

# Hamworthy Offshore

Environmentally sound solutions for offshore applications



# OUR SOLUTIONS ENSURE SAFE, FLEXIBLE AND RELIABLE OPERATION FOR OFFSHORE APPLICATIONS

Hamworthy is a global leader in the design and manufacture of specialist equipment for the marine, oil & gas and industrial markets. Our innovative solutions include oil & gas handling, pumping, emissions control, inert gas systems and water management systems.

Hamworthy also benefits from having its own naval architecture consultancy, which supports the wider Group into developing solutions with the customer in mind, as well as providing cost-effective systems and vessel design direct to customers.



Our products and systems benefit offshore facilities engaged in every stage of field development, from exploration and drilling through to production and transport, including fixed and floating production platforms and shuttle tankers.

We supply products that include FPSOs (floating production storage and offloading), seismic vessels, drillships, semi-submersible rigs/jack-up rigs, production test ships, FSOs (floating storage, offloading units), LNG and LPG FPSOs, shuttle tankers, intervention vessels, pipe layers and crane vessels.

Our offshore product range:

#### PUMPING APPLICATIONS

- ▶ Cargo pump systems
- ▶ Deepwell ballast pumps
- ▶ Deepwell process pumps
- ▶ Deepwell fire pumps
- ▶ Deepwell seawater lift pumps
- ▶ Engine room pumps
- ▶ Fire pump packages
- ▶ Pump room systems

#### WATER MANAGEMENT

- ▶ Fresh water generators
- ▶ Membrane bioreactors
- ▶ Sewage treatment plants
- ▶ Vacuum toilet systems

#### SAFETY & EMISSION REDUCTION

- ▶ Anti-flare solutions
- ▶ Exhaust gas cleaning
- ▶ Flare gas recovery
- ▶ Hydrocarbon blanketing systems
- ▶ Hydrocarbon gas compressors
- ▶ Inert gas systems
- ▶ VOC recovery

#### PROCESS SEPARATION

- ▶ VIEC® technology
- ▶ iPhase® profiler

#### GAS HANDLING

- ▶ LNG regasification
- ▶ LNG reliquefaction
- ▶ LPG cooling and reliquefaction

#### EXPLORATION APPLICATIONS

- ▶ Nitrogen generators
- ▶ Riser tensioner compressors
- ▶ Seismic compressors



# PUMPING APPLICATIONS

With our strong focus on the offshore industry, our pumps have been designed specifically to provide environmental and reliable solutions that meet the requirements of the offshore market.



DEEPWELL SEAWATER LIFT PUMPS



PUMP ROOM SYSTEMS

FIRE PUMPS

ELECTRIC DRIVEN DEEPWELL CARGO PUMPS

## Engine room pumps

Hamworthy's engine room pump comes in a large range of sizes, ensuring there is one that will match your requirement and therefore most efficiently meet your needs. When it comes to repairs and servicing, the pump's design enables quick turnaround.

Our C2G range is a single-suction inline centrifugal pump, designed for reliable and efficient operation upon offshore installations. The compact design of the pump gives low weights of parts to be handled and has both high suction performance and a low power requirement.

Many shipowners and rig operators are replacing their old pumps with our latest range of centrifugal pumps, designed with minimum number of parts and a high degree of standardisation of components for low spares inventory.

## Pump room systems

The traditional Pump Room System is characterised by a separate room for pumping equipment located between the engine room and the cargo hold – an arrangement that provides easy access to all key components for regular inspection and maintenance. Important features of the system are compact and space-saving configurations for optimal pump room layouts – combined with high operational efficiency.

The CB cargo and COW pumps are specially designed for pumping crude oil and oil products at nominal heads and capacities from 400 to 6500 m<sup>3</sup>/h in vertical or horizontal orientations. The pumps are of exceptionally compact design and with various nozzle configurations.

## Deepwell seawater lift & fire pumps

Hamworthy provide a range of deepwell seawater lifting pumps and fire pumps designed specifically for the offshore market. Our seawater lift pumps run in capacity up to 2600 m<sup>3</sup>/hr and with a differential pressure up to 180 mlc. The pumps are driven by a dry mounted electric motor in explosion-proof execution, through a pipe stack with transmission shaft and cargo lubricated bearings.

For seawater lift pumps and fire pumps installed in caissons, Hamworthy can supply its inflatable intermediate support system which has been developed in order to secure proper installation and support of the pump in the caisson. The caisson installed deepwell pump is typically delivered for FPSOs, semi-submersible production units and platforms, and are available upon request according to API 610.

## Fire pump packages

Hamworthy fire pump packages are crucial for the safety on board FPSO/FSOs. Hamworthy has developed various system solutions to meet customer's requirements for fire pump package installations. All units meet NFPA 20 and class requirements.

## Deepwell cargo, process and ballast pumps

For FPSOs/FSOs with a requirement for a distributed pump systems, Hamworthy has developed a cost effective, crude handling system comprising electrically driven deepwell pumps. In providing long term benefits of lower maintenance and less downtime, Hamworthy's electric driven deepwell pumps also use less energy than other comparable distributed pump systems. Onboard maintenance is also lower when it comes to the electric system because of the shaft lubrication system used, the fact that the pump house is easily dismantled and cards on converters are easily interchanged. In the operational phase, electric equipment is more environmentally friendly, because CO<sub>2</sub> emissions are minimal due to higher efficiency and lower power utilisation and there is no hydraulic oil spillage risk.

Hamworthy deepwell process pumps are designed for continuous operation, pumping medium such as produced water and oil. The pumps, type OPL, can be delivered according to API 610.

The deepwell ballast pump is a single suction in-line centrifugal pump, designed for a reliable and efficient operation and consists of a submerged pump head, transmission to deck and electric motor. The pump is designed for DOL starting and can also be operated with frequency converter or other means of variable speed regulation.



WITH A CONTINUED EMPHASIS ON SAFER AND MORE ENVIRONMENTALLY FRIENDLY CARGO PUMPING SYSTEMS, WOODSIDE SPECIFIED HAMWORTHY ELECTRIC DRIVEN DEEPWELL CARGO PUMPS FOR ITS FPSO NGANHURRA (PICTURED). IT IS ALSO EQUIPPED WITH HAMWORTHY CARGO LIFT PUMPS, CARGO BOOSTER PUMPS, SLOP PUMPS, SKIMMING PUMP, TANK CLEANING PUMP AND BALLAST PUMPS.

# SAFETY & EMISSION REDUCTION

Having served many of the world's offshore installations, we are now helping the offshore market deal with environmental and regulatory issues, from waste water treatment in sensitive areas to emissions control. Its further evidence of Hamworthy know-how meeting today's challenges.



## Inert gas systems

Hamworthy has over 20 years experience in the design and manufacturing of inert gas generator systems for FPSOs and FSOs. These unique systems are well known for their high quality with regard to material selection and inert gas quality.

The Moss inert gas generator system is a design based on compact modules, offering important savings in space and installation cost both for new buildings and for retrofit on existing FPSOs and FSOs.

Hamworthy also provide offshore nitrogen generation systems for the offshore industry which can supply dry and oil-free inert gas for purging, pressurising and blanketing functions for various top site and marine users.

## Hydrocarbon blanketing

Hamworthy's Hydrocarbon Blanketing System eliminates the environmental damage and economic loss caused by emissions of gas vented to the atmosphere in a conventional process. The purpose of the system is to replace the use of inert gas in FPSOs by pure hydrocarbon gas as a blanket gas in the cargo tanks, and to recover the blanket gas during the filling of cargo tanks with produced oil. The blanket gas prevents intrusion of oxygen into the cargo tank atmosphere, creating a closed system.

Extensive work has been done to evaluate the implications of the technology on the operational and safety integrity of the FPSO concepts. Both theoretical studies and practical experience support the feasibility of the hydrocarbon blanketing concept. Hamworthy's Hydrocarbon Blanketing Systems are already used on board several installations in the North Sea and West Africa and have been contracted to supply to the Goliat FPSO to be located in the Barents sea and on the CLOV FPSO off Angola.



INERT GAS SYSTEM

HYDROCARBON BLANKETING

VOC RECOVERY

## Flare gas recovery

The flare is the most visible sign of wasted resources and pollution from oil, gas and petrochemical plants. Hamworthy provides technology to safely capture and handle this flare gas.

Our environmentally friendly system will extend the lifetime of the flare tips, saving significant maintenance costs on shutdown and flare tip replacement.

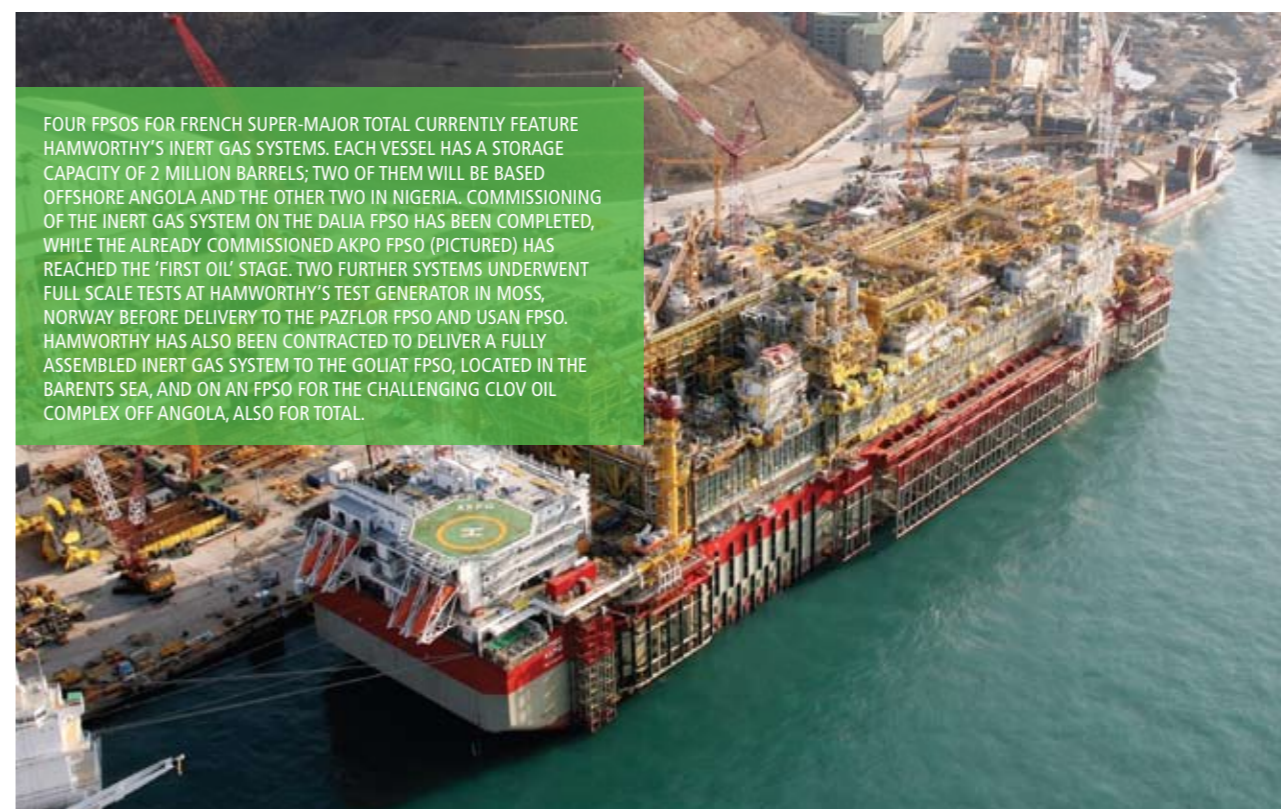
The concept comprises flare header isolation equipment, a gas recovery system and a reliable flare gas ignition system. The flare gas recovery system will be designed to meet the specific process conditions on the plant. The flare ignition system has been developed to guarantee safe and reliable ignition of the flare whenever required.

## VOC recovery

Hamworthy is paving the way for complete recovery of VOC emissions during offshore oil loading. Hamworthy has developed a solution for VOC recovery that not only meets the Norwegian authorities' requirements for NMVOCs, but also exceeds them by reducing VOC emissions by 100 per cent. This includes methane, which is not currently specified in the regulatory requirements.

## Exhaust gas cleaning

Hamworthy's technology virtually eradicates sulphur emissions, cutting them by 99.9% even when burning residual fuel oil. The sea water scrubbing unit is also designed to remove 85% of particulates and nitrogen oxide emissions by up to 10%, thus complying with the EU in-port and MARPOL Annex VI requirement of a 0.1%S fuel. It provides for silencing of the exhaust noise and is both light in weight and self supporting.



FOUR FPSOS FOR FRENCH SUPER-MAJOR TOTAL CURRENTLY FEATURE HAMWORTHY'S INERT GAS SYSTEMS. EACH VESSEL HAS A STORAGE CAPACITY OF 2 MILLION BARRELS; TWO OF THEM WILL BE BASED OFFSHORE ANGOLA AND THE OTHER TWO IN NIGERIA. COMMISSIONING OF THE INERT GAS SYSTEM ON THE DALIA FPSO HAS BEEN COMPLETED, WHILE THE ALREADY COMMISSIONED AKPO FPSO (PICTURED) HAS REACHED THE 'FIRST OIL' STAGE. TWO FURTHER SYSTEMS UNDERWENT FULL SCALE TESTS AT HAMWORTHY'S TEST GENERATOR IN MOSS, NORWAY BEFORE DELIVERY TO THE PAZFLOR FPSO AND USAN FPSO. HAMWORTHY HAS ALSO BEEN CONTRACTED TO DELIVER A FULLY ASSEMBLED INERT GAS SYSTEM TO THE GOLIAT FPSO, LOCATED IN THE BARENTS SEA, AND ON AN FPSO FOR THE CHALLENGING CLOV OIL COMPLEX OFF ANGOLA, ALSO FOR TOTAL.

# GAS HANDLING

Tailor made, trustworthy solutions which increases efficiency and reduce costs and risks – thanks to Hamworthy know-how



LPG COOLING



LNG REGASIFICATION



SANHA LPG FPSO

## LPG cooling and reliquefaction

Hamworthy has built up a number of references for the supply of its LPG cooling and reliquefaction plants onboard LPG FPSOs.

The high pressure LPG liquid stream coming into the barge needs to be cooled down before it is expanded into the cargo tanks by the installed cooling plant. The reliquefaction plants can be designed for operation on LPG with high ethane content in the LPG liquid phase and secure that cargo condition is at low pressure and temperature down to -50°C in the cargo tanks. A sufficient number of cooling and reliquefaction units should be installed in order to ensure redundancy and efficient operation.

Hamworthy supplied to Chevron's Sanha LPG FPSO for its LPG handling system. Currently the world largest with a storage capacity for 135,000 m<sup>3</sup>, the contract put us at the forefront of gas liquid cargo handling systems in this specialised market. For the same project Hamworthy also supplied LPG cargo pumps, sewage treatment systems and inert gas generators.

## LNG regasification

Hamworthy's LNG regasification units are skid-mounted, very compact and can easily be arranged on deck.

Hamworthy's technology is based on an intermediate closed propane loop, using seawater as the heating medium for vaporising LNG. The equipment has a high level of efficiency and therefore requires less fuel and operating cost to regasify the LNG than steam-based systems.

It is anticipated that future offshore terminals will be attractively close to market areas that have significant variations in the seawater temperature, and this has been taken into consideration in the design of the regasification plant.

Hamworthy provide regasification systems for FSRUs and SRVs. Currently in operation are systems for the Neptune offshore terminal in Massachusetts, Guanabara in Brazil and Dusop terminal in Dubai.

## LNG reliquefaction

Hamworthy offer an alternative propulsion system which uses far better fuel economy than steam turbines. Instead of previous practice using boil-off gas as fuel, Hamworthy's reliquefaction system establishes a solution to liquefy the boil-off gas and return the LNG back to the cargo tanks. This results in increased cargo quantity delivered and improved propulsion redundancy. The system is prefabricated in skid modules for installation and hook up onboard and limited re-arrangement of cargo machinery space is required.



HAMWORTHY SIGNED A CONTRACT WITH GOLAR LNG FOR LNG REGASIFICATION UNITS FOR THE 138,000M<sup>3</sup> LNG CARRIER GOLAR WINTER (PICTURED), WHICH WAS CHARTERED BY PETROBRAS AS AN FSRU IN AN LNG IMPORT PROJECT IN GUANABARA BAY, BRAZIL. FOLLOWING THIS ORDER HAMWORTHY DELIVERED THE REGASIFICATION SKIDS FOR THE 1977-BUILT LNG CARRIER GOLAR FREEZE, WHICH WAS CONVERTED INTO AN FSRU, CHARTERED TO DUBAI SUPPLY AUTHORITY AND SHELL AND MOORED PERMANENTLY ALONGSIDE A PURPOSE-BUILT JETTY WITHIN JEBEL ALI PORT.

## WATER MANAGEMENT

Hamworthy's wealth of experience in shipboard wastewater treatment – notably with its sewage treatment plant and membrane bioreactor (MBR) system – was used to create solutions capable of meeting current and future effluent quality standards.



## PROCESS SEPARATION

Hamworthy has designed solutions to improve the separation and quality of produced oil and water.



### Sewage treatment

Hamworthy's ST-C enhanced sewage plant uses an extended aeration process which has been honed for marine and offshore application over four decades. The technology, which is fully compatible with gravity and vacuum collection systems, features an automatic control system for unattended operation and minimum maintenance and is available in a modular compact construction for retrofit applications.

Hamworthy became one of the first companies to receive type approval for its ST-C series of sewage treatment plants in accordance with the IMO MEPC 159 (55) standard. The new regulations call for cutting permissible sewage discharge levels of suspended solids from newbuild ships by more than half, even in the open sea, allowable faecal coliform discharges by more than 70%, and biochemical oxygen demand (BOD) by one half.

### Membrane bioreactor systems

With effluent discharge requirements within areas such as the Caspian, Sakhalin Island, the Barents Sea and the Arctic becoming increasingly tighter, the need for an advanced waste water treatment system to meet these and future requirements has become essential. Hamworthy's MBR system is based on biological degradation and membrane separation and is a evolution of the proven sewage

treatment plant technology, this process produces the highest quality discharge without requiring any addition or generation of chemicals that are hazardous to the environment.

Hamworthy continues to optimise the MBR system and by building on our successful experiences, and working closely with customers, we have most recently designed the miniMBR, a smaller more compact version of the innovative MBR system. The system is primarily aimed at FPSOs and accommodation platforms, also smaller cruise vessels and ferries of up to 200 personnel.

### Vacuum toilet systems

Hamworthy provide a range of vacuum generation equipment which can be supplied separately or integrated into the sewage treatment plant system. Our range of vacuum toilets has been designed to be mechanically simple, operationally reliable and stylish in appearance.

Hamworthy also provides a range of cost effective technologies to manage and treat ballast water, helping vessel owners and operators comply with IMO and other legislation and to protect the marine and offshore environment.

Hamworthy are able to customise separators and separation systems to help our customers enhance and increase production, reduce operational costs and cut weight and space requirements.

Hamworthy perform in-house characterization and testing of oils in their own lab. This combined with our expert knowledge of chemistry, sophisticated separation and fluid dynamic modeling means we can provide the complete process and operational experience.

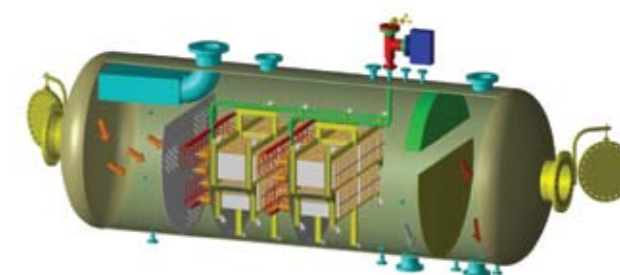
We have developed compact and transportable separation systems based on the use of our VIEC® Technology that may be used for:

- ▶ Early production
- ▶ Wellhead water removal
- ▶ Mobile/remote production

Hamworthy's VIEC® (Vessel Internal Electrostatic Coalescer) system solves the often experienced problem with emulsion and capacity limits in separators. It enhances the speed and efficiency of the

separation process by forcing small water droplets to merge and form larger, faster sedimenting drops. Whilst the VIEC-LW® (Vessel Internal Electrostatic Coalescer-Low Water) is designed to remove the last traces of water in oil and can be installed separately and downstream the standard VIEC® in order to polish the oil to export quality, or be used for bulk water removal for high viscosity oils.

In addition its iPhase® profiler measures the oil water interface and provides accurate measurements of oil in water concentration inside hydrocarbon separators.



VIEC-LW®

# EXPLORATION APPLICATIONS

Safe, flexible plant operations with user friendly systems – care of Hamworthy know-how



RIG TENSIONING COMPRESSORS

SEISMIC COMPRESSORS

NITROGEN GENERATORS

## Nitrogen generators

Hamworthy Moss has recently developed a new design to develop nitrogen generators from niche, supplementary small-volume inerting into large-scale main inert gas units.

The combination of a technically advanced solution, a competitive price, and an extensive service offering all contribute to its success in the offshore market.

Moss offshore nitrogen generation systems supply dry and oil-free inert gas for purging, pressurising and blanketing functions for various top site and marine users.

The systems consist of two 100% inlet air filters, pre-heater with thyristor control, separator membranes, O2 analyser, UCP, controls and instruments for safe and automatic operation. Hamworthy is now working on even larger units for this growing market.

## Rig tensioning compressors

Hamworthy's rig tensioning compressors and heave compensation compressor packages are fully integrated, lightweight, compact and engineered for the offshore environment.

They combine a 4 stage compressor, air dryer and filtration package with a contained cooling system, producing dry, filtered, high pressure air/gas suitable for riser tensioning and offshore applications world-wide. Units are tested and fully assembled ready for installation. The module also meets the requirements of the major marine classification societies.

## Seismic compressors

Hamworthy seismic compressors offer you an integrated and compact solution to your high-pressure needs.

Their high efficiency with low lift concentric valve and generous inter-stage cooling minimise the amount of absorbed power. Each machinery package includes a choice of drive, skid base and control system and is engineered to suit your seismic requirements.

Its low unit noise and vibration improves reliability and reduces interference with survey results. An option to containerise offers contractors and operators flexibility in vessel utilisation. Thanks to easy access features and simple modular construction it enables low and easy maintenance. Multiple unit control system provides local and remote operation of two or more compressors.



HAMWORTHY WON A CONTRACT TO SUPPLY A PURPOSE DESIGNED AND MANUFACTURED COMPRESSOR PACKAGE UNIT PRODUCING DRY, FILTERED, HIGH PRESSURE AIR FOR RISER TENSIONING APPLICATIONS TO THE STENA DRILLING 1V (PICTURED). THE UNIT WAS PROVIDED FULLY PIPED AND WIRED WITH ALL CONNECTIONS BEING BROUGHT TO THE BASE EDGE AND IDENTIFIED FOR EASE OF INSTALLATION AND OPERATION IN VARIOUS OFFSHORE CONDITIONS WORLD-WIDE.

PICTURE COURTESY OF STENA DRILLING LTD – WWW.STENA-DRILLING.COM

# HAMWORTHY SERVICES

Our global network of sales and service centres ensures that we can provide first class technical, spares and service support to our customers wherever they are around the world.



Hamworthy have support centres in Europe, East & South East Asia, The Middle East and North & South America. You also benefit from our extensive network of agents and distributors covering over 50 countries.

### Europe

- ▶ Denmark (Aalborg)
- ▶ Germany (Geesthacht)
- ▶ Netherlands (Rotterdam)
- ▶ Norway (Asker, Bergen & Moss)
- ▶ Poland (Gdynia)
- ▶ Spain (Villa Garcia de Arosa)
- ▶ UK (Poole & Dover)

### Middle East

- ▶ UAE (Sharjah)

### East & South East Asia

- ▶ China (Dalian, Guangzhou, Shanghai & Suzhou)
- ▶ Korea (Busan)
- ▶ India (Mumbai)
- ▶ Singapore

### North & South America

- ▶ USA (Miami & Houston)
- ▶ Brazil (Rio de Janeiro)

Hamworthy work with you to ensure complete project control from conception through to operation and service support, including the following services:

- ▶ 24 hour global support
- ▶ Cargo control system upgrades
- ▶ Commissioning/IMO certification assistance
- ▶ Installation work & supervision
- ▶ Original spare parts
- ▶ Overhaul and repair
- ▶ Process tuning for energy consumption
- ▶ Replacement products
- ▶ Retrofits
- ▶ Service & maintenance (contracts)
- ▶ Training
- ▶ Troubleshooting/pre-docking inspection
- ▶ Upgrades (mechanical, electrical and automation systems and components)



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