

Shut-In Fluid Levels in Today's Environment – Part 1

Presented by Echometer Team

Today's Presenters

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Outline of Discussion

- Part 1 of a Series
- Benefits of Shutting in Wells
- Practical Considerations
- SBHP vs. PBHP
- SBHP Calculation from Fluid Levels on Pumping Wells
- *Question and Answer*
- TAM example
- *Question and Answer*
- Well Inflow Performance
- Determination of Pump-off Rate
- Summary – *Question and Answer*

Shut-In Fluid Levels in Today's Environment

- SBHP information is important, but often difficult to obtain during times when we attempt to maximize production
 - We want to maximize production, so we don't want to shut in wells.
- The current oilfield environment is causing many wells to be shut-in
 - Don't miss the opportunity to collect useful important data by acquiring static fluid level records.

Why Do We Need SBHP Information?

- Determine Well's Potential
 - Properly size production equipment
- Evaluate present production efficiency
- Determine Pump-off Rate
- Evaluate Individual Well Depletion
- Provide Data to Determine Reserves

What is Required to Shut-In Well for SBHP Test?

- Management Approval
 - Would rather have production instead of number
- Planned Well Shut In (Don't miss an opportunity)
 - Gas Plant Turn Around
 - Storage Facilities at Capacity
 - Offshore Platform Maintenance/Safety
- Well Down for Mechanical Problems
 - Rod Part
 - Motor Failure
 - Belts
 - Flowline Leaks
 - Etc.

Differences Between Producing and Static Fluid Levels

- Producing Fluid Levels have fluids flowing into and out of wellbore
 - Tend to be noisier, especially if they have gas production
 - Have to correct for gas in the fluid column
 - Oil in the Annulus above pump in a steady state condition
- Static Fluid Levels have no fluid flowing into or out of the wellbore
 - Quiet
 - No gaseous liquid column correction
 - Can have oil and water in the annulus above the pump

Static vs. Producing bottom hole pressure



A Producing Fluid Level CAN NOT be used to calculate Static bottom hole pressure

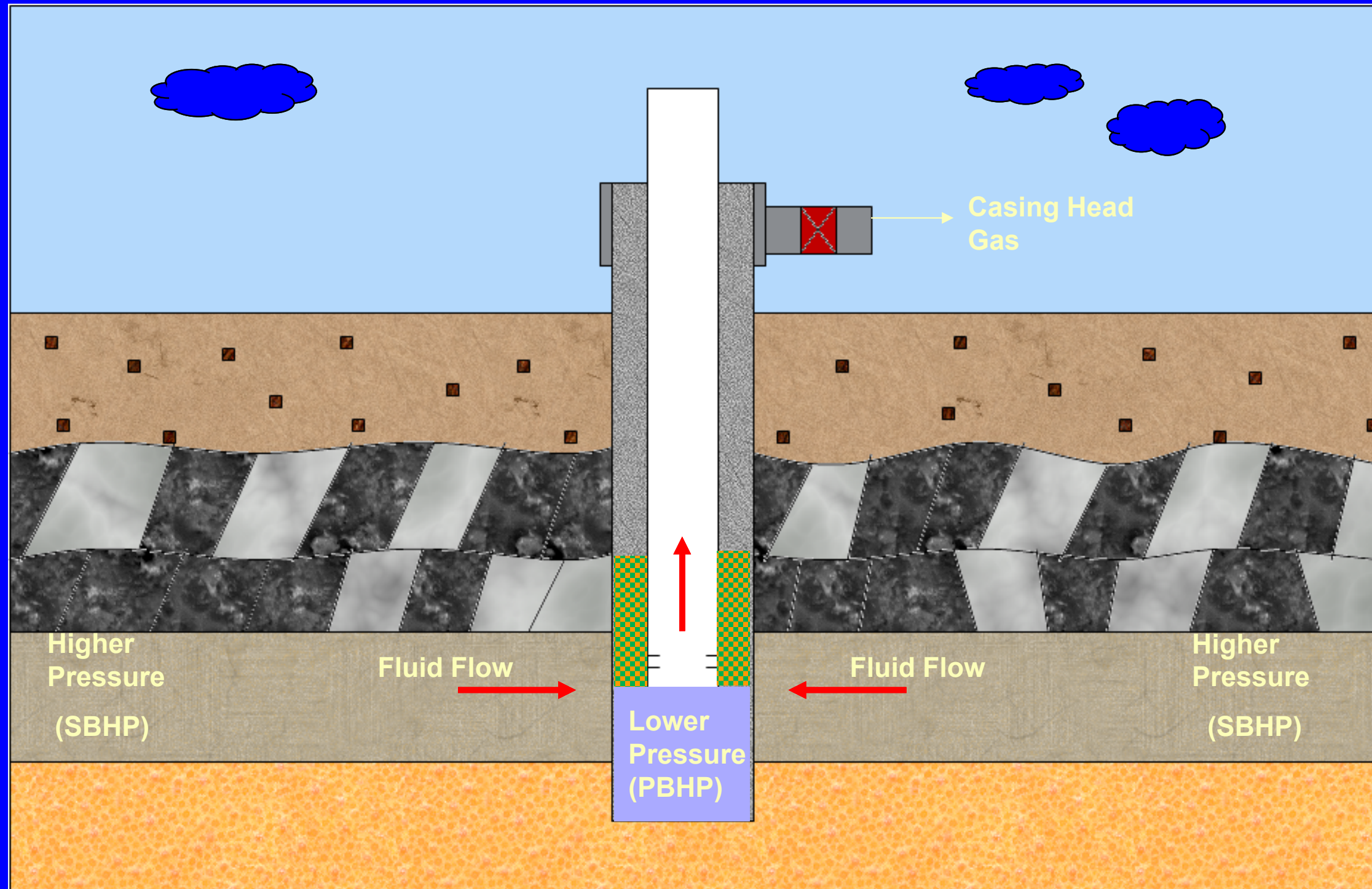
Preparing Well for Shut-In

- Make sure team is aware of well shut-in status
 - Lock Out – Tag Out
- Verify Condition of Well
 - Safe Working Pressure of Well (Expected Maximum Wellhead Pressure)
 - Leaks
 - Stuffing Box Condition
- Gather Baseline Production Rate Information –Well Test
- Obtain Fluid Level on Well During Production Prior to Shut-In

Preparing for Extended Shut-In

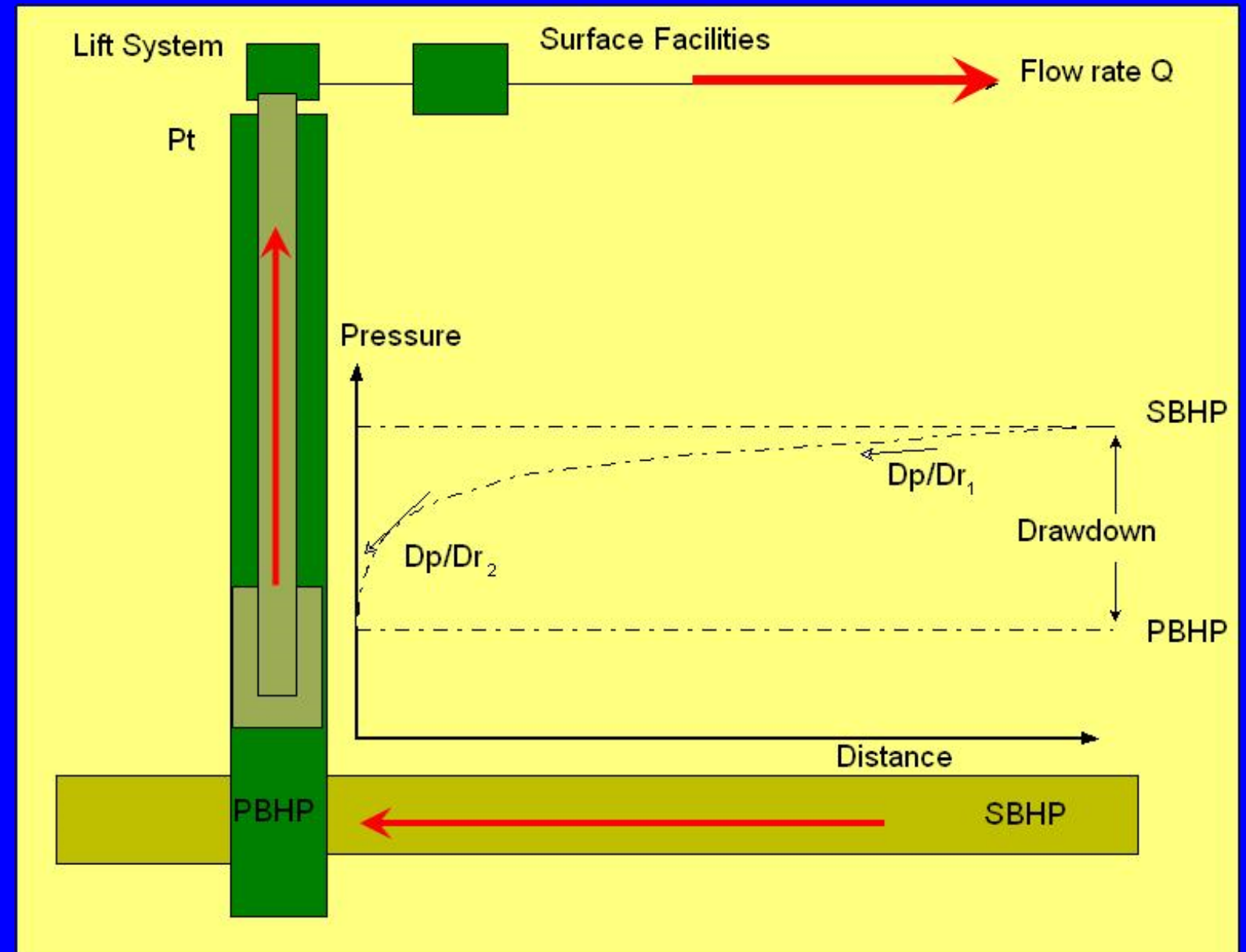
- Land and Leasehold Issues
- Long term shut-in may affect the performance of the well.
 - Wellbore Damage
 - » Corrosion
 - » Fill
 - Reservoir Damage
 - » Crossflow
 - » Incompatible fluids
- Additional Testing Prior to Shut-In
 - Dynamometer
 - Plunger Tracking
- Additional Testing During Shut-In
 - Pressure Transient

Fluid Removal

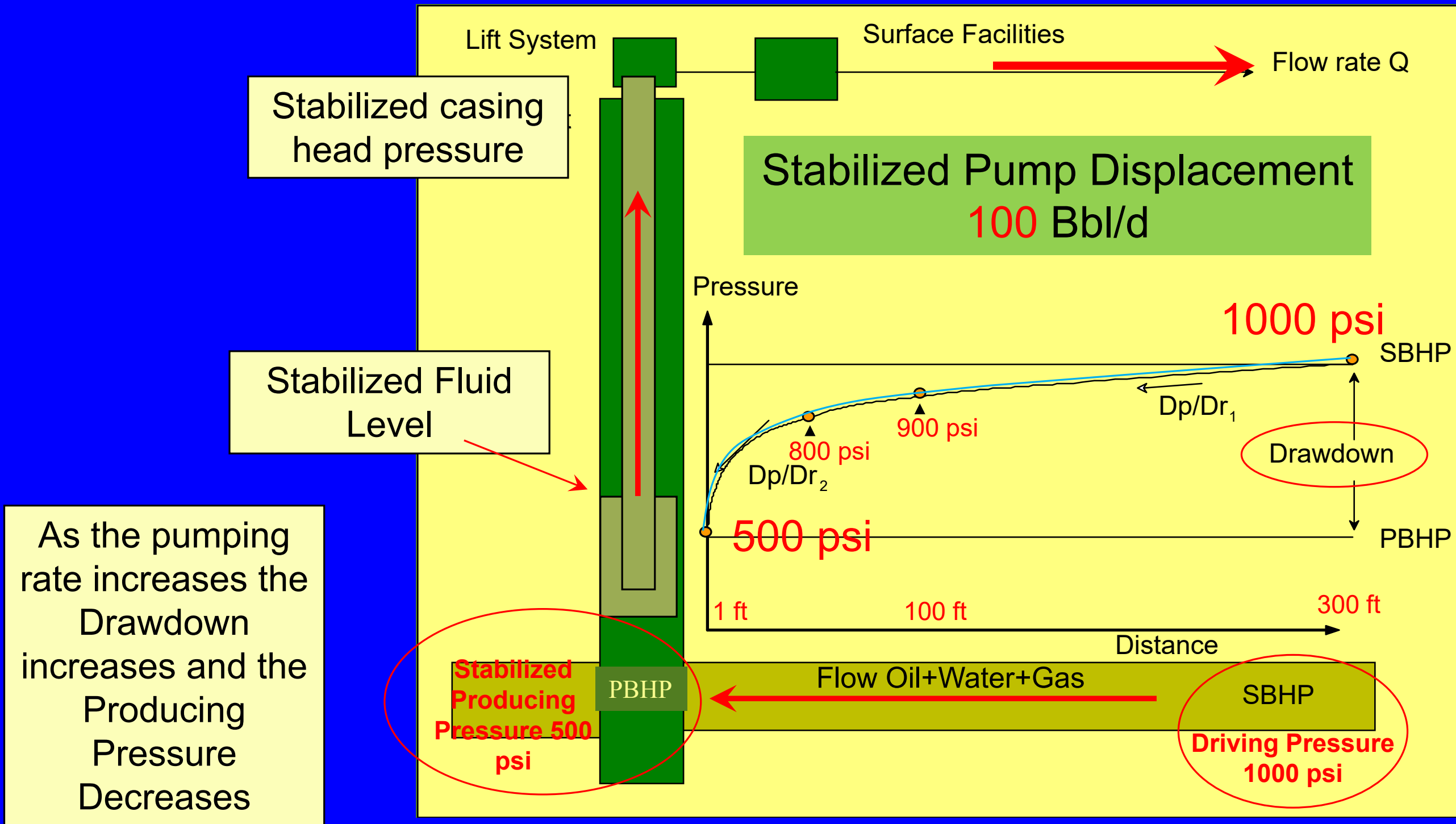


Static BHP

- SBHP: also known as the Reservoir Pressure at the drainage radius, P_{re} .
- Represents the pressure available to push the fluids to the wellbore from the formation.

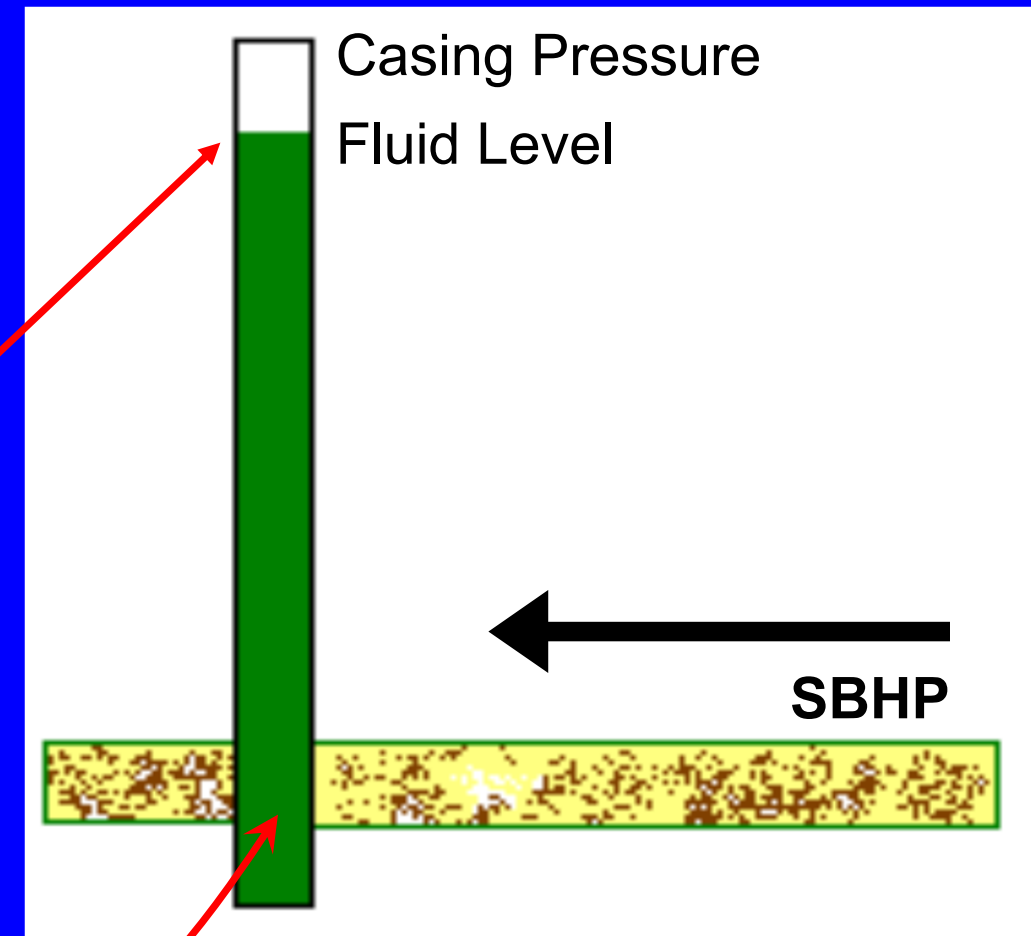


Mechanism of Flow into Wellbore



Static Bottom Hole Pressure - SBHP

- Generally *GUESSED*
- Needed within +/- 15% for well potential calculation.
- Operator Should Measure Static Fluid Level and Casing Pressure in wells shut-down for any reason (mechanical failure).
- Use TAM, TWM or AWP2000 to compute the SBHP



Calculation of SBHP from Fluid Level

Static BHP =

Casing Pressure +

Gas Column Pressure +

Oil Column Pressure +

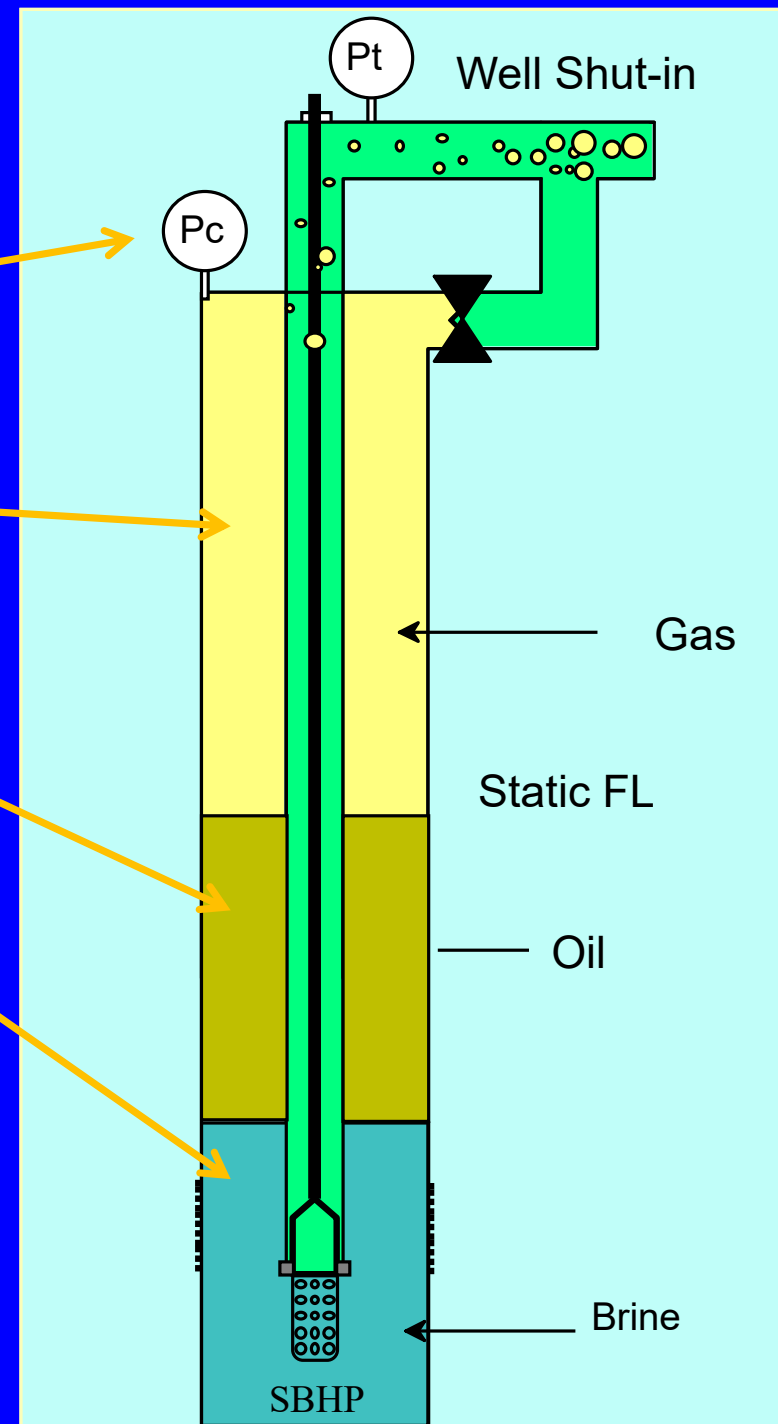
Brine Column Pressure.

Note:

All flow from perforations has stopped

Fluids Segregated by Gravity

Depth of Oil/Brine interface above pump intake must be computed.

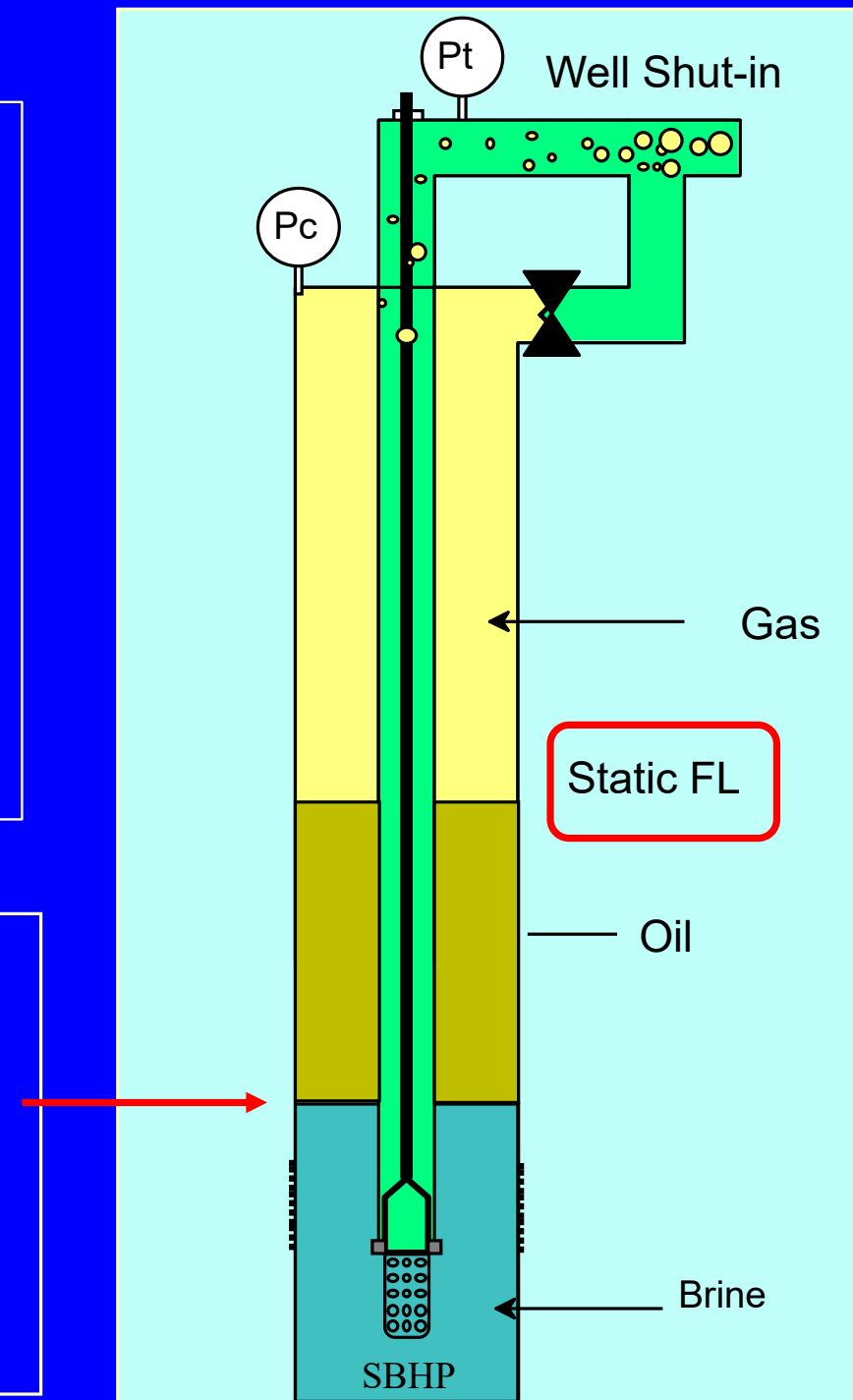


Oil/Water Interface at end of shut-in

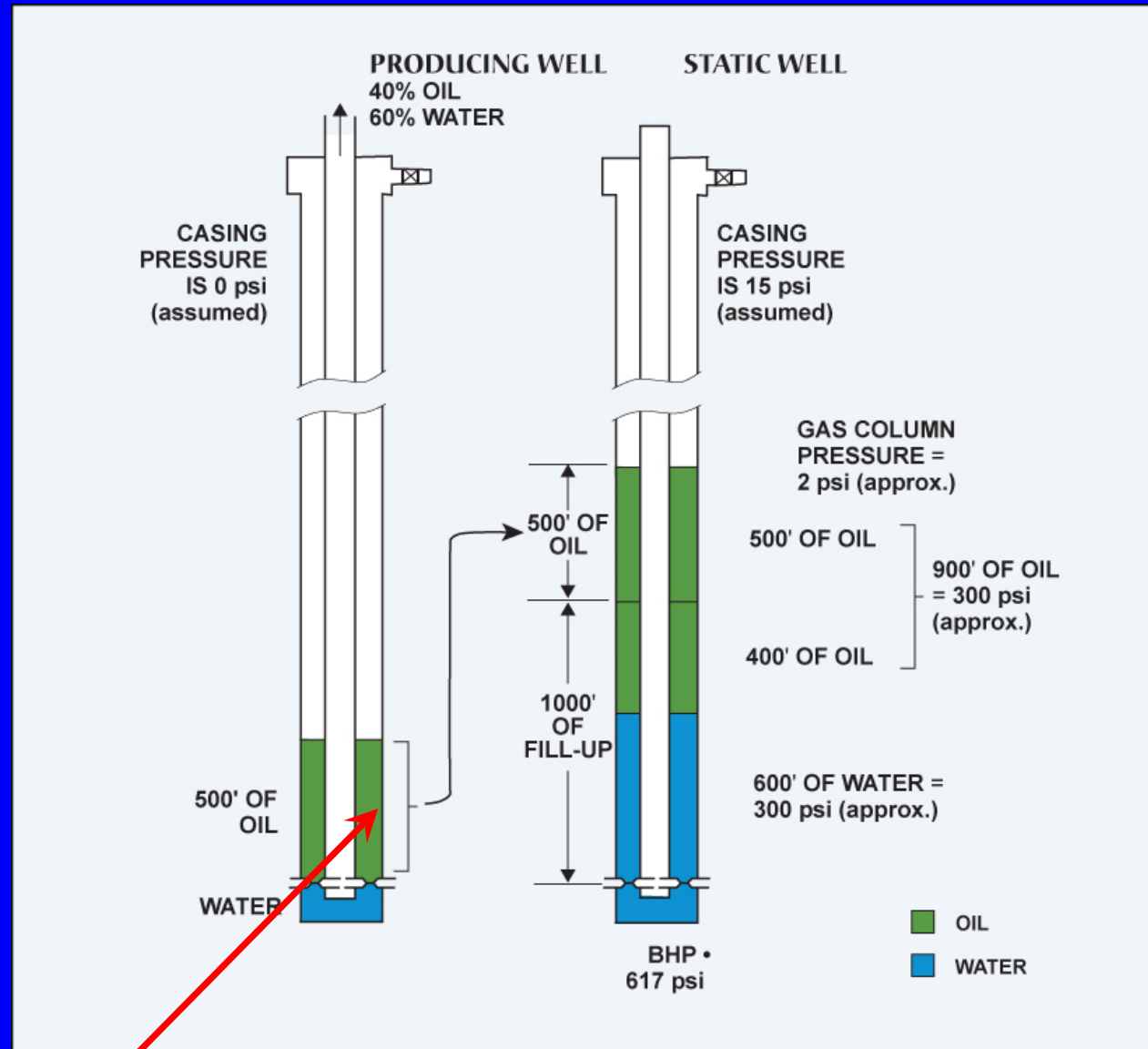
- Cannot Accurately Predict WOR during after-flow.

Assume that during after-flow the WOR remains same as that measured by well test.

Program computes location of water/oil interface from the Static Fluid Level, the last measured Producing Fluid Level and the wellbore dimensions.



Static Bottom Hole Pressure, Pump Intake near Perforations



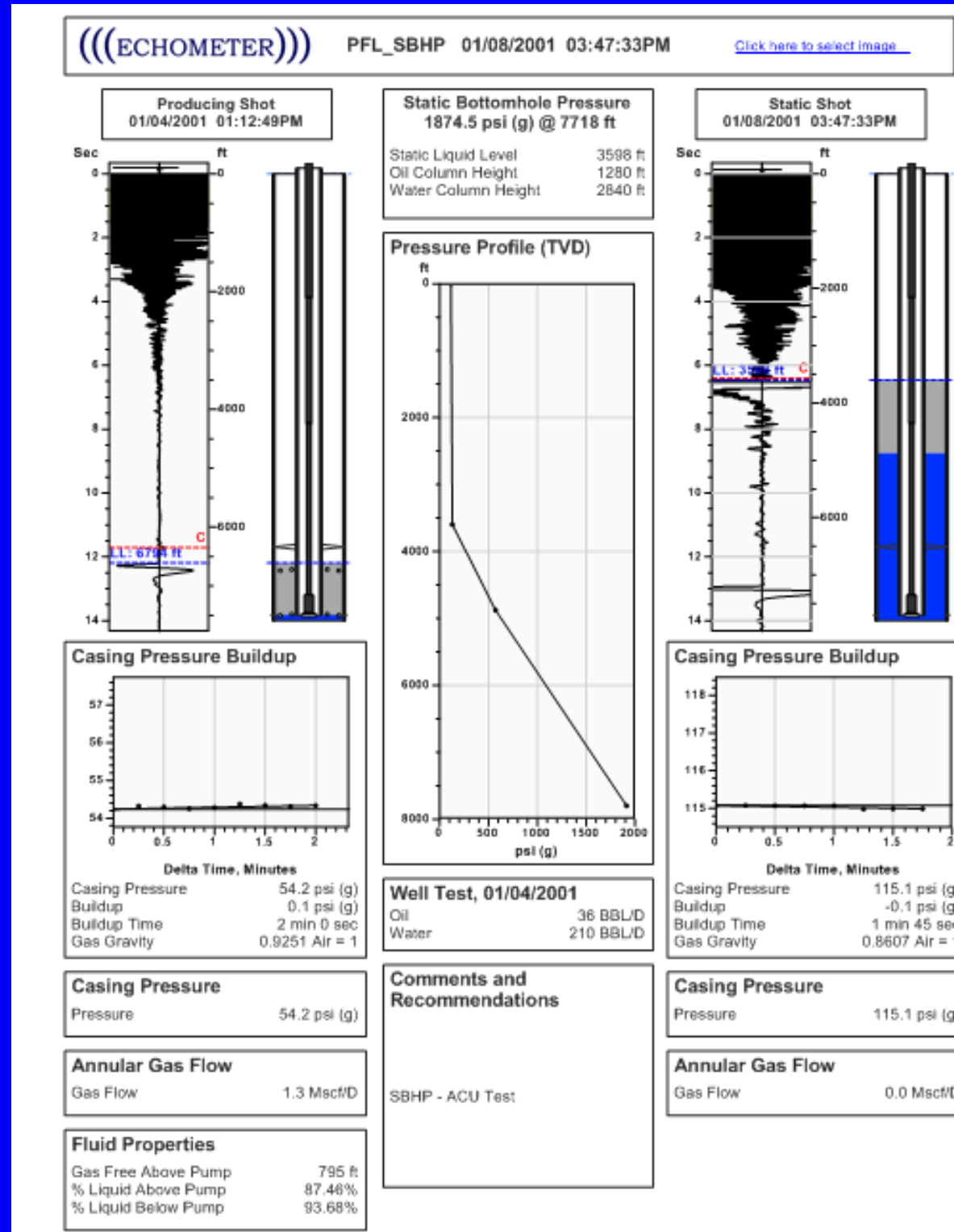
Need to compute % of oil and water in annulus at end of fill-up period.

Gas-free Fluid (oil) Level is generally above pump intake when Producing (GFAP)

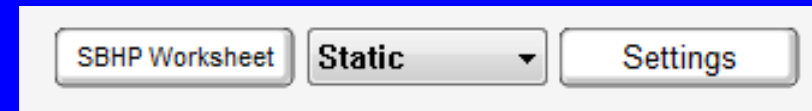
Fluid Levels for PBHP and SBHP

- PBHP requires one fluid level, surface pressure and surface pressure buildup
- SBHP ideally requires two fluid levels on pumping well
 - Producing shot
 - static

SBHP in TAM Fluid Level Report



1 - Select "Static" for well condition



2- Click "SBHP Worksheet"

3- Enter fluid level and % liquid from last producing fluid level shot as shown in next slide.

TAM – SBHP Worksheet

SBHP Worksheet: Select or Enter Producing Fluid level ✕

Existing Producing Shot
01/04/2001 01:12:49PM

Thumbnail	DateTime	LL
	02/07/2001 05:47:28PM	8264
	01/04/2001 01:12:49PM	6794

Manual Entry

LL ft % Liquid

Well Test

Oil BBL/D Water BBL/D

Pump Depth is at 7704 ft

Production Case

Static Case

Determination of Accurate SBHP

- Pump should be shut-down for a time sufficient to stabilize casing pressure and fluid level.
- Determination of Fluid Level depth
- Measurement of surface pressure and of pressure buildup rate (at Producing and Static Conditions)
- Oil, water and annular gas densities
- Wellbore description
- Select “Static” in final fluid level record analysis.
- Enter the last Producing Fluid Level and % liquid in annular fluid column into the SBHP worksheet.

How to know if the well is a Static condition?

Surface measurements can be used to identify when stabilized conditions have been reached.

- Periodic (once a day) fluid level measurements
- Periodic (once a day) casing pressure measurements. Telemetry systems can help to easily monitor the CHP stabilization.
- Also, a “flat” casing pressure buildup during fluid level measurements is often a good indication.

Break for answering Questions

Hands on TAM-SBHP exercise

- Ask Echometer

Ask Echometer SBHP Example

Summary of Determining BHPs

- Static and Producing BHPs can be determined from acoustic liquid level surveys.
- Accurate surface pressure and pressure buildup rate determines % Liquid.
- $BHP = \text{Surface Pressure} + \text{Pressure from each column of fluid in the wellbore.}$
- Fluid Distribution in wellbore is based on stabilized conditions.

Break for answering Questions

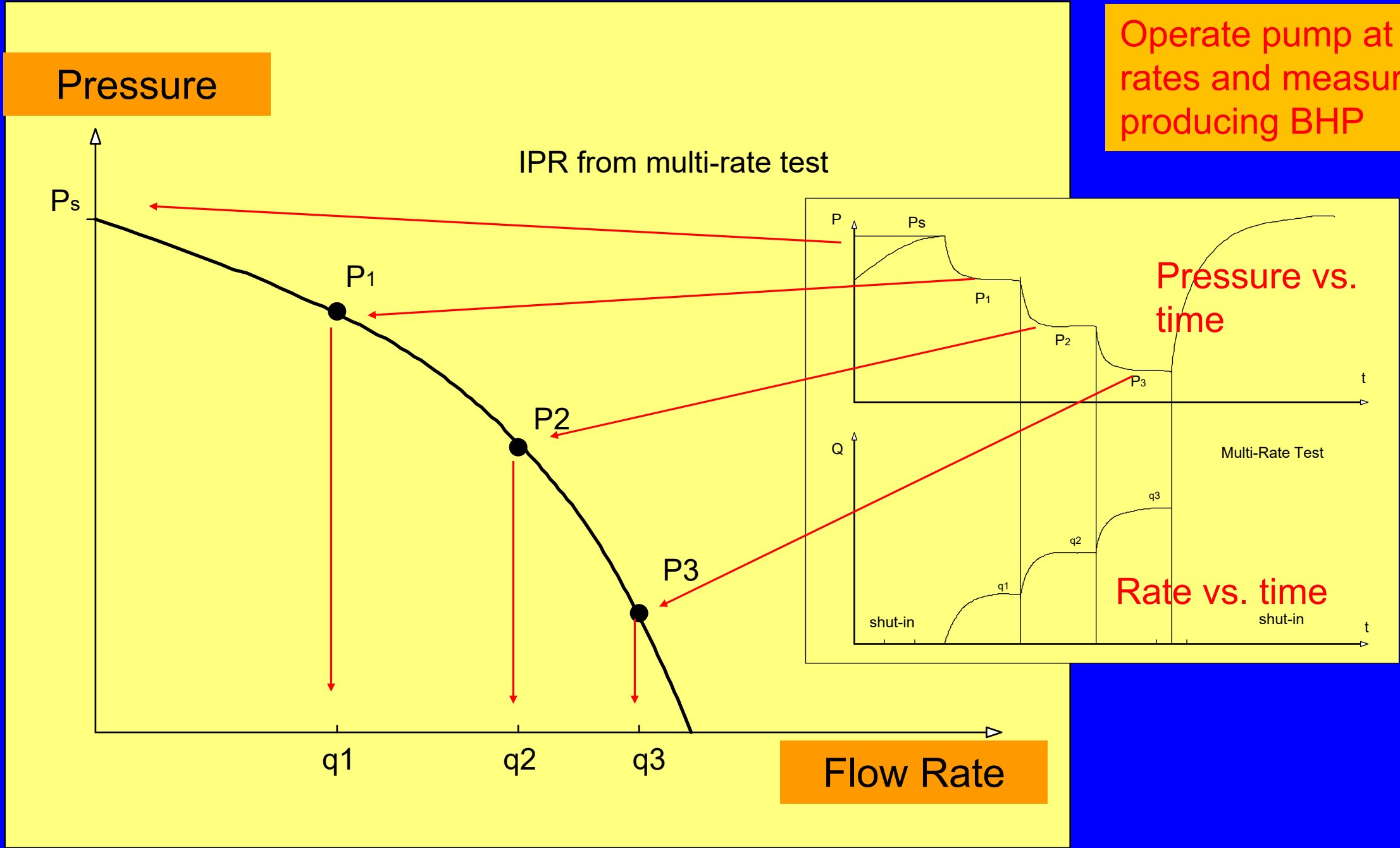
Well Performance

- Now that we have a good estimate of SBHP what can we determine?
- 1) Pressure Draw Down corresponding to a given production rate.
- 2) Rate that will cause the well to be pumped-off.
- 3) Maximum rate that the formation can produce.

These quantities are determined by establishing a relation between the pumping rate and the producing BHP known as the IPR of the well.

Measured IPR from Multi-rate Flow Test

Operate pump at different rates and measure the producing BHP



Vogel (IPR)

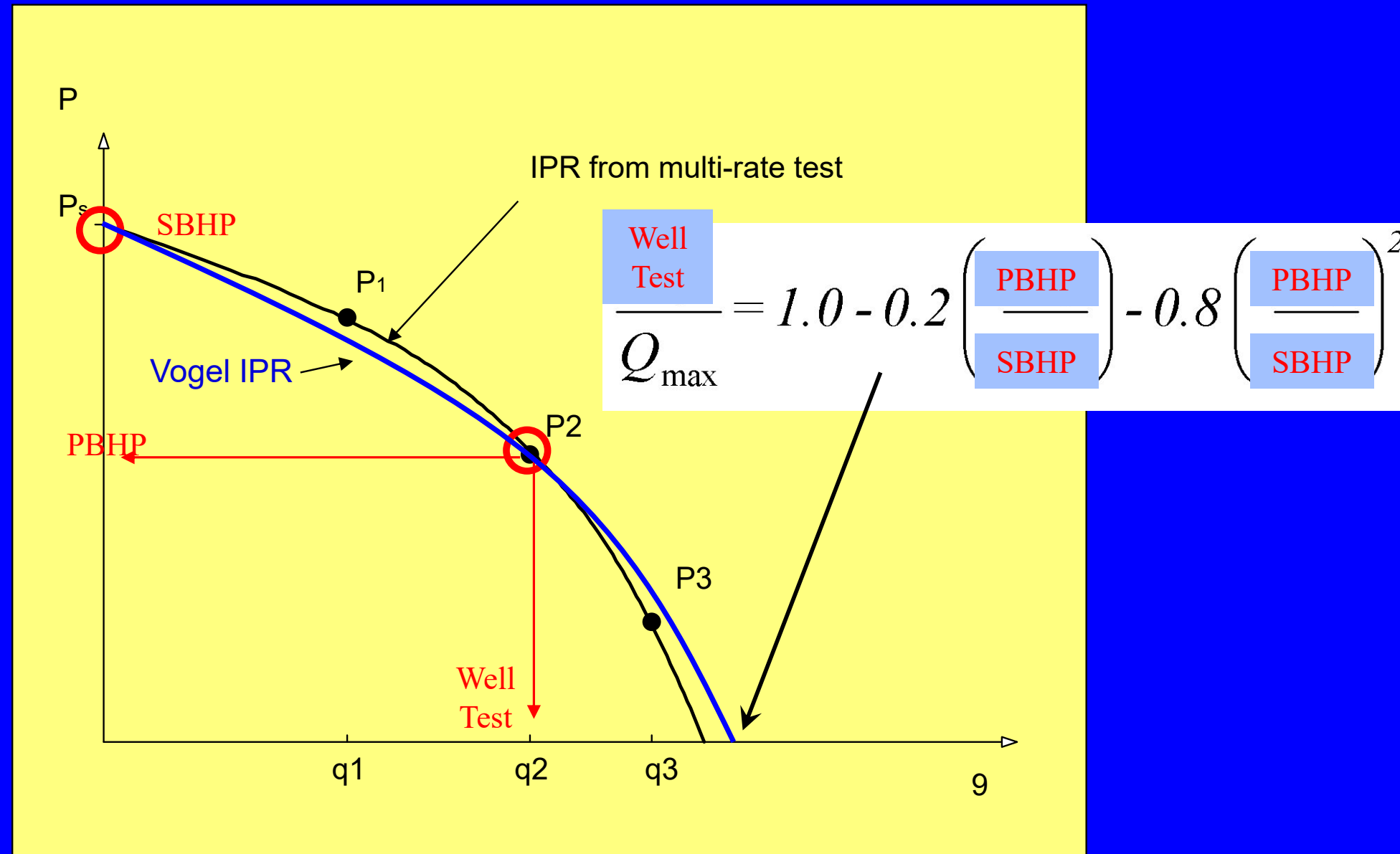
Inflow Performance Method

- Generalized Inflow Performance Relationship (IPR)
- Called the Vogel IPR Method
- Describes well performance when both free gas and liquids flow simultaneously from the reservoir.
- Method applicable for gas drive reservoirs with pressures below the bubble point pressure, gas wells, CBM wells.
- Allows determining performance using only one stabilized flow rate

Comparing IPR from Vogel's One-Rate Test and from Multi-Rate Test

Vogel's IPR is a good approximation of the actual well performance.

Requires only SBHP and one producing fluid level test



“Pumper” IPR based on Fluid Level Above Pump

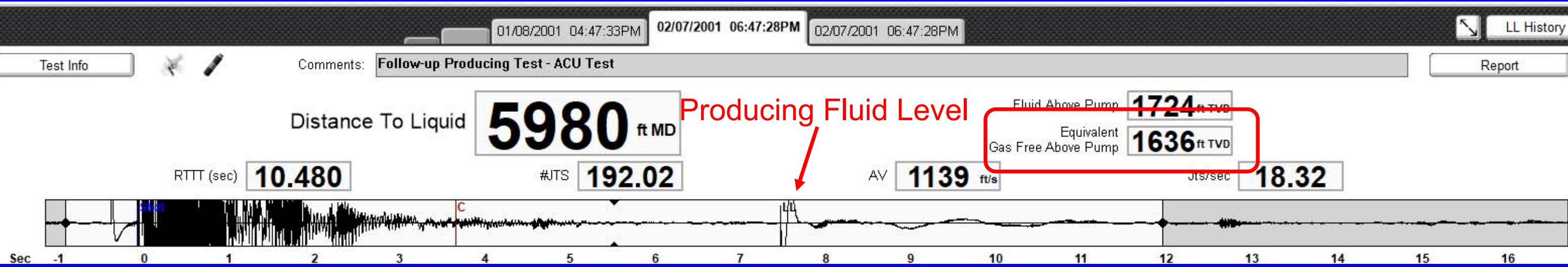
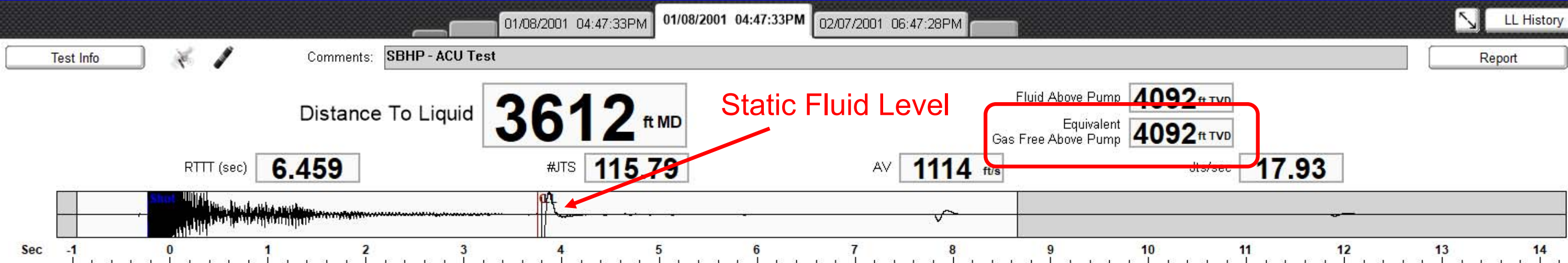
Given the Fluid Above Pump when the well was shut in and static (SFAP)

and

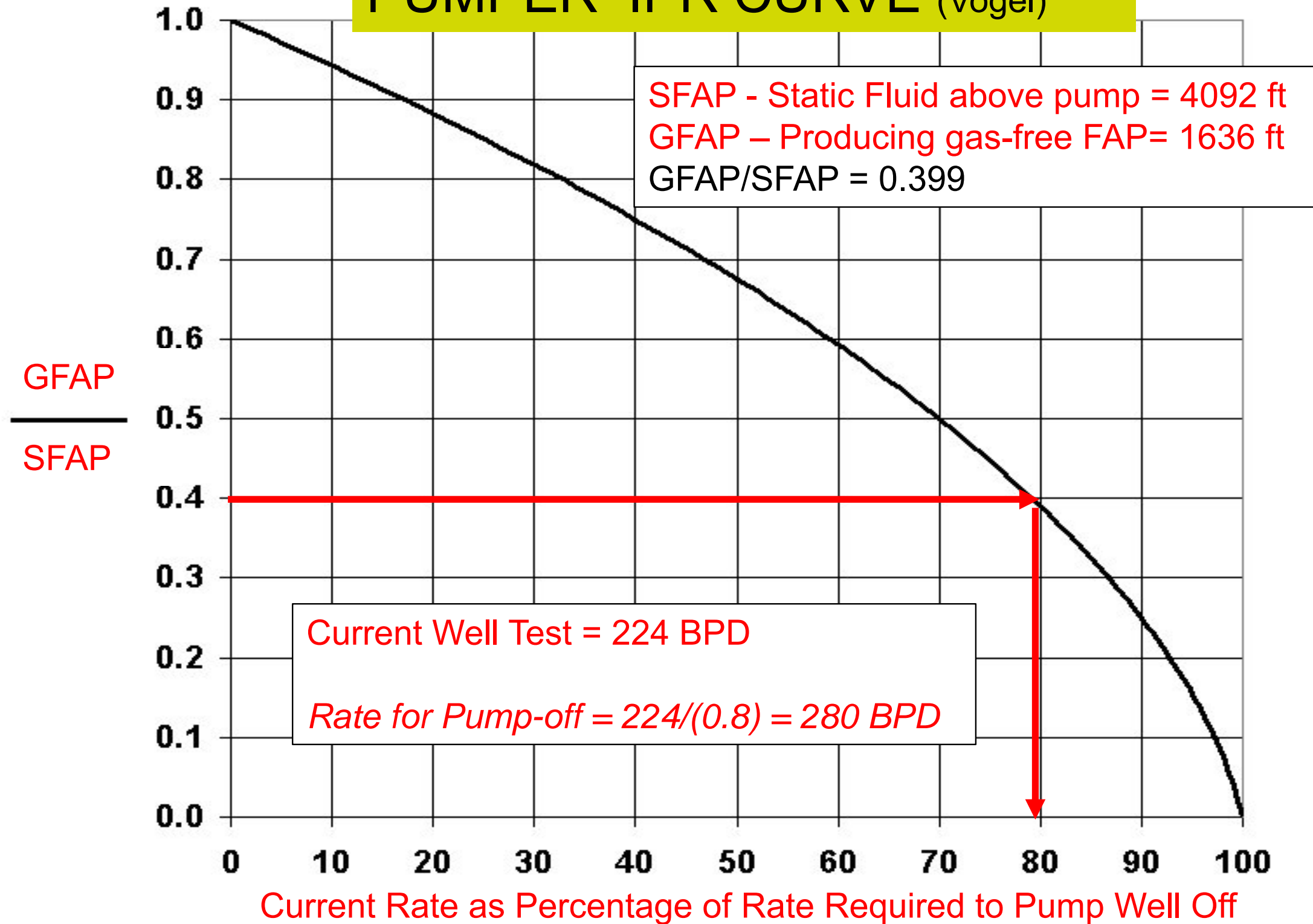
the present producing Gas Free Fluid Above Pump (GFAP)

Their ratio estimates the pump rate that will draw the fluid down to the pump intake and achieve pump-off

Fluid above Pump Data for "Pumper" IPR



PUMPER IPR CURVE (Vogel)



Pumper IPR

Determine the Producing Gas-Free Fluid above Pump and compare it to the Static Fluid above Pump

When the ratio of Producing GFAP to Static GFAP is less than 10% the rate is close to 95% of the Pump Off Rate of the well.

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Summary

- SBHP is a very important quantity for determination of well performance
- Fluid Level measurements can yield good estimates of SBHP
- Should determine static fluid level in all wells that are shut-in for any operational requirements.
- The ratio of the producing to the static BHP pressures can be used to estimate the well performance
- The longer the well is shut-in the more representative the estimated BHP is of the formation pressure.

Break for answering Questions
