GL00998

THERMAL POWER COMPANY

Geothermal Well: Utah State 72-16 ML-25128
Roosevelt Field, Beaver County, Utah

24-Hour Flow Test, April 4, 1977 - April 6, 1977

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SUMMARY

Test

The pre-test safety checks of the wellhead proved to be of great value. Only minor leaks (a seal pot and a flange) were incurred.

Even with two reserve pits only one day's worth of production could be stored. An injection well would be required for long term testing of this well.

The instruments and control valves of the pipeline operated satisfactorily.

Well Production Capacity

The well's flow rate failed to stabilize. Wellhead pressure and flow rate dropped throughout a 16-hour portion of the test while the valve opening was constant. The total mass flow rate as measured by James' method was 1,309,000 lbm./hr. @ T_w = 416°F, P_w = 294 psia @ 800 hrs. on 4/5/77. A Pressure versus Flow Rate plot suggests the well's maximum production rate to be in excess of 1.4×10^6 lbm./hr. A longer flow period is required to determine the significance of the decline - whether it shall continue to depletion or stabilization.

Measurements

The James' method of determining the flow rate of a two-phase flow continues to be less than satisfactory. Separation of steam and water would provide sorely needed, accurate production data and provide a standard against which the James' method might be quantified or improved.

Improved reservoir information is dependent on longer flow tests.

Utah State 72-16

TEST DESCRIPTION

April 3, 1977

1500 hrs.: AAA welding arrived at location and checked the annulus and kill-line valves, the kill-line, and the bolts on the wellhead as per their checklist. The other duties on the checklist had been performed only two days previously and were not repeated. The pipeline was repressured and checked for leaks. It was then unpressured via the ball valve. The 12" wing valve was audibly leaking and was shut with a 36" wrench.

April 4, 1977

0730 hrs.: Pressure, temperature and flow measurement devices were installed.

0900 hrs.: Well ready to be opened. Waited for WKM personnel (Sug Roberts) to arrive.

0930 hrs.: 12" wing valve opened and line pressured.

0945 hrs.: 8" ball valve opened to indicated 25% opening.

0947 hrs.: Differential pressure meter engaged in order to monitor flow rate. Well surging because of throttling across ball valve.

0955 hrs.: Water started dripping from annulus pipe.

1000 hrs.: Took water sample.

1004 hrs.: Opened 8" ball valve to 50% indicated opening.

1025 hrs.: Opened 8" ball valve to 75% indicated opening.

1029 hrs.: Throttled well back by closing ball valve to 50% indicated opening because of excessive vibration of meter run and wellhead. Sent for railroad ties to chock pipe @ meter run and at 45° angle at wellhead.

April 4, 1977

1100 hrs.: Opened ball valve to 70% indicated opening after line chocked.

1115 hrs.: Opened ball valve to 75% indicated opening.

1130 hrs.: Closed ball valvue to 60% indicated opening momentarily. Re-opened almost immediately back to 75% indicated opening.

1145 hrs.: Opened ball valve to 80% indicated opening.

1215 hrs.: Broke and replaced thermometer.

1600 hrs.: H_2O sample grabbed. Opened ball valve to 87% indicated opening because of decreases in lip and differential pressure readings.

1800 hrs.: USGS (Al Truesdale) arrived to gather water and steam samples.

2200 hrs.: H_2O sample grabbed.

2230 hrs.: USGS finished sampling.

April 5, 1977

0200 hrs.: H_2O sample gathered. Winds shifted from East to light Southerly. Sump condition tenuous.

0500 hrs.: About 4' capacity remaining in Sump #2.

0600 hrs.: H_2O sample grabbed.

0829 hrs.: 8" ball valve started leaking at seal flanges. Shut-in well via wing valve and tightened ball valve flange with hammer wrench. Opened 12" wing balve completely, 8" ball valve to 25% indicated opening. Sump #2 filled to within 1-foot of bottom of culvert, so decision made to have Agnew and Sweet Production Specialists (A&S) set-up for build-up pressure run immediately.

0845 hrs.: USGS arrived to begin second sampling.

April 5, 1977

0855 hrs.: Seal pot @ Location 1 developed leak. Well shut-in at master valve to weld seal pot.

0915 hrs.: Well re-opened to 25% indicated opening.

1020 hrs.: Well shut-in. Wellhead pressure 350 psig. Sump water ≈ 87°F. A&S immediately started "feeler" run with sinker bar and maximum reading thermometer (MRT).

1027 hrs.: Sinker bar on bottom @ 1248'.

1035 hrs.: Retrieved sinker bar and MRT. MRT reading 467°F.

1100 hrs.: Dual 0-1600 pressure tools with a second MRT made up on wireline.

1113 hrs.: Tools hung 1-foot off bottom @ 1247'. 7.5" orifice inspected and found bowed 1/32" from complete flatness. Silica deposits on bottom of orifice suggest separated flow with water flowing on bottom of pipe and steam and gas above occurring at some time during test. This flow regime probably occurred during high pressure, low flow rate conditions. The 12" wing valve had a slight leak.

April 6, 1977

1130 hrs.: A&S retrieved all tools. MRT and one pressure instrument failed. One more MRT survey was run, yielding a temperature of 456°F (note that this is 24-hours after flow had ended!).

1300 hrs.: A&S released after doing a field reduction of the one good instrument's data. 12" valve shut tightly with 36" cheater.

April 7, 1977

12" valve leaking once again, so no decision made to have repaired.

Stainless steel sampler at Location 1 inspected and found to have no signs of abrasions or impact.

DATA REDUCTION METHODS

From James' "Metering of Steam-Water Two-Phase Flow By Sharp-Edged Orifices," Institute of Mechanical Engineering Proceedings 1965-1966, Volume 180, Part 1.

Nomenclature

b_p = state at back pressure.

D = diameter of pipe in meter run (inches).

d_c = diameter of pipe where critical flow occurs (inches).

d_m = diameter of primary metering device, or in this case, the orifice (inches).

G = mass velocity (lbm./ft.^{2} sec.).

h_f = specific enthalpy of saturated liquid (BTU/lbm.).

h_{fbp} = specific enthalpy of saturated liquid at a given back pressure (BTU/lbm.).

h_{fgbp} = specific enthalpy of vaporization at a given back pressure (BTU/lbm.).

h_o = specific stagnation enthalpy (BTU/lbm.).

$L=h_{fg}$ = specific latent heat defined by state of flow by P_o. (BTU/lbm.).

m = mass flow rate (lbm./hr.).

$Patm$ = atmospheric pressure (psia).

P_c = critical lip pressure (psia). $P_c = P_L + Patm$.

P_L = critical lip pressure (psig).

P_o = line pressure upstream of orifice (psia) $P_o = R^2 \times 5 + Patm$.

R = static pressure reading upstream of orifice (red).

ΔR = differential pressure reading across orifice (blue).

ν_f = specific volume of saturated liquid @ P_o (ft.^{3}/lbm.).

ν_g = specific volume of saturated vapor @ P_o (ft.^{3}/lbm.).

y = centerline distance of ¼" npt tap from discharge pipe lip.

Y_{TP} = expansion factor for two-phase flow from Figure 14.

β = d_m/D.

$\emptyset_{TP}$ = meter differential (mmH_g).

Conversion Factors and Equations

$$P_o = R^2 \times 5 + Patm \quad (1)$$

$$\phi_{TP} = (\Delta R)^2 \times 15.5145 \quad (2)$$

ϕ_{TP} in psid $= (\Delta R)^2 \times 0.3$

Patm is corrected from the barometric pressure from the Milford airport to that at the well's location.

Flow Rate Determination

$$G = 10450 \div y^{0.063} \times P_c^{0.96} \div h_o^{1.102} \text{ if } y \leq 0.3 \text{ in.} \quad (3)$$

$$\dot{m} = \tau \div 4 \left(\frac{dc}{12}\right)^2 \times 3600 \times G \quad (4)$$

$$\dot{m} = \tau \div 4 \left(\frac{dc}{12}\right)^2 \times 3600 \times 10450 \div y^{0.063} \times P_c^{0.96} \div h_o^{1.102}$$

$$\dot{m} = 205{,}185.27 \frac{dc^2}{y^{0.063}} \times \frac{P_c^{0.96}}{h_o^{1.102}} \quad (5)$$

$\dot{m}_{1/4}" = 1.013\dot{m}$ ($\dot{m}_{1/4}$ used on Utah State 14-2 test)

Enthalpy Determination

$$h_o^{1.102} = 1450 \frac{P_c^{0.96}}{Y_{TP}} \left(\frac{dc}{dm}\right)^2 \sqrt{1-B^4} \frac{\sqrt{\left(\frac{h_o-h_f}{L}\right)^{1.5} (\nu g-\nu f) + \nu f}}{\sqrt{\phi_{TP}}} \quad (6)$$

From Eq. (6), squaring both sides, and gathering terms,

$$h_o^{2.204} = (1450)^2 \frac{P_c^{1.92}}{Y_{TP}^2} \left(\frac{dc}{dm}\right)^4 (1-B^4) \frac{\left[\left(\frac{ho - hf}{L}\right)^{1.5} (\nu g-\nu f)+\nu f\right]}{\phi_{TP}}$$

$$\frac{h_o^{2.204} \cdot Y_{TP}^2 \times \phi_{TP}}{(1450)^2 P_c^{1.92} \left(\frac{dc}{dm}\right)^4 (1-B^4)} = \left(\frac{h_o-h_f}{L}\right)^{1.5} (\nu g-\nu f) + \nu f$$

Flow Rate Determination

$$h_o^{2.204}\left[\frac{Y_{TP}^2\,\phi_{TP}\,dm^4}{1450\,P_c^{1.92}\,dc^4\,(1-B^4)\,(\nu g-\nu f)}\right]-\frac{(h_o-h_f)^{1.5}}{L}-\frac{\nu f}{\nu g-\nu f}=0 \quad (7)$$

$$\text{let } A=\frac{Y_{TP}\,\phi_{TP}\,dm^4}{1450\,P_c^{1.92}\,dc^4\,(1-B^4)\,(\nu g-\nu f)} \quad (8)$$

$$C=\frac{\nu f}{\nu g-\nu f} \quad (9)$$

Then Eq. (7) becomes:

$$f(h_o)=A\,h_o^{2.204}-\frac{(h_o-h_f)^{1.5}}{L}-C=0 \quad (10)$$

$$\text{and } f^1(h_o)=2.204\,A\,h_o^{1.204}-\frac{1.5\,(h_o-h_f)^{0.5}}{L^{1.5}} \quad (11)$$

Applying the Newton-Raphson method for solving the roots of the equation (10), $f=\phi(h_o)$,

$$\delta nrl=f(h_o^n)-\overline{f'}(h_o^n), \qquad h_o(n+1)=h_o^n+\delta^{ntl}$$

and the computer stops when $\delta^{ntl}\leq\varepsilon$, ε being a predetermined accuracy for h_o.

A computer program complete with appropriate logic to provide the necessary exits was thus designed to solve for h_o. Once h_o was found, the mass flow ($\dot{m}$) was calculated through equation (5). Then percent flash proportions for back pressures of 70, 80 and 125 psig were calculated through the equation.

$$\%\ \text{flash}=100\times\frac{h_o-h_{fbp}}{h_{fgbp}} \quad (12)$$

Variable Assignments

A = COF1 % flash @ 70 psig = PF70 ϕ_{TP} = PHI

C = un * % flash @ 80 psig = PF80 B = un

D = D % flash @ 125 psig = PF125 E = EPSI

d_c = DC P_L = un $\dot{\delta}$ = DEL

d_m = DM P_o = PO

G = un R = un

h_p = HF ΔR = un

L = HFG ν_p = UF

$\dot{m}$ = MF ν_g = UG

Patm = un y = Y

P_c = PC Y_{TP} = YTP

Patm, Po, ϕ_{TP}, ν_f, ν_g, h_f, and hfg must be hand calculated for this program. See the example problem that follows.

* = Unused.

SAMPLE CALCULATION

Data

For this particular test, the physical parameters were:

$D = 10.02"$

$dc = 7.625"$

$dm = 7.500" \pm 0.0001"$

$y = 5/16"$

At 0800 hrs. on April 5, 1977, the following data was gathered:

$R = 7.30$	$T_1 = 414°F$	$P_2 = 211$ psig	$BP = 25.180"$ Hg
$\Delta R = 9.57$	$P_W = 282$ psig	$T_2 = 391°F$	$P_L = 95.6$ psig
$P_1 = 266$ psig	$T_W = 416°F$		

$Patm = (25.180 - 0.73) \div 0.4911 = \underline{12.01 \text{ psia} = Patm}$

0.73 is a correction for altitude from the airport to the site.

0.4911 converts "of H_g to psia.

From Eq. (1) $P_o = (7.30)^2 \times 5 + 12.01 = 266.5 + 12.01 = \underline{278.5 \text{ psia} = P_o}$

From Eq. (2) $\emptyset_{TP} = (9.57)^2 \times 15.5145 = \underline{1420.9 \text{ mm}H_g = \emptyset_{TP} \text{ (27.5 psid)}}$

Since P_o, and using the Steam Tables generated by the USGS for this particular brine:

$\nu g = 1.6608 \text{ ft.}^3/\text{lbm.}$ $\quad h_f = 381.4$ BTU/lbm.

$\nu f = 0.018794 \text{ ft.}^3/\text{lbm.}$ $\quad h_g = 813.9$ BTU/lbm.

From Figure 14 in James' paper, the line for the value of the expansion factor Y_{TP} for $B^2 = 0.56$ follows the equation:

$$Y_{TP} = 1 - .01555 \frac{(\emptyset_{TP})}{P_o}$$

so $Y_{TP} = 1 - .01555\ (1420.9) = \underline{0.921 = Y_{TP}}$

$P_c = P_L + Patm = 95.6 + 12.01 = \underline{107.61 \text{ psia} = P_c}$

Inputting the date, time, $\emptyset_{TP}$, Y_{TP}, P_o, P_c, νf, νg, h_r and hfg into the program yields:

4/5 800 hours
h_o = 467.4 BTU/lbm.
T_w = 416°F, P_w = 294 psia
$\dot{m}$ = 1,309,000 lbm./hr. + 15%

which, when flashed at 80 psig, would yield 263,100 lbm./hr. of steam, or roughly enough steam to sprovide 12.5MW of electrical generation capacity at a heat rate of 21,000 lbm./steam MW.

DISCUSSION OF TEST RESULTS

Flow Rate

From Graph 1, it is apparent that a gradual throttling up of flow rate was performed during the first three hours. A slow decline during the flowing four hours caused the well to be opened up slightly more at 1600 hours. From 1600 hours to 0830 hours the following day the throttle was not disturbed. During that time flow rate fell from about $1.35 \times 10^6 \pm 15\%$ lbm./hr. to about $1.31 \times 10^3 \pm 15\%$ lbm./hr., or a decline of 3%. This decline is highlighted in Graph 2. The 3% decline in mass flow rate, in wellhead pressure, P_w, upstream-of-orifice static pressure, P_o location 1 pressure, P^1, as well as a reduction in calculated h_o are clearly evident. The changes in the calculated values of h_o and $\dot{m}$ could be possibly attributed to many other variable changes had not the pressures declined so uniformly. The decline in flow rate at 2550 lbm./hr., if linearly extrapolated, would indicate that the well's flow would drop from 1.35×10^6 lbm./hr., to zero in only 22 days, with a commensurate drop in wellhead pressure to atmosphere. Of course, this extrapolation should under no circumstances be taken literally. An increase in flow rate and pressure occurred at 0800 hours just before the well was shut-in, and could suggest that a leveling out of the flow rate might have been starting. What the decline does dictate is the absolute necessity of a much longer (> 30 days) flow test to more completely determine the well's production capacity and delineate the characteristics of the reservoir from which it is producing before commitments to generate power are made.

Flow Rate versus Wellhead Pressure

Graph 3 depicts the relationship of $\dot{m}$ as a function of P_w for early times during the test such that the production potential of the reservoir in its initial state is represented. The curve suggests that the well's maximum flow rate would probably be in excess of 1.4×10^6 lbm./hr. $\pm$ 15% as measured by the James method.

The points labeled 1-4 are data points gleaned at later times during the flow test. Disturbingly, they suggest that the curve delineated at the initial time is shifting progressively downward to the left with time, indicative of a decline in the producing capacity of the well.

Measurement Accuracy

Enthalpy (h_o) and Flow Rate ($\dot{m}$)

Enthalpy measurements (h_o) for the time of somewhat stable flow (1600 hrs. to 0830 hrs., or region 8 of Graph 1) varied less than 1% from an average and median value of 469.6 BTU/lbm. However, the temperature of the saturated water in the reservoir (from the pre-test temperature survey and the MRT run immediately after the flow) is only 468°F, which means the water has an enthalpy of only 444.7 BTU/lbm. By the first law of thermodynamics, the water at the surface, regardless of its percentage of flash, cannot have an enthalpy greater than that of the water in the reservoir. (Measurements at Utah State 14-2 indicated a reservoir enthalpy of about 480 BTU/lbm. with a surface enthalpy of 445 BTU/lbm. - a reasonable and rational amount of difference due to losses incurred from the water "pumping" itself several thousand feet to the surface, turbulence, and drag.) This serious descrepancy, then, of the calculated surface enthalpy (h_o) being greater than that associated with the reservoir deserves an exploration of its effects and causes.

First, the 5.5% over-estimate in h_o can have a significant result on the flow rate calculation of total mass and steam. For example if one recalculates the 0800 hrs. flow rate with h_o = 440 BTU/lbm. as opposed to 467.4 BTU/lbm. (a 5.9% decrease in h_o) then the flow rate increases from 1.309×10^6 lbm./hr. to 1.399×10^6 lbm./hr. (a 6.9% increase in $\dot{m}$). However, the substitution of the more accurate value of h_o causes a decrease in the % of flash (for example, from 20.1% to 17.1% at 80 psig). The end result is a significant decrease in the calculated amount of steam producible at a given back pressure (from 263,600 lbm./hr. to 238,700 lbm./hr. in this case, or a 9.5% drop!). Since this is the quantity we look at for power generation purposes, the evaluation of enthalpy becomes important. It causes changes in the calculation of $\dot{m}$ and of % flashes (in the James method) and thus flavors the evaluation of the well.

Essentially, several elements of the testing equipment and operation vary outside of the limits of the method as declared by Russell James. These variances include, in suspected order of degree of effect:

1) The equipment effect that flange taps were used for measuring $\emptyset_{TP}$ as opposed to James' use of vena contracta taps (tap at a diameter upstream, ½ diameter downstream). (This is a result of blindly following again the footsteps of our predecessor in the field, and not setting up precisely as the literature states.) The effect of this misplacement is rather large, causing $\emptyset_{TP}$ and thus h_o to be too large.

2) The operational fact that h_o in this test was calculated with $\emptyset_{TP}$ of over 800mm Hg for most of the test, and of > 1400mm for the entire "decline" period. James' has only measured extensively in the range of $15 < \emptyset_{TP} < 780$ mm H_g. This effect is minor.

In the future, then, larger orifices with D and ½ D taps should be employed when using the James' method in an effort to get a true h_o calculation.

Alternatively, the long learning process for measuring two-phase flow could be avoided by separating the phases and measuring them separately.

Pressure and Temperature on Flow-line

Pressure measurements at the wellhead and lip were very satisfactorily and accurately measured with precision gauges. Needle valves effectively damped flow pulsations. The combination pressure-temperature measurements at the wellhead Location 1, and Location 2 will prove very helpful in determining pressure drop along the pipeline as a function of flow rate, the percentages of flash of the various locations, and even whether significant thermodynamics properties of the fluid are different from those of regular water. For example, a precursory comparison of wellhead pressure and temperature to those for water under the same saturated conditions suggested that the fluid indeed acts differently from pure water. Consequently, a USGS-produced table for the thermodynamic properties of the fluid of Utah State 14-2 was used in reducing the data for Utah State 72-16. Use of the regular Steam Table's values produced $\dot{m}$'s 2% lower than the geothermal fluid's values.

Wellbore Pressure

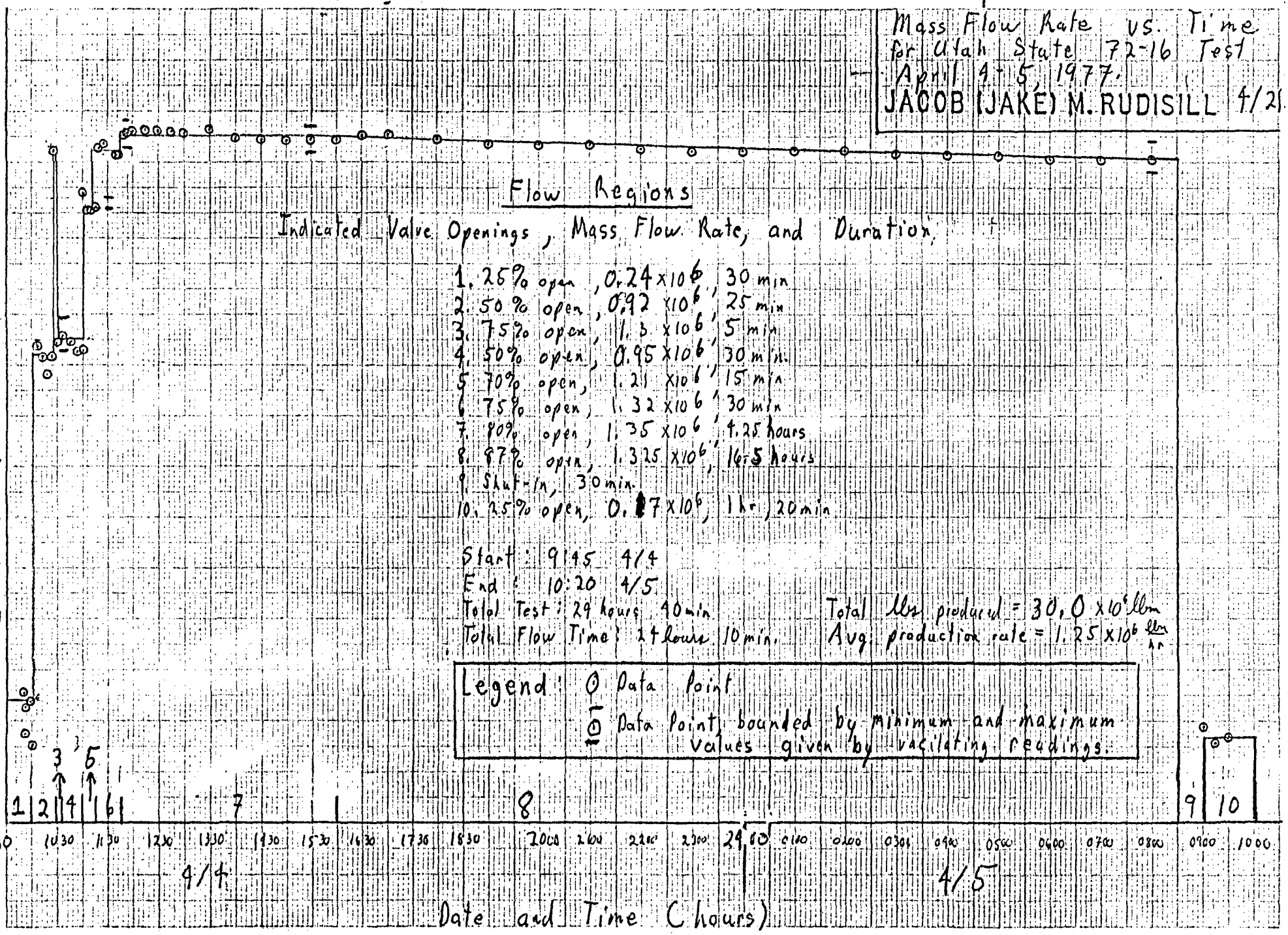
Enough build-up data was probably not gathered due to the desire to check the wellbore for any obstructions with a "feeler" run before lowering the tools. Since no real problems were encountered with obstruction or the well producing any rocks, I suggest future build-up runs to be done as soon after shut-in as possible.

I also suggest we attempt to use another contractor in an effort to get better repeatability in pressure surveys, better tool performance and lower cost.

JRM/tti-4/27/77

Graph # 1

Mass Flow Rate vs. Time
for Utah State 72-16 Test
April 4-5, 1977.
JACOB (JAKE) M. RUDISILL 4/2



Flow Regions

Indicated Valve Openings, Mass Flow Rate, and Duration.

1. 25% open, 0.24×10^6, 30 min
2. 50% open, 0.92×10^6, 25 min
3. 75% open, 1.3×10^6, 5 min
4. 50% open, 0.95×10^6, 30 min.
5. 70% open, 1.21×10^6, 15 min
6. 75% open, 1.32×10^6, 30 min
7. 90% open, 1.35×10^6, 4.25 hours
8. 87% open, 1.325×10^6, 16.5 hours
9. Shut-in, 30 min.
10. 25% open, $0.\blacksquare 7 \times 10^6$, 1 hr, 20 min

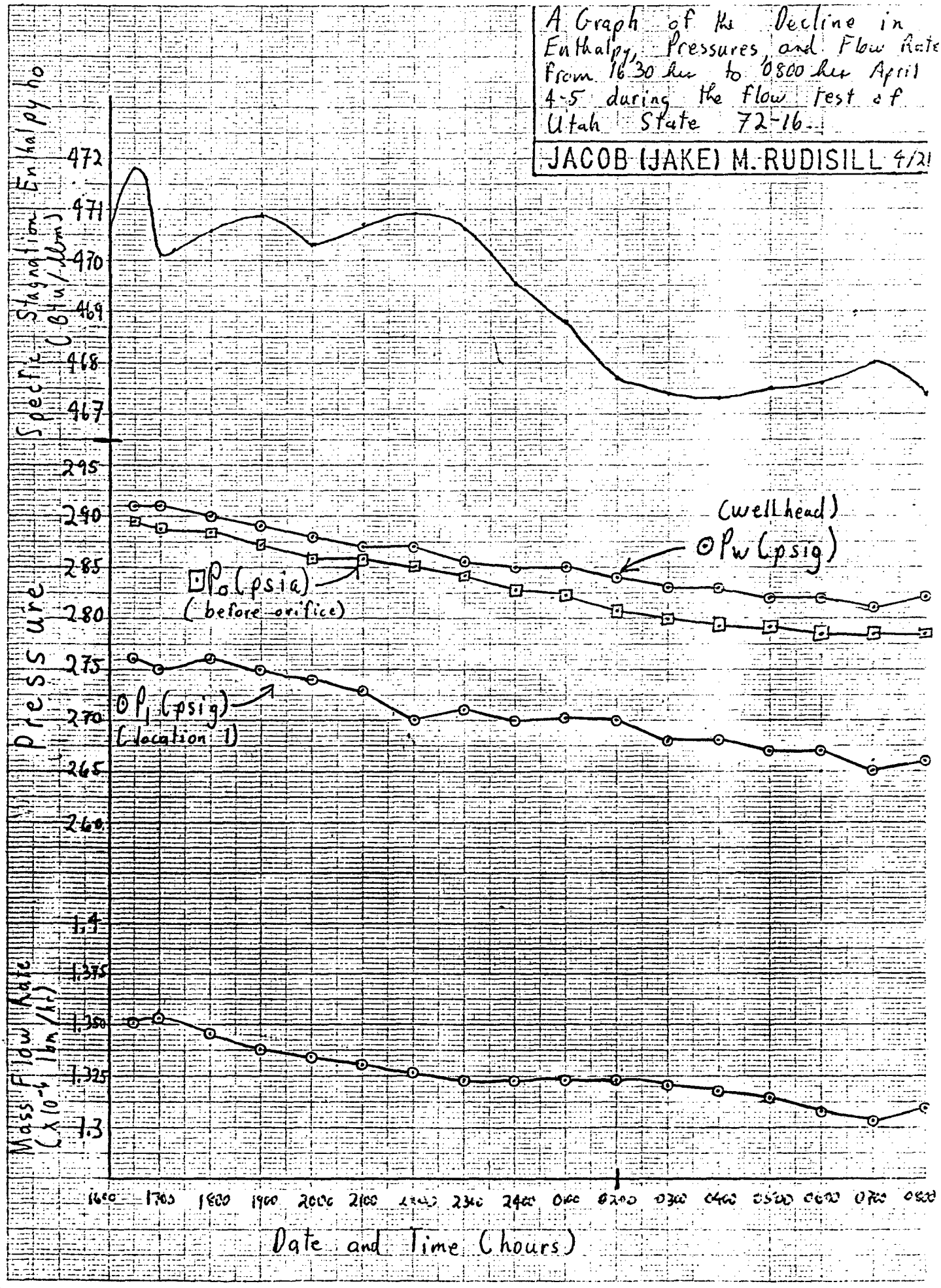
Start: 9:45 4/4
End: 10:20 4/5
Total Test: 29 hours 40 min
Total Flow Time: 24 hours 10 min.

Total lbs produced = 30.0×10^6 lbm
Avg. production rate = 1.25×10^6 $\frac{\text{lbm}}{\text{hr}}$

Legend: ⊙ Data Point
⊙ Data Point, bounded by minimum and maximum values given by vacilating readings.

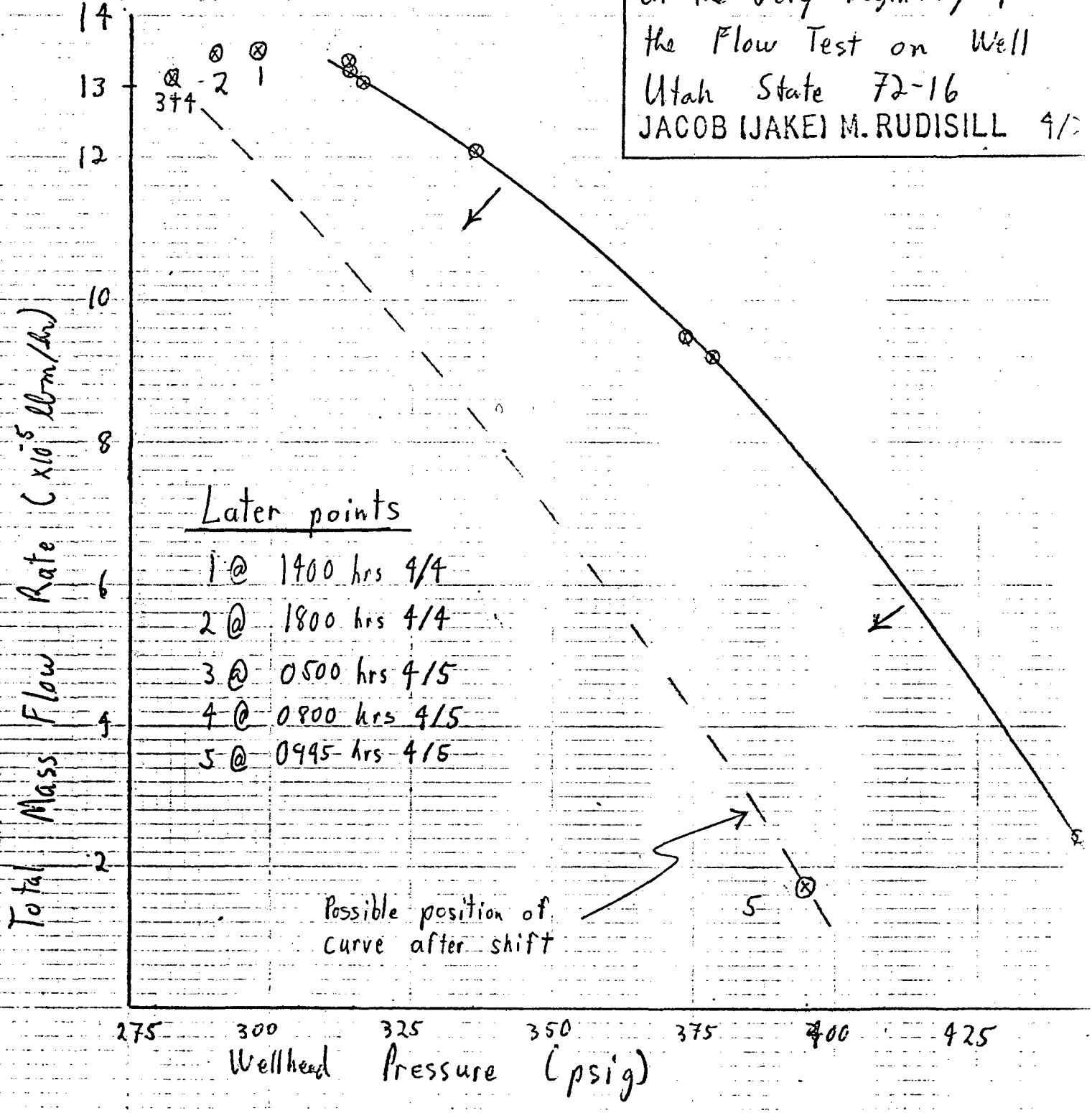
A Graph of the Decline in Enthalpy, Pressures, and Flow Rate From 1630 hrs to 0800 hrs April 4-5 during the Flow Test of Utah State 72-16.

JACOB (JAKE) M. RUDISILL 4/21



Graph # 3

The Graph of Total Mass Flow Rate (lbm/hr) versus Wellhead Pressure at the very beginning of the Flow Test on Well Utah State 72-16
JACOB (JAKE) M. RUDISILL 4/



ADDITION TO TEST DESCRIPTION

0823 hrs.:	Well cut back to 0.17×10^6 lbm./hr. - for 2 min.
0825 hrs.:	Shut-in completely - for 5 min.
0830 hrs.:	Turned on to 0.17×10^6 lbm./hr. - for 25 min.
0855 hrs.:	Shut-in for 20 min.
0915 hrs.:	Re-opened to 170,000 lbm./hr. for 65 min.
1020 hrs.:	Shut-in.

Totals for	0823 - 1020 hrs.
Shut-in	170,000 lbm./hr.
25 min.	1 hr. 32 min.

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OL:JANOD

WHAT?
OLD:JANOD

READY
:L
00010C THIS IS A ROUTINE TO TAKE THE SEMI-REDUCED DATA FROM A TEST OF A GEOTHERMAL WELL BY THE JAMES METHOD AND
00020C THUS DETERMINE THE SPECFIC STAGNATION ENTHALPY,HO, THE TOTAL MASS FLOW,M, AND THE % FLASH OF THE FLOW TO STEAM
00030C AT VARIOUS BACK PRESSURES FOR GIVEN TIMES DURING THE TEST.
00040C
00050C THIS PROGRAM WILL BE MODIFIED TO DO TOTAL DATA REDUCTION IN THE NEAR FUTURE!
00070  COMMON HEAD(16),MO,IDAY,IME,PC,PO,PHI,YTP,HF,HFG,VG,VF,D,DM,DC,H1,EPSI,ADATE(2)
00080  REAL MF,PF70,PF80,PF125
00090  REAL*8 DATAF
00100  FPLAIN(H1)=(COF1*(H1**2.204))-(((H1-HF)/HFG)**1.5)-(VF/(VG-VF))
00110  FPRIME(H1)=(2.204*COF1*(H1**1.204))-((1.5/HFG)*(((H1-HF)/HFG)**0.5))
00130  PRINT 10
00140  10 FORMAT("ENTER THE NAME OF THE DATA FILE TO BE USED")
00150  READ(16,20)DATAF
00160  OPENF(5,DATAF)
00170  20 FORMAT(A6)
00180  READ (5,30)HEAD
00190  30 FORMAT(24A5)
00200  READ(5,*) H1,EPSI
00210  READ(5,*) D,DM,DC
00220  CALL DATE(ADATE)
00230  PRINT 40
00240  40 FORMAT(" SET PAPER--HIT C/R")
00250  READ(16,*)DUMB
00260  PRINT 900,HEAD,(ADATE(I),I=1,2)
00270 900FORMAT(16A5/1X,2A5//)
00280 PRINT 905,D,DM,DC
00290  905 FORMAT( "THE METER RUN'S INSIDE PIPE DIAMETER=",F6.3," INCHES,THE ORIFICE'S DIAMETER=",F6.3,
00295&" INCHES, AND",/,"THE DISCHARGE PIPE'S INSIDE DIAMETER= ",F6.3," INCHES.",//)
00310 PRINT 910
00320 910FORMAT( 4X,"DAY",7X,"TIME",11X,"MASS FLOW",18X,"SPECIFIC STAGNATION ENTHALPY",10X,"% FLASH @",1X/14X,
00330&"(HOURS)",7X,"(LBM/HOUR)",24X,"(BTU/LBM)",16X,"70 PSIG",4X,"80 PSIG",4X,"125 PSIG",///)
00335 49 READ(5,*,END=100),MO,IDAY,IME,PHI,PO,PC,HF,HFG,VG,VF,YTP
00340 NI=0
00345 51  IF(NI.EQ.1) H1=470.
00355 COF1=PHI*(YTP**2.)/(2102500.*(1.-(DM/D)**4.)*((DC/DM)**4.)*(PC**1.92)*(VG-VF))
00375 N=0
00385  50 DEL=FPLAIN(H1)/-(FPRIME(H1))
00395  H1=DEL+H1
00405 N=N+1
00415 IF (ABS(DEL).LT. EPSI) GO TO 90
00425 IF (N.GT.10) GO TO 99
00445 GO TO 50
00460 90 PF70=(H1-279.8)/8.9644
00470 PF80=(H1-288.11)/8.9028
00480 PF125=(H1-318.53)/8.6687
00500 MF=((205185.27*(DC**2.))*(PC**.96))/(((5./16.)**.063)*(H1**1.102))
00520 PRINT 915,MO,IDAY,IME,MF,H1,PF70,PF80,PF125
00530 915  FORMAT(3X,I2,"/",I2,7X,I4,12X,F8.0,24X,F5.1,20X,F4.1,7X,F4.1,9X,F4.1)
00550 GO TO 49
00554 99 NI=NI+1
00555 IF(NI.EQ.1) GO TO 51
00556 PRINT 998,IME
00557 998 FORMAT("   ENTHALPY CALCULATION FAILED TO CONVERGE FOR THE TIME ",I4)
00558 GO TO 49
00590 100 PRINT 999
00595 999 FORMAT(//"ALL DATA HAS BEEN REDUCED")
00600 END
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00610 4,4,2200,1463.,285.,109.9,383.6,811.8,1.6237,.018825,.92
00620 4,4,2300,1460.,284.3,109.6,383.3,812.1,1.6277,.018822,.92
00630 4,4,2400,1451.,282.8,109.2,382.8,812.5,1.6362,.018814,.92
00640 4,5,100,1445.,282.1,109.1,382.6,812.7,1.6401,.018811,.92
00650 4,5,200,1439.,280.6,108.8,382.1,813.2,1.6486,.018804,.92
00660 4,5,300,1433.,297.9,108.4,381.8,813.4,1.6526,.018801,.92
00670 4,5,400,1430.,279.2,108.1,381.6,813.6,1.6567,.018797,.92
00680 4,5,500,1427.,279.2,107.9,381.6,813.6,1.6567,.018797,.92
00690 4,5,600,1424.,278.5,107.5,381.4,813.9,1.6608,.018794,.92
00700 4,5,700,1421.,278.5,107.3,381.4,813.9,1.6608,.018794,.921
00710 4,5,800,1421.,278.5,107.6,381.4,813.9,1.6608,.018794,.921
00720 4,5,8700,1460,285.6,107.6,383.9,811.6,1.6193,.018829,.92
00730 4,5,8708,1377.,271.2,107.6,378.8,816.2,1.7044,.018758,.921
00740 4,5,900,26.22,401.,16.5,416.9,778.7,1.1592,.019344,.999
00750 4,5,945,18.77,403.6,13.75,419.7,778.,1.1518,.019355,.999
00760 4,5,1000,15.5,403.6,13.8,419.7,778.,1.1518,.019355,.999

READY
RUN:JAMOD

JAMOD  17:53  RDS11   APR 20 77 WED

ENTER THE NAME OF THE DATA FILE TO BE USED ?UT7216

SET PAPER--HIT C/R ?
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24-HOUR TEST OF THE WELL UTAH STATE 72-16 ON APRIL 4-5,1977
20-Apr-77

THE METER RUN'S INSIDE PIPE DIAMETER=10.020 INCHES,THE ORIFICE'S DIAMETER= 7.500 INCHES, AND
THE DISCHARGE PIPE'S INSIDE DIAMETER= 7.625 INCHES.

DAY	TIME (HOURS)	MASS FLOW (LBM/HOUR)	SPECIFIC STAGNATION ENTHALPY (BTU/LBM)	% FLASH @ 70 PSIG	80 PSIG	125 PSIG
4/ 4	950	254864.	466.0	20.8	20.0	17.0
4/ 4	951	226111.	519.5	26.7	26.0	23.2
4/ 4	953	177052.	575.5	33.0	32.3	29.6
4/ 4	959	241949.	477.6	22.1	21.3	18.4
4/ 4	1003	158951.	552.6	30.4	29.7	27.0
4/ 4	0	201970.	504.1	25.0	24.3	21.4
ENTHALPY CALCULATION FAILED TO CONVERGE FOR THE TIME 1005						
4/ 4	1007	936861.	457.0	19.8	19.0	16.0
4/ 4	1013	917934.	465.6	20.7	19.9	17.0
4/ 4	1017	881526.	483.0	22.7	21.9	19.0
4/ 4	1025	917934.	465.6	20.7	19.9	17.0
4/ 4	1027	1322075.	472.2	21.5	20.7	17.7
4/ 4	1029	943522.	448.7	18.8	18.0	15.0
4/ 4	1031	943876.	464.6	20.6	19.8	16.8
4/ 4	1034	956656.	464.2	20.6	19.8	16.8
4/ 4	9999 50%	min 926751.	477.8	22.1	21.3	18.4
4/ 4	0 open	max 992601.	448.9	18.9	18.1	15.0
4/ 4	1046	943876.	464.6	20.6	19.8	16.8
4/ 4	1052	928314.	466.2	20.8	20.0	17.0
4/ 4	1056	928857.	466.0	20.8	20.0	17.0
4/ 4	1100	1237524.	469.5	21.2	20.4	17.4
4/ 4	1105	1202511.	473.7	21.6	20.8	17.9
4/ 4	1108	1202511.	473.7	21.6	20.8	17.9

4/ 4	70	70%	min	1210418.	479.0	22.2	21.4	18.5
4/ 4	7	open	max	1229342.	464.3	20.6	19.8	16.8
4/ 4	1115			1211266.	472.6	21.5	20.7	17.8
4/ 4	1120			1329046.	473.7	21.6	20.6	17.9
4/ 4	1125			1338036.	469.0	21.1	20.3	17.4
4/ 4	1140			1313220.	473.3	21.6	20.8	17.8
4/ 4	1145			1313220.	473.3	21.6	20.8	17.8
4/ 4	1149			1354224.	476.7	22.0	21.2	18.2
4/ 4	1154			1358320.	475.4	21.8	21.0	18.1
4/ 4	1159			1359900.	474.9	21.8	21.0	18.0
4/ 4	1215			1362024.	474.2	21.7	20.9	18.0
4/ 4	80	80%	min	1328316.	485.1	22.9	22.1	19.2
4/ 4	8	open	max	1382328.	467.9	21.0	20.2	17.2
4/ 4	1230			1361192.	474.4	21.7	20.9	18.0
4/ 4	1245			1361192.	474.4	21.7	20.9	18.0
4/ 4	1300			1358210.	474.3	21.7	20.9	18.0
4/ 4	1330			1366014.	472.2	21.5	20.7	17.7
4/ 4	1400			1347778.	473.2	21.6	20.8	17.8
4/ 4	1430			1344401.	473.2	21.6	20.8	17.8
4/ 4	1500			1342554.	472.0	21.4	20.7	17.7
4/ 4	8012	80% 12:00	min	1331665.	484.0	22.8	22.0	19.1
4/ 4	812	open	max	1387553.	466.3	20.8	20.0	17.0
4/ 4	8053	80% 15:30	min	1316627.	480.4	22.4	21.6	18.7
4/ 4	853	open	max	1368418.	463.9	20.5	19.7	16.8
4/ 4	1530			1346954.	470.6	21.3	20.5	17.5
4/ 4	1600			1344950.	470.5	21.3	20.5	17.5
4/ 4	1630			1351144.	471.8	21.4	20.6	17.7
4/ 4	1700			1353134.	470.1	21.2	20.4	17.5
4/ 4	8717	87%	min	1329336.	477.7	22.1	21.3	18.4
4/ 4	8710	open	max	1670468.	388.3	12.1	11.3	8.0
4/ 4	1800			1345642.	470.6	21.3	20.5	17.5
4/ 4	1900			1337858.	470.9	21.3	20.5	17.6
4/ 4	2000			1334984.	470.3	21.3	20.5	17.5
4/ 4	2100			1331354.	470.7	21.3	20.5	17.6
4/ 4	2200			1325164.	470.9	21.3	20.5	17.6
4/ 4	2300			1322477.	470.6	21.3	20.5	17.5
4/ 4	2400			1321193.	469.5	21.2	20.4	17.4
4/ 5	100			1322452.	468.8	21.1	20.3	17.3
4/ 5	200			1322135.	467.7	21.0	20.2	17.2
4/ 5	300			1318415.	467.4	20.9	20.1	17.2
4/ 5	400			1315260.	467.3	20.9	20.1	17.2
4/ 5	500			1312367.	467.5	20.9	20.1	17.2
4/ 5	600			1307351.	467.6	21.0	20.2	17.2
4/ 5	700			1303674.	468.0	21.0	20.2	17.2
4/ 5	800			1309154.	467.4	20.9	20.1	17.2
4/ 5	8780	87%	min	1281983.	476.4	21.9	21.1	18.2
4/ 5	8708	open	max	1338981.	457.9	19.9	19.1	16.1
4/ 5	900			169953.	526.1	27.5	26.7	23.9
4/ 5	945			157968.	530.6	28.0	27.2	24.5
4/ 5	1000			168528.	501.9	24.8	24.0	21.2

ALL DATA HAS BEEN REDUCED

USED: 38.6 UNITS

READY

24-HOUR TEST OF THE WELL UTAH STATE 72-16 ON APRIL 4-5,1977
22-Apr-77

THE METER RUN'S INSIDE PIPE DIAMETER=10.020 INCHES,THE ORIFICE'S DIAMETER= 7.500 INCHES, AND
THE DISCHARGE PIPE'S INSIDE DIAMETER= 7.625 INCHES.

DAY	TIME (HOURS)	MASS FLOW (LBM/HOUR)	SPECIFIC STAGNATION ENTHALPY (BTU/LBM)	% FLASH @ 70 PSIG	80 PSIG	125 PSIG
4/ 4	1245	1361192.	474.4	21.7	20.9	18.0
4/ 4	1300	1358210.	474.3	21.7	20.9	18.0
4/ 4	1330	1366014.	472.2	21.5	20.7	17.7
4/ 4	1400	1347778.	473.2	21.6	20.8	17.8
4/ 4	1430	1344401.	473.2	21.6	20.8	17.8
4/ 4	1500	1342554.	472.0	21.4	20.7	17.7
4/ 4	1530	1346954.	470.6	21.3	20.5	17.5
4/ 4	1600	1344950.	470.5	21.3	20.5	17.5
4/ 4	1630	1351144.	471.8	21.4	20.6	17.7
4/ 4	1700	1353134.	470.1	21.2	20.4	17.5
4/ 4	1800	1345642.	470.6	21.3	20.5	17.5
4/ 4	1900	1337858.	470.9	21.3	20.5	17.6
4/ 4	2000	1334984.	470.3	21.3	20.5	17.5
4/ 4	2100	1331354.	470.7	21.3	20.5	17.6
4/ 4	2200	1325164.	470.9	21.3	20.5	17.6
4/ 4	2300	1322477.	470.6	21.3	20.5	17.5
4/ 4	2400	1321193.	469.5	21.2	20.4	17.4
4/ 5	100	1322452.	468.8	21.1	20.3	17.3
4/ 5	200	1322135.	467.7	21.0	20.2	17.2
4/ 5	300	1318415.	467.4	20.9	20.1	17.2
4/ 5	400	1315260.	467.3	20.9	20.1	17.2
4/ 5	500	1312387.	467.5	20.9	20.1	17.2
4/ 5	600	1307351.	467.6	21.0	20.2	17.2
4/ 5	700	1303674.	468.0	21.0	20.2	17.2
4/ 5	800	1309154.	467.4	20.9	20.1	17.2
4/ 5	900	189953.	526.1	27.5	26.7	23.9
4/ 5	945	157968.	530.6	28.0	27.2	24.5
4/ 5	1000	168528.	501.9	24.8	24.0	21.2

ALL DATA HAS BEEN REDUCED

USED: 23.7 UNITS

READY

Utah State 72-16 24 hour Test 4/4/77 - 4/5/77

Day	Time hr	BP in. Hg	P_{atm} psia	P_L psig	R	ΔR	$\emptyset_{TP}$ mm Hg	P_o psia	P_c psig	h_f Btu/lbm	L Btu/lbm	v_g lbm/ft³	v_f lbm/ft³	$\frac{\rho_{TI}}{556 P_o} \times 100$	Y_{TP}	Remarks
4/4	0945	25.173	12.00	–	7.05	–	–	260.5	–	–	–	–	–	–	–	Ball valve opened 25%.
	0946	"	"	–	7.05	–	–	260.5	–	–	–	–	–	–	–	
	0947	"	"	–	7.05	–	–	260.5	–	–	–	–	–	–	–	
	0948	"	"	9.0	7.05	–	–	260.5	13.0	–	–			–	–	Bellows engaged
	0950	"	"	7.5	8.8	1.2	22.3	399.2	19.5	418.4	779.2	1.1644	0.019337	0.10	.999	
	0951	"	"	7.5	9.8	1.5	34.9	399.2	19.5	418.4	779.2	1.1644	0.019337	0.157	.999	
	0953	25.174	12.00	5.0	8.9	1.5	34.9	408.11	17.0	420.9	776.83	1.1391	0.019374	0.153	.999	
25%	0959	25.174	12.00	7.0	8.95	1.2	22.3	412.5	19.0	422.0	775.7	1.1270	0.019393	0.0969	.999	High
	1003	25.175	12.00	2.5	9.0	1.2	22.3	417	14.5	423.2	774.5	1.1148	0.019411	0.096	.999	Low } for 0955-1005
	Avg	25.175	12.00	4.75	8.95	1.2	22.3	412.5	16.75	420.9	775.7	1.1270	0.019393	0.097	.999	Avg }
	1005	25.175	12.00	60.0	8.8	3.2	158.9	399.2	72.0	418.4	779.2	1.1644	0.019337	0.713	.994	Opened well to 50%
	1007	25.176	12.01	62.0	8.65	4.3	286.9	386.1	74.0	414.8	782.7	1.2038	0.019281	1.33	.988	
50%	1013	25.178	12.01	62.0	8.65	4.5	314.2	386.1	74.0	414.8	782.7	1.2038	0.019281	1.46	.987	Avg figures for 50%
	1017	25.178	12.01	62.0	8.65	4.9	372.5	386.1	74	414.8	782.7	1.2038	0.019281	1.73	.985	High for 1005-1025
	1025	25.179	12.01	62	8.65	4.5	314.2	386.1	74	414.8	782.7	1.2038	0.019281	1.46	.987	
75%	1027	25.179	12.01	98	7.78	8.7	1174.3	314.6	110	393.4	802.9	1.4741	0.018964	6.69	.942	Valve opened to 75%
	1029	25.180	12.01	61	7.8	5.0	387.9	316.2	73	393.9	802.4	1.4668	0.018972	2.20	.981	Valve returned to 50%
	1031	25.180	12.01	64	8.60	4.65	335.5	381.8	76	413.6	783.8	1.2173	0.019263	1.58	.986	Well stabilized
50%	1034	25.181	12.01	65	8.60	4.70	342.7	381.8	77	413.6	783.8	1.2173	0.019263	1.61	.986	Averaged flow
	High		12.01	65	8.67	4.95	380.1	387.9	77	415.3	782.2	1.1982	0.019289	1.76	.985	High
	Low		12.01	65	8.52	4.40	300.4	375	77	411.7	785.7	1.2393	0.019234	1.44	.988	Low
	1046	25.183	12.01	64	8.60	4.65	335.5	381.8	76	413.6	783.8	1.2173	0.019263	1.57	.986	
	1052	25.184	12.01	63	8.60	4.63	332.6	381.8	75	413.6	783.8	1.2173	0.019263	1.56	.986	
	1058	25.185	12.01	63	8.60	4.62	331.1	381.8	75	413.6	783.8	1.2173	0.019263	1.55	.987	Last reading @ 50%.

Calculation Table

Utah State 72-16 24 hour test 4/4 - 4/5/77

Day 4/4	Time hr	BP in. Hg	P_{atm} psia	P_L psig	R	ΔR	$\emptyset_{TP}$ mm Hg	P_o psia	P_c psig	h_f Btu/lbm	L Btu/lbm	v_g lbm/ft³	v_f lbm/ft³	$\frac{\rho_{TP}}{100}$	Y_{TP}	Remarks
	1100	25.185	12.01	90	8.075	7.3	826.8	338	102	400.8	796.0	1.3735	0.019070	4.38	.962	Well opened to 70%
	1105	"	"	88	"	"	826.8	338	100	400.8	796.0	1.3735	0.019070	4.38	.962	
70%	1108	25.185	12.01	89	8.075	7.3	826.8	338	101	400.8	796.0	1.3735	0.019070	4.38	.962	Average flow
	high			90	8.15	7.5	872.7	344.1	102	402.6	794.3	1.3495	0.019097	4.55	.961	for 1100 - 1115
	Low			88	8.00	7.1	782.1	332	100	399.0	797.7	1.3979	0.019043	4.22	.963	
	1115	25.184	12.01	89.5	8.075	7.3	826.8	338	100.5	400.8	796.0	1.3735	0.019070	4.38	.962	
	1120	25.183	12.01	99.0	7.8	8.8	1201.4	316.2	111	393.9	802.4	1.4668	0.018972	6.8	.941	75% open
75%	1125	25.183	12.01	98.5	7.7	8.8	1201.4	308.5	110.5	391.5	804.7	1.5026	0.018936	7.0	.939	
	1140	25.182	12.01	97.5	7.8	8.65	1160.8	316.2	109.5	393.9	802.4	1.4668	0.018972	6.6	.943	
	1145	25.181	12.01	97.5	7.8	8.65	1160.8	316.2	109.5	393.9	802.4	1.4668	0.018972	6.6	.943	
80%	1149	25.181	12.01	102	7.60	9.75	1474	300.8	114	389.0	807.0	1.5403	0.018900	8.8	.924	Well opened to 80% after 1145
	1154	25.180	12.01	102	7.59	9.72	1466	300.1	114	388.7	807.2	1.5437	0.018896	8.8	.924	
	1159	25.180	12.01	102	7.59	9.70	1460	300.1	114	388.7	807.2	1.5437	0.018896	8.7	.924	
	1215	25.177	12.01	102	7.58	9.70	1460	299.3	114	388.4	807.4	1.5478	0.018893	8.7	.924	
	high		12.01	102	7.68	9.90	1521	306.9	114	391.0	805.1	1.5105	0.018928	8.9	.923	
	Low		12.01	102	7.50	9.50	1400	293.3	114	388.4	807.4	1.5788	0.018865	8.6	.925	
	1230	25.175	12.00	102	7.58	9.70	1460	299.3	114	388.4	807.4	1.5478	0.018893	8.6	.925	
	1245	25.172	12.00	"	"	"	1460	299.3	114	388.4	807.4	1.5478	0.018893	8.6	.925	
	1300	25.170	12.00	101.7	7.57	9.70	1460	298.5	113.7	388.2	807.7	1.5519	0.018889	8.8	.924	
	1330	25.165	12.00	101.8	7.55	9.67	1451	297	113.8	387.7	808.1	1.5596	0.018882	8.8	.924	
	1400	25.160	12.00	100.5	7.53	9.65	1445	295.5	112.5	387.2	808.6	1.5672	0.018875	8.8	.924	
	1430	25.155	12.00	100.2	7.52	9.65	1445	294.8	112.2	386.9	808.8	1.5709	0.018872	8.8	.924	
	1500	25.150	11.99	99.7	7.52	9.55	1415	294.7	111.7	386.9	808.9	1.5714	0.018872	8.6	.925	

Calculation Table

Day	Time hr	BP in.Hg	P_{atm} psia	P_L psig	R	ΔR	ϕ_{TP} mm Hg	P_o psia	P_c psig	h_f Btu/lbm	L Btu/lbm	v_g lbm/ft³	v_f lbm/ft³	$\sigma_{T,55.6}/100$	γ_{TP}	Remarks
4/4																
80%	high		12.00	102	7.68	9.85	1505	306.9	114.0	391.0	805.1	1.5105	0.018928	8.8	.924	≈12:00
	Low		12.00	102	7.50	9.55	1415	293.2	114	386.4	809.3	1.5793	0.018864	8.6	.925	
	high		11.99	99.7	7.60	9.70	1460	300.8	111.7	389.0	807.0	1.5403	0.018900	8.7	.924	≈1530
	Low		11.99	99.7	7.42	9.45	1385	287.3	111.7	384.4	811.1	1.6111	0.019836	8.6	.925	
	1530	25.142	11.99	99.7	7.51	9.52	1406	294	111.7	386.6	809.1	1.5751	0.018868	8.6	.925	
	1600	25.135	11.99	99.5	7.50	9.52	1406	293.2	111.5	386.4	809.3	1.5793	0.018864	8.6	.925	after this reading opened to 87%
87%	1630	25.127	11.98	100.4	7.45	9.76	1478	289.5	112.4	385.1	810.5	1.5990	0.018847	9.1	.921	
	1700	25.120	11.99	100.1	7.44	9.75	1475	288.7	112.1	384.8	810.7	1.6034	0.018843	9.2	.920	
	high		11.98	100.1	7.51	9.90	1520	294	112.1	386.6	809.1	1.5751	0.018868	9.3	.919	
	Low		11.98	100.1	7.36	9.60	1430	282.8	112.1	382.8	812.5	1.6362	0.018814	9.1	.921	
	1800	25.120	11.98	99.6	7.43	9.75	1475	288.0	111.6	384.6	810.9	1.6073	0.018839	9.2	.920	
	1900	25.115	11.98	99.0	7.42	9.73	1469	287.3	111.0	384.4	811.1	1.6111	0.018836	9.2	.920	
	2000	25.120	11.98	98.6	7.40	9.72	1466	285.8	110.6	383.9	811.6	1.6193	0.018829	9.2	.920	
	2100	25.125	11.98	98.4	7.40	9.72	1466	285.8	110.4	383.9	811.6	1.6193	0.018829	9.2	.920	
	2200	25.130	11.98	97.9	7.39	9.71	1463	285.0	109.9	383.6	811.8	1.6237	0.018825	9.2	.920	
	2300	25.130	11.98	97.6	7.38	9.70	1460	284.3	109.6	383.3	812.1	1.6277	0.018822	9.2	.920	
	2400	25.135	11.99	97.2	7.36	9.67	1451	282.8	109.2	382.8	812.5	1.6362	0.018814	9.2	.920	
4/5/77	0100	25.140	11.99	97.1	7.35	9.65	1445	282.1	109.1	382.6	812.7	1.6401	0.018811	9.2	.920	
	0200	25.140	11.99	96.8	7.33	9.63	1439	280.6	108.8	382.1	813.2	1.6486	0.018804	9.2	.920	
	0300	25.135	11.99	96.4	7.32	9.61	1433	279.9	108.4	381.8	813.4	1.6526	0.018801	9.2	.920	
	0400	25.135	11.99	96.1	7.31	9.60	1430	279.2	108.1	381.6	813.6	1.6567	0.018797	9.2	.920	
	0500	25.140	11.99	95.9	7.31	9.59	1427	279.2	107.9	381.6	813.6	1.6567	0.018797	9.2	.920	
	0600	25.145	11.99	95.5	7.30	9.58	1424	278.5	107.5	381.4	813.9	1.6608	0.018794	9.2	.920	

Day	Time hr	BP in. Hg	P_{atm} psia	P_L psig	R	ΔR	$\emptyset_{TP}$ mm Hg	P_o psia	P_c psig	h_f BTU/lbm	L BTU/lbm	v_g lbm/ft³	v_f lbm/ft³	$\alpha_{T_1 55.8}/100$	Y_{TP}	Remarks
	0700	25.165	12.00	95.3	7.30	9.57	1421	278.5	107.3	381.4	813.9	1.6608	0.018794	9.1	.921	
	0800	25.180	12.01	95.6	7.30	9.57	1421	278.5	107.6	381.4	813.9	1.6608	0.018794	9.1	.921	
	high		12.01	95.6	7.47	9.70	1460	285.8	107.6	382.9	811.6	1.6193	0.018829	9.2	.920	
	Low		12.01	95.6	7.23	9.42	1377	271.2	107.6	378.8	816.2	1.7044	0.018758	9.1	.921	
	0830	—	12.01	—	—	—										Well cut back to 25%
	0900	25.180	12.01	4.5	8.82	1.3	26.22	401.0	16.5	418.9	778.7	1.1592	0.019344	0.12	.991	
	0930		12.01													Closed re-opened with
	0945		12.01	1.75	8.85	1.1	18.77	403.6	13.75	419.7	778.0	1.1518	0.019355	0.08	.999	
	1000	25.185	12.01	1.8	8.85	1.0	15.5	403.6	13.8	419.7	778.0	1.1518	0.019355	0.069	.999	
	1020	—	—	—	—	—	—	—	—	—	—	—	—	—	—	well shut-in
	MRT	read	467°	@	1035	hrs										
	Pressure	tools	hung		@ 1113											

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Branch of Experimental Geochemistry and Mineralogy
345 Middlefield Road, Menlo Park, California 94025

November 14, 1977

Keith Davis
Thermal Power Co.
601 California St.
San Francisco, Ca 94108

Dear Keith:

I enclose chemical analyses of water collected last April from your Utah State 72-16 well at Roosevelt Hot Springs. As Rudisill has probably told you the premature end of the flow test prevented our collection of properly separated steam and water samples. The water analyses appear O.K. but the "steam condensates" are also all water. The calculated aquifer temperature and aquifer chloride contents are a little lower than those for the 14-2 well and if possible I would like to resample the well to see if this is real. The gas analyses are in progress and I will send them but the goal/steam ratio will also suffer from the poor steam/water separation. We may be able to obtain some sort of a number by analysing for chloride in the gas bottles. The ion ratios are very similar in 14-2 and 72-16:

	14-2	72-16
Cl/SiO_2	5.7	6.2
Na/K	5.5	5.0
Cl/Na	1.7	1.6

so probably the gas contents are similar.

I hope these analyses are of use to you. Gene Ciancanelli has requested a copy but I thought this should come from you.

Best regards,

Alfred H. Truesdell

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NEW DOWNHOLE CHEMISTRY PROGRAM--VERSION OF 11/1/77
WELL NUMBER?  THERMAL US 72-16
DATE OF COLLECTION? APRIL 1977
PRESSURE UNITS: ABSOLUTE- BARS=1,KG/CM2=2,PSI=3
                GAUGE-    BARS=4,KG/CM2=5,PSI=6
ENTER SILENCER PRESSURE,UNITS 0.8 1
     IN BARS ABSOLUTE= 0.8
ENTER SEPARATOR PRESSURE,UNITS 286 6
     IN BARS ABSOLUTE= 20.3969088
COLLECTION POINT? (SILENCER=0,SEPARATOR=1) 1
ENTER CHLORIDE,SILICA IN PPM  3110 510
ENTER ENTHALPY AND UNITS(1=JOULES,2=CALORIES,3=BTU) 1047 1
WATER FRACTION IN SILENCER=0.769360372016
WATER IN SEPARATOR HAS 3110 PPM CL
                   AND 510 PPM SIO2
WATER FRACTION IN SEPARATOR= 0.919548317504
ENTHALPY OF AQUIFER FLUID IN JOULES/GM
     MEASURED=1047,FROM SILICA=1067.87348644
     IN BTU/LB= 450.128976764 AND 459.102983135
AQUIFER TEMPERATURE
     FROM ENTHALPY=242.029951288,FROM SILICA=246.381692532
WATER IN AQUIFER HAS 2859.79526759 PPM CL
                 AND 468.969041953 PPM SIO2
EXCESS ENTHALPY=-20.8734364375 (IN BTU/LB= -8.97396235491)
PERCENT STEAM IN AQUIFER= -1.20327840858
```

```
WELL NUMBER?  14-2 ROOSEVELT
DATE OF COLLECTION? NOV 76
PRESSURE UNITS: ABSOLUTE- BARS=1,KG/CM2=2,PSI=3
                GAUGE-    BARS=4,KG/CM2=5,PSI=6
ENTER SILENCER PRESSURE,UNITS 0.8 1
     IN BARS ABSOLUTE= 0.8
ENTER SEPARATOR PRESSURE,UNITS 177 6
     IN BARS ABSOLUTE= 13.0037252
COLLECTION POINT? (SILENCER=0,SEPARATOR=1) 1
ENTER CHLORIDE,SILICA IN PPM  3650 640
ENTER ENTHALPY AND UNITS(1=JOULES,2=CALORIES,3=BTU) 1160 1
WATER FRACTION IN SILENCER=0.813913537005
WATER IN SEPARATOR HAS 3650 PPM CL
                   AND 640 PPM SIO2
WATER FRACTION IN SILENCER= 0.837623365938
ENTHALPY OF AQUIFER FLUID IN JOULES/GM
     MEASURED=1160,FROM SILICA=1135.30850473
     IN BTU/LB= 498.710232158 AND 488.094799971
AQUIFER TEMPERATURE
     FROM ENTHALPY=265.14228723,FROM SILICA=260.189390499
WATER IN AQUIFER HAS 3057.32528567 PPM CL
                   AND 536.0789542 PPM SIO2
EXCESS ENTHALPY=24.6914952671 (IN BTU/LB= 10.6154321871
PERCENT STEAM IN AQUIFER= 1.48611429399
F
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U.S. Geological Survey, Water Resources Division
Quality of Water Branch, Menlo Park, California

ANALYTICAL STATEMENT

RECEIVED
NOV 28 1977
TPC

Source: Roosevelt # 2 Water

Lab. No. RO7-77-3

Location:
_____ ¼ Sec. _____, T. _____, R. _____

Point of coll:

Disch. _____, Temp. (°F.) _____
Date of coll.: _____
Collected by: Truesdell
WBF:

Analyst: _____
Date completed: 28 Oct 77
Checked by: _____

	mg/l	me/l		mg/l	me/l
SiO_2	510		HCO_3	181	
Al			CO_3		
Fe			OH		
Mn					
			SO_4	33	
			Cl	2110	
			F	5.2	
As			Br		
			I		
Ca	12.4		NO_2		
Mg	0.29		NO_3		
Sr	1.36		PO_4		
Ba			B	26.4	
Na	1800				
K	380				
Li	15.0				
NH_4					
Cation totals:			Anion totals:		

$SO_4^{=}$ by Ba^{+2} Turbimetric

Dissolved solids:
Calculated (mg/l) 6074
Residue (180°C) (mg/l) _____
Hardness as $CaCO_3$ (mg/l) 297
N. C. Hardness as $CaCO_3$ (mg/l) 71.5

Specific conductance (micromhos at 25°C) _____
pH 7.83 ; Density at 20°C (g/ml) _____
Sulfides as H_2S (mg/l) _____
(Unpublished records, subject to revision. Copied from original record.)

☆ GPO 680-240

U.S. Geological Survey, Water Resources Division
Quality of Water Branch, Menlo Park, California

ANALYTICAL STATEMENT

RECEIVED
NOV 28 1977
TPC

Source: Roosevelt #1 Condensate

Lab. No. RU7-77-2

Location:
_____ ¼ Sec. _____, T. _____, R. _____

Point of coll.:

Disch. _____, Temp. (°F.) _____
Date of coll.: _____
Collected by: _____
WBF:

Analyst: _____
Date completed: _____
Checked by: _____

	mg/l	me/l		mg/l	me/l
SiO_2	104+		HCO_3	193	
Al			CO_3		
Fe			OH		
Mn					
			SO_4	34	
			Cl	3180	
			F	5.3	
As			Br		
			I		
Ca	12.2		NO_2		
Mg	0.28		NO_3		
Sr	1.20		PO_4		
Ba			B	27.2	
Na	2000				
K	400				
Li	15.0				
NH_4					
Cation totals:			Anion totals:		

SO_4^{-2} by Ba^{+2} Turbimetric

Dissolved solids:
Calculated (mg/l) 5868
Residue (180°C) (mg/l) _____
Hardness as $CaCO_3$ (mg/l) 316
N. C. Hardness as $CaCO_3$ (mg/l) 64.6

Specific conductance (micromhos at 25°C) _____
pH 7.72 ; Density at 20°C (g/ml) _____
Sulfides as H_2S (mg/l) _____
(Unpublished records, subject to revision. Copied from original record.)

☆ GPO 690-240

U.S. Geological Survey, Water Resources Division
Quality of Water Branch, Menlo Park, California

ANALYTICAL STATEMENT

RECEIVED
NOV 28 1977
TPC

Source: Roosevelt #2 Condensate
Lab. No. R07-77-4

Location:
_____ ¼ Sec. _____, T. _____, R. _____

Point of coll:

Disch. _____, Temp. (°F.) _____
Date of coll.: _____
Collected by: Truesdell
WBF:

Analyst: _____
Date completed: _____
Checked by: _____

	mg/l	me/l		mg/l	me/l
SiO_2	104+		HCO_3	134	
Al			CO_3		
Fe			OH		
Mn					
			SO_4	25	
			Cl	2330	
			F	3.8	
As			Br		
			I		
Ca	8.2		NO_2		
Mg	0.23		NO_3		
Sr	1.06		PO_4		
Ba			B	183	
Na	1350				
K	290				
Li	12.0				
NH_4					

SO_4 by Ba Turbimetric

Cation totals: 6835

Anion totals:

Dissolved solids:
Calculated (mg/l) 4277
Residue (180°C) (mg/l) _____
Hardness as $CaCO_3$ (mg/l) 220
N. C. Hardness as $CaCO_3$ (mg/l) 48.4

Specific conductance (micromhos at 25°C) _____
pH 7.91 ; Density at 20°C (g/ml) _____
Sulfides as H_2S (mg/l) _____
(Unpublished records, subject to revision. Copied from original record.)

U.S. Geological Survey, Water Resources Division
Quality of Water Branch, Menlo Park, California

RECEIVED
NOV 28 1977

ANALYTICAL STATEMENT

Lab. No. R07-77-1

Source: Roosevelt #1 (Water)

Location:
_____ ¼ Sec. _____, T. _____, R. _____

Point of coll:

Disch. _____, Temp. (°F.) _____
Date of coll.: _____
Collected by: Truesdell
WBF:

Analyst: _____
Date completed: 28 Oct 77
Checked by: _____

	mg/l	me/l
SiO_2	521	
Al		
Fe		
Mn		
As		
Ca	12.20	
Mg	0.29	
Sr	1.20	
Ba		
Na	2000	
K	400	
Li	16.0	
NH_4		
Cation totals:		

	mg/l TPC	me/l
HCO_3	181	
CO_3		
OH		
SO_4	32	
Cl	3260	
F	5.3	
Br		
I		
NO_2		
NO_3		
PO_4		
B	27.2	
Anion totals:		

SO_4 By Ba^{+2} Turbimetric

Dissolved solids:
Calculated (mg/l) 6444
Residue (180°C) (mg/l) _____
Hardness as $CaCO_3$ (mg/l) 297
N. C. Hardness as $CaCO_3$ (mg/l) 64.6

Specific conductance (micromhos at 25°C) _____
pH 7.53 ; Density at 20°C (g/ml) _____
Sulfides as H_2S (mg/l) _____
(Unpublished records, subject to revision. Copied from original record.)

KRD/10-29-76

Utah State Well 14-2 ML-27536
Roosevelt KGRA, Utah
Core #1

Interval 2600'-12' cut 12' Rec 10' (83%). Core in summary is granodiorite with about 5 thin (1") zones of quartz filled fractures cutting core at high angles. Near top of core a 1.5' zone of predominate quartz is noted.

Fractures are not open. Core is not in reservoir. Local green alteration zones of chlorite after biotite, also a tan material after hornblende. Some red staining. Trace pyrite.

Cut 12' in 5 hours with new 6½" Christensen diamond core head. Core head wornout at end of run.

Geothermal Resources Well Summary Report

SUBMIT IN DUPLICATE

Operator THERMAL POWER COMPANY Well No. UTAH STATE 72-16 ML-25128

Sec. 16, T. 27S., R. 9W., SL B. & M. ROOSEVELT Field BEAVER County.

Location 990' South and 990' West from the Northeast corner of Section 16.
(Give location from property or section corner, or street center lines)

Elevation of ground above sea level 5880 feet.

All depth measurements taken from top of Kelly Bushing which is 21 feet above ground.
(Derrick Floor, Rotary Table or Kelly Bushing)

The information given herewith is a complete and correct record of the present condition of the well and all work done thereon, so far as can be determined from all available records.

Date January 17th, 1977

Signed W. E. D'Olier

Hathaway Engineering (Engineer or Geologist) _____ (Superintendent)

Title Vice President (President, Secretary or Agent)

Commenced drilling October 22, 1976

Completed drilling December 31, 1976

Total depth 1254' Plugged depth _____

Junk _____

GEOLOGICAL MARKERS	DEPTH
Alluvium w/zones of hydrothermal alteration	0' - 290'
Conglomerate	290' - 425'
Granite (fractured)	425' - 1254' (T.D.

Commenced producing not yet on production. (Date)

Geologic age at total depth: 9-15 mybp

Date	Static test Shut-in well head		Production Test Data								
			Total Mass Flow Data					Separator Data			
	Temp. °F	Pres. Psig	Lbs/Hr	Temp. °F	Pres. Psig.	Enthalpy	Orifice	Water cuft/Hr	Steam Lbs/Hr	Pres. Psig	Temp.
	Short Preliminary test on 12-30-76 indicated mass flow capability is approximately 1,000,000 pounds per hour of steam and hot water, with flowing wellhead pressure of 355 psig and temperature of 432°F.										

Casing Record (Present Hole)

Size of Casing (A. P. I.)	Depth of Shoe	Top of Casing	Weight of Casing	New or Second Hand	Seamless or Lapweld	Grade of Casing	Size of Hole Drilled	Number of Sacks of Cement	Depth of Cement if through perf.
20"	85	Surface	94#	N	S	H-40	26"	200	
13-3/8"	580	Surface	54.5#	N	S	K-55	17½"	400	
9-5/8"	1,098	Surface	40#	N	S	K-55	12¼"	650	

Perforated Casing

(Size, top, bottom, perforated intervals, size and spacing of perforation and method.)

Was analysis of effluent made? NO Cement Bond Logs. Surface to 522' Surface to 999'

Temperature log depths Surface to 525' 50' to 1012' Surface to 1210

History of Geothermal Resources Well

SUBMIT IN DUPLICATE

OPERATOR THERMAL POWER COMPANY FIELD ROOSEVELT

Well No. UTAH STATE 72-16 ML-25128, Sec. 16, T. 27S, R. 9W, SL B. & M.

Date January 17th, 1977 Signed W. L. D'Olier

601 California Street
San Francisco, CA 94108 415/981-5700 Title Vice President
(Address) (Telephone Number) (President, Secretary or Agent)

It is of the greatest importance to have a complete history of the well. Use this form to report a full account of all important operations during the drilling and testing of the well or during re-drilling, altering of casing, plugging, or abandonment with the dates thereof. Be sure to include such items as hole size, formation test details, amounts of cement used, top and bottom of plugs, perforation details, sidetracked junk, bailing tests, shooting and initial production data and zone temperatura.

Date	
1976	
10-22	Rigged up Loffland Brothers Company Rig No. 5. Spudded well at 4:00 P.M. Drilled 12¼" hole to 85' and then opened up hole to 26". Ran 20" O.D., 94#, H-40, Buttress Conductor Casing to 85'.
10-23	Cemented 20" casing to surface with 200 sacks Class B Cement containing 2% Calcium Chloride. Landed 20" casing. Installed 20" Hydril GK BOP. Drilled 17½" hole to 163' with 9 ppg mud. Alpha Beta Gamma logging equipment installed and commenced operating at 85'.
10-24	Drilled 17½" hole to 312', with mud. Well started flowing water. Built up mud weight to 10.5 ppg and killed well. Displaced 900 cubic feet of slurry consisting of Class B Cement, Perlite and Silica Flour through drill pipe at 252'. Shut well in.
10-25	Stood cemented. Ran in hole with 17½" bit and found top of cement at 100'. Cleaned out cement to 156' with 9.8 ppg mud.
10-26	Cleaned out cement to 261'. Well started flowing water! Mixed mud to higher weight.
10-27	Mixed mud to 12.2 ppg.
10-28	Mixed mud to 14 ppg and killed water flow. Cleaned out to 312'. Displaced 100 sacks of 16 ppg neat construction cement at 286'.
10-29	Stood cemented. Drilled 17½" hole to 319' with 13.3 ppg mud.
10-30	Drilled 17½" hole to 498' with 13.5 ppg mud.
10-31	Drilled 17½" hole to 585' with 14.5 ppg mud. Well flowed small amount of water diluting 14.5 ppg mud.

History of Geothermal Resources Well

SUBMIT IN DUPLICATE

OPERATOR THERMAL POWER COMPANY FIELD ROOSEVELT

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Date	
1976	
11-1	Built mud weight to 15.2 ppg and ran 13-3/8", 54.5#, K-55, Buttress Seamless casing to 580'. Used float shoe and 5 centralizers. Cemented with 400 sacks Class B Cement mixed 1:1 with Perlite, 40% Silica Flour and 2% Gel. Obtained good cement returns to surface. ✓
11-2	Stood cemented. (Some hot water flow surfaced from annulus between 13-3/8" and 20" casing strings.) Waited on Halliburton to cement annulus.
11-3	Small hot water flow commenced in cellar outside 20" casing. Filled cellar with 15.8# slurry neat cement. Pumped 360 sacks Class B Cement mixed with 40% Silica Flour, 2% Gel and ½% HR-5 Retarder down annulus between 13-3/8" and 20" casing strings. Some fresh cement appeared in cellar and water flow in cellar stopped.
11-4	Stood cemented.
11-5	Ran Schlumberger Cement Bond Log, w/Gamma Ray and Temperature Survey. Excellent bond from surface to 100', fair bond from 100' to 260', excellent bond from 260' to 522' (top of cement plug inside 13-3/8" casing). Cleaning out cement from cellar.
11-6	Cleaning out cement from cellar. Landed 13-3/8" casing.
11-7	Installed 12" Series 900 Shaffer Double BOP, Hydril GK BOP, and Grant Rotating Head. Tested casing and Shaffer blind rams with 1000 psig, pipe rams with 1500 psig, Hydril with 600 psig, Kelly Cock with 1000 psig and kill lines with 1500 psig. All O.K. Cleaned out cement plug inside 13-3/8" casing to 565' with 12¼" bit.

History of Geothermal Resources Well

SUBMIT IN DUPLICATE

OPERATOR THERMAL POWER COMPANY FIELD ROOSEVELT

Well No. UTAH STATE 72-16 ML-25128, Sec. 16, T. 27S., R. 9W., SL B. & M.

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San Francisco, CA 94108 415/981-5700 Title Vice President
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Date	
1976	
11-8	Cleaned out remaining cement plug in 13-3/8" casing and drilled out casing shoe. Drilled 12¼" hole to 633' with water. Well started flowing hot water. Built mud weight to 14.2 ppg and killed flow. Ran short flow test.
11-9	Drilled 12¼" hole to 742'. Mud weight cut from 14.2 ppg to 10.1 ppg from hot water entry and CO_2 gas.
11-10	Drilled 12¼" hole to 836'. Ran short flow test. Installed de-gasser to eliminate CO_2 from mud. Installed cooling loop for mud.
11-11	Mixed mud weight to 15.2 ppg and drilled 12¼" hole to 879'.
11-12	Drilled 12¼" hole to 990' with 15.2 ppg mud.
11-13	Drilled 12¼" hole to 1089' with 14.9 ppg mud.
11-14	Drilled 12¼" hole to 1208' with 15.2 ppg mud.
11-15	Drilled 12¼" hole to 1245' with 15.3 ppg mud. Lost complete mud returns at 1245'. Ran short flow test on well.
11-16	Shut in well. Mixed mud. Waited on Otis snubbing equipment.
11-17	Ran Agnew and Sweet Temperature Survey. Waited on Otis snubbing equipment.
11-18	Mixing mud and waiting on Otis snubbing equipment.
11-19	Installing Otis snubbing equipment.

History of Geothermal Resources Well

SUBMIT IN DUPLICATE

OPERATOR THERMAL POWER COMPANY FIELD ROOSEVELT

Well No. UTAH STATE 72-16 ML-25128 Sec. 16, T. 27S., R. 9W., SL B. & M.

Date January 17th, 1977 Signed W. L. D'Olier

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Date	
1976	
11-20	Snubbed drill string out of hole and closed well in with Shaffer blind rams.
11-21	Rigging up to snub in Halliburton EZSV Retainer-bridge plug.
11-22	Ran EZSV and set at 207'.
11-23	Displaced 40 sacks Class B Cement mixed 1:1 with Perlite, 40% Silica Flour, ½% CFR-2 and 4/10% HR-5 at 206'. Stood cemented.
11-24	Tested casing and BOP at 1000 psig. Mixed mud.
11-25	Installed master valve and extension spool. Small hot water seep observed from ground about 25' SW of well. Also very small hot water seep observed outside 20" Conductor Casing in cellar.
11-26	Rigged up BOP stack. Tested blind rams and 13-3/8" casing with 1400 psig O.K.
11-27	Stripped in hole with Grant Turbodrill and 12¼" bit and found top cement at 88'.
11-28	Drilled out 1' of cement plug when cones on bit locked. Pulled out of hole and ran back in with new 12¼" bit and double Grant Turbodrill.
11-29	Drilled out cement plug to 174'.
11-30	Pulled out of hole and added 8" drill collars to drill string. Drilled out cement plug to 186'.

History of Geothermal Resources Well

SUBMIT IN DUPLICATE

OPERATOR THERMAL POWER COMPANY FIELD ROOSEVELT

Well No. UTAH STATE 72-16 ML-25128, Sec. 16, T. 27S., R. 9W., SL B. & M.

Date January 17th, 1977 Signed W. G. D'Olier

601 California Street
San Francisco, CA 94108 415/981-5700 Title Vice President
(Address) (Telephone Number) (President, Secretary or Agent)

It is of the greatest importance to have a complete history of the well. Use this form to report a full account of all important operations during the drilling and testing of the well or during re-drilling, altering of casing, plugging, or abandonment with the dates thereof. Be sure to include such items as hole size, formation test details, amounts of cement used, top and bottom of plugs, perforation details, sidetracked junk, bailing tests, shooting and initial production data and zone temperature.

Date	
1976	
12-1	Drilled out cement plug to 189'.
12-2	Drilled out cement plug to 207'. Drilled on EZSV Retainer at 207', came loose with strong jolt.
12-3	Grant Turbodrill ceased upward working. Pushed Retainer down to 580'. Would not push farther. Started pulling out of hole.
12-4	Finished pulling out of hole. Layed down Grant Turbodrill.
12-5	Ran in hole with 12¼" bit and 8" drill collars. Pushed Retainer down to 694'.
12-6	Pushed Retainer to 1235' where it stopped.
12-7	Ran second Halliburton EZSV Retainer to 629' where it stopped. Set same.
12-8	Pulled out of hole with drill string and EZSV Setting Tool. Started running drill string in hole with 12¼" bit and 8" drill collars.
12-9	Finished running in hole. Drilled on Retainer No. 2 for 5 minutes when it started moving downhole. Pushed Retainer No. 2 to 1239' where it stopped. Pulled out of hole.
12-10	Started in hole with Halliburton EZSV Retainer No. 3.
12-11	Set Retainer No. 3 at 1144'. Preparing to place cement plug on top of Retainer No. 3.
12-12	Pipe stuck. Freed same with water circulation.

History of Geothermal Resources Well

SUBMIT IN DUPLICATE

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Date	
1976	
12-13	Pulled out of hole.
12-14	Rigged down Otis snubbing equipment. Ran in hole open ended.
12-15	Placed cement plug at 1138' with 35 sacks Class B Cement mixed 1:1 with Perlite, 40% Silica Flour, ½% CFR-2 and 3/10% HR-5.
12-16	Ran 12¼" bit and cleaned out hole to 1100'. Circulated water to cool hole, then displaced water with 16 ppg mud.
12-17	Ran 9-5/8", 40#, K-55, Buttress Casing to 1098'. Casing equipped with float shoe, float collar on top first joint, stab-in float collar on top second joint, centralizers 10' down on first joint and on top of third joint.
12-18	Circulated water around casing to cool hole. Displaced water with mud. Ran in hole with drill pipe and stab-in tool. Stabbed into special stab-in float collar, circulated cold water, then displaced with 15 ppg mud and cemented casing with 650 sacks Class B Cement mixed with 40% Silica Flour, ½% CFR-2 and 3/10% HR-5. Slurry weighed 15.6 ppg. Displaced cement in drill pipe with water, pulled stab-in tool out of float collar and circulated cold water inside 9-5/8" casing.
12-19	Circulated water inside 9-5/8" casing to allow cement to set properly. Displaced water with 15 ppg mud and pulled drill pipe out of hole. Cut off 9-5/8" casing.
12-20	Landed 9-5/8" casing in expansion spool. Installed BOP Stack consisting of 1-10" Series 600 master valve, 1-10" Series 900 Shaffer Double BOP, 2-10" Series 900 Hydril GK BOP's, and 1 Grant Rotating Head. Tested casing with 1000 psig for 5 minutes O.K. Tested BOP Stack. Tried to run Schlumberger CBL, but tool stopped at 260' in caked mud.

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Date	
1976	
12-21	Cleaned out hole and ran logs in water. Ran CBL to 999' and Temperature log to 1012'. CBL indicated excellent bonding from 999' up to 85', then good to fair bonding from 85' to surface. Temperature log inconclusive due to unstabilized temperature of water.
12-22	Ran in hole with 8½" bit and cleaned out cement and drilled out float collars to 1092'. Pulled 8½" bit and ran 8½" mill. Milled out cement and float shoe and cleaned out to Retainer. Milled on Retainer.
12-23	Milled out Retainer. Ran 8½" bit and milled and pushed Retainer to 1241' with 13.6 ppg mud. Displaced mud with water. Pulled out of hole.
12-24	Tested well. Shut well in. Shut rig down at 4:00 P.M. for Holidays.
12-25	Rig shut down for Holidays.
12-26	Rig shut down for Holidays.
12-27	Commenced operations at 8:00 A.M. Lowered well pressure by pumping in water and mud. Ran in hole with 8½" bit.
12-28	Mixed mud to 16.4 ppg. Cleaned out Retainers and drilled new hole from 1245' to 1247'.
12-29	Pulled out of hole and changed bits. Drilled to 1254'.
12-30	Tested well.
12-31	Installed 12" Series 400 master valve above 10" Series 600 master valve and closed in well. Rigged down. Released rig at 4:00 P.M.

THERMAL POWER COMPANY
Utah State Well No. 72-16
Sec. 16, T27S, R9W, SLB&M, Beaver County, Utah
Loffland Rig No. 5
Spud: 10/23/76 Completed: 12/31/76

Bit No.	Bit Size	Bit Mfg.	Bit Type	Serial No. of Bit	Jet Size 1 2 3	Depth Out	Ftge.	Total Hrs.Run	Weight 1000 lbs.	Rotary RPM	Pump Pressure
				retip							
1	12¼"	HTC	XIG	62685	14 14 14	85	85			60	600
2	17½	HTC	OSC3AJ	RR166	16 16 0	288	203	4	10/15	50/60	300
3	17½	SEC	S88	RR	16 0 0	525	217	36-3/4	10/25	55/60	400
4	12¼	HTC	OSC16	RR	open	595	70	1-¼			
5	12¼	HTC	X44	MW020	20 20 20	836	241	23-3/4	40	50	600
6	12¼	HTC	X44	MX944	20 20 20	1208	369	57¼	30/35	50/60	900/1200
7	12¼	SEC	M88	439675	24 24 24	1245	37				
8	12¼	HTC	OWVJ	ZN860	open	1245	drilling cement				
9	12¼	HTC	OSC12	XZ264		drilling cement to 207'					
10	12¼	HTC	OWV	TZ935		" "					
11	12¼	HTC	OWV	ZX457	open	no hole					
12	12¼	HTC	OWV	RR							
13	8½	HTC	ODV	SJ828		no hole					
14	8½	HTC	J7	VM456	open	drilling cement					
15	8½	HTC	V7	VR633	open	drill out plug to 1247'					
16	8½	HTC	V7	VM456		drill out plug					

OP
9/28/77

THERMAL POWER
COMPANY

Operator: Thermal Power Company

Well: Utah State 72-16 ML-25128

Location: 990 feet south and 990 feet west from the northeast corner of Section 16, T27S/R9W, SLB&M, Beaver County, Utah.

Elevation:

Take all measurements from top KB.
Keep hole full at all times.
Check operation of BOE each round trip or daily, whichever first occurs.

Drilling Program

1. Drill 26" or 27½" hole to 40'+ to fit 20" casing. Cement with Class B cement treated with 2% $CaCl_2$ to fill annulus to cellar floor. Use 2 centralizers. Drill rat hole.

2. Drill 17½" hole to 650' to fit 13-3/8" casing.

3. Cement 13-3/8", 54.5#, K-55, buttress casing at 650' with 400 sacks Class B cement premixed with 1.0 cf/sack perlite, 2% gel and 40% silica flour. (100% excess). Run guide shoe with insert fillup. Tack weld and Bakerlok bottom 4 collars, weld shoe solid. Use top rubber plug only, plug holding head. Bump plug on shoe. Use 3 centralizers.

4. After 4 hours (or cement is firm), land 13-3/8" casing. Weld on 12" Series 900 WKM geothermal wellhead. Test weld with 1000 psig. Install 12" Series 900 Shaffer double hydraulic control gate and Hydril GK. All blowout preventers on this well to have high temperature packing elements. Test each preventer, casing, kelly cock, valves and check valve in kill line and blow down line valves to 1000 psig. for five minutes. Notify Utah Division of Water Rights to witness preventer tests 3 days in advance of testing (801/586-4231, Cedar City, Gerald Stoker). Enter test results on tour sheet.

5. Drill 12¼" hole to 1820' to fit 9-5/8" casing. One or more cores may be taken. Run Schlumberger Induction, FDC/CNL and Sonic logs at 1820'.

6. Cement 9-5/8", 40#, K-55, buttress casing at 1820' with 350 sacks Class B cement premixed with 1.0 cf/sack perlite, 2% gel, 40% silica flour and 0.3-0.4% HLX-C214 retarder (% retarder to be determined by maximum thermometers). (40% excess). Run fillup shoe and fillup collar on shoe joint. Tack weld top and bottom, bottom 4 collars, weld shoe solid. Use top and bottom rubber plug and plug holding head. Centralize 40' above shoe and every 5th joint above shoe. Have WKM (505/327-3359, Farmington, Sug Roberts) install centralizing elements in 12" head prior to cementing.

7. Land 9-5/8" casing. WKM install 12" Series 900 by 10" Series 600 14" stroke casing spool. Test pack off with 1000 psig. Install 10" gate valve, two double hydraulic Shaffer control gates, Hydril GK and Grant rotating head. All equipment to have high temperature packing elements. Test all blowout preventers, casing and valving as before with 1000 psig. for five minutes each. Notify Utah DWR to witness preventer tests. Enter test results on tour sheets.

8. Drill 8½" hole to total depth, estimated at 6,000'. One or more cores may be taken. Run Schlumberger logs as ordered. Complete or abandon. 7" casing may be run as protection or production casing if required.

9. Survey hole angle every 2-300', on dull bits. Drillable wing stablizers are to be run in 12¼" and 8½" holes, and 17½" hole if required. A multi-shot or wireline angle survey may be run if hole angle exceeds 5° over several thousand feet. Run drill pipe float valve in 8½" hole and have "wet plug" with valve in open position on floor at all times.

10. Install ABC mud logging service at shoe of 20" conductor. Record continuous mud in and out temperature, H_2S, CH_4, lithology, drilling rate. Have pit level indicator and intercom to drillers station. Take 2 sets W&D samples every 10' above 1800' and every 5' below 1800'. Mail daily copies of the mud log to:

Thermal Power Co. (3 copies)	Hathaway Engineering (1 copy)
601 California Street	3382 El Camino, Suite 37
San Francisco, CA 94108	Sacramento, CA 95821
Attn.: W. L. D'Olier	

Keep 3 copies up to date and spliced in trailer.

11. Mud Program. American Mud Company 505/327-2525

Surface-650'.	Water and gel, 8.3-9.0 ppg.
650'-TD	Milford City water, add sodium chloride if required.

Have lost circulation material on location.

12. Run and record maximum recording thermometers on each Totco run.

13. Telephone numbers:

Thermal Power Company	415/981-5700	
W. L. D'Olier	415/982-5630	Nites
	805/833-8313	Weekend
W. N. Hathaway	916/489-1206	Office
	916/944-3884	Home
H. E. Wheeler	916/485-2715	

October 14th, 1976