DNV·GL

CLASS GUIDELINE

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Schematic principles for steering gear hydraulics

DNV GL AS

FOREWORD

DNV GL class guidelines contain methods, technical requirements, principles and acceptance criteria related to classed objects as referred to from the rules.

Any comments may be sent by e-mail to *rules@dnvgl.com*

CHANGES – CURRENT

This is a new document.

CONTENTS

SECTION 1 INTRODUCTION

1 Scope

This class guideline is considered to be a supporting document to the *DNV GL rules for classification of ships* and the *DNV GL rules for classification of high speed, light craft and naval craft*, RU SHIP Pt.4 Ch.10 *Steering gear*.

Examples of acceptable arrangements have been given differentiating between various ship types and -sizes.

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, see *DNV GL rules for classification of ships* RU SHIP Pt.4 Ch.10 Sec.1 [2]. 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.

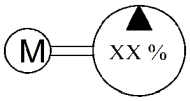
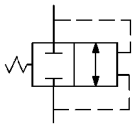
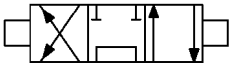
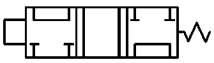
Note that these are only examples, and other arrangements may also be acceptable.

3 Use of symbols

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

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

Symbol	*Illustration*
	— working pipe line (main flow) — return line
	— pilot (control) line
	— tank for hydraulic oil

Symbol	*Illustration*
	— hydraulic pump, including electric motor — the percentage indicates (when applicable) volume flow capacity relative to the main steering gear requirement.
	— relief valve
	— directional control/shut-off valve
	— gate valve as e.g. isolating/by-pass (single) valve. May be manually, remotely, or automatically operated — normally open
	— gate valve (see above) — normally closed
	— automatic isolating/by-pass (double) valve
	— non-return valve

SECTION 2 REQUIREMENTS

1 Introduction

Following the systematics of *IMO* the requirements for steering gears are aligned to the different potential risk assumptions for certain ship types.

2 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 subsections [2] to [7].

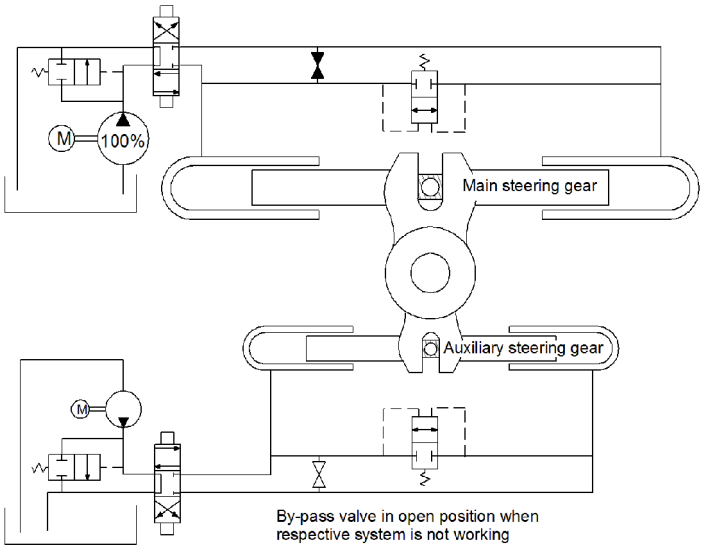


Figure 1 Main and auxiliary steering gear

The arrangement in Figure 1 fulfils 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 Figure 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 subsections [2] and [6]).

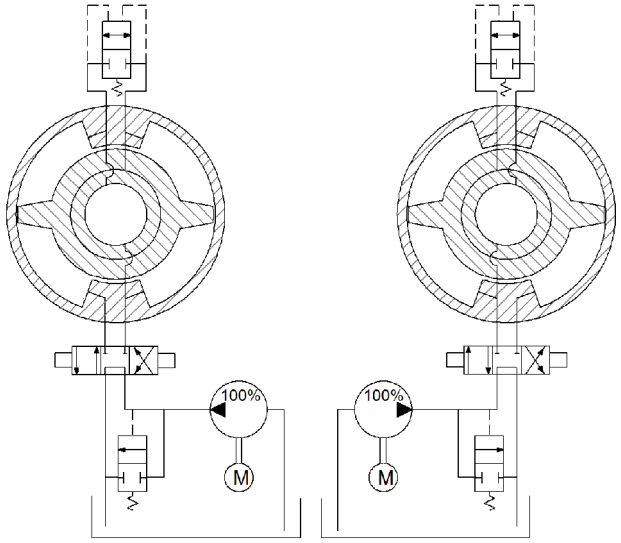


Figure 2 Twin rudder arrangement

The steering gear arrangement illustrated in Figure 2 fulfils 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 fulfils the capacity requirements for the main steering gear.

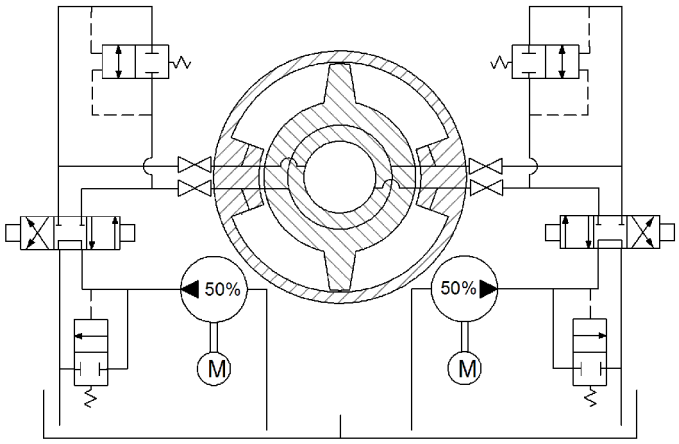


Figure 3 No auxiliary steering gear (2 x 50% power units)

The steering gear arrangement illustrated in Figure 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 Figure 3 is not acceptable for passenger ships (see subsections [3] and [4]) nor tankers of 10 000 GT and upwards (see subsection [6]).

3 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 subsection also fulfil the requirements of subsection [1].

The arrangement illustrated in Figure 2 is acceptable with the same assumptions as mentioned in subsection [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 Figure 3 also fulfils the minimum requirements relevant for cargo ships of 70 000 GT and upwards.

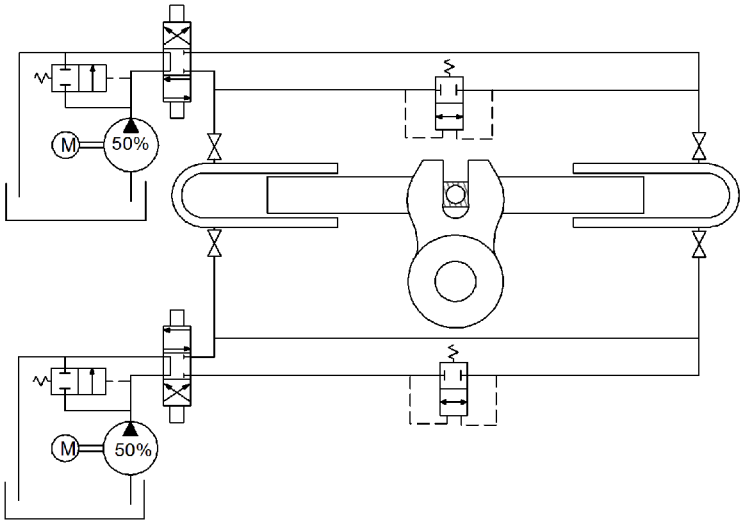


Figure 4 Single actuator with two power units/piping systems

The steering gear in Figure 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 Figure 4 fulfils the additional requirements for cargo ships of 70 000 GT and upwards.

The arrangement in Figure 4 is not acceptable for passenger vessels (see subsection [4]) nor tankers of 10 000 GT and upwards (see subsection [6])

4 Passenger vessels of less than 70 000 GT

The steering gear arrangements illustrated in this subsection also fulfil the requirements of subsection [1].

The arrangement illustrated in Figure 2 is acceptable for all ships, with the same assumptions as mentioned in subsection [1].

The arrangements illustrated in Figure 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.

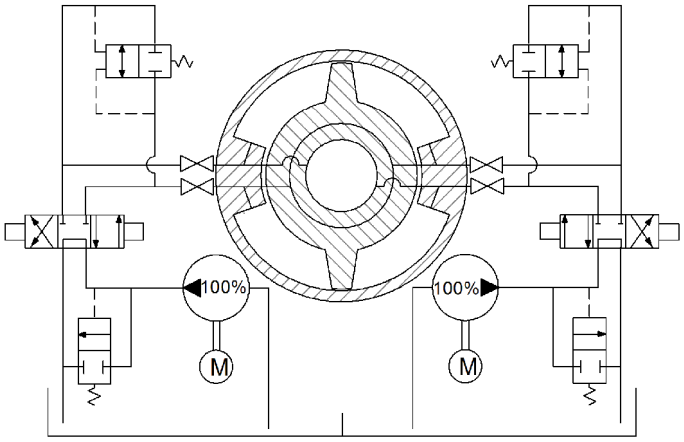


Figure 5 No auxiliary steering gear (2 x 100% power units)

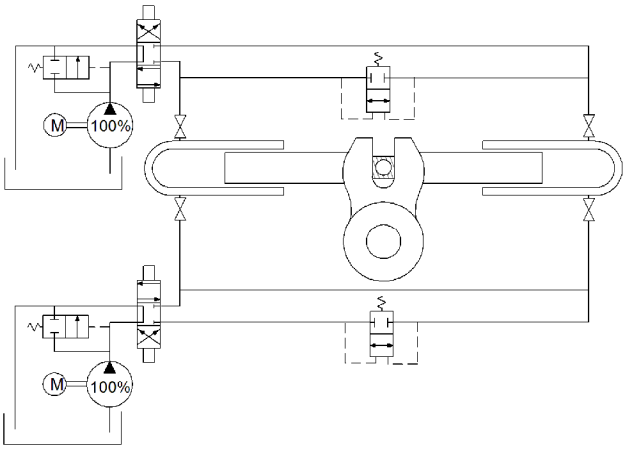


Figure 6 Single actuator with two power units (2 x 100%)/piping systems

Figure 5 is quite similar to Figure 3, and Figure 6 is quite similar to Figure 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.

5 Passenger vessels of 70 000 GT and upwards

The steering gear arrangements mentioned in this subsection also fulfil the requirements relevant for subsections [1], [2] and [3].

The arrangement illustrated in Figure 2 is acceptable for all ships, with the same assumptions as mentioned in subsection [1]. One power unit per actuator for twin rudder installations is accepted on basis of the equivalency principle.

The steering gears indicated in Figure 5 and Figure 6 comprises two identical power units, and an auxiliary steering gear is not required (see subsection [2]), and hence the additional requirement for passenger vessels of 70 000 GT and upwards is met for these arrangements.

6 Tankers less than 10 000 GT

There are no additional requirements for tankers less than 10 000 GT. Requirements as given in subsection [1] applies as minimum.

7 Tankers of 10 000 GT and upwards

The steering gear arrangements illustrated in this subsection also fulfil the requirements relevant for subsections [1], [2] and [5].

All the arrangements would also have acceptable for passenger vessels (subsections [3] and [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 Figure 2 is acceptable for all ships, with the same assumptions as mentioned in subsection [1]. One power unit per actuator for twin rudder installations is accepted on basis of the equivalency principle.

7.1 "IMO" steering gears

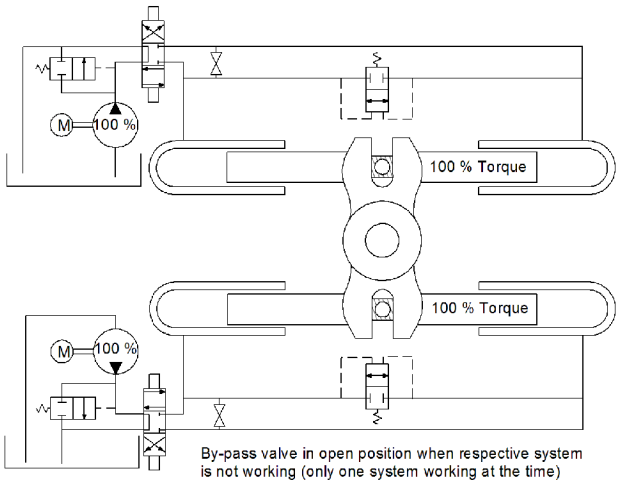


Figure 7 "IMO" steering gear – two identical, separate power actuating systems

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

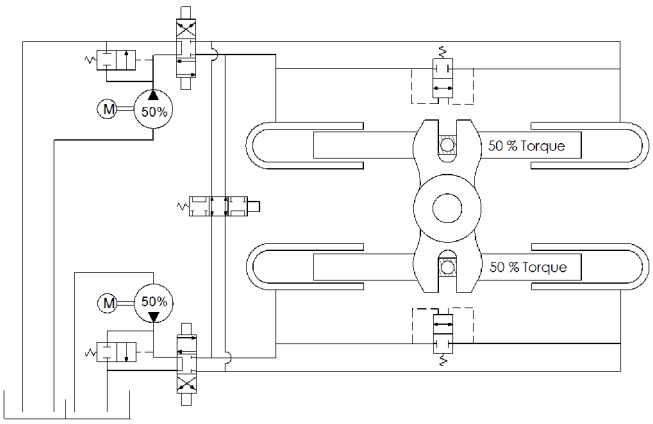


Figure 8 "IMO" steering gear – two interconnected identical power actuating systems

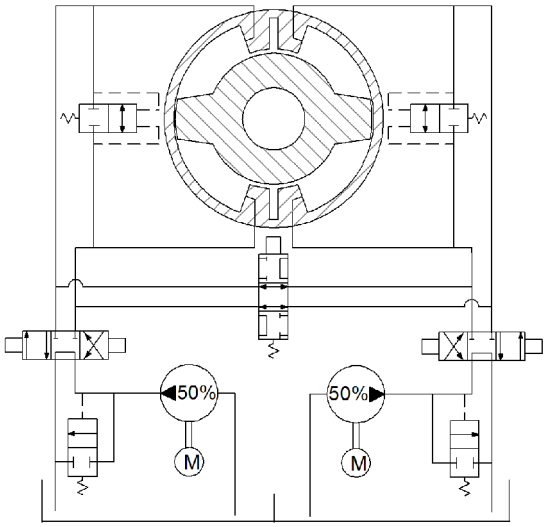


Figure 9 "IMO" steering gear – rotary vane type

The steering gear arrangements illustrated in Figure 8 and Figure 9 are permissible for tankers of 10 000 GT and upwards, provided that a single failure (i.e. loss of oil) 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 upon detection 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 supplying 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.

7.2 "Appendix A" (see SHIP RU Pt.4 Ch.10 App.A) steering gear (tankers of 10 000 GT and upwards, but of less than 100 000 tonnes DW)

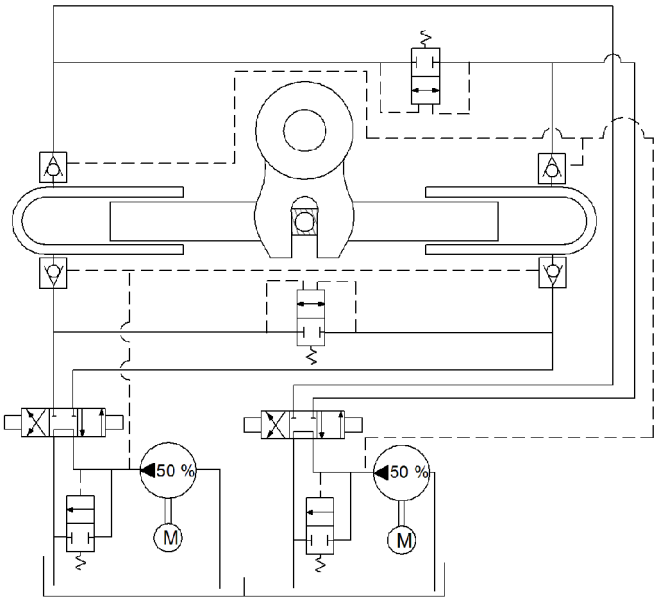


Figure 10 "Appendix A" (see SHIP RU Pt.4 Ch.10 App.A) steering gear – two ram type

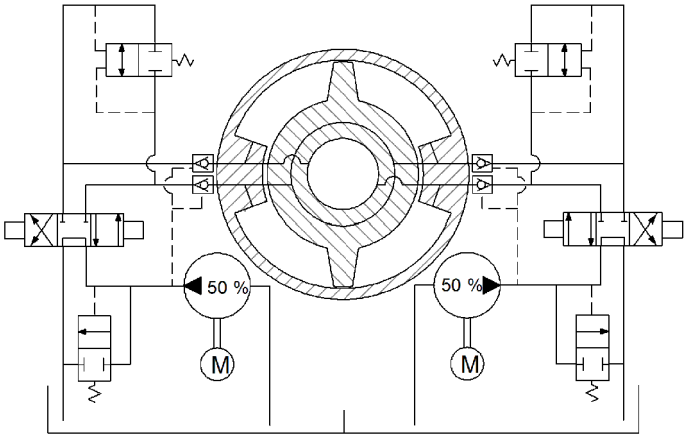


Figure 11 "Appendix A" (see SHIP RU Pt.4 Ch.10 App.A) steering gear – rotary vane type

Figure 10 and Figure 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 SHIP RU Pt.4 Ch.10 App.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.

8 Tankers of 100 000 tonnes DW and upwards

The steering gear arrangements mentioned in this subsection also fulfils the requirements relevant for subsections [1], [2], [5] and [6]. All the arrangements would also have acceptable for passenger vessels (subsection [3] and subsection [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 Figure 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 Figure 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 Figure 8 and Figure 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.

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