SOLUTIONS FOR NAVAL VESSELS

CONVERTEAM
THE POWER CONVERSION COMPANY

Powering the Navies with Converteam's Integrated Power and Propulsion Solutions

Royal Navy's LPD & AO – HMS Bulwark & Wave Knight

A Global Offer
For Naval Vessels

Converteam has more than 100 years of manufacturing experience and is an industry leader in electrical engineering, systems integration and design / manufacture of a wide range of electrical machines, power electronic converter drives, drive systems, switchboards, controls and automation systems.

Converteam represents the optimum choice for single-source solutions for all power and propulsion systems needs.

With in-depth knowledge of electrical systems – from power generation to propulsion, distribution and automation systems – Converteam engineers work in close partnership with every customer on every project. This kind of collaboration ensures a precise evaluation of every individual requirement, from the development of customised products to meet specific needs to final solutions designed to meet client expectations.

Each product and system has built its own track record of proven, reliable operation in some of the World's most difficult environments and includes:

- Total power system design and integration
- Multiple designs and topologies
- Diesel generator sets
- Generators
- Electric motors
- Converters AC, DC
  - Drive systems
- Power quality systems
  - Passive and active filtering
- Switchboards, distribution
  - MV, LV, MCC – AC, DC
- Automation products
  - Power management
  - Vessel management
  - Alarm and monitoring
  - Dynamic positioning
- Automation architecture
  - Simplex, duplex, triplex
- Control and automation
- Damage control

Electric Propulsion
Engineering

Converteam provides complete power and propulsion system packages, including prime movers (in some cases), power generation, electrical distribution, fixed or variable speed drives including motors for the propulsion thrusters and large electrical systems.

Power and propulsion systems are fully integrated with power management, automation and monitoring systems, controls, alarms, data network systems and dynamic positioning systems, as required.

Converteam's expertise in ship power and propulsion includes fully integrated electric and hybrid based systems, power generation from either diesel and/or gas turbine prime movers. Converteam references include controllable pitch propeller (CPP) shafting arrangements and fixed pitch propeller (FPP)'s with direct drive propulsion electric motors powered by variable frequency converters.

From the supply of turnkey contracts to providing technical assistance, the experience and know-how of Converteam is demonstrated to our clients in a number of ways.

System engineering
Converteam has proven expertise in the design and supply of electric or hybrid propulsion systems for naval vessels.
For each application, system engineering can include:
- Technical specifications, calculations and analysis
- Operational assessments and requirements analysis
- Feasibility studies and evaluation of alternative propulsion concepts
- Availability, reliability and maintenance studies
- Conceptual design and specification of optimized propulsion systems
- Shock, noise and vibration studies
- Integration of the power and propulsion and distribution systems components with each other and other interfaces in the vessel.

Electric propulsion on a wide range of ships

More than 800 vessels equipped with Converteam systems

Wave Knight Auxiliary Oiler

System design
- Detailed design and specification of propulsion and auxiliary systems
- Machinery space arrangement and installation design
- Finite element calculations of structural and mechanical systems
- Dynamic simulation of ships and propulsion plant behaviour
- Total electrical systems modelling and characteristics evaluations.

System packaging
- Equipment definition and selection
- Supply of fully engineered and integrated propulsion packages
- Design, build and operation of bespoke test facilities
- Programme management
- Installation setting to work, trials and training
- After sales service and integrated logistic support.

Electric Propulsion
Advantages and Achievements

A most notable success for Converteam has been the low noise and vibration electric propulsion system for the Royal Navy's Type 23 Duke Class (ASW) frigates, for which Converteam was the 600V system design authority and supplier of the electric propulsion system. Integrated diesel-electric propulsion systems have been supplied on several significant vessels:

- The Royal Navy's two Landing Platform Docks (LPDs), HMS Albion and HMS Bulwark
- Two Auxiliary Oilers (AOs), Wave Knight and Wave Ruler
- The Mistral and Tonnerre Landing Helicopter Docks (LHDs) for French Navy
- US Navy's T-AKE Class ships
- US Navy and Royal Navy Test facilities

Technological advancements

Converteam has worked with the navies around the world to provide them with the best solutions for their specific applications. For the US Navy, Converteam has provided the electric power generation and propulsion requirements for the landbase Integrated Power System (IPS) programmes. This propulsion technology is currently being upgraded in support of the DDG1000 programme and is a potential option for future surface combatants with power capacity in excess of 80MW.

Some of the other navies around the world using Converteam equipment include:

Australia, Brazil, Canada, Denmark, Germany, Greece, India, Republic of Korea, Malaysia, Netherlands, New Zealand, Spain, Turkey…

DDG1000 artist impression

Advanced Induction Motor Drive

The trend towards high power, compact, Pulse Width Modulated (PWM) fed induction motors was made possible by developments in electrical machine design and digital control techniques that were pioneered in the early 1990's.

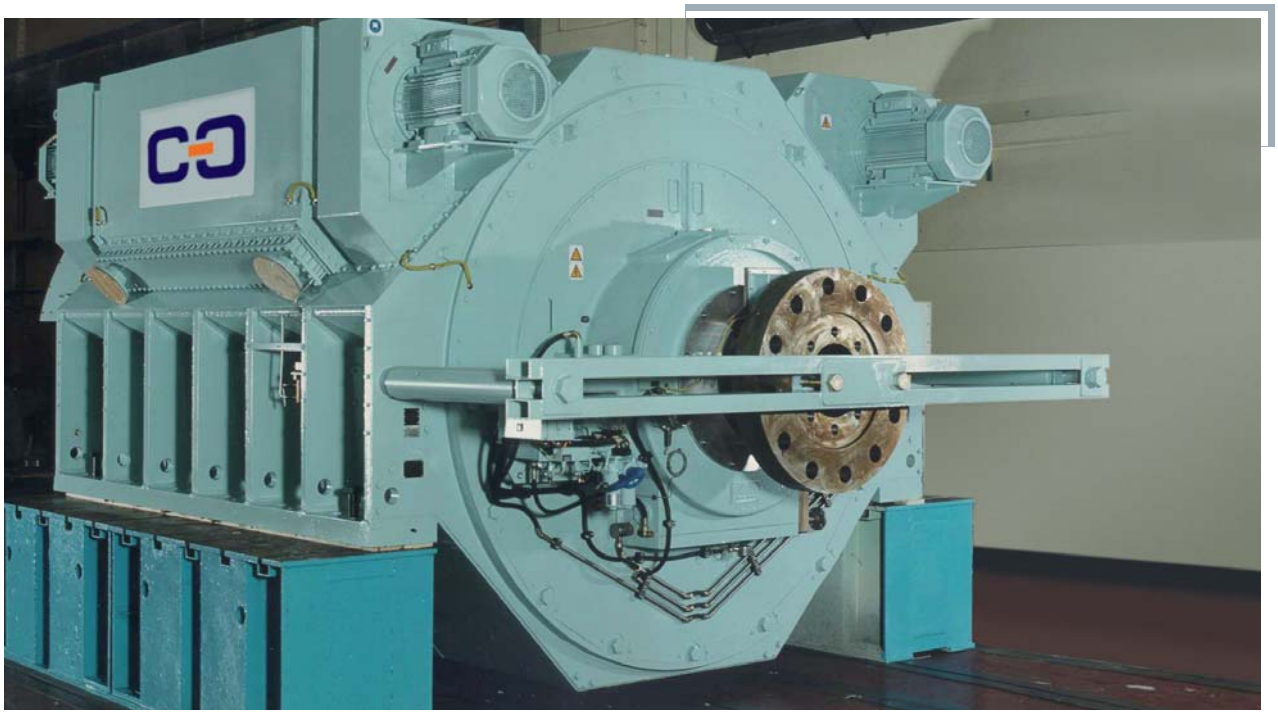
These early examples were developed for industrial applications and although the induction motors were 2 x 3 phase and transformer fed, the principle of Advanced Induction Motors (AIM) under variable speed control was established.

The AIM motor was designed for converter starting which allows more flexibility and optimisation of the electromagnetic design. This in turn, enables improved efficiency and power factor whilst allowing a larger air gap to provide a good shock withstand capability. The modern naval AIM system consists of a multi-phase machine driven by its complementary PWM converter.

Key features for naval applications include:
- High power density
- High efficiency
- Direct connection to high voltages (no transformers)
- Low noise & vibration level
- Any water-cooling
- High shock withstand
- Redundancy
- Low through-life cost and maintenance.

The Converteam AIM design was initially installed and thoroughly tested at the US Navy test facility in 1995 and the next generation is operational in the Electric Ship Technology Demonstrator in the UK. These motors are being installed on the Type 45 destroyers and was supplied to the USN's full power DDG1000 Engineering Development Model.
The Converteam AIM propulsion drive system is now the baseline for the Royal Navy and the French Navy aircraft carriers (CVF and PA2) and the US Navy's first two vessels of the DDG1000 programme.

One 5 Phase Channel or 15 Phases converter arrangement



The Electric Ship Technology Demonstrator 15 Phase Advanced Induction Motor

AIM Drive
Major Applications

Type 45
Anti-Air Warfare Destroyers for The Royal Navy

Main electrical characteristics:

- Initial studies and evaluation of propulsion systems
- Electric power plant:
  - 2 x 21MW GTA sets
  - 2 x 4160V switchboard sections
  - 2 x ship service transformers
  - 2 x 2MW DG sets
- Electric propulsion:
  - 2 x 20MW Advanced Induction Motors
  - 2 x 20MW PWM converters
- Harmonic filters
- Power management
- Back-to-back testing
- Shore integration testing
- Combined automation testing
- Setting-to-work and trials
- Through-life support

Converteam solutions form the baselines for capital ships.

PA2
Aircraft Carrier for The French Navy

CVF
Aircraft Carriers for The Royal Navy

Fully Integrated Electric Solution

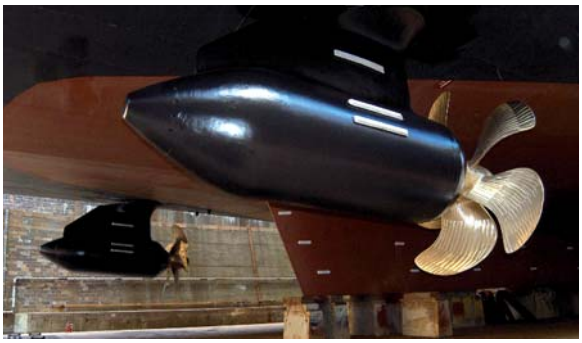
PWM MV7000 Converter and Induction Motor Solution

Recent developments in IGBT (Insulated Gate Bipolar Transistor) components have opened up new opportunities in power conversion. The use of press-pack IGBTs has helped design more efficient converters. Converteam has adopted this press-pack technology for the new MV7000 medium voltage PWM converters. In combination with induction motors, these converters significantly enhance electric propulsion in terms of efficiency, ease of maintenance and low noise & vibration levels. Elimination of harmonic filtering and a powerful encoderless controller further optimizes the total power & propulsion plant

Pourquoi Pas? Vessel Induction Motor

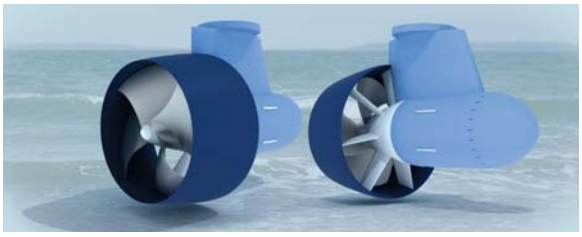
Podded Solutions

POD propulsion offers significant advantages in efficiency, reliability, space-saving since the system has been designed to require a minimum number of mechanical parts and provide excellent manoeuvrability which is essential for navigation in shallow water, and the embarkation / disembarkation phases.
Due to these advantages, the French Navy has selected this solution for its "Bâtiments de Projection et de Commandement" vessels: the Mistral and Tonnerre LHDs.



New pod developments

A new pod solution is being designed to integrate the state-of-the-art developments in power and control electronics and hydrodynamics to offer customers an optimal high-performance pod system.



SD7000 Solution: Mature and Proven Technology

An extensive range of ship types, in particular cruise ships, chemical tankers, auxiliary ships and research vessels bear out the efficiency of the synchronous drive solution. The combination of synchronous motors and synchroconverters has been widely adopted as illustrated by several references accumulated over many years. This solution is very well adapted to ships with high power requirements with twin shafts or single shaft tandem motors arrangements.

T-AKE Class Compact Tandem Motor

Fully Integrated Electric Solution

Major Applications

Pourquoi Pas?
Research vessel for French Navy and Ifremer

Number of shaft line:	2
Power rating:	2 x 1,650kW at 148 rpm
Scope of supply:	Electric propulsion
Associated systems:	A-series Dynamic Positioning System

The deep sea research vessel Pourquoi Pas ? is the first ship to be fitted with the new medium voltage PWM press-pack IGBT MV7000 converters.

Mistral & Tonnerre LHDs for French Navy

Number of shaft line:	2
Power rating:	2 x 7MW at 156 rpm
Pod rotation:	n x 360° in maneuvers (up to 10 knots)
Associated systems:	Power Management System

The Mistral & Tonnerre Landing Helicopter Docks are the first military vessels to implement the "All Electric Ship" concept and fitted with pods.

HMS Albion & HMS Bulwark LPDs for Royal Navy

Number of shaft line:	2
Power rating:	2 x 6MW at 150 / 180 rpm
Scope of supply:	Electric Power Plant, Electric Propulsion and Harmonic Filters
Associated systems:	Propulsion Control

The HMS Albion and HMS Bulwark are the first Amphibious Warfare ships and the first Royal Navy ships with fully integrated electric propulsion.

Wave Knight & Wave Ruler Auxiliary Oilers for Royal Navy

Number of shaft line:	1
Power rating:	2 x 7MW at 118 / 135 rpm
Scope of supply:	Electric Power Plant, Electric Propulsion and Harmonic Filters
Associated systems:	Integrated Platform Management System

The HMS Wave Knight and HMS Wave Ruler are the first Mobile Logistic ships fitted with fully integrated electric propulsion.

T-AKE Class Combat Logistics for US NAVY

Number of shaft line	1 with Compact Tandem Configuration
Power rating	2 x 11.20MW at 120 rpm
Scope of supply	Electric Power Plant, Electric propulsion, Bow Thrusters and Harmonic Filters
Associated systems	Integrated Automation System

The Combat Logistic T-AKE Class vessels for US Navy are the first military vessels equipped with a compact tandem electric propulsion.

Vessel Control Systems

Integrated Automation Systems

As part of its core solutions for the marine and offshore industry, Converteam offers its enhanced 'A' Series Vessel Control (AVC) System for full remote supervisory control and monitoring of all ship systems.

The AVC system combines shipwide supervisory control and monitoring together into a single system, enabling operators to have a complete overview of all ship systems. Distributed field stations provide local plant interface, with multi-function operator workstations providing the Human Machine Interface (HMI). System components are integrated using a high speed, redundant Ethernet network.
The AVC system covers a wide range of applications throughout the naval, offshore and merchant marine industries. Installations have included auxiliary ships, landing platforms, destroyers, fixed platforms, supply vessels, cruise liners, FPSOs, tankers, drill ships and cable layers.
The AVC system consists of a number of software modules, which may form stand-alone applications or which can be run together as a single entity.

Benefits

- Distributed architecture saves cabling
- 'I/O anywhere' philosophy
- Integration of hardware saves space and cost
- Network allows for easy future expansion
- High level of system redundancy
- Hazardous area compatible
- Commonality of hardware throughout
- Reduced spares holding
- Common look and feel across systems
- High level diagnostic features
- OPC interconnectivity.

Efficient Power Management Systems

Converteam has many years' proven expertise in providing complex power management control. A major competence within Converteam is the design and supply of power generation and distribution systems, leading to a thorough understanding of power management control requirements.
The power management system (PMS) constantly monitors, adapts and optimises electric energy generation and consumption (propulsion and ship service). The power management system can be a part of the integrated control monitoring system.

Dynamic Positioning Systems

Dynamic positioning enables a vessel to maintain heading and station, fixed or moving, by use of propulsors to counteract the effects of displacing forces such as wind, current and wave action. This method of manoeuvring, although simple, allows the system to control very complex operations safely and efficiently.
Today's integrated dynamic positioning solutions provide manual lever control, combined joystick control, fixed and tracking control and form a major part of the integrated bridge solution.

Modular Hardware Design

Converteam's 'A' Series systems are based on a modular approach, to allow customers the flexibility to use the Converteam 'A' Series award-winning console design or to deploy Converteam's system within third party consoles. The modular design has proved very popular for both new and retrofit installations where the navigation bridge is compact and space is at a premium.

Comprehensive Service Range
for Enhanced Reliability and Performance

As a forerunner in high technology systems and services, Converteam aims at providing its customers with optimal support. Converteam makes available a complete set of service packages, ranging from basic services - such as spare parts, training and access to a call center for maintenance and expert evaluation service agreements. Our service teams are strategically located worldwide and can intervene on vessels anywhere in the world at very short notice.

Technical Assistance around two Main Services ▷▷

- Access to 24 hours/7 days call center: Converteam's technical support is available to assist ship operators in trouble-shooting
- Telediagnostic facilities: efficient data transfer from the vessel to Converteam's main office for remote trouble-shooting by Converteam's skilled engineers.

High Quality Training to Enhance Crew Skills
At Converteam, training is given prime importance. The teaching staff comprises experts in electric propulsion systems, power electronics and control systems to give ship operators relevant and sound knowledge. Training sessions are either conducted on-board, at customer's or at Converteam's marine training centres.

Maintenance
Maintenance services feature access to Converteam's call centres for on-call inspection and technical assistance, regular inspection and routine maintenance, maintenance of equipment during dry and wet dockings, spare parts management and training sessions on-board or in Converteam's training centres.

Expert Evaluation
Converteam offers expert evaluation services including technical assistance, system and product technical assessment, Equipment and System Health Monitoring (EHSM), trouble-shooting and technical recommendations.

Upgrades and Modernisation
To help shipowners with the quick and continuous evolution of performance, safety regulations and more stringent environmental requirements, Converteam offers a wide range of possible upgrades of its systems. Each solution will be designed with the latest technologies and suited to meet customers' specific requirements.

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