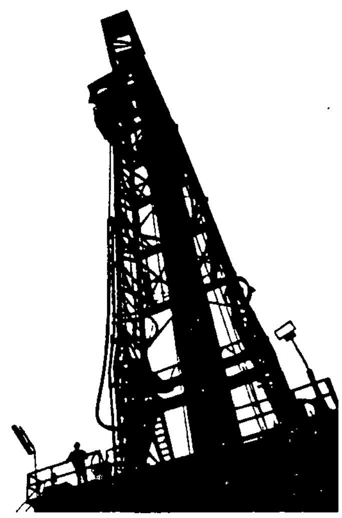
GL00564



Appendix R

Geothermex / First Flow Test Report

GeothermEx, Inc.

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SALTON SEA SCIENTIFIC DRILLING PROGRAM

FLOW TEST OF WELL STATE 2-14,

28-30 DECEMBER 1985

for

BECHTEL NATIONAL, INC.

SAN FRANCISCO, CALIFORNIA

by

GeothermEx, Inc.

June 1986

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FIGURES

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CONCLUSIONS

The following conclusions are based on direct observations and analysis of data collected during the flow test of well State 2-14 conducted from 28 to 30 December 1985:

1. The well encountered a permeable zone at 6,100 to 6,227 feet in depth, with a resource temperature of 581°F measured downhole. This corresponds to lost circulation and lithologic evidence of a production zone between 6,110 and 6,130 feet in depth.

2. The produced fluid had a calculated pre-flash total dissolved solids (TDS) content of approximately 27 weight-% and an estimated enthalpy of 400 BTU/lb. At atmospheric pressure, this resulted in a steam fraction of 26.5 weight-% and a 37 weight-% TDS content in the separated brine.

3. Pre-flash TDS content calculated by GeothermEx (27.2 weight-%) and by D. Michels (24.5 weight-%), are in reasonable agreement. Michels also estimated the pre-flash gas content to be 0.17 weight-%, consisting of about 99.6% carbon dioxide. Chemical analyses based on samples collected by Kennecott are suspect, as the TDS of samples collected at 460 and 195 psig are not in agreement. The sample collected at 460 psig appears to be diluted by excess steam.

4. Under throttled conditions, the flow rate stabilized at approximately 140,000 lbs/hr at a wellhead pressure of 450 psig. No stabilized data were obtained with the well flowing fully open, because of the short discharge time. Data collected during this time

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showed a decrease in wellhead pressure from 245 to 190 psig, with a corresponding decrease in flow rate from 490,000 to 360,000 lbs/hr. Because of the steep rate of pressure and mass flow decline, no estimate of stabilized conditions has been made.

5. The producing zone has a productivity index of 300 lbs/hr/psi, based on a pressure survey conducted with the well flowing at 140,000 lbs/hr.

6. Pressure-buildup data were analyzed using both constant-pressure outer-boundary and infinite outer-boundary models. The formation flow capacity was estimated to be 6,500 and 11,700 millidarcy feet (md·ft) respectively from the two models; with skin factors of +6 and +10 respectively. The positive skin factors suggest that the well is damaged.

7. Temperature and pressure data from surface and downhole measurements were adequate to define the boiling-point curve for the brine. Some of the data, however, follow the pure-water boiling-point curve, and this is believed to indicate that separation of brine and steam occurred in the flowline between the wellhead and the sampling loop. It is recommended that pressure and temperature gauges be installed at the bottom of the pipeline prior to the next flow test to confirm this interpretation.

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RECOMMENDATIONS

1. During the flow test, problems were encountered with the operation of the James tube, muffler and weirbox due to mineral deposition. It is thought that the majority of these problems can be overcome by simple modifications to the system before the next flow test. The following modifications are recommended and have already been discussed with Bechtel:

   a. The James tubes should be extended in length, to ensure that they discharge directly into the muffler and not into the baffle pipe.

   b. An 8-inch line should be installed from the muffler to the brine pit, to allow the muffler to be drained.

   c. The baffles in the weirbox and the weir plate should be removable so that sludge can quickly be cleaned out of the weirbox on a routine basis during the flow test.

   d. A nitrogen bottle should be connected to the lip pressure tap line so that it can be blown down on a routine basis to prevent scaling.

2. In addition to the above mechanical modifications, the following changes are recommended to improve observations and the accuracy of the collected data:

   a. The sight glass on the weirbox should be relocated at least two feet upstream of the weir to ensure that the maximum head is being measured.

b. The weir crest length should be reduced from the present 15 inches to 10 inches.

c. The pressure taps at the measuring orifice should be changed from flange taps to pipe taps, and gauges should be used to measure the pressure drop across the orifice.

3. The well should be flowed at only two rates during the final flow test to ensure that stabilized conditions are achieved because slow reservoir response was observed when the well was fully opened.

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1. INTRODUCTION

As part of the Salton Sea Scientific Drilling Program, well 2-14 was flowed from 28 to 30 December 1985, after encountering part losses of circulation between 6,100 and 6,227 feet in depth, when drilling out below the 9-5/8-inch casing shoe at 6,000 feet. During the flow test, the well was discharged to an atmospheric muffler and the well's output was determined by use of the James lip-pressure method combined with water-flow measurements across a weir. This method is not normally used for testing of high-salinity brine wells because of the problems with mineral deposition. Recognizing this problem, GeothermEx, Inc. recommended the use of a high-pressure separator, with continuous metering of the separated steam and brine phases for calculating total mass-flow rate and enthalpy. However, because of the cost of such an installation, it was decided to proceed with the atmospheric muffler and weirbox.

GeothermEx, Inc. personnel were on-site during the period of preparation for the flow tests and during the testing and sampling of 28 to 30 December. However, no GeothermEx personnel were present during the attempted downhole sampling of 31 December 1985.

GeothermEx, Inc. is responsible for the interpretation of physical and other data collected during the test. In addition, GeothermEx, Inc. has provided advice to Bechtel on various aspects of testing, logging and sampling the well.

The purpose of this report is to present the physical data collected during the flow test and an interpretation of that data.

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1.1 Flow-Test Facility

The facility used for testing well State 2-14 is shown schematically in figure 1. Using this facility it was possible to discharge the well to either:

a) the mud pit used during drilling;

b) directly to the brine pit through the bypass blooie line; or

c) to the atmospheric muffler/separator, with the water being discharged to a weirbox and then to the brine pit.

The pipeline in the facility was constructed of 10-inch schedule 40 pipe, instrumented with temperature and pressure gauges at the measuring points shown in figure 1. In the fluid-sampling loop, 4 orifice plates were installed at the locations shown in figure 1 (FO-1 to 4) to provide 4 fluid-sampling environments at different temperatures and pressures. A bypass around the sampling loop was also provided, so that the discharged fluid only flowed through the sampling loop during periods of sampling.

The mass flow rate and enthalpy of the brine discharging to the muffler was monitored by recording the lip pressure at the end of the James tube and by measuring the water flow rate over a weir. Initially a 90° V-notch weir was installed, but this was later replaced with a 15-inch rectangular-notch weir. An orifice plate was also installed upstream of the James tube to provide another method of calculating the mass flow rate and enthalpy. A Foxboro recorder was used to continuously monitor (a) the pressure upstream of the orifice plate, (b) the orifice plate differential pressure and (c) the lip pressure. The fluid level in the weir box was measured with both a dipstick and a sight glass.

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2. DESCRIPTION OF THE FLOW TEST

Well State 2-14 was flowed as part of the Salton Sea Scientific Drilling Program from 28 to 30 December 1985. The discharge history is summarized in figure 2 and in the following section. This section is based mainly on records and data collected by the U.S. Geological Survey on-site Science Manager and his staff.

The decision to flow the well was made on 24 December 1985 after partial losses of circulation were encountered between 6,100 and 6,227 feet in depth. After this decision was made, the drilling mud was displaced from the hole with fresh water, and the rig was put on standby status. A suite of logs, including static temperature and pressure surveys, was then run in the well, and these were completed by 28 December 1985. By this time the wellhead pressure had risen to 165 psig, because of heating and subsequent expansion of the fresh water; and it was felt that the well could possibly discharge without the need for nitrogen injection.

The well was opened to the mudpit at 1324 hours on 28 December 1985, and the initial flow was estimated to be approximately 35 gallons per minute (gpm), at a wellhead pressure of 6 psig. The flow continued at this rate, with discharge temperature increasing from 165°F to 196°F. However, the temperature stabilized at 196°F, and it was noted that the fluid was becoming more muddy and the flow rate was decreasing. Therefore, at 1530 hours the decision was made to inject nitrogen in order to initiate a full discharge. Tubing was run into the well to 1,500 feet, and nitrogen was pumped at a constant rate of 250 cubic feet per minute (cfm). By 1800 hours the well was discharging to the mudpit.

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At 1830 hours the flow was bypassed to the brine-pit blooie line, which was equipped with a lip-pressure tap (figure 1), to give an initial indication of the flow rate. At 1858 hours the flow was bypassed to the atmospheric muffler, with the separated water flowing across a 90° V-notch weir into the brine pit.

At 1938 hours it was noted that water was backflowing out of the baffle pipe surrounding the James tube. It was believed that this was caused by flooding of the muffler, because of limited capacity in the weir-box, and the flow was diverted back to the blooie line at 1944 hours. To increase the capacity of the weirbox, it was decided to replace the 90° V-notch weir with a rectangular-notch weir having a crest length of 15 inches. It was also decided that the first baffle in the weirbox should be reduced in height.

While waiting for the welder to make the modifications, the flow was throttled back and rediverted to the muffler at 2151 hours. This was necessary because spray from the blooie line was being carried beyond the brine pit.

Modifications to the weirbox were completed at 0327 hours on 29 December 1985. While the modifications were being carried out, the flow was diverted to the blooie line, and the inside of the muffler was inspected to see if scale buildup was restricting the two 12-inch outlet lines. A coating of salt scale of approximately 1/4- to 1/2-inch thickness was found on the sides of the muffler; scale buildup also had occurred in the center of the muffler base. However, the two outlet pipes were clear.

It was also decided to replace the 7-inch James tube with a 5-inch James tube. After the James tube was removed, a buildup of scale was

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observed inside the baffle pipe, starting where the fluid would have discharged from the end of the James tube. This was cleaned out and the 5-inch tube was installed. A vacuum truck was also utilized to clean out the weirbox, which was found to be full of sludge.

The flow was diverted back to the muffler after the modifications were completed. However, at 0413 hours the flow was again diverted to the blooie line because of excessive fluid backflow past the James tube. The James tube was removed and the baffle pipe was found to be badly scaled. The scale was removed and a 10-inch James tube was installed. The flow was rediverted to the muffler at 0522 hours. However, the same problem was encountered, and the flow again was diverted to the blooie line at 0654 hours. After a few minutes it was realised that spray from the blooie line was still being carried beyond the brine pit, and that it would be necessary to modify the end of the line to direct the flow down into the brine pit. The flow was therefore rediverted to the muffler.

At 0753 hours the flow was diverted through the sampling loop so that fluid sampling could be started. However, it was found that the temperature drop between each of the sampling spools was inadequate and that it was thus necessary to replace the pressure-reducing orifice plates. The flow was therefore diverted back to the bypass line at 0915 hours. The orifice plates were replaced, and flow restarted through the sampling spools at 1234 hours. As before, the temperature drops were found to be inadequate, and the flow was bypassed at 1244 hours. After further changes were made in orifice diameter, the flow was diverted back to the sampling loop successfully at 1416 hours. Sampling continued until 2005 hours.

While the orifice plates in the sampling loop were being replaced, the end of the blooie line was modified, to direct the flow down into the

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brine pit. Flow was bypassed from the muffler at 1227 hours. With the flow going to the blooie line, it was possible to remove the 10-inch James tube and to clean out the baffle pipe. The 10-inch James tube was also extended in length so that fluid would discharge directly into the muffler rather than into the baffle pipe, to overcome the problem of backflow from the baffle pipe. At the same time, preparations were underway to conduct temperature and pressure surveys with the well on discharge, using the "dewared" Kuster temperature and pressure tools.

However, prior to conducting the surveys, it was found that the flange above the master valve was leaking. It was decided to abort the surveys and shut in the well. The well was shut at 2115 hours, whereupon the bottom flange on the master valve also began to leak. Both flanges were retightened and a kill line was installed.

The well was reopened to the brine-pit blooie line at 0113 hours, 30 December 1985. At 0328 hours the flow was diverted to the muffler and the flow rate slowly was increased. The well was fully opened by 0435 hours. No problems were encountered with backflow at the baffle pipe, and there was no sign of excessive water carryover in the steam. It was found, however, that the weirbox quickly filled with salt sludge, and by 0515 hours the level was close to the bottom of the weir notch. The sludge was shovelled out manually, with the well continuing to flow to the muffler. However, the rate of scale buildup was sufficiently great to make this method of cleanout impractical. In addition, it appeared that the lip-pressure tap on the James tube had scaled up by 0548 hours.

With the well fully open, Kennecott then began to take fluid samples at sampling point PI-SP-2 (figure 1). It was observed, however, that the well output was falling off, possibly because of scaling in the

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well. Hence, it was decided that the well should be throttled back as soon as possible. Kennecott completed their sampling by 0613 hours, and the well was throttled back.

Flow was diverted through the sampling loop at 0743 hours to allow the second round of fluid sampling. Sampling was completed by 1520 hours.

During the morning of 30 December 1985, rigging up was completed for the flowing temperature and pressure surveys; running in-hole began at 1350 hours. After completing the surveys, the tools were left in the hole at 5,950 feet (measured depth) to record pressure and temperature buildup after the well was shut-in.

After sampling was completed, the well continued to flow through the sampling loop until 1700 hours, at which time a thermowell (TI-6) in the low-pressure spool of the sampling loop washed out. The flow was then bypassed, and the well was shut-in at 1730 hours. The wellhead pressure had declined to zero by 2008 hours, and the temperature and pressure tools were recovered at 0100 hours on 31 December 1985.

Following recovery of the temperature and pressure tools, the downhole sampler from Los Alamos National Laboratory was rigged up and run into the well at 0400 hours. The tool was recovered, but it was found that the sampling valve had not opened, perhaps because of high cable resistance caused by leaks in the cable head. The cable head was serviced and a second attempt was made to recover a fluid sample. This was also unsuccessful, and it was concluded that leaks between the conductors in the cable were preventing the valve from opening when a surface power source and conductor cable were used.

Hence it was decided to use a battery pack, supplied by Sandia National Laboratory, to actuate the valve from downhole. During this run it was found that the valve did open, but because of the flashing which occurred when fluid entered the evacuated sampling vessel, the entry point scaled up. The motor was unable to close the valve because of the scale; and when the tool was recovered it was found that the battery pack had burnt out. After unsuccessful attempts were made to close the valve on the surface using a spare battery pack, it was concluded that the motor used to operate the valve also had burnt out.

Downhole sampling was therefore aborted at 2200 hours, and injection of the discharged brine back into the well was started at 2300 hours on 31 December 1985, at an approximate flow rate of 600 gpm.

During the downhole surveying and sampling, no evidence of scaling was found in the wellbore, indicating that the decrease noted in the flowrate when the well was fully open was a reservoir response and was not due to choking in the wellbore.

After completion of the flowtest, the pipelines and muffler were inspected for scale deposition. Pipelines were found to be relatively deposit-free, but deposits up to 18-inches thick were found in the muffler. The most severe deposition occurred opposite the tangential inlet, with a decreasing thickness away from that point. When the manhole cover was removed, a deposit 6 to 7 inches in thickness was found on the inside surface.

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3. ANALYSIS OF THE DATA

Data collected from the wellhead, sample spool and muffler during the flow tests are tabulated in Appendix A and plotted in figures 3, 4 and 5. These surface data, along with data collected from downhole surveys, are analyzed in the following sections.

3.1 Estimation of Fluid Enthalpy and Pre-Flash TDS

The discharge enthalpy has been estimated from the temperature (581°F) measured at the bottom of the casing with the well on discharge (figure 6), modified for TDS, using the following formula:

$$h_t = 0.36(T)^{1.16} \cdot 10^{-0.6x}, \qquad (1)$$

where: h_t = total fluid enthalpy (BTU/lb),
T = temperature (°F), and
x = TDS (weight fraction)

TDS could not be measured directly, because of steam separation. However, by use of the chemical concentration measured in the weirbox (370,000 ppm), combined with percentage-steam-flash calculations and equation (1) in an iterative process, the fluid enthalpy and pre-flash TDS were estimated respectively to be 400 BTU/lb and 272,000 ppm or 27.2 weight-%. Using this value for enthalpy, the steam fraction at atmospheric pressure is calculated to be 26.5 weight-%.

The calculated pre-flash TDS of 27.2 weight-% is close to the value of 24.5 weight-% estimated by Michels. Michels also estimated the pre-flash gas content to be about 0.17 weight-%, consisting of 99.6% weight-%

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carbon dioxide. Michels gives no estimate of the fluid enthalpy but indicates that the solution of mixed salts appears to have a smaller heat capacity than its weight-equivalent of sodium chloride brine. This would suggest that the value of enthalpy calculated using equation (1) may be slightly high. However, for calculations of flow rate, it is believed that the estimated enthalpy of 400 BTU/lb is reasonable.

Chemical samples were also collected by Kennecott using an LLL probe to sample at various points across the pipe. If the sampling was representative, the measured TDS should be the same as the pre-flash TDS. However, samples collected at 460 psig and 195 psig had TDS values of 102,430 ppm and 292,735 ppm respectively. The sample collected at 460 psig appears to be diluted with respect to the sample collected at 195 psig, probably due to entrainment of a higher percentage of steam. The sample collected at 195 psig is thought to be more representative of the true pre-flash TDS. However, unless the enthalpy of the sample is equal to the enthalpy of the steam and brine mixture in the pipe, the sample TDS will not be the same as the pre-flash TDS.

3.2 Flow Rate Calculations

The separated water flow rates were calculated from water levels measured in the weirbox (figure 5) using equations (2) and (3):

$$w_f = 8953.2\,\rho_w\,H^{2.481} \quad \text{(90° V-notch weir)} \qquad (2)$$

$$w_f = 11988\,\rho_w\,(1.25-0.2H)H^{1.5} \quad \text{(15-inch rectangular weir)} \qquad (3)$$

$$w_f = 11988\,\rho_w\,(1.25-0.2H)(H+H_v)^{1.5} - 3600\,H_v^{1.5} \qquad (4)$$

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where: w_f = water flow rate (lbs/hr)

ρ_w = water density (lbs/ft^3)

H = water level above weir (ft)

H_v = velocity head = $\frac{velocity^2}{2g}$ (ft)

The density of water in the weirbox was measured and found to be 72 lbs/ft^3. In the calculations of water flow rate, it is assumed that density remained constant at this value throughout the flow test.

The calculated values of water flow rate, based on both the dipstick and sight-glass measurements, are plotted in figure 5.

Equations (2) and (3) assume zero approach-velocity upstream of the weir. With the buildup of salt sludge in the weirbox, this assumption may not always be valid. Equation (4) is used for a rectangular weir when the upstream velocity is not negligible; it indicates that the actual flow rate will be greater than in the zero-velocity case. Therefore, equations (2) and (3) yield a minimum water flow rate. For an upstream velocity of 2 ft/s, the actual flow rate could be underestimated by approximately 20%.

The total mass flow rates shown on figures 3, 4 and 5 have been calculated from the estimated enthalpy of 400 BTU/lb and the measured water flow rate using flash calculations. Where possible, the flow rate also has been estimated from the lip-pressure measurements, using the James (1962) method, corrected for TDS. The correction to the James formula was made following the method outlined by Karamarakar and Cheng (1980) using the Fauske model for 2-phase flow. The total mass flow rates calculated by this method are included in figures 3, 4 and 5; the results match closely with flow rates calculated from the water flow rates and the estimated enthalpy of 400 BTU/lb.

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Data were available from the orifice plate upstream of the James tube for only a short period on the night of the 28 December 1985. Therefore, these data are not analyzed in this report.

From the above calculations, the well was found to produce a stable total flow rate of approximately 140,000 lbs/hr throttled to a wellhead pressure of 450 psig. The well also was discharged with the throttling valve fully open; however, flow rate and wellhead pressure did not begin to stabilise during the period of observation: wellhead pressure declined from 245 to 190 psig, with a corresponding decline in flow rate from approximately 490,000 to 360,000 lbs/hr. Because of the continued high rates of decline in pressure and mass flow, it has not been possible to estimate a final stabilized flow rate.

3.3 Temperature and Pressure Data

Temperature and pressure data were collected from a number of points in the surface pipework (figure 1) during the discharge test, and from downhole surveys conducted while the well was flowing (figure 6). Data measured at the surface and the 2-phase data from the downhole surveys are plotted in figure 7. The data for pure water have been included in figure 7 for comparison purposes.

Measurements taken at the sampling spools and the downhole data lie close to a single curve, which is believed to define the boiling-point curve for this brine. Data from TI-8/PI-8, located upstream of the sampling loop (figure 1), follow the pure-water curve, whereas data from TI-1/PI-1 follow the brine curve at low pressures and the pure water curve at high pressures. The data are replotted to a larger scale in figure 8 to show these trends more clearly.

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These data and trends indicate that water and steam have separated in the pipeline, and that water is flowing along the bottom of the pipe with steam at the top. Hence, the measurements at TI-8/PI-8 were made in steam which is essentially pure, and the measured temperatures and pressures thus reflect pure-water saturation conditions. Similarly, at TI-1/PI-1 there are indications that separation is occurring at low flow rates (high pressures), where the measured temperatures and pressures follow the pure-water curve; but that at high flow rates (low pressure), turbulence has reduced the amount of steam separation, and the measurements follow the brine curve.

To test this hypothesis, it is suggested that temperature and pressure gauges be installed at the bottom of the pipe near TI-8/PI-8 for the next flow test.

The chemical samples collected by Kennecott also support the above hypothesis, as the high-pressure sample has only 35% of the TDS measured in the low-pressure sample. This suggests that the LLL probe was preferentially sampling steam.

3.4 Reservoir Deliverability

From the downhole static- and flowing-pressure surveys (figure 6), the drawdown during flow at 140,000 lbs/hr was calculated to be approximately 470 psi. This indicates that the well has a productivity index of 300 lbs/hr/psi, based on this single point.

The measured pressure buildup after shut-in is plotted on semi-log and log-log coordinates in figures 9 and 10, respectively. The last 4 data points are at the same pressure, suggesting that the well may have been

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affected by a constant pressure outer boundary. The data have therefore been analyzed using both a constant pressure outer boundary solution as well as the more common infinite outer-boundary solution. Using the constant pressure outer boundary solution and fluid properties for a 27.2 weight-% brine, the formation flow capacity and skin factor are calculated to be 6,500 millidarcy feet (md·ft) and +6, respectively. The positive value of skin factor indicates that formation near the well was possibly damaged. The measured productivity index will also be affected by this damage.

Using the more common infinite outer-boundary solution (figure 10), the formation flow capacity is calculated to be 11,700 md·ft, with a skin factor of +10.

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APPENDIX A

Data Collected During Flow Test

A.1: DATA FROM WELLHEAD AREA

DELTIME	PISP1	PI1	TI1	TI2	PISP2	PI8	TI8
1.100	6	-1.	-1.	173	-1.	-1.	-1.
1.267	6	-1.	-1.	181	-1.	-1.	-1.
1.433	6	-1.	-1.	189	-1.	-1.	-1.
1.600	6	-1.	193	193	-1.	-1.	-1.
1.767	6	-1.	197	197	-1.	-1.	-1.
1.933	6	-1.	201	200	-1.	-1.	-1.
2.100	6	-1.	202	200	-1.	-1.	-1.
2.267	6	-1.	202	200	-1.	-1.	-1.
2.450	6	-1.	202	200	-1.	-1.	-1.
4.350	6	-1.	-1.	173	-1.	-1.	-1.
4.450	6	-1.	-1.	168	-1.	-1.	-1.
4.550	6	-1.	-1.	168	-1.	-1.	-1.
4.617	30	10	250	250	-1.	-1.	-1.
4.684	15	-1.	240	240	-1.	-1.	-1.
4.767	22	9	263	258	5	-1.	-1.
4.850	50	35	293	290	8	-1.	-1.
4.933	-1.	85	370	340	8	-1.	-1.
5.017	140	90	355	350	-1.	-1.	-1.
5.100	190	170	390	383	150	140	370
5.217	180	150	382	378	120	115	345
5.384	200	175	398	395	165	155	365
5.600	180	175	398	395	175	160	370
5.717	220	220	412	408	220	205	387
5.967	220	220	415	410	210	205	388
6.267	220	220	415	410	205	200	385
6.400	200	180	405	400	170	165	370
6.634	200	185	400	398	170	165	370
6.834	200	180	400	395	165	160	368
7.067	200	180	397	392	145	120	365
7.284	190	170	390	390	155	155	365
7.650	180	170	388	390	150	148	362
7.767	180	165	395	390	150	145	360
8.167	180	175	393	390	150	150	360
8.450	210	200	410	400	195	200	380
8.800	260	260	420	415	250	240	398
8.900	260	262	410	400	255	250	395
9.117	245	235	400	395	225	240	390
9.217	210	190	385	380	200	200	380
9.500	240	240	400	395	240	248	393
9.717	300	300	420	419	300	310	415
9.983	320	320	425	420	312	320	418
10.200	330	325	425	422	325	330	420
10.483	340	330	426	425	330	340	422
10.750	340	338	428	426	340	350	425
11.217	350	350	432	430	350	355	428
11.650	360	360	434	432	367	370	430
12.133	375	370	436	435	370	375	430
12.650	380	380	439	438	380	382	433
13.100	388	388	441	439	388	390	436
13.433	395	390	441	439	390	395	440

DELTIME	PISP1	PI1	TI1	TI2	PISP2	PI8	TI8
14.017	400	390	442	440	395	400	440
14.350	410	410	446	445	412	420	442
14.950	420	412	446	447	415	420	442
15.467	420	420	449	449	420	425	441
15.967	420	420	450	448	420	425	442
16.217	420	420	465	460	390	390	445
16.517	400	400	455	445	400	405	445
17.050	415	415	458	448	420	415	445
17.534	410	415	457	449	410	415	449
17.950	415	418	447	446	415	422	441
18.400	405	400	445	442	405	410	440
18.500	405	405	445	442	405	410	442
18.717	415	420	459	459	415	420	449
19.217	425	425	450	449	430	440	448
19.650	430	430	450	449	430	435	445
20.300	415	415	447	445	418	425	440
20.867	415	415	446	446	415	422	442
21.617	410	410	445	442	415	420	442
22.383	410	410	445	445	410	415	440
23.200	410	410	445	444	410	415	446
23.450	440	440	450	450	430	440	448
23.883	450	450	454	452	450	455	450
24.450	450	460	455	455	455	455	450
24.800	450	452	455	453	453	460	452
25.283	450	460	455	455	445	465	450
25.700	450	455	455	455	460	460	450
26.150	450	460	455	455	465	465	450
26.483	450	460	455	455	460	462	450
27.017	450	460	455	455	460	462	452
27.567	450	460	455	455	460	470	450
28.100	455	460	455	455	460	468	450
28.600	455	465	455	455	460	465	453
29.150	455	460	455	455	-1.	470	453
29.683	455	460	455	455	-1.	470	452
30.233	460	465	455	455	-1.	470	450
30.800	460	465	455	455	-1.	470	450
31.717	460	465	460	455	-1.	470	450
32.017	450	-1.	397	400	-1.	-1.	380
36.033	-1.	-1.	-1.	-1.	-1.	175	-1.
36.133	-1.	-1.	-1.	-1.	-1.	210	380
36.233	-1.	-1.	-1.	-1.	-1.	235	388
36.317	-1.	-1.	-1.	-1.	-1.	262	400
36.383	-1.	-1.	-1.	-1.	-1.	290	408
36.466	-1.	-1.	-1.	-1.	-1.	313	415
36.533	-1.	-1.	-1.	-1.	-1.	332	420
36.600	-1.	-1.	-1.	-1.	-1.	340	423
36.683	-1.	-1.	-1.	-1.	-1.	350	427
36.767	-1.	-1.	-1.	-1.	-1.	365	430
36.850	-1.	-1.	-1.	-1.	-1.	380	431
36.933	-1.	-1.	-1.	-1.	-1.	390	433

DELTIME	PISP1	PI1	TI1	TI2	PISP2	PI8	TI8
37.033	-1.	-1.	-1.	-1.	-1.	410	440
37.100	-1.	-1.	-1.	-1.	-1.	410	440
37.183	-1.	-1.	-1.	-1.	-1.	420	445
37.266	-1.	-1.	-1.	-1.	-1.	430	445
37.350	-1.	-1.	-1.	-1.	-1.	440	447
37.600	-1.	-1.	-1.	-1.	-1.	450	450
37.876	-1.	450	455	450	-1.	450	450
38.417	-1.	450	466	458	-1.	470	455
38.967	-1.	450	462	452	-1.	450	450
39.333	-1.	245	422	420	-1.	220	392
39.450	-1.	-1.	-1.	-1.	-1.	205	-1.
39.517	-1.	228	416	416	-1.	210	388
39.750	-1.	220	413	412	-1.	200	385
40.000	-1.	210	420	410	-1.	190	380
40.267	-1.	200	407	405	-1.	180	380
40.667	-1.	190	402	401	-1.	170	375
41.100	-1.	310	425	420	-1.	320	412
41.383	-1.	280	422	422	-1.	300	412
41.750	-1.	360	449	438	-1.	350	435
42.300	-1.	390	455	442	-1.	380	440
42.650	-1.	405	450	442	-1.	410	442
43.167	-1.	425	453	442	-1.	420	448
43.533	-1.	430	455	450	-1.	430	450
44.183	-1.	438	457	450	-1.	450	450
44.983	-1.	445	460	452	-1.	440	452
45.433	-1.	445	455	450	-1.	440	452
46.300	-1.	445	460	452	-1.	443	452
46.767	-1.	450	458	452	-1.	440	452
47.300	-1.	455	465	452	-1.	422	452
47.937	-1.	450	460	452	-1.	442	452
48.650	-1.	450	468	450	-1.	450	450
49.400	-1.	455	458	450	-1.	-1.	-1.
50.250	-1.	450	463	452	-1.	450	452
50.850	-1.	460	460	452	-1.	450	452
51.217	-1.	460	458	455	-1.	450	455
51.883	-1.	460	458	455	-1.	465	455
52.033	400	-1.	-1.	-1.	-1.	-1.	-1.
52.633	400	-1.	-1.	-1.	-1.	-1.	-1.
53.267	375	-1.	-1.	-1.	-1.	-1.	-1.
53.567	340	-1.	-1.	-1.	-1.	-1.	-1.
54.183	60	-1.	-1.	-1.	-1.	-1.	-1.
54.733	0	-1.	-1.	-1.	-1.	-1.	-1.

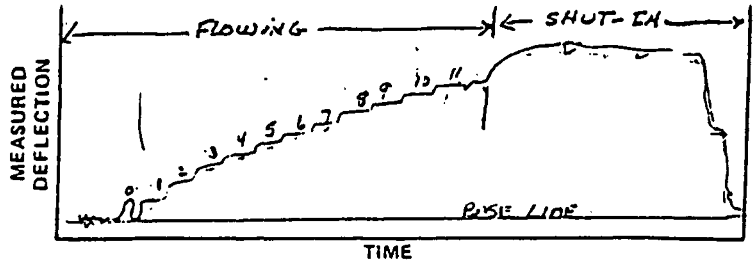
A.2: DATA FROM SAMPLING SPOOLS

DELTIME	PI3	TI3	PI4	TI4	PI5	TI5	PI6	TI6
25.733	270	-1.	110	-1.	62	-1.	40	-1.
26.200	260	-1.	110	-1.	59	-1.	38	-1.
26.517	275	432	125	372	56	330	40	307
27.050	268	432	125	377	59	331	40	307
27.600	270	432	120	373	59	333	40	309
28.150	275	431	120	373	55	327	40	309
28.633	275	428	120	374	58	325	40	306
29.200	275	428	120	374	57	326	40	306
29.767	275	432	120	372	58	325	40	-1.
30.267	250	432	120	373	56	326	40	307
30.833	250	434	100	373	54	325	40	309
31.733	250	430	120	373	58	327	38	310
37.883	210	-1.	120	-1.	50	-1.	30	-1.
43.233	350	447	180	392	70	346	60	328
43.600	325	452	165	393	82	348	55	328
44.000	335	454	165	393	80	349	59	329
44.383	335	454	170	393	91	348	65	329
44.800	350	452	170	395	84	348	60	326
45.167	338	454	170	395	80	350	60	326
45.633	335	454	165	394	80	350	60	329
46.150	323	456	170	398	85	350	61	328
46.817	355	457	160	395	80	350	58	329
47.367	343	453	170	395	82	350	62	329
47.967	340	451	175	396	79	350	58	328
48.750	350	452	175	393	86	345	58	323
49.337	360	454	175	395	80	347	58	328

A.3: DATA FROM MUFFLER AREA

DELTIME	PI10	PI9	LI1	LI1A	PI11	WF1	WF2	TMF
5.150	20.0	-1.0	-1.000	-1.000	-1.0	-1.00	-1.00	-1.00
5.183	75.0	-1.0	-1.000	-1.000	10.0	-1.00	-1.00	-1.00
5.267	60.0	-1.0	-1.000	-1.000	5.0	-1.00	-1.00	-1.00
5.350	80.0	-1.0	-1.000	-1.000	13.0	-1.00	-1.00	-1.00
5.433	80.0	-1.0	-1.000	-1.000	12.0	-1.00	-1.00	-1.00
5.517	75.0	-1.0	-1.000	-1.000	12.0	-1.00	-1.00	-1.00
5.633	82.0	-1.0	-1.000	-1.000	12.0	-1.00	-1.00	-1.00
6.133	70.0	-1.0	12.625	10.438	-1.0	710.86	443.37	968.19
6.317	80.0	-1.0	-1.000	-1.000	12.0	-1.00	-1.00	-1.00
6.500	70.0	-1.0	-1.000	-1.000	12.0	-1.00	-1.00	-1.00
6.650	85.0	-1.0	-1.000	-1.000	12.0	-1.00	-1.00	-1.00
6.867	75.0	-1.0	-1.000	-1.000	12.0	-1.00	-1.00	-1.00
7.100	75.0	-1.0	-1.000	-1.000	12.0	-1.00	-1.00	-1.00
7.317	70.0	-1.0	-1.000	-1.000	10.0	-1.00	-1.00	-1.00
7.683	70.0	-1.0	-1.000	-1.000	10.0	-1.00	-1.00	-1.00
7.950	70.0	-1.0	-1.000	-1.000	9.0	-1.00	-1.00	-1.00
8.217	70.0	-1.0	-1.000	-1.000	9.0	-1.00	-1.00	-1.00
8.483	80.0	-1.0	10.875	10.938	-1.0	490.92	497.95	668.63
8.717	50.0	-1.0	10.375	9.188	-1.0	436.81	323.09	594.94
9.000	20.0	-1.0	7.625	6.188	-1.0	203.45	121.16	277.10
9.267	15.0	-1.0	7.875	6.438	-1.0	220.41	133.68	300.20
9.583	27.0	-1.0	8.375	7.188	-1.0	256.78	175.71	349.73
9.800	25.0	-1.0	7.875	6.438	-1.0	220.41	133.68	300.20
9.867	20.0	-1.0	8.000	6.688	-1.0	229.19	146.93	312.16
10.017	20.0	-1.0	8.000	9.313	-1.0	229.19	334.10	312.16
10.250	20.0	-1.0	8.000	9.313	-1.0	229.19	334.10	312.16
10.517	20.0	-1.0	7.875	9.313	-1.0	220.41	334.10	300.20
10.817	30.0	-1.0	7.440	8.563	-1.0	191.43	271.27	260.72
14.133	75.0	33.0	-1.000	-1.000	-1.0	-1.00	-1.00	-1.00
14.433	95.0	37.0	1.875	3.688	-1.0	63.17	169.90	86.03
16.117	50.0	-1.0	4.125	4.688	-1.0	199.78	240.09	272.10
16.283	110.0	-1.0	5.125	5.188	-1.0	272.76	277.52	371.50
16.600	45.0	-1.0	3.625	3.688	-1.0	165.74	169.90	225.74
17.100	40.0	-1.0	3.125	3.188	-1.0	133.59	137.50	181.95
17.467	50.0	-1.0	2.625	2.688	-1.0	103.56	107.19	141.05
18.067	-1.0	-1.0	1.625	1.688	-1.0	51.14	54.07	69.65
18.450	-1.0	-1.0	1.375	1.688	-1.0	39.94	54.07	54.40
19.217	-1.0	-1.0	2.125	2.188	-1.0	75.95	79.26	103.45
19.833	-1.0	-1.0	1.750	1.688	-1.0	57.05	54.07	77.71
20.417	-1.0	-1.0	1.625	1.688	-1.0	51.14	54.07	69.65
20.933	-1.0	-1.0	1.625	1.688	-1.0	51.14	54.07	69.65
21.683	-1.0	-1.0	1.625	1.688	-1.0	51.14	54.07	69.65
22.583	-1.0	-1.0	1.375	1.563	-1.0	39.94	48.26	54.40
23.317	35.0	-1.0	-1.000	-1.000	5.0	-1.00	-1.00	-1.00
23.350	25.0	-1.0	-1.000	-1.000	-1.0	-1.00	-1.00	-1.00
23.533	22.0	-1.0	-1.000	-1.000	3.0	-1.00	-1.00	-1.00
23.783	25.0	-1.0	-1.000	-1.000	2.0	-1.00	-1.00	-1.00
24.500	23.0	-1.0	-1.000	-1.000	6.0	-1.00	-1.00	-1.00
24.950	25.0	-1.0	-1.000	-1.000	7.0	-1.00	-1.00	-1.00
25.350	25.0	-1.0	-1.000	-1.000	7.0	-1.00	-1.00	-1.00

DELTIME	PI10	PI9	LI1	LI1A	PI11	WF1	WF2	TMF
25.767	25.0	-1.0	-1.000	-1.000	10.0	-1.00	-1.00	-1.00
26.250	25.0	-1.0	-1.000	-1.000	10.0	-1.00	-1.00	-1.00
26.717	25.0	-1.0	-1.000	-1.000	9.0	-1.00	-1.00	-1.00
27.167	25.0	-1.0	-1.000	-1.000	8.0	-1.00	-1.00	-1.00
27.700	20.0	-1.0	-1.000	-1.000	10.0	-1.00	-1.00	-1.00
28.267	23.0	-1.0	-1.000	-1.000	8.0	-1.00	-1.00	-1.00
28.783	28.0	-1.0	-1.000	-1.000	7.0	-1.00	-1.00	-1.00
29.267	25.0	-1.0	-1.000	-1.000	7.0	-1.00	-1.00	-1.00
29.850	20.0	-1.0	-1.000	-1.000	5.0	-1.00	-1.00	-1.00
30.333	25.0	-1.0	-1.000	-1.000	7.0	-1.00	-1.00	-1.00
30.917	20.0	-1.0	-1.000	-1.000	8.0	-1.00	-1.00	-1.00
31.817	10.0	-1.0	-1.000	-1.000	-1.0	-1.00	-1.00	-1.00
38.050	20.0	7.0	2.125	3.688	-1.0	75.95	169.90	103.45
38.500	50.0	10.0	3.750	3.688	-1.0	174.08	169.90	237.10
38.883	50.0	7.0	3.500	3.688	-1.0	157.52	169.90	214.54
39.183	155.0	25.0	5.875	-1.000	-1.0	331.18	-1.00	451.07
39.267	150.0	24.0	6.250	-1.000	-1.0	361.42	-1.00	492.26
39.283	150.0	24.0	6.250	-1.000	-1.0	361.42	-1.00	492.26
39.350	135.0	22.0	6.000	-1.000	-1.0	341.19	-1.00	464.70
39.433	130.0	22.0	5.625	-1.000	-1.0	311.39	-1.00	424.12
39.800	127.0	20.0	5.500	5.688	-1.0	301.61	316.31	410.80
40.033	120.0	20.0	5.458	5.688	-1.0	298.35	316.31	406.35
40.300	-1.0	15.0	5.250	5.188	-1.0	282.30	277.52	384.49
40.333	110.0	17.0	-1.000	-1.000	-1.0	-1.00	-1.00	-1.00
40.717	115.0	15.0	5.000	5.188	-1.0	263.31	277.52	358.64
41.117	20.0	15.0	1.750	1.688	-1.0	57.05	54.07	77.71
41.433	30.0	15.0	3.500	3.688	-1.0	157.52	169.90	214.54
41.833	45.0	15.0	3.375	3.438	-1.0	149.42	153.45	203.51
42.333	60.0	15.0	3.625	3.938	-1.0	165.74	186.81	225.74
42.683	45.0	15.0	2.750	3.188	-1.0	110.86	137.50	150.99
42.967	-1.0	-1.0	2.750	3.188	-1.0	110.86	137.50	150.99
43.217	40.0	10.0	2.750	3.188	-1.0	110.86	137.50	150.99
43.567	50.0	10.0	2.875	3.188	-1.0	118.29	137.50	161.12
44.267	45.0	10.0	2.875	3.188	-1.0	118.29	137.50	161.12
45.017	40.0	10.0	2.750	2.688	-1.0	110.86	107.19	150.99
45.433	40.0	10.0	2.625	2.938	-1.0	103.56	122.07	141.05
46.637	40.0	12.0	2.625	2.938	-1.0	103.56	122.07	141.05
46.933	40.0	8.0	2.625	2.688	-1.0	103.56	107.19	141.05
47.467	43.0	8.0	2.625	2.688	-1.0	103.56	107.19	141.05
48.033	38.0	7.0	2.375	2.438	-1.0	89.43	92.91	121.81
48.800	45.0	7.0	2.750	2.688	-1.0	110.86	107.19	150.99
49.437	45.0	7.0	2.625	2.563	-1.0	103.56	99.97	141.05
50.383	35.0	7.0	2.625	3.063	-1.0	103.56	129.72	141.05
51.150	40.0	10.0	2.500	3.188	-1.0	96.42	137.50	131.33
51.600	-1.0	-1.0	1.875	2.688	-1.0	63.17	107.19	86.03
52.367	0.0	5.0	-1.000	-1.000	-1.0	-1.00	32.14	-1.00

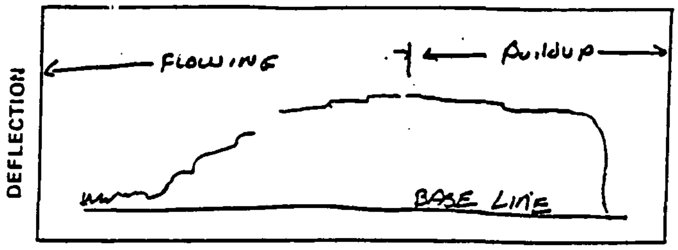


TEST DESCRIPTION A.4: FLOWING SURVEYS AND PRESSURE BUILDUP 850468 (5950 ft.)

ELEM. NO. READ NO.	ELEM. NO. TEST NO.	DATE 1985	ELAPSE TIME MIN.	ELAPSE TIME HR.	REAL TIME	TIME DEPL INCH	PSI DEPL INCH	PSI @ 80°C	ADJUSTMENTS FACTORS °F	ADJUSTMENTS FACTORS DEPL	ADJUSTED DEPL	ADJUSTED PSI	DEPTHS MEASURE	REMARKS
0	2	12-30				0	0		–	–	–	–	Surface	ZERO in
1	2				1415	0	.1405	416.0					275 ft Gage	
2	2				1451	.3305	.1925	570.0					1500	20 min sto.
3	2				1510	.4340	.2150	636.6					2000	
4	2				1522	.5320	.2440	722.5					2500	
5	2				1535	.638	.2710	832.1					3000	
6	2				1550	.7415	.330	977.2					3500	
7	2				1617	.913	.3955	1170.3					4000	20 min
8	2				1631	1.012	.4680	1385.0					~~4500~~	4497
9	2				1645	1.1165	.540	1598.2					5000	4995
10	2				1659	1.220	.6130	1814.3					5500	5493
11	2				1726	1.310	.6880	2032.6					5950'	5939
			Build-up											Unit Time
12	2	12-30	0	0		1.451	.6890	2038.6					5950'	1.272 - 1.41
13	2		1	.017		1.458	.6955	2060.8					5950'	20"/.124
14	2		2	.03		1.465	.7035	2099.3					5950'	1"/.00695
15	2		3	.05		1.472	.720	2133.4					5950'	
16	2		4	.07		1.479	.7305	2164.6					5950'	
17	2		5	.08		1.486	.739	2189.8					5950'	
18	2		6	.10		1.493	.747	2213.5					5950'	
19	2		7	.12		1.500	.754	2234.2					5950'	
20	2		8	.13		1.507	.7605	2253.5					5950'	
21	2		9	.15		1.514	.767	2278.2					5950'	
22	2		10	.17		1.520	.772	2287.6					5950'	
23	2		11	.18		1.527	.777	2302.4					5950'	
4	2		12	.20		1.534	.781	2314.3					5950'	
5	2		13	.22		1.541	.785	2326.2					5950'	
6	2		14	.23		1.548	.789	2338.0					5950'	

SSSDP 16937
Supplier LASL/Sandia/Lee Walder
Carrier
Received By C. A. Harper
Date 1/1/86

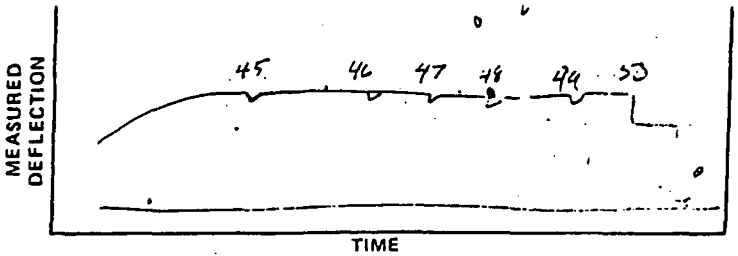
1 -- Unadj



TEST DESCRIPTION FLOWING / BUILDUP TEMP. STATE "2-14 ELEMENT # 27934

ELEM. 27934	READ LOC.	TEST NO.	DATE 1985	ELAPSE TIME MIN	HOURS	REAL TIMES	TIME DEPF	TEMP DEPF	TEMP °C	DEPTH ft	REMARKS
	0	2	12-30			1405	462	?		Surface	Difficult To locate on Chart
	1	2				1451	507.7	1.0910	264.3 238.7	1500	Flowing
	2	2				1510	517.8	1.117	269.9 244.3	2000'	
	3	2				1522	530.6	1.1500	277 251.4	2500'	
	4	2				1535	543.7	1.1840	284.3 258.7	3000'	
	5	2				1550	558.0	1.220	292.2 266.6	3500	
	6	2				1617	565.9	1.2455	297.7 272.1	4000'	
	8	2				1631	575.2	1.2640	301.8 276.2	4500'	4497
	8	2				1645	576.9	1.2655	302.7 277.1	5000'	4995
	9	2				1659	578.7	1.2736	303.7 278.1	5500'	5493
	10	2				1726	580.6	12780	304.8 279.2	5942'	5939
							↑				
							TEMP				Note Base Line
							(°F)	- corrected for			DRAWN AT
								ambient temp.			Approx 78°F
											Add 25°C To READS

LEE Wallen



TEST DESCRIPTION (CONTINUED) Buildup - ELEMENT 850468 STATE [illegible]

ELEM. NO. READ NO.	ELEM. NO. TEST NO.	DATE 1951	ELAPSE TIME MIN.	ELAPSE TIME HR.	REAL TIME	TIME DEPL INCH	PSI DEPL INCH	PSI @ 80°C	ADJUSTMENTS FACTORS °F	ADJUSTMENTS FACTORS DEPL	ADJUSTED DEPL	ADJUSTED PSI	DEPTHS MEASURE	REMARKS
27	2		15	.25		1.555	.793	2349.9					5950	-Buildup-
28	2		16	.27		1.562	.795	2352.8					5950'	
29	2		17	.28		1.569	.7985	2363.2					5950'	
30	2		18	.30		1.576	.8015	2375.1					5950'	
31	2		19	.32		1.583	.5032	2382.5					5950'	
32	2		20	.33		1.590	.8065	2389.9					5950'	
33	2		21	.35		1.597	.8035	2395.9					"	
34	2		22	.37		1.604	.810	2400.3					"	
35	2		23	.38		1.611	.812	2406.2					"	
36	2		24	.40		1.618	.8135	2410.2					"	
37	2		25	.42		1.625	.8150	2415.1					"	
38	2		26	43		1.632	.8160	2418.1					"	
39	2		27	.45		1.639	.8175	2421.5					"	
40	2		28	.47		1.646	.8185	2425.5					"	
41	2		29	.48		1.652	.8195	2428.5					"	
42	2		30	.50		1.660	.821	2432.9					"	Time Unit
43	2		40	.67		1.729	.828	2453.2					"	10'=.0645
44	2		50	.83		1.799	.8320	2465.5					"	
45	2		60	1.0		1.868	.8350	2474.4					"	
46	2		120	2.0		2.307	.840	2489.3					"	
47	2		180	3.0		2.742	.841	2492.2					"	
48	2		240	4.0		3.176	.841	2492.2					"	
49	2		300	5.0		3.602	.841	2492.2					"	
50	2		327	5.45		3.932	.841	2492.2					5950'	pull out [illegible]
51	2		343	5.72		4.120	.555	1642.6					4000'	Ascending

LEFWALDEN

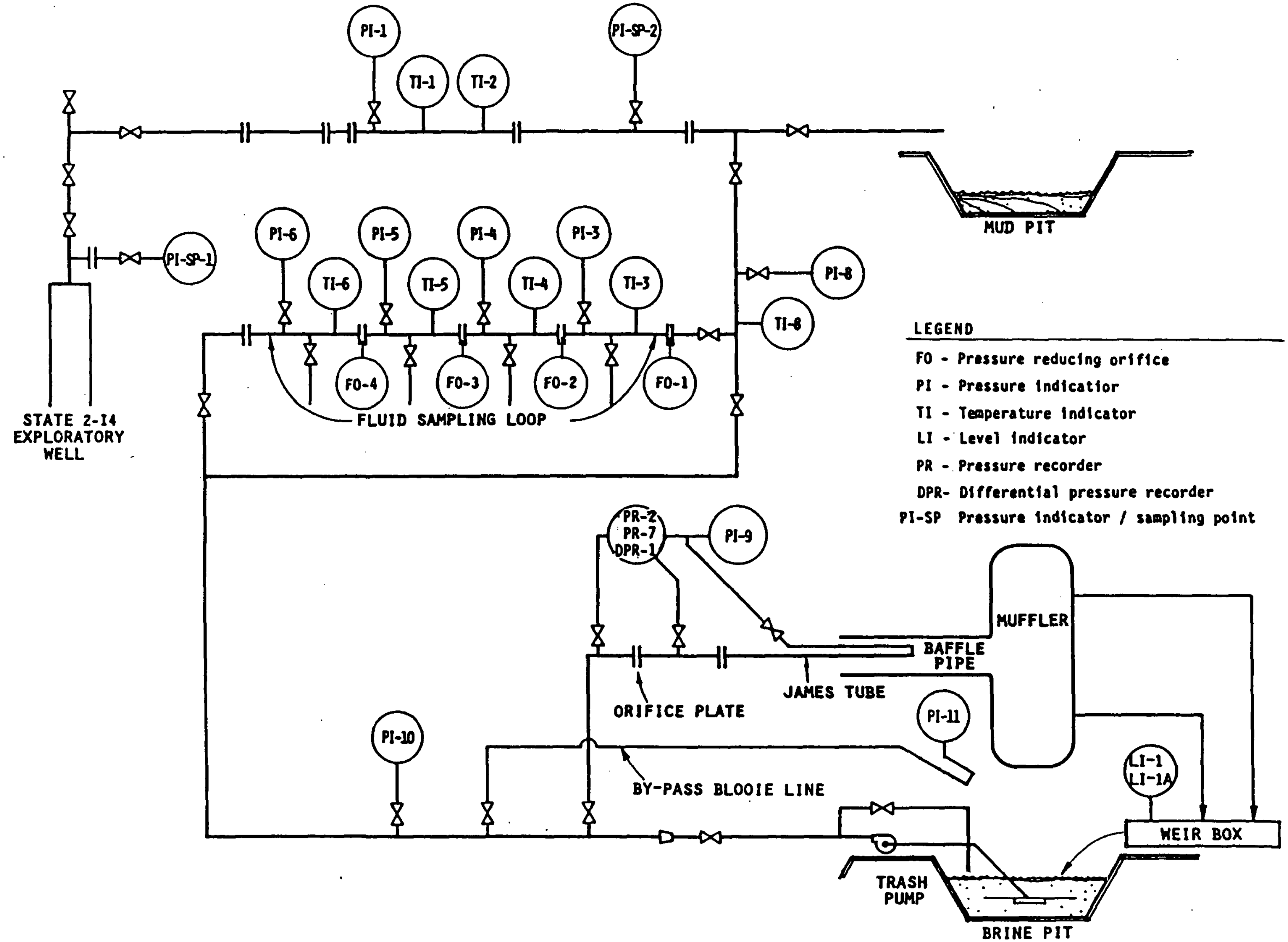


Figure 1. Schematic of flow test facility

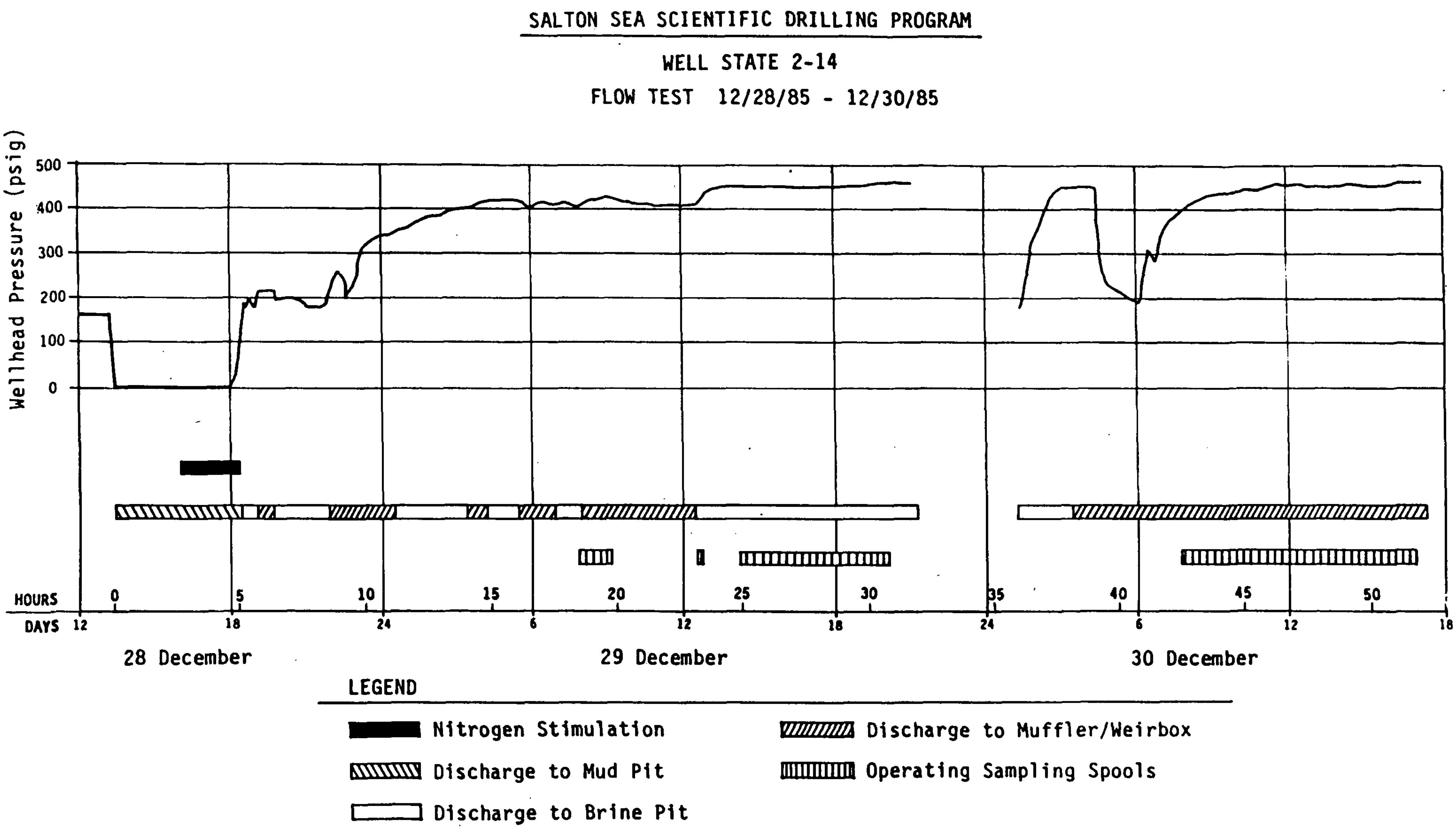


Figure 2. Summary of discharge history

FIGURE 3: DATA FROM WELLHEAD AREA, WELL STATE 2-14 FLOWTEST

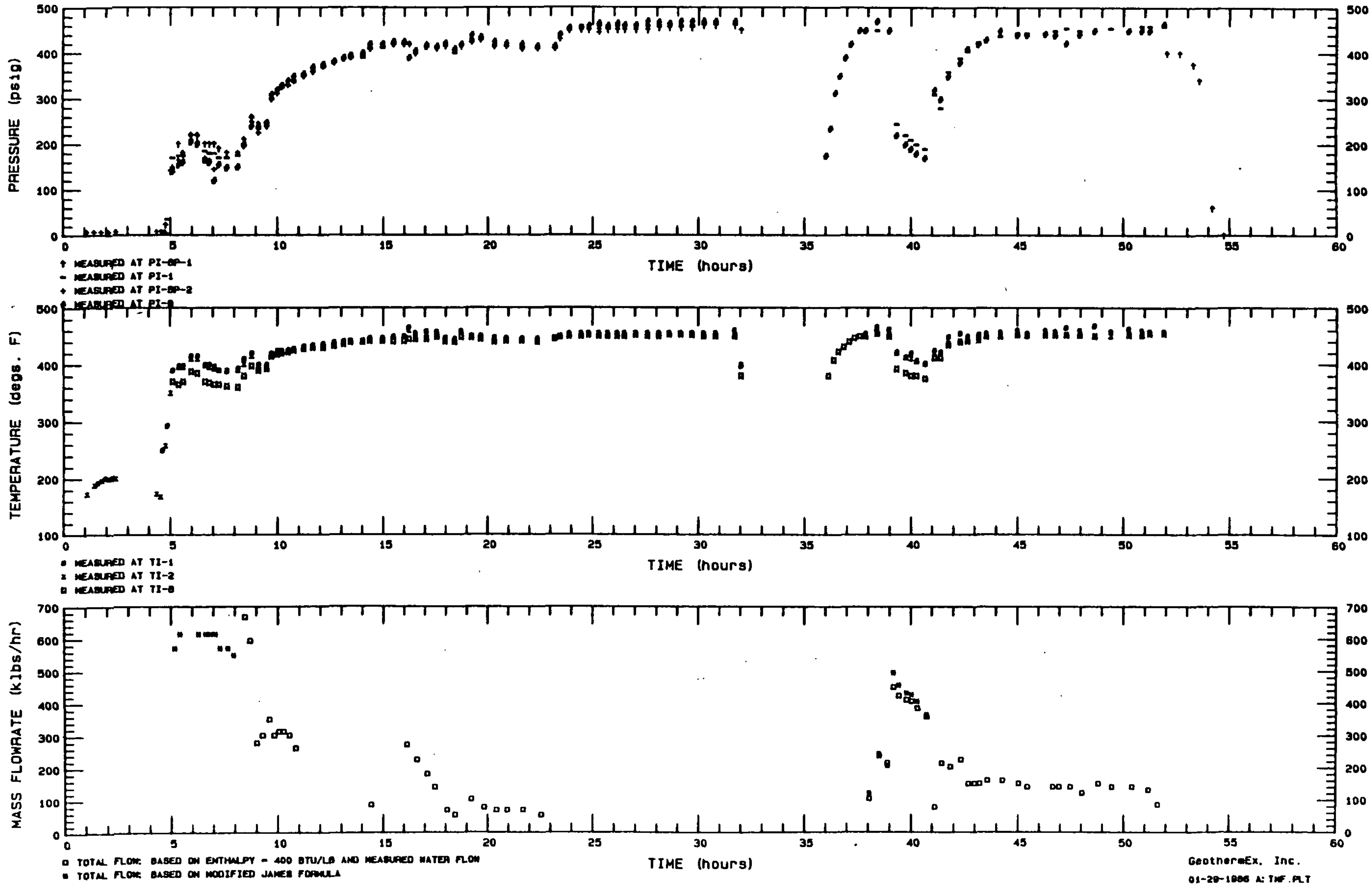


FIGURE 4: DATA FROM SAMPLE SPOOLS, WELL STATE 2-14 FLOWTEST

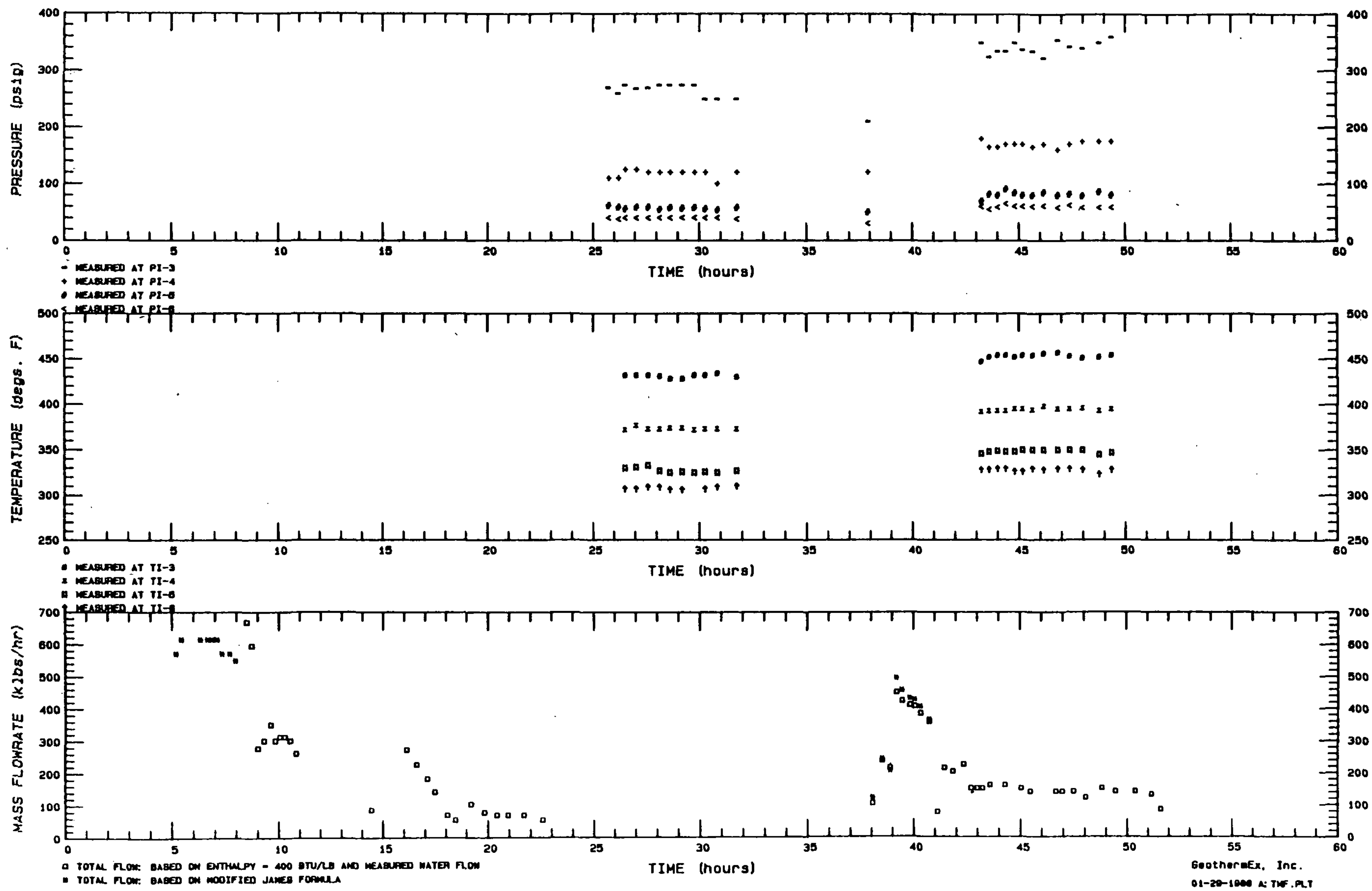


FIGURE 5: DATA FROM MUFFLER AREA, WELL STATE 2-14 FLOWTEST

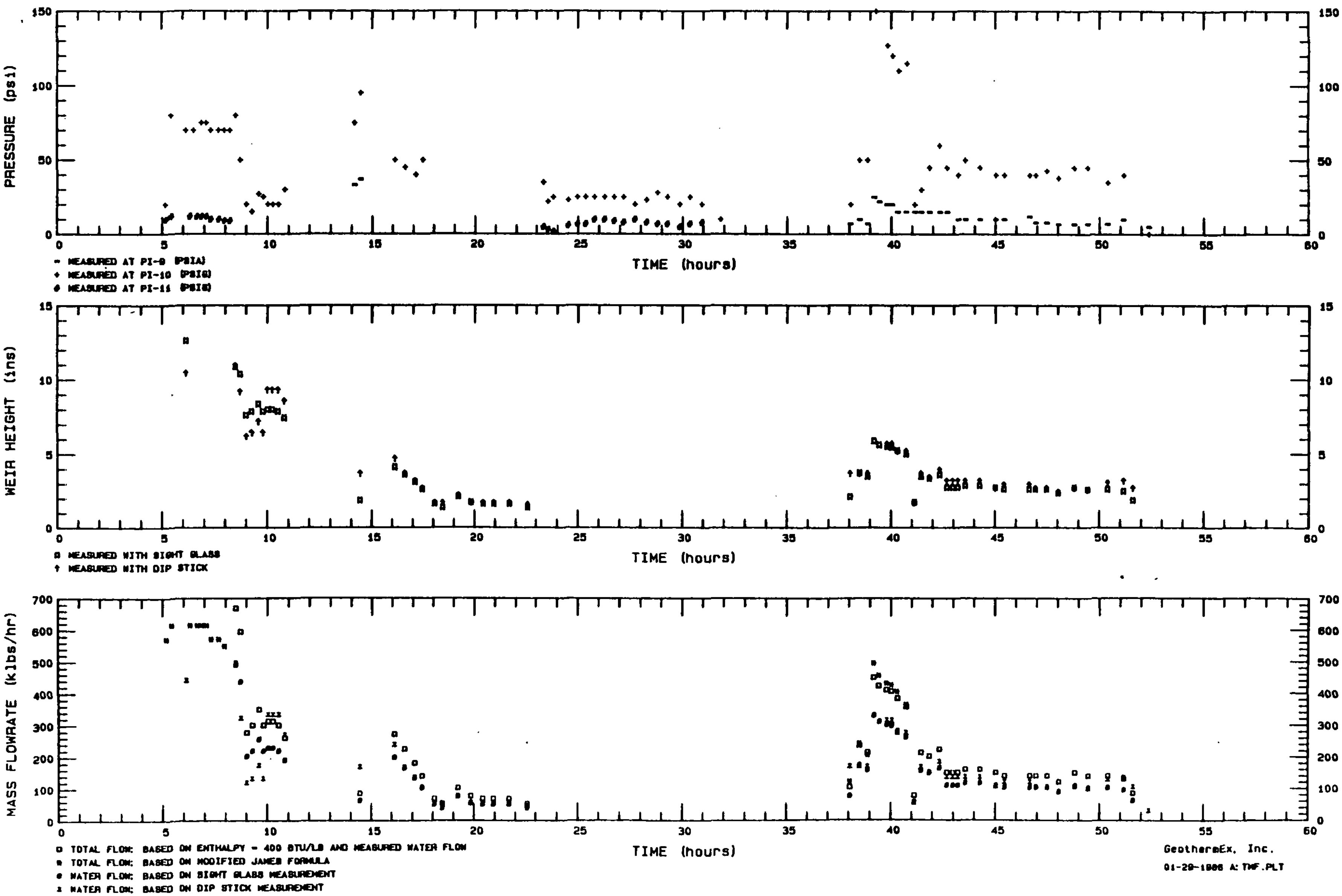


FIGURE 6: TEMPERATURE/PRESSURE SURVEYS, WELL STATE 2-14

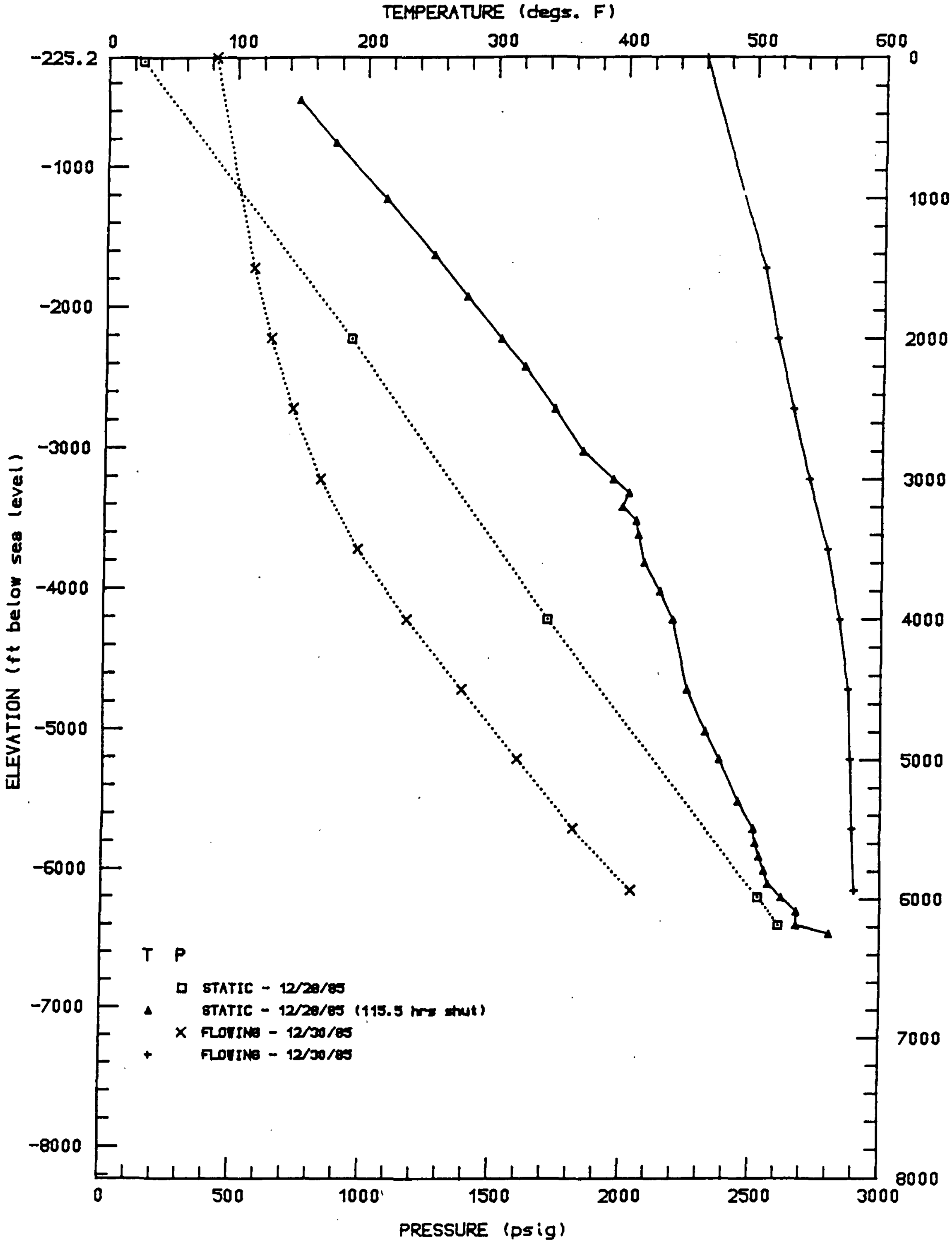


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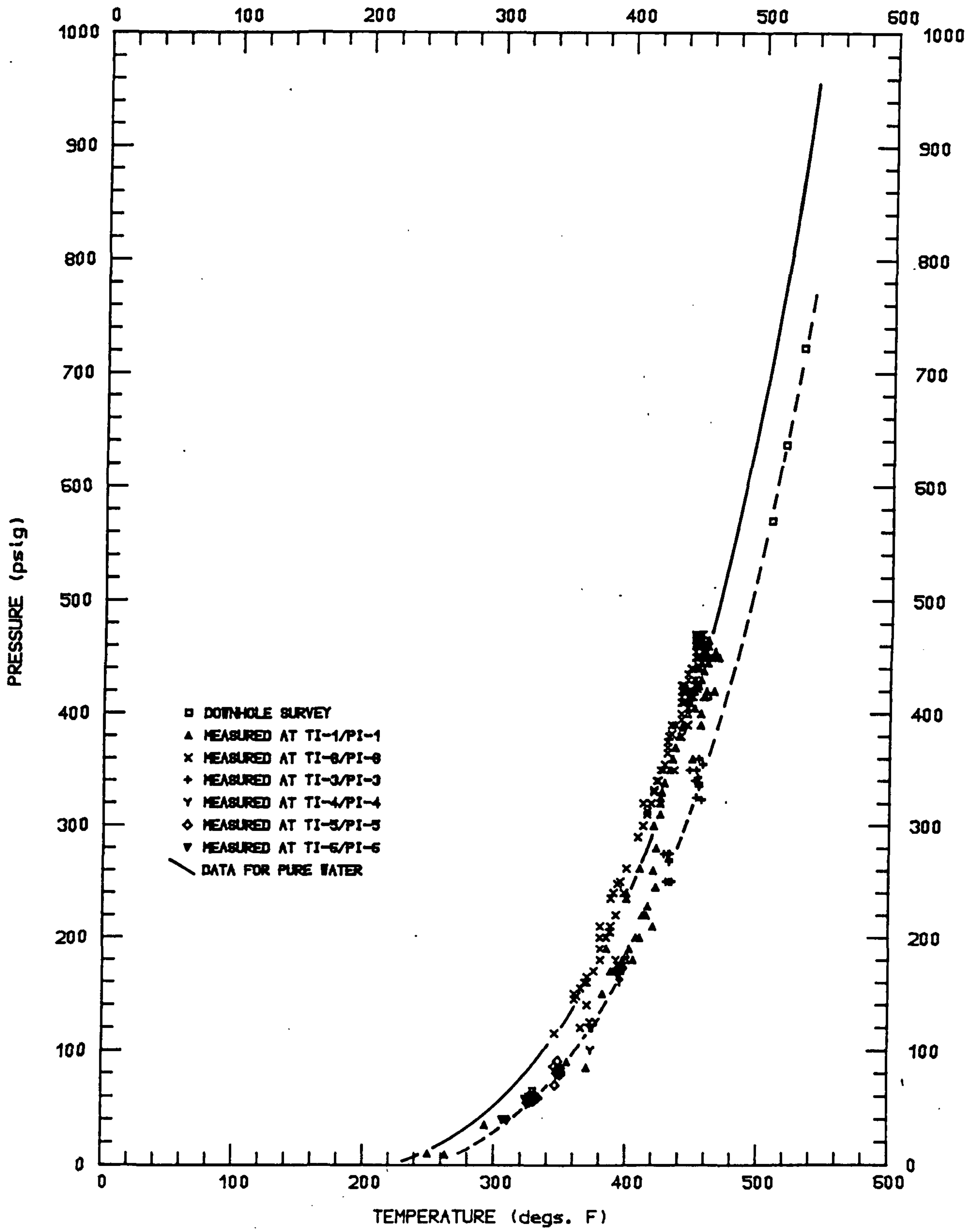
FIGURE 7: BOILING POINT CURVE, WELL STATE 2-14



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02-14-1986 A:DHTP.PLT

FIGURE 8: BOILING POINT CURVE, WELL STATE 2-14

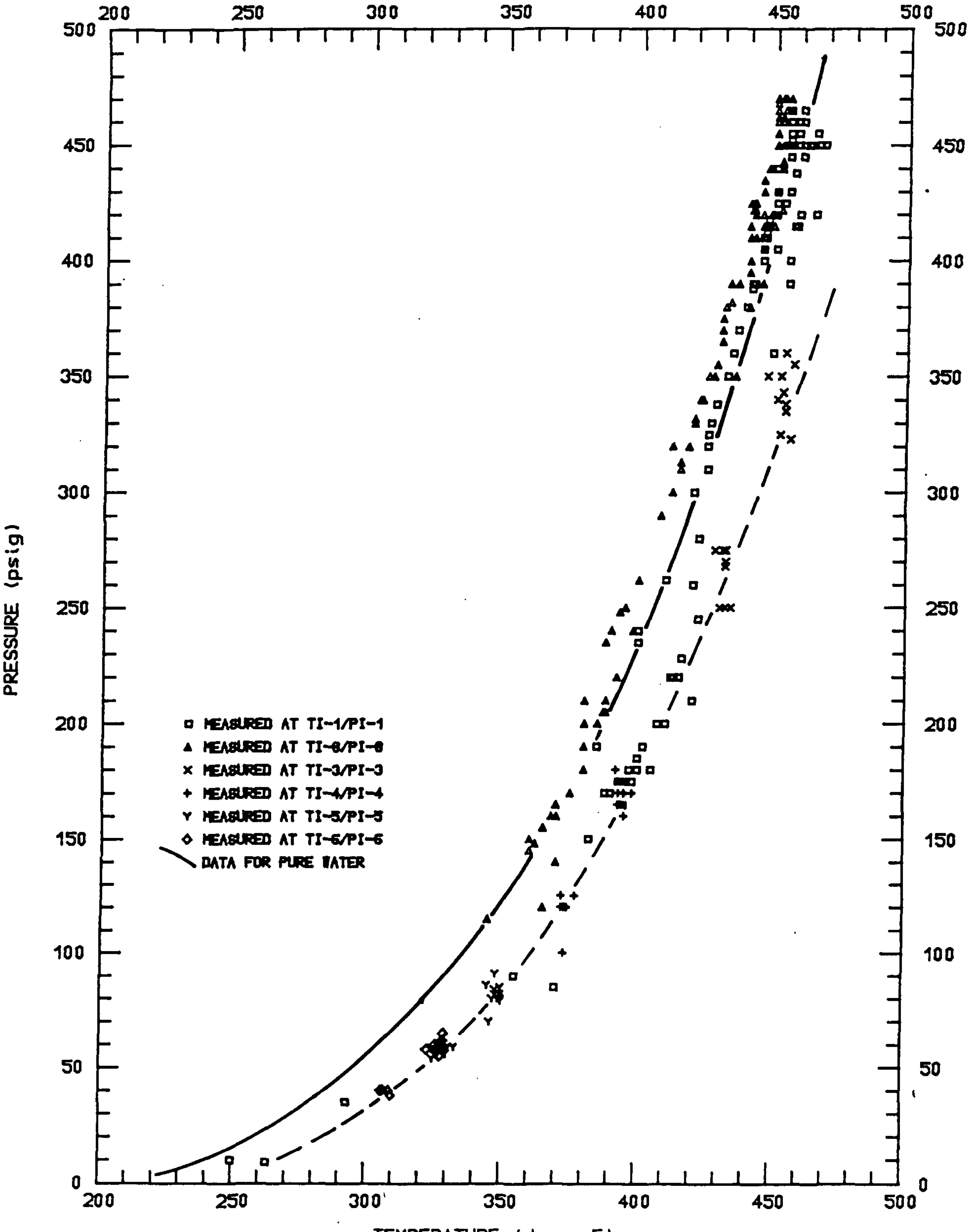

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FIGURE 9: PRESSURE BUILDUP TEST (SEMI-LOG PLOT), WELL STATE 2-14

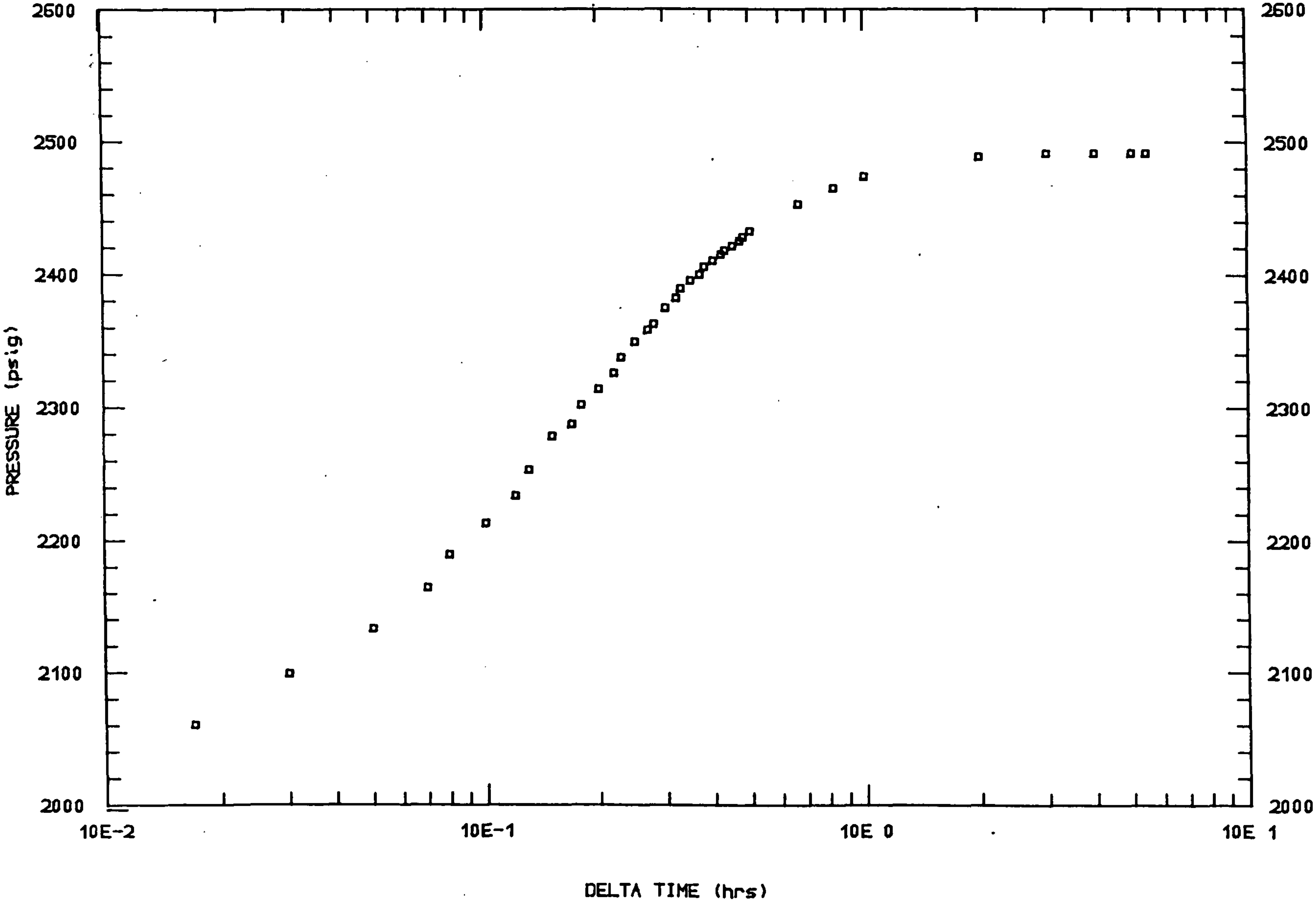

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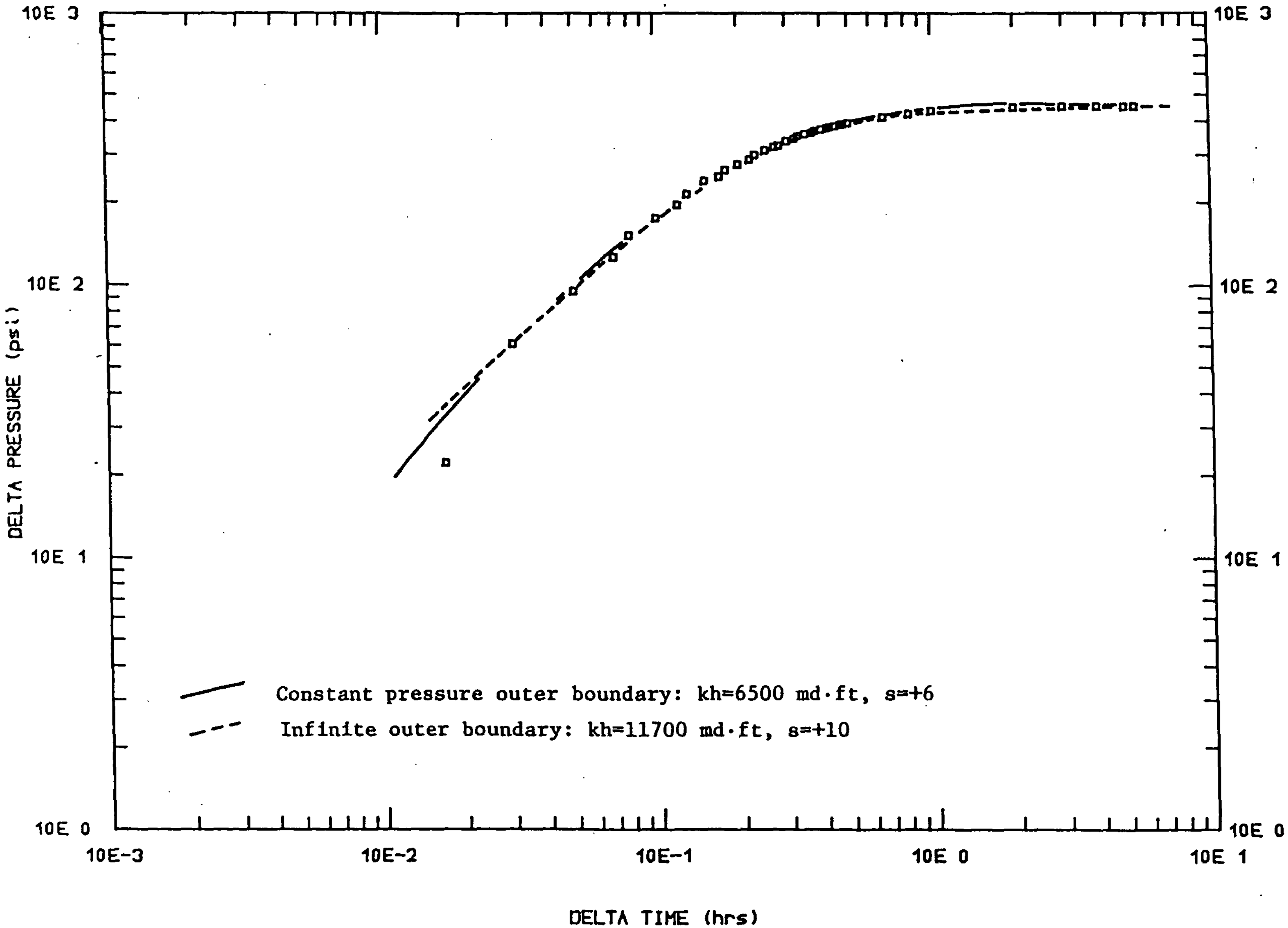
FIGURE 10: PRESSURE BUILDUP TEST (LOG-LOG PLOT), WELL STATE 2-14



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02-14-1986 A:SSSDPPBU.PLT