Ask Echometer Online Seminar – May 20, 2020

Direction of Kick on Acoustic Traces

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(((ECHOMETER)))

TOTAL ASSET MONITOR (TAM)

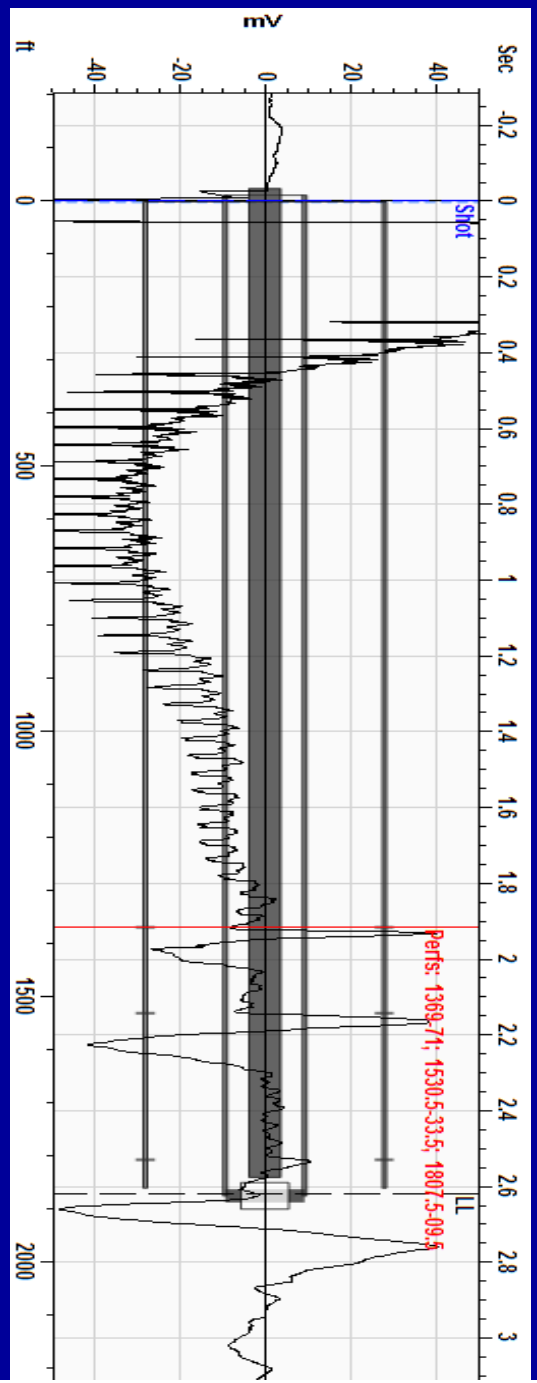
http://www.echometer.com/Software/Total-Asset-Monitor

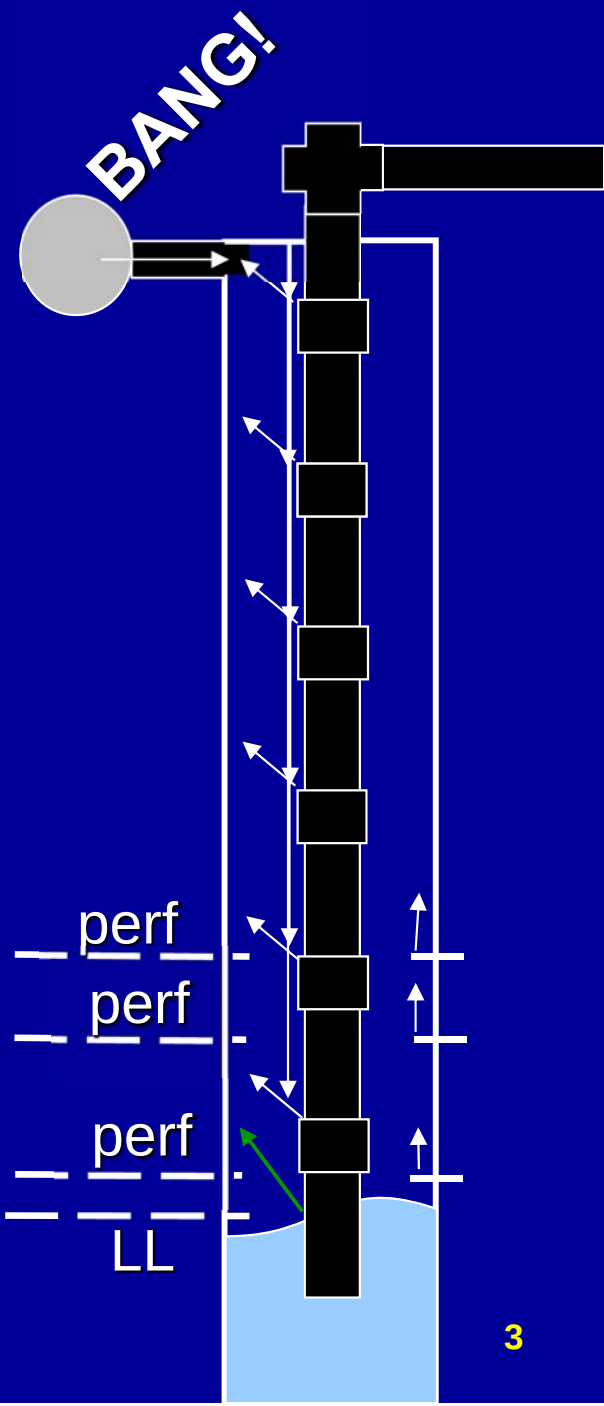
Introduction

- New technology displaying the acoustic trace together with the wellbore diagram provides:
  - Improved analysis method for determining accurate distance to the liquid level
  - Troubleshooting Tool
- On the acoustic trace the direction of the reflected echo indicates a well bore cross-sectional area enlargement or reduction.
- Overlaying the acoustic trace on the top of a wellbore schematic allows for a quick visual confirmation of each echo belonging to a change in the cross-section of the well
- Downhole Marker Method - Display of the acoustic trace with round trip time travel to each anomaly echo associated to the measured depth to the anomaly
- Distance to the liquid level provides beneficial information with respect to the pump and complicated well bores.

What is an Acoustic Fluid Level

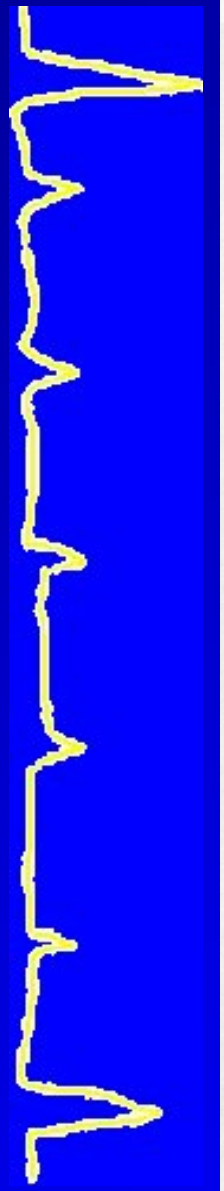
- Created by a pressure change in a gas or liquid. – ***Bang the Shot is Fired***
- Propagate through the gas at a speed of sound called ***Acoustic Velocity***.
- Portion of ***Traveling Wave*** or sound/pressure wave is reflected by solids or liquids in the path of the wave.
- ***Echoes*** created inside a tube when reflected by changes in diameter of tube.
- The greater the change in diameter the larger is the amplitude of the reflected wave. (More Energy Reflected need ***Increased Charge Pressure***)



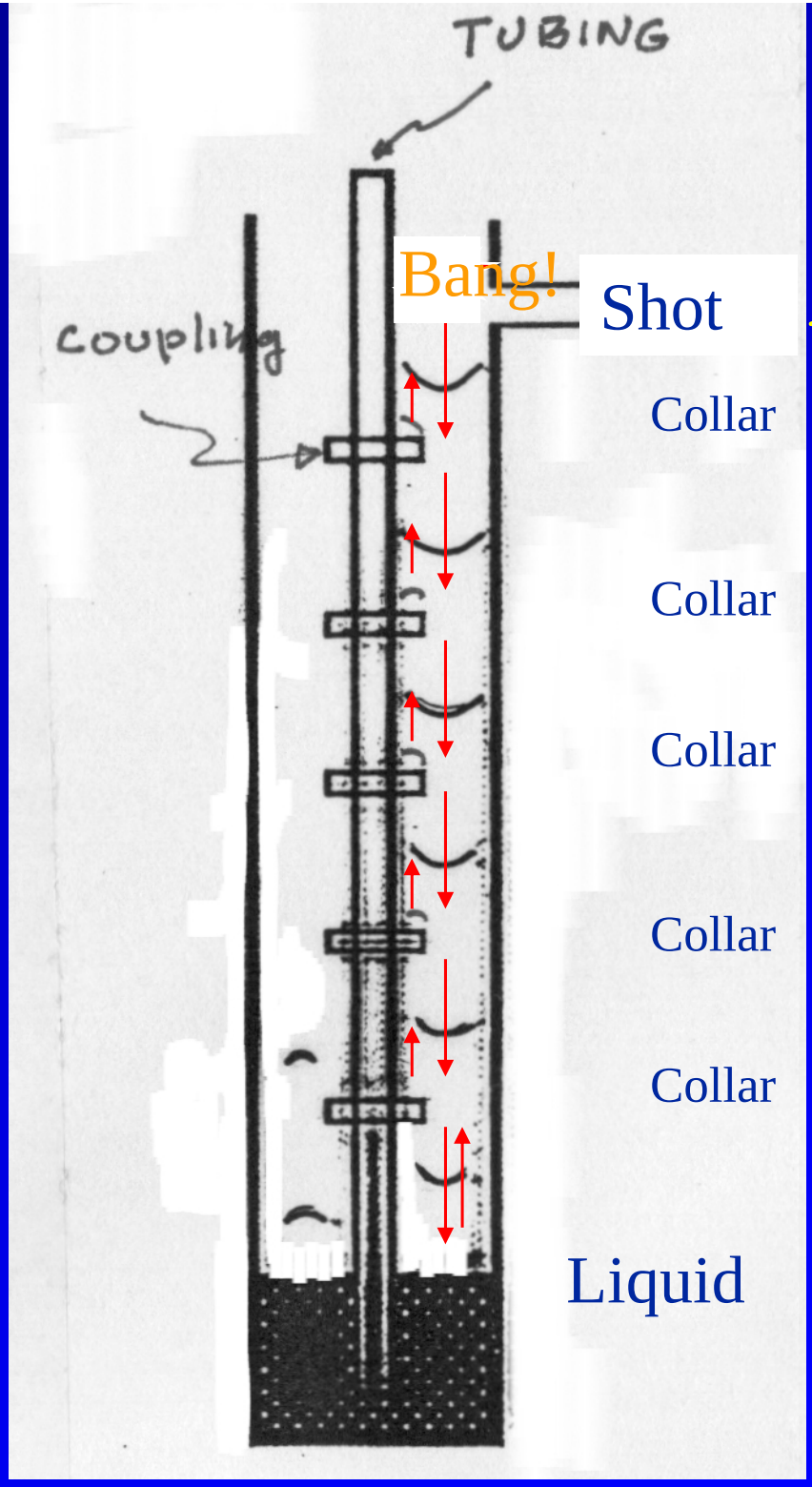


Echoes in Well

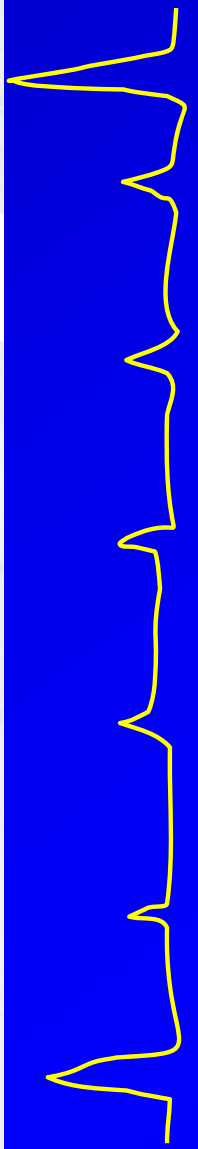
Compression Pulse



1. Changes in cross-sectional area cause sound waves to reflect back to microphone
2. Initial kick from gun blast.
3. Series of small kicks indicate the tubing collars.
4. Low frequency kick from Liquid level recorded.
5. Recorded signal trace corresponds to the pulse traveling from the gun's microphone to the liquid level and then back to the surface.



Implosion Pulse

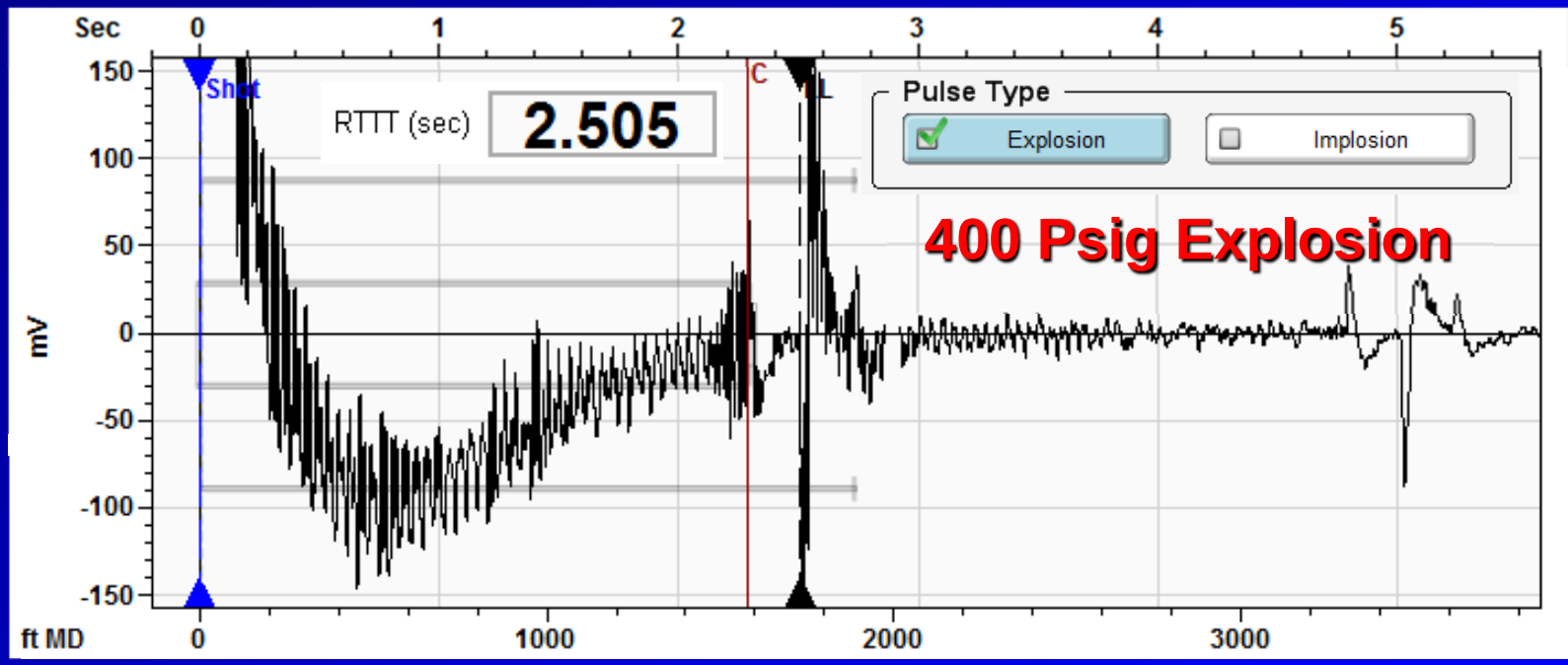


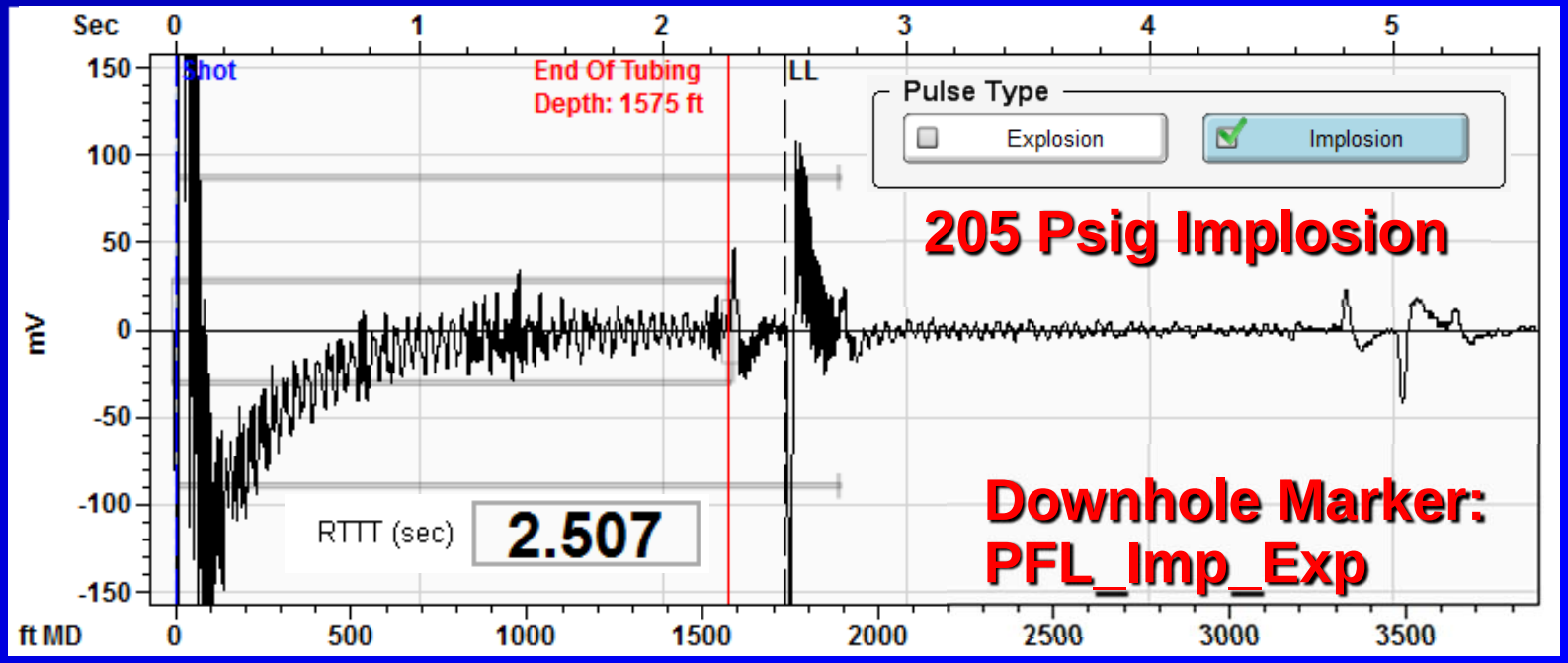
Explosion Vs Implosion Example

Data collected on a shut-in gas well JW-131 using Compact Gas Gun.

Compact Gas Gun charged to 400 Psig to generate the compression acoustic pulse.

Well's casing pressure of 205 Psig used to generate implosion pulse.





Acquire a Quality Fluid Level Shot

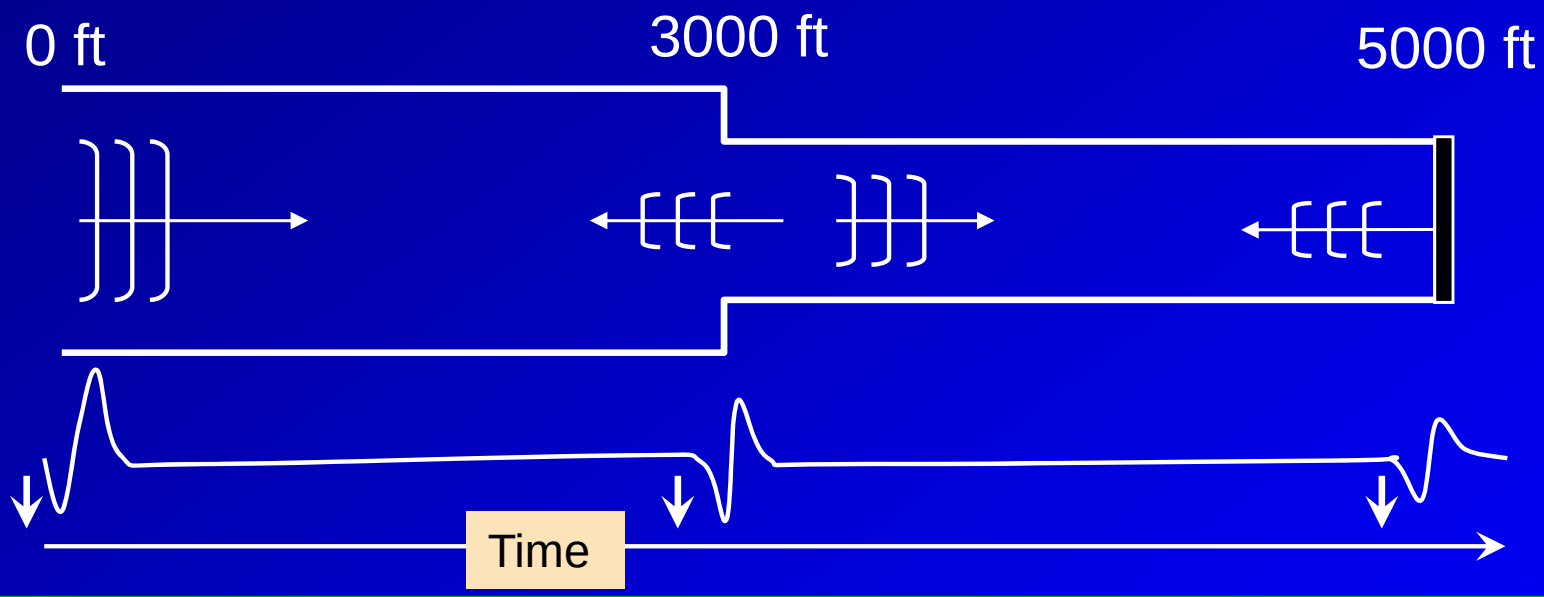
- Requires stabilized conditions for accurate BHP.
- Determination of Liquid Level Depth: obtain a clear indication fluid level echo.
- Correct average tubing joint length: required to calculate distance to fluid level and accurate acoustic velocity.
- Wellbore deviation survey: required to compute pressure in wellbore and at pump intake
- Measurement of casing pressure: required for correct calculation of pump intake pressure
- Measurement of casing pressure change vs. time: required to calculate annular gas flow rate and annulus liquid fraction.
- Tubing, Casing diameters: required for calculation of annular gas rate.
- Oil, water and annular gas densities: required for calculation of pressure gradients
- Measurements should be repeated whenever excessive acoustic noise is present and fluid level echo is not clearly identifiable (always acquire 2 shots).

Direction of Kick of the Acoustic Signal

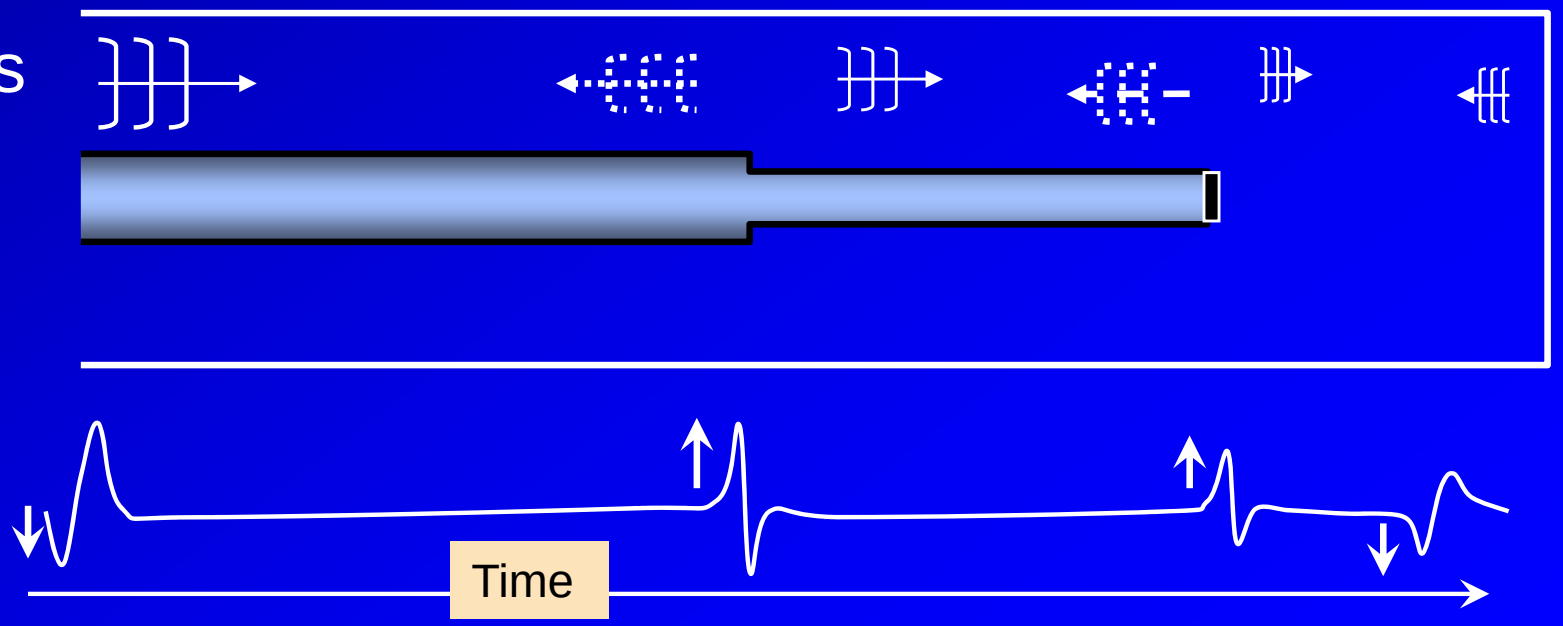
1. On the acoustic trace the direction of the reflected echo kick indicates enlargements and reductions
2. For an Explosion shot reduction in the cross sectional area are displayed as downward kicks.
3. Wellbore decreases displayed as a **down kick**:
   - **Liners tops, tubing anchors, paraffin/scale deposits, blockages, the liquid level**
4. Wellbore increase displayed as **upward kick**:
   - **Hole in tubing, perforations, open hole, sliding sleeves, parted casing, parted tubing, end of tubing**
5. Implosion created acoustic trace, then the echoes will be reversed from explosion pulse echoes
6. **Select pulse type: Explosion OR Implosion** then wellbore decreases will be displayed as downward kicks and increases as upward kicks

Echoes from Diameter (cross section area) Changes

Restrictions inside tubing

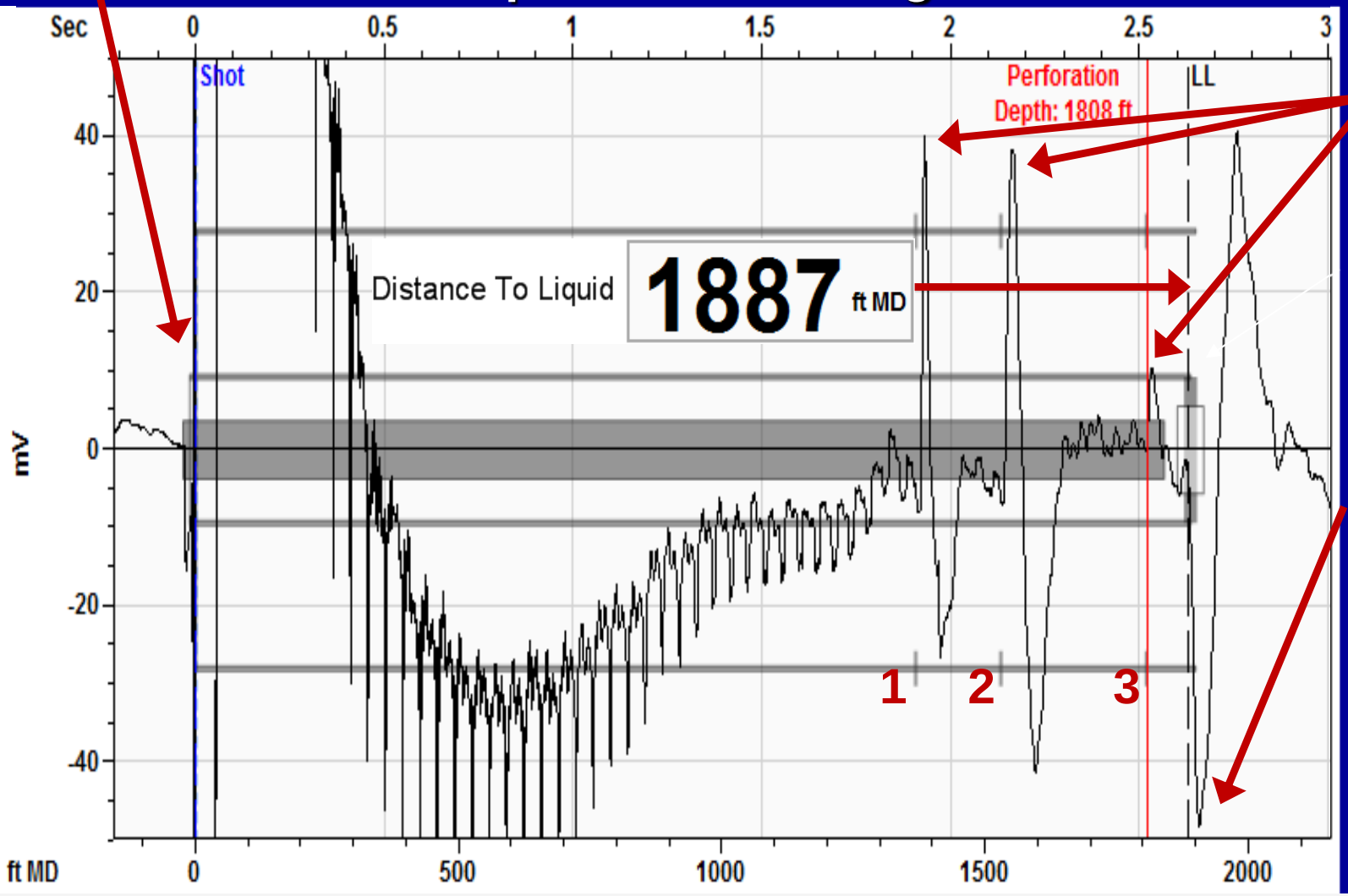


Enlargements in annulus



Direction Kick Identifies Downhole Echo

Initial Acoustic Pulse – explosion of compressed gas into the casing annulus forms compression traveling wave.



Up Kick– INCREASE in the annular cross-sectional area displayed as an upward kick on the acoustic trace.

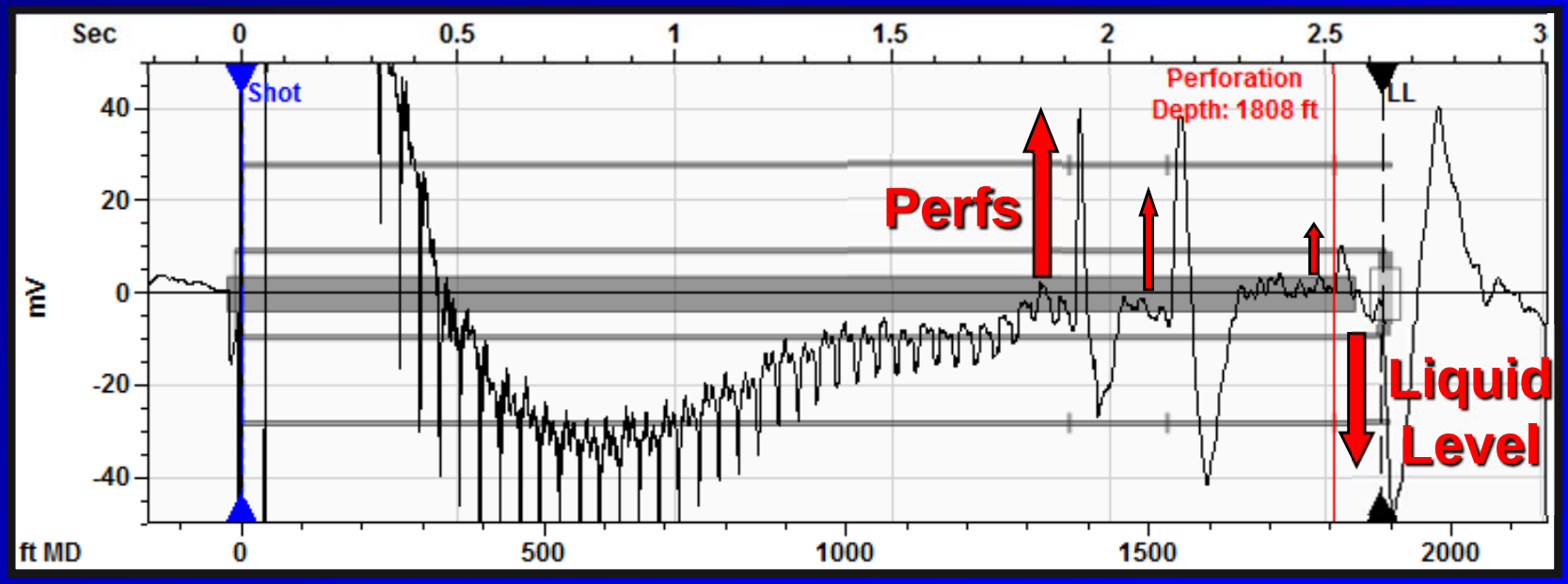
Down Kick - DECREASE in the annular cross-sectional area displayed as an downward kick on the acoustic trace.

1 Perforation	2 Perforation	3 Perforation	End Of Tubing
Depth: 1369 ft	Depth: 1531 ft	Depth: 1808 ft	Depth: 1889 ft

Downhole Marker: PFL_DHM_CoalBedPerfs

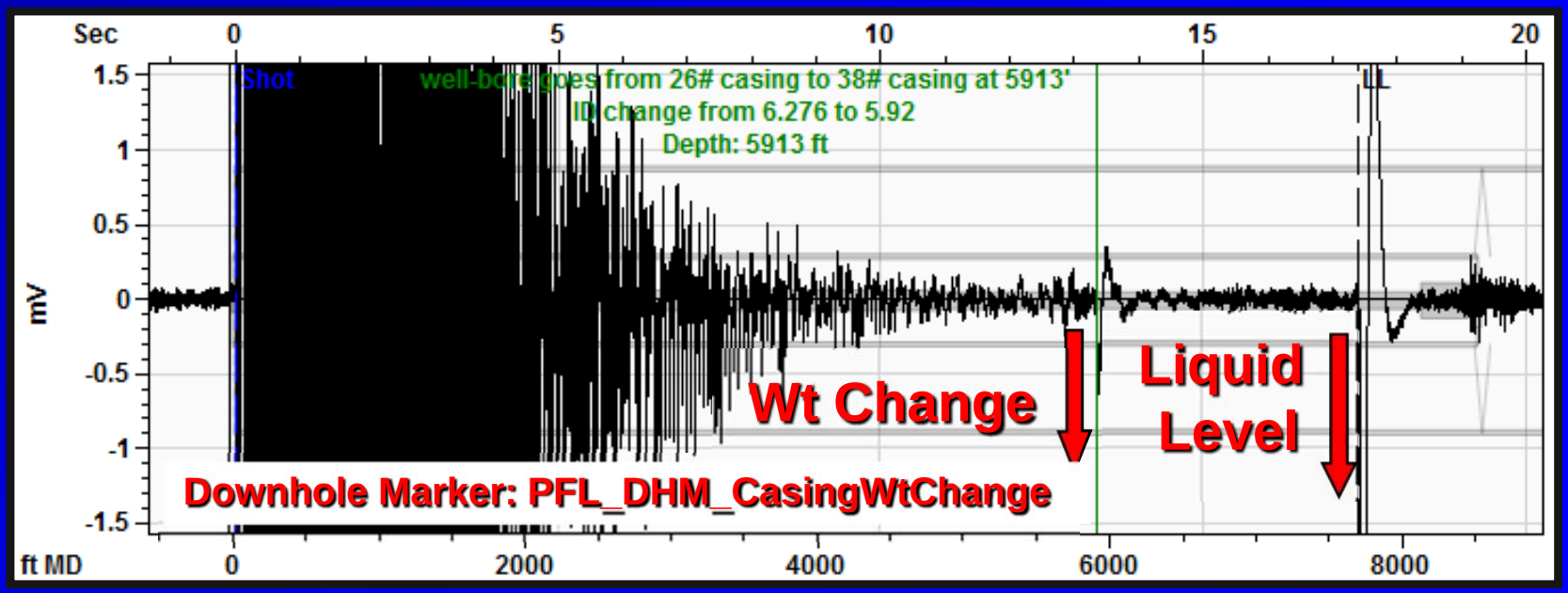
Only Liquid Level Can Move Observe Downhole Anomalies

Perfs:
1369. –1371.
1530.5-33.5
1807.5-09.5



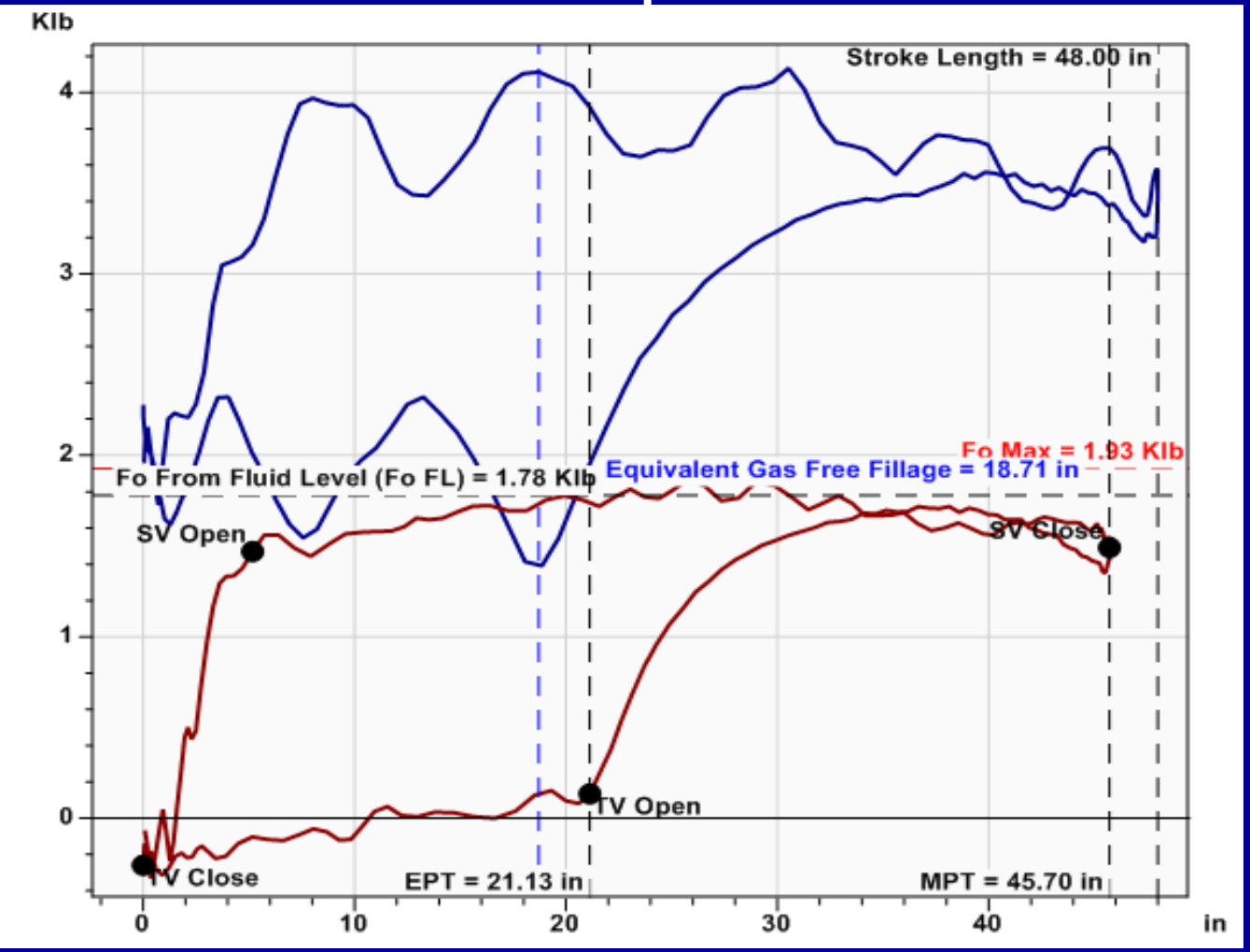
Casing Wt Change from 26# to 38# at 5913'

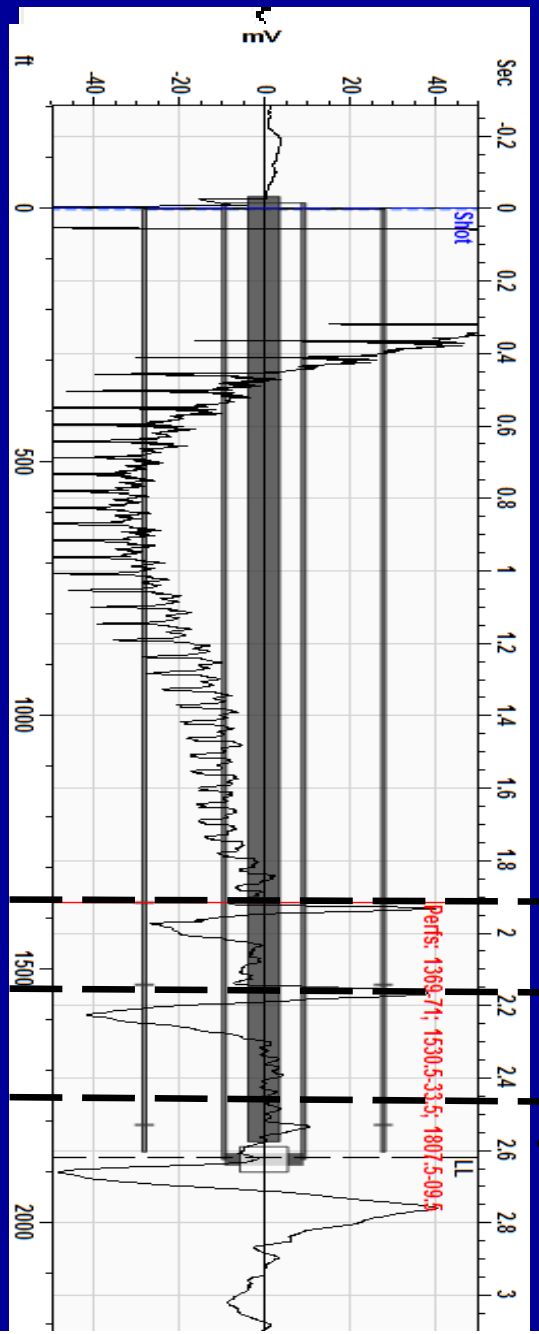
ID change from 6.276” to 5.92”



Location of the Liquid Level Can Be Used to Determine Well Performance

- ☒ Liquid Level is at Pump Intake
- ☒ Only Casing Pressure Acting on Formation, No Pressure from Liquid

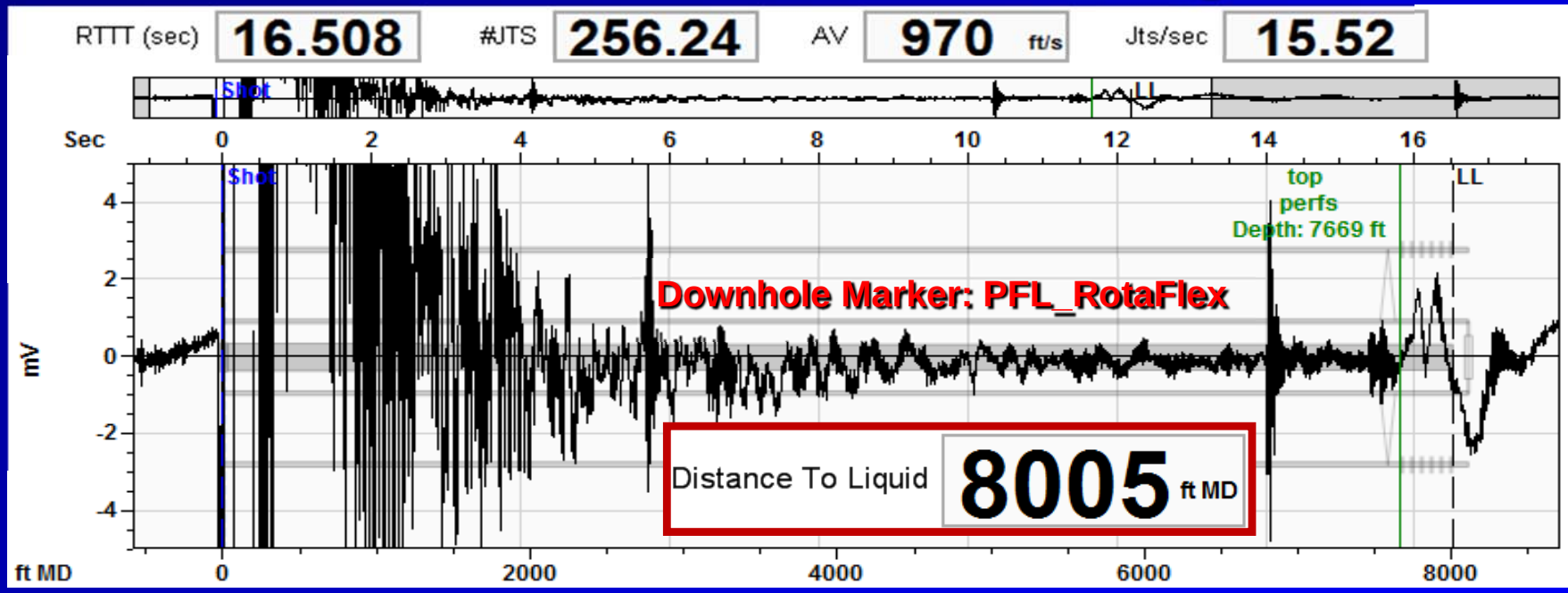




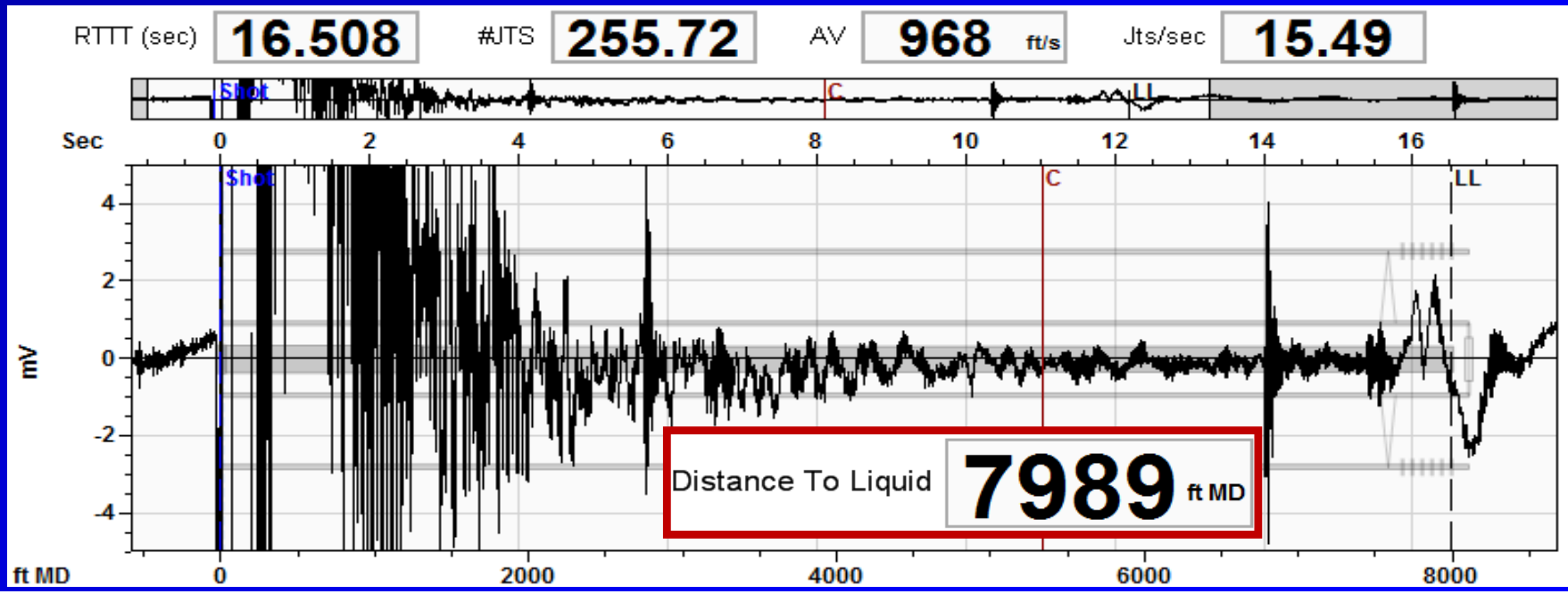
Downhole Marker using Perforations VS. Automatic Collar Counting

Liquid Level:

Downhole Marker

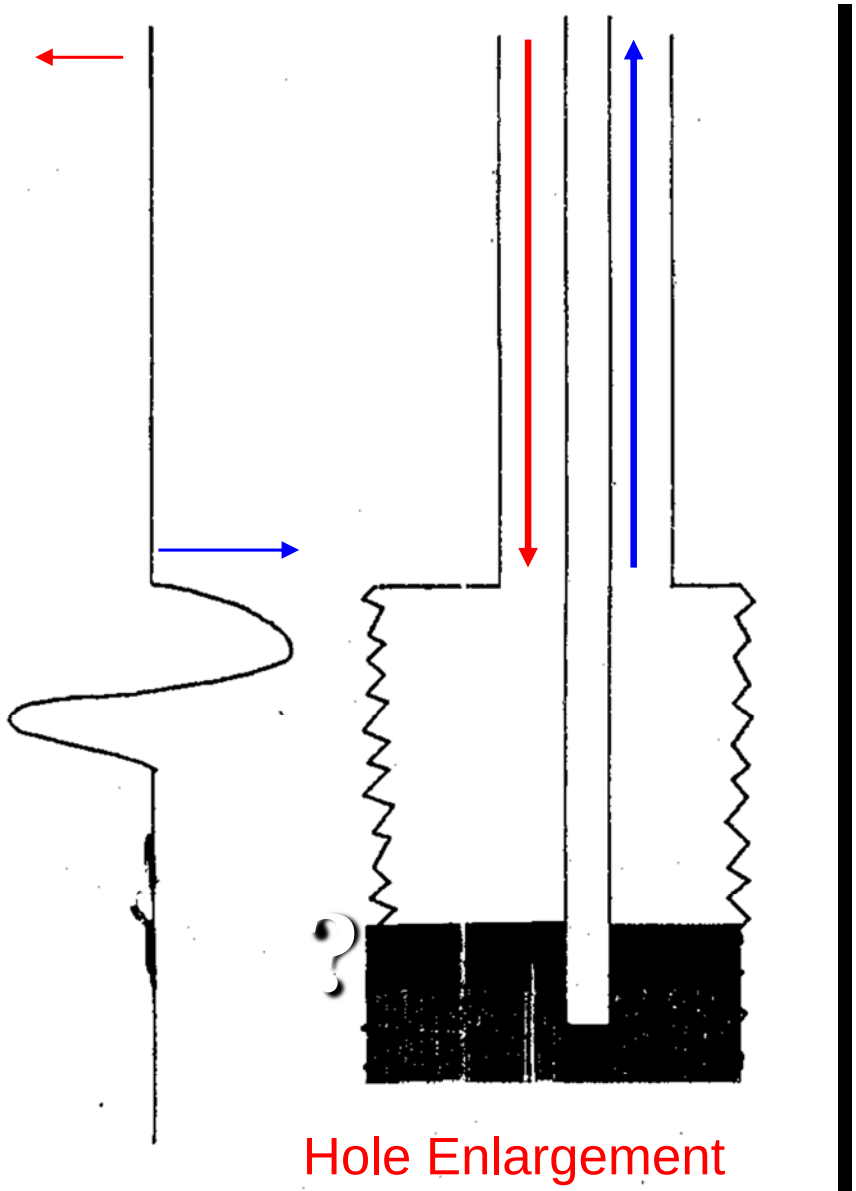


Automatic Collar Count

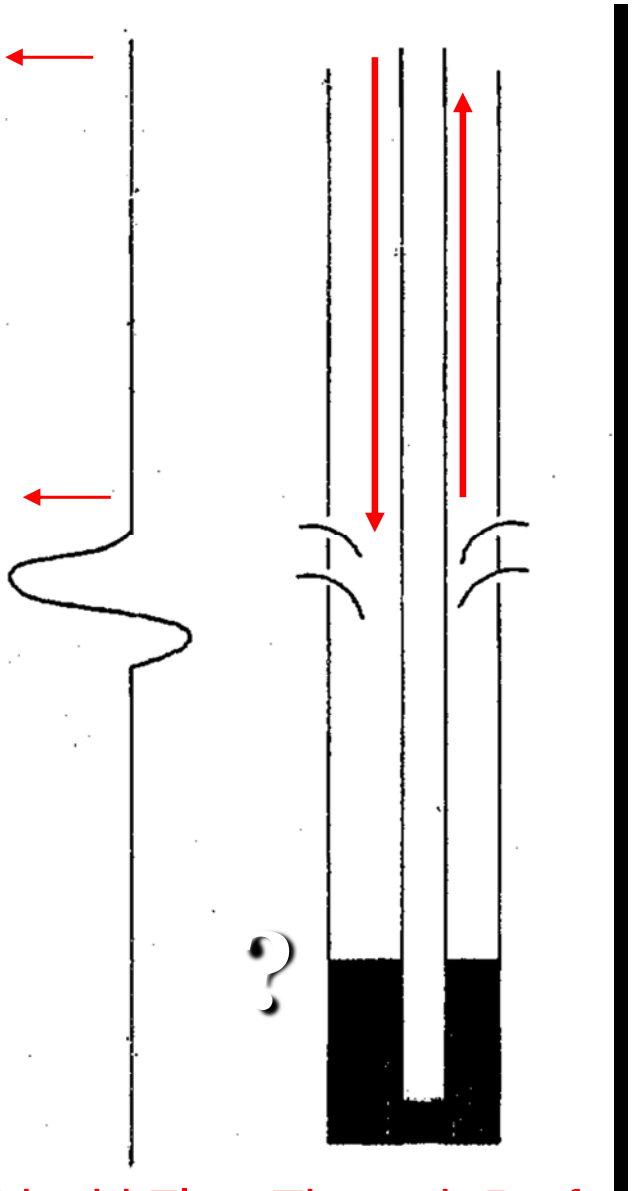


Echoes due to Wellbore Area Changes

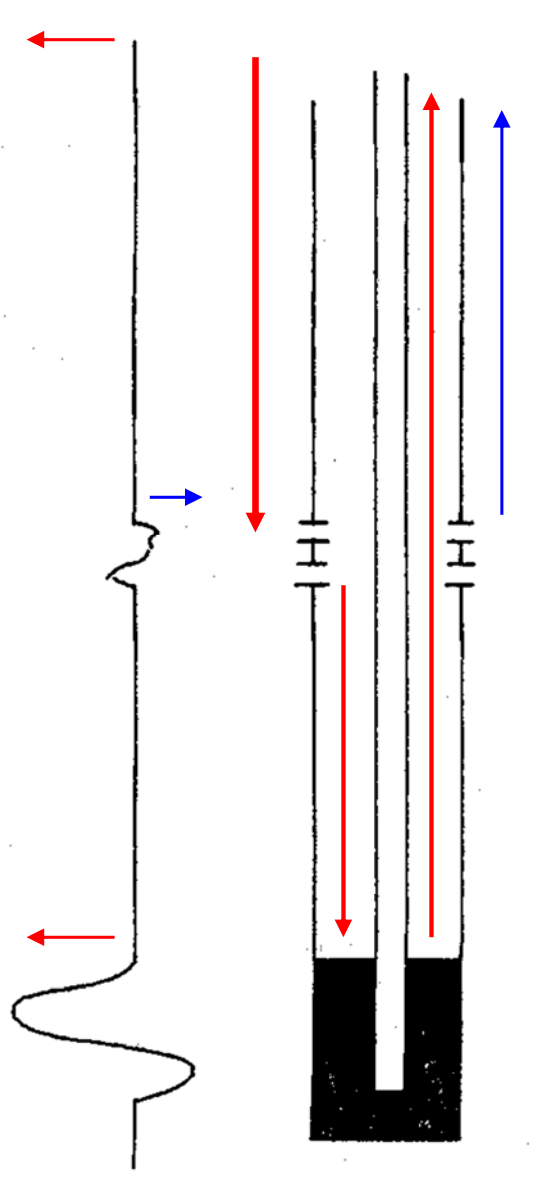
Enlargements cause inversion of pulse polarity



Hole Enlargement

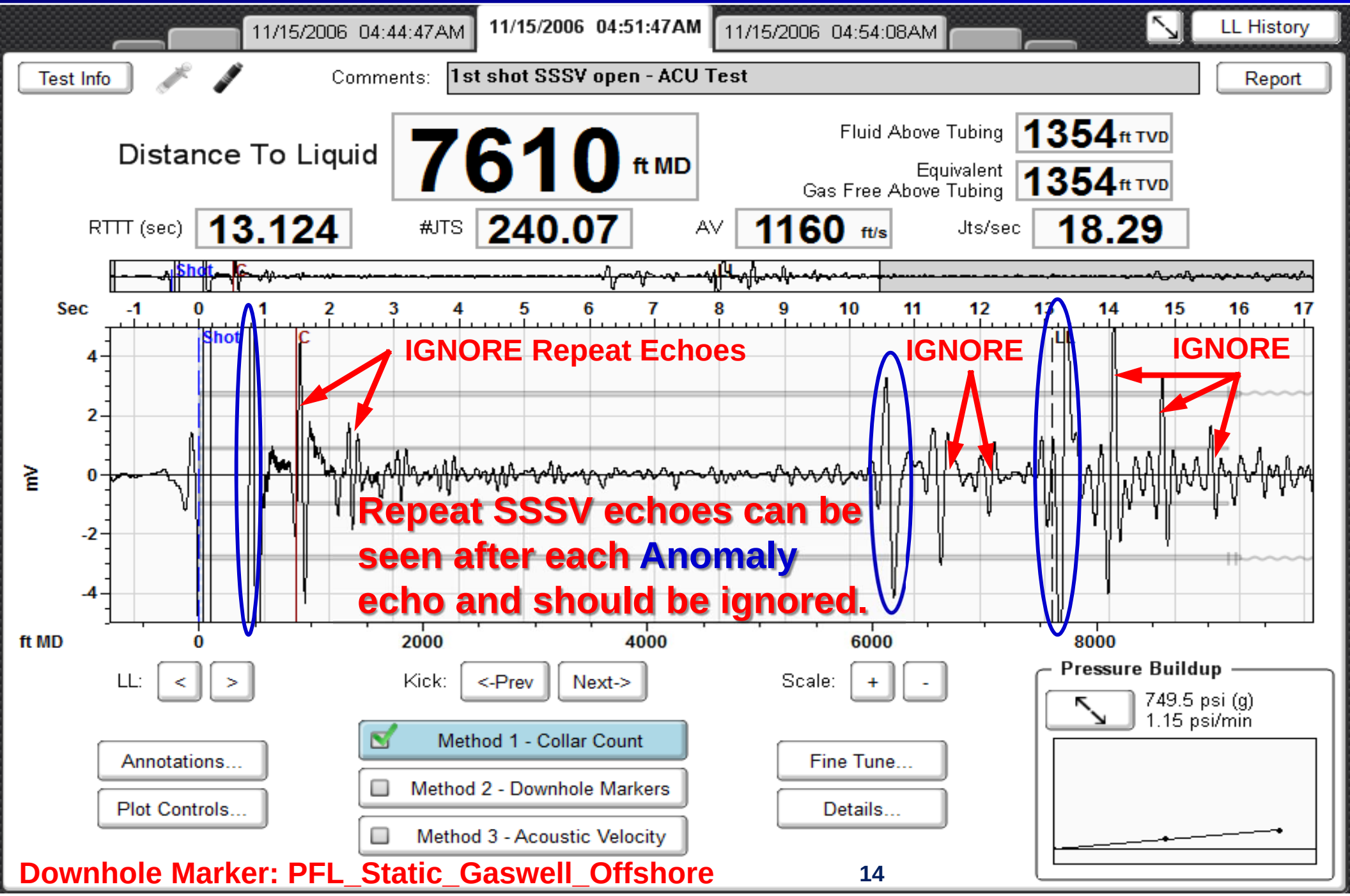


Liquid Flow Through Perfs



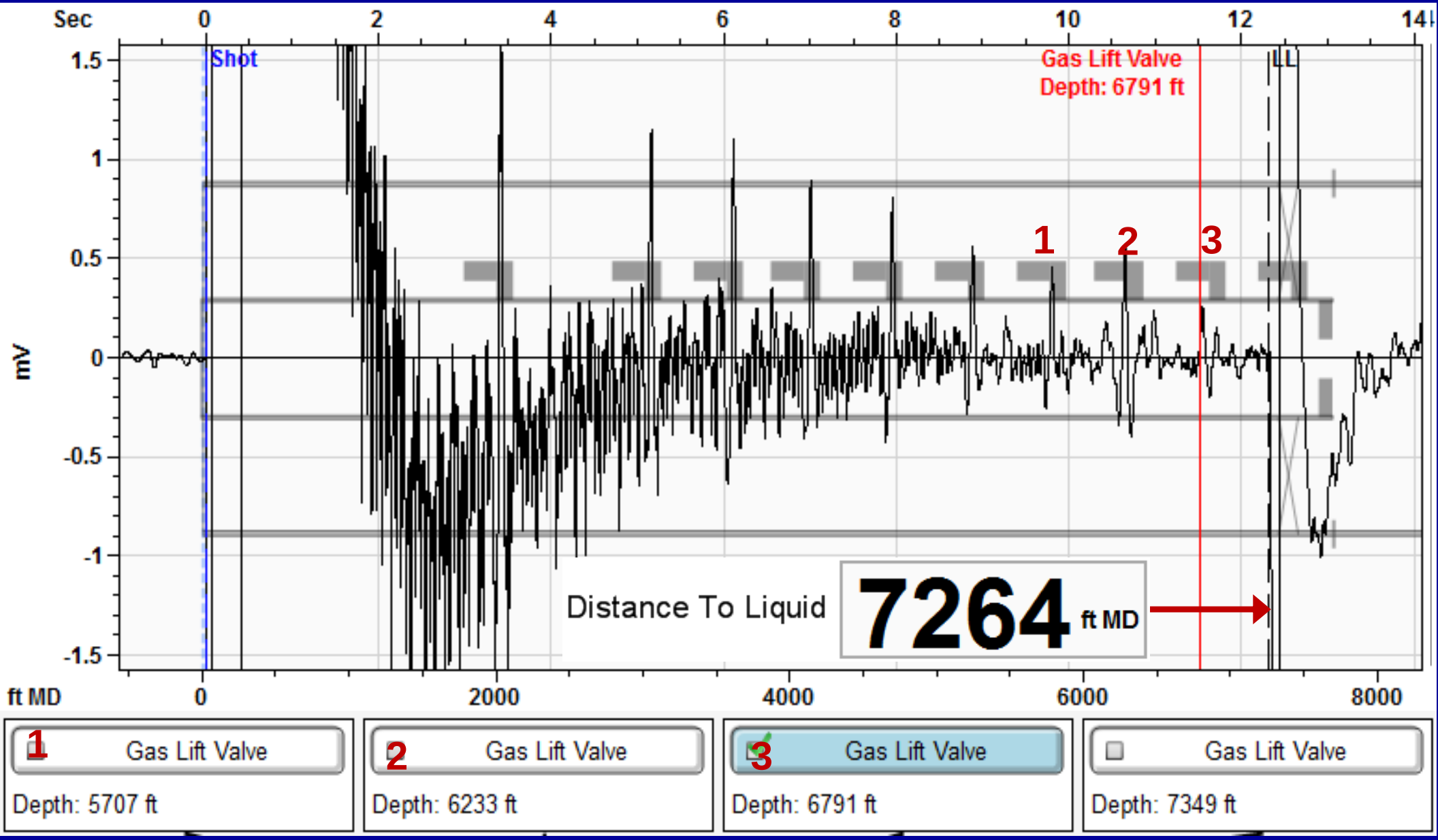
Open Perfs

Multiple Reflectors – Plus Repeat Echoes



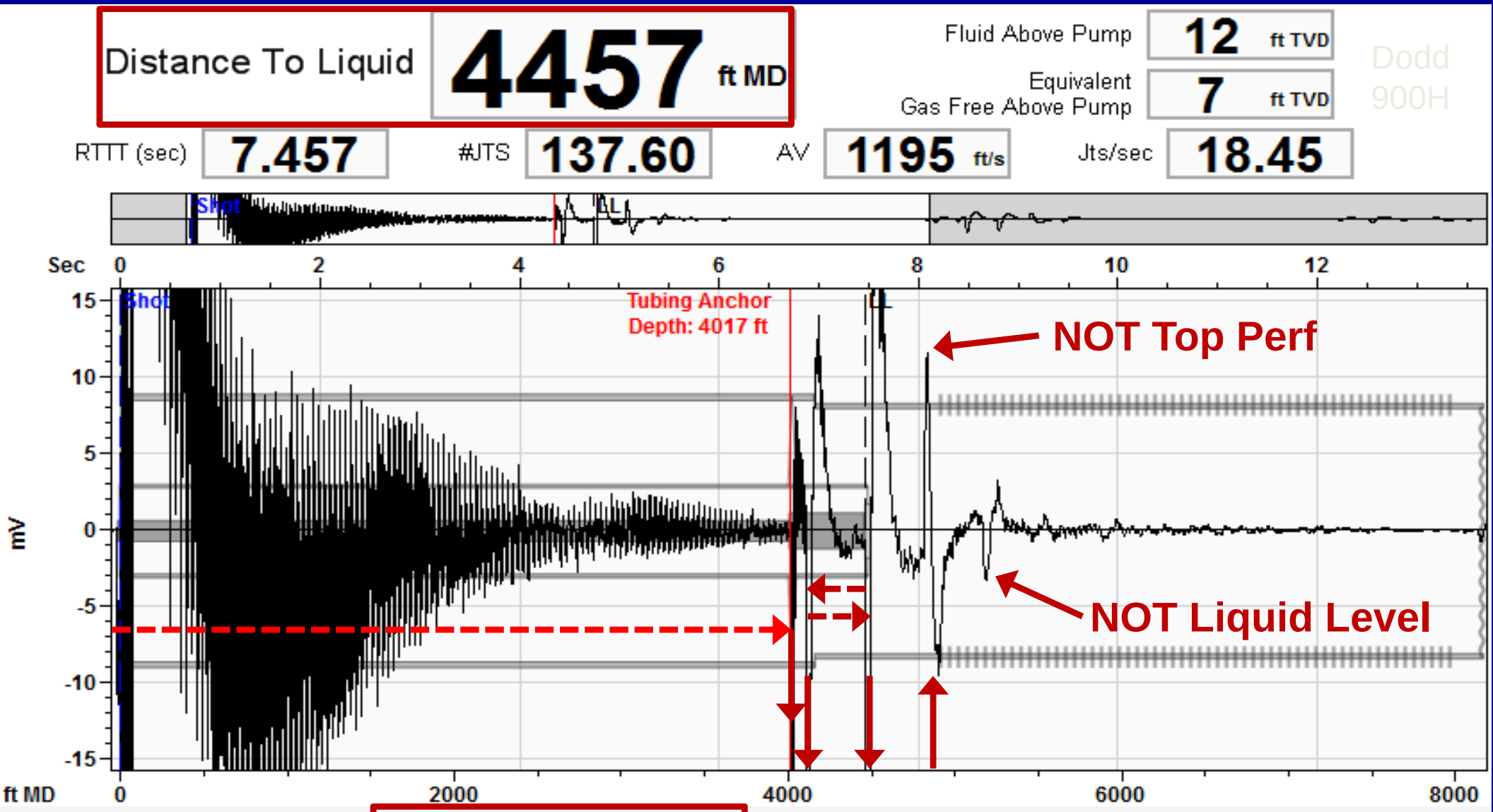
Wellbore Overlay for Gas-Lift Well

Downhole Marker Method Often Used on Gaslift Wells



Downhole Marker: PFL_Gaslift_Conventional

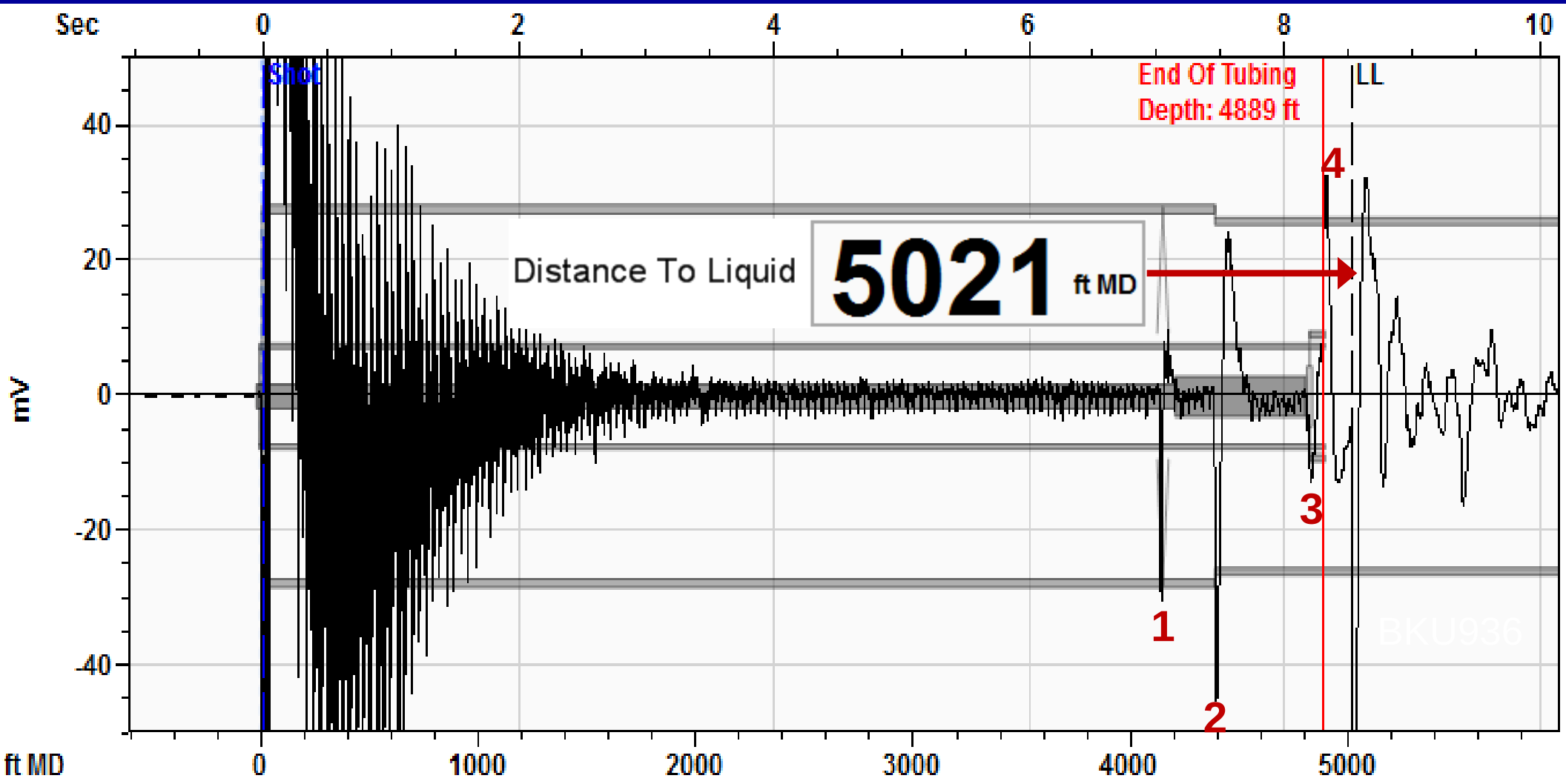
Multiple Echoes Due to Liner
Makes LL Selection Difficult



Tubing Anchor	Liner	End Of Tubing	Perforation
Depth: 4017 ft	Depth: 4152 ft	Depth: 4470 ft	Depth: 4907 ft

Downhole Marker: PFL_TAC Liner_Separator

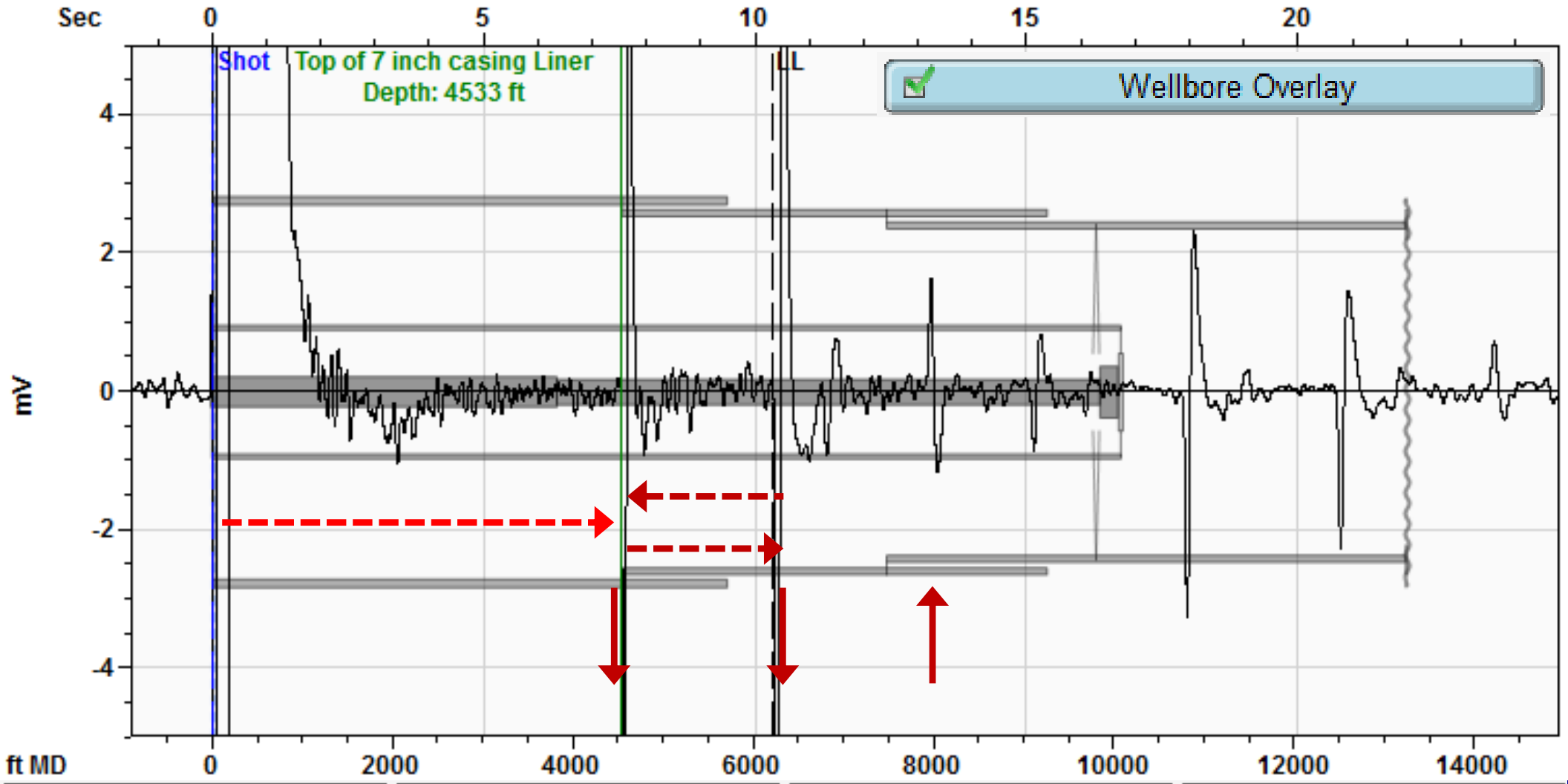
Which Down Kick is the Liquid Level



1 Tubing Anchor	2 Liner	3 Gas Separator	4 End Of Tubing
Depth: 4144 ft	Depth: 4384 ft	Depth: 4819 ft	Depth: 4889 ft

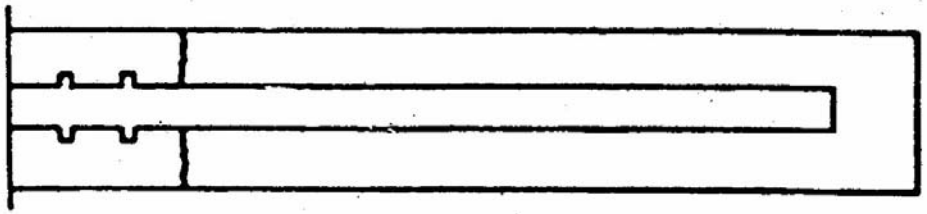
Downhole Marker: PFL_TAC Liner_Separator

Look for Liner Down-Down-Up Kicks

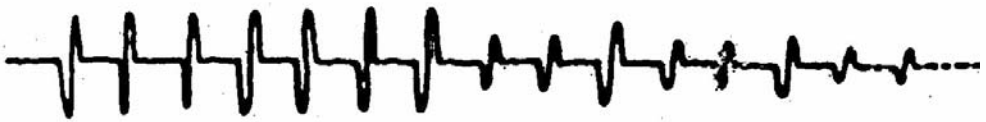


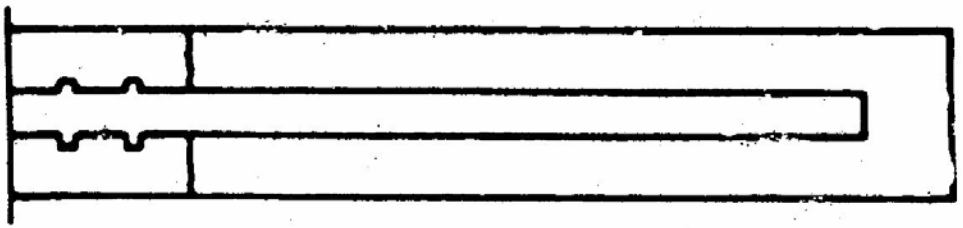
Top of 7 inch casing Liner	Liner	Tubing Anchor	End Of Tubing
Depth: 4533 ft	Depth: 7469 ft	Depth: 9793 ft	Depth: 10068 ft

Downhole Marker: PFL_Liner_ManyRepeats

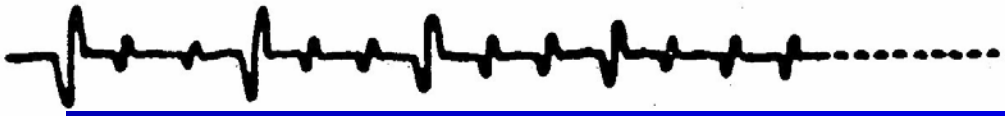


Too High Charge Pressure

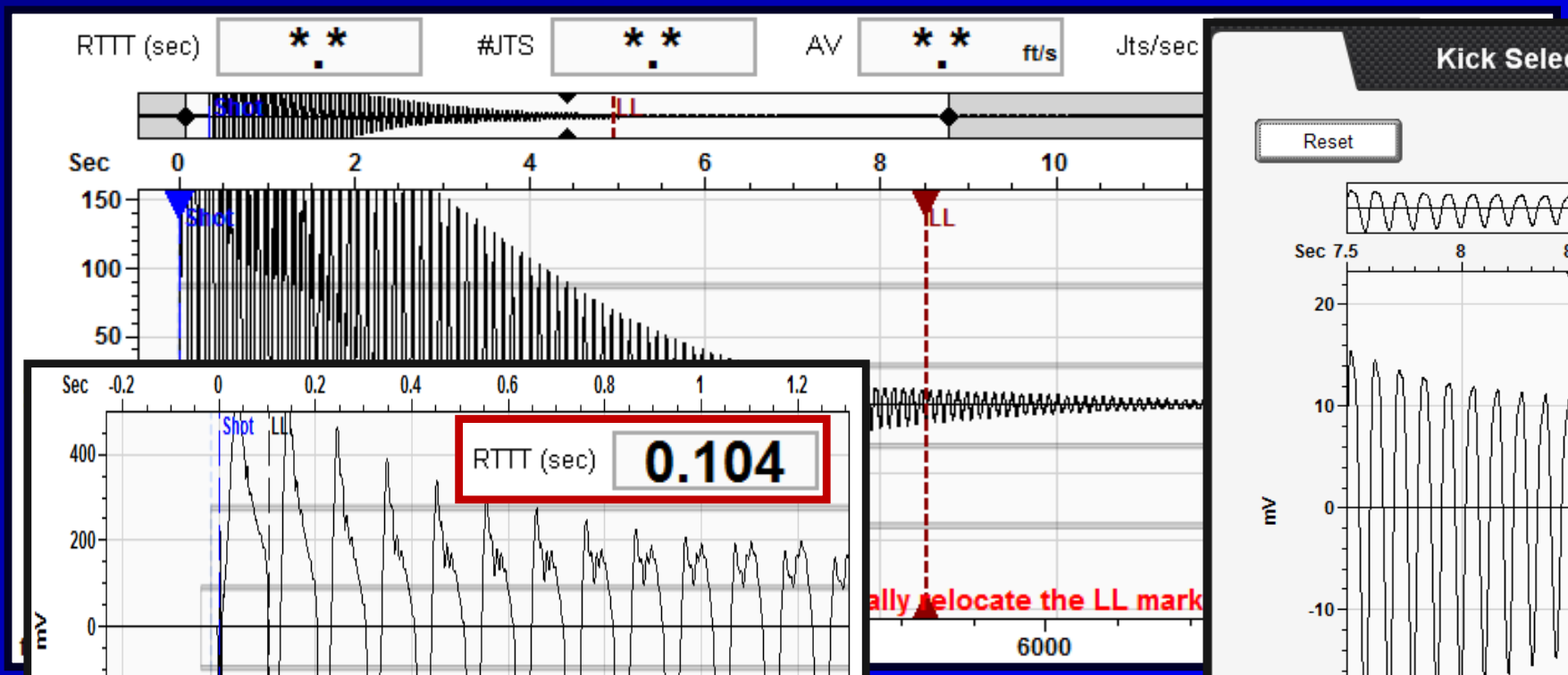


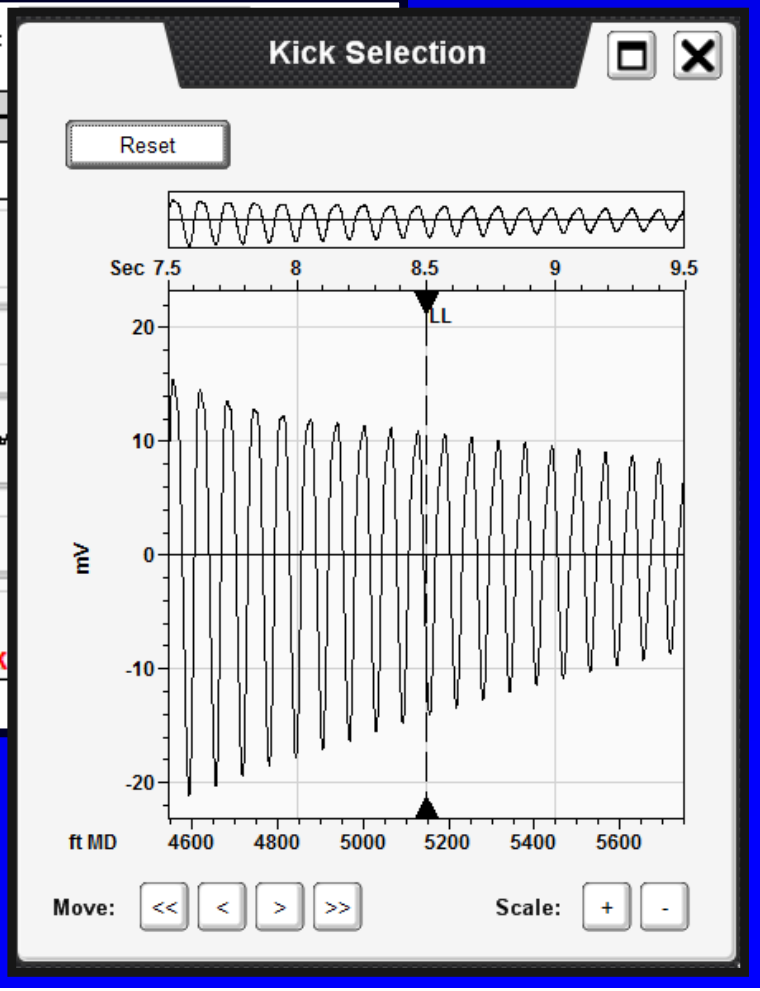


Proper Charge Pressure



Downhole Marker: PFL_Very_High

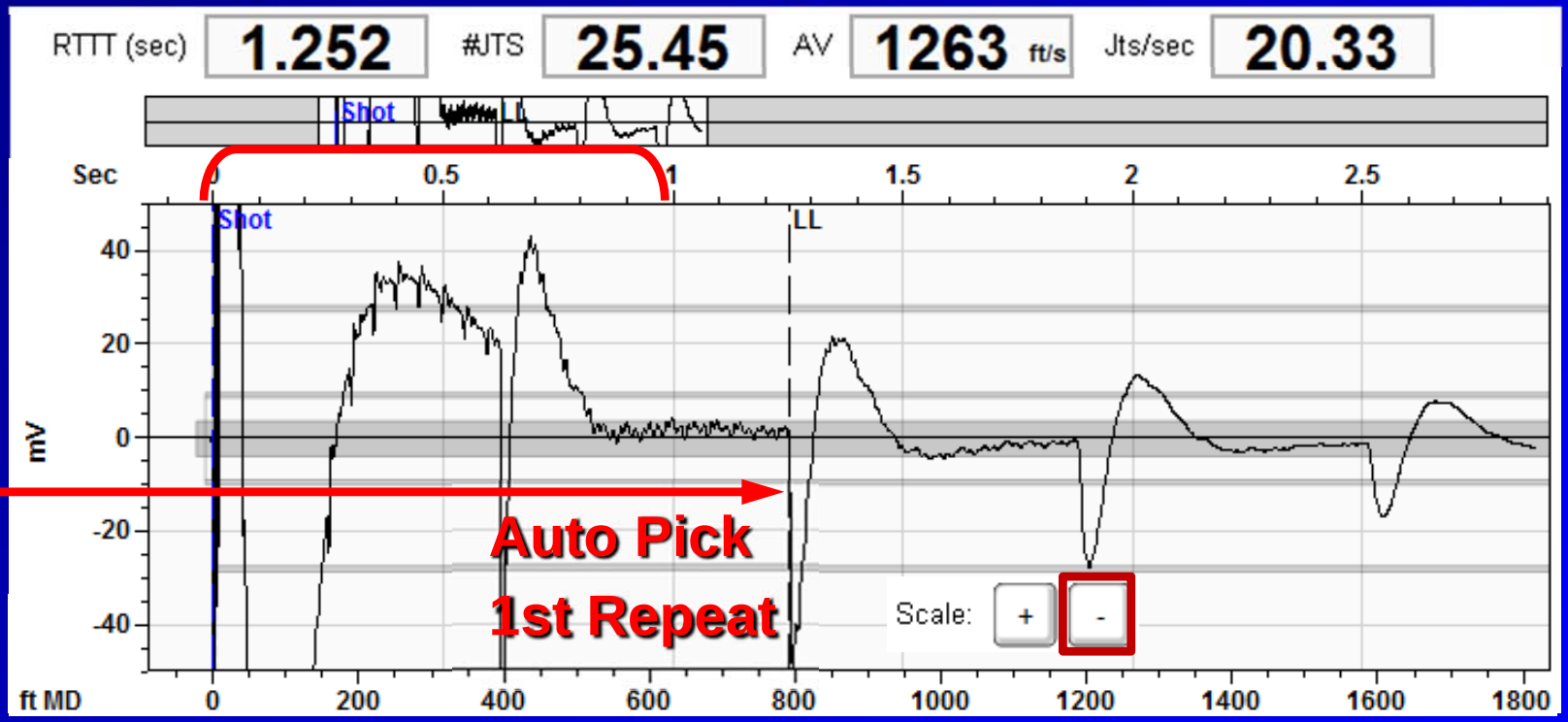




Shallow Liquid Level

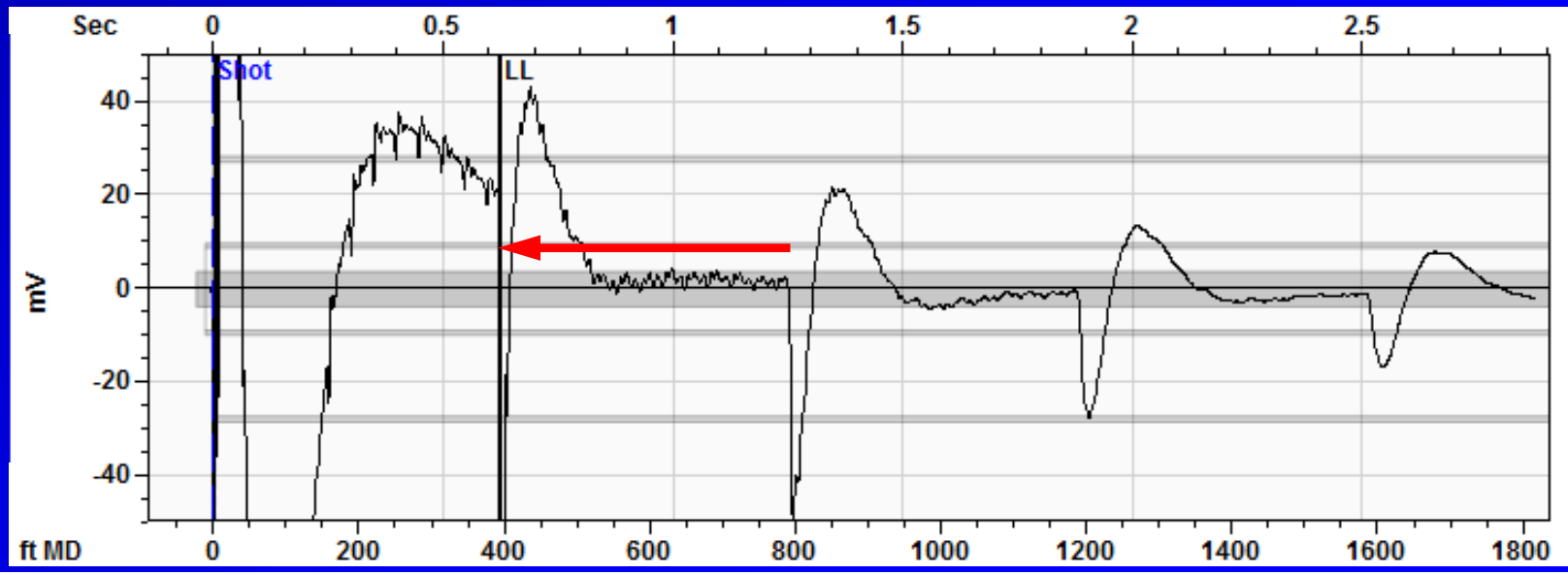
Must Manually Select High Liquid Level

1st Second of Acoustic Data Is ignored in Automatic Processing for Liquid Level Detection



Downhole Marker: PFL_High

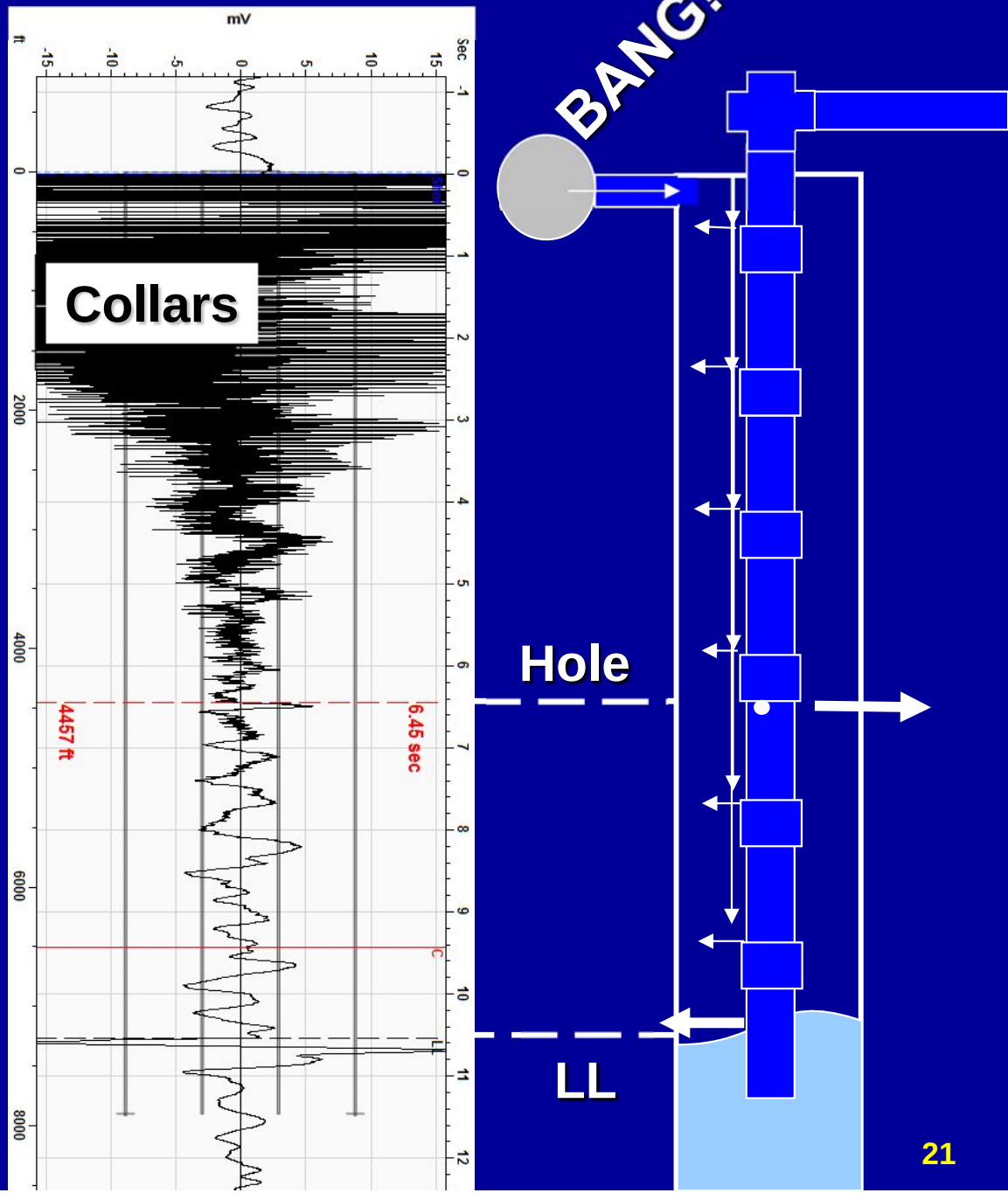
Operator ***Must*** Manually Moved LL marker to 0.628 Seconds



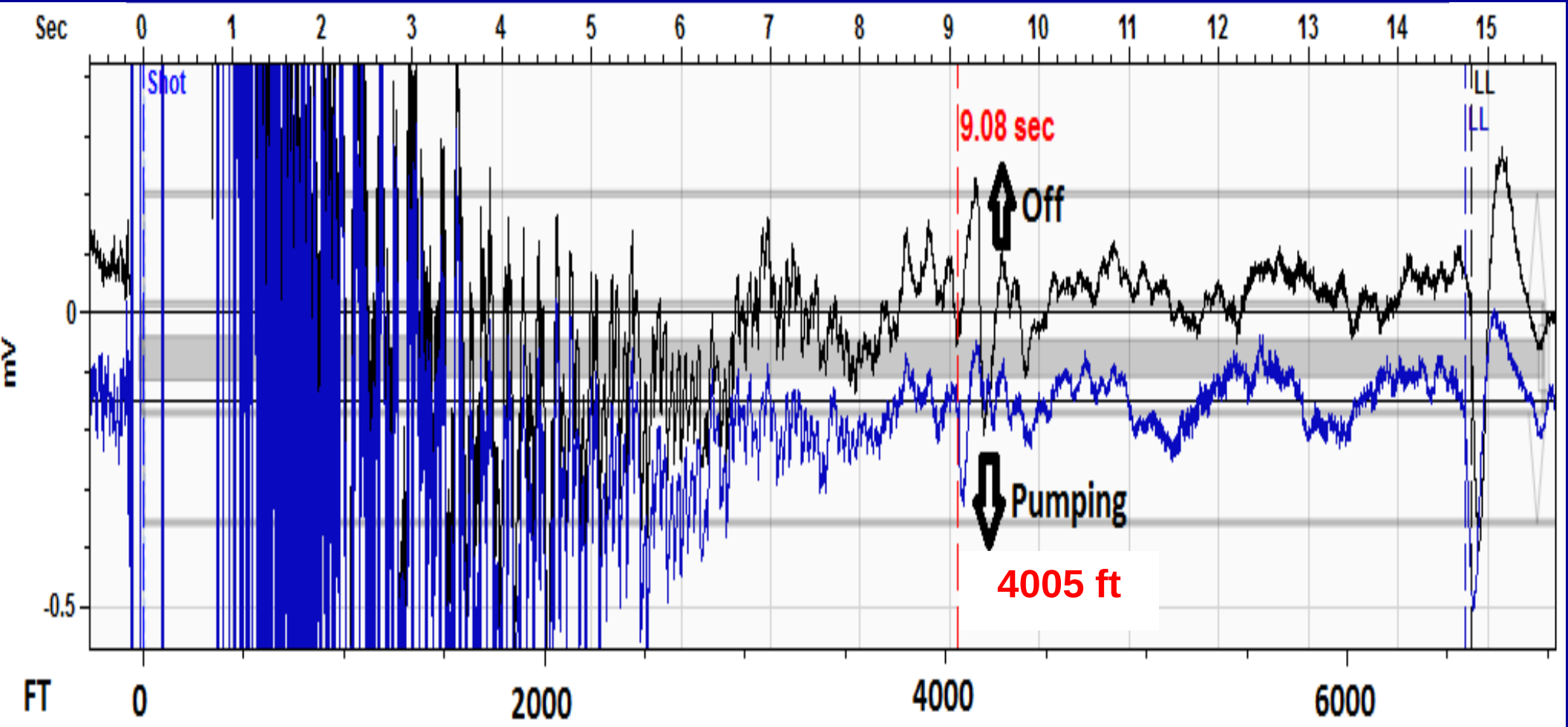
Shoot a Fluid Level to Find a Hole

- Common to use acoustic liquid level instrument to shoot distance to the liquid level in the casing annulus
- Much-lesser-known is to shoot fluid levels inside the tubing (instead of just inside the casing annulus)
- Use Up Kick to Find Depth to the Hole

Downhole Marker: Plunger_Hole_4325



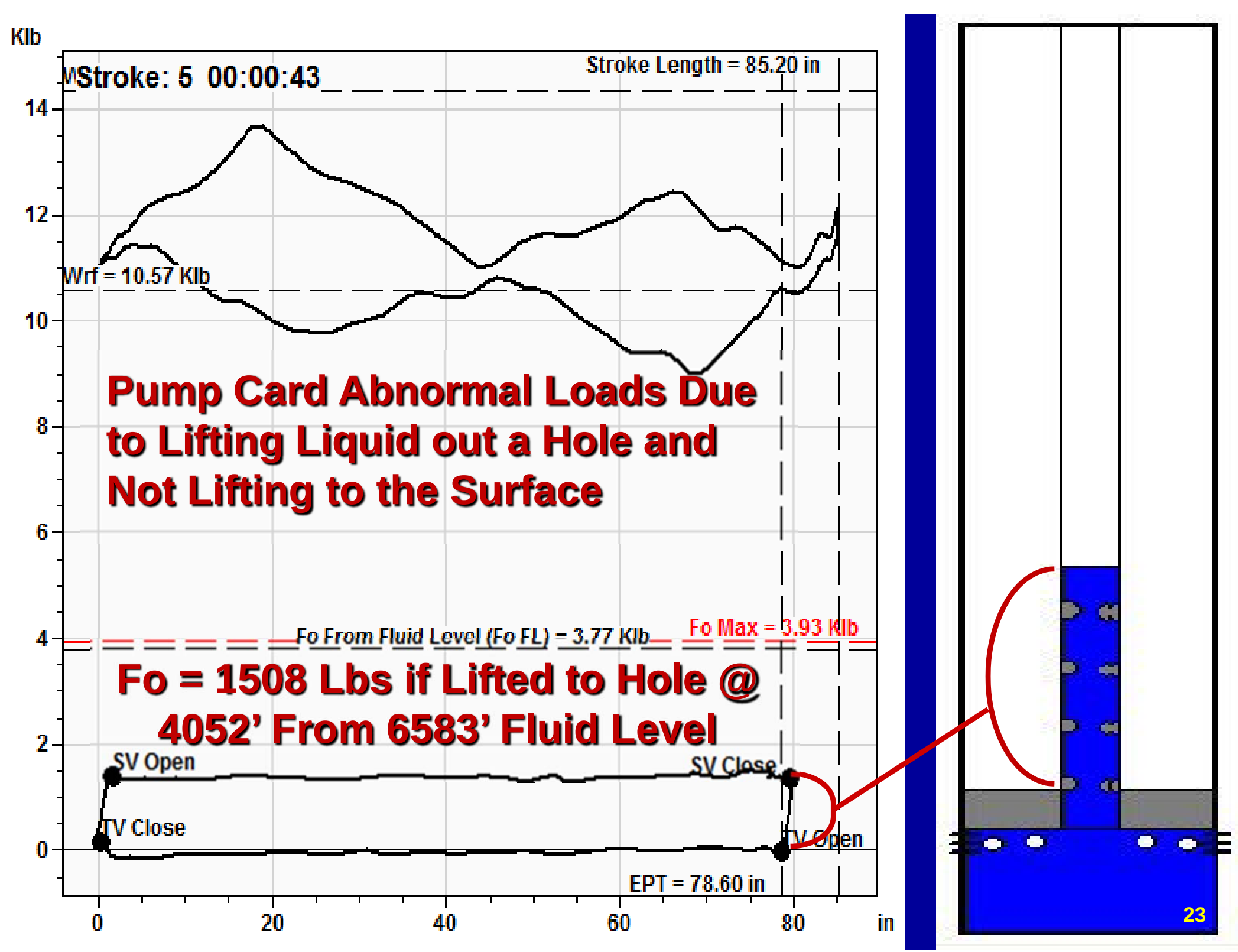
Tubing Leak, No Fluid to Surface



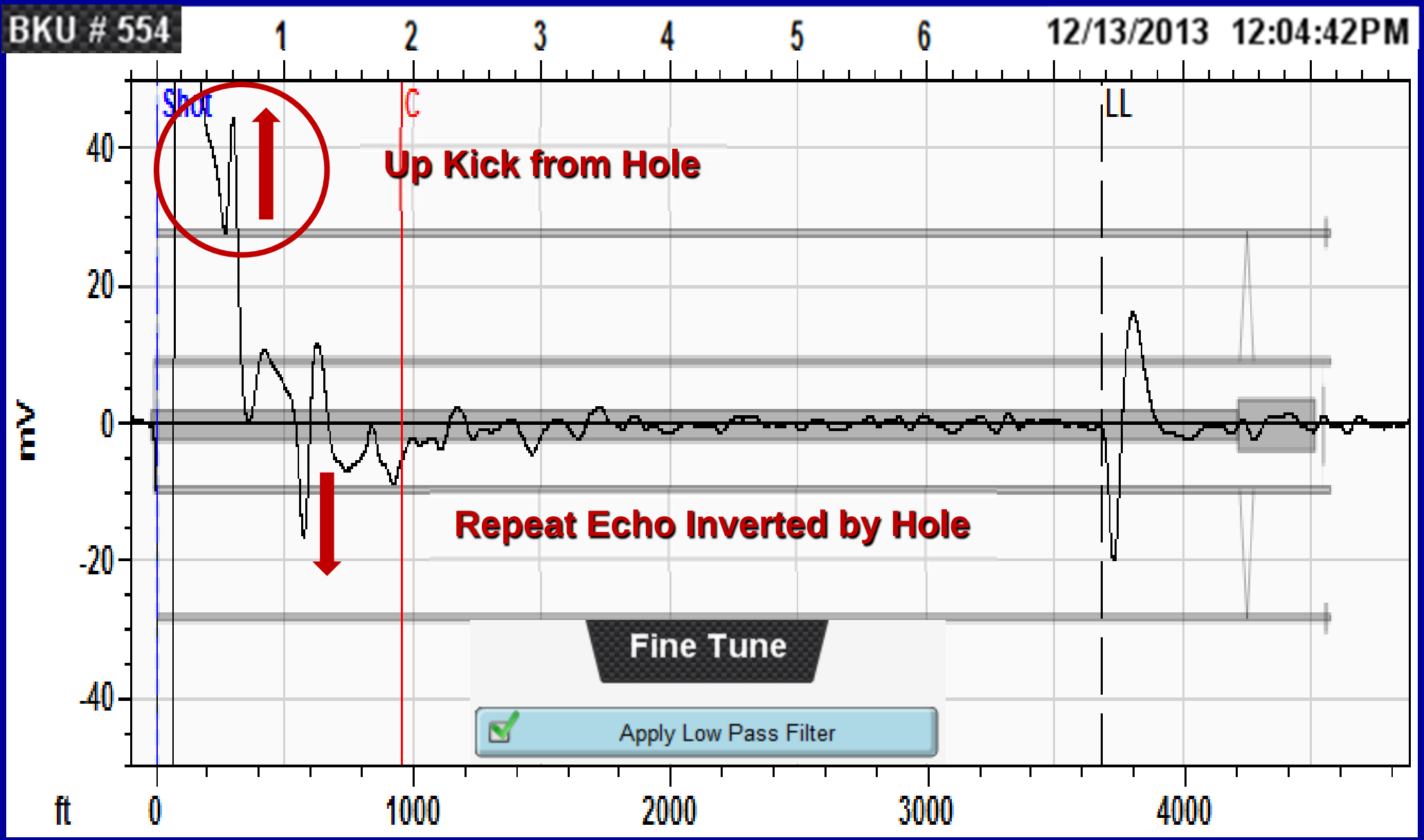
1. Hole in Tubing Shown as ***Up Kick*** when ***Pump Off*** and Time has Passed to Allow Liquid to Drain out of Tubing.
2. Hole in Tubing Shown as Down Kick when ***Pumping*** Liquid Out Tubing Hole into Casing Annulus

"TROUBLESHOOT ROD PUMPED WELLS USING TUBING FLUID LEVEL SHOTS", J. Sparks, L. Rowlan, SWPSC 2014

Downhole Marker: Leak Tubing Hole

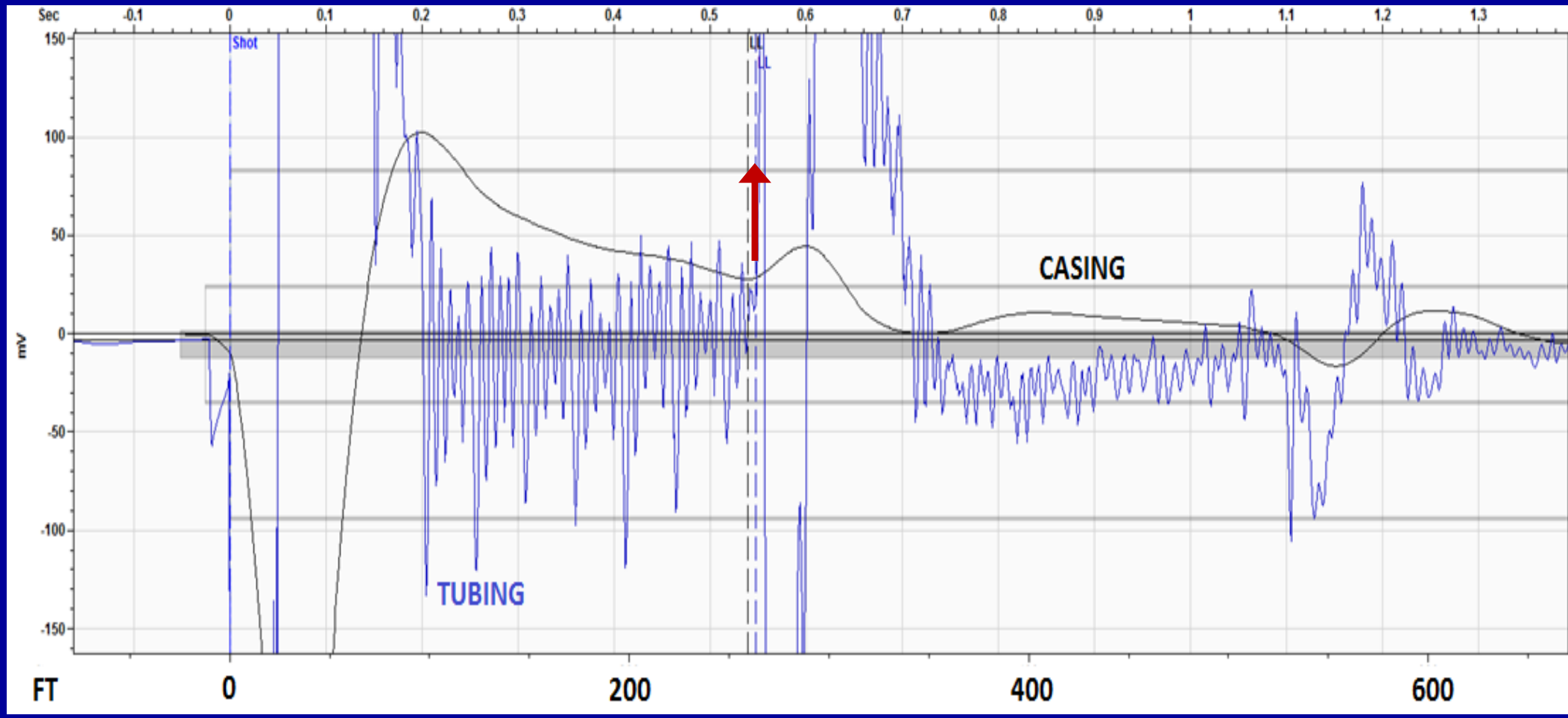

Klb
Stroke: 5 00:00:43
Stroke Length = 85.20 in
14
12
10
8
6
4
2
0
Wrf = 10.57 Klb
Pump Card Abnormal Loads Due to Lifting Liquid out a Hole and Not Lifting to the Surface
Fo From Fluid Level (Fo FL) = 3.77 Klb
Fo Max = 3.93 Klb
Fo = 1508 Lbs if Lifted to Hole @ 4052' From 6583' Fluid Level
SV Open
SV Close
TV Close
TV Open
EPT = 78.60 in
0
20
40
60
80
in
23

Remove Collar Noise Collars to See HIT



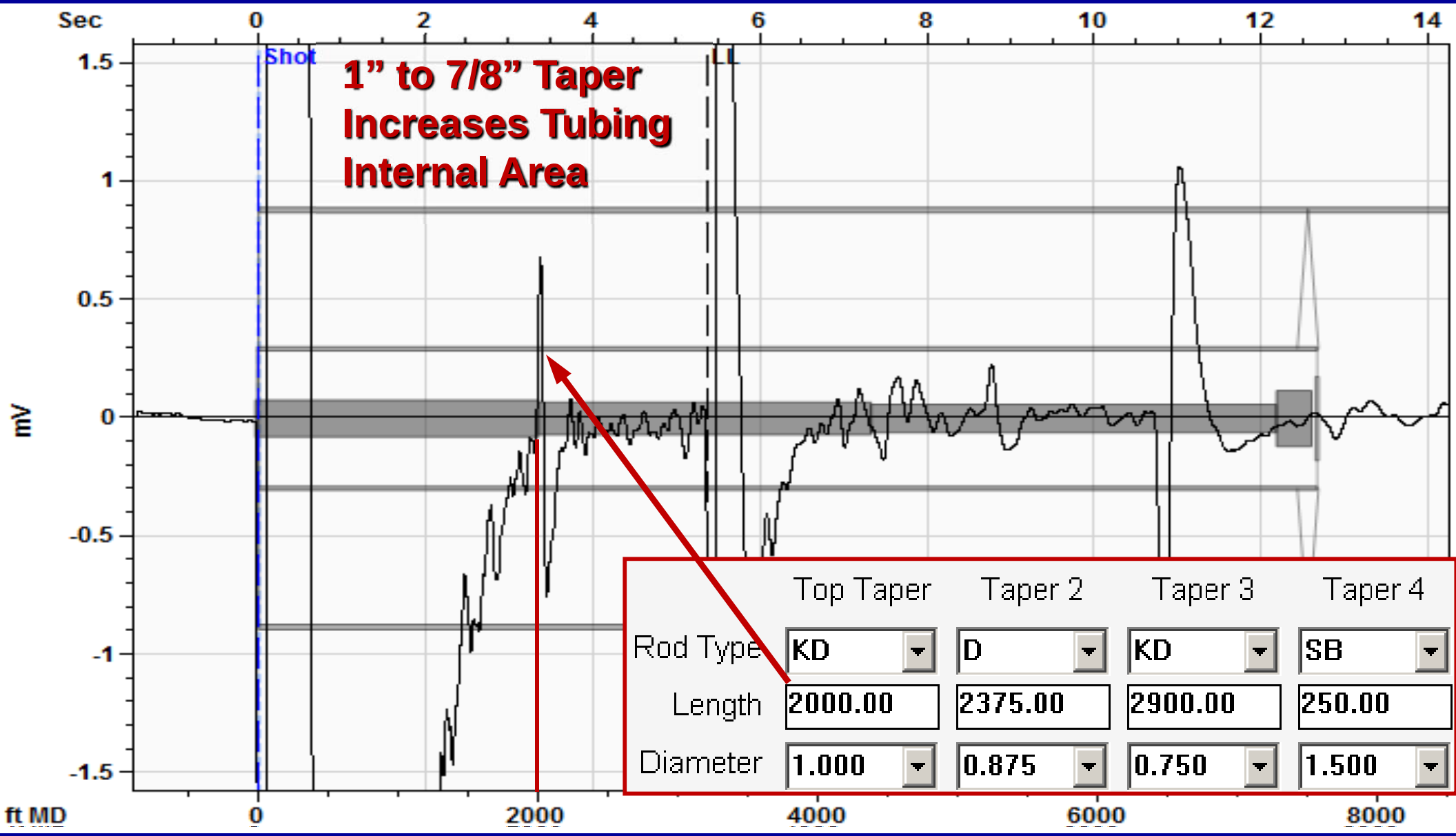
Use less pressure differential in gas gun to shoot the liquid level and see echoes near the surface OR *apply low pass filter to remove noise*.

Comparing Hole in Tubing Echo Overlay of Low Pass Filter Casing Shot to Raw Tubing Shot



Distance to the Hole is 263 feet

Is Up Kick on Tubing Shot From Hole?



Conclusion

- Displaying the acoustic trace together with the wellbore diagram provides an improved ability for analysis
- On the acoustic trace use the direction of the reflected echo to identify each well bore cross-sectional area enlargement or reduction.
- Need to use an accurate and representative wellbore schematic!
- If using Collar Count, make sure the Average Joint Length is correct.
- The deeper the Marker, the more accurate the liquid level depth
- If there is a question between using the Collar Count or DHM, use whichever is closest to the liquid level.

Recommendation

Handbook for those that would like to learn more, please click on following link:

https://www.amazon.com/Acoustic-Fluid-Level-Measurements-Handbook/dp/0886982790/ref=sr_1_1?s=books&ie=UTF8&qid=1505073594&sr=1-1&keywords=Acoustic+fluid+level+handbook

to "Acoustic Fluid Level Measurements in Oil and Gas Wells Handbook Paperback – January 1, 2017" by Dr. A. L. Podio (Author), Jim McCoy (Author)

A comprehensive technical handbook that discusses the importance, application, and interpretation of acoustic fluid level measurements for all types of wells and measurement instrumentation, ranging from strip charts to digital sensors.