Ship Maneuverability In an Era of Environmental Focus

15, June 2022.

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Paris agreement on Climate change and IMO

The Paris Agreement dealing with greenhouse-gas-emissions mitigation was adopted on 12th Dec. 2015.

The long-term goal of the Agreement is to keep the increase in global average temperature to well below 2 °C above pre-industrial levels;

and to limit the increase to 1.5 °C, since this would substantially reduce the risks and effects of climate change.

IMO has decided to reduce GHG emissions from the international shipping by at least 50% by 2050 compared to 2008.

IMO regulations for the prevention of air pollution

IMO's MARPOL

Annex VI Prevention of Air Pollution from ships was entered into force in 2005.

Chapter III is to regulate the main air pollutants including SOx and NOx from ships' exhaust gas

Chapter IV adopted EEDI(Energy Efficiency Design Index) and SEEMP(Ship Energy Efficiency Management Plan) for the reduction of GHG emissions from ships in 2011 and entered into force on 1st Jan. 2013.

MARPOL Annex VI Chapter III

Chapter III : Requirements for control of emissions from ships

Regulation 12 : Emissions from Ozone depleting substances from refrigerating plants and fire fighting equipment

Regulation 13 : Nitrogen Oxide(NOx) emissions from diesel engines

Regulation 14 : Sulphur Oxide(SOx) emissions from ships

Regulation 15 : Volatile Organic compounds emissions from cargo oil tanks

Regulation 16 : Emissions from shipboard incinerators

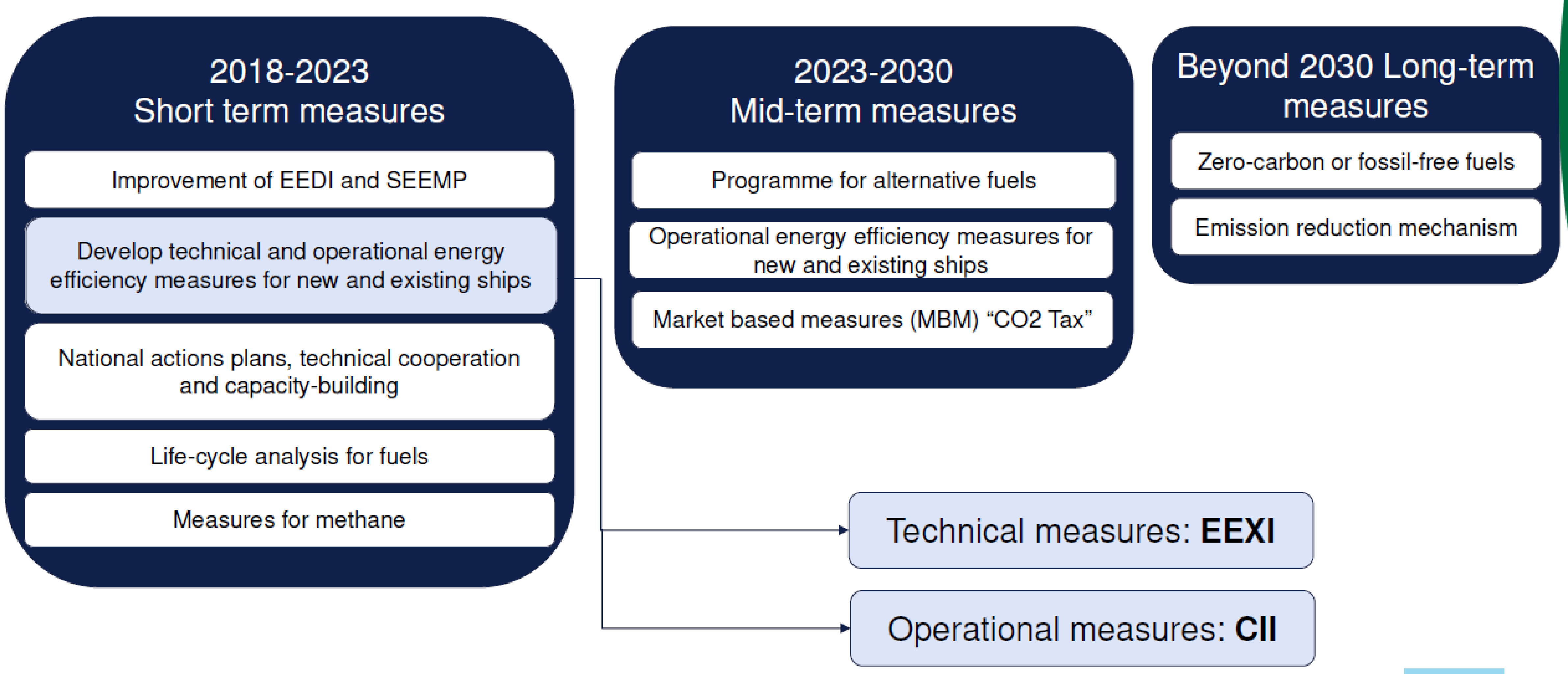
MARPOL Annex VI Chapter IV

Chapter IV Regulations for Energy Efficiency for ships

Regulation 20 : Attained EEDI
Regulation 21 : Required EEDI
Regulation 22 : SEEMP
Regulation 23 : Promotion of technical co-operation and transfer of technology relating to the improvement of energy efficiency of ships

- Draft roadmap for developing a strategy : MEPC70(Oct. 2016)
- GHG initial strategy : MEPC72(Apr. 2018)
- GHG revised strategy : 2023

IMO GHG strategy



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IMO Roadmap and Strategy for the reduction of GHG emission from ships

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IMO Roadmap and Strategy for the reduction of GHG emission from ships

- IMO's Initial Strategy for GHG reduction identifies levels of ambition

.1 carbon intensity of the ship to decline through implementation of further phases of the energy efficiency design index (EEDI) for new ships

.2 carbon intensity of international shipping to decline
to reduce CO_2 by at least 40% by 2030, pursuing efforts towards 70% by 2050, compared to 2008

.3 GHG emissions from international shipping to peak and decline
to peak GHG emissions as soon as possible and reduce the total annual GHG emissions by at least 50% by 2050 compared to 2008

Sulphur Cap

Sulphur Oxide(SOx) is controlled by the limitation of the Sulphur content in the bunker fuel. The mandate limits Sulphur content of Fuel Oil used onboard ships on a global basis to 0.5% from 1st Jan. 2020.

Shipowners have to either install exhaust gas cleaning unit (scrubber) or use 0.5% Sulphur content fuel oil or LNG. The Installation of scrubber for either existing ships or new ships changed the shape of superstructure.

PHOTOs

Comparison of superstructure before and after retrofitting scrubber(VLCC C.Galaxy)
This bigger superstructure will possibly affect the ships' maneuverability.

PHOTOs

New ship with scrubber (Aristfanis)

Existing ship without scrubber

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EEDI
(Energy Efficiency Design Index)

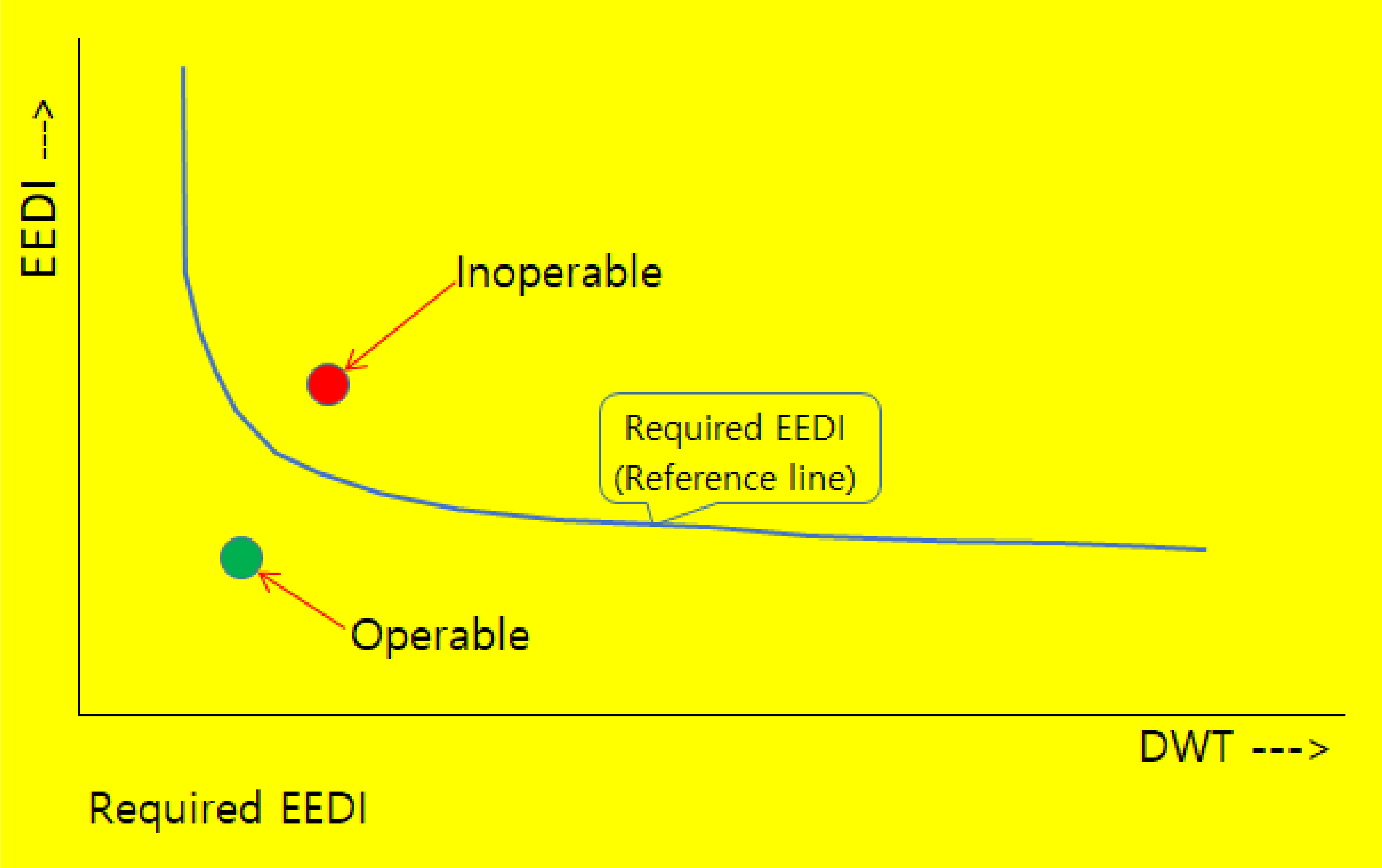
EEDI is the amount of CO2 in grams emitted by a ship per capacity-mile(ton-mile) of work.

Ton-mile is the unit of work done by a ship.

If a ship with dwt 20,000mt travels 2 NMs, it has done 40,000 ton-mile of work.

$$EEDI = \frac{CO2\ emission}{transport\ work} \propto \frac{CO2\ emission\ (in\ grams)}{Capacity(DWT) \times distance\ travelled(in\ NM)}$$

EEDI
(Energy Efficiency Design Index)



As the name suggests, EEDI is the tool that is used during the design or construction stage of a vessel.

Annex VI Chapter VI Reg. 21 provides the formula for the required EEDI(Reference line)

The calculation of reference line value is complex.

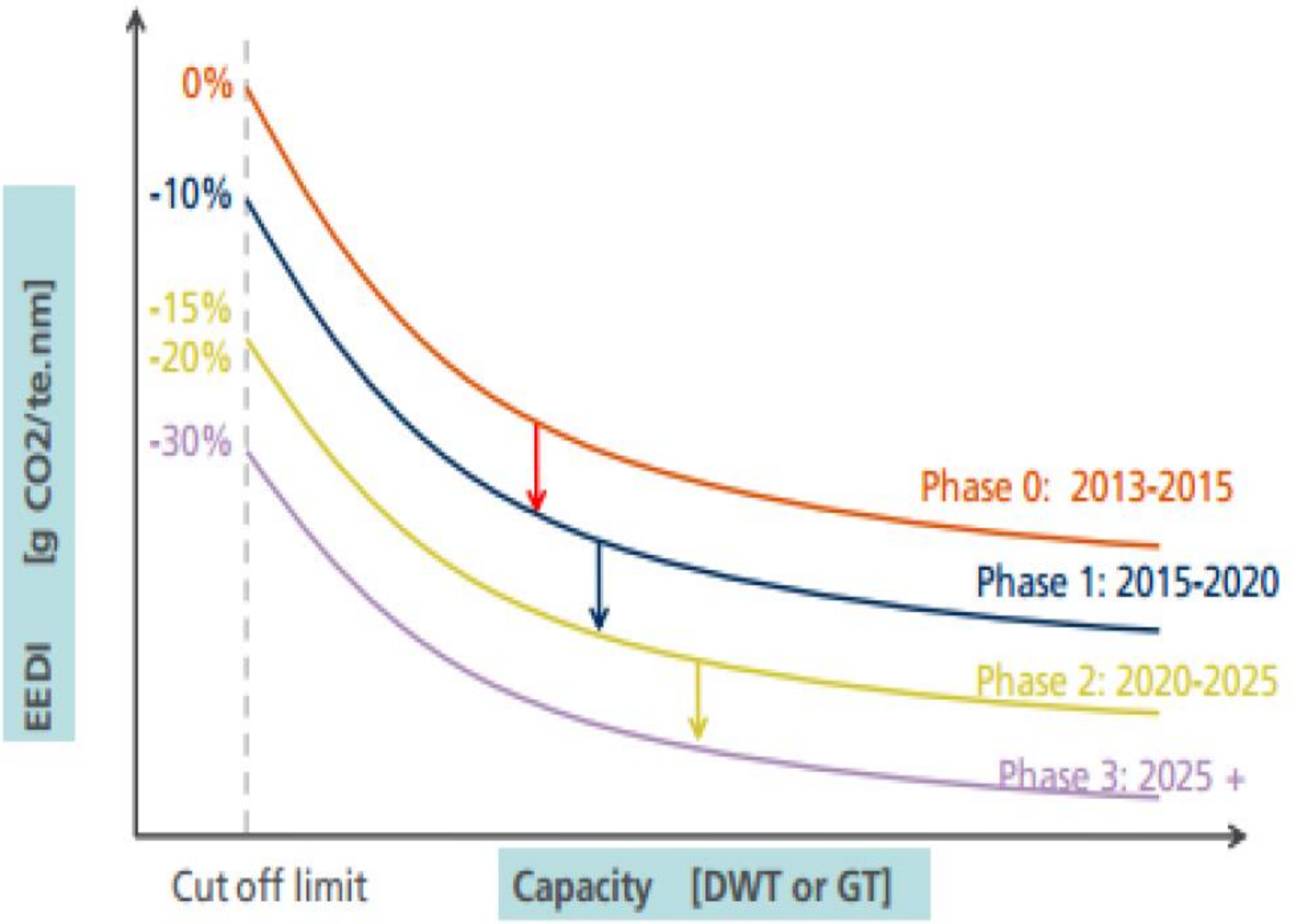
In brief the reference line value is the function of dwt and type of the ship.

- Required EEDI is the maximum allowable value of EEDI required for the ship
- Attained EEDI is the actual value of EEDI attained for the ship

Vessels with higher EEDI than the required are inoperable.

EEDI

(Energy Efficiency Design Index)



The reduction factor is used to tighten the EEDI regulations in phases over time by increasing its value so that the ship's engines are getting more energy efficient.

Required EEDI = (1 - x/100) x *Reference line value*

where x = Reduction factor

Implementation phases: The EEDI is Implemented in phases. Currently, it is in phase 2 that runs from year 2020 to 2024. Phase 1 was over and phase 3 is from year 2025 and onwards.

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EEXI
(Energy Efficiency Existing Ship Index)

EEXI and CII were newly adopted at MEPC 76 in 2021 to regulate the energy efficiency and operational efficiency of existing ships according to IMO's GHG strategy short-term measures.

EEXI is to expand EEDI which is applied to only new ships built after 2013 to existing ships.

EEXI is calculated once in a lifetime and based on standard reference conditions. If a ship does not comply with required EEXI, the shipowner considers engine power limitation, shaft power limitation, energy saving devices, hull optimization or replacement with new ships.

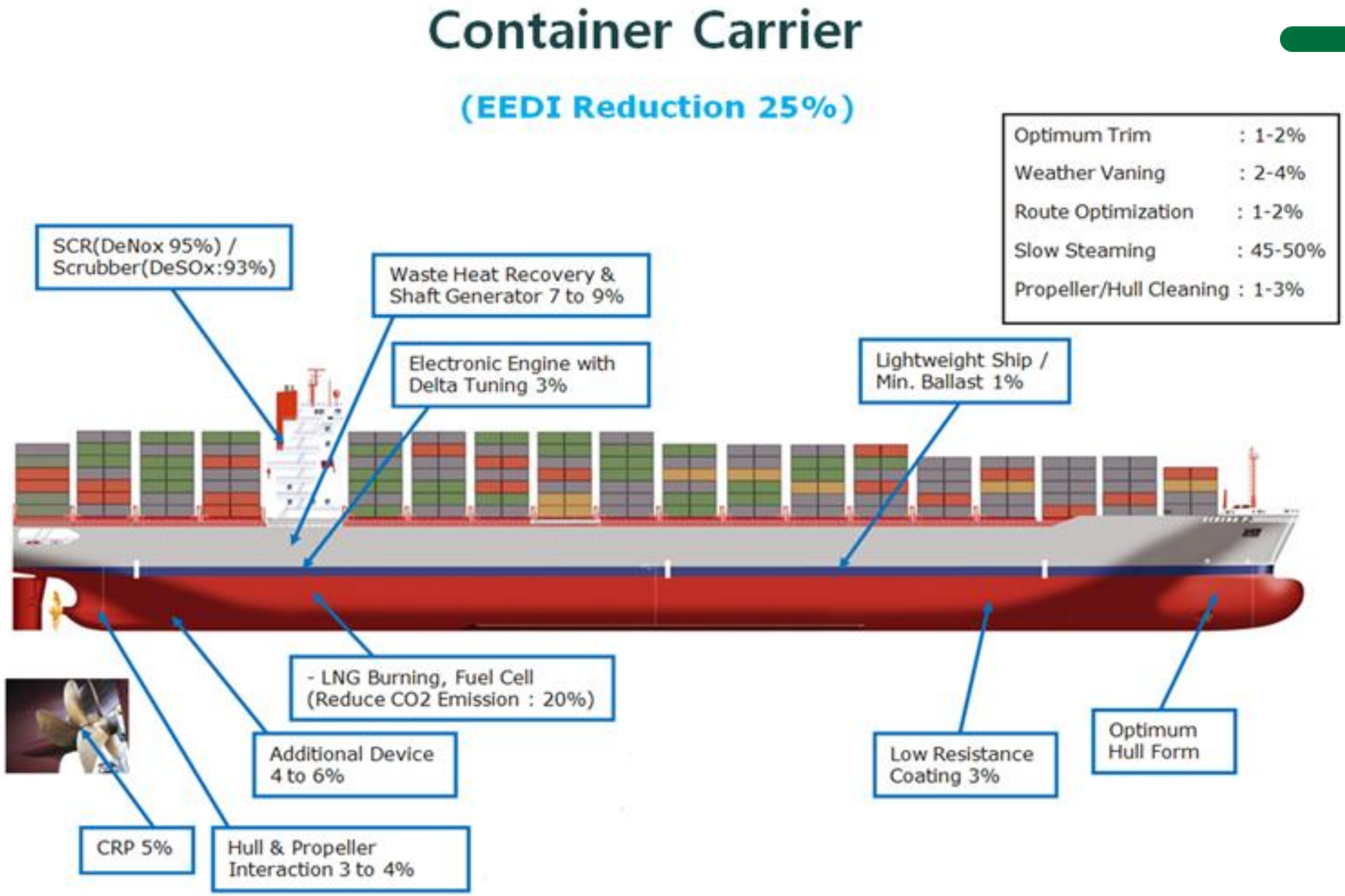
CII
(Carbon Intensity Indicator)

CII is an operational measure to reduce CO_2. CII measures how efficiently a ship transports cargo or passengers and is based on fuel consumption reporting(DCS : Data Collecting System) and calculated and given in grams of CO_2 emitted per capacity-mile of work. CII will be calculated annually starting from 2023. The ship is then given an annual rating from A to E, whereby the rating thresholds will become Increasingly stringent towards 2030. C is Min. Compliance. If the annual CII rating is E or 3xD, shipowners need to develop and implement an approved corrective action plan as part of SEEMP.

Methods and Technologies for improving EEDI

Various technologies are developed for the improvement of EEDI. They are minimal ballast water, optimum hull form, air lubrication system, low resistance hull coating, waste heat recovery and shaft generator, electronic engine with delta tuning, hull and propeller interaction and CRP.
Possible EEDI reduction by technologies is thought to be about 25%(EEDI phase 2). Burning of eco-friendly fuels such as LNG, LPG and methanol can reduce about 10 to 20% additionally.
Ships are getting bigger, their operating speed is slowing down, and eco-friendly energy fueled ships which generate less CO_2 have appeared.

Methods and Technologies for improving EEDI



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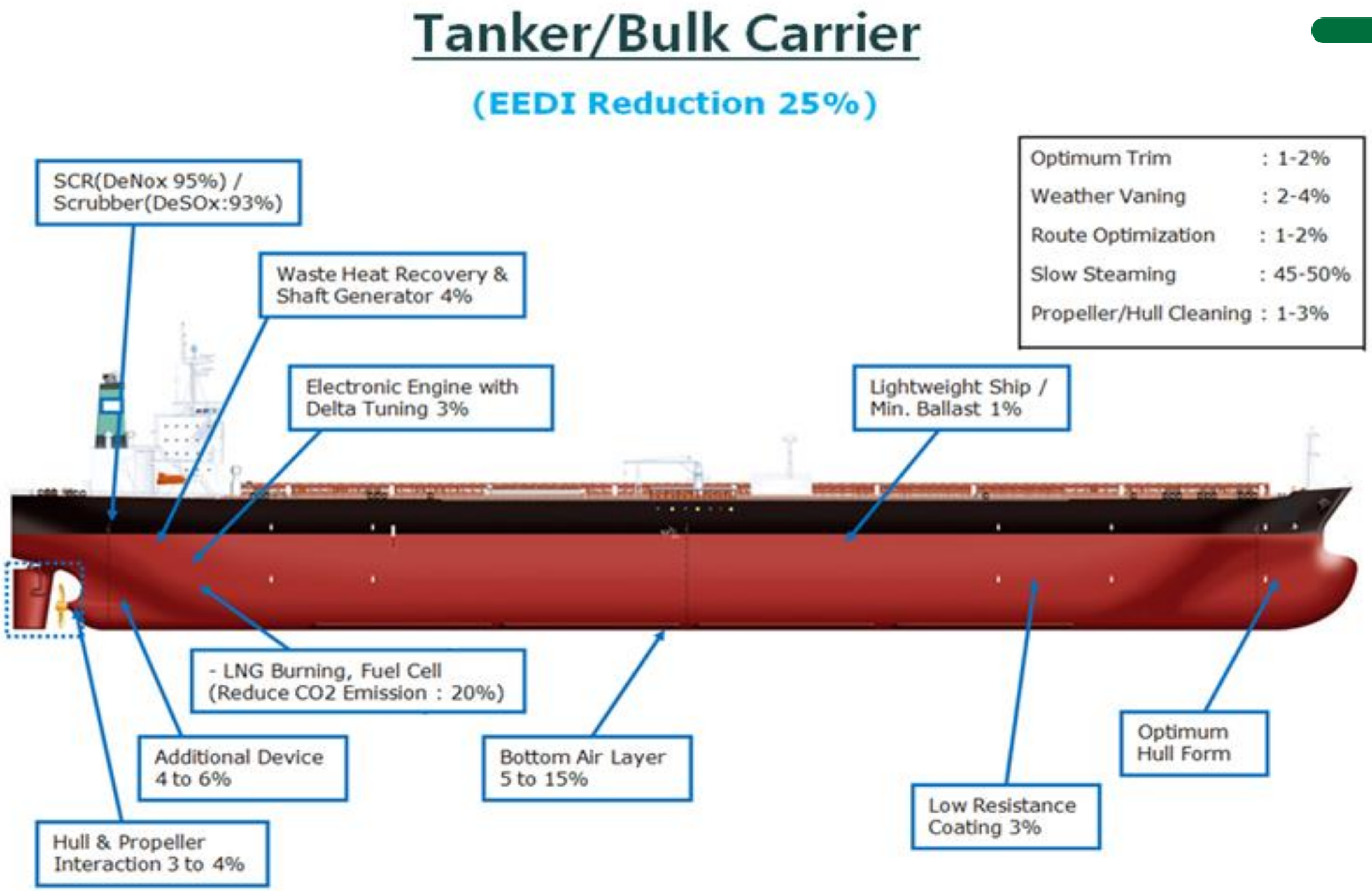
Methods and Technologies for improving EEDI



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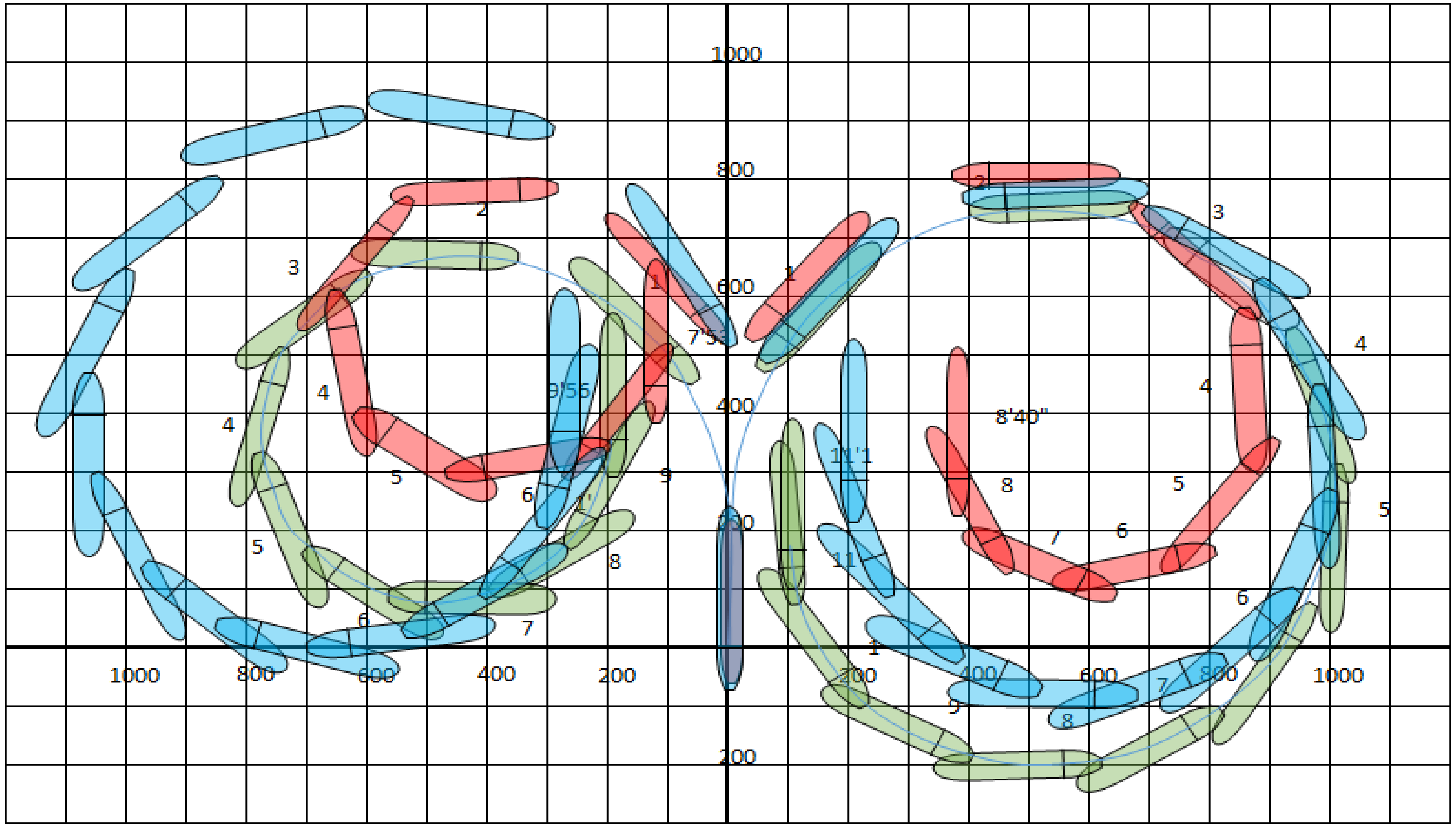
Turning ability

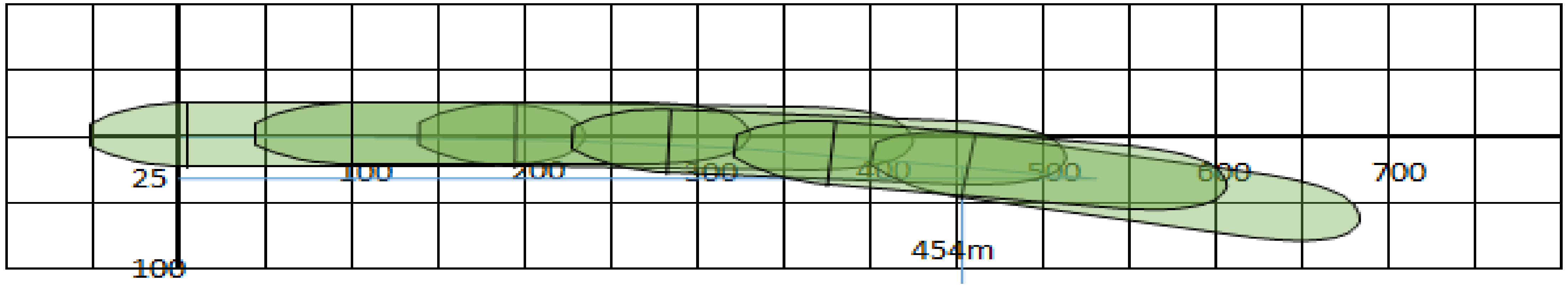
The advance should not exceed 4.5 ship lengths (L) and the tactical diameter should not exceed 5 ship lengths in the turning circle maneuver.



IMO's Standards for ship maneuverability

Initial turning ability

With the application of 10° rudder angle to port/ stbd, the ship should not have travelled more than 2.5 ship lengths by the time the heading has changed by 10° from the original heading.



IMO's Standards for ship maneuverability

IMO's Standards for ship maneuverability

Yaw-checking and course-keeping abilities

.1 The value of the first overshoot angle in the 10°/10° zigzag test should not exceed :

.1 10° if L/V is less than 10 s;

.2 20° if L/V is 30 s or more; and

.3 (5 + 1/2 (L/V)) degrees if L/V is 10 s or more but less than 30 s, where L and V are expressed in m and m/s, respectively.

.2 The value of the second overshoot angle in the 10°/10° zig-zag test should not exceed :

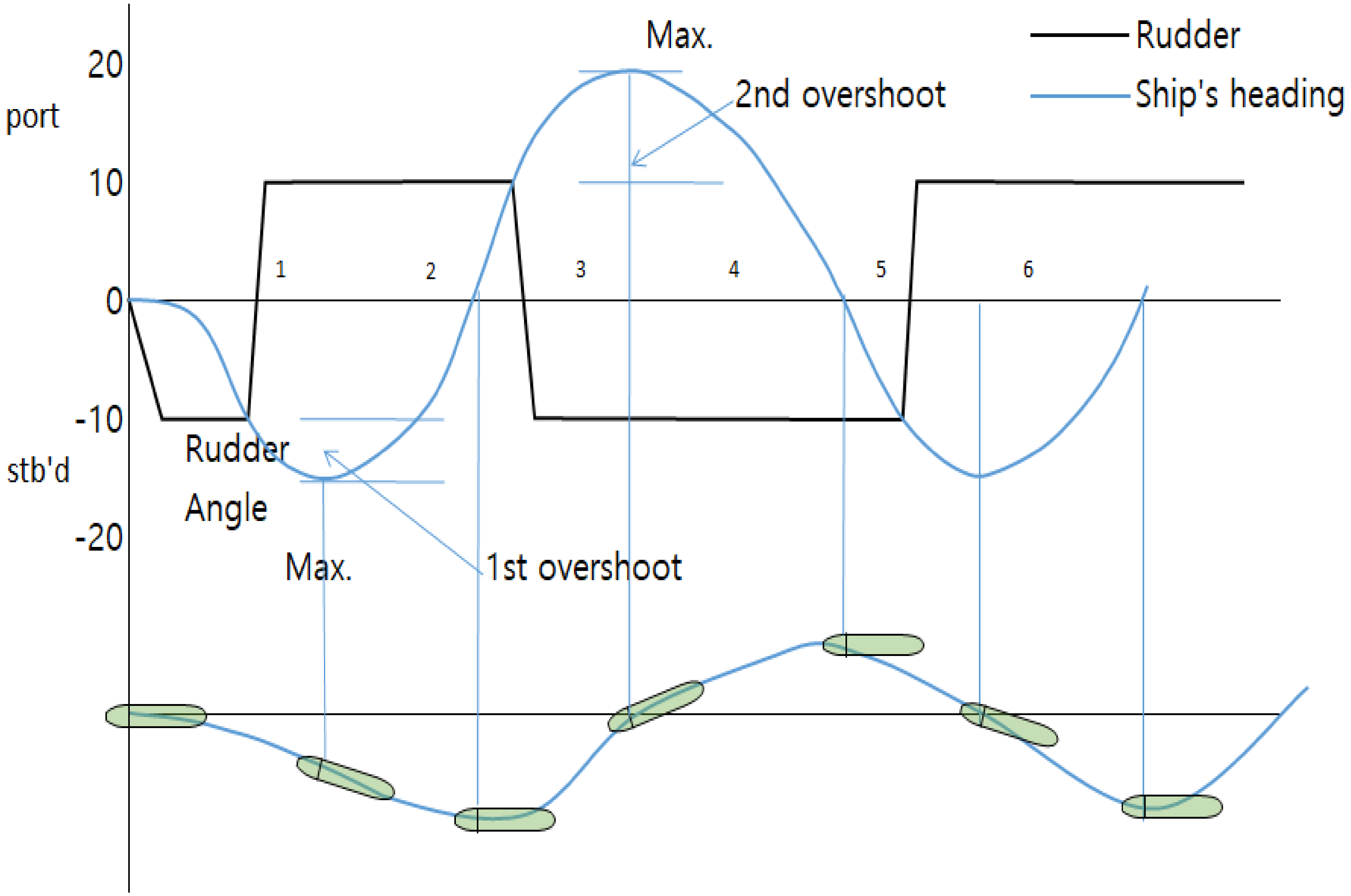
.1 25°, if L/V is less than 10 s;

.2 40°, if L/V is 30 s or more; and

.3 (17.5 + 0.75(L/V))°, if L/V is 10 s or more, but less than 30 s.

.3 The value of the first overshoot angle in the 20°/20° zig-zag test should not exceed 25°.

Yaw-checking and course-keeping abilities



IMO's Standards for ship maneuverability

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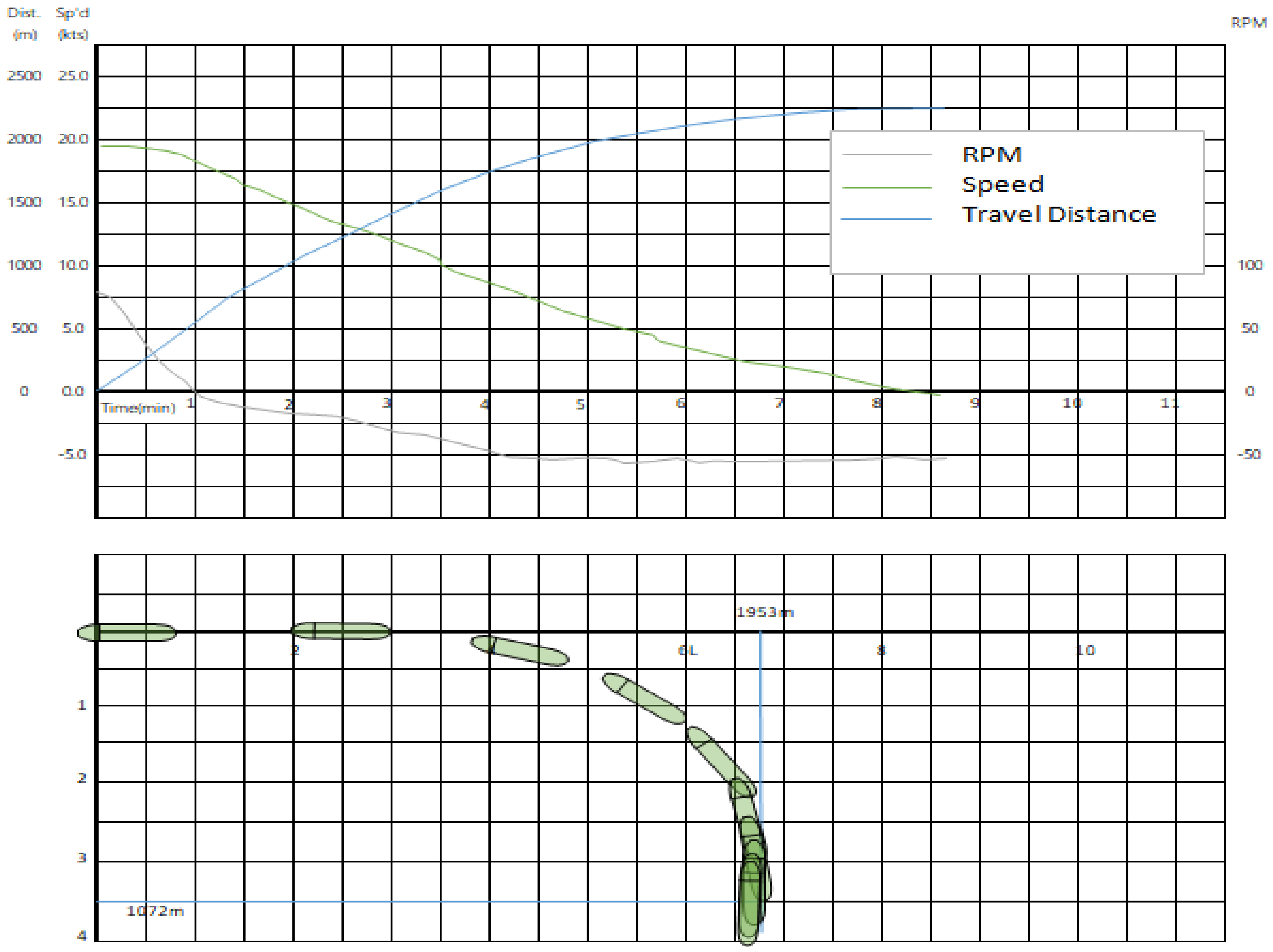
Stopping ability

The track reach in the full astern stopping test should not exceed 15 ship lengths. However, this value may be modified by the administration where ships of large displacement make this criterion impracticable, but should in no case exceed 20 ship lengths.



IMO's Standards for ship maneuverability

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Comparison of ship Maneuverability (Container ships)

Turning ability(Ballast) Criteria Advance ≤ 4.5Lpp Tacitcal diameter ≤ 5.0Lpp

Type of ship	G/T	Dwt	LOA(m) /Lpp(m)	Breadth (m)	LOA/B ratio	Block-coefficient	Advance		Tactical diameter		EEDI, fuel and year built
							port	stb'd	port	stb'd	
Feedermax (2,550Teu)	26,836	33,434	210/199	30	7.0	0.64	673m (3.38Lpp)	689m (3.46Lpp)	846m (4.25Lpp)	879m (4.42Lpp)	before EEDI FO
Feedermax (2,800Teu) KMTC SHENZHEN, B&W 26,740hp	28,827	39,829	223/211	30	7.4	No record	682m (3.23Lpp)	665m (3.15Lpp)	869m (4.12Lpp)	958m (4.54Lpp)	before EEDI FO, 2013
Feedermax (2,550Teu) KMTC SEOUL, B&W 23,360hp	27,997	37,200	196/185	32	6.1	No record	694m (3.75Lpp)	729m (3.94Lpp)	830m (4.49Lpp)	803m (4.34Lpp)	EEDI phase I LSFO, 2020
Feeder (1,800Teu) PANCON BRIDGE B&W 16,030hp	18,040	22,426	172/163	27.4	6.3	No record	496m (3.03Lpp)	533m (3.26Lpp)	628m (3.84Lpp)	701m (4.29Lpp)	EEDI phase II LSFO, 2022
ULCV(18,200Teu) Mærsk, Twin MAN, 39,800hp x 2	194,849	194,397	399/376	59	6.8	0.71	1,215m (3.23Lpp)	1,177m (3.13Lpp)	1,786m (4.75Lpp)	1,738m (4.62Lpp)	before EEDI, FO, 2011
ULCV(23,000Teu) HMM OSLO, 78,000hp	232,311	229,039	399/383	61.5	6.5	0.73	991m (2.59Lpp)	990m (2.59pp)	1,249m (3.26Lpp)	1,345m (3.51Lpp)	EEDI phase II LSFO, 2020

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Comparison of ship Maneuverability (Container ships)

Initial turning ability　　Criteria　　travelled distance ≤ 2.5Lpp

Type of ship	G/T	Dwt	LOA(m) /Lpp(m)	Breadth (m)	LOA/B ratio	Block-coefficient	Sailing distance		elapsed time (sec)	remark	EEDI, fuel and year built
							Port	Stb'd			
Feedermax (2,550Teu)	26,836	33,434	210/199	30	7.0	0.64	no record	323m (1.62Lpp)	28	ballast 22.4kts	before EEDI FO
Feedermax (2,800Teu) KMTC SHENZHEN, B&W 26,740hp	28,827	39,829	223/211	30	7.4	no record	no record	327m (1.55Lpp)	29	ballast 21.9kts	before EEDI FO, 2013
Feedermax (2,550Teu) KMTC SEOUL, B&W 23,360hp	27,997	37,200	196/185	32	6.1	No record	309m (1.67Lpp)	no record	29	ballast 20.7kts	EEDI phase I LSFO, 2020
Feeder (1,800Teu) PANCON BRIDGE B&W 16,030hp	18,040	22,426	172/163	27.4	6.3	no record	no record	285m (1.75Lpp)	28	ballast 19.8kts	EEDI phase II LSFO, 2022
ULCV(18,200Teu) Mærsk, Twin MAN, 39,800hp x 2	194,849	194,397	399/376	59	6.8	0.71	518m (1.38Lpp)	500m (1.33Lpp)	46 44	ballast 21.9kts	before EEDI
ULCV(23,000Teu) HMM OSLO, 78,000hp	232,311	229,039	399/383	61.5	6.5	0.73	no record	576m (1.50Lpp)	50	ballast 22.4kts	EEDI phase II LSFO, 2020

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Comparison of ship Maneuverability (Container ships)

Yaw checking and course keeping ability(overshoot angle)

Criteria	10°/10° zig-zag test	1st OA angel ≤ 10°/20°, 2nd OA ≤ 25°/40°
	20°/20° zig-zag test	1st OA angel ≤ 25°

Type of ship	G/T	Dwt	LOA(m) /Lpp	Breadth (m)	LOA/B ratio	Block-coefficient	10°/10° zig-zag test				20°/20° zig-zag test				EEDI, fuel and year built
							port		stb'd		port		stb'd		
							1st	2nd	1st	2nd	1st	2nd	1st	2nd	
Feedermax (2,550Teu)	26,836	33,434	210/199	30	7.0	0.64			3.5	4.3			8.4		before EEDI FO
Feedermax (2,800Teu) KMTC SHENZHEN, B&W 26,740hp	28,827	39,829	223/211	30	7.4	No record			5.8	5.6			9.2		before EEDI FO, 2013
Feedermax (2,550Teu) KMTC SEOUL, B&W 23,360hp	27,997	37,200	196/185	32	6.1	No record	3.6	3.3			6.4	5.7			EEDI phase I LSFO, 2020
Feeder (1,800Teu) PANCON BRIDGE B&W 16,030hp	18,040	22,426	172/163	27.4	6.3	No record			3.5	3.5			7.7		EEDI phase II LSFO, 2022
ULCV(18,200Teu) Mærsk, Twin MAN, 39,800hp x 2	194,849	194,397	399/376	59	6.8	0.71	2.9	2.4	2.7	2.1	4.5	5.0	5.3	4.5	before EEDI
ULCV(23,000Teu) HMM OSLO, 78,000hp	232,311	229,039	399/383	61.5	6.5	0.73			2.7	2.9			5.7		EEDI phase II LSFO, 2020

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Comparison of ship Maneuverability (Container ships)

Stopping ability Criteria Track reach ≤ 15Lpp

Type of ship	G/T	Dwt	LOA(m) /Lpp	Breadth (m)	Crash stop astern	Remark	
					Full ahead --> Full Astern	Condition design speed	EEDI, fuel and year built
Feedermax (2,550Teu)	26,836	33,434	210/199	30	2,702m (13.58Lpp)	Ballast 21.0kts	before EEDI FO
Feedermax (2,800Teu) KMTC SHENZHEN, B&W 26,740hp	28,827	39,829	223/211	30	2,546m (12.06Lpp)	Ballast 22.1kts	before EEDI FO, 2013
Feedermax (2,550Teu) KMTC SEOUL, B&W 23,360hp	27,997	37,200	196/185	32	2,572m (13.90Lpp)	Ballast 19.6kts	EEDI phase I LSFO, 2020
Feeder (1,800Teu) PANCON BRIDGE B&W 16,030hp	18,040	22,426	172/163	27.4	2,431m (14.86Lpp)	Ballast 19.65kts	EEDI phase II LSFO, 2022
ULCV(18,200Teu) Mærsk, Twin MAN, 39,800hp x 2	194,849	194,397	399/376	59	3,726m (9.90Lpp)	Ballast 23.6kts	before EEDI
ULCV(23,000Teu) HMM OSLO, 78,000hp	232,311	229,039	399/383	61.5	4,250m (11.10Lpp)	Ballast 21.3kts	EEDI phase II LSFO, 2020

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Comparison of ship Maneuverability (Tankers)

Turning ability(Loaded)   Criteria   Advance ≤ 4.5Lpp   Tacitcal diameter ≤ 5.0Lpp

Type of ship	G/T	Dwt	LOA(m) /Lpp(m)	Breadth (m)	LOA/B ratio	Block-coefficient	Advance		Tactical diameter		EEDI, fuel and year built
							port	stb'd	port	stb'd	
VLCC 316K, Sulzer 43,030hp	163,066	316,373	333/319	60	5.6	0.83	856m (2.68Lpp)	904m (2.83Lpp)	945m (2.96Lpp)	1,029m (3.22Lpp)	before EEDI, FO, 2011
VLCC 293K H ELEPHANT B&W 39,200hp	161,969	293,384	333/320	60	5.6	0.81	979m (3.06Lpp)	1,021m (3.19Lpp)	825m (2.58Lpp)	888m (2.78Lpp)	before EEDI, FO, 2012
VLCC 300K NAUTILUS B&W 32,700hp	154,163	299,392	333/322	60	5.6	0.80	964m (2.99Lpp)	959m (2.98Lpp)	846m (2.63Lpp)	1,128m (3.50Lpp)	EEDI phase I FO, 2016
46K PC FINNANGER B&W 12,700hp	29,807	46,251	183/174	32.2	5.7	No record	534m (3.07Lpp)	589m (3.39Lpp)	470m (2.70Lpp)	526m (3.02Lpp)	before EEDI, FO, 2009
50K PC BOXER B&W 11,140hp	29,447	49,852	183/175	32.2	5.7	No record	400m (2.29pp)	416m (2.38Lpp)	470m (2.69Lpp)	469m (2.68Lpp)	EEDI phase I LSFO, 2019
50K PC MARI INNOVATOR, B&W 10,160hp	30,873	49,999	186/177	32.2	5.8	0.79	364m (2.06Lpp)	397m (2.24Lpp)	443m (2.50Lpp)	466m (2.63Lpp)	EEDI phase II LSFO/Methanol 2021
50K PC CLEAROCEAN, B&W 9,620hp	29,530	49,999	183/175	32.2	5.7	No record	395m (2.56Lpp)	405m (2.31Lpp)	447m (2.55Lpp)	445m (2.54Lpp)	EEDI phase II LSFO, 2021

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Initial turning ability　　Criteria　　travelled distance ≤ 2.5Lpp

Type of ship	G/T	Dwt	LOA(m) /Lpp(m)	Breadth (m)	LOA/B ratio	Block-coefficient	Sailing distance Port	Sailing distance Stb'd	elapsed time (sec)	remark	EEDI, fuel and year built
VLCC 316K, Sulzer 43,030hp	163,066	316,373	333/319	60	5.6	0.83	no record	525m (1.65Lpp)	68	laden 15.1kts	before EEDI, FO, 2011
VLCC 293K H ELEPHANT B&W 39,200hp	161,969	293,384	333/320	60	5.6	0.81	no record	542m (1.69Lpp)	70	laden 15.1kts	before EEDI, FO, 2012
VLCC 300K NAUTILUS B&W 32,700hp	154,163	299,392	333/322	60	5.6	0.80	575m (1.79Lpp)	no record	75	laden 14.9kts	EEDI phase I FO, 2016
46K PC FINNANGER B&W 12,700hp	29,807	46,251	183/174	32.2	5.7	No record	315m (1.81Lpp)	no record	40	laden 15.3kts	before EEDI, FO, 2009
50K PC BOXER B&W 11,140hp	29,447	49,852	183/175	32.2	5.7	No record	322m (1.84Lpp)	238m (1.36Lpp)	45/34	laden 13.8kts	EEDI phase I LSFO, 2019
50K PC MARI INNOVATOR, B&W 10,160hp	30,873	49,999	186/177	32.2	5.8	0.79	no record	252m (1.42Lpp)	35	laden 14.0kts	EEDI phase II LSFO/Methanol 2021
50K PC CLEAROCEAN, B&W 9,620hp	29,530	49,999	183/175	32.2	5.7	No record	no record	319 (1.82Lpp)	43	laden 14.4kts	EEDI phase II LSFO, 2021

Comparison of ship Maneuverability (Tankers)

Comparison of ship Maneuverability (Tankers)

Yaw checking and course keeping ability(overshoot angle)

Criteria 10°/10° zig-zag test 1st OA angel ≤ 10°/20°, 2nd OA ≤ 25°/40°

20°/20° zig-zag test 1st OA angel ≤ 25°

Type of ship	G/T	Dwt	LOA(m) /Lpp	Breadth (m)	LOA/B ratio	Block-coefficient	10°/10° zig-zag test				20°/20° zig-zag test				EEDI, fuel and year built
							port		stb'd		port		stb'd		
							1st	2nd	1st	2nd	1st	2nd	1st	2nd	
VLCC 316K, Sulzer 43,030hp	163,066	316,373	333/319	60	5.6	0.83			18.2	39.2			19.1		before EEDI, FO, 2011
VLCC 293K H ELEPHANT B&W 39,200hp	161,969	293,384	333/320	60	5.6	0.81	12.2	26.7			18.2	18.5			before EEDI, FO, 2012
VLCC 300K NAUTILUS B&W 32,700hp	154,163	299,392	333/322	60	5.6	No record			9.3	38.2			14.0		EEDI phase I FO, 2016
46K PC FINNANGER B&W 12,700hp	29,807	46,251	183/174	32.2	5.7	No record	8.7	20.4			19.9				before EEDI, FO, 2009
50K PC BOXER B&W 11,140hp	29,447	49,852	183/175	32.2	5.7	No record	13.7	29.7	17.3	32.0	23.0		20.7		EEDI phase I LSFO, 2019
50K PC MARI INNOVATOR, B&W 10,160hp	30,873	49,999	186/177	32.2	5.8	0.79			9.7	22.5			15.7		EEDI phase II LSFO/Methanol 2021
50K PC CLEAROCEAN, B&W 9,620hp	29,530	49,999	183/175	32.2	5.7	No record			14.1	27.6			19.5		EEDI phase II LSFO, 2021

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Comparison of ship Maneuverability (Tankers)

Stopping ability   Criteria   Track reach ≤ 15Lpp

Type of ship	G/T	Dwt	LOA(m) /Lpp	Breadth (m)	Crash stop astern	Remark	
					Full ahead --> Full Astern	Condition design speed	EEDI, fuel and year built
VLCC 316K, Sulzer 43,030hp	163,066	316,373	333/319	60	4,513m (14.15Lpp)	Laden 15.0kts	before EEDI, FO, 2011
VLCC 293K H ELEPHANT B&W 39,200hp	161,969	293,384	333/320	60	5,637m (17.6Lpp)	Laden 15.7kts	before EEDI, FO, 2012
VLCC 300K NAUTILUS B&W 32,700hp	154,163	299,392	333/322	60	4,600m (14.3Lpp)	Laden 14.8kts	EEDI phase I FO, 2016
46K PC FINNANGER B&W 12,700hp	29,807	46,251	183/174	32.2	1,826m (10.5Lpp)	Laden 15.0kts	before EEDI, FO, 2009
50K PC BOXER B&W 11,140hp	29,447	49,852	183/175	32.2	2,006m (11.5Lpp)	Laden 13.7kts	EEDI phase I LSFO, 2019
50K PC MARI INNOVATOR, B&W 10,160hp	30,873	49,999	186/177	32.2	2,297m (13.0Lpp)	Laden 14.0kts	EEDI phase II LSFO/Methanol 2021
50K PC CLEAROCEAN, B&W 9,620hp	29,530	49,999	183/175	32.2	1,851m (10.57Lpp)	Loaded 14.30kts	EEDI phase II LSFO, 2021

Comparison of ship Maneuverability (LNG/LPG Carrier)

Turning circle(Ballast) Criteria Advance ≤ 4.5Lpp Tacitcal diameter ≤ 5.0Lpp

Type of ship	G/T	Dwt	LOA(m) /Lpp(m)	Breadth (m)	LOA/B ratio	Block-coefficient	Advance		Tactical diameter		EEDI, fuel and year built
							port	stb'd	port	stb'd	
155K GTT Mark III DFDE 54,250hp single screw	102,064	84,303	288/275	44.2	6.5	0.76	757m (2.75Lpp)	791m (2.88Lpp)	636m (2.31Lpp)	821m (2.99Lpp)	before EEDI FO/LNG, 2007
165K SPB DFDE 33,257hp single screw	122,142	88,700	300/292	48.9	6.1	0.70	811m (2,70Lpp)	767m (2.56Lpp)	853m (2.84Lpp)	866m (2.89Lpp)	EEDI phase I FO/LNG, 2019
177K Moss DFDE 33,070hp twin screw	135,951	82,254	300/286	48.9	6.1	0.70	no record	943m (3.30Lpp)	no record	1182m (4.13Lpp)	EEDI phase I FO/LNG, 2019
174K GT96 ME-GI 32,319hp twin screw	115,541	98,344	296/284	46.4	6.4	no record	920m (3.24Lpp)	778m (2.74Lpp)	897m (3.16Lpp)	883m (3.11Lpp)	EEDI phase I FO/LNG, 2017
180K Mark III XDF 34,730hp twin screw	122,166	97,494	299/294	47.8	6.3	no record	972m (3.31Lpp)	1221m (4.16Lpp)	888m (3.03Lpp)	1102m (3.75Lpp)	EEDI phase I FO/LNG, 2019
40K LPG KAUPANG B&W 11,270hp	26,614	29,649	180/174	28.7	6.3	No record	492m (2.83Lpp)	513m (2.95Lpp)	650m (3.75Lpp)	658m (3.79Lpp)	EEDI phase II LSFO/LPG, 2022

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Comparison of ship Maneuverability (LNG/LPG Carrier)

Initial turning ability   travelled distance ≤ 2.5Lpp

Type of ship	G/T	Dwt	LOA(m) /Lpp(m)	Breadth (m)	LOA/B ratio	Block-coefficient	Sailing distance		elapsed time (sec)		remark	EEDI, fuel and year built
							Port	Stb'd				
155K GTT Mark III DFDE 54,250hp single screw	102,064	84,303	288/275	44.2	6.5	0.76	374m (1.36Lpp)	479m (1.74Lpp)	36	47	ballast 19.8kts	before EEDI FO/LNG, 2007
165K SPB DFDE 33,257hp single screw	122,142	88,700	300/292	48.9	6.1	0.70	460m (1.58Lpp)	482m (1.65Lpp)	42	44	ballast 21.3kts	EEDI phase I FO/LNG, 2019
177K Moss DFDE 33,070hp twin screw	135,951	82,254	300/286	48.9	6.1	0.70	462m (1.61L)	453m (1.58L)	45	44	ballast 20.2kts/ 19.9kts	EEDI phase I FO/LNG, 2019
174K GT96 ME-GI 32,319hp twin screw	115,541	98,344	296/284	46.4	6.4	no record	419m (1.48Lpp)	no record	43	no rec	ballast 18.9kts	EEDI phase I FO/LNG, 2017
180K Mark III XDF 34,730hp twin screw	122,166	97,494	299/294	47.8	6.3	no record	no record	421m (1.41Lpp)	no rec	44	ballast 18.6kts	EEDI phase I FO/LNG, 2019
40K LPG KAUPANG B&W 11,270hp	26,614	29,649	180/174	28.7	6.3	no record	350 (2.01Lpp)	no record	42		ballast 16.2kts	EEDI phase II LSFO/LPG, 2022

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Yaw checking and course keeping ability(overshoot angle)

Criteria 10°/10° zig-zag test 1st OA angel ≤ 10°/20°, 2nd OA ≤ 25°/40°

20°/20° zig-zag test 1st OA angel ≤ 25°

Type of ship	G/T	Dwt	LOA(m) /Lpp	Breadth (m)	LOA/B ratio	Block-coefficient	10°/10° zig-zag test				20°/20° zig-zag test				EEDI, fuel and year built
							port		stb'd		port		stb'd		
							1st	2nd	1st	2nd	1st	2nd	1st	2nd	
155K GTT Mark III DFDE 54,250hp single screw	102,064	84,303	288/275	44.2	6.5	0.76	12.6	9.7	5.0	16.4	16.2		12.1		before EEDI FO/LNG, 2007
165K SPB DFDE 33,257hp single screw	122,142	88,700	300/292	48.9	6.1	0.70	4.6	5.0	3.8	6.4	11.3		9.6		EEDI phase I FO/LNG, 2019
177K Moss DFDE 33,070hp twin screw	135,951	82,254	300/286	48.9	6.1	0.70	3.4	3.2	3.8	3.7	6.1		6.3		EEDI phase I FO/LNG, 2019
174K GT96 ME-GI 32,319hp twin screw	115,541	98,344	296/284	46.4	6.4	no record	12.4	14.5			16.3				EEDI phase I FO/LNG, 2017
180K Mark III XDF 34,730hp twin screw	122,166	97,494	299/294	47.8	6.3	no record			11.3	14.6			12.4		EEDI phase I FO/LNG, 2019
40K LPG KAUPANG B&W 11,270hp	26,614	29,649	180/174	28.7	6.3	No record			1.7	3.7			11.1		EEDI phase II LSFO/LPG, 2022

Comparison of ship Maneuverability (LNG/LPG Carrier)

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Comparison of ship Maneuverability (LNG/LPG Carrier)

Stopping ability Criteria Track reach ≤ 15Lpp

Type of ship	G/T	Dwt	LOA(m)/ Lpp	Breadth (m)	Crash stop astern	Remark	
					Full ahead --> Full Astern	Condition design speed	EEDI, fuel and year built
155K GTT Mark III DFDE 54,250hp single screw	102,064	84,303	288/275	44.2	3,364m (12.23Lpp)	Ballast 19.0kts	before EEDI FO/LNG, 2007
165K SPB DFDE 33,257hp single screw	122,142	88,700	300/292	48.9	3,033m (10.6Lpp)	Ballast 21.0kts	EEDI phase I FO/LNG, 2019
177K Moss DFDE 33,070hp twin screw	135,951	82,254	300/286	48.9	3,519m (12.3Lpp)	Ballast 20.2kts	EEDI phase I FO/LNG, 2019
174K GT96 ME-GI 32,319hp twin screw	115,541	98,344	296/284	46.4	3,502m (12.3Lpp)	Ballast 16.1kts	EEDI phase I FO/LNG, 2017
180K Mark III XDF 34,730hp twin screw	122,166	97,494	299/294	47.8	4,194m (14.3Lpp)	Ballast 18.6kts	EEDI phase I FO/LNG, 2019
40K LPG KAUPANG B&W 11,270hp	26,614	29,649	180/174	28.7	2,536m (14.61Lpp)	Ballast 16.11kts	EEDI phase II LSFO/LPG, 2022

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Conclusion

The world is changing rapidly and the paradigm for the environment is also changing. As all of you know, many diesel cars have been replaced by electric cars or hydrogen-fueled cars recently. The road map for the reduction of GHG emissions from international shipping has been established and is being implemented under the command of IMO. We are at the center of these changes. Sulfur cap and EEDI changed the shape of ships' superstructure and are accelerating changes in the fuels of ships' engines. I planned this presentation under the subject "Ship maneuverability in an era of environmental focus" and tried to find and explain the impact on the ships' maneuverability numerically using "IMO's standards for Ship maneuverability".

Conclusion

I compared ships' maneuverability by classifying them into non-EEDI and EEDI-applied ships and fuel.

However, I could not find any significant differences in maneuverability among them and there was no vessel out of IMO Standards.

According to the Information from shipbuilders and engine manufacturers, if the engine output is the same, there is not much difference in the ship's maneuverability between any type of fuel.

At the 2014 Panama Congress, when I presented "The Maneuverability of Very Large and Ultra Large Container Ship", I concluded that the maneuvering characteristics remain unchanged, though ships are getting bigger unless the hull shape is changed.

Conclusion

Now, I would like to say cautiously, "My conclusion is the same.
The ships' maneuverabiltiy remains unchanged in an era of environmental focus. However, as the engine power is generally reduced, it will inevitably affect the stopping ability.
We need to pay special attention to the engine power.
Since decarbonization and fuel transitions are on going, I will continue to keep an eye on ships' maneuverability and would like to suggest that IMPA do more research on this topic.

Any Questions?

Or Contact to Capt. Goag, jemis904@kmpilot.or.kr

Thank You, Gracias!

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