NEW ORLEANS CHAPTER
EST. 1982

Drilling-with-Casing (DwC™)

Overcoming Wellbore Stability Issues

Steve Rosenberg – U.S. Region Product Line Manager

Tuesday April 21st, 2009

Presentation Outline

- Definition and Benefits of DwC
- Drilling Hazard Mitigation Value
- DwC Hydraulics.
- DwC Systems
- Drillable DrillShoes
- Casing Drive Systems
- Liner Drilling
- Applications Engineering
- Case Histories
- Future DwC Technology

What is DwC™ Technology?

Drilling-with-Casing/Liner technology uses the casing string as the ‘drill string’ instead of drill pipe.

DwC reduces well construction costs and improves drilling efficiency.

Key Value Drivers for DwC™

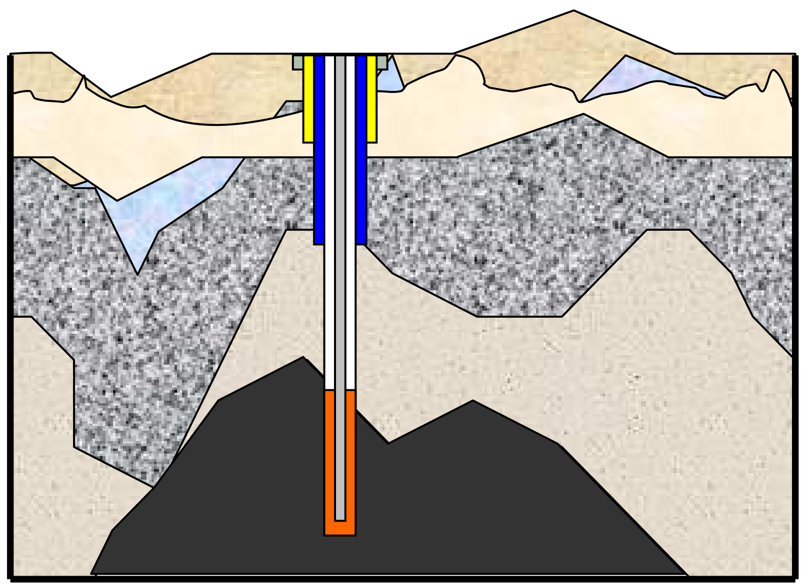
Safety

Cost/Time Reduction

Problem Resolution

DwC™ / DwL™ Benefits

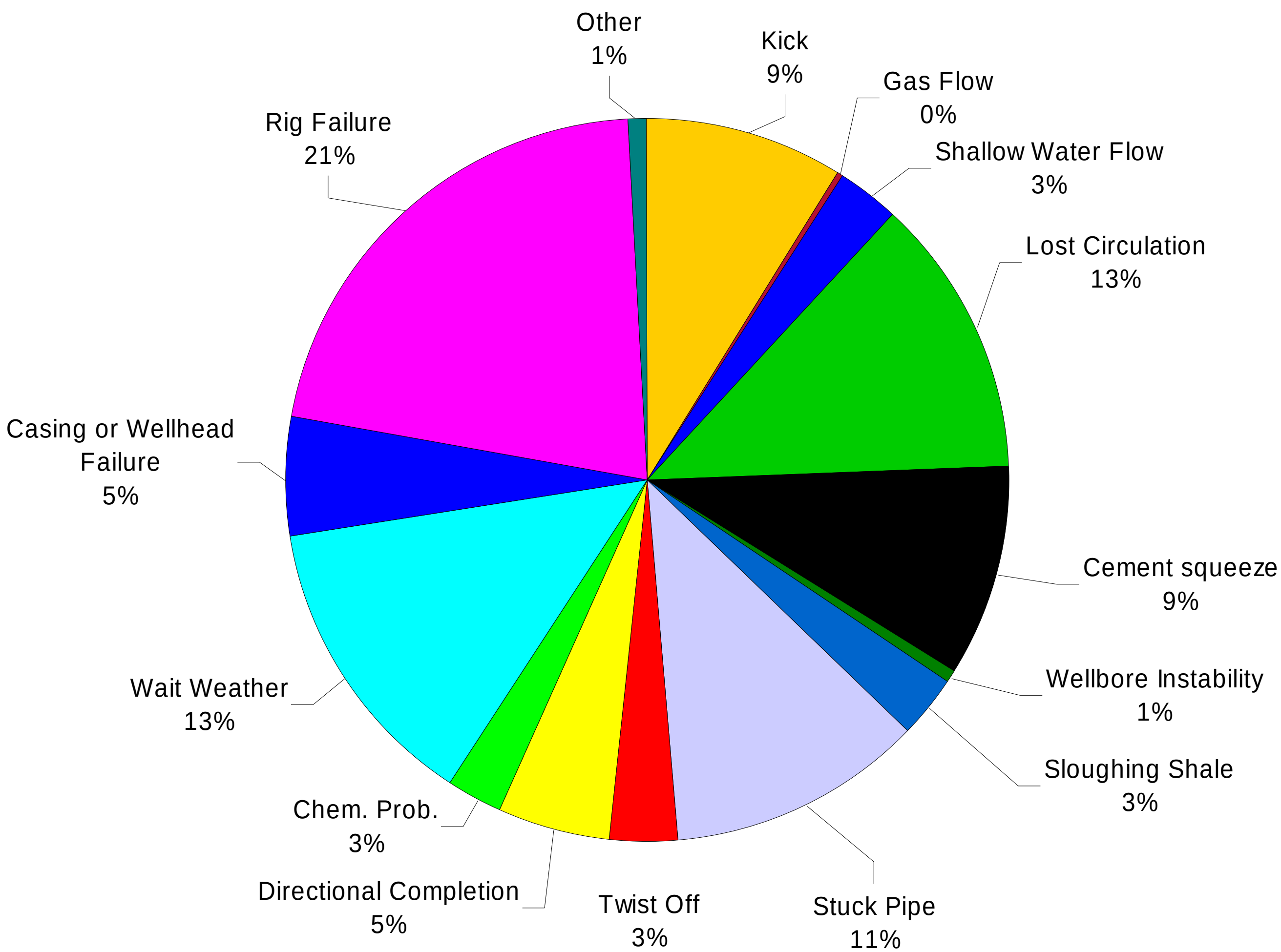
- Increased safety. Reduced trips and less handling of heavy BHA's
- Improve efficiency by eliminating flat spots in the drilling curve = Reduced Well Construction Costs
- Improved wellbore quality (less wellbore tortuosity)
- Improved hole cleaning
- Risk reduction and problem mitigation (lost circulation, unstable formations, depleted reservoir sections)
- Trip margin requirement eliminated
- Getting casing to bottom



Drilling Hazard Mitigation

Problem Incidents – GOM Shelf Gas Wells

Wellbores Drilled 1993 – 2002; Water Depth = <600 feet



Impact of Trouble Time

Drill Days Lost to Trouble Time

- 24% of 25,321 total drill days from spud date to date TD was reached

Trouble Time Cost Impact – GoM Shelf Gas Wellbores

- Deep wells average dry-hole cost per foot = $444. Average impact = $98
- ‘Shallow well average dry-hole cost per foot = $291. Average Impact = $71

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Client Value

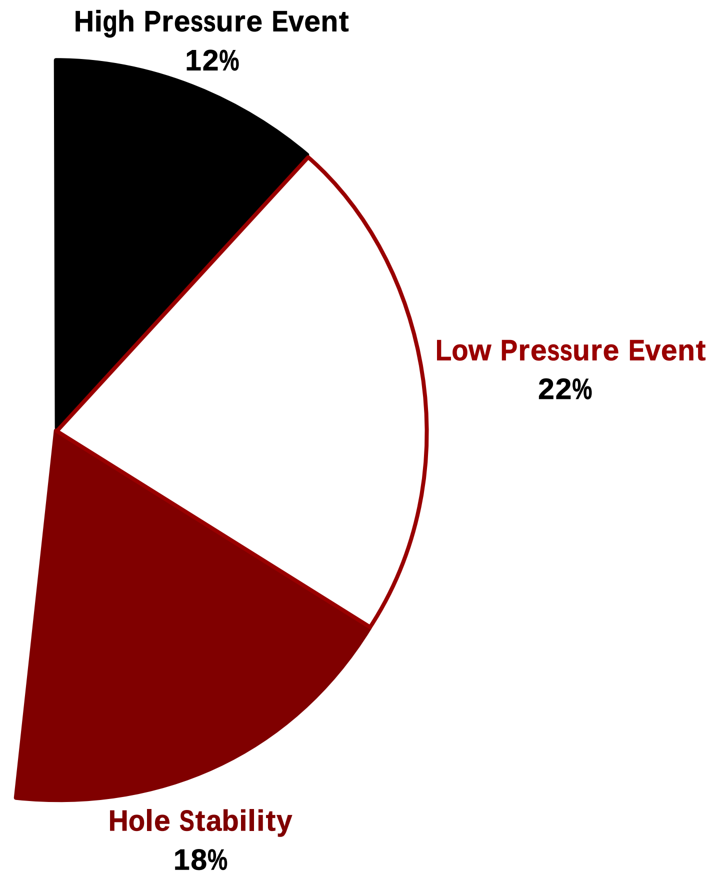
Drilling Hazard Mitigation

The Issue

- Drilling hazards add 12% to drilling time
- 50% of hazards relate to pressures and wellbore instability (pie chart to right shows a breakdown of these drilling hazards)
- As fields mature, depletion issues increase
- Conventional methods are time consuming, costly and largely ineffective

The Answer

- Apply proper technology to address issue
- Drilling with casing, expandable tubulars and managed pressure drilling
- Combine complementing technologies to deliver integrated engineered systems and techniques



Drilling Hazard Mitigation

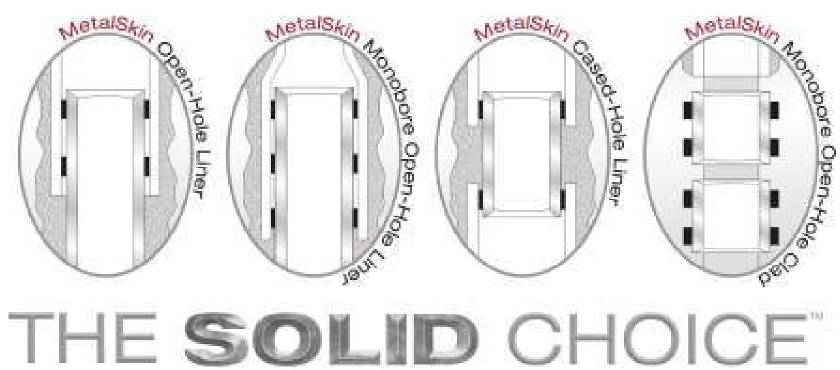
Drilling with Casing DwC™

A suite of technologies that individually, or in combination, radically reduce non-productive time due to drilling hazards.

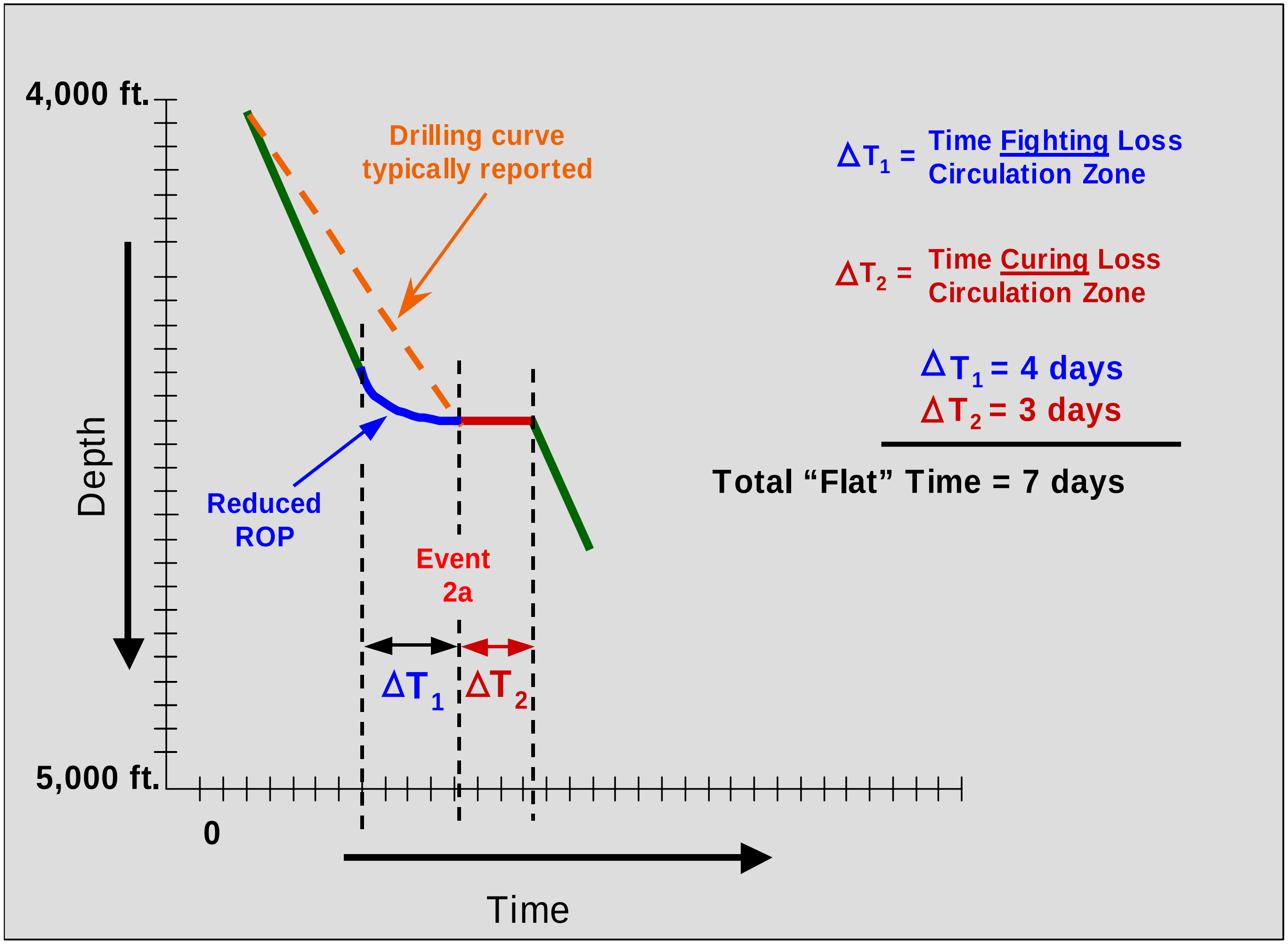
Controlled Pressure Drilling®

A better way to drill

Solid Expandable Systems

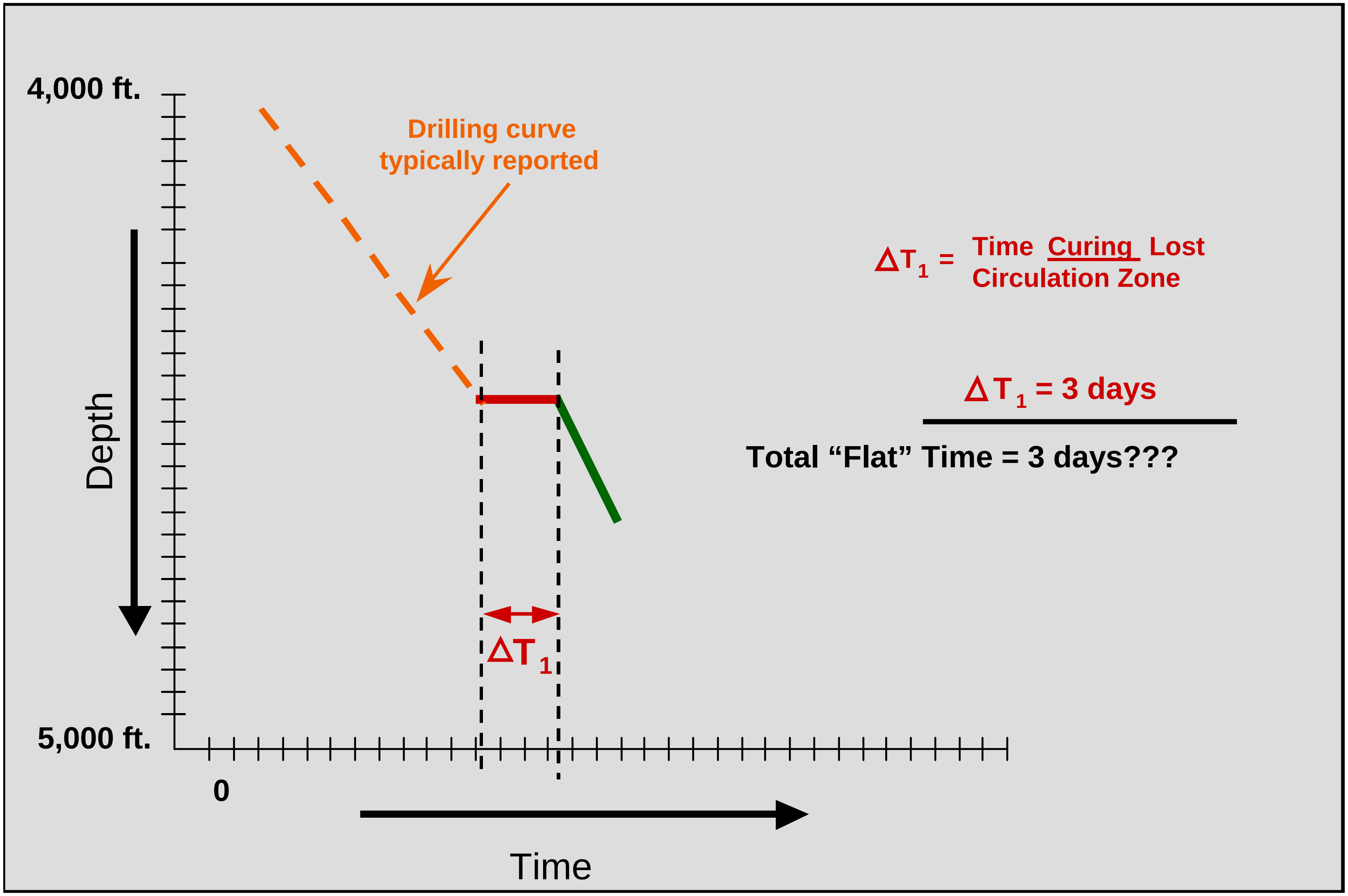


Hidden NPT - Time reduction



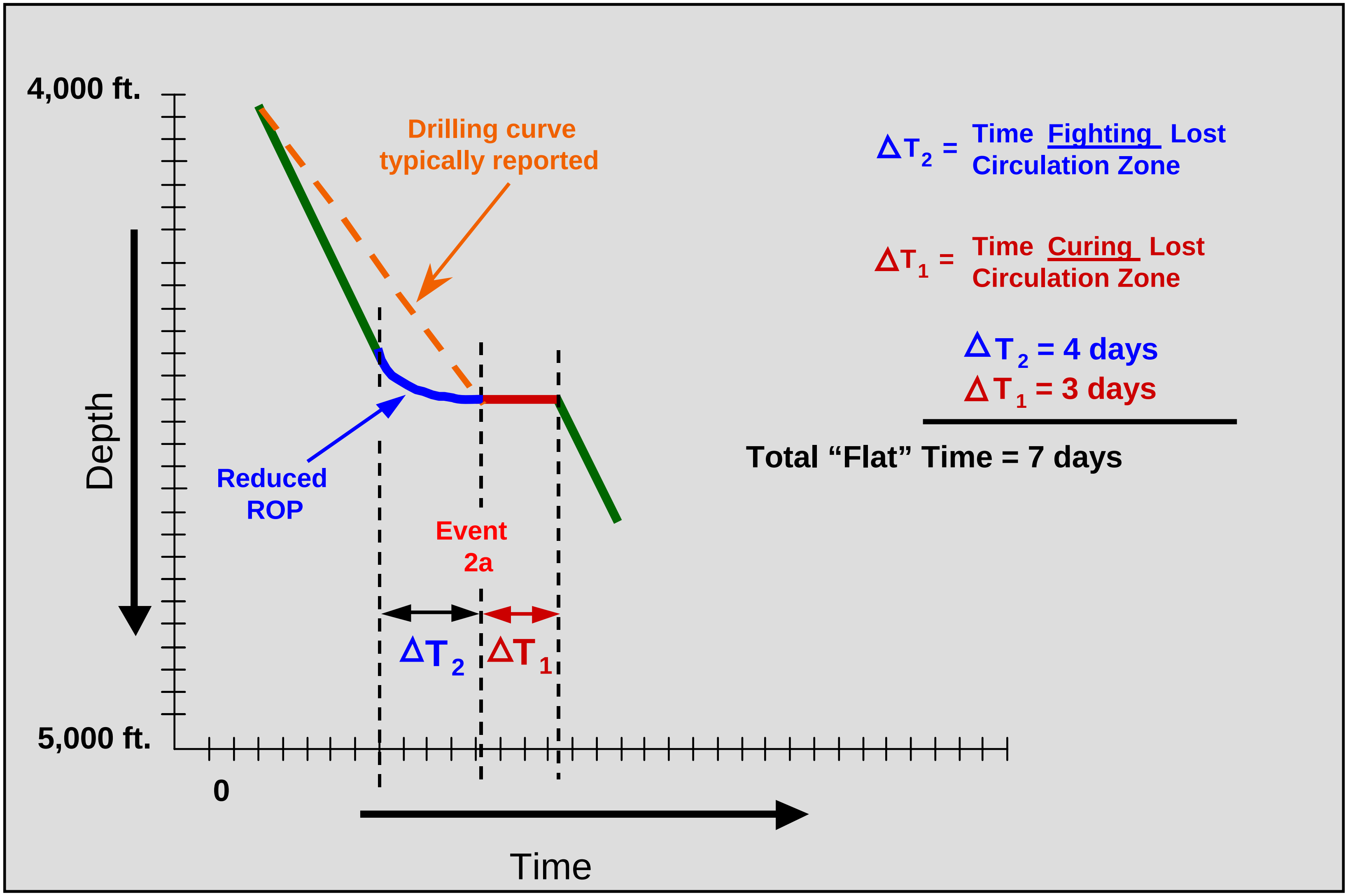
Non-Productive Time (NPT)

Lost Circulation: Time spent curing losses

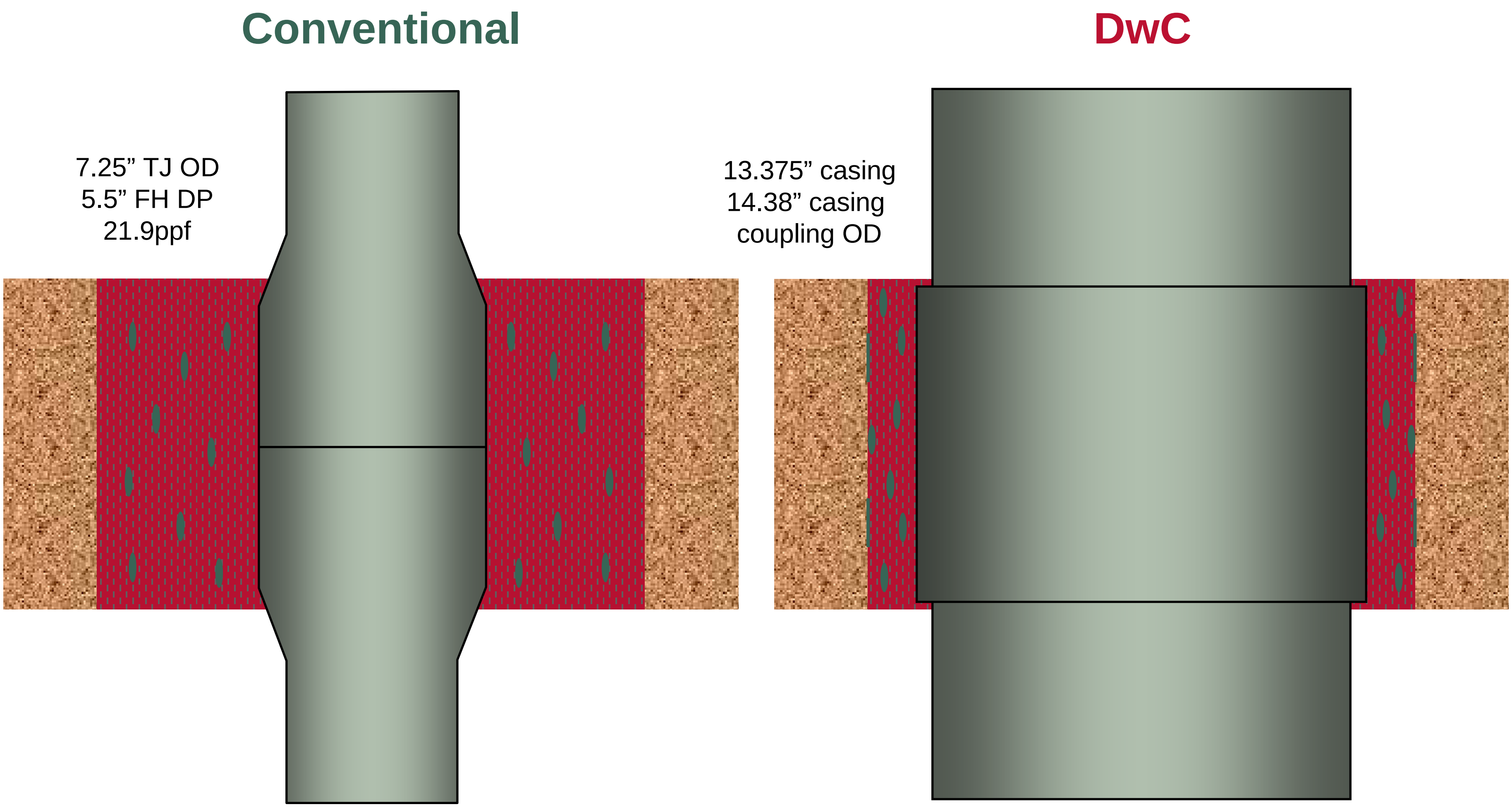


Non-Productive Time (NPT)

Lost Circulation: Time spent fighting and curing losses



What is the “Smear” or “Plaster” Effect?



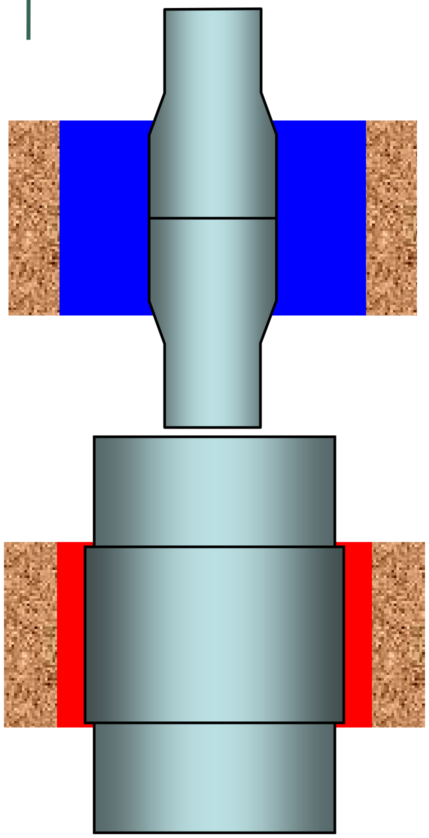
Industry belief the ‘Smear’ effect cures or reduces lost circulation

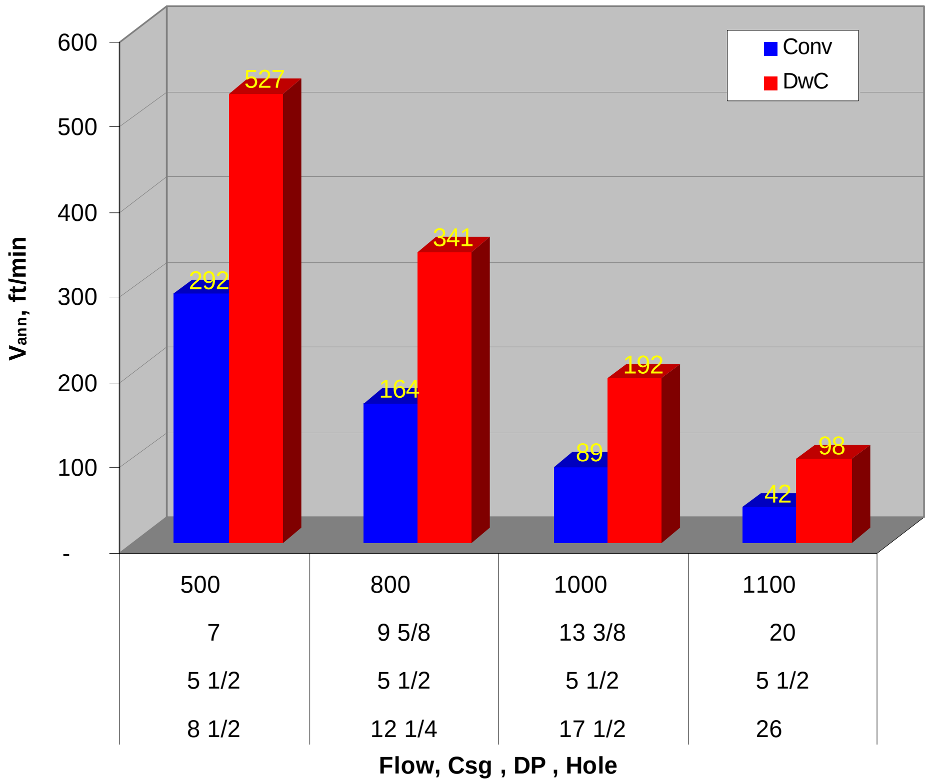
Smear effect

- Finer ground cuttings
- 10% to 20% less cuttings circulated to the surface

DwC Hydraulics

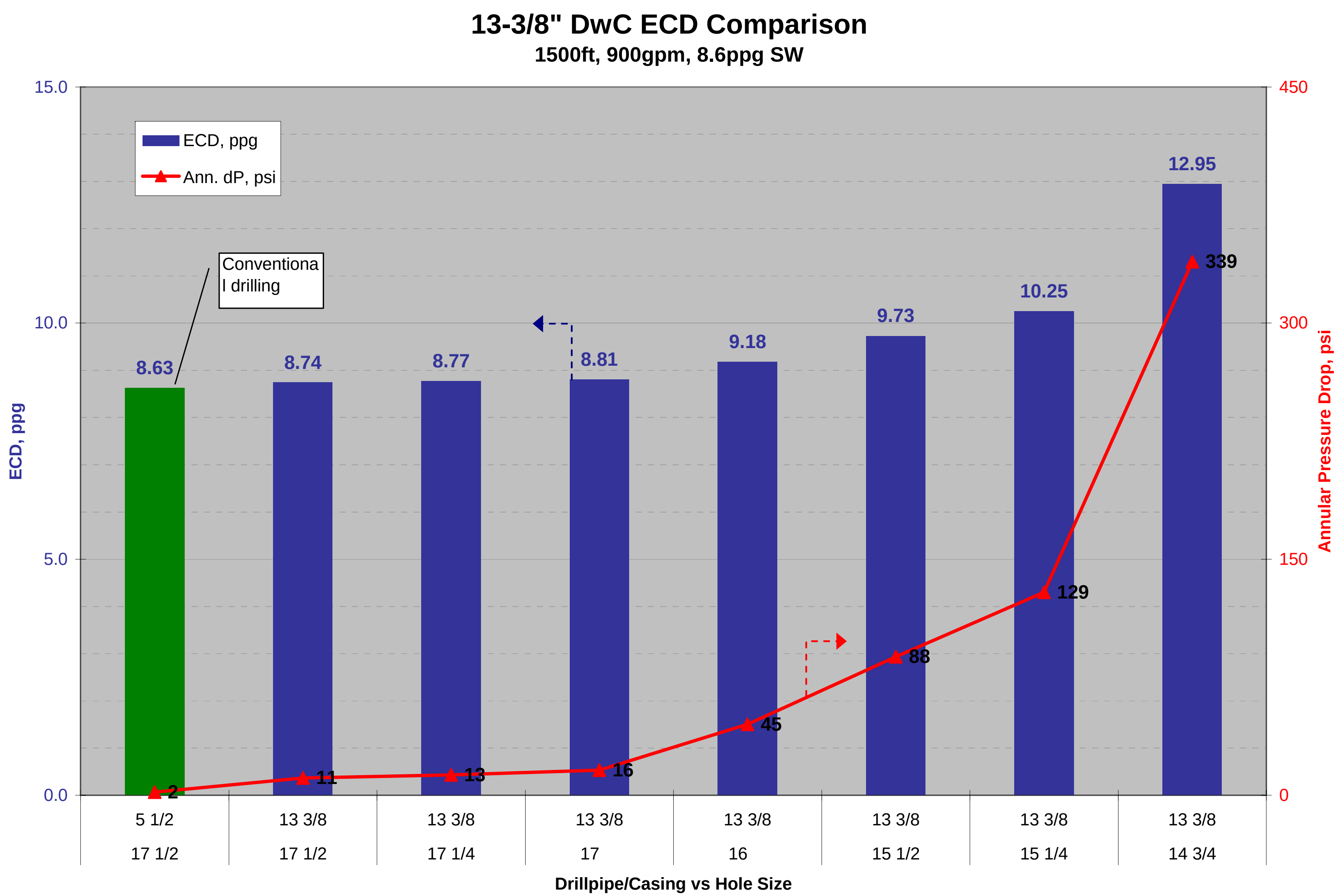
DwC™ vs Conventional Annular Flow



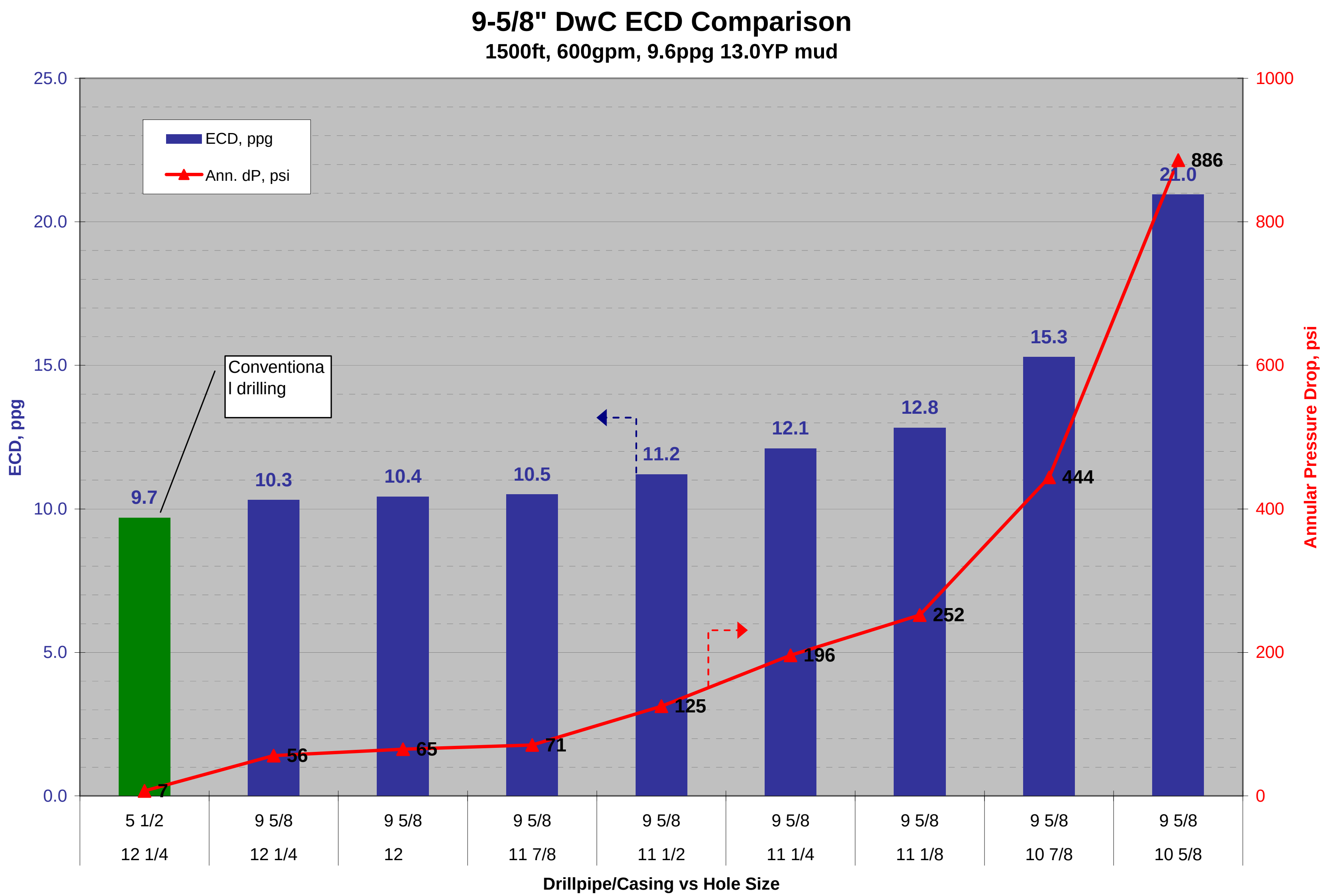


Hole Size	OD DP	OD Csg	Flow Rate, gpm	Annulus Area, in^2		V_{ann}, ft/min		DwC V_{ann} vs Conv
				Conv	DwC	Conv	DwC	
8 1/2	5 1/2	7	500	33	18	292	527	**1.8 X**
12 1/4	5 1/2	9 5/8	800	94	45	164	341	**2.1 X**
17 1/2	5 1/2	13 3/8	1000	217	100	89	192	**2.2 X**
26	5 1/2	20	1100	507	217	42	98	**2.3 X**

DwC™ ECD with 13-3/8” Casing



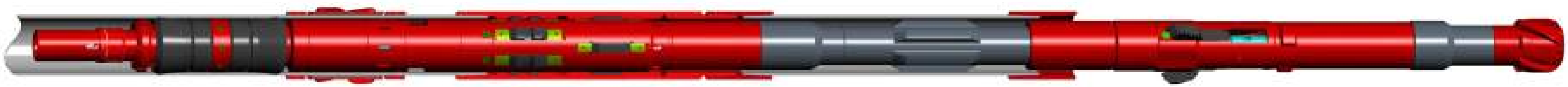
DwC™ ECD with 9-5/8” Casing



Today's DwC™ Technology

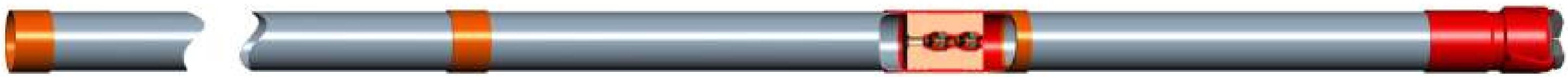
BHA latched into The Lower Casing Joint

Retrievable Bits & BHA's



Cement-in-Place Non-Retrievable DwC System

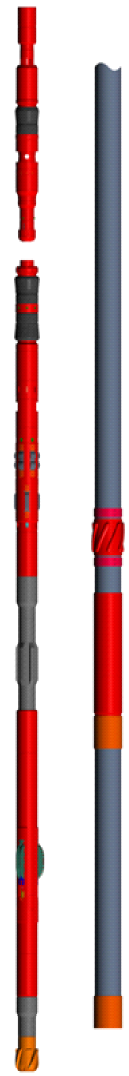
Drillable Drill Shoes



4-1/2" , 5", 7" x 8-1/2", 7-5/8" x 8-1/2", 9-5/8" x 12", 9-5/8" x 10 5/8", 11-3/4 x 12-1/4, 11-7/8" x 12-1/4", 13-3/8" x 14-3/4", 13-3/8" x 17", 18-5/8" x 24", 20" x 24", 24" x 27"

DrillShoe™ and Latch Systems Compared

***Drillable DrillShoe* System**	
Advantages	**Disadvantages**
Low Cost	Limited directional control
Simple to operate	Cased hole logs only
No rig modifications required	Limited DrillShoe selection
Zero risk of irretrievable tools in the hole	
Cementing can commence immediately TD is reached	



Latch System	
Advantages	**Disadvantages**
Ability to steer	High Cost
MwD/LwD capability	More complicated to set up and operate
Wide range of bit selections to suit formation and distance	Rig modification required
	Risk of irretrievable tools in the hole
	Unable to cement immediately upon reaching TD

DrillShoe™ 2

The DrillShoe™ is made in 2 parts:

1. The "body" is machined from a piece of 4145 ASI Steel bar.
2. The "nose" is machined from Aircraft Grade Aluminium. 6mm round pieces of TSP (Thermally Stable Polycrystalline Diamond) are then pressed into pre-drilled holes on the front of the blades. The blades are then hardfaced with HVOF Tungsten Carbide.
3. Available in 3, 4 and 5 blade designs

7,000 psi CCS Formations

Excellent Reaming Tool

DwC DrillShoe™ 2 Construction

EZCase Bit

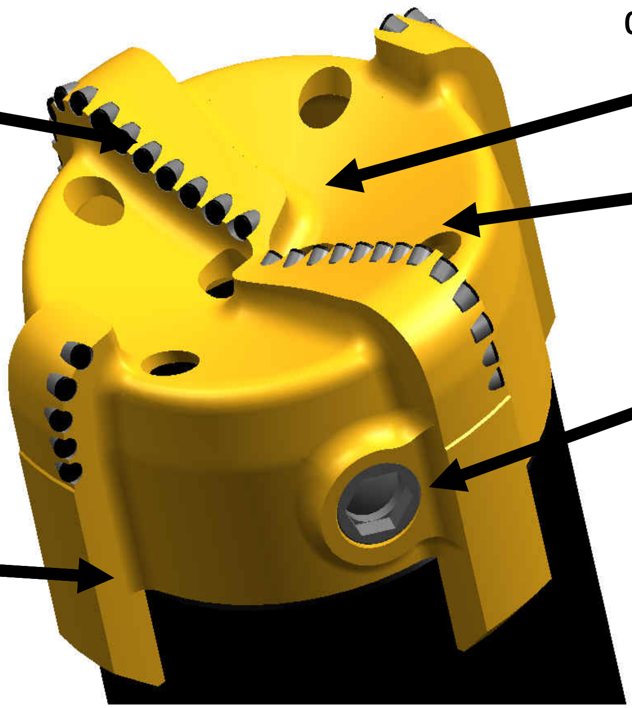
PDC cutting structure

Engineered internal profile for efficient drill-out

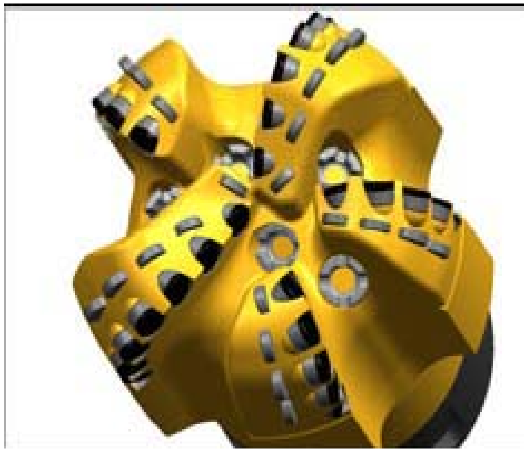
Nozzle placement optimized using Computational Fluid Dynamics (CFD)

Secondary bypass port

Casing bit crown welded to custom pups



- Steel alloy PDC design for robust reaming / drilling
- ***PDC drillable only with Genesis PDC bits***
- ***EZ Case nozzles not field interchangeable***
- Secondary flow path for cement reliability

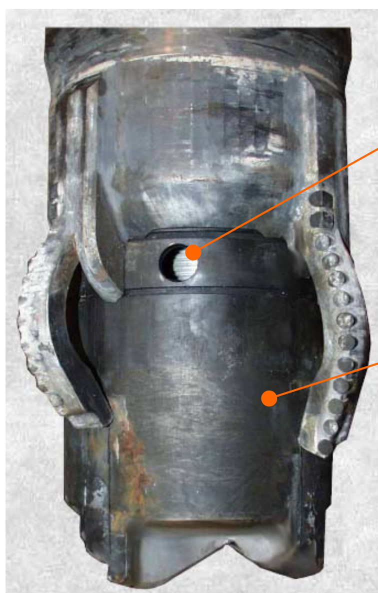


DrillShoe™ 3

- 5 or 6 Bladed PDC Bit
- 13 to 19 mm PDC Cutters
- Up to 20,000 psi CCS
- Converts to drillable cement shoe
- Simple pressure cycle
- Drillout with tri-cone or PDC Bit

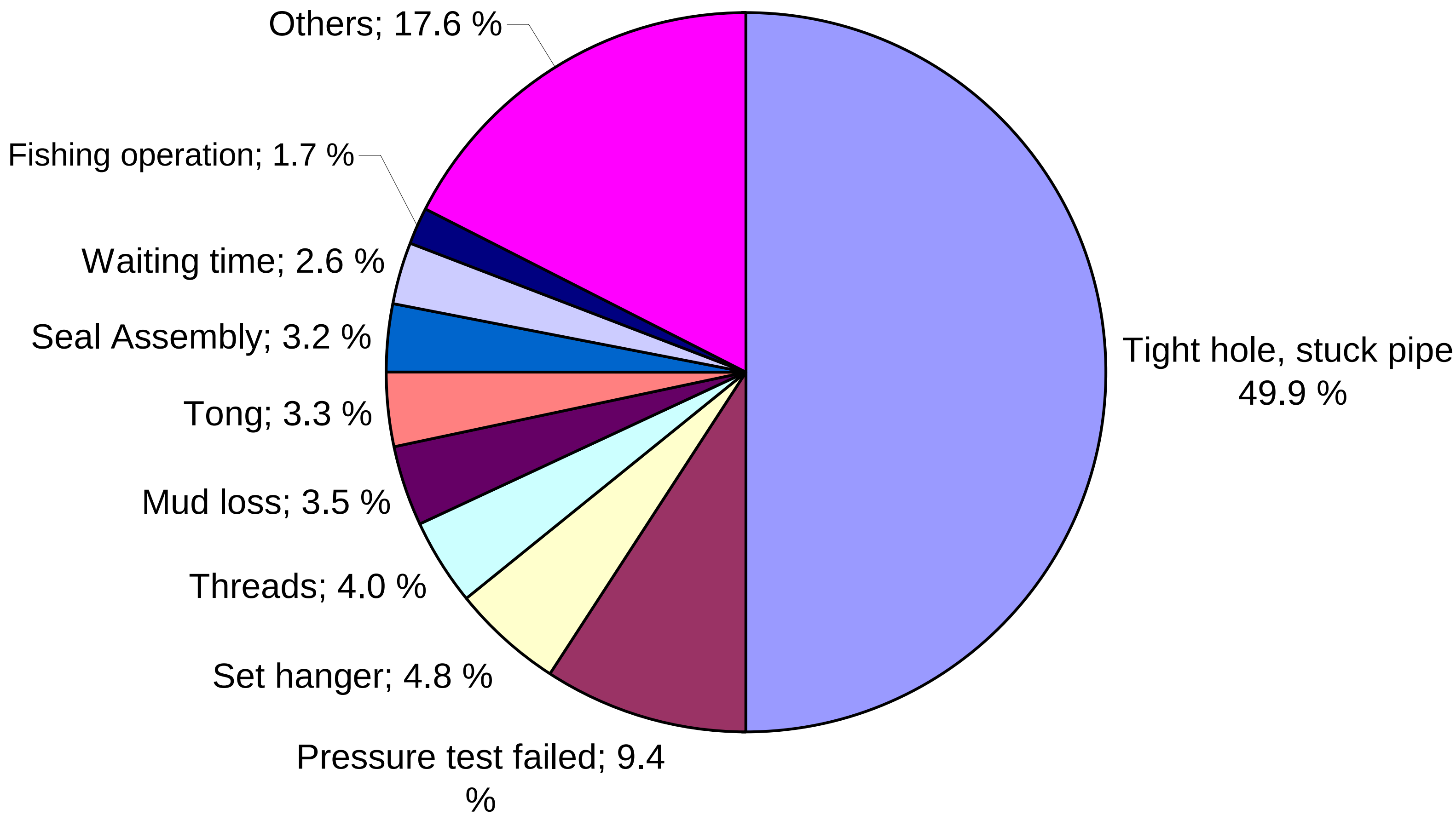
DrillShoe™ 3

- Drills like a PDC bit
- After simple pressure cycle, DrillShoe 3 becomes drillable
- Cement as normal
- Drill-thru with a normal PDC bit
- 15,000 to 20,000 psi CCS



Contributions to NPT

Running Casing and Liner



Casing Running NPT Analysis by North Sea Operator

Non productive days due to tight hole/stuck pipe: **57 days over 27 months**.

Excluding cost impact of setting casing high.

Reaming Shoes

Weatherford DrillShoe 2	Weatherford CleanReam	Tesco Warthog	Baker EZReam	Davis Lynch Penetrator
				

Centralizers for DwC Applications

Non-Rotating Rubber Lined

In-Line

HydroForm

Spray Metal Process

Surface Drive Systems

Surface Drive Systems

Internal Casing Drive Tool (ICDT)	Casing Drive System (CDS)	OverDrive™
		

OverDrive™ Casing Running and Drilling System

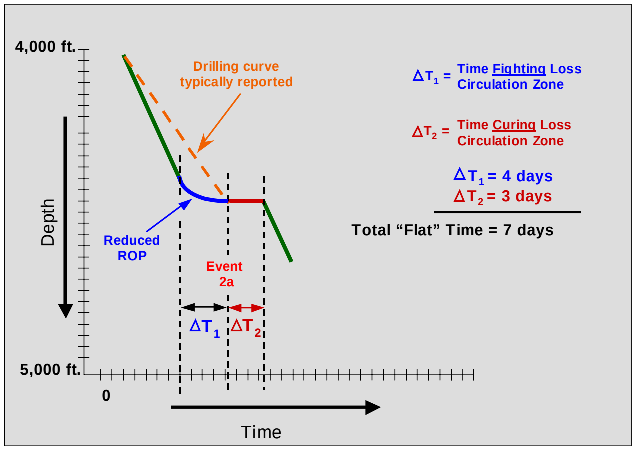
- Applications *(rigs with top drives)*
  - Casing Running
  - Drilling & Reaming w/ Casing
  - Extended Reach and Deviated Wells
  - Troublesome Well Bores
  - Safety Driven Operations

OverDrive System Features

- Removes personnel and equipment from derrick and rig floor
- Eliminates need for conventional tongs, elevators, and related personnel.
- Fill-up tool design allows switching between fill-up and circulation modes without repositioning tool.
- Multiple safety interlocks enhance efficiency and safety by preventing unplanned events such as dropped objects.
- Used for pushing down, reciprocating, circulating, and rotating casing if required.
- Torque sub measures the true torque applied to the connection without erroneous torque readings from mechanical losses and friction in the top drive and hydraulic swivel.

Liner Drilling Applications

- Depleted Formations
- Loss Zones
- Pressure Transition Zones
- Managed Pressure Drilling
- Unstable Formations
- Reaming liner through problem zones
- Just getting the Liner to bottom

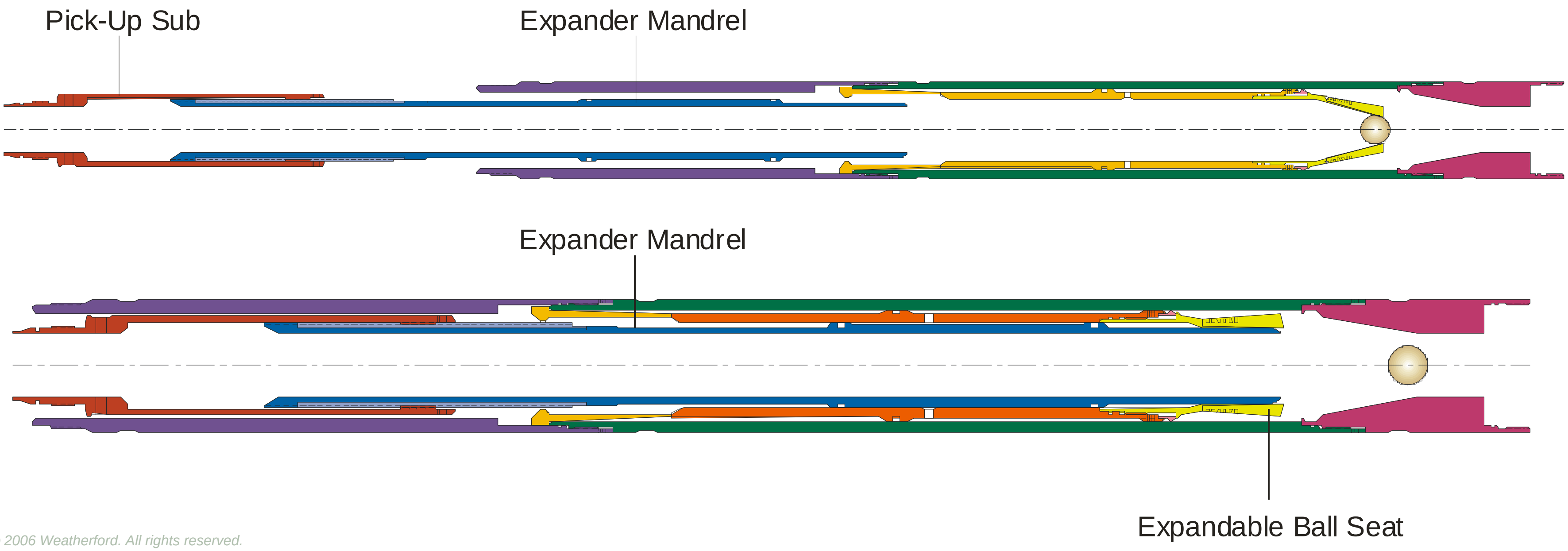


Nodeco Liner Drilling/Reaming Systems

- Drillable casing bit or conventional bit
- Float Collar (auto-fill or conventional)
- Centralizers (in-line or solid slip-on)
- Hydraulic rotating or rotatable hanger
- Liner Top Packer (integral or second trip)
- Retrievable seal mandrel
- High torque running tool
- Effective junk screening
- Diverter tool (optional)
- Drill Pipe to surface

Mechanically Expanded Ball Seat

- Ball released with mechanical expansion
- No pressure surge to formation
- Can not prematurely shear out before hanger set and running tool released
- Enables higher shear pin setting pressures for hanger and running tool



BLTT Liner Drilling System

- Drillable Casing DrillShoe™ (or conventional bit)
- 5”, 5-1/2”,7”, 7-5/8”,13-5/8” Liner Sizes
- 2nd Trip Packer Capability
- No Liner Hanger – Set Liner on Bottom
- Transmit torque to liner outer sleeve through spline.

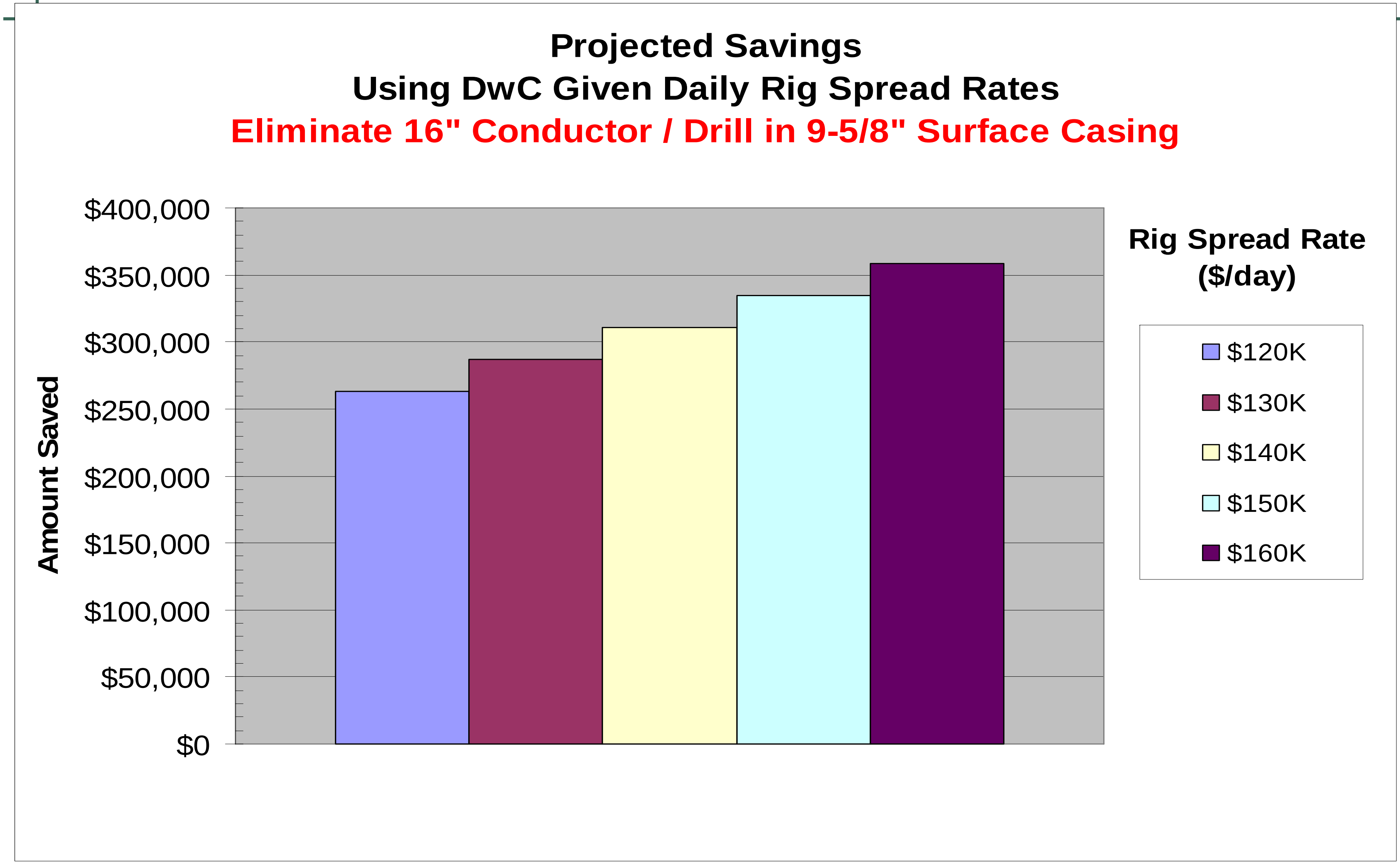
  (torque > most DP connections)
- 5” Tool Torque = 35K ft-lbs.
- 7-5/8” Tool Torque = 53,000 ft-lbs.
- 13-5/8” Tool Torque = 80,000 ft-lbs.
- ∆ P will not release running tool - A drop ball pumped down to setting sleeve with hydraulic pressure is required to release running tool.
- Drill Pipe to surface

Benefits of Reaming with Liners

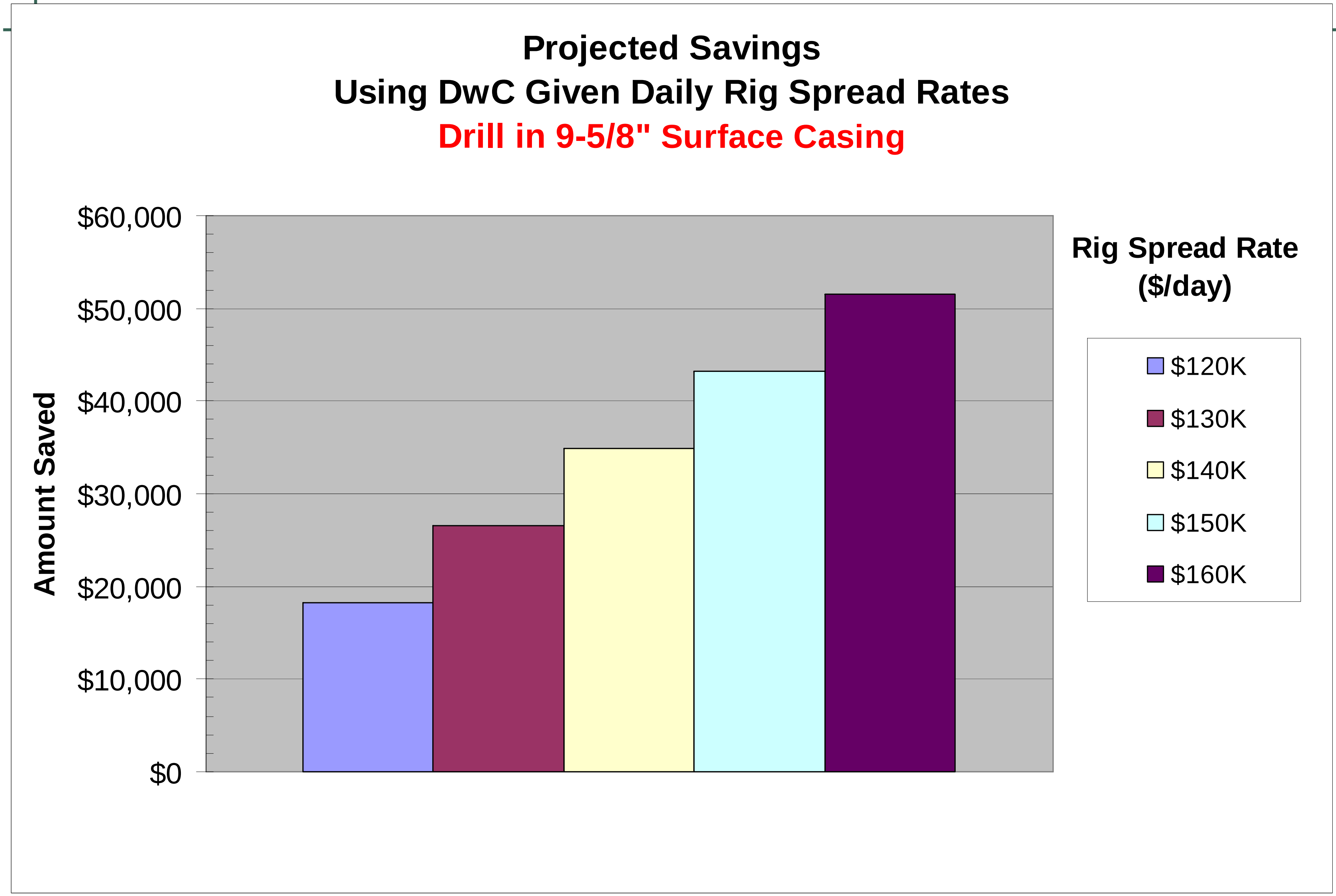
- Maximum Insurance to get the Liner to bottom
- Minimum impact to normal running operations
- No need for extra wiper trips
  - Eliminate Trip Margin Required.
- Minimize mud losses
- Minimum open hole time / formation damage
- Reduces equipment handling (better HSE)

Gulf of Mexico Shelf DwC Opportunities

GoM Shelf


Projected Savings
Using DwC Given Daily Rig Spread Rates
Eliminate 16" Conductor / Drill in 9-5/8" Surface Casing
Amount Saved
$400,000
$350,000
$300,000
$250,000
$200,000
$150,000
$100,000
$50,000
$0
Rig Spread Rate ($/day)
$120K
$130K
$140K
$150K
$160K

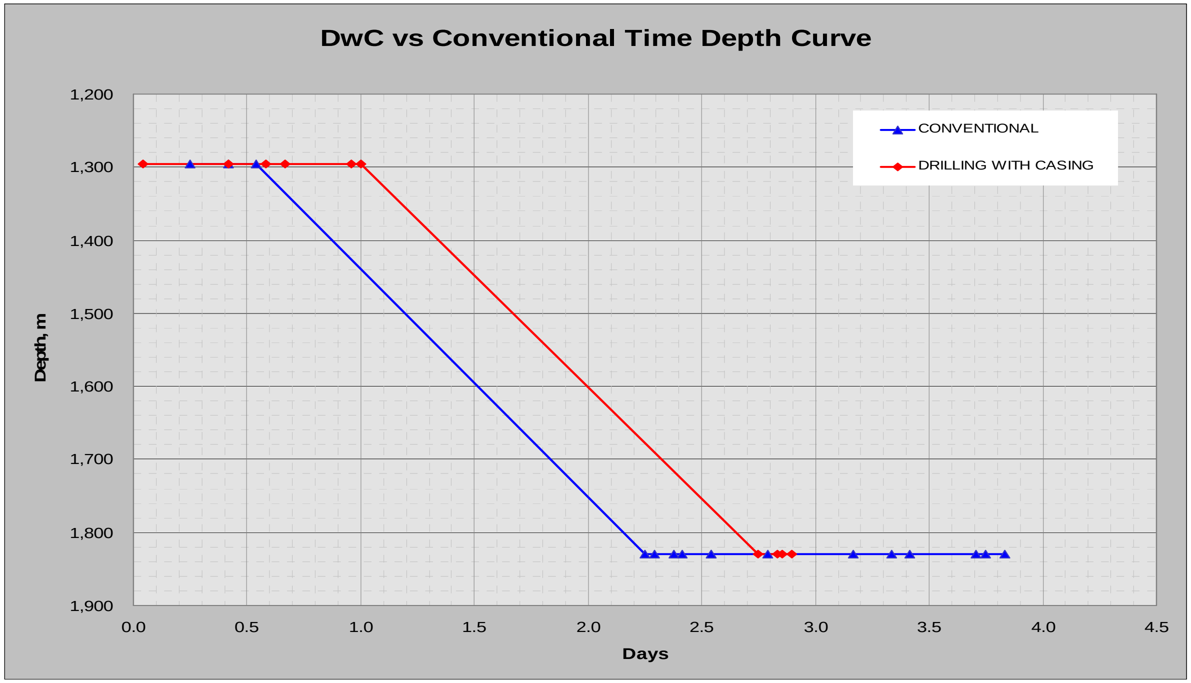
GoM Shelf


Projected Savings
Using DwC Given Daily Rig Spread Rates
Drill in 9-5/8" Surface Casing
Amount Saved
$60,000
$50,000
$40,000
$30,000
$20,000
$10,000
$0
Rig Spread Rate ($/day)
$120K
$130K
$140K
$150K
$160K

GoM Conductor and Surface Casings DwC

- Economic savings can be achieved using DwC techniques
- Average around 26% drilling cost savings based upon flat time reduction
- Savings as much as $350K without additional individual savings if 16” and 10-3/4” casing are replaced with 9-5/8” DwC
- Savings still realized if only 10-3/4” section utilizes DwC technology

Financial Analysis Study – Drill in 20-in Conductor Casing with HP Housing



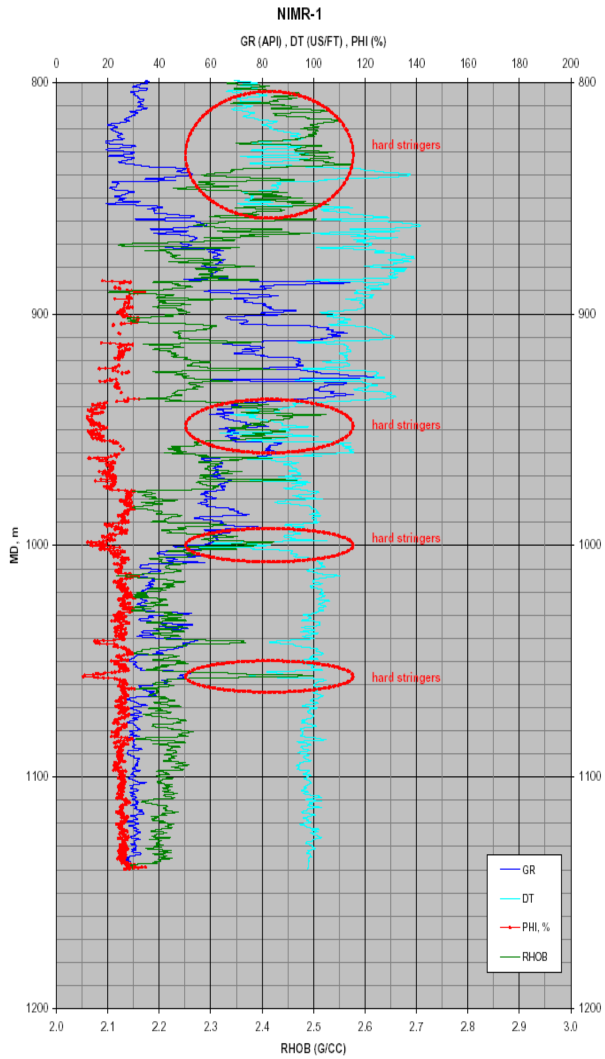
- Spread Rate $550k
  - Projected Time Savings = 24.5% or 24 hours
  - Projected Financial Savings = $380k

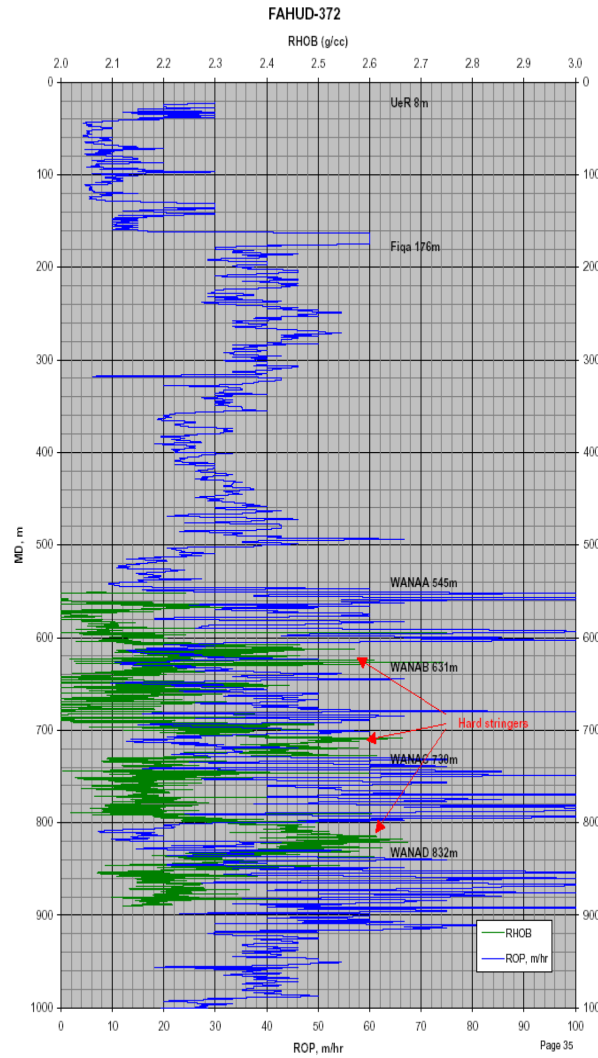
Applications Engineering

PLANNING IS KEY TO SUCCESSFUL DwC OPERATIONS!!

DwC Planning Tools

- Analyze electric logs to determine compressive strength
- D-Exponent
- Mud Logs
- Drill Bit Records
- Connection Design
- Torque Drag Model
- Stress Cycles Model





DwC Connection Design

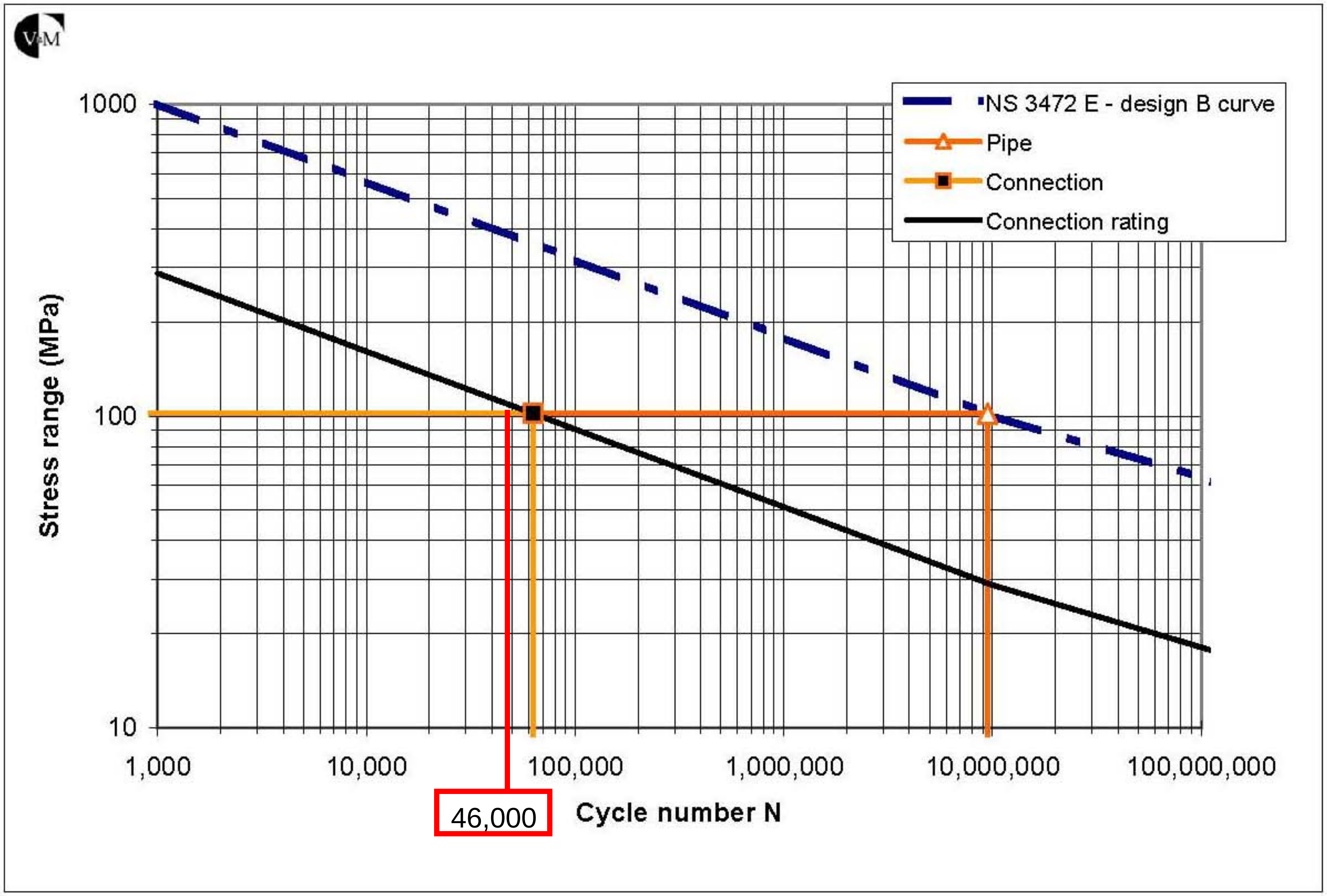
Proven Connections

- Standard Buttress
- Modified Buttress - GB CDE, DWC/C
- Hydril Wedge Threads – 513, 521, 523, 563
- Vam SLIJ II, Vam Top
- Hunting SLSF

Design Factors

- MU Torque
- DLS – critical when rotating off whipstocks
- Fatigue (Stress-Cycles Plot)
- Torque Drag Modeling

Estimation of load and Number of cycle to failure for
7" 26# VM80 13Cr VAM TOP for 4.86°/100ft bending



Surface Torque Plot	
Case:	Rotating On Bottom at 10 kips, 1000 ft-lbf Torque at Bit
Friction Factor:	CHFF 0.20 - 0.30 / OHFF 0.35 – 0.55
Remarks:	-

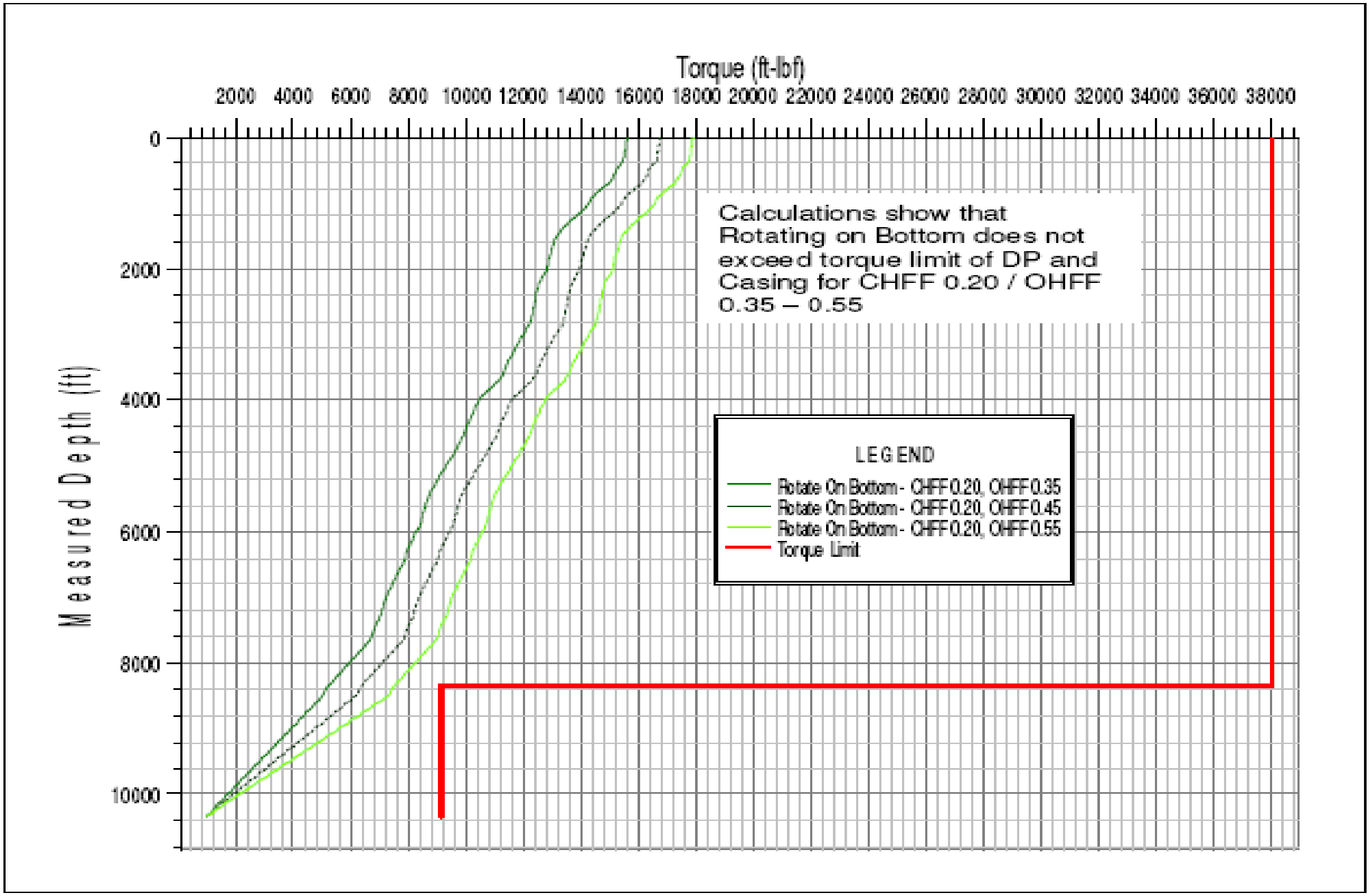


Figure 13: Surface Torque at CHFF 0.20 / OHFF 0.35 – 0.55

Weight on Bit Plot	
Case:	Rotating On Bottom at 10 kips, 1000 ft-lbf Torque at Bit
Friction Factor:	CHFF 0.20 - 0.30 / OHFF 0.35 – 0.55
Remarks:	-

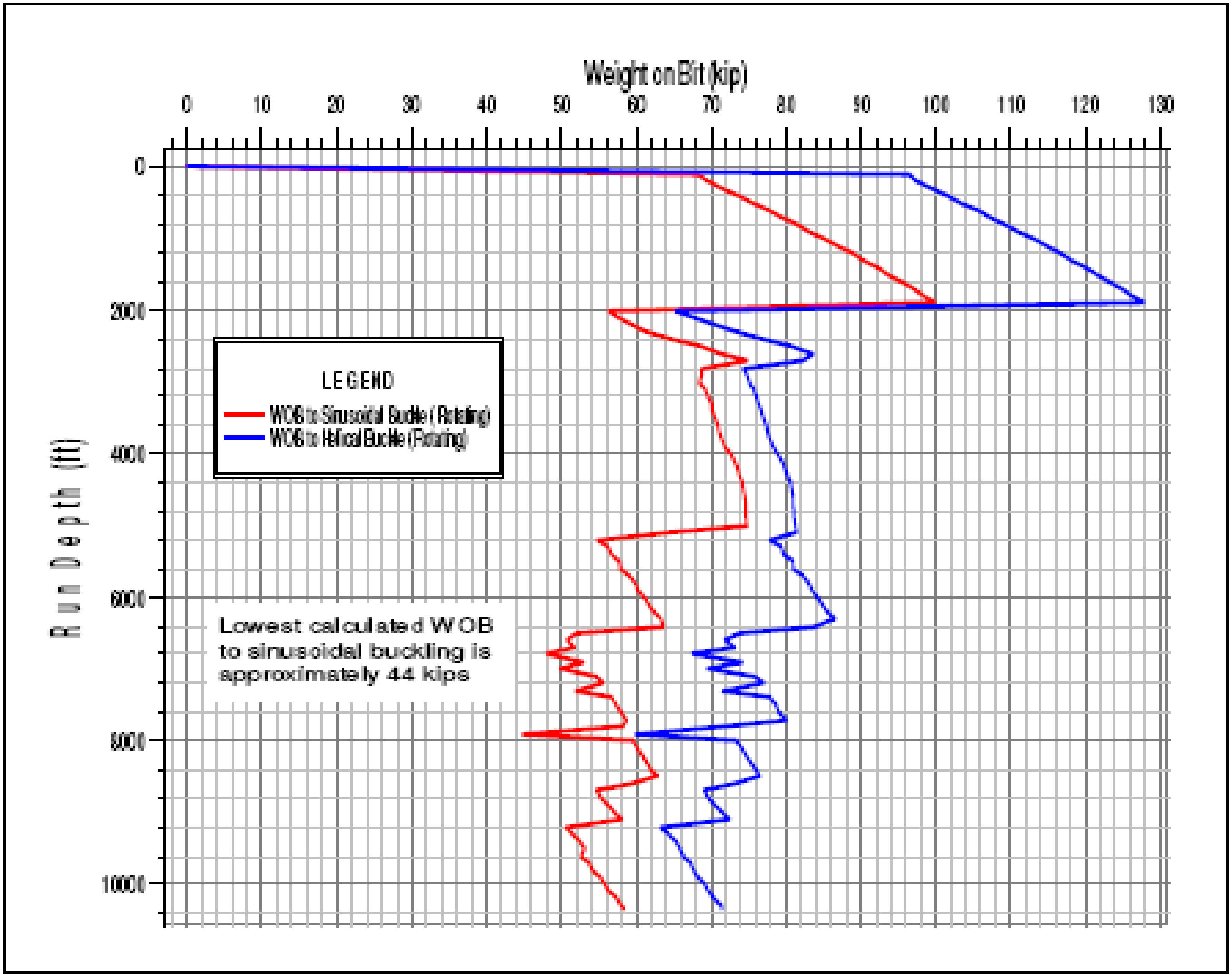


Figure 16: WOB Plot for Drilling at 10 kips

Case Histories

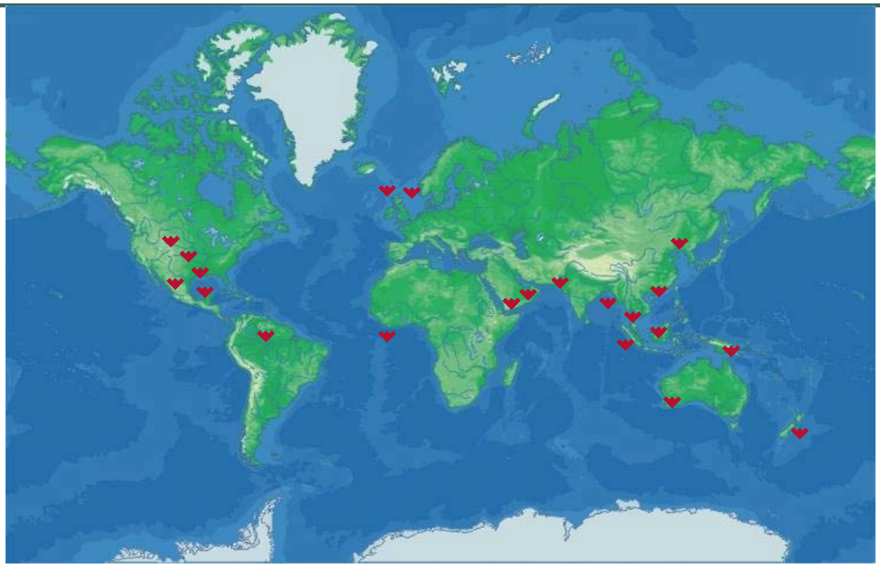
Client Value

Client Mariner Energy

Location MC 674 – Gulf of Mexico

Results 7-5/8” DwL through thief zone @ 20,400’ where 2 wellbores were lost due to severe losses

Value Enabled Operator to strategically set 7-5/8” liner in competent interval to < MW and drill depleted production zone with no reported OBM fluid losses.



Client El Paso **(OTC 17687)**

Location EI 364 – Gulf of Mexico

Results DwL 269 ft, with 9-5/8” liner through catastrophic thief zone without losses. Previous wellbore lost over 3,000 bbls.

Value Saved **96 hours** of rig time and approximately **US$ 750K**

Client Pemex **(SPE/IADC 105403)**

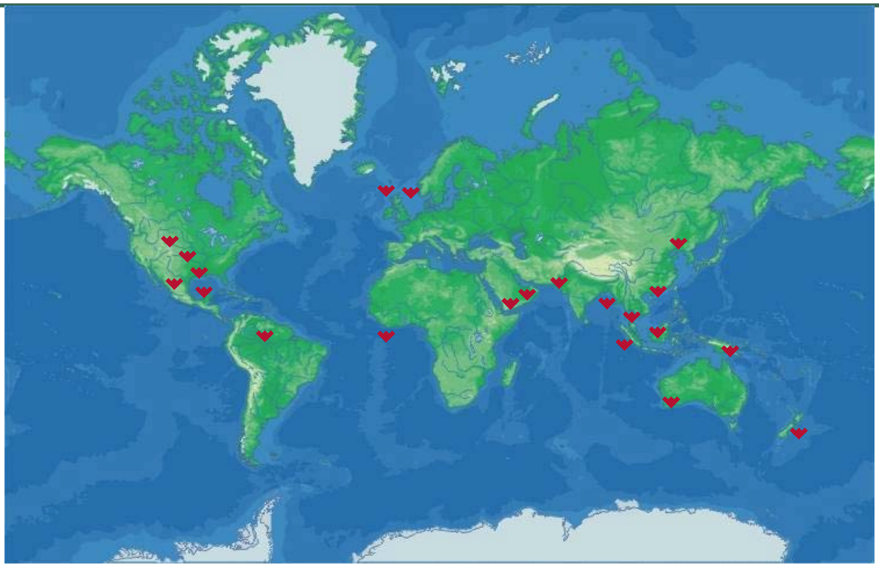
Location Veracruz, Mexico – Gulf of Mexico

Results Drilled with liner in high angle hole to reach fractured formation susceptible to extreme losses

Value Saved **39.5 days**, representing a cost reduction of **US$ 4.5 million**

Client Value

Client	Spinnaker Exploration
Location	High Island – Gulf of Mexico
Results	DwL system reams and drills through unstable shale and 2 ppge depleted sand in 38º hole without fluid losses. Reamed and drilled 5-1/2” liner with DrillShoe 2 from 13,685-ft to 13798 -ft MD to reach planned liner TD obtaining 18.3 ppge FIT
Value	Successfully installed liner by reaming and drilling through drilling hazards enabling client to subsequently drill required 4-1/2” hole for completion..

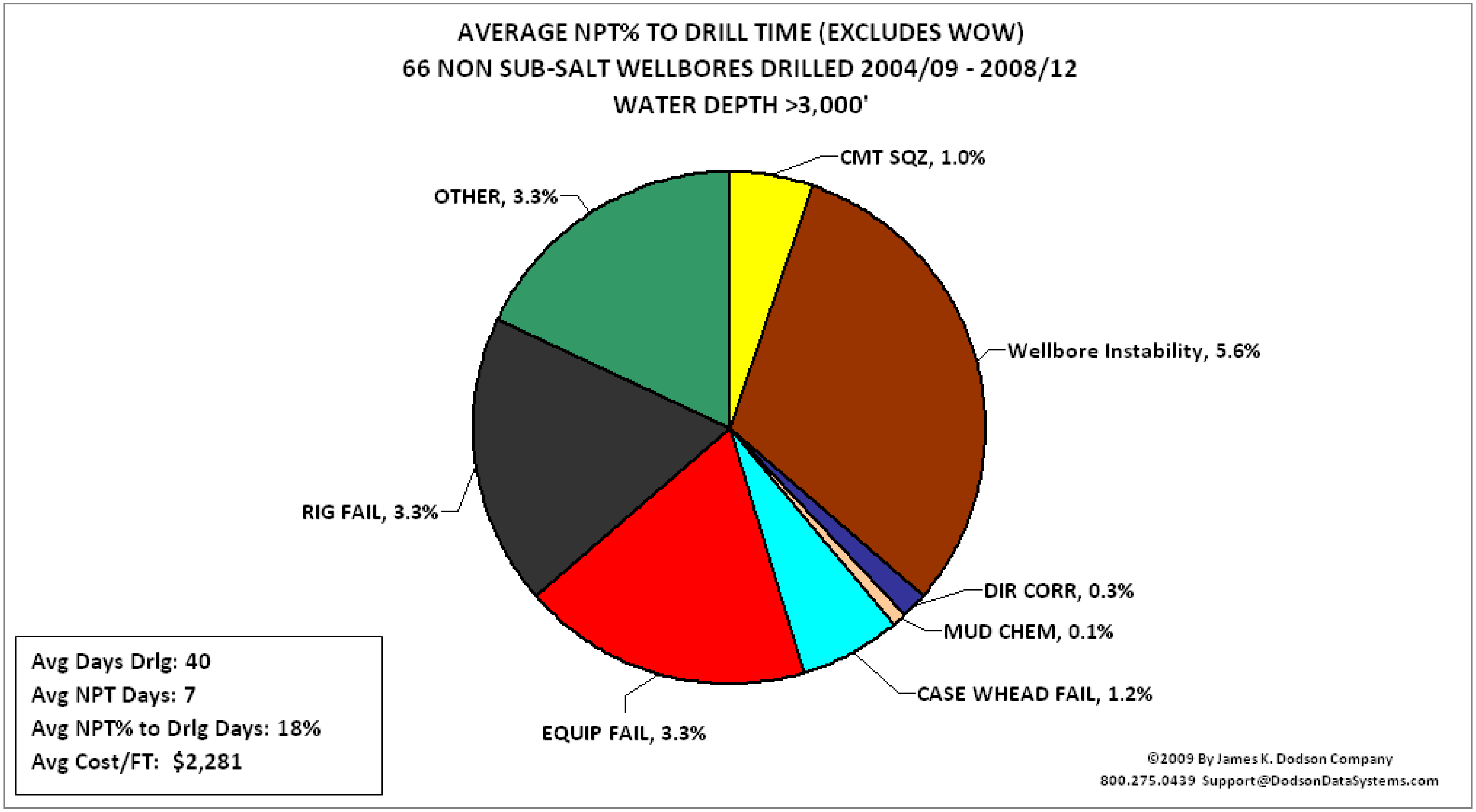


Client	CNOOC **(SPE/IADC 118806)**
Location	Banuwati Field, Offshore Indonesia
Results	DwL system drills through wellbore instability and severe loss interval to reach liner objective. Drilled 7” liner with DrillShoe 3 from 9,968-ft to 10,317-ft MD in 68º hole successfully isolating drilling hazards
Value	DwL technology was successful getting liner to planned TD, where conventional methods were unsuccessful. Estimated **$1MM USD** savings realized.

. Client	Anadarko **(OTC 18245)**
Location	Salt Creek CO2 Injection Field, Wyoming
Results	5” casing was drilled to 2,300-ft using DwC and UB technology due to high shallow overpressures (est @ 18 ppge).
Value	ROP was doubled and cementing was completed within 3 hrs. of reaching TD. The well did not have to be killed to run casing.

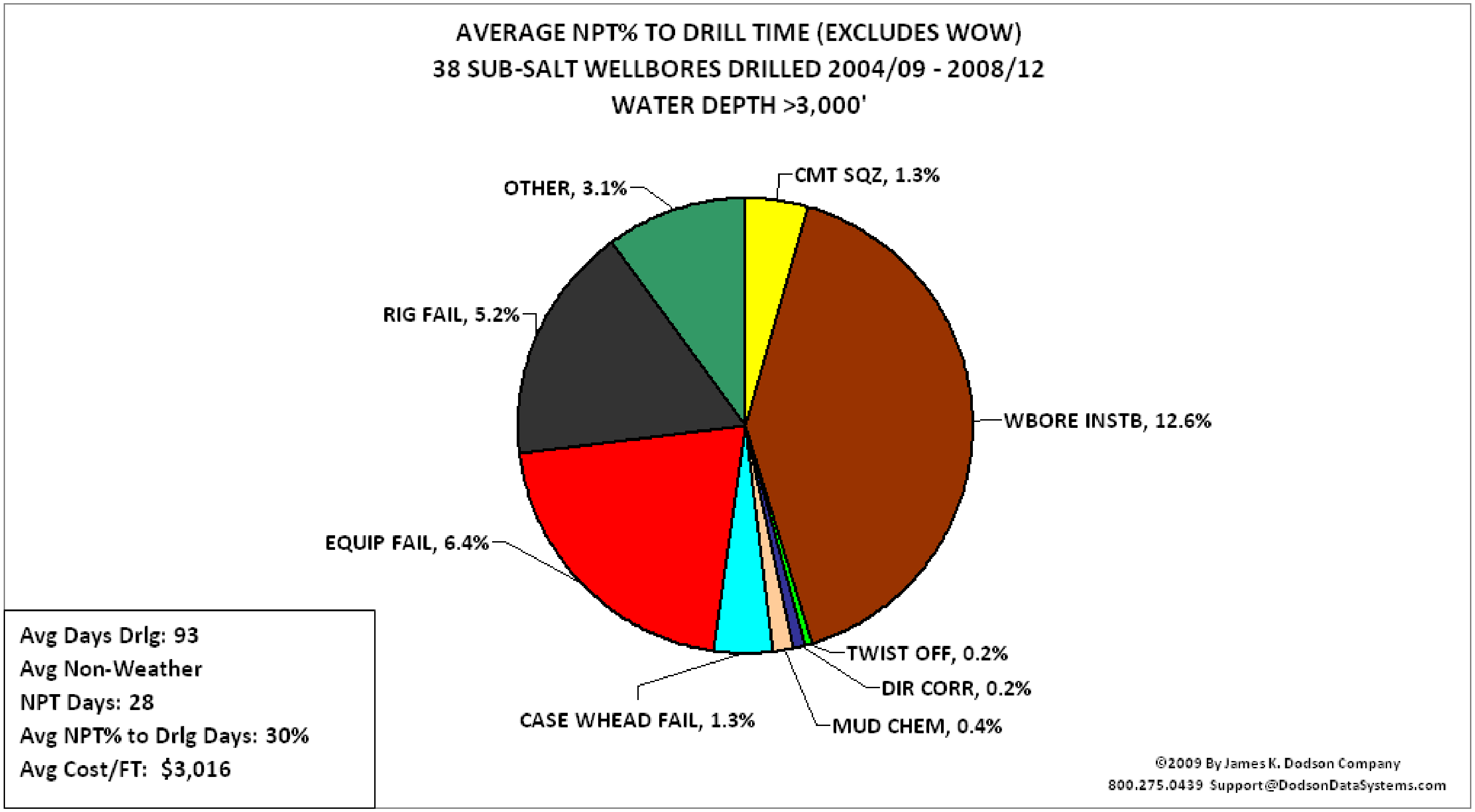
Deepwater DwC….. The Future

GoM Non Sub-Salt Wellbores NPT (OTC 20220)



Based on the above cost/ft, this relates to $ 128/ft for Wellbore Instability.
Based on a hypothetical 20,000' MD well: $ 2,500,000/Well

GoM Sub-Salt Wellbores NPT (OTC 20220)



Based on the above cost/ft, this relates to $ 380/ft for Wellbore Instability.
Based on a hypothetical 20,000' MD well: $ 7,600,000/Well

Why Deepwater DwC??

•Deepwater operations are notoriously expensive

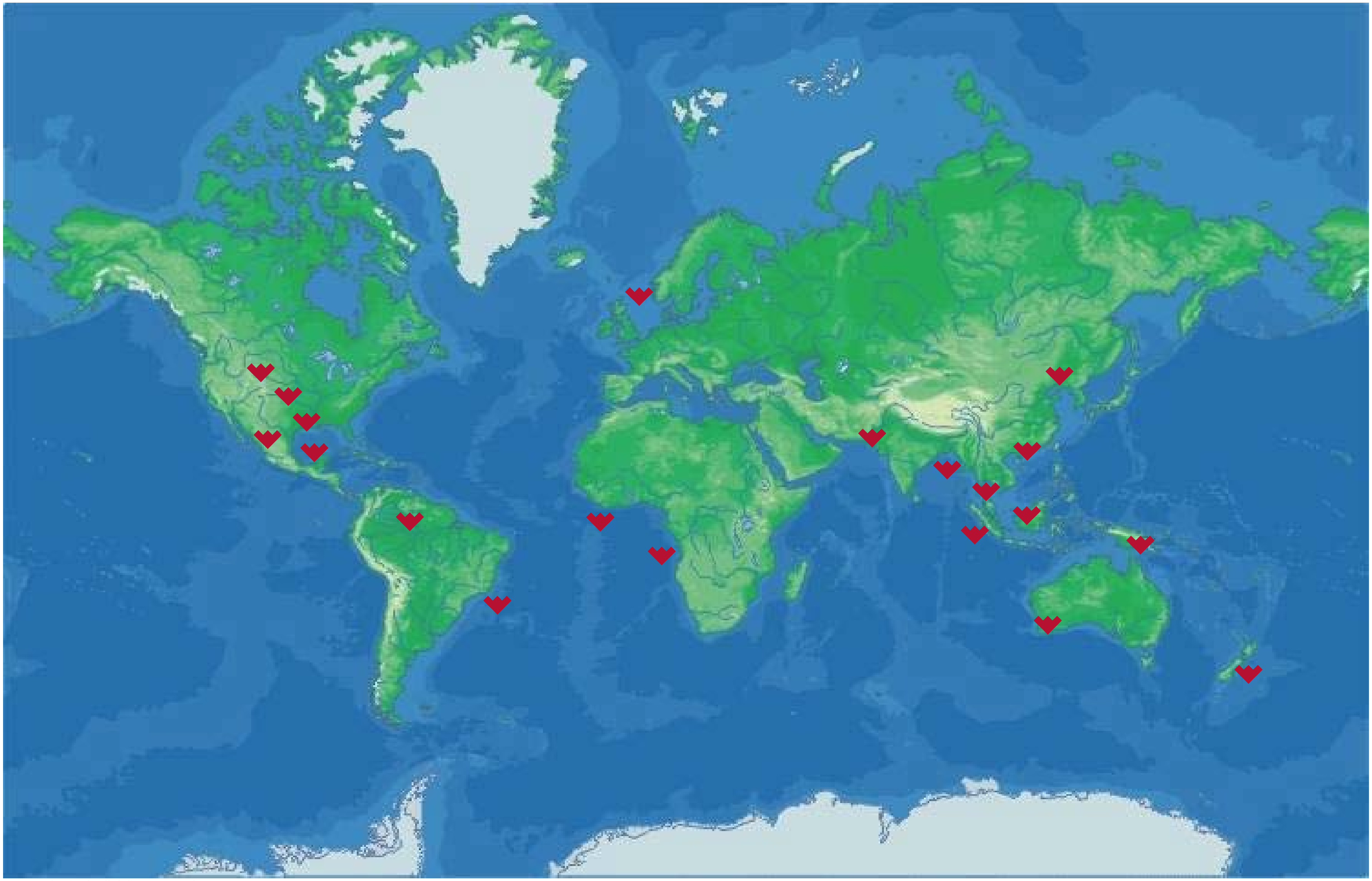
•Daily rig spread rates frequently exceeding $750,000/day

•Ability to apply innovative technology to reduce time/cost spent in challenging sub-sea environments is a hurdle many operators face.

•The development of a system based on proven DwC technology that enhances drilling efficiency and mitigates many drilling hazards, can be applied in a Sub-Sea Environment.

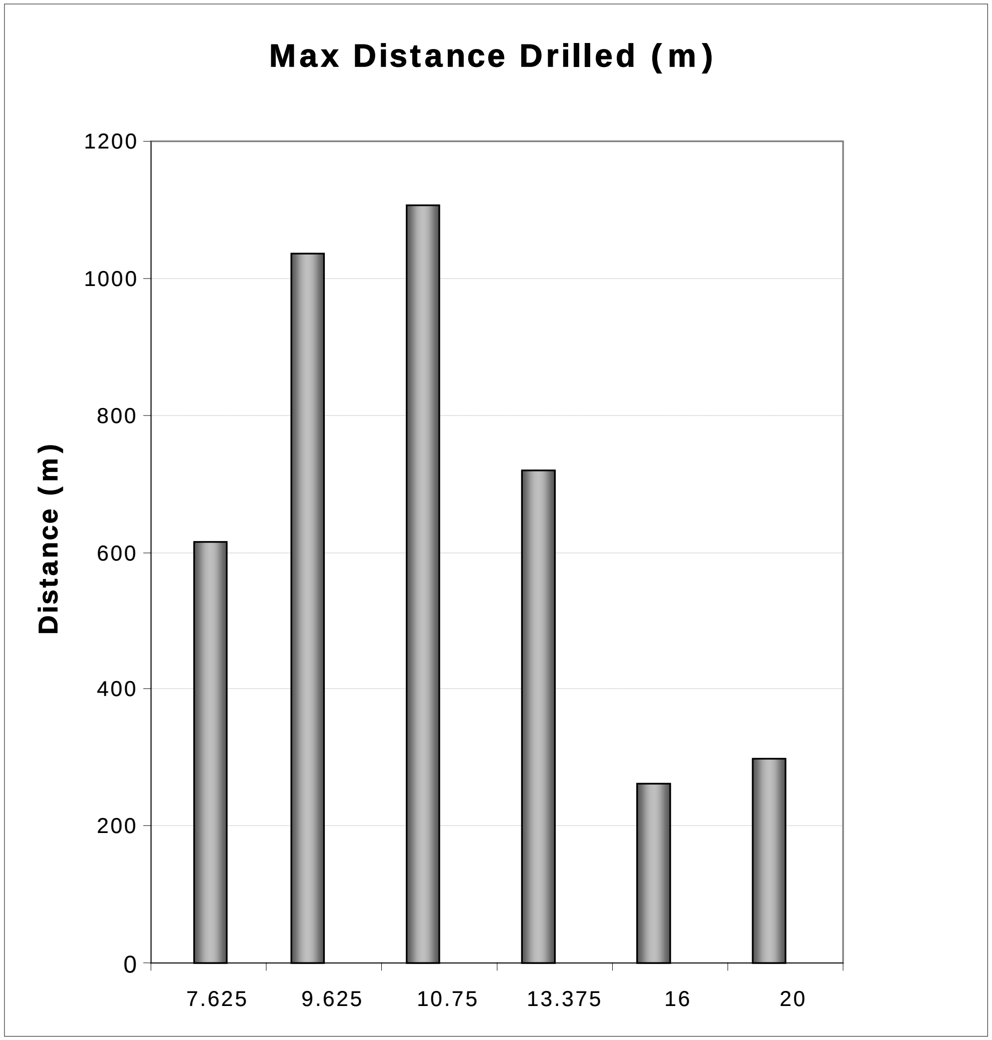
•Conservative time savings estimates show Deepwater DwC to be 25% more efficient

DwC Applications – 6 Continents



Weatherford DwC Market

- Focus on cement in place system
  - Time saving
  - Problem resolution
- Drilled > 800 wells to date
- > 750,000 feet drilled
- Manufactured and shipped 1,000 DwC systems to date
- Over 60 Clients



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Drilling-with-Casing (DwC™)

Overcoming Wellbore Stability Issues

Steve Rosenberg – U.S. Region Product Line Manager

Tuesday April 21st, 2009