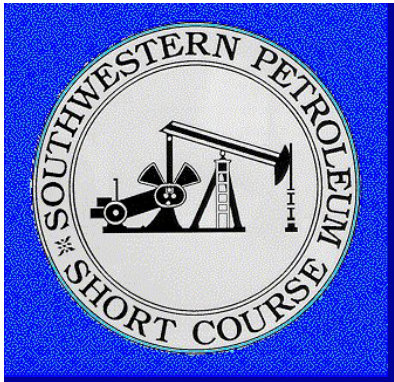
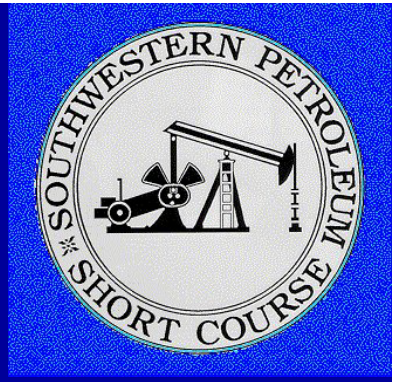



**Southwestern Petroleum Short Course**
**Lubbock TX , 23-24 April 2008**




# Pumping Flumping Sucker Rod Lifted Wells

**James Harris – H & H Well Service, LLC**
**Robert Harris – H & H Well Service, LLC**

**Lynn Rowlan – Echometer Co.**
**James N. McCoy – Echometer Co.**

# What is a Flumping Sucker Rod Lifted Well

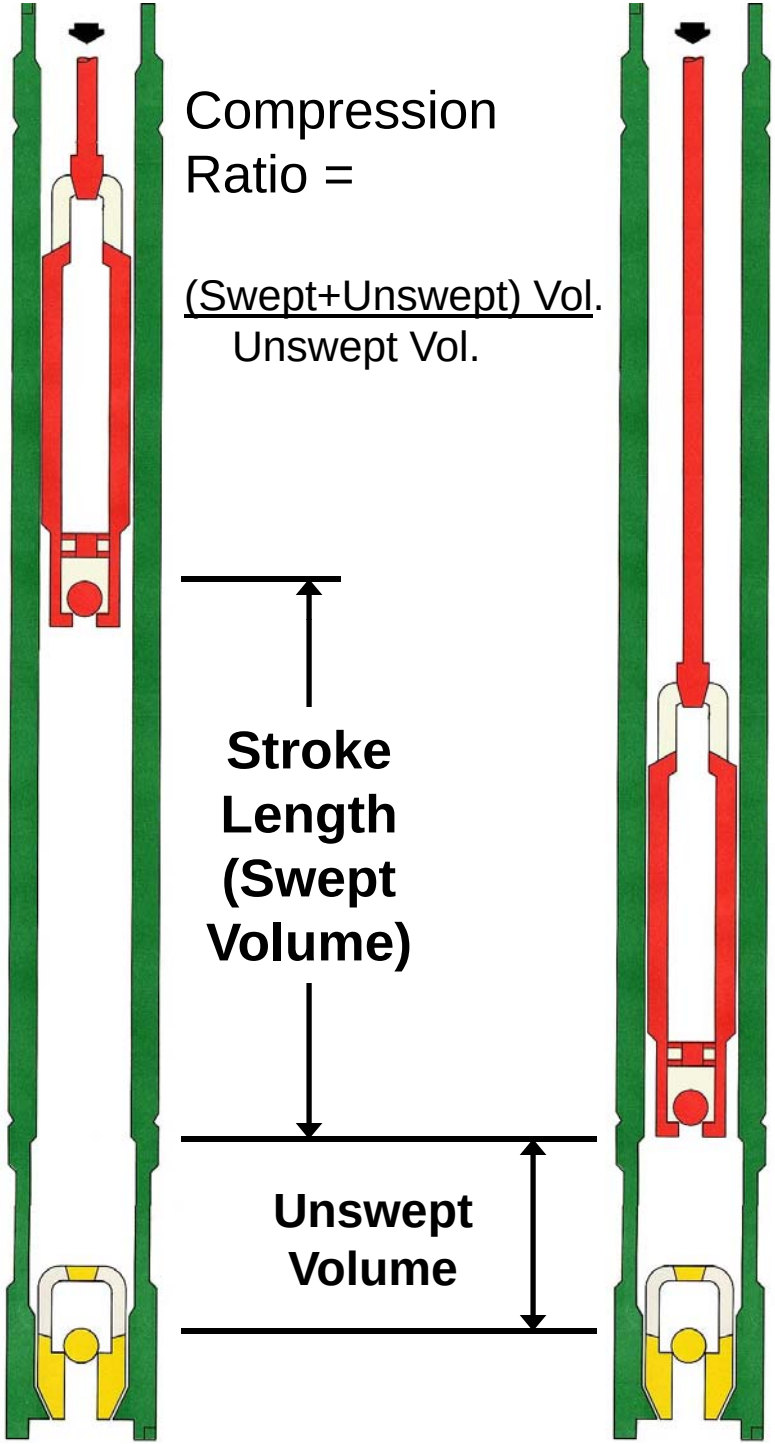
1. ***Flumping*** - the well is flowing fluids to the surface up the casing annulus, plus at the same time fluids are being lifted up the tubing to the surface
2. Oil wells flump because:
   - High producing bottom hole pressure and/or
   - High gas rate flowing up the casing annulus; lightening the fluid column above the formation.
3. Flumping often continues for long time period until the gas rate decreases or producing bottomhole pressure decreases.

# Possible Solutions to Flumping

1. Back-pressure Valve
   - Backpressure on Tubing
   - Backpressure on Casing Annulus
2. Try to Keep Most of Gas out of Tubing
   - Downhole Gas Separator
   - When possible, set the pump below the perforations
3. Use a specialty pump such as a VSP® pump to discharge gas into tubing.
4. Use longer stroke length to increase compression ratio
5. Space out the pump to minimize dead space at bottom of stroke

# Gas Separator Summary

- Best gas separation efficiency by locating pump intake below gas entry point.
- Poor Boy gas separators tend to be ineffective because of limited liquid capacity due to small flow area inside separator
- Improved efficiency by maximizing flow areas for gravity separation.
- Proper anchor selection must take into account gas production rate and well liquid capacity.
- Decentralization of the gas separator improves efficiency by providing maximum flow area for gas flow on the high side of annulus and liquid accumulation on the low side .

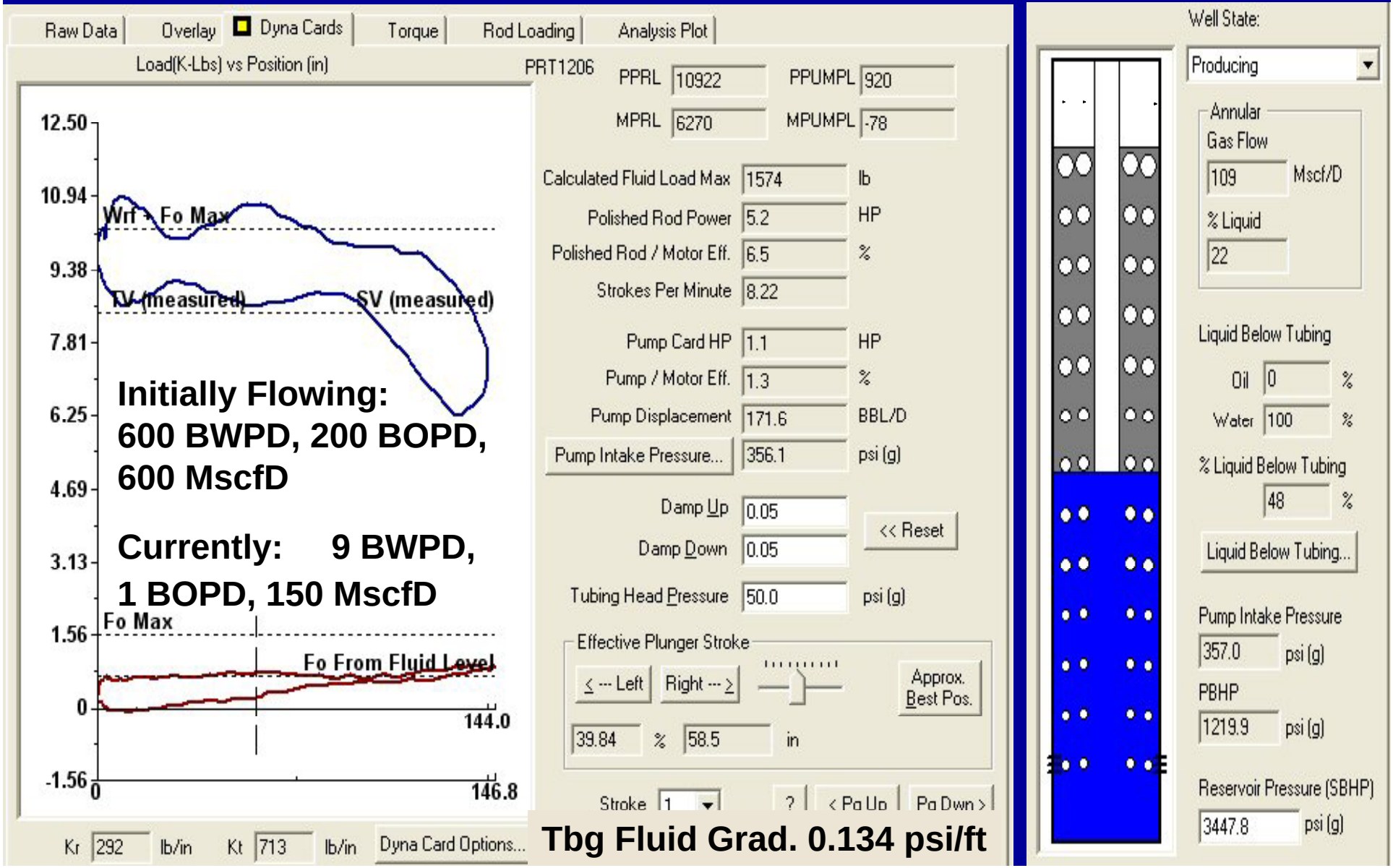



# High Compression Ratio Helps Prevent Gas Lock But, Space Pump High or High Tubing Pressure and Gas Lock Possible

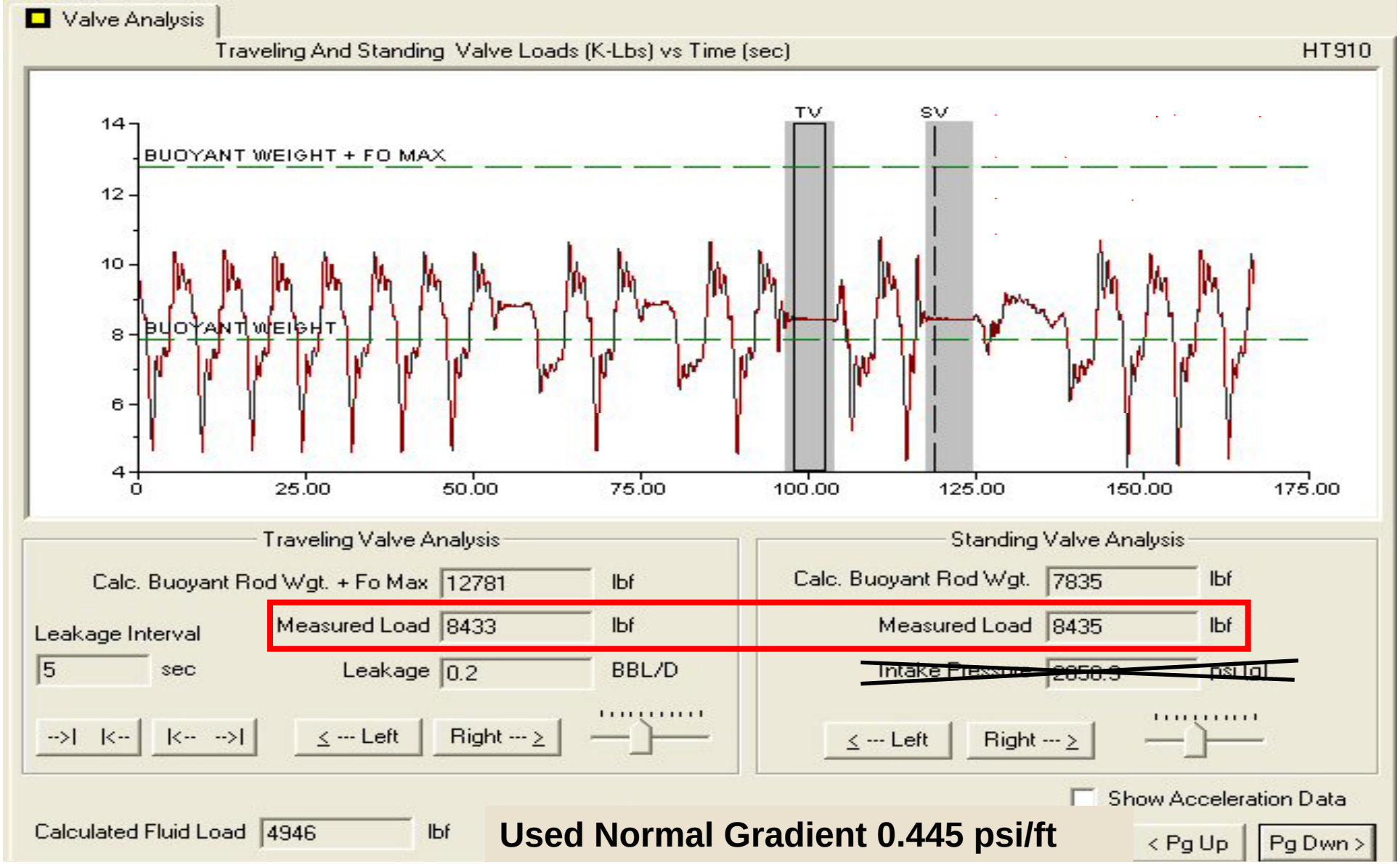
**Example:**
**2-1/4” plunger**
**53.9” downhole stroke length**
**6 cubic inches unswept volume**
**(214.4 + 6) / 6 = 36.7**

**Pump Barrel Pressure =**
**(Intake Press) times (C R)**
**Example:**
**14.7 psia Intake Pressure**
**36.7 compression ratio, C R**
**14.7 times 36.7 = 539.7 psia**
**539.7 > 368.5 Pump Discharge Pressure**

# Well Flowing off Tubing + Casing With Fluid Level at/near Surface: Poor Pump Action & Low Production Rate



# Symptoms of Well Flowing up Tubing and/or Casing: Measured TV and SV loads Approximately Equal



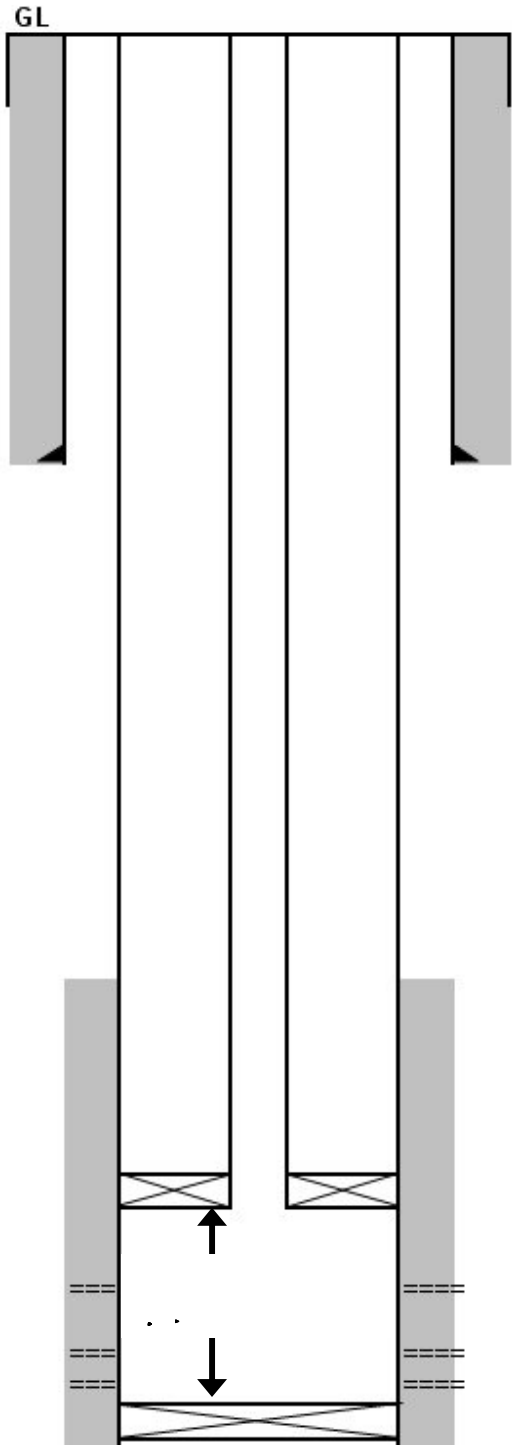
# Flumping Well Bore Description

**Pump Depth: 4509.7’**
**Pump Displ. >350 BPD**

**Perforations:**
**8376-8380, 8384-8388'**
**8412-8418, 8420-8428’**

**Poor Boy Gas Separator:**
**1”x18’ Dip Tube**
**2 7/8” Slotted Pup**
**Area = 3.9 sq. in.**

***Liquid Capacity: 195 BPD***




***Rodded up on 5/17/07***

| | |
|---|---|
| **Spud Date:** | |
| **Completion Date:** | Dec-99 |
| **GL Elev:** | |
| **KB Elev:** | 12 |

**Elevation 12'**

***Tubing Detail***

| | Elevation 12 | |
|---|---|---|
| 142 JTS 2-3/8" | 4376.77 | 4388.77 |
| 2-3/8" 4-1/2" TAC | 3.02 | **4391.79** |
| 3 JTS 2-3/8" J-55 | 88.68 | 4480.47 |
| 2-3/8" pup | 4.03 | 4484.50 |
| 1-3/4" Working BBL Pump | 24.10 | 4508.60 |
| SN | 1.09 | **4509.69** |
| 2-3/8" x 2-7/8" x 0 | 0.74 | 4510.43 |
| 2-7/8" Slotted Pup | 4.15 | **4514.58** |
| 1 JT 2-7/8" tubg | 32.42 | 4547.00 |
| B.P. | 0.71 | 4547.71 |
| | EOT | 4547.71 |

***Rod Detail***

| | Elevation 12 | |
|---|---|---|
| 1-1/2" Polished Rod | 26.00 | 38.00 |
| 1 - 7/8" x 4' pony | 4.00 | 42.00 |
| 79 7/8" Norris 97 sucker rods | 1975.00 | 2017.00 |
| 94 - 3/4" Norris 97 sucker rods | 2350.00 | 4367.00 |
| 6 - 1-1/2" weight bars | 150.00 | 4517.00 |
| 5" x 1-3/4" plunger | 5.00 | 4522.00 |

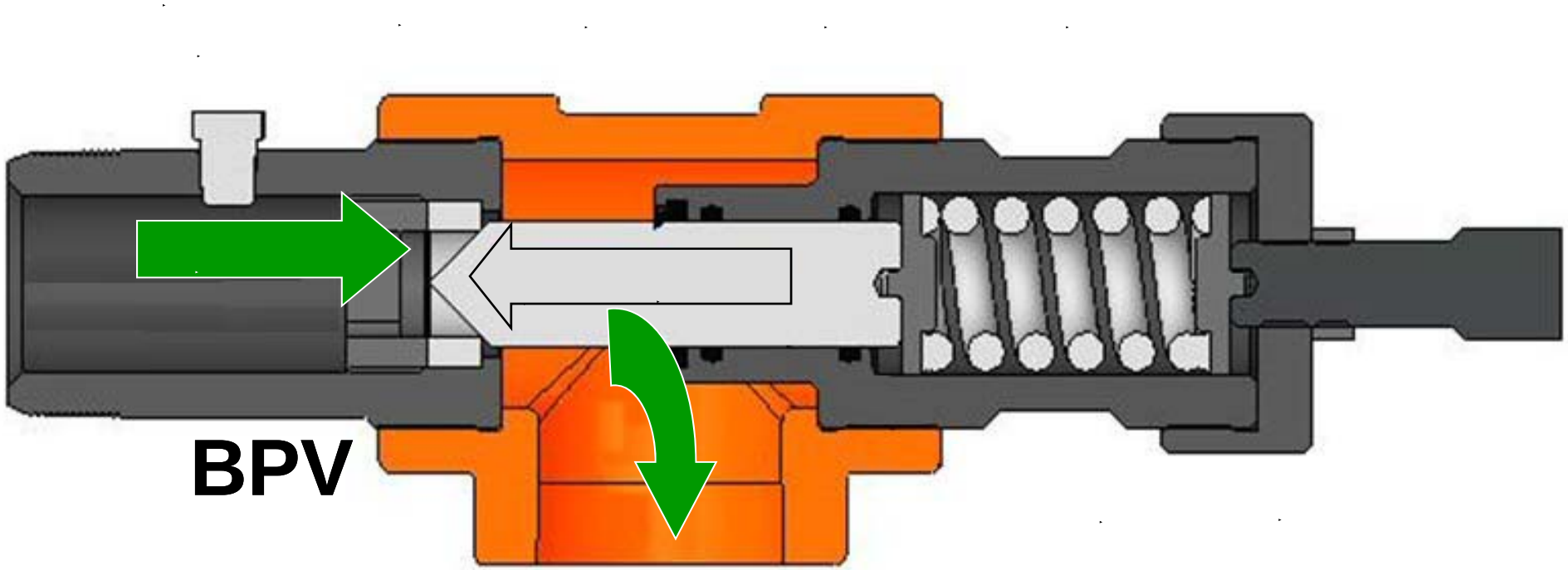
***Pump Detail***
1-3/4" Working BBL Pump
1-3/4" x 5' plunger
1" x 18' gas anchor

***Casing Detail***
4 1/2" 11.6# J-55 LTC @ 8862'

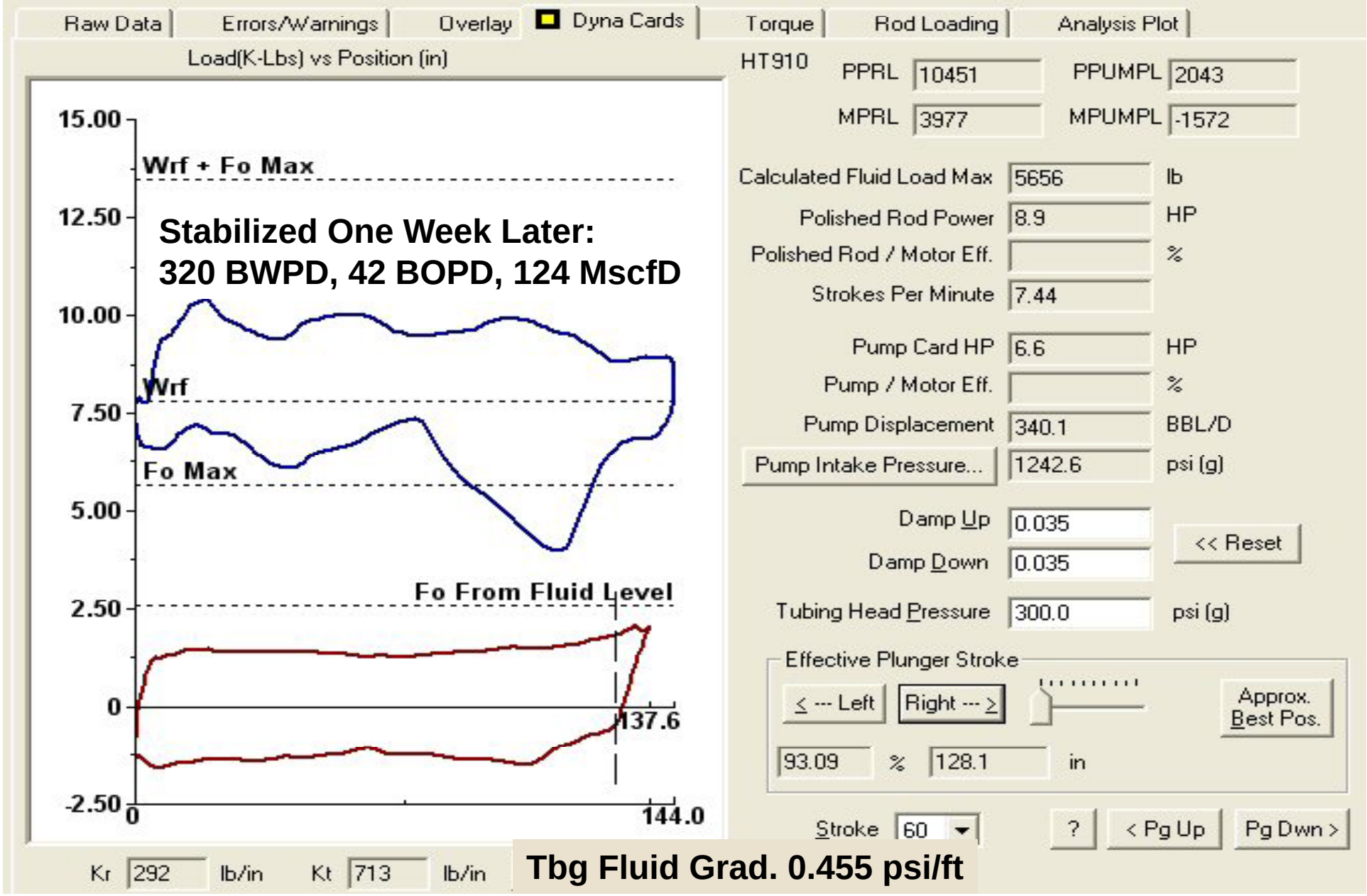
# Prevent Flumping Up The Tubing by Using a Back-pressure Valve

**Gas Flowing through Pump OR Pumped into Tubing**

- **Back-pressure valve maintains high tubing pressure to prevent gas from blowing all of the liquid out of tubing**
- **Without BPV Pump action erratic & discharge may STOP**



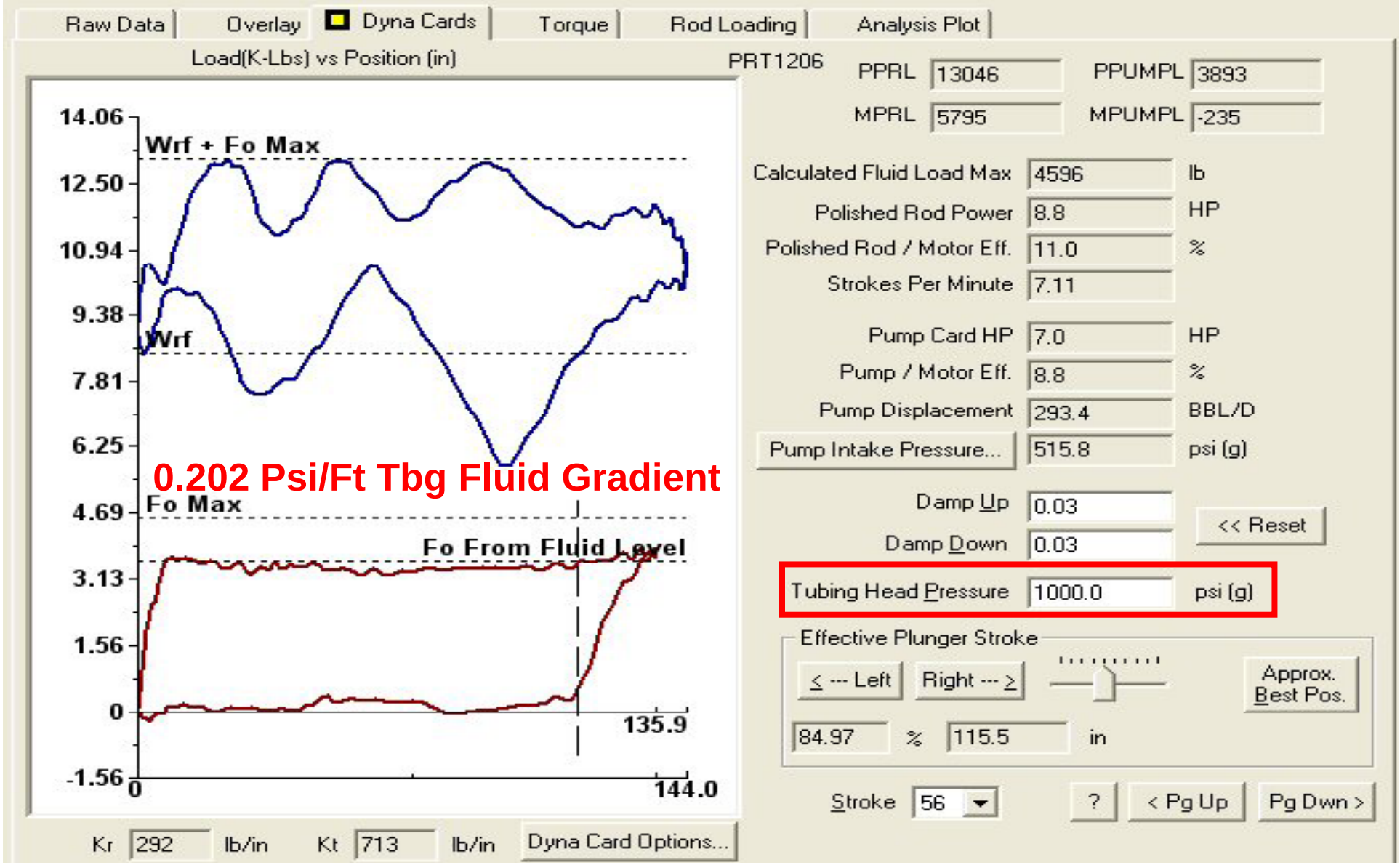
# Used Back-pressure Valve to Increase Tubing Pressure to 300 – Water up Tubing & Oil up Casing



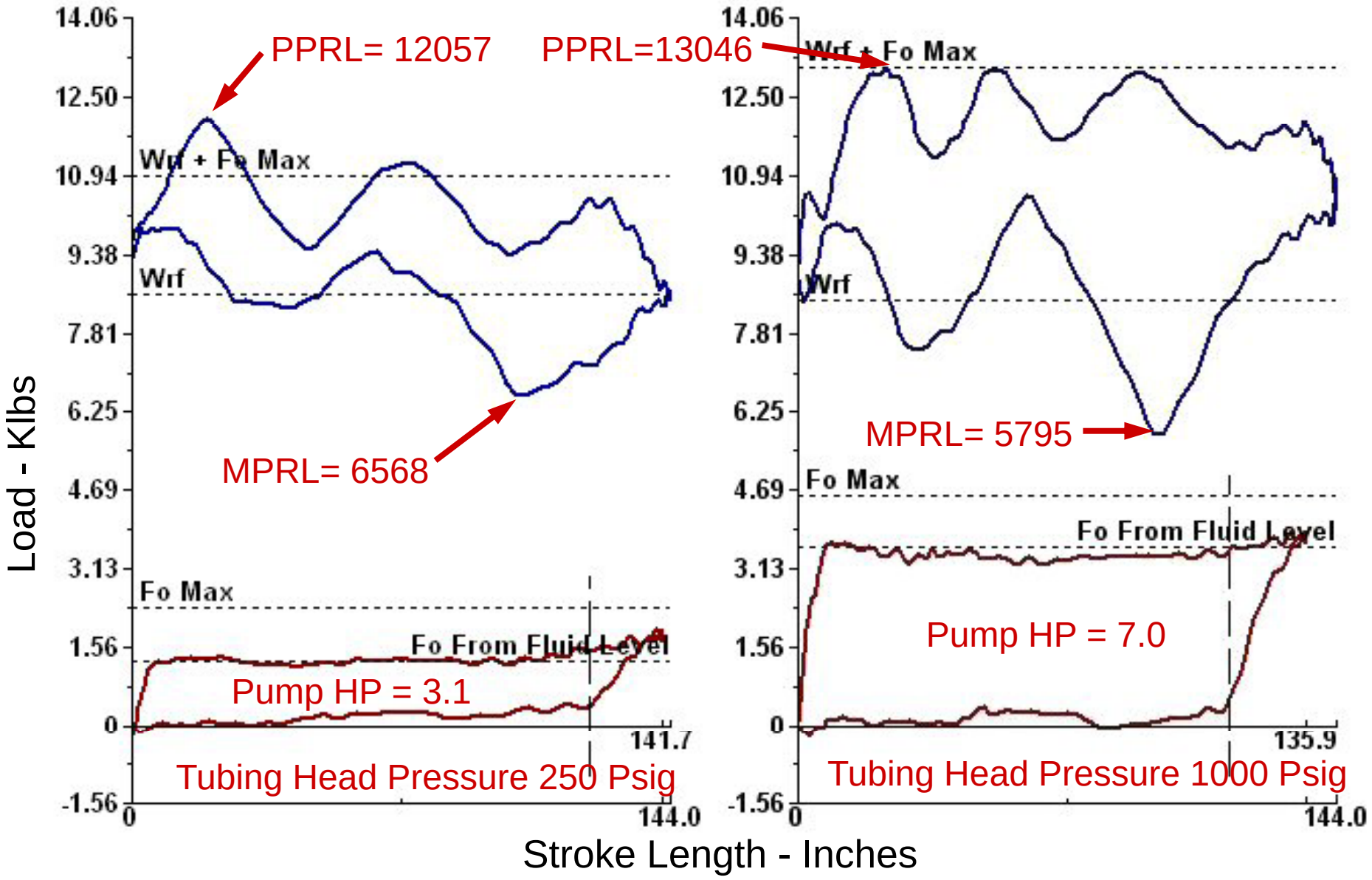

**Tbg Fluid Grad. 0.455 psi/ft**

# Week Later Back Pressure Test

## Slight Tag Due to Increased Static Stretch



# Compare
# 250 to 1000 Psig Backpressure

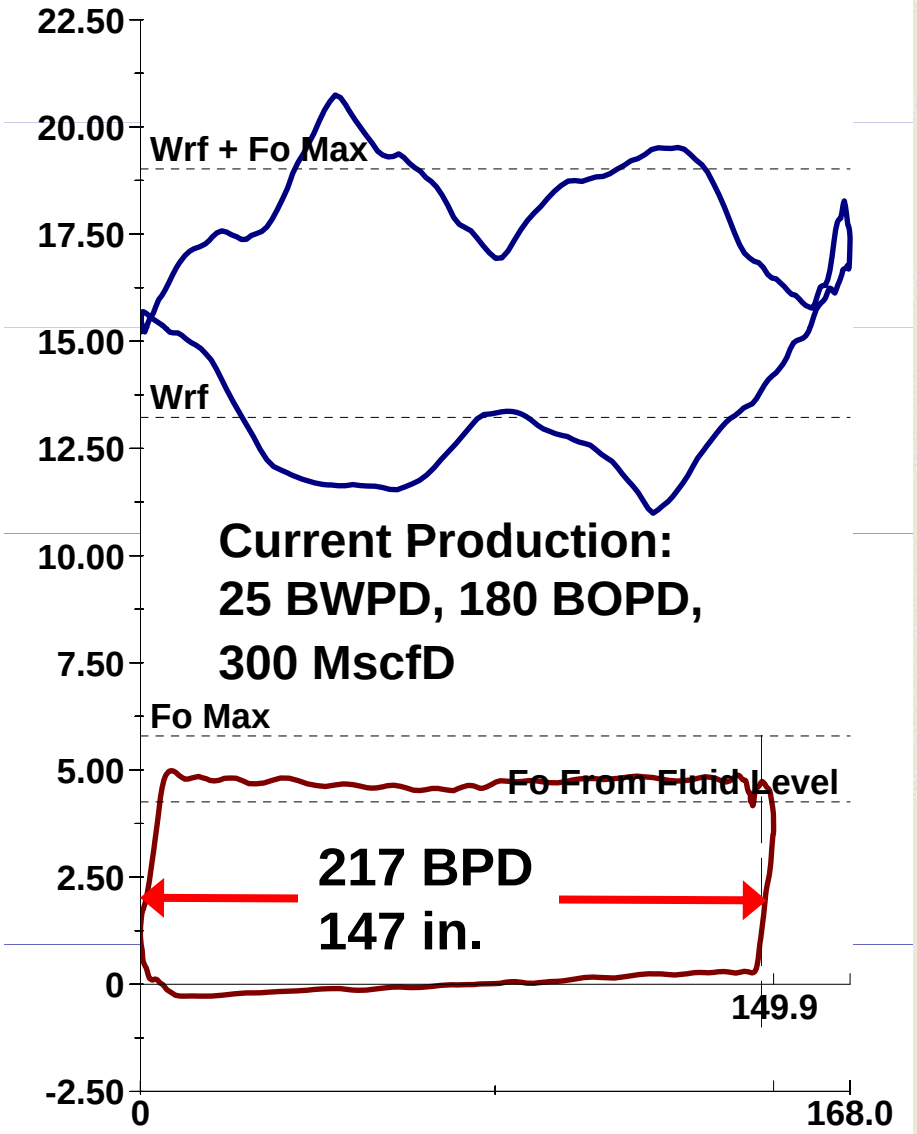


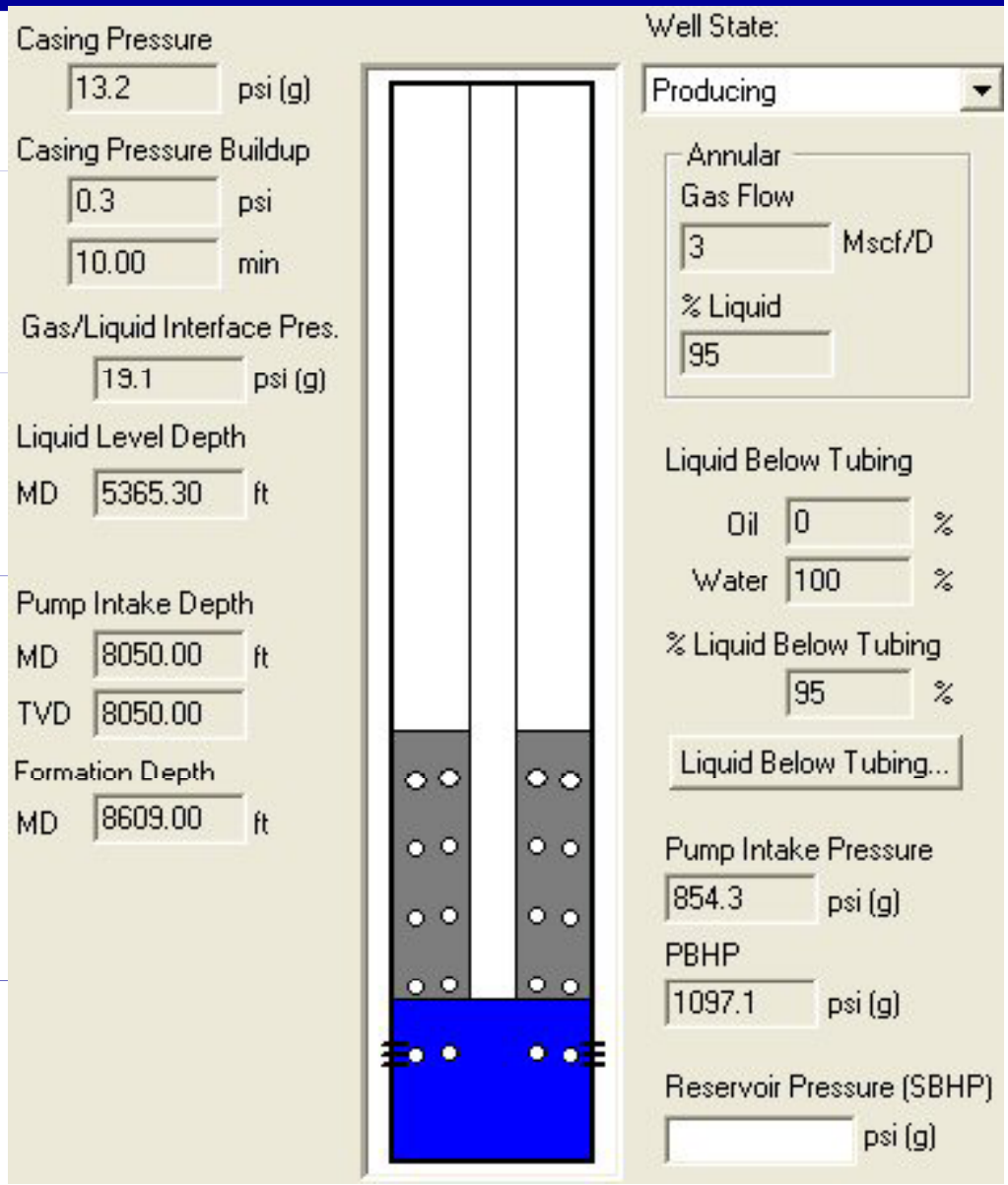
# Summary of Adding Pressure to the Tubing by Using a Back-pressure Valve

**Increasing Back-pressure to prevent gas from blowing tubing "dry": increases HP, reduces SPM, increases rod load, caused slight tag, and reduces pump displacement.**

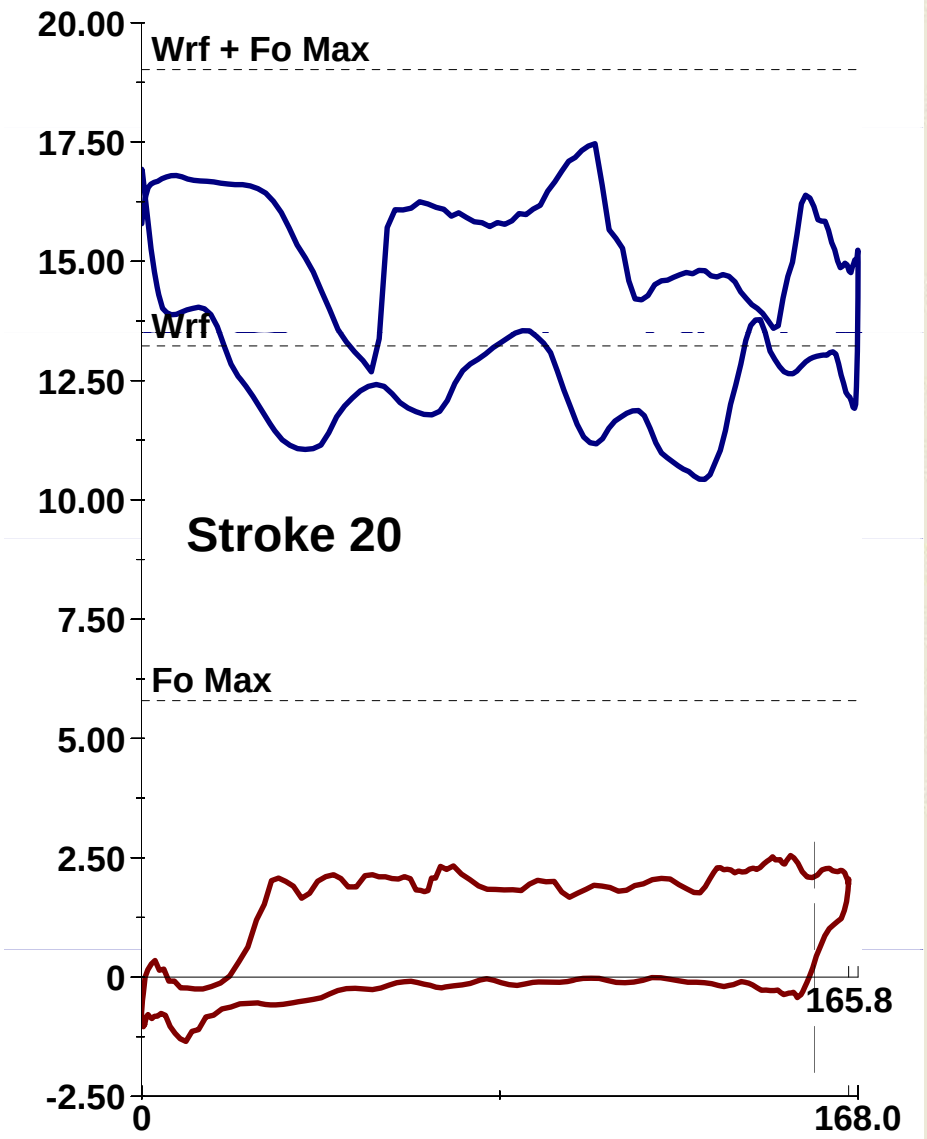
| Tubing Head Pressure (Psig) | Estimated Tubing Fluid Gradient (psi/ft) | Fluid Load on Pump (Lbs) | Polished Rod HP | Strokes per Minute | Effective Pump Disp. BPD |
|---|---|---|---|---|---|
| 250 | 0.160 | 2337 | 6.3 | 8.74 | 381.0 |
| 500 | 0.187 | 2700 | 7.7 | 8.14 | 334.1 |
| 750 | 0.202 | 3461 | 8.9 | 7.83 | 312.4 |
| 1000 | 0.202 | 3893 | 8.8 | 7.11 | 293.4 |
| Ratio 1000 to 250 | | 1.666 | 1.397 | 0.814 | 0.770 |

# Different Well ~ First Survey: 5.7 SPM Everything Looks A-OK



# Well Survey 5-Days Later 7.0 SPM:
## Flowing Up Tbg & Csg w/ High Fluid Level




Casing Pressure
81.2 psi (g)

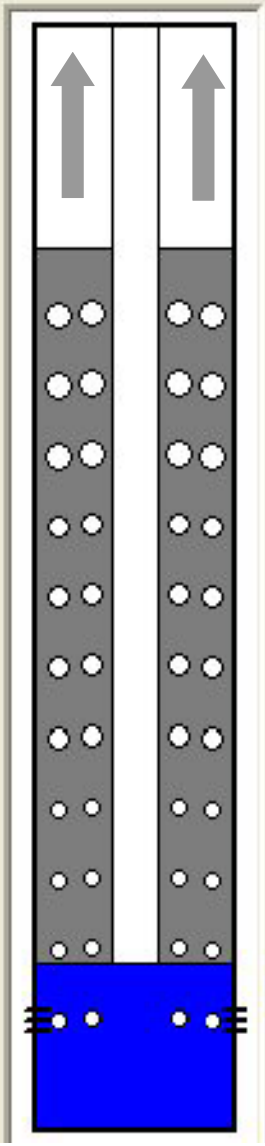
Casing Pressure Buildup
1.5 psi
2.00 min

Gas/Liquid Interface Pres.
84.5 psi (g)

Liquid Level Depth
MD 1083.11 ft

Pump Intake Depth
MD 8050.00 ft
TVD 8050.00

Formation Depth
MD 8609.00 ft



Well State:
Producing

Annular
Gas Flow
102 Mscf/D
% Liquid
30

Liquid Below Tubing
Oil 0 %
Water 100 %

% Liquid Below Tubing
42 %

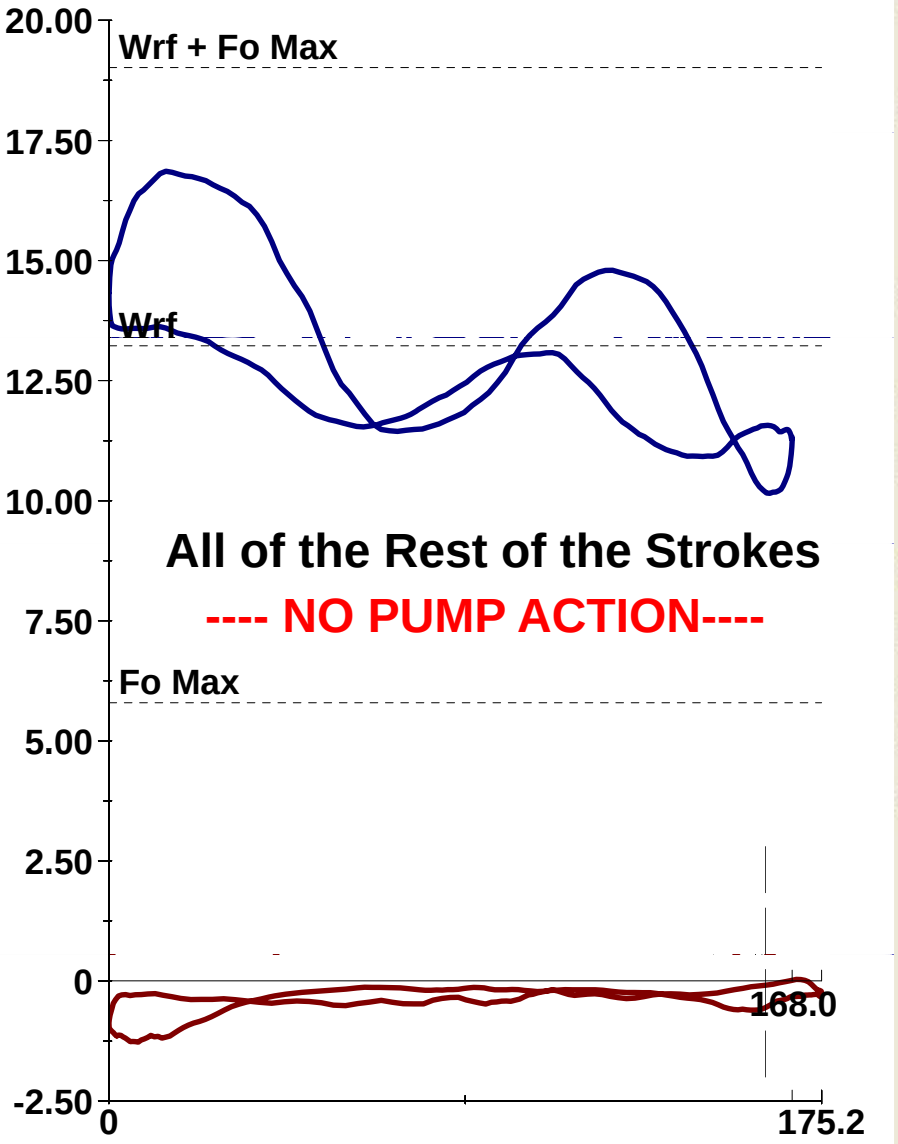
Liquid Below Tubing...

Pump Intake Pressure
775.1 psi (g)

PBHP
880.8 psi (g)

Reservoir Pressure (SBHP)
psi (g)

# Well Survey 5-Days Later 7.0 SPM:
# Flowing Up Tbg & Csg w/ High Fluid Level




Casing Pressure
81.2 psi (g)

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1.5 psi
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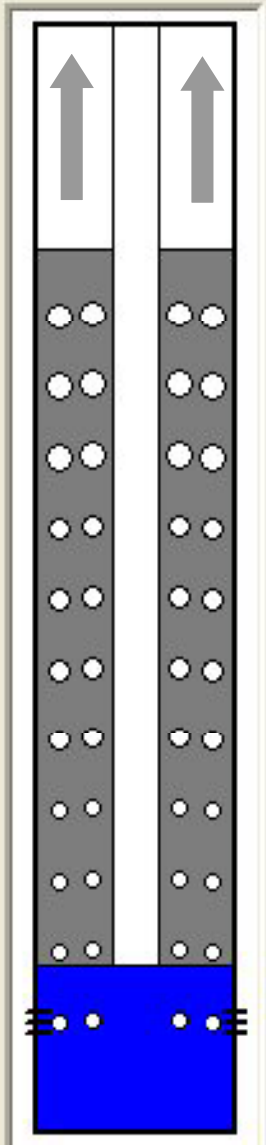
Gas/Liquid Interface Pres.
84.5 psi (g)

Liquid Level Depth
MD 1083.11 ft

Pump Intake Depth
MD 8050.00 ft
TVD 8050.00

Formation Depth
MD 8609.00 ft



Well State:
Producing

Annular
Gas Flow
102 Mscf/D
% Liquid
30

Liquid Below Tubing
Oil 0 %
Water 100 %

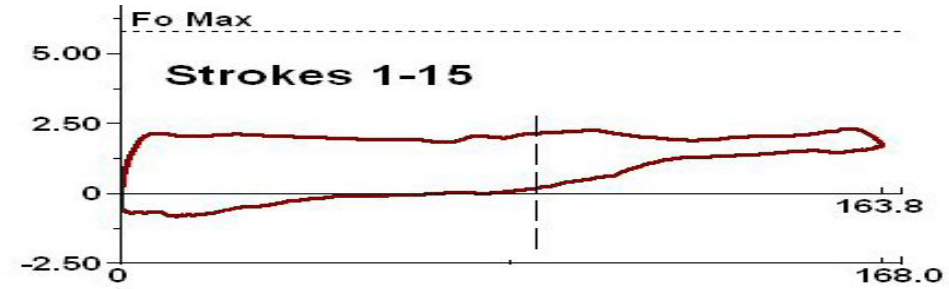
% Liquid Below Tubing
42 %

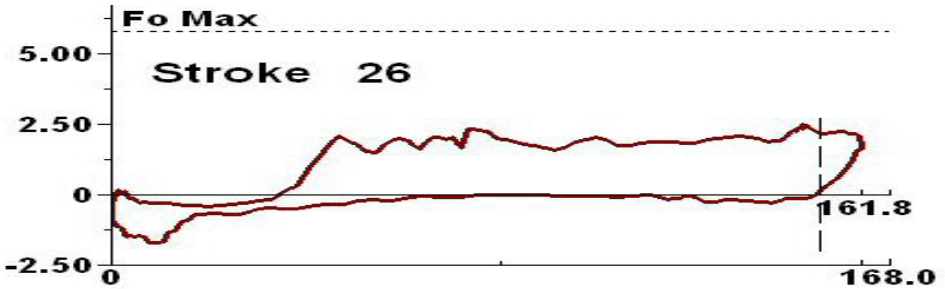
Liquid Below Tubing...

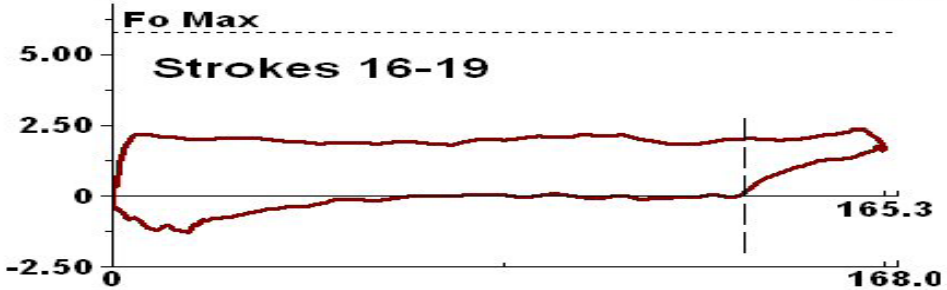
Pump Intake Pressure
775.1 psi (g)

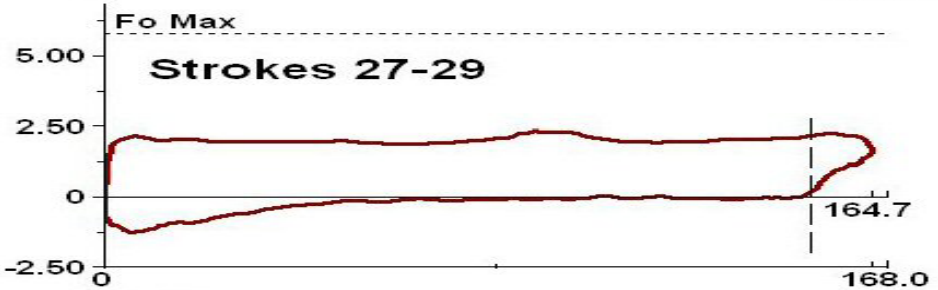
PBHP
880.8 psi (g)

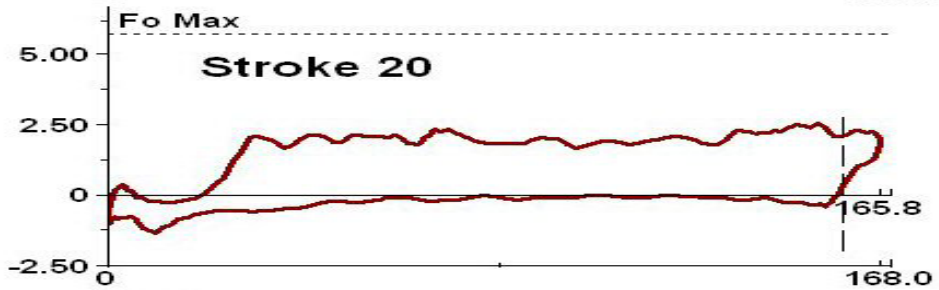
Reservoir Pressure (SBHP)
psi (g)

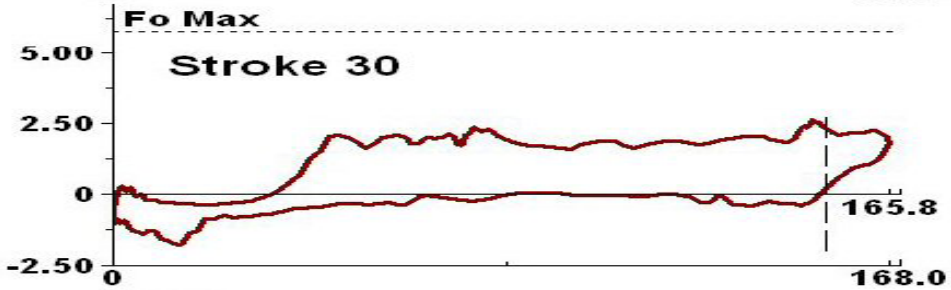

Fo Max
Strokes 1-15
5.00
2.50
0
-2.50
0
163.8
168.0

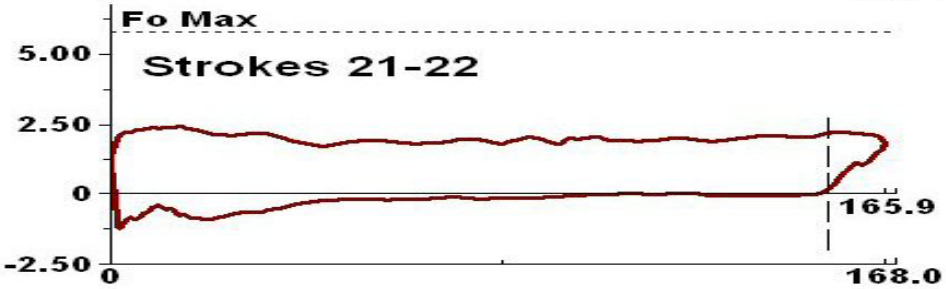

Fo Max
Stroke 26
5.00
2.50
0
-2.50
0
161.8
168.0

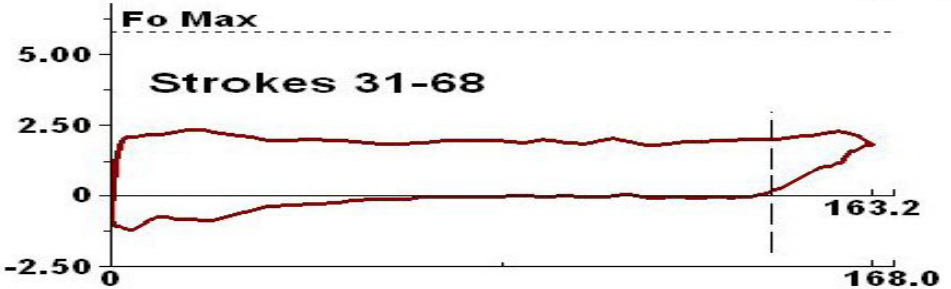

Fo Max
Strokes 16-19
5.00
2.50
0
-2.50
0
165.3
168.0

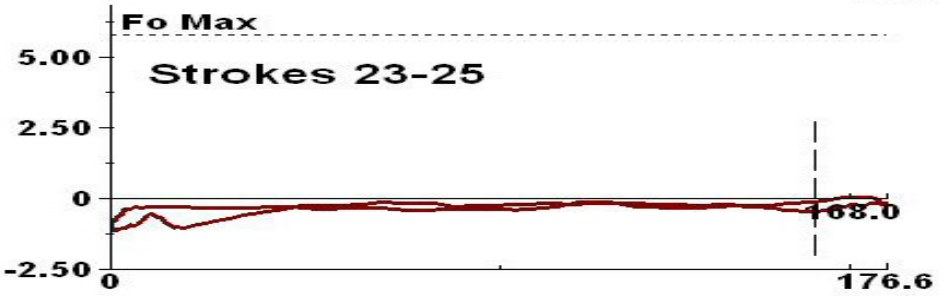

Fo Max
Strokes 27-29
5.00
2.50
0
-2.50
0
164.7
168.0

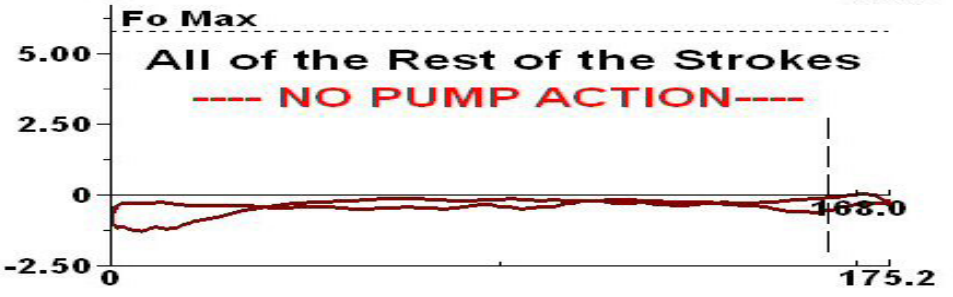

Fo Max
Stroke 20
5.00
2.50
0
-2.50
0
165.8
168.0


Fo Max
Stroke 30
5.00
2.50
0
-2.50
0
165.8
168.0

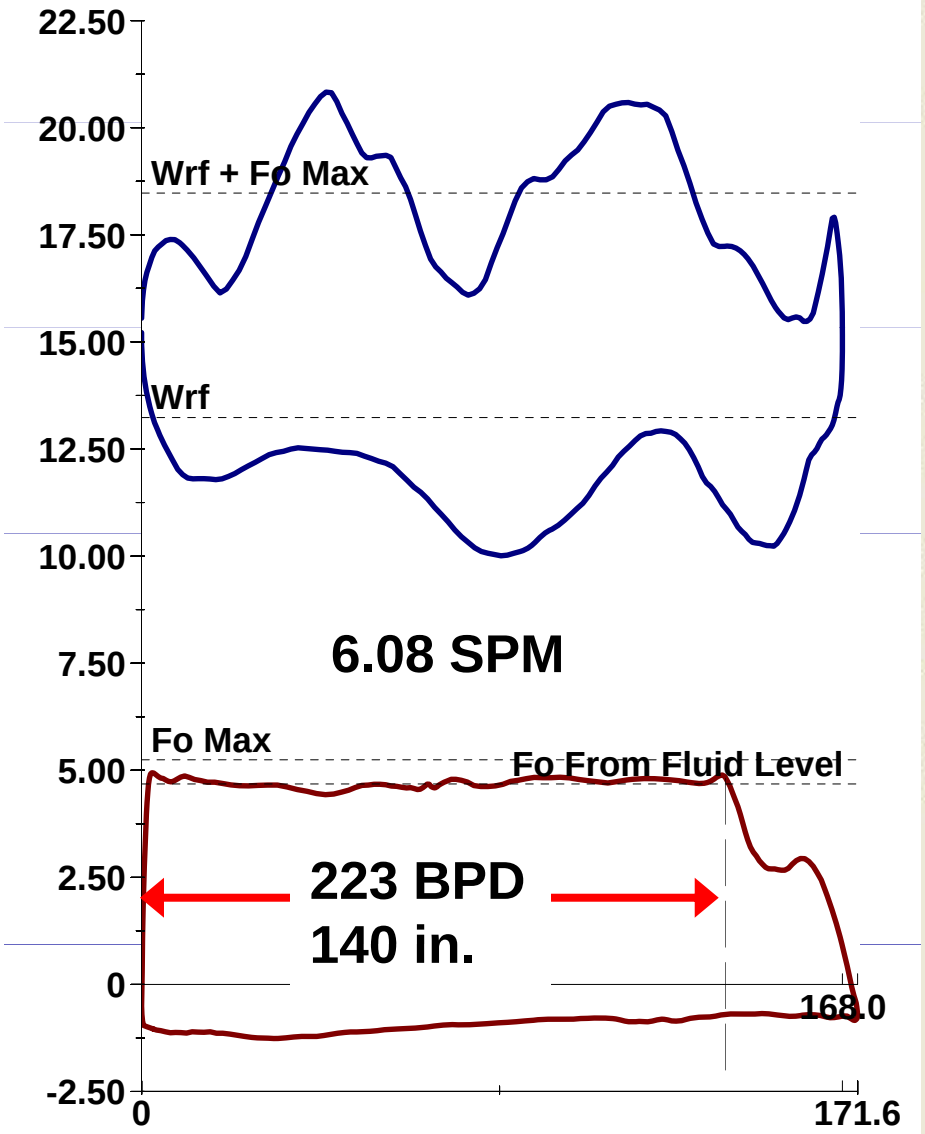

Fo Max
Strokes 21-22
5.00
2.50
0
-2.50
0
165.9
168.0

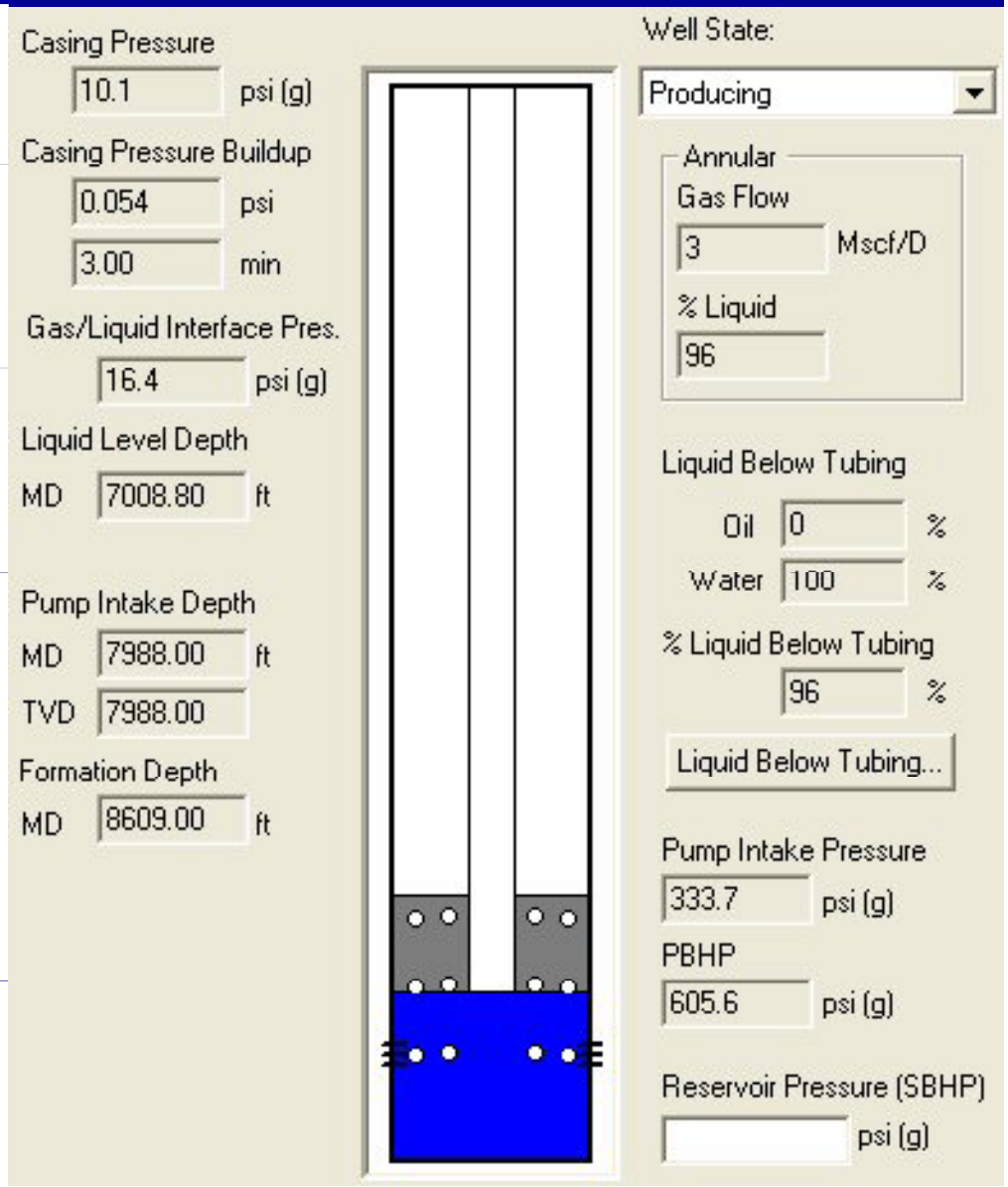

Fo Max
Strokes 31-68
5.00
2.50
0
-2.50
0
163.2
168.0

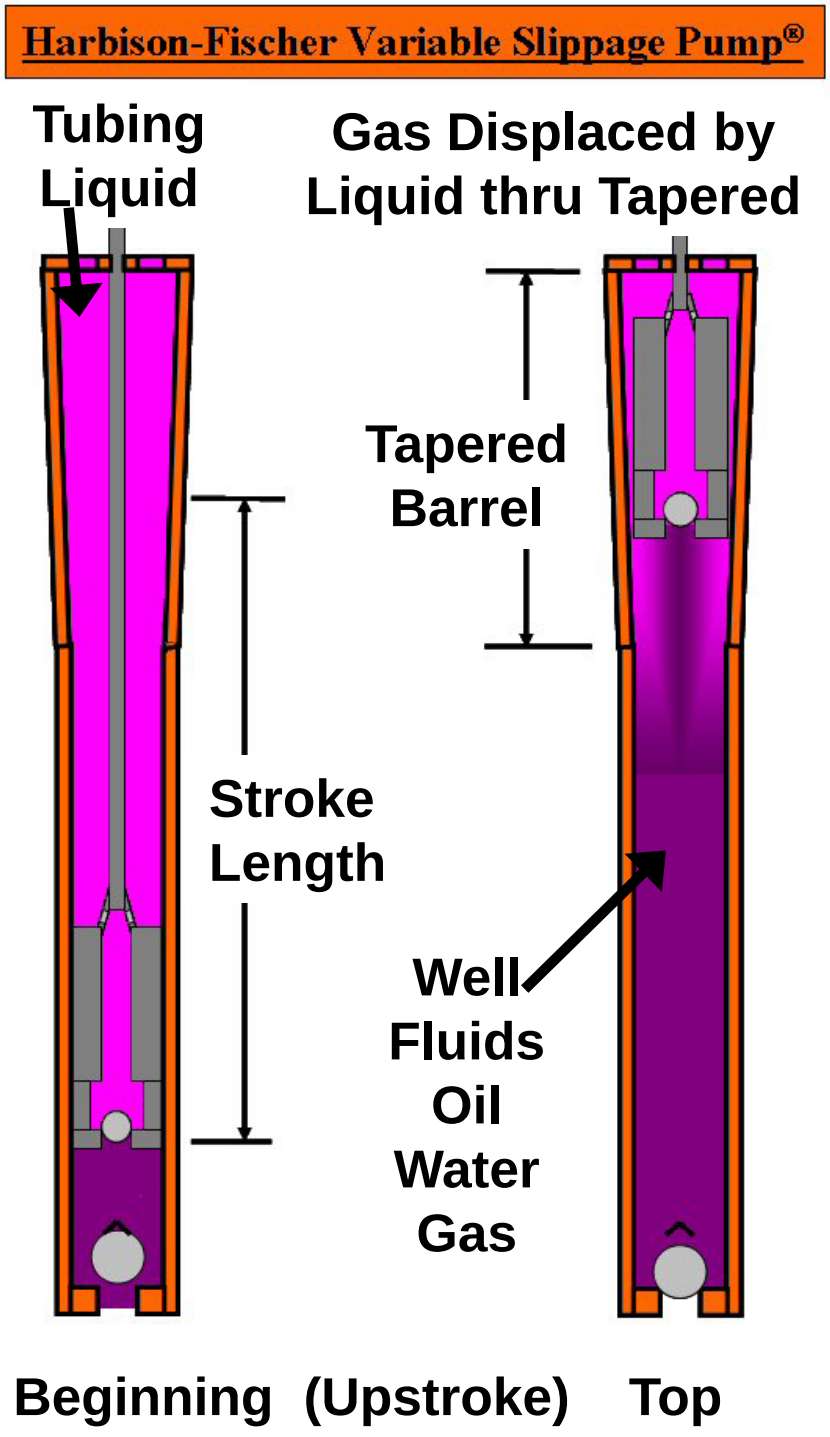

Fo Max
Strokes 23-25
5.00
2.50
0
-2.50
0
168.0
176.6


Fo Max
All of the Rest of the Strokes
---- NO PUMP ACTION----
5.00
2.50
0
-2.50
0
168.0
175.2

# Installed Variable Slippage Pump and Downhole Gas Separator






# Spacing HF Variable Slippage Pump

## Spacing at the well site:

a. Touch bottom with tubing loaded with fluid

b. Pick up overtravel length

c. Pick up spacing allowance, normally 12"

d. The lower end of the plunger should slightly enter the start of the VSP® taper. This position gives the least amount of bypass slippage. After well has stabilized, space the plunger higher in small increments for more bypass slippage to achieve desired results.

## Re-space well as needed after stabilized:

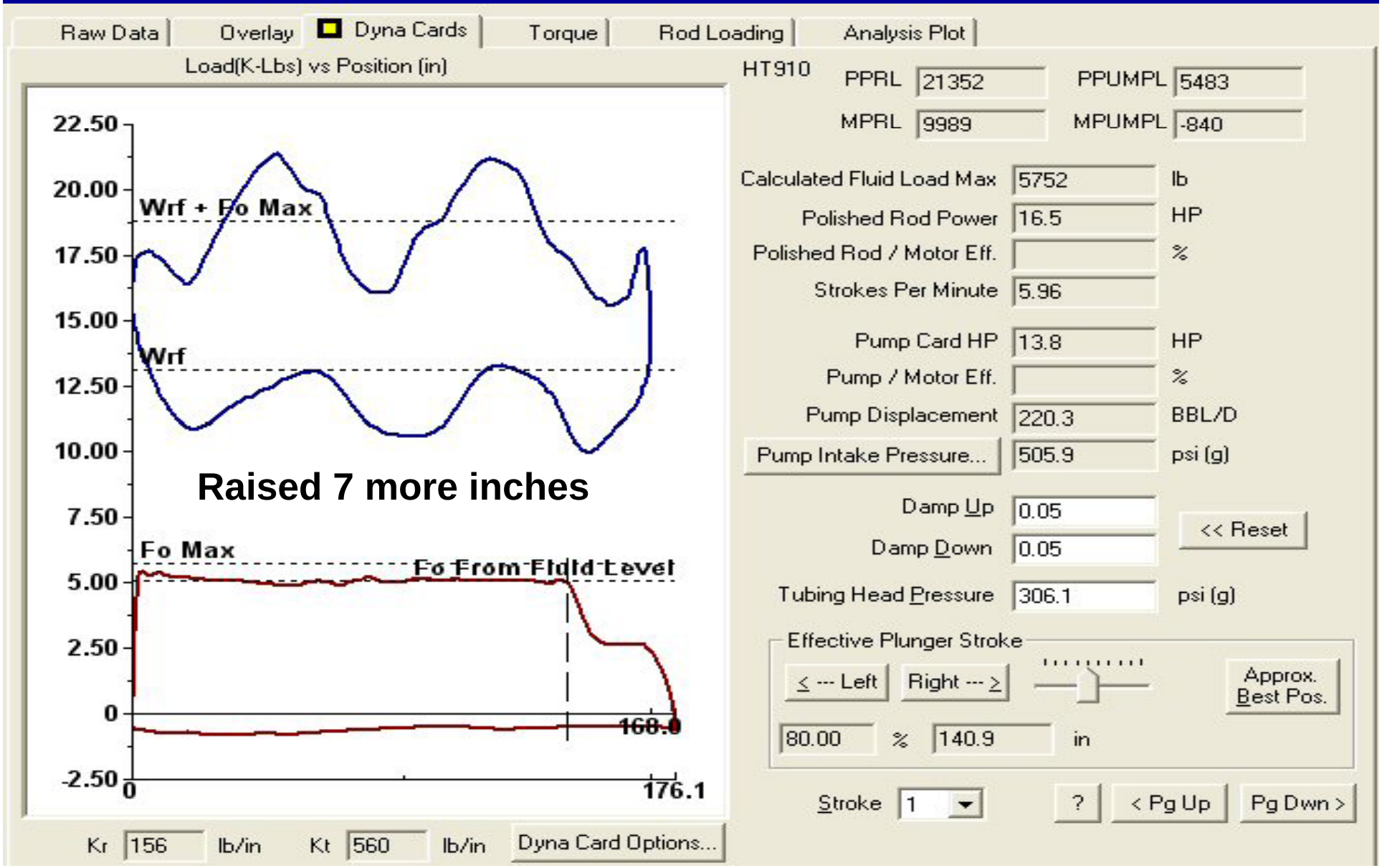
a. Lower rods for a light tag at pump, then raise slightly for stroking close to bottom without entering VSP® taper.

b. After accomplishing raise rods in 6 inch increments until bottom of plunger enters taper.

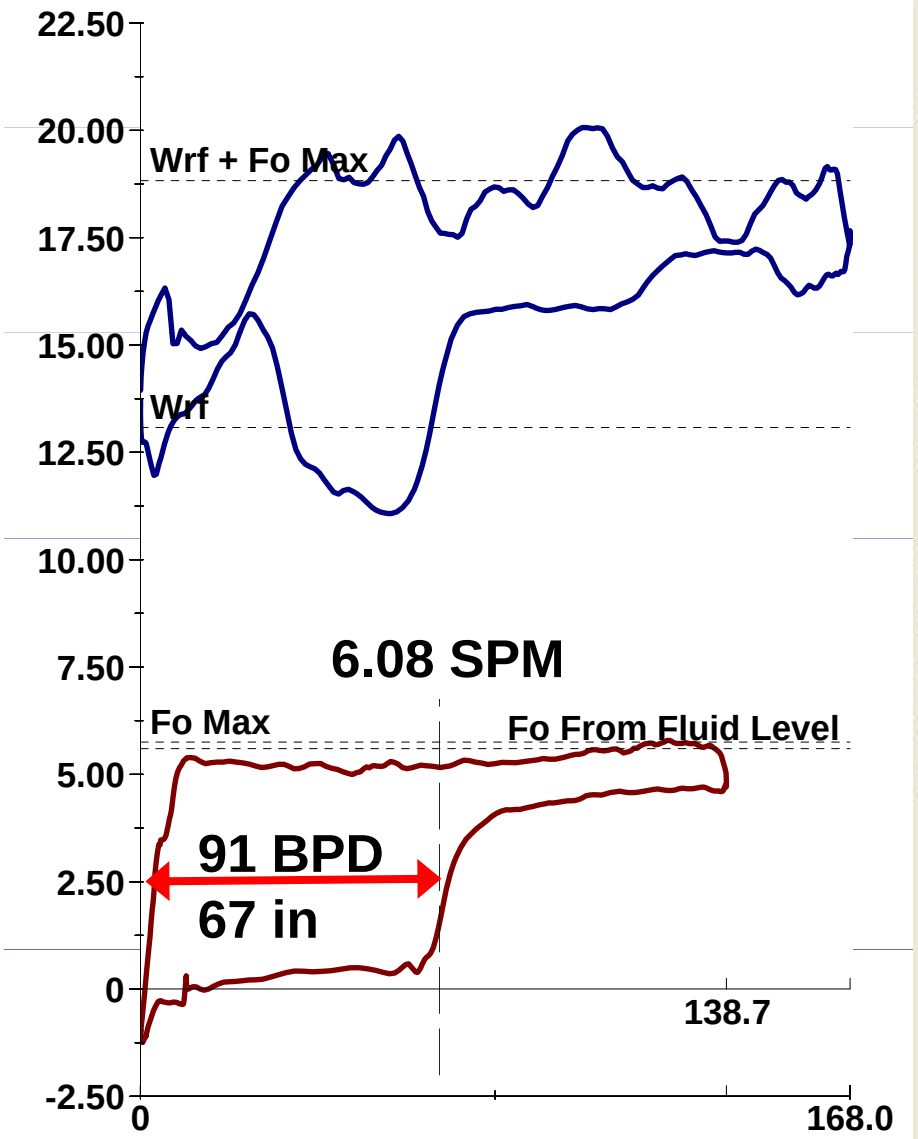
"Spacing allowance: 30" down to 4,000 feet well depth, then add 6" for every 1,000 feet well depth below 4,000 feet.

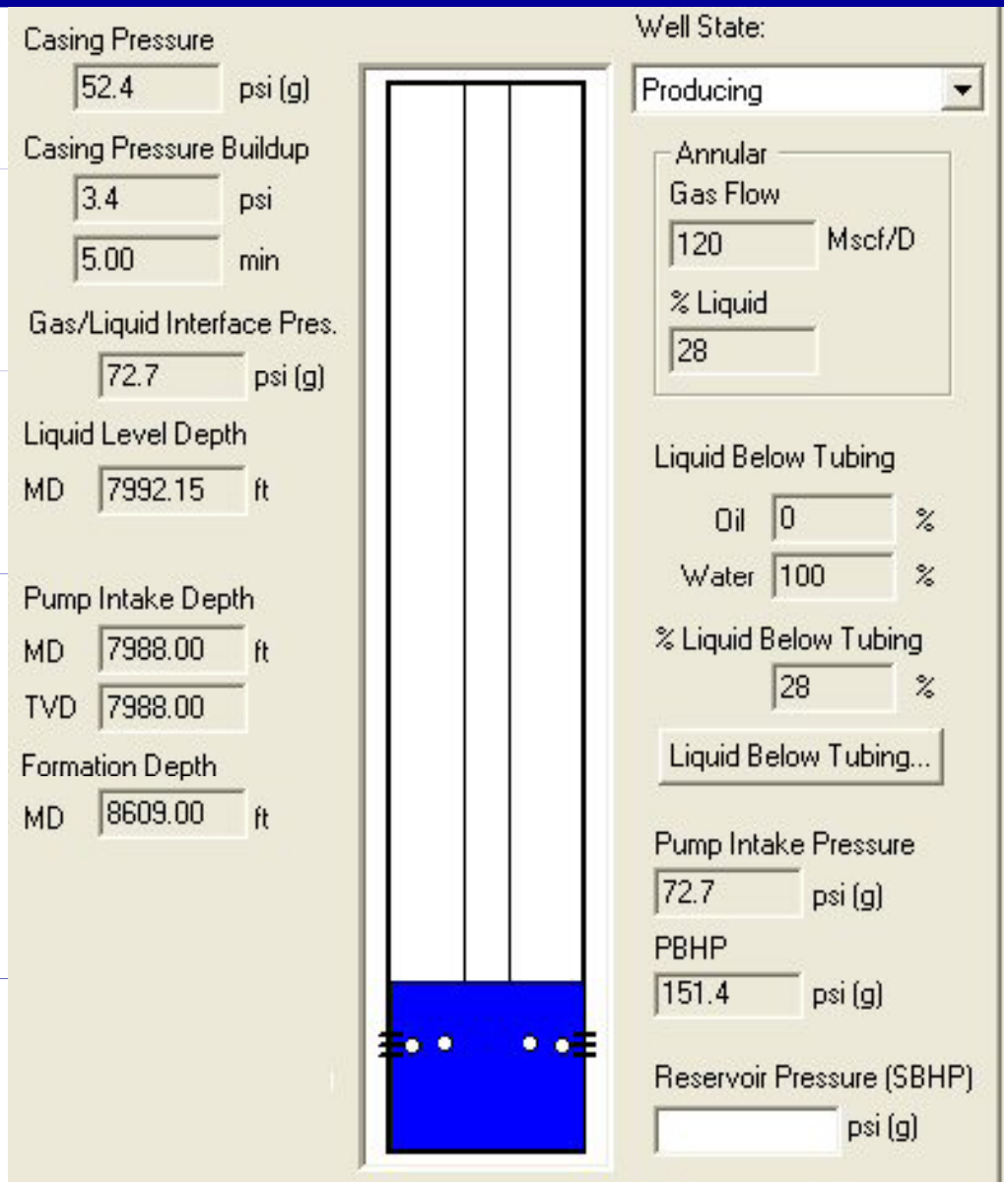
**Pumping Gas Into Tubing**

# Re-Spaced VSP



# 7 Months Later Fluid Level @ Pump Need to Control Run Time



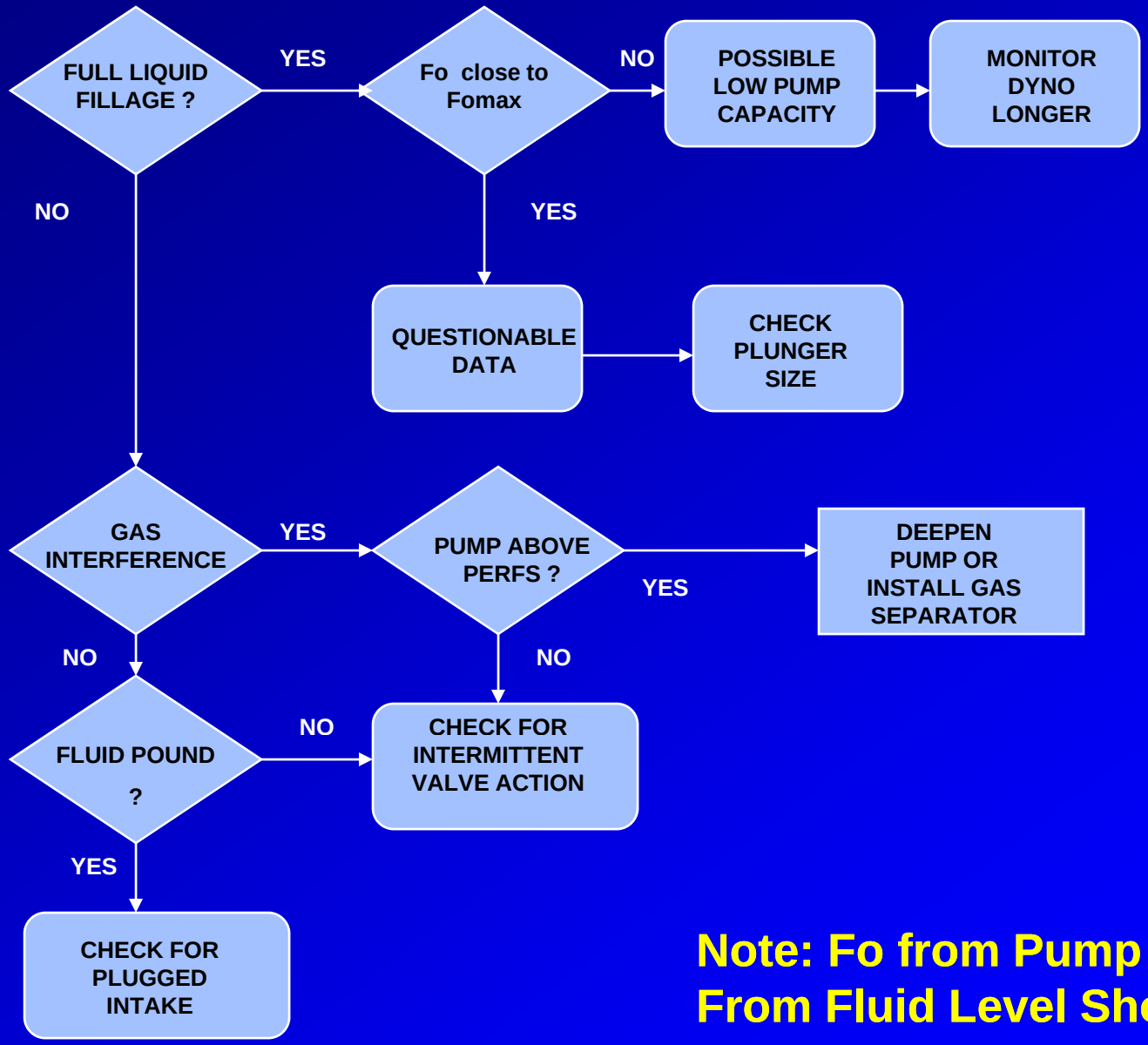
# Observations

- Gassy Wells Difficult to Pump
- Laterals in Horizontals Unload a LOT OF GAS
- Back-pressure Valve on Tubing Improved performance of these Rod Pumped Wells
- Too much Back-pressure Detrimental to Operation of Sucker Rod Lifted Well
- Wells that will Flump can Produce more Liquids than Pumping up Tubing Alone.
- Poor Boy Gas Separators did not keep Gas out of the Tubing
- VSP® used effectively to Drawdown Well

# Production Methods Used to Produce Flumping Wells

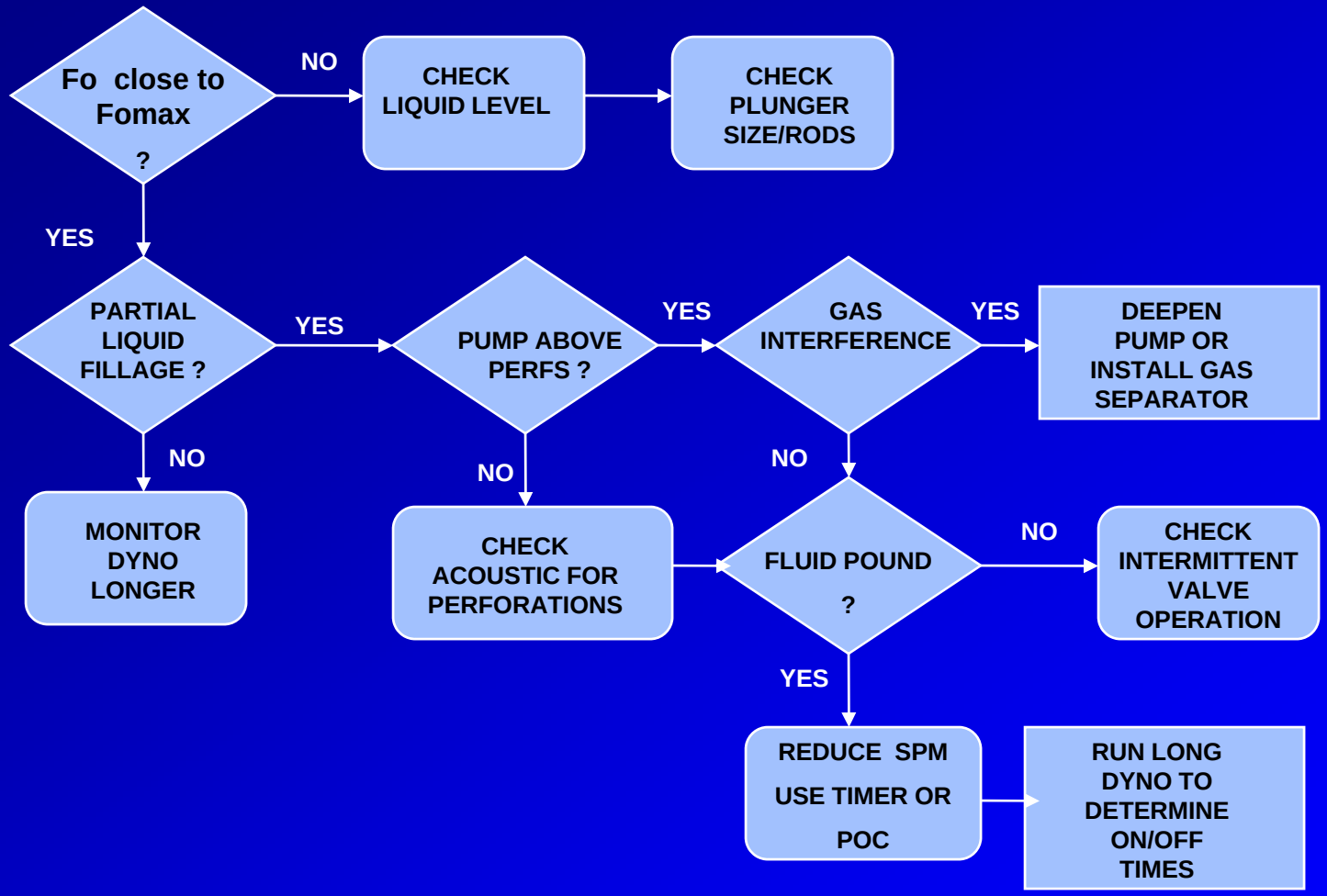
1. Set the pump intake as deep as possible.
2. Set the pump in the rat hole, if one exist
3. If no rat hole, run an improved gas separator
4. Increase pump compression ratio with long stroke length
5. Space out the pump to minimize dead space at bottom of stroke
6. Use a specialty pump such as a VSP® pump to handle gas.
7. Use a backpressure valve on the tubing and sometimes on casing, if pump action erratic or stops.

# Analysis of Dynamometer Data for Fluid Level Above Pump Intake




**Note: Fo from Pump Card and Fo From Fluid Level Should Match.**

# Analysis of Dynamometer Data for Fluid Level At/Near Pump Intake




**Note: Fo from Fluid Level and Fo from Pump Card should be near FoMax**

# Casing Pressure:

1. Lower casing pressure is better.

2. High casing pressure restricts flow from the formation in the same manner as a high fluid level.

3. Check the casing side check valve to be sure it is operating properly.

4. Use Back-pressure Valve only if well unloads and flows up the tubing or the casing annulus