

**Ship manoeuvrability
guidelines for rudder
area**

SHIP TYPE: All ships above 100 m in length and all chemical and gas tankers

Background

In recent years it has been discovered that a number of ships have inferior manoeuvrability characteristics. Lack

of relevant tests and acceptance criteria has apparently enabled them to enter service without the deficiencies being disclosed. Designers have relied on the ship-handling skills of human operators to compensate for any inherent deficiencies in the manoeuvring qualities of the ship.

Nevertheless, there are examples of pilots having 'blacklisted' ships as a result of poor manoeuvring performance, while one owner even obtained a court injunction to decline acceptance of a newbuilding owing to its poor manoeuvrability, in spite of it having been approved by maritime authorities.

Manoeuvrability of ships is not covered by DNV class rules, which only cover requirements relating to function and strength of the steering gear, although a guidance note is provided in order to determine minimum rudder area. The rudder area provided for in the guidance note has been sufficient to ensure normally acceptable manoeuvring performance for conventional ships, but the development of efficient hull forms has introduced ships which are course-unstable.

Manoeuvrability properties are complex and are influenced by factors involving hull lines, propellers and rudder geometry.

Rudder torque may also vary dramatically according to whether a ship is partly or fully laden. It is therefore difficult to provide a general guideline for determining rudder area that would ensure an acceptable standard of manoeuvrability for all ships.

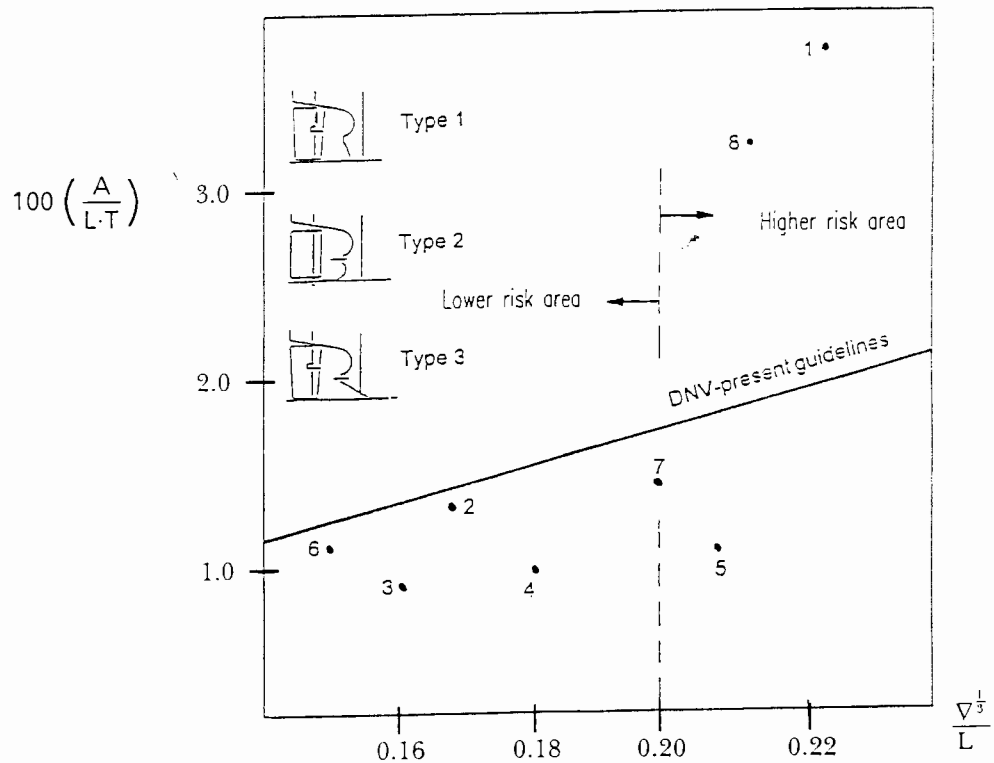
The International Maritime Organisation (IMO) resolution A751(18)

IMO has established an Interim Standard for Ship Manoeuvrability which came into force in July 1994 for a trial

Required Rudder Area to Obtain Compliance with IMO resolution A751(18)

Results from 8 ships

	Ship No.	Type	L/B	B/T	C _b	∇ ^{1/3} /L
A = Rudder area	1	3	5.5	2.5	0.83	0.22
L = Length	2	1	5.5	4.0	0.62	0.17
B = Breadth	3	1	7.0	3.1	0.60	0.16
T = Draft	4	2	7.4	2.4	0.78	0.18
C _b = Block coefficient	5	2	6.1	2.4	0.83	0.21
∇ = Volume displacement	6	1	6.6	3.6	0.56	0.15
	7	1	6.5	2.6	0.83	0.20
	8	3	5.6	2.9	0.81	0.21



The figure shows that the DNV guidelines give acceptable rudder area for ships with $\left(\frac{\nabla^{1/3}}{L}\right) \leq 0.2$ and that ships with $\left(\frac{\nabla^{1/3}}{L}\right) > 0.2$ may require significantly larger rudder area.

period of 5 years. The standard shall apply to all ships above 100 m in length, and to all chemical tankers and gas carriers regardless of length.

Actions taken by DNV

DNV has focused on manoeuvrability of ships in several research activities in recent years, and is now equipped with the tools necessary to predict manoeuvrability performance at the design stage. These tools can also be used to forecast a ship's compliance with the IMO standard.

The rudder area required to achieve sufficient yaw checking, course-keeping and initial turning ability is shown in the figure and table overleaf. It is assumed that the rudder is of conventional shape with an aspect ratio of approximately 1.6 (Aspect ratio = rudder height divided by rudder width). The figure illustrates the considerable influence that hull design has on these parameters.

Lessons to be learned

The present DNV guidelines for rudder

area are sufficient to meet the new IMO-criteria for most ships. Some ships of full lines in the aft body are, by experience, course-unstable, and may require significantly larger rudder area in order to meet the requirements. In extreme cases it may not be practical to obtain acceptable manoeuvrability performance simply by increasing the rudder area, due to inherent geometrical and physical constraints, and hull redesign or the application of a high-lift rudder may be required. For ships with a displacement-length ratio larger than 0.2 ($1/3/L$), studies at the de-

sign stage are recommended to ensure safe manoeuvring performance and compliance with the IMO standard. The IMO standard is a minimum requirement to ship manoeuvring performance in open sea. Where appropriate, manoeuvring at low speed in confined waters should also be considered.