

## NASNET® POSITIONING

**NAUTRONIX**  
BY imenco



Imenco has, for more than 40 years, been a dynamic, technology driven supplier of smart solutions to the ocean industries. We are active in offshore oil & gas, marine & naval, renewable energy and aquaculture.

Imenco has a leading position within subsea camera technology, retrofit systems for corrosion protection, helicopter refueling systems, subsea lifting & handling and underwater acoustic systems. Further, Imenco is a major player within hydraulics systems, diving systems and EPC contracts.

Our engineering team is specialized in the area of mechanics, hydraulics and electronics engineering and we provide products & services for some of the world's leading oil and drilling companies.

With over 200 full time, highly skilled employees spread over six office locations together with a substantial network of agents and profesional partners, we support clients in achieving project success.



Introduction	4
NASNet® LBL positioning	6
Full field positioning	8
Project positioning	9
Remote Tracking	9
Sparse LBL	9
Dynamic positioning input	10
Array design	12
Project expertise	14
Support services	16
Case study: Aasta Hansteen	18
Case study: Stampede	20



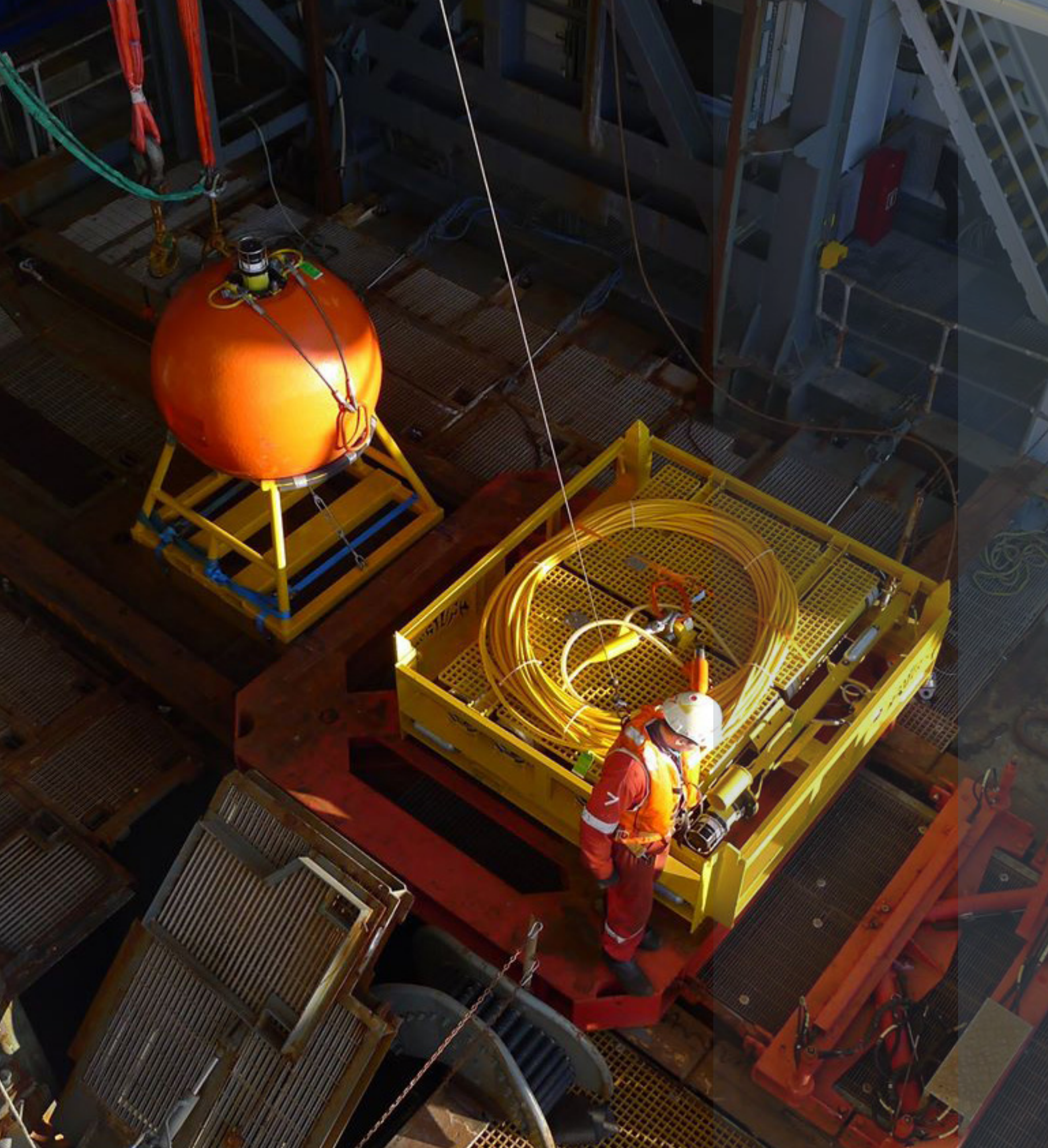
## The ultimate subsea positioning solution

Imenco Nautronix remains a world leader in supplying advanced underwater acoustic systems, which employ our patented, unique acoustic digital spread spectrum (ADS2) technology to provide world leading subsea positioning and communications capability.

Through organic growth and the acquisition of like-minded companies with shared strengths and complementary technologies, Imenco has taken on some of the best known acoustic brands in the industry – Nautronix and Helle Engineering, which has strengthened our overall capabilities and expertise.

Today, Imenco Nautronix is a world leader in supplying advanced underwater acoustic positioning systems. This includes the NASNet® subsea positioning system, which employs our patented buoy tracking system and acoustic digital spread spectrum (ADS<sup>2</sup>) signalling technology. Originally developed for defence applications, ADS<sup>2</sup> has a proven reliability of over 99% for safety critical applications. Furthermore, because the signals are so highly encrypted they need only be transmitted at low power levels, making it marine wildlife friendly.


NASNet® can be used to provide a broad range of standard and bespoke positioning solutions for even the most challenging projects over the life of a subsea field. NASNet® can be provided as a standalone option, integrated into a combined positioning and communication network, or integrated with other services provided by Imenco.






# NASNet® LBL POSITIONING

While GNSS accuracy and reliability for surface positioning has improved significantly since its introduction, development of equivalent acoustic subsea positioning systems has lagged behind. Imenco Nautronix has addressed the limitations of conventional subsea acoustic positioning systems and taken subsea positioning to a new level by combining the GNSS concept with our unique ADS<sup>2</sup> acoustic signalling technology to develop NASNet®.

2016  Stampede project in Gulf of Mexico, 1,100 metres

2015  Aasta Hansteen project in Norway, 1,300 metres

2012  Mk2 version launched

2008  Frade project in Brasil, 1100m and Cascade and Chinook project in Gulf of Mexico, 2,700 metres

## The acoustic subsea network.

NASNet® is an advanced subsea positioning system that provides accurate and reliable, true multi user positioning in all water depths. Its positioning capabilities offers real, measurable cost and operational benefits whether being used during short installation projects or for life of field developments. The versatile features of the system means it is ideal for meeting deepwater, construction and general hydrographic survey operations.

NASNet® uniquely uses one way broadcast acoustics between the seabed array and passive receivers on vessels and equipment, very similar to satellite based GPS. This provides much faster information updates with no frequency management. Multiple seabed array and passive receivers on vessels and equipment. This provides much faster information updates with no frequency management. Multiple users equipped with the appropriate receivers can use the system over long ranges without interference from or effect on other users.

NASNet®'s flexible and low risk solutions delivers significant cost advantages over the alternatives. The system is highly accurate over long ranges, which means less seabed assets are required, with no need for frequency management. NASNet® provides simple system installation, including optional single lift deployment capability for installing NASNet® stations. The calibration process can be carried out using an alternative acoustic system, thus negating the need to interrupt vessel systems. Coupled with a battery life of up to four years (regardless of the number of users) using NASNet® results in a significant reduction of vessel days required to install, operate and maintain the system.

NASNet® is available in multiple formats to suit varying project requirements. All stations are fully compatible with each other and an array can consist of a combination of station types and accessories, according to project need. NASNet® has also been proven to work in parallel with alternative USBL and LBL systems, without interference.

As a result, the system provides universal, field wide positioning that both increases operational efficiency and reduces the risk and cost effects of schedule or operational changes.







## Flexible solutions, no matter the project size

### Full field positioning

NASNet® large stations counter the limited coverage available from traditional seabed installed acoustic systems by raising the range transmitter elevation, which dramatically increases range capability. NASNet® large stations have up to 100 metre tethered buoys anchored to a seabed frame containing battery packs and sophisticated control electronics.

NASNet® positioning signals can be detected in excess of ten kilometres from a station, depending on local environmental conditions.

For seabed positioning from a NASNet® station, ranges of between four and five kilometres are more usual, with maximum ranges of around seven to eight kilometres being typical at the surface.

By raising the transmitter further above the seabed, the system takes advantage of a downward acoustic signal path to allow longer ranges to be visible close to the seabed. This elevation enables unrivalled coverage where seabed topography is difficult or challenging, while care is taken to ensure that dead zones are eliminated.

This dramatically increases signal reliability over long ranges. The patented elevated transmitter also overcomes the effects of ray bending. Sound doesn't travel in a straight line through water, and in deep water the signals tend to refract towards the surface. This creates 'blind' areas close to the seabed and is normally more of a limiting factor for seabed ranges than the actual range capability of the signal.

Given the buoys are floating so far above the seabed, uncorrected buoy movement would cause positioning errors as the ocean current causes the buoy to move. NASNet® therefore uses a patented buoy tracking system (BTS) to identify, measure and correct for buoy movement.

### Project positioning

For more localised, high accuracy positioning, NASNet® mini stations (MS) and compact stations (CS) are a viable alternative to conventional LBL. NASNet® MS and CS provide high accuracy positioning through the water column, using the same signalling technology as the large stations.

Seabed ranges are shorter as the transmitter is closer to the seabed, so arrays have to be denser. This makes MS and CS arrays efficient for corridors, smaller areas and for vessel positioning of objects through the water column.

Even in shallow water where USBL would be the usual system of choice, MS arrays can remove the frequency management issues normally associated with simultaneous operations involving multiple vessels and subsea items.

### Remote tracking

Once all stations are installed the array positions are accurately determined by a combination of standard box in and baseline adjustment functions. For remote objects that require individual positioning, the NASNet® mobile transceiver (MTrx) can be used.

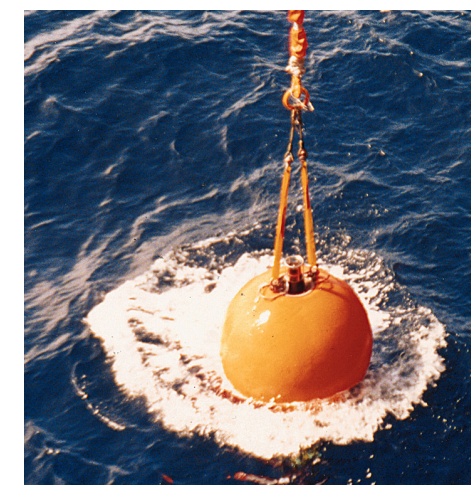
These are autonomous battery powered units, which relay signals to the user interface (UI). The NASNet® UI software is a modular system providing operating control, security and positioning functions to the operational tasks.

For tracking ROVs and powered subsea vehicles, the NASNet® VTrx system is fitted. NASNet® VTrx is a transmitter and receiver designed to provide the vessel or survey team with high update rate, low latency, highly accurate positioning, considerably reducing operational risks.

### Sparse LBL

NASNet® is supplied INS ready, with the capability to provide both position and raw range aiding to an inertial navigation system (INS). This allows 'sparse LBL' solutions to be provided for ROV positioning, making use of a reduced number of mini stations to provide ranges for input to the INS.

NASNet®'s ability to constantly provide low latency range measurements makes it the ideal acoustic system for sparse LBL applications.





# DYNAMIC POSITIONING INPUT

NASNet® DPR combines the traditional LBL acoustic positioning concept with GNSS inspired 'receive only' functionality to provide an extremely stable, fast update positioning solution for use in dynamic positioning systems.

## Increased acoustic positioning redundancy with NASNet® DPR.

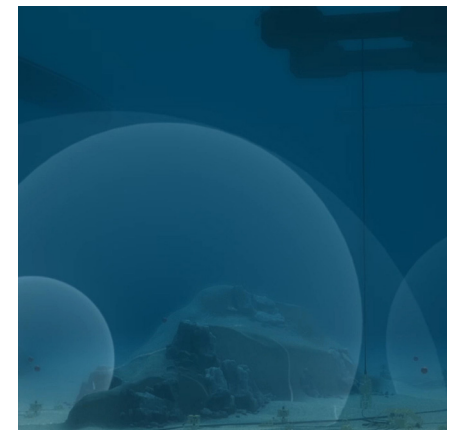
NASNet® DPR is an acoustic based dynamic positioning (DP) reference system. Independent of GNSS, the system provides a DP reference input that remains immune to instability caused by periodic episodes of scintillation – a phenomenon affecting satellite positioning systems, particularly in tropical latitudes, caused by solar activity affecting the earth's atmosphere. In addition, NASNet® mitigates against possible GPS outages, which can be caused by instances of scintillation or from GPS spoofing.

Ranges in excess of 7.5 kilometres can be used for positioning, meaning that in an existing NASNet® field large numbers of stations lie within a usable range. This provides dual benefits of fast update rate (typically 1Hz) and high levels of redundancy, ensuring stable and reliable positioning.

NASNet® DPR can easily be used on a vessel moving into a pre-installed NASNet® array. In this scenario, no additional subsea station deployment is necessary with the vessel-based NASNet® DPR topside equipment simply communicating with the existing seabed array. A reliable DP position reference can be established within minutes of arrival in the field.

NASNet® DPR can also be used if working in a location where NASNet® stations have not been pre-installed. In this case a localised grid of NASNet® mini stations would be installed from the vessel in the most effective operational manner.

Due to the one way range measurement techniques and ADS<sup>2</sup> signalling technology used, multiple NASNet® DPR systems can be used simultaneously with the same NASNet® stations. This provides increased acoustic positioning redundancy and enables multiple vessels to position simultaneously using the same array.





# ARRAY DESIGN

With an experienced team of onshore and offshore personnel we provide a comprehensive range of planning support for acoustic array deployment. Careful planning offers significant operational benefits and cost savings, maximising coverage with fewer stations.

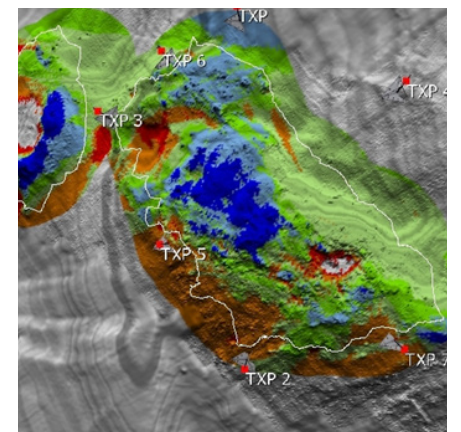
## Fully integrated service for array design, installation and calibration.

The principles of NASNet® array design are no different from any other LBL system. However array design and analysis is part of the service provided by Imenco Nautronix and this is carried out using the advanced GeoLine3D array planning software.

In order to design and fully assess the expected performance of NASNet® arrays for a project we need the following:

- AutoCAD compatible field layout with areas of required coverage identified
- Accurate sound velocity profile for the relevant area
- Digital terrain model (xyz text format) of the area

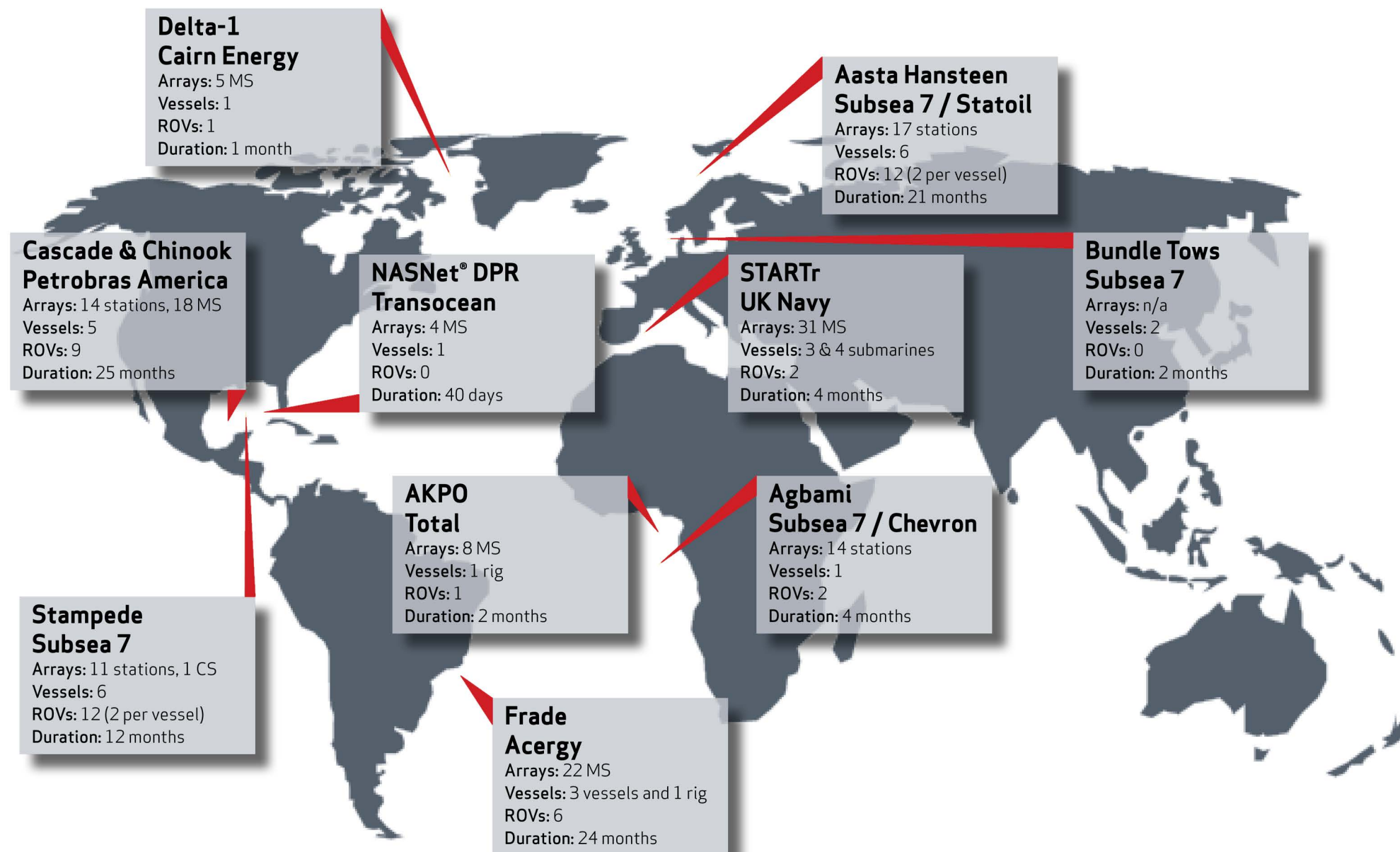
Imenco Nautronix can provide preliminary designs based on limited data but these may be subject to change in terms of number of stations required and station locations.





# PROJECT EXPERTISE

Imenco Nautronix has an established track record in the delivery of NASNet® projects to a wide variety of clients globally, for a number of different project types. Attention to detail and advance planning by operationally experienced onshore personnel with current technical skill sets is the key to our success.





# SUPPORT SERVICES

## Fully integrated customer service as standard.

Our teams leverage their years of expertise to manage the risks, costs and safety of our clients' projects. No two projects are the same. We provide a tailored and integrated set of project management processes and systems for consistent and rigorous project delivery. We appoint an experienced person to be the single point of contact for each client project. This individual is then responsible for ensuring the project is completed on time, on budget and to the agreed quality.

Service to our customers is the mainstay of our operations and we provide this at every stage through our globally integrated customer service (ICS) team, providing 24/7 support all year round to customer installations.

Our ICS team provides service and support for all Imenco Nautronix acoustic technology products onshore and offshore, offering:

- Field site surveys, installation and commissioning
- Base and on-site repair
- Routine maintenance
- Engineering solutions
- Technical assistance
- Recommendations on critical spares holding
- Hardware and software upgrades to extend the life of older systems
- Customer training offering standard and tailor-made courses

The team can be mobilised to any location worldwide to meet customer requirements.





# Positioning Case Study

## Aasta Hansteen Development - Subsea Positioning

Client: Subsea 7

Location: Norwegian Sea

Equipment: NASNet® positioning  
system Sea temp: -1.2 C

Water Depth: 1,200 metres



**The NASNet® array at Aasta Hansteen provided acoustic positioning for over 200 vessel days spread across six different vessels over a two year period, supported by NASNet® trained services personnel.**

### Background

In 2015 Subsea 7 selected NASNet® to provide field wide acoustic positioning throughout Statoil's Aasta Hansteen field. An array consisting of 17 NASNet® stations was installed along with various NASNet® MTrx QC references. ROV and vessel deployed VTrx systems provided ROV positioning and enabled system management functions to be performed.

### Project Description

The NASNet® equipment was mobilised and installation of the subsea array was completed by March 2015. The NASNet® array was successfully used by a range of construction vessels for various construction and survey tasks, including the installation of suction anchors and umbilicals.

The end of July 2015 marked the end of the first phase of the project, after which three NASNet® stations were recovered from the seabed array in areas no longer requiring coverage. The remaining stations were put into standby mode until they were required for the

second phase of the project, in March 2016.

As the campaign re-commenced, vessels were deployed to install turn-point anchors and continue their construction operations over a four month period. Once the project was completed the 14 remaining NASNet® stations were recovered from the seabed and returned to Imenco Nautronix Howe Moss facility.

All in field construction activities were completed using NASNet®. ROV positioning, which made use of the NASNet® VTrx system, with the dunking version being used as necessary from the vessels' decks. To facilitate safe deployment of the dunker, Imenco Nautronix supplied a NASNet® deck deployment system (DDS).

Structure installation and position quality verifications were performed using NASNet® MTrx, providing position and telemetry data acoustically to the ROVs.

### Scope

Imenco Nautronix NASNet® equipment was shipped to Sandnessjøen, Norway where

the client's vessel mobilised for the installation and calibration of the NASNet® array. Despite challenging environmental conditions, NASNet® stations were deployed and positioned, averaging at less than four and a half hours per unit including calibration.

A series of campaigns with multiple vessels and operators used NASNet® during the project. Tasks undertaken include the installation of foundation and mooring piles, templates, jumpers and general ROV positioning in support of construction and in-field umbilical installation.

### Conclusion

The NASNet® array at Aasta Hansteen provided acoustic positioning for over 200 vessel days spread across six different vessels over a two year period. Throughout the project Imenco Nautronix has supported offshore operations with the NASNet® project team and NASNet® trained Services personnel.



# Positioning Case Study

## Stampede Development - Subsea Positioning

Client: Subsea 7 Houston  
Location: Gulf of Mexico  
Equipment: NASNet® positioning  
system Water depth: 1,100 metres



## The NASNet® array at Stampede allowed for all subsea hardware installations to take place quickly and precisely, performing well within the system's specified tolerances.

### Background

As a result of the substantial benefits and cost savings experienced on the Aasta Hansteen development in Norway, in late 2015 Subsea 7 once again elected to use NASNet® as the primary subsea acoustic system on Hess's Stampede field.

If Subsea 7 had elected to use conventional stations at a three metre elevation, 73 units would have been required, and even then some areas were patchy.

With NASNet®, an array consisting of just eleven large stations and one CS station was installed along with four MTrx QC references throughout field. ROV and vessel deployed VTrx systems provided ROV positioning and enabled system management functions to be performed.

### Project Description

The NASNet® equipment was mobilised and installed by August 2016. A number of NASNet® MTrx's were fitted to seven sleepers at the Morgan City construction yard and were tested prior to the sleepers arriving in the field.

The NASNet® array was successfully used by a range of construction vessels for various construction and survey tasks, including the installation of jumpers, suction anchors and umbilicals as well as flowlines including all cut to length calculations.

The middle of December 2016 marked the end of the first phase of the project. Vessel schedules resulted in a break in installations. The stations were therefore put into standby mode until they were required for the second phase of the project in February 2017.

As the campaign re-commenced, vessels were deployed over a five month period to install flowlines, jumpers and rigid pipes to continue construction operations. Once the project was completed the NASNet® stations were recovered from the seabed and returned to Imenco Nautronix Howe Moss facility.

All in field construction activities were completed using the NASNet® VTrx system for ROV positioning. A dunking version was also used as necessary from the vessels' decks. To facilitate safe deployment of the dunker, Imenco Nautronix supplied a NASNet® DDS system.

Structure installation and position quality verifications were performed using NASNet® MTrx, providing position and telemetry data acoustically to the ROVs.

### Scope

Imenco Nautronix NASNet® equipment was shipped to our Houston facility to allow customer factory acceptance testing. The equipment was then transported to Fourchon for loading onto the Grant

Candies for installation and calibration of the NASNet® array.

The introduction of a single lift deployment system was required as the installation vessel only had a single crane. This new system was designed and implemented within two months and resulted in a much safer installation and control of the NASNet® stations.

Box-in calibrations were conducted using an autonomous surface vessel (ASV). This allowed the vessel to continue other installation tasks without having to break off to conduct box-ins. As the ASV was not on the critical path, multiple box-ins were conducted, which gave consistent results. Installation on average took two hours while calibration took 45 minutes.

### Conclusion

The NASNet® array at Stampede allowed for all subsea hardware installations to take place quickly and precisely, performing well within the system's specified tolerances.

As the LIDAR system was used to conduct metrologies, independent comparisons were possible, which showed excellent correlation between NASNet® and LIDAR.

Multi-beam surveys were completed using only NASNet® and again this was done ahead of schedule due to the speed of NASNet® position updates.



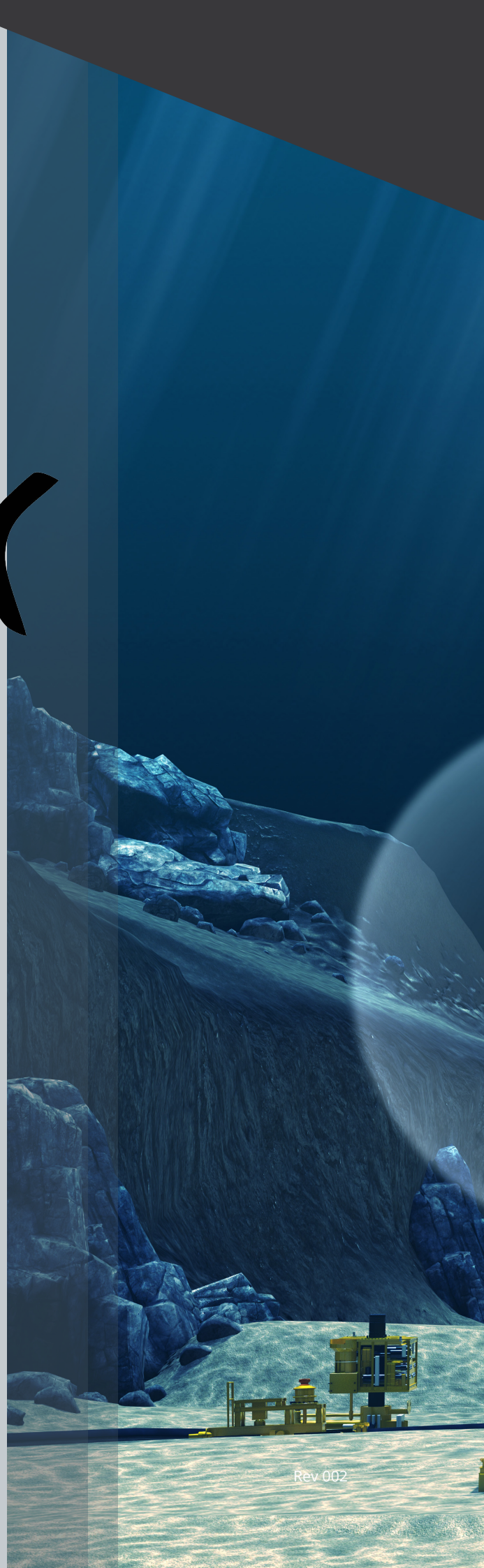
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