

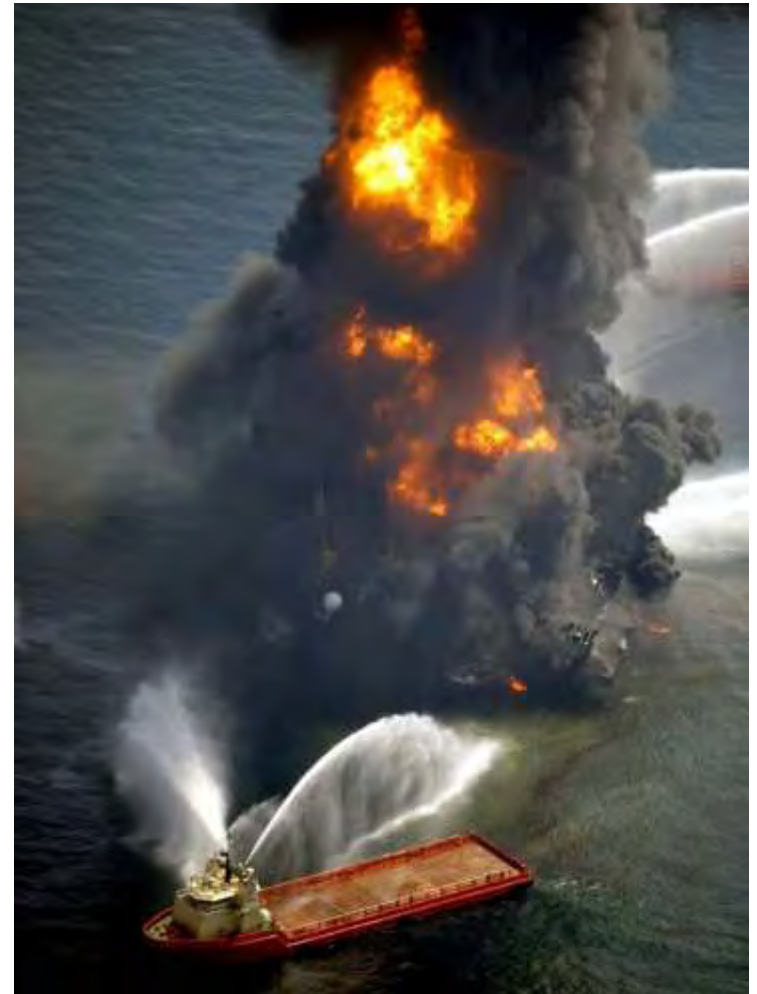
Lillehammer
March 3rd, 2011

Macondo – Well Control efforts



Dr. Ole B. Rygg, add wellflow as

- Macondo MC252 #1
- What happend
- Efforts to control the flow
- Comparison
 Macondo-Montara
- Are we prepared?



Deepwater Horizon Blowout

Facts

- Evening April 20, 2010
- 11 people lost their lives
- 17 people were injured
- Fire lasted 36 hours until the rig sank
- Hydrocarbons continued to flow for 87 days
- Well shut-in July 15



Baton Rouge

New Orleans

Dauphin Island
Cat Island Petit Bois Island

Santa Rosa Island

Macondo Prospect
Mississippi Canyon Block 252
MC 252

80 km

Transocean Deepwater Horizon

- 5th generation DP rig
- Built 2001
- Hyundai Heavy Industries
- 15,000 psi BOP
- Harsh environment
- Capable of operating in 9,000 ft water depth
- In 2009 TO DH drilled the deepest oil well in history at a vertical depth of 35,050 ft (10,683 m)



add wellflow's role?

Investigation Team

- What went wrong?
- Causes?
- Flow path?
- Why?
- How?
- When?

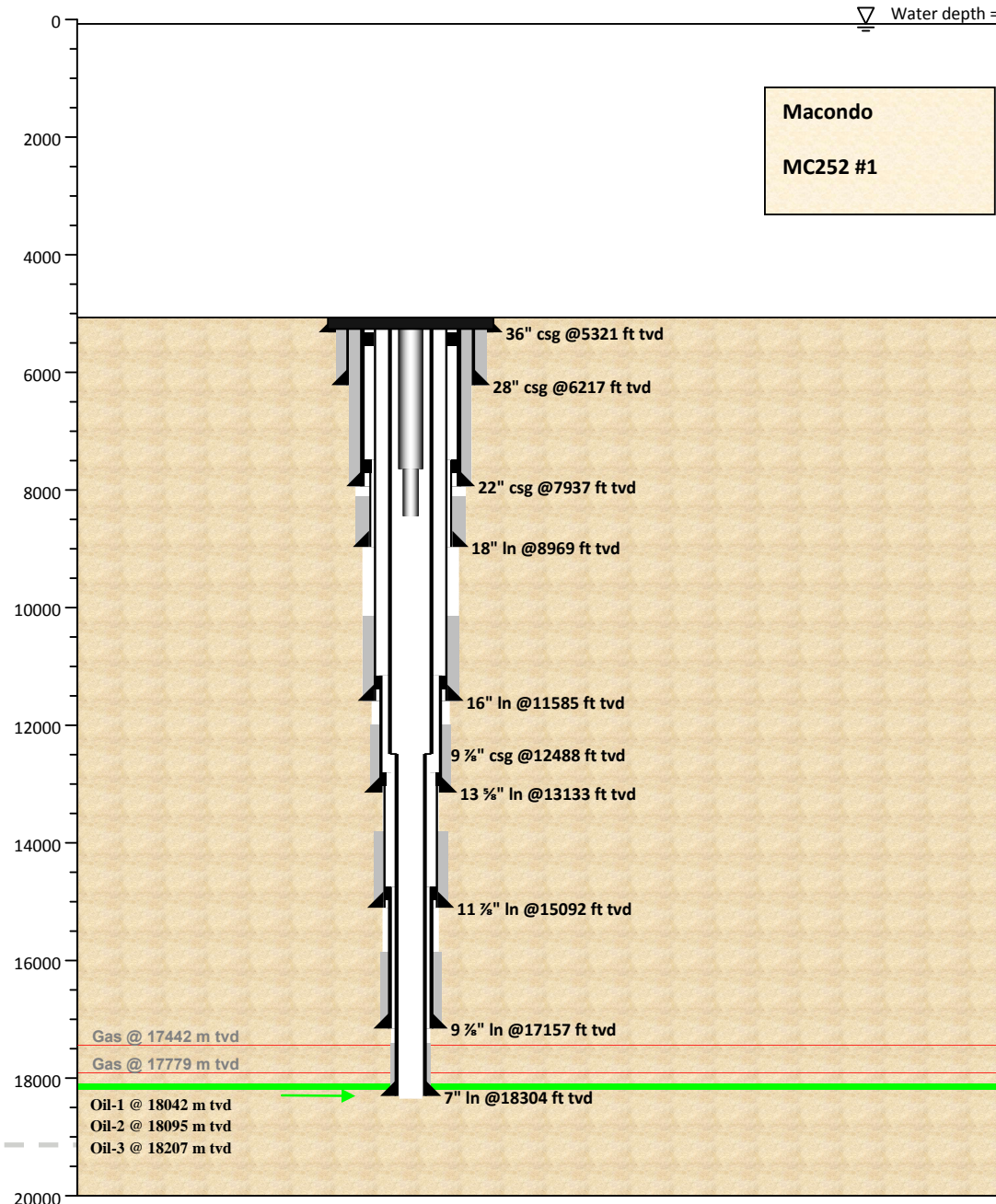
Response Team

- Diagnostics
- Flow path?
- How to mitigate?
- Kill plans
- Risk evaluation
- Supervision



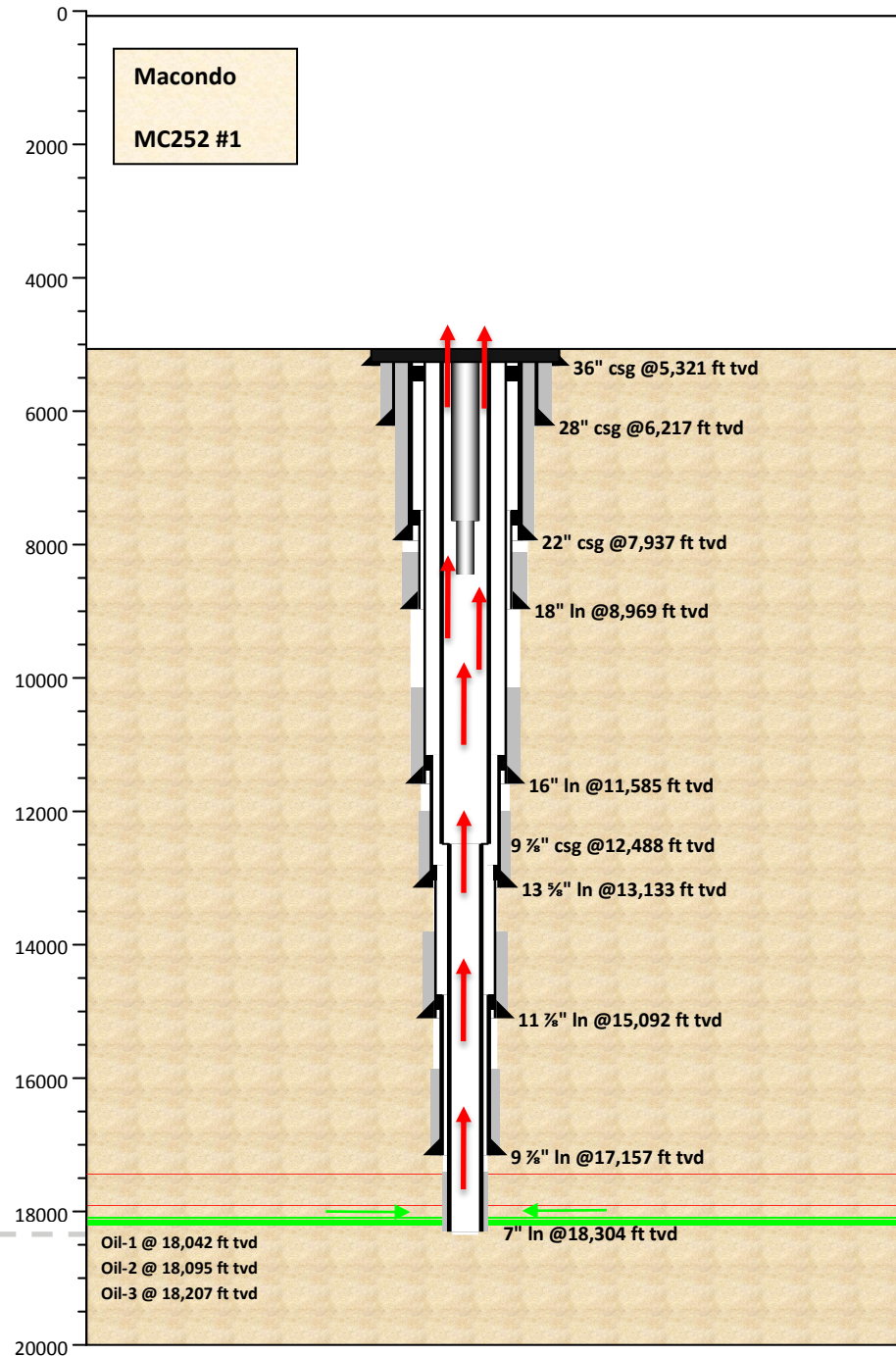
Macondo Well

- 3 oil sands
- Very prolific
- Deep water 1500 m
- Top reservoir at 5500 m
- High pressure 818 bar
- Temperature 114 °C
- High gas content
- Flashing below BOP
- Complex well



Flow path?

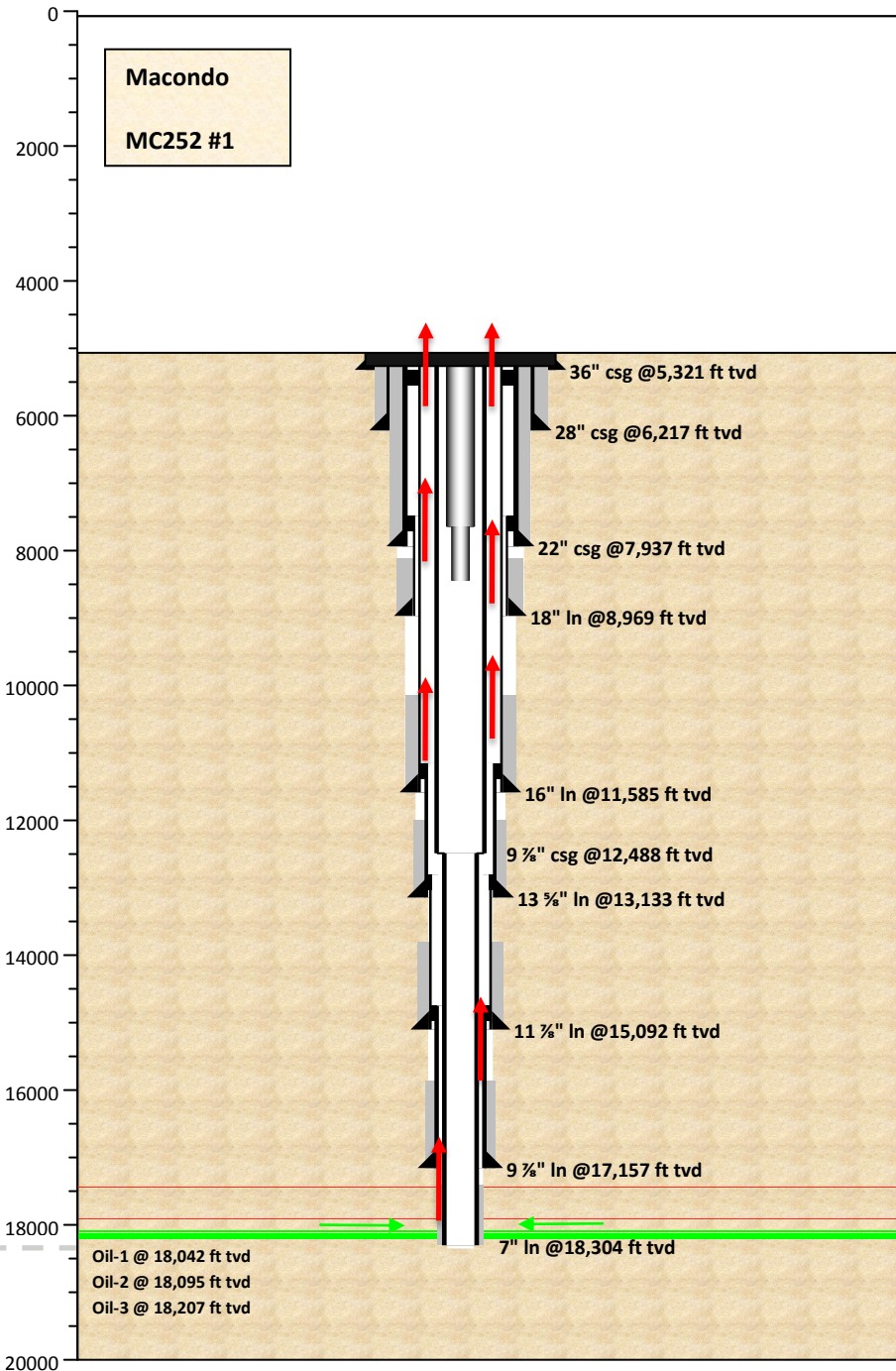
Flow inside 7" x 9 7/8" production casing



Flow path?

Flow inside 7" x 9 7/8" production casing

Flow in 7" x 9 7/8" production casing annulus

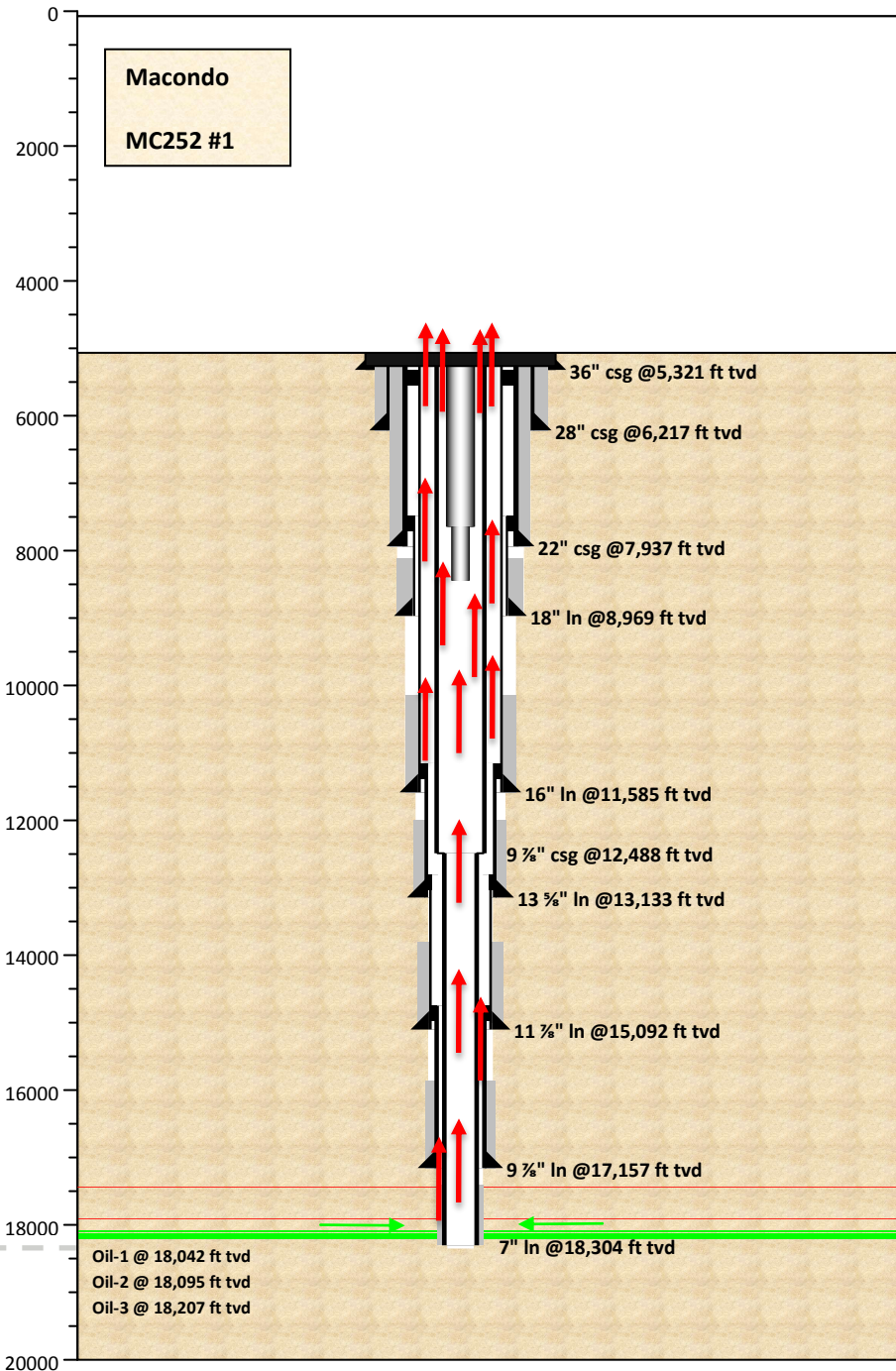


Flow path?

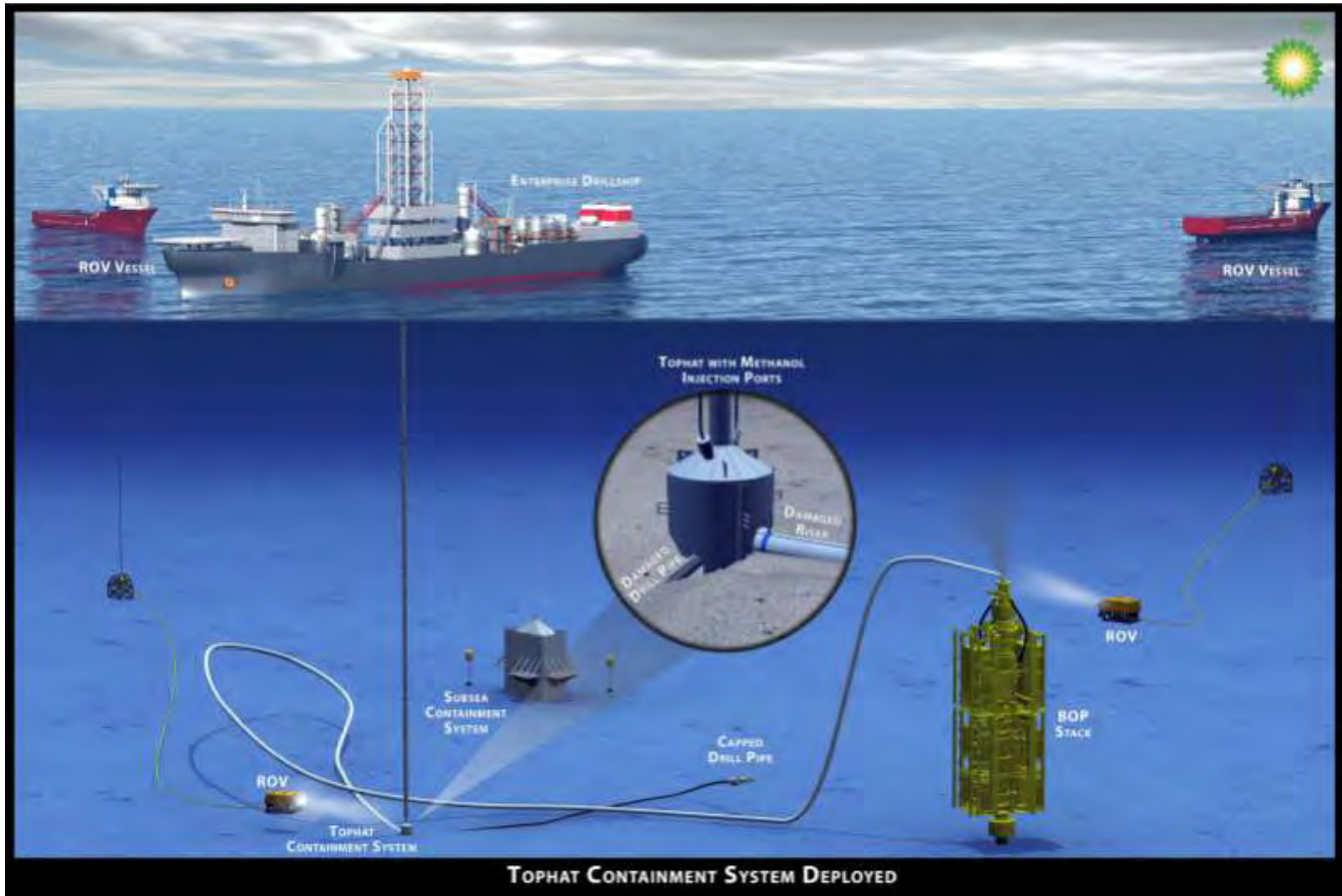
Flow inside 7" x 9 7/8" production casing

Flow in 7" x 9 7/8" production casing annulus

Flow outside and inside 7" x 9 7/8" production casing



Containment efforts – Top hat

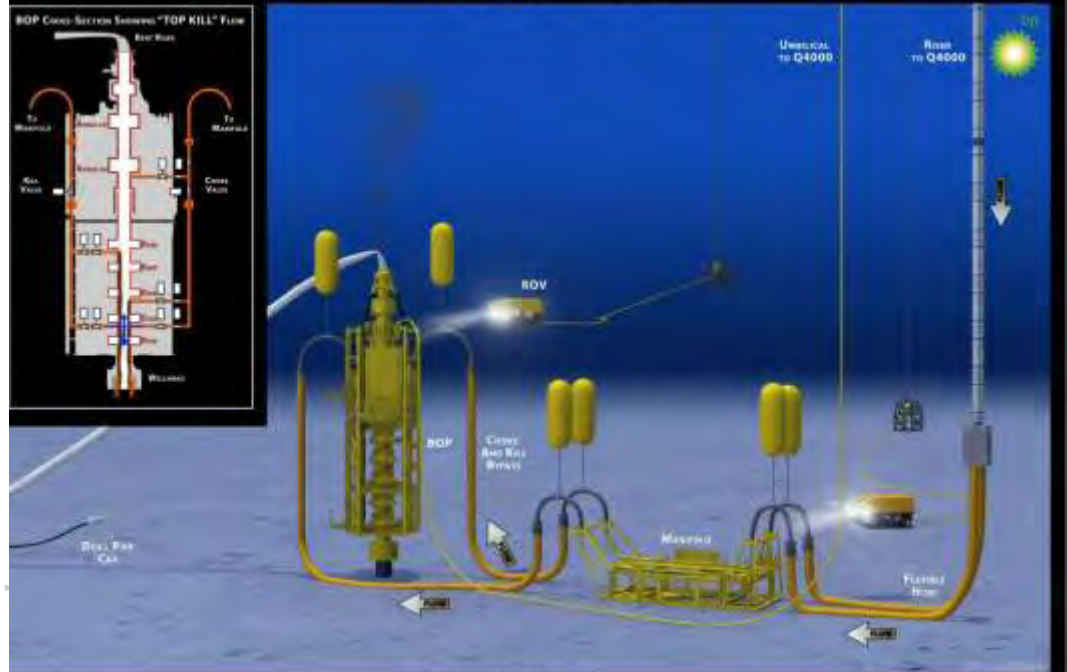


Top Kill Operation

- Pump mud into the BOP at high rate
- The mud mix with oil flow and create a pressure drop through the hole in the BOP
- The pressure increase and the inflow from the reservoir stops



TOP KILL SURFACE OPERATIONS LAYOUT

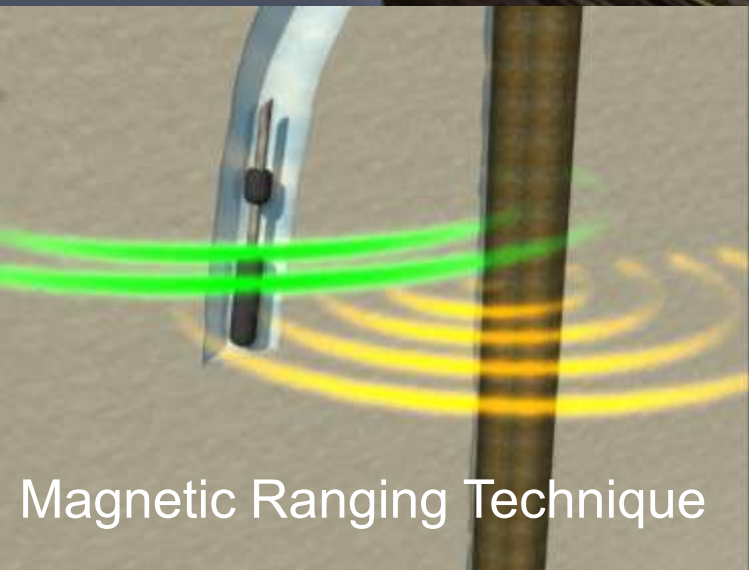
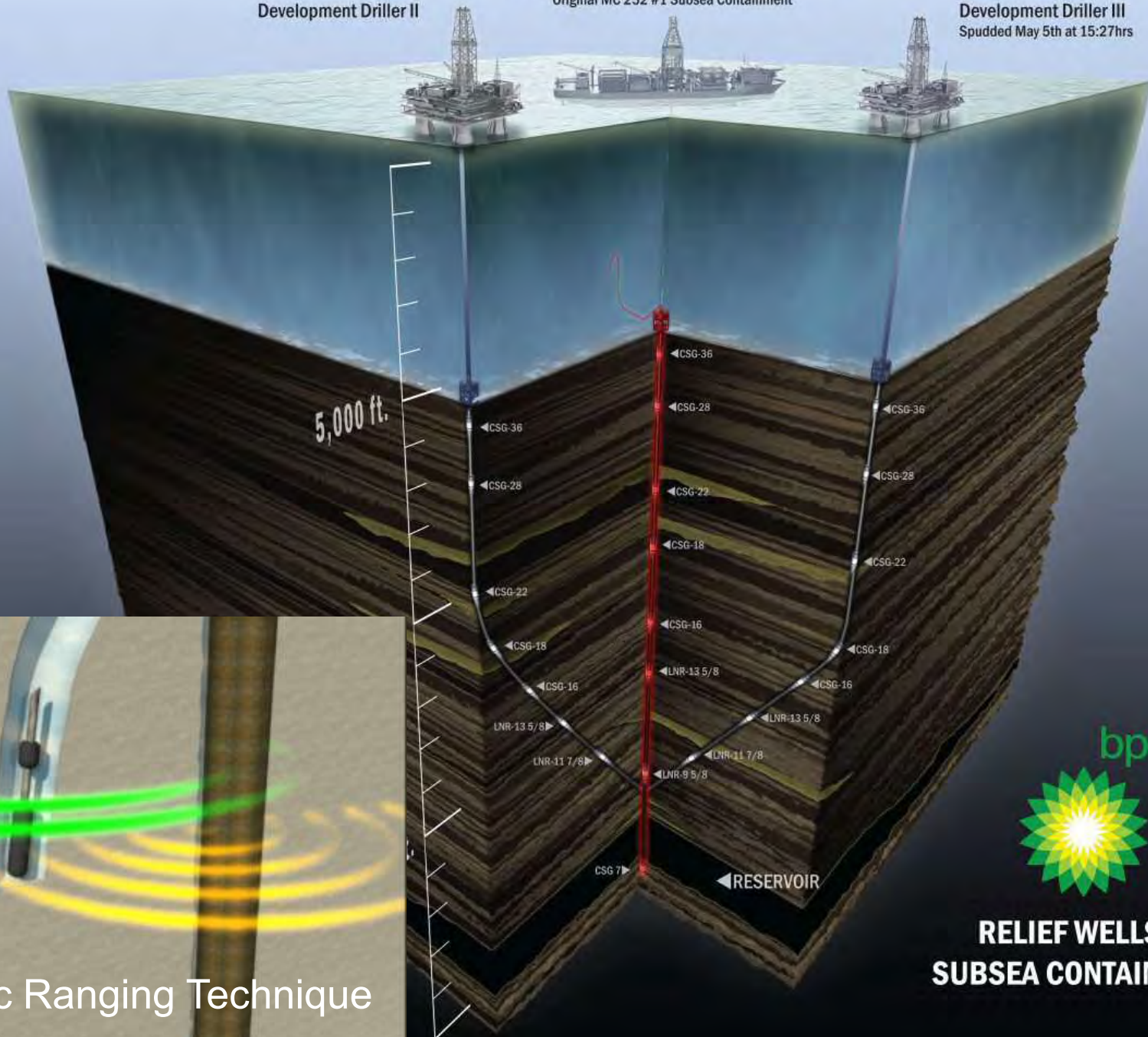


TOP KILL

RELIEF WELL #2
Development Driller II

DISCOVERER ENTERPRISE DRILL SHIP
Original MC 252 #1 Subsea Containment

RELIEF WELL #1
Development Driller III
Spudded May 5th at 15:27hrs



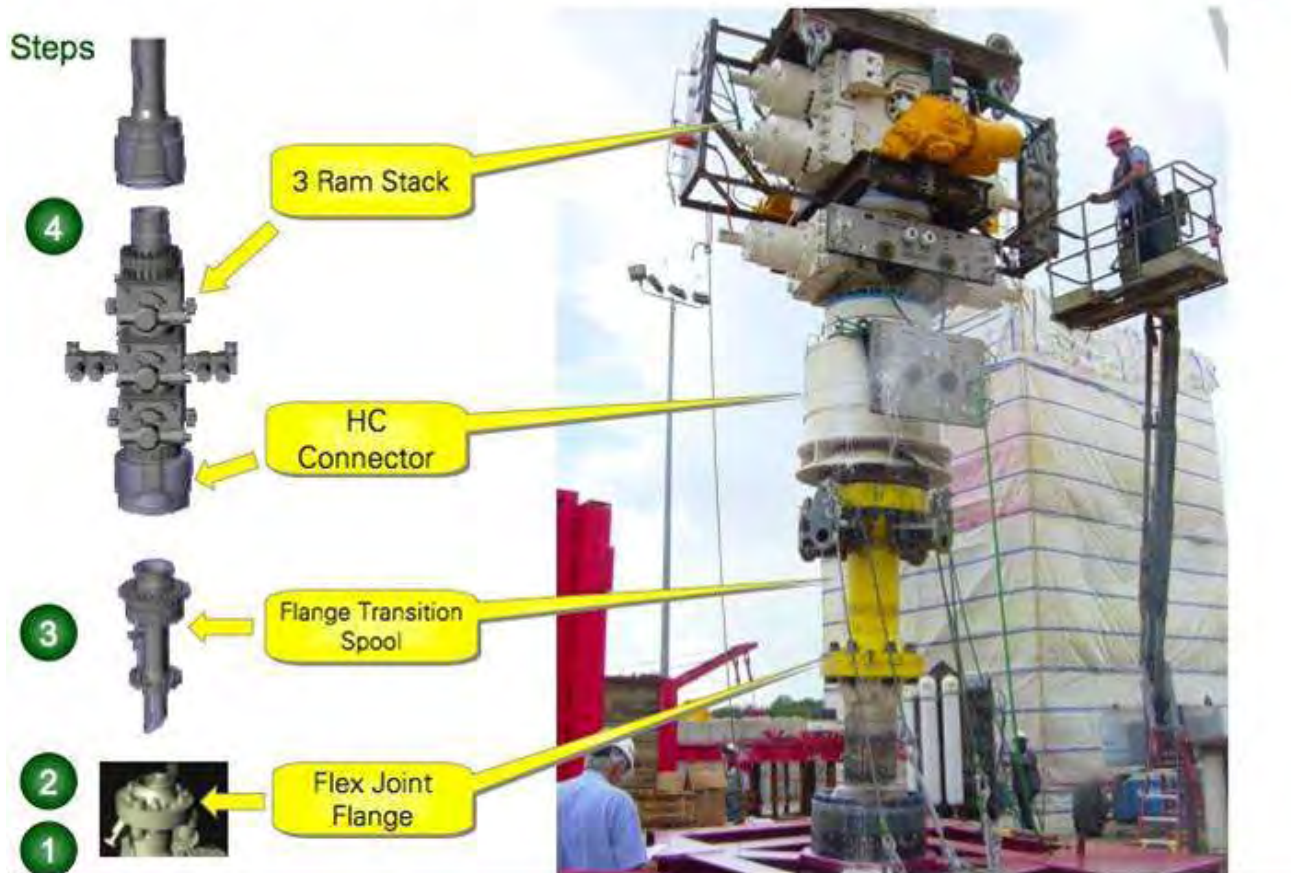
Magnetic Ranging Technique



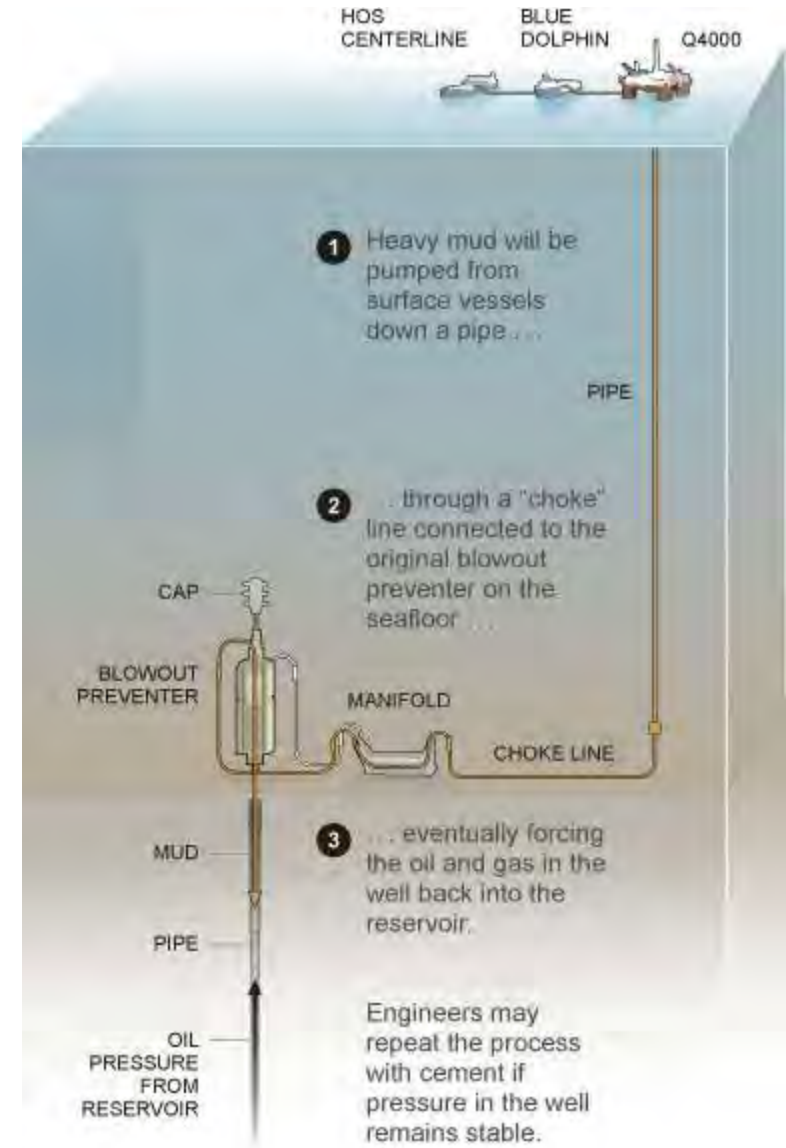
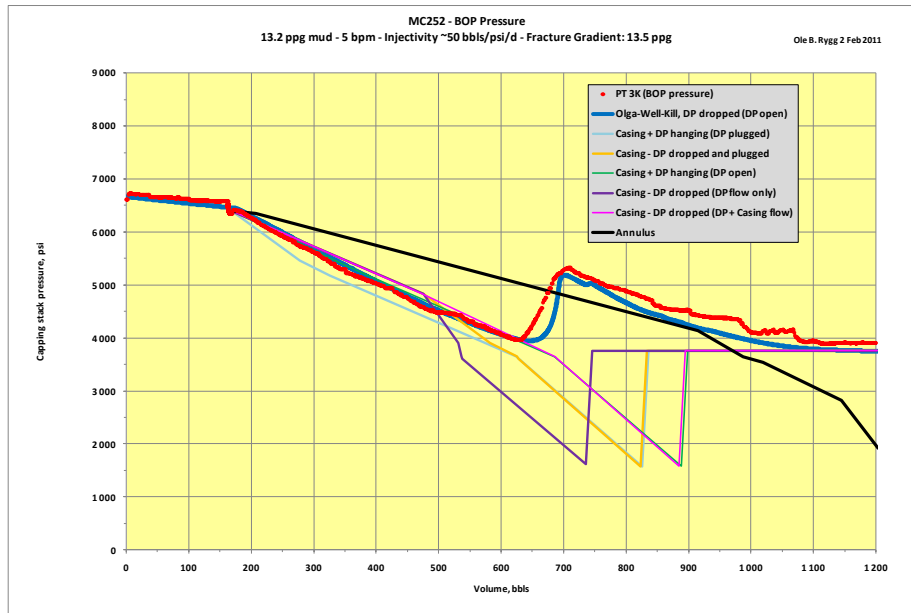
**RELIEF WELLS &
SUBSEA CONTAINMENT**

Installation of Capping Stack

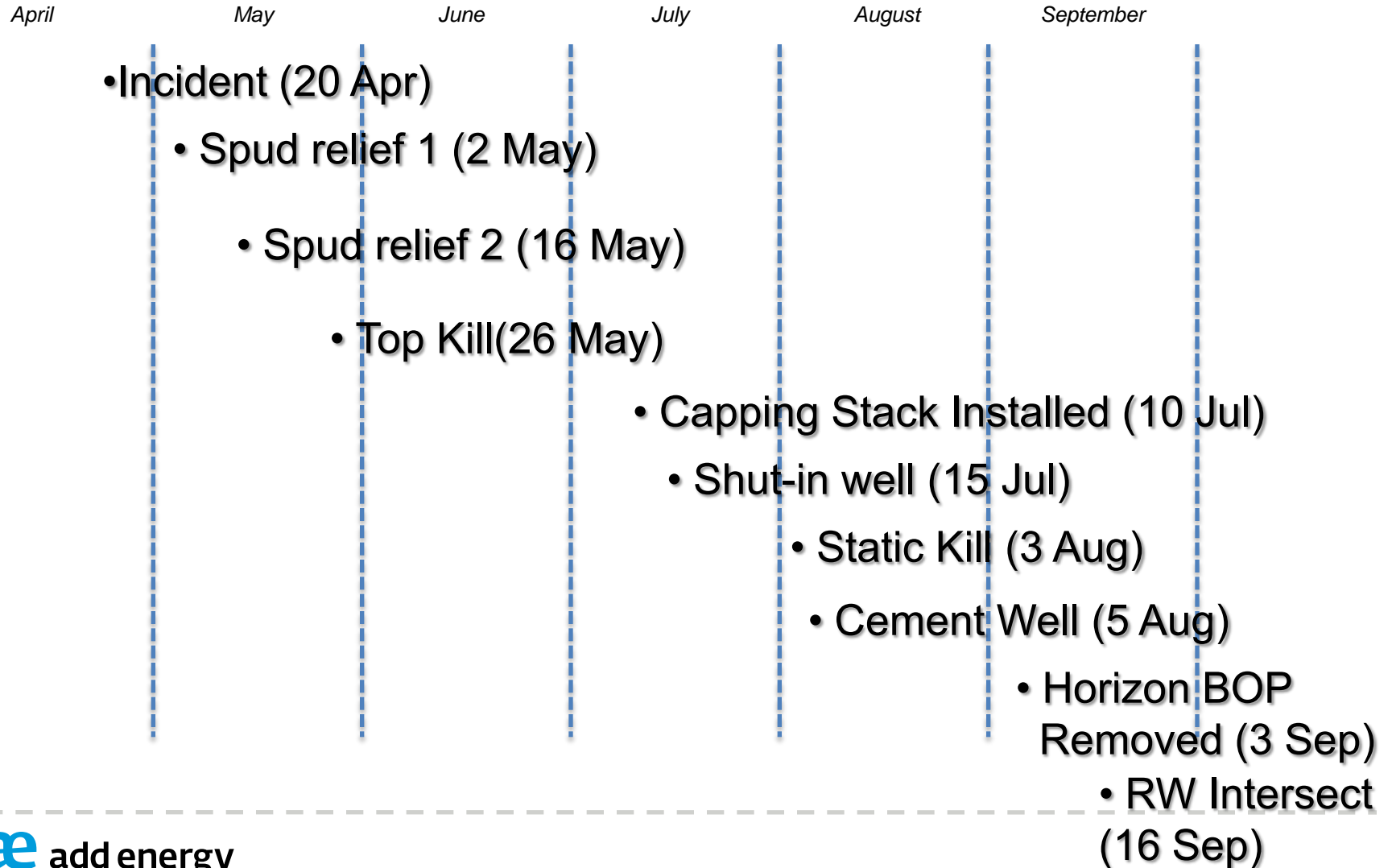
Sealing Cap Installation Steps



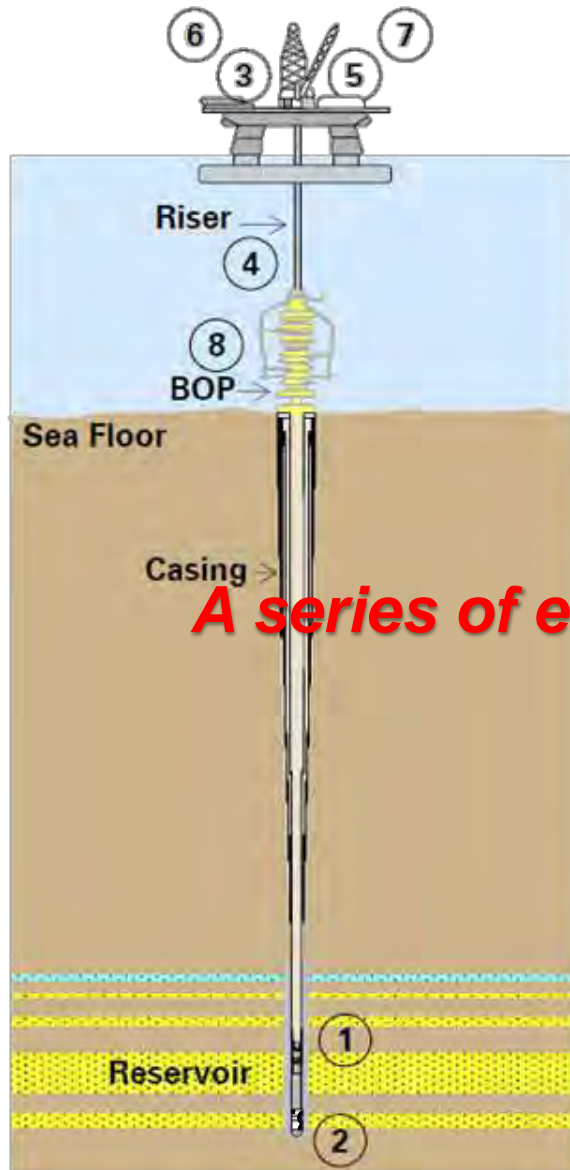
Shut-in of well followed by Static Kill (Bullheading)



Timeline - Operations



Summary of Key Findings



A series of events leading up to a full 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 modes did not seal well

Montara



Horizontal

77 m

2650 m

Gas + cond

272 bar

New

Open hole

Well

Water depth

Reservoir depth

Reservoir Fluid

Reservoir Pressure

Equipment

Blowout type

Macondo



Vertical

1500 m

5500 m

Light oil

818 bar

New

Open hole

Montara



Small

High

Low

High

1

Relief well

74

**Operator
Media attention**

**Government
involvement**

Pollution

Relief wells

Kill method

Days to stop flow

Macondo



Major

Extreme

High

Extremely high

2

**Capping/Relief
well**

87

Montara



Macondo



Yes	Chain of events	Yes
Yes	Cement failure	Yes
Yes	Shoe track failure	Yes
Yes	Failure to recognize inflow	Yes
Yes	Risk and impact of blowouts not well understood	Yes
Yes	Barrier failures	Yes
Yes	Trigger regulatory changes	Yes

What is the problem?

- Deep water?
- High pressure?
- Complex design?

- Risk awareness
- Complacency
- Competence

What should we prepare for
and how can we improve the response?

Response efforts - Containment

Pro

- Reduce spill
- Give time to implement final solution



Contra

- Not a final solution
- Reduce the access to the flow
- Increase complexity in the final solution
- Dependent on water depth and rate?
- Simops

SIMOPS



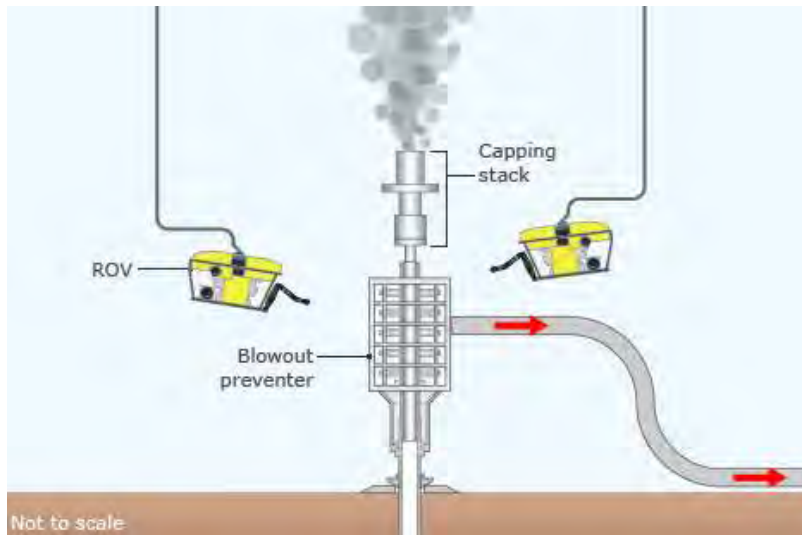
Response efforts - Capping

Pro

- Final solution
- Timing
- Reduce oil spill

Contra

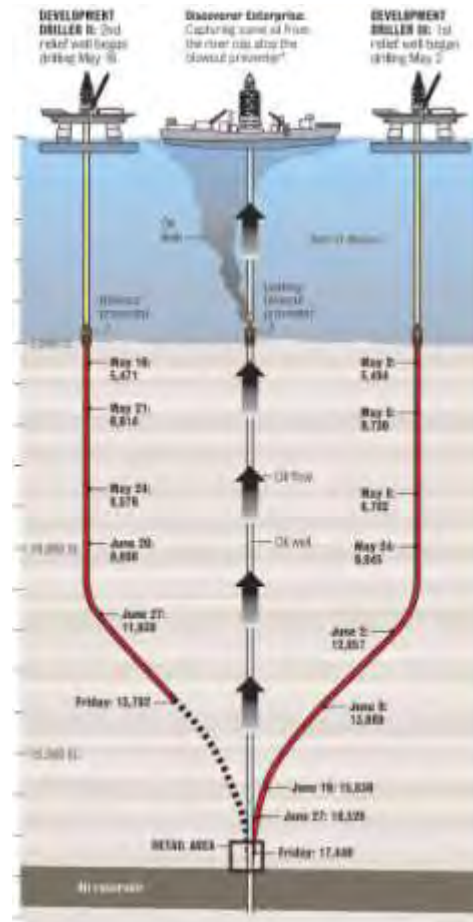
- Require access to well
- Rely on well integrity
- Limited subsea experience world-wide
- Access to equipment
- Simops



Response efforts – Relief wells

Pro

- Final solution
- Experience
- High success rate

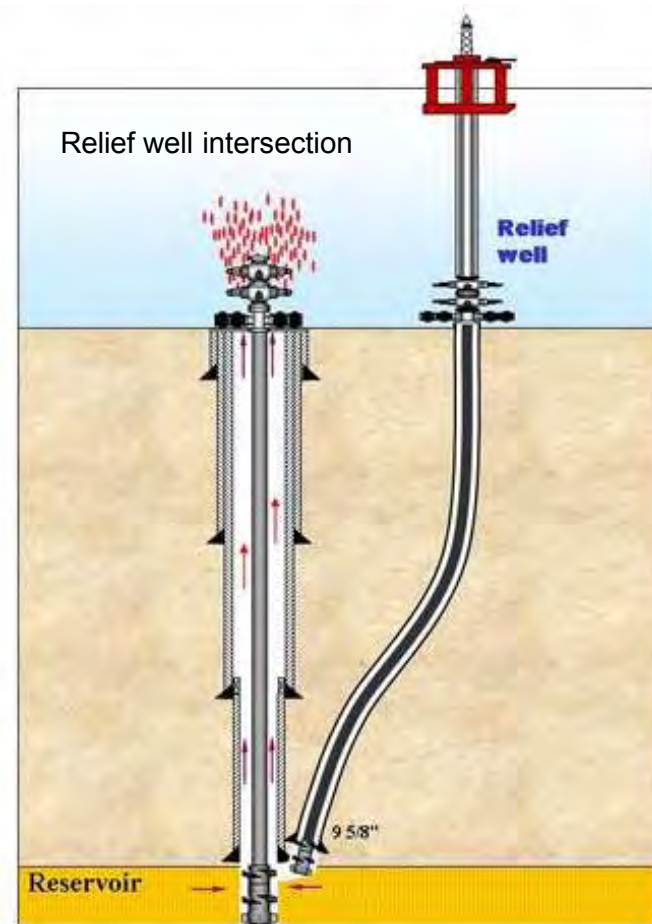


Contra

- Time
- Require access to rig(s)

Contingency planning

- ❑ **How much flow?**
- ❑ **Is it possible to stop it?**
- ❑ **How can I stop the flow?**
- ❑ **Do I have a rig available?**
- ❑ **Can I reduce the risk of my operation?**
- ❑ **Is my design robust?**





add energy
power to perform