



**becker** marine systems

Often copied, never surpassed  
Genuine and original **product range**



**becker** marine systems

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MANOEUVRING

MATERIAL HANDLING

COMMUNICATION

Often copied, never surpassed  
Genuine and original **product range**



*Dirk Lehmann, Henning Kuhlmann*

### **A word from the management**

Dear reader of this presentation folder of our manoeuvring products. We, the management team of Becker Marine Systems, are pleased to raise your attention and interest about our challenging world of state of the art Rudder and Nozzle systems. Our technical team of naval architects, designers and draftsmen spend their daily efforts and lifetime experiences together to design and deliver reliable, robust and good performing manoeuvring systems.











Becker Flap Rudders are known worldwide and they are famous for providing the highest manoeuvrability. The TLKSR<sup>®</sup> Twisted Full Spade Rudder for large and fast ships is today's successful solution in avoiding rudder erosion from cavitation and additionally saves fuel during ship operation.

Our products are based on over 60 years of successful business with the world's shipping and shipbuilding industry. Becker products have been installed on over 7,000 ships and we still continue to improve and further develop manoeuvring solutions for the future.

Becker teamed up with several international industry and institute partners to jointly develop even better products. We use global trademarks and industrial property rights to protect our knowledge base.



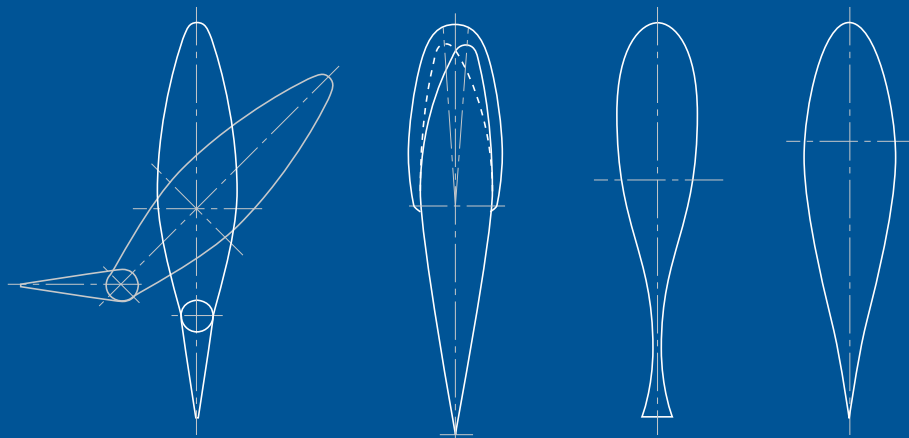
# Rudder profile & design combinations

		RUDDER PROFILES				
		TWISTED 	FLAP 	SCHILLING® 	NACA & other 	KORT NOZZLE 
RUDDER DESIGNS	FULL SPADE 		S-C HRC-C	MONOVEC-C VECTWIN	N-C	FK-C
	KSR SUPPORT 	TLKSR®	FKSR	SCHILLING® KSR	KSR	
		TLFKSR				
	HEEL SUPPORT 		S-A HRC-A	MONOVEC-A	N-A	FK-A
	HERUS® SUPPORT 			NAVIGATOR	HERUS®	
SEMI-SPADE 			MARINER			

Our rudder systems are a combination of a Becker rudder profile and a Becker rudder design (type of rudder support). Each rudder is tailor-made to the individual demands of the ship in question. The table above shows you our best-proven combinations of Becker rudder profiles and Becker rudder designs.

On the following pages we have introduced the benefits and characteristics of each rudder profile and each rudder design. Look at the index bar on the right side to quickly access product pages and to overview the recommended combinations of profile and design.

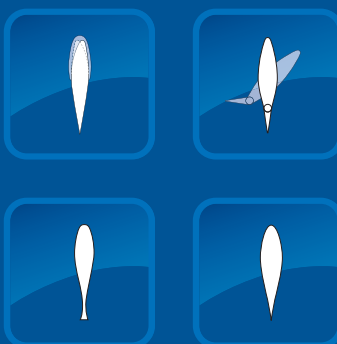




# Becker rudder profiles



The rudder profile determines the lift and drag of a rudder. Whether it is a high-lift rudder or a (more economical) standard profile, a special profile for cavitation avoidance, improving ship's speed, fuel saving or navigation in ice - Becker has the right solution according to your ship's requirements.







# Genuine Becker technology Twisted leading edge



Available for

KORT NOZZLE

HERUS® SUPP./SEMI-SPADE

HEEL SUPPORT

KSR SUPPORT

FULL SPADE

RUDDER DESIGNS

NACA&OTHER

SCHILLING®

FLAP

TWISTED

RUDDER PROFILES

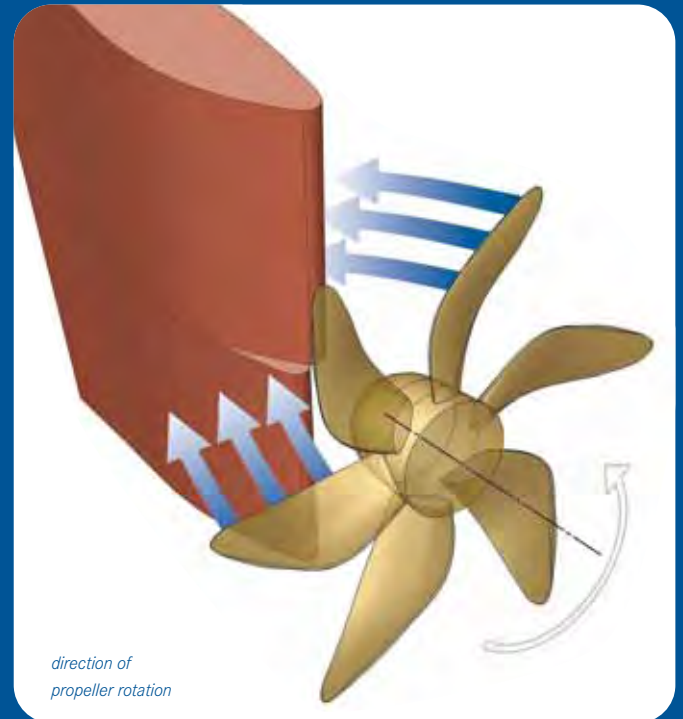


# Genuine Becker technology Twisted leading edge

Conventional rudders are placed behind the propeller with the rudder cross section arranged symmetrically about the vertical rudder centre plane. However, this arrangement does not consider the fact that the propeller induces a strong rotational flow that impinges on the rudder blade. This results in areas of low pressure on the blade that induce cavitation and associated erosion problems. To avoid cavitation and to improve the manoeuvrability performance of a full spade rudder, Becker has enhanced the development of twisted leading edge rudder types.

## More characteristics:

- Extended uncritical rudder angle sector
- No rudder horn, no gap cavitation
- Optimised profile
- Higher propulsion efficiency
- Reduced profile thickness



Becker rudder designs with twisted rudder profile:

- **KSR support**  
(Twisted Leading Edge Rudder TLKSR®,  
Twisted Leading Edge Flap Rudder TLKFSR)

## Cavitation erosion of conventional semi-spade rudders

PROBLEM



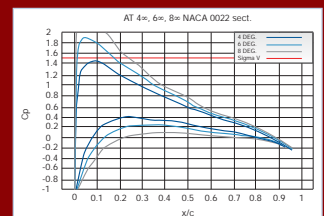
Underwater view of cavitation



Cavitation test



Cavitation damage after sea-trials



CFD: Velocity on NACA profile

## Becker Marine Systems' twisted leading edge technology

SOLUTION



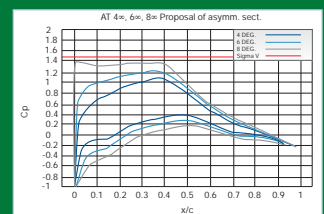
TLKSR® at 26 knots – no rudder cavitation



TLKSR® cavitation test – no cavitation



TLKSR® after 1 year of service – no erosion



CFD: Velocity on TLKSR® profile

# Twisted leading edge rudder TLKSR®



The twisted leading edge technology combined with the Becker KSR (King Support Rudder) arrangement provides multiple benefits for high-speed vessels compared to conventional semi-spade rudder designs. Typical applications include container vessels, reefers, Ro/Pax ferries, cruise ships and naval vessels.

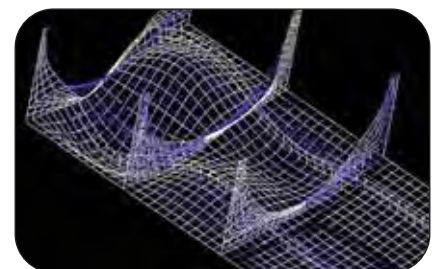
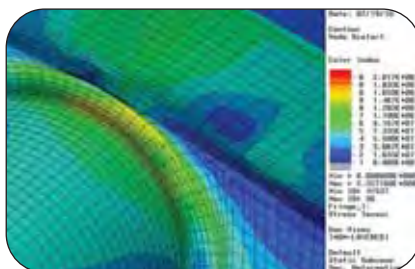
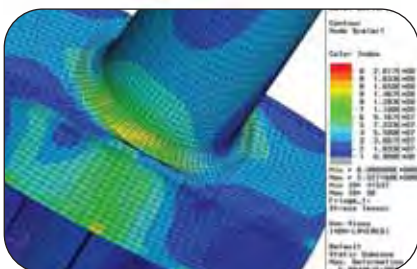
- No rudder induced cavitation erosion
- Improved manoeuvring performance
- No horn required – reduced weight
- Lower installation costs, no cast parts
- Reduced maintenance costs
- Reduced number of bearings
- Proven fuel saving

Becker rudder design with Twisted Leading Edge profile:

- **KSR support**



*Extensive use of FEM & CFD techniques as well as cavitation tunnel tests and full scale observations has been made in the development of Becker's TLKSR.*



### Improved developments:

1. Twisted Rudder with B-Deflector
2. Twisted Rudder with S-Deflector

# Twisted leading edge flap rudder TLFKSR



The Twisted Leading Edge Flap Rudder TLFKSR is a Becker Flap Rudder in combination with Twisted Leading Edge KSR (King Support Rudder) mounting and has the following benefits:

- Best manoeuvring performance at low speed due to flap
- Minimised cavitation erosion due to incorporation of twisted leading edge
- Reduced fuel consumption due to rudder profile adapted to propeller flow
- Reduced risk of vibration
- Low installation height

Becker's Twisted Flap Rudder is especially suitable for faster applications such as Ro/Ro, Ro/Pax, cruise vessels and car carriers.

Becker rudder design with Twisted Flap Rudder profile:

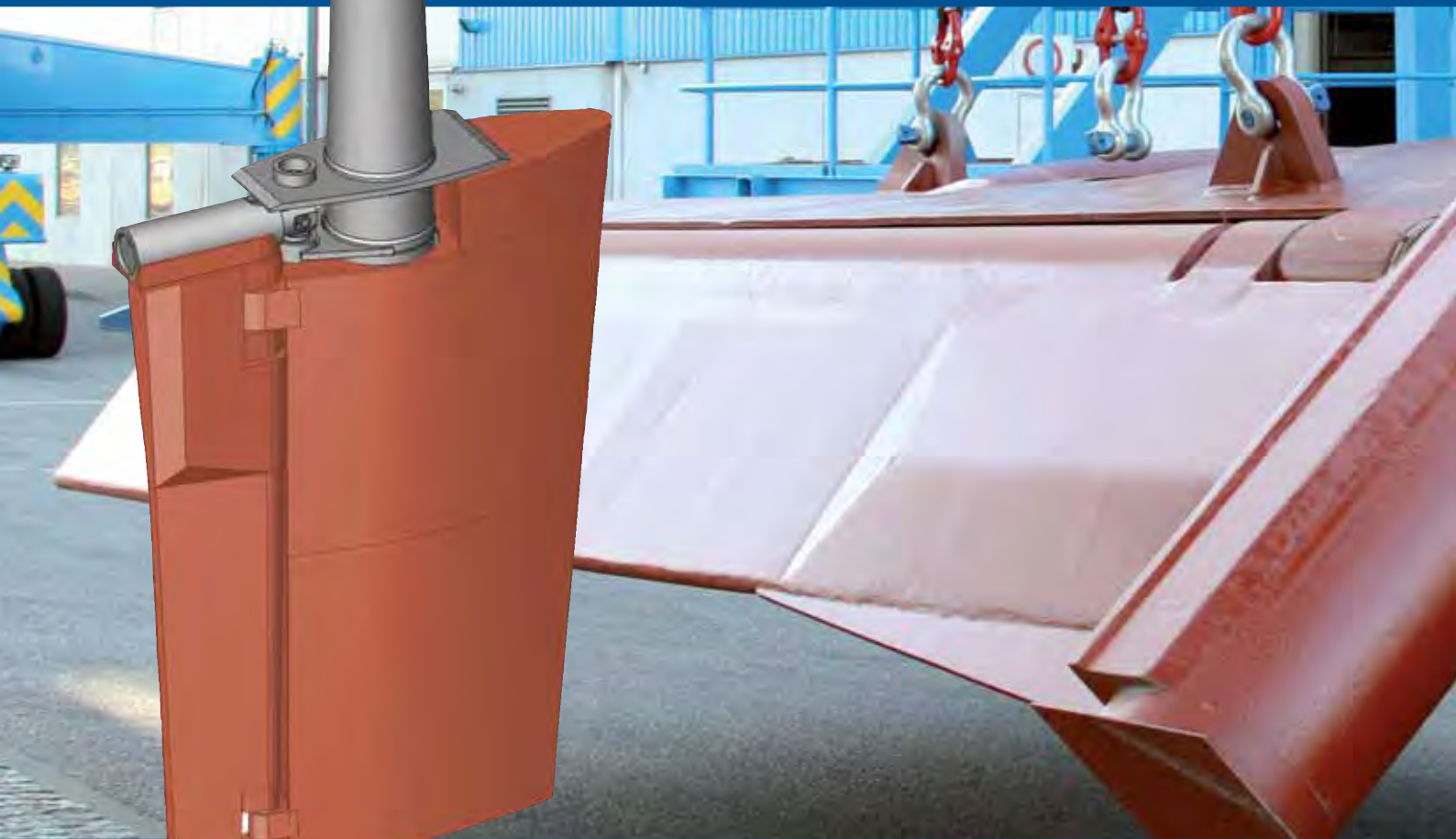
- **KSR support**





Available for





# Becker rudder profiles

## Flap rudders



The Becker Flap Rudder family consists of the classic Becker Flap Rudder and the Heracles Flap Rudder designs. The Becker Flap Rudder is the most popular rudder type worldwide and is derived from the first developments made by company founder Willi Becker. In combination with KSR bearing and twisted profile it is unlimited in size and speed. The Heracles Rudder is a Flap Rudder with closed linkage for enhanced safety, in ice conditions and sandy environments for example.

These high-performance rudders have an optimum balance and flap area and thus offer best possible manoeuvrability and low fuel consumption.

Becker rudder designs with flap profiles:

- **Full spade**  
(Becker Flap S-C, Heracles Flap HRC-C)
- **KSR support**  
(Becker Flap FKSR, Becker Twisted Flap TLFKSR)
- **Heel support**  
(Becker Flap S-A, Heracles Flap HRC-A)



Flap rudder profile  
**Becker flap**



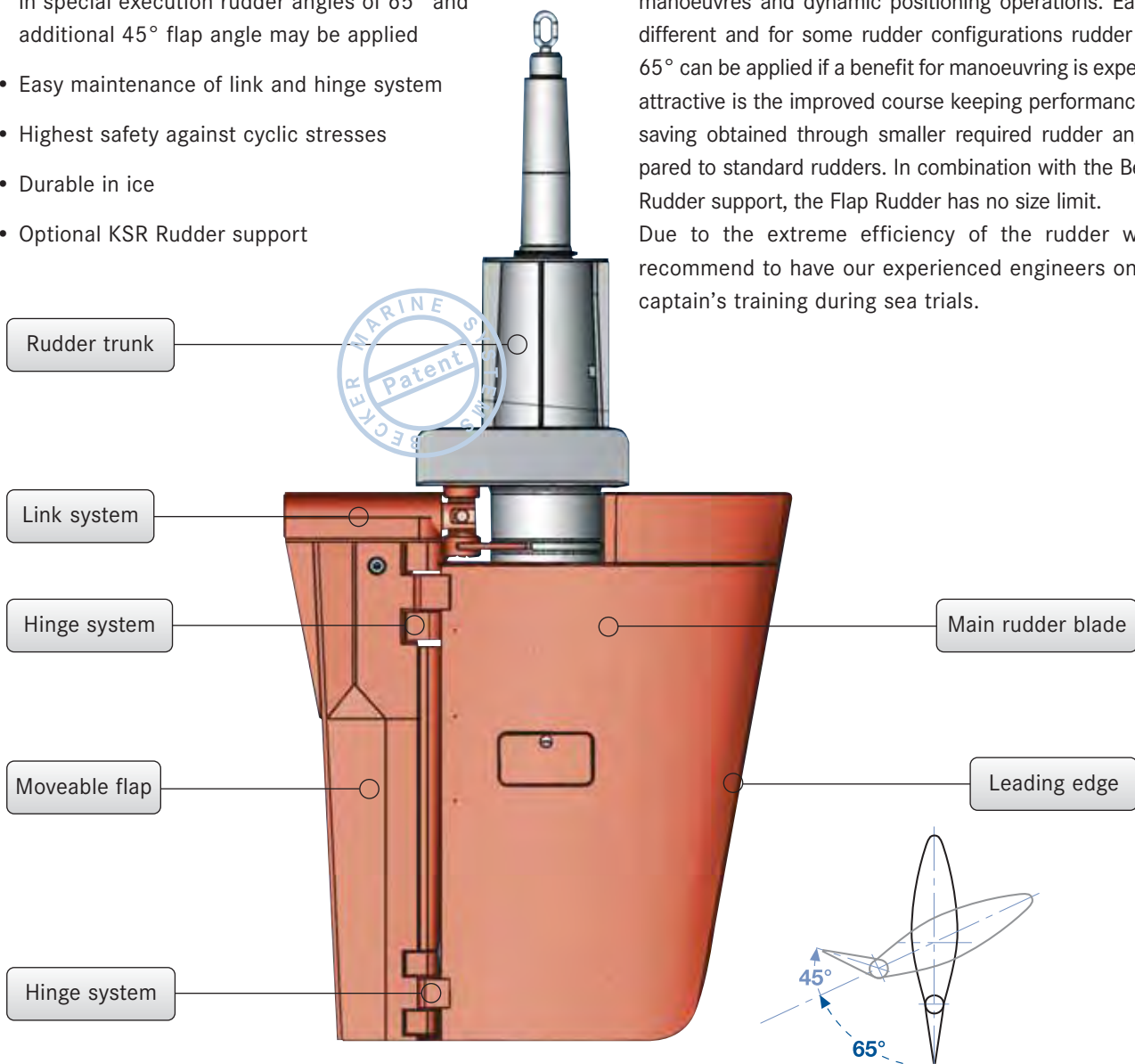
Becker Flap Rudders guarantee the best possible manoeuvrability for your vessel at all speeds with lowest possible fuel consumption.

- Optimum balance and flap area
- Minimum steering gear size
- Highest insurance against flexural vibration, best values of natural vibration
- Rudder angles of  $45^\circ$  and additional  $45^\circ$  of the flap, in special execution rudder angles of  $65^\circ$  and additional  $45^\circ$  flap angle may be applied
- Easy maintenance of link and hinge system
- Highest safety against cyclic stresses
- Durable in ice
- Optional KSR Rudder support

The Becker Flap Rudder is the ultimate rudder solution when it comes to ship manoeuvrability. With decades of research, development and practical experience behind it this rudder is the most mature design of all flap rudders in the shipbuilding industry. Optimised profiles, rudder balance, deflection ratio between rudder blade and flap, hinge and link systems guarantee a reliable and efficient tool for your vessel.

Often copied but never equalled, the combination of all the outstanding features ensures a superb rudder. Rudder angles of  $\pm 45$  degrees and additional 45 degrees of the flap permit extreme manoeuvres and dynamic positioning operations. Each ship is different and for some rudder configurations rudder angles of  $65^\circ$  can be applied if a benefit for manoeuvring is expected. Also attractive is the improved course keeping performance and fuel saving obtained through smaller required rudder angles compared to standard rudders. In combination with the Becker KSR Rudder support, the Flap Rudder has no size limit.

Due to the extreme efficiency of the rudder we always recommend to have our experienced engineers onboard for captain's training during sea trials.



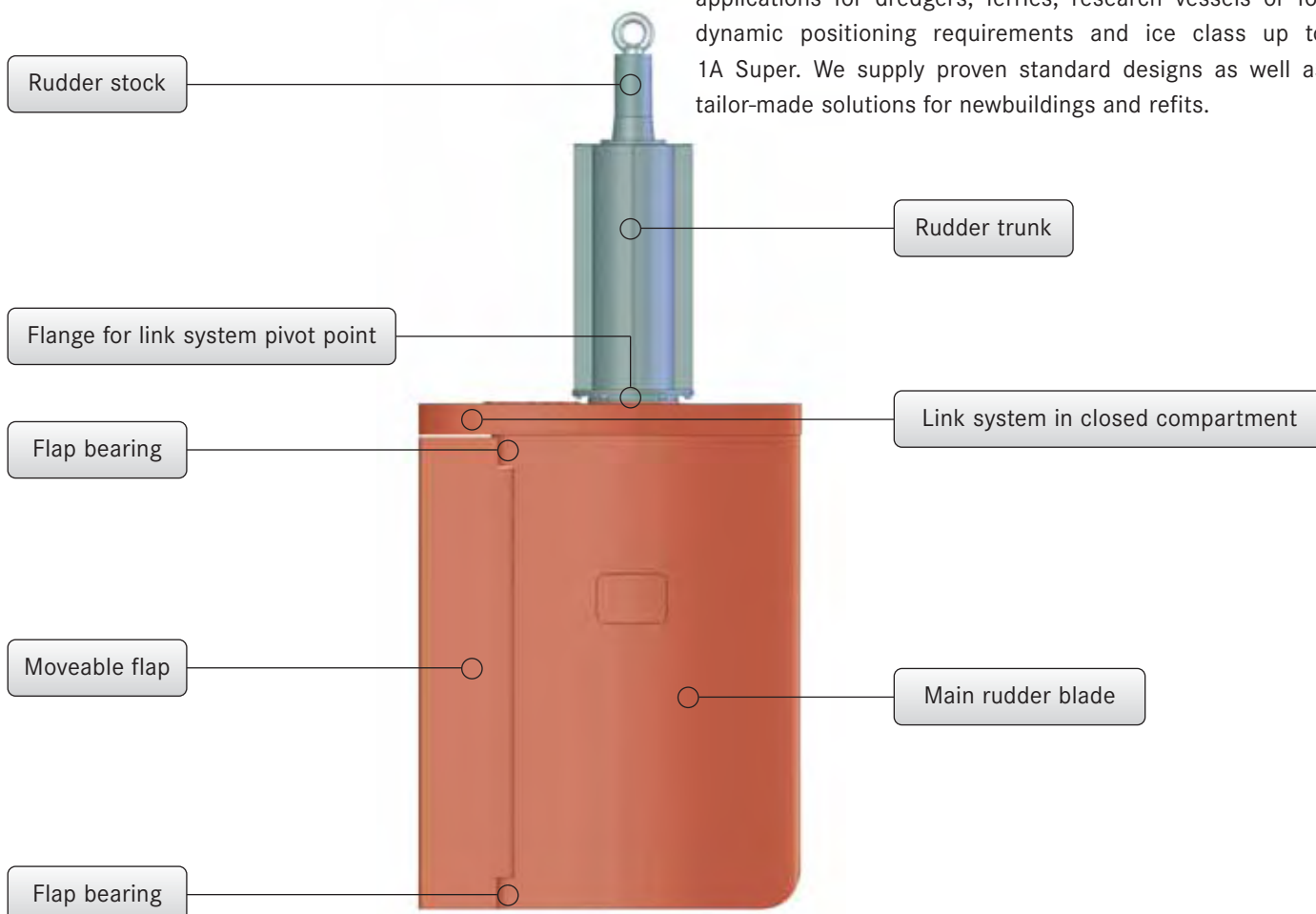
# Flap rudder profile Heracles flap



- Closed flap link system filled with grease
- Optimum protection of link system against ice and sand
- High durability of link system
- Progressive flap action ensures superior manoeuvring and steering properties
- Total flap angle up to 100° at rudder angle 45°
- Safe & reliable link system with protection device against excessive forces
- Minimum size of steering gear
- Easy installation – no adjustment of link system required
- Optional: neck bearing with spherical shell for low neck bearing tolerance & especially suitable for low noise requirements

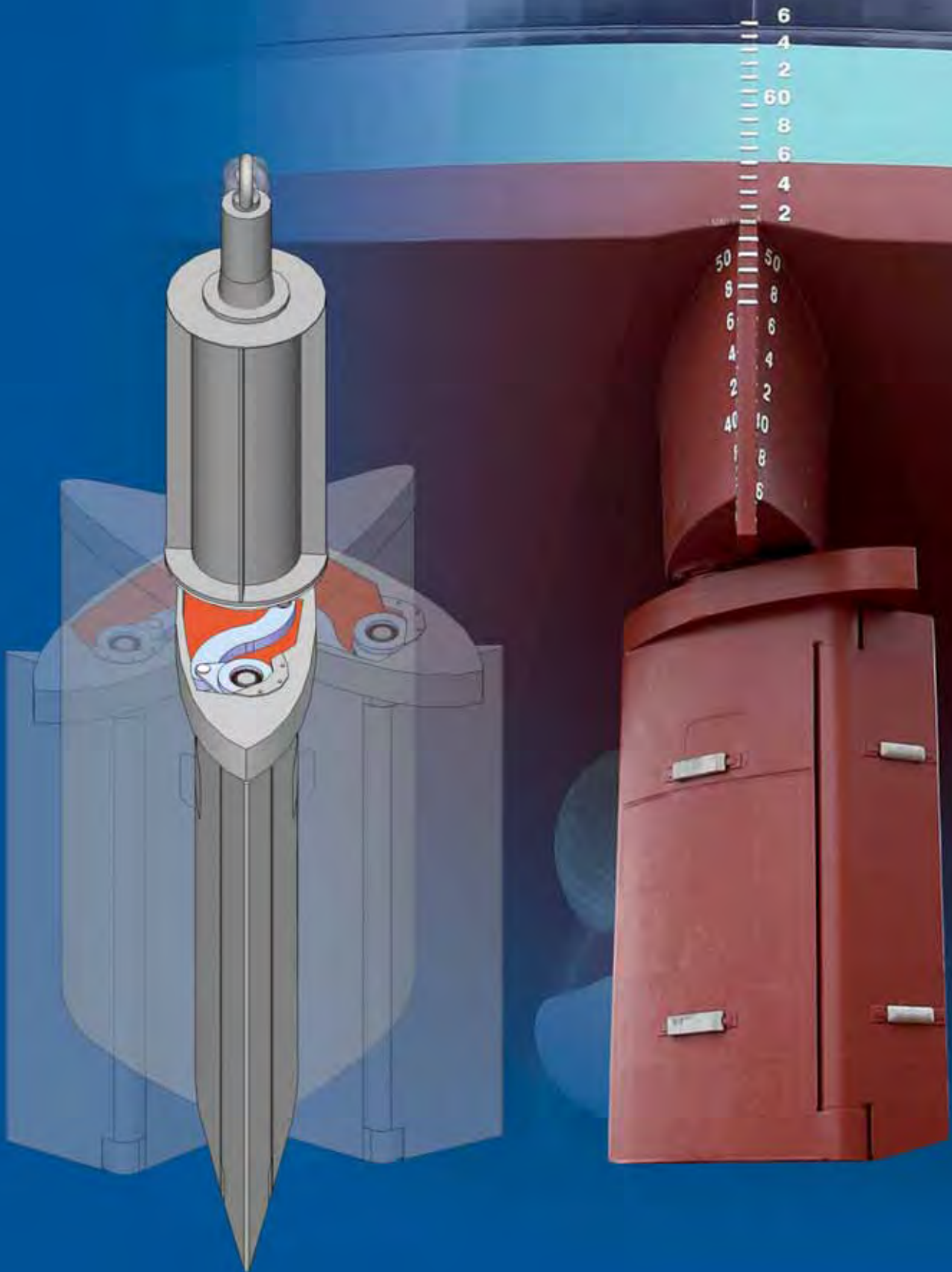
HERACLES stands for High Efficiency Rudder Acting with Closed Linkage providing Enhanced Safety. Its sophisticated design incorporates the benefits of a flap mechanism which is protected in a hydrodynamically shaped top section of the rudder blade with an increased flap angle ratio. This provides both high manoeuvrability at high rudder angles as well as smooth steering response and low resistance under steering. Enhanced safety is achieved via a safety device on the flap axis which prevents both the mechanism from being damaged as well as the rudder being rendered inoperable due to flap blockages and obstruction.

These features make the Heracles rudder the rudder of choice when you demand high efficiency manoeuvring, excellent course keeping, low fuel costs and long lifetime. You can rely on our extensive know-how if you ask for a simple solution on a commercial vessel as well as for the most demanding applications for dredgers, ferries, research vessels or for dynamic positioning requirements and ice class up to 1A Super. We supply proven standard designs as well as tailor-made solutions for newbuildings and refits.





# GOUVERNEUR ZWARTSLUIS



KURT NOZZLE	HERUS® SUPP./SEMI-SPADE	HEEL SUPPORT	KSR SUPPORT	FULL SPADE	Available for	RUDDER DESIGNS	NACA&OTHER	SCHILLING®	FLAP	TWISTED	RUDDER PROFILES
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# Becker rudder profiles Schilling® rudders



The new and optimized Schilling® Rudder profile offers further improved manoeuvring for all sizes and types of vessels. It is available as a full spade design (Schilling® MonoVec) or in semi-spade design (Schilling® Mariner). The Schilling® Navigator Rudder closes the gap between conventional semi-spade and full spade rudders. The new Schilling® KSR Rudders offers large tankers and bulkers the advantages of the High-Lift Schilling rudder profile and the enhanced manoeuvrability of a full spade rudder in combination with the KSR King Size Rudder support.

Becker rudder designs with Becker Schilling® profiles:

- Full spade (Schilling® MonoVec-C & VecTwin)
- Full spade KSR support (Schilling® KSR)
- Heel support (MonoVec-C)
- HERUS® support (Schilling® Navigator)
- Semi-spade (Schilling® Mariner)

Becker Schilling® Rudder profiles provide:

- Exceptional full speed course-keeping ability
- Reduced rudder “hunting” under autopilot operation
- Significantly reduced overshoot angles
- Reduced head reach and lateral deviation
- Improved crabbing and zero-speed control, reducing reliance on tug assistance
- Enhanced turning capability with significantly reduced turning circles at speed
- Single-piece construction with no moving parts makes Schilling® ideally suited for all ice notations



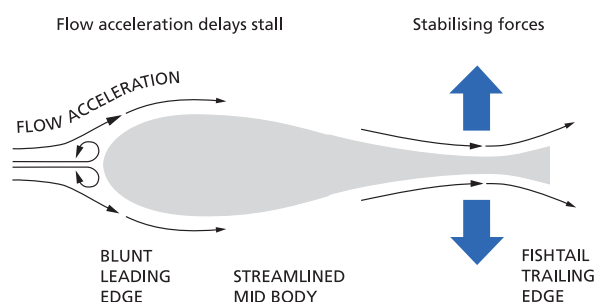
# Becker rudder profile Schilling®



The Schilling® Rudder is a high-lift rudder, designed for vessels of any size, and supplied in single or multiple configurations. Being of a single piece construction with optimised shape and no moving parts, the Schilling® Rudder dramatically improves both course-keeping and vessel control characteristics.

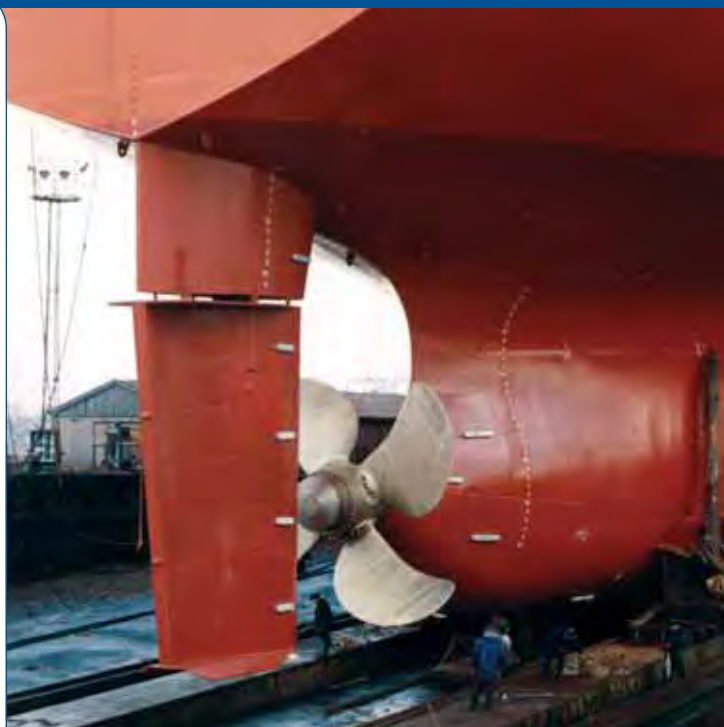
With operating angles up to 70° port and starboard, the Schilling® Rudder can control the propulsive force to achieve an efficient “side thrust” effect at a ship’s stern.

The enhanced levels of ship handling and control achieved with the Schilling® Rudder system gives ship owners and operators access to a range of long term operating, cost and safety benefits.

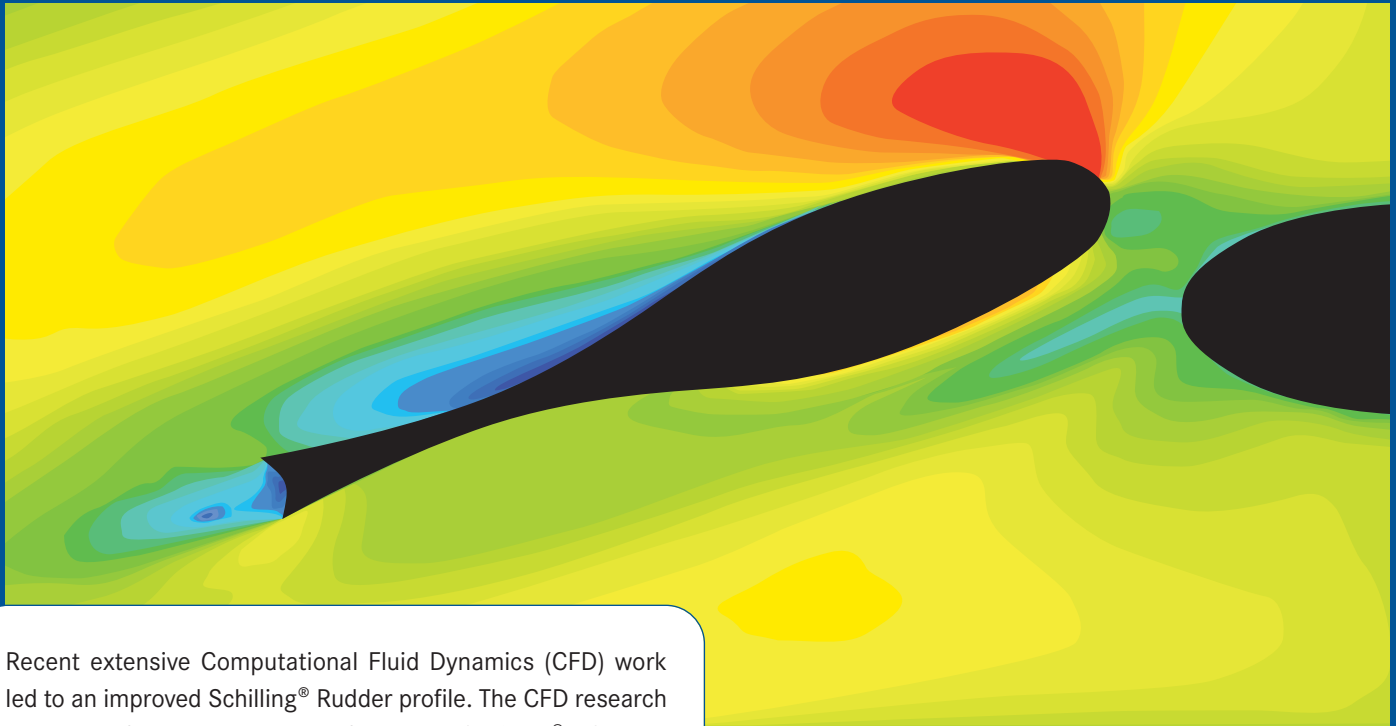


The unique profile of the Schilling® Rudder incorporates:

- New enhanced high-lift low drag profile
- A rounded leading edge promoting good flow properties at all rudder angles
- A fishtail trailing edge that accelerates the flow and recovers lift over the aft section of the rudder
- End and optional intermediate plates to control propeller slipstream
- High rudder balance optimising propeller coverage
- Fully welded steel construction of the rudder blade
- Rudder blade to stock connection by keyless conical or flange coupling
- Single or multiple bearing support with no moving parts



# Becker rudder profile Schilling®

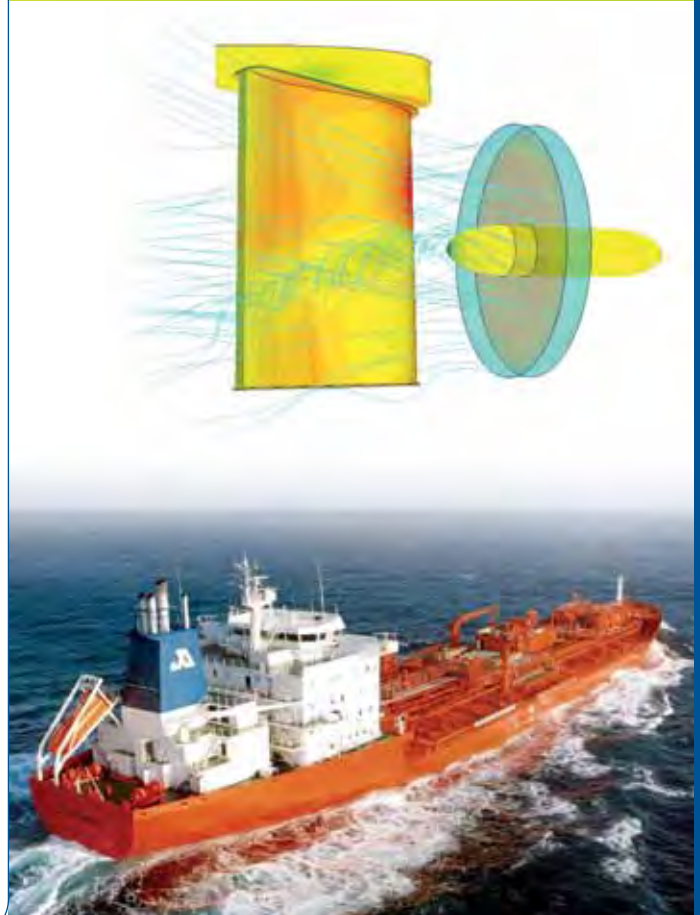


Recent extensive Computational Fluid Dynamics (CFD) work led to an improved Schilling® Rudder profile. The CFD research was part of the development of the new Schilling® KSR and Schilling® Navigator Rudder systems. The improved profile enhances the advantages of the Schilling® design:

- Reduced drag at full scale
- Preserves the already excellent lift characteristics
- Moves the main thickness of the section aft to house the KSR bearing

All calculations were performed at full scale and proved a rudder drag reduction at normal cruising helm angles by approx. 25 %, with the lift (side force) identical to the original section. A new concave streamlined fishtail is incorporated, which improves the flow separation characteristics compared to previous fishtail designs. Also, the main thickness of the section has been moved further aft, eliminating the requirement for additional strength 'bulges' for faster vessels and/or cases with highly loaded propellers.

Further research work with particular emphasis on the leading edge performance under heavy propeller load resulted in an optimised profile, the detailed end-plate optimisations are carried out individually to suit particular operational scenarios.



Becker rudder profiles  
NACA & more





Economic alternative with proven NACA 0020 profile for applications with standard requirements. On demand, special profiles like NACA 63 or HSVA MP73 may be offered.

Becker rudder designs with NACA profile:

- Full spade (N-C)
- KSR support (KSR)
- Heel support (N-A)
- HERUS® support (HERUS®)





# Becker rudder designs



The rudder designs are the different solutions for the rudder support. From full spade or heel-supported rudders for smaller and slower vessels to big vessels with Mariner or HERUS® support, Becker Marine Systems offers the full range.

But when it comes to fast, big or both there is no alternative to Becker's proven KSR support, a solution which allows to build a rudder at any size.





# Becker rudder design Full spade



Full spade rudders are the solution of choice for smaller and low-speed vessels. Like the economic Becker Full Spade Flap Rudder (SC), especially designed for typical applications like river boats, supply and fishing vessels, tugs, coasters and small ferries.

Becker rudder profiles for the full spade design:

- **Becker Flap (S-C)**
- **Heracles Flap (HRC-C)**
- **Schilling® MonoVec-C**
- **Schilling® VecTwin**
- **NACA (N-C)**
- **Kort Nozzle (FK-C)**



Available for

KORT NOZZLE

HERUS® SUPP./SEMI-SPADE

HEEL SUPPORT

KSR SUPPORT

FULL SPADE

RUDDER DESIGNS

Available for

NACA&OTHER

Available for

SCHILLING®

Available for

FLAP

TWISTED

RUDDER PROFILES



Becker rudder design  
KSR Support







The KSR (King Support Rudder) design extends the trunk into the rudder blade and makes it possible, that Becker's full spade rudders, such as the TLKSR® Twisted Leading Edge Rudder, the Flap Rudder (FKSR) or the Schilling® KSR with unchallenged manoeuvrability can be supplied for vessels of any type and size. With the KSR design Becker can supply full spade rudders in practically any size.

Becker rudder profiles for the KSR design:

- **Becker Twisted Leading Edge Flap (TLFKSR)**
- **Becker Twisted Leading Edge (TLKSR®)**
- **Becker Flap (FKSR)**
- **Schilling® KSR**
- **NACA (KSR)**

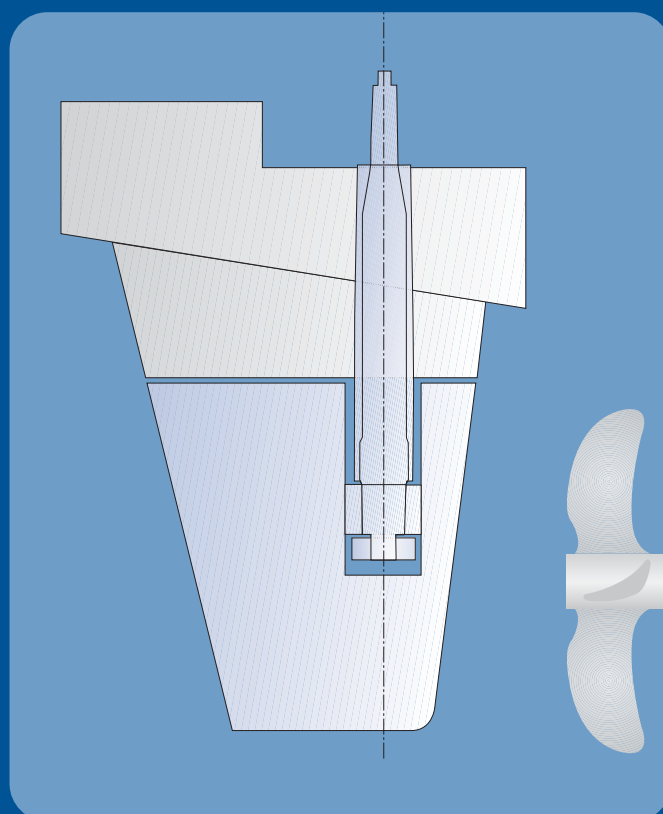
# Becker rudder design KSR Support



In order to avoid typical disadvantages of conventional rudders, Becker Marine Systems has developed the KSR (King Support Rudder) bearing arrangement concept.

With this arrangement the trunk is extended into the rudder blade so that the lower neck bearing is positioned as close as possible to the vertical centre of pressure of the rudder. This results in reduced stresses and bending moments in the rudder blade as well as in the rudder stock.

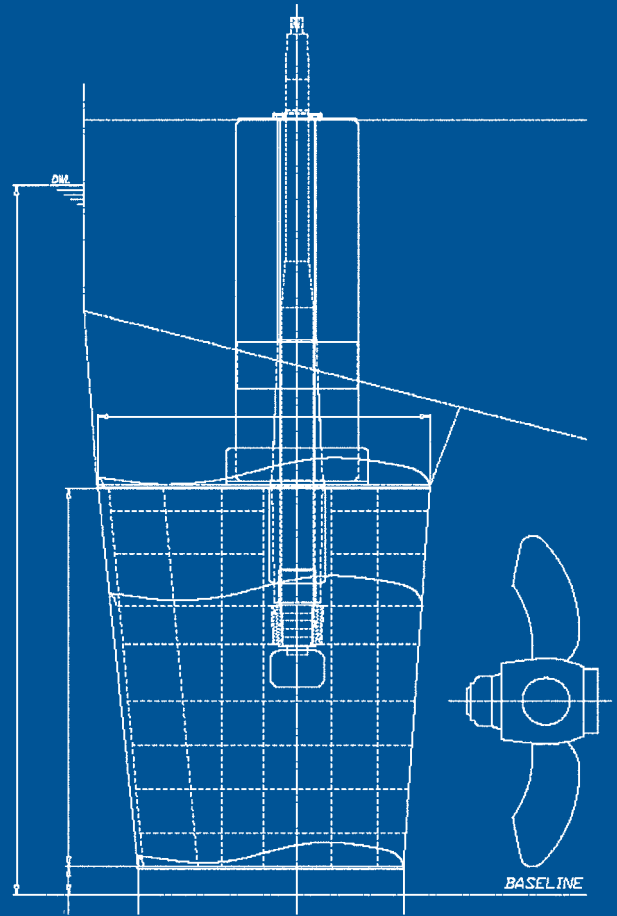
The reaction forces in the neck and carrier bearings are much smaller, making it a very rigid rudder and with a consequently high natural frequency above the exciting frequency of the propeller, so that risk of the resonance is very unlikely. Vibrations are reduced to a minimum.







A first generation TLKSR®



The new Schilling® KSR







# Becker rudder design Heel support

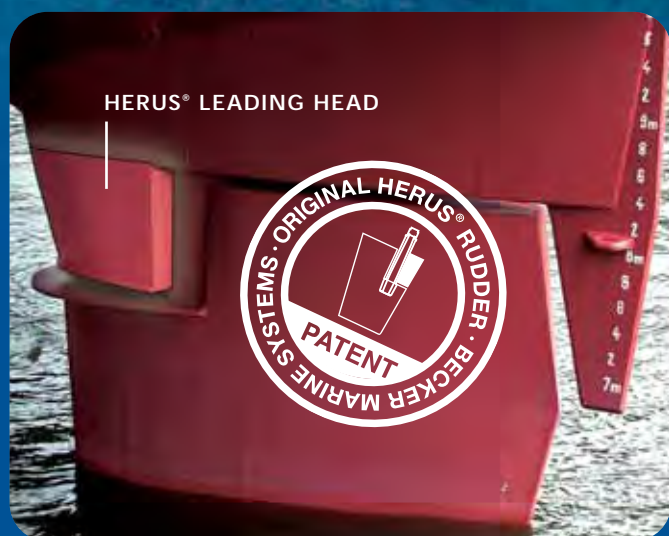


The heel-supported Becker rudders are economic systems for small and low speed vessels. River boats, supply vessels, tugs, fishing boats and research vessels are all ideal candidates for this rudder solution. This design reduces the loads on the neck bearing and the rudder carrier.

Becker rudder profiles with heel support:

- **Becker Flap (S-A)**
- **Heracles Flap (HRC-A)**
- **Schilling® (MonoVec-A)**
- **NACA (N-A)**
- **Kort Nozzle (FK-A)**

# Becker rudder design HERUS® support



Designed for relatively slow and large vessels (e.g. bulk carriers and tankers). The leading head section and the rudder trunk are combined into one component. The design comprises hydrodynamic efficiency, simple installation and reduced maintenance.

Becker rudder profiles with HERUS® support:

- Schilling® Navigator
- HERUS® Rudder



# Becker rudder design Semi-spade

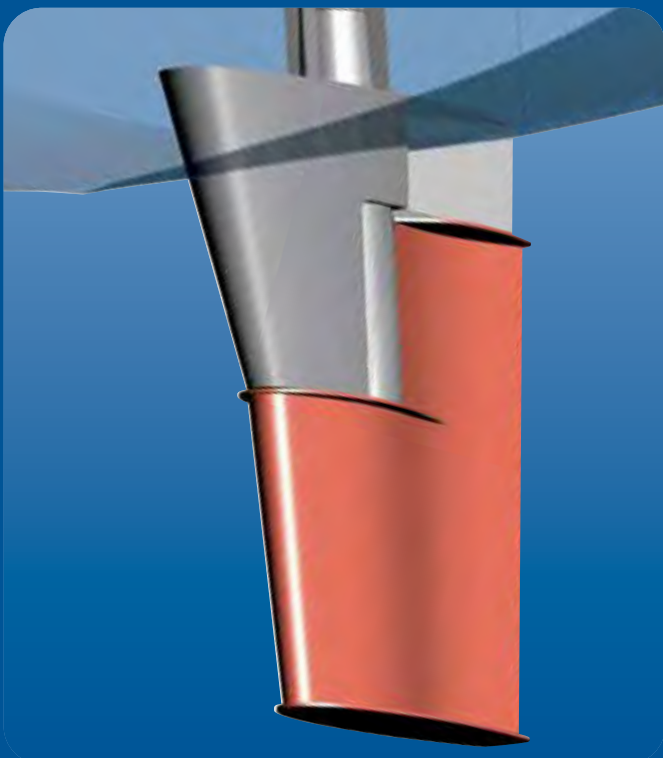


Becker's well-proven semi-spade rudder design comes with the Schilling Mariner rudder profile. The Schilling Mariner consists of a rudder horn, pintle and semi-spade rudder blade. Primarily intended for very large rudders, it provides the necessary support for the Schilling high-lift profile.

Becker rudder profiles for the semi-spade design:

- **Schilling® Mariner**

## Recommended product Schilling® Navigator



The Schilling® Navigator Rudder closes the gap between the conventional semi-spade rudder and a full spade rudder. It is specifically designed for relatively large and slow vessels to improve course-keeping and manoeuvrability. Easily installed components make this high efficiency rudder solution an ideal choice both for shipyards and owners.

- Integrated rudder trunk replaces conventional rudder horn
- Welded steel design of the leading head
- Reduced installation time and effort
- Traditional Schilling® manoeuvring advantages such as improved crabbing, zero-speed control & reduced turning circles

More information according to the rudder profile page:

- **Schilling® Navigator**

Available for

# Becker Kort Nozzle

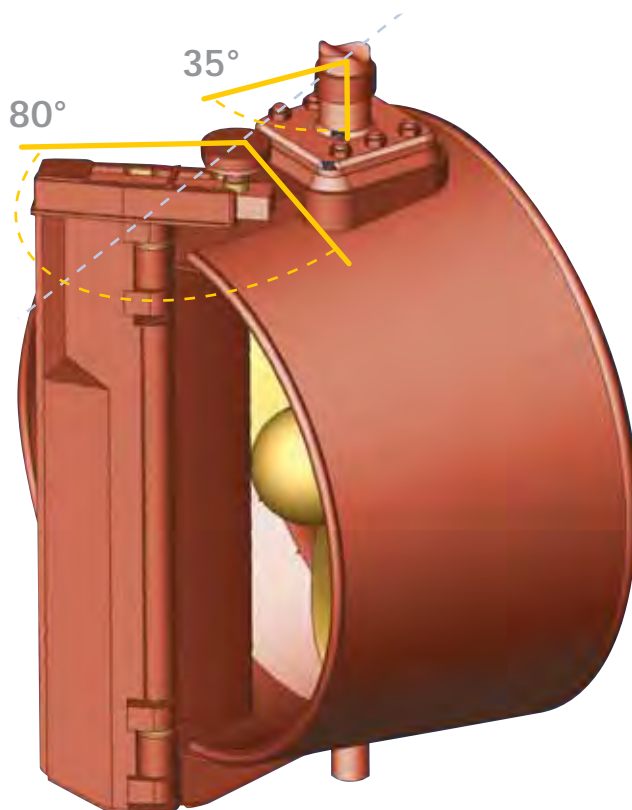


## Advantages of the Becker Kort Nozzle:

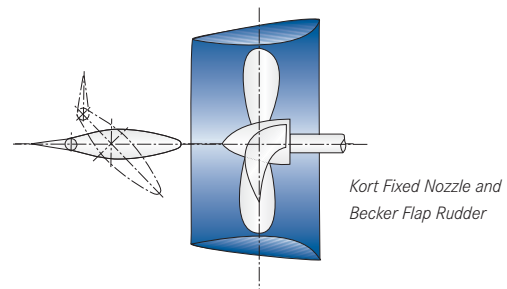
- Increased bollard pull
- Increased thrust
- Better propulsion efficiency
- Better steeraage capacity
- Reduced vibrations
- Protection of propeller against damage
- Reduced operation costs – fuel saving

## Particularly suited for the following ship types:

- Tugs and pusher tugs
- Fishing vessels
- Research vessels
- Supply vessels and special ships
- Dredger and cable-laying vessels
- Inland-water vessels
- Vessels with full aft-end forms

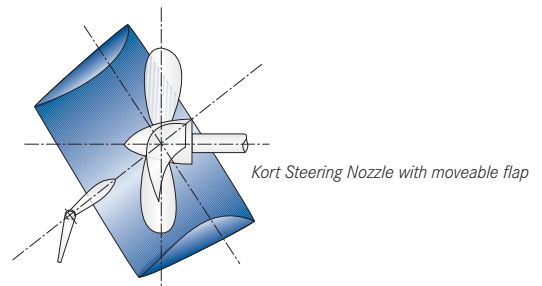


## Available Kort Nozzle designs:



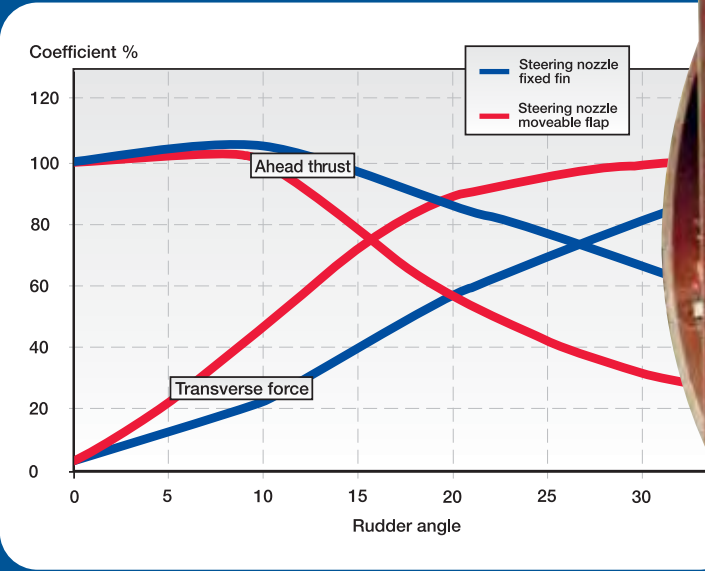
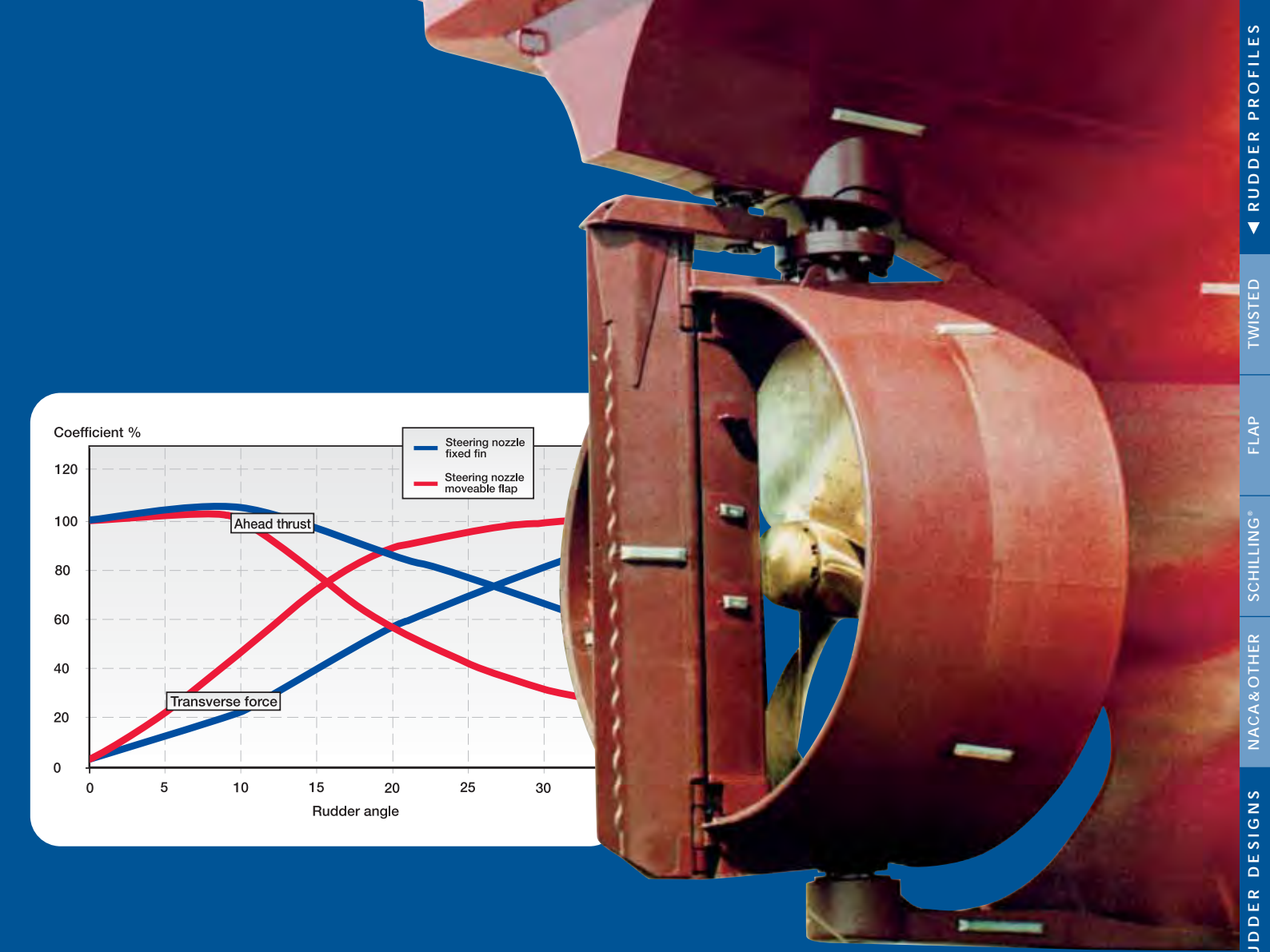
### Fixed nozzles

- Standard nozzles with NSMB-19A profile or Kort profile.
- Nozzles with NSMB-37 profile for icebreaker and vessels generating a high degree of astern thrust.



### Kort Steering Nozzles

Heel-supported or free hanging. Kort Steering Nozzles are generally used on vessels with restricted aft end space, and are used in lieu of a conventional rudder arrangement. Combining short installation length and high bollard pull, it is the ideal solution for ships like tugs and fishing vessels which require high lateral thrust. Additionally, steering nozzles with moveable flaps reduce vibrations and increase the manoeuvrability of the vessel. Steering nozzles are also available with NSMB-19A and NSMB-37 profile.







TLK SR<sup>®</sup>, 8400 TEU, 26 knots  
no rudder cavitation

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