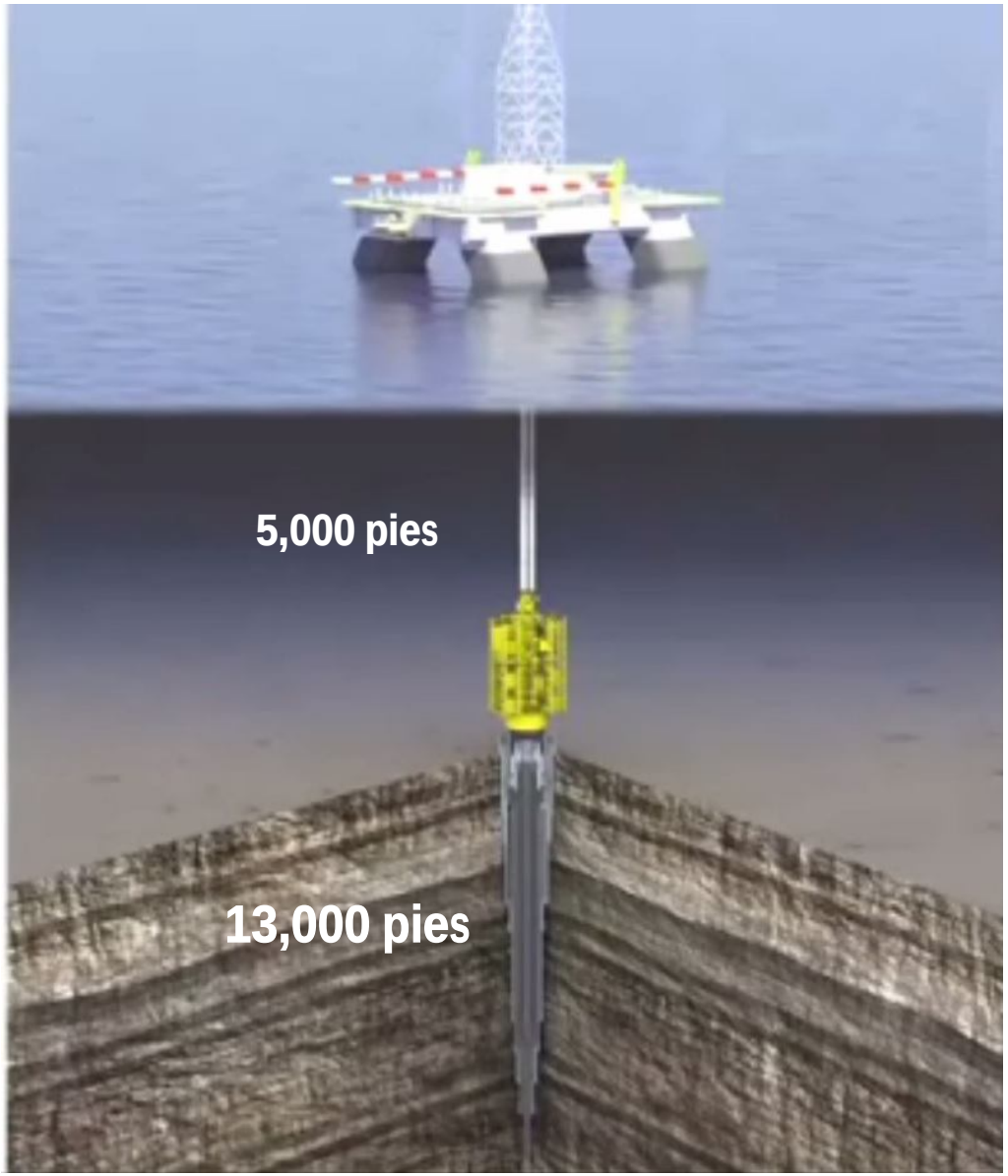
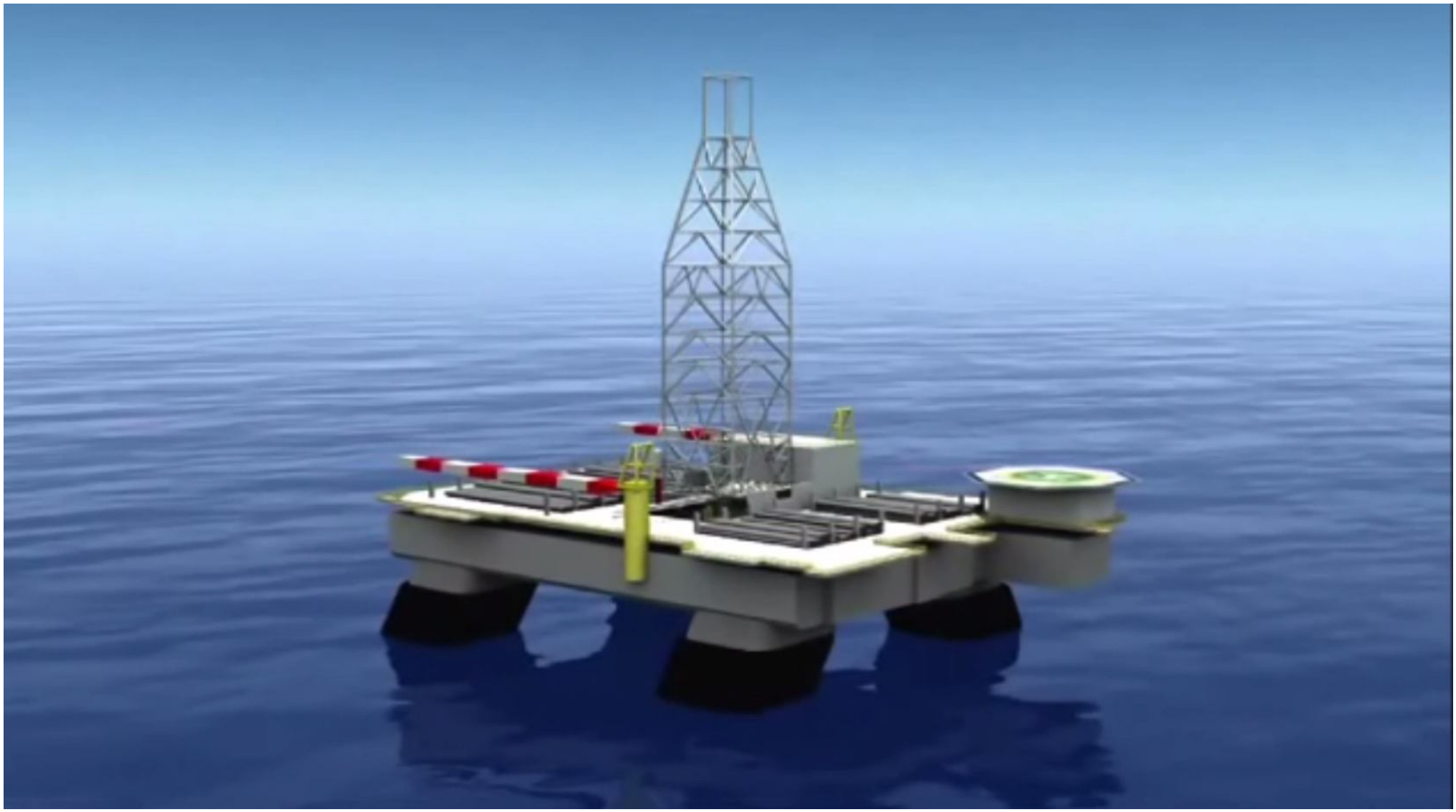
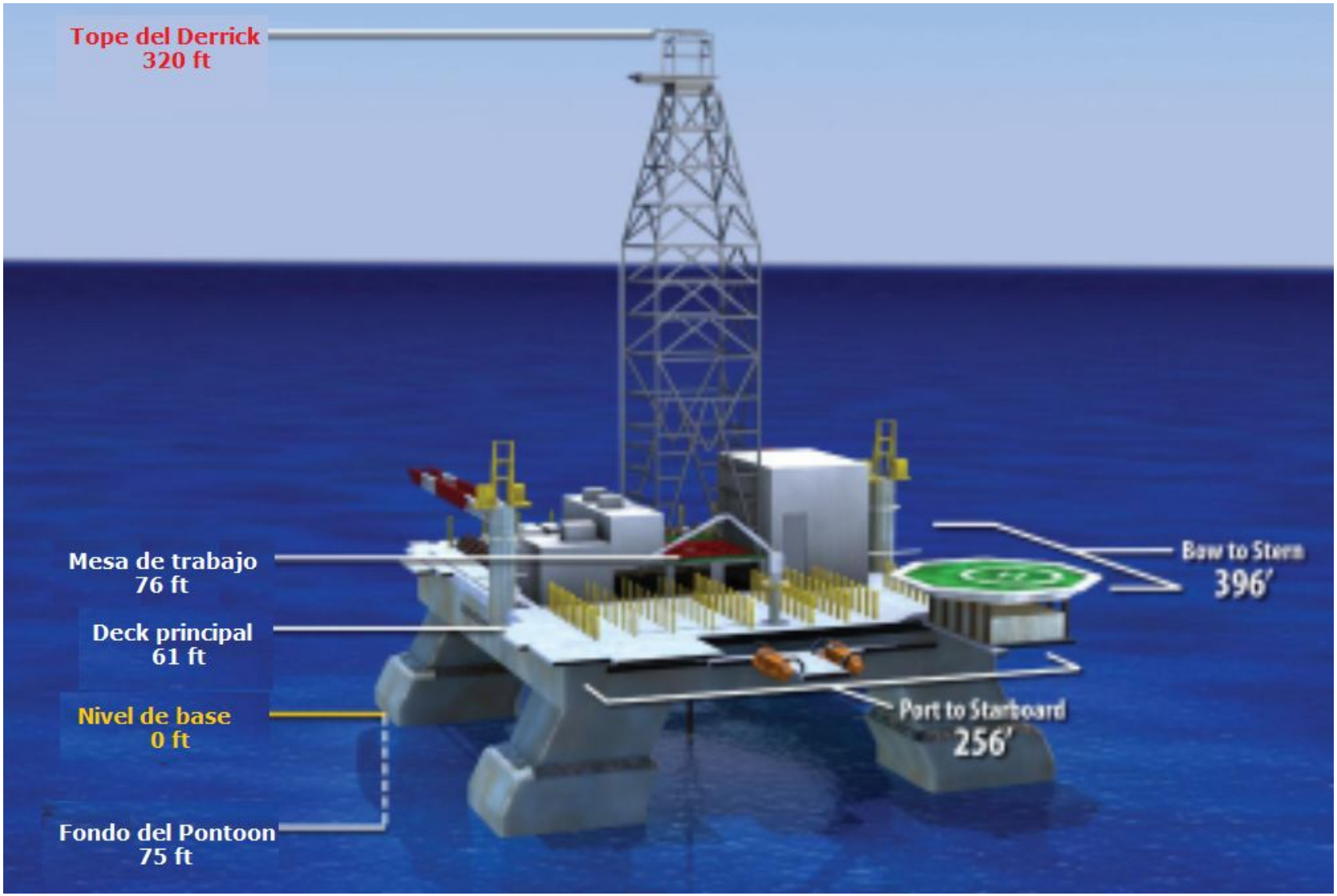


Perforación en aguas profundas

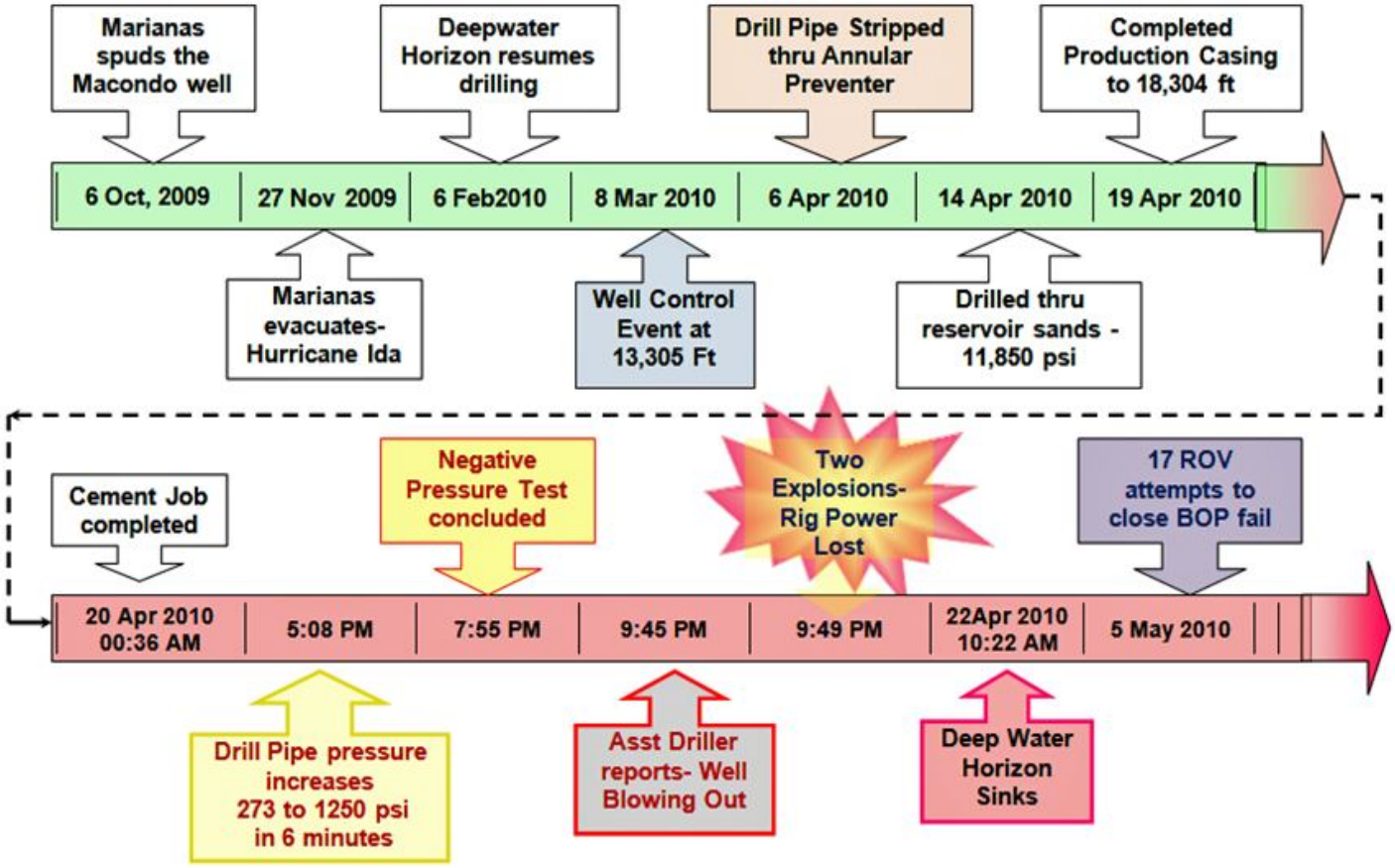
- Riser y BOP
- Posicionamiento dinámico
- Rotación (21/21 , 12/12)
- Aislamiento en el mar
- Múltiples contratistas
- Costoso

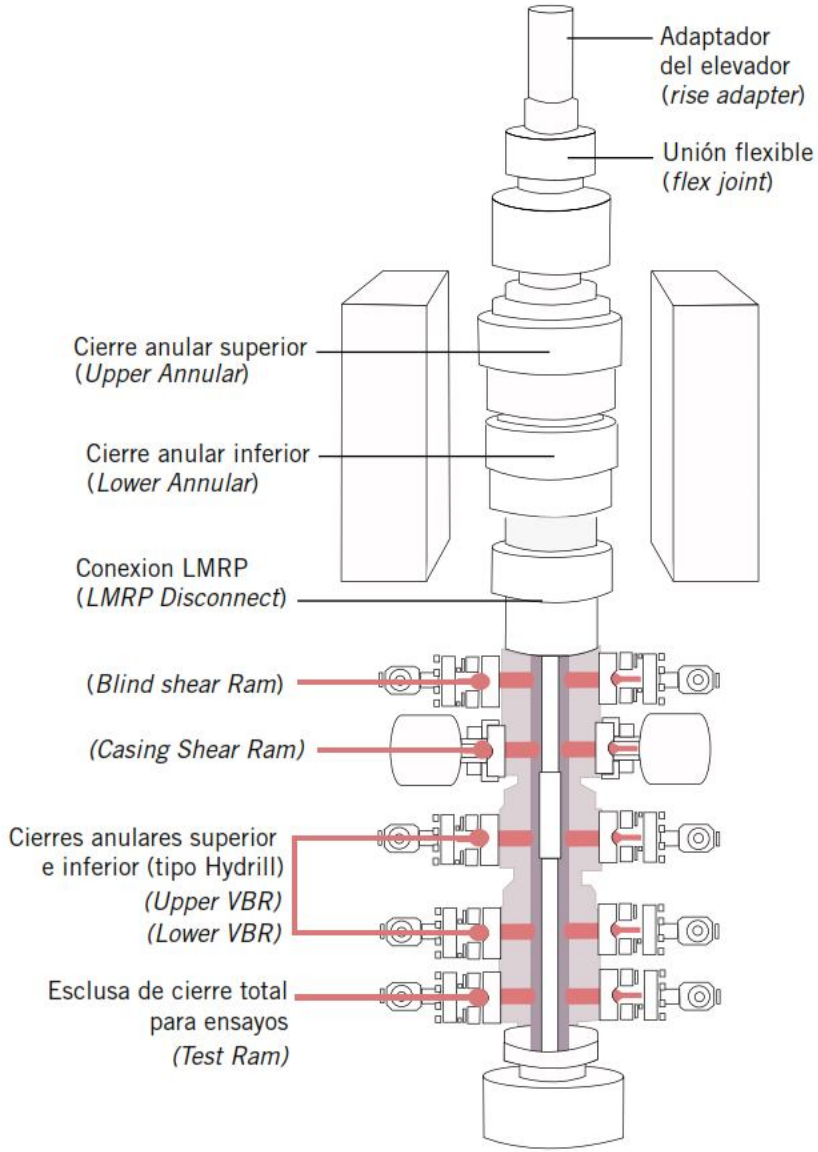

BLACK MARLIN

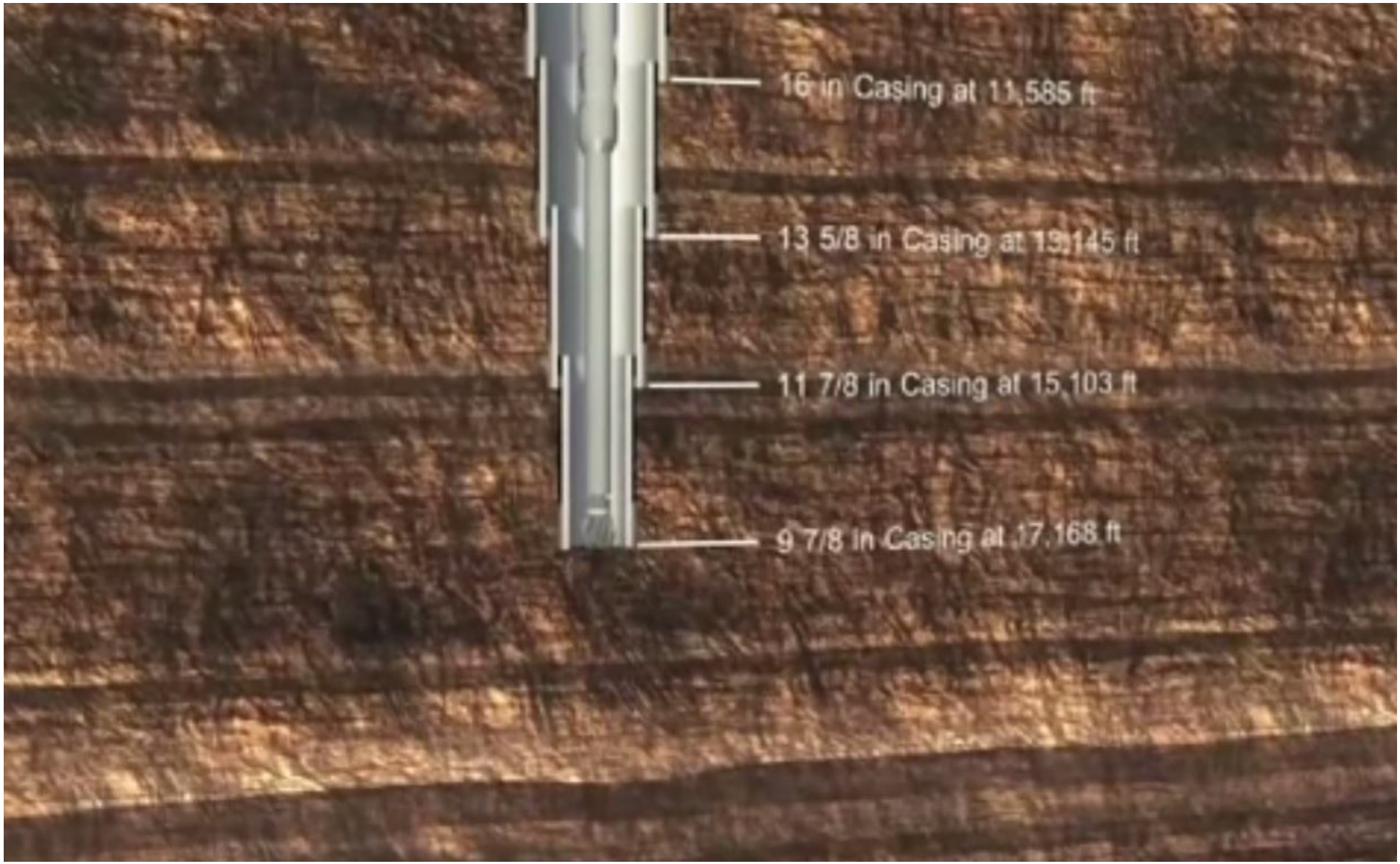


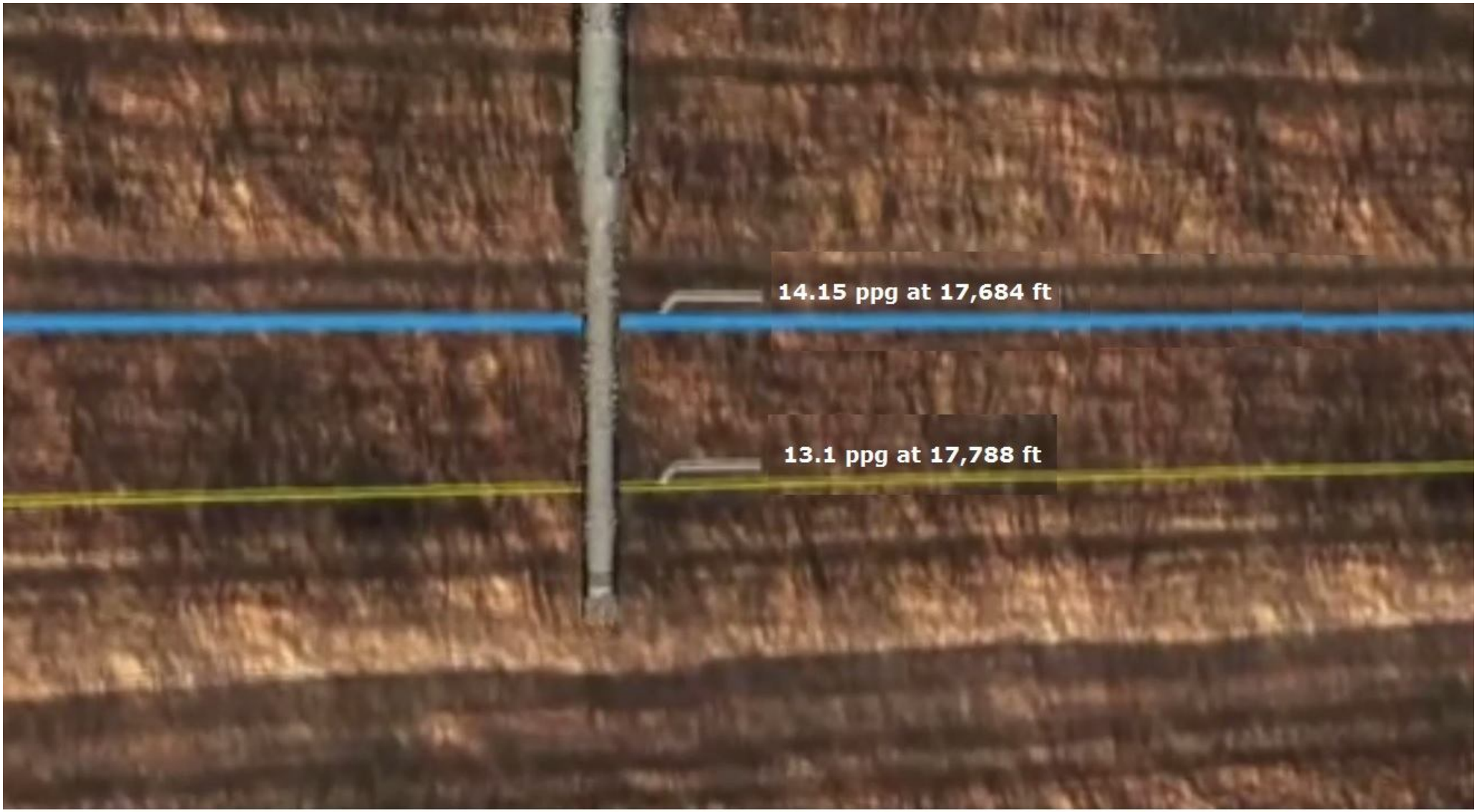

Tope del Derrick
320 ft
Mesa de trabajo
76 ft
Deck principal
61 ft
Nivel de base
0 ft
Fondo del Pontoon
75 ft
Baw to Stern
396'
Port to Starboard
256'

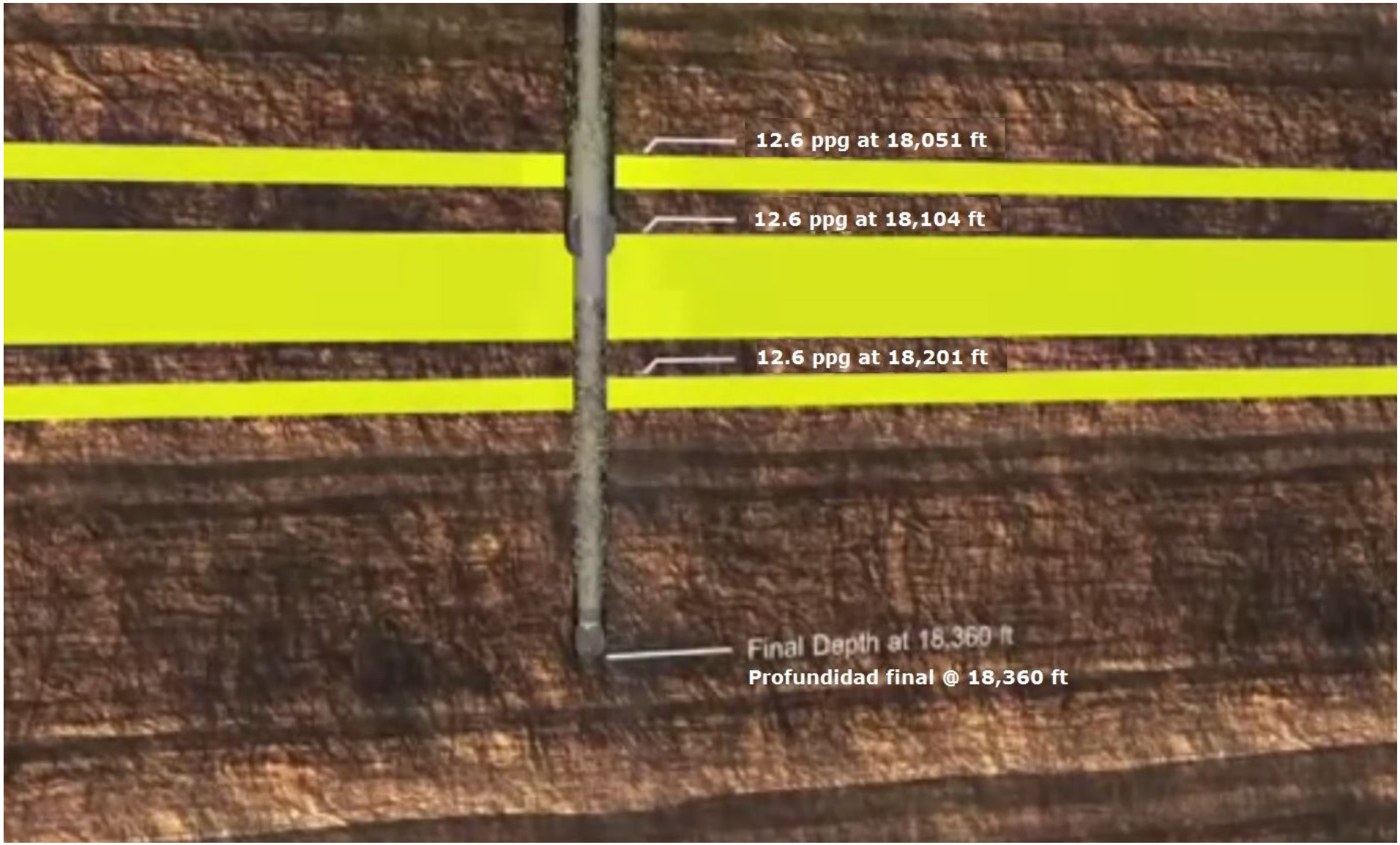
Deep Water Horizon Accident Timeline

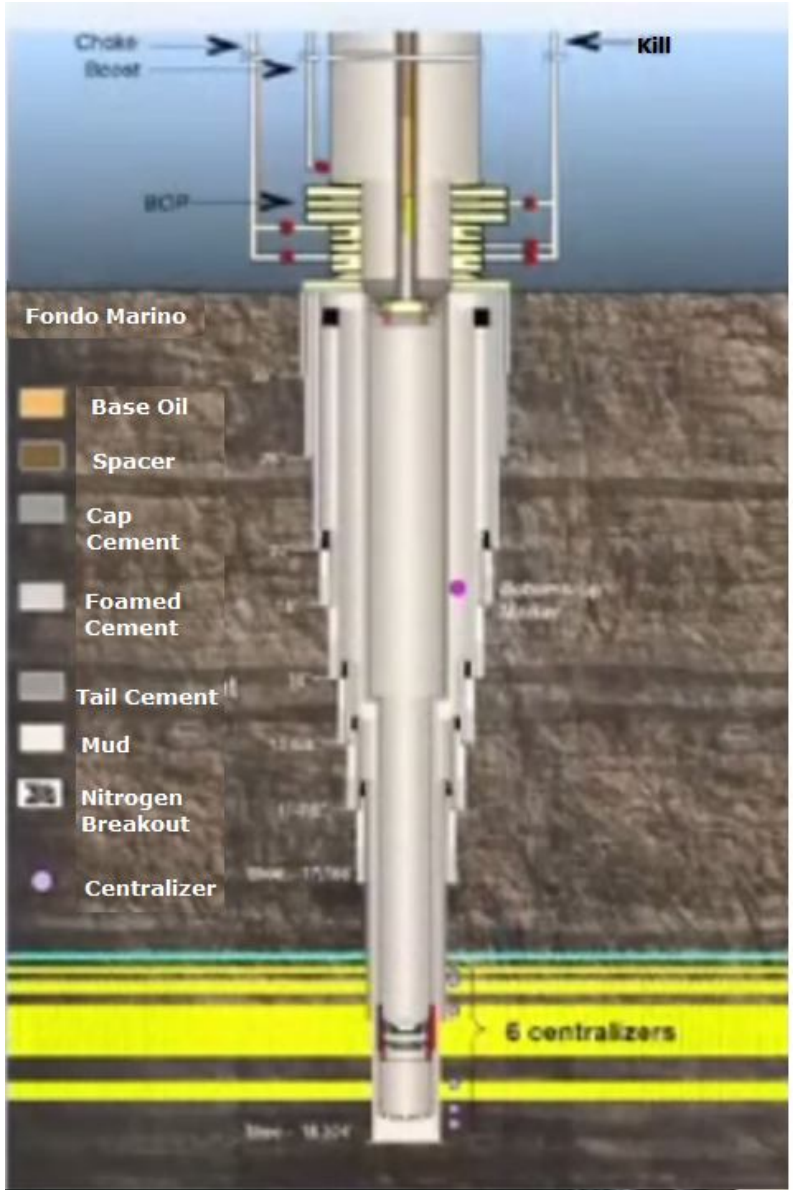


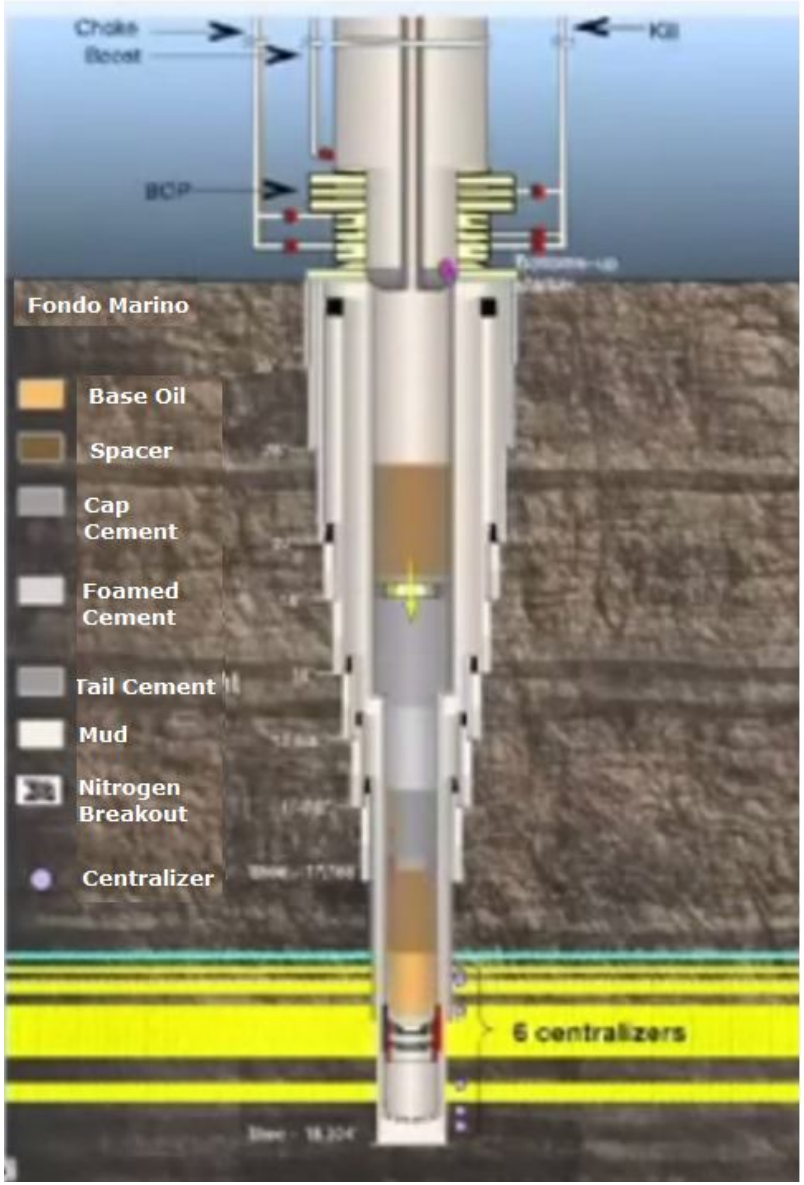

Adaptador
del elevador
(*rise adapter*)
Unión flexible
(*flex joint*)
Cierre anular superior
(*Upper Annular*)
Cierre anular inferior
(*Lower Annular*)
Conexion LMRP
(*LMRP Disconnect*)
(*Blind shear Ram*)
(*Casing Shear Ram*)
Cierres anulares superior
e inferior (tipo Hydrill)
(*Upper VBR*)
(*Lower VBR*)
Esclusa de cierre total
para ensayos
(*Test Ram*)


16 in Casing at 11,585 ft
13 5/8 in Casing at 13,145 ft
11 7/8 in Casing at 15,103 ft
9 7/8 in Casing at 17,168 ft


14.15 ppg at 17,684 ft
13.1 ppg at 17,788 ft


12.6 ppg at 18,051 ft
12.6 ppg at 18,104 ft
12.6 ppg at 18,201 ft
Final Depth at 18,360 ft
Profundidad final @ 18,360 ft


Choke
Boost
Kill
BOP
Fondo Marino
Base Oil
Spacer
Cap Cement
Foamed Cement
Tail Cement
Mud
Nitrogen Breakout
Centralizer
6 centralizers


Choke
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Cap Cement
Foamed Cement
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Mud
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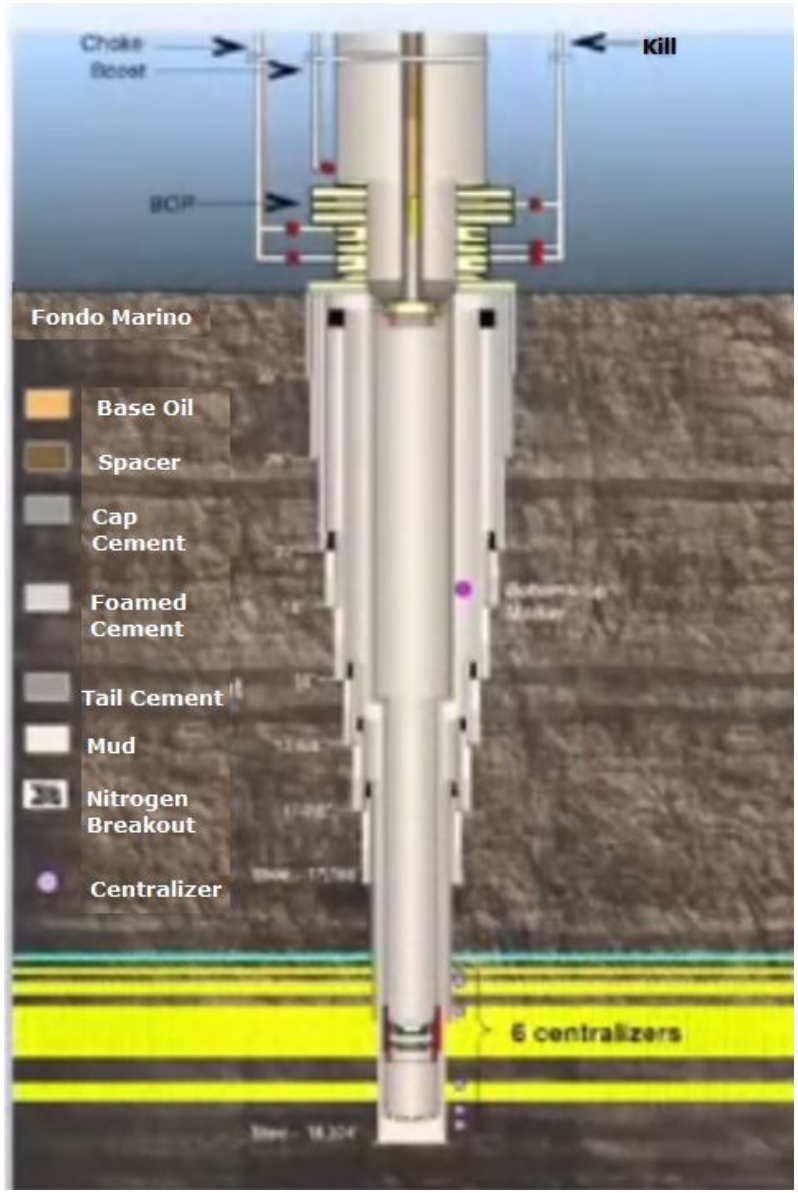
6 centralizers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Boost
Kill
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Base Oil
Spacer
Cap Cement
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Mud
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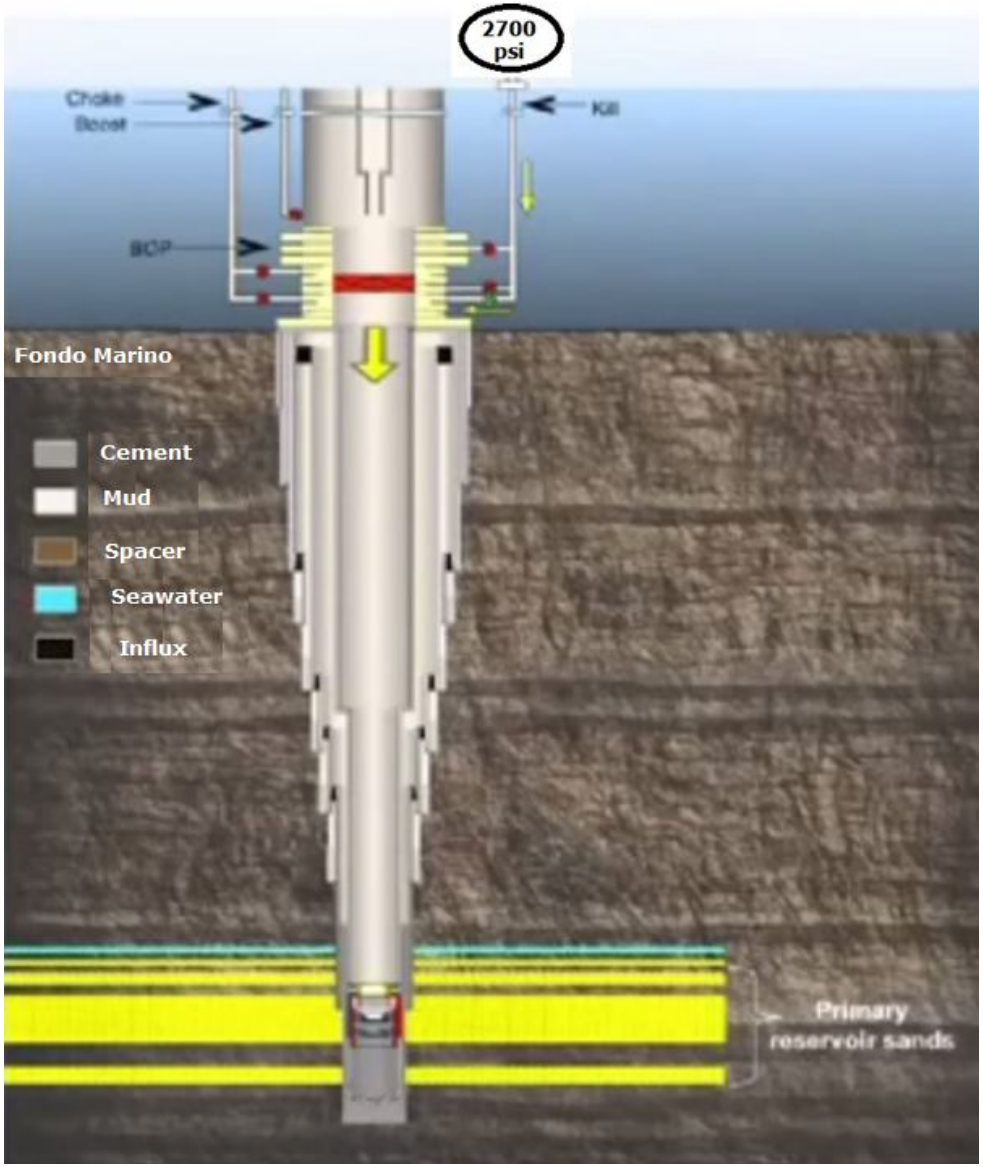
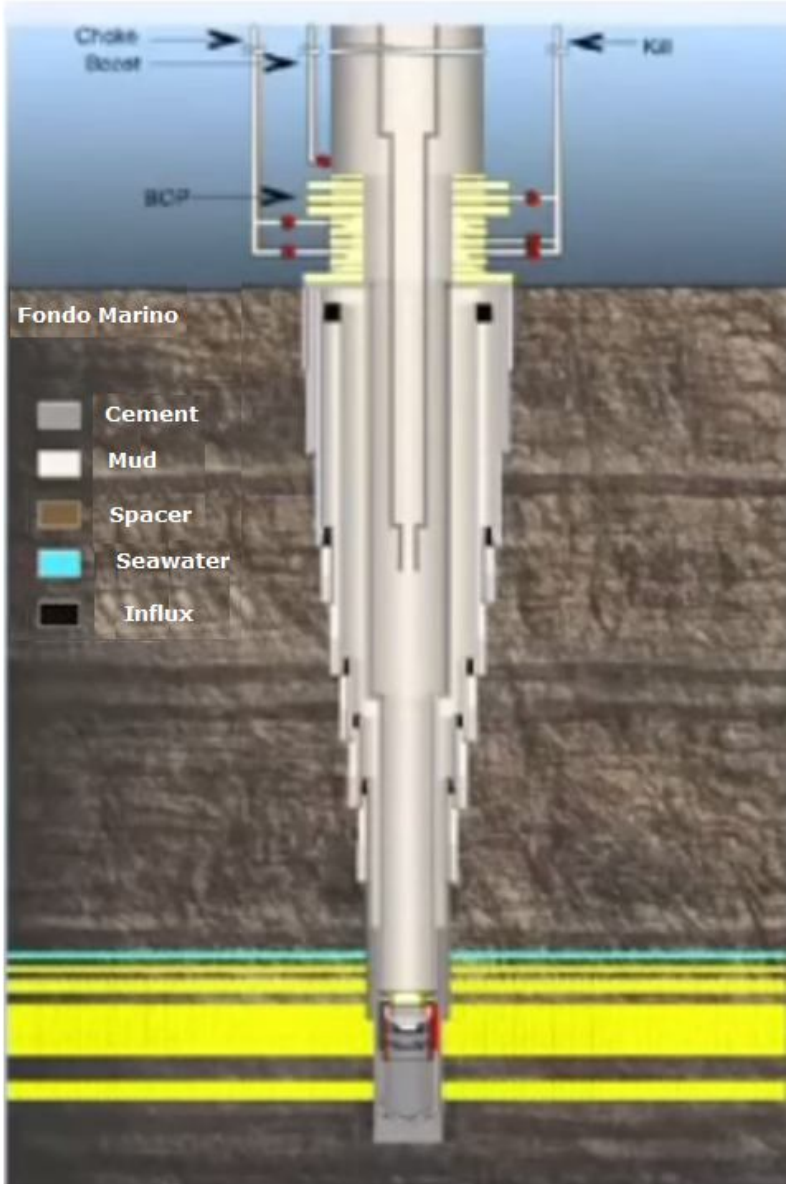
6 centralizers

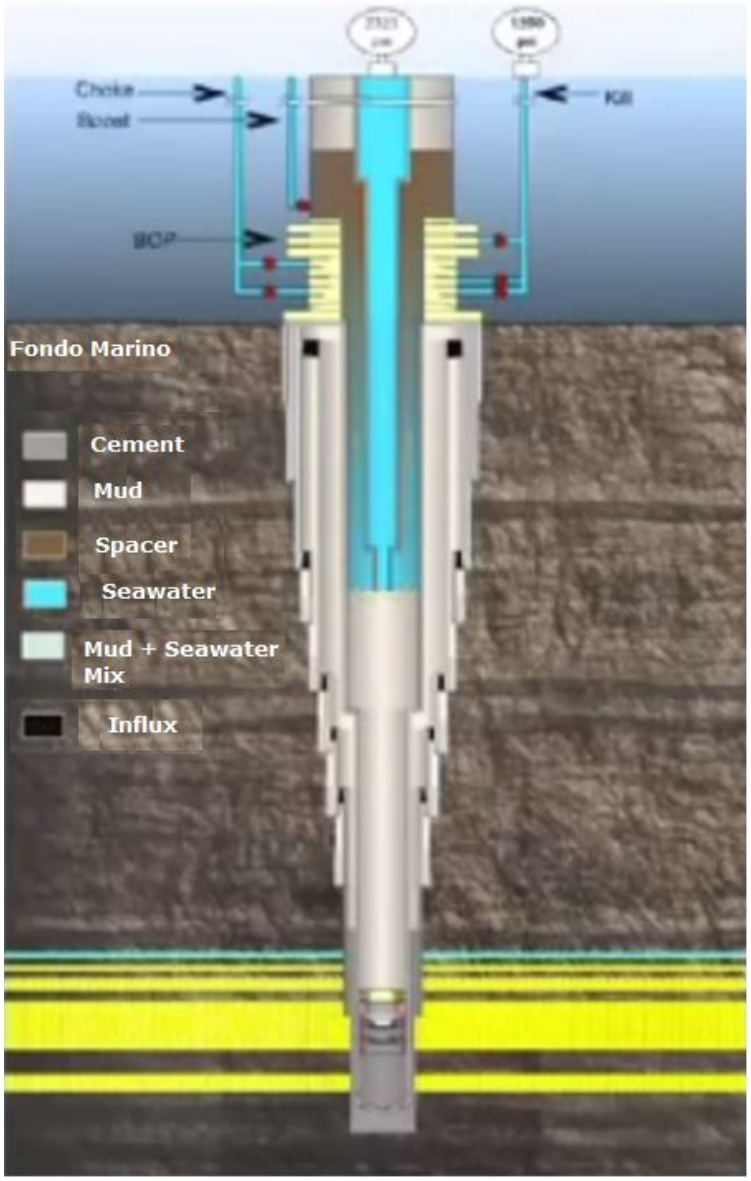
Prueba de
PRESION POSITIVA



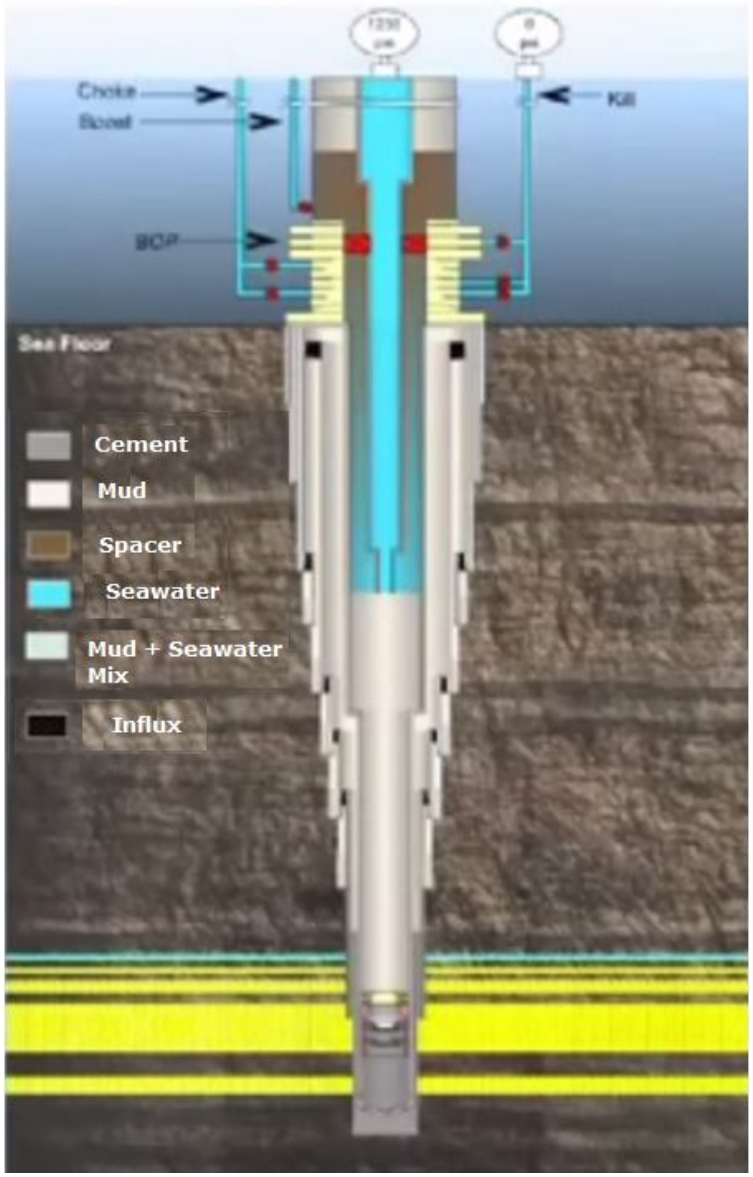
Prueba de
PRESION NEGATIVA

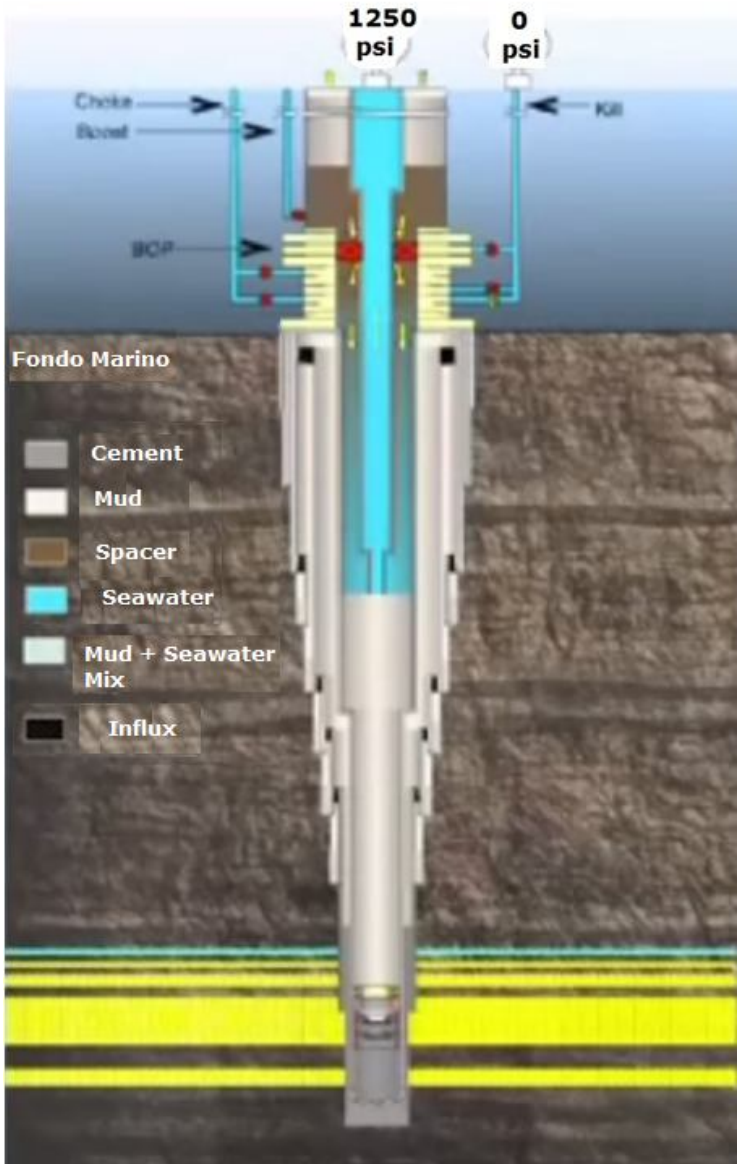


Prueba de
PRESION NEGATIVA

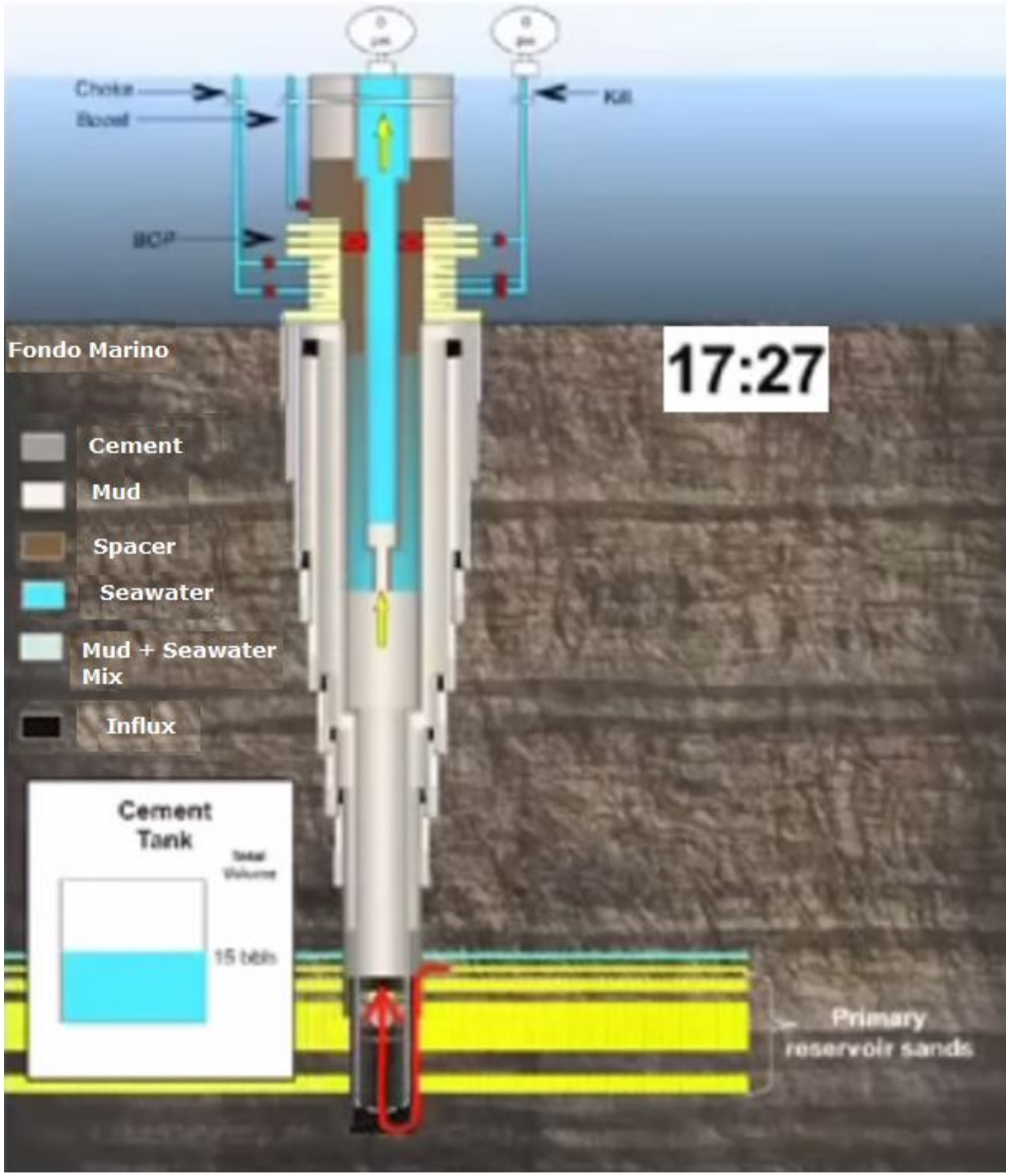


Prueba de
PRESION NEGATIVA

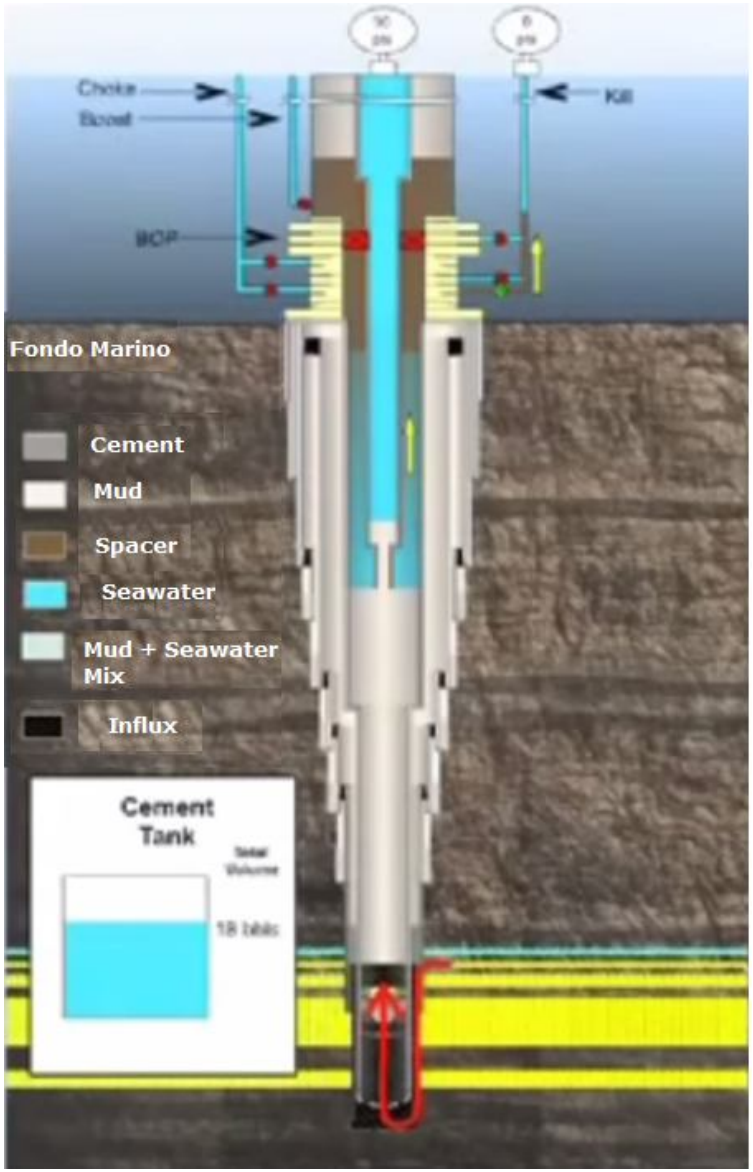



1250
psi
0
psi
Choke
Boost
Kill
BOP
Fondo Marino
Cement
Mud
Spacer
Seawater
Mud + Seawater
Mix
Influx

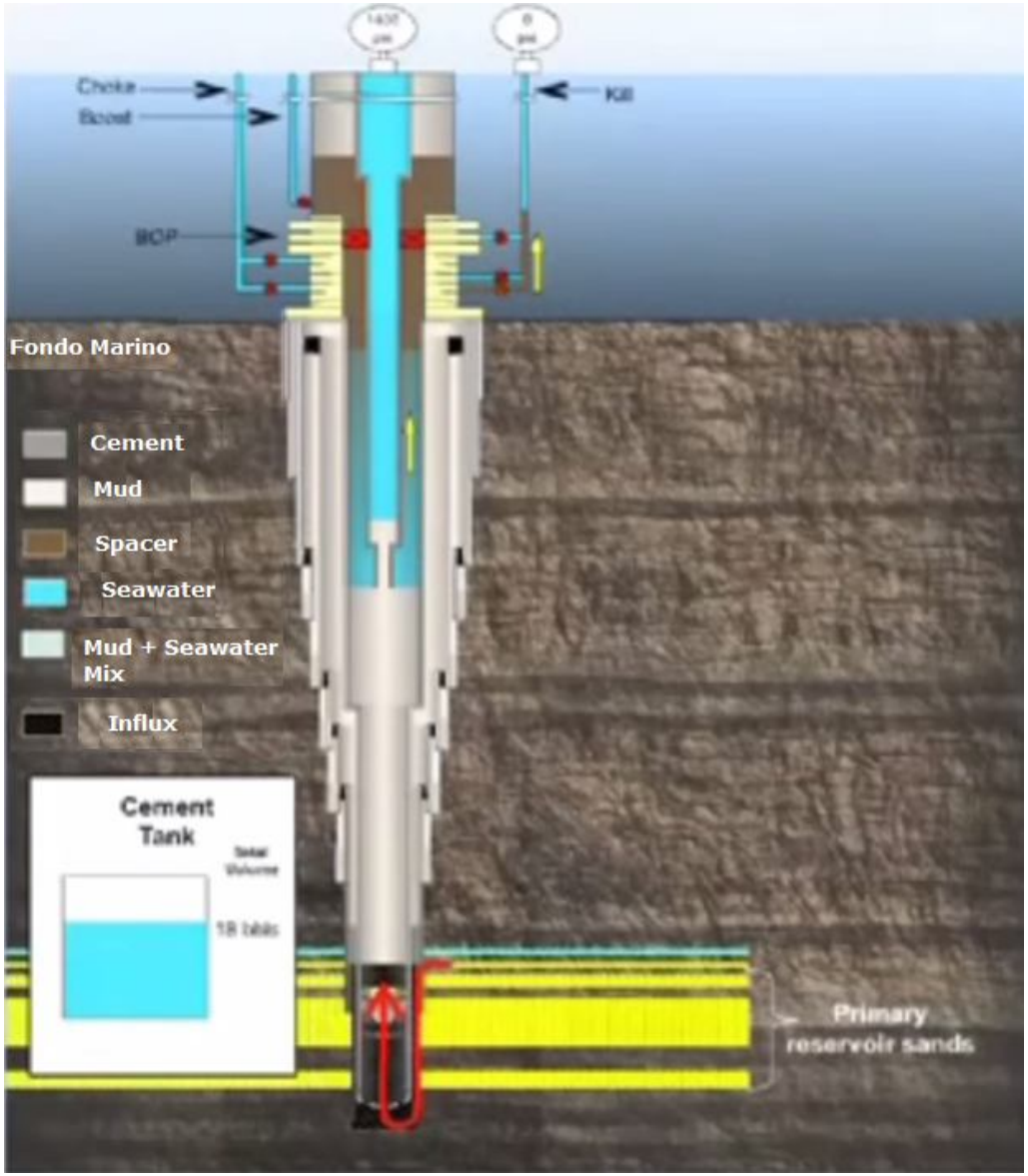
Prueba de
PRESION NEGATIVA

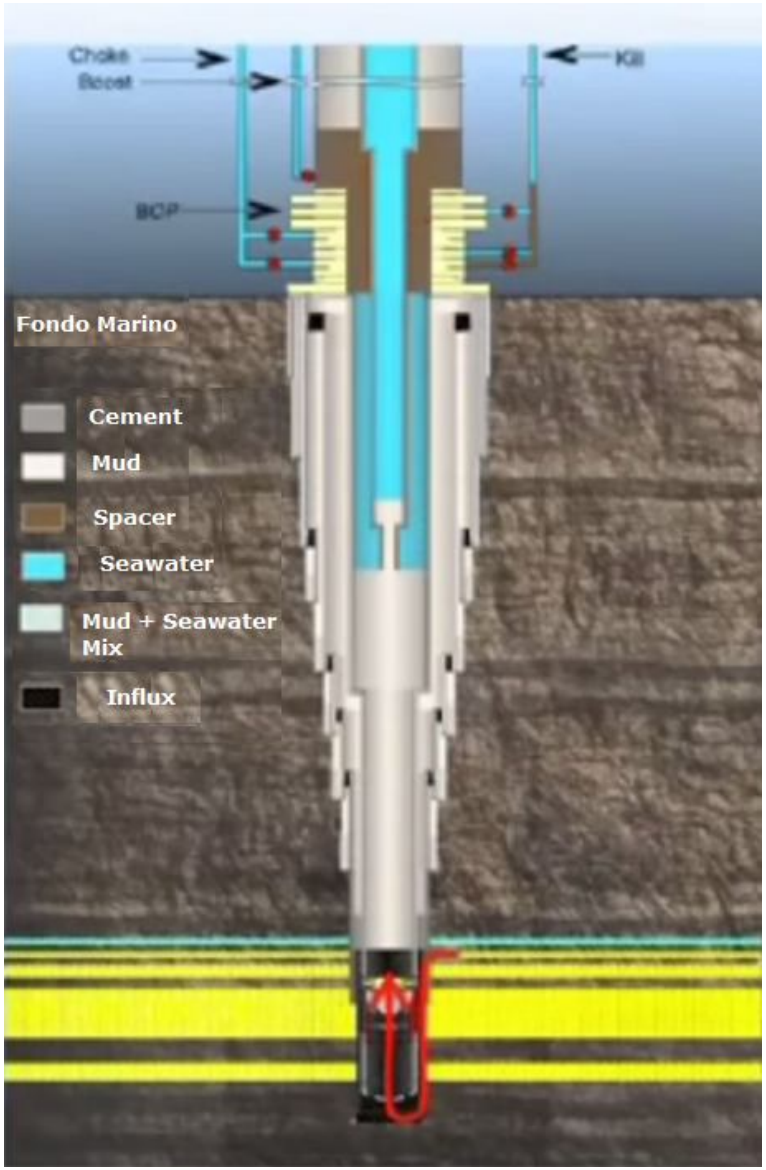


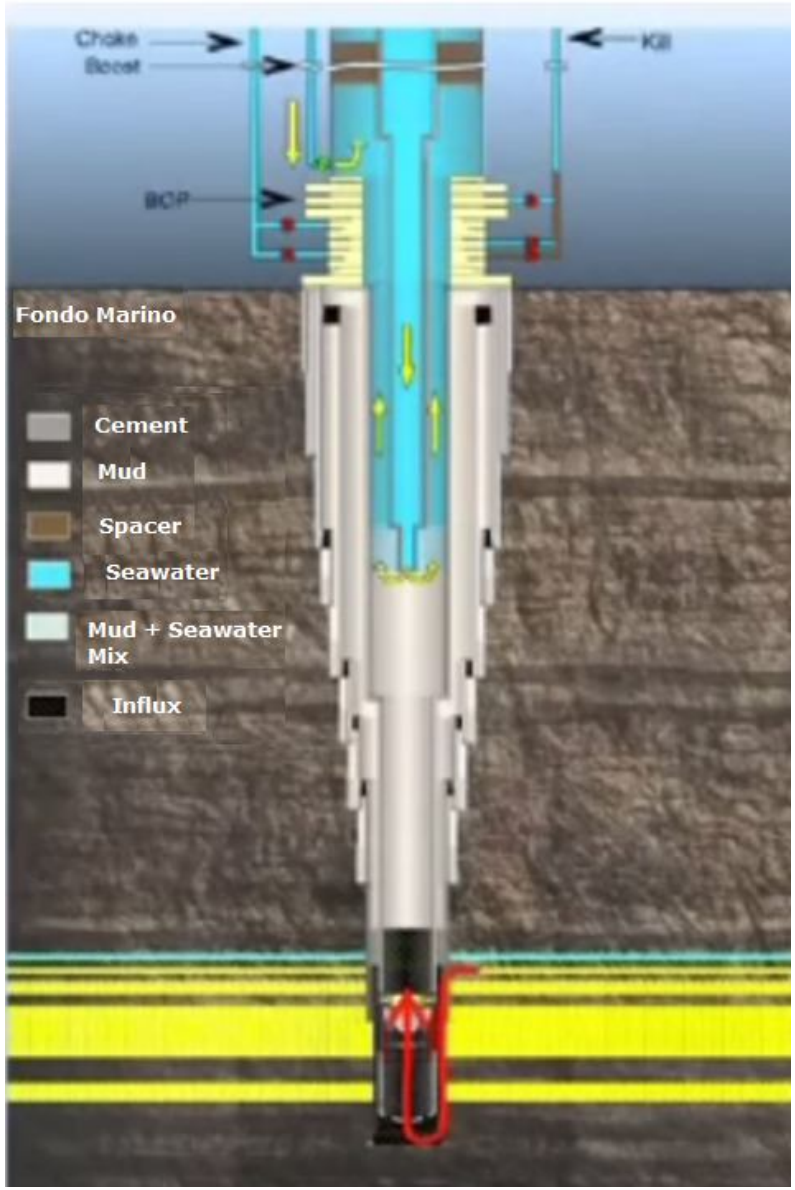
Prueba de
PRESION NEGATIVA



Prueba de
PRESION NEGATIVA




Choke
Boost
Kill
BOP
Fondo Marino
Cement
Mud
Spacer
Seawater
Mud + Seawater Mix
Influx


Choke
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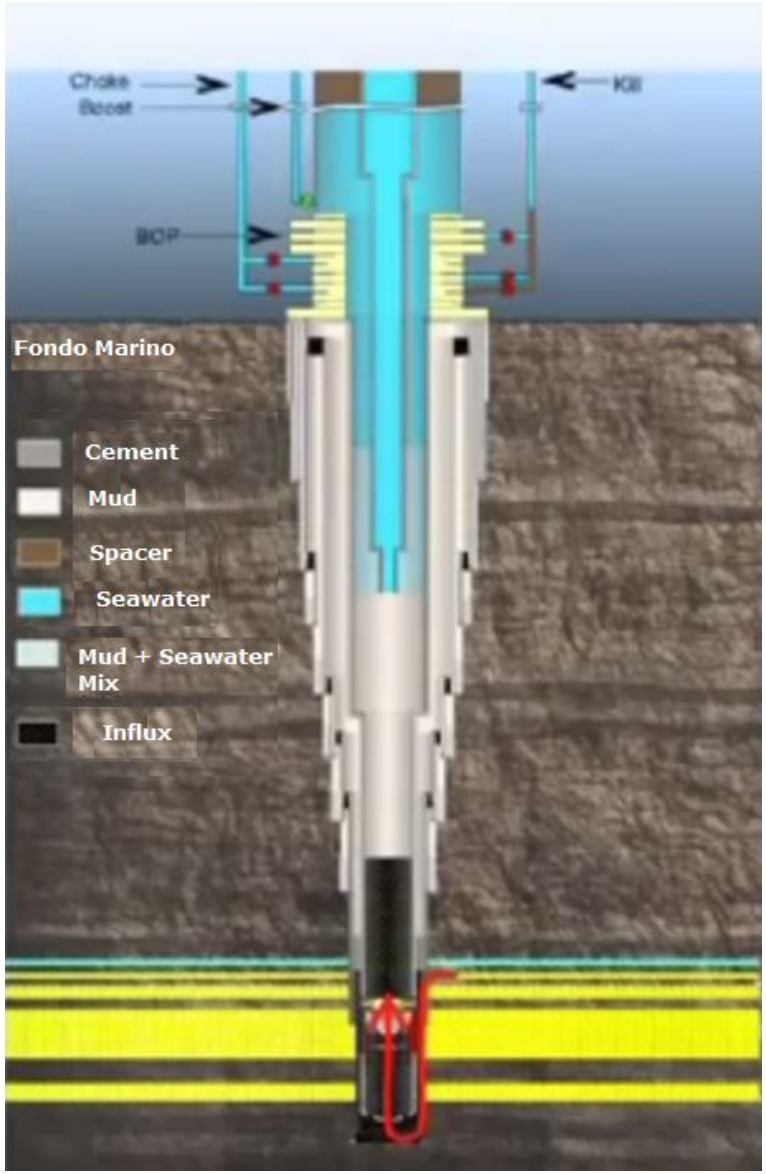
Cement
Mud
Spacer
Seawater
Mud + Seawater Mix
Influx


Choke
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Kill
BOP
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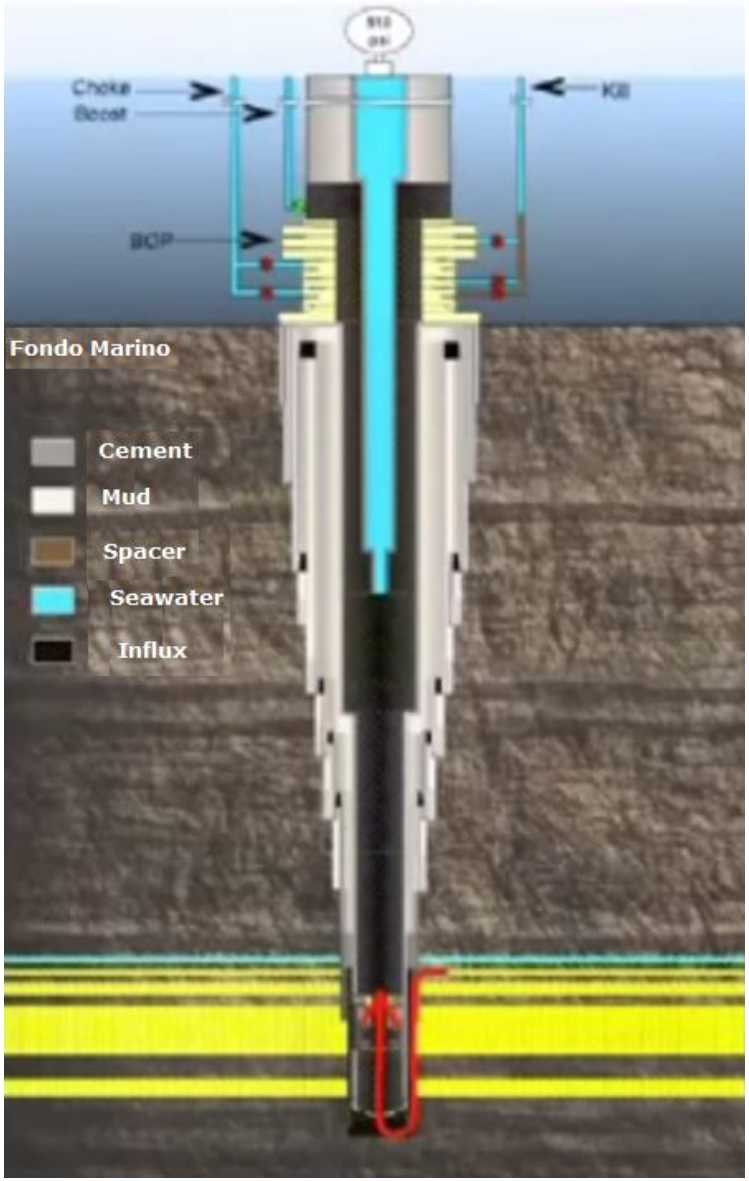
Cement
Mud
Spacer
Seawater
Mud + Seawater Mix
Influx


Choke
Boost
Kill
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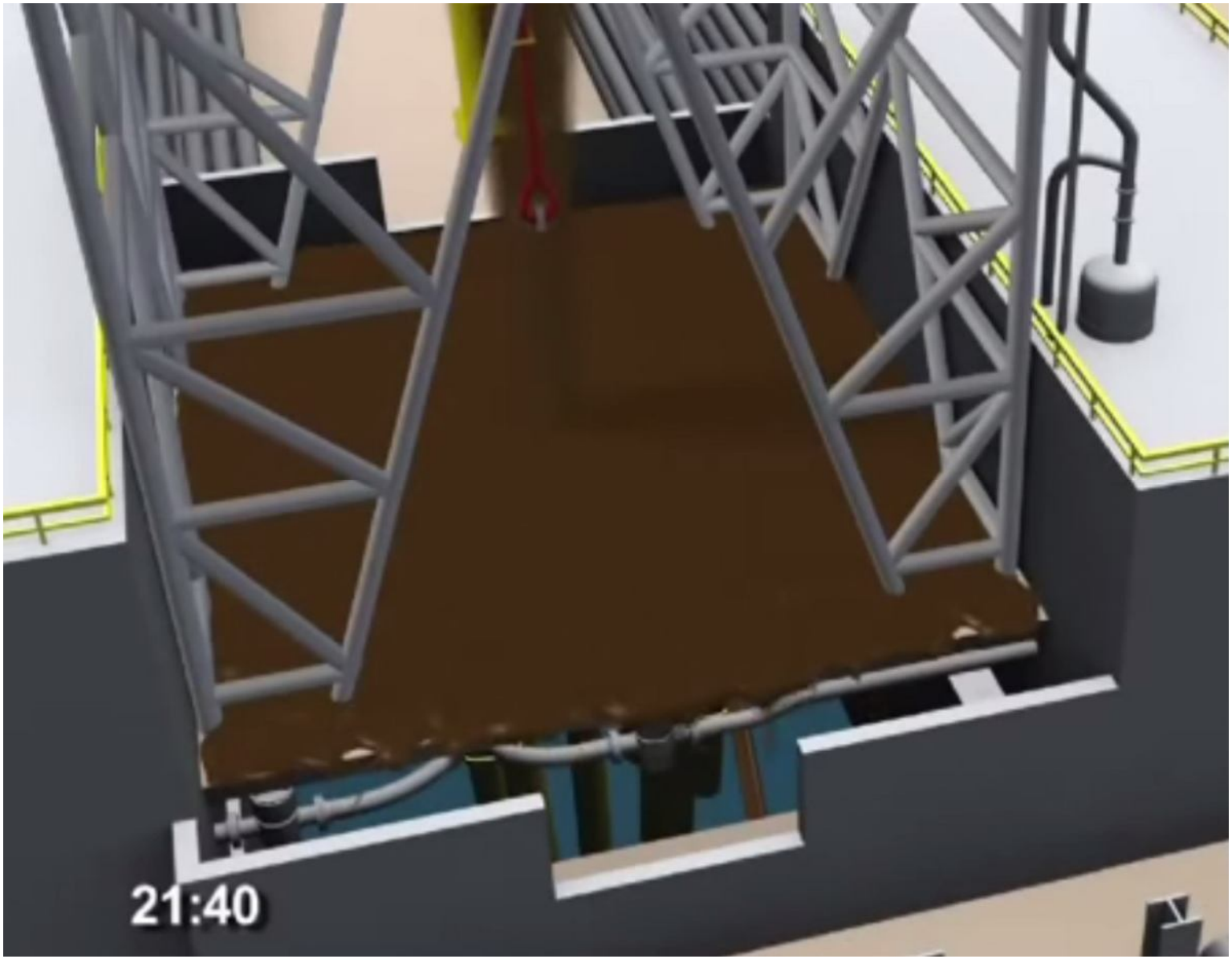
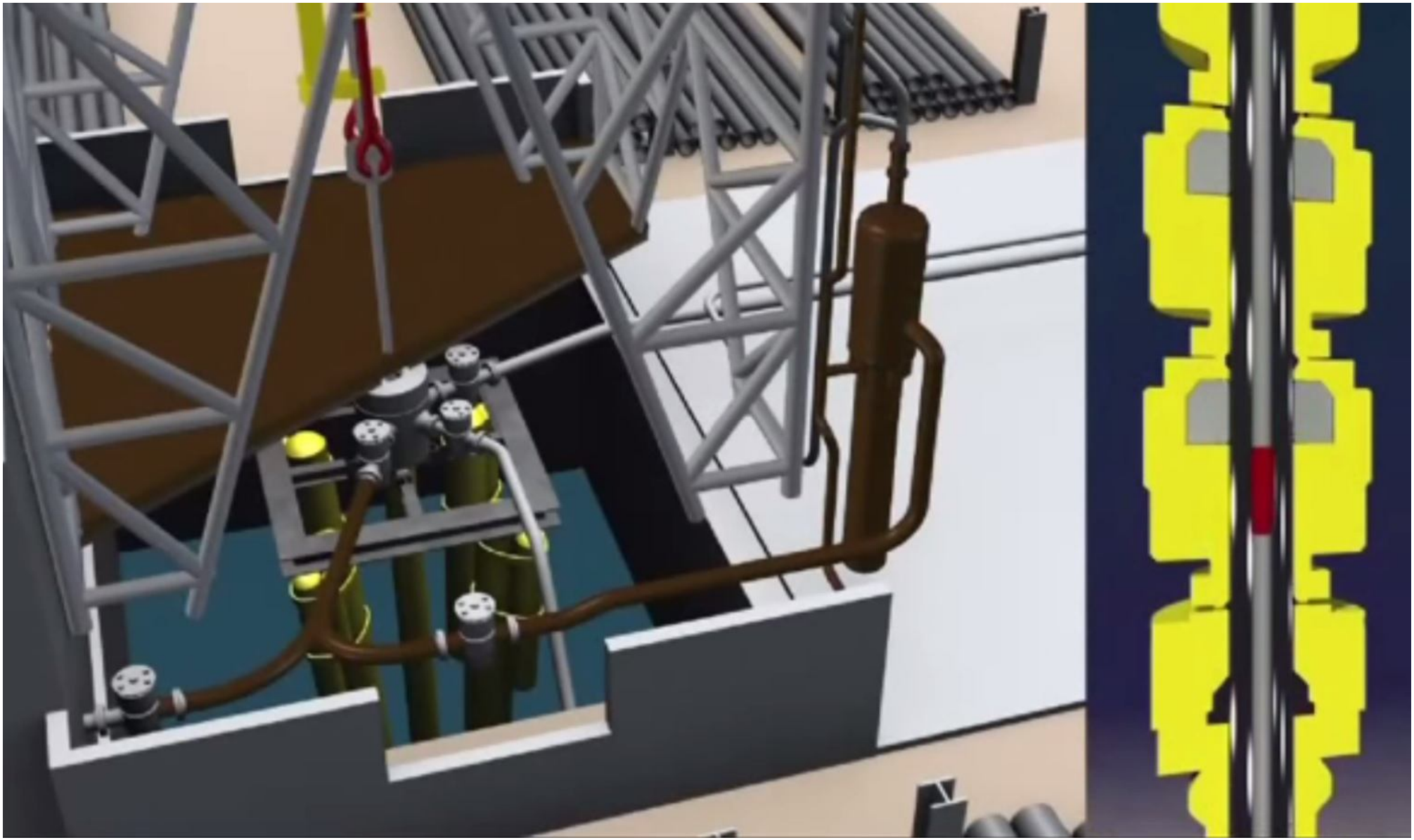
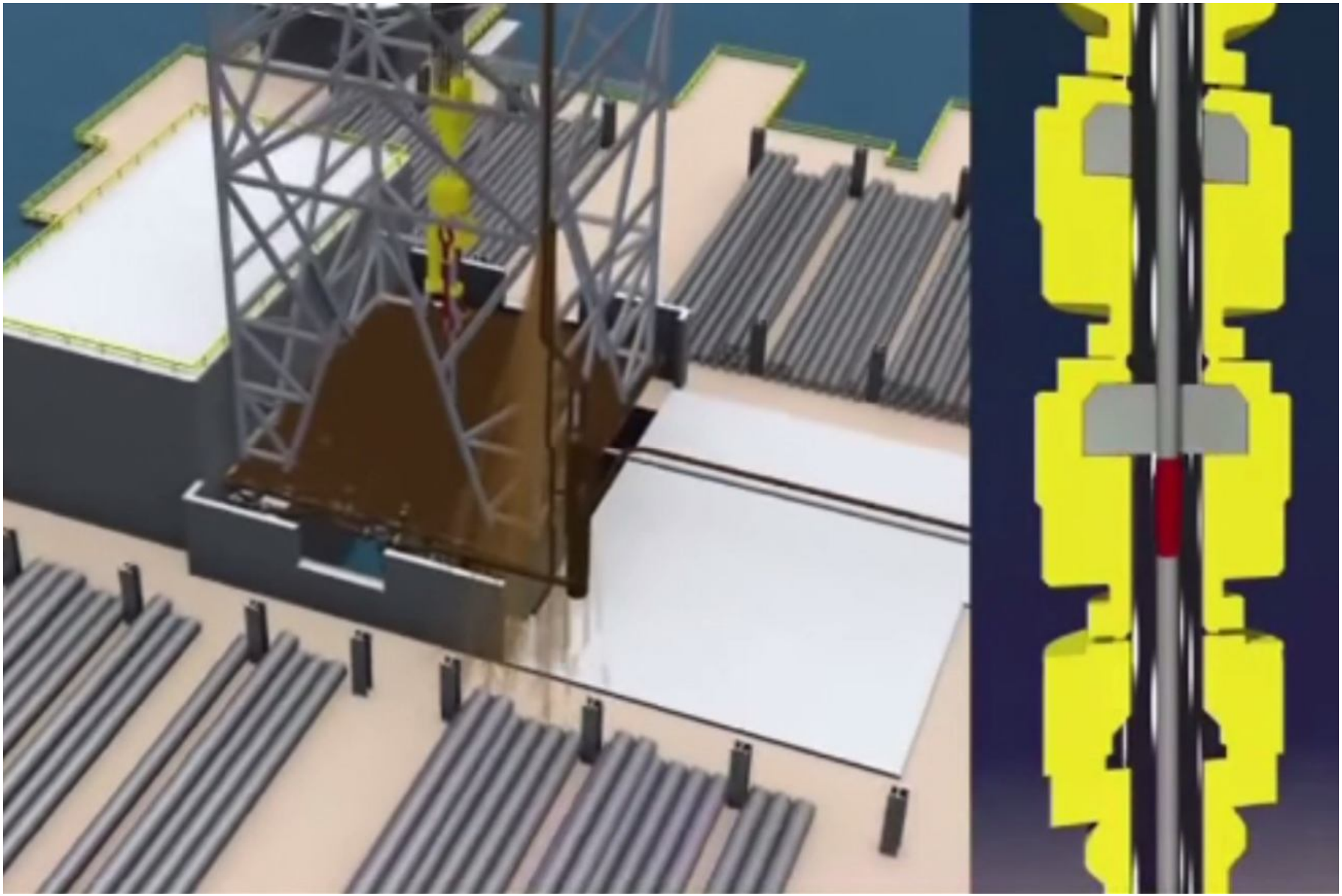
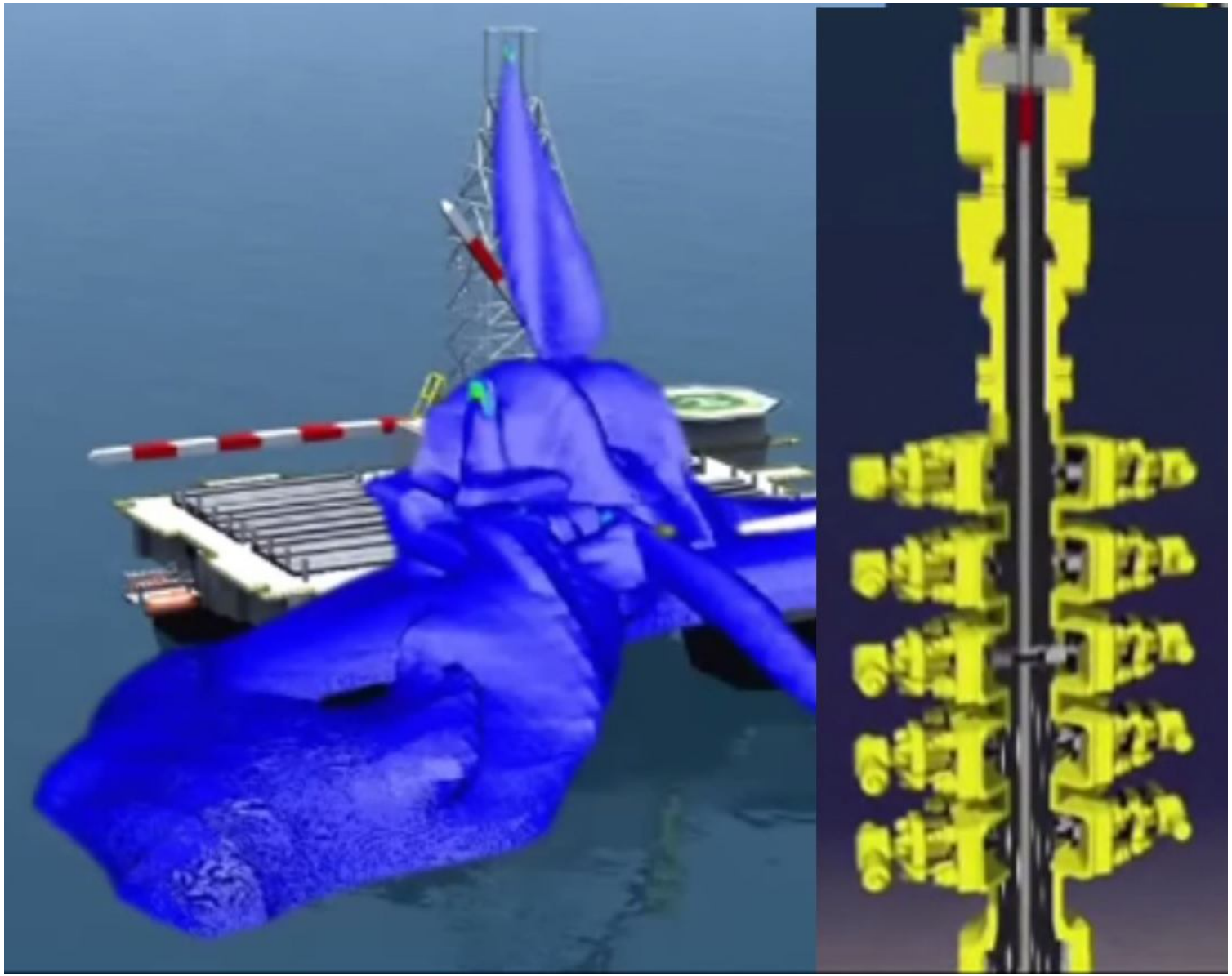
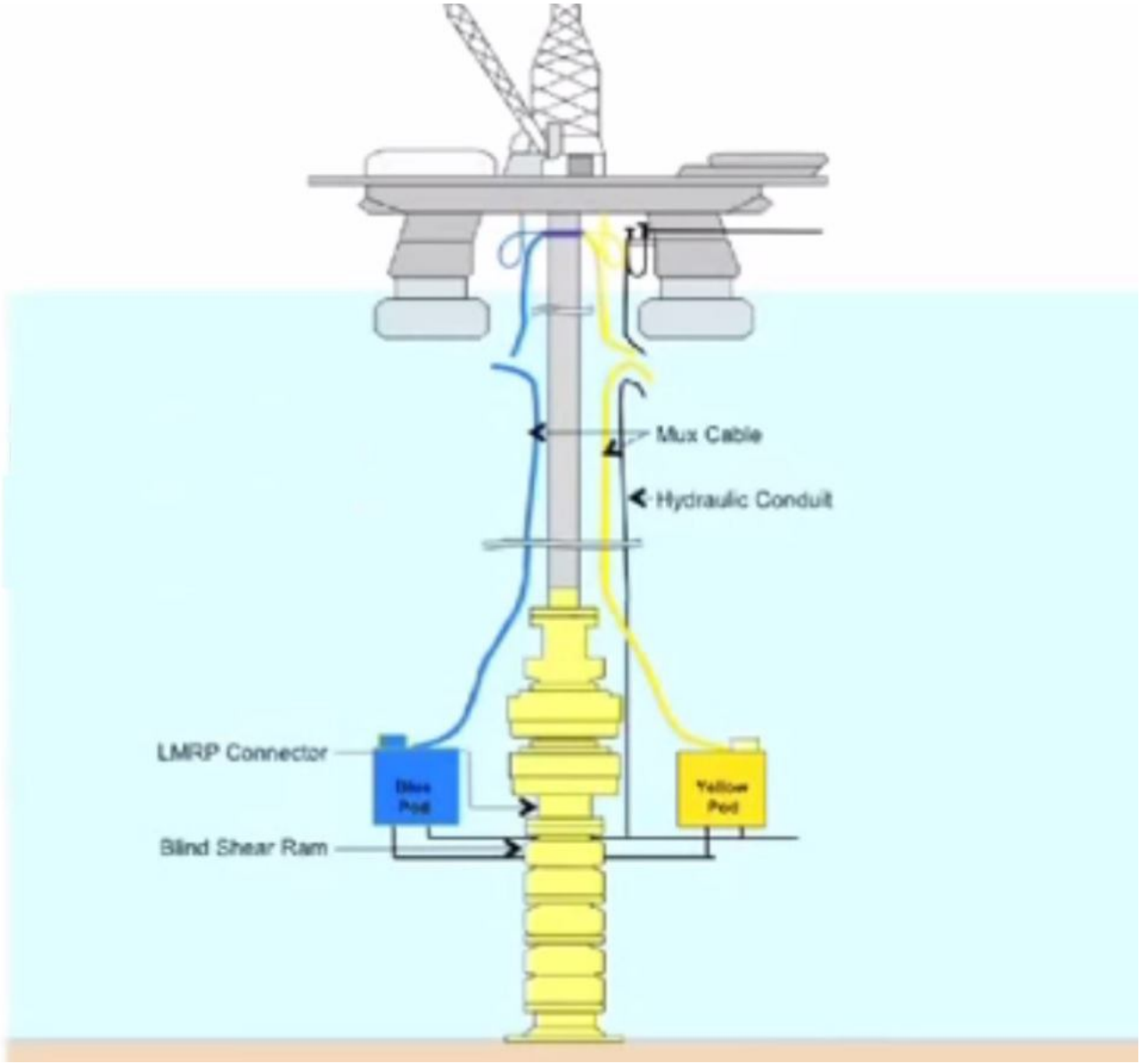
Cement
Mud
Spacer
Seawater
Influx

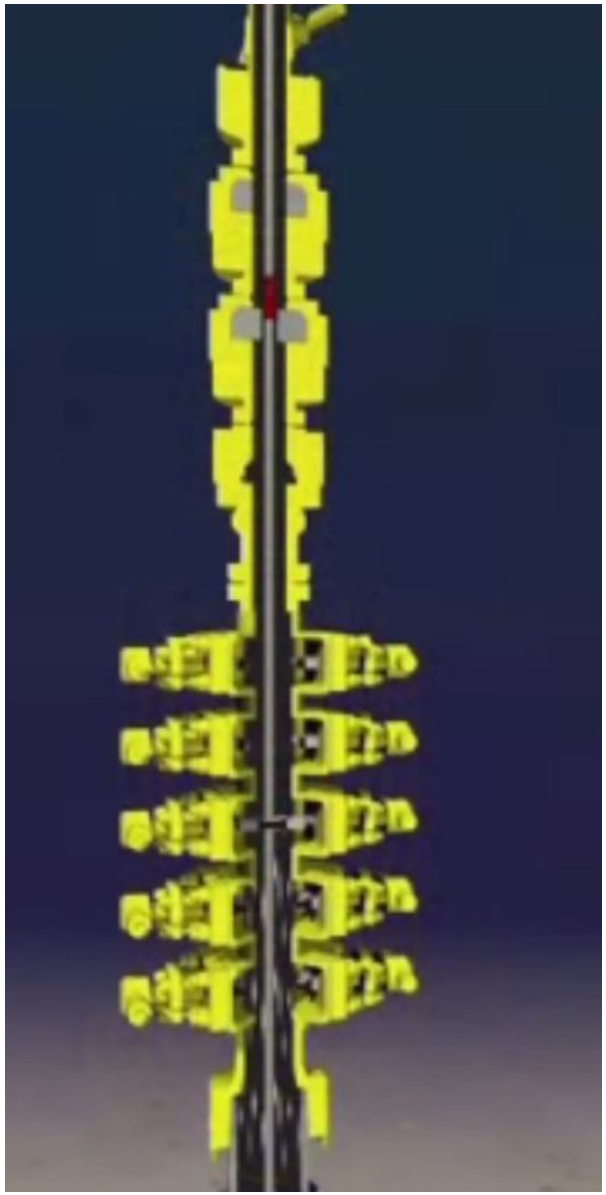

21:40

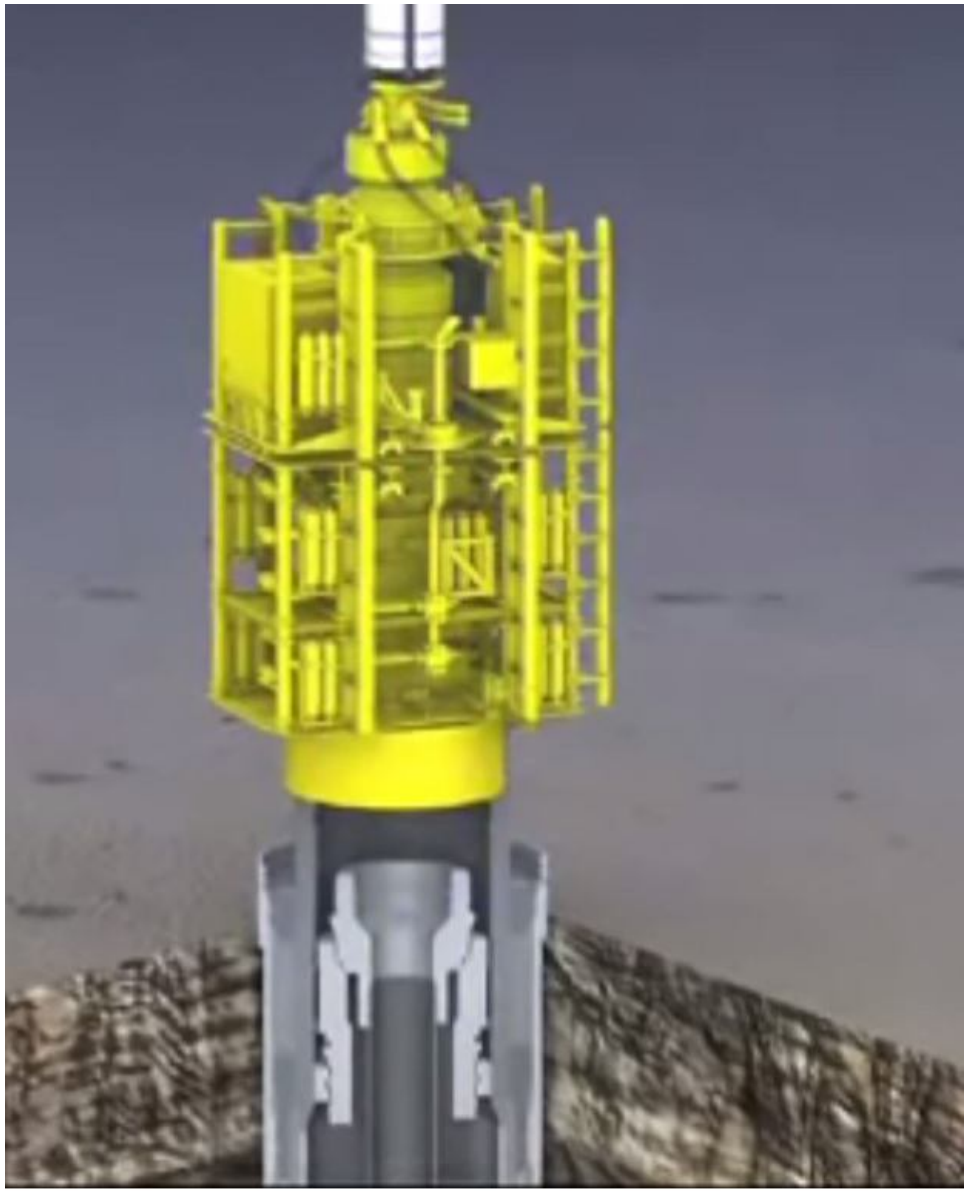




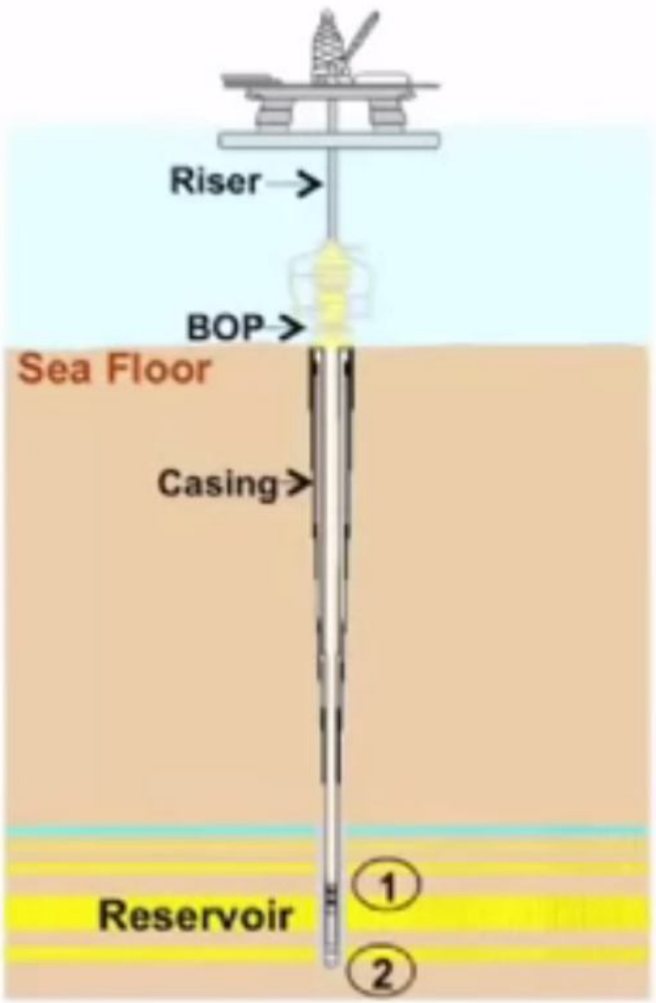



Mux Cable
Hydraulic Conduit
LMRP Connector
Blue Pod
Yellow Pod
Blind Shear Ram





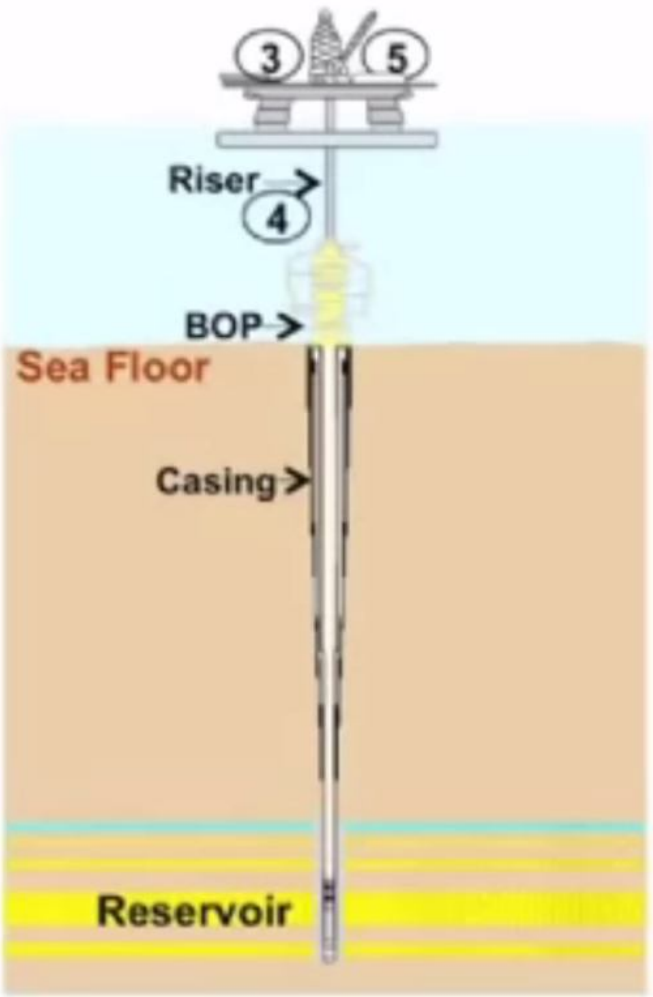
Eight Barriers Were Breached



Well integrity was not established or failed

1. Annulus cement barrier did not isolate hydrocarbons
2. Shoe track barriers did not isolate hydrocarbons

Eight Barriers Were Breached



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5. Well control response actions failed to regain control of well

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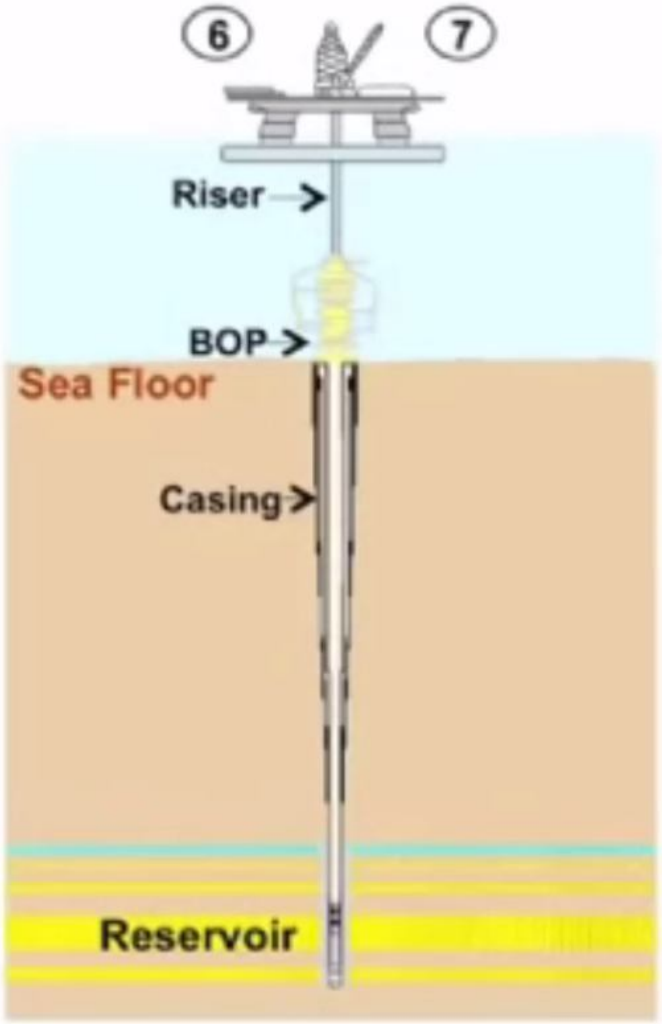

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Hydrocarbons ignited on the *Deepwater Horizon*

6. Diversion to mud gas separator resulted in gas venting onto rig
7. Fire and gas system did not prevent hydrocarbon ignition

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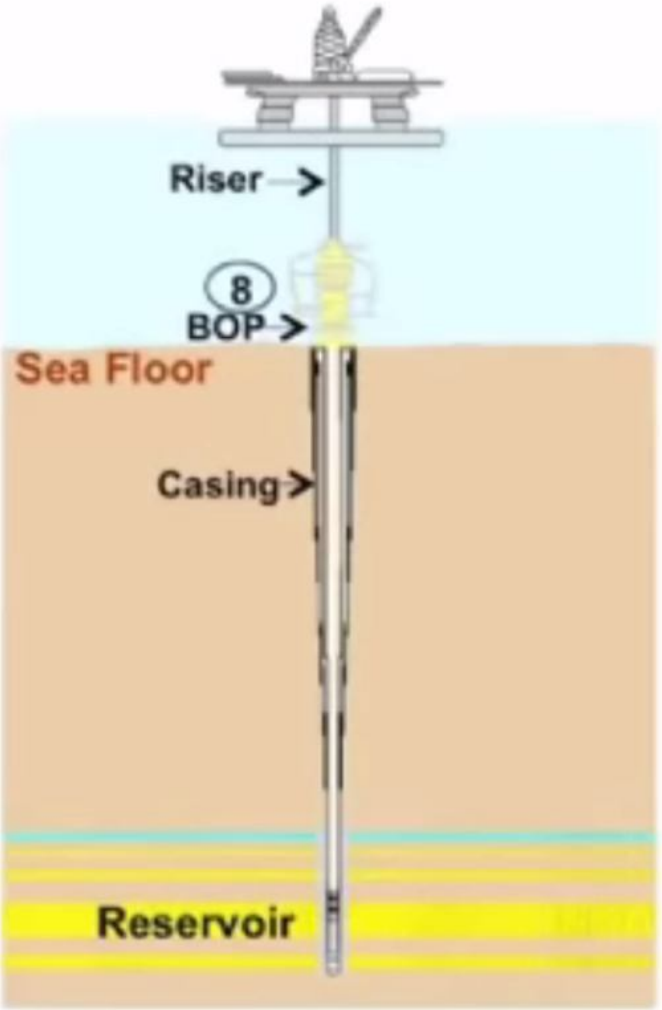

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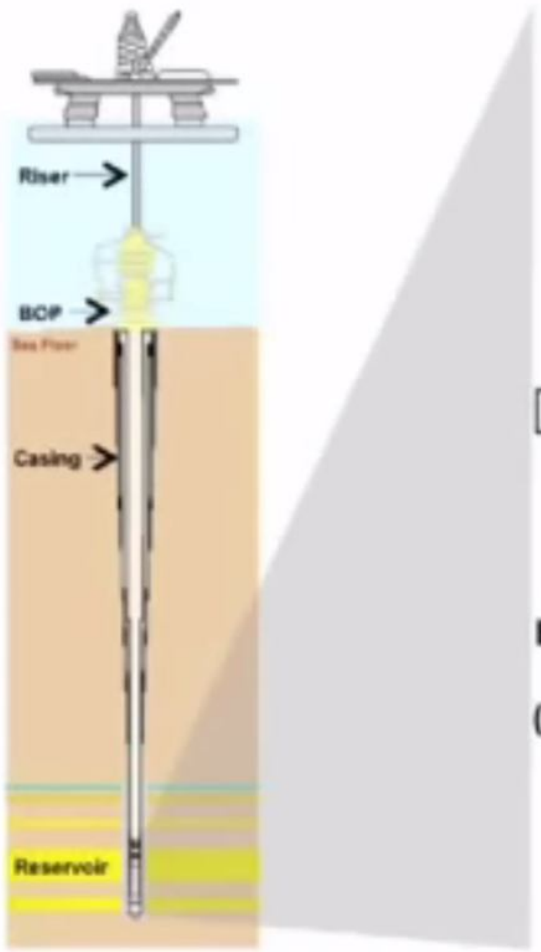
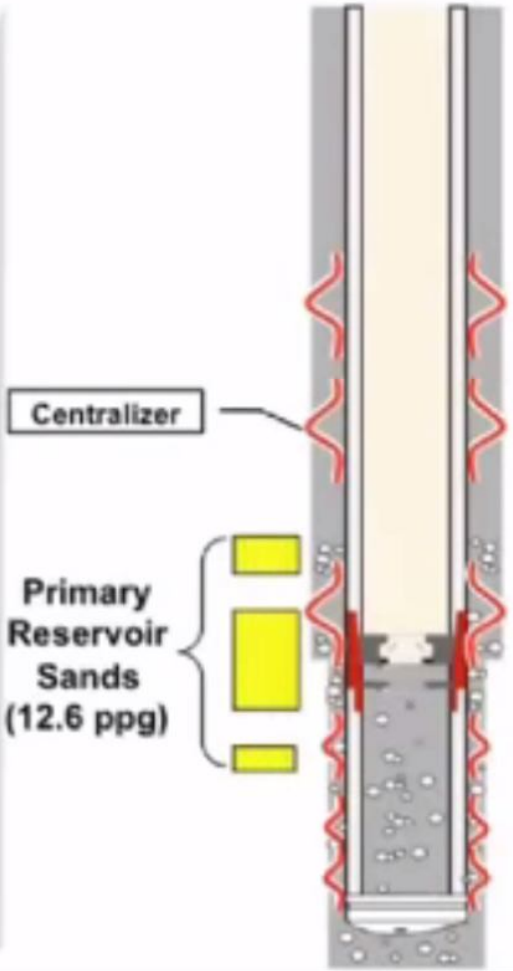
Blowout preventer did not seal the well

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

Key Finding #1

Annulus cement barrier did not isolate reservoir hydrocarbons

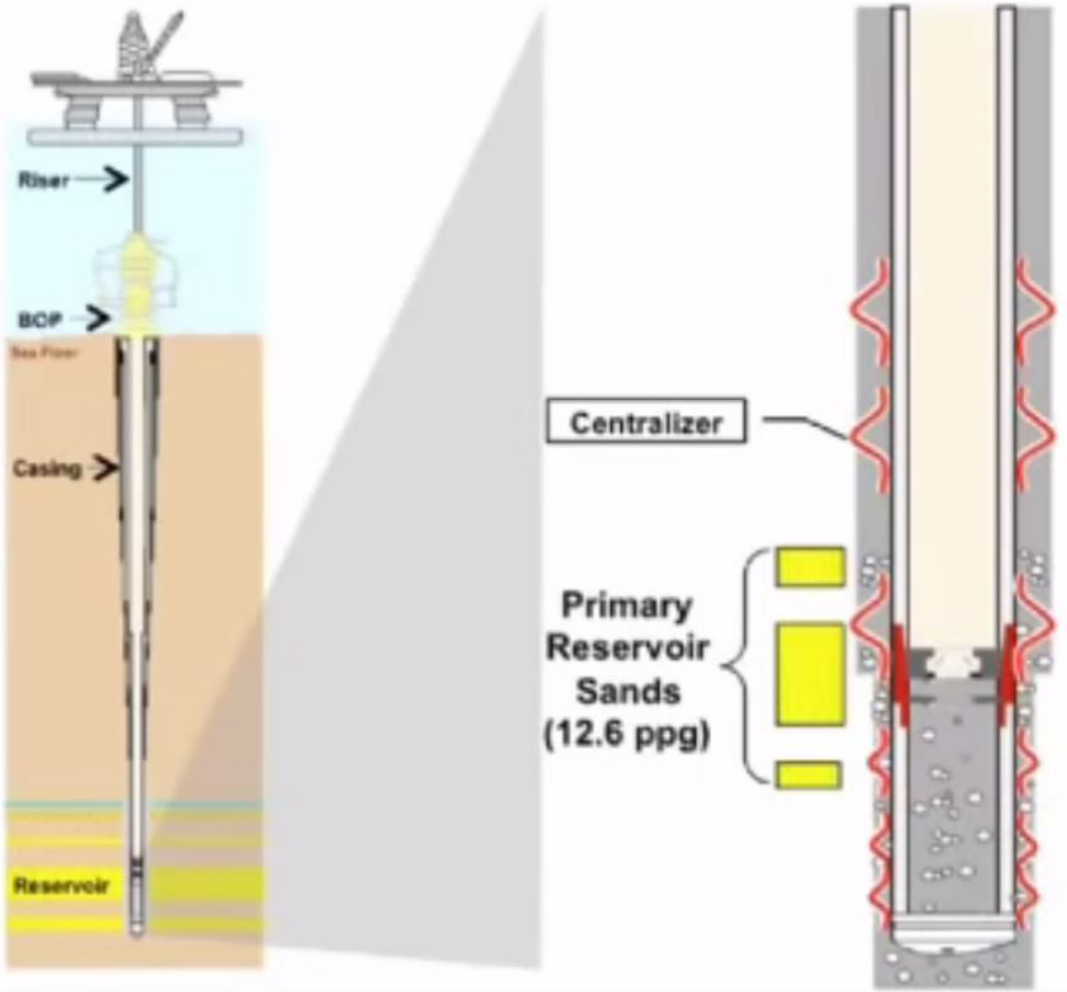




- High percentage of nitrogen made it difficult to create a stable foam
- No fluid loss additives in cement
- Small volume of cement in relation to displacement volume
- Cement lab tests were not comprehensive

Key Finding #1

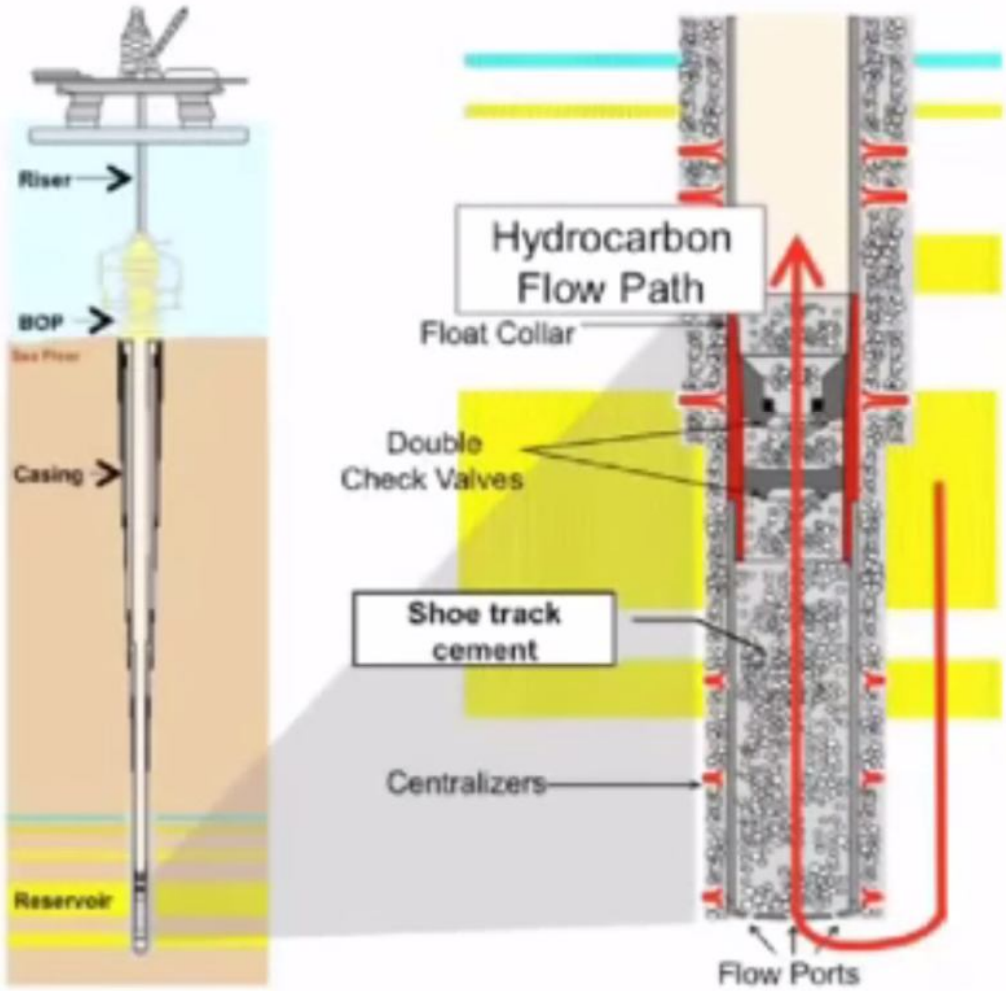
Annulus cement barrier did not isolate reservoir hydrocarbons



- Foam slurry was likely unstable and resulted in nitrogen breakout
- Casing was well-centralized across the primary hydrocarbon zones

Key Finding #2

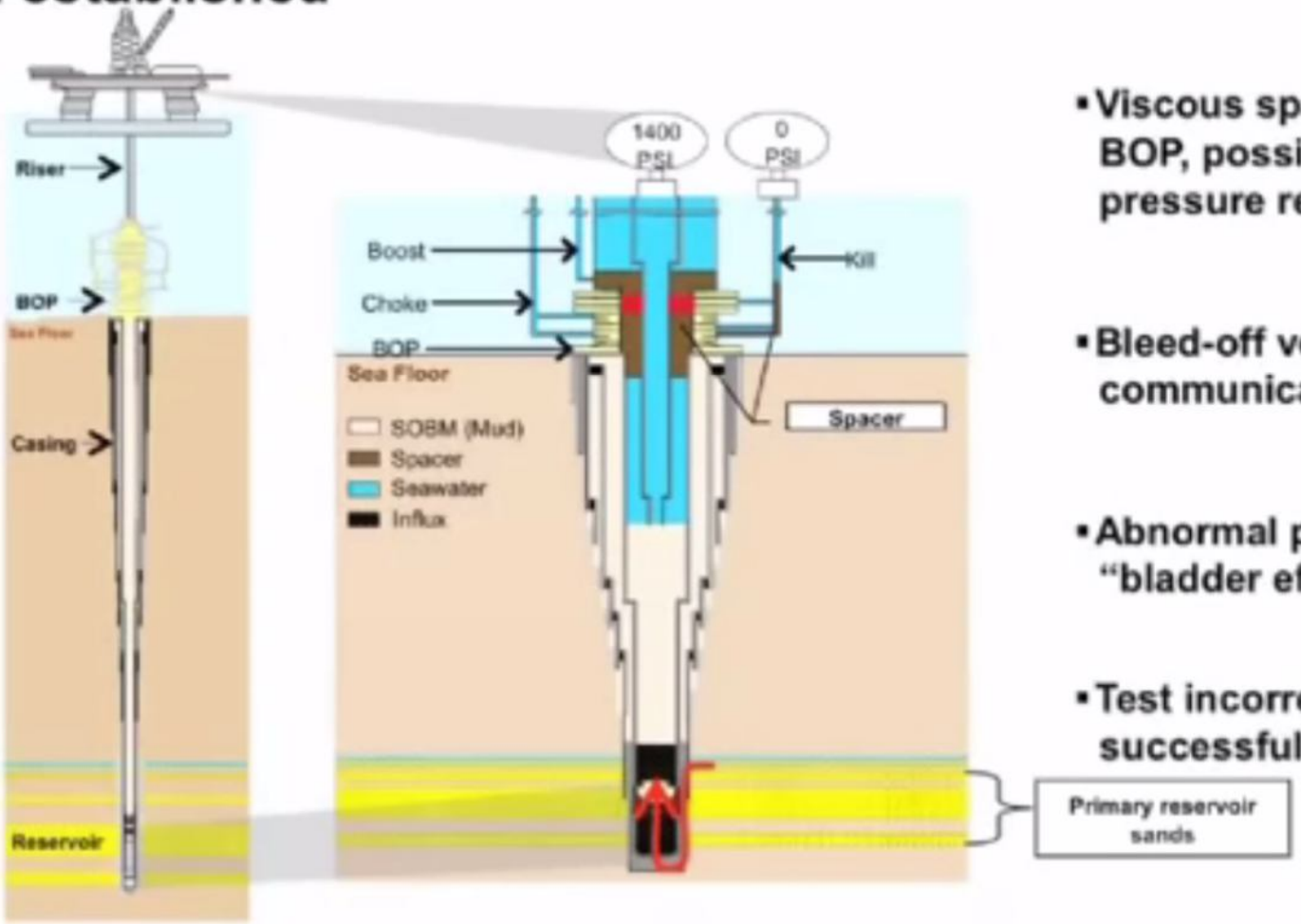
Shoe track mechanical barriers did not isolate hydrocarbons



- Shoe track cement failed to prevent influx
- Float collar valves failed to seal
- Flow came through the shoe track at the bottom of the casing

Key Finding #3

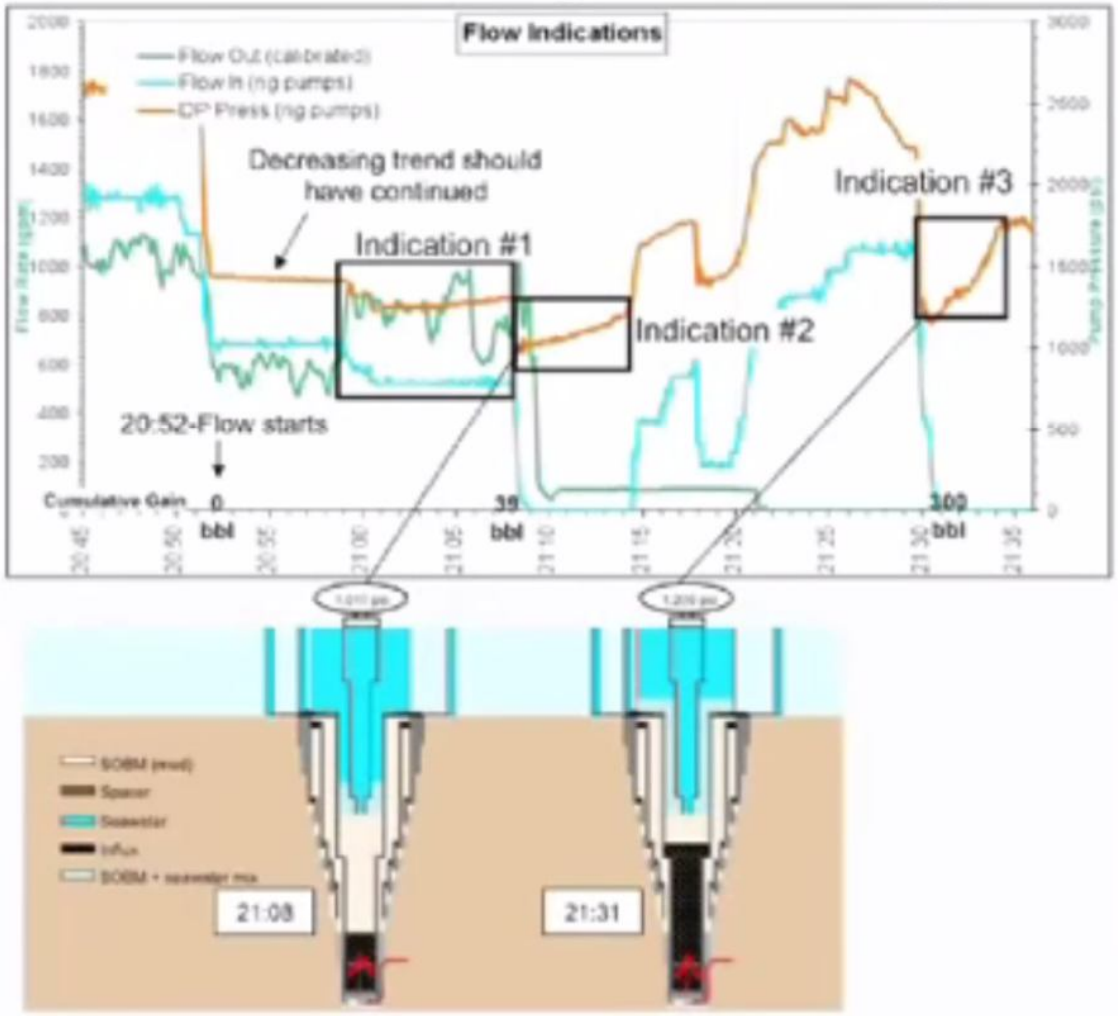
Negative pressure test was accepted, although well integrity had not been established



- Viscous spacer flowed across BOP, possibly inhibiting kill line pressure readings
- Bleed-off volumes indicated communication with reservoir
- Abnormal pressure attributed to "bladder effect"
- Test incorrectly deemed successful

Key Finding #4

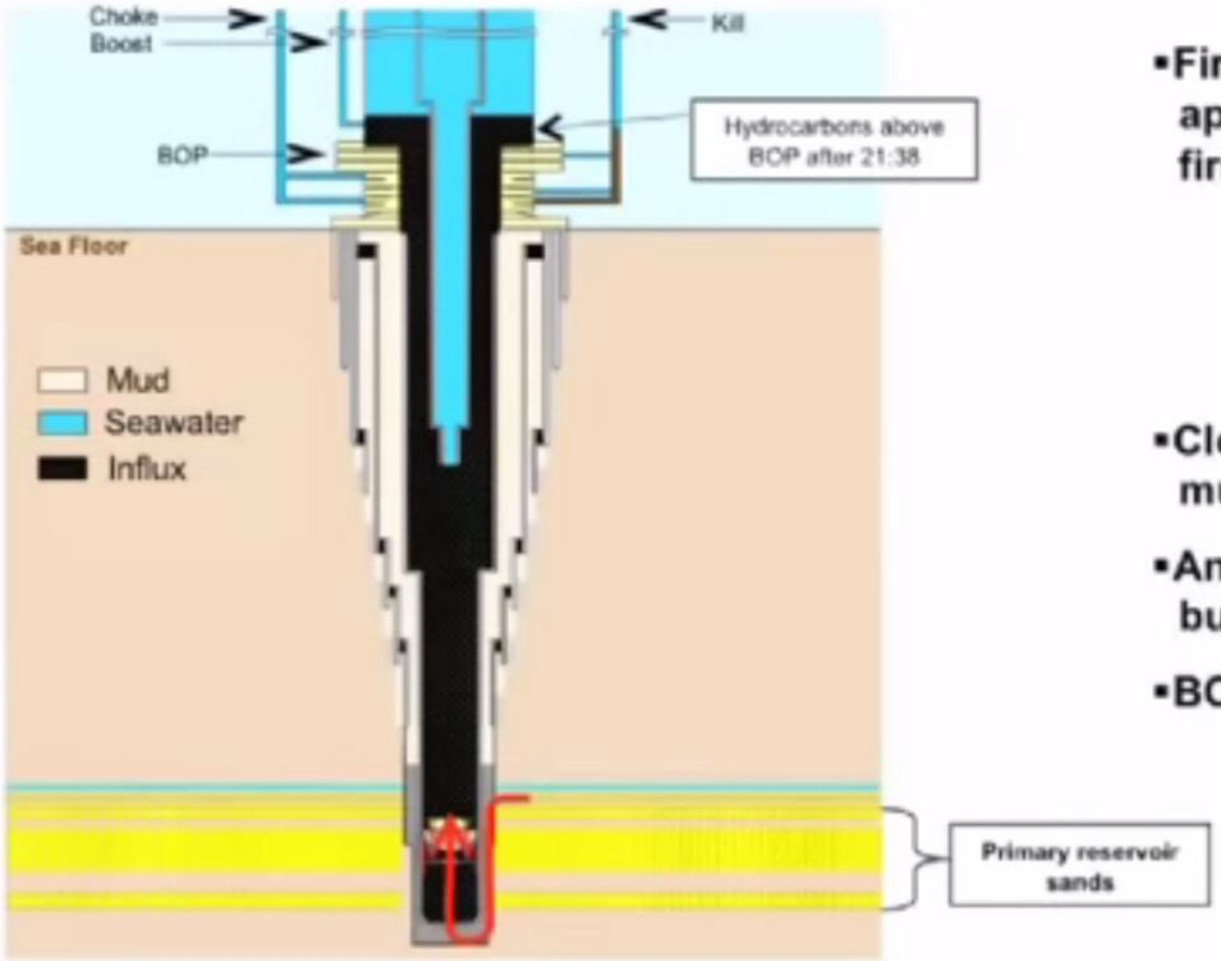
The influx was not recognized until hydrocarbons were in the riser



- Flow indications
  - #1: Drill pipe pressure increased by 100 psi, expected decreased – ~39 bbl gain from 20:58 to 21:08
  - #2: Drill pipe pressure increased by 246 psi with pumps off
  - #3: Drill pipe pressure increased by 556 psi with pumps off - ~300 bbl gain
- No well control actions taken

Key Finding #5

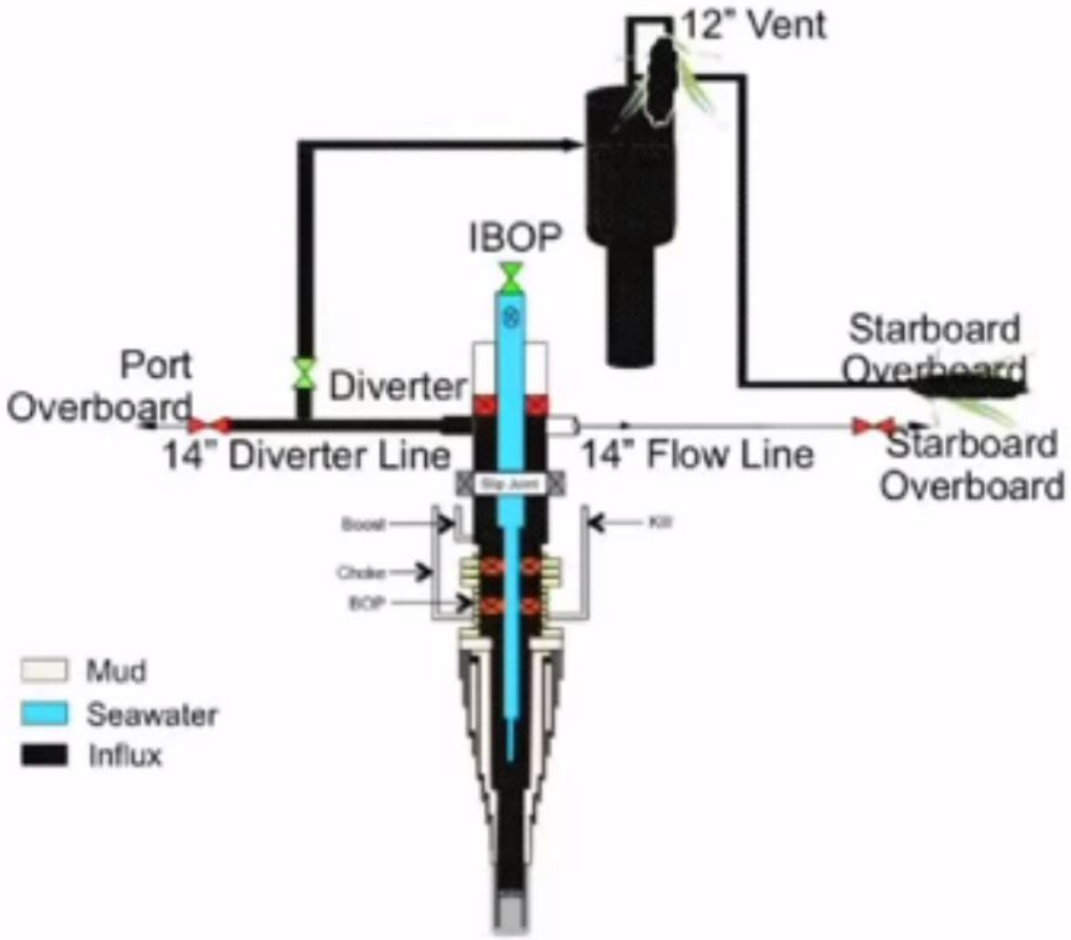
Well control response actions failed to regain control of well



- **First well control response approximately 40 minutes after first indication**
  - Hydrocarbons above BOP after 21:38
- **Closed diverter and routed flow to mud gas separator**
- **Annular preventer was activated, but did not seal**
- **BOP sealed six minutes later**

Key Finding #6

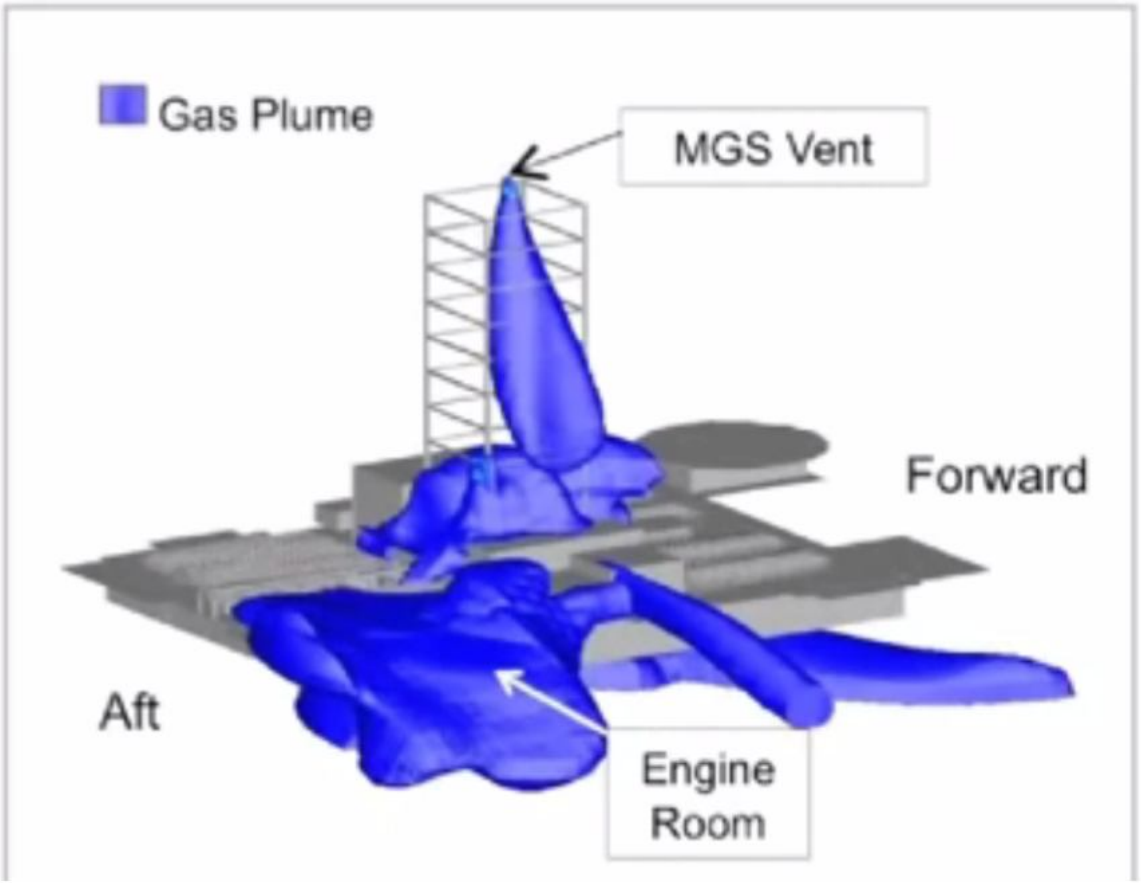
Diversion to mud gas separator resulted in gas venting onto rig



- Hydrocarbons diverted to mud gas separator versus routing overboard
- Surface gas handling system overwhelmed
- Combustible gas vented onto rig, enveloping possible ignition sources

Key Finding #7

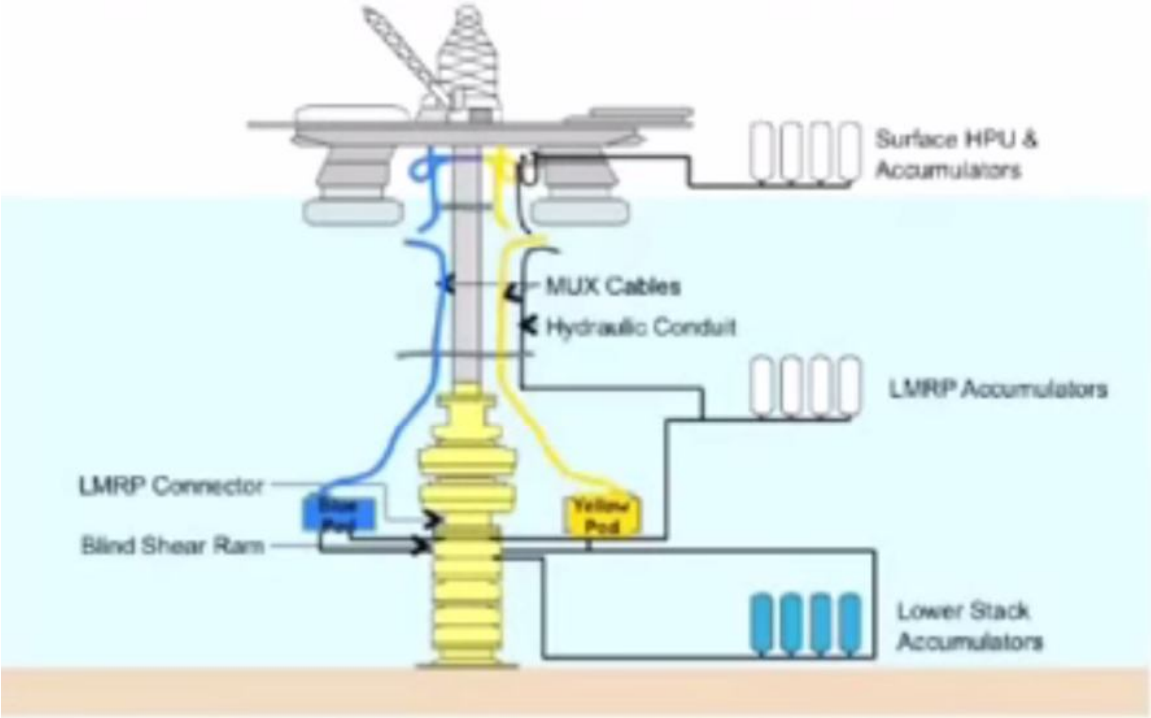
Fire and gas system did not prevent hydrocarbon ignition



- **Gas dispersed rapidly across rig**
  - Gas entered engine room through air intakes
  - Engines went into over-speed
  - Engines were one potential source of ignition

Key Finding #8

BOP emergency mode did not seal well

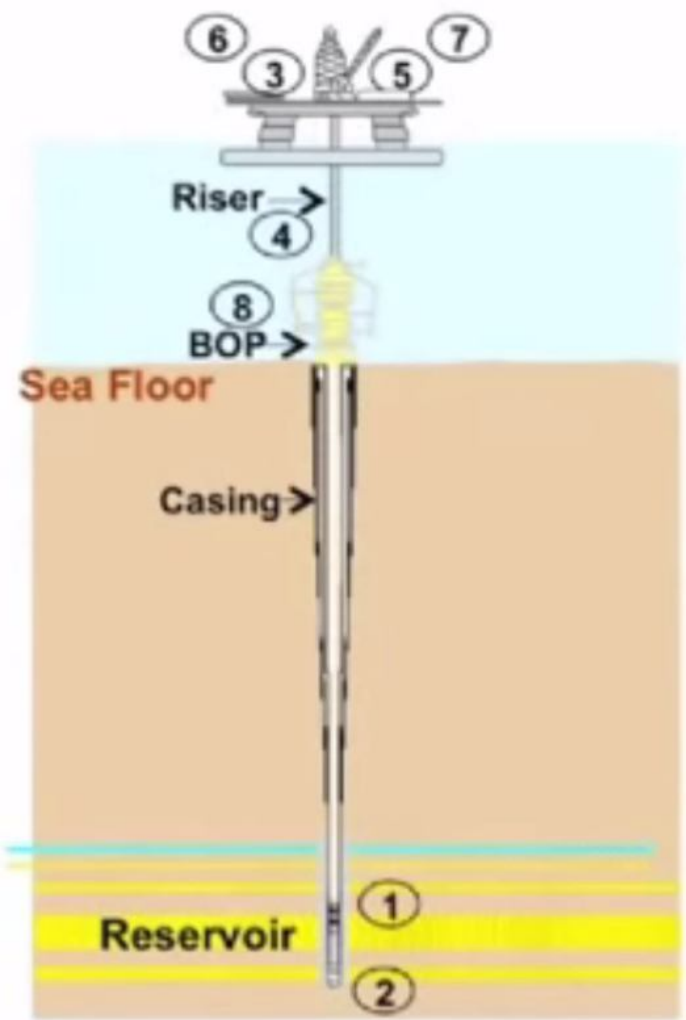


Emergency Methods of BOP Operation Available

Manual	Automatic	ROV Intervention
EDS HP Blind Shear	AMF	HOT Stab AMF Auto-shear

- **Initial explosions and fire**
  - Damaged MUX cables and hydraulic line
  - Resulted in failure of the emergency disconnect system
- **Automatic Mode Function did not complete due to:**
  - Defective solenoid valve
  - Insufficient charge on batteries
- **Post-accident ROV intervention likely activated blind shear rams**
- **Potential weaknesses in testing and maintenance of BOP**

Eight Barriers Were Breached



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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