SUBSEA WELL CONTAINMENT

Global Basis

Deepwater & Emerging Technologies Group (DETG)
AADE – Houston Chapter
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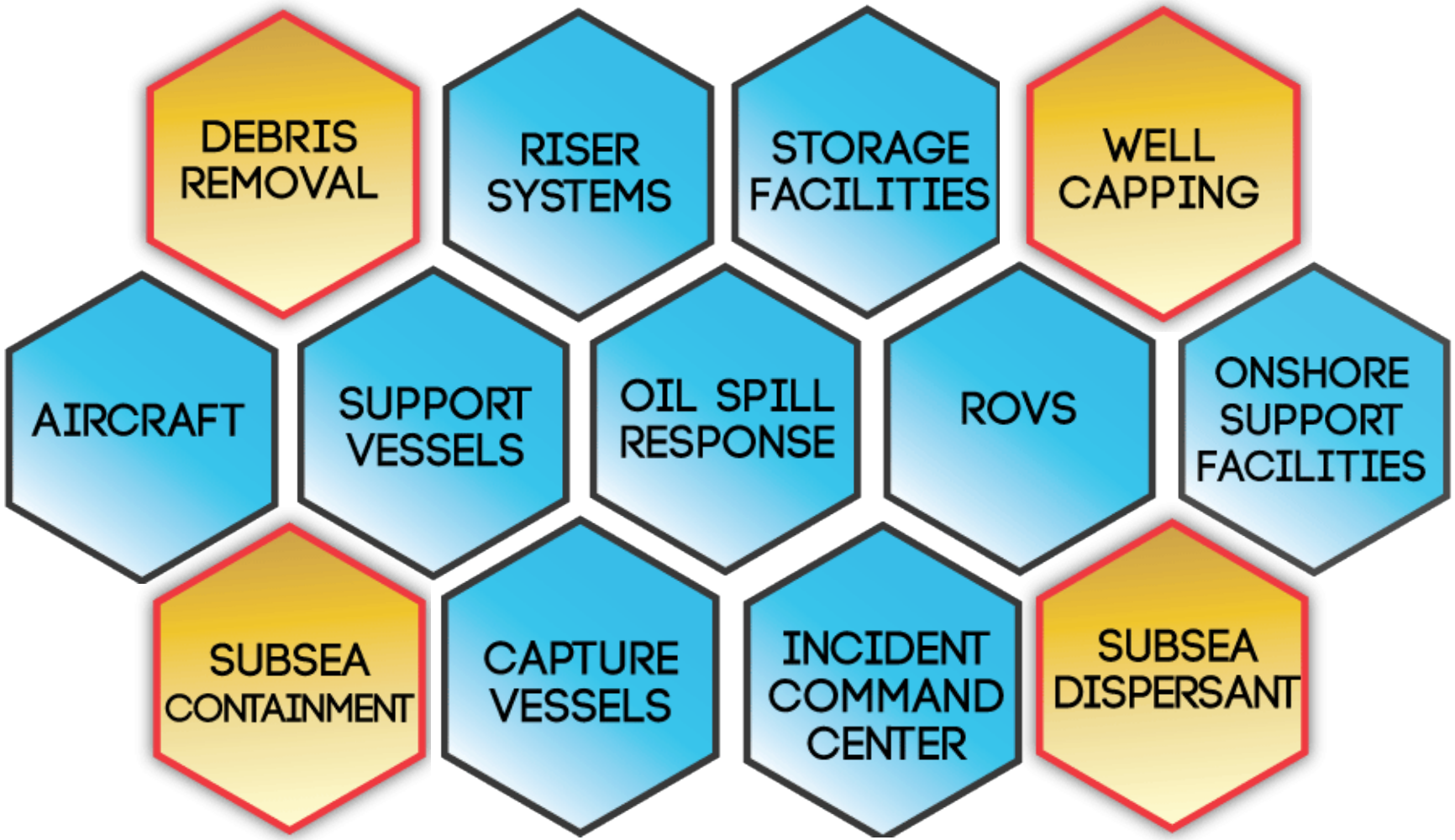
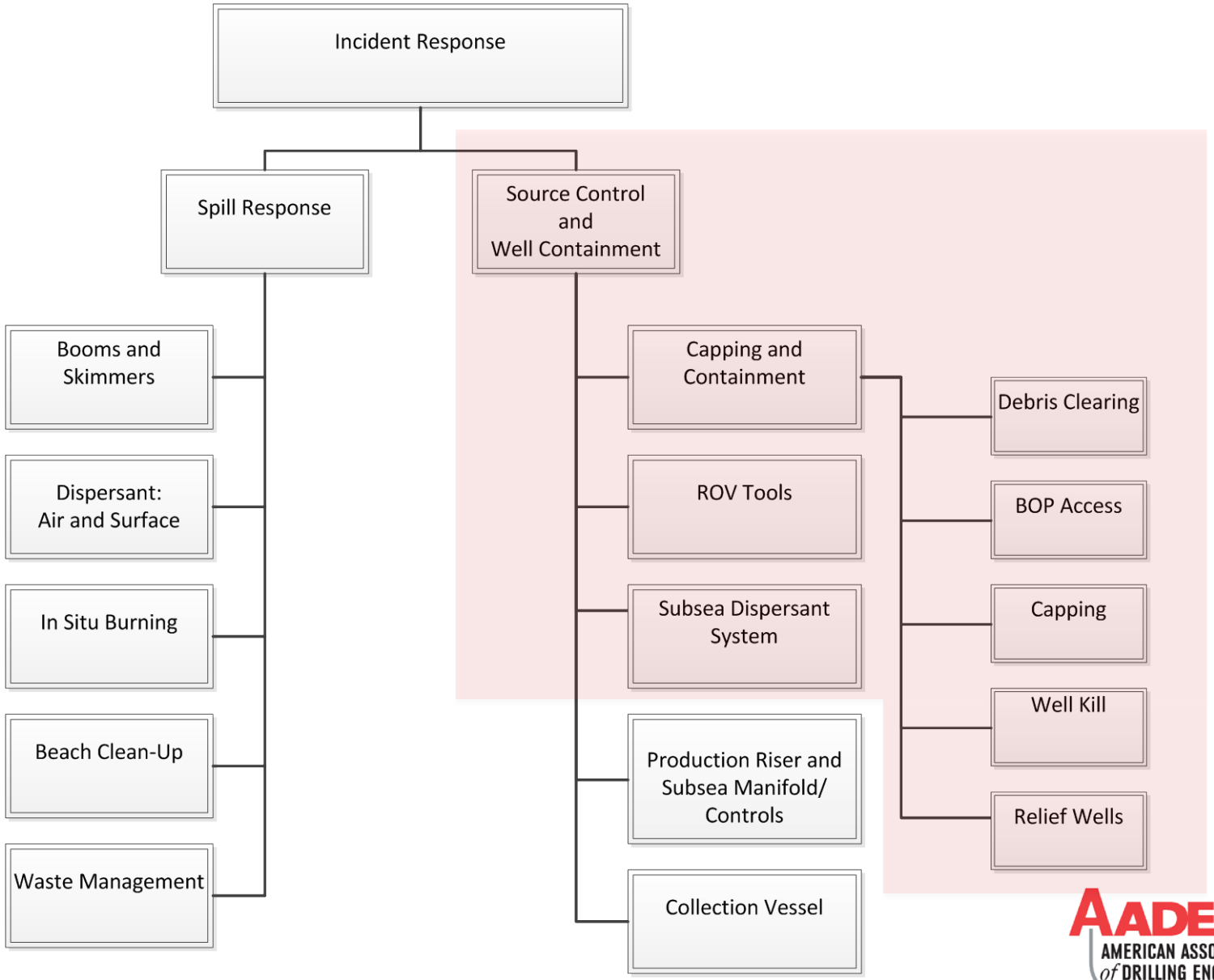
Wild Well Control

Response Components



- Plus Many More Components

Subsea Source Control



Today's Status on Global Basis

Systems Ready for Deployment

- Wild Well Control's Global Subsea Well Containment System

Ongoing Group Studies

- Intl Oil & Gas Producers (OGP) > GRIR > SWRP
- APPEA
- OFFB
- OSPRAG
- API / RP
- Plus more…….

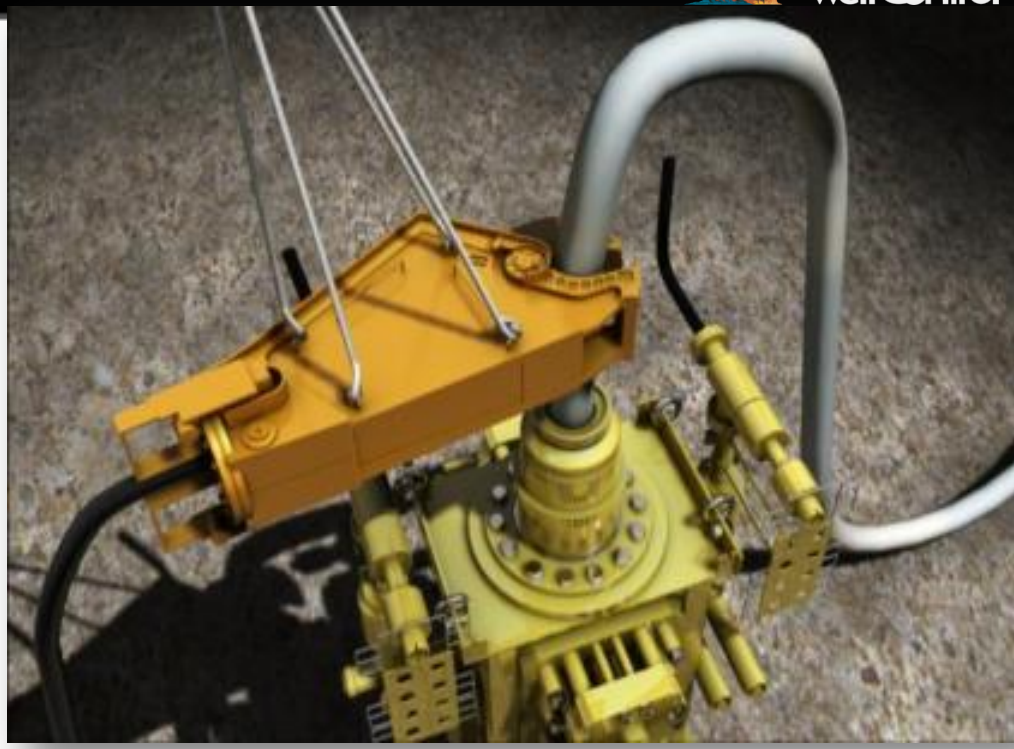
WWCI's GLOBAL SUBSEA WELL CONTAINMENT SYSTEM

- Consists of equipment owned and maintained by WWCI. Access provided via contractual agreement.
- 18-3/4" 15K Three Ram Capping Stack.
- Rated to 10,000' water depth.
- System includes Dispersant and Debris Clearing Equipment.
- System designed for air transportability.
- Based in Aberdeen for global deployment.
- Subsea Well Containment Management System - includes required plans for deployment, etc.

Current Status

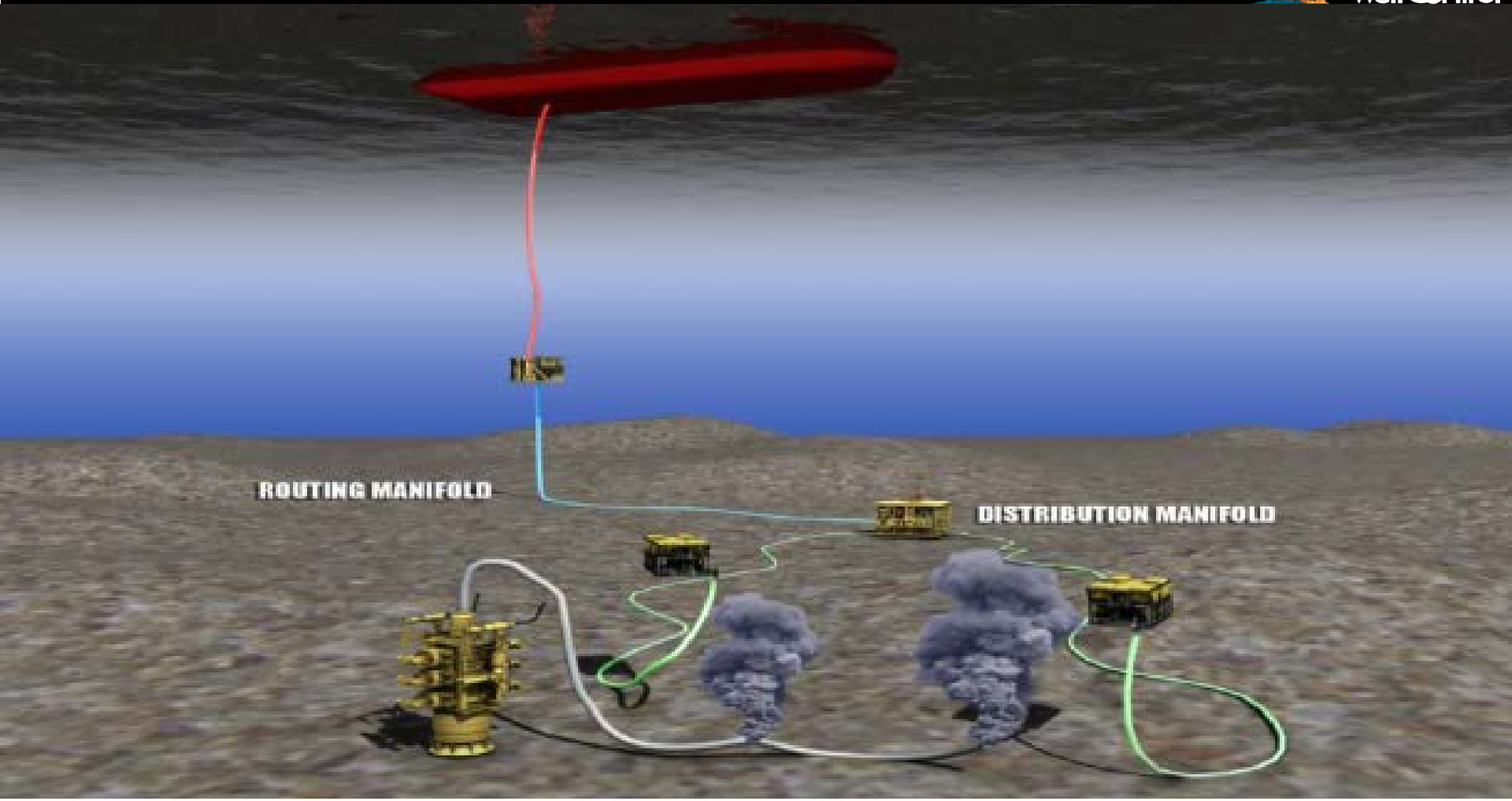
- Stored in Peterhead, Scotland
- EFAT, witnessed by DnV, being conducted at this time.
- Delivery of SHPU (rated to 10,000') is scheduled Mar/Apr.
- After testing, Equipment to be disassembled and stored in mobilization ready mode.

Subsea Debris Clearing Equipment



Model	Shear Weight (lbs)	Jaw Opening (Inches)	Jaw Depth (Inches)	Shear Force 5,000PSI	Shear Force 5,500PSI
GXP 660	13,300	32	32	1,475 tons	1,625 tons
GXP 2500	45,000	46	48	3,015 tons	3,317 tons

Subsea Dispersant System Illustration



- CT Deployed to Routing Manifold
- ~ 1,000’ Chemical Hose from Routing Manifold to Distribution Manifold
- ~ 250’ Chemical Hose from Distribution Manifold to Applicators

Subsea Dispersant System

Routing Manifold

Distribution Manifold

- **Routing Manifold**
  - Coil Tubing connects to surface
  - Acts as a clump weight
  - Suspended from vessel (off the sea bed)
  - Chemical hoses transfer dispersant
- **Distribution Manifold**
  - Dispersant is brought from Routing Manifold
  - Distributes dispersant to Injection Wands or Input Connections through multiple 1” chemical hoses

Subsea Well Response Project (SWRP)

- SWRP is a Subcommittee under Intl Oil & Gas Producers' (OGP) Global Industry Response Group (GIRG)
- Newsletter #2, Dec 2011 reports that –
  - Preparing to construct four capping stacks.
    - *Two 13-5/8" 10K and Two 7-1/16" 10K ?*
  - Expect to make awards for the Equipment 1Q 2012.
  - Delivery of Capping Stacks and Dispersant Equipment expected early 2013.
  - To identify Equipment staging locations during 2012.
    - *South America, Europe, Africa, and Australasia?*
  - Developing commercial structure for accessing the Equipment.

What is Needed in a System?

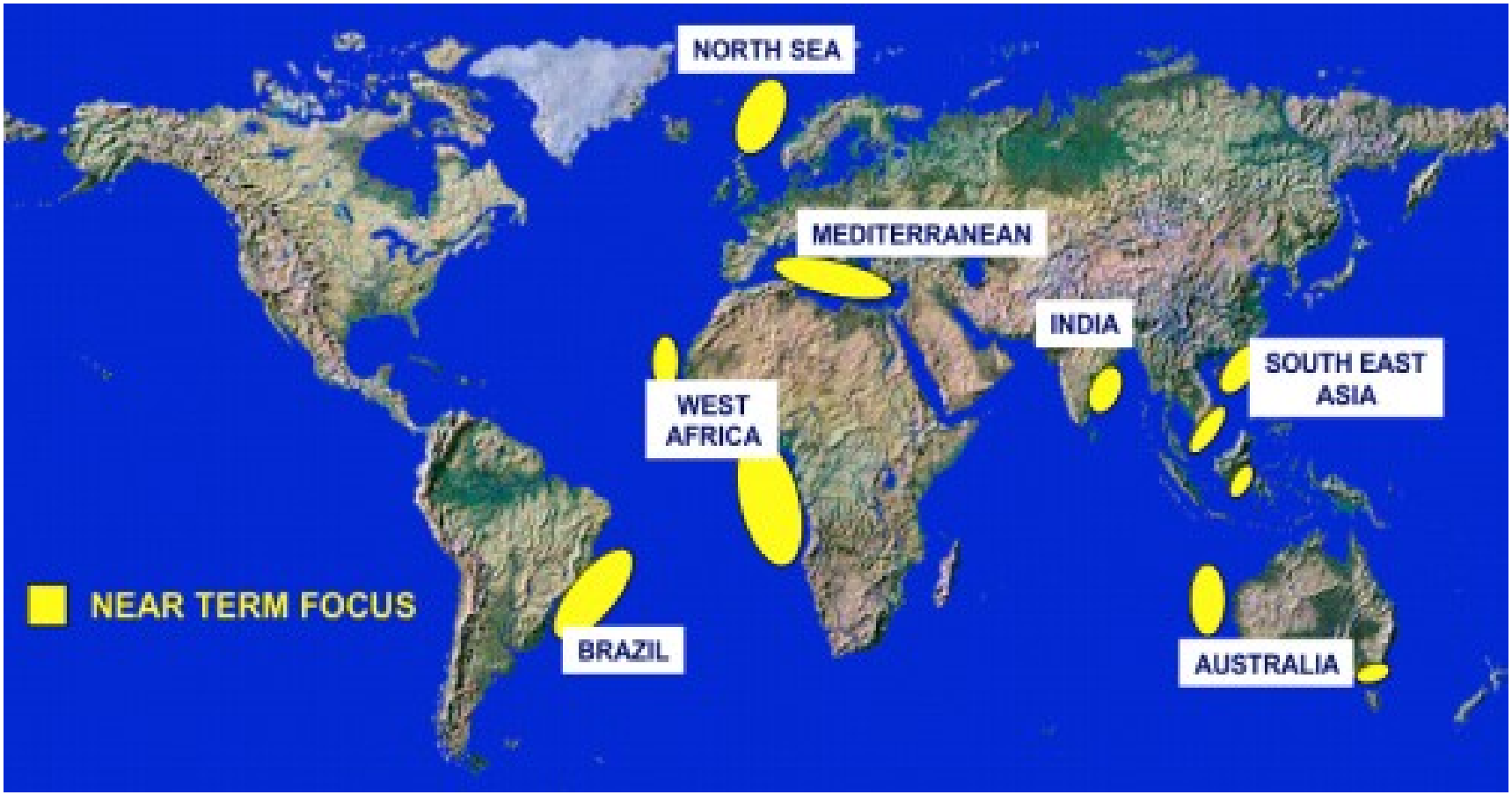
- Dedicated Inventory, OEM Maintained
- Proven Technology Utilized
- Comprehensive Operational Plans
  - Mobilization
  - Deployment
  - Operational
- 24/7 State of Readiness
- Experienced Personnel
- Multiple Contingencies Required

Concerns Going Forward

- The regulations in the GOM, and proposed elsewhere globally, only address a “Macondo” type event.
- Ability to access the LMRP, BOP, or Wellhead.
- Bent / damaged wellheads.
- Broaching of seabed.
- TLPs / SPARs – Restricted access to well conductors.
- Deployment of Equipment in inclement seas / weather.

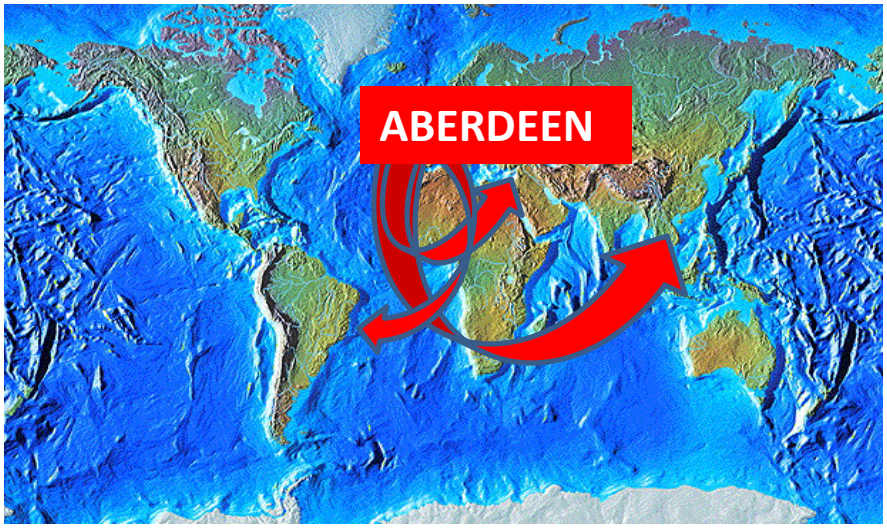
How Many Capping Stacks Required?

And, where do you stage them?



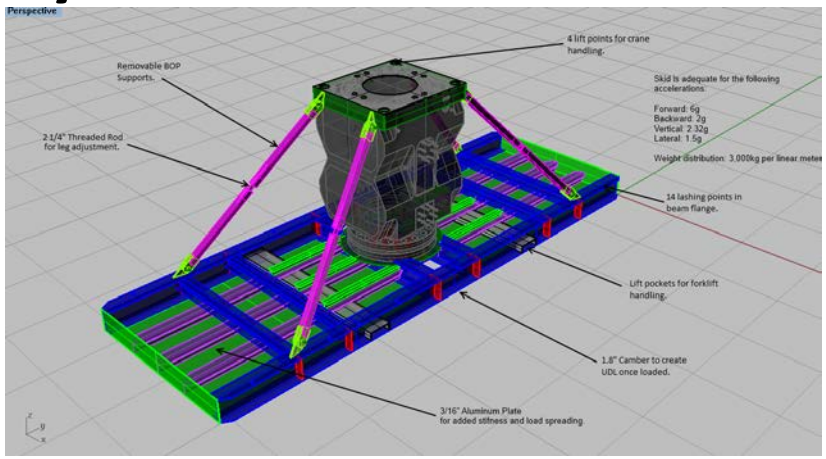
Projected Mobilization Schedule

Mobilize Equipment to the Airport (Preswick)	12 - 18 hours
Identify and stage charter aircraft	24 - 48 hours
Flight (depending on destination)	12 – 18 hours
Customs Clearance	24 hours
Transport Stack to Dock Area for Assembly	12 hours
Assembly Capping Stack and Test	48 hours
Mobilize to Wellsite	Total elapsed time 5 – 7 days



Other Concerns

- **Vessel Availability / Capability**
- **Logistics**
  - Unloading at Destination
  - Port Capability
  - Weather Restrictions



- **Individual Country's Regulatory Actions**
- **Sanctioned Countries**
  - Cuba
- **Remote Regions**
  - Arctic - Dedicated Capping Stacks in Region

Basic Philosophies of Well Control

Principles of Capping a Well

- Gain access to the Wellhead / BOP Stack
- Conduct thorough assessment of the Wellhead / BOP Stack.
- After analysis, develop intervention plan with highest chance of success. Must include multiple contingencies / redundancies.
- Execute the Plan.

Subsea Well Control Events are still Well Control Events

- Utilization of ROV's instead of people.
- Containment equipment is very large and heavy.
- Maximum coordination of many sim-ops is required.

Response Plan is an absolute must

- Clearly identifies the decision makers.
- Identifies the required interfaces.
- Identifies the required resources.

Known Facts from Well Control Experience

- There is no single solution for all well control incidents.
- There are no two well control incidents alike.
- Conditions of the event will likely get worse before better.
- It takes time to properly complete assessment, develop comprehensive plan with contingencies, mobilize and execute flawlessly. Do not rush.
- Remain flexible to adapt to the well's changing condition.
- Decisions must be made without delay.

BE PREPARED.

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Well Design
Impact on Dynamic Kill Planning

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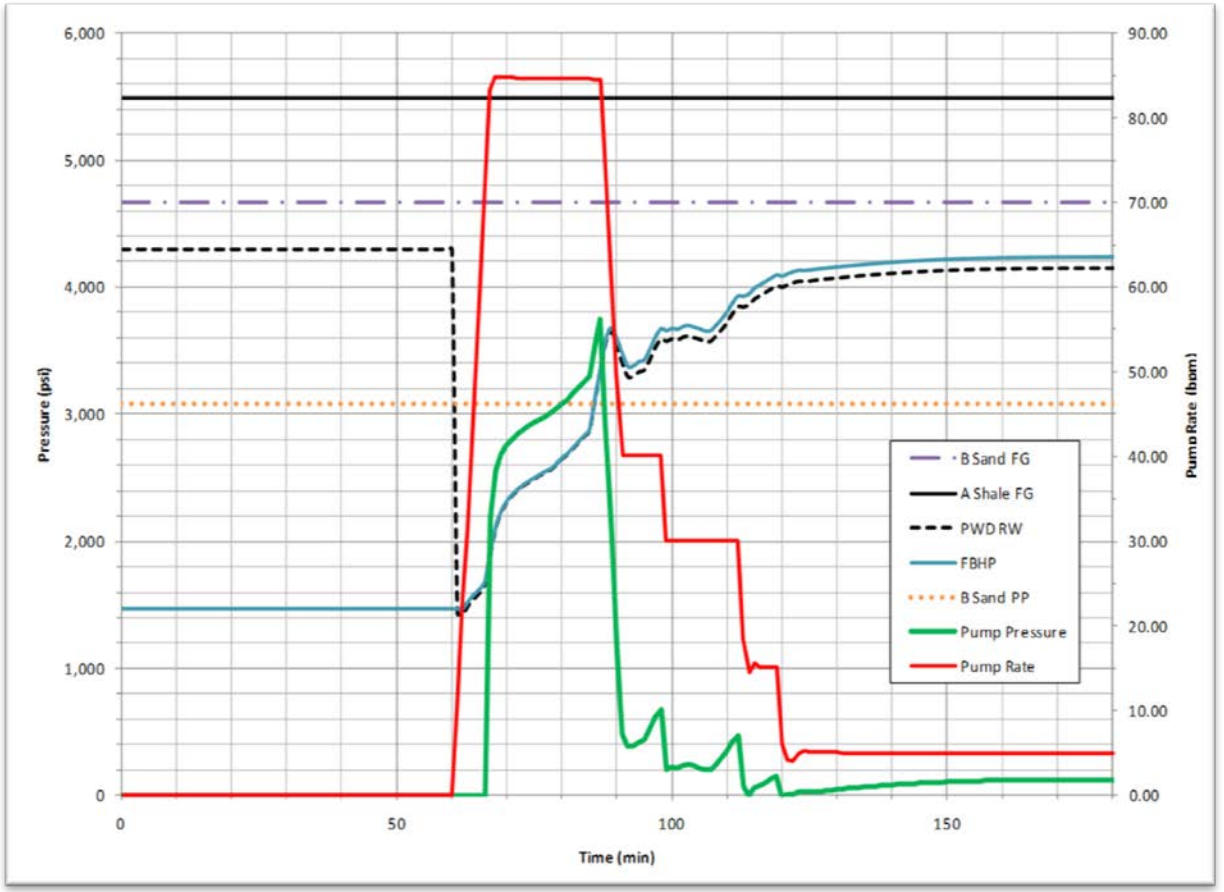
Anatomy of Dynamic Kill

- Intercept At T = 60
- Q Raised to 85 bpm
- Q Remains 85 bpm for 20 minutes (T = 65 to T = 85)
- PWD indicates BHP steadily increasing
- When PWD indicates BHP above PP (T = 85 minutes)
- Q reduced in stages to maintain FP > BHP > PP
- V = 3,000 bbls in this example



Dynamic Kill – Key Factors for Rate & Volume

The key parameters that will impact required rate & volume include:

- **Blowout hole size – larger hole requires more Q & V**
- **Drill pipe in blowout well – flowing geometry much larger without DP**
- **Distance between deepest casing shoe in blowout well and flowing reservoir – gas column effect, lubrication of 'rat hole'**
- **Fracture pressure at deepest casing shoe in blowout well – if well can't be shut in with reservoir fluid to the casing shoe then dynamic kill is very difficult**

Dynamic Kill – Limiting Factors

The key parameters that will enhance the chances of being able to deliver the kill fluid at the required rate include:

- **Water depth – length of choke & kill lines, U-tube affect**
- **Internal Diameter (ID) of the choke & kill lines – need later generation rig with large ID choke & kill lines**
- **Geometry & measured depth of the relief well – large hole size, use of liners instead of full casings strings and small drill string / BHA to enhance deliverability through the relief well**
- **Fluid properties – determine the most appropriate tradeoff between reduced friction through the relief well versus the friction component in the blowout well which is necessary for the dynamic kill**

Summary

- Dynamic Kills Are Done Under Controlled Circumstances
  - Establish BHP Above PP But Below FP
  - Circulate Hydrocarbons Once Reservoir Flow is Stopped
- Key Factors Related to Rate & Volume
  - Hole Size – smaller hole size, long strings vs liners
  - DP in Blowout – limited control
  - Casing shoe to blowout reservoir
  - Fracture pressure at deepest casing shoe

Questions?

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