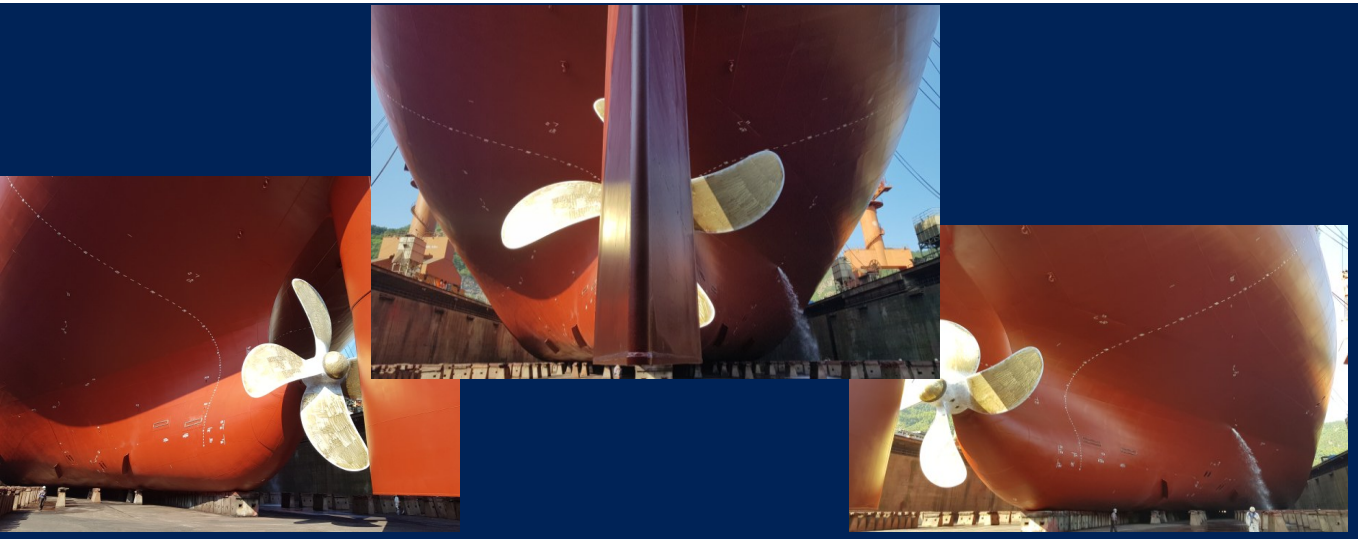
OCEANCARE
BEST SOLUTION YOUR PARTNER

ESF (Energy Saving Fins)



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CONTENTS

1. Introduction of ESD (Energy Saving Devices)

Reduction of Resistance

~'1995 ~'2000 ~'2005 ~2010 ~2015

Reduction of wave making resistance
Gooseneck bulb

OceanCare Business Area

Form drag reduction
SAVER Fin (2007)
SHI

Air lubrication
(MHI, 2011~2012)

Flipper Fin (2008) Japan

New trend - Bulb retrofit

Improvement of Propulsive Effciency

PBCF (MOLTech, 1987)

Semi duct (Japan, 1990's)

Thrust Fin (HHI, 2008)

SARB[1] (2008)
SHI

Mewis duct
(BMS, 2010)

Twisted fin
(BMS, 2013)

Pre-Swirl Stator
(TK, MHI, 1990)

Friend-fin
(Tsuneishi社, 2005)

Pre-Swirl Stator(DSME, 2008)

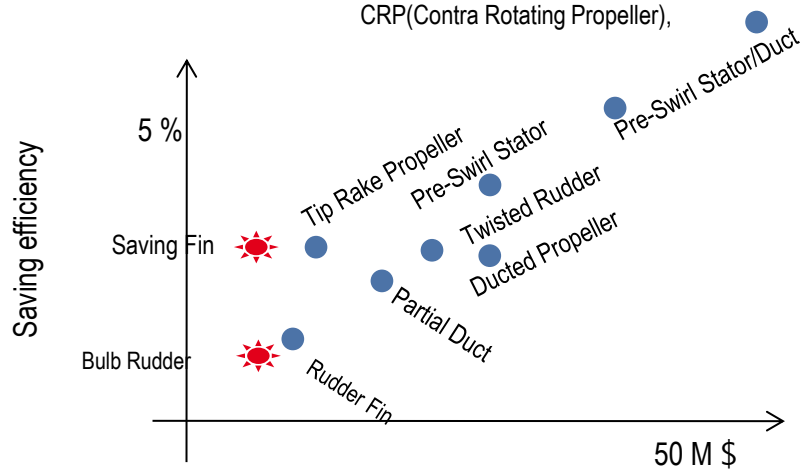
1. Introduction of ESD (Energy Saving Devices)

What is ES-Fins?

1ST – Easy installation

"ESF" can be mounted without extension for the normal period of dry dock repair. (Installation need time : dry dock 6~8 day)

2nd – Excellent cost effectiveness



3rd - Durability

It is a permanent installation.
Also, no maintenance is required.

4th – Additional benefit

Hull vibration can be reduced by 30 to 80%.
(If designed to reduce hull vibration, there may be a fuel penalty.)

2. Reliability

Is this technology reliable?

It is a reliable technology introduced to various institutions and institutions related to ship building.

Quote from KOSHIPA

(Korea Offshore & Shipbuilding Association)

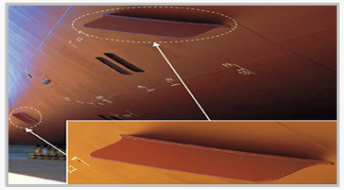
Eco-Friendly ship

Technology for Eco-friendly ship

- Post treatment Technology
- Engine Technology
- Hull Form & Propulsion Technology
- Fuel Technology
- Electric Propulsion Technology
- Material Technology

Saver Fin

- To control water flow and vibration around hull
- Reduction of 2~3% ship fuel,
- Reduction hull vibration max 70%



Research of green technologies is being continued

KOSHIPA 한국조선협회

SAMSUNG HEAVY INDUSTRIES

Quote from GCRC SOP

(Global Core Research Center for Ships and Offshore Plants)

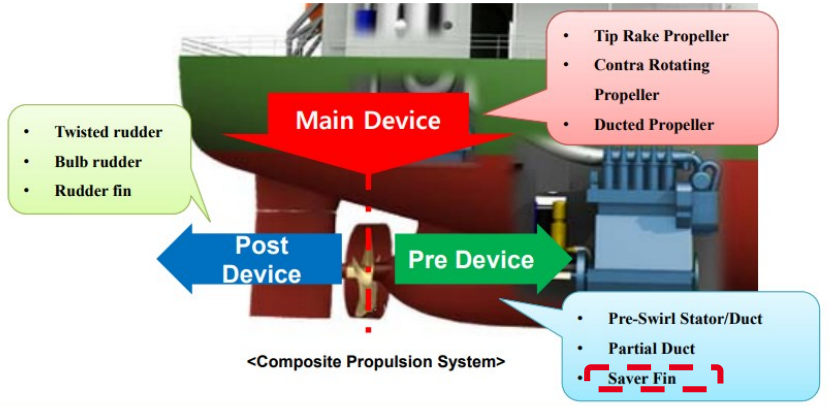
Research Background

GCRC SOP

Necessity

✓ **Hybrid Propulsion System**

- Pre Device : Pre-Swirl Stator/Duct, Partial Duct, Saver Fin
- Main Device : CRP(Contra Rotating Propeller), Tip Rake Propeller, Ducted Propeller
- Post Device : Twisted Rudder (Wavy Type), Bulb Rudder, Rudder Fin



<Composite Propulsion System>

#1-2: Technology for new concept energy-saving propulsion system

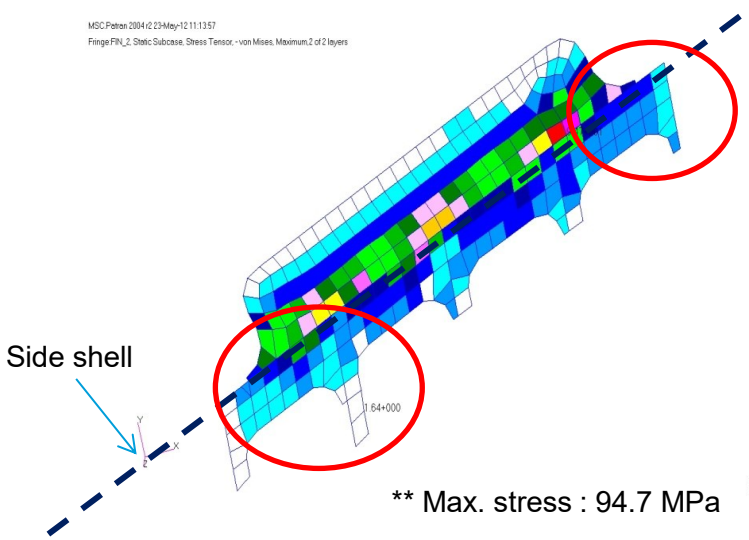
5

2. Reliability

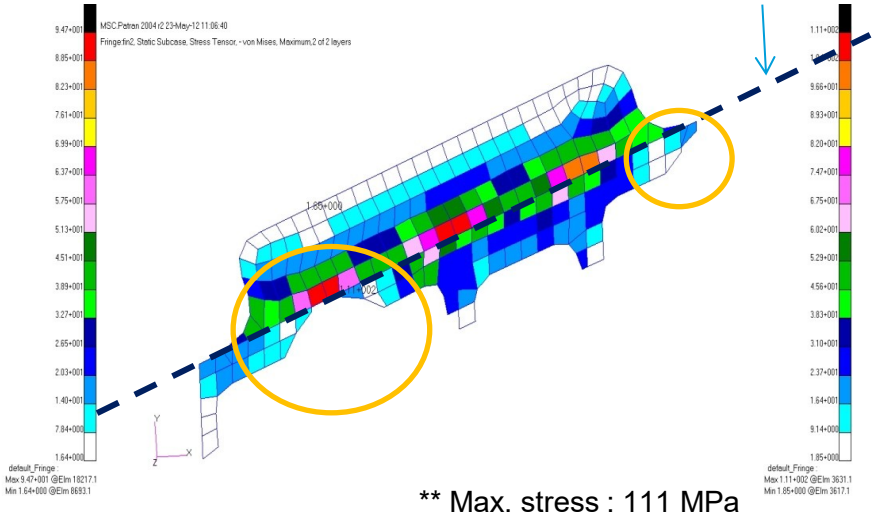
Is this technology reliable?

Stability was confirmed through structural analysis.

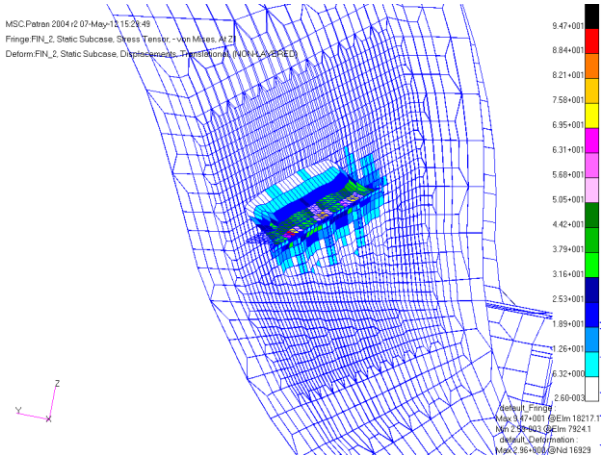
- Structural safety of ES-Fins is verified by structural analysis in heavy sea
- Saving fin is a safe structure with little stress on the hull.

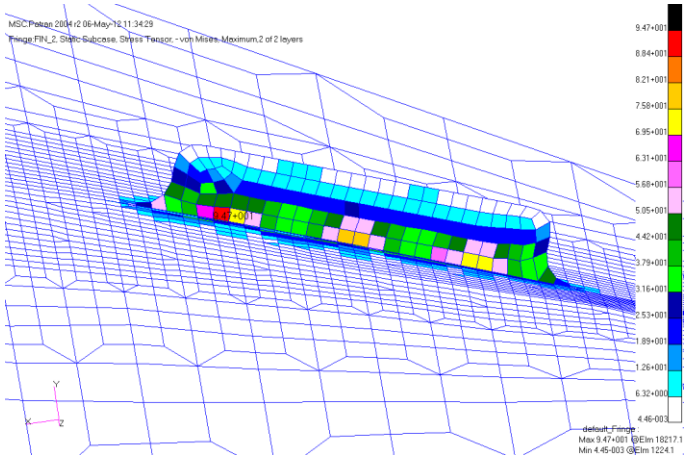


** Max. stress : 94.7 MPa



** Max. stress : 111 MPa





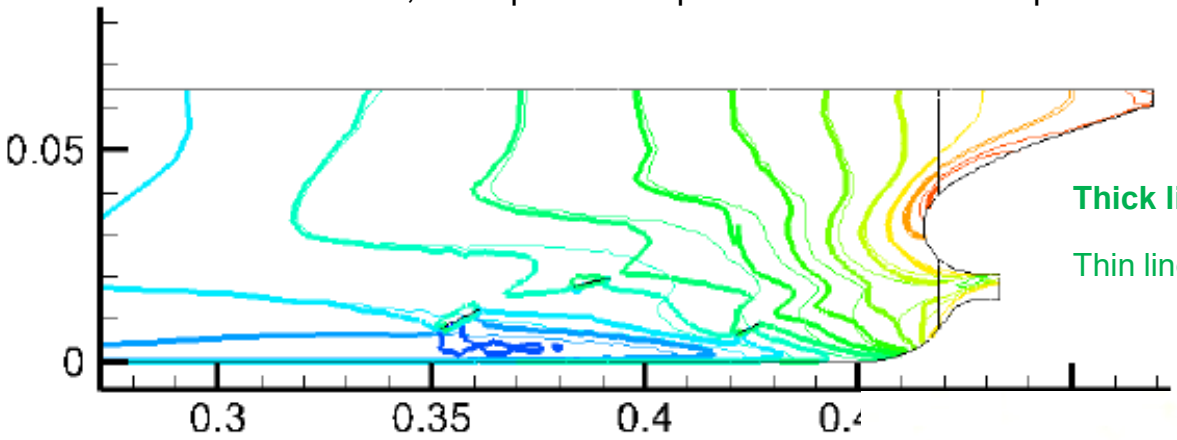
(Source : SHI)

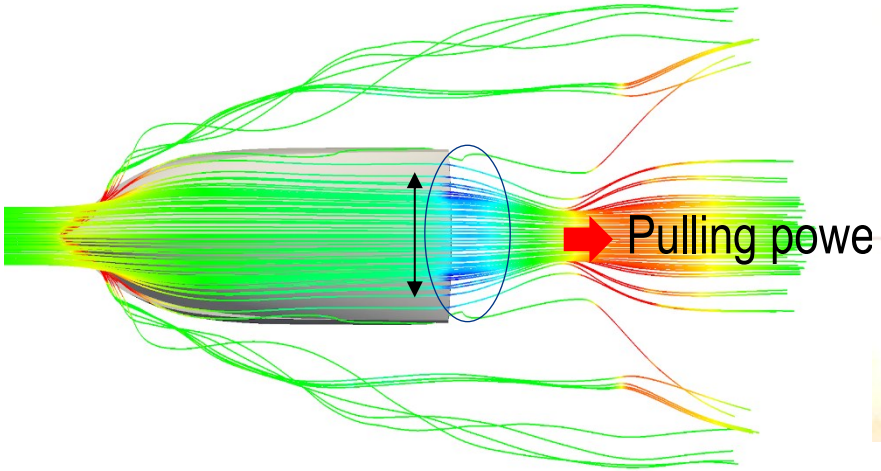
3. Basic principles

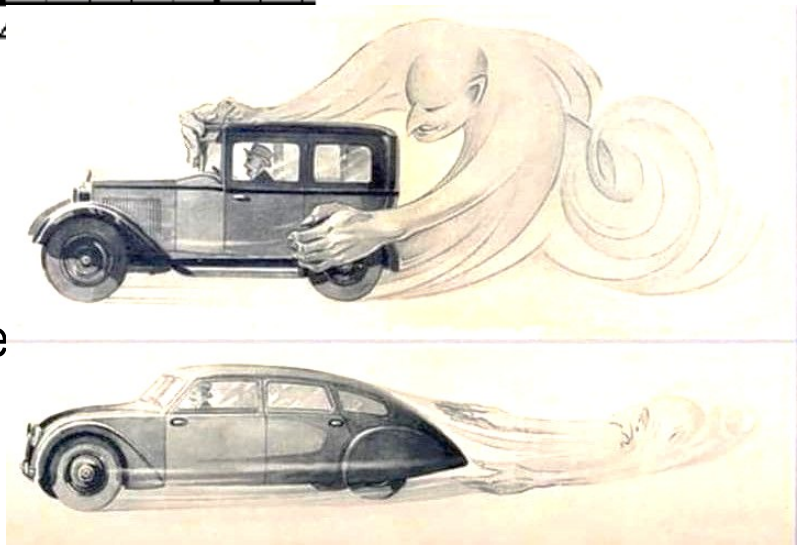
ESF can achieve savings in **two main ways.**

1ST - Recovery stern pressure (Reduced hull resistance)

If the pressure of the stern is low, it will pull the ship. So fins recovers the pressure and relieves it.

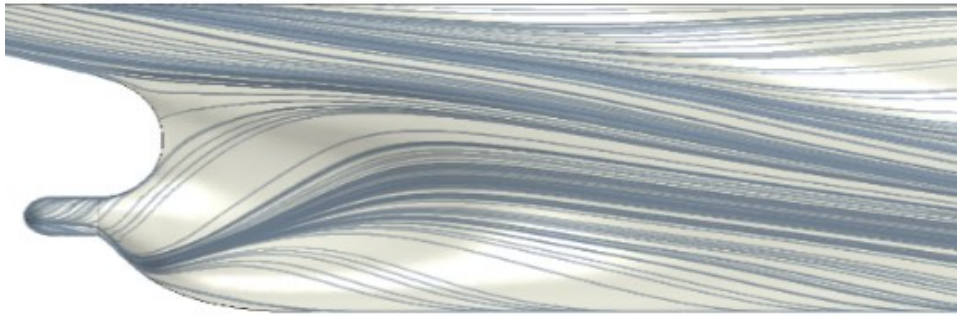


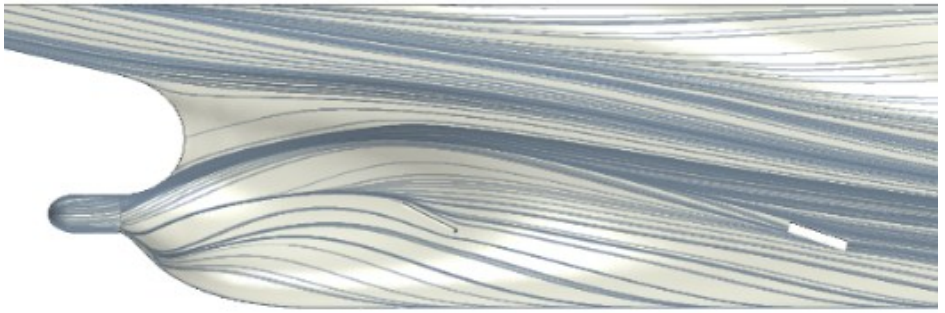


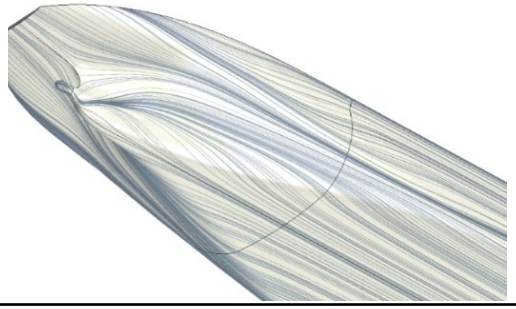
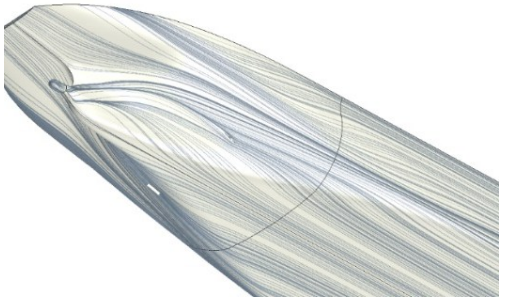
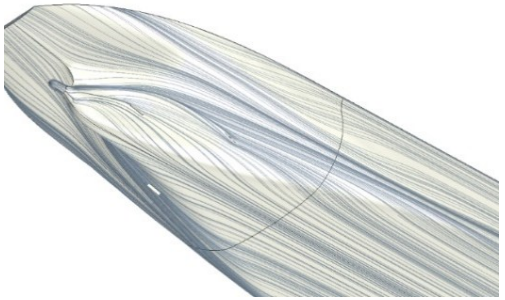
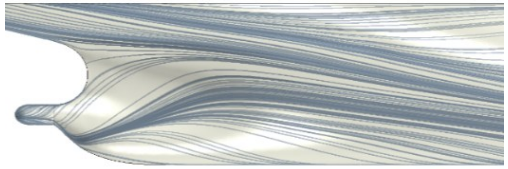
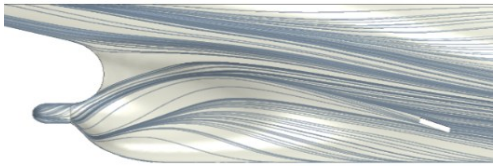
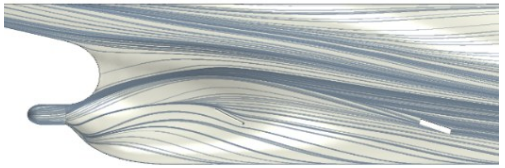


2ND - Increase propulsion efficiency by controlling streamline

Improve propulsion efficiency by controlling the streamline flowing into the propeller.





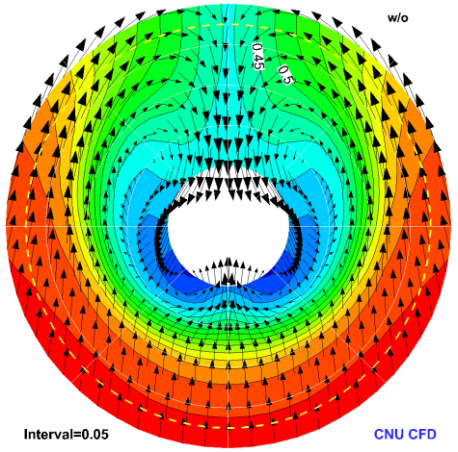
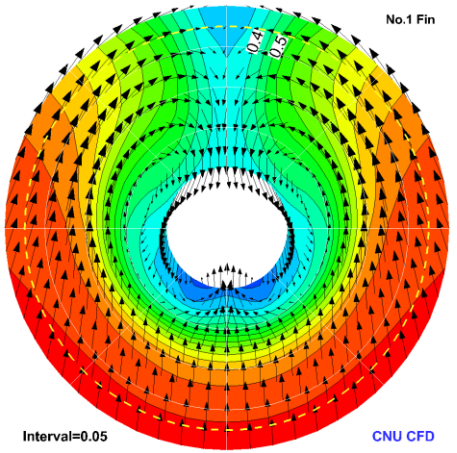
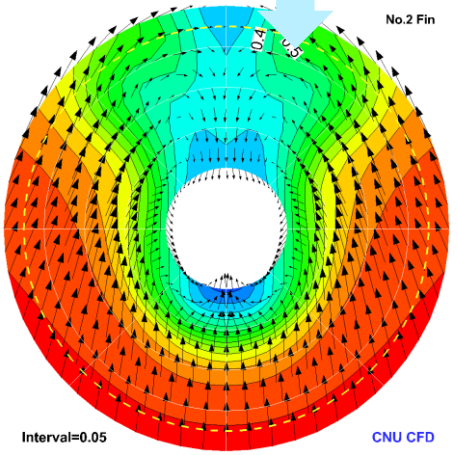
	w/o Fin	No.1 Fin	No.2 Fin
View 1			
View 2			

Additional - Reduce vibration through improved Wake

Improves the pressure of the Wake into the propeller to reduce the vibration generated by the propeller.

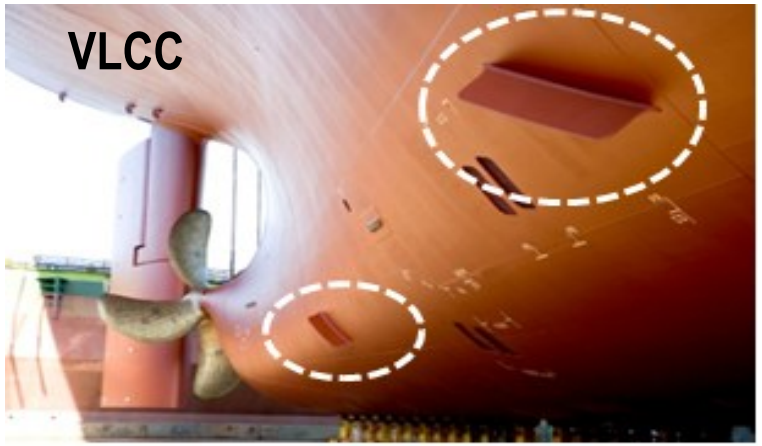
It can be confirmed that the propulsion efficiency is improved and the vibration of the hull is reduced by changing the water stream.

Comparative analysis of the wake before and after installation of fins

	w/o Fin	No.1 Fin	No.2 Fin
$R_n = 1.114\ e7$			

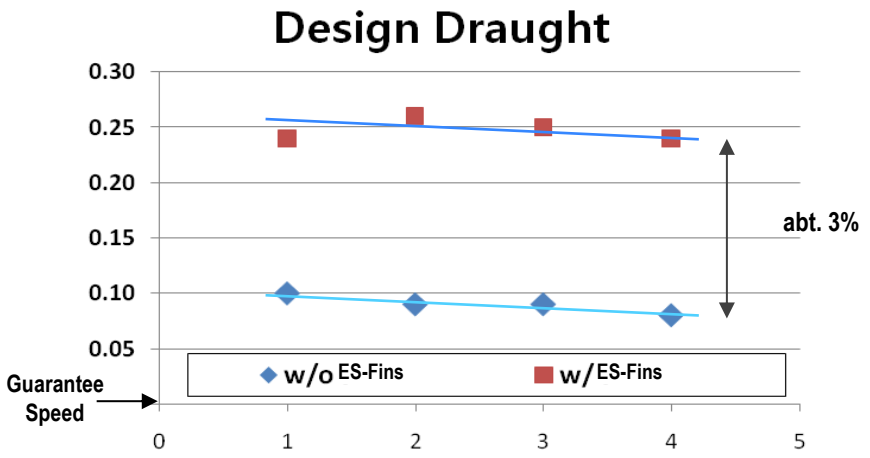
4. Performance

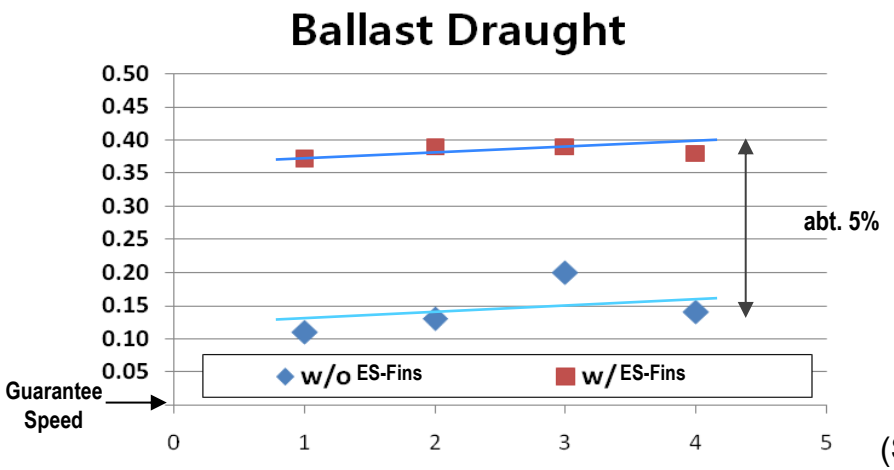
◆ Power Reduction for Tanker : 3~5%



(Source : SHI)

Increase ship speed depend on ESF installation



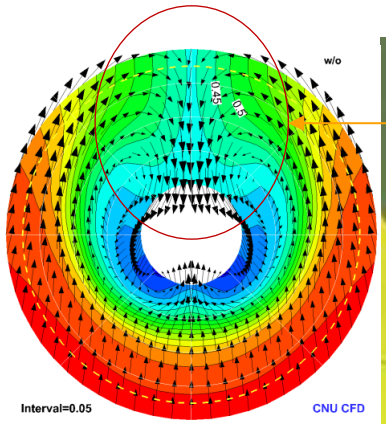


(Source : SHI)

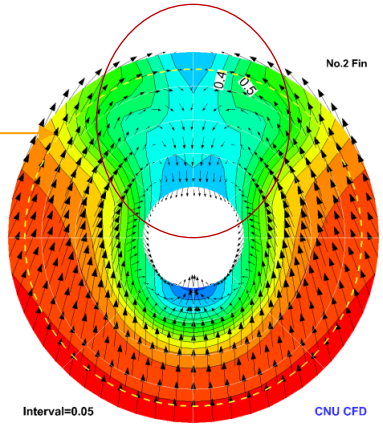
4. Performance

- **Reduction of pressure fluctuation force for TK/BC : abt. 30%**

[Cavitation of propeller: w/ESD vs w/o ESD]

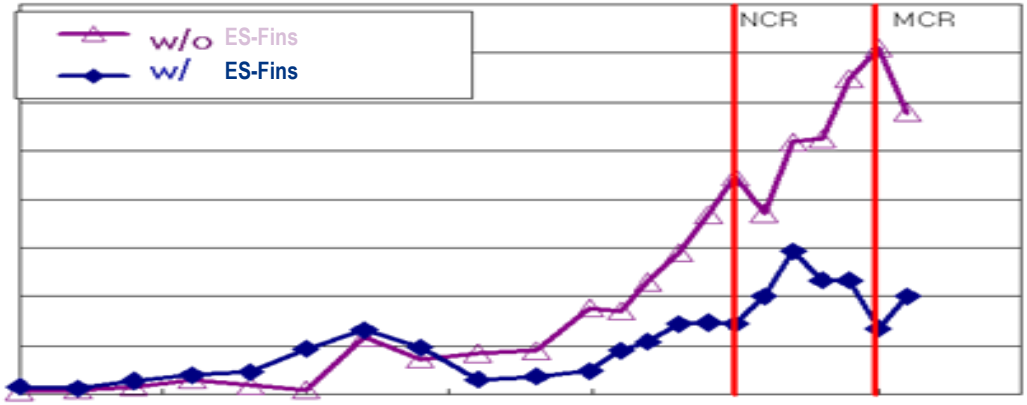


Reference Figure



Reference Figure

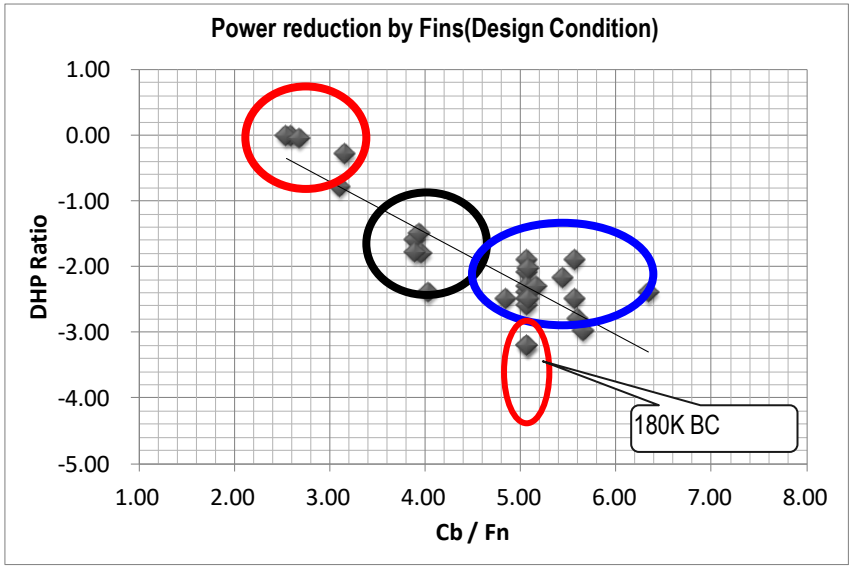
Reduction Hull vibration (Before & After)



(Source : SHI)

4. Performance

☐ 180K Bulk Carrier : 3.2 % Saving



▪ Main dimensions

Item	Bulk Carrier
Capacity	180K
LBP	292/283.5
Breadth	45.0
Depth	24.7
Draft	16.5/18.2

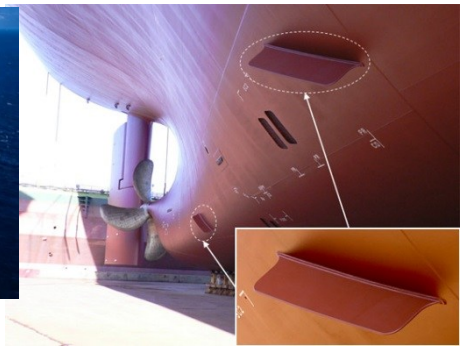
▪ Expected of Power Saving

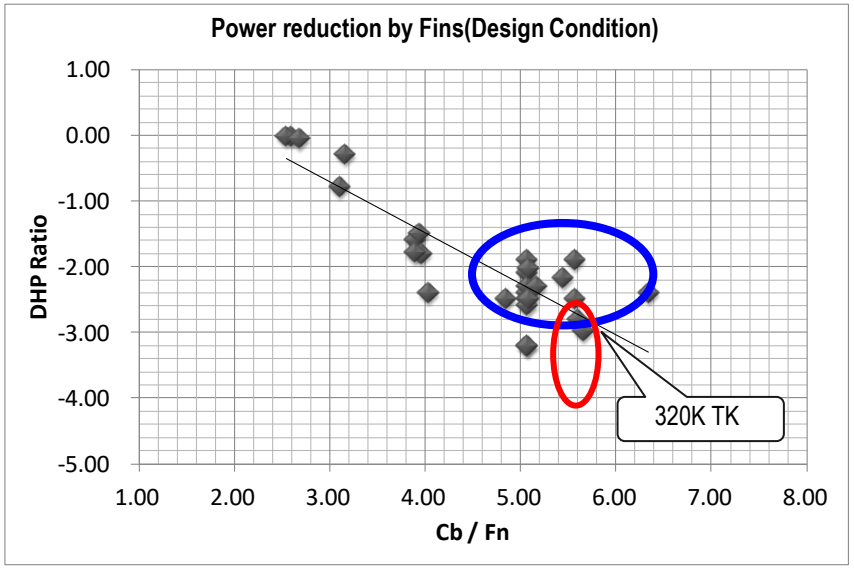
Item	Saving Rate
Energy Fins	3~4%
Rudder Bulb	1~2%

4. Performance

☐ 320K COT(NITC, 'Marbat') : 3 % Saving

※ Delivered in 2008





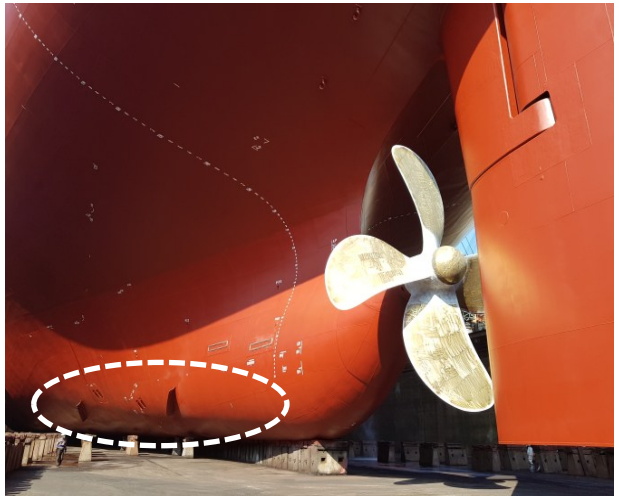
▪ Main dimensions

Item	Dimension
Capacity	320K
LBP/LOA	319/330
Breadth	60.0
Depth	30.5
Draft	21/22.5

▪ Expected of Power Saving

Item	Saving Rate
Energy Fins	3~4%
Rudder Bulb	1~2%

4. Performance



▪ Expected Power Saving

Vessel	Item	Saving Rate
180K Bulk Carrier	Energy Saving Fin	3~4%
	Rudder Bulb	1~2%
320K COT	Energy Saving Fin	3~4%
	Rudder Bulb	1~2%

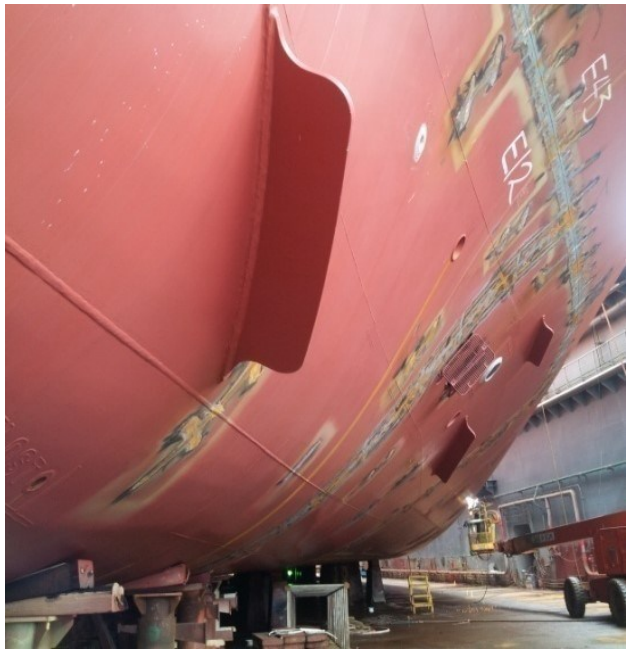
▪ Expected Payback Time

Daily FOC (450 USD 기준)	Payback Time
30ton/DFOC	abt. 0.9 year
70ton/DFOC	abt. 0.4 year
110ton/DFOC	abt. 0.2 year

5. Reference

■ How many times have you applied this tech.?

- Energy Saving Fins : Over 150 vessels
- Rudder Bulb : Over 60 vessels



6. Verification

- Company “P” installation VLOC 4 vessels, 2014
- Comparison of F.O.C

Item	RPM	Vs	ME F.O.
Before Re-Dock	60.4	13.0	56.8
After Re-Dock	60.2	13.0	46.7

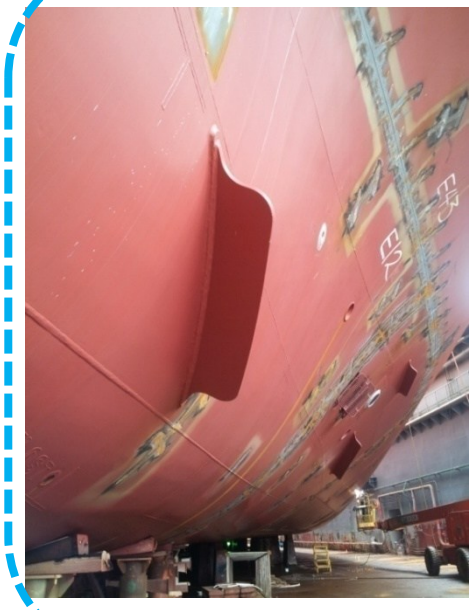
- **Improvement of hydrodynamic performance for each item**
  : Quote company “P” report

	Silicon Paint (hull)	Silicon Paint (propeller)	Engine Maintenance	ESF
Reduction of FOC (%)	8%	1.5%	3.5%	4.9%

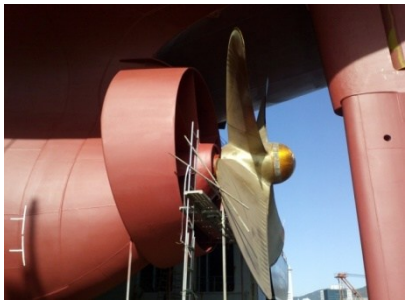
■ Energy Saving Devices for MR Tanker

- Hull Form & Propeller designed by SHI

■ Saving Fins & Rudder Bulb



■ M--- Duct(BMS)



6. Verification

▪ Speed Performance

Speed		Saving Fin + Rudder Bulb	M duct
Model Test	w/o ESD	Base	←
	w/ ESD	4% Power Saving	3.8% Power Saving
	Tester	SSMB	SVA(Potsdam Model Basin)
Sea Trial	w/ ESD	7.5 % Power Saving	1.0% Power Saving

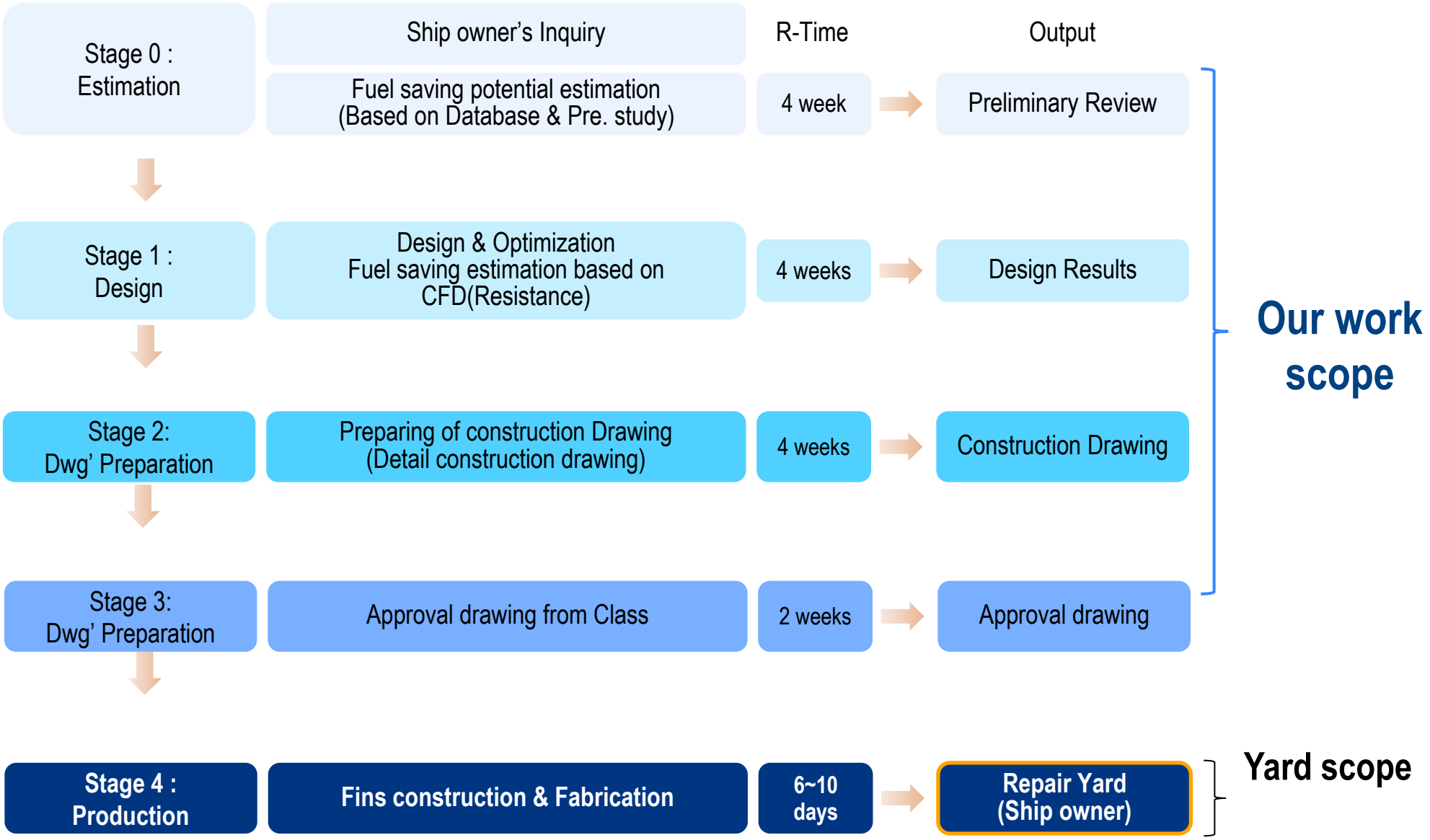
▪ Results of RPM Margin

RPM	Saving Fin + Rudder Bulb	M duct
Main engine at NCR	Base	Base
Sea Trial	5.0% margin	1.2% margin

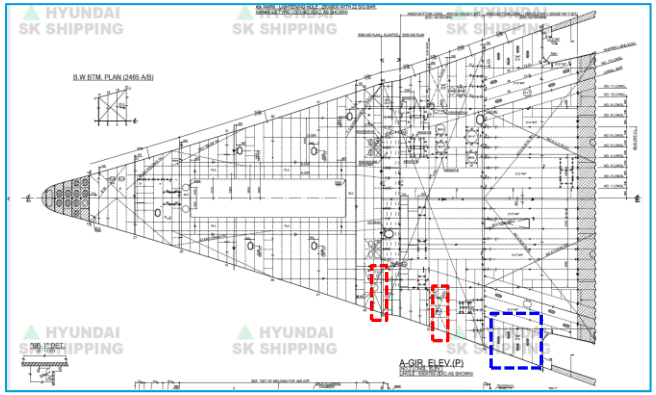
6. Verification

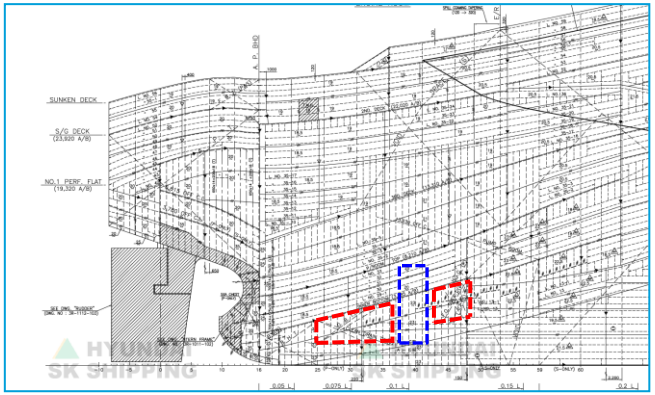
	Ship type	Condition	ESF	M**** DUCT	Data source
New building	35 K Case 1	Model	4.0 % (with Bulb)	3.8 %	Internal shipyard report
		Sea trial	7.5 % (with Bulb)	1.0 %	
		At Design	4.0 % (with Bulb)	3.8 %	Model test
	150 K Case 2	Model	4.0 % (with Bulb)	3.3 %	Internal shipyard report
		Sea trial	5.3 % (with Bulb)	2.2 %	
		At Design	4.2 % (with Bulb)	3.4 %	
Exist vessel (Exception Rudder bulb)	150 K Case 3	Sister vessel Comparison	4.5 %	-	Ship owner internal report
		(Remark)	- Comparison of navigation 150K 3 vessles data (Korea to Australia) - 2 ships have 9.2% effect after drydock and ESF installed ships have improved performance by 13.9%.		
	VLOC Case 4	Exception of Drydock impact	4.9 %	-	Ship owner internal report
	VLCC Case 5	HHI build	Avg. 3 %	-	Ship owner internal report
		China build vessel	AVG. 7 %	-	

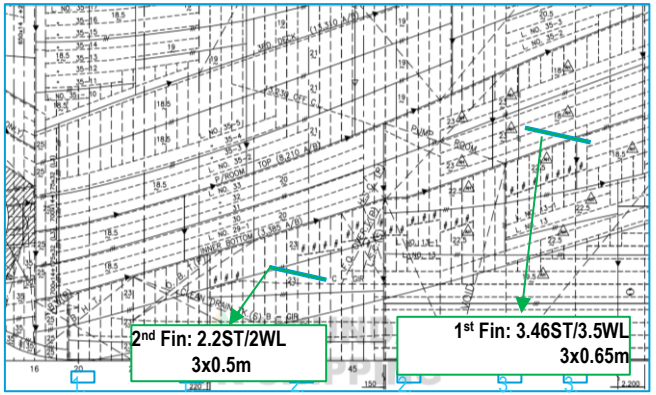
7. Retrofit scheme – processing schedule

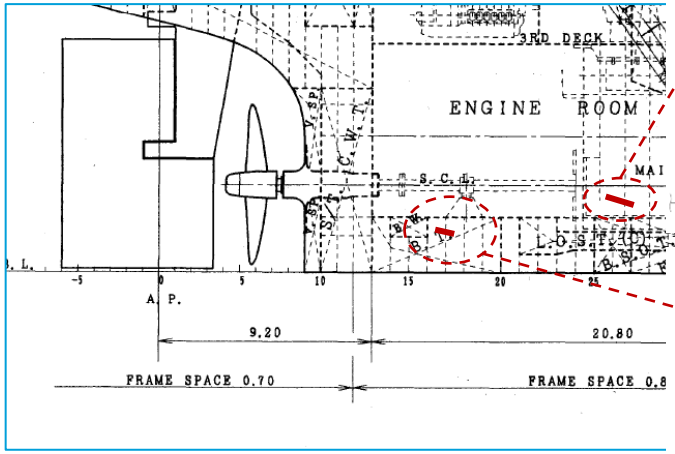


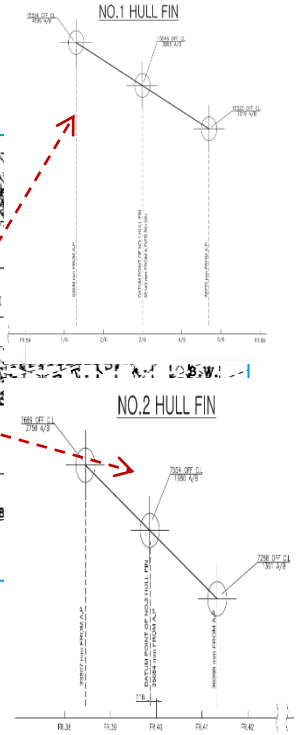
7. Retrofit scheme - example

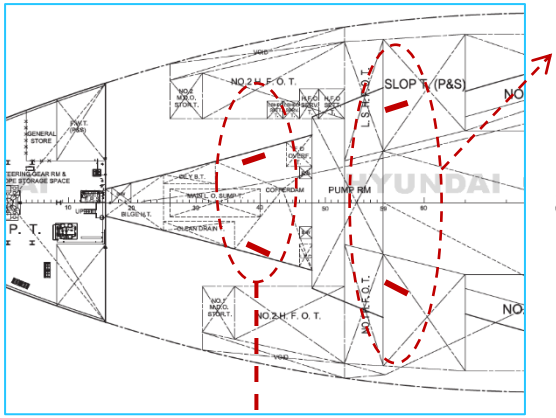


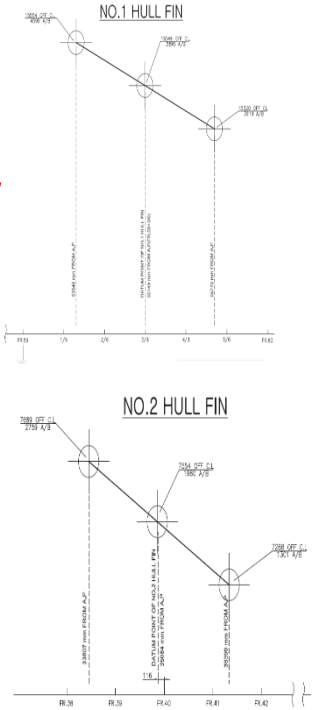












Conclusion

- Simple and efficient fuel saving equipment suitable for operating ships. ESF devices provided by our company are highly recommended as work air, price-effectiveness, and risk-free optimization technologies.

- As a technology that aims to reduce resistance and improve propulsion efficiency by controlling water streamlines, so many times of model tests and multiple streamline verifications have been completed along with a six-year or more development period.

- Unlike conventional ESD equipment that has an effect on predetermined speed and flow, the effect of our ESF is less variable and the performance is maintained.

- The simple structure is visually simple, but if it is not supported by accurate evaluation and experience, it is important to be cautious about similar technologies as they act as resistance.

- We're working with the source development team to create a Ph.D. personnel who have been in charge of PM many times.

- To generate customer benefits through increased fuel and energy effectiveness of ships.
  I'm becoming a professional company for it.

Thank you so much…