NOV Floating Production Solutions offers a unique value to the market and a strong center of drive and innovation, directed at all operators in the Floating Production and SURF markets. NOV Floating Production Solutions is your independent advisory partner and provider of integrated, tailor-made solutions, based on unique combination of existing and customary designs, which are often ground breaking.

By mastering the design and fabrication, NOV obtains smart and robust solutions. Solutions that will drive cost reduction and increase your profit in a long term perspective.

Our capabilities extend beyond the design and supply of project resources, equipment, and systems. But also leverage planning, purchasing, and project management services along with numerous manufacturing and fabrication facilities to provide the customer with turnkey solutions that will improve your overall revenue and profits.

The goal is simple: Create the best and most innovative solutions combined with life-cycle commitment. The reward therein lies in sharing your success.

Advanced Production and Loading (APL) was established with the objective of developing and exploiting the Submerged Turret Loading (STL™) and Submerged Turret Production (STP™) mooring system. These technologies are still an essential part of APL’s product offerings, yet have been extended to moor customer units in any situation.

We have also acquired a solid naval architecture expertise. APL are thus able to best manage typhoons in the South China Sea or offshore Australia and to protect the unit.

The APL technology is now serving specially built LNG Carriers with on-board regasification to transfer gas directly into the pipeline and on to the consumers thanks to the APL Buoy.

National Oilwell Varco (NOV) acquired APL in December 2010 and allowed APL technology to benefit from an even larger pool of expertise and know how.

World’s first Offshore LNG Receiving Terminal based on STL, Gulf Gateway – 110 miles offshore Louisiana

“YUM K’AK’ NÁAB”, the first FPSO in the Gulf of Mexico. Moored on the APL STP System.

STL moored FPSO “Nordic Apollo” off-loading crude oil at the Banff field, UK sector North Sea.

Building on 20 years’ experience in the Floating Production Business, APL technology is ready to face new challenges. Since its foundation in 1993, Advanced Production and Loading (APL™) has become one of the world’s leading mooring providers for offshore oil and gas production and transfer.
STL Basics
• A buoy moored to the seabed is pulled into and secured in a mating cone into the vessel.
• The buoy incorporates a turret connected to the mooring and the riser(s).
• All STLs are based on standardized mating cone geometry in the vessel.

Permanent or Disconnect Mooring
• The STL system can be designed for disconnect service (OLT or Shuttles) or for permanent mooring throughout the field life (FSO).
• Disconnection takes only a couple of minutes and can be performed in any weather condition.
• The buoy drops clear of the vessel, and floats in an equilibrium position approximately 30-50 meters below sea level.

Advantages
• The STL system allows for schedule decoupling between the offshore and the shipyard work. STL, mooring and riser can be completed independently from the OLT or FSO. The STL system is installed on site prior to the FSO or OLT arrival at the field. Upon arrival, the vessel hooks up onto the STL on its own.
• Unplanned repair, upgrading, inspections and replacement of the FSO, as well as abandonment of the field, is simplified by the disconnect feature of the buoy based STL system.
• Connection in sea states between 5 and 7 m Hs (Significant Wave Height). Weather independent offshore loading.
• Disconnect regardless of weather conditions.
• High level of safety.

STL Integration
• With bearing structures integrated in the STL buoy, as opposed to bearings integrated directly in the hull, the turret integration in vessel is simplified. Vessel modifications are limited to standard steelwork.
• The STL compartment is a cylinder extending from bottom to upper deck with the receiving cone as the lower part. With a diameter of 10 to 12 meters, the impact on the hull is minimal.

STL System References
STL systems in service cover a wide range of application from the harsh North Sea environment to cyclone prone areas such as China or Australia, mooring caters for seas as high as 19 m Hs (Significant Wave Height), water depth up to 2500 m, vessel sizes up to ULCCs, throughput up to 600,000 BOPD etc.

STL for High Pressure LNG Re-Gas
• The STL is widely used to moor LNG carriers either FSRUs or Regas Vessels (RV).

STL in ice
• Icebergs and ice ridges in arctic environments are better addressed with the quick disconnect features provided by the STL system.
• STL systems are verified in ice environments.
• Model tests have documented survival of a vessel moored in 1.6 m level ice with drift speed of 0.75 m/s.
The Submerged Turret Production (STP) is a unique, innovative and flexible turret mooring system for Floating Production, Storage and Offloading vessels (FPSO) making it suitable for a wide range of applications. As a further development of the STL system, STP is combined with a high pressure multi-path swivel to create a complete turret and swivel package.

Advantages
- As for STL, the STP system allows for schedule decoupling between the offshore and the shipyard work.
- As for STL, yet far more importantly for an FPSO Process Plant, unplanned repair, upgrading, inspections and replacement is dramatically simplified by the disconnect feature of the buoy based STP system.

STP Integration
- The STP compartment in the FPSO is a cylinder extending from bottom to upper deck with the receiving cone as the lower part.
- With a diameter of 10 to 18 meters, the impact on the hull is minimal.
- Only local reinforcements of standard steelwork are required.
- With bearing structures integrated in the STP buoy as opposed to bearings integrated with FPSO hull, the turret integration in the FPSO hull is simplified.

STP System References
STP systems in service cover a wide range of application from harsh North Sea environment to cyclone prone areas such as China or Australia, mooring caters for sea as high as 16 m Hs (Significant Wave Height), water depth up to 2600 m, vessel sizes up to VLCCs, through-put up to 600,000 BOPD etc.

STP in ice
- Icebergs and ice ridges in arctic environments are better addressed with the quick disconnect features provided by the STP system.
- STP systems are verified in ice environments.
- Model tests have documented survival of a vessel moored in 1.6 m level ice with drift speed of 0.75 m/s.

STP™ Basics
- STP for FPSO mooring is developed from the basis of the proven STL system.
- The STP swivel mounted on top of the turret buoy transfers oil, water, gas, signals and power from the geo-stationary riser system to the piping and cabling system of the freely weather varying production vessel.

Permanent or Disconnect Mooring
- As for STL, the STP system can be designed for disconnect service or for permanent mooring throughout the field life.
**SIT**

The Ship Integrated Turret (SIT) is an innovative and flexible turret mooring system for Floating Production, Storage and Offloading vessels (FPSO). Modular design allows for upgrades or modifications to suit different field requirements. Developed from a unique modularized design, these units are available in various sizes and with varying riser capacities to suit the client’s requirements.

The units are comprised of a number of standard components and feature a combination of roller and journal type bearings, thus providing adequate load capacity for use in all areas and water depths. The units are available with multiple decks on the turret shaft thereby allowing for manifolding, pigging equipment, subsea control and chemical injection equipment and safe riser handling.

Winches are provided for riser handling and chain tensioning which can be performed from the turret shaft assembly. Interfaces with the vessel are well defined and the units can be integrated into all vessel types.

The SIT moored FPSO Polvo offshore Brasil.

**ETP**

The External Turret Production (ETP) is mounted forward on the bow of the Floating Production, Storage and Offloading vessels (FPSO) with the turret, swivel and main parts of the transfer system above the main deck level. The turret is supported in a ring-shaped turret support structure, which is mounted onto the vessel’s bow by a cantilever structure.

ETP moored FPSO Berge Helene at the Chinguetti field offshore Mauritania.

ETP for the Thang Long field offshore Vietnam.

Assembly of the ETP module to the hull, FPSO Berge Helene.
SYS Basics

- A SYS Base anchored into the seabed integrates the PLEM (Pipeline End Manifold) and a mooring yoke with chain connection to the FPSO at her bow. The yoke weight and heights are adjusted to cater for any vessel size and high sea states.
- A column transfers the torque and supports the topsides inclusive of the swivel stack and associated piping and valves.
- Flexible jumpers transfer oil, gas, water and utilities to and from the FPSO in a U shaped catenary.

Advantages

- The SYS allows for schedule decoupling between the offshore and the shipyard work. Initial installation of SYS can be completed independently from the FPSO conversion or new build at shipyard. The SYS system is installed offshore prior to the FPSO arrival at the field. Upon arrival, the vessel hooks up onto the SYS with the help of tugs but no construction vessel is required to assist.
- The SYS provides for reduced bending moment onto the structure as opposed to traditional Jacket Soft Yoke. In turn, reduced bending moments allow for a more cost efficient structure less prone to fatigue issues.
- The SYS allows for high sea states in very shallow waters. Up to 10 m Hs in water depths of 42 m and 5 m Hs in depths of 18 m.
- During offshore installation, the SYS chain connection to the FPSO is decoupled from the yoke. The yoke is controlled by a RAM winch and the chains are load free while the connection is performed.

SYS Integration

- Vessel modifications are in the bow area and limited to chain connecting arms, gutters and equipment lay out as opposed to bow integration of a yoke.

SYS System References

- SYS systems have been installed in the Bohai Bay in China.

SYS in ice

- The SYS has a minimum sea surface interface. Its column diameter can further be equipped with a conical shaped ice breaker allow the SYS to sustain up to 50 cm of ice sheet.

SYS for High Pressure LNG Re-Gas

- The SYS can be used to moor FSRUs.

SYS is developed for water depths ranging from vessel minimum to 50 metres.

Indeed, APL looks at the complete arrangement with interaction inclusive of the following:

- Naval Architecture with hull global strength (ULS & Fatigue), hull local analysis, stability (stability book, inclination tests ), accelerations and model scale testing.
- Spread Mooring: anchors, mooring legs
- Riser Arrangement / Riser Balcony
- Deck Equipment: Fairleads, Winches, etc

And as APL supplies “all of the above”, APL is in a position to optimize the SMS based on its wide experience and intimate knowledge of components.

With a recent reference, a VLCC was moored with an APL SMS in 1200 m of water, with exposure to a 100 years significant wave Hs as of 9.1 m and the riser arrangement catered for 53 risers.

Complete and optimized Spread Moored System.
The Single Anchor Loading (SAL™) system is a low-cost alternative to traditional CALM Buoy systems. It is designed for Oil Loading Tankers (OLTs) or Floating Storage and Offloading vessels (FSOs). The SAL™ system integrates the PLEM (Pipeline End Manifold), a mooring turret, and an in-line swivel. It utilizes a Clump Weight for damping and includes a quick connect/disconnect coupler for mooring release. The system can be designed for either permanent or disconnect service, with advantages including reduced risk of collision with traditional CALM Buoys and remote control and monitoring. SAL™ systems are used in various environments, including harsh North Sea conditions and Arctic Russia. The SAL™ system is particularly effective in ice-covered areas and can accommodate flexible risers instead of hose string assemblies for high-pressure LNG re-gas operations.
The BLS is based on years of operational experience in the harsh North Sea. The BLS also incorporates optimized versions for Brazil and for the Arctic.

The BLS incorporates a ball joint at the Loading Manifold, which provides a “moment free” connection between the loading hose and the vessel. This enhances the durability and service life of both the loading hose, hose end piece and coupling. The system may also incorporate a sliding chain stopper (SPM Auto), which minimises manual operations during the mooring and unmooring sequences.

The first BLS was delivered in 1992, and since then a significant number of BLS systems have been supplied to ship owners and yards worldwide.

The SDS incorporate the following features:

- The hose assembly is stored from a dedicated hose reel providing for rapid and safe deployment.
- A vertical drum mooring & hawser handling winch, which is specifically designed for tandem mooring. The mooring operation is significantly simplified as the winch stores chain and rope on the same drum. To avoid wear on the soft mooring hawser both chafing chains are stored in a special recess at the bottom flange. The vertical drum construction also prevents chain fall-off, which is a common problem for horizontal drum winches
- A ball joint (optional) for “moment free” termination of the loading hose, thus protecting it from excessive strain.
- The winch can also be equipped (optional) with tension monitoring and quick release of the mooring hawser.

The first SDS was delivered in 1993 for M/T «Vinga», operating as an FSO on the Shell/Esso Fulmar Field in the North Sea. Since then, a significant number of SDS Systems have been delivered worldwide.
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