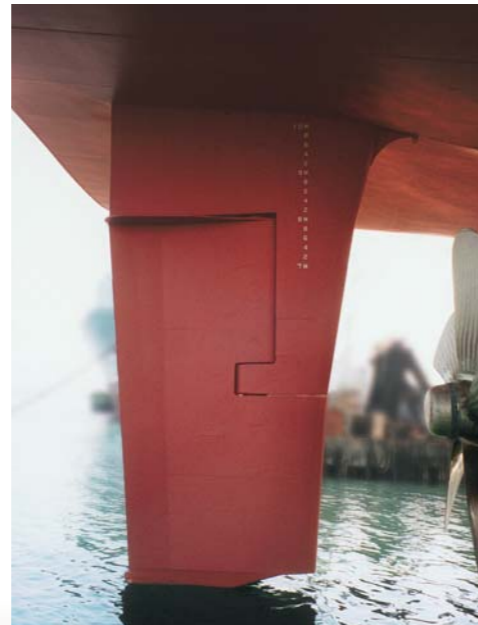


# Mariner Schilling Rudder®

Mariner  
Schilling  
Rudder

An Example of a "Mariner Schilling Rudder"  
Installed on Board a Full-scale Vessel



**Container Ship "WANHAI 301"**

Owned by Wan Hai Lines Ltd.  
Built at Setoda Shipyard of Naikai Zosen Corporation  
Overall Length 188.0m  
Normal Speed 21.5kts



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The specification, design, etc. described in this catalog may be altered without a notice for improvement.



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**Japan Hamworthy & Co., Ltd.**

# Mariner Schilling Rudder®

## An Increasing Demand for Schilling Rudders

A Schilling rudder is a rudder in special shape, having sectional profile of fish-tail-like trailing edge. This rudder remarkably improves ship's maneuverability and course keeping quality without any propulsive loss, and significantly contributes to safety and economy of ships. Schilling Rudders have established high appraisal in Japan, and have already been installed on board more than 2,000 vessels. Recently, maneuverability of large blocky vessels comes into question, and importance of Schilling Rudders is steadily rising.

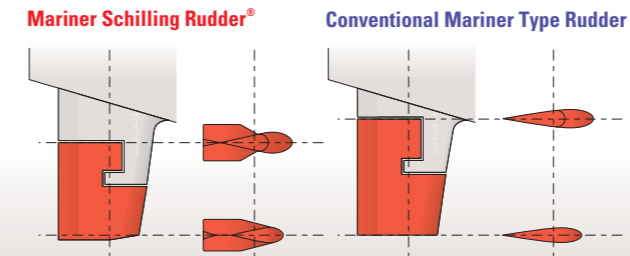
## Development of a "Mariner Schilling Rudder®"

In case of a hanging rudder, rudder stock diameter becomes large for large vessels or high speed vessels. By this reason, development of a Schilling Rudder of Mariner type has been demanded. Japan Hamworthy & Co., Ltd. succeeded in development of "Mariner Schilling Rudders", in which investigation was given to rudder in terms of performance and construction, under subsidy from the Ship & Ocean Foundation in 1993 and 1994. The "Mariner Schilling Rudders" have been installed on board such vessels as a high speed container ship (188m, 24kts), roll-on/roll-off ships, a supply ship of the Defense Agency, 145,000m<sup>3</sup> LNG carrier, etc., and obtained good results in their actual operation.

## Special Features of a "Mariner Schilling Rudder®"

A "Mariner Schilling Rudder" is such that sectional profile of a movable part of a Mariner type rudder is made as that of a Schilling Rudder. So to say, it is a Schilling Rudder having a rudder horn.

(The below illustration shows sectional profile of a "Mariner Schilling Rudder" and a conventional Mariner type rudder.)



Compared with a conventional Mariner type rudder, a "Mariner Schilling Rudder" exhibits remarkably high lift coefficient, and at the same time, high drag coefficient when the rudder is turned. Accordingly, it gives excellent maneuverability. On the other hand, there is little difference between both in drag coefficient in a neutral rudder angle zone.

Like a case of a Schilling Rudder, it is sufficient for a "Mariner Schilling Rudder" to have such rudder dimension as to catch and deflect a propeller slip stream. Accordingly, it is possible to reduce a rudder area. Despite of a reduced rudder area, a "Mariner Schilling Rudder" still has remarkable maneuverability, course keeping quality and yaw quick respond ability.

## Tank Tests

Model tests were carried out at the Osaka University and the Akashi Ship Model Basin Co., Ltd. with respect to the case that a "Mariner Schilling Rudder" is applied to a 260,000DWT type tanker.

## 1 Test by 4m Self-propulsive Model Ship

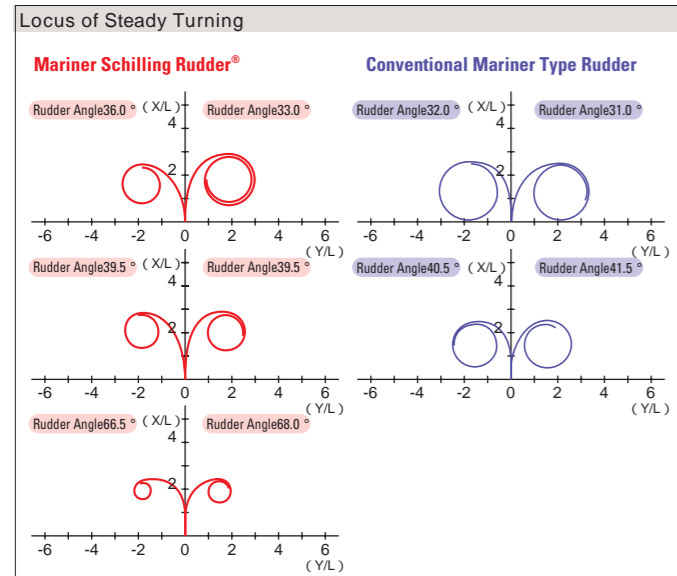
[At Osaka University]

### Prototype of Models

Item	Mariner Schilling Rudder®	Conventional Mariner Type Rudder
Spec. of Ship		
LxBxDxδ (m)	313.0 × 56.6 × 28.6 × 19.6	
Ship Speed (kt)	14	
Propeller	∅ 9.35m × I (FPP)	
Rudder		
Size (m)	10.0 × 7.0	13.8 × 9.2
Rudder Angle	2 × 70°	2 × 35°

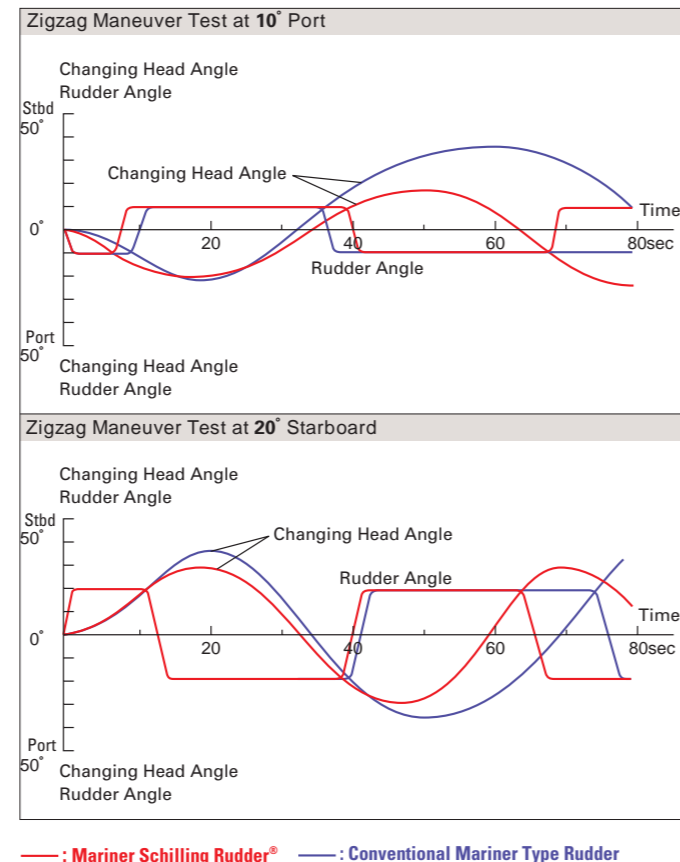
### Turning Test

A "Mariner Schilling Rudder" is very excellent in turning performance, compared with a conventional Mariner type rudder. Particularly, it showed extremely good performance in turning at 65° rudder angle.



### Zigzag Maneuver Test

In both 10° and 20° zigzag maneuver tests, it was proved that a "Mariner Schilling Rudder" shows smaller overshoot angle than a conventional Mariner type rudder, and thus it is excellent in course stability.

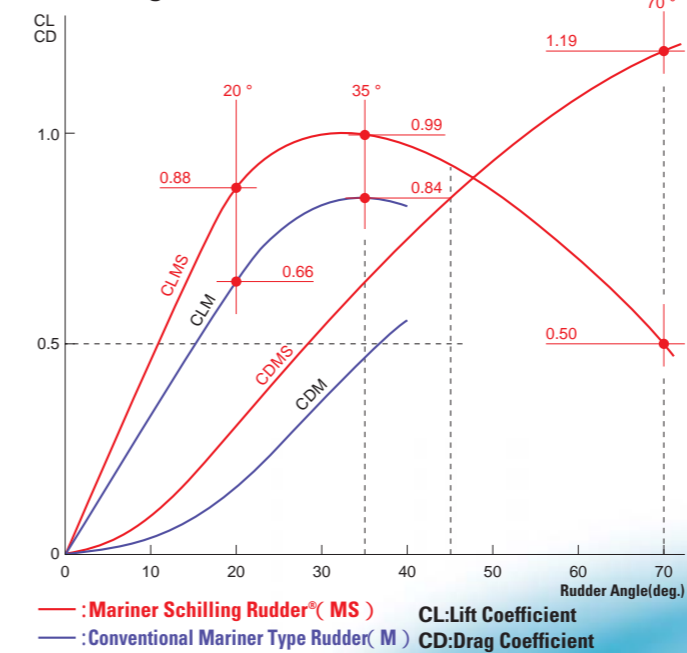


## 2 Independent Test (Wind Tunnel Test)

[At Osaka University]

A "Mariner Schilling Rudder" showed very high values both in lift coefficient and drag coefficient, compared with a conventional Mariner type rudder, except smaller drag coefficient in a neutral zone.

### Lift/Drage Coefficient



## 3 Resistance and Self-propulsive Test by Large-scale Model Ship (7.2m)

[At Akashi Ship Model Basin Co., Ltd.]

Required propulsive horsepower at the test is as shown in the table, and it was proved that, even in case that a "Mariner Schilling Rudder" is adopted, its required propulsive horsepower is nearly equal to that of a conventional Mariner type rudder. Furthermore, an additional test where trailing edge angle of a "Mariner Schilling Rudder" is made as 5° ("Ocean Mariner Schilling Rudder") showed that the required propulsive horsepower is less than that of a conventional Mariner type rudder.

### Extract from Test Results for Required Propulsive Horsepower

Kind of Rudders	Mariner Schilling Rudder®	Ocean Mariner Schilling Rudder® (Trailing Edge Angle 5°)	Conventional Mariner Type Rudder
	Ship Speed		
13kt	15,493BHP	15,395BHP	15,660BHP
14kt	19,786	19,560	19,790
15kt	25,067	24,654	24,975