🎤Keynote Speaker Spotlight: **Hyangan Hwang** (Andrew Hwang) – Advancing antifouling coating technology from a shipbuilding perspective

At the upcoming International Antifouling Conference 2025, we are thrilled to welcome Hyangan (Andrew) Hwang, Group Leader in Coating & Advanced Materials Research at Samsung Heavy Industries (SHI), as a keynote speaker. With over 25 years at marine coating sector, Andrew is a driving force behind testing and the development of sustainable antifouling solutions for highly efficient ships and shipyards.

What to Expect:
Topic: Sustainable Antifouling Coating Technologies for New-building Ships

Key Insights:
✅ Navigating recent regulatory challenges (HAPs, IMO, BPR, K-REACH) for marine coatings
✅ The newly-assigned roles of antifouling technologies in ship and shipbuilding industries
✅ Various attempts to strike a balance regulatory needs and technology development
✅ How partnerships between shipbuilders, coating manufacturers, and regulators are shaping the future of antifouling

As the maritime industry moves toward stricter environmental regulations and sustainability goals, Mr. Hwang´s session will provide invaluable insights into the challenges and solutions for future-proof coating applications during the shipbuilding process.

Join us to hear from one of the industry's most influential voices in research and development of sustainable shipbuilding and coating technology!

#IAC2025 #Antifouling #SustainableShipping #MarineCoatings

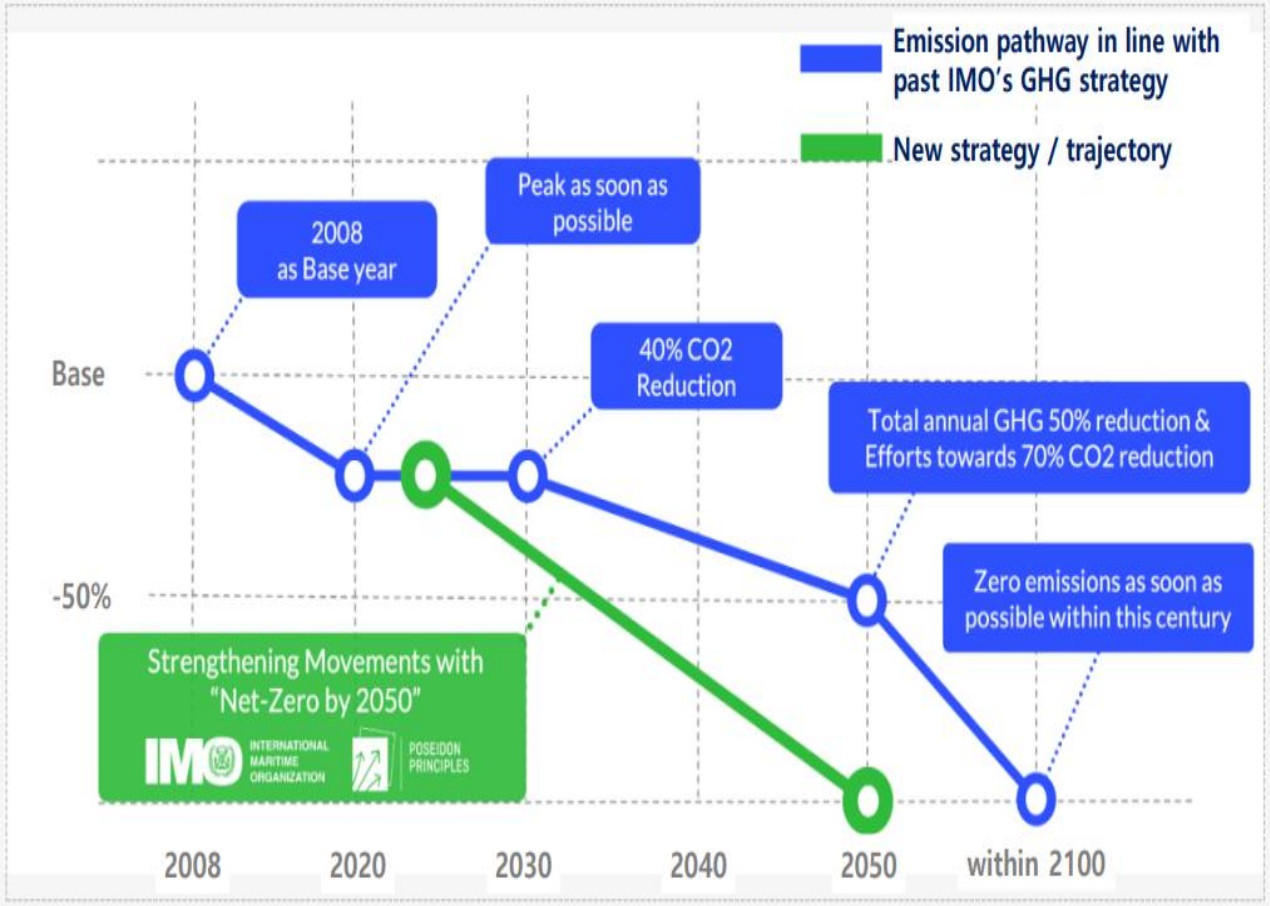
Sustainable Antifouling Coating Technology for New-building Ships

Andrew Hwang
Low-toxic AFC development TF Leader
SAMSUNG HEAVY INDUSTRIES

Contents

Background & Challenges

IMO's GHG Reduction Strategy

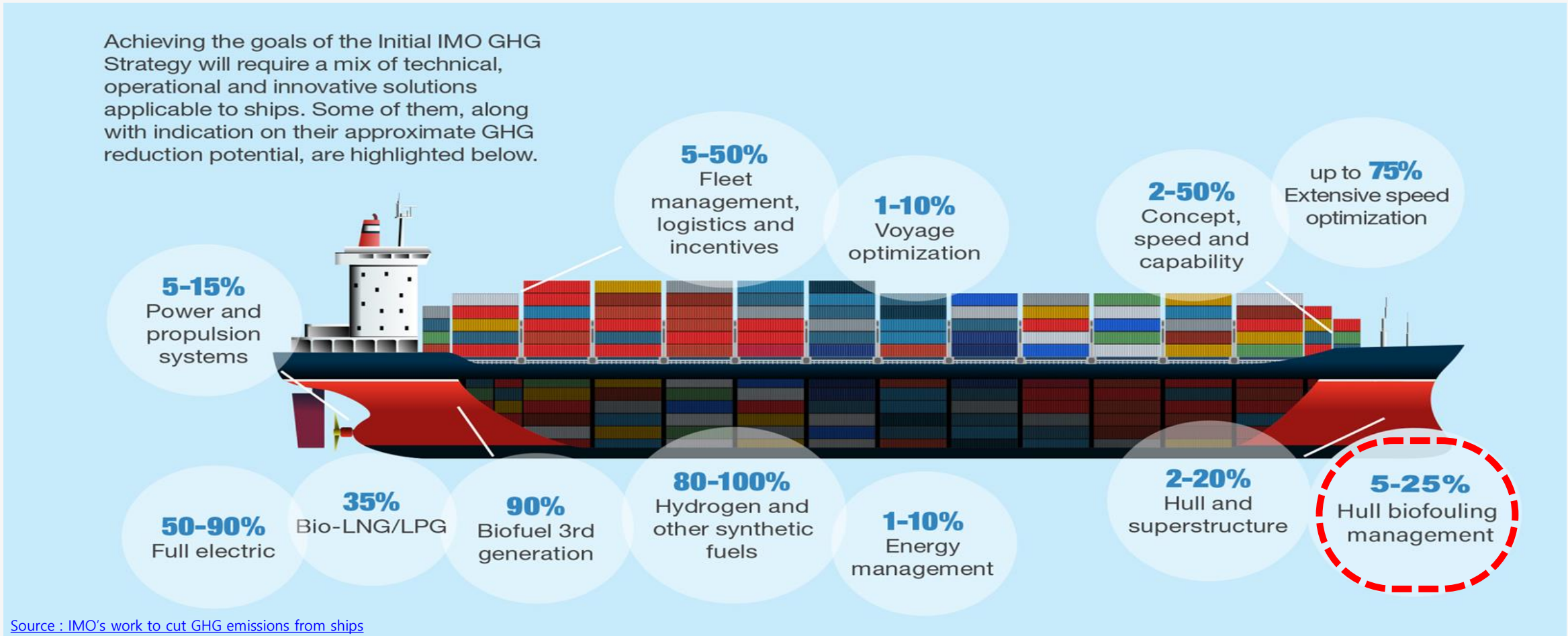


Ships' Environmental Regulation		'20	'22	'23	'25
New-building Ships	EEDI	Phase II (-20%)	Phase III (-30 ~ -50%) LNGC, Container Ship		Phase III (-30%) COT, Bulk Carrier
Existing Ships	EEXI			Ship's energy efficiency verification required (-15 ~ -50%) Ships of more than 400GT	
	CII			Rating from A to E according to energy efficiency Ships of more than 5,000GT	

Background & Challenges

Basic Roles of AFC in New-building Ships

Work to cut GHG emissions from ships by a wide variety of solutions

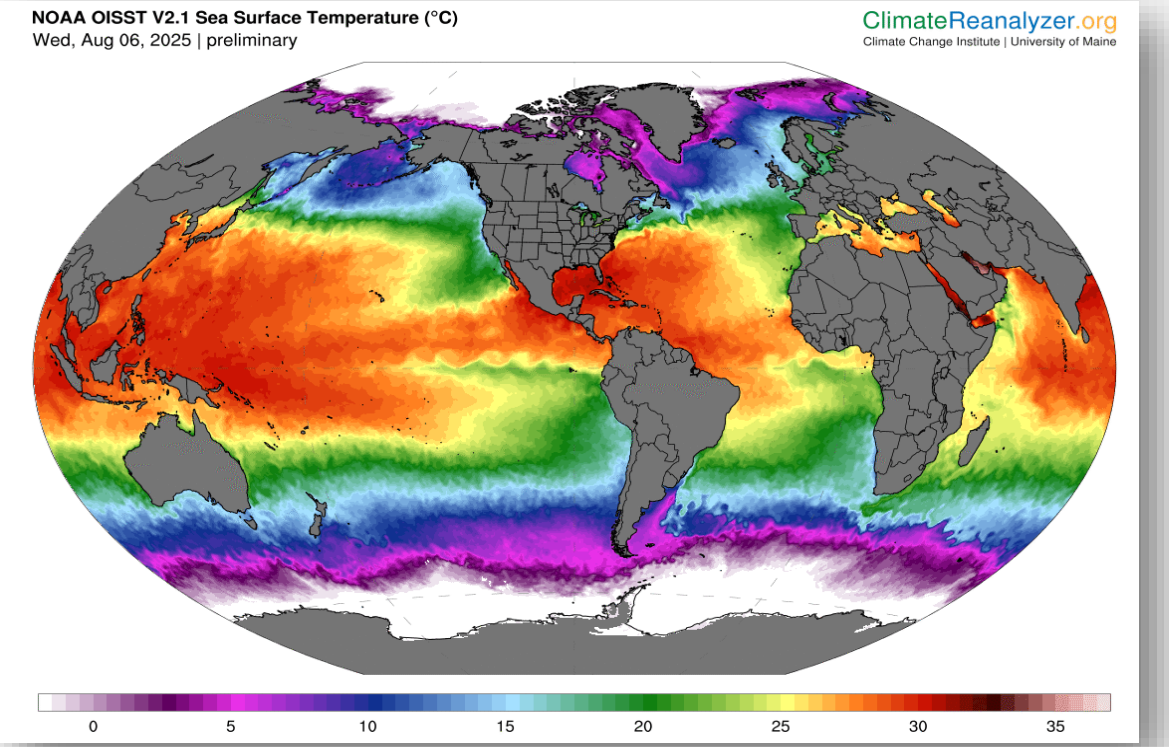


Source : IMO's work to cut GHG emissions from ships

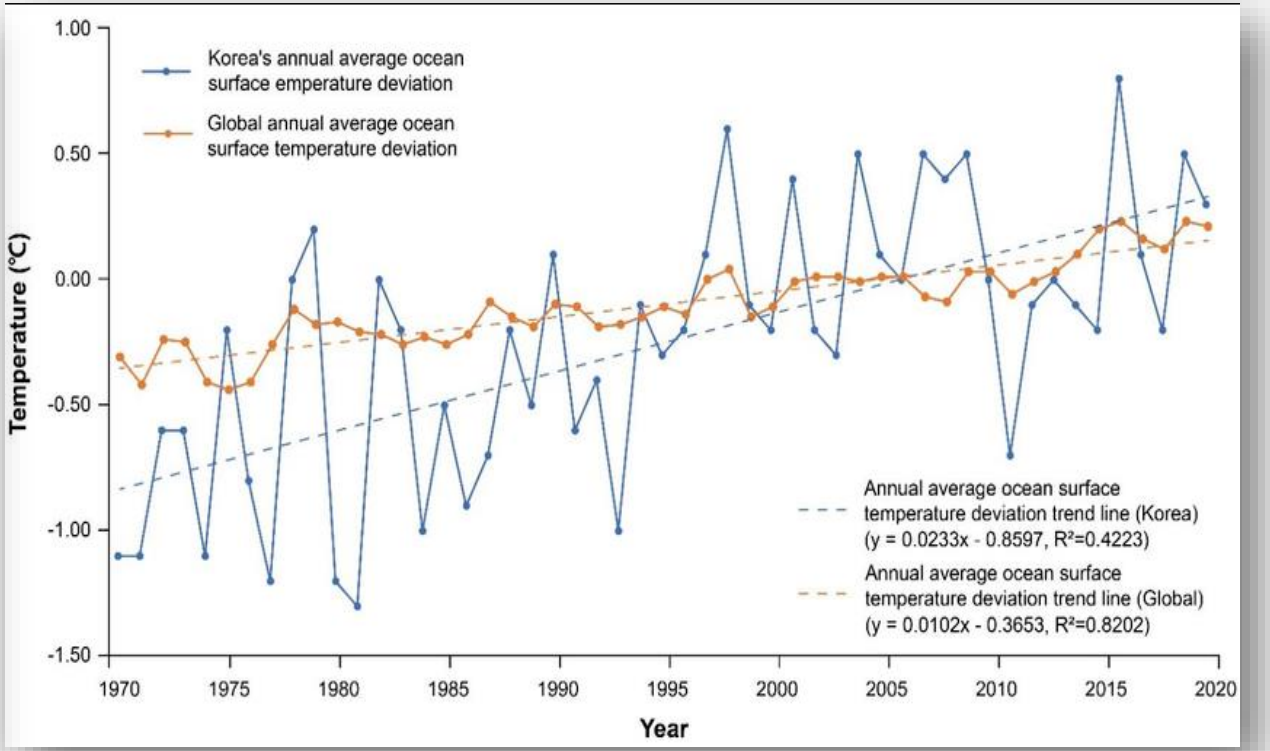
Background & Challenges

Threats of Antifouling Coating Technology

Impact of Rising Sea Surface Temperature on Anti-fouling Performance



Heat Map of Global Sea Surface Temperature on Aug., 2025



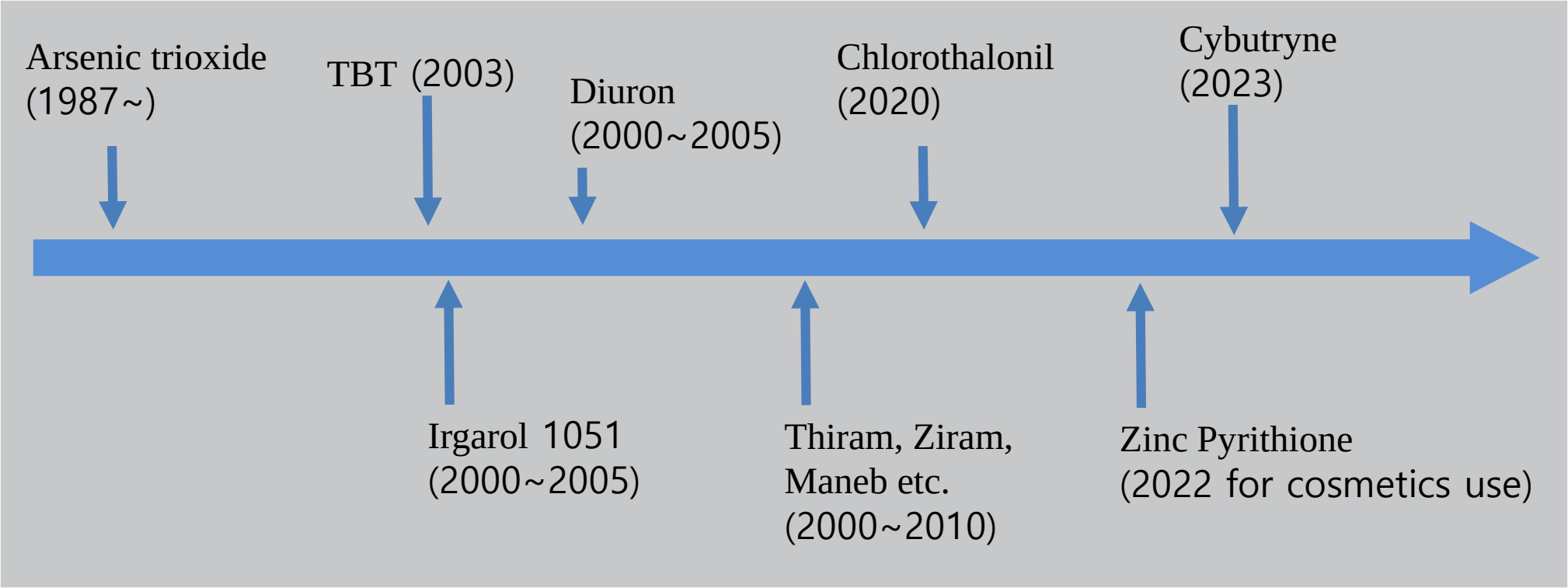
Korea's annual average ocean surface temperature increase trend against global trend

Background & Challenges

Threats of Antifouling Coating Technology

History of ban on the use of biocides (by BPR, ECHA, and IMO)

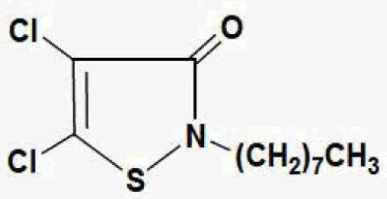
→ Regulatory approval for anti-fouling agents with no adverse ecological impact



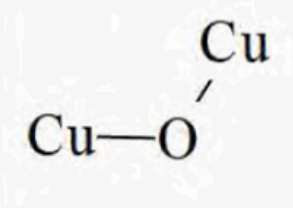
Background & Challenges

Threats of Antifouling Coating Technology

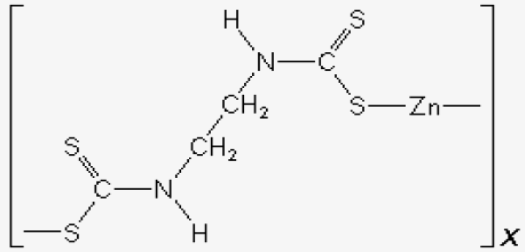
Biocides being currently survived (based on BPR, ECHA, and IMO)



DCOIT

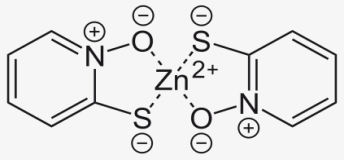


Cu_2O

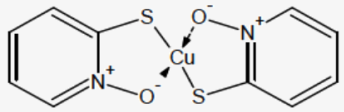


Zinc Ethylenebis(dithiocarbamate)

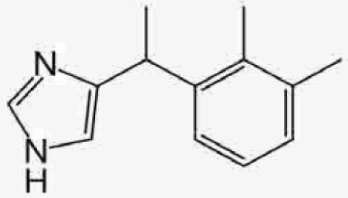
What is the next?



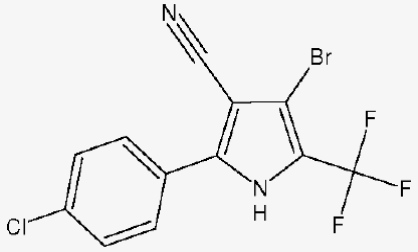
ZnPT



CuPT



Medetomidine



Tralopyril

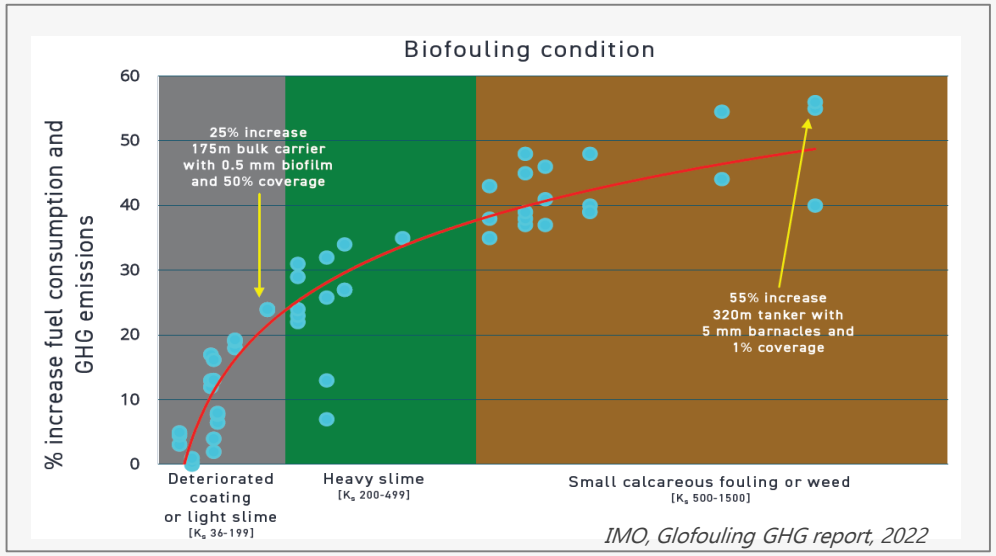
▶▶ **Threats** : The number of available biocides in the world are getting limited.

Background & Challenges

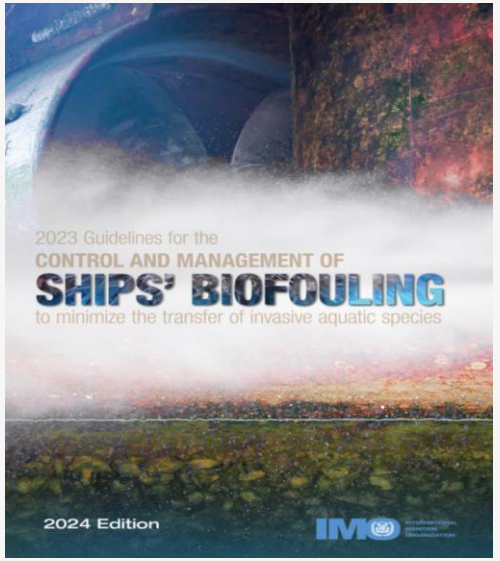
Threats of Antifouling Coating Technology

International Environmental Regulation Trends

→ Nevertheless, the demand for upgrade of anti-fouling performance is increasing.



De-carbonization Efforts (2050 Net-Zero Plan)



Biofouling Control of IAS

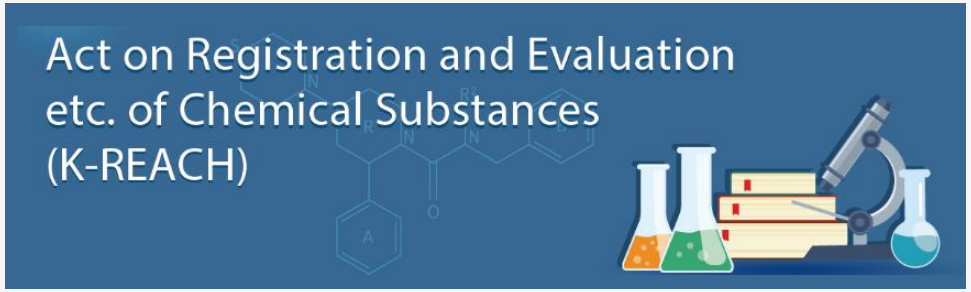
Background & Challenges

Threats of Antifouling Coating Technology

Regional Environmental Regulation Trends in KOREA (K-REACH, K-BPR)

→ Biocides and antifouling coatings are being regulated from the perspective of human toxicity.

Ministry of Environment



- For biocides category,
  it will be addressed and issued from 2029.

Background & Challenges

EU-REACH vs K-REACH

EU-REACH

Toxicity Analysis → If it is judged as toxic, → **Risk Assessment** (according to dosage, frequency, duration) → It is classified as:

- Substance requiring permission
- Restricted substance
- Prohibited substance

→ **There is no Control Act.**

VS

K-REACH

Toxicity Analysis → If it is judged as toxic, → **Act on the Registration and Evaluation of Chemical Substances** + **Chemical Substances Control Act**

Without ~~Risk Assessment~~

- ◆ Designation of Toxic Substances
- ◆ Unilateral/surprise announcement
  - → Not allow the exclusion of notice
  - → Not permit to increase allowable limit of toxic substance in the mixtures (AF coating)

- ◆ Management regulations for import/manufacturing/transportation/use must be followed.
  - Duty to notify to public
  - Handler(Worker) training
  - Prevention of scattering

→ **Impossible to comply with!**

Background & Challenges

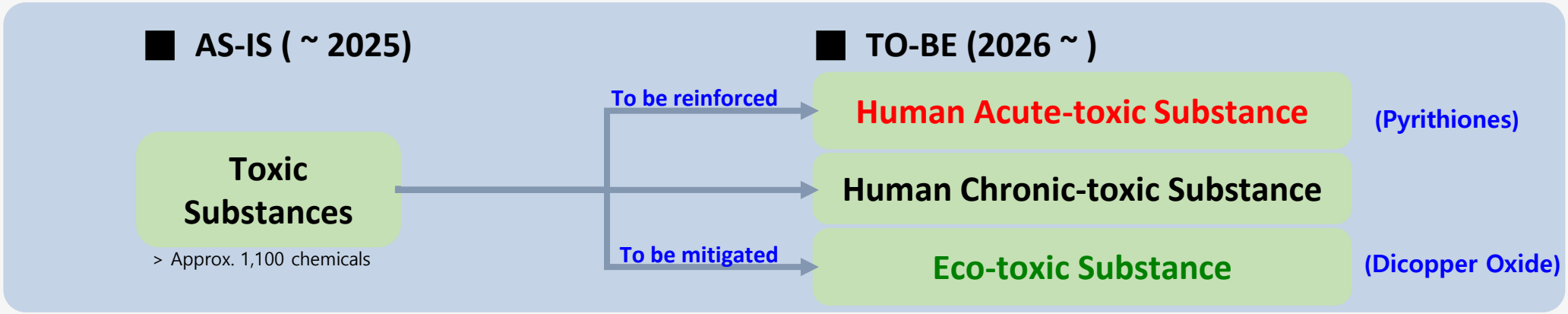
The Recent Issues on Biocides and Antifouling Coatings in K-REACH

❖ Major Ingredients in SPC Antifouling Coatings have been designated in K-REACH.

Biocides	Purposes	Regulated content	Existing Content in AF	Degree of Toxicity	Designation Date of Toxic Substances
Dicopper Oxide	Main biocide ※ Mainly acts on macro-fouling	≥1%	30~50%	**Aqua-toxic**	**7th Dec. 2022**
Pyrithiones (CuPT, ZnPT)	Co-biocides ※ Mainly acts on micro-fouling	≥1%	5~10%	**Acute-toxic Aqua-toxic**	**6th Oct., 2022**

❖ Revision Plan of K-REACH of the Ministry of Environment in Korea

- Classification of toxic substances into three types → Differential application of Control Act according to toxicity



▶ **In case of Antifouling Coatings, they will be classified as acute toxic substances, if it contains ≥1% of Pyrithiones.**

Contents

Strategic Approaches

Develop Antifouling Coatings? or Upgrade Antifouling Systems?

Opt. 1

Application of Fouling Release Coating

- ✓ Present problem : Applicable only on high speed ships
- ✓ Challenges : It must be applicable to all ship types and also material cost should be optimized

Opt. 2

Application of Underwater Cleaning System

- ✓ Possible method : Periodic hull cleaning at the slime stage after applying hard coating

Hard Coating + Hull Cleaning ROV + Monitoring System

- ✓ Challenges : 100% Unmanned cleaning technology is needed to prevent diver casualties.

Opt. 3 ✓

New Type of SPC Antifouling Coating

- ✓ Challenges : Discover of alternative biocides packages → Substances must not be in violation of K-REACH/BPR

→ Development of New Type of SPC Antifouling Coating with Low Toxicity

Strategic Approaches

How to Balance Both Regional and International Regulations?

KOREA (Ministry of Environment)

- K-REACH
- K-BPR

"Minimize toxicity"

Contradiction!

IMO (International Maritime Organization)

- De-carbonization
- Biofouling Management

"Maximize antifouling property"

▶▶ **Key strategy** :

Plan A : Develop antifouling coatings consisted of only 'eco-toxic substances that are harmless to human'

or Plan B : Develop antifouling coatings comprised with 'completely free of toxic substances'

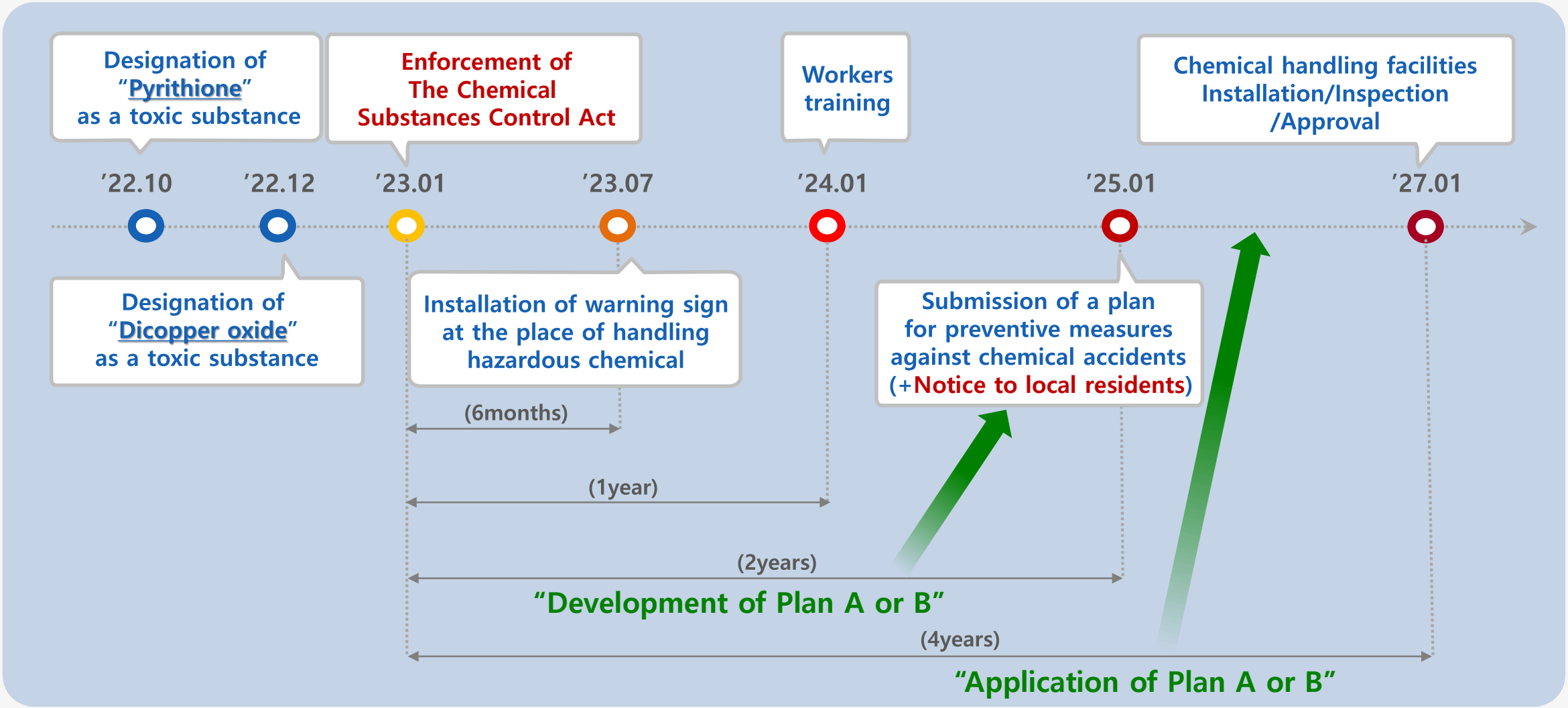
Strategic Approaches

How to Develop New Type of AF Coating with Low Toxicity?

		Plan A (Short-term PJT)	Plan B (Long-term PJT)
Concept	Pyrithiones (Human-toxic)	≤ 1%	≤ 1%
	Dicopper Oxide (Eco-toxic)	30~50% (Maintain current level)	≤ 1%
	Other biocides	Human-toxic Substances ≤ 1%	Human-toxic Substances ≤ 1%
Positive Effects		• Application of Chemical Substances Control Act, but only designated as "Eco-toxic substance" → Possible discussion on mitigation of application of the Chemical Substances Control Act → Easy to appeal to workers and local residents	• Minimize toxic substances → No application of the Chemical Substances Control Act → Possible to resolve local residents complaints
Development Period		2 years (Jan. '23 ~ Dec. '24)	5 years (Jan. '23 ~ Dec. '27)

Strategic Approaches

How to Fit into the K-RAECH Implementation Timeline?



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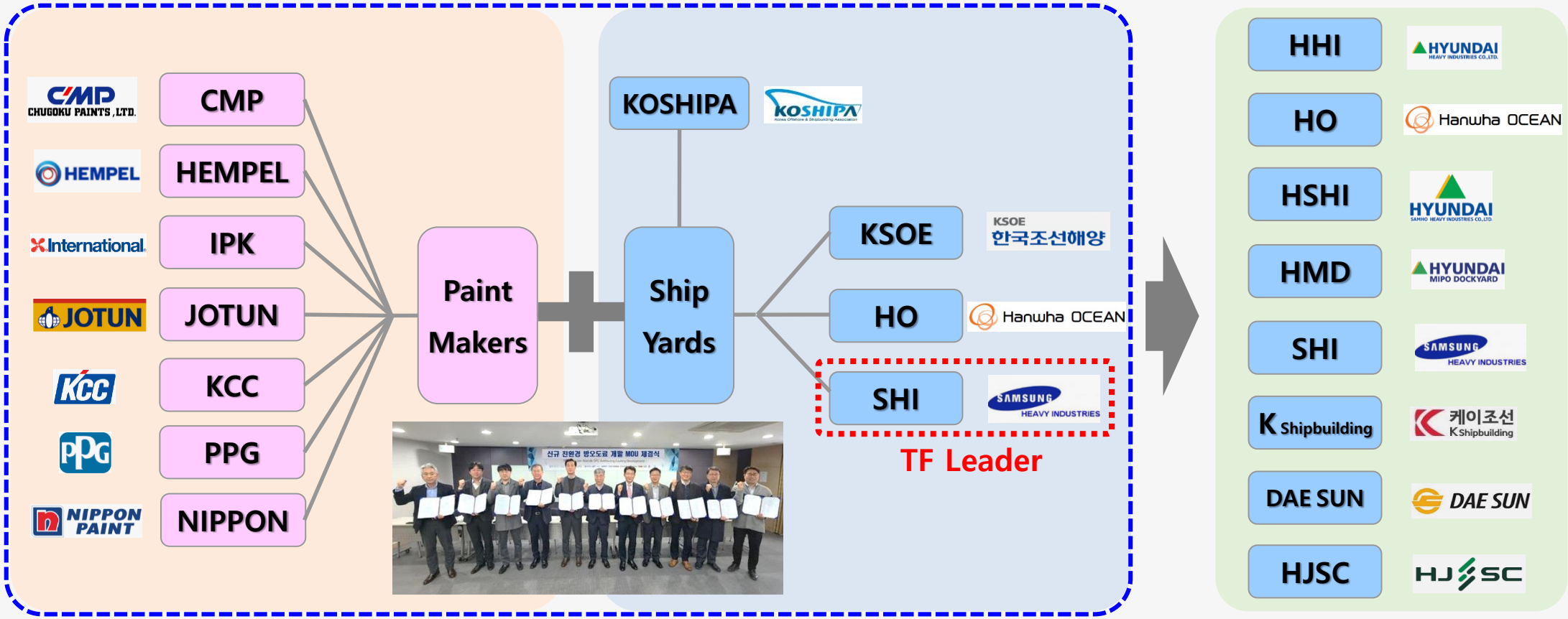
Methodologies

Joint Development Project for New Antifouling Coatings

❖ Task force together with Korean shipyards & marine coating manufacturers has launched since Jan.,'23.



Methodologies

Development Plans of New Type of SPC Antifouling Paint

Activities		Schedule (Jan. '23 ~ Dec. '24)																								Party in charge
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	
1st year	• Kick-off																									Shipyard + Paint Maker
	• Development of initial formulation																									Paint Maker
	• Specimen production																									Shipyard → Paint Maker
	• Antifouling evaluation																									Shipyard
	• Physical properties evaluation																									Paint Maker
	• Summary of results																									Shipyard
	• Selection of middle products																									Shipyard + Paint Maker
2nd Year	• Improvement and optimization of formulation																									Paint Maker
	• Specimen production																									Shipyard → Paint Maker
	• Antifouling evaluation																									Shipyard
	• Physical properties evaluation																									Shipyard
	• Summary of results																									Shipyard
	• Selection of final products																									Shipyard + Paint Maker
Finalizing	• Final product launching																									Paint Maker
	• Reflected in the paint Spec.																									Shipyard

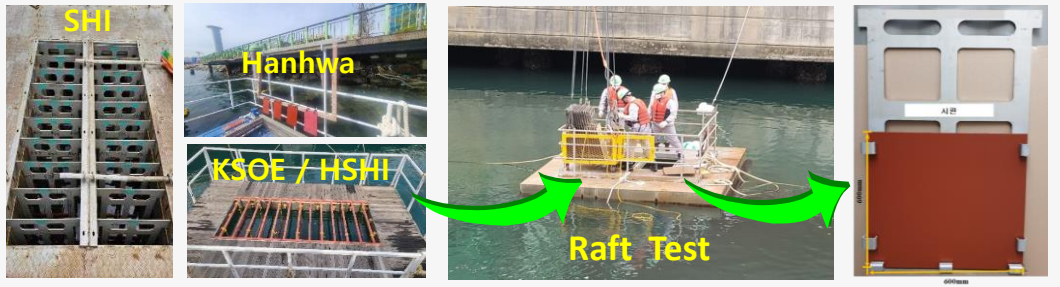
Methodologies

Development Methods of New Type of SPC Antifouling Paint

Short-term Project

- Development of initial formulation
- 1st Antifouling evaluation
- 1st Physical properties and workability evaluation
- Improvement of physical properties
- 2nd Antifouling / Physical properties / workability evaluation
- Selection of final products → Final product launch

Antifouling Property Evaluation Sites



Shipyards Activities Paint Makers Activities

Contents

Outcomes

Antifouling Performances of Candidate Formulations – Raft Test

✓ '23~'24 Test Results → **19 / 51 Plan A test formulations** are satisfied the criteria.

Plan A products

Pyrithiones (Human-toxic)	≤ 1 wt%
Dicopper Oxide (Eco-toxic)	= 30~50% (current level)
Other biocides	≤ 1 wt% (for human-toxic substances)

[Accepted]

[Accepted]

[Not accepted]

Outcomes

Antifouling Performances of Candidate Formulations – Raft Test

✓ '23~'24 Test Results → **0 / 19 Plan B test formulations** are satisfied the criteria.

Plan B products

Pyrithiones (Human-toxic)	≤ 1 wt%
Dicopper Oxide (Eco-toxic)	≤ 1 wt%
Other biocides	≤ 1 wt%

(for Acute/Chronic-toxic substances)

[Not accepted]

[Not accepted]

[Not accepted]

Outcomes

Other Film Performances of Candidate Formulations

Weatherability

F-2-L

Initial	After 2 cycles	Discoloration	remarks
		ΔE 10.72	Fail
		ΔL 10.69	much lighter
		Δa -1.68	slightly greener
		Δb -1.26	slightly bluer

F-4-L

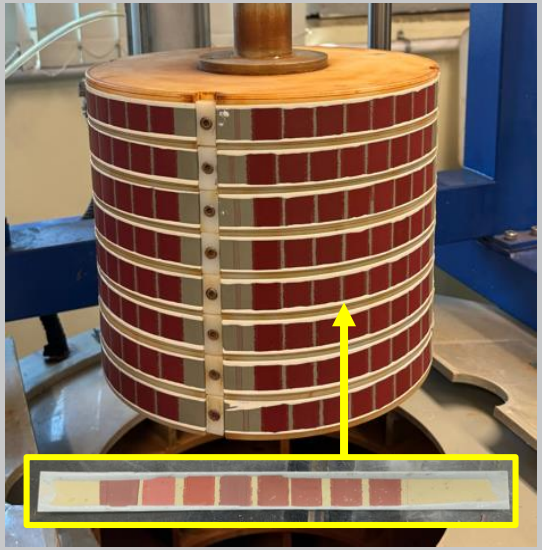
Initial	After 2 cycles	Discoloration	remarks
		ΔE 9.65	Fail
		ΔL 9.63	much lighter
		Δa -0.47	
		Δb -0.99	

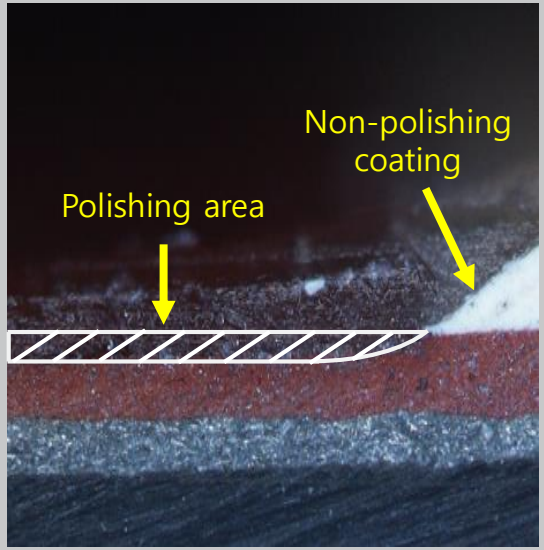
시편번호	F-1-L	F-2-L	F-3-L	F-4-L	F-5-S
Pass/ Fail	Pass	Fail	Fail	Fail	Pass
ΔE	3.12	10.72	10.36	9.65	2.91

[Test Condition : 2cycles]

- Outdoor exposure (2weeks)
- Seawater immersion (4weeks)
- Outdoor exposure (2weeks)

Polishing Rate

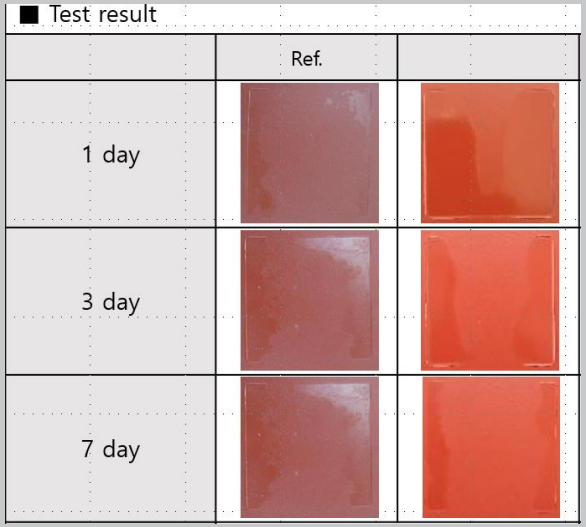




[Test Condition]

- Voyage factor : 100%
- Speed : 15knots
- Seawater temperature : 23℃

Block Damage Resistance



[Test Condition]

- Apparatus : Hydraulic press
- Compressive load : 40kgf/cm^2
- Pressing duration : 60min

Outcomes

Antifouling Performances of Plan A Candidates – Patch Test

LBP	74.00 M
Breadth	18.00 M
Depth	7.00 M
Draft	3.60 M
Gross Tonnage	abt. 2,600 Tons
Speed	min 10.0 KTS
Duration	abt. 1,000 nm
Crew (researchers)	10 (+15)
navigation area	coastal

[Features of the marine tested ship]

IMO INTERNATIONAL MARITIME ORGANIZATION

E

MARINE ENVIRONMENT PROTECTION COMMITTEE
78th session
Agenda item 7

MEPC 78/INF.24
1 April 2022
ENGLISH ONLY
Pre-session public release: ☒

REDUCTION OF GHG EMISSIONS FROM SHIPS

Marine testbed ship for alternative fuels and electric propulsion systems

Submitted by the Republic of Korea

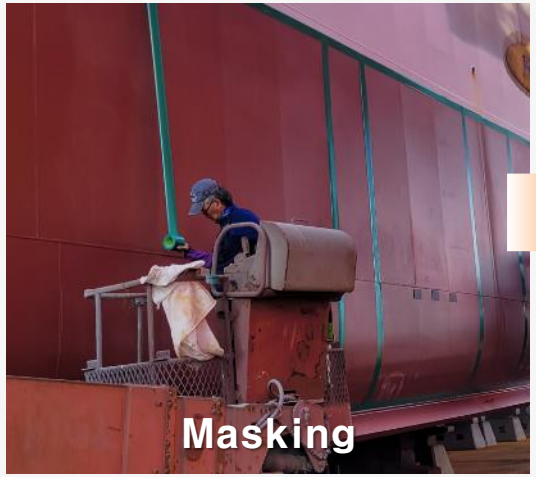
SUMMARY

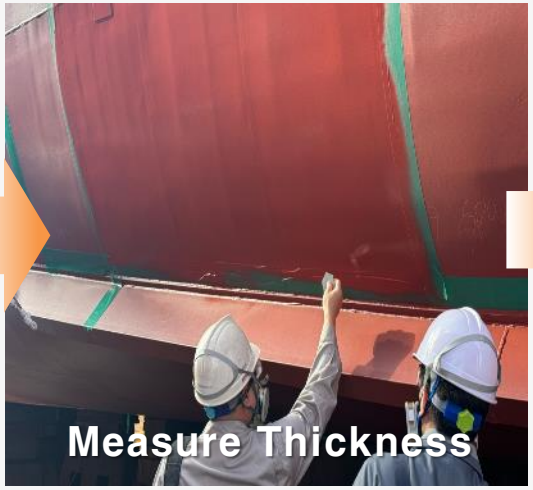
Executive summary:	This document provides information on the marine testbed ship for alternative fuels and electric propulsion systems
Strategic direction, if applicable:	3
Output:	3.2
Action to be taken:	Paragraph 24
Related documents:	MEPC 75/7/15 and MEPC 77/7/1

[IMO MEPC 78 / INF.24]

Outcomes

Antifouling Performances of Plan A Candidates – Patch Test

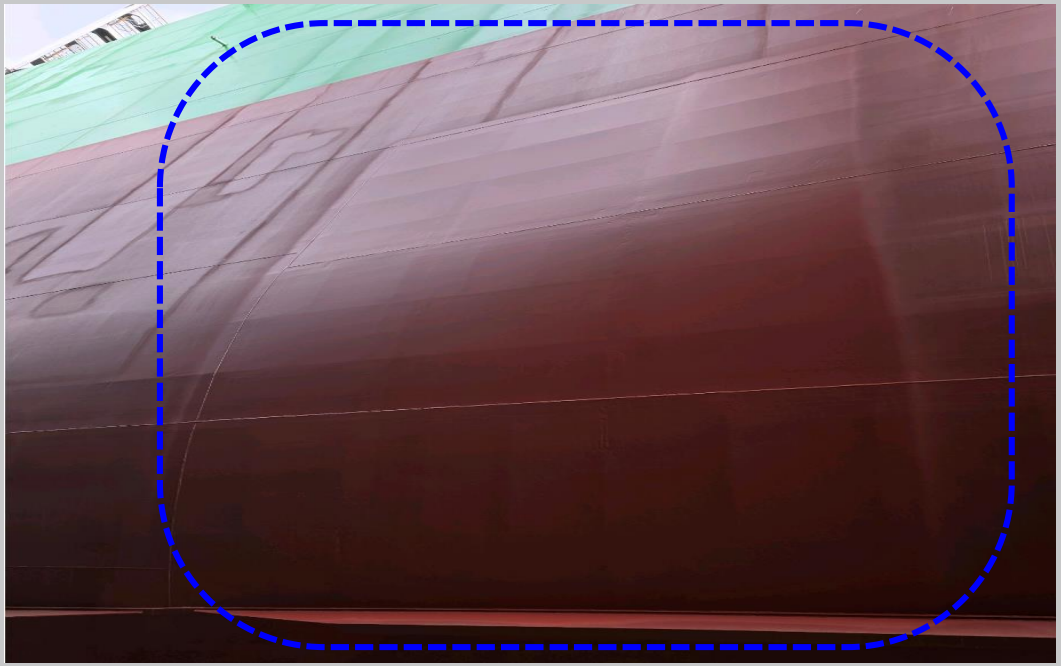




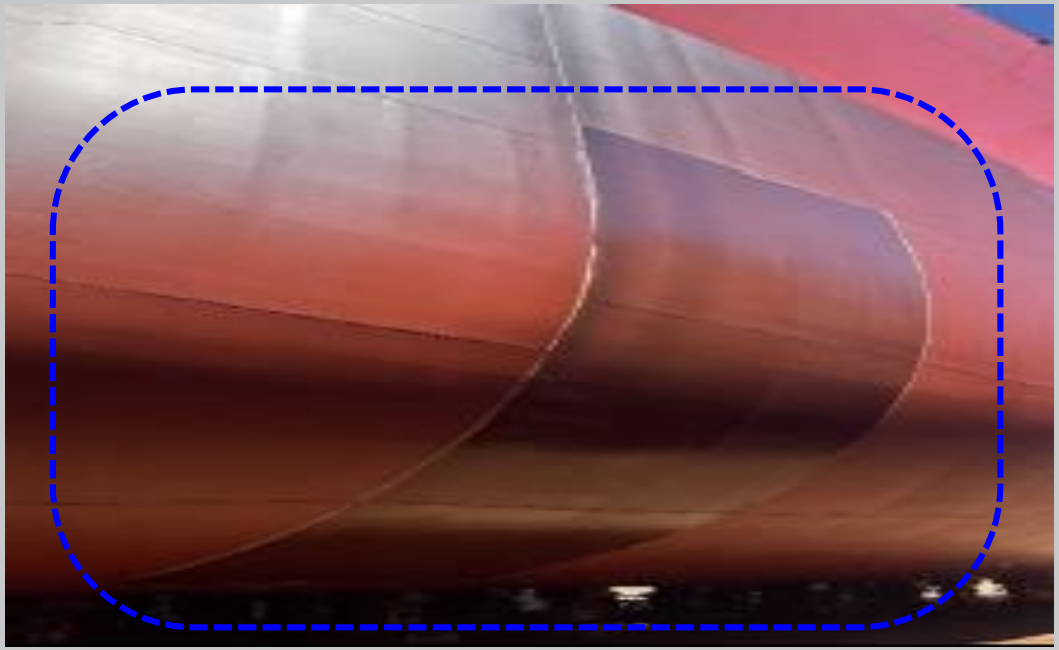
Outcomes

Application of Plan A Commercial Products in New-building Shipyard

- ❖ Applied Period : Nov., 2024
- ❖ Vessel Type : 15,000TEU Container Ship
- ❖ Paint Manufacturer : Company ⑤



- ❖ Applied Period : Aug., 2025
- ❖ Vessel Type : 88K Very Large Gas Carrier
- ❖ Paint Manufacturer : Company ①



Outcomes

Summary of Task Force Activities

❖ A total of 70 candidate formulations from 7 Marine coating manufacturer have been simultaneously evaluated for anti-fouling performance under static condition over a 6 months each year at 4 raft test sites in Korea.

- **Plan A** : Out of a total of **51** candidates, **19 passed** the criteria from 4 sites at the same time.
  (However, there was a tendency for the products to be slightly weak against plant-based fouling.)

- **Plan B** : Out of a total 19 candidates, **no ones passed** the criteria during the evaluation
  (It is still challenging, but high potential to improve was observed in some products.)

❖ As a result of the field application on actual ships, the workability was satisfactory, and the anti-fouling performance also showed a similar trend to the raft test, proving the reliability of the good quality.

Contents

Future Works

New AFC Products Release Plan

Paint Makers	2025							2026						Product Naming
	6	7	8	9	10	11	12	1	2	3	4	5	6	
Company ①					●		★							✓ Done
Company ②					●		★							✓ Done
Company ③										★				Not yet
Company ④								★						✓ Done
Company ⑤					●									✓ Done
					★									
Company ⑥								★						✓ Done
Company ⑦								★						Not yet

Future Works

Promotion Plan for New AFC Technology

Oct. ’25 — KORMARINE 2025 (International Maritime & Energy Exhibition) in Pusan, South Korea

Oct. ’25 — The annual Tripartite meeting 2025 (among ship owners, shipbuilders and classification societies) in Seoul, South Korea

Dec. ’25 — MARINTEC CHINA 2025 in Shanghai, China

Feb. ’26 — IMO PPR 13 (Sub-Committee on Pollution Protection and Response) Meeting in London, UK

Oct. ’26 — IMO MEPC 84 (Marine Environment Protection Committee) Meeting in London, UK

Contents

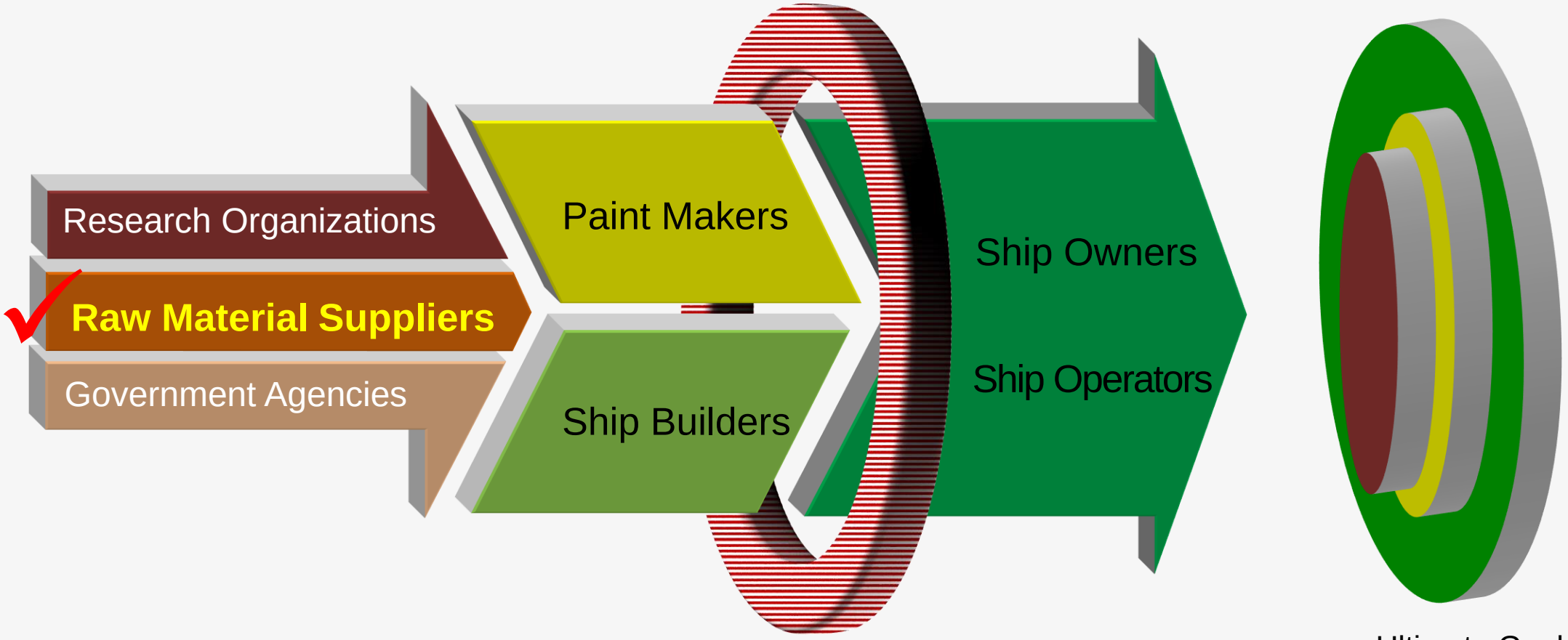
Suggestions

Synergy in “Always Clean Hull” via UW Cleaning Technology Upgrades

- ✓ Respond to continued rise in global ocean temperatures and strengthening regulatory trends.
- ✓ Need to introduce proactive UW hull cleaning as a complementary measure to maintain an always clean hull.
- ✓ 100% unmanned ROV cleaning technology is essential to provide a safer working environment.

Suggestions

Consistent Efforts of Core Materials Research & Development



Thank you for listening!

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