

# UURI

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September 13, 1978

Dr. Neil J. Stefanides  
Geothermal Division  
Union Oil Co., of California  
Union Oil Center, Box 7600  
Los Angeles, CA 90051

Dear Neil:

Enclosed are two copies of a map with our proposed resistivity line locations for the geothermal case study at Cove Fort. We hope to read induced polarization data simultaneously for selected lines, but low resistivity and long reading times may restrict the IP effort. The line locations indicated here have been considered for access, avoidance of grounded structures, minimum (parallel) coupling with major structures, and the general distribution of the geothermal system. Our aim is to produce a two dimensional model for each line through numerical modeling. I would appreciate any added input to these line selections that you or your staff would care to make. We hope the geophysical contractor, Mining Geophysical Surveys, can begin this work on Sept. 18.

In addition to the electrical survey, we have completed detailed geologic mapping of approximately 14 square miles through the efforts of Joe Moore. He finds the volcanic stratigraphy understandable and the faulting very complex. We have also contracted Aerial Surveys, Inc. to complete a detailed aeromagnetic survey which will cover the entire map area. The survey parameters are: north-south flight lines at a spacing of one-half kilometer (about 3 lines per mile); 1000 feet above mean terrain surface, smoothly draped. We expect this flying to be completed before September 30 with a preliminary map available by mid-October.

We look forward to some interesting discussions with you and your staff when you schedule will allow.

Sincerely,

*Howard*

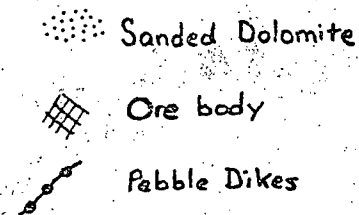
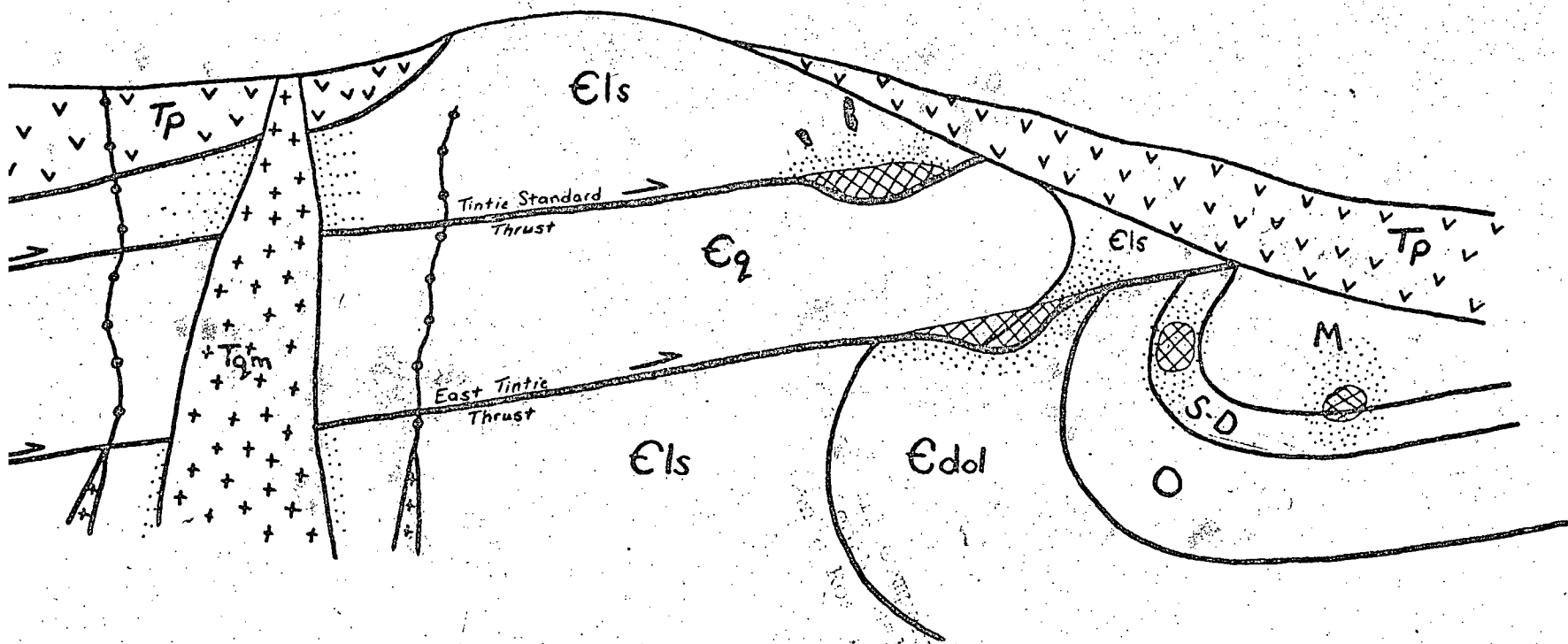
Howard P. Ross  
Project Manager

HPR:srm

enc.

cc: (w/o enc.)  
S.H. Ward  
P.M. Wright  
J.N. Moore

Diagrammatic section of the East Tintic District, Utah, showing relation of sanded dolomite areas to structure and lithology



- Tqm Quartz monzonite intrusive  
 Tp Packard quartz latite  
 M Mississippian  
 S-D Silurian and Devonian  
 O Ordovician  
 Edol Cambrian, dolomite  
 Els Cambrian, limestone  
 Eq Cambrian, quartzite

CFSU 42-7  
Cove Fort, Sulphurdale Unit  
Initial Flow Test

Union Oil Company of California  
Geothermal Division  
Santa Rosa, California

Brian Maassen  
July 24, 1978

SUMMARY OF CFSU 42-7 PIT TEST

PRODUCTION TEST

Date	5/16/78
Start Nitrogen Injection	15:45
Stop Nitrogen Injection	22:45
End Flow Period	7:25 7/17/78
Maximum Rate	47,000 lb/hr
Wellhead Pressure	3 psig
Maximum Bottom Hole Temperature	336°F @ 6900'
Total Fluid Produced	1,800,000 lbs

INJECTION TEST

Date	5/17/78
Injection Rate	53,000 lb/hr
Injection Temperature	70°F
Injection Wellhead Pressure	vacuum
Final Wellhead Pressure	0 psig
KH	±23,000 MDFT

## CONCLUSIONS

1. The well will produce at a rate of 47,000 lb/hr at a wellhead pressure of 3 psig.

The well dies immediately after shutin.

2. The reservoir temperature in the vicinity of the wellbore is  $\pm 330^{\circ}\text{F}$ . This corresponds to a flash of 0% at 100 psig and 4.22% flash at 50 psig.

3. The permeability of the formation is in the order of 23,000 md-ft.

4. The well should make an excellent injector because the pressure at 5000 ft is 688 psi below the normal hydrostatic gradient of 0.433 psi/ft. Calculations assuming the above permeability and steady-state radial flow indicate the well could take injection rates on the order of 1,000,000 lb/hr before fluid reaches the surface.

## INTRODUCTION

A combination production and injection test was performed on CFSU 42-7 in Beaver County, Utah during the week of May 15, 1978. The test was designed to obtain temperature, chemical, production, injection, and permeability data. The results of the test are discussed in the following report.

## BACKGROUND

The CFSU 42-7 was completed on March 14, 1978 with 7" tie-back from the surface to 3084' and 7" liner from 3084' to 7610'.

The slotted liner sections are located between 4320' and 7520'

The last temperature survey prior to the flow test was made on April 5, 1978 and indicated a maximum temperature of 325°F at 6050'.

A bridge was encountered at 6064' during the survey. Temperatures of 344°F were measured at 7327' during production logging prior to completion of the well. The free standing fluid level during drilling operations was 1310'.



## OPERATIONS

### STATIC SURVEY

A static continuous temperature and differential survey was run on 5/15/78 prior to the flow test. The survey indicated a maximum temperature of 328°F at 6040' where a bridge was encountered. The 2500 foot isothermal zone from  $\pm$ 3600 to  $\pm$ 6100 found in surveys run prior to completion of the well was no longer present. A sensitive spinner tool was hung at several points in the zone and no flow was detected.

### FLOW TO PIT

The test apparatus was set up as shown in Figure 1. It consists of a two-phase meter run, choke manifold and a flow spreader. The flow rates were calculated using the Murdock 2 phase correlation for orifice meters. The pit was also measured and a table of volume versus depth was prepared to use as a rough check against the metered rates. Flow rates could not be calculated during nitrogen injection because the Murdock correlation does not take the nitrogen into account.

Open ended coiled tubing was run into the well on 5/16/78 at  $\pm$ 50 ft/min, while circulating nitrogen at 1500 cubic feet per minute. An obstruction was encountered at 591 feet. When an attempt was made to back off 50 feet, the tubing parted and 591 feet was lost

jet on the end to act as a guide shoe. The tubing was run at the same speed and nitrogen rate as above, past the bridge at 6040, until it tagged bottom at 7211'. Several attempts were made to get past 7211' but all were unsuccessful.

Fluid appeared at the surface several minutes after the tubing passed the free standing fluid level at 1310'. The well was lifted on nitrogen assist for 6 hours. Nitrogen rates were varied to see what effect it would have on production rates.

The results indicated that the higher the nitrogen rate the higher the production rate. At times, the well produced a small amount of black, sandy grit. The nitrogen was shut off at 22:40 on 5/16/68. Flow continued unassisted at a rate of  $\pm 48,000$  lb/hr at 3 psig of wellhead pressure and decreased gradually over the next 9 hours to 43,000 lb/hr. The well was shut-in at 7:25 a.m. on 5/17/78. Shortly after shut-in, a 3" valve was opened on the wellhead, a noncondensable gas head was bled off and the wellhead pressure dropped to 0 psi. A total of 1,822,142 lbs was produced during the entire flow period.

#### CHEMICAL ANALYSIS

Several chemical samples were taken during the flow period and analyzed by Research. The complete analysis is shown in Table 1. The fluid had a total dissolved solids content of 3950 ppm. The silica geothermometer was analyzed and indicated a fluid temperature of 334°F. This is very close to the actual measured maximum temperature of 336°F. The Na, K, Ca geothermometer indicated a temperature of 436°F. This is unrealistic when

compared with temperature measured downhole.

#### POST FLOW SURVEY

Two hours after shut-in, a second continuous temperature and differential temperature survey was run, but the indicated temperatures were unrealistically high. A wireline temperature survey was run with Kuster tools as a check. The Kuster tool indicated a maximum temperature of 332°F at 6900'. The continuous survey was declared a misrun and a second temperature and differential temperature survey was run with a new tool. The results of this agreed with the Kuster run and a maximum temperature of 336°F was measured at 6900'.

#### INJECTION PERIOD

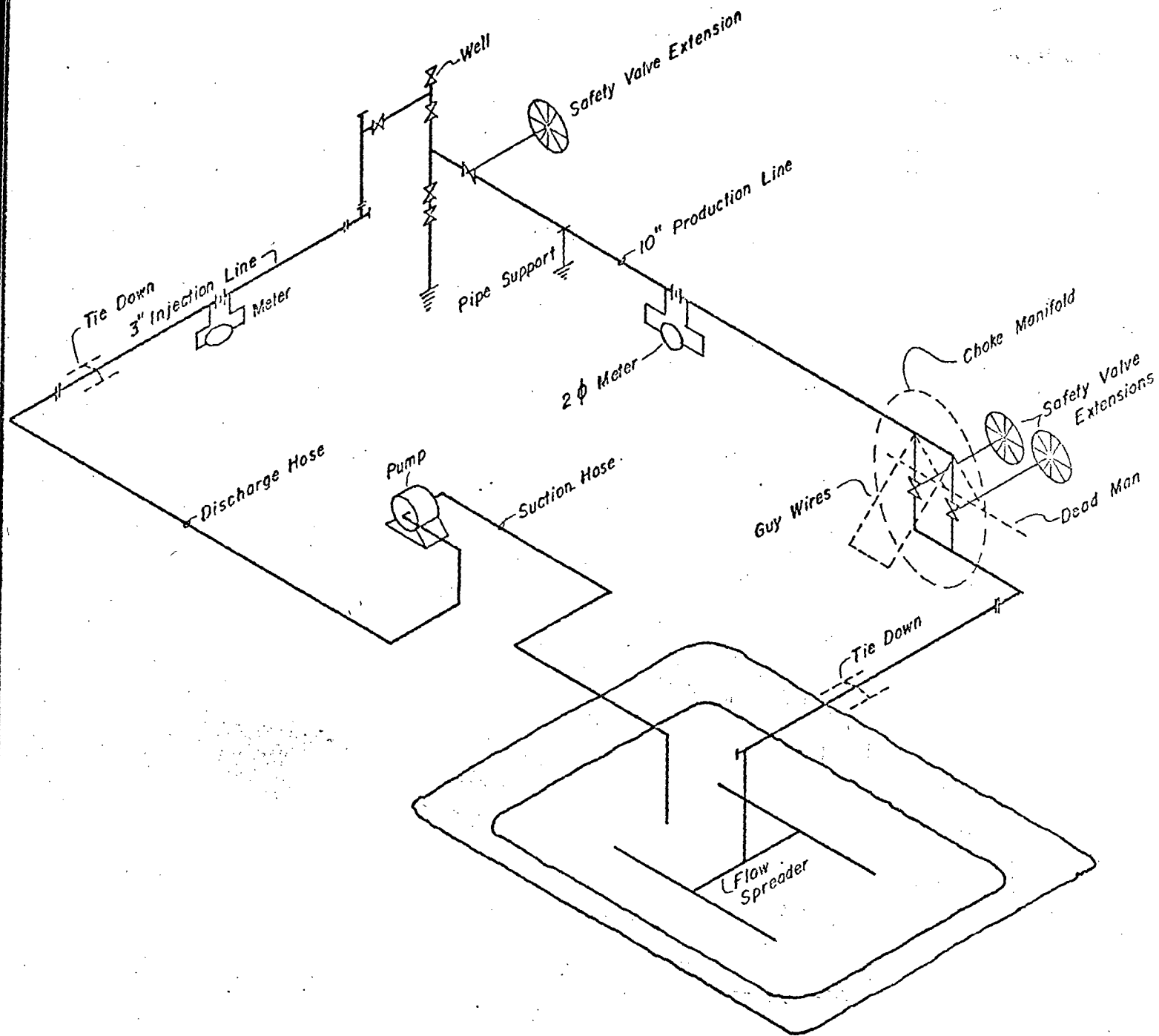
The produced fluid was injected into the well for 17 hours on 5/17 and 5/18/78. The average injection rate was 53,000 lb/hr with the wellhead on a vacuum. Injection rates were limited by pump capacity. Flow rates were measured by the 3" meter run shown in Figure 1. A spinner survey was run but the results were inconclusive. The fluid level was found at 1370'.

A radioactive tracer survey showed fluid leaving the wellbore at the following locations:

<u>Slotted Interval</u>	<u>Percent</u>
4353'-4473'	51
4860'-4989'	3
5112'-5319'	20
5534'-5660'	13
below 5800'	13

No tracer shots were made below 5800' due to temperature limita-

Data from flowing injection survey indicated a 29 psi pressure drop across the sandface at a flow rate of 50,000 lb/hr. A pressure falloff taken after shut-in indicated a permeability of 23,000 md-ft. It should be noted that the small pressure changes (29 psi) measured downhole are at the limits of the tools resolution; therefore, the accuracy of the permeability calculated here could be subject to a significant error. However, the very fact that the pressure drops were so small is an indication of high permeability. More accurate numbers could be obtained by injecting at higher rates in the region of 500,000 lb/hr.



REVISED

DATE

UNION

DRAWN

FOR: B. W. M.

UNION OIL COMPANY OF CALIFORNIA - GEOTHERMAL

TABLE 1

Cove Fort Well (CFSU42-7) Compositional Analyses  
5-16-78

Total Steam Production.

H <sub>2</sub> S, ppm	97, 147	(2 separate samples)
NH <sub>3</sub> , ppm	36, 78	(2 separate samples)

Separated Water. (pH=8.7)

Physical Properties

Specific Gravity	1.0028
Conductivity, $\mu$ S/cm	5930
Suspended Solids, mg/l	392
Total Dissolved Solids, mg/l	3950

Elemental Analyses

Arsenic, mg/l	1.90
Boron, mg/l	7
Calcium, mg/l	43
Iron, mg/l	<.05
Magnesium, mg/l	6.0
Mercury, mg/l	nd<.0005
Potassium, mg/l	209
Silver, mg/l	<.02
Sodium, mg/l	1500

Anions

Bicarbonate, mg/l	101
Carbonate, mg/l	55
Chloride, mg/l	1590
Fluoride, mg/l	5.8
Nitrate, mg/l	0.03
Sulfate, mg/l	0.5
Sulfide, mg/l	3.5

Ammonia, mg/l 5.5

Silicon, mg/l 190, 200, 200 (3 separate samples)

Emission Spectrographic Analyses:

	<u>TDS</u>	<u>Suspended Solids</u>
Major, >10%	Na	Ca
Moderate, 1-10%	K	Fe, Si
Slight, 0.1-1%	Ca, Si	

APPENDIX

BWM

I 3

KH DETERMINATION FROM FALLOFF ON CFSU 42-7

DATE OF TEST 5/18/78  
RATE

DETERMINE AVERAGE INJECTION

<u>RATE</u>	<u>HRS</u>	<u>Q</u>
1	64,800	64,800
1.75	76,600	134,050
0.50	74,000	37,000
0.75	58,000	43,500
<u>5.50</u>	<u>52,000</u>	<u>286,000</u>
9.5		565,350

AVERAGE RATE = 59000 LB/HR

FLOW TIME = 9.5 HRS

<u>ΔT</u> (MINUTES)	<u>T + ΔT</u> <u>ΔT</u>	<u>PRESS</u> (PSIG)
0	—	1966
1	571	1964
2	286	1962
3	191	1960
4	143	1960
5	115	1900
10	58	1898
15	39	1898
60	10.5	1895
120	5.75	1894
180	4.17	1892
240	3.38	1890
300	2.90	1888
360	2.58	1888
420	2.36	1888
439	2.30	1888



Falloff on CFSU 42-7 5/18/78 Cont

Slope = 7 PSI/~

Rate = 59000 LB/HR

TEMP = 250° SPVOL = 0.017006 u = 0.23

CONVERT RATE TO BBL/DAY

(59000)(0.017006)(24) / 5.615 = 4288 BPD

kh = (162.6)(0.23(4288)) / 7 = 22900 mdft

S = 1.151 [ (Pwf - P1HR) / m - Log( kh / (phi H u c rw^2) ) + 3.23 ]

- Pwf = 1906, P1HR = 1891, KH = 9960, phi H = 200, u = 0.23, c = 12 x 10^-6, rw^2 = 0.1329, m = 7

S = 1.151 [ (1906 - 1891) / 7 - Log( 22900 / ((200)(0.23)(12 x 10^-6)(.1329)) ) + 3.23 ]

S = -3.6, delta Ps = 0.87(m)(s) = 0.87(7)(-3.12) = -19 PSI

EFF = (Pwf - Pws - delta Ps) / (Pwf - Pws) = (1906 - 1880 - (-19)) / (1906 - 1880) = 1.73

Falloff on CFSU 42-7 5/18/78

CHECK STEADY STATE KH AGAINST BUILD UP

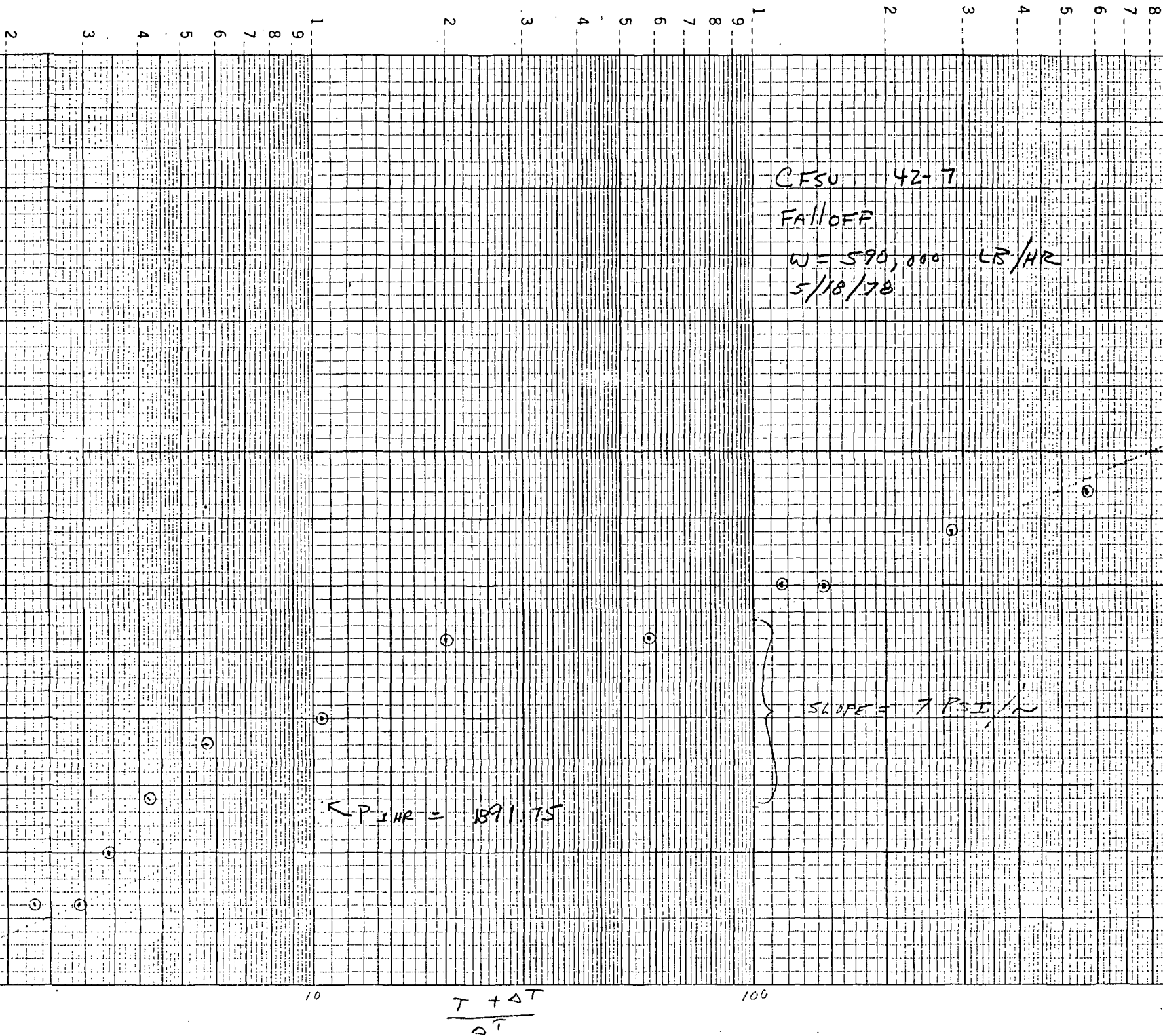
$$h = \frac{603.86 W(\text{SPV}) (\mu) \ln\left(\frac{R_E}{r_w}\right)}{\Delta P E}$$

$$P_{ws} = 1877 \text{ FM } 5/9/78$$

$$PWF = 1906$$

$$\Delta P = 1906 - 1877 = 29$$

$$h = \frac{603.86 (59000) (0.017006) (0.73) (7.06)}{29 (1.73)} = \boxed{19600 \text{ md ft}}$$



LOCATION  
LOG

AK

5 16 78 1 5

CPSU 42-7 PIT TEST

5/16 - N<sub>2</sub> INJECTION & Flow Test

Time

0700 SAFETY MEETING

0913 BLEED-OFF PRESSURE

0915 OPEN VALVE

0930 ATTEMPT TO RUN TUBING INTO WELL

0935 PULL TUBING OUT & DISCONNECT ROPE TO INSTALL  
CENTRALIZER ON TUBING

CONTINUOUS ATTEMPTS TO RUN TUBING UNSUCCESSFUL,  
APPARENTLY CATCHING ON 7" TIEBACK LAP AT WELLSHEAD.  
RUN FREE STINGER OF TUBING PAST LIP, THEN CONNECT IT TO  
TUBING ON SPOOL.

1338 ATTEMPT TO RUN TUBING INTO HOLE, INJECTING N<sub>2</sub> @ 1200 CFM

1349 HIT OBSTRUCTION - DROPPED 591' OF TUBING INTO HOLE

1518 USING SAME METHOD, START RUNNING TUBING INTO HOLE

1545 TUBING ENTERED FLUID LEVEL (APPROX 1300')

1550 FLUID TO SURFACE - FROTHY, WHITE FLUID

1600 2500' TUBING DEPTH - GRAY FLUID TO SURFACE

PK

5 16 78 2 5

CPSU 42-7 Pit Test

TIME

- 1640 INCREASE N<sub>2</sub> INJECTION RATE TO 1500 CFM
- 1655 BEGIN TO METER FLOW WITH BARTON #1 - NO BACK PRESSURE
- 1657 CONTINUE RUNNING INTO HOLE PAST 5000'
- 1705 BARTON #1 METER FAILED
- 1720 NO SIGN OF BRIDGE - TUBING DEPTH = 6000'
- 1723 BARTON #1 METER RUNNING AGAIN
- GRIT PRODUCED THROUGHOUT TEST
- 1735 HIT OBSTRUCTION AT 7011', PULLED TO 7160' & HOLD  
STILL INJECTING 1500 CFM  
PRODUCING MILKY WHITE FLUID AGAIN  
ALSO PRODUCING LARGER AMOUNTS OF GRIT
- 1835 RUN SLOWLY INTO HOLE TO 7011', HIT OBSTRUCTION  
PULL BACK TO 7160' & HOLD
- 1840 CUT N<sub>2</sub> INJECTION RATE TO 500 CFM
- 1918 INCREASE N<sub>2</sub> INJECTION TO 750 CFM
- 2100 CUT N<sub>2</sub> INJECTION RATE TO 300 CFM
- 2130 START PULLING TUBING OUT OF HOLE

Pk

5 16 78 3 5

CFSU 42-7 Pit Test

Time

2257 PARTIALLY CLOSE 10" MASTER VALVE TO CHECK FOR TUBING

2330 CLOSE INJECTION LINE, BEGIN TO METER SLIGHT FLOW

DUE TO CONNECTORS ON TUBING, UNABLE TO PULL  
MOMSCO TUBING COMPLETELY OUT OF WELLHEAD.

5/17/78

0700 11:00 AM @ PSI 5" H<sub>2</sub>O

0705 START-IN WELL @ 2 PSI

0707 ~~LEAKED~~ P<sub>5</sub> = 5 PSI0712 P<sub>5</sub> = 7 PSI0730 P<sub>5</sub> = 10 PSI

8:05 " = 13 PSI

8:15 " = 15 PSI

8:30 " = 19 PSI

8:45 " = 25 PSI

8:50

OPENED 3" AND BLEW OFF NON CONDENSIBLES  
0 PSI, WELL DIED1025 RUN TEMP SURVEY -  
REACHED FLUID LEVEL @ 1270'1125 ~~TEMP~~ TEMP TOOL FAILED AT 1900'

1155 RUN IN HOLE W/TEMP TOOL AT 1900'

1240 TOOL FAILED @ 6750' - 6250'

1455

PK

CFSU 12-7

1625 RUN KUSTER TEMP SURVEY

1000	193	NO FLUID
2000	306	
3000	306	
4000	321	
5000	327	
6000	332	
6900	332	

FLUID LEVEL @ 1270'

1920 START INTO HOLE WITH GO TEMP SURVEY

1935 TOOL FAILED - POH

1955 TOOL REPAIRED, START IN HOLE AGAIN

2130 PICK UP DEPTH @ 6919' 336.2°F  
START POH

POSSIBLE TOP OF TUBING FISH @ 6500'

2230 BEGIN INJECTING WATER SLOWLY  
INITIAL PIT LEVEL = 5'

2250 SHUT-DOWN PUMP DUE TO SAND PLUGGING VALVE

2310 RESTART PUMP @ 30 SPM

5/15  
0730 PUMP LOST PRIME

0800 PUMP RUNNING AGAIN

0815 PUMP

0910

0930

0138

4055

1130

1145

1200

1245

~~1420~~

1540

1700

1830

1850

2100

PUMP DOWN

PUMP ON

DOWN

BACK ON

START SPINNER SURVEY

TOOL FAILED - PCH

RI# W/SPINNER SURVEY, TOOL FAILED - PDK

RI# W/SPINNER SURVEY

COMPLETE TEMP SURVEY

START RA SURVEY

COMPLETE RA SURVEY

START CLOCKS FOR FALL-OFF & GRADIENT SURVEY

START IN HOLE W/AIR

SHUT DOWN PUMPS & ∴ BEGIN FALL-OFF SURVEY



SIZES: 7 1/2"  
RUN: 15"

TIME START: 1518

P<sub>TS</sub> @ TIME OF TEST 10 PSI  
T<sub>INITIAL</sub> = AMBIENT < 50°F

DEPTH (ft)	WELLHEAD TEMP OF	PIPSTREAM (PSIG)	DIFFERENTIAL INCHES (H <sub>2</sub> O)	PIT LEVEL/VOLUME/RATE	COMMENTS
10	< 50			2 1/2 / 6387 FT <sup>3</sup> / -	
20	105				BEGIN INTERMITTANT FLOW TO SURFACE
15	190				INT N <sub>2</sub> @ 1200 fpm
17	190				
17	209				
25	218				@ 3210'
25	222				
25/23 GLASS	227				
25	228			3' / 10285 FT <sup>3</sup> / 73540115/hr	@ 4400'
25	226				
25	225/228 GLASS				@ 5000'
25	NOT SETTLED 227/230 GLASS				N <sub>2</sub> @ 1500 fpm
25	228				@ 5000'
30	240				@ 5000'
35	242				@ 5000'
35	242		18"	17	
35	244		18"		METER FAILED
30	228				
35	235				@ 6000'
35	236				
35	236	22	43		
35	237/231 GLASS	20	42		

CFSU 42-7

PIT TEST

Production Parameters

PK

Pressure (PSIG)	Wellhead Temp (°F)	Pipestream (PSIG)	Differential (Inches H <sub>2</sub> O)	PIT Level/Volume/Rate	COMMENT
			52		CFSU 42-7
30	240/242 GUS	25	41		1500 @ 6100
30	240	18	40		" @ 7191'
30	236	20	45		" @ 7011'
35	241	19	62		" @ 7160'
40	250	25	45	3 1/2 / 15,176 FF <sup>3</sup> / 215,000 B/HR	" " " "
35	240	23	45		" " " "
40	243	20	65		" " " "
40	242	37	42		" " " "
40	244	22			" " " "
35	242	24	47		5.2 @ 7160' Production
40	248	25	55		" " " "
35	238	19	44		" " " "
30	230	15	35		750 @ 7160' Reserves
33	238	18	43		" " " "
45	250	27	60		" " " "
40	244	23	50	4 1/2 / 10,67 FF <sup>3</sup> / 186,000 B/HR	" " " "
40	245	23	52		" " " "

Pressure (PSIG)	Wellhead TEMP (°F)	Pupstream (PSIG)	Differential (INCHES H <sub>2</sub> O)	PIT Level/VOLUME/RATE	COMMENTS
35	243	22	48		75% 2160'
36	245/250 GROSS	24	52		" "
37/39 GROSS	245	24	52		" "
37/39 GAUGE	244	22	51		300' 2160'
36	237	20	43		" "
32	230	17	35		START OUT OF HOLE
30	230	14	35		CONTINUE N <sub>2</sub> @ 300 CFM
30	231	15	36		
33	232	15	36 ±		4 1/2' @ 840 SCF @ 39, 700 L/HR
30	229	14	34		
30	230	14	36		
40	243	20	44		
40	241	20	50		
35	235	16	45		
35	237	17	45		
33	232	15	40		
27	227	14	36		
25	223	12	31		
SHUT-OFF N <sub>2</sub> INJECTION					
14	208	6	16		
2	205	4	15"		OPEN INJECTION LINE

CFSU

42-7

PIT TEST

Production

Refrigerant

WELLHEAD PRESS (PSIG)	WELLHEAD TEMP (°F)	UPSTREAM (PSIG)	DIFFERENTIAL (INCHES H <sub>2</sub> O)	PIT LEVEL/VOLUME/RATE	COMMENTS
W	200				
W	195				
W	205				
W	205				
W	205				
W	205				
	205	3	11		
	203	3	11		
	203	3	11		
	200	2	7½		
	199	2	7½		
	197	2	7		
	197	2	7		
	197	2	6½		
	200	2	6	5' / 35,588 FT <sup>3</sup> / 54,150	
	197	3	5½		

CFSL 12-7

Production

RETAINES

<u>SPM</u>	<u>PUMP RATE</u>	<u>ΔP</u>	<u>RT</u>	<u>Pit Level</u>	<u>Comments</u>
30	1	10"	—	5' (MARKER 14)	
40	—	16"	—		
40	—	16"	—		
40	—	16"	—		
45	—	16"	—		
15	—	0	—		SHUT DOWN DUE TO PLUGGING
30	—	9"	—		
30	—	9"	—		
35	—	10"	—		INCREASE PUMP RATE TO 35 SPM
25	—	10"	VAC		
35	—	10"	VAC		
34	—	11½"	VAC	4½' (MARKER 15)	
34	—	11½"	VAC		
34	—	11"	VAC		
34	—	11"	VAC		
34	—	10½"	VAC		
34	—	10½"	VAC		

JCSU 49-7 INJECTION TEST

CF50 - 42-7 INTERFERIUM TEST

<u>SPM</u>	<u>PUMP/STATION</u>	<u>DP</u>	<u>PR</u>	<u>PIT LEVEL</u>	<u>COMMENTS</u>
34	-	10 1/2"	1 1/2 PSI		
					RIMP DOWN @ 0825, ON AGAIN @ 0855
34	-	7"	2 1/2 PSI		
					RIMP DEAD @ 0910 ON AGAIN @ 0930
40	-	7"	0		
PUMP					DOWN @ 0938 ON AGAIN @ 1055
50	-	9"	3 PSI		
50	-	20"	VAC		
50	12 PSI	19"	VAC		
50	18 PSI	20"	VAC		
50	33	25	VAC		
50	40	39	VAC		4' IN SUMP
50	44	38 1/2	VAC		
50	50	26	VAC		
36	27	16	VAC		CUT BACK TO 36 SPM @ 1430
32	17 1/2	12	VAC		3 1/2' IN PIT
					SHUT DOWN TO SURVEY FULL OFF PRESSURES

Steve Lipman

Del Pyle

Dick Dondanville

Don Ash

Olin Whitescarver

Frank Corbin ✓

Reservoir File