

# Continuous Mud Monitoring

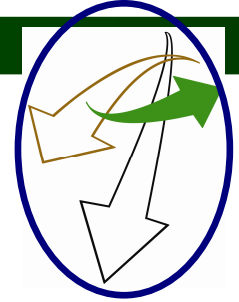
## Adding Value to the Drilling Operation



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AADE FMG Meeting Presentation, November 17th 2010

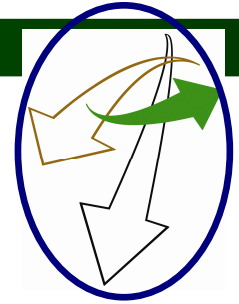
# Continuous Mud Monitoring



## ➤ Agenda:

- The What, How and Why of Current Mud Monitoring
- The Pros and Cons of the Current Monitoring Approach
- Technology Description
- Field Results
- Potential Identification of Incipient Loss Time events
- Additional Measurements to further Enhance the value of Continuous Mud Monitoring

# Current Mud Monitoring Approaches

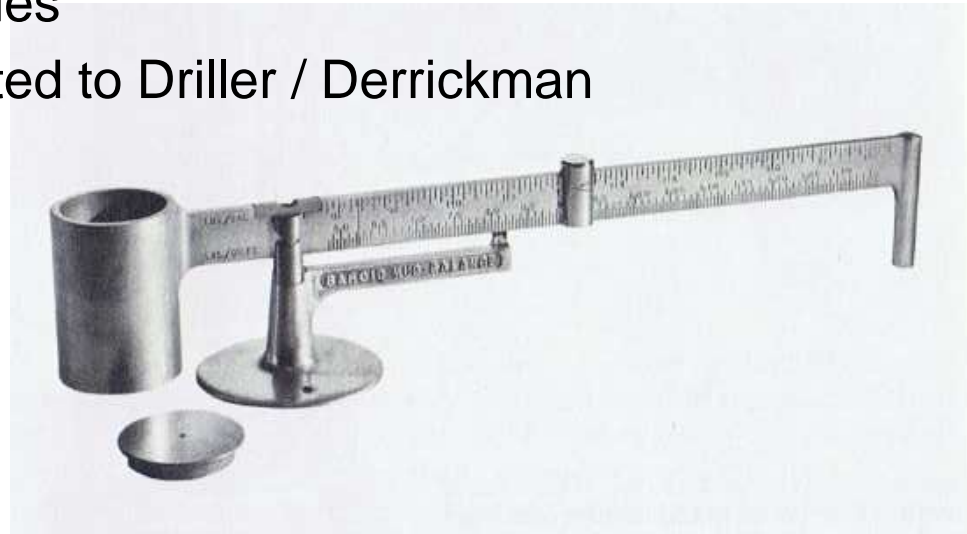


- Full Physical & Chemical Evaluation of the Mud System every 6 to 8 hrs whilst Circulating.
- The Measurement of Mud Density and Funnel Viscosity, normally taken every 15 to 30 minutes, sometimes, more frequently during critical stages of the Well.

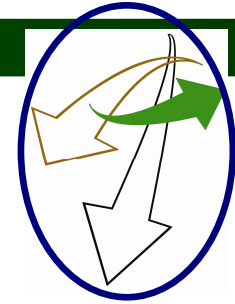
# Current Situation (1)

## ➤ Drilling Fluid Density is Manually Monitored using a Mud Balance:

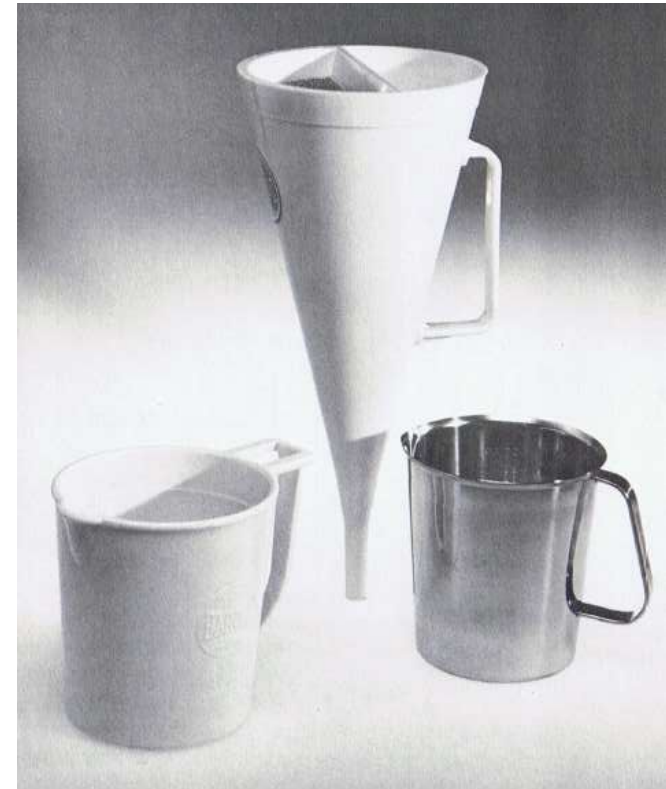
- Periodic Testing (15 to 30 minute intervals)
- Potential for User Errors, Especially with Pressurised Mud Balance
- Manual Sampling of the Drilling Fluid / Brine
- Occupational Hygiene Issues
- Data Verbally Communicated to Driller / Derrickman
- Data Recorded Manually



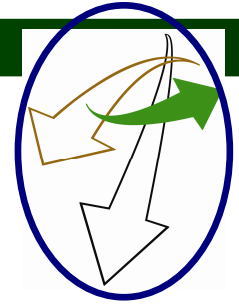
## Current Situation (2)



- Drilling Fluid Viscosity is Characterised using a Marsh Funnel:
  - Method developed by H.N.Marsh and published in 1931.
  - Not a True Measure of Viscosity
  - Periodic Testing (15 to 30 minute intervals)
  - Requires Manual Sampling of the Drilling Fluid / Brine
  - Occupational Hygiene Issues
  - Data Recorded Manually
  - Data Verbally Communicated to Driller / Derrickman



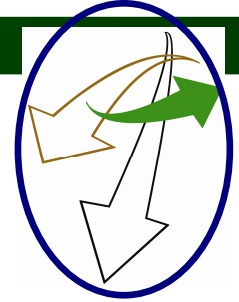
# Monitoring Justification



The objective of the current Mud Monitoring programme is to generate frequent measurements of Key Drilling Mud parameters so as to identify whether the trend over time is one of stability or change.

The justification for the monitoring is that it provides an early warning of changes that may indicate developing bore-hole or drilling mud problems that warrant short term action or further detailed examination.

# Pros & Cons of Current Methodology



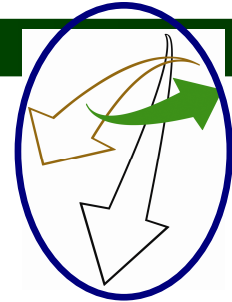
## ➤ Pros:

- Easy Measurements to take
- Measurements do not required dedicated / specialist Engineers.
- Parameters widely 'understood'

## ➤ Cons:

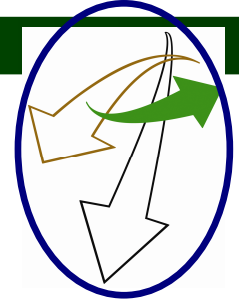
- Limited frequency of Readings will miss localised abnormalities in the Mud and limit the ability to respond in a timely fashion.
- Limited access to the Data
- Limited recourse to historical data

# Design Envelope for a Monitoring Instrumentation Package



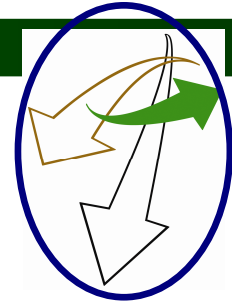
- Continuously monitor the Drilling Fluid Density & Funnel Viscosity.
- Is Accurate, Reliable, and Easy to Operate, Calibrate, Service & Maintain.
- Export the Readings to the Mud Loggers or Rig Data Acquisition System
- Reduce Rig Crew Exposure to the Noise and Fumes within the Shaker House and Contact with the Mud.
- Has No requirement for dedicated / specialist Service Engineers.
- Is Operated & Maintained by Existing Rig Crews.
- Releases Rig Crews for more Productive Tasks.

# Instrument Technology Selection



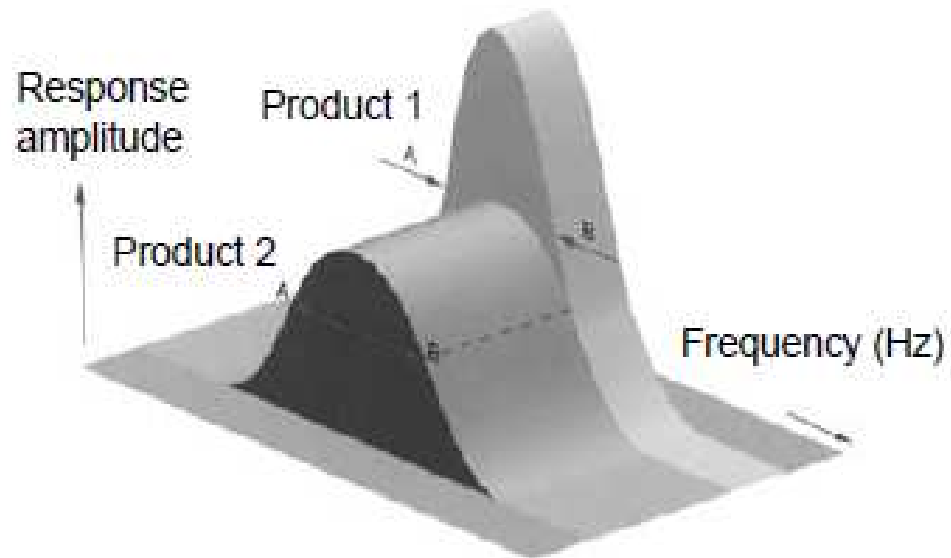
- Viscosity:
  - Rotational Viscometers
  - Pipe Viscometers
  - Standing Wave Behaviour in a liquid medium.
  
- Density:
  - Coriolis Meters
  - Vibrating Element Technology
  - Flootation devices
  - Radioactive Sensors
  - Oscillating U-Tubes
  - Standing Wave Behaviour in a liquid medium.

# Viscosity / Density Instrumentation



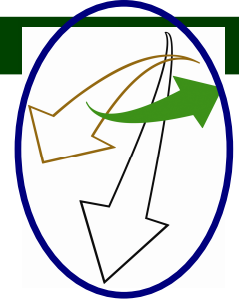
## Principle of Operation

The sensor is a simple tuning fork maintained in vibration electronically. The density is a function of the resonant frequency, the viscosity is a function of the bandwidth.

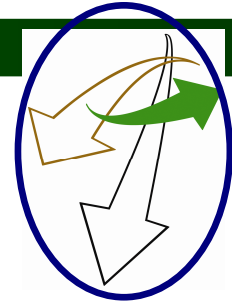


Product 1: Low viscosity  
Product 2: High viscosity

# Critical Success Factors



- Zone 1 Compliant Design
- Continuous and Consistent Laminar Flow through Sample Chamber.
- Back Pressure on Sample Chamber to Simulate Pressurised Mud Balance Density Measurements.
- Ability to Export Data
- Reliable and Robust
- Capable of being Operated, Calibrated, Maintained and Repaired by existing Crew members.



# The Mud Watcher

## Instrument Monitoring

Sample Chamber Pressure

Pump Pressure

Air Delivery Pressure

## Local Controls

Power Switch

Emergency Air Cut-off

Air Regulator



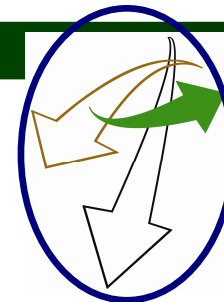
Local Displays

'Funnel' Viscosity

Density

Test Temperature

# Left & Right Side Access Ports

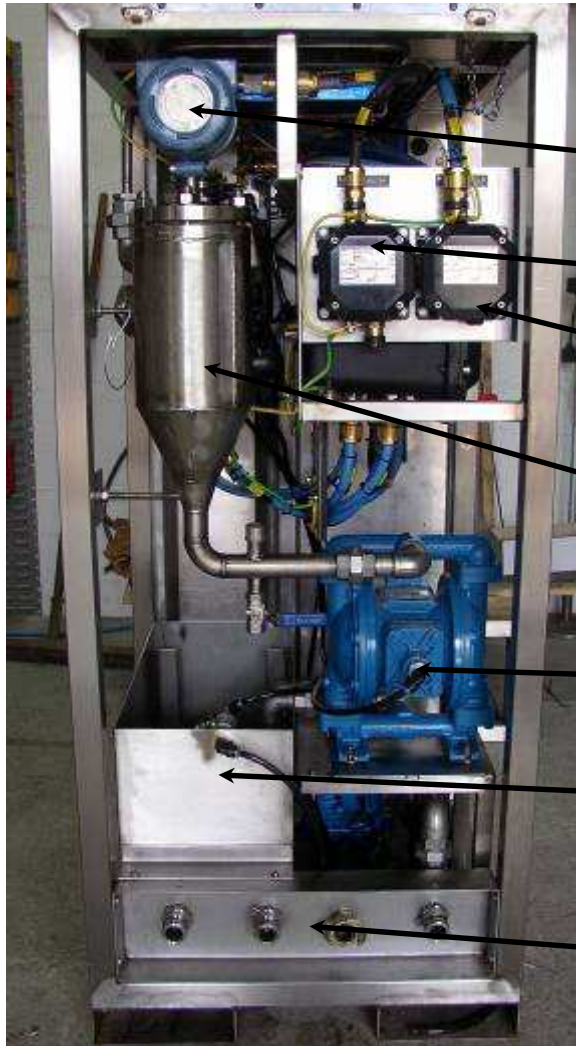
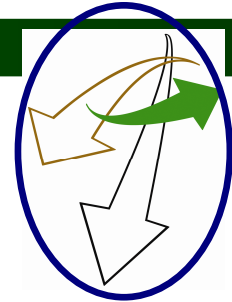


Calibration  
Potentiometers



Back Pressure  
Choke Valve

# Mud-Watcher - Rear View



Note: Rear Panel Removed for Access

Density / Viscosity Instrument

Explosion Proof Power Supply Unit

Intrinsically Safe Data Output Junction Box

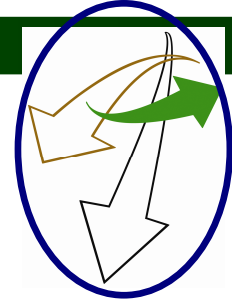
Sample Chamber

Air Diaphragm Pump

Drilling Fluid Reservoir Tank

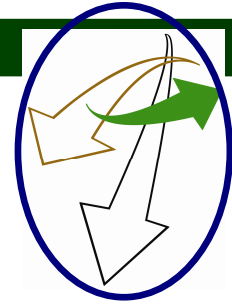
Rear Entry Suction, Discharge ,  
Overflow and Air Supply Connections

# Instrument Readings



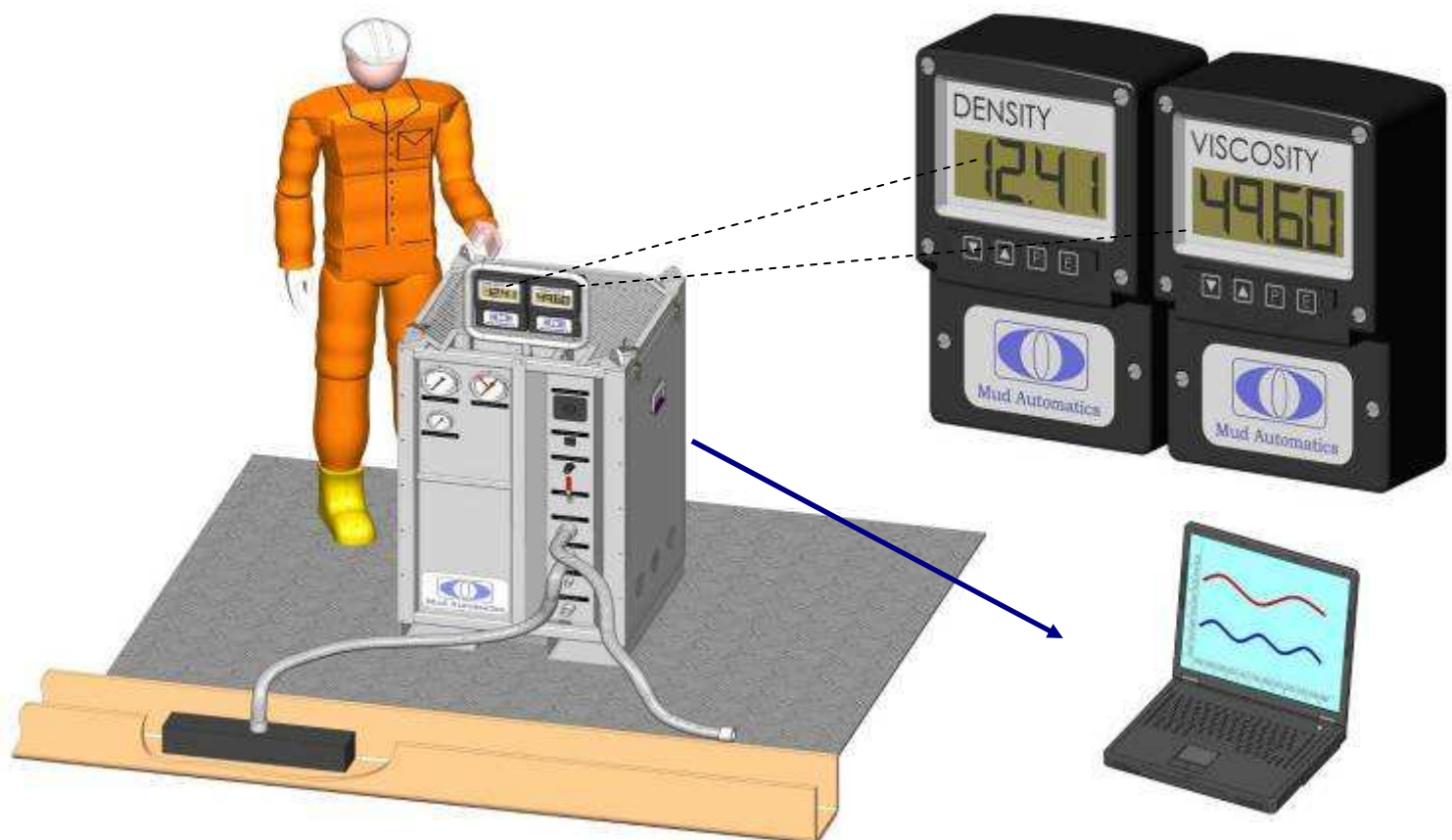
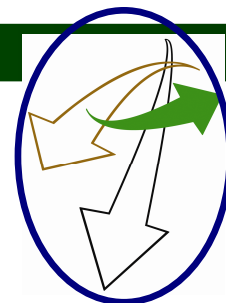
- Density is an Absolute Reading which can be Displayed in any Desired Units
- Viscosity Reading is a Dynamic Value normally measured in Centi-Stokes and is a Function of the Shear-rate in the Sample Chamber.
- Viscosity Display is Normally in 'Funnel Vis' equivalent Seconds. Alternatively, the viscosity can be reported as Centi-Poise or Centi-Stokes.
- The Correlation between Centi-stokes and Funnel Vis is non-linear, so the Reading has to be initially Calibrated to match the known Measurement using a standard Marsh Funnel.
- Further Calibration is only required if the Drilling Fluid properties change substantially e.g. significantly increasing the Drilling Fluid Density or a major conditioning treatment is carried out.

# Mud-Watcher Display

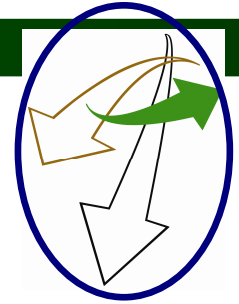


- Back-lit Display Ensures High Visibility even from a Distance
- Intrinsically Safe, Rugged Design
- Folds Back into Mud Watcher Unit for Transportation
- Remote Mounting Capability

# Installation Schematic

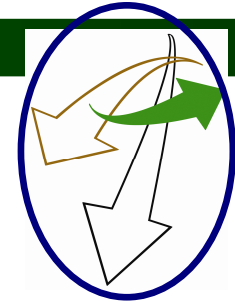


# Specification / Utilities



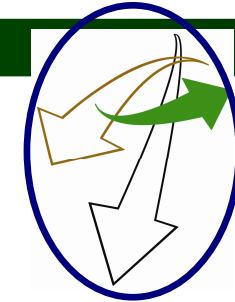
- Certified for Zone 1 Operating Environment
- 85 / 264 volt; 50 / 60 Hz Electrical Supply; 2 amp Current
- 100 - 120 psi (7 to 8.5 bar) Rig Air Supply; 20 to 50 scf/m
- Flexible or Hard Piped 1" Suction & Discharge Hoses
  
- Weight 400 Kg approx.
- Manoeuvred through use of a Forklift or Block & Tackle
- Dimensions 620 mm x 623 mm Footprint; 1,480 mm High (1,760 mm to top of Display unit)

# UKCS Operation – 12 ¼” Section



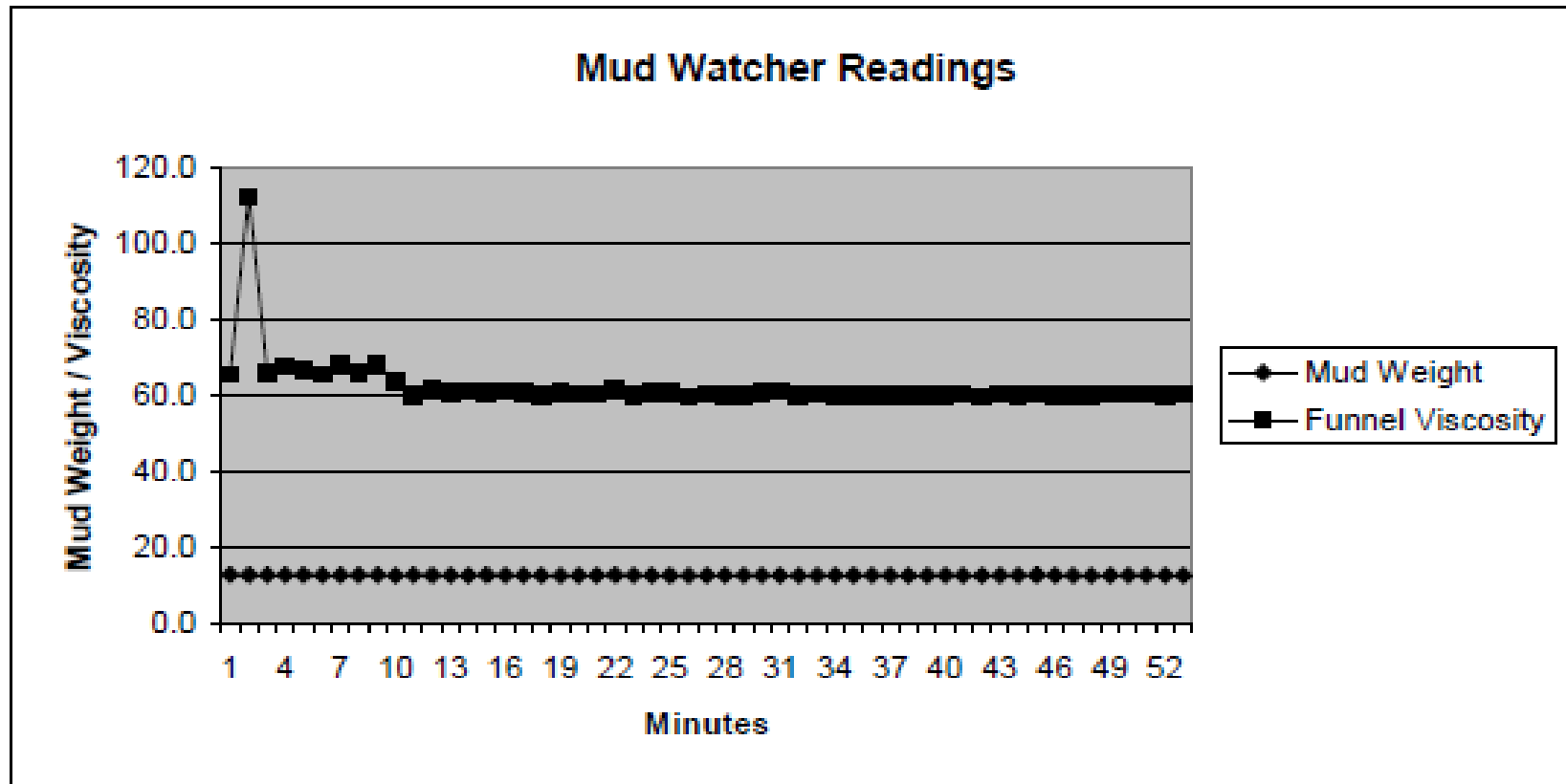
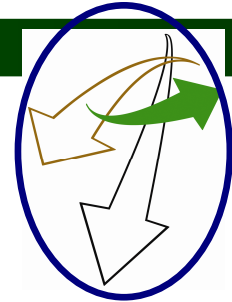
Operation		Drilling from 3,317 ft to 6,373 ft						
Date		30/01/2010		31/01/2010			01/02/2010	
Time		13:30	20:00	02:00	12:30	20:00	02:00	13:00
Depth		3,364	3,720	3,953	4,487	5,021	5,483	6,325
Sample		Pit 3	Pit 3	Pit 3	Pit 3	Pit 3	Pit 3	Pit 3
<b>Manual M.Weight (ppg)</b>		12.6	12.6	12.5	12.5	12.5	12.5	12.5
<b>M.Watcher M.Weight (ppg)</b>	Max	12.6	12.6	12.6	12.5	12.6	12.5	12.5
	Min	12.5	12.6	12.5	12.5	12.6	12.5	12.5
	Avg	12.6	12.6	12.6	12.5	12.6	12.5	12.5
<b>Manual F.Vis (secs)</b>		71	71	66	65	65	58	57
<b>M.Watcher F.Vis (secs)</b>	Max	70	76	81	63	69	62	62
	Min	68	67	64	63	62	62	61
	Avg	69	71	68	63	65	62	61

# UKCS Operation - 12 1/4" Section

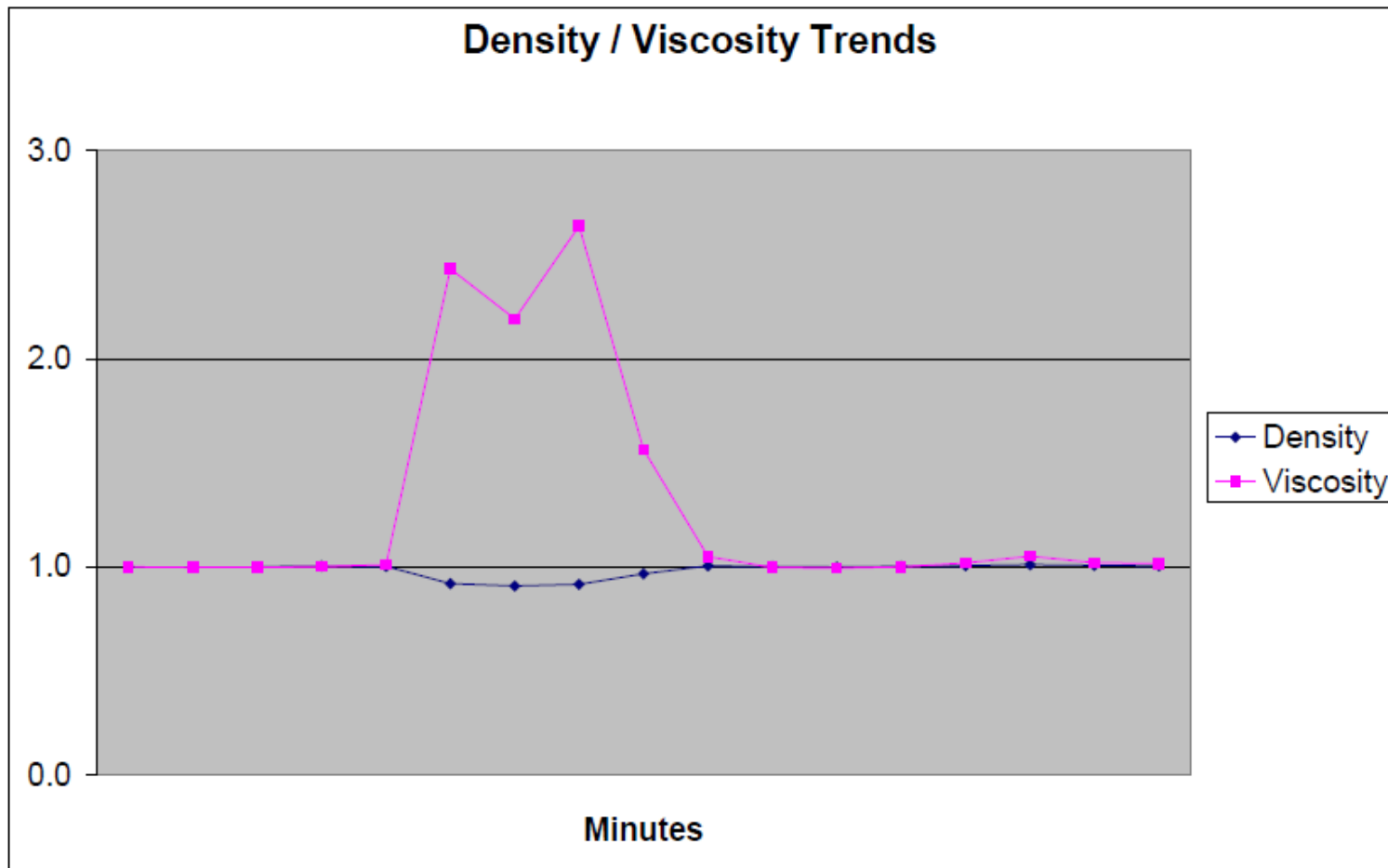
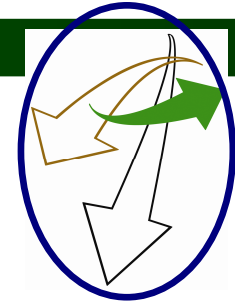


Operation		Drilling from 6,373 ft to 11,291 ft							
Date		06/02/2010		07/02/2010			08/02/2010		
Time		12:30	21:00	02:30	12:30	21:30	04:00	14:30	21:45
Depth		6,989	7,896	8,358	9,488	9,488	10,496	11,045	11,272
Sample		F.Line	F.Line	F.Line	F.Line	F.Line	F.Line	F.Line	F.Line
Manual M.Weight (ppg)		12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5
M.Watcher M.Weight (ppg)	Max	12.6	12.6	12.7	12.7	12.5	12.6	12.5	12.6
	Min	12.6	12.5	12.7	12.6	12.5	12.5	12.5	12.5
	Avg	12.6	12.5	12.7	12.6	12.5	12.6	12.5	12.5
Manual F.Vis (secs)		62	63	63	61	62	63	63	63
M.Watcher F.Vis (secs)	Max	62	61	64	67	62	64	63	64
	Min	62	60	63	60	62	63	62	61
	Avg	62	61	64	64	62	63	63	62

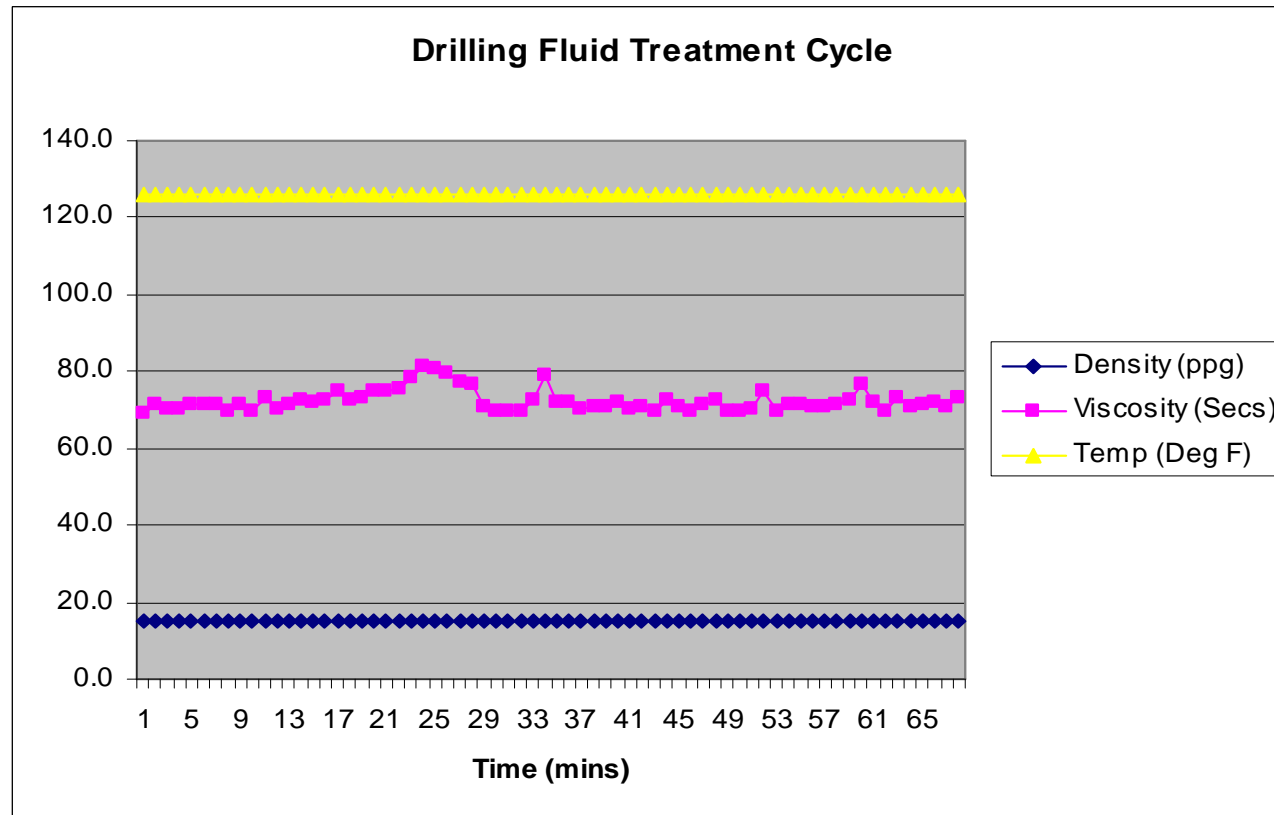
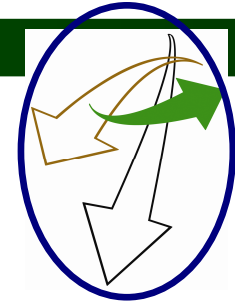
# Drilling Connection Signature



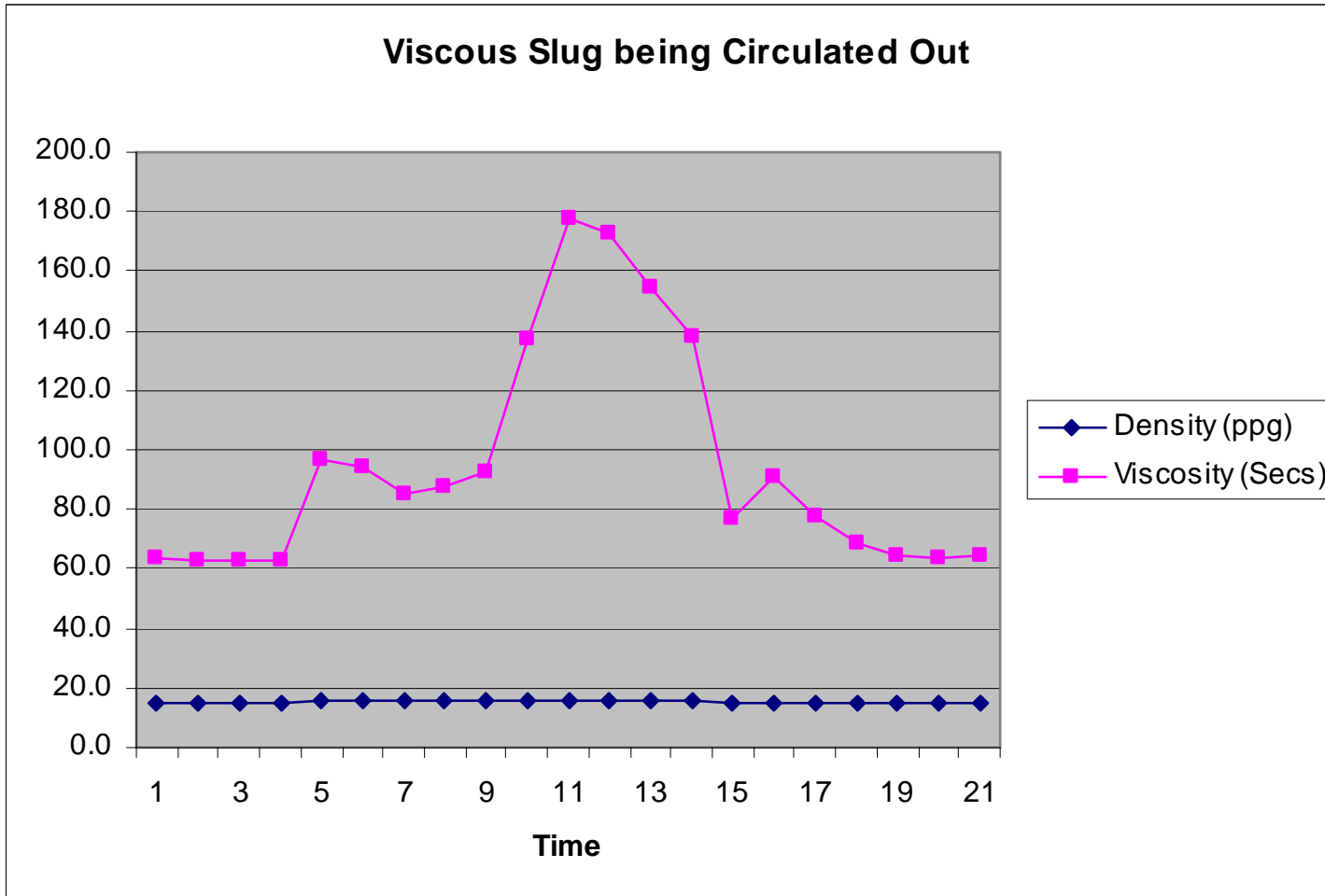
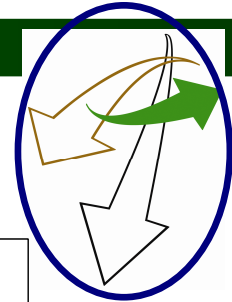
# Drilling Fluid Treatment Event



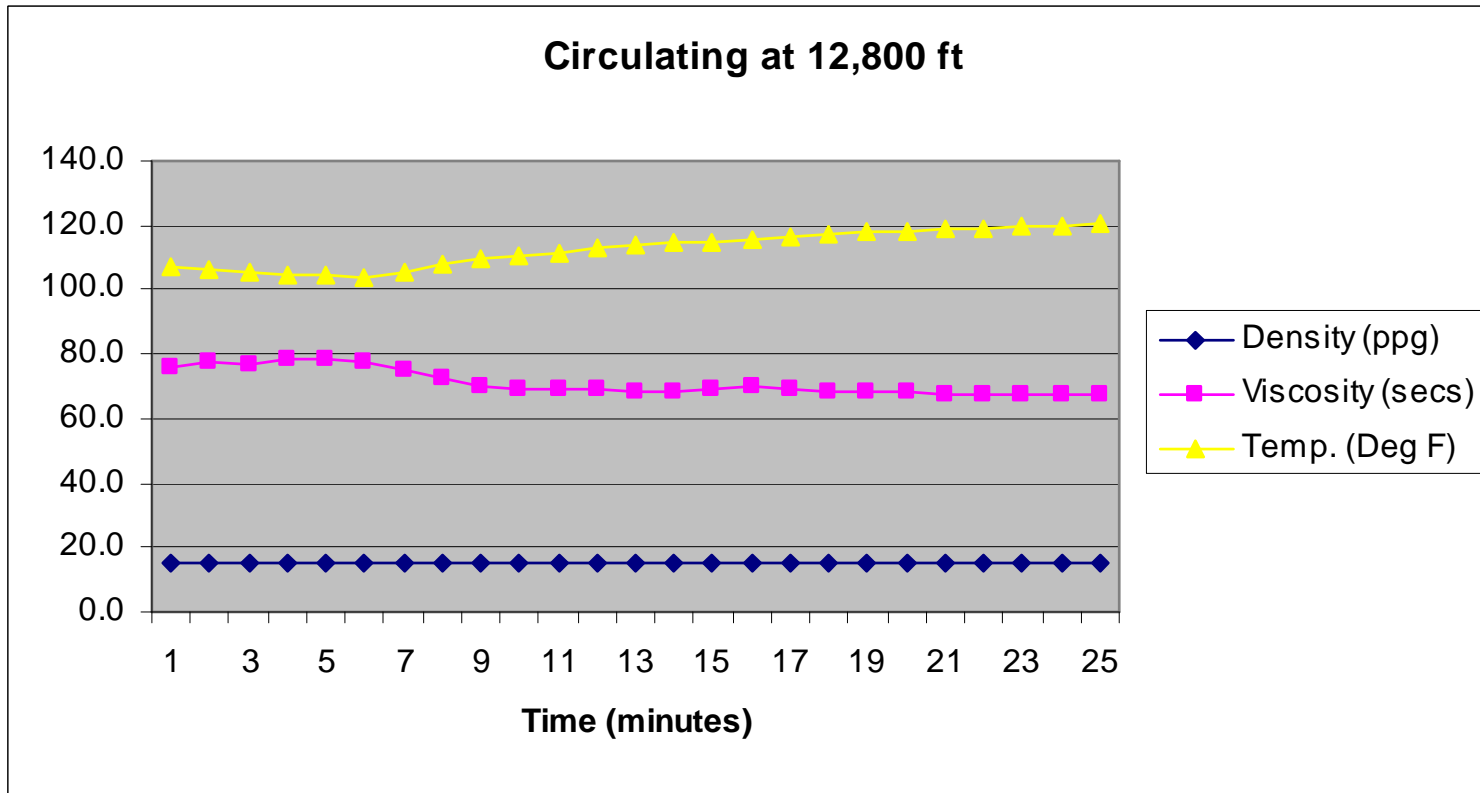
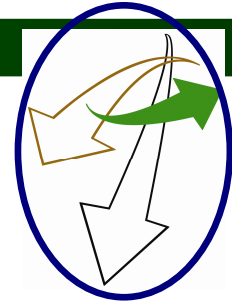
# Drilling Fluid Conditioning



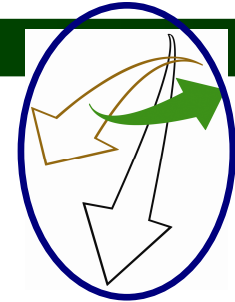
# 'Viscous Slug' Circulation



# Temperature Effects

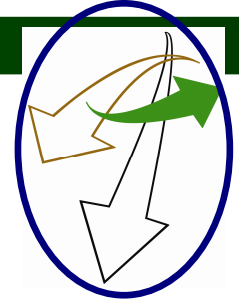


# Instrument Applications



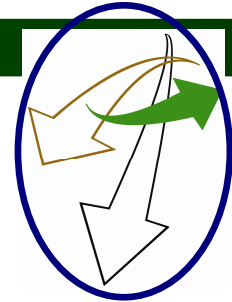
- **Monitoring of Drilling Fluid Returns:**
  - Indication of Drilling Fluid Stability from the Observed Trend Lines
  - Early Water Flow Detection
  - Early Kick Detection
  - Barytes Sag Indicator
  - Hole Volume Calculations giving Indications of developing Wash-outs, Hole Cavings & Hole Diameter Reductions
  - Direct Measurement of Hole Cleaning Efficiencies for ERD / Horizontal Well Drilling Operations.
- **Monitoring Active / Suction Pit Properties:**
  - Quality Assurance
  - Early Indication of Barytes Drop-out
  - Early Indication of Cross Contamination between Storage Pits
  - Early Indication of Inadvertent Water or Base Oil Additions
- **Quality Assurance of Cuttings Slurry for CRI Operations.**

# Additional Sensors



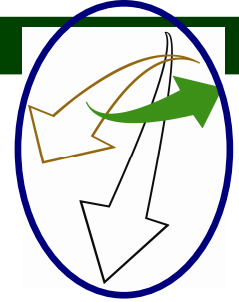
- Need to conform to the design principles of the current instrument package and demonstrably add value to the drilling operation:
  - Conductivity – WBM & Brines (Developed)
  - Electrical Stability – OBM / SOBM (in Development)
  - Detection of Oversize Particles?

# Mud Watcher – Demonstrated Capabilities



- ✓ Continuously monitors the Drilling Fluid Density & Viscosity.
- ✓ Widely Disseminates the Information by Exporting the Readings as Intrinsically Safe Analogue Signals to the Rig Data Acquisition System
- ✓ Provides an early indication of developing Hole or Drilling Fluid changes that may be precursors to drilling problems.
- ✓ Reduces Rig Crew Exposure to the Noise and Fumes within the Shaker House.
- ✓ Is Accurate, Reliable, and Easy to Operate, Service & Maintain.
- ✓ Has No requirement for dedicated / specialist Service Engineers.
- ✓ Is Operated & Maintained by Existing Rig Crews.
- ✓ Releases Rig Crews for more Productive Tasks.

# Further Information



For Further Information, Please Contact:

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