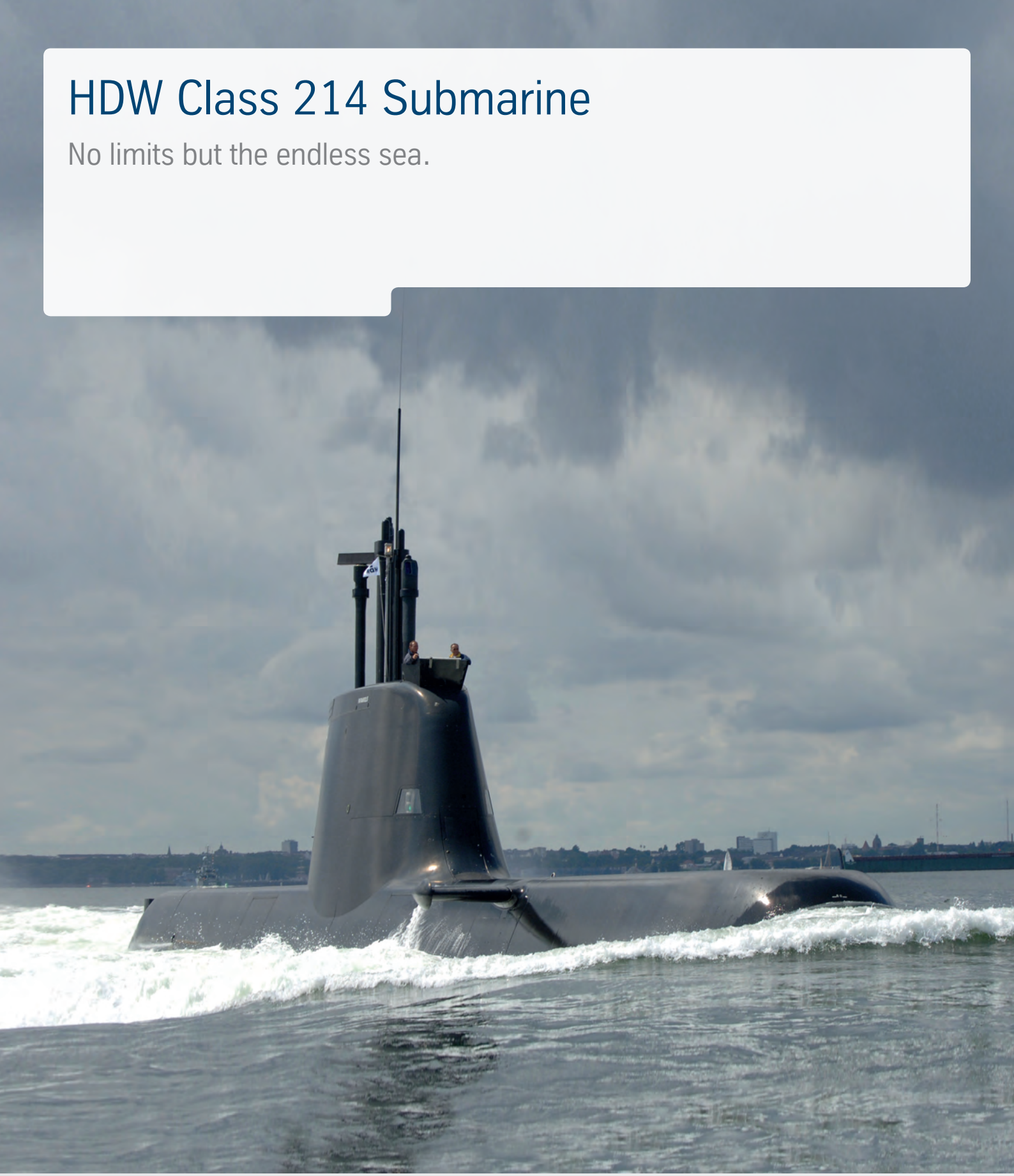
HDW Class 214 Submarine

No limits but the endless sea.



ThyssenKrupp Marine Systems

ThyssenKrupp

HDW Class 214 Submarine

ThyssenKrupp Marine Systems in Kiel with a HDW Class 214 submarine in foreground, heading for sea trials.

HDW Class 214 Submarine

ThyssenKrupp Marine Systems developed the HDW Class 214 submarine on the basis of the proven design principles of the HDW Class 209 family.

Additional incorporation of innovative features from HDW Class 212A has made this type of boat the most modern submarine in the world. The result is an outstanding air-independent but non-nuclear submarine with exceptional anti-submarine capabilities as well as extremely good stealth features and a high payload in the sensor and weapons field.

This boat thus meets all requirements when it comes to operations in littoral as well as in deepwater areas. Thanks to its modular design, the HDW Class 214 allows for a wide variety of options to respond to the individual navy's requirements.

The main improvements of HDW Class 214:

- Powerfully extended underwater endurance and low detection risk using the proven fuel cell system for air-independent propulsion (AIP)
- Incresed diving depth and overall efficiency
- Minimised acoustic, thermal and magnetic signatures thanks to the most advanced design and construction methods.

At present, numerous units are either under construction for or in operation with international navies.

Country	HDW Class	Year	Number
Greece	214	2000	3 (2*)
South Korea	214	2000	3*
Greece	214	2002	1*
Portugal	214 (209PN)	2004	2
South Korea	214	2008	6*
Turkey	214	2009	6*

*Assembled in customer's country

Operational Prerequisites and their Impact on the Concept of HDW Class 214 Submarines

1 Shipbuilding parts of HDW Class 214 under construction

2 A glimpse inside the production line (from left: HDW Class 214 and HDW Class 209)

3 Installation of the CIC into the platform of a HDW Class 214 submarine

4+5 HDW Class 214 during sea trials

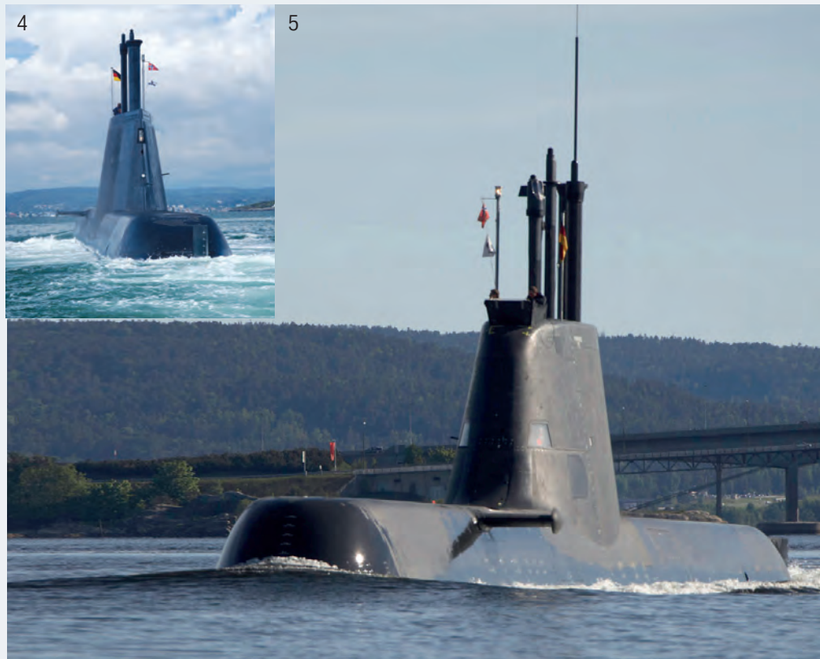
When ThyssenKrupp Marine Systems started to develop the HDW Class 214 submarine, the “Cold War” had come to an end. Geopolitical defence obligations that had been prominent during this period of time had become less important than considerations regarding international crisis management and conflict prevention.

These changed scenarios had an essential impact on the operational planning of navies and their demands on new submarines. Since 80% of all regions with a potential for crisis and conflict are either coastal regions or not more than 100 miles away from their respective coasts, nowadays submarines primarily have to perform missions in littoral areas. Due to their size nuclear submarines are in no way suited to fulfil this kind of task. The new operational requirements call for small conventional boats able to operate in coastal areas but still laid out for ocean-going patrols.

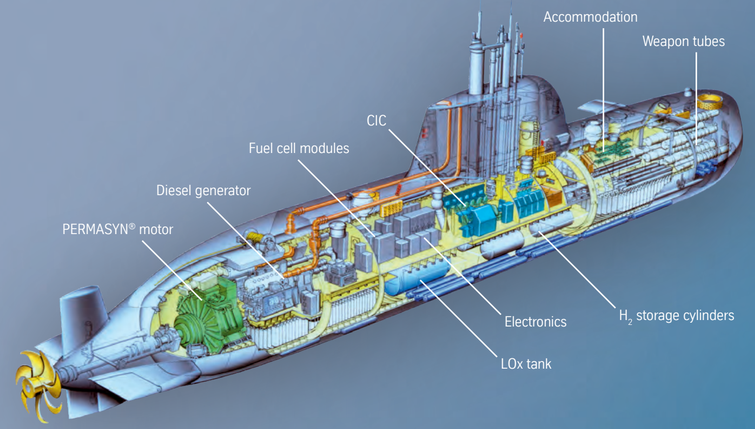
The “lone wolf” serving as a torpedo carrier is no longer required in the changed defence scenarios. This was by no means new ground to be broken by ThyssenKrupp Marine Systems. Unlike other suppliers, the German submarine industry has always concentrated on the development and construction of small and medium-sized non-nuclear submarines. The experience gained during building this kind of boat for the German parent navy as well as various international customers remains unrivalled in the world of naval shipbuilding. It goes without saying that HDW Class 214 also benefited from long-term know-how with regard to compact and highly manoeuvrable submarines. Apart from this, the modern modular weapon and sensor mix of HDW Class 214 allows for a multi-mission capability including:

- anti-surface and anti-submarine operations
- intelligence, surveillance and reconnaissance tasks
- covert mine-laying
- training and combat operations in a common task force.

The superior tactical advantages of the air-independent and extremely quiet new generation of submarines provide the basis for sensor performance levels second to none. The multiple sonar facilities permit improved classification ability for target data generation and weapon employment and control. The Command and Weapon Control System (CWCS) combines sensors, effectors and the navigation section via a high-performance data bus with centralised computer facilities.



Main Characteristics and Components



General Data

Length overall	approx. 66 m
Height	approx. 13 m
Pressure hull diameter	approx. 6.3 m
Surface displacement	approx. 1,800 t
Crew	27 (+3) (+5)
Pressure hull	ferromagnetic steel

Propulsion Plant

Propulsion motor	PERMASYN® motor
Fuel cell system	PEM fuel cell modules (2 x 120 kW)
Diesel generators	2 x 16 V 396
Main battery voltage range	450 – 900 V
Low-noise propeller	

Armament

8 full-size swim-out weapon tubes in the forward bulkhead for all kinds of torpedoes (4 tubes equipped with weapon expulsion systems for missiles and mine laying equipment)
Optional: IDAS (Interactive Defence and Attack System for Submarines)

Sensor System

- Cylindrical array sonar
- Flank array sonar
- Towed array sonar (option)
- Passive ranging sonar
- Active sonar
- Intercept detection ranging sonar
- Optronic mast
- Attack periscope
- Mine avoidance sonar

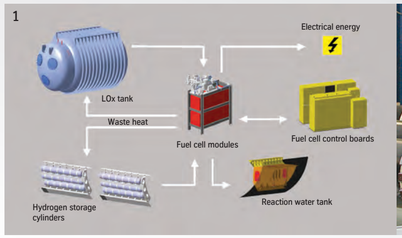
Navigation System

- Nav-Commander-Console
- Inertial Navigation System (INS)
- Navigation sensors
- GPS

Integrated Radio Communication System

- Hoistable communication masts
- Radar recognition system (IFF)
- Emergency communication system
- Buoyant wire antenna (option)
- Internal communication system

The HDW Fuel Cell Propulsion System



1 HDW fuel cell propulsion system
2 H_2 storage cylinders
3 LOx tank
4 Siemens 120 kW fuel cell module

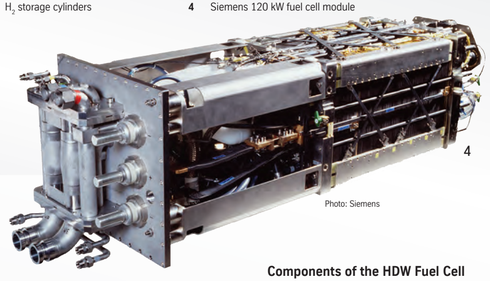


Photo: Siemens

The propulsion plant for HDW Class 214 is a hybrid system which allows the submarine to perform missions of several weeks' duration permanently submerged and largely independent of outer air. The hybrid system consists of two diesel generator sets, two batteries, fuel cell system and propulsion motor.

The HDW Fuel Cell (FC) System

The dream of staying submerged for an extensive period of time with a non-nuclear submarine has become a reality thanks to air-independent propulsion (AIP) systems. ThyssenKrupp Marine Systems recognised the potential of fuel cell technology at an early date and began to develop a fuel cell plant for air-independent submarine propulsion in the late 70s.

Fuel cells are energy converters which transform chemical energy to electric current without combustion or noise generation and independent of diving depth. Distilled water is the only reaction product besides electrical power. Fuel cell plants are ideally suited for submarine propulsion as they meet the highest demands of ensuring both extremely efficient energy conversion and lowest possible signatures.

The development of the HDW fuel cell propulsion system was advanced in close co-operation with Germany's Federal Office of Bundeswehr Equipment, Information Technology and In-Service Support (BAAINBw). Having evaluated different AIP solutions, the BAAINBw decided in favour of the HDW fuel cell system for integration into the new HDW Class 212A submarines. Meanwhile foreign navies such as those of Italy, Greece, South Korea, Portugal, Israel and Turkey have also chosen this future-orientated technology for their submarine flotillas. It is not only being installed in a fully integrated version onboard the HDW Class 212A, 214, 209PN and Dolphin AIP submarines but also in form of a plug-in section on board Greek HDW Class 209 submarines.

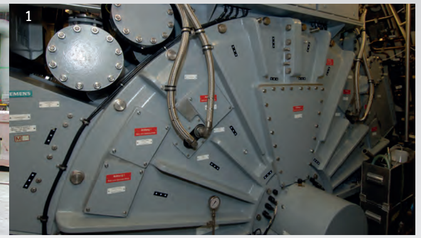
Components of the HDW Fuel Cell System

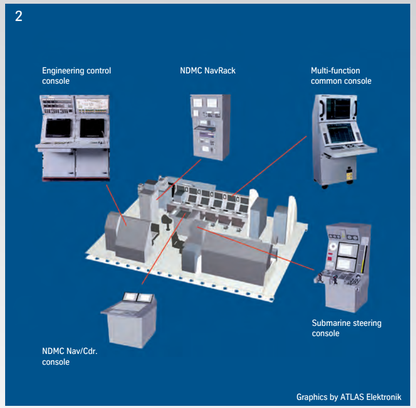
The heart of the fuel cell system is the Siemens polymer electrolyte membrane (PEM) fuel cell. It contains a solid polymer electrolyte which conducts hydrogen ions to the cathode, where they react with oxygen. The fuel cells are assembled in rows and form one complete stack within a pressure-tight housing. The PEM fuel cell operates at low temperatures (less than 80°C) with an efficiency of up to 65%.

The hydrogen is stored in metal hydride cylinders developed and built by ThyssenKrupp Marine Systems and located outside the pressure hull of the submarine. The lattice structure of the metal hydride enables it to absorb hydrogen atoms, which can be released by heat application and conducted as an energy carrier to the fuel cell.

The oxygen is carried on board in liquid form in a specially insulated tank mounted inside the pressure hull.

The PERMASYN® Motor and the Engineering Monitoring and Control System





The 2nd Generation PERMASYN® Motor

Power to the propeller is provided by an inverter-fed synchronous motor with pemanent magnet excitation (Siemens PERMASYN® motor). Control and monitoring functions are integrated in the motor. The PERMASYN® motor is considerably smaller than a comparable conventional DC motor. It achieves the same thrust at much lower revolutions and with improved efficiency. This enables a slow-turning propeller to be used, with optimal hydro-acoustic characteristics. The motor torque can be continuously adjusted over the entire speed range. The construction method ensuring a low leakage factor, the high shock resistance and low maintenance requirements make the PERMASYN® motor the tailor-made propulsion motor for HDW Class 214.

Engineering Monitoring and Control System (EMCS)

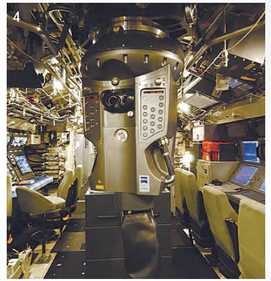
The task of the engineering monitoring and control system (EMCS) is the coordination of ship's technical systems.

The EMCS consists of different components which are:

- Engineering control console (ECC)
- Engineering control boards
- Diesel control and monitoring system (DCMS).

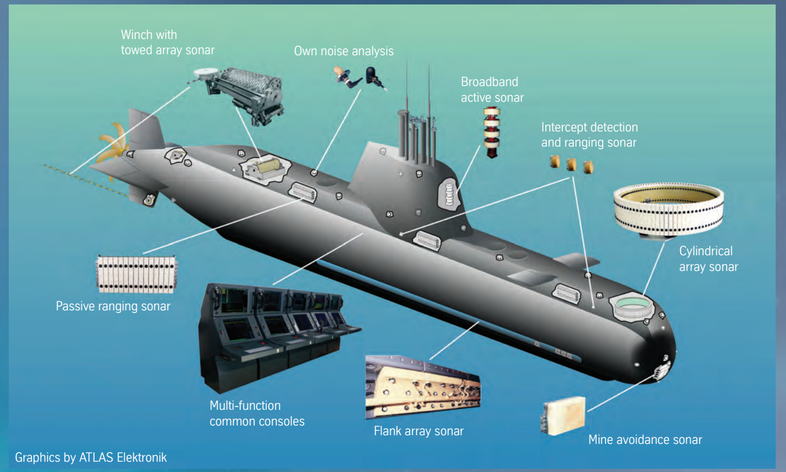
Process preparation, operation and monitoring are basically carried out from the ECC but also can be done from the other components.

The processing components ECC, ECBs and DCMS are connected by a redundant optical data bus. The EMCS is configured in such a way that processing functions (e.g. signal conditioning, open and closed loop control functions and signal generating) are performed in one of the components as ECC, ECBs and DCMS. Alarms, warnings and events are automatically togged in a separate alarm archive. Process functionality is conditioned in approximately 70 process pictures (HMI) also including measuring values of all analogue sensors and states of all binary sensors, valves, pumps and motors.



1 Siemens PERMASYN® motor
2 Chart of combat information centre
3 Engineering control colsole
4 Combat information centre

The Integrated Sensor, Command & Control and Weapon Engagement System ISUS 90



Graphics by ATLAS Elektronik

The ISUS 90 system made by ATLAS Elektronik is an advanced and sea proven fully integrated sensor, command & control and weapon engagement system for the HDW Class 214 submarines. Thanks to its open system architecture and modularity ISUS 90 matches all applications and requirements.

The Integrated Submarine Combat System ISUS 90 is built using subsystems for sensors, command and control and effector systems. It is equipped with sonar facilities for panoramic detection, analysis and classification of surface vessels, submarines and torpedoes. ISUS 90 integrates these acoustic sensors with optical and electronic sensors to allow for comprehensive command and control in the submarine system, as well as control of long range wire-guided torpedoes and missiles.

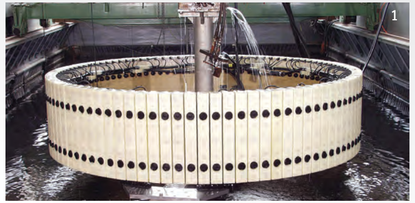
ISUS 90 offers the following main features:

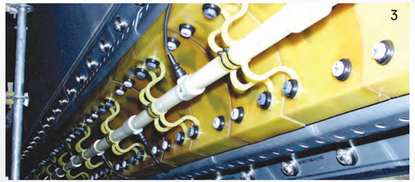
Open and Modular System Architecture

- Common infrastructure and software throughout the whole system
- Redundant design of all mission-critical functions
- Multi-function Common Consoles (MFCC) with two high resolution flat screen displays
- Open system allowing easy integration of third party applications
- Use of COTS components wherever possible.

Sonar Sensors and Functions Automatic

- Detection of acoustic signals using digital array technology
- Automatic tracking of sonar contacts
- Interactive classification of noise and pulse data
- Own Noise Analysis (ONA) for continuous monitoring of the submarine's noise behaviour.





1 Cylindrical array sonar

2 TAS winch (aft casing)

3 Flank array mounted on submarine

Command & Control

- System track/target management
- Target motion analysis (TMA) based on multi-sensor data processing
- Display of tactical situation
- Automatic threat and combatability analysis
- Integrated navigation, including electronic sea chart integration into tactical displays
- Integrated non-acoustic sensors allowing control and operation of:
  - Attack periscope/optronic mast
  - Radar
  - Electronic support measures (ESM)
- Data link for simultaneous reception, filtering, reformatting and transmission on multiple data link nets
- Integrated interfaces to internal and external communication systems supporting network centric operations.

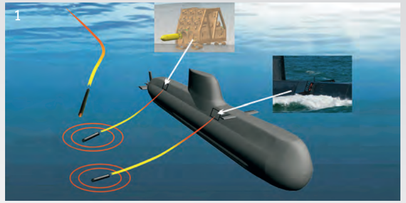
Weapon Control

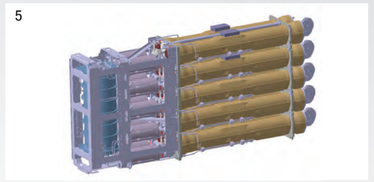
- Monitoring of system and weapon status
- Individual attack planning solutions simultaneously at each console
- Pre-setting and launching of weapons
- Simultaneous wire guidance of torpedoes
- Missile firing
- Mine laying support
- Release of torpedo alarm and control of torpedo countermeasures (TCM).

Support Functions

- Data recording system using an object-oriented data base management system
- Printing of sonar sensor data on a graphic recorder
- Digital multi-channel sonar raw data recording
- On-board simulation and training with the integrated simulation facility
- Built-in test and fault diagnostics for both hardware and software failures
- Sonar performance information range and integration tool (SPIRIT).

HDW CIRCE (Containerised Integrated Reaction Countermeasures Effectors)





HDW CIRCE is a rapid reaction, multi-effector system developed to meet the needs for a softkill torpedo countermeasures system (TCM). It is designed to counter modern and advanced lightweight torpedoes as well as wire-guided and non wire-guided acoustic homing heavyweight torpedoes by effectively decoying them using threat-matched jam and decoy functions.

Torpedo threat detection and alarm are provided by the submarine sonar system and continuously fed to the TCM system. HDW CIRCE is in constant standby condition ready to respond to any alert.

The jammers transmit broadcast noise on a significantly higher level than the reflected echo signal from the submarine. This broadband noise masks the submarine and breaks the contact between submarine and torpedo. The mobile target emulators (MTE) generate signals similar to the characteristics of the real target. The movement and false target signatures lead the torpedo away from the submarine.

The main components of the HDW CIRCE system are the remote control unit (RCU) with a functional interface to the CWCS, the swing-out devices integrated into the superstructure of the submarine, the container control units (CCU), the launch containers with 10 discharge tubes each and the effectors with their stationary jammers and mobile target emulators.

HDW CIRCE is an optional component of HDW Class 214 submarines. The HDW Class 214 submarines for the Hellenic Navy as well as the HDW Class 209/1400mod submarines for the South African Navy are the first boats that feature this outstanding TCM system. Since HDW CIRCE can easily be integrated into existing submarines as well, it is also a good opportunity for any navy with an ongoing or future refit programme to protect its submarines against torpedoes.

1 Torpedo countermeasures scenario

2,3,4 Swing-out device and launch container

5 Illustration of the TCM launch container

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