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Research on Ship URN Technology in KOREA

(Ship EE-URN improvement device : KRISO Vortex Generator)

2023. 9. 18.

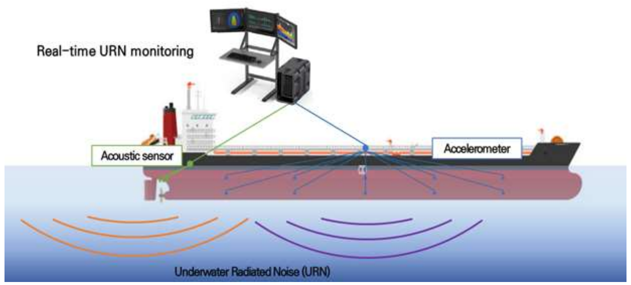
Korea Research Institute of Ships and Ocean Engineering (KRISO)

Hanshin Seol

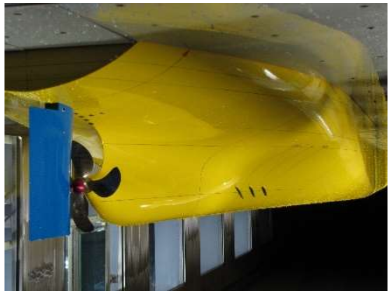
KRISO 선박해양플랜트연구소 KOREA RESEARCH INSTITUTE OF SHIPS & OCEAN ENGINEERING

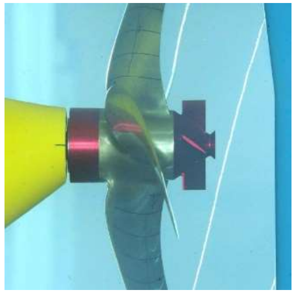
Research on Ship URN in Korea

- The IMO has set a goal for net zero GHG emission by 2050, and is putting an effort to reduce GHG by introducing mandatory measures and indices EEDI, SEEMP, EEXI and CII.
- In the meantime, discussions were underway to address and minimize adverse impacts of underwater radiated noise from shipping.
- After the 2014 URN guidelines were published, KRISO has been developing URN-related technologies, including numerical prediction, model scale and full scale URN test.
- In these days, more attention has been paid to the URN, especially from shipyards, and the need for developing relevant technologies has been increasing.
- A national project was launched in Korea, which focused on developing URN monitoring and mitigation methods.



Ship URN monitoring based on on-board sensor





Ship URN mitigation method

Korea Ship URN Research Project

- Project title: Development of Ship underwater noise monitoring and noise reduction technology
- Project duration: 42 months (Jul. 2020 ~ Dec. 2023)
- Budget: $ 4.3M (funded by Korea Government and co-funded by industrial participants)
- Coordinator: Dr. Hanshin Seol, Korea Research Institute of Ships and Ocean Engineering

Participants

KIOST

HD한국조선해양

부산대학교 PUSAN NATIONAL UNIVERSITY

Project leader

KRISO 한국해양과학기술원 부설 선박해양플랜트연구소 KOREA RESEARCH INSTITUTE OF SHIPS & OCEAN ENGINEERING

Industrial partners

HD현대중공업

현대미포조선

Hanwha Ocean

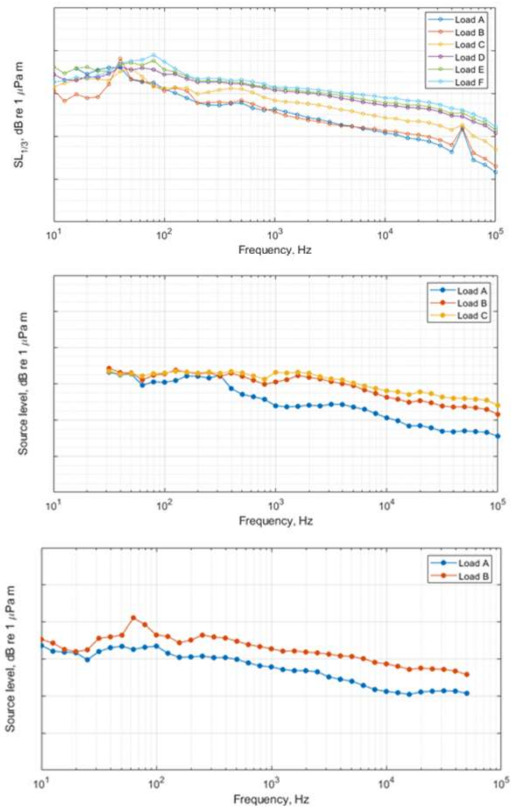
SAMSUNG HEAVY INDUSTRIES

HMM

Project objectives & Results #1

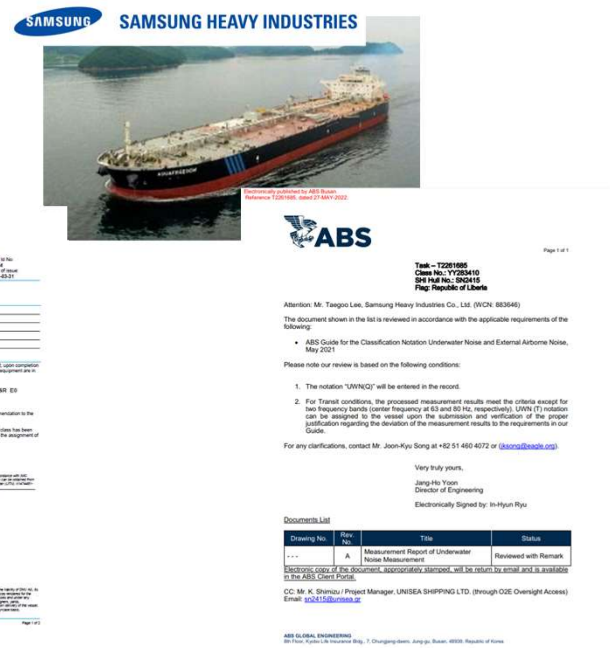
Identification of current underwater radiated noise level from ships

- Full scale underwater radiated noise measurements for various type ships (measured with ISO standard)
- Class Societies' URN notation awarded (DNV SILENT-E notation, ABS UWN(Q) notation…)



Measured URN

DNV Silent-E Notation

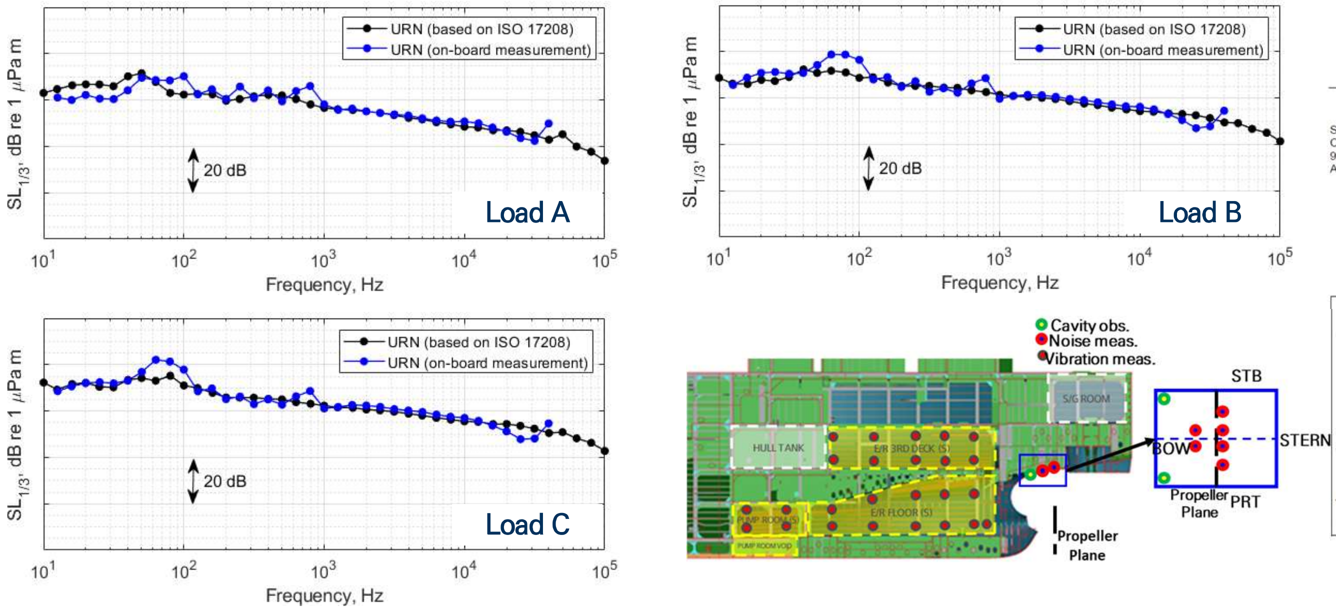


ABS UWN(Q) notation

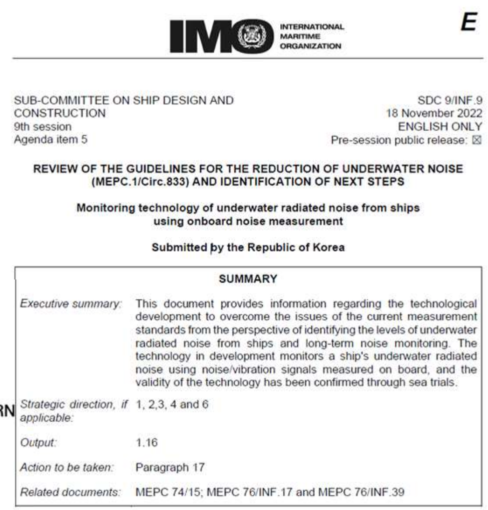
Project objectives & Results #2

Development of a ship URN monitoring method using on-board sensors

- Estimation of underwater radiated noise using on-board noise and vibration signals
- Comparison and validation of the method with measured URN following ISO standard
- Generally good agreement at all load conditions
- More validation measurements should be followed to ensure the reliability
- The results of this technology were registered as an information document at the 9th SDC meeting



Comparison between measured URN & Estimated URN using on-board signals



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SUB-COMMITTEE ON SHIP DESIGN AND CONSTRUCTION
9th session
Agenda item 5

SDC 9/INF.9
18 November 2022
ENGLISH ONLY
Pre-session public release: ☒

REVIEW OF THE GUIDELINES FOR THE REDUCTION OF UNDERWATER NOISE (MEPC.1/Circ.833) AND IDENTIFICATION OF NEXT STEPS

Monitoring technology of underwater radiated noise from ships using onboard noise measurement

Submitted by the Republic of Korea

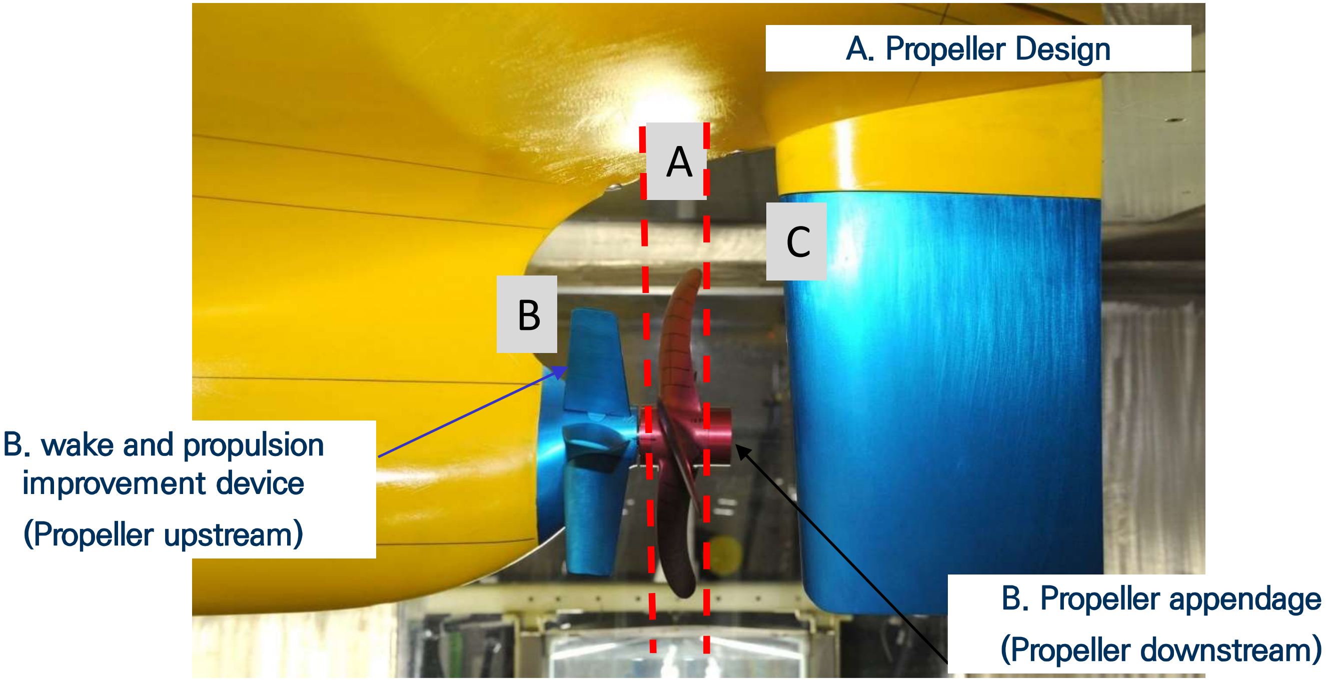
SUMMARY	
Executive summary:	This document provides information regarding the technological development to overcome the issues of the current measurement standards from the perspective of identifying the levels of underwater radiated noise from ships and long-term noise monitoring. The technology in development monitors a ship's underwater radiated noise using noise/vibration signals measured on board, and the validity of the technology has been confirmed through sea trials.
Strategic direction, if applicable:	1, 2,3, 4 and 6
Output:	1.16
Action to be taken:	Paragraph 17
Related documents:	MEPC 74/15; MEPC 76/INF.17 and MEPC 76/INF.39

INF. Doc. (SDC9)

Project objectives #3

Development of ship URN mitigation technology

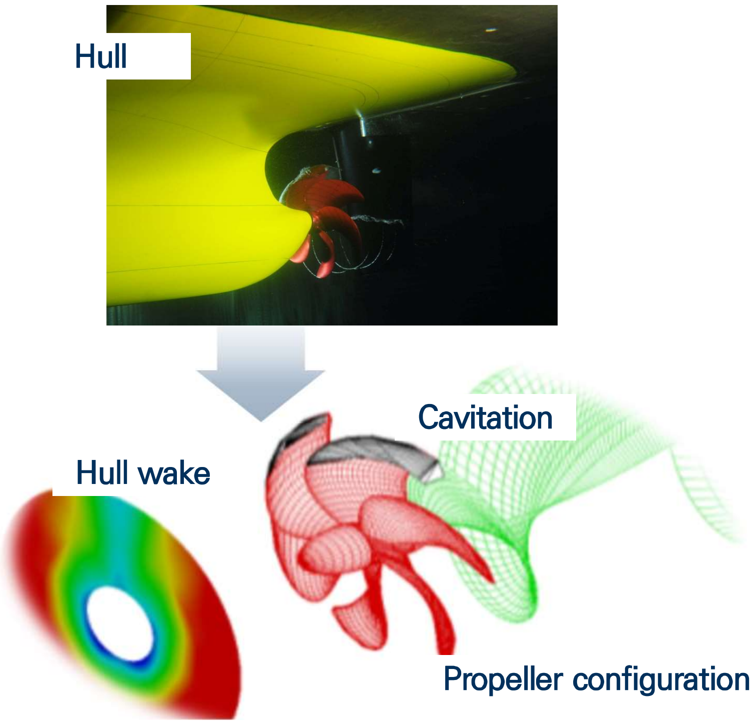
- Analysis of ship EE-URN relationship according to ship design perspective (propeller, ESD design..)
- Development EE-URN improvement device to improve energy efficiency and underwater radiated noise
- Performance evaluation at model and full scale measurements (test)

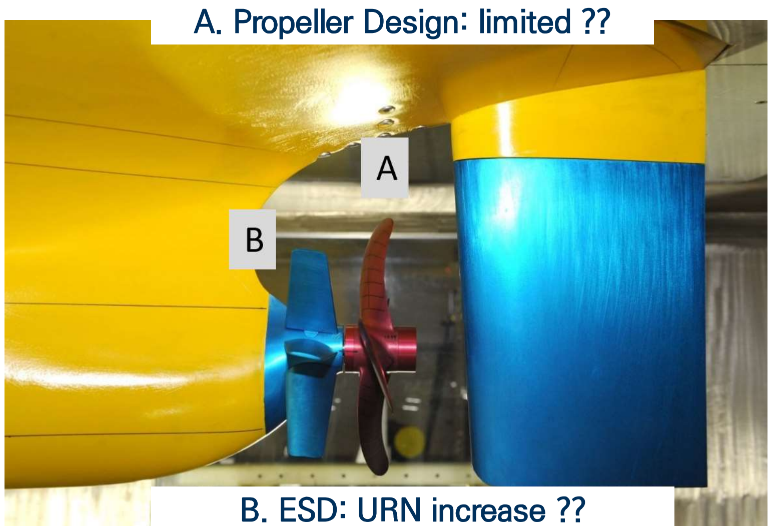


Noise Source of Ship URN

How to control Propeller cavitation: Propeller design or ESD ?

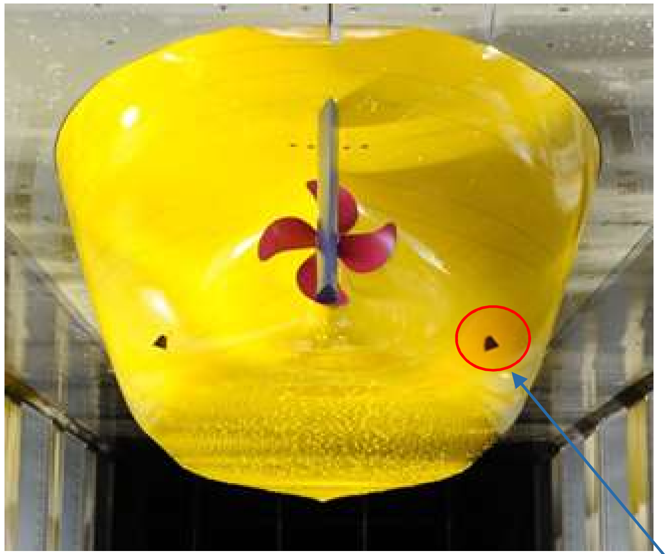
- Because the propeller operate behind the vessel, propeller cavitation is affected by the hull wake and propeller geometry
- To reduce ship's URN, one has to improve the propeller geometry or hull wake
- Reducing URN by changing the propeller design would be limited
- ESD designed from the perspective of propulsion efficiency generally increase the URN by increasing the propeller loading

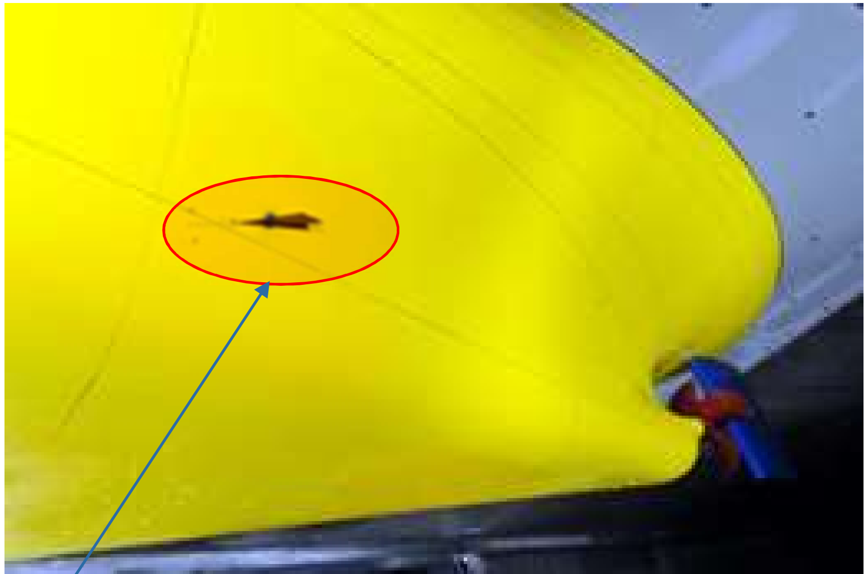




Vortex generator as an URN Reduction Device

- In the shipbuilding industry (ship design), V.G. is being used as a propeller inflow improvement device when excessive hull vibration or propeller erosion occurs due to excessive propeller cavitation
- This means that V.G. can reduce the underwater radiated noise
- However, there is a reduction of 2–3% in propulsion efficiency, which makes shipowners and shipyards avoid using them

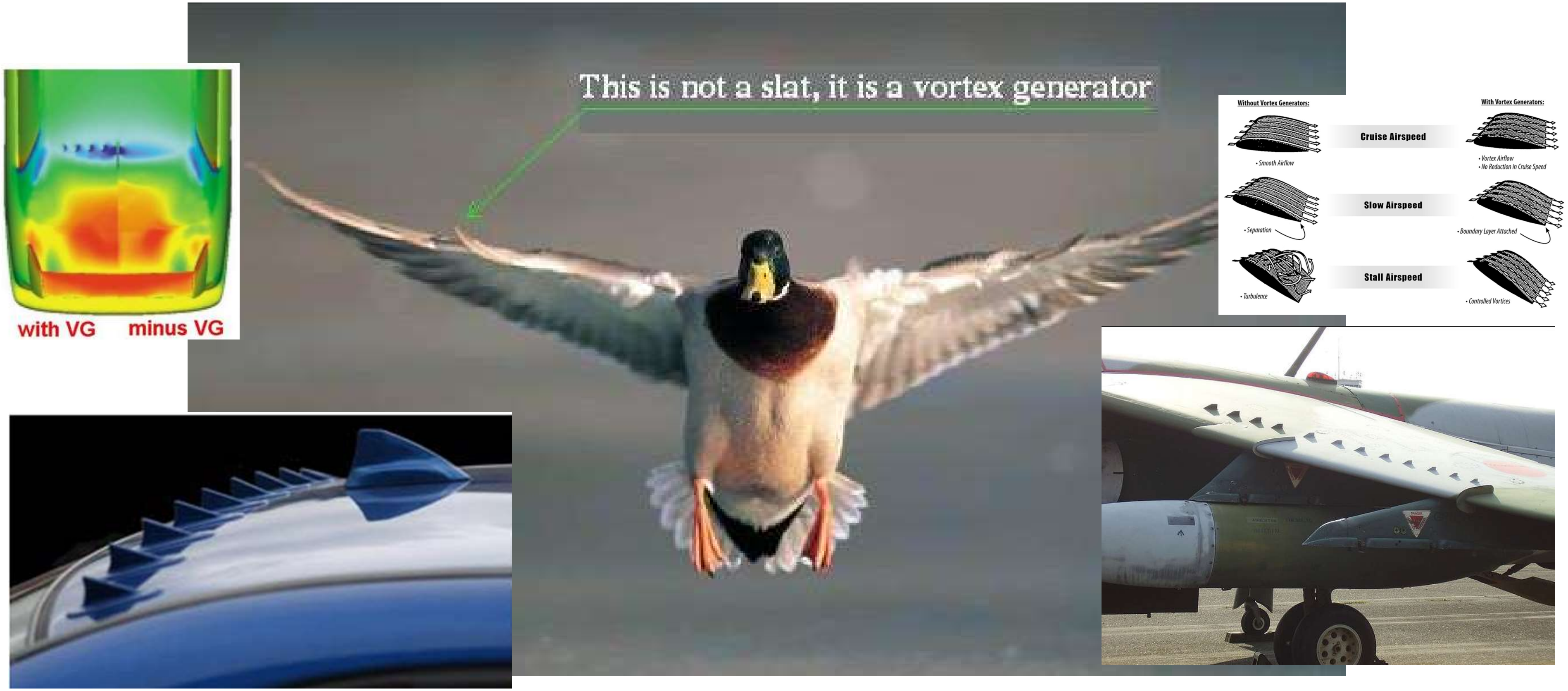




Vortex Generator model test (KRISO, 2014)

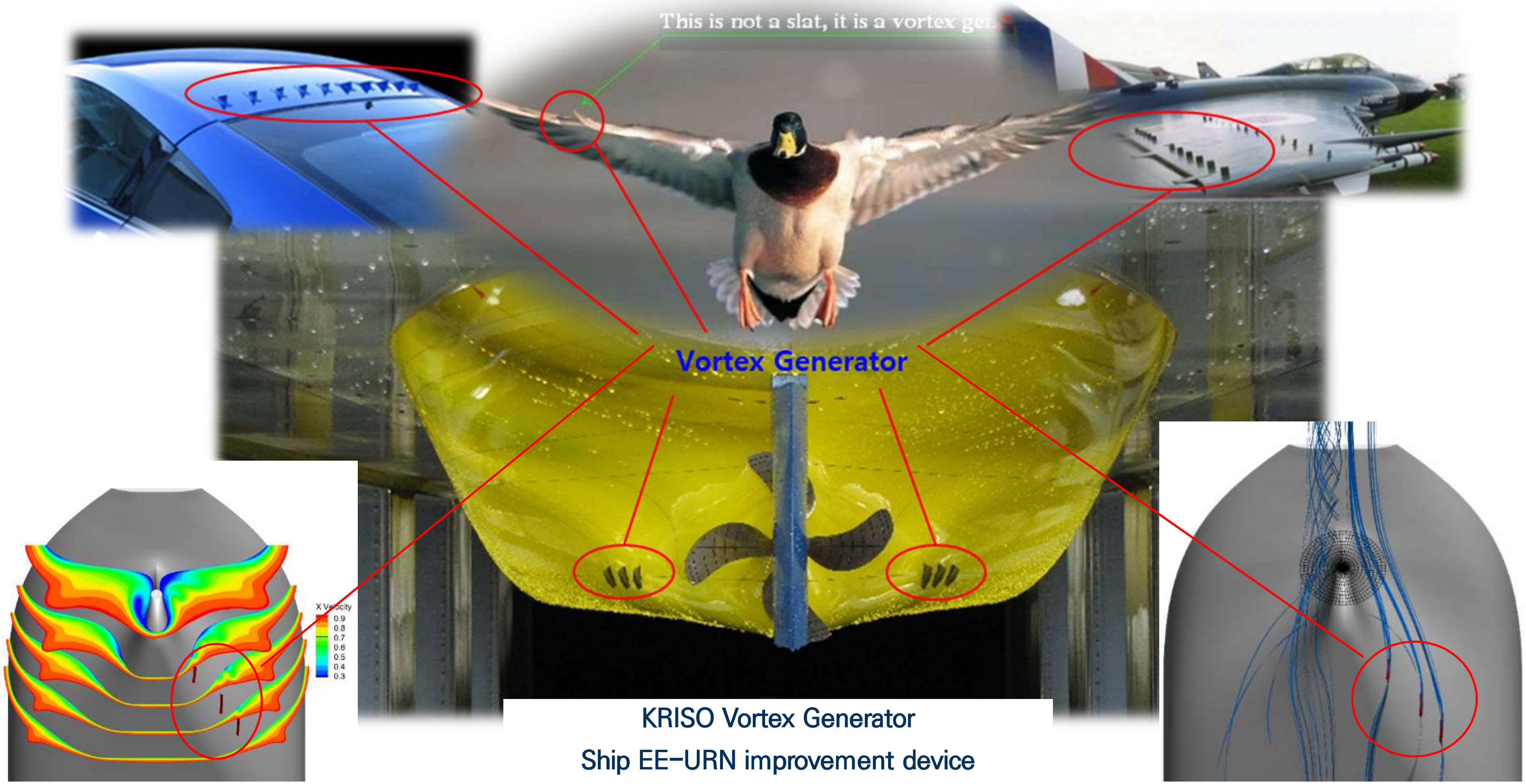
Vortex generator as an Energy Saving Device

- In nature, birds have vortex generators which helps to increase the lift of the wing.
- In aviation and motor industries, vortex generators are used as high lift device or decrease the drag force



Vortex generator as an EE-URN improvement device

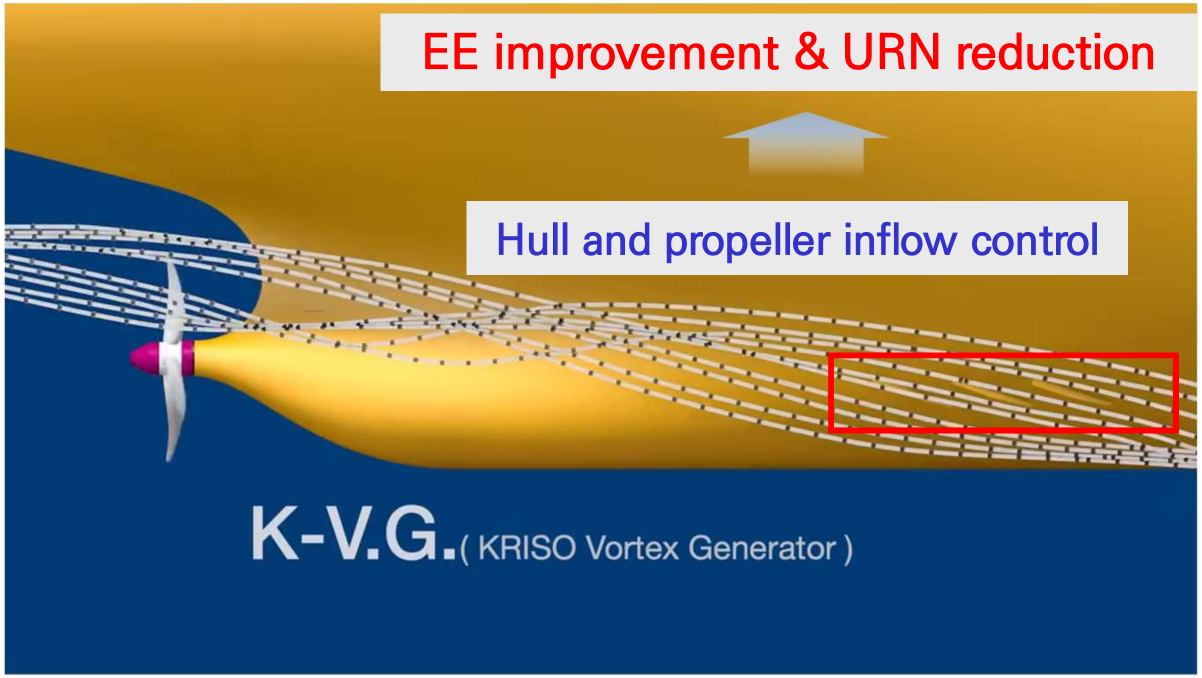
- K-V.G.: Combination of wake improvement and energy saving

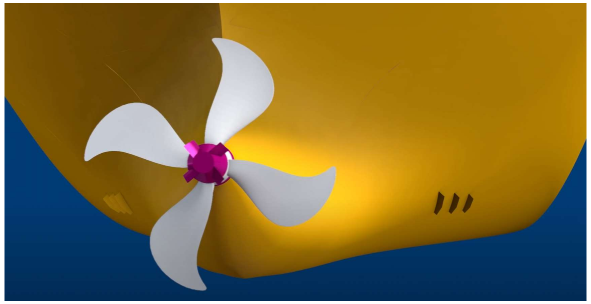


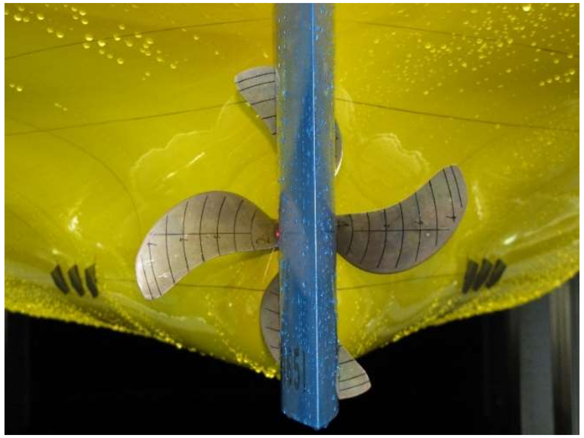
KRISO Vortex Generator
Ship EE-URN improvement device

Technology concept

- Increase the energy efficiency by reducing the hull resistance
- Reduce and improvement propeller cavitation characteristics and its noise by controlling the inflow wake

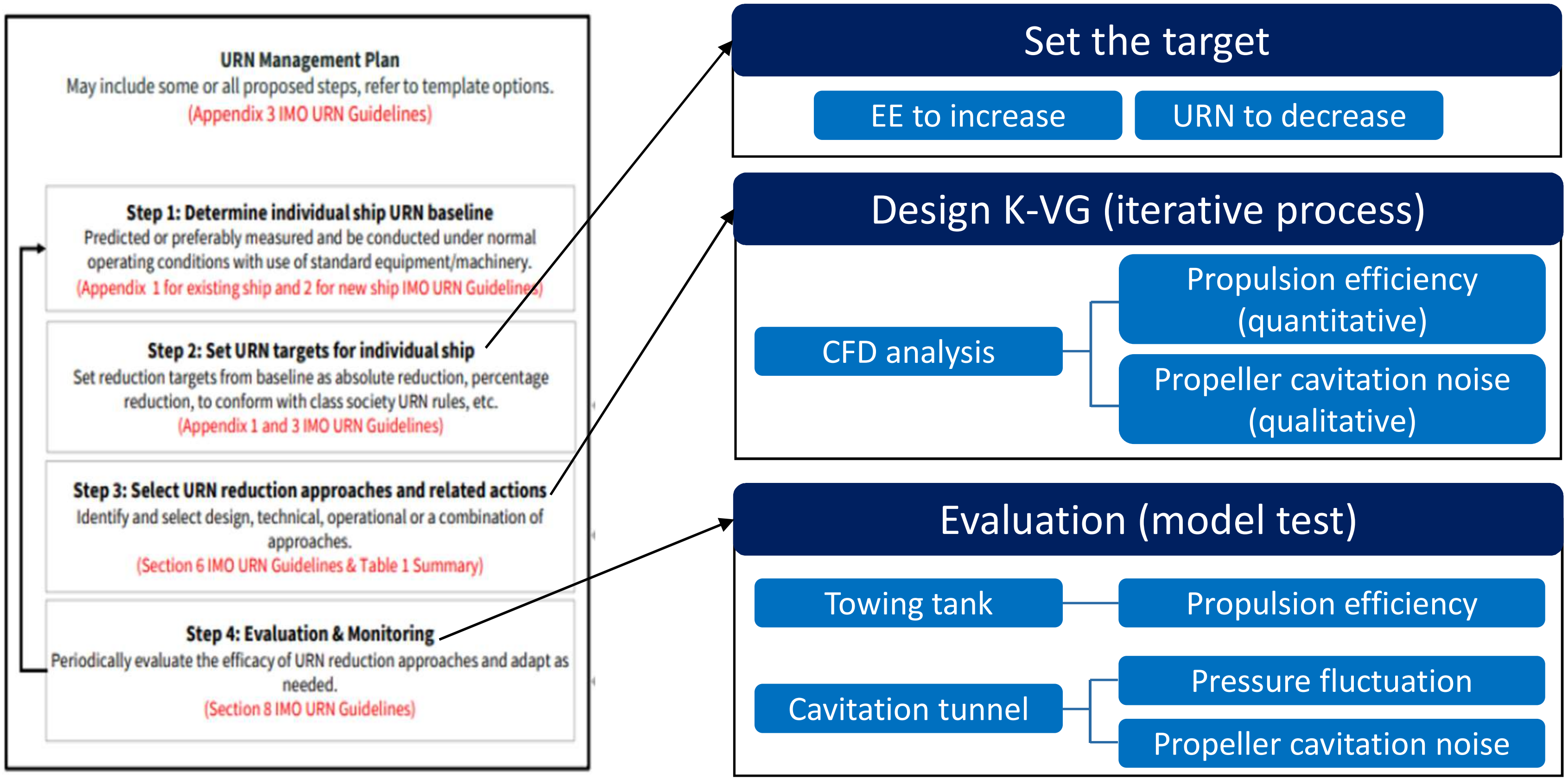






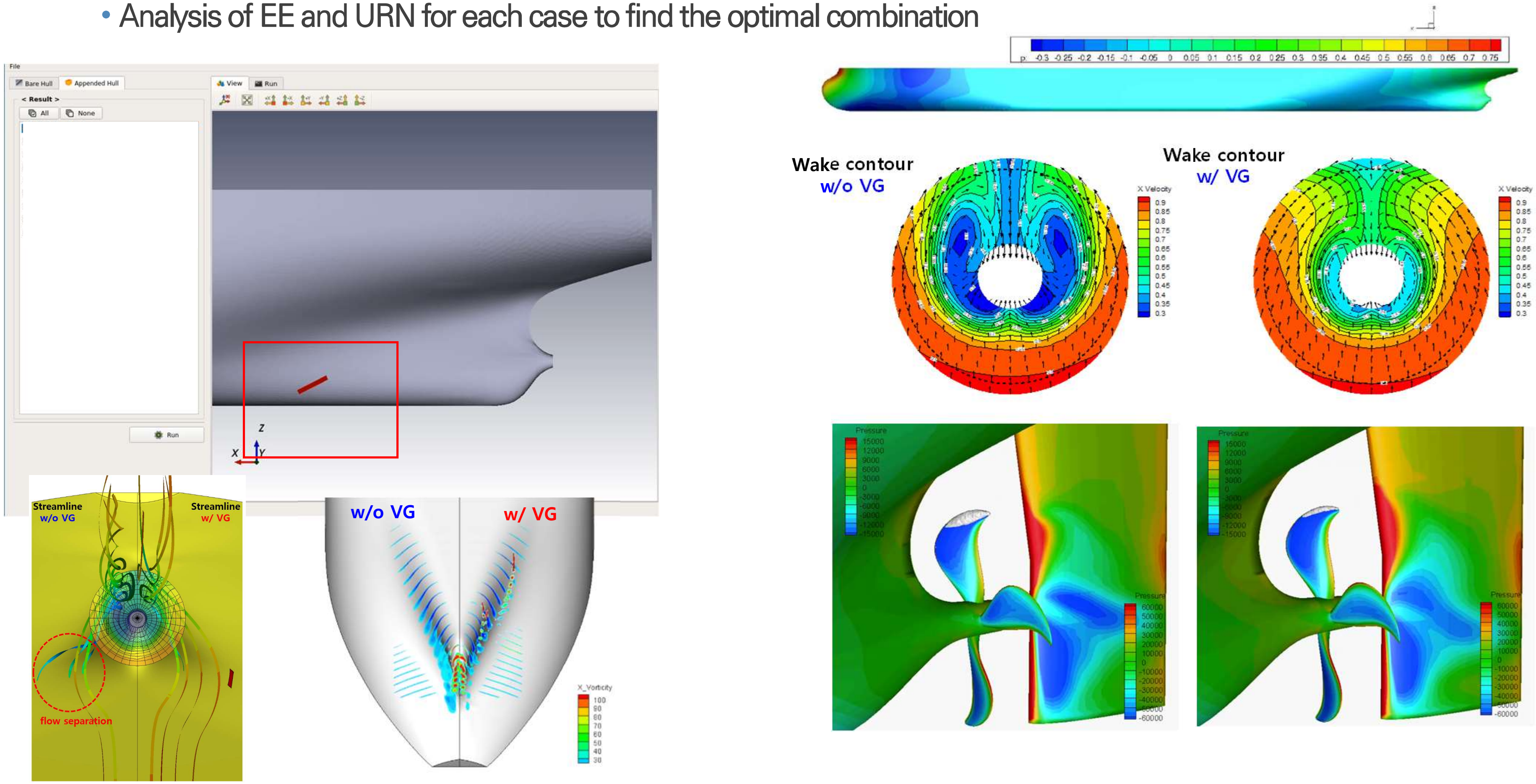
K-V.G. Design & verification process: similar to URNMP

- The EE and URN targets are weighted depending on the designer's purpose
- Ship propeller noise can also be estimated numerically



K-VG design Process

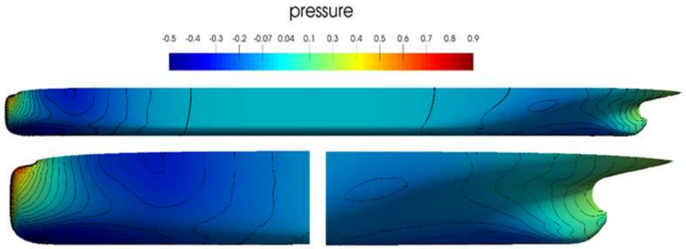
- Numerical simulation to determine position, size, angle, geometry and the number of VGs
- Analysis of EE and URN for each case to find the optimal combination

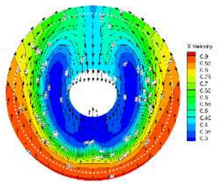


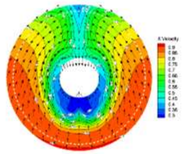
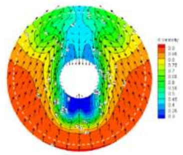
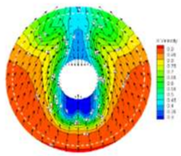
K-V.G. Design process & performance evaluation

K-V.G. Design & EE-URN relation analysis

- Performance varies depending on the design of K-V.G. (URN-EE trade-off relationship)
- However, they can both be improved.





	K-VG designs	Wake distribution	EE Improvement	URN reduction
Case 1			2.8%/4.0% (Design/Ballast)	Large
Case 2			3.7%/5.3% (Design/Ballast)	Medium
Case 3			4.0%/5.7% (Design/Ballast)	Small (-3dB)

Final selection due to GHG regulation

KRISO Vortex Generator (K-V.G.)

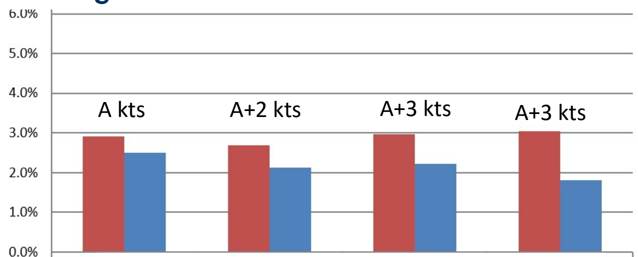
Performance Verification (VLCC built in '21)

Comparison of Energy efficiency & Cavitation pattern

- Design draft (EE): PSD 2.2%, K-VG 3.0% improvement @ design speed
- Ballast draft (EE): PSD 4.4%, K-VG 5.8% improvement @ design speed

BHP savings

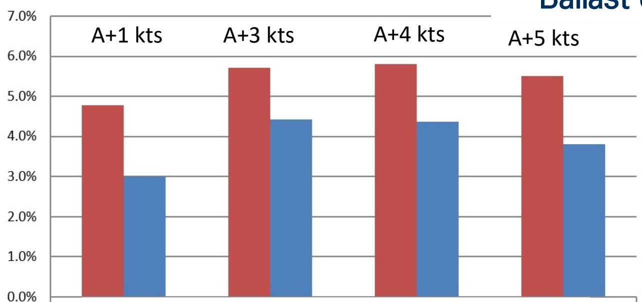
Design draft



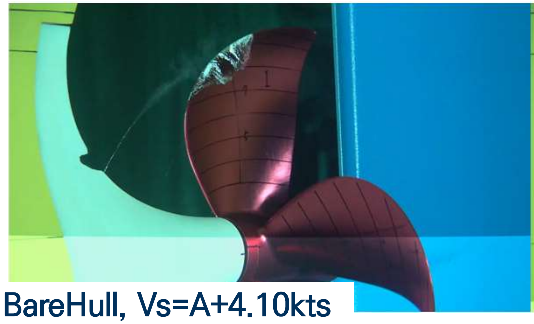
K-VG/Bare	2.9%	2.7%	3.0%	3.0%
Duct/Bare	2.5%	2.1%	2.2%	1.8%

BHP savings

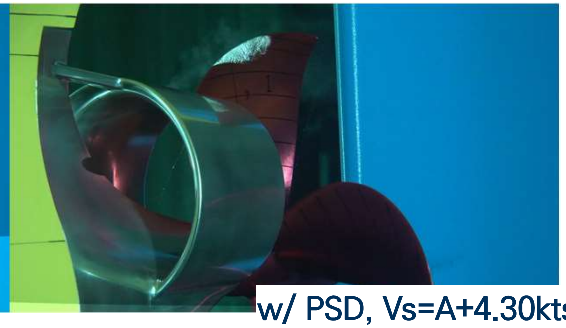
Ballast draft



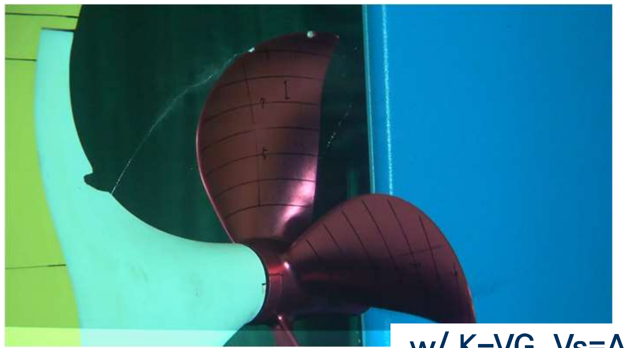
K-VG/Bare	4.8%	5.7%	5.8%	5.5%
Duct/Bare	3.0%	4.4%	4.4%	3.8%



BareHull, Vs=A+4.10kts



w/ PSD, Vs=A+4.30kts



w/ K-VG, Vs=A+4.37kts

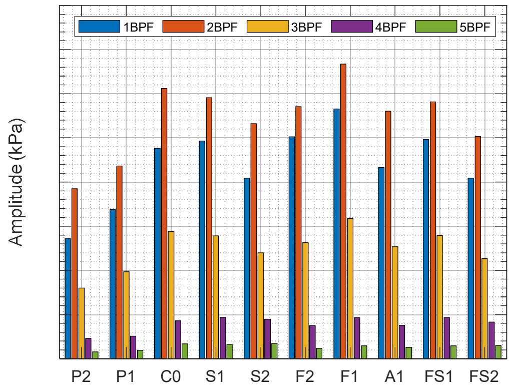
Ballast draft load condition

KRISO Vortex Generator (K-V.G.)

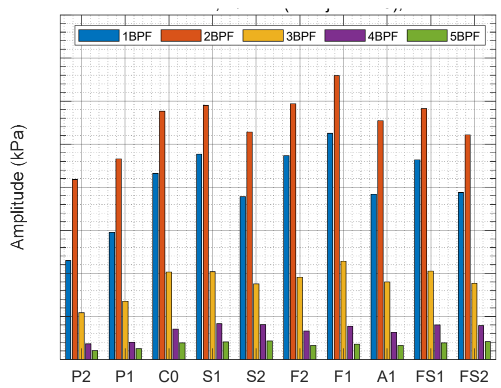
Performance Verification (VLCC built in '21)

Comparison of Hull pressure fluctuation & Propeller noise

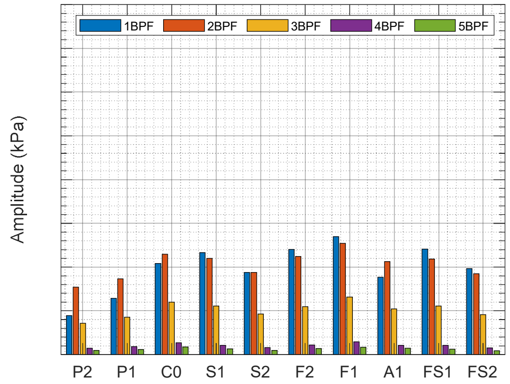
- URN & Hull pressure fluctuation is dramatically reduced.



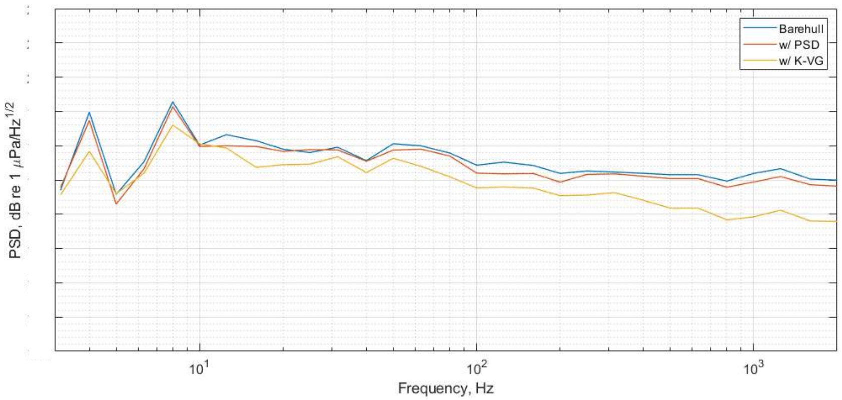
Bare Hull



w/ PSD



w/ K-V.G.



Propeller noise measurement

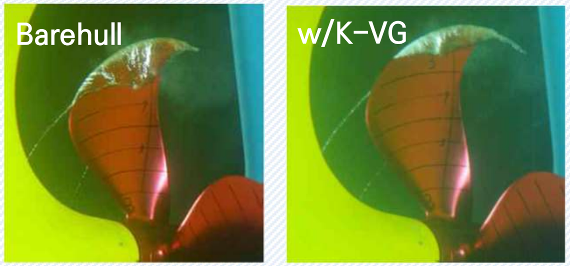
KRISO Vortex Generator (K-V.G.)

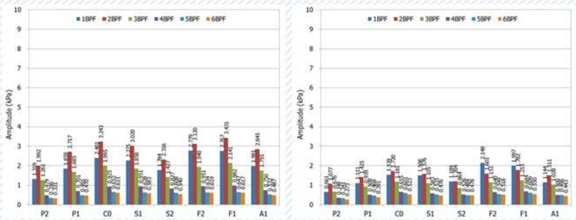
Performance Verification

- Model test were conducted in KRISO & Other research institute
- Improvement propulsion efficiency
- Improve propeller cavitation behavior by K-V.G. ➔ reduction of hull vibration & Noise

2~6% propulsion efficiency improvement at model test

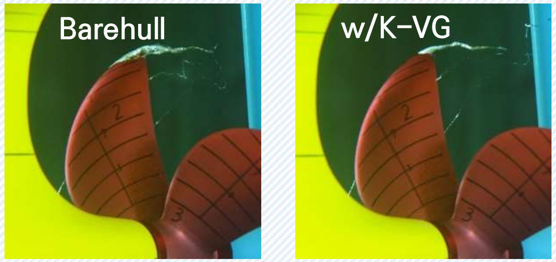
300K VLCC (K-V.G.)

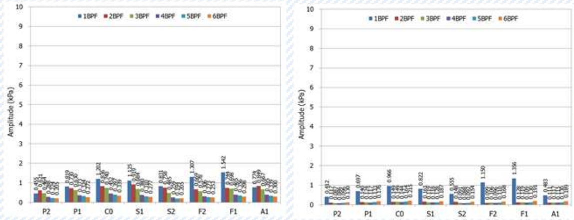




1.9% ~ 3.2%
Propulsion performance improvement

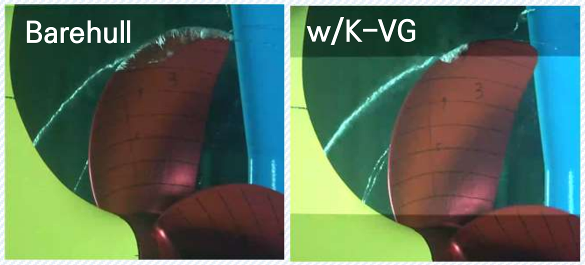
Aframax Tanker (K-V.G.)

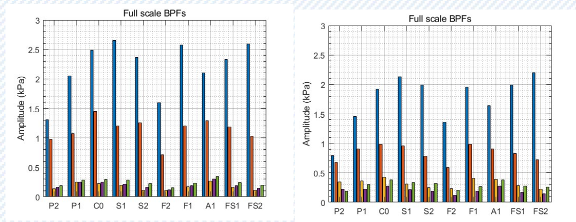




3.7% ~ 5.0%
Propulsion performance improvement

300K VLCC (K-V.G.)

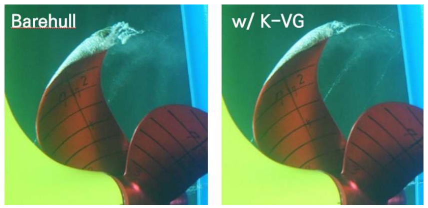
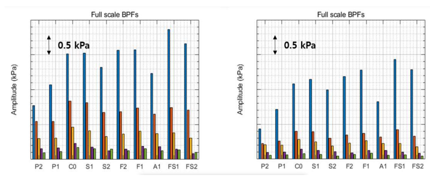
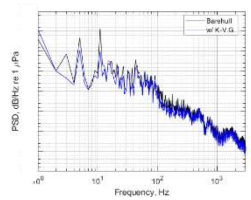
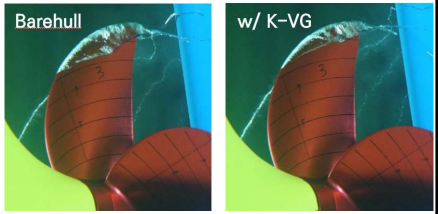
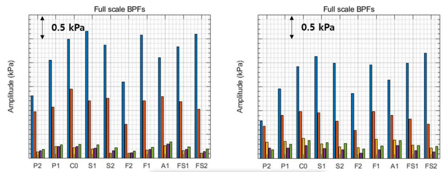
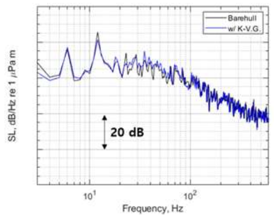
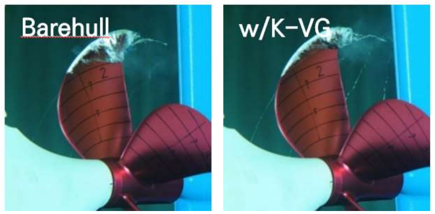
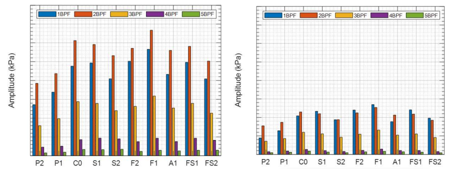
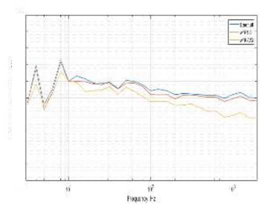




4.0% ~ 5.7%
Propulsion performance improvement

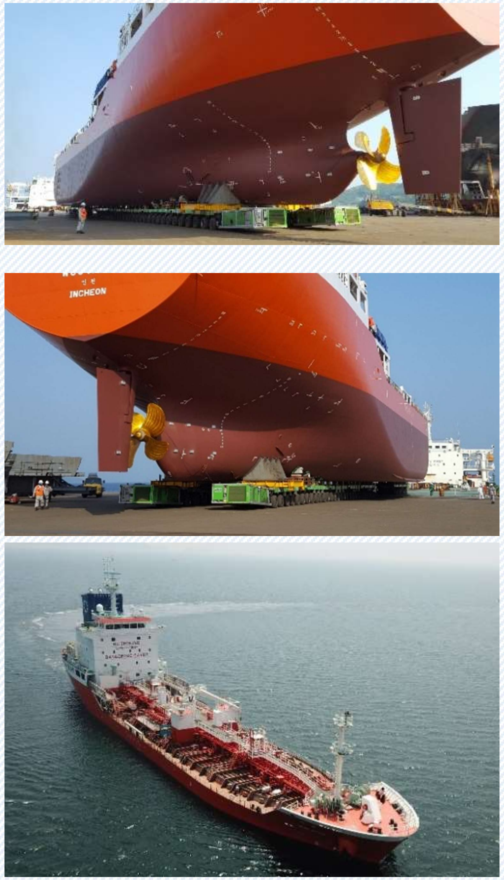
KRISO Vortex Generator (K-V.G.)

Performance Verification

Ship	Propeller Cavitation	EE Improvement	Hull Pressure Fluctuation	URN reduction
50K MR Tanker		1.0%/3.0 % (Design/Ballast)		
60K Bulk Carrier		4.0%/6.0% (Design/Ballast)		
300K VLCC		3.0%/5.8% (Design/Ballast)		

KRISO Vortex Generator (K-V.G.)

Installation K-V.G. on full-scale ship



Summary

Key takeaways

- In the shipbuilding industry, ship design was focused only on EE due to GHG emission regulations
- If we pay attention to EE-URN improvement technology, we will be able to reduce URN while improving EE
- K-V.G. could be an example

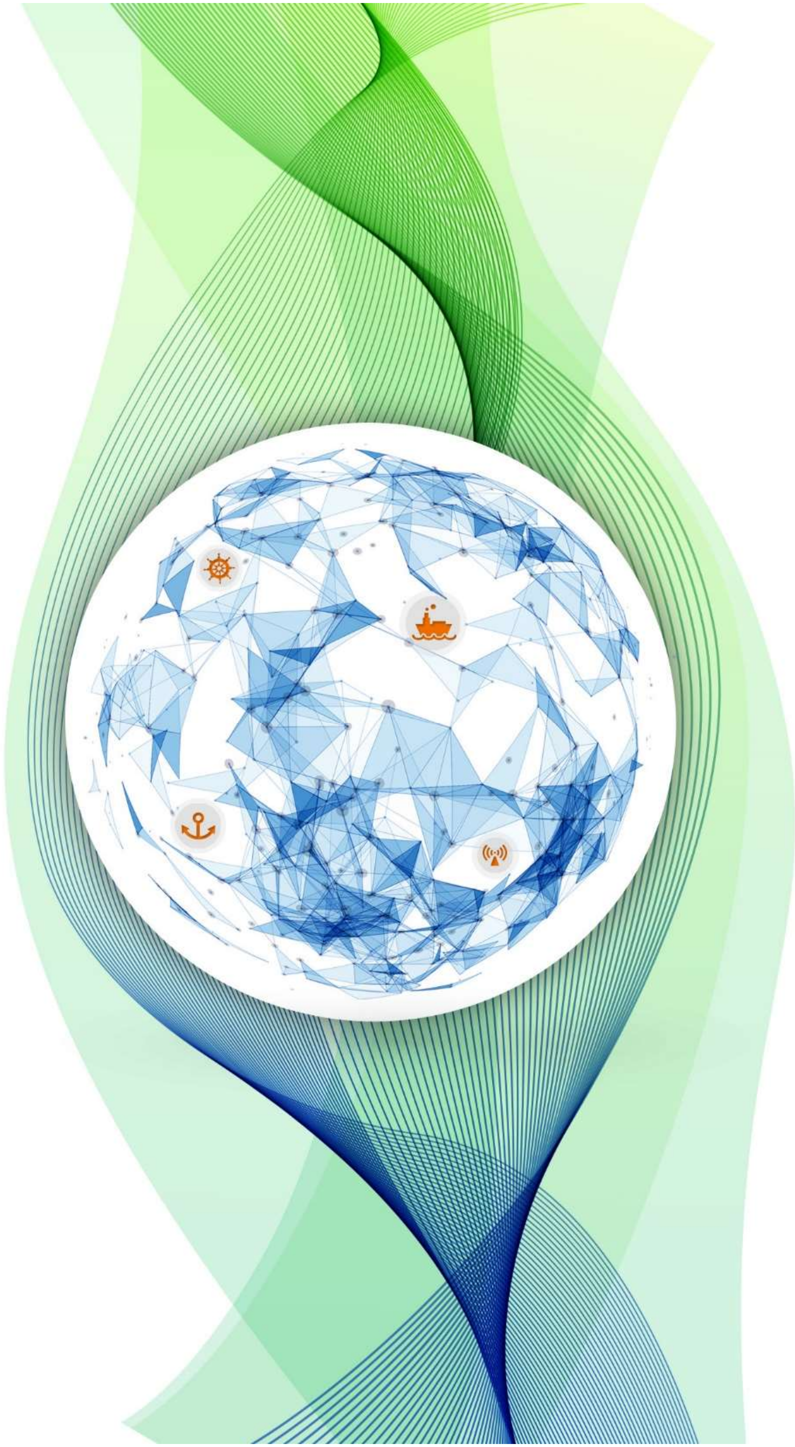
  : K-V.G. can improve URN and EE simultaneously

  : The performance of K-VG depends on its design concept: there may be a trade-off relationship between EE and URN.

Future work

- Full scale URN measurement w/ K-VG.
- Identification of other mitigation methods that improve both EE and URN

Thank you



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