



JOHNSTON TESTERS

A WORLD OF EXPERIENCE

DRILL STEM TEST SPECIAL DATA ANALYSIS

Test Ticket No. C 3327

Maximum Reservoir Pressure
Po 1948 P.S.I.G.

Slope of Shut-in Curve
M 50 PSI log cycle

Estimated Damage Ratio
EDR 5.7

Potentiometric Surface
Datum Plane, Sea Level
PS 1796 ft.

Effective Transmissibility
 $\frac{K_h \text{ or } K_h}{\mu B \mu Z}$ 1506.7 $\frac{\text{Md-ft.}}{\text{Cp.}}$

Productivity Index
P.I. .36026 Bbl/Day/PSI

Flow Rate
 463.3 Bbls Day

Estimated from back pressure
1767' Oil entered pipe in 68
Minutes.

This appears to be a good formation and mechanical test. The data obtained appears to be adequate for reliable analysis.

#1 WELL BORE DAMAGE

The calculated "Estimated Damage Ratio" of 5.7 indicates that well bore damage is present during the time and at the conditions of this test. The EDR of 5.7 infers that this test interval should have produced at a rate of approximately 2640.8 Bbls/Day with the same flowing pressures observed during the test if the well bore damage were removed.

#2 PERMEABILITY

The calculated transmissibility factor of 1506.7 Md-ft/Cp. indicates the average effective permeability for the 112 foot test interval to be approximately 13.5 Md. This value was calculated assuming that the product of the viscosity and formation volume factor for the reservoir fluid was 1.0.

#3 GENERAL COMMENTS

The initial shut-in pressure plot indicates a maximum reservoir pressure of 1941 P.S.I.G. The final shut-in pressure plot indicates a maximum reservoir pressure of 1940 P.S.I.G. Both plots appear to be good and yield good straight lines for extrapolation purposes. The 7 P.S.I. difference between the two maximum readings is within recorder accuracy I have utilized the maximum reading from the final shut-in for these calculations. From these test data and empirical calculations it is indicated there is oil production from a good permeable zone having some well bore damage present. No unusual characteristics or abnormalities were observed from these test data, pressure plots or calculations.

M. S. Edwards
INTERPRETATION AND EVALUATION SECTION.

Socony Mobil Oil of Canada
SMWM Chance YTG-8
66°-7'-18.1"N-137°-30'-50.8"W
Chance Sand DST # 10
4413-4525

SM 'M Coances YTC-8
 66°-7'-18.1"N-137°-30'-50.8"W DST#10

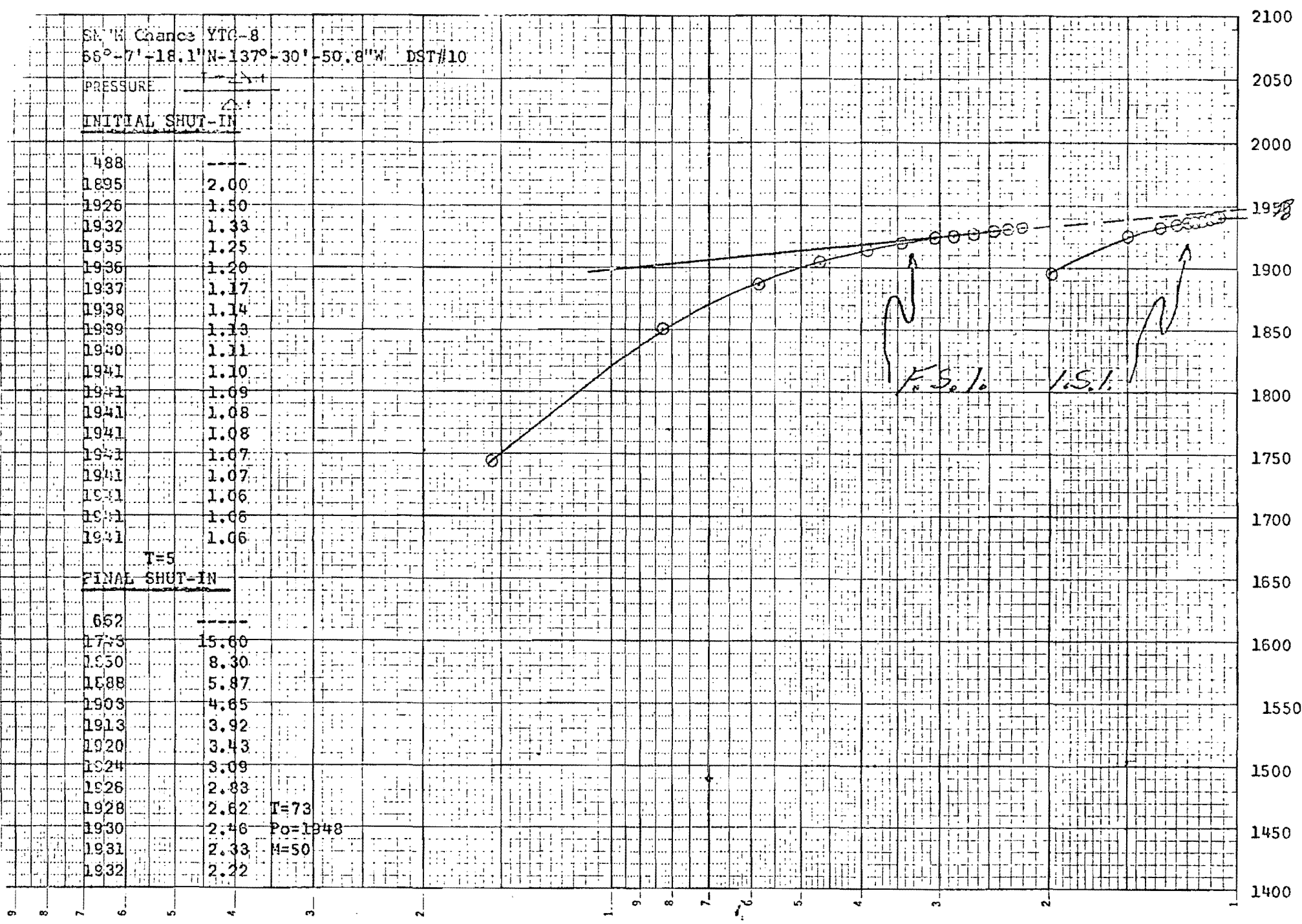
PRESSURE
 INITIAL SHUT-IN

488	---
1895	2.00
1926	1.50
1932	1.33
1935	1.25
1936	1.20
1937	1.17
1938	1.14
1939	1.13
1940	1.11
1941	1.10
1941	1.09
1941	1.08
1941	1.08
1941	1.07
1941	1.07
1941	1.06
1941	1.06
1941	1.06

T=5
 FINAL SHUT-IN

652	---
1773	15.60
1850	8.30
1888	5.87
1903	4.65
1913	3.92
1920	3.43
1924	3.09
1926	2.83
1928	2.62
1930	2.46
1931	2.33
1932	2.22

T=73
 P₀=1348
 M=50



Assumptions made for Calculations for Gas Recoveries

1. Q is taken as steady state flow and unless stated otherwise at standard conditions 14.7 P.S.I. and 60° F.
2. P_r is formation flowing pressure at steady state flow.
3. Formation flow is taken as single phase flow. If liquid (condensate) is produced at surface, condensation is assumed to have occurred in drill pipe.
4. Radial flow is assumed.
5. Unless given, gas specific gravity is assumed to be 0.7 (air 1.0) and having critical temperature at 390° Rankin and critical pressure of 666 P.S.I.A.
6. Other standard radial flow, steady state assumptions.

Empirical Equations:

1.
$$EDR = \frac{1}{\log T + 2.65} \left[\frac{P_o^2 - P_r^2}{M_g} \right] \quad \text{Where } M_g = \frac{\Delta P^2}{\log \text{ cycle}}$$
2.
$$\text{Transmissibility } \frac{Kh}{\mu Z} = \frac{1637 \text{ } ^\circ T_r Q}{M_g}$$
3.
$$P.S. = \left[P_o \times 2.309 \text{ ft./PSI} \right] - \left[\text{Recorder depth to sea level.} \right]$$

Assumptions made for Calculations for Liquid Recoveries

1. Q is taken as steady state flow.
2. P_r is formation flowing pressure at steady state flow.
3. Formation flow is taken as single phase flow. If gas is produced at surface, phase separation is assumed to have occurred in drill pipe.
4. Radial flow is assumed.
5. Where PVT data is not available then it is assumed that: Effective permeability, K, will fall between .1 to 200 md
Formation porosity, f, will fall between0.1 to 0.3
Fluid compressibility, c, will fall between10⁻⁶ to 10⁻⁴
Fluid viscosity, μ, will fall between0.05 to 50 cp.
Well bore radius, r_w, will fall between3 3/8" to 4 3/4"
Which gives an average value for the function $\log \frac{K}{f \mu c r_w^2}$ of5.5
6. Other standard radial flow, steady state assumptions.

Empirical Equations:

1.
$$EDR = \frac{1}{\log T + 2.65} \left[\frac{P_o - P_r}{M} \right]$$
2.
$$\text{Transmissibility } \frac{Kh}{\mu B} = \frac{162.6Q}{M}$$
3.
$$P.I. = \frac{Q}{P_o - P_r}$$
4.
$$P.S. = \left[P_o \times 2.309 \text{ ft./PSI} \right] - \left[\text{Recorder depth to sea level.} \right]$$

Symbols	Dimensions	Symbols	Dimensions
B	Formation volume factor	Q	Rate of flow during test
c	Fluid compressibility	Q _o	Rate of oil flow during test
EDR	Estimated damage ratio	Q _w	Rate of water flow during test
f	Formation porosity	Q _g	Rate of gas flow during test
h	Producing interval	r _w	Well bore radius
J	Productivity index	t	Final shut-in time period
K	Permeability	Δt	Increment time of final shut-in time period
M	Slope of shut-in build up	T	Open flow time period
M _g	Slope of shut-in build up	°T _r	Formation temperature
P _r	Final flowing pressure	μ	Fluid viscosity
P _{r(t)}	Final shut-in pressure, at time t	Z	Gas deviation factor (Compressibility factor)
P _{i(t)}	Initial shut-in pressure	$\frac{Kh}{\mu B}$ or $\frac{Kh}{\mu Z}$	Transmissibility factor
P _o	Maximum reservoir pressure		Md. — ft. Cp.
P. S.	Potentiometric surface		

In making any interpretation, our employees will give Customer the benefit of their best judgment as to the correct interpretation. Nevertheless, since all interpretations are opinions based on inferences from electrical, mechanical or other measurements, we cannot, and do not, guarantee the accuracy or correctness of any interpretations, and we shall not be liable or responsible, except in the case of gross or wilful negligence on our part, for any loss, costs, damages or expenses incurred or sustained by Customer resulting from any interpretation made by any of our agents or employees.

JOHNSTON TESTERS

JTL-CD-4

TEST DATA									
Formation	Chance Sand		Zone Thickness	Ft.		Elevation	1722 KB	1708 GL	
Interval	4413	To	4525	T.D.	4525	Bottom Hole Choke Size	1/2"		
Type of Test	Open Hole, Bottom Hole					Fluid Cushion Type			
Time Started in Hole	0445	Hrs.	Tool Open	0809	Hrs.	Amount			
First Flow	5	Min.	Shut In	90	Min.	TOOL SEQUENCE			
Second Flow	68	Min.	Final Shut In	60	Min.	Tool	Length	O.D.	
Pulled Loose @	1152	Hrs.	Out of Hole	1600	Hrs.	Sub.	.85	6"	
Wt. Set on Packer	30,000	#	Pulled Loose Wt.	35,000	#	P.O. Sub.	.80	4 5/8"	
Remarks	Mud Dropped 6 Feet During Test Period.					Sub.	.60	6"	
Description of Blow During Test	Strong Blow, Dead in 40 Minutes. Strong Blow Throughout Remainder of Test.					D.P. Sub.	.50	5 1/2"	
						Shut in Tool	6.05	4 5/8"	
						Hyd. Tool	7.45	4 5/8"	
						Safety Jt.	1.75	4 5/8"	
						T.C. & Pkr.	6.20	6 5/8"	
GAS BLOW MEASUREMENTS						T.C. & Pkr.	6.10	6 5/8"	
Measured with						Total	30.30		
Type of Instrument						Stub	.90	4 5/8"	
Time	Sfce. Choke	Reading	Inches	Cubic Feet/Day		Perf.	3.00	4 5/8"	
						Recorder	5.90	4 7/8"	
						Recorder	5.90	4 7/8"	
						Perf.	5.00	4 5/8"	
						Sub.	.70	4 5/8"	
						D.C.	87.05	6 1/4"	
						Sub.	.65	6"	
						Perf. & B. Nose	2.50	4 5/8"	
						Total Interval	111.60		
FLUID RECOVERY									
Was Test Reverse Circulated Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>									
Fluid Recovered (Total) 510' Ft.						Total Length	141.90		
Description of Fluid Recovered 100' Oil Cut Drilling Fluid. 410' Oil.						MUD AND HOLE DATA			
Remarks Test Satisfactory.						Mud Type	Gel and Chem	W.L. 8.0	
						Filter Cake	2/32	Visc. 59	Wt. 9.4
						Time Taken	January 19, 1965 @2200 hrs.		
						Contractor	Parker Drilling		
							Rig No. 10		
Co. Rep. A. Warden						Drill Pipe Size	4 1/2	XH	
Tester D. Matson						Drill Collar Size	2 7/8 ID	Length 518'	
District Edmonton						Main Hole Size	8 5/8"		
Company Socony Mobil Oil of Canada						Rat Hole Size			
Well Name SMWM Chance YTG-8						Ticket No. C 3327 Date January 20/65			
Number 66°-7'-18.1"N 137°-30'-50.8"W						Address P.O. Box 240, Dawson Creek, B. C.			
Formation Chance Sand DST#10						Test No.	10	J.T.L. Test No. 10	
and Interval 4413-4525						Field	Wildcat	Province Yukon	
Distribution of Reports 8 - Dawson Creek						Consultant			

JOHNSTON TESTERS

Pressure Data

Test Ticket No. C 3327

Recorder No.	T-52	T-49	
Capacity (P.S.I.G.)	7000	7000	
Recorder Depth	4418	4424	
Pressure Gradient P.S.I. Ft.			
Well Temperature °F.	94°	94°	
A. Initial Hydrostatic	2213#	2249#	
B. First Initial Flow	442#	488#	
C. Initial Shut-In-Press	1939#	1941#	
D. Flowing Pres	428#	476#	
E. Final Flow	616#	662#	
F. Final Shut-In	1928#	1932#	
G. Final Hydrostatic	2194#	2235#	

Remarks

T-52 - Outside Recorder

T-49 - Outside Recorder

JTL-CD-5

JOHNSTON TESTERS

SMWM Chance YTG-8
 66°-7'-18.1"N-137°-30'-50.8"W
 DST#10

Pressure Breakdown Data

Date January 20, 1965

Test Ticket No. C 3327

Recorder No. T-49 Capacity 7000 Recorder Depth 4424

Clock No. _____ Clock travel _____ inches per min. Well Temperature 94 °F.

Point	Pressure	Time Given	Time Computed
A Initial Hydrostatic _____	2249#	0809	M.
B First Initial Flow _____	488#	5	Mins.
C Initial Shut-In-Pres _____	1941#	90	Mins.
D Flowing Pres _____	476#	68	Mins.
E Final Flow _____	662#	60	Mins.
F Final Shut-In _____	1932#		
G Final Hydrostatic _____	2235#		

Remarks: _____

PRESSURE INCREMENTS								
INITIAL SHUT-IN			FINAL SHUT-IN					
Breakdown: <u>18</u> increments of <u>5</u> mins. and a final increment of _____ mins.			Breakdown: <u>12</u> increments of <u>5</u> mins. and a final increment of _____ mins.			Breakdown: _____ increments of _____ mins. and a final increment of _____ mins.		
Point Minutes	Pressure	$\frac{T + \Delta t}{\Delta t}$	Point Minutes	Pressure	$\frac{T + \Delta t}{\Delta t}$	Point Minutes	Pressure	$\frac{T + \Delta t}{\Delta t}$
0	488	----	0	662	-----			
5	1895	2.00	5	1743	15.60			
10	1926	1.50	10	1850	8.30			
15	1932	1.33	15	1888	5.87			
20	1935	1.25	20	1903	4.65			
25	1936	1.20	25	1913	3.92			
30	1937	1.17	30	1920	3.43			
35	1938	1.14	35	1924	3.09			
40	1939	1.13	40	1926	2.83			
45	1940	1.11	45	1928	2.62			
50	1941	1.10	50	1930	2.46			
55	1941	1.09	55	1931	2.33			
60	1941	1.08	60	1932	2.22			
65	1941	1.08						
70	1941	1.07						
75	1941	1.07						
80	1941	1.06						
85	1941	1.06						
90	1941	1.06						

JTL-CD-6

OIL AND OR WATER CALCULATIONS

Test No. 10 Ticker No. C-3327

Company SOCONY MORIL OIL OF PANAMA LTD

Well Name & No. S.M. W.M. CHANCE Y.T G-8 66°-7'-18.1"N 137°-30'-50.8"W

Q =	1440	{ Drill Collar Capacity Recovery + Drill Pipe Capacity (Recovery) Initial + Final Flow Time } } }	(1249)	
Q =	1440			(.0080 + .518) + .0142
Q =	<u>463.3</u>			Bbls Day

Est. From Back Press.
1767' OIL ENTERED
PIPE IN 63 MIN

Transmissibility

kh	162.6Q	162.6	<u>463.3</u>	<u>1506.7</u>	Md-Ft.
μB	M		<u>50</u>		cp.

Average Effective Permeability h = 112 ft. TEST INTERVAL

K	<u>1506.7</u>	<u>13.5</u>	md ft.
μB	<u>112</u>		cp.

Productivity Index

J	Q	<u>463.3</u>	<u>.36026</u>	Bbl Day P.S.I.
	Po - Pf	<u>1286</u>		

Estimate Damage Ratio

E.D.R. = $\frac{1}{\log T + 2.65} \left[\frac{P_o - P_f}{M} \right] \frac{1}{4.4825} \left[\frac{1286}{50} \right] = .2230 (25.7200)$

E.D.R. = 5.7

Potentiometric Surface

P.S. = $(P_o \times 2.309 \text{ Ft PSI}) - (\text{Recorder Depth to Sea Level})$

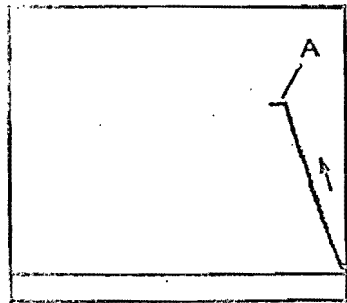
P.S. = $(1948 \times 2.309) - (2702)$

P.S. = 1796 Ft.

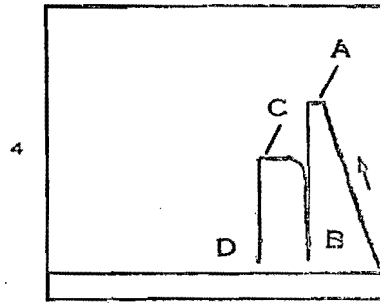
Estimate Potential with Damage Ratio Removed

E.D.R. / Q	<u>5.7</u>	<u>463.3</u>	<u>2640.8</u>	Bbls Day
------------	------------	--------------	---------------	----------

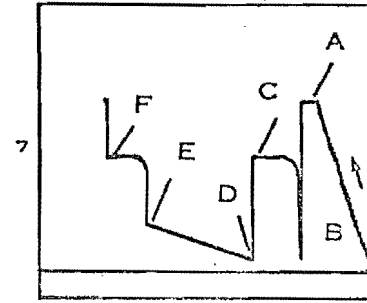
GUIDE TO INTERPRETATION AND IDENTIFICATION OF DRILL STEM TEST PRESSURE CHARTS



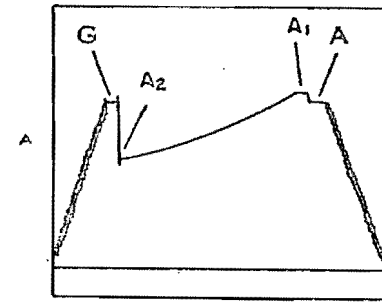
The pressure chart records the build-up in hydrostatic pressure as the testing assembly is lowered into the hole. Upon reaching the testing depth the hydrostatic head or pressure of mud column is recorded.



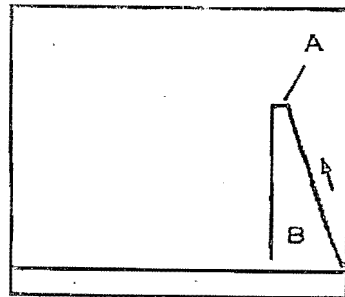
The chart indicates a pressure drop. The test tool has been opened to the surface by rotating the 4 stage shut-in tool into the open position. Permitting the open formation to produce.



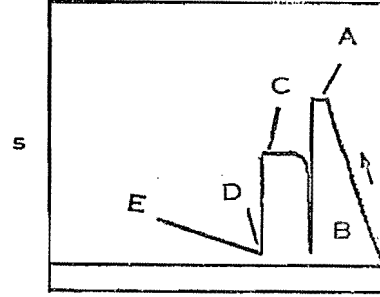
The chart shows the equalizing, the by-pass ports have been opened permitting the drilling fluid to flow through the packer to the test zone. Thus, pressure is equalized above and below the packer. The equalization of the pressure facilitates easier removal of the packer from the packer seat.



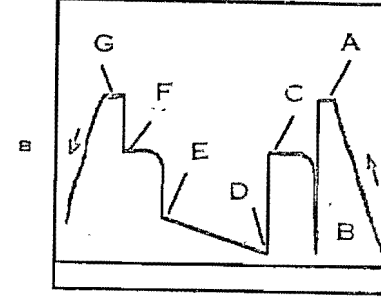
The above is a typical illustration of a chart from a recorder that is run below the bottom packer on a conventional straddled test. Only the hydrostatic mud pressures are recorded. When the tool is opened, there is a pressure differential across the bottom packer. This differential is lessened by the rubber flow of the packer element, which in turn causes a draw-down in pressure. If the below straddled chart reads the same as a chart that is run to record pressures of the test zone, then the bottom packer has failed. If this occurs, all zones below the top packer are being tested.



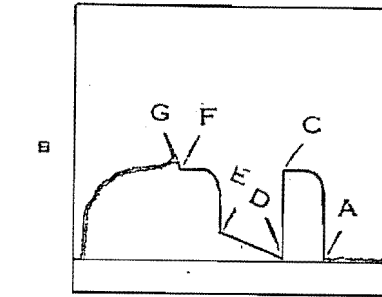
The packer is expanded and set to isolate the test zone. When the test valve is opened, a pressure drop is indicated on the pressure chart. This pressure drop is caused by removal of the hydrostatic mud pressure from the formation, allowing the formation to produce.



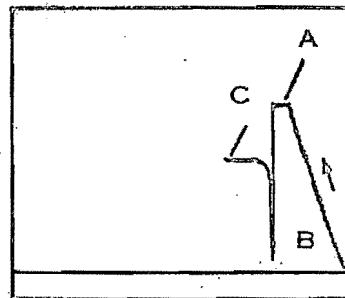
The pressure of fluid flowing from the formation into the well bore, through the perforated anchor, and into the drill pipe, is recorded on the chart.



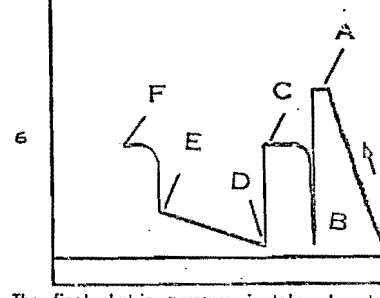
The packer has been unseated. The testing assembly is being removed from the hole.



In this case a recorder has been run in an air chamber. The hydrostatic mud pressures are not influencing the recorder while going in or coming out of the hole due to the main tester valve being closed. The flow pressures and shut-in pressures are recorded while the main tester valve is opened.



This chart shows the initial shut-in pressure. There is one mechanical method commonly used to obtain this pressure. A 4 stage shut-in tool, that is run-in in the open position and rotated closed when the desired amount of initial flow time is obtained. This initial shut-in pressure is the best method yet devised for recording the original undisturbed reservoir pressure of a formation.



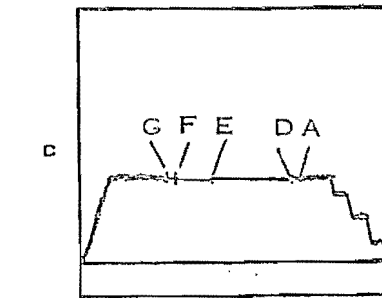
The final shut-in pressure is taken by stopping the flow of formation pressure fluid into the drill pipe. Note the characteristic build-up curve. The well bore pressure is approaching equilibrium with the static reservoir pressure. When the shut-in curve levels-off the static reservoir pressure has been reached.

INDEX OF LABELED POINTS:

- A—Initial Hyd. Mud
- B—First Initial Flow
- C—Initial Shut-in
- D—Initial Flow
- E—Final Flow
- F—Final Shut-in
- G—Final Hyd. Mud

The following points are either fluctuating pressures or points indicating other packer settings, (testing different zones).

- A-1, A-2, A-3, etc. Initial Hyd. Pressures.
- B, B-1, B-2, B-3, First Initial Flow.
- C-1, C-2, C-3, etc. The Initial Shut-in Pressures.
- D-1, D-2, D-3, etc. Flowing Pressures.
- E1, E-2, E-3, etc. The Final Flow Pressures or Final Shut-in Pressures.
- F-1, F-2, F-3, etc. The Final Shut-in Pressures.
- G-1, G-2, G-3, etc. Final Hyd. Mud Pressures.
- Z — Special pressure points such as pumping pressure recorded for formation breakdown.



In this case a recorder has been run above the main tester valve with a fluid cushion used in the drill pipe. No pressure is recorded as the testing tool is being lowered into the hole. Then the fluid cushion pressure is recorded as the drill pipe is filled with fluid. As more stands are run into the hole, the recorder registers the hydrostatic pressures of the cushion. When the main testing valve is opened the pressure of the cushion column or the flowing pressure of the formation, (which ever is greater), is recorded.