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Discharge Characteristics of Well BO-4 after 3 Months of Continuous Production

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Short Report
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INTRODUCTION

Well BO-4 was drilled in the 1970's in two stages to a total depth of 2505 m. The well was completed with a 9 5/8" casing from surface to 558 m depth, a slotted 7" liner from 541 m to 1199 m and 4 ½" slotted liner from 1184 m to 2504 m. The main circulation losses during drilling were attributed to the interval 560 m to 1050 m. Discharge testing performed between July 1978 and June 1979 yielded about 60 t/h (16.7 kg/s) total discharge rate at about 4 bar-g wellhead pressure. There off at that pressure about 10 t/h (2.8 kg/s) was steam. Due to the poor performance of the well it was not considered economical to utilize the well at that time.

Well BO-4 was stimulated in 1998, but before that operation a short reference production test (RPT) was carried out. The performance of the well was then considerably better than indicated by the tests performed in 1978 to 1979. The discharging wellhead pressure was much higher or about 20 bar-g while the total discharge rate was similar or slightly higher. However, it was difficult to confirm the discharge rate due to malfunctioning of the flow measuring equipment. Obstruction was found at the top of the casing liner at about 540 m depth, which hindered logging tools to go deeper into the well. The well was stimulated by altering between injection of inhibited seawater and warm-up periods. Logging during the stimulation job indicated that the obstruction was diminishing and possibly that the near wellbore permeability was increased with thermally induced fracturing. Evaluation production test (EPT) was carried out after the stimulation job and data from it and the stimulation job indicated a 50% increase in well BO-4 productivity compared with the RPT. However, despite modifications on the flow measuring equipment problems were encountered with them, so reliable production characteristics could not be obtained for well BO-4. Flow characteristic curves were calculated from matches with dynamic pressure and temperature profiles measured in well BO-4 during the RPT and EPT. The curve calculated for the EPT was basically only supported by one good flow rate determination.

In 1999 the author assisted in initiating a discharge test for well BO-4. The test was planned as a long-term production test. After obtaining measuring points for the discharge characteristic curve from short steps in flow rate, the well was adjusted for about 65 t/h (18.1 kg/s) long-term discharge through an orifice. However, due to noise restrictions and complains by neighbors there about, the well was closed, as the long-term discharge was to start. The discharge data obtained confirmed the results of the stimulation job in 1998. Furthermore, logging the width of the well showed that the well was clean and free from obstructions down to 1100 m depth.

This report describes the activity that the author participated in during his stay in Guadeloupe in May 2000. The data collected by the author during the final phase of a long-term discharge test of BO-4 that started in January 2000 is reported. Some discussion is provided with the data and preliminary evaluation. Observations made on well BO-2 at that time have been reported in the short report "Preliminary Evaluation of Well BO-2" (Omar Sigurdsson, 2000). The author enjoyed a generous support of Mr. Herlander Correia during the final phase of the discharge test.

MAIN ACTIVITY IN MAY 2000

May 8th: Travelled from Iceland to Paris and stayed there over night.
May 9th: Met CFG personnel at Orly airport on way to Guadeloupe. Arrived there in the afternoon and went to the BO-4 site. Well BO-4 was discharging at a small rate. The weir box was full of scale, the first stage in it overflowed and scale had dammed up a small pond around the weir box. Flow rate could not be measured at that time.
May 10th: The weir box was cleaned so the water rate could be measured. The discharge was transferred to the 2" bleed pipe line so the main 10" discharge pipe line could cool down during the night for change of lip-pipe.
May 11th: The 8" lip-pipe was replaced with 4" lip-pipe to allow measurements of critical pressure for flow determination. At around 11 o'clock the discharge was transferred to the discharge pipe line which had a 150 mm orifice plate near the wellhead, a control valve down stream and the 4" lip going to a twin tower atmospheric separator. Discharge rate was reduced for the night to minimize noise annoyances at the neighboring households. A small opening was also kept on the 2" bleeding line over the night.
May 12th: In the morning the discharge was increased again. Chain used to control the opening of the control valve was set to the link above the marked link for 70 t/h. Fairly stable flow conditions were obtained during the day with a discharge of around 66 t/h (18.3 kg/s), but it was observed that the water height in the weir box oscillated with a 5-6 minute period. That is a phenomenon, which had not been observed before during step rate discharge testing of the well. It is assumed that the oscillation was caused by water holdup in the separator due to scaling in the drainage pipe from the atmospheric separator to the weir box. As before the well had to be throttled to a smaller discharge rate for the night.
May 13th: Flow increased in the morning by fixing the chain on the control valve to link marked 90 t/h. The discharge started well above 100 t/h, but during the 5 hour flow step it was stabilizing around the 100 t/h (27.8 kg/s). Same oscillating behavior was observed as before. The flow was a little sluggish with the critical pressure increasing by about 0.7 bar-g in the water slugs. In the afternoon the well was throttled for the weekend.
May 14th: Day of from regular work.
May 15th: Discharge from well BO-4 increased slightly and preparation for logging dynamic pressure and temperature profiles made. While the dynamic pressure and temperature logging was carried out to 1100 m depth, the discharge was between 33-35 t/h (9.2-9.7 kg/s). When the dynamic logging was finished, the flow was increased more and the chain fixed to link marked 70 t/h. However, after only two hours for the increased flow the well had to be throttled for the night.
May 16th: Pc gauge changed and flow increased. An attempt was made to obtain a maximum discharge rate for the installed surface measuring equipment. In the beginning the total flow rate was well over 120 t/h (33.3 kg/s), but the control valve could not be kept in a fixed position so its opening had to be reduced slightly. Small vibration was on the discharge pipe line mainly due to sluggish flow. In the afternoon the well was throttled for a planned higher night flow rate than before. Consideration for buildup test were given, but due to noise complains from people in the city, the discharge rate was reduced further for the night.
May 17th: Decided to close well BO-4 and terminate the long-term discharge test. A deep temperature log was aborted as information were recalled about lost portion of a Kuster sampler in the well and a Kuster pressure gauge with 80 m of wire. Wellhead closing pressure went to 23.1 bar-g. Discharge pipe line disconnected from the wellhead and equipment prepared for storage at the power plant. Contraction of the wellhead started in the afternoon when wellhead pressure was down to 7.5 bar-g. Cuttings or sand was observed on the bottom in both towers of the separator and the water drainage pipe was clean leaving the separator. However, at the weir box the inside diameter of the 8.5" OD drainage pipe was down to 13 cm (5") due to scale.
May 18th: Analysis of data, packing and travel to Paris, France.
May 19th: Continued travel from Paris to Iceland.

PRELIMENARY EVALUATION AND DISCUSSION OF DATA

Well BO-4 was put into production at the end of January 2000 for a long-term discharge test. The well was equipped with a 10" discharge pipe line, which had a 150 mm orifice plate installed and a butterfly type control valve, and a 8" lip going to a twin tower atmospheric silencer. The water phase from the silencer was drained through an 8.5" pipe to a V-notch weir box. This type of discharge equipment is design for the use of the Russell James method to determine total discharge rate, water rate and enthalpy of the fluid. The Russell James method is well founded and widely used for determine flow rates of high enthalpy geothermal wells during their testing period. Due to households close to the well site noise had to be kept at minimum which limited the output from well BO-4 for the installed equipment. To comply with the noise restriction the discharge was kept at a relatively small rate around 22.5 t/h (6.2 kg/s) during most of the discharge period. Interim measurements were made in March 2000 to check the well characteristics and flowing conditions of the well, but those measurements are not dealt with here. After about 15 weeks of continuous production the well characteristics were measured again in May 2000. Those measurements and other observations on well BO-4 are discussed here.

Dynamic pressure and temperature profiles were measured in well BO-4 at restricted flow rate. The profiles are shown in figures 1 and 2 along with older measurements for comparison and the numerical values are given in table 1 in the appendix. The flowing conditions of the well were very similar during measurements of both profiles, but the two profiles do not give consistent results. Reading of the black charts from both gauges was repeated with same results. The first value in the pressure profile for the wellhead is slightly lower than was read of the wellhead pressure gauge, but other values appear to be in order and within the expected detection (error) limit for the gauge. The temperature value at the wellhead is in agreement with the pressure from the wellhead pressure gauge, but other values are expected to be too high by upto 5°C. This can not be confirmed until the gauges have been recalibrated.

Looking at the pressure profiles in figure 1, it can be seen that the static profile from 1996 is in error below 500 m depth. It appears that there has been a shift in the base-line when the gauge hit the liner hanger at 543 m depth. If that is the case the 1996 static profile would follow the profile from July 29th, 1998 and be about 1.5 kg/cm^2 higher than the 1999 static profile. This difference would bring those measurements at the error limit for the pressure gauge, but it was calibrated before the measurement in 1999. The pressure drawdown caused by the small discharge of 35 t/h (9.7 kg/s) after 15 weeks of production is then about 4.0-4.5 kg/cm^2. For that discharge the boiling level is at about 400 m depth in the well.

The temperature profiles are shown in figure 2. As mentioned earlier, it is expected that the May 2000 profile is showing upto 5°C too high values for the temperature. This can not be confirmed until the gauge has been recalibrated, but its calibration is from 1996. Assuming that the current temperature readings are about 5°C too high and adjusting for that, then the May 2000 profile would coincide with the static profile from 1999 at the reservoir depth. That would make the reservoir temperature to be about 252°C, which is slightly higher than indicated by the static profile from 1996. Furthermore, no reversal is observed in the temperature profiles from 1998 to 2000 down to 1100 m depth in contrast with the reversal that started at 1050 m depth in the 1996 profile. The temperature reversal could still be there but at somewhat greater depth or the conditions in the reservoir have changed since 1996 towards a warmer stage. It was not considered worth the risk to check this out as information say that portion of a Kuster sampler was lost in the well during the stimulation job in 1998. Also lost in the well at that time was a Kuster gauge with 80 m of wireline. This debris could be sitting on top of the 4 ½" liner hanger at 1184 m depth thus probably hindering temperature gauge to go deeper into the well and possibly make the gauge stuck in the well. Until the well has not been probed with GO-devil (basket) to depth greater than 1100 m it is not recommended to go deeper with measuring gauges.

Arriving at well BO-4 in May the water flow rate was measured to be 15.8 t/h (4.4 kg/s), but at atmospheric condition about 70% of the total discharge is water so the total discharge was estimated to be 22.5 t/h (6.2 kg/s). Assuming that this has been the average flow rate during the long-term discharge test, the total production amounts to 56700 tons. This is more than five times the amount of seawater that was injected into the well during the stimulation job in 1998.

For discharge measurements the 8" lip was replaced with a 4" lip to bring the critical pressure at the lip into suitable pressure range. The measurement data collected by the author are given in tables 2 and 3 in the appendix along with calculation of total discharge rate, water rate and enthalpy using the Russell James method. At higher flow rates a small vibration was observed on the discharge pipe line and the flow was a little sluggish. Under such conditions the critical pressure fluctuates, but an eyeballed average value is recorded by the data collector. Furthermore, oscillation of the water height (level) in the weir box was observed for the higher flow rates with a period of 5-6 minutes. This is normally not the case for such measurements, but was attributed to scale in the separator drain pipe where it came into the weir box. There its inside diameter was reduced from about 20 cm down to 13 cm, which could have caused some water holdup in the atmospheric separator. Therefore, fluctuation was inherent in the two main readings used for calculation in the Russell James method, that is water height and critical pressure.

The results of the eyeballed average values are given in tables 2 and 3 in the appendix. The results show some fluctuation in the determination of enthalpy, but generally on the higher side to what can be expected for the measured reservoir temperature. As the reservoir is in liquid phase with measured temperature in the range 248-254°C the expected enthalpy should be in the range 1076-1105 kJ/kg. In tables 4 and 5 in the appendix the data has been adjusted so the enthalpy will fall within the expected range. As shown in table 4, only minor changes were needed to bring the enthalpy within the expected range. Normally the critical pressure value had to be change less than 0.2 bar-g, while its fluctuation was ten times bigger. The water height had to be changed by less than 1 cm after the oscillation was noted, but it could be 4-6 cm. The average of the resulting enthalpy corresponds to reservoir temperature around 251-252°C.

Selected points from the adjusted data are used to construct a characteristic curve for well BO-4 that is shown in figure 3. Also shown in figure 3 are calculated characteristic curves from matches with dynamic pressure and temperature profiles measured during the RPT and EPT in 1998, and points measured during a short test in 1999. The steps for each flow rate were shorter in 1999 than in May 2000 so the well could have stabilized at lower values given longer time in 1999, particularly for the highest flow rates. After the longer production the wellhead is warmer in May 2000 than in 1999 or 1998 so the wellhead pressure is somewhat higher, shifting the characteristic curve for the smaller flow rates towards higher wellhead pressures. The highest discharge rate obtained was maybe 135 t/h (37.5 kg/s) at the beginning of the step on May 16th with the control valve fully open, but it had to be reduced slightly to have control over the measurements. Taking the different conditions prevailing at each test into account, the characteristics of well BO-4 have remained more or less the same since after the stimulation job in 1998.

CONCLUSIONS

Results from logging dynamic pressure and temperature profiles in well BO-4 are not consistent. The calibration for the temperature gauge is expected to be off rather than the pressure gauge calibration. If that is the case, the temperature profile could be indicating temperature upto 5°C too high. Taking that into account the reservoir temperature at well BO-4 is about 252°C.

A moderate production of 35 t/h (9.7 kg/s) causes drawdown of 4.0-4.5 kg/cm^2. For those conditions the flashing level is around 400 m depth in the well.

The long-term discharge test of well BO-4 lasted for approximately 15 weeks, during which the well discharged at a small total flow rate averaging about 22.5 t/h (6.2 kg/s). This is about 3-4 times less production load than the well is expected to have under commercial exploitation.

The highest flow steps started with a total discharge rate around 115 t/h (31.9 kg/s) and were approaching stabilized flowing conditions around 100 t/h (27.8 kg/s) after 5 hours of discharge. At that rate and for such short time the flow is sluggish. The well can stabilize at 65 t/h (18.1 kg/s) in less time and the flow is much less sluggish. For a long-term exploitation of well BO-4 the discharge rate is likely to be in the range of 65-100 t/h (18.1-27.8 kg/s), but sustainable discharge rate is expected to be somewhat higher than 65 t/h (18.1 kg/s), so an exploitation at around 80 t/h (22.2 kg/s) can be assumed.

Reasonable exploitation rate for well BO-4 can be assumed to be about 80 t/h (22.2 kg/s) with wellhead pressure 19 bar-g or less. Chemical analysis of the produced fluid will determine further the safe operation range for the well regarding scaling potentials. Assuming separation at 6 bar-a for a power plant, about 20% of the produced fluid are steam. For the assumed total exploitation rate the concurrent steam rate is 16 t/h (4.4 kg/s), which depending on turbine condition could equal 2.0 MWe.

Reykjavik 2 August 2000

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REFERENCES

Omar Sigurdsson, 2000: "Preliminary Evaluation of Well BO-2". Short Report Orkustofnun, Omar-2000/01, 3p.

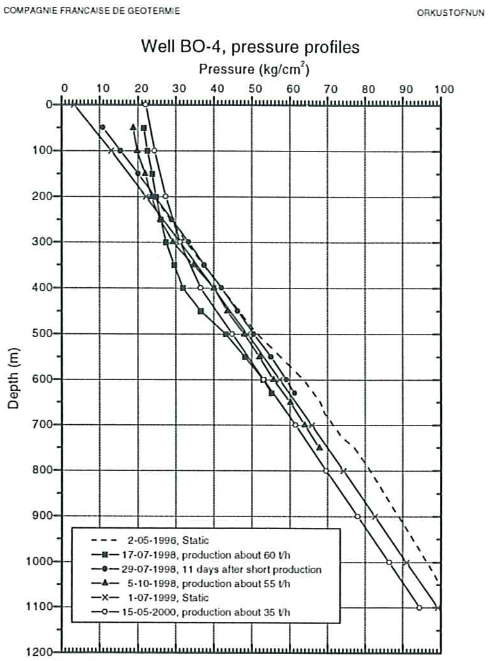

Figure 1. Pressure profiles in well BO-4

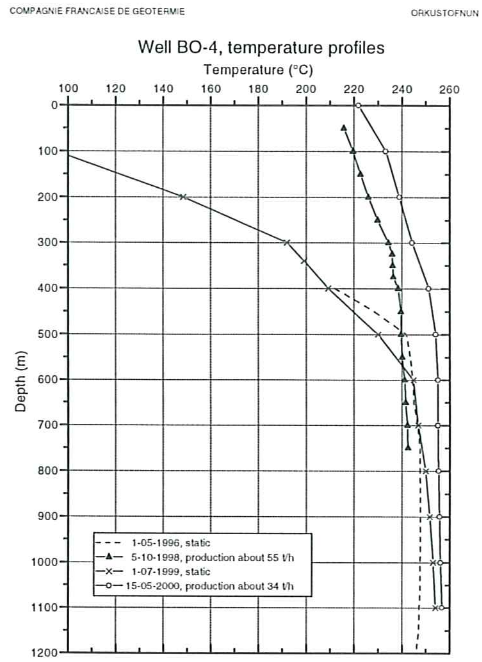

Figure 2. Temperature profiles in well BO-4

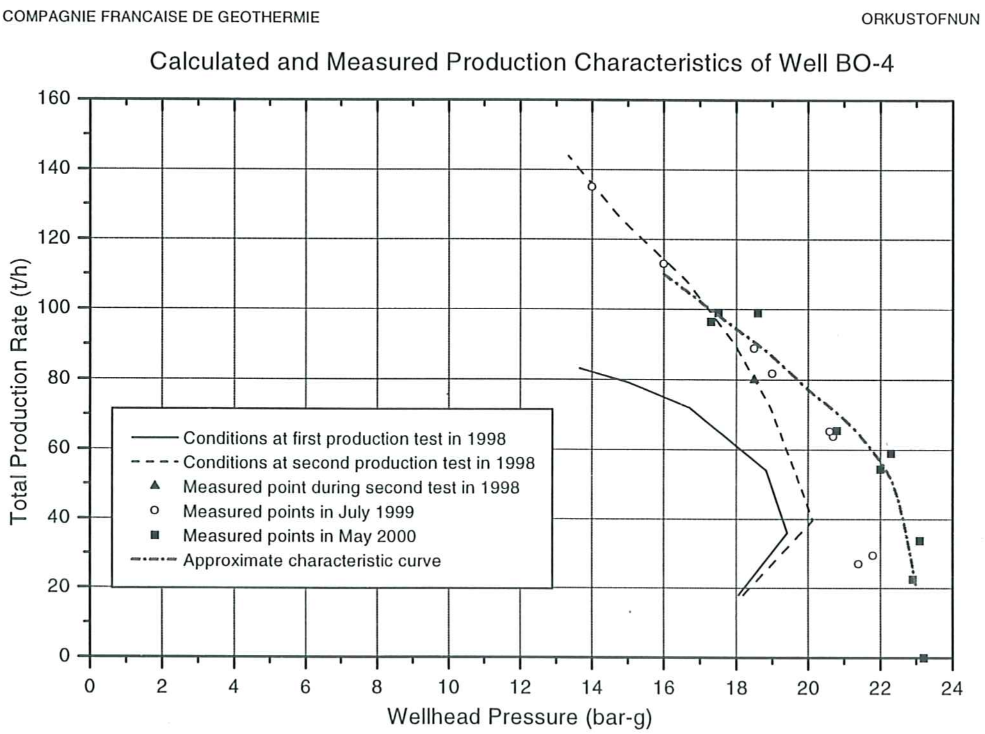

Figure 3. Discharge measurements and well BO-4 characteristics

APPENDIX

Dynamic temperature and pressure logging in well BO-4

Discharge measurements at well BO-4

Discharge from well BO-4 in kg/s and ton/hr

Adjusted discharge from well BO-4

Adjusted discharge from well BO-4 in kg/s and ton/hr

DYNAMIC TEMPERATURE AND PRESSURE LOGGING IN WELL BO-4

Date: 15-05-2000

Temperature gauge KT-27786; Clock 6h, serial no. V4101; Time 13:26-15:09
Pressure gauge KP-V3851; Clock 6h, serial no. V4101; Time 10:52-12:22
Zero reference at 3" valve, which is about 2m above ground.

TEMPERATURE				PRESSURE			
Depth (m)	Deflection (cm)	Temperature (°C)	Observations (Temp. Logging)	Deflection (cm)	Pressure (bar)	Pressure (kg/cm^2)	Observations (Press. Logging)
			Calibration 5-3-1996				Calibration 21-4-1999
0	3.810	221.7	WHP=23.1 bar-g	0.796	21.65	22.08	WHP=22.9 bar-g
100	4.041	233.3		0.878	23.94	24.41	Pc=0.5-0.6 bar-g
200	4.147	238.9	WHP=23.1 bar-g	0.979	26.84	27.37	
300	4.246	244.3		1.106	30.49	31.09	Pc=0.4-0.5 bar-g
400	4.356	251.3		1.290	35.79	36.50	
500	4.396	254.2	WHP=23.2 bar-g	1.571	43.95	44.82	WHP=23.2 bar-g
600	4.409	255.1		1.850	52.03	53.06	
700	4.409	255.1		2.134	60.26	61.45	Pc=0.3-0.6 bar-g
800	4.413	255.4		2.410	68.29	69.64	
900	4.419	255.9		2.690	76.44	77.95	
1000	4.424	256.2		2.974	84.72	86.39	Pc=0.4 bar-g
1100	4.432	256.8		3.245	92.61	94.44	
0	3.973	229.8		0.825	22.43	22.87	

DISCHARGE MEASUREMENTS AT WELL BO-4

Separator pressure set at 6 bar-a for calculations

Date	Time	WHP range (bar-g)	WHP best (bar-g)	Pc range (bar-g)	Pc best (bar-g)	Weir level (cm)	Weir height (cm)	Total flow (kg/s)	Enthalpy (kJ/kg)	Water flow (kg/s)	Steam flow (kg/s)	Water at sep (kg/s)	Steam at sep (kg/s)	Observations
10.5.2000	12:35		22.9			40.4	10.1			4.4				With 8" lip-pipe and 150mm orifice
10.5.2000	15:30		22.9			40.4	10.1			4.4				Flow transferred to 2" line
11.5.2000	15:45	22.1-22.5	22.3	0.8-2.0	1.4	35.5	15.0	16.4	1053.3	11.8	4.6	13.4	3.0	With 4" lip-pipe, flow reduced for night
12.5.2000	08:35		22.2			42.3	8.2			2.6				Restricted flow, small opening on 2" line
12.5.2000	08:50		22.7		2.6	36.8	13.7	17.1	1437.4	9.4	7.7	10.8	6.3	Flow increased
12.5.2000	10:55	20.7-21.4	21.1	1.7-2.0	1.8	37.0	13.5	14.9	1307.8	9.0	5.9	10.3	4.6	
12.5.2000	14:40	20.6-21.1	20.9	1.4-2.2	1.8	34.8	15.7	18.6	1073.7	13.2	5.4	15.0	3.6	Oscillating water level (5-6 minutes)
12.5.2000	16:05	20.5-21.0	20.8	1.7-1.9	1.8	35.0	15.5	18.2	1093.1	12.8	5.4	14.5	3.7	between 31.5-37.7 cm. Throttled
13.5.2000	08:05		21.8			43.0	7.5			2.1				Restricted flow
13.5.2000	08:10	21.6-22.0	21.8		4.0	30.0	20.5	34.6	1008.4	25.6	9.0	29.0	5.6	Flow increased
13.5.2000	08:30		20.5		3.9	32.1	18.4	29.1	1160.0	19.6	9.5	22.3	6.8	Oscillating weir level between 30.4-33.8 cm
13.5.2000	10:35	17.8-18.5	18.3	3.1-3.8	3.4	32.9	17.6	26.2	1164.7	17.6	8.6	20.0	6.2	Oscillating weir level between 30.5-35.4 cm
13.5.2000	13:05	16.6-18.2	17.5	2.5-4.3	3.3	33.1	17.4	25.5	1168.7	17.0	8.5	19.4	6.1	Oscillating weir level between 30.5-35.8 cm
13.5.2000	13:25													Pc up by 0.7 bar in water slugs. Throttled
15.5.2000	09:05		21.1			43.6	6.9			1.7				Restricted flow, increased at 9:10
15.5.2000	11:35		23.2	0.4-0.6	0.5	38.8	11.7	9.4	1156.7	6.3	3.1	7.2	2.2	During Pressure profile
15.5.2000	13:45		23.1	0.3-0.6	0.4	38.8	11.7	9.2	1116.2	6.3	2.9	7.2	2.0	During Temperature profile
15.5.2000	14:15		23.2	0.3-0.5	0.4	38.8	11.7	9.2	1116.2	6.3	2.9	7.2	2.0	During Temperature profile
15.5.2000	16:10	20.0-20.4	20.2		3.5	32.5	18.0	27.3	1143.4	18.5	8.8	21.1	6.2	Flow increased more at 15:40 (link 70)
15.5.2000	17:55	18.3-18.9	18.6	2.8-4.3	3.3	32.6	17.9	26.6	1125.1	18.3	8.3	20.8	5.8	Weir level steady. Throttled
16.5.2000	08:10		22.3			42.0	8.5			2.9				Restricted flow
16.5.2000	10:00	16.2-18.4	18.0	2.0-5.5	4.3	32.0	18.5	30.3	1198.5	19.8	10.5	22.6	7.7	Flow increased
16.5.2000	11:10	15.8-18.2	17.5	2.3-4.6	3.5	32.2	18.3	28.0	1118.0	19.3	8.7	22.0	6.0	
16.5.2000	12:45	16.0-18.0	17.3	2.3-5.6	3.3	32.5	18.0	26.8	1116.6	18.5	8.3	21.1	5.7	Weir level steady. Flow reduced at 12:50
16.5.2000	15:25	21.7-22.2	22.0	0.9-1.5	1.3	35.8	14.7	15.6	1059.0	11.2	4.4	12.7	2.9	Oscillating weir level between 33.6-38.0 cm
16.5.2000	15:50		20.8			44.4	6.1			1.3				Flow reduced more at 15:30
16.5.2000	16:15					43.6	6.9			1.7				
17.5.2000	08:25		21.0		0.0	43.5	7.0			1.8				Restricted flow, well closed at 8:55

DISCHARGE FROM WELL BO-4, IN kg/s AND ton/hr

Separator pressure set at 6 bar-a for calculations

Date	Time	Total flow (kg/s)	Enthalpy (kJ/kg)	Water flow (kg/s)	Steam flow (kg/s)	Water at sep (kg/s)	Steam at sep (kg/s)	Total flow (t/h)	Water flow (t/h)	Steam flow (t/h)	Water at sep (t/h)	Steam at sep (t/h)
10.5.2000	12:35			4.4					15.8			
10.5.2000	15:30			4.4					15.8			
11.5.2000	15:45	16.4	1053.3	11.8	4.6	13.4	3.0	59.0	42.5	16.6	48.2	10.8
12.5.2000	08:35			2.6					9.4			
12.5.2000	08:50	17.1	1437.4	9.4	7.7	10.8	6.3	61.6	33.8	27.7	38.9	22.6
12.5.2000	10:55	14.9	1307.8	9.0	5.9	10.3	4.6	53.6	32.4	21.2	37.2	16.4
12.5.2000	14:40	18.6	1073.7	13.2	5.4	15.0	3.6	67.0	47.5	19.4	54.0	12.9
12.5.2000	16:05	18.2	1093.1	12.8	5.4	14.5	3.7	65.5	46.1	19.4	52.2	13.3
13.5.2000	08:05			2.1					7.6			
13.5.2000	08:10	34.6	1008.4	25.6	9.0	29.0	5.6	124.6	92.2	32.4	104.4	20.2
13.5.2000	08:30	29.1	1160.0	19.6	9.5	22.3	6.8	104.8	70.6	34.2	80.2	24.6
13.5.2000	10:35	26.2	1164.7	17.6	8.6	20.0	6.2	94.3	63.4	31.0	72.0	22.3
13.5.2000	13:05	25.5	1168.7	17.0	8.5	19.4	6.1	91.8	61.2	30.6	69.9	21.9
13.5.2000	13:25											
15.5.2000	09:05			1.7					6.1			
15.5.2000	11:35	9.4	1156.7	6.3	3.1	7.2	2.2	33.8	22.7	11.2	26.0	7.9
15.5.2000	13:45	9.2	1116.2	6.3	2.9	7.2	2.0	33.1	22.7	10.4	26.0	7.1
15.5.2000	14:15	9.2	1116.2	6.3	2.9	7.2	2.0	33.1	22.7	10.4	26.0	7.1
15.5.2000	16:10	27.3	1143.4	18.5	8.8	21.1	6.2	98.3	66.6	31.7	76.0	22.3
15.5.2000	17:55	26.6	1125.1	18.3	8.3	20.8	5.8	95.8	65.9	29.9	74.9	20.9
16.5.2000	08:10			2.9					10.4			
16.5.2000	10:00	30.3	1198.5	19.8	10.5	22.6	7.7	109.1	71.3	37.8	81.5	27.6
16.5.2000	11:10	28.0	1118.0	19.3	8.7	22.0	6.0	100.8	69.5	31.3	79.2	21.6
16.5.2000	12:45	26.8	1116.6	18.5	8.3	21.1	5.7	96.5	66.6	29.9	75.9	20.6
16.5.2000	15:25	15.6	1059.0	11.2	4.4	12.7	2.9	56.2	40.3	15.8	45.7	10.5
16.5.2000	15:50			1.3					4.7			
16.5.2000	16:15			1.7					6.1			
17.5.2000	08:25			1.8					6.5			

ADJUSTED DISCHARGE FROM WELL BO-4

Separator pressure set at 6 bar-a for calculations
Changes made on Pc and Weir level/height to have enthalpy between 1076-1110 kJ/kg corresponding to 248°C to 255°C water

Date	Time	WHP range (bar-g)	WHP best (bar-g)	Pc range (bar-g)	Pc best (bar-g)	Weir level (cm)	Weir height (cm)	Total flow (kg/s)	Enthalpy (kJ/kg)	Water flow (kg/s)	Steam flow (kg/s)	Water at sep (kg/s)	Steam at sep (kg/s)	Changes on readings
10.5.2000	12:35		22.9			40.4	10.1			4.4				
10.5.2000	15:30		22.9			40.4	10.1			4.4				
11.5.2000	15:45	22.1-22.5	22.3	0.8-2.0	1.5	35.6	14.9	16.4	1086.9	11.6	4.8	13.1	3.3	Pc +0.1 bar and Weir h -0.1 cm
12.5.2000	08:35		22.2			42.3	8.2			2.6				
12.5.2000	08:50		22.7		2.2	34.2	16.3	20.7	1094.6	14.5	6.2	16.5	4.2	Pc -0.4 bar and Weir h +2.6 cm
12.5.2000	10:55	20.7-21.4	21.1	1.7-2.0	1.8	35.0	15.5	18.2	1093.1	12.8	5.4	14.5	3.7	Weir h +2.0 cm
12.5.2000	14:40	20.6-21.1	20.9	1.4-2.2	1.8	34.8	15.7	18.6	1073.7	13.2	5.4	15.0	3.6	
12.5.2000	16:05	20.5-21.0	20.8	1.7-1.9	1.8	35.0	15.5	18.2	1093.1	12.8	5.4	14.5	3.7	
13.5.2000	08:05		21.8			43.0	7.5			2.1				
13.5.2000	08:10	21.6-22.0	21.8		4.0	31.0	19.5	32.0	1083.1	22.6	9.4	25.7	6.3	Weir h - 1.0 cm
13.5.2000	08:30		20.5		3.8	31.5	19.0	30.3	1098.6	21.2	9.1	24.1	6.2	Pc - 0.1 bar and Weir h +0.6 cm
13.5.2000	10:35	17.8-18.5	18.3	3.1-3.8	3.4	32.0	18.5	28.2	1088.3	19.8	8.4	22.6	5.6	Weir h +0.9 cm
13.5.2000	13:05	16.6-18.2	17.5	2.5-4.3	3.3	32.2	18.3	27.5	1091.4	19.3	8.2	22.0	5.5	Weir h +0.9 cm
13.5.2000	13:25													
15.5.2000	09:05		21.1			43.6	6.9			1.7				
15.5.2000	11:35		23.2	0.4-0.6	0.5	38.5	12.0	9.7	1098.1	6.8	2.9	7.7	2.0	Pc -0.05 bar and Weir h +0.3 cm
15.5.2000	13:45		23.1	0.3-0.6	0.4	38.6	11.9	9.4	1090.4	6.6	2.8	7.5	1.9	Weir h +0.2 cm
15.5.2000	14:15		23.2	0.3-0.5	0.4	38.6	11.9	9.4	1090.4	6.6	2.8	7.5	1.9	Weir h +0.2 cm
15.5.2000	16:10	20.0-20.4	20.2		3.4	32.1	18.4	28.0	1096.5	19.6	8.4	22.3	5.7	Pc -0.1 bar and Weir h +0.4 cm
15.5.2000	17:55	18.3-18.9	18.6	2.8-4.3	3.3	32.2	18.3	27.5	1091.4	19.3	8.2	22.0	5.5	Weir h +0.4 cm
16.5.2000	08:10		22.3			42.0	8.5			2.9				
16.5.2000	10:00	16.2-18.4	18.0	2.0-5.5	4.1	31.0	19.5	32.3	1094.6	22.6	9.7	25.7	6.6	Pc -0.2 bar and Weir h +1.0 cm
16.5.2000	11:10	15.8-18.2	17.5	2.3-4.6	3.4	32.1	18.4	28.0	1096.5	19.6	8.4	22.3	5.7	Pc - 0.1 bar and Weir h +0.1 cm
16.5.2000	12:45	16.0-18.0	17.3	2.3-5.6	3.2	32.4	18.1	26.8	1094.3	18.8	8.0	21.4	5.4	Pc - 0.1 bar and Weir h +0.1 cm
16.5.2000	15:25	21.7-22.2	22.0	0.9-1.5	1.3	36.1	14.4	15.1	1090.1	10.6	4.5	12.1	3.0	Weir h +0.3 cm
16.5.2000	15:50		20.8			44.4	6.1			1.3				
16.5.2000	16:15					43.6	6.9			1.7				
17.5.2000	08:25		21.0		0.0	43.5	7.0			1.8				

ADJUSTED DISCHARGE FROM WELL BO-4, IN kg/s AND ton/hr

Separator pressure set at 6 bar-a for calculations
Changes made on Pc and Weir level/height to have enthalpy between 1076-1110 kJ/kg corresponding to 248°C to 255°C water

Date	Time	Total flow (kg/s)	Enthalpy (kJ/kg)	Water flow (kg/s)	Steam flow (kg/s)	Water at sep (kg/s)	Steam at sep (kg/s)	Total flow (t/h)	Water flow (t/h)	Steam flow (t/h)	Water at sep (t/h)	Steam at sep (t/h)
10.5.2000	12:35			4.4					15.8			
10.5.2000	15:30			4.4					15.8			
11.5.2000	15:45	16.4	1086.9	11.6	4.8	13.1	3.3	59.0	41.8	17.3	47.3	11.8
12.5.2000	08:35			2.6					9.4			
12.5.2000	08:50	20.7	1094.6	14.5	6.2	16.5	4.2	74.5	52.2	22.3	59.4	15.1
12.5.2000	10:55	18.2	1093.1	12.8	5.4	14.5	3.7	65.5	46.1	19.4	52.2	13.3
12.5.2000	14:40	18.6	1073.7	13.2	5.4	15.0	3.6	67.0	47.5	19.4	54.0	12.9
12.5.2000	16:05	18.2	1093.1	12.8	5.4	14.5	3.7	65.5	46.1	19.4	52.2	13.3
13.5.2000	08:05			2.1					7.6			
13.5.2000	08:10	32.0	1083.1	22.6	9.4	25.7	6.3	115.2	81.4	33.8	92.4	22.8
13.5.2000	08:30	30.3	1098.6	21.2	9.1	24.1	6.2	109.1	76.3	32.8	86.7	22.4
13.5.2000	10:35	28.2	1088.3	19.8	8.4	22.6	5.6	101.5	71.3	30.2	81.2	20.3
13.5.2000	13:05	27.5	1091.4	19.3	8.2	22.0	5.5	99.0	69.5	29.5	79.0	20.0
13.5.2000	13:25											
15.5.2000	09:05			1.7					6.1			
15.5.2000	11:35	9.7	1098.1	6.8	2.9	7.7	2.0	34.9	24.5	10.4	27.8	7.2
15.5.2000	13:45	9.4	1090.4	6.6	2.8	7.5	1.9	33.8	23.8	10.1	27.0	6.8
15.5.2000	14:15	9.4	1090.4	6.6	2.8	7.5	1.9	33.8	23.8	10.1	27.0	6.8
15.5.2000	16:10	28.0	1096.5	19.6	8.4	22.3	5.7	100.8	70.6	30.2	80.2	20.6
15.5.2000	17:55	27.5	1091.4	19.3	8.2	22.0	5.5	99.0	69.5	29.5	79.0	20.0
16.5.2000	08:10			2.9					10.4			
16.5.2000	10:00	32.3	1094.6	22.6	9.7	25.7	6.6	116.3	81.4	34.9	92.6	23.6
16.5.2000	11:10	28.0	1096.5	19.6	8.4	22.3	5.7	100.8	70.6	30.2	80.2	20.6
16.5.2000	12:45	26.8	1094.3	18.8	8.0	21.4	5.4	96.5	67.7	28.8	76.9	19.6
16.5.2000	15:25	15.1	1090.1	10.6	4.5	12.1	3.0	54.4	38.2	16.2	43.4	10.9
16.5.2000	15:50			1.3					4.7			
16.5.2000	16:15			1.7					6.1			
17.5.2000	08:25			1.8					6.5			