SCHEMATIC PRINCIPLES FOR STEERING GEAR
HYDRAULICS

FEBRUARY 2005
FOREWORD

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A list of Classification Notes is found in the latest edition of Pt.0 Ch.1 of the "Rules for Classification of Ships” and the "Rules for Classification of High Speed, Light Craft and Naval Surface Craft”.

The list of Classification Notes is also included in the current “Classification Services – Publications” issued by the Society, which is available on request. All publications may be ordered from the Society’s Web site http://exchange.dnv.com.

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CONTENTS

1. INTRODUCTION .................................................... 4
  1.1 Scope............................................................................4
  1.2 Basic principles............................................................4
  1.3 Use of symbols ............................................................4

2. REQUIREMENTS .................................................. 5
  2.1 General (for ships with no additional requirements related to vessel type or vessel size).........................5
  2.2 Cargo ships of 70 000 GT and upwards.........................6
  2.3 Passenger vessels of less than 70 000 GT .......................6
  2.4 Passenger vessels of 70 000 GT and upwards ..................7
  2.5 Tankers less than 10 000 GT .......................................7
  2.6 Tankers of 10 000 GT and upwards ................................7
  2.7 Tankers of 100 000 tonnes DW and upwards .................8
1. Introduction

1.1 Scope
This classification note is considered to be a supporting document to the Rules for Classification of Ships and the Rules for Classification of High Speed, Light Craft and Naval Surface Craft, Pt.4 Ch.14 “Steering Gear”.
Examples of acceptable arrangements have been given differentiating between various ship types and -sizes.

1.2 Basic principles
Illustrations of hydraulic systems that satisfy the relevant requirements have been given. Only main components (including relief valves) have been included in order to illustrate the differences in functional requirements related to vessel type and -size (rule reference Pt.4 Ch.14 Sec.1 B600-800). Other components not illustrated may also be required, for instance filters. Further, many hydraulic systems would also need to utilize counter balance valves in order to ensure smooth operation in case external forces are acting in the direction of rotation.

The illustrations show steering gears with actuators of ram-type and rotary vane type. The principles are not dependent of type of steering gear and are valid for other actuator types too, for instance systems utilizing double acting cylinders. Further, the illustrations show systems utilizing constant delivery pumps and directional control valves but other arrangements are possible, e.g. use of variable displacement pumps which may eliminate the control valves.

Fulfilment of the requirements does in some cases imply additional requirements to adjacent systems (indications, alarms, control systems and power supplies). These are in general not specified here.

Note that these are only examples, and other arrangements may also be acceptable.

1.3 Use of symbols
In the illustrations of hydraulic systems the following symbols have been used:

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Illustration</th>
</tr>
</thead>
<tbody>
<tr>
<td>— — — — —</td>
<td>Working pipe line (main flow)</td>
</tr>
<tr>
<td>— — Return line</td>
<td></td>
</tr>
<tr>
<td>— —</td>
<td>Pilot (control) line</td>
</tr>
<tr>
<td>— —</td>
<td>Tank for hydraulic oil</td>
</tr>
<tr>
<td>M XX %</td>
<td>Hydraulic pump, including electric motor</td>
</tr>
<tr>
<td>— The percentage indicates (when applicable) volume flow capacity relative to the main steering gear requirement.</td>
<td></td>
</tr>
<tr>
<td>— —</td>
<td>Relief valve</td>
</tr>
<tr>
<td>— Directional control/shut-off valve</td>
<td></td>
</tr>
</tbody>
</table>
2. Requirements

2.1 General (for ships with no additional requirements related to vessel type or vessel size)

The following figures illustrate steering gear hydraulic arrangements satisfying the minimum general requirements, which are applicable to any ship.

Illustrated arrangements show electro-hydraulic power operated steering gears. However, manually operated steering gear (e.g. wheel pump) may be accepted if required rudder stock diameter in way of tiller is less than 230/120 mm for main / auxiliary steering gear, respectively.

Note that additional requirements related to ship type and –size may also be applicable. Consequences of such additional requirements are illustrated in sections 2.2 to 2.7.

Table 1-1  Illustration of Hydraulic Symbols (ISO 1219-1) (Continued)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Illustration</th>
</tr>
</thead>
</table>
| ![Gate valve](image) | — Gate valve as e.g. isolating/by-pass (single) valve. May be manually, remotely, or automatically operated  
— Normally open |
| ![Gate valve](image) | — Gate valve (see above)  
— Normally closed |
| ![Automatic isolating/by-pass](image) | — Automatic isolating/by-pass (double) valve |
| ![Non-return valve](image) | — Non-return valve |

Figure 2-1
Main and auxiliary steering gear

The arrangement in Fig. 2-1 fulfills the minimum general requirements for steering gears. It can be seen that there is a main and an auxiliary steering gear, each fulfilling their respective capacity requirements. Failure in one steering gear does not render the other steering gear inoperative (in this respect tiller can be excluded). Each steering gear is provided with separate power piping.

The arrangement in Fig. 2-1 is not acceptable for use in tankers of 10 000 Gross tonnes (GT) or upwards or any other ships of 70 000 GT and upwards (see sections 2.2 and 2.6).

Figure 2-2
Twin rudder arrangement

The steering gear arrangement illustrated in Fig. 2-2 fulfills the minimum general requirements for steering gears and all additional requirements depending on ship type and –size, provided that the ship is navigable with only one rudder in operation and fitted with the necessary means to bring the rudder back into the neutral position in the event of failure in one steering gear.

Any single failure in one steering gear does not influence the other steering gear, and consequently steering is not lost.

Each steering gear fulfills the capacity requirements for the main steering gear.
The steering gear arrangement illustrated in Fig. 2-3 fulfils the minimum general requirements for steering gears. Auxiliary steering gear need not to be fitted because there are two identical power units, which fulfil the main steering gear capacity requirements when working together. Interconnections between power piping have been provided with quick operating isolating valves (isolation allows steering capability to be speedily regained after a single failure in piping system or power unit).

The arrangement in Fig. 2-3 is not acceptable for passenger ships (see sections 2.3 and 2.4) nor tankers of 10 000 GT and upwards (see section 2.6).

### 2.2 Cargo ships of 70 000 GT and upwards

In this context, cargo ship means any other ship but passenger vessel.

The steering gear arrangements illustrated in this section also fulfil the requirements of section 2.1.

The arrangement illustrated in Fig. 2-2 is acceptable with the same assumptions as mentioned in section 2.1, provided that the power units are identical. One power unit per actuator for twin rudder installations is accepted on basis of the equivalency principle.

The arrangement illustrated in Fig. 2-3 also fulfils the minimum requirements relevant for cargo ships of 70 000 GT and upwards.

### 2.3 Passenger vessels of less than 70 000 GT

The steering gear arrangements illustrated in this section also fulfil the requirements of section 2.1.

The arrangement illustrated in Fig. 2-2 is acceptable for all ships, with the same assumptions as mentioned in section 2.1. The arrangements illustrated in Fig. 2-1 is acceptable for passenger vessels of less than 70 000 GT. This is because there are no additional requirements for these vessels when the ship is provided with a main and an auxiliary steering gear.

### 2.4 No auxiliary steering gear (2 x 50% power units)

The steering gear arrangement in Fig. 2-3 fulfils the minimum general requirements for steering gears. Auxiliary steering gear need not to be fitted because there are two identical power units, which fulfil the main steering gear capacity requirements when working together. Interconnections between power piping have been provided with quick operating isolating valves (isolation allows steering capability to be speedily regained after a single failure in piping system or power unit).

The arrangement in Fig. 2-3 is not acceptable for passenger vessels (see section 2.4) nor tankers of 10 000 GT and upwards (see section 2.6).

### 2.5 Single actuator with two power units/piping systems

The steering gear in Fig. 2-4 comprises two identical power units, which fulfil the requirements for main steering gear capacity with all power units running. Separate power piping is provided for each power unit, and the piping systems may be separated by isolating valves directly fitted onto the actuator. Auxiliary steering gear is not required because the two identical power units fulfil the capacity requirements when working together.

Hence the arrangement in Fig. 2-4 fulfils the additional requirements for cargo ships of 70 000 GT and upwards.

The arrangement in Fig. 2-4 is not acceptable for passenger vessels (see section 2.4) nor tankers of 10 000 GT and upwards (see section 2.6).

### 2.6 Single actuator with two power units (2x100%)/piping systems

Fig. 2-5 is quite similar to Fig. 2-3, and Fig. 2-6 is quite similar to Fig. 2-4, except that the arrangement fulfils the main steering gear capacity requirements with any one of the power units out of operation, and hence the additional requirement for passenger vessels is met.
2.4 Passenger vessels of 70 000 GT and upwards

The steering gear arrangements mentioned in this section also 
fulfil the requirements relevant for sections 2.1, 2.2 and 2.3.

The arrangement illustrated in Fig. 2-2 is acceptable for all 
ships, with the same assumptions as mentioned in section 2.1. 
One power unit per actuator for twin rudder installations is ac-
cepted on basis of the equivalency principle.

The steering gears indicated in Fig. 2-5 and 2-6 comprises two 
identical power units, and an auxiliary steering gear is not re-
quired (see section 2.2), and hence the additional requirement 
for passenger vessels of 70 000 GT and upwards is met for 
these arrangements.

2.5 Tankers less than 10 000 GT

There are no additional requirements for tankers less than 
10 000 GT. Requirements as given in section 2.1 applies as 
minimum.

2.6 Tankers of 10 000 GT and upwards

The steering gear arrangements illustrated in this section also 
fulfil the requirements relevant for sections 2.1, 2.2 and 2.5.

All the arrangements would also have acceptable for passenger 
vessels (sections 2.3 and 2.4), if the steering gear fulfilled the 
capacity requirements for main steering gear with any one 
power unit out of operation.

The arrangement illustrated in Fig. 2-2 is acceptable for all 
ships, with the same assumptions as mentioned in section 2.1. 
One power unit per actuator for twin rudder installations is ac-
cepted on basis of the equivalency principle.

2.6.1 “IMO” Steering gears

By-pass valve in open position when respective system 
is not working (only one system working at the time)

Figure 2-7
“IMO” steering gear – two identical, separate power actuating 
systems

Fig. 2-7 illustrates a steering gear arrangement that is permis-
sible for all tankers of 10 000 GT and upwards. This is because 
a single failure in any of the two separate power actuating sys-
tems (failure of tiller and actuator may be excluded) does not 
lead to loss of steering.

Figure 2-8
“IMO” steering gear – two interconnected identical power actuating systems

The steering gear arrangements illustrated in Fig. 2-8 and Fig. 
2-9 are permissible for tankers of 10 000 GT and upwards, pro-
vided that a single failure (i.e. loss of oil) in any of the two 
identical power actuating systems may be detected and auto-
matically isolated, leaving the other power actuating system 
fully operational. Automatic isolation is initiated upon detec-
tion of loss of hydraulic oil (low oil level).

Isolation must be followed by shut down of one power unit in 
case both systems are running simultaneously. A low-low level 
alarm must be followed by shut down of the power unit sup-
plying the failed system and start-up of a stand-by power unit 
in case only one power unit is running.

The systems fulfil the capacity requirements for main steering 
gear when operating together.
2.6.2 “Appendix A” steering gear (tankers of 10 000 GT and upwards, but of less than 100 000 tonnes DW)

Fig. 2-10 and Fig. 2-11 illustrate steering gear arrangements permissible for tankers of 10 000 GT and upwards, but of less than 100 000 tonnes DW. This is because the steering capability may be regained within 45 seconds, after a single failure in any one of the power units or in the piping system (here: non-return valves, closing in case of pressure loss either due to piping failure or malfunction of power unit).

However, a single failure in actuator may cause loss of steering. This is compensated for by increasing the mechanical requirements related to the actuator (according to “Appendix A”).

A “low-low level” alarm must be followed by shut down of power unit supplying the failed system and start-up of stand-by power unit in case only one power unit is running.

The systems fulfil the capacity requirements for main steering gear when operating together.

2.7 Tankers of 100 000 tonnes DW and upwards

The steering gear arrangements mentioned in this section also fulfil the requirements relevant for sections 2.1, 2.2, 2.5 and 2.6. All the arrangements would also have acceptable for passenger vessels (sections 2.3 and 2.4), if the steering gear fulfilled the capacity requirements for main steering gear with any one power unit out of operation.

An arrangement as illustrated in Fig. 2-2 is acceptable provided that ship is navigable with one rudder out of operation and fulfil capacity requirement for main steering gear.

The arrangement illustrated in Fig. 2-4 is permissible for all ships, also tankers of 100 000 tonnes DW and upwards. This is because a single failure in any of the separate power actuating systems does not lead to loss of steering.

The steering gear arrangements illustrated in Fig. 2-8 and Fig. 2-9 are permissible for tankers of 100 000 tonnes DW and upwards. This is because a single failure in any of the two identical power actuating systems may be detected and automatically isolated, leaving the other power actuating system fully operational. Automatic isolation is initiated by power failure alarm, hydraulic locking alarm or low oil level alarm.

Isolation must be followed by shut down of one power unit in case both systems are running simultaneously. A low-low level alarm must be followed by shut down of power unit supplying the failed system and start-up of stand-by power unit in case only one power unit is running.

The systems fulfil the capacity requirements for main steering gear when operating together.