4. RRGP-4AB FLOW TEST, NOVEMBER 28 - DECEMBER 2, 1978

4.1 Test Description

The RRGP-4AB flow test began on November 29, 1978. Artesian flow was used in an attempt to preheat the RRGP-4AB wellbore. RRGP-4AB sustained the artesian flow for only 10 minutes. Testing later showed the wellbore did not preheat to an isothermal condition. Following preheat, a 0.63 lps (10 gpm) flow was established in an attempt to maintain thermal quasi-equilibrium and allow the well to recover. The test consisted of allowing the well to artesian flow at 0.93 lps (15 gpm), beginning once recovery from the preheating was apparent. The test was termined after 18 hours due to the combination of low production rate, low wellhead pressure and flashing in the discharge line. Pulse tests were cancelled due to the rapid decline of wellhead pressure.

Raft River Field Operations constructed and instrumented a flow line from the wellhead to the RRGP-4AB pond (see Figure 42). Reservoir Engineers monitored the discharge rate by means of a strip-chart pressure recorder, recording the pressure differential across an orifice. The recorder indicated the discharge held constant at 1.6 lps (25 gpm). Measurements with a 1.32 l (5 gal) bucket and stop watch showed it to vary between 0.95 lps (15 gpm) and 2.8 lps (45 gpm). The low flow rate was at the limits of the measuring and recording instruments.

Appendix E is an execution copy of FET-10A-78, the test plan prepared for producing RRGP-4AB.

A thermocouple measured wellhead temperature, and a digiquartz pressure transducer and a Heise pressure gauge measured wellhead pressure at RRGP-4AB. The Hewlett-Packard downhole temperature-pressure probe was not used because it was out-of-service for repair. Digiquartz pressure transducers and continuous recorders collected observation well data at RRGE-1, RRGP-5B, MW-1, and USGS-3.

4.2 Preliminary Test Assessment

Wellhead pressure increased for more than four minutes after production began (Figure 43). This was caused by the thermal effects of hotter, lower density water entering the wellbore [3]. Thermally affected data cannot be used for qualitative or quantitative analysis without computer corrections. It may be possible to obtain interpretable data with a downhole temperature-pressure probe, if wellhead temperature cannot be brought to equilibrium. Discharge water temperature stabilized after 300 minutes at 110°C (230°F). Borehole geophysical logs had recorded a maximum downhole temperature of 123°C (254°F).

The method of shut-in is believed to have caused the linear trend in the initial minute and a half of recovery data (Figure 44). A valve located approximately eight meters (25 ft) down the discharge line was used to shut-in the well, rather than the valve at the wellhead. The line was apparently partially filled with air, causing a lag in pressurizing the system. This valve was chosen for shut-in, so that temperature measurements could be obtained during recovery. The data plot as a continuous curve after four and a half minutes, and cannot be analyzed by the modified nonequilibrium method. The data are unquestionably thermally affected.

A nonequilibrium analysis (Figure 45) was employed in an attempt to interpret the recovery data. Although not commonly applied to production well data, the nonequilibrium method should be applicable to recovery data, as well losses do not occur during recovery. The data do not match any standard-type curve.

No interference effects are apparent between wells RRGE-1, RRGP-5B, and RRGP-4AB (Figure 46). The observation wells are assumed to penetrate the same geologic structure and perhaps the same or similar aquifers. The differing curves raise questions about observation well activity. RRGE-1 provides stabilized artesian flow at ±3% of a preset rate; RRGP-5B had been shut-in since the RRGP-5B 72-hour test from November 1 to 7, 1978. The inconsistent RRGE-1 data suggest that either the discharge rate from RRGE-1 was not maintained within the ±3% flow-stabilization limits, or

the limits are not exact enough for the production of required hydrogeologic data.

A graph of RRGE-1 wellhead pressure (Figure 49) was constructed to investigate the possibility that the inconsistency in data was related to a natural phenomenon, such as earth tides or the barometric efficiency of the aquifer(s) penetrated. Wellhead pressure data were scrutinized for temporal trends. No temporal trends are apparent. No pressure response at well RRGE-1 is recognized during the RRGP-4AB production or recovery (Figures 47 and 48).

Wellhead pressure changes greater than 690 Pa (0.1 psi) were not observed at USGS-3 and MW-1 (Figure 50) during the RRGP-4AB production test. USGS-3 and MW-1 were apparently not affected by the production of RRGP-4AB at 0.95 lps (15 gpm).

4.3 Conclusions

It is estimated that pumping RRGP-4AB at 6.2 lps (100 gpm) would result in 3.6×10^3 kPa (520 psi) of drawdown over one day of production (Figure 51). The extrapolation was derived by linear extension of the production test data, assuming no boundaries and utilizing simple ratios of production rates. The estimate contains inherent errors due to the non-Darcian response of fractured wells, control of discharge rate, and possible flashing in the discharge line during the test. Additional testing of RRGP-4AB is required before a final decision concerning the well is resolved. It is recommended that future testing consist of short duration production or injection tests, with rate and duration based on Figure 51. The tests could serve as a basis for comparison if it is decided to stimulate the well.

No effects of the test were seen in the observation well. The rate and the length of the test cannot be considered sufficient to yield interference data suitable for qualitative or quantitative analysis.

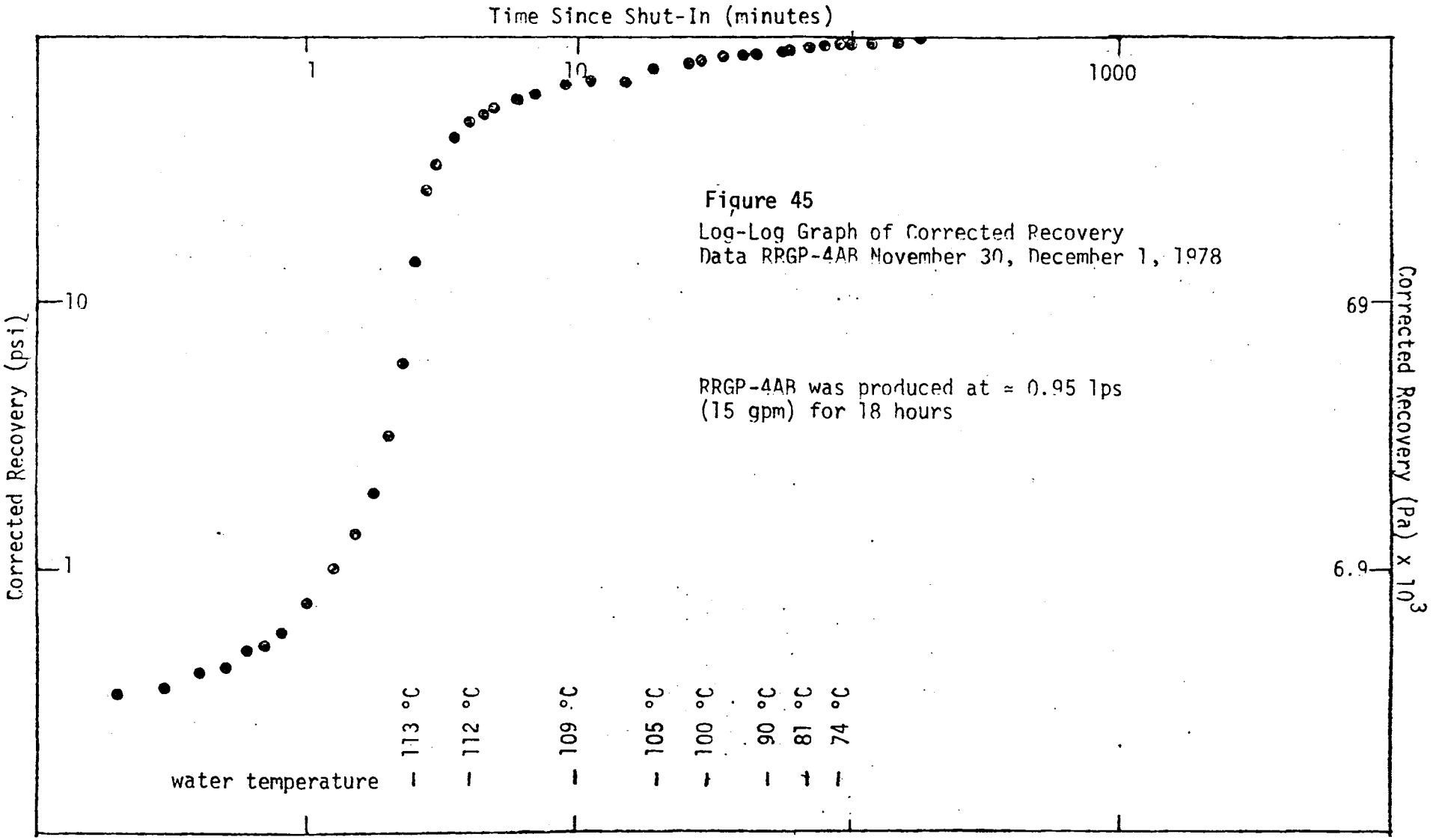


Figure 45
Log-Log Graph of Corrected Recovery
Data RRGP-4AR November 30, December 1, 1978

RRGP-4AR was produced at ≈ 0.95 lps
(15 gpm) for 18 hours

Figure 46

RRGE-1 and RRGP-5B
WELLHEAD PRESSURE NOV. 27 - DEC. 1, 1978

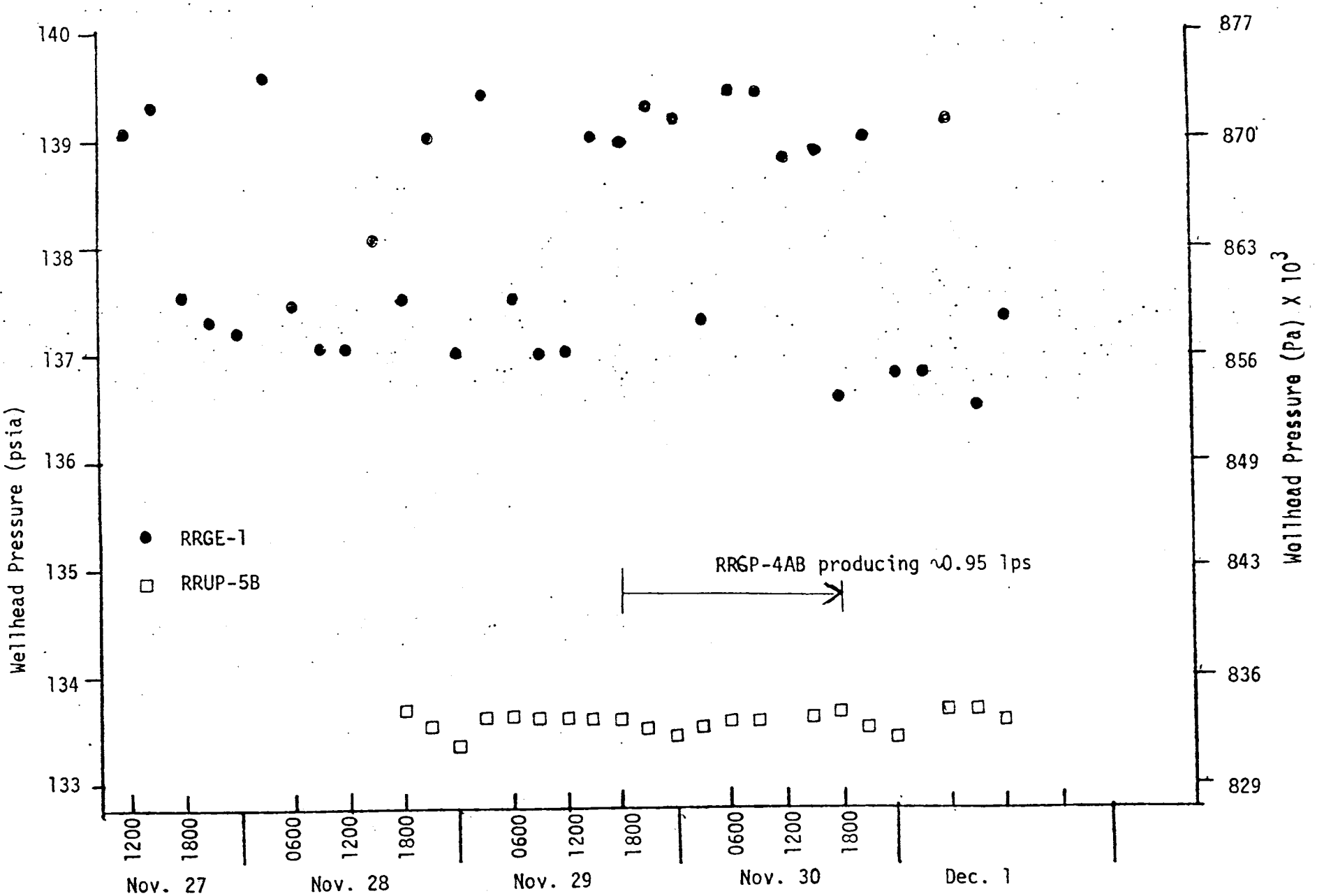
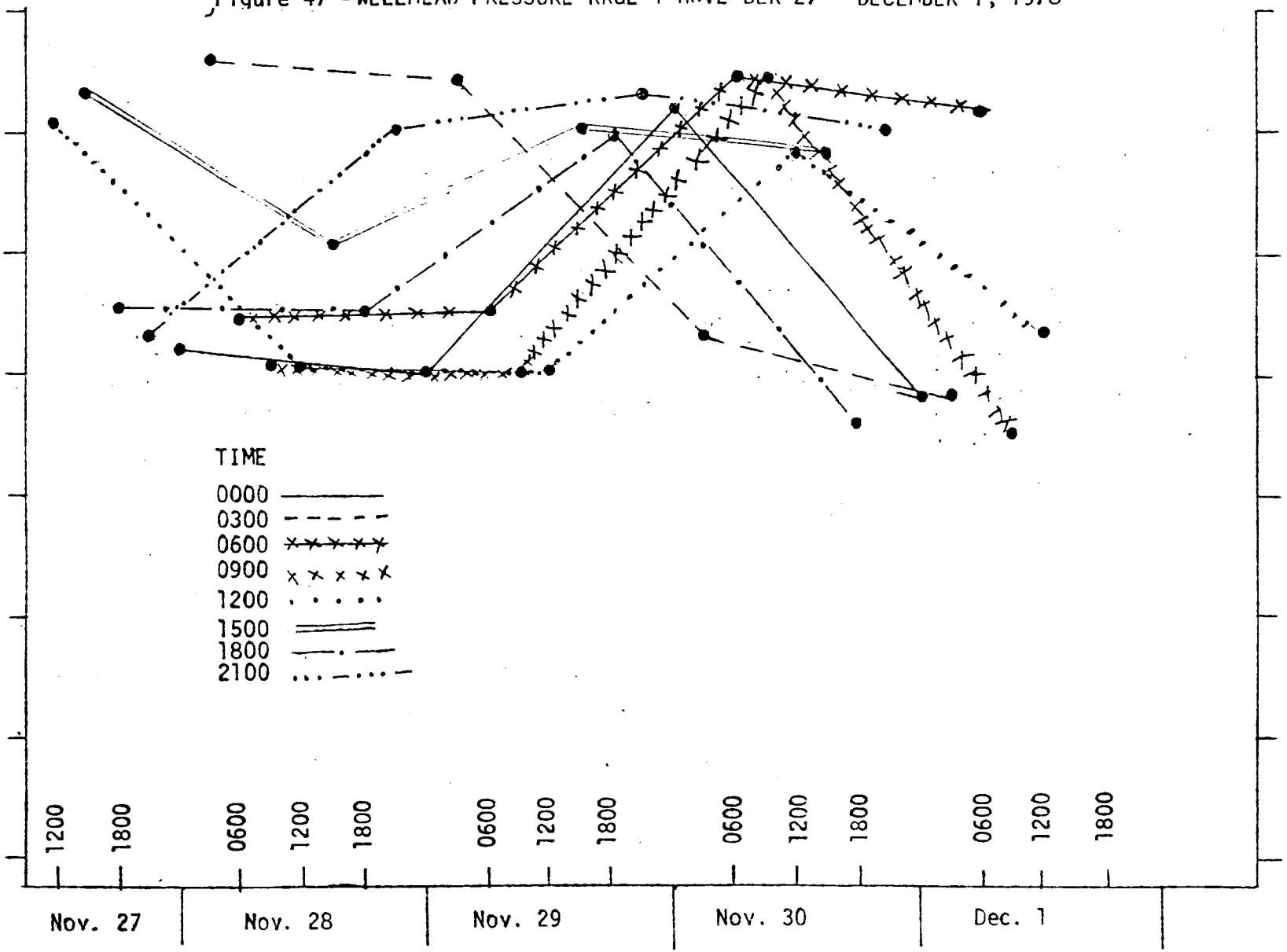
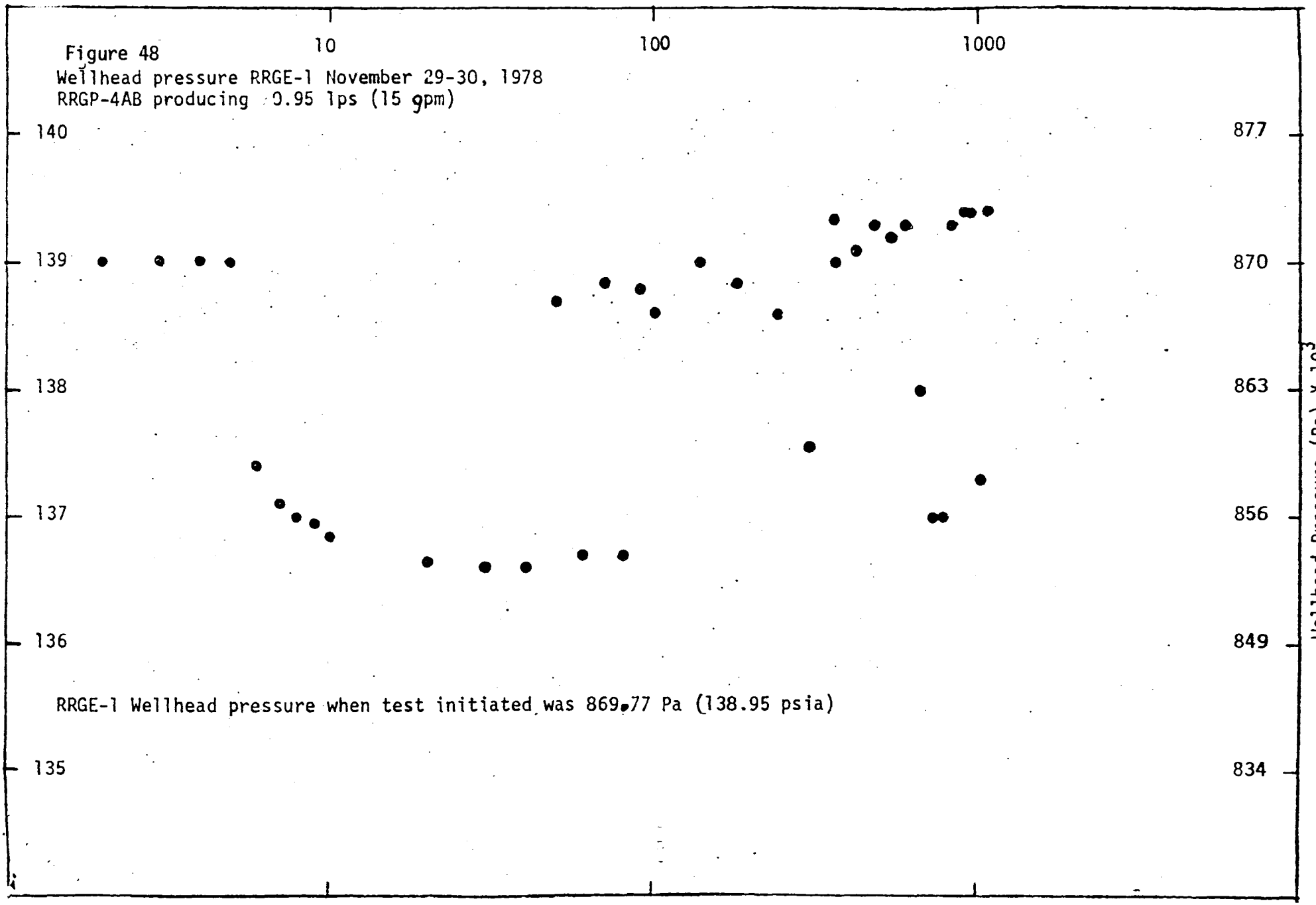


Figure 47 -WELLHEAD PRESSURE RRGE-1 NOVEMBER 27 - DECEMBER 1, 1978




RRGP-4AB PRODUCTION TIME (MINUTES)
10
100
1000
Figure 48
Wellhead pressure RRGE-1 November 29-30, 1978
RRGP-4AB producing 0.95 lps (15 gpm)
140
139
138
137
136
135
877
870
863
856
849
834
Wellhead Pressure (psia)
Wellhead Pressure (Pa) X 10³
RRGE-1 Wellhead pressure when test initiated was 869.77 Pa (138.95 psia)

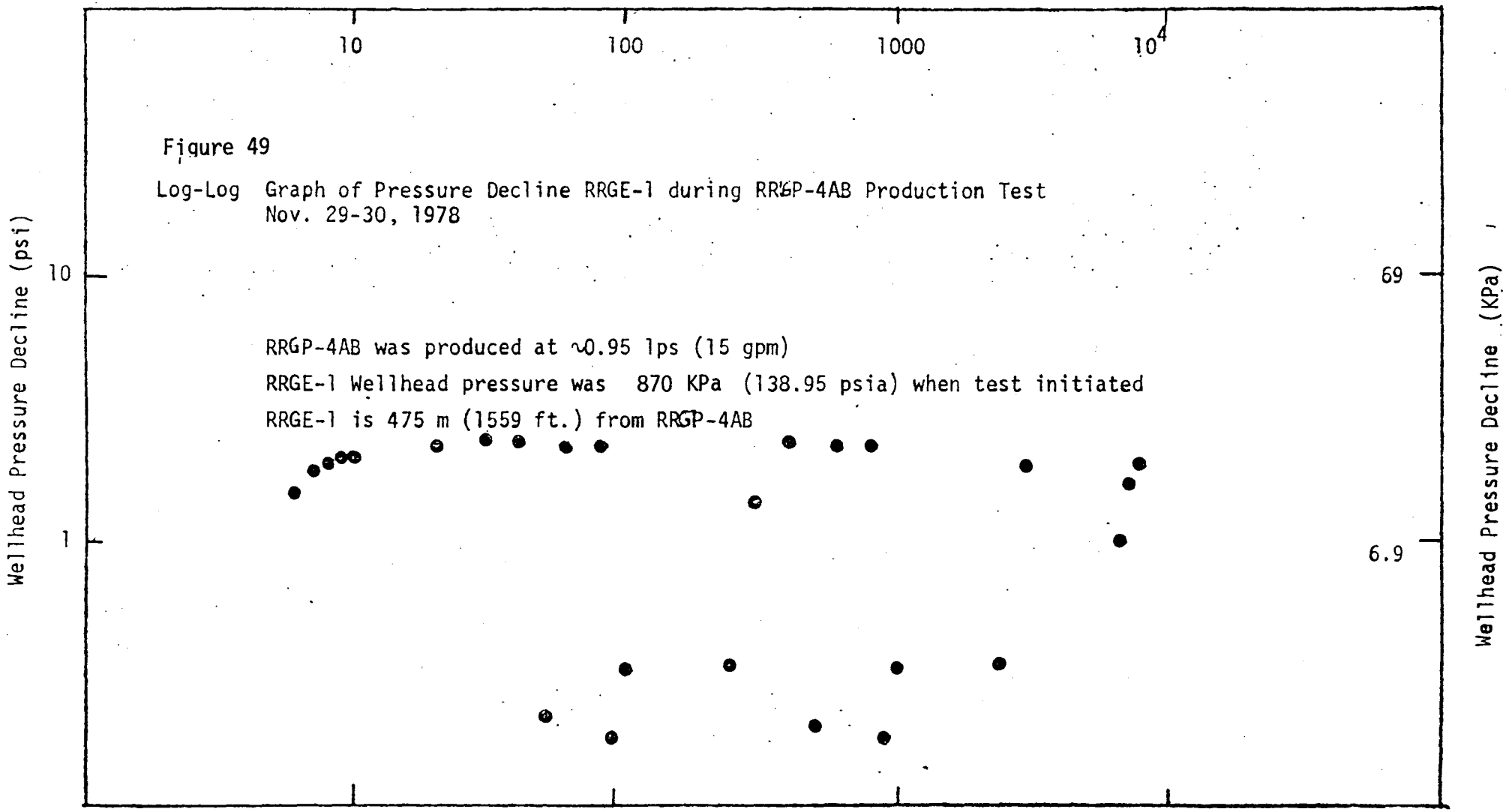


Figure 49

Log-Log Graph of Pressure Decline RRGE-1 during RRGP-4AB Production Test
Nov. 29-30, 1978

RRGP-4AB was produced at ~0.95 lps (15 gpm)

RRGE-1 Wellhead pressure was 870 KPa (138.95 psia) when test initiated

RRGE-1 is 475 m (1559 ft.) from RRGP-4AB

Figure 50,
USGS-3 & MW-1 WELLHEAD PRESSURE NOV. 27 THRU DEC 1, 1978

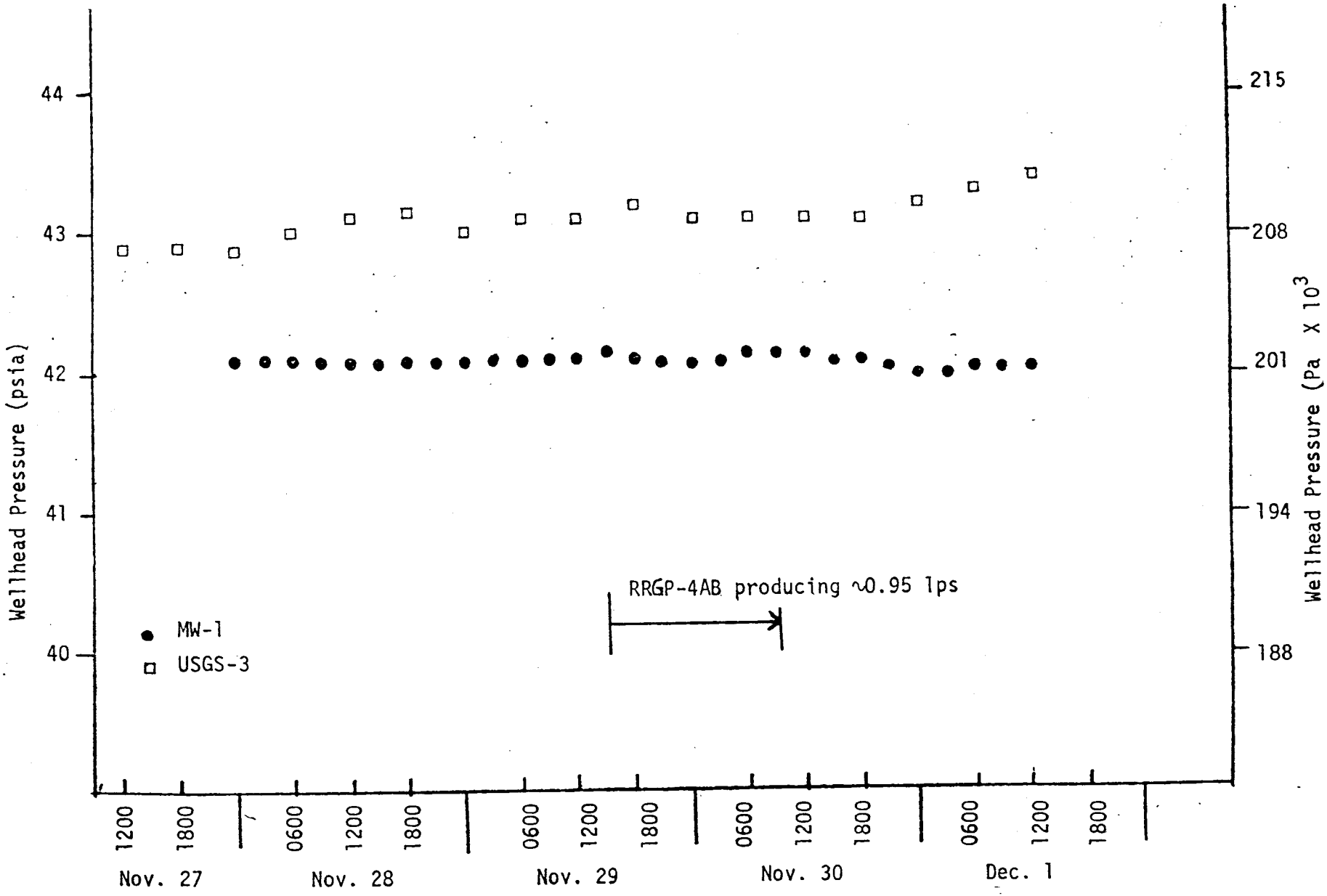
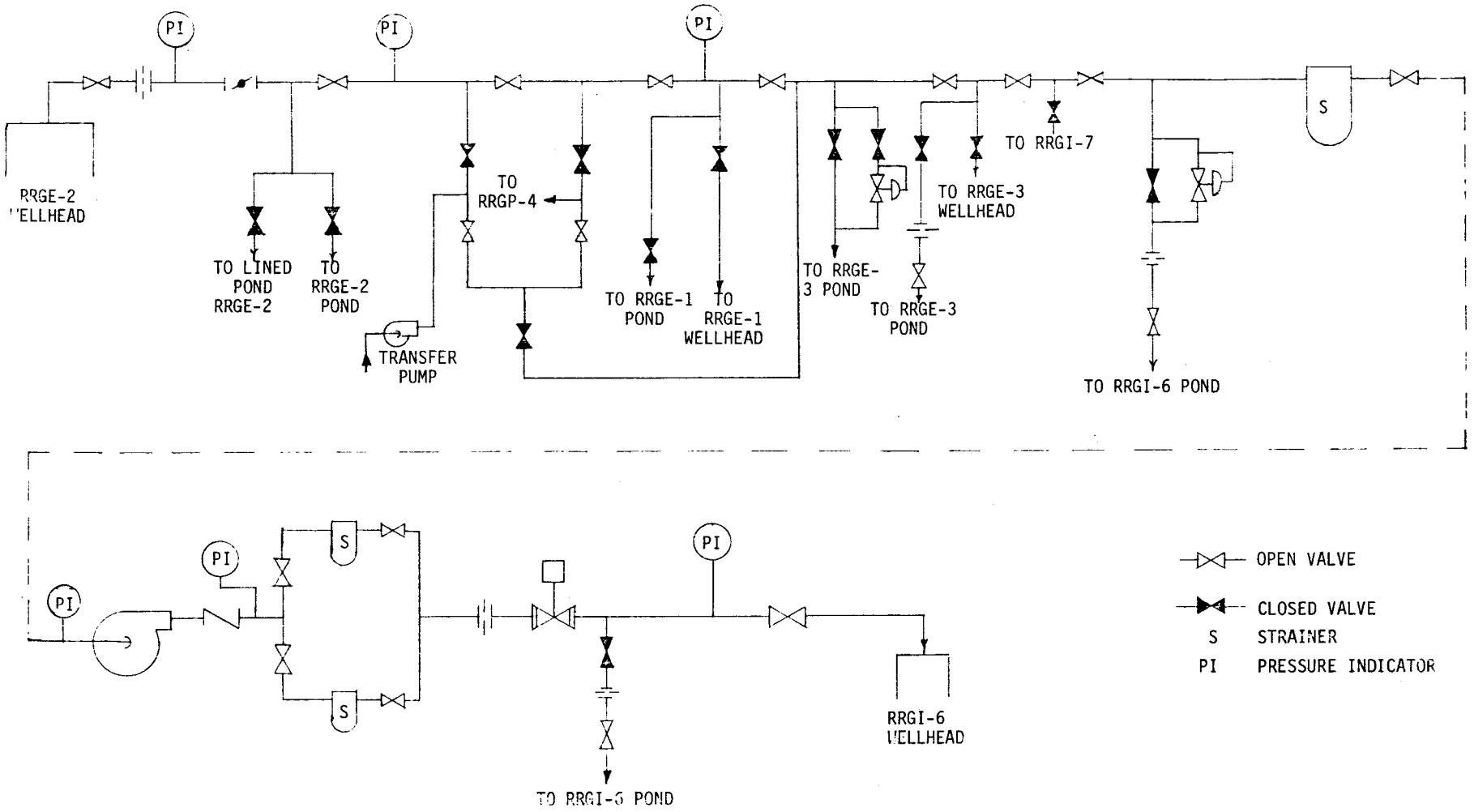
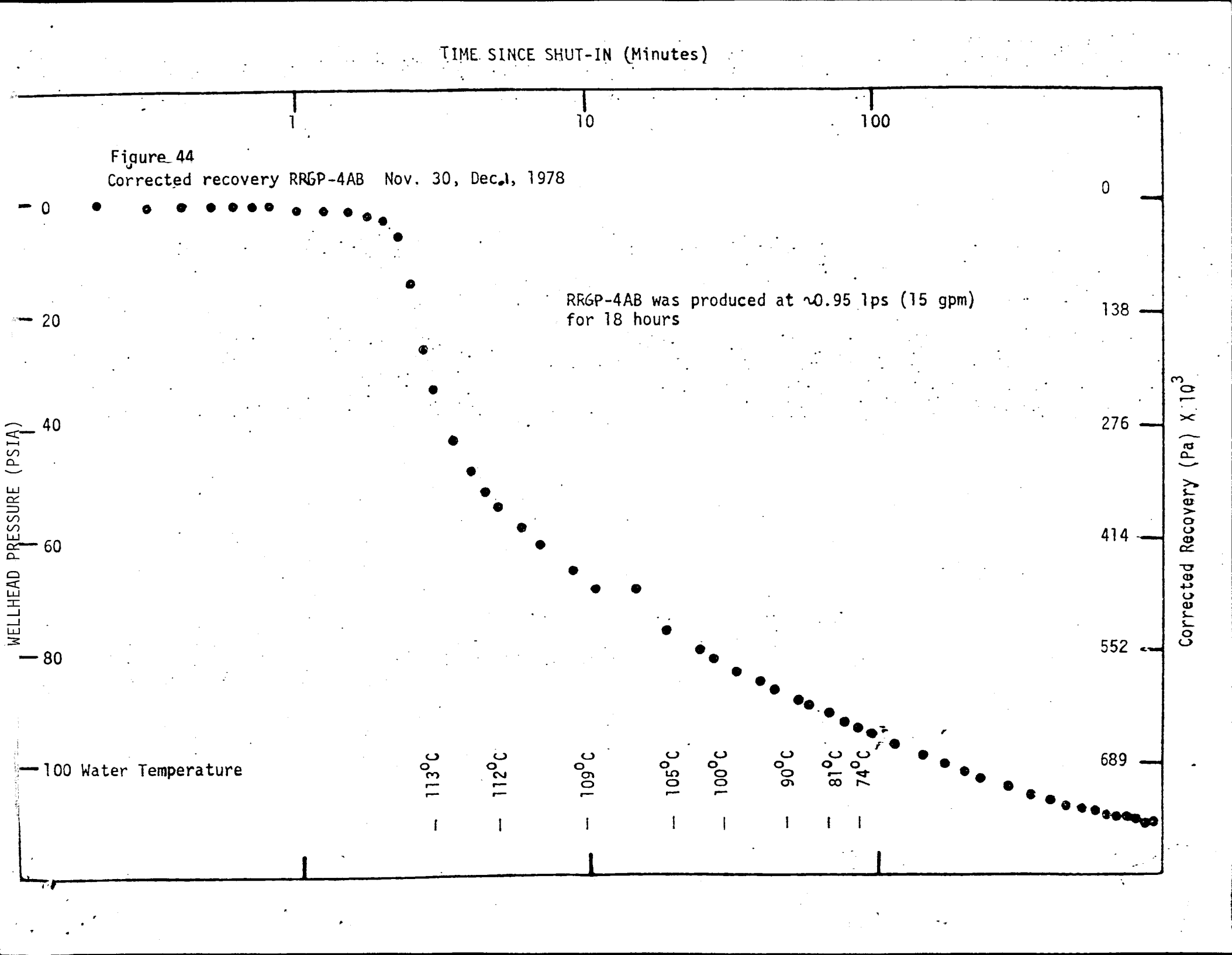


FIGURE 52 FLOW DIAGRAM FROM RRGE-2 TO RRGI-6




TIME SINCE SHUT-IN (Minutes)
1
10
100
Figure 44
Corrected recovery RRGP-4AB Nov. 30, Dec. 1, 1978
RRGP-4AB was produced at ~0.95 lps (15 gpm)
for 18 hours
WELLHEAD PRESSURE (PSIA)
0
20
40
60
80
100 Water Temperature
Corrected Recovery (Pa) X 10^3
0
138
276
414
552
689
113°C
112°C
109°C
105°C
100°C
90°C
81°C
74°C

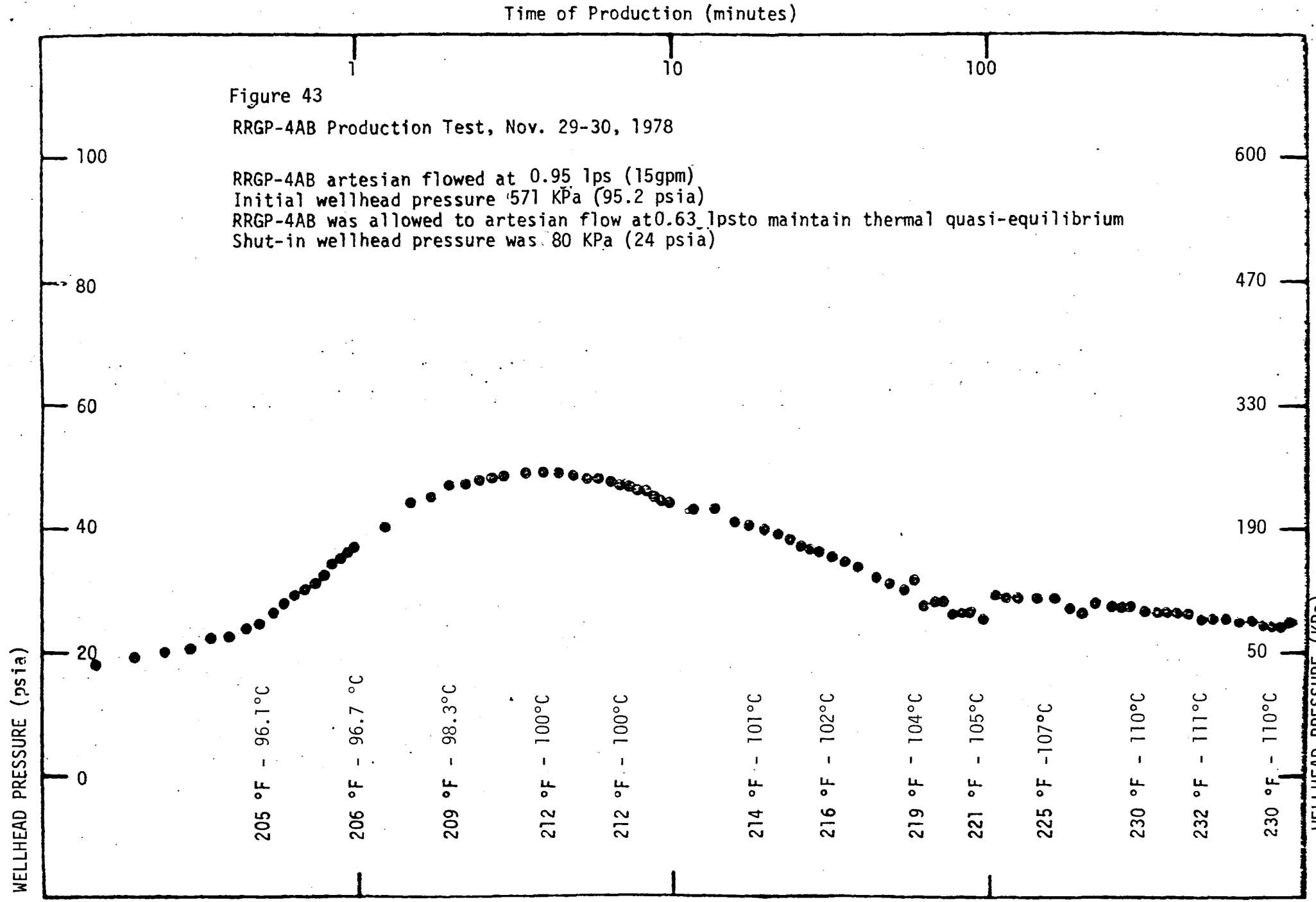
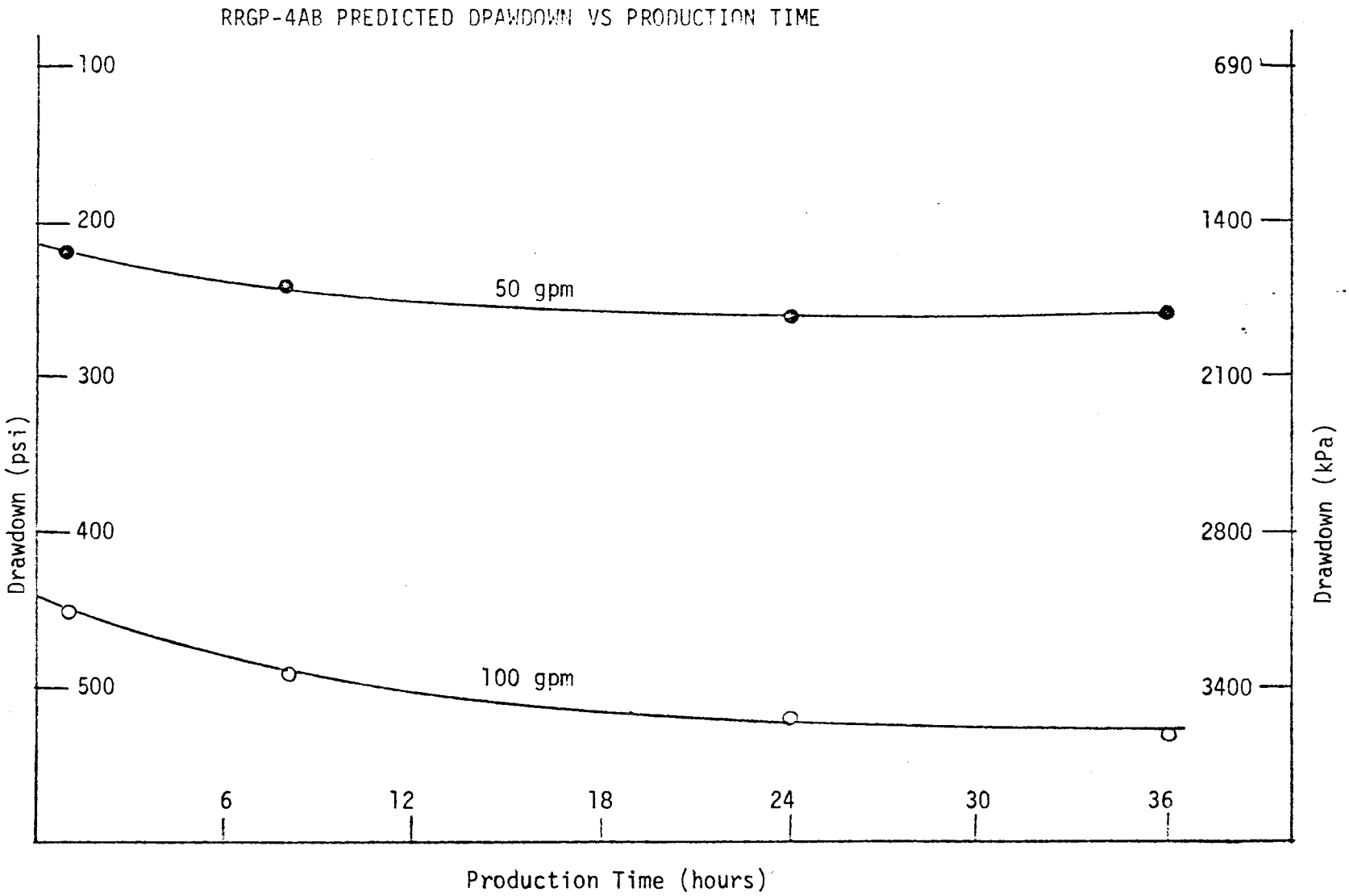

Time of Production (minutes)
1
10
100
Figure 43
RRGP-4AB Production Test, Nov. 29-30, 1978
RRGP-4AB artesian flowed at 0.95 lps (15gpm)
Initial wellhead pressure 571 KPa (95.2 psia)
RRGP-4AB was allowed to artesian flow at0.63 lpsto maintain thermal quasi-equilibrium
Shut-in wellhead pressure was 80 KPa (24 psia)
100
80
60
40
20
0
600
470
330
190
50
WELLHEAD PRESSURE (psia)
WELLHEAD PRESSURE (KPa)
205 °F - 96.1°C
206 °F - 96.7 °C
209 °F - 98.3°C
212 °F - 100°C
212 °F - 100°C
214 °F - 101°C
216 °F - 102°C
219 °F - 104°C
221 °F - 105°C
225 °F -107°C
230 °F - 110°C
232 °F - 111°C
230 °F - 110°C

Figure 51


RRGP-4AB PREDICTED DRAWDOWN VS PRODUCTION TIME
100
200
300
400
500
690
1400
2100
2800
3400
50 gpm
100 gpm
Drawdown (psi)
Drawdown (kPa)
6
12
18
24
30
36
Production Time (hours)