Weatherford

AADE
AMERICAN ASSOCIATION of DRILLING ENGINEERS

Design and Concept Integration- MPD Technology in Deepwater Rigs

Julmar Shaun S. Toralde, Global Deepwater Managed Pressure Drilling Champion

Managed Pressure Drilling

An **adaptive** drilling process used to more precisely control the annular pressure profile throughout the wellbore.

The objectives of MPD are:

- to ascertain the downhole pressure environment limits;
- to manage the annular hydraulic pressure profile accordingly.

SOURCE: IADC

MPD and Bottomhole Pressure (BHP)

Conventional Drilling: Open to the Atmosphere System

BHP = MW + Friction

- Only adjustments available with mud in the hole are pumps on, pumps off and pump speed.

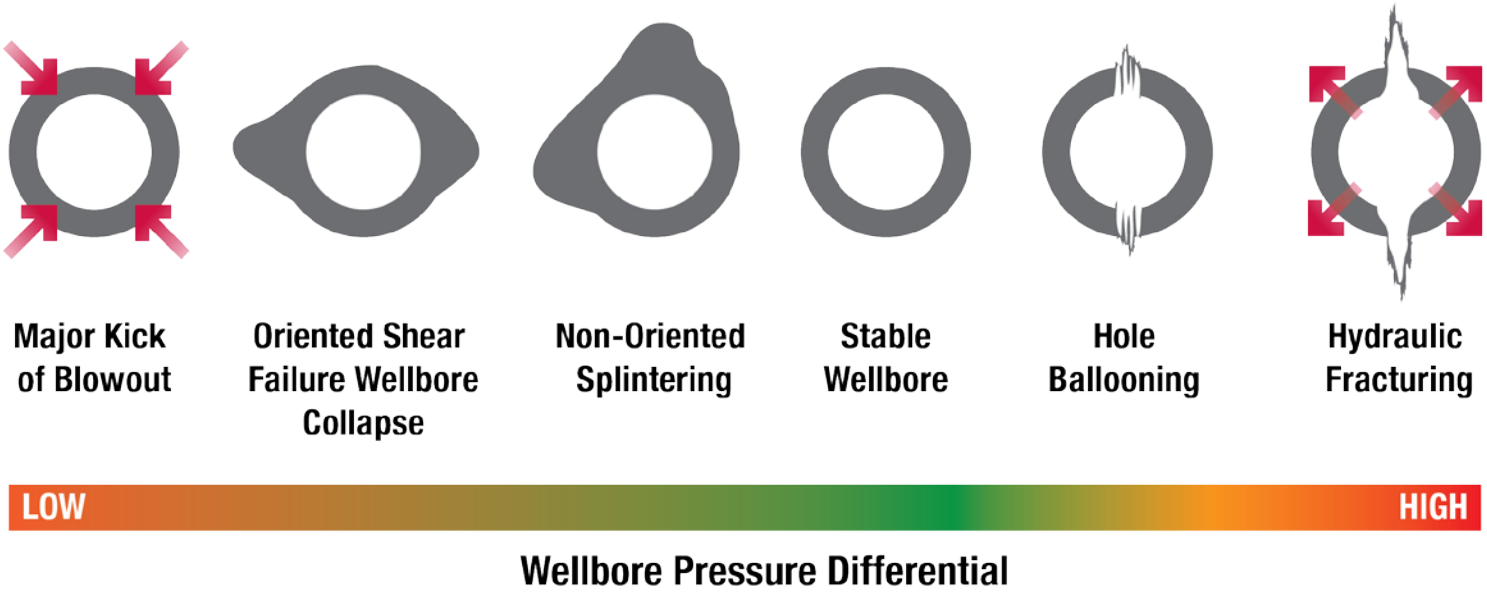
Managed Pressure Drilling (MPD): Closed System

BHP = MW + Friction + Surface Backpressure

- Effective BHP can be changed significantly and quickly with fewer interruptions to drilling ahead.

Borehole Behavior With Pressure

- Consequences of a delayed reaction to wellbore pressure issues could be severe in critical wells.

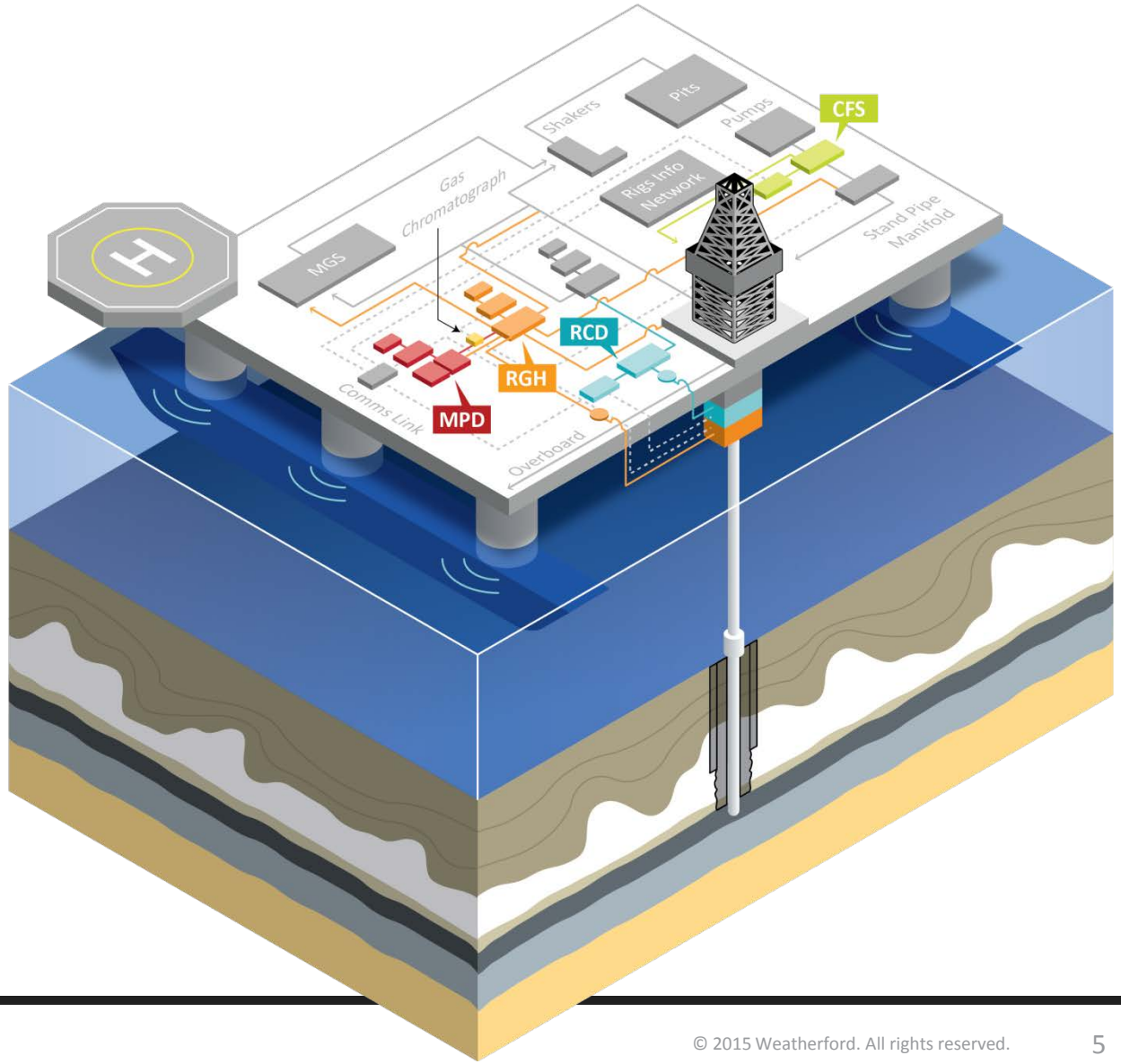


- In drilling, **managed pressure is managed cost** .
- In drilling, **managed pressure is managed safety** .

Deepwater MPD Technology Sets

Deepwater MPD (SBP) Equipment Sets

RCD	Closes the loop
MPD	PMCD, CBHP, RFC, RGM, DG
RGH	Mitigates riser gas

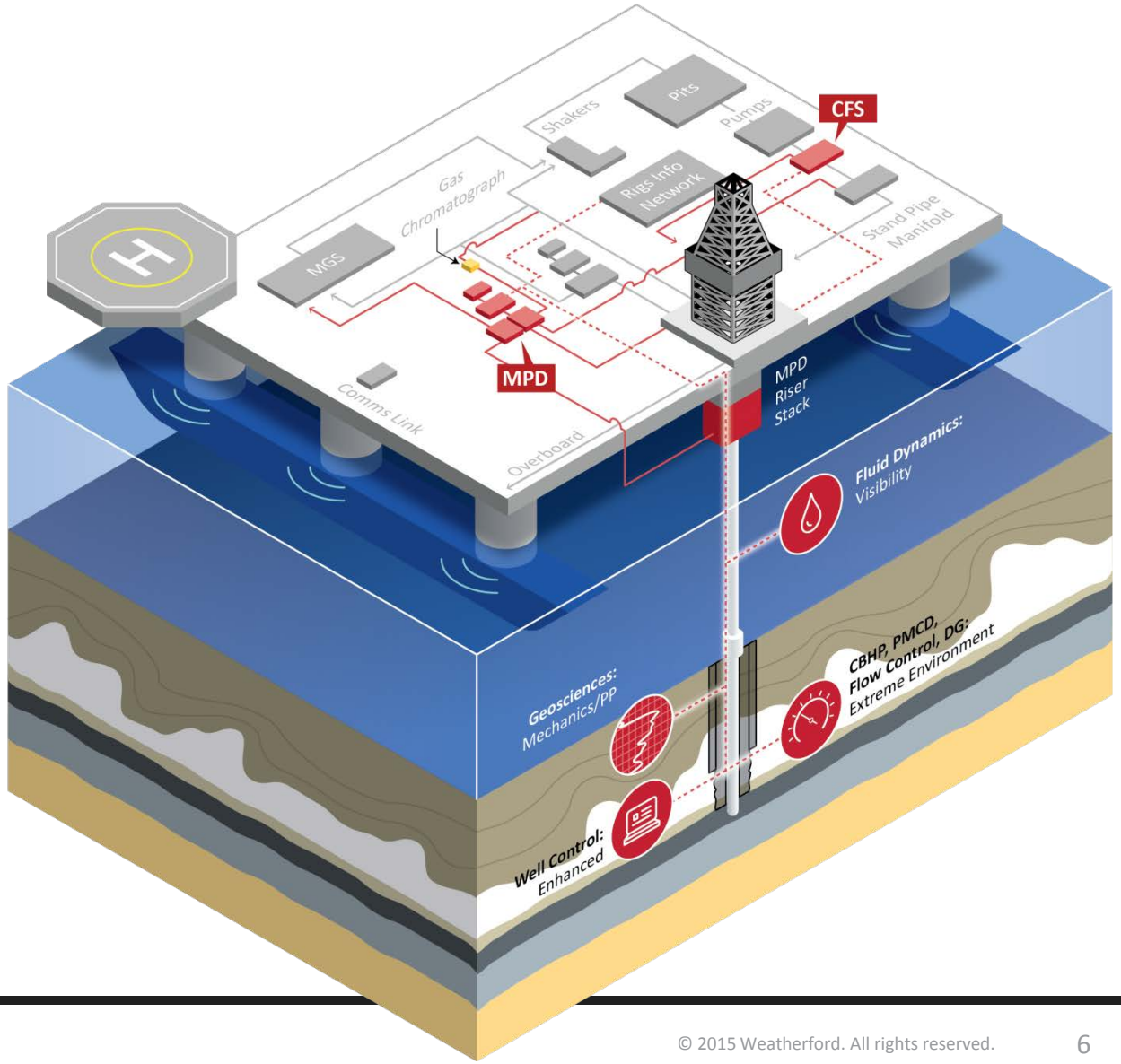


RGH – Riser Gas Handling
RCD – Rotating Control Device
MPD – Managed Pressure Drilling

Deepwater MPD Techniques

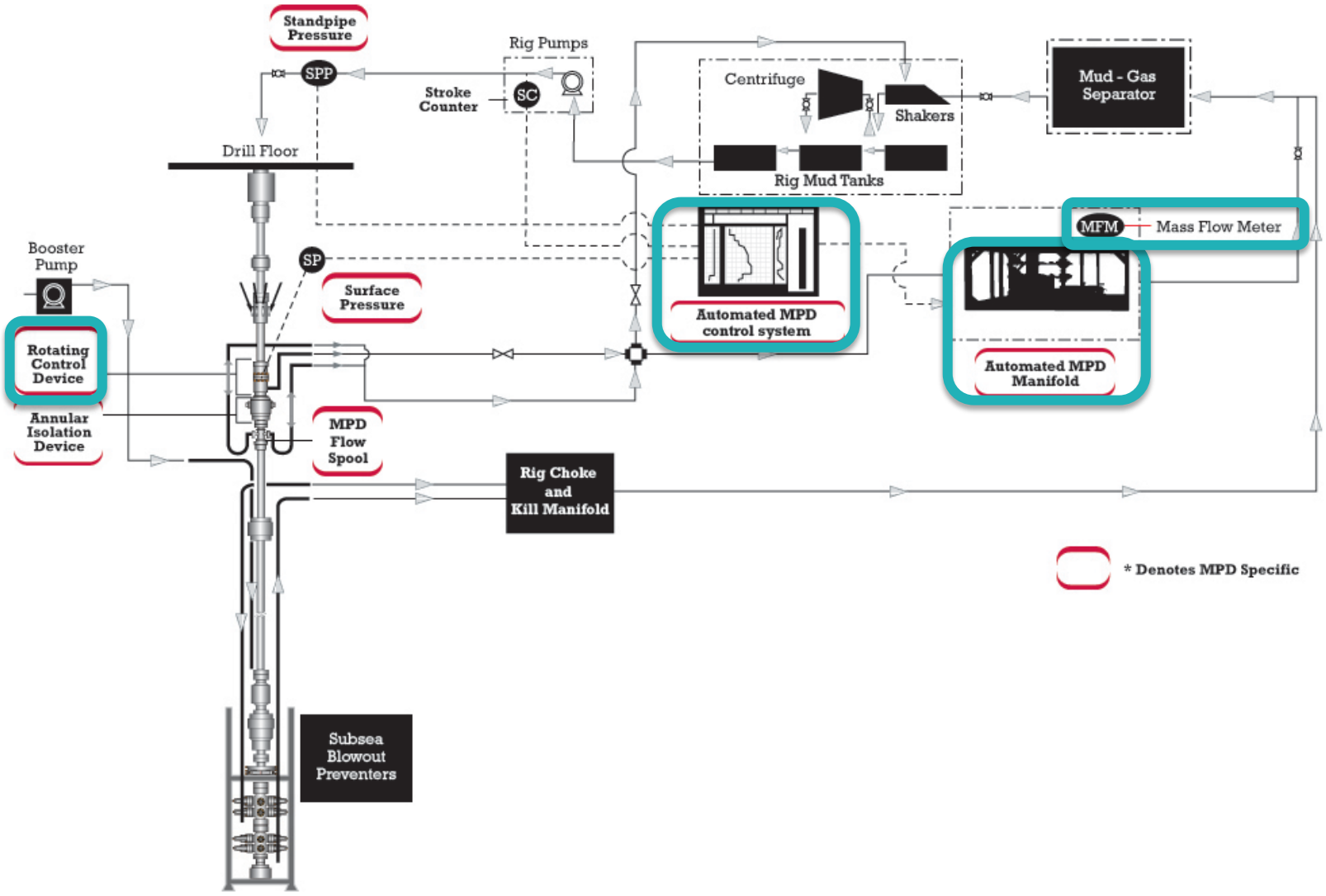
Deepwater MPD (SBP) Techniques

RFC	Detects/controls kick/loss early
RGM	Keeps large gas kicks from riser
CBHP	Minimizes pressure spikes downhole
PMCD	Drills through severe losses

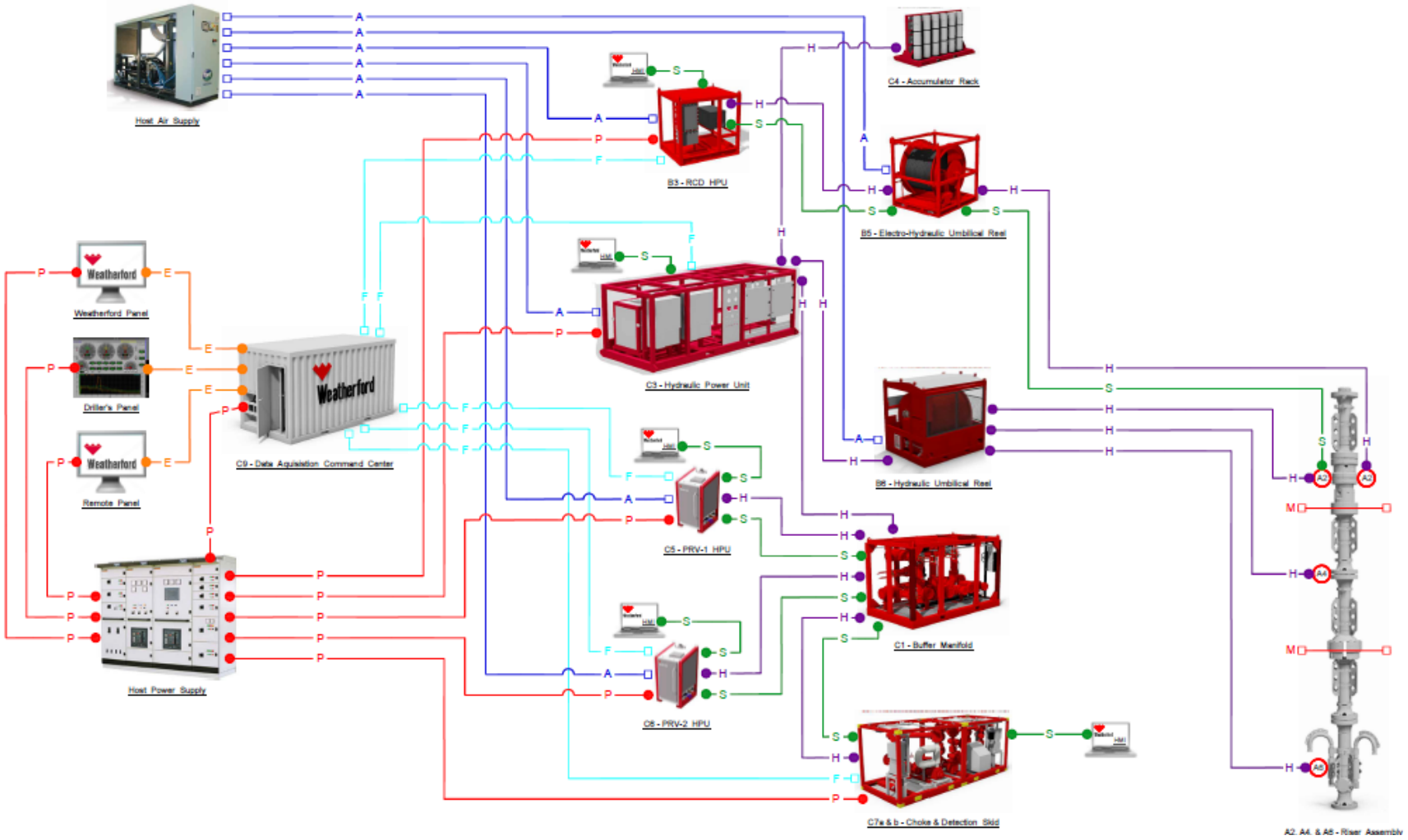


RFC – Returns Flow Control
RGM – Riser Gas Mitigation
CBHP – Constant Bottomhole Pressure
PMCD – Pressurized Mud Cap Drilling

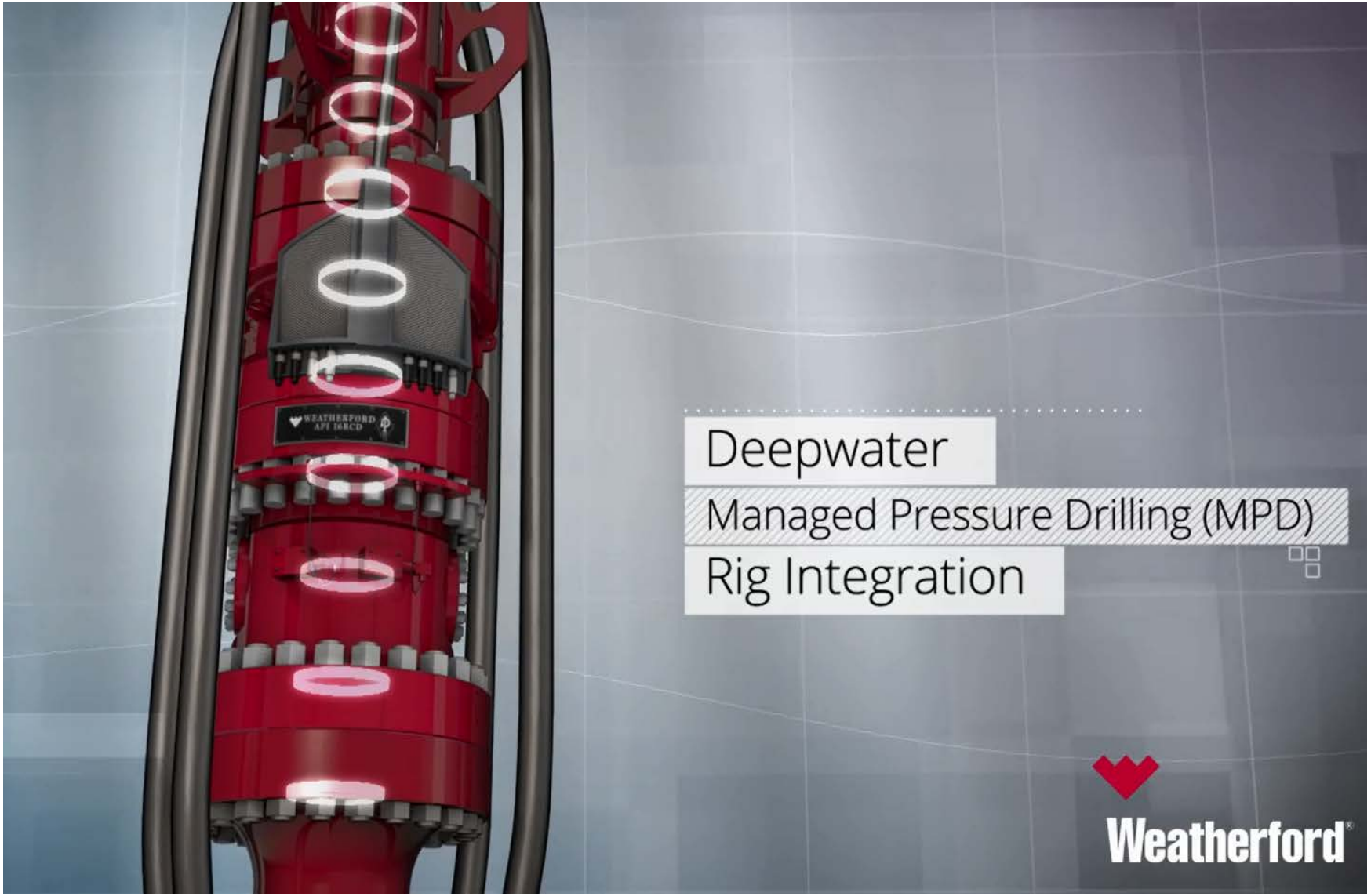
Deepwater MPD System



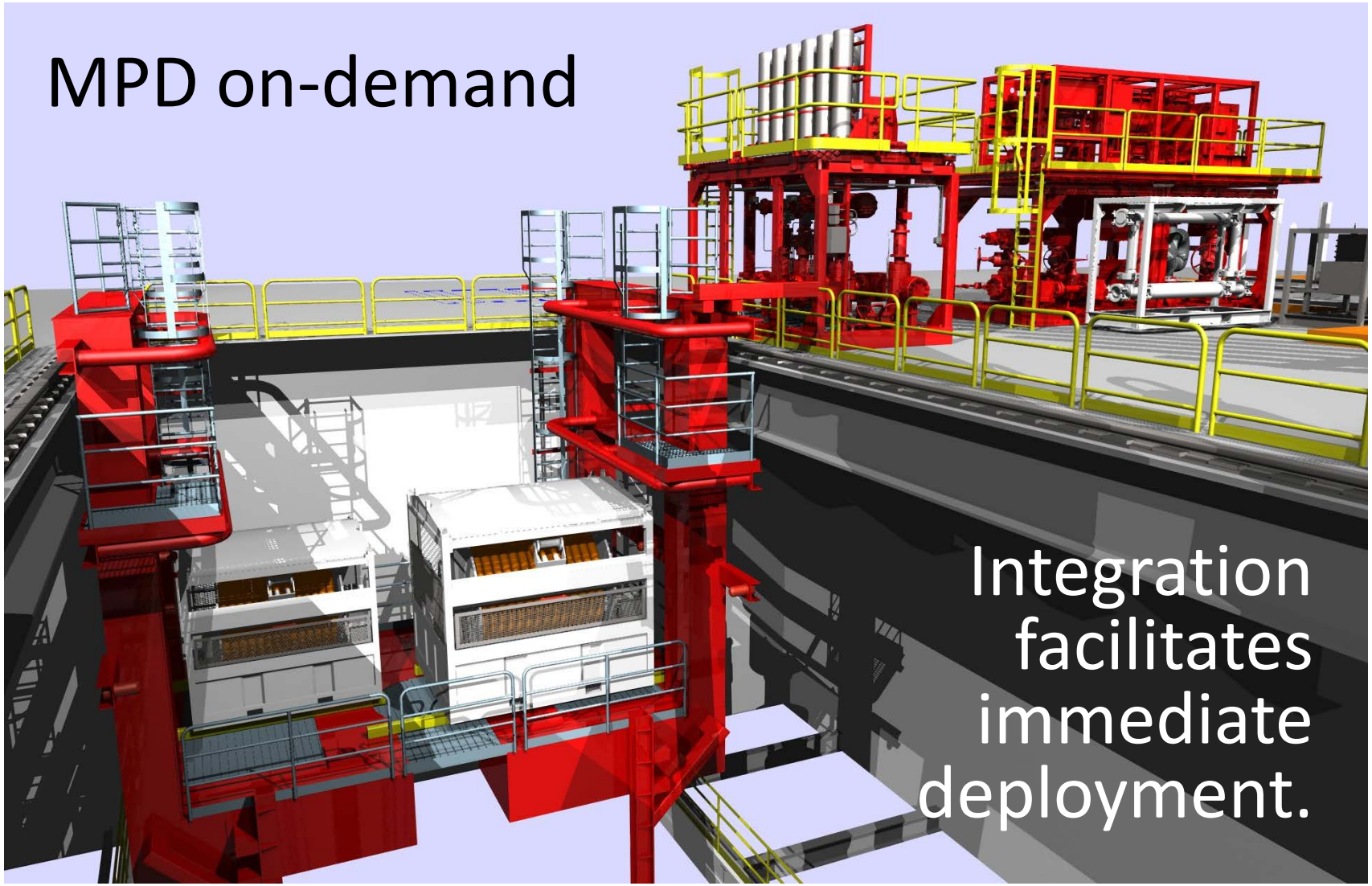
Deepwater MPD Equipment Set-up



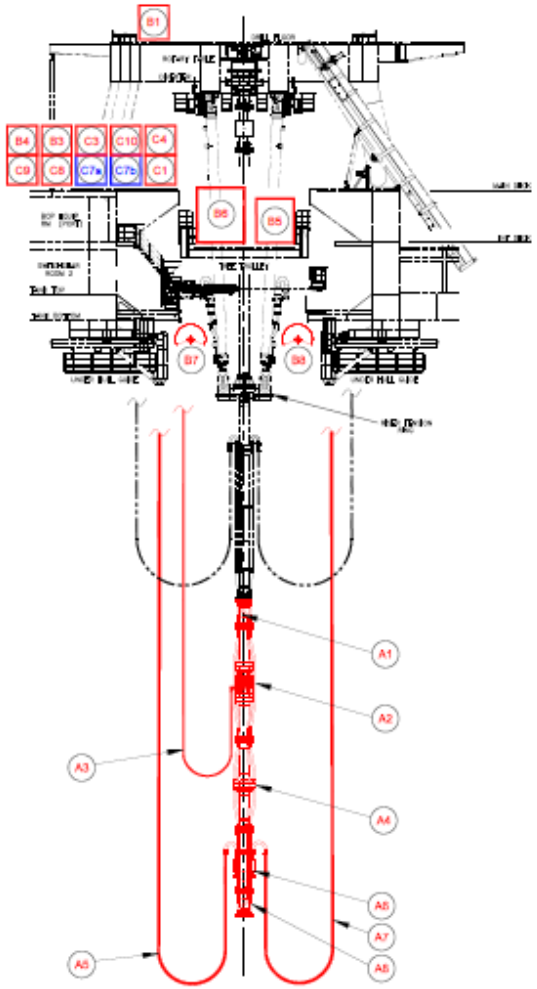
Deepwater MPD Rig Integration



Why Rig Integration?

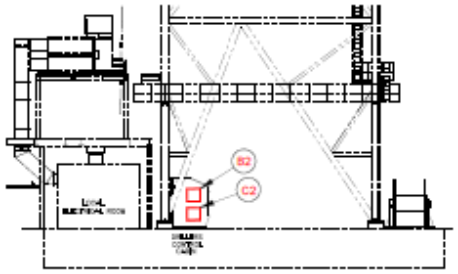


MPD Integration into a Floating Rig



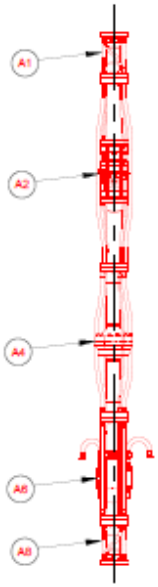
MPD - EQUIPMENT

Below Tension Ring - Deepwater Managed Pressure Drilling System



MPD - EQUIPMENT

Topside Arrangement



MPD - EQUIPMENT

Riser Component Arrangement

MPD EQUIPMENT - Main Deck - ISO View

MPD EQUIPMENT - Moonpool Tree Trolley - ISO View

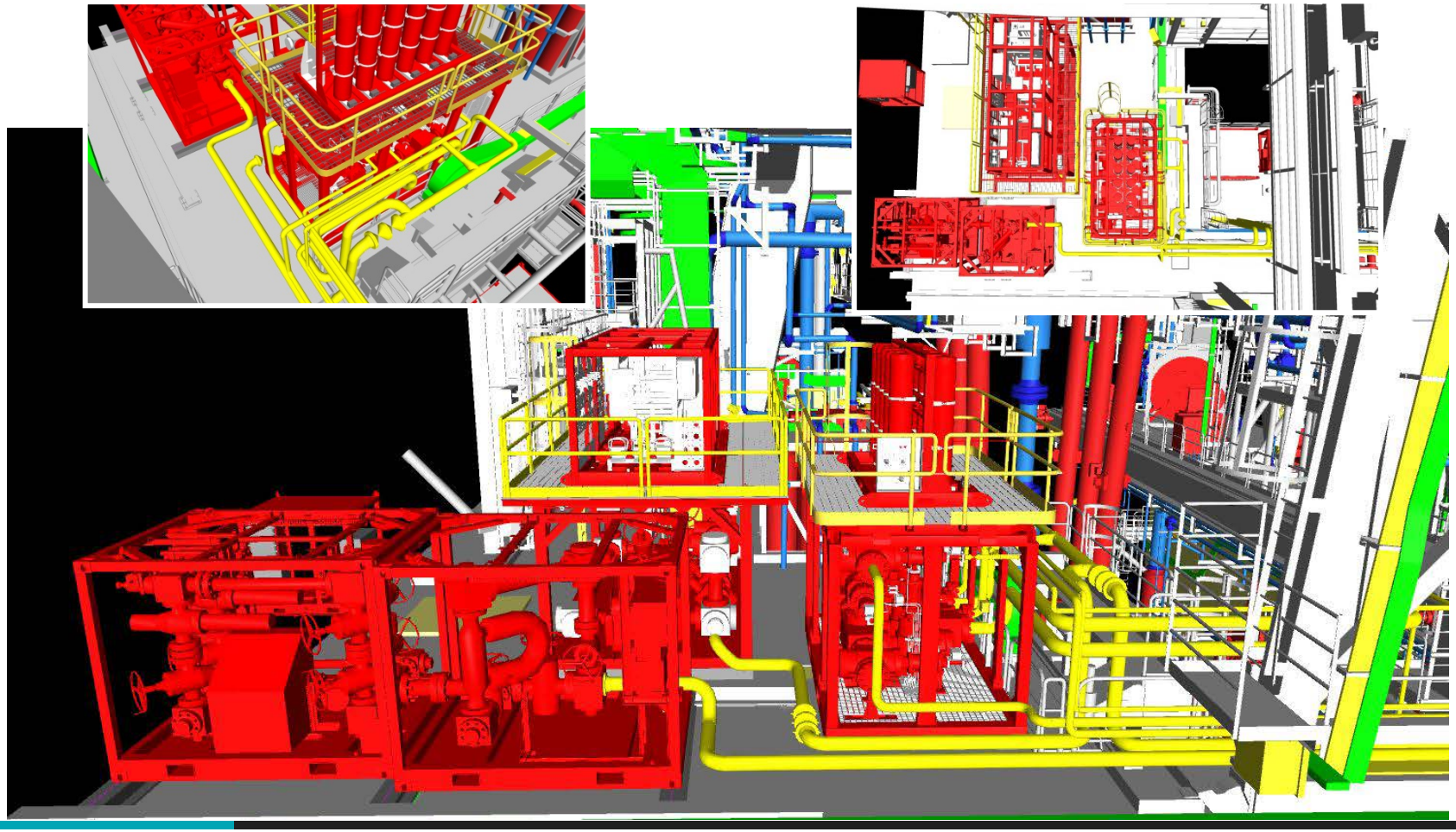
Weatherford — COMPONENT I.D. & CHARACTERISTICS —

I.D.#	DESCRIPTION	Dimensions (ft /m) Length x Width x Height	Weight (lb / kg)	POWER	Air Supply (psi / bar)	Tensile Rating (lb)
A	MPD - RISER JOINT					
A1	Upper Adaptor Spool	TBD	TBD	None	None	3,500,000
A2	RealShield™ Below Tension Ring (BTR) Rotating Control Device (RCD)	Height: 25.28ft / 7.65m	44,000lb / 19,958kg	None	None	3,500,000
A3	RCD Riser/Isolation Line	Diameter: 2.00in	TBD	None	None	None
A4	MPD Annulus Isolation Device	Height: 20ft / 6.10m	28,000 lb / 13,154 kg	None	None	3,500,000
A5	MPD Flow Line (SECONDARY)	Diameter: 6.00in	TBD	None	None	None
A6	MPD Flow Spool	Height: 12.5ft / 3.81m	17,000 lb / 7,711kg	None	None	3,500,000
A7	MPD Flow Line (PRIMARY)	Diameter: 6.00in	TBD	None	None	None
A8	Lower Adaptor Spool	Height: TBD	TBD	None	None	3,500,000
B	MPD - SURFACE EQUIPMENT FOR RISER JOINT					
B1	RCD Bearing Assembly Running Tool Control Console (Pneumatic)	2.0ft x 2.0ft x 6.0ft (0.6m x 0.6m x 1.8m)	265 lb / 120 kg	None	80 psi / 10.4 bar	None
B2	RCD Human – Machine Interface (HMI)	2.0ft x 1.0ft x 1.0ft (0.6m x 0.45m x 0.3m)	33 lb / 15 kg	None	None	None
B3	RCD Hydraulic Power Unit (HPU)	6.0ft x 8.0ft x 6.0ft (1.8m x 1.0m x 1.8m)	4,409 lb / 2,000 kg	480 VAC, 3P 60Hz	None	None
B4	RCD Tool Container	10.0ft x 8.0ft x 8.0ft (3.0m x 2.4m x 2.4m)	15,432 lb / 7,000 kg	220 VAC, 1P + N + E, 60 Hz	None	None
B5	RCD Electro - Hydraulic Umbilical Reel	TBD	8,501 lb / 3,856 kg	None	100 psi / 6.89 bar	None
B6	MPD Hydraulic Umbilical Reel	8.0ft x 7.2ft x 8.0ft (2.4m x 2.2m x 2.6m)	19,841 lb / 9,000 kg	None	100 psi / 6.89 bar	None
B7	RCD Electro - Hydraulic Umbilical Sheave	TBD	650 lb / 294.8 kg	None	None	None
B8	MPD Hydraulic Umbilical Sheave	TBD	1300 lb / 589.6 kg	None	None	None
C	MPD - SURFACE EQUIPMENT TO COMPLETE SYSTEM					
C1	MPD Buffer Manifold	14.2ft x 8.0ft x 6.1ft (4.3m x 2.4m x 2.0m)	40,785 lb / 18,500 kg	None	None	None
C2	MPD Buffer Manifold Human – Machine Interface (HMI)	2.0ft x 1.0ft x 1.0ft (0.6m x 0.45m x 0.3m)	33 lb / 15 kg	None	None	None
C3	MPD Buffer Manifold Hydraulic Power Unit (HPU)	20.0ft x 8.0ft x 7.2ft (6.0m x 2.4m x 2.2m)	26,000 lb / 13,000 kg	LPR backup supply from 110 VAC, 12 Amps, 1P 60 Hz Primary Pump supply From Rig, 480 VAC, 65 Amps, 3P 60 Hz Secondary Pump Supply From Rig, 480 VAC 65 Amps, 3P 60 Hz	100 psi / 6.89 bar	None
C4	MPD Buffer Manifold Accumulator Rack	12.3ft x 8.0ft x 7.2ft (3.75m x 2.0m x 2.2m)	13,227 lb / 6,000 kg	Mains supply from Rig for Buffer Manifold Rack Relay Lamps, 110/240 VAC 6 Amps, 1P 60 Hz Supply from WPT RGH LPR HMI, 110/240 VAC, 3 Amps 1P 60 Hz	None	None
C5	MPD Buffer Manifold PRV HPU/MM	3.0ft x 3.0ft x 4.0ft (1.0m x 1.0m x 1.2m)	TBD	110-240 VAC, 1P 60Hz 2.5A	None	None
C6	MPD Buffer Manifold PRV HPU/MM	3.0ft x 3.0ft x 4.0ft (1.0m x 1.0m x 1.2m)	TBD	110-240 VAC, 1P 60Hz 2.5A	None	None
C7a	Microflux® Control System MPD Choke Manifold (Choke Mod)	8.0ft x 8.0ft x 8.0ft (2.4m x 2.0m x 2.4m)	16,000 lb + 8,000 lb / 7,528 kg + 4,480 kg	110 – 120 V AC, 4.2A	Fresh (sump) 40 psi / 2.76 bar Mud (sump) 60 psi / 0.5 bar	None
C7b	Microflux® Control System MPD Choke Manifold (Detection Mod)	8.0ft x 10.2ft x 8.0ft (2m x 3.1m x 2.0m)	21,000 lb / 9,752 kg	110 – 120 V AC, 4.2A	None	None
C8	Microflux® Workshop Container	10.0ft x 8.0ft x 8.0ft (3.0m x 2.4m x 2.8m)	15,432 lb / 7,000 kg	None	None	None
C9	Data Acquisition Command Center (HAM / LWD3 - ABI Rated)	18.0ft x 8.0ft x 9.0ft (6.8m x 2.4m x 2.7m)	19,000 lb / 8,618 kg	480 VAC 60 Hz, 60A 3 - Phase	None	None
C10	Junk Catcher	17.0ft x 8.0ft x 8.0ft (5.2m x 2.0m x 2.4m)	TBD	None	None	None

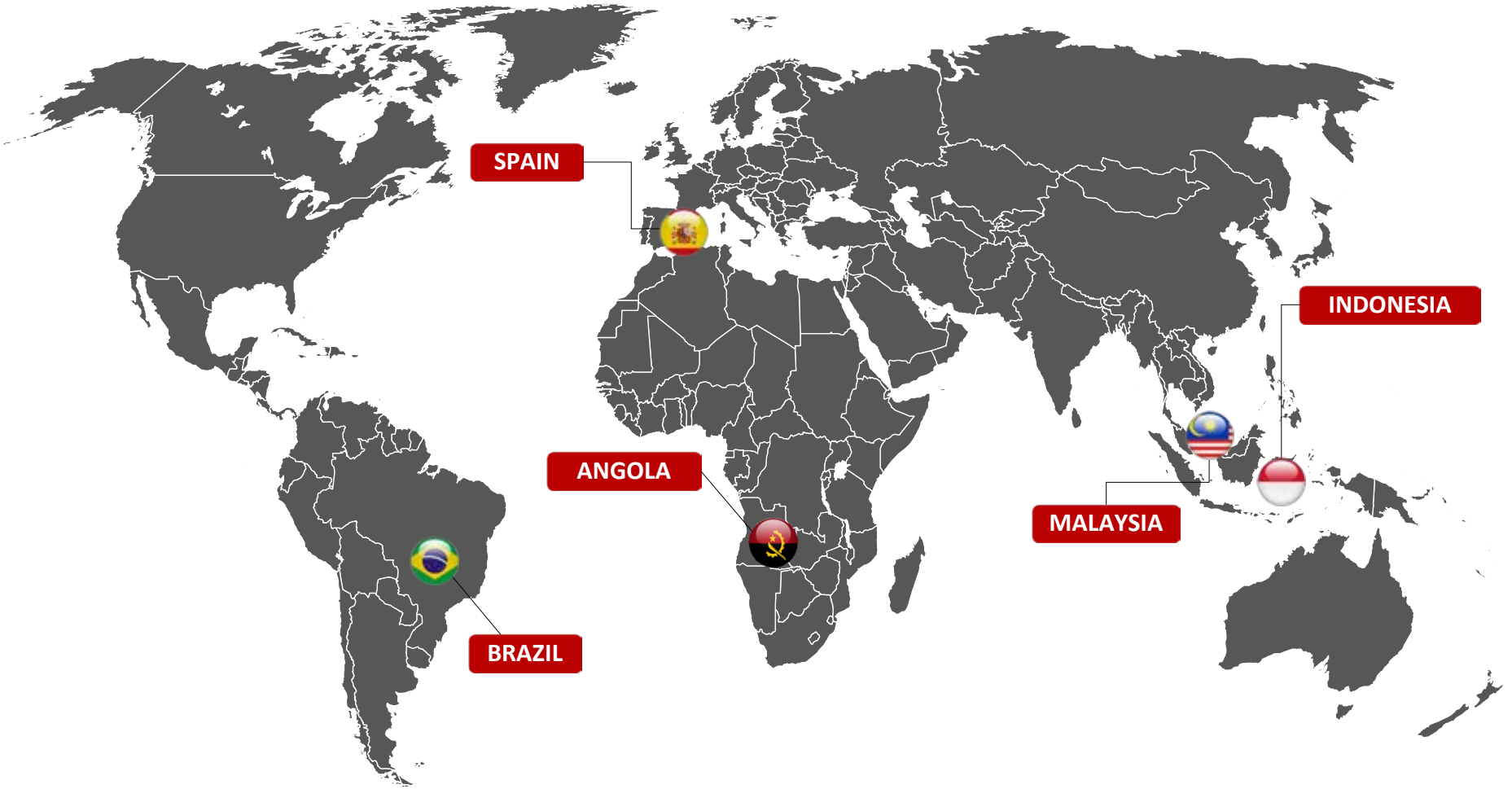
- Snapshot of prepared rig integration plans.

MPD Integration into a Floating Rig

- Rig integration plans have been developed for numerous floating rigs in DW / UDW settings.



Deepwater MPD (BTR) Projects



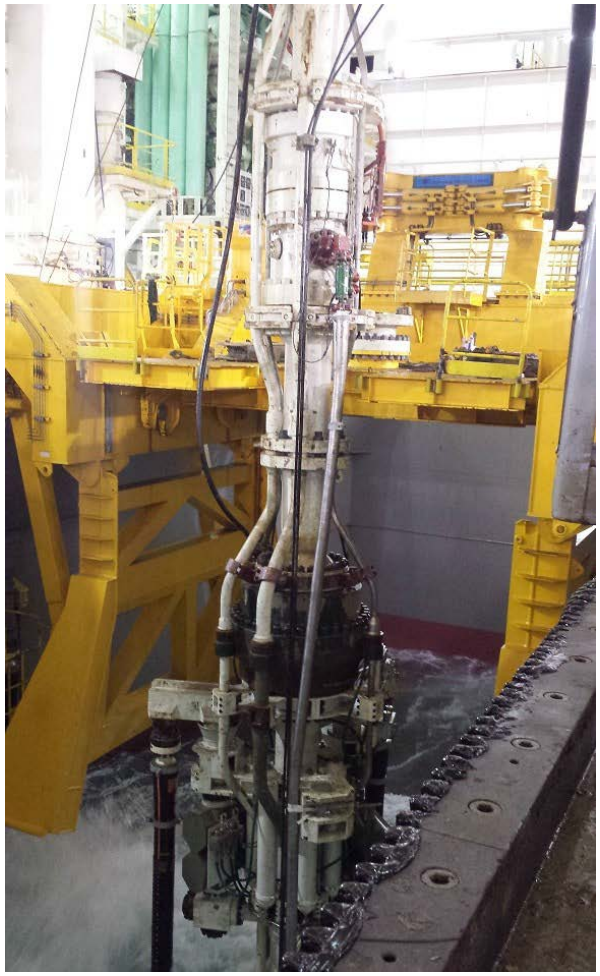
30+ Deepwater MPD Wells | **20+** DW MPD Rigs

10+ Deepwater Contractors | **10+** Deepwater Operators

Retrofit Integration (Shipyard)

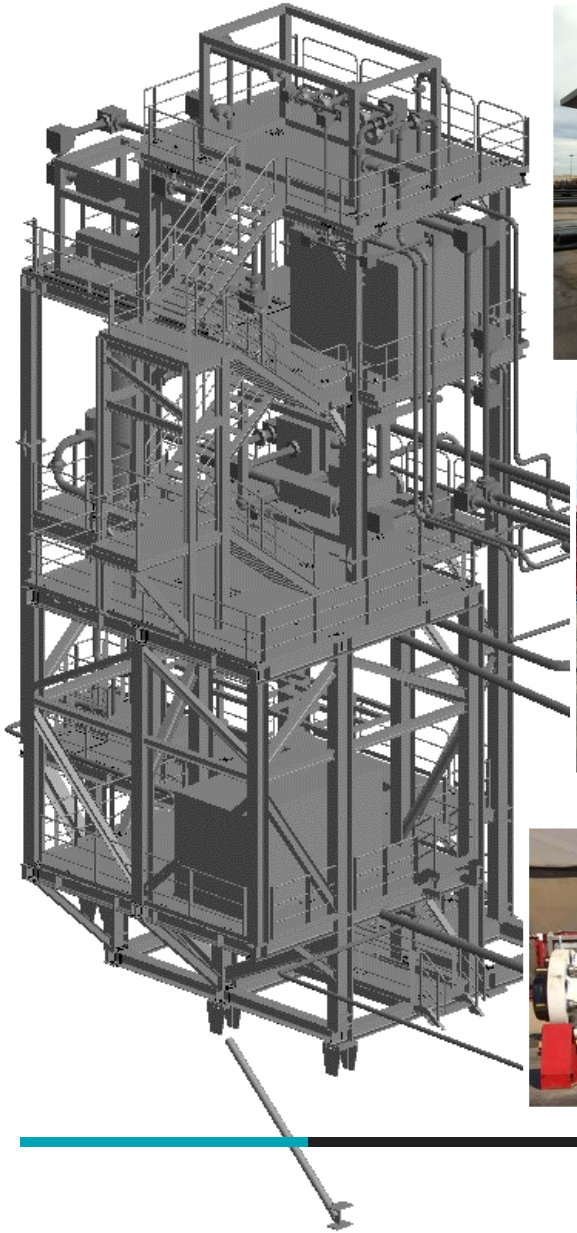
- MPD integration performed on shipyards and *in situ* for more than 20 deepwater rigs.

Retrofit Integration (In Transit)

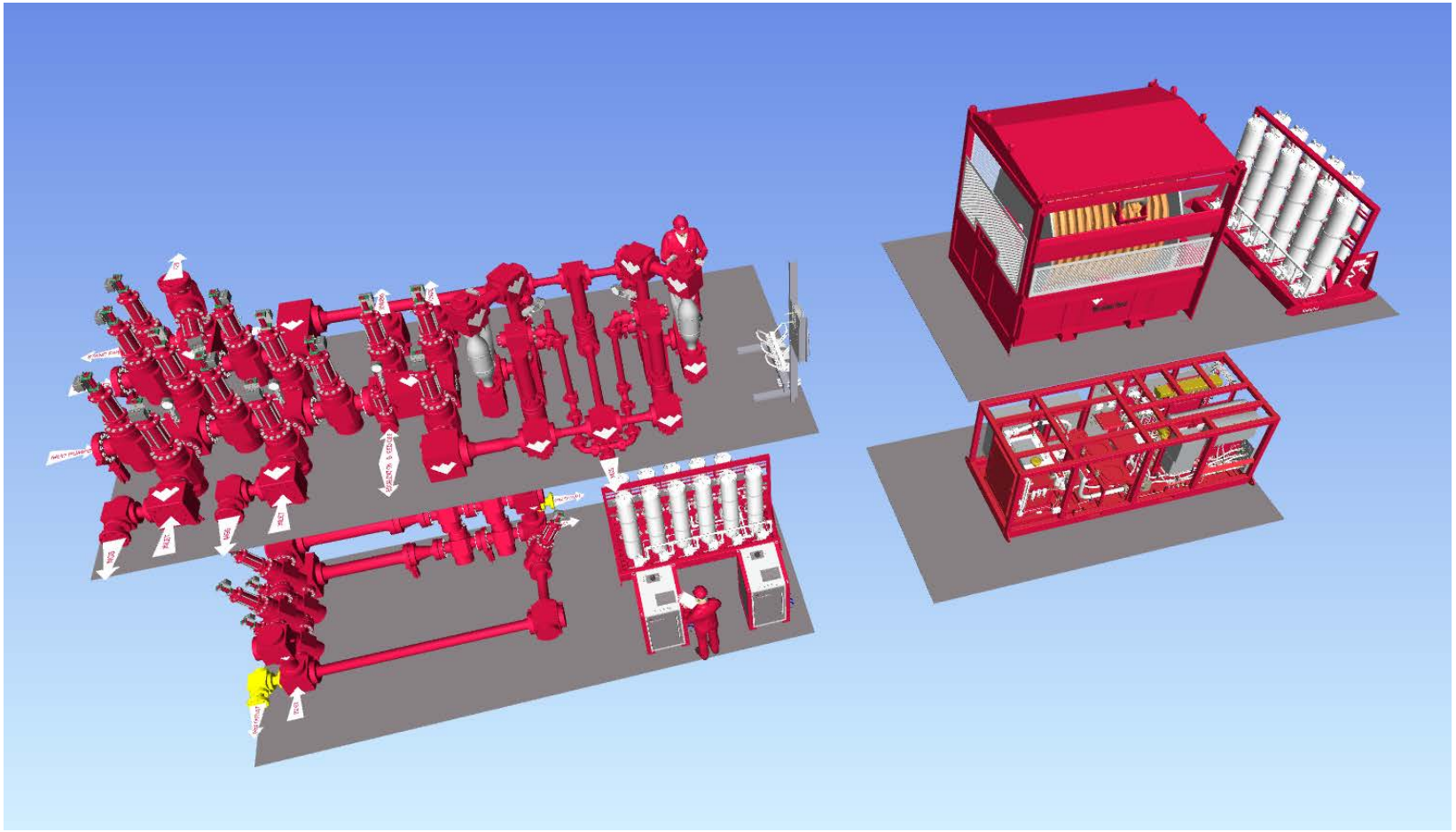


Retrofit Integration (*In Situ*)

Retrofit Integration

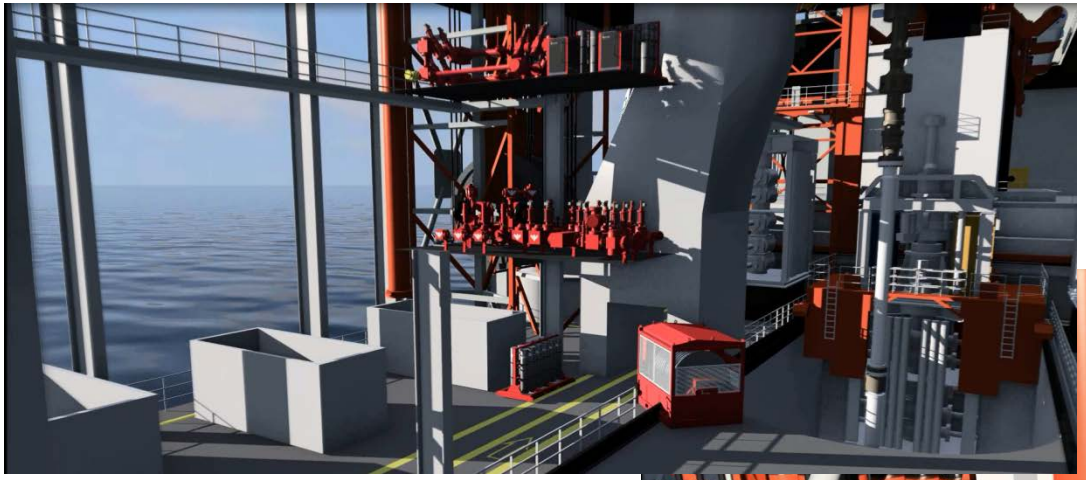


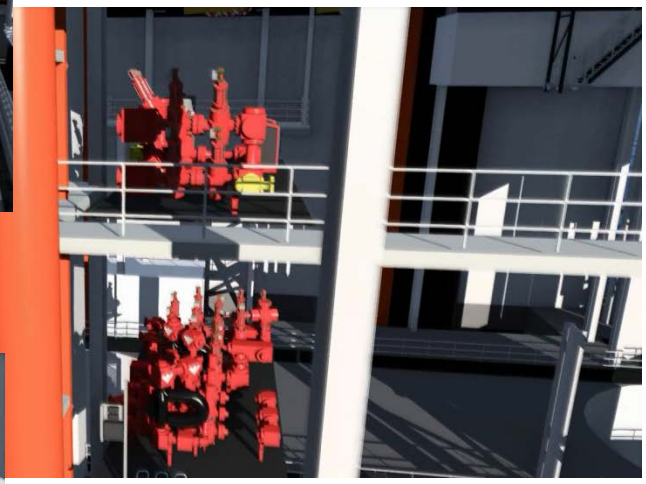
New Build Integration



- Development with ship builders of MPD designs for long-term permanent placement on deepwater drilling rigs.

New Build Integration





- Rig Design Integration Snapshots.

DW MPD Integration: Industry-Wide

- **Operators** - key drivers for deepwater MPD rig integration projects, a majority of which are an outcome of operational requirements.
- **Rig contractors-** proactively planning and preparing for MPD rig integration to maintain a competitive advantage.
- **Shipyards / Rig designers-** now incorporating MPD technologies into next-generation rig designs to expand client offering.

Summary

- Integration of MPD systems into floating mobile offshore drilling units is rapidly becoming the norm; dozens of MPD-ready deepwater drilling rigs equipped currently.
- Rig contractors, drilling rig designers and shipyards have begun collaborating with MPD specialists to develop MPD integration approaches and concepts.
- This presentation discusses the approaches that have been taken by companies (specifically those working with Weatherford) involved in the initiative, with the objective of sharing knowledge and providing guidance on the fast-developing subject.
- Case studies of successfully performed deepwater MPD projects or, those currently underway from a floating drilling rig design and concept standpoint will be presented to provide the industry with otherwise unavailable insight and guide future MPD deepwater integration initiatives.

Presenter

- Julmar Shaun Sadicon Toralde is the Global Champion for Deepwater Managed Pressure Drilling (MPD), Downhole Deployment Valve (DDV) and SteadyState Continuous Flow System technologies of Weatherford, Houston, Texas, USA.
- He helped pioneer deepwater MPD deployment on a dynamically positioned drillship in 2010 and is actively involved in major deepwater MPD rig integration projects globally.
- Shaun hails from the Philippines and holds a Geothermal Engineering degree from Negros Oriental State University, where he taught and conducted research on energy engineering.
- He has 50 technical publications and various MPD training courses to his name.

Real Results

Pioneering MPD System on Dynamically Positioned Drillship Enables Safe Drilling of Rank Wildcat Deepwater Wells in Indonesia

Objective:

- Drill rank wildcat deepwater wells in a safe and efficient manner from a dynamically positioned drillship equipped to perform MPD variations that address several drilling challenges.

Solution:

- Weatherford provided an API16RCD-certified SeaShield® Model 7875 RCD that can be installed below the tension ring (BTR) of the drillship and totally submerged in seawater for an extended period of time.
- Engineering, personnel and equipment for automated MPD system utilizing Microflux® Control and SeaShield RCD technologies were also supplied.

Value to Client:

- Microflux Control technology was successfully used to rapidly and accurately apply and manage backpressure to determine actual pressure profile of wells and allowed for immediate detection and control of kicks.
- When circulation losses could no longer be managed with the mud supply, the system was switched to pressurized mud cap drilling (PMCD). System allowed the deepwater well to be drilled safely to its targeted depth.
- Well was subsequently logged safely through the RCD system despite of total loss of circulation.

LOCATION
Makassar Strait, Indonesia

WATER DEPTH
Approximately 6,000 ft

Real Results

Deepwater MPD System Installed *In Situ* Allows Highly Efficient Drilling Through Severe Losses in Carbonate Formations

Objective:

- Install a managed pressure drilling (MPD) system on location on a dynamically positioned semi-submersible within a very limited time frame while the rig is conducting deepwater drilling operations.
- Drill efficiently through karstified carbonate formations prone to severe circulation losses to isolate the same and access deeper target reservoirs.

Solution:

- Weatherford performed fast-track development of a slim version of the API16RCD-certified Seashield® Model 7875 below-tension-ring RCD to deployment through a 19.1” telescopic joint.
- Deep involvement with *in situ* MPD rig integration preparations.
- Engineering, personnel and equipment for automated MPD system utilizing Microflux control and SeaShield® RCD technologies were also supplied.

Value to Client:

- In situ deepwater MPD rig integration accomplished in less than six months.
- Drilling was switched to pressurized mud cap drilling (PMCD) in two consecutive hole sections that experienced severe losses and proceeded safely and efficiently, subsequently allowing for isolation of the same, facilitating access to the deeper target reservoirs.

LOCATION
Malaysia

Real Results

MPD Addresses Uncertainties and Risks Associated with Sub-salt Formations

Challenge:

- Reenter a plugged, cemented, and abandoned well in the deepwater pre-salt area of Brazil. The vertical well was situated in 6,562 ft (2,000 m) of water.
- Reach the targeted production zone at 16,781 ft (5,115 m), and mitigate fluid losses and a narrow drilling window.

Solution:

- Previous drilling encountered a severe fluid loss zone that consumed 600 bbl/hr (95 m3/hr). The cost of the fluid losses led to plugging and abandonment.
- MPD used until total losses experienced. The team switched to PMCD, which enabled the operator to maintain the drilling phase, manage the bottomhole pressure, and avoid massive mud losses. Target depth was reached and completion deployed.
- MPD revived a previously abandoned, multimillion-dollar investment. The well produces 20,000 B/D (3,180 m3), which earns the operator US $2 million per day.

LOCATION
Brazil, Santos Basin

WELL TYPE
Offshore, vertical

REASON FOR ABANDONMENT
Massive fluid losses while drilling

FLUID LOSS RATE
600 bbl/hr (95 m3/hr)

PLUG DEPTH
16,348 ft (4,983 m)

TARGET DEPTH
16,781 ft (5,115 m)

Real Results

Deepwater MPD Rig Integration Enables Safe, Efficient Drilling of Exploration Wells

Challenge:

- Deepwater MPD rig integration into the riser gas handling system of a dynamically positioned drillship *en route* to location.
- Upgrade the conventional drilling system on the deepwater rig to enable it to immediately detect, react to and exert control over pressure-related events in deepwater exploration wells to be drilled in environmentally sensitive areas.

Solution:

- Detailed MPD rig survey was performed while the rig was still under construction at the shipyard.
- Equipment installation and necessary rig modifications were performed while the drillship was en route to drilling location.
- MPD technologies enabled the operator to drill three hole sections of different sizes, avoid total losses, and manage nuisance gas in a challenging deepwater environment.
- Use of MPD resulted in safer and faster drilling performance that saved the operator significant time and costs.

LOCATION
Angola

WELL TYPE
Deepwater, gas

RIG TYPE
Drillship

HOLE SIZES
Section A: 18-1/8 in.
Section B: 14-1/2 × 16-1/2 in.
Section C: 12-1/4 in.