12	2923.31	1793.80	379.39	2-24-89	24.20	3.81
QPP13	2923.17	1793.79	382.30	2-24-89	23.44	3.81
QPP14	2923.14	1793.79	383.52	2-24-89	23.20	3.81
QPP15	2923.09	1793.80	384.61	2-27-89	23.04	3.81
QPP21	2936.54	1793.71	386.91	3-7-89 to 3-8-89	24.54	10.16
QPP22	2930.49	1793.81	387.07	3-20-89	23.10	3.81
QPP23	2927.59	1793.83	387.12	3-20-89	22.89	3.81
QPP24	2926.13	1793.83	386.71	3-21-89	22.86	3.81
QPP25	2925.50	1793.82	386.79	3-21-89	22.86	3.81

3.4 Borehole Surveys

After drilling, an optical survey was performed to locate the collar and corresponding backsight coordinates used to align the drill. By placing a laser in the hole and pointing it back out towards the backsight, the actual drill alignment was measured. Hole deviation or curvature was measured with in-hole magnetic surveys. Using these hole-direction measurements along with hole lengths from drilling logs, the as-built coordinates that define the back of the hole were derived.

The borehole surveys showed that the test regions intersect the host rock around Room Q in a plane approximately 23 m from the wall of the Instrument Alcove. Figure 3-3 shows the location of these test regions relative to the stratigraphy around Room Q, assuming that stratigraphic makeup is constant throughout the repository. The figure combines a vertical projection of the local stratigraphy and a projection of the borehole test region locations. The stratigraphic projection is based on the map units listed in Appendix A. Data on near-field WIPP stratigraphy were obtained from studies conducted by Deal et al. (1989). The borehole-test-region locations are derived from the survey data, which is presented in Appendix A.

Figure 3-3 illustrates the stratigraphic layers intersected by each of the test boreholes and shows how the test regions appear in one slice of the stratigraphy 23 m west of the borehole collars.



TRI-6119-246-0

Figure 3-3. Test regions relative to extrapolated WIPP stratigraphy.

4.0 TEST EQUIPMENT

This section describes the test tools and instruments used to conduct the borehole tests in the host rock surrounding Room Q. Equipment calibration methods are also discussed. Test equipment included single-packer and dual-packer test tools, data-acquisition instruments, a constant-pressure fluid volume measurement system, and devices to measure borehole diameter.

4.1 In-Hole Test Tools

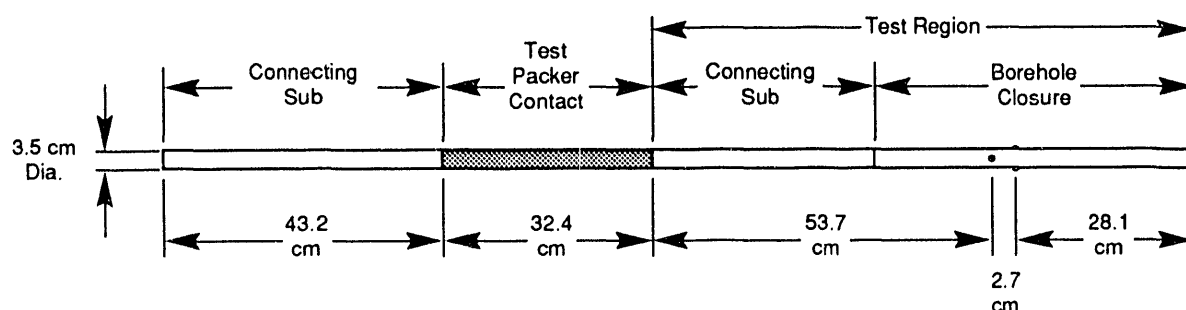
Three different tool configurations were used in the tests. The large-diameter holes accepted the 8.9-cm dual-packer tools. The small-diameter holes held the 3.5-cm single-packer and dual-packer test tools. All the packers were designed and built specifically for the borehole-testing program by TAM International of Houston, TX. All the tools isolated a test zone at the bottom of the borehole. The test zone extended from the bottom of the hole to the seal contact of the deepest packer. The dual packers provided an isolated guard zone in addition to the test zone. The guard zone was the area between the seals of the two packers. All the packers had sliding ends. In the slim tools, these ends were oriented away from the guard zones on the dual-packer tools and away from the test zone on the single-packer tools. In the large holes, the sliding ends were oriented toward the top of the hole. All tools were mounted on an open mandrel through which stainless steel tubing and wiring passed, connecting the closure gauges, packers, test zone, and guard zone with the transducers and instruments in the Instrument Alcove. Injection and vent ports to the test and guard zones enabled technicians to apply underpressures and overpressures to the isolated zones. Borehole-closure measuring devices were mounted on the lower end of the test-tool assembly. Packer-inflation pressures were monitored by transducers attached to the packer-inflation lines. Thermocouples measured test-zone temperatures in the three 8.9-cm dual-packer tools. Additional thermocouples were attached to the slim-hole tools at the outer end of the slim hole for monitoring temperature changes during mine-by.

4.1.1 The Slim-Hole Single-Packer Test Tool

Six of the 12 slim-hole tools were single-packer tools. The single sliding-end packer test tool shown in Figure 4-1 formed one test zone within the borehole. It held one 3.5-cm outside-diameter packer mounted on an open mandrel. The packer had a 50.8-cm-long, inflatable 6101-natural-rubber

element with a seal length of approximately 40 cm in a 3.8-cm-diameter borehole. The test-zone length in the six single-packer holes was 85 cm.

The downhole sections of the test tool had an outside diameter of 3.5 cm in order to minimize the brine volume in the 3.8-cm-diameter hole. Minimizing the brine volume within the test zones reduces the response times to applied pressure pulses, allowing more rapid equilibration between borehole and formation pressures.



TRI-6119-240-0

Figure 4-1. Slim-hole single-packer test tool.

4.1.2 The Slim-Hole Dual-Packer Test Tool

The dual-packer tools isolated both a test zone and a guard zone. Guard zones can be used to detect leakage or to secure additional measurements.

The dual-packer test tool used two 3.5-cm outside-diameter sliding-end packers mounted on an open mandrel. Each packer had two 50.8-cm-long, inflatable 6101-natural-rubber elements that had a borehole seal length of about 40 cm in a 3.8-cm-diameter borehole. The downhole sections of the test tool had an outside diameter of 3.5 cm. When inflated, the dual packers isolated a 14-cm guard zone and a 90-cm test zone. In the slim-hole tools, the sliding ends were opposing and the fixed ends were adjacent to the guard zone. As the packers inflated, the sliding ends moved in response to the expansion of the rubber. The sliding ends moved toward the guard zone along the mandrel as the packer inflated. Guard-zone length was relatively fixed in these holes because most of the packer movement was at the top and bottom of the tool. The slim-hole dual-packer tool is shown in Figure 4-2.

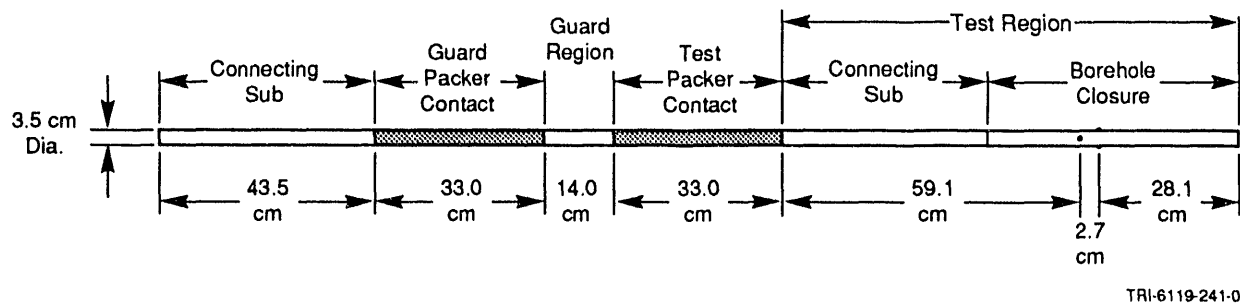


Figure 4-2. Slim-hole dual-packer test tool.

4.1.3 The Large-Hole Dual-Packer Test Tool

The dual-packer 8.9-cm-diameter tools were installed in the three uncased boreholes farthest from Room Q. The large-hole dual-packer tool held two sliding-end, 8.9-cm outside-diameter inflatable packers mounted on a 4.8-cm outside-diameter mandrel and oriented with the fixed ends toward the bottom of the hole. The packers had two 92-cm-long inflatable rubber elements that had an 81-cm seal length when inflated in the 10.2-cm-diameter hole. The dual-packer tools formed a guard zone 76 cm long. Test zones lengths in the three open holes ranged from 135 to 188 cm.

Each dual-packer tool was equipped with ports to connect the test zone, guard zone, and packers to the control panel. One electrical bundle contained the wire bypass that transmitted electrical signals from the closure gauges and the thermocouples. Figure 4-3 shows the 8.9-cm dual-packer tool and the nominal dimensions of the tool parts.

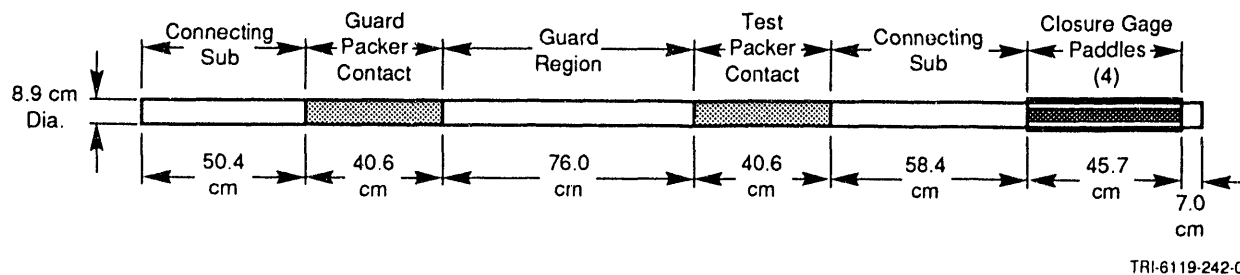


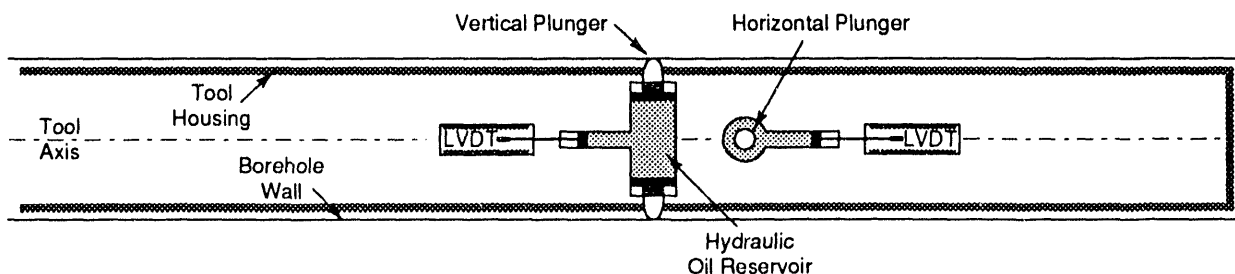
Figure 4-3. Large-hole dual-packer test tool.

4.1.4 Closure-Measurement Devices

Closure-measurement devices were made up and then installed in the downhole section of the tools. The devices were attached to the packer assembly with steel pins. Two types of closure-measurement devices were used: a hydraulically actuated, opposing plunger closure gauge in the slim holes; and a mechanically actuated, opposing plate gauge in the large holes.

The 3.5-cm tool closure gauge consisted of two sets of opposing plungers. The plungers made point contact with the borehole. Each set of plungers transmitted its diametrical change via a hydraulic reservoir to a linear variable-differential transformer (LVDT) mounted on-axis in the tool. An on-axis piston moved the LVDT core. The magnitude of the voltage output from the LVDT varied directly with the diameter of the borehole. The application of calibration coefficients converted this signal into engineering units. However, the hydraulic reservoirs in these closure gauges appear to have developed air bubbles during the testing phase. The existence of gas bubbles in the hydraulic reservoir is documented in the field test notes for June 1990. Several attempts were made to quantify the approximate size of these gas bubbles. The closure data for the slim holes should be viewed with skepticism since it is unclear whether the measurements reflect actual borehole closure or instead result from the compressibility of the small gas bubbles. The opposing plunger closure gauge is shown in Figure 4-4.

The 8.9-cm tool closure gauges consisted of two sets of opposing paddles that contacted the borehole along a 45.7-cm length. An LVDT was mounted between each set of opposing paddles; it measured the total diametrical change of the paddles as the hole closed in the vertical and horizontal axes. These mechanical closure gauges gave true borehole diameters. Borehole deformation changes were then calculated during data reduction.



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Figure 4-4. Schematic of the vertical and horizontal slim-hole closure gauges.

4.2 Instruments

The instruments used in the borehole tests included flowmeters, pressure transducers, differential pressure transducers, thermocouples, and LVDTs. Most of the instruments used were housed in cabinets in the Instrument Alcove.

4.2.1 Flow Meters

Flow testing with the 8.9-cm tools was monitored through a control and flow manifold consisting of individual flow-control panels for each of the three tools. In addition, the flow-control manifold contained a number of brine supply/inflow reservoirs to supply brine to the test and guard zones. Two systems measured inflow and outflow of brine from the test zone. Two additional systems measured inflow and outflow from the guard zones.

4.2.2 Transducers

Test- and guard-zone fluid pressures were measured to within 1 kPa, and fluid volumes were measured to within 0.01 cc using transducers calibrated to a National Institute of Standards and Technology (NIST) reference. The fluid and inflation pressures in the test zones, guard zones, and packers were monitored with externally mounted Foxboro/ICT model 1225 and Data Instruments model SA transducers. Sensotek AD111 AP differential pressure transducers monitored zone inflow and brine volumes in the slim-hole tools.

Each transducer was calibrated only once, before test installation, according to procedures described in Section 4.4. The transducers were mounted outside the boreholes on the control panels located in the Instrument Alcove. They were connected to the test and guard zones and packers via 0.32-cm outside-diameter stainless steel tubing, which was fed through the mandrel to the monitored zones.

4.2.3 Linear Variable-Differential Transformers

An LVDT converts mechanically sensed borehole diameters into an output voltage by responding to the position of a magnetic core relative to a surrounding coil. This type of instrument is capable of accurately detecting very small changes in borehole diameters. Each closure gauge (two in each

test zone) was fitted with an LVDT, resulting in a total of 30 for these tests. The LVDTs were located inside the tool body. The LVDTs used in the borehole tests were manufactured by Trans-Tek Inc.

4.2.4 Thermocouples

Because the thermal expansion of water in an isolated test zone can have a significant effect on the measured fluid-pressure response during testing, the three 8.9-cm dual-packer test tools were equipped with a thermocouple in the test zone. The remaining slim-hole tools were equipped with two thermocouples mounted outside the test region. These latter thermocouples allowed the instrument operators to monitor the thermal effects from excavation; however, because of their location, they could not be used for interpretation of test-zone data. All thermocouples were equipped with weather-sealed connectors and junction boxes for protection from the saline environment of the WIPP underground facility.

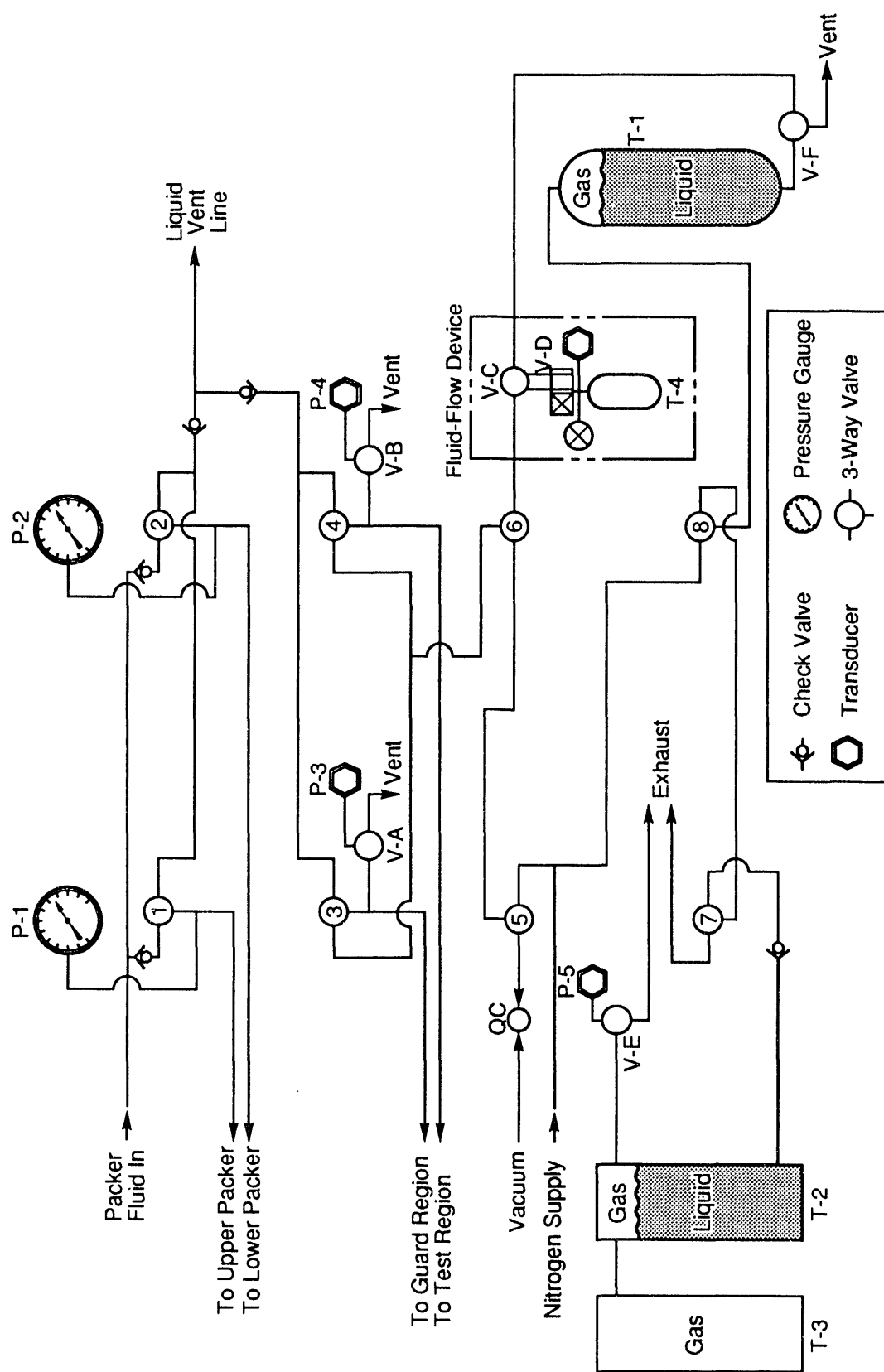
4.3 Fluid Flow Systems

The fluid-flow systems used in the borehole tests were actuated by compressed gas. Figure 4-5 is a schematic representation of the fluid-flow system for the large tools. Figure 4-6 represents the fluid-flow system for the small tools and the packer-inflation and test-region fluid-management systems for each of the slim-hole tools.

4.3.1 Test-Zone Fluid-Flow System

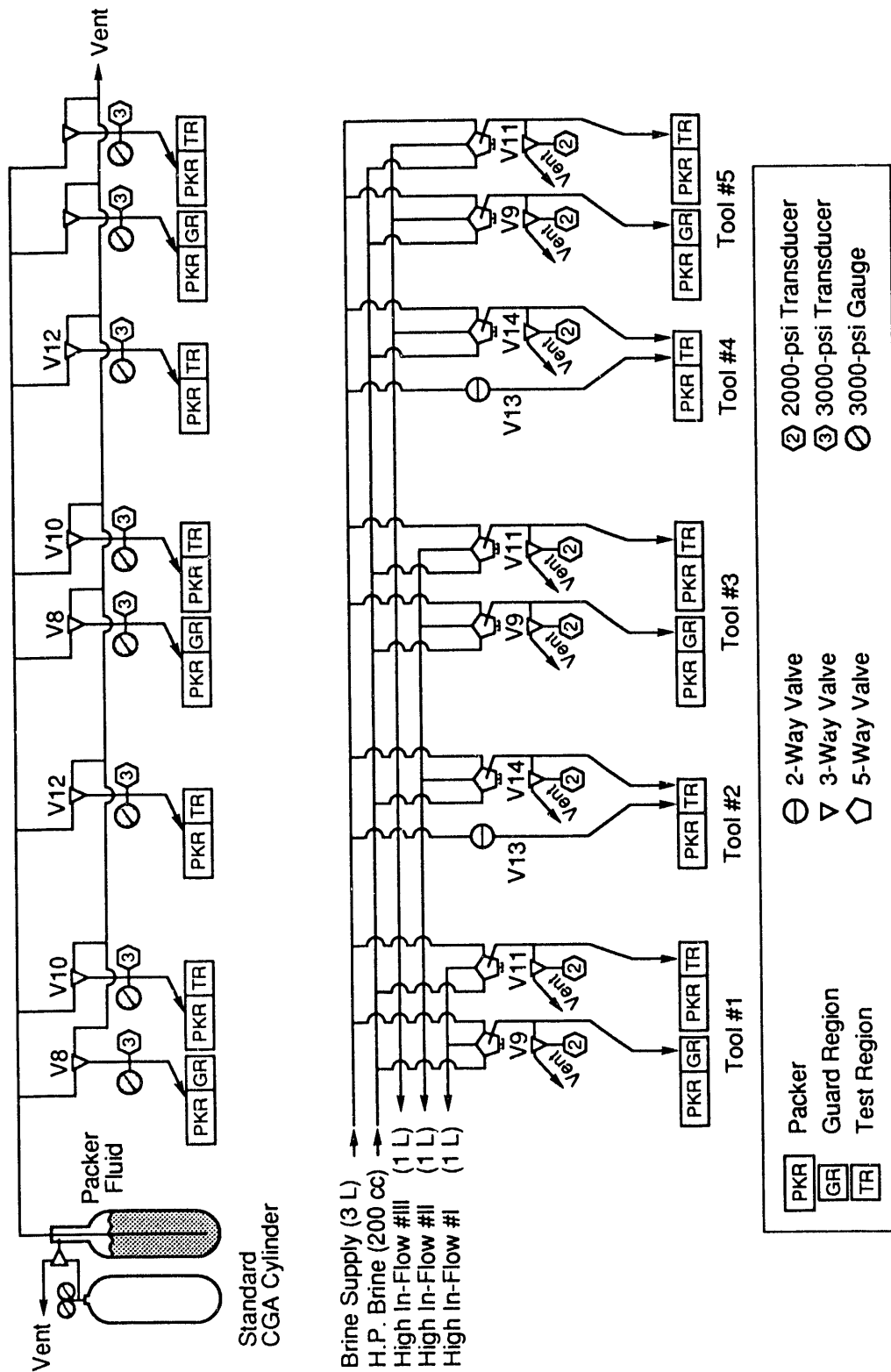
The fluid-injection system was the same for all the tools, but the method used to inject fluid into the test and guard zones varied depending on the angle of the borehole in the salt. The tools that were angled upward required that a vent be placed near the end of the hole and that the fluid be injected at the outer, guard-zone packer. The entire test region was filled with brine. A vacuum was usually drawn on the test region during filling to eliminate any trapped air pockets that could change the compressibility of the test region.

The holes that were angled downward or horizontally were easier to fill. The test region could be filled before the tool was positioned in the borehole and the packers had been inflated. In all cases, the outermost packer was inflated first to isolate the test region. Efforts to eliminate trapped gases were followed in all holes.



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Figure 4-5. Fluid-flow handling system, large tools.



TRI-6119-250-0

Figure 4-6. Fluid-flow handling system, small tools.

The fluid-injection system consisted of a brine reservoir and a low-pressure gas supply regulated at 68 kPa. Using the low-pressure gas supply and selecting the proper valve for each tool, the test region was filled with brine until all the air in the hole was displaced. After the test regions were filled with brine, the valves were closed. The packers that isolate the test zones from the guard zones were then inflated. Figure 4-7 is a schematic representation of the low-pressure brine-injection system.

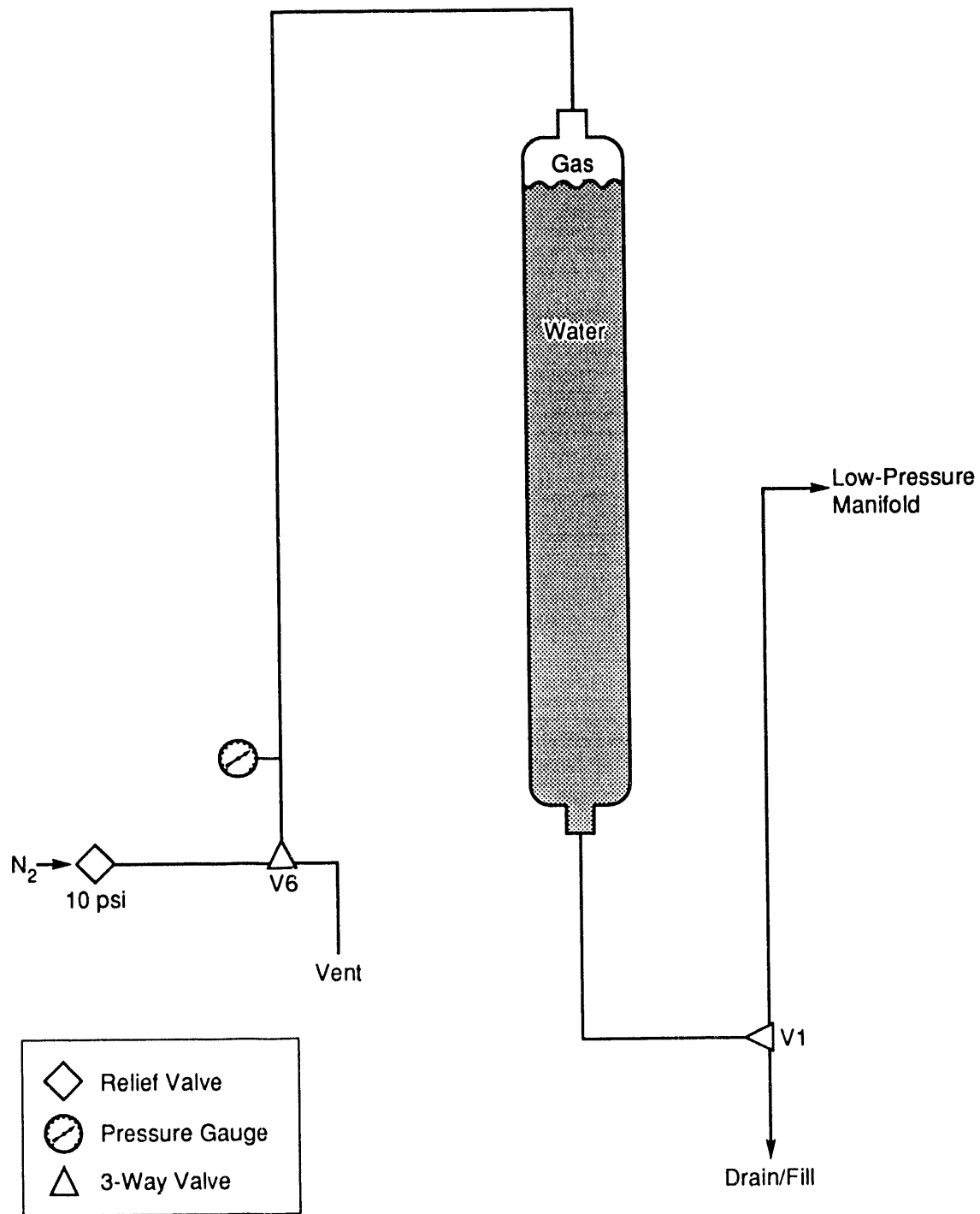
4.3.2 Constant Pressure Injection/Withdrawal System

During the flow testing phase, it is important to know the pressure at which the brine is flowing into or out of the formation. To accomplish this pressure monitoring, each of the slim-hole tool control panels is equipped with an instrument that measures the amount of brine injected or withdrawn from the test region at a preselected constant pressure. Each instrument consists of three stainless-steel tubes of the same diameter. Figure 4-8 illustrates the configuration of the system and the flow paths that relate to the injection/withdrawal measurement system. The leftmost tube provides the reservoir for injecting or collecting brine from the test region. The center tube is used as a buffer for the gas head supply. The rightmost tube is filled with a measured volume of brine; this is the reference volume. Because the three tubes are the same diameter and length, any brine volume in the left tube can be directly related to the volume in the reference tube. The volume is measured with a differential pressure gauge located between the bottom of the reference tube and the bottom of the collection tube. Since both sides of the gauge are influenced by the injection/withdrawal pressure head supplied by the compressed nitrogen, the difference in the pressure head of the two tubes is the ratio of the brine-column height in the reference tube to the brine-column height of the fluid in the injection/withdrawal tube.

4.3.3 Packer Fluid-Handling System

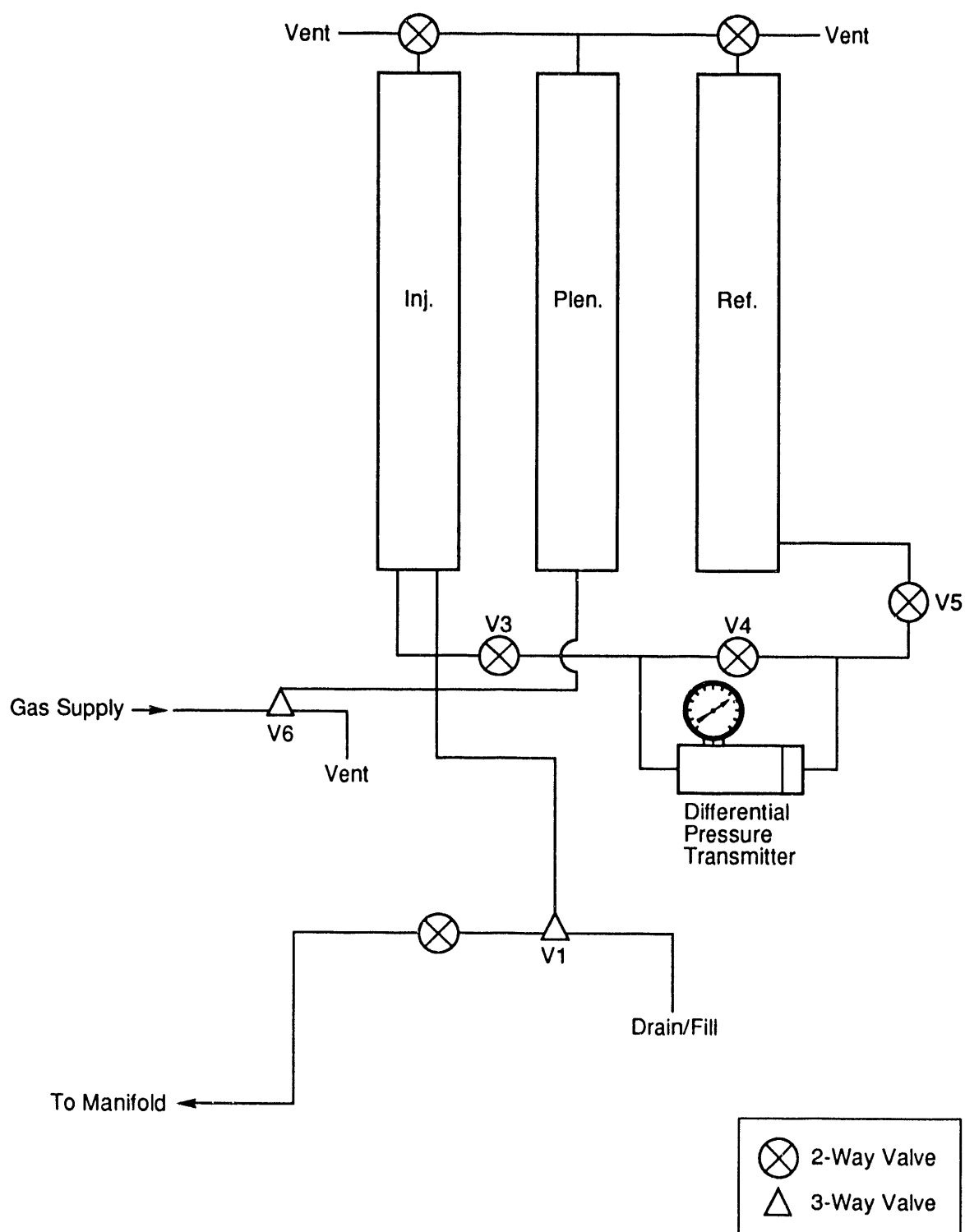
The packer-inflation method is similar to the method used for injecting brine into the test region; however, the system operates under high pressure and uses fresh water as the injection fluid.

After the lines connecting the packers have been flushed free of gases and the tool is positioned in the borehole, the packers can be inflated. Packer inflation is accomplished by filling the supply reservoir tank with fresh water and then connecting a compressed nitrogen bottle and regulator to the top of the reservoir. The regulator on the gas bottle is adjusted to the



TRI-6119-248-0

Figure 4-7. Low-pressure brine-injection system.



TRI-6119-251-0

Figure 4-8. Slim-hole brine-measurement system.

pre-selected packer-inflation pressure. Then the valve to that packer is opened, allowing fluid in the pressurized reservoir to flow into the inflatable rubber element and pressurize the packer. After the packer pressure stabilizes, the packer is shut in, and the pressure is removed from the fluid supply reservoir. Adjustments to packer pressures are accomplished using the same technique.

The packer-inflation plumbing and manifold connections for both large and small holes are presented above in Figures 4-5 and 4-6.

4.4 Data Recording System

A computer-controlled data-acquisition system (DAS) monitored the progress of the tests and recorded output from the transducers, thermocouples, and LVDTs. The DAS contained a line conditioner, power supplies to activate the sensors, a digital voltmeter to read the sensor signals, and a microcomputer to control test progress and store and process the data. The DAS was designed to accept and condition signals from the large variety of sensors and equipment used in the borehole tests. All pressure transducers and flow-measurement systems were contained in the control panel/DAS cabinet. Packer and zone pressures were displayed by dial gauges and digital meters for operational purposes and were monitored as part of daily maintenance. The high-pressure system had a 15 MPa maximum allowable working pressure. Transducers used in pressure measurements were located on the control panel. The DAS and general configuration of the test control panels and computer station are shown in Photo 4-1.

The DAS consisted of a Leading Edge computer using Labtech Notebook software to monitor the data. All pressure, flow, and closure data were transmitted to the computer using HANZON 4000 series 20 channel (16 input and 4 output) data loggers. The data loggers were connected in series, with channels 0 through 19 as the master data logger and the remaining channels slaved to the master. Software developed and assembled by S-Cubed automated the DAS to re-boot after power failures and to direct personnel with minimal computer experience to perform scheduled maintenance, such as copying data to floppy disks for transport to SNL quality assurance and S-Cubed. The DAS computer crashed in early November 1991 and was not recoverable. The unit was subsequently replaced by a Texas Microsystems B-386 S/16-4 megabyte computer, which was installed and operable for data recovery after late November 1991.



Photo 4-1. Test-control panels and computer station.

All data were recorded on the computer hard disk. Preselected parameters measured at the test locations could be displayed on the screen in real-time to aid in test setup or interpretation. The computer provided easy access to test data and permanent records for later detailed analyses. The maximum file-length period was limited to seven days. At each scheduled interval, the file for that period was closed and a new file was started for the next seven-day period. The data on the hard disk were transferred to two diskettes and then archived on the hard disk. To prevent loss of data from power interruptions, the data files were closed after each reading. If power was lost, software written by S-Cubed would automatically close the existing data file on a re-boot and create a new data file when power was regained.

4.5 Equipment Calibration Procedures

4.5.1 Pressure Transducers

The pressure transducers were calibrated by the manufacturer and then calibrated onsite by testing them in a pressure-calibration fixture. The fixture was connected to three cylinders of compressed gas which were set to deliver three different delivery pressures. The cylinders were connected by a common manifold to a 0-3000 psig dial gauge which was calibrated to NIST standards. The transducers were plumbed to a common input line and the pressure calibration fixture was connected to the line. Pressures on the fixture were set to 0, 500, 1500, and 2000 psig in sequence. Transducer readings were then plotted against known standard values, and a linear equation was written to convert the logged transducer voltage to the pressure value for each transducer. Coefficients obtained from calibration were converted to parameters of scale and offset and then entered into the data-logging system for each pressure channel.

4.5.2 Closure-Measurement Devices

The closure-measurement devices were calibrated using ring fixtures of known diameters. The devices were inserted into the calibrated ring fixture; then the output voltages generated by each device were measured. A computer logged the closure gauge voltage sequentially for on-axis and cross-axis gauges in the large-, intermediate-, and small-diameter rings. A least-squares fit equation was then performed to relate closure gauge voltages and ring diameters. Coefficients were converted and entered into the data-logging program as they were for the pressure transducers.

4.5.3 Thermocouples

Thermocouples were calibrated before delivery to the WIPP Site. Thermocouple wire is manufactured to specifications that conform to National Bureau of Standards tables. Typically, the manufacturer will calibrate the wire as a quality assurance check on fabrication, operation, and material specifications. Wires were not recalibrated at the WIPP calibration laboratory.

Thermocouple voltages were read directly by the DAS, and voltages were then converted to temperatures based on equations generated by the National Bureau of Standards for type E thermocouples. Polarity checks involved attaching a multimeter to the thermocouple leads, then heating the tips to verify that voltage readings became more positive as the temperature increased.

5.0 TOOL INSTALLATION AND TEST STARTUP

Fifteen test tools were emplaced in the boreholes around Room Q to form a plane of test zones located 23 m west of the room collar. Tools were emplaced before the beginning of the Room Q excavation process. To obtain data on the responses of the host rock to the boring process, measurements were made before, during, and after Room Q was bored. The objective was to obtain a significant data base to support the development of a mechanistic model that describes brine flow from the host rock to an excavation. Tests were performed in the uncased end regions of the cased boreholes and the end regions of the uncased boreholes. The uncased test zones were filled with brine and isolated from the remainder of the borehole with an inflatable packer system.

The test tools and their calibration procedures are described above in Section 4. All test tools were pre-assembled as much as possible, with final assembly completed onsite.

Table 5-1 lists all the pertinent information concerning tool types and test-region dimensions for each test hole.

5.1 Leak-Check Procedures

A leak-check test was performed on each test tool before installation in the hole by installing and testing the system in a length of steel oil field casing.

Prior to installation, leak integrity of the flow- and packer-control manifolds was evaluated by connecting the flow and control manifolds to a supply of compressed nitrogen and then using a soapy solution to monitor the system for signs of leakage. Manifold pressure was monitored with a transducer.

5.2 Installation of Test Tools

Test boreholes were drilled, lined, grouted, and instrumented before the Room Q mine-by so that baseline measurements could be logged and the effect of the mine-by could be recorded. After the test tool installation was completed, baseline data were recorded for 77 days. Mine-by occurred from day 78 through day 105. The boring machine actually passed the plane containing the test zones on day 90.

Table 5-1. As-built Test Configuration

Tool/Hole Number	Radial Distance from Q Axis (m)	Hole Diam. (cm)	Tool Type *	Tool Diam. (cm)	Test Zone Length (cm)	Test Zone Volume (cc)	Guard Zone Length (cm)	Guard Zone Volume (cc)	Install Date
QPP01	13.73	10.16	DP	8.89	188	5100	76	2000	5/7/89
QPP02	7.63	3.81	SP	3.49	85	290	-	-	4/24/89
QPP03	4.36	3.81	DP	3.49	90	300	14	135	4/24/89
QPP04	3.38	3.81	SP	3.49	85	290	-	-	4/24/89
QPP05	2.28	3.81	DP	3.49	90	300	14	135	4/24/89
QPP11	13.77	10.16	DP	8.89	135	6000	76	2000	5/6/89
QPP12	7.63	3.81	SP	3.49	85	290	-	-	4/19/89
QPP13	4.72	3.81	DP	3.49	90	300	14	135	4/19/89
QPP14	3.50	3.81	SP	3.49	85	290	-	-	4/19/89
QPP15	2.41	3.81	DP	3.49	90	300	14	135	4/19/89
QPP21	13.44	10.16	DP	8.89	136	6100	76	2000	5/8/89
QPP22	7.39	3.81	SP	3.49	85	290	-	135	4/23/89
QPP23	4.49	3.81	DP	3.49	90	300	14	-	4/23/89
QPP24	3.05	3.81	SP	3.49	85	290	-	135	4/23/89
QPP25	2.41	3.81	DP	3.49	90	300	14	-	4/23/89

* DP = Dual Packer SP = Single Packer

Notes:

1. Test Zone length is the distance between the hole end and borehole contact of the deepest packer.
2. Test and Guard Zone volumes include the volume of the connecting lines.
3. Guard Zone length is the distance between packer borehole contacts.
4. The elevation of Room Q axis (at test location) is 387.02 m amsl.
5. Install dates refer to the time when tool installation was complete.

Holes were cased soon after drilling, but the test zones sat open for up to two months before tool installation. To prepare the holes for tool installation, they were cleaned and then sized: calipers were run into the holes to check hole diameters for compliance with tool size.

All holes were blown out with compressed air. Holes that sloped up were squared off at the end with a hand-held rod. Horizontal and downward-sloping holes were swabbed to remove accumulated brine. Installation technicians noted a substantial amount of mud or clay at the end of QPP01, so an 86.3-cm extension or "bullnose" was added to the end of the tool for that hole to ensure that the closure gauges and test-zone packer would be located off the hole bottom where the borehole walls were more competent.

To ease installation, 1.3-cm steel conduit was attached to the outer end of the tools and used as a push rod to run the tools to total depth (see Photo 5-1). Some of the tools were difficult to install because of borehole deformation that occurred between the time of drilling and installation. Technicians sometimes used come-alongs or ratchets to force these tools to the desired setting depth.

Three different tool configurations were installed: the single-packer 3.5-cm tools were set in six holes, the dual-packer 3.5-cm tools were set in six holes, and the dual-packer 8.9-cm tools were set in three uncased holes. Figures 5-1 through 5-3 show the tool placement in each of the holes. The tools shown in Figure 5-3 are identical except for the 86-cm bullnose attached to the downhole end of the QPP01 tool.

5.2.1 Closure Gauge

The closure gauges were located in the test zones and measured changes in vertical- and horizontal-borehole diameters within 1 micron. They were connected to the DAS with wire leads. The electrical leads for the borehole closure gauge LVDTs were run through the packer mandrel and the 1.3-cm conduit to the hole collar and then to the appropriate DAS.

5.2.2 Brine Supply Connection

Three brine-supply reservoirs supplied fluid to the test regions via 3.2-mm stainless steel tubing. The supply lines were bled and brine reservoirs filled immediately before calibration of the reservoir transducers. Volume requirements were established from the known capacity of the test region minus the volume displaced by the tool.

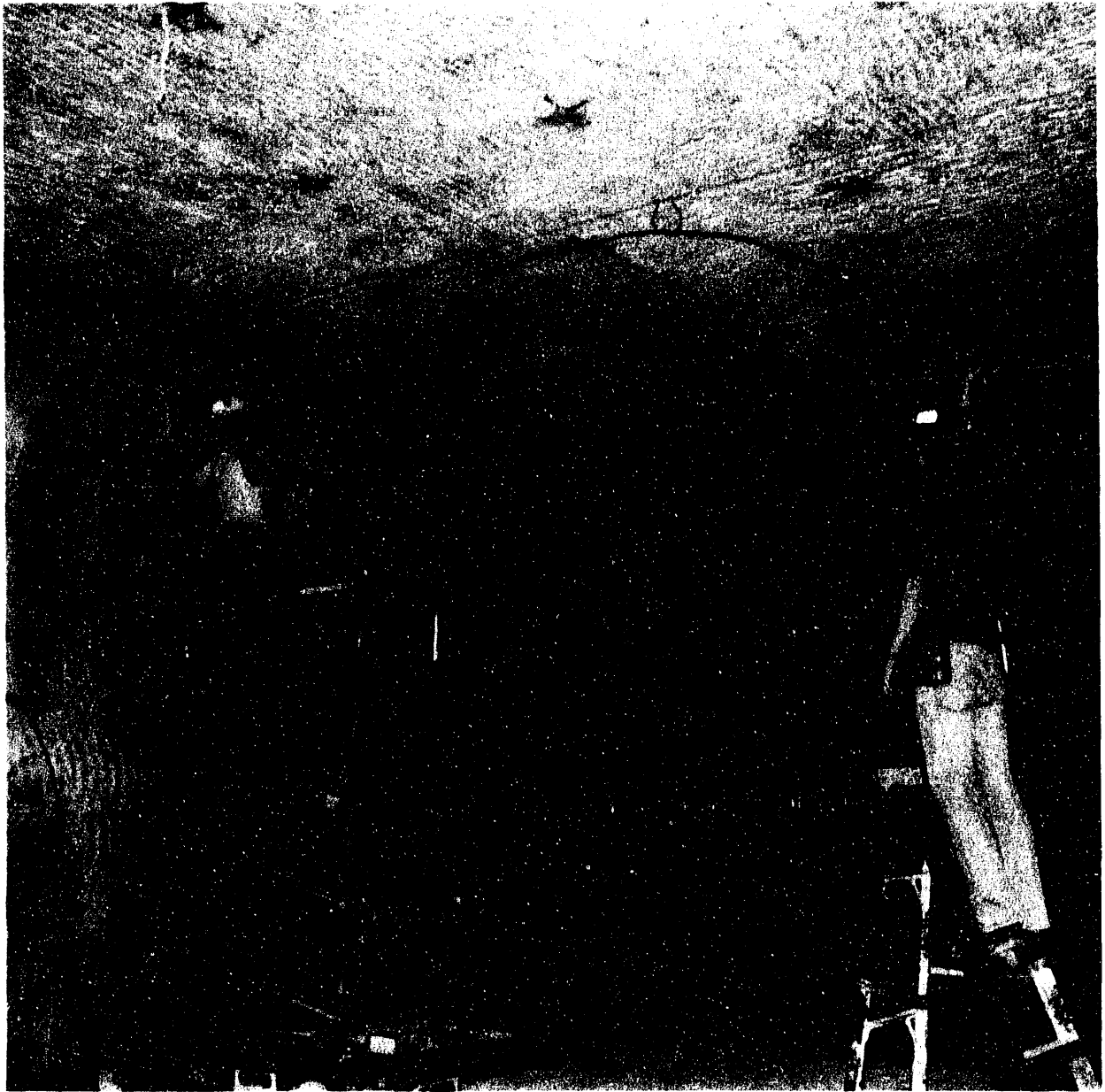
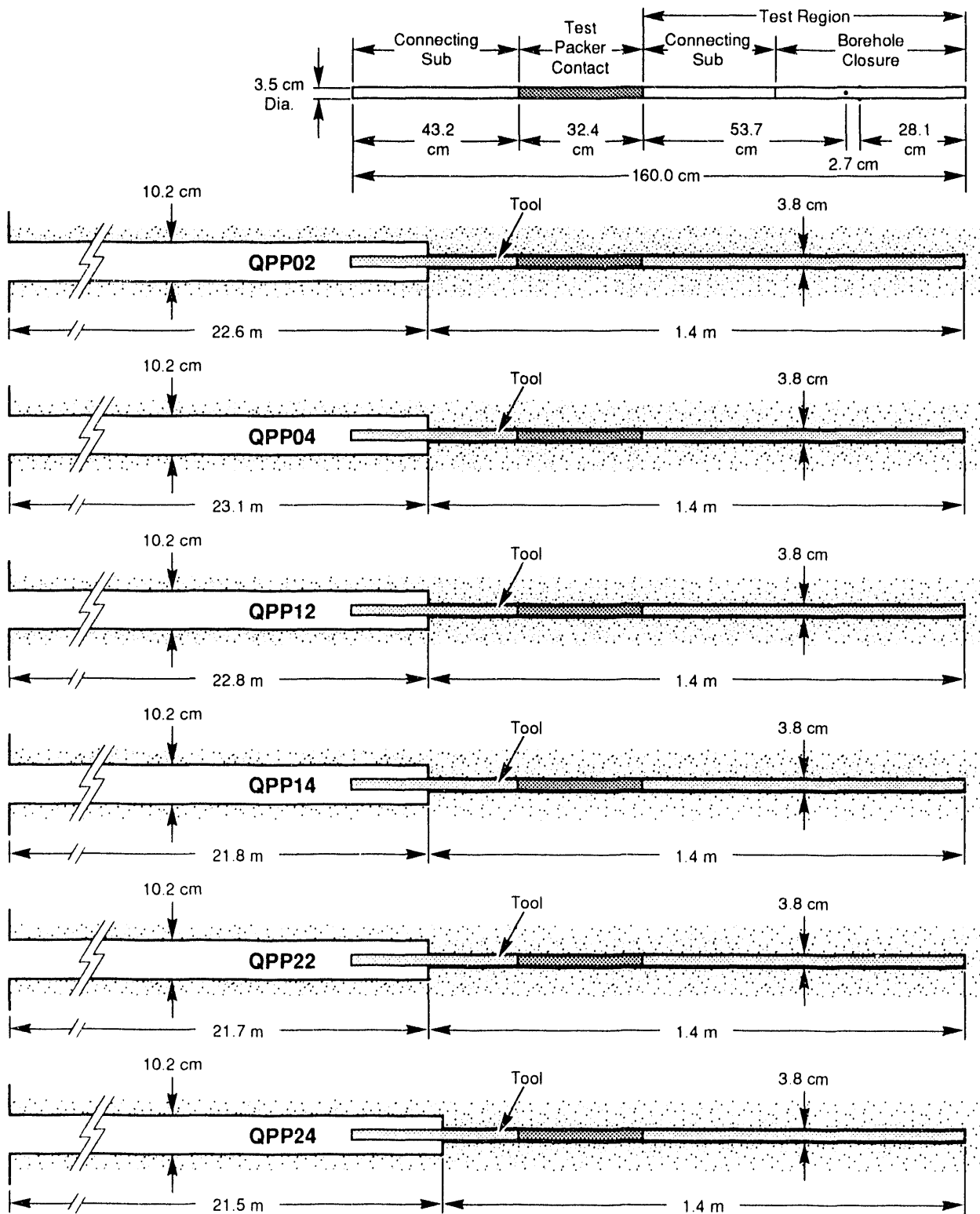
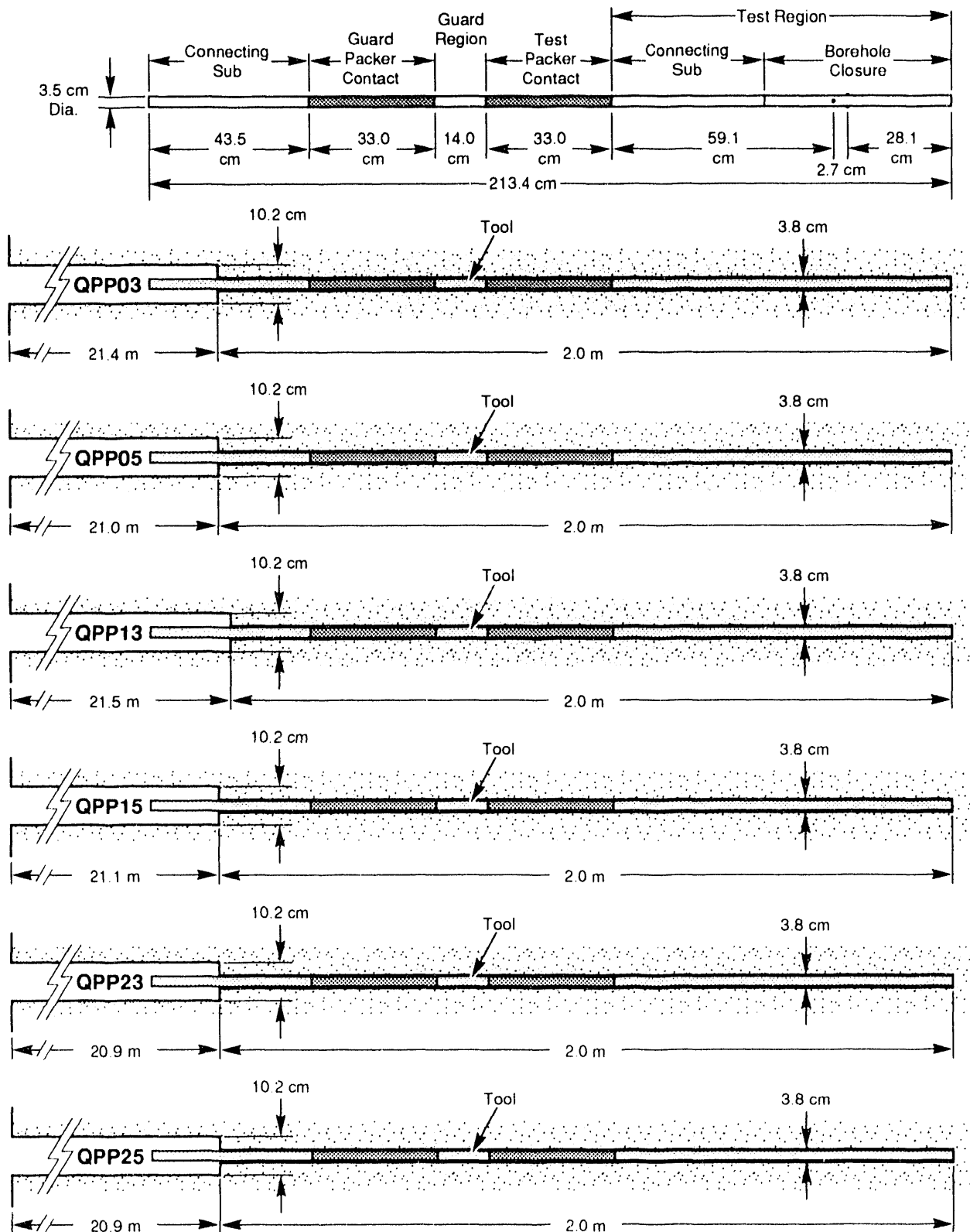


Photo 5-1. Installation with steel conduit.



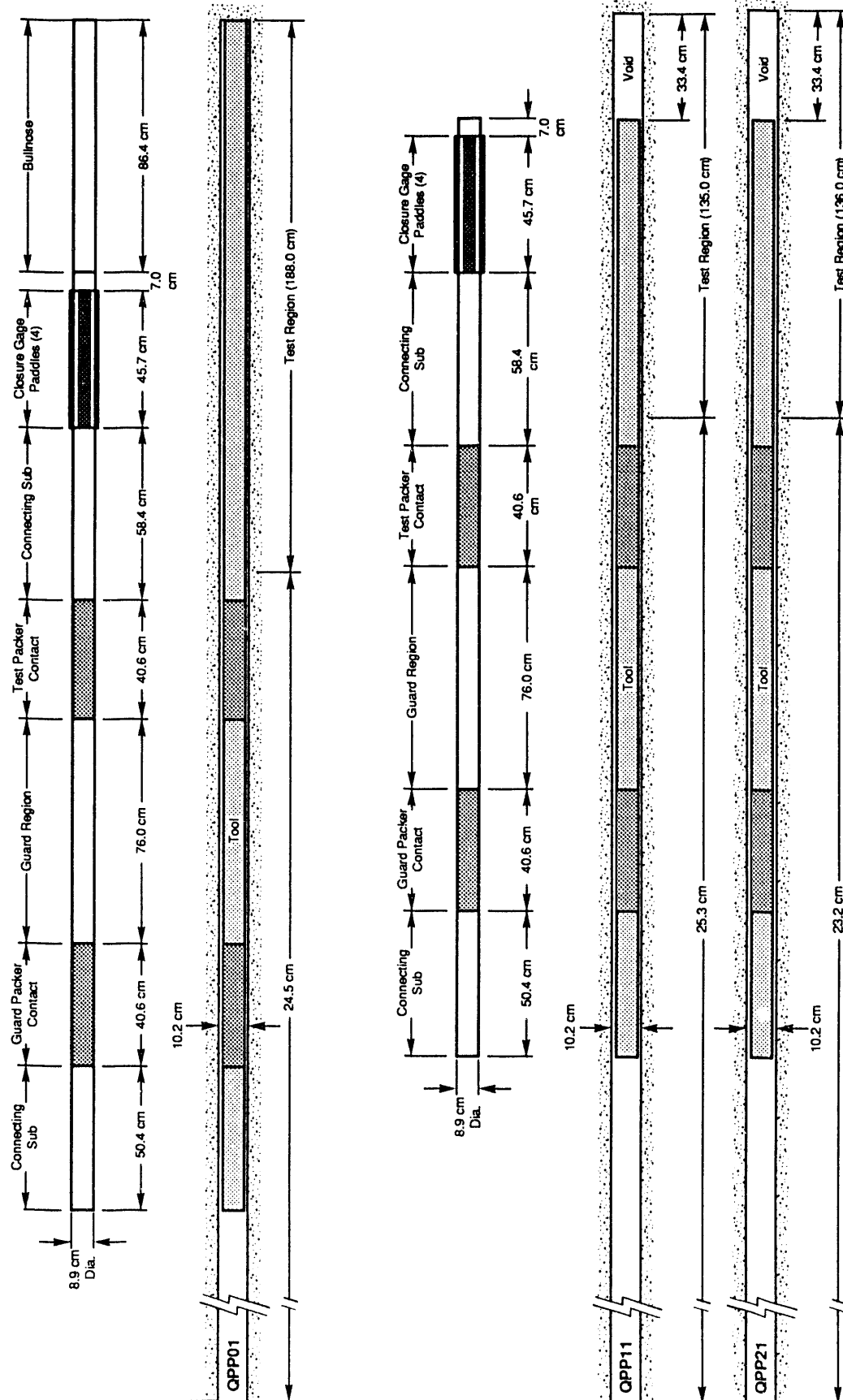
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Figure 5-1. Installation diagram showing placement of 3.5-cm-diameter single-packer tools.



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Figure 5-2. Installation diagram showing placement of 3.5-cm-diameter dual-packer tools.



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Figure 5-3. Installation diagram showing placement of 8.9-cm-diameter dual-packer tools.

For the dual-packer systems, the guard-region packer was pressurized and inflated. Fluid was then circulated from the low-pressure brine reservoir to the test region until the air in the region was displaced completely with fluid. The test-region packer was inflated, and a prescribed amount of fluid was injected into the test region. Any pressure changes were noted. If no unacceptable leakage was detected, testing proceeded.

5.3 Test Startup

Tools were inserted into the 15 holes. Packers were then inflated with fresh water via the packer fluid-handling system and monitored until they stabilized. The test regions were then filled with brine. Test and guard zones were shut in, and fluid pressures increased as zone pressures equilibrated with formation pressure. Testing was initiated after the rate of pressure-increase in the test zone slowed, and the pressure curve flattened.

Tests were initiated between April 25 and May 8, 1989 and continued for 911 days, until October 22, 1991. Three types of tests were performed: a pulse test to measure formation reaction to high-pressure pulse injection or low-pressure pulse withdrawal, a shut-in test to estimate pore pressure buildup, and a long-term flow test for estimating brine inflow at constant pressure. Borehole closure was continuously monitored so that post-test data analysis could incorporate hole deformation influence on pressure response.

5.3.1 Pulse Tests

Pulse-withdrawal tests were initiated in the test zones by opening the vent valves and allowing fluid to flow from the zone until the shut-in pressure had decreased to a predetermined level. After venting, the test zone was again shut in by closing the valves. The volume of fluid released from each withdrawal test was measured and recorded. After shut in, the re-equilibration of the zone-fluid pressure and the formation-pore pressure were monitored by the DAS. After the zone pressure had recovered to approximately pre-test values, the test was repeated to ensure that pressure responses were reproducible.

For the pulse-injection tests, the pressure in the test zones was increased and the zone was shut in. The time required for the fluid pressure to decrease to relative stability was then observed and recorded. For example, in the pulse-injection test for QPP11 (see below, Figure 6-44) operators increased pressure in the test zone by about 5 MPa. In this test, fluid pressure stabilized before mine-by.

5.3.2 Shut-in Tests

For the shut-in tests, the guard and test regions were isolated while the pressure equilibration between the formation and the test regions was measured.

5.3.3 Flow Tests

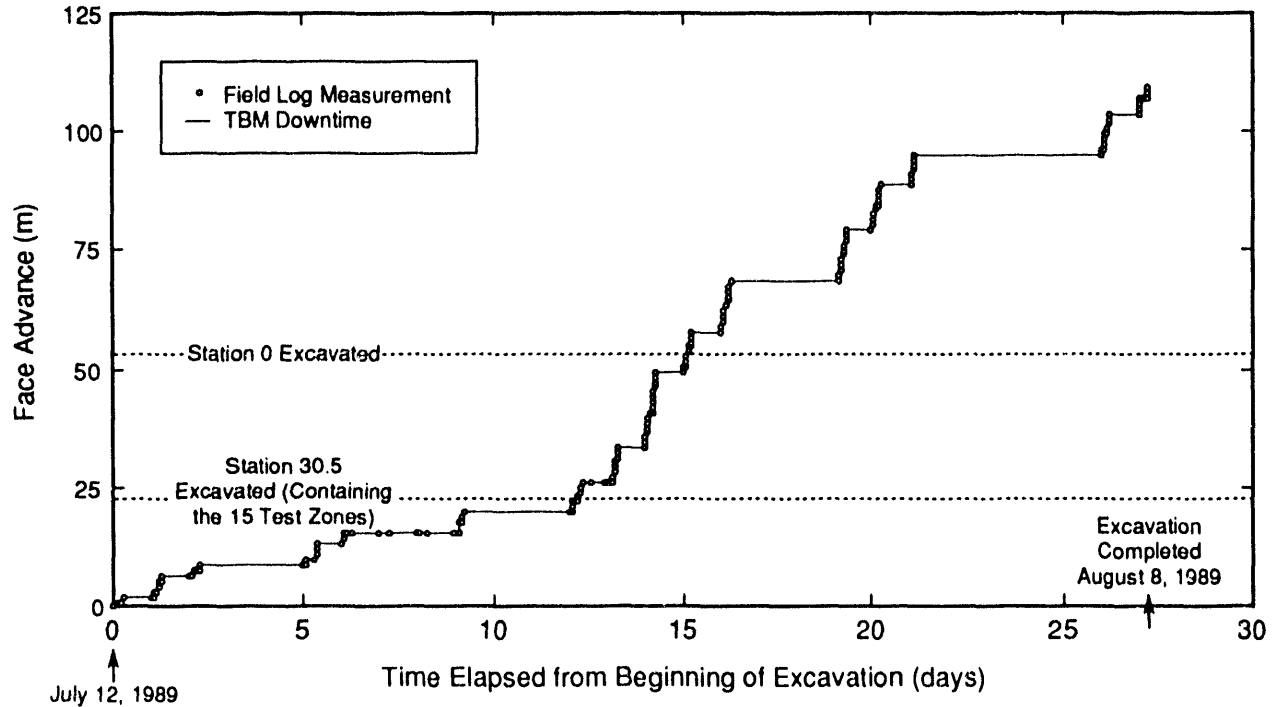
For the flow tests, pressure in the test zones was reduced and controlled at a pre-determined value by a regulated gas pressure head on the flow columns connected to the zone. Pressure was held constant at the regulated level for about 150 days. Fluid was drained from the flow columns periodically while maintaining the pressure head using the valve system on the control panel. After the flow test, the test zone was again shut in to measure pressure response over time.

5.4 Room Q Excavation

Almost three months after test startup, excavation of Room Q began. The room was mined in one pass with a Robbins Hard Rock Tunnel Boring Machine (TBM). A launching frame was used to position the TBM above the elevation selected for the floor of the Instrument Alcove and align it with Room Q. Boring began on July 12, 1989, at the west wall of the Alcove. Progress was slow for the first few days because of alignment problems, but excavation progressed more rapidly after about ten days. Figure 5-4 shows the Room Q excavation sequence and the point when the boring machine progressed past the station at +30.5 m at about noon on July 24, 1989.

The excavation of Room Q impacted the data collected in the test boreholes. Data impact can be seen in the figures that accompany Section 6.

Measurement stations are located in terms of stations along the axis of Room Q. The origin, Station 0, is at the midpoint of the Room Q axis. The station at +53.3 m is the west face of the Instrument Alcove where the collars to the test boreholes are located. All the test boreholes terminate at station +30.5 m to establish the location of the test regions, which include both the test and guard zones. The test zone is deepest, and is defined by the area between the deepest packer and the end of the borehole. As shown in Figures 3-1 and 3-3, all the test zones lie in a plane that extends radially outward from the centerline of Room Q. Three groups of five test zones are located at distances of approximately 2.4, 3.3, 4.6, 7.6, and 13.6 meters from the room centerline.



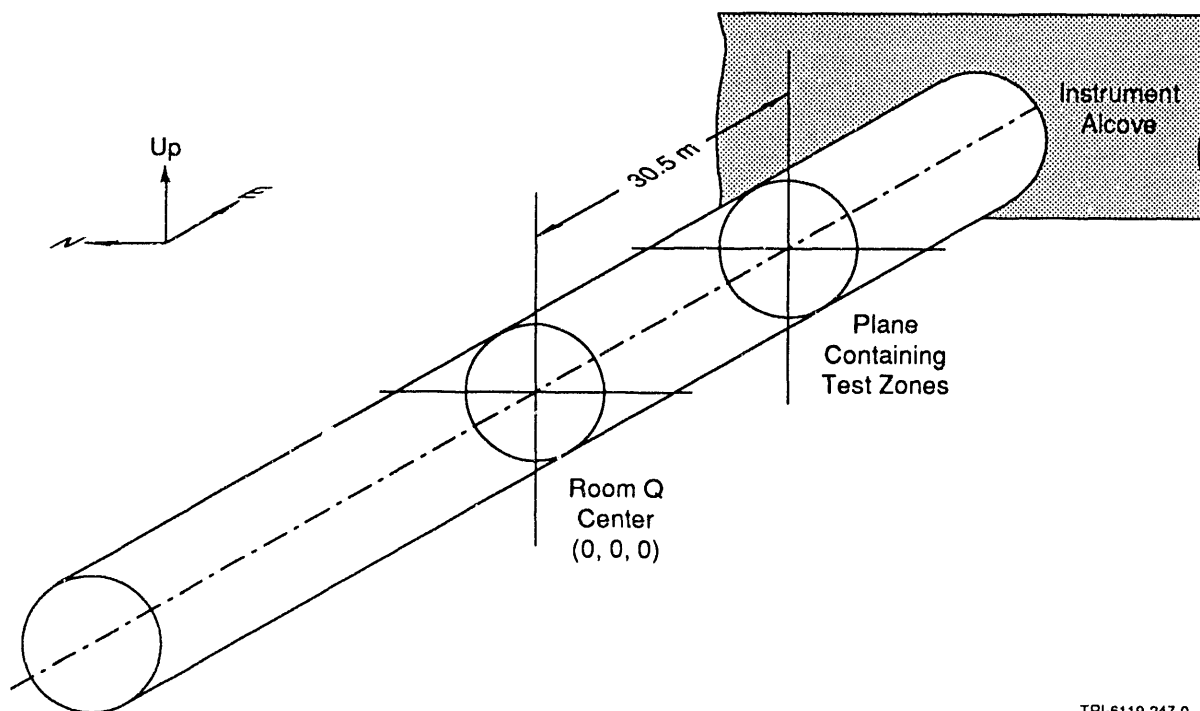
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Figure 5-4. Room Q excavation rate.

Table 5-2 presents cartesian coordinates that describe the end and collar location of each test borehole relative to the axis of Room Q at station 0. The coordinates are based on the same WIPP survey system as described for Table 3-1. Two sets of coordinates are given here, one for the collar and another for the end. Thus the collar of hole QPP01 is located 4.87 m south, 53.32 m east, and 1.26 m above the approximate geometric center of Room Q at Station 0. The test-zone end of the same hole is 0.33 m north, 30.5 m east, and 13.41 m above the same reference point.

Table 5-2. End and Collar Locations Relative to Room Q Center

Hole Number	Room Q Coordinates (m)					
	Hole Collar			Hole End		
	North (+) of Center	East (+) of Center	Above (+) Center	North (+) of Center	East (+) of Center	Above (+) Center
QPP01	-4.87	53.32	1.26	0.33	30.50	13.41
QPP02	-4.28	53.32	1.24	0.06	30.47	7.30
QPP03	-3.68	53.38	1.21	-0.01	30.50	4.03
QPP04	-3.05	53.40	1.22	0.35	29.16	3.03
QPP05	-2.45	53.42	1.26	-0.07	30.69	1.95
QPP11	-4.91	53.39	-1.18	-0.02	30.61	-14.10
QPP12	-4.29	53.39	-1.17	0.21	30.59	-7.96
QPP13	-3.67	53.40	-1.17	0.07	30.58	-5.05
QPP14	-3.06	53.41	-1.18	0.04	30.58	-3.83
QPP15	-2.46	53.45	-1.19	-0.01	30.60	-2.74
QPP21	4.82	53.44	0.53	13.44	30.50	-0.44
QPP22	4.22	53.44	0.52	7.39	30.60	-0.28
QPP23	3.61	53.48	0.54	4.49	30.62	-0.23
QPP24	2.98	53.46	0.50	3.03	30.62	-0.64
QPP25	2.40	53.46	0.53	2.40	30.62	-0.56



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Figure 5-5. Room Q coordinate reference diagram.

6.0 TEST RESULTS

This section reports on the sequence of events from the recovery of the raw data files in the DAS to the creation of the final plot files. The raw data were received from the test tools and stored in a mix of engineering units (both U.S. and metric) depending on the instrument output. For instance, the output data were given in pressure units of psig, temperature units of degrees centigrade, test zone diameters of inches, and fluid volume of cubic centimeters. These data had to be standardized before data reduction and presentation.

The DAS recorded time values of days, hours, minutes and seconds. Readings were recorded once every six minutes for the first few hours, with time increasing to every six hours. Data were routinely dumped to floppy disks every few days.

6.1 Data Preparation

Data preparation involved several steps: file organization, conversion to standard units, reduction of the number of data points. The DAS monitored all data channels regardless of operational activities, so the raw data sets contained all data, including non-operational information. Thus, at times when tools were off-line, anomalous data were recorded (as noted in the field notes). Anomalous points were usually the result of signal spikes or signal conditioning problems. To eliminate this extraneous data, an annotated data set was developed. The procedure is explained in Appendix C. An annotated and full set of original data are available from SNL WIPP quality assurance and Department 6119.

Further data reduction of the annotated set was necessary for presentation in this report. The annotated data files contained over 10,000 data points for each gauge because data were recorded at a high frequency for about 1000 days. Therefore, data reduction was performed to increase the clarity of the data plots. First, the data were sorted according to borehole number, recording time, and measurement type (e.g., "vertical closure"). Second, the time interval since zero-hour of April 25, 1989, was calculated. Third, the data for pressure and test zone diameters were converted from U.S. to metric units (i.e., psig to MPa and inches to mm). Fourth, closure values were calculated by subtracting the initial hole diameter from all subsequent measured diameters. The change in diameter became the plotted value. Fifth, redundant values were filtered out with a data filter that responded to both the reading frequency and the amount of change between measured values. That

is, in cases where the y-axis value was flat because of little change over time, the data were systematically reduced. However, at times when the y-axis value changed rapidly, all data were retained.

6.2 Ideal Test Response

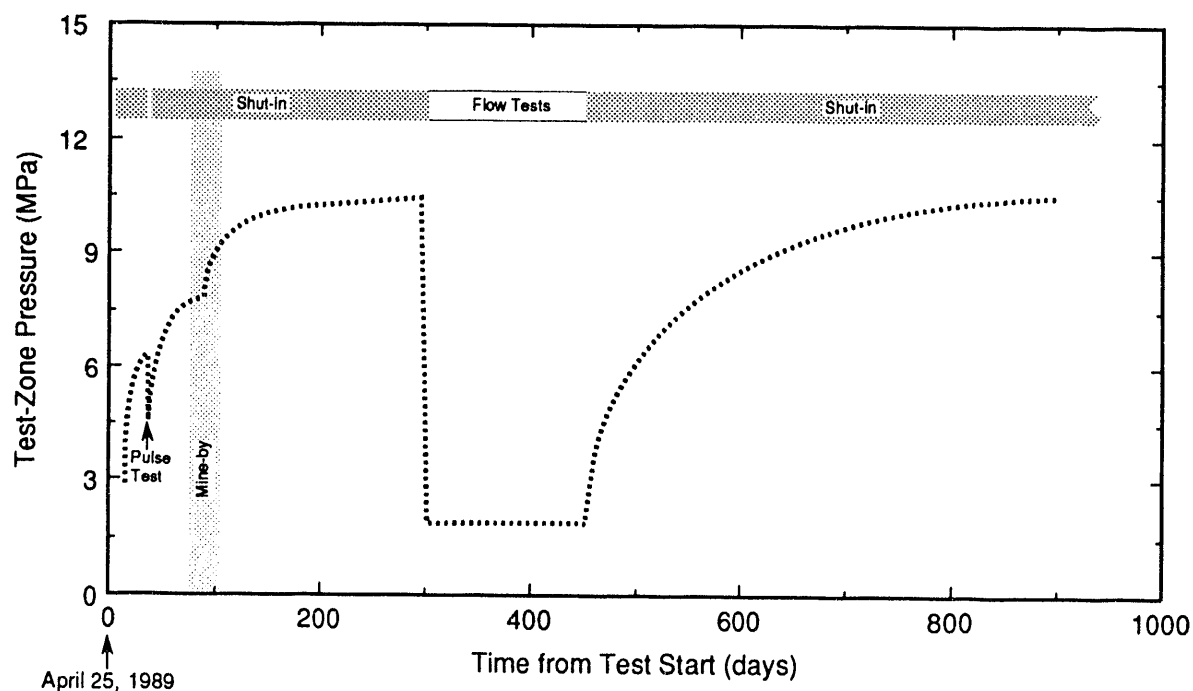
For comparison with the actual test data, an ideal test-zone pressure response from a typical Room Q borehole test is presented in Figure 6-1. Under perfect conditions, a test zone is shut in at constant volume to begin the test. Pressure then rises in the test zone until it approaches formation pressure. A pulse test (pressure withdrawal in this example) is initiated. Fluid is vented from the test zone to reduce pressure by a predetermined amount, and the released fluid volume is measured. Then the test zone is again shut in, and the time required for the pressure to return to pre-pulse test levels is noted.

About 80 days into the test, the mine-by alters formation stresses and accelerates the change in test-zone pressure. The proximity of the test zone to the excavation influences the magnitude of the pressure change. After the pressure levels off, or stabilizes, long-term flow tests are initiated: fluid and pressures are vented from the test zone and held constant at a specified pressure with the fluid-withdrawal system. After about 150 days of data collection, the test zone is shut in again and pressure increases are recorded.

6.3 Data Presentation

Data plots are presented here in a series of figures that are grouped by borehole number. The plots are then ordered according to the depth of the measurement location within each borehole. Thus data from the deepest gauge in borehole QPP01 are presented in the first data plot, Figure 6-2.

In all the figures, time is represented on the x ordinate in units of days from test startup. Day zero is April 25, 1989, the arbitrary date designated for the initiation of the Room Q borehole tests. All tools were installed and recording data within 14 days after this date. The data plots presented here normally give a range from zero to 1000 days, except in two cases: 1) tests where gauges became inoperable, and 2) flow tests, which normally ranged for 150 days, from about day 300 to day 450.



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Figure 6-1. Ideal test-zone pressure response.

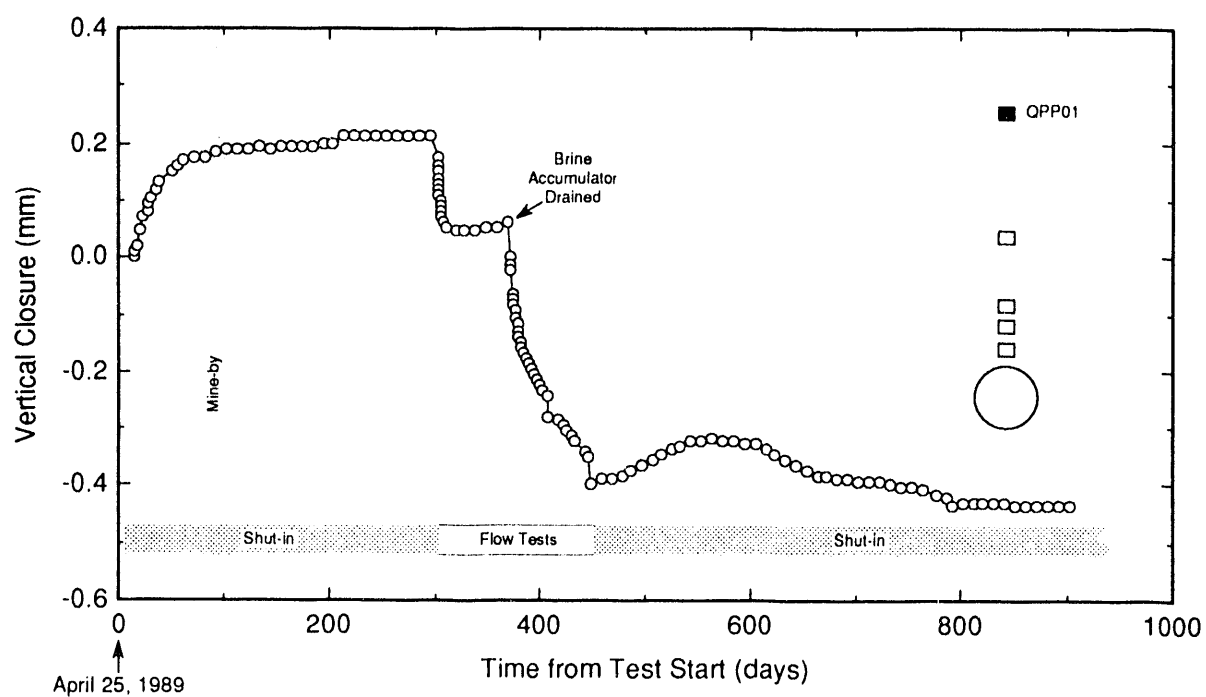
The y ordinates in the figures reflect positive changes in measured test values, except for the closure tests. Closure, or decreasing hole diameter, is shown as a negative slope. Most closure plots demonstrate both negative and positive slope, possibly caused by the response of the borehole wall or the instrument to pressure buildup during shut in.

Some data are not provided because of instrument failure or loss of data. In particular, no data are shown for the closure gauges in hole QPP21 and no flow data are shown for hole QPP11. Tests performed in holes QPP14 and QPP15 show a data anomaly about 380 days into the tests: between day 383 and day 447, pressure transducer data channels were transposed. This pressure data anomaly affects calculated closure data for these holes. Operational logs offered no explanation for the transposition problem (see Appendix C).

Icons have been inserted into the figures to aid interpretation of the data. Diagrams set within the chart identify the test region under discussion and show its location relative to Room Q. The test borehole is identified by a darkened square.

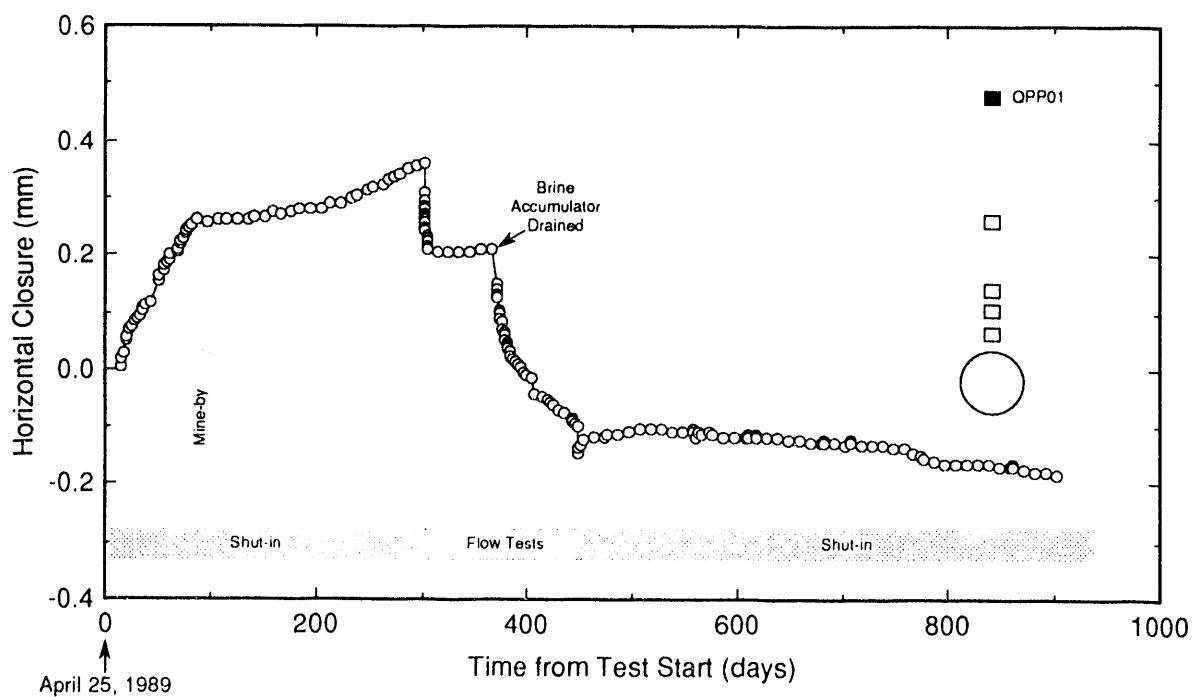
Test activities are also displayed within the bounds of the chart by two methods: 1) a stipled bar is used to indicate the time period for the shut-in tests, flow tests, and mine-by; 2) callouts refer to single or short-term events like the pulse tests, the draining of the brine accumulator, or the opening of a guard zone. The activity logs in Appendix C are the information source for these events.

Analysis and evaluation of the data exceed the scope of this report.



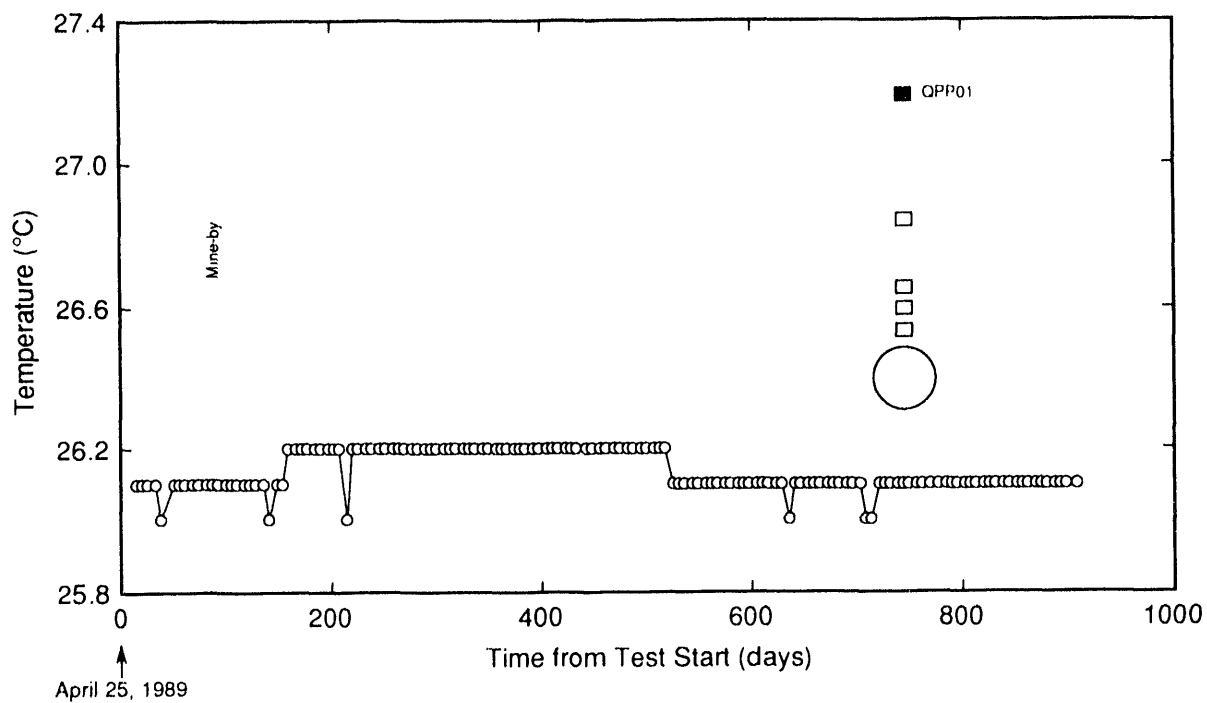
TRI-6119-75-0

Figure 6-2. Vertical closure measured in the test zone of hole QPP01.



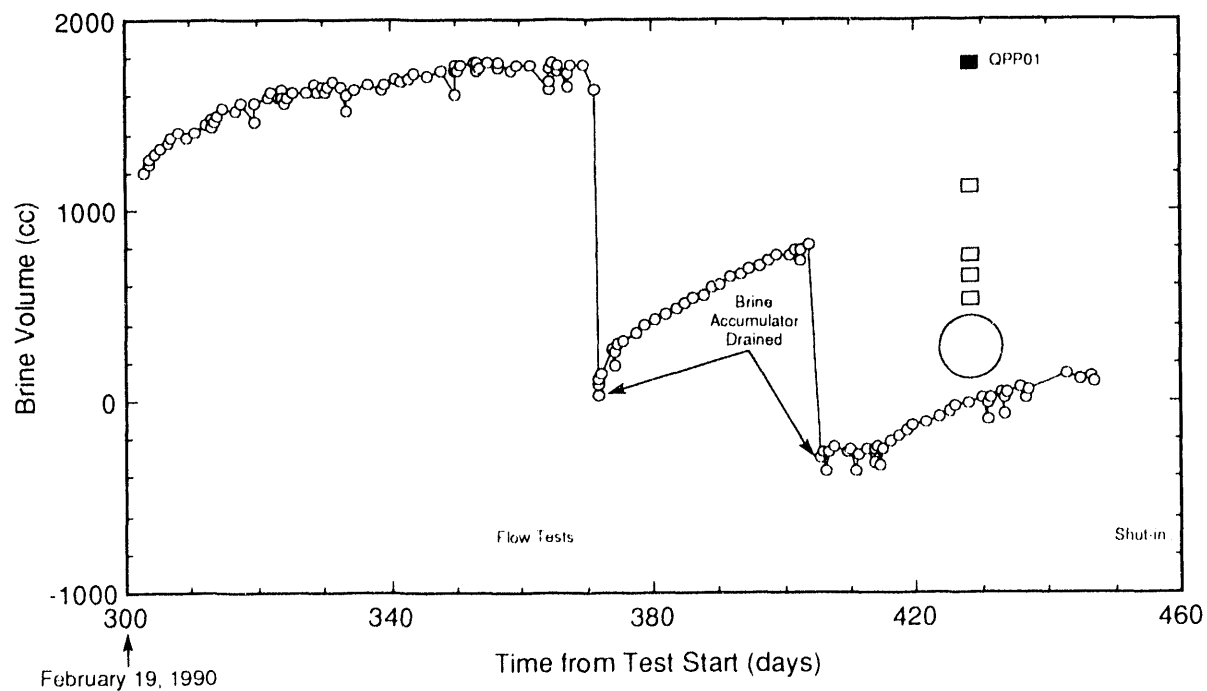
TRI-6119-76-0

Figure 6-3. Horizontal closure measured in the test zone of hole QPP01.



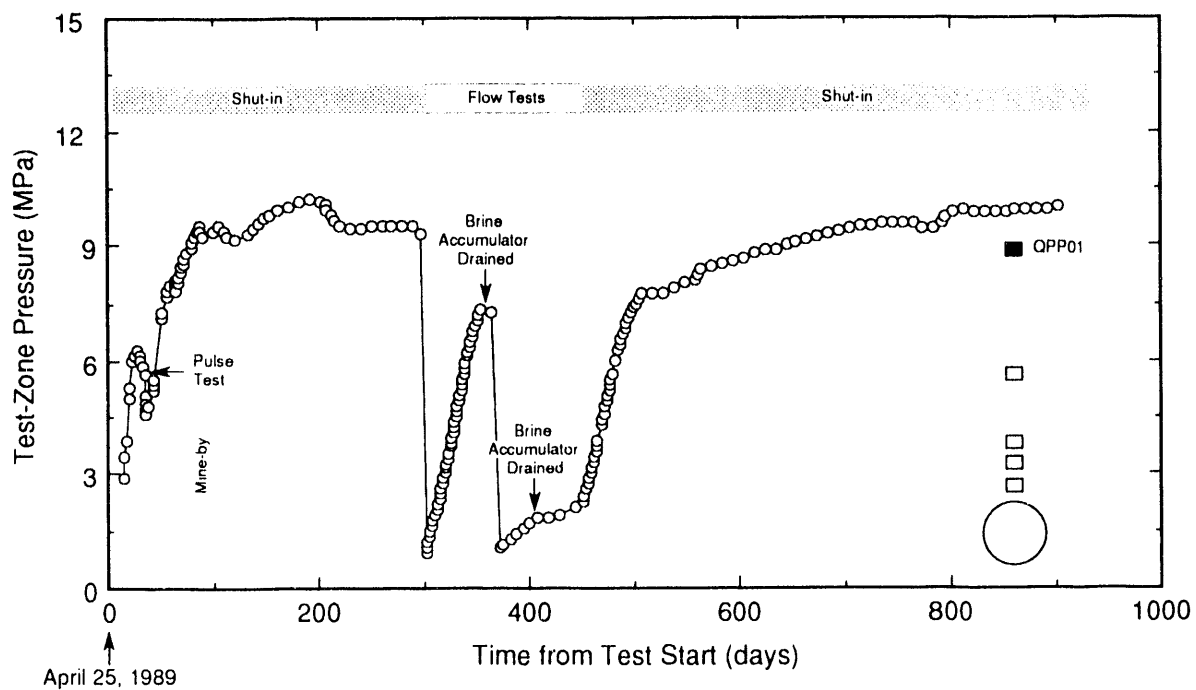
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Figure 6-4. Hole QPP01 test-zone temperature.



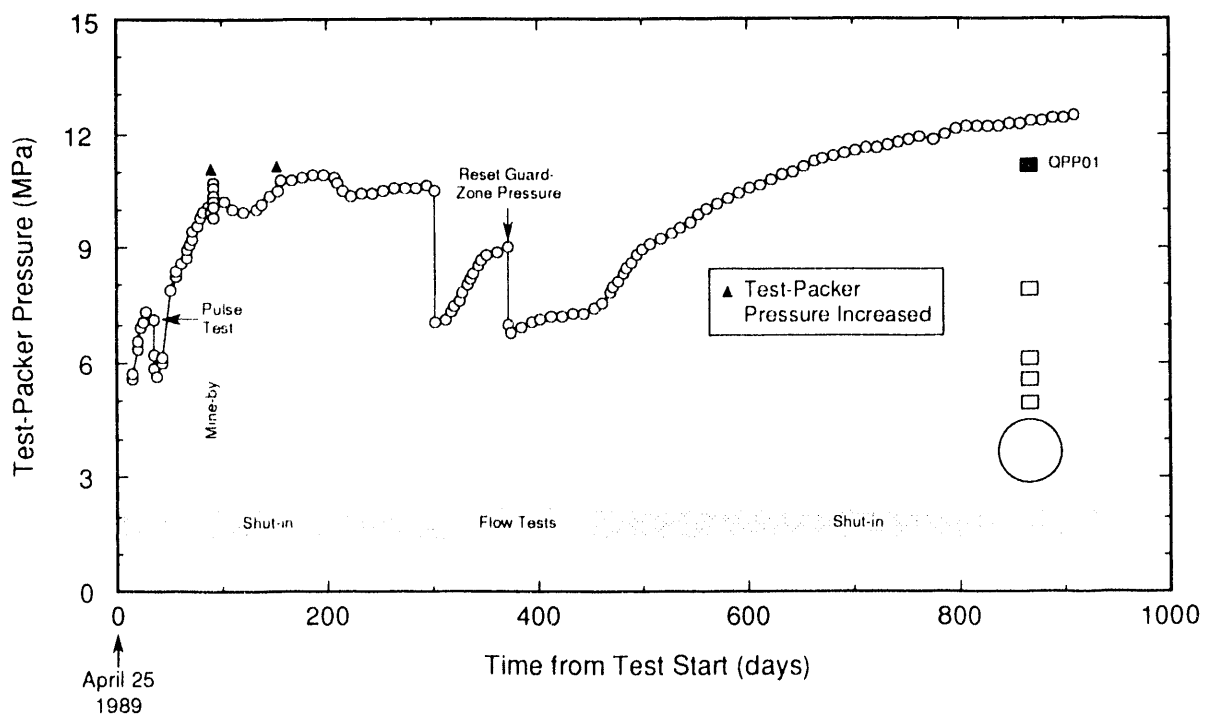
TRI-6119-77-0

Figure 6-5. Brine collected from QPP01 test zone during flow testing.



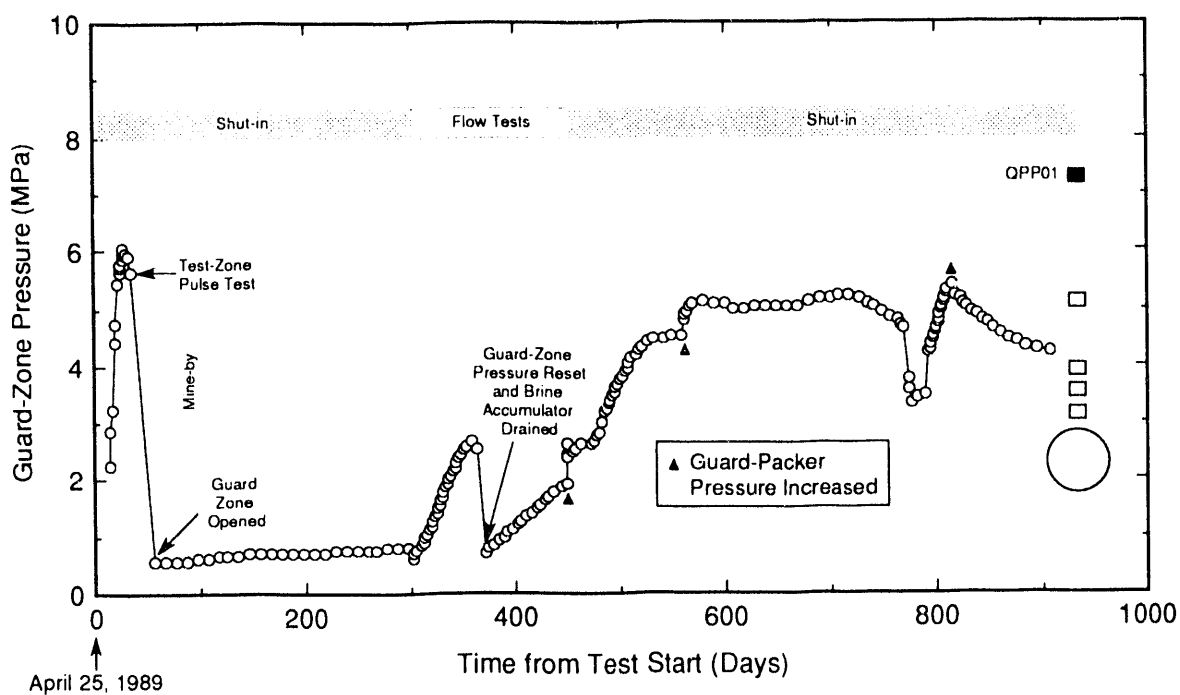
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Figure 6-6. Hole QPP01 test-zone pressure.



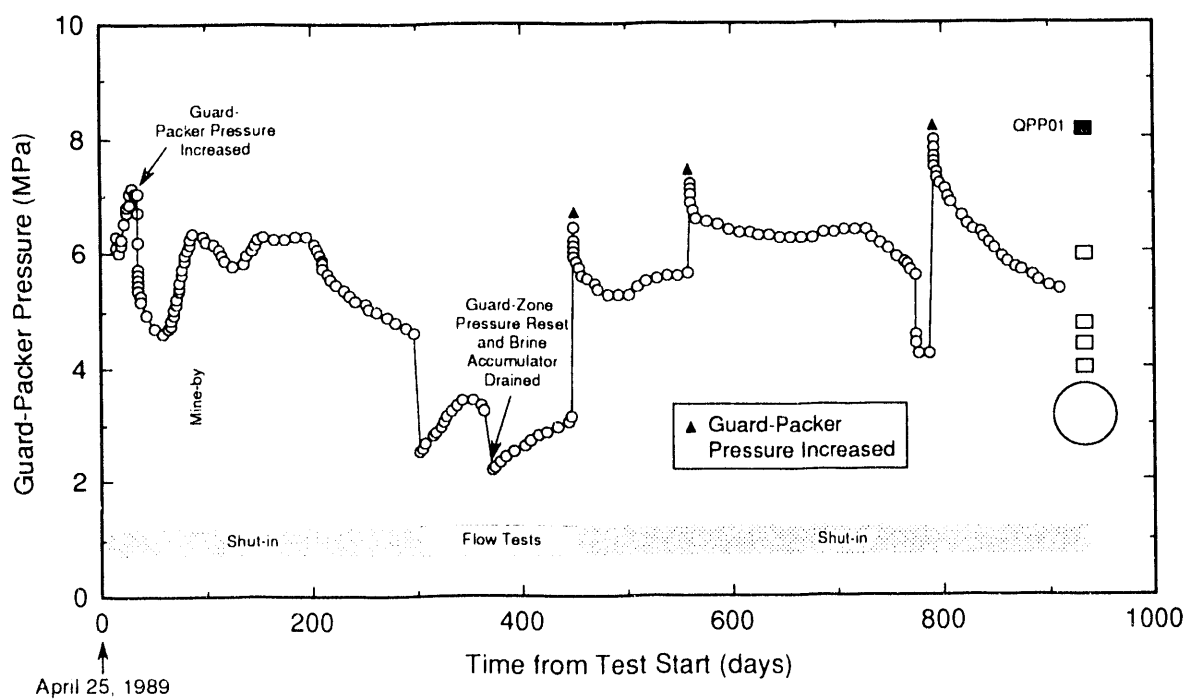
TRI-6119-79-0

Figure 6-7. Hole QPP01 test-packer pressure.



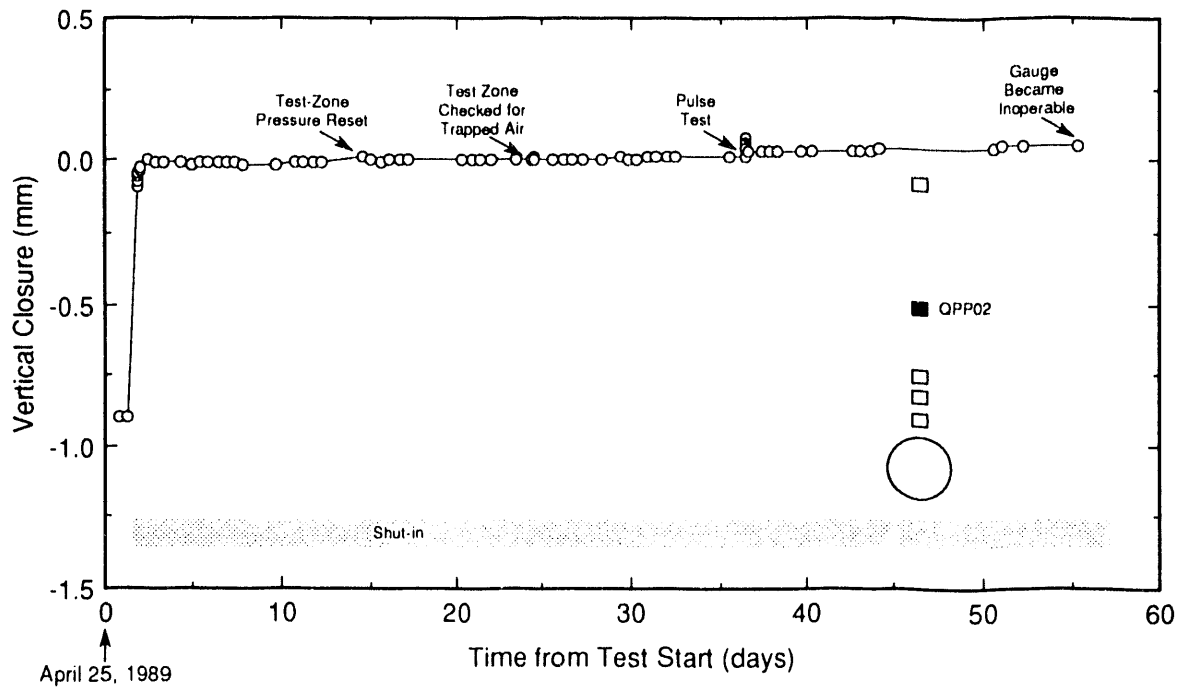
TRI-6119-80-0

Figure 6-8. Hole QPP01 guard-zone pressure.



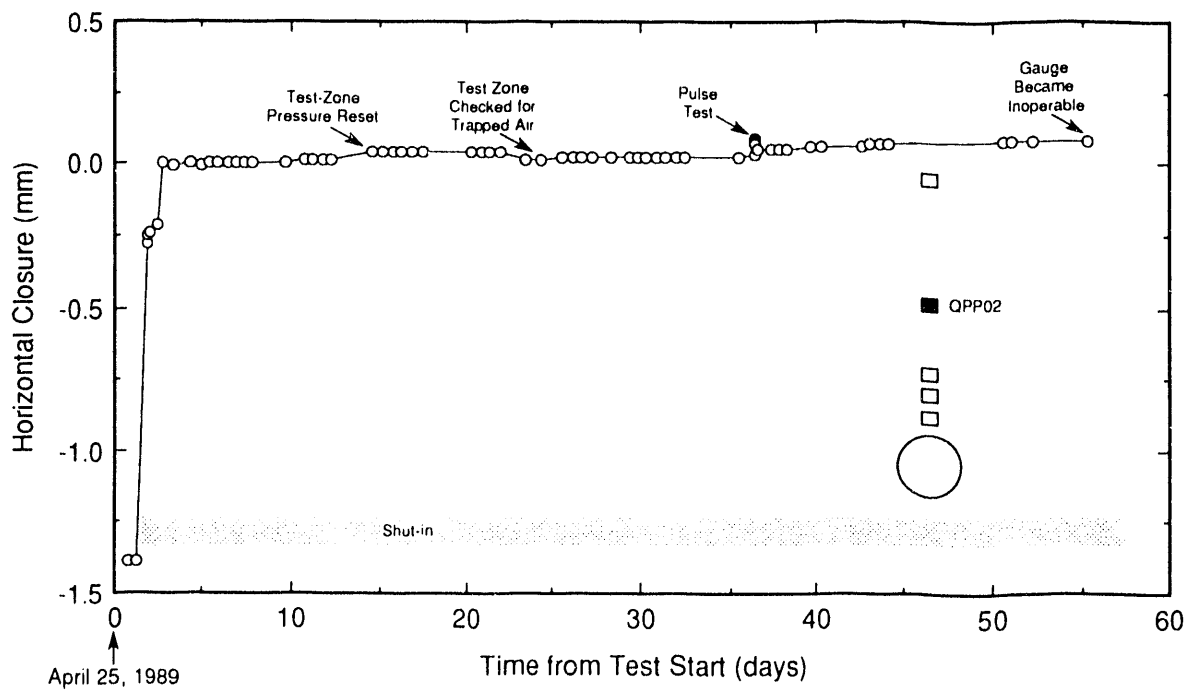
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Figure 6-9. Hole QPP01 guard-packer pressure.



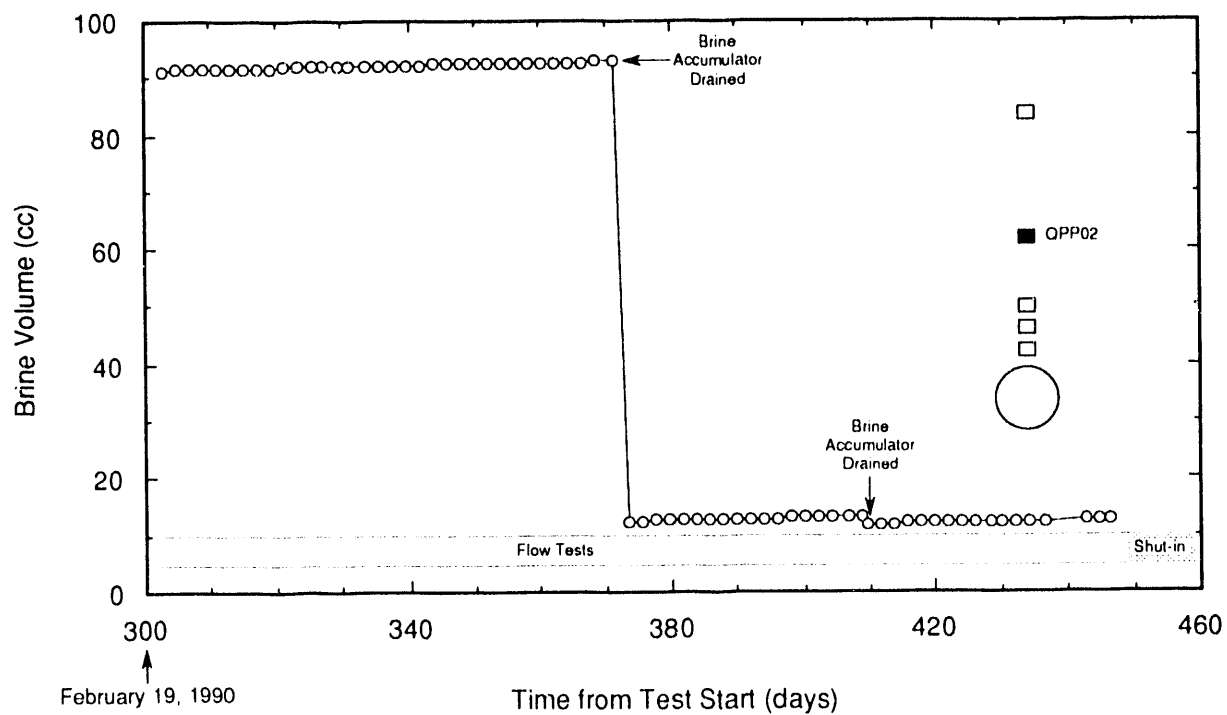
TRI-6119-82-0

Figure 6-10. Vertical closure measured in the test zone of hole QPP02.



TRI-6119-83-0

Figure 6-11. Horizontal closure measured in the test zone of hole QPP02.



TRI-6119-84-0

Figure 6-12. Brine collected from QPP02 test zone during flow testing.

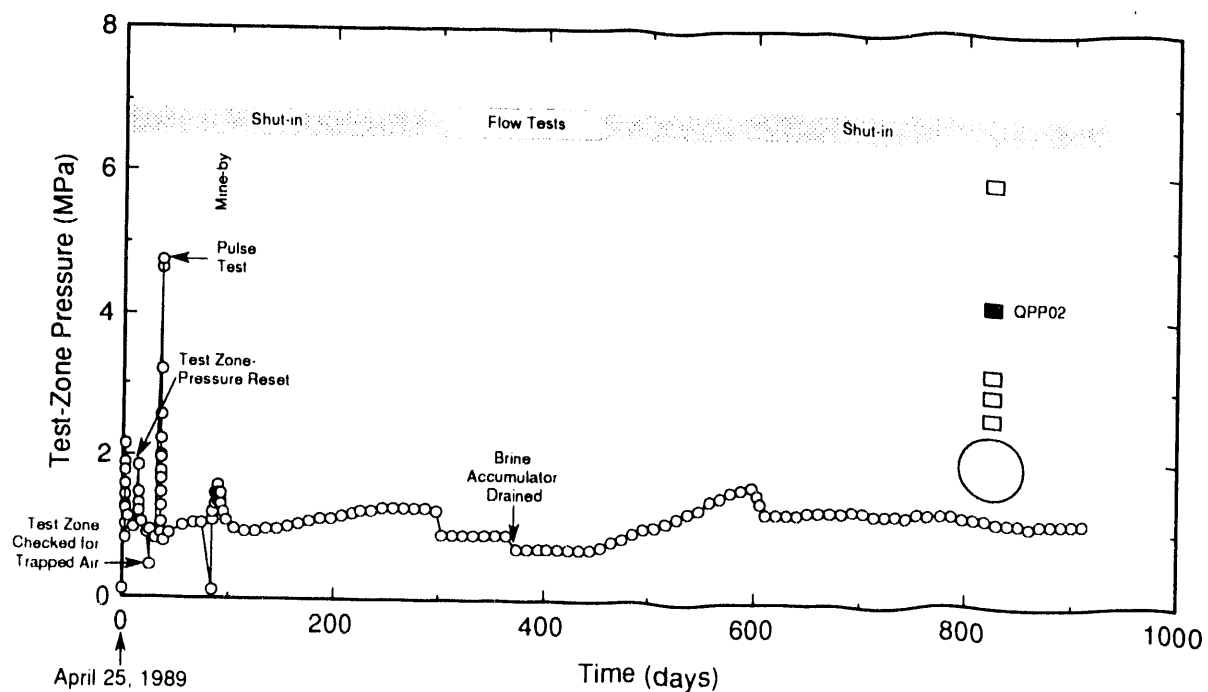


Figure 6-13. Hole QPP02 test-zone pressure.

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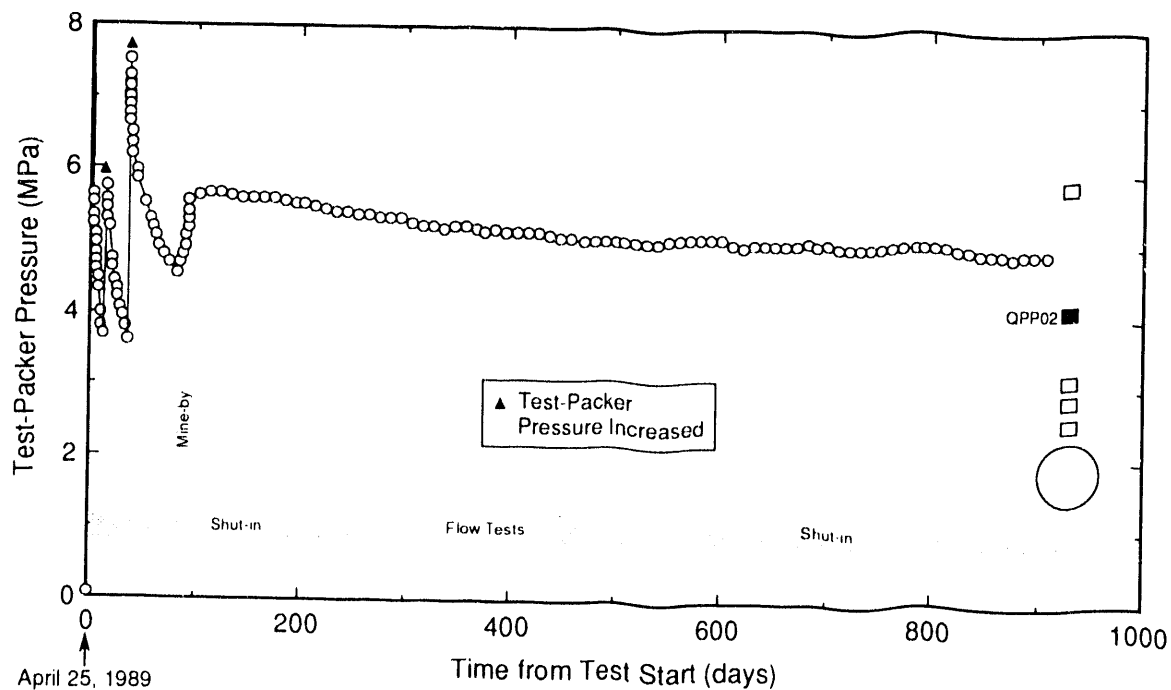


Figure 6-14. Hole QPP02 test-packer pressure.

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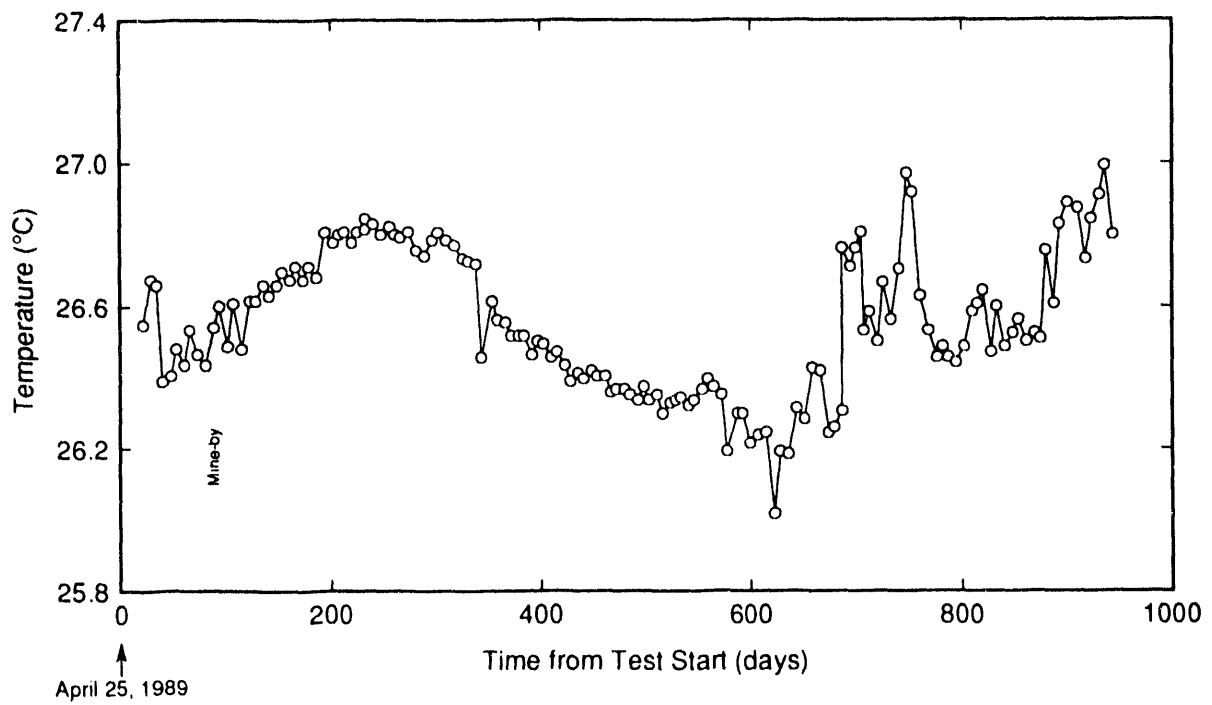


Figure 6-15. Hole QPP02 tool temperature.

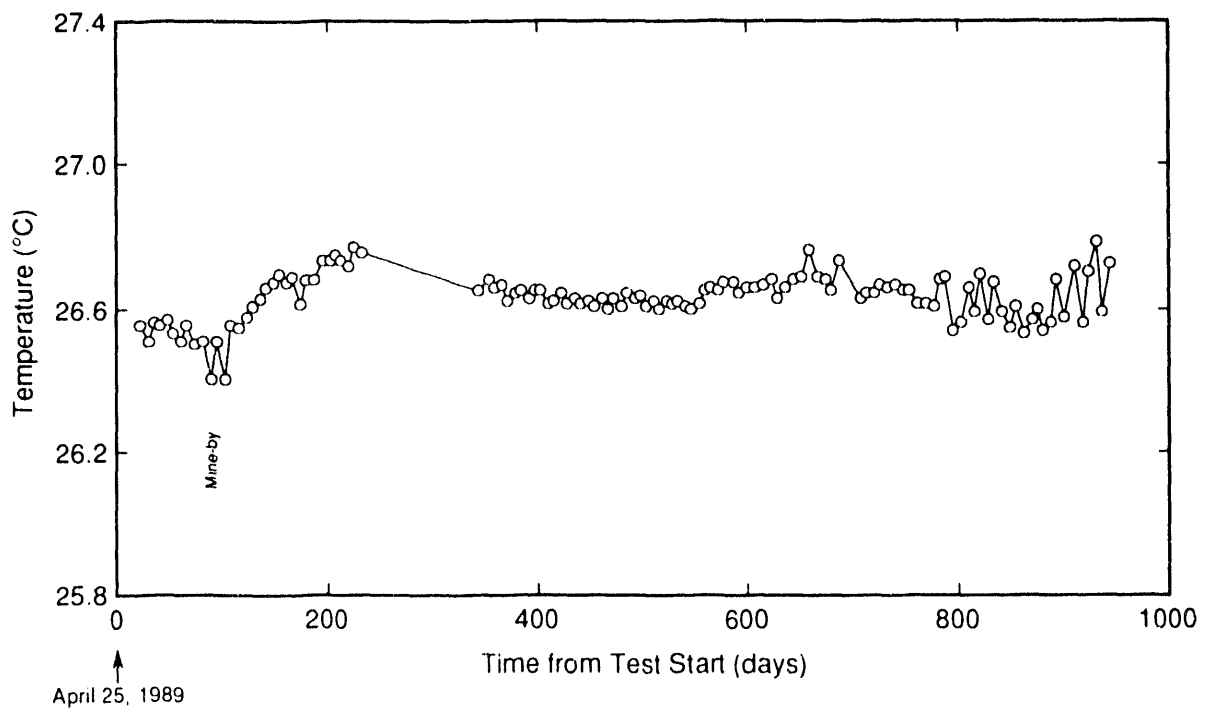
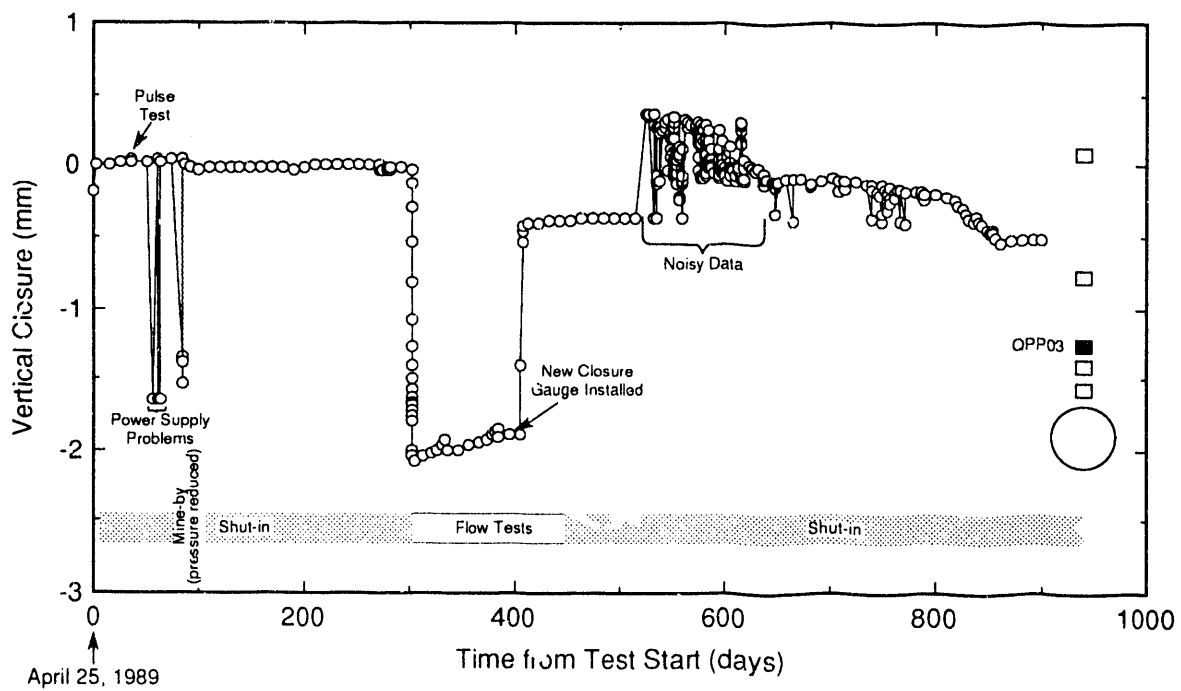
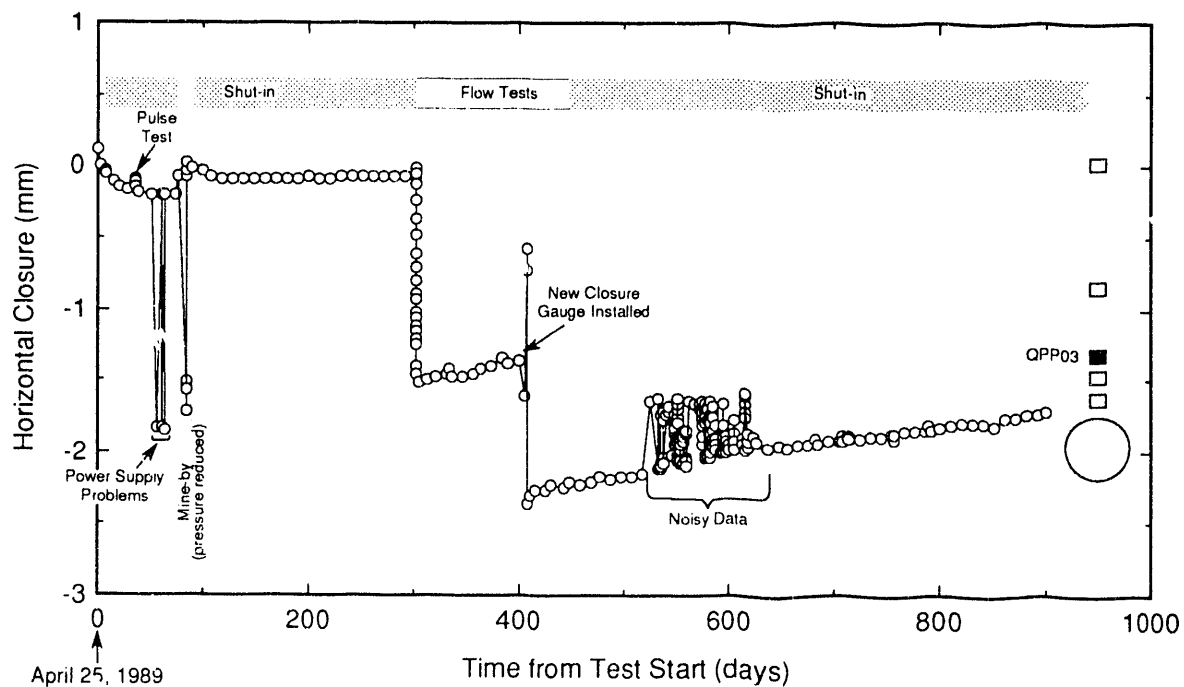


Figure 6-16. Hole QPP02 casing temperature.



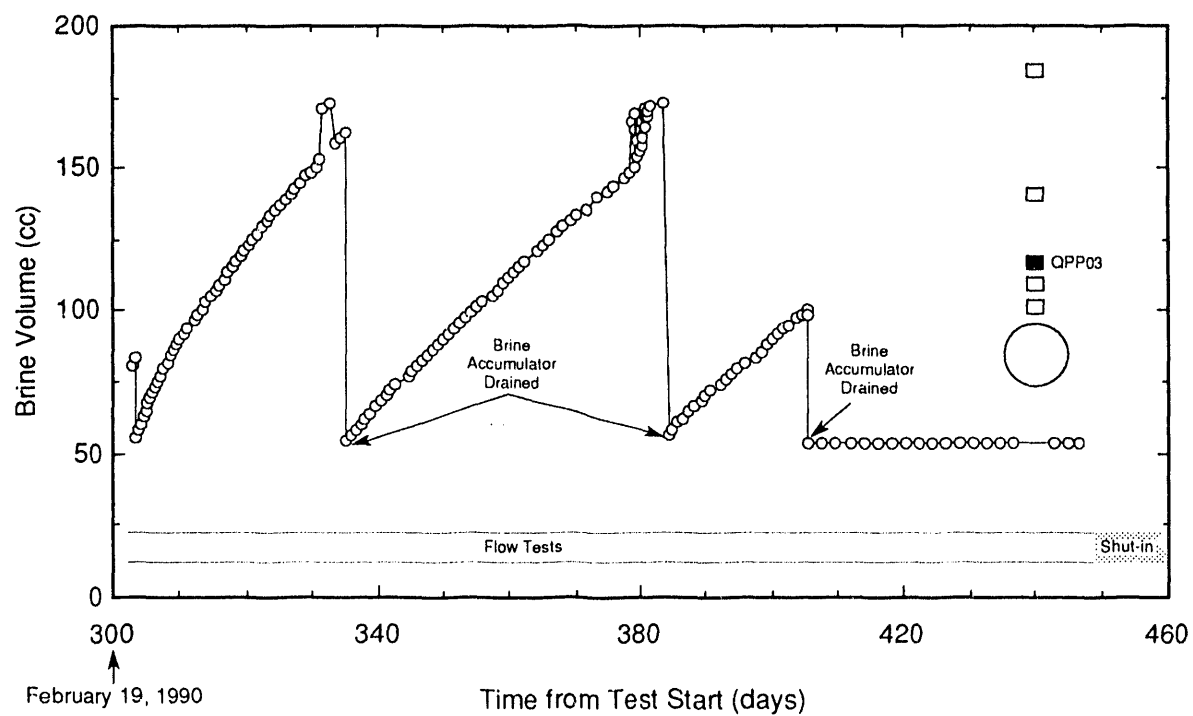
TRI-6119-87-0

Figure 6-17. Vertical closure measured in the test zone of hole QPP03.



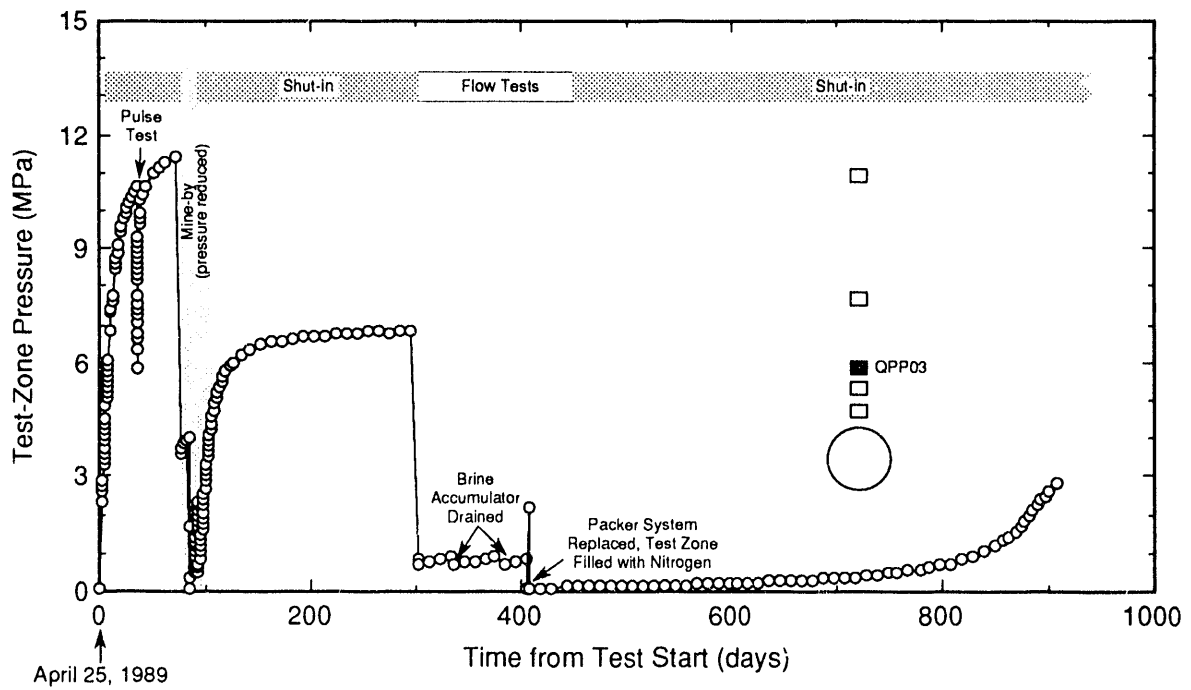
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Figure 6-18. Horizontal closure measured in the test zone of hole QPP03.



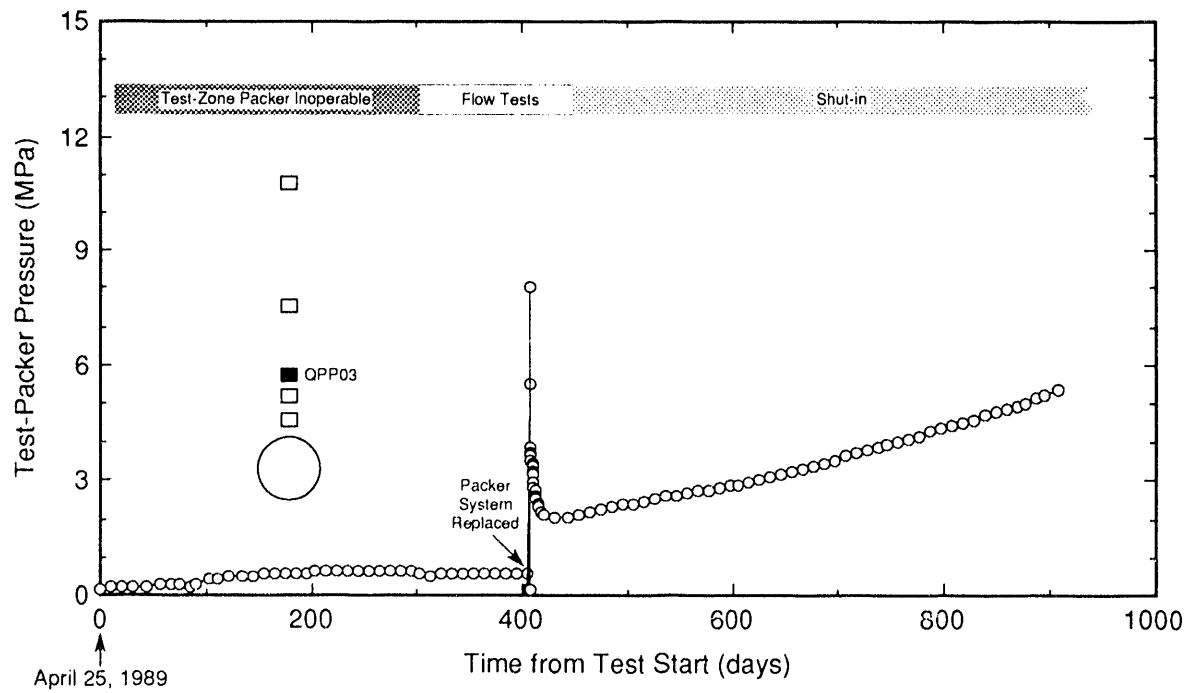
TRI-6119-89-0

Figure 6-19. Brine collected from QPP03 test zone during flow testing.



TRI-6119-90-0

Figure 6-20. Hole QPP03 test-zone pressure.



TRI-6119-91-0

Figure 6-21. Hole QPP03 test-packer pressure.

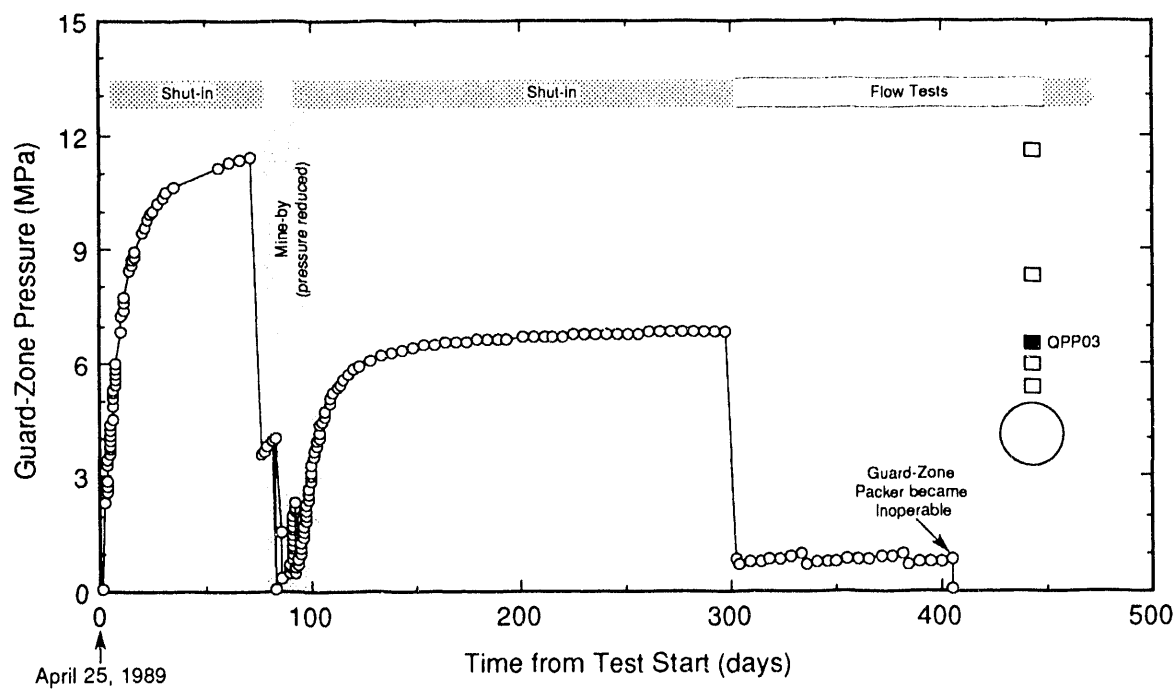


Figure 6-22. Hole QPP03 guard-zone pressure.

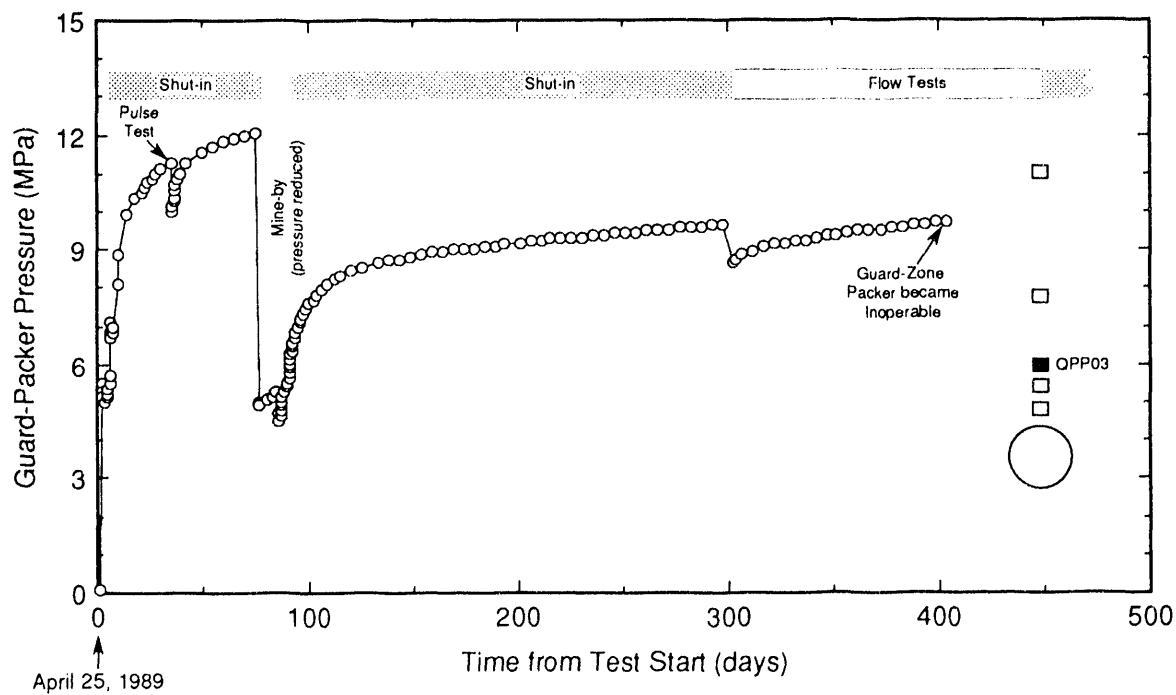


Figure 6-23. Hole QPP03 guard-packer pressure.

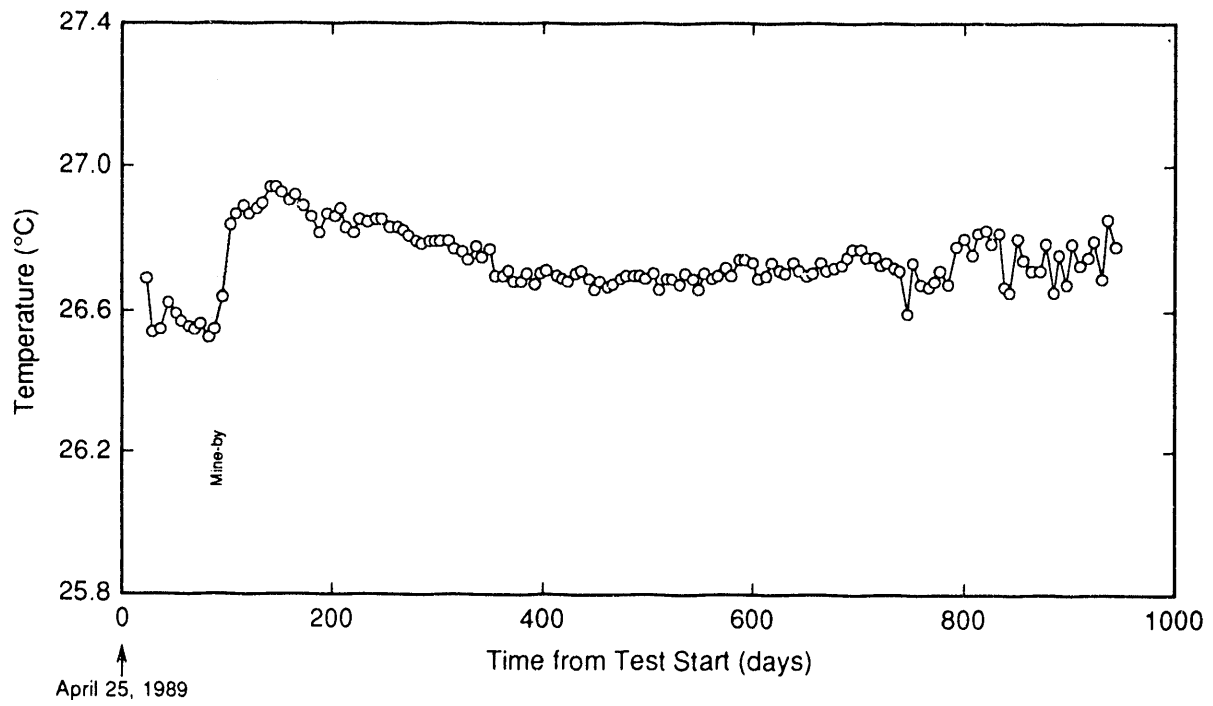


Figure 6-24. Hole QPP03 tool temperature.

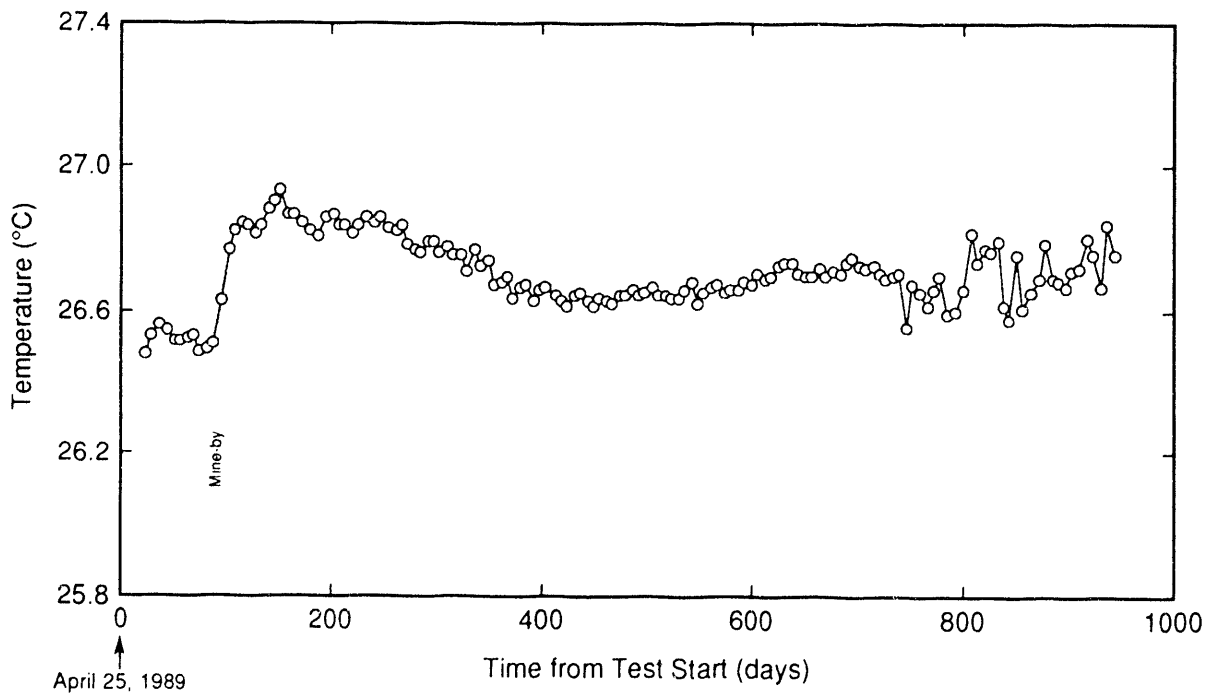
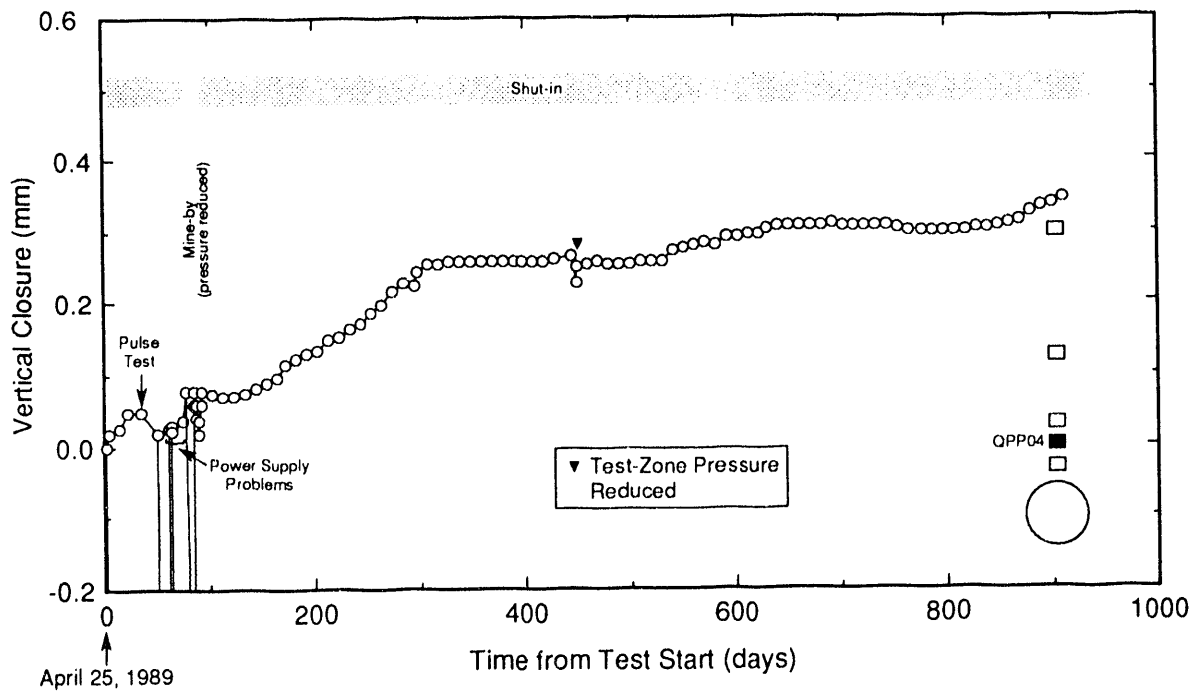
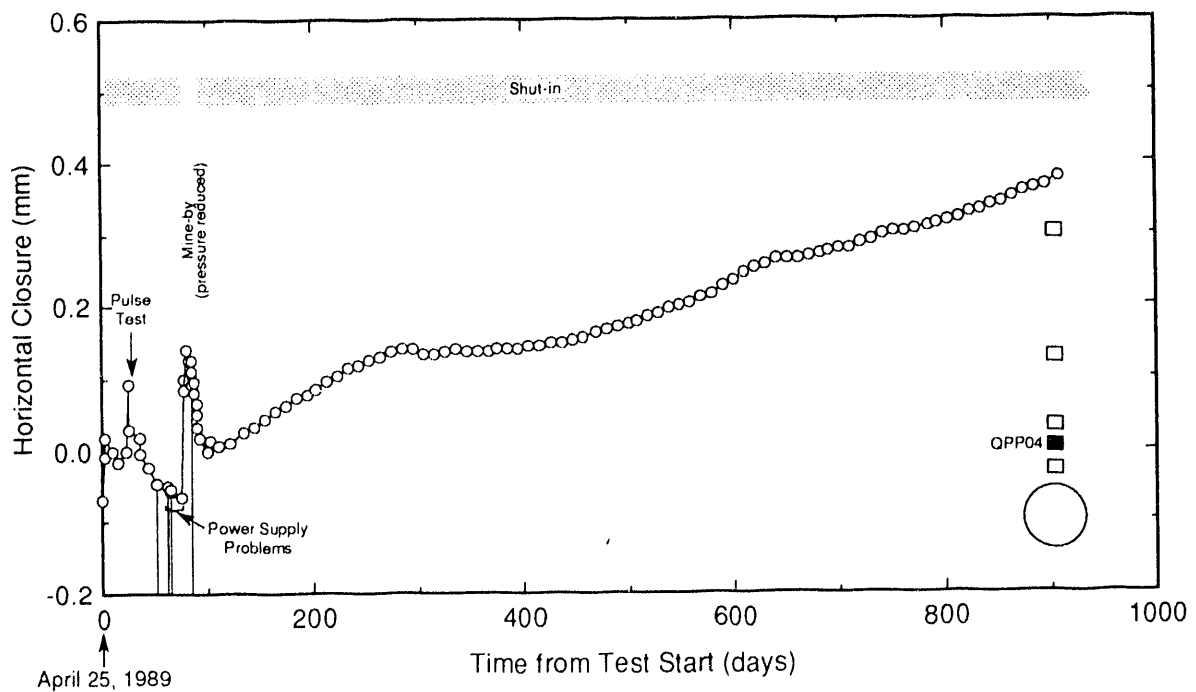


Figure 6-25. Hole QPP03 casing temperature.



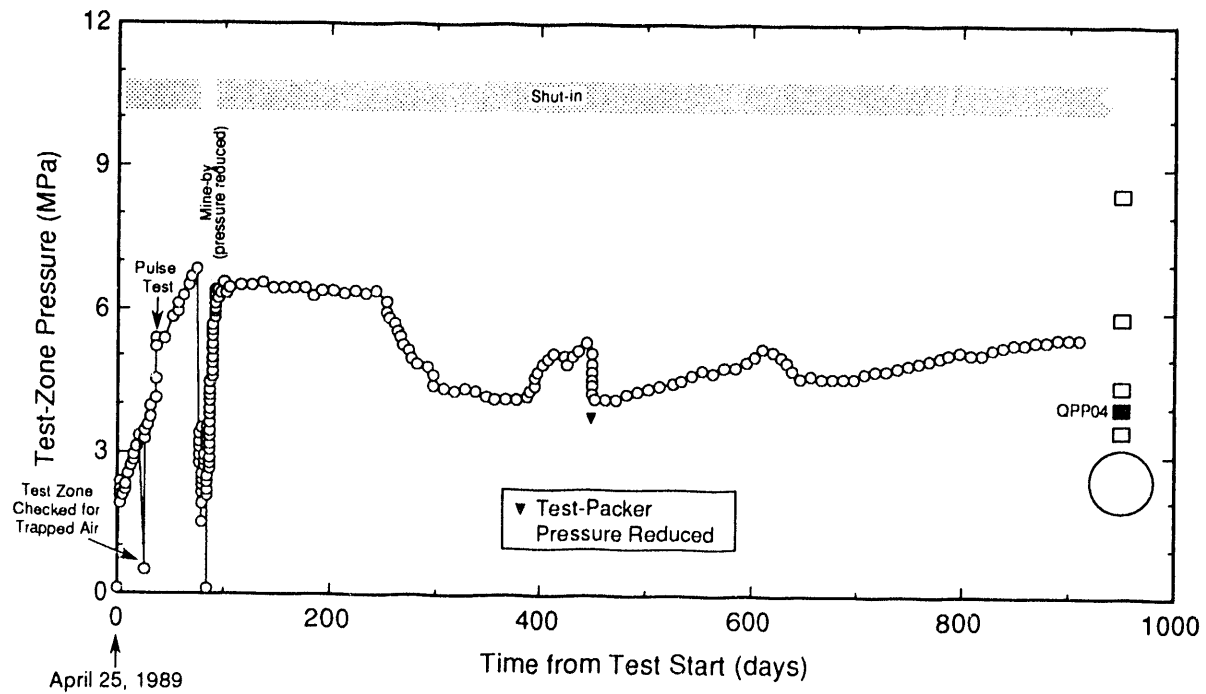
TRI-6119-94-0

Figure 6-26. Vertical closure measured in the test zone of hole QPP04.



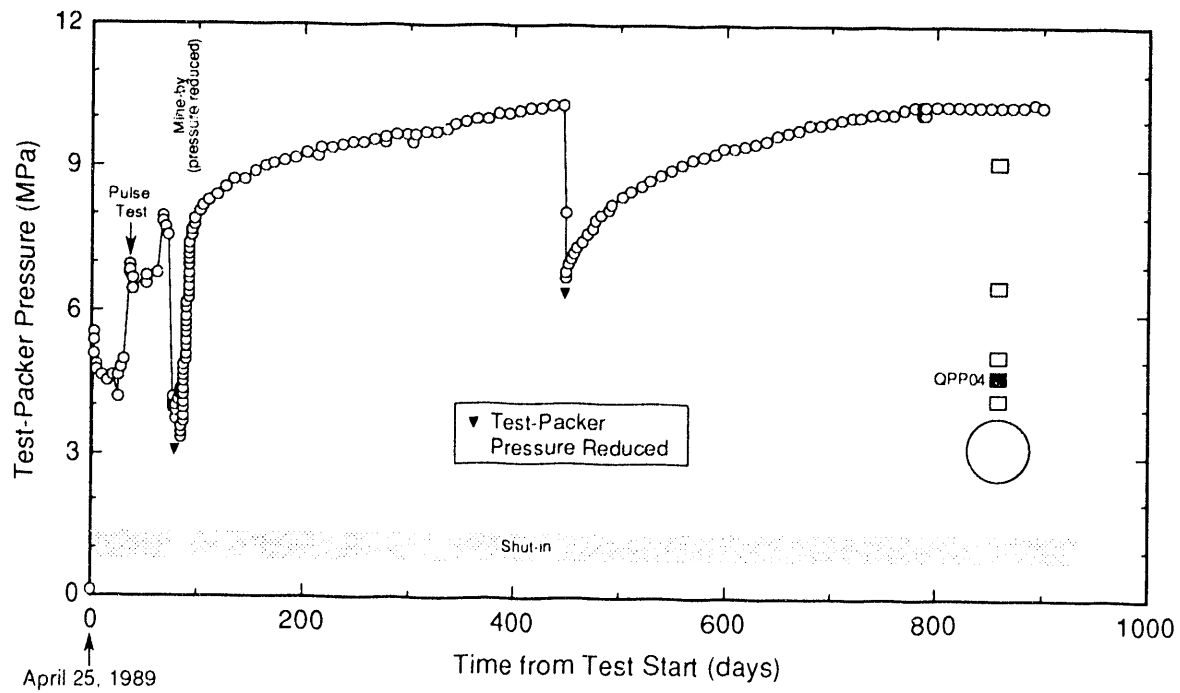
TRI-6119-95-0

Figure 6-27. Horizontal closure measured in the test zone of hole QPP04.



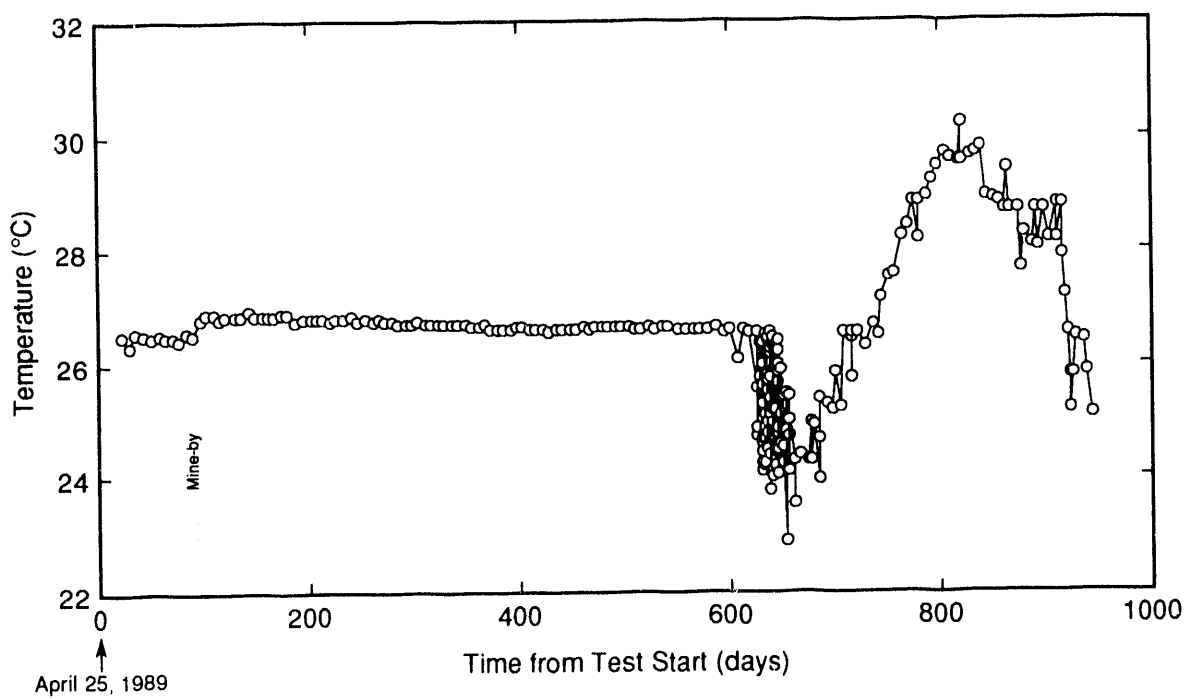
TRI-6119-96-0

Figure 6-28. Hole QPP04 test-zone pressure.



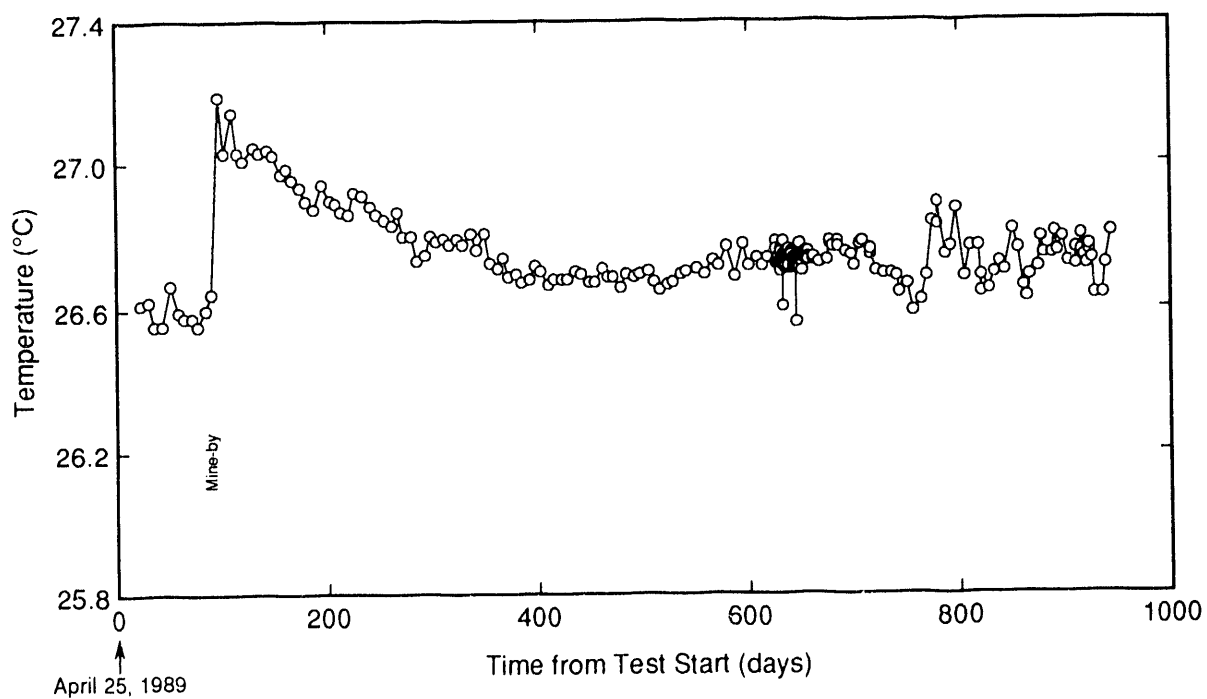
TRI-6119-97-0

Figure 6-29. Hole QPP04 test-packer pressure.



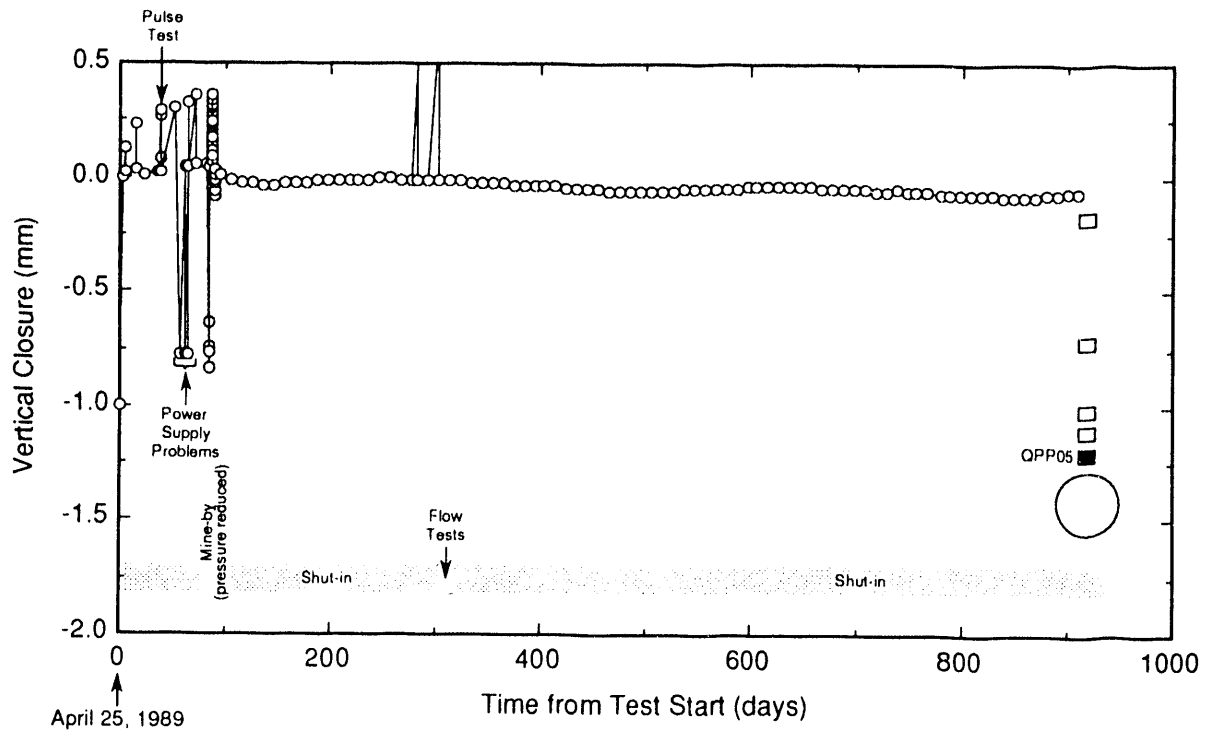
TRI-6119-27-0

Figure 6-30. Hole QPP04 tool temperature.



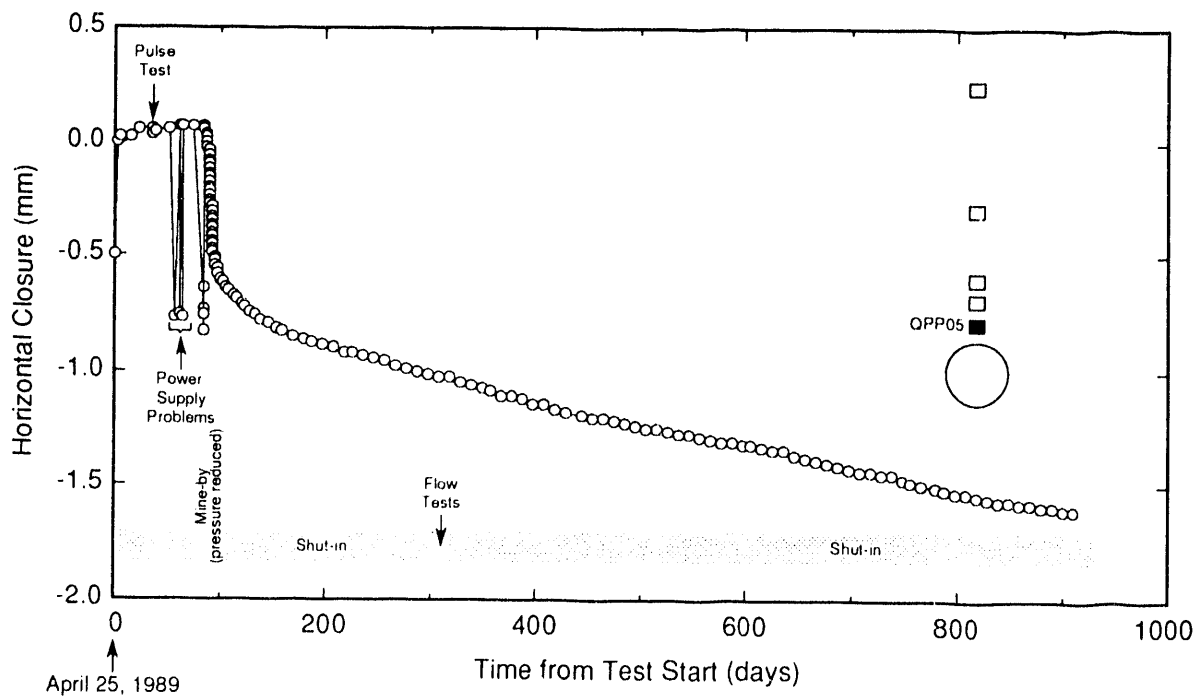
TRI-6119-28-0

Figure 6-31. Hole QPP04 casing temperature.



TRI-6119-98-0

Figure 6-32. Vertical closure measured in the test zone of hole QPP05.



TRI-6119-99-0

Figure 6-33. Horizontal closure measured in the test zone of hole QPP05.

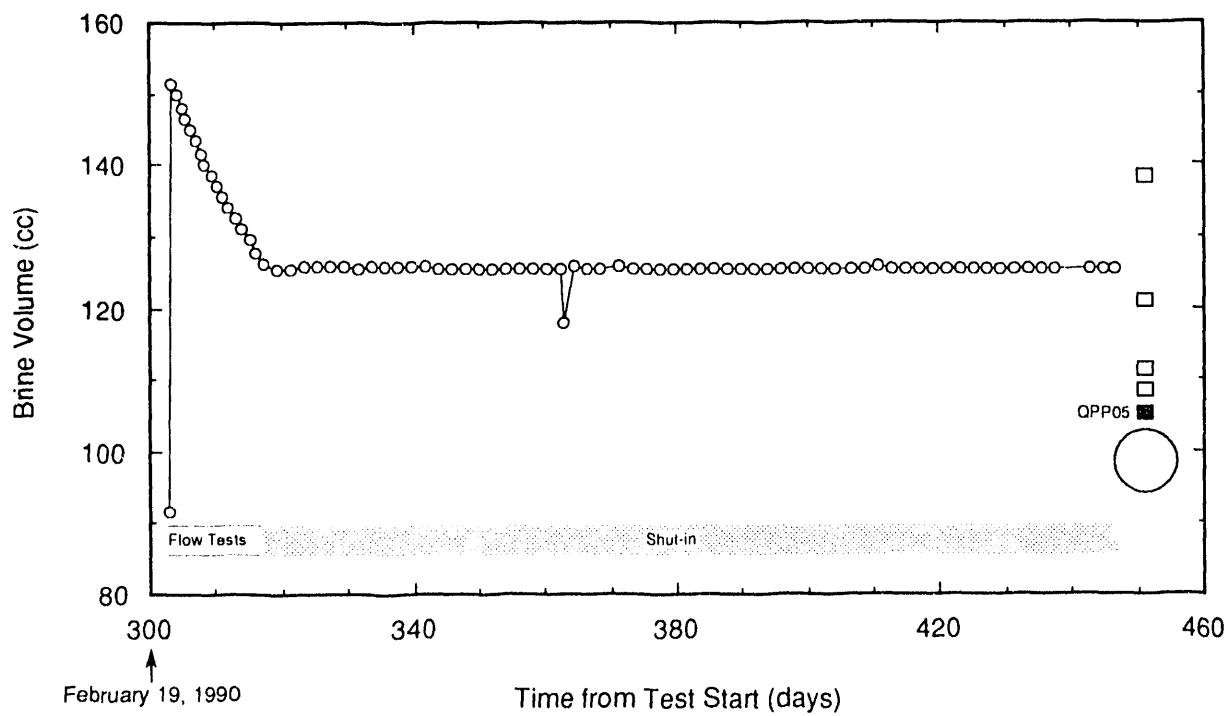
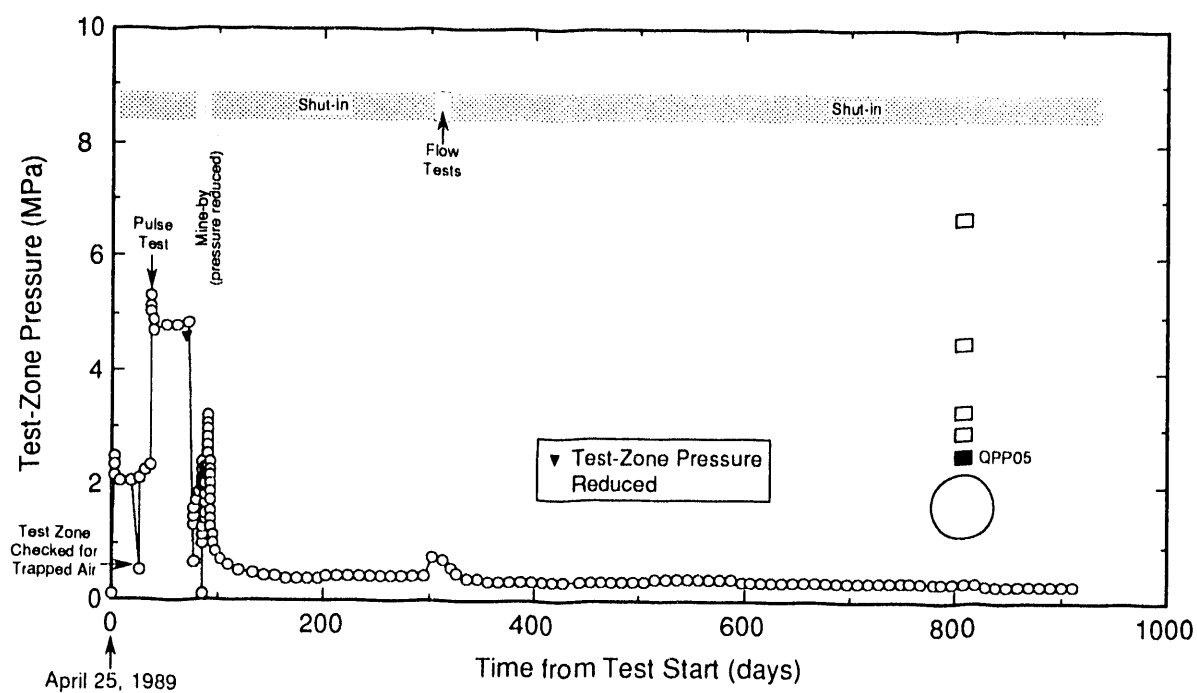
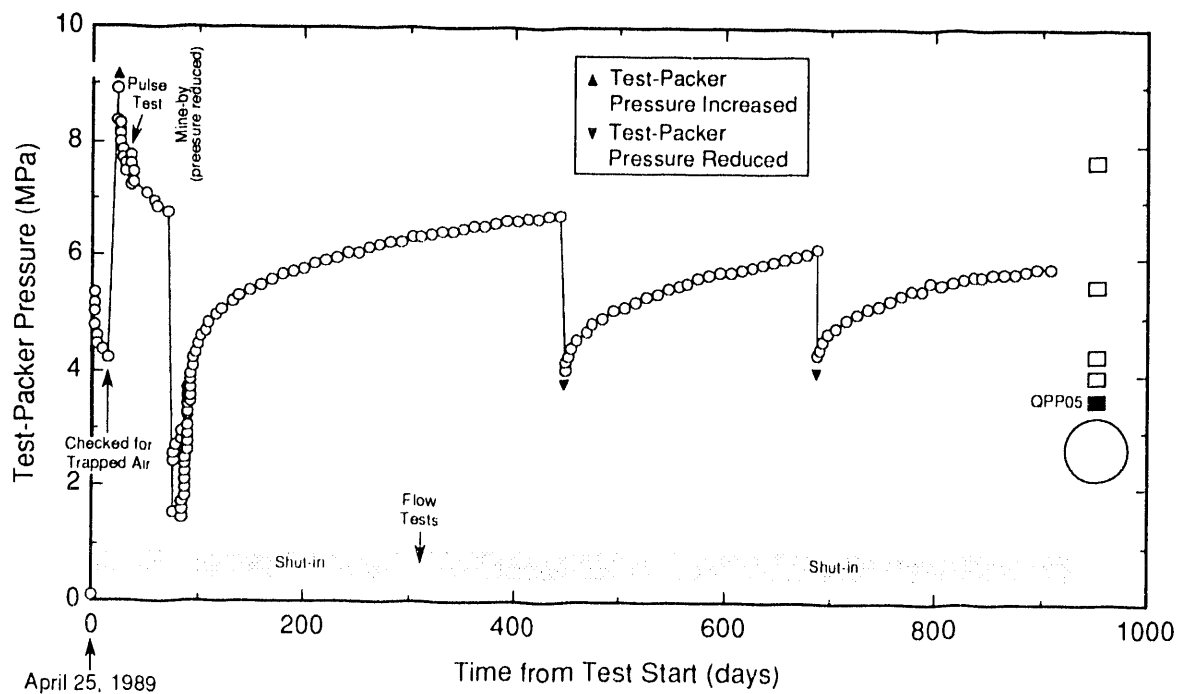


Figure 6-34. Brine lost from QPP05 test zone during flow testing.



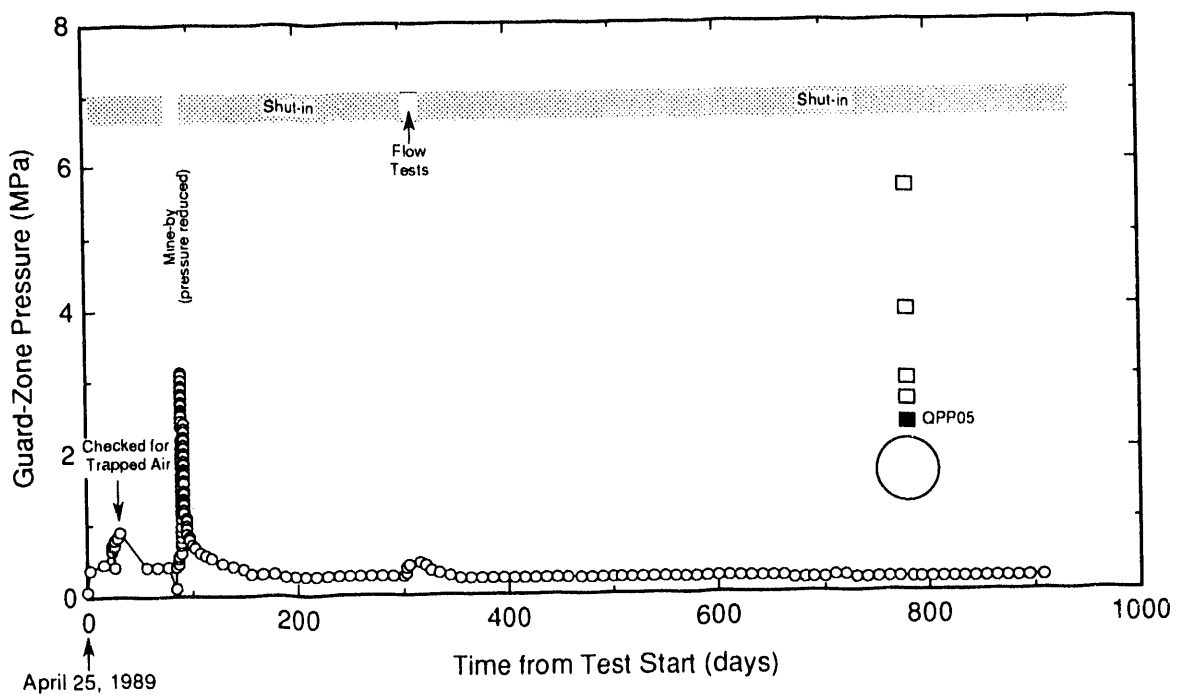
TRI-6119-173-0

Figure 6-35. Hole QPP05 test-zone pressure.



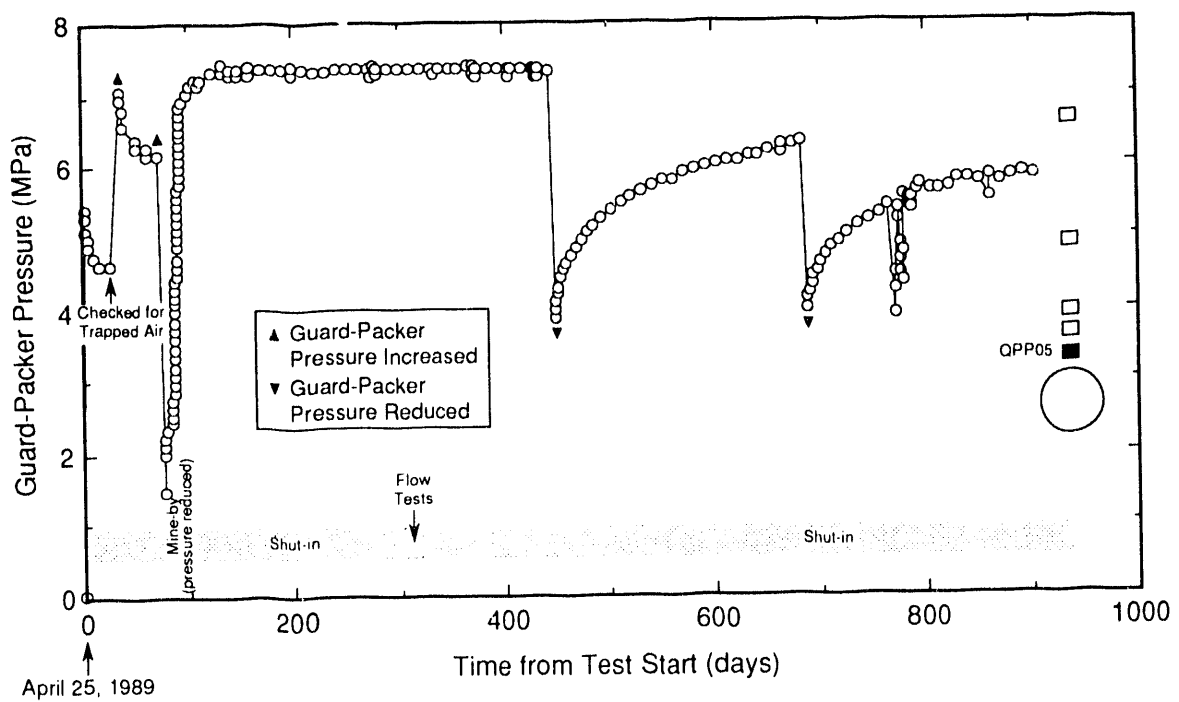
TRI-6119-174-0

Figure 6-36. Hole QPP05 test-packer pressure.



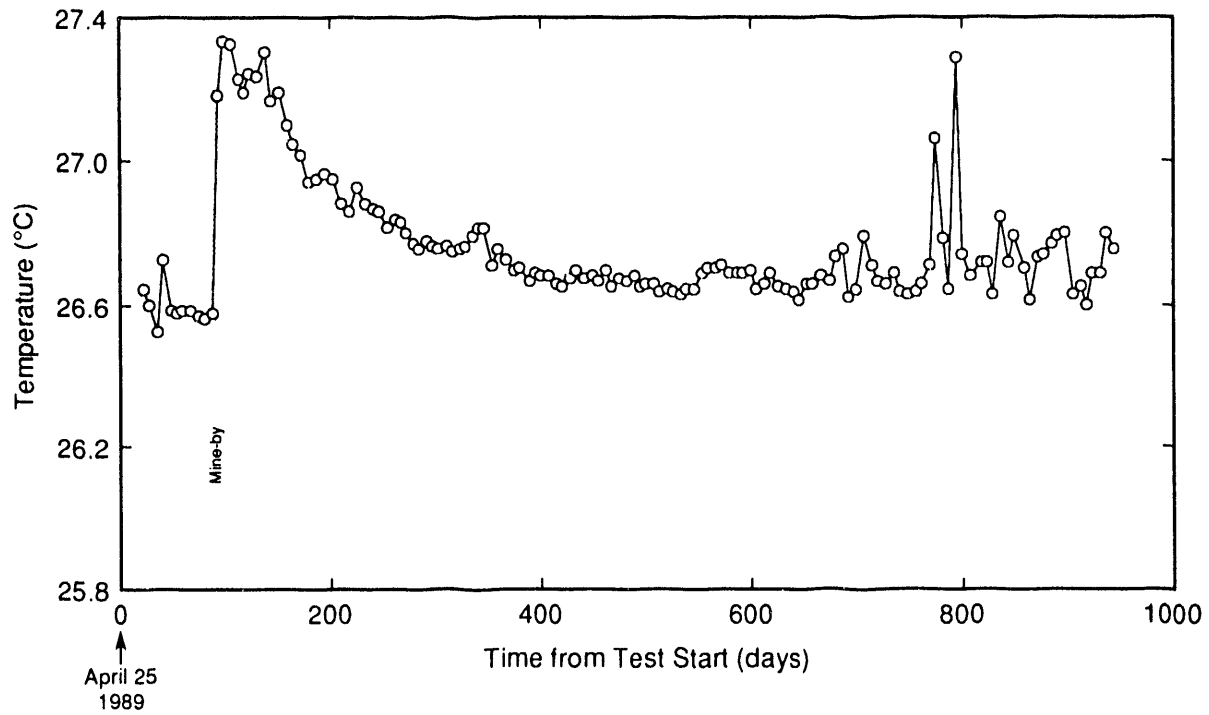
TRI-6119-175-0

Figure 6-37. Hole QPP05 guard-zone pressure.



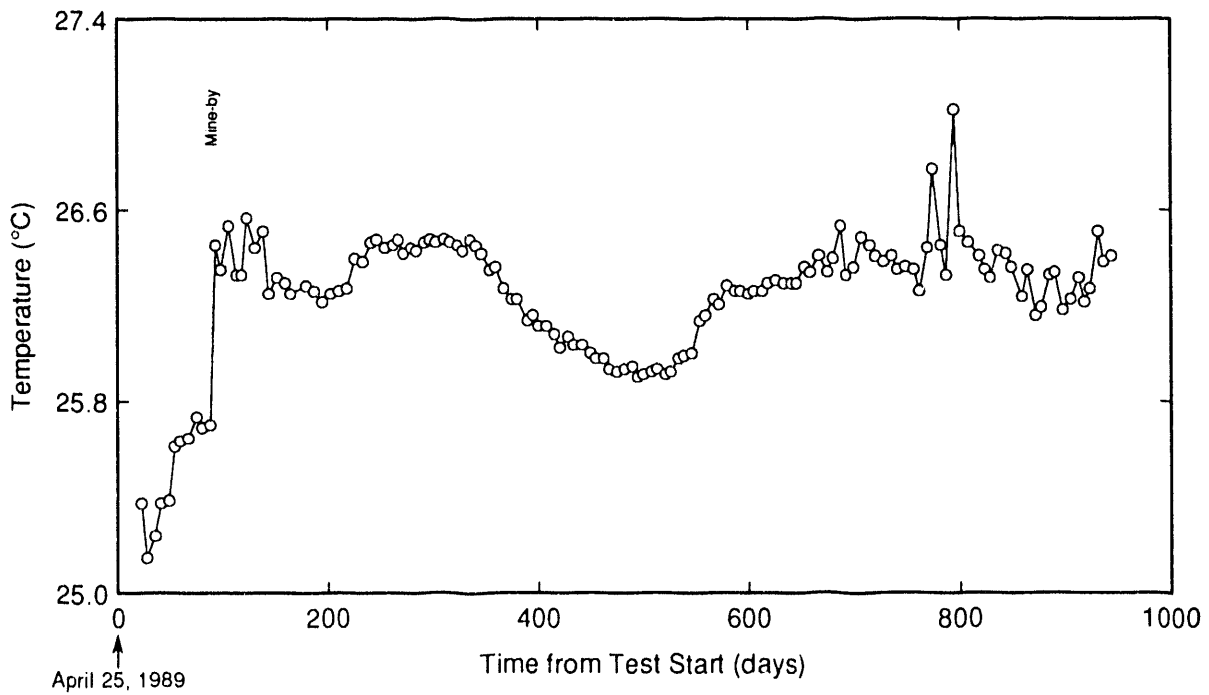
TRI-6119-176-0

Figure 6-38. Hole QPP05 guard-packer pressure.



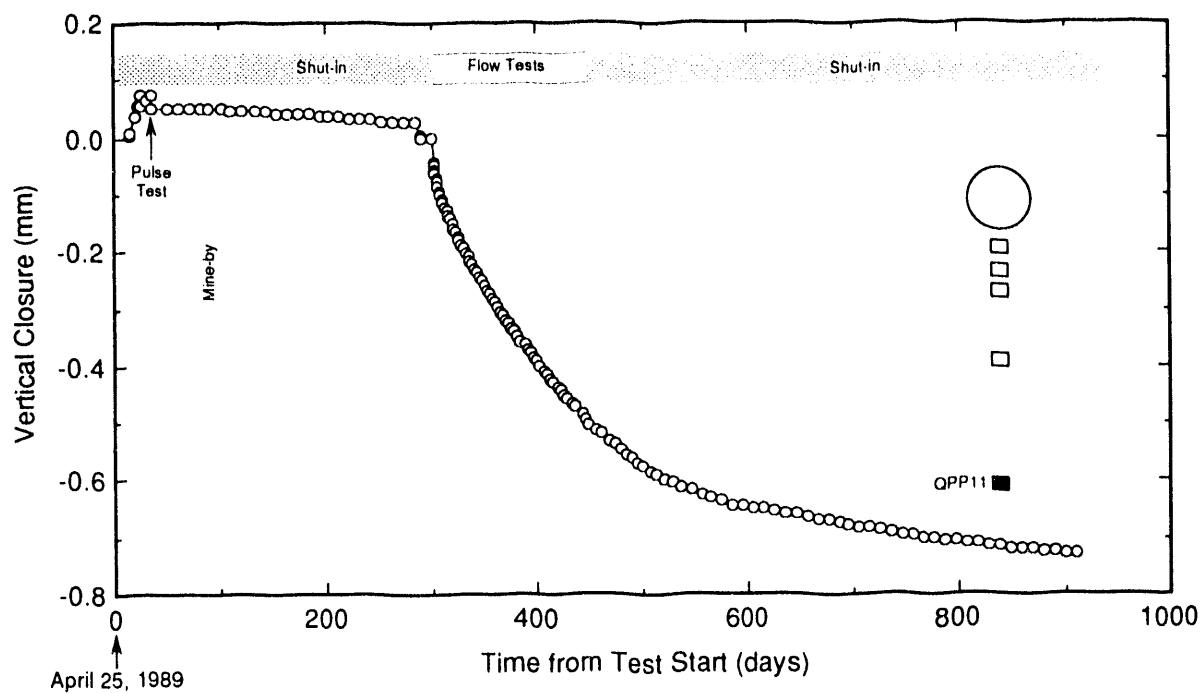
TRI-6119-29-0

Figure 6-39. Hole QPP05 tool temperature.



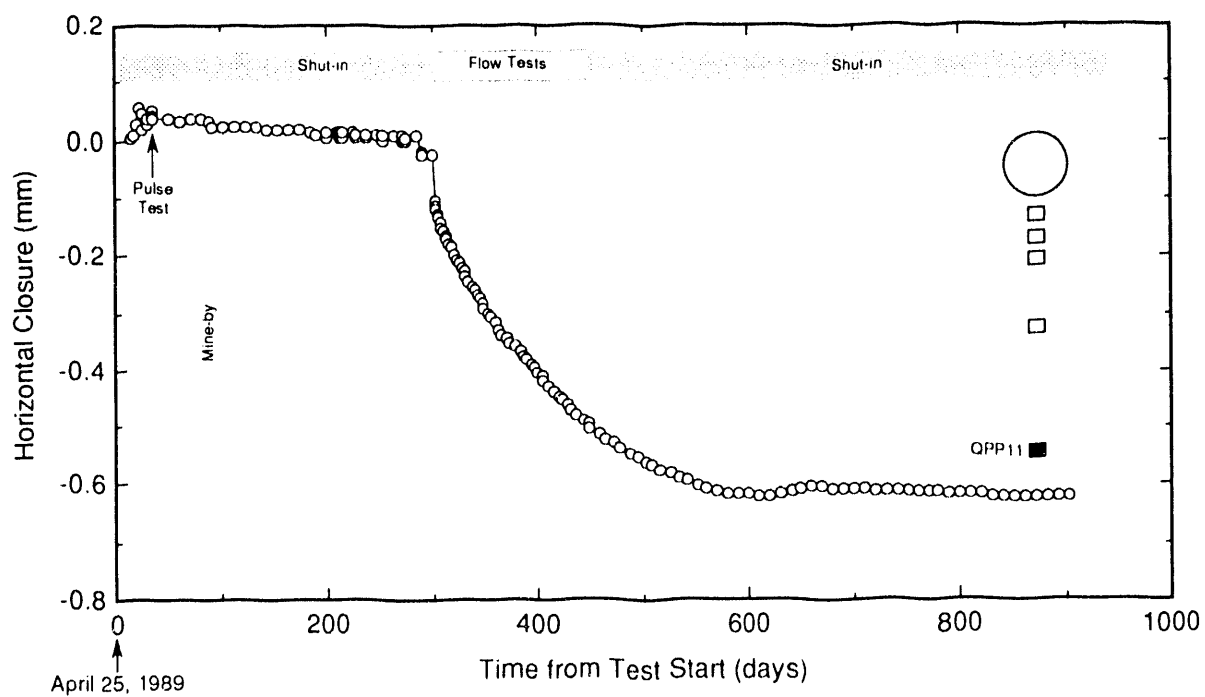
TRI-6119-30-0

Figure 6-40. Hole QPP05 casing temperature.



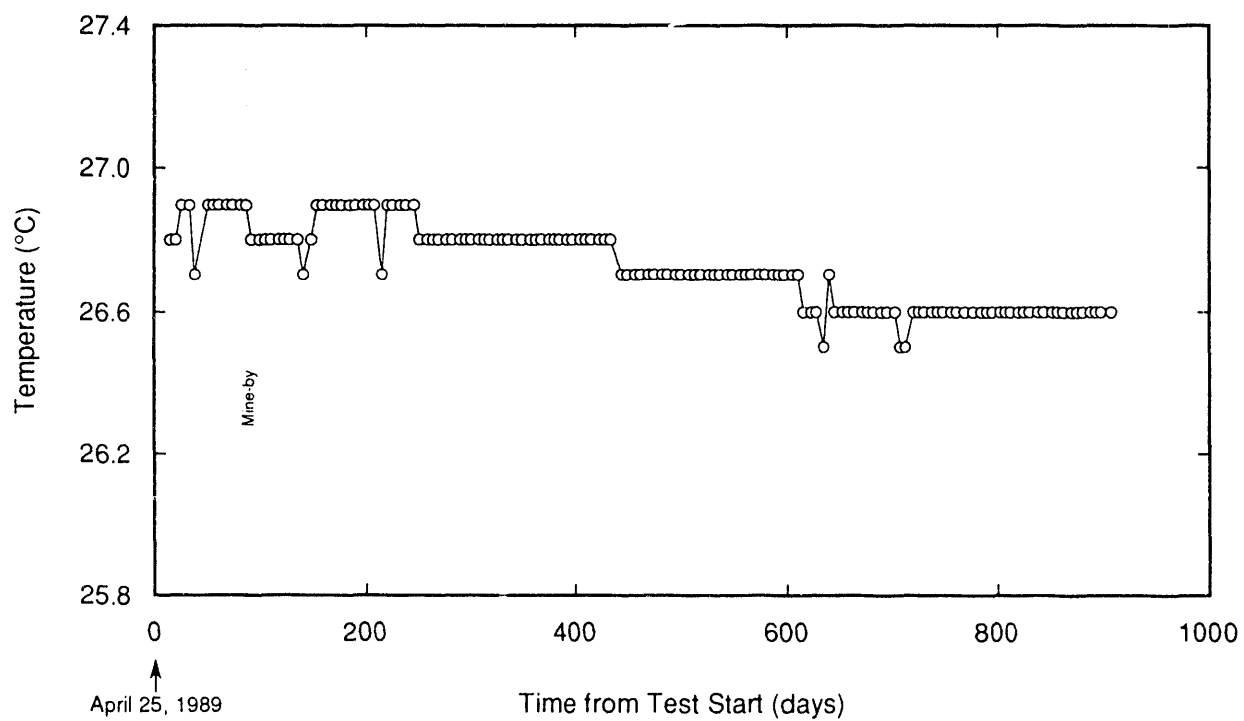
TRI-6119-177-0

Figure 6-41. Vertical closure measured in the test zone of hole QPP11.



TRI-6119-178-0

Figure 6-42. Horizontal closure measured in the test zone of hole QPP11.



TRI-6119-48-0

Figure 6-43. Hole QPP11 test-zone temperature.

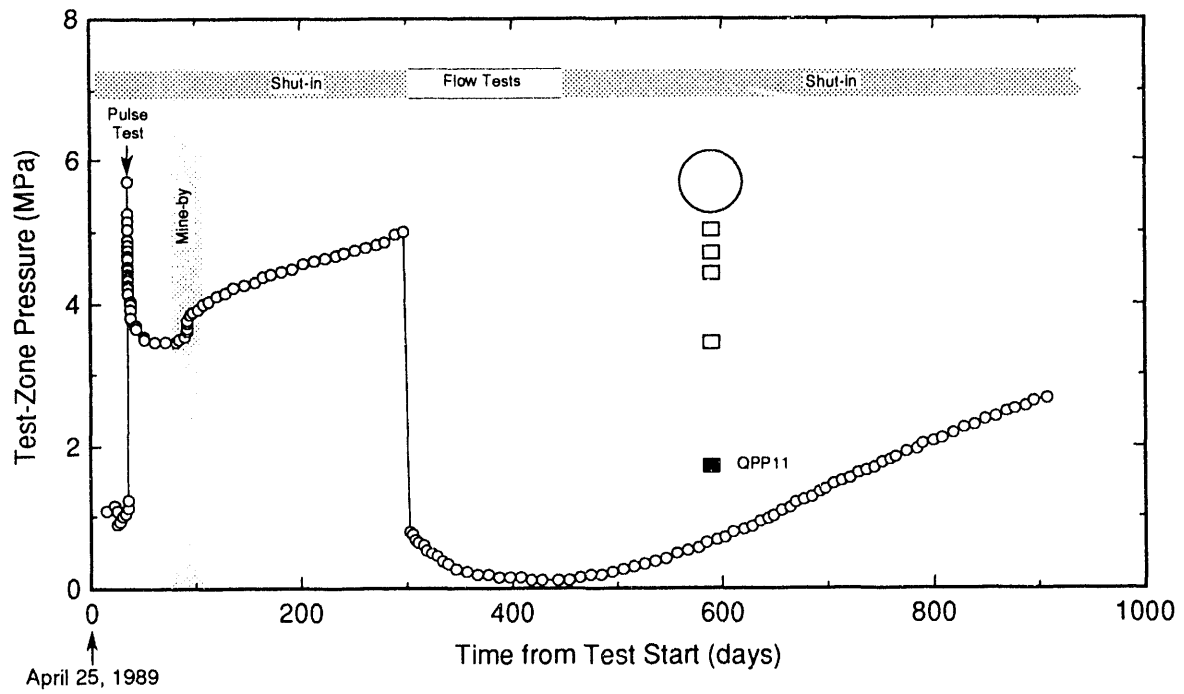


Figure 6-44. Hole QPP11 test-zone pressure.

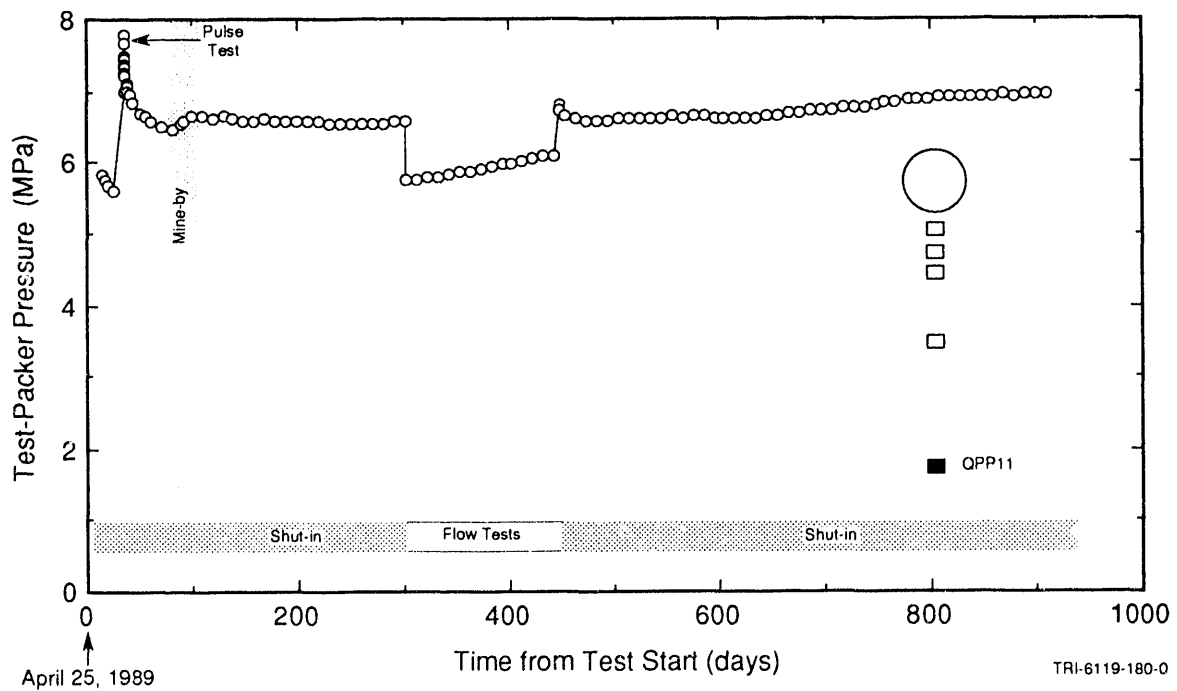
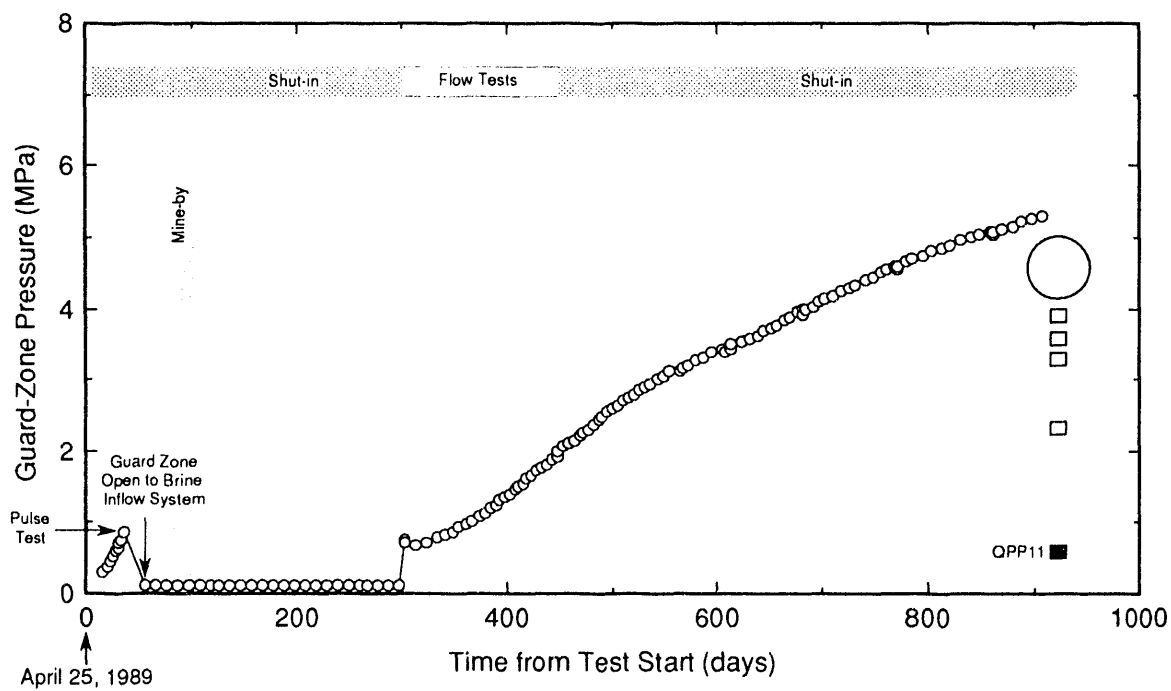
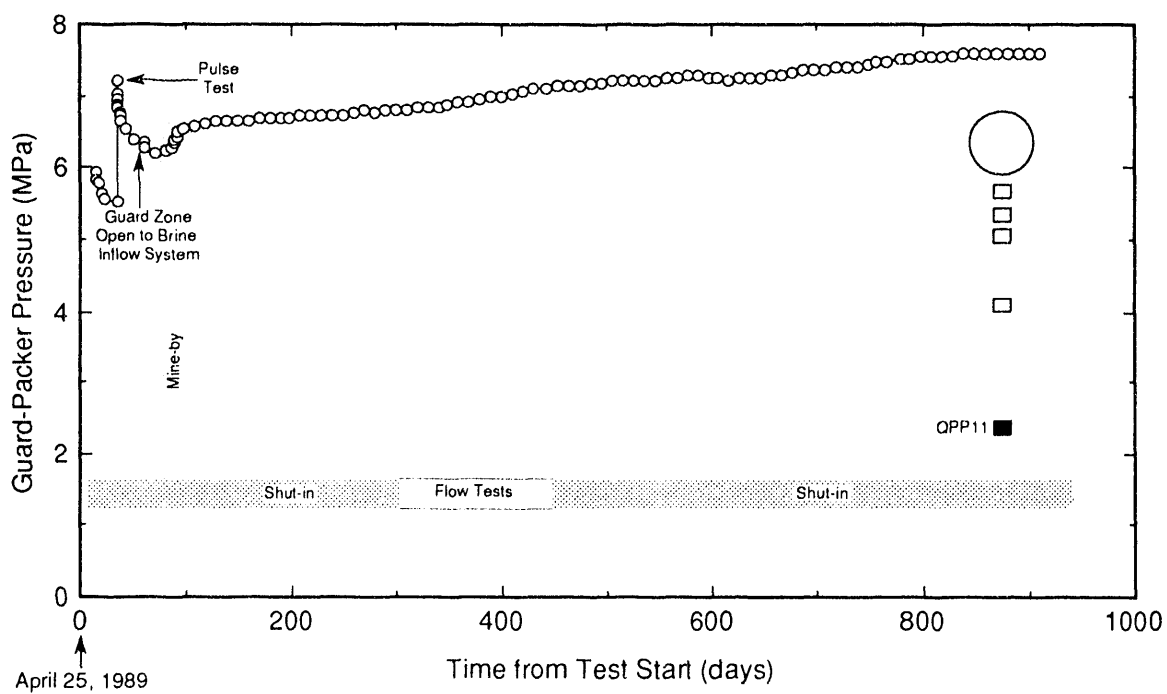


Figure 6-45. Hole QPP11 test-packer pressure.



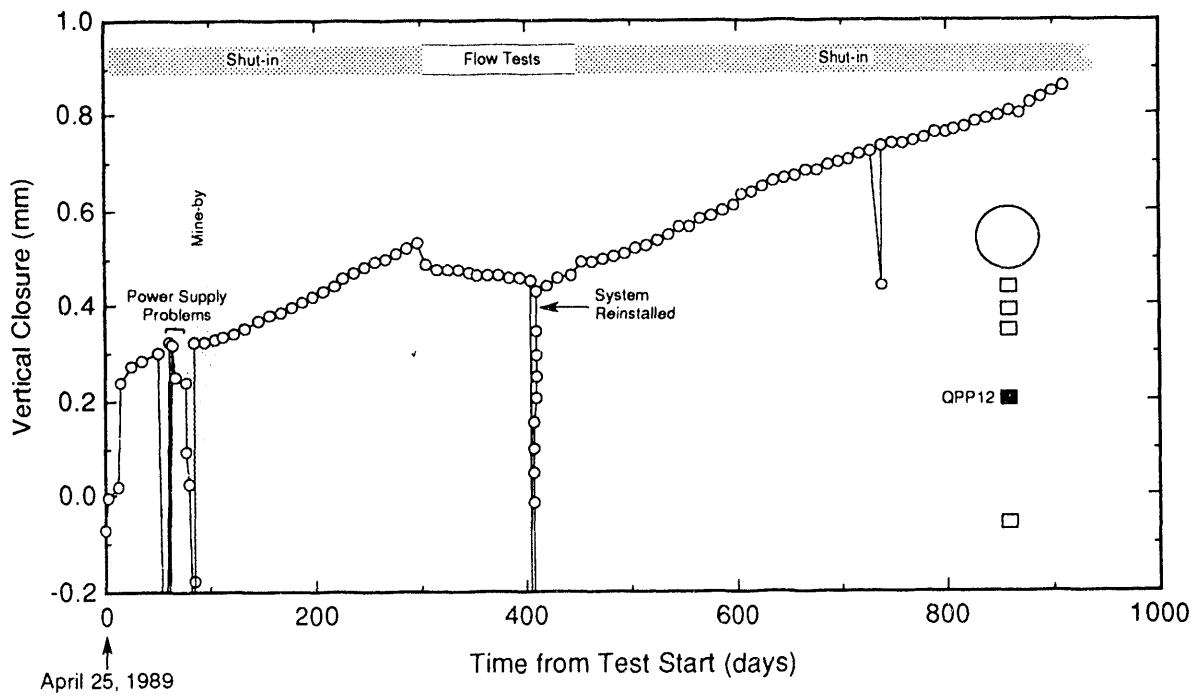
TRI-6119-181-0

Figure 6-46. Hole QPP11 guard-zone pressure.



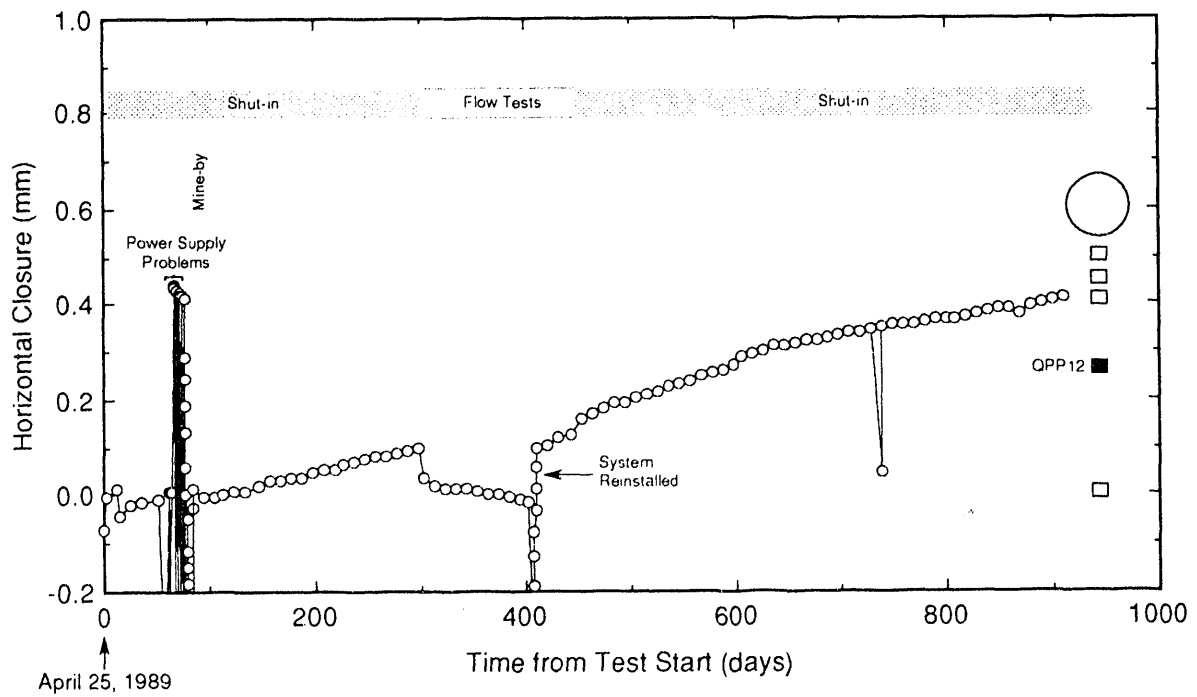
TRI-6119-182-0

Figure 6-47. Hole QPP11 guard-packer pressure.



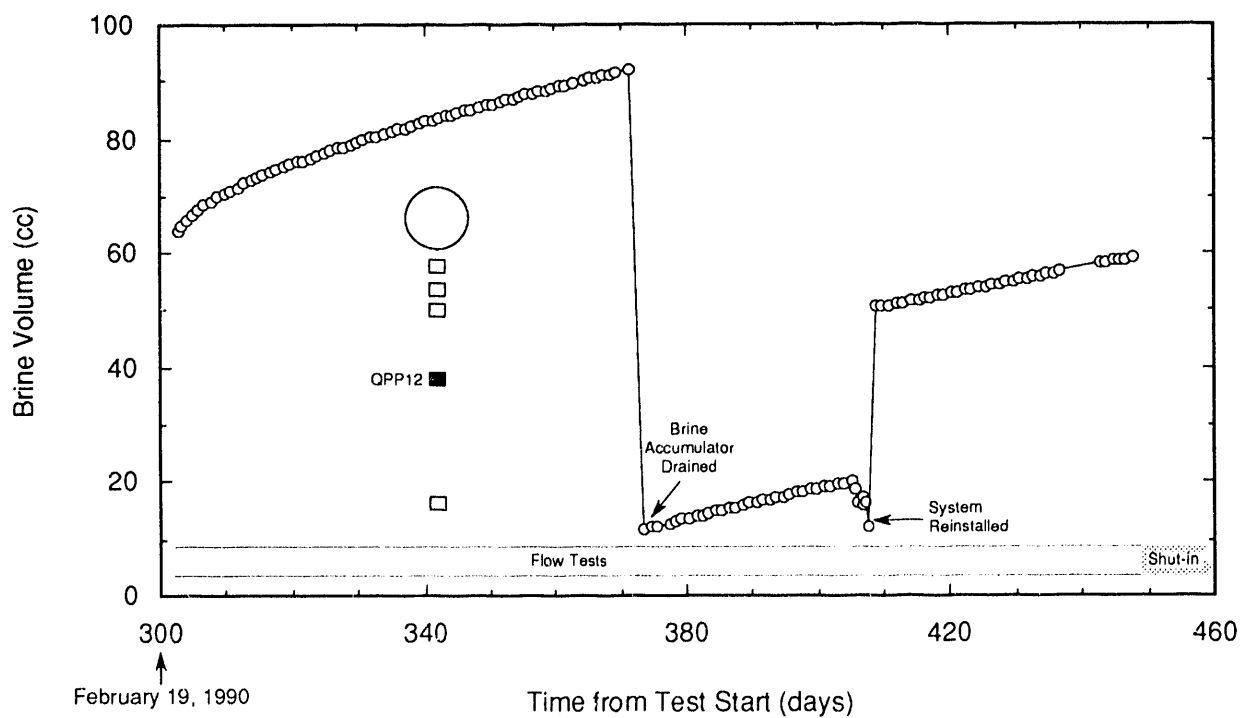
TRI-6119-183-0

Figure 6-48. Vertical closure measured in the test zone of hole QPP12.



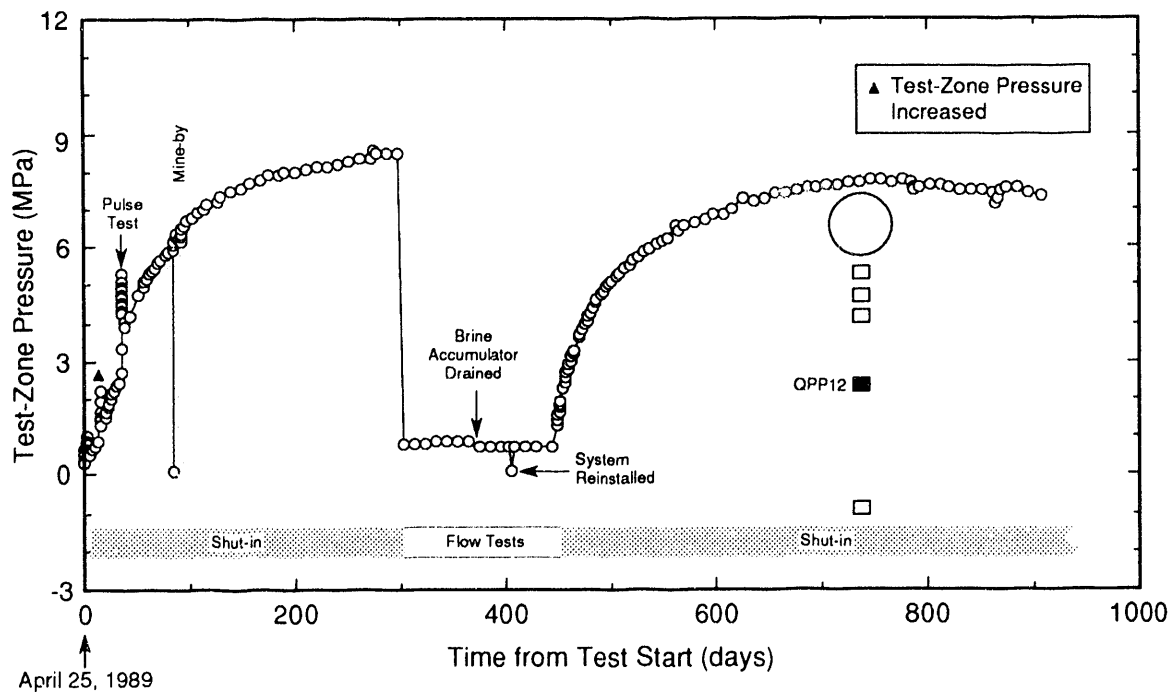
TRI-6119-184-0

Figure 6-49. Horizontal closure measured in the test zone of hole QPP12.



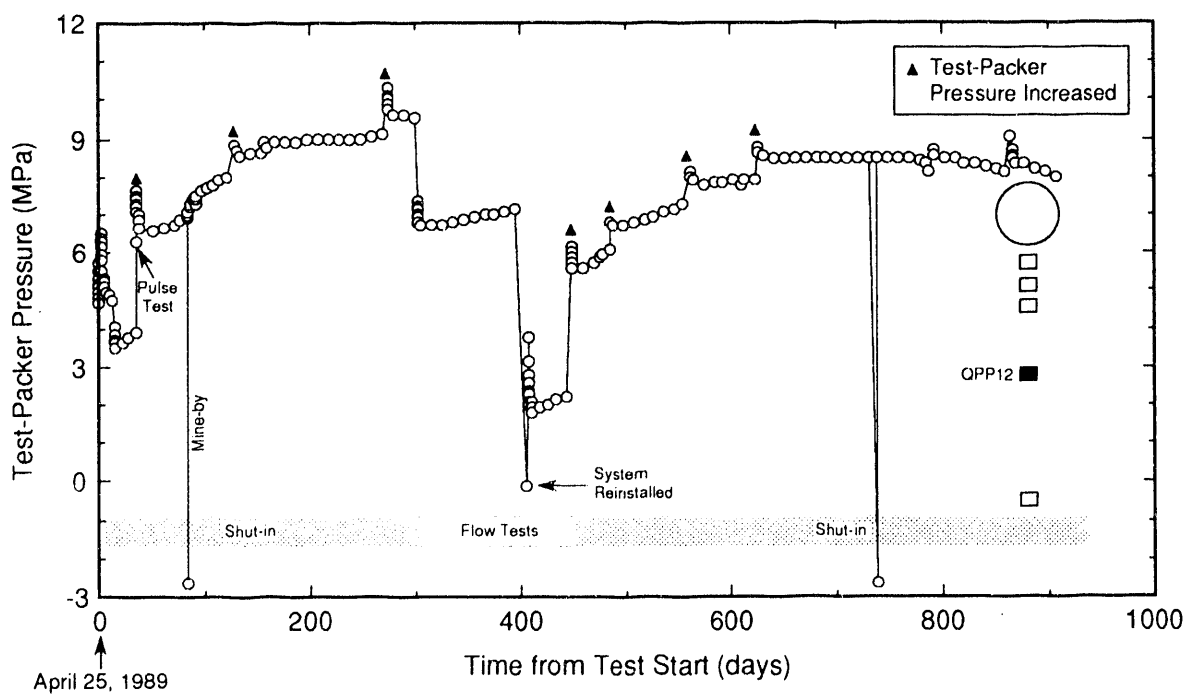
TRI-6119-185-0

Figure 6-50. Brine collected from QPP12 test zone during flow testing.



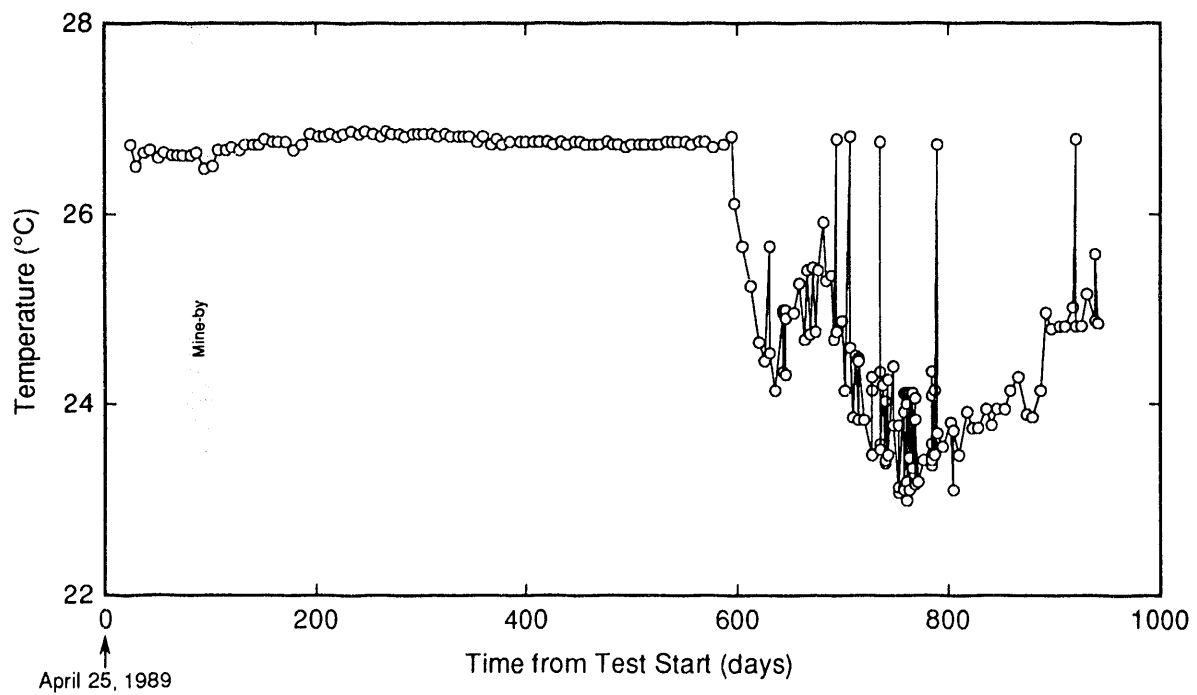
TRI-6119-186-0

Figure 6-51. Hole QPP12 test-zone pressure.



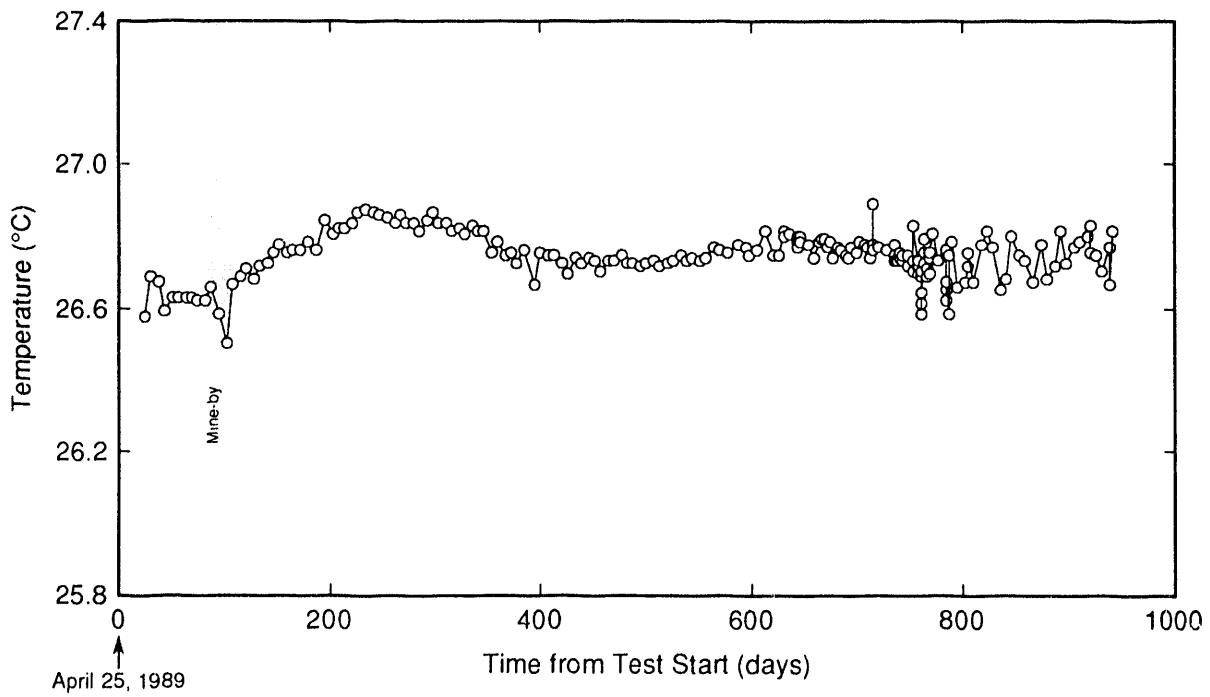
TRI-6119-187-0

Figure 6-52. Hole QPP12 test-packer pressure.



TRI-6119-31-0

Figure 6-53. Hole QPP12 tool temperature.



TRI-6119-32-0

Figure 6-54. Hole QPP12 casing temperature.

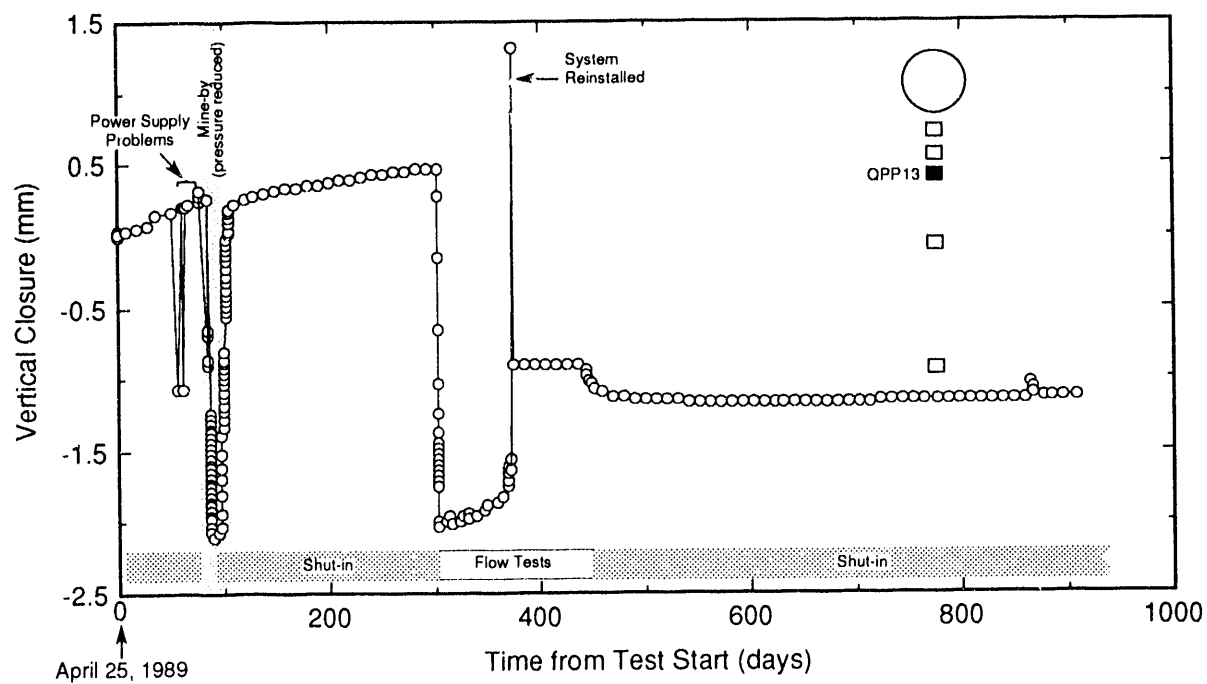


Figure 6-55. Vertical closure measured in the test zone of hole QPP13.

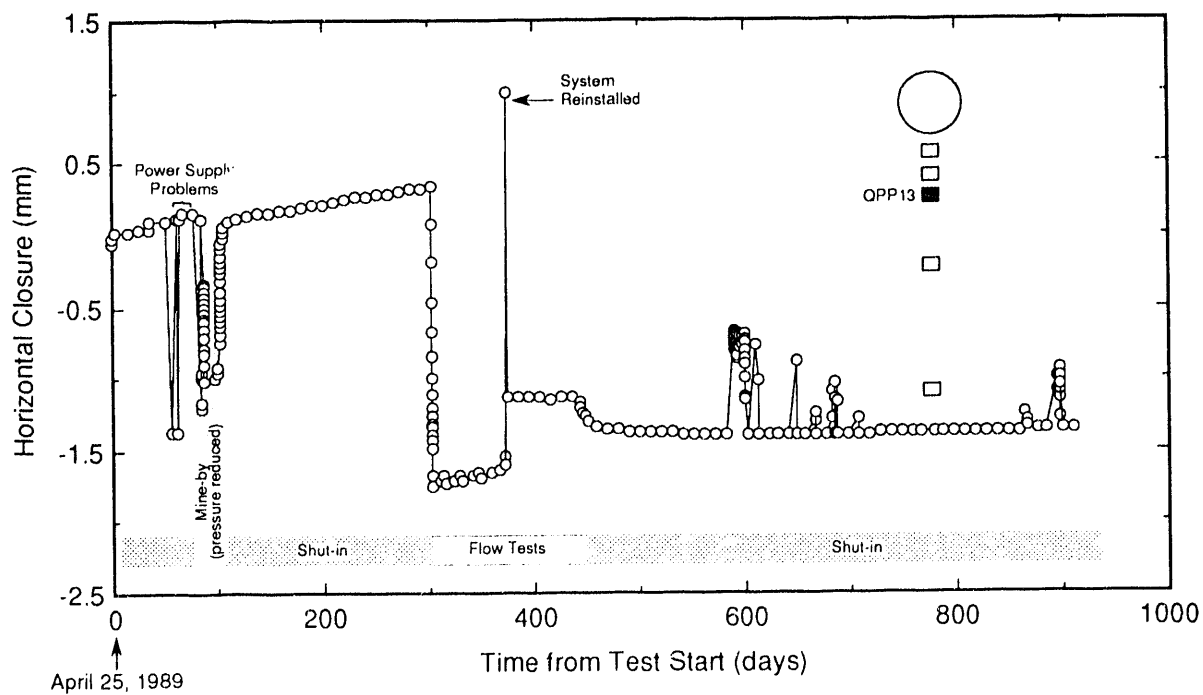
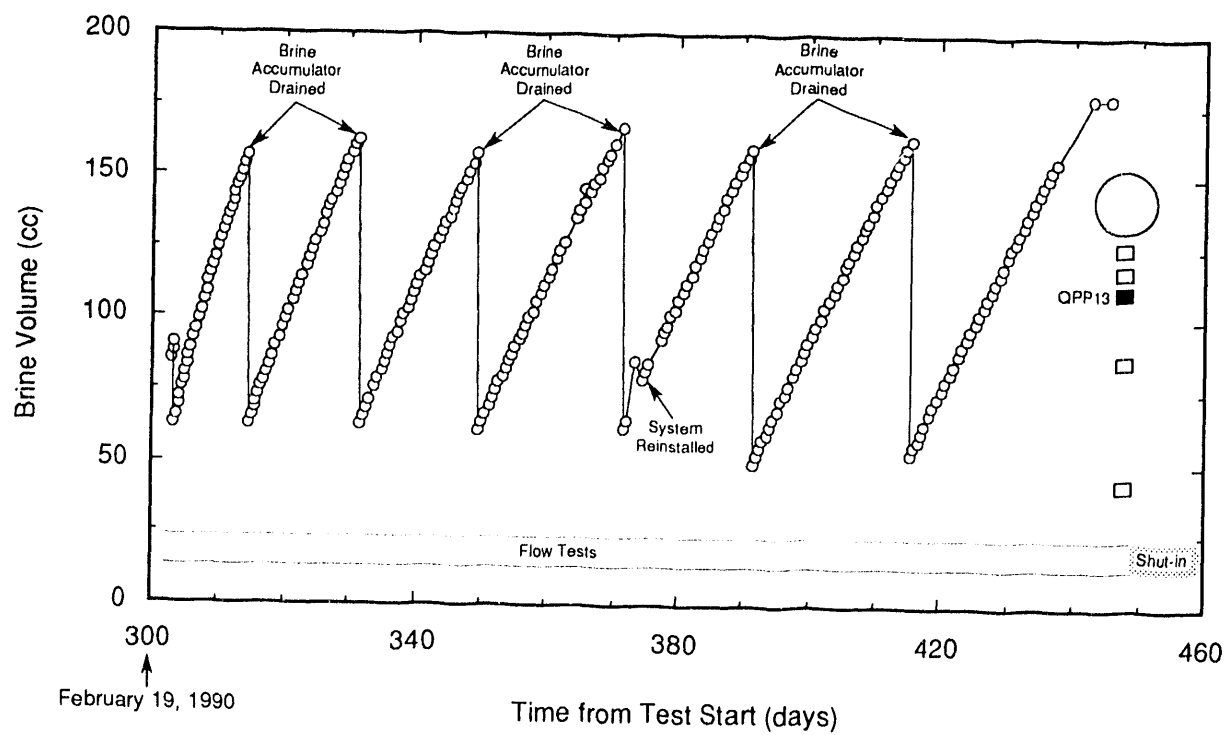


Figure 6-56. Horizontal closure measured in the test zone of hole QPP13.



TRI-6119-190-0

Figure 6-57. Brine collected from QPP13 test zone during flow testing.

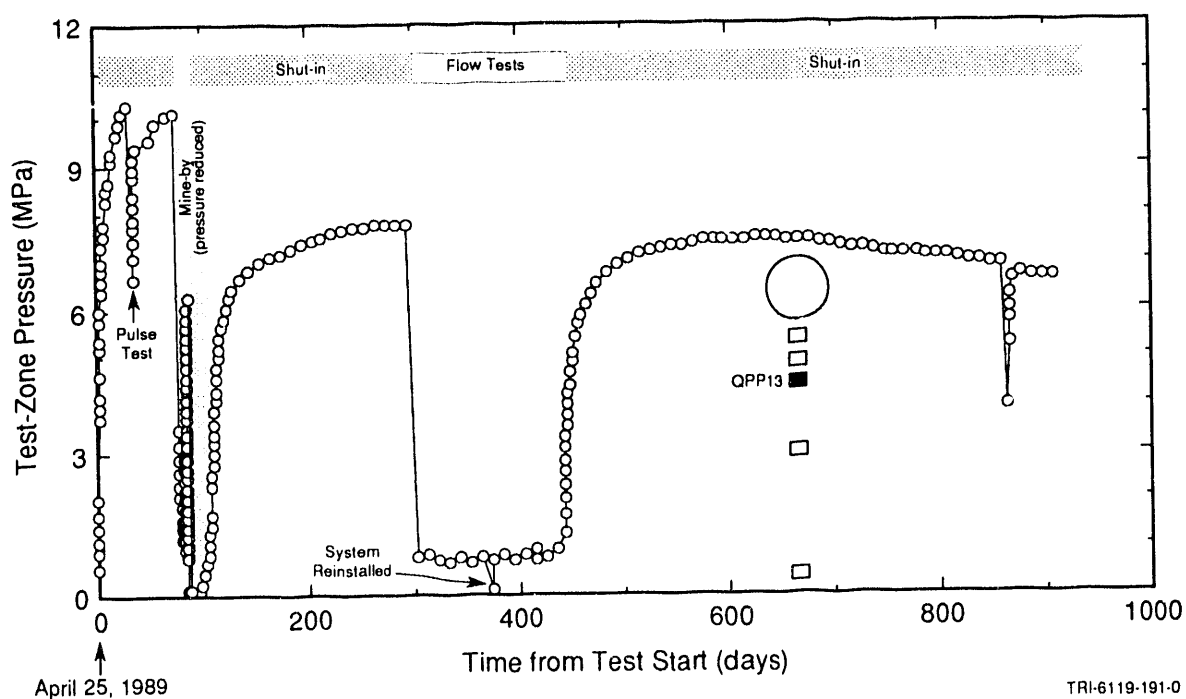


Figure 6-58. Hole QPP13 test-zone pressure.

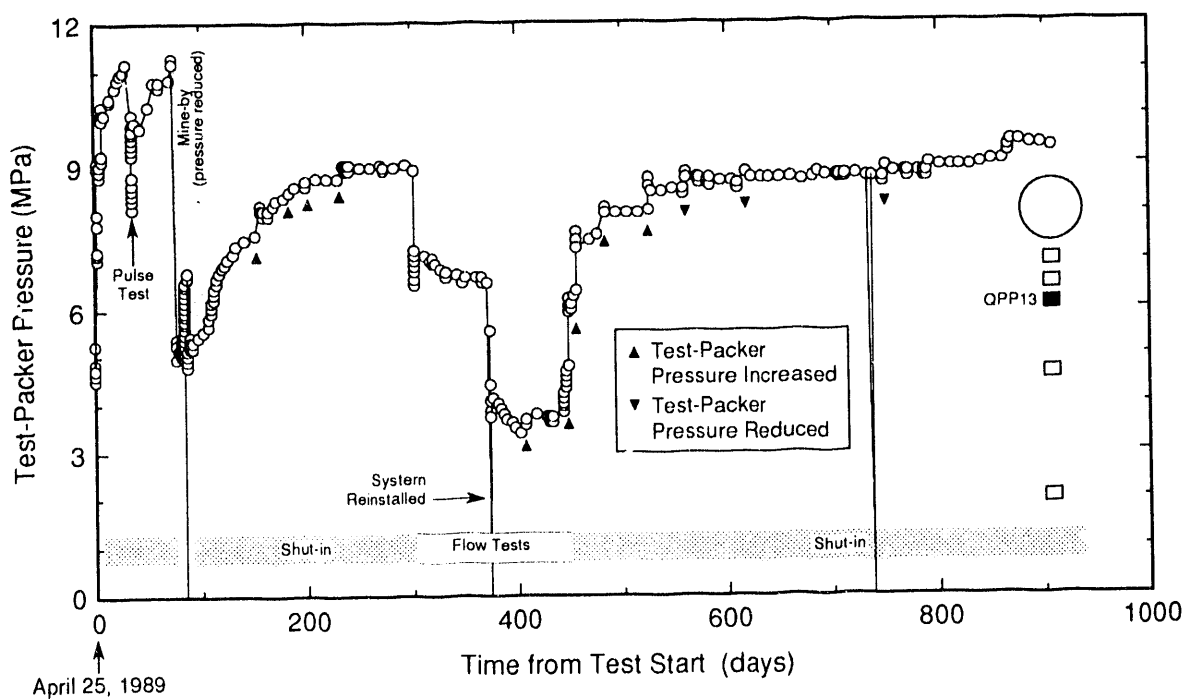


Figure 6-59. Hole QPP13 test-packer pressure.

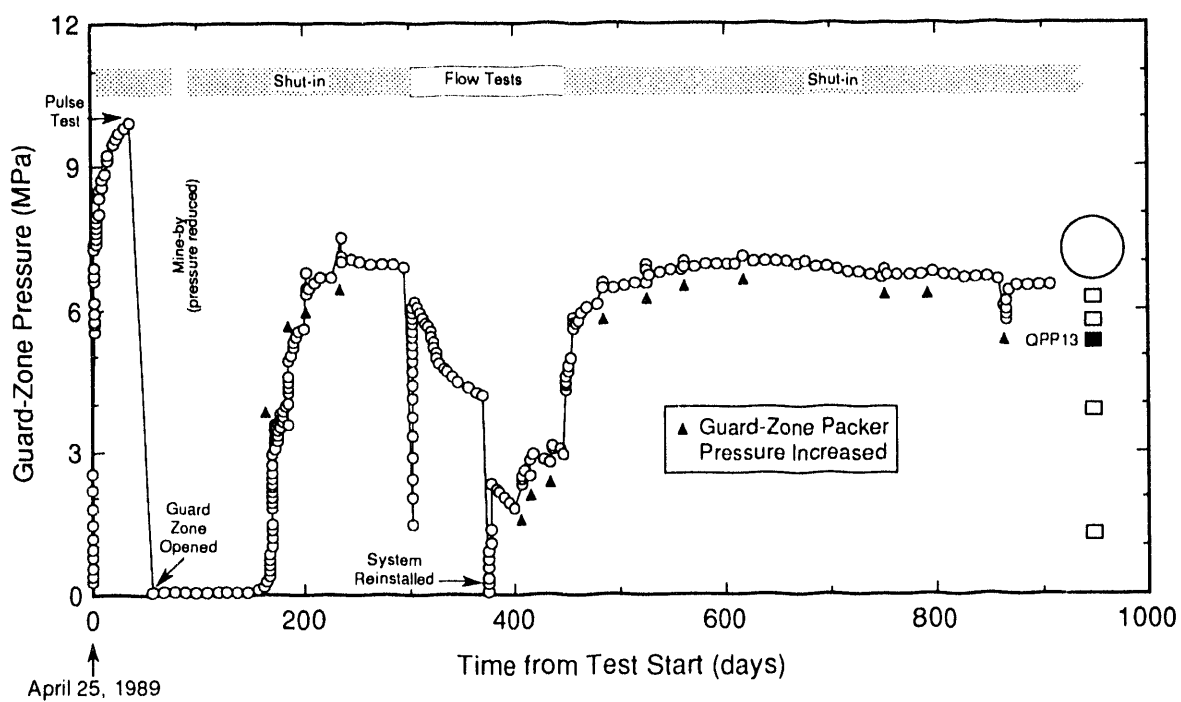


Figure 6-60. Hole QPP13 guard-zone pressure.

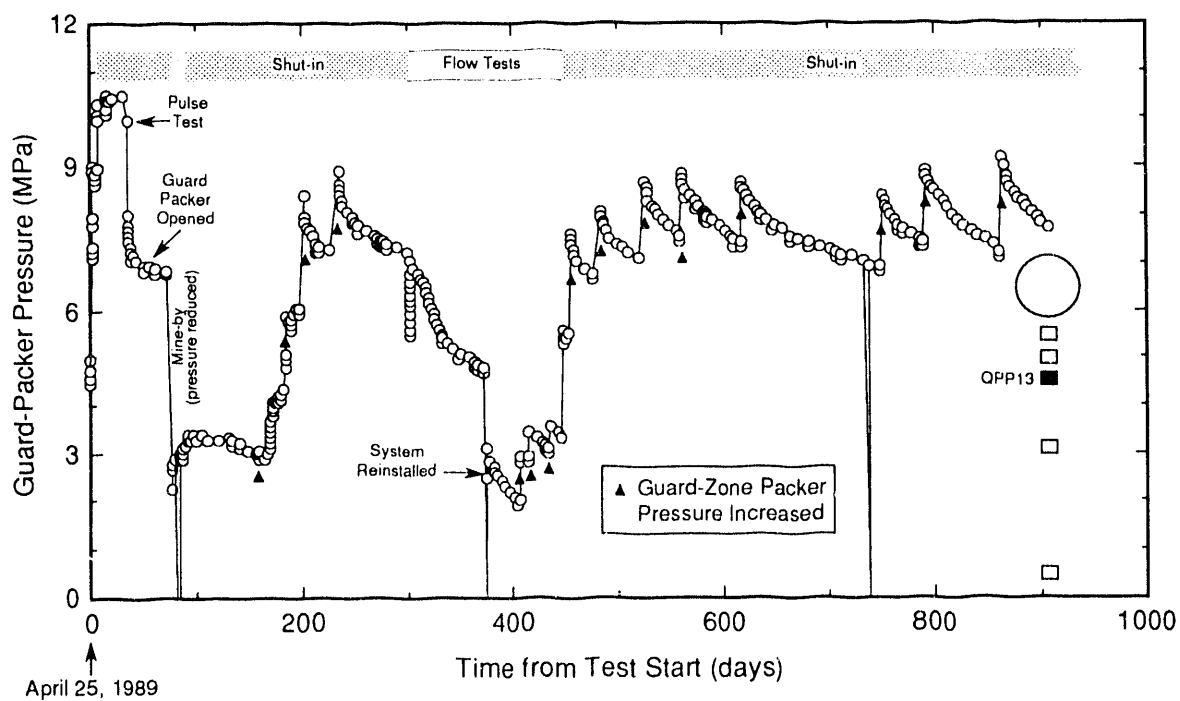
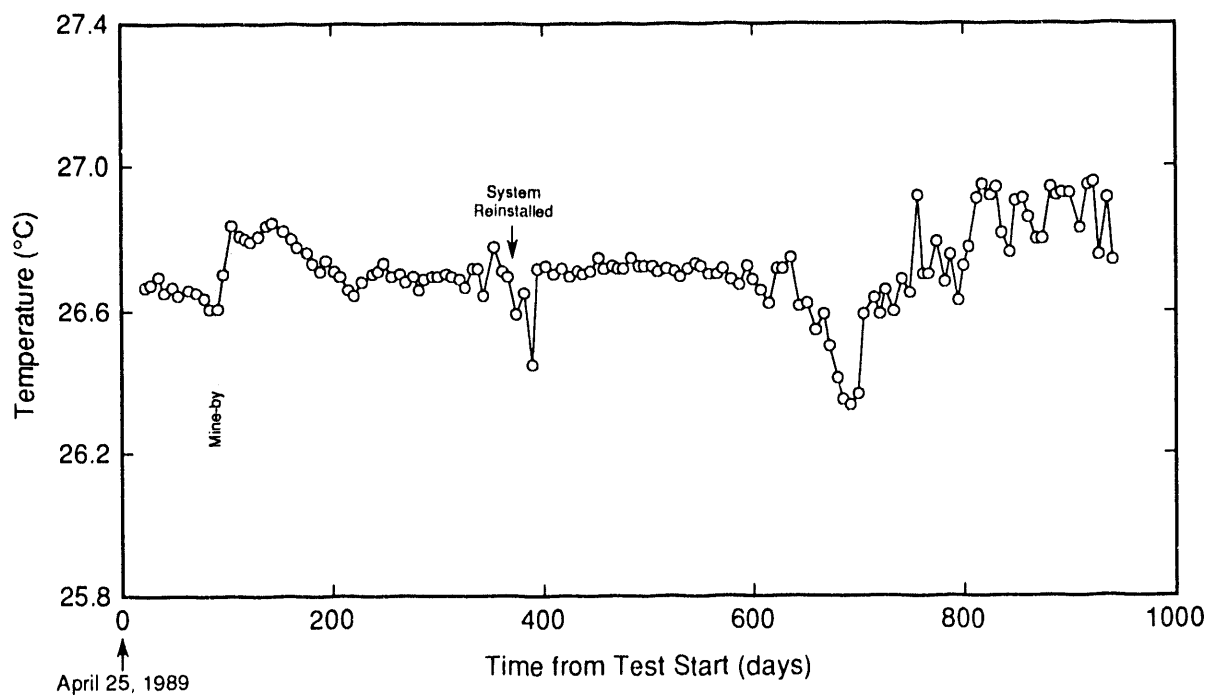
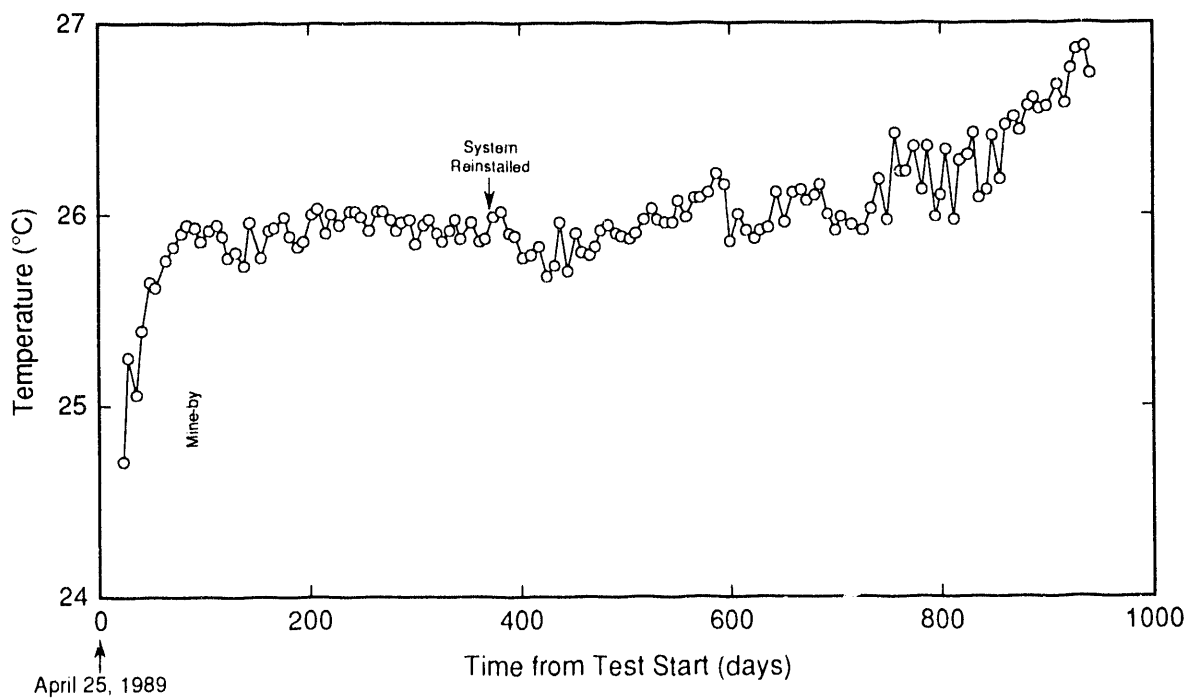


Figure 6-61. Hole QPP13 guard-packer pressure.



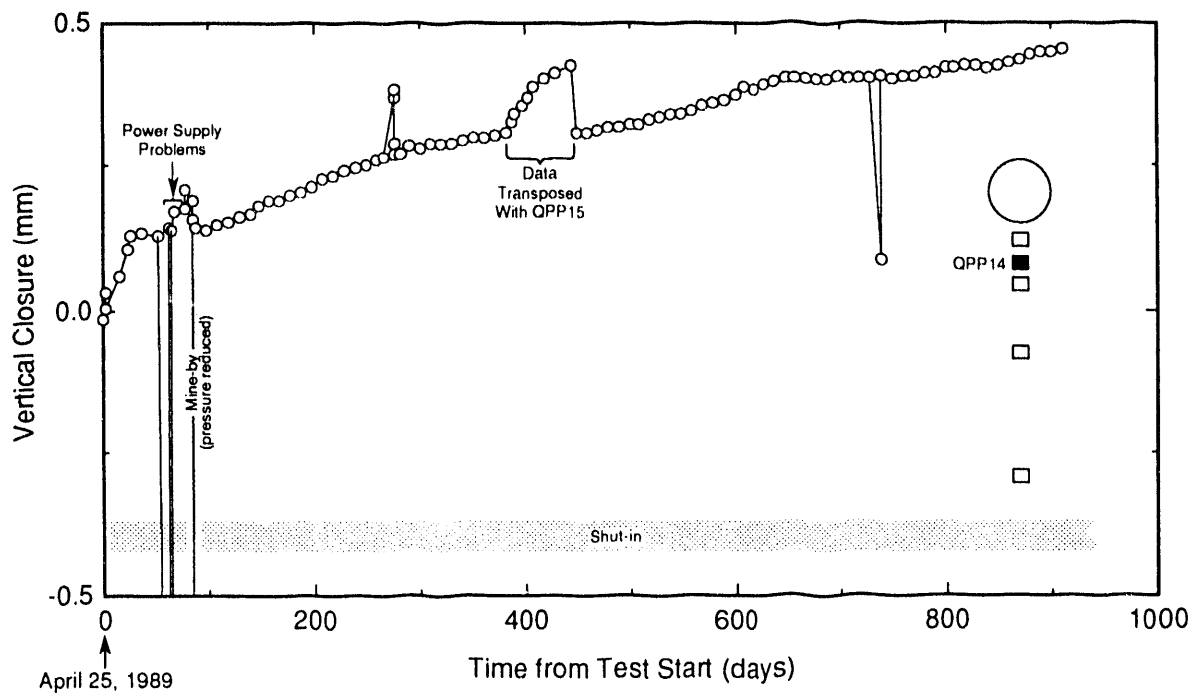
TRI-6119-33-0

Figure 6-62. Hole QPP13 tool temperature.



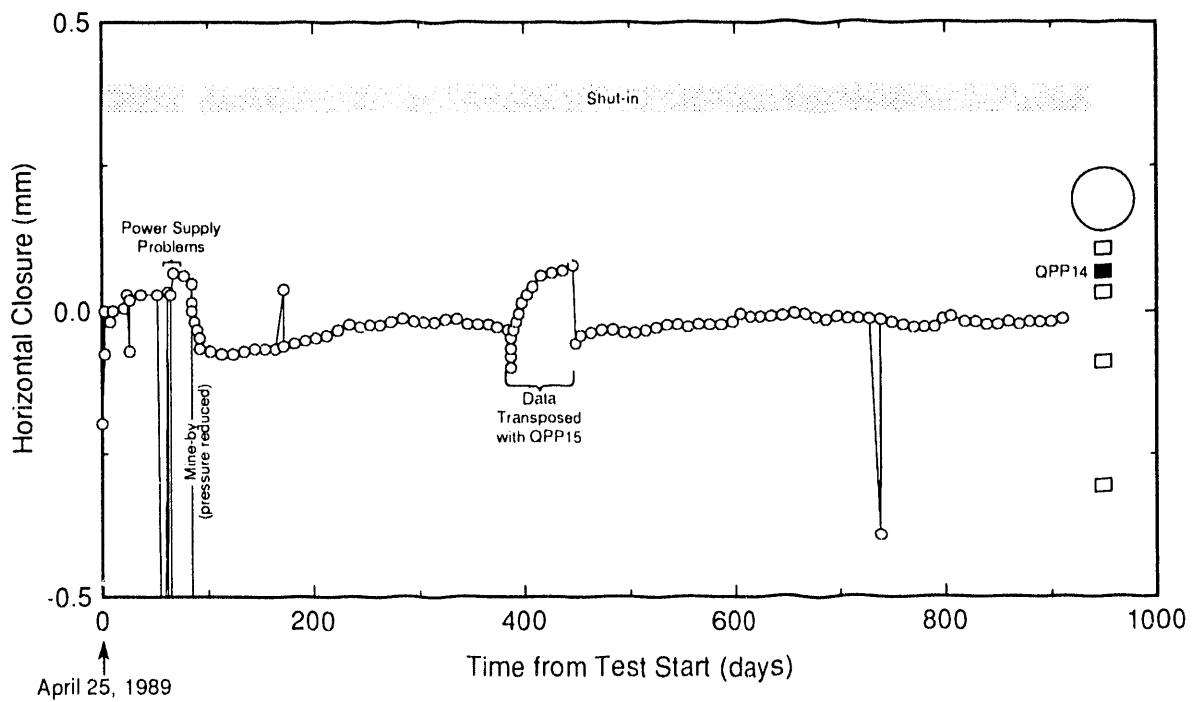
TRI-6119-34-0

Figure 6-63. Hole QPP13 casing temperature.



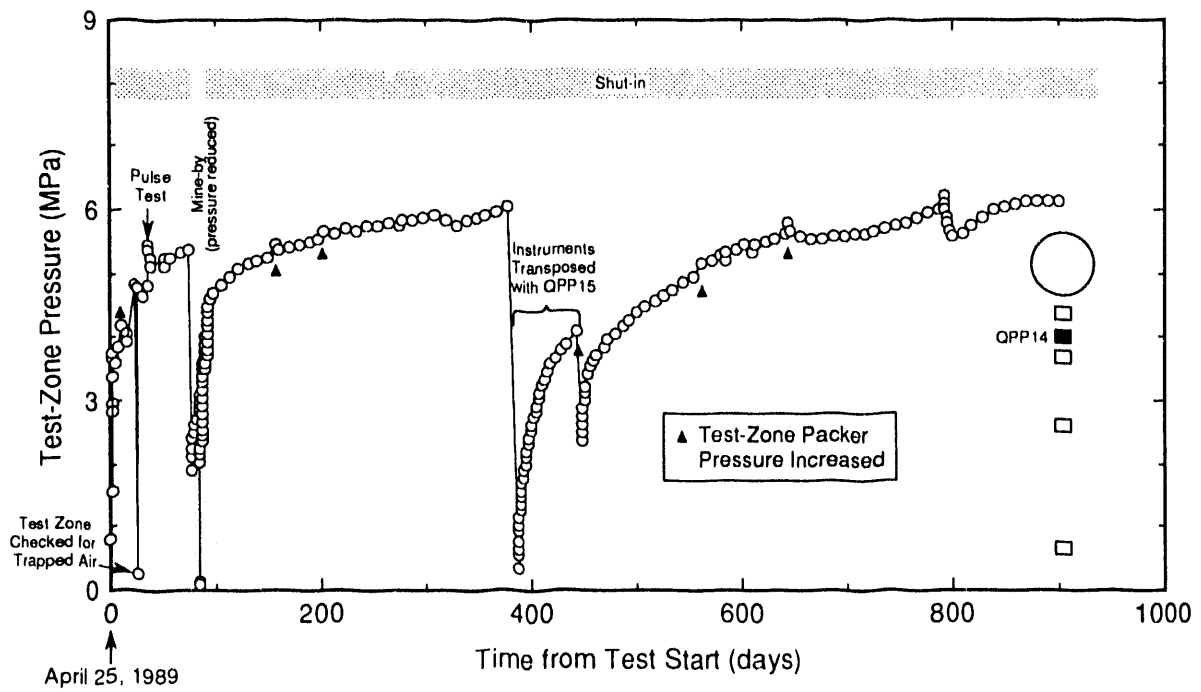
TRI-6119-195-0

Figure 6-64. Vertical closure measured in the test zone of hole QPP14.



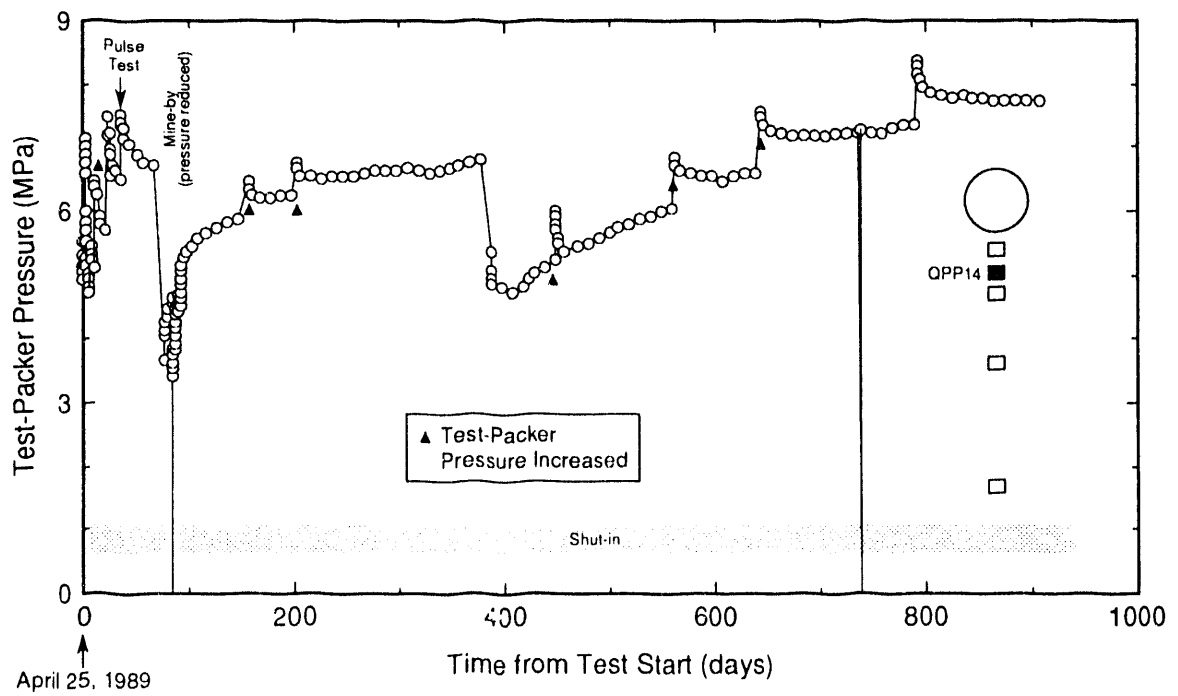
TRI-6119-196-0

Figure 6-65. Horizontal closure measured in the test zone of hole QPP14.



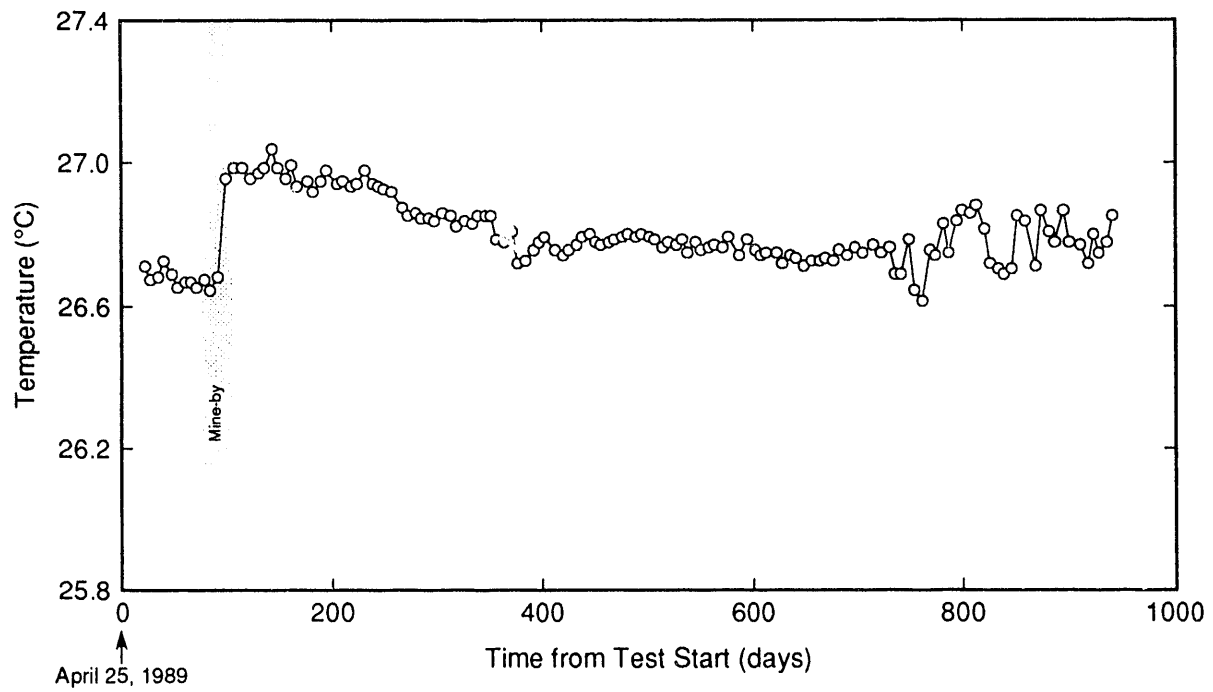
TRI-6119-197-0

Figure 6-66. Hole QPP14 test-zone pressure.



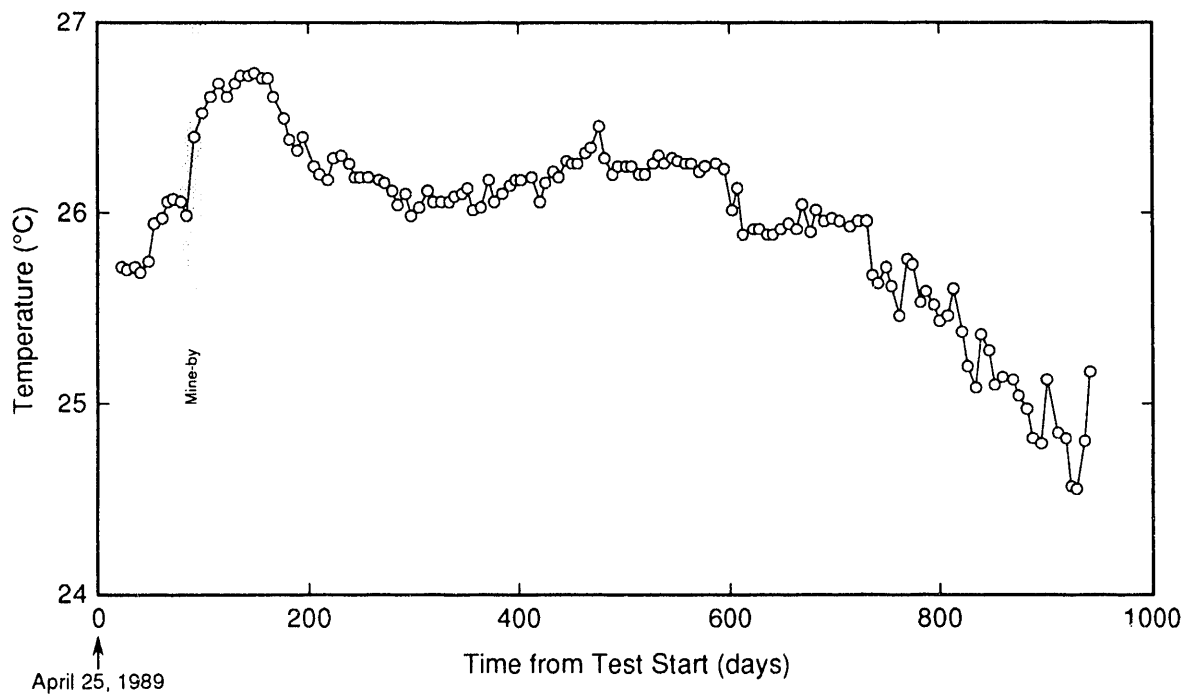
TRI-6119-198-0

Figure 6-67. Hole QPP14 test-packer pressure.



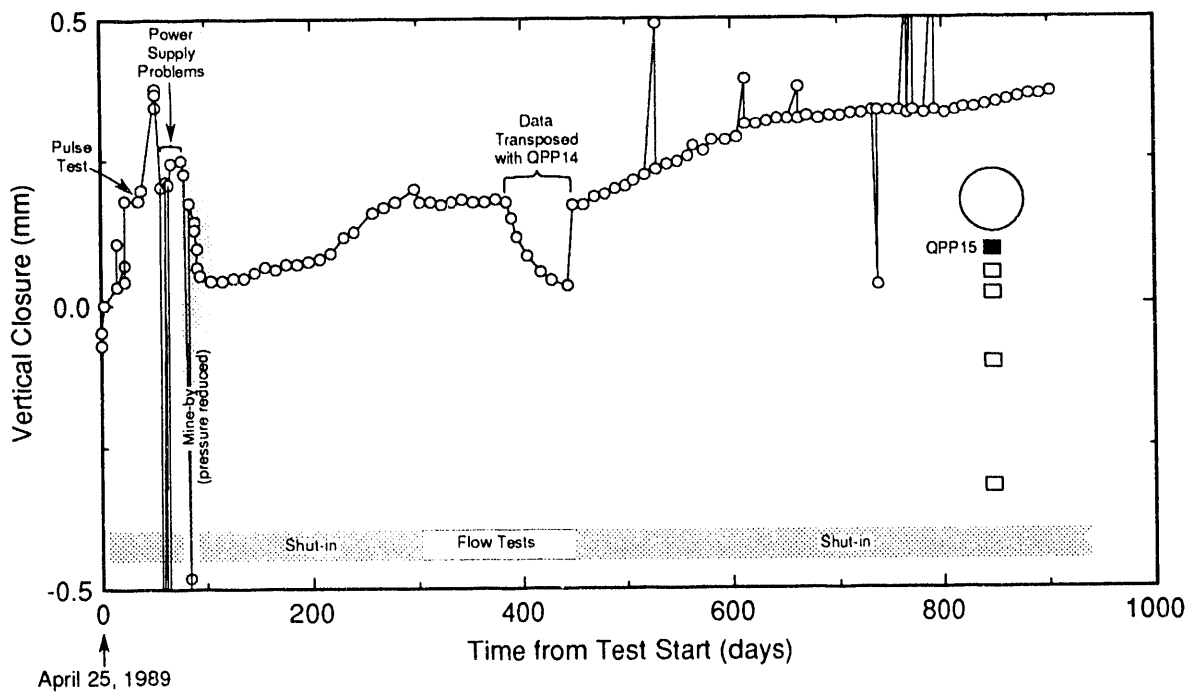
TRI-6119-35-0

Figure 6-68. Hole QPP14 tool temperature.



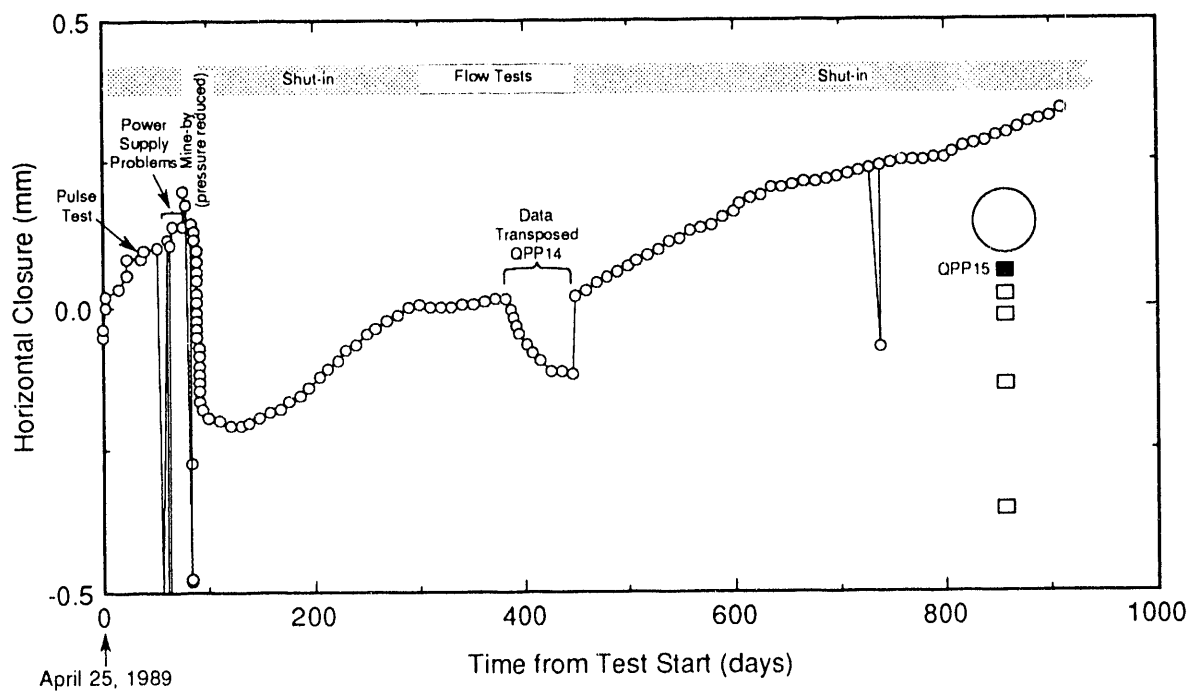
TRI-6119-36-0

Figure 6-69. Hole QPP14 casing temperature.



TRI-6119-199-0

Figure 6-70. Vertical closure measured in the test zone of hole QPP15.



TRI-6119-200-0

Figure 6-71. Horizontal closure measured in the test zone of hole QPP15.

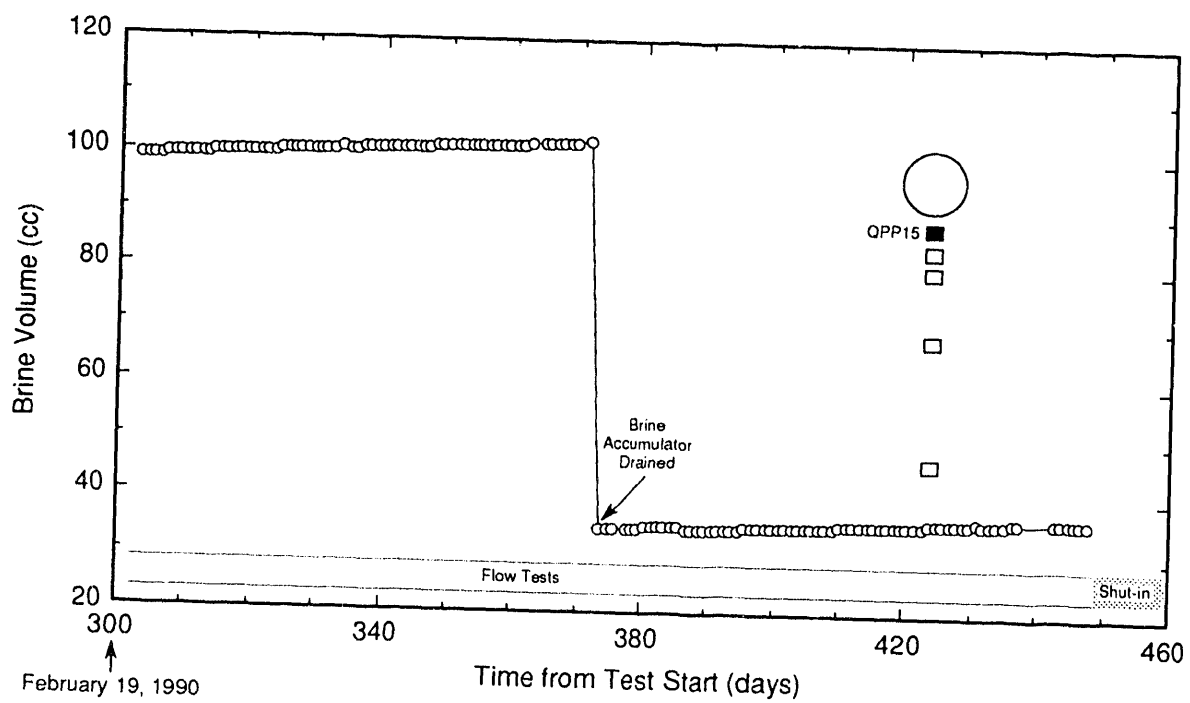
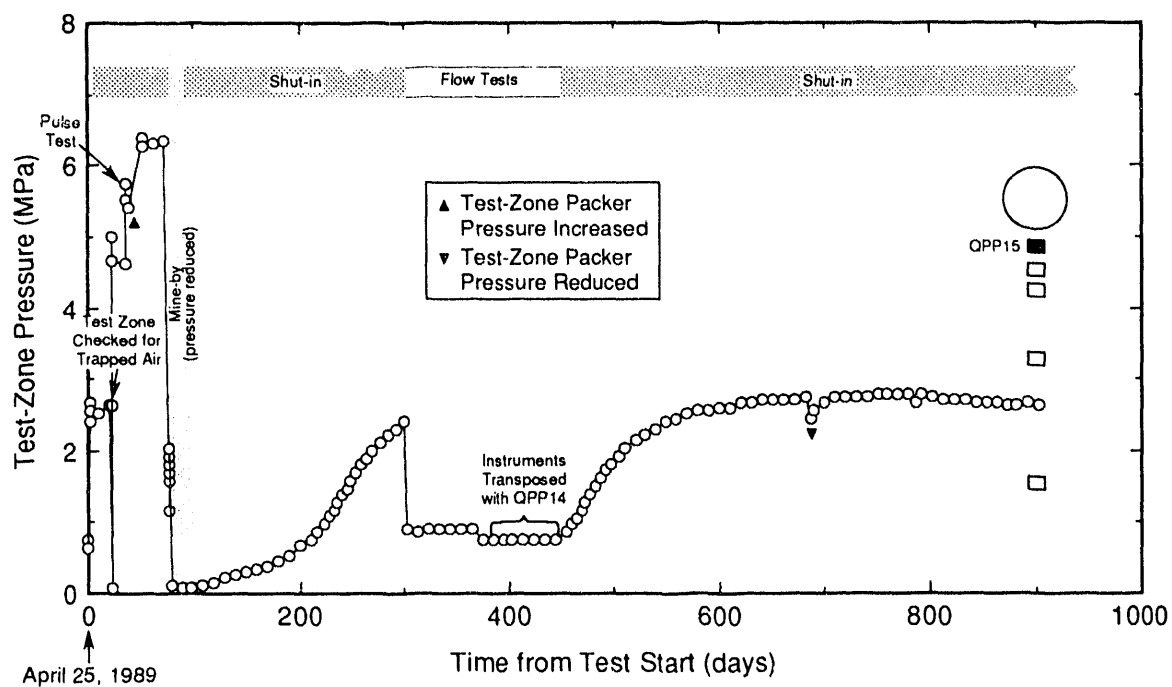


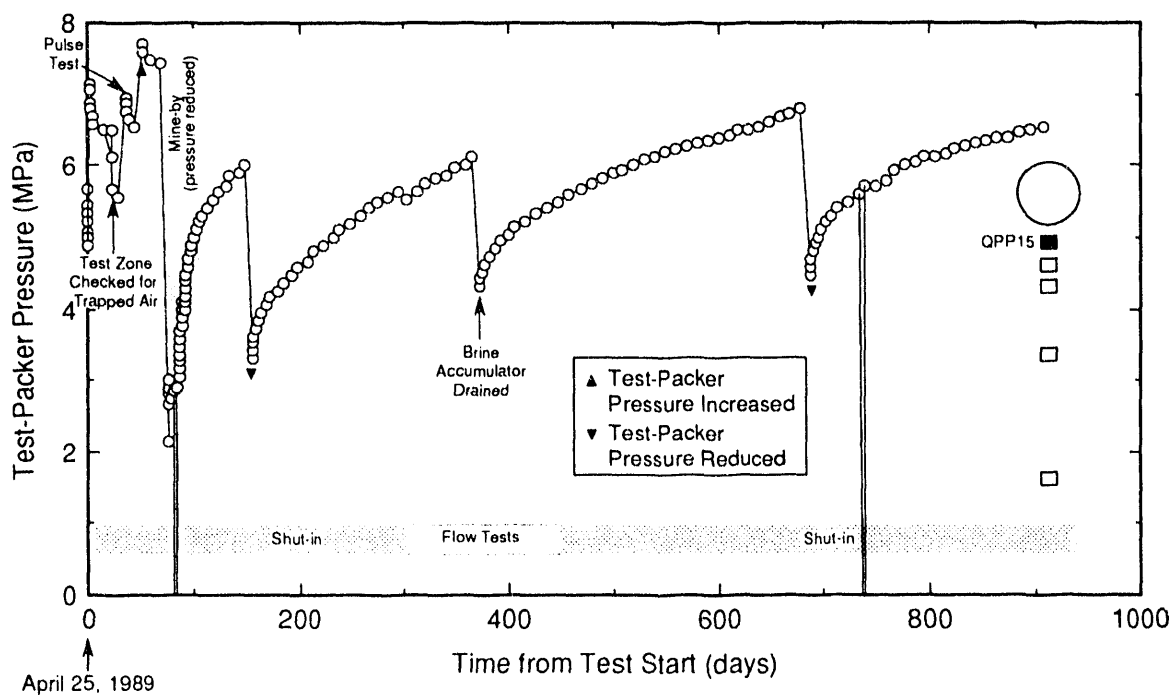
Figure 6-72. Brine collected from QPP15 test zone during flow testing.

TRI-6119-201-0



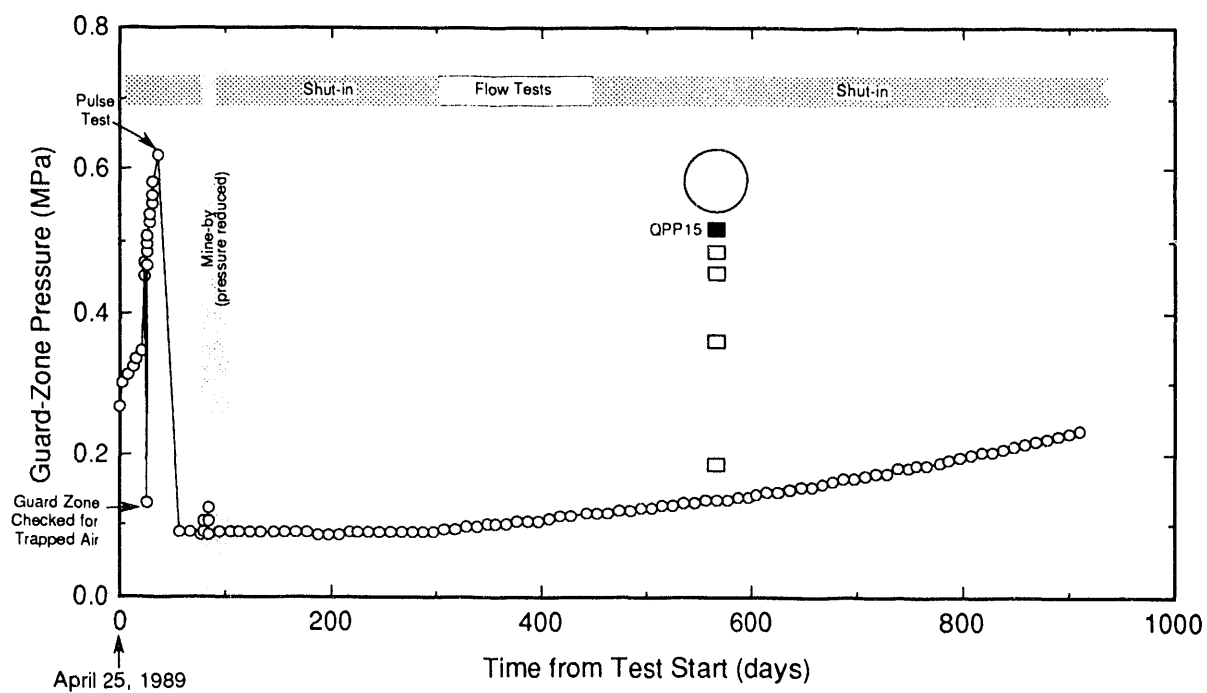
TRI-6119-202-0

Figure 6-73. Hole QPP15 test-zone pressure.



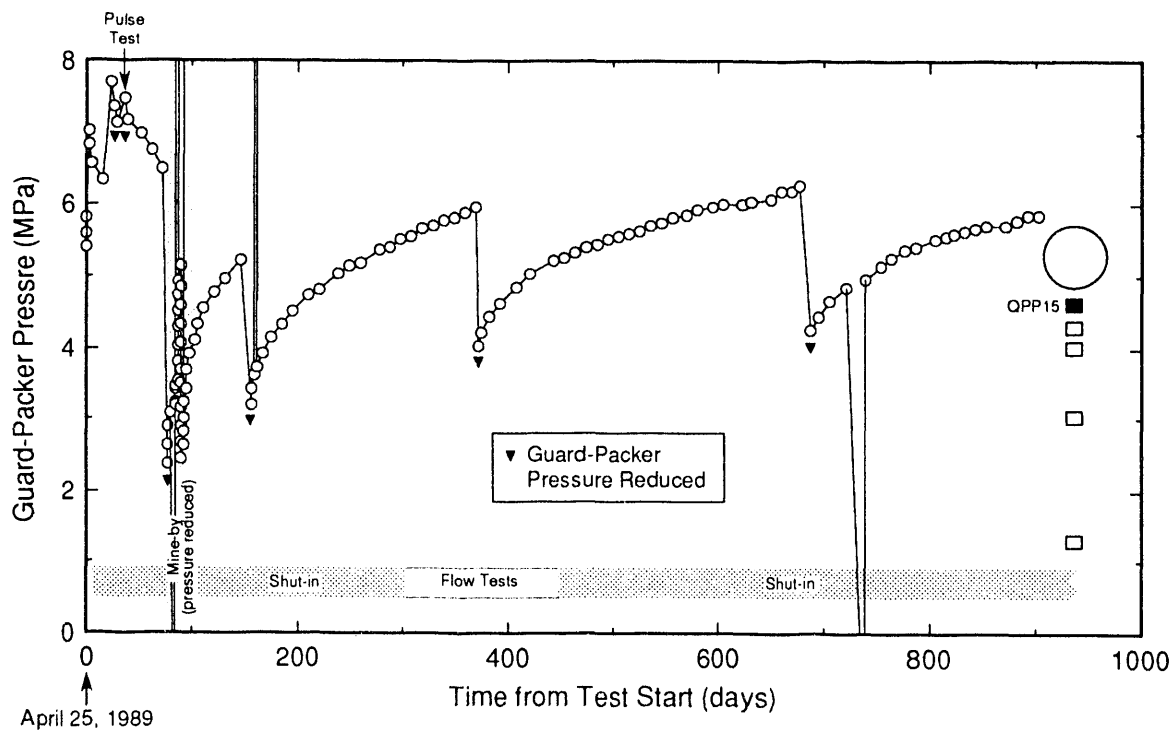
TRI-6119-203-0

Figure 6-74. Hole QPP15 test-packer pressure.



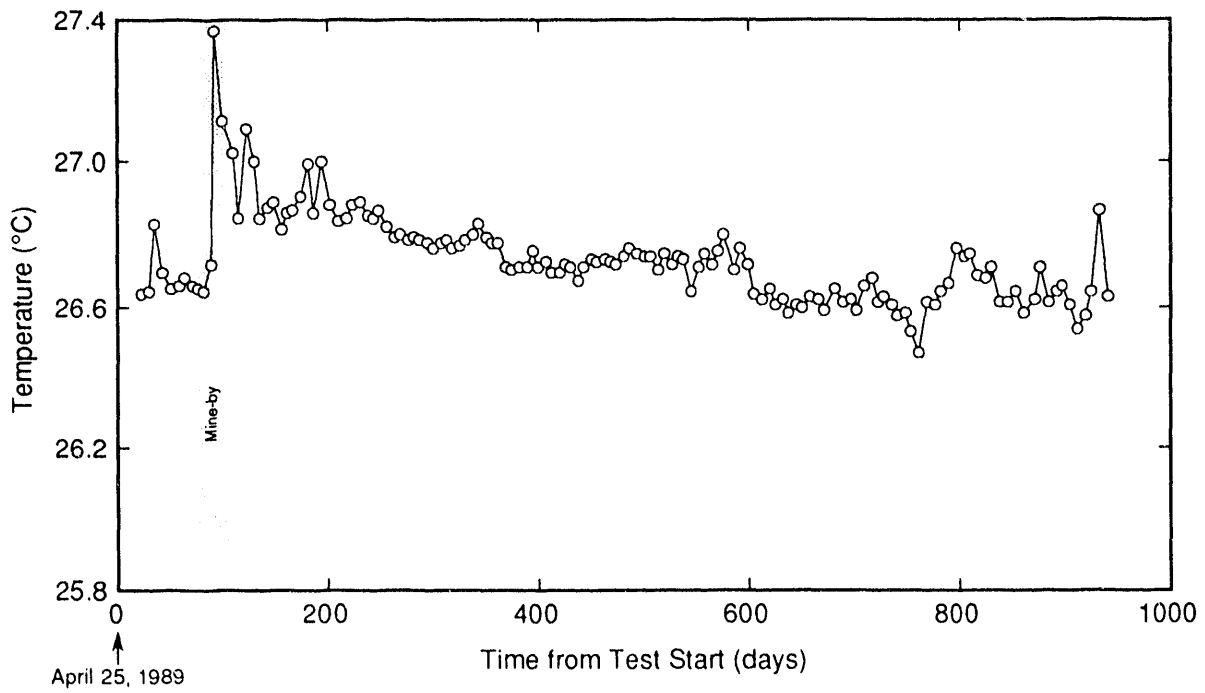
TRI-6119-204-0

Figure 6-75. Hole QPP15 guard-zone pressure.



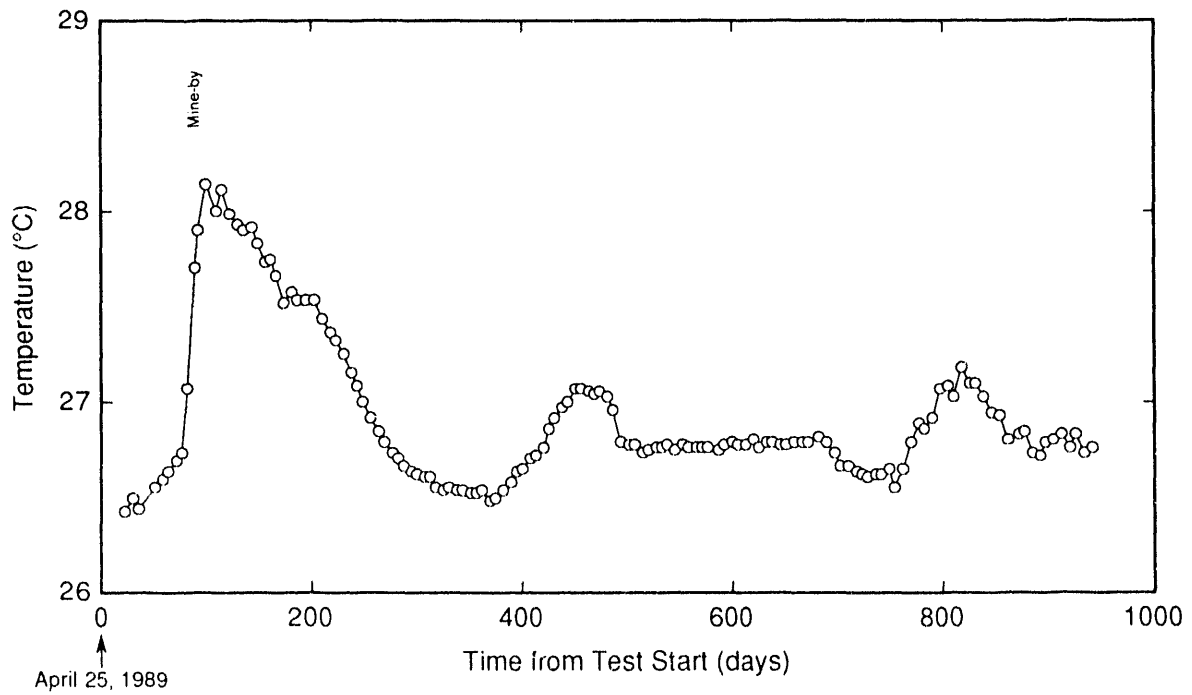
TRI-6119-205-0

Figure 6-76. Hole QPP15 guard-packer pressure.



TRI-6119-37-0

Figure 6-77. Hole QPP15 tool temperature.



TRI-6119-38-0

Figure 6-78. Hole QPP15 casing temperature.

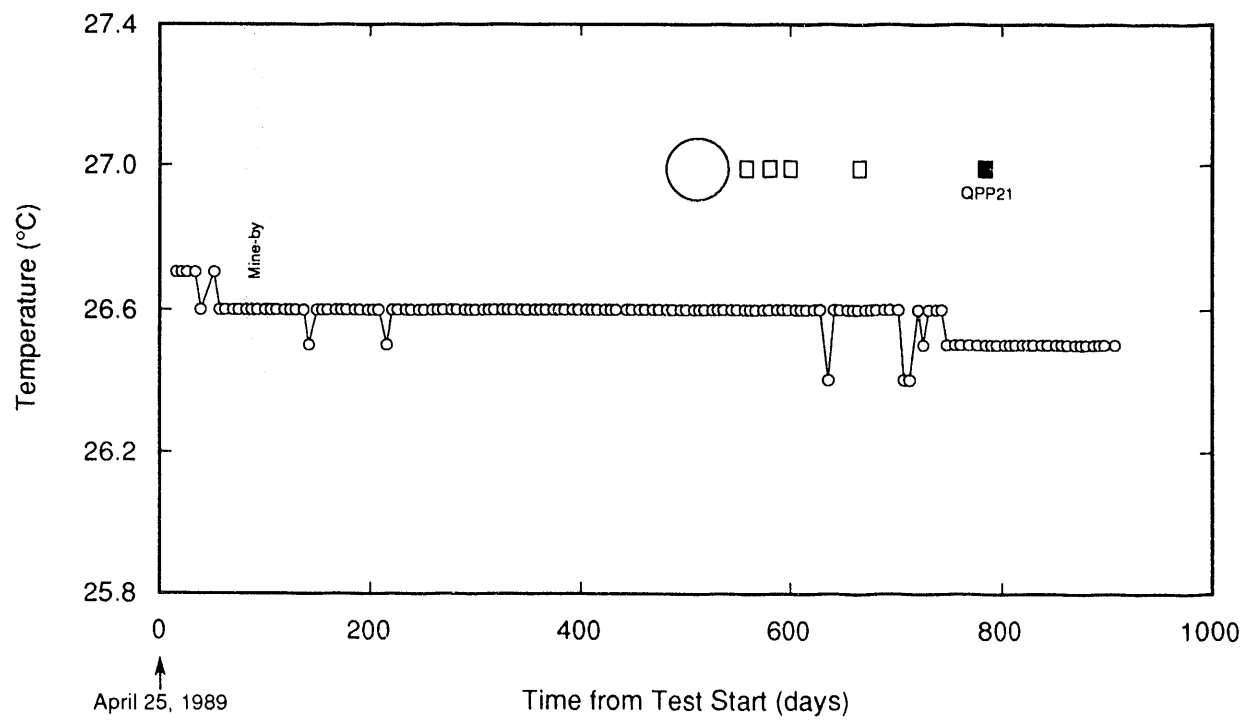
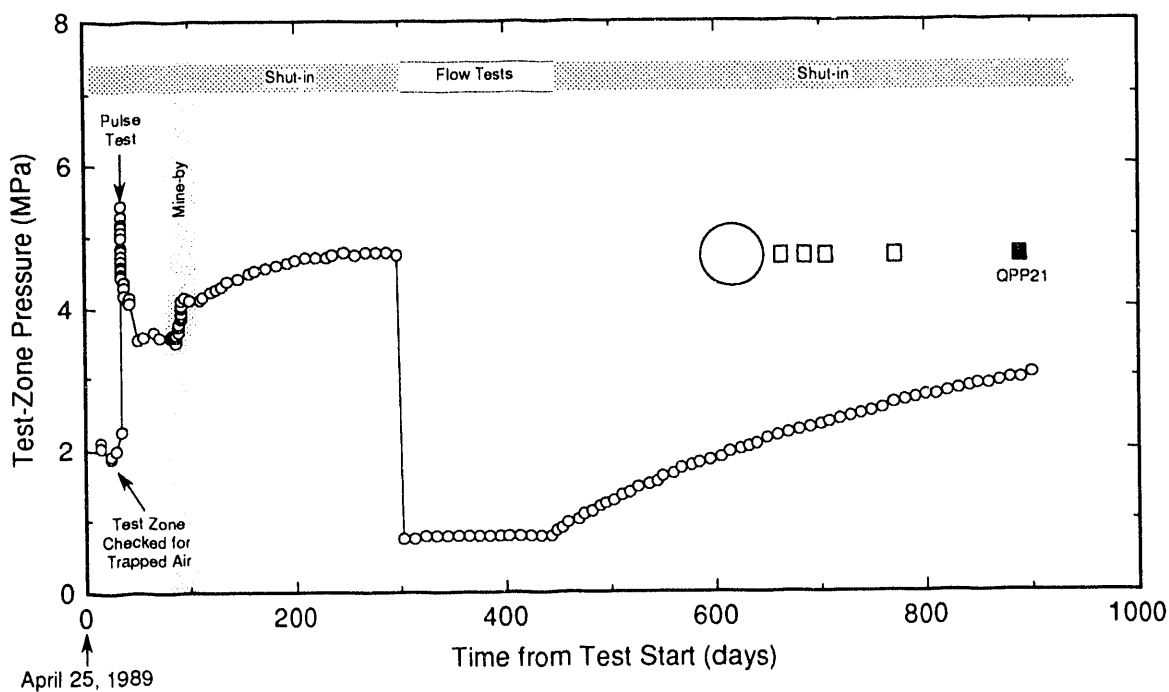


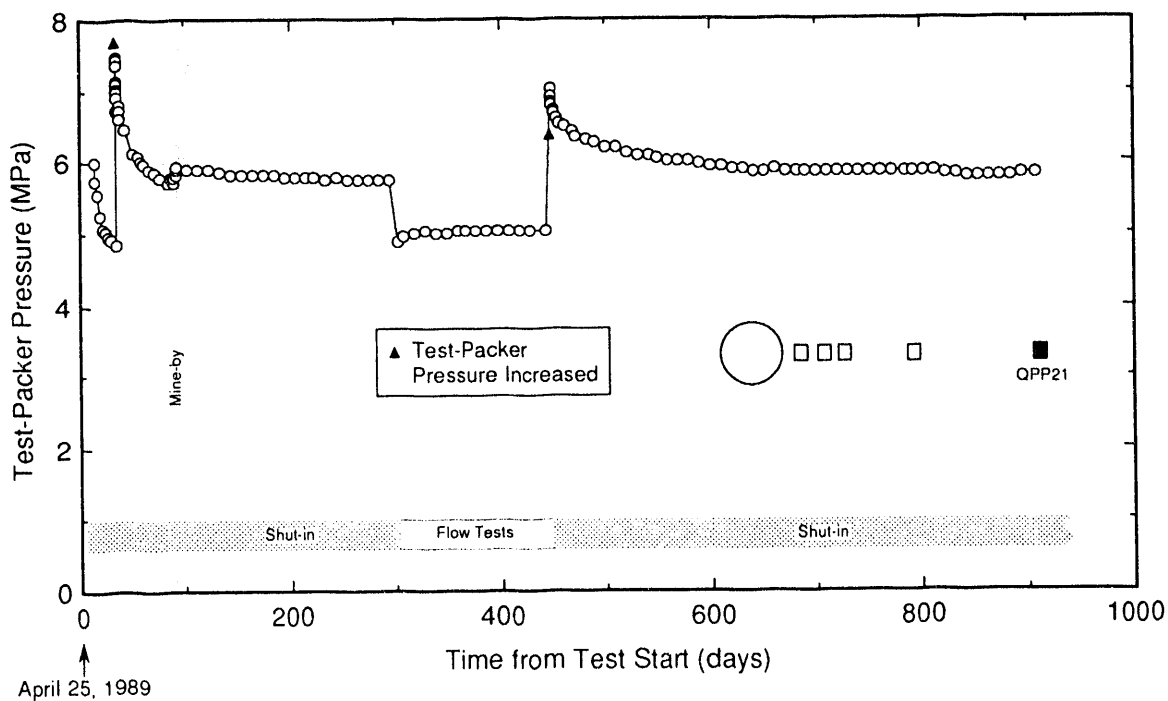
Figure 6-79. Hole QPP21 test-zone temperature.

TRI-6119-49-0



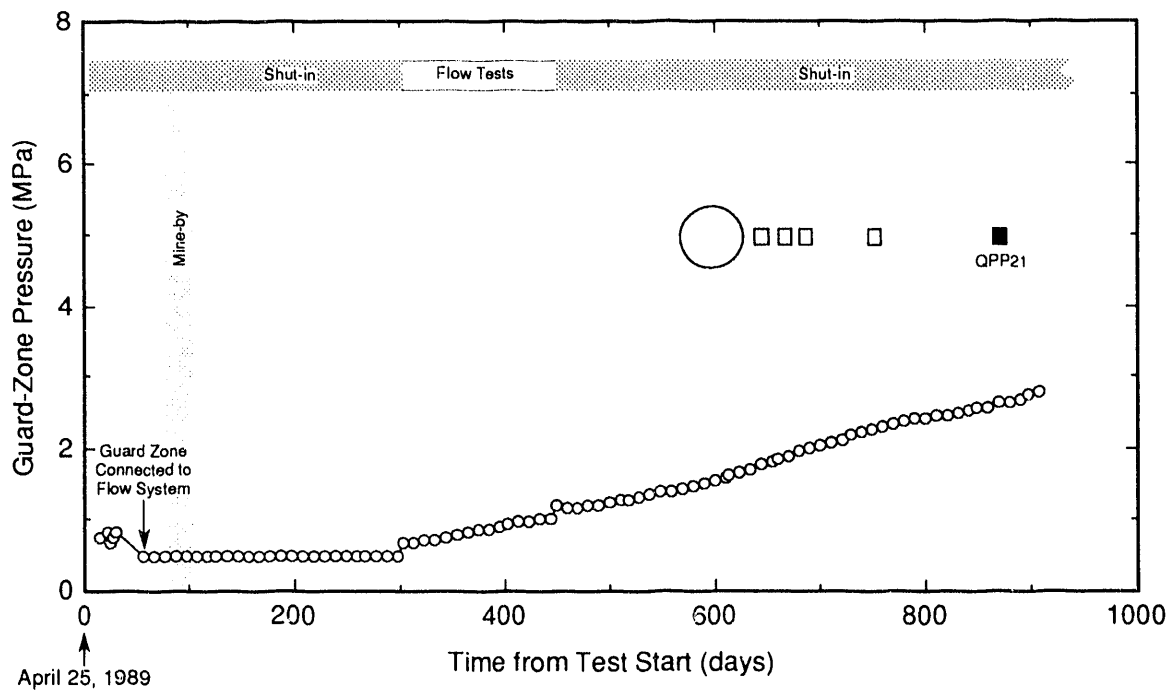
TRI-6119-206-0

Figure 6-80. Hole QPP21 test-zone pressure.



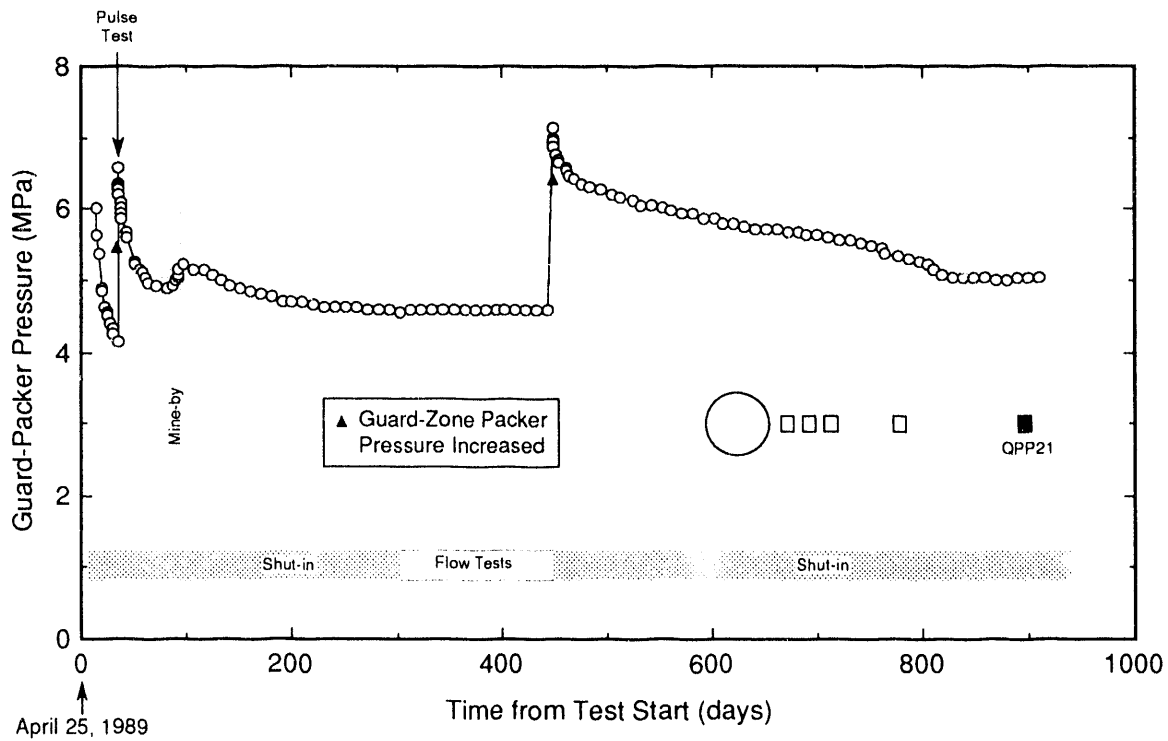
TRI-6119-207-0

Figure 6-81. Hole QPP21 test-packer pressure.



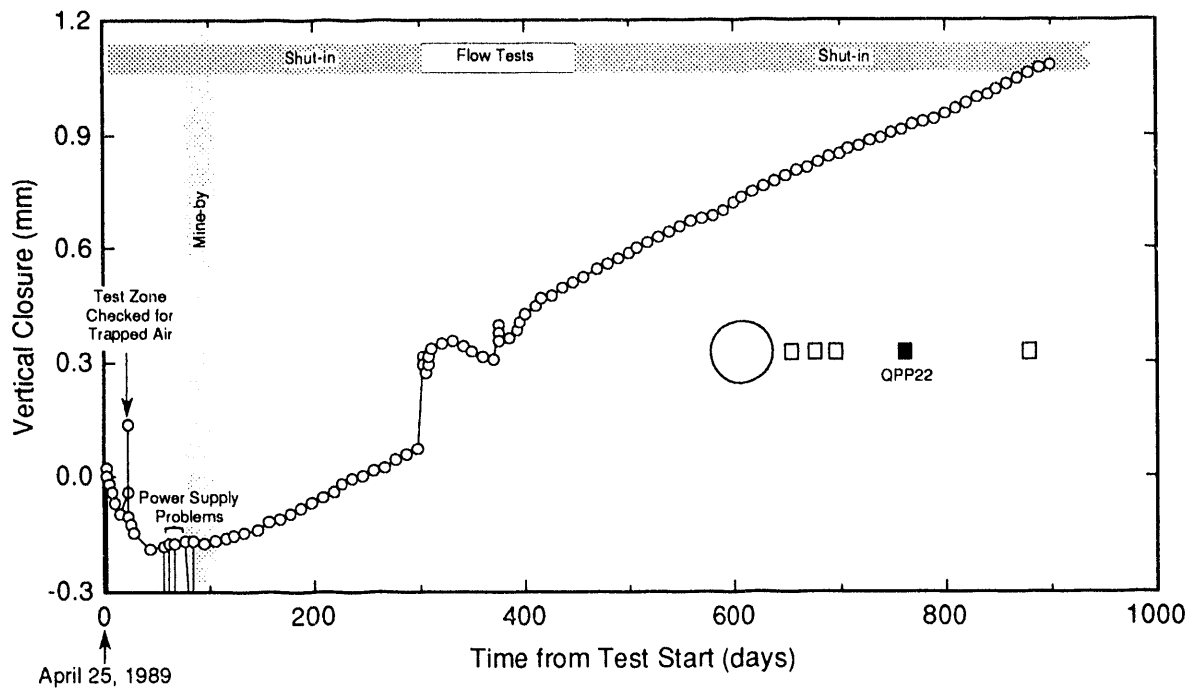
TRI-6119-208-0

Figure 6-82. Hole QPP21 guard-zone pressure.



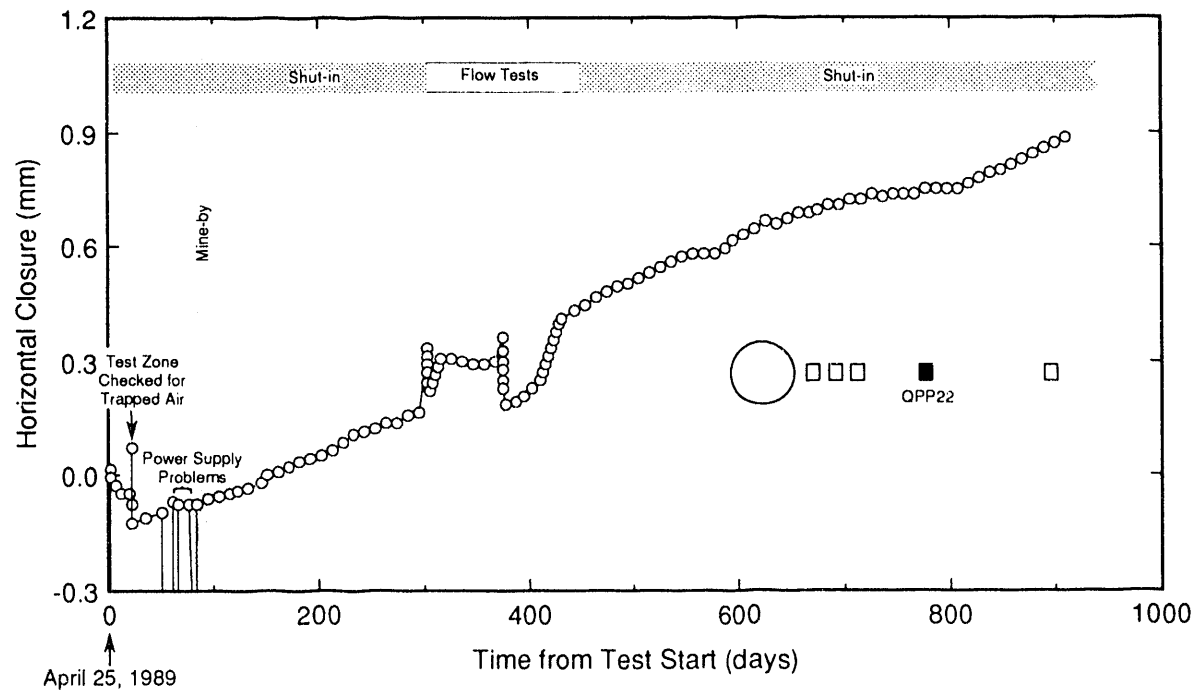
TRI-6119-209-0

Figure 6-83. Hole QPP21 guard-packer pressure.



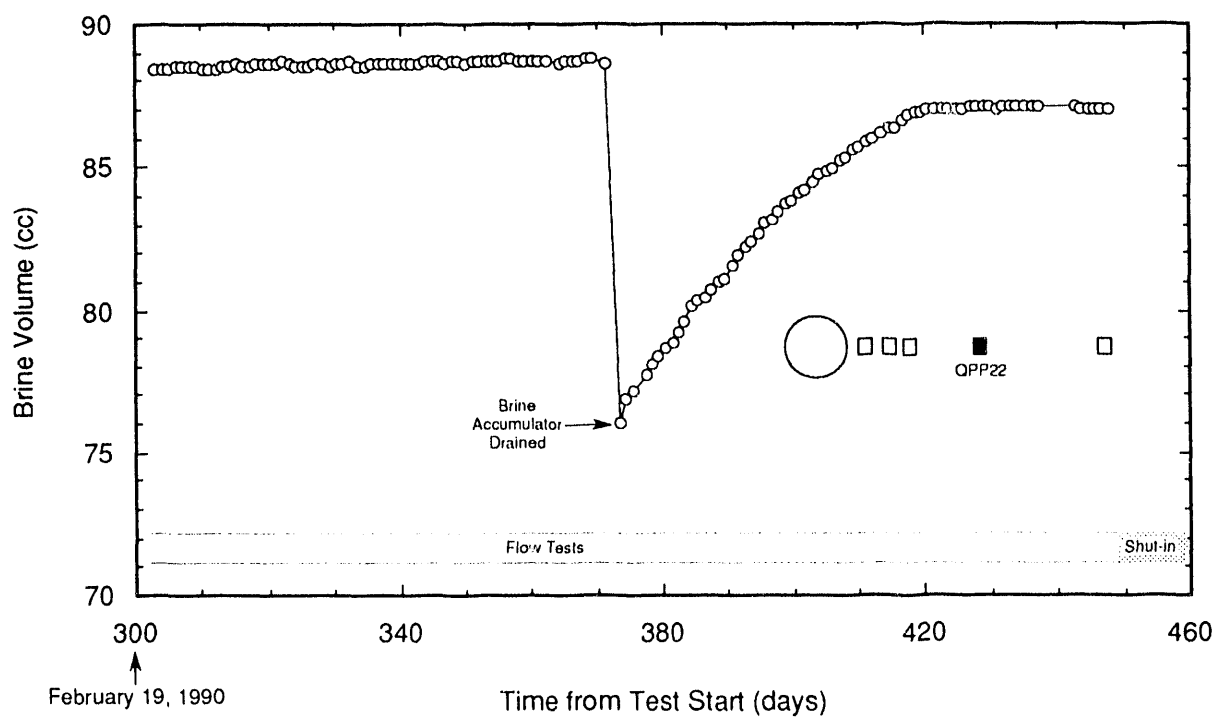
TRI-6119-210-0

Figure 6-84. Vertical closure measured in the test zone of hole QPP22.



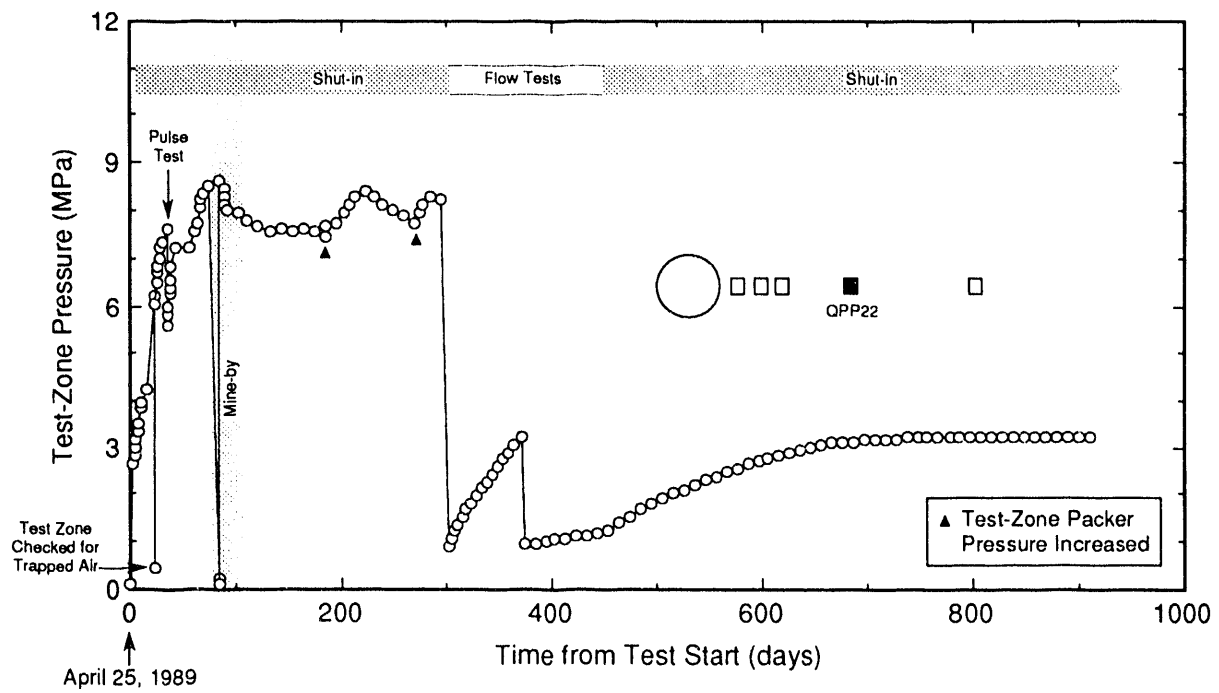
TRI-6119-211-0

Figure 6-85. Horizontal closure measured in the test zone of hole QPP22.



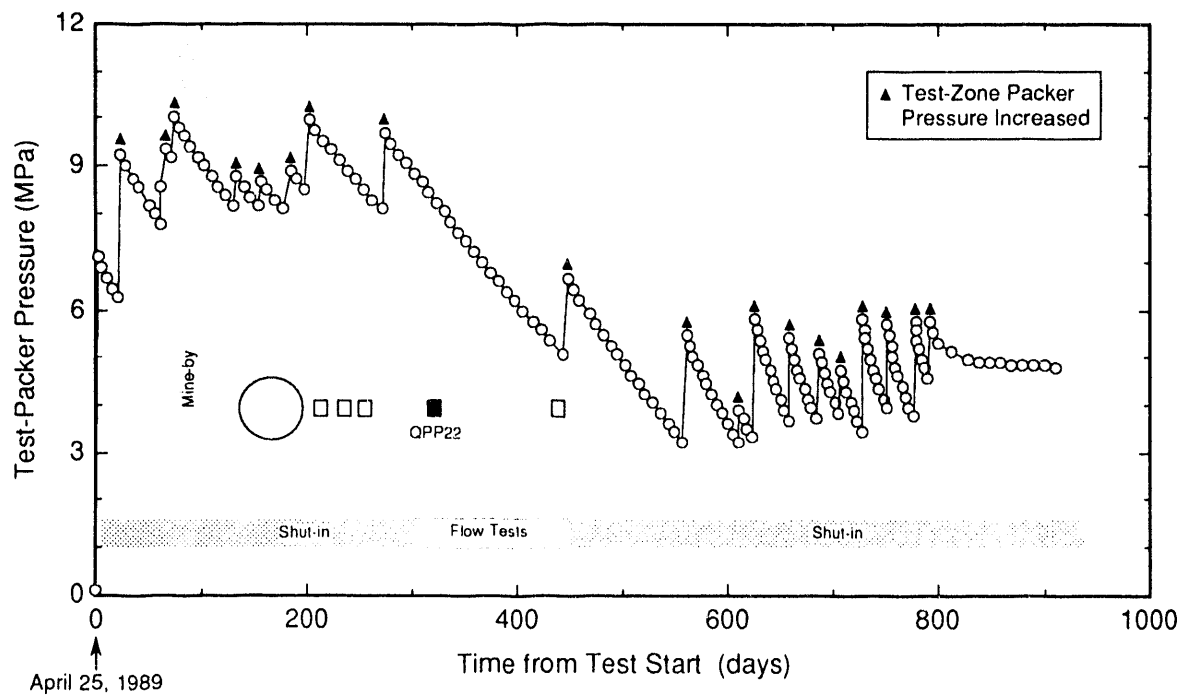
TRI-6119-212-0

Figure 6-86. Brine collected from QPP22 test zone during flow testing.



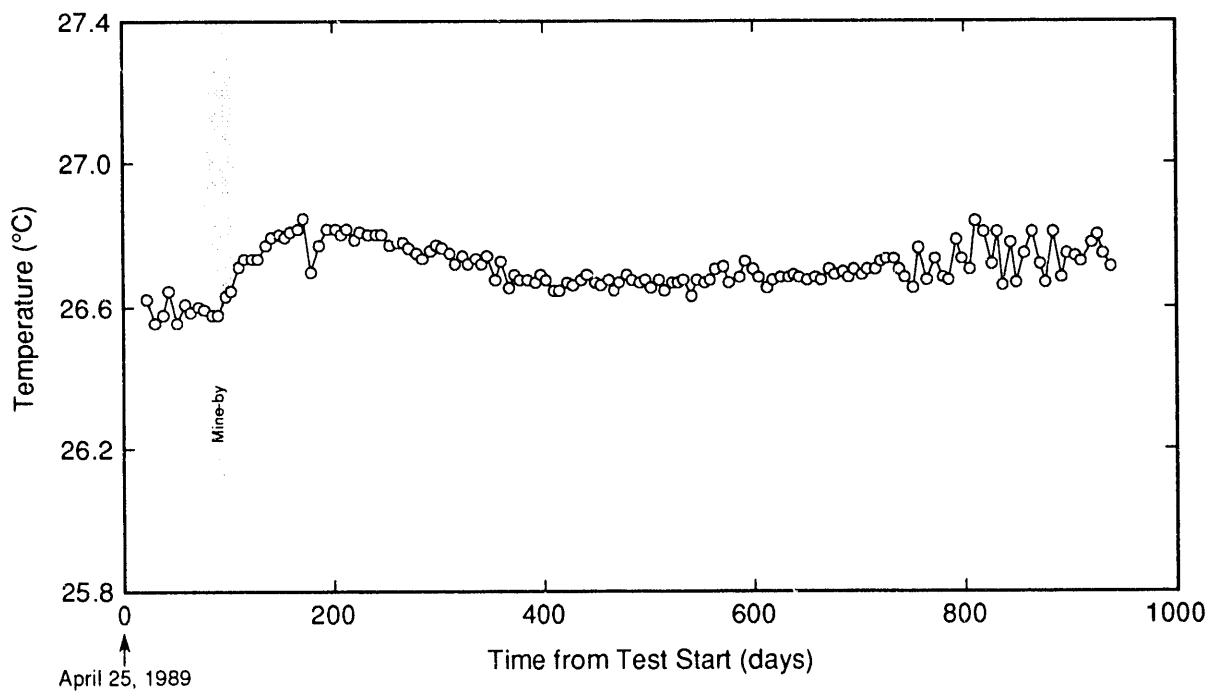
TRI-6119-213-0

Figure 6-87. Hole QPP22 test-zone pressure.



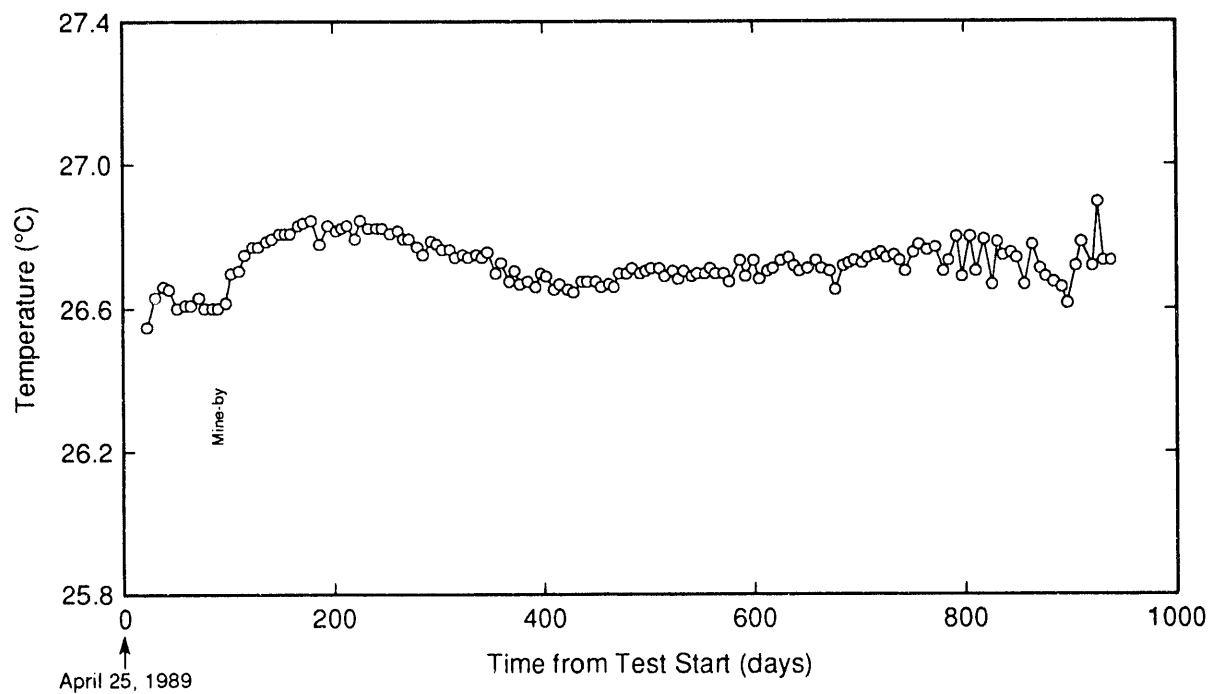
TRI-6119-214-0

Figure 6-88. Hole QPP22 test-packer pressure.



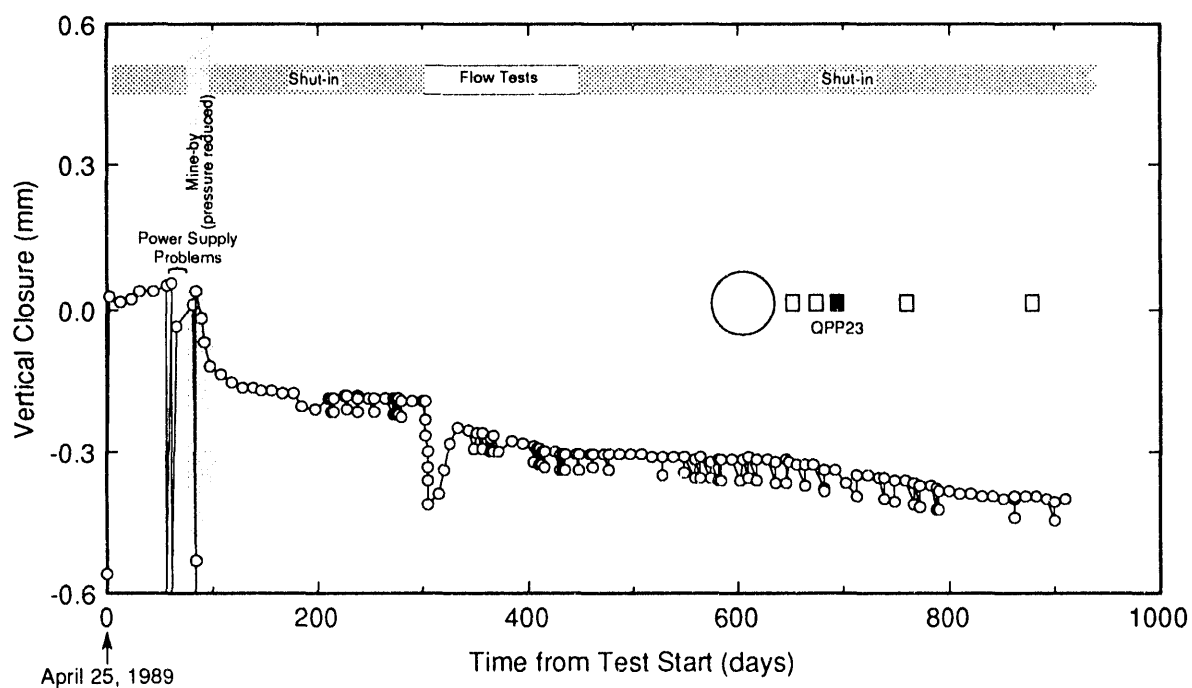
TRI-6119-39-0

Figure 6-89. Hole QPP22 tool temperature.



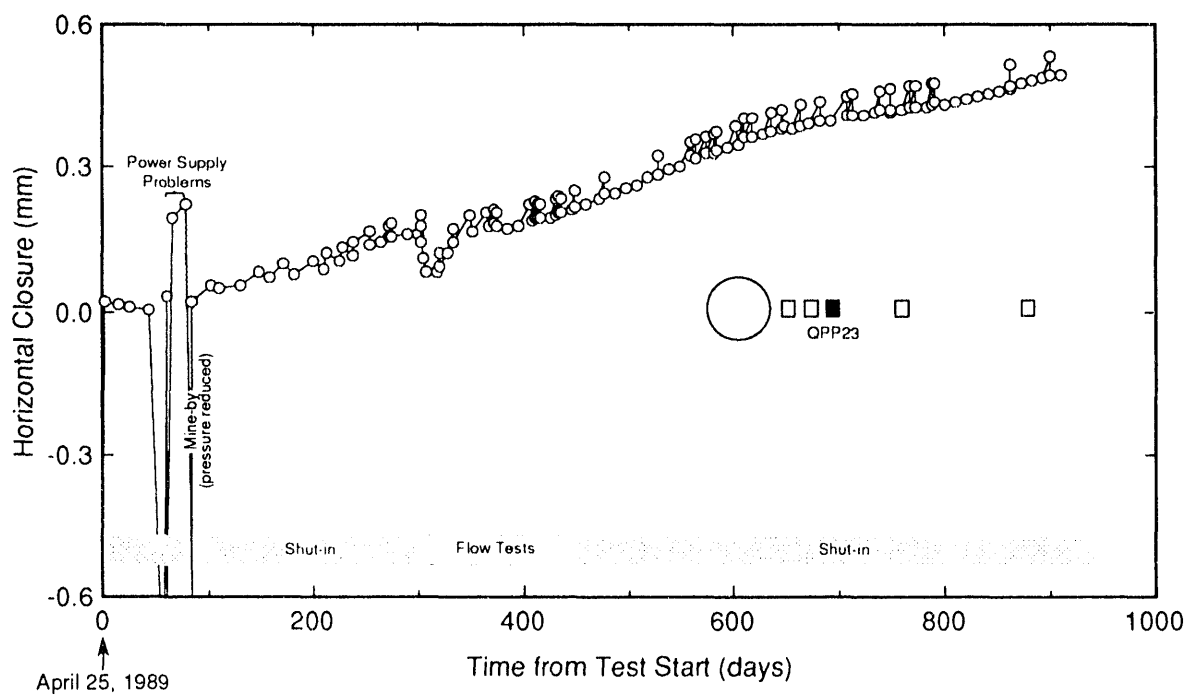
TRI-6119-40-0

Figure 6-90. Hole QPP22 casing temperature.



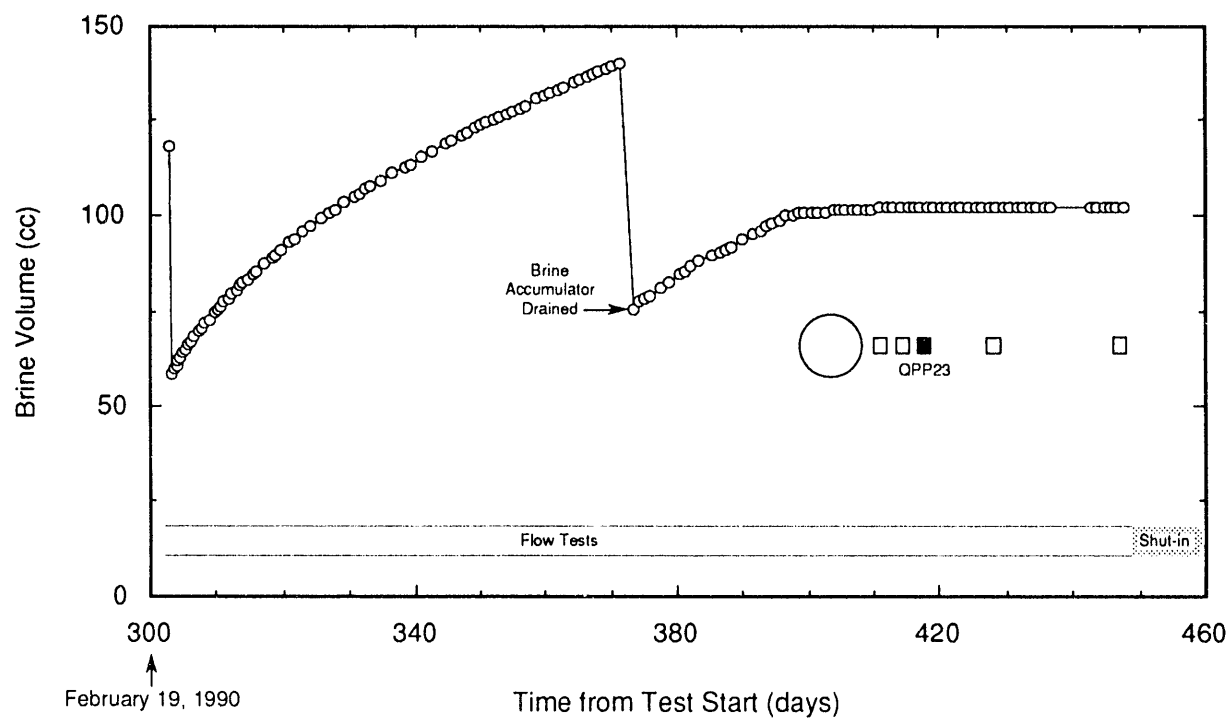
TRI-6119-215-0

Figure 6-91. Vertical closure measured in the test zone of hole QPP23.



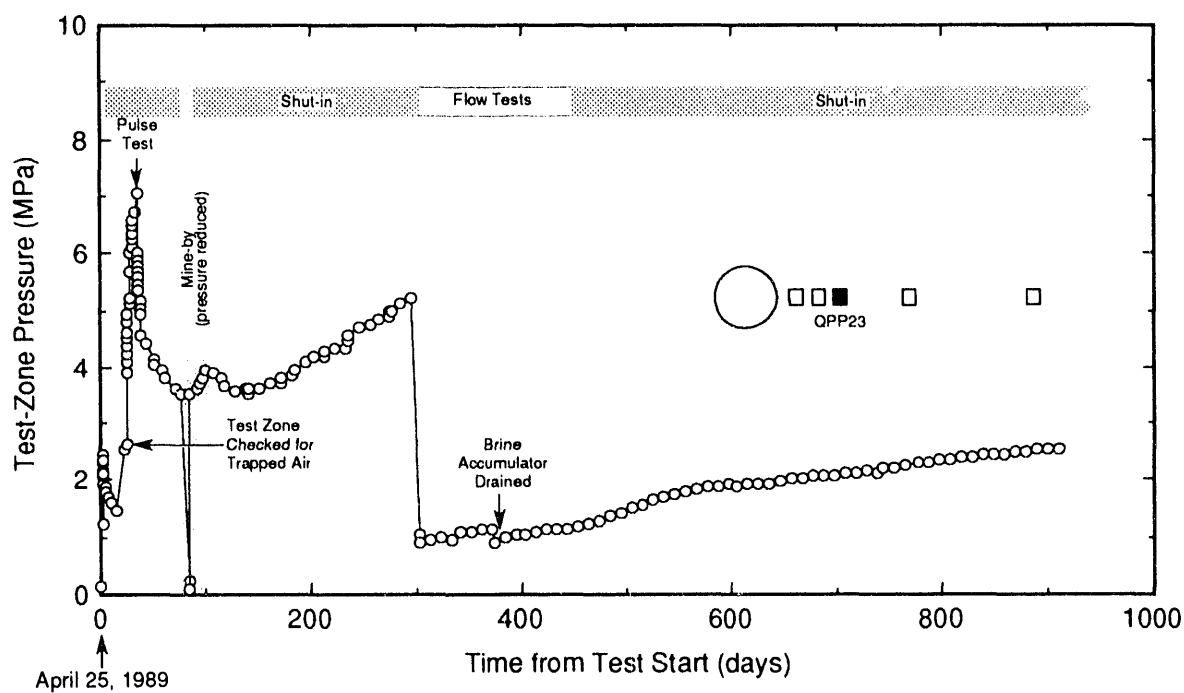
TRI-6119-216-0

Figure 6-92. Horizontal closure measured in the test zone of hole QPP23.



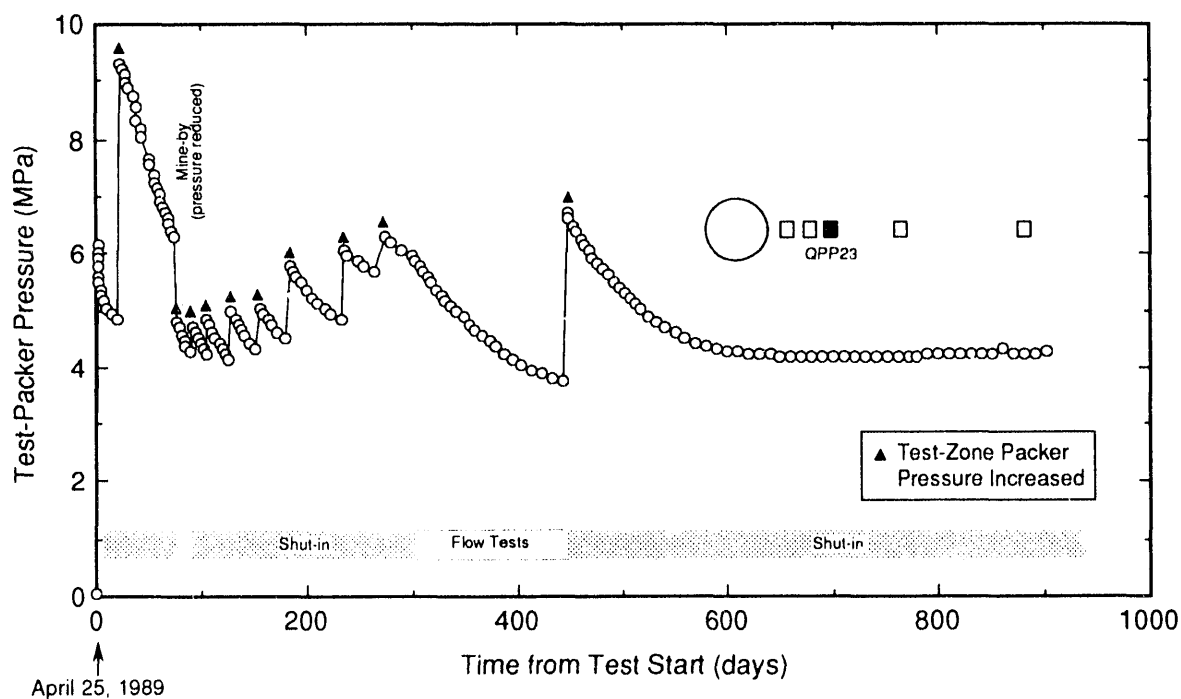
TRI-6119-217-0

Figure 6-93. Brine collected from QPP23 test zone during flow testing.



TRI-6119-218-0

Figure 6-94. Hole QPP23 test-zone pressure.



TRI-6119-219-0

Figure 6-95. Hole QPP23 test-packer pressure.

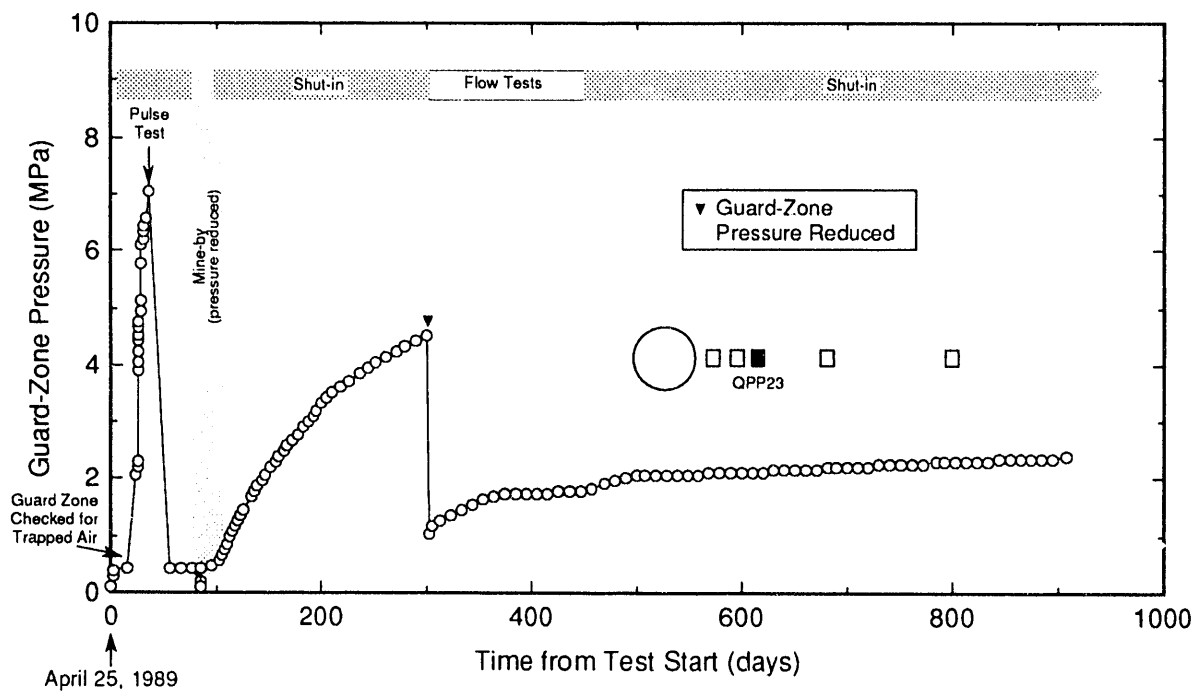


Figure 6-96. Hole QPP23 guard-zone pressure.

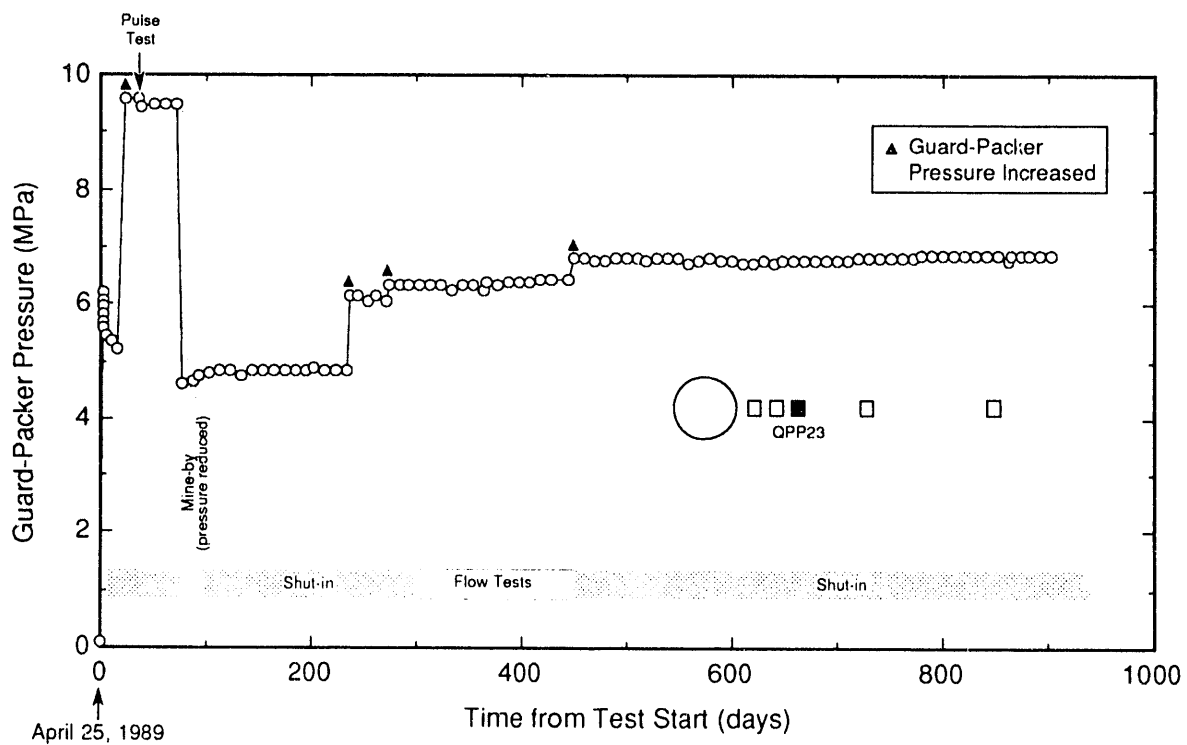


Figure 6-97. Hole QPP23 guard-packer pressure.

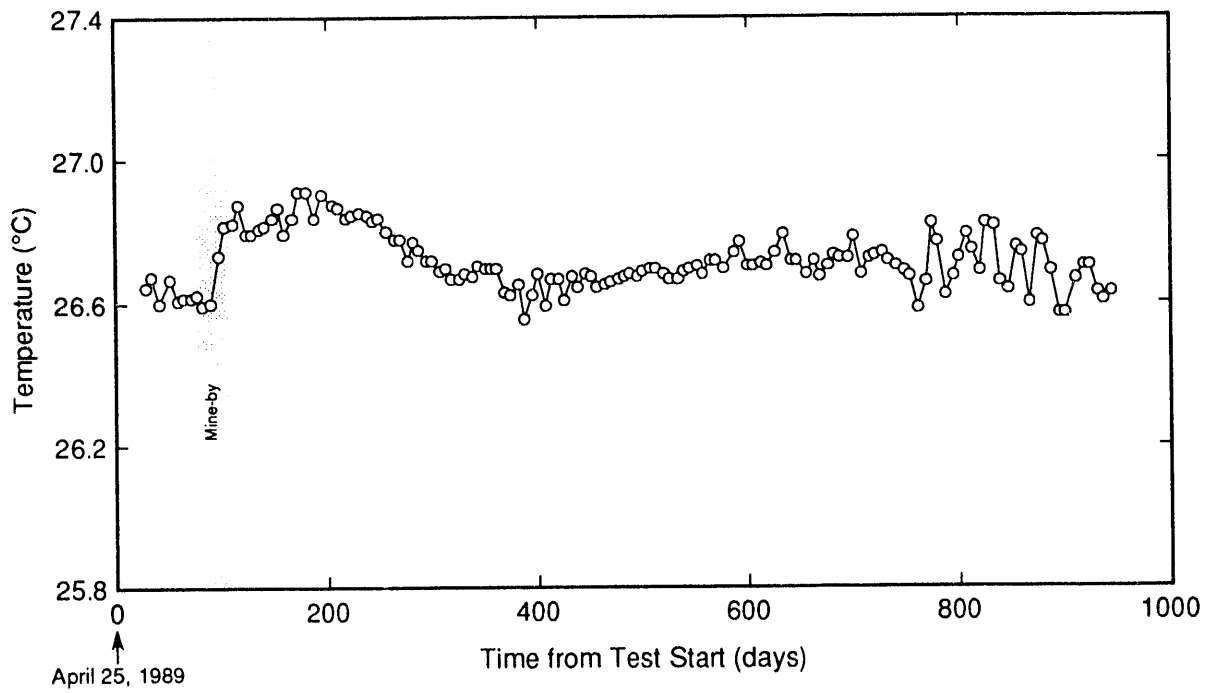


Figure 6-98. Hole QPP23 tool temperature.

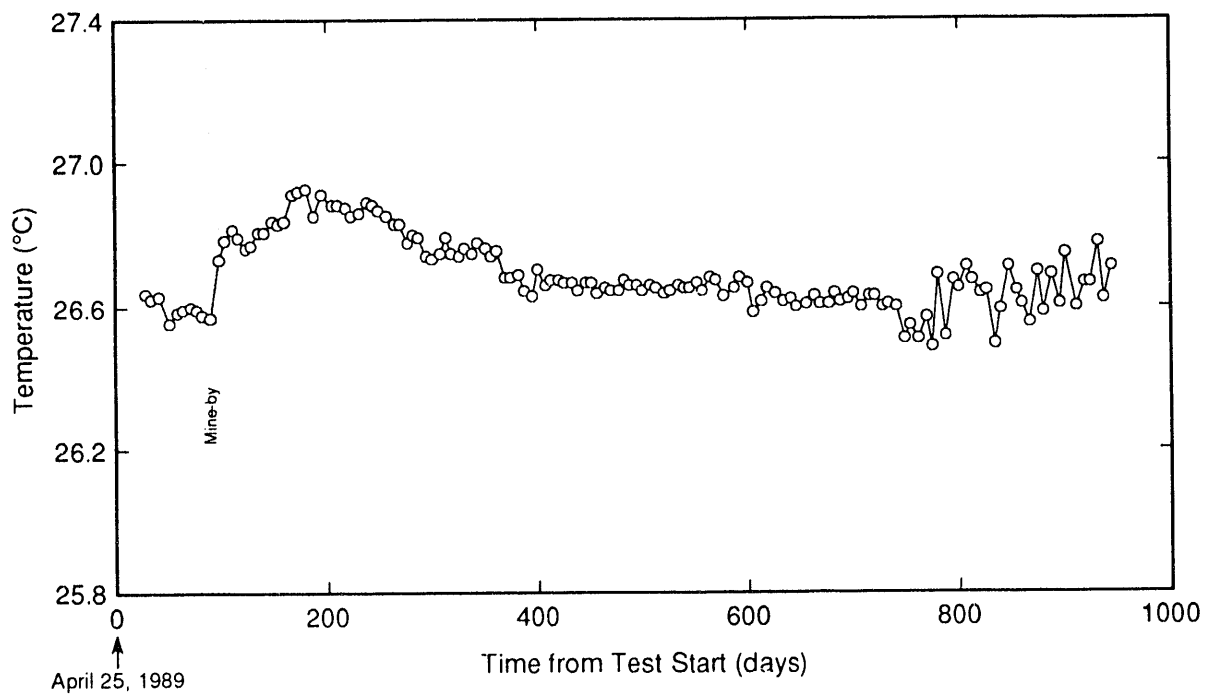
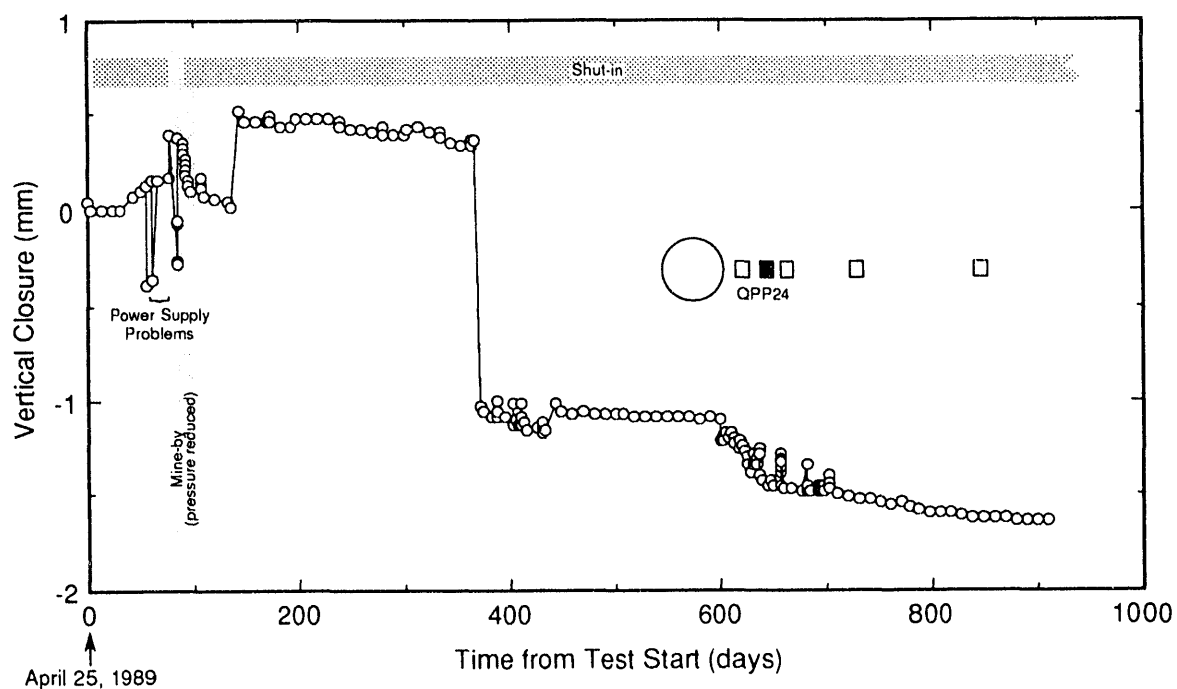
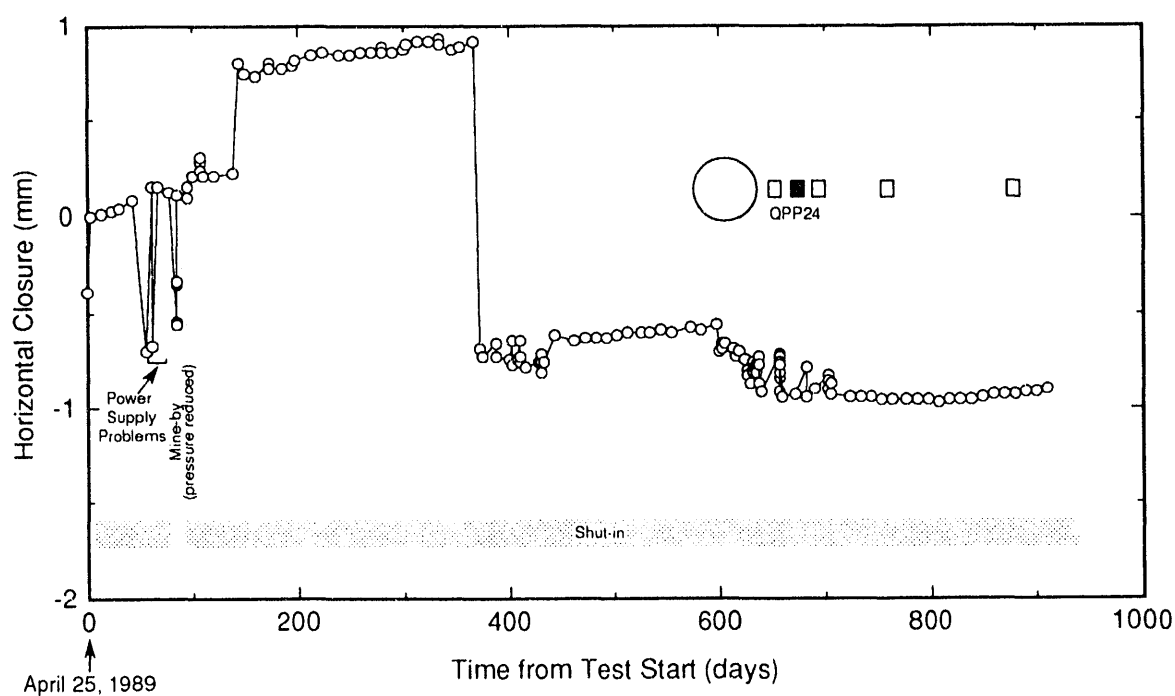


Figure 6-99. Hole QPP23 casing temperature.



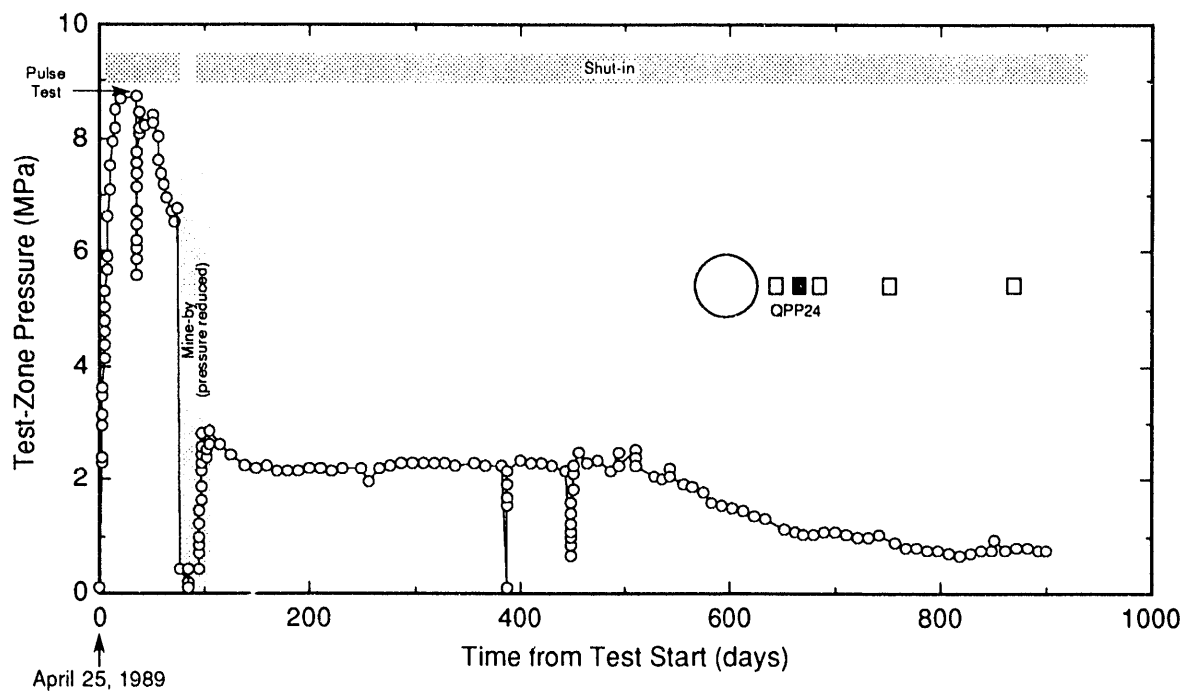
TRI-6119-222-0

Figure 6-100. Vertical closure measured in the test zone of hole QPP24.



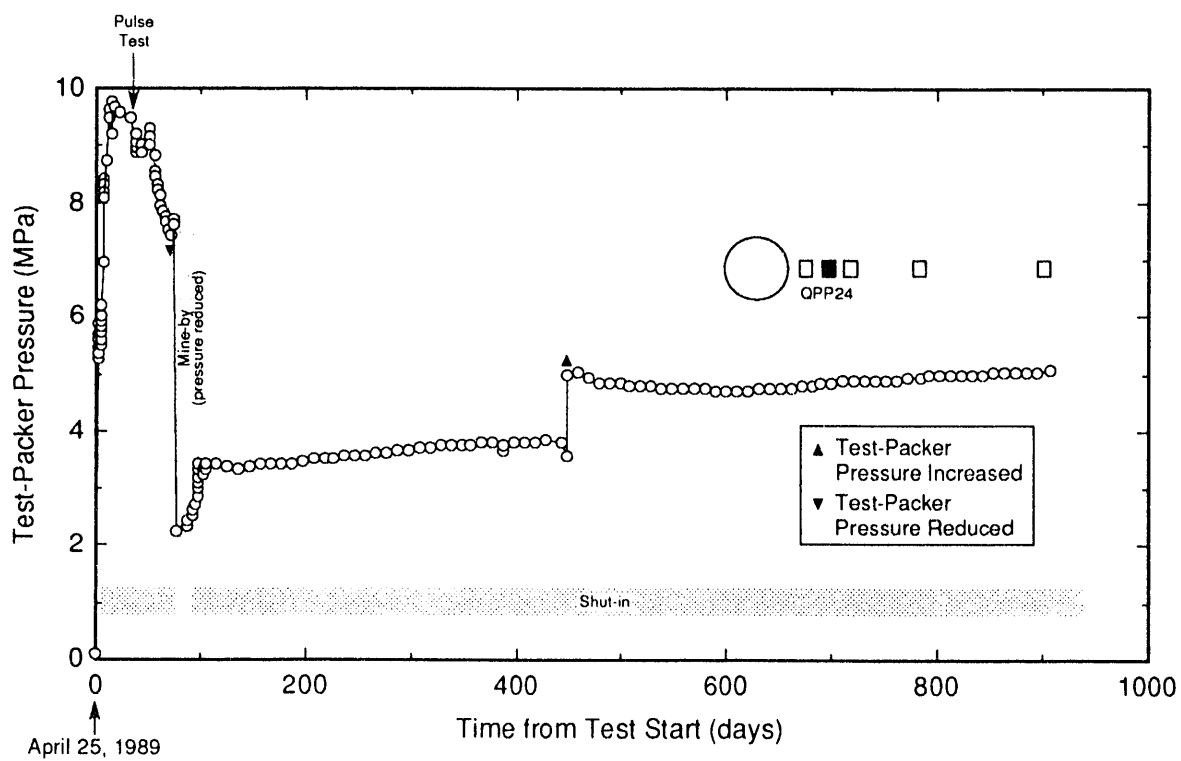
TRI-6119-223-0

Figure 6-101. Horizontal closure measured in the test zone of hole QPP24.



TRI-6119-224-0

Figure 6-102. Hole QPP24 test-zone pressure.



TRI-6119-225-0

Figure 6-103. Hole QPP24 test-packer pressure.

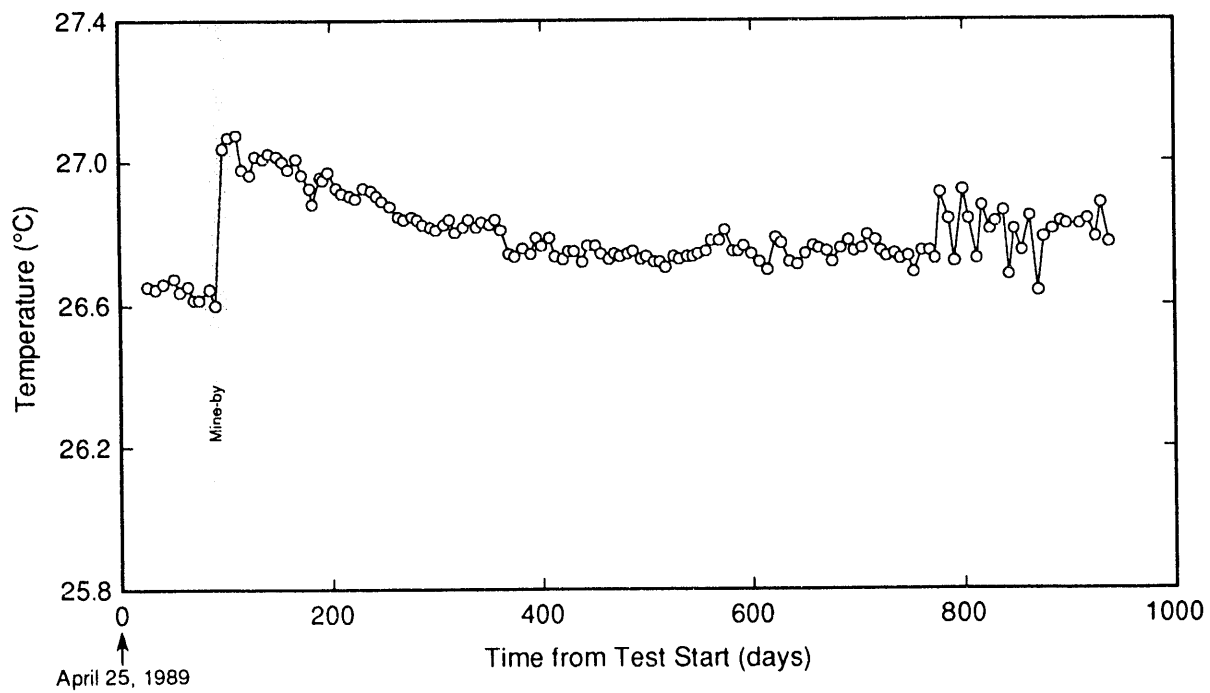


Figure 6-104. Hole QPP24 tool temperature.

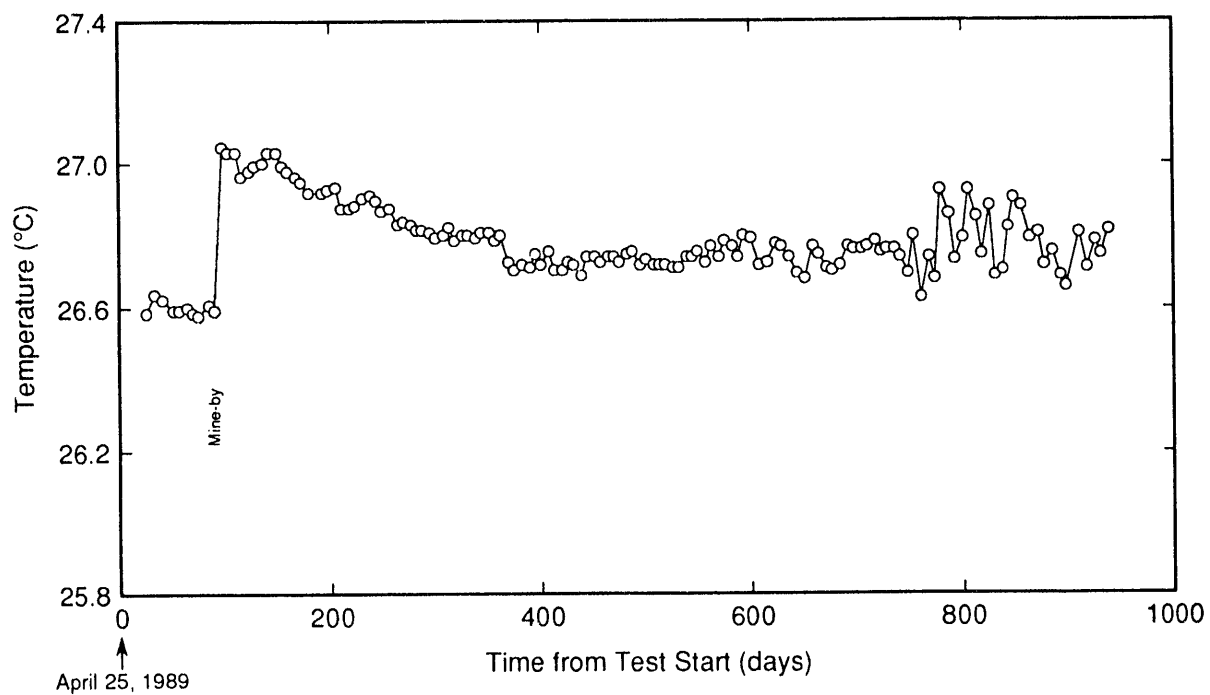
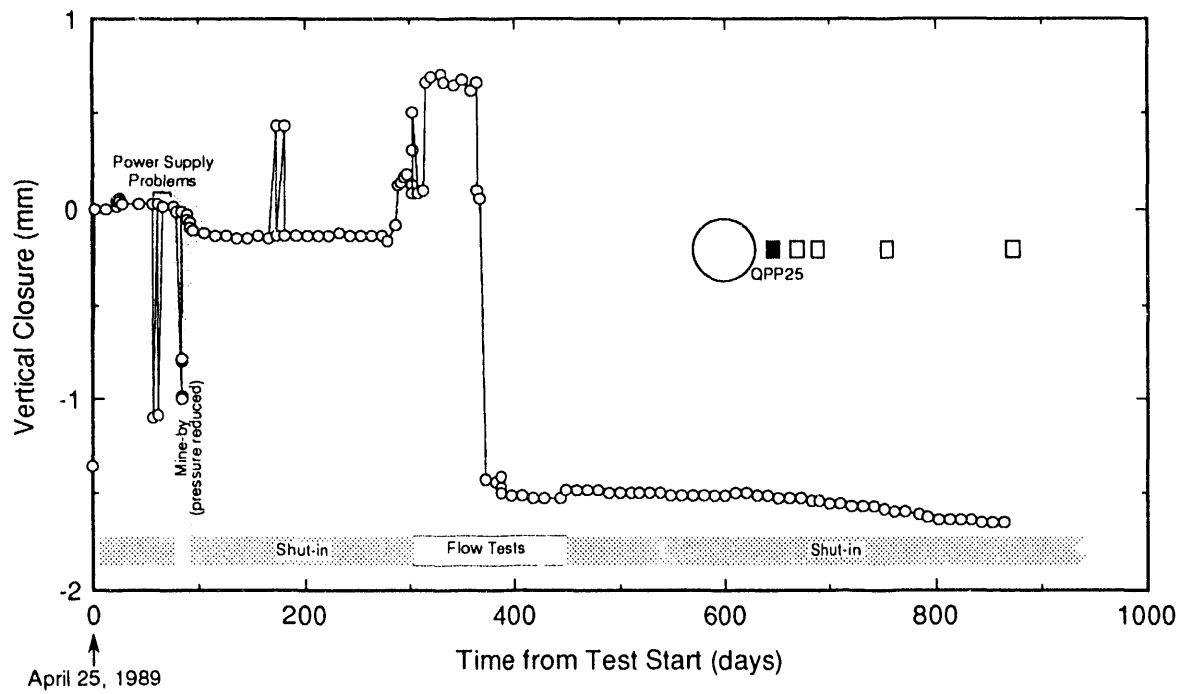
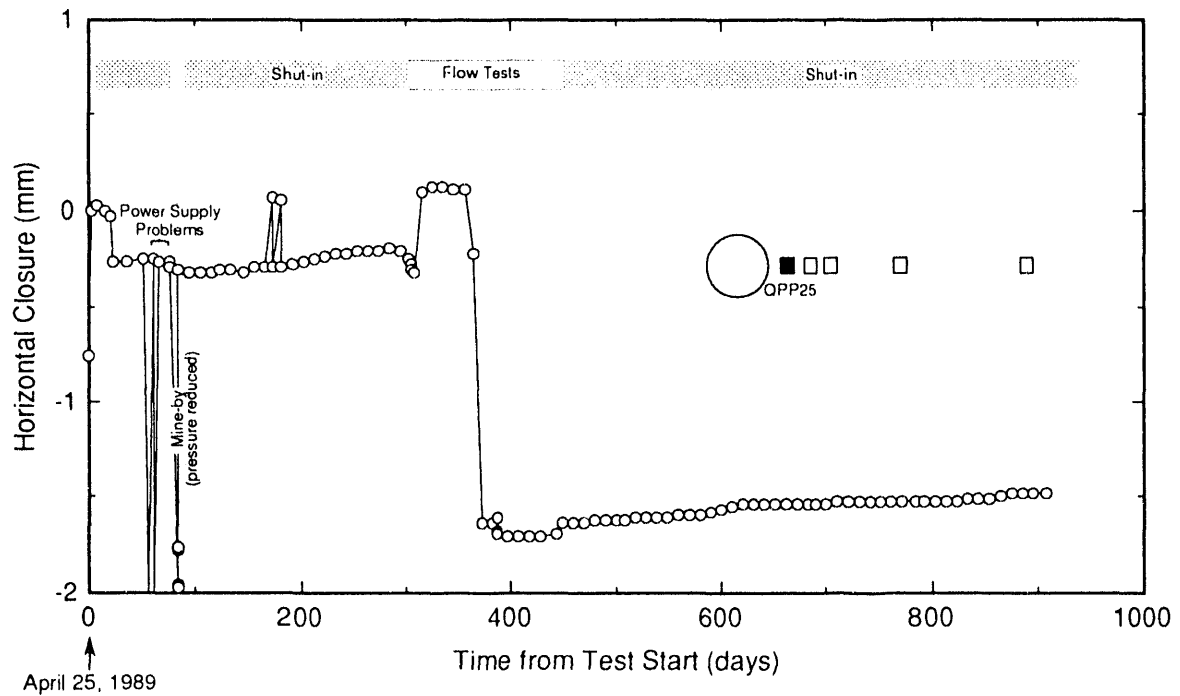


Figure 6-105. Hole QPP24 casing temperature.



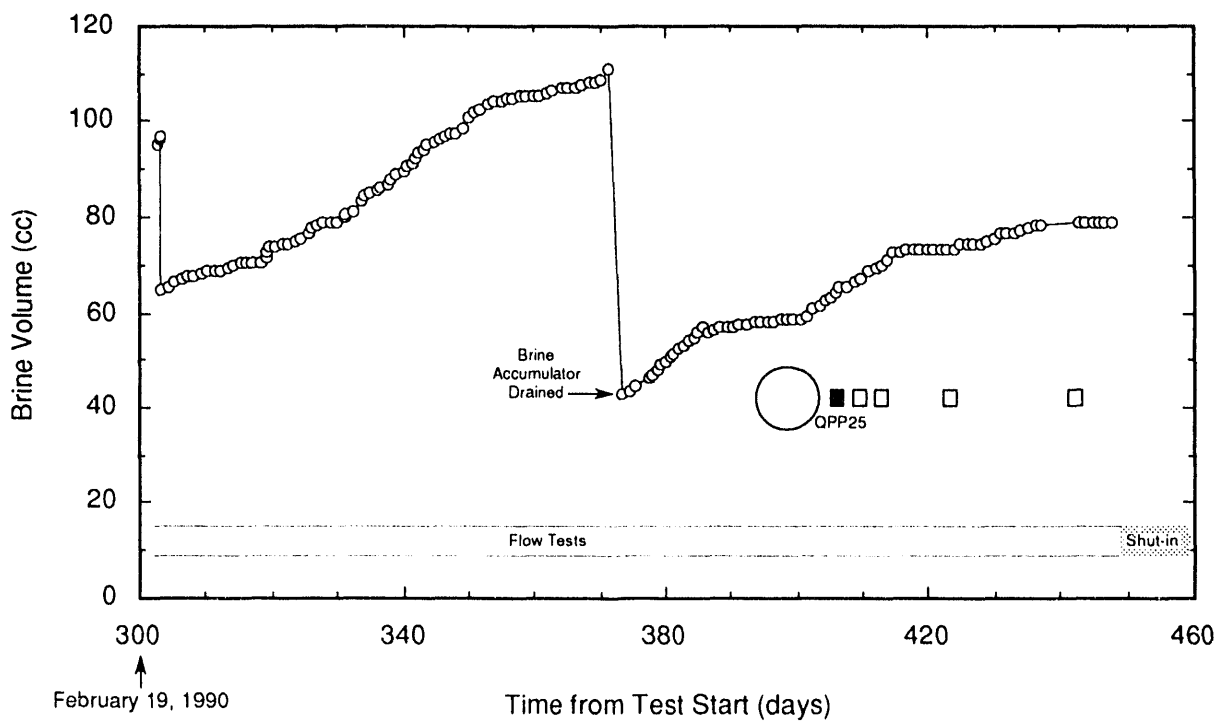
TRI-6119-226-0

Figure 6-106. Vertical closure measured in the test zone of hole QPP25.



TRI-6119-227-0

Figure 6-107. Horizontal closure measured in the test zone of hole QPP25.



TRI-6119-228-0

Figure 6-108. Brine collected from QPP25 test zone during flow testing.

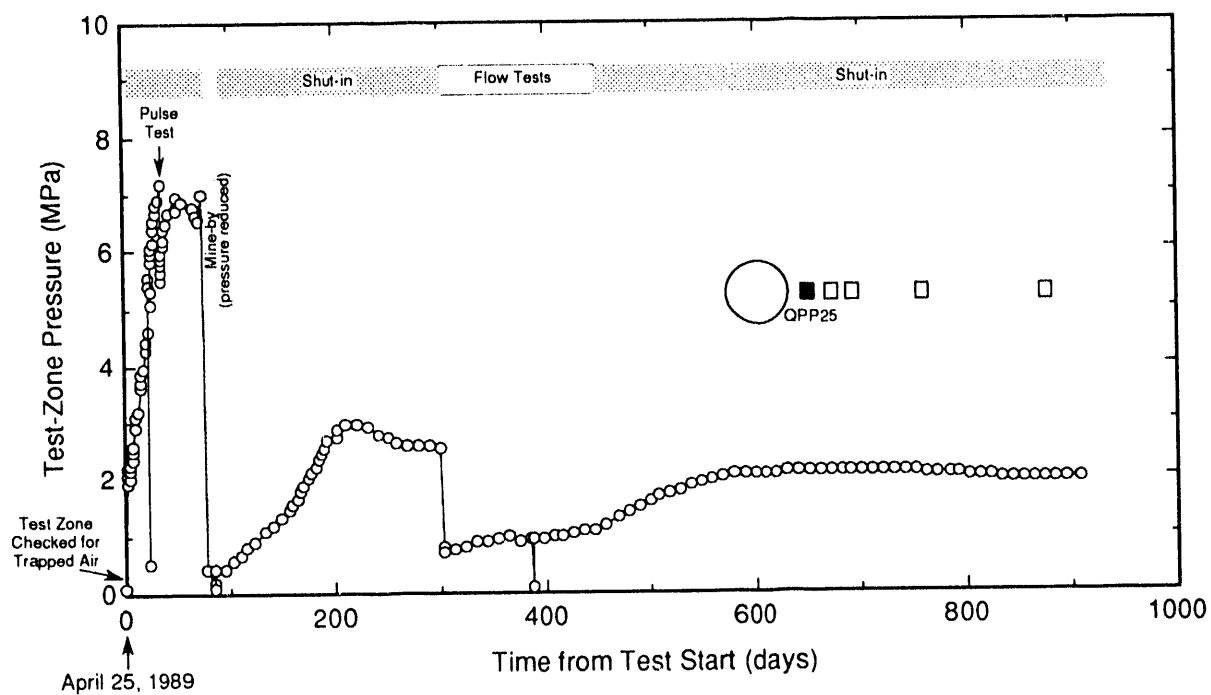


Figure 6-109. Hole QPP25 test-zone pressure.

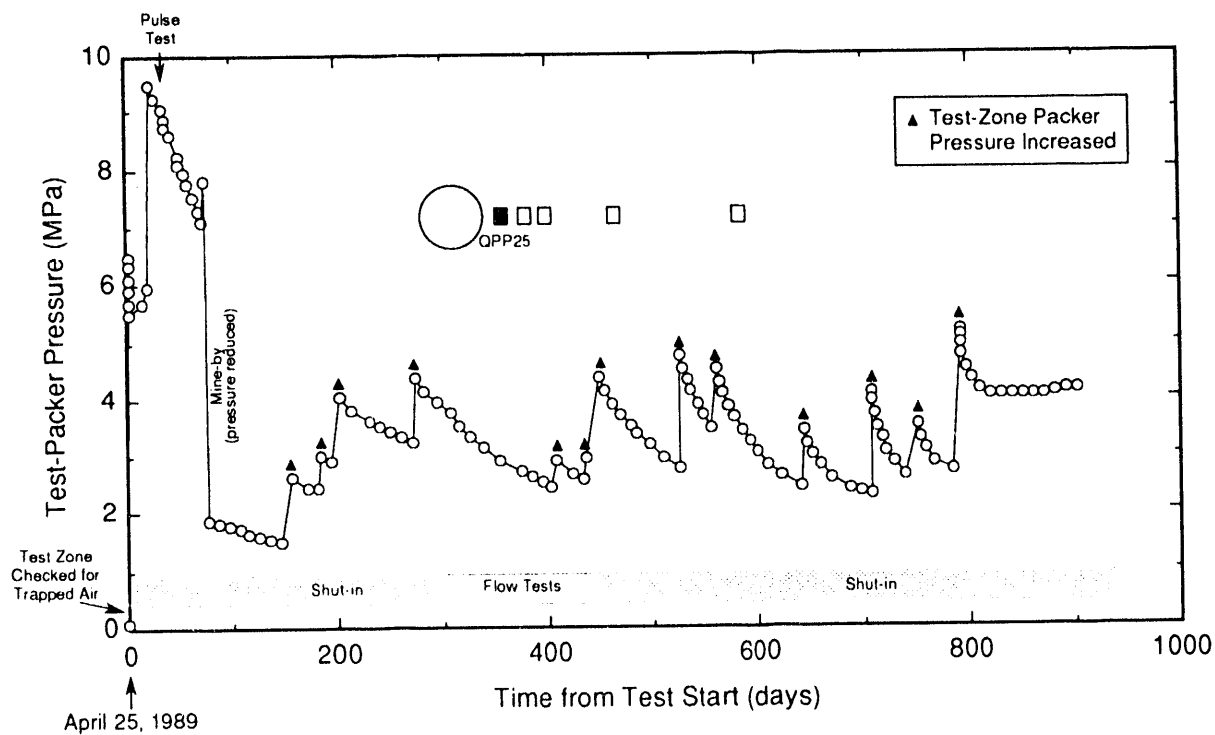
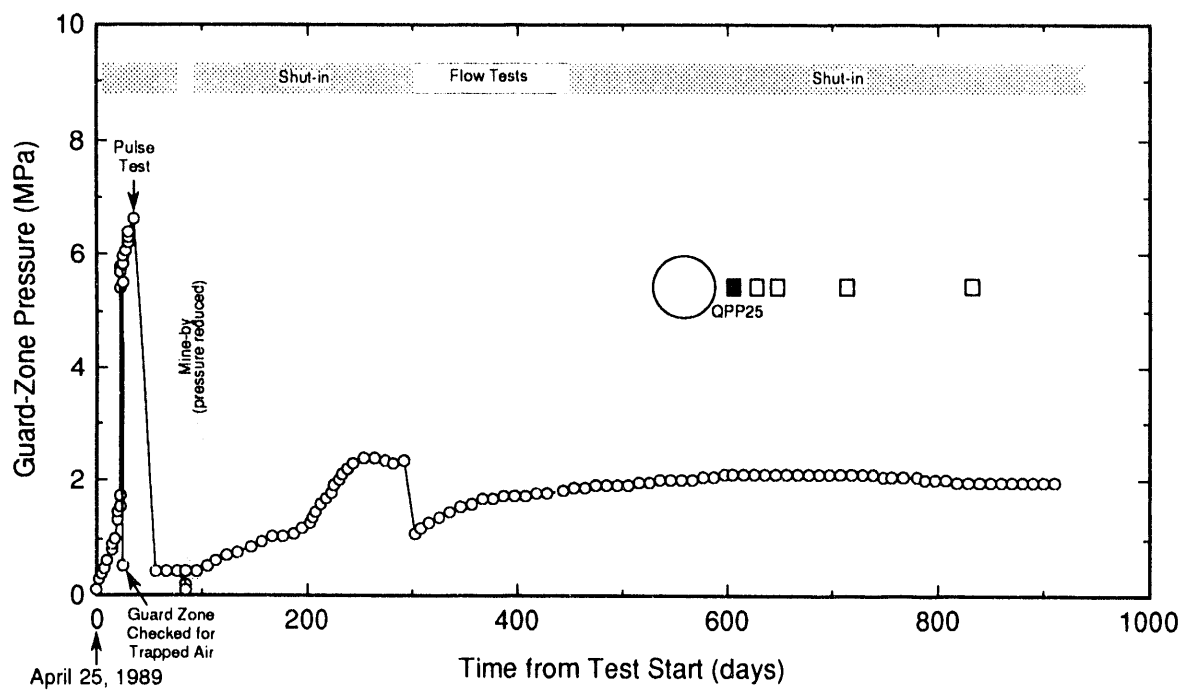
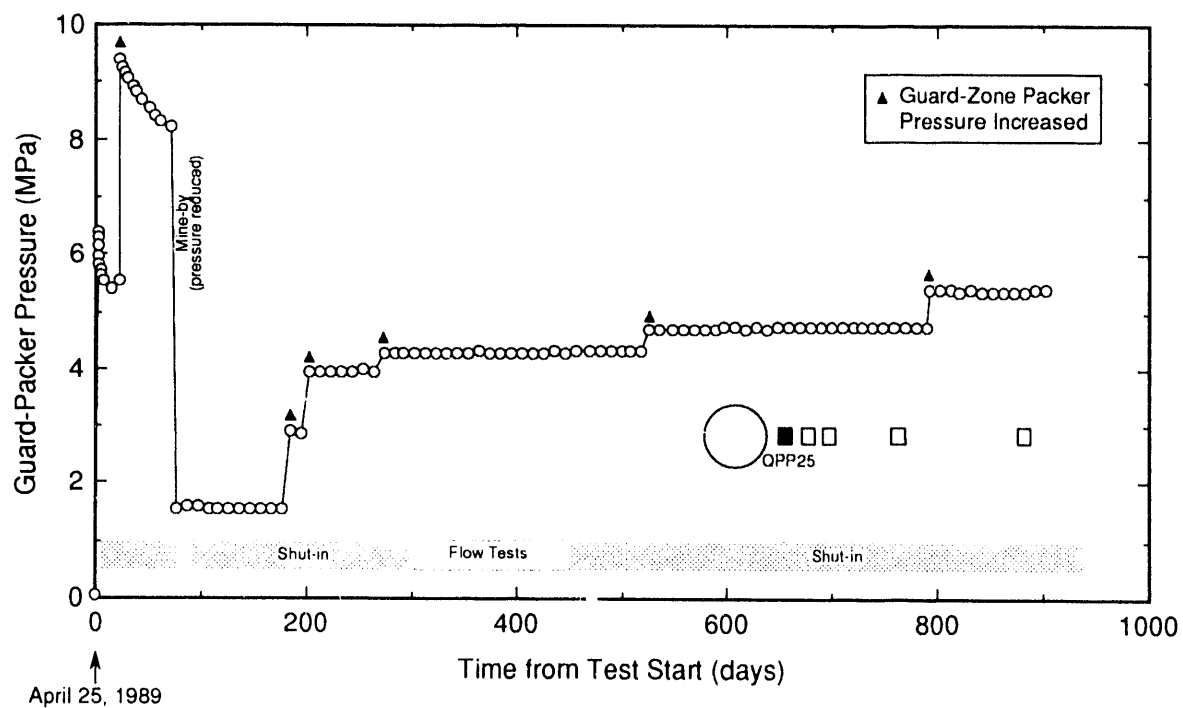


Figure 6-110. Hole QPP25 test-packer pressure.



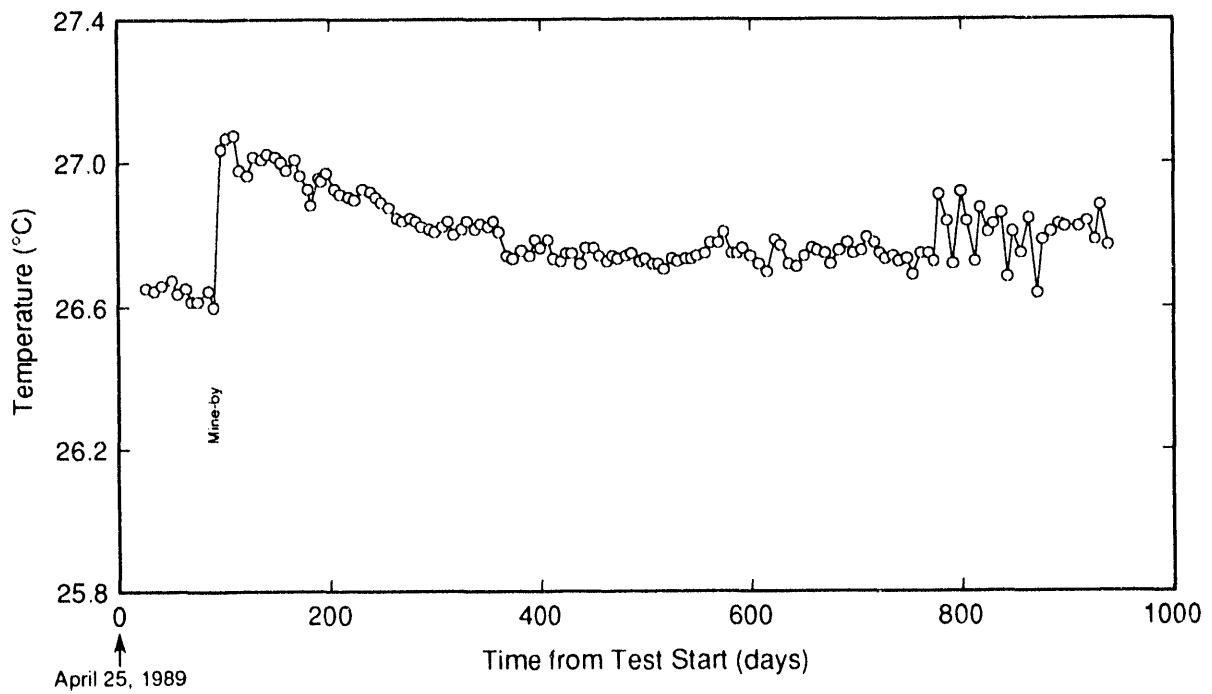
TRI-6119-231-0

Figure 6-111. Hole QPP25 guard-zone pressure.



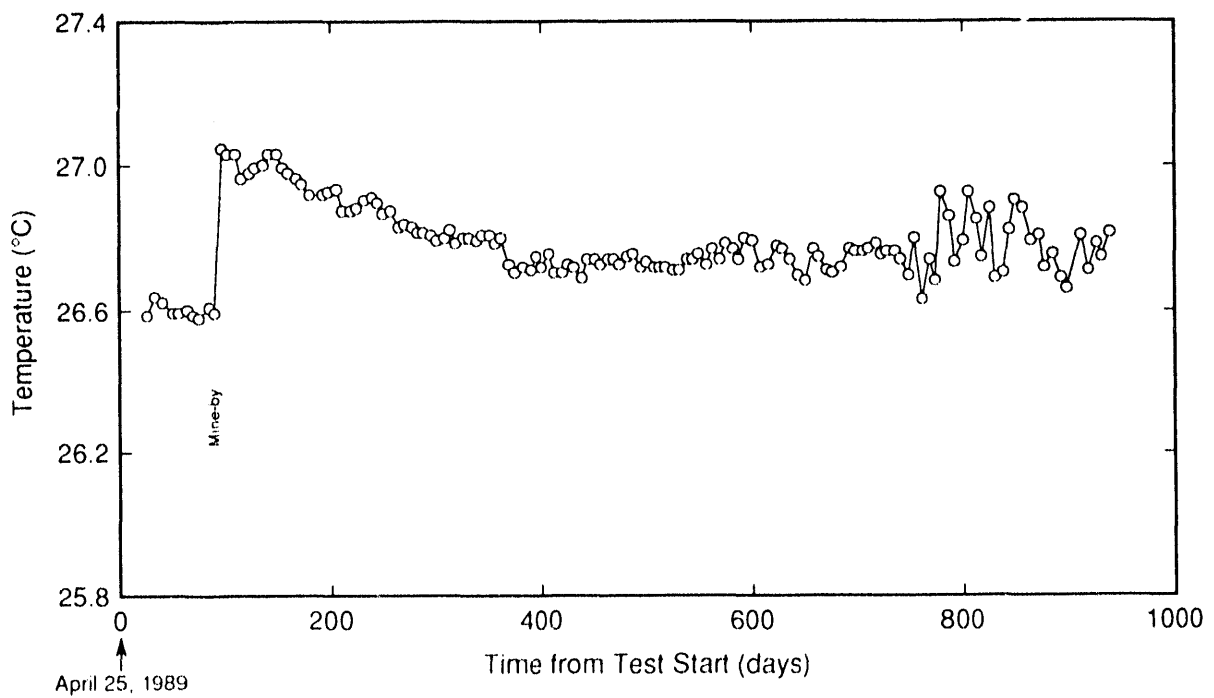
TRI-6119-232-0

Figure 6-112. Hole QPP25 guard-packer pressure.



TRI-6119-45-0

Figure 6-113. Hole QPP25 tool temperature.



TRI-6119-46-0

Figure 6-114. Hole QPP25 casing temperature.

7.0 FUTURE TESTING

Plans are under way to refurbish and improve the systems used for borehole testing around Room Q. Several improvements are needed so that more accurate and reliable data can be obtained in the future. These improvements are listed below.

- Tools will be pulled and their condition inspected. The closure assemblies will be removed from all the slim-hole tools. A new system will measure test-zone length variation (axial movement of all the tools). Radial measurements currently taken with the 3.5-cm diameter tools will continue.
- All of the existing pressure transducers will be recalibrated.
- The instrument panel will be redesigned to allow pressure transducer calibration while the tool is in the hole during the testing phase.
- Compliance and compressibility tests to determine tool reaction to applied pressures will be performed.
- The sensitivity of the existing thermal measurements taken in the 10.2-cm-diameter test holes will be increased, and test zone thermal measurements will be taken with the slim hole test tool.
- The DAS will be redesigned to monitor each group of five tools by using three individual DASs. The new system will record raw data in addition to engineering units. Data recorded for the tests described in this report did not include raw data in the form of voltages. Voltage data are useful when there is an error in instrument calibration.
- A series of tests will be performed to establish the pore pressure gradient around Room Q. Flow testing will be performed to understand conductivity between test holes. These tests will provide comparisons with existing data.
- All holes will be video mapped to establish actual elevations of the contacts between stratigraphic units.

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APPENDIX A

**STRATIGRAPHIC UNITS (MAP UNITS) NEAR THE WIPP
FACILITY HORIZON**

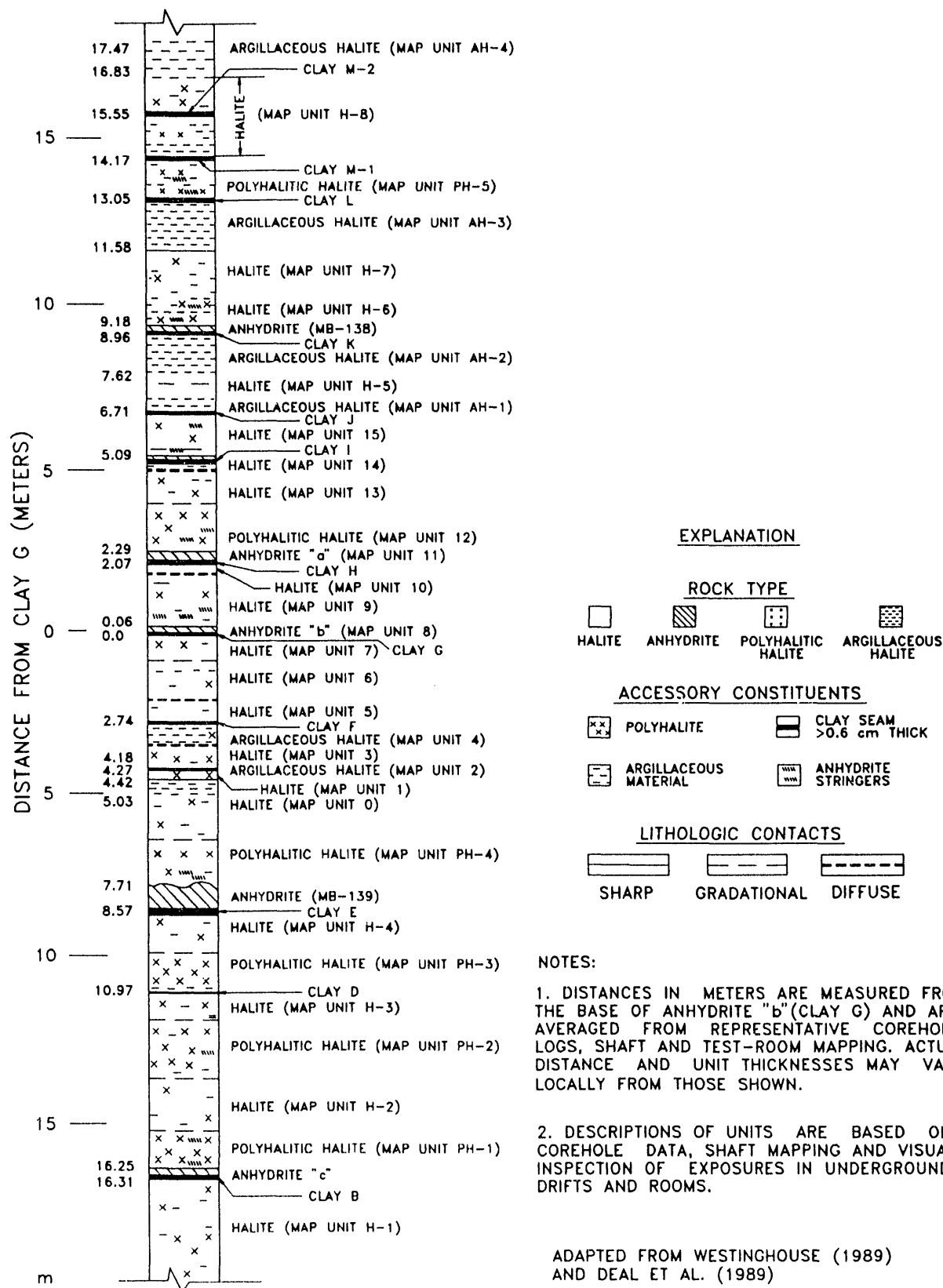


Figure A-1. Detailed Stratigraphy Near the WIPP Underground Facility.

Table A-1
Description of Generalized Stratigraphy*

Approximate Distance From Clay G (Meters)	Stratigraphic Unit	Description
20.1 to 21.2	Polyhalitic halite (PH-7)	Clear to moderate reddish orange/brown, fine to coarsely crystalline, <1-3% polyhalite.
19.3 to 20.1	Halite (H-9)	Clear to light moderate reddish orange, medium to coarsely crystalline, ≤1% polyhalite. May contain ≤1% brown and gray clay.
17.5 to 19.3	Polyhalitic halite (PH-6)	Clear to moderate reddish orange/brown, medium to coarsely crystalline, <1-3% polyhalite. May contain traces of gray clay and/or scattered anhydrite.
16.8 to 17.5	Argillaceous halite (AH-4)	Clear to moderate brown, medium to coarsely crystalline. <1 to 3% brown clay. Intercrystalline and discontinuous breaks. In one core hole, consists of a 2.54 centimeter thick clay seam. Unit can vary up to 1.2 meters in thickness. Contact with lower unit is gradational.
14.2 to 16.8	Halite (H-8)	Clear to moderate reddish orange and moderate brown, coarsely crystalline, some medium. ≤1% brown clay, locally argillaceous (clays M-1 and M-2). Scattered anhydrite stringers locally.
13.0 to 14.2	Polyhalitic halite (PH-5)	Clear to moderate reddish orange, some moderate brown, coarsely crystalline. <1 to 3% polyhalite. None to 1% brown and some gray clay. Scattered anhydrite locally. Contact with unit below is fairly sharp.
11.6 to 13.0	Argillaceous halite (AH-3)	Clear to moderate brown, medium to coarsely crystalline, some fine. <1 to 5% brown clay. Locally contains 10% clay. Intercrystalline and scattered breaks. Locally contains partings and seams. Contact with lower unit is gradational based on increased clay content. Average range of unit is 11.6 to 13.0 meters above clay G but does vary from 10.3 to 14.0 meters.
10.4 to 11.6	Halite (H-7)	Clear to moderate brown, some moderate reddish brown, coarsely crystalline, some fine and medium. ≤1% brown clay, trace gray clay locally. Scattered breaks. Locally argillaceous. <1% polyhalite. Contact with unit below is gradational based on clay and polyhalite content.

*From *Brine Sampling and Evaluation Program 1988 Report*, DOE/WIPP 89-015, Deal et al. (1989).

Table A-1**Description of Generalized Stratigraphy (Continued)**

Approximate Distance From Clay G (Meters)	Stratigraphic Unit	Description
9.2 to 10.4	Halite (H-6)	Clear to moderate reddish orange, coarsely crystalline. <1 to 3% polyhalite. Commonly polyhalitic. Scattered anhydrite stringers with anhydrite layers up to 1.27 centimeters thick locally. Scattered brown clay locally. Contact with MB-138 below is sharp.
9.0 to 9.2	Anhydrite (MB-138)	Light to medium gray, microcrystalline. Partly laminated. Scattered halite growths. Clay seam K found at base of unit.
7.6 to 9.0	Argillaceous halite (AH-2)	Clear to moderate brown, some light moderate reddish orange. Medium to coarsely crystalline. <1 to 3% brown clay, some gray. Locally up to 5% clay. Clay is intercrystalline with scattered breaks and partings present. <1/2% dispersed polyhalite. Contact with lower unit is gradational based on clay content. Upper contact with clay K is sharp.
7.0 to 7.6	Halite (H-5)	Clear, some light moderate brown, coarsely crystalline. <1/2% brown clay. Contact with clay J below varies from sharp to gradational depending if clay J is a distinct seam or merely an argillaceous zone.
6.4 to 7.0	Argillaceous halite (clay J; AH-1)	Usually consists of scattered breaks or argillaceous zone containing <1 to 3% brown clay. In C&SH shaft, it is a 1.27 centimeters thick brown clay seam.
5.1 to 6.4	Halite (map unit 15)	Clear, coarsely crystalline, scattered medium. Up to 1% dispersed polyhalite and brown clay. Scattered anhydrite. Lower contact is sharp with clay I.
4.8 to 5.1	Halite (map unit 14)	Clear to grayish orange-pink, coarsely crystalline, some medium. <1/2% dispersed polyhalite. Scattered discontinuous gray clay stringers. Clay I is along upper contact. Contact with lower unit is diffuse.
3.5 to 4.8	Halite (map unit 13)	Clear to moderate reddish orange and moderate brown, medium to coarsely crystalline, some fine. ≤1% brown clay, locally up to 3%. Trace of gray clay. Scattered discontinuous breaks. <1% dispersed polyhalite and polyhalite blebs. Contact with unit below is gradational based on clay and polyhalite content.

Table A-1**Description of Generalized Stratigraphy (Continued)**

Approximate Distance From Clay G (Meters)	Stratigraphic Unit	Description
2.3 to 3.5	Polyhalitic halite (map unit 12)	Clear to moderate reddish orange, coarsely crystalline. ≤1 to 3% dispersed polyhalite and polyhalite blebs. Scattered anhydrite stringers. Contact is sharp with unit below.
2.1 to 2.3	Anhydrite ("a" - map unit 11)	Light to medium gray, light brownish gray and sometimes light moderate reddish orange. Microcrystalline. Halite growths within. Partly laminated. Clear, coarsely crystalline halite layer up to 5.1 centimeters wide, found within exposures in waste experimental area. Thin gray clay seam H at base of unit.
1.7 to 2.1	Halite (map unit 10)	Clear to moderate reddish orange/brown, fine to coarsely crystalline. ≤1% brown and/or gray clay and dispersed polyhalite. Discontinuous clay stringers locally. Contact with lower unit is diffuse based on crystal size and varying amounts of clay and polyhalite.
0.1 to 1.7	Halite (map unit 9)	Clear to light moderately reddish orange, coarsely crystalline, some medium. None to <1% polyhalite. Trace of gray clay locally. Scattered anhydrite stringers. Contact with unit below is sharp.
0.0 to 0.1	Anhydrite ("b" - map unit 8)	Light to medium gray, microcrystalline anhydrite. Scattered halite growths. Thin gray clay seam G at base of unit.
0.0 to -0.7	Halite (map unit 7)	Clean to light/medium gray, some moderate reddish orange/brown. Coarsely crystalline, some fine and medium. ≤1% brown and gray clay. Locally up to 2% clay. <1% dispersed polyhalite. Upper contact is sharp with clay G. Contact with lower unit is gradational.
-0.7 to -2.1	Halite (map unit 6)	Clear, some moderate reddish orange, coarsely crystalline, some fine to medium locally. <1/2% gray clay and polyhalite. Contact with lower unit gradational and/or diffuse.
-2.1 to -2.7	Halite (map unit 5)	Clear, coarsely crystalline. <1/2% gray clay. Contact with lower unit usually sharp with clay F.

Table A-1**Description of Generalized Stratigraphy (Continued)**

Approximate Distance From Clay G (Meters)	Stratigraphic Unit	Description
-2.7 to -3.5	Argillaceous halite (map unit 4)	Clear to moderate brown and moderate reddish brown, coarsely crystalline. <1% polyhalite. <1 to 5% argillaceous material; predominantly brown, some gray, locally. Intercrystalline and discontinuous breaks and partings common in upper part of unit. Decreasing argillaceous content downward. Contact with lower unit is gradational.
-3.5 to -4.2	Halite (map unit 3)	Clear to moderate reddish orange, coarsely crystalline. ≤1% dispersed polyhalite and polyhalite blebs. Locally polyhalitic. Scattered gray clay locally. Contact with lower unit is sharp.
-4.2 to -4.3	Argillaceous halite (map unit 2)	Moderate reddish brown to medium gray, medium to coarsely crystalline. <1 to 3% argillaceous material. Contact with lower unit is usually sharp.
-4.3 to -4.4	Halite (map unit 1)	Light reddish orange to moderate reddish orange, medium to coarsely crystalline. ≤1% dispersed polyhalite. Contact with lower unit is sharp.
-4.4 to -6.7	Halite (map unit 0)	Clear to moderate reddish orange/brown, moderate brown and grayish brown. Medium to coarsely crystalline. <1 to 5% argillaceous material. Predominantly brown, some gray, intercrystalline argillaceous material and discontinuous breaks and partings. Upper 0.6 meters of unit is argillaceous halite decreasing in argillaceous material content downward. None to <1% polyhalite. Contact with lower unit is gradational based on polyhalite content.
-6.7 to -7.7	Polyhalitic halite (PH-4)	Clear to moderate reddish orange. Coarsely crystalline, some medium locally. <1 to 3% polyhalite. Scattered anhydrite. Scattered gray clay locally. Contact with lower unit (MB-139) is sharp, but commonly irregular and undulating. Trace of gray locally present along this contact.
-7.7 to -8.6	Anhydrite (MB-139)	Moderate reddish orange/brown to light and medium gray, microcrystalline anhydrite. "Swallowtail" pattern, consisting of halite growths within anhydrite, common in upper part of unit. Locally, hairline, clay-filled, low-angle

Table A-1

Description of Generalized Stratigraphy (Continued)

Approximate Distance From Clay G (Meters)	Stratigraphic Unit	Description
		fractures found in lower part of unit. Thin halite layer common close to lower contact. Clay seam E found at base of unit. Upper contact is irregular, undulating and sometimes contains <0.16 centimeters gray clay.
-8.6 to -9.5	Halite (H-4)	Clear to moderate reddish orange, and light gray. Coarsely crystalline, some fine and medium. ≤1% polyhalite and intercrystalline gray clay. Contact with lower unit is gradational based on increased polyhalite content.
-9.5 to -11.0	Polyhalitic halite (PH-3)	Clear to moderate reddish orange, coarsely crystalline. <1 to 3% polyhalite. Contact with lower unit is usually sharp along clay D.
-11.0 to -11.5	Halite (H-3)	Clear to moderate reddish orange, some light gray. Medium to coarsely crystalline. ≤1% polyhalite and gray clay. Contact with lower unit is gradational based on increased polyhalite content.
-11.5 to 13.0	Polyhalitic halite (PH-2)	Clear to moderate reddish orange/brown, coarsely crystalline. <1 to 3% polyhalite. Trace of clay locally. Scattered anhydrite locally. Contact with lower unit is gradational, based on decreased polyhalite content.
-13.0 to 14.4	Halite (H-2)	Clear to moderate reddish orange, medium to coarsely crystalline. <1% dispersed polyhalite. <1% brown and/or gray clay. Contact with lower unit is gradational and/or diffuse.
-14.4 to -16.2	Polyhalitic halite (PH-1)	Clear to moderate reddish orange. Coarsely crystalline with some medium sometimes present close to lower contact. <1 to 3% polyhalite. Scattered anhydrite especially common close to anhydrite "c". Lower contact is sharp with anhydrite "c".
-16.2 to -16.3	Anhydrite ("c")	Light to medium gray, microcrystalline anhydrite. Scattered halite growths. Faintly laminated locally. Clay seam B found at base of unit.

Table A-1

Description of Generalized Stratigraphy (Concluded)

Approximate Distance From Clay G (Meters)	Stratigraphic Unit	Description
-16.3 to -20.0	Halite (H-1)	Clear to medium gray and moderate brown. Medium to coarsely crystalline, some fine locally. $\leq 1\%$ polyhalite, locally polyhalitic. < 1 to 3% clay, both brown and gray. Intercrystalline clay with discontinuous breaks and partings. Zones of argillaceous halite found within unit. Seams of clay mixed with halite crystals present locally. Upper contact of this unit is sharp with clay B.

APPENDIX B: BOREHOLE SURVEY AND DRILLING LOGS

SURVEY NOTES

Survey notes transmitted include Electronic Data Collection File which in this case include beginning and backsight coordinates and then a series of radial side shots recording horizontal and vertical angles. Distance is not measured in this collection because it was not possible to use the prisms.

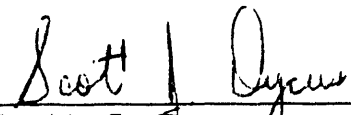
Next is the field Data File Log. This gives you the calculated bearing of your backsight or reference line and your HI (Height Instrument). On this file we key in the slope distance (SD) which makes it possible to calculate the coordinates.

Finally, the finished product. Beginning point coordinates, bearings of all foresights and horizontal distance to calculate all X, Y, Z coordinates.

Note: B.S. Qpp 22, 24, & 25 were destroyed and are not in file.

Should you have any questions please feel free to call (887-8191).

By:



Scott J. Dycus
Underground Engineering
Support & Hoisting

ELECTRONIC DATA COLLECTION

Collection File: QROOM.COP
 eld Data Log

Word	Code	INFO 1 Hz Circle	INFO 2 Vt Circle	INFO 3 Distance	INFO 4 PPM Prism Offset
1		+000000100	-000000000	+000000042	
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11		+000000042	+06270307	+09590132	-000000000
32					
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		48 04 26.0	79 04 11.0	0.00	-0035 +000
		52 41 57.0	71 10 01.0	0.00	-0035 +000
		53 08 51.0	91 44 39.0	0.00	-0035 +000
		80 10 24.0	63 54 01.0	0.00	-0035 +000
		68 38 00.0	103 22 06.0	0.00	-0035 +000
		133 30 38.0	91 30 50.0	0.00	-0035 +000
		137 23 58.0	91 32 23.0	0.00	-0035 +000
		141 44 42.0	91 42 17.0	0.00	-0035 +000
		146 42 43.0	91 50 46.0	0.00	-0035 +000
		152 01 25.0	92 05 01.0	0.00	-0035 +000
		134 10 23.0	71 27 01.0	0.00	-0035 +000
		137 50 44.0	70 29 27.0	0.00	-0035 +000
		141 48 40.0	69 24 52.0	0.00	-0035 +000
		146 51 33.0	68 01 24.0	0.00	-0035 +000
		152 18 24.0	66 35 54.0	0.00	-0035 +000
		208 15 35.0	73 28 24.0	0.00	-0035 +000
		213 36 03.0	74 38 51.0	0.00	-0035 +000
		218 51 54.0	75 09 39.0	0.00	-0035 +000
		222 58 32.0	76 20 24.0	0.00	-0035 +000
		226 46 43.0	77 06 19.0	0.00	-0035 +000
		331 47 24.0	74 11 30.0	0.00	-0035 +000

Job File: Q-ROOM.CMD
 Word File: Q-ROOM.CRP
 Field Data File: Q-ROOM.FLD
 Plot File: Q-ROOM.PLT
 Summary File: Q-ROOM.CMD

=====

LD DATA ENTRY AND TRAVERSE CALCULATIONS

=====

ld Data File Log

Units of Measurement:
 Units: DDD.mmssss Distances: USFeet
 Units of Measurement:
 Units: DIRS Distances: EDM

	Command	HZ	VT	SD	
01	1 START	100	42	N 89 59 37.6 E	
02	2 OCCUPY	100	1267.55	42	
03	32 RADIAL	101	42		
04	BS	00 00 00.0	00 00 00.0	0.00	
05	FS	102	B.S. OFF-21		0.00
		11 00 07.0	81 49 21.0	53.48	
06	FS	103	B.S. OFF-15		0.00
		31 15 07.0	85 39 10.0	22.44	
07	FS	104	B.S. OFF-5		0.00
		31 26 43.0	74 53 26.0	23.04	
08	FS	105	B.S. OFF-14		0.00
		40 16 06.0	82 35 18.0	22.20	
	FS	106	B.S. OFF-4		0.00
		40 23 05.0	77 40 02.0	22.44	
10	FS	107	B.S. OFF-3		0.00
		48 03 21.0	81 46 24.0	22.89	
11	FS	108	B.S. OFF-13		0.00
		48 04 26.0	79 04 11.0	23.05	
12	FS	109	B.S. OFF-12		0.00
		52 41 57.0	71 10 01.0	26.10	
13	FS	110	B.S. OFF-2		0.00
		53 08 51.0	91 44 39.0	24.50	
14	FS	111	B.S. OFF-11		0.00
		80 10 24.0	63 54 01.0	22.60	
	FS	112	B.S. OFF-1		0.00
		68 38 00.0	103 22 06.0	23.20	
16	FS	113	OFF-11		0.00
		133 30 38.0	91 30 50.0	22.02	
17	FS	114	OFF-12		0.00
		137 23 58.0	91 32 23.0	20.60	
18	FS	115	OFF-13		0.00
		141 44 42.0	91 42 17.0	19.26	
19	FS	116	OFF-14		0.00
		146 42 43.0	91 50 46.0	18.05	
20	FS	117	OFF-15		0.00
		152 01 25.0	92 05 01.0	16.96	
21	FS	118	OFF-1		0.00
		134 10 23.0	71 27 01.0	23.31	
22	FS	119	OFF-2		0.00
		137 50 44.0	70 29 27.0	22.00	
23	FS	120	OFF-3		0.00
		141 48 40.0	69 24 52.0	20.65	
24	FS	121	OFF-4		0.00
		146 51 33.0	69 01 24.0	19.48	
25		122	OFF-5		0.00

026		123		QPP-25		0.00
	FS	208 15 35.0		73 28 24.0	17.65	
027		124		QPP-24		0.00
	FS	213 36 03.0		74 38 51.0	18.56	
028		125		QPP-23		0.00
	FS	218 51 54.0		75 09 39.0	19.72	
		126		QPP-22		0.00
	FS	222 58 32.0		76 20 24.0	21.09	
030		127		QPP-21		0.00
	FS	226 46 43.0		77 06 19.0	22.44	
031		128		B.S. QPP-23		0.00
	FS	331 47 24.0		74 11 30.0	23.08	

LD DATA COMPILE

Old Data File: Q-ROOM.FLD
 Ordinate File: Q-ROOM.CRD
 Plot File: Q-ROOM.PLT

File Check:

Boiler Errors: 0
 Missing Data: 0

Point	Descriptor	NORTH	EAST	ELEV
Reference Line From:	100	N 89 59 37.6 E		
Sight Point:	42			
Scale Factor:	1.0000000			
		9590.1000	5975.1170	0.0000

File Balance: ON
 Horizontal Adjustment: COMPASS
 Vertical Adjustment: OFF

ADJUSTED COORDINATES

Point	42	9590.1000	5975.1170	0.0000
-------	----	-----------	-----------	--------

SHOTS FROM ADJUSTED COORDINATES

Shot	From	To	Horizontal Dist	Vertical Dist	Total Dist
Shot 1	100	42	1267.55		
Shot 2	S 79 00 15.4 E	B.S. QPP-21	52.94	6027.0814	1275.16
Shot 3	S 58 45 15.4 E	B.S. QPP-15	22.38	5994.2469	1269.25
Shot 4	S 58 33 39.4 E	B.S. QPP-5	22.24	5994.0950	1273.56
Shot 5	S 49 44 16.4 E	B.S. QPP-14	22.01	5991.9162	1270.41
Shot 6	S 49 37 17.4 E	B.S. QPP-4	21.92	5991.8169	1272.34
Shot 7	S 41 57 01.4 E	B.S. QPP-3	22.65	5990.2612	1270.83
Shot 8	S 41 55 56.4 E	B.S. QPP-13	22.63	5990.2408	1271.92
Shot 9	S 37 18 25.4 E	B.S. QPP-12	24.70	5990.0890	1275.98
Shot 10	S 36 51 31.4 E	B.S. QPP-2	24.49	5989.8064	1266.80
Shot 11	S 9 49 58.4 E	B.S. QPP-11	20.30	5978.5830	1277.49

eshot	E 21 22 22.4 E B.S. QPP-1	Hx. Dist: 22.0 9562.0309	Vt. Dist: 1266.97 5983.3428	1266.97 1266.1359
eshot	S 43 30 15.6 W QPP-11	Hx. Dist: 22.01 9574.1340	Vt. Dist: 1266.97 5959.9635	1266.97 1266.9683
eshot	S 47 23 35.6 W QPP-12	Hx. Dist: 20.59 9576.1596	Vt. Dist: 1267.00 5959.9605	1267.00 1266.9965
eshot	S 51 44 19.6 W QPP-13	Hx. Dist: 19.25 9578.1786	Vt. Dist: 1266.98 5960.0008	1266.98 1266.9770
eshot	S 56 42 20.6 W QPP-14	Hx. Dist: 18.04 9580.1968	Vt. Dist: 1266.97 5960.0375	1266.97 1266.9685
eshot	S 62 01 02.6 W QPP-15	Hx. Dist: 16.95 9582.1476	Vt. Dist: 1266.93 5960.1497	1266.93 1266.9334
eshot	S 44 10 00.6 W QPP-1	Hx. Dist: 22.10 9574.2481	Vt. Dist: 1274.97 5959.7195	1274.97 1274.9656
eshot	S 47 50 21.6 W QPP-2	Hx. Dist: 20.74 9576.1811	Vt. Dist: 1274.90 5959.7454	1274.90 1274.8971
eshot	S 51 48 17.6 W QPP-3	Hx. Dist: 19.33 9578.1466	Vt. Dist: 1274.81 5959.9242	1274.81 1274.8107
eshot	S 56 51 10.6 W QPP-4	Hx. Dist: 18.06 9580.2225	Vt. Dist: 1274.84 5959.9921	1274.84 1274.8400
eshot	S 62 18 01.6 W QPP-5	Hx. Dist: 17.00 9582.1994	Vt. Dist: 1274.91 5960.0683	1274.91 1274.9057
eshot	N 51 44 47.4 W QPP-25	Hx. Dist: 16.92 9598.1099	Vt. Dist: 1272.57 5960.2121	1272.57 1272.5708
eshot	N 56 24 19.4 W QPP-24	Hx. Dist: 17.90 9600.0030	Vt. Dist: 1272.46 5960.2087	1272.46 1272.4639
eshot	N 51 08 28.4 W QPP-23	Hx. Dist: 19.06 9602.0598	Vt. Dist: 1272.60 5960.2733	1272.60 1272.6004
eshot	N 47 01 50.4 W QPP-22	Hx. Dist: 20.49 9604.0685	Vt. Dist: 1272.53 5960.1216	1272.53 1272.5306
eshot	N 43 13 39.4 W QPP-21	Hx. Dist: 21.87 9606.0383	Vt. Dist: 1272.56 5960.4355	1272.56 1272.5577
eshot	N 61 47 01.6 E B.S. QPP-23	Hx. Dist: 22.21 9600.5995	Vt. Dist: 1273.84 5994.6852	1273.84 1273.8375

WIPP
WASTE ISOLATION
PILOT PLANT

TITLE: DRILLING LOG

Sandia National Laboratories
 PROCEDURE _____
 REVISION 0

DATE <u>3/7/89</u> SHIFT <u>Days</u>	ROOM <u>Q Brine Rm.</u> STATION _____	HOLE NO. <u>QPP01</u> GAGE NO. _____ GAGE TYPE _____	TEAM <u>SC, RB, GH</u> APPROVAL <u>ATS</u> Q. A. <u>JAT</u>
---	--	---	--

TIME	DEPTH	REMARKS
<u>1400 to 1510</u>	<u>0' to 17'</u>	
<u>0830 to 1400</u>	<u>17' to 86' 6"</u>	

	X ₁ (R ₁)	X ₂ (R ₂)	Y ₁ (θ ₁)	Y ₂ (θ ₂)	Z ₁	Z ₂
SPECIFIED HOLE CORD.	<u>0</u>	<u>-25</u>	<u>-16</u>	<u>0</u>	<u>5</u>	<u>45</u>

ACTUAL HOLE LENGTH 86' 6"
 SPECIFIED DIA. 4"
 ACTUAL DIA. 4"

DRILL RIG & BIT TYPE Diamond 230 4" Dia. Plug

NOTES:

1. SUBSCRIPT 1 SIGNIFIES BEGINNING OF HOLE & SUBSCRIPT 2 SIGNIFIES END OF HOLE

COMMENTS _____

Start 10/6 w/ 4" core bit

WIPP
WASTE ISOLATION
PILOT PLANT

TITLE: DRILLING LOG



Sandia National Laboratories

PROCEDURE _____

REVISION 0

DATE 3/6/89
SHIFT Day

ROOM Q BRme
STATION _____

HOLE NO. QPP02
GAGE NO. _____
GAGE TYPE _____

TEAM DP SC RB
APPROVAL BAS
Q. A. [Signature]

3-6-89

TIME	DEPTH	REMARKS
0715/1440	0 to 74'3 1/2"	4" Depth
		Drilled 1 1/2" hole
		55" deep 3/23/89

	X ₁ (R ₁)	X ₂ (R ₂)	Y ₁ (θ ₁)	Y ₂ (θ ₂)	Z ₁	Z ₂
SPECIFIED HOLE CORD.	0	-7.5	-14	0	S	-25

ACTUAL HOLE LENGTH 78'10 1/2" SPECIFIED DIA. 4" ACTUAL DIA. 4"

DRILL RIG & BIT TYPE Diamac 330 - 4" Diamon Plug bit

NOTES:

- SUBSCRIPT 1 SIGNIFIES BEGINNING OF HOLE & SUBSCRIPT 2 SIGNIFIES END OF HOLE

COMMENTS Started hole with
4" case Bbl. 30"

4" hole depth 74'3 1/2"
Total hole depth 78'10 1/2"

3-5-89

	$X_1(R_1)$	$X_2(R_2)$	$Y_1(\theta_1)$	$Y_2(\theta_2)$	Z_1	Z_2
SPECIFIED HOLE CORD.	0	-75	-12	0	5	15

DRILL RIG & BIT TYPE Diamac 230 4" Dia. Plug

COMMENTS _____

4" 70' 2 1/4"
1 1/2" 76' 7 1/4" 3-23-89

**WIPP
WASTE ISOLATION
PILOT PLANT**

TITLE: DRILLING LOG



Sandia National Laboratories

PROCEDURE _____

REVISION 0

DATE 3/3/89
SHIFT SWING

ROOM QB Rm Rm
STATION _____

HOLE NO. QPP04
GAGE NO. _____
GAGE TYPE _____

TEAM SC, DP, RB
APPROVAL MS
Q. A. 1/11

TIME	DEPTH	REMARKS
1700 to 1930	0' to 75'	
3-4-89 0830 to 1000	45' to 75' 11"	4" Depth
	3-23-89	1 1/2" hole drilled to 55"

	X ₁ (R ₁)	X ₂ (R ₂)	Y ₁ (θ ₁)	Y ₂ (θ ₂)	Z ₁	Z ₂
SPECIFIED HOLE CORD	0	-75	-10	0	5	11

ACTUAL HOLE LENGTH 75' 11" SPECIFIED DIA. 4" ACTUAL DIA. 4"

DRILL RIG & BIT TYPE Diamond 230 4" Dia. Plug

NOTES:

- SUBSCRIPT 1 SIGNIFIES BEGINNING OF HOLE & SUBSCRIPT 2 SIGNIFIES END OF HOLE

COMMENTS

1 1/2 inch hole drilled from
75' 11" to 80' 6" on 3-23-89

WIPP WASTE ISOLATION PILOT PLANT	TITLE: CORE DRILLING DATA	<div style="display: flex; justify-content: space-between;"> <div> PROCEDURE <u>92</u> REVISION <u>0</u> </div> <div> LOG ID. _____ Q. A. _____ </div> </div>
---	----------------------------------	---

DATE <u>2/27/89</u> SHIFT <u>Day</u>	ROOM <u>Brine Room</u> STATION _____ MINE COORDINATES _____	HOLE NO. <u>QPP05</u>	TEAM <u>SLCH DP</u> APPROVAL <u>AS</u> Q. A. <u>[Signature]</u>
---	--	------------------------------	--

DRILL SPECS <u>Diamet 230</u> CORE BARREL SPECS <u>4" x 34"</u> DRILLING FLUID <u>Air</u>	HOLE DIA. <u>4"</u> (in) HOLE LENGTH <u>75' 6"</u> (ft)
--	--

HOLE LOCATION EXACT _____ APPROXIMATE _____			
COLLAR X_1 (or R) <u>0</u>	Y_1 (or θ) <u>-8</u>	Z_1 <u>5</u> (ft)	
BOTTOM: X_2 (or R) <u>-75</u>	Y_2 (or θ) <u>0</u>	Z_2 <u>8</u> (ft)	
HOLE COMPASS DIRECTION <u>West</u> ORIENTATION <u>Angle Up</u>			

DATE	SEGMENT OR BOX NUMBER	CORE INTERVAL (DEPTHS)		STORAGE LOCATION/REMARKS
		BEGINNING	END	
2-27-89	Run #1	0"	3.2"	4" Retrieved
2-28-89	#2	3.2"	48"	6" Retrieved
	#3	4'	6' 9"	22" "
	#4	6' 9"	9'	16' 9" to 9' 7"
	#5	9'	12' 10"	No Recovery
	#6	12' 10"	15' 6"	
	#7	15' 6"	18' 2"	
	#8	18' 2"	20' 8"	
	#9	20' 8"	23' 6"	
	#10	23' 6"	25' 9"	
3-1-89	#11	25' 9"	28' 7"	
	#12	28' 7"	30' 6"	Lost 5" of Core
	#13	31' 1"	33' 11.5"	
	#14	33' 11.5"	37' 5"	
	#15	37' 5"	41' 10"	Recovered 30"

COMMENTS Salt is very clear in core area. Its very brittle and is breaking up and being blown out of the hole. First 5 Runs.

-OVER-

WIPP
WASTE ISOLATION
PILOT PLANT

TITLE: DRILLING LOG



Sandia National Laboratories

PROCEDURE _____

REVISION 0

DATE 2/21/89
SHIFT Day
Swing

ROOM Brine Room
STATION _____

HOLE NO. QPD11
GAGE NO. _____
GAGE TYPE _____

TEAM DP, RB, HF, SC
APPROVAL BTS
Q. A. [Signature]

2-22-89

TIME	DEPTH	REMARKS
1330 to 1930	0' to 65'	
0900 to 1330	65' to 87' 5"	

	$X_1(R_1)$	$X_2(R_2)$	$Y_1(\theta_1)$	$Y_2(\theta_2)$	Z_1	Z_2
SPECIFIED HOLE CORD.	0	-75	-16	0	-3	-45

ACTUAL HOLE LENGTH 87' 5" SPECIFIED DIA. 4" ACTUAL DIA. 4"

DRILL RIG & BIT TYPE Diamec 270 4" Dia Plug

NOTES:

- SUBSCRIPT 1 SIGNIFIES BEGINNING OF HOLE & SUBSCRIPT 2 SIGNIFIES END OF HOLE

COMMENTS _____

DE 1

2-18-89
2-24-89

2-18-89
2-24-89

2-18-89
2-24-89

2-18-89
2-24-89


2-18-89
2-24-89

2-18-89
2-24-89

2-18-89
2-24-89

**WIPP
WASTE ISOLATION
PILOT PLANT**

TITLE: DRILLING LOG

 Sandia National Laboratories
PROCEDURE _____
REVISION 0

DATE 2/15/89
SHIFT Day
Swing

ROOM Brine Room
STATION _____

HOLE NO. QPP14
GAGE NO. _____
GAGE TYPE _____

TEAM SLDP, GH
APPROVAL RLS
Q. A. [Signature]

TIME	DEPTH	REMARKS
1230 / 1930	0' to 71' 6"	4" Hole Depth
2-24-89 1830 / 1730	71' 6" to 76' 1"	1 1/2" Hole Drilled at Bottom of 4" Hole

	X ₁ (R ₁)	X ₂ (R ₂)	Y ₁ (θ ₁)	Y ₂ (θ ₂)	Z ₁	Z ₂
SPECIFIED HOLE CORD.	0	-75	-10	0	-3	-11

ACTUAL HOLE LENGTH 76' 1" SPECIFIED DIA. 4" ACTUAL DIA. 4"

DRILL RIG & BIT TYPE Diameter 230 4" Dia. Plus
1 1/2" Dia. Plus

NOTES:

- SUBSCRIPT 1 SIGNIFIES BEGINNING OF HOLE & SUBSCRIPT 2 SIGNIFIES END OF HOLE

COMMENTS

71' 6" Deep 4" Hole
55" Deep 1 1/2" Hole

WIPP WASTE ISOLATION PILOT PLANT	TITLE: DRILLING LOG	Sandia National Laboratories PROCEDURE _____ REVISION <u>0</u>
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DATE <u>2/7/89</u> SHIFT <u>Days</u>	ROOM <u>Brine Room</u> STATION _____	HOLE NO. <u>QPP15</u> GAGE NO. _____ GAGE TYPE _____	TEAM <u>SC, DP, GH</u> APPROVAL <u>ATS</u> Q. A. <u>[Signature]</u>
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	TIME	DEPTH	REMARKS
	1440 / 1500	0' to 29"	Light source and laser
2-8-89	0930 / 1330	2'5" to 47.5'	Survey skewed hole to
2-9-89	0930 / 1000	47.5' to 52.5'	be online and straight.
	1210 / 1415	52.5' to 69'2"	
2-27-89	0930 to 1000	69'2" to 75'7"	Extend hole 77" x 1 1/2"

	X ₁ (R ₁)	X ₂ (R ₂)	Y ₁ (θ ₁)	Y ₂ (θ ₂)	Z ₁	Z ₂
SPECIFIED HOLE CORD.	0	-75	-8	0	-3	-8

ACTUAL HOLE LENGTH	<u>69'2"</u> <u>75'7"</u>	SPECIFIED DIA.	<u>4"</u>	ACTUAL DIA.	<u>4"</u>
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DRILL RIG & BIT TYPE	<u>Diamco 230</u> <u>4" Dia. Plug</u> <u>Started hole with 4" x 32" Dia. Core BBL.</u>
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NOTES:

- SUBSCRIPT 1 SIGNIFIES BEGINNING OF HOLE & SUBSCRIPT 2 SIGNIFIES END OF HOLE

COMMENTS

Angle Down hole

Started hole w/ core barrel
so 4" bit would start
straight.

Ventilation problems in
Room.

1 1/2" hole 77"

WIPP
WASTE ISOLATION
PILOT PLANT

TITLE: DRILLING LOG



Sandia National Laboratories

PROCEDURE _____

REVISION 0

DATE 3/13/89
SHIFT Days

ROOM Q-Brine Room
STATION _____

HOLE NO. QPP21
GAGE NO. _____
GAGE TYPE _____

TEAM SCRL DP
APPROVAL BTS
Q. A. JP

TIME	DEPTH	REMARKS
3-13 ⁵⁹ 1330 to	0' to	
3-15 ⁵⁹ 1415	85' 5 1/2"	

	X ₁ (R ₁)	X ₂ (R ₂)	Y ₁ (θ ₁)	Y ₂ (θ ₂)	Z ₁	Z ₂
SPECIFIED HOLE CORD.	0	-75	16	45	2.62	0

ACTUAL HOLE LENGTH 80' 5 1/2" SPECIFIED DIA. 4" ACTUAL DIA. 4"

DRILL RIG & BIT TYPE Diamac 230 4" Dia. Plug

NOTES:

1. SUBSCRIPT 1 SIGNIFIES BEGINNING OF HOLE & SUBSCRIPT 2 SIGNIFIES END OF HOLE

COMMENTS _____

4" hole only
NO 1 1/2" Reg.

WIPP
WASTE ISOLATION
PILOT PLANT

TITLE: DRILLING LOG



Sandia National Laboratories

PROCEDURE _____

REVISION 0

DATE 3/11/89
SHIFT 1001/5

ROOM Q Brine Rm
STATION _____

HOLE NO. QPP22
GAGE NO. _____
GAGE TYPE _____

TEAM DP FP RB
APPROVAL BAS
Q. A. ggt

	TIME	DEPTH	REMARKS
3/11/89	1410	0	
	1450	25'	
3/13/89	0830 to 1100	25' to 71' 3"	4" hole
3-20-89	1000 to 1020	71' 3" to 75' 10"	drilled 1 1/2" dia back of 4"

	X ₁ (R ₁)	X ₂ (R ₂)	Y ₁ (θ ₁)	Y ₂ (θ ₂)	Z ₁	Z ₂
SPECIFIED HOLE CORD.	0	-75	14	25	2.62	0

ACTUAL HOLE LENGTH 75' 10" SPECIFIED DIA. 4" ACTUAL DIA. 4"

DRILL RIG & BIT TYPE Diamond 230 4" diamond plug

NOTES:

- SUBSCRIPT 1 SIGNIFIES BEGINNING OF HOLE & SUBSCRIPT 2 SIGNIFIES END OF HOLE

COMMENTS started hole w/ 4"
core bbl. 30"

4" hole depth 71' 3"

1 1/2" hole depth 75' 10" 3-20-89

WIPP WASTE ISOLATION PILOT PLANT	TITLE: DRILLING LOG	Sandia National Laboratories PROCEDURE _____ REVISION <u>0</u>
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DATE <u>3/11/89</u> SHIFT <u>Day</u>	ROOM <u>QBrine Rm</u> STATION _____	HOLE NO. <u>QPP23</u> GAGE NO. _____ GAGE TYPE _____	TEAM <u>DP FPRB</u> APPROVAL <u>ATS</u> Q. A. <u>[Signature]</u>
---	--	--	--

	TIME	DEPTH	REMARKS
3/11/89	0945	0	
	1145	68' 8 1/2"	
3-20-89	1100 to 1120	68' 0' 1/4" to 75' 1' 1/4"	Drilled 77" 1 1/2" Dia back of 4" hole

	X ₁ (R ₁)	X ₂ (R ₂)	Y ₁ (θ ₁)	Y ₂ (θ ₂)	Z ₁	Z ₂
SPECIFIED HOLE CORD.	0	-75	12	15	2.62	0

ACTUAL HOLE LENGTH	<u>75' 1 1/4"</u>	SPECIFIED DIA.	<u>4"</u>	ACTUAL DIA.	<u>4"</u>
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DRILL RIG & BIT TYPE	<u>Diamond 230 4" Diamond plug</u>
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NOTES:

1. SUBSCRIPT 1 SIGNIFIES BEGINNING OF HOLE & SUBSCRIPT 2 SIGNIFIES END OF HOLE

COMMENTS Started hole w/
4" core bbl. 30"

4" hole depth 68' 8 1/2"

1 1/2" hole depth 75' 1 1/4"
on 3-20-89

WIPP WASTE ISOLATION PILOT PLANT	TITLE: DRILLING LOG	 Sandia National Laboratories

DATE <u>3/10/89</u> SHIFT <u>Day</u>	ROOM <u>Q. Berne Room</u> STATION _____	HOLE NO. <u>QPP24</u> GAGE NO. _____ GAGE TYPE _____	TEAM <u>DP SL RL</u> APPROVAL <u>BAS</u> Q. A. <u>JRJ</u>
---	--	--	---

	TIME	DEPTH	REMARKS
3/10/89	14:40	0	
	18:50	70' 5 1/2"	Drill 55' deep 1 1/2" hole
3/21/89			in back of 4" hole

	X ₁ (R ₁)	X ₂ (R ₂)	Y ₁ (θ ₁)	Y ₂ (θ ₂)	Z ₁	Z ₂
SPECIFIED HOLE CORD.	0	-75	10	11	2.62	0

ACTUAL HOLE LENGTH <u>75' 1/2"</u> SPECIFIED DIA. <u>4"</u> ACTUAL DIA. <u>4"</u>

DRILL RIG & BIT TYPE <u>Diamac 23D - 4" Diamond Plug</u>
--

NOTES: 1. SUBSCRIPT 1 SIGNIFIES BEGINNING OF HOLE & SUBSCRIPT 2 SIGNIFIES END OF HOLE

COMMENTS <u>started hole w/</u> <u>4" Core Bbl. 3D"</u> <u>4" hole Depth 70' 5 1/2"</u> <u>1 1/2" hole Depth 75' 1/2" on</u> <u>3/21/89</u>
--

WIPP
WASTE ISOLATION
PILOT PLANT

TITLE: DRILLING LOG



Sandia National Laboratories

PROCEDURE _____

REVISION 0

DATE 3/10/89
SHIFT Day

ROOM Q Brine Room
STATION _____

HOLE NO. GPP25
GAGE NO. _____
GAGE TYPE _____

TEAM DP SC RL
APPROVAL BYS
Q. A. gr1

	TIME	DEPTH	REMARKS
3/10/89	09:45	0	Started hole w/ 4" core Bbl.
	13:15	68' 7 1/2"	30" depth.
3/21/89			Drilled 57" in BACK of 4" hole

	X ₁ (R ₁)	X ₂ (R ₂)	Y ₁ (θ ₁)	Y ₂ (θ ₂)	Z ₁	Z ₂
SPECIFIED HOLE CORD.	0	75	8	8	262	0

ACTUAL HOLE LENGTH 68' 7 1/2" SPECIFIED DIA. 4" ACTUAL DIA. 4"

DRILL RIG & BIT TYPE Diamet 230 - 4" Diamond Plug

NOTES.

- SUBSCRIPT 1 SIGNIFIES BEGINNING OF HOLE & SUBSCRIPT 2 SIGNIFIES END OF HOLE

COMMENTS Drilled 30" w/ 4" core
burrer - hole wet at 24"

4" hole depth 68' 7 1/2"
1 1/2" hole depth 75' 1/2" on
3-21-89

BOYLES BROS.
SALT LAKE CITY, UTAH

HOLE NUMBER: 09P05

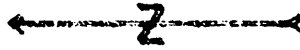
JOB NUMBER: 32-0255-12

INTRUN SURVEY
BY MINIMUM CURVATURE

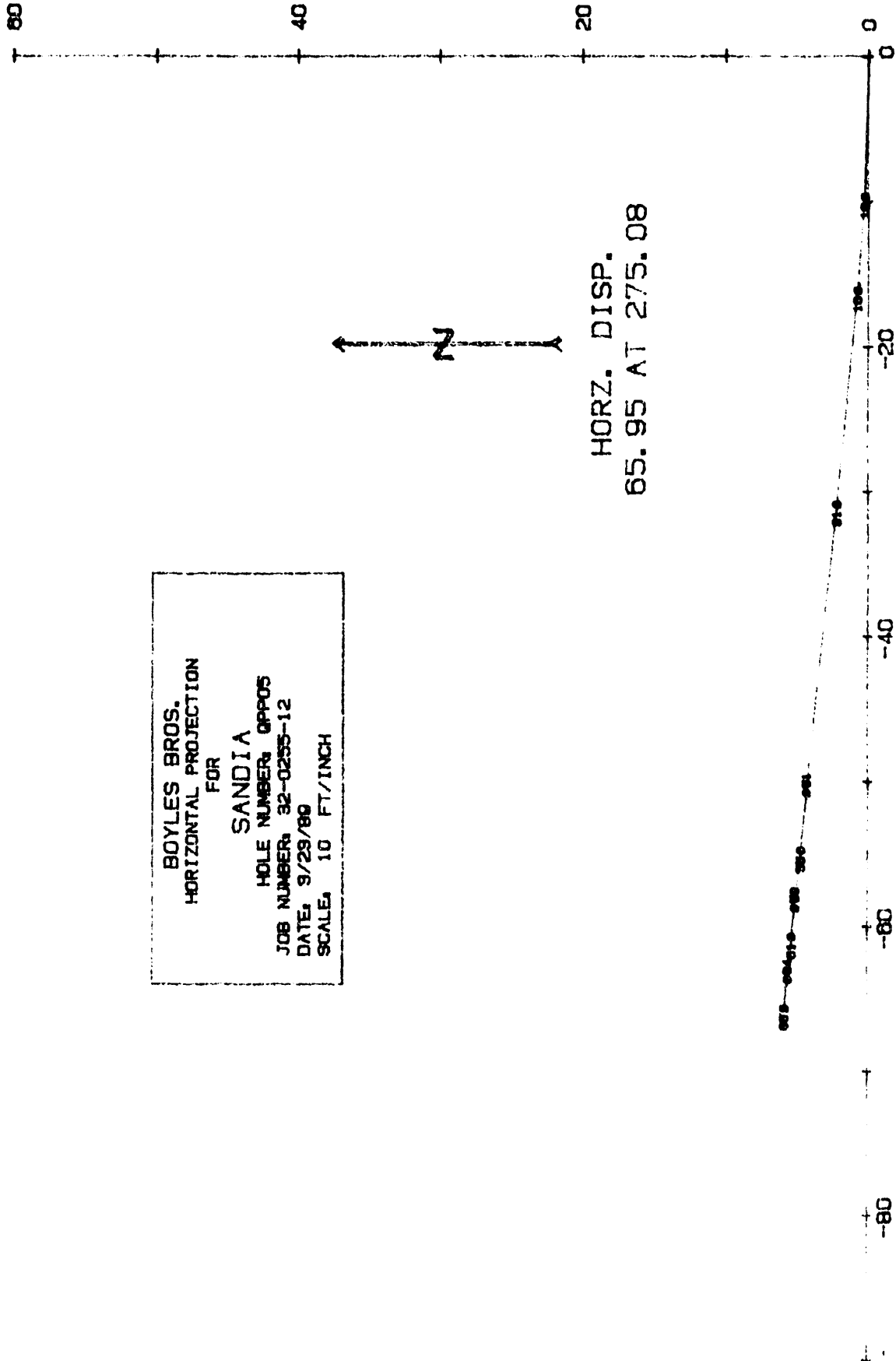
MEAS. DEPTH	VERT DEPTH	VERT. SECT.	INCL	BEARING AZIMUTH	COORDINATES LATITUDE	DEPARTURE	D-LEG /100	D-LEG /CL	STATION DISP.	DISPLACEMENT DIRECTION
0.0	0.00	0.00	91.50	269.00	0.00 N	0.00 E	0.00		0.00	AT 000.00
2.3	-0.06	2.33	91.50	269.00	0.04 S	2.33 W	0.00	0.00	2.33	AT 269.00
9.7	-0.25	9.66	91.50	274.00	0.15 N	9.66 W	68.10	5.00	9.66	AT 270.90
16.2	-0.42	16.13	91.50	275.00	0.66 N	16.14 W	15.38	1.00	16.15	AT 272.35
31.0	-0.81	30.85	91.50	276.00	2.08 N	30.90 W	6.74	1.00	30.97	AT 273.86
51.0	-1.42	50.70	92.00	276.00	4.17 N	50.78 W	2.50	0.50	50.95	AT 274.70
55.0	-1.51	54.67	90.50	276.00	4.59 N	54.75 W	37.50	1.50	54.95	AT 274.79
59.0	-1.58	58.63	91.50	276.00	5.01 N	58.73 W	25.00	1.00	58.94	AT 274.87
61.0	-1.62	60.62	91.00	276.00	5.22 N	60.72 W	25.00	0.50	60.94	AT 274.91
64.0	-1.66	63.60	90.50	276.00	5.53 N	63.70 W	16.67	0.50	63.94	AT 274.96
66.0	-1.69	65.58	91.00	276.00	5.74 N	65.69 W	25.00	0.50	65.94	AT 274.99

* THE HORIZONTAL DISPLACEMENT AT THE DEPTH OF *
* *****
* *****
* 66.0 FEET EQUALS 65.74 FEET AT 274.99 *
* *****

BOYLES BROS.
HORIZONTAL PROJECTION
FOR
SANDIA
HOLE NUMBER: 32-0255-12
JOB NUMBER: 32-0255-12
DATE: 9/29/86
SCALE: 10 FT/INCH



HORZ. DISP.
65.95 AT 275.08



BOYLES BROS.
SALT LAKE CITY,UTAH

MAGNETIC DIRECTIONAL SURVEY
BY MINIMUM CURVATURE

FDR

* SANDIA *

JOB NUMBER: 82-0255-12

HOLE NUMBER: 0FF05

LOCATION: CARLSBAD NM

SURVEY DATE: 3/23/89

SURVEY ENGINEER: E. STENSON

MAGNETIC DECLINATION: 10.00E

TIE-ON COORDINATES AT: 0 M.D.

VERTICAL SECTION CALCULATED IN A
PROFOSAL DIRECTION OF: S89-00W

***** DEPTH MEASURED IN FEET *****

COMMENTS: COMPLETION REPORT FROM SINGLE
SHOT SURVEYS TAKEN BY
B. STENSON

***** THIS DIRECTIONAL SURVEY REPORT IS *****
***** CORRECT TO THE BEST OF MY KNOWLEDGE *****
***** AND IS SUPPORTED BY ACTUAL FIELD DATA *****

***** *Maynard St. hay* *****
***** COMPANY REPRESENTATIVE *****

CALCULATIONS:

DATE 3/10/82 **ROOM** 5
SHIFT Day **STATION** ---
TIME 13:00

HOLE NO. GPR01 **TEAM** TAB DG
GAGE NO. --- **APPROVAL** [Signature]
GAGE TYPE --- **O. A.** ---

$\sqrt{(2.5)^2 + (1.5)^2} = 3.535$
 $\tan^{-1} \left(\frac{3.535}{3.00} \right) = 66.1^\circ$

LASER ALIGNMENT

DEPTH FROM COLLAR	2 1/2"	3"	4"	5"	6"	7"	8"	9"	10"	11"	12"
LIGHT-SOURCE PATTERN	○	○	○	○	○	○	○	○	○	○	○
DEPTH FROM COLLAR	1"	2"	3"	4"	5"	6"	7"	8"	9"	10"	11"
LIGHT-SOURCE PATTERN	○	○	○	○	○	○	○	○	○	○	○

LIGHT SOURCE

1. BOREHOLE COLLAR LOCATION: ±1 INCH

2. BOREHOLE DIAMETER (NON STRESS GAGE): ±0.1 INCH

3. BOREHOLE DIAMETER (STRESS GAGE): ±0.01 INCH

4. BOREHOLE DEPTH: +0.75 FEET, -0.0 FEET

5. BOREHOLE ORIENTATION: HOLE MUST BE CONTAINED WITHIN A 1° ENVELOPE STARTING AT COLLAR

6. LIGHT MUST BE VISIBLE AT BOTTOM OF HOLE

IN SPEC? Y

IN SPEC? Y

IN SPEC? Y

IN SPEC? Y

IN SPEC? Y

IN SPEC? Y

SPECIFICATIONS

<p>CALCULATIONS:</p> <p style="text-align: center;">LASER ALIGNMENT</p>	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%;">DATE <u>3/21/88</u></td> <td style="width: 50%;">ROOM <u> </u></td> </tr> <tr> <td>SHIFT <u>Day</u></td> <td>STATION <u> </u></td> </tr> <tr> <td>TIME <u>09:18</u></td> <td></td> </tr> <tr> <td>HOLE NO. <u>QPP2</u></td> <td>TEAM <u>TAB DG</u></td> </tr> <tr> <td>GAGE NO. <u> </u></td> <td>APPROVAL <u>BAS</u></td> </tr> <tr> <td>GAGE TYPE <u> </u></td> <td>O. A. <u>[Signature]</u></td> </tr> </table> $X = \sqrt{(1.5)^2 + (1.5)^2} = 1.58$ $X = \tan^{-1} \left(\frac{1.58}{361.25} \right) = 0.293^\circ$	DATE <u>3/21/88</u>	ROOM <u> </u>	SHIFT <u>Day</u>	STATION <u> </u>	TIME <u>09:18</u>		HOLE NO. <u>QPP2</u>	TEAM <u>TAB DG</u>	GAGE NO. <u> </u>	APPROVAL <u>BAS</u>	GAGE TYPE <u> </u>	O. A. <u>[Signature]</u>
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<p>LIGHT SOURCE</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20%;">DEPTH FROM COLLAR</td> <td style="width: 80%;"> <div style="display: flex; justify-content: space-around;"> 74.3" </div> </td> </tr> <tr> <td>LIGHT-SOURCE PATTERN</td> <td> <div style="display: flex; justify-content: space-around;"> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px; display: flex; align-items: center; justify-content: center;">0</div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; 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LIGHT-SOURCE PATTERN	<div style="display: flex; justify-content: space-around;"> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px; display: flex; align-items: center; justify-content: center;">0</div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> </div>												
DEPTH FROM COLLAR	<div style="display: flex; justify-content: space-around;"> </div>												
LIGHT-SOURCE PATTERN	<div style="display: flex; justify-content: space-around;"> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> </div>												
DEPTH FROM COLLAR	<div style="display: flex; justify-content: space-around;"> </div>												
LIGHT-SOURCE PATTERN	<div style="display: flex; justify-content: space-around;"> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> <div style="border: 1px solid black; border-radius: 50%; width: 20px; height: 20px;"></div> </div>												

<p>SPECIFICATIONS</p> <ol style="list-style-type: none"> 1. BOREHOLE COLLAR LOCATION: ±1 INCH 2. BOREHOLE DIAMETER (NON STRESS GAGE): ±0.1 INCH 3. BOREHOLE DIAMETER (STRESS GAGE): ±0.01 INCH 4. BOREHOLE DEPTH: -0.75 FEET, -0.0 FEET 5. BOREHOLE ORIENTATION: HOLE MUST BE CONTAINED WITHIN A 1° ENVELOPE STARTING AT COLLAR 6. LIGHT MUST BE VISIBLE AT BOTTOM OF HOLE 	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%;">IN SPEC? <u> </u></td> <td style="width: 50%;">IN SPEC? <u> </u></td> </tr> <tr> <td>IN SPEC? <u> </u></td> <td>IN SPEC? <u> </u></td> </tr> <tr> <td>IN SPEC? <u> </u></td> <td>IN SPEC? <u> </u></td> </tr> <tr> <td>IN SPEC? <u> </u></td> <td>IN SPEC? <u> </u></td> </tr> <tr> <td>IN SPEC? <u> </u></td> <td>IN SPEC? <u> </u></td> </tr> <tr> <td>IN SPEC? <u> </u></td> <td>IN SPEC? <u> </u></td> </tr> </table>	IN SPEC? <u> </u>	IN SPEC? <u> </u>	IN SPEC? <u> </u>	IN SPEC? <u> </u>	IN SPEC? <u> </u>	IN SPEC? <u> </u>	IN SPEC? <u> </u>	IN SPEC? <u> </u>	IN SPEC? <u> </u>	IN SPEC? <u> </u>	IN SPEC? <u> </u>	IN SPEC? <u> </u>
IN SPEC? <u> </u>	IN SPEC? <u> </u>												
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IN SPEC? <u> </u>	IN SPEC? <u> </u>												
IN SPEC? <u> </u>	IN SPEC? <u> </u>												

CALCULATIONS:

↑ up
N ←

DATE <u>3/7/82</u>	ROOM _____
SHIFT <u>Day</u>	STATION _____
TIME <u>09/12</u>	
HOLE NO. <u>QPP 3</u>	TEAM <u>788 DG</u>
GAGE NO. <u>-</u>	APPROVAL <u>AS</u>
GAGE TYPE <u>-</u>	Q. A. <u>[Signature]</u>

$$X = \tan^{-1} \left(\frac{3.00}{356} \right) = 0.482^\circ$$

$$x = T_{AN} - 1 \left(\frac{3.00}{3.56} \right) = 0.482^\circ$$

[illegible]

SPECIFICATIONS

1. BOREHOLE COLLAR LOCATION: ± 1 INCH
2. BOREHOLE DIAMETER (NON STRESS GAGE): ± 0.1 INCH
3. BOREHOLE DIAMETER (STRESS GAGE): ± 0.01 INCH
4. BOREHOLE DEPTH: $+0.75$ FEET, -0.0 FEET
5. BOREHOLE ORIENTATION: HOLE MUST BE CONTAINED WITHIN A 1° ENVELOPE STARTING AT COLLAR
6. LIGHT MUST BE VISIBLE AT BOTTOM OF HOLE

IN SPEC?	_____
IN SPEC?	_____
IN SPEC?	_____
IN SPEC?	<u>YES</u>
IN SPEC?	_____
IN SPEC?	<u>YES</u>
IN SPEC?	<u>YES</u>

IN SPEC?	_____
IN SPEC?	_____
IN SPEC?	_____
IN SPEC?	<u>No</u>
IN SPEC?	<u>Yes</u>
IN SPEC?	<u>Yes</u>

1. BOREHOLE COLLAR LOCATION: ± 1 INCH
2. BOREHOLE DIAMETER (NON STRESS GAGE): ± 0.1 INCH
3. BOREHOLE DIAMETER (STRESS GAGE): ± 0.01 INCH
4. BOREHOLE DEPTH: ± 0.75 FEET, -0.0 FEET
5. BOREHOLE ORIENTATION: HOLE MUST BE CONTAINED WITHIN A 1° ENVELOPE STARTING AT COLLAR
6. LIGHT MUST BE VISIBLE AT BOTTOM OF HOLE

1.	BOREHOLE COLLAR LOCATION: ±1 INCH	IN SPEC?	_____
2.	BOREHOLE DIAMETER (NON STRESS GAGE): ±0.1 INCH	IN SPEC?	_____
3.	BOREHOLE DIAMETER (STRESS GAGE): ±0.01 INCH	IN SPEC?	_____
4.	BOREHOLE DEPTH: +0.75 FEET, -0.0 FEET	IN SPEC?	<u>No</u>
5.	BOREHOLE ORIENTATION: HOLE MUST BE CONTAINED WITHIN A 1° ENVELOPE STARTING AT COLLAR	IN SPEC?	<u>Yes</u>
6.	LIGHT MUST BE VISIBLE AT BOTTOM OF HOLE	IN SPEC?	<u>Yes</u>

LASER ALIGNMENT

CALCULATIONS:

$$D = \sqrt{(2^2) + (3^2)} = 4.414"$$

$$\tan^{-1} \left(\frac{4.414}{4.14} \right) = 61.0^\circ$$

DATE 3/3/82
SHIFT Day
TIME 13/45

ROOM G
STATION -

HOLE NO. Q2205
GAGE NO. -
GAGE TYPE -

TEAM THB LT
APPROVAL [Signature]
Q. A. -

DEPTH FROM COLLAR	68' 11.5"	63' 11.5"	59' 8 1/2"	55' 8 1/2"	51' 8 1/2"	47' 8 1/2"	43' 8 1/2"	39' 8 1/2"	35' 8 1/2"	31' 8 1/2"	27' 8 1/2"	23' 8 1/2"	19' 8 1/2"	15' 8 1/2"	11' 8 1/2"	7' 8 1/2"	3' 8 1/2"
LIGHT-SOURCE PATTERN	[Pattern]	[Pattern]	[Pattern]	[Pattern]	[Pattern]	[Pattern]	[Pattern]	[Pattern]	[Pattern]	[Pattern]	[Pattern]	[Pattern]	[Pattern]	[Pattern]	[Pattern]	[Pattern]	[Pattern]
DEPTH FROM COLLAR																	
LIGHT-SOURCE PATTERN	[Pattern]	[Pattern]	[Pattern]	[Pattern]	[Pattern]	[Pattern]	[Pattern]	[Pattern]	[Pattern]	[Pattern]	[Pattern]	[Pattern]	[Pattern]	[Pattern]	[Pattern]	[Pattern]	[Pattern]

SPECIFICATIONS

1. BOREHOLE COLLAR LOCATION: ±1 INCH
2. BOREHOLE DIAMETER (NON STRESS GAGE): ±0.1 INCH
3. BOREHOLE DIAMETER (STRESS GAGE): ±0.01 INCH
4. BOREHOLE DEPTH: +0.75 FEET, -0.0 FEET
5. BOREHOLE ORIENTATION: HOLE MUST BE CONTAINED WITHIN A 1° ENVELOPE STARTING AT COLLAR
6. LIGHT MUST BE VISIBLE AT BOTTOM OF HOLE

IN SPEC? -

IN SPEC? -

IN SPEC? -

IN SPEC? Yes

IN SPEC? Yes

IN SPEC? N.D.

IN SPEC? -

IN SPEC? -

IN SPEC? -

IN SPEC? Yes

IN SPEC? Yes

IN SPEC? N.D.

LASER ALIGNMENT

CALCULATIONS:

\swarrow
 $N \leftarrow$
 \searrow

$TAN^{-1} \left(\frac{.23}{30.17} \right) = .436^\circ$

DATE <u>2/24/82</u>	ROOM <u> </u>
SHIFT <u>Day</u>	STATION <u> </u>
TIME <u>08:27</u>	
HOLE NO. <u>QPP12</u>	TEAM <u>THS DG</u>
GAGE NO. <u> </u>	APPROVAL <u> </u>
GAGE TYPE <u> </u>	Q. A. <u> </u>

DEPTH FROM COLLAR	74' 7 1/2"										
LIGHT-SOURCE PATTERN											
DEPTH FROM COLLAR											
LIGHT-SOURCE PATTERN											

<p>SPECIFICATIONS</p> <ol style="list-style-type: none"> BOREHOLE COLLAR LOCATION: ±1 INCH BOREHOLE DIAMETER (NON STRESS GAGE): ±0.1 INCH BOREHOLE DIAMETER (STRESS GAGE): ±0.01 INCH BOREHOLE DEPTH: +0.75 FEET, -0.0 FEET BOREHOLE ORIENTATION: HOLE MUST BE CONTAINED WITHIN A 1° ENVELOPE STARTING AT COLLAR LIGHT MUST BE VISIBLE AT BOTTOM OF HOLE 	<p>IN SPEC? <u> </u></p> <p>IN SPEC? <u> </u></p> <p>IN SPEC? <u> </u></p> <p>IN SPEC? <u>Yes</u></p> <p>IN SPEC? <u>Yes</u></p> <p>IN SPEC? <u>Yes</u></p>
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CALCULATIONS:

$TAN^{-1} \left(\frac{0.2 + 0.05}{29.29} \right)$

DATE <u>2/22/87</u>	ROOM <u>7</u>	STATION <u>---</u>
SHIFT <u>Day</u>		
TIME <u>8:30</u>	TEAM <u>IRB LT</u>	APPROVAL <u>AS</u>
HOLE NO. <u>QPP13</u>	O. A. <u>---</u>	
GAGE NO. <u>---</u>		
GAGE TYPE <u>---</u>		

.489°

[illegible]

1.	BOREHOLE COLLAR LOCATION: ±1 INCH	IN SPEC?	—
2.	BOREHOLE DIAMETER (NON STRESS GAGE): ±0.1 INCH	IN SPEC?	—
3.	BOREHOLE DIAMETER (STRESS GAGE): ±0.01 INCH	IN SPEC?	—
4.	BOREHOLE DEPTH: +0.75 FEET, -0.0 FEET	IN SPEC?	Yes
5.	BOREHOLE ORIENTATION: HOLE MUST BE CONTAINED WITHIN A 1° ENVELOPE STARTING AT COLLAR	IN SPEC?	Yes
6.	LIGHT MUST BE VISIBLE AT BOTTOM OF HOLE	IN SPEC?	Yes

LAZER ALIGNMENT

CALCULATIONS:

$\tan^{-1} \left(\frac{.27}{30.59} \right) = .50^\circ$

DATE <u>2/17/82</u>	ROOM <u>Q</u>
SHIFT <u>Day</u>	STATION <u>-</u>
TIME <u>10:08</u>	

HOLE NO. <u>QPR14</u>	TEAM <u>TRG DG</u>
GAGE NO. <u>-</u>	APPROVAL <u>BAS</u>
GAGE TYPE <u>-</u>	O. A. <u>[Signature]</u>

DEPTH FROM COLLAR	71' 6"										
LIGHT-SOURCE PATTERN	○	○	○	○	○	○	○	○	○	○	○

DEPTH FROM COLLAR											
LIGHT-SOURCE PATTERN	○	○	○	○	○	○	○	○	○	○	○

SPECIFICATIONS	IN SPEC? <u>Yes</u>
1. BOREHOLE COLLAR LOCATION: ±1 INCH	IN SPEC? <u>-</u>
2. BOREHOLE DIAMETER (NON STRESS GAGE): ±0.1 INCH	IN SPEC? <u>-</u>
3. BOREHOLE DIAMETER (STRESS GAGE): ±0.01 INCH	IN SPEC? <u>Yes</u>
4. BOREHOLE DEPTH: +0.75 FEET, -0.0 FEET	IN SPEC? <u>Yes</u>
5. BOREHOLE ORIENTATION: HOLE MUST BE CONTAINED WITHIN A 1° ENVELOPE STARTING AT COLLAR	IN SPEC? <u>Yes</u>
6. LIGHT MUST BE VISIBLE AT BOTTOM OF HOLE	IN SPEC? <u>Yes</u>

<p>LASER ALIGNMENT</p>	<p>CALCULATIONS:</p>	<p>DATE <u>3/22/82</u> ROOM <u>Q</u> SHIFT <u>Day</u> STATION <u> </u> TIME <u>08:30</u></p>
	<p>HOLE NO. <u>QPPZ1</u> TEAM <u>TAB DG</u> GAGE NO. <u> </u> APPROVAL <u> </u> GAGE TYPE <u> </u> Q.A. <u> </u></p>	<p>$\sqrt{(2.5)^2 + (10.5)^2} = 10.7"$ $TAN^{-1} \left(\frac{10.7}{843.7} \right) = 0.72^\circ$</p>

<p>LIGHT SOURCE</p>	<p>DEPTH FROM COLLAR <u>80' 6"</u></p>	
<p>LIGHT SOURCE</p>	<p>DEPTH FROM COLLAR <u> </u></p>	

<p>SPECIFICATIONS</p>	<p>1. BOREHOLE COLLAR LOCATION: ± 1 INCH IN SPEC? <u> </u> 2. BOREHOLE DIAMETER (NON STRESS GAGE): ± 0.1 INCH IN SPEC? <u> </u> 3. BOREHOLE DIAMETER (STRESS GAGE): ± 0.01 INCH IN SPEC? <u> </u> 4. BOREHOLE DEPTH: $+0.75$ FEET, -0.0 FEET IN SPEC? <u>YES</u> 5. BOREHOLE ORIENTATION: HOLE MUST BE CONTAINED WITHIN A 1° ENVELOPE STARTING AT COLLAR IN SPEC? <u>YES</u> 6. LIGHT MUST BE VISIBLE AT BOTTOM OF HOLE IN SPEC? <u>YES</u></p>
------------------------------	--

IN SPEC?	_____
IN SPEC?	_____
IN SPEC?	_____
IN SPEC?	<u>Yes</u>

IN SPEC?	<u>Yes</u>
IN SPEC?	<u>Yes</u>

DATE <u>3 / 14 / 84</u>	ROOM <u>5</u>
SHIFT <u>Day</u>	STATION <u>-</u>
TIME <u>13 / 10</u>	

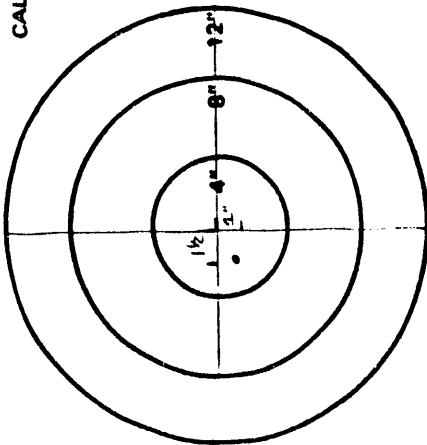
HOLE NO. <u>QRP 23</u>	TEAM <u>TAB DG</u>
GAGE NO. <u>-</u>	APPROVAL <u>[Signature]</u>
GAGE TYPE <u>-</u>	O. A. <u>[Signature]</u>

HOLE NO.	QDP 23	TEAM	IRB DG
GAGE NO.	-	APPROVAL	<i>[Signature]</i>
GAGE TYPE	-	Q. A.	<i>[Signature]</i>

GAGE TYPE

$$D = \sqrt{1\frac{1}{2}z + 1^2} = 1.80$$

$$\tan^{-1} = \left(\frac{1.80}{392.5} \right) = 0.26$$



CALCULATIONS:

LASER ALIGNMENT

LIGHT SOURCE

[illegible][illegible]

SPECIFICATIONS

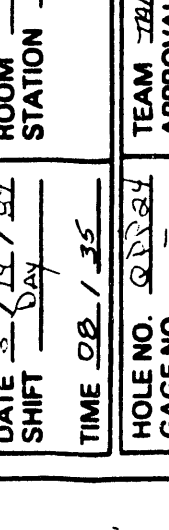
1. BOREHOLE COLLAR LOCATION: ± 1 INCH
2. BOREHOLE DIAMETER (NON STRESS GAGE): ± 0.1 INCH
3. BOREHOLE DIAMETER (STRESS GAGE): ± 0.01 INCH
4. BOREHOLE DEPTH: $+0.75$ FEET, -0.0 FEET
5. BOREHOLE ORIENTATION: HOLE MUST BE CONTAINED WITHIN A 1° ENVELOPE STARTING AT COLLAR
6. LIGHT MUST BE VISIBLE AT BOTTOM OF HOLE

IN SPEC?	_____
IN SPEC?	_____
IN SPEC?	_____
IN SPEC?	<u>Yes</u>

IN SPEC?	<u>Yes</u>
IN SPEC?	<u>Yes</u>

LASER ALIGNMENT

CALCULATIONS:



UP
6"

4 1/2"

N

$$D = \sqrt{(4.5)^2 + (6)^2} = 7.5$$

$$\tan^{-1} = \left(\frac{7.5}{4.5} \right) = 1.04^\circ$$

[illegible]

1. BOREHOLE COLLAR LOCATION: ± 1 INCH
 2. BOREHOLE DIAMETER (NON STRESS GAGE): ± 0.1 INCH
 3. BOREHOLE DIAMETER (STRESS GAGE): ± 0.01 INCH
 4. BOREHOLE DEPTH: $+0.75$ FEET, -0.0 FEET
 5. BOREHOLE ORIENTATION: HOLE MUST BE CONTAINED WITHIN A 1° ENVELOPE
 STARTING AT COLLAR
 6. LIGHT MUST BE VISIBLE AT BOTTOM OF HOLE

CALCULATIONS:

DATE 3/14/82 **ROOM** 108
SHIFT Day **STATION** 1

TIME 02:30

HOLE NO. QPR25 **TEAM** 108 DG
GAGE NO. — **APPROVAL** [Signature]
GAGE TYPE — **O. A.** [Signature]

$\tan^{-1} = \left(\frac{5.25}{414.5} \right) = .72^\circ$

[illegible]

SPECIFICATIONS

1. BOREHOLE COLLAR LOCATION: ± 1 INCH	IN SPEC? _____
2. BOREHOLE DIAMETER (NON STRESS GAGE): ± 0.1 INCH	IN SPEC? _____
3. BOREHOLE DIAMETER (STRESS GAGE): ± 0.01 INCH	IN SPEC? _____
4. BOREHOLE DEPTH: ± 0.75 FEET, -0.0 FEET	IN SPEC? <u>Yes</u>
5. BOREHOLE ORIENTATION: HOLE MUST BE CONTAINED WITHIN A 1° ENVELOPE STARTING AT COLLAR	IN SPEC? <u>Yes</u>
6. LIGHT MUST BE VISIBLE AT BOTTOM OF HOLE	IN SPEC? <u>Yes</u>

APPENDIX C: TEST OPERATIONAL LOGS



SSS-DPR-91-12902/R1

**OPERATIONAL LOG
Room Q Boreholes
QPP01-05, 11-15, 21-25**

**T. Barker
F. Howard
E. Peterson**

**Maxwell Laboratories, Inc.
S-Cubed Division
P.O. Box 1620
La Jolla, CA 92038-1620**

Revised: January 1992

Contract No. 66-2646

Prepared for

**Sandia National Laboratories
Albuquerque, New Mexico**

January 30, 1992

Mr. L. Jensen
Sandia National Laboratories
Organization No. 6344
P.O. Box 5800
Albuquerque, NM 87185

Dear Lee:

Two complete sets of floppy discs that contain the Room Q borehole data collected between April 25, 1989, and October 22, 1991 are enclosed. Data on these sets of discs are referred to either as "usable" or "all".

Data on the set of discs referred to as "usable" are *windowed* in that extraneous information has been removed. Deleted information include data collected during the time a system may have been removed from the borehole, brine accumulation data obtained during a shut-in test, closure values obtained during the period when the power supplies were not working properly, etc. These extraneous data are obtained because the data acquisition system continuously monitors all data channels. The *windowed* data were generated at the request of the SNL Delegated Representative acting at the time the data set was prepared. Operational activities that affect these Room Q data are described in the S-Cubed document SSS-DPR-91-12902R1. Plots showing the data included on these discs are provided in document SSS-DPR-91-12094R1. This set of information was previously transferred to Sandia in November 1991.

The set of discs referred to as "all" represent a complete set of *raw* data. Again, operational activities that affect these data are described in document SSS-DPR-91-1290R1. Plots showing the data included on this second set of discs are provided in document SSS-DPR-92-13051. Please note that when the Room Q data are taken, on approximate weekly intervals, from the hard



disc on the computer located in the Room Q alcove, two floppy discs are made. One disc, written to an ASCII file, is retained by SNL and one is sent to S-Cubed. Data included on the set of floppy discs labeled "all", generated in response to the request of the SNL Delegated Representative at the November 14, 1991 meeting with S-Cubed, are identical to the data contained on the set of discs retained by SNL.

Data on the 84 floppy discs include the test zone pressure (tzp), test zone packer pressure (tpp), brine accumulation (bin), on-axis closure (oac), cross-axis closure (cac), guard zone pressure (gzp), and guard zone packer pressure (gpp). As requested, the format on the discs is the same as for the previously transmitted sets. For each sample (logical record), the time in days, the calendar date, the time of day, and the measured parameter are written. The pressure is given in MPa, brine accumulation in cubic centimeters, and borehole diameter change (e.g. closure) in centimeters. The file names have the form QPPxx.var, where QPPxx denotes the Room Q hole identifier, and "var" is one of the previously identified variables. Note that the on-axis and cross-axis gauges are oriented in the vertical and horizontal directions respectively.

Sincerely yours,

A handwritten signature in cursive script, appearing to read 'E. W. Peterson'.

E. W. Peterson

- Enclosures: 1.) Windowed Data (Includes 42 floppy discs labeled "usable").
- 2.) Raw Data (Includes 42 floppy discs labeled "all").
- 3.) Document SSS-DPR-91-12902R1 titled "Operational Log, Room Q Boreholes QPP01-05, 11-15, 21-25".
- 4.) Document SSS-DPR-91-12904R1 titled "Summary of Room Q Windowed Data".
- 5.) Document SSS-DPR-92-13051 titled "Summary of Room Q Raw Data".

INTRODUCTION

Operational activities, conducted between April 25, 1989 and October 22, 1991, that affect the Room Q borehole data contained on the floppy disks sent to SNL, are described in this document. Plots of these data are provided in S-Cubed document SSS-DPR-91-12904/R1 and _____.

Abbreviations found in this document refer to the

- test region pressure (TZP), and
- brine accumulation data (BIN),
- guard region pressure (GZP),
- test region packer pressure (TPP),
- guard region packer pressure (GPP),
- cross-axis closure data (CAC), and
- on-axis closure data (OAC).

This document provides a log of those activities that produce observable changes in data. For example, these changes result from procedures such as:

- changing a packer pressure,
- the replacement of a power supply,
- the removal of a system from the borehole,
- the termination of a slow test and initiation of a shut-in test.

Note that the data acquisition system continuously monitors all data channels. As a result, the raw data current contained on disks retained by SNL QA include extraneous information such as data collected during the time a system may have been removed from the borehole, brine accumulation data collected during a shut-in test, closure data obtained during the period when the power supplies were not working properly, etc.

TEST HISTORY FOR ALL BOREHOLES

TEST HISTORY FOR ALL BOREHOLES

<u>DATE(s)</u>	<u>DAYS SINCE 4/25/89</u>	
4/25/89-5/6/89	0-11	Tests are initiated.
5/31/89	36	Pulse test. Test regions shut-in after test region pressure reset to ~5.6 MPa.
7/12/89-8/8/89	78-105	Mined Room Q. <ul style="list-style-type: none"> • Boreholes QPP01, 02, 11, 12, 21, and 22 test regions remain shut-in. • The QPP03, 04, 05, 13, 14, 15, 23, 24, and 25 test and guard regions were connected to common flow manifolds in order to prevent the downhole pressures from approaching potential hydrofracture values during the excavation process. These data were not intended to be used for analyses. • After the excavation, these test regions were shut-in. • All brine inflow systems for 1 3/8" tools were replaced.
2/21/90-7/18/90	302-449	Flow tests initiated on boreholes QPP01, 02, 03, 05, 11, 12, 13, 15, 21, 22, 23, and 25. QPP04, 14, and 24 test regions remain shut-in. All guard regions shut-in.
7/17/90	449	All test and guard regions shut-in.

GENERAL PARAGRAPHS

QPP01, 11, 21 - Use mechanical closure gauges with 19" platens that contact borehole wall.

QPP02, 03, 04, 05, 12, 13, 14, 15, 22, 23, 24, 25 - Use hydraulic closure gauges with 5/16" diameter pins that contact the borehole wall.

Changes in test region pressures will induce changes in packer pressures and also result in offsets on borehole diameter measurements. A change in packer pressure may also result in a smaller change in the test region or guard region pressures. Closure data represent changes in borehole diameter, not absolute values.

We have indicated in this log offsets which are the result of maintenance procedures (such as changes in packer pressure) or in experimental status (flowing or shutin).

INDIVIDUAL BOREHOLE TEST HISTORIES

TZP

5/31/89	36	Pulse test conducted.
2/21/90	302	Flow test initiated.
4/30/90	370	Brine accumulator drained.
6/5/90	406	Brine accumulator drained.
7/14/90	448	All test and guard regions shut-in.

BIN

5/4/90	374	Brine accumulator drained (it was overfilled prior to draining).
6/4/90	405	Brine accumulator drained.
7/14/90	448	All test and guard regions shut-in; flow meter valve closed.

TPP

7/24/89	90	Test region packer increased.
9/27/89	155	Test region packer increased.

GZP

5/1/89	6	Tests initiated by shutting-in guard region.
5/27/89-6/20/89	32-56	Data gap - data channels in use for flow meter calibration.
6/20/89	56	Guard region open to brine flow system.
2/21/90	302	All guard regions shut-in.

5/1/90	371	Brine accumulator drained, guard region pressure reset at 93.4 psi.
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7/17/90	448	Guard region packer increased.
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10/27/90	560	Guard region packer increased.
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GPP

7/9/90	448	Guard region packer increased.
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10/27/90	560	Guard region packer increased.
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6/25/91	791	Guard region packer pressure increased due to decrease in guard region pressure starting near day 720 (4/15/91).
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OAC and CAC

2/21/90	302	Flow test started and test zone pressure increased.
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4/30/90	370	Brine accumulator drained.
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7/9/90	448	Guard region shut-in.
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TZP

4/25/89-5/6/89	0-11	Test initiated by shutting in test region.
5/7/89-5/9/89	12-14	Test region pressure reset.
5/19/89	24	Test region checked for trapped air and shut-in.
5/31/89	36	Pulse test conducted.
2/21/90	302	Flow test initiated.
5/1/90	371	Brine accumulator drained.
7/18/90	449	Shut-in.

BIN

5/1/90	371	Brine accumulator drained.
6/4/90	410	Brine level reset.

TPP

5/9/89	14	Test region packer pressure increased.
5/31/89	36	Test region packer pressure increased.

OAC and CAC

6/20/89	56	Gauge became inoperable on 6/20/89.
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QPP03

TZP

4/25/89-5/6/89	0-11	Test initiated by shutting in test region.
5/31/89	36	Pulse test conducted.
7/12/89-8/8/89	78-105	Mining. Test region pressures were reduced to prevent hydrofracture of the boreholes during the excavation process.
7/26/89	92	Test region shut-in.
2/21/90	302	Flow test initiated.
3/25/90	334	Brine accumulator drained.
5/16/90	386	Brine accumulator drained.
6/1/90	402	Entire QPP03 packer system replaced with an identical system. Test region filled with N ₂ and shut-in. Test region packer located at previous position of guard region packer in order to maintain the same test region length.

BIN

2/21/90	302	Flow test initiated.
3/26/90	335	Brine accumulator drained.
5/14/90	384	Brine accumulator drained.
6/4/90	405	Brine accumulator drained. Flow test terminated.

TPP

4/25/89-6/1/90	0-402	Up to day 402, test region packer was inoperable.
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6/2/90	403	New system installed in borehole. Test region packer located at previous position of guard region packer. Test region packer shut-in.
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6/6/90	407	New packer set to 1170 psi (8 MPa).
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GZP

5/30/89-6/20/89	35-56	Data channels in use for flow meter calibration. Guard region pressure history is identical to test region pressure history until day 402 since test region packer not seated.
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6/4/90	405	Guard region packer pressure is zero since guard region packer inoperable.
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GPP

7/10/89	76	Guard region packer pressure reduced.
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6/2/90	403	Guard region packer inoperable.
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OAC and CAC

6/20/89-7/20/89	56.6-76.4	Power supply problems.
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6/2/90	403	New closure gauge installed.
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10/1/91-1/20/91	524-635	Noisy data.
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TZP

4/25/89-5/6/89	0-11	Test initiated by shutting in test region.
5/19/89	24	Checked test region for trapped air and then shut-in.
5/31/89	36	Pulse test conducted.
7/12/89-8/8/89	78-105	Mining. Test region open to flow until day 92.
7/26/89	92	Test region shut-in.
7/17/90	448	Test region packer pressure reduced.

TPP

5/31/89	36	Test region packer pressure increased.
6/30/89	76	Test region packer pressure reduced.
7/17/90	448	Test region packer pressure reduced to 1000 psi.

OAC and CAC

6/20/89-7/20/89	56.6-76.4	Power supply problems.
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TZP

4/25/89-5/6/89	0-11	Test initiated by shutting in test region.
5/19/89	24	Checked test region for trapped air and then shut-in.
5/31/89	36	Pulse test conducted.
7/10/89	76	Test region pressure reduced prior to mining.
7/12/89-8/8/89	78-105	Mining. Test region open to flow until day 92.
7/26/89	92	Test region shut-in.
2/21/90	302	Flow test initiated.
3/8/90	317	Shut-in test region because brine was flowing from accumulator into formation.

BIN

2/21/90-3/8/90	302-317	Flow test.
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TPP

5/18/89	23	Test region packer pressure increased.
7/10/89	76	Test region packer pressure reduced.
7/17/90	448	Test region packer pressure reduced.
3/13/91	687	Test region packer pressure reduced.

GZP

5/19/89	24	Checked test region for trapped air and then shut-in.
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	30-55	Data gap - data channels in use for flow meter calibration. Guard region pressure history is identical to test region pressure history.
	78-105	Mining. Guard region open to flow.
2/21/90	302	Guard region shut-in, guard region pressure is similar to test region pressure.

GPP

5/30/89	35	Test region packer pressure increased.
7/10/89	76	Test region packer pressure increased.
7/17/90	448	Test region packer pressure reduced.
3/13/91	687	Test region packer pressure reduced.

OAC and CAC

6/20/89-7/20/89	56.6-76.4	Power supply problems.
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TZP

4/25/89-5/6/89	0-11	Test initiated by shutting in test region.
5/31/89	36	Pulse test conducted.
7/12/89-8/8/89	78-105	Mining.
2/21/90	302	Flow test initiated.
7/18/90	449	Flow test terminated. Shut-in.

HBP / BIN

Data is questionable because data obtained subsequent to termination of test on day 442 suggests that Anders and Hauser measurement system is operating erratically and/or brine accumulator system may leak.

TPP

5/30/89	35	Test region packer pressure increased.
7/17/90	448	Packer pressure increased.

GZP

5/30/89-6/20/89	35-56	Data gap - data channels in use for flow meter calibration. Guard region pressure history is identical to test region pressure history.
6/20/89	56	Guard region is open to brine inflow system.
	302	Guard region shut-in.

GPP

5/30/89	35	Guard region packer pressure reduced.
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OAC and CAC

No action taken.

TZP

4/25/89-5/6/89	0-11	Test initiated by shutting in test region.
5/9/89	14	Increased test region pressure and re-initiated test.
5/31/89	36	Pulse test conducted.
	78-105	Mining. Test region open to flow.
2/21/90	302	Flow test initiated.
5/2/90	372	Drained brine accumulator.
6/4/90-6/7/90	405-408	System removed from hole. Borehole diameter gauge calibration checked and test re-initialized.
7/18/90	449	Flow test terminated. Shut-in.

BIN

2/21/90	302	Flow test initiated.
5/2/90	372	Drained brine accumulator.
6/4/90-6/7/90	405-408	System removed from hole. Borehole diameter gauge calibration checked and test re-initialized.
7/18/90	449	Flow test terminated. Shut-in.

TPP

5/30/89	34.8	Test region packer pressure increased.
8/31/89	128.5	Test region packer pressure increased.
1/23/90	272.6	Test region packer pressure increased.
6/4/90-6/7/90	405-408	System removed from hole.
7/17/90	447.7	Test region packer pressure increased.

8/22/90	484.7	Test region packer pressure increased.
11/6/90	559.7	Test region packer pressure increased.
1/9/91	624.7	Test region packer pressure increased.

OAC and CAC

6/20/89-7/20/89	56.6-76.4	Power supply problems.
6/4/90-6/7/90	405-408	System removed from hole.

TZP

4/25/89-5/6/89	0-11	Test initiated by shutting in test region.
5/31/89	36	Pulse test conducted.
7/10/89	76	Test region pressure reduced prior to mining.
7/12/89-8/8/89	78-105	Mining. Test region open to flow until day 92.
7/26/89	92	Test region shut-in.
2/21/90	302	Flow test initiated.
3/5/90	314.4	Brine accumulator drained.
3/22/90	331.1	Brine accumulator drained.
4/9/90	349.4	Brine accumulator drained.
5/1/90	371.3	Brine accumulator drained.
5/3/90	373.9	Removed system from the hole and removed borehole diameter measurement gauges and then re-initiated brine inflow tests.
5/20/90	390.2	Brine accumulator drained.
6/14/90	415.3	Brine accumulator drained.
7/18/90	449	Flow test terminated. Shut-in.

BIN

5/30/89-6/20/89	35-56	Data gap - data channels in use for flow meter calibration. Guard region pressure history is identical to test region pressure history.
6/20/89	56	Guard region is open to flow system.
9/30/89	158	System region shut-in.

2/21/90	302	Flow test initiated.
3/5/90	314.4	Brine accumulator drained.
3/22/90	331.1	Brine accumulator drained.
4/9/90	349.4	Brine accumulator drained.
5/1/90	371.3	Brine accumulator drained.
5/3/90	373.9	Removed system from the hole and removed borehole diameter measurement gauges and then re-initiated brine inflow tests.
5/20/90	390.2	Brine accumulator drained.
6/14/90	415.3	Brine accumulator drained.
7/18/90	449	Flow test terminated. Shut-in.

TPP

5/31/89	36	Pulse test conducted.
7/7/89	73.4	Test region packer pressure increased.
7/10/89	76.2	Test region packer pressure reduced.
9/26/89	154.2	Test region packer pressure increased.
9/27/89	155.5	Test region packer pressure increased.
10/27/89	185.7	Test region packer pressure increased.
11/13/89	202.4	Test region packer pressure increased.
12/15/89	234.5	Test region packer pressure increased.
2/21/90	302	Flow test initiated.
5/2/90	372.2	System removed from hole.
6/6/90	407.3	Test region packer pressure increased.
6/15/90	416.1	Test region packer pressure increased.

7/17/90	448.4	Test region packer pressure increased.
7/25/90	456.5	Test region packer pressure increased.
8/23/90	485.4	Test region packer pressure increased.
10/3/90	526.4	Test region packer pressure increased.
11/6/90	560.4	Test region packer pressure reduced.
1/2/91	617.6	Test region packer pressure reduced.
5/17/91	752.4	Test region packer pressure reduced.

GZP

5/30/89-6/20/89	35-56	Data gap - data channels in use for flow meter calibration. Guard region pressure history is identical to test region pressure history.
6/20/89	56	Guard region is open to brine inflow system.
10/2/89	160	Guard region shut-in.
10/5/89	163	Guard region packer pressure increased.
10/26/89	184.3	Guard region packer pressure increased.
11/13/89	202.4	Guard region packer pressure increased.
12/15/89	234.5	Guard region packer pressure increased.
2/21/90	302	Flow test initiated.
5/2/90	372.2	System removed from hole.
6/6/90	407.3	Guard region packer pressure increased.
6/15/90	416.1	Guard region packer pressure increased.
7/3/90	434.4	Guard region packer pressure increased.
7/17/90	448.4	Guard region packer pressure increased.
7/25/90	456.5	Guard region packer pressure increased.

8/23/90	485.4	Guard region packer pressure increased.
10/3/90	526.4	Guard region packer pressure increased.
11/6/90	560.4	Guard region packer pressure increased.
1/2/91	617.6	Guard region packer pressure increased.
5/17/91	752.4	Guard region packer pressure increased.
6/25/91	791.5	Guard region packer pressure increased.
9/7/91	865.2	Guard region packer pressure increased.

GPP

5/30/89-6/20/89	35-56	Data gap - data channels in use for flow meter calibration. Guard region pressure history is identical to test region pressure history.
6/20/89	56	Guard region is open to brine inflow system.
10/2/89	160	Guard region shut-in.
10/5/89	163	Guard region packer pressure increased.
10/26/89	184.3	Guard region packer pressure increased.
11/13/89	202.4	Guard region packer pressure increased.
12/15/89	234.5	Guard region packer pressure increased.
2/21/90	302	Flow test initiated.
5/2/90	372.2	System removed from hole.
6/6/90	407.3	Guard region packer pressure increased.
6/15/90	416.1	Guard region packer pressure increased.
7/3/90	434.4	Guard region packer pressure increased.
7/17/90	448.4	Guard region packer pressure increased.
7/25/90	456.5	Guard region packer pressure increased.

8/23/90	485.4	Guard region packer pressure increased.
10/3/90	526.4	Guard region packer pressure increased.
11/6/90	560.4	Guard region packer pressure increased.
1/2/91	617.6	Guard region packer pressure increased.
5/17/91	752.4	Guard region packer pressure increased.
6/25/91	791.5	Guard region packer pressure increased.
9/7/91	865.2	Guard region packer pressure increased.

OAC and CAC

6/20/89-7/20/89	56.6-76.4	Power supply problems.
4/30/90	370	System removed from hole.

QPP14

TZP

4/25/89-5/6/89	0-11	Test initiated by shutting in test region.
5/5/89	10.8	Test region packer pressure increased.
5/19/89	24	Checked test region for trapped air and then shut-in.
5/31/89	36	Pulse test conducted.
7/10/89	76	Test region pressure reduced prior to mining.
7/12/89-8/8/89	78-105	Mining. Test region open to flow until day 92.
7/26/89	92	Test region shut-in.
9/27/89	155.6	Test region packer pressure increased.
11/13/89	202.4	Test region packer pressure increased.
7/17/90	448.4	Test region packer pressure increased.
11/6/90	560.4	Test region packer pressure increased.
1/28/91	643.5	Test region packer pressure increased.
5/13/90-7/16/90	383-447	QPP14 test region pressure was measured using the QPP15 test region pressure transducer during this period. The pressure excursions at those two days result from changing the transducers.
6/24/91	791.5	Test region packer pressure increased.

TPP

5/5/89	10.8	Test region packer pressure increased.
9/27/89	155.6	Test region packer pressure increased.
11/13/89	202.4	Test region packer pressure increased.

7/17/90	448.4	Test region packer pressure increased.
11/6/90	560.4	Test region packer pressure increased.
1/28/91	643.5	Test region packer pressure increased.
5/13/90-7/16/90	383-447	QPP14 test region pressure was measured using the QPP15 test region pressure transducer during this period. The pressure excursions at those two days result from changing the transducers.
6/24/91	791.5	Test region packer pressure increased.

OAC and CAC

6/20/89-7/20/89	56.6-76.4	Power supply problems.
5/13/90-7/16/90	383-447	QPP14 test region pressure was measured using the QPP15 test region pressure transducer during this period. Closure data are compensated for test region pressure and should therefore be ignored in this period.

QPP15

TZP

4/25/89-5/6/89	0-11	Test initiated by shutting in test region.
6/8/89	44	Test region packer pressure increased.
5/19/89	24	Checked test region for trapped air and then shut-in.
5/31/89	36	Pulse test conducted.
7/10/89	76	Test region pressure reduced prior to mining.
7/12/89-8/8/89	78-105	Mining. Test region open to flow until day 92.
7/26/89	92	Test region shut-in.
9/27/89	155	Test region packer pressure reduced.
2/21/90	302	Flow test initiated.
5/1/90	371	Test region packer pressure reduced.
5/13/90-7/16/90	383-447	QPP15 test region pressure was measured using the QPP14 test region pressure transducer during this period. The pressure excursions at those two days result from changing the transducers.
7/18/90	449	Flow test terminated. Shut-in.
3/13/91	687	Test region packer pressure reduced.

TPP

6/8/89	44	Test region packer pressure increased.
9/27/89	155	Test region packer pressure reduced.
5/1/90	371	Test region packer pressure reduced.
3/13/91	687	Test region packer pressure reduced.

BIN

2/21/90	302	Flow test initiated.
5/2/90	372	Brine accumulator drained.
7/18/90	449	Flow test terminated. Shut-in.

GZP

7/12/89-8/8/89	78-105	Mining.
5/19/89	24	Checked test region for trapped air and then shut-in.
5/30/89-6/20/89	35-56	Data gap - data channels in use for flow meter calibration. Guard region pressure history is identical to test region pressure history.
6/20/89-2/21/90	56-302	Guard zone connected to flow system.
2/21/90	302	Guard region shut-in.

GPP

1.2	Guard region packer pressure increased.
22.4	Guard region packer pressure increased.
35.5	Guard region packer pressure increased.
76.1	Guard region packer pressure reduced.
155.5	Guard region packer pressure reduced.
371.3	Guard region packer pressure reduced.
687.4	Guard region packer pressure reduced.

OAC and CAC

6/20/89-7/20/89	56.6-76.4	Power supply problems.
5/13/90-7/16/90	383-447	QPP14 test region pressure was measured using the QPP15 test region pressure transducer during this period. Closure data are compensated for test region pressure and should therefore be ignored in this period.

TZP

4/25/89-5/6/89	0-11	Test initiated by shutting in test region.
5/19/89	24	Checked test region for trapped air and then shut-in.
5/31/89	36	Pulse test conducted.
7/12/89-8/8/89	78-105	Mining. Test region shut-in.
2/21/90	302	Flow test initiated.
7/18/90	449	Flow test terminated. Shut-in.

HPB (BIN)

Brine inflow system inoperable.

TPP

5/30/89	35.1	Test region packer pressure increased.
7/17/90	448	Test region packer pressure increased.

GZP

5/30/89-6/20/89	35-56	Data gap - data channels in use for flow meter calibration. Guard region pressure history is identical to test region pressure history.
6/20/89-2/21/90	56-302	Guard zone connected to flow system.
2/21/90	302	Guard region shut-in.

GPP

5/30/89	35	Guard packer pressure increase, pulse test.
7/17/90	448	Guard region packer pressure increased.

OAC and CAC

Cross-axis and on-axis closure gauges inoperable.

QPP22

TZP

4/25/89-5/6/89	0-11	Test initiated by shutting in test region.
5/19/89	24	Checked test region for trapped air and then shut-in.
5/31/89	36	Pulse test conducted.
7/12/89-8/8/89	78-105	Mining. Test region open to flow.
7/24/89	90.7	Test region packer pressure increased.
9/4/89	132.8	Test region packer pressure increased.
9/26/89	154.9	Test region packer pressure increased.
10/25/89	183.6	Test region packer pressure increased.
11/12/89	201.7	Test region packer pressure increased.
1/22/90	272.6	Test region packer pressure increased.
2/21/90	302.2	Test region connected to brine inflow system. Flow to brine inflow system apparently restricted resulting in test region pressure increase. Repaired on day 372.
7/17/90	448	Test region packer pressure increased.
7/18/90	449	Flow test terminated. Shut-in.
11/5/90	559	Test region packer pressure increased.
12/25/90	609	Test region packer pressure increased.
1/9/91	624	Test region packer pressure increased.
2/12/91	658	Test region packer pressure increased.
3/12/91	686	Test region packer pressure increased.

4/2/91	707	Test region packer pressure increased.
4/23/91	728	Test region packer pressure increased.
5/15/91	751	Test region packer pressure increased.
6/12/91	778	Test region packer pressure increased.
6/25/91	791	Test region packer pressure increased.

BIN

2/21/90-5/2/90	302-372	Test region connected to brine inflow system. Flow to brine inflow system apparently restricted resulting in test region pressure increase. Repaired on day 372.
	370	Drain brine accumulator.
7/18/90	449	Flow test terminated. Shut-in.

TPP

5/18/89	23.3	Test region packer pressure increased.
6/26/89	62.4	Test region packer pressure increased.
6/30/89	66.3	Test region packer pressure increased.
9/4/89	132.8	Test region packer pressure increased.
9/26/89	154.9	Test region packer pressure increased.
10/25/89	183.6	Test region packer pressure increased.
11/12/89	201.7	Test region packer pressure increased.
1/22/90	272.6	Test region packer pressure increased.
7/17/90	448	Test region packer pressure increased.
7/18/90	449	Flow test terminated. Shut-in.
11/5/90	559	Test region packer pressure increased.

12/25/90	609	Test region packer pressure increased.
1/9/91	624	Test region packer pressure increased.
2/12/91	658	Test region packer pressure increased.
3/12/91	686	Test region packer pressure increased.
4/2/91	707	Test region packer pressure increased.
4/23/91	728	Test region packer pressure increased.
5/15/91	751	Test region packer pressure increased.
6/12/91	778	Test region packer pressure increased.
6/25/91	791	Test region packer pressure increased.

OAC and CAC

6/20/89-7/20/89	56.6-76.4	Power supply problems.
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TZP

4/25/89-5/6/89	0-11	Test initiated by shutting in test region.
5/19/89	24	Checked test region for trapped air and then shut-in.
5/31/89	36	Pulse test conducted.
7/12/89-8/8/89	78-105	Mining. Test region open to flow.
2/21/90	302	Flow test initiated.
5/1/90	371.2	Brine accumulator drained.
7/18/90	449	Flow test terminated. Shut-in.

BIN

2/21/90	302	Flow test initiated.
5/1/90	371.2	Brine accumulator drained.

TPP

		Leaking packer. Packer pressure was increased many times.
5/17/89	22.6	Test region packer pressure increased.
7/9/89	75.7	Test region packer pressure reduced.
7/24/89	90.7	Test region packer pressure increased.
8/8/89	105.7	Test region packer pressure increased.
8/31/89	128.3	Test region packer pressure increased.
9/26/89	154.6	Test region packer pressure increased.

10/25/89	183.4	Test region packer pressure increased.
12/14/89	233.8	Test region packer pressure increased.
1/21/90	271.9	Test region packer pressure increased.
7/16/90	447.3	Test region packer pressure increased.

GZP

5/19/89	24	Checked test region for trapped air and then shut-in.
5/30/89-6/20/89	35-56	Data gap - data channels in use for flow meter calibration. Guard region pressure history is identical to test region pressure history.
6/21/89-8/1/89	57-98.0	Guard region open.
8/1/89	98	Guard region shut-in.
	301.9	Guard region pressure lowered.

GPP

	22.6	Guard region packer pressure increased.
	74.4	Guard region packer pressure increased.
	232.9	Guard region packer pressure increased.
	272.7	Guard region packer pressure increased.
7/14/90	445.8	Guard region packer pressure increased.

OAC and CAC

6/20/89-7/20/89	56.6-76.4	Power supply problems.
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QPP24

TZP

4/25/89-5/6/89	0-11	Test initiated by shutting in test region.
5/31/89	36	Pulse test conducted.
7/10/89	76	Test region pressure reduced prior to mining.
7/12/89-8/8/89	78-105	Mining. Test region open to flow until day 92.
7/26/89	92	Test region shut-in.
2/21/90	302	Flow test initiated.
7/18/90	449	Flow test terminated. Shut-in.
5/15/90-7/16/90	385-447	QPP24 test region pressure was measured using the QPP25 test region pressure transducer during this period. The pressure excursions at those two days result from changing the transducers.
7/16/90	447	Test region packer pressure increased.

TPP

7/6/89	72.9	Test region packer pressure reduced.
7/16/90	447	Test region packer pressure increased.

OAC and CAC

6/20/89-7/20/89	56.6-76.4	Power supply problems.
5/13/90-7/16/90	383-447	QPP14 test region pressure was measured using the QPP15 test region pressure transducer during this period. Closure data are compensated for test region pressure and should therefore be ignored in this period.

QPP25

TZP

4/25/89-5/6/89	0-11	Test initiated by shutting in test region.
5/19/89	24	Checked test region for trapped air and then shut-in.
5/31/89	36	Pulse test conducted.
7/10/89	76	Test region pressure reduced prior to mining.
7/12/89-8/8/89	78-105	Mining. Test region open to flow until day 92.
7/26/89	92	Test region shut-in.
2/21/90	302	Flow test initiated.
5/15/90-7/16/90	385-447	QPP24 test region pressure was measured using the QPP25 test region pressure transducer during this period. The pressure excursions at those two days result from changing the transducers
7/18/90	449	Flow test terminated. Shut-in.

BIN

2/21/90	302	Flow test initiated.
4/30/90	370	Brine accumulator drained.
7/18/90	449	Flow test terminated. Shut-in.

TPP

5/18/89	23.6	Test region packer pressure increased.
7/24/89	90.7	Test region packer pressure reduced.
9/26/89	154.1	Test region packer pressure increased.
10/25/89	183.4	Test region packer pressure increased.

11/12/89	201.1	Test region packer pressure increased.
1/22/90	272.6	Test region packer pressure increased.
6/3/90	404.5	Test region packer pressure increased.
7/2/90	433.9	Test region packer pressure increased.
7/15/90	446.2	Test region packer pressure increased.
10/1/90	524.9	Test region packer pressure increased.
11/5/90	559.2	Test region packer pressure increased.
1/27/91	642.1	Test region packer pressure increased.
4/2/91	707.4	Test region packer pressure increased.
5/16/91	751.7	Test region packer pressure increased.
6/25/91	791.5	Test region packer pressure increased.

GZP

5/19/89	24	Checked test region for trapped air and then shut-in.
5/30/89-6/20/89	35-56	Data gap - data channels in use for flow meter calibration.
6/20/89-8/1/89	56-98	Guard region connected to brine inflow system.
8/1/89	98	Guard region shut-in to evaluate flow meter system.
2/21/90	301.7	Guard region pressure lowered.

GPP

5/18/89	23.6	Guard region packer pressure increased.
7/9/89	75.3	Guard region packer pressure reduced.
10/25/89	183.6	Guard region packer pressure increased.
11/2/89	201.7	Guard region packer pressure increased.

1/21/90	271.0	Guard region packer pressure increased.
10/2/90	525.0	Guard region packer pressure increased.
6/25/91	791.5	Guard region packer pressure increased.

OAC and CAC

6/20/89-7/20/89	56.6-76.4	Power supply problems.
5/13/90-7/16/90	383-447	QPP14 test region pressure was measured using the QPP15 test region pressure transducer during this period. Closure data are compensated for test region pressure and should therefore be ignored in this period.

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