Deepwater Isn’t Really That Scary

Presentation to OCSAB Workshop
Feb 3, 2016
Agenda

Presentation Goal: Give land professionals a broad overview on the history, challenges and development of deepwater projects.

1. Deep Gulf Energy
2. How Deep is Deepwater?
3. History of Deepwater Oil E&P
4. How Do We Decide Where and Whether To Drill?
5. Drilling and Completions
6. Macondo
7. Subsea Systems
8. Floating Production Systems
9. Project Management, Cost, Schedule
10. Major Messages
DGE Company Summary and Focus

DGE Highlights

- Formed 2005 by key management of Mariner Energy:
- Primary backer: First Reserve Corp
- Spent $1.5B to date
- No LTAs or spills
- Specialize in subsea developments tied back to existing host platforms
- Develop projects that are not material to the major oil companies
- Focus on exploitation and low risk exploration prospects: 80% exploration success rate so far
- Concentrate in oil prone areas of the DW GOM near existing Infrastructure
- Low cost operator
- Get projects on stream quickly (less than 2 years from discovery to first production)
- Partner to diversify risk

Overview of Deepwater Development

DGE Strategic Focus

Standalone Development
- Cost: $4-6 billion
- Reserves: 250 Mmboe +
- Prod: 75 MBOPD
- First Prod: 5-10 yrs

DGE Subsea Development
- Cost: $170-250 million
- Reserves: < 20 Mmboe
- Prod: 10 MBOPD
- First Prod: 2-3 yrs
“*%$&/#*!! – another deepwater development – they must be getting desperate up there.”
Traditionally “Deepwater” is 1000’: Max normal working depth for divers
Bullwinkle: GOM, 1066’ W.D.
About as deep as you can go with gravity
“Deepwater” is really the technology used, not just the water depth.
Does not float and thus not “Deepwater”
Troll Field
North Sea
426’ W.D.
Expensive but not deepwater
GOM Offshore Wells

Source: Wood Mackenzie
Simple Deepwater Development
300' - 10,000' WD

UTA

SCM

Subsea well with tree

FPF

Flowline 4" - 18"

Offset Distance 2 - 96 miles
How do we decide whether to drill?
Prospect Evaluation

If the chance of success is 40%

Drill Baby Drill!
Air-gun is the source of shock waves - compressed air is more environmentally friendly than explosives.

Hydrophones - there are up to 3000 hydrophones on a 3000m cable.
What are we looking for?
Is it big enough?

Structure: Hyal B
What is it?

Key Parameters

- 82% N/G
- 32.9% PHI
- 26.6% Sw
- 31 API
- 1229 GOR
- Saturated

Formation Pressure Gradient

- 84 ft Gross
- 69 ft Net

Equation:

\[ y = 0.2964x + 3474.6 \]

\[ R^2 = 0.9995 \]
DRILLING/COMPLETIONS
Mud passing through the bit, keeping it cool and carrying cuttings to the surface.
GB 339 Wellbore Schematic

10,000 psi Vertical Tree

Chemical Injection Mandrel
Dome Charged SCSSV (below hydrate region)

4-1/2” 13 Cr Tubing, Premium Connections

Frac Pack Completion
9-5/8” at 8473’
SITP @ Tree = 13,870 psi (U4/8)
Est Sea Floor Temp 42 F

Control Line Minimums
- 1/4" x 1/4" x 3/8" 4,472
- 3/8" x 3/8" 21,267
- 1/4" x 1/4" x 1/4" 21,567

TEC Electrical 21,567

36" 5,151' MD/TVD
28" 6,898' MD/TVD
17-7/8" 7,285' MD/TVD

2.562" TF Twin Flow
2.562" XD sliding sleeve
ID = 2.562" (up to close)

3/8" 25,000'

1/4" x 1/4" x 3/8" Need: 6,000'

3-1/2" 10.2# 13 Cr 110 BTS-8 isolation
"Q" Reservoir (oil)
Grad = 0.288 psi/ft
Burst = 18,390 psi
Collapse = 19,010 psi

2.515" FS-2
ID = 3.560", Wall ID = 3.640"
ID = 3.560", Wall ID = 3.640"
Connection OD = 5.313"

9-7/8" Liner 27,542' MD / 26,347' TVD
9-7/8" ID: 8.519"
9-7/8" Connection ID: 8.559"
9-7/8" Drift: 8.500"

"U4" Reservoir (oil)
Grad = 0.315 psi/ft
1.910" min id through IB4 shifter

2.770 IB4

"U8" Reservoir (oil)
Grad = 0.295 psi/ft
2.255" min ID for 2.895" OD CT
2.255" min ID for 2.895" OD CT

7-5/8" Liner 29,937' MD / 28,532' TVD
7-5/8" ID: 6.625"
7-5/8" Connection ID: 6.635"
7-5/8" Drift: 6.500"

Revised: 3/18/2015
Moored Semi-submersible

Dynamically Positioned Drillship

21” Riser with buoyancy

BOP Stack
Riser Being Run Thru Moonpool
BOP Stack

Blind Shear Ram

Variable Bore Ram

Riser Adapter

Upper Annular

Lower Annular

LMRP Connector

Blind Shear Ram

Casing Shear

3 1/2 TO 6 5/8 VBR

3 1/2 TO 6 5/8 VBR

3 1/2 TO 6 5/8 VBR Test Ram

Top of Wellhead

TL Blowout Preventer
Hub for LMRP
Choke Line
Lower Stack
CUSS 1
The first floating drilling rig
1956
Conoco Union Superior Shell
6th Generation DP Drillship

- Twin derricks for dual activity
- Main derrick rated to 907 Mt (2,000,000 lbs)
- 180 man quarters
- Capable of drilling to 10,700m (35,100’) total depth.
- Can rack back drill pipe in quads 38 m (124’)
- 228m (748’) OAL x 42m (138’) Wide
- Operate in 3000 m (9840’) water depth.
Blue Water 1 industry's first semisubmersible drilling rig

1962
COSL Deepwater Semi-submersible Drilling Rig
A new design of deepwater drilling rig based on the success of Spar production platforms
Directional Drilling

GC195 Tiger
Final wellbore sketch and status

2196 ft 260 ft BML
4022 ft 2106 ft BML
6006 ft 4090 ft BML
10,308 ft 8392 ft BML
14,183 ft 12,267 ft BML
15,800 ft 13,884 ft BML

16'-0" TOC 4500 ft
11-7/8" TOL 9,980 ft
9-5/8" TOL 13,890 ft
9-5/8" TOC
Cement Retax

Build and hold at 3 deg/100' to 50 deg inc. on 108 deg az.
No hydrocarbon zones exist in the open hole

TD 19,309 ft MD 19,300 ft TVD
17,384 ft TVD BML

TD 19,400 ft MD 18,577 ft TVD
16,661 ft TVD BML
Deepwater Directional Drilling
Heck, deepwater drilling is not that much different than in shallow water!
She came in!
Macondo was not a difficult well: In Theory

Macondo Well - MC 252

Deepest Wells According to Water Depth/Total Depth

4,992 ft. (1,521 m) Water Depth

18,360 ft. (5,608 m) Total Depth

BHP ~ 13,000 psi

10,011 ft. (3,078 m) Water Depth

35,055 ft. (10,683 m) Total Depth

BHP >20,000 psi
This is where they were

This is where they were going to

Sea Floor

Pay Sands

End of Cement Job

Sea Floor

Lockdown sleeve

3300 feet of mud removed

Cement plug

Temporarily Abandoned
Key Causes of Blowout

Well integrity was not established or failed
1. Annulus cement barrier did not isolate hydrocarbons
2. Shoe track barriers did not isolate hydrocarbons

Hydrocarbons entered the well undetected and well control was lost
3. Negative pressure test was accepted although well integrity had not been established
4. Influx was not recognized until hydrocarbons were in riser
5. Well control response actions failed to regain control of well

Hydrocarbons ignited on the Deepwater Horizon
6. Diversion to mud gas separator resulted in gas venting onto rig
7. Fire and gas system did not prevent hydrocarbon ignition

Blowout preventer did not seal the well
8. Blowout preventer (BOP) emergency mode did not seal well

Deepwater Horizon Accident Investigation
Helix Fast Response System

- Non-DP Storage Tanker
- Helix Producer I
- 12" Flex Export Line Floating Offloading Hose (Hawser not shown)
- 5" 10,000 PSI Flexible Riser
- Intervention Riser System
- Stack Can Connect to BOP, Wellhead or Tree
- Riser
- IRS
- SSOD
- BOP Stack
- Subsea Shut Off Device / Well Cap
Subsea Well Completions Per Year Since 1961
The world’s first subsea tree being retrieved. 1961-1995
Modern Subsea Tree
Simple Deepwater Development
300' - 10,000' WD

FPF

Offset Distance
2 - 96 miles

Umbilical

Flowline
4'' - 18''

UTA

SCM

Subsea well with tree

FLET
Where are we going to tie back to!?!
GB 206
27.2 Miles

VR 398
30 Miles

EC 381
39.4 Miles

GB 72
22.3 Miles

GB 208
11 Miles

GB 516
10.4 Miles

Auger
6.2 Miles

GB 602
20.4 Miles

Distances are Approximate Values
CONTROLS
Umbilical System
Test time!

When, where and why was the first subsea pipeline?
Project Pluto: Pipeline Under The Ocean
1’st subsea pipeline 1944
One of the most secret places in WW2
Pluto pumping station today
Fluor Chickasaw
1970 Scrapped 2014
Santa Fe Apache, 1979
Now upgraded, Technip
Pipe being welded ready to reel on ship.
Allseas Solitaire
World’s largest
deepwater
pipelay vessel
Any lawyers in the crowd?
Loops currents cost us more than hurricanes
How do we hook this stuff up?
Subsea Hookup
Diver Dog!
World’s First ROV: British Royal Navy “Cutlet” 1956
Shilling’s latest Remotely Operated Vehicle (ROV)
AUV
Should have talked to the Reservoir Engineers !!!
Flow Assurance Challenges

- Prevention and remediation of;
  - Hydrates
  - Paraffin
  - Scales
  - Asphaltene
  - Corrosion
  - Erosion

- Production of heavy oil with low GOR

- Mechanical treatment;
  - Pigging
  - Scrapping
  - Chemical solvents
  - Thermal intervention

- Sand incursion & control measures
Hydrates and wax problems can be severe in deepwater: “Flow Assurance”
TW 58, Argyll Oil Field - North Sea 1975
First floating production facility, first UK North Sea oil, Hamilton Brothers Oil & Gas
BP Thunder Horse
GOM
250,000 BOPD
World’s Biggest SS FPF
World's first FPSO – Shell’s 'Castellon' - in Spain (1977)
Total’s Usan FPSO: World’s biggest
Total’s Dalia FPSO: World’s Biggest
Total’s PAZFLOR: World’s biggest
Petrobras Cascade, GOM, BW Pioneer, world’s deepest
Marco Polo TLP (Tension Leg Platform)
32” Casing
“Tendons”
Anadarko Constitution Spar GOM
Major Spar Equipment
S7000 setting deck on Spar
Saipem 7000 Crane Barge
Real Man Hook!
USS Kearsarge as crane ship in 1922
250 tons lift capacity
Where do we go to get good people these days?
1975-2015 Average Yearly Crude Oil Price - Nominal vs. Real (in Dec-15 $)
The contractor’s idea of a good deal these days!
Get us on stream fast!
Major Challenges Overcome by the Deepwater Oil Industry

- Improved exploration results with deepwater seismic tools and interpretations
- Developed the technology to drill and produce not only in deepwater but in remote, harsh locations
- Survived terrible accidents in life, equipment and pollution
- Environmentally acceptable in most areas of the world
- Successfully negotiated difficult fiscal changes and nationalizations
- Rode the commodity rollercoaster
- Created huge wealth: Went from 0 to a $170B/yr industry in 45 years
Ya see: deepwater is really not scary at all!
Major Messages for Deepwater Projects
Get the right engineers from day 1!
Be prepared for all sorts of engineering surprises!
It takes courage and confidence to operate in deepwater!
Contracts should be clear but fair.
Deal only with the best companies.
Be the team that works together for a common goal.
Risk Management is key to success!
Humans cause most engineering disasters
Deepwater needs the best engineers in the world
Don’t be afraid to take on deepwater challenges.
Hang in there! The oil price will come back.
And don’t forget to work real hard!
It will be an exciting year for Deepwater!