

EEXI Regulation Compliance Introduction of EEXI-EPL system

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Contents

- 1. Trends in GHG emission regulations**
- 2. Outlines of the EEXI regulation**
- 3. EEXI improvement methods (EPL)**
- 4. Introduction of EEXI-EPL system**
- 5. Summary of EPL methods**
- 6. Improvement by Energy saving**

1. Trends in GHG emission regulations

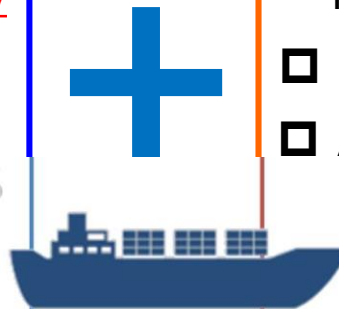
The following two measures have been ratified for implementation.

⇒ **EEXI (Energy Efficiency Existing Ship Index)** : A new regulation requiring existing ships to have the same level of fuel efficiency as new ships (EEDI ships)

⇒ **CII (Carbon Intensity Indicator) Rating** : A rating for fuel efficiency performance

EEXI regulation

- ❑ Due to engine power limitations, The same level of fuel efficiency as new ships (EEDI regulation)
- ❑ Preliminary inspection and certification of ships for **Fuel efficiency**
【Features】
 - ❑ Not affected by weather, sea conditions, etc.
 - Fair and just evaluation of energy-saving performance



CII rating

- ❑ One year fuel consumption results are checked.
 - ❑ Rated on a 5-point scale from A-E
 - ❑ An **improvement plan** is formulated for low ratings (E, D for three consecutive years).
- 【Features】
- ❑ Actual fuel cons. results can be grasped.
 - ❑ Difficult to implement uniform regulations due to significant effects of weather, sea conditions, etc.



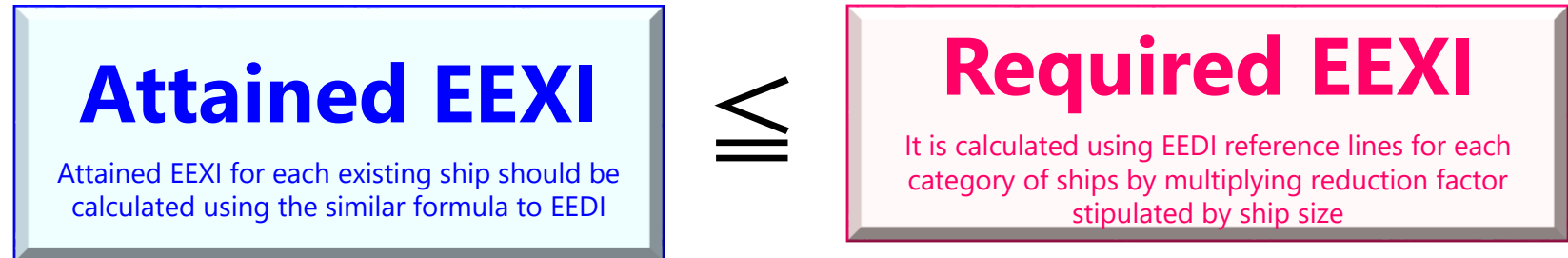
(Created by referring to MLIT document(<https://www.mlit.go.jp/common/001406844.pdf>))

2. Outlines of the EEXI regulation

◆ Target of EEXI regulation

All ships **400 GT and above engaged in international trade** (Some ships excluded)

Required to **meet Required EEXI** on EEXI regulated vessels



◆ Deadline for compliance with EEXI regulations

Regulatory compliance by annual, interim, and renewal inspections of the first IAPP certificate after **January 1, 2023**



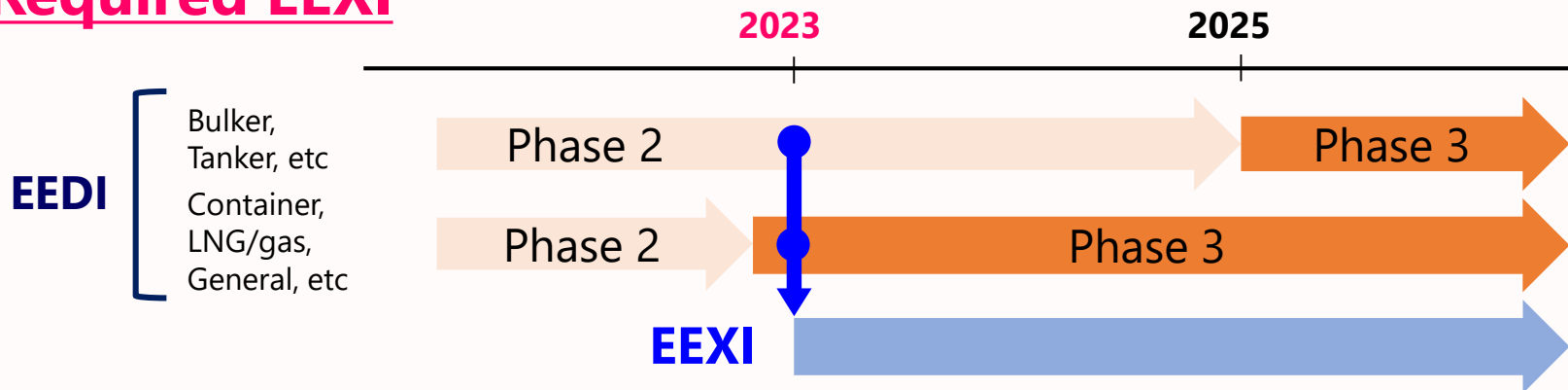
(Excerpt from ClassNK Consulting Service HP)

2. Outlines of the EEXI regulation

◆ Attained EEXI calculation formula

$$\text{EEXI} \frac{[\text{g/ton} \cdot \text{mile}]}{=} \frac{\text{CO}_2 \text{ Conversion factor } (C_F) \times \text{Fuel cons. } (SFC) [\text{g/kW} \cdot \text{h}] \times \text{Engine Power } (P_{ME}) [\text{kW}]}{\text{Capacity } [\text{ton}] \times \text{Ship speed } [\text{mile/h}]}$$

◆ Required EEXI



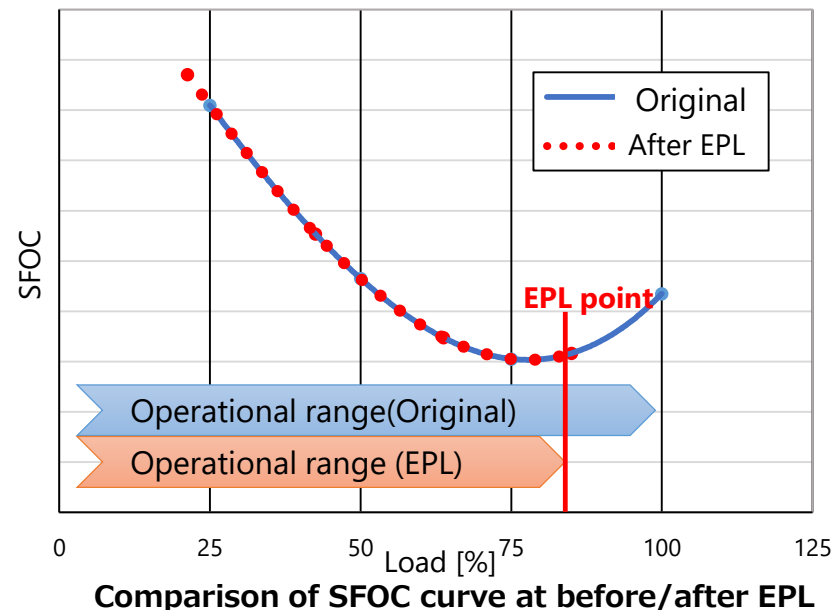
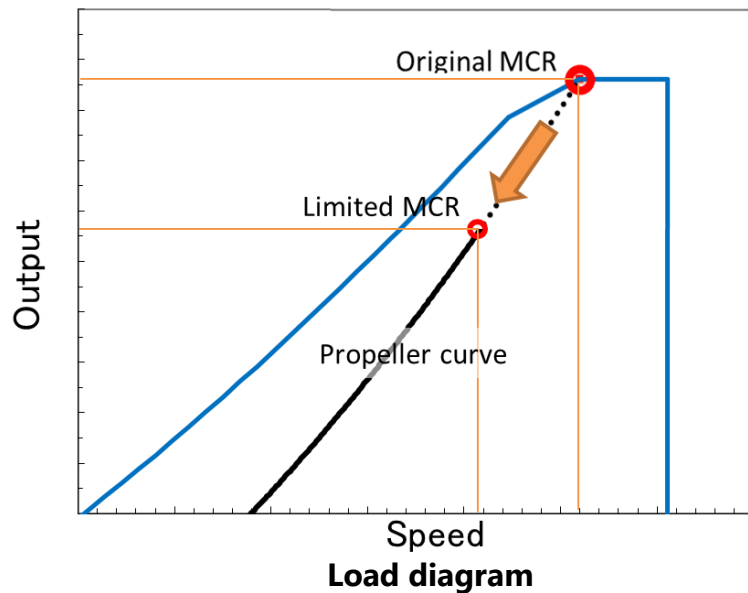
Basically, the same level as the EEDI regulation value of new ships as of 2023 will be regulated.

Many existing ships require measures such as **engine power limitation (EPL)** and **energy-saving modifications**.

3. EEXI improvement methods (EPL)

What's Engine Power Limitation (EPL) ?

- ◆ EPL is power limitation modification to the main engine.
- ◆ To limit engine output by EPL Reduce engine output which is a factor of EEXI evaluation
➔ **improving EEXI evaluation**
- ◆ More cost-effective than improvement by energy-saving modification, and EPL work is relatively easy
- ◆ As the modification is only power limitation, there is no change in the performance of the main engine, and the same operation as before is possible under the limit load.
- ◆ Temporary cancellation is permitted for emergencies and engine maintenance

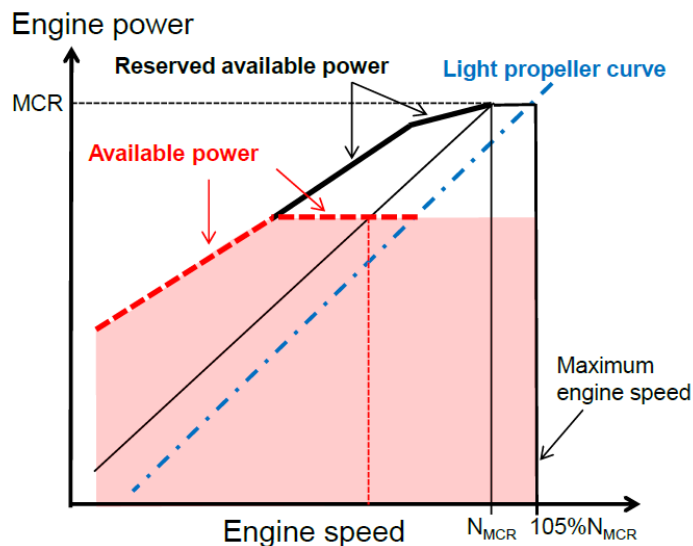


3. EEXI improvement methods (EPL)

EPL methods

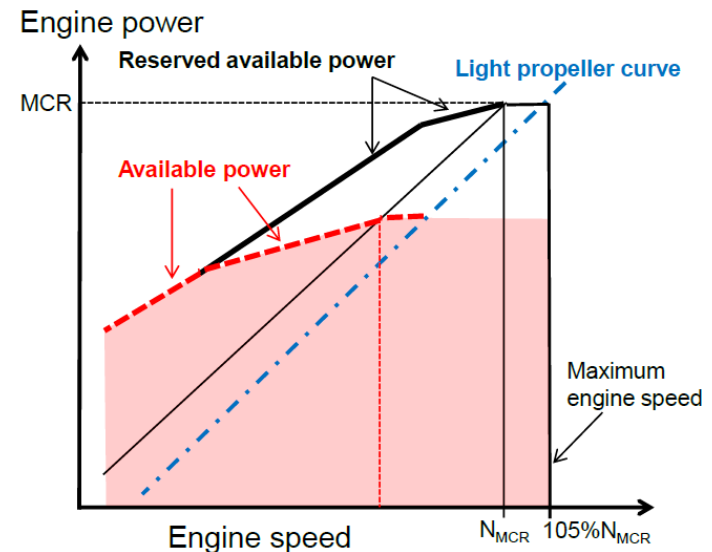
◆ Limits by estimation power control : EPL-Power

To control the Fuel index and engine speed according to the actual estimated power so as not to exceed the limit power



◆ Limits by Fuel index equivalent to power : EPL-FI

To limit with the Fuel index equivalent to the limit power calculated based on the shop trial test data



✳ Since EPL-Power requires an advanced control system, EPL-FI, which is a method of limiting the fuel index with a mechanical stopper, is widely adopted in mechanical engines (MC engines).

3. EEXI improvement methods (EPL)

Problems with mechanical stopper type EPL

1. Cannot be easily unlocked or re-limited
2. Cannot be quickly unlocked
3. Cannot be limited with a constant load



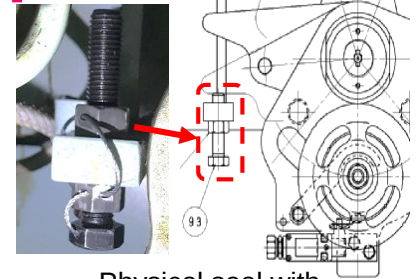
The decision to cancel may be restricted



Cannot respond in an emergency



Limited load depends on the conditions of the hull and sea



Physical seal with mechanical stopper

To solve these problems and support safe operation

Mitsui E&S Machinery and Mitsui E&S Systems Research Inc.(MSR)
Have developed the “EEXI-EPL system” for mechanical engines

This method does not use a mechanical stopper seal.

4. Introduction of EEXI-EPL system

What's EEXI-EPL system

The system is EPL-Power compliant featuring a remote control system which can limit main engine load control, and an EPL Monitoring Unit (EMU).

Contents of Modification :

- ① **Software upgrade for the remote control system**
- ② **Additional installation of EMU**

① Upgrade remote controller & Governor



+

② Installation of EMU



4. Introduction of EEXI-EPL system

System Feature & Benefits

◆ The remote control system software compliant with engine load control

1. EPL-Power compatible
2. Instant release is possible with the EPL release switch installed on the Remote Control screen.
(BMS : at Wheel House, EMS : at Control Room)
3. Easy EPL reconfiguration by resetting EPL cancellation
4. Engine running under engine load stable control



◆ EPL Monitoring Unit (EMU)

1. Monitoring and recording of load/fuel index negates the necessity of sealing the mechanical stopper.
2. It can be installed independently on engines with other manufacturers' remote control systems to make the mechanical stopper sealing unnecessary.
3. EMU can output a trend graph of load (or fuel index) during EPL cancel operation.
4. Tamper proof
5. By connecting VDR information to EMU, it is possible to record information such as wind direction, wind speed, GPS, etc.



4. Introduction of EEXI-EPL system

Target remote EEXI-EPL system

➤ EPL-Power <Recommendation>

MC/MC-C engine which is equipped below MSR Remote controller

Remote controller type	[BMS-2000III , EMS-200III BMS-2000II , EMS-200II
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➤ EPL-FI

Other remote controllers

EPL-FI with EPL monitoring unit(EMU)

4. Introduction of EEXI-EPL system

Comparison of EEXI-EPL methods

EPL method	EPL-Power	EPL-FI
Target remote controller	For MC • MC-C engine BMS-2000III , EMS-200III BMS-2000II , EMS-200II	All remote control systems
Control parameter	Engine load	Fuel index
Required modification	Remote controller upgrade Additional installation of EMU	Additional installation of EMU
Crash Astern start	No limitation	Depending on load limit, fuel amount can be limited at M/E start. Starting performance is decreased.
EPL cancellation	Cancellation is done on display at once.	Governor setting value is required to be changed.
Load stable control	Equipped as standard function	-
EPL monitoring Parameter	M/E load, M/E rpm	Fuel index, M/E rpm
Optional function	Importing VDR info. Note: Contacting VDR maker is required.	Importing VDR info. Note: Contacting VDR maker is required.

4. Introduction of EEXI-EPL system

A. EPL-Po : Limited by estimated load control

Applicable systems :

- BMS-2000III, EMS-200III
- BMS-2000II, EMS-200II

Remote controller
Governor

Software
upgrade



Alarm
monitoring
system

Engine load
information

Alarm signal

EPL Monitoring Unit (EMU)



VDR



* Optional
Importing VDR info.

B. EPL-FI : Limited by Fuel index

Applicable systems :

All remote control systems

Remote controller
Governor



Alarm
monitoring
system

Fuel index
information

Alarm signal

EPL Monitoring Unit (EMU)



VDR



* Optional
Importing VDR info.

5. Summary of EPL methods

EPL methods

MC/-C engine

The EPL of **MC/MC-C engine** is as follows.

(A) **EPL-Po by EEXI-EPL system**

(B) **EPL-FI with EPL monitoring unit(EMU)**



No.	Symbol	Description	Min. Set	Max. Set	Value	Unit
1	F1 MAX	Manual max. fuel limit	0.0	21 MAX	21.0	%
2	F1 MAX	Maximum posit. of actuator	0.0	50.0	24.0	%
3	F1 MAX	Resolution of fuel mode	10.0	100.0	64.0	rpm
4	DEFTW	Variation range of raw set	0.0	10.0	0.2	rpm
5	SLDR1	Slope inside dead band	0.0	5.0	0.2	rpm
6	SLDR2	Slope outside dead band	0.0	5.0	0.0	rpm
7	SLDRN	Slope in revivation zone	0.0	5.0	0.0	rpm
8	PRMR	Range of dead band (RPM)	0.0	10.0	1.0	rpm
9	DEFTS	Range of dead band (RPM)	0.0	10.0	1.5	rpm
10	FWTS	Load during W/S start	0.0	21 MAX	50.0	%
11	FWTSR	Over limit at normal start	0.0	21 MAX	50.0	%
12	FWTSR	Over limit at W/S start	0.0	21 MAX	70.0	%
13	FWTSR	Detection of stable running	0	1700	1700	rpm
14	DEFTW	Load estimation (Normal)	0.0	10.0	7.5	rpm
15	DEFTS	Load estimation (Start)	0.0	10.0	10.0	rpm
16	FWTSR	Filter for differential	0.00	1.00	0.04	sec

[Change of setting on Remote controller]

ME/-C/-B engine

ME engines already have the limiter functions by MOP and automatically record the engine status by the CoCoS system.

Therefore, EPL can be set without adding equipment such as the EEXI-EPL system.

The EPL of the ME engine can be done by either of the following methods.

(A) Change **Chief Max Load** setting (**EPL-Po**) or

(B) Change **Chief Index Limit** setting (**EPL-FI**)

※ The EPL method differs depending on ME-ECS Ver.



Chief Max Load	Engine Max Load	Chief Max Load	Engine Max Load
10.0 RPM	91.5 RPM	110.5	110.5

[Change of limiter on MOP]

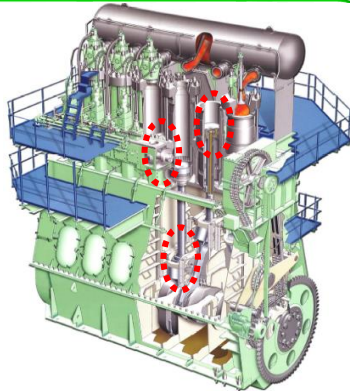
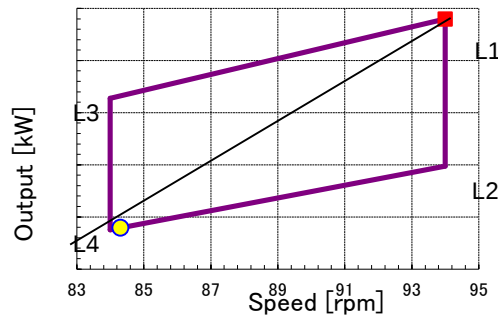
6. Improvement method by Fuel Saving

➤ Cases that require Fuel saving modification

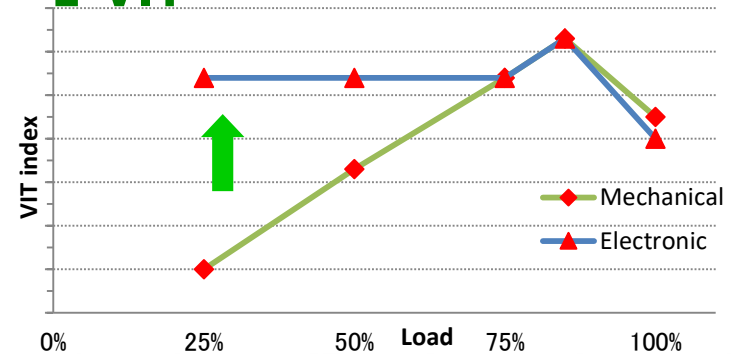
- CII improvement
- Unacceptable low load operation

➤ Applicable Fuel saving modification

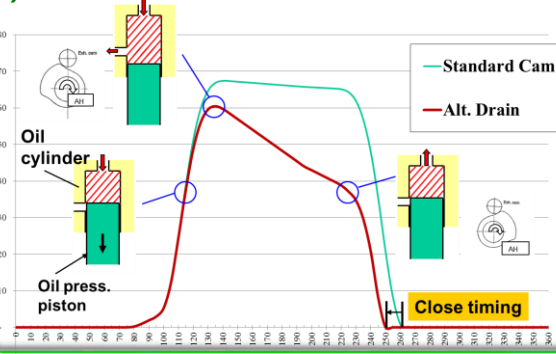
1) Derating



3) E-VIT



2) EcoCam



4) EcoNozzle



6. Improvement method by Fuel Saving

	1) Derating	2) EcoCam	3) E-VIT	4) EcoNozzle
Summary	Change MCO, Re-matching engine	Control Exh. valve by EcoCam	Control VIT index by I/P Converter	Change Atomizer with optimized combustion
Benefit range	Below 85%Load	Below 60%Load	Below 75%Load	Whole range
Target engine	Mechanical or Electrical controlled engine (Depend on Orig.MCO)	S50MC-C S60MC-C S70MC-C	Installed Mech. VIT with actuator and NOx Tier I compliance	S50MC-C Mk 7/8 with NOx Tier II compliance
Estimated Work period	7-10 days (without Onboard measurement)	3 days (without Onboard measurement)	3 days	1 day

6S50MC-C (@50%Load, 4740kW) Estimated fuel consumption reduction effect

SFOC improvement (Δ SFOC@50%load) [g/kWh]	4.5	2.5	2	3
Reduction gain [Ton/Year]	128	71	57	85
Reduction gain [million JPY/Year]	7.0	3.9	3.1	4.7
Pay back year	Abt. 6 year	Abt. 2 year	Abt. 2 year	Abt. 1 year

※As the applicability, improvement effects and modification details are different depending on the engine specifications, please contact us for a consultation.

Calc condition
6000 hrs/year
500 US\$/ton (VLSFO)
110 JPY/\$



Mitsui E&S Machinery Co., Ltd.

~ Make with Heart ~

Thank you for your attention !