



Ulstein Aquamaster US 205 FP

全回转舵桨技术规格书

SHIPYARD:

OWNER: 汕尾电厂 Shanwei Power Plant

CONSULTANT:

SHIP: Stern Drive tug 尾推进式拖轮

PRIME MOVER: Diesel engine 柴油机

CLASS: China Classification Society (CCS)

DEFINITION: **Ulstein Aquamaster US 205 FP** is a Z-drive azimuthing thruster for direct diesel engine drive, furnished with a fixed pitch propeller (running in a TK-nozzle). There is a bolt-in type with bottom well cover for mounting to the vessel. The steering of thruster is controlled by the Aquapilot DBL control system.

Ulstein Aquamaster US 205 FP 为 Z-形全回转推进器，由柴油机带动，装有固定螺距螺旋桨，螺旋桨在 TK 型导流管内转动。推进器带有螺栓连接式上部安装的围井盖，装在船体结构内。US205 舵桨装置的回转由 Aquapilot DBL 回转控制系统操纵。

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1. TECHNICAL DATA 技术参数

1.1 THRUSTER UNIT 舵桨单元

Thruster type/size 舵桨型号	Ulstein Aquamaster US 205 FP
Propeller type 桨叶形式	monoblock, fixed pitch 整体铸造固定螺距
Number of blades 桨叶数量	4
Propeller material 桨叶材质	Nickel-Aluminum-Bronze 镍铝青铜
Manufacturing standard 制造标准	ISO 484/2 - 1981 class II
Propeller diameter 桨叶直径	2,200 mm
Nozzle material 导流管材质	mild steel 船用钢板
Stem length ¹ 轴间距	3,000 mm
Direction of rotation looked at the input shaft 舵桨输入轴转向	Counterclockwise ²
Mounting 安装方式	bolt-in type with bottom well cover 螺栓连接围井式
Upper assembly design 上部结构设计	identical units 相同结构
Propeller speed 桨叶转速	256 rpm
Propeller rotation looked at ship's stern 桨叶旋向	outboard 外旋
Clutch type 离合器形式	build-in, hydraulically operated 内置式液压操作
Steering gear 回转齿轮	hydraulically operated 液压驱动
Steering speed ³ 回转速度	3 rpm
Steering/Lubrication pump drive 回转/润滑泵	mechanically, V-belt drive 机带泵
Seal oil tank 密封油柜	Gravity type 重力式

1.2 PERFORMANCE DATA 性能参数

The bollard pull of a stern drive tug with the engine power specified is tested in accordance with the Code of Procedure for Bollard Pull Trials of Tugs with Ulstein Aquamaster Propulsion Units.

在额定主机功率下对尾推进式拖轮所发出的系柱拖力的测试时，船厂需按照舵桨厂家提供的试验大纲进行试验。

1.3 PRIME MOVER 主机

Prime mover type 主机形式	diesel engine 柴油机
Max. power on the input shaft 主机发出最大功率	1471 kW
Diesel engine speed, 100 % MCR 主机额定转速	750 rpm
Diesel engine idling speed 主机怠速	350-400 rpm

¹ the vertical distance between the input shaft and the prop. shaft

² i.e. the engine is running clockwise when looked at the flywheel

³ at engine speed of 33-100% of the nominal input speed rpm



1.4 COOLER DATA FOR STEERING HYDRAULICS / UNIT 回转液压系统冷却器参数/台机

Heat dissipation 散热量	8 kW
Total demand of cooling water 所需冷却水量	ca. 1,2 m ³ / h
Max. cooling water inlet temperature 冷却器进口最高温度	+38°C
Pressure difference 压差	<0.1 bar

1.5 COOLER DATA FOR LUBRICATION OIL / UNIT 润滑系统冷却器参数/台机

Heat dissipation 散热量	45 kW
Total demand of cooling water 所需冷却水量	ca. 6,8 m ³ / h
Max. cooling water temperature (inlet) 冷却器进口最高温度	+38°C
Pressure difference 压差	<0.1 bar

1.6 OIL VOLUMES 油容量

Steering hydraulic oil tank 回转液压油柜	ca. 150 liters
Lubrication oil in the unit 舵桨本体中的润滑油	ca. 1200 liters
Gravity tank for sealings 密封油柜	35 liters

1.7 WEIGHTS (DRY WEIGHT PER ONE THRUSTER UNIT) 重量 (每台套干重)

Azimuth thruster 舵桨单元	ca. 21,460 kg
Intermediate shaft line ca. 8 m 中间轴, 长约 8 米	ca. 1,900 kg
Other components (controls, spare parts etc.) 其它部件	ca. 200 kg

1.8 VOLTAGE SUPPLY FOR CONTROL SYSTEM PER ONE THRUSTER UNIT 每桨电源

Power supply unit (SUP) 变压单元	3*380 VAC, 50 Hz/ 300W
Supply Change over Unit (SCU) 自动切换单元	24 VDC / 300 W



2. SCOPE OF SUPPLY AND EXCLUSIONS 供货范围

2.1 THRUSTER UNIT 舵桨单元

Azimuth thruster 舵桨本体 2 pcs

2.2 INBOARD COMPONENTS 舱内部件

Gravity type seal oil tank 重力式密封油柜 2 pcs

2.3 SHAFT LINE 轴系

Intermediate shaft line 中间轴系 2 pcs

2.4 ECR EQUIPMENTS 机舱监控室

- Aquamaster control unit (ACU) 舵桨控制单元 2 pcs

- Power supply unit (SUP) 变压单元 2 pcs

- Supply change over unit (SCU) 自动切换单元 2 pcs

- Alarm panel 报警板 2 pcs

2.5 MAIN CONTROL STATION 驾驶室

Control consoles for Aquapilot control system 驾控台 2 pcs

Each Including 每台包括：

Aquapilot control head (AQP) 控制手柄 1 pc

Thrust direction indicator (TDI) 舵角指示器 & 舵桨转速表 1 pc

Aquapilot control panel (ACP) 控制面板 1 pc

Back-up Control panel (BCP) 备用控制面板 1 pc

Bridge I/O-unit (SLIO) 桥楼输入/输出单元 1 pc

Alarm panel (HAC) 报警板 1 pc

2.6 MISCELLANEOUS ITEMS 其它

Data transmission cables between WH and Ulstein Aquamaster unit (cable length 400 m)
数据传输电缆 (400 米长) 1 set

2.7 SPARE PARTS 备件

Onboard spare parts 随机备件 1 set

2.8 TOOLS 工具

Hand tools 标准手动工具 1 set

Hand Held Terminal 手持编程器 1 pc



2.9 SPECIAL TOOLS 特殊工具

Special tools for propeller dismounting 桨叶拆装工具..... 1 set

2.10 DOCUMENTS 文件资料

Approval Drawings 认可图..... 6 sets

Engineering documents for shipyard 工作图 6 sets

Manuals (In English and Chinese)完工资料中英文及 2 套光盘 6 sets

- Service manual 机械部分
- Service Manual for control system 电气控制部分
- User Guide 用户手册
- 2 x CD-ROM 光盘

2.11 CERTIFICATES 证书

CCS certificate 中国船级社 CCS 1 set

2.12 SUPERVISION AT THE SHIPYARD 服务调试

The commissioning of the thruster equipment for one ship includes two (2) trip by a field engineering at the shipyard for maximum of ten (14) consecutive working days in total. Possible extra days will be charged according to the list of rates valid at the time of the service.

2 次共 14 天，由厂家上海办事处的工程师完成。



2.13 EXCLUSIONS 不包括的项目

The following items are not included in the Rolls-Royce Oy Ab supply unless otherwise agreed 一下项目不包括在舵桨的供货范围之中:

- installation onboard 设备的上船安装
- prime movers 主机
- 380 VAC electric supply 380 伏电源
- 24 VDC batteries 24 伏电池组
- water supply for the heat exchangers 冷却水
- cabling between the control units 控制单元之间的连线
- external piping 外部管路的连接
- oil fillings (lubrication oil and steering hydraulics oil) 液压油及润滑油及加油

3. THRUSTER MECHANICAL CONSTRUCTION 舵桨机械结构

3.1 UPPER ASSEMBLY 上部结构

3.1.1 Power line 动力传输结构

The power line contains: 包括

- Horizontal input shaft 水平输入轴
- Vertical / Internal shaft connected to intermediate power line by tooth coupling 垂直/内部轴，由齿型联轴节与中部结构连接
- Bevel gear pair 伞型齿轮
- Bearing arrangement 相关轴承

3.1.2 Steering gear 回转齿轮

Two planetary gear (driven by hydraulic motor) is mounted on the upper body of the drive. The pinion gear (on the output shaft of the planetary gear) turns the large tooth rim on the slewing ring providing steering torque.

二组行星齿轮由安装在上部的液压马达驱动。位于齿轮输出轴上的小齿轮带动大齿圈，从而提供足够大的回转力矩。

3.1.3 Direction indicator 舵角指示器

A mechanical azimuth angle indicator is mounted on the upper body, driven by a slewing ring gear. The gear also drives the electronic transmitter of the thrust direction indicator and a feed-back transmitter for the control system

独立的机械舵角指示器（推力方向指示器）安装在上部箱体上，并由大齿圈驱动。此齿轮装置还带动电位器发送信号至电子舵角指示器以及发送反馈信号给控制系统。

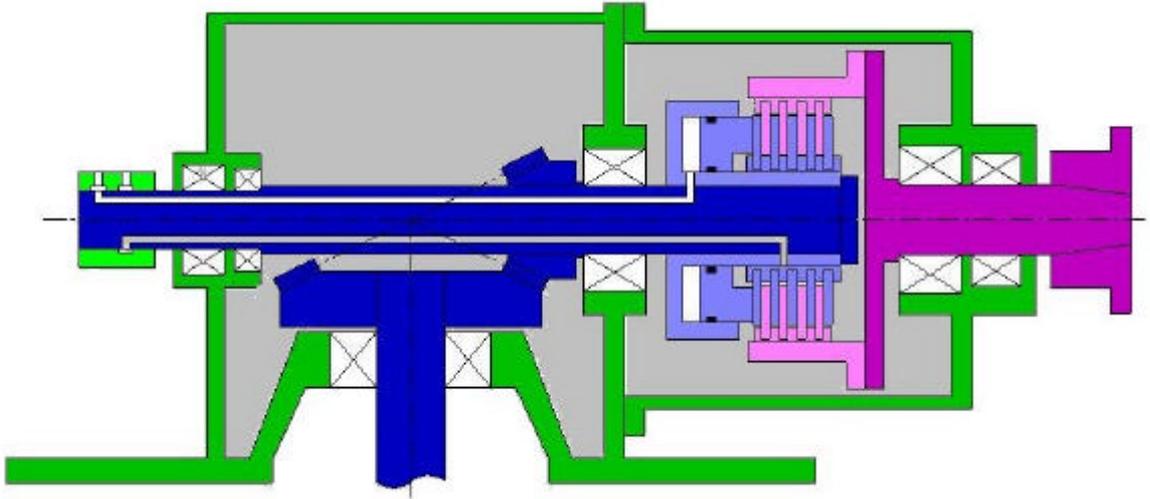
3.1.4 Built-in clutch 内置式离合器

A built-in multi-disc clutch is used for engage/disengage the engine at idle speed running. 输入轴在箱体内的一端装有液压多片式离合器。离合器在主机怠速时进行啮合或脱开的操作。

The clutch elements are on the thruster input shaft inside the compact housing. 离合器摩擦片等部件装在舵桨输入轴端的上部腔室内。

There are two oil lines from pump via rotary coupling and borings: 来自机带泵的两个油路经过旋转联轴节及油孔进入离合器腔:

- Pressure line for moving the piston and thus connecting the torque on and off 压力油，用于推动活塞从而使离合器啮合或脱开。
- Flushing line for cooling and lubricating oil between brake discs 冷却油，用于摩擦片的润滑及冷却。



The clutch is remote controlled with Aquapilot lever in the wheel house. In case of sudden electric power loss the clutch maintains the position. If the hydraulic pressure is lost the clutch disengages but it can be locked manually to engaged position.

离合器由驾驶室控制手柄进行遥控操作。一旦发生失电，则离合器保持在失电之前的位置。如果失去压力，则离合器自动脱开，但是仍可以在就地通过手动使其啮合。

3.2 INTERMEDIATE ASSEMBLY 中间结构

3.2.1 Power line 动力传输结构

The power line contains 包括:

- Vertical shaft 垂直轴
- Tooth couplings 齿型联轴节

3.2.2 Slewing ring 回转环

A large diameter slewing ring is used to support the turning body. The slewing ring is an integration of the roller bearing and a tooth rim. The slewing ring withstands part of radial load and thruster weight.

一个大直径的回转环由一个大的滚柱轴承和内齿圈组合而成，用于支承下部齿轮箱的回转。这种设计可提供较大的力偶臂来承受由螺旋桨产生的侧向力偶，由于有较长的力臂，因而可具有很大的回转力矩。

3.2.3 Steering tube 回转管

The steering tube is a heavy tubular element supporting the lower drive leg. It is connected to slewing ring through a conical support element and heavy duty screw joints. 回转管是一个管状部件，用于支承下部齿轮箱。它是由一个锥型体和高强度螺栓与回转齿环连接的。

It is connected to lower assembly with flange joint. 它与下部结构通过法兰连接。

3.2.4 Stem tube 舵管

The stem tube is provided with flanges to connect the propulsion unit to the bottom well cover. 带法兰舵管是用来连接推进装置和围井或直接焊接在船体上。

There is a lower support roller bearing in between the stem tube and steering tube. 舵管和回转管之间的滚柱轴承比使用滑动轴承具有径向间隙小的优点，而径向间隙小能使密封工作可靠，因为密封装置不允许有较大的径向运动。

3.2.5 Bottom well cover 围井

Ulstein Aquamaster propulsion unit is fastened to the bottom well cover. The bottom well cover is made according to the vessel hull lines and is fastened to the bottom well casing flange with a screw joint. 围井是水密的，推进装置就座落在围井之中。围井的底部与船体线型相吻合。围井是用螺栓和 O 型密封圈与作为船体一部分的围井座连接在一起。

Mounting flange bolts, nuts and O-ring are included in the delivery. O 型密封圈、连接螺栓与螺帽包括在供货中。

The groove of O-Ring on casing plate made by shipyard. 围井座上的密封槽由船厂加工。

3.3 LOWER ASSEMBLY 下部结构

3.3.1 Power line 动力传输结构

The power line contains 包括:

- Tooth coupling between vertical shaft and pinion shaft 垂直轴之间的齿型联轴节
- Vertical pinion shaft 垂直齿轮轴
- Bevel gear pair 伞齿轮
- Propeller shaft line 螺旋桨轴
- Bearing arrangement 相关轴承

3.3.2 FP-propeller 固定螺距螺旋桨

The propeller is mounted on the propeller shaft with a keyless conical shrink fit. 螺旋桨通过无键锥面过盈式安装在螺旋桨轴上。

3.3.3 Nozzle 导流管

Nozzle type TK used in Ulstein Aquamaster is the patented nozzle. 用于 Aquamaster 导流管是具有专利的 TK-导流管。

The longitudinal position of the propeller is close to the trailing edge. This is to reduce the steering torque and still maintain the length of the nozzle for excellent bollard pull. The inner of nozzle is made of mild steel.

螺旋桨的纵向位置接近随边位置，这样既可减少回转力矩，又可维持导流管的一定长度以获得较大的系柱拖力。导流管是用优等的船用钢板制造的。

3.4 GENERAL DESIGN FEATURES 设计特点综述

3.4.1 Body parts, stem tube and steering tube 本体，舵管及回转管

The housing, stem tube and steering tube are fabricated of primed steel or steel tube by welding in jigs. The welding stresses are removed by annealing before machining.

舵桨机壳体，舵管及回转管都是用优质钢板或钢管焊接而成。在送至 CNC 加工中心进行切削加工之前，所有的焊接应力都用退火方法予以消除和处理。

这种加工方法确保了零件形位公差和尺寸公差都能符合设计的要求。

此外，这种结构能进行方便和可靠的修理。

3.4.2 Gear wheels in the upper and lower gear 上下齿轮箱中的传动齿轮

- Cyclo-palloid wheels with arched teeth 摆线弧型齿
- Surface hardened and HPG -machined or lapped in pairs
表面硬化处理后经过 HPG 加工或配对研磨
- Material: steel 17 Cr Ni Mo 6 材料：合金钢 17 Cr Ni Mo 6
- Designed for continuous operation with maximum torque.
所有的齿轮都是按最大持续扭矩而设计的。

3.4.3 Shafts 轴系

The internal shafts of Ulstein Aquamaster azimuth thrusters are made of high tensile steel. 舵桨机内部的轴都是用高强度钢 ST 52C 制成。

The vertical shaft is split into two sections. The sections are connected with tooth coupling for easy installation of the lower assembly and to avoid alignment problems. The tooth coupling is also a safety feature to accommodate the shear-off of the lower assembly in case of severe accident. 立轴是分成二部分，其间是用齿型联轴节连接。这种设计可降低下部齿轮箱的对中要求而使安装方便。另外，一旦发生严重海损事故时，齿型联轴节具有保护作用，避免昂贵的下部齿轮箱受损。

Shaft and shaft joints are designed for continuous operation with maximum torque. 轴及其连接结构的设计都是按照在最大扭矩下的持续运转的条件设计的。

All the shaft joints are one of the following type: 为了确保轴的强度和更长的使用寿命，所有轴的连接都是使用下面无键连接的一种：

- Bolted flange joint 螺栓法兰连接
- Cylindrical shrink fit joint 圆柱面红套连接
- Conical shrink fit joint 锥体面液压连接

3.4.4 Bearings of the power transmission 功率传输机构中的轴承

All of the bearings are of roller type. Only the highest available bearing quality is assembled. Only SKF is the accepted bearing for the power train. The calculated lifetime is complying with the classification society requirements. 所有传输功率的轴承都是滚柱型的，Aquamaster 只选用最高质量的名牌轴承，如 SKF。轴承的计算寿命都是根据船级社的要求设计的。

3.4.5 Sealings 密封

- Lip seal on the drive shaft. 驱动轴的轴密封
- O-rings between the body parts. 各部件间的 O 型圈
- The seal between the stem tube and the steering tube between sea water and oil is a pair of double lip seals. The positive head oil pressure by gravity tank prevails between the seals preventing the water from seeping in. 位于舵杆和回转管之间，密封海水和滑油的是一对 Chesterton 式的骨架密封圈，由重力油柜提供的位于密封圈之间的正压力油防止海水的进入。
- Propeller shaft seal system: 螺旋桨轴密封
 - Dirt barrier and two lip seals between water and gravity oil. 刮沙环及在重力油柜于海水之间的两道唇型密封。
 - The oil pressure by gravity tank prevails in between two seal systems. 水封及油封之间的来自重力油柜的密封油。
 - One lip seal between gravity oil and gearbox oil. 一道唇型密封位于重力油柜密封油及齿轮油之间。
 - The propeller shaft seal system is protected by a rope guard. 防绳罩
 - Net Knife 渔网割刀

3.4.6 Anodes 锌块

The units are equipped with sacrificing zinc anodes against electrolytic corrosion. If Impressed Current Cathodic Protection system is fitted then the specification is to be agreed with Rolls-Royce Oy Ab.

为防止电腐蚀，装置带有保护锌块。如果船上使用电流阴极保护，其保护电流强度须与 Rolls-Royce Oy Ab. 协商。



3.5 SURFACE TREATMENT FOR THRUSTER MECHANICAL PART 表面处理

3.5.1 Surface preparation 表面预处理

Sand blasting to SA 2.5. 喷砂达 SA 2.5 级。

3.5.2 Underwater parts 水下部分

1. Epoxy Primer 环氧底漆 50 μm , white 白色
2. Epoxy coating 焦油环氧 250 μm , black 黑色

3.5.3 Other outer surfaces 其它外表面

1. Epoxy primer 环氧底漆 50 μm , white 白色
2. Primer 环氧底漆 50 μm , grey 灰色
3. Polyurethane top coating 碱性面漆 40 μm , blue RAL 5012 蓝色

3.5.4 Inner surfaces in contact with oil 油腔内表面

3. Epoxy primer 环氧底漆 50 μm , white 白色



4. STEERING HYDRAULICS 回转液压系统

4.1 GENERAL 综述

The steering hydraulic system performs the steering (azimuthing) of the propulsion unit. 液压系统将实现舵桨的回转功能。

All components of the hydraulic system are ready installed on the thruster and tested at factory for easy and time-saving installation onboard, except the components mentioned in the delivery list as separate items. 液压系统中的所有部件都在制造厂车间内装配完成并进行过台架试验，这样可以大大简化在船厂安装舵桨时的工序和工作量，除个别说明的部件外，所有的部件都安装在围井上发运。

The steering hydraulic system is complete with necessary pump, motor, valves, filters and cooler. 回转液压系统包括必要的液压马达、阀件、滤器和冷却器

The system is independent of the electric power other than 24 V DC battery – so turning function is fully operational also during an electric black-out. 该系统除 24 伏电源外，不需要任何电源，所以在全船处于失电状态是，该系统仍可完全正常地工作。

The steering hydraulic system has a separate oil tank, and thus is entirely separated from the lubrication system. 回转液压系统还包括有一个独立的油箱，所以该系统与润滑系统是完全分开的，这样可以避免由于润滑系统中进入杂质而使液压回转系统中昂贵的部件受损。

Steering pump 主回转泵..... variable displacement axial piston pump 轴向柱塞式变量泵

Turning control 回转控制proportional adjuster of the pump 通过对泵进行比例调节

4.2 STEERING OF THE PROPULSION UNIT 舵桨单元的回转

The oil flow, produced by a pump is led directly into the hydraulic motors connected to steering gear. 由液压主泵产生的液压油直接导入与回转齿轮相连的液压马达内，液压马达转动与中间部件连接的回转环，从而实现推进装置的转动

The steering speed is proportional to the difference between the actual value and the set value. 根据舵桨机实际的位置和要求位置的差值的大小，控制系统通过电气对主回转泵进行比例调节。

4.3 MAINTENANCE / LOCAL STEERING METHOD 维修/ 应急转舵

- Manual local control on the main hydraulic pump without a tool (in case of electric control system failure). 就地控制，通过舵桨舱内的按钮进行回转控制（需要 24 伏电源）

5. LUBRICATION OIL SYSTEM 润滑系统

5.1 GENERAL 总论

The lubrication oil system performs the following functions: 润滑系统实现以下功能

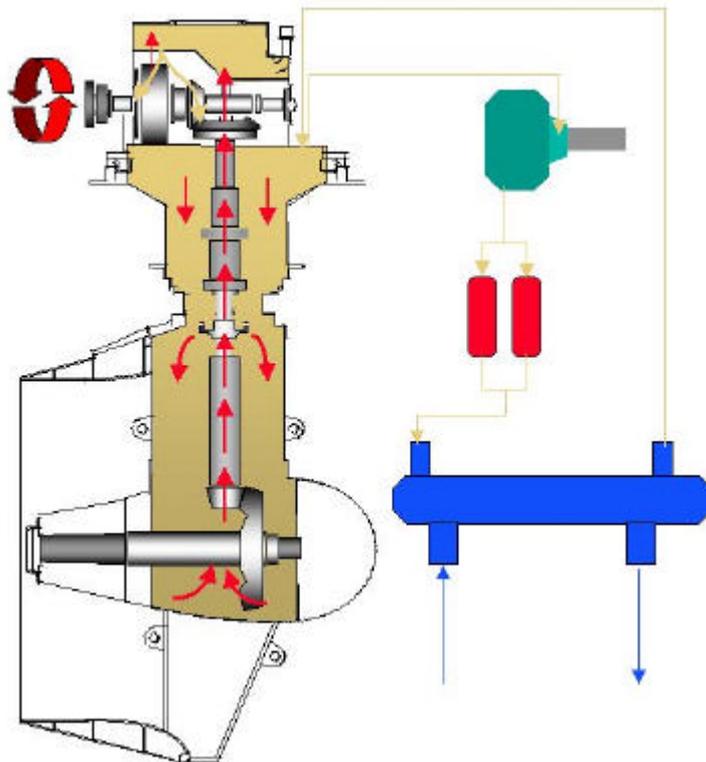
- Lubrication 润滑
- Cooling 冷却
- Lubrication oil filtering 对润滑油进行过滤
- Clutch operation 离合器的控制
- Gravity tank 密封油柜

Lubrication pump 润滑泵.....fixed displacement pump 定量泵

5.2 LUBRICATION 润滑

The lubrication of the Ulstein Aquamaster thruster is a self-sustained, built-in arrangement. 舵桨机具有内置自润滑系统（即无动力式润滑），润滑系统与回转液压系统为完全分开的油路。

The lubricated objects are either immersed or sprayed with oil. The oil circulation is arranged with internal boosters. 所有的润滑部位都是通过油浴或喷淋的方式进行润滑的。使油产生循环的动力来自系统内置的增压器。不论是有主机驱动舵桨，还是由于水流带动舵桨旋转，该系统的润滑作用总是充分的。





5.3 COOLING 冷却

Lubrication oil is cooled with an external cooler. The cooler is of tube type and is suitable for either freshwater or seawater use. 润滑油由外置的冷却器进行冷却，冷却器为管式，适用于海水。

5.4 LUBRICATION OIL FILTERING 润滑油滤器

For lubrication oil filtering and cooling there is an external pump. 润滑油的过滤和冷却是由机带泵进行传动的

5.5 CLUTCH OPERATION 离合器的控制

The clutch is engaged with lubrication oil pressure and disengaged with springs. The engagement and disconnection is intended to use with idle speed of engine. 离合器的控制是由润滑油压进行啮合，当油压释放后，通过弹簧张力脱开。离合器的啮合或脱开需在主机怠速下进行操作。

The clutch control valve is electrically controlled, but also manual control is available. The valve is designed to maintain its position in the case of loss of control signal. If the hydraulic pressure is lost the clutch disengages but it can be locked manually to 'engaged' position. 离合器的控制阀是电控式，但也可以通过手动控制。该阀设计为当失去控制信号时，可以保持在原来位置。当液压压力失去时，离合器自动脱开。但是这时也可以通过手动将其保持在啮合位置

5.6 SEAL OIL TANK (GRAVITY TYPE) 密封油柜（重力式）

The oil in the gravity tank line maintains the internal static pressure against water for the propeller shaft and steering tube seal cavities. If any of these seals starts leaking the oil level in the gravity tank drops which indicates the crew that there may be something wrong with the seals. When the oil level in the gravity tank goes below the limit there will be an alarm. 重力油维持螺旋桨轴和回转管密封内的内部静压，使在密封受到损坏时可以立即收到报警信号，以便及时修理。当密封油柜中的油位下降时，将控制系统中将产生报警。

Installation of seal oil tank is taken care by shipyard. 重力油柜的安装和油管的连接由船厂施工。

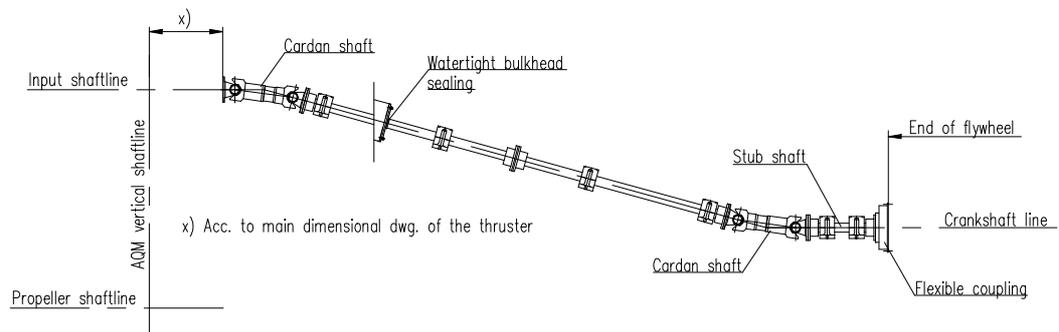
6. INTERMEDIATE SHAFT LINE 中间轴系

6.1 COMPONENTS OF INTERMEDIATE SHAFT LINE 轴系的组成

One shaftline consists of the following components 每根轴系包括如下部件:

- two cardan shafts, make GWB. 2 根万向轴，牌号 GWB。
- solid shafting in needed length with grease lubricated roller bearings (make SKF), bearing housings, shaft flanges and fixing bolts; the bearings and flanges are pre-assembled on the shafts 适当长度的固定轴。带有油脂润滑的滚柱轴承(SKF，轴承座，轴法兰和固定螺栓。法兰和轴承已预装在轴上。
- one watertight bulkhead sealing of standard Ulstein Aquamaster type 一个水密舱壁填料函。
- one stub shaft in roller bearings, with a flange and **flange** for connection to flexible coupling on the main engine; the bearings and flange are pre-assembled on the shafts 一根短轴：带有轴承和与主机的弹性联轴节连接的法兰。轴承和法兰都已组装在轴上。包括安装螺栓。

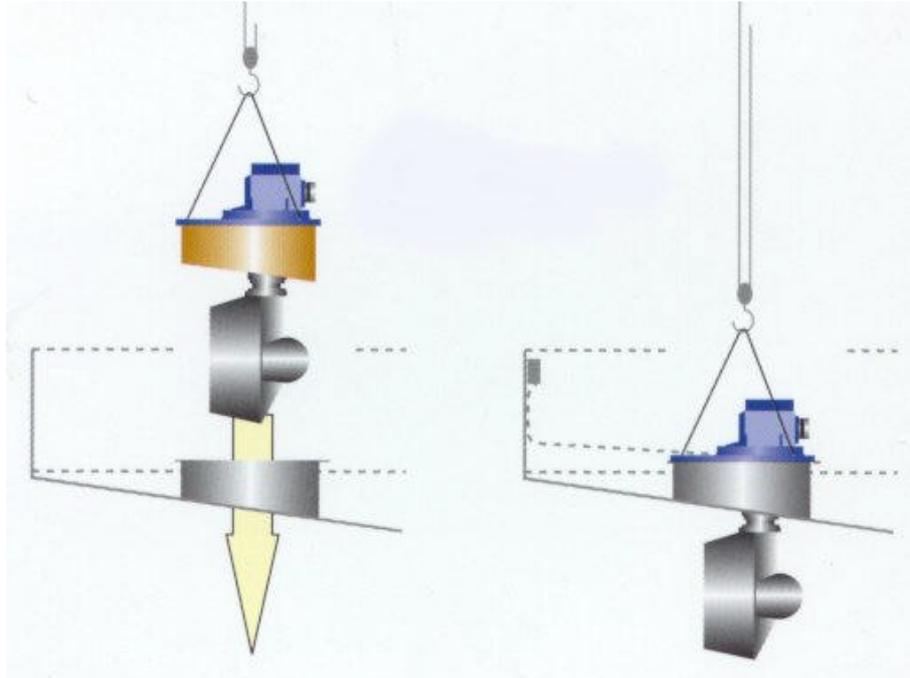
6.2 ARRANGEMENT PRINCIPLE OF THE SHAFT LINE 轴系布置图



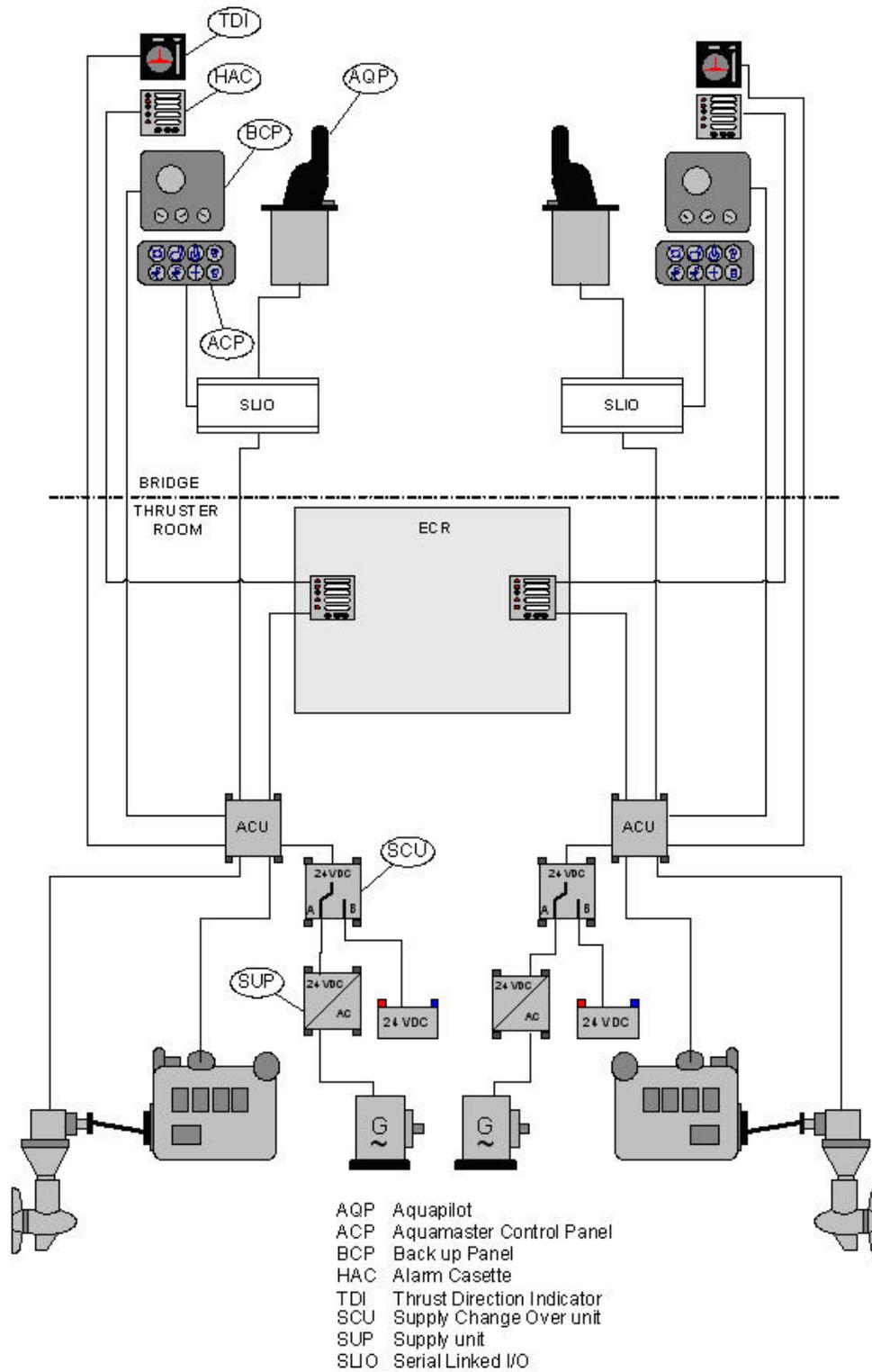
7. MOUNTING / INSTALLATION 安装

Bolt-in, top mounting 螺栓式，上部安装

First the casing plate is welded into the hull. Then the complete thruster unit is mounted into well and fastened by bolts. 首先将井架焊接在船体结构上，然后将整台舵桨装入井架内并用螺栓固定。



8. CONTROL SYSTEM (DBL) 控制系统





8.1 GENERAL DESCRIPTION 总论

8.1.1 Ulstein Aquamaster control system 控制系统

The Aquapilot is an independent follow-up control system with integral time dependent back-up control system for one Ulstein Aquamaster azimuth thruster. This means that each Aquamaster has an independent control system.

Aquapilot 控制系统是一种独立的随动控制系统，每台舵桨都带有自己的非随动备用控制系统。也就是说两台舵桨的控制系统互相不受任何影响。

8.1.2 Bridge control electronics and bridge control and indication devices 驾驶室控制电路及控制指示设备

The basic operation unit of the system is the Aquapilot control head, which is a single lever for operation of the functions (steering, rpm, pitch) of the thruster. 控制系统的基本操作装置是 Aquapilot 控制手柄，控制手柄，这是一个单手柄，可对每台舵桨机的回转、转速以及离合器进行控制。

Selections and indications of Aquapilot control system are controlled by Aquapilot control panel(s). 控制系统的选择和指示功能通过控制面板进行。

All indication lights for Ulstein Aquamaster controls are dimmer controlled by push buttons on Ulstein Aquamaster control panel. 控制系统的所有的指示灯的亮度都可以通过控制面板上的调光按钮来进行调节。

8.1.3 Steering control 回转控制

Ulstein Aquamaster has a digital follow-up (FU) type Aquapilot control system for controlling the azimuth of the Ulstein Aquamaster unit. The Aquapilot control head provides Ulstein Aquamaster turning (steering) control by horizontal rotation through a continuous 360 degrees.

Aquamaster 配备数字式随动 (FU) 控制系统 Aquapilot，水平转动手柄将控制舵桨机在 360 度范围内进行连续的回转，并且在手柄上每 90 度的位置都有一个停顿点。

8.1.4 Prime Movers rpm control by Aquapilot 主机的转速控制

PM's speed is controlled by tilting the Aquapilot lever.

通过扳动 Aquapilot 控制手柄，可以对主机进行速度控制。

The rpm set signal to PM's governor is as standard 4...20 mA.

发到主机调速器的转速控制信号为 4...20 mA。

8.1.5 Clutch control 离合器控制

The Aquapilot lever engages the Ulstein Aquamaster clutch by tilting the lever five degrees from the upright position. 通过将控制手柄从直立位置扳动到 5 度的位置，可以向离合器发出啮合指令。

When returning the lever back to the upright position there is a step for sensing the clutch operation range. This is to avoid inadvertent clutch disengagement.



当将手柄扳回直立位置时，可以在离合器操作位置感到一个停顿点，这是用于防止意外操作而使离合器脱开而设计的。

8.1.6 Thrust direction and propeller rpm indication 推力方向及转速指示

The Thrust Direction Indicator is electrically independent from the control system. The propeller speed indications are integrated with the thrust direction indicator. 推力方向指示是电信号，并与控制系统完全独立。螺旋桨转速显示是与推力方向组合在同一块板上。

The indicator is hardwired to the propulsion unit. 指示器是用导线与推进装置内部的传感器直接相连接的。



8.2 ALARMS 报警信号

Alarm transducers are separate from control and monitoring sensors. 用于报警的传感器是与控制和监视用传感器完全分开的

8.2.1 Alarms per Ulstein Aquamaster 每台舵桨的报警信号

8.2.1.1 Ulstein Aquamaster control system alarms 控制系统报警

ACU Warning , 系统故障 Breaking contact 常闭触点

ACU Failure , 失效 Breaking contact 常闭触点

更精确的故障原因可以通过手持编程器 (HHT) 从控制单元中 (ACU) 读出, 手持编程器包括在供货范围中。

8.2.2 Ulstein Aquamaster lubrication system alarms 舵桨润滑系统

Ulstein Aquamaster oil level low 低油位 Breaking contact 常闭触点

Ulstein Aquamaster oil temperature 油温高 Breaking contact 常闭触点

Cooling & clutch control oil pressure low 离合器油压低 Breaking contact 常闭触点

Ulstein Aquamaster oil filter clogged 滤器堵塞 Breaking contact 常闭触点

Ulstein Aquamaster oil filter clogged 滤器堵塞 Breaking contact 常闭触点

8.2.3 Ulstein Aquamaster steering hydraulic alarms 回转液压系统

Booster pressure low 回转泵压力低 Breaking contact 常闭触点

Hydraulic oil tank level low 液压油柜低油位 Breaking contact 常闭触点

Hydraulic oil tank temperature 液压油温高 Breaking contact 常闭触点

Hydraulic oil filter clogged 滤器堵塞 Breaking contact 常闭触点

Hydraulic oil filter clogged 滤器堵塞 Breaking contact 常闭触点

8.2.4 Gravity oil tank alarms 密封油柜

Gravity tank oil level low 低油位 Breaking contact 常闭触点



8.3 INTERFACE ULSTEIN AQUAMASTER - PRIME MOVER 主机舵桨的接口

8.3.1 From Ulstein Aquamaster to prime mover (diesel engine) 从舵桨到主机

PM rpm control, main 转速控制信号4...20 mA

PM starting allowed 主机起动联锁 常闭触点

All the other interfaces between PM and Ulstein Aquamaster will be co-ordinated between the engine maker and Rolls-Royce Oy Ab.

所有其它未提及的主机与舵桨之间的信号将有主机厂商与 AQM 友好协商解决。

8.3.2 PM starting allowed 主机起动连锁

Ulstein Aquamaster propulsion units are supplied with Fixed Pitch Propellers (FPP). This means, that when the propeller is rotating, it gives a certain thrust. To avoid this thrust in a start-up situation, the rpm set value from the Aquapilot Control Lever has to be idle.

The Ulstein Aquamaster Control Unit has an interlocking contact at the idle speed (rpm) position. This relay contact has to be connected to the prime mover's start-up circuit (contact closed in start-up situation).

由于本是舵桨机使用的固定螺距桨，因而，一旦螺旋桨转动，就发出一定的推力。

为了避免在起动时发生此类情况，控制手柄必须置零(即离合器脱开位置)。

Aquamaster 舵桨控制单元提供一个连锁触点串联在主机起动回路中（在起动时该触点闭合）。



8.4 DESIGN FEATURES FOR CONTROL SYSTEM 控制系统设计规格

8.4.1 Contact specifications 接触器规格

Voltage 电压	30 VDC
Current 电流	2 A
Power 功率	60 W

8.4.2 Control cabinets 控制箱

Installation 安装方式	wall type 壁挂式
Enclosure 箱体	steel cabinet 钢板
Cable entrance 电缆进线	cable glands on the bottom of the cabinet 从箱底部
Cable connectors 接线方式	Face Clamp-type (spring loaded) row terminals 弹簧夹子式接线排
Grounding connection 接地	on the bottom of the cabinet 从箱底
Painting 油漆颜色	RAL 7032 light grey 浅灰
Protection class 防护等级	IP44

8.4.3 Electronic devices and panels 面板

Installation 安装方式	drop-in 嵌入式
Protection class (above) 防护等级	IP44
Cable connection 接线	row terminal with 1,5 m cable 带有 1.5 米的电缆
Grounding connection 接地	below the module 从模块底部
Painting 油漆颜色	Black 黑色



9. TESTING 试验

The Ulstein Aquamaster quality assurance policy includes the testing of each azimuth thruster. 质量保证体系包括对每台装置进行台架试验

The tests are performed under the supervision of the classification society when applicable. Also the customers or their representatives are welcome to observe the trials.

Aquamaster 试验是在油管船级社验船师和工厂质检部门同时参与下进行的。同时将邀请用户到厂一起参车间试验。

The test program comprises: 试验程序包括：

- Adjusting and testing of the steering system 调整试验回转液压系统和润滑系统
- Adjusting and testing of the lubrication system 润滑系统的测试和调整
- Adjusting and testing of the alarm and the indication transducers 测试报警和显示传感器
- Pressure test of the hydraulic system 液压系统压力试验
- Adjusting and testing of the control system 调整和试验控制系统
- Functional test 功能试验
- Full torque test 全负荷试验
- Checking of tooth contact 检查齿轮接触表面
- Full rpm test 全速试验
- Gravity line shaft sealing test 重力油柜和密封试验



标准手动工具 Standard hand tools

A 8816356 + AAA 9350273-000

2 x Ulstein Aquamaster

US 205 AZIMUTH THRUSTERS

Pos.	Code 编号	Name 名称		Pcs
1	A 8816359	HEXAGONAL WRENCH SET (1.5mm-10mm)	内六角扳手 套件	1
2	A 8813027	HEXAGONAL WRENCH 12mm	内六角扳手	1
3	A 8813031	HEXAGONAL WRENCH 14mm	内六角扳手	1
4	A 8813037	HEXAGONAL WRENCH 17mm	内六角扳手	1
5	A 8813040	HEXAGONAL WRENCH 19mm	内六角扳手	1
6	A 8830133	SCREW DRIVER 1MM X 6.5 MM	螺丝刀	1
7	A 8811013	OPEN END WRENCH 13mm	开口扳手	1
8	A 8811019	OPEN END WRENCH 19mm	开口扳手	1
9	A 8810501	OPEN END WRENCH 27mm/30mm	开口扳手	1
10	A 8810505	OPEN END WRENCH 32mm/34mm	开口扳手	1
11	A 8810509	OPEN END WRENCH 41/46mm	开口扳手	1
12	A 8811024	RING WRENCH 24mm	环形扳手	1
13	A 8812639	SOCET SPANNER ¾ DRIVE 24mm	套筒扳手	1
14	A 8812645	SOCET SPANNER ¾ DRIVE 36mm	套筒扳手	1
15	A 8812651	SOCET SPANNER ¾ DRIVE 46mm	套筒扳手	1
16	A 8812653	SOCET SPANNER ¾ DRIVE 50mm	套筒扳手	1
17	A 8812835	T-WRENCH ¾ DRIVE	T形扳手	1
18	A 8812900	RATCHET ¾ DRIVE	棘齿	1
19	A 8812905	EXTENSION ¾ DRIVE UNION	延长管	1
20	A 6680005	PRESSURE GAUGE 0-40 BAR	压力表	1
21	A 6680008	PRESSURE GAUGE 0-250 BAR	压力表	1
22	A 6639186	MEASURING CONNECTOR 2103-05-01.00 M16X2 G ¼	测量接头	1
23	A 6639248	MEASURING CONNECTOR 2120-04-01.00 M16X2	测量接头	1
24	A 9450311	ADAPTER M20X1/4	接头	1
25	A 9450266	ADAPTER R ¼ X R 1/4	接头	1
26	A 8870115	TOOL BOX 5-SECTION	工具箱	1
27	AAA 9350273	Oil drain pipe	放油管	1
28		Oil drain plug	放油旋塞	1
29	A 3885501	GLUE FOR HYDRAULICK JOINT 50ML LOCTITE 542	胶水	1
30	A 3885513	GLUE FOR PIPE JOINT 50ML LOCTITE 577	胶水	1



随机备件 Onboard spare parts
 (适用二年正常使用 suitable for two year usage)
2 x Ulstein Aquamaster
US 205 AZIMUTH THRUSTERS

No. 序号	Code 编号	Name 名称	Pcs 数量
MECHANICAL SPARES 机械部分备件 (Z 6455543-0-000)			
Upper Assembly 上部结构			
1	A 6353627	O-ring 64.5x3.0mm	1
2	A 6353640	O-ring Moulded 69.2x5.7mm	1
3	A 6354960	O-ring Moulded 119.2x5.7mm	3
4	A 6335752	Radial seal for input shaft 60x80x10mm	1
5	A 6356696	O-ring 239.3x5.7mm	3
6	A 6358130	O-ring Moulded 499.2x5.7mm	1
7	A 6359429	V-ring for input shaft V160 A NBR	1
8	A 6355270	O-ring 134.5x3.0mm	2
9	A 6356695	O-ring 229.2x5.7mm	1
10	A 6356990	O-ring 259.3x5.7mm	1
11	A 6359419	O-ring 299.3x5.7mm	1
12	A 6358924	V-ring V140 A NBR	1
13	A 6354950	O-ring 114.5x3.0mm	2
14	A 6357000	O-ring 269.3x5.7mm	2
15	A 6351635	O-ring 24.2x3.0mm	2
16	A 6354175	O-ring 84.2x5.7mm	3
17	A 6359360	O-ring 104.5x3.0mm	1
18	A 6358099	O-ring 479x4.7mm	1
19	A 6349594	Radial seal for input shaft 160x190x15mm DI	1
Intermediate assembly 中间结构			
20	A 6358298	O-ring 719.2x5.7mm	1
21	A 6358270	O-ring 689.3x5.7mm	1
22	A 6358244	O-ring 629.2x5.7mm	2
23	A 6358233	O-ring 599.2x5.7mm	1
24	A 6358220	O-ring Moulded 579.3x5.7mm	2
25	A 6355880	O-ring 179.2x5.7mm	2
26	A 6351635	O-ring 24.2x3.0mm	4
27	A 6358130	O-ring Moulded 499.2x5.7mm	3
28	A 6358190	O-ring 534.3x5.7mm	2
29	A 6355320	O-ring 139.3x5.7mm	1
Lower Part 下部结构			
30	A 6359471	O-ring 879.3x5.7mm	1
31	A 6358345	O-ring 769.2x5.7mm	1
32	A 6357890	O-ring Moulded 339.3x5.7mm	1



33	A 6357020	O-ring 279.3x5.7mm	○形圈	1
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HYDRAULIC SPARES 液压部分备件 (ZHV 8450533-0-R01)

1	A 6659858	Filtter insert FC7006,F10,BK	滤芯	4
2	A 6659861	Filtter insert FC7007,F025,BK	滤芯	4
3	A 6659880	Seal set for filters FD1145-B	滤器密封	4
4	AHV8450385	Seal set ZHV8450385-000	密封	2
5	A 6680006	Pressure gauge 0-40 bar	压力表	2
6	A 6639211	Measuring connector	接头	2
7	A 6350586	O-Ring 12.0x2.0mm	○型圈	4
8	A 6352380	O-Ring 47.32x3.53mm	○型圈	4
9	A 6352270	O-Ring 37.69x3.53mm	○型圈	4
10	A 6352250	O-Ring 32.92x3.53mm	○型圈	4
11	A 6351637	O-Ring 24.99x3.53mm	○型圈	4
12	A 635 9362	O-Ring 35.50x3.0mm	○型圈	4
13	A 7429766	Pressure switch	压力开关	1
14	A 7427312	Pressure switch	压力开关	1

CONTROL SYSTEM SPARES 电气部分备件 ZSA 6454905- B- 001

1	A 7587115	Signal lamp bulb	灯泡	10
2	A 7435014	Lens for signal lamp	灯罩	2
3	A 7435022	Lens of push button, blue	按钮罩 (蓝色)	2
4	A 7429726	Signal lamp	灯泡	1
5	A 7429749	Rotary Handle Key	旋钮	1
6	A 7435012	Push-button with signal	带灯按钮	1
7	A 7435032	Push-button with signal	带灯按钮	1
8	A 7435023	Lens of push button	按钮罩	2
9	A 7537099	Circuit breaker	断路器	1
10	A 7537061	Circuit breaker	断路器	1
11	A 7914002	Transient protection	瞬间电流抑制器	5
12	A 7429724	Relay Module	继电器模块	1
13	A 7429729	Service tool	装灯工具	1



特殊工具 Special tools
 Z 6454891 – 0 – 000
2 x Ulstein Aquamaster
 US 205 AZIMUTH THRUSTERS

序号	描述	数量/船套
1.	牛油嘴 (适配器) Nipple (adapter)..... R1/4 / M20	1
2.	吊环 Lifting loop..... M16 DIN 580.....	1
3.	吊环 Lifting loop..... M20 DIN 580.....	1
4.	高压油泵 High pressure hand pump	1