

# Solan Subsea Oil Storage Tank

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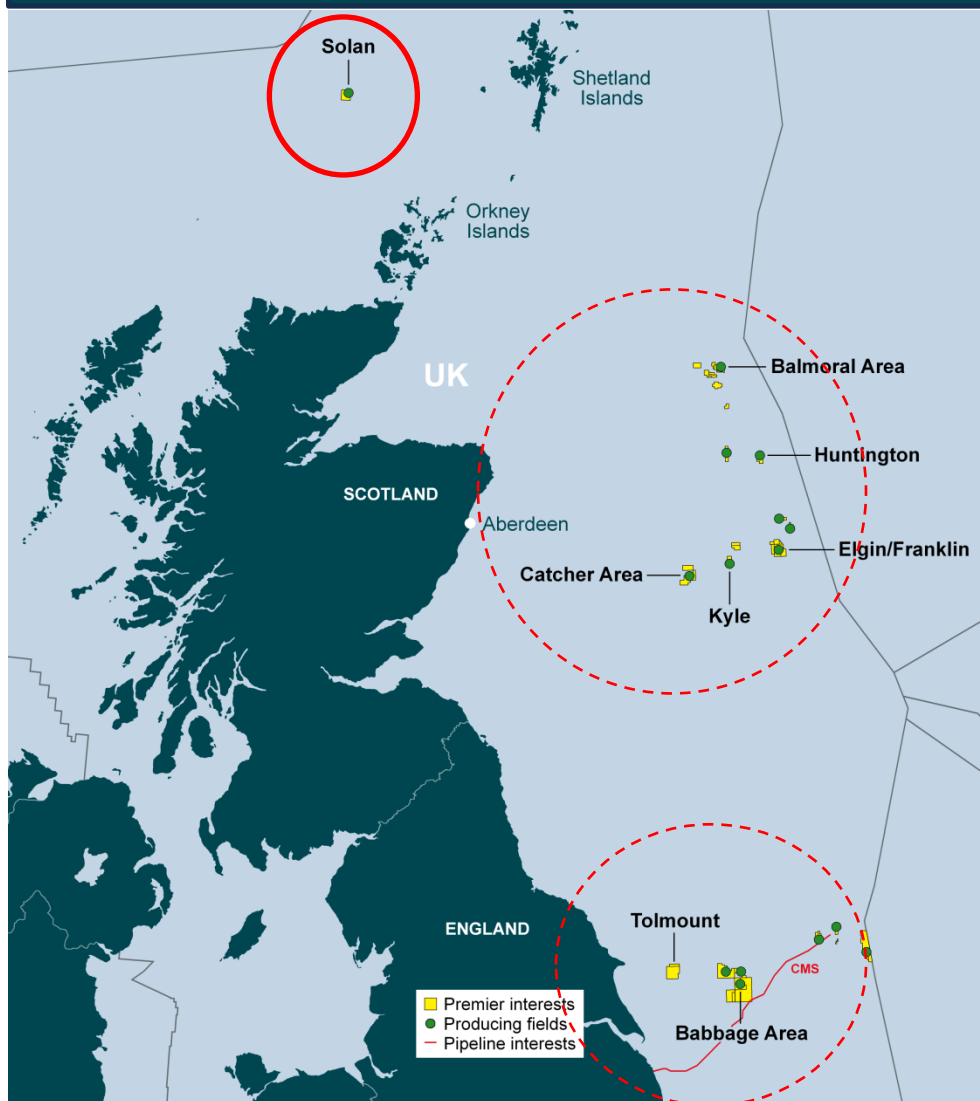


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# Field Introduction

## Premier UK Assets



### Project

Solan

### Operator

Premier (100%)

### Status

Producing

### Licence

P164

### Block

205/26

### Water Depth

132m

### 1<sup>st</sup> Oil

Apr 2016

### Reservoir

Jurassic Solan sandstones

### API

27°API

### Wells

2 producers and 2 WI

### Facilities

Jacket and Storage Tank

# Facilities Overview

## Platform (Jacket and Topsides)

- 7500 tonne conventional steel jacket in 138m of water
- Processing facilities, water injection system and power generation
- Produced water treatment for re-injection
- Designed as normally unmanned and operated remotely

## Wells

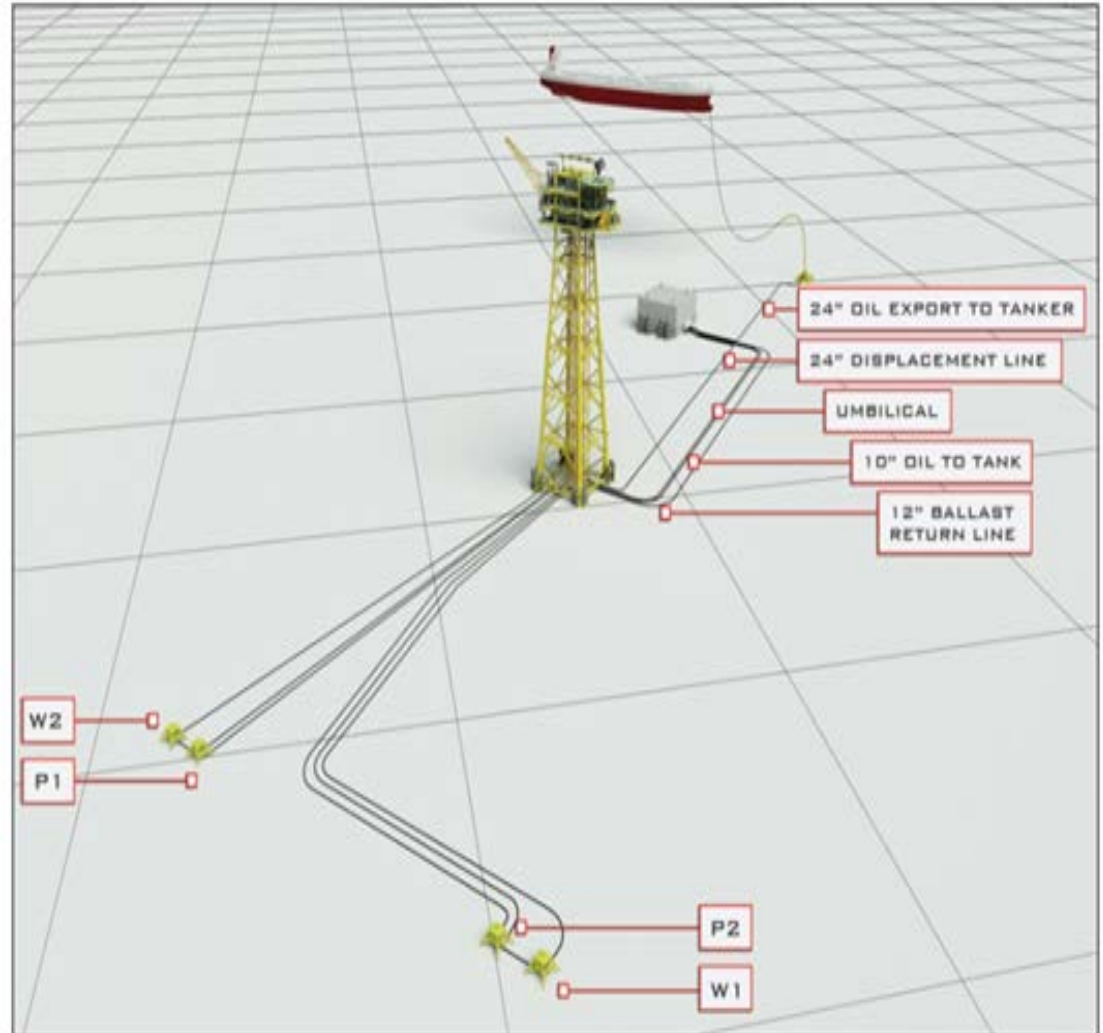
- 4 subsea wells
- (2 x producers, 2 water injectors)

## Storage Tank - SOST

- 300,000 storage tank
- Winter period - manage offloads to avoid shutdowns based on weather forecasts.

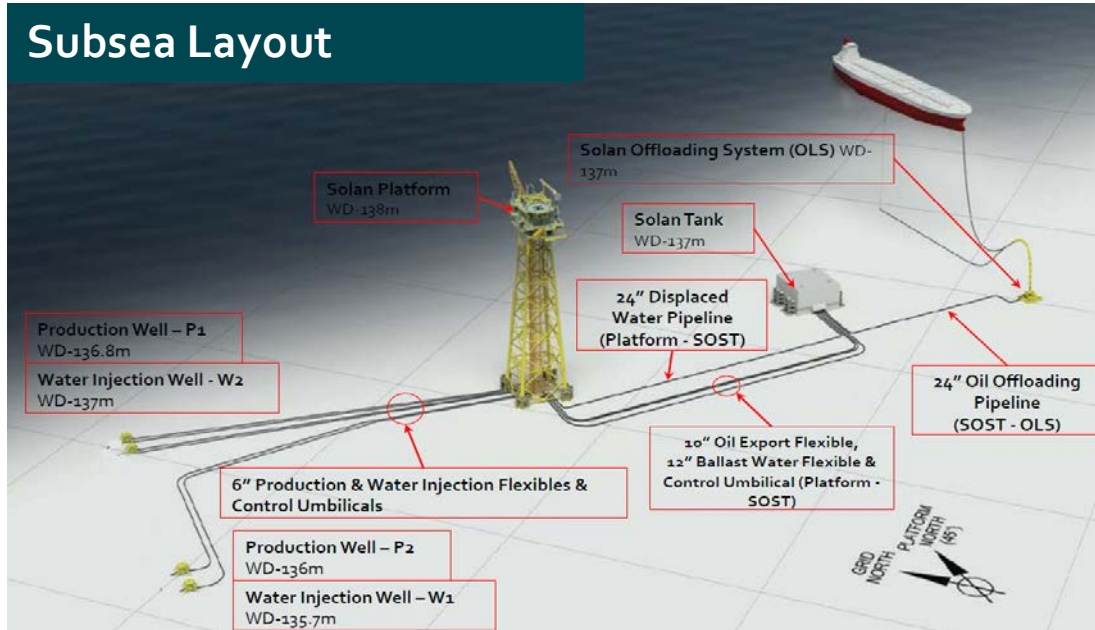
## Tanker loading system

- Shuttle tankers connect and transport oil
- Teekay, the tanker operator is well regarded and experienced with the system.



# Subsea Facilities

## Subsea Layout

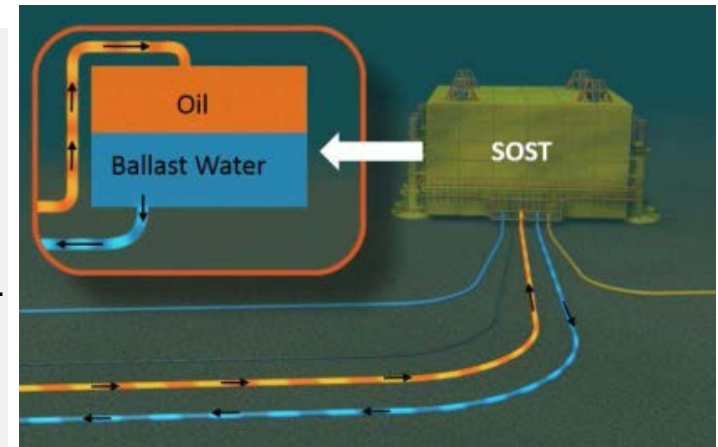


- 4 Horizontal wells
- Two drill centres located c. 300m from the platform.
- Producers completed with ESPs
- P1 single ESP ( failed )
- P2 dual ESP system online.
- Individual flexible tie backs to the platform

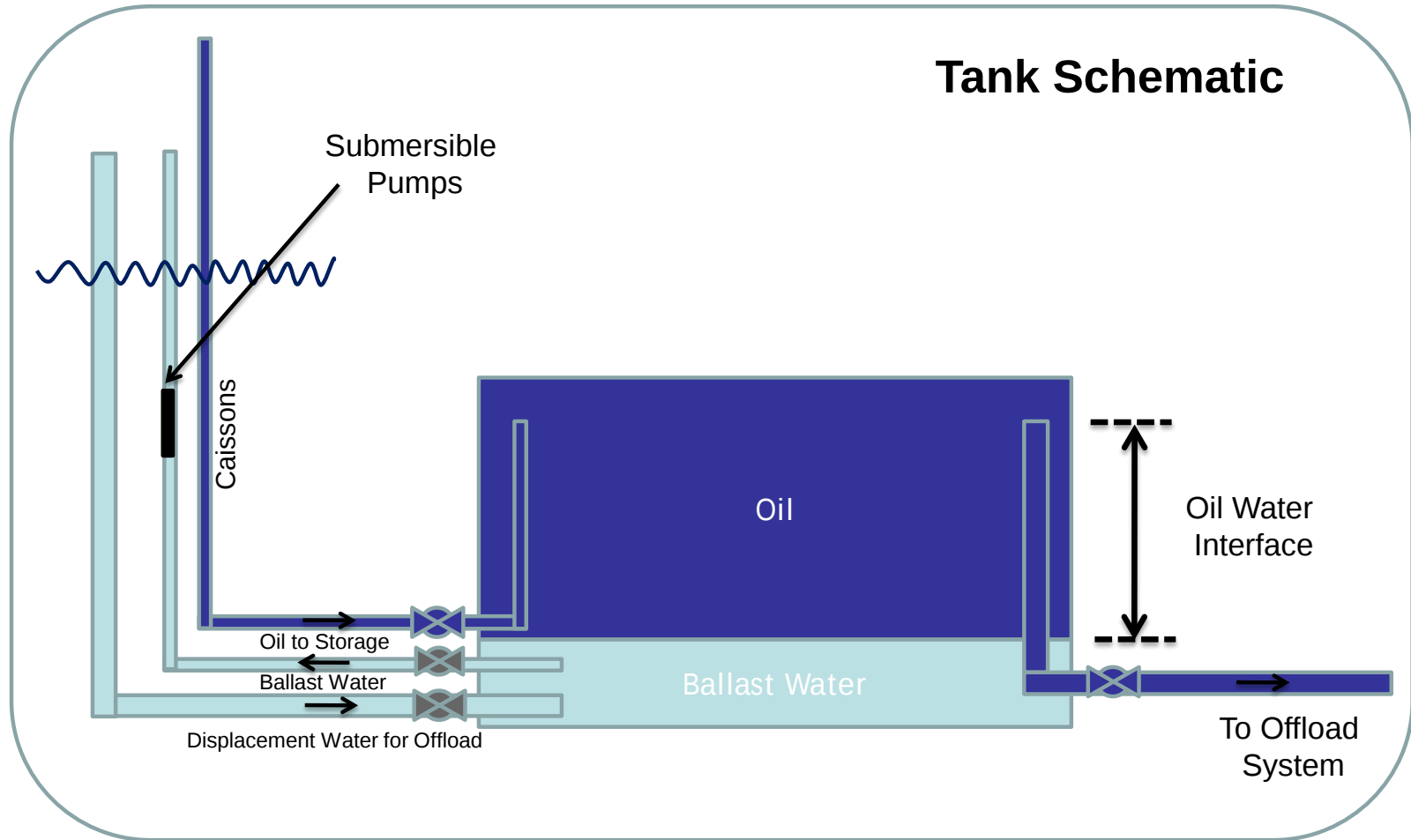
## Subsea Storage Tank



- The tank uses an 'oil over water' storage system. ( SOST )
- As oil is produced, it is introduced to the top of the tank thereby displacing seawater from the bottom of the tank as ballast water.
- The ballast water is routed to the process system and injected into the reservoir.



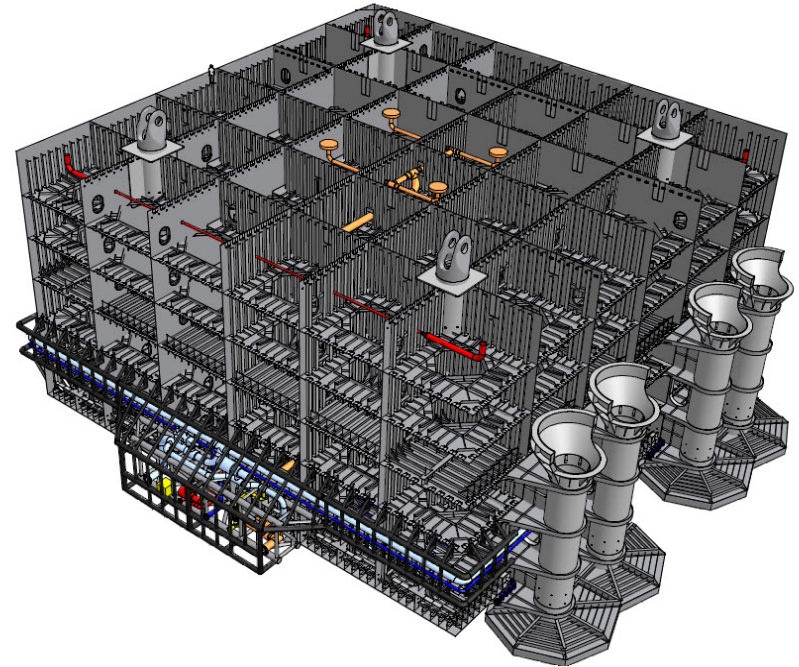
# So how does it work?



Its not a pumped solution...oil is displaced !!

# Subsea Oil Storage Tank (SOST)

- 10,100 te carbon steel box
- 45 x 45 x 25m Theoretical volume 314,538 bbls – useable volume ~275,000 bbls
- 8x 96" piles driven to 45m + mud mats; bottom sits ~1m above sea-bed
- External ESDV porch and line connections are low on tank
- Tank designed for a 30 year lifecycle
- 10" Oil / 12" ballast and 24" displacement pipeline
- Oil export to tanker via 24" pipeline



# SOST Construction

Early subsite cell fabrication



- SOST built in a major Dubai Dry dock
- Approx. 1500 personnel on site each day during peak construction
- Complex internal construction – approx 120km of welding



Later cell stack up in main fab yard



# Construction Completion



- Took 23 months from first steel cut to sailaway versus plan of 18 months – hot market, weld access and also change to weld spec was key impacts
- Actual man-hours to complete ~4,000,000 for total project and ~2.3 million construction man hours – all LTI free with controlled culture.

# Installation, Hook up and Commissioning

HLV arrival in Lerwick ➡

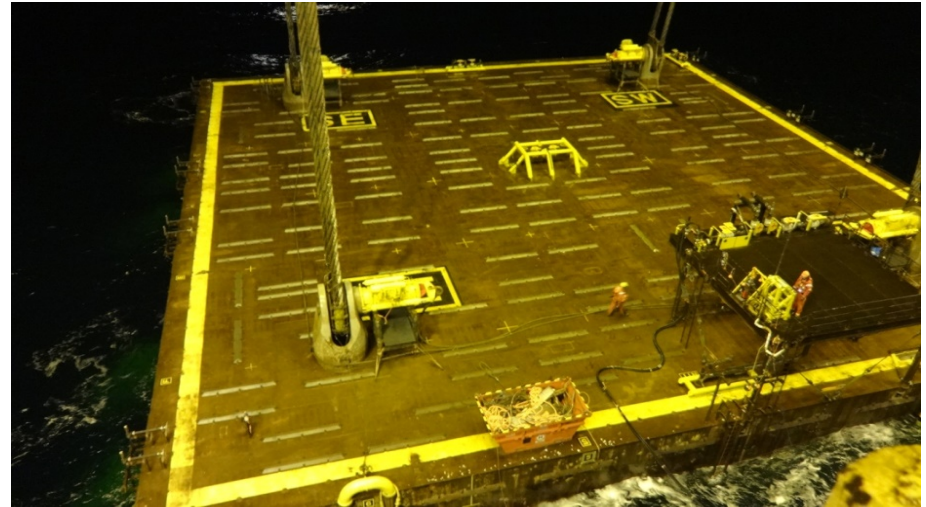
- 1 month journey via Suez on an HLV from Dubai to Lerwick
- 3 tug tow to field – main tug on bridle and two on sides.
- 80 nm from Lerwick to the field took approx 26 hours

Positioning of SOST to HLV with tug assist ➡



# Installation, Hook up and Commissioning

- Crew transferred from HLV to SOST via basket
- Tugs connected at all times
- 16 flooding valves – 4 x valves in each quadrant to displace air during install
- SOST pre dosed with oxy scav, biocide and leak detection dye
- Valves and vent platforms all removed once installation and piling complete
- All flowlines / pipeline connections completed by diver
- Leak tested by filling caisson t +28m LAT and inspected by ROV
- SOST dynamic commissioning by water to tanker prior to flowing hydrocarbons topside



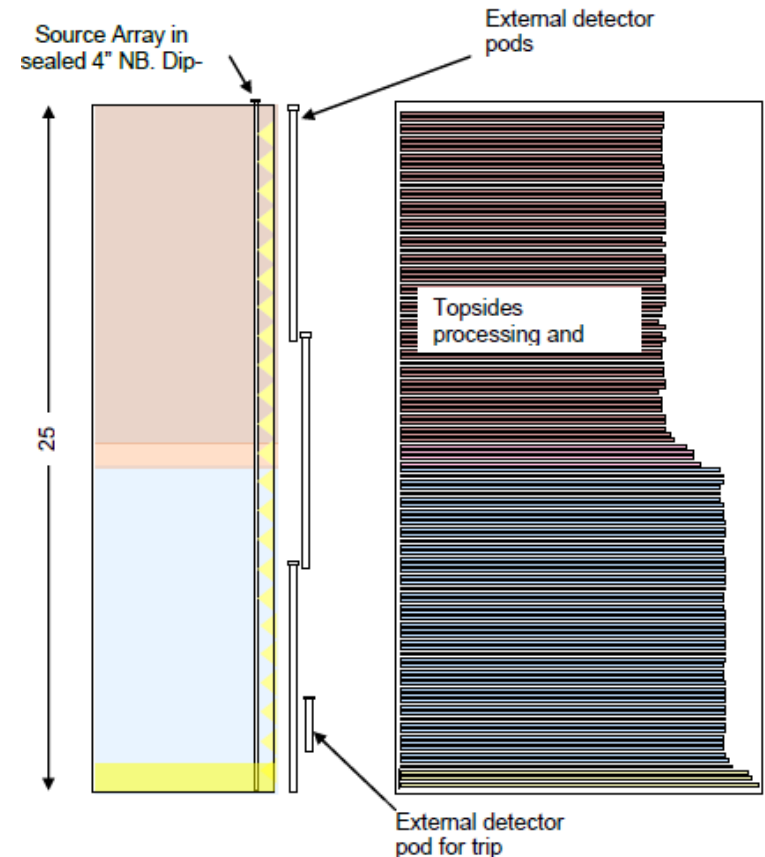
# Mechanical Design

- Cyclic loadings include
  - Sea-state
  - Oil-water level changes during offloading
- Steel is the economic choice with
  - Major external & internal cathodic protection
  - Lower internal 2m is coated
  - Internal pipework is CRA 25Cr
  - Biocide & corrosion inhibitor use
- Cathodic protection not unusual but...
  - No access to SOST internal....
  - 23,792 anodes inside....this number doubled during design.
  - 1421 external...again this doubled during design
- Fatigue...
  - Full 3D model created to assure lifecycle design and ongoing analysis through operations



# Process Design

- Ballast water returns to topsides - Treat to inject to reservoir or to sea
- Detailed pressure surge work mitigates resonance, hammer and fatigue risks
- Control & instrumentation;
  - External pod nucleonic level array
  - + Independent LL external level trip
  - ESD logic and hardware installed
- Emulsion “rag” layer can be offloaded
- Open water caissons as ultimate spill is crucial to the SOST if topsides issues - +28m or equivalent to 2.8bar
- Nucleonic resolution to 120-240mm resolution – can see rag layer
- SOST has its own dedicated umbilical
- ESD porch low on tank contains ESD and bypass valving/lines
- Ballast water line is open and only an ROV operable valve installed – it is the tanks pressure protection.



# Into Production Operations....

- 22 x ~250 kbbls cargo offloads since start up in 2016
- Field availability >96% ; zero SOST tank tops deferral or tanker waiting....
- No rag layer clearly observed to date
- Subsea inspection carried out on an annual basis
- Hydrogen sulphide management has required biocide/scavenger batching
- Assumptions from the design stage have been shown to be robust regarding offloading, weather dependency and times required.

# Oil Offloading....West Of Shetland via Shuttle Tanker



It's a millpond out there of course.....

# Oil Offloading....West Of Shetland via Shuttle Tanker



...Or maybe not.....Storm Gertrude...22M waves recorded January 2016

# Oil Offloading....West Of Shetland via Shuttle Tanker

- Hydraulic studies showed head delta drives 275,000 bbls oil via a 24" seabed flowline & 20" hose to the tanker bow in ~30 hrs.
- No platform/SOST host oil export metering
- Tanker connection uses standard SAL system with messenger line and HEV
- Offload operations & communications uses a "green line" system; tanker can trip the platform's SOST water displacement pumps
- Operating Limits West of Shetland 4.5 Hs for connection and 5.5m Hs Disconnection
- 22 x cargoes successfully offloaded to date
- Tanker operations around 36 hours from arrival – Departure for a 240k bbl parcel...
- Winter period 2015 / 2016 as an example....26 days of nothing below a sea state of 3m Hs



# Observations / Conclusions

- An ~300kbbbls stand-alone SOST project has been executed in the hostile WoS environment
- The concept can offer advantages to marginal fields especially
  - where tie-back ullage is unavailable
  - stand-alone FPSO/FSO schemes are high cost/unavailable
- A rigorous design approach will mitigate hazard & environmental risks
  - e.g. safe field layouts, a closed liquid system with caisson level control, detailed material selection, fatigue analysis, compartments etc..

# AOB

