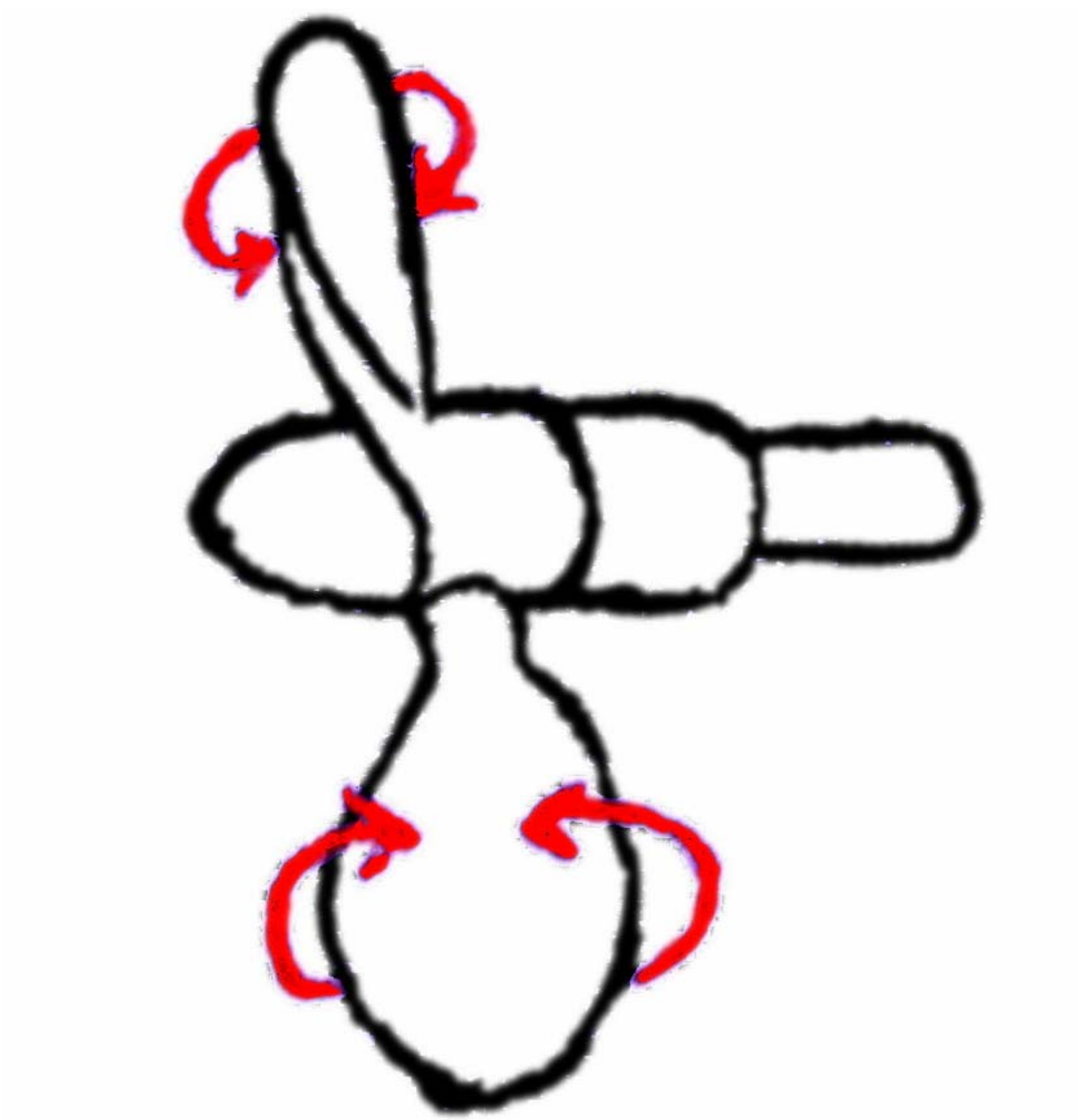
Controllable **P**itch **P**ropellers (**CPP**)

Controllable pitch propellers CPP for marine propulsion, systems have been designed to give the highest propulsive efficiency for any speed and load condition. When the vessel is fully loaded with cargo the propulsion required at a given ship speed is much higher than when the vessel is empty. By adjusting the blade pitch, the optimum efficiency can be obtained and fuel can be saved. In addition, the controllable pitch propeller has a "vane"-stance, which is useful with combined sailing/motor vessels as this stance gives the least water resistance when not using the propeller (eg when the sails are used instead).



While it is true that a **F**ixed **P**itch **P**ropeller (**FPP**) can be more efficient than a controllable pitch propeller, it can only be so at one rotational speed and the designed load condition. At that one rotational speed and load, it is able to absorb all the power that the engine can produce. At any other rotational speed, or any other vessel loading, the FPP cannot, either being over pitched or under pitched. A correctly sized controllable pitch propeller can be efficient for a wide range of rotational speeds, since pitch can be adjusted to absorb all the power that the engine is capable of producing at nearly any rotational speed.

The CPP also improves maneuverability of a vessel. When maneuvering the vessel the advantage of the CPP is the fast change of propulsion direction. The direction of thrust can be changed without slowing down the propeller and depending on the size of the CPP can be changed in approximately 15 to 40 seconds. The increased maneuverability can eliminate the need for docking tugs while berthing.

A reversing gear or a reversible engine is not necessary anymore, saving money to install and service these components. Depending on the main engine rotational speed and the size of the CPP, a reduction gear may still be required. A CPP does require a hydraulic system to control the position of the blades. A CPP does not produce more or less wear or stress on the propeller shaft or propulsion engine than an FPP. Therefore this will not be an argument to choose between an FPP or a CPP.

Most ships that would not take a CPP are large vessels that make long trips at a constant service speed, for example, crude oil tankers or the largest container ships, which have so much power that a CPP is not yet designed for them. A CPP can mostly be found on harbor or ocean-going tugs, dredgers, cruise ships, ferries and cargo vessels that sail to ports with limited or no tug assistance.

At the moment the range of CPP goes up to 44000 kW (60,000 hp).

A controllable pitch propeller installation consists of a hub, propeller blades, shafting, hydraulics and electronic remote control, as well as any further accessories needed to meet operational condition.

- HUB. The blades are operated by an actuating yoke and a hydraulic piston, cylinder combination in the hub. The axial movement of the yoke is transferred into a rotation of the propeller blades.
- SHAFT LINE. The oil to change the position of the hydraulic piston is pumped through the inside or along the outside of the moving oil pipe in the shaft line.
- HYDRAULIC POWER EQUIPMENT. The energy, required to adjust the position of the blades (the pitch) is generated by a hydraulic pump which supplies the oil through the oil distribution box into the running shaft. The oil is directed either to the inside or to the outside of the moving oil pipe and thereby to the aft side or the forward side of the actuating cylinder. During the time that the pitch is not changed, the hydraulic oil in the shaft line is trapped by a blocking valve in the moving oil pipe.

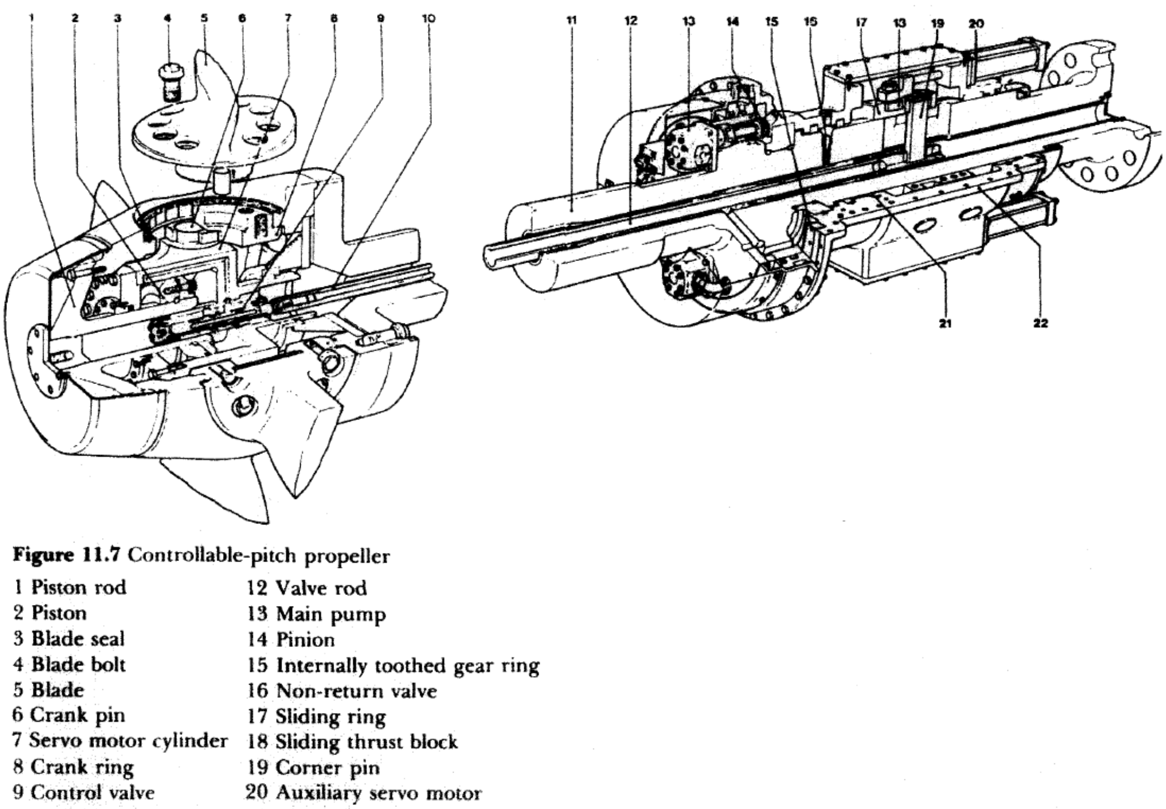


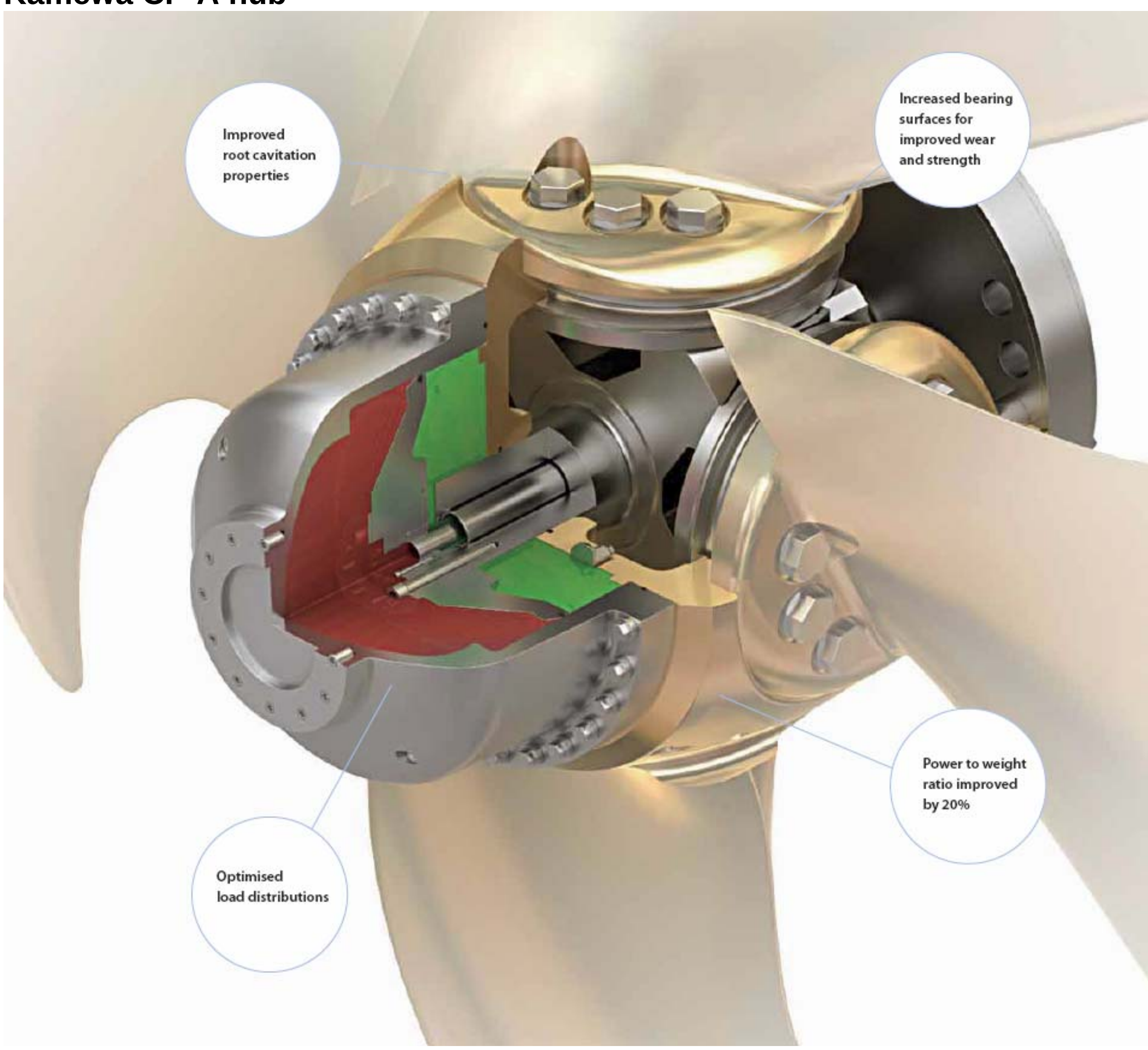
Figure 11.7 Controllable-pitch propeller

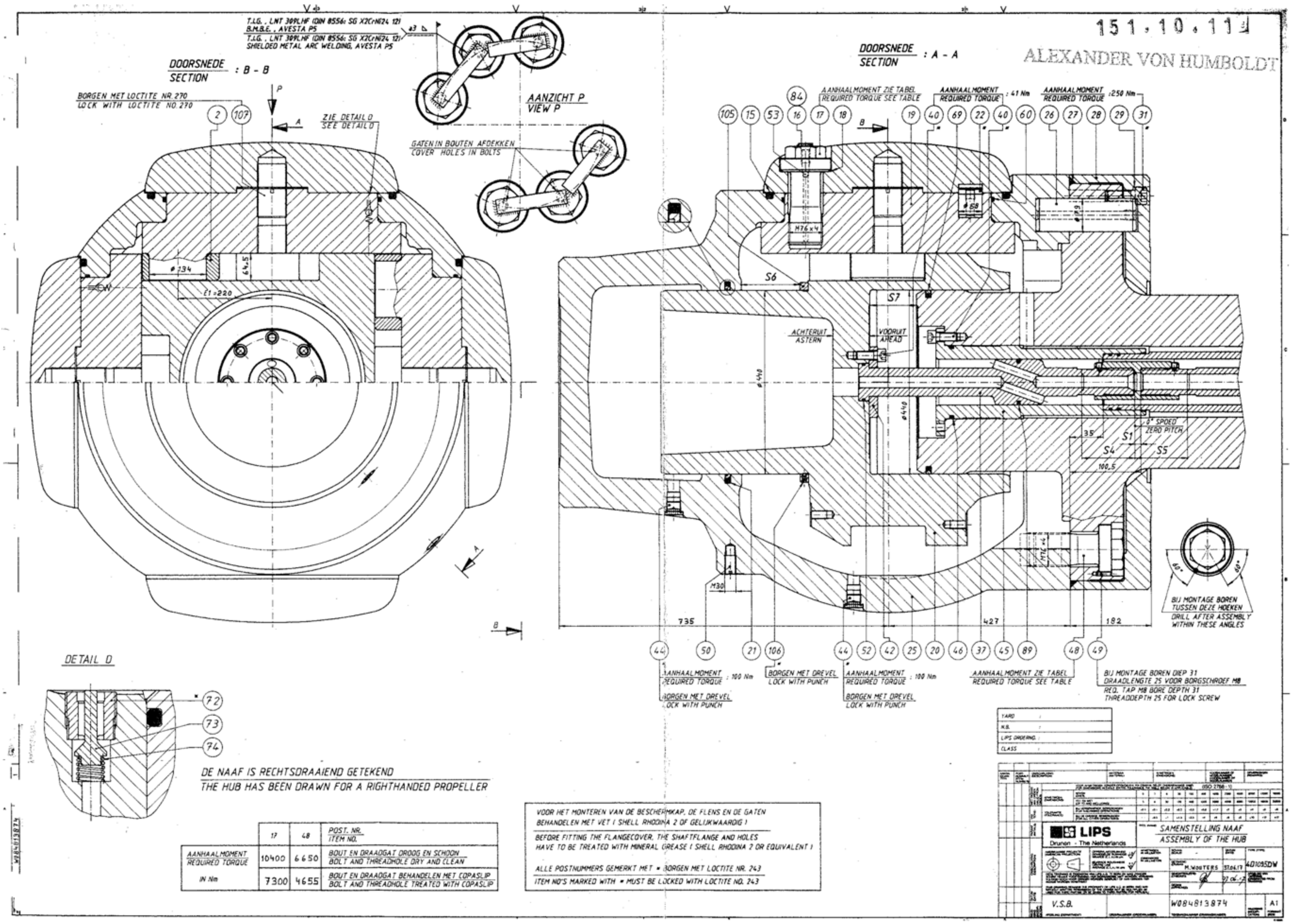
1 Piston rod
2 Piston
3 Blade seal
4 Blade bolt
5 Blade
6 Crank pin
7 Servo motor cylinder
8 Crank ring
9 Control valve
10 Valve rod
11 Mainshaft
12 Valve rod
13 Main pump
14 Pinion
15 Internally toothed gear ring
16 Non-return valve
17 Sliding ring
18 Sliding thrust block
19 Corner pin
20 Auxiliary servo motor
21 Pressure seal
22 Casing

Propeller hub with blades

The hub mechanism is of compact design and contains a minimum number of parts.

Kamewa CP-A hub



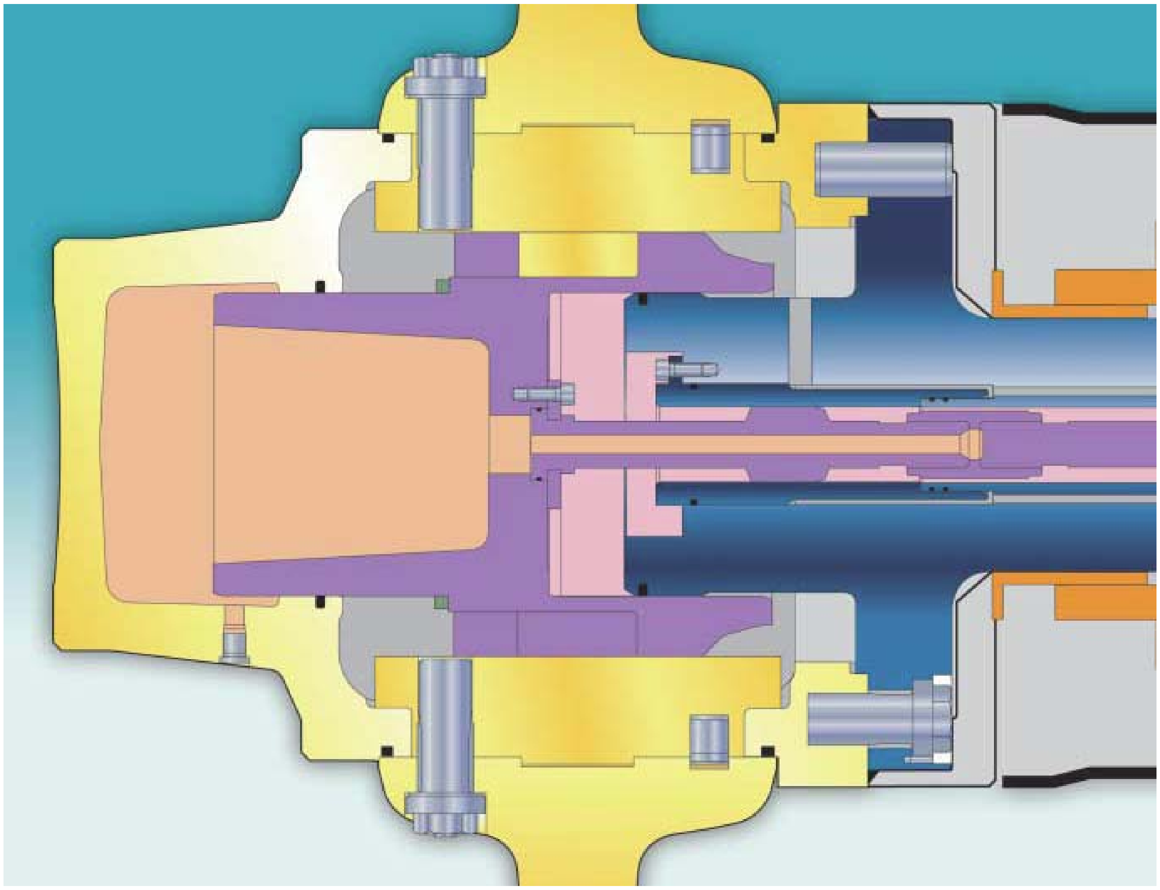

151.10.111
ALEXANDER VON HUMBOLDT
DOORSNEDE : B - B
SECTION
DOORSNEDE : A - A
SECTION
T.I.G., LNT 309LHF (DIN 8556: SG X2CrNi24 12)
B.M.B.E., AVESTA P5
T.I.G., LNT 309LHF (DIN 8556: SG X2CrNi24 12)
SHIELDED METAL ARC WELDING, AVESTA P5
BORGEN MET LOCTITE NR 270
LOCK WITH LOCTITE NO 270
ZIE DETAIL D
SEE DETAIL D
AANZICHT P
VIEW P
GATEN IN BOUTEN AFDEKKEN
COVER HOLES IN BOLTS
AANHAALMOMENT ZIE TABEL
REQUIRED TORQUE SEE TABLE
AANHAALMOMENT : 41 Nm
REQUIRED TORQUE
AANHAALMOMENT : 250 Nm
REQUIRED TORQUE
ACHTERUIT
ASTERN
VOORUIT
AHEAD
0° SPOED
ZERO PITCH
BIJ MONTAGE BOREN TUSSEN DEZE HOEKEN
DRILL AFTER ASSEMBLY WITHIN THESE ANGLES
AANHAALMOMENT : 100 Nm
REQUIRED TORQUE
BORGEN MET DREVEL
LOCK WITH PUNCH
AANHAALMOMENT ZIE TABEL
REQUIRED TORQUE SEE TABLE
BIJ MONTAGE BOREN DIEP 31
DRAADLENGTE 25 VOOR BORGSCHROEF M8
REQ. TAP M8 BORE DEPTH 31
THREADDEPTH 25 FOR LOCK SCREW
DETAIL D
DE NAAF IS RECHTSDRAAIEND GETEKEND
THE HUB HAS BEEN DRAWN FOR A RIGHTHANDED PROPELLER
AANHAALMOMENT
REQUIRED TORQUE
IN Nm
POST. NR.
ITEM NO.
17
48
10400
6650
BOUT EN DRAADGAT DROOG EN SCHOON
BOLT AND THREADHOLE DRY AND CLEAN
7300
4655
BOUT EN DRAADGAT BEHANDELEN MET COPASLIP
BOLT AND THREADHOLE TREATED WITH COPASLIP
VOOR HET MONTEREN VAN DE BESCHERMKAP, DE FLENS EN DE GATEN BEHANDELEN MET VET (SHELL RHODINA 2 OF GELIJKWAARDIG)
BEFORE FITTING THE FLANGECOVER, THE SHAFTFLANGE AND HOLES HAVE TO BE TREATED WITH MINERAL GREASE (SHELL RHODINA 2 OR EQUIVALENT)
ALLE POSTNUMMERS GEMERKT MET • BORGEN MET LOCTITE NR. 243
ITEM NO'S MARKED WITH • MUST BE LOCKED WITH LOCTITE NO. 243
LIPS
Drunen - The Netherlands
SAMENSTELLING NAAF
ASSEMBLY OF THE HUB
M.WOUTERS
V.S.B.
W084813874
A1
735
427
182
M30
S6
S7
S4
S5
S1
35
100,5

The hub body is cast in one piece with large bearing collars, to absorb the loads exerted by the blades and by the crank-slot mechanism with moderate surface pressures.

Each blade is connected to its blade carrier by means of bolts and dowels. The bolts have heads for a hexagonal spanner and underneath the bolt heads are O-rings for sealing. The bolts must be tightened with a dynamometric wrench.

LIPS

LIPS design



D-hub Lips controllable pitch propeller systems

One-piece hub casting with integrated hub cover
Extra rigidity and robust construction
No water in hub in case of sterntube sealing leakage
Safe operation and no interference with sterntube lubrication system
Well-proven blade foot sealing system
Simple OD box mounted at forward side of gearbox or mounted in shaft line
Suitable for direct-driven systems and extremely long shaft lines
Integrated non-return valve for pitch blocking integrated into OD box
Manual emergency pitch setting in ahead condition
Mechanical and electrical pitch feedback
Reliable and safe operation
Integrated hydraulic power pack
Easy installation and maintenance
Safe operation
Bumpless pitch control through use of proportional valve.

- Rotation of blades and carriers is effected by the axially moving yoke through the crank-slot mechanism. The slots are located in the yoke. The crank pins are integral with the blade carriers; they are located underneath the trailing edge of the blades. The pins are provided with high-strength bronze sliding blocks.

- The yoke moves axially across two pistons. The forward piston forms an integral part with the propeller shaft. The aft piston is part of the yoke. The aft piston is supported by an integral cylinder in the aft part of the hub body.

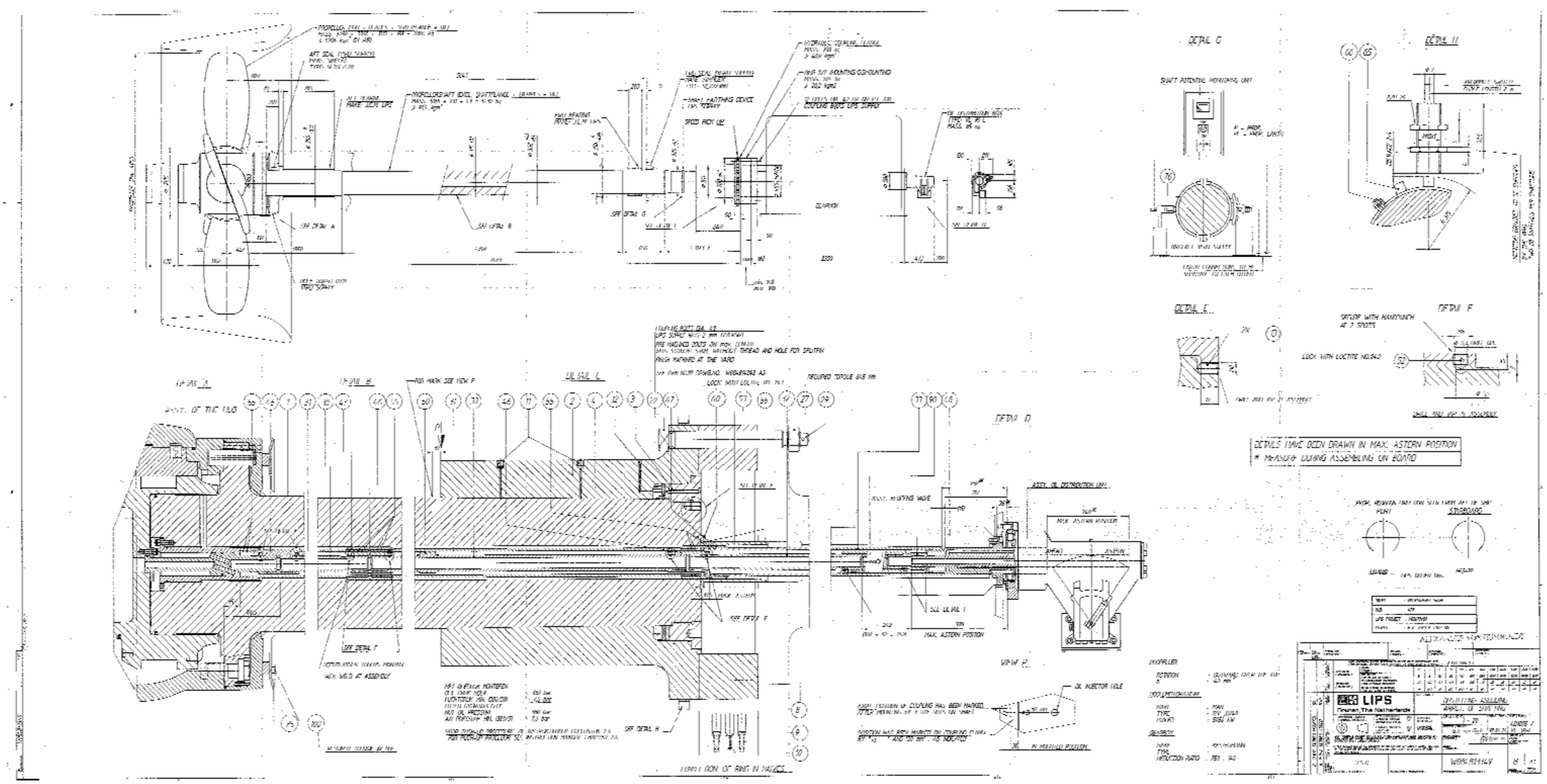
- When oil is pumped through the inner oil pipe to the forward cylinder, the yoke moves aft causing blade rotation to increase pitch. Oil can be pumped to the aft cylinder, causing the yoke to move forward, resulting in blade rotation towards astern pitch. The pitch of the propeller blades is fed back to the control system by means of the inner pipe which is connected to the moving yoke.

The hydraulic pressures to actuate the blades depend on the characteristics of the pitch actuating (blade spindle) torque which in turn depends on the hydrodynamic design of the blade and the friction in the hub mechanism. A hydrodynamic blade design made a LIPS D type hub is made such that the blade spindle torque always acts to astern direction. In consequence the pressure to adjust the blades to the ahead direction will always be greater than while adjusting to astern.
In the inner oil pipe a blocking valve is incorporated. When the pitch is not adjusted, or during a hydraulic failure, this blocking valve automatically closes. Because of the tendency of the blades to move to astern the pitch will be kept on the closed oil volume in the front cylinder.

The mechanism inside the hub is lubricated by the hydraulic oil. The hub cavity is connected with the OD box via the oil channel between the outer stationary pipe and the inside bore of the shafts. By means of a header tank connected to the OD box, static pressure is maintained in the hub cavity. Provisions are made to de-aerate the hub cavity and the aft cylinder.

The blade seals are synthetic rubber endless cord O-rings, mounted under the blade flange. The sealinq-rinqs and grooves are dimensioned in such a way that the tolerance in the blade bearing dimensions can be easily absorbed while retaining the proper compression rate required for the sealing action. The blade seals are subjected to only header tank pressure oil. They are relieved from varying actuating pressures. During shutdown of the hydraulic system, the blade seals remain under a head that exceeds the pressure of the surrounding water, since the header tank is to be located above the waterline.

Shaft line


DETAIL G
DETAIL E
DETAIL F
DETAILS HAVE BEEN DRAWN IN MAX. ASTERN POSITION
LIPS
Drunen The Netherlands

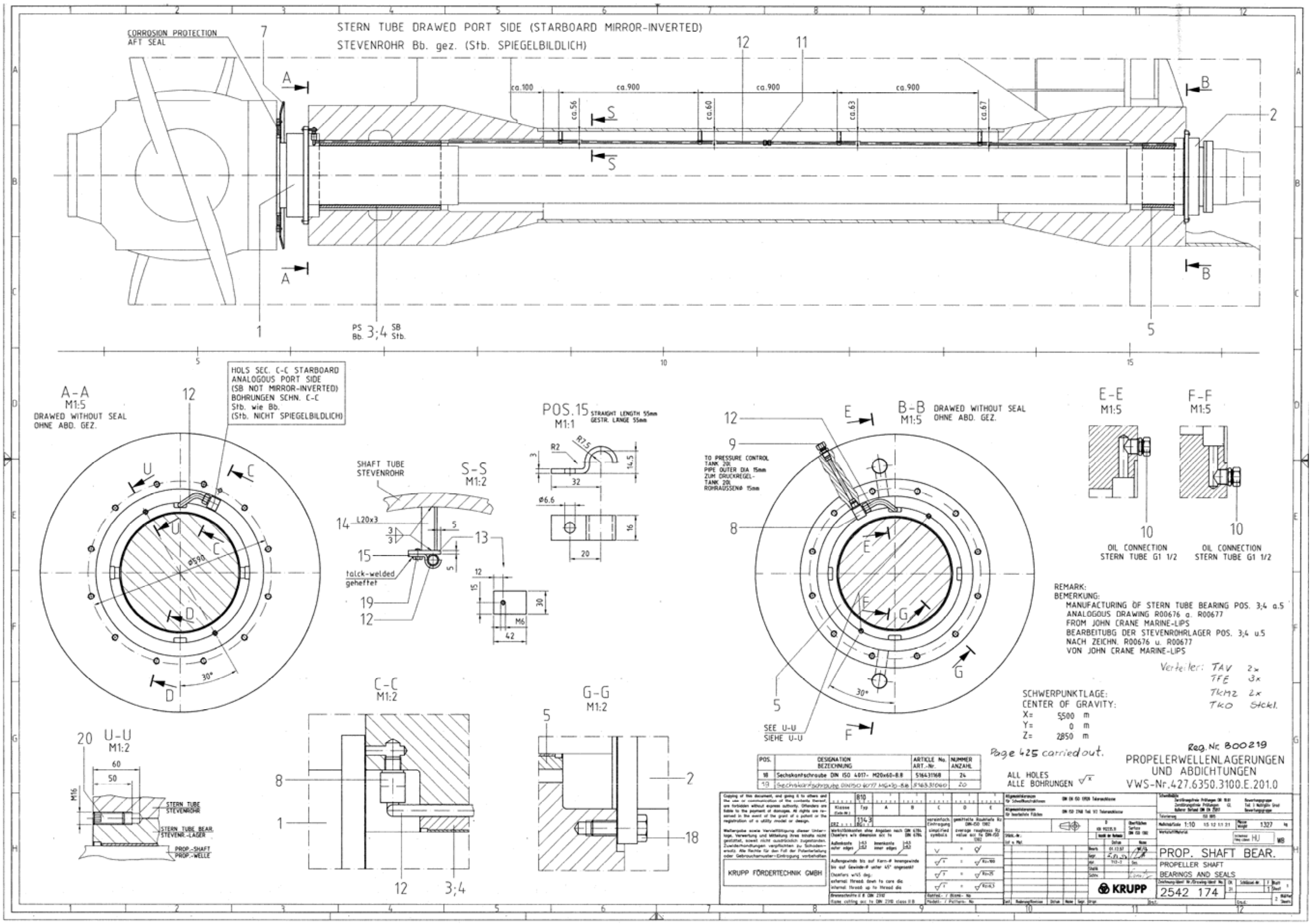
The shaft line of the controllable pitch propeller installation consists of, from:

- hub with blades,
- propeller shaft, with hydraulically fitted flange coupling demounting ring (gear wheel shaft)
- pitch servo unit

The hub is connected to the propeller shah flange with bolts and dowels. These are protected by a flange cover fitted with sealing rings and filled with mineral grease.
The shafts are hollow to contain the hydraulic pipe insert. This pipe insert consists of two co-axial pipes. The inner moving pipe connects the cylinderyoke in the hub with the feedback mechanism in the pitch servo unit. It transmits the position of the cylinder-yoke and thereby the blade position. It also transmits oil to the forward side of the cylinder-yoke to adjust the pitch in the ahead direction. The outer stationary pipe is fitted in the shaft bore and transmits oil to the astern side of the cylinder-yoke to maintain the blade position or to adjust the pitch in the astern direction. A third channel is available between the stationary pipe and the inside of the shafts. This channel connects the hub with the header tank. The header tank is located at a certain distance above the shaft line such that a static overpressure in the lubrication system of the hub is maintained. The inner pipe has, where necessary, sleeves with longitudinal flats to keep the unsupported length within required limits. The outer oil pipe has welded-on longitudinal strips for the same purpose.

A removable demounting ring in two halves is incorporated in the shaft line to provide the possibility to reach the local pipe coupling.

The inner pipe is provided with a built-in blocking valve. It holds the pitch during the time when no changes are required, and in emergency conditions. It is a non-return valve, pilot-operated and pressure actuated:
directly by oil pressure inside the pipe or with a pilot piston by oil pressure outside the pipe, depending on the direction of oil flow required.



CORROSION PROTECTION AFT SEAL
STERN TUBE DRAWED PORT SIDE (STARBOARD MIRROR-INVERTED)
STEVENROHR Bb. gez. (Stb. SPIEGELBILDLICH)
ca.100
ca.900
ca.900
ca.900
PS Bb. 3;4 SB Stb.
A-A M1:5
DRAWED WITHOUT SEAL OHNE ABD. GEZ.
HOLS SEC. C-C STARBOARD ANALOGOUS PORT SIDE (SB NOT MIRROR-INVERTED) BOHRUNGEN SCHN. C-C Stb. wie Bb. (Stb. NICHT SPIEGELBILDLICH)
SHAFT TUBE STEVENROHR
S-S M1:2
talck-welded geheftet
POS.15 M1:1
STRAIGHT LENGTH 55mm GESTR. LÄNGE 55mm
TO PRESSURE CONTROL TANK 20l PIPE OUTER DIA 15mm ZUM DRUCKREGEL-TANK 20l ROHRAUSSENØ 15mm
B-B M1:5
DRAWED WITHOUT SEAL OHNE ABD. GEZ.
E-E M1:5
F-F M1:5
OIL CONNECTION STERN TUBE G1 1/2
OIL CONNECTION STERN TUBE G1 1/2
REMARK:
BEMERKUNG:
MANUFACTURING OF STERN TUBE BEARING POS. 3;4 a.5 ANALOGOUS DRAWING R00676 a. R00677 FROM JOHN CRANE MARINE-LIPS
BEARBEITUBG DER STEVENROHRLAGER POS. 3;4 u.5 NACH ZEICHN. R00676 u. R00677 VON JOHN CRANE MARINE-LIPS
SCHWERPUNKTLAGE:
CENTER OF GRAVITY:
U-U M1:2
STERN TUBE STEVENROHR
STERN TUBE BEAR. STEVENR.-LAGER
PROP.-SHAFT PROP.-WELLE
C-C M1:2
G-G M1:2
SEE U-U SIEHE U-U
Page 425 carried out.
Reg. Nr. 800219
PROPELERWELLENLAGERUNGEN UND ABDICHTUNGEN
VWS-Nr.427.6350.3100.E.201.0
ALL HOLES ALLE BOHRUNGEN
KRUPP FÖRDERTECHNIK GMBH
PROP. SHAFT BEAR.
PROPELLER SHAFT BEARINGS AND SEALS
KRUPP
2542 174

Pitch servo unit

The OD box was used to transfer hydraulic oil into the rotating shaft. The indication of oil channels is as shown on the hydraulic diagram with list of symbols. Besides this function, the 00 box is used to transfer the pitch feed back signal from the inner moving and rotating oil pipe to the stationary world.

In the main, the pitch servo unit consists of a guide bush fitted to the gear wheel shaft and an Oil Distribution (OD) box fitted to the gearbox housing. The guide bush also supports the outer stationary oil pipe. A torque stay connected with the gearbox or the ship is not needed.

Three high-pressure floating seals were used, closed up between the housing, the rings and the flange. The seals can float in radial direction and are prevented from rotation by the cylindrical pins. Between the forward and the middle ring oil is pumped through the moving oil pipe to the forward end of the hydraulic cylinder; between the middle and the aft ring oil is pumped to the aft end of the cylinder via the channel between the oil pipe and the shaft. Aft of the seal assembly a low pressure oil seal is fitted. The housing of the OD box is utilized to collect leakage oil from the floating seals and from the channel between the stationary pipe and the shaft. The OD box is connected with the hydraulic power pack by pipes.

Emergency pitch setting can be effected if the hydraulic power is down or the hydraulic control system is out of order. The control plug will be replaced with an insert with a self-closing quick-release coupling.
The insert closes the connection with the proportional valve and thus with the power pack tank. The hose end of the emergency pump can be put into the coupling in order to pump oil through the insert to the hub. For normal operation the original situation has to be restored again, i.e. the special plug has to be removed and to be replaced with the original plug. The procedure is described in instruction book.

A transmitter box is attached to the OD box housing. By means of a slip ring which is attached to the moving oil pipe and a sliding block attached to a feed back lever. the pitch feed back signal is transferred to a spindle. This spindle transfers the achieved pitch position to the pointer and to the transmitter box. This box houses two potentiometers, one for feedback of the achieved pitch and one for the pitch indicating/monitoring system.

Emergency pitch setting

In case of an emergency in the hydraulic system, it may not be possible to restore the proper operation of the controllable pitch propeller within the time span available. In such a condition, the propeller blades may be adjusted to a suitable ahead position with the emergency equipment.

- Emergency pitch setting operation has to be carried out with the shaft stopped. The blades can be moved to and blocked in a ahead position in which the propeller installation can be driven like a fixed pitch system.
- The suitable pitch for starting and running of a fixed pitch propeller system is depending on the main engine and clutch (if available) characteristics.
- During emergency pitch setting operation, the pitch can be read locally from the scale and mechanically driven pointer on the pitch control unit,
- The blocking valve in the shaft line will secure the pitch in that position and block the tendency of the blades to change pitch in the astern direction.

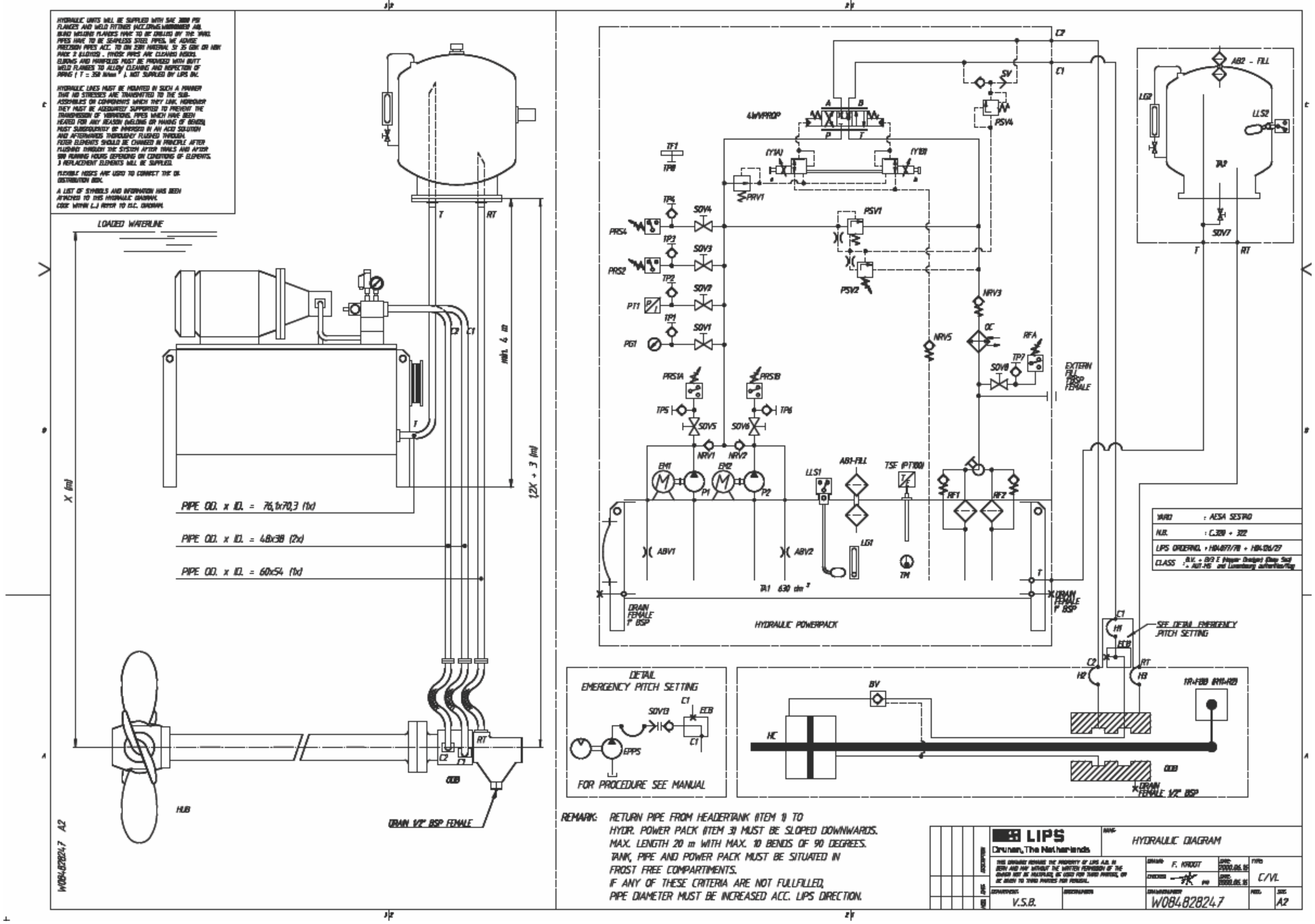
Hydraulic power equipment

The hydraulic installation consists of:

- piston-cylinder-yoke arrangement inside the hub
- in-shaft pipes with blocking valve in the moving oil pipe pitch servo unit with OD box which has a built-on mechanical pitch indicator and pitch transmitter box as well as an emergency pitch setting connection
- hydraulic power pack with power pack tank
- header tank

The parts of the hydraulic installation inside the hub, the shaft and the pitch servo unit have been outlined in the respective systems descriptions previously.

Power pack mounted hydraulic pitch control equipment



Hydraulic description

The hydraulic power pack mainly consists of an oil tank with built onto the top two electrically driven pumps, duplex return filter and the valve for hydraulic pitch control. One pump is acting as main pump, the other one as stand-by pump, as directed from the engine room. Pressure switch PRSl provides the signal 'oil pressure available'.

In case of a main pump failure, pressure switch PRS1A or PAS1B provides the signal to switch on the stand-by pump and switch off the main pump. A continuing low pressure condition will trigger an alarm by pressure switch PRS2. PRSl and PRS2 can be adjusted.

When a pitch change is required, the pitch control valve is electrically operated. One of the pumps will supply oil to the appropriate ring-shaped chamber in the OD box via this valve. Consequently, the oil is pumped through the moving oil pipe or via the cavity outside this pipe to the intended side of the piston in the hub to change pitch. Return oil from the piston is flowing to the OD box and,
together with OD box leakage oil, to the power pack tank.

The pitch control valve is a 4-way, pilot-operated, proportional valve (4WVPROP). The extent of the opening of this valve (4WVPROPI is regulated by a built-on pilot valve. The extent by which the pilot valve is opened in turn is proportional to the variable electric input signal from the remote control system, regulating the constant rate of pitch change.

The load-sensing valve PSV4 senses the pressure in either line C1 or C2, whichever is higher as directed by the shuttle valve SV. A pressure signal, adjusted by PSV4. is transmitted to the relief valve PSV1 to the effect that the pressure drop across the proportional valve is constant at all times at a level of only about 8 bar, depending on pump delivery and the size of the valve.
As long as no pitch change is needed, the piston and yoke in the hub are kept almost in their required position by the blocking valve (BV). The lines C1 and
C2 are pressureless, as is the interconnected return line. The oil of the pump, now delivers at a level of 13-20 bar depending on pump delivery (see pressure gauge), is returned to the power pack tank via the relief valve and the return
filter. Thermal losses are minimized during this action. When a pitch change is required, the proportional valve is activated and oil is pumped into the appropriate line C1 or C2, again with a pressure drop of about 8 bar across the proportional valve because of the action of PSV4 and PSV1. The blocking valve (BV) is opened and the return oil flows via the proportional valve 14WVPROPj to the power pack tank.
In order to avoid undesirable pressure build-up the safety valve PSV2 limits the maximum pressure in the oil supply line.
Pressure switch PAS4 provides a signal for high system pressure alarm.

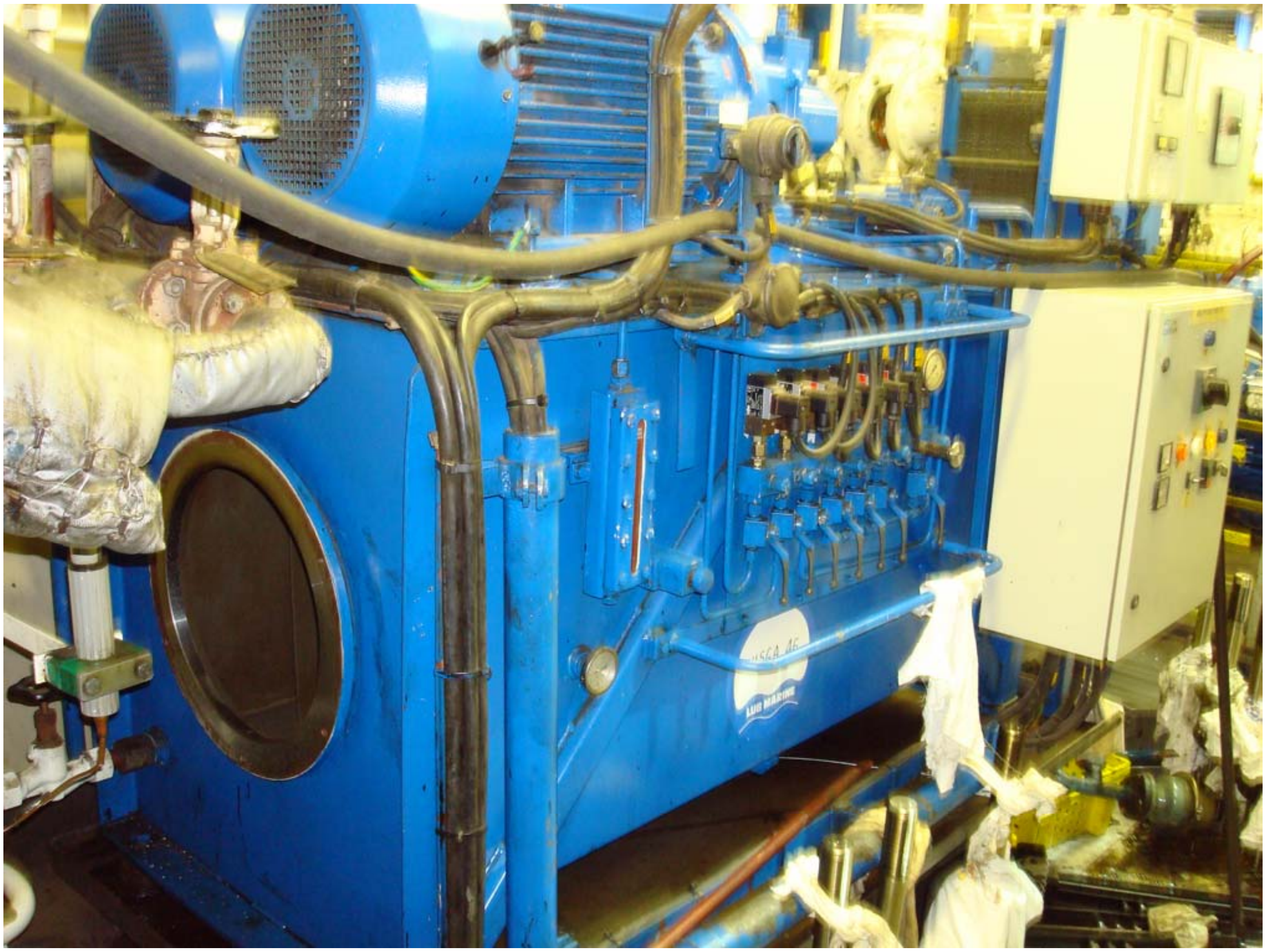
Temperature sensor TSE provides a signal that can be used by the ships alarm system to trigger a high temperature alarm and analog read out of the hydraulic oil temperature.

An oil cooler is built on which is to be connected with the cooling water system.

The hydraulic oil is used for hub lubrication. The space between the stationary oil pipe and the shaft is tilled with oil and connects the hub cavity with the OD box.

The hydraulic system is kept under static pressure by the header tank, which is to be located at a distance above the shaft line in accordance with the instruction on the hydraulic diagram. The leakage oil from the OD box is flowing to the header tank. Excess of oil in the header tank will flow to the lower tank. The header tank is fitted with a filler breather, low level switch and dip stick

The power pack tank is to be located at some distance below the header tank and above the shaft line in accordance with the instruction on the hydraulic diagram.



OIL

Filling (LIPS installation)

- Inspect the inside of the header tank on cleanliness before starting the filling operation.
- Always use one of the recommended type's of oil as listed in instruction book. Use clean oil. Make sure that all material used for filling is cleaned.
- All internal SOVs have to be open, except SOV7, *located* underneath the headertank, which has to be closed.
- When in dry dock, the bleed screws of the hub lubrication cavity and the aft cylinder chamber have to be set in the twelve-o'clock position and removed while filling, the bleed holes have to be observed during the entire filling operation and closed immediately on the appearance of oil with the proper torque applied to the screw.

- The bleed screw of the pitch servo unit has to be removed, observed during the entire filling operation and closed on the appearance of oil with the proper torque applied to the screw.
- Open the external connection to the power pack tank and start filling via
- The combined respiration device and filling connection (AB1-FILL) with clean oil until the tank is up to the maximal allowable level.
- The header tank may be filled through the combined respiration device and filling connection (AB2-FILL) with clean oil.
- Alternatively, the header tank will be filled slowly but automatically with leakage of the pitch servo unit when starting a pump.

Draining

In case work has to be done on hydraulic parts in the shaft line, the header tank has to be drained by opening SOV7, to the effect that the content will flow to the power pack tank; at the same time the power pack tank has to be drained sufficiently.
The pitch servo unit has a bleed screw and a drain plug.

Oil sampling instruction

The good results of the analysis of an oil sample and the related interpretation and diagnosis are depending on the following:

- Take the sample always from the same place, in the same condition and in accordance with this instruction.
- Always use clean sampling tools, check that the bottle had never been opened and/or used before.
- Take sample in good hygienic environment.
- The system should be at operating temperature. If possible the installation has to be in operation (propeller running) during the sampling, if not, take sample not more than 30 min. after propeller stop; pump of hydraulic system must be in operation.
- Note all data on the sticker of the sampling bottle.
- Send sample always to the same laboratory.

Sampling

- Remove the pressure gauge from its minimess connection.
- Clean the sampling point with paraffin and connect the sampling hose.
- Let ± 2 liter of hydro fluid flow away into a bucket or can. This removes all the dirt out of the minimess connection and hose.
- Screw the cover of the sampling bottle open and prick the tube through the cellophane. Fill the bottle up to ± 80%.
- Disconnect the sampling hose and let it drain in the bucket or can.
- Screw the cover back on the bottle.
- Replace the pressure gauge on the minimess connection.

Recommended hydraulic oil table

The following types of oil may be used in the hydraulic stem and the gear type pumps. The oil has to have anti-wear additives.

Oil company	Trade name	Pour point	Viscosity in cSt		Viscosity index
		°C	40°C	50°C	
AGIP	OSO 46	-27	45.0	29.0	105
	Arnica 46	-28	44.0	30.0	165
ARAL	Vitam GF46	-30	46.0	30.0	105
	Vitam HF46	-51	46.0	33.0	200
BP	Energol SHF46	-36	45.0	31.5	153
	Bartran HV46	-30	46.5	32.0	152
CASTROL	Hyspin AWS46	-21	46.0	29.5	95
	Hyspin AWH46	-33	46.0	31.5	150
CHEVRON	Mechanism LPS46	-42	46.0	32.0	164
ELF	Visga 46	-42	48.5	33.5	155
	Hydrelf	-36	46.0	31.5	155
ESSO	Nuto H46	-32	43.0	28.5	106
	Univis HP46	-42	45.0	31.5	172
FINA	Hydran 46	-30	45.5	30.0	101
	Hydran HV46	-39	45.0	31.5	153
KUWAIT	Gulf Harmony AW46	-30	44.0	29.5	113
MOBIL	DTE 15 M	-40	47.5	32.3	150
SHELL	Tellus 46	-27	46.0	30.0	103
	Tellus T46	-42	46.0	33.0	182
TEXACO	Rando Oil HD46	-30	44.6	29.0	101
TOTAL	Azolla 46	-27	46.5	30.5	99
	Equivis	-40	46.0	32.0	160

Cathodic Protection

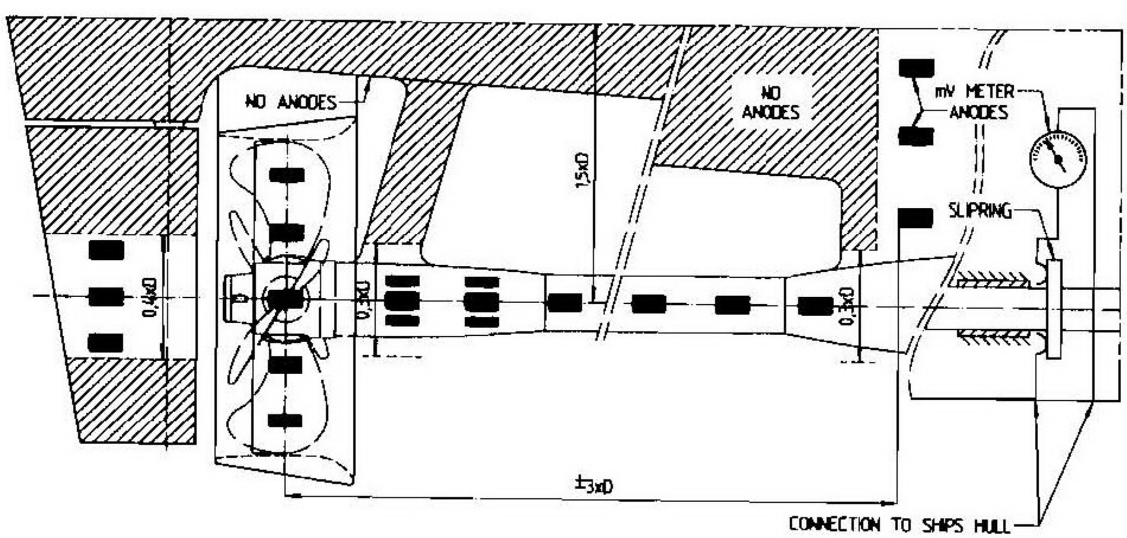
Though bronze propellers are inherently resistant to corrosion by seawater, galvanic processes may give rise to electro-chemical corrosion. Prevention of this corrosion can be achieved by:

- installation of zinc or aluminium anodes or an impressed current system.
- short circuiting the tailshaft to the hull by means of an earthing device (slipring). This earthing device is part of the LIPS scope of supply.

For a good protection it is also necessary to take care of the following:

- Use only anodes which can be welded to the hull.
- Paint only the welded areas of the anodes.
- Attach sufficient anodes near the stern of the ship to protect the propeller. This protection must be regarded as additional to the protection system of the ship. (See also figure 1 of this paragraph)
- Attach no anodes where they are likely to cause cavitation on the propeller. See shading in figure 1 of this paragraph)
- Locate the earthing device on the propeller shaft or at least as much as possible aft on the shaftline. Every shaftconnection where the protective current has to pass will cause significant reduction of the effect of the earthing device.
- Periodically check and replace the anodes.

W084815233 *97-10-22 I*	INSTRUCTION SHEET CATHODIC PROTECTION FOR PROPELLER ARRANGEMENT OF ANODES ON STERNFRAME AND RUDDER	Type NOZZLE



Total area of anodes:
Sacrificial current density for propeller:

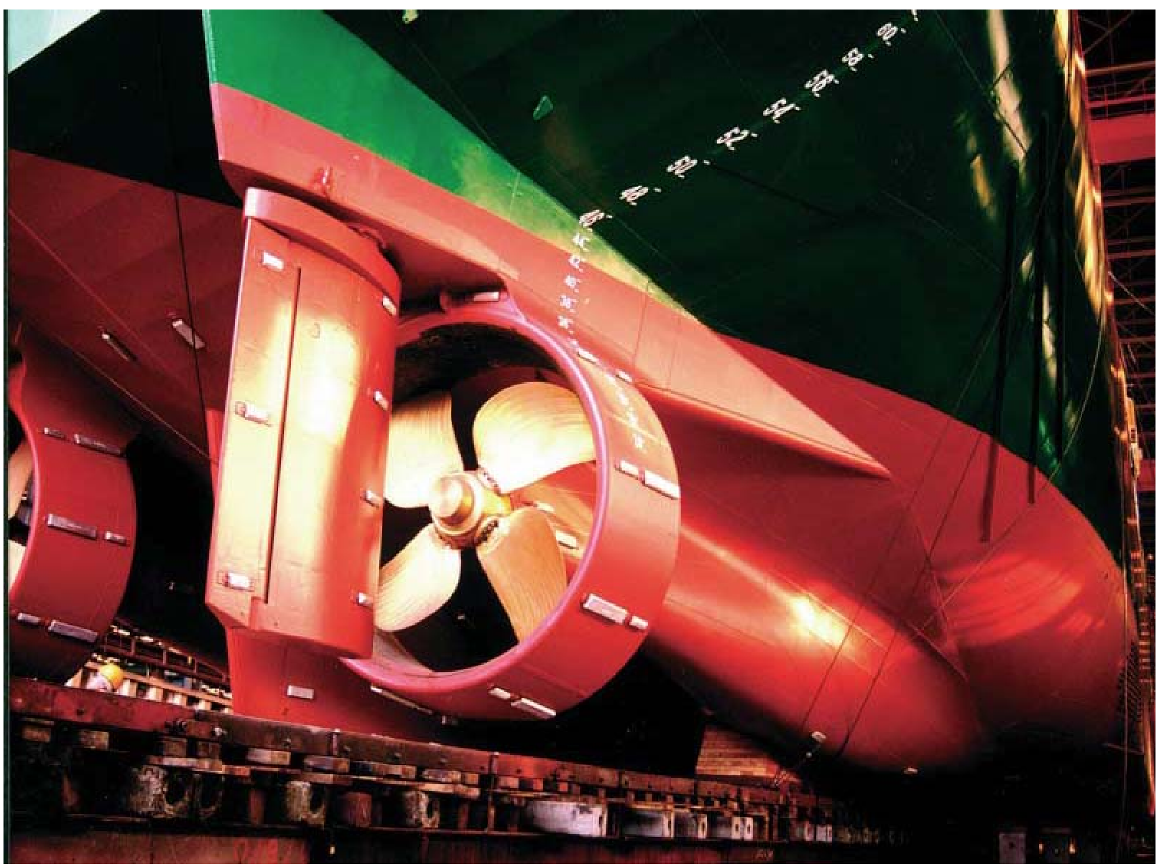
Normal trade, RD-RO, Passenger	: Is = 0,7	Aim'
~ Tugs, Dredgers, Fishery vessels	: Is = 1,0	Aim'
~ Ice breakers	: Is = 1,4	Aim'

Sacrificial current density for

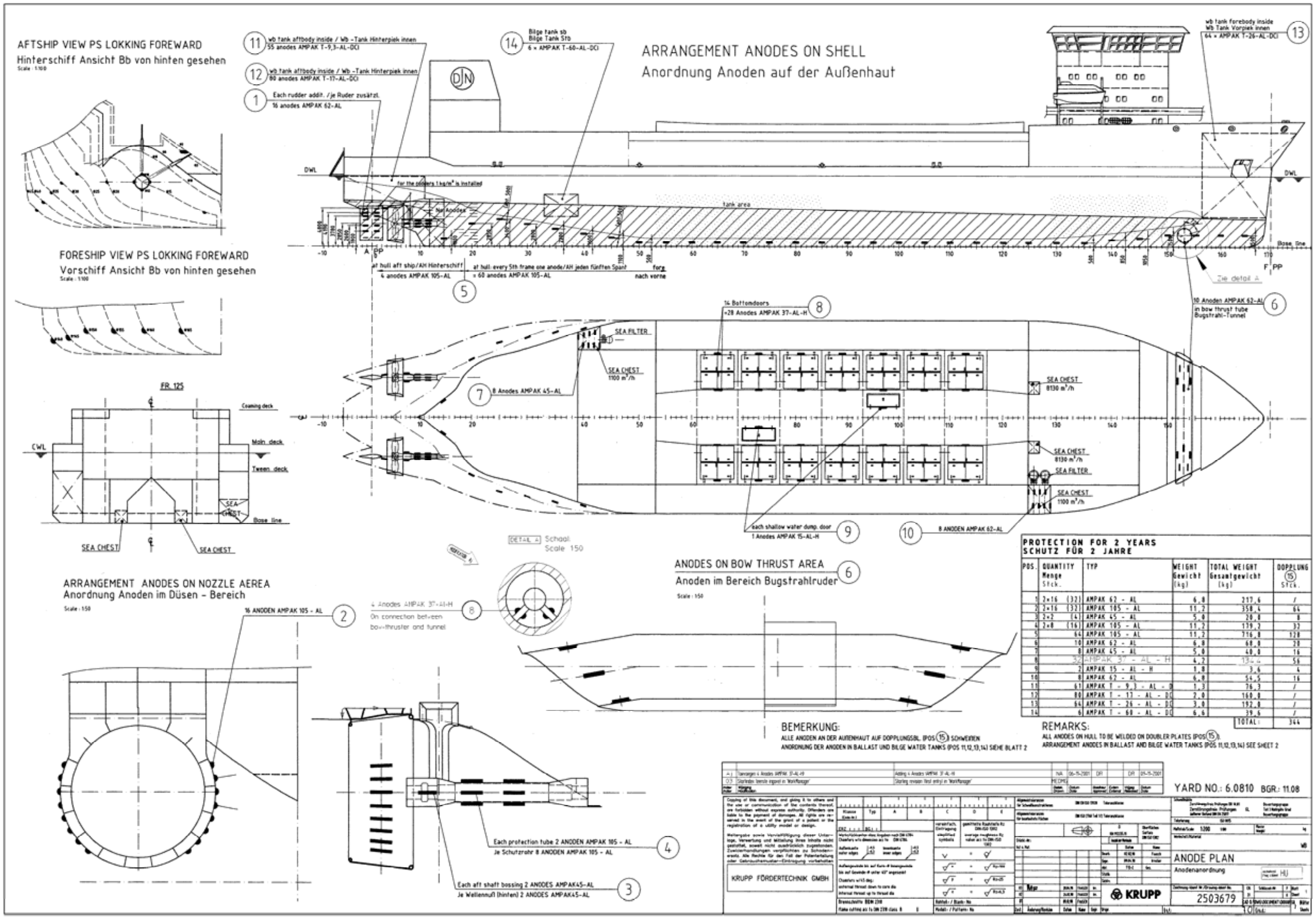
.. stainless steel of inner ring of nozzle	: Is =	0,6 Aim'
• painted steel plate of nozzle	: Is =	0,05 Aim'
Current capacity of zinc	: Iz =	11,5 Aim'
Current capacity of aluminium	: See data supplier	

TOTAL AREA OF ZINC = AREA OF SURFACE TO BE PROTECTED X Is / Iz

Notes: For good cathodic protection of the propeller and other rotating parts in the shaftline, an earthening device must be applied . .. For propeller running in extremely polluted water a higher value must be applied, .. Area of anodes is for propeller protection only and is additional to protection system of the hull.



Anode plan


AFTSHIP VIEW PS LOKKING FOREWARD
Hinterschiff Ansicht Bb von hinten gesehen
ARRANGEMENT ANODES ON SHELL
Anordnung Anoden auf der Außenhaut
FORESHIP VIEW PS LOKKING FOREWARD
Vorschiff Ansicht Bb von hinten gesehen
FR. 125
SEA CHEST
SEA FILTER
ARRANGEMENT ANODES ON NOZZLE AEREA
Anordnung Anoden im Düsen - Bereich
16 ANODEN AMPAK 105 - AL
ANODES ON BOW THRUST AREA
Anoden im Bereich Bugstrahlruder
PROTECTION FOR 2 YEARS
SCHUTZ FÜR 2 JAHRE
BEMERKUNG:
REMARKS:
Each protection tube 2 ANODEN AMPAK 105 - AL
Je Schutzrohr 8 ANODEN AMPAK 105 - AL
Each aft shaft bossing 2 ANODES AMPAK45-AL
Je Wellennuß (hinten) 2 ANODES AMPAK45-AL
KRUPP FÖRDERTECHNIK GMBH
YARD NO.: 6.0810
ANODE PLAN
Anodenanordnung
KRUPP
2503679

Maintenance

During all maintenance and repair operations, especially on the hydraulic system, the utmost care and cleanliness is essential. Impurities can always cause dangerous malfunctions in the hydraulic system.

- At docking
- Visual check of blades; pitting and surface deterioration should be repaired; it is advisable to have the blade surfaces professionally reconditioned in order to achieve efficient operating conditions.
- Visual check of all external bolts, locking strips and wire.
- Sample the hub oil to check that there has been no water ingress
- The part of the hull and the appendages around the propeller require cathodic protection. Check the anodes and carry out replacements where necessary to sustain another period till going into dry dock again
- Renew the blade seals every four years. It is to be advised to check the condition of the blade seals whenever the vessel enters dry dock.

Maintenance Schedule

Daily check

- Filter cartridges are to be checked on the visual indication of clogged filter.
- Oil level in the tanks.
- Oil temperature in the tank.
- Observe for abnormal noise of pumps.
- Oil pressures and temperatures of the hydraulic system

Weekly check

- Inspection and cleaning of the shaft-to-mass slipring assembly.
- With the ship underway regularly check the potential difference between the shaft and the ships hull. If the potential difference is more than 60 mV, reconditioning of the brushes and slip-rinqs is necessary.
- Check the functioning and condition of the cooler.

Monthly check

- The oil in sterntube and hub has to be checked
- Check if the stand-by pump is starting.
- Check low-pressure alarm is triggered.
- Change running pump and stand-by pump function.

Yearly check

- Pitch servo unit, checks to be carried out, pipe connections, clearances between OD box and shaft connections of all sealing rings, all other outside bolt and screw connections
- Testing of oil samples
- Tank cleaning and renewal of oil, everyone or two years depending on the number of operating hours and the oil condition.
- Test of safety valve, back-pressure valve and pressure switch setting

Malfunctions

Possible malfunctions

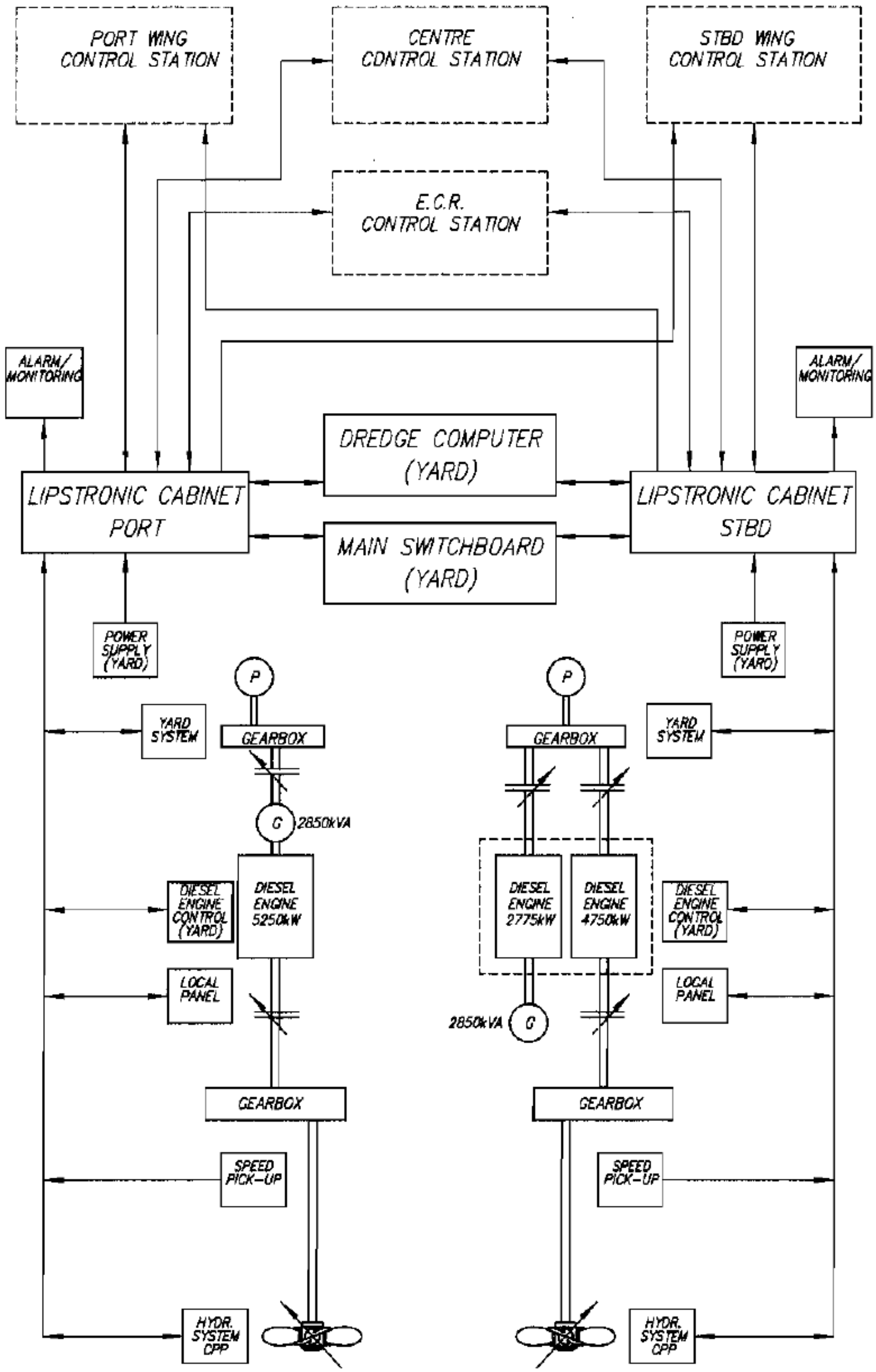
- No pitch change
- System hydraulic oil low pressure alarm
- Hydraulic oil tank low level alarm
- Hydraulic oil high temperature alarm
- Hydraulic pump noisy or system noisy
- Clogged oil filter, alarm

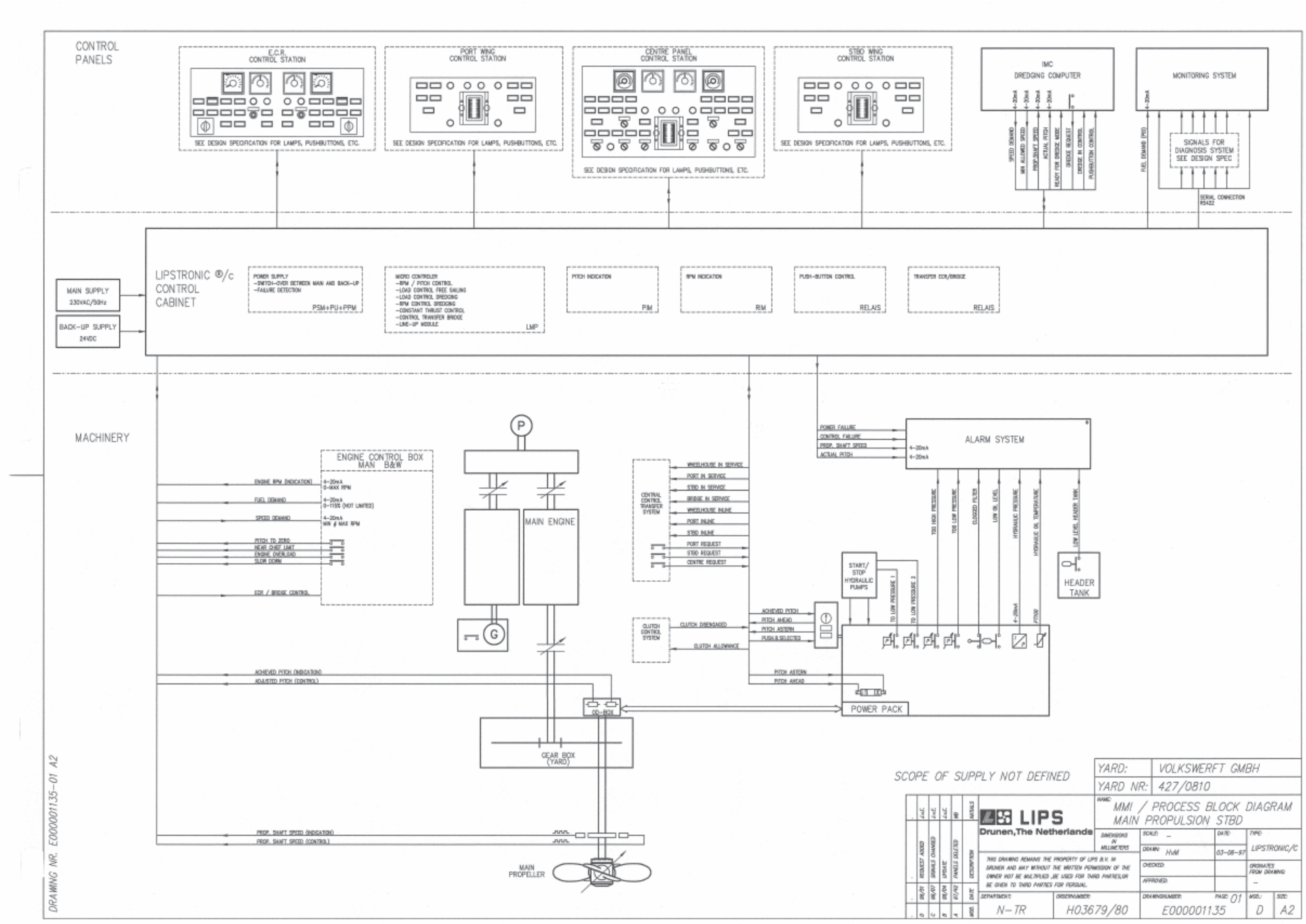
Control system

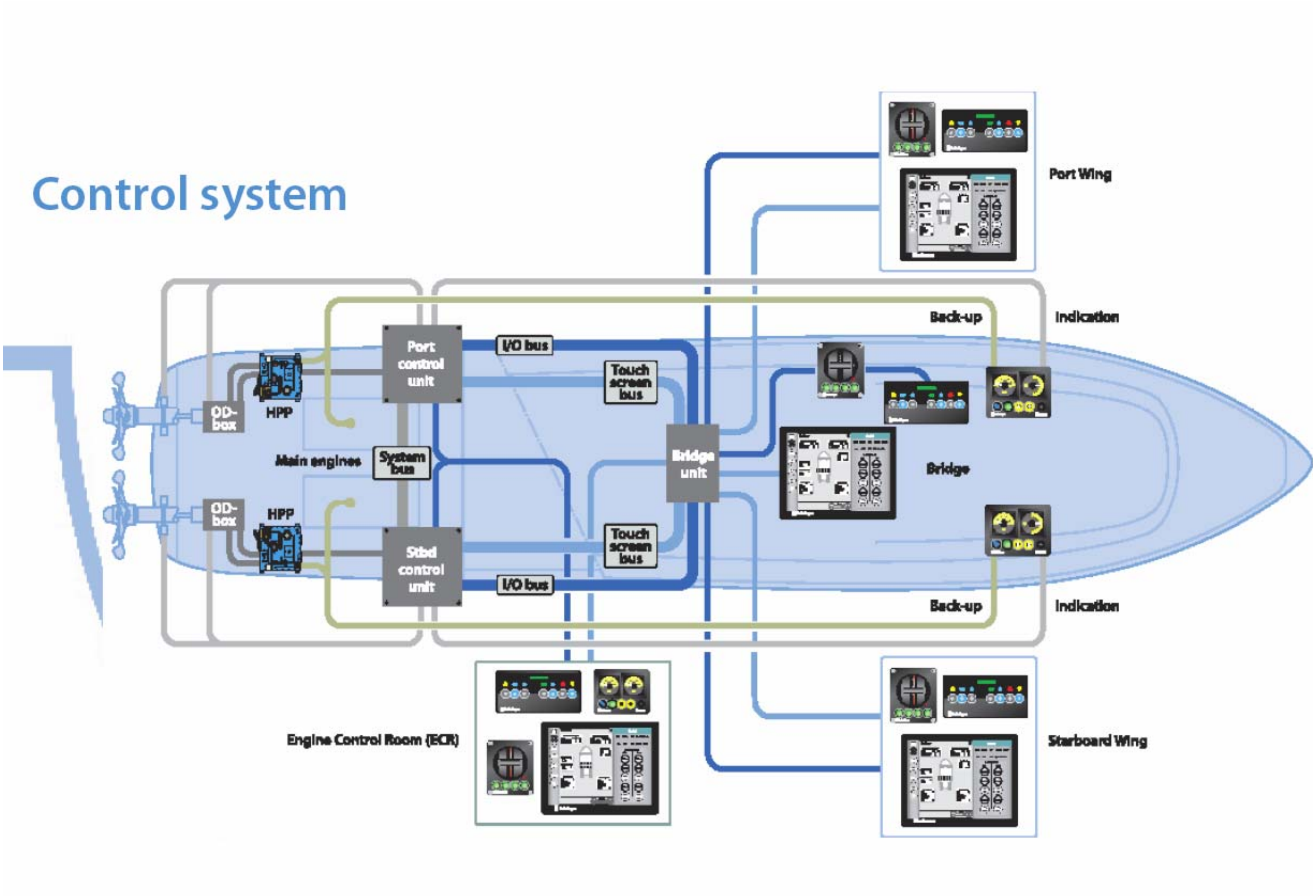
For the controlling and monitoring the main functions of the CPP control system had been developed.

Control system main components are,

- Remote control panels (Engine control room, Center Bridge, PS and SB wing)
- Local control panel
- Main control cabinet
- Alarm / monitoring panels
- Pick up sensors
- Main switchboard
- Ships computer (dredging)


PORT WING CONTROL STATION
CENTRE CONTROL STATION
STBD WING CONTROL STATION
E.C.R. CONTROL STATION
ALARM/ MONITORING
ALARM/ MONITORING
DREDGE COMPUTER (YARD)
LIPSTRONIC CABINET PORT
LIPSTRONIC CABINET STBD
MAIN SWITCHBOARD (YARD)
POWER SUPPLY (YARD)
POWER SUPPLY (YARD)
P
P
YARD SYSTEM
GEARBOX
GEARBOX
YARD SYSTEM
G
2850kVA
DIESEL ENGINE CONTROL (YARD)
DIESEL ENGINE 5250kW
DIESEL ENGINE 2775kW
DIESEL ENGINE 4750kW
DIESEL ENGINE CONTROL (YARD)
LOCAL PANEL
LOCAL PANEL
2850kVA
G
GEARBOX
GEARBOX
SPEED PICK-UP
SPEED PICK-UP
HYDR. SYSTEM CPP
HYDR. SYSTEM CPP


CONTROL PANELS
E.C.R. CONTROL STATION
PORT WING CONTROL STATION
CENTRE PANEL CONTROL STATION
STBD WING CONTROL STATION
SEE DESIGN SPECIFICATION FOR LAMPS, PUSHBUTTONS, ETC.
IMC DREDGING COMPUTER
MONITORING SYSTEM
SIGNALS FOR DIAGNOSIS SYSTEM SEE DESIGN SPEC
SERIAL CONNECTION RS422
MAIN SUPPLY 230VAC/50Hz
BACK-UP SUPPLY 24VDC
LIPSTRONIC ®/c CONTROL CABINET
POWER SUPPLY
-SWITCH-OVER BETWEEN MAIN AND BACK-UP
-FAILURE DETECTION
PSM+PU+PPM
MICRO CONTROLLER
-RPM / PITCH CONTROL
-LOAD CONTROL FREE SAILING
-LOAD CONTROL DREDGING
-RPM CONTROL DREDGING
-CONSTANT THRUST CONTROL
-CONTROL TRANSFER BRIDGE
-LINE-UP MODULE
LMP
PITCH INDICATION
PIM
RPM INDICATION
RIM
PUSH-BUTTON CONTROL
RELAIS
TRANSFER ECR/BRIDGE
RELAIS
MACHINERY
ENGINE CONTROL BOX MAN B&W
MAIN ENGINE
ALARM SYSTEM
START/STOP HYDRAULIC PUMPS
HEADER TANK
POWER PACK
OD-BOX
GEAR BOX (YARD)
MAIN PROPELLER
SCOPE OF SUPPLY NOT DEFINED
YARD: VOLKSWERFT GMBH
YARD NR: 427/0810
LIPS
Drunen,The Netherlands
MMI / PROCESS BLOCK DIAGRAM
MAIN PROPULSION STBD
DRAWN: HvM
03-06-97
LIPSTRONIC/C
DEPARTMENT: N-TR
ORDERNUMBER: H03679/80
DRAWINGNUMBER: E000001135
PAGE: 01
D
A2
DRAWING NR. E000001135-01 A2


Control system
Port Wing
Back-up
Indication
Port control unit
I/O bus
Touch screen bus
OD-box
HPP
Main engines
System bus
Bridge unit
Bridge
Stbd control unit
I/O bus
Touch screen bus
OD-box
HPP
Back-up
Indication
Engine Control Room (ECR)
Starboard Wing

Electric system description

The thrust of the propeller is controlled by changing the pitch of the propeller;
This is realized by turning the propeller blades. The position of the blades is changed hydraulically; hydraulic oil under pressure is pumped through the hollow propeller shaft and gearboxs haft towards the hub of the of the propeller.
The hydraulic powerpack is installed in the engineroom.
Propellerblades can be turned in forward and backward direction to get respectively thrust ahead and thrust astern. The thrust astern is lesser than the thrust ahead. (In case of a fixed propeller (a propeller with a fixed pitch), thrust can be changed only by changing the propeller revolutions).These option is also possible, emergency operation or push buttons.

- Lever control is possible from the bridge panels. Depending from the selected mode, combinator, constant rpm or dredge model the propeller pitch and rpm are controlled.
- Whenever a wire-break of the lever transducer Is detected, the pitch and rpm command signals will be frozen and an alarm (lever control failure) will be given.
- Via a line-up system the levers must be in-line to ensure bumpless control transfer between the bridge panels. When not in line it is not possible to transfer the control.
- Lever running-up/down The demand set by the lever unit is going into a running up/down module. A running-up/down adjustable module is active which incorporates two rates for load increase and two rates for load decrease. The running up/down module has only effect on the lever demand. During dredge mode the rates will be slower.
- Pitch/RPM scheduling. For the different modes also different pitch and rpm schedules are present
  - ✓ Combi mode, pitch and rpm are both controlled via a single lever. In this mode, the thrust is controlled by optimizing the pitch in combination with the engine speed, or finally the propeller speed. This mode of control has a positive influence on the efficiency of the propulsion plant; the efficiency is even better than in constant speed mode. This mode is advantageous when the ship has to operated for long terms with very low thrust, i.e. ship is standby, or is sailing at low speed. A disadvantage is that maximum thrust is not immediately available because it takes longer before the engine power is available.
  - ✓ Constant mode, pitch is controlled via a single lever unit while rpm have constant value. The advantage is that the thrust can be increased much faster, because there is much engine power nearly immediately available. A disadvantage is that is thrust control is more difficult in the small thrust ranges. When sailing at low ships' speed, a lot of engine power is lost due to water turbulence and too high propeller speed. Besides, the specific fuel consumption of the engine in part load is higher !

- ✓ Dredge mode, the lever position defines a demanded thrust. A special schedule calculates the demanded pitch to maintain this thrust demand independent of the rpm demand.
- ✓ Emergency operation mode, the pitch of propeller can be independently changed by pushbutton control in the navigation desk. Before this is possible, the selector switch 'PUSHBUTTON CONTROL' must be selected ON. With the pushbuttons AHEAD and ASTERN, the solenoids in the engineroom are controlled directly.

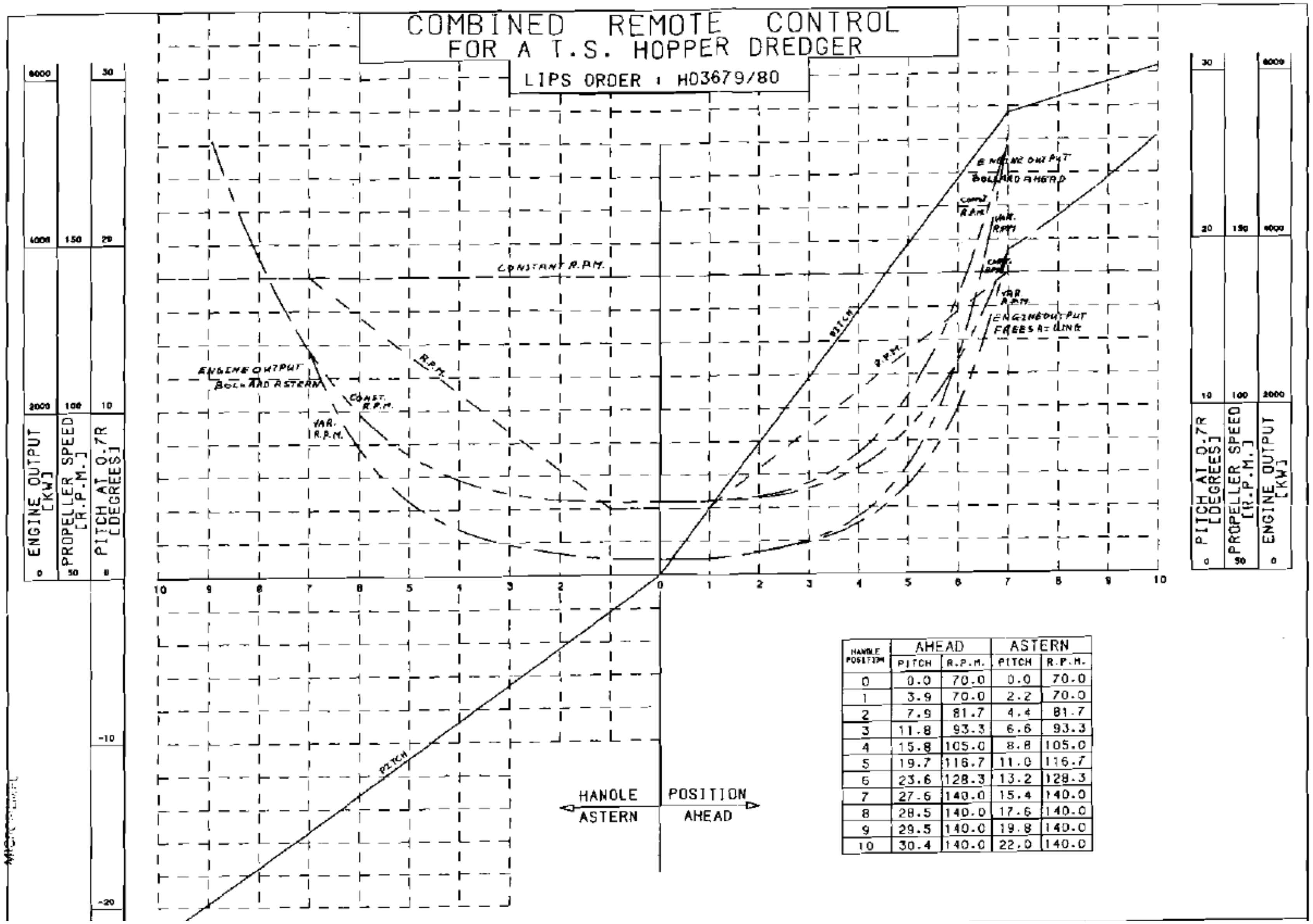
Important: the loadcontrol is not working anymore in 'pushbutton control'
Also, when the propulsion is on ECR control, the pitch can changed with pushbuttons in the ECR desk; the load control is not active!

- Load control is operational during the free sailing and constant rpm mode.
- During dredging the load control becomes active when the engine speed drops below 70% of the maximum RPM. The load-control system will reduce the pitch demand (coming from the pitch schedule) whenever a main engine overload is detected.
- The maximum allowed fuel-rack position is the lowest value of:
  - ✓ Maximum allowed fuel-demand for continuous operation as function of the rpm demand. During dredge mode the maximum load of the main engine is limited to 100% between 70 and 100% of the maximum rpm (engine can run against torque limit).
  - ✓ The limit set with the "'load limit" potentiometer within the remote control cabinet. This limit can be set between approximately 70% and 100%,
  - ✓ This limit can be set by the "load slow down" contact coming from main engine controls. Default for this setting is 70% of the maximum load.

- The pitch governing system is active when dredge mode is selected and there is a dredge request. This system will only become active when the actual propeller RPM drops below the "minimum allowed RPM". The pitch will be reduced in such a way that the minimum propeller speed will be maintained.
- The subsystem for indication is executed in independent circuitry. These subsystems consist of a pitch indication module (PIMJ for propeller pitch and a RPM indication module (RIMI for propeller shaft RPM.
  - ✓ For pitch indication a feed-back potentiometer is mounted in the DO-box. Pitch indication is available on all panels and at the aft bridge. On the pitch indication module a contact "ZERO PITCH" is available for engagement interlock of the main engine.
  - ✓ For propeller shaft RPM indication a speed pick-up is mounted at the propeller shaft. Indication is provided on all panels.
  - ✓ For engine RPM indication a signal coming from the engine will be used.

Alarm system
There are two alarms which are could be send to the alarm system

E-power failure: A tripped fuse or a power failure in the control system.
Control failure: A wire-break if any sensor or potentiometer meter, or a follow up failure.



HANDLE POSITION	AHEAD		ASTERN	
	PITCH	R.P.M.	PITCH	R.P.M.
0	0.0	70.0	0.0	70.0
1	3.9	70.0	2.2	70.0
2	7.9	81.7	4.4	81.7
3	11.8	93.3	6.6	93.3
4	15.8	105.0	8.8	105.0
5	19.7	116.7	11.0	116.7
6	23.6	128.3	13.2	128.3
7	27.6	140.0	15.4	140.0
8	28.5	140.0	17.6	140.0
9	29.5	140.0	19.8	140.0
10	30.4	140.0	22.0	140.0

Literature:
Introduction to Marine Engineering D. A. Taylor,
LIPS BV, The Netherlands
Kamewa, www.rolls-royce.com/marine/products