PNE-RB-70

PROJECT RIO BLANCO
FINAL REPORT
REENTRY DRILLING AND TESTING OF RB-E-01 WELL

October 1975

CER Geonuclear Corporation
Continental Oil Company

PREFACE

This volume is a report on the postdetonation reentry and production phases of Project Rio Blanco. The predetonation and detonation phases were reported on in the Project Rio Blanco Detonation Phase Final Report.[1]

For planning details on the Project, refer to the Project Rio Blanco Definition Plan[2] in three volumes. Volume I contains a general description of the entire project.

Volume II details the tasks that were needed for the operational scope of work related to the detonation such as site construction, power installation and distribution, drilling of the emplacement well, stemming plans, operational safety, seismic effects documentation, and ground water protection program, as well as several add-on programs. Volume III incorporates all planning of the activities that were related to the chimney reentry and reservoir testing and evaluation. For the most part, these plans will not be repeated here.

The three nuclear explosives for Project Rio Blanco were detonated at 1000:00.12$\pm$0.01 second, Mountain Daylight Time, or 1600:00.12$\pm$0.01 second, Greenwich Mean Time, on May 17, 1973. The three explosions occurred within the Fort Union and Mesaverde formations at depths of 5,838.5 feet, 6,229.7 feet, and 6,689.5 feet. The three explosions occurred nearly simultaneously as planned and were completely contained. Available data indicate that the yields of the three explosives totalled approximately 90 kt. The elevation of the ground at the emplacement well, RB-E-01, is 6,629.9 feet above mean sea level. RB-E-01 is located 1,080.50 feet south of the north line and 1,188.49 feet east of the west line in Section 14, Township 3 South, Range 98 West of 6th P.M., Rio Blanco County, Colorado, which corresponds to geodetic coordinates of 108°21'59" west longitude and 39°47'35" north latitude.

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I. INTRODUCTION

Project Rio Blanco was designed as the first phase of a three-phase experimental program to demonstrate the potential of commercial development of a natural-gas field by nuclear stimulation techniques in the Piceance Basin in Rio Blanco County, Colorado. Because the gas is tightly held within the surrounding rock, this field has not been developed by conventional stimulation methods. At the time of this writing, however, massive hydraulic fracturing experiments are underway to investigate further this technology for development of gas fields. One of these experiments[3] is being conducted at a site within one mile of the nuclear experiment.

The first phase of the nuclear experiment consisted of the simultaneous detonation of three nuclear explosives at different depths within the Fort Union and Mesaverde formations. The detonations were designed to stimulate a 1,350-foot vertical section of the Fort Union and Mesaverde formations. After a five-month waiting period, a reentry well was completed into the gas-filled chimney associated with the upper explosive, and the reservoir testing and evaluation began. The field activities related to this reentry drilling and chimney pressure drawdown are the subject of this report. Figure 1 shows the principal locations of project activities.

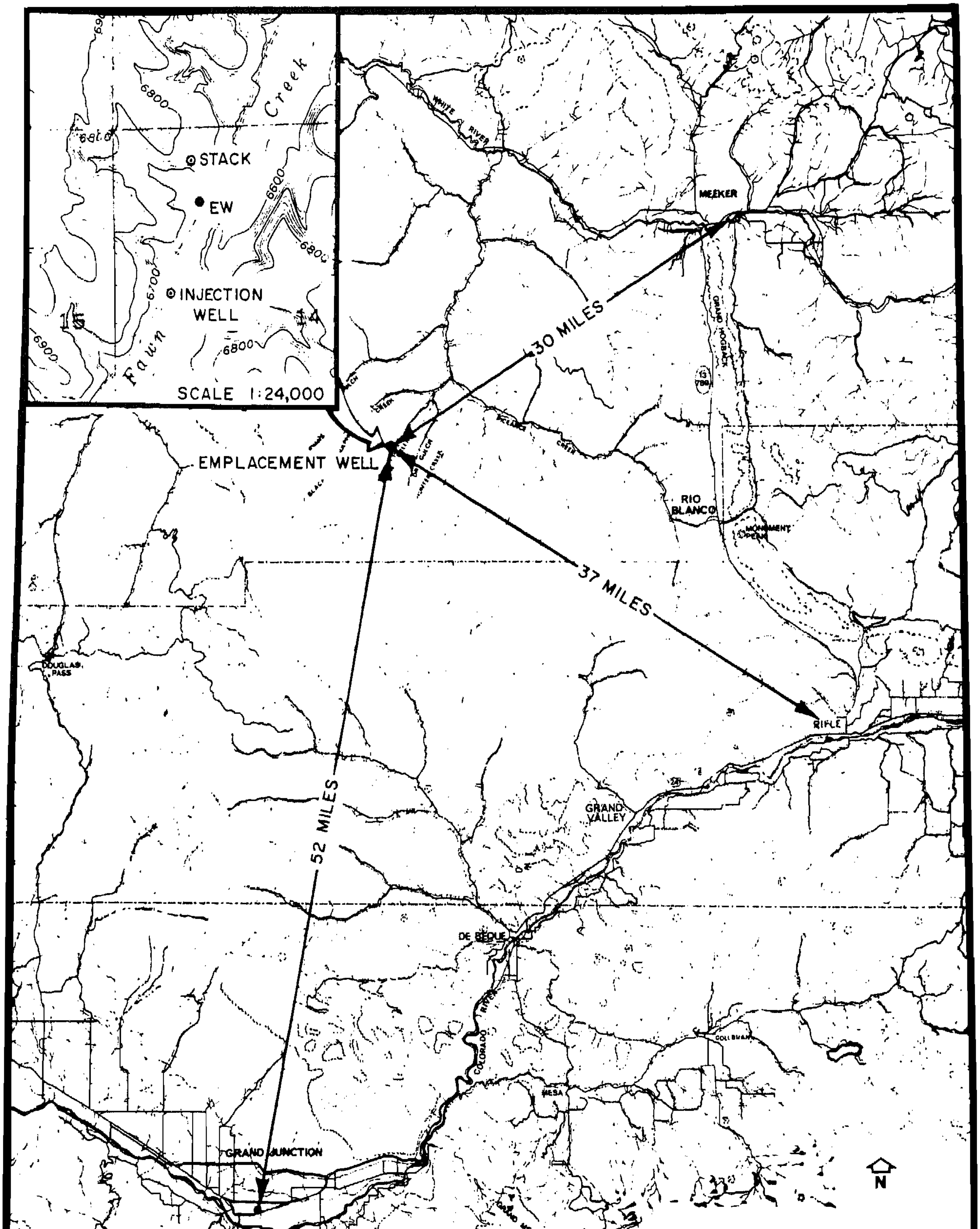

Figure 1. Effluent release and disposal points, Project Rio Blanco production testing.

2. GENERALIZED SITE ACTIVITIES

2.1 SITE PREPARATION

Prior to the start of reentry drilling activities, the Fawn Creek access road and emplacement well (EW) were regraded and prepared for the subsequent activities.

An office trailer was provided for the use of the Atomic Energy Commission (AEC), Lawrence Livermore Laboratories (LLL), CER Geonuclear Corporation (CER), Continental Oil Company (Conoco), and other project participants. Two mobile homes were provided, one for LLL and representatives of the drilling tool companies and the other for CER/Conoco personnel. The drilling contractor provided a self-contained camping trailer for its superintendent during the drilling phase. The radiological protection trailers used by the Radiological Support Contractor (RSC) were supplied by the AEC as Government-furnished-equipment. CER's own effluent documentation system, the TRY-KRY, was also installed in a trailer. Figure 2 shows the placement of all trailers on-site during the reentry drilling and production testing of the RB-E-01 well.

The flare stack was located in the clearing to the northwest and above the EW, and the previously cleared cableway became the process piping route. The areas which included the flare stack, process piping, storage and condensate tanks, separator, and wellhead equipment were fenced with three strand barbed wire to prevent livestock from entering the area and to control personnel access.

The Grand Junction Control Point (GJCP) at the CER/Conoco office and warehouse complex (Figure 3) in Grand Junction was maintained through the conclusion of the production testing of the RB-E-01 well.

2.2 POWER INSTALLATION AND DISTRIBUTION

As equipment and trailers were delivered, the electric distribution cables and connections were reestablished to the electrical distribution panels. Sufficient spare safety switches were initially installed to provide the following anticipated electrical demand.

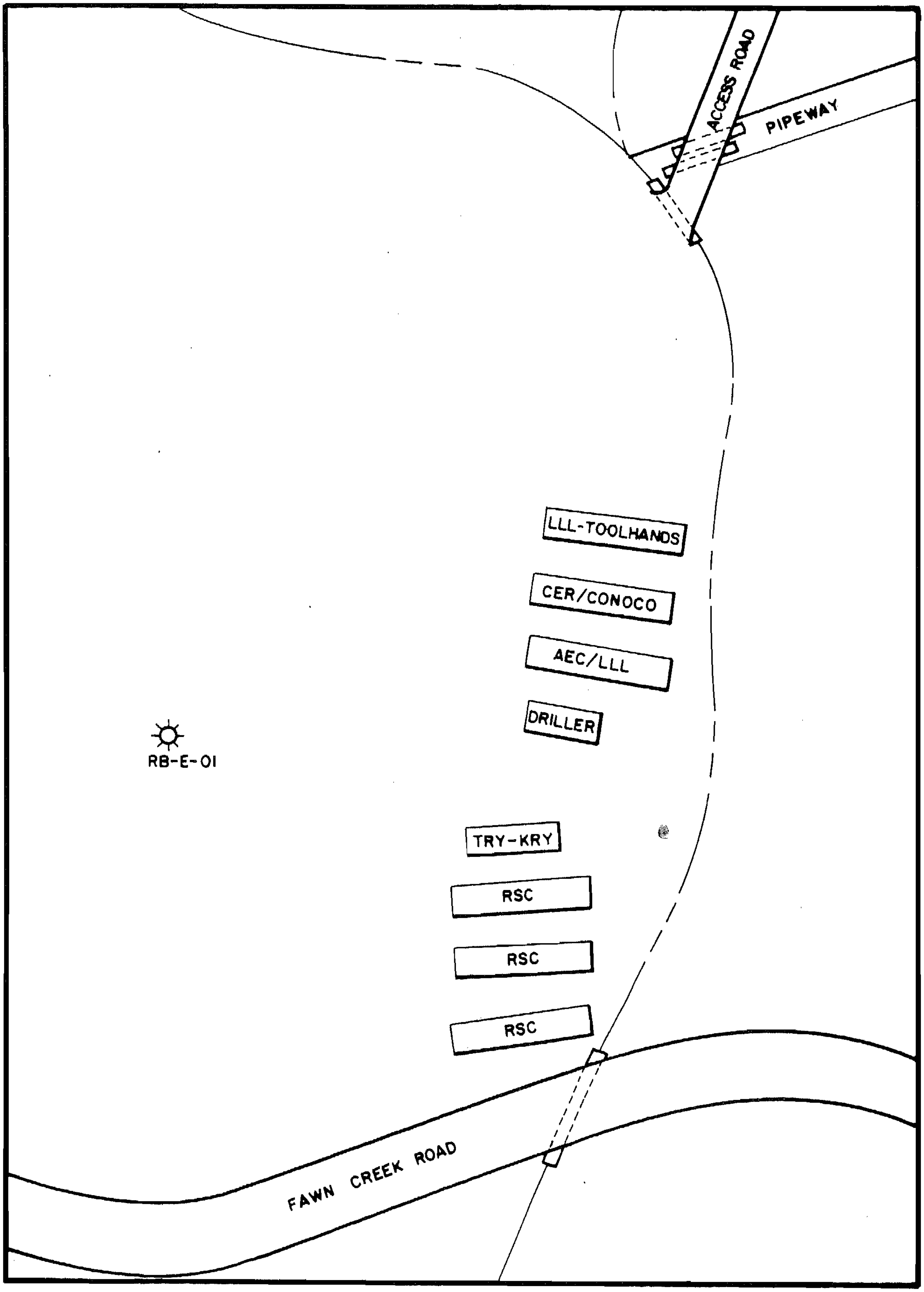

Figure 2. Layout of trailers during reentry drilling and production testing.

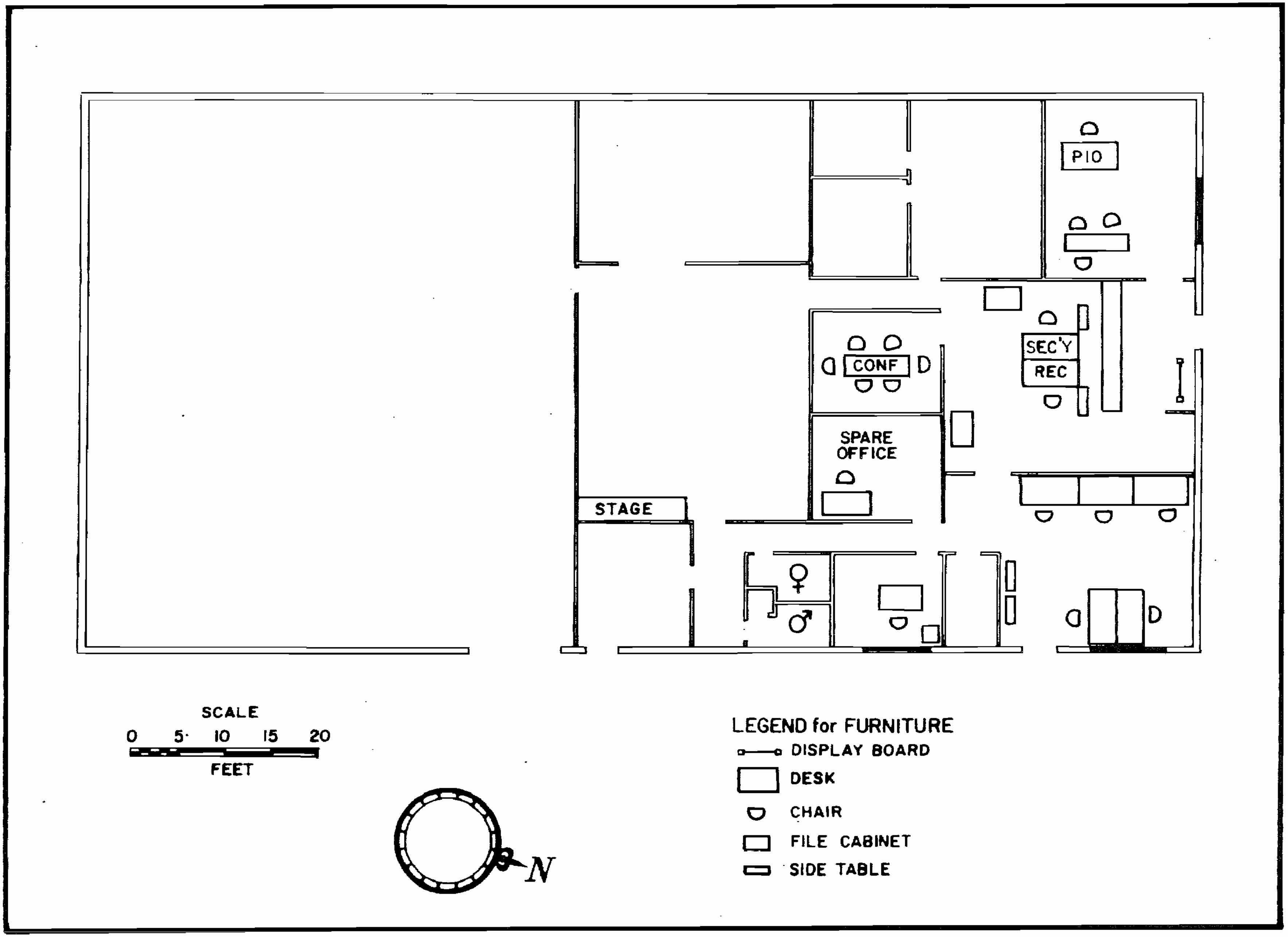

Figure 3. Grand Junction office and warehouse complex.

	Drilling (KW)	Testing (KW)
Radiological Safety Contractor (RSC)	40	40
AEC	10	10
Tool Hands	5	--
Tool Pusher	5	5
CER	10	10
Area Lighting	10	10
TRY-KRY	30	30
Instrumentation	1	5
Water Injection Pump	--	50
Communications Equipment	5	5
Heat Tape	--	40
Total	116	185
Use Load Factor	0.8	0.8
Power Required	93	148

An additional 50-kVA, 3-phase transformer was provided to supply power to the 50-horsepower water injection pump. This increased the electric power provided to the EW to 150 kw (nominal). However, during the first production test, it was determined that the temperature of the flowing gas was excessive; and the decision was made to add fin-fan coolers upstream of the separator before further testing. The 13 kw required made it necessary to change from a 50-kw transformer to a 75-kw transformer.

Electric service from a commercial source was available at the GJCP and was distributed as shown in the project definition plan.[2]

2.3 COMMUNICATIONS

The principal telephone and radio communication facilities for the project were located in Grand Junction where the CER microwave telephone system interconnects with the Mountain Bell telephone system.

Microwave communication equipment was utilized for both the telephone and the VHF duplex radio net. Microwave telephone relay stations were located at Lands End and Monument Peak with terminal equipment in the CER communications shed approximately 1/2 mile west of the EW. A VHF base station was also located in the communications shed. Existing signal cable laid during the detonation phase was utilized to provide telephone and VHF radio service to the EW area, as shown in Figure 4. A Xerox telecopier was available at both the GJCP and the EW for transmission of printed or written material.

The CER telephone system at the EW site operates over a microwave link as a direct dialing extension of a Grand Junction telephone exchange of the Mountain Bell telephone system. Four telephone lines originate in a Grand Junction

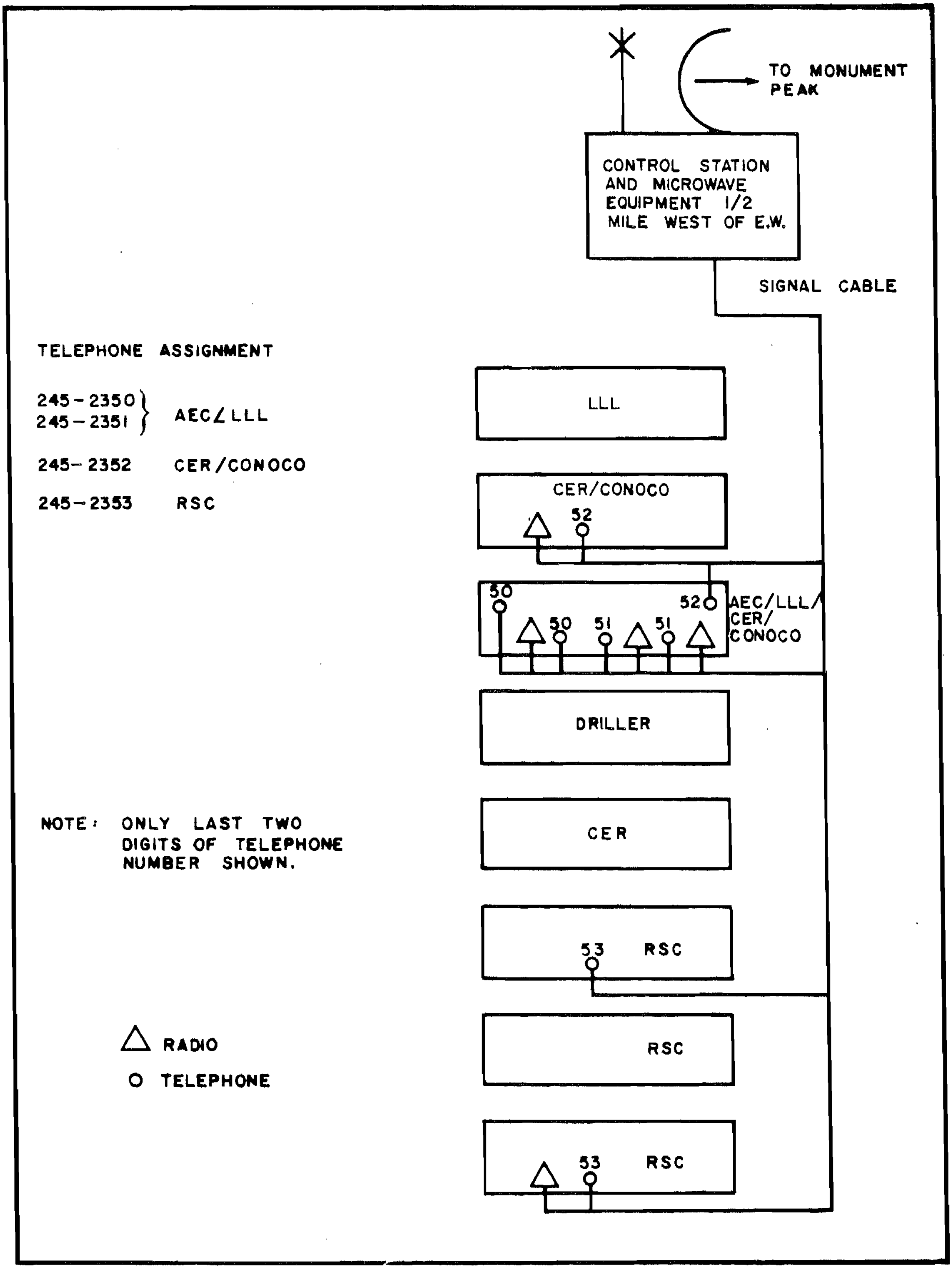

Figure 4. Distribution of telephone and radio circuits in the EW area.

telephone exchange and terminate at the EW. Figure 5 diagrams the microwave telephone and radio system.

Individual telephone numbers were assigned to each of the four telephone lines from the Grand Junction telephone office. A telephone directory of telephone numbers and respective locations and organizations was published.

A radio relay station located at Monument Peak provided adequate radio communication between fixed stations at the EW and GJCP and among fixed stations and mobiles in the Piceance Creek Basin. Communication with mobiles outside the basin was limited by line-of-sight restrictions.

A limited number of mobile radios were furnished by CER for use by those project participants directly involved with field activities during the experiment and were used primarily for coordination of logistic requirements.

In the event of commercial power failure, the microwave telephone system and the VHF radio repeater and control station continue to operate on battery power for a minimum of 8 hours.

Frequencies for the CER VHF radio net are:

Repeater/fixed, mobile	Transmit/Receive	153.350 MHz
Repeater/fixed, mobile	Receive/Transmit	158.370 MHz

Transmit frequencies for the microwave system are as follows:

Grand Junction to Lands End	956.700 MHz
Lands End to Monument Peak	953.500 MHz
Monument Peak to EW	956.900 MHz
EW to Monument Peak	953.300 MHz
Monument Peak to Lands End	957.100 MHz
Lands End to Grand Junction	953.100 MHz

2.4 INDUSTRIAL SAFETY

2.4.1 General

CER operations and activities were conducted in accordance with the standards of the Occupational Safety and Health Act of 1970. All participating organizations were responsible for the health and safety of their own personnel and for conducting all activities in accordance with procedures that assure:

1. A safe and healthful environment for their employees.

2. Control and minimization of hazards to the public and to personnel of other participants.

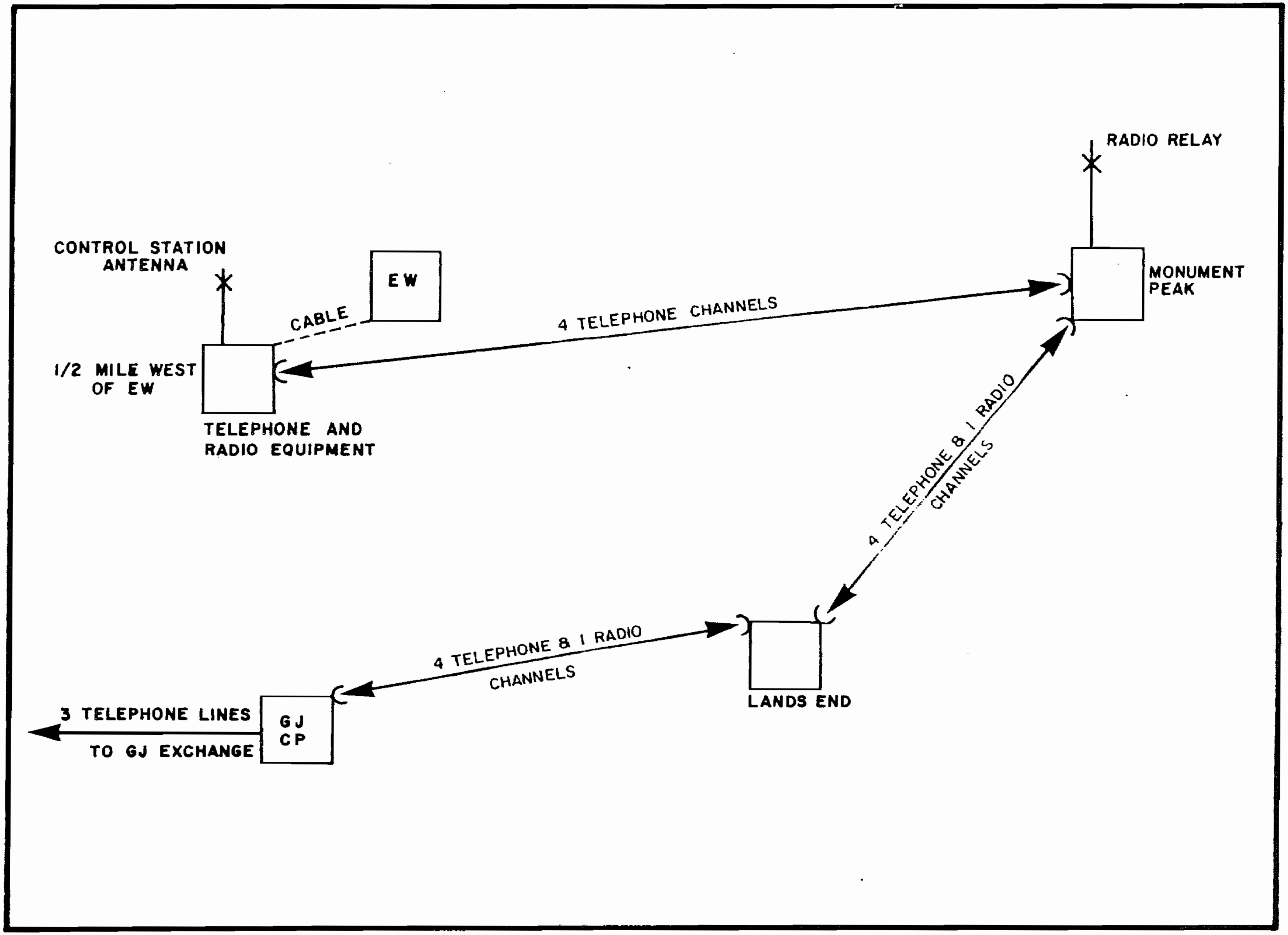

Figure 5. Diagram of microwave telephone and radio system.

3. Minimization of the accidental damage or loss of company and privately owned equipment, materials, and property.

2.4.2 General Safety

Reentry of the stimulated gas zone involve general construction work, drilling, and installation of high-pressure piping and pressure vessels. The following safety standards were established as criteria for the performance of this work:

1. National
2. General Safety Requirements - Corps of Engineers
3. ASME - Boiler and Pressure Vessel Code
4. API - Recommended Standards and Procedures
5. AAODC - Tool Pushers Manual

2.4.3 First Aid

During the reentry drilling and first production testing, CER provided an experienced first aid man and a radio equipped ambulance on each work shift. The first aid men were off-duty personnel of the Grand Junction emergency rescue division of the fire department. The first aid man was stationed in the office trailer, provided by CER, which was equipped with suitable first aid supplies as recommended by a local physician. CER also provided each participating agency contacts with local medical facilities and physicians in the Grand Junction, Rifle, and Meeker areas for use in the event of accident or illness. The availability of an ambulance and a first aid man on-site was suspended after the first production test and not resumed during the second production test because of reduced manning level.

2.5 GENERAL SUPPORT REQUIREMENTS

Drinking water was furnished in cool cans at the EW. Janitorial service was provided at the EW on a minimal basis. Occasional secretarial and clerical services were also available. Office furniture was supplied at the GJCP as shown in Figure 3. Chemical toilets were provided at the EW. Waste and garbage cans were provided around the working areas at both the GJCP and EW. Disposal of refuse was handled by an approved local agency. Air conditioning was not generally furnished to trailers at the EW. Trailers furnished by CER were heated by propane fuel. The RSC and TRY-KRY trailers were air conditioned as required to assure stability of electronic equipment. Furnaces or heaters were of an approved vented type. An emergency fuel and lubricating oil supply for vehicles and equipment was furnished at the EW.

Dry chemical type fire extinguishers were located around the EW as were barrels filled with a mixture of water and antifreeze in the event of fire. No fires were experienced on the project.

CER/Conoco provided miscellaneous labor to support the project as well as transporting, shipping, receiving, and hauling various supplies and materials for the participants. Approximately 1,200 square feet of enclosed warehousing was utilized at the GJCP office. Limited enclosed storage was available at the EW area for spare parts and equipment. Sufficient open storage space was available at the GJCP and EW areas. Dust control, snow removal, and normal "good housekeeping" maintenance of the access road and EW area were performed on an as required basis.

2.6 ROLLUP

The rollup activities contemplated in the project definition plan (2) have not been accomplished as of the date of this report. Additional drilling and testing activities reported elsewhere or yet to be undertaken have resulted in indefinite postponement of this activity.

2.7 OTHER SUPPORT

The GJCP was operated during normal business hours to support the project. Normal functions of administrative, secretarial and clerical work were performed. Warehousing, shipping, and receiving facilities were maintained. The GJCP served also, during this period, as a base for handling claims resulting from the detonation, as described in Reference 1, and for limited public information activities.

3. REENTRY DRILLING PROGRAM - RB-E-01

Upon conclusion of the principal activities associated with the detonation phase of the Rio Blanco experiment, CER/Conoco began preparation for reentry drilling and subsequent production testing of RB-E-01. The initial step was to relocate the RSC trailers to the emplacement well pad and to initiate routine radiological surveillance of the area during the 3-month delay that was scheduled to allow the decay of short-lived radioactivity in the chimney, in particular, ^{131}I.

Pipe and assorted materials were delivered to the site and welding and assembly of the various pipe lines began. The flare stack and drip pans were shop fabricated and delivered to the site. As soon as the foundation and guy anchors were installed for the flare stack, it was erected. Tankage (water and condensate storage) was set in place and interconnecting piping was installed for the tankage, separator, and water disposal pump. Instrumentation was installed and associated signal cable routed to connect to the alarm and control panel.

While this preparatory work was in progress, the gas sampling program described in the project definition plan(2) was attempted with indifferent results. Attempts to remedy downhole blockage of the gas sampling tube were not successful. The effort was finally abandoned and the open downhole portion of the tube was plugged with epoxy as planned as a precautionary measure.

Difficulty was experienced in obtaining a drill rig that met the safety and operating criteria. Even after a suitable drill rig was located, a delay occurred while the drill rig completed another assignment before moving to the reentry well location. Once the drill rig availability was established, the drilling well control (DWC) unti, blowout preventer (BOP) equipment, explosive gas monitoring system, radiation detection equipment, and various other supplies were coordinated into the reentry schedule. (See Figure 6 for layout of reentry equipment.) As the assembly and erection of the drill rig progressed, drip pans were installed at the wellhead cellar, DWC, shaker table, and drill pipe stands on the rig floor and decontamination pad areas. The natural gas pipe line from the Fawn Creek Government No. 1 Well was completed and the natural gas used as a purge system in the flow lines to prevent an explosive mixture from accumulating.

Prior to the start of drilling, tests of the BOP, DWC, flow lines, and safety monitoring systems were satisfactorily conducted. With the testing completed, reentry drilling betan on September 23, 1973.

3.1 REENTRY DRILLING

Reentry was through the 7-in. emplacement casing using a downhole motor (Dyna Drill) and a 6-1/8-in. mill to drill out the cement plug inside the 7-in.

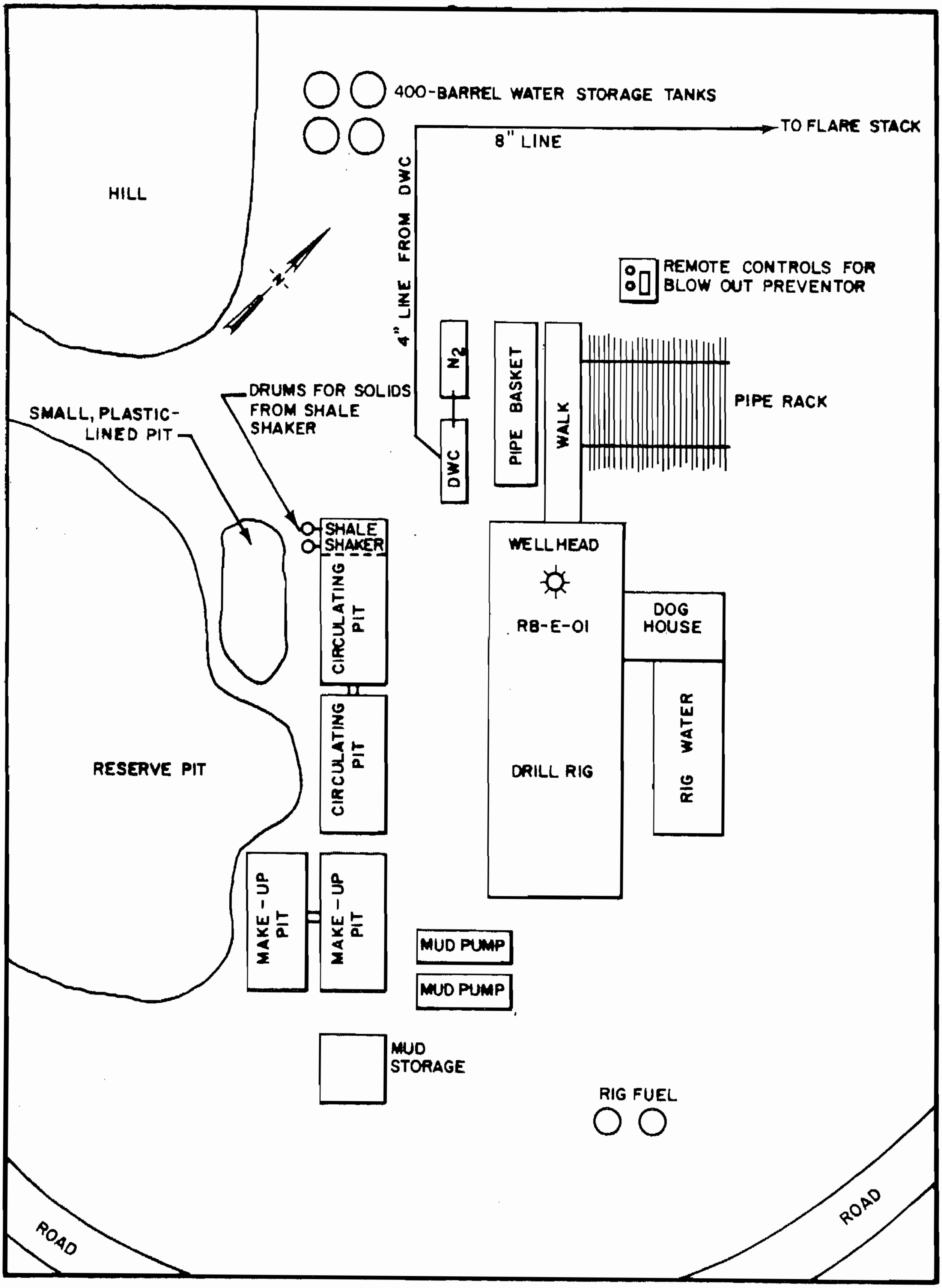

Figure 6. Schematic of drill rig layout for reentry drilling (not to scale).

casing from approximately 2, 797 ft KB (Kelly Bushing) to approximately 5, 194 ft KB. Below the cement plug, it was found that the gelled water used in stemming had failed to do the expected, i.e., lose its high viscosity and flow into the chimney. Hence, progress into the hole was made by circulating out the gel to 5, 351 ft KB. Below 5, 351 ft KB, it was necessary to mill through crushed casing over the following intervals: 2 ft at 5, 351 ft, 2 ft at 5, 452 ft, 1 ft at 5, 484 ft, 4 ft at 5, 494 ft and 43 ft at 5, 506 ft, all depths KB. Only 5 ft of hole was made below 5, 549 ft KB with returns being formation plus metal. Apparently the hole was milled through the 10-3/4-in. casing at about 5, 551 ft KB.

Due to continuing difficulties, it was decided to abandon the well below 5, 350 ft KB and proceed with alternate reentry plan number one, described in Reference 2 as follows. A whipstock was set at 5, 322 ft KB. A mill was used to drill out of the 7-in. and 10-3/4-in. casings. Drilling continued outside the casings to a total depth of 5, 706 ft KB with no drilling mud returns at all below 5, 633 ft KB. Gas pressure was encountered and recorded at the surface at 5, 671 ft KB. The well was then completed (Figure 7) and, after a 1-3/4-hour flow test through the DWC unit to ensure adequate communication with the chimney, the drill rig was released. The well was then ready for connection to the production and testing equipment. The daily drilling reports for reentry are presented in Appendix A.

3.2 SCHEDULE AS ACHIEVED

The schedule of the major elements of the Reentry Drilling Program, as achieved is shown in Figure 8.

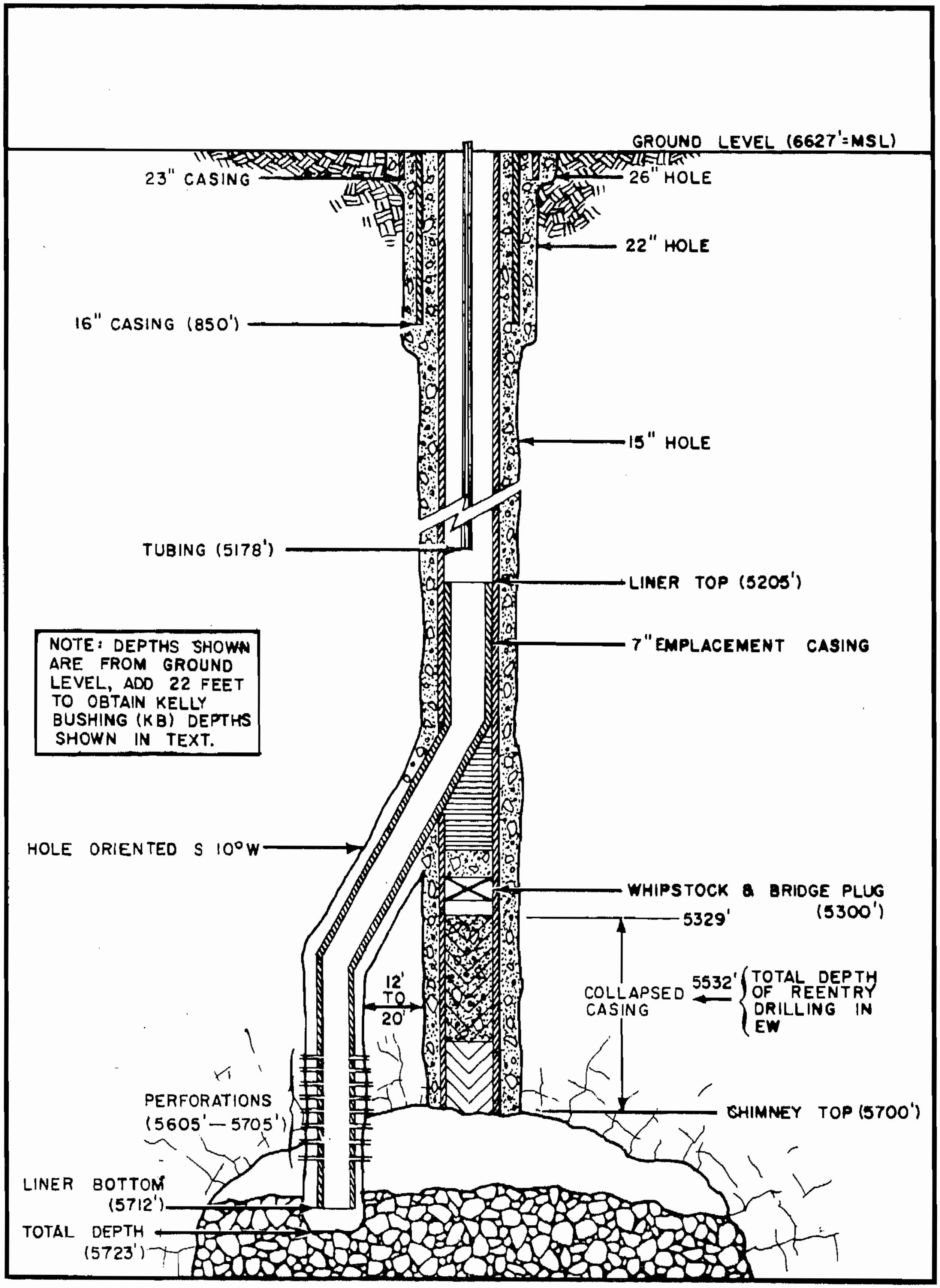

Figure 7. Schematic of completed reentry well.

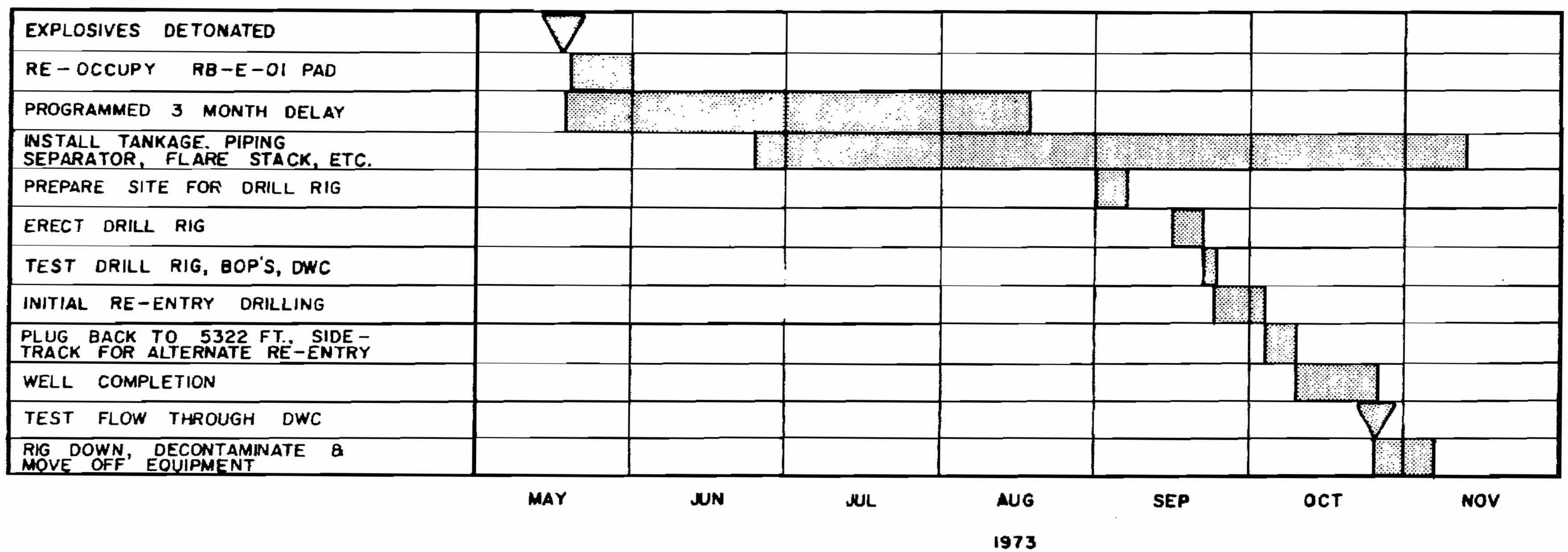

Figure 8. Reentry drilling schedule as accomplished.

4. PRODUCTION TESTING

4.1 GENERAL

The objectives of the production testing program were:

1. A production period to measure the pressure drawdown occurring within the chimney in relationship to the quantity of gas produced in order to calculate chimney volume and effective fracture volume.

2. A long-term pressure buildup to determine the extent of fracturing and virgin reservoir characteristics.

3. Quantitative analysis of the produced gas to determine its physical components including radioactive species and to determine the degree of communication between chimneys.

4. Detailed analysis of results compared to predictions.

4.2 SITE LAYOUT

Figure 9 indicates the location of the components for the two production testing phases. Due to the problems encountered from the high temperature of the flowing gas, the first production test was shortened in order to make certain modifications, including installation of three fin-fan coolers ahead of the separator to drop the temperature of the flowing gas to an acceptable level. The flow configuration of the produced gas and the separator products is shown in Figure 10.

4.3 EQUIPMENT

Prior to and during the reentry drilling, installation of the production and testing equipment progressed. Water and condensate storage tanks, water disposal pump, separator, critical flow prover, gas sampling spool, and flare stack were installed. The piping connecting the various components was fabricated and installed. The instrument control piping was completed to provide control gas to various instruments as well as natural gas to the pilot lights on the flare stack and heaters in the water storage tanks and separator. The control panel with its alarm and monitoring functions was installed and signal cable terminated to its appropriate device and tested. Tubing was connected to the gas sampling spool and run to the gas conditioning skid which supplied dry gas to the RSC and TRY-KRY trailers for sampling. With rig, BOP, and DWC removed, it was necessary to reroute and install additional flow piping for the production testing of the well. As the piping was assembled into the various systems and neared completion, each line was pressure tested to ensure against leaks.

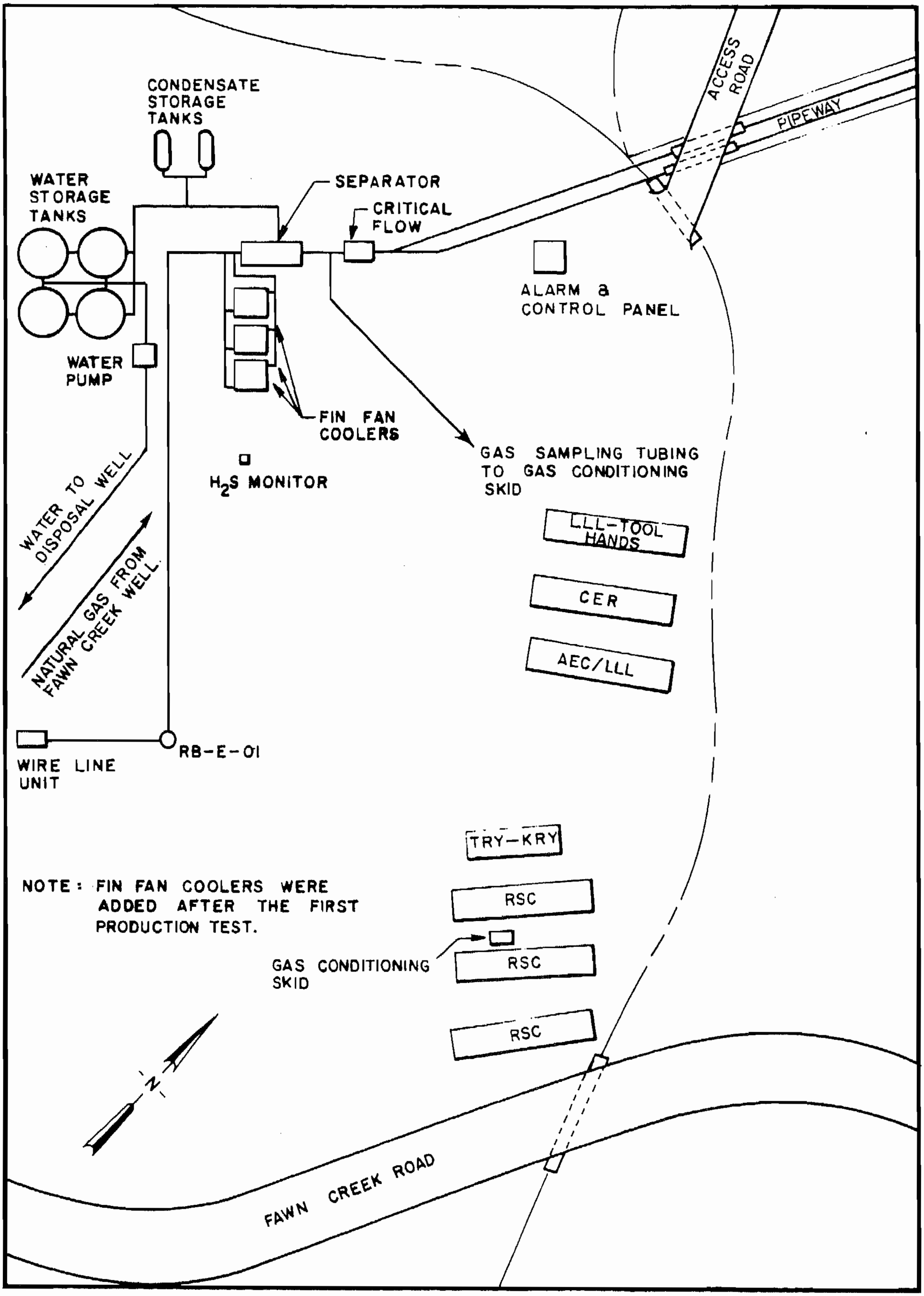

Figure 9. Layout of facilities during production testing.

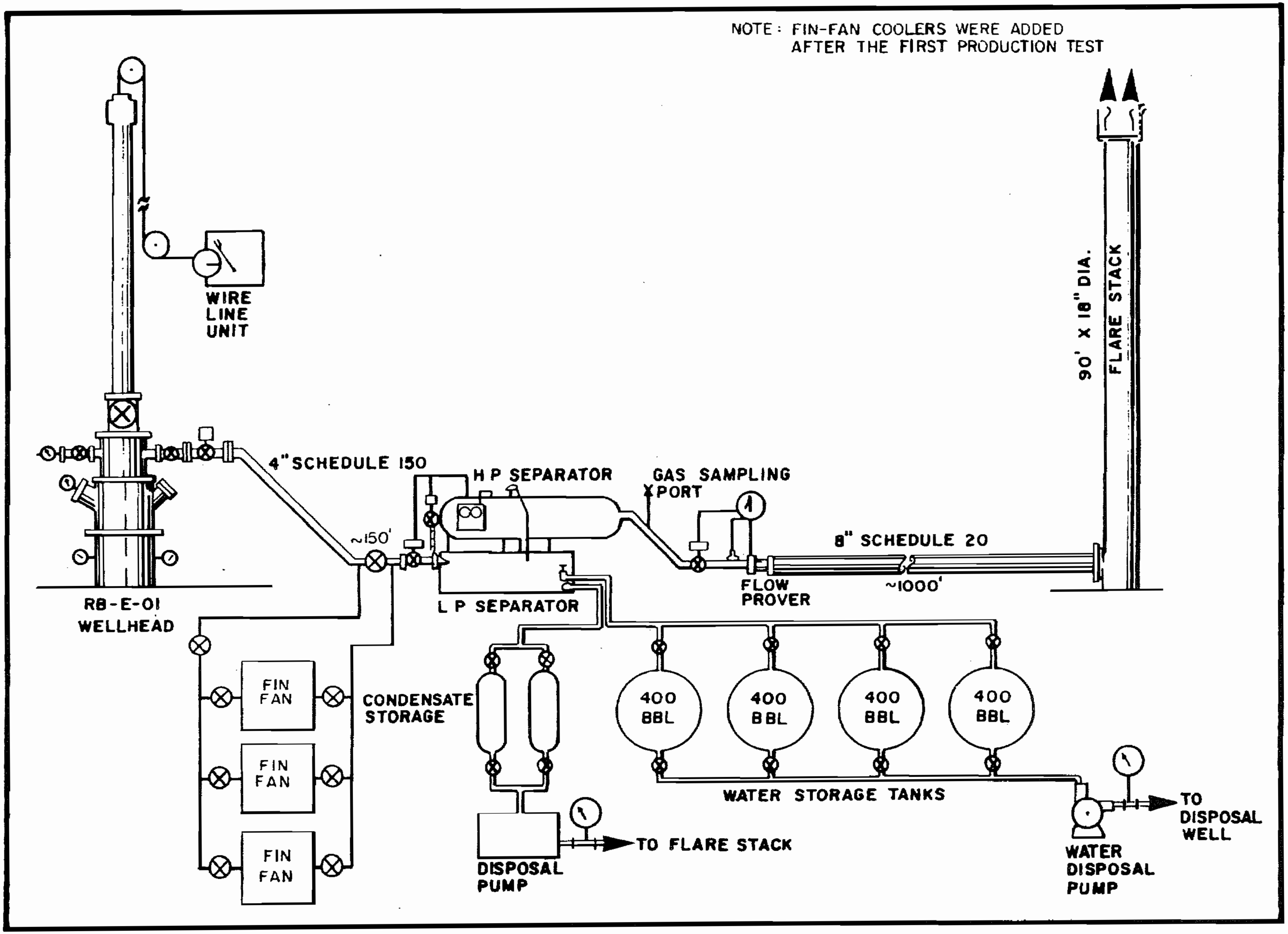

Figure 10. Flow configuration during production tests.

The wellhead configuration was modified for production testing and handling of the downhole pressure and temperature instruments as indicated in Figure 11. With winter approaching, it was necessary to apply heat tape, insulation, and a weatherproofing material to all flow lines (such as piping, valves, pumps, and filters) which would contain water prior to the start of production testing. These flow lines were:

1. Separator water outlet to the water storage tanks.

2. Interconnecting piping between the four water storage tanks.

3. Water storage tank outlets to and including water disposal pump, filters, and water disposal line to Fawn Creek Government Number 1 Well, about 1,300 ft away.

4. Separator condensate outlet to the condensate storage tanks including a bypass line to the water storage tanks. This line was protected since during the first production testing the high temperature of the gas stream was causing water vapor to appear in the condensate portion of the separator. Upon discharging from the separator to the condensate storage tanks, the water was subject to freezing.

5. Wet gas sampling lines at the wellhead.

6. Water line from water supply well RB-D-01 to the fresh (uncontaminated) water storage tank.

7. RSC gas sample line from sampling ports downstream of separator to the gas conditioning skid adjacent to the RSC laboratory trailers.

Before the start of production testing, drip pans had been installed in the wellhead cellar, under the separator and the water disposal pump, and in a decontamination area.

At the conclusion of the production testing, drip pans were cleaned and contaminated items were put in barrels and stored for future disposal.

Sampling ports were provided to allow collection of fluid samples at the following locations

1. Fawn Creek Government Number 1 Well natural gas supply could be sampled near the EW wellhead fixture, while associated water could be sampled at the Fawn Creek separator.

2. The emplacement well nuclear stimulated gas could be sampled at a EW wellhead fixture, downstream of the separator, and downstream of the critical flow prover.

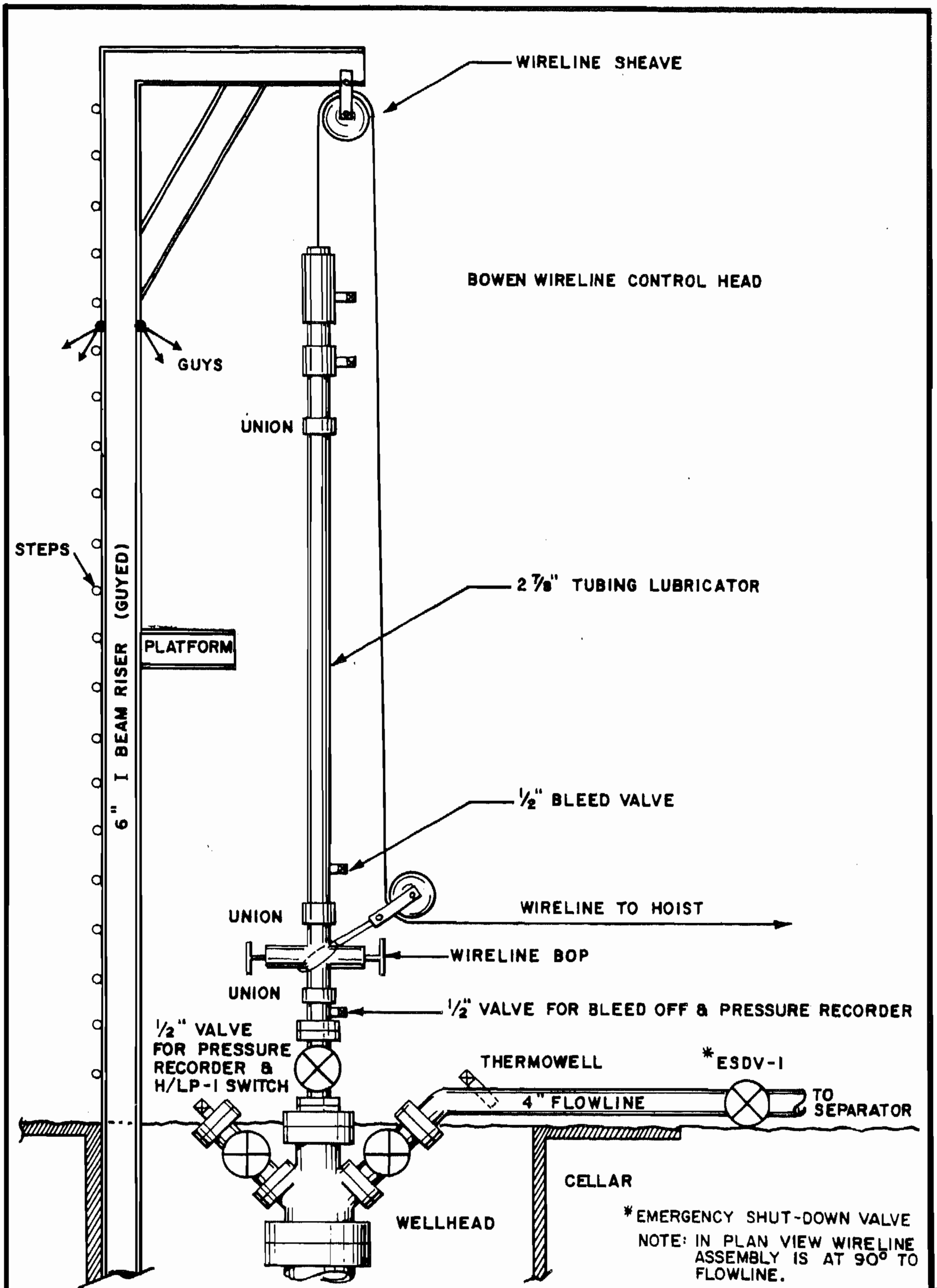

Figure 11. Schematic of RB-E-01 wellhead and lubricator for production testing.

3. Condensate sampling ports were located at the condensate storage vessles and the separator.

4. Water sampling ports were provided on each water storage tank, at the separator, and on the eight-in. flow line to flare stack.

4.4 TEST SCHEDULE FLOW RATE AND DURATION

The original test schedule called for one flow period lasting 10 days at a constant rate of approximately 30 MMSCFD followed by a long-term buildup. However, the conditions encountered dictated otherwise and the test schedule was modified as the first flow period was in progress.

The initial flow rate, beginning at 1245 hours on November 14, 1973, was approximately 5 MMSCFD. At 1440 hours, the flow rate was increased to approximately 15 MMSCFD. At 1500 hours, the emergency shutdown valve automatically shut in the well because of a false alarm. At 1550 hours, the well was again flowing at approximately 15 MMSCFD. At 1750 hours, the flow rate was increased to 24 MMSCFD; however, lift off and flame out of the gas stream was occurring at the flare stack. At 1800 hours, the flow rate was reduced to approximately 15 MMSCFD. From 1900 to 2200 hours, a steady flow rate of approximately 15.4 MMSCFD was maintained. At 2200 hours, the well was manually shut in because of operating difficulties.

It was necessary to stop the production test from 2200 hours, November 14, to 1135 hours, November 16, 1973, to correct some of the operating difficulties resulting from high temperatures. The corrective actions were as follows:

1. The separator was partially plugged and was cleaned.

2. A regulator on the separator was leaking water (steam) and this was corrected.

3. A valve on the separator was leaking through its plug seal and would not completely shut off the flow. This condition was partially corrected.

4. The emergency shutdown valve at the well was inoperable since it was in a bind because of thermal distortion of the flowline. This condition was corrected.

The production testing resumed on November 16, 1973, at 1135 hours, and was concluded on November 20, 1973 at 1007 hours because of the high operating temperature and the significant decrease in bottom hole pressure. During the initial production and testing of the gas, November 14 through 20, 1973 (with the exception of down time from 2200 hours, November 14 to 1152 hours, November 16, 1973), the operating temperature of the separator steadily and gradually increased to a maximum of 345 °F just prior to shut in on November 20, 1973, as shown in Figure 12. The temperature of the flowing gas at the wellhead was approximately 25 °F higher. The time history of the bottom hole pressure and temperature during the same time period is shown in Figure 13. The pressure and temperature data are presented in Appendix D-1.

During the production testing, hydrogen sulfide gas (H_2S) was detected in the gas stream. Its odor was evident at the EW pad and its source was found to be the elevated exhaust of the sample gas at the RSC laboratory trailers. Increasing the elevation of the exhaust eliminated the odor. However, in the interest of personnel safety, a hydrogen sulfide detection instrument with alarm was procured and installed in the vicinity of the personnel trailers. It was also necessary to replace the carbon steel wire on the wire line unit used to suspend the pressure and temperature instruments within the well with stainless steel wire. H_2S causes embrittlement and probable failure of carbon steel wire which might have resulted in the loss of the instruments downhole.

At the conclusion of the first production test, steps were taken to decontaminate the various items of equipment such as the separator, wellhead, cellar and other appurtenances in the wellhead area, drip pans, condensate storage, and the water storage areas.

One valve on the separator was found to be badly eroded and was replaced. Other valves checked were found to be satisfactory as well as all other production test equipment.

The data obtained during the first production test, including the analyses of gas samples taken periodically during the flow test, provided no evidence of flow communication between the top chimney and the lower ones. The rate of decrease was consistent with communication with only the top chimney. Analysis of the produced gas failed to reveal any significant quantity of tracer gas which had been added to the middle chimney.

During the period between the two production tests (November 21, 1973 to January 28, 1974) three fin-fan coolers were added in parallel into the gas flow stream between the wellhead and the separator to solve the high-temperature operating condition problem. The addition of the three fin-fan coolers was found to provide adequate cooling of the produced gas. With the fin-fan coolers in operation, the separator operating temperature was generally in the range of 105 °F to 150 °F, and never exceeded 180 °F, well within the normal temperature operating range of the separator, even though the flowing gas temperature measured at the wellhead increased rapidly and remained close to 400 °F (204 °C). The time history of the temperatures is shown in Figure 14.

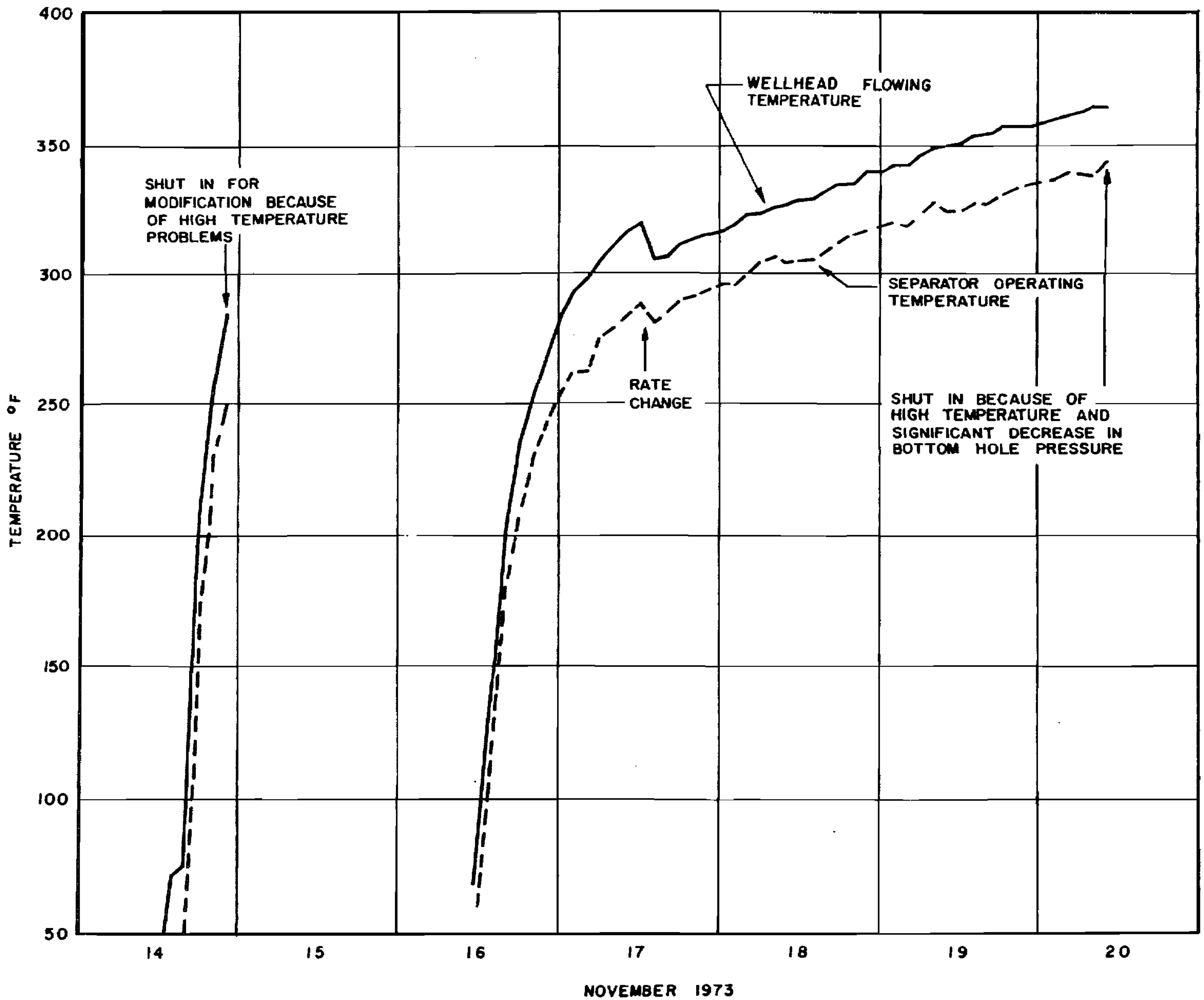

Figure 12. Time history of operating temperatures, first production test.

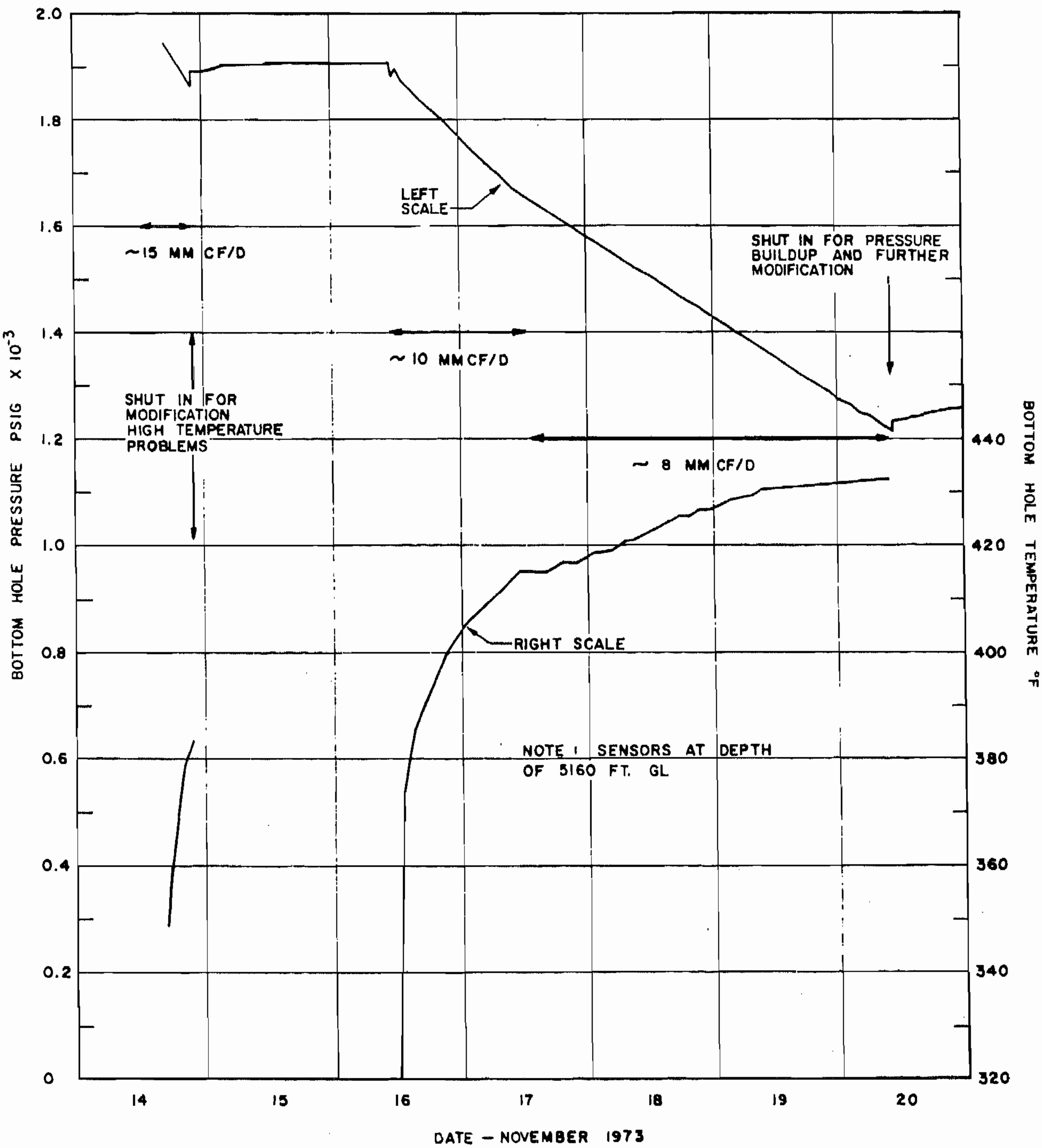

Figure 13. Time history of bottom-hole pressure and temperature, first production test.

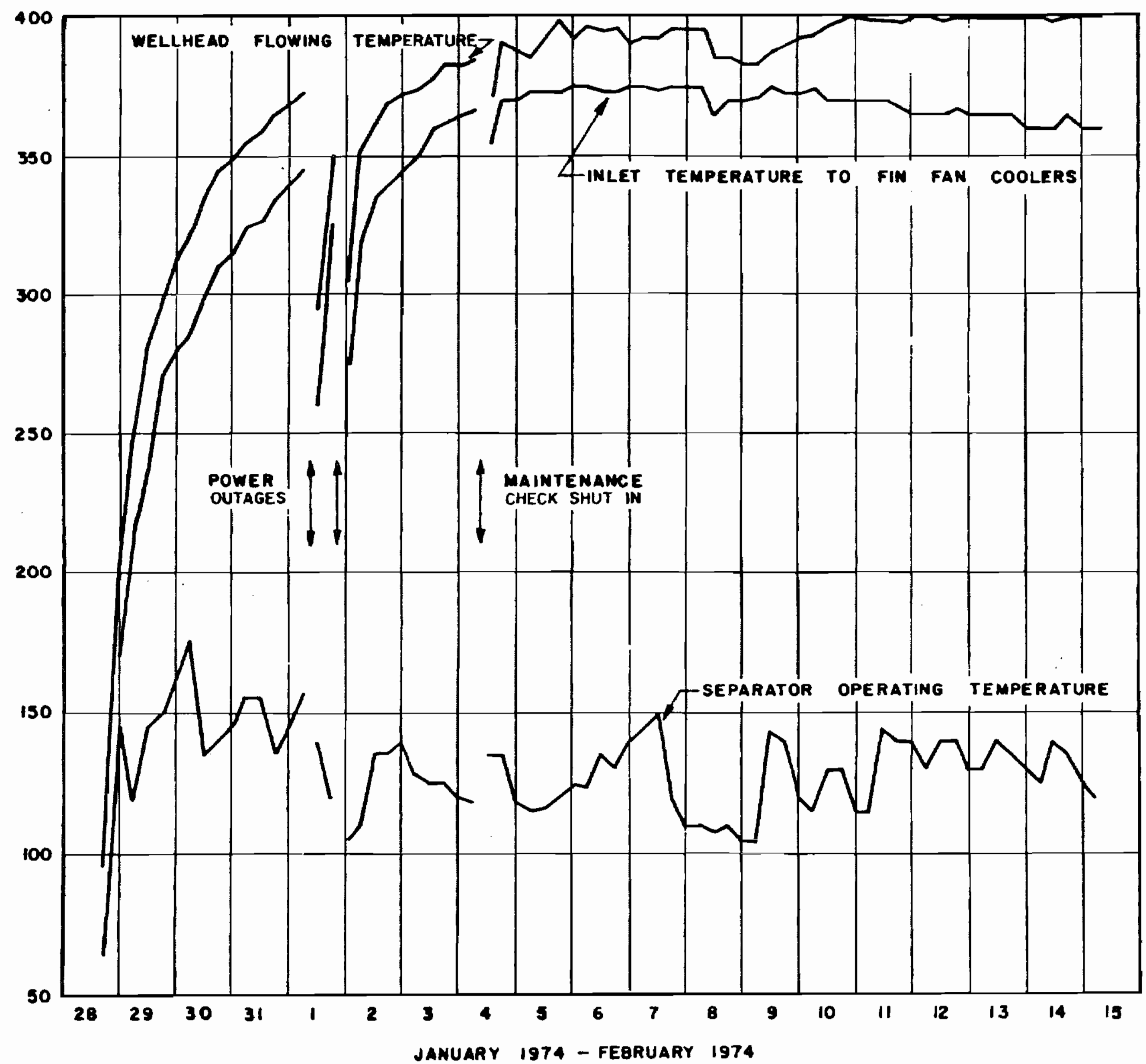

Figure 14. Time history of operating temperatures, second production test.

Also during the second flow test, commercial electric power failed twice (blown fuses due to overload) on February 1, 1975, for a few hours and production testing was halted because the fin-fan coolers and the water injection pump were inoperable. After the second fuse failure, a larger transformer was installed to power the fin-fan coolers and the water injection pump.

However, general concern was expressed about the possibility of a total commercial power failure which would result in all the water flow lines being without electrical power for the heat tapes and thus being subject to freezing and bursting. A 37.5-kVA generator was connected in a standby configuration through a manual transfer switch to the electric distribution panel so that, in the event of a commercial power failure, the heat tapes on the water lines on the EW pad would continue to protect the lines. The alarm and control panel, minimum exterior lighting, and personnel trailers were also placed on this circuit. Sufficient power would not be available from this standby generator to operate the water injection pump, fin-fan coolers, or heating tapes on the water disposal line to the Fawn Creek Government Number 1 Well. Therefore, these operations would necessarily cease until commercial electric power had been restored.

Bottom hole pressure was monitored during the pressure build up following each of the two production tests of RB-E-01. The data for the first build up, from November 20, 1973, to January 28, 1974, are listed in Appendix D-2 and are plotted in Figure 15. The pressure and temperature data for the second drawdown and the pressure data for the following pressure build up are shown in Figures 16 and 17, respectively. The pressure and temperature data for the second drawdown are listed in Appendix D-3, while those for the second build up are given in Appendix D-4.

Monitoring of the bottom hole pressure build up after the second drawdown was terminated on June 24, 1975, 494 days after shut in.

With respect to water production at the separator during drawdown of the RB-E-01 Well from the nuclear chimney, the predetonation predictions contained in Volume III of Reference 2 postulated that about 20 bbls, 7,000 lbs, of free water would be produced with each million SCF of total gas flowed. This prediction was based on published data(4) of water content of natural gas and on the assumptions that the initial downhole pressure and temperature were 2500 psi and 450 $^{\circ}$F, respectively, and that the separator was operated at 1000 psi and 300 $^{\circ}$F. The prediction also assumed a pressure drawdown of about 30 percent. It was found during the first production test that the downhole pressure was about 80 percent of the assumed value but that the bottom hole temperature was close to the assumed 450 $^{\circ}$F. The lower initial bottom hole pressure resulted in the production of water at an initial rate of about 10,700 lbs/MMSCF total gas, increasing to 16,600 lbs/MMSCF total gas at the end of the first drawdown. During the second drawdown, which was continued until the total gas leaving the chimney was over 80 percent steam, the water

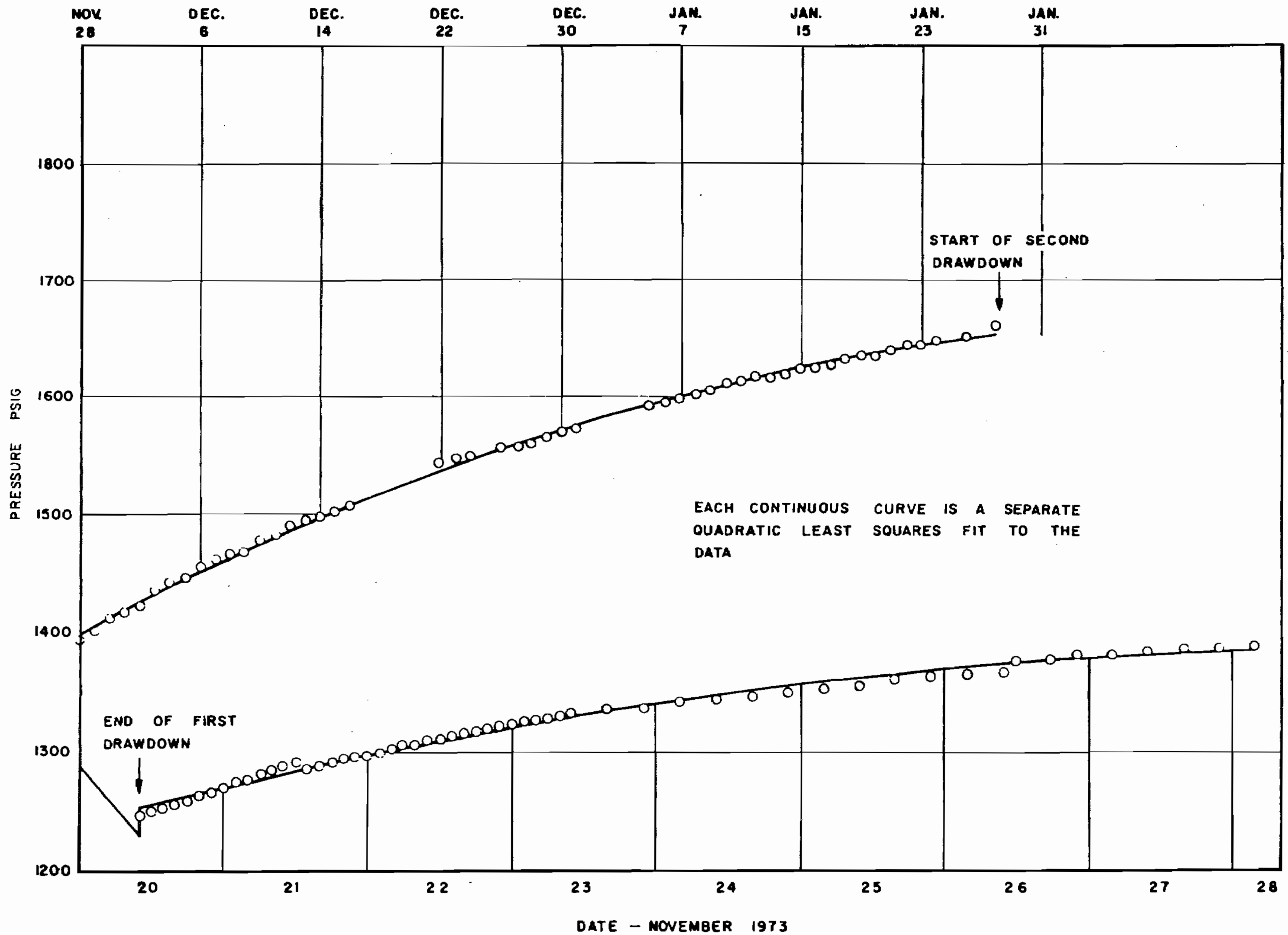

Figure 15. Bottom hole pressure buildup, RB-E-01, after first production test.

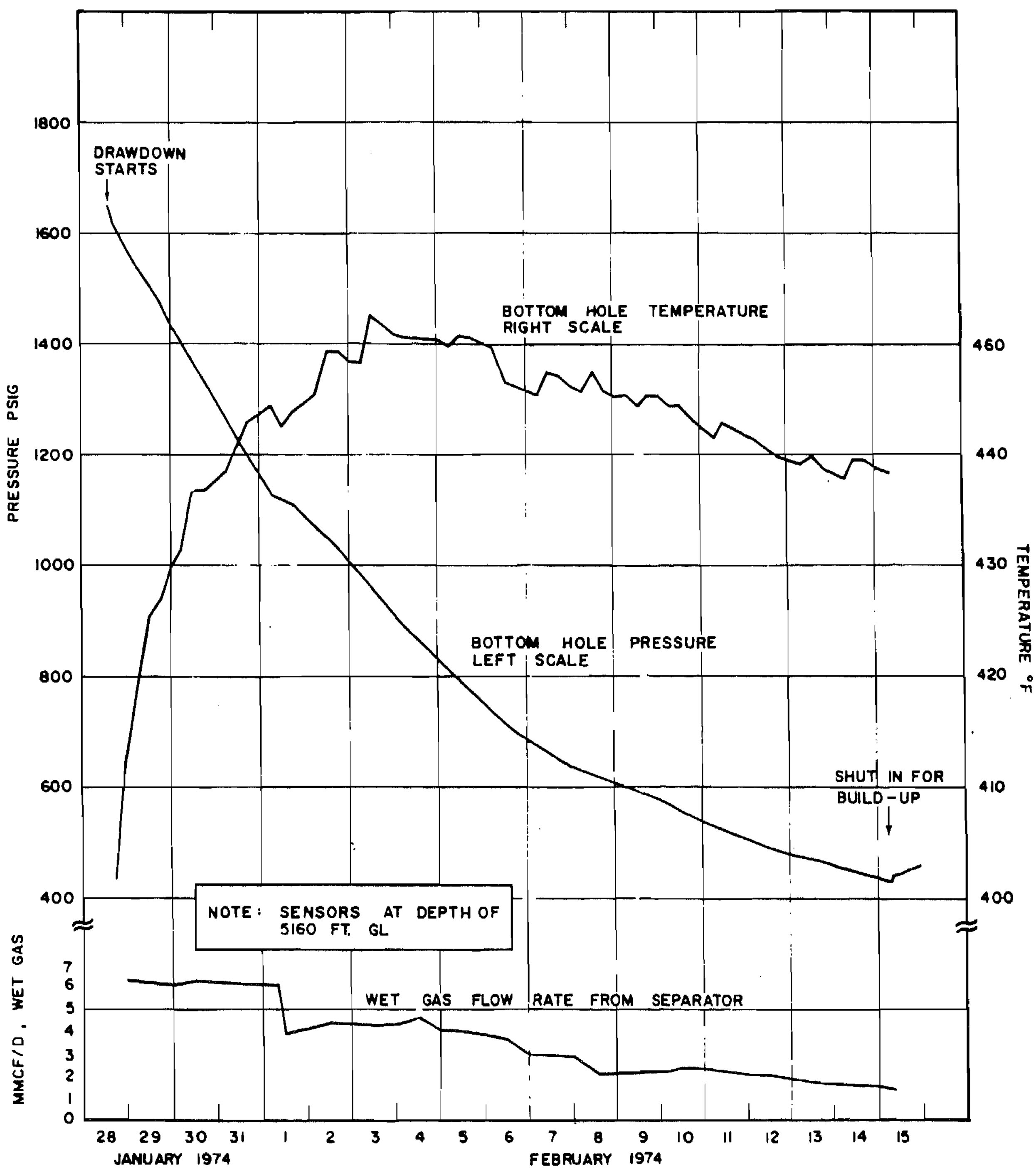

Figure 16. Time history of bottom hole pressure, temperature and flow rate, second production test.

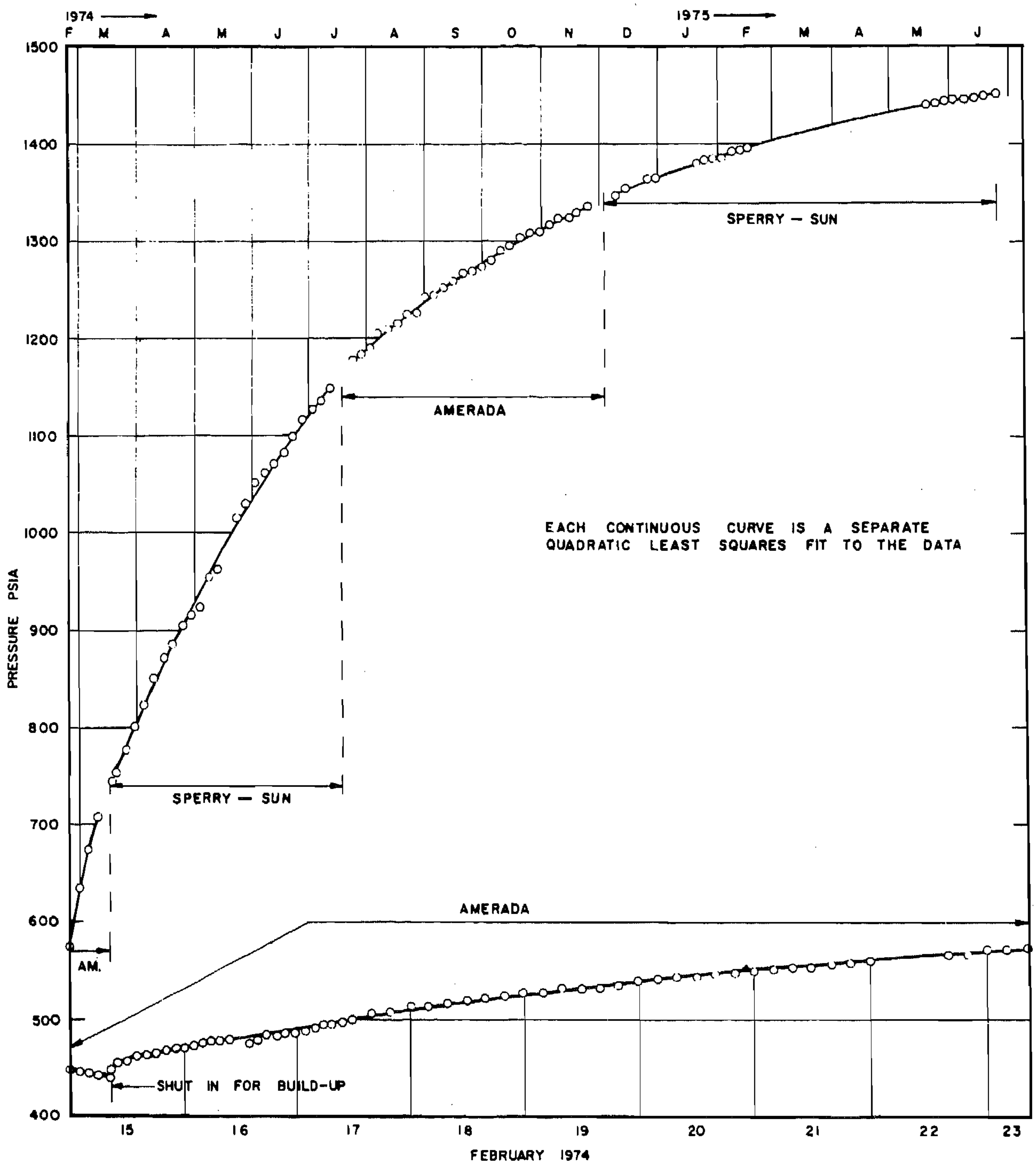

Figure 17. Bottom-hole pressure buildup, RB-E-01, after second production test.

production rate climbed steadily to 38,200 lbs/MMSCF total gas. The time history of the ratio of water produced to total gas volume is shown in Figure 18, with correlative bottom hole pressures.

4.5 AUTOMATION AND ALARM SYSTEM

4.5.1 Instrumentation

In many locations it was possible to use visual monitoring, of a sight gauge such as a thermometer or sight glass, to determine whether operating conditions were satisfactory. However, experience has taught that thermometers can malfunction and the sight glass become opaque, misleading operating personnel into believing that operating conditions were satisfactory where in reality danger existed. For this reason, instrumentation for the production testing was duplicated in many instances. As an example, temperature of the gas flowing from the wellhead was observed on a direct reading mechanical thermometer; however, a few feet away was a high-temperature automatic shutdown switch, thermostat controlled (electronic), connected to the alarm panel and emergency shutdown valve at the wellhead. Thus, the mechanical thermometer could fail but the operating personnel would be aware of the automatic shutdown from a high-temperature condition. These systems were tested prior to production of the well to ensure their operation.

4.5.2 High- and Low-Level Alarms

The high- and low-level alarm instrumentation consists of a float switch which activates a signal lamp at the control panel. The high- and low-level switches were used in each of the four water storage tanks. The high-level alarm would indicate the tank was full and no further filling should occur or the tank would overflow via piping to the next tank, etc., until all four alarms were activated. Additional filling would trigger the fifth alarm which would automatically shut in the well before spilling out of the tankage could occur.

The low-level alarm was also used in each of the four water storage tanks to indicate to the personnel that a tank was empty. The alarm automatically shut down the high-pressure water disposal pump. There was also a visual gauge on the exterior of the tanks that indicated depth of fill.

The two condensate storage vessels had instrumentation similar to that on the water storage tanks; i.e., high- and low-level signals, high-level automatic shutdown and a sight glass to determine depth of fill.

The high-pressure water disposal pump was equipped with a high- and low-pressure limit switch. The high-pressure switch was preset in order not to overpressurize the disposal well or interconnecting piping. The switch also reacted on startup if the water disposal line froze or the water filters were plugged by immediately shutting down the pump. The low-pressure switch would indicate a ruptured line and stop operation of the pump.

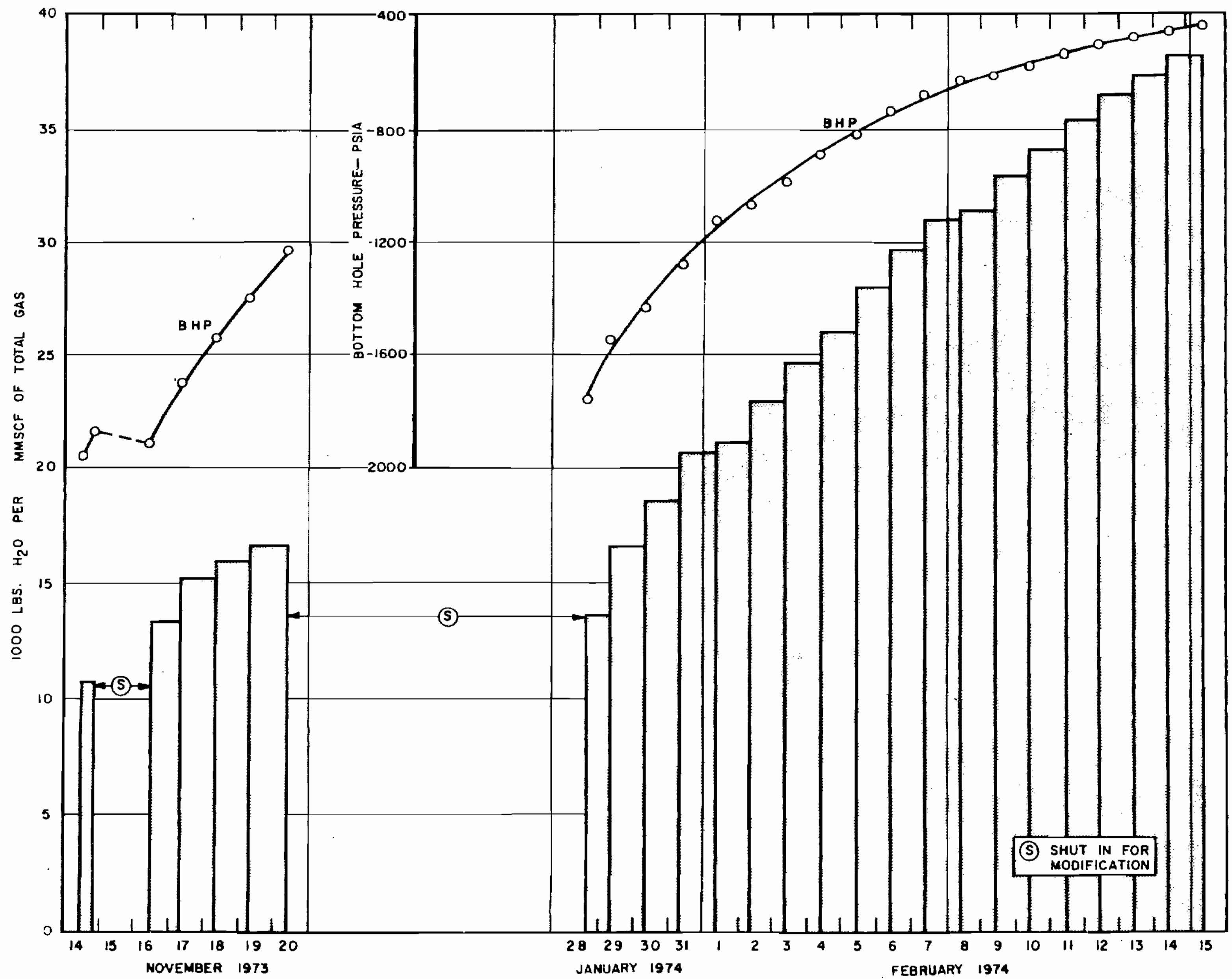

Figure 18. Time history of water production (kilopounds) per unit volume (MMSCF) of total gas flow, with correlative bottom-hole pressures.

The flare stack ignition system utilized electrical arcing to ignite the pilot gas and flame sensors detecting heat from the pilot flame controlled the electrical arcing. If the pilot flames were extinguished, the heat sensor automatically started the ignition sequence again, and activated an alarm light on the alarm panel until the pilot flame was re-ignited.

The Alarm and Control Panel (Figure 19) controlled and monitored the safety functions during the production testing of the well. The separator was equipped with three safety devices. A low-pressure switch would be activated if there were a rupture in the system and the well would be shut in.

A high-pressure switch would also shut in the well if there were no downstream flow past the separator. This could be caused by freezing, plugging, or closing the flow line choke valve downstream of the separator. A flow switch would be activated. If the pressure relief disc were to rupture and allow the gas to flow through the separator to the flare stack without removing the liquids, the well would be shut in by the consequent activation of a flow switch.

A high- and low-pressure switch was installed at the wellhead. The low-pressure switch would be activated by plugging of the well or rupture of the surface piping system and would shut in the well. The high-pressure switch was preset in order not to overpressurize the piping and equipment downstream of the well. The well would also shut in if the switch was activated.

The principal control valve for shutting in the well automatically is the emergency shutdown valve located immediately downstream from the wellhead. This valve requires pneumatic pressure to operate and was therefore connected to the instrument control gas supply. Loss of gas pressure automatically closes the valve. The valve is electrically controlled from the alarm and control panel. In addition to this emergency shutdown valve, a shutdown valve was located at the inlet of the separator, water disposal system, and condensate disposal system. Any malfunction, whether true or false, that triggers the emergency shutdown valve also closes the additional shutdown valves. A bypass switch was installed so that the water disposal system could operate even though the well was shut in.

4.6 OPERATIONAL PROCEDURES

Two persons were on duty around the clock during the production testing of the well. The two personnel monitored the production equipment for normal functioning and recorded data and operating details for evaluation. In the case of an emergency, two persons could take corrective actions more quickly than one. In any event, the presence of H_2S required that two persons be on hand as a safety measure.

During the production testing of the well, the following data were recorded on an hourly basis by the operations personnel:

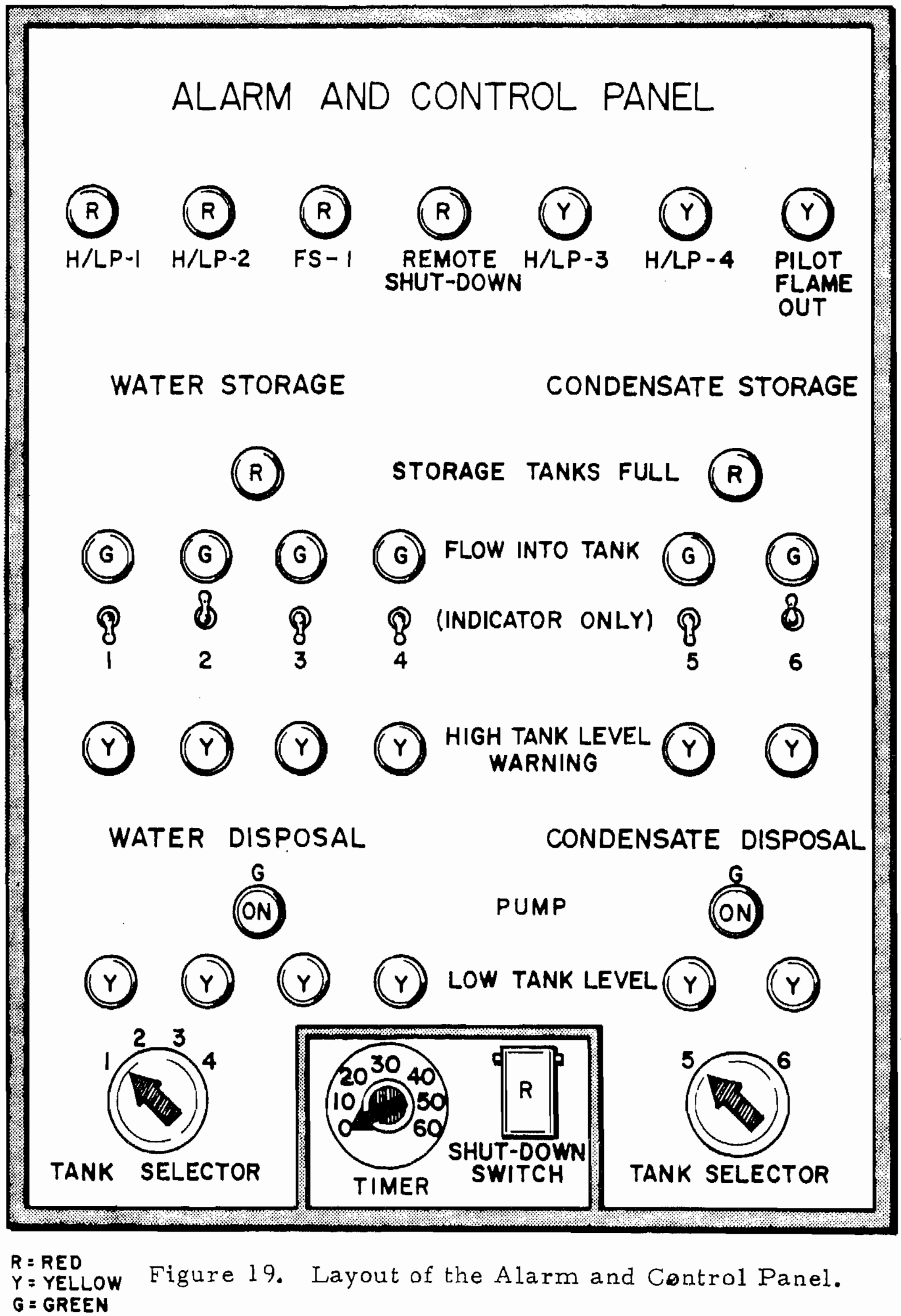

Figure 19. Layout of the Alarm and Control Panel.

1. Date
2. Time
3. Operators initials
4. Wellhead readings

    a. Casing pressure in psig
    b. Tubing pressure in psig
    c. Flowing temperature in degrees F.

5. Separator Readings

    a. Instrument gas pressure in psig
    b. Operating temperature in degrees F.
    c. Operating pressure in psig
    d. Cumulative water production in barrels
    e. Tank number receiving water
    f. Cumulative condensate production in barrels
    g. Tank number receiving condensate
    h. Remarks

6. Fin-Fan Coolers (second production test only)

    a. Inlet temperature in degrees F.
    b. No. 1 outlet temperature in degrees F.
    c. No. 2 outlet temperature in degrees F.
    d. No. 3 outlet temperature in degrees F.

7. Main Gas Line Orifice Readings

    a. Plate sizes
    b. Upstream pressure in psig
    c. Upstream temperature in degrees F.
    d. Downstream pressure in psig

8. Wet gas flow rate in MMSCF/D
9. Specific gravity relative to air of gas
10. Water tank levels

    a. Water tank #1 depth measurement in feet
    b. Water tank #2 depth measurement in feet
    c. Water tank #3 depth measurement in feet
    d. Water tank #4 depth measurement in feet

11. Condensate tank levels

    a. Condensate tank #5 depth measurement in feet
    b. Condensate tank #6 depth measurement in feet

12. Water injection system readings

    a. Water pump injection pressure in psig
    b. Cumulative water injection amount in barrels (two meters)
    c. Suction tank number

13. Condensate injection systems readings. These data (similar to those for the water injection system) were not taken because no condensate was found during the production tests. However, the pump and meters were used, and data recorded, for transfer of dilution water to the water tank being used during part of the first production test to minimize boiling of the separated water.

Considerable use was made of telecopiers to transmit data and other documents to the GJCP and elsewhere. Production test data generated by the operations personnel in the field were sent via telecopier to the GJCP where the data was typed on the appropriate forms, telecopied to the EW for approval, and then transmitted via mail or telecopier to interested project participants.

A copy machine located in the office trailer at the EW provided copies of approved data to interested project participants in the field.

4.7 GAS SUPPLY/WATER DISPOSAL WELL

The Fawn Creek Government Number 1 well, located about 1,340 ft S18°W of the EW, was stemmed prior to the detonation of the nuclear explosives as a containment precaution. A Baker Model D packer was set at 5,653 ft KB. A Baker Model C retrievable bridge plug was set at 5,580 ft KB. The well was then stemmed with sand to 5,530 ft KB and cement to 4,377 ft KB.

As tentatively planned, the well was reentered in June, 1973, and recompleted in September, 1973, as both a gas producing well and a contaminated-water disposal well. Reentry operations commenced on June 19, 1973. The top of soft cement was tagged at 4,364 ft KB and the cement was drilled out with no problems until a depth of 5,524 ft KB was reached on June 26, 1973, when the bit encountered metal. The problem was identified as collapsed casing at and below the bottom of the cement plug. Twenty-one more days of milling through the collapsed section, which had a minimum apparent bore of 3-1/2 in., were required to tag the Model D packer at 5,654 ft KB. Attempts to remove the Model D packer were unsuccessful, as also were attempts to mill out the bottom slips and allow the packer to drop down hole. The packer was finally left open at a depth of 5,667 ft KB.

The well was first recompleted on August 4 with a Baker Lockset packer on 2-1/16-in. tubing set at 5,643.5 ft KB and 1.9-in. tubing run to 5,572 ft KB. Attempts to bring the well into production from the perforated zone, 5,600 to

5,630 ft KB, including an acidizing treatment of the zone on August 24, were not successful and the decision was made about August 31 to kill the well for a planned fracture of the zone 5,082 to 5,128 ft KB. This was accomplished on September 8 and the well flowed back successfully. On September 12 the well was tested through a critical flow prover at rates up to about 500 MCF/D.

The well was again killed and recompleted with a Baker Model FH hydrostatic packer on 2-1/16-in. tubing set at 5,293 ft KB. A Baker F plug nipple was located at 5,288 ft KB. The 2-1/16-in. tubing was hydrotested joint by joint as it was run in the hole. Two bad joints were rejected. The 1.9-in. tubing for gas production was run in and landed at 5,084 ft KB. The well was swabbed in and flowed to the pit to clean up. At the time of shut in on September 17, 1973, the estimated flow rate was 450 MCF/D.

The detailed daily drilling reports are given in Appendix B. The as-built downhole completion detail is shown in Figure 20.

After the workover rig was removed, the wellhead was enclosed in an insulated wood-frame structure and an explosion-proof electric heater was installed for the winter operations. A conventional 3-phase separator was installed on the Fawn Creek Government Number 1 Well pad and connected to the wellhead fixture to supply gas for the Project Rio Blanco production and testing program. Two high-pressure pipe lines were laid to the EW area, one for the natural gas supply and the second for the water disposal line. The water disposal line was heat taped, insulated, and wrapped with plastic sheeting to weatherproof the insulating material.

Use of the Fawn Creek Government No. 1 well as a disposal well for contaminated water separated out during the two productions required the permission of the Colorado Water Quality Control Commission, and the consequent issuance of a permit by the Colorado Department of Health. Application for such a permit was made on June 11, 1973, and a public hearing held before a Hearing Officer for the Water Quality Control Commission on September 24, 1973. The text of the Findings of Fact by the Hearing Officer and of the Permit for Subsurface Disposal, which was issued on November 9, 1973, are given in Appendix C. The principal stipulations of the permit were that the volume of water injected could not exceed 24,000 bbls and the tritium concentration could not exceed 0.05 microcuries per milliliter (μCi/ml) while the injection pressure could not exceed 1800 psig.

During the first production test, about 1873 bbls of water were produced at the separator and stored for analysis prior to disposal. Dilution of the produced water with fresh water to drop the temperature below the local boiling point (200 ^{o}F) and decontamination of equipment raised the volume of water to be injected to 3378 bbls, with an average tritium concentration of 0.029 μCi/ml, well within the disposal permit limitations.

During the second production test, when the bottom-hole pressure was allowed to drop to a value just above the steam point, about 11,470 bbls of

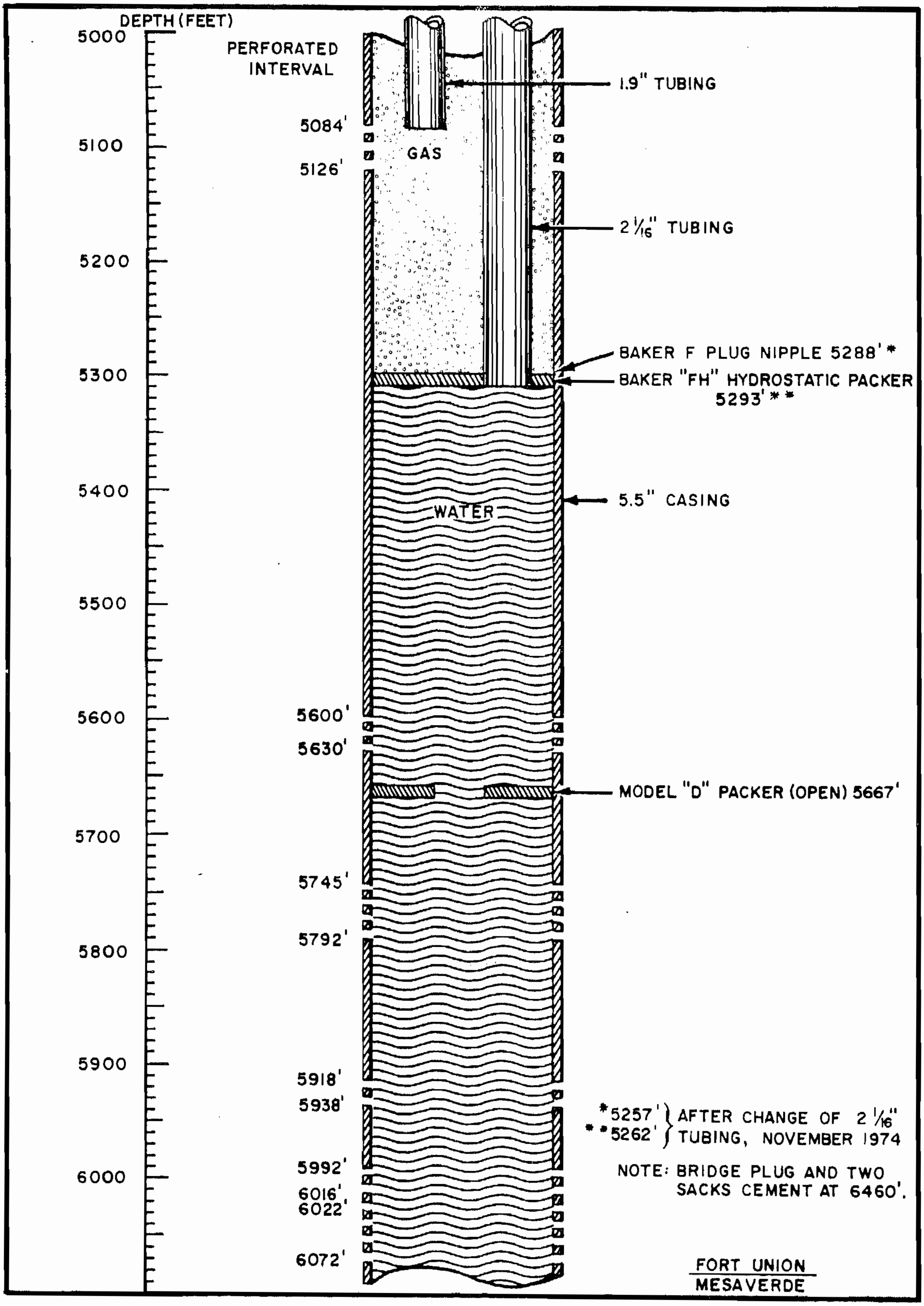

Figure 20. As-built downhole completion detail, Fawn Creek Government No. 1 Well.

water were separated and stored for analysis and subsequent disposal. The Colorado Water Quality Control Division was requested on January 16, 1974 to relax the limit on tritium concentration from 0.05 μCi.ml to 0.075 μCi.ml, in the light of expert testimony before the Hearing Officer that the value of 0.05 μCi/ml was a best estimate with some probable error. The request was denied, however, unless further public hearings were held on the question. Because completion of preparations for the second production test was imminent, the decision was made to proceed under the existing limitation, and to dilute the water to the required concentration upper limit. Accordingly, a total of 17,459 bbls were injected during the second production test with an average tritium concentration of 0.048 μCi/ml. Without dilution, the average tritium concentration of the separated water was 0.074 μCi/ml, just under the proposed amended value. The cost of the additional effort required to dilute has not been evaluated, but it was certainly a small fraction of the costs of additional public hearings, legal fees, and personnel, and other costs associated with project delays.

During the course of the second production test, some tenuous evidence was obtained that small amounts of tritium were being found in liquids produced with the gas from the Fawn Creek Government No. 1 well. After completion of laboratory analyses of gas and water samples and evaluation of the data, it was concluded[5] that the data were inadequate to determine the source or magnitude of the observed tritium activity or the mechanism for the occurrence of the activity in the produced liquids.

To answer the questions, tests were performed on the well over the period April 5-11, 1974, inclusive. A plug was set in the injection string on April 5, 1974; the string was pressurized with fresh water and the pressure recorded for a period of 88 hours. A pressure drop was observed which was equivalent to a leak rate of one gallon per day flowing into the gas producing annulus. The well was flowed to the mudpit for a period of 48 hours, and was periodically sampled for tritium in the gas and in the water. All gas samples were negative with respect to tritium. The initial water samples showed tritium concentrations in the neighborhood of 2500 pCi/ml. The concentration decreased to one-third of that value by the end of the test.

Evaluation of the tritium concentrations and the volumes of water involved lead to the conclusion that the data were consistent with the leak rate of one gallon per day observed in the pressure test.

Remedial action was later taken in November-December 1974, prior to resumption of further testing activities in a new sidetracked well, RB-AR-02 (which are beyond the scope of this report), in the form of replacement of the 2-1/16-in. injection string. The final downhole configuration is shown in Figure 20. The daily reports for this operation are included in Appendix B.

4.8 SCHEDULE

The schedule as accomplished of the production testing and pressure buildup monitoring is shown in Figure 21.

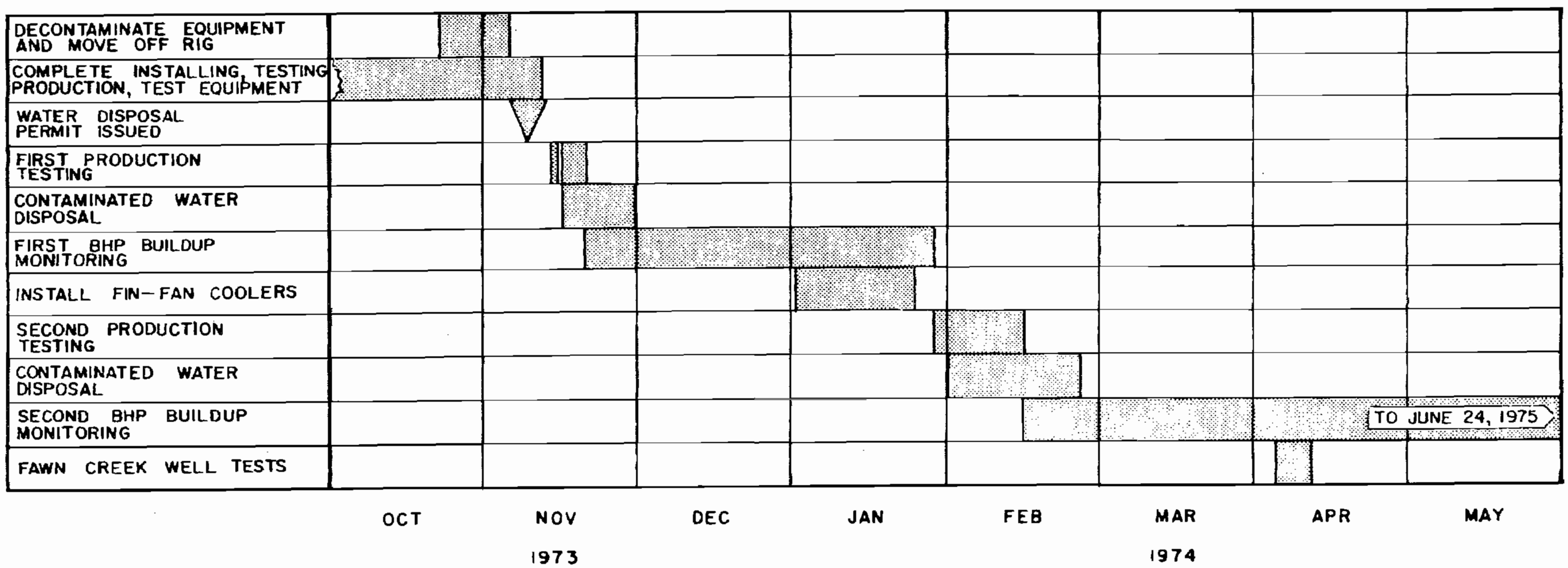

Figure 21. Production testing and pressure buildup monitoring schedule as accomplished.

5. RADIOLOGICAL SAFETY AND EFFLUENT DOCUMENTATION

Radiological protection and documentation of radioactive effluents was provided in a limited way during the programmed waiting period of three months and fully during the reentry drilling and both production test periods. The bulk of the work was performed by the Eberline Instrument Corporation under contract to CER. CER operated its TRY-KRY monitoring system for gaseous effluent documentation during releases through the DWC and during both production test periods. The radiological protection equipment used on the project, apart from the TRY-KRY, was government-furnished from existing equipment on loan to CER. Expendable equipment and supplies was furnished by CER.

5.1 OPERATIONAL GUIDES

Radiation exposure criteria and radioactive concentrations guides were governed by AEC Manual Chapter 0524 as augmented by letter, AEC PNE/DAT, "Radiological Safety Guidance for Experiments involving Nuclear Stimulation of Natural Gas Wells," dated April 17, 1972. In the event of accidental or emergency exposure, provisions of both AEC Manual Chapters 0502 and 0524 as augmented by the mentioned letter were to be followed as applicable.

Personnel radiological explosure criteria were that the quarterly whole body exposure should not exceed 3 rem, while the annual should not exceed 5 rem, with other dose commitments for various parts of the body. In practice, all dose measurements made on project participants were not detectable.

The toxicological exposure criteria were the threshold limit values of toxic materials as recommended by the American Conference of Government Industrial Hygienists or those deriving from the Occupational Safety and Health Act.

Considering only the most likely contaminant to be found, tritium, the criterion for release of vehicles and other equipment for public use elsewhere was that any contamination should not exceed 1000 disintegrations per minute (dpm) on any 100 cm^2.

5.2 ACCESS CONTROL

An Access Control trailer was located at the entrance to the EW pad to serve these functions: to act as the central control point for radiological monitoring support operations in the field; to be the source of issue and supply for radiological safety support items such as portable survey instruments, dosimetric devices, respiratory protection equipment, anti-contamination clothing, and other related supplies; to act as the Access Control Point for personnel and vehicular traffic into "controlled areas" where the presence of dispersed radioactive materials exists; to provide limited dressing and washing facilities and supply of full Anti-C clothing for the regular work force on drilling operations when required; and to provide a supply of limited Anti-C clothing for visitors.

The access control trailer remained in the EW area during the programmed delay period, reentry drilling, and the two production test periods.

To ensure that project participants were aware of potential exposures and good practices, EIC routinely provided a radiological safety indoctrination to all workers on site and to new workers as they arrived.

5.3 PERSONNEL DOSIMETRY AND BIOASSAY

From the start of reentry drilling through the first production test, a program of personnel dosimetry was conducted which applied to all project participants on site, including visitors. Thermoluminescent dosimeters (TLD's) were issued to each person for wear on site. All badges were readout routinely on a monthly basis or on departure of the participant or visitor from the site. Urine samples were also provided by project participants before reentry drilling and before and after the first production test. Bioassays for ^{3}H were performed on the urine samples. All TLD readouts were background as were all bioassays.

Because of the favorable results during the reentry drilling and first production test, during the second production test, a much more limited program of dosimetry was undertaken. TLD's were issued only to CER and EIC persons having access to radioactive calibration sources. Bioassays were limited to persons handling contaminated materials. Again, all results were background.

EIC maintained all explosure records and furnished them to CER after each production test. CER forwarded the exposure records to the Reynolds Electrical and Engineering Company for inclusion in the NVOO master exposure files.

5.4 EFFLUENT DOCUMENTATION DURING THE DELAY PERIOD

EIC mounted a beta-gamma radiation detector at the wellhead to monitor for fission product radioactivity, primarily ^{85}Kr. The output of the detector was recorded continuously on a strip chart recorder installed in the access control trailer near the EW. The system was alarmed at a preset level and included a fail-safe failure light to indicate malfunction of the detector. The system was inspected daily by a qualified person. EIC manned the EW during daylight hours seven days a week during this period to maintain the detection system and make periodic surveys of the immediate vicinity of the EW. No data above background were obtained during the period.

5.5 EFFLUENT DOCUMENTATION DURING INITIAL REENTRY DRILLING

During the first 4,700 feet of reentry drilling radiological protection procedures were limited to that described below. No data above background were obtained.

5.5.1 An RM-3C with a bare Anton 112 beta-gamma detector was provided on the rig floor work area to sense ^{85}Kr or other fission products with continuous recording off the rig. The detector was set to alarm at twice the normal upper limit of background readings.

5.5.2 The output of the shielded scintillation detector on the mud return line was continuously recorded off the rig, with an alarm set at twice the normal upper limit of background readings.

5.5.3 Daily samples of mud and any drill cuttings returned were obtained from the mud return line and analyzed for particulate fission products by gamma spectra at 1-pCi/ml sensitivity referenced to ^{137}Cs and by liquid scintillation for ^{3}H at 1-pCi/ml sensitivity.

5.5.4 Mud and waste water which dripped from the drilling equipment were collected from the cellar or drip pans in a lined pit. Prior to disposal, samples of the collected water were assayed for ^{3}H.

5.5.5 A gas flare line monitoring system was installed on the flare line downstream from the DWC unit, to be activated when the DWC unit was used.

5.5.6 A rig air sampler and a site air sampler elsewhere, each consisting of a particulate filter and a charcoal cartridge were continuously operated, with daily change of filters. The particulate filters were analyzed for gross beta and alpha and gamma scanned. The cartridges were gamma scanned.

5.5.7 The rig floor air was sampled for ^{3}H with a molysieve air moisture absorbent. Samples were collected daily and were assayed for ^{3}H by liquid scintillation counting with a sensitivity of 2 pCi/ml for a 5-ml water sample.

5.5.8 Temperature, barometric pressure, and humidity were recorded to provide necessary data for quantifying site air and rig air samples.

5.6 EFFLUENT DOCUMENTATION DURING SUBSEQUENT REENTRY DRILLING

Below a depth of 4,700 feet, which was reached within four days of the start of drilling on September 22, 1973, the radiological program outlined above was continued and augmented as described below.

5.6.1 A qualified radiological protection monitor, equipped with a portable beta-gamma survey meter and a portable explosimeter, was on duty on or near the drill rig at all times. When tripping out of the hole, each stand of pipe was monitored as the joint was broken.

5.6.2 The collection and analysis schedule for mud, water, air, and drill cutting samples was increased from once per day to once per 8-hour shift.

5.6.3 Mud, drill cuttings, and waste water were disposed of with no restrictions imposed by radioactivity as long as there was no detectable fission product activity. The only contaminant found was tritium as moisture in solids and in decontamination water. Tritiated water from decontamination activities was transferred to one of the storage tanks for later injection into the disposal well. A few barrels of tritiated solid waste were accumulated for subsequent disposal in an approved manner.

5.7 EFFLUENT DOCUMENTATION DURING PRODUCTION TESTING

During the production testing period, gas produced from the chimney was continuously sampled and monitored by the production test sampling system shown schematically in Figure 22. The on-line system was coupled to the flare line between the separator and the flow-measurement equipment to provide a reasonably isokinetic and homogeneous sample of the gas stream being flared. The production test sampling system dehydrator provided pressure reduction and cooling for complete liquid removal prior to the gas entering the radiation monitoring sections. After radiation measurements were made on the dry gas stream, the gas was released to the atmosphere through a 20-foot high vent at a rate of several CFM. The shielded gamma scintillation detector was recorded and the alarm set at twice the normal upper level of background readings to alert if any unexpected fission products were in the gas. No such readings above background were obtained. The sample line was heated with heat tapes and maintained the oil and moisture in vapor form until the gas sample reached the heat exchanger, thus keeping the line from freezing up during unfavorable conditions. The bulk liquids trap dropped out the bulk of the water which was transferred to the contaminated water storage tanks for injection into the disposal well. The integrating flow meter was used to quantify the analyses of the particulate and charcoal samples. The sample manifold, exhaust, and calibration system were so connected that each detector was independent of the operating condition of the other.

During both production test periods, measurements were made as described below. The TRY-KRY system was operated periodically and provided data on the concentrations of ^{85}Kr and ^{37}Ar. It was found that the low levels of ^{3}H encountered and the interfering response of the system to the higher levels

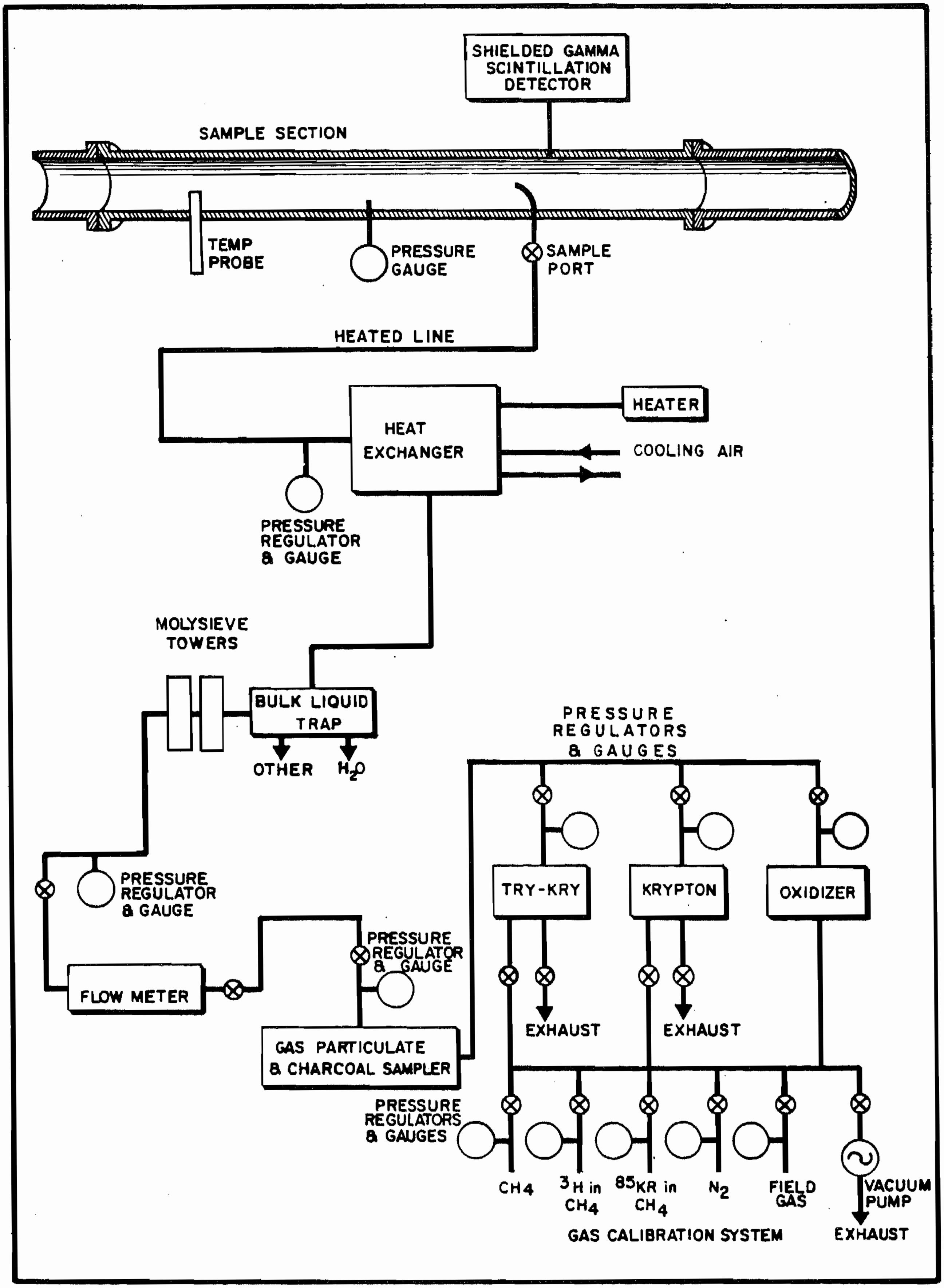

Figure 22. Production test gas sampling system.

of ^{37}Ar precluded the evaluation of ^{3}H concentrations by the TRY-KRY. The krypton chamber was operated and recorded continuously to provide data on ^{85}Kr concentrations for comparison with the TRY-KRY. The ^{85}Kr calibration gases for both systems were normalized to agree with a calibration sample provided by the Quality Assurance Branch, National Environmental Research Center, U.S. Environmental Protection Agency, Las Vegas, Nevada.

The oxidizer was operated several times daily to provide combustion water samples from the gas. These were counted by liquid scintillation means to provide data on the ^{3}H concentration.

Particulates in the dry conditioned gas were integrated over each production test period and subsequently counted with a sensitive Ge (Li) system in one of EIC's laboratories.

Samples of water were taken from the separator daily and from each water tank after filling. Analyses were made for ^{3}H concentration, by gross beta and alpha counting, and by gamma spectrometry. All data obtained were at background levels except for ^{3}H. No samples of hydrocarbon condensates were analyzed, for none was separated during either production test.

A site air particulate and moisture sampling system was operated continuously during production testing. Particulate filters were analyzed by gross beta and alpha counting. Both the particulate and charcoal filters were analyzed by gamma spectrometry. The air moisture samples were assayed for ^{3}H by liquid scintillation means. All data were at background levels except for ^{3}H.

During both production tests, gas and liquid samples were taken by EIC in containers supplied by LLL and turned over to LLL's representative for shipment.

5.8 SUMMARY OF EFFLUENT DATA

The data obtained in the CER/EIC effluent documentation effort have been reported in detail in References 6 and 7. Data obtained by LLL in gas sample analyses is included in Reference 7. In summary form, during the two production tests from the upper chimney about 52 curies (Ci) of ^{3}H, 776 Ci of ^{85}Kr, and 89 Ci of ^{37}Ar were released to the flare stack, with fractional curie amounts of ^{39}Ar, ^{14}C, and ^{131m}Xe. A trace quantity, on the order of 10^{-5} Ci, of ^{203}Hg, was released during the second drawdown. ^{203}Hg was not detected during the first drawdown. About 150 Ci of ^{3}H in the produced water were injected into the water disposal well.

6. RADIOLOGICAL MONITORING IN THE ENVIRONMENT

The routine radiological monitoring program for the environment as described in Reference 2 was extended to July 31, 1974, as a result of the decision to drawdown the top chimney the second time. The detailed results of this effort have been reported by EIC in a set of quarterly reports collectively identified as Reference 8. The last three of these reports, covering the period November 1973 to July 1974, relate to the two RB-E-02 production test periods. Summaries of these quarterly reports are included as Appendix E to this report. No elevated levels of radioactivity which were attributable to Project Rio Blanco were observed in this environmental monitoring program.

During the first production testing, the routine radiological monitoring program was augmented in the areas of water, air particulate, and air moisture sampling. Some additional effort was expended in sampling soils, vegetation and milk-cow feed, in bioassays, in external background measurements and opportune precipitation sampling.

During the second production testing and because of the favorable results obtained during the first production test, augmentation of the routine program was limited primarily to water sampling at nearby locations and to precipitation and snow sampling near the flare stack. Some additional effort was expended on air moisture sampling, bioassays, and external radiation measurements in the immediate site vicinity.

The results of the augmented radiological programs were generally consistent with background observations. The only data obtained showing above background were for ^3H in some soil and precipitation sampling near the flare stack and in some site air moisture samples. The flare stack area sampling results ranged from not detectable (<2pCi ^3H per ml liquid) to 102.3 pCi/ml. The site air moisture sampling results ranged from not detectable to 16.4 pCi/ml. These programs are reported in greater detail in Reference 6.

The paucity of positive data in the environmental radiological monitoring programs precludes meaningful calculation of dose to persons in the environment and confirms the predictions of the environmental statement[9] that the dose would be so low as to be unmeasurable. The ^{90}Sr data and gamma scan of air particulate, water, and vegetation confirm that no measurable quantities of long-lived particulate fission products were added to the environment. The TLD data are in the same range as those previously reported in the reports collectively identified as Reference 8. It is concluded that the environmental impact of the releases of radioactivity to the atmosphere in the flaring of gas from the RB-E-01 well is not measurable above the sensitivities stated in References 6 and 8. Therefore, it is estimated that the potential radiation dose equivalents, considering the sensitivities of the analytical procedures, were a very small fraction of the Radiation Protection Standards of AEC Manual Chapter 0524.

APPENDIX A
DAILY DRILLING REPORTS
RB-E-01

1973

September 22 - Rigging and testing. Rig personnel available on September 21, 1973: one driller and two men. Unable to start on 12 hr shifts. Lost two men each on two crews. Total available now: two drillers and four men. Changed out liner on mud pump to 5-inch. Drilled rat hole. KB 22 ft above ground level. All depths KB.

September 23 - Picked up 3-1/2-inch drill pipe. Tested mud system to 2000 psig. Tested okay. Held operations meeting with drilling crews. Ran Servco 6-1/8-inch Economill, 5-inch Dynadrill, two Gray inside BOP's, one 5-inch drill collar, Otis drill pipe plug nipple (Type "Q"), five additional 5-inch drill collars, and Otis drill pipe plug nipple (Type "N"). Ran in hole in 3-1/2-inch I.F. drill pipe to 2500 ft KB. Circulated and set drilling instruments. Closed pipe rams on 3-1/2-inch drill pipe. Left well shut in overnight. Have two drillers and five men.

September 24 - Drilling cement at 3530 ft KB. 6-1/8-inch hole. (Prog. 733 ft) Ran mill to 2797 ft and tagged top of cement. Drilled cement from 2797 ft to 3530 ft KB. Circulated hole clean. Pulled two stands. Closed in well. SDON. Crew remaining: two drillers and six men. Bit #1 - Servco Economill - 2797 ft to 3530 ft - 733 ft in 9 hrs. Six 5-inch drill collars; WOB 6000 lb; 250-300 RPM with Dynadrill; drill pipe tool jts.: 3-1/2-inch I.F.; drill collar tool jts.: 3-1/2-inch I.F.; 5-inch pump; 50 SPM; 250-300 GPM; PP 800-1000 lb. Drilling with water. Operating 12 hrs./day.

September 25 - Drilling cement at 4365 ft. (Prog. 835 ft) 6-1/8-inch bit. Drilled cement from 3530 ft KB to 4365 ft KB. Circulated hole 30 min. Pulled two stands drill pipe. Closed in well. SDON. Crew status: two drillers and eight men. Bit #1 - Servco Economill - 2797 ft to 4365 ft - 1568 ft in 19 hrs. Six 5-inch drill collars; WOB 6000 lb; 250-300 RPM; drill pipe tool jts.: 3-1/2-inch I.F.; drill collar tool jts.: 3-1/2-inch I.F.; 5-inch pump; 50 SPM; 250-300 GPM; PP 800-1000 lb. Drilling with water. Operating 12 hrs./day.

September 26 - Testing BOP's and mixing mud. Depth 4700 ft KB. (Prog. 335 ft) 6-1/8-inch hole. Drilled cement from 4365 ft to 4700 ft KB. Circulated well 30 minutes. Displaced water with mud. Pulled out of hole. Laid down Dynadrill #1 and mill. Dumped water from circulating pits. Started cleaning pits and testing BOP stack. SDON. Crew: two drillers and eight men. Bit #1 - Servco Economill - 2797 ft to 4700 ft - 1903 ft in 24 hrs. Six 5-inch drill collars; WOB 6000 lb; 250-300 RPM; drill pipe tool jts. - 3-1/2-inch I.F.; drill collar tool jts. - 3-1/2-inch I.F.; 5-inch pump; 50 SPM; 250-300 GPM; PP 800-1000 lb. Drilling with water. Operating 12 hrs./day.

September 27 - Drilling cement at 4762 ft. (Prog. 73 ft) 6-1/8-inch hole. Finished pressure testing BOP to 3000 psi. Operated D.W.C. and Otis equipment. Checked okay. Mixed mud. Strapped in to 4691 ft. Corrected Geolograph to 4691 ft. Have 3 drillers and 12 men. Started 24 hr. operation September 27, 1973. No radiation or gas detected to date. Bit #2 - Servco - 4691 ft to 4762 ft. Six 5-inch drill collars; WOB 6000 lb; 250-300 RPM; drill pipe tool jts. - 3-1/2-inch I.F.; drill collar tool jts. - 3-1/2-inch I.F.; 5-inch pump; 50 SPM; 250-300 GPM; PP 800-1000 lb. BHA: Servco mill, 5-inch Dynadrill, 1 Gray inside BOP, 5-inch drill collar, 1 Gray BOP, Otis "Q" nipple, Five 5-inch drill collars, and 1 Otis nipple. Drilling with low lime mud - Wt. 9.0 lb; Vis. 44. Operating 12 hrs. - daylight.

September 28 - Tripping for tapered mill. (Prog. 723 ft) Depth 5485 ft - cement and casing. 6-1/8-inch hole. Operating 24 hrs. Drilled cement from 4762 ft to 5194 ft. Circulated out gel-water solution to 5351 ft. Hit iron. Milled 2 ft and washed to 5452 ft. Milled iron 2 ft. Washed to 5484 ft. Milling on iron. Milled to 5485 ft. Coming out of hole for tapered mill. Will lay down Dynadrill. No radiation or gas shows. Bit #2 - Servco - 4691 ft to 5485 ft. Six 5-inch drill collars; WOB 6000 lb; 250-300 RPM; 3-1/2-inch I.F. drill pipe tool jts.; 3-1/2-inch I.F. drill collar tool jts.; 5-inch pump; 50 SPM; 250-300 GPM; PP 800-1000 lb; BHA: Servco mill, 5-inch Dynadrill, 1 Gray inside BOP, 5-inch drill collar, 1 Gray BOP, Otis "Q" nipple, five 5-inch drill collars, and 1 Otis nipple. Low lime mud - Wt. 8.6 lb; Vis. 40; WL 6 cc; FC 2/32; pH 12; PV 52; Yp 32.

September 29 - Trip for mill #5. Depth 5508 ft - cement and iron. (Prog. 23 ft) 6-1/8-inch hole. Mill #4 milled on iron 5494-5498 ft. Washed down to 5506 ft and milled on iron 5506-08 ft. Pulled out of hole. Shows wear around outside and around center of mill. Mill #3 shows wear around shoulders of 6-1/8-inch O.D. section and extreme wear on bottom. All center cut is gone over an O.D. of approximately 2-1/2-inch. Water course out bottom was nearly sealed off.

September 30 - Trip in with mill #6. Depth 5549 ft - metal. (Prog. 41 ft) 6-1/8-inch hole. Low lime mud - Wt. 9.0 lb.

October 1 - Reaming tight spot in casing. Depth 5554 ft - formation - metal. (Prog. 5 ft) 6-1/8-inch hole. Reamed with mill #6 back to bottom. Apparently went outside of 10-3/4-inch casing at 5551 ft. Started getting some shale back to surface. Made trip for mill #7. Went in hole. Found tight spot 5506-5510 ft. Reamed through tight spot several times. Still pulled tight. Pulled 140,000 lb to get loose. Worked through spot and went to 5522 ft. Milled for 2 hrs. Made 1 ft. Pulled out of hole. Ran tapered mill and started reaming up hole at 5350 ft. Went through tight spot once. Reamed back again. Apparently went off other side. Could not make any hole. Picked up and reamed through tight spot. Okay. Went to 5450 ft and reamed through tight spot. Went to 5486 ft. While reaming, got stuck. Pulled free with 175,000 lb.

No radiation or gas to surface. Six 5-inch drill collars; WOB 4000 - 8000 lb 40-70 RPM; 5-inch pump; BHA: mill, Baker float, 1 drill collar, Gray inside BOP, Otis plug nipple Type "Q", five 5-inch drill collars, Otis plug nipple Type "N". Low lime mud - Wt. 9.0 lb; Vis. 38.

October 2 - Logging with Schlumberger. Depth 5554 ft. (Prog. 0 ft) Circulated hole at 5430 ft for 1 hr. Pulled out of hole. Inspected drill collars and sub. Found cracked pin on Baker float sub. Laid down sub. Ran Baker 7-inch casing scraper to 5360 ft KB. Pulled out of hole. Rigged up Schlumberger to run Caliper and Collar Locator. Prep. to set Baker Model "N" bridge plug in interval 5300-5350 ft and set whipstock for alternate reentry plan. Mill #8 - Acme tapered - reaming. Six 5-inch drill collars; 5-inch pump; BHA: same as October 1, 1973. Low lime mud - Wt. 9.0 lb; Vis. 40.

October 3 - Picking up whipstock. PBTD 5322 ft. Ran Schlumberger Casing Caliper and Collar Locator Log from 5400 ft to 2500 ft KB. Set Baker Model "N" drillable bridge plug on wireline at 5322 ft KB. Tested plug and casing below blind rams to 1000 psi surface pressure. Tested BOP units to 3000 psi. Held okay. Ran 6-1/4-inch O.D. window mill to 5322 ft KB. Pulled out of hole. Prep. to pick up Bowen whipstock.

October 4 - PBTD 5322 ft. 6-1/4-inch hole. Oriented S 10° W. 4° taper on whipstock. Top of tapered portion 5303 ft KB. Mill #9 - milled 5304-5307 ft in 7 hrs. Mill #10 milled 5307-5309 ft in 8 hrs. Six 5-inch drill collars; WOB 4,000-8,000 lb; 40 RPM; 5-inch pump; BHA: mill, 1 drill collar, Otis "Q" plug nipple, 5 drill collars, and Otis Type "N" plug nipple Low lime mud - Wt. 9.0 lb; Vis. 40.

October 5 - Trip into hole with Bit #13. PBTD 5316 ft. On Bit #11, got to formation. Pulled and ran bit #12 with 3-pt. roller reamer to dress window. Could not make hole in formation. Ran Reed 6-1/8-inch bit with 3-pt. roller reamer. Plan to make 50 ft to 100 ft, run survey, pull out of hole and lay down 3-pt. reamer before drilling ahead. Bit #10 - 6-1/4-inch finishing mill - 5307-5312 ft in 10 hrs. Bit #11 - 6-1/4-inch finishing mill - 5312-5316 ft - 6-1/2 hrs. Bit #12 - 6-1/4-inch finishing mill - 5316 ft - no progress - 1-1/4 hrs. Bit #13 in hole. Six 5-inch drill collars; 5-inch pump; BHA: 6-1/8-inch bit, 3-pt. roller reamer, Gray inside BOP, one 5-inch drill collar, Otis plug nipple Type "Q", five 5-inch drill collars, and Otis plug nipple Type "N". Low lime mud - WT. 8.8 lb; Vis. 40.

October 6 - Drilling shale at 5356 ft. 6-1/8-inch hole. Bit #13 - Reed Y31R - 0 ft in 2 hrs. Bit #14 - flat bottom - 6-1/4-inch - 5316-5329 ft - 13 ft in 7 hrs. Bit #15 - Reed Y31R - in hole. Bit #14 was bald when pulled out of hole - badly out of gauge. Dev.: 3° at 5328 ft.

October 7 - Trip for Bit #17. Depth 5429 ft - sand and shale. Made 73 ft. 6-1/8-inch hole. Bit #15 - Reed Y31R - 5329 ft to 5371 ft. Bit #16 - HTC

OWC-J - 5371 ft to 5429 ft. Dev.: 2-3/4° at 5361 ft; 2-1/2° at 5419 ft.

October 8 - Drilling sand and shale at 5580 ft in sidetracked hole. Made 151 ft. Bit #17 - Williams dia. - in hole. Six 5-inch drill collars; WOB 8,000-12,000 lb; 300 RPM; 5-inch pump; BHA: dia. bit, Dynadrill, change-over sub, float sub, Gray inside BOP, one 5-inch drill collar, Gray inside BOP. Otis "Q" nipple, five 5-inch drill collars, Otis "N" nipple and 3-1/2-inch drill pipe. No gas or radiation to surface. Low lime mud - Wt. 8.9 lb, Vis. 48.

October 9 - Mixing mud. Depth 5614 ft. 6-1/8-inch hole. Made 34 ft. Dev.: 2° at 5510 ft. Tripped at 5585 ft to change out Dynadrill. Drilled ahead with 6-1/8-inch bit and new Dynadrill. Lost partial returns at 5597 ft. Drilled to 5602 ft. Healed up lost circulation zone. Pumped in mud at rate of 10 BPM with no returns. Pumped down annulus and drill pipe. Could not get returns. Lost 400 bbls. mud. Pulled 4 stands to get Dynadrill inside 7-inch casing. Pumped 200 bbls. additional water. No returns. No gas to surface after 6 hrs. No radioactivity to surface. Bit #17 - Williams - dia. - 5429-5614 ft - 185 ft in 26 hrs. 5-inch pump. Low lime mud - Wt. 8.9 lb. (Appears that lost circulation zone is caused from roof sag above chimney without communication with chimney. Intend to mix viscous mud, pull Dynadrill, run conventional bit and drill ahead without returns, if necessary.)

October 10 - Drilling sand and shale at 5620 ft. Drilled 6 ft, reamed 280 ft. 6-1/8-inch hole. Mixed mud. Pulled out of hole and laid down Dynadrill. Ran bit #18. Had problems getting through whipstocked window. Established circulation. Cleaned shale bridges in 6-1/8-inch hole from 5334 ft to 5614 ft. Had to overhaul power swivel. Swivel motor seals went out. Lost 500 bbls. mud while reaming hole from 5334 ft to 5614 ft and while drilling to 5620 ft. Have Halliburton on location mixing mud. Bit #18 - HTC OWV reg. - 5614 ft to 5620 ft. Six 5-inch drill collars; WOB 2,000-6,000 lb; 50-70 RPM; BHA: bit, bit sub, Baker float sub, Gray inside BOP, one 5-inch drill collar, Gray inside BOP, Otis nipple Type "Q", five 5-inch drill collars, and Otis nipple, Type "N", Gel-Chem - Wt. 9.0 lb; Vis. 65-75; WL 11.2 cc; FC 2/32.

October 11 - Drilling shale at 5620 ft (corrected). Made 8 ft. 6-1/8-inch hole. Pulled out of hole. Laid down power swivel. Not enough power to drill. Laid down rotating head. Installed Hydril. Tested BOP's. Strapped pipe out and in. Corrected depth 5620 ft KB at 8 a.m. October 11, 1973. Drilling ahead with partial circulation. Halliburton mixing mud. Lost approximately 250 bbls. mud in last 24 hrs. Using LCM to partially heal lost circulation zone. No gas or radioactivity to surface. Bit #18 - HTC OWV - 5601-5612 ft - 11 ft in 12 hrs. - drlg. and rmg. - slightly out-of-gauge. Bit #19 in hole. 5-inch pump. BHA: bit, bit sub, Baker float sub, Gray inside BOP, one 5-inch drill collar, Gray inside BOP, Otis nipple Type "Q", five 5-inch drill collars, and Otis nipple, Type "N". Gel-water - Wt. 8.8 lb; Vis. 75.

October 12 - Rigging up bottom snubbers. Depth 5706 ft - sand and shale. Made 86 ft. 6-1/8-inch hole. Drilled from 5620 to 5633 ft with partial lost circulation. Ran out of mud. Pulled 5 stands to mix more mud and obtain more water. Ran back to bottom. Drilled to 5706 ft KB with no returns. Ran out of mud. Lost 4000 bbls. mud while drilling from 5620 ft to 5706 ft. Pulled 10 stands into derrick. Ran 90 jts. 3-1/2-inch drill pipe. Started rigging up bottom snubbers.

Note: Had pressure buildup of gas to surface while mixing mud at 5671 ft. Pressure up to 320 psi. Sample of gas indicated Krypton-85 and Tritium. Pumped 150 bbls. mud down annulus to kill well. Bled remaining gas to flare stack through D. W. C. Bit #19 - HTC OWV - 5612-5706 ft - 94 ft in 8 hrs. Still in hole. Six 5-inch drill collars; WOB 2,000-8,000 lb; 50-90 RPM; BHA: bit, bit sub, Baker float sub, Gray inside BOP, one 5-inch drill collar, Gray inside BOP, Otis nipple Type "Q", five 5-inch drill collars, and Otis nipple, Type "N". Gel-water - Wt. 8.8 lb; Vis. 75.

October 13 - Running in with wireline to set packer. Finished rigging up snubbing equipment. Came out of hole laying down 3-1/2-inch drill pipe. Laid down all 3-1/2-inch drill pipe. Stood back 6 drill collars. Did not need to snub out of hole. Pumped in mud at slow rate while coming out of hole. Shut blind rams. Rigged up Birdwell and 7-inch lubricator to run packer and bottom hole assembly. Had 750 psig gas pressure on casing at 8:00 a.m. No radioactivity contamination.

October 14 - Rigging up to pull Otis plugs. Depth of packer 5260 ft KB. Pumped in 300 bbls. fresh water down the casing. 0 lb at surface. Equalized above and below blind rams. Opened rams. Ran packer in hole on wireline. Set packer at 5260 ft KB. Bottom hole assembly from bottom up is bull plug, 8-inch screen jt., Otis "N" plug with 2-inch SN plug installed, 2 ft 2-3/8-inch tubing nipple, tail pipe adapter, Otis Permatrieve PW wireline set packer. Rigged down Birdwell. Filled hole with water. Packer held okay. Laid down six 5-inch drill collars. Changed bottom 3-1/2-inch and 5-inch BOP rams to 2-7/8-inch rubing rams. Ran 168 jts. 2-7/8-inch EUE tubing and one 4 ft sub to the tubing hanger with Otis equipment on bottom of the tubing as follows: Mule shoe guide, "J" latch assembly without locking bar, "N" nipple with 2-1/2-inch PXN plugs installed, and tubing centralizer. Landed tubing at 5229 ft KB. OCT hanger locked into wellhead. Landing nipple to hanger made up to 700 ft.-lb torque. Remainder of string made up to 1300 ft.-lb torque. Used 2-7/8-inch tubing nipples from hanger to rig floor. Installed 2-7/8-inch full bore tubing valve. Pressure tested valve to 3000 psi before installation. Pressure tested between tubing hanger and BOP 2-7/8-inch tubing rams to 3000 lb. Held okay. Started rigging up Otis equipment to pull plugs.

October 15 - Well SI. Building up pressure. Rigged up Otis equipment to pull tubing plugs. Surface wireline equipment broke down. Called out Wireline truck. Pulled Otis PXN plug from bottom of tubing. Attempted to pull Otis SN plug from packer. Sheared off of plug twice. Put 250 psig Nitrogen pressure on annulus and unloaded water up the tubing. Bled off Nitrogen pressure. Ran retrieving tools with Wireline hydraulic jars. Pulled SN plug from packer at 10:30 p.m. October 14, 1973. No radiation on tools or plug. Surface CP at 6 a.m. October 15, 1973 was 300 psig.

October 16 - Well shut in. Pressure at 8 a.m. October 16, 1973 400 psig.

October 17 - Preparing to kill well and pull tubing. Pressured annulus with N_2 with 2700 psig from 400 psig. Started at 1000 cu. ft./min., increased to 2000 cu. ft./min. Pressure increased to 2500 psig in 30 min. Decreased rate gradually to 1000 cu. ft./min. Pressure increased to 2700 psig. Estimated water displaced through screen on packer at 50 bbls. Shut down N_2 injection. Flowed well to flare stack through D.W.C. unit. Well loaded up and died twice. Injected additional N_2 into annulus to clean water out of hole. Rec. 100 BW to storage tank. At end of clean up, well was flowing 510 MCF/D at an apparent stabilized CP of 500 psig with 200 psig on the D.W.C. unit. Radiation level at stabilized rate was approximately 400 pCi/cc of Krypton 85. Radiation level of produced water was background. Total N_2 injection was 170,000 cu. ft. Total flow back 135,000 cu. ft. Well was SI 7:15 p.m. October 16, 1973. Pressure at 7:15 p.m. October 16, 1973 was 500 psig. Pressure at 10 p.m. October 16, 1973 was 1075 psig; pressure at 7 a.m. October 17, 1973 was 1650 psig. Preparing to blow well down, kill with mud, and pull packer.

October 18 - Pulling tubing and packer from well. Blew well down to flare stack through D.W.C. unit. CP at start of blow down 1650 psig. Went down to 450 psig. Killed well with mud. Screen joint appeared to be partially plugged. Well would pressure up while trying to pump down hole. Pumped water down tubing to wash contamination out of tubing. Ran in with wireline tools to position packer retrieving sleeve. Made several trips to position sleeve. Latched onto packer with tubing. Released packer. Could not pump past packer down the annulus. While pulling packer, started swabbing the hole. Pumping down tubing out the bottom of the packer around the outside of the screen joint every 15 stands to keep well killed. Plan to pick up bit, clean out hole, and drill a few feet deeper.

October 19 -Drilling and washing back to bottom. Depth 5633 ft. 6-1/8-inch hole. Pulled packer and screen jt. out of hole. Screen jt. plugged with fine cuttings. Decontaminated packer and sent in for redressing. Screen jt. will have to remain on location until decontaminated. Tripped into hole with 6-1/8-inch bit to clean out and drill ahead. Hit bridges from 5560 ft KB down. Present depth 5633 ft. TD of hole 5706 ft. Lost returns at 5565 ft KB. Gained partial returns at 5575 ft. Lost total of 750 bbls. in the last 24 hrs. Circulating system is contaminated. Radioactivity level 44 pCi/ml. Bit #20 - HTC OWV - drilled and washed - 6 hrs. - still in hole. Six 5-inch drill collars;

5-inch pump; BHA: bit, bit sub, Baker float sub, Gray inside BOP, one 5-inch drill collar, Gray inside BOP, Otis "Q" nipple, 5 drill collars, and Otis "N" nipple. Gel-water - Wt. 8.8 lb; Vis. 45.

October 20 - Laying down 3-1/2-inch drill pipe. PBTD 5634 ft. Washed to bottom at 5706 ft. Drilled to 5745 ft. No circulation. Had several good drilling breaks. Pulled out of hole. Strapped out at 5745 ft KB. Ran 16 jts. 5-inch O.D., 15 lb, JCS hydril flush jt with Brown Type "V" shoe and 2 valve float collars just above shoe. Ran Brown "Hyflo" H.D. 5-inch, 18 lb hanger packer on top of liner. I.D. of hanger 4-9/32-inch. I.D. of liner 4-3/8-inch. Length of liner shoe, float collar and hanger 507 ft. "Baker-Lok'd" all jts. Bottom of liner 5735 ft KB and tagged fill. Set liner with bottom at 5734 ft KB. Top of hanger 5227 ft KB. Starting out of hole, laying down drill pipe. Liner is overlapped 76 ft into 7-inch casing. Bit #20 - HTC OWV reg. Washed at 5706 ft. Drilled from 5706 ft to 5745 ft - 39 ft in 2 hrs. BHA: same as October 19, 1973. Gel-water - Wt. 8.9 lb; Vis. 60-70.

October 21 - Waiting on Birdwell. Finished laying down 3-1/2-inch drill pipe and 5-inch drill collars. Ran 167 jts. 2-7/8-inch tubing. Tubing string from bottom up: mule shoe, 4 ft pup with centralizer, Otis "XN" nipple, 167 jts 2-7/8-inch tubing, 4 ft pup, and tubing hanger. Bottom of tubing at 5200 ft KB. Waiting on Birdwell.

October 22 - Logging. Birdwell attempted to run GR survey. Tool quit working after getting to bottom. Came out of hole. Ran Temperature Survey. Temperature went to 270° F. at 5565 ft, then failed. Pulled temperature tool. Repaired and reran. Maximum temperature on survey 286° F. Appeared to have two peaks: 286° at 5630 ft and 283° at 5665 ft. Called out Schlumberger with high temperature line temperature survey tool and GRN tool. Schlumberger temperature survey indicated single peak - much broader with peak of 265° F. at 5675 ft. It appears that fluid may still be moving down hole. Pumped in 50 BW. Running Temperature Survey to determine hot spots. Will continue survey until hot spots are stabilized. Cleaned out mud tanks and filled with water.

October 23 - Rigging up Halliburton and hauling water. Completed running temperature surveys. Hot areas indicated between 5632 ft KB and bottom of liner at 5734 ft KB. Gamma Ray Neutron Log did not show definition of chimney or fractured region. Plan to perforate using through-tubing jets. Birdwell perforated with strip gun #1 from 5727 ft to 5702 ft KB with one 1-11/16-inch jet/ft. Total of 25 shots. Pumped 50 BW down annulus. Started in hole with strip gun #2 to perforate 5702-5677 ft KB. Unable to get below liner top. Started out of hole to check strip gun. Well started blowing in through cable head pack-off. Could not completely shut off stuffing box control head. Pulled gun into lubricator. Shut tubing master valve. Released Birdwell truck with 5/16-inch line. Ordered out unit with 3/16-inch line and a grease injection control head to finish perforating. Started rigging up Halliburton to pump down tubing while perforating.

October 24 - Perforating with Birdwell. Changed out tubing floor valves. Have two new floor valves on tubing. Keeping well killed by pumping water down annulus and tubing periodically. Rigging up Birdwell perforating truck with grease injection system and 3/16-inch line. Perforated liner 5702-5677 ft KB with 2 JSPF using 1-11/16-inch ceramic jets. Preparing to run in and perforate 5677-5652 ft KB.

October 25 - Well shut in to build up pressure. Perforated liner from 5677 ft to 5652 ft KB with 2 JSPF using 1-11/16-inch ceramic jets. Perforated 5652-5627 ft KB with 1 JSPF. Rigged down Birdwell. Finished perforating at 12:15 p.m. October 24, 1973. Casing pressure as follows:

Time	CP
10/24/73	
1:15 p.m.	125
2:15 p.m.	260
3:00 p.m.	385
5:00 p.m.	700
7:00 p.m.	960
9:00 p.m.	1250
11:00 p.m.	1450
12 midnight	1525
10/25/73	
2:00 a.m.	1510
4:00 a.m.	1525
6:00 a.m.	1510
7:30 a.m.	1525

Plan to flow well this a.m.

October 26 - Waiting on O.C.T. representative. Flowed well through D.W.C. unit for 1 hr. 45 min. Initial CP 1525 psig, final CP 1600 psig. Initial rate 5110 MCF/D. Final rate 5816 MCF/D. Avg. rate 5480 MCF/D. Initial specific gravity 1.084, final specific gravity 1.127. All free liquids produced stored in 400-bbl. tank. Total contaminated liquids produced 47 bbls. Stored in 400-bbl. tank for injection later. Cumulative gas produced 399 MCF. H_2S in gas monitored at 300 ppm. Shut down flow after 1 hr. 45 min. Pumped 30,000 SCF N_2 down tubing. Pumped 150,000 SCF N_2 down annulus. Rigged up Otis and ran Otis "XN" plug in nipple at 5196 ft KB. Bled TP to 900 psig. CP 1700 psig. Plug held okay. Ran Otis "DB" collar latch plug to 212 ft KB and set. Bled off pressure inside of tubing above plug to 0 psig. Held okay. Attempted to bleed off pressure above tubing hanger and lower set of 2-7/8-inch pipe rams. Would not bleed off. Called out O.C.T. representative. To arrive on location at 9 a.m. Suspect hanger compression ring problem.

October 27 - Rigging down rental equipment. Pressured between tubing hanger and pipe rams on BOP several times to 3000 psi. Bled back. Finally got hanger seal to hold. Checked tubing plugs. Holding okay. Opened pipe rams and Hydril. Backed out tubing from top of hanger. Closed blind rams. Removed all BOP's except blinds. Found pressure between blinds and tubing hanger. Bled off. Found small leak around outside of hanger from the annulus. Removed blinds. Installed master valve and tubing head bonnet flange. Pressure tested valve to bonnet connection to 5000 psi. Held okay. Unable to pressure test internal sealing connection from bonnet to valve because of small leak around hanger. No external leaks detected. Started rigging down lines to BOP controls and Otis equipment. Preparing to decontaminate D. W. C. unit.

October 28 - Decontaminating equipment. Decontaminated all rental equipment except for D.W.C. unit. Having to steam out inside of unit using rig boiler.

October 29 - Waiting on trucks to move out rig. Finished decontamination of D.W.C. unit. Released rig at 3 p.m. October 28, 1973. Trucks to tear down and move out rig expected on November 1, 1973.

October 30 - Waiting on trucks for rig move-out. Otis equipment moved out and all other rental equipment except D. W. C. moved off site. D. W. C. waiting on trucks.

October 31 - Waiting on trucks to move out D. W. C. unit. Trucks for rig expected on November 1, 1973. Surface CP on well at 1 p.m. October 30, 1973 - 1740 psig.

November 1 - Waiting on trucks to rig down. Moved out D. W. C. unit.

November 2 - Tearing down and moving rig off location.

November 3 through November 6 - Moving off rig.

November 7 - Finished tearing down and moving off location.

APPENDIX B
DAILY DRILLING REPORTS
FAWN CREEK GOVERNMENT #1 WELL
REENTRY AND RECOMPLETION - June 18 - September 17, 1973
AND
REMEDIAL WORK - November 23 - December 5, 1974

1973

June 18 - Moved in Colorado Well Service, Inc. workover rig - rigging up.

June 19 - Rigging up - set water tank and circulating equipment - installed Hydril, double gate BOP - Tested - Ran Hughes Tool Co. 4-3/4-inch bit with four 3-1/8-inch D.C. and 135 joints 2-3/8-inch EUE tubing - tagged top of soft cement at 4364 ft KB. Shut in overnight.

June 20 - Mixed 10 sacks of KCl with 135 barrels of water. Rigged up to drill. Drilled cement from 4364 ft to 4569 ft KB. Mud pump went down, lost two hours, 4:00 p.m. to 6:00 p.m. Shut down overnight.

June 21 - Drilled cement with 2% KCl water from 4569-4845 ft KB. Bit #1 cum. 14 rotating hours and 481 ft - weight on bit 6000# at 70 RPM, pump press 450, reverse circulation. Hart Gleason, LLL, on location.

June 22 - Drilled cement with 2% KCl water from 4845-5062 ft KB. Bit #1 cum. 21 hrs rotating at 698 ft. Wt on bit 6000#, 80 RPM, pump press 300 psig, reverse circulation. Hart Gleason, LLL, on location. Changed stripper head rubber in a.m. and p.m.

June 23 - Drilled cement with 2% KCl water from 5062-5247 ft KB. Bit #1 cum. 26-1/2 hrs rotating at 883 ft. Wt on bit 6000#, 80 RPM, pump press 300 psig - reverse circulating. Laid down power swivel - removed stripper head. Cleaned cement from flat tank. Started out of hole with string to change bit, elevator latch broke with one-half string out. Shut down overnight for elevator repair. Hart Gleason, LLL, and John Glock, EIC, on location.

June 24 - Filled flat tank with water and added KCl to 2% concentration. Repaired elevators. Pulled out of hole with Bit #1. Good condition. Some bearing wear. Bit #1 checked for radiation, tested OK. Picked up Bit #2 HTC 4-3/4-inch WO #TD047. Went in hole with Bit #2 and four 3-1/8-inch drill collars on bottom and broke circulation at 12:30 hrs - drilling at 12:45 hrs. Drilled 26 ft of cement to 5273 ft KB and service unit motor fuel injection pump broke. Shut down overnight waiting on repairs. Hart Gleason, LLL, and John Glock, EIC, on location.

June 25 - Down for rig engine repairs from 8:00 a.m. to 11:00 a.m. Drilled cement with 2% KCl water from 5273-5435 ft KB. Circulated hole clean. Shut down overnight.

June 26 - Drilled cement from 5435-5524 ft KB. Bit stopped drilling - appears to be on junk or metal. Circulated out very fine metal shavings. Have recovered no sand in cuttings. Pulled out of hole. Strap out at 5524 ft KB. Outside 3/8-inch of 4-3/4-inch bit appears to have been drilling on metal - Shut down overnight.

June 27 - Picked up Acme taper mill 4-13/16-inch OD Bowen hydraulic jars and trip in hole. Tagged probable collapsed casing at 5524 ft. Rig up drilling equipment and drill 18 inches with mill. Extremely hard returns contained excessive fine shavings of steel and good hard cement. Total rotating hrs with mill - 3-1/2 hrs. Trip out of hole - mill was worn out significantly 18 inches from the bottom up. Evidently casing is collapsed extremely bad. Shut down overnight.

June 28 - Wait on orders from 8:00 a.m. to 3:00 p.m. Shut down overnight.

June 29 - Trip in hole with 4-inch OD Acme tapered mill. Circulated down to 5542 ft. Returns contained frac sand and some cement. Power swivel broke down. Pulled three stands of 2-3/8-inch tubing. Shut well in and shut down.

June 30-July 4 - Well shut in - Rig shut down (Standby) - Wait on orders.

July 5 - Pressured 5-1/2-inch casing with water to 575 psig surface pressure. Held OK for 10 minutes. Pulled 4-inch mill - ran 4-3/4-inch OD Impression block to 5525 ft KB. Set down with 10,000 lbs - pulled out of hole. Impression indicates apparent one-half circle of 5-1/2-inch casing looking up. Impression is 1/4-inch wide around the outside of the block and has bit tooth marks visible on one end. Bore through problem area appears to be 4-1/2 inches. Shut down overnight.

July 6 - Ran Eastman casing roller - Calipered 4-13/16-inch OD - Rotated with 1000 ft lbs torque, 1000-1500 lbs wt on roller at 5525 ft KB - Tool torques up - Made 2 inches in 4-1/2 hrs - Believe most of 2 inches is make up in 2-3/8-inch EUE tubing - Started out of hole laying down 2-3/8-inch tubing - Shut down overnight.

July 7 - Laid down remainder of 2-3/8-inch tubing - Pulled Eastman casing roller - Seven rollers lost downhole off of tool - changed out BOP rams to 2-7/8 inches - Ran 4-inch mill on bottom of string type tapered mill located 7 ft above 4-inch mill - Ran in with jars and four 3-1/8-inch drill collars - picked up 57 joints of 2-7/8-inch drill pipe with 3-1/8-inch OD tool joints - shut down overnight - waiting on remainder of 2-7/8-inch drill pipe - plan to fish out lost rollers after milling through tight spot - shut down overnight.

July 8 - Picked up remainder of 2-7/8-inch drill pipe - pipe strap in hole to problem area was 5522 ft KB - Milled through damaged casing with two 3000# wt, 70 to 80 rpm and 1600 ft lbs torque - Ran 4-inch mill on bottom to depth of 5539 ft KB. 4-7/8-inch mill to depth of 5532 ft KB. Reamed through tight spot several times - did not drag - circulated hole clean - started out of hole for magnet - Shut down overnight.

July 9 - Strapped 2-7/8-inch drill pipe out of hole - Bottom of 4-inch mill 5539 ft KB, depth of 4-7/8-inch mill 5532 ft KB - laid down string mill - Ran 4-1/2-inch OD Magnet with jars and 2-7/8-inch drill pipe - set down on bottom at 5539 ft KB - Reverse circulated to 5545 ft KB - Recovered frac sand - started out of hole - shut down overnight.

July 10 - Pulled out of hole with magnet - recovered four of seven rollers - Ran back in hole with 4-1/2-inch OD magnet - set down at 5545 ft KB - Reverse circulated to 5550 ft KB - Recovered frac sand - Pulled out of hole - recovered three remaining rollers lost from casing roller - shut down for night.

July 11 - Ran 4-3/4-inch bit on 2-7/8-inch drill pipe - washed frac sand from 5550-5570 ft KB - Pressure tested 5-1/2-inch casing using 2% KCl water with 500 psig surface pressure for 10 minutes - held OK. Pulled out of hole - laid down jars and 4-3/4-inch bit - picked up Baker 4-1/2-inch OD Retrieving Tool for retrievable bridge plug - started into hole - shut down overnight.

July 12 - Cleaned pits - mixed 100 bbls of 2% KCl water - washed sand from 5570-5580 ft KB - released bridge plug - well went on vacuum - pulled and laid down bridge plug - Ran 4-3/4-inch bit to 5500 ft KB. Shut down overnight.

July 13 - Ran 4-3/4-inch bit to 5626 ft KB - Started taking weight - pulled out of hole - strap out at 5628 ft - Laid down 4-3/4-inch bit - Picked up 4-inch OD tapered mill - Jars - Ran mill to 2500 ft KB. Shut down for night.
Note: Perforations are from 5600-5630 ft KB.
Casing collars are at 5610 ft and 5640 ft KB
Cement Bond Log indicates poor bond at 5628 ft KB
Baker Model "D" is at 5653 ft KB
Largest OD on Latch in tool is 3.750 inches
Plan to attempt to wash 4-inch OD tool to 5653 ft KB - Not to rotate - if can't will pull out of hole and run impression block.

July 14 - Ran 4-inch Mill to 5628 ft - would not go through tight spot - Rotated with tubing tongs and circulated for five minutes - would not go - pulled out of hole - Laid down 4-inch Mill - Mill appeared to be drilling on metal with a bore of about 3-1/2 inches - Ran 4-3/4-inch OD impression block - Set down with 12,000 lbs at 5626 ft - Tight pulling up - Jars tripped - pulled out of hole to 5000 ft KB - Shut down for night.

July 15 - Finished pulling of impression block - Block indicates casing collapsed in from one side - no impression on bottom - Picked up Bowen 5-1/2-inch casing roller - 4-13/16-inch OD - Ran into hole - started taking wt at 5620 ft KB - Rotated to 5625 ft - Could not get below 5625 ft - Rotated with 2500 ft lbs torque, 30 RPM, 500 to 1000 lbs wt - Additional wt stops power swivel - worked for three hours - no progress - Pulled four stands - shut in well - shut down overnight - Plan to run 4-13/16-inch string mill with 4-inch tapered mill on bottom.

July 16 - Pulled casing roller - ran string pipe mill 4-13/16-inch OD with 4-inch OD tapered mill on bottom - 7 ft below string mill. Ran in hole to 5622 ft KB - Connected power swivel - swivel pump engine locked up - pulled three stands - shut in for repairs.

July 17 - Shut down for rig repairs from 8:00 a.m. to 1:00 p.m. Ran three stands of drill pipe in hole. Rig up drilling equipment - tagged problem section at 5630 ft KB. Milled from 5630-5632 ft - Kicked power swivel out - slack off - tagged Model D Packer at 5654 ft KB. Pulled three stands of drill pipe - Shut down overnight.

July 18 - Trip in with three stands drill pipe - tag Model "D" Packer at 5654 ft KB - pick up two feet and circulate off top of packer 3/4 hr - lay down drill pipe and drill collars - change slip segments - stripper head rubber and pipe rams to accommodate 2-1/16-inch tubing. Pick up Baker Latch-In tool with plug nipple and plug on top of Latch-In tool. Pick up two joints 2-1/16-inch tubing. Shut down overnight.

July 19 - Ran 175 joints 2-1/16-inch IJ tubing - pressure tested tubing with rig pump to 1200 psig surface pressure every 20 joints, all tests OK. Tagged packer at 5654 ft KB - Unable to latch into Model "D". Shut down overnight.

July 20 - Pulled Baker tubing plug with wireline equipment - circulated to clean out bore of Model "D" - Pressure up to 1400 psig down tubing when wt is set on Model "D" - Does not latch in - Reverse circulated out small amount of fine metal shavings - Set down on packer - pressured to 1400 psig (maximum output of rig pump) - Held for 10 minutes - Pulled out of hole - Assembly indicates bottom seals apparently going into bore of packer - however seals mostly torn up and some indications of metal damage around bottom seal - bottom of tube on seal assembly shows no damage - unable to determine why water was not going into perfs below Model "D" at 1400 psig - Flapper valve would have been open and tube through the bottom of the packer with bottom seals seated in the Model "D" - shut down overnight.

July 21 - Ran Baker Model "A" lockset retrievable packer on 2-1/16-inch tubing to 5500 ft KB - Unable to get Halliburton or Dowell pump truck for injection test - Moved on Colorado Well Service Triplex - unable to start up pump engine - Down from 10:30 to 2:30 for pump engine repair - got engine started - started down hole with packer - got to 5628 ft KB - Unable to get any deeper - OD of packer 4.641 inches - Pulled packer out of hole - Marks on packer indicates probable casing collapse again - shut down.

July 22 - Shut down - no standby charge

July 23 - Ran 4-inch tapered mill with 4-7/8-inch string mill section six feet above 4-inch mill - picked up 2-3/8-inch tubing - tagged Model "D" at 5654 ft KB - Had no problem through damaged section at 5628 ft KB - Ran through 5628 ft interval several times - Pulled out of hole - Plan to extend string mill section from 18 inches to about 5 ft and rerun.

July 24 - Ran string mill with flat section of 50 inches, 4-13/16-inch OD, tapered each end - ran with hydraulic jars and 2-3/8-inch EUE tubing - tagged top problem area at 5525 ft KB - would not go through - milled to 5529.5 ft in five hours - unable to get through section - started out of hole - plan to run string mill with 36 inches of flat section and 4-3/4-inch OD.

July 25 - Pulled mill from hole - Mill appears to have been drilling on metal about 4-3/4-inch in diameter - replacement mill was built with OD too large - Acme Tool Co. grinding down mill - shut down overnight.

July 26 - Ran string mill 4-3/4-inch OD 36 inches length tapered both ends - with 4-inch OD tapered mill 3 ft below string mill - ran in hole with hydraulic jars and 2-3/8-inch EUE tubing - milled out casing from 5529.5-5531 ft KB and milled casing from 5628-5630 ft KB - Tagged Model "D" at 5654 ft KB - Reverse circulated at top of Model "D" for 30 minutes - laid down 2-3/8-inch tubing - shut down overnight.

July 27 - Ran Baker Lockset Packer with 2-1/16-inch stinger below 5 ft long with mule shoe - Baker plug receiving nipple above packer - Pan in hole with 2-1/16-inch tubing - Had no problems in previously milled casing points - tagged at 5644 ft KB - Washed down to 5647 ft KB - Reversed out metal cuttings - Set packer and set at 5638 ft KB - could not pressure up - circulated up annulus - pulled packer to 5500 ft KB - shut down overnight.

July 28 - ,Pulled packer out of hole - had deep scratches around outside in metal - Ran Baker Model "D" milling tool with packer catcher, four 3-1/8-inch drill collars, with 2-3/8-inch tubing - ran to 5500 ft - shut down for night.

July 29 - Tagged apparent damaged section in casing at 5647 ft KB - Milled through section - cleaned out to Model "D" - started milling on Model "D" - Packer is apparently going down hole slowly during milling - followed down hole to 5660 ft KB where packer stopped - started getting rubber back indicating top slips are milled up - packer catcher is not latched below Model "D" - string is free on pickup - will have to mill over bottom slips and allow packer body to drop down hole.

July 30 - Milled on Model "D" packer - Recovered some rubber in returns. Tripped out of hole. Safety joint was broken allowing packer catcher to collapse. Made up safety joint, ran back in hole with milling tool - latched into Model "D" packer - pulled 30,000 lbs over string wt - Could not move packer - milled on packer. Made unsuccessful attempt to drive packer downhole. Pulled two stands of tubing - String was free on pickup - no drag - Packer is at 5664 ft KB. Shut down for night.

July 31 - Ran two stands of tubing, picked up power swivel and milled on Model "D" from 5664-5667 ft KB. Mill stopped cutting - Tripped out of hole - left spring, latch, safety joint, and 2.43-inch OD inside mill off of Baker Model C-1 packer milling - retrieving tool in hole. Shut down for night.

August 1 - Trip in hole with Baker Lockset packer and 2-3/8-inch tubing - Set packer 5656 ft KB - Repaired leaks in triplex pump. Pump down tubing into formation at 1 BPM. Pressure varied from 1300 psi initially to 750 psi. Laid down 2-3/8-inch tubing and 3-1/2-inch drill collars. Changed pipe rams, slip segments, and elevators and prepared to run Baker Lockset packer on 2-1/16-inch tubing. Shut down overnight.

August 2 - Picked up Baker Lockset packer with plug nipple just above packer. Tripped into hole with 2-1/16-inch IJ tubing - spaced out and set packer at 5654 ft KB. Pressured up down tubing - fluid communicated up annulus. Released packer and reset at 5655 ft KB. Fluid communicated up annulus - reset packer at 5652 ft KB. No communication. Spaced out and hung tubing in head with packer set at 5652 ft KB. Pressured up down tubing - fluid communicated. Set packer at 5650 ft and fluid communicated. Hung tubing in head, installed well head - shut down overnight.

August 3 - Remove well head - Set Baker Lockset packer at 5642 ft KB - Pressure up - Pump into formation at 1400 psi at about 1 BPM. Space out - set packer at 5643.5 ft KB - pump into formation OK - Hung tubing in head. Nipple up - Rig up to run 1.9-inch OD tubing - Run 40 joints tubing-tong head broke - shut down overnight.

August 4 - Pick up 133 joints 1.9-inch OD tubing (total of 173 joints) landed at 5572 ft KB. Hung in well head - Remove BOP's - lower split tubing hangers - install well head - Rig up to swab.

August 5 - Shut down - No standby charge

August 6 - Swabbed liquid level from 300 ft to 4200 ft through 1.90-inch IJ tubing string - No gas entry - shut down overnight.

August 7 - Found liquid level at 2000 ft from surface - swabbed down to 4000 ft making four to five runs per hour - No gas entry yet - shut down overnight.

August 8 - Found liquid level at 3800 ft from surface - swabbed down to 5570 ft - Pulling two runs per hour, 1000 ft liquid per run - Casing pressure built up to 25 psig - shut in overnight.

August 9 - Found liquid level at 4300 ft from surface - casing pressure built up to 40 psig overnight - Swabbed down to 5570 ft - Pulling two runs per hour - 600 to 800 ft of liquid per run - Casing pressure built up to 50 psig - Shut in for night - EIC analysis of water and gas indicates no radioactivity from nuclear detonation.

August 10 - Found liquid level at 4300 ft from surface casing - pressure 70 psig - built up to 70 psig overnight - Swabbed down to 5570 ft - Making two swab runs per hour, pulling 400-500 ft of liquid per run - casing pressure built up to 75 psig - Shut in for night.

August 11-12 - Shut down - No standby charge

August 13 - Found casing pressure at 95 psig, liquid level at 3800 ft from surface. Swabbed well down to 5570 ft - Making two runs per hour, pulling 400-500 ft per run. Casing pressure went down to 80 psig - Shut in overnight.

August 14 - Found casing pressure at 95 psig - liquid level at 4300 ft from surface. Swabbed well down to 5570 ft - Making two runs per hour - pulling 400-500 ft of liquid per run - Casing pressure went down to 90 psig. Shut in overnight.

August 15 - Found casing pressure at 100 psig - Liquid level at 4300 ft from surface. Swabbed well down to 5570 ft - making two runs per hour - Pulling 400-500 ft of liquid per run - casing pressure went down to 90 psig - Ran swab down 2-1/16-inch tubing - found liquid level at 900 ft from surface - 2-1/16-inch string had 10 psig at surface - shut in well overnight.

August 16 - Found casing pressure at 110 psig - Liquid level at 4400 ft from surface - Swabbed well down to 5570 ft Making one run per hour - Pulling 700-800 ft per run - Casing pressure went down to 100 psig - Shut well in for night. Caught samples of recovered liquid to send to Dowell Research Laboratory for analysis and evaluation for planned stimulation job - Liquid appears dark-colored and is carrying very fine sediments.

August 17 - Found casing pressure at 140 psig - 2-1/16-inch tubing pressure 0 psig - 1.90-inch tubing pressure at 25 psig - Liquid level at 4500 ft from surface - swabbed well down to 5570 ft - Making one run per hour, pulling 600-700 ft per run - Casing pressure remained at 150 psig - Shut well in for night.

August 18 - Found casing pressure at 150 psig - 2-1/16-inch tubing pressure 0 psig - 1.90-inch tubing pressure at 25 psig - Liquid level at 4600 ft from surface - Swabbed well down to 5570 ft - Making one run per hour pulling 600 to 700 ft per run - Casing pressure remained at 150 psig - Shut well in for night.

August 19 - Shut down - No standby charge.

August 20 - Found casing pressure at 200 psig - 2-1/16-inch tubing pressure at 50 psig - 1.90-inch tubing pressure at 55 psig - Liquid level at 4500 ft from surface. Swabbed well down to 5570 ft - Making one run per hour pulling 500-600 ft per run - Casing pressure remained at 200 psig. Shut in well for night.

August 21 - Found casing pressure at 225 psig - 2-1/16-inch tubing pressure at 25 psig - 1.90-inch tubing pressure at 50 psig - Liquid level at 4700 ft from surface - Swabbed down to 5570 ft - Making one run per hour, pulling 600 ft of liquid per run - casing pressure remained at 225 psig - Shut down overnight.

August 22 - Found casing pressure at 240 psig - 2-1/16-inch and 1.90-inch tubing pressures at 50 psig - Liquid level at 4700 ft from surface - Swabbing from 5570 ft - Making one run per hour pulling 600 ft of liquid per run - casing pressure remained at 240 psig - Shut down overnight.

August 23 - Found casing pressure at 270 psig - 2-1/16-inch at 25 psig, 1.90-inch at 60 psig - Liquid level at 4700 ft from surface - Swabbing well from 5570 ft. Making one run per hour, pulling 500-600 ft of liquid per run, casing pressure went up to 280 psig - well unloaded and flowed for 15 minutes then died, casing pressure down to 240 psig - Shut well in - Moved off workover rig - Preparing to stimulate well on August 24.

August 24 - Found casing pressure at 270 psig - 2-1/16-inch tubing pressure at 50 psig - 1.90-inch tubing pressure at 80 psig - connected Dowell and Nowsco lines and pressure tested - Pumped in 70 bbls of inhibited gas well acid mixed with 12,000 scf of N_2 at 2300 psig - Casing pressure at end of displacement was 1800 psig - Connected lines to annulus and displaced gas well acid into perfs (5600-5630 ft) with 80,000 scf of N_2. Final and maximum pressure was 3200 psig - Immediate SIP 3200, 15 minute SIP 3200 psig. At 70,000 scf displacement down annulus, pressure on 2-1/16-inch tubing increased to 1200 psig - No breaks in pressure while spotting or displacing acid - Left well shut in for one hour and started flowing well to pit from 1.90-inch tubing at 1:45 p.m. - Well died at 8:00 p.m. - had 80 psig on annulus - had 60 psig on 2-1/16-inch tubing string - Shut in well overnight.

August 25 - Found 750 psig on annulus, 200 psig on 2-1/16-inch tubing, opened up 1.90-inch tubing to pit - would not unload - moved on workover rig and rigged up - Swab carrier threads were damaged - Waited on new carrier - Swabbed two hours, liquid level at 3000 ft from surface - Casing pressure at 4:00 p.m. 850 psig. Shut down overnight.

August 26 - Shut down.

August 27 - Found casing pressure at 1100 psig - 2-1/16-inch tubing pressure at 200 psig, 1.90-inch tubing pressure at 700 psig - Opened well to pit from 1.90-inch string - Well would not unload - Swabbed well in - Flowed for two hours and died - Casing pressure went down to 400 psig - Swabbing from 5570 ft, making two runs per hour and pulling 1000 ft of liquid per run - Well comes in and flows for about 10 minutes and dies - Casing pressure staying at 300 psig - Shut well in at 4:00 p.m. Casing pressure at 300 psig.

August 28 - Found casing pressure at 600 psig - 2-1/16-inch tubing pressure at 200 psig - Opened well to pit from 1.90-inch string - Well died - Casing pressure would not unload well - Found liquid level at 3800 ft from surface - Swabbed well in - flowed for two hours and died - Making one swab run per hour from 5570 ft - Well flows for about 30 minutes and dies. Casing pressure remaining at 250 psig - Shut well in at 4:00 p.m. - Casing pressure at 250 psig.

August 29 - Found casing pressure at 475 psig - 225 on 1.90-inch tubing. Opened to pit, well would not unload - Found liquid level in 1.90-inch at 4300 ft from surface. Swabbed well in, flowed for one hour and died. Casing pressure went down to 250 psig - making one swab run per hour. Well flows about 30 minutes and dies - Casing pressure remaining at 250 psig - shut well in at 4:00 p.m. - Casing pressure at 250 psig. Shut down overnight.

August 30 - Found casing pressure at 475 psig - 2-1/16-inch tubing pressure 200 psig - 1.90-inch tubing pressure 225 psig. Opened to pit from 1.90-inch tubing - would not unload. Found liquid level in 1.90-inch at 4300 ft from surface - Swabbed well in - flowed for 45 minutes and died - casing pressure went down to 250 psig - making one swab run per hour, well flows about 30 minutes and dies - Casing pressure remaining at 250 psig. Shut well in at 4:00 p.m., casing pressure 250 psig. Shut down overnight.

August 31 - Found casing pressure at 475 psig - Shut down swabbing - Moving in 400 bbl tank and circulating equipment. Pumping water to mix 2% KCl water to kill well for planned frac on zone 5082-5128 ft on about September 7, 1973.

September 1 - Found casing pressure at 850 psig - Pumping water to 400 bbl tanks, rigging up circulating equipment.

September 2-3 - Shut down, casing pressure 1000-1100 psig. No standby charge.

September 4 - Casing pressure 1200 psig - Blew well down - Mixed 900 bbls of 2% KCl water with 2 gal Adamol per 1000 gal water - Killed well down 1.90-inch tubing with 125 bbls. Filled 2-1/16-inch tubing with 2 bbls - Installed Shaffer double gate Hydril BOP - Rigged up floor - Worked for three hours trying to release Baker Lockset Packer - Could not release - Shut well in - Preparing to circulate down near top of packer with 1.90-inch tubing before pulling 1.90-inch tubing from hole.

September 5 - Circulated to 5640 ft KB with bottom of 1.90-inch tubing - Pulled 1.90-inch tubing from hole - Released Lockset Packer and pulled 2-1/16-inch tubing. Shut down overnight. (Laid down 15 joints each of 1.90-inch and 2-1/16-inch).

September 6 - Moved in 2-7/8-inch EUE Tubing - Ran Baker 5-1/2-inch casing scraper on 2-7/8-inch tubing to 5378 ft KB. Started out of hole. Shut down overnight.

September 7 - Finished pulling 2-7/8-inch tubing, laid down casing scraper. Rigged up Dresser Atlas to log and perforate. Ran CBL-Variable Density Log from 5400-4500 ft. Bond log was identical to Bond Log run on 4/25/70 prior to the nuclear stimulation. Perforated upper Fort Union sand interval with 18 NCF-V jets as follows: 5084, 86, 88, 90, 94, 97, 98, 5100, 02, 06, 08, 10, 12, 14, 16, 22, 24, 5126 ft KB. Rigged down Dresser Atlas, Ran Baker Model "C" Retrievable Bridge Plug and Model "E" Retrievable Packer on 2-7/8-inch tubing. Set Bridge Plug at 5327 ft KB and Model "E" at 5010 ft KB. Shut down overnight.

September 8 - Rigged up Dowell to frac interval from 5084-5126 ft KB. Pressured annulus to 1000 psig using rig pump. Dowell tested lines to 7300 psig - Held OK. Fraced with 10,000 lbs of 20-40 sand and 2900 lbs 10-20 sand. Average sand concentration was 3/4#/gallon. Average rate 12.5 BPM with approximately 1200 SCF/bbl of CO_2. Used total of 40 tons of CO_2, 520 bbls of 2% KCl water mixed with 2 gal of Adamol per 1000 gal of water. Job started at 10:30 a.m. - finished at 11:13 a.m. Started flowing to pit at 12:05 p.m. Formation broke down at 5500 psig. Broke back to 4500 psig. ISIP 1600 psig. Blew well overnight. Making CO_2 and water - Gas started burning continuously after six hours of flowing. Estimate 300-400 bbls of water flowed back.

September 9 - Well still flowing - estimate water production at 1 bbl per hour and slowly decreasing. Estimate gas rate at 100-150 MCF/D. Shut in well for buildup at 9:15 a.m.

September 10 - Surface tubing pressure 960 psig - Well shut in - Rig shut down.

September 11 - Surface tubing pressure 1380 psig - Well shut in - Rig shut down.

September 12 - Surface tubing pressure 1510 psig at 8:00 a.m. Started flowing well to pit at 12:30 a.m. with 2-inch Critical Flow Prover with 0.125-inch orifice. Initial pressure 1515 psig. Stabilized at 930 psig. Rate #1 = 322 MCF/D, changed to 0.250-inch orifice - stabilized at 330 psig, Rate #2 - 480 MCF/D, changed to 0.375-inch orifice. Stabilized at 150 psig - Rate #3 = 498 MCF/D. Shut well in at 1:45 a.m., September 13. Well built up to 1210 psig at 8:00 a.m. September 13.

September 13 - Bled well down to pit - killed well down 2-7/8-inch tubing with 40 bbls of 2% KCl water mixed with 2 gals of Adamol per 1000 gals of water. Released Baker Packer - Reversed out 20 ft of frac sand from above Baker Bridge Plug. Released Bridge Plug. Lost 80 bbls of 2% KCl water while reversing out sand. Started out of hole with bridge plug and packer, laying down 2-7/8-inch tubing. Shut down overnight.

September 14 - Laid down remainder of 2-7/8-inch tubing and Baker Bridge Plug and Packer - Ran Baker Model "F.H." double grip Hydrostatic packer on 163 joints of 2-1/16-inch tubing - Hydrotested tubing into hole - laid down 2 bad joints - Baker "F" plug nipple located at 5288 ft KB, Packer landed at 5293 ft KB. Halliburton circulated hole with 33 bbls, dropped ball and pumped down 2-1/16-inch with 12 bbls, pressured up and set packer, Ball sheared out of packer at 2200 psig. Pumped down 2-1/16-inch at 1-1/2 BPM at 1000 psig for 3 minutes, no water returns to surface. Annulus went on vacuum while pumping down 2-1/16-inch tubing. Released Halliburton. Shut in well. Shut down overnight.

September 15 - Found no pressure on well. Rigged up to run 1.90-inch IJ tubing - Ran 3 ft pinned joint on bottom and 158 joints of 1.90-inch tubing landed at 5084 ft KB. Removed BOP and installed dual wellhead, rigged up to swab 1.90-inch tubing - Found liquid level at 300 ft, made 6 swab runs. Shut down overnight. (Laid down 11 bad joints of 1.90-inch tubing).

September 16 - Swabbed well down to 1600 ft, casing pressure at 600 psig - well started flowing gas and water to pit - Let well flow overnight to clean up. Estimated rate 250 MCF/D. Well appears to be cleaning up and rate increasing.

September 17 - Well flowed to pit to clean up until 4:30 p.m., Shut in well. Estimated rate at shut-in 450 MCF/D. Released pulling unit and moved off of hole. Pressure at 8:00 a.m. September 18 - Tubing Pressure at 1340 - Casing pressure at 1400 psig.

REMEDIAL WORK - November 23 - December 5, 1974

1974

November 23 - Nippled down tubing head. Total depth 7895 ft. Plugback total depth 6460 ft. Workover unit on location at 0930, moved in and rigged up. Dowell pump truck did not show. Called Halliburton. Pump truck on location at 1430. Mixed 550 bbls of 2% KCl water and killed annulus by pumping 25 bbls water down 1.9-inch tubing and 100 bbls water down 5-1/2-inch casing. Pump down overnight.

November 24 - Rigged up to pull 2-1/16-inch tubing. Unit operation derrick man did not show up for work. Found well had frozen up, used EIC steamer to thaw same. Nippled down wellhead, nippled up BOP. Pulled 1.9-inch tubing out of hole. Started rigging up to pull 2-1/16-inch tubing and Baker Model FH packer out of hole.

November 25 - Total depth 7895 ft. Plugback total depth 6460 ft. Finished rigging up to pull 2-1/16-inch tubing and packer. Filled annulus with 23 barrels of water. Pulled 50,000 lbs on packer. Would not release. Rigged up wire line truck and pulled Baker Model FWG plugs out of seating nipple at 5288 ft. Pumped 27 bbls of water down 2-1/16-inch tubing at 1-1/2 barrels per minute at 800 psig. Established communication with annulus with 19 barrels. Rigged down Halliburton. Shut well in overnight.

November 26 - Pumped 25 barrels of 2% KCl water in annulus. Picked up 38,000 lbs on 2-1/16-inch tubing and released packer. Pulled out of hole - laid down 172 joints of 2-1/16-inch IJ tubing. Laid down Baker Model FH packer. Filled hole with 35 barrels of water. Shut well in. Tallied 172 joints of new 2-1/16-inch IJ tubing. 2 joints of 172 were bad.

November 27 - Found no pressure on well. Pump froze up. Did not pump 2% KCl water. Picked up redressed Baker Model FH hydrostatic packer with Baker Model F nipple 5 ft above packer. Went in hole with 94 joints 2-1/16-inch IJ tubing. Hydrotested each joint into hole with 3250 psig. Bottom packer of hydrotester tool locked up approximately 70 ft down hole in 92nd joint into hole. Unable to release - laid down 3 joints. Found hydrotested packer 1 ft before box end of 92nd joint into hole. Well required welder to split joints into recovered tool. Filled hole with 20 barrels of 2% KCl water. Shut in well. Found no leaks in 91 joints currently in hole.

November 28 - Shut down for Thanksgiving.

November 29 - Found no pressure on well. Pump froze up. Laid Baker Model FH packer to 5262 ft GL with 167 joints 2-1/16-inch IJ tubing. Baker

F Nipple at 5257 ft GL. Hydrotested all 2-1/16-inch IJ tubing in hole to minimum pressure of 3000 psig. Filled hole with 2% KCl water. Set packer and sheared out ball at 2700 ft psig. Pumped 10 barrels of 2% KCL water down 2-1/16-inch tubing at 1-1/2 barrels per minute and 1300 psig casing or on vacuum. Shut well in. Started rigging up to run 1.90-inch IJ tubing.

November 30 - Found no pressure on well. Pumped no water into hole. Ran 155 joints of 1.90-inch IJ tubing with 3 ft bent joint on bottom. Landed 1.90-inch IJ tubing at 4969 ft GL. Removed BOP's. Installed wellhead and pressure tested seals to 3000 psig. Held OK. Rigged up and unloaded tubing on casing side with nitrogen. Shut well in.

December 1 - Found well on vacuum. Connected Nowsco to 1.90-inch tubing string. Displaced 80 barrels of water up annulus with 60,000 SCF nitrogen into flat tank. Maximum 2500 psig. Unloaded water. Shut down nitrogen injection. Let well flow for 2 hours at rate of approximately 1 MMSCF per day. No water to surface after initial 80 barrels. Surface tubing pressure 1500 psig. Started to change flow from casing to tubing. Master valve on wellhead tubing tree would not hold pressure. Left Nowsco valve on head. Disconnected Nowsco truck. Will have to kill well, change out master valve and unload well with nitrogen. Shut in overnight - arranged for Halliburton for December 2, 1974 a.m. EIC checked recovered water. No detectable tritium in water.

December 2 - Killed well with 150 barrels 2% KCl water. Changed out master valve on 1.90-inch IJ tubing side. Connected Nowsco to 5-1/2-inch x 1.90-inch annulus. Unloaded well with 100,000 SCF nitrogen. Maximum pressure 2500 psig. Left well flowing overnight.

December 3 - Full well flowing at estimated rate of 125 MCF per day, fine water mist with gas. Shut well in, released R&R, started tie-in of well to separator.

December 4 - Finished tie-in of well to separator. Tied in water injection line to 2-1/16-inch tubing string. Serviced all WKM valves on wellhead.

December 5 - Installed building over wellhead. Finished heat taping water injection line.

APPENDIX C

PERMIT FOR SUBSURFACE DISPOSAL FINDINGS OF FACT, PUBLIC HEARING ON WATER DISPOSAL APPLICATION

WATER QUALITY CONTROL DIVISION COLORADO DEPARTMENT OF HEALTH

November 9, 1973

APPLICATION OF CER - GEONUCLEAR CORPORATION AND THE CONTINENTAL OIL COMPANY TO OPERATE A SUBSURFACE DISPOSAL SYSTEM UPON AND UNDER A TRACT OF LAND 739 FEET FROM THE WEST LINE AND 2357 FEET FROM THE NORTH LINE OF SECTION 14, T3S, R98W, RIO BLANCO COUNTY, COLORADO	)	PERMIT FOR SUBSURFACE DISPOSAL

1. The Colorado Water Quality Control Commission has found, after Public Hearing and due consideration, that subsurface disposal, as proposed in the application by CER Geonuclear Corporation and the Continental Oil Company, could take place within the meaning of Section 66-28-505(1) of the Colorado Water Quality Control Act of 1973.

2. The Colorado Water Quality Control Division hereby grants CER Geonuclear and the Continental Oil Company a permit for the operation of a subsurface disposal system as provided for in Section 66-28-505(2) of the Act and as provided for in Section 3(d) of the Emergency Rules for Subsurface Disposal Systems, effective October 16, 1973; subject to the following conditions and stipulations:

   A) Discharge under this permit may occur for a period of twelve months beginning on November 10, 1973.

   B) Total volume injected shall not exceed 24,000 barrels (42 gal./bbl) and concentration of tritium shall not exceed 0.05 micro Ci/ml.

   C) Injection pump pressure shall not exceed 1800 p.s.i.g.

   D) Injection interval shall be from 5600 feet to 6072 feet.

   E) Construction of the system and appurtenances, either as constructed or to be constructed, shall conform to the plans and specifications as proposed in the Project Rio Blanco - Subsurface Water Disposal Application submitted by CER Geonuclear June 11, 1973, except that the disposal interval includes the zone from 5600 to 5630 feet, as subsequently amended by the applicant.

F) Operational procedures, including alarm systems, shall be implemented as proposed in the application referred to above.

G) If testing of the RB-E-01 well and subsequent disposal into the Fawn Creek Government No. 1 well (proposed disposal system) is conducted in phases, the Water Quality Control Division and the Occupational and Radiological Health Division of the Colorado Department of Health shall be notified immediately upon completion of the testing period and at least five days before the resumption of a new testing period.

H) Any deviation from testing or injection procedures as outlined in the application referred to in (E) above shall require prior approval of the Water Quality Control Division and shall be requested in writing in sufficient time to provide adequate time for review and approval.

I) Employees of Department of Health and Department of Natural Resources shall be allowed access to the site without prior notification for purpose of observation of operations and sample collection of waste and/or products. Such access, however, to be subject to established health and safety precautions.

J) This permit shall not be assigned nor operations contracted to another party without prior written approval of the Colorado Water Quality Control Division.

3. Monitoring shall be conducted by CER Geonuclear and the Continental Oil Company as follows:

A) Samples of gas and injected fluid shall be analyzed for chemical and radiological constituents from the locations and at the frequencies indicated in Exhibit "A". Analyses shall be performed by the applicant's laboratory or an independent laboratory approved by the Division and the results of the analyses certified.

B) Upon request of the Colorado Water Quality Control Division, the applicant shall promptly furnish, at the time intervals indicated and at the applicant's cost, samples for analysis by the Colorado Department of Health. The samples shall be in the quantity and from the locations as specified by the Division and shall be properly labeled.

C) CER Geonuclear Corporation and Continental Oil Company, by undertaking the discharge which is the subject of the application, agree to perform such additional monitoring procedures and installations as may be required upon subsequent review by the Division, at the expense of the applicants.

4. All rules, regulations, orders, guidelines, etc., by the Colorado Water Quality Control Commission presently in effect, as well as any subsequent rules or regulations adopted by the Commission, shall be observed by the applicants.

5. This authority to discharge shall terminate in all respects, except for such monitoring and reporting procedures as required in Exhibit "A", twelve months from the effective date, unless the Colorado Water Quality Control Division shall extend the termination date.

6. This permit shall in no way be construed to relieve the applicants from complying with the requirements and regulations of other State and Federal regulatory agencies, including the Occupational and Radiological Health Division of the Colorado Department of Health. Nothing herein contained shall be construed to relieve the permittees from the observance of, performance of, or compliance with, any conditions, duties, or obligations imposed by any order, permit or license issued by any agency of the State of Colorado.

BY ORDER OF THE COLORADO WATER QUALITY CONTROL DIVISION

s/Frank J. Rozich
Frank J. Rozich, P.E.
Director, Colorado Water
Quality Control Division

s/Roy L. Cleere
Roy L. Cleere, M.D., M.P.H.
Executive Director, Colorado
Department of Health

WATER QUALITY CONTROL DIVISION
COLORADO DEPARTMENT OF HEALTH

November 9, 1973

MONITORING PROCEDURES FOR SUBSURFACE DISPOSAL SECTION 14, T3S, R98W, RIO BLANCO COUNTY, COLORADO	)	EXHIBIT "A"

As a condition of the permit for subsurface disposal, CER Geonuclear and Continental Oil Company shall perform the following monitoring procedures:

1. Gas and water sampling schedules and analyses as proposed in the application (Table IVD-1, Page 94), shall also include an analysis for tritium for the gas and water produced from the disposal well (Fawn Creek Government No. 1). Results of the chemical and radiological analyses of the samples will be submitted to the Division within five days after the completion of the analyses.

2. Water injection rates and pressures shall be monitored continuously and recorded on a daily basis. Daily records shall indicate the maximum injection pump pressure as well as the average (or operating) pressure and rate. Daily records, including volume, shall be submitted monthly in duplicate to the Division by the tenth day of the month for the proceeding month, or ten days after the completion of any testing period.

3. The disposal well shall be shut down and a pressure fall off test performed at each ten day interval and at the conclusion of any testing period. The shut down period is to be as long as necessary to obtain conclusive results. Data and/or charts are to be submitted to the Division within five days after completion of the pressure fall off test.

4. Water samples shall be collected and analyzed for radioactive constituents from the following wells: RB-D-01, RB-S-03, and RB-W-01 (W-1), as identified and located on Plate 11 of the Project Rio Blanco - Subsurface Water Disposal Application.

   Collection and analysis shall be weekly throughout the disposal period and for one month thereafter. If no anomalous amounts of radioactive constituents are observed during this period, then collection and analysis shall be on a monthly basis for twelve months after injection has terminated. If at any time anomalous amounts of radioactive constituents are observed, the injection system shall be shut down and the Water Quality Control Division promptly notified. Reinjection shall not be started without permission from the Division.

Monitoring procedures and conditions outlined above are supplemental to the present monitoring program required in the Permit for Subsurface Nuclear Detonation and in no way relieves CER Geonuclear from the requirements of the previous permit.

BEFORE THE WATER QUALITY CONTROL COMMISSION
OF THE STATE OF COLORADO

IN THE MATTER OF APPLICATION OF C. E. R. GEONUCLEAR CORPORATION ENTITLED "PROJECT RIO BLANCO SUBSURFACE WATER DISPOSAL APPLICATION" DATED JUNE 11, 1973, AS AMENDED)	FINDINGS OF FACT

This matter came on for public hearing on September 24, 1973 before John Phillip Linn, Hearing Officer for the Water Quality Control Commission, State of Colorado. The hearing was closed the same day.

Continental Oil Company, the unit operator of the Rio Blanco unit, whose employees and executives are making the management decisions concerning Project Rio Blanco, was admitted as a party to the proceedings.

C. E. R. Geonuclear Corporation, hereinafter referred to as Petitioner, and Continental Oil Company were represented by James D. Voorhees, Esq., of the firm Moran, Reidy & Voorhees, Denver, Colorado.

William Tucker, Assistant Attorney General, State of Colorado, appeared on behalf of the Water Quality Control Commission.

FINDINGS OF FACT

1. The Water Pollution Control Commission of the State of Colorado approved the Petitioner's request for a permit in regard to a nuclear detonation plan for Rio Blanco County, applicable to Phase One only of Project Rio Blanco, on May 4, 1973, nunc pro tunc as of April 17, 1973.

2. Three 30 kiloton nuclear explosives, especially designed for gas stimulation purposes, which had been placed in the Project Rio Blanco Well No. RB-E-01 bore at depths of 5840, 6230 and 6690 feet below the surface of the earth, were detonated on May 17, 1973. The simultaneous explosions of the detonations created a cylindrical chimney, having an overall height of approximately 1,350 feet and a radius from the center line of the chimney of some 80 feet. The maximum extent of fracture from the centerline of the chimney is less than 400 feet. The object of the detonation was to fracture various sandstone layers or lenses in which natural gas occurs.

3. The chimney exists within the base of the Fort Union Formation and the top of the Mesa Verde Formation. Between the top of

the chimney and the surface of the earth are approximately 1,000 feet of Fort Union Formation; over 2,000 feet of Wasatch Formation; and some 3,000 feet of the Green River Formation.

4. Contained within the chimney interval are some five million feet of void volume into which an estimated 540,000,000 standard cubic feet of natural gas has flowed. The gas in the chimney is expected to consist primarily of methane (CH_4)--54 to 42 volume percent; carbon dioxide (CO_2)--30 to 25 volume percent; hydrogen (H_2)--10 to 13 volume percent; and water vapor (H_2O)--6 to 20 volume percent.

5. Following detonation of the Project Rio Blanco, the Oil and Gas Conservation Commission of the State of Colorado authorized Petitioner to re-enter and test Well No. RB-E-01 of the Project Rio Blanco by its Order No. 264-2 dated July 17, 1973.

6. The Petitioner now seeks a permit approving the underground disposal of radioactive waste, i.e., tritiated water separated during the testing of Well No. RB-E-01, as part of the Second Phase of the Project Rio Blanco experiment, which is a joint activity of the Atomic Energy Commission and Petitioner to determine the feasibility of using nuclear explosives in the production of natural gas from formations which will not produce under conventional methods.

7. The petitioner expects to produce 300,000,000 standard cubic feet of natural gas, but there is a contingency to produce up to 800,000,000 standard cubic feet of natural gas, during the testing period.

8. The radioisotopes of primary interest in all of the natural gas created by the explosion are krypton-85 (^{85}Kr)--something less than 2,000 curies; and tritium (^{3}H)--something less than 3,000. Three thousand curies is the equivalent of approximately 3/10s of a gram of tritium. Essentially all of the ^{85}Kr and about 10 percent of the ^{3}H are mixed with the chimney gas. Other contributions to the total radioactivity of the chimney gas are small amounts of carbon-14 (^{14}C); argon-37 (^{37}Ar); and argon-39 (^{39}Ar).

9. Through Well No. RB-E-01, re-entry will penetrate the chimney and fractured zone, and at the conclusion of the re-entry conventional production separation equipment will be placed on the surface of the earth. Gas from the chimney will be produced up the well bore as a result of the pressure and temperature decrease during this production and some water will condense from the vapor phase and be separated as liquid water in the separator.

10. The Applicant proposes to reinject the water produced in the Rio Blanco Project into the formation and area from which it came in order to minimize the amount of radioactivity to the biosphere during the

testing of the project re-entry well. This water will be stored in four 400-barrel storage tanks, analyzed for its radioactivity and other contents, and then be re-injected through a 2-inch line into the Fawn Creek Government Number 1 Well, some 1320 feet to the south, into an area essentially opposite of the chimney and in the same lower Fort Union Formation.

11. Hydrocarbon condensate, which will condense out in the separator, will be sent to condensate storage tanks, be checked for radioactivity, be pumped up the flare stack and be burned along with the gas.

12. Tritium concentrations in the water produced along with the gas, which will be separated at the surface of the earth, will be 0.05 micro-curies per milliliter, or .05 millions of a curie of tritium per milliliter of water. This is 16 times greater than the present standard accepted for drinking water as published by the Federal Radiation Council and the International Council for Radiation Protection, which is .003 micro-curies per milliliter for an individual, and .001 micro-curies per milliliter for the populous at large.

13. Tritium is an isotope of hydrogen, having a mass of three. It is a unique radioactivity of the isotope hydrogen. It decays with a 12.26 year half life, emitting exclusively beta particles. Half life is a convenient representation of the life time that the radionuclide exhibits. A half life of 12.26 years means a given quantity of tritium will be reduced to one-half that level in a period of 12.26 years, and will be one-fourth of the initial amount in two one-half lives, or 24 years. Tritium decays into inactive helium-3. Water having .05 micro-curies of tritium per milliliter would take approximately 50 years to decay to .003 micro-curies per milliliter, and would take approximately 70 years to decay to .001 micro-curies per milliliter. Consequently, water which will be produced from and during the testing of the RB-E-01 Well will be potable in approximately 70 years on the basis of present knowledge and under existing standards.

14. In the production of 300,000,000 standard cubic feet of natural gas from Well No. RB-E-01, some 296 curies of tritium will be produced, of which 50 curies will be separated in the separator in the liquid water condensed from the gas phase and be diluted in 6,500 barrels of water. That 6,500 barrels of water will be injected into the Fawn Creek Government Number 1 Well. The remaining 246 curies of tritium existing in the gas will be metered, sent to the flare stack, and burned off into the atmosphere.

15. If production of natural gas goes to the full 800,000,000 standard cubic feet, the total tritium production from the well will be 580 curies, of which 130 curies would be diluted in 20,000 to 24,000 barrels of water which would be injected into the Fawn Creek Government Number 1 Well. The remaining 450 curies of tritium existing in the gas would be metered, sent to the flare stack, and burned off into the atmosphere. In any case, the krypton-85 and carbon-14 will have to be flared into the atmosphere.

16. Radiological protection and documentation of radioactive effluents will be provided until the end of the production testing and subsequent site rollup. It is expected that measurable quantities of radioactivity will be deposited in the immediate vicinity of both the Emplacement Well, No. RB-E-01, and the flare stack areas. Water samples will be collected immediately before and after the flaring operation at each of six locations. Intermediate samples will be taken at intervals of 3 days. Additional samples will be collected at two class locations weekly during and after the flaring operation for a period of at least 4 weeks, extending until at least 1 week following the conclusion of flaring. These samples will be assayed for tritium activity by liquid scintillation methods and for other nuclides by gamma spectrometry. Meteorological and ecological studies indicate that even with release of all gaseous radioactivity to the atmosphere, the maximum commitment in the vicinity will be much less than 1 percent of the annual natural background radiation.

17. The Fawn Creek Government Number 1 Well, into which the tritiated water will be injected, was drilled by Equity Oil Company in 1958. The Petitioner tested two intervals in 1969. Then, in early 1973, Petitioner perforated additional sand lenses and ran a water injectivity test which showed that the rate of water influx into the sand intervals of 5745 to 6072 feet was in excess of 3,000 barrels a day at 1,500 psi surface pressure. The interval from 5600 to 5630 feet was shown from experience to take water. In early September, 1973, Petitioner perforated the zone from 5084 to 5126 feet and received ample quantities of gas for its production facility. Petitioner also ran a cement bond log from the interval 5400 to 4600 feet and it was shown that there is solid cement from the gas interval at 5084 to 5126 to the interval where the water will be injected from 5600 down to 6072 feet. The cement will constitute a barrier so that there will be no water migration up on the outside of the casing.

18. Petitioner has successfully seated a Baker FH Hydrostatic Packer 5300, in the casing of the Fawn Creek Government Number 1 Well. This particular type of packer has been used in connection with water containing tritium. Any packer failure would be evidenced immediately because water would move up through the 1.9 inch casing of the gas production string and eventually the gas production would die. In the event of a leak, it would be necessary to pull the tubing strings and run a new packer after inhibiting the water or filling the casing with fresh water pumped down the 1.9 inch tube.

19. There is a dual hanger in the Fawn Creek Government Number 1 Well. The connection at which the tubing screws into the tubing hangers has been tested to 4300 psi and was found to have no leaks. The joints between the 2 1/16" water injection tubing and the entire string have been pressure tested to 3,000 psi. The injection pressure through that tubing will be less than 1500 psi, probably 1000 psi. An injection pressure of 1500 psi would provide 3770 psi pressure at the point against the bottom of the packer. The gas zone has a bottom hole pressure of 1890 psi so the differential is less than 2000 psi. The packer should hold even when the differential is 7000-8000 psi.

20. The calculated flooded radius from injected water during the flow period, if approximately 6500 barrels of water would be produced, in the sand interval from 5600 to 6072 feet, where the net sand that has been opened is 150 feet, would be roughly a radius of 100 feet (less than an acre) even if only 20 feet of the 150 feet interval were taking water. If 20,000 to 24,000 barrels of water were produced and injected into the same area under a maximum 30-day injectivity test, the flooded area would be 190 to 195 feet in radius if only 20 feet of the interval took water. The water will be distributed reasonably uniformly around the well bore in an eccentric elipse approaching a circle. Water injectivity tests, performed by Petitioner in 1973 from roughly 5660 feet down below that point, which did not include the zone from 5600 to 5630, showed that in excess of 3,000 barrels of water per day could be injected into these lower zones at 1500 psi. surface pressure. The rate of water production which Petitioner anticipates during the testing is 600 barrels a day.

21. Petitioner's understanding of the geological formations within a radius of at least ten miles from the Fawn Creek Government Number 1 Well is based upon all available geological information, with respect to that area, including an examination of all available well logs, drilling records, core analysis, and other physical data generally developed as part of a drilling program; including geophysical studies and reflection seismic studies; including a detailed study in the emplacement well area to determine if there were any faults and to check the authenticity and accuracy of previous geophysical surveys; and including examinations of the outcrops in the area.

22. In the area of Well No. RB-E-01 and the Fawn Creek Government Number 1 Well, the lowest or deepest geological aquifer or rock that contains sufficient permeability and porosity to have a reasonable amount of water is the B-aquifer located under the Mahogany Zone in the area of the Fawn Creek Government Number 1 Well. The bottom of this zone is approximately 1400 feet subsurface. There is no evidence of aquifers containing moving water below the B-aquifer.

23. The Mahogany Zone constitutes a barrier to water migration. Above the Mahogany Zone is a fractured shale sequence called the A-aquifer. Above the A-aquifer is the Evacuation Creek, which is shales and sandstones having very low capacity. And in the stream valleys there is a thin layer of alluvium which contains water. The alluvium, the A-aquifer and the B-aquifer constitute the viable aquifers in the area in question.

24. The bottom of the B-aquifer is approximately 5,000 feet above sea level. The top of the fractured zone of Well No. RB-E-01 is approximately 1,000 feet above sea level. The tritiated water will be injected into the Fawn Creek Government Number 1 Well at an interval from 500 to 1,000 feet above sea level. There is approximately 3,000 feet of impermeable shale between the top of the zone into which water will be injected and the B-aquifer.

25. The B-aquifer, as the lowest and deepest area containing presently useable water, moves at a rate of about 35 feet per year. There is no source of withdrawal from the B-aquifer, near the location of the Fawn Creek Government Number 1 Well, for human use or irrigation or any other public use. Approximately three and one-half miles from this location there is a fault zone which may allow vertical migration of water which might result in water occurring in the alluvium, but at the rate of water movement in the B-aquifer it would take several hundred years for that water in the area of the Fawn Creek Government Number 1 Well to travel to this fault.

26. The A-aquifer has a velocity approximately ten times that of the B-aquifer. Water from the A-aquifer is being used within a distance of approximately four miles from Project Fio Blanco. The hydrologic report shows that the flow volume in the A-aquifer, the B-aquifer and the alluvium aquifer systems is so great that the dilution factor would prevent any hazard even if tritiated water could somehow mingle with the waters in these aquifers.

27. The water that will be produced during the test is connate water or fossil water, i.e., water deposited with the sediments or very close to the sediments in which it is currently found, which was laid down 50 to 60 million years ago and has remained localized in the sands during that time.

28. The water which will be injected into the Fawn Creek Government Number 1 Well to the same stratigraphic levels from which it came will have no present or foreseeable beneficial use and there is no reasonable probability that such water, while adversely affected, will mingle with or be tributary to beneficial, useable waters of the State of Colorado.

29. Petitioner has proven beyond a reasonable doubt that in disposing of radioactive water by injection into Fawn Creek Government Number 1 Well, as detailed in its "Project Rio Blanco Subsurface Water Disposal Application," dated June 11, 1973, as amended, that there will be no pollution resulting therefrom or that the pollution, if any, will be limited to waters in a specified limited area from which there is no risk of significant migration and that the disposal of the radioactive water is justified by public need.

October 15, 1973

s/John Phillip Linn
John Phillip Linn, Hearing Officer

APPENDIX D-1

BOTTOM HOLE PRESSURE AND TEMPERATURE DATA,
WITH CORRESPONDING FLOW RATES
FIRST PRODUCTION TEST

November 14, 1973 to November 20, 1973

1973 Date	Time	#33508 Press. psig	#33509 Press. psig	#33510 Temp. °F	Flow MMSCF/D
Nov. 14	1245	2002.0	2006.2	---	0.0
	1400	---	---	---	5.0
	1440	---	---	---	15.0
	1500	---	---	---	0.0
	1550	---	---	---	15.0
	1600	---	---	314.6	15.0
	1700	---	1949.3	348.6	13.1
	1800	1928.0	1930.8	360.9	15.8
	1900	1909.5	1913.9	372.8	15.9
	2000	1894.1	1900.0	378.6	15.6
	2100	1878.6	1883.1	381.4	15.3
	2200	1861.7	1867.7	383.5	15.2
	2200	1891.0	1898.5	---	0.0
	2300	1891.0	1898.5	340.3	Shut in
	2400	1891.0	1898.5	307.2	---
Nov. 15	0100	1891.0	1898.5	288.2	---
	0200	1894.0	1901.6	276.4	---
	0300	1896.7	1903.1	267.4	---
	0400	1901.8	1906.2	260.5	---
	0500	1901.8	1907.7	255.1	---
	0600	1903.3	1907.7	249.9	---
	0800	1904.9	---	242.3	---
	1000	1904.9	1910.8	235.8	---
			Pulled Amerada gauge		
	1200	1904.9	Misrun	225.1	---
	1300	1904.9	---	---	---
	1500	1906.4	---	---	---
	1700	1906.4	---	---	---
	1900	1907.2	---	221.4	---
	2100	1907.2	---	---	---
	2300	1907.9	---	217.4	---
Nov. 16	0100	1907.9	---	---	---
	0300	1907.9	---	214.8	---
	0500	1909.5	---	---	---
	0700	1909.5	---	213.0	---

1973 Date	Time	#33508 Press. psig	#33509 Press. psig	#33510 Temp. °F	Flow MMSCF/D
Nov. 16	0900	1909.5	Misrun	---	---
	1100	1909.5	---	211.7	---
	1130	1881.7	---	---	12.0
	1152	1895.6	---	297.5	Shut in
	1215	---	---	---	11.1
	1300	1880.2	---	373.7	11.1
	1500	1858.6	---	384.9	10.3
	1700	1838.5	---	391.1	10.0
	1900	1861.9	---	395.5	10.0
	2100	1796.9	---	399.8	10.0
	2300	1778.4	---	402.8	10.0
Nov. 17	0100	1758.3	---	405.9	10.1
	0300	1739.8	---	---	10.1
	0500	1719.8	---	---	10.1
	0700	1701.3	---	---	10.1
	Pulled bomb off bottom 0700.				

1973 Date	Time	#33508 Press. psig	#33509 Press. psig	#23585 Temp. °F	Flow MMSCF/D
Nov. 17	1000	1669.0	1672.0	---	10.2
	1100	1664.0	1664.0	415.0	10.3
	1300	1653.0	1656.0	414.7	7.9
	1500	1639.0	1641.0	414.3	8.0
	1700	1626.0	1629.0	416.1	8.2
	1900	1612.0	1615.0	416.8	8.4
	2100	1599.0	1601.0	416.8	8.2
	2300	1585.0	1588.0	417.5	8.2
Nov. 18	0100	1572.0	1574.0	418.4	8.2
	0300	1559.0	1562.0	418.7	8.3
	0500	1547.0	1548.0	419.6	8.2
	0700	1535.0	1535.0	420.6	8.2
	0900	1522.0	1525.0	420.9	8.0
	Elements out of hole 0900-1200				
	1200	1503.8	1509.3	---	8.0
	1300	1497.7	1503.1	423.6	8.0
	1500	1483.8	1490.8	424.5	8.1
	1700	1473.0	1478.5	425.8	8.0
	1900	1460.7	1466.2	425.8	8.0
	2100	1448.3	1453.9	426.7	8.0
	2300	1434.4	1440.0	427.0	8.0
Nov. 19	0100	1422.1	1429.3	427.6	8.1
	0300	1409.8	1415.4	428.5	7.9

1973 Date	Time	#33508 Press. psig	#33509 Press. psig	#23585 Temp. °F	Flow MMSCF/D
Nov. 19	0500	1397.4	1403.1	429.1	8.0
	0700	1385.1	1392.3	429.7	8.0
	0900	1372.7	1378.5	430.4	8.0
	0930	1371.2	1376.9	430.7	8.0

Ran instruments back into hole - on bottom at 1310 hours Temp. element #23585 with 3 hours Hi Temp. clock - one press. element with spare 72 hours - Hi temp. clock - other element with bed clock - All three 72 hours Hi temp. clocks malfunctioned when retrieved from hole - Ran ok to surface- /Change in temp. - Down hole temp. 431 °F, Surface 31°F.

Nov. 19	1400	1338.8	**Misrun**	430.7	8.0
	1600	1326.5	Clock	---	8.0
	1800	1314.1	Stopped	---	8.0
	2000	1301.8	---	---	8.0
	2200	1290.9	---	---	8.0
	2400	1277.1	---	---	8.0
Nov. 20	0200	1264.8	---	---	8.0
	0400	1252.4	---	---	8.0
	0600	1241.6	---	---	8.0
	0800	1229.3	---	---	8.1
	1007	1218.5	---	432.5	8.1
	1007	1233.9	---	---	0.0

APPENDIX D-2

BOTTOM HOLE PRESSURE AND TEMPERATURE DATA
FIRST PRESSURE BUILD-UP PERIOD
November 20, 1973 to January 28, 1974

1973 Date	Time	#33508 Press. psig	#33509 Press. psig	#33510 Temp. °F
Nov. 20	1007	1218.5 Flowing	Misrun	---
	1007	1233.9 Shut-In	Clock	---
	1100	1237.0	Stopped	---
	1200	1237.0	---	---
	1300	1238.5	---	---
	1400	1240.1	---	---
	1600	1243.2	---	---
	1800	1247.8	---	---
	2000	1250.9	---	---
	2200	1254.0	---	---
	2400	1258.6	---	---
Nov. 21	0200	1263.2	---	---
	0400	1266.3	---	---
	0600	1270.9	---	---
	0800	1274.0	---	---
	1000	1277.1	---	---
	1200	1280.2	---	---

Start off bottom at 1210 hours Nov. 21 with Amerada gauges
Back on bottom at 5160 ft GL at 1400 Nov. 21.

1973 Date	Time	#33508 Press. psig	#33509 Press. psig	#33510 Temp. °F
Nov. 21	1400	---	1275	Misrun
	1600	1279	1277	---
	1800	1280	1280	---
	2000	1283	1283	---
	2200	1285	1285	---
	2400	1288	1286	---
Nov. 22	0200	1290	1288	---
	0400	1291	1291	---
	0600	1294	1294	---
	0800	1296	1295	---
	1000	1297	1299	---
	1200	1300	1300	---
	1400	1302	1302	---
	1600	1303	1305	---
	1800	1305	1306	---
	2000	1306	1308	---
	2200	1308	1311	---
	2400	1310	1311	---

1973 Date	Time	#33508 Press. psig	#33509 Press. psig	#33510 Temp. °F
Nov. 23	0200	1311	1314	---
	0400	1314	1315	---
	0600	1316	1317	---
	0800	1317	1319	---
	1000	1320	1322	---
	1600	1322	1325	232.0
	2200	1327	1326	232.6
Nov. 24	0400	1331	1331	232.6
	1000	1334	1334	232.2
	1600	1339	1337	231.8
	2200	1340	1339	231.2
Nov. 25	0400	1343	1342	230.8
	1000	1348	1345	230.4
	1600	1353	1349	229.8
	2200	1354	1351	229.2
Nov. 26	0400	1357	1354	228.9
	1000	1360	1357	228.5

Reran instruments with 72-hour clocks
Reran to 5160 ft GL at 1130 Nov. 26.

Nov. 26	1200	1362	1365	223.0
	1800	1364	1366	225.3
	2200	1365	1368	225.5
Nov. 27	0400	1368	1369	225.7
	1000	1371	1372	225.7
	1600	1373	1374	225.7
	2200	1373	1374	225.5
Nov. 28	0400	1376	1377	225.3
	1000	1379	1380	225.3

Returned bombs to 5160 ft GL on bottom at Nov. 28
with 72 hour clocks.

Nov. 28	1600	Misrun	1383	---
	2200	Clock	1385	222.3
Nov. 29	0400	Malfunction	1386	222.8
	1000		1388	223.0
	1600		1391	223.4
	2200		1391	223.4

1973 Date	Time	#33508 Press. psig	#33509 Press. psig	#33510 Temp. °F
Nov. 30	0400	Misrun Clock	1392	223.4
	1000	Malfunction	1394	223.4

Instruments reran to 5160 ft GL on Nov. 30 on bottom at 0930 with 72-hr clock. Replaced bad clock with one in temperature sensor and replaced one in temperature sensor with a non-high temperature clock.

1973 Date	Time	#33508 Press. psig	#33509 Press. psig	#33510 Temp. °F
Nov. 30	1600	1401	1400	220.5
	2200	1402	1400	221.2
Dec. 1	0400	1404	1403	221.7
	1000	1407	1406	221.9
	1600	1408	1406	221.9
	2200	1410	1408	222.1
Dec. 2	0400	1411	1411	222.3
	1000	1414	1412	222.3
	1600	1416	1412	222.3
	2200	1418	1414	222.3
Dec. 3	0400	1419	1417	222.5

Reran instruments with 72 hour clocks to 5160 ft GL on bottom at 1200 Dec. 3.

1973 Date	Time	#33508 Press. psig	#33509 Press. psig	#33510 Temp. °F
Dec. 3	1600	1422	1425	218.1
	2200	1424	1428	219.2
Dec. 4	0400	1425	1429	219.7
	1000	1428	1431	220.1
	1600	1430	1432	220.3
	2200	1430	1432	220.3
Dec. 5	0400	1431	1434	220.5
	1000	1433	1435	220.5

Reran instruments with 72 hour clocks to 5160 ft GL on bottom at 1130 Dec. 5.

1973 Date	Time	#33508 Press. psig	#33509 Press. psig	#33510 Temp. °F
Dec. 5	1600	1438	1437	217.4
	2200	1438	1439	218.3
Dec. 6	0400	1439	1440	219.0
	1000	1442	1443	219.7
	1600	1444	1443	219.9
	2200	1444	1445	220.1

1973 Date	Time	#33508 Press. psig	#33509 Press. psig	#33510 Temp. °F
Dec. 7	0400	1445	1446	220.1
	1000	1447	1448	220.5

Reran instruments to 5160 ft GL on bottom at 1115 Dec. 7. Replaced temp. element #33510 with temp. element #17592 to test for long response time in #33510.

1973 Date	Time	#33508 Press. psig	#33509 Press. psig	#17592 Temp. °F
Dec. 7	1600	1450	1451	195.7
	2200	1451	1451	195.5
Dec. 8	0400	1453	1452	195.4
	1000	1455	1454	195.2
	1600	1455	1455	195.0
	2200	1456	1455	195.0
Dec. 9	0400	1458	1457	194.8
	1000	1459	1457	194.7
	1600	1461	1457	194.5
	2200	1461	1459	194.4
Dec. 10	0400	1464	1460	194.4
	1000	1464	1460	194.1

Reran instruments to 5160 ft GL on bottom at 1115 Dec. 10.

1973 Date	Time	#33508 Press. psig	#33509 Press. psig	#17592 Temp. °F
Dec. 10	1600	1464	1466	194.4
	2200	1465	1468	194.4
Dec. 11	0400	1467	1469	194.4
	1000	1468	1471	194.1
	1600	1468	1471	194.0
	2200	1470	1472	194.0
Dec. 12	0400	---	1474	194.0
	1000	---	1475	193.8

Reran instruments to 5160 ft GL on bottom at 1200 Dec. 12.

1973 Date	Time	#33508 Press. psig	#33509 Press. psig	#17592 Temp. °F
Dec. 12	1600	1478	1479	194.3
	2200	1479	1480	194.1
Dec. 13	0400	1481	1482	194.0
	1000	1482	1483	193.7
	1600	1482	1483	193.5
	2200	1484	1485	193.4

1973 Date	Time	#33508 Press. psig	#33509 Press. psig	#17592 Temp. °F
Dec. 14	0400	1485	1486	193.4
	1000	1485	1486	193.3
	1600	1484	1486	---
	2200	1485	1488	---
Dec. 15	0400	1488	1489	---
	1000	1490	1491	---
	1600	1490	1491	---
	2200	1493	1492	---
Dec. 16	0400	1495	1494	---
	1000	1496	1495	---
	1600	1498	1495	---
	2200	1499	1497	---
Dec. 17	0400	---	1497	---
	1000	1501	1499	---

Lost bombs in hole. No data until Dec. 22. Ordered new elements from Geophysical Research Corporation. Otis to retrieve old tools.

1973 Date	Time	#26170N Press. psig	#14379 Temp. °F
Dec. 22	1600	1532	193.7
	2200	1532	193.7
Dec. 23	0400	1533	193.7
	1000	1535	193.3
	1600	1535	192.8
	2200	1535	192.8
Dec. 24	0400	1536	192.4
	1000	1538	191.9
	1600	1538	191.5
	2200	1538	191.5
Dec. 25	0400	1539	191.0
	1000	1539	190.6

Reran instruments to 5160 ft GL. On bottom at 1130 Dec. 26.

Dec. 26	1600	1545	192.4
Dec. 27	0400	1546	194.6
	1600	1546	195.1
Dec. 28	0400	1549	195.1
	1600	1549	195.1

1973-74 Date	Time	#26170N Press. psig	#14379 Temp. °F
Dec. 29	0400	1552	195.5

Reran instruments to 5160 ft GL. On bottom at 1330 on Dec. 29.

Dec. 29	1600	1555	Misrun Clock
Dec. 30	0400	1556	Malfunction
	1600	1558	---
Dec. 31	0400	1559	---
	1600	1561	---
<u>1974</u>			
Jan. 1	0400	1562	---

Otis on location. Did not rerun instruments at this time.

Jan. 5	0400	1580	195.5
	1600	1581	196.4
Jan. 6	0400	1584	197.3
	1600	1584	197.3
Jan. 7	0400	1587	197.3
	1200	1588	197.8

Change from Mountain Standard Time to Mountain Daylight Time on Jan. 7. Reran instruments to 5160 ft GL. On bottom at 1330 Jan. 7.

Jan. 7	1600	1588	194.6
Jan. 8	0400	1590	197.8
	1600	1591	198.7
Jan. 9	0400	1594	199.6
	1200	1595	200.0

Reran instruments to 5160 ft GL. On bottom at 1430 Jan. 9.

Jan. 9	1600	1595	194.2
Jan. 10	0400	1598	196.9
	1600	1600	197.3
Jan. 11	0400	1601	197.8

Reran instruments to 5160 ft GL. On bottom at 1500 Jan. 11. Changed packing on stuffing box. Pulled off approximately 210 ft of wire on wireline unit.

1974 Date	Time	#26170N Press. psig	#14379 Temp. °F
Jan. 11	1600	1603	197.8
Jan. 12	0400	1606	199.6
	1600	1606	199.6
Jan. 13	0400	1607	199.6
	1600	1607	198.7
Jan. 14	0400	1610	198.7

Installed tool trap between lubricator and BOP. Reran instruments to 5160 ft GL. On bottom at 1545 Jan. 14.

Jan. 14	1600	1608	196.0
Jan. 15	0400	1611	200.0
	1600	1613	200.6
Jan. 16	0400	1614	201.0

Reran instruments to 5160 ft GL. On bottom at 1445 Jan. 16.

Jan. 16	1600	1614	196.4
Jan. 17	0400	1616	198.7
	1600	1617	200.0
Jan. 18	0400	1619	200.3

Reran instruments to 5160 ft GL. On bottom at 1330 Jan. 18.

Jan. 18	1600	1621	195.5
Jan. 19	0400	1623	197.3
	1600	1623	197.8
Jan. 20	0400	1624	197.8
	1600	1624	197.8
Jan. 21	0400	1626	198.7

Reran instruments to 5160 ft GL. On bottom at 1430 Jan. 21.

Jan. 21	1600	1629	194.6
Jan. 22	0400	1630	197.8
	1600	1632	198.7
Jan. 23	0400	1633	199.6

Reran temperature element #14379, pressure element #26170N, and pressure element #34225 with 3-hour clocks for survey.

1974 Date	Time	Depth From GL	Minutes Stop Time	#26170N Press. psig	#34225 Press. psig	#14379 Temp. °F
Jan. 23	1523	5160	15	1633	1632	192.8
	1546	5215	5	1636	1634	195.5
	1553	5315	5	1639	1636	197.3
	1558	5415	5	1643	1642	199.1
	1604	5515	5	1646	1645	201.6
	1610	5565	10	1649	1647	209.0
	1620	5615	5	*1645	1652	320.7
	1625	5635	5	*1636	1652	389.9
	1630	5655	5	*1642	1652	Off
	1635	5675	10	*1650	1658	Scale
	1645	5685	5	*1652	1659	---
	1650	5695	5	*1653	1660	---

*Temperature affected.

Jan. 24 Reran instruments with 3-hour clocks. New temperature element #23585 (400°F - 650°F). Ran 3-hour bottom hole pressure and temperature survey.

Jan. 24	1400	5160	10	1636	1630	---
	1410	5200	10	1637	1632	---
	1421	5400	10	1645	1640	---
	1432	5600	10	1649	1645	---
	1443	5625	10	*1640	1648	---
	1453	5650	10	*1649	1650	404.8
	1504	5675	15	*1655	1658	415.5
	1520	5685	10	*1655	1658	415.9
	1530	5695	10	*1656	1658	415.5
	1540	5705	5	*1656	1658	415.5

Tagged TD at 5707 ft GL.

*Temperature affected.

Jan. 25 Reran temperature element #34226 (150 °F - 400 °F). Pressure element #33508 (3000 psi), pressure element #34225 (3000 psi), with 72-hour clocks to 5160 ft GL. On bottom at 1330.

1974 Date	Time	#33508 Press. psig	#34225 Press. psig	#34226 Temp. °F
Jan. 25	0400	1638	1640	189.7
Jan. 26	0400	1640	1641	193.5
	1600	1640	1640	195.4
Jan. 27	0400	1641	1639	196.5

Jan. 27 — Reran instruments with new high range temperature element #23585 (400°F - 650°F) to GL depth of 5650 ft for 3 hours, at 1200 hours, 5700 ft GL for 3 hours at 1500 then back to 5160 ft GL at 1800. Will pull again for readings Jan. 28 a.m.

1974 Date	Time	#33508 Press. psig	#34225 Press. psig	#23585 Temp. °F
Jan. 27	1500 (5650' GL)	1670	1660	408.9
	1800 (5700' GL)	1671	1661	414.1
Jan. 28	0400 (5160' GL)	1645	1630	---

Reran same instruments to 5160 ft GL. On bottom at 1030 Jan. 28.

Jan. 28	1200	1652	1654	---
	1300	1652	1654	---
	1400	1652	1654	---
	1500	1652	1654	---

APPENDIX D-3

BOTTOM HOLE PRESSURE AND TEMPERATURE DATA
WITH CORRESPONDING FLOW RATES
SECOND PRODUCTION TEST
January 28 - February 15, 1974

1974 Date	Time	#33508 Press. psig	#34225 Press. psig	#23585 Temp. °F	Flow MMSCF/D
Jan. 28	1200	1652	1654	Below scale	---
	1300	1652	1654	---	---
	1400	1652	1654	---	---
	1500	1652	1654	---	---
	1535	Startup	---	---	6.5
	1600	1632	1634	---	---
	1625	1631	1634	---	6.0
	1625	1636	1638	---	0.0
	1700	1625	1632	---	6.8
	1800	1619	1626	401.9	6.2
	1900	1614	1619	403.7	6.1
	2000	1608	1611	405.6	6.8
	2100	1600	1605	407.4	6.0
	2200	1594	1599	410.0	6.2
	2300	1588	1592	411.1	6.0
	2400	1582	1586	412.6	6.3
Jan. 29	0100	1575	1579	414.1	6.2
	0200	1568	1573	414.8	6.1
	0300	1561	1565	415.5	6.0
	0400	1557	1560	416.3	6.0
	0500	1550	1552	417.0	5.8
	0600	1544	1547	417.8	5.7
	0700	1538	1539	418.1	5.8
	0800	1532	1535	418.5	5.9
	1000	---	---	419.4	6.1
	1100	1514.6	1522.7	425.3	6.2
	1200	1509.9	1516.3	425.3	6.2
	1300	1502.1	1509.9	425.6	6.4
	1400	1497.4	1503.5	425.9	6.4
	1500	1491.2	1497.1	426.3	6.3
	1505	1488.0	1495.5	---	---
	1510	1492.7	1498.7	417.8	---
	1600	1484.9	1492.3	426.3	6.3
	1700	1478.7	1485.9	426.6	6.4
	1800	1474.0	1479.5	426.9	6.2
	1900	1467.8	1473.1	427.5	6.2

1974 Date	Time	#33508 Press. psig	#34225 Press. psig	#23585 Temp. °F	Flow MMSCF/D
Jan. 29	2000	1461.5	1468.3	427.8	6.2
	2100	1455.3	1460.3	428.4	6.2
	2200	1449.1	1455.5	428.7	6.2
	2300	1442.8	1449.1	429.7	6.1
	2400	1436.6	1447.7	430.0	6.1
Jan. 30	0100	1431.9	1437.9	430.0	6.1
	0200	1425.7	1429.9	430.6	6.1
	0300	1419.4	1425.2	430.6	6.0
	0400	1414.7	1420.4	431.2	6.0
	0500	1408.5	1412.4	431.5	5.9
	0600	1403.8	1407.6	431.5	5.9
	0700	1397.6	1401.2	431.8	5.9
	0800	1389.8	1393.2	432.8	6.5
	1200	1377.2	1374.2	436.7	6.3
	1400	---	---	436.7	6.2
	1600	---	---	436.7	6.2
	1800	---	---	436.9	6.2
	2000	---	---	437.2	6.2
	2200	---	---	437.5	6.2
	2400	---	---	437.7	6.2
Jan. 31	0200	---	---	437.7	6.2
	0400	---	---	438.0	6.2
	0600	---	---	438.3	6.2
	0800	1257.6	1268.1	438.5	6.2

Re-ran instruments to 5160 ft GL. Reached that depth at 1130. Neither clock in press. instruments ran. Replaced clock in #34225 with 3-hour high temperature clock and replaced clock in #33508 with 72-hour high temperature clock. 3-hour clock loaded at 1050.

	1200	1232	---	---	6.2
	1300	1229	---	---	6.1
	1400	1221	1222	442.5	6.1
	1600	3-hour	1209	442.5	6.1
	1800	clock	1197	442.8	6.3
	2000	only	1186	443.0	6.3
	2200	---	1173	443.3	---
	2400	---	1162	443.6	6.0
Feb. 1	0200	---	1152	443.8	6.0
	0400	---	1141	444.1	5.9
	0600	---	1128	444.4	6.0
	0800	---	1117	444.6	6.3

Re-ran instruments to 5160 ft GL. Used 72-hour clocks on all instruments. Reached 5160 ft GL at 1115, Feb. 1. Well shut in 0945 to 1153, Feb. 1.

1974 Date	Time	#33508 Press. psig	#34225 Press. psig	#23585 Temp. °F	Flow MMSCF/D
Feb. 1	1400	1119	1118	442.5	---
	1600	1116	1114	443.3	4.3
	1700	---	---	---	4.2
	1800	1109	1107	443.8	---
	2000	1101	1099	444.4	4.2
	2125	1090.4	1086.2	---	4.2
	2125	1098.3	1094.2	444.6	0.0
	2400	Startup	---	---	4.2
Feb. 2	0200	1086	1081	444.1	4.2
	0400	1076	1075	444.6	4.0
	0600	1070	1067	445.2	3.8
	0800	1062	1059	445.4	4.2*

Re-ran instruments to 5160' GL. On bottom at 1000, Feb. 2. Downhole flow rate at shut-in approximately 4.2 MMSCF/D gas + 3.4 MMSCF water vapor. Well shut in 2125 to 2400, Feb. 1.
*Starting at 0800, Feb. 2, flow data are averages of the previous 4 hours.

1974 Date	Time	#33508 Press. psig.	#34225 Press. psig.	#23585 Temp. °F	Preceding 4-hr. Ave. Flow MMSCF/D
	1200	1051.1	1049.8	449.1	4.4
	1400	1043.2	1041.7	449.1	---
	1600	1035.4	1035.3	449.1	4.4
	1800	1027.5	1025.6	449.1	---
	2000	1019.6	1019.2	448.7	4.4
	2200	1011.8	1011.1	448.2	---
	2400	1005.5	1003.1	448.2	4.4
Feb. 3	0200	997.6	995.0	448.2	---
	0400	989.7	987.0	448.2	4.4
	0600	981.9	978.9	448.2	---
	0800	974.0	972.5	448.0	4.4

Re-ran instruments to 5160 ft GL. Reached depth at 1030, Feb. 3. Exchanged 72-hour clock in #34225 with 24-hour clock.

	1200	955.1	958.0	452.5	4.3
	1400	945.3	950.0	452.3	---
	1600	937.8	941.9	451.8	4.5
	1800	929.9	933.9	451.6	---
	2000	922.1	925.8	451.4	4.4
	2200	914.2	917.8	451.1	---
	2400	906.3	909.7	450.9	4.4

1974 Date	Time	#33508 Press. psig.	#34225 Press. psig.	#24585 Temp. °F	Preceding 4-hr. Ave. Flow MMSCF/D
Feb. 4	0200	900.0	901.7	450.7	---
	0400	892.2	893.6	450.7	4.2
	0600	884.3	885.6	450.5	---
	0800	874.9	875.9	449.8	4.2

Re-ran instruments to 5160 ft GL. On bottom at 1000 Feb. 4. Exchanged bad 72-hour clock in temperature element with 24-hour clock.

	1000	868.8	---	---	---
	1050	870.4	870.5	---	---
	1050	881.5	881.9	---	0.0
	1200	886.2	883.5	---	---
	1300	---	---	---	4.6
	1400	864.1	867.3	450.0	---
	1600	857.7	859.2	450.2	4.6
	1800	849.8	851.1	450.2	---
	2000	841.9	844.6	450.2	4.5
	2200	837.1	838.2	450.2	---
	2400	829.2	831.7	450.2	4.1
Feb. 5	0200	822.9	822.0	450.0	---
	0400	815.0	815.5	449.8	4.0
	0600	808.7	807.4	449.8	---
	0800	800.8	801.0	449.6	4.0

Re-ran instruments to 5160 ft GL. On bottom at 1000 Feb. 5. Well shut in 0945 to 0955 and 1050 to 1210.

	1200	786.5	791.3	450.7	4.0
	1400	778.6	784.8	450.7	---
	1600	772.3	778.3	450.7	3.9
	1800	765.9	771.8	450.5	---
	2000	761.2	765.4	450.5	3.8
	2200	753.3	758.9	450.2	---
	2400	748.5	752.4	450.0	3.8
Feb. 6	0200	742.2	745.9	450.0	---
	0400	735.9	737.8	449.8	3.7
	0600	728.0	731.4	449.6	---
	0800	721.6	724.9	449.3	3.7

Re-ran instruments to 5160 ft GL. Reached depth at 1030, Feb. 6. Replaced bad clock in #23585 with 72-hour clock.

1974 Date	Time	#33508 Press. psig.	#34225 Press. psig.	#24585 Temp. °F	Preceding 4-hr. Ave. Flow MMSCF/D
Feb. 6	1200	Misrun	712.2	446.8	3.6
	1400	---	708.9	446.8	---
	1600	---	704.1	446.8	3.6
	1800	---	697.6	446.2	---
	2000	---	695.9	445.7	3.1
	2200	---	694.3	446.0	---
	2400	---	689.4	445.7	3.0
Feb. 7	0200	---	682.9	445.4	---
	0400	---	679.7	445.4	2.9
	0600	---	676.4	445.4	---
	0800	---	671.5	445.2	2.9
	Re-ran instruments to 5160 ft GL. Reached depth at 1020, Feb. 7.				
	1200	660.5	666.7	447.3	2.8
	1400	655.7	663.4	447.3	---
	1600	652.5	660.2	447.3	2.9
	1800	647.7	655.3	447.0	---
	2000	644.6	650.4	446.5	2.8
	2200	639.8	647.2	446.5	---
	2400	636.6	642.3	446.2	2.8
Feb. 8	0200	631.8	637.4	446.0	---
	0400	628.6	632.5	445.7	2.7
	0600	625.5	627.6	445.7	---
	0800	620.7	624.4	445.4	2.7
	Re-ran instruments to 5160 ft GL. On bottom at 1045, Feb. 8.				
	1200	623.9	622.8	447.3	2.1
	1400	620.7	619.5	446.8	---
	1600	619.1	617.9	446.0	2.2
	1800	615.9	616.3	445.7	---
	2000	614.3	614.6	445.4	2.2
	2200	612.7	611.4	445.7	---
	2400	609.5	608.1	445.2	2.1
Feb. 9	0200	606.4	604.9	445.4	---
	0400	603.2	603.2	445.4	2.1
	0600	600.0	601.6	445.4	---
	0800	596.8	598.4	445.4	2.1

Re-ran instruments to 5160 ft GL. On bottom at 1115, Feb. 9.

1974 Date	Time	#33508 Press. psig	#34225 Press. psig	#24585 Temp. °F	Preceding 4-hr. Ave. Flow MMSCF/D
Feb. 9	1200	590.5	592.0	444.4	2.2
	1400	588.9	590.2	445.7	---
	1600	587.3	587.0	445.4	2.2
	1800	584.1	585.4	445.2	---
	2000	580.9	582.1	445.7	2.2
	2200	579.3	580.5	445.7	---
	2400	576.1	577.2	445.2	2.2
Feb. 10	0200	569.8	572.4	444.9	---
	0400	568.2	569.1	444.9	2.1
	0600	565.0	565.8	444.4	---
	0800	563.4	564.2	444.4	2.1

Re-ran instruments to 5160 ft GL. Reached bottom at 1015, Feb. 10.

	1200	552.3	Misrun	444.4	2.4
	1400	549.1	---	444.1	---
	1600	547.5	---	442.8	2.3
	1800	544.3	---	443.0	---
	2000	541.1	---	442.5	2.3
	2200	537.9	---	442.5	---
	2400	534.7	---	442.2	2.3
Feb. 11	0200	533.2	---	442.0	---
	0400	530.0	---	441.7	2.2
	0600	525.2	---	441.4	---
	0800	522.0	---	441.2	2.2

Re-ran instruments to 5160 ft GL. On bottom at 1030, Feb. 11. Replaced bad clock in #34225.

	1200	520.4	520.3	442.8	2.1
	1400	517.3	517.1	443.0	---
	1600	514.1	515.4	442.5	2.1
	1800	512.5	512.2	442.2	---
	2000	509.3	510.6	442.0	2.1
	2200	506.1	507.3	442.0	---
	2400	502.9	505.7	441.7	2.0
Feb. 12	0200	501.3	502.4	441.4	---
	0400	498.1	500.8	441.4	2.0
	0600	495.0	499.2	441.2	---
	0800	493.4	497.6	442.2	2.0

Re-ran instruments to 5160 ft GL. On bottom at 1045, Feb. 12.

1974 Date	Time	#33508 Press. psig	#34225 Press. psig	#24585 Temp. °F	Preceding 4-hr. Ave. Flow MMSCF/D
Feb. 12	1200	487.1	488.6	---	2.0
	1400	485.5	487.0	440.1	---
	1600	483.9	488.4	439.9	1.9
	1800	480.7	483.8	439.9	---
	2000	479.1	482.2	439.6	1.9
	2200	477.5	480.5	439.6	---
	2400	475.9	477.3	439.6	1.8
Feb. 13	0200	472.7	475.7	439.3	---
	0400	471.1	474.1	439.3	1.8
	0600	469.5	472.5	439.1	---
	0800	467.9	472.5	439.1	1.7
	Re-ran instruments to 5160 ft GL. On bottom at 1000, Fe. 13.				
	1200	466.3	469.2	439.9	1.7
	1400	464.7	467.6	439.6	---
	1600	463.1	464.4	438.8	1.7
	1800	459.9	464.4	438.8	---
	2000	458.3	462.7	438.8	1.7
	2200	456.7	459.5	438.5	---
	2400	455.1	457.9	438.3	1.6
Feb. 14	0200	453.5	456.3	438.3	---
	0400	450.4	454.6	438.0	1.6
	0600	448.8	453.0	437.7	---
	0800	447.2	449.8	437.5	1.6
	Re-ran instruments to 5160 ft GL. On bottom at 1045, Feb. 14.				
	1200	447.2	443.3	439.6	1.6
	1400	445.6	443.3	439.9	---
	1600	444.0	441.7	439.6	1.5
	1800	Clock failed	440.1	439.6	---
	2000	---	438.5	439.3	1.5
	2200	---	436.9	439.1	---
	2400	---	436.9	438.8	1.5
Feb. 15	0200	---	435.2	438.5	---
	0400	---	432.0	438.5	1.5
	0600	---	430.4	438.3	---
	0800	---	430.4	438.0	1.4
	0820	---	430.4	---	---
	0820	---	436.9	---	0.0

Well shut in 0820 for long-term buildup.

APPENDIX D-4

BOTTOM HOLE PRESSURE AND TEMPERATURE DATA SECOND PRESSURE BUILD-UP PERIOD

February 15, 1974 to June 24, 1975

(Temperature data, February 15 to March 11, 1974, only)

1974 Date	Time	#33508 Press. psig	#34225 Press. psig	#33510 Temp. °F
Feb. 15	0820	Instant. Shut in	436.9	---
	1200	445.6	443.3	356.6
	1400	448.8	446.6	340.7
	1600	450.4	449.8	329.6
	1800	452.0	451.4	321.6
	2000	455.2	454.7	315.6
	2200	458.3	456.3	309.5
	2400	458.3	459.5	305.6
Feb. 16	0200	461.5	461.1	302.2
	0400	464.7	462.7	298.5
	0800	466.3	464.4	295.5
	1000	467.9	467.6	293.2

Temperature element range, 180-400°F. Instruments on bottom, 5160 ft GL at 1110, Feb. 15. Reran instruments to 5160' GL. On bottom at 1245, Feb. 16.

1974 Date	Time	#33508 Press. psig	#34225 Press. psig	#33510 Temp. °F
Feb. 16	1400	464.7	475.7	289.2
	1600	467.9	477.3	287.6
	1800	471.1	478.9	285.9
	2000	471.1	480.5	283.9
	2200	474.3	483.8	282.3
	2400	475.9	485.4	280.7
Feb. 17	0200	477.5	487.0	279.2
	0400	479.1	488.6	277.9
	0600	482.3	490.3	276.5
	0800	483.9	491.9	275.4
	1000	485.5	493.5	274.2
	1200	487.1	493.5	273.0

Reran instruments to 5160 ft GL. On bottom at 1330, Feb. 17. #33508 has 24-hour clock, others 72-hour clock.

1974 Date	Time	#33508 Press. psig	#34225 Press. psig	#33510 Temp. °F
Feb. 17	1600	496.7	493.5	272.3
	2000	498.3	496.7	270.1
	2400	503.1	500.0	268.0
Feb. 18	0400	504.7	501.6	266.1
	0800	506.2	504.8	264.5
	1200	507.8	508.1	263.0
	1600	---	509.7	261.4
	2000	---	512.9	260.0
	2400	---	516.1	258.8
Feb. 19	0400	---	517.8	257.5
	0800	---	519.4	256.1

Reran instruments, all with 72-hour clocks, to 5160 ft GL.
On bottom at 1115, Feb. 19.

Feb. 19	1200	519.0	522.6	---
	1600	520.6	524.2	254.1
	2000	523.8	527.6	252.9
	2400	527.0	530.7	252.0
Feb. 20	0400	528.6	532.3	251.0
	0800	530.2	533.9	250.3
	1200	531.8	535.6	249.7
	1600	535.0	538.8	248.8
	2000	536.6	540.4	248.2
	2400	538.2	542.0	247.4
Feb. 21	0400	539.8	543.6	246.9
	0800	541.4	545.3	246.3
	1200	543.0	546.9	245.7
	1600	546.2	548.5	245.2
	2000	547.8	550.1	244.6
	2400	549.4	551.7	244.2
Feb. 22	0400	---	551.7	243.5
	0800	---	555.0	242.9

Reran instruments to 5160 ft GL. On bottom at 1330, Feb. 22

Feb. 22	1600	555.6	564.2	236.8
	2000	557.2	567.5	235.9
	2400	560.4	569.1	235.4
Feb. 23	0400	561.9	570.7	235.1
	0800	563.6	573.9	234.9

1974 Date	Time	#33508 Press. psig	#34225 Press. psig	#33510 Temp. °F
Feb. 23	1200	565.2	575.6	234.4
	1600	566.7	577.2	234.2
	2000	568.3	578.9	233.7
	2400	569.9	580.5	233.4
Feb. 24	0400	573.1	582.1	232.9
	0800	573.1	583.7	232.5
	1200	574.7	583.7	232.2
	1600	576.3	585.4	232.0
	2000	577.9	587.0	231.7
	2400	581.1	588.6	231.2
Feb. 25	0400	582.7	590.2	231.0
	0800	---	591.9	230.7

Reran instruments to 5160 ft GL. On bottom at 1215, Feb. 25.

1974 Date	Time	#33508 Press. psig	#34225 Press. psig	#33510 Temp. °F
Feb. 25	1600	592.2	596.7	231.2
	2000	595.4	600.0	230.7
	2400	597.0	601.6	230.5
Feb. 26	0400	598.6	604.9	230.2
	0800	600.2	604.9	230.0
	1200	601.8	606.5	229.7
	1600	603.4	609.8	229.4
	2000	605.0	611.4	229.4
	2400	606.6	613.0	229.1
Feb. 27	0400	608.1	613.0	229.1
	0800	609.7	614.6	228.9
	1200	611.3	614.6	228.6

Reran instruments to 5160 ft GL. On bottom at 1300, Feb. 27.
Changed clock on #33508.

1974 Date	Time	#33508 Press. psig	#34225 Press. psig	#33510 Temp. °F
Feb. 27	1600	Misrun	614.6	226.9
	2000	---	617.9	226.9
	2400	---	619.5	227.2
Feb. 28	0400	---	621.1	227.5
	0800	---	622.8	227.5
	1200	---	624.4	227.5
	1600	---	626.0	227.5
	2000	---	627.6	227.5
	2400	---	629.3	227.2
Mar. 1	0400	---	629.3	226.9
	0800	---	630.9	226.9

Reran instruments to 5160 ft GL. On bottom at 1230, Mar. 1. Replaced temperature element #33510 with element #34226 150-400°F. Replaced bad clock in #33508.

1974 Date	Time	#33508 Press. psig	#34225 Press. psig	#34226 Temp. °F
Mar. 1	1600	632.0	634.1	216.0
	2000	635.2	635.8	217.3
	2400	636.8	637.4	217.8
Mar. 2	0400	638.4	639.0	218.3
	0800	638.4	640.6	218.5
	1200	640.0	642.3	218.8
	1600	641.6	643.9	219.3
	2000	644.8	643.9	219.5
	2400	646.4	645.5	219.5
Mar. 3	0400	646.4	647.1	219.8
	0800	647.9	647.1	219.8
	1200	649.5	648.8	220.0
	1600	651.1	648.8	220.0
	2000	652.7	650.4	220.3
	2400	654.3	652.0	---
Mar. 4	0400	655.9	652.0	---
	0800	655.9	655.3	---

Reran instruments to 5160 ft GL. On bottom at 1400, Mar. 4.

1974 Date	Time	#33508 Press. psig	#34225 Press. psig	#34226 Temp. °F
Mar. 4	1600	655.9	655.3	214.5
	2000	657.5	656.9	214.5
	2400	659.1	660.2	215.3
Mar. 5	0400	660.7	661.8	216.3
	0800	662.3	663.4	216.8
	1200	662.3	665.0	217.0
	1600	663.9	666.7	217.0
	2000	665.5	668.3	217.5
	2400	667.0	669.9	217.8
Mar. 6	0400	667.0	669.9	218.0
	0800	668.6	671.5	217.8
	1200	668.6	671.5	218.0
	1600	671.8	673.2	218.0
	2000	671.8	676.4	218.3
	2400	673.4	676.4	218.5

1974 Date	Time	#33508 Press. psig	#34225 Press. psig	#34226 Temp. °F
Mar. 7	0400	675.0	678.0	218.8
	0800	---	678.0	218.8
	1200	---	679.7	218.8

Reran instruments to 5160 ft GL. On bottom at 1315, Mar. 7.

Mar. 7	1600	679.8	682.9	209.2
	2000	681.4	684.5	211.0
	2400	683.0	686.2	211.9
Mar. 8	0400	684.6	687.8	212.7
	0800	684.6	689.4	213.3
	1200	686.2	689.4	213.3
	1600	687.7	691.1	214.2
	2000	689.3	692.7	214.5
	2400	690.9	692.7	214.5
Mar. 9	0400	690.9	694.3	215.0
	0800	690.9	694.3	215.0
	1200	692.5	695.5	215.0
	1600	694.1	695.5	215.5
	2000	695.7	697.6	215.8
	2400	697.3	697.6	215.8
Mar. 10	0400	697.3	699.2	216.0
	0800	---	699.2	216.0
	1200	---	700.8	216.0

Reran instruments with 24-hour clocks to 5160 ft GL. On bottom at 1515, Mar. 10.

Mar. 10	1600	Misrun	699.2	203.4
	2000	---	704.1	206.3
	2400	---	705.7	207.5
Mar. 11	0400	---	707.3	208.1
	0800	---	707.3	209.0
	1200	---	708.9	209.5

Pulled down lubricator and stripped .092 stainless wire from wire line unit in preparation for installation of Sperry Sun equipment on Mar. 12.

1974 Date	Time	BHP psia
Mar. 13	1435	713.6
	2400	718.7
Mar. 14	0800	720.6
	1600	723.9

Sperry Sun downhole chamber is located at 5160 ft GL. Gas Column inside of tube is helium. In calculating bottom-hole psia, surface psig was corrected to psia by using average barometric pressure of 11.5 psia prior to applying correction factor of 1.02265 for mass per unit area of gas column.

Data from 2400, Mar. 14 to 0800, Mar. 18 omitted because of a small leak which was found and repaired on Mar. 18 as noted below.

Mar. 18. Checked Sperry Sun equipment and found pressure readout at 681 surface psig, a drop from data on Mar. 15. Checked all fittings with soap solution and found small leak on 3-way valve. Repaired leak and repurged system with helium.

1974 Date	Time	BHP psia
Mar. 18	1600	743.4
	2400	746.0
Mar. 19	0800	747.6
	1600	750.7
	2400	750.5
Mar. 20	0800	752.3
	1600	755.6
	2400	755.8
Mar. 21	0800	757.1

Reset time mechanism on Sperry Sun equipment at 1300, Mar. 21.

1974 Date	Time	BHP psia
Mar. 21	1600	760.9
	2400	760.6
Mar. 22	0800	762.1
	1600	764.7
	2400	767.0

1974 Date	Time	BHP psia
Mar. 23	0800	768.7
	1600	771.5
	2400	771.5
Mar. 24	0800	772.9
	1600	775.5
	2400	775.9
Mar. 25	0800	777.9
	1600	781.3
	2400	780.7
Mar. 26	0800	782.5
	1600	785.5
	2400	785.7
Mar. 27	0800	786.9
	1600	790.7
	2400	789.8
Mar. 28	0800	791.7

Reset pressure and time mechanism on Sperry Sun equipment at 1600, Mar. 28.

1974 Date	Time	BHP psia
Mar. 28	1600	794.3
	2400	794.6
Mar. 29	0800	796.4
	1600	799.8
	2400	799.8
Mar. 30	0800	801.0
	1600	803.8
	2400	804.6
Mar. 31	0630	805.1
	1600	807.7
	2400	808.4
April 1	0800	809.8
	1600	812.4
	2400	813.1
April 2	0800	814.7
	1600	816.8
	2400	817.7
April 3	0800	819.2
	1600	821.4
	2400	322.1
April 4	0800	823.4

Reset pressure and time mechanism on Sperry Sun equipment at 1500, April 4. Recorder malfunction at 0800, Mar. 31.

1974 Date	Time	BHP psia
April 4	1600	826.5
	2400	826.9
April 5	0800	828.9
	1600	831.7
	2400	832.2
April 6	0800	833.7
	1600	837.6
	2400	838.5
April 7	0800	840.0
	1600	842.4
	2400	842.4
April 8	0800	844.1
	1600	847.8
	2400	850.0
April 9	0800	851.3
	1600	854.6
	2400	854.2
April 10	0800	855.8
	1600	857.1
	2400	858.0
April 11	0800	859.3

Reset pressure and time mechanism on Sperry Sun equipment at 1000, April 11.

April 11	1600	860.8
	2400	862.0
April 12	0800	863.0
	1600	865.0
	2400	865.5
April 13	0800	866.8
	1600	869.0
	2400	869.4
April 14	0800	870.6
	1600	873.3
	2400	873.0
April 15	0800	874.7
	1600	879.4
	2400	876.5
April 16	0800	878.4
	1600	882.5
	2400	878.5
April 17	0800	879.4
	1600	886.0
	2400	881.3

1974 Date	Time	BHP psia
April 18	0800	879.9

Reset pressure and time mechanism on Sperry Sun equipment at 1500, April 18.

April 18	1600	889.5
	2400	885.3
April 19	0800	885.1
	1600	889.9
	2400	885.9
April 20	0800	884.0
	1600	891.0
	2400	890.0
April 21	0800	890.5
	1600	898.1
	2400	893.6
April 22	0800	892.1
	1600	904.4
	2400	898.4
April 23	0800	896.9
	1600	907.3
	2400	902.7
April 24	0800	903.5
	1600	909.9
	2400	908.1
April 25	0800	908.2
	1600	914.2

Reset pressure and time mechanism on Sperry Sun equipment at 1830, April 25.

April 25	2400	911.1
April 26	0800	908.6
	1600	914.8
	2400	912.2
April 27	0800	910.4
	1600	917.9
	2400	913.7
April 28	0800	911.7
	1600	923.5
	2400	918.8
April 29	0800	915.6
	1600	925.7
	2400	919.4

1974 Date	Time	BHP psia
April 30	0800	918.2
	1600	932.1
	2400	925.7
May 1	0800	925.9
	1600	934.5
	2400	931.0
May 2	0800	934.2
	1600	935.5
	2400	931.2
May 3	0800	929.5
	1600	940.6
	2400	936.8
May 4	0800	933.6
	1600	944.1
	2400	939.2
May 5	0800	935.8
	1600	946.7
	2400	943.7
May 6	0800	942.3
	1600	949.8
	2400	947.6
May 7	0800	945.7
	1600	955.5
	2400	951.0
May 8	0800	949.4
	1600	958.5
	2400	954.4
May 9	0800	953.8
	1600	961.6
	2400	958.3
May 10	0800	957.5
	1600	963.2
	2400	958.6
May 11	0800	955.1
	1600	965.3
	2400	961.2
May 12	0800	958.4
	1600	968.4
	2400	966.8
May 13	0800	964.6
	1600	970.3
	2400	966.2
May 14	0800	963.2
	1600	973.4
	2400	969.4

1974 Date	Time	BHP psia
May 15	0800	970.6
	1600	978.0
	2400	974.6
May 16	0800	970.7
	1400	979.9
	1600	1002.8

At 1400, May 16, closed valve in instrument tubing at reel and disconnected Surface Recorder S.N. PMS-4. Instrument zeroed in 9983.4 psi or minus 16.6 psi. Installed Surface Recorder S.N. PMS-3. Purged twice with helium. Pressure read-out after purges indicated complete system had been purged. Reset at 1600, May 16. All surface connections were tested for leaks.

1974 Date	Time	BHP psia
May 20	1630	Reset
	1635	Purged with 4.5 cu ft helium
	2400	1007.2
May 21	0800	988.4
	1600	1012.8
	2400	1009.9
May 22	0800	1011.2
	1600	1015.8
	2400	1013.0
May 23	0800	1014.0

Valves and fittings were received for adding a Barton Model 202A pressure recorder and a Dead Weight Pressure Gauge test connection into the surface system.

1974 Date	Time	BHP psia
May 23	1600	1018.1
	2400	1016.8
May 24	0800	1016.1
	1600	1020.6
	2400	1020.0

1974 Date	Time	BHP psia
May 25	0800	1018.4
	1600	1023.9
	2400	1023.4
May 26	0800	1020.8
	1600	1026.3
	2400	1026.1
May 27	0800	1022.9
	1600	1028.4
	2400	----
May 28	1600	1031.1
	2400	1027.8
May 29	0800	1029.7

At 1300, May 29, shut down equipment for installation of Barton 202A Pressure Recorder and Dead Weight Tester on tailgate of Sperry Sun equipment. Repurged system with helium, reset time and pressure.

May 29	1400	1039.3
	1600	1041.5
	2400	1040.2
May 30	0800	1040.4

Checked Dead Weight against Sperry Sun equipment and found 2 psi difference. Chart from previous 24 hour period showed no appreciable amount of fluctuation.

May 30	1600	1046.4
	2400	1041.6
May 31	0800	1043.8
	1600	1049.2
	2400	1044.7
June 1	0800	1046.3
	1600	1051.0
	2400	1046.5
June 2	0800	1049.1
	1600	1054.1
	2400	1050.1
June 3	0800	1051.1
	1600	1054.1
	2400	1052.3

1974 Date	Time	BHP psia
June 4	0800	1053.8
	1600	1055.5
	2400	1055.1
June 5	0800	1055.0
	1600	1056.4
	2400	1057.0
June 6	0800	1058.0
	1600	1060.0

Reset time mechanism on Sperry Sun equipment at 1630, June 6.

June 6	2400	1060.0
June 7	0800	1060.5
	1600	1062.5
	2400	1062.4
June 8	0800	1062.2
	1600	1064.1
	2400	1064.4
June 9	0800	1064.7
	1600	1066.9
	2400	1064.8
June 10	0800	1066.7
	1600	1069.0
	2400	1066.3
June 11	0800	1068.5
	1600	1072.4
	2400	1068.6
June 12	0800	1070.6
	1600	1074.4
	2400	1071.7
June 13	0800	1070.9

Reset time mechanism on equipment at 1130, June 13.

June 13	1600	1076.9
	2400	1072.2
June 14	0800	1076.5
	1600	1079.3
	2400	1074.7
June 15	0800	1077.1
	1600	1081.0
	2400	1078.4

1974 Date	Time	BHP psia
June 16	0800	1078.4
	1600	1082.7
	2400	1078.4
June 17	0800	1080.7
	1600	1084.6
	2400	1081.1
June 18	0800	1083.3
	1600	1086.9
	2400	1082.5
June 19	0800	1073.2
	1600	1073.1
	2400	1054.8
June 20	0800	1053.9

Replaced Sperry Sun equipment with new surface readout and print out machine supplied as replacement by Sperry Sun.

The data from 2400, June 18, to 0800, June 20, are questionable since they drop off quite rapidly. The connections on all of the equipment were checked for leaks but none were found.

June 20	1600	1104.0
	2400	1098.8
June 21	0800	1099.3
	1600	1105.8
	2400	1101.5
June 22	0800	1099.9
	1600	1106.5
	2400	1103.4
June 23	0800	1099.8
	1600	1108.7
	2400	1105.5
June 24	0800	1102.1

At 1100, June 24, the Perma Gauge was moved from its old location in the office trailer to a rack mounted position in the lab trailer. A considerable difference was noticed in the amount of fluctuation caused by change in temperature on the electronics and Bourdon tube in the Perma Gauge recorder. The controlled temperature the machine is now experiencing will have a much more reliable build-up trend.

1974 Date	Time	BHP psia
June 24	1600	1109.9
	2400	1110.1
June 25	0800	1110.7
	1600	1110.8
	2400	1111.3
June 26	0800	1111.3
	1600	1111.2
	2400	1114.3
June 27	0800	1114.3

Reset time mechanism on Sperry Sun equipment at 1330, June 27.

June 27	1600	1116.1
	2400	1117.6
June 28	0800	1117.8
	1600	1117.6
	2400	1118.8
June 29	0800	1119.7
	1600	1120.2
	2400	1119.8
June 30	0800	1119.9
	1600	1122.9
	2400	1123.9
July 1	1600	1126.5
	2400	1126.5
July 2	0800	1126.5
	1600	1127.7
	2400	1127.8
July 3	0800	1127.9
	1600	1127.9
	2400	1127.9
July 4	0800	1128.8

Reset time mechanism on Sperry Sun equipment at 1300, July 5. Power failure 0800, July 1.

1974 Date	Time	BHP psia
July 4	1600	1128.7
	2400	1128.7
July 5	0800	1134.2
	1600	1135.0
	2400	1134.9
July 6	0800	1134.9
	1600	1136.6
	2400	1137.6
July 7	0800	1137.6
	1600	1137.6
	2400	1137.6
July 8	0800	1137.6
	1600	1137.6
	2400	1137.6
July 9	0800	1137.6
	1600	1142.9
	2400	1143.7
July 10	0800	1143.7
	1600	1144.9
	2400	1146.0
July 11	0800	1145.9

Checked Sperry Sun equipment with Dead Weight and checked out the same as read out. Purged system with helium. Reset time mechanism on Sperry Sun equipment at 1100, July 11.

July 11	1600	1148.1
	2400	1149.5
July 12	0800	1148.9
	1600	1149.8
	2400	1149.8
July 13	0800	1149.8
	1600	1149.8
	2400	1149.8
July 14	0800	1149.8
	1600	1149.8
	2400	1149.8
July 15	0800	1149.8
	1600	1149.8
	2400	1149.8
July 16	0800	1149.8
	1600	1150.9

1974 Date	Time	BHP psia

Power was off several times during the previous 144 hour period. Each time the equipment was reset but no buildup was observed. At 0800, July 17, the bottom hole sensor was brought to the surface and preparation was made to run Amerada pressure and temperature instruments. No data available for the period July 17 to July 23, inclusive.

1974 Date	Time	#34225 Press. psig	#33509 Press. psig
July 24	1600	1172.7	1165.9
	2400	1172.7	1165.9
July 25	0800	1172.7	1165.9
	1600	1172.7	1165.9
	2400	1174.3	1167.5
July 26	0800	1175.9	1167.5
	1600	1175.9	1167.5
	2400	1175.9	1169.0
July 27	0800	1175.9	1169.0
	1600	1175.9	1169.0
	2400	1175.9	1169.0
July 28	0800	1175.9	1170.6
	1600	1175.9	1170.6
	2400	1175.9	1170.6
July 29	0800	1175.9	1170.6
	1600	1175.9	1170.6
	2400	1175.9	1172.1
July 30	0800	1175.9	1172.1

Reran pressure element numbers 34225 and 33509 to 5160 ft GL. On bottom at 1300, July 30, with 144 hour clocks.

1974 Date	Time	#34225 Press. psig	#33509 Press. psig
July 30	1600	1179	----
	2400	1179	----
July 31	0800	1179	1175
	1600	1179	1177
	2400	1179	1177
Aug. 1	0800	1181	1178
	1600	1181	1178
	2400	1181	1178
Aug. 2	0800	1181	1178
	1600	1181	1178
	2400	1181	1180
Aug. 3	0800	1181	1181
	1600	1181	1181
	2400	1181	1181
Aug. 4	0800	1181	1181
	1600	1181	1183
	2400	1181	1185
Aug. 5	0800	1181	1185

Reran instrument to 5160 ft GL. On bottom at 1200, Aug. 5.

1974 Date	Time	#34225 Press. psig	#33509 Press. psig
Aug. 5	1600	1192	Misrun
	2400	1192	----
Aug. 6	0800	1192	----
	1600	1192	----
	2400	1194	----
Aug. 7	0800	1194	----
	1600	1195	----
	2400	1195	----
Aug. 8	0800	1195	----
	1600	1195	----
	2400	1195	----
Aug. 9	0800	1197	----
	1600	1197	----
	2400	1197	----
Aug. 10	0800	1197	----
	1600	1197	----
	2400	1197	----
Aug. 11	0800	1198	----

Reran instrument to 5160 ft GL. at 1200, Aug. 12.

1974 Date	Time	#34225 Press. psig	#33509 Press. psig
Aug. 12.	1600	1204.8	1198.5
	2400	1204.8	1198.5
Aug. 13	0800	1204.8	1198.5
	1600	1204.8	1198.5
	2400	1206.4	1200.0
Aug. 14	0800	1206.4	1200.0
	1600	1206.4	1201.6
	2400	1206.4	1201.6
Aug. 15	0800	1206.4	1201.6
	1600	1206.4	1201.6
	2400	1208.0	1203.1
Aug. 16	0800	1208.0	1203.1
	1600	1209.6	1203.1
	2400	1209.6	1203.1
Aug. 17	0800	1209.6	1204.7
	1600	1209.6	1206.2
	2400	1209.6	1206.2

1974 Date	Time	#34225 Press. psig	#33509 Press. psig
Aug. 18	0800	1209.6	1206.2

Reran instrument to 5160 ft GL. On bottom at 1300, Aug. 19.

Aug. 19	1600	1213	1209
	2400	1213	1209
Aug. 20	0800	1213	1209
	1600	1213	1211
	2400	1213	1211
Aug. 21	0800	1213	1212
	1600	1213	1212
	2400	1213	1212
Aug. 22	0800	1213	1212
	1600	1214	1214
	2400	1216	1216
Aug. 23	0800	1216	1216

At 1300, Aug. 23, instruments were pulled to surface because of a lubricator packing failure. Instruments were back at a depth of 5050 ft GL at 1500, Aug. 23. The instruments were set at this depth because of a bad kink in wireline caused by bad packing on the pullout.

Aug. 23	1600	1222	1211
	2400	1222	1211
Aug. 24	0800	1224	1211
	1600	1224	1212
	2400	1224	1212
Aug. 25	0800	1226	1214
	1600	1226	1214
	2400	1226	1214
Aug. 26	0800	1226	1214
	1600	1226	1214
	2400	1227	1216
Aug. 27	0800	1227	1216
	1600	1227	1217
	2400	1227	1217
Aug. 28	0800	1227	1217
	1600	1227	1219
	2400	1230	1219

1974 Date	Time	#34225 Press. psig	#33509 Press. psig
Aug. 29	0800	1230	1219

At 0900, Aug. 29, pulled instrument from hole and changed 0.092-in. stainless steel wireline. On bottom, 5160 ft GL at 1800, Aug. 29.

The above data was obtained from instrument at 5050 ft GL as noted above.

Aug. 29	2400	1238	1228
Aug. 30	0800	1238	1228
	1600	1238	1228
	2400	1240	1230
Aug. 31	0800	1240	1230
	1600	1240	1230
	2400	1242	1230
Sept. 1	0800	1242	1230
	1600	1242	1230
	2400	1242	1230
Sept. 2	0800	1242	1231
	1600	1243	1231
	2400	1243	1231
Sept. 3	0800	1243	1231
	1600	1243	1231
	2400	1243	1233
Sept. 4	0800	1243	1233

Reran instrument to 5160 ft GL. On bottom at 1600, Sept. 4.

Sept. 4	2400	1238	1234
Sept. 5	0800	1238	1234
	1600	1238	1234
	2400	1240	1234
Sept. 6	0800	1240	1234
	1600	1240	1236
	2400	1240	1236
Sept. 7	0800	1240	1236
	1600	1240	1236
	2400	1242	1236
Sept. 8	0800	1242	1237
	1600	1242	1237
	2400	1242	1237

1974 Date	Time	#34225 Press. psig	#33509 Press. psig
Sept. 9	0800	1242	1239
	1600	1242	1239
	2400	1243	1240
Sept. 10	0800	1243	1240

Reran instrument to 5160 ft GL. On bottom at 1330, Sept. 10.

Sept. 10	1600	1250	1242
	2400	1250	1242
Sept. 11	0800	1250	1242
	1600	1250	1242
	2400	1251	1243
Sept. 12	0800	1251	1243
	1600	1251	1243
	2400	1251	1243
Sept. 13	0800	1251	1243
	1600	1253	1245
	2400	1253	1245
Sept. 14	0800	1253	1245
	1600	1253	1245
	2400	1253	1245
Sept. 15	0800	1253	1245
	1600	1253	1247
	2400	1253	1247
Sept. 16	0800	1254	1248

Reran instrument to 5160 ft GL. On bottom at 1500, Sept. 16.

Sept. 16	1600	Misrun	1250
	2400	----	1250
Sept. 17	0800	----	1250
	1600	----	1251
	2400	----	1251
Sept. 18	0800	----	1251
	1600	----	1251
	2400	----	1251
Sept. 19	0800	----	1251
	1600	----	1253
	2400	----	1253
Sept. 20	0800	----	1253
	1600	----	1254
	2400	----	1254

1974 Date	Time	#34225 Press. psig	#33509 Press. psig
Sept. 21	0800	----	1256
	1600	----	1256
	2400	----	1257
Sept. 22	0800	----	1257

Reran new element #33508 and same element #33509 to 5160 ft GL. On bottom at 1400, Sept. 23.

1974 Date	Time	#33508 Press. psig	#33509 Press. psig
Sept. 23	1600	1257	1256
	2400	1257	1257
Sept. 24	0800	1259	1257
	1600	1259	1257
	2400	1259	1259
Sept. 25	0800	1259	1259
	1600	1259	1259
	2400	1259	1259
Sept. 26	0800	1259	1259
	1600	1259	1261
	2400	1261	1261
Sept. 27	0800	1261	1262
	1600	1261	1262
	2400	1261	1262
Sept. 28	0800	1261	1262
	1600	1262	1264
	2400	1262	1264
Sept. 29	0800	1262	1265

Reran instrument to 5160 ft GL. On bottom at 1500, Sept. 30.

Sept. 30	1600	1261	1262
	2400	1261	1262
Oct. 1	0800	1261	1262
	1600	1262	1262
	2400	1262	1264
Oct. 2	0800	1264	1264
	1600	1264	1264
	2400	1264	1264

1974 Date	Time	#33508 Press. psig	#33509 Press. psig
Oct. 3	0800	1264	1264
	1600	1265	1264
	2400	1265	1265
Oct. 4	0800	1265	1265
	1600	1265	1267
	2400	1267	1267
Oct. 5	0800	1267	1267
	1600	1267	1268
	2400	1268	1268
Oct. 6	0800	1268	1268

Reran instrument to 5160 ft GL. On bottom at 1600, Oct. 7.

Oct. 7	2400	1265	1278
Oct. 8	0800	1265	1278
	1600	1265	1278
	2400	1265	1278
Oct. 9	0800	1267	1278
	1600	1267	1279
	2400	1267	1279
Oct. 10	0800	1267	1279
	1600	1267	1279
	2400	1267	1279
Oct. 11	0800	1268	1279
	1600	1268	1279
	2400	1268	1279
Oct. 12	0800	1268	1279
	1600	1268	1281
	2400	1270	1281
Oct. 13	0800	1270	1281

Reran instrument to 5160 ft GL. On bottom on 1300, Oct. 14.

Oct. 14	1600	1281	1284
	2400	1281	1284
Oct. 15	0800	1281	1284
	1600	1282	1284
	2400	1282	1285
Oct. 16	0800	1284	1285
	1600	1284	1285
	2400	1284	1285

1974 Date	Time	#33508 Press. psig	#33509 Press. psig
Oct. 17	0800	1284	1285
	1600	1284	1285
	2400	1285	1287
Oct. 18	0800	1285	1287
	1600	1285	1287
	2400	1285	1287
Oct. 19	0800	1285	1287
	1600	1287	1287
	2400	1287	1288
Oct. 20	0800	1287	1288
	1600	1288	1290

Reran instrument to 5160 ft GL. On bottom at 1700, Oct. 21.

Oct. 21	2400	1290	1292
Oct. 22	0800	1290	1292
	1600	1290	1293
	2400	1292	1293
Oct. 23	0800	1292	1295
	1600	1292	1295
	2400	1292	1295
Oct. 24	0800	1292	1295
	1600	1292	1295
	2400	1292	1296
Oct. 25	0800	1293	1296
	1600	1293	1296
	2400	1295	1296
Oct. 26	0800	1295	1298
	1600	1295	1298
	2400	1295	1299
Oct. 27	0800	1295	1299
	1600	1295	1299

Reran instrument to 5160 ft GL at 1400, Oct. 28. Changed from Mountain Daylight Time to Mountain Standard Time at this point.

Oct. 28	1600	1298	1301
	2400	1298	1302
Oct. 29	0800	1298	1302
	1600	1299	1302
	2400	1299	1302

1974 Date	Time	#33508 Press. psig	#33509 Press. psig
Oct. 30	0800	1299	1304
	1600	1299	1304
	2400	1299	1304
Oct. 31	0800	1299	1304
	1600	1301	1304
	2400	1301	1304
Nov. 1	0800	1301	1304
	1600	1301	1306
	2400	1301	1306
Nov. 2	0800	1302	1306
	1600	1304	1306
	2400	1304	1307
Nov. 3	0800	1304	1307

Reran instrument to 5160 ft GL at 1300, Nov. 5.

Nov. 5	1600	1306	1307
	2400	1306	1307
Nov. 6	0800	1307	1307
	1600	1307	1309
	2400	1309	1309
Nov. 7	0800	1309	1309
	1600	1309	1309
	2400	1309	1309
Nov. 8	0800	1309	1309
	1600	1310	1309
	2400	1310	1310
Nov. 9	0800	1312	1310
	1600	1312	1310
	2400	1312	1310
Nov. 10	0800	1312	1310
	1600	1313	1310
	2400	1315	1312
Nov. 11	0800	1315	1312

Reran instrument to 5160 ft GL. On bottom at 1500, Nov. 12.

Nov. 12	1600	1316	1312
	2400	1316	1312

1974 Date	Time	#33508 Press. psig	#33509 Press. psig
Nov. 13	0800	1316	1312
	1600	1318	1312
	2400	1318	1312
Nov. 14	0800	1318	1312
	1600	1319	1313
	2400	1319	1313
Nov. 15	0800	1319	1313
	1600	1319	1313
	2400	1319	1315
Nov. 16	0800	1319	1315
	1600	1319	1315
	2400	1319	1315
Nov. 17	0800	1321	1315
	1600	1321	1316
	2400	1323	1316
Nov. 18	0800	1323	1318

Reran instrument to 5160 ft GL. On bottom at 1300, Nov. 19.

Nov. 19	1600	1327	1319
	2400	1327	1319
Nov. 20	0800	1327	1319
	1600	1327	1319
	2400	1327	1319
Nov. 21	0800	1327	1321
	1600	1327	1321
	2400	1327	1321
Nov. 22	0800	1327	1321
	1600	1327	1321
	2400	1327	1321
Nov. 23	0800	1327	1323
	1600	1327	1323
	2400	1327	1323
Nov. 24	0800	1327	1323
	1600	1327	1323
	2400	1327	1324
Nov. 25	0800	1327	1324

Did not rerun instrument in preparation for installing Sperry Sun equipment on Dec. 7. Installed Sperry Sun Permagauge on Dec. 7. Had problems with moisture freezing in capillary tubing and physical location of surface equipment. Permagauge in operation at 1500, Dec. 10.

1974 Date	Time	BHP psig
Dec. 10	1600	1335.7
Dec. 11	0800	1336.7
Dec. 12	0800	1336.9
Dec. 13	0800	1337.8
Dec. 14	0800	1340.8
Dec. 15	0800	1342.0
Dec. 16	0800	1342.2
Dec. 17	0800	1343.1
Dec. 18	0800	1345.2

No data for dates of Dec. 19 to Dec. 26.

Dec. 27	0800	1352.7
Dec. 28	0800	1351.4
Dec. 29	0800	1352.2
Dec. 30	0800	1352.8

Lost power, reset at 1030, Dec. 31.

Dec. 31	1200	1351.7

1975

Jan. 1	0800	1351.2
Jan. 2	0800	1352.4
Jan. 3	0800	1353.0
Jan. 4	0800	1368.7
Jan. 5	0800	1373.1

Machine disconnected for move to different location on surface. No data for period Jan. 6 to Jan. 20. Arrived location at 1200, Jan. 21. Changed routing of capillary tubing on surface so it would reach to new location of Sperry Sun Permagauge. Hooked line in to Permagauge and checked for leaks. Purged system with 50 ft^3 of helium and let Permagauge reach equilibrium. Entered correction factors and reset machine.

1975 Date	Time	BHP psig
Jan. 21	1600	1368.4
	2400	1368.2
Jan. 22	0800	1368.5
	1600	1368.7
	2400	1369.0
Jan. 23	0800	1369.1
	1600	1369.6
	2400	1369.2
Jan. 24	0800	1369.6
	1600	1369.8
	2400	1370.0
Jan. 25	0800	1370.2
	1600	1370.2
	2400	1370.8
Jan. 26	0800	1370.8
	1600	1371.1
	2400	1371.2
Jan. 27	0800	1371.3
	1600	1371.6
	2400	1371.7
Jan. 28	0800	1372.0
	1600	1372.1
	2400	1372.2
Jan. 29	0800	1372.4
	1600	1372.8
	2400	1372.9
Jan. 30	0800	1373.0
	1600	1373.2
	2400	1373.8
Jan. 31	0800	1373.5
	1600	1373.6
	2400	1373.8
Feb. 1	0800	1373.8
	1600	1374.1
	2400	1374.5
Feb. 2	0800	1374.2
	1600	1375.0
	2400	1375.1
Feb. 3	0800	1375.3
	1600	1377.0
	2400	1377.2
Feb. 4	0800	1377.5
	1600	1377.5
	2400	1377.8

1975 Date	Time	BHP psig
Feb. 5	0800	1378.3
	1600	1378.3
	2400	1378.5
Feb. 6	0800	1378.8
	1600	1379.4
	2400	1379.6
Feb. 7	0800	1379.8
	1600	1379.8
	2400	1380.1
Feb. 8	0800	1380.4
	1600	1380.4
	2400	1380.6
Feb. 9	0800	1380.8
	1600	1381.1
	2400	1381.1
Feb. 10	0800	1381.5
	1600	1381.6
	2400	1381.7
Feb. 11	0800	1381.9
	1600	1382.3
	2400	1382.1
Feb. 12	0800	1382.4
	1600	1382.9
	2400	1383.1
Feb. 13	0800	1383.3
	1600	1383.2
	2400	1383.6
Feb. 14	0800	1383.6
	1600	1383.9
	2400	1384.2
Feb. 15	0800	1384.2
	1600	1384.5
	2400	1384.9
Feb. 16	0800	1385.1
	1600	1385.2
	2400	1385.4

Data omitted for Feb. 17 to Feb. 26 and for Mar. 31 to May 15. Data were unreliable because of temperature effects on Sperry-Sun equipment. No equipment was available for the period Feb. 27 to Mar. 30.

On May 16, recorder was moved to controlled environment. System purged with helium.

1975 Date	Time	BHP psig
May 16	1600	1430.6
	2400	1430.6
May 17	0800	1430.8
	1600	1430.9
	2400	1427.9
May 18	0800	1428.1
	1600	1428.1
	2400	1428.3
May 19	0800	1428.5
	1600	1429.0
	2400	1428.9
May 20	0800	1429.0
	1600	1429.4
	2400	1429.3
May 21	0800	1429.6
	1600	1429.8
	2400	1429.9
May 22	0800	1430.2
	1600	1430.0
	2400	1430.0
May 23	0800	1430.8
	1600	1430.7
	2400	1430.3
May 24	0800	1430.7
	1600	1430.8
	2400	1430.8
May 25	0800	1430.8
	1600	1431.0
	2400	1431.1
May 26	0800	1432.1
	1600	1431.7
	2400	1431.4
May 27	0800	1432.2
	1600	1432.0
	2400	1432.5
May 28	0800	1432.8
	1600	1432.8
	2400	1433.1

1975 Date	Time	BHP psig
May 29	0800	1433.4
	1600	1433.1
	2400	1433.2
May 30	0800	1433.9
	1600	1433.8
	2400	1433.4
May 31	0800	1433.8
	1600	1433.8
	2400	1433.9
June 1	0800	1434.1
	1600	1434.3
	2400	1434.3
June 2	0800	1434.5
	1600	1434.9
	2400	1434.7
June 3	0800	1434.6
	1600	1435.0
	2400	1435.0
June 4	0800	1434.8
	1600	1435.5
	2400	1435.2
June 5	0800	1435.4
	1600	1435.9
	2400	1435.8
June 6	0800	1436.1
	1600	1436.4
	2400	1436.5
June 7	0800	1436.2
	1600	1436.1
	2400	1435.6
June 8	0800	1435.5
	1600	1435.4
	2400	1435.7
June 9	0800	1435.9
	1600	1436.0
	2400	1436.0
June 10	0800	1436.3
	1600	1436.1
	2400	1436.1
June 11	0800	1436.3
	1600	1436.6
	2400	1436.4

1975 Date	Time	BHP psig
June 12	0800	1436.3
	1600	1437.0
	2400	1435.9
June 13	0800	1436.0
	1600	1437.1
	2400	1436.8
June 14	0800	1436.5
	1600	1437.6
	2400	1437.5
June 15	0800	1436.8
	1600	1438.4
	2400	1438.1
June 16	0800	1437.6
	1600	1438.6
	2400	1438.1
June 17	0800	1438.0
	1600	1438.6
	2400	1438.8
June 18	0800	1438.5
	1600	1438.5
	2400	1438.0
June 19	0800	1438.0
	1600	1438.8
	2400	1438.7
June 20	0800	1438.6
	1600	1438.5
	2400	1438.8
June 21	0800	1439.1
	1600	1439.3
	2400	1439.1
June 22	0800	1439.2
	1600	1439.8
	2400	1439.7
June 23	0800	1439.6
	1600	1440.6
	2400	1440.5
June 24	0800	1440.2

Terminated long term pressure build-up monitoring on June 24.

APPENDIX E
SUMMARIES FROM RELEVANT RADIOLOGICAL MONITORING PROGRAM REPORTS

(From Reference 8, PNE-RB-51-7 to -10 inclusive)

1. SUMMARY OF RESULTS FOR NOVEMBER 1, 1973 THROUGH FEBRUARY 4, 1974

Beta radioactivity in air particulate samples for this period remained at very low concentrations, ranging from 0.02 to 0.13 pCi/m^3. These values are consistent with values observed by Eberline at other sites during this period, at Rio Blanco during previous periods, and with values reported by the Environmental Protection Agency (EPA) Air Surveillance Network. Gamma scans of the air particulate samples (composite) indicated that the concentrations of gamma emitters were below the minimum detectability of the 4-inch diameter x 4-inch thick NaI(Tl) detector.

TLD data for this period indicated an average background radiation dose rate of 2.25 millirem per week. This is consistent with the dose rate measured during the previous winter. Lower dose rates during the winter are attributable to attenuation of radiation from terrestrial sources due to snow cover.

Soil samples collected in November 1973 were analyzed for isotopes of plutonium, uranium and thorium. The concentration of plutonium was within the range of expected values due to worldwide fallout. The concentrations of uranium and thorium were within ranges that occur naturally.

Tritium concentrations in water measured by electrolytic enrichment were in the range of <0.1 pCi/ml to 0.4 pCi/ml. Other beta activity was in the range of 0.0 to 10.8 pCi/l.

2. SUMMARY OF RESULTS FOR FEBRUARY 4, 1974 THROUGH APRIL 30, 1974

Beta radioactivity in air particulate samples increased in March and April to a peak of 0.47 pCi/m^3 from a mid-winter low of 0.02 pCi/m^3. A seasonal increase is always noted in the spring, but this increase is more than usual and is attributable to injection of year-old fission products from the upper atmosphere inventory due to spring mixing of the upper and lower atmosphere. The presence of a fission product mixture consistent with the time delay since the June 26, 1973 test by the People's Republic of China indicates that this test is responsible for most of the increase in the spring of 1974. The increase is not attributable to Rio Blanco because it was typical of levels measured throughout the United States by Eberline and by the Environmental Protection Agency. For example, gamma isotopic analysis of composite filters from the southeastern United States showed the presence of the same approximately year-old fission product mixture at similar concentrations as measured at Rio Blanco.

Vegetation samples (Goldenrod, Sagebrush, Willow, Greasewood and Milk Cow Feed) were collected on March 29, 1974. Sr-89, tritium, and gamma emitters (other than natural K-40) were not detected in any of the samples. The concentration of Sr-90 ranged from 0.04 to 0.18 pCi/g (dry weight) and is attributable to worldwide fallout.

TLD data for this period indicated an average background dose rate of 3.0 mrem/week. This is higher than the dose rate measured during the winter (2.25 mrem/week) and is attributable to increased dose rate from terrestrial sources due to the melting of the winter snow cover or to the increased worldwide fallout during this period.

Water samples collected during March 1974 did not indicate the presence of any unexpected radioactivity. Gross beta concentrations ranged up to a maximum of 8 ± 4 pCi/l. Tritium was measured in some of the samples by electrolytic enrichment. Concentrations of tritium ranged from 0.12 ± 0.08 to 0.25 ± 0.08 pCi/ml.

Gamma emitters, other than natural radioactivity were not detected in samples collected on March 29, 1974.

Cesium-137 was measured in soil samples collected on March 29, 1974 with concentrations ranging from less than 0.09 to 0.9 pCi/g (dry weight). Tritium and gamma emitters (except natural radioactivity) were not detected in any of the samples.

3. SUMMARY OF RESULTS FOR MAY 1, 1974 THROUGH JULY 29, 1974

Beta radioactivity in air particulate samples continued to increase into May 1974 as noted during the previous period, peaking during the first two weeks of May 1974. This increase is attributable, as in the previous period, to injection of year-old fission products from the upper atmosphere due to spring mixing of the upper and lower atmosphere. The increase in radioactivity is not attributable to Project Rio Blanco. After the second week in May, the air concentration shows a decreasing trend from a peak concentration of 0.54 pCi/m^3 in May to less than 0.1 pCi/m^3 at the end of July.

TLD data for this period indicated an average background dose rate of 2.2 mrem/week. There is no evidence of any increase due to Rio Blanco.

Water samples collected during July 1974 did not indicate the presence of any unexpected radioactivity. Gross beta concentration, other than tritium, were below 10 pCi/l. Tritium was measured in four samples by electrolytic enrichment followed by liquid scintillation counting. Concentrations of tritium ranged from 0.14 ± 0.08 to 0.49 ± 0.08 pCi/ml. This tritium is attributable to natural production in the atmosphere and worldwide fallout from weapons testing. This concentration is a small fraction of the peak in 1963 caused by weapons testing in the atmosphere. Gamma emitters were not detected by gamma spectrometry in any of the samples.

Gamma emitters other than natural K-40 were not detected in three milk samples collected in July 1974.

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9. Environmental Statement, Rio Blanco Gas Stimulation Project, WASH-1519, U.S. Atomic Energy Commission, April 1972, with addendum March 1973.