

Azipod® CO Product Introduction

Power and productivity
for a better world™



Preface

This Product Introduction provides system data and information for preliminary project planning of Azipod podded propulsion and steering system outfit. Furthermore, our project and sales departments are available to advise on more specific questions concerning our products and regarding the installation of the system components.

Our product is constantly reviewed and redesigned according to the technology development and needs of our customers. Therefore, we reserve the right to make changes to any data and information herein without notice.

All information provided by this publication is meant to be informative only. All project specific issues shall be agreed separately and therefore any information given in this publication shall not be used as part of agreement or contract.

Helsinki, November 2010

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Index of items

| | |
|---------------------------------------------|-----------|
| Preface | 2 |
| Index of items | 3 |
| 1 General | 4 |
| 1.1 Azipod propulsion and steering | 4 |
| 1.2 Type designation for the Azipod product | 5 |
| 1.3 Propeller output ratings per frame size | 5 |
| 1.4 Electric propulsion and power plant | 6 |
| 1.5 Steering angle convention | 7 |
| 2 Scope of supply | 8 |
| 2.1 General | 8 |
| 2.2 Azipod-specific delivered items | 8 |
| 2.3 Ship-specific delivered items | 8 |
| 2.4 Main dimensions and weights | 10 |
| 2.5 Steering module | 12 |
| 2.6 Propulsion Module | 12 |
| 2.7 Steering drive units | 13 |
| 3 Ambient reference conditions | 14 |
| 4 Interface to the ship | 15 |
| 5 Examples of typical installations | 16 |
| 5.1 Power plant ship example | 16 |
| 5.2 Offshore supply vessels | 17 |
| 5.3 Train ferries | 18 |
| 5.4 Private yacht “Ice” | 19 |
| 6 Azipod questionnaire sheet | 20 |
| Notes | 22 |

1 General

The first original Azipod® installation onboard was commissioned in 1990. By November 2010, the milestone of 5.8 million cumulated operating machinery hours has been reached. This is the total figure obtained with the various product variants of which the Azipod CO is one particular application.

1.1 Azipod propulsion and steering

The Azipod CO main propulsion and steering system was originally developed with the experiences gained from the already existing family of larger Azipod products. Azipod is a podded electric main propulsion and steering device driving a fixed-pitch propeller at a variable speed setting.

Azipod CO propulsion is designed for the preferential use of the (directly driven) pulling propeller when driving in the ahead direction. Azipod CO is azimuthing (steering around its vertical axis) infinitely by 360° and is available in three different frame sizes for propeller power ratings of up to 4,5 MW.

The full ship system consists of the required number of Azipod CO steering propulsors, plus the delivery of an “ACS” series marine Propulsion Power Drive per each Azipod. Additionally propulsion supply transformers (if needed), and the power plant (generators, switchboards) are usually included in the scope of the delivery.

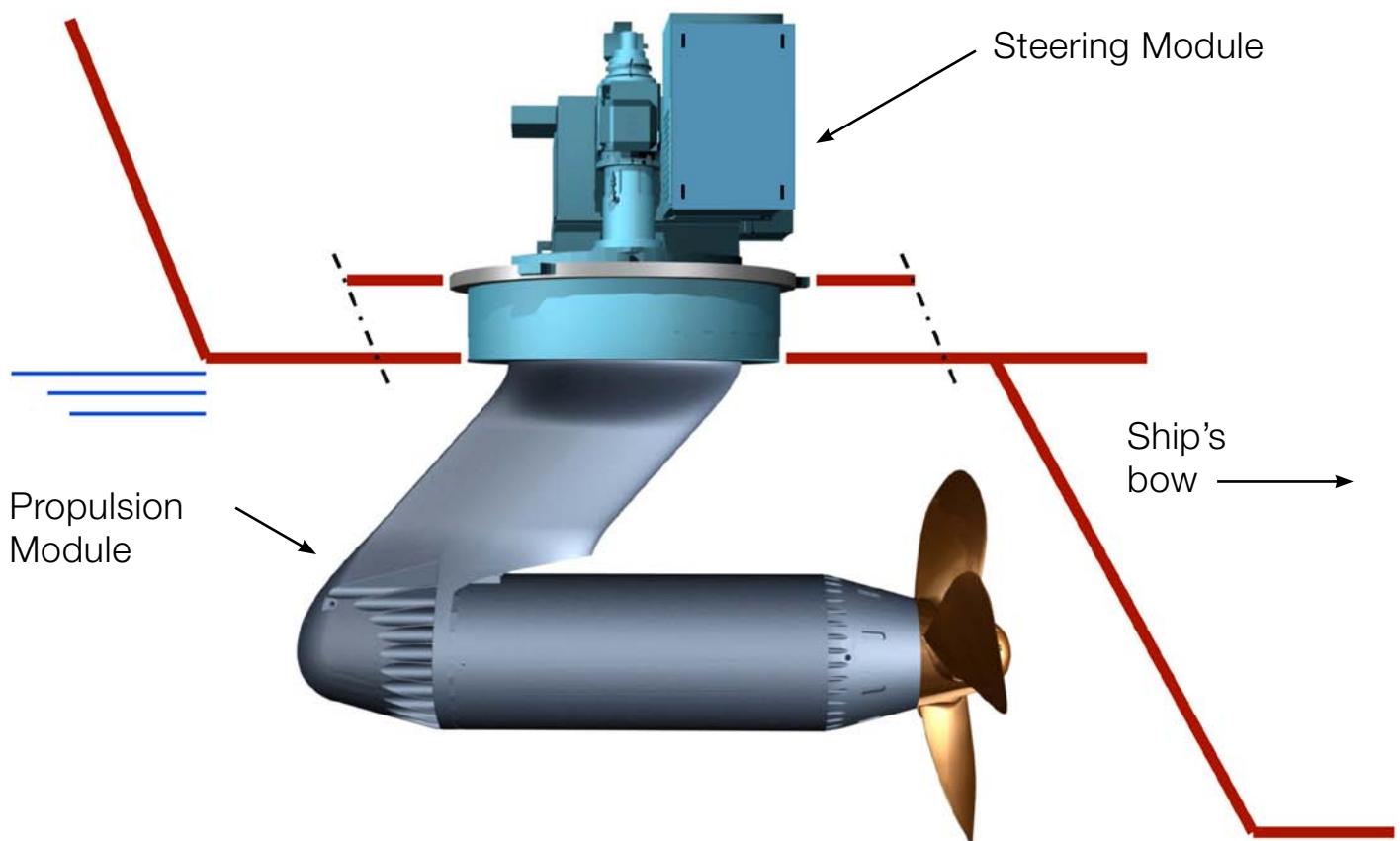
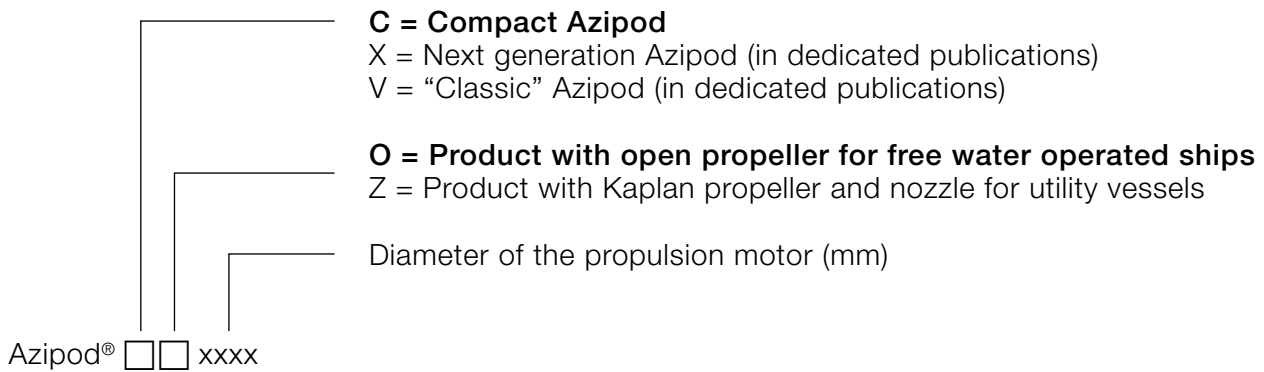


Figure 1-1 Basic arrangement of the Azipod CO

1.2 Type designation for the Azipod product

In the ship concept design stage, the following main designation is used. (A more specific type code will be allocated for the product during the advanced design stage).



1.3 Propeller output ratings per frame size

The darkened area on each of the three frame sizes is the recommended standard applied level for maximum rated propeller power:

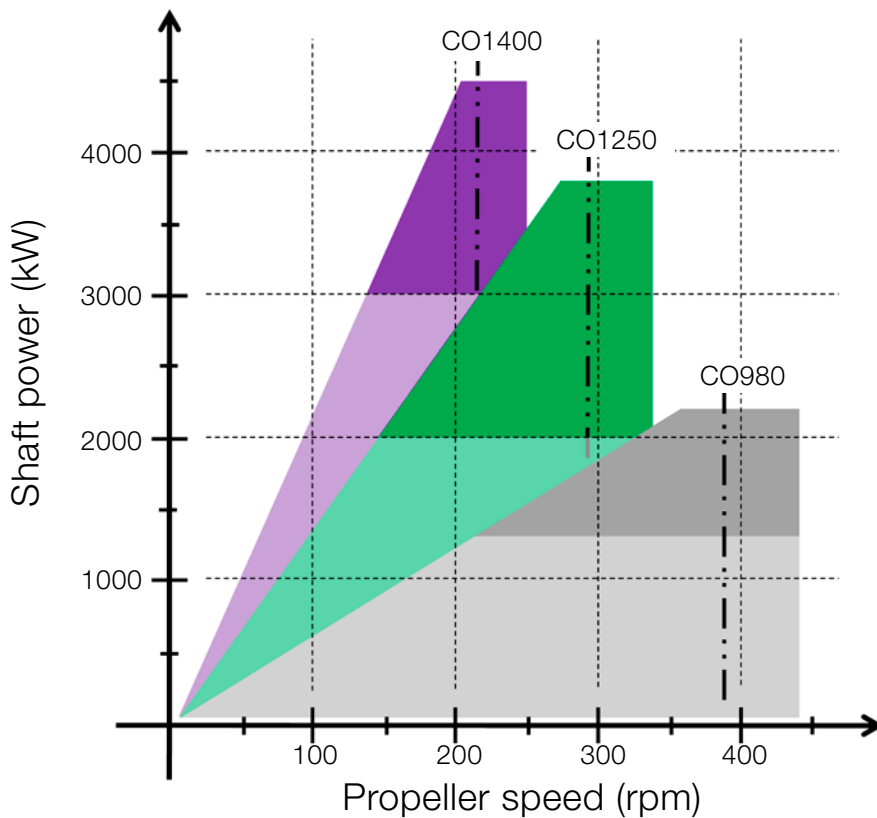


Figure 1-2 Output power in function of the RPM range

1.4 Electric propulsion and power plant

In order to drive the Azipod propulsion system the ship needs an electric power plant (not specifically presented on this document). Alternator sets supply power to the 50 or 60 Hz installation of electric switchboards for distribution to all consumers onboard, including Azipod propulsion.

Generally, ABB would aim to deliver the power plant as well as the Azipod system. Our mechanical interface to the engine maker is basically standard, although dependant on the delivery of engines or e.g. gas turbines from the contractors.

During the whole project the basic tool for power plant design is the so-called single line diagram. The actual onboard configuration can be efficiently discussed already in the early stages of work by using this clear visual representation.

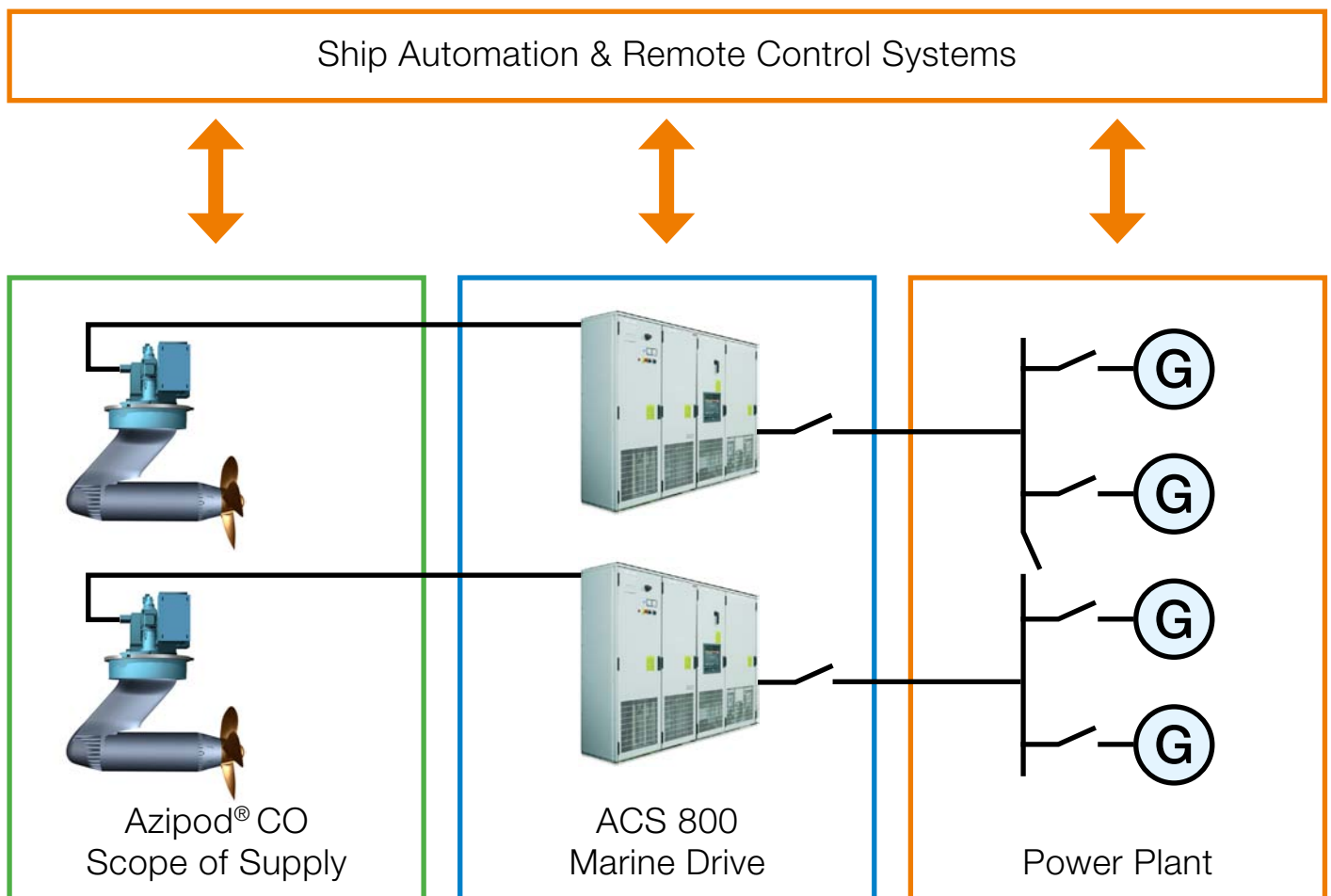


Figure 1-3 Simplified single line diagram of the power plant with a propulsion system.

1.5 Steering angle convention

The traditional ship steering convention of **PORT** (signal Red) and **STARBOARD** (signal Green) is used. Therefore, two main ship control configurations are to be considered:

- A. Ahead going ships
- B. Astern going ships

The steering equipment on double-ended ships (e.g. river ferries) usually needs to be outfitted as an appropriately configured combination of these two cases.

NOTE: The terms Port and Starboard refer to ship steering. The angle indicator instrument will show the actual rotational direction of the Azipod.

(Example of STARBOARD turn)

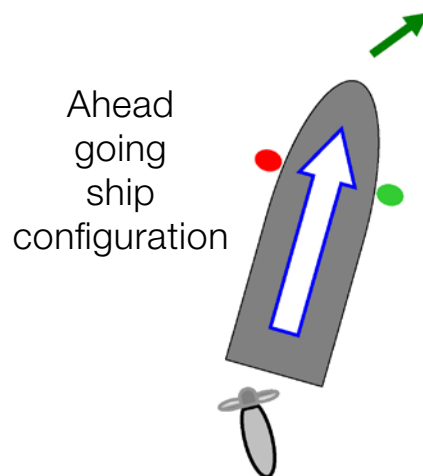
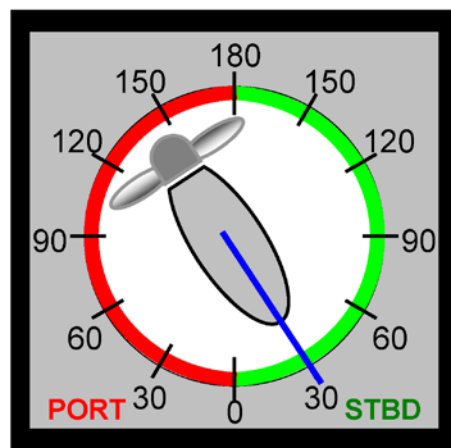


Figure 1-4
"Ahead sailing" concept:
rear pointer helm angle
indication

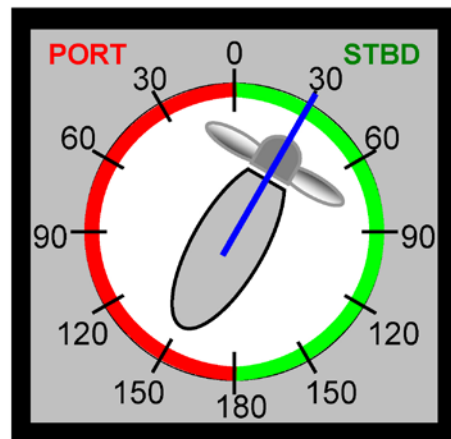
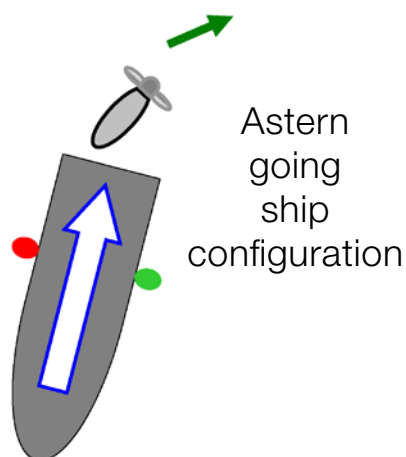


Figure 1-5
"Astern sailing" concept:
front pointer helm angle
indication

2 Scope of supply

2.1 General

The **Steering Module** is intended for connection into the ship's hull, and acts as the structural interface with the Propulsion Module. Internally, the Steering Module includes the fully electro-mechanical steering gear actuators as well as the functional accessories and connection points for propulsion and steering.

The **Propulsion Module** of the CO includes a permanent magnet synchronous motor with a fixed-pitch propeller that is mounted directly onto the motor shaft. The motor is directly cooled via convection to the surrounding seawater without using any additional cooling media. The motor is pressurized by air. The Propulsion Module is connected to the Steering Module by means of a cast steel strut.

The strut acts therefore as the connecting component in the CO structure. Control cables, as well as power supply bus bars and piping are located inside this single piece strut.

2.2 Azipod-specific delivered items

Each Azipod CO consists of four (4) separately delivered items for installation into the ship:

- One (1) Steering Module (Mounting interface with the ship)
- One (1) Propulsion Module (Strut, motor and propeller)
- Two (2) Steering Drive Units (Power electronic cubicle)

2.3 Ship-specific delivered items

In addition to the above listed delivery, the ABB scope of supply would typically include all or most of the following items:

- A. One Propulsion Power Drive per each Azipod CO
- B. Remote Control System
- C. The Generator and Switchboard power network outfit

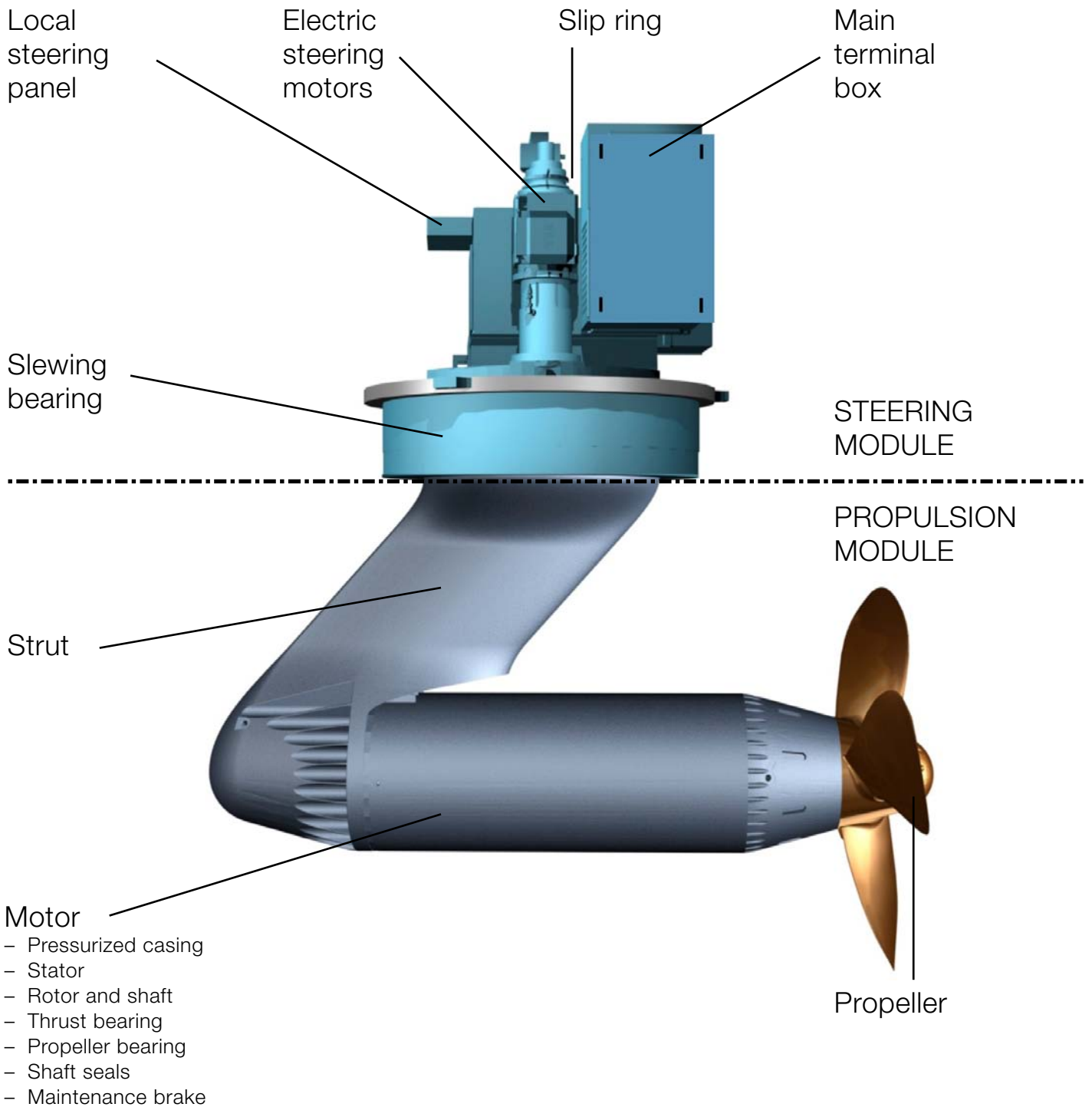


Figure 2-1 Functional elements of the Azipod CO

2.4 Main dimensions and weights

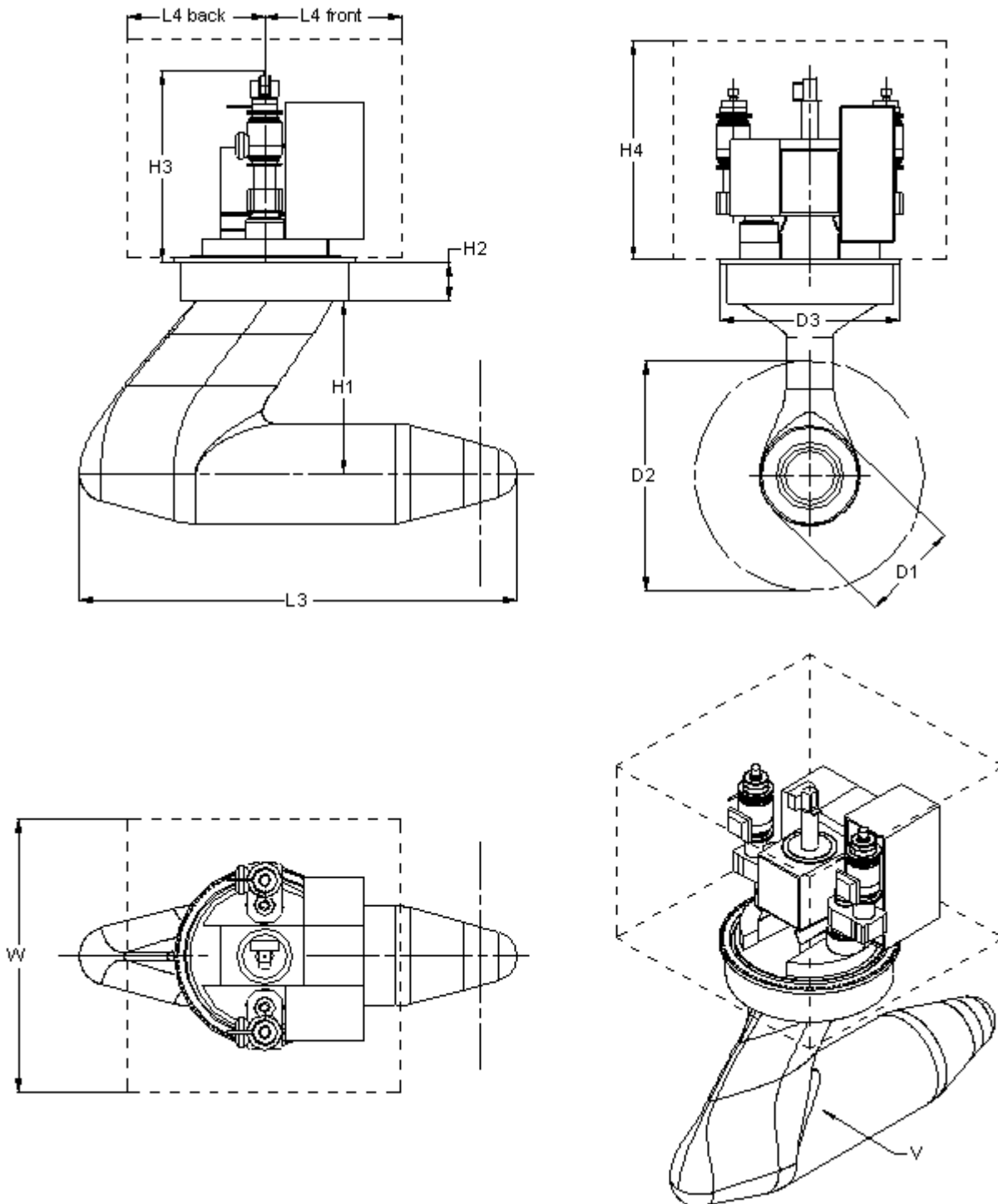


Figure 2-2 Dimensional codes for the Azipod CO

| Figure | CO0980 | CO1250 | CO1400 |
|---------------------------------------------------------------------------------------------------|-------------|-------------|-------------|
| D1 [mm] Outer diameter of the motor | 1039 | 1310 | 1470 |
| D2 [mm] Propeller diameter (min. – max.) | 1900 – 2600 | 2400 – 3500 | 2700 – 4000 |
| D3 [mm] Connection flange outer diameter | 2300 | 2780 | 2780 |
| L3 [mm] Length of the Propulsion Module | 4800 | 5730 | 6200 |
| H1 [mm] Height from motor shaft line to the ship bottom | 1950 | 2710 | 3090 |
| H2 [mm] Height of slewing bearing assembly to the connection flange lower surface | 495 | 650 | 650 |
| H3 [mm] Height from connection flange lower surface to the top of the steering module | 1980 | 1980 | 1980 |
| H4 [mm] Maintenance area | 2300 | 2300 | 2300 |
| L4 back [mm] Maintenance area | 1400 | 1700 | 1700 |
| L4 front [mm] Maintenance area | 2100 | 2250 | 2250 |
| W [mm] Maintenance area | 4000 | 4000 | 4000 |
| M1 [ton] Total weight of complete Azipod | 27 | 49 | 60 |
| M2 [ton] Weight of the Steering Module | 7 | 11 | 11 |
| M3 [ton] Mass of the Propulsion Module (including approximate max. weight of propeller) | 20 | 38 | 49 |
| V [m³] Displacement of the Propulsion Module (at assumed draft) | 4 | 8,5 | 11 |
| v [knots] Maximum water speed at the Azipod | 18 | 19 | 21 |
| R [mm] Azipod turning radius | 2700 | 3050 | 3350 |
| M4 [ton] Mass of the Steering Drive | 2 x 0,5 | 2 x 0,5 | 2 x 0,5 |
| n [degr/sec] Maximum available steering rate | 12 | | |

Figure 2-3 Technical figures of the Azipod CO

2.5 Steering module

The Steering Module consists of local control and equipment boxes, slip rings, steering motors with gearboxes and the slewing bearing. The steering components are mounted onto the Steering Module, and are delivered completely assembled to the shipyard. The Steering Module is to be mounted to the ship hull by the shipyard.



Figure 2-4 Steering Module ready for packing and for delivery to the shipyard

2.6 Propulsion module

The Motor and the Strut are mounted together with the propeller at ABB to form the Propulsion Module. The Propulsion Module is attached at the shipyard to the Steering Module by bolted connection.

The Propulsion Module incorporates a permanent magnet synchronous motor with a fixed-pitch propeller that is mounted directly onto the motor shaft. The motor section of the Propulsion Module therefore includes the complete electric motor with bearings, shaft seals, and a maintenance brake.

Permanent magnet technology brings a number of benefits. The design enables the motor to be directly cooled via convection to the surrounding sea water without using any additional cooling media. The outer diameter of the motor can thus be decreased for obtaining improved hydrodynamic efficiency.

The propeller shaft seal assembly combines a water lubricated face type seal and two grease lubricated lip type seals running on a steel liner. The set air pressure inside the motor prevents sea water from entering into the Propulsion Module.

The Strut is designed to enhance hydrodynamic steering performance and acts also as a connective element in the Azipod CO structure. Control cables, piping and power supply bus bars for the propulsion motor are located inside the single piece cast strut module.

2.7 Steering drive units

The electric steering gear of the Azipod CO is driven by two (2) Steering Drive Units of the ACS800 type. These two Steering Drive Units operate together by the master – slave closed control principle. One of the drives is to be fed from a main switchboard, and the other from the emergency switchboard. In case of a malfunction to one of the units, the other can steer the Azipod with a lower helm torque.

The Steering Drive Units are typically located in the Azipod room.

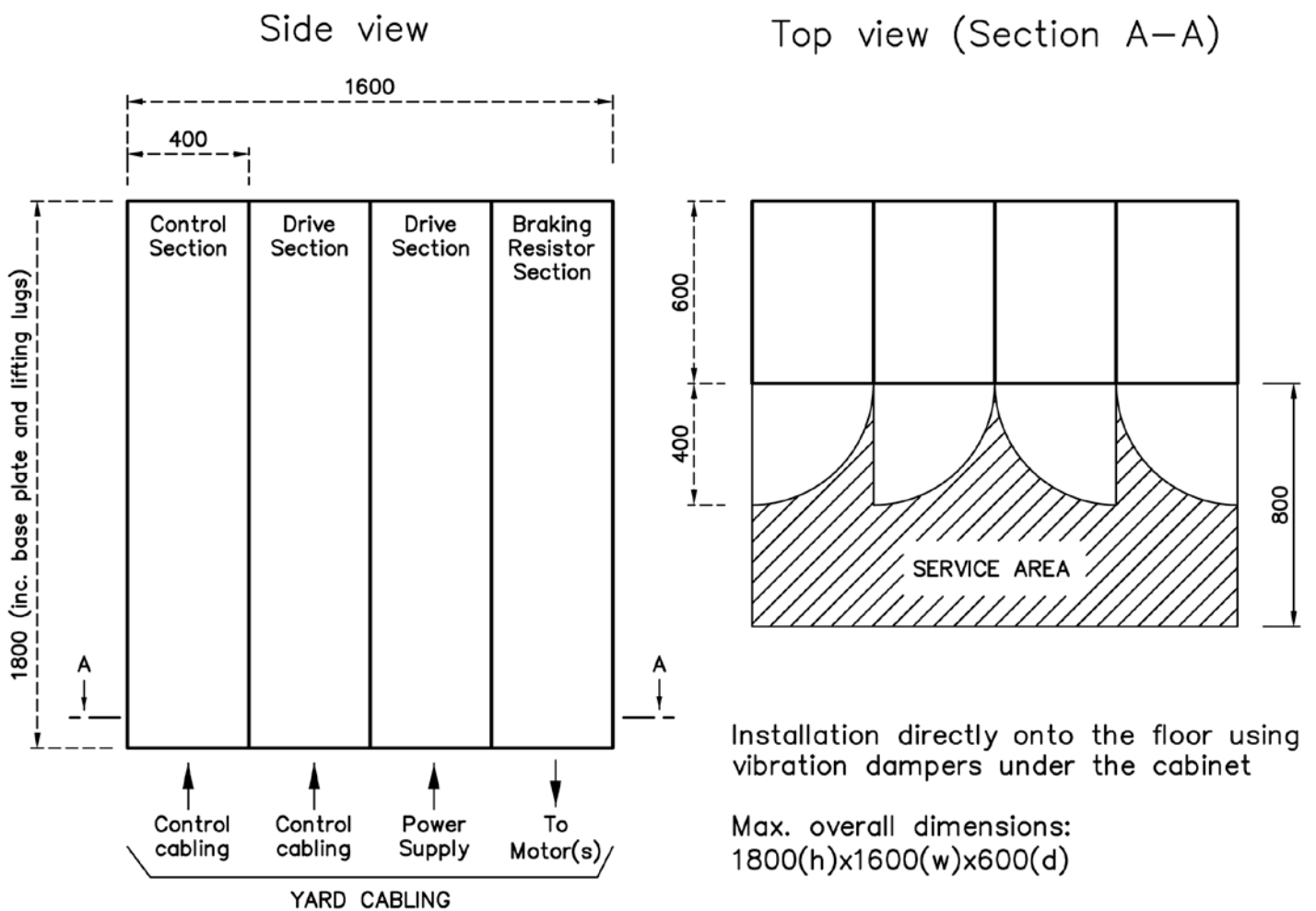


Figure 2-5 Typical dimensions of one Steering Drive Unit for Azipod CO

3 Ambient reference conditions

Azipod

| | | |
|---------|------------------------------|---------------|
| | Rated sea water temperature | -2 ... +32 °C |
| T and V | Maximum resultant tilt angle | ± 6° |

If there is a need to exceed these angles please consult ABB.

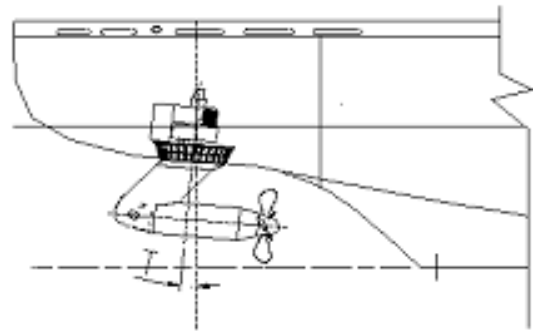
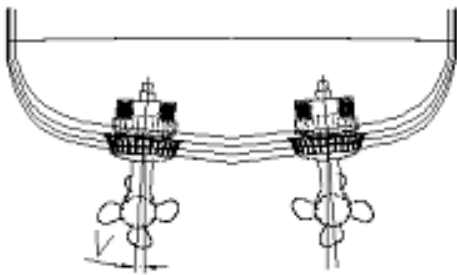


Figure 3-1 Azipod orientation

Azipod room

| | |
|-----------------------------|------------------------------|
| Maximum ambient temperature | +45 °C |
| Minimum ambient temperature | +2 °C |
| Relative humidity | 95%, no condensation allowed |

Propulsion Power Drives (ship specific item)

| | |
|---------------------------------------|------------------------------|
| Rated ambient temperature | +45 °C |
| Relative humidity | 95%, no condensation allowed |
| Cooling fresh water inlet temperature | +2 ... +38 °C |
| Pressure | 200 ... 600 kPa |

4 Interface to the ship

The Azipod CO propulsion controls can be built to operate with or without a ship automation system. The ship automation system is needed for monitoring the propulsion system. It should also control the auxiliaries of the propulsion, e.g. the cooling water flow. The ship automation interface is to be carried out with a serial data link and by hard wired connections.

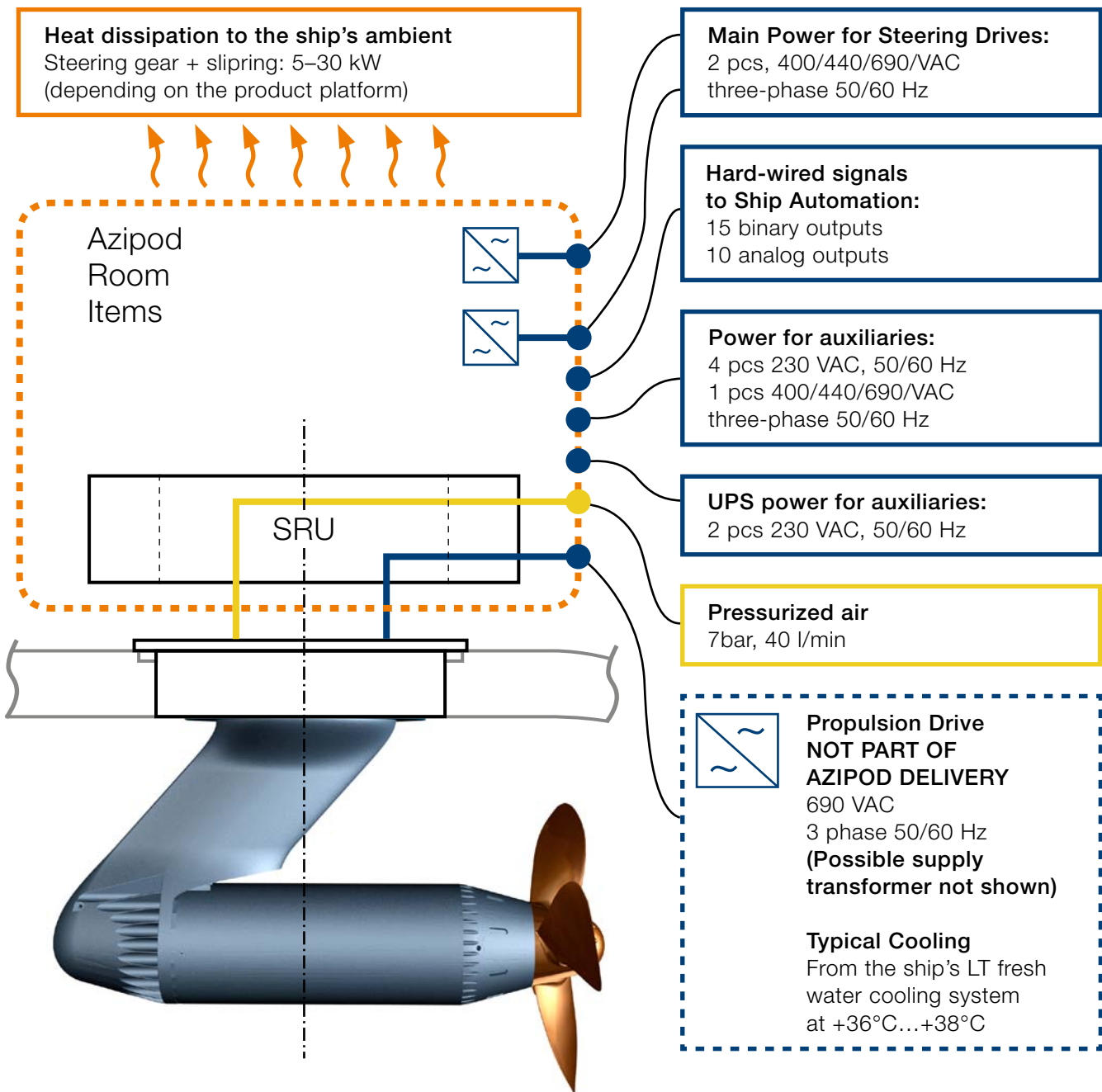


Figure 4-1 Azipod ship interface diagram in a preliminary project format

5 Examples of typical installations

The electrical power plant operates with very high efficiency practically at the whole operating range. This is achieved by having the generators connected to the network only in high load conditions. Being able to operate the prime movers with high loads all the time keeps the total propulsion system efficiency high. The following single line example shows the principle arrangement and configuration flexibility of the electrical propulsion system.

5.1 Power plant ship example

In this typical configuration three main generators are connected to the main switchboard, and the low voltage switchboard is supplied by two ship service transformers. The total harmonics' distortion (THD) is brought to the required level with the use of filters. The main switchboard can be divided into two separate networks by means of the tie breaker to increase the redundancy of the powerplant. A typical system configuration with Azipod CO propulsion consists of the following components:

- Three main generators
- Propulsion switchboard 690 V with a tie breaker
- Two ACS 800 marine Propulsion Power Drive frequency converters
- Two Azipod CO1400 steering propulsors
- Bow thruster with electrically driven motor
- Two ship service transformers 690V/440V
- 440V switchboard
- Total Harmonics Distortion (THD) Filters
- UPS and UPS supply panel
- Two low voltage transformers 440V/220V
- 220V switchboard / panel
- Emergency generator

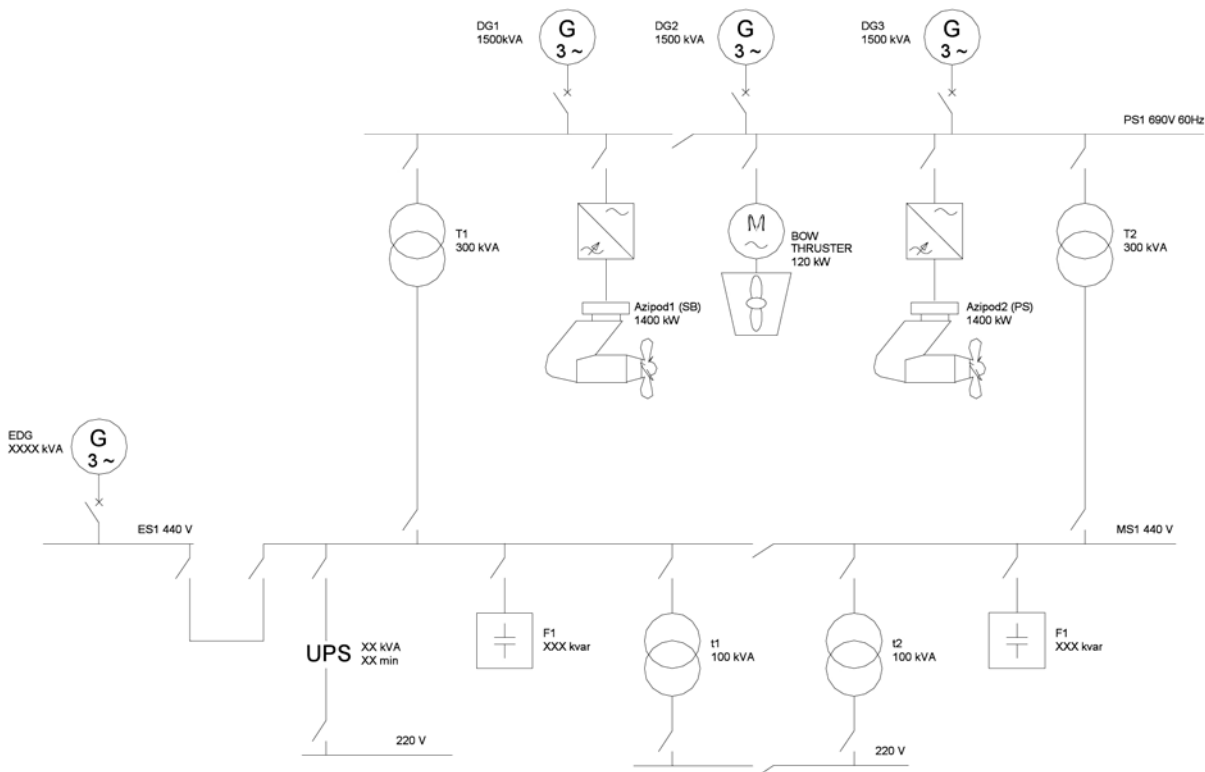


Figure 5-1 Example of a typical electrical power plant

5.2 Offshore supply vessels

| | | | |
|---------------------|---------|----------------------|------------------|
| Length overall | 92,40 m | DWT | 4000 t |
| Length between p.p. | 80,75 m | Speed | 15 knots |
| Breadth | 18,8 m | Azipod CO propulsors | 2 × 2300 kW |
| Draft | 7,6 m | Ship deliveries | 2001, 2002, 2003 |

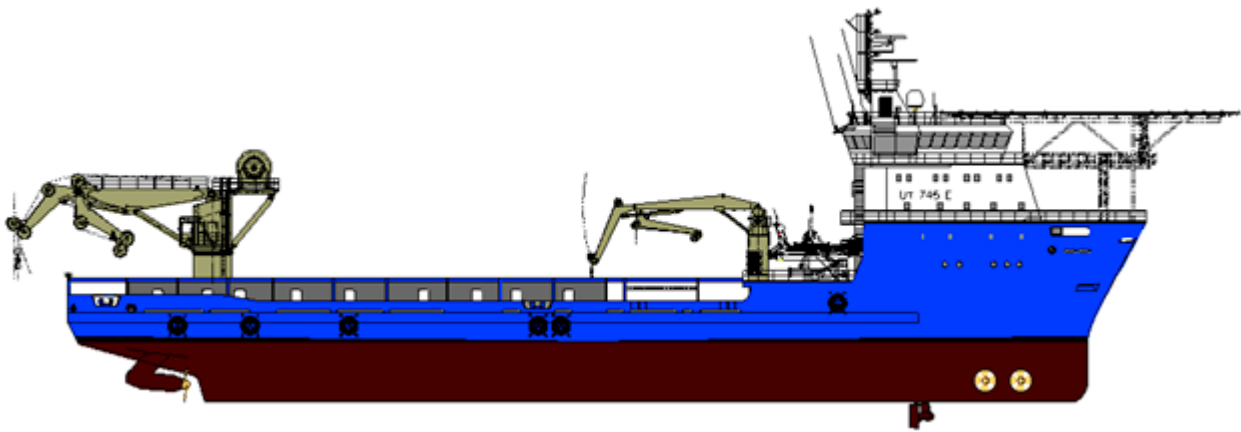


Figure 5-2 Multi functional Platform Supply / ROV Vessel. Normand Rover.



Figure 5-3 Azipod CO1400 propulsor ready for installation at Søviknes Verft.

5.3 Train ferries

| | | | |
|---------------------|---------|----------------------|------------------|
| Length overall | 182,6 m | DWT | 9000 t |
| Length between p.p. | 164,6 m | Service speed | 18 knots |
| Breadth | 24,8 m | Azipod CO propulsors | 2 × 4088 kW |
| Draft | 9,0 m | Ship deliveries | 2006, 2007, 2008 |



Figure 5-4 Yantai-Dalian Train Ferry ready to depart en route



Figure 5-5 Operating area and Azipod propulsors ready for original shipment from Helsinki

5.4 Private yacht “Ice”

| | | | |
|----------------|------|-----------------------------------------|---------------------|
| Length overall | 90 m | Azipod CO propulsors Ship deliveries | 2 × 2500 kW 2005 |
|----------------|------|-----------------------------------------|---------------------|



Figure 5-6 The “Ice” yacht is built to sail to long-range operational requirements



Figure 5-7 CO steering propulsors for “Ice” ready for dispatch to the Lürssen shipyard

6 Azipod questionnaire sheet

| PROJECT INFORMATION | |
|------------------------------------------------|--------------------------------------------------------------------------------------|
| Company | |
| Contact person | |
| Project no. | |
| Tel. No. | |
| Fax. No. | |
| Ship type | |
| DESIGN DATA | |
| Ship main dimensions | L ~ _____ m D ~ _____ m B ~ _____ m |
| Propulsion power | _____ × _____ kW |
| Main voltage | <input type="checkbox"/> 690 V / <input type="checkbox"/> Other _____ V |
| Generator power | _____ × _____ kVA |
| Max. vessel speed | _____ knots |
| Bollard pull | _____ kN _____ metric tons |
| Classification society | _____ |
| Class notation | _____ |
| Nozzle | <input type="checkbox"/> No (Azipod CO) / <input type="checkbox"/> F Yes (Azipod CZ) |
| QUANTITY & APPLICATION INSTALLATION | |
| Number of vessels | _____ pcs |
| Estimated time of delivery | _____ |

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