Drill Stem Test Report

Virgil's TESTERS

Reliable Drill Stem Testing

Rocky Mountain Region

HOME OFFICE
STERLING
COLORADO
POST OFFICE BOX 712
PHONE 522-1206

Operator Helmerich & Payne, Inc.
ADDRESS See Distribution
Well Name and No. McCalham-Federal # 1-19
Ticket No. 16628 Date 9-23-75
DST No. 1
No. Final Copies 9

PHONE 522-1206 AREA 303

VIRG'S TESTERS, INC.

BOX 712 STERLING, COLORADO

Operator Helmerich & Payne, Inc.

ADDRESS See Distribution

Well Name and No. McCalham-Federal # 1-19

Ticket No. 16628 Date 9-23-75

DST No. 1 No. Final Copies 9

Contractor Signal Drlg. Co.
Rig No. 4
Spot NE-NW
Sec. 19
Twp. 9 N
Rng. 78 W
Field --
County Jackson
State Colorado
Elevation 8320' "Ground"
Formation Niobrara

Top Choke 1"
Bottom Choke 9/16"
Size Hole 7 7/8"
Size Rat Hole None
Size & Wt. D. P. 4½" 16.60
Size Wt. Pipe None
I. D. of D. C. 2½"
Length of D. C. 300'
Total Depth 5870'
Interval Tested 5790'-5870'
Type of Test Straight

Tool Open @ 10:25 AM.

Flow #1 20 Min. SIP #1 60 Min. Flow #2 120 Min SIP #2 60 Min.
Flow #3 ____ Min. SIP #3 ____ Min. Flow #4 ____ Min. SIP #4 ____ Min.

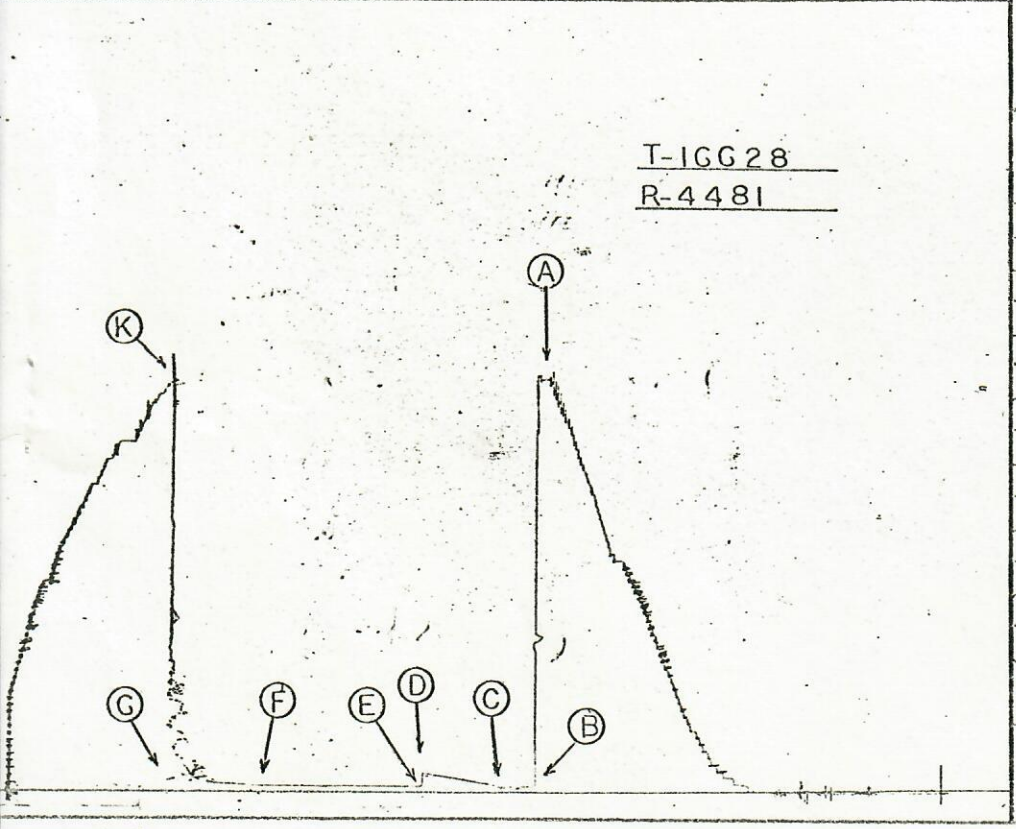
B. H. T. -- Gravity
Mud Wt. 9.1 Viscosity 48

TOOL SEQUENCE

5781

5790

TD 5870



PRD Make Kuster AK-1 No. 4481 Cap. 5200 @ 5769			
Press		Field	Corrected
IH	A	2709	2726
FH	K	2669	2690
Flow #1-IF	B	40	37
FF	C	40	32
SIP #1	D	106	125
Flow #2-IF	E	40	40
FF	F	26	34
SIP #2	G	66	71
Flow #3-IF	H	None	Taken
FF	I	"	"
SIP#3	J	"	"
Pressure Below Bottom Packer Bled To			

Our Tester: Fred Webb

Witnessed By: R. Dahlgren

RECOVERY IN PIPE

65' Mud = 0.40 Bbl.

DID WELL FLOW - Gas No Oil No Water No

REMARKS:

1st Flow- Tool opened with weak ½" underwater blow, increased to 1½" underwater blow at end of flow period.

2nd Flow- Tool opened with weak 2" underwater blow, decreased slowly to 1/8" underwater blow at end of flow period.

Breakdown of shut-in pressures not practical.

Phone 522-1206

VIRG'S TESTERS, INC.

Box 712 — Sterling, Colo.

Fluid Sample Report

Date 9-23-75 Ticket No. 16628

Company Helmerich & Payne, Inc.

Well Name & No. McCalham-Federal # 1-19 DST No. 1

County Jackson State Colorado

Sampler No. -- Test Interval 5790'-5870'

Pressure in Sampler 0 PSIG BHT -- °F

Total Volume of Sampler: 2150 cc.

Total Volume of Sample: 1400 cc.

Oil: Scum cc.

Water: None cc.

Mud: 1400 cc.

Gas: None cu. ft.

Other: None

Resistivity

Water: ..... @ ..... of Chloride Content ..... ppm.

Mud Pit Sample ..... @ ..... of Chloride Content ..... ppm.

Gas/Oil Ratio ..... Gravity ..... °API @ ..... °F

Where was sample drained .....

Remarks: .....

RECEIVED
OCT 14 1975
COLO. OIL & GAS CONS. COMM.

2
80751

Operator Helmerich & Payne, Inc.

Address See Distribution

Well Name and No. McCalham-Federal # 1-19

Ticket No. 1651

Date 10-2-75

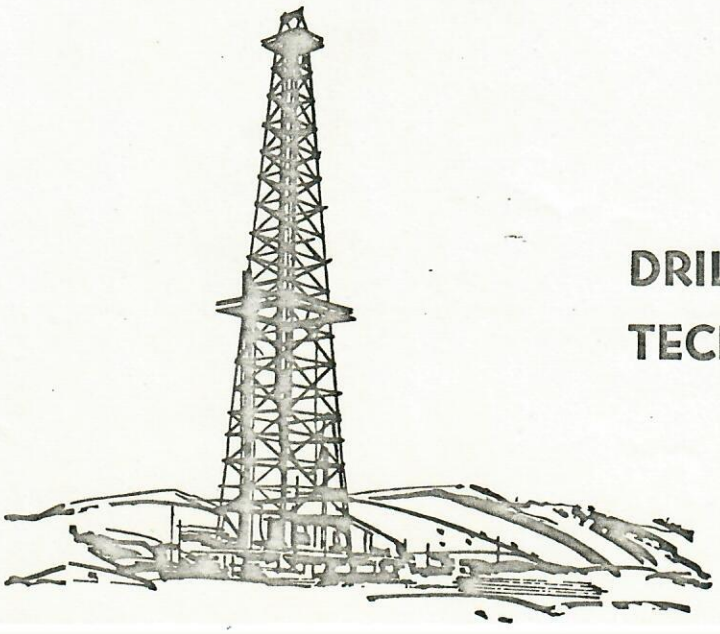
DST No. 2

No. Final Copies 9

LYNES

BRIGHT NAME IN THE OIL PATCH

Inflatable and Conventional Packer Tools



DRILL STEM TEST
TECHNICAL SERVICE REPORT

Phone
522-1206 Area 303

LYNES UNITED SERVICES

DIVISION OF LYNES, INC.

Box 712
Sterling, Colo. 80751

Operator Helmerich & Payne, Inc.

Address See Distribution

Well Name and No. McCalham-Federal # 1-19

Ticket No. 1651

Date 10-2-75

DST No. 2

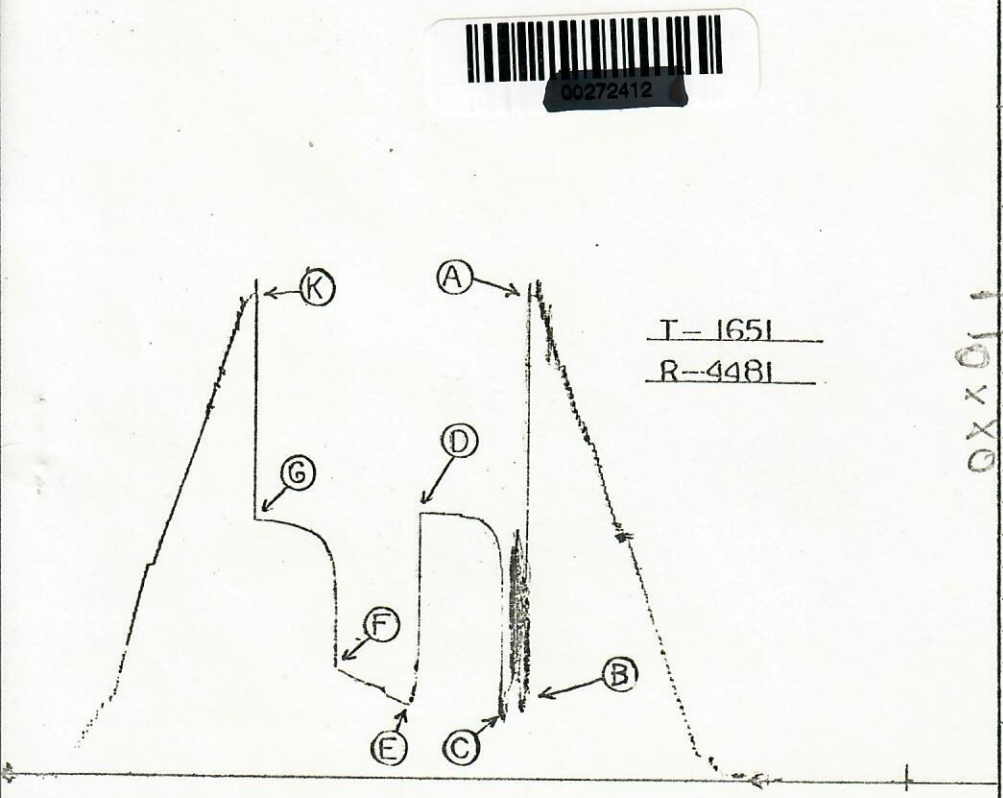
No. Final Copies 9

Contractor	Signal Drlg. Co.	Top Choke	1"
Rig No.	4	Bottom Choke	1"
Spot	NE-NW	Size Hole	7 7/8"
Sec.	19	Size Rat Hole	None
Twp.	9 N	Size & Wt. D. P.	4½" 16.60
Rng.	78 W	Size Wt. Pipe	None
Field	Wildcat	I. D. of D. C.	2¼"
County	Jackson	Length of D. C.	300'
State	Colorado	Total Depth	6925'
Elevation	8320' "Ground"	Interval Tested	6750'-6910'
Formation	Muddy & Dakota	Type of Test	Straddle Conventional.

Flow No. 1	15	Min.
Shut-in No. 1	60	Min.
Flow No. 2	60	Min.
Shut-in No. 2	60	Min.
Flow No. 3	--	Min.
Shut-in No. 3	--	Min.

Bottom Hole Temp.	--
Mud Weight	9.2
Gravity	--
Viscosity	40

Tool opened @ 8:00 AM.



PRD Make Kuster AK-1
No. 4481 Cap. 5200 @ 6770

		Press	Corrected
Initial Hydrostatic	A		3219
Final Hydrostatic	K		3216
Initial Flow	B		500
Final Initial Flow	C		414
Initial Shut-in	D		1766
Second Initial Flow	E		496
Second Final Flow	F		726
Second Shut-in	G		1721
Third Initial Flow	H		--
Third Final Flow	I		--
Third Shut-in	J		--
Pressure Below Bottom Packer Bled To			1777

Our Tester: F. Webb

Witnessed By: R. Dahlgren

Did Well Flow – Gas No Oil No Water No

RECOVERY IN PIPE: 1600' Total
180' Gas cut mud = 2.56 Bbl.
1180' Mud & gas cut water = 16.19 Bbl.
240' Gas cut water = 1.18 Bbl.

REMARKS:

1st Flow- Tool opened with weak 3" underwater blow, increased to off bottom of bucket in at end of flow period.

2nd Flow- Tool opened with weak 3" underwater blow, increased to off bottom of bucket in 10 minutes, and remained thru flow period.

Corrected pressures in 6 minute increment readings on following page.

LYNES UNITED SERVICES
DIVISION OF LYNES, INC.

Operator Helmerich & Payne, Inc. Lease & No. McCalham-Federal # 1-19 DST No. 2

Initial Shut-in

0	min.	414	psi.
6	"	1643	"
12	"	1698	"
18	"	1733	"
24	"	1740	"
30	"	1750	"
36	"	1759	"
42	"	1762	"
48	"	1764	"
54	"	1765	"
60	"	1766	"

Final Shut-in

0	min.	726	psi.
6	"	1532	"
12	"	1606	"
18	"	1639	"
24	"	1663	"
30	"	1679	"
36	"	1692	"
42	"	1701	"
48	"	1709	"
54	"	1716	"
60	"	1721	"

LYNES UNITED SERVICES
DIVISION OF LYNES, INC.

Fluid Sample Report

Date 10-2-75 Ticket No. 1651

Company Helmerich & Payne, Inc.

Well Name & No. McCalham-Federal # 1-19 DST No. 2

County Jackson State Colorado

Sampler No. 3-16 Test Interval 6750'-6910'

Pressure in Sampler 50 PSIG BHT -- °F

Total Volume of Sampler: 2100 cc.

Total Volume of Sample: 2100 cc.

Oil: None cc.

Water: 2100 cc.

Mud: None cc.

Gas: 0.50 cu. ft.

Other: None

Resistivity

Water: 10 @ 68° of Chloride Content 530 ppm.

Mud Pit Sample 0.53 @ 70° of Chloride Content 11,500 ppm.

Gas/Oil Ratio ____ Gravity ____ °API @ ____ °F

Where was sample drained Rig Floor

Remarks:

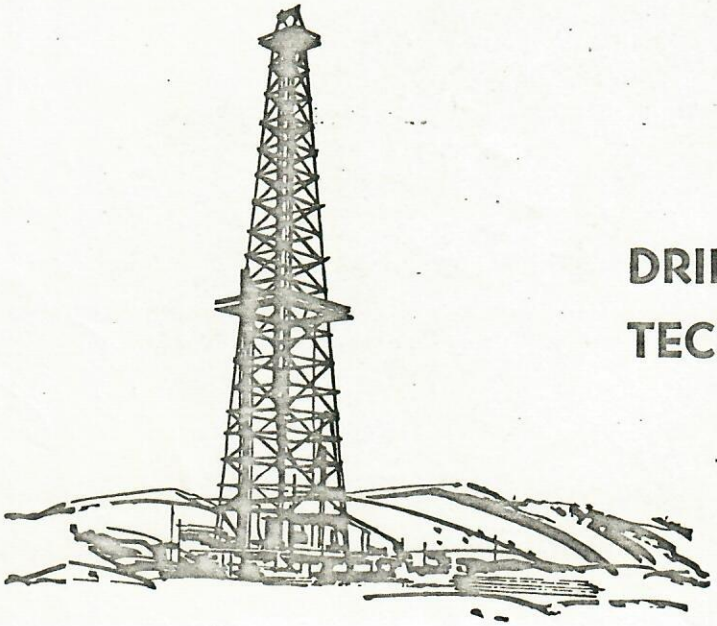
2
80751

Operator Helmerich & Payne, Inc.
Address See Distribution
Well Name and No. McCullum-Federal #1-19
Ticket No. 1676
Date 10-5-75
DST No. 3
No. Final Copies 9

LYNES

BRIGHT NAME IN THE OIL PATCH

Inflatable and Conventional Packer Tools



DRILL STEM TEST
TECHNICAL SERVICE REPORT

Phone
522-1206 Area 303

LYNES UNITED SERVICES

DIVISION OF LYNES, INC.

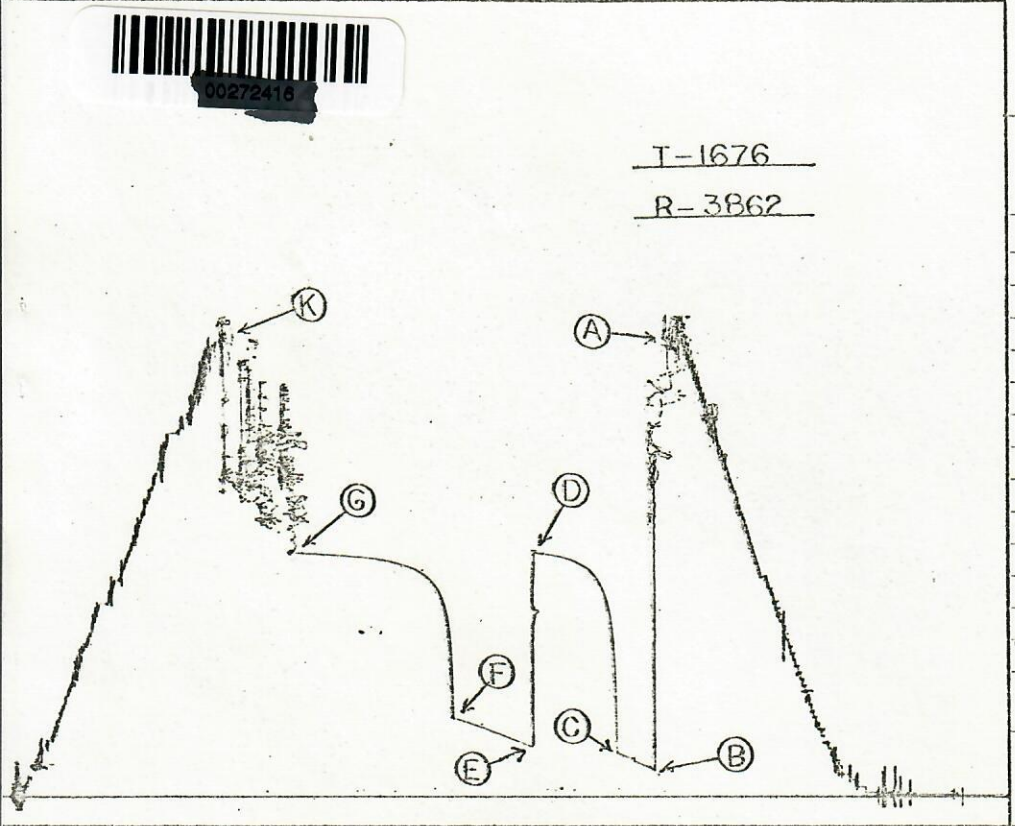
Box 712
Sterling, Colo. 80751

Contractor	Signal Drlg. Co.	Top Choke	1"
Rig No.	4	Bottom Choke	9/16"
Spot	NE-NW	Size Hole	7 7/8"
Sec.	19	Size Rat Hole	None
Twp.	9 N	Size & Wt. D. P.	4½" 16.60
Rng.	78 W	Size Wt. Pipe	None
Field	Wildcat	I. D. of D. C.	2¼"
County	Jackson	Length of D. C.	265'
State	Colorado	Total Depth	7066'
Elevation	8320' "Ground"	Interval Tested	6892-7066
Formation	Lakota	Type of Test	Conventional Straight

Flow No. 1	30	Min.
Shut-in No. 1	60	Min.
Flow No. 2	60	Min.
Shut-in No. 2	120	Min.
Flow No. 3	---	Min.
Shut-in No. 3	---	Min.

Bottom Hole Temp.	---
Mud Weight	9.3
Gravity	---
Viscosity	42

Tool opened @ 8:00 A.M.



I-1676

R-3862

PRD Make Kuster AK-1
No. 3862 Cap. 5750 @ 6899'

	Press	Corrected
Initial Hydrostatic	A	3330
Final Hydrostatic	K	3316
Initial Flow	B	175
Final Initial Flow	C	311
Initial Shut-in	D	1780
Second Initial Flow	E	361
Second Final Flow	F	569
Second Shut-in	G	1780
Third Initial Flow	H	---
Third Final Flow	I	---
Third Shut-in	J	---
Pressure Below Bottom Packer Bled To		

Our Tester: Rick Hanson

Witnessed By: Tom Carroll

Did Well Flow – Gas No Oil No Water No

RECOVERY IN PIPE: 1277' Total fluid
1277' Gas cut water = 15.67 Bbl.

REMARKS:

1st Flow – Tool opened with weak blow, increased to bottom of bucket in 7 minutes and remained thru open.

2nd Flow – Tool opened with weak blow, increased to bottom of bucket and remained thru open.

Corrected pressures in 6 and 12 minute increment readings on following page.

Address See Distribution

Operator Helmerich & Payne, Inc.

Well Name and No. McCullum-Federal #1-19

Ticket No. 1676

Date 10-5-75

DST No. 3

No. Final Copies 9

LYNES UNITED SERVICES
DIVISION OF LYNES, INC.

Operator Helmrich & Payne, Inc. Lease & No. McCullum-Federal #1-19 DST No. 3

Initial Shut-in

0	min.	311 psi.
6	"	1374 "
12	"	1551 "
18	"	1638 "
24	"	1684 "
30	"	1716 "
36	"	1736 "
42	"	1754 "
48	"	1765 "
54	"	1772 "
60	"	1780 "

Final Shut-in

0	min.	569 psi.
12	"	1525 "
24	"	1639 "
36	"	1691 "
48	"	1720 "
60	"	1739 "
72	"	1751 "
84	"	1762 "
96	"	1768 "
108	"	1775 "
120	"	1780 "

LYNES UNITED SERVICES
DIVISION OF LYNES, INC.

Fluid Sample Report

Date 10-5-75 Ticket No. 1676

Company Helmrich & Payne, Inc.

Well Name & No. McCullum-Fed., #1-19 DST No. 3

County Jackson State Colorado

Sampler No. 3-15 Test Interval 6892-7066

Pressure in Sampler 75 PSIG BHT -- °F

Total Volume of Sampler: 2150 cc.

Total Volume of Sample: 2150 cc.

Oil: Trace cc.

Water: 2150 cc.

Mud: None cc.

Gas: .26 cu. ft.

Other: None

Resistivity

Water: .5 @ 72° of Chloride Content 11,500 ppm.

Mud Pit Sample .3 @ 75° of Chloride Content 20,000 ppm.

Gas/Oil Ratio ____ Gravity ____ °API @ ____ °F

Where was sample drained Rig.

Remarks:

NOMENCLATURE (Definition of Symbols)

Q	=	average production rate during test, bbls./day
Q_g	=	measured gas production rate during test, MCF/day
k	=	permeability, md
h	=	net pay thickness, ft. (when unknown, test interval is chosen)
μ	=	fluid viscosity, centipoise
Z	=	compressibility factor
T_f	=	reservoir temperature, ° Rankine
m	=	slope of final SIP buildup plot, psig/cycle (psig²/cycle for gas)
b	=	approximate radius of investigation, feet
r_w	=	wellbore radius, feet
t_o	=	total flowing time, minutes
P_o	=	Extrapolated maximum reservoir pressure, psig
P_f	=	final flowing pressure, psig
P.I.	=	productivity index, bbls./day/psi
$P.I._t$	=	theoretical productivity index with damage removed, bbl./day/psi
D.R.	=	damage ratio
E.D.R.	=	estimated damage ratio
AOF	=	absolute open flow potential, MCF/D
AOF_t	=	theoretical absolute open flow if damage were removed
Z	=	subsea depth
W	=	water gradient based on salinity
H_w	=	potentiometric surface

INTERPRETATION CALCULATIONS (OIL/WATER)

AVERAGE PRODUCTION RATE DURING TEST

Q = 1440 (drill collar capacity x recovery + drill pipe capac. x recovery) / initial flow time + final flow time

= 1440 [( ) ( ) + ( ) ( )] / ( ) + ( )

= 1440 (.0145 or .0073) ( ) / ( )

= ..... bbls./day

Mud Expansion = ... ft. (Drill Collar Conversion Is Considered)

FLUID PROPERTIES — Estimated Bottom Hole Temperature °

API Gravity @ 60° F. ..... ° Specific Gravity @ 60° F. ..... Est. Viscosity ..... cp

TRANSMISSIBILITY

$\frac{kh}{\mu} = \frac{162.6Q}{m} = \frac{162.6\ (\quad)}{(\quad)} =$ ..... md.-ft/cp

IN SITU CAPACITY

kh = ( ) ( ) = ... md.-ft.

AVERAGE EFFECTIVE PERMEABILITY — Estimated Pay Thickness Ft. / Actual Pay Thickness Ft.

$k = \frac{(\quad)}{(\quad)} =$ ..... md.

PRODUCTIVITY INDEX

$PI = \frac{Q}{P_o - P_f} = \frac{(\quad)}{(\quad) - (\quad)} =$ ..... bbl./day-psi

DAMAGE RATIO

$D.R. = \frac{0.183\ (P_o - P_f)}{m} = \frac{0.183\ [(\quad) - (\quad)]}{(\quad)} =$ .....

PRODUCTIVITY INDEX WITH DAMAGE REMOVED

$P.I._t$ = P.I. x D.R. = ( ) ( ) = ... bbl./day-psi

APPROXIMATE RADIUS OF INVESTIGATION

$b = \sqrt{kt_o} = \sqrt{(\quad)(\quad)} =$ ..... ft.

Drawdown Factor = $\frac{\text{I.S.I.P.} - \text{F.S.I.P.}}{\text{I.S.I.P.}} \times 100 = \frac{(\quad) - (\quad)}{(\quad)} \times 100 =$ ..... % (4% to 5% is considered serious or substantial)

Potentiometric Surface = $H_w = Z + \frac{P_o}{w}$ h_w = ... + ( ) / ( ) = + ... ± ..... ft.

INTERPRETATION CALCULATIONS (GAS)

$R(T_f)$ = ...°

ESTIMATED GAS PROPERTIES — Estimated Bottom Hole Temperature °

Gravity @ 60° F ..... Viscosity (Res.) ..... cp. Compressibility Factor (Z) .....

TRANSMISSIBILITY — Measured D.S.T. Gas Rate = ... mcf/d.

$\frac{kh}{\mu} = \frac{1637\ Q_g\ ZT_f}{m}$ $\frac{1637\ (\quad)(\quad)(\quad)}{(\quad)} =$ ..... md.-ft./cp.

IN SITU CAPACITY

kh = ( ) ( ) = ... md.-ft.

AVERAGE EFFECTIVE PERMEABILITY — Estimated Pay Thickness Ft. / Actual Pay Thickness Ft.

$k = \frac{(\quad)}{(\quad)} =$ ..... md.

APPROXIMATE RADIUS OF INVESTIGATION

$b = 0.02\ \sqrt{kt_oP_o} = 0.02\ \sqrt{(\quad)(\quad)(\quad)} =$ ..... ft.

ACTUAL CAPACITY

$kh = \frac{3270\ Q_g\ \mu\ Z\ T_f\ \log(0.472\frac{b}{r_w})}{P_o^2 - P_f^2} = \frac{3270\ (\quad)(\quad)(\quad)(\quad)(\quad)}{(\quad) - (\quad)} =$ ..... md.-ft.

DAMAGE RATIO — E.D.R. = $\frac{(P_o^2 - P_f^2)}{m\ (\log T_o + 2.65)}$

$D.R. = \frac{\text{In Situ Capacity}}{\text{Actual Capacity}} = \frac{(\quad)}{(\quad)} =$ .....

E.D.R. = ...

ESTIMATED RANGE OF AOF POTENTIAL

Max. AOF = $\frac{Q_g P_o^2}{P_o^2 - P_f^2} = \frac{(\quad)(\quad)}{[(\quad) - (\quad)]} = \frac{(\quad)}{(\quad)} =$ ..... MCF/D

Min. AOF = $\frac{Q_g P_o}{\sqrt{P_o^2 - P_f^2}} = \frac{(\quad)(\quad)}{\sqrt{[(\quad) - (\quad)]}} = \frac{(\quad)}{(\quad)} =$ ..... MCF/D

ESTIMATED RANGE OF AOF POTENTIAL, DAMAGE REMOVED

Max. AOF_t = (Max. AOF) (D.R.) = ( ) ( ) = ... MCF/D

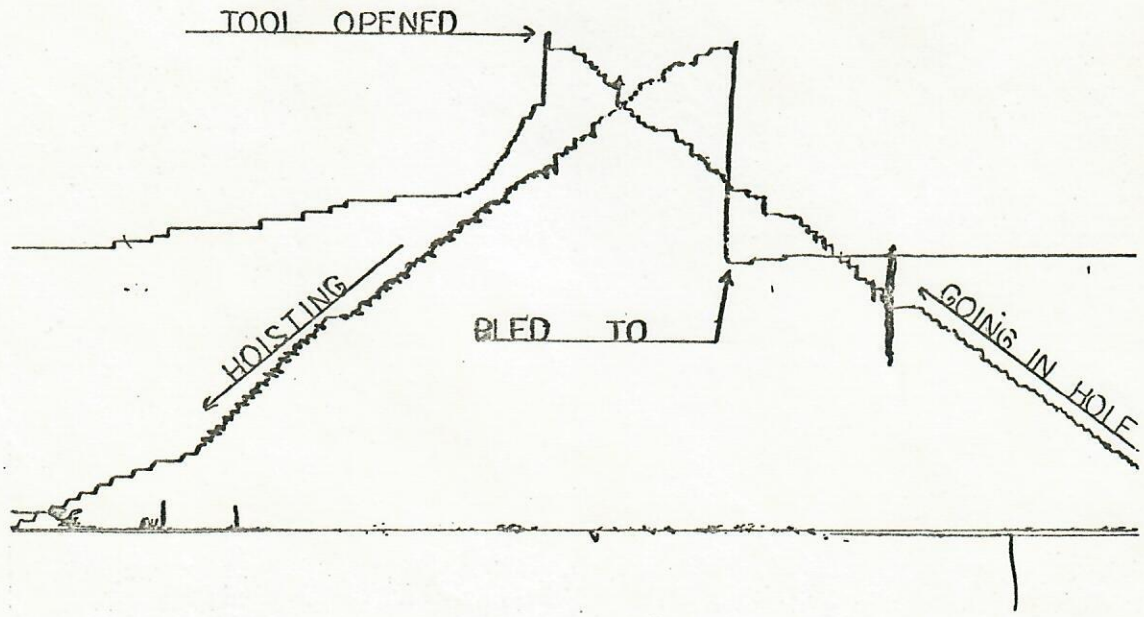
Min. AOF_t = (Min. AOF) (D.R.) = ( ) ( ) = ... MCF/D

Drawdown Factor = $\frac{\text{ISIP} - \text{FSIP}}{\text{ISIP}} \times 100 = \frac{(\quad) - (\quad)}{(\quad)} \times 100 =$ ..... % (4% to 5% is considered serious or substantial)

Potentiometric Surface = $H_w = Z + \frac{P_o}{w}$ H_w = ... + ( ) / ( ) = + ... ± ..... ft.

LYNES UNITED SERVICES
DIVISION OF LYNES, INC.

Operator Helmerich & Payne, Inc. Lease & No. McCallum-Federal #1-19 DST No. 2



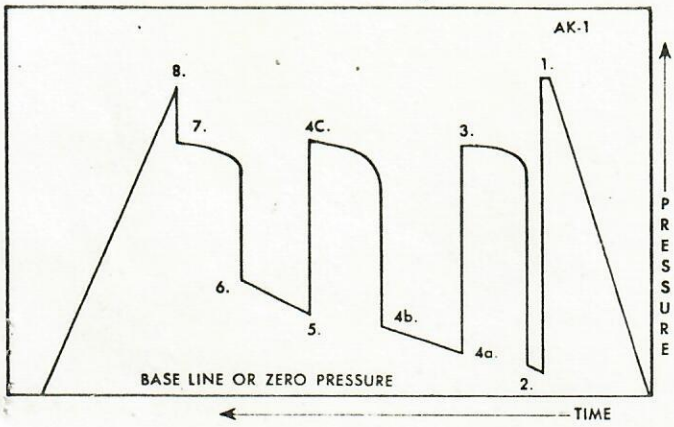
This recorder blanked off below the bottom packer and since pressure bled to only 1777 lbs., which is more than the shut-in pressure, the bottom packer held. Recorder No. VT-38 .

LYNES

GUIDE TO INTERPRETATION AND IDENTIFICATION OF LYNES DRILL STEM TEST PRESSURE CHARTS

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.

AK-1 recorders. Read from right to left.

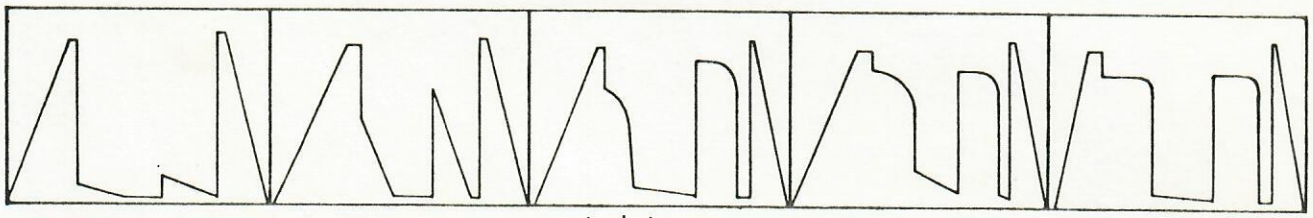


K-K-3 recorders. Read from left to right.

1. INITIAL HYDROSTATIC MUD PRESSURE
2. PRE-FLOW
3. INITIAL SHUT-IN
4a. 2nd INITIAL FLOW
4b. 2nd FINAL FLOW
4c. 2nd SHUT-IN
5. 3rd INITIAL FLOW
6. FINAL FLOW
7. FINAL SHUT-IN
8. FINAL HYDROSTATIC MUD PRESSURE

N.B. When only two shut-in and flow periods are run, 4a. 4b and 4c are omitted.

Typical charts for visual field analysis ranging from very low to high permeability.



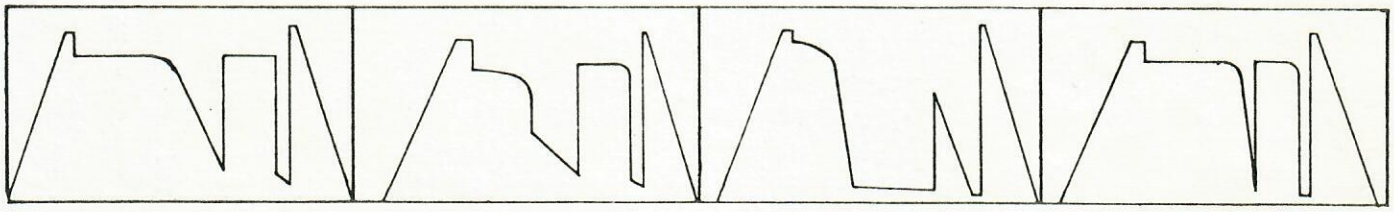
Very low permeability. Usually only mud recovered from interval tested. Virtually no permeability.

Slightly higher permeability. Again usually mud recovered.

Slightly higher permeability. Small recovery, less than 200' ft).

Average permeability. Final and initial shut-ins differ by 50 psi.

Average permeability. Strong damage effect. High shut-in pressure, low flow pressure.



Excellent permeability where final flow final shut-in pressure.

High permeability where ISIP and FSIP are within 10 psi.

Deep well bore invasion or damage. Final shut-in higher than the initial shut-in.

Tight hole chamber tester. Permeability very difficult to interpret unless the recovery is less than chamber length. Flow pressure builds up rapidly if recovery is large, similar to a shut-in

NOMENCLATURE (Definition of Symbols)

Q	=	average production rate during test, bbls./day
Q_g	=	measured gas production rate during test, MCF/day
k	=	permeability, md
h	=	net pay thickness, ft. (when unknown, test interval is chosen)
μ	=	fluid viscosity, centipoise
Z	=	compressibility factor
T_f	=	reservoir temperature, ° Rankine
m	=	slope of final SIP buildup plot, psig/cycle (psig²/cycle for gas)
b	=	approximate radius of investigation, feet
r_w	=	wellbore radius, feet
t_o	=	total flowing time, minutes
P_o	=	Extrapolated maximum reservoir pressure, psig
P_f	=	final flowing pressure, psig
P.I.	=	productivity index, bbls./day/psi
$P.I._t$	=	theoretical productivity index with damage removed, bbl./day/psi
D.R.	=	damage ratio
E.D.R.	=	estimated damage ratio
AOF	=	absolute open flow potential, MCF/D
AOF_t	=	theoretical absolute open flow if damage were removed
Z	=	subsea depth
W	=	water gradient based on salinity
H_w	=	potentiometric surface

INTERPRETATION CALCULATIONS (OIL/WATER)

AVERAGE PRODUCTION RATE DURING TEST

Q = 1440 (drill collar capacity x recovery + drill pipe capac. x recovery) / initial flow time + final flow time

= 1440 [( )( ) + ( )( )] / ( ) + ( )

= 1440 (.0145 or .0073) ( ) / ( )

= ..... bbls./day

Mud Expansion = — ft. (Drill Collar Conversion Is Considered)

FLUID PROPERTIES — Estimated Bottom Hole Temperature °

API Gravity @ 60° F. ° Specific Gravity @ 60° F. Est. Viscosity ..... cp

TRANSMISSIBILITY

$\frac{kh}{\mu} = \frac{162.6Q}{m} = \frac{162.6 ( )}{( )}$ = ... md.-ft/cp

IN SITU CAPACITY

kh = ( )( ) = ... md.-ft.

AVERAGE EFFECTIVE PERMEABILITY — Estimated Pay Thickness Ft. / Actual Pay Thickness Ft.

$k = \frac{( )}{( )}$ = ... md.

PRODUCTIVITY INDEX

$PI = \frac{Q}{P_o - P_f} = \frac{( )}{( ) - ( )}$ = ... bbl./day-psi

DAMAGE RATIO

$D.R. = \frac{0.183 (P_o - P_f)}{m} = \frac{0.183 [( ) - ( )]}{( )}$ = ...

PRODUCTIVITY INDEX WITH DAMAGE REMOVED

$P.I._t$ = P.I. x D.R. = ( ) ( ) = ... bbl./day-psi

APPROXIMATE RADIUS OF INVESTIGATION

$b = \sqrt{kt_o}$ = $\sqrt{[ ][ ]}$ = ... ft.

Drawdown Factor = I.S.I.P. - F.S.I.P. x 100 / I.S.I.P. = ( ) — ( ) / ( ) x 100 = ... % (4% to 5% is considered serious or substantial)

Potentiometric Surface = $H_s = Z + \frac{P_o}{w}$ h_w = + ( ) = + ± ..... ft.

INTERPRETATION CALCULATIONS (GAS)

$R(T_f)$ = ...°

ESTIMATED GAS PROPERTIES — Estimated Bottom Hole Temperature °

Gravity @ 60° F ..... Viscosity (Res.) ..... cp. Compressibility Factor (Z) .....

TRANSMISSIBILITY — Measured D.S.T. Gas Rate = ... mcf/d.

$\frac{kh}{\mu} = \frac{1637 Q_g Z T_f}{m}$ $\frac{1637 ( )( )( )}{( )}$ = ... md.-ft. / cp.

IN SITU CAPACITY

kh = ( ) ( ) = ... md.-ft.

AVERAGE EFFECTIVE PERMEABILITY — Estimated Pay Thickness Ft. / Actual Pay Thickness Ft.

$k = \frac{( )}{( )}$ = ... md.

APPROXIMATE RADIUS OF INVESTIGATION

$b = 0.02 \sqrt{\frac{kt_o P_o}{\phi}} = 0.02 \sqrt{[ ][ ][ ]}$ = ... ft.

ACTUAL CAPACITY

$kh = \frac{3270 Q_g \mu Z T_f \log(0.472 \frac{b}{r_w})}{P_o^2 - P_f^2} = \frac{3270 ( )( )( )( )}{( ) — ( )}$ = ... md.-ft.

DAMAGE RATIO — E.D.R. = $\frac{(P_o^2 - P_f^2)}{m [\log T_o + 2.65]}$

$D.R. = \frac{\text{In Situ Capacity}}{\text{Actual Capacity}} = \frac{( )}{( )}$ = ...

E.D.R. = ...

ESTIMATED RANGE OF AOF POTENTIAL

Max. AOF = $\frac{Q_g P_o^2}{P_o^2 - P_f^2} = \frac{( )( )}{[( ) — ( )]} = \frac{( )}{( )}$ = ... MCF/D

Min. AOF = $\frac{Q_g P_o}{\sqrt{P_o^2 - P_f^2}} \sqrt{[ ) — ( ]} = \frac{( )}{( )}$ = ... MCF/D

ESTIMATED RANGE OF AOF POTENTIAL, DAMAGE REMOVED

Max. AOF_t = (Max. AOF) (D.R.) = ( ) ( ) = ... MCF/D

Min. AOF_t = (Min. AOF) (D.R.) = ( ) ( ) = ... MCF/D

Drawdown Factor = ISIP — FSIP x 100 / ISIP = ( ) — ( ) / ( ) x 100 = ... % (4% to 5% is considered serious or substantial)

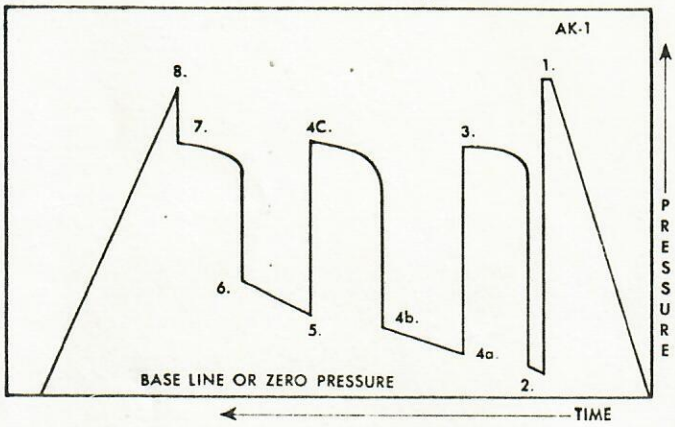
Potentiometric Surface = $H_w = Z + \frac{P_o}{W}$ H_w = ( ) + ( ) = + ± ..... ft.

LYNES

GUIDE TO INTERPRETATION AND IDENTIFICATION OF LYNES DRILL STEM TEST PRESSURE CHARTS

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.

AK-1 recorders. Read from right to left.

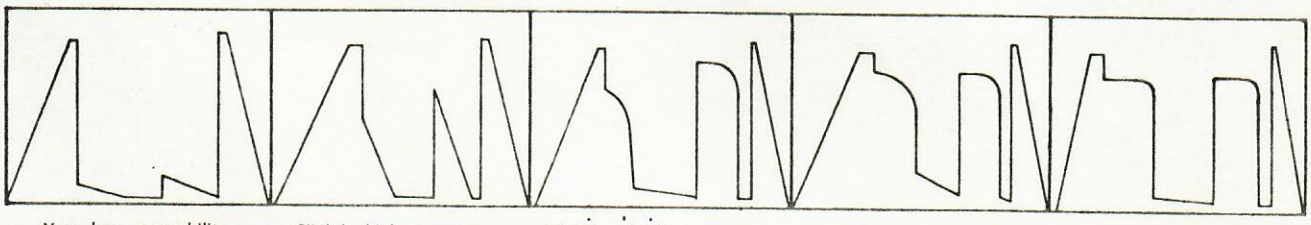


K-K-3 recorders. Read from left to right.

1. INITIAL HYDROSTATIC MUD PRESSURE
2. PRE-FLOW
3. INITIAL SHUT-IN
4a. 2nd INITIAL FLOW
4b. 2nd FINAL FLOW
4c. 2nd SHUT-IN
5. 3rd INITIAL FLOW
6. FINAL FLOW
7. FINAL SHUT-IN
8. FINAL HYDROSTATIC MUD PRESSURE

N.B. When only two shut-in and flow periods are run, 4a, 4b and 4c are omitted.

Typical charts for visual field analysis ranging from very low to high permeability.



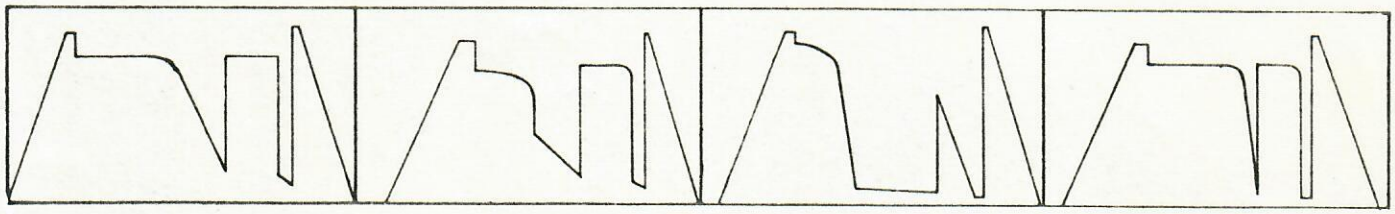
Very low permeability. Usually only mud recovered from interval tested. Virtually no permeability.

Slightly higher permeability. Again usually mud recovered.

Slightly higher permeability. Small recovery, less than 200 ft).

Average permeability. Final and initial shut-ins differ by 50 psi.

Average permeability. Strong damage effect. High shut-in pressure, low flow pressure



Excellent permeability where final flow final shut-in pressure.

High permeability where ISIP and FSIP are within 10 psi.

Deep well bore invasion or damage. Final shut-in higher than the initial shut-in.

Tight hole chamber tester. Permeability very difficult to interpret unless the recovery is less than chamber length. Flow pressure builds up rapidly if recovery is large, similar to a shut-in