

Product introduction

Eco-friendly low-friction A/F paint

친환경 기능성 저마찰 A/F 도료

BN GreenGuard FS

Bⁿ CHEMICAL

Exclusive Agency



OCEANCARE

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Contents

1. Overview
2. Mechanism
3. Verification
4. Application





Overview

Summery

Bio fouling

Low friction

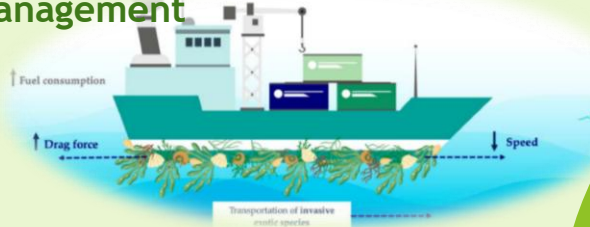
Marine Pollution Prevention

CII Management

Awareness

Protection Bio fouling

- Biofouling's response to tightening regulations (enforcing Australia)
- Hull-attached organisms solve marine ecosystem disturbances
- Reduce fuel consumption (carbon generation)
- Prevention of ship speed degradation
- CII Rating Management



Self polishing Resin Synthesis Method

Vessel life extension

- Extending the life of the ship's environment
- Improve your business environment

Conversion of ship life

Durability
lifetime

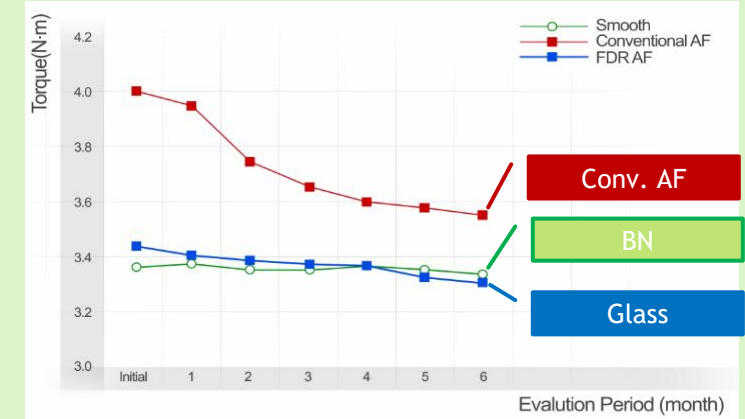
Economic
lifetime

Environmental
Lifetime

Reduced hull friction resistance

- Reduce fuel consumption (carbon generation)
- improvement of ship speed
- Best return on investment
- CII Rating Management

👍 Compared to existing A/F paint : **33% reduction**



Marine Pollution Protection

- Cu-free : does not use heavy metal Cu2O
- Application of Magnetic Wear Resin Synthesis Technology
- the improvement of the marine ecological environment



Cu-free pint (BN GreenGuard)

2000' Cu2O Fouling paint application

'70 THT+Cu2O Fouling paint application

'50 Apply hull paint

Tar

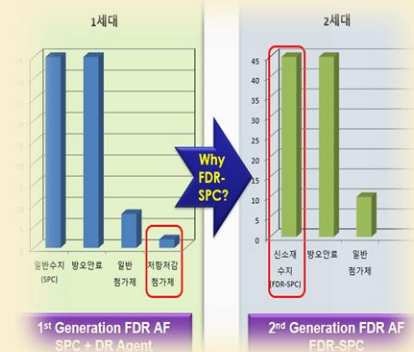
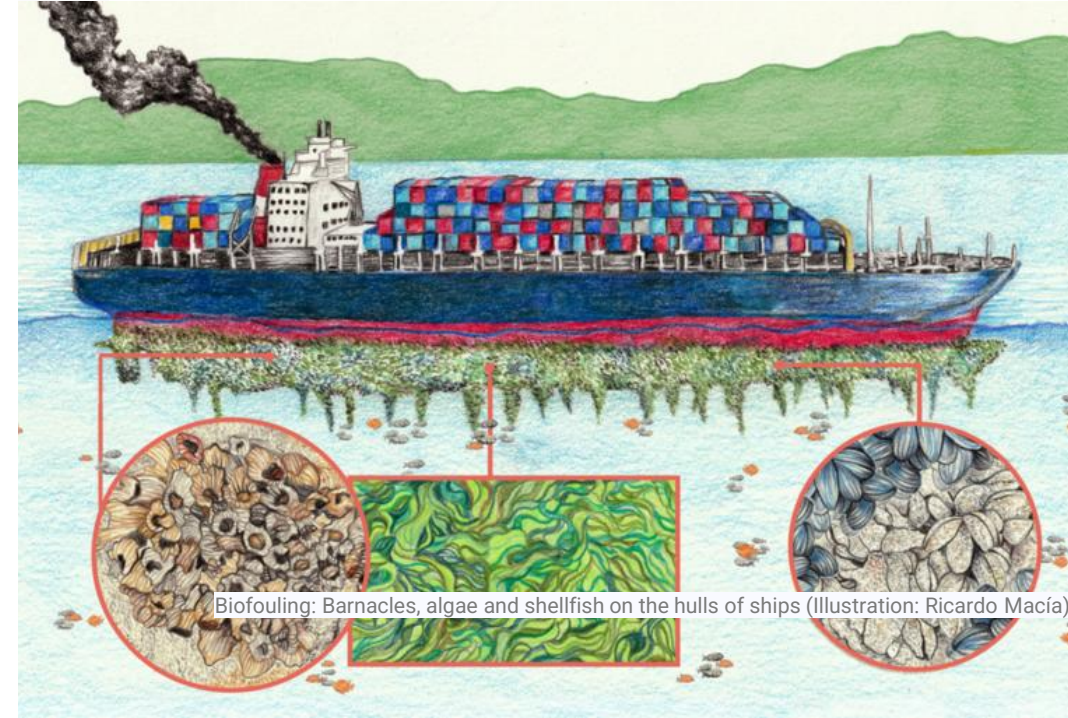
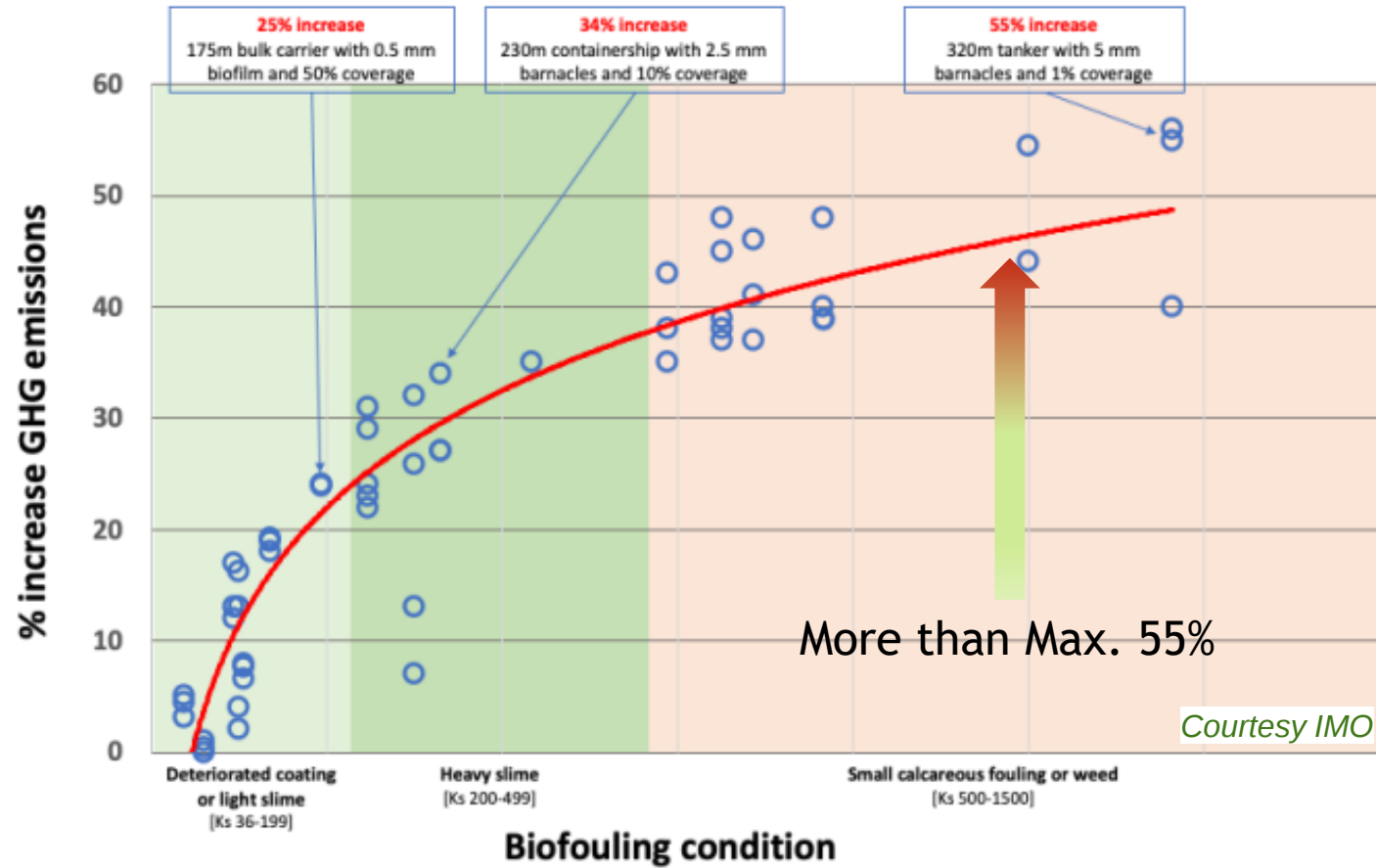


CHART: IMPACT OF SHIP HULL BIOFOULING ON GHG EMISSIONS

Compendium of results from published research studies

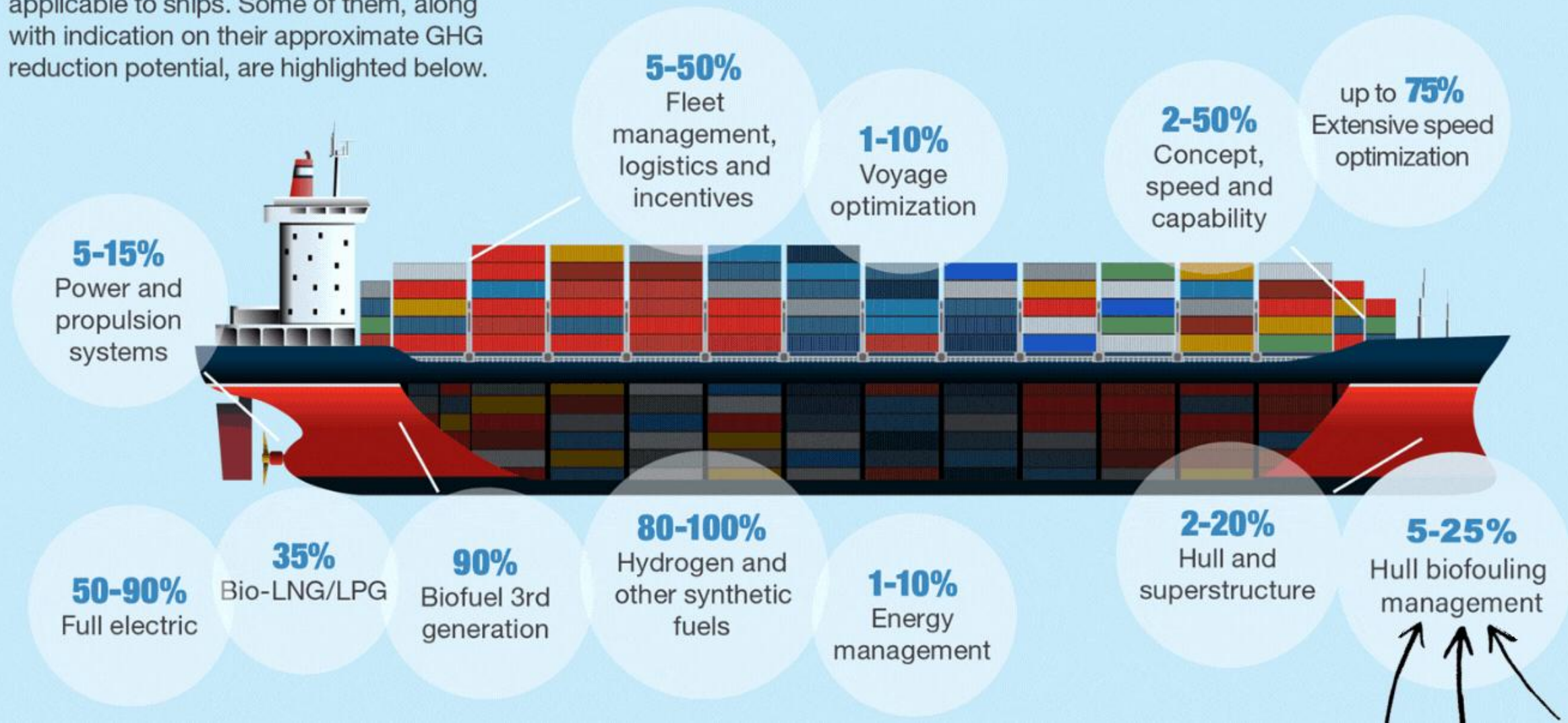


Increase hull roughness

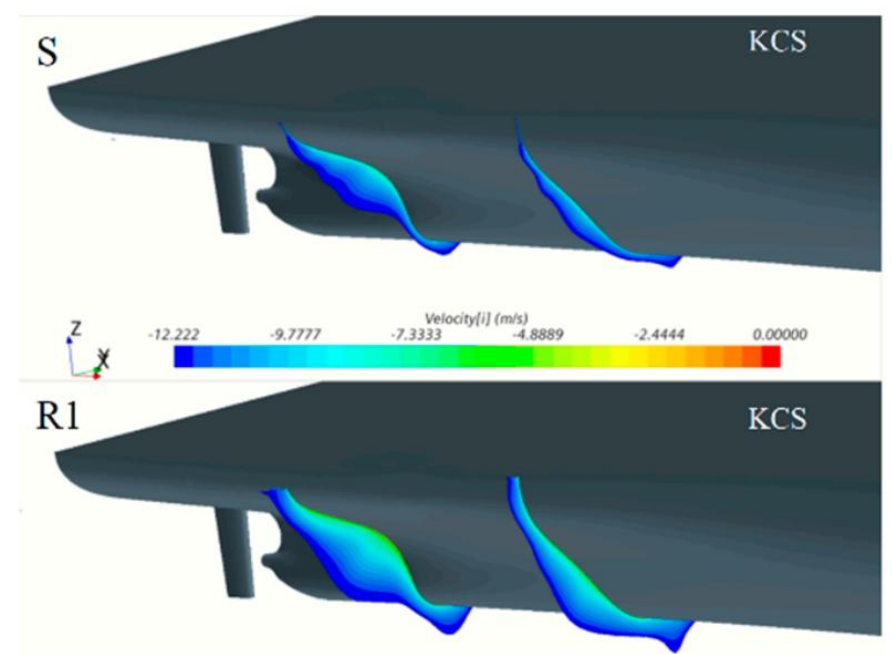
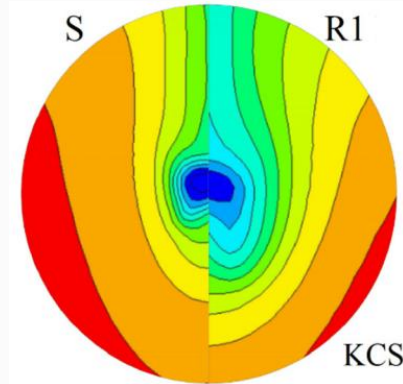


A wide variety of design, operational and economic solutions

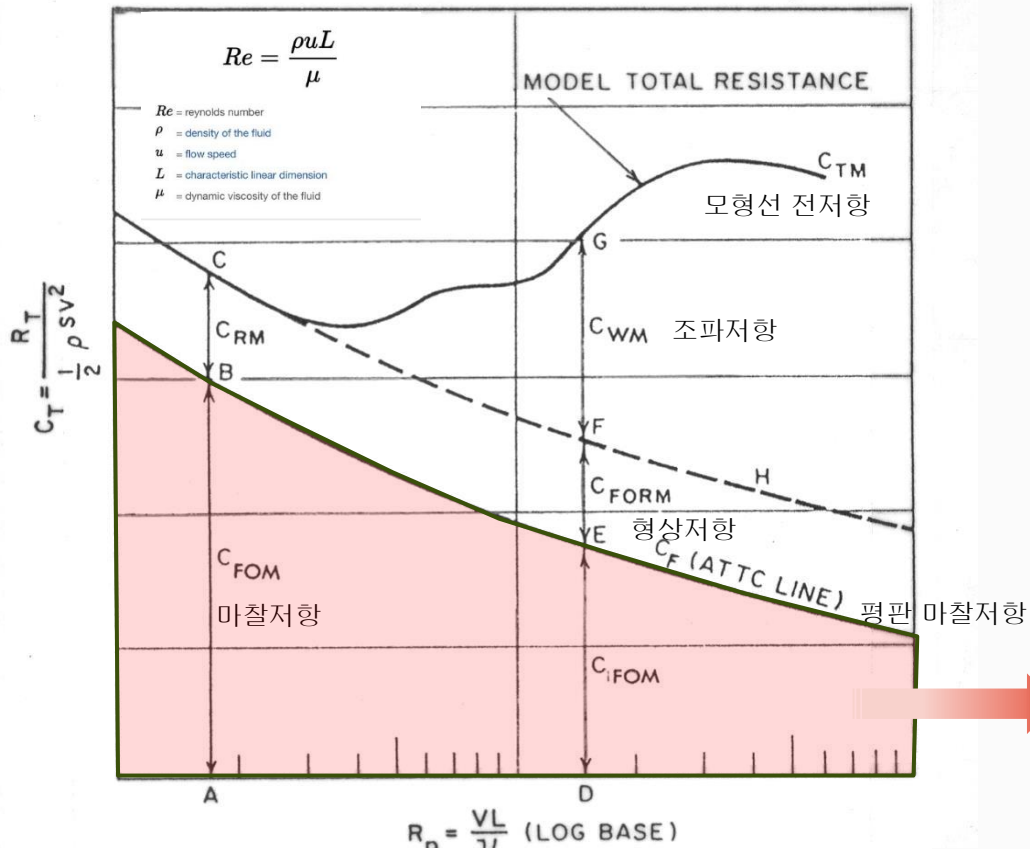
Achieving the goals of the Initial IMO GHG Strategy will require a mix of technical, operational and innovative solutions applicable to ships. Some of them, along with indication on their approximate GHG reduction potential, are highlighted below.



Low Friction



Source : MDPI Impact of Hard Fouling on the Ship Performance of Different Ship Forms (2020)



Reducing “frictional resistance” has a significant impact on improving energy efficiency.

Friction resistance

High speed vessel : 40~ 50%

Low speed vessel : 70~ 80%



Marine Pollution Prevention

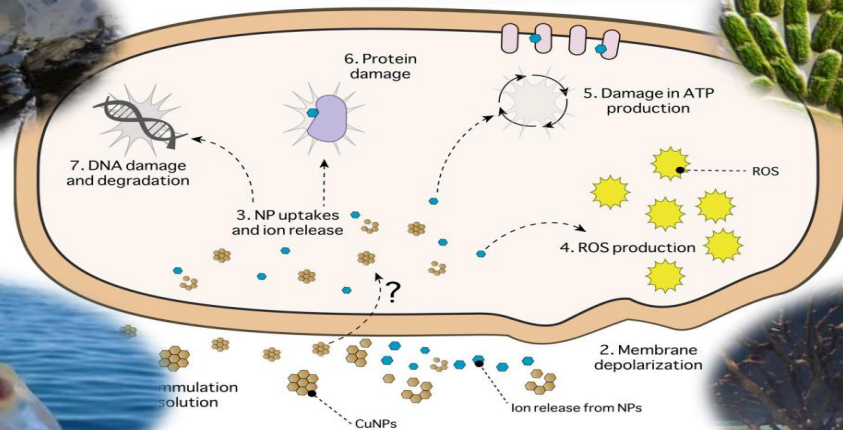
Tin-free, Cu-free



Death



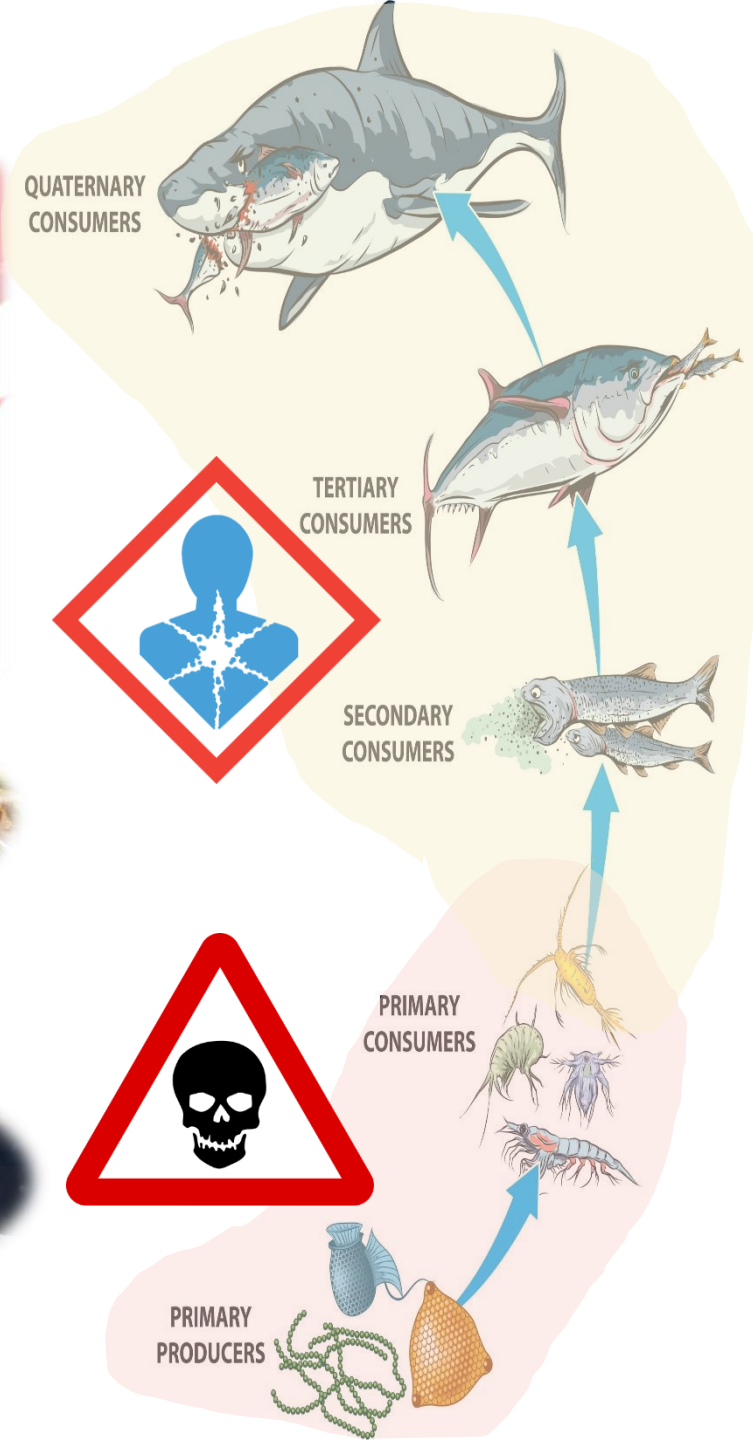
Deformity



Reduction



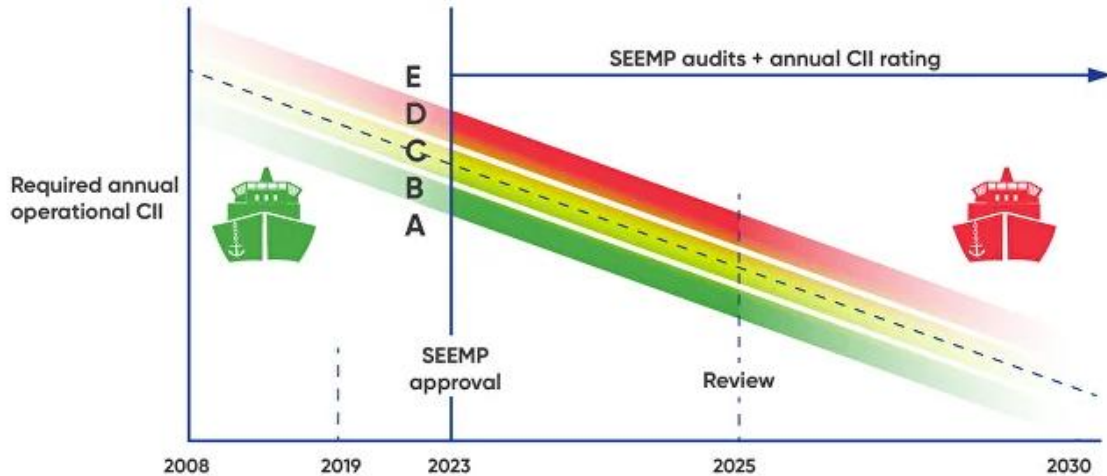
Extinction



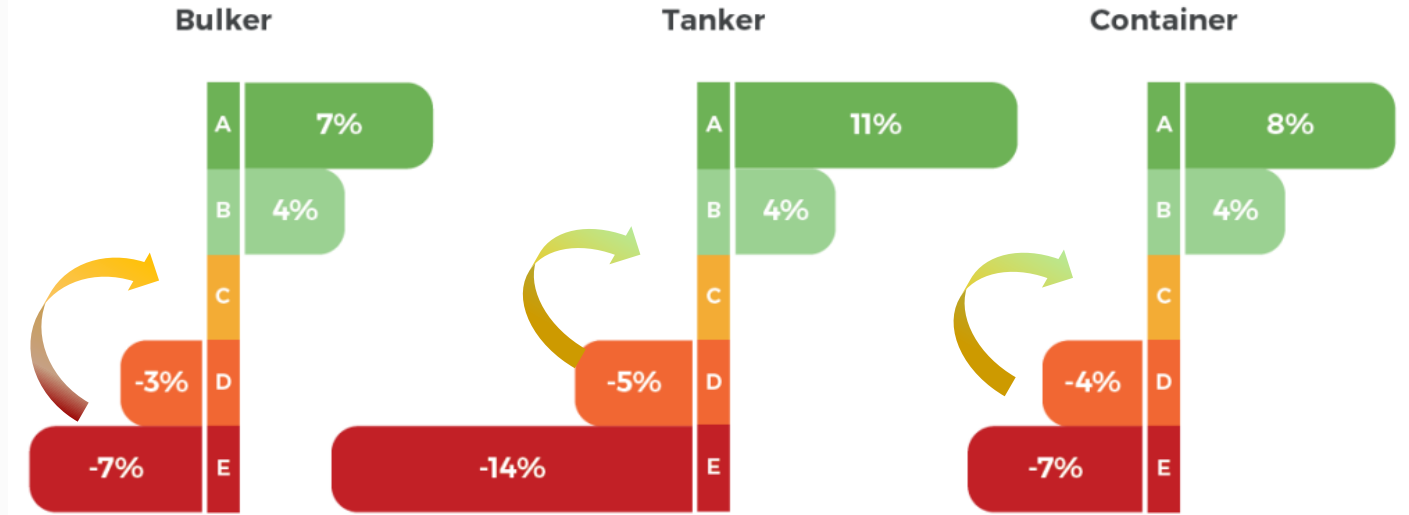
CII Management



CII rating will become stricter over time



Status of CII ratings by ship's type
<선형별 CII 등급 현황>



Grade CII, which is lowered every year

매년 떨어지는 CII 등급

Year	Reduction factor	Required CII	Attained CII	CII rating	Grade
2023	5%	4.808	4.471	0.93	B
2024	7%	4.707	4.471	0.95	C
2025	9%	4.605	4.471	0.971	C
2026	11%	4.504	4.471	0.992	C
-	-	-	-	-	-
Sometime in the future	17%	4.2	4.471	1.064	D

Scrap



Awareness

일간지더스경제
선박 오손 막고 마찰 줄인 방오도로, 선속 개선·연료 절감 '효과'
[김지혜 기자]
부산대학교 이인원·박현 교수팀 5년 연구결과
국제해상물자 '사이언티픽 리포트' 온라인 게재
해상물자 적재 방지 방오도로 선박 필수 도로
마찰 줄이는 수지 적용
선속 3.72% 높이고 연
기후변화 대응 IMO규

부산대 개발 방오도로 효과
[정은주 기자]
부산대 연구팀, 방오도로 효과 검증
[김정희 기자]
조선해양공학과 이인원·박현 교수팀
실제 바다에서 속도 3.7% 개선, 11.7%

부산대 개발 연료 절감
[부산CBS 박창호 기자]
방오도로 이용 선박, 연료
공과대 조선해양공학과 이

국제 부산대 검증
[디지털뉴스]
방오도로
· 공과대
· 실제 바
방오도로 이용 선
부산대

연합뉴스 최선기사 정치 북한 경제 마켓+ 산업 사회 전국 세계 문화 건강 연예 스포츠
#미국 #이민이날 #코스닥 #코스피 #건조주의보
뉴스룸 최선기사
선박 연료비 확 줄이는 선박용 신소재 페인트 개발
송고시간 | 2015-07-22 14:54

| 비엔케미칼-부산대, 미래를 보는 경제신문
EBN 산업경제 전자
(부산=연합뉴스) 이영호
장 큰 과제로 떠오르고 있다. 코스닥 866.64 ▼ 0.84(-0.1%) USD\$ 1364.0 ▼ 7.0 EURE 1464.4 ▼ 6.0
공유 인쇄 텍스트 축소 확대
20피트짜리 컨테이너 1
연료비로만 600억원가
선박의 연료 효율을 결정

매일경제 BN그룹, 조선기자재 세계 1위...IT·물류 13개 계열사 탄탄
◆ 2018 부산 베스트기업 ◆
2024.5.3(금)
20.2℃ 부산
미세먼지 좋음 / 미세먼지 좋음
국제신문
사회 정치 경제 해양수산 국제 문화 주말엔 스포츠 기획 인터뷰
비엔케미칼 선박 방오도로 국산화
연료저감형·친환경 페인트, 'BN 그린가드 FS' 개발 완료
윤정길 기자 yjkes@kookje.co.kr | 입력 · 2015-07-22 20:23:35 | 본지 14면

이인원/박현 교수팀은 FDR-SPC를 기반으로 한 저마찰 방오도로를 개발해 해상 및 선박 침적 시험으로 방오성능을 시험했으며, 조선소 현장 평가를 통한 선박 도장 공정 호환성 시험 등 실선 적용성을 검증했다. 아산화동(Cu2O) 방오제를 함유하지 않는 이 방오도로를 2015년 11월 재화중량 17만6천 톤급 벌크선(길이 292m)의 수선 하부 전체 면적에 도장한 시점 이전 1년과 이후 4년, 총 5년간 실 해역 운항 데이터를 수집, 선박의 속도 성능을 분석한 결과가 이번 논문에 게재된 것이다.

이번 논문의 특징은 다음 두 가지로 요약된다. 첫째, 선박의 운항에 큰 영향을 미치는 조류와 바람, 파도 등의 기상 조건의 영향을 제거하고 선박의 성능을 정량적으로 분석하기 위해 제정된 국제 표준인 ISO19030을 기반으로 저마찰 방오도로가 적용된 선박의 실해역 성능을 검증했다는 점이다. 둘째, 3년의 간격을 두고 첫 번째 운항 기간에는 저마찰 방오도로, 두 번째 운항 기간에는 일반 방오도로를 적용함으로써 입거수리(정기검사) 직후의 동일한 선박 상태에서 방오도로만 교체된 객관적인 비교평가 조건을 재현했다. 논문에는 2014년 12월부터 약 5년간 570만 회에 걸쳐 계속된 선박 운항 빅데이터를 분석한 결과도 기술돼 있다.

저마찰 방오도로와 일반 방오도로가 도장된 직후 각각 1년간의 데이터만을 상호 비교한 결과, 저마찰 방오도로를 도장했을 때 선속이 평균 3.72% 증가하는 것으로 나타난다. 이를 동일 선속으로 환산하면 소모 동력과 연료 소모량이 11.7% 감소하며, 온실가스 배출량도 동일하게 감소함을 의미한다.

부산대 산학협력
김지혜 기자 (부산=부산대 제공)
이인원·박현 교수팀은 저마찰 선박 도장 시 3.7%의 속도 개선 효과(사이언티픽 리포트(Scientific Reports))

비엔케미칼이
비엔케미칼과
FS) 개발에 따
이 도료는 부산
원으로 사용했

환경
한경비즈니스 한경비즈니스마켓 집콕노미 오피니언 경제 대용 산업 정치 사회
[新산업 갈아입는 부산] 비엔케미칼 친환경 선박용 페인트 기술
김태현 기자
입력 2018.05.23 15:58 수정 2018.05.23 15:58 지면 C5

☆ ↗ 💬 😊 📄
진동소음 낮추는 그래핀소재 독점 생산

2024.5.3(금)
20.2℃ 부산
미세먼지 좋음 / 미세먼지 좋음
국제신문
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비엔케미칼 선박 방오도로 국산화
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윤정길 기자 yjkes@kookje.co.kr | 입력 · 2015-07-22 20:23:35 | 본지 14면
f X blog
인쇄
주소
배치
스크랩
경남 양산 소주공단에 위치한 비엔케미칼 공장에서 연료저감형 방오도로 생산작업이 진행되고 있다. 비엔케미칼 제공



Mechanism

Fuel-saving paint concept

Background technology

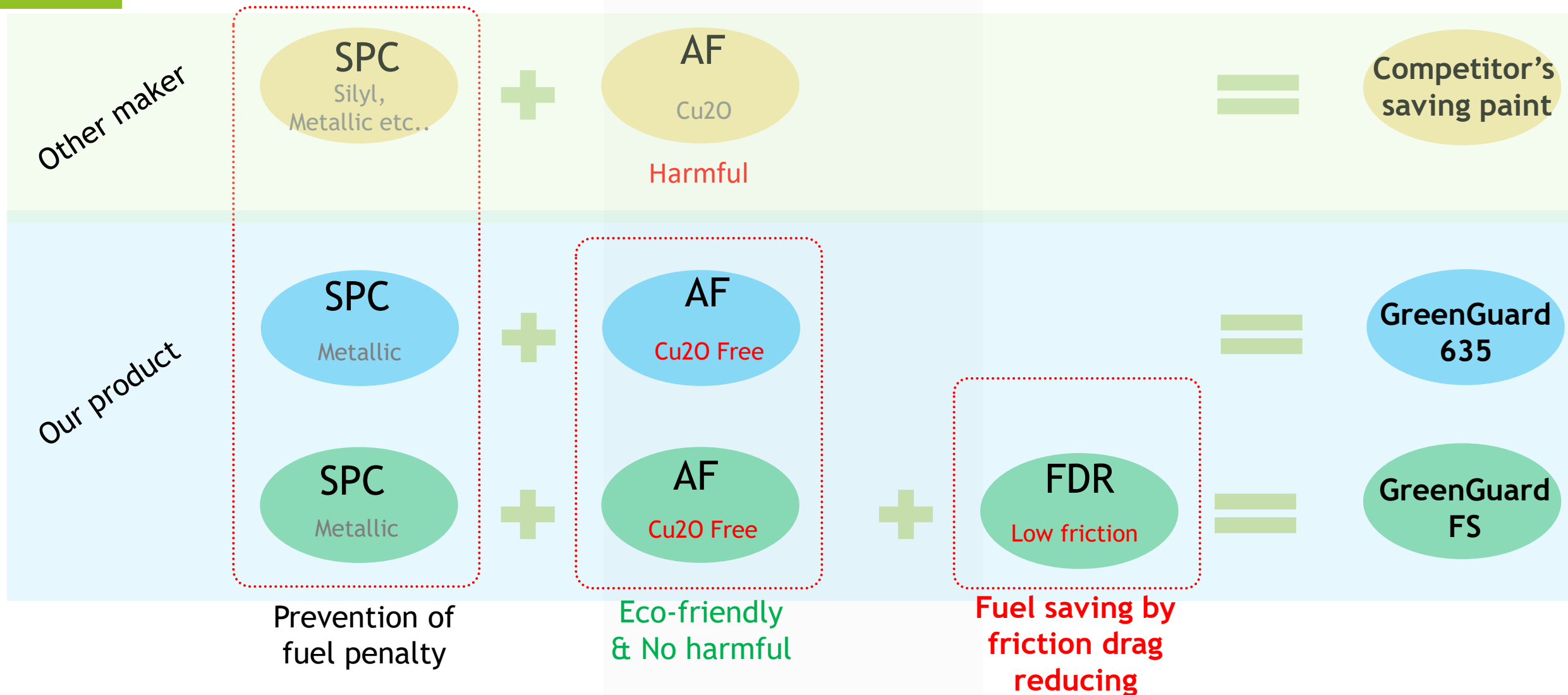
Technical principles

Application of ship's paint

Patent

SPC : Self polishing copolymer
AF : Anti fouling
FDR : Friction drag reducing

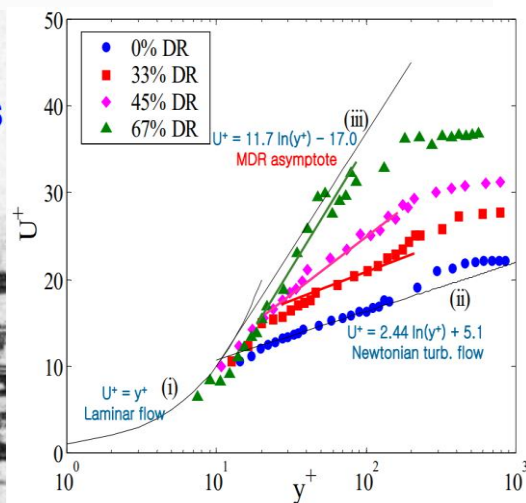
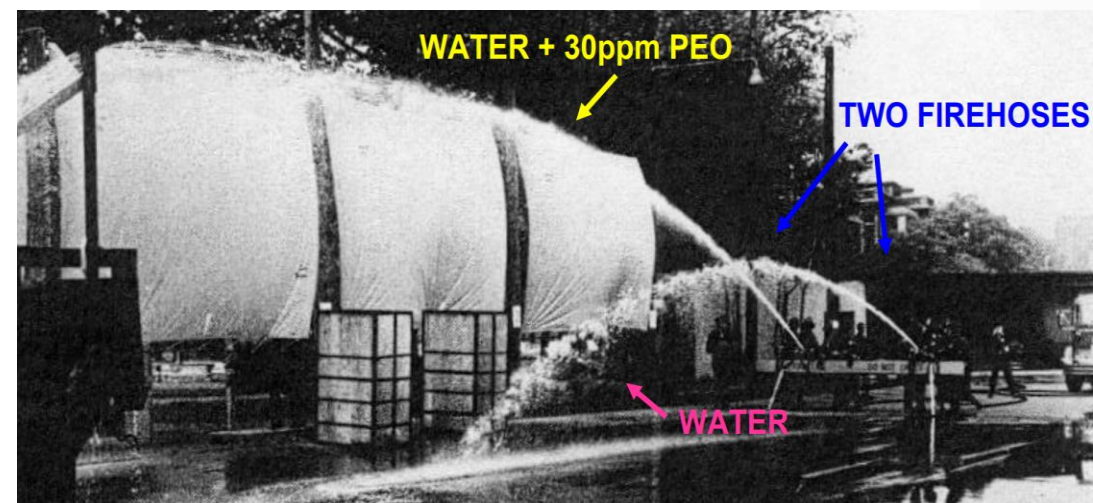
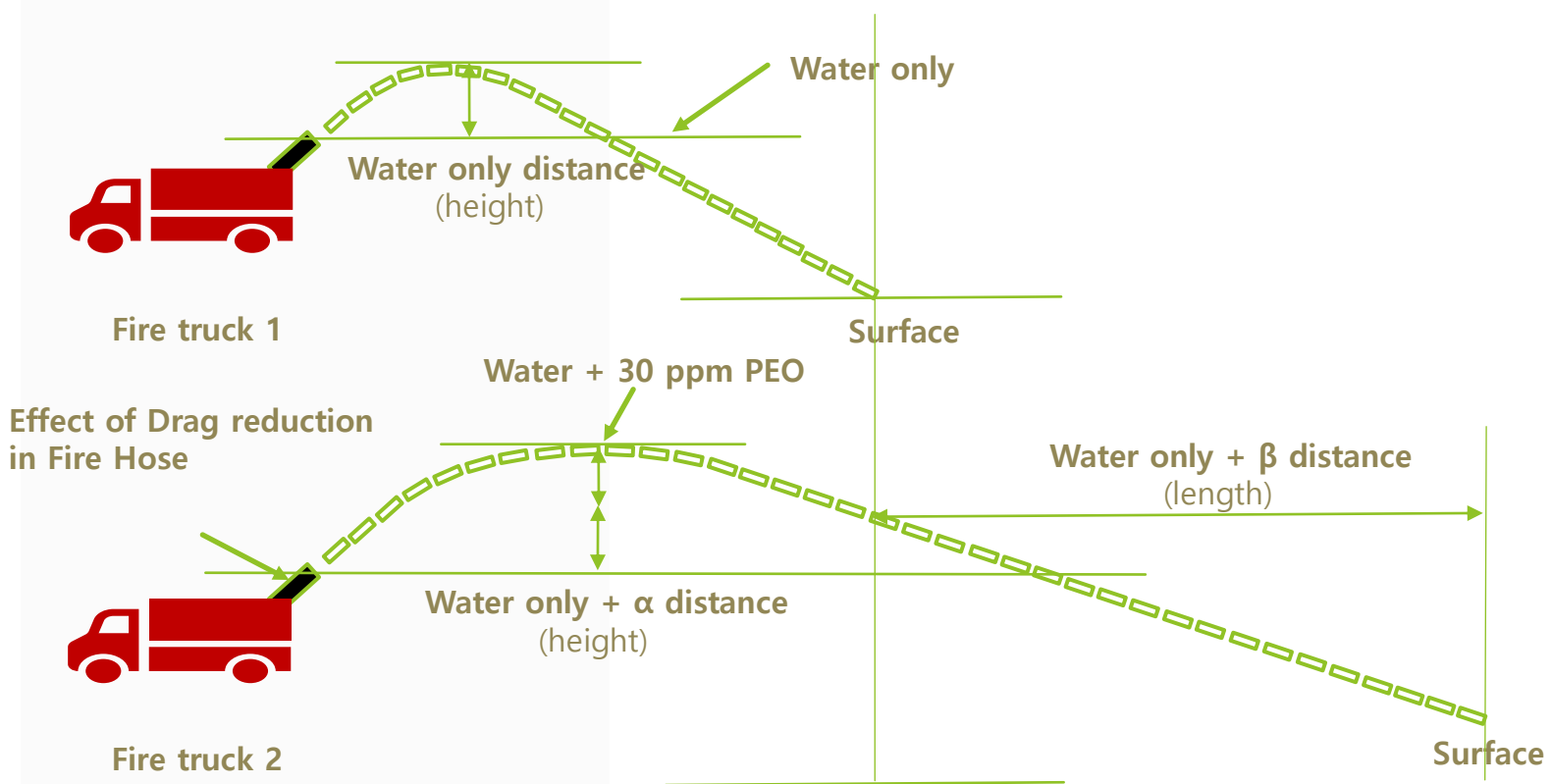
Fuel-saving paint concept



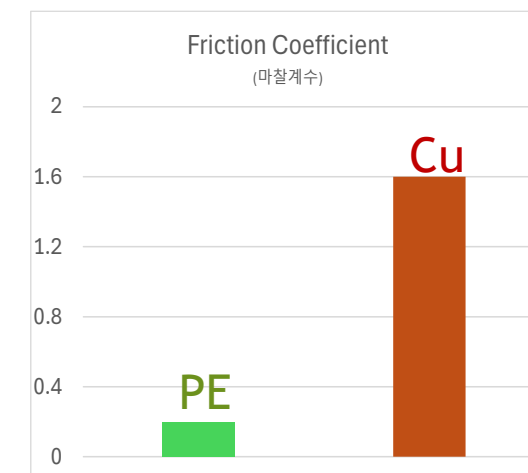
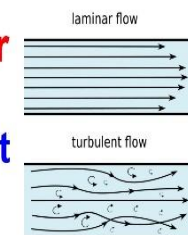
FDR Background technology

Toms effect

- Tom (1949): Dissolve polymer material very thin
- 80% reduction in frictional resistance
- Pipeline application from the 1970s
- Ship's paint application



Laminar & Turbulent Flow



FDR Background technology

(Quote from Role of Bio-Based Polymers on Improving Turbulent Flow Characteristics)

3. Flow Geometry for Turbulence

To study the drag reduction properties, most studies adopted turbulent pipe flow that produces pressure-driven flow within a closed conduit as an internal flow. As shown in Figure 1, there are three flow layers in turbulent pipe flow, including a laminar sublayer (next to the wall), a transitional zone, and a fully turbulent layer (in the center of pipe). With the addition of polymer additives to a pipeline flow system, minute amounts of polymer suppress the formation of turbulent bursts in the buffer region and the propagation of turbulent eddies [40].

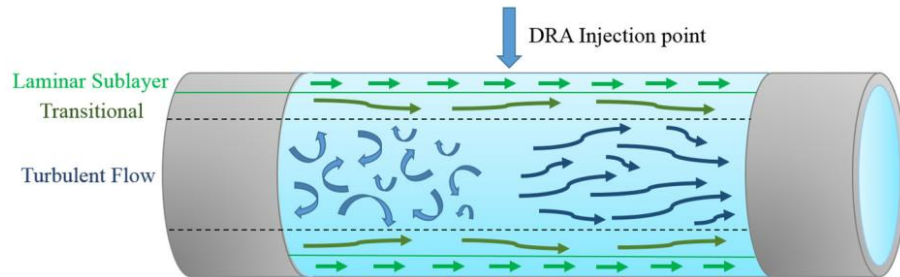


Figure 1. Schematic diagram for the methods of added polymer to a solution with pipeline turbulent flow.

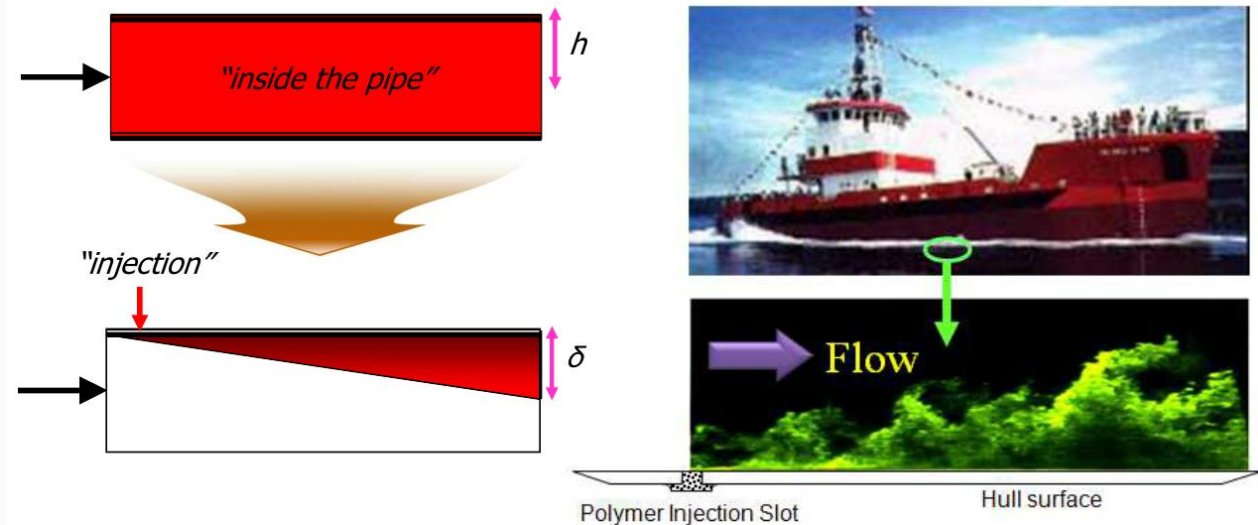
Toms effect & Polymer FDR Agent

Ship application ? Injection holes ? Reliability ?

SPC (Self-Polishing Copolymer) + Polymer DR agent

Friction-reduction paint

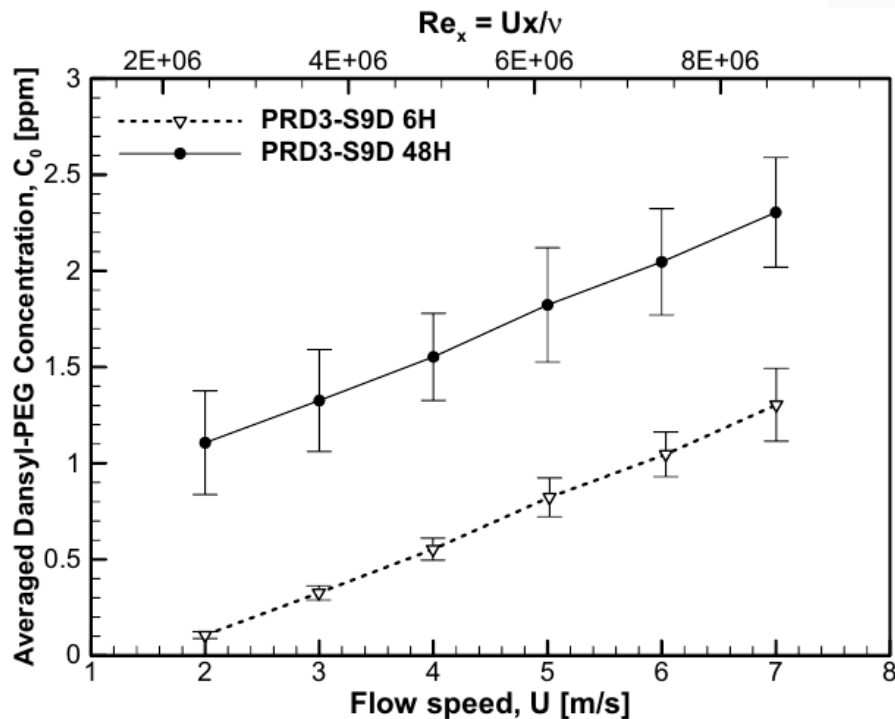
A preliminary study to reduce the hull resistance of the U.S. Navy



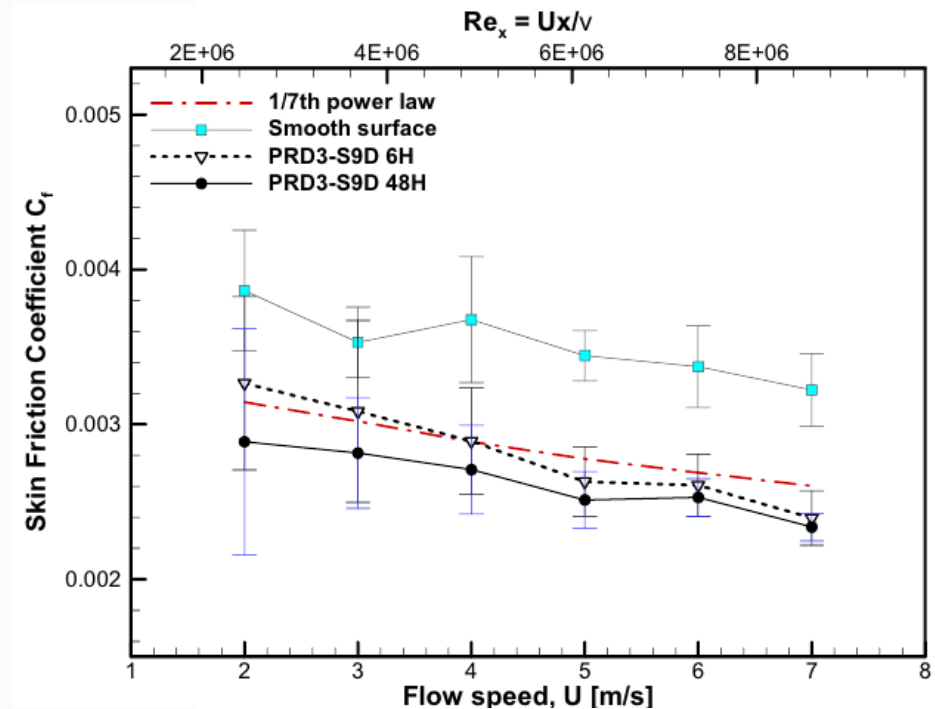
Technical principles

A novel frictional drag reducing self-polishing copolymer (FDR-SPC) was first developed by the authors. The FDR-SPC is a special derivative of an SPC that was designed to achieve skin frictional drag reduction in turbulent water flow by releasing polyethylene glycol (PEG) into water through a hydrolysis reaction.

FDR-SPC elution control for speed



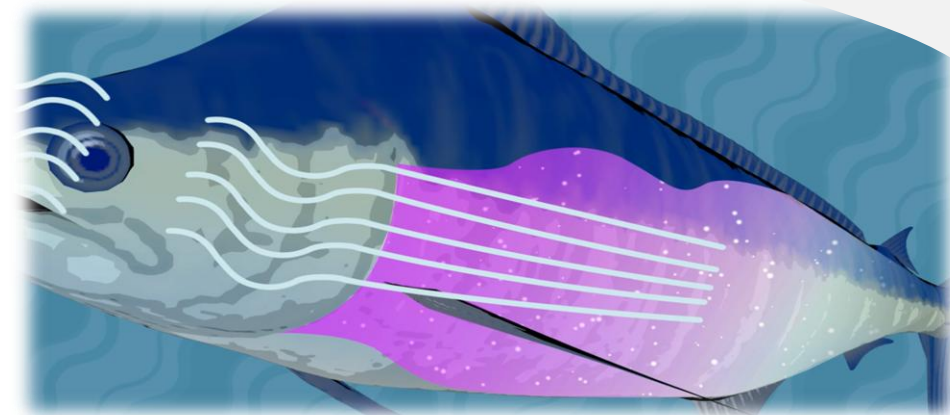
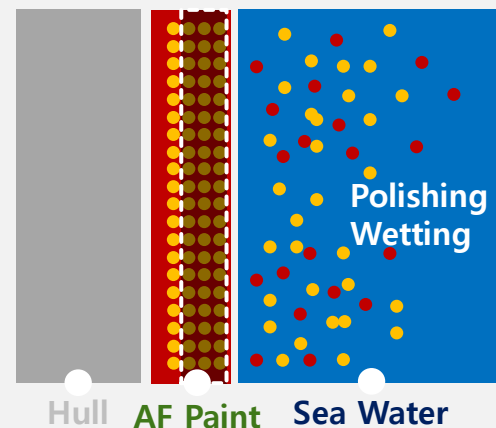
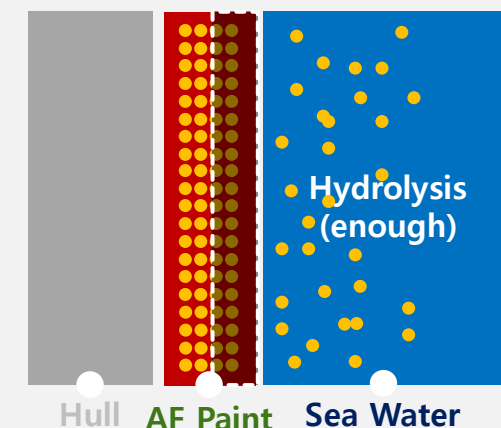
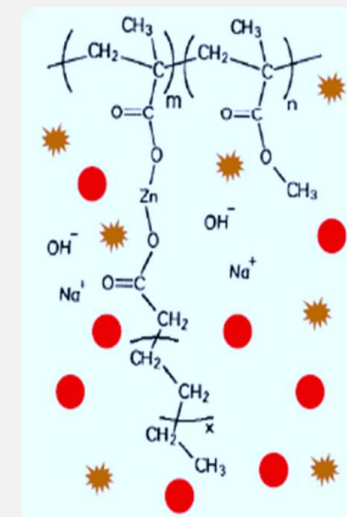
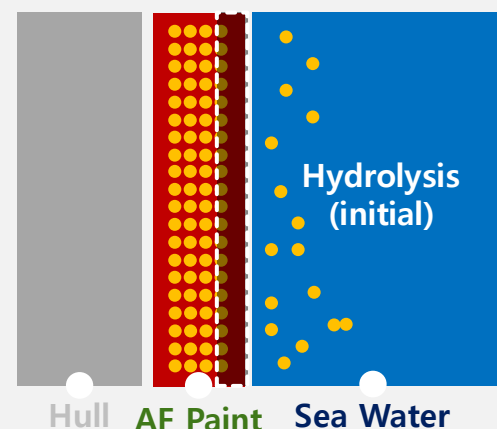
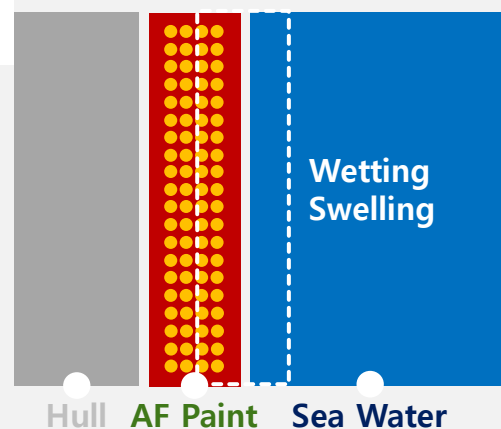
Verifying the coefficient of friction for velocity



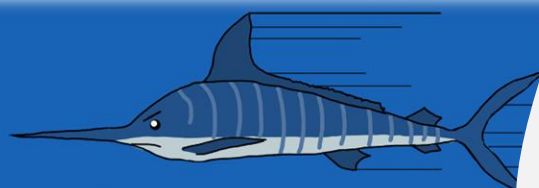
Application of ship's paint

The surface of the fastest fish, the marlin, was applied.

● FDR
● Anti Foultant



STRIPED MARLIN ARE SOME OF THE FASTEST-SWIMMING FISH IN THE SEA, REACHING SPEEDS OF AT LEAST 30 KILOMETERS PER HOUR.



Patent

- ✓ 박현, 이인원, 전호환, 2015, 친수성 폴리머를 포함하는 공중합체 및 이를 포함하는 마찰저항 저감용 조성물, 등록번호 10-1524729-0000, 등록일자 2015.05.26
- ✓ 전호환, 이인원, 박현, 2012, 마찰저항 저감 코팅 조성물, 등록번호 10-1133078-0000, 등록일자 2012.03.28
- ✓ Chun, H. H., Lee, I., Park, H., Chung, W. S. and Jo, N. J., 2011, "Antifouling Paint Composition", 미국특허 7,989,520 B2, 등록일자 2011. 8. 2.





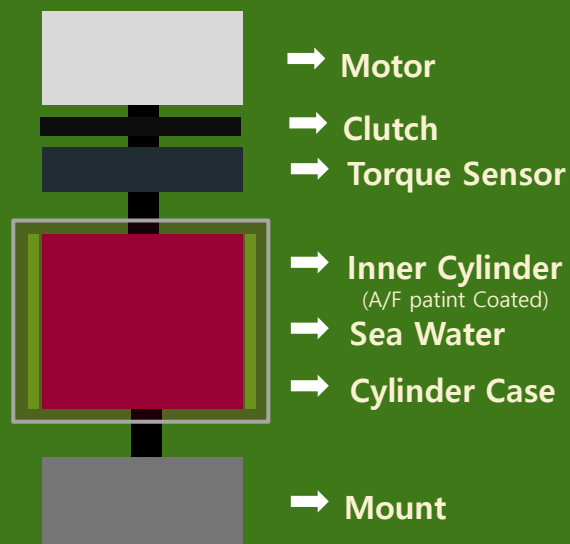
VERIFICATION

Verification

1. **Rotor Test** (Skin Friction Reduction Test)
2. **High-Speed Water Tunnel Test**
(Skin Friction Reduction Test)
3. **Static Immersion Test by HHI**
(Antifouling Performance Test)
4. **Static Immersion Test (During 2 years)**
5. **Patch Test**
(Antifouling Performance Test) / 181K Bulk Carrier
6. **Existing Vessel Verification by ISO 19030**

Rotor Test (Skin Friction Reduction Test)

1-1



▶ Rotor Test I step

- Rotating A/F Paint Coated Inner Cylinder until 500 RPM(equal to 16.3 kts)
A/F 도료를 원통에 도장을 한 상태로 500 RPM으로 Rotor를 기동
- Cut off the Power by Clutching at the 500 RPM
500 RPM에서 Power 를 차단

- Time check from power off to inner cylinder stop

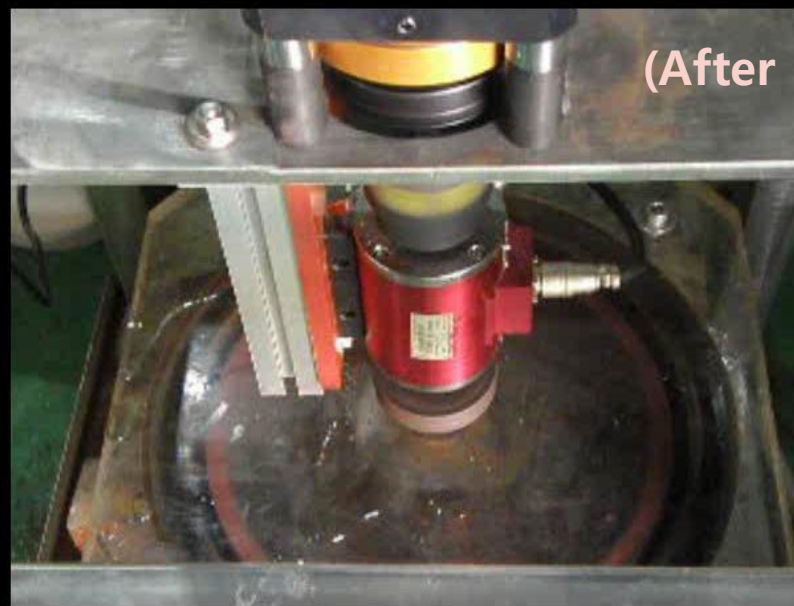
물은 회전에 의해 계속 원주 방향으로 돌며, 도장 마찰력에 의해 Rotor가 정지함에 따라 멈출 때 까지 시간을 Check 한다.

▶ Rotor Test II step (After 6 month inundated state)

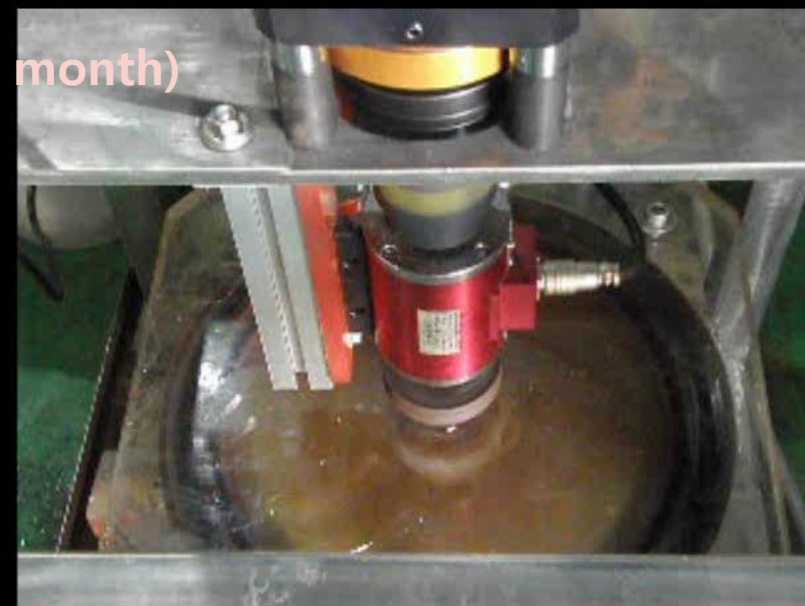
- Rotating A/F Paint Coated Inner Cylinder for 6 month
도장 상태 그대로 6개월 침지 후 Rotor를 재 기동하여 테스트
- Check Troque variations each of A/F Paint Coated Inner Cylinders
Rotor 기동 정지 후 멈출 때 까지 시간을 Check하여 변화를 점검

Conventional A/F Paint
(18.2 sec.)

BN GreenGurad FS
(32.3 sec.)



(After 6 month)



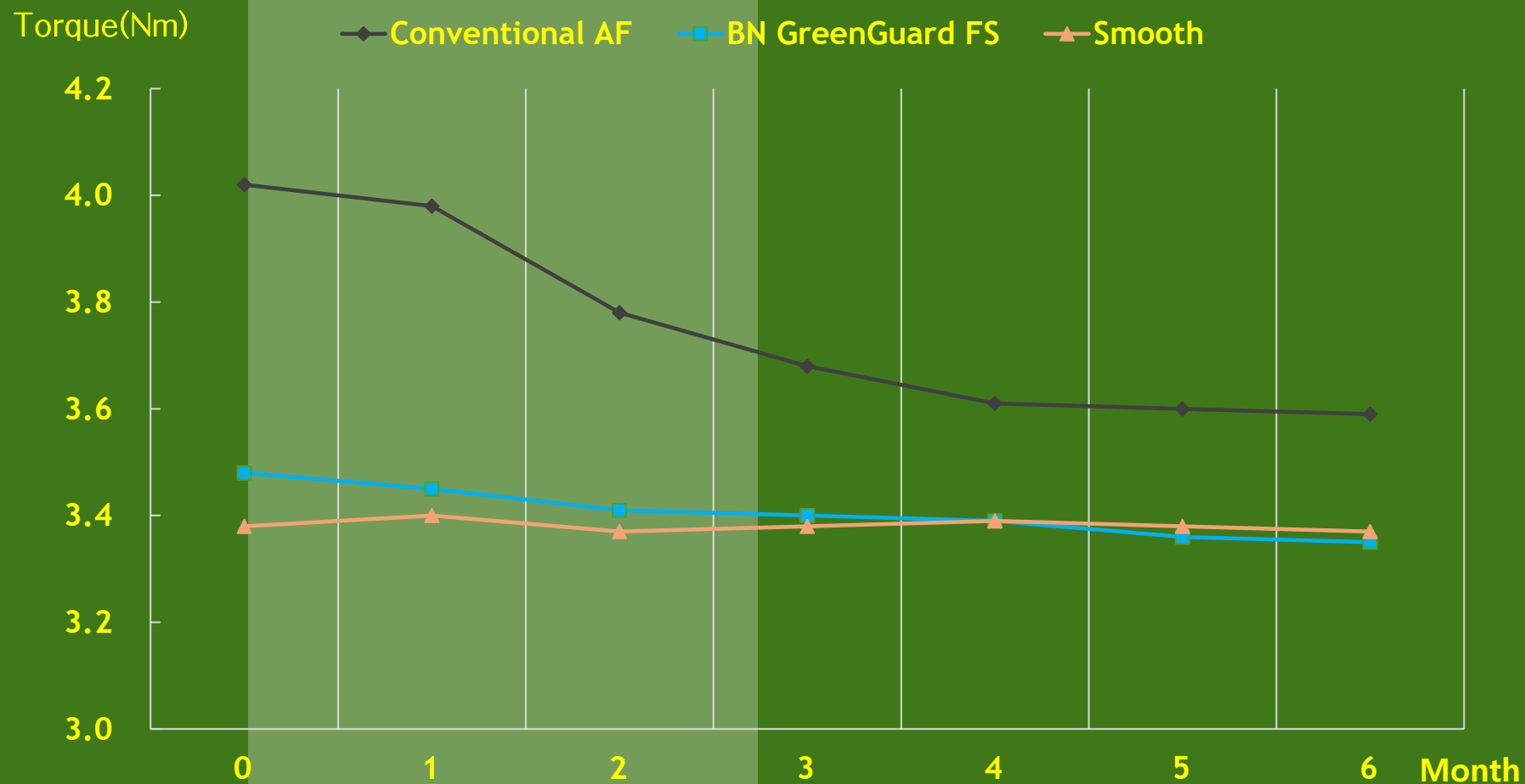
Rotor Test Result (Skin Friction Reduction Test)

1-2

Torque

Average 7.6%
reduction

- Performance was checked monthly for 6 months.
- BN GreenGuard FS Shows avg. 7.6 % Skin Friction Reduction Effect compared with Conventional
- AF in a Chart

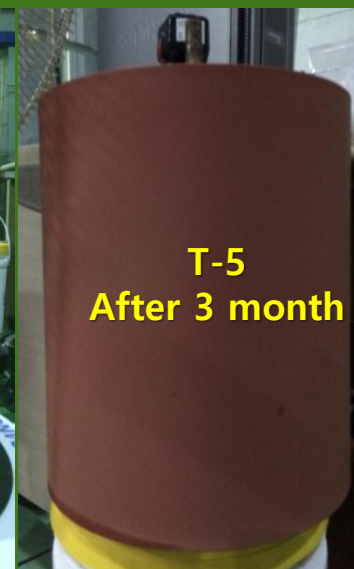
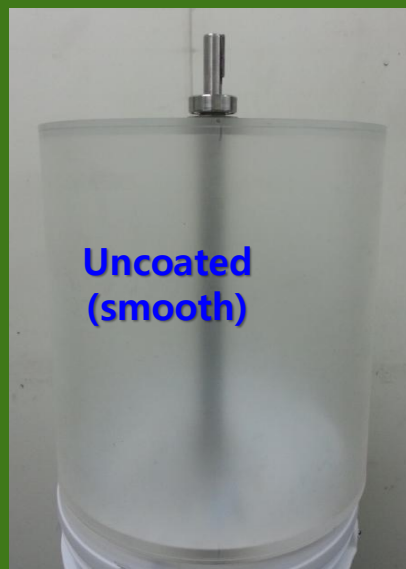
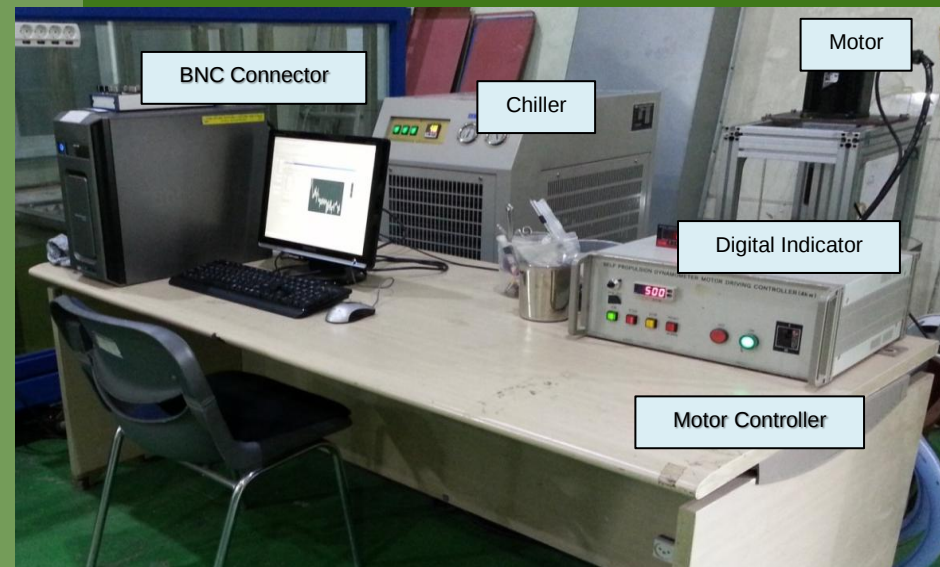


High-Speed Water Tunnel Test (Skin Friction Reduction Test)

1-3

➤ Rotor Torque Measurement

- ✓ Verification of long-term FDR performance : around 6 months



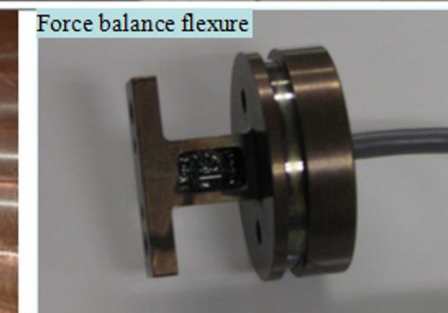
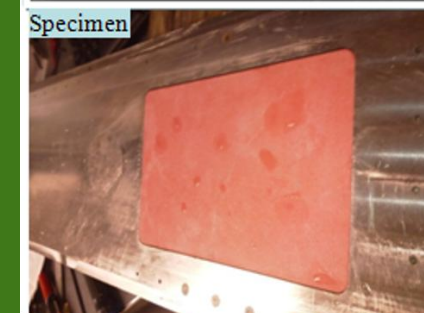
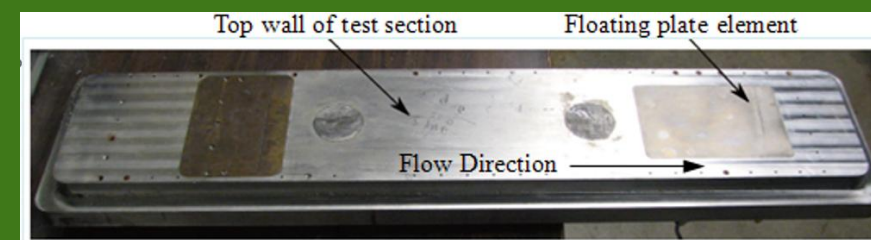
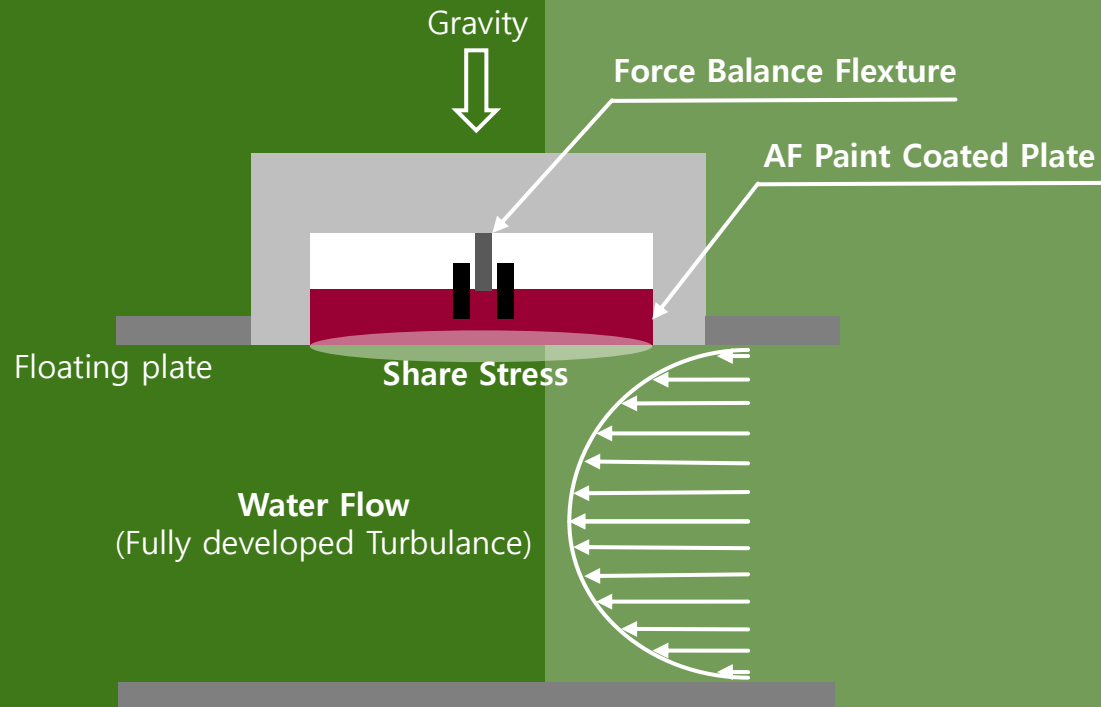
For reference: Various tests are conducted for product development

참조용 : 제품 개발을 위해 여러 시험 시행함

High-Speed Water Tunnel Test (Skin Friction Reduction Test)

2₋₁

- Measure Skin Resistance of Smooth Plate
- Measure Skin Resistance of Reference AF Paint Coated Plates and BN GreeGuard FS Coated Plate.
- Compare Measured Skin Resistance



- ✓ 1/14 scale model of LCC
- ✓ Test section : 0.22m × 0.22m
- ✓ Local skin friction measurement : floating plate balance
- ✓ Performed ONR project : "Skin Friction Testing of Various Coatings"
- ✓ Force balance flexure : shear force measurement on flush-mounted specimen
- ✓ Flow speed : 1.24~10.4 m/s ($Re_x = 1.04 \sim 8.70 \times 10^6$)

High-Speed Water Tunnel Test **Result** (Skin Friction Reduction Test)

2₋₂

Evaluation based on Resistance Reduction Agent Content

C_F results : Average DR effect

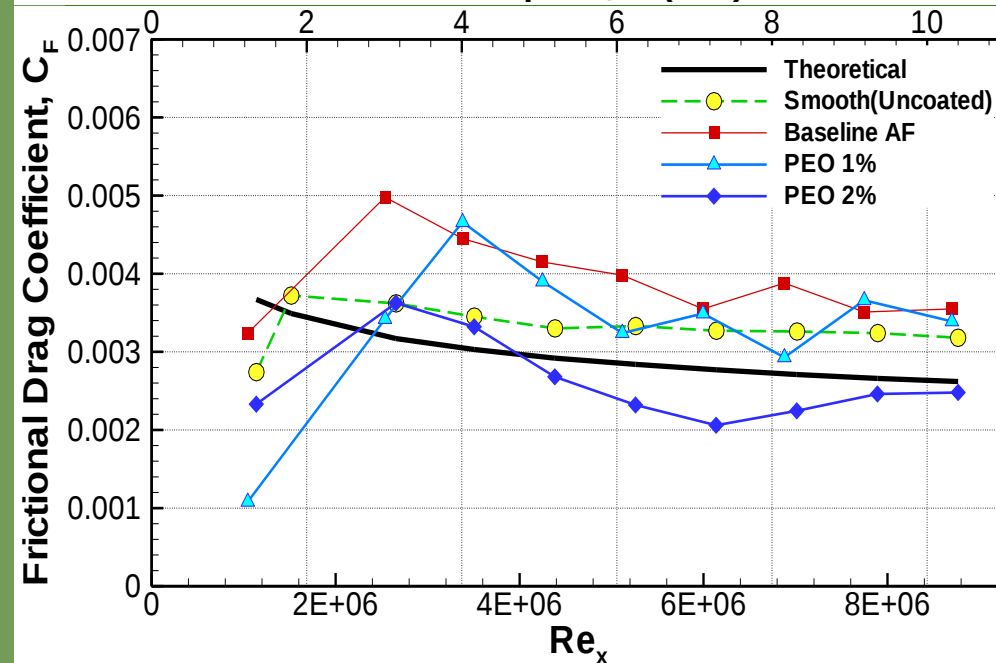
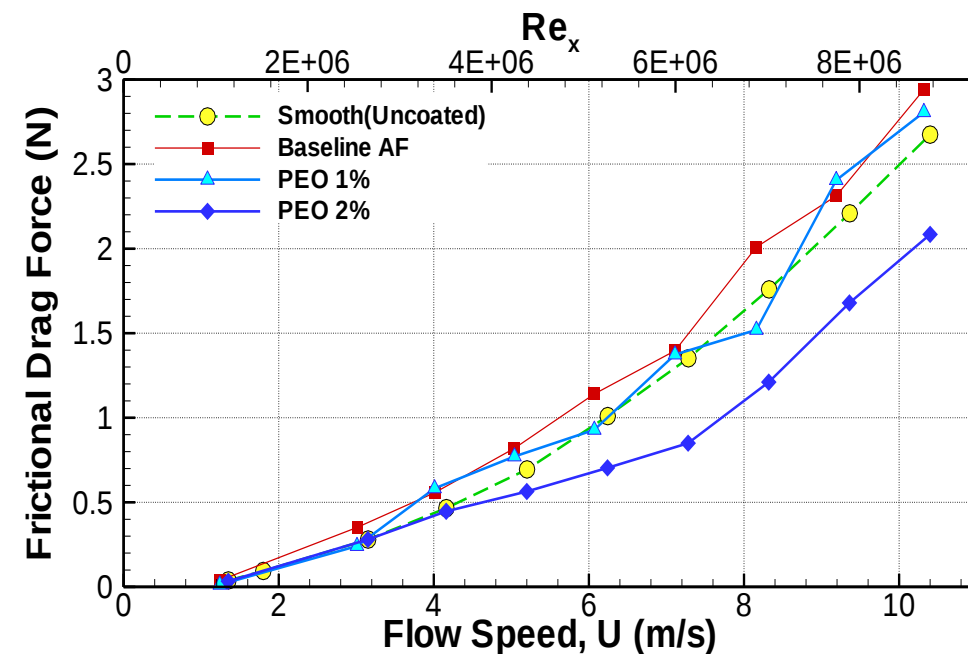
✓ PEO 1%

- 16.0% (rel. to baseline AF, 기존 AF 대비)
- 0.5% (rel. to uncoated, 매끈한 평판 대비)

✓ PEO 2%

- 33.1% (rel. to baseline AF)
- 21.7% (rel. to uncoated)

U(m/s)	$Re_x (\times 10^{-6})$	Uncoated (Smooth)	Baseline AF	PEO 1%		PEO 2%	
		$C_F (\times 10^{-3})$	$C_F (\times 10^{-3})$	$C_F (\times 10^{-3})$	DR(%)	$C_F (\times 10^{-3})$	DR(%)
1.24	1.041	2.74	3.24	1.08	66.67	2.33	26.91
3.01	2.537	3.62	4.98	3.42	31.33	3.63	26.52
4.01	3.379	3.45	4.45	4.66	-4.72	3.32	24.90
5.04	4.249	3.30	4.15	3.90	6.02	2.68	34.98
6.07	5.118	3.33	3.98	3.24	18.59	2.32	41.50
7.11	5.996	3.27	3.55	3.49	1.69	2.06	41.76
8.16	6.879	3.26	3.88	2.93	24.43	2.25	41.93
9.19	7.751	3.24	3.51	3.66	-4.27	2.46	29.65
10.32	8.697	3.18	3.55	3.39	4.51	2.48	29.87

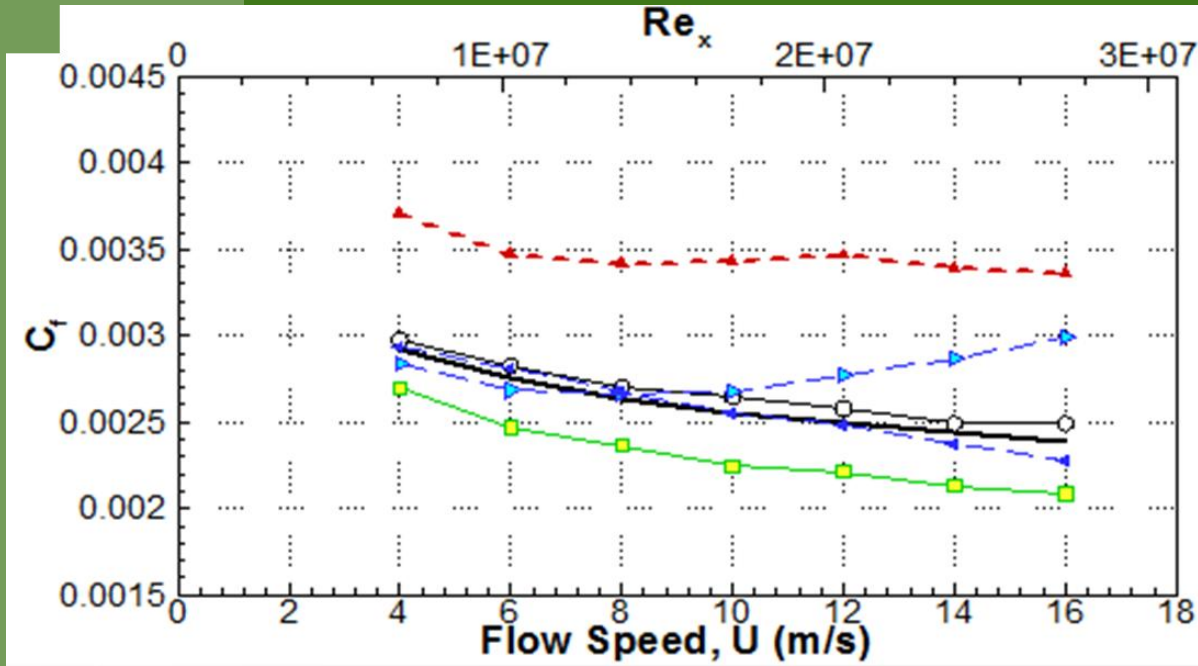
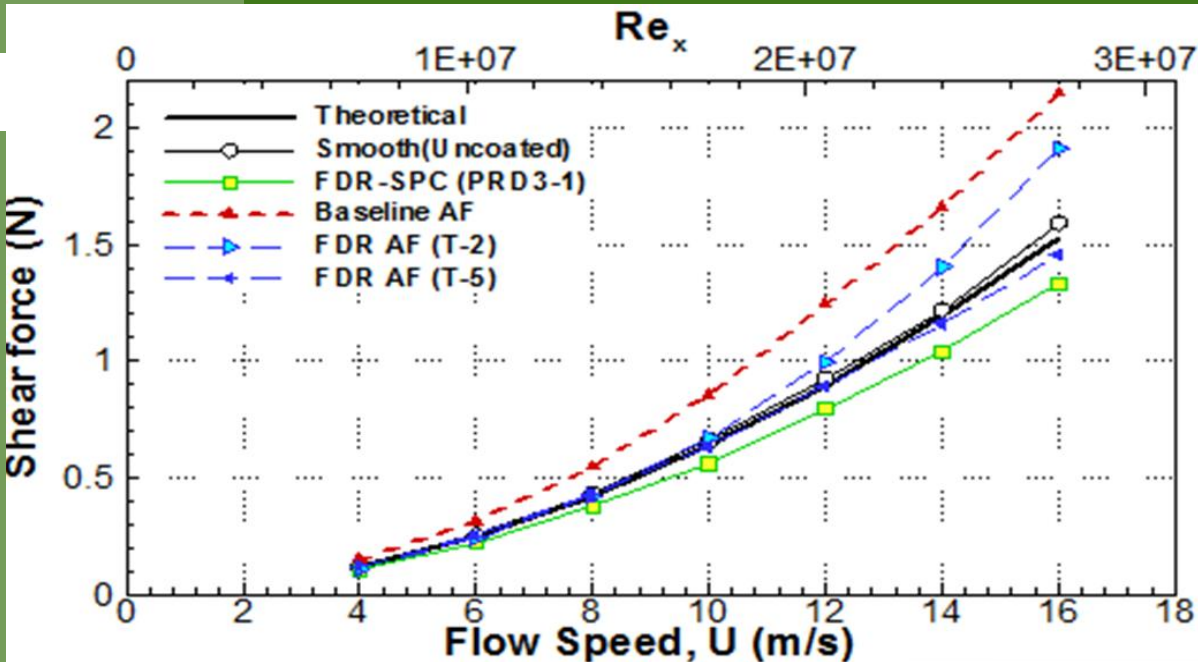


High-Speed Water Tunnel Test Result (Skin Friction Reduction Test)

2-3 Evaluation of Developed Products

- ❖ Compared to Smooth
 - . PRD3-1 : Avg. 13.53 % reduction
- ❖ Compared to Baseline AF
 - . Development paint T-2 : Avg. 19.54% reduction
 - . Development paint T-5 : Avg. 25.38 % reduction

U(m/s)	Re _x (×10 ⁻⁶)	Uncoated (Smooth)		FDR-SPC (PRD3-1)		Baseline AF		FDR-AF (T-2)		FDR-AF (T-5)	
		C _F (×10 ⁻³)	DR(%)	C _F (×10 ⁻³)	DR(%)	C _F (×10 ⁻³)	DR(%)	C _F (×10 ⁻³)	DR(%)	C _F (×10 ⁻³)	DR(%)
4	6.85	2.977	9.30	2.700	3.708	2.838	23.46	2.935	20.85		
6	10.28	2.829	12.65	2.471	3.472	2.684	22.70	2.813	18.98		
8	13.71	2.708	12.74	2.363	3.415	2.665	21.96	2.677	21.61		
10	17.14	2.646	15.12	2.246	3.431	2.674	22.06	2.551	25.65		
12	20.56	2.580	14.26	2.212	3.467	2.771	20.07	2.485	28.32		
14	23.99	2.491	14.41	2.132	3.392	2.869	15.42	2.374	30.01		
16	27.42	2.490	16.18	2.087	3.362	2.989	11.09	2.279	32.21		



High-Speed Water Tunnel Test **Result** (Skin Friction Reduction Test)

2⁻⁴

Friction

**Average 25.4%
reduction**



- BN GreenGuard FS Shows avg. 25.4% Skin Friction Reduction Effect compared with Conventional AF



Static Immersion Test by HHI (Antifouling Performance Test)

3₋₁

▶ Test&Verification Company

- Hyundai Heavy Industry Co., Ltd.

▶ Test Place (Korea)

- Ulsan(Bangeojin), Gyeongsangnam-do(Geoje), Busan(Dadaepo)

▶ Test Period

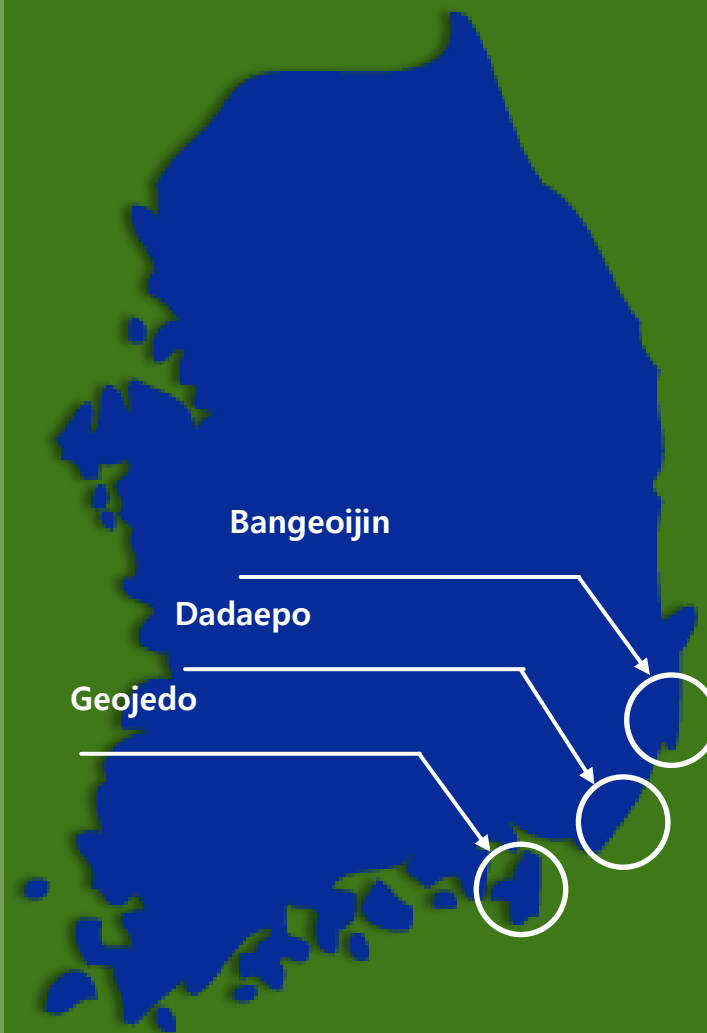
- 6 Month('14. April ~ '14. October)

▶ Test Method

- Collected AF Paint on sale from Manufacturer
- AF Paint Coated to the Test Plate by HHI
- Performed Immersion Test at the 3 Places for 6 Month
- Checked Immersion Test Execution Result

▶ Verification Method

- Visual Inspection after 6 month by HHI



Static Immersion Test by HHI (Antifouling Performance Test) / Bangeojin

3₋₂

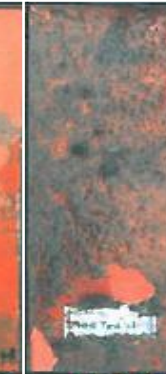


	A	B	C	D	E	F	G	H	I
Manu- facturer	K	K	N	C	J	I	BN Chemical	BN Chemical	Silicone Paint
Product Type							BN GreenGu ard CF	BN GreenGu ard FS	
After 1 Month (Jun)									
After 5 Month (October)									

Static Immersion Test by HHI (Antifouling Performance Test) / Dadaepo

3₋₃

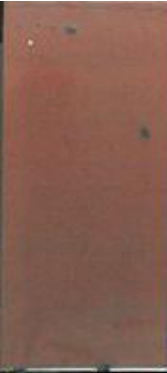


	A	B	C	D	E	F	G	H	I
Manu- facturer	K	K	N	C	J	I	BN Chemical	BN Chemical	Silicone Paint
Product Type							BN GreenGu ard CF	BN GreenGu ard FS	
After 1 Month									
After 6 Month									

Static Immersion Test (Antifouling Performance Test) / Geojeodo

3⁻⁴



	A	B	C	D	E	F	G	H	I
Manu- facturer	K	K	N	C	J	I	BN Chemical	BN Chemical	Silicone Paint
Product Type							BN GreenGu ard CF	BN GreenGu ard FS	
After 1 Month									
After 6 Month									

Static Immersion Test Report (Company(HHI) Internal)-2

3-5

5) 방오 성능 평가 결과

- ① 침적 1개월 부터 표면에 식물성 파울링이 생성되기 시작함.
- ② 침적 6개월에 BN 케미칼 방오도료를 제외하고 모든 제품에서 동물성 파울링이 생성되기 시작함(다대포 및 거제).
- ③ 방어진(KCC), 다대포(BN), 거제도(IP)의 해양환경 차이로 해양생물의 부착 속도 차이가 발생함.
 - ☞ 동해에 근접한 방어진에서는 5개월 까지 동물성 파울링이 없음.
 - ☞ 남해안 환경에 가까운 다대포 및 거제도는 동물성 파울링 발생 속도가 빨라짐
- ④ 마찰 저감 방오도료가 대조군 대비 유사한 방오성능을 가짐.
- ⑤ G, H 도료는 모든 환경에서 우수한 방오 성능을 확보하고 있어, 기존 도료와 비교 검토 후 확대 적용이 기대됨.

5) Antifouling Performance Evaluation Results

- ① Plant fouling begins to form on the surface one month after immersion
- ② Animal fouling starts to be produced in all products except BN chemical antifouling at 6 months of immersion. (Dadaepo and Geoje)
- ③ Differences in the attaching speed of marine life occur due to differences in the marine environment of Bangeojin, Dadaepo, and Geoje Island.
 - ☞ No animal fouling until 5 months in defense close to the East Sea.
 - ☞ Dadaepo and Geoje Island, which are close to the southern coastal environment, have a faster occurrence of animal fouling.
- ④ Friction reduction antifouling paint has similar antifouling performance compared to the control group.
- ⑤ G.H Chemical has excellent antifouling performance in all environments, so it is expected to be expanded after comparative review with existing paints.

Static Immersion Test by SeaHawk / California (USA)

- Period : Apr. ~ Sep. 2017 (5 months)
- Place : Florida / USA
- Owner : Erik Norrie(CEO), Mario Garneau(CTO)
enorrie@seahawkpaints.com / mario@seahawkpaints.com

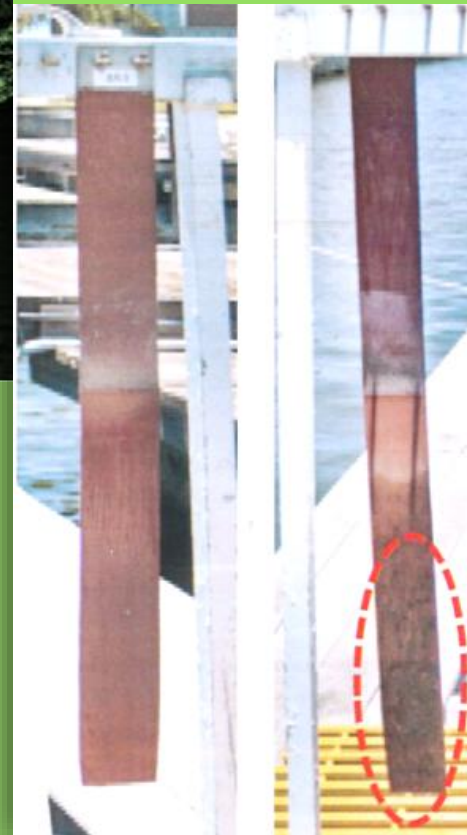
EMPLOYEE SPOTLIGHT — Mario Garneau



AkzoNobel

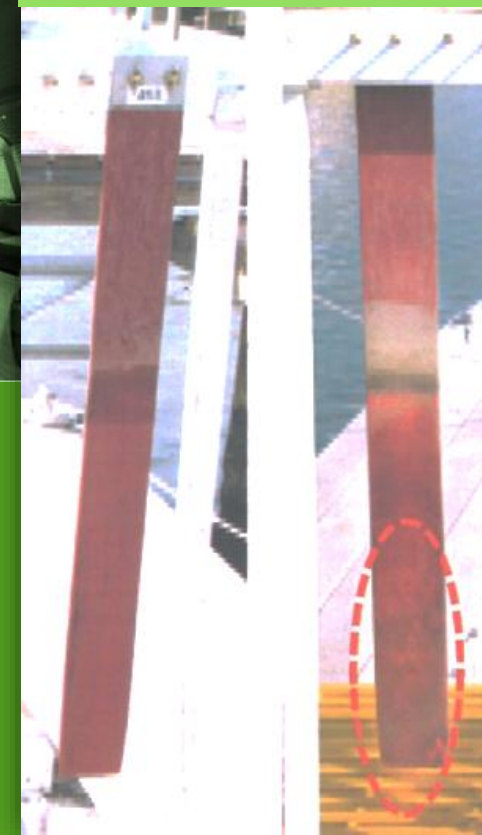
“I have never had to scrub with any pressure to remove algae. it is always one or two light passes with the soft side of a sponge and panel looks brand new the waterline cleans easily, and i have never witnessed more than 1 barnacle growing”
(commented by Mario garneau on Sep.30'17)

2 months exposure



Very light and loosely attached algae

5 months exposure

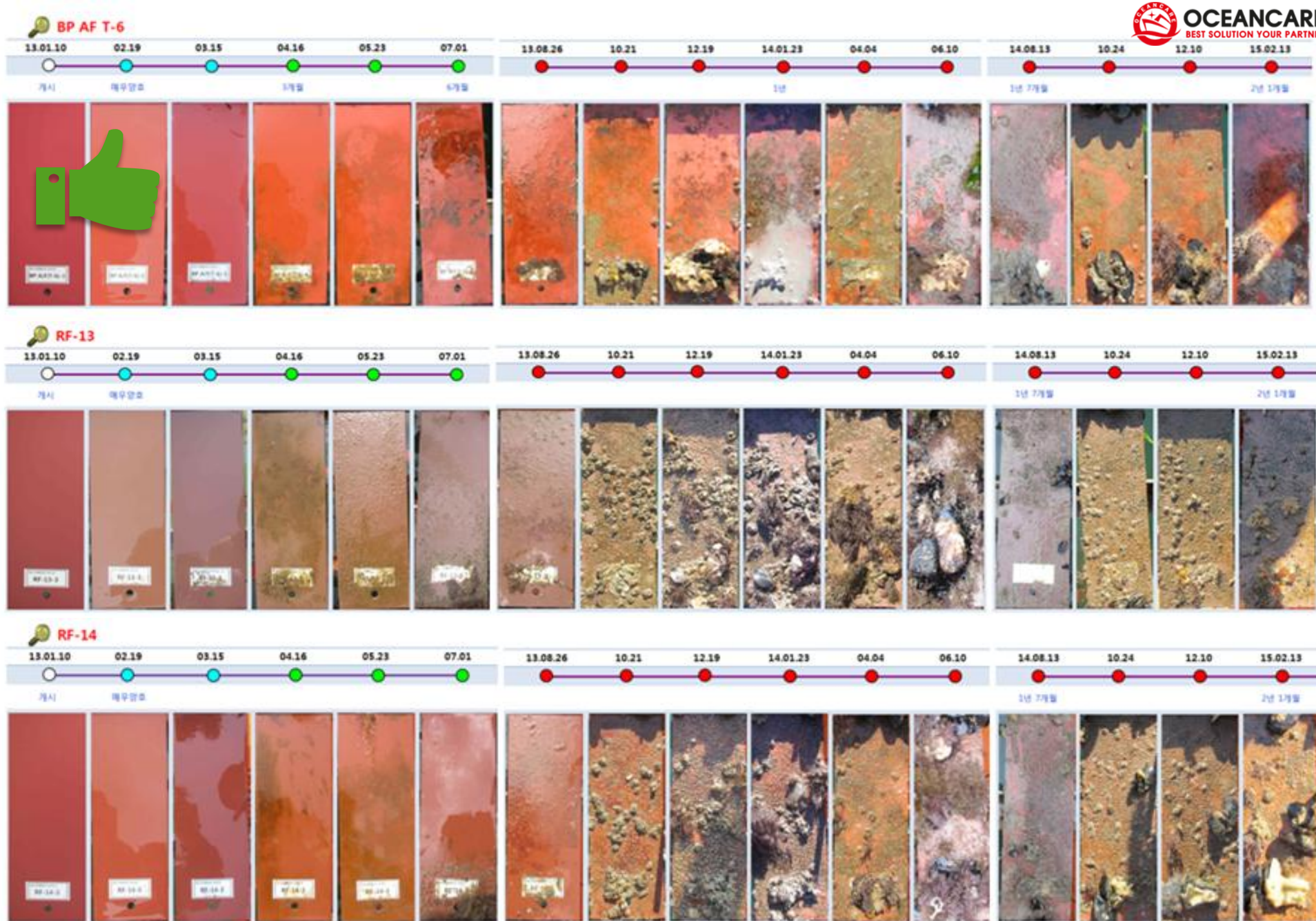


Very light.
No barnacles growing

Static Immersion Test (During 2 years)

4

- ❖ **Period**
 - 2 years
(1 Jan. 13 ~ 13 Feb.15)
- ❖ **Method**
 - Long term Immersion
(장기 침지 시험)
- ❖ **Place**
 - Dadaepo/Busan
- ❖ **Sample (3 makers)**
 - functional low-friction paint (저마찰도료)
 - Our product 1 type
 - Global maker 2 type

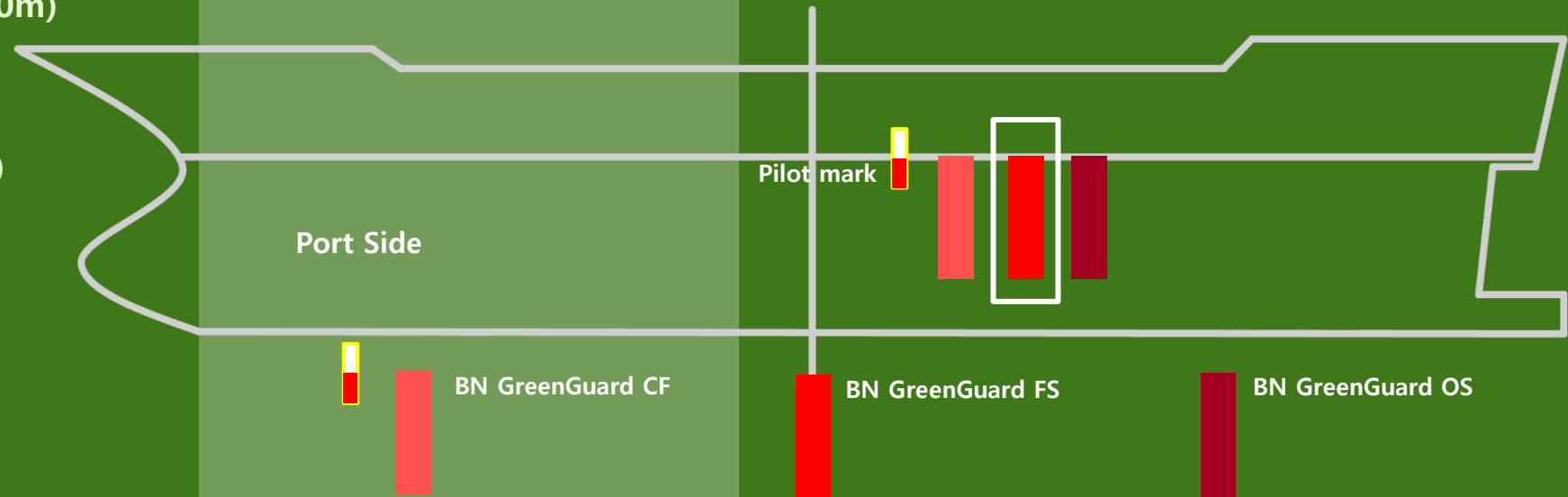


Patch Test (Antifouling Performance Test) / 181K Bulk Carrier

5₋₁

- Name of vessel : M/V "NEW JOY"
- Tonnage : DWT 149,297(Cape size)
- Test Period : Dock('13 Jun) to Next Dock
- Manag. company : STX MARINE SERVICE
- Place of dockyard : Shanhaikwan in China
- Apply : BN GreenGuard Series (2m x 10m)
- Method : Visual inspection

Spot patch up test (During 36 months)



Patch Test (Antifouling Performance Test) / 181K Bulk Carrier

5₋₂



Port Side



Starboard Side

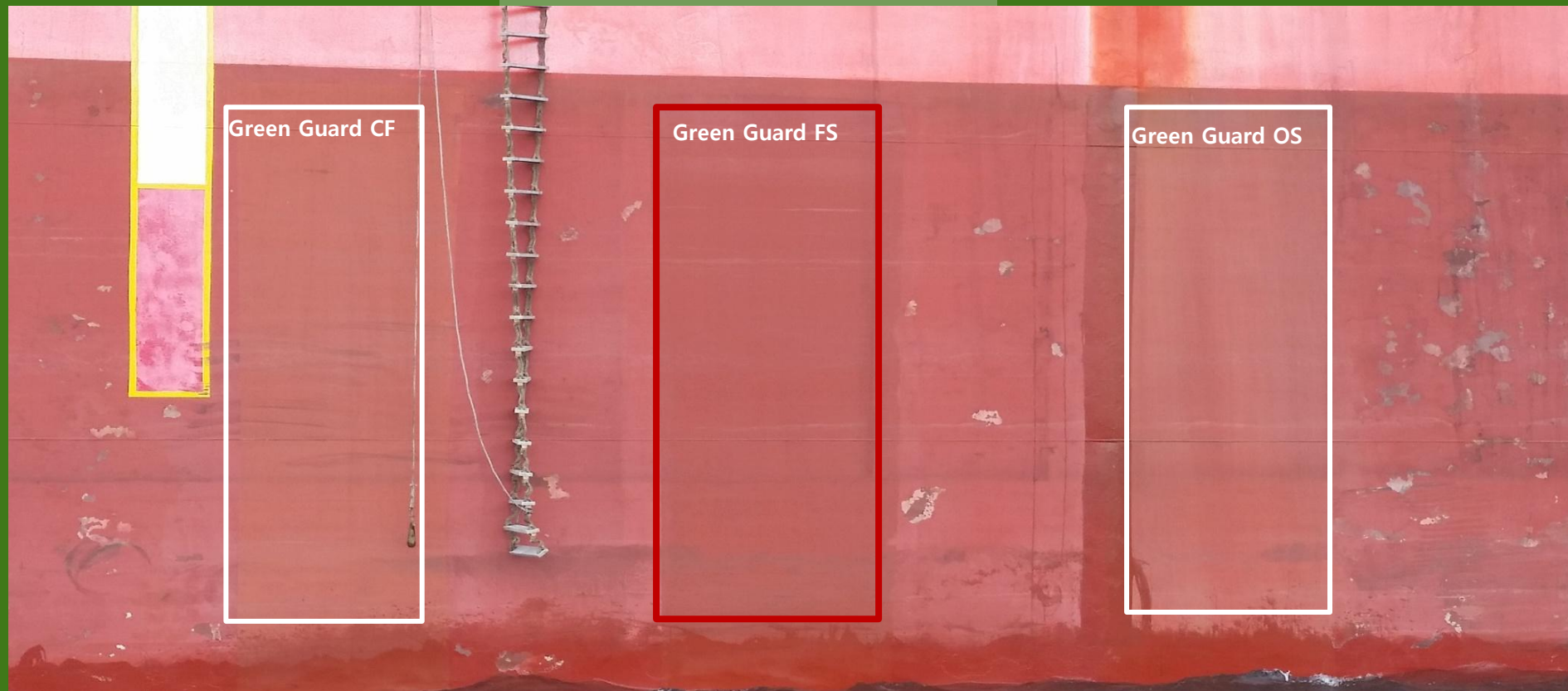
Patch Test (Antifouling Performance Test) / 176K Bulk Carrier

5₋₃

- **Intermediate Inspection ('15. August)**
 - Keep a reliable Antifouling Condition

After 31 months

Excellent condition



Port Side

Adhesive performance

5₋₄

It is very good (Grade 5A) for compatible adhesion with other maker products.
 여러 메이커 제품과 접착력 검증결과 매우 우수한 Grade 5A 등급 검증

Specimen	Viscosity (KU)	Specific Gravity	Solid Volume Ratio (SVR, %)	Sagging Res. (W.F.T, μ m)	Particle size (μ m)	Non-volatility (N.V, %)
T-2	89.3	1.72	62.9	350	30	80.67
T-5	104.1	1.73	55.9	600	35	75.99
T-6	102.5	1.55	53.3	500	40	72.65
T-6A	96.0	1.58	65.0	500	30	81.43

Specimen			Commercial Control		
T-2	T-5	T-6A	RF-05	RF-13	RF-14
5A	4A	4A	3A	5A	3A
					



Existing Vessel Verification by ISO 19030

6₋₁

- ✓ Ship Yard : NTS
- ✓ LOA(m) : 291.8 , Breadth(m); 16.6
- ✓ Deadweight(M/T): 175,132.6(S.S.W) Designed Speed(kts): 14.9
- ✓ M/E Engine: MAN B&W 6S70MC (16,860kW x 91RPM)



Event	Time/period	AF Coating	Voyage no.
SPMS Installation (Ship Performance Monitoring System)	Nov. 2014		
1 st service period (5years, data available only for the 5 th year after SPMS installation)	Dec.2014 ~ Nov.2015	Conventional	Ballast / Laden 29~37
Relative wind speed and direction	Nov. 2015		
Ship heading	Nov.2015~Nov.2018	FDF	Ballast / Laden 38~63
Shaft revolutions	Dec. 2018		
Static draught fore and aft	Jan. 2019~Dec.2019	Conventional	Ballast / Laden (64~75)



Existing Vessel Verification by ISO 19030

6-1

■ Collected data

Data Exclusion Conditions

- Abnormal data (sensor malfunction, fault, etc.)
- Data with large variation (during acceleration/deceleration, turning, etc.)
- After dividing the data into 10-minute increments to obtain the mean value and standard deviation, remove the Outlier using Chauvenet's Criteria

Items	Unit	Filtering	Validation ^{R1)}	Correction
Speed over ground	[knots]	10.0 ~ 16.5	Standard deviation less than 0.5knots	-
Shaft Power	[kW]	4,000~20,000	-	-
Relative wind speed and direction	[knots],[°]	Less than 15.6 knots (Less than BF 4)	- [°]	Using a correction method ISO1506
Ship heading	[°]	-	-	-
Shaft revolutions	[min ⁻¹]	-	Standard deviation Less than 3 RPM	-
Static draught fore and aft	[m]	-	-	-
Water depth	[m]	-	-	-
Rudder angle	[°]	± 5 °	Standard deviation Less than 1 °	-
Seawater temperature	[°]	More than 2 °	-	-

- 1) Validation ^{R1)}: If the standard deviation of each block does not meet the above criteria, the entire block is removed by dividing the data into blocks in 10-minute increments
- 2) Speed-power displacement can be calibrated with an Admiralty formula within the actual displacement ± 5%
- 3) Speed-Power Trim is only available if it is within ±Lpp, ± 0.2% of the actual Trim

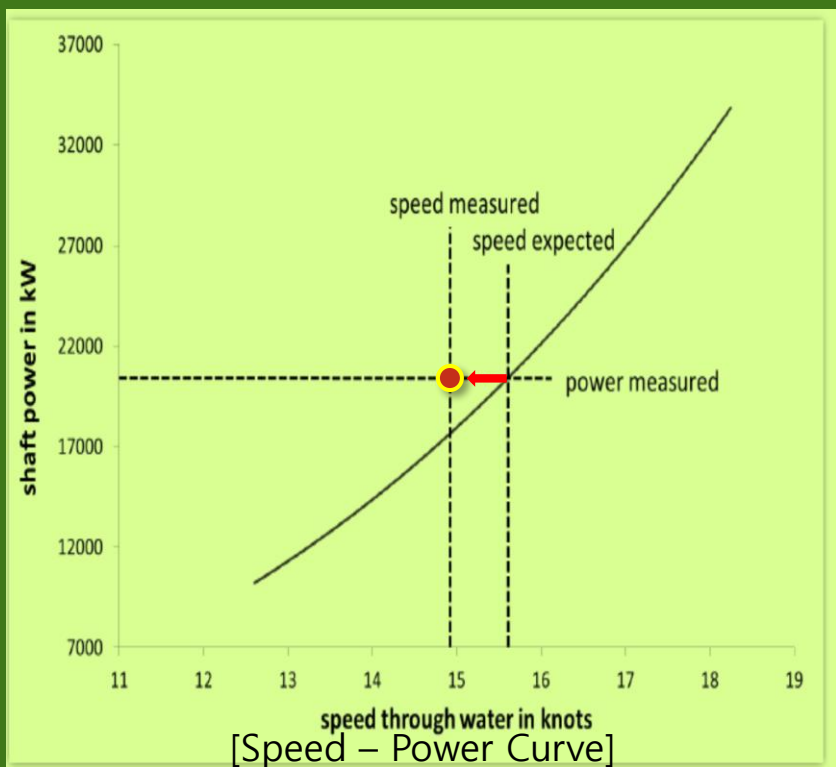
- 1) Validation^{R1)} : 데이터를 10분 단위로 블록으로 나누어 각 블록의 표준편차가 상기 기준을 부합하지 않을 경우 블록 전체 제거
- 2) Speed-power 의 Displacement는 실제 Displacement ± 5%이내에서 Admiralty formula로 보정하여 사용 가능
- 3) Speed-Power의 Trim은 실제 Trim의 ±Lpp , ± 0.2%이내인 경우에만 사용 가능

Existing Vessel Verification by ISO 19030

6₋₂

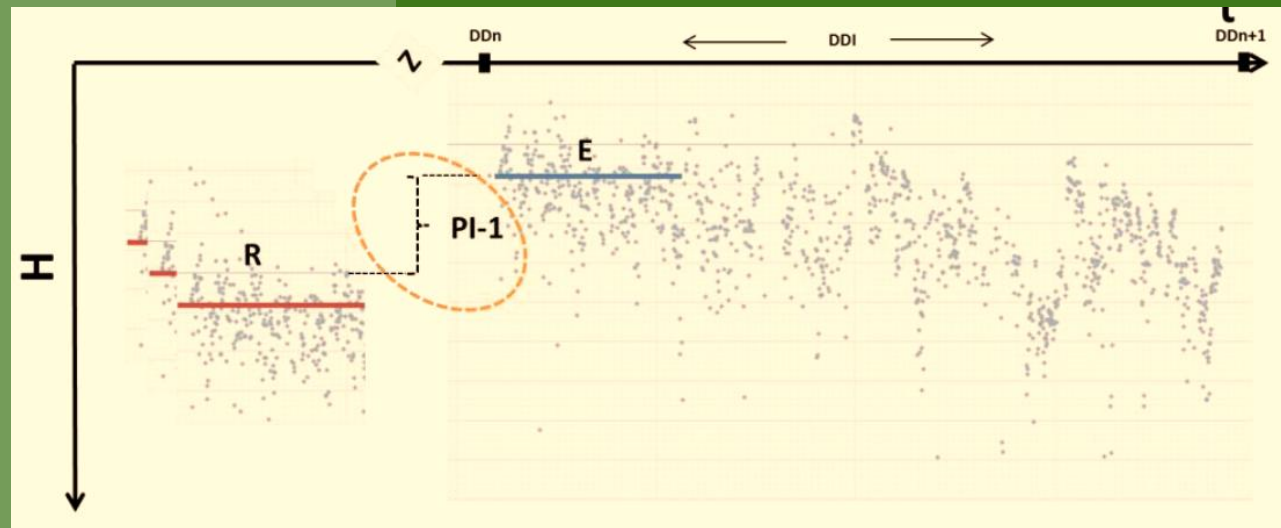
Performance Value Calculation

- ✓ Performance Value : (measured speed-expected speed)/expected speed x 100(%)
- ✓ Speed -power curve
 - ISO15016에 부합하는 방법으로 수행한 시운전 결과
 - 모형 시험 결과



ISO/DIS 19030 : Standard for the in-service performance analysis

- ✓ Ships and marine technology — Measurement of changes in hull and propeller performance
- ✓ The relationship between the condition of a ship's underwater hull and propeller and the power required to move the ship through water at a given speed



$$P_D = \frac{R_T V}{\eta_D}, \quad R_T = R_{SW} + R_{AA} + R_{AW} + R_{AH}$$

$$R_{AH} = \frac{P_D \times \eta_D}{V} - (R_{SW} + R_{AA} + R_{AW})$$





Existing Vessel Verification by ISO 19030

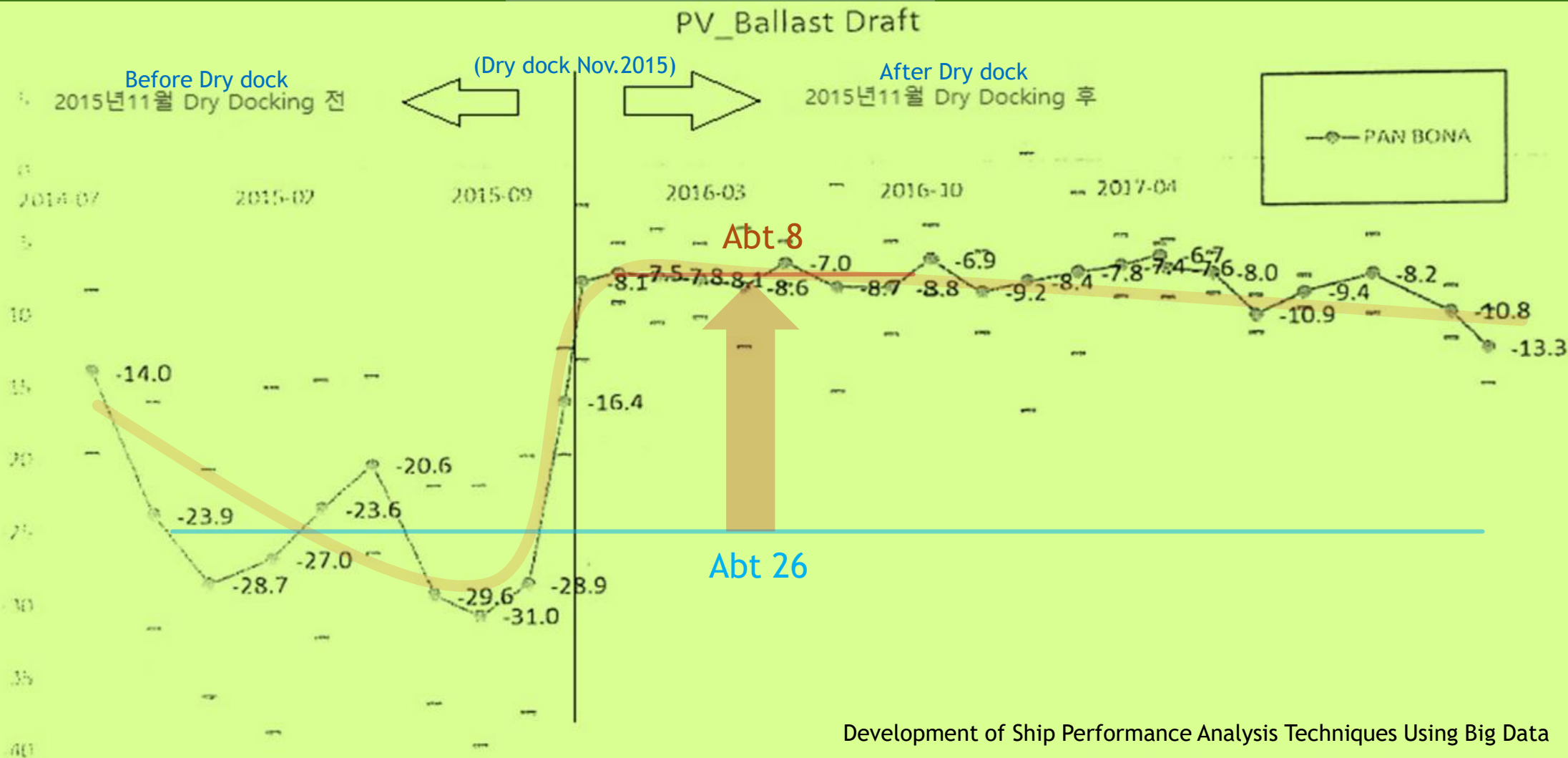
6-3

[Confirmation of Friction Resistance Reduction, 마찰저항저감 확인]

- Results after 32 months of solid line application
- Confirmation of performance improvement when comparing PV values before and after BN GreenGuard FS painting.

실선 적용 32 개월 후 결과

BN GreenGuard FS 도장 전/후 PV 값 비교 시 성능 향상 확인.



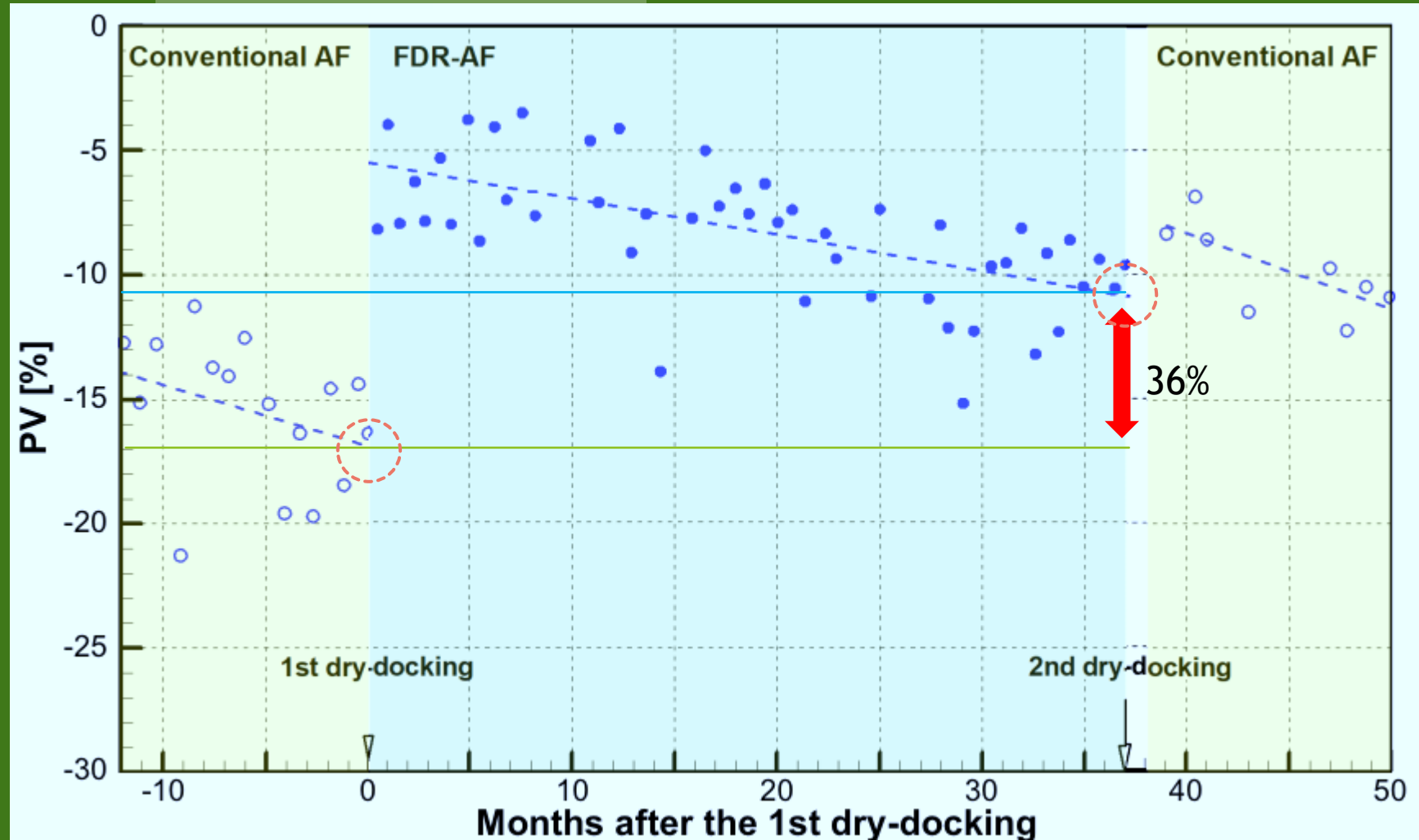
Existing Vessel Verification by ISO 19030

6₋₄

PV

Average 36%
Improvement

Comparison before DD



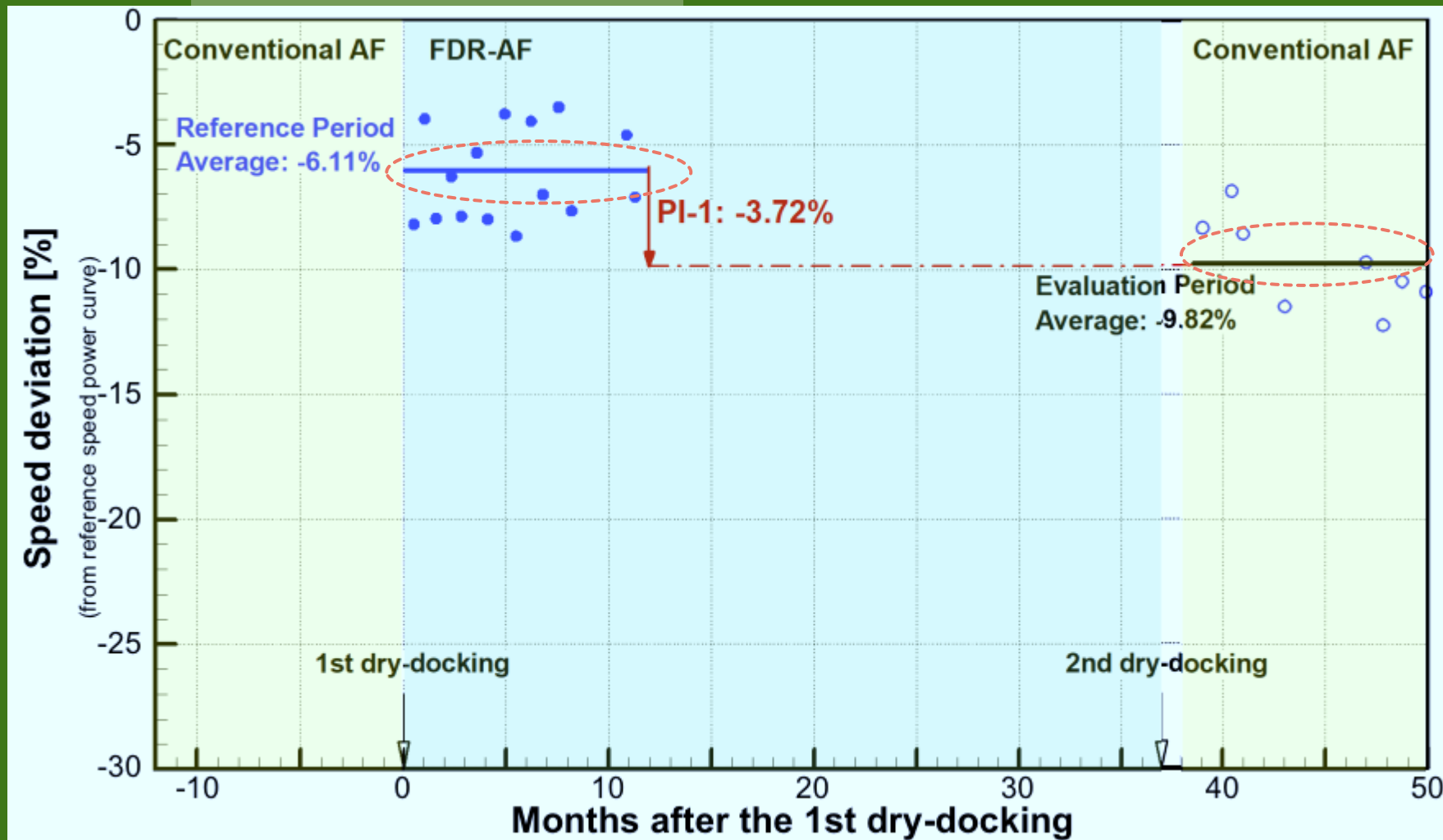
Existing Vessel Verification by ISO 19030

6⁻⁵

SPEED

Average 3.72%
Improvement

Aft Dry dock



Existing Vessel Verification by ISO 19030

6₋₆

SPEED

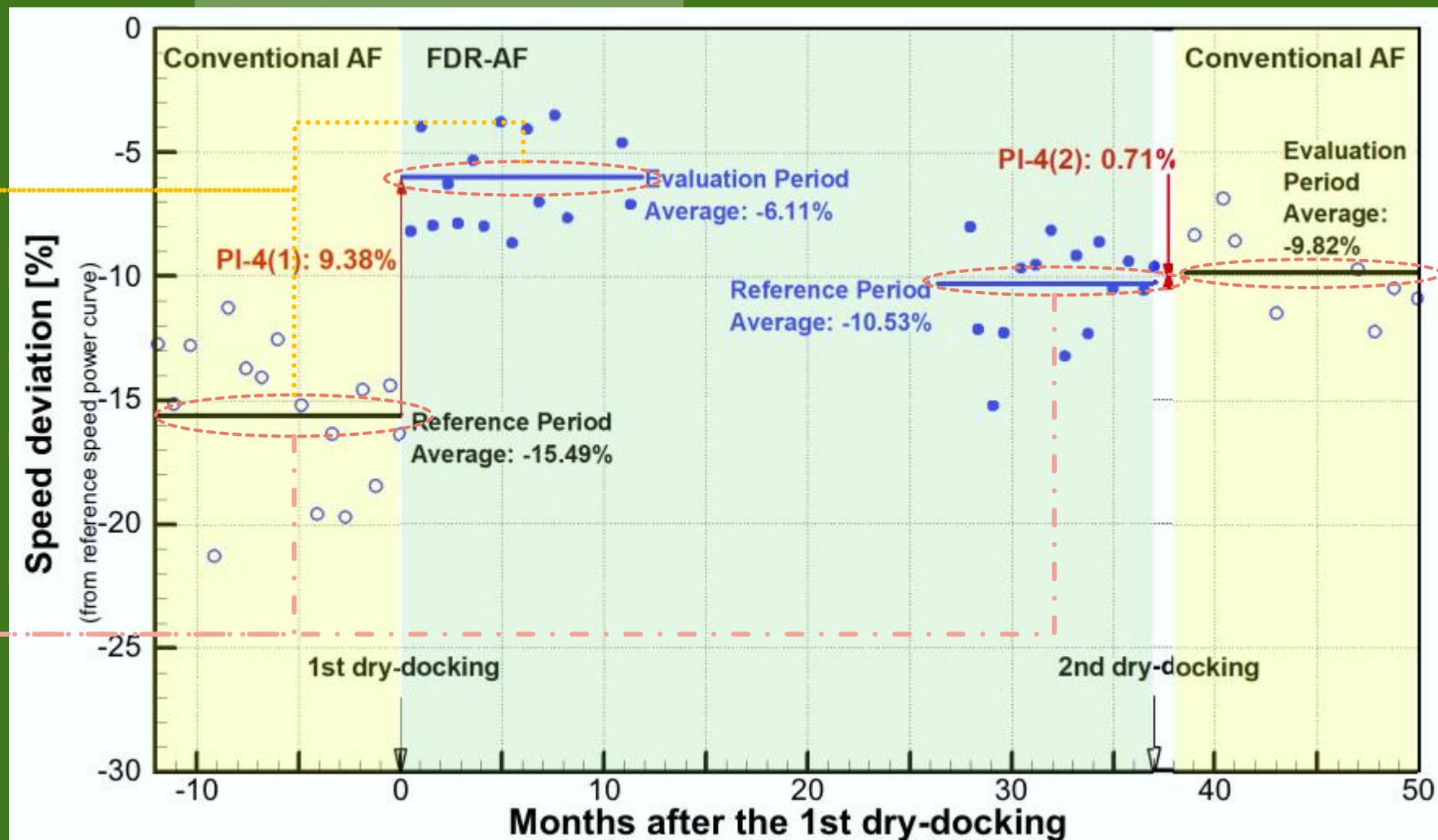
Average 9.38%
Improvement

Before/After Dry dock

SPEED

Average 4.96%
Improvement

before Dry dock





Existing Vessel Verification by ISO 19030

6₋₇

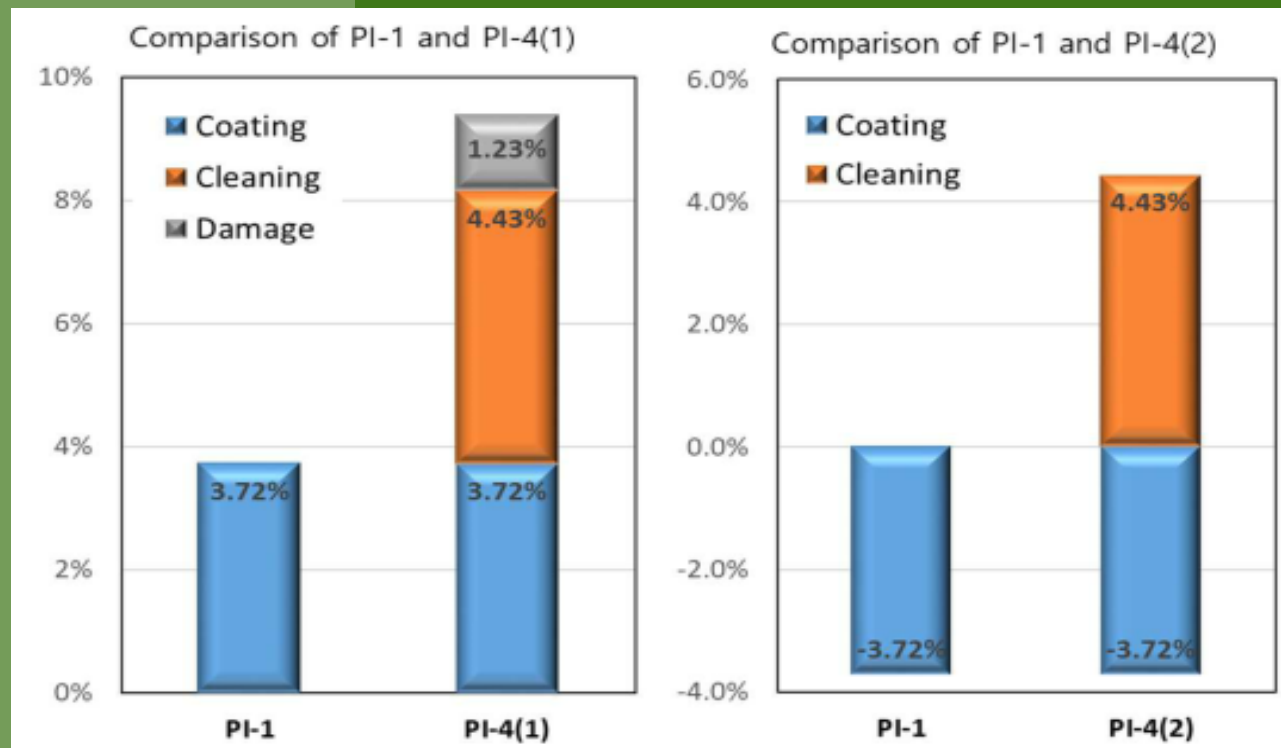
Power saving

11.7 %

Quantification of fuel efficiency improvement

- Speed drop ($\Delta V/V$) and the power increase ($\Delta P/P$)
- n: determined by the vessel type and draft (n=1.91, 2.40 for VLCC for the laden & ballast respectively)
- Power saving by FDR-AF coating (n=2.16) $\rightarrow (\Delta P/P) = 11.7\%$ (from $\Delta P/P = 3.72\%$)

- Cleaning effect: differences in surface conditions before and after dry docking
- Damage Recovery effect: compensate for the effects of initial coating damage before dry docking

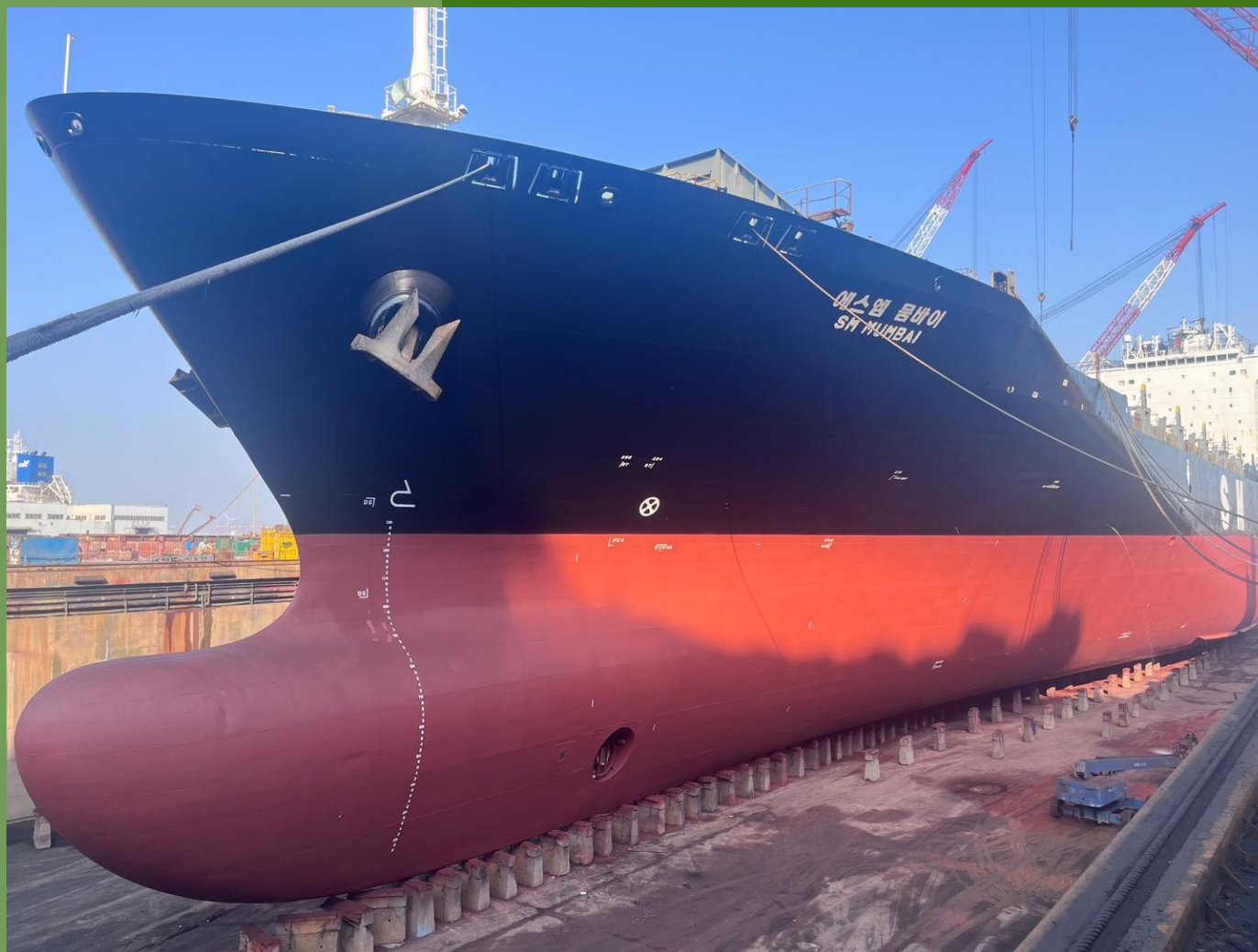


$$\text{PI-4(2)} = -\text{Coating Effect} + \text{Hull Cleaning Effect} \\ (0.71 = -3.72 + 4.43)$$

$$\text{PI-4(1)} = \text{Coating Effect} + \text{Hull Cleaning Effect} + \text{Damage Recovery Effect} \\ (9.38 = 3.72 + 4.43 + 1.23)$$

Date	Place	Dock interval	Product	PIC
2024.10.03 ~ 2024.10.10	ZHOUSHAN LONG SHAN SHIPYARD	183 months	GreenGuard FS (A/F)	S.M Joung

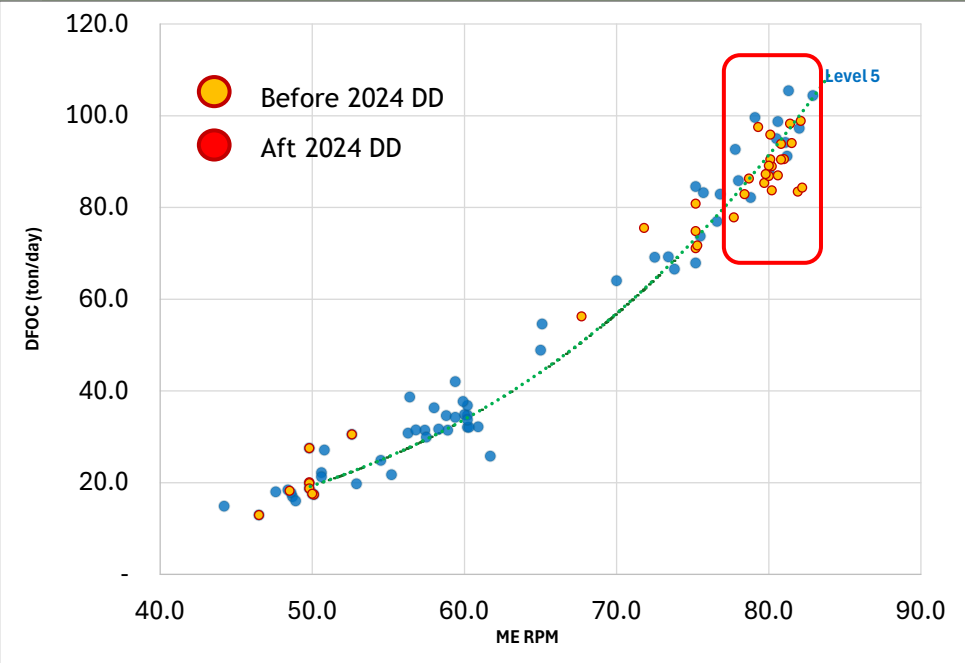
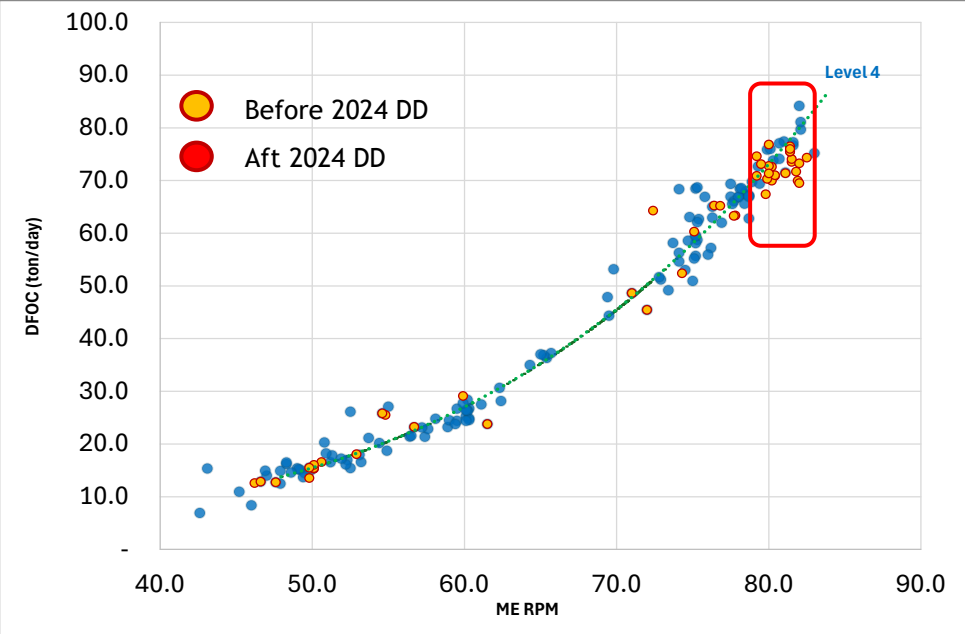
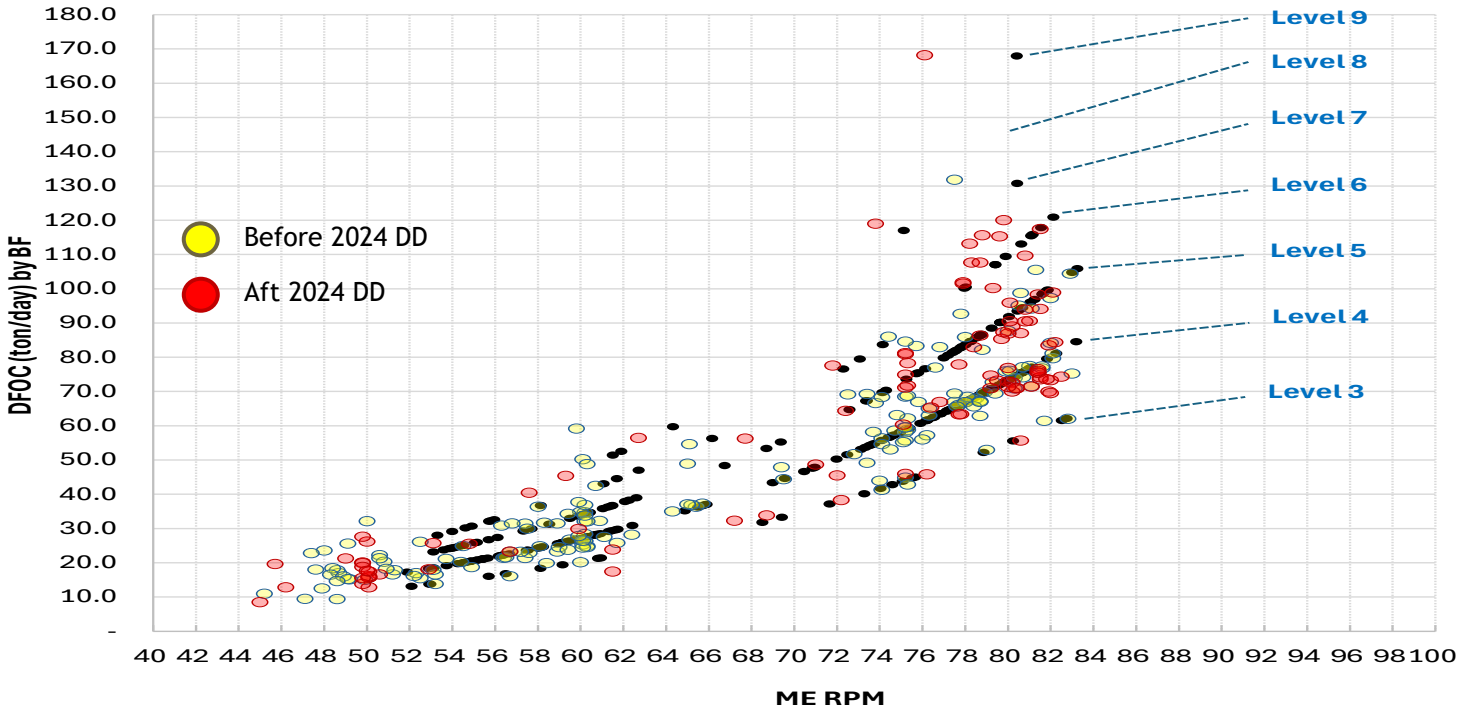
- ❖ Builder : SAMSUNG HEAVY INDUSTRIES CO.,LTD.
- ❖ Delivery : July-2009
- ❖ Kind : 4.3K Full CONTAINER SHIP
- ❖ GT : 40,029
- ❖ DWT : 50,815
- ❖ Length
 - LOA : 260.00 M
 - LBP : 245.00 M
 - Breath : 32.30 M
 - Depth : 19.30 M
- ❖ CLASS : KR



6 months after Dry dock to verify performance

7-2

Obj.	BF Level	Sub. Saving ratio	Saving Ratio (Converting BF Level 2)	Saving ratio
2024 DD Before & Aft	Level 4	8.3 %	12.5 %	13.3 %
	Level 5	7.0 %	14.0 %	
2019 DD Before & Aft	Level 3	4.0 %	4.4 %	4.4 %
	Level 4	2.0 %	3.0 %	
	Level 5	2.9 %	5.8 %	

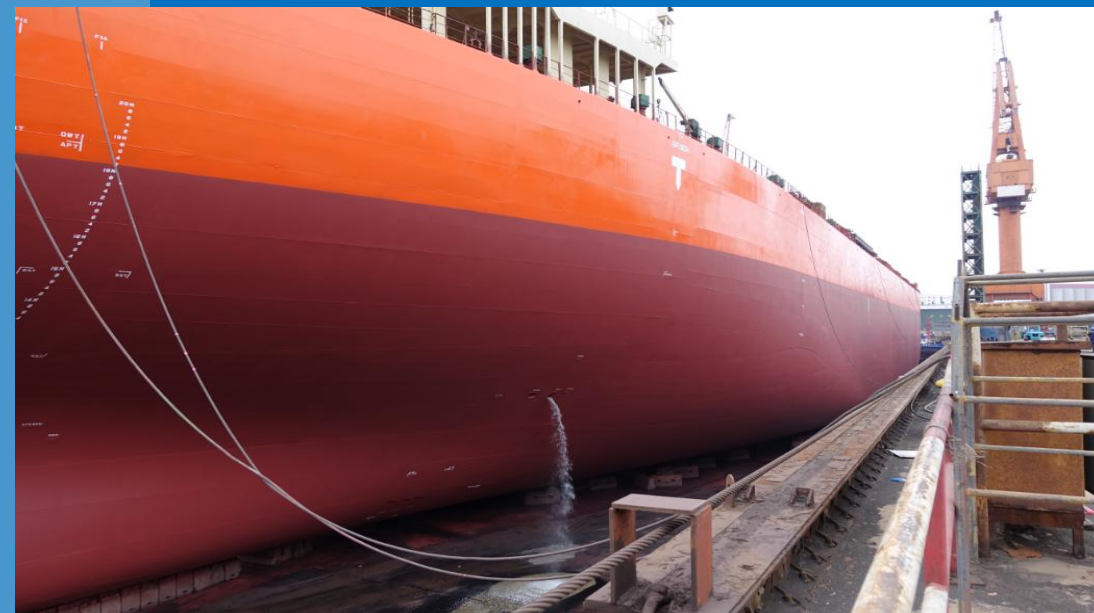
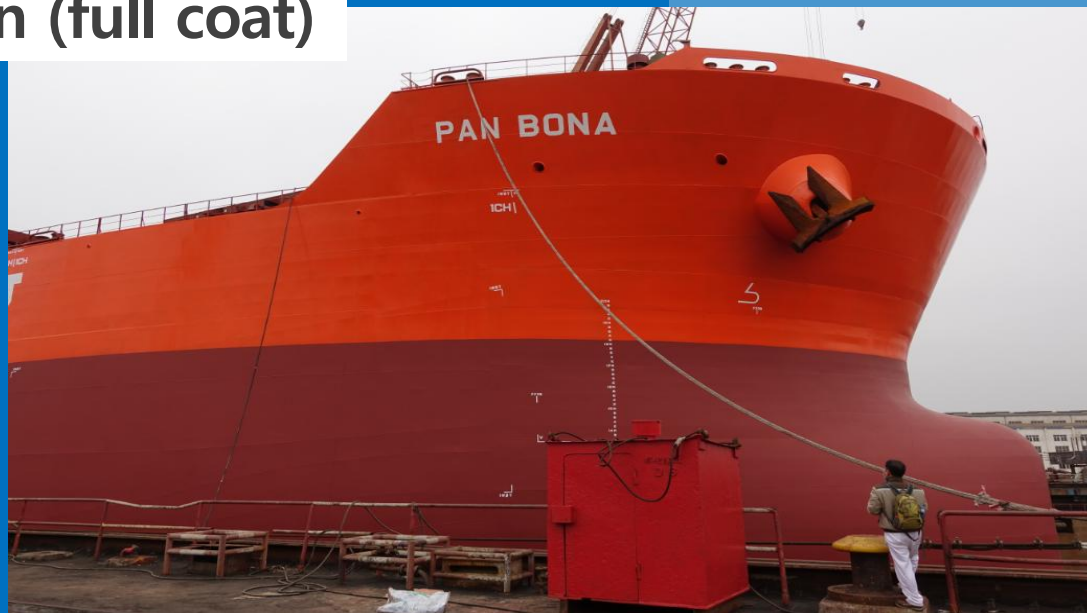




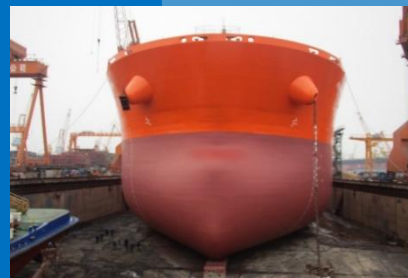
Application



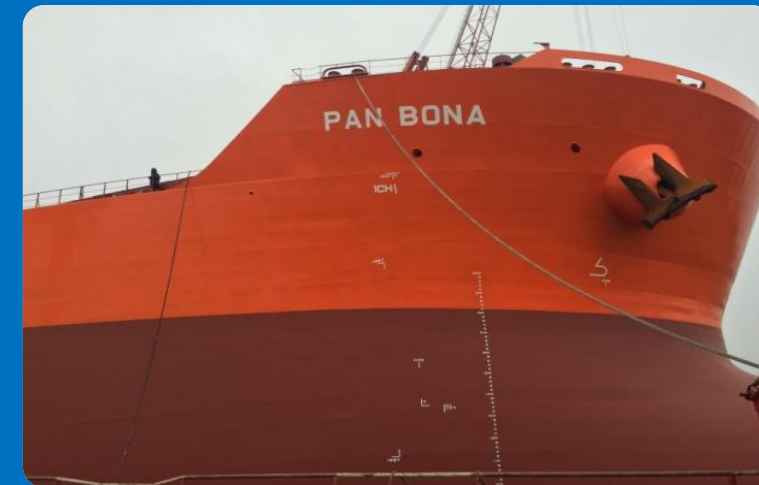
Application (full coat)



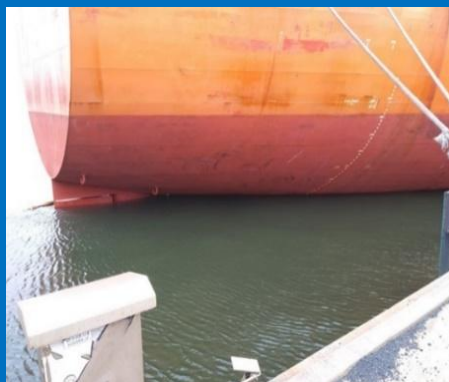
- Name of vessel : M/V "PAN BONA"
- Tonnage & Type : DWT 175,401 Bulk carrier
- Apply : BN GreenGuard FS
- Ship's owner : PANOCEAN
- Ship's operator : STX MARINE SERVICE
- Date of dockyard : November 2015
- Place of dockyard : Shanhaikwan in China



Application (full coat)



Upper side of waterline



Under water side



<After 32 months>

Application (full coat)

- ✓ Name of vessel : M/V "SEA INDONESIA"
- ✓ Tonnage & Type : DWT 404,389 & ORE carrier
- ✓ Ship's owner
 - PANOCEAN
- ✓ Ship's operator
 - BERNHARD SCHULTE SHIPMANAGEMENT
- ✓ Date of dockyard : Aug. 2017
- ✓ Place of dockyard
 - PAX OCEAN SHIPYARD / CHINA



Application (full coat)

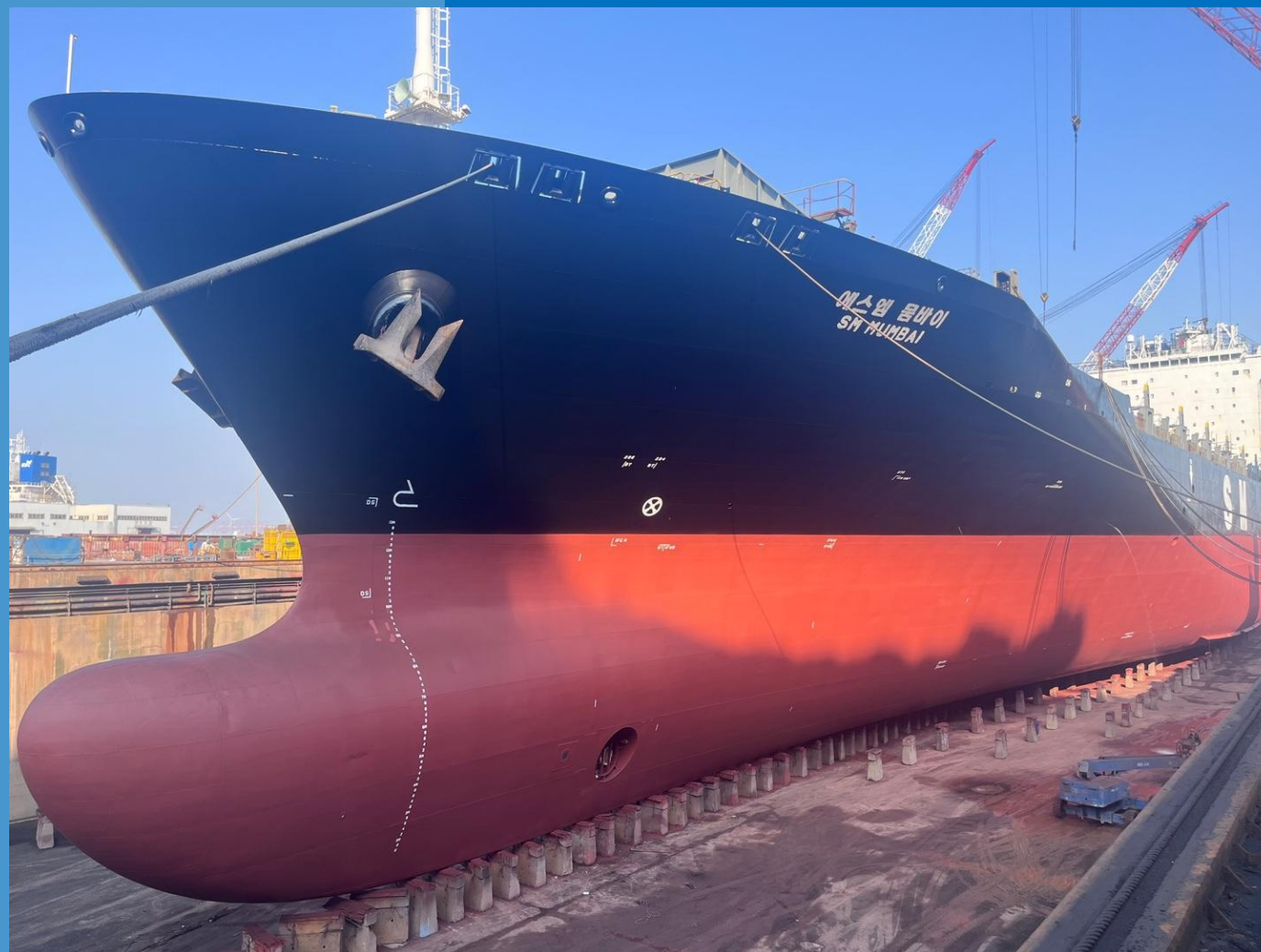


Coast Guard's high-speed ship
해경 고속선 8척 (2016년 5월)

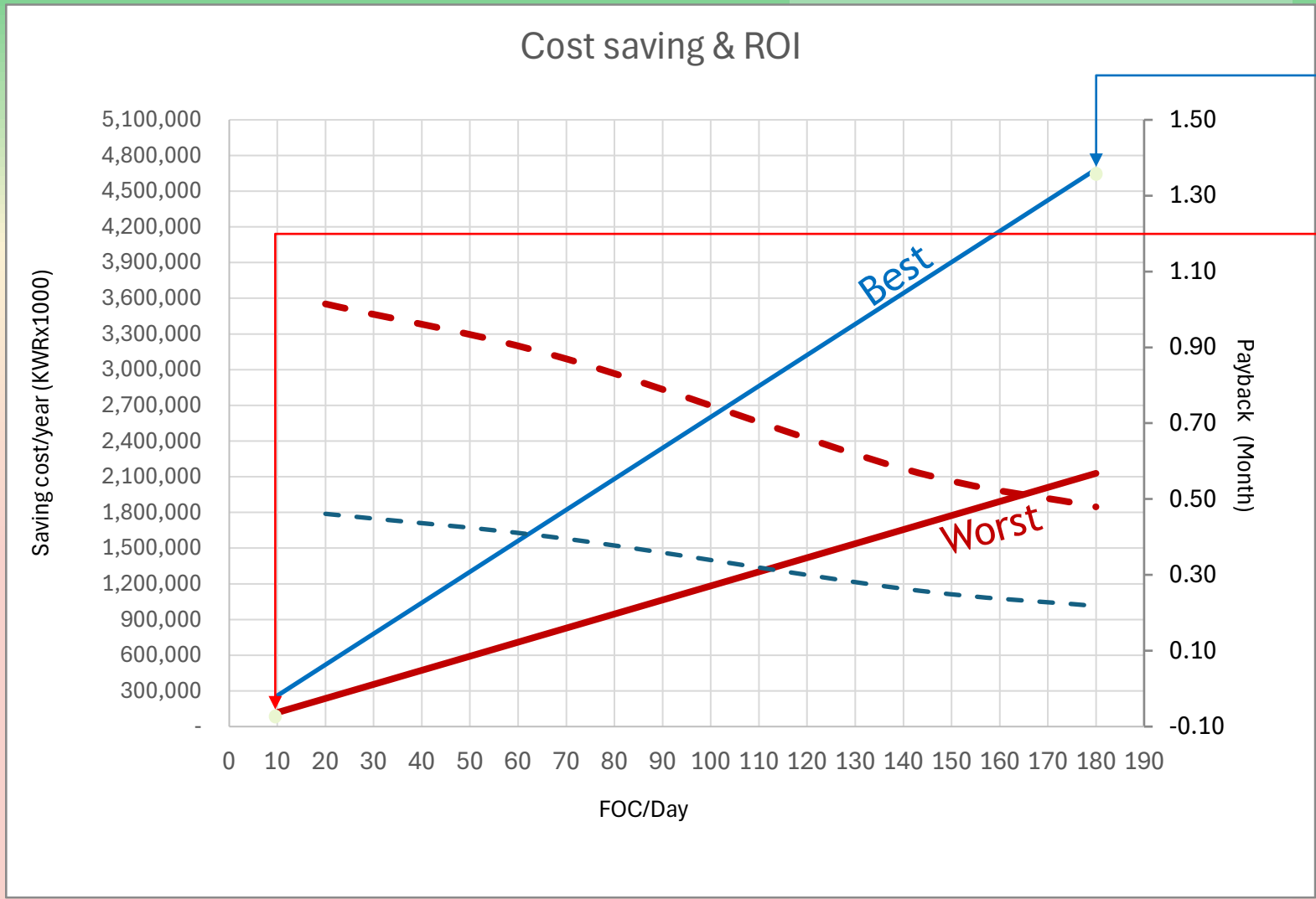


Date	Place	Dock interval	Product	PIC
2024.10.03 ~ 2024.10.10	ZHOUSHAN LONG SHAN SHIPYARD	183 months	GreenGuard FS (A/F)	S.M Joung

- ❖ Builder : SAMSUNG HEAVY INDUSTRIES CO.,LTD.
- ❖ Delivery : July-2009
- ❖ Kind : 4.3K Full CONTAINER SHIP
- ❖ GT : 40,029
- ❖ DWT : 50,815
- ❖ Length
 - LOA : 260.00 M
 - LBP : 245.00 M
 - Breath : 32.30 M
 - Depth : 19.30 M
- ❖ CLASS : KR



Simulation of Cost saving & ROI



FOC_Ton/day	Saving Amt	Saving cost_USD	Saving cost_KRW	Investment/year	Pay back	ROI
10	241	192,720	260,172	20,000	0.46	26.0
20	482	385,440	520,344			
30	723	578,160	780,516			
40	964	770,880	1,040,688			
50	1,205	963,600	1,300,860			
60	1,445	1,156,320	1,561,032	60,000	0.40	30.4
70	1,686	1,349,040	1,821,204			
80	1,927	1,541,760	2,081,376			
90	2,168	1,734,480	2,341,548			
100	2,409	1,927,200	2,601,720			
110	2,650	2,119,920	2,861,892	80,000	0.26	45.5
120	2,891	2,312,640	3,122,064			
130	3,132	2,505,360	3,382,236			
140	3,373	2,698,080	3,642,408			
150	3,614	2,890,800	3,902,580			
160	3,854	3,083,520	4,162,752	85,000	0.22	55.1
170	4,095	3,276,240	4,422,924			
180	4,336	3,468,960	4,683,096			



Thank you for your attention.

