
“How Far Can We Go”, and “How Fast Can We Get There?”



IADD Forum “Motor vs. RSS”

November 11th, 2011

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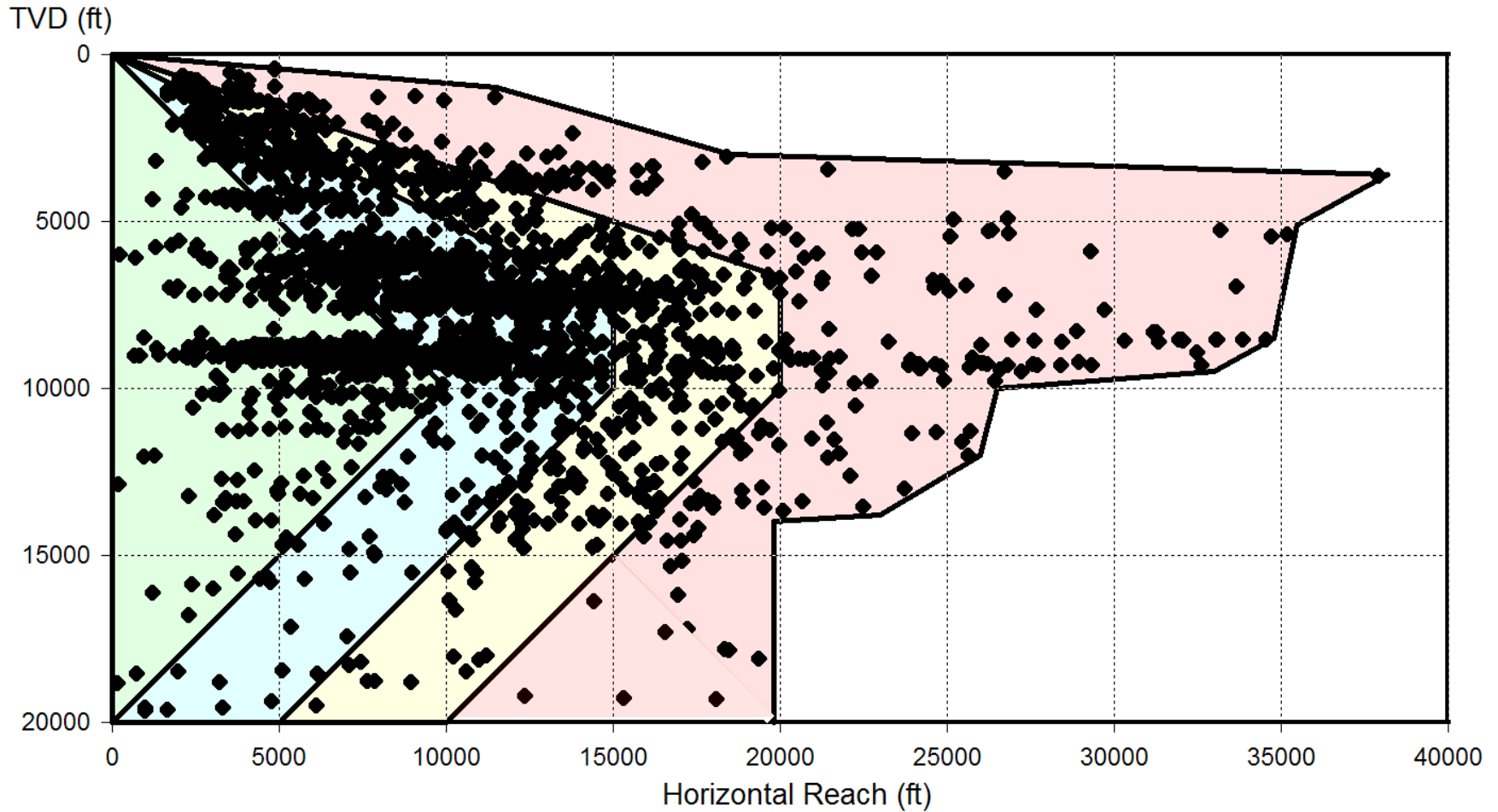
Outline

- Motor or RSS?
- Where have we been?
- Where are we going?
- What are the limiting factors?
- What is needed to go further?

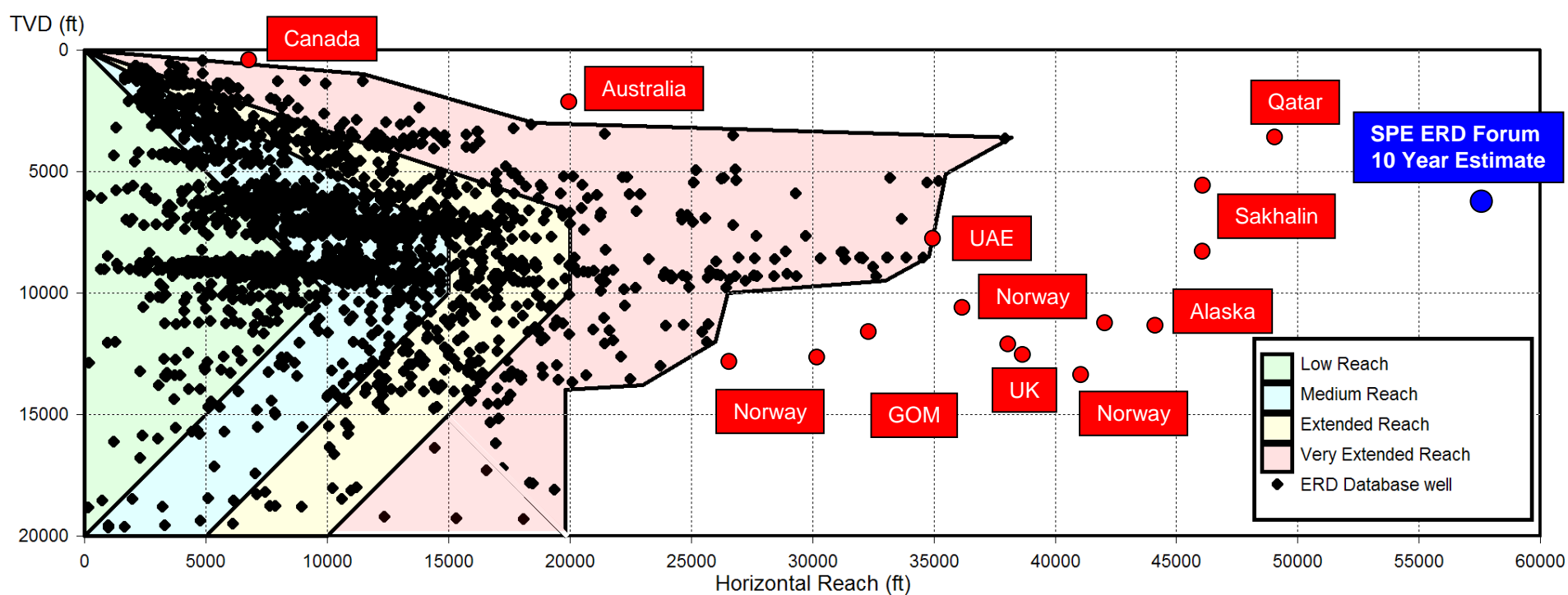
Motor vs. RSS

- For ERD, there isn't really any debate
 - RSS is required for drag and buckling reasons
 - This technology will take us a long way
- **HOWEVER**, RSS isn't the best choice for everyone
 - For example, $\pm 5,000'$ laterals onshore US
 - Haynesville: 5 day curve + lateral w/ motor
- Things to think about before picking up RSS
 - Bit RPM limitations (motors can drill faster)
 - Susceptibility to stick-slip (affects bit selection and WOB)
 - Tolerance for solids (clean mud is more crucial)
 - Dogleg requirements (damn geologist)

ERD: Where Have We Been?

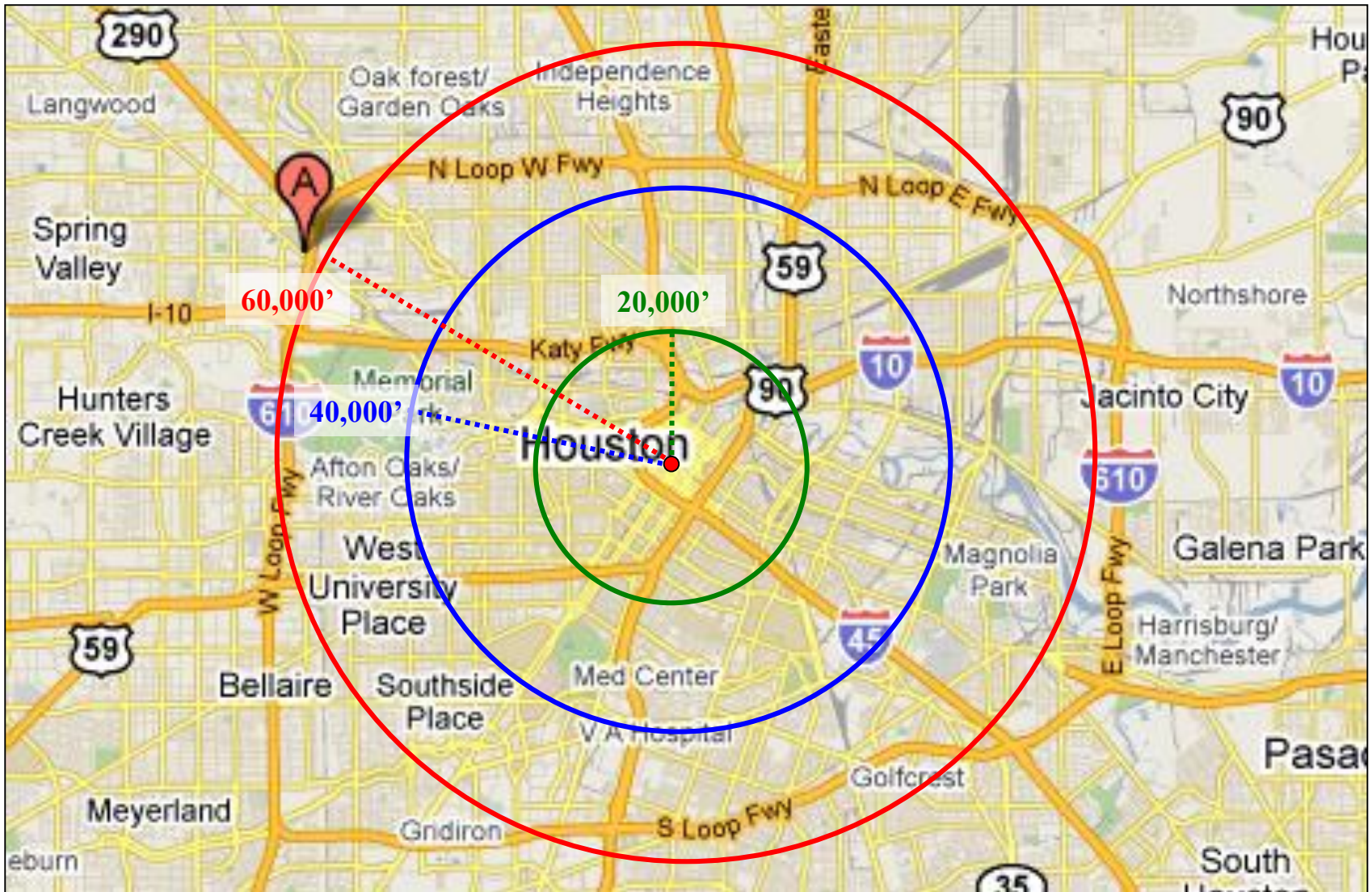


ERD: Where Are We Going?

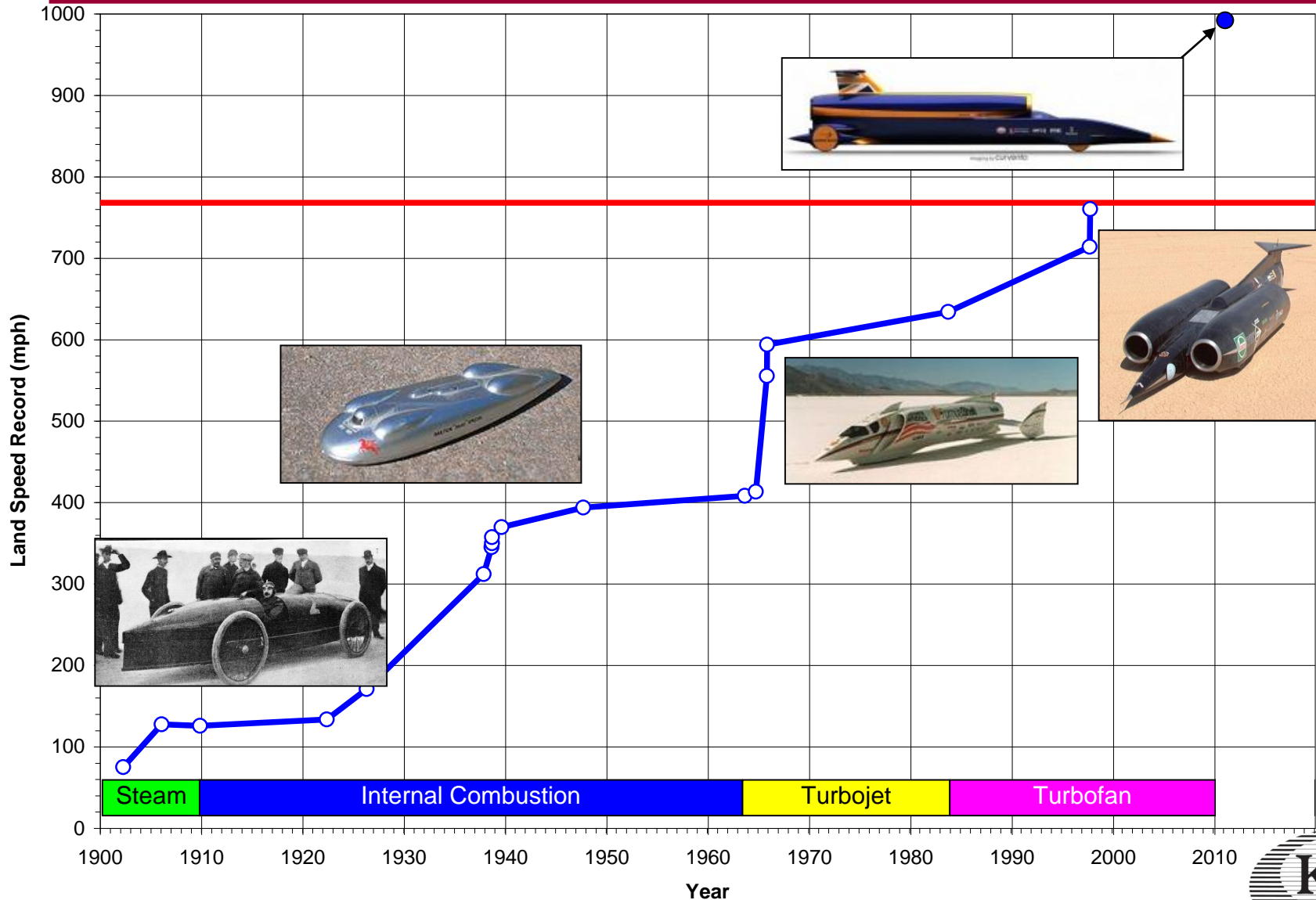


- All wells feasible with existing technology
 - Many are on hold for economic reasons
 - Some are in the late stages of planning

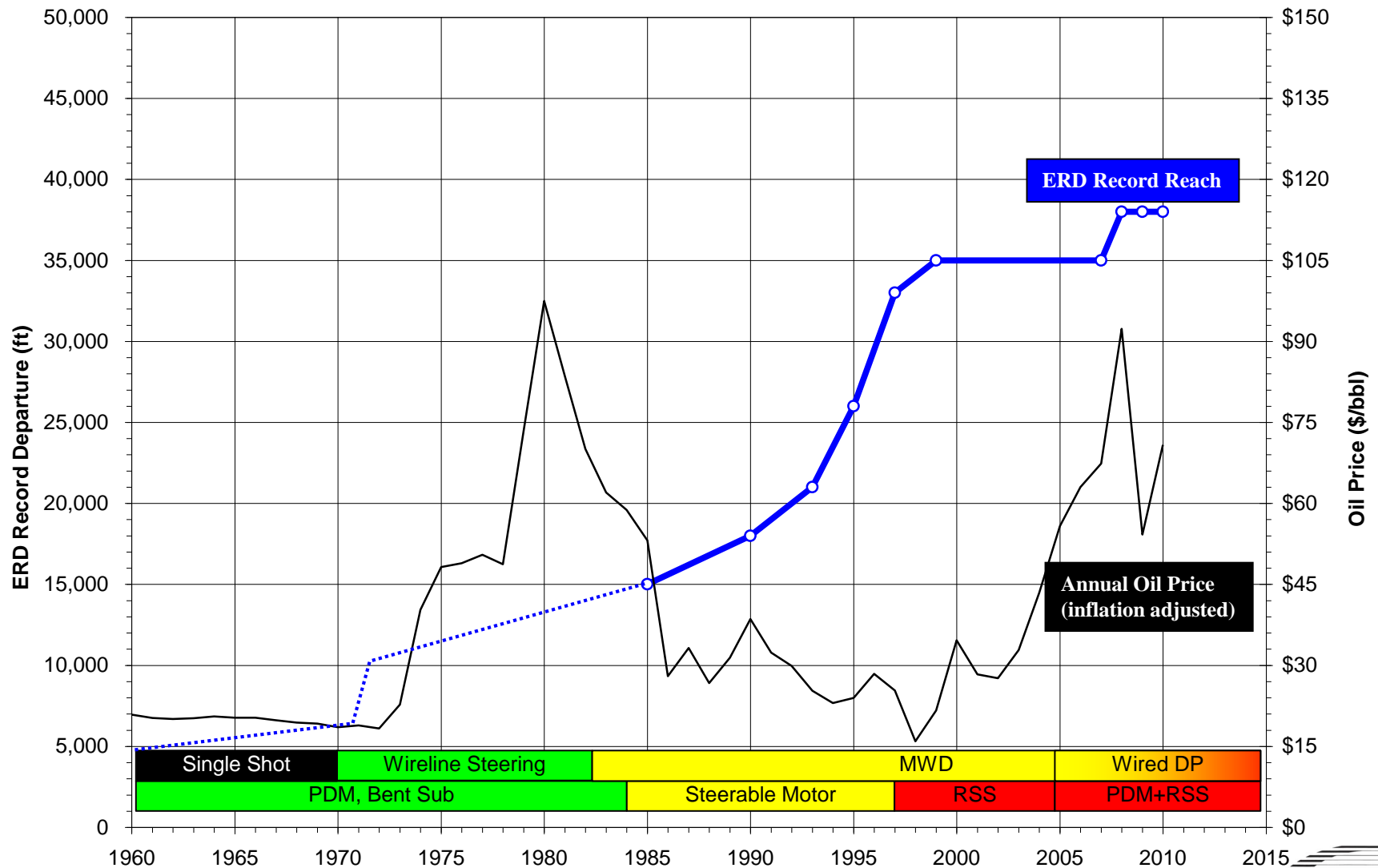
ERD: Big Numbers In Context



Land Speed Record



Extended Reach Drilling Record



Potential Limiters

- Drag / Buckling –RSS, casing/liner flotation and/or rotation
- Pump Pressure – Big drillpipe, big pumps
- Tension – Only an issue at deep TVD
- Telemetry – Wired DP, Acoustic, better mud pulse
- Position Uncertainty – Gyro, IIFR, advanced TVD
- Torque – High torque DP, light DP, big top drive
- ECD – Big hole, small pipe, thin mud
- Logistics – Depends on the location – MOQ ran out of DP!
- Economics – Who's going to pay for all this?

Technology Parallels

Directional Technology

- Single Shot/Stabs
- Motor/MWD
 - HT Drillpipe
 - HP Pumps
 - Flotation
- RSS
 - Huge Top Drives
 - Lightweight Material
 - Wired Telemetry
 - Powered RSS
- Tunneling Machine?

Propulsion Technology

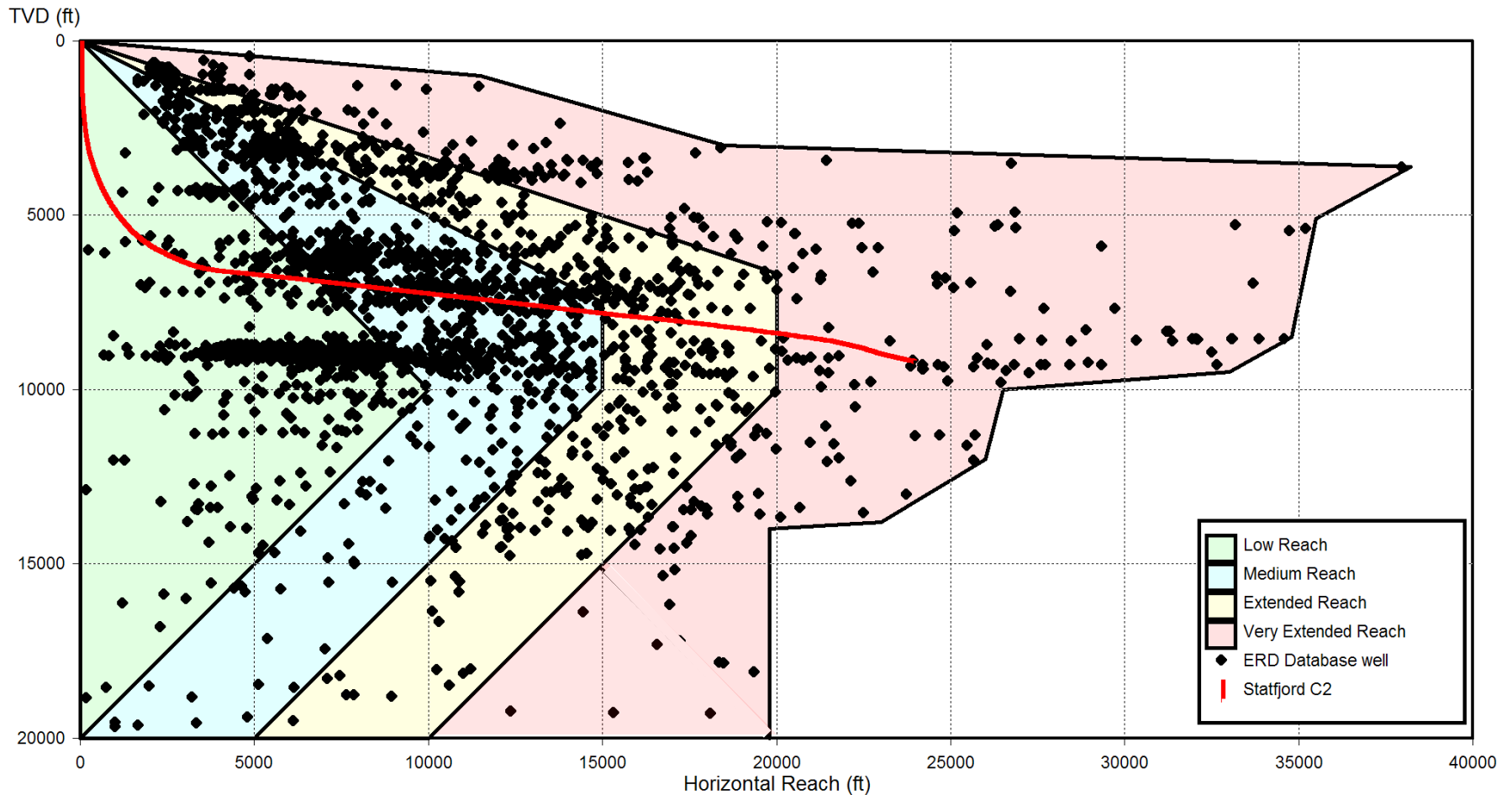
- Steam
 - Tires
 - Aerodynamics
 - Supercharger
- Jet
 - CFD Aerodynamics
 - Wheel Technology
 - Steering
 - Turbofan
- Rocket

Lessons From The Past

Statoil Statfjord C2

- Drilled to $\pm 29,000'$ MD ($\pm 23,000'$ reach) in 1992
 - Entirely with motors, but configured differently than today
 - 0.78° ABH and 0.30° FB, 5% Sliding in the tangent
 - Using 150-180 rpm, with up to 250 hr long runs
 - 2x1600 hp pumps
 - Fit for purpose drillstring design
 - $5\frac{1}{2}'' \times 6\frac{5}{8}''$ in the $12\frac{1}{4}''$
 - $5\frac{1}{2}'' \times 5''$ in the $8\frac{1}{2}''$
 - Ester Based Mud
 - Pseudo catenary wellpath
- $12\frac{1}{4}''$ TD was cut short by due to torque (30 k ft-lbs)
- 7" Liner got stuck off bottom

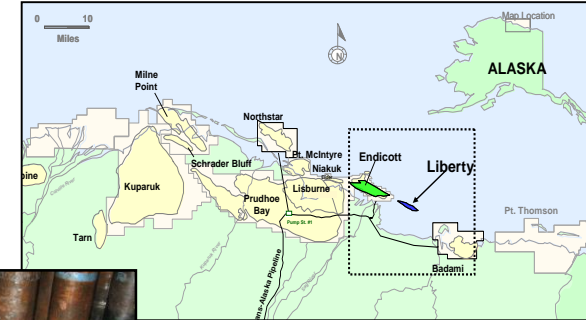
Lessons From The Past



A Look To The Future

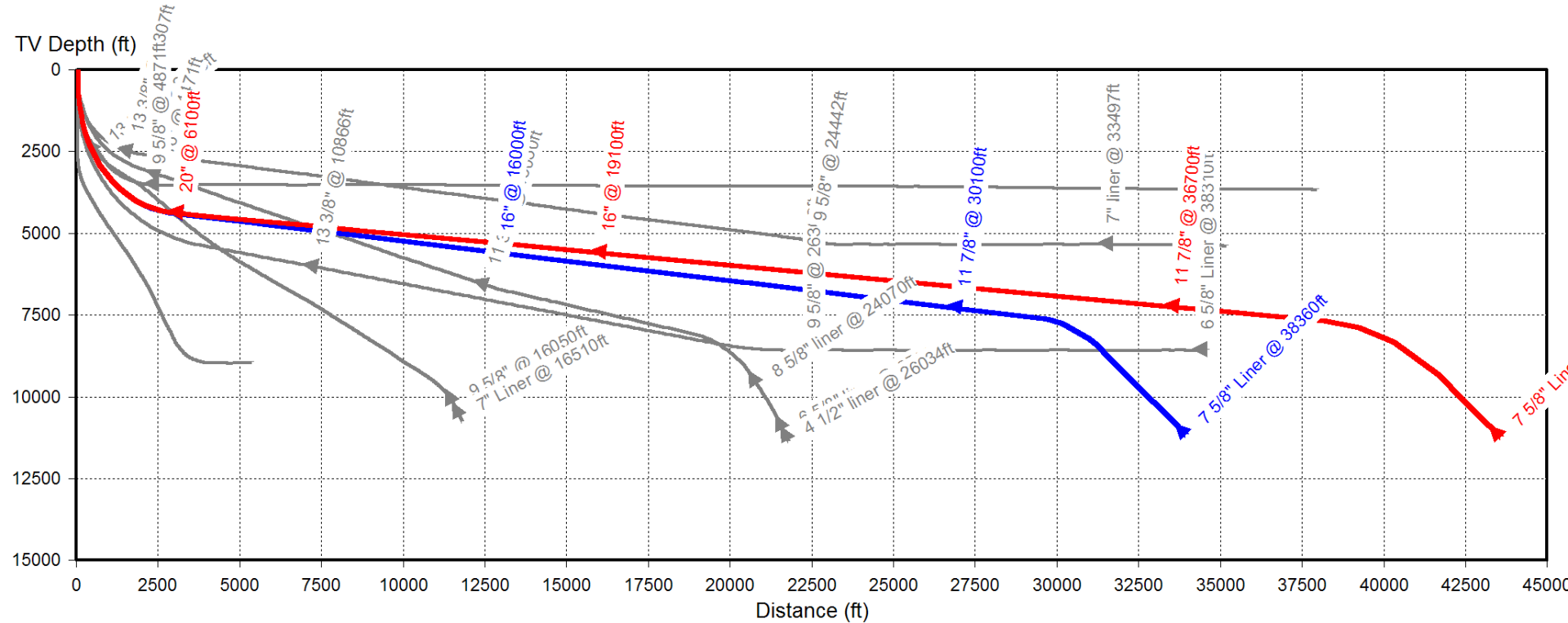
BP Liberty

- 5 Well Development of ± 100 Million BOE
- 38,000' – 48,000' Well Length
- >\$1 Billion Capital Expenditure
- Custom Drillpipe
 - Thin Wall High Strength Steel
 - Aluminum (contingency)
- Massive Rig
- “Designer” Architecture
 - 20”x16”x11 $\frac{7}{8}$ ”x7 $\frac{5}{8}$ ”
 - For ECD Management
 - A consequence of geology



Liberty vs. Record Wells

Unwrapped Length
Liberty vs. Alaska and "Industry" Record ERD



- Prudhoe Bay (MD)
- Endicott 4-48 K43 (MD)
- Northstar NS33A (MD)
- Chayvo Z12 (MD)
- Wytch Farm M16 (MD)
- Al Shaheen BD-04A (MD)
- Liberty SDI-01 (MD)
- Liberty SDI-05 (MD)



“Big ERD” Comparison

Operator	Well	MD	Reach	Ratio
Maersk	BD-04A	40,320'	37,956'	10.8
XOM	Z12	38,310'	34,567'	6.6
BP	M16	37,001'	35,197'	4.1
BP	SDI-05	±48,000'	±44,000'	4.9

Well	Pumps	Standpipe	TDS	Drillpipe
Al Shaheen	2x1600 hp	5,000 psi	45 k	5", 4"
Chayvo	4x1600 hp	7,500 psi	60 k	5 ⁷ / ₈ ", 5"
Wytch Farm	3x1600 hp	5,000 psi	45 k	6 ⁵ / ₈ ", 5 ¹ / ₂ ", 5"
Liberty	4x2200 hp	7,500 psi	110 k	6 ⁵ / ₈ ", 5 ⁷ / ₈ ", 5", 4"

Summary

- Where have we been?

>40,000'

- Where are we going?

>45,000' soon, >55,000' later

- What are the limiting factors?

Not the DD tool anymore!

Maybe telemetry or position/geologic uncertainty eventually

- What is needed to go further?

Lower Torque, Lower ECD, Lower Cost, Less Uncertainty