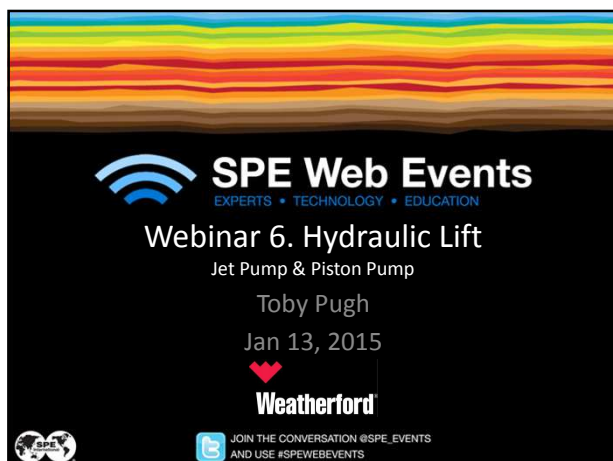
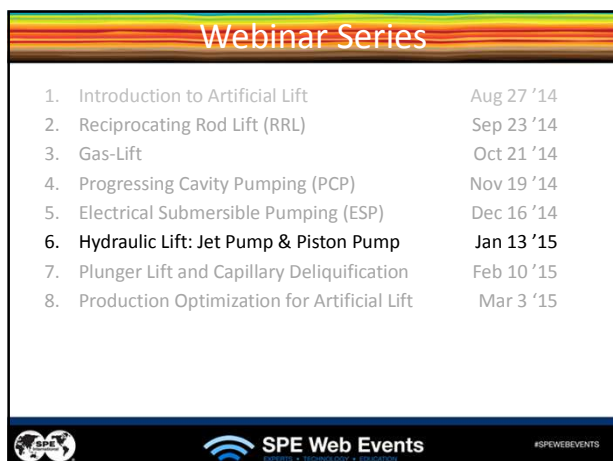
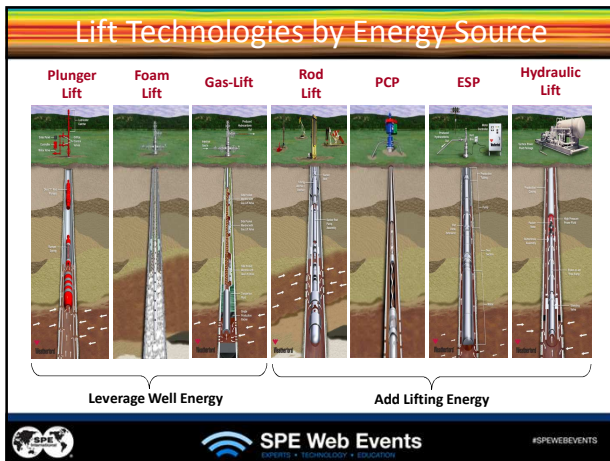
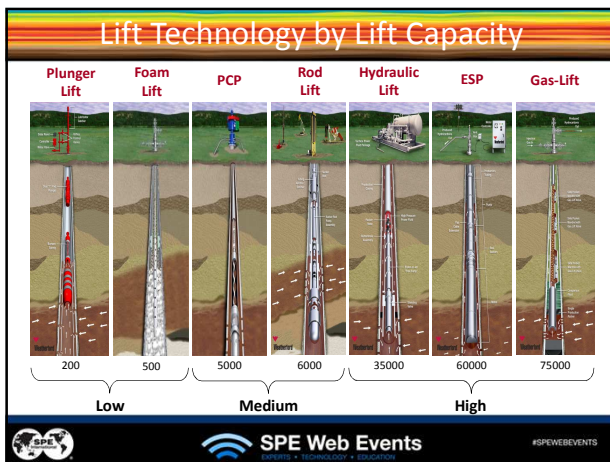


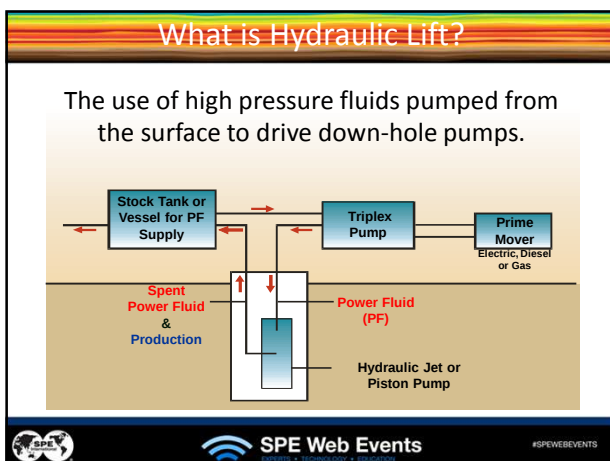




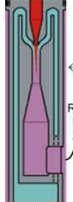








What Type of Downhole Pumps?



Hydraulic **Jet** Pumps

Two types of downhole hydraulic pumps

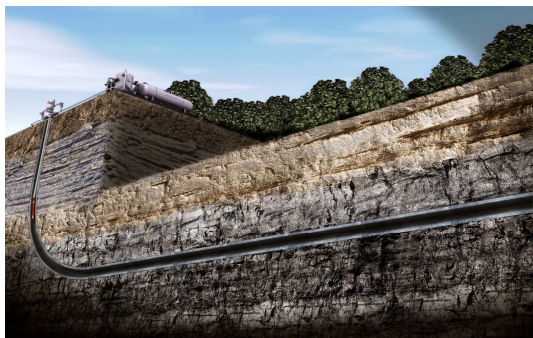
→ Hydraulic **Piston** Pumps

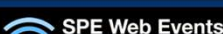




#SPEWEBEVENTS

Horizontal Wells (Jet or Piston)





#SPEWEBEVENTS

Hydraulic Jet Pump Animation





Weatherford

Hydraulic Lift Systems



#SPEWEBEVENTS

Free Pump Operation

Pump-Off: When the handle is in the down position, high-pressure power fluid from the injector or multiple power pump circulates the "free" hydraulic pump down the tubing to the bottom of the well.

Operate: The power fluid begins to operate the pump once it's seated at the standing valve. Produced fluid and the trapped power fluid then return up the casing annulus through the valve and lift the flow line.

Pump-Out: With the selector handle in the up position, power fluid is directed down the casing annulus and returned up the tubing. After the pump and the fluid flows back to the surface.

Bypass, Bleed and Pump Removal: The power fluid bypass valve is opened and the selector handle is placed in mid position. This permits the well to be bled down and the pump to be removed and replaced.

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How The Jet Pump Works

The diagram illustrates the flow characteristics of a jet pump. Power fluid (red) is injected into the nozzle, creating a high-velocity core. This core entrains secondary flow (grey) from the casing annulus. The mixture of power and secondary fluid is labeled as mixed flow. The flow then passes through the throat and into the diffuser, where the pressure is recovered. Key parameters shown are Power Fluid pressure (P_n), Power Fluid flow rate (Q_n), Secondary Flow pressure (P_s), Secondary Flow flow rate (Q_s), and Discharge pressure (P_d) and flow rate (Q_d).

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How The Jet Pump Works

This diagram shows the pressure and velocity profiles of the power fluid (red dashed line) and secondary flow (grey dashed line) as they move through the nozzle, throat, and diffuser. The power fluid pressure drops sharply in the nozzle and throat, then rises in the diffuser. The secondary flow pressure remains relatively constant. The power fluid velocity is highest in the nozzle and throat, then drops in the diffuser. The discharge pressure (P_d) is shown at the end of the diffuser.

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Hydraulic Jet Pump Advantages

- Diversity of applications
- High volume
- Run and retrieve by circulation or wireline
- Deviated wells
- No rods in tubing (no rod/tubing wear)
- Works extremely well with solids, corrosive fluids, and high temperatures
- No moving parts downhole (no mechanical wear)



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Hydraulic Jet Pump Limitations

- Low efficiency
- Requires a high pressure surface line for the power fluid
- Cannot “pump-off” a well



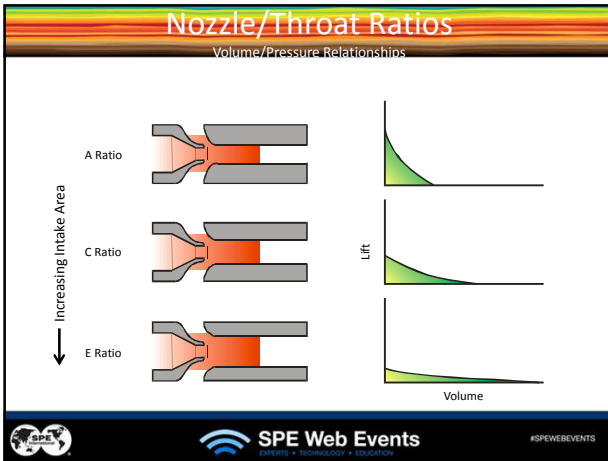
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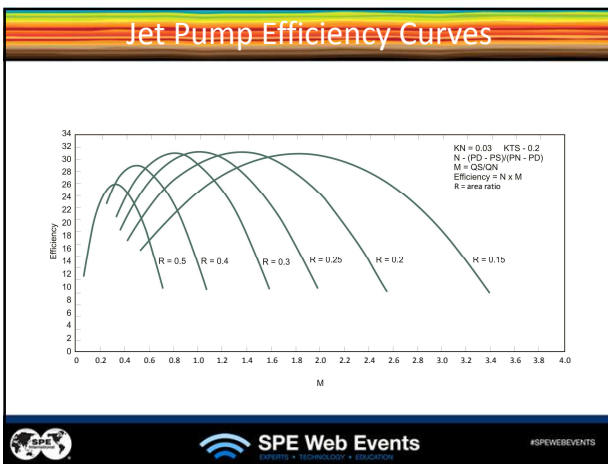
Jet Lift Application Considerations

	Typical Installations	Current Maximums*
Operating Depth	5,000 to 10,000' TVD	20,000' TVD
Operating Volume	300 to 1,000 BPD	>35,000 BPD
Operating Temperature	100° to 250°F	500°F
Wellbore Deviation	0 to 20° Hole Angle	0 to 90° Pump Placement <45°/100' Build Angle
Corrosion Handling		Excellent
Gas Handling		Good
Solids Handling		Good
Fluid Gravity		≥6° API
Servicing		Hydraulic or Wireline
Prime Mover Type		Multi-cylinder or Electric
Offshore Application		Excellent
System Efficiency		10% to 30%



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Jet Pump Applications

- The well has stopped flowing
- De-watering gas wells (usually a coiled tubing jet)
- To boost production from wells
- When an existing gas-lift well is proving cost prohibitive (i.e. the gas is depleting)
- When the casing is no longer a viable fluid flow conduit (parallel/concentric installation required)

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Jet Pump Subsurface Equipment

15/16" DHJP



2.5" DHJP



7" DHJP



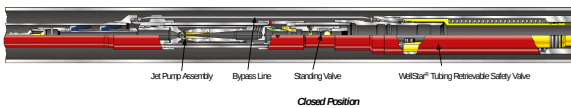
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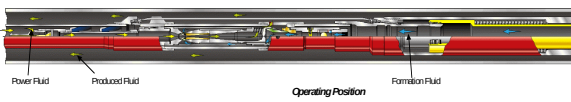
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Jet Pump / Tubing-Retrievable SSSV System

(China)



← Tubing To Surface



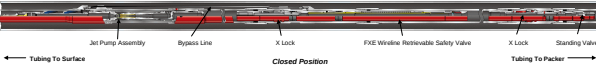
Power Fluid Produced Fluid Formation Fluid Operating Position

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Jet Pump / Wireline-Retrievable SSSV System

(Egypt)



← Tubing To Surface Tubing To Packer →

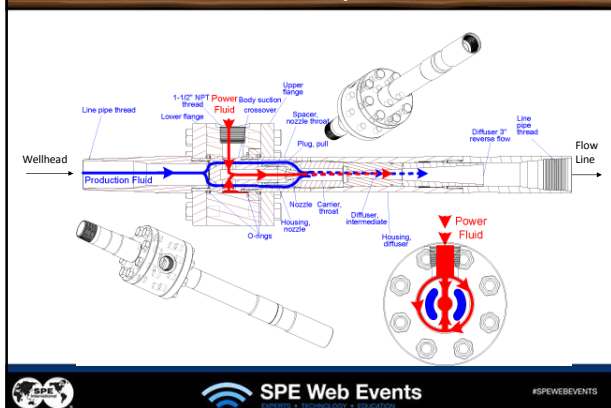


Power Fluid Produced Fluid Formation Fluid Operating Position

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Surface Jet Pump Installation



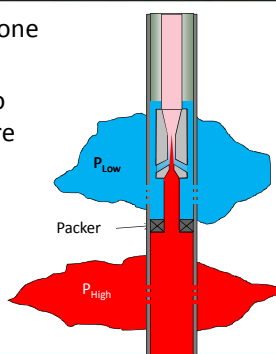
Jet Pumps for Frac Flow-back

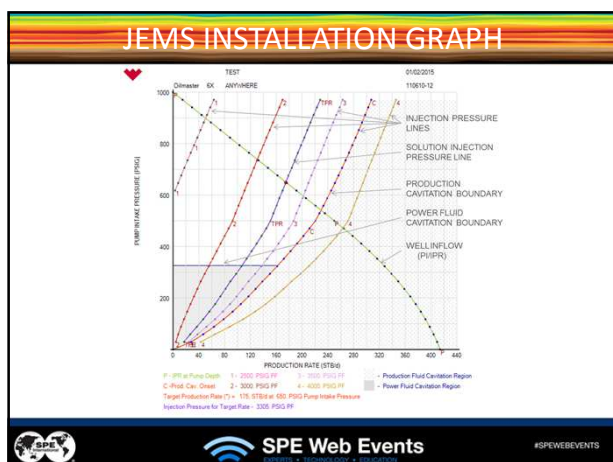
- Freestyle pump and portable surface unit
- 80% faster fluid recovery versus nitrogen and swabbing
 - 1 to 3 days for small frac volumes
 - 1 to 3 weeks for larger frac volumes > 15,000 BPD



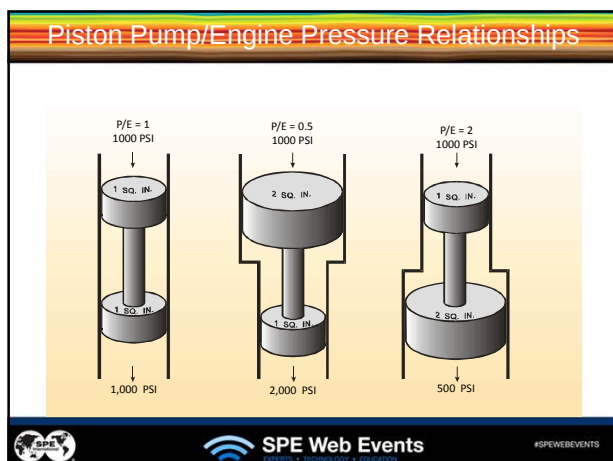
Formation Powered Jet Pump

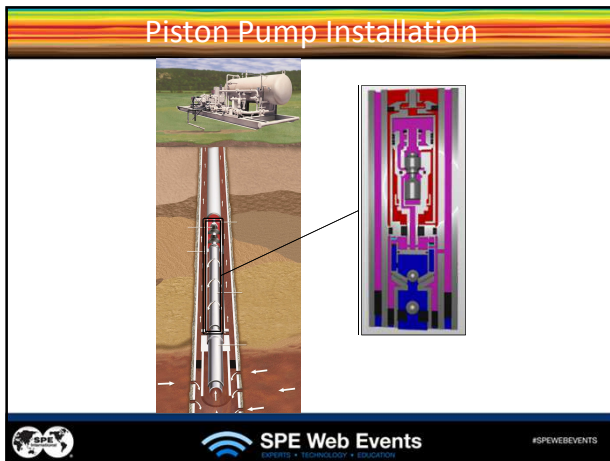
High pressure liquid from one zone...
...can be the *power fluid* to produce a lower pressure zone.

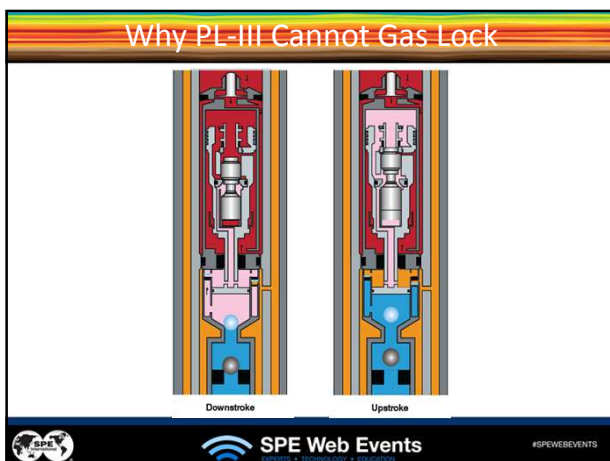


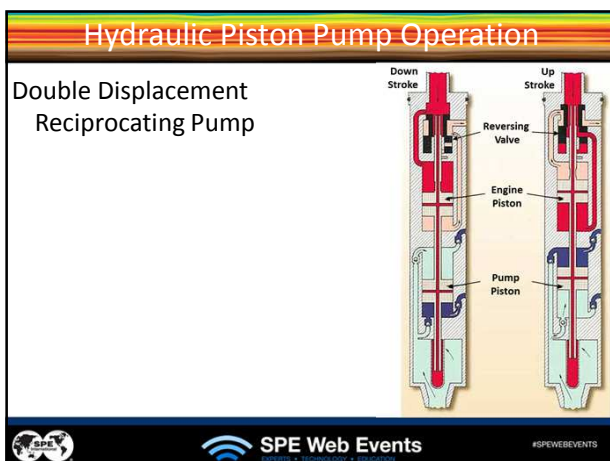






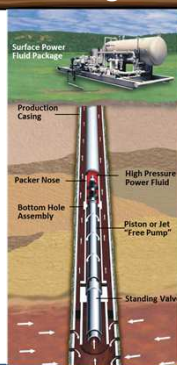






Hydraulic Piston Lift System Advantages

- Retrievable by circulation or wireline
- Positive displacement – strong drawdown
- Double-acting efficiency
- Good depth/volume capability to over 15,000 ft.
- Deviated wells
- Multi-well production from single surface package
- No rods in tubing



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Heavy Oil Production and Hydraulic Pumps



Horse statuette presented to Dresser Guiberson (now Weatherford) was carved from heavy crude production in Liao-He Oilfield in China.

Hydraulic pumps using heated power fluid enables production of the field.

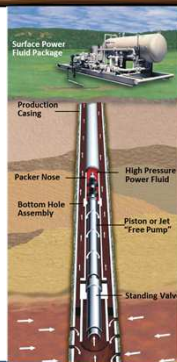


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Hydraulic Piston Lift System Limitations

- Solids
- Free gas (volumetric efficiency)
- Volume ≤ 1000 BPD
- Requires service facilities
- Requires high-pressure surface system

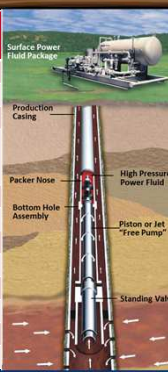


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Hydraulic Piston Lift Application Considerations

	Typical Piston Pump Installations	Current Piston Pump Maximums*
Operating Depth	7,500 to 10,000' TVD	17,000' TVD
Operating Volume	50 to 500 BPD	4,000 BPD
Operating Temperature	100°F to 250°F	500°F
Wellbore Deviation	0 to 90° Landed Pump	0 to 90° Pump Placement < 25°/100' Build Angle (Depending on Pump)
Corrosion Handling		Good
Gas Handling		Excellent (PL-III)
Solids Handling		Poor
Fluid Gravity		+/- 8° API
Servicing		Hydraulic or Wireline
Prime Mover Type		Multi-cylinder or Electric
Offshore Application		Good
System Efficiency		40% to 50% *Several analysis required



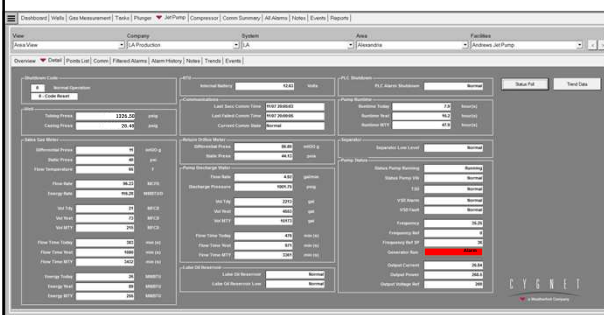
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HSE Arrangements



Electronics ESD **Mechanical Safety Relief**

Jet/Piston Lift Surveillance



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