

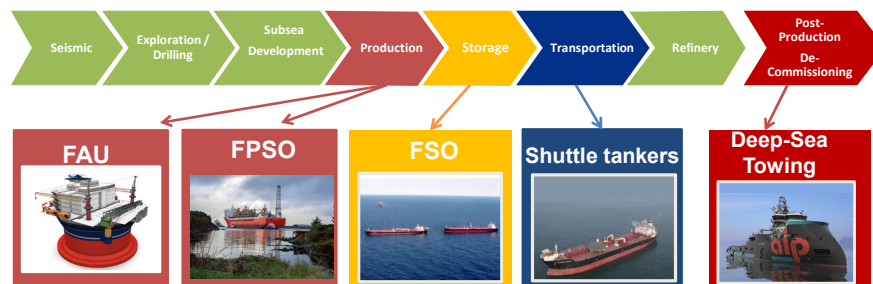
## Session 2.3 Offshore Loading

### FPSO Training Course 2016

Kjell Egil Helgøy  
Profession Lead DP EIA  
Teekay Offshore Logistics



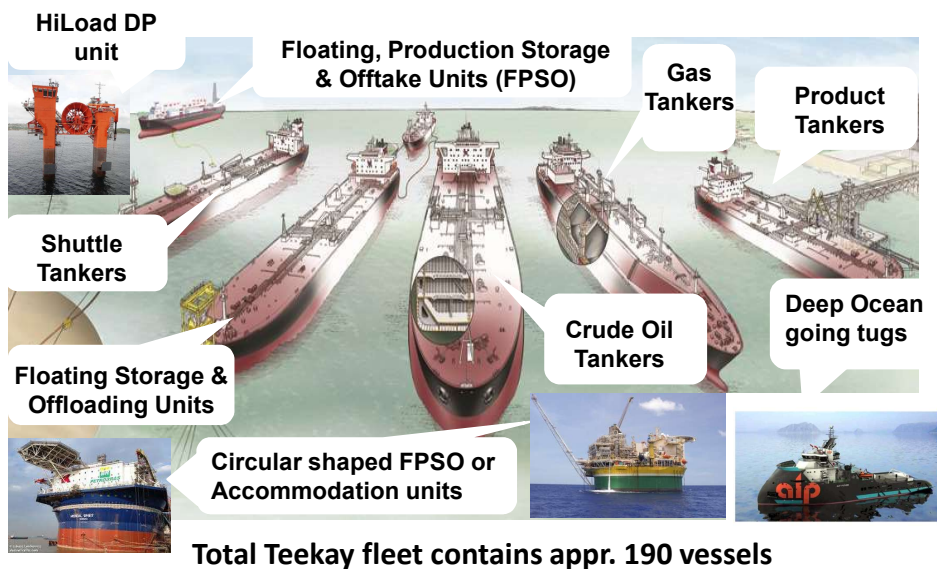
## Teekay – The Midstream Company



- ❑ Company founded in 1973 by the late Torben Karlshøj (TK)
- ❑ Transnational company with Head Office in Vancouver in addition to 24 Site Offices around the world.
- ❑ More than 6800 employees representing 35 nationalities
- ❑ Transporter of approximately 10% of the world's seaborne oil.



## Teekay's Fleet segment



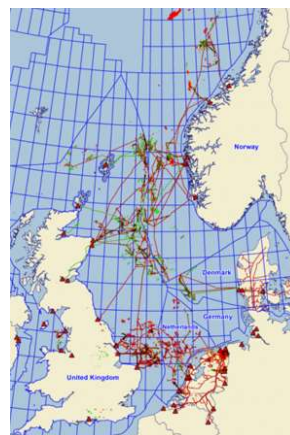
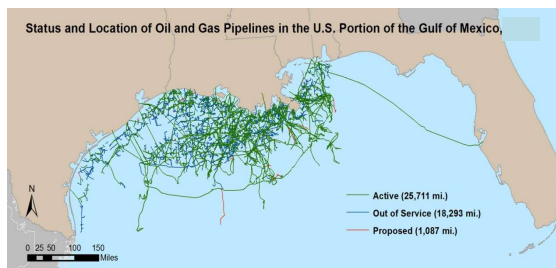
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## Crude Export Options

### ○ Pipelines

- More than 25,000 miles of active oil and gas pipelines are installed in Gulf of Mexico
- There is also an extensive network of oil and gas pipelines in and near the North Sea



## Crude Export Options cont'd

- **Non Dedicated Tankers**

*Conventional tankers, i.e. standard tankers with no purpose built equipment.*

- *Loading via standard midship manifold.*
- *Tug assisted positioning or pulling astern manually*



Conventional tanker connecting directly to calm buoy.

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FSO permanently connected to calm buoy



## Crude Export Options cont'd

- **Shuttle tankers**

- *Standard in the North Sea; East Cost of Canada and Brazil*



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## What is a Shuttle Tanker?

- “A **shuttle tanker** is a ship designed for oil transport directly from an off-shore [oil field](#) as an alternative to constructing [oil pipelines](#). It is equipped with off-loading equipment compatible with the oil field in question. This normally consists of a taut hawser arrangement or [dynamic positioning](#) to maintain the position relative to the field, an off-loading arrangement of pipes, and redundant safety systems to ensure that the potentially flammable crude oil is handled safely in a harsh environment.”

*Wikipedia*



## Dedicated DP Shuttle Tankers

- DP Shuttle Tankers are designed with variable pitch propellers and side thrusters, dynamic positioning systems and sophisticated loading systems for loading cargo at the offshore facilities.
- DP Shuttle Tankers are primarily used in regions with harsh environmental conditions requiring robust maneuvering capabilities and the ability to operate independently in all weather conditions. This requires specialized and highly trained crew.
- DP Shuttle Tankers significantly increase the efficiency and reliability of offshore loading
  - DP operated vessels can carry out safe loading operations in far more extreme weather conditions compared with manual positioning
  - Less risk of damage and wear and tear both to the field export system and the vessels' loading systems



## Statistics; Oil Spill – TK Shuttle Tankers

- >23.000 offshore loading operations have been carried out since 1979
- >16 000,000,000 (16 billion) barrels of oil have been safely shipped ashore

Legislative requirement introduced in 1997 to report any oil spill above 1 barrel

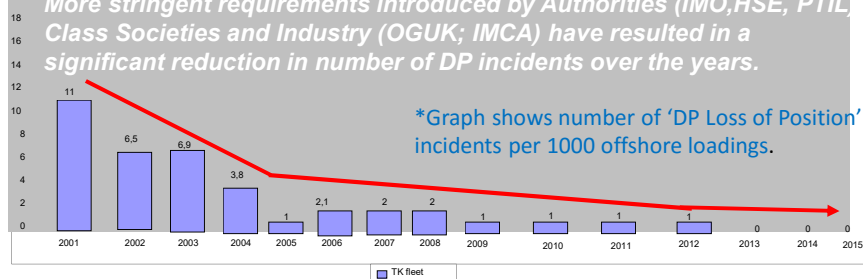
- 4 oil spills registered since requirement came into force.



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## Statistics; Loss of Dynamic Position

*More stringent requirements introduced by Authorities (IMO, HSE, PTIL, Class Societies and Industry (OGUK; IMCA) have resulted in a significant reduction in number of DP incidents over the years.*



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## First generation offshore loading tankers



'Polytraveller' 1st generation DP vessel



1st generation DP computer

- *Single hull tankers (modified conventional tankers)*
- *Single CPP main propeller*
- *Double bow thrusters*
- *Dedicated Bow Control House*
- *Single Computer DP*
- *Single Pos. Ref. System*

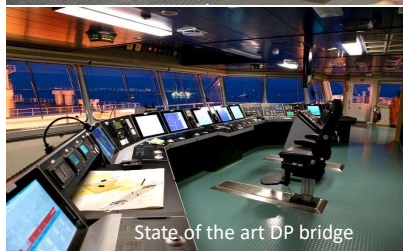
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## Latest generation DP tankers



'Amundsen Spirit' – DP2 Shuttle Tanker



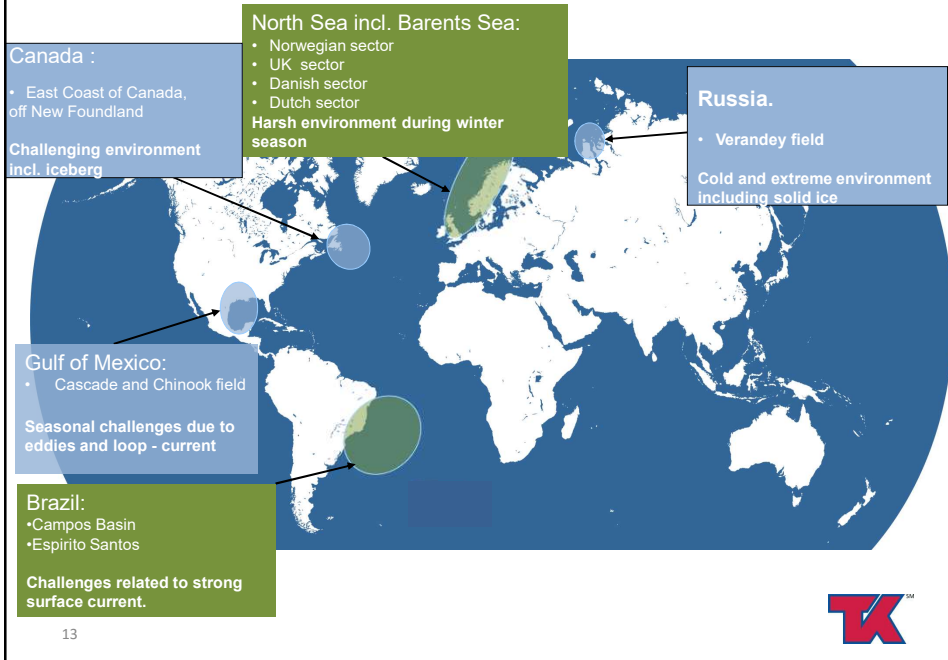
State of the art DP bridge

- *Double hull*
- *Twin engine; 2 CPP main propellers*
- *3 bow thrusters (1 tunnel + 2 retractable azimuth)*
- *2 aft thrusters (retractable azimuth)*
- *Built to IMO DP Class 2 notation*

- *Dual DP computer in network configuration*
- *Dual DGPS pos.ref. system*
- *Dual GPS relative pos.ref. system*
- *Dual HPR/HiPAP acoustic pos.ref.system*
- *Artemis microwave based pos.ref.system*
- *RADius/Radascan radar based pos.ref. system*
- *DP Independent Position Monitoring System*



## Main areas for use of Shuttle Tankers.



## North Sea oil fields served by Shuttle tankers

- **UK sector;**
  - Alba - FSO
  - Anasuria – FPSO
  - Banff - FSO
  - Captain - FPSO
  - Curlew - FPSO
  - Fife - FPSO
  - Gryphon - FPSO
  - Pierce - FPSO
  - Ross - FPSO
  - Schiehallion - FPSO
  - Triton – FPSO
  - Foinhaven – FPSO
  - Leadon – FPSO
  - Hummingbird FPSO
- **Norwegian sector;**
  - Norne - FPSO
  - Aasgaard A - FPSO
  - Aasgaard C - FPSO
  - Njord B – FPSO
  - Statfjord - OLS
  - Heidrun - STL
  - Draugen - FSL
  - Jotun – FPSO
  - Balder – FPSO
  - Glitne – FPSO
  - Varg – FPSO
  - Alvhelm – FPSO
  - Volve – FSO
  - Skarv FPSO
  - Knarr FPSO



## Extended Well Testing (EWT)

- DP Shuttle tankers are frequently used in connection with EWT projects.
- EWT projects require ability to stay on DP for longer periods of time.

### Examples:

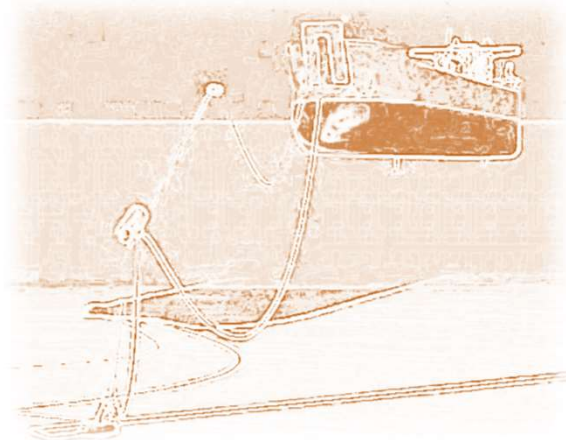
- Shell BS4 EWT (Brasil 2006); appr 30 days continuously on DP
- Diega EWT(West Africa 2013); appr. 100 days continuously on DP
- Malampaya EWT(Asia2002); appr. 180 days continuously on DP



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## Concepts for offloading offshore

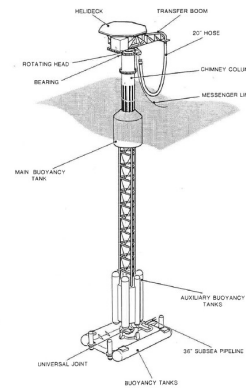
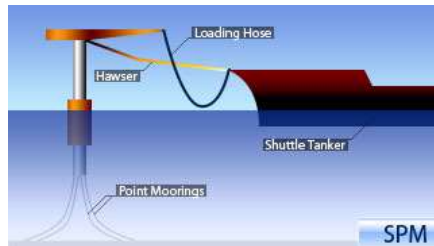


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## Single Point Mooring (SPM)

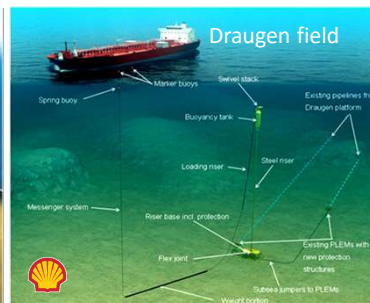


- Column could either be anchored (floating tower) or fixed/hinged to seabed frame.
- System allows for DP Operation as well as Taut- Hawser Operation (manual)
- The only field left in operation with SPMs is Beryl field, UK Sector

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## Subsea systems OLS and FLS

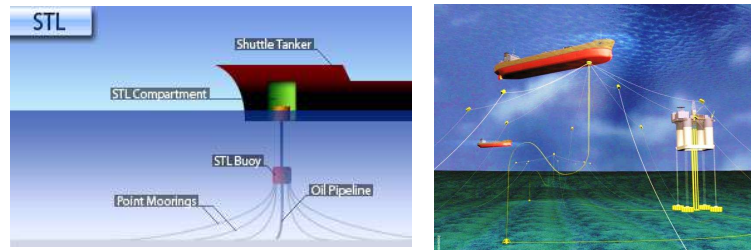


- Top of Riser located typically 60 meter below sea surface
- Loading hose parked on sea bed when in idle condition
- Confined to DP operation only
- Legislative requirement to utilize DP Class 2 vessels (Norwegian Continental Shelf)

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## Submerged Turret Loading (STL)

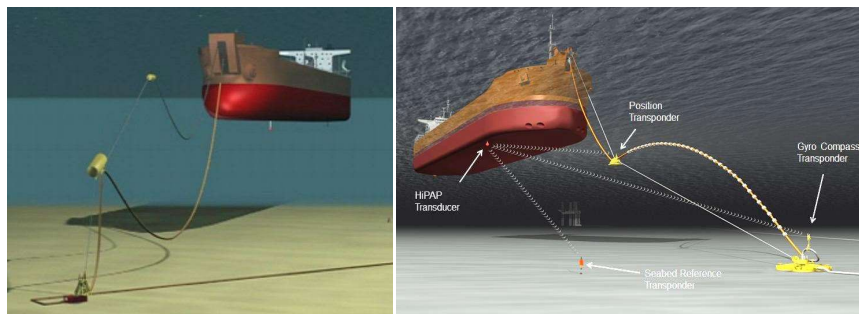


- STL buoy anchored by means of mooring lines.
- Requires special STL compartment to be built into Shuttle Tanker
- During hook-up of STL buoy the tanker is controlled by means of DP.
- Once moored DP and Propulsion machinery could be switched off.
- Allow loading in higher sea state than other systems

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## Single Anchor Loading (SAL)



- Designed for shallow water operation.
- Water depth limitations due to weight
- Various type of anchors can be used
- Confined to DP operation only

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## Tandem Loading from FPSO/FSO

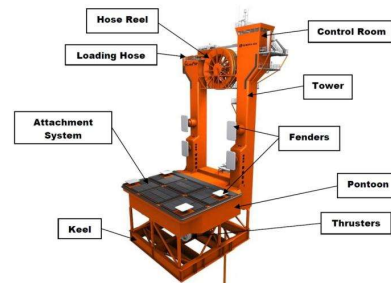
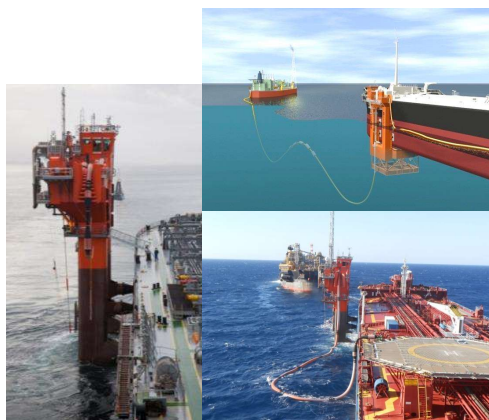


- **North Sea:** Standard mode of operation is based on DP operation.
- DP operation requires installation of positioning reference systems onboard FPSO/FSO
- **Brazil:** Use of DP is still in an early phase. DP mainly used for the approach mode only. Tugs are most often utilized to assist the shuttle tanker in position keeping when loading from fixed moored FPSO.

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## Hiload DP

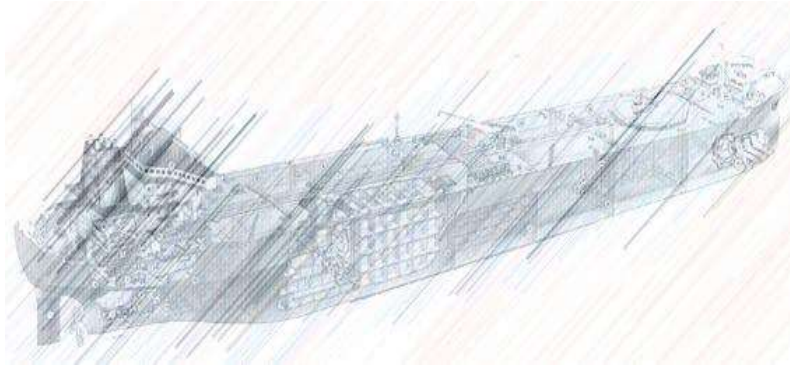


- Hiload unit itself is DP operated.
- Intended for use with conventional tankers up to Suezmax size.
- Mainly designed for benign waters.
- Trial program ongoing in Brazil

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## Some design issues:

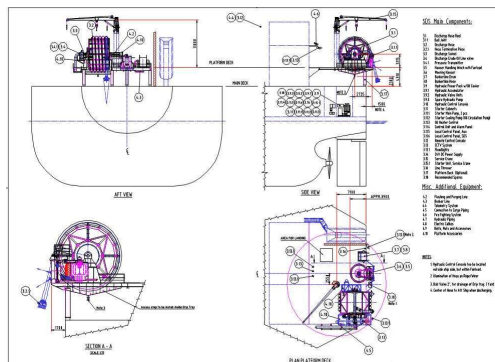


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## Design issues affecting FPSO/FSO

- It is important to reduce the inherent risks related to offloading to shuttle tanker at all stages, starting at the concept design or concept selection stage of a project.
- Shuttle Tanker operators possess thorough knowledge and experience which may be useful in any FPSO/FSO development project phase to ensure best practices are implemented.
- It is crucial important to establish the interface between FPSO and Shuttle tanker as early as possible in the project



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## Design issues FPSO/FSO – FPSO design

- A slender stern may reduce collision damage and reduce potential for collision (may allow the Shuttle Tanker to steer clear in a worst case drive off scenario)
- In order to keep risk as low as possible only equipment related to the offtake operation should be installed in the stern area as the area is exposed for potential collisions
- Flare stack on the FPSO should be placed away from the potential collision zone
  - Heat radiation exposure must be considered for both the FPSO and Shuttle Tanker
- Gas turbine exhaust at FPSO stern could cause problems for gas sensors and crew onboard the Shuttle Tanker

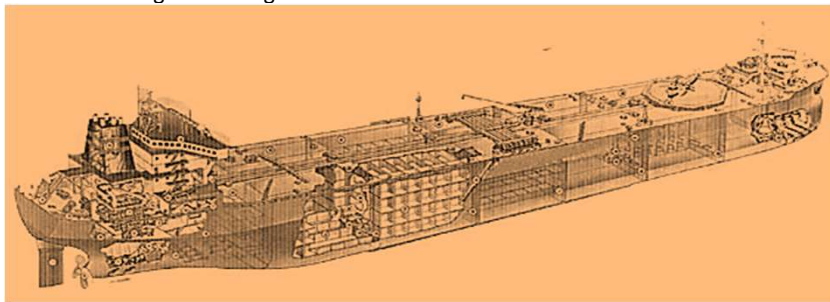


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## Storage Capacity

- Undersized storage capacity onboard the FPSO could lead to the need for multiple offtake operations; as a result thereof the Shuttle Tanker will have to wait at the field for the next cargo parcel to be produced.
- Typical Shuttle Tanker capacity is normally between 550.000 - 850.000 bbls
- FPSO storage capacity should ideally match the commercially agreed parcel size allowing for loading the shuttle tanker in one batch.



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## Design issues FPSO/FSO – Heading Control

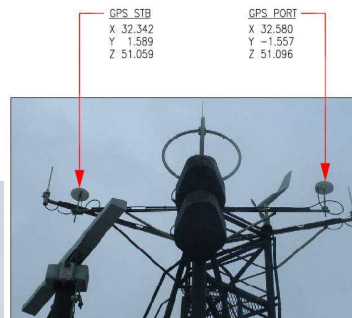
- ❑ The FPSO/FSOs are typically either DP controlled, active heading controlled or passive (free weather vaning)
- ❑ An FPSO/FSO with the ability to control both the heading and its surge movement, is an advantage for the joint offtake operation
- ❑ Adequate propulsion and maneuvering capabilities should be installed on the FPSOs to enable heading and surge control
  - Safer and more controlled operation
  - A DP controlled FPSO/FSO will control its own surge and sway movement resulting in a safer offtake operation.
  - Active heading control also has the side effect of providing the ability to damp out any roll motions during certain sea conditions
- ❑ Passive weather-vaning FPSOs
  - FPSO/ST heading misalignment problems can, to a certain level, be controlled by the Shuttle tanker applying tension in mooring hawser
  - The joint offtake operation is more vulnerable to wind, wave and/or current changes as it could be difficult to maintain heading within defined limits

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## FPSO/FSO design issues –DP and safety related systems

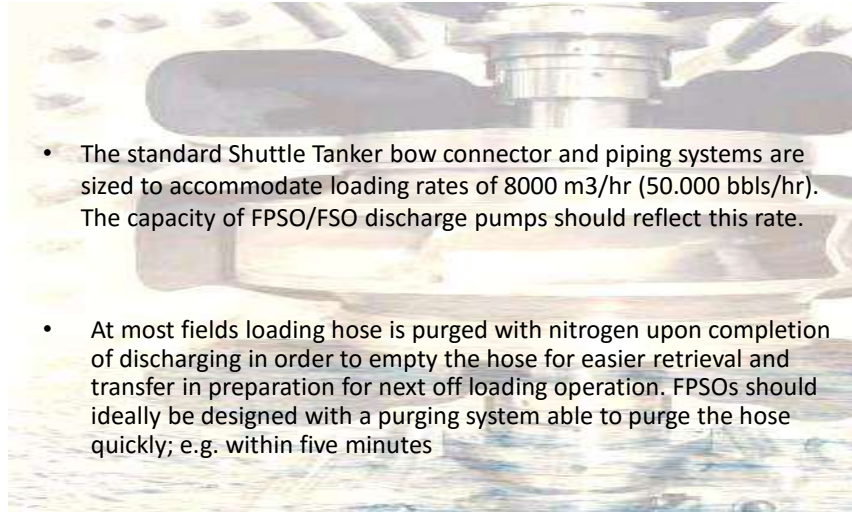
- The location of position reference units and antennas should be covered at the FPSO concept phase
  - Optimum location of the antennas to be selected
- The antenna positions should be surveyed to get accurate coordinates as they constitute a part of offset calculation in the DP model
- Gyros onboard the FPSO/FSO should be of high accuracy type, as heading will affect Shuttle Tanker positioning accuracy



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## Design issues FPSO/FSO – discharge and purging

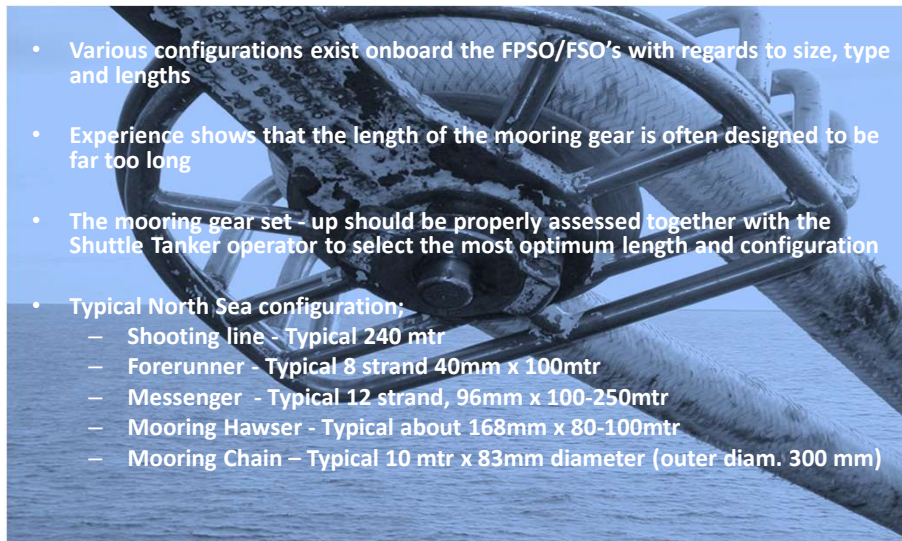


- The standard Shuttle Tanker bow connector and piping systems are sized to accommodate loading rates of 8000 m<sup>3</sup>/hr (50,000 bbls/hr). The capacity of FPSO/FSO discharge pumps should reflect this rate.
- At most fields loading hose is purged with nitrogen upon completion of discharging in order to empty the hose for easier retrieval and transfer in preparation for next off loading operation. FPSOs should ideally be designed with a purging system able to purge the hose quickly; e.g. within five minutes

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## Design issues FPSO/FSO – Mooring Gear

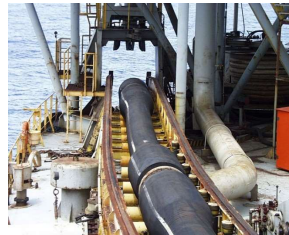


- Various configurations exist onboard the FPSO/FSO's with regards to size, type and lengths
- Experience shows that the length of the mooring gear is often designed to be far too long
- The mooring gear set - up should be properly assessed together with the Shuttle Tanker operator to select the most optimum length and configuration
- Typical North Sea configuration;
  - Shooting line - Typical 240 mtr
  - Forerunner - Typical 8 strand 40mm x 100mtr
  - Messenger - Typical 12 strand, 96mm x 100-250mtr
  - Mooring Hawser - Typical about 168mm x 80-100mtr
  - Mooring Chain – Typical 10 mtr x 83mm diameter (outer diam. 300 mm)

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## FPSO/FSO design issues – Hose arrangement

- The most typical hose arrangement is either cradle or storage reel
- Storage reel is preferred solution from a DP Shuttle Tanker operational point of view
  - Less wear and tear of the equipment
  - More controlled and safer operation
- If cradle is used the hose should be stored as close to the hawser point as possible and the friction between the cradle and hose to be kept as low as possible
  - The Shuttle Tanker has to reposition in line with the hose point before applying tension in the line. To pull a hose from a cradle typical requires > 25 tons pulling force.



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## Tanker trial program

Prior to any first time off take operation, or if a Shuttle Tanker is introduced to any new field, is it of utmost importance to perform a set of prequalification trials:

- Loading and mooring arrangements
- Safety systems (Telemetry, ESD I, ESD II)
- Procedures related to the loading operations
- DP and reference systems (Field specific DP software)
- Communication systems (VHF, UHF)
- Vessel's and crew's performance against quality and competence requirements
- Emergency Towing operation with PSV/SBV



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## Operational issues:



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## Environmental challenges vary from area to area

### North Sea:



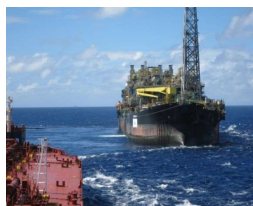
Wind and Waves



Fog



Sea Spray Icing



**Brazil:** Strong surface currents

**GoM:** Loop currents and eddies



**Russia (Varandey):** Frozen Sea



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## DP Shuttle Tanker Operating Envelope



- Connection up to 4.5 meter significant waveheight  
(Corresponding to approximately 30 knots fully developed wind)
- Loading up to 5.5 meter significant waveheight  
(Corresponding to approximately 38 knots sustained wind)
- Visibility > 500 meters



## Taut Hawser Operation

### Principle:

- Hawser kept tight by reversing shuttle tanker's main engine. Manual levers are used to control the vessel's thrusters and propulsion system
- Reduced "operational window" compared to DP operation
  - Connection up to 3.5 meter significant waveheight
  - Loading up to 4.5 meter significant waveheight





## Joint Field Specific Operational Manuals (JOM); Purpose and Scope

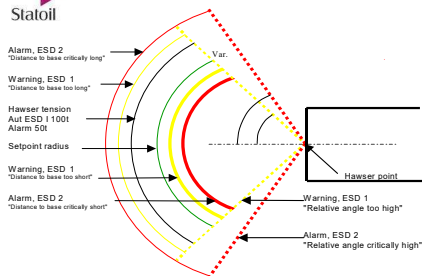
- The JOM shall contain information and procedures needed for a safe and efficient offtake operation at the specific field
- The purpose of the JOM is to ensure that all phases of the offtake operation are carried out in a safe manner with regards to personnel safety, oil spill prevention, protection of FPSO, Shuttle Tanker and other involved vessels.
- The JOM document is the property of the Field Operator but is normally jointly compiled between Field Operator and Transportation Operator.
- The JOM normally contains 'Step-By Step' procedure for shuttle tanker movements both during approach phase and departure phase

Step	Action	When	ST m/min	OS m/min
12	Clearance to approach from FPSO			
13	When clearance to approach has been given by FPSO, the Shuttle Tanker shall re-check equipment systems and prepare the vessel for the offtake operation. <ul style="list-style-type: none"> <li>Navigation instruments</li> <li>Position reference systems (as far as possible)</li> <li>Flow loading equipment</li> <li>Operator panel for bow loading operations and maneuvering</li> <li>Communication equipment</li> <li>Dynamic position equipment</li> <li>Machinery and systems in the engine room</li> <li>Any other system required for safe and efficient operation</li> </ul> Shuttle tanker to report any defects to OIM at the FPSO	~ 10 min		
14	Exchange latest information: Name of Vessel, latest weather data/forecast, tidal data, helicopter operations, any defects/restrictions Shuttle Tanker and/or FPSO, etc	10 min > 3 nm		
15	Proceed to 7 nm zone at appropriate speed at Shuttle Tanker Master's discretion	10 min > 3 nm		
16	Shuttle tanker to reduce vessel speed to 7 knots and notify FPSO when passing the 3 NMZ	3 min		
17	Shuttle tanker to notify FPSO when passing the 3000 meter zone and reduce vessel speed to maximum 3 knots	3000 m		
18	Shuttle tanker to go on DP-Joystick mode before vessel enters 2000 m zone	2000 m		
19	Shuttle tanker to select DUPS as position reference system	2000 m		
20	Stop the vessel and initiate the DP Testing. <ul style="list-style-type: none"> <li>Select the DUPS as the primary position reference system</li> <li>Select Auto position</li> <li>Stay for minimum 15 min to build up the mathematical model</li> <li>DP field arrival checks to be completed</li> <li>Notify OIM Ship</li> <li>Ensure BLOM system is active</li> </ul>	2000 m		

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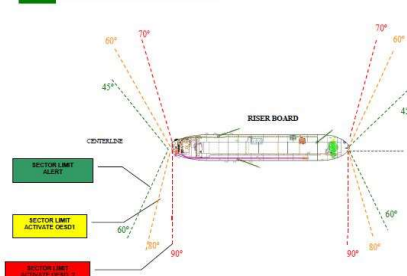
## Example of Operational Limits for Tandem Loading



Typical operational sector **turret** moored FPSO



PETROBRAS



Typical operational sector **spread** moored FPSO

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## FPSO/FSO - Maintenance

- Regular adequate service and maintenance including function testing of all systems affecting the joint offshore loading operation, must be established onboard the FPSO; this applies to e.g.
  - Gyros
  - Telemetry Cargo pump stop time
  - Positioning reference systems and antennas
- Quality control prior start of offloading operation
  - All loading and mooring equipment onboard the FPSO must be properly assessed and found to be in satisfactory condition prior start of loading operation
    - Loading hose, hose handling line and bridle
    - Forerunner, messenger, hawser etc.

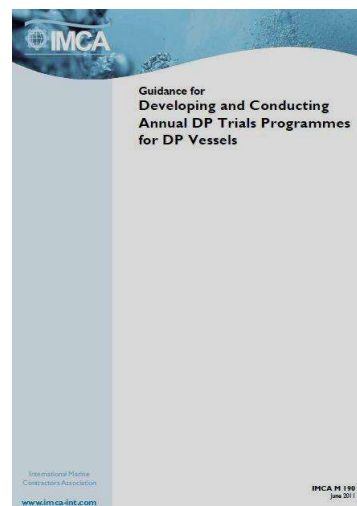


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## Legislative and industrial test requirements

- All shuttle tankers are subject to regular vetting inspections from the oil companies in order to maintain acceptance certificates.
- All shuttle tankers are required to perform FMEA trials (Failure Mode and Effect Analysis) witnessed by independent 3rd party prior to be accepted for operation.
- DP Annual trials have to be performed in accordance with Class requirements and Industry standards (IMCA)



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## Crew Competence and Training requirements

- All Officers and Crew have to comply with stringent Competence and Training requirements set by Class and Industry (e.g. IMO, OGU, NI)
- Prior to any Crew change a Competence matrix for onsigning Crew has to be presented. Matrix is subject to approval by Field Operator.
- Tailor made DP simulator programme (DP-CAP) have been installed onboard all shuttle tankers to improve and maintain DP skills.

OGUK Matrix 1:- Training of personnel oib DP shuttle Tanker \_\_\_\_\_  
Voy \_\_\_\_\_ Date \_\_\_\_\_

Senior DPO1 on watch with Junior DPO 1 / 2 (delete as appropriate)  
Senior DPO2 on watch with Junior DPO 1 / 2 (delete as appropriate)

Please turn form sideways and print name below rank in this row.	Master	Senior DPO1	Senior DPO2	Junior DPO1	Junior DPO2	Chief Engineer	1st Engineer	Electrician
DP Basic <sup>1</sup> (Induction)	Y	Y	Y	Y	Y	N	N	N
DP Advanced <sup>1</sup> (Simulator)	Y	Y	Y	Y	N	N	N	N
Maritime Crew Resource Management	Y	Y	Y	Y	N	N	N	N
Offshore Loading Phase 1 (Basic) <sup>2</sup>	Y	Y	Y	Y	N	N	N	N
Offshore Loading Phase 2 (Advanced) <sup>2</sup>	Y	Y	Y	N	N	N	N	N
Offshore Loading Phase 3 (Refresher) <sup>2</sup>	Y	Y	Y	N	N	N	N	N
Date of Last DP Training or Refresher Course	<2Y	<2Y	<2Y	<2Y	<2Y	N	N	N
Restricted IMD / Nautical Institute DP Certificate	Y	Y	Y	N	N	N	N	N
Date of Last Facility Specific DP Training course. Please specify type in blank row (other than PISO or SAL)	PISO	<2Y	<2Y	<2Y	<2Y	N	N	N
	SAL	<2Y	<2Y	<2Y	<2Y	N	N	N
	specify other					N	N	N
	Acemits	Y	Y	Y	N	N	N	N
	DGPS	Y	Y	Y	N	N	N	N
Position Reference Operating courses	DAFPS	Y	Y	Y	N	N	N	N
	BRS	Y	Y	Y	N	N	N	N
	BLOM	Y	Y	Y	N	N	N	N
	RADUS	Y	Y	Y	N	N	N	N
	specify other					N	N	N
Position Reference Maintenance courses	DP	N	N	N	N	N		
	Telemetry	N	N	N	N	N		
	Acemits	N	N	N	N	N		
	DGPS	N	N	N	N	N		
	DAFPS	N	N	N	N	N		
1 PERSON ONBOARD TANKER TRAINED FOR EACH INSTALLED SYSTEM								
Maintenance courses	BRS	N	N	N	N	N		
	HPAP	N	N	N	N	N		
	BLOM	N	N	N	N	N		
specify other								

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## Safety Barriers:



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## Safety Barriers

Several Safety Barriers are implemented to ensure safe and efficient transfer of the crude oil from the FPSO to the Shuttle Tanker with the paramount objective of

- Zero harm to people and property
- Zero oil spill and minimize the impact of the operations to the environment
- Ensure reliable performance

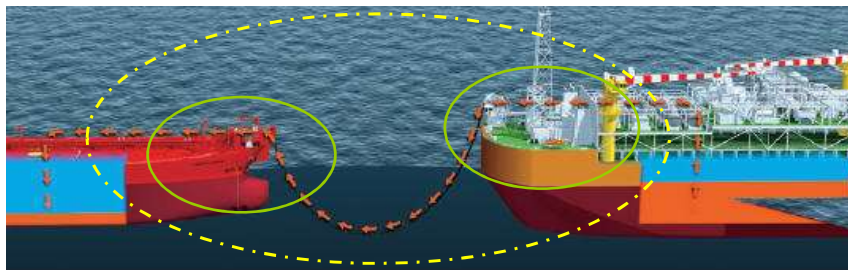


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## Oil transfer – Tandem operation

- The oil transfer from an FPSO/FSO to a Shuttle Tanker includes two main systems;
  - Stern Discharge System (FPSO/FSO)
  - Bow Loading System (Shuttle Tanker)
- This involves individual operational and safety systems as well as a joint safety system, ensuring a joint safe and efficient offtake operation

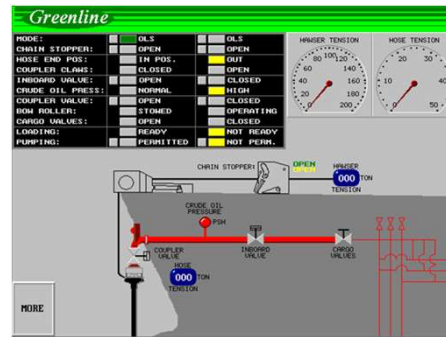


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## System Barrier; "Green Line" system (BLS/STL)

- "Green Line" is a systematic means of interlocking the mooring and loading system on board the Shuttle Tanker and FPSO via a telemetry link
- Loss of any of the "Green Line" indications will automatically break the valid "Green Line" and consequently the telemetry link between the units resulting in;
  - Shutdown of the Installation's cargo export pumps and/or closure of the ESD valve
  - Closure of the Shuttle Tanker's Inboard and Coupler valve



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## Additional Safety Barriers onboard Shuttle Tanker

### Automatically activated Safety Barriers

- An automatic shutdown of the cargo transfer will typically be triggered if;
  - A signal in the 'green line' is lost
  - Loading pressure exceeds 7 bars
  - Hawser tension exceeds limit e.g. 100 t

### Manually activated Safety Barriers

- ESD I (Emergency Shutdown Class I)
- ESD II (Emergency Shutdown Class II)
- Telemetry Stop button



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## Dynamic Positioning (DP):



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## Forces and motions

The Dynamic Positioning control system calculates the forces that the thrusters must produce in order to control the vessel's motion in three degrees of freedom - surge, sway and yaw

### ❖ Three degrees of freedom

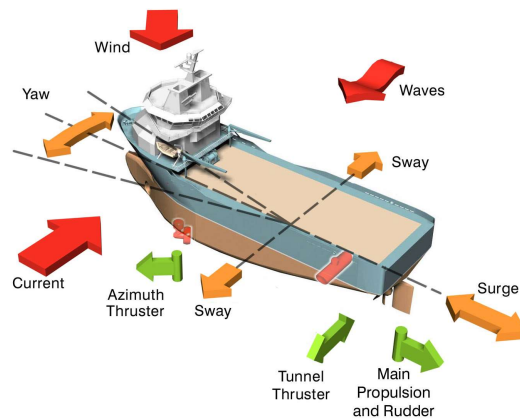
- ✓ Surge
- ✓ Sway
- ✓ Yaw

### ❖ Environmental Forces

- ✓ Wind
- ✓ Waves
- ✓ Current

### ❖ Thruster Forces

- ✓ Tunnel thrusters
- ✓ Azimuth Thrusters
- ✓ Propulsion/ Rudders

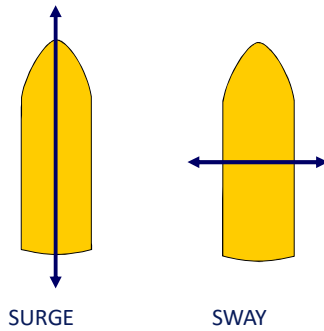


**NOTE:** A DP system is only capable of controlling the surge, sway and yaw movements of a vessel

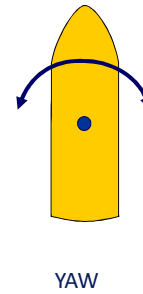


## Measurements – Position and Heading

Measured by means of  
Position Reference Systems:



Measured by means  
of Gyro compass:



## Position Reference Systems and Sensors

### Position Reference Systems:

- Satellite Systems (e.g. DGPS; GPS Rel)
- Laser based Systems (e.g. Cyscan, Spottrack, Fanbeam)
- Microwave Systems (Artemis)
- Acoustic Systems (HPR / HIPAP)
- Taut Wire

### Motion Reference Sensor(s):

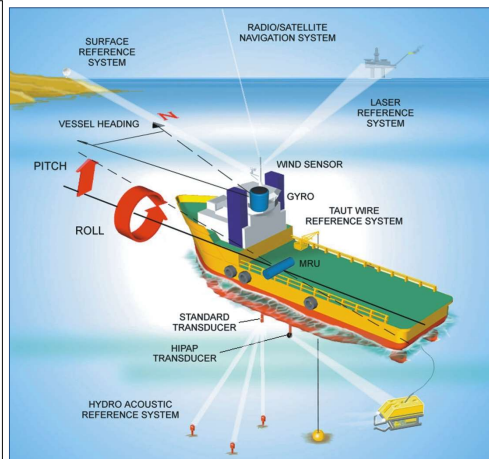
- Roll ; Pitch and Heave

### Wind sensor(s):

- Wind Speed & Direction

### Gyro Compass(s):

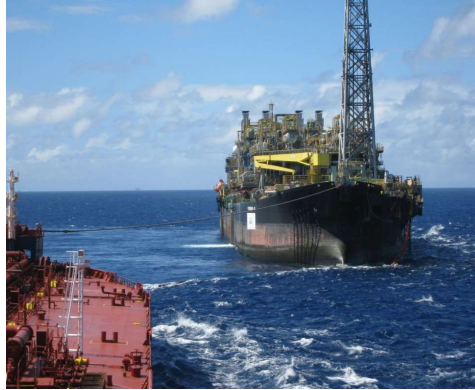
- Vessel Heading



Input to the  
Dynamic Positioning System



## 24 - hours DP Operation; Challenges



Major challenges:

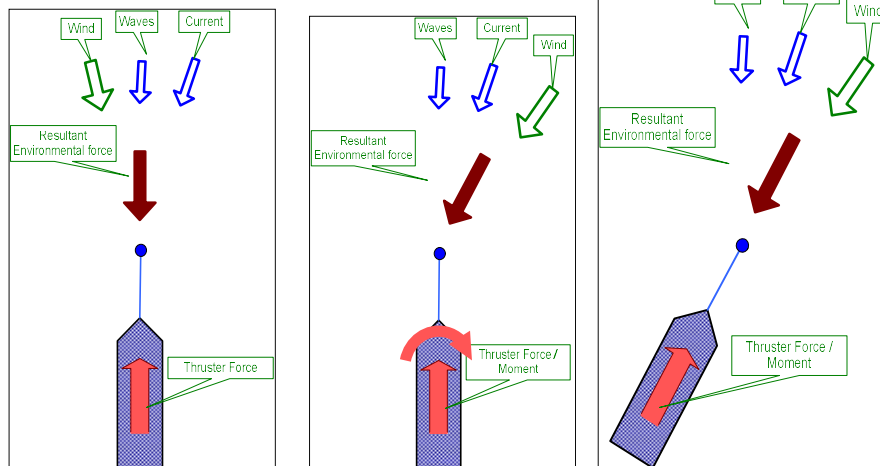
- Strong surface currents (particularly off Brazil and GoM)
- Diverging direction of wind and current
- Accessibility and quality of Positioning Reference System
- Rapid tide changes

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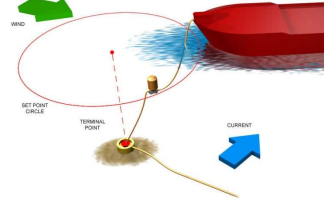
## Weathervane principle

Standard operation mode for Shuttle Tankers when in DP is 'Weather Vane' mode.

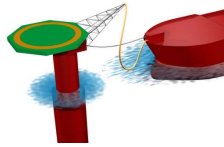


## Offshore Loading - Basic Weather Vaning

**Weather Vaning** modes of operation reduces thruster force by utilizing the natural stabilizing effect of the environment



Basic Weather vaning are used with following offloading loading concepts:



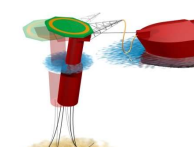
Single-point mooring  
SPM



Loading boy  
OLS



Single anchor loading  
SAL



Floating loading tower  
FLT/FLP



## Offshore Loading - Special Weather Vaning

### Challenges related to use of basic weather vaning when loading from FPSO/FSO:

- **FPSO stern treated as fixed point in DP**
  - ÷ All FPSO movements treated as own movements
  - ÷ Extensive use of thrusters to compensate for FPSO movements
  - ÷ Heading differences between units not handled
- ÷ **Escalating problem when loading from FPSOs with no control of position or heading**



#### Tandem Loading

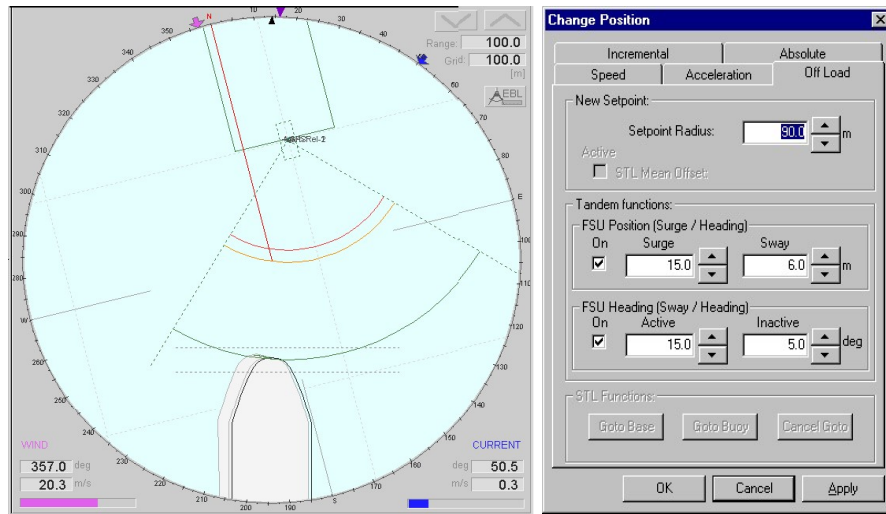
Reference point changes with FPSO/FSO movements  
Both relative- and absolute position deviations are measured

#### Special Tandem Loading functions:

- Tandem Position Control (surging, fishtailing)
- Tandem Heading Control (follow FPSO/FPSO heading)



## User Interface; improved Tandem Loading DP Model



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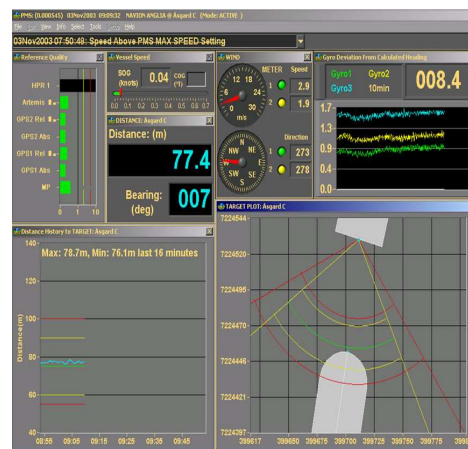


## Positioning Monitoring system / “Black box”

- All Teekay shuttle tankers are equipped with an independent position monitoring monitoring system

- The system monitors and stores input from all sensors fed into DP in addition to calculate **DP independent** alarms:

- High Position Variance
- Speed above DP max speed settings
- All Reference Systems lost
- Gyro not Available. Positioning unreliable
- Crossing Safe Sector Warning Boundaries
- Crossing Safe Sector Alarm Boundaries
- Alarms from “Rolling Mean Position”



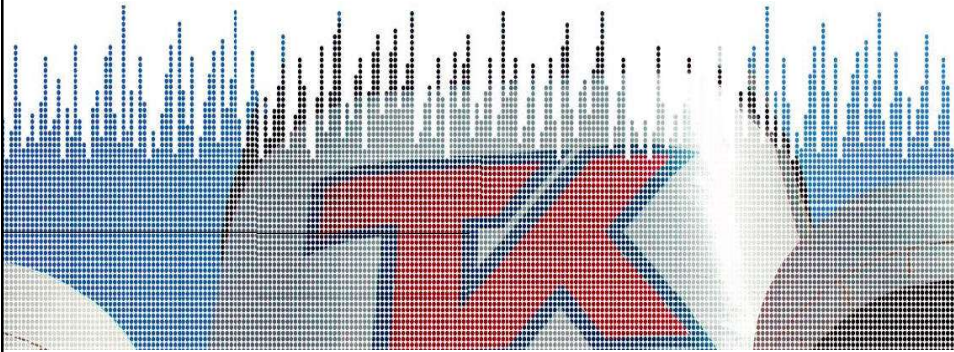
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## Teekay – The Marine Midstream Company ®

Thank you for your attention! 😊



*We welcome your feedback, formal or informal.*