JOHNSTON TESTERS

A WORLD OF EXPERIENCE

SPECIAL DATA ANALYSIS

FEBRUARY 20, 1964

THIS APPEARS TO BE A GOOD MECHANICAL DRILL STEM TEST DURING WHICH THE TOOLS DID FUNCTION PROPERLY. WELL CONDITIONS WERE SATISFACTORY, AND THE FORMATION WITHIN THE TEST INTERVAL DID PRODUCE ENOUGH RESERVOIR FLUID FOR PROPER IDENTIFICATION. SUFFICIENT RESERVOIR PRESSURE DRAWDOWN DID OCCUR FOR THE ADEQUATE SHUT-IN BUILD-UPS FOR RELIABLE SPECIAL DATA ANALYSIS. THE LENGTHS OF TIME OF THE FLOW PERIODS AND SHUT-IN PERIODS OF THIS TEST ARE SUFFICIENT. THE DATA OBTAINED SHOULD BE ADEQUATE FOR RELIABLE SPECIAL DATA ANALYSIS.

1. RESERVOIR PRESSURE: EXTRAPOLATION OF THE INITIAL SHUT-IN PRESSURE BUILD-UP PLOT, INDICATES A MAXIMUM RESERVOIR PRESSURE OF 1663 P.S.I.G. AT RECORDER DEPTH. EXTRAPOLATION OF THE FINAL SHUT-IN PRESSURE BUILD-UP PLOT INDICATES A MAXIMUM RESERVOIR PRESSURE OF 1615 P.S.I.G. AFTER THIS TEST. THE DIFFERENCE BETWEEN THESE TWO PRESSURES OF 48 P.S.I. IS JUST WITHIN RECORDER ACCURACY, BUT DETAIL IS SUFFICIENT THAT SOME RESERVOIR PRESSURE DEPLETION MAY HAVE TAKEN PLACE DURING THE TEST. IF DEPLETION DID OCCUR A LIMITED RESERVOIR HAVING VERY SMALL VOLUME MAY EXIST.

2. PERMEABILITY: THE CALCULATED TRANSMISSIBILITY FACTOR OF 3157 MD.-FT./CP. INDICATES AN AVERAGE EFFECTIVE PERMEABILITY TO GAS OF 3.3 MD. FOR THE REPORTED 14 FOOT TEST INTERVAL. THIS VALUE WAS CALCULATED ASSUMING THE GAS GRAVITY TO BE 0.70 AND SELECTING APPROPRIATE VALUES FOR GAS VISCOSITY AND DEVIATION FROM THE PERFECT GAS LAW FROM THE AVAILABLE TECHNICAL LITERATURE.

3. WELL BORE DAMAGE: THE CALCULATED ESTIMATED DAMAGE RATIO OF 1.8 INDICATES THAT WELL BORE DAMAGE IS PRESENT AT THE TIME AND CONDITIONS OF THIS TEST. THIS VALUE INFERS THAT THE RATE OF PRODUCTION OBSERVED AT THE FORMATION FACE DURING THIS TEST MAY BE INCREASED 1.8 TIMES IF THE WELL BORE DAMAGE ALONE WERE REMOVED. IT IS INTERESTING TO NOTE THAT THE SLOPE VALUE OF THE SECONDARY SLOPE, 576,300 PSI ^{2}/CYCLE, DIVIDED BY THE PRIMARY SLOPE FACTOR OF 331,100 PSI ^{2}/CYCLE GIVES A RATIO VALUE OF 1.74 WHICH AGREES VERY FAVORABLY TO THIS CALCULATED DAMAGE RATIO.

4. RADIUS OF INVESTIGATION: THE CALCULATED RADIUS OF INVESTIGATION OF THIS TEST IS 133 FEET BASED ON AN ASSUMED POROSITY OF 25%, FLUID COMPRESSIBILITY OF 50×10^{-5} AND OTHER ASSUMPTIONS AS PER ITEM 2 ABOVE.

5. GENERAL COMMENTS: THIS APPEARS TO BE A TEST OF A GAS BEARING FORMATION WITH SOME WELL BORE DAMAGE. ARTIFICIAL STIMULATION SHOULD HELP YIELD COMMERCIAL RATES OF FLOW OF GAS PRODUCTION.

L. O. PETTY
EVALUATION ENGINEER

MOBIL OIL COMPANY
ROONEY #2, SEWARD COUNTY, KANSAS
TEST #1, 5408' TO 5422'

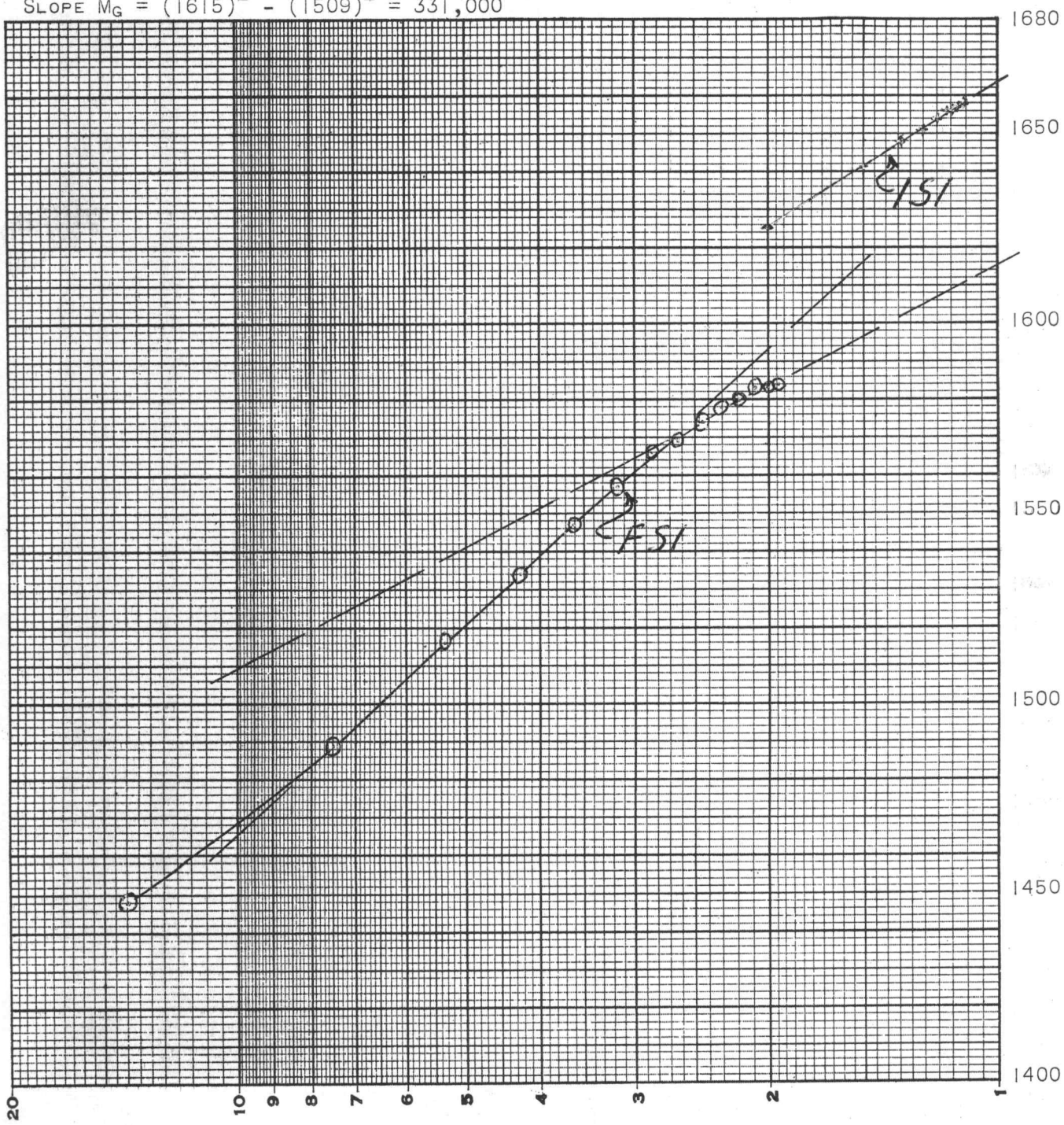
FIELD REPORT #07243 A

JOHNSTON TESTERS
Gas Reservoir Engineering Data

Recorder No. T-165 Field Report No. 07243 A

Estimated Damage Ratio	EDR	1.81	Effective Transmissibility	$\frac{Kh}{\mu Z}$	3157 Md-ft./Cp.
Maximum Reservoir Pressure	P_o	1663 P.S.I.G.	Flow Rate	Q_g	1075 MCF/Day
Slope of Shut-in Curve	M_g	331,000 PSI^2/log cycle	Flow Rate	Q	
Potentiometric Surface (Datum Plane, ~~Sea Level~~)	PS	3840 ft. ABOVE RECORDER	Flow Rate	Q	
Radius of Investigation		133 ft.	K (Effective to GAS)		3.3 Md.

SLOPE $M_G = (1615)^2 - (1509)^2 = 331,000$



Assumptions made for Calculations for Gas Recoveries

1. Q_g is taken as steady state flow and unless stated otherwise at standard conditions 14.7 P.S.I. and 60° F.

2. P_f is final 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 pseudo critical temperature at 385° Rankin and pseudo critical pressure of 666 P.S.I.A.

6. Other standard radial flow, steady state assumptions.

Empirical Equations:

1. $EDR = \dfrac{P_o^2 - P_f^2}{M_g(\log T + 2.65)}$ Where $M_g = \dfrac{P_1^2 - P_{10}^2}{\text{Log Cycle}}$

2. Transmissibility $\dfrac{Kh}{\mu Z} = \dfrac{1637^\circ T_f Q_g}{M_g}$

3. P.S. $= \left[P_o \times 2.309 \text{ ft./PSI}\right] - \left[\text{Recorder depth to sea level.}\right]$

Symbols		Dimensions
B	Formation volume factor	vol./vol.
c	Fluid compressibility	vol./vol./psi.
EDR	Estimated damage ratio	
ϕ	Formation porosity	fractional
h	Net Producing interval	feet
J	Productivity index	Bbls./day/PSI
k	Permeability (effective)	Millidarcies
M_g	Slope of shut-in build up	PSI^2/log cycle
P_f	Final flowing pressure	PSIG
P_{fsi}	Final shut-in pressure at time t	PSIG
P_{isi}	Initial shut-in pressure	PSIG
P_o	Maximum reservoir pressure	PSIG
P_1	Final shut-in buildup plot Intercept @ 1	PSIG
P_{10}	Final shut-in buildup plot Intercept @ 10	PSIG
P.S.	Potentiometric surface	ft.

Symbols		Dimensions
Q	Rate of flow during test	Bbls./day
Q_o	Rate of oil flow during test	Bbls./day
Q_w	Rate of water flow during test	Bbls./day
Q_g	Rate of gas flow during test	MCF/day
r_w	Well bore radius	inches
t	Shut-in time period	minutes
Δt	Increment time of shut-in period	minutes
T	Open flow time period	minutes
$^\circ T_f$	Formation temperature	°Rankin
μ	Fluid viscosity (Reservoir conditions)	Centipoise
Z	Gas deviation factor (Compressibility factor)	
$\frac{Kh}{\mu B}$ or $\frac{Kh}{\mu Z}$	Transmissibility factor	$\frac{\text{Md.} - \text{ft.}}{\text{Cp}}$

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.

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Pressure Breakdown Data

Date 2-14-64 Field Report No. 07243 A

Recorder No. T-165 Capacity 5000# Recorder Depth 5400'

Recorder Run INSIDE Clock Travel 0.02359 inches per min. Well Temperature 134 °F.

Point	Pressure
A Initial Hydrostatic Mud	2727
B Initial Shut-in	1658
C Initial Flow	240
D Final Flow	298
E Final Shut-in	1584
F Final Hydrostatic Mud	2717

	Time Given	Time Computed
Opened Tool	0650	
Initial Flow	05 Mins.	05 Mins.
Initial Shut-in	60 Mins.	51 Mins.
Final Flow	60 Mins.	60 Mins.
Final Shut-in	60 Mins.	69 Mins.

C-1 240
C-2 213

Remarks: CLOCK STOPPED BETWEEN POINTS "C" AND "C-1".

PRESSURE INCREMENTS

Breakdown: ____ increments of ____ mins. and a final increment of ____ mins.

Point Minutes	Pressure	$\frac{T+\Delta t}{\Delta t}$

INITIAL SHUT-IN

Breakdown: 10 increments of 5 mins. and a final increment of - mins.

Point Minutes	Pressure	$\frac{T+\Delta t}{\Delta t}$
C-1 0	240	
5	1625	2.000
10	1641	1.500
15	1648	1.333
20	1651	1.250
25	1654	1.200
30	1656	1.167
35	1656	1.143
40	1657	1.125
45	1658	1.111
B 50	1658	1.100

FINAL SHUT-IN

Breakdown: 15 increments of 5 mins. and a final increment of 4 mins.

Point Minutes	Pressure	$\frac{T+\Delta t}{\Delta t}$
D 0	298	
5	1448	14.000
10	1489	7.500
15	1516	5.333
20	1534	4.250
25	1547	3.600
30	1557	3.167
35	1566	2.857
40	1569	2.625
45	1574	2.444
50	1578	2.300
55	1580	2.182
60	1583	2.083
65	1583	2.000
E 69	1584	1.942

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SURFACE INFORMATION

Well Flowed	Amount
GAS	

Reversed Out	Amount
NO	

Recovered	Amount
MUD	90' (.44 BBLS.)

Maximum Surface Pressure 160#

Description (Rate of Flow)	Time	Pressure (P.S.I.G.)	Surface Choke
Opened Tool	0650	-	1/2"
VERY STRONG BLOW			
GAS TO SURFACE	0655	-	"
CLOSED FOR INITIAL SHUT-IN	0655	-	-
RE-OPENED TOOL	0755	-	1/2"
GAS 500 MCF/DAY	0800	65	"
GAS 800 MCF/DAY	0805	115	"
GAS 1000 MCF/DAY	0810	140	"
GAS 1050 MCF/DAY	0815	155	"
GAS 1075 MCF/DAY	0820	160	"
GAS 1075 MCF/DAY	0825	160	"
GAS 1075 MCF/DAY	0835	160	"
GAS 1075 MCF/DAY	0845	160	"
GAS 1075 MCF/DAY	0855	160	"
CLOSED FOR FINAL SHUT-IN	0855	160	"
PULLED PACKER LOOSE	0955		

Remarks:

TOOL, HOLE & MUD DATA

Type Test SELECTIVE ZONE STRADDLE
Formation Tested MORROW
Elevation - Ft.
All Depths Measured From DERRICK FLOOR

TOOL SEQUENCE

Tool	Size/Type	Depth/Length/I.D.
DRILL PIPE	4½" FH	5138'3.8"
DRILL COLLAR	4½" H-90	238'2.25"
DOUBLE PIN SUB	4½" REG	
CIRCULATING SUB	4½" PIN	
4-STAGE SHUT-IN	4 3/4"	
HYDRAULIC TOOL	3½" C	
RECORDER CARRIER	4 7/8" T	6'
JARS	3½" HS-1	
BOB-TAIL PACKER	6 5/8"	5408'
PERF. ANCHOR	3½" FH	5'
RECORDER CARRIER	4 7/8" L	4'
PERF. ANCHOR	3½" FH	3'
BLANK ANCHOR	4½" REG	1'
CONV. PACKER	6 5/8"	5422'
PERF. ANCHOR	3½" FH	30'
SELECTIVE ZONE		
ANCHORING DEVICE	6"	5452'
RECORDER	3" L	2'
RECORDER	3" L	2'

Total Depth 5700 Ft.
Main Hole Size 7 7/8" Rat Hole Size -
Casing Size - Liner Size -
Bottom Choke Size 3/4" Mud Type CHEM
Mud Wt. 9.0 Mud Viscosity 60
Water Loss 4.4 C.C.

Cushion Type	Amount	Pressure
-	-	-

TIME DATA

Initial Flow - Hrs. 5 Mins.
Initial Shut-in 1 Hrs. - Mins.
Final Flow 1 Hrs. - Mins.
Final Shut-in 1 Hrs. - Mins.

Customer SAME AS BELOW

Company MOBIL OIL COMPANY; BOX 400; HUGOTON, KANSAS Date 2-14-64
Well ROONEY #2 Field CUTTER Location 7-31-34 W
Test Interval 5408' TO 5422' Formation Test # 1 Casing Test # -

County SEWARD State KANSAS Field Report No. 07243 A
Tester CHANCE (LIBERAL) Test Approved By MR. JACK P. ANDERSON No. DST Reports Requested 5

JOHNSTON TESTERS

Pressure Data

Field Report No. 07243 A

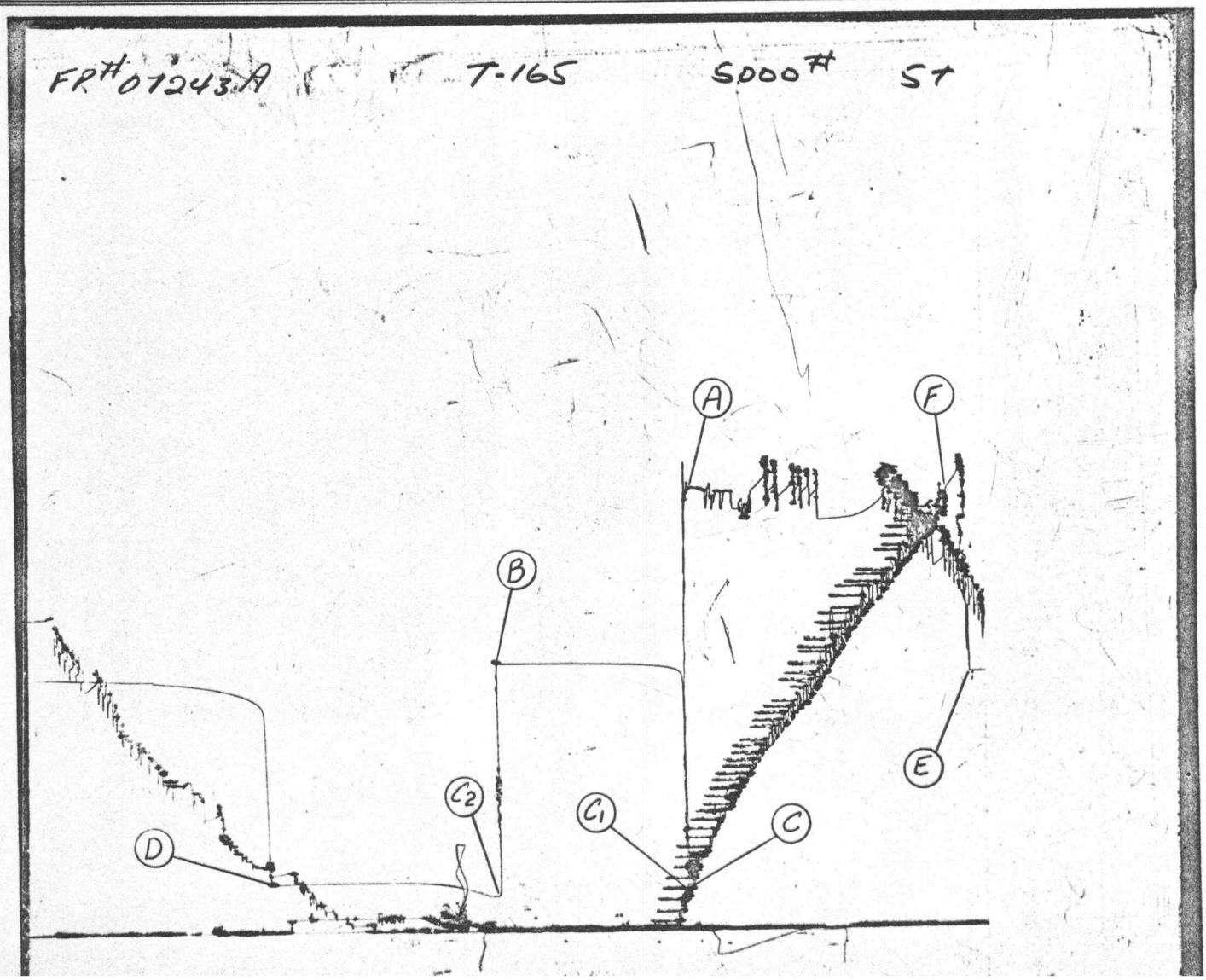
Recorder No.		T-165	INSIDE			
Capacity (P.S.I.G.)		5000				
Recorder Depth		5400'				
Pressure Gradient P.S.I./Ft.						
Well Temperature °F.		134				
A Initial Hydrostatic Mud		2727				
B Initial Shut-in	*	1658				
C Initial Flow		240				
D Final Flow		298				
E Final Shut-in	*	1584				
F Final Hydrostatic Mud		2717				

Remarks: C-1 240

C-2 213

CLOCK STOPPED BETWEEN POINTS "C" AND "C-1".

*Shut in pressure did not reach static reservoir pressure.



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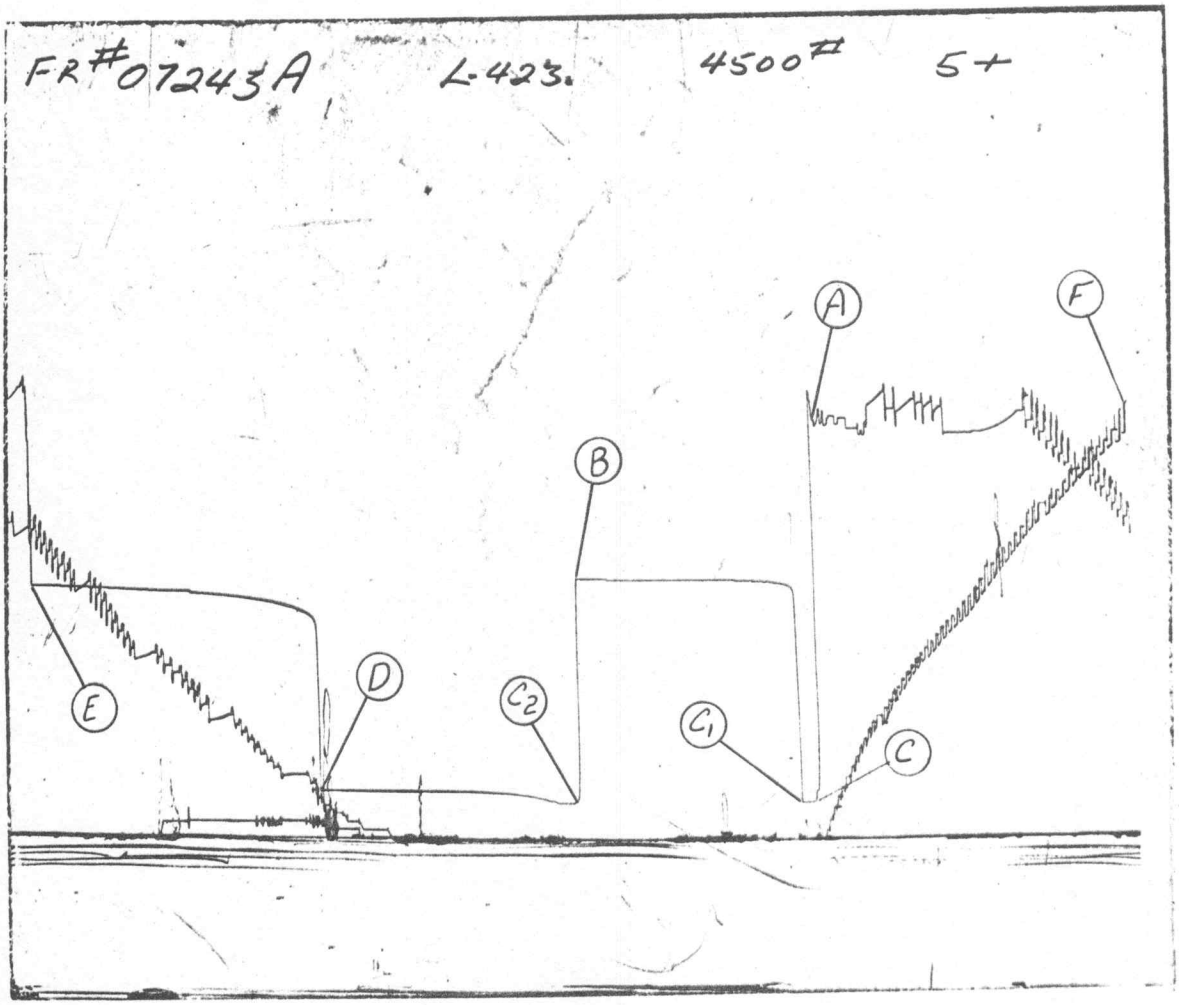
Pressure Data Field Report No. 07243 A

Recorder No.		L-423	OUTSIDE			
Capacity (P.S.I.G.)		4,500				
Recorder Depth		5,415'				
Pressure Gradient P.S.I./Ft.						
Well Temperature °F.		134				
A Initial Hydrostatic Mud		2724				
B Initial Shut-in	*	1664				
C Initial Flow		212				
D Final Flow		285				
E Final Shut-in	*	1624				
F Final Hydrostatic Mud		2835				
Remarks: c-1		208				
c-2		208				

*Shut in pressure did not reach static reservoir pressure.



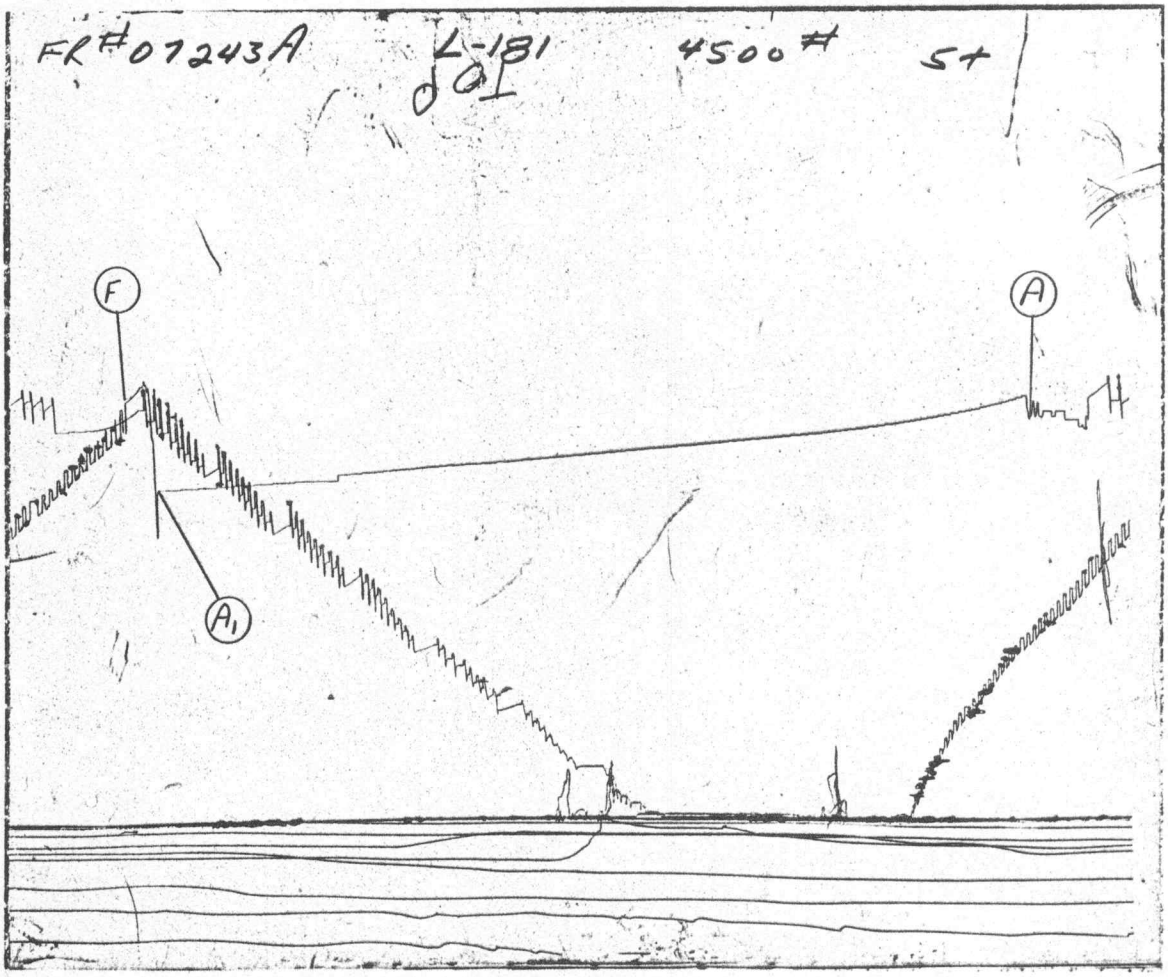
JOHNSTON TESTERS

Pressure Data Field Report No. 07243 A

Recorder No.	L-181	OUTSIDE			
Capacity (P.S.I.G.)	4500				
Recorder Depth	5457'				
Pressure Gradient P.S.I./Ft.					
Well Temperature °F.	134				
A Initial Hydrostatic Mud	2625				
B Initial Shut-in	-				
C Initial Flow	-				
D Final Flow	-				
E Final Shut-in	-				
F Final Hydrostatic Mud	2748				

Remarks: A-1 2165
BELOW STRADDLE

*Shut in pressure did not reach static reservoir pressure.



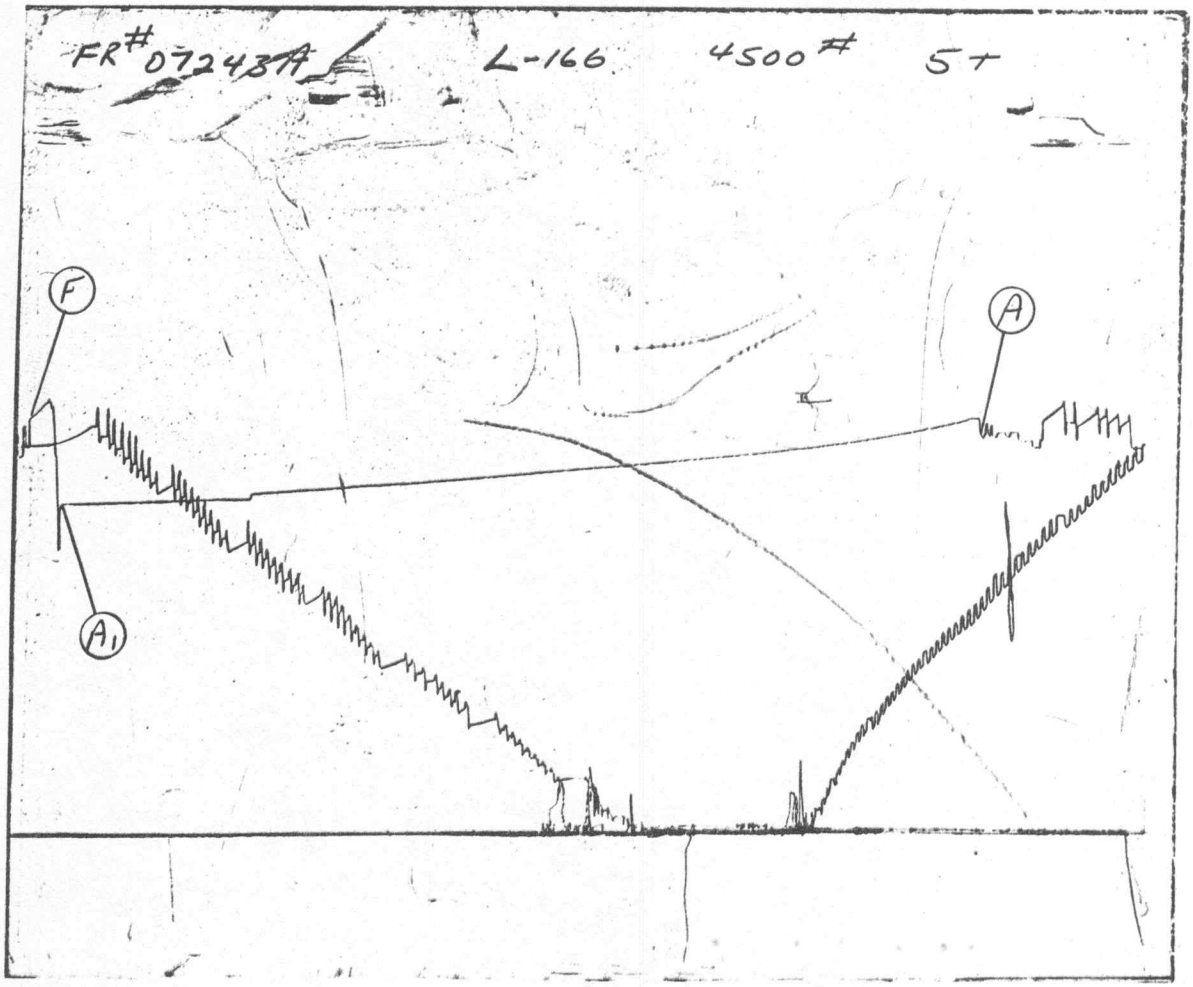
JOHNSTON TESTERS

Pressure Data Field Report No. 07243 A

Recorder No.	L-166	OUTSIDE				
Capacity (P.S.I.G.)	4500					
Recorder Depth	5459'					
Pressure Gradient P.S.I./Ft.						
Well Temperature °F.	134					
A Initial Hydrostatic Mud	2674					
B Initial Shut-in	-					
C Initial Flow	-					
D Final Flow	-					
E Final Shut-in	-					
F Final Hydrostatic Mud	2768					

Remarks: A-1 2181
BELOW STRADDLE

*Shut in pressure did not reach static reservoir pressure.



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Pressure Log*

Field Report No. 07243A

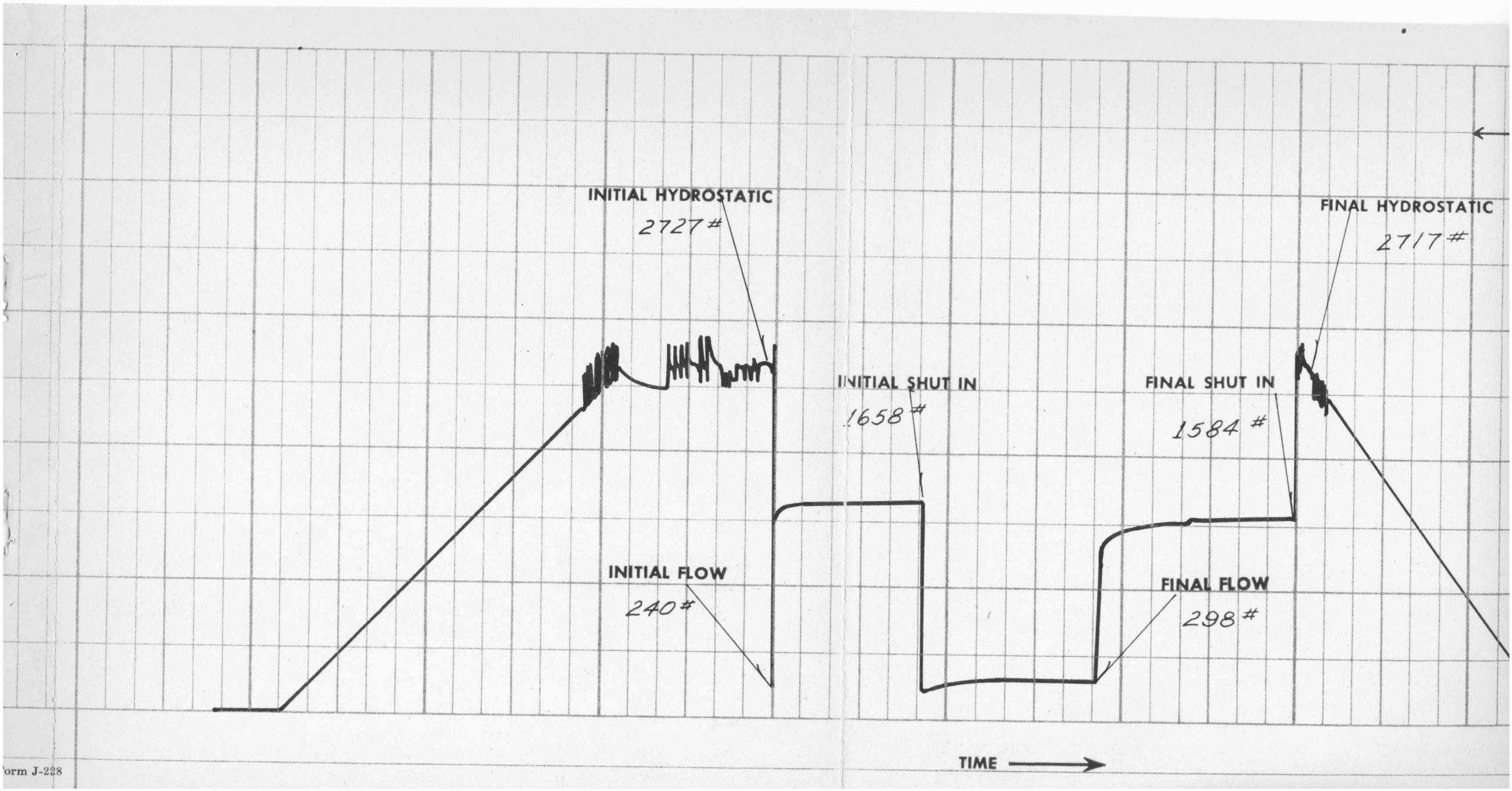
Recorder No. T-165

Capacity 5,000 p.s.i.

Recorder Depth 5,400 ft.

*a continuous tracing of the original chart

Form J-21


INITIAL HYDROSTATIC
2727#
INITIAL FLOW
240#
INITIAL SHUT IN
1658#
FINAL FLOW
298#
FINAL SHUT IN
1584#
FINAL HYDROSTATIC
2717#
TIME

Form J-228