



Jet Drilling Tool Update

Presentation for
Microhole II Integration Meeting
November 16, 2005

Update and Milestones



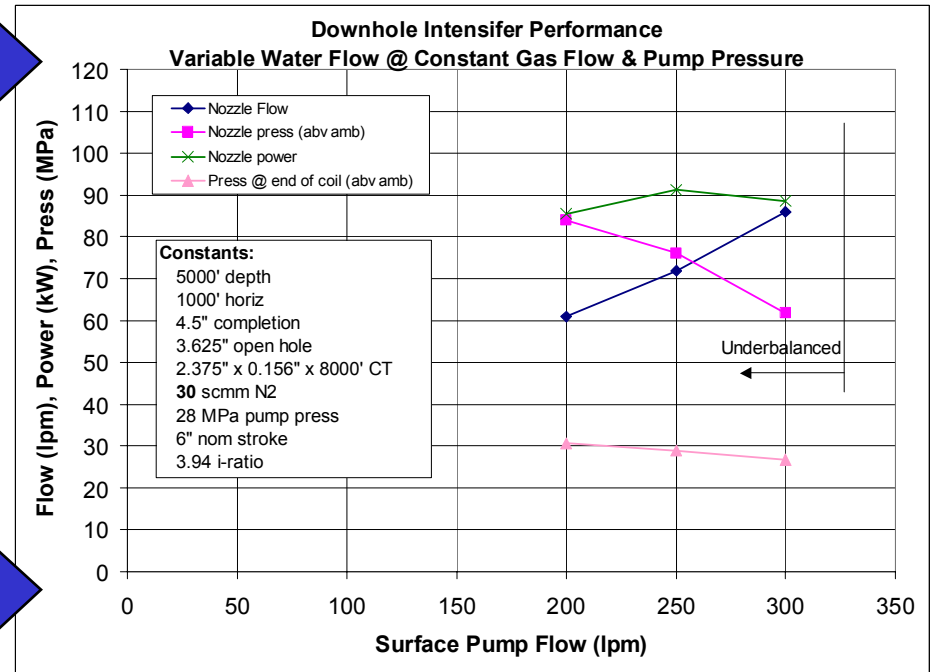
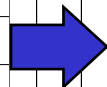
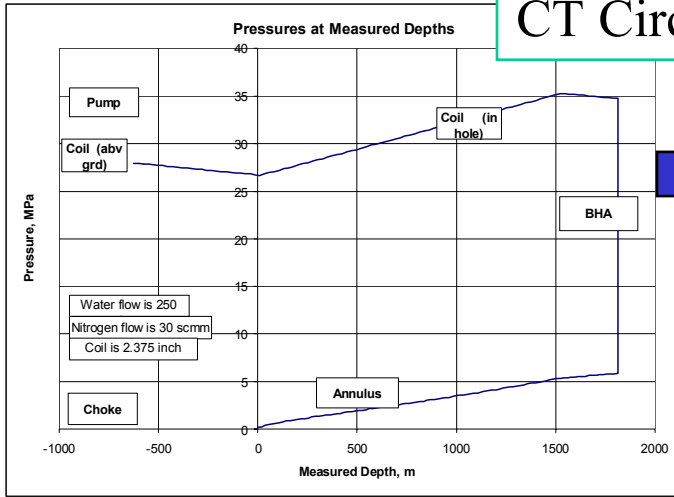
- ◆ **Microhole Tool Configuration**
 - Focus on jet drilling short radius holes
 - Completed system analysis and specifications
- ◆ **Downhole Intensifier / Jet Drill**
 - Completed initial tests of 2-1/8” prototype
 - Completed preliminary mechanical design of 2-3/4” intensifier
 - Completed preliminary design of 3-5/8” jet drill
- ◆ **Gas Separator**
 - Completed testing of 1-11/16” prototype
 - Sized 2-3/8” tool
 - Standalone application for PDMs
- ◆ **Future Milestones**

Microhole Tool Configuration

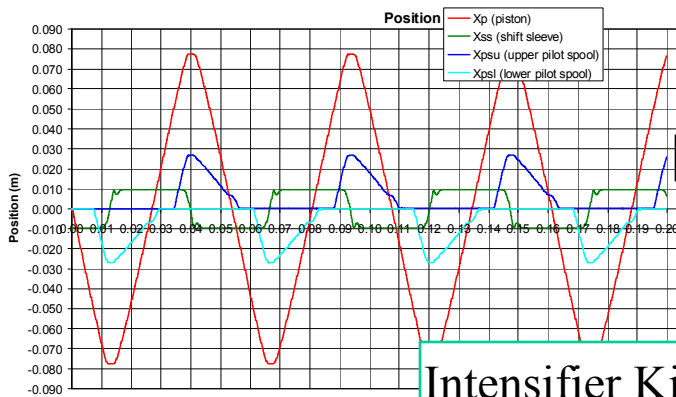
- ◆ Focus on jet drilling tools
 - Unique capability for ultra-short radius drilling
 - Immediate commercial applications for thru-tubing milling
- ◆ Integrate gas separator with PDM
 - Immediate commercial application for UBD
- ◆ Delay mechanically-assisted jet drill
 - High-pressure PDM requires significant bearing and seal development
 - Lower market potential for integrated BHA because of complexity, length and limited steerability

Jet Drilling System Modeling

CT Circulation Model



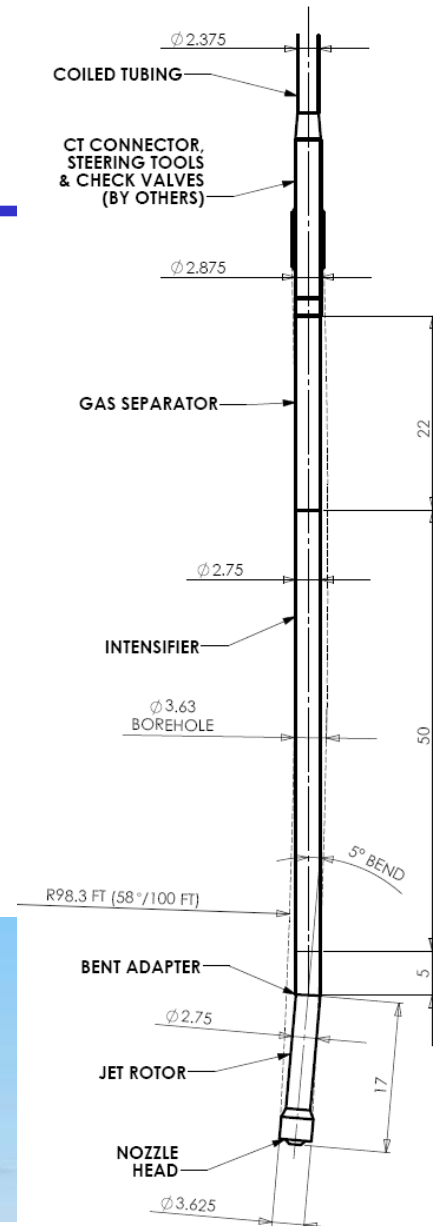
System Optimization



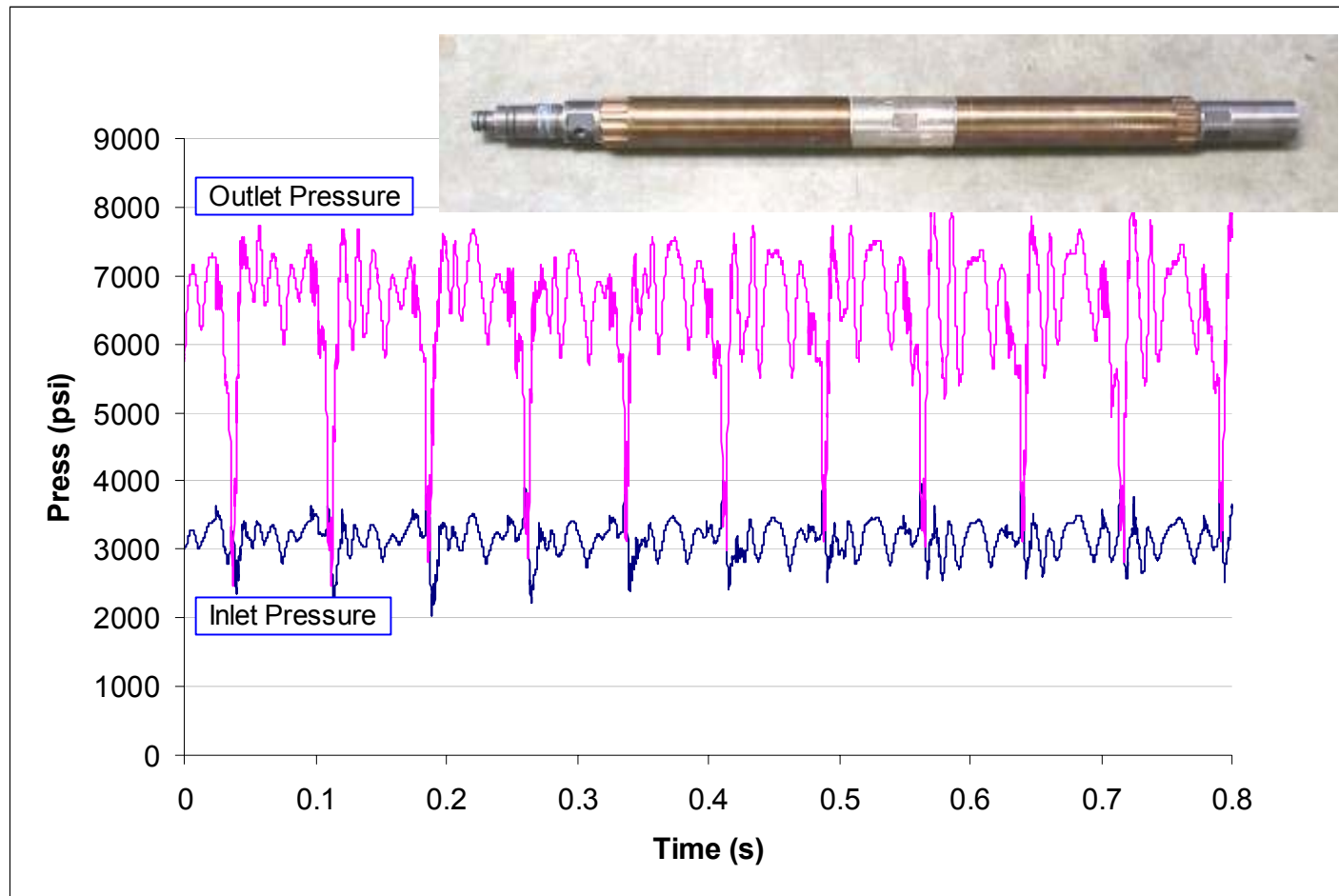
Intensifier Kinetic Model

Jet Drilling BHA

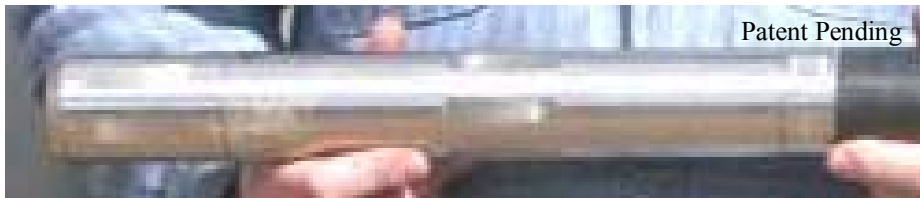
- ◆ Gas Separator / Intensifier / Jet Drill
 - Zero thrust, zero torque drilling
 - No mechanical vibration
 - Compact BHA /ultra-short radius (60°/100 ft) curves
 - 250 lpm water, 30 scmm N2 max
 - 28 MPa pump, 77 MPa jets
 - 90 kW hhp jets on 2-3/8” coil
 - 3-5/8” hole diameter



2-1/8" Intensifier Testing

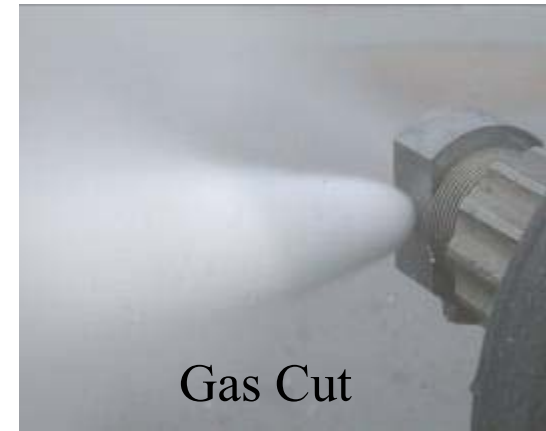


Compact CT Gas Separator



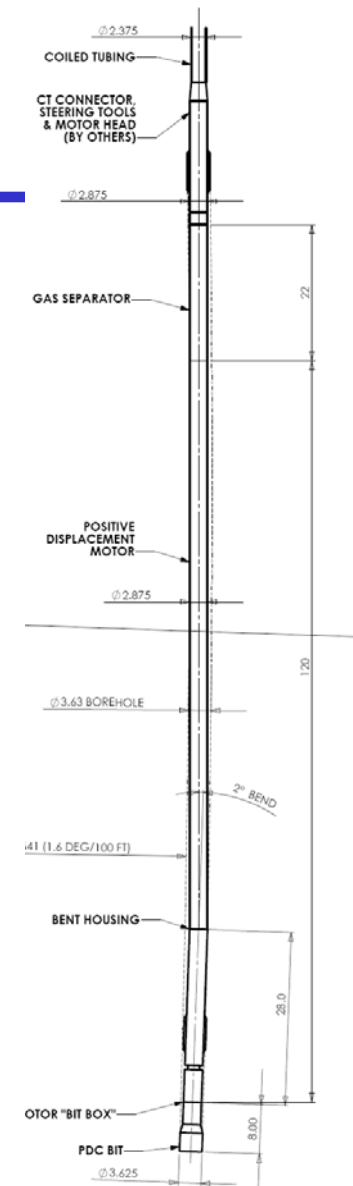
- ◆ Improves jetting performance
 - Gas shrouding increases jet range
 - Increased pressure differential at tool
 - Underbalanced jetting prevents formation damage
- ◆ 1-11/16”-inch Prototype
 - High efficiency rotary gas separator
 - 1-11/16” to 2-1/8” PDM, jet rotor or intensifier
 - 50-150 lpm water / 10-25 scmm nitrogen
 - Completed full scale yard tests
 - < 1% gas cut from co-mingled water & nitrogen
 - Field testing planned this year
- ◆ 2-3/8” Microhole Version
 - 2-3/8” to 2-7/8” PDM, jet rotor or intensifier
 - 100 - 450 lpm water / 12 - 45 scmm nitrogen

Prototype Tests



Gas Separator/PDM

- ◆ Poor PDM performance on two-phase flow
 - Gas severely limits differential pressure and reduces torque capacity
 - High vibration levels due to poor torque curve and lack of hydraulic dampening
- ◆ Separated flow
 - Over 99% of gas discharged above motor
 - Could be run above MWD tools
 - Water-only restores torque capacity to multistage motors
 - Water around bit and motor restores hydraulic dampening – reduces BHA vibration
 - Efficient motor operation with good hole cleaning



Milestones

Task Name	2005				2006				200
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
Phase 1 - Prototype Design & Yard Test	■				■				
Define operating parameters			■	8/31					
Prototype Tool Ready to test					■	2/8			
Complete Phase I Prototype Bench Testing					■	4/6			
DOE Decision Point						■	6/1		
Phase 2 - Downhole Test						■			
Phase II tools ready for field testing								■	9/28
Complete Phase II field tests								■	11/9