Utilising DSV Dive System for Air-TUP Diving - Operational Experiences

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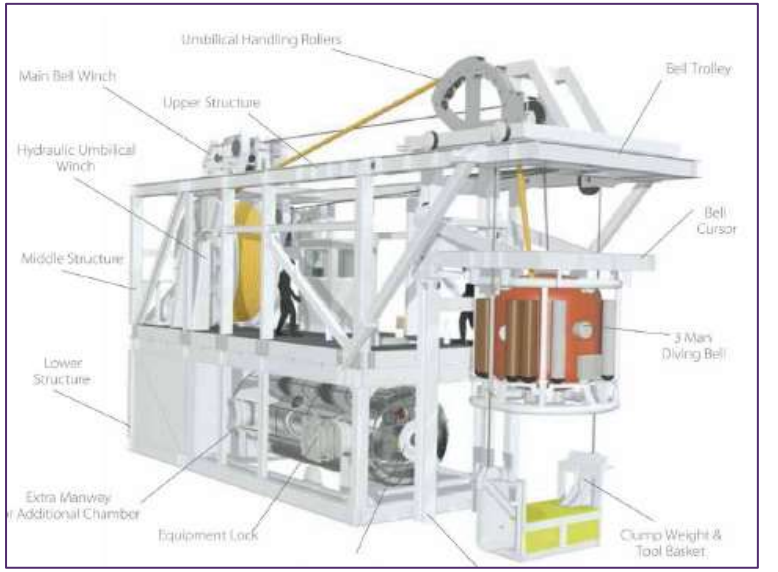
Agenda / Scope

- Air-TUP Background
  - Seminar 2019
  - TFMC Assets
  - Technique Comparison
- Aim / Meaning
  - Key Features
- Operational Challenges
  - Efficiency
  - Development Cycle
  - Evacuation
  - Tending
- Project Execution

Air-TUP - Looking back at 2019 Conference

- Resurgence in the technique and one of the main ‘hot topics’ with multiple presentations
- Focus on Air-TUP as being a mobile system
- Focus on Air-TUP as an alternative to Saturation in the <50 msw range



DSV Fleet Overview

Deep Arctic

- DP3 (Battery Hybrid)
- 400Te + 58Te Crane
- 157m LBP
- 1700m3 Deck Space
- Sat System
  - 18 Man
  - 350msw
  - NORSOK
  - Twin Bell
- 2 UHD III ROVs + Lynx ObsROV

Deep Discoverer

- DP3
- 250Te Crane
- 121m LBP
- 1050m3 Deck Space
- Sat System
  - 18 Man
  - 300msw
  - Twin Bell
- Nitrox, Basket Surface System
- L-WROV

Deep Explorer

- DP3
- 400Te + 58Te Crane
- 157m LBP
- 1700m3 Deck Space
- Sat System
  - 24 Man
  - 350msw
  - NORSOK
  - Twin Bell
- 2 XLX WROV+ Lynx ObsROV

Shallow Techniques - High Level Relative Comparison

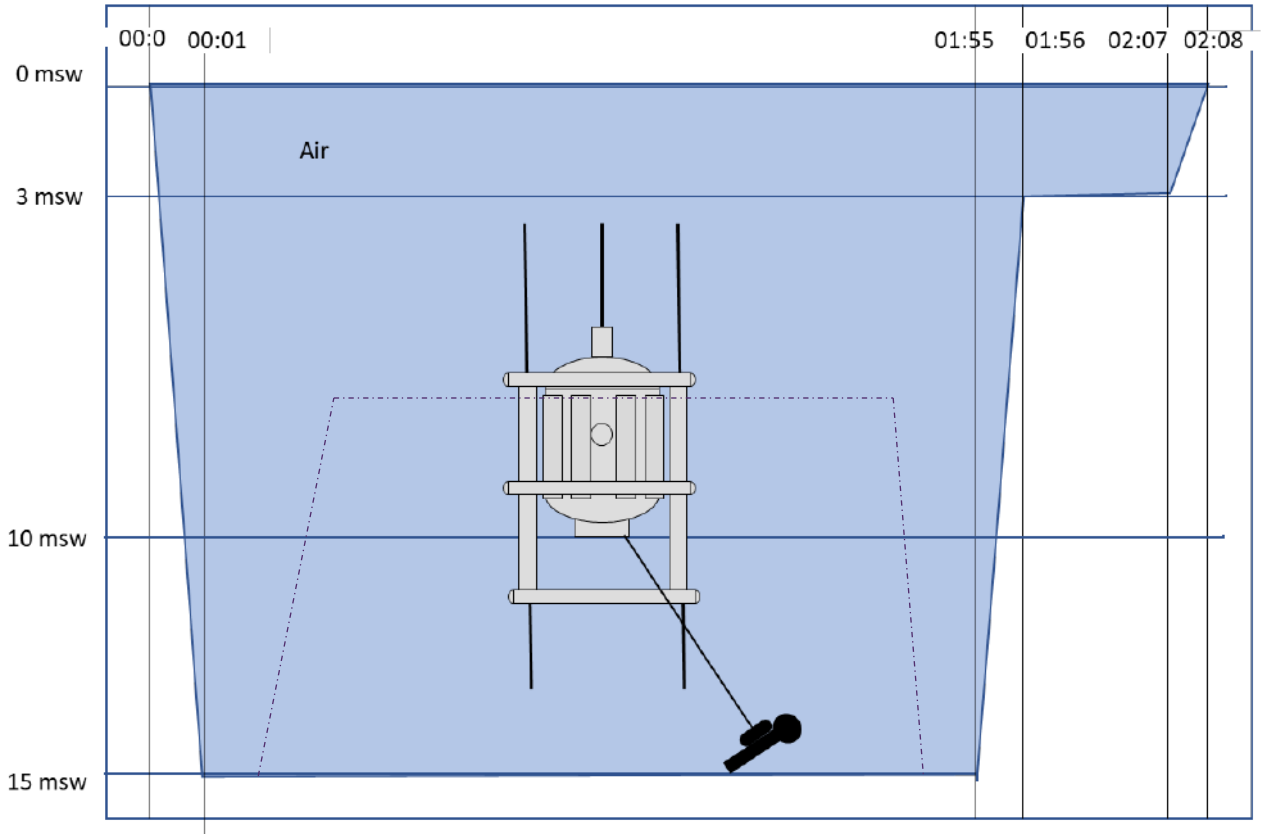
** All very subjective & depth/project dependent etc. + Many more factors to consider*

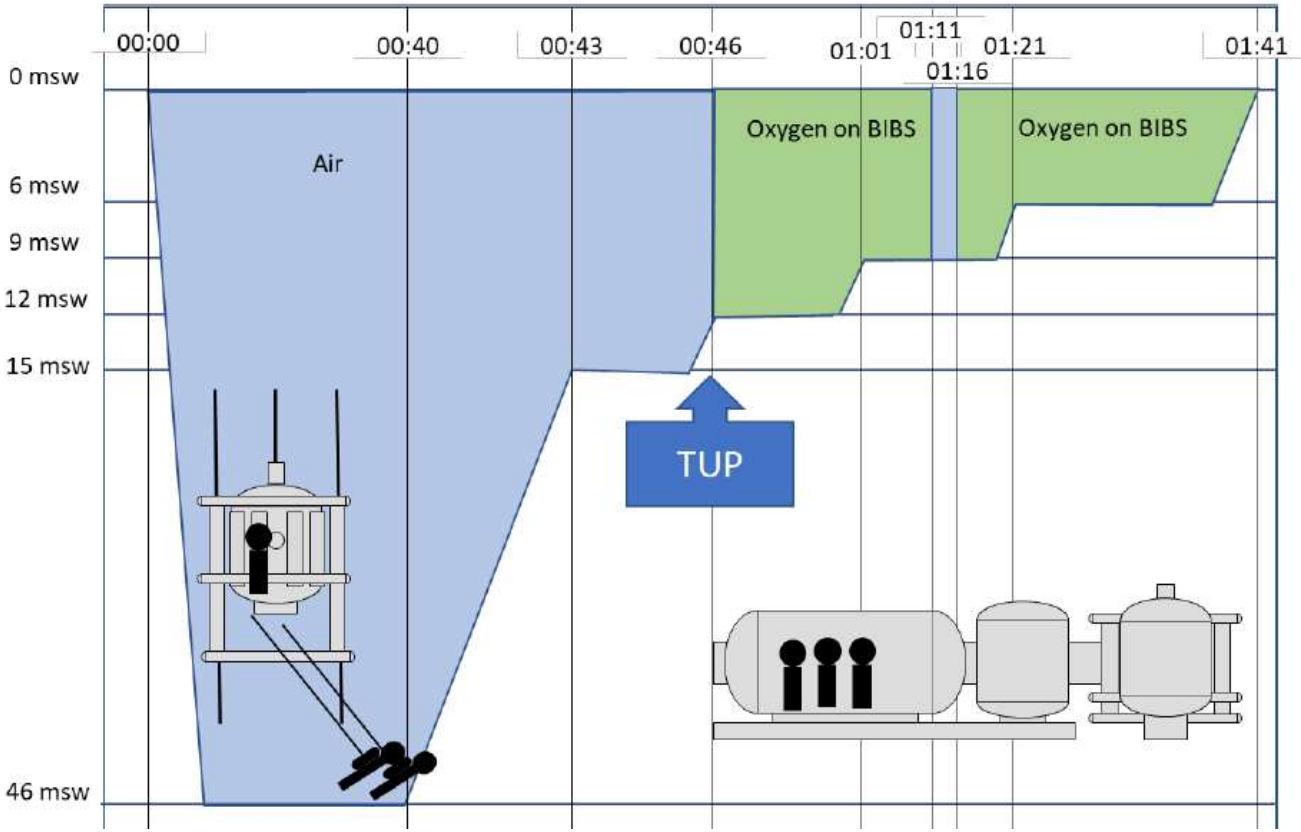
	Shallow Saturation Diving	No-Stop Nitrox Diving				Air-TUP Diving
		Built In Basket	Mobile Basket	Mobile Wet Bell	LDC	
Mobilisation Time						
Mobilisation Lead Time						
Extra Equipment Costs	-					
PM&E						
Deck Space	-	-				-
Crewing Levels						
Productivity						
Weather Limits						
Vertical Excursions	*(NORSOK14m min depth)*					
Operational Complexity						
Decompression Time		0	0	0	0	

TFMC Shallow Air-TUP - Diving Definition / Limits

- Divers utilise a vessel's existing Saturation System but with air instead of Heliox as breathing medium.
- Nitrox not feasible (O_2 clean/design components + explosion risk)
- Limited to 50msw (but practically and economically <24msw)
- Divers deployed in bell to circa 11-15m (to clear the cursor/hull/moonpool effects) or their working depth
- If required, divers excursion to the working depth and complete their workscope
- Divers retreat to the bell and are recovered to surface, under pressure
- Divers then either decompress in the bell or transfer back to the system and decompress to surface
  - Divers not kept in saturation – Any transfer >12msw.
  - Bell decompression only practical at the shallow end scale and where space etc allows.
- Air-TUP (O2 cycle) or standard decompression (only standard deco in bell) tables – all based on MT92

Air-TUP Diving Profiles





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Shallow Air-TUP - Diving Meaning / Limits

- TechnipFMC does allow mixed saturation / Air-TUP use of system in correct circumstances
  - Gas Management / Segregation
- Excursion window larger than saturation - But not unlimited
- Bottom time increase as per L103 ACOP TUP (Note improvement on non-TUP times)
- **Key Aspects:-**
  - Economical way of shallow diving on vessel with existing saturation system / no surface spread
  - Removal of mobilisation / demobilisation risks associated with mobile spreads
  - Removal of mobilisation / demobilisation time associated with mobile spreads
  - Better Deck Space utilisation
  - Better weather criteria than over-side systems (but longer to site)
  - Decompression added into dive
  - Closed Bell Qualifications & Life Support Team Required

Practical Considerations

Efficiency Comparison Twin/Single Bell - Transfer into System

Efficiency Comparison Twin/Single Bell- Transfer into system

Key Points:-

- Twin bell operations first step to improving efficiency
  - Approx. 50% improvement
  - More divers needed to achieve
  - Intensive workload on Supervisors / Technicians

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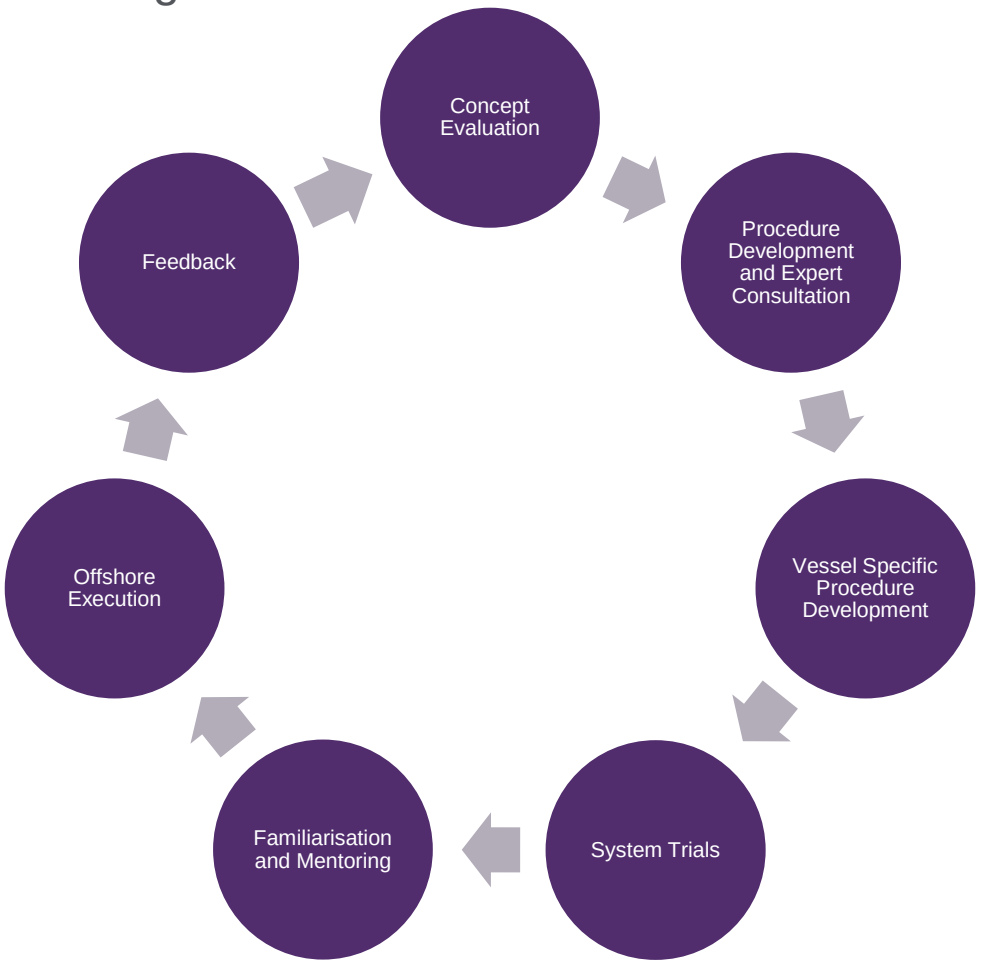
Development Cycle and Challenges

- Understand the background to tables / limits / decompression gradients
- Each dive system / gas distribution system unique. One size fits all not possible.
- Validate the expected performance of the systems - Testing/drills leading to mentors
- Safety
  - Deco introduction- controlled environment
  - No mob activities
  - Longer swims
  - Bell/moonpool Deployment
  - Bellman
- Challenges - Perception of technique
  - What's in a name?
  - What's done/aimed for elsewhere



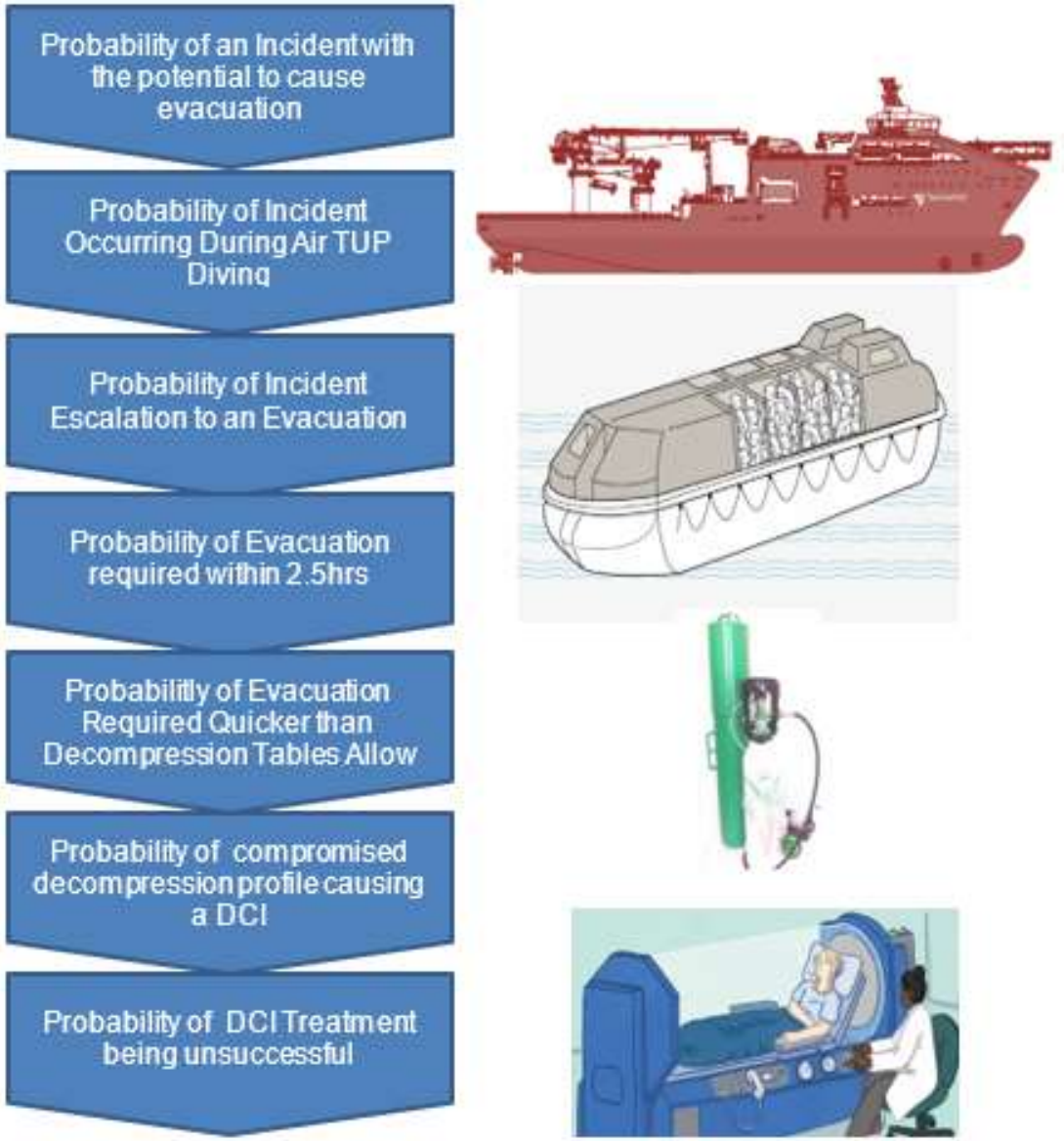
Evacuation Considerations

- Methods available
  - No Stop – Evacuate as per rest of crew
  - Prescribed Rates
  - Fast Deco, O2 set & remote treatment
  - SPHL

- How likely is an evacuation?
  - What is likely timeframe
  - How does timeframe affect method

- What is the Risk?
  - How does it compare to other Diving Methods
  - Industry standards

- How does combining Air-TUP & saturation in one system affect each other's evacuation?

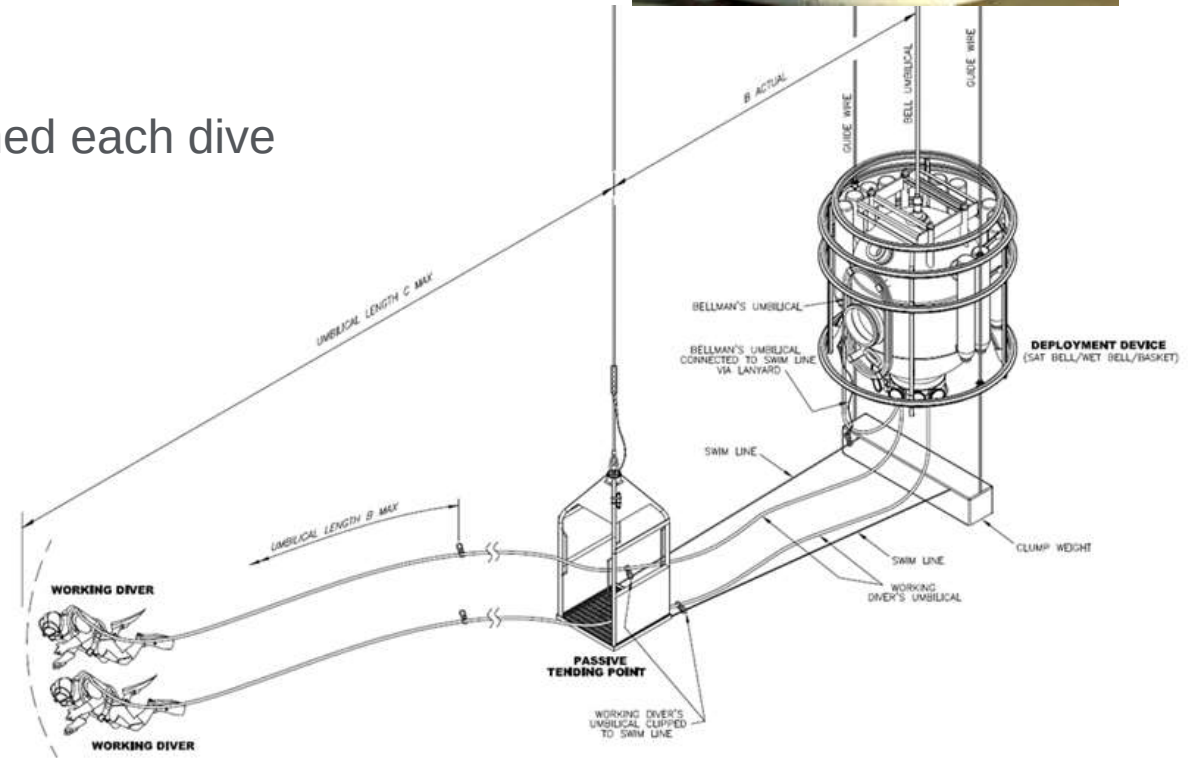


Standard Passive Tending Arrangement

- Bell Clump Weight connects to the Golden Gate ‘tend point’ via wire swimlines

- Particularly with offside bells, these swims can be a significant length
  - Excursion window
  - Fatigue
  - Entanglement

- On integrated clump weight bell designs
  - This set-up requires to be re-established / de-established each dive



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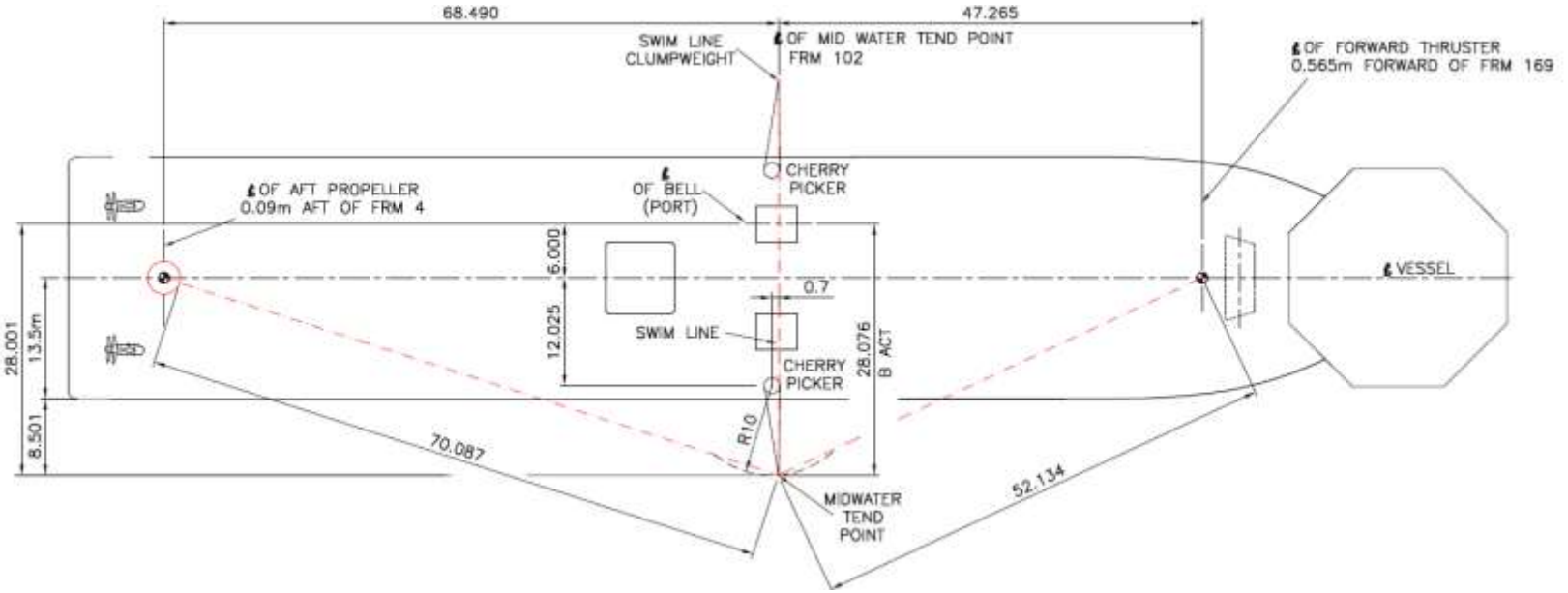
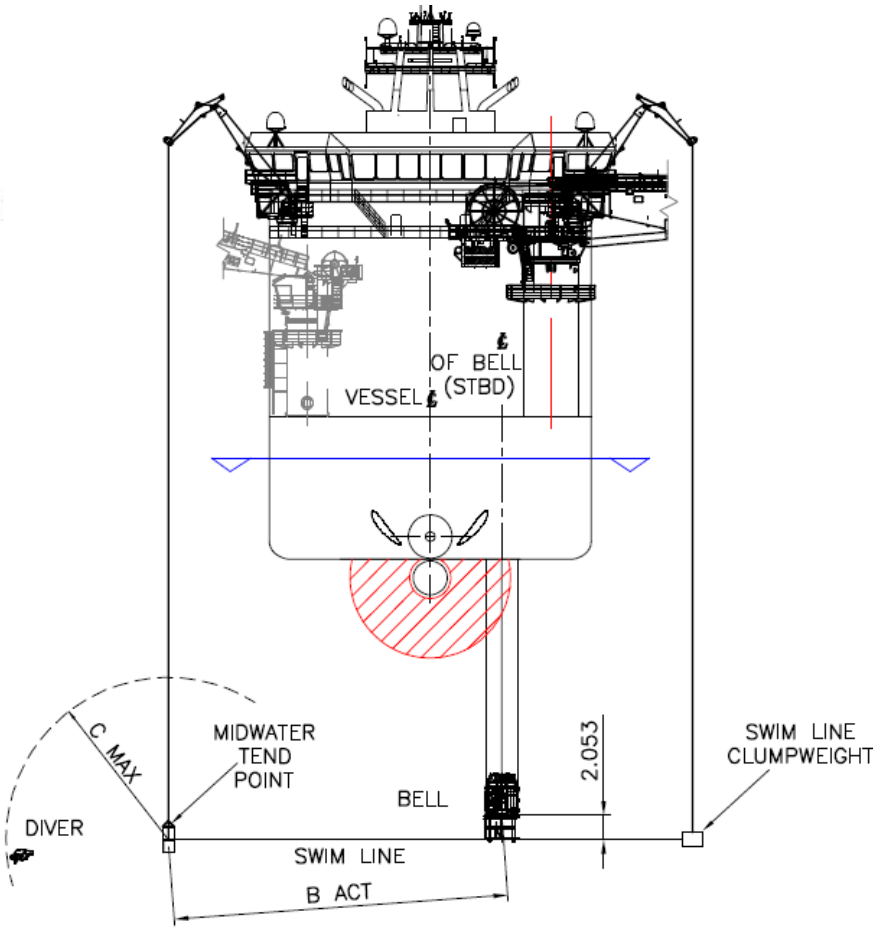
The ‘Flying Swimline’ concept





The ‘Flying Swimline’ concept

- Permanent swimline left connected between Tending Basket & CW suspended on Port and Starboard Pickers

- Line routes directly underneath both bells
  - The connection point has to be low profile to allow the large locking carabiners to pass over easily when divers are deployed from the far bell.

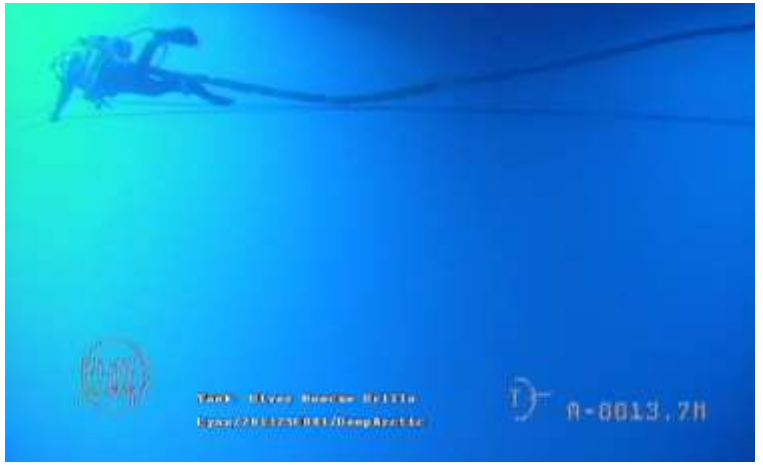
- Bell lowers into position above swimline / connects using positive locking hook
  - Any attachment rigging can’t create snag points

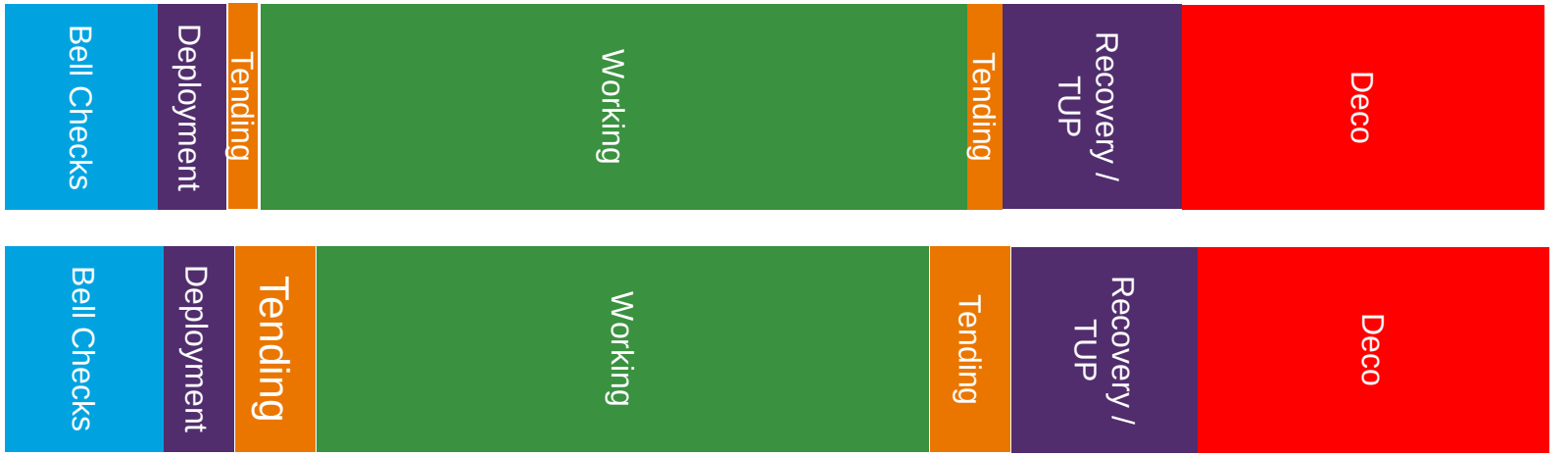
- Swimline can be established by WROV or other divers at any depth
  - Weight limitations (non-buoyant/not heavy)
  - Grip/Wear factors to consider

The ‘Flying Swimline’ concept

Key Advantages:

- Reduced diver fatigue for swimline set-up. Less mistakes/more achieved
- Set-up done in ‘dead’ time
- Additional safety measure as divers can go directly to the golden gate using the swimline for support
- Removes the need for mid-water swims holding the swimline and controlling umbilical.
- Flying swimline arrangement allows for easier/quicker diver deployment & bell recovery in case of emergency.
- Grip Better, separation maintained better
- Marginal Gains = big overall effect





Project Execution

West of Shetland Campaign

- Work scopes circa 15.5 msw
  - Anticipated Vertical Excursions - Excludes saturation
  - Over-side surface systems – Feasible
  - Harsh environment
  - AirTUP considered

- Two Campaigns
  - April - Deep Arctic: Inspection Activities
  - Summer - Deep Discoverer: Caisson / Clamp Installation

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Campaign 1 - Deep Arctic

- Large Bell with Offset Door - Bell Decompression Method Chosen
  - Key issue encountered - Depths more than expected = step change in table times
  - Other SIMOPS influences
  - Good Seastates – More than 2m Hs for majority of campaign

- 11 Day Vessel Availability Window
  - Mobilisation / demobilisation durations / Weather / Transits / SIMOPS = Small window to achieve work
  - Air-TUP generated estimated 3 - 5 extra days of operations (weather + mobilisation time)

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Campaign 2 - Deep Discoverer

- Smaller Bell and simpler system – Chamber Deco Method Chosen

- Higher percentage of work shallower than 15.5 m Elevation level

- Vessel Overside Nitrox Basket System
  - Used almost exclusively as found to be more efficient
  - Passive Tending not always required
  - Good bottom times at the shallower depths
  - Vessel Lee – better than expected weather sheltering
  - Less Impact for breakaways (SIMOPS)

Summary

- In many ways, campaigns summarised what was expected
  - Air-TUP very useful on a vessel without a dedicated spread
  - Air-TUP can improve weather criteria
  - Air-TUP very useful tool in the very shallow saturation / surface range options
    - Particularly where larger excursions expected
  - Over Side Systems generally more efficient but accrue mobilisation time etc if not ‘built in’

- Air-TUP can be a project enabler and has its place
  - But needs to be used in the correct situations.
  - One of many tools - not the only one.


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