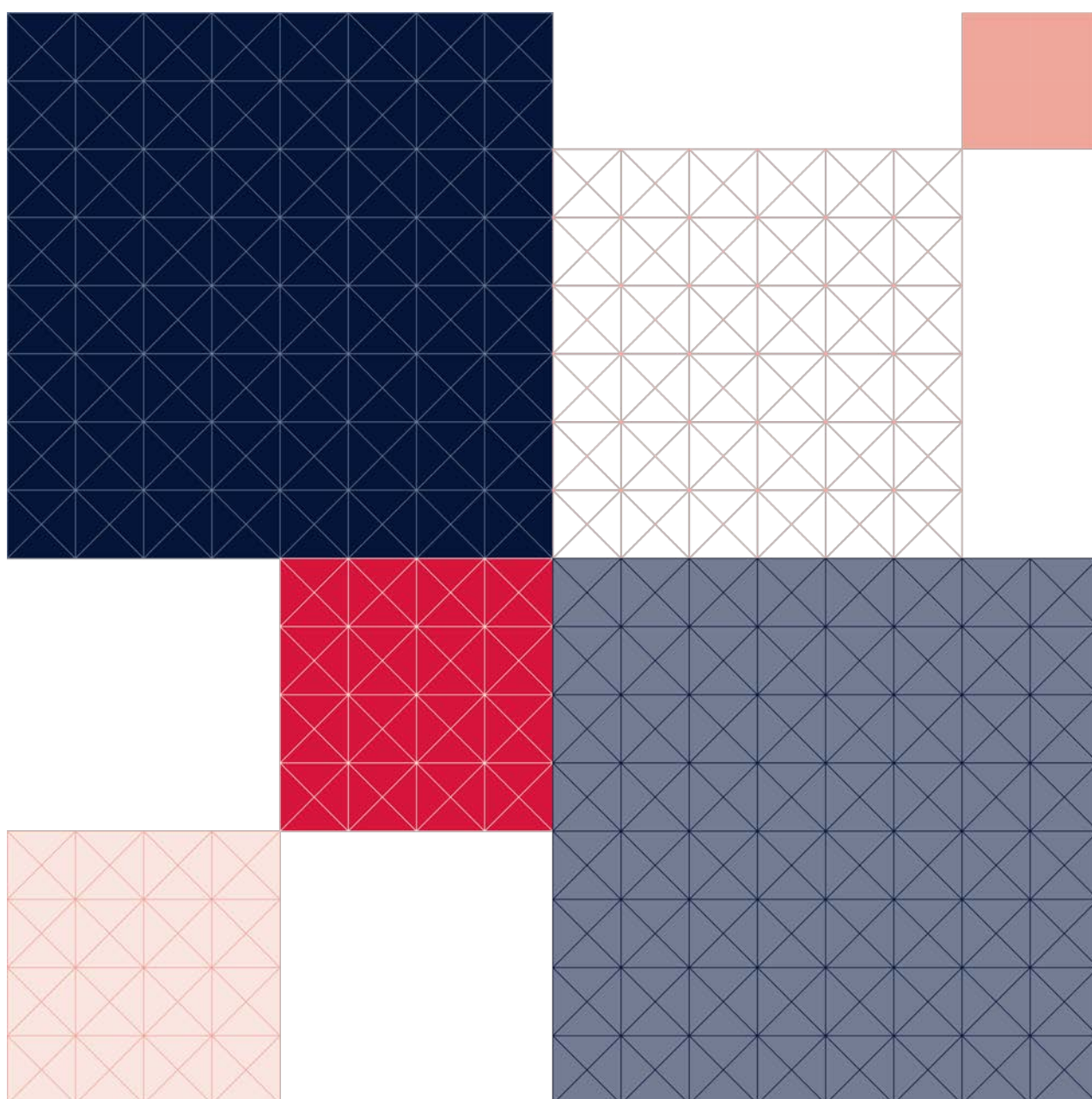




KONGSBERG

# Maintenance Manual

## Kongsberg Steering Gear type SR and SV





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## Safety

Please take the time to read this chapter carefully, as it concerns your safety.

### General statement

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## Safety annotations

All safety directions must be respected in order to avoid damage to personnel, environment and equipment. In this document the following annotations are used with belonging significance:



### WARNING

Indicates possibilities for hazards or unsafe practices, which **COULD** result in fatal or severe personnel injuries or substantial product or property damage, if the required precautions are not taken.



### Note!

*Draws attention to specific information of technical significance which might not be obvious to specialist personnel, or points at important remarks in the procedures to follow.*



## 1. Introduction

This manual provides the Kongsberg Maritime maintenance recommendations and instructions for the SR and SV type steering gears. All recommendations are provided in relation to general Class requirements and guidelines.

## 2. Maintenance overview

Kongsberg Maritime (KM) steering gears are designed for safe operation with a minimum maintenance. To prevent unexpected problems or downtime, it is recommended that the users maintain the steering gear system at regular intervals.

For scheduled class survey and general service or repair, it is recommended to use Kongsberg Maritime service engineers. This will decrease the time of repair to a minimum and ensure continuous safe operation.

This document describes all relevant maintenance procedures and activities to be carried out by the crew, in addition to the maintenance recommended to be performed by Kongsberg Maritime engineers. Any other information may be found in the steering gear OPERATING AND MAINTENANCE MANUAL (USER MANUAL) or by contacting [service.dmss@km.kongsberg.com](mailto:service.dmss@km.kongsberg.com)

After a certain number of years in operation it is, however, necessary to service the equipment and replace internal and external wear parts in order to achieve a predictable and safe life-cycle for the steering gear equipment. The service intervals are depending on factors such as:

- Alignment of rudderstock and steering gear
- Radial forces from rudder and the operation profile of the steering gear
- Oil temperature, pressure and oil condition
- Duty cycles and degrees travelled
- Other conditions such as DP operations
- General maintenance

It is important to monitor the condition and performance of the equipment and take notice of any changes. This might be important to reveal any problem about to develop before a breakdown occur.



### Note!

*It is requested that any failures or maintenance work on the equipment, no matter how small, should be reported to Kongsberg Maritime at; [service.dmss@km.kongsberg.com](mailto:service.dmss@km.kongsberg.com)*

By reporting, any failures and maintenance work, an accurate equipment history can be maintained. This history will be continuously monitored and compared to other vessels with similar equipment. With this information, we can provide better service, faster delivery of spare parts, and guidance for preventive maintenance.



### 3. Docking related service and maintenance tasks

Please see below intervals for service and maintenance recommended in relation to scheduled class surveys or docking.

Service and maintenance	5 YEAR	10 YEAR	15 YEAR	20 YEAR	25 YEAR
Change of actuator seals and bearings*	(x)	x	(x)	x	(x)
Change Oil*	(x)	x	(x)	x	(x)
					(x)
Service of distribution valve*		x	(x)	x	(x)
Change flexible coupling hydraulic pump No 1 and 2*		x	(x)	x	(x)
Replace vibration dampers (if applicable)		x	(x)	x	(x)
Replace hydraulic pump No 1 and 2*		x	(x)	x	(x)
Replace frequency converters		x	(x)	x	(x)
Replace coolers (if applicable)		x	(x)	x	(x)
Replace rubber hoses		x	(x)	x	(x)
Replace or overhaul electric motors		x	(x)	x	(x)
<b>Condition based recommendation</b>	<b>x</b>	<b>(x)</b>	<b>x</b>	<b>(x)</b>	<b>x</b>

\*Recommended to be carried out in dry dock/port, by Kongsberg Maritime service engineers.

(X) - Service or maintenance recommendation dependent on equipment condition and service history.

X - Recommendation based on number of years in service (minimum every 10 years).

#### X - Condition based recommendation:

The Condition based recommendation is based on several condition values reported through a mobile application provided by KM to the customer to perform inspection of the steering gear equipment themselves. The Mobile application contains a Self - Assessment, leakage and manoeuvre time test and loading of SG PMS Log files by using our dedicated application – customer sync result back to KM for recommendations, ideally six months in advance of the vessels planned class surveys or docking.

#### Steering Gear Performance Monitoring System (SG PMS):

The purpose of the performance monitoring system is to continuously monitor the performance and operation of the steering gear, and provide an alarm when degraded or irregular performance is detected. The SG PMS Amplifier card is part of the standard delivery for all new steering gears type SR/SV - FCP, as of early 2019. The SG PMS solution is also available as an upgrade on all steering gear installations completed in 2005 or later.

#### Service and maintenance intervals:

**5 years:** Service and maintenance recommendations based on current equipment performance and conditions reported through the Kongsberg Mobile application including:

- Self – Assessment or Maintenance Inspection report (ref. chapter 8)
- Leakage and manoeuvring time test



- Steering gear PMS log files for the last 12 months (if SG PMS amplifier card is available)

**10 years:** Recommended service and maintenance according to above table, and previous service history.

**15 years:** Recommendations will be based on previous service and maintenance completed, current equipment performance and condition reported through the Kongsberg Mobile application including:

- Self – Assessment or Maintenance Inspection report (ref. chapter 8)
- Leakage and manoeuvring time test
- Steering gear PMS log files for the last 12 months (if SG PMS amplifier card is available)

**20 years:** Recommended service and maintenance according to above table, and previous service history.

**25 years:** Recommendations will be based on previous service and maintenance completed, current equipment performance and condition reported through the Kongsberg Mobile application including:

- Self – Assessment or Maintenance Inspection report (ref. chapter 8)
- Leakage and manoeuvring time test
- Steering gear PMS log files for the last 12 months (if SG PMS amplifier card is available)



## 4. Regular maintenance tasks

The Maintenance instructions below details all preventative maintenance activities to be carried out by the Crew on a regular basis. Please add below tasks to applicable vessel maintenance system.

System (a)	Sub-System (b)	Part (c)	Maintenance Task (d)	Maint (e)	Freq (f)	Type (g)	Skill Level (h)	Facility (I)
Steering Gear system		Actuator	Check for any leakage around the steering gears inboard part.	Prev	1 day	CHK	A	A
Steering Gear system		Actuator	Check surface temperatur of the equipment( pipes from pumps)	Prev	1 day	CHK	A	A
Steering Gear system		Actuator	Check for abnormal vibrations/noises on the equipment.	Pre	1 day	CHK	A	A
Steering Gear system	Controls System	Frequency Converter	Check Frequency Converter display for error message.	Prev	1 wk	CHK	A	A
Steering Gear system	Hydraulic System	Oil Tank	Check oil level in the expansion tank and top up if necessary	Prev	1 wk	CHK	A	A
Steering Gear system	Hydraulic System	Standby Pump	Start/stop standby pump	Prev	1 wk	TST	A	A
Steering Gear system			Cleaning of Steering Gear unit and surroundings	Prev	1 mth	CL	A	A
Steering Gear system	Actuator	Actuator	Perform test of Steering Gear modes, Emergency Steering and normal steering from all stations.	Prev	1 mth	TST	A	A
Steering Gear system		Actuator	Check manoeuvring time according to SOLAS	Prev	1 mth	CHK	A	A
Steering Gear system	Hydraulic System	Duplex Filter	Check filter blockage indicators, change filter element if necessary.	Prev	1 mth	CHK	A	A
Steering Gear system	Controls System	Controll Panels	Make sure that all electrical indications push buttons back light bulbs are ok	Prev	1 mth	CHK	A	A
Steering Gear system	Hydraulic Pumps	Actuator	Perform visual check of pump and motor coupling	Prev	1 mth	CHK	A	A
Steering Gear system	Alarm System	Alarms	Function test of alarm system according to manual.	Prev	3 mth	CHK	A	A
Steering Gear system		Coolers	Visual inspection of coolers	Prev	6 mth	CHK	A	A
Steering Gear system		Actuator	Internal leakage test	Prev	6 mth	TST	A	A
Steering Gear system	Hydraulic System		Collect sample of hydraulic oil from the actuator	Prev	6 mth	SAM	A	A
Steering Gear system	Hydraulic System		Change filter	Prev	6 mth	FC	A	A
Steering Gear system	Controls System	Frequency Converter	Check of alarm log	Prev	1 yr	CHK	C	A
Steering Gear system	Intercom system	Steering gear room	Check communication system between Steering gear room and the bridge.	Prev	1 yr	CHK	A	A
Steering Gear system	Controls System	Electric Motor	Megger test electric motors	Prev	1 yr	MEG	A	A
Steering Gear system	Control System	Motor Controller	Freq Converter (small starters), Annual Check	Prev	1 yr	CHK	C	A
Steering Gear system	Control System	El system	Perform a visual check of all Electrical components, eartings, cable conetctions.	Prev	1 yr	INSP	A	A
Steering Gear system	El system	El system	Replace vibration dampers (Freq converters)	Prev	5 yr	REP	A	A



The table below illustrates the intervals for service and maintenance recommended in relation to scheduled class surveys or docking, recommended to be carried out in dry dock/port, by Kongsberg Maritime service engineers, (also described under section 3. of this manual). Please add below tasks to applicable vessel maintenance system.

System (a)	Sub-System (b)	Part (c)	Maintenance Task (d)	Maint (e)	Freq (f)	Type (g)	Skill Level (h)	Facility (i)
Steering Gear system	Steering Gear system	Actuator	Change of seals and bearings	Prev	10 yr	REP	C	A
Steering Gear system	Steering Gear system	Actuator	Change Oil	Prev	10 yr	OC	C	A
Steering Gear system	Steering Gear system	Valve	Overhaul distribution valve	Prev	10 yr	INSP	C	A
Steering Gear system	Steering Gear system	Hydraulic Pump No1	Change flexible coupling	prev	10 yr	REP	C	A
Steering Gear system	Steering Gear system	Hydraulic Pump No2	Change flexible coupling	prev	10 yr	REP	C	A
Steering Gear system	Controls System	Frequency Converter No1	Replace frequency converter	Prev	10 yr	REP	C	A
Steering Gear system	Controls System	Frequency Converter No2	Replace frequency converter	Prev	10 yr	REP	C	A
Steering Gear system	Hydraulic System	Hydraulic Pump No1	Replace Pump	Prev	10 yr	REP	C	A
Steering Gear system	Hydraulic System	Hydraulic Pump No2	Replace Pump	Prev	10 yr	REP	C	A
Steering Gear system	Controls System	Electric Motor No 1 and No2	Replace or overhaul electric motor	Prev	10 yr	OVH	B	A/D
Steering Gear system		Coolers	Replace coolers	Prev	10 yr	REP	A	A
Steering gear system	Hydraulic system		Replace rubber hoses	Prev	10 yr	REP	A	A

**Column description:**

- Columns **a, b & c** illustrate the hierarchical relationship between the components/sub-assemblies (column c) on which maintenance is performed and the high level module (column a).
- Column **d** describes the maintenance activity.
- Column **e** identifies the maintenance activity as either Preventative or Corrective.
- Column **f** details the frequency of the maintenance activity.
- Column **g** groups the maintenance activity into a category which facilitates the rapid analysis of the maintenance data, eg one can search on OC to identify when the equipment underwent an oil change.
- Column **h** identifies which skill level is required for the maintenance activity.
- Column **i** identifies what facility is required for the maintenance activity.

**Maintenece categories:**

Abreviation	Description
BC	Bearing Change
CHK	Check
CL	Clean
FC	Filter Change
FLU	Flush
INSP	Inspect
LUB	Lubricate
MEA	Measure
MEG	Megger
OC	Oil Change
OVH	Overhaul
REP	Replace
KM OVH	Kongsberg Maritime Overhaul
SAM	Sample
TST	Test

**Skill level and facilities:**

The skill levels indicate the skill level of the person responsible for the maintenance task, the facility indicates the physical location of the vessel during the maintenance procedure. The skill and facility codes are:

- Maintenance Level A is general operational maintenance carried out by the ships crew on board, with no additional support or facilities.
- Maintenance Level B is maintenance carried out in port, using ships crew and local port supplied support and facilities.
- Maintenance Level C is maintenance carried out in port, requiring specialist Kongsberg Maritime support.
- Maintenance Level D is repair and overhaul activities undertaken in a Kongsberg Maritime specialist workshop.

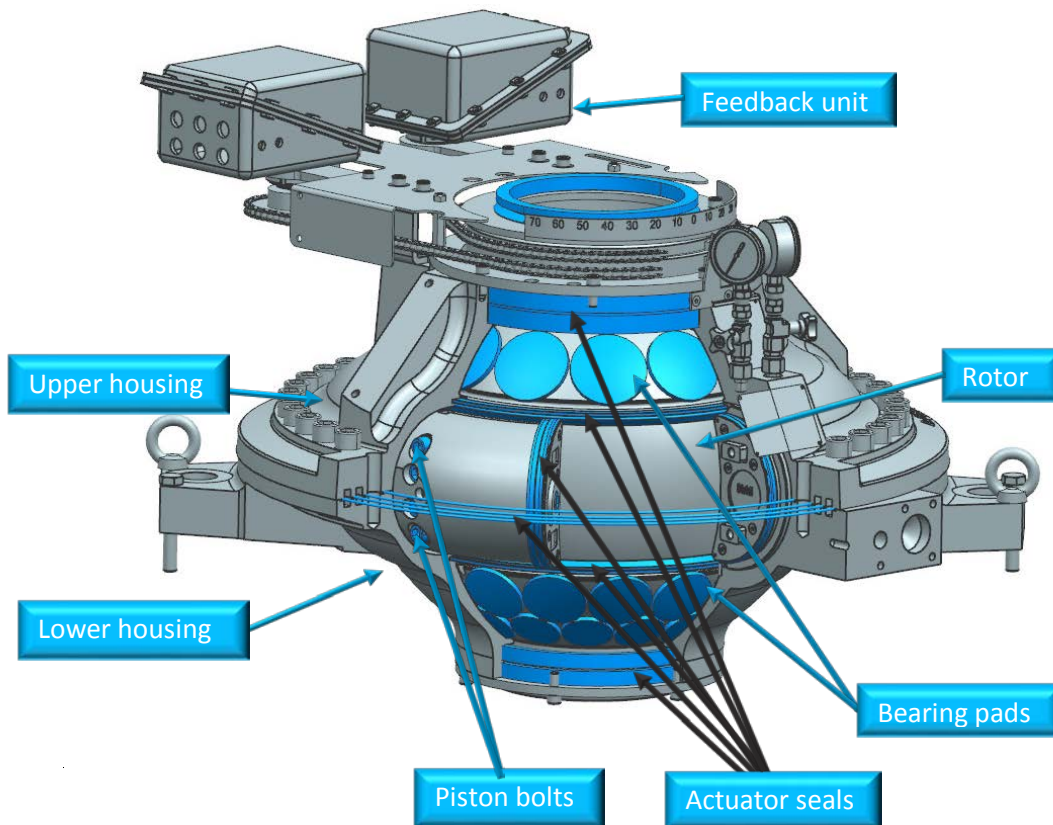
The facility indicates the physical location of the vessel during the maintenance procedure.

The codes for facility are:

- A – Onboard
- B – Harbour
- C – In dry dock
- D – In Workshop (Kongsberg Maritime or port workshop facilities)

## 5. Steering gear actuator

The function of the hydro-mechanical steering gear unit is to provide the rotational power to operate the rudder unit. The steering gear has a compact and unique design with cylindrical rudderstock.



The vanes/pistons work in a spherical shaped rotor with the rudder stock as the centre. The vane/pistons are fastened to the rotor in a manner; which allows them to absorb and adjust to the spherical deflection of the rotor due to misalignment in installation or deflection of the rudder stock.

The housing has a cast spherical shape with oil channels leading the oil to the different chambers. The housing is divided with an upper and lower part which are connected by several bolts.

The synthetic bearing pads maintain hundred percent surface contact at all times, even as the rudder stock flexes. It will also absorb and suppress vibrations and shock pulses. The bearing surface is continuously lubricated by the hydraulic oil.



### Note!

*In order to access the lower seals and bearing pads the rotor will need to be lifted up, prior to this operation the rudder unit will need to be blocked and secured, and lifting gear made available.*

*Kongsberg Maritime is not responsible for the securing of the rudder. It is the customer responsibility to engage a yard or a suitable third party to undertake this task. If there is less than 1.5 meter free height above the steering gear, arrangements to cut the deck above the steering gear room and/or lower the rudder stock will be required.*

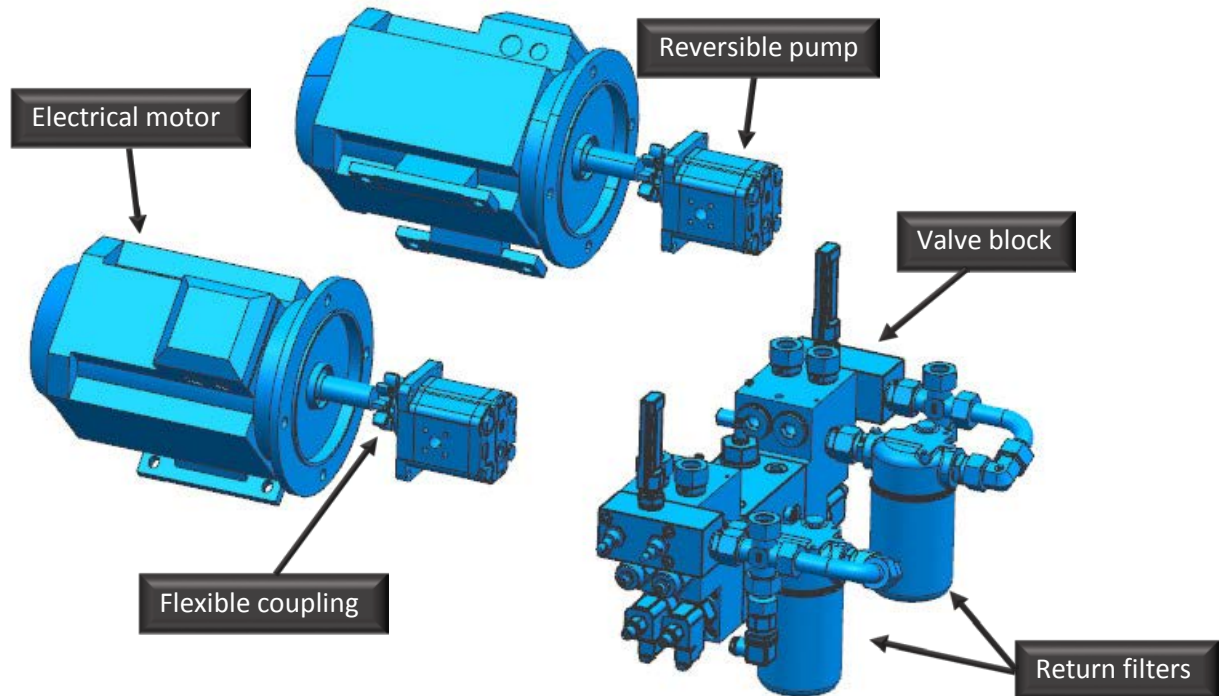
*After service, KM will document the actual condition of the steering gear in a separate report with picture, and it is the customer's responsibility to notify the class society in order for them to survey the completed service.*

## 6. Steering gear electrical motor, pump and valve block

The SR and SV steering gears can be installed with either a conventional pump unit (PU) or a frequency controlled pump (FCP) system.

### 6.1 Steering gear with frequency controlled pumps

The **frequency driven** steering gears have a compact design with two frequency controlled reversible pump units, valve block and electrical feedback units fitted to the steering gear.



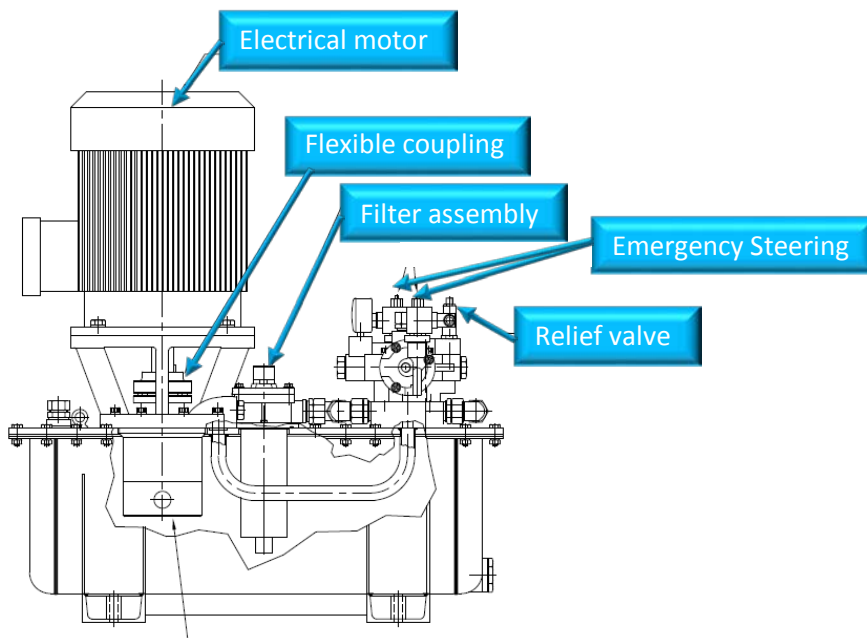
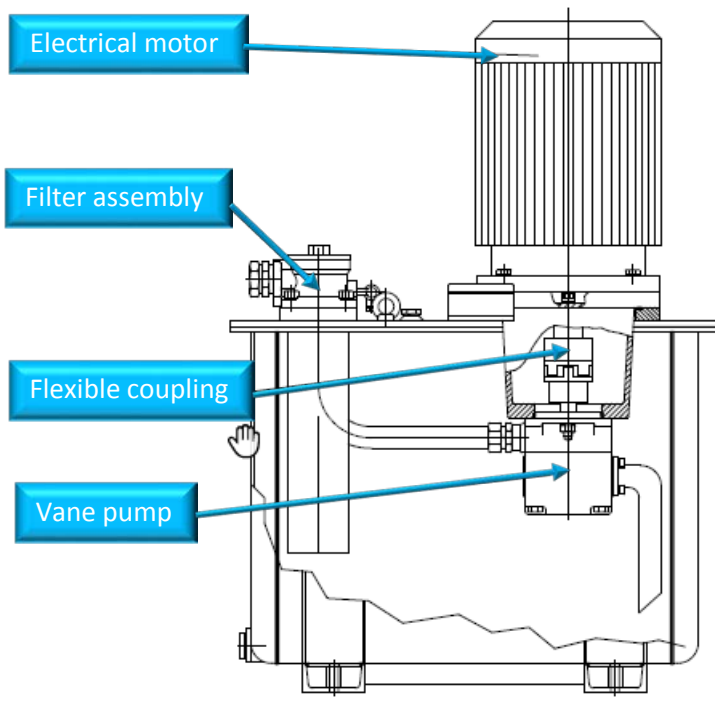
The electrical motor for each pump unit starts when a rudder command signal is given and stops when the rudder has reached the desired position. The power for operating control and steering systems are both hydraulically and electrically separated and independent. The normal running condition is achieved when one pump is running, when both pump units are running the steering gear will run twice as fast. The pump units consist of four main parts which are; reversible pump, electrical motor, and bell house with a flexible coupling inside.

The integrated valve block with filter units has fewer and less complex valves due to the reversible pumps. The distributing valve housing is flanged to the housing of the Steering gear containing the non-return valves (not illustrated), load control valves (1), solenoid operated isolating valves and coil (2), relief valve (3), and return filter units.

## 6.2 Steering gear with conventional pumps

The steering gears fitted with a **conventional pump system** have separate pump units, the pumps are constantly running and the oil is controlled by a manoeuvring valve. The pump unit consists of a tank with foundation, manoeuvring valve (on steering gear for PU50 and FV2 or FV10 valve), return filter and vane pump (PU30 uses gear pumps) with flexible coupling. The electric motor is flanged to the top plate (flanged to the side on PU30).

The pump runs submerged in oil and an arrow on the pump flange indicates the direction of rotation. The pump unit is to be connected by three pipes; two to the distributing valve on the actuator and one to the oil reservoir. (Different types of installations will have individual variances).



## 7. Maintenance task procedures

Please see below maintenance support procedure and guidelines required for maintaining the steering gear system in a safe and correctly manner.

### 7.1 Frequency converter error log

1. Check that there are no obstructions to the flow of cooling air over the cooling ribs of the FC and that the FC is not covered by dust.
2. Check that the cover is properly secured
3. Press the alarm log push button on the frequency converter's local control panel. All incidents in the alarm log are time stamped with running hours as reference.
4. Use the up and down push buttons to navigate in the alarm log.
5. Press the Status push button to finish reading the alarm log.



Frequency Converter

## 7.2 Oil recommendations



### WARNING

- Using oil other than that specified by Kongsberg Maritime CM may cause malfunctions when manoeuvring the vessel. This may cause personal injury and equipment damage.
- Before using other brands, please contact Kongsberg Maritime CM.



### Note!

*The oil is one of the main components in a hydraulic steering gear, and must therefore be selected and handled with this in mind.*

*Do not mix hydraulic oil with other types of oil. Even very small amounts of other oil in the hydraulic oil, will considerably lower the quality of these oils.*

The performance of the unit is highly depended on the viscosity of the oil. The surrounding temperatures of the hydraulic components when operating at extreme temperature conditions, tropic or arctic waters, shall be taken into account when selecting type of oil.

General requirement to the hydraulic fluids used on Kongsberg steering gear should meet DIN 51524.

The viscosity index improve must not be broken down and effect flow and lubrication properties

Pour point should be below -30° centigrade.

The oil must contain the following additives.

Performance qualities:

- Anti-wear properties
- Water and foaming resistance

The following hydraulic oils are approved and recommended by Kongsberg Maritime:

Manufacturer	Type	Bio-degradable type
AGIP	AGIP ARNICA 32	
BEVEROL	HV-ISO32	
BP	BARTRAN HV32	
CALTEX	RANDO HDZ32	
CASTROL	HYPIN AWH-M 32	Biobar 32
CENTURY	NEVIS 7	



Manufacturer	Type	Bio-degradable type
CEPSA	CEPSA HV 32	
CHEVRON	RANDO HDZ32	
SHELL	TELLUS S2 VX 32	
STATOIL	HYDRAWAY HVXA 32	
TEXACO	RANDO HD Z32	
YUKONG	ZIC SUPERVIS X32	
EXXON MOBIL	DTE10 EXCEL 32	
NYNÄS	HYDOL 32	
ESSO (Exxon)	UNIVIS N 32	
HISPANO QUIMICA, S.A	HYDRO DRIVE HP150	
LUB MARINE (TOTAL)	VISGA 32	
MOBIL SYNTHETIC	MOBIL SHC 524	

#### Change the oil when laboratory tests show:

- High neutralizing number
- Low remaining amount of EP-additives
- High amounts of insoluble particles in the oil
- Oil cleanliness no longer is within 17/14 or better according to ISO standard 4406, class 8 or better according to NAS 1638
- If components of the hydraulic system have been broken down.



## 7.3 System oil volume

### Oil volume for steering gears with frequency controlled pumps:

Model type SR	Oil volume
SR 562	Approx. 35 litre
SR 622	Approx. 45 litre
SR 642	Approx. 50 litre
SR 662	Approx. 65 litre
SR 722	Approx. 125 litre
SR 723	Approx. 120 litre
SR 742	Approx. 160 litre
SR 743	Approx. 160 litre

Model type SV	Oil volume
SV 430	Approx. 145 litre
SV 650	Approx. 135 litre
SV 570	Approx. 250 litre
SV 850	Approx. 230 litre

### Oil volume for steering gears with conventional driven pumps:

Actuator type	Pump unit type	Oil volume
SR 562	PU30	Approx. 60 litre
SR 622	PU30	Approx. 70 litre
	PU45	Approx. 205 litre
SR 642	PU30	Approx. 80 litre
	PU45	Approx. 215 litre
SR 662	PU45	Approx. 230 litre
SR 722	PU50	Approx. 455 litre
SR 723	PU50	Approx. 450 litre
SR 742	PU50	Approx. 485 litre
SR 743	PU50	Approx. 485 litre
SV 570	PU50	Approx. 570 litre

## 7.4 Inspection of oil level and condition



### WARNING

- IT IS EXTREMELY IMPORTANT THAT OIL BOTTLE USED FOR OIL SAMPLING IS CHEMICALLY PURE, AND THAT THE PROCEDURE IS PERFORMED WITH A HIGH DEGREE OF CLEANLINESS.

## 7.5 Oil level

Examine the oil level in the expansion tank. When oil is visible in the upper level gauge glass the tank is properly filled up. Unchanged oil level for a long time indicates no leakage.

If the oil level in the expansion tank is low, refill with the oil from the storage tank.

Do visual inspections of all components including pipes and connectors on a regular basis to identify leakages. Repair the oil leak immediately.

## 7.6 Oil sampling



### Note!

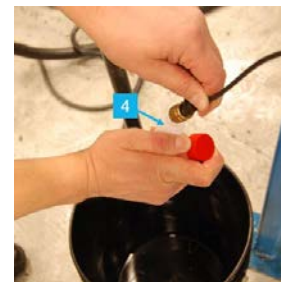
- *The hydraulic system must be operated for a while before the oil sampling procedure is carried out.*
- *The oil must at all times meet the specification for actual type of oil used in the system. Take oil samples regularly.*
- *Follow the instructions regarding oil change intervals or the recommendations based on an oil sample test.*

The oil sampling points [1] can be located either on the upper housing port and stbd, upper rear side of the valve block or on the filter housing, as illustrated in the picture.

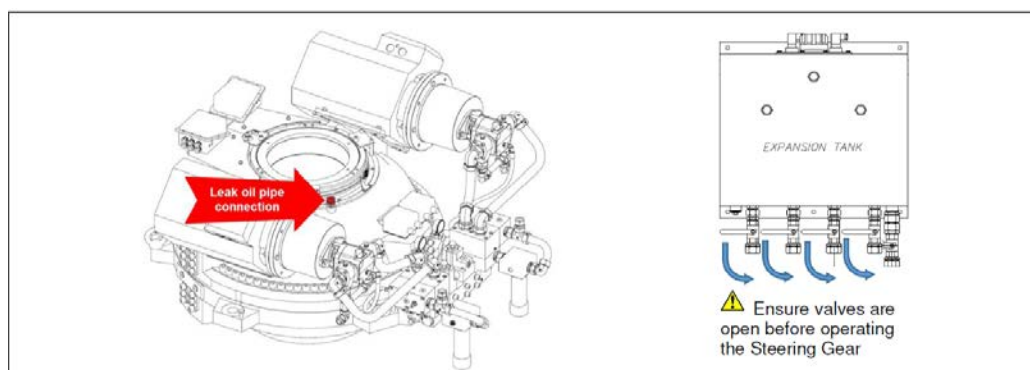
1. Locate the sampling point.



2. Remove the protecting cap [2], as illustrated in the picture below. (The sampling plug contain a non-return valve to prevent oil spill prior to connection of sampling hose.)
3. Connect the sampling hose [3] to the sampling point.
4. While the Steering gear is operated flush the hose by letting some of the oil run through the hose and in to a bucket.
5. Fill a clean sample bottle [4] with oil.
6. Close the sample bottle and attach label to sample bottle indicating oil type, date, sample taken by and oil used for how long.
7. Compare sample with new oil by visual examination. If the oil colour has clearly changed or impurities are present in the oil consider replacing the oil.
8. Send the oil sample to be examined immediately.



## 7.7 Internal leakage test - with frequency controlled pumps



### Note!

*Performance of this test to be managed by the Chief Engineer when vessel is lying still in sheltered waters. The test is to be done first with Pump no 1 and then again with pump no 2.*

1. Close the valve on leak oil pipe connected to the expansion tank.
2. Loosen the leak oil pipe from the fitting on top of the actuator.
3. Make a suitable pipe or hose to divert escaping return (overflow) oil into a drum or bucket, and attach to the fitting on top of the actuator.
4. Preparing for test with Pump no. 1 at Motor Controller Cabinet in steering gear room:
  - Pump no. 2: Turn selector switch to Stop
  - Pump no. 1: Turn selector switch to Local Control
  - Use Emergency Steering push buttons (3) to operate the steering gear with Pump no.1.
5. Start test:
  - Move the rudder to a position about 33 deg angle to Stbd.
  - Start moving the rudder to Port by using the push buttons (3).
  - Start timing when the rudder passes 30 deg angle and stop timing when position reaches 30 deg Port. Release the push button
  - Measure the amount of oil collected, the time it takes to move, the pressure and oil temperature.
6. Start test:
  - Move the rudder to a position about 33 deg angle to Port.
  - Start moving the rudder to Stbd by using the push buttons (3). Start timing when the rudder passes 30 deg angle and stop timing when position reaches 30 deg Stbd. Release the push button.
  - Measure the amount of oil collected, the time it takes to move, the pressure and oil temperature.
7. Preparing for test with Pump no. 2 at Motor Controller Cabinet in steering gear room –
  - Pump no. 1 : Turn selector switch to Stop
  - Pump no. 2: Turn selector switch to Local Control
  - Use Emergency Steering push buttons (3) to operate the steering gear with Pump no.2.
8. Repeat steps 5 to 6.
9. When testing is completed; Re-connect the leak oil pipe to the actuator
10. Ensure that valve connected to the expansion tank is put back to OPEN position after completing the test.



## TEST RESULTS:

To be recorded in the table in chapter 7.9 Feedback form of this document, test #3, when requested or if any alarms occur send a copy to Kongsberg Maritime.

**For vessels with two steering gears, please perform one test per unit!**

## 7.8 Manoeuvring time test - with frequency controlled pumps

For the purpose of confirming the healthy condition of the internal seal of the steering gear unit, the following test procedure is to be followed. The procedure will rely on timing the movement going from 30 deg rudder position on one side to 30 deg on the opposite side.



### Note!

*Performance of this test to be managed by the Chief Engineer when vessel is lying still in sheltered waters. The test is to be done first with Pump no 1 and then again with pump no 2.*

1. Ensure that all valves connected to the Expansion tank are in OPEN position.
2. Preparing for test with Pump 1 at Motor Controller Cabinet in Steering gear room:
  - Pump no. 2: Turn selector switch to Stop
  - Pump no. 1: Turn selector switch to Local Control
  - Use Emergency Steering push buttons (3) to operate the steering gear with Pump no.1.
3. Start test:
  - Move the rudder to a position about 33 deg angle to one side.
  - Start moving the rudder to the other side by using push buttons (3).
  - Start timing when rudder passes 30 deg angle and stop timing when position reaches 30 deg on the opposite side. Release push button.
4. Repeat step 3 in opposite direction.
5. Preparing for test with Pump 2 Motor Controller Cabinet in steering gear room:
  - Pump no. 1 : Turn selector switch to Stop
  - Pump no. 2: Turn selector switch to Local Control
  - Use Emergency Steering push buttons (3) to operate the steering gear.
6. Ensure that all valves connected to Expansion tank are in OPEN position after completing the test.



Motor Controller Cabinet

### TEST RESULTS:

To be recorded in the table in chapter 7.9 Feedback form of this document, test #1 and #2, when requested or if any alarms occur send a copy to Kongsberg Maritime.

**For vessels with two steering gears, please perform one test per unit!**



## 7.9 Feedback form

**FEEDBACK FORM**  
 (Please copy this Feedback Form if you have two steering gears)

**PLEASE SEND YOUR RESULTS TO:**

[service.dmss@km.kongsberg.com](mailto:service.dmss@km.kongsberg.com)

Vessel Name: \_\_\_\_\_  
 Unit serial number: \_\_\_\_\_  
 Date tested: \_\_\_\_\_

IMO Number: \_\_\_\_\_  
 Hydraulic oil – Maker type: \_\_\_\_\_  
 Signature: \_\_\_\_\_

### Test #1 – Seal integrity test (only prior to docking or on request)

	Position	Leakage	Time	Pressure	Temp
Pump no 1	Hard to Port	Liter	Sec	Bar	°C
Pump no 1	Hard to Stbd	Litre	Sec	Bar	°C
Pump no 2	Hard to Port	Litre	Sec	Bar	°C
Pump no 2	Hard to Stbd	Litre	Sec	Bar	°C

### Test #2 – Steering Gear manoeuvring time (30° – 0° – 30°)

	Direction	Time	Pressure
Pump no 1	Stbd to Port	Sec	Bar
Pump no 1	Port to Stbd	Sec	Bar
Pump no 2	Stbd to Port	Sec	Bar
Pump no 2	Port to Stbd	Sec	Bar

### Test #3 – Leakage rate running

	Direction	Leakage	Time	Pressure	Temp
Pump no 1	Stbd to Port	Litre	Sec	Bar	°C
Pump no 1	Port to Stbd	Litre	Sec	Bar	°C
Pump no 2	Stbd to Port	Litre	Sec	Bar	°C
Pump no 2	Port to Stbd	Litre	Sec	Bar	°C

## 7.10 Internal leakage test – with conventional pumps

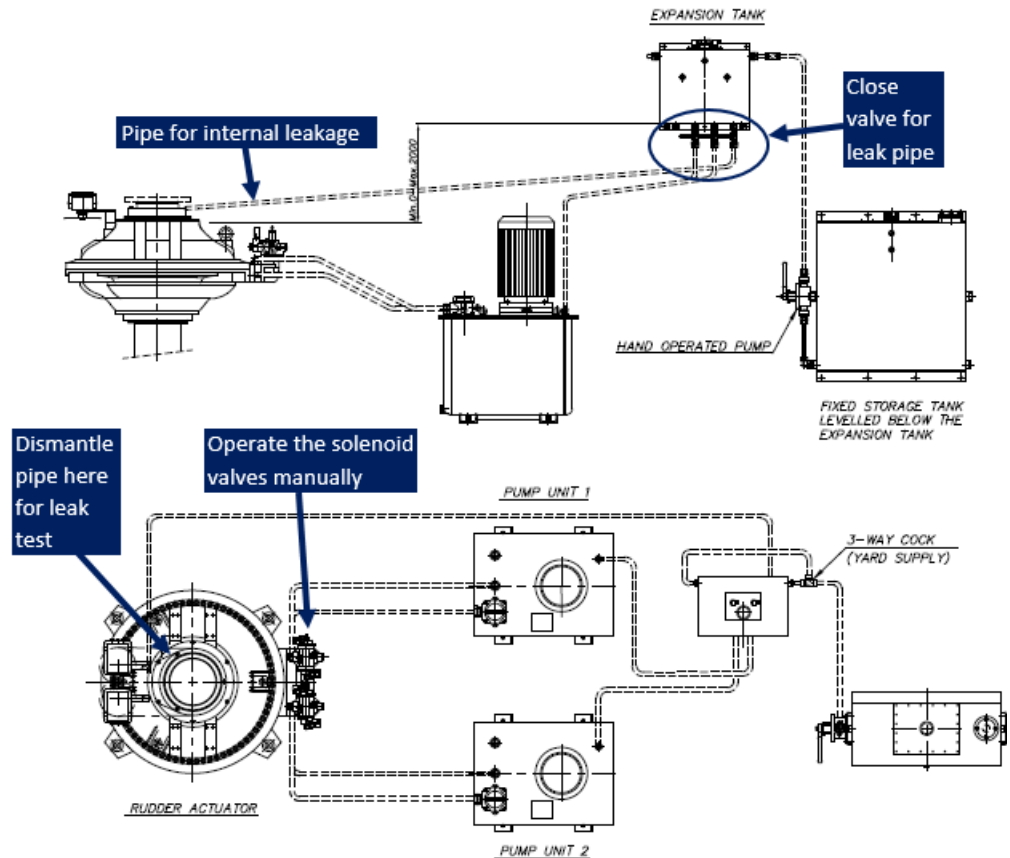
Internal leakage test – for actuators with manoeuvring valve operation



**Note!**

*Performance of this test to be managed by the Chief Engineer when vessel is lying still in sheltered waters. The test is to be done first with Pump no 1 and then again with pump no 2.*

1. Close ball valve on return pipe to expansion tank.
2. Loosen return pipe from fitting on top of actuator.
3. Make up a suitable pipe or hose to divert escaping return (overflow) oil into a drum or bucket, and attach to fitting on top of actuator.
4. By using emergency controls on solenoids run the steering from hard over STBD to hard over PORT Measure amount of oil collected in 1 minute (or 30 secs).
5. Run actuator against mechanical stop at hard over PORT and measure oil collected in 1 minute (or 30 secs).



6. Repeat from PORT to STBD. and at hard over STBD.

You should now have 4 separate test results.

7. Re-fit return oil pipe to fitting and re-open oil cock on expansion tank.

**TEST RESULTS:**

To be recorded in the table in chapter 7.9 Feedback form of this document, test #1 and #2, when requested or if any alarms occur send a copy to Kongsberg Maritime.

**For vessels with two steering gears, please perform one test per unit!**

## 7.11 Manoeuvring time test – with conventional pumps

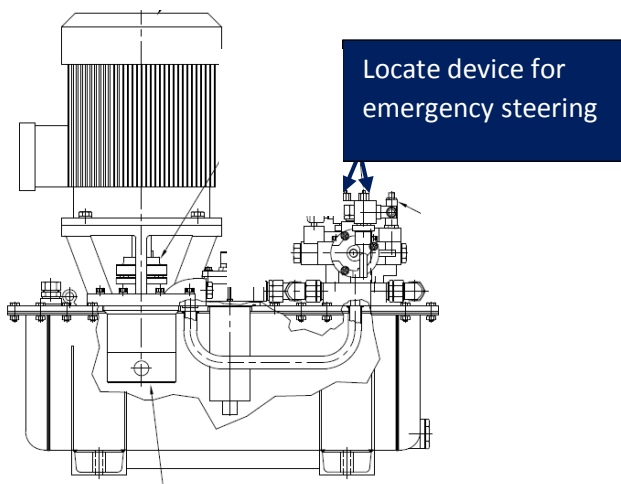
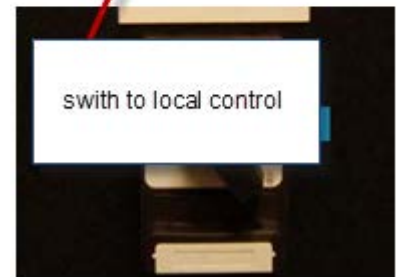
For the purpose of confirming the healthy condition of the internal seal of the steering gear unit, the following test procedure is to be followed. The procedure will rely on timing the movement going from 30 deg rudder position on one side to 35 deg on the opposite side.



**Note!**

*Performance of this test to be managed by the Chief Engineer when vessel is lying still in sheltered waters. The test is to be done first with Pump no 1 and then again with pump no 2.*

1. Switch to Local Control on Control Cabinet located in SG room.
2. Use pump unit 1, measure time used from 30<sup>0</sup> Port - 35<sup>0</sup> STBD.
3. Using pump unit 1, measure time used from 30<sup>0</sup> STBD. - 35<sup>0</sup> Port.
4. Repeat test for pump unit 2.
5. Return to 0<sup>0</sup> position and switch back to remote control.
6. Locate device for emergency steering either on the pump unit or on the steering gear actuator.



### TEST RESULTS:

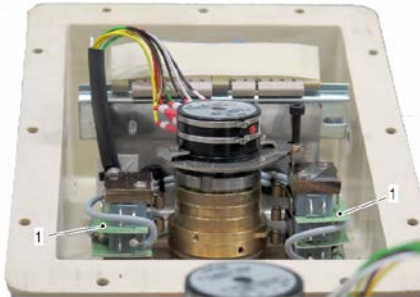
To be recorded in the table in chapter 7.9 Feedback form of this document, test #3, when requested or if any alarms occur send a copy to Kongsberg Maritime.

**For vessels with two steering gears, please perform one test per unit!**

## 7.12 Visual inspection

### Check the Limit Switches:

1. Open feedback unit and observe the limit switch activation when running the Steering Gear.
2. Check the setscrews on the activation cams are present and tight.
3. Activate the switches by hand to confirm spring and switch functionality.



### Check the Solenoids Coil:

Check solenoid coil connection plug for water or moist that can cause earth fault or short circuit.



### Check of Feedback Potentiometer:

1. Open the feedback unit and observe the potentiometer (1) when running the Steering Gear.
2. Check if the setscrew (1) securing potentiometer shaft is secure.
3. Check for any loose wires.



## 7.13 Test of emergency steering

Make sure that the crew is informed before doing emergency steering test operations. While doing emergency steering operation always be in radio contact with the bridge.

1. Turn selector switch for both Motor Controllers to position 3 "LOCAL CONTROL" to enable the emergency push buttons located on the Motor Controllers.
2. Perform steering by pushing the Emergency Steering buttons on the Motor Controller Cabinet.
3. After the test is completed, return both Selector switches to position 1 "Remote Control" to regain steering capability on the bridge.





## 7.14 Function test of alarm system

Please follow below procedure in order to complete a function test of the applicable alarms on the alarm system installed, either for frequency driven pumps (FCP), or a conventional driven pumps (PU).



### Note!

*Note there are 5 sec delay in the alarm system and if any alarm is present in the alarm system the auto start/stop will not work, so please acc. all alarms on the alarm panel before you test the next alarm.*

#### **Overload alarm:**

*FCP systems:* Indicate an overload of the current limit converter, class requirement is 200% for 1 minute; we do not recommend to test this. Disconnect the overload contact in motor controller or on the frequency converter. See drawing for reference. The stand-by pump should start if not already running.

*PU systems:* Push the test button on the overload relay in motor controller. The stand-by pump should start if not already running.

#### **Phase failure alarm:**

Remove one of the fuses supplying the phase failure monitoring relay in the motor controller cabinet, the stand-by pump should start if not already running.

#### **Pw/Frequency failure:**

Turn of main switch S1 in the motor controller or the circuit breaker from switch board. The stand-by pump should start if not already running.

#### **Power control failure alarm:**

Set the S2 selector switch located on the outside of the motor controller cabinet to **local** control or **stop**, the stand-by pump should start if not already running.

#### **Low oil level alarm:**

Disconnect the connection plug on top of the expansion tank.  
The stand-by pump should start if not already running.

#### **Hydraulic lock alarm:**

*FCP systems:* Disconnect X1- 2 in the connection boxes on top of the valve, there are one alarm box for each pump.

*PU systems:* Activate manual solenoid in either direction while the motor controller is in remote control. Keep activated for more than 5 seconds.

The stand-by pump should start if not already running.

#### **High oil temp:**

Remove the plug on the temperature sensor. This alarm do not have auto start of the stand-by pump.



## **Isolating valve failure alarm:**

### ***FCP systems only***

Keep pump #1(3) running and pump#2(4) in stop from bridge, disconnect the plug on the magnetic coil for pump#1(3), the pump #1(3) should stop and the pump#2(4) should auto start. Note there are a class requirement for 5 sec delay in the alarm system repeat for all pumps.

## **Aux alarm:**

Missing feedback from steering gear to the control system.

Locate the U10 module inside the control system cabinet. Remove the feedback line wires on terminals 9 to 11. Alarm should appear after 5 seconds. Vessels with DP2 class or higher also have “rudder freeze” as a consequence for this alarm.

There are no auto start of stand-by pump for this alarm.



## 7.15 Check for proper earth connection

### **For testing on units with power supply switched on:**

Use a voltage meter to verify the voltage between a component's earth potential (EI-Motor, Frequency Converter or Motor controller) and the ship hull, true earth. Reading above 0V might indicate abnormal component voltage potential, presence of induced current in cable screen/earth wire or multiple earth failures and risk of electrical shock is present. It is mandatory to implement measures to reduce risk of electrical shock. Ship's electrician or authorized personnel should be called to investigate.

With verified potential free component to true earth a visual verification of component protective earth connection can be done.

### **For testing on units without power supply:**

Use an ohmmeter to check the resistance between a component's earth potential and the ship's hull, true earth (neutral ground).

## 7.16 Check for system temperature

While examining the hydraulic system it is recommended to measure the system temperature by an infrared thermometer. Examine and make sure that there is no sudden change in temperature of the pump, valve block, steering gear housing or expansion tank. Systems have alarm sensors that monitor the temperature as an alternative.

The usual system temperature will change from system to system according to ambient temperature and the condition it operates under.

The maximum permitted ambient temperature according to the class standard is 45 °C. Maximum recommended short time peak temperature on the system is 70°C - 80 °C.

If the systems are cold (below 10°C - 20 °C) it is recommended to increase the ambient temperature. If it is not possible to increase the ambient temperature, replace the hydraulic oil to one viscosity grade lower.

## 7.17 Replacement of filter



### Note!

Verify if normal system temperature is achieved as this is important for the oil viscosity. Too cold oil can indicate as clogged filter.

A clogged filter will be indicated either by an alarm, or locally by an indicator [1] on the Steering gear filter, as illustrated.



1. Turn the selector switch on the current motor controller [2] to position 2 "stop".



2. Turn the connecting oil chocks on the expansion tank to closed position.



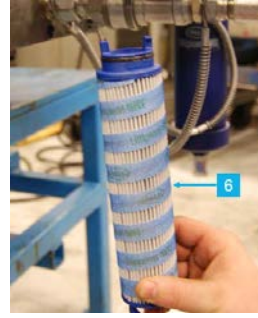
3. Place a bucket under the filter bowl.
4. Open the nut underneath [4], if applicable, to drain oil from the filter.



5. Remove the filter bowl [5].



6. Change the filter insert [6].
7. Replace the filter bowl and tighten and refit the nut and tighten.
8. Open the connecting oil chocks on the expansion tank.
9. De-air by drain the top of distributing valve.
10. Turn the selector switch on the motor controller to position 1 "remote control".



## 7.18 Cleaning of air oil cooler type B10/M10-30



### WARNING

Wear suitable protective gear such as glasses and gloves when handling acid and other cleaning solutions.



### Note!

*Some contaminants may be easily removed by back flushing with water or acid, as detailed in the following steps, while heavy fouling requires disassembly and manual cleaning in accordance with step 7. In this case, cooler replacement may be the practical corrective action*

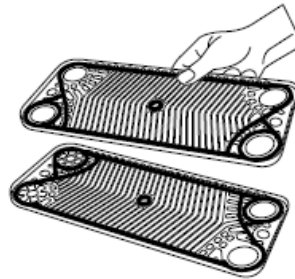
*Gaskets deformed due to the tightening must dry for 24 hours to revert to their original form before reassembly. This will reduce the risk of leakage. Otherwise, replacement gaskets may be installed (See Table 5-4 Spares).*

1. Set the motor controller selector switch to position 2 - STOP.
2. Loosen the cooler holding clamp by unscrewing the nuts. Inspect the vibration dampers and clamp rubber, replace if damaged.
3. Make sure the system is depressurized, and disconnect the hydraulic pipes from the cooler matrix.
4. With minor contamination, deposits may be removed by back flushing the cooler with water. This can be performed by temporarily connecting the water supply hose to the cooler outlet connection and using the other hose to route the water from the inlet connection to a bucket, then opening the supply water valve until the water runs clear. See also step 5.
5. With heavy contamination, fouling may be removed by flushing a solution of water with 5% phosphoric acid or, if cleaned frequently, a solution of water with 5% oxalic acid from an external source. If performed, continue with step 6. Otherwise, skip to step 7.
6. Rinse the cooler with a large quantity of water. Ensure all acid is removed before restarting the system.
7. For heavy fouling not removed with acid flushing, M10 type seawater cooler may be disassembled and manually cleaned. In which case, continue with step 8. For B10 type cooler the cooler must be replaced if the contamination does not flush out. Otherwise, skip to step 15. Connect the flexible hydraulic hoses to the cooler matrix.
8. Close the expansion tank ball valve for the pump unit and disconnect the cooler oil circulation hoses from the cooler. Install protective covers to prevent contamination.
9. Move the cooler to a container for cleaning and disassembly. Start by releasing the center bolt and nut and unscrew the bolt from the cooler. To keep the plates parallel during disassembly, loosen the bolts and nuts at each end 2-3 mm at a time at alternating ends until fully released. Place the cooler on the back side and remove one plate at a time. Number each plate to note the order of assembly and reserve gaskets, gasket rings, screws, nuts and washers for reassembly.

10. Clean the plates using a fiber brush. If required, remove grease deposits with paraffin. If required, remove organic deposits with warm 2% caustic soda. If required, remove calcium stains with 10% nitric acid. Finish by rinsing in clean water.

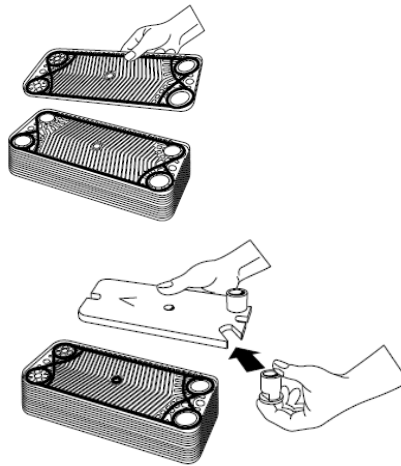
11. Inspect gaskets and gasket rings and replace if damaged.

Illustration show Cooler Endplate and First Channel Plate with Gaskets.



12. Re-assemble the cooler in reverse order as follows. First, position the endplate with the chevron pattern pointing down, and the gasket holes to the right. Next, alternate the direction between each plate and gasket set. The gasket between the last plate and the front frame with the connections is made up of two gaskets to seal around each hole.

Illustration show Cooler Plate with Gaskets and Front Frame.



13. Install the outer bolts and washers and use screw clamps to tighten the cooler unit in parallel while installing the nuts and lock washers and hand tighten. Last, install the center bolt and washer, nut and lock washer and tighten all screws equally. Tightening must be judged by hand and depends on the gasket condition and the screw clamp pressure, but the unit should not be tightened once the width of the plate package is 88.4 mm, or the plates may be damaged. If leakage still occurs, the gaskets must be replaced.

Illustration show Cooler Clamping and Assembly

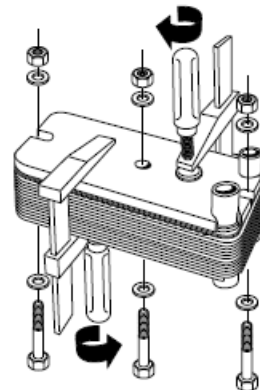
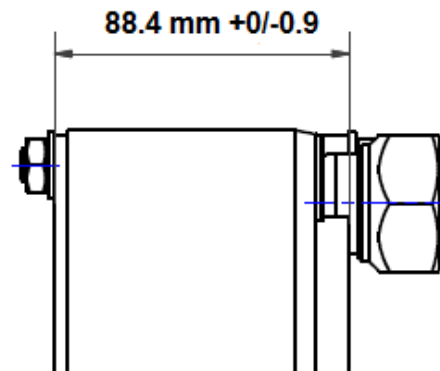


Illustration show Cooler Plate Package Nominal Width



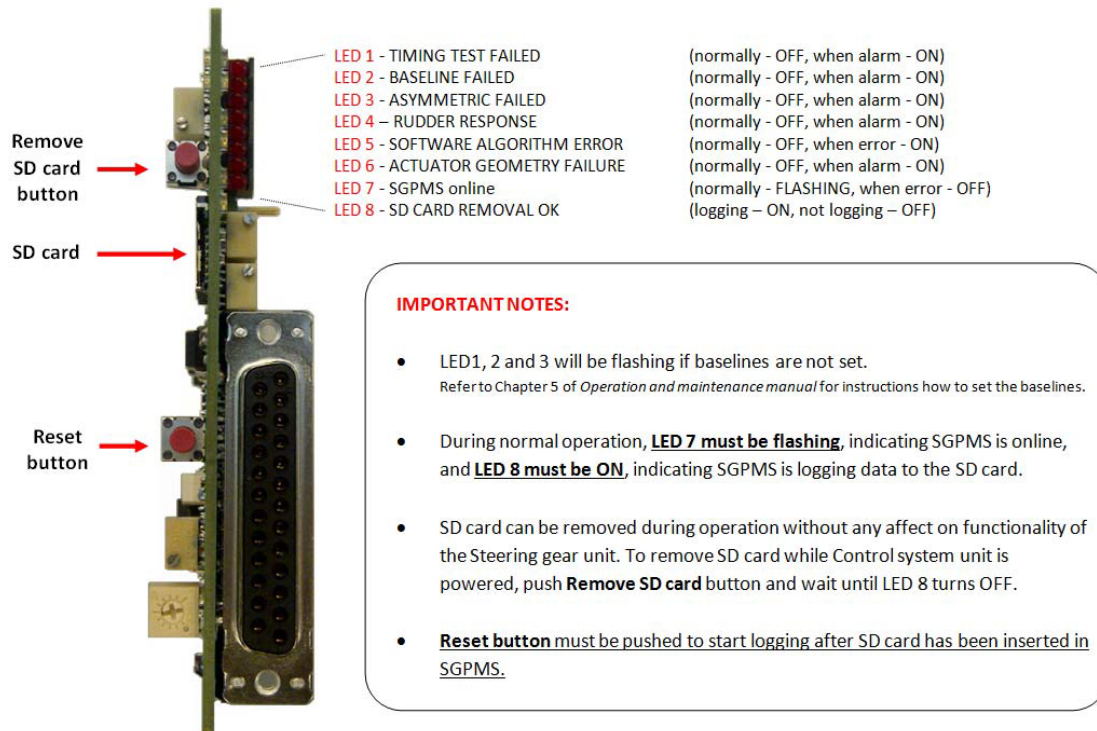
14. Reconnect the cooler oil circulation hoses, tighten ¼ turn after torque starts to noticeable increase, and open the expansion tank ball valve.



15. Reconnect the cooler water supply hoses, tighten  $\frac{1}{4}$  turn after torque starts to noticeable increase, reinstall the holding clamp, and open the water supply valves.
16. Place the motor controller selector switch temporarily in position 1 – LOCAL CONTROL to fill the cooler with oil before returning the switch to position 3 – REMOTE CONTROL.

## 7.19 Log files submission procedure

The SGPMs records operational and performance data to a log file on the microSD memory card located on the amplifier card, as shown in figure below.



Data is recorded into individual files on the SD memory card on daily basis, with following naming convention:

File name: **RRYYMMDD.LOG**

**RR** – Rolls-Royce

**YY** - Year

**MM** – Month

**DD** – Day

These log files can be used as input during remote troubleshooting or as part of the condition based maintenance recommendation. When asked, log files should be submitted to [sg.pmscard@km.kongsberg.com](mailto:sg.pmscard@km.kongsberg.com) email, or through the Mobile Form application.

### When log files are submitted via email:

- For vessels with two steering gears (PORT and STBD), the log file names are the same. Therefore, the files will need to be sent **in separate emails**, with PORT or STBD steering gear in the title of the email.
- Preferred naming of email with log files would be: Vessel IMO – Vessel name – Steering gear identification (PORT or STBD) – Date when files are sent



## Accessing log files:

SD card can be removed during operation without affecting functionality of the steering gear unit.

For each steering gear

- Press the Remove SD card button, as shown on User interface label in CS cabinet, and Figure 3 of this document.
- The SGPMS online LED (LED 7), which blinks every second, will blink twice per second as the system closes the file on the memory card.
- Once the file is closed, the SD card removal OK LED (LED 8) will turn off.
- Remove the SD card from the holder on amplifier card by first pushing it inwards
- Using the USB reader that you have received in the upgrade kit, access files stored on the SD card. Attach the log file with most recent date to an email and send it to:  
[sg.pmscard@km.kongsberg.com](mailto:sg.pmscard@km.kongsberg.com)
- Insert the SD card into the SGPMS.
- Press the Reset button to activate logging functionality. You will notice all LED's illuminate for 2-3 seconds, followed by LED 8 being lit (logging activated) and the SGPMS online LED (LED 7) flashing.

This concludes the log file transfer procedure.



## 8. Self - Assessment and Maintenance Inspection

KONGSBERG offers Self-Assessment inspection checklist in a digital format, enabling the condition of your KONGSBERG steering gear equipment to be verified. By referring to the checklist, Self-Assessment appraisals can be conducted by crew or other qualified personnel on board a vessel.

Access to the Self – Assessment application can be provided, please contact [service.dmss@km.kongsberg.com](mailto:service.dmss@km.kongsberg.com) well in advance of the vessels planned docking survey or regular maintenance.

The Self-Assessment tool can be accessed through the Kongsberg Mobile Forms application in App Store for IOS devices. We recommend to use an iPad or iPad mini for the Self – Assessment inspection, an Android Tablet or a laptop computer together with a phone for pictures.

### How to access the Self – Assessment mobile application:

- Download application called Kongsberg Mobile forms application in App store.
- When installed, follow this procedure when starting the application
- When application installed, enter login information provided by Kongsberg in a separate mail to access the check lists.
- Please allow the device to synchronize with internet connection. Whenever data loaded, the device can be used in offline mode. Data will be synchronized whenever internet connection is re-established.

The condition and availability of the steering gear equipment depends on the quality of maintenance, how the equipment has been operated and external effects such as exposure to the elements. Understanding the condition of equipment is vital to ensure that it is always ready for service, throughout its entire lifecycle.

### Maintenance Inspection:

If you prefer the inspection to be completed by a Kongsberg Maritime service engineer please send a request for a Maintenance Inspection to [service.dmss@km.kongsberg.com](mailto:service.dmss@km.kongsberg.com). It is recommended that the inspection take place well in advance of the vessels planned docking survey or regular maintenance. This will ensure sufficient time to process recommendations for spares and resources in line with any recommended repairs, a Maintenance Inspection can also be offered as part of a service attendance.

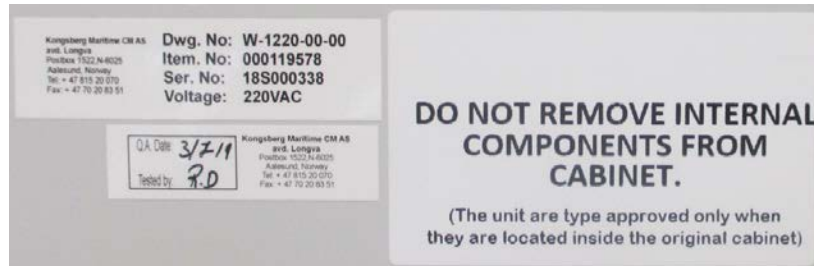


## 9. Spare parts



**Note!**

- Information regarding the steering gear type and installation number is found on a nameplate mounted on the steering gear housing.
- Information regarding the steering gear electrical system is found on a sticker on the inside of all the electrical cabinets.



KONGSBERG recommend to keep the below listed spare parts on board as a minimum of on board spare parts, for additional tailored recommendations please contact [km.support@kongsberg.com](mailto:km.support@kongsberg.com)

### Mechanic / Hydraulic:

On board spare parts	On board	Need to replace
4x Filter		
2x Load sense valve		
2x Proximity switch		
2x Magnetic coils		

### Controls:


On board spare parts	On board	Need to replace
1x Phase failure relay		
2x Relay K13 – K16		
2x Selector card		
1x Pump control card		
1x Power supply U3		
1x Feedback pot meter		
1x Spare part kit , el. 2 year consumables (SP-34***)		

When ordering spare parts please make sure to include the following information to spares department, please see below table for contact details.

<b>Vessel name:</b>		<b>Shipping address :</b>	
<b>Owner name:</b>		<b>Invoicing address:</b>	
<b>IMO number:</b>		<b>Drawing number:</b>	
<b>Steering Gear type:</b>		Position number	
<b>Installation:</b>		Article number	
		Quantity	



## 10. Contact

Country	Contact information
NORWAY	<div style="display: flex; justify-content: space-between;"> <div style="width: 80%;"> <p>KONGSBERG MARITIME CM AS Deck Machinery and Motion Control Aarsundveien 24 N-6270 Brattvaag</p> <p><b>Support and Spares for Deck Machinery and Motion Control:</b> Phone: +47 700 13 300 E-mail: <a href="mailto:service.dmss@km.kongsberg.com">service.dmss@km.kongsberg.com</a></p> <p><b>24/7 Global Customer Support:</b> Phone: +47 33 03 24 07, E-mail: <a href="mailto:km.support@kongsberg.com">km.support@kongsberg.com</a></p> <p>Home page: <a href="http://www.kongsberg.com">www.kongsberg.com</a></p> </div> <div style="width: 15%; text-align: center;">  KONGSBERG                 </div> </div>