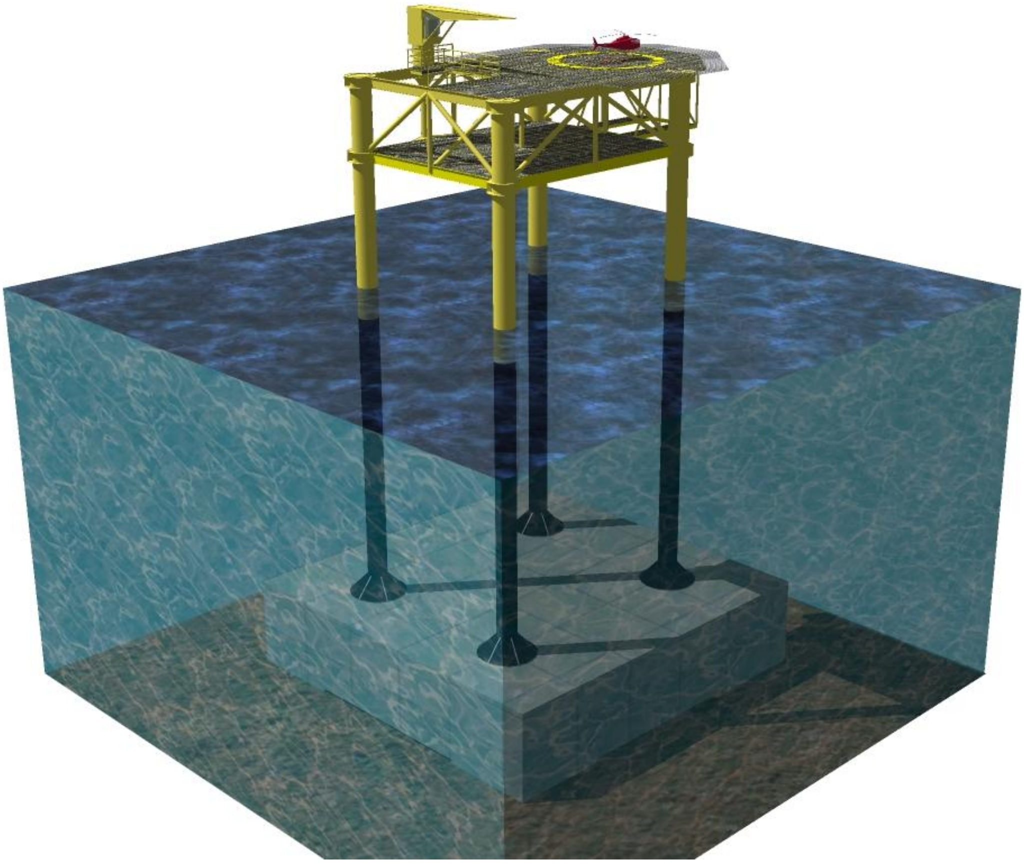
SEANODE



SeaNode is a Self-Installing Configurable Platform
for
Large Wind Farm Arrays
where
One or more Hubs (Nodes) are required for Substations and/or Accommodation

Ocean Resource Ltd

(The Offshore Wind Energy Division of Ocean Resource Ltd)

SEANODE

SeaNode is designed in every aspect by Ocean Resource to save its owners and operators money.

SeaNode is vastly cheaper to manufacture and deploy than comparable fixed systems, but more than that its simple design philosophy offers huge flexibility in capacity, use and location, including substations and accommodation platforms.

Once in operation, the SeaNode design offers further ongoing advantages by reducing medium and long term cost through its ease of maintenance and its ability to be simplyredeployed or recovered back to shore for refit thus maximising economical service life.

SeaNode is a proven and existing design.

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Unocal's Q1 Halfweg platform, a six-well unmanned gas production facility in the Dutch Offshore Sector, has over 15 years successful operation. It was designed for self installation and consists of a concrete gravity base which supports a manned process deck by means of four tubular steel legs in 24 meters water depth. This particular design is applicable to water depths of up to 40 metres though the ***SeaNode*** *platform has been designed to operate in depths up to 110 metres.*

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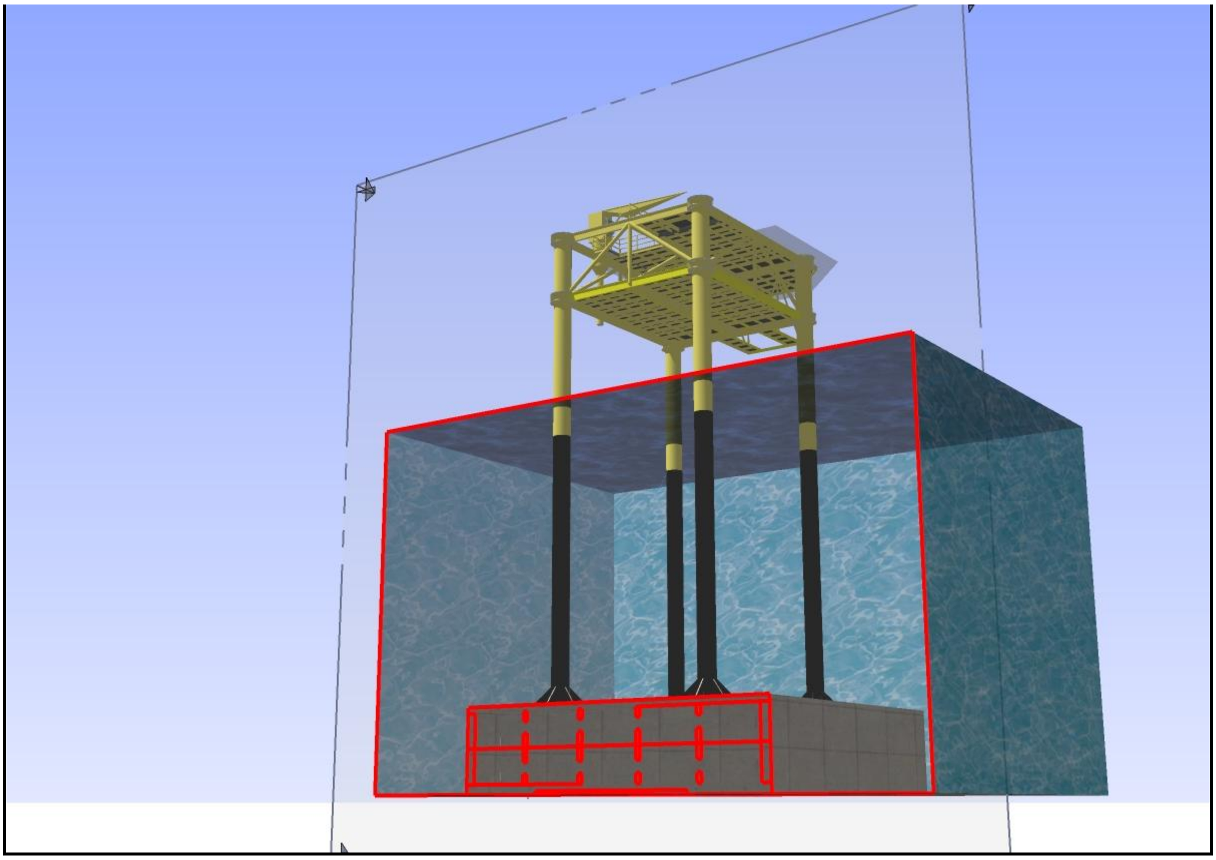


Schematic Cross section of Typical SeaNode with Gravity Base Structure foundation

Introduction

The SeaNode Minimum Facilities Platform (MFP) System provides a low cost durable offshore platform for switch rooms, substations and accommodation and is up to 25% cheaper than any comparable alternative offshore platform design.

SeaNode is a sister development of, Ocean Resource's SeaNova shallow offshore platform.

The SeaNode Platform System is a proven design. Four platforms have been built and deployed, two for offshore gas production in the UK and Holland and two for defence purposes. The design has been reviewed by major oil companies including BP and Exxon-Mobil and is considered to be a major advance in MFP design. It can be used for oil and / or gas production, manned or unmanned, for accommodation or associated facilities.

SeaNode offers wind farm developers a winning combination of proven economic construction costs, self-installation, large topside load capacity and existing certification. The design fully conforms with all relevant codes and standards normally applicable to North Sea structures.
SeaNode enables operators a design that is already proven and certified for water depths up to 110 metres

The SeaNode Platform System typically comprises a cellular concrete gravity base which provides an integral and rigid foundation for four tubular steel un-braced column legs. The columns in turn support a conventional trussed rectangular topside structure, which can support the switch rooms, transformers, control room, integrated or separate helideck and accommodation etc. The base, columns and topside form an extremely rigid portal frame arrangement eliminating the need for a complex bracing arrangement.

For very poor seabed conditions, foundations can also use either conventional piles or suction piles instead of the usual and more economic gravity base.

Design Features include:-

- **95% Commissioned onshore**
- **Rapid Installation or Removal**
- **Low Seabed Loading**
- **Self-Installing**
- **Maximum Water Depth examined to date: 110 metres**
- **Maximum Topside Weight examined to date: 9,000 tonnes**
- **Subsea Fluid Storage can be incorporated**
- **Lowest Life-cycle costs**
- **Re-usable/deployable**
- **Integral HeliDeck option**
- **Accommodation (optionally bridge-linked to Sub Station platform)**

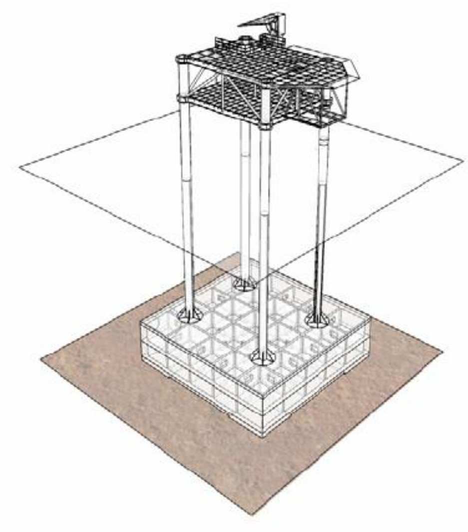
The SeaNode Platform System is essentially a self-installing (SIP) self-erecting structure. It differs from conventional drilling jack-ups in that moment support is provided at both the upper and lower ends of the un-braced column legs, hence the legs are subject to lower stresses. Furthermore, the jacking system is only attached during installation. There are no high fatigue areas such as exist in a conventional jack-up systems and the locking system is both simple and low-stressed.

As the structure is a simple un-braced 4-legged structure, it has no complicated K-joints or nodes to inspect. The exposed area of steel in the splash zone or beneath Mean Sea Level (MSL) is less than for a similar performance conventional platform hence corrosion and marine growth are less problematic. Cleaning marine growth is a relatively easy operation and the legs can be inspected from the inside which is dry. Because of this and the simpler inspection regime, maintenance costs are considerably reduced (maintenance costs for the substructure are typically 10% of those attributable to a conventional platform).

A feature of considerable advantage in the current development scenario is SeaNode's ability to be easily removed and redeployed. This obviates high decommissioning provision and is particularly attractive to future maintenance and major refit requirements.

Ocean's SeaNode Platform System is flexible providing a large deck area. As the SeaNode Platform design is driven by lateral (environmental) loading, it can carry a very significant payload without increase in the steel member sizes or weight. The topside structure comprises a conventional - trussed structure with two or more large pancake decks facilitating maintenance-friendly equipment layouts. The topside structure is supported by four (or more) tubular columns extending from one of the foundation options specified above.

SeaNode can typically incorporate an integrated helideck that can accommodate a large service (S76 or equivalent) helicopter. The helideck can be integral or separate and SeaNode will support a crane, life craft or other associated facilities. A boat landing platform is also available so that the facility can be serviced by helicopter or boat or both as required.



Construction

The fabrication and fit-out of the topside is entirely conventional. It can be implemented by any competent topside or module fabricator using techniques specific to their expertise and facilities.

The SeaNode deck steelwork is typically laid out on a shop floor and welded up with temporary corner nodes to create each deck. This is carried out for lower, any intermediate or mezzanine decks and the upper deck which may include an integrated or separate helideck. The decks or sections of the decks may be built upside down to facilitate ease and quality of welding.

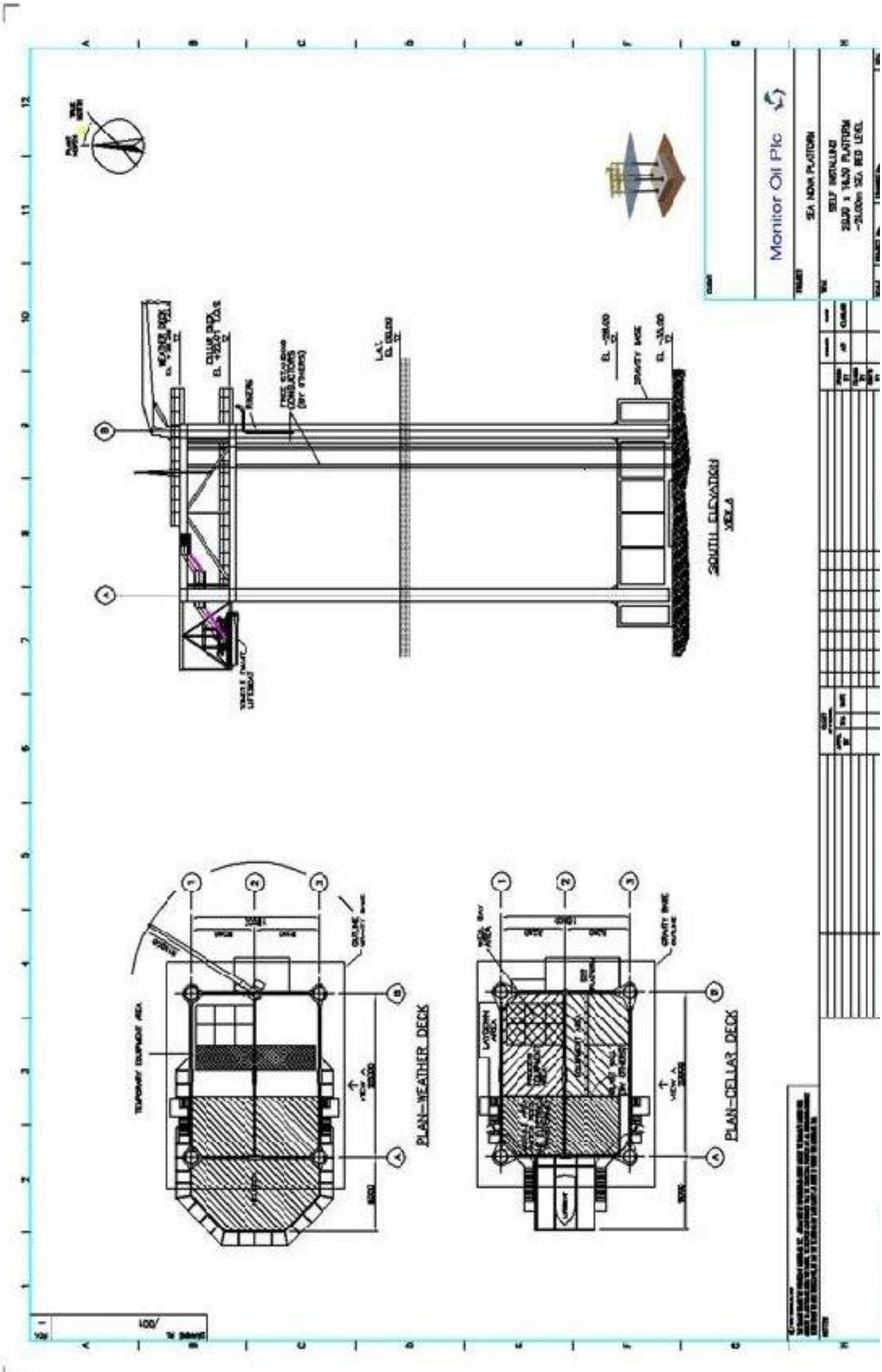
The corner brackets are separately manufactured as they require high tolerances and alignment. Their integration into the main structure also requires well controlled dimensional control. It is essential that in final assembly these brackets are closely aligned to facilitate jacking though no exceptionally high tolerances are required. The top deck is held in position by the inter deck trusses which are welded into position to create the topside structure. Additional vertical spacer tubulars are located inboard of the main column positions to position the brackets both during construction and during installation before the main connection brackets are secured.

Equipment fit-out is implemented following topside fabrication though some equipment may be positioned prior to completion of structural assembly to facilitate insertion. In general, however, SeaNode's spacious design makes equipment positioning fairly easy. Deck sections may be omitted until last so that equipment or modules can be inserted in from the top of the structure onto the lower decks.

The design can accommodate modularised equipment units either during the initial installation or subsequently for later expansion of facilities.

Fabrication may be carried out on a quayside and then the completed unit skidded onto a barge for load-out to the final assembly area. Alternatively the topside may be fabricated at the same site as the foundation structure and the two units can be mated without the use of a fabrication/assembly barge.

The nature of the design which requires no offshore lifting enables most, if not all, systems to be pre-commissioned at full power on-shore. This has a very significant impact on both the cost and time required for offshore hook-up and minor re-commissioning. It also reduces the required weather window for offshore installation.


Monitor Oil Plc
SOUTH ELEVATION
VIEW A
PLAN-WEATHER DECK
PLAN-CELLAR DECK

Millom West topside module in the fabrication yard located on transit / installation barge

Foundation Options

Several foundation options may be used with the **SeaNode** Platform enabling it to be installed in almost any offshore seabed conditions likely to be encountered.

These are:

i) Gravity Base Structure (GBS)

ii) Conventionally-piled Structure

iii) Suction -piled Structure

The first option comprises a Cellular Concrete self-floating structure whose main role is to apply low loading to the seabed. This unit is buoyant prior to ballasting and its inherent buoyancy is used to aid installation. Hence no specialised lifting vessels are required during installation and costs are minimal. This foundation type is generally applicable to around 85% of potential sites in the UK offshore sector and is generally the cheapest solution.

The Conventionally-piled foundation structure relies on the installation barge for buoyancy but again no offshore lift is required.

The suction pile option tends to be more expensive due to the size of the suction caissons but is a useful option where the seabed soils are not suitable for alternative foundations. An installation barge is used to support the platform during tow-out and installation. Again, the use of this type of foundation still allows SeaNode to be installed without the use of heavy offshore lift vessels.

Halfweg Platform in Fabrication yard complete with gravity base, topsides (including integrated Helideck) ready for leg attachment. The topside structure is lowered for transit with the transit/installation barge in position.

All these foundation options therefore provide a clear advantage for SeaNode over traditional offshore platforms that require the topside to be lifted onto the supporting structure once the latter is installed offshore using a heavy life crane vessel.

The elimination of the offshore crane vessel reduces the SeaNode installation costs significantly, including elimination of the major additional costs incurred when weather delays hold up a standard installation process.

Gravity Base Structure (GBS)

The concrete gravity base structure (GBS) typically comprises a rectangular hollow reinforced concrete structure of proven design. It is self-floating and when de-ballasted its inherent buoyancy is used to aid towage and installation. No specialised vessels or heavy-lift facilities are required during installation hence reducing costs whilst increasing project flexibility.

During sea tow and installation, the GBS acts as the floating element and is designed to withstand the environmental forces of towage and the hydrostatic pressure of submerging to 110m (subject to specified option).

When it is installed at its operating location, its function is to maintain the stability of the platform by providing a fixed support structure for the platform support columns without the need for expensive piling. This type of foundation also offers advantages where there is any possibility of seismic activity.

The hollow cells are divided into a number of discreet groups. This is done so that if a breach of the gravity base exterior occurs, the damage will be contained in only one cell group. This will ensure that the gravity base has adequate damage stability during towage or installation. It also permits

differential ballasting during installation. The cell groups are pressure-tested on-shore to check their watertight integrity. This also ensures that the cells are airtight and the ballasting process can be reversed.
Once the floating gravity base structure is in position, the cell groups are ballasted with seawater through ballasting pipes cast into the top slab of the gravity base. The ballasting process is controlled through an equalising system to ensure even distribution of seawater throughout the five cell groups.

Pumping air in to the air vent pipes, also located on the gravity base top slab can reverse this procedure at any time. An airtight manhole located at the top of each cell provides access for inspections and for access during construction.

The submerged weight of the gravity base, the platform steel and equipment weights and loadings are transferred to the seabed soil foundation via four detachable footpads located at the corners of the gravity base each tailored to meet a specific site's characteristics in relation to level or seabed conditions.
The use of these footpads also simplifies later removal of the platform at the end of its field life. If required, a steel skirt attached to the outside perimeter of the footpads will penetrate into the seabed to provide better lateral resistance or to reduce liquefaction effects.

The four detachable footpads are designed for easy removal by disconnecting a mechanical lock which holds them in place until the gravity base is ready to be removed. The detachable footpads ensure that soil suction during removal is obviated when the gravity base is required to be removed. The detachable footpads are easily removed after the gravity base has been re-floated and towed off-site.

The four steel tubular support columns are integrally cast into the gravity base structure inside circular reinforced concrete sleeves that span between the upper and lower horizontal slabs of the base itself. The columns provide a watertight environment for services, and internal inspection if required.

A steel collar surrounds each support column at the top slab of the gravity base. The steel collar provides transfer of lateral loading from the support column to the gravity base. A system of ballast pipe work is fitted to allow differential ballasting or de-ballasting of the base structure.

Proven Design

Ocean's SeaNode Platform System is an approved design. It has been built and deployed in UK waters for both gas production and defence purposes and in the Dutch Offshore Sector for gas production. The design and construction of these platforms has been to Lloyds Register, Ministry of Defence Approval and to the requirements of the Dutch Mining Regulations and Safety Rules. SeaNode will comply with any contemporary offshore Codes of Practice or Standards.

The SeaNode platforms deployed to date have demonstrated years of cost-effective and low maintenance service. They have proved operationally durable with a maintenance-friendly working environment. Subsequent review visits) have indicated that operations staff are generally very pleased with the design and found SeaNode an easy platform to work (principally because of the flat-deck layout).

The units deployed for the UK Ministry of Defence have now been successfully removed from their offshore location (at the end of their 10 year deployment) and brought ashore for resale. This clearly demonstrated the mobility of the design for use on sequential field developments.

An Existing Platform (Halfweg) In Detail

The following section describes an existing platform (Halfweg) in greater detail. Alternative specifications and performance parameters can be readily accommodated.

General

The design life of the platform is 25 years, but the minimum fatigue life of the platform is twice the design life, i.e. 50 years.

The design maximum still water depth is 100-110 metres, but greater depth can be accommodated. Halfweg has been designed for a maximum depth of 32 metres. The platform has been designed on the basis of a Normally Unmanned Installation (N.U.I) classification, but can support accommodation if required.

The following materials are used throughout:-

Structural Steel UTS 500N/mm 2	Grade S355J2G3
Concrete	Grade 45N/mm^2
Reinforcing Steel	UTS 460N/mm^2
Liners	80 Shore Hardness Neoprene

Halfweg Platform on station

Topside Facility

The facilities typically include chemical injection, water treatment, pigging, ESD, switchgear, emergency generators, workshop, cold vent, temporary safe refuge, emergency accommodation, safety equipment and escape craft. Since the platform has a large area for equipment, it can accommodate a wide range of onboard facilities.

The platform is designed to be powered by a range of options depending on what is available locally, e.g. a cable can be run from a host platform, or onboard multi-fuel engines may be used to drive generators. Even a wind turbine could be used or solar panels and a battery bank to supplement power.

There are two main decks. These are:-

Main Equipment Deck

This supports the wellheads and Xmas trees, a laydown area, the utilities and process equipment and accommodation. Hazardous area zones one and two are separated from the Motor Control Centre (MCC) and accommodation areas by a blast and firewall rated to H60 and 1.0 bar over-pressure. The main deck is designed to accept a U.D.L of 12kN/m2 overall. There is also provision for a standard container imposing a load of 25kN/m2 to be located in any position. The laydown and well bay areas are also designed to accept a loading of 25kN/m2.

There is a mezzanine deck over the wellhead area to facilitate well operations and tree maintenance. Wellhead access is through removable hatches.

A totally enclosed davit-launched life-craft is provided suspended under the helideck protected from the hydrocarbons area by a blast wall.

Helideck / Upper Deck

This provides a helicopter landing area comprising typically a 16 metre diameter landing circle and is also designed to accept stores and provide weather protection to the lower deck. Access to the lower deck is provided through this deck for equipment loading or coil tubing operations.
The helideck is designed for the operational and survival loads imposed by a large service helicopter (S76 or equivalent). A crash impact factor of 2.5 and dynamic amplification factor of 1.33 is applied. During crash conditions local damage to the platform is allowed by design. The helideck is also designed to accept a UDL of 25kN/m^2 to accommodate stores and equipment.

Geometry

The main deck can be sized to meet specific client requirements and studies have been implemented for deck sizes of 30 x 20 metres (600m^2 per deck) and larger. **SeaNode** is expandable design where two or more decks can be employed to accommodate any desired equipment or accommodation layout.

For the Halfweg Platform which is a minimally equipped shallow-water platform facility the main deck is typically 20 metres by 16 metres (say up to 40 metres water depth). The clearance between LAT and the underside of the lowest beams of the main deck is typically 16 metres. For deeper water deck sizes of 20 metres x 30 metres or 30 metres x 40 metres, might be expected.
The clearance between the lower deck and the lowest beams of the upper deck is around 7 metres though this can be modified to accommodate any equipment spread.

Air Gap

The recommended Air Gap is 1.5 metres (API RP 2A Current Edition) but 3.0 metres has been arbitrarily chosen to keep ancillary items such as sump tanks, pipework etc. clear of the survival wave crest.

Scour Protection

Temporary and permanent scour protection systems can be provided if conditions dictate. These are site specific but in general artificial seaweed is considered the best and most cost effective solution.

The permanent scour protection is designed such that it does not obstruct jack-up drilling operations (dictated by closest approach of jack-up mudmats).

Rules and Regulations

The following rules and regulations form the design basis for **Ocean's SeaNode** Platform System to date. The design will comply with any current offshore standards.

- API Recommended Practice 2A-WSD - Recommend Practice for Planning, Designing and Constructing Fixed Offshore Platforms. (20th Edition)
- Lloyds Register of Shipping Offshore Rules for Fixed Platforms
- Rules for Building and Classing Offshore Installations 1983 - American Bureau of Shipping.
- Offshore Installations: Guidance on Design, Construction and Certification - Health & Safety Executive.
- AQAP 5 (Military Standards)

Installation

The SeaNode Platform System is essentially a self-installing platform in all its variants. Therefore, it requires a minimum of marine vessels and no specialised or heavy lift vessels for installation.

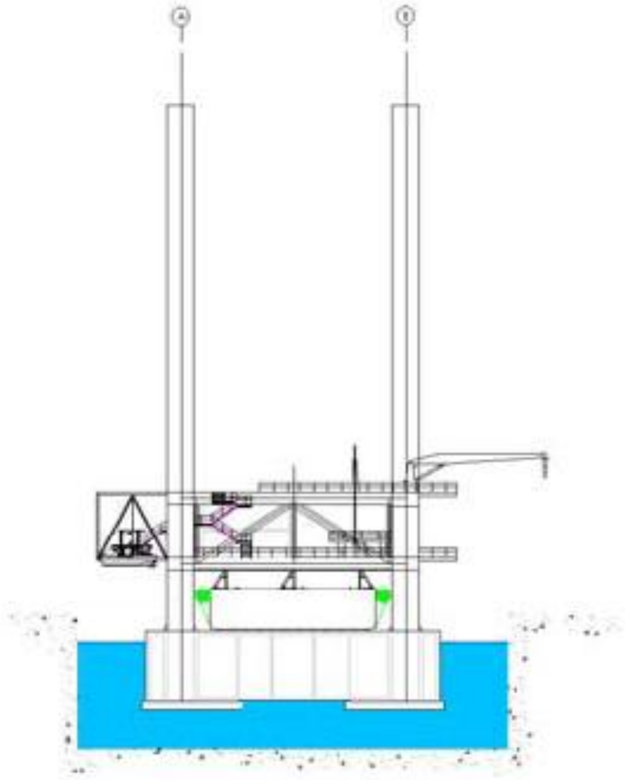
Installation techniques have been developed for each SeaNode Platform System variant described in this document.
Those procedures proposed for both the suction pile and gravity base variants have been successfully employed on numerous occasions and are approved and proven.

The SeaNode Platform System is ideal for installation where little or no infrastructure is available.

The installation technique, which is reversible, also lends itself to rapid removal and redeployment of the unit. The structure is designed for construction, tow-out and installation to any depth within its operating range.

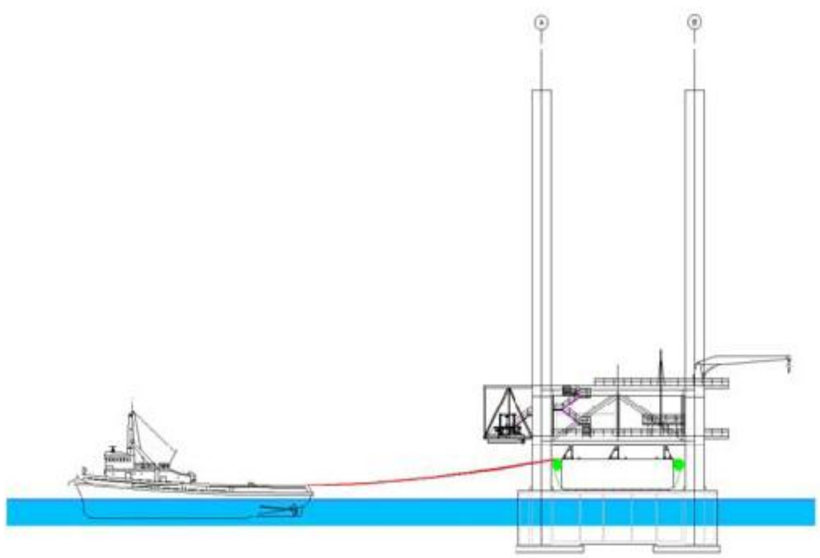
Example Installation Procedure

Stage 1 - Gravity Base De-ballasted, Structure is prepared for tow out



Upon completion of the construction phase and the on-shore testing of systems, the structure is readied for sea-tow to the final installation site. The installation clamps and sea fastenings will be engaged prior to tow-out. The barge will be secured to the top slab of the gravity base structure (GBS) by way of two wire winches on each side of the barge.

Stage 2 - Structure towed to site



Next, the main towing tug is attached to the main tow bridle via fairleads to the towing points on the GBS exterior wall and barge and the braking tug is attached to the aft bridle. When ready, the quayside mooring lines can be let go and tow can commence.

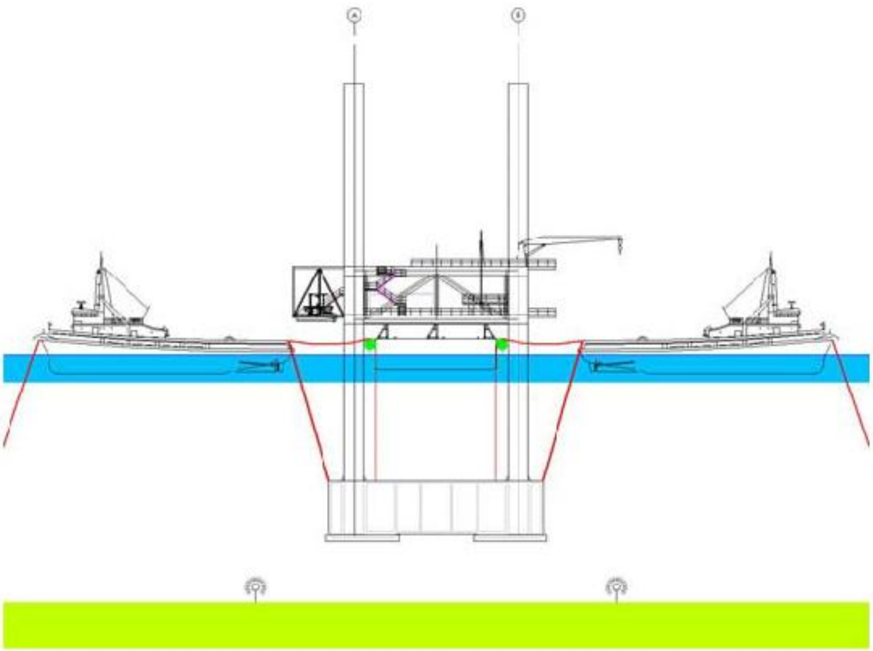
An estimated combined bollard pull of 60 tonnes is required to achieve a deep-sea tow speed of 4-5 knots. A bollard pull of around 5-10 tonnes is required for departure from the mating yard at a tow speed of 2 knots.

The deep-sea tow will only be commenced when a favorable forecast of less than force 5 and decreasing has been confirmed for a minimum of 48 hours. The structure will be towed with the GBS upper deck ballasted to just below the water to preclude "slap" on the bottom of the installation barge during tow. The installation barge is secured to the GBS upper deck and the topside structure is secured to the top of the barge via the sea fastenings and installation clamps. The structure is very stable in this condition.

Immediately before installing the **SeaNode**, the seabed will be re-inspected by ROV to ensure that there are no recent obstructions. A bathymetric survey will have been undertaken on a 5m x 5m grid extending out beyond the gravity base footprint by 20m. The initial desired platform position and orientation will be checked using DGPS or other electronic surveying / positioning equipment and the GBS position adjusted until a pre-installed transponder array is matched.

The transponder array system will consist of the reference transponder located on the seabed. The system must remain operational in the event of losing two of five transponders. The transponder array will be capable of setting the position and orientation of the GBS to an accuracy of plus or minus 500mm and plus or minus 2.5 degrees.

Stage 3 - Structure located between pre laid moorings

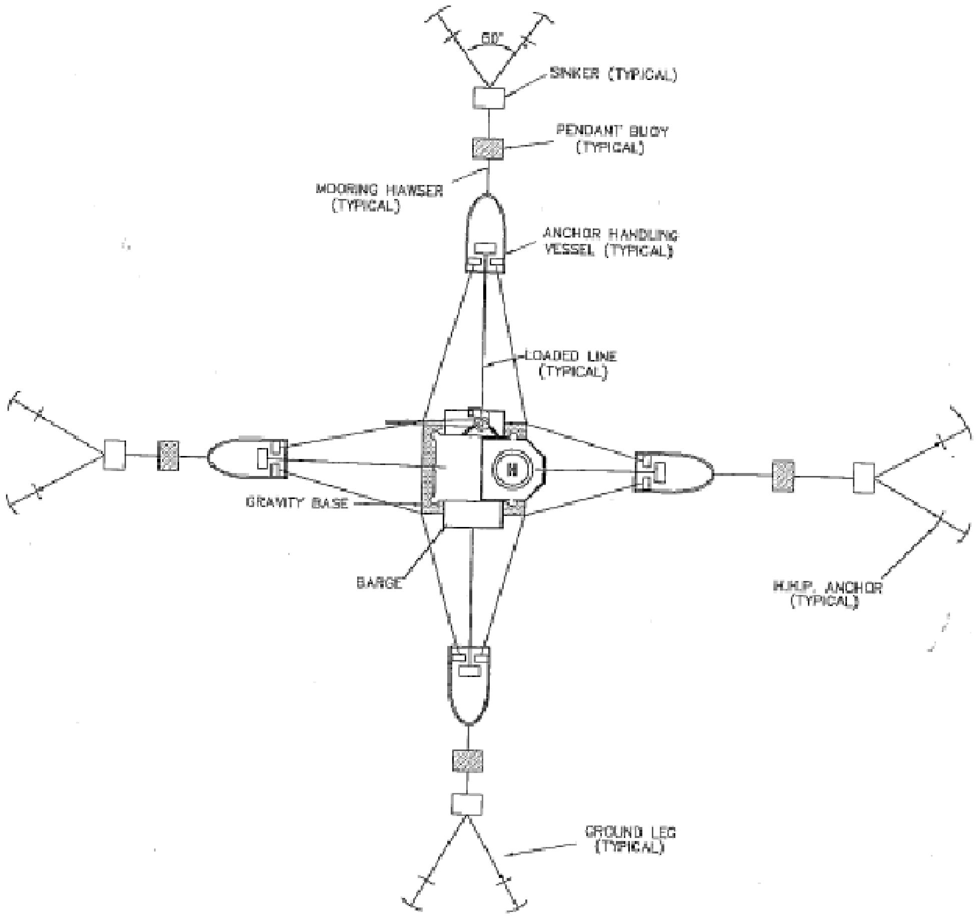


Once on site, the platform structure will be manoeuvred between pre-laid mooring buoys and mooring lines laid in a star configuration. Positive mooring will be necessary to position the structure precisely. The required four Anchor Handling Vessels (AHV) for installation will pick up pre-laid moorings over their bow roller and make them secure. In deeper water dynamically positioned vessels may be considered.
The AHVs will then run a descent control line to each of the four lowering brackets on the corners of the GBS top slab and a second control line to one of the four connection points on the corner of the barge. Additional control lines will be connected to the adjacent corners to the first two tow wires of the GBS and barge.
This will enable the structure to be rotated during lowering without the need to reposition the AHVs. The structure will be manoeuvred into position using the AHVs' winches, guided by the seabed-mounted acoustic positioning system.

Stage 4 - Gravity base descends to sea bed

Electronic surface systems will also be used to aid positioning. The barge control lines will be continuously paid out during the gravity base ballasting, maintaining a preset tension on each line. The control line tension will be controlled continuously during the ballasting procedure to adjust the platform position.

If docking is to be achieved over existing wellheads or a pre-drilled template, CCTV and docking guides will be used in the moonpool area of the GBS to assist final docking with the wellhead.
The GBS ballasting pumps and equipment will be located on the upper deck of the installation barge and connected via hoses to the GBS upper deck ballasting valves.



Mooring Configuration for Installation

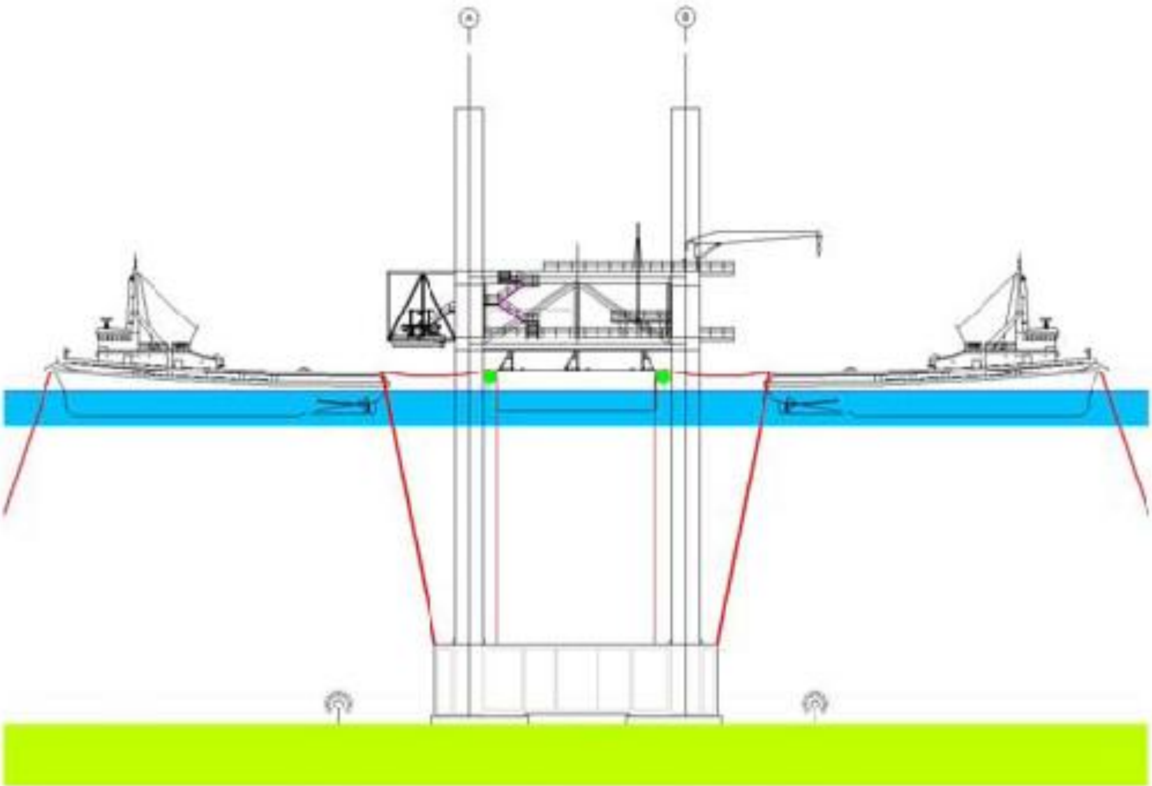
Once the platform position has been confirmed the installation clamps and sea fastenings are disengaged and the column legs are then free to move vertically within the permanent clamps, which are held partially open by spacers. The topside structure is now supported solely on the sea fastenings attached to the barge. Ballasting of the GBS will then be initiated to create negative buoyancy; allowing the gravity base to descend to the seabed in a controlled operation.

This operation will be halted when the GBS is approximately 2m above the seabed. The position and orientation will be confirmed before the final docking and set down takes place. Once docking and touchdown is confirmed, then the gravity base is fully ballasted to maximise the on-bottom stability.
The ballasting operation can be halted at any stage. Furthermore the lowering operation can be reversed at any stage if required.

The installation barge ensures that the structure is positively stable throughout the lowering operation. The barge also provides temporary buoyancy for the topside structure and through the use of two wire winches attached to each side of the barge and to the top deck of the GBS will provide a continuous system while lowering the gravity base. In addition, the use of a roller attached to each of the support columns from the barge ensures lateral stability throughout the operation.

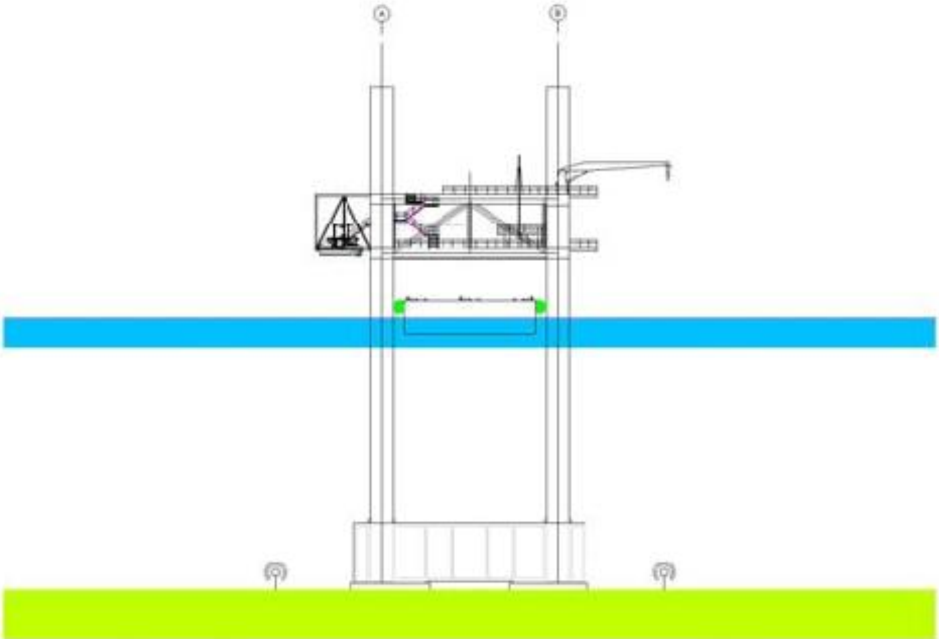
As the GBS is immersed, the water plane area is progressively reduced and the displacement increased with a consequent reduction in metacentric height. When the top of the GBS is fully submerged stability is provided by the installation barge.

Stage 5 - Gravity Base touches down on seabed.



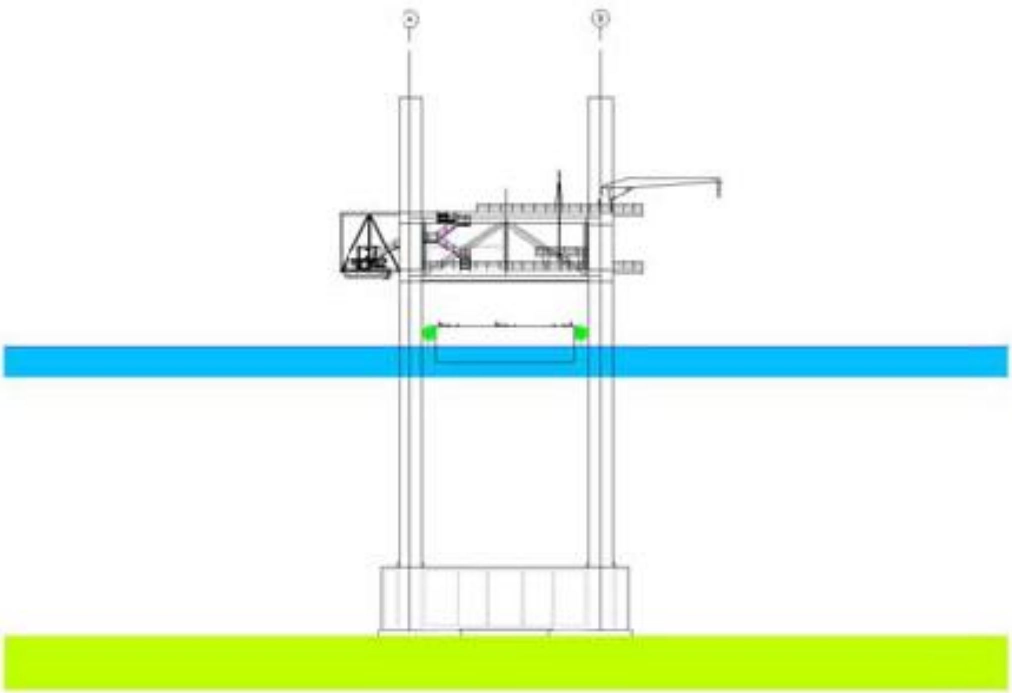
As the decent continues, the centre of buoyancy will move upward improving stability.
The GBS descent will normally be designed to occur during a falling tide.

Stage 6 - Preparation for platform lift.



Installation jacking clamps locked and sea fastenings collapsed. Tow boat wire winch lines to barge and gravity base removed (an alternative option is to lift the barge with the Topside and lower it at the completion of installation).

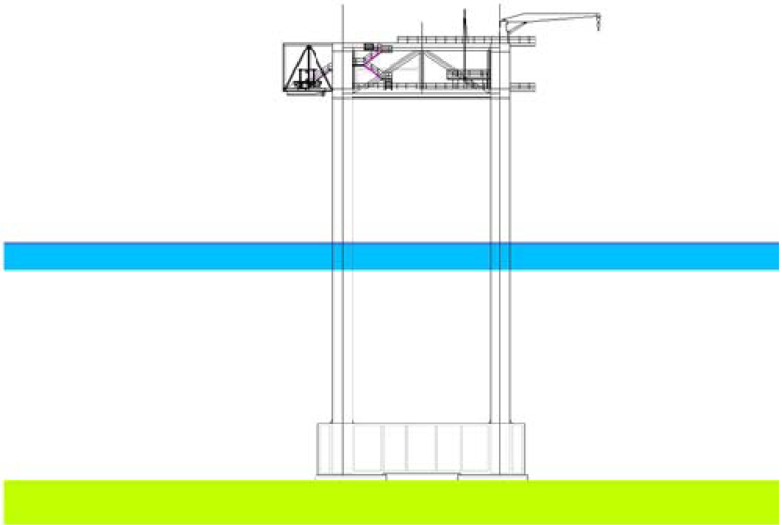
Stage 7 - Topside is raised to operating level



Once the GBS is on the seabed and fully ballasted the topside structure is ready to be jacked up. The sea fastenings will be relocated. During tow out and lowering of the GBS the topside structure is supported by temporary collapsible sea fastening supports located under the main deck trusses. These are hinged units in six positions and are designed to collapse, once the installation jacking system is initiated. In doing so, they will provide 2.5m clear vertical space between the underside of the topside structure and the barge thus ensuring that, in the conditions prevailing for installation, the barge will not impact with the underside of the topside structure once released.

The maximum conditions that are considered to be acceptable for this installation are 1.5m – 2.5m significant wave height.

Stage 8 - Final adjustments



Topside level adjusted Gravity Base fully ballasted - Barge removed. Permanent jacking clamps removed - Deployment complete.

The weight of the barge is used to settle the GBS into the seabed.

*Millom West **SeaNode** stands in a water depth of 33m but is designed to a capability of 39 metres.*

A strand jacking system is used to raise the topside structure to the appropriate level required to achieve the desired permanent air gap.

Once the topside structure is at its final operating level, the clamp spacers are removed and the permanent clamps are fully bolted to the support columns. Once all the permanent clamps are secure, the installation jacking system is removed and shear keys are welded underneath the permanent clamps. Welded overlocks may be added to the clamps for additional security. At this stage, the barge will be removed and the deployment is complete. Platform commissioning can then be carried out.

The removal process for **SeaNode** is a simple reversal of the method used for installation.

About Xanthus

Xanthus Energy was founded in 2008 as a separate portfolio of Ocean Resource Ltd's products specifically to offer our expertise and products to the offshore wind industry.

Over the past forty years we have gained unsurpassed experience in subsea and ocean engineering worldwide, providing a wide range of complex and innovative engineering to the offshore petrochemical, energy and defence industries building, installing, maintaining and operating these systems on a turnkey basis.

Ocean Resource understand the issues in building offshore wind farms and know that the designs offered on these pages when utilised will completely re-write the accepted economics of developing, commissioning and operating a wind farm.

We offer simple innovative and radical solutions to the complex issues involved, driving maximum cost efficiency in construction, servicing, maintenance and ultimately disposal.

The purpose of Xanthus is to completely re-engineer the economics of offshore wind energy.

The Xanthus products have the potential to generate enormous additional profits for the power companies that deploy them because in the first instance they drastically reduce the installation and near term costs of establishing wind farms.

Ocean Resource understands that offshore wind energy quickly needs profitability without subsidy to garner public support and be fully sustainable.

Xanthus products will also deliver far more cost effectively over the medium and long terms, prolonging the useful life and ongoing viability through much cheaper servicing and maintenance, thus ensuring that the operator, consumer and taxpayer receives the best possible value and maximum sustainability of supply.

Re-Engineering the Economics of Offshore Wind!

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