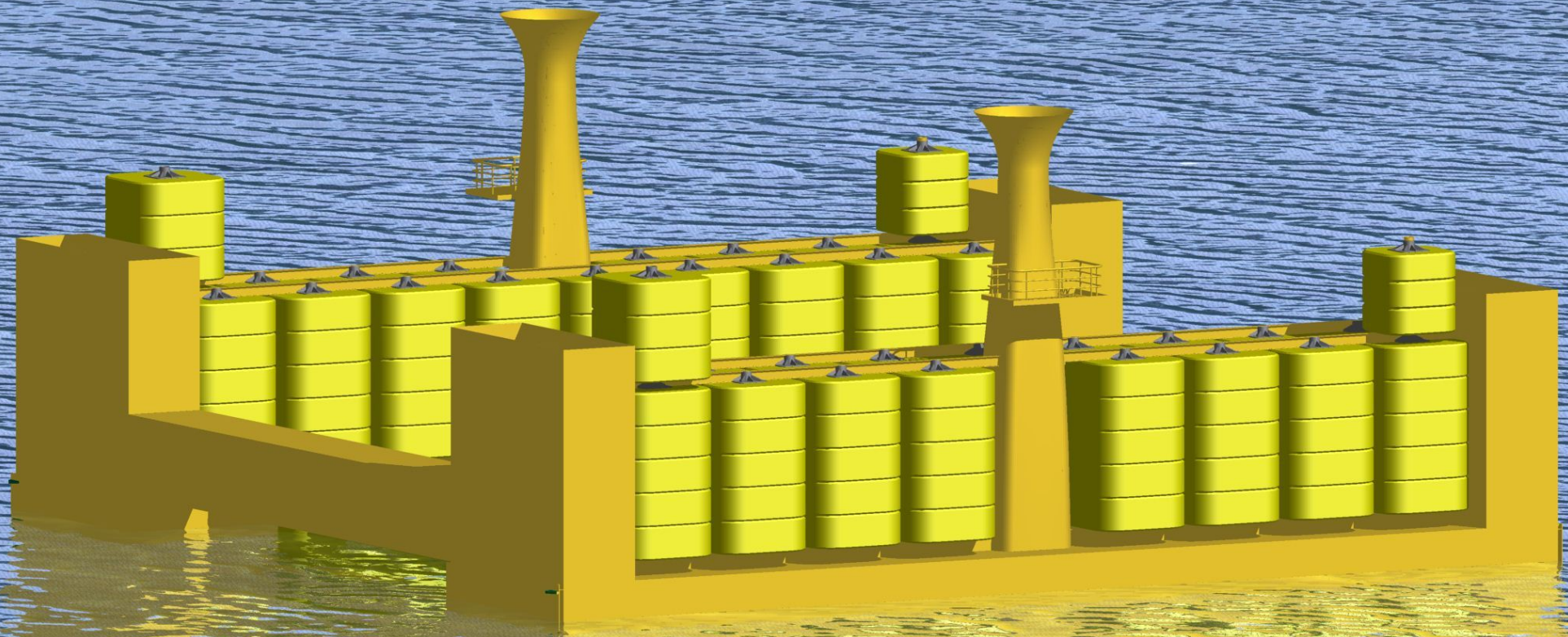
Fully Submersible Heavy Lift Vessel



Arnbjorn Joensen

Aberdeen Maritime Branch

(28th January 2015)

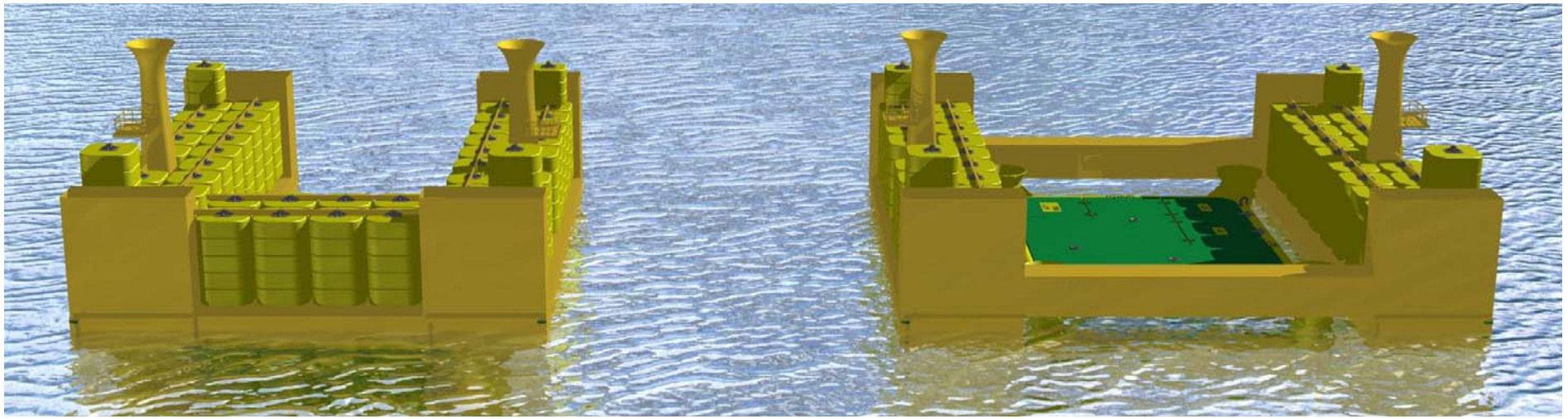
Subsea Deployment Systems Ltd.

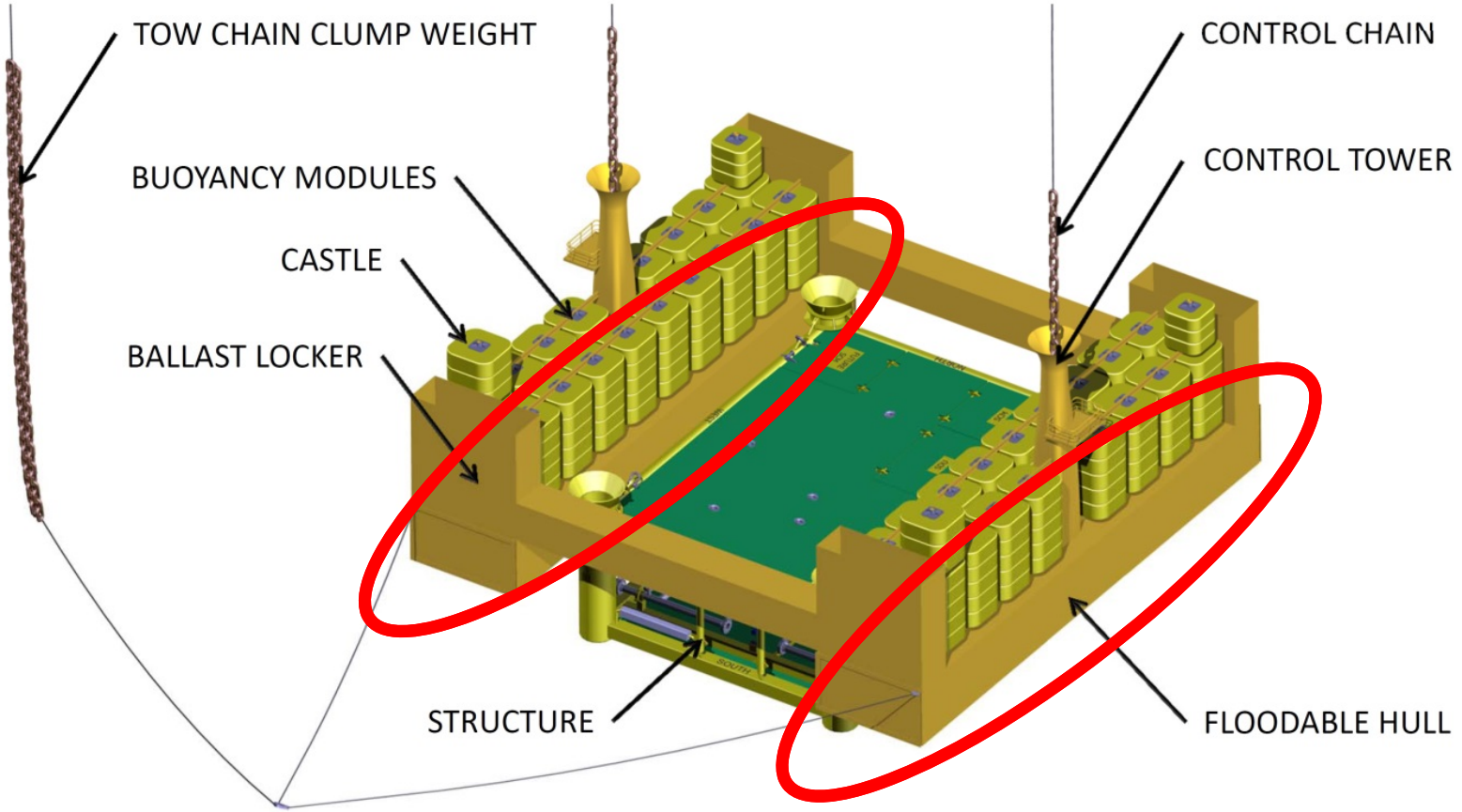
PRESENTATION

- Introduction to the Subsea Deployment Vessel
- Installation method
- Tank test video
- Potential failure modes and response
- Potential applications
- Variations to the presented model
- Questions

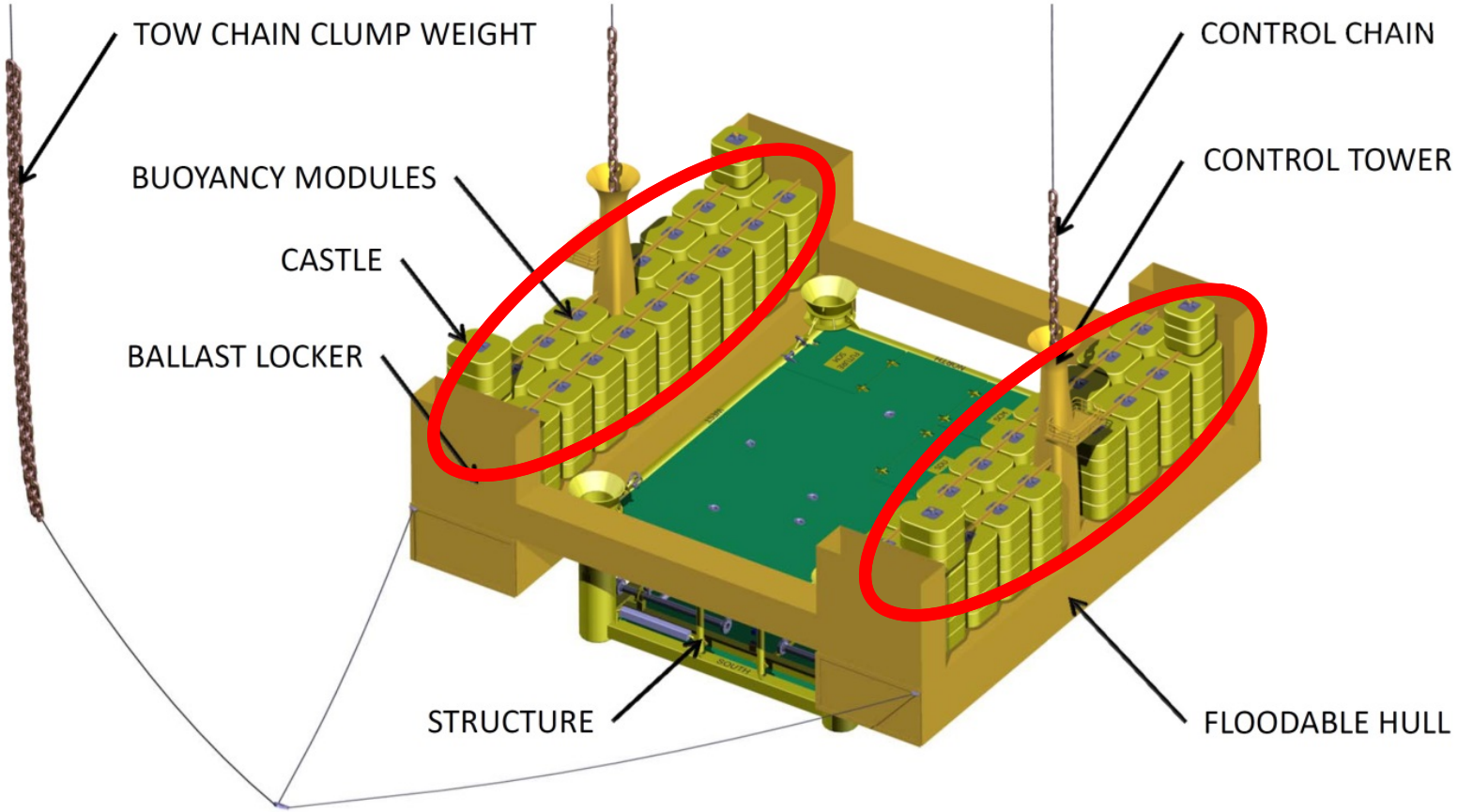
PRODUCT

- An alternative to an HLV for the deployment and recovery of subsea structures
- Allows even the smallest crane vessel to deploy and recover large structures
- Operations largely independent of weather

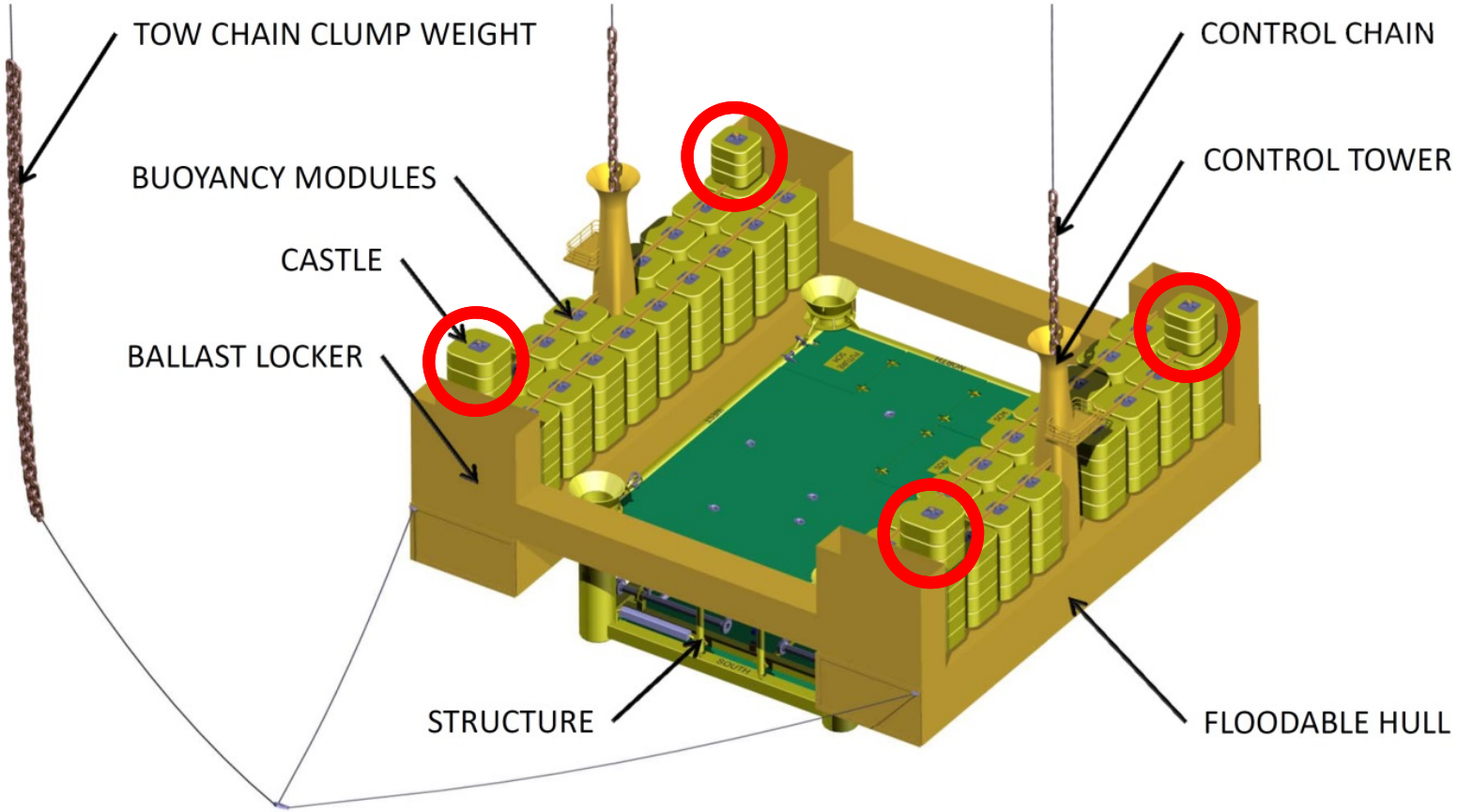




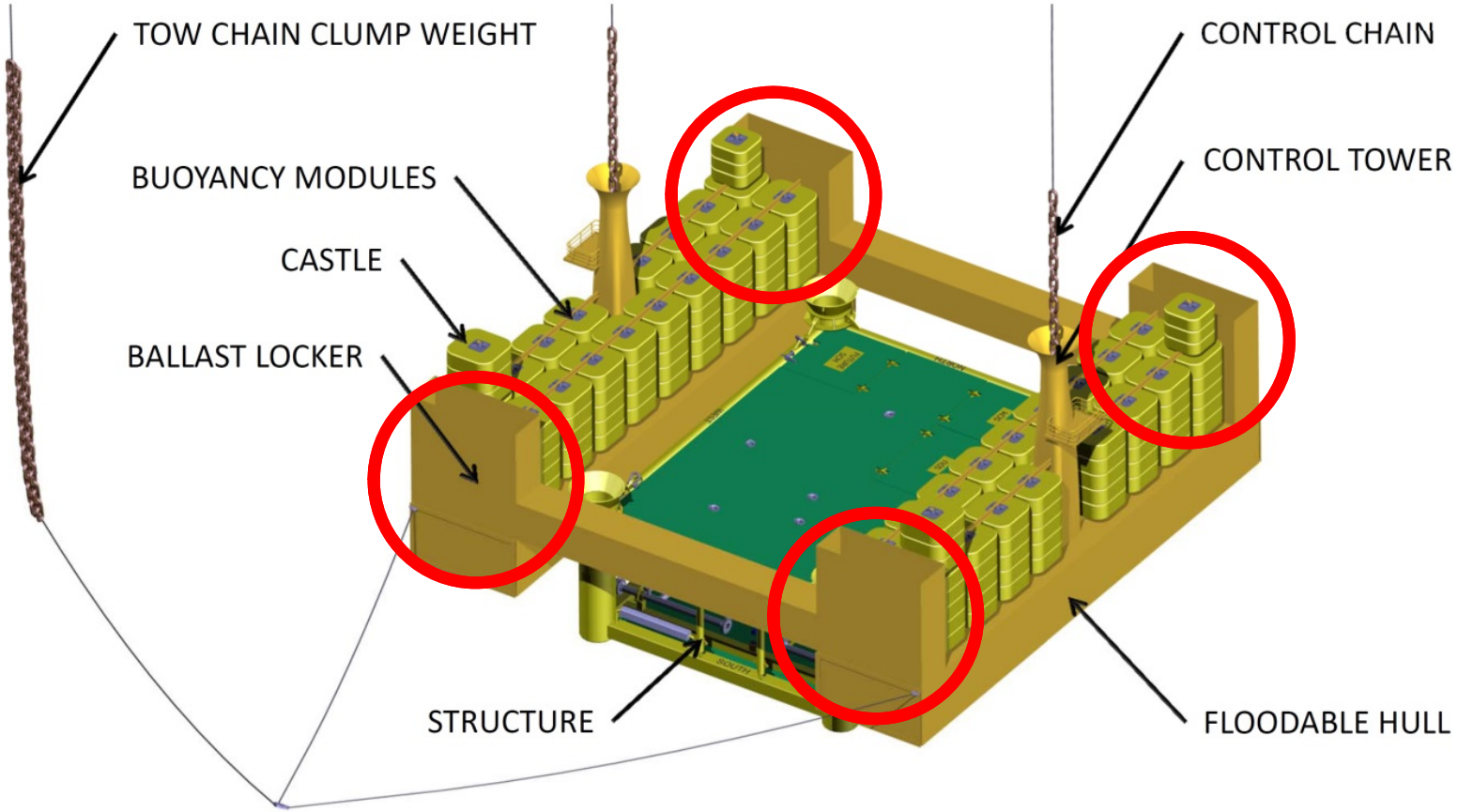
The SDV consists of two **FLOODABLE HULLS** which have ballasting facilities. This enables the SDV to be towed at a shallow draught. The SDV hulls will be fully ballasted during the submerged tow and all valves will remain open to the sea to avoid hydrostatic collapse



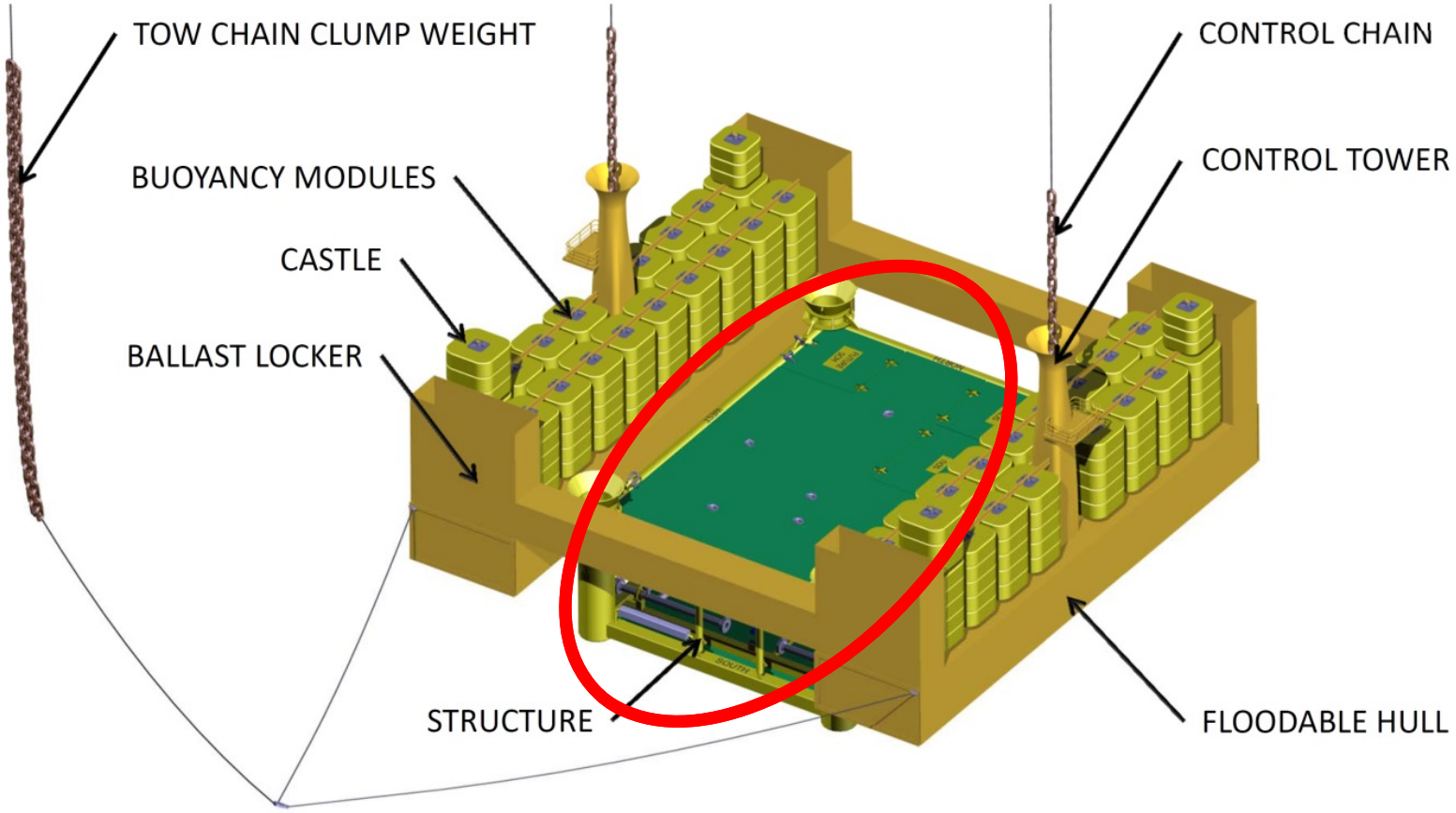
Solid **BUOYANCY MODULES** (syntactic foam) rated to the installation water depth are located above the hulls. The amount of buoyancy is sufficient to render the combined SDV and payload slightly positively buoyant



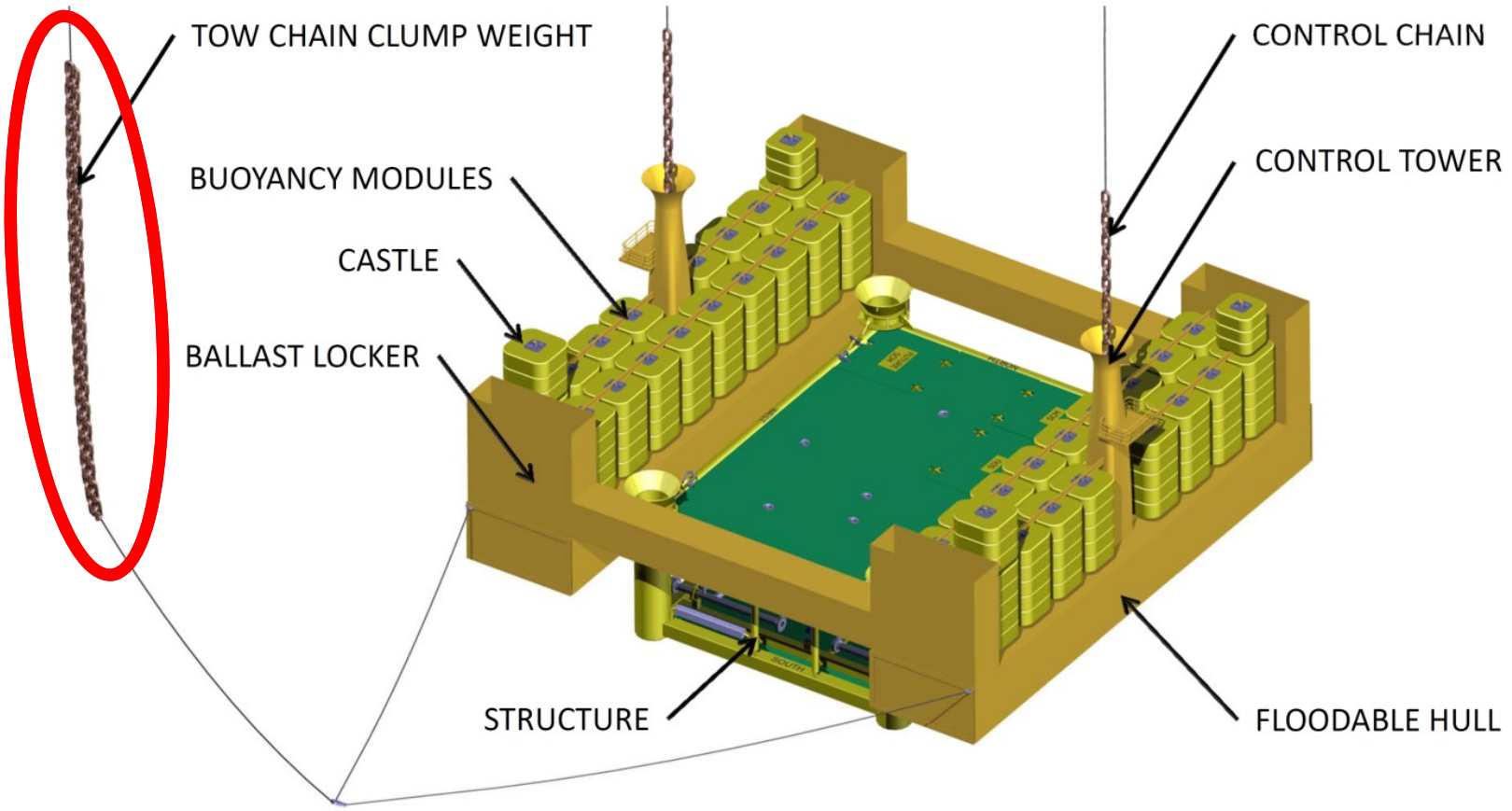
The **CASTLES** are positioned above the majority of the solid buoyancy and protrude above the waterline in the deep draught condition allowing fine tuning of the trim



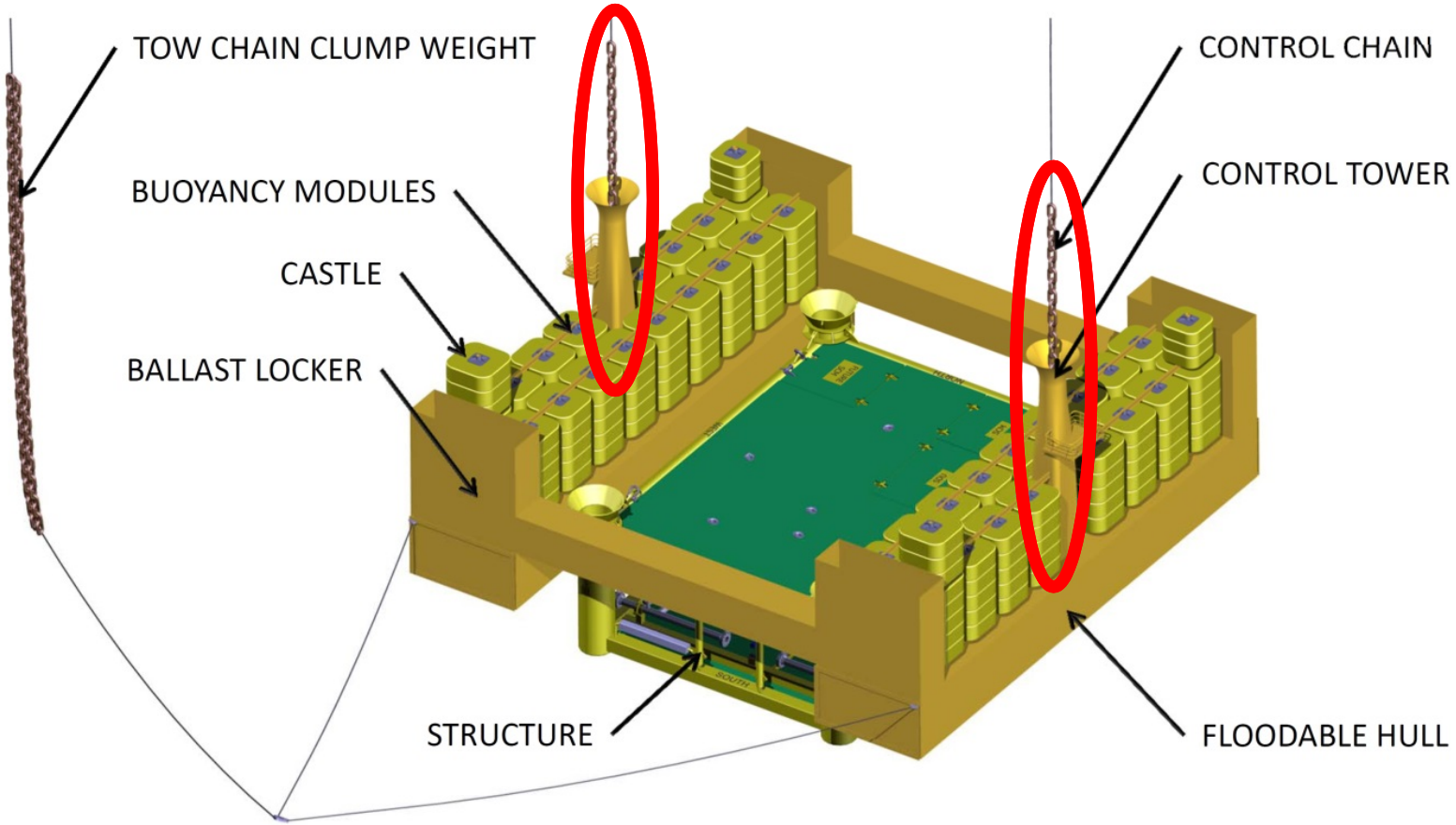
BALLAST LOCKERS are typically placed at each corner. They are used to trim the SDV to suit the weight and centre of gravity of the structure prior to the tow. They are also used to hold the ballast weight which replaces the structure (payload) after installation



The **STRUCTURE (payload)** will be connected to the SDV via interface beams at a lower level than buoyancy to ensure that there is always a positive separation between the Centre of Buoyancy (CoB) and the Centre of Gravity (CoG).



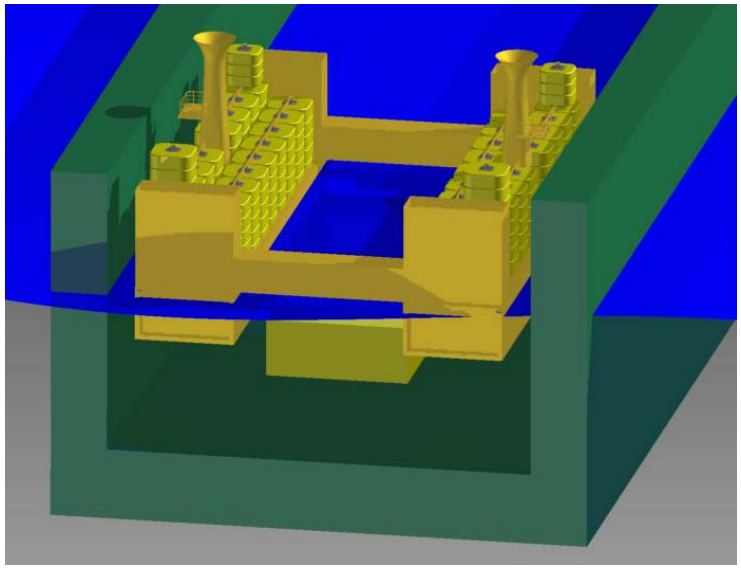
The **TOW CHAIN CLUMP WEIGHT** is inserted into the tow rigging to provide the necessary weight to submerge the SDV from the deep draught tow condition to the submerged tow condition. It also acts as an anchor for the SDV when parked above the seabed

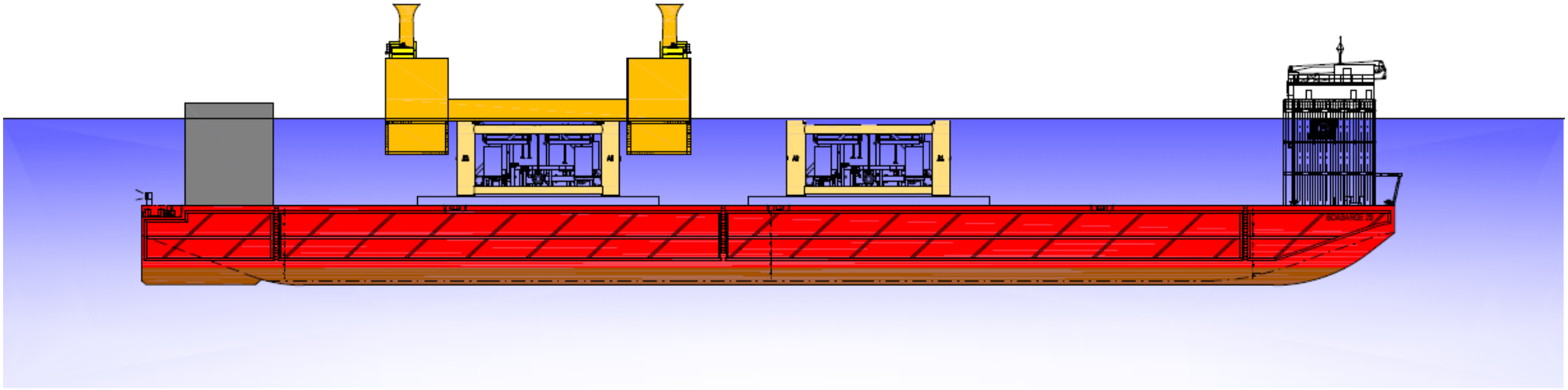


The **CONTROL CHAINS** are lowered into chain **CONTROL TOWERS** to control the SDV during installation. The weight of the chain supported by the SDV at the base of the chain towers is used to control the height of the SDV. The length (weight) of chain suspended within the chain towers provides lateral and rotational control of the SDV

LOAD OUT

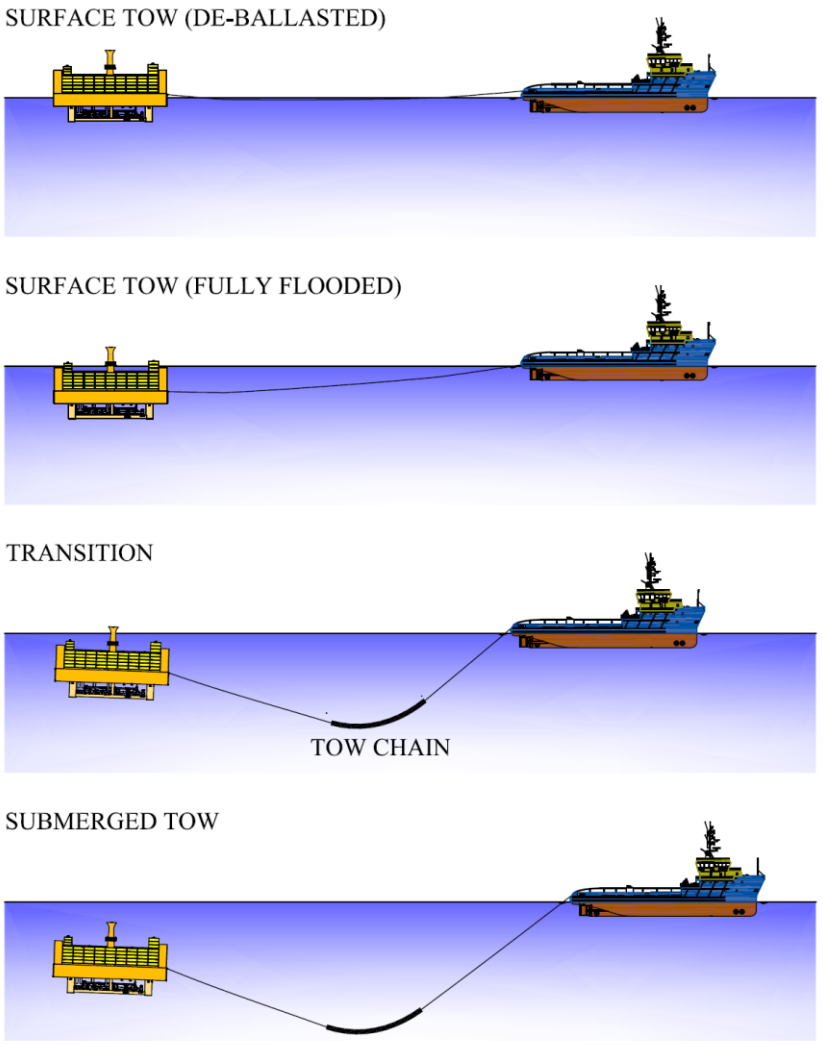
- Lifted
- Float off
- Submersible barge
- Floating dock
- Dry dock





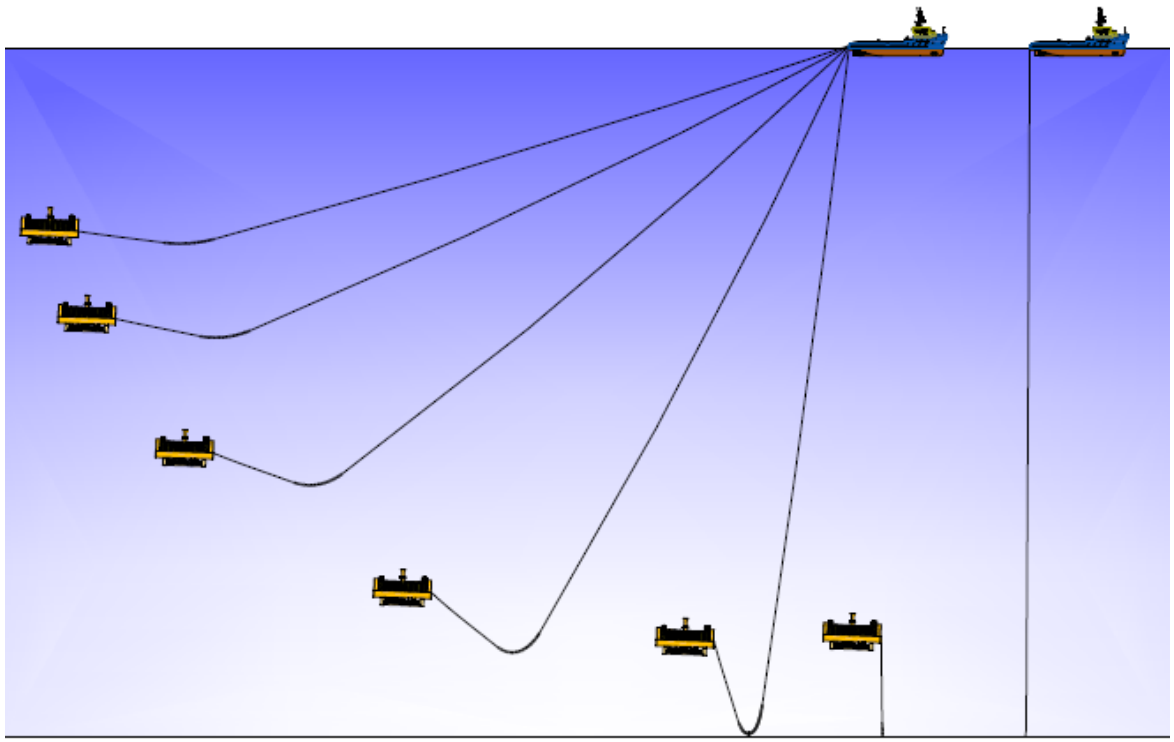
SURFACE TOW

- Shallow surface tow
- Flood compartments
- Insert tow chain clump weight
- Pay out tow wire and adjust speed



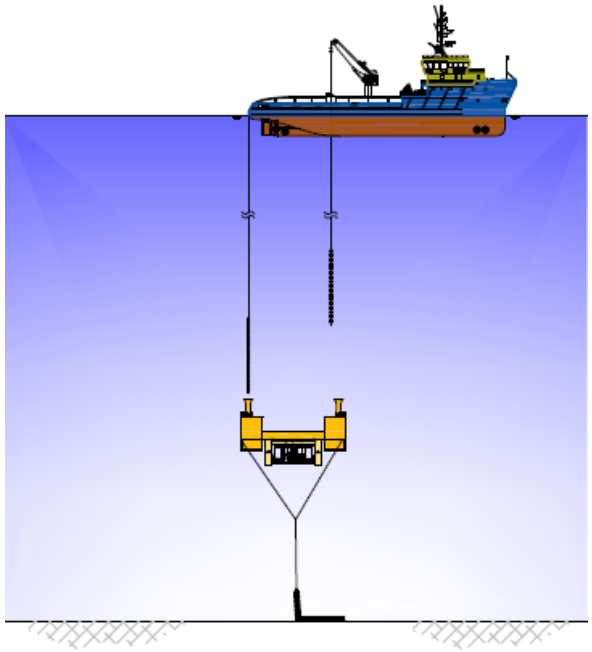
SUBMERGED TOW

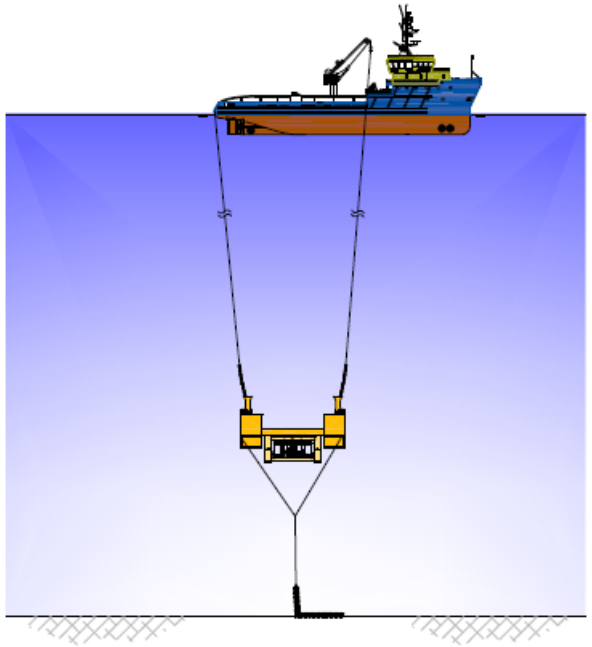
- Adjust tow wire and speed
- Slow down to lower the system
- Pay out tow wire to lower clump weight

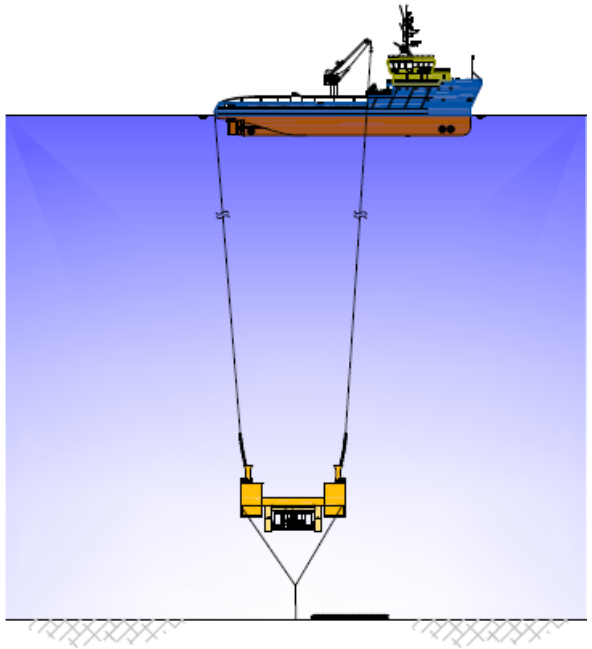


LOWER STRUCTURE

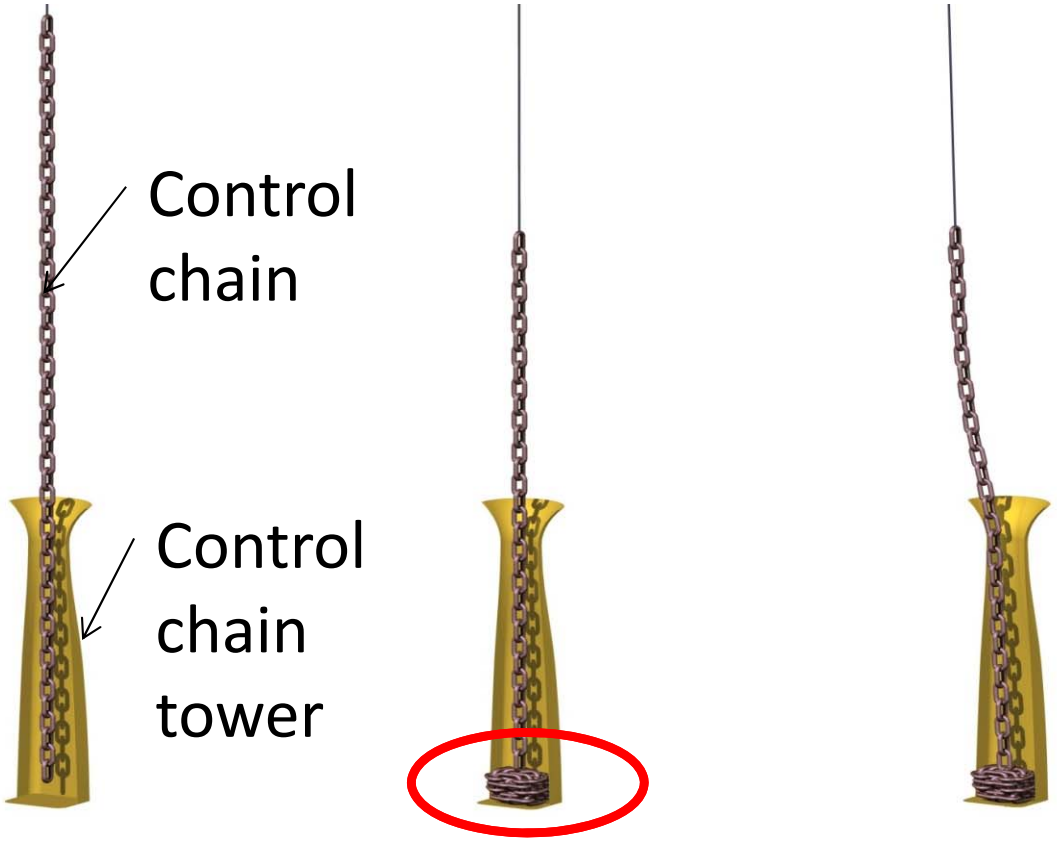
- AHT disconnects the tow wire
- Lower control chains into the control chain towers
- Slew crane to create lead on control chains
- Pay out chain until the system is neutral







CONTROL CHAIN AND TOWERS

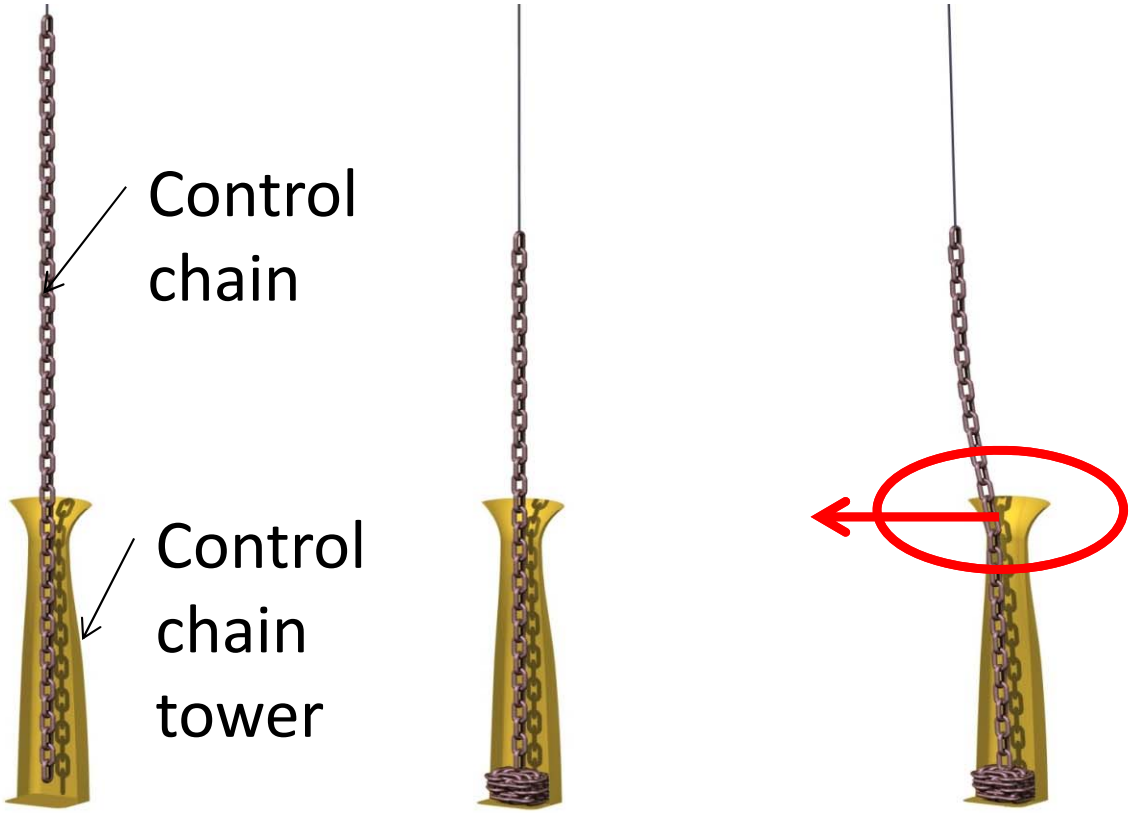


The weight of the chain supported by the SDV at the base of the chain towers is used to control the height of the SDV.

CONTROL CHAIN AND TOWERS

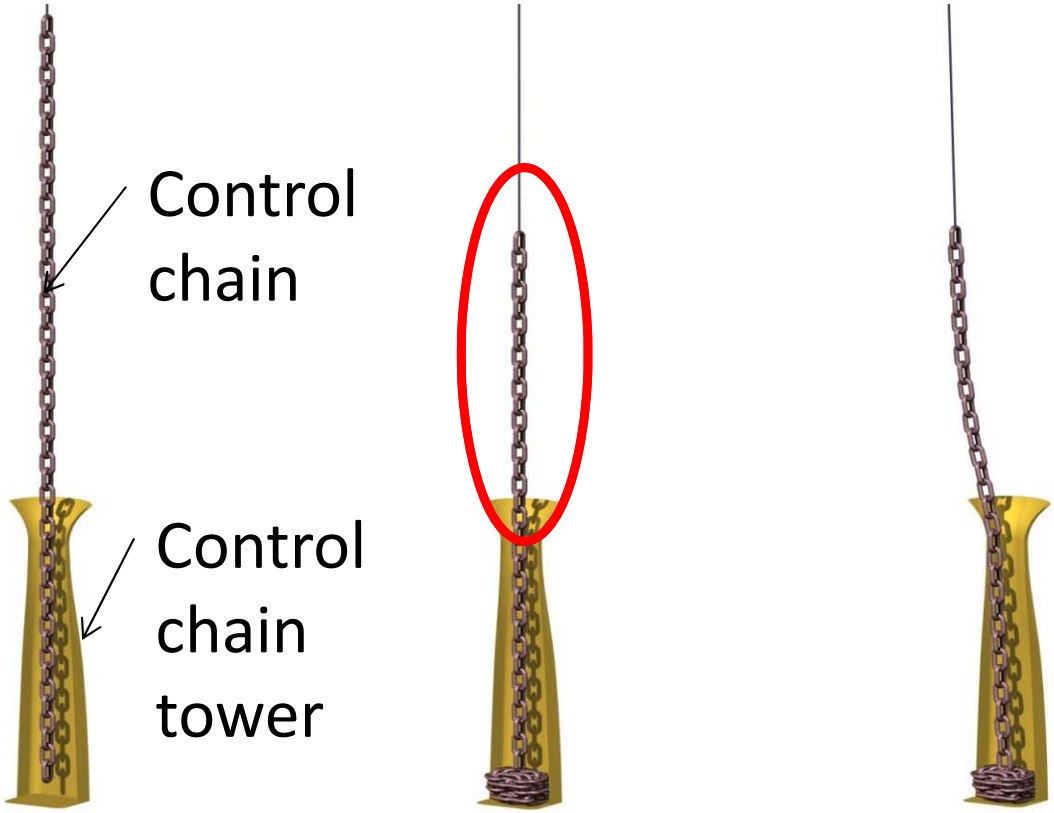
The length (weight) of chain suspended within the chain towers……

CONTROL CHAIN AND TOWERS



…… provides lateral and rotational control of the SDV

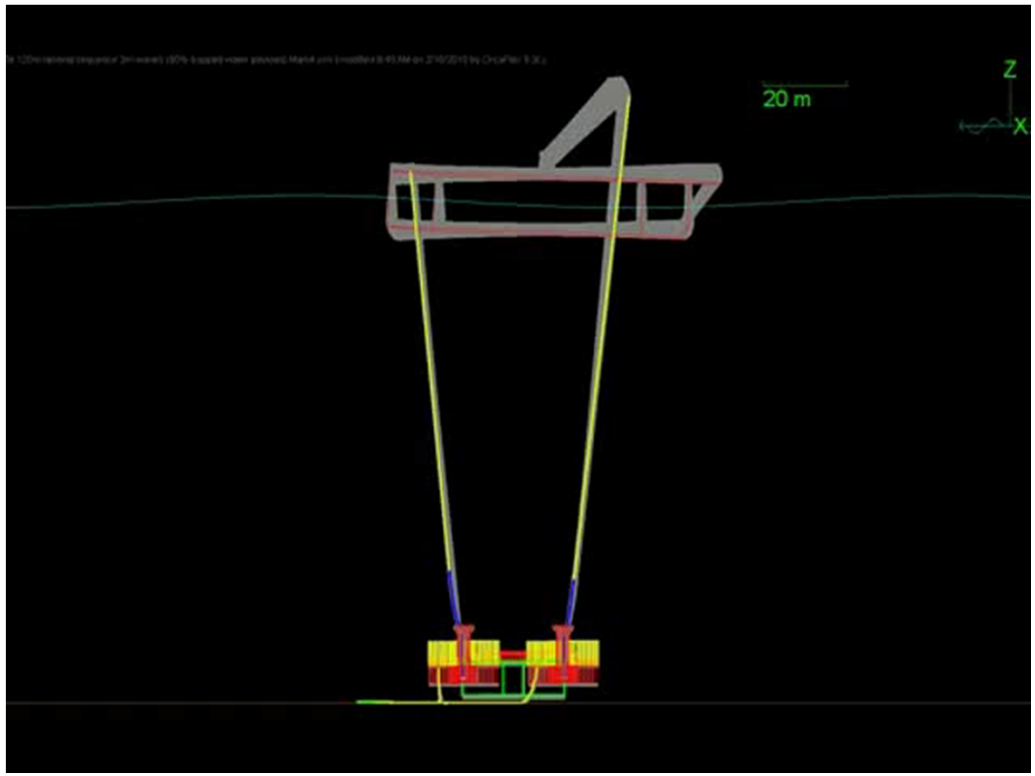
CONTROL CHAIN AND TOWERS

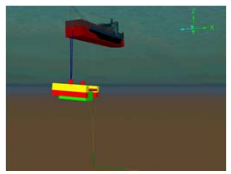


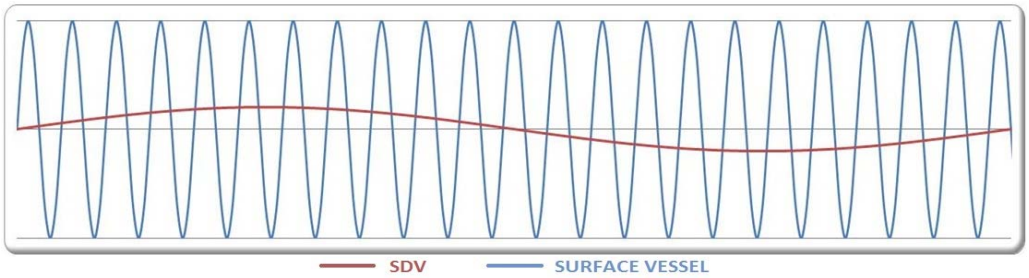
The length (weight) of chain suspended above the chain towers is for contingency and to reduce relative offset from surface vessel

DYNAMICS

- Response governed by the natural period of the system
- Typically the natural period of a >1000t system > 120s
- Increased weather window for set down
- Minimal dynamic loading on the surface crane and structure

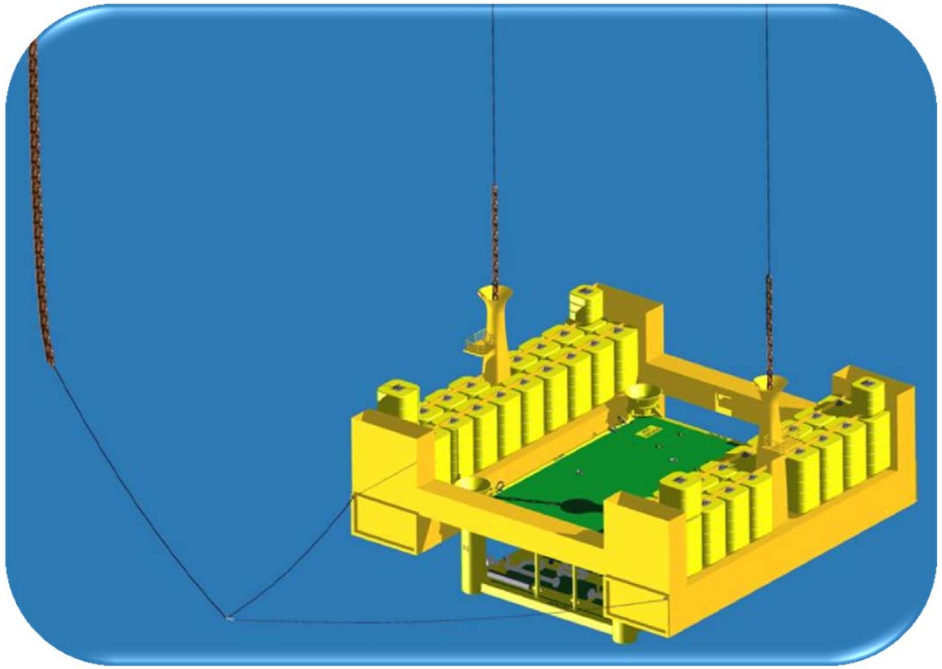


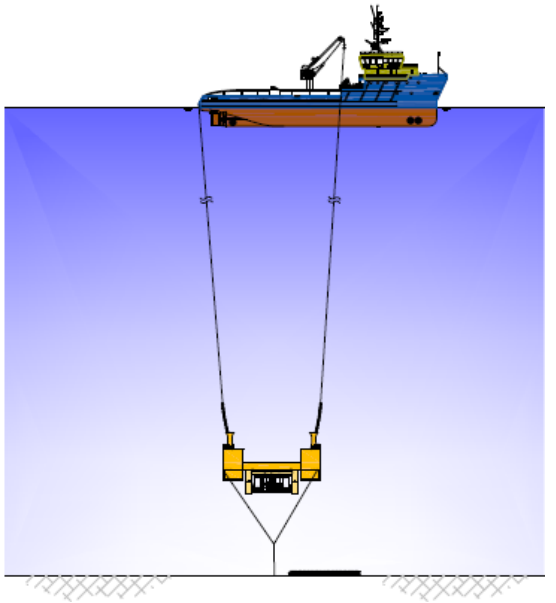


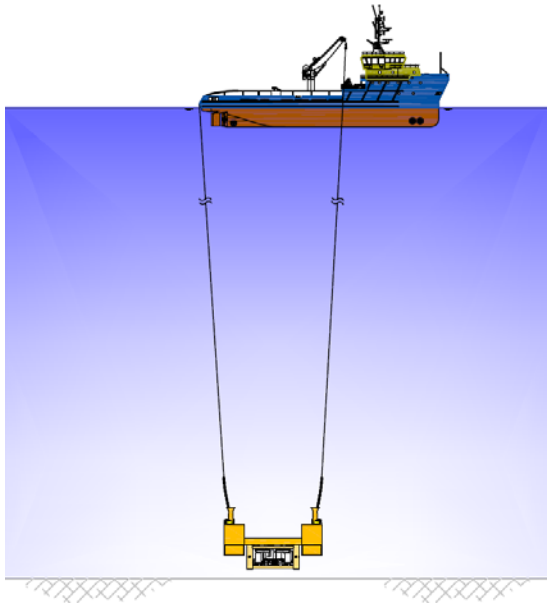


INSTALLATION

- AHT manoeuvres the system to final target

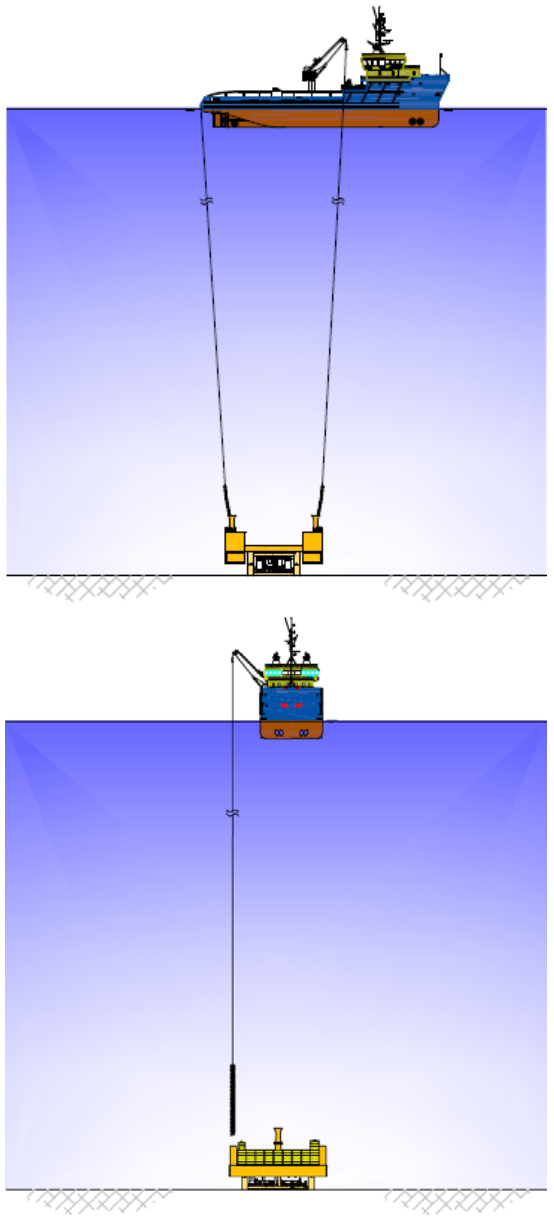






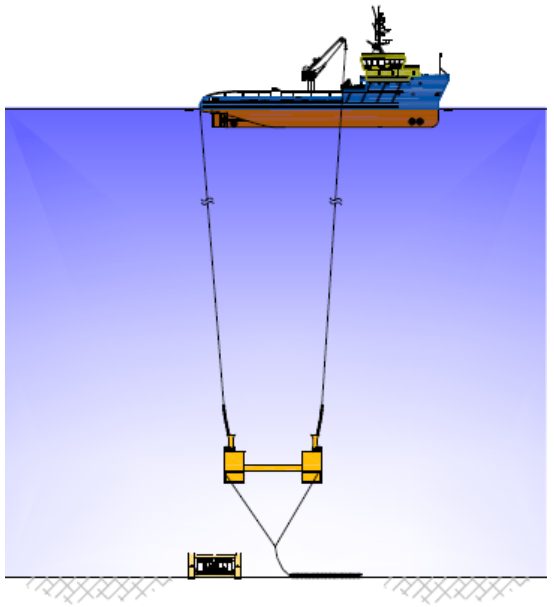
BALLASTING

- Lower system slowly on to target
- Pay out remaining control chain into control chain towers
- Install ballast weight to balance the payload weight



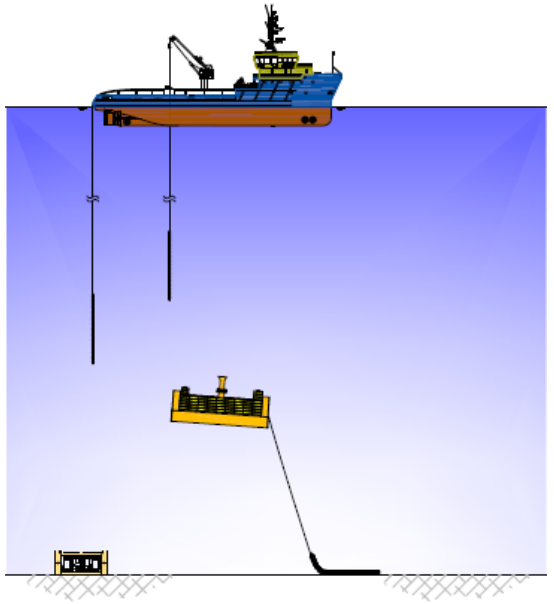
LIFT-OFF

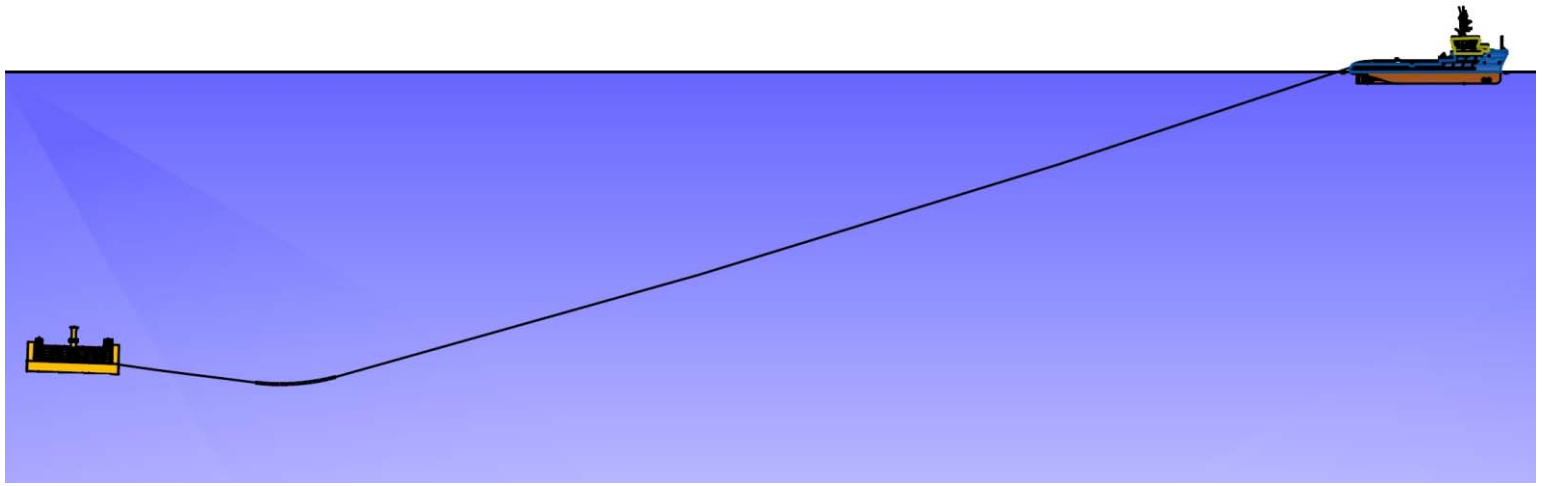
- WROV disconnects payload
- Deploy down lines and reconnect to the control chains
- Recover the control chains until the subsea deployment vessel starts rising
- Continue raising until well clear of subsea assets



RETURN TO SHORE

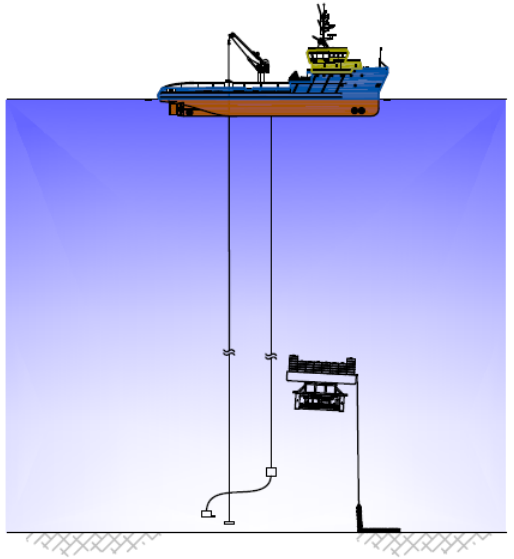
- Recover control chains until clear of the control chain towers
- AHT tows the subsea deployment vessel back to shore

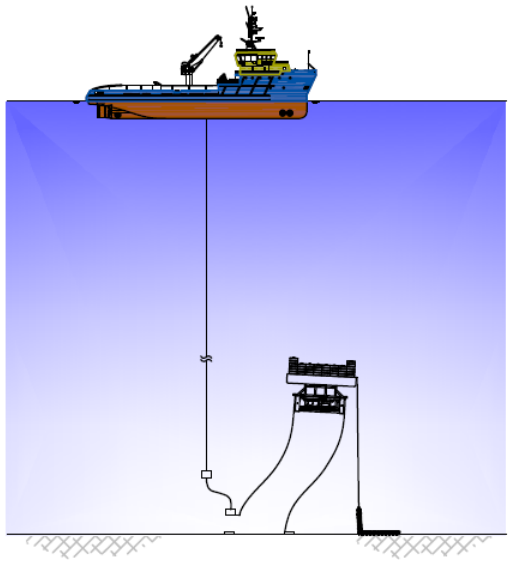




PULL-DOWN ALTERNATIVE

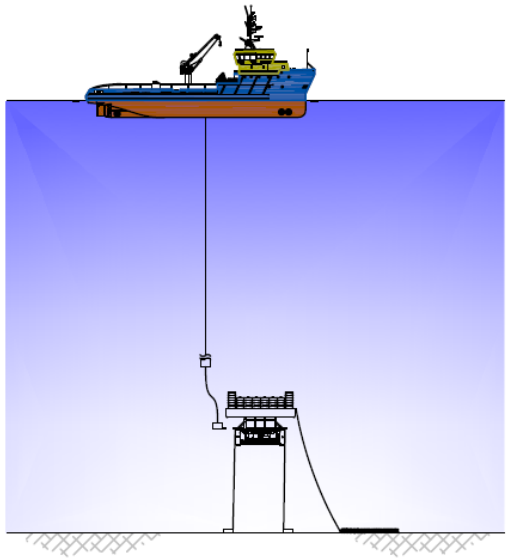
- SDV is landed within reach of final target
- DMA's will be prepositioned on the seabed or use of existing template
- Winch wires are then connected
- Winches can be fitted to:-
  - DMA's
  - Interface Frame
  - SDV

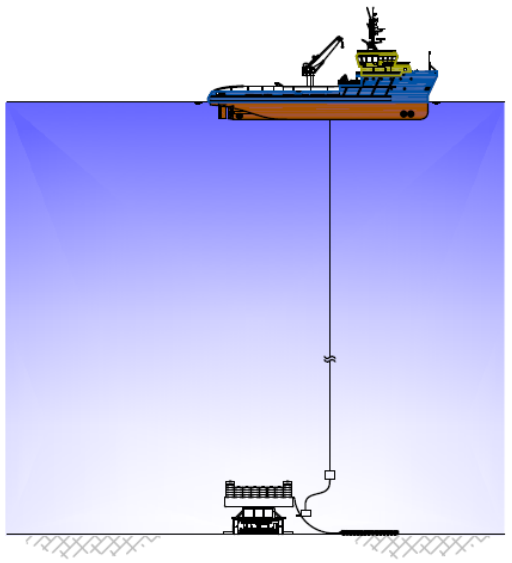




PULL-DOWN ALTERNATIVE

- SDV is then lowered by operating the winches
- Ballasting of SDV as per original procedure
- Recovery of SDV by use of the winches
- Some benefit when wanting to install structures close to surface obstructions although crane access is required

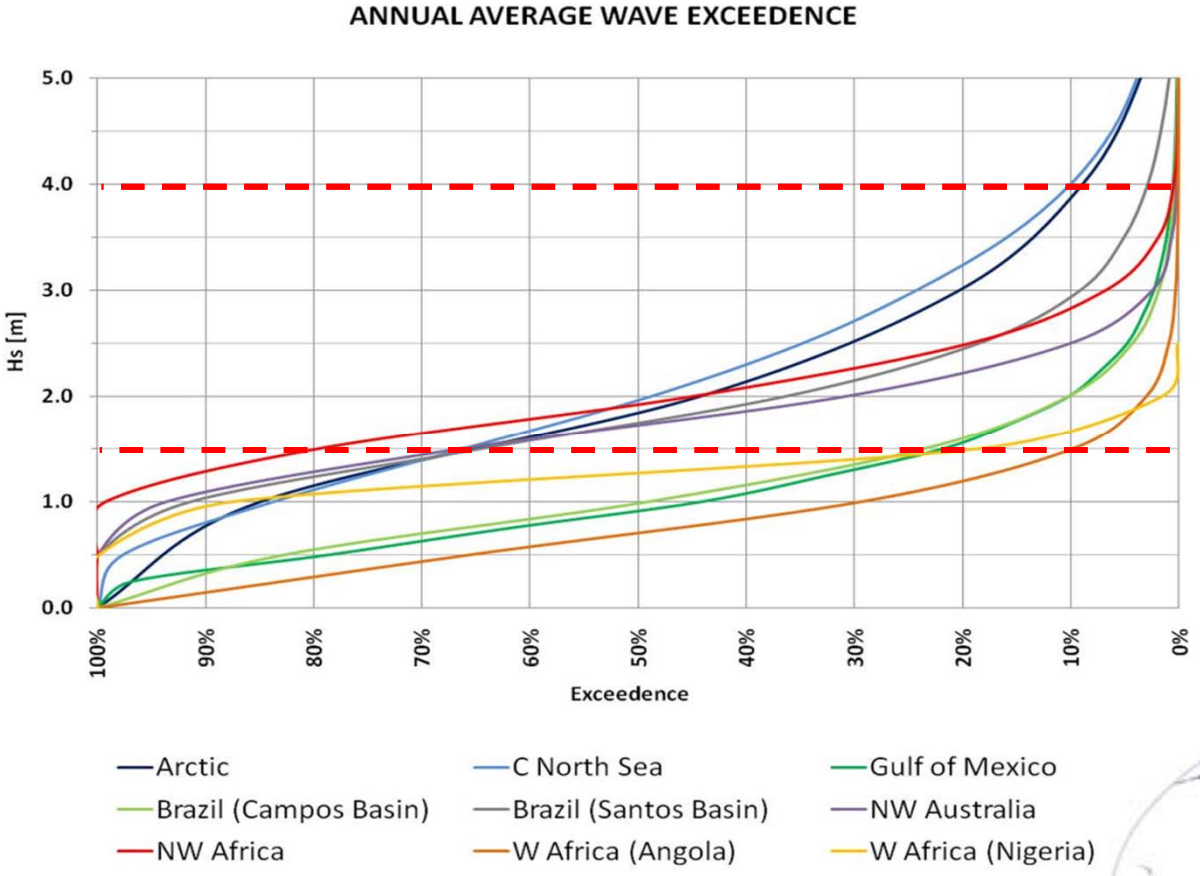




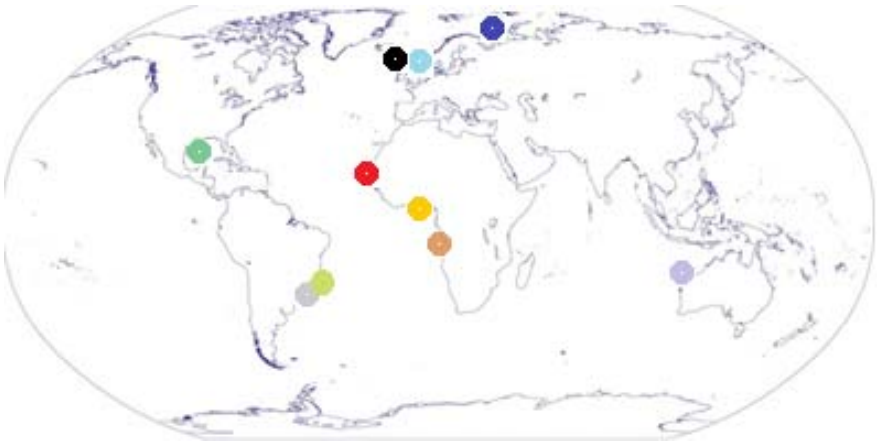
Tank Testing of 1:75 Scale Model

Subsea Deployment Systems Ltd.

SEASTATE STATISTICS

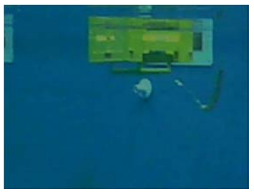


- Subject to operational windows and seasonal variations



INHERENT SAFETY

- Total loss minimised – “Close to neutral”
- No point of ‘no return’
- Rigging failure
- Buoyancy loss

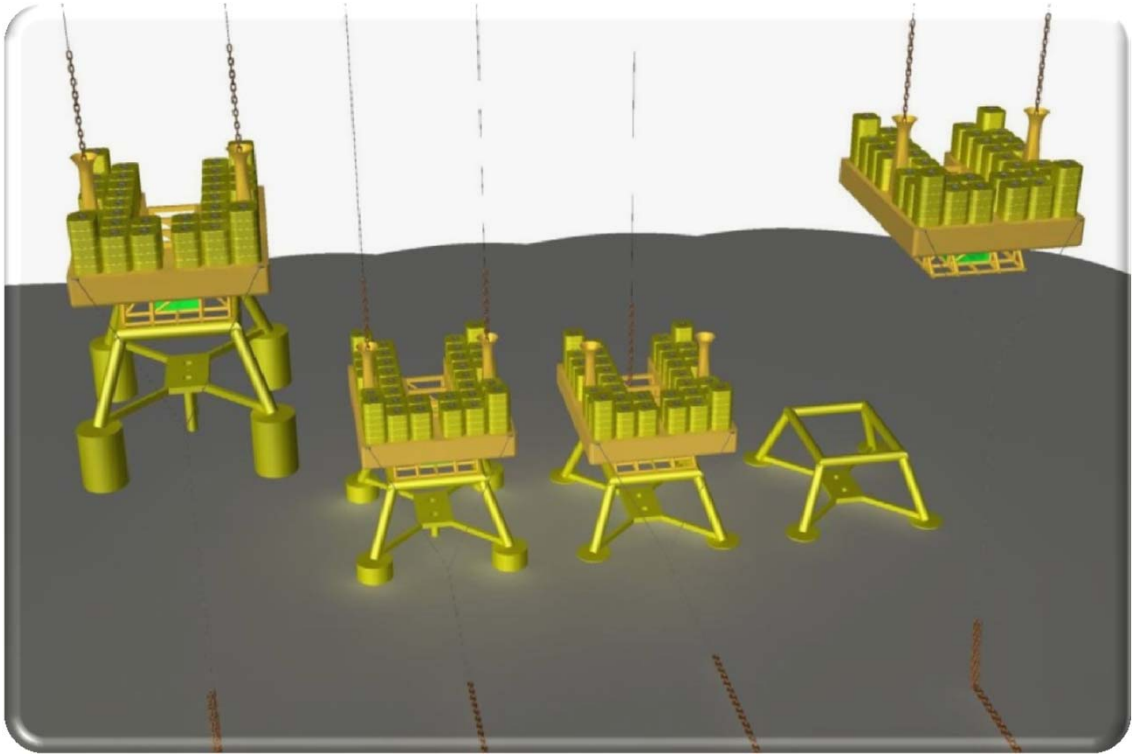


TOW WIRE FAILURE (10x)

POTENTIAL APPLICATIONS

Installation

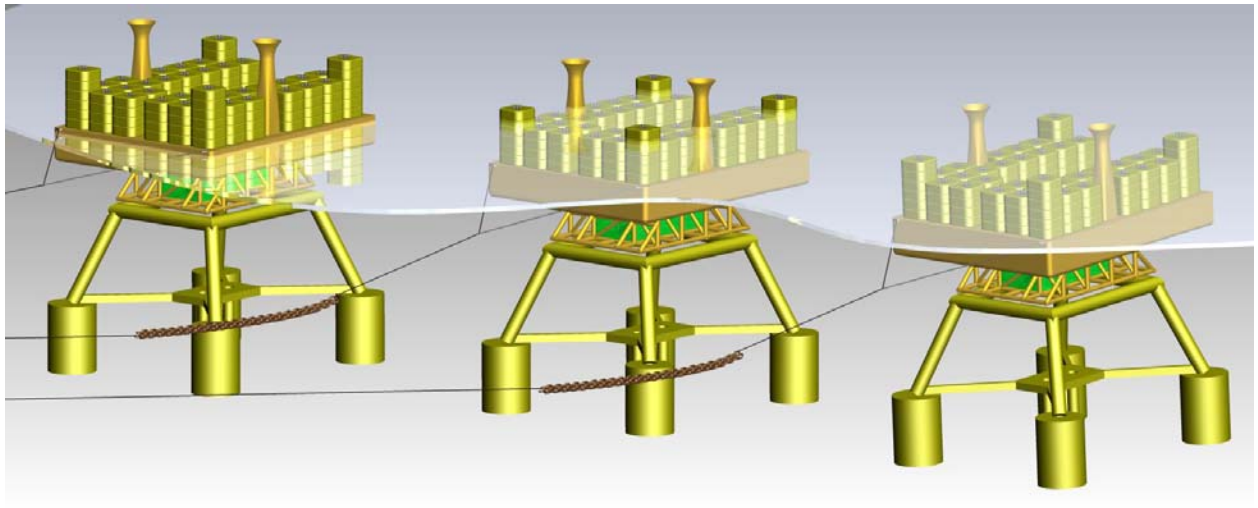
- 100t to several 1000t structures
- Water depth 80m – 3000m
- Hostile environments



POTENTIAL APPLICATIONS

Transportation

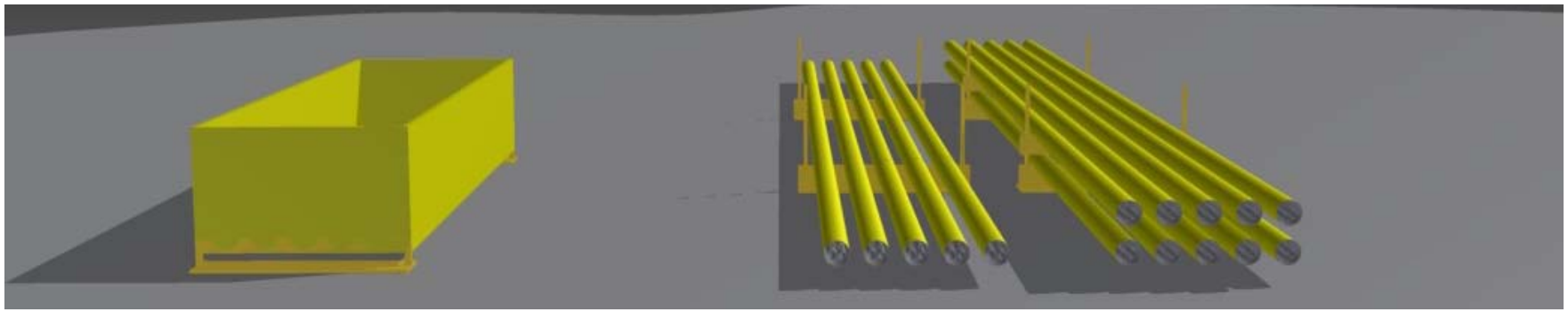
- Complex Spools
- Large Piles
- Modules
- Multiple smaller items to field



POTENTIAL APPLICATIONS

Decommissioning

- Operation is fully reversible for new structures
- Interfacing flexibility with existing structures
- Minimal dynamic loading
- Existing structures recovered without lifting to deck
- Skip / Rack



POTENTIAL APPLICATIONS

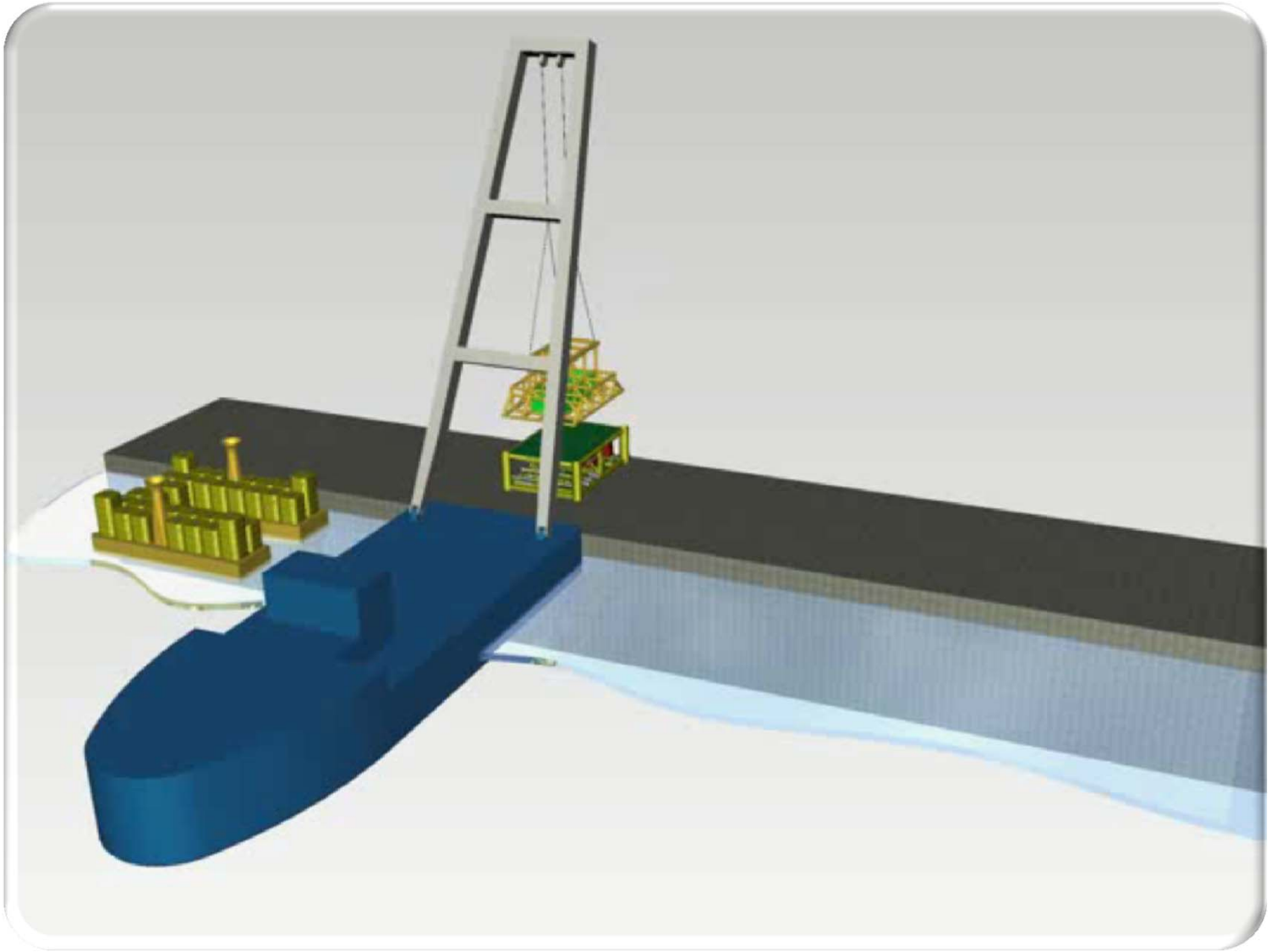
Salvage

- Wrecks
- Deployment vessel can be parked at wreck site for prolonged periods

Emergency Response

- Transport of heavy equipment with vessel of opportunity at short notice

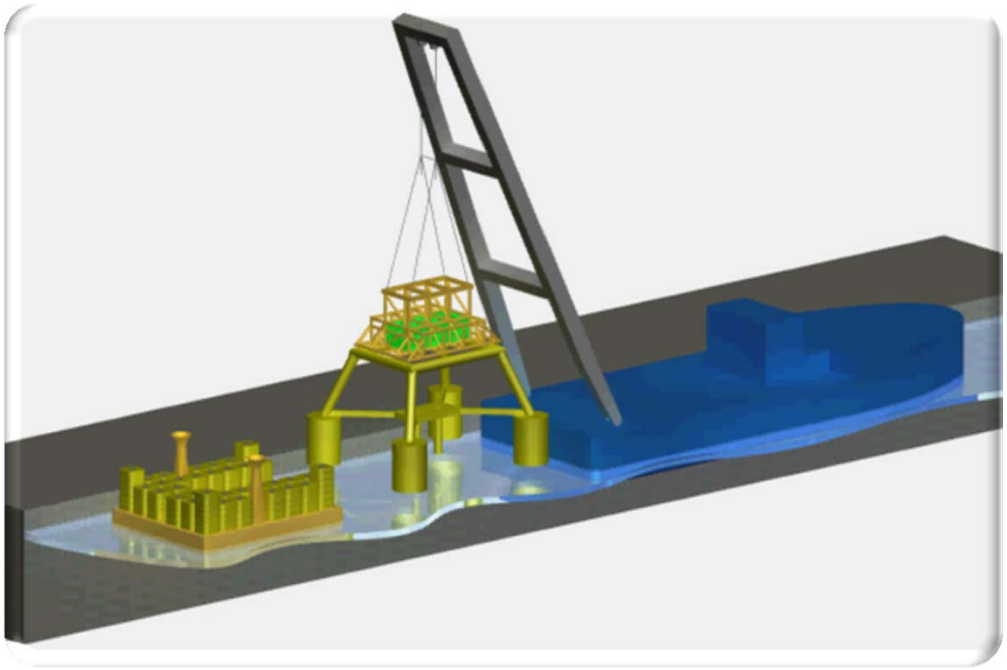
U-SHAPE WITH INTERFACE FRAME

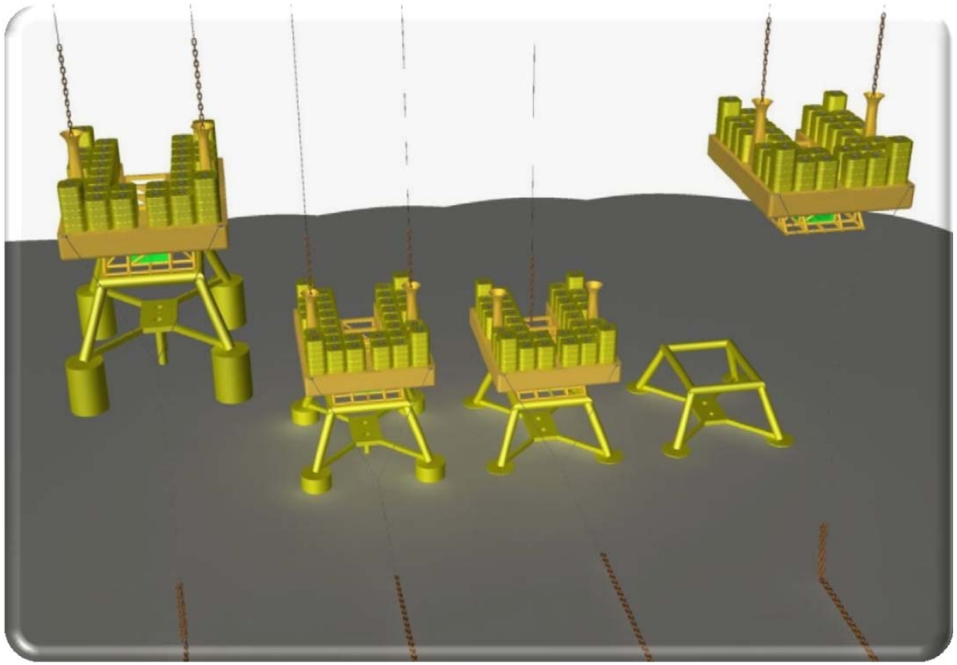


U-SHAPE WITH INTERFACE FRAME

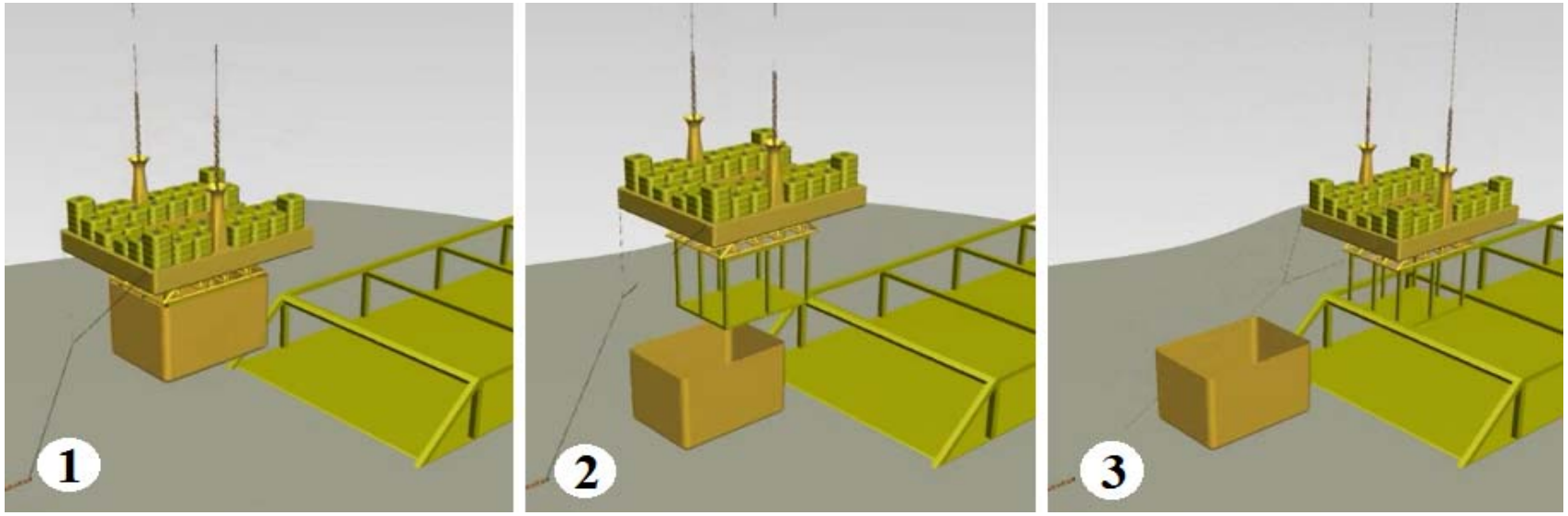
Templates / manifolds

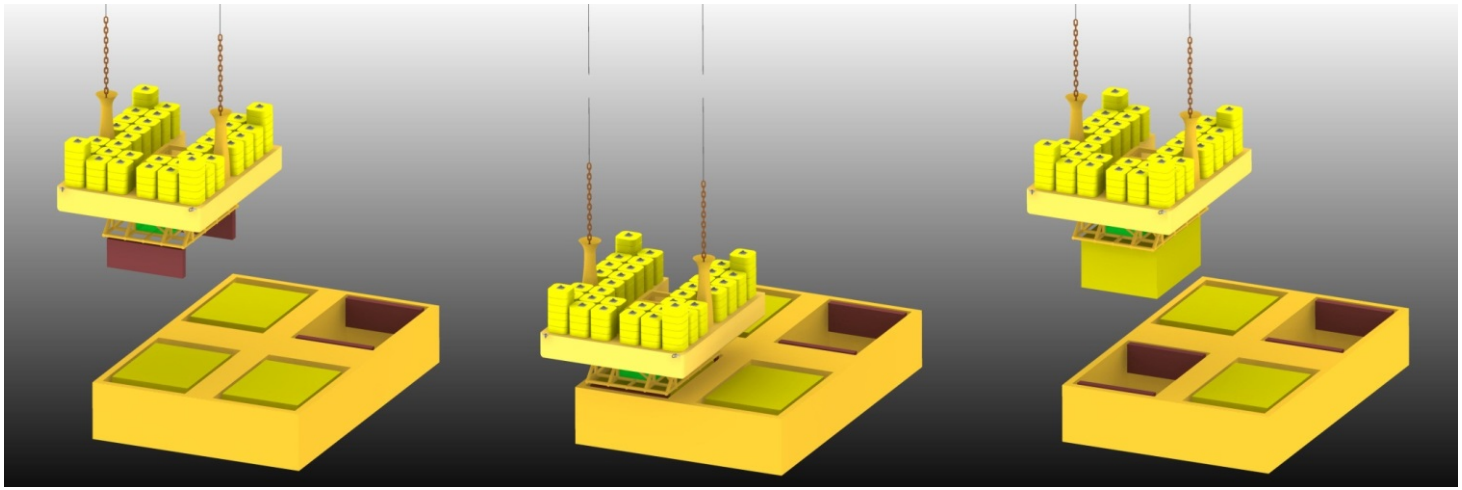
- Opportunity to increase slots
- Suction cans vs. mudmats



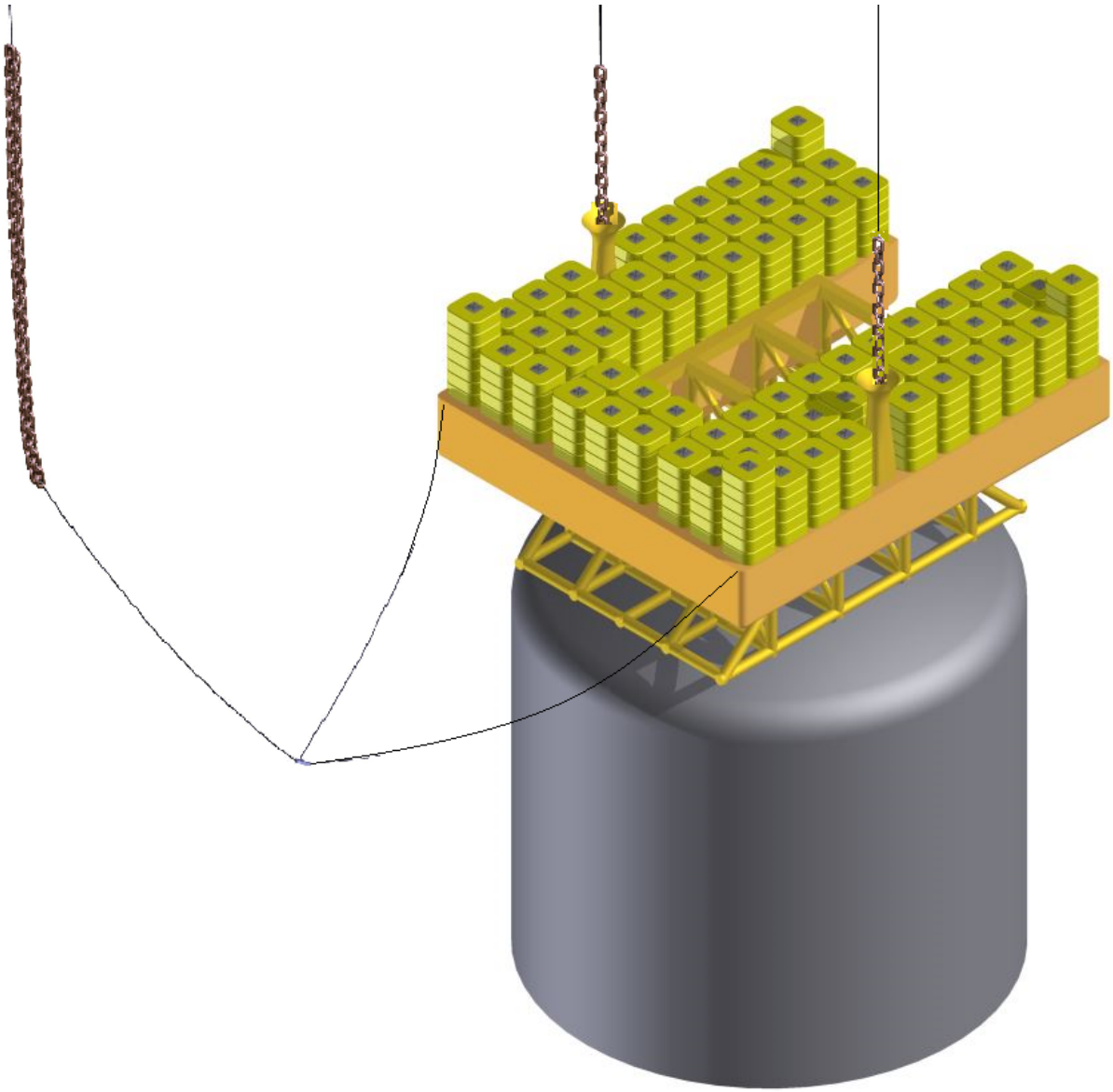


SUBSEA COMPRESSION (MODULES)





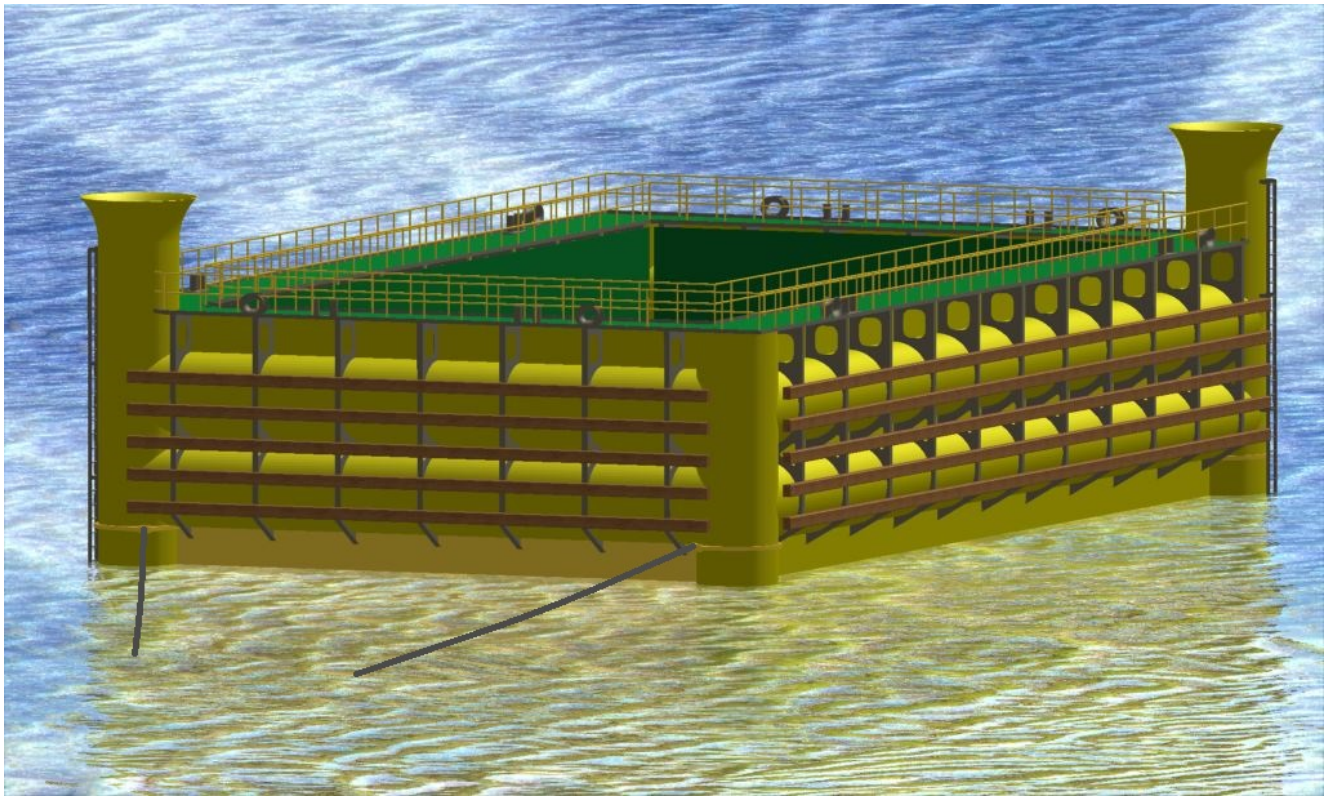
SUBSEA STORAGE UNIT



SKIP

- Skip hold can be de-ballasted to bring it to shallow draught
- Skip can be used for both subsurface and surface transport
- Demonstrated skip
  - Length 32m
  - Width 16m
  - Depth 8m
  - Weight 300Te
  - Capacity (sub) 300Te
  - Depth rating* 150m

** May be deeper if upper tubulars are pressurised*

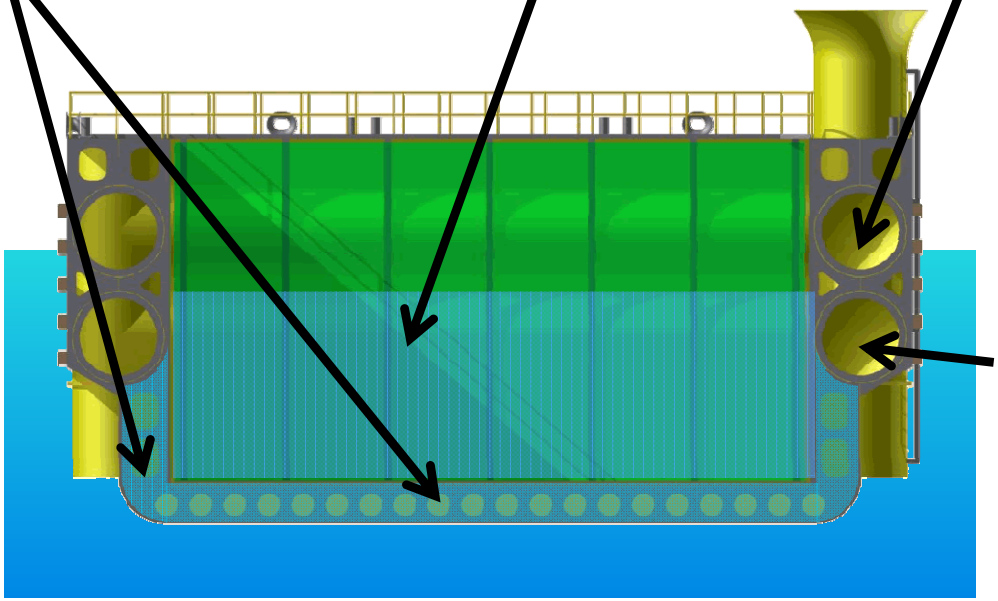


SURFACING

Remotely operated
(Valves will be operated remotely for de-ballasting)

Hold
(water can be pumped out of the hold using pressurised air from lower tubular)

Side and Double Bottom Tanks
(high point open to the sea)

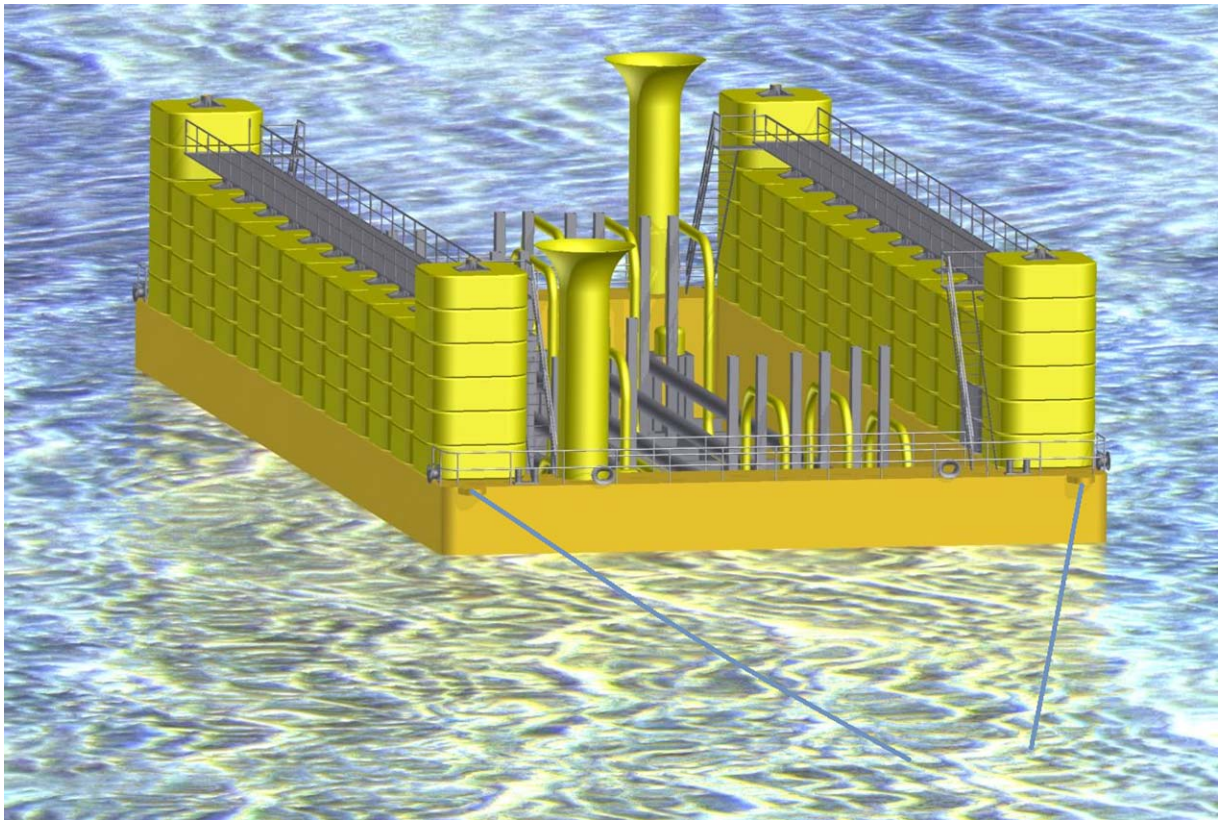


Upper tubular
(fully sealed, buoyancy equals submerged weight of skip)

Lower tubular
(c/w ballasting facilities)

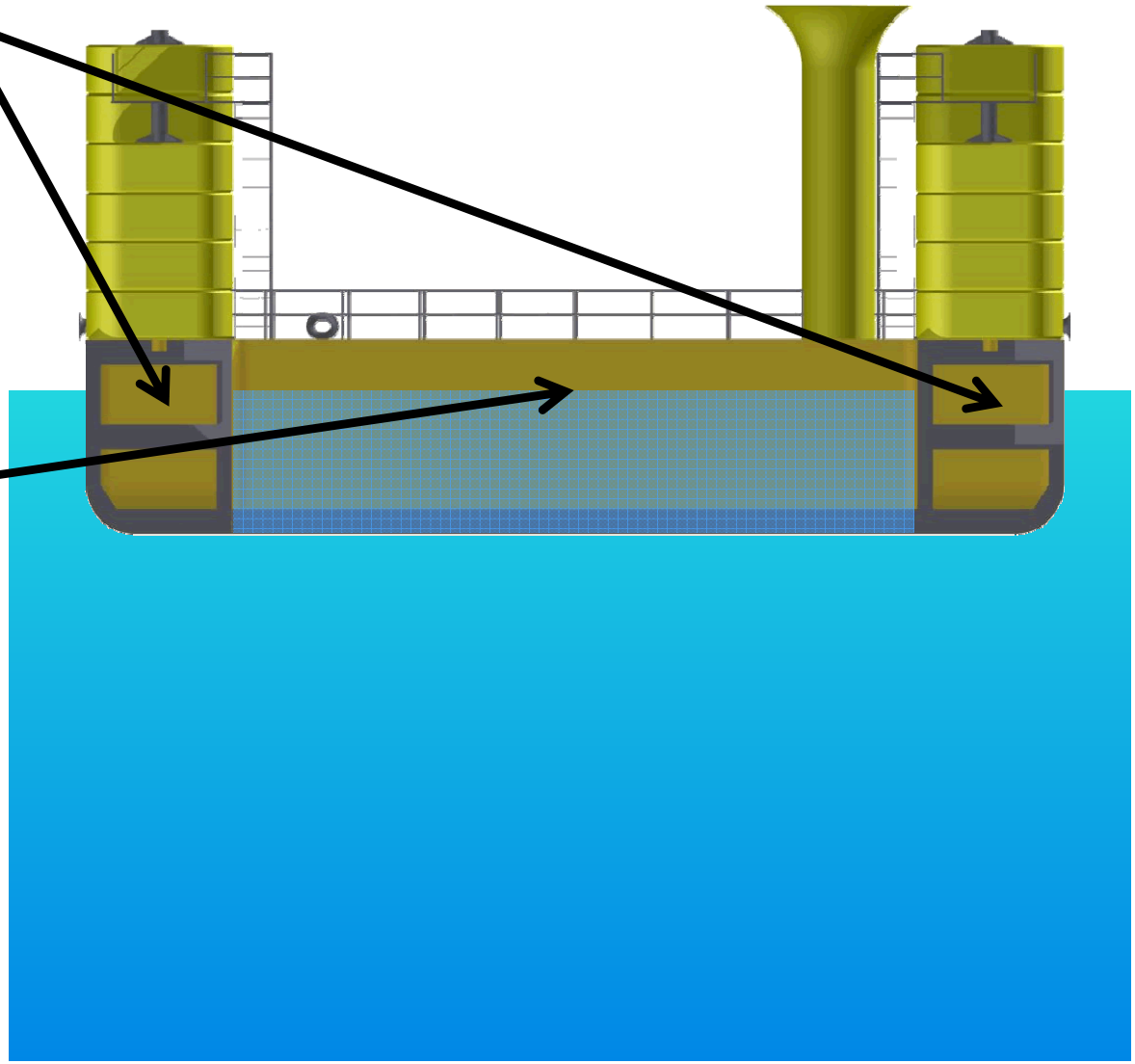
DEEPWATER SDV / SKIP

- SDV hold can be de-ballasted to bring it to shallow draught
- SDV can be used for both subsurface and surface transport
- As demonstrated
  - Length 42m
  - Width 20m
  - Depth 4m
  - Steel Weight 210Te
  - Net Buoyancy 450Te
  - Capacity (sub) 275Te
  - Depth rating 2000m



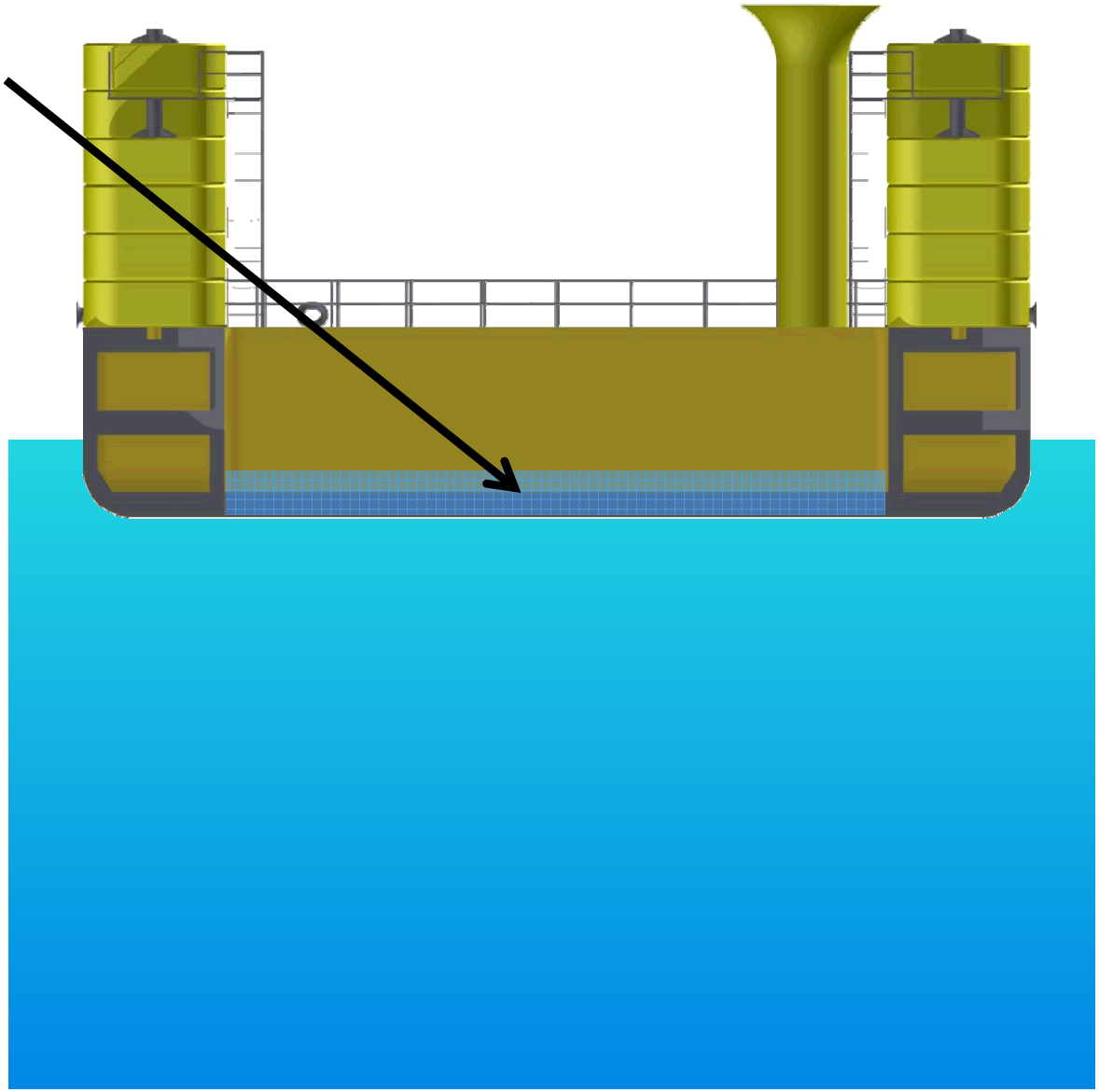
SURFACING

- The side compartments would be emptied to bring hull above water level
- Water trapped inside ‘hatch coaming’ is allowed to escape to level with sea level



SURFACING

- When the SDV has settled water pumps will be activated to expel the remaining water in the hold



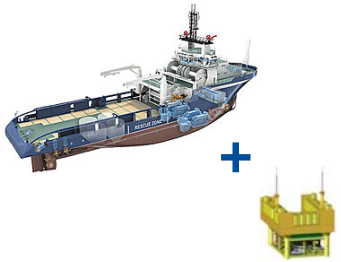
TOW & INSTALLATION VESSELS

- Construction vessels for installation & AHT for tow
- Alternatively AHT (c/w ROV) from the spot market:-
  - 8 off BP 200-299Te DP II Class AHTs
  - 4 off BP >300Te DP II Class AHTs


REM GAMBLER (DP II) BP 344T

SAFETY AND ENVIRONMENT

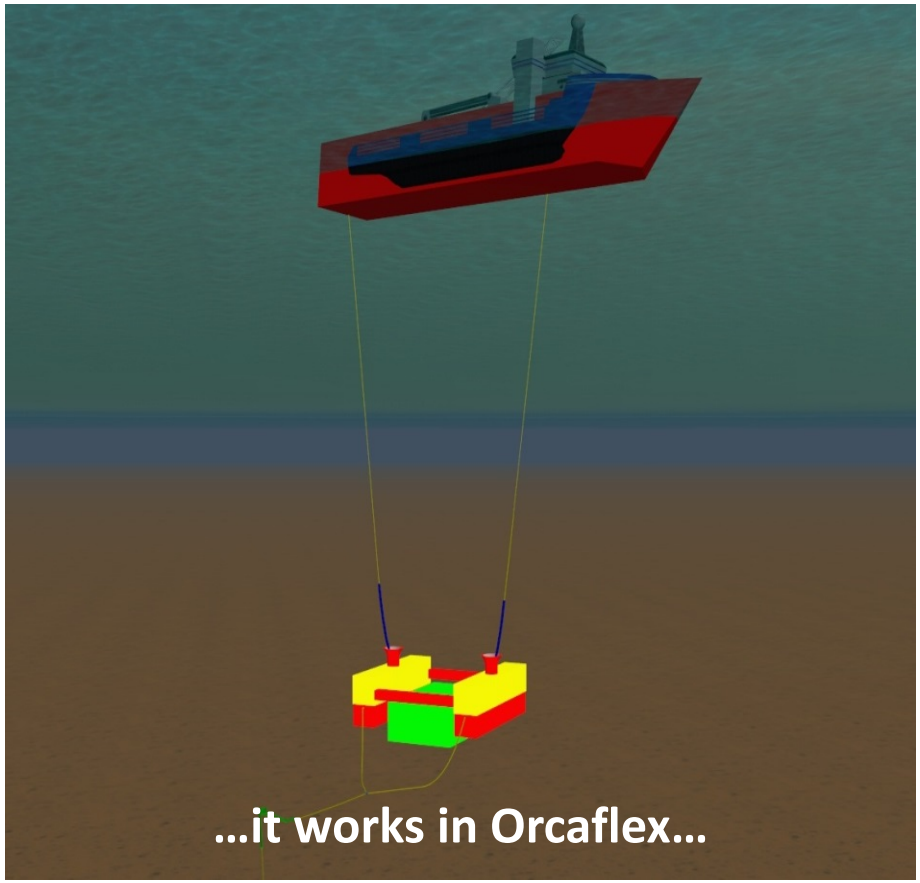
- Low tech / fail safe
- Operations can be suspended at any time (no point of no return)
- Operations insensitive to weather
- Negligible dynamic loading
- Structures are not recovered to deck
- Reduced risk of catastrophic loss
- Fewer personnel
- Low carbon footprint



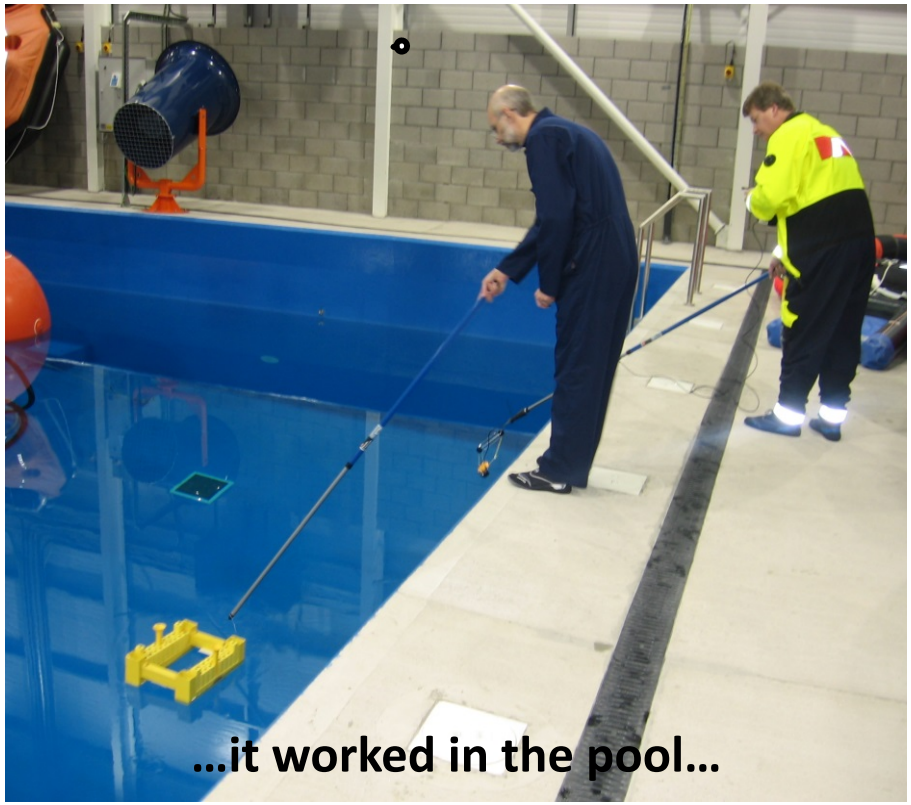
VS

SUMMARY

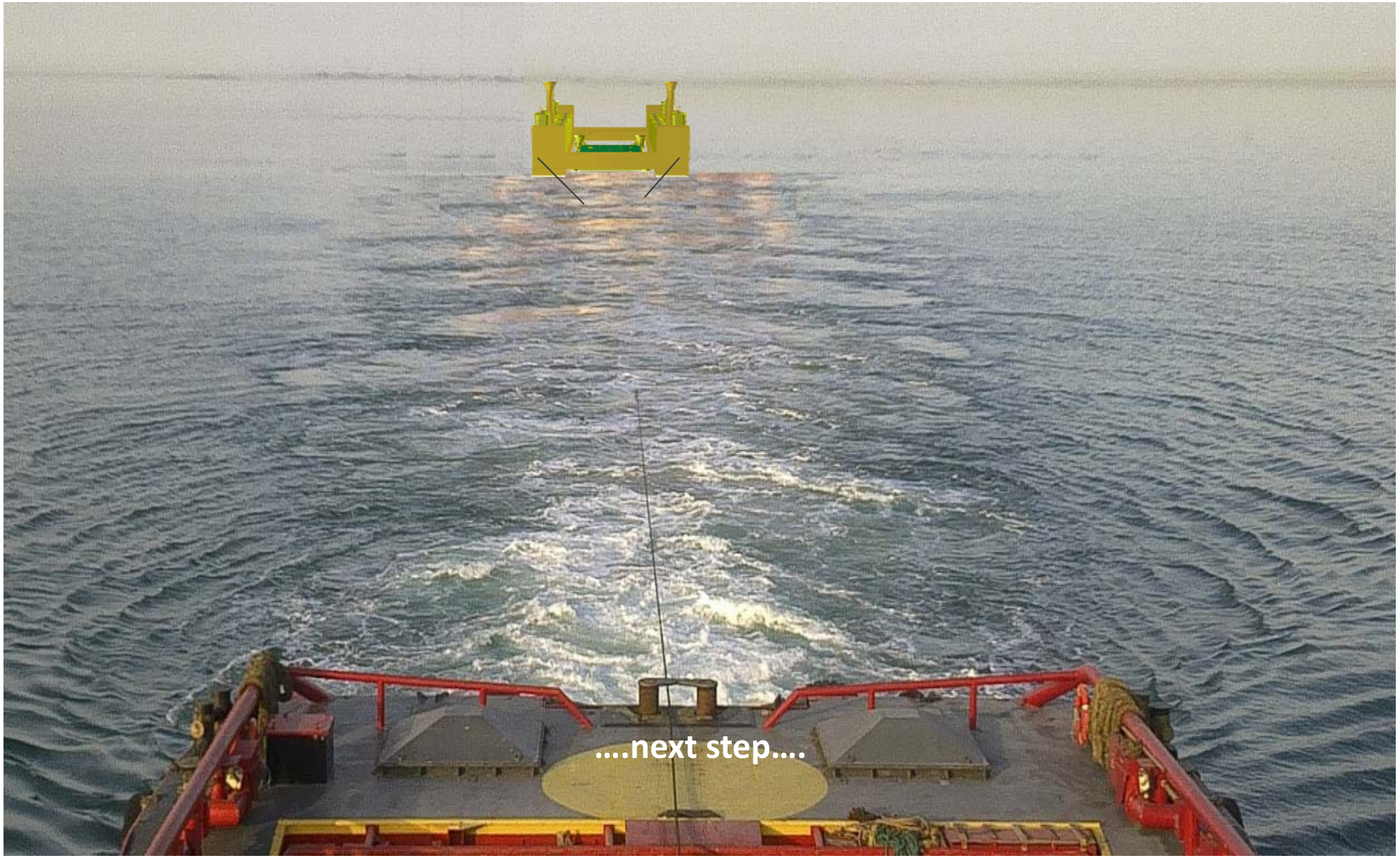
SUMMARY

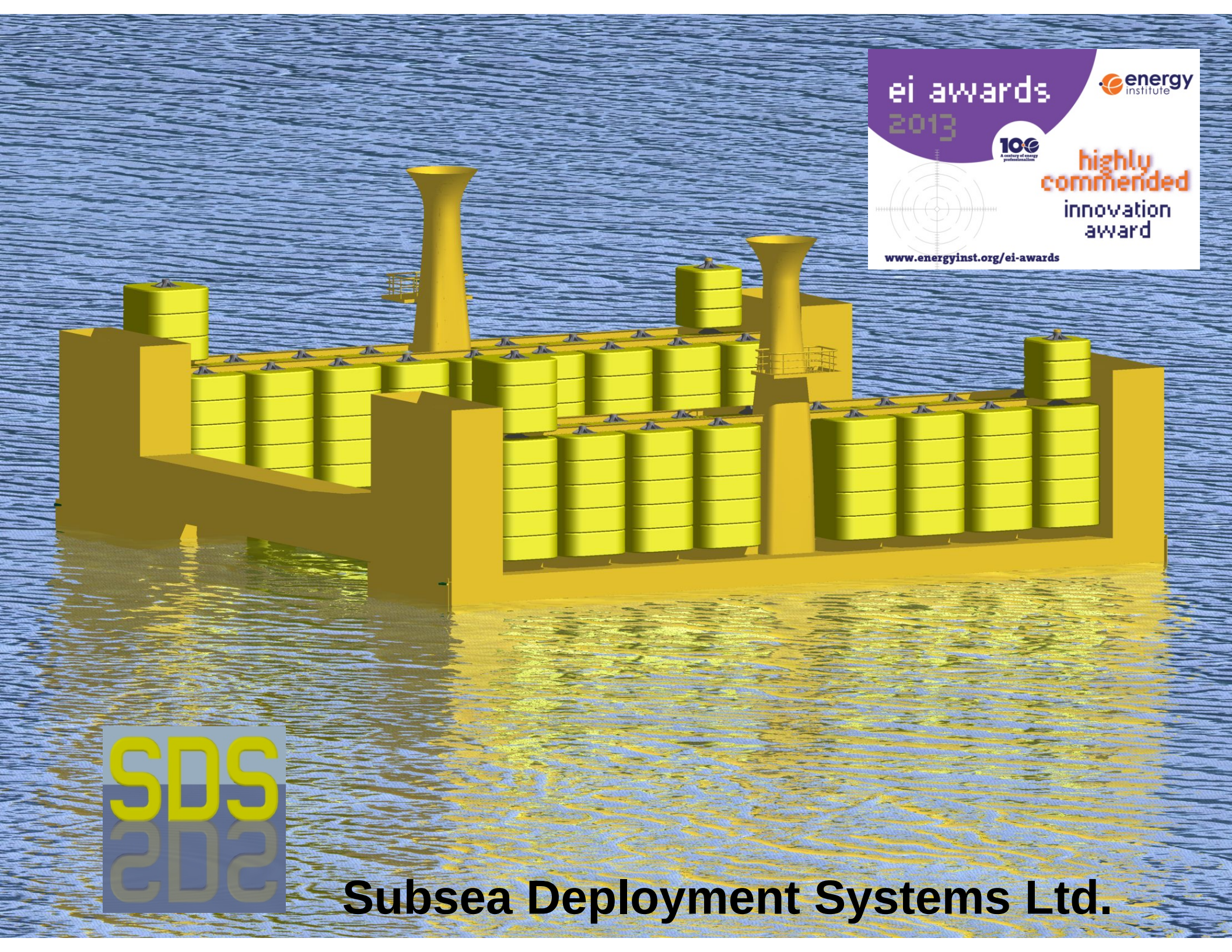


SUMMARY



SUMMARY

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