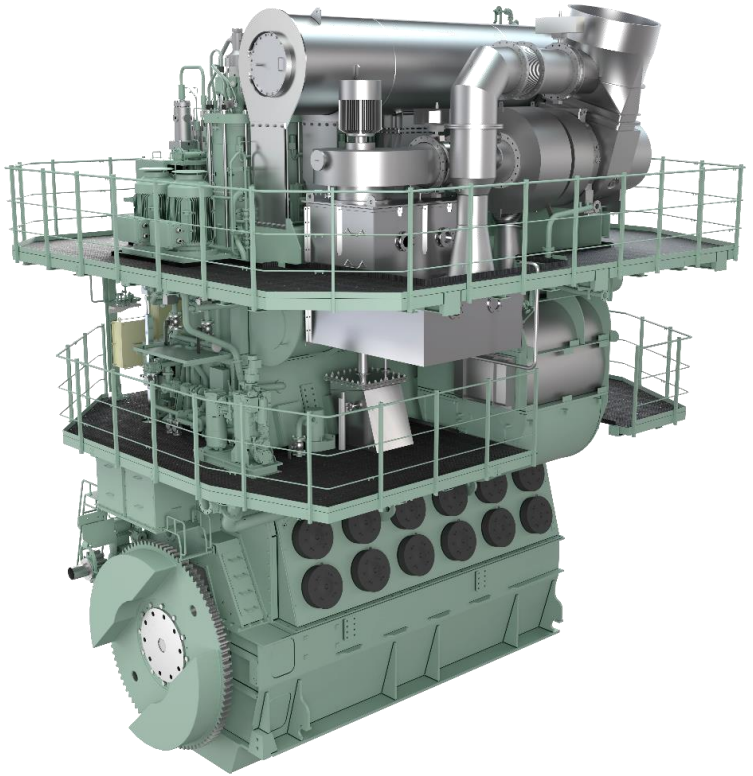
Tier III technology for UE engine

LP-EGR system



Mar. 2023

Japan Engine Corporation

NOx emission control area（ECA）

The emission regulations of IMO for NOx and sulfur content in fuel are getting strict year by year.

As for the NOx regulation, from 2011 Tier II regulation is in effect.

As the result of MEPC66, from 2016 Tier III regulation became into effect.

Its level is over 75% less than that of Tier II inside of ECA. Outside of ECA its emission level is same as Tier II.

Existing ECA

＜NOx-ECA＞（2021～）

IMO NOx Tier III Solutions

UEC engine complies with IMO NOx Tier III regulation
by LP-EGR, HP-SCR or LP-SCR system, which has the enough ability to reduce NOx emission for the regulation.

①METHODS IN-ENGINE
- **EGR (Exhaust Gas Recirculation)**

②AFTER TREATMENT
- SCR (Selective Catalytic Reduction)

Contents

Design Concepts

➢ Simple System

- ✓ **Simple configuration and components**, due to low press. and low temp.
- ✓ **J-ENG Zero-Bleed-off system** will contribute to the reduction of environmental load.

➢ Simple Operation and Control

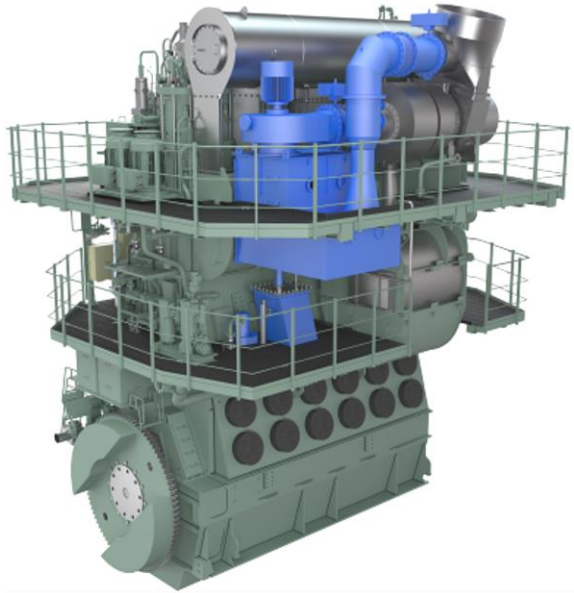
- ✓ Operation is executed by an ON/OF control of the EGR valves. (within 5 minutes)
- ✓ **Good response and stability** in the maneuvering and for load fluctuation in heavy weather

➢ High performance

- ✓ Minimum SFOC deterioration, complying with NOx Tier3 regulation.
- ✓ Verified high reliability of engine parts and EGR components through the bench test and on-board test

➢ Low CAPEX and OPEX

- ✓ **Low installation works** with a simple configuration
- ✓ **Low maintenance costs**
- ✓ Enjoy low fuel costs, acc. to the advantage of low SFOC



【6UEC50LSH-Eco-C3-EGR】

Completely in-house developed technology

- ☆ **All knowledge and experience gained during the development process have been utilized**
- ☆ **No black box, quick response in case of emergency**

Contents

LP-EGR Development / Delivery Record

Japan Engine Corporation

As of Mar. 2023

2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023

Fundamental test → **Test Eng.** → **On-Board Test** → **EGR(commercial)** → **In Service**

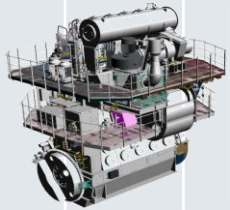
EGR : 370h

4UEC60LSE-Eco-B2-EGR

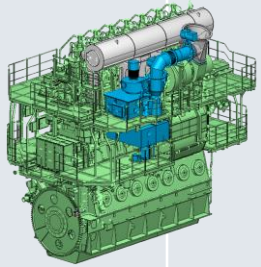
EGR : 860h

6UEC45LSE-Eco-B2-EGR

EGR : 150h



5UEC50LSJ-EGR



7UEC60LSE-Eco-A2-EGR

★2020-11/ 6-50LSH-Eco
★2020-12/ 7-60LSE-Eco

★2021-9/ 6-60LSE-Eco
★2021-9/ 6-50LSH-Eco
★2021-11/ 6-50LSH-Eco
★2022-1/ 6-42LSH-Eco
★2022-2/ 6-60LSE-Eco
★2022-2/ 6-42LSH-Eco
★2022-4/ 6-42LSH-Eco
★2022-5/ 6-50LSH-Eco
★2022-5/ 6-42LSH-Eco
★2022-6/ 6-50LSH-Eco
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★2022-10/ 6-50LSH-Eco
★2022-10/ 6-42LSH-Eco
★2022-12/ 6-42LSH-Eco
★2022-12/ 6-42LSH-Eco
★2023-2/ 6-50LSH-Eco
★2023-3/ 6-42LSH-Eco
(Eng. deli.: Apr.2023) 6-42LSH-Eco★
(Eng. deli.: May.2023) 6-50LSH-Eco★
(Eng. deli.: Jun.2023) 6-42LSH-Eco★

[Verification items]
- ☑ Engine performance (NOx, SFOC)
- ☑ Reliability and performance of size-down EGR equipment
- ☑ Reliability and performance of water treatment equipment
- ☑ Reliability of engine components (Combustion chamber parts, T/C, A/C, etc)

[Verification items]
- ☑ Engine performance (NOx, SFOC)
- ☑ Functions and performance of water treatment system
- ☑ Long-term reliability of equipment (Combustion chamber parts, T/C, A/C, WTS, etc.)

Ordered and expected orders : over100 sets
Delivered : 19 sets

Contents

Non-EGR operation (Global Area)

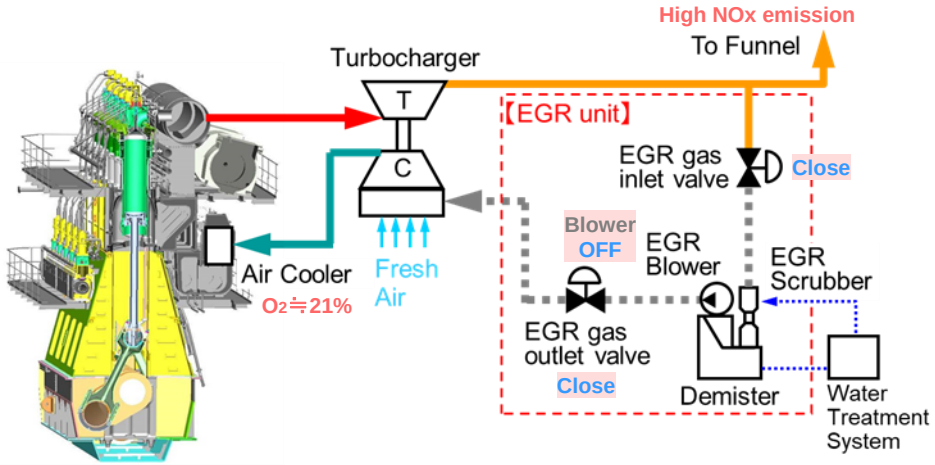
- Non-EGR operation is same as conventional engine (Tier2).
- Scavenging air (O2 concentration≒21%)
- Because of higher combustion temperatures, NOx emission is high.

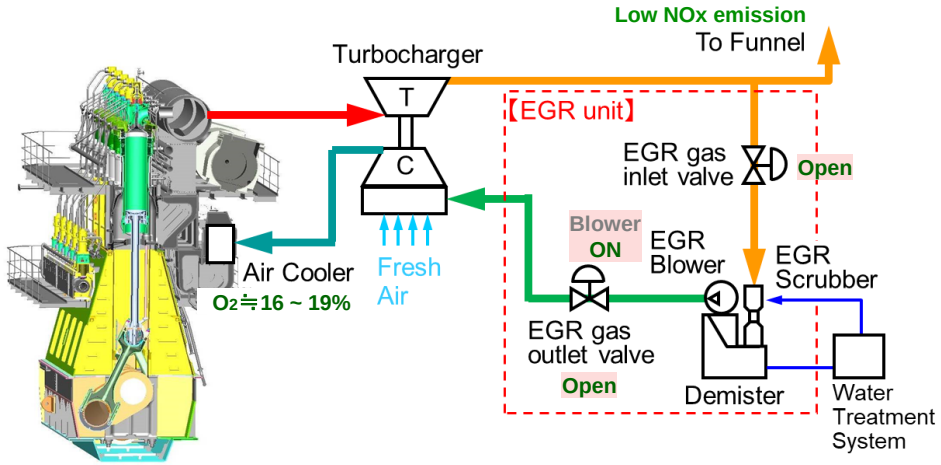
EGR operation (NECA)

- A part of exhaust gases is recirculated to engine.
- Scavenging : mixture of air and recirculated exhaust gas (O_2 concentration≒16 to 19%)
- Slow speed combustion results in low thermal-NOx emission.

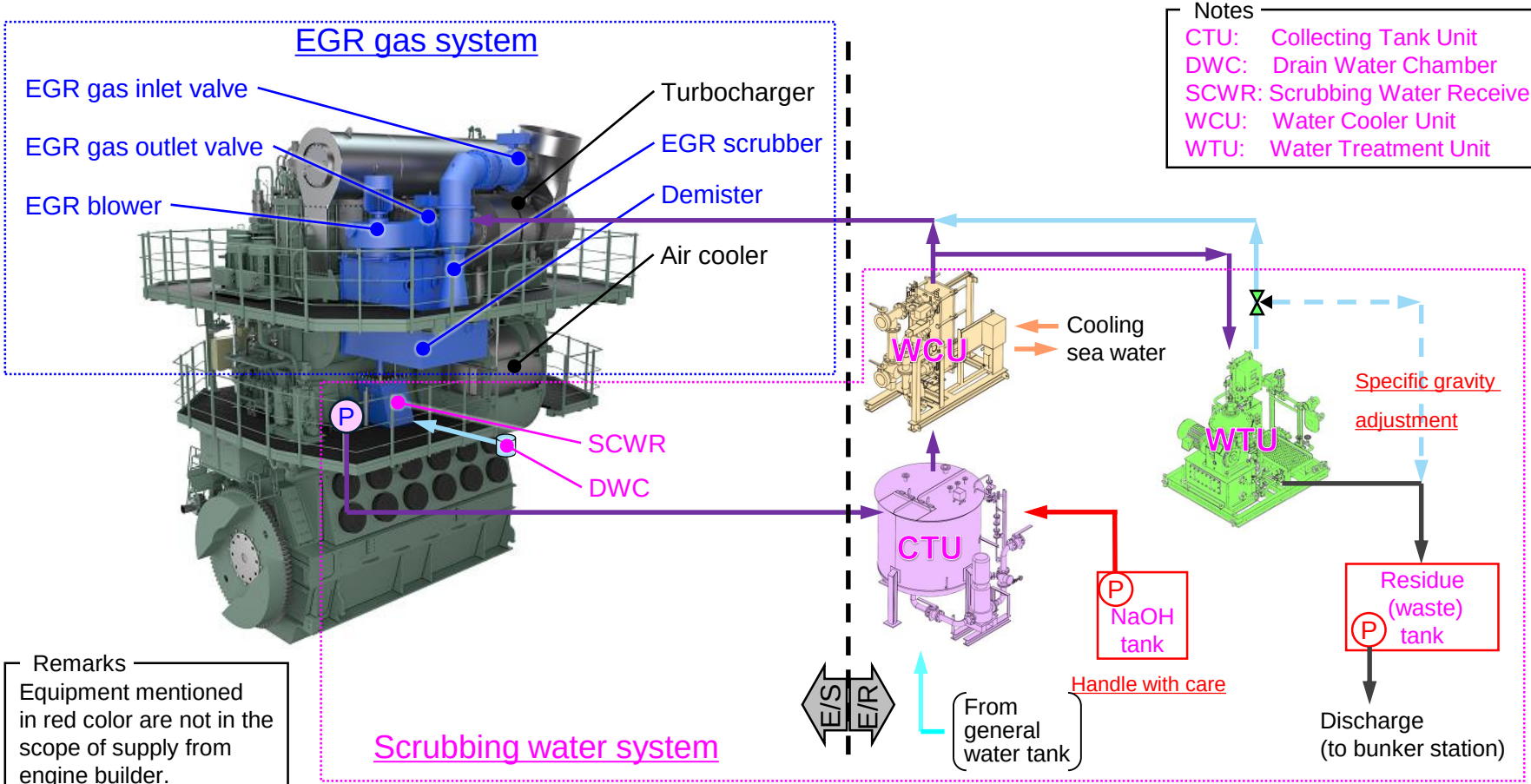
The mode can be changed from the Eco engine control panel

※ O2 sensor calibration required before EGR operation (Press the calibration button on the touch panel)





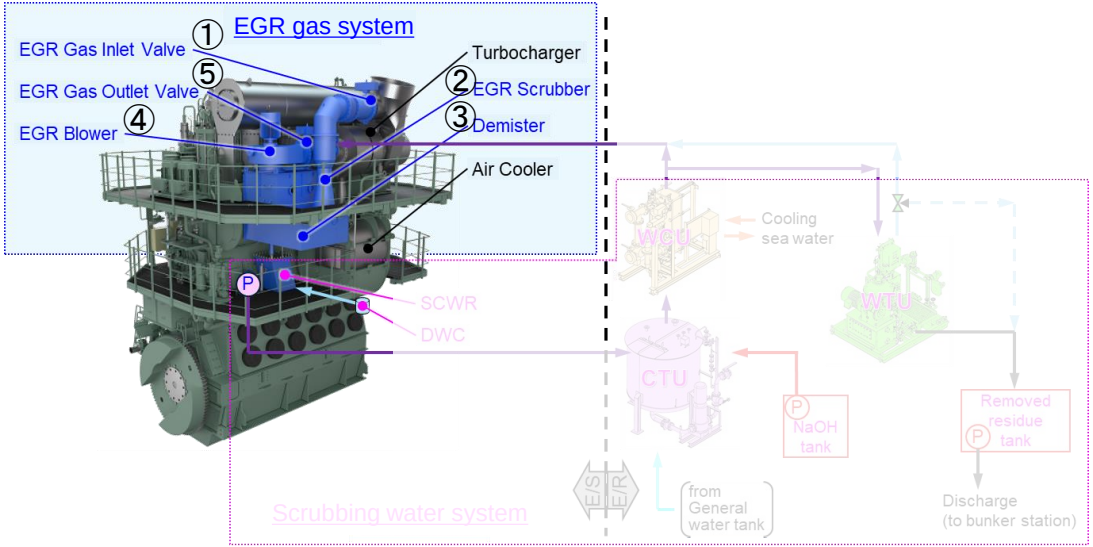
Latest configuration of LP-EGR system



Notes
CTU: Collecting Tank Unit
DWC: Drain Water Chamber
SCWR: Scrubbing Water Receiver
WCU: Water Cooler Unit
WTU: Water Treatment Unit

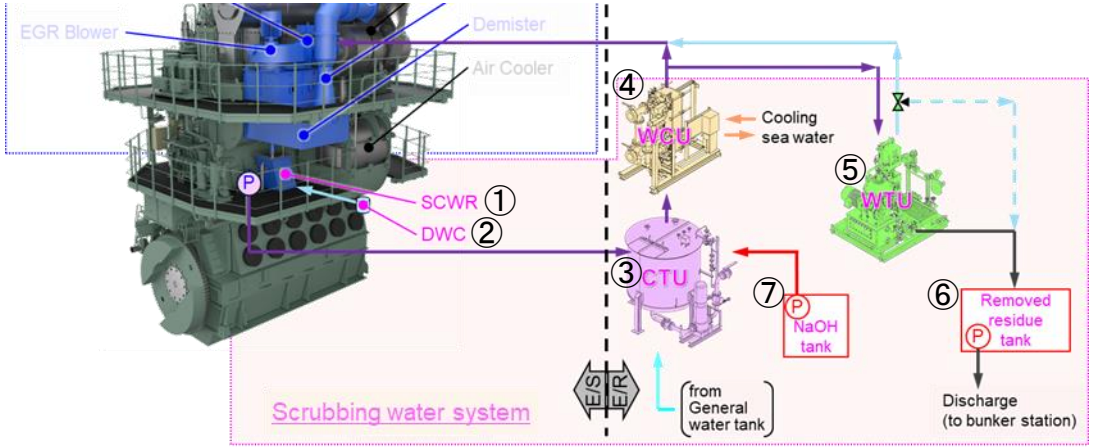
Remarks
Equipment mentioned in red color are not in the scope of supply from engine builder.

Main Function of Major Equipment : EGR gas system



EGR gas system	Function
①EGR gas inlet valve	During Non-EGR mode, prevention of exhaust gas infiltration
②EGR scrubber	Spraying scrubbing water to exhaust gas (EGR gas), removal of soot particles and sulfur contents
③Demister	Water (mist) separation of EGR gas
④EGR blower	Transfer of EGR gas to turbocharger compressor
⑤EGR gas outlet valve	Prevention of EGR gas to engine incase of emergency stop of EGR system

Main Function of Major Equipment : Scrubbing water system



LP-EGR system basically does not require the addition of fresh water.

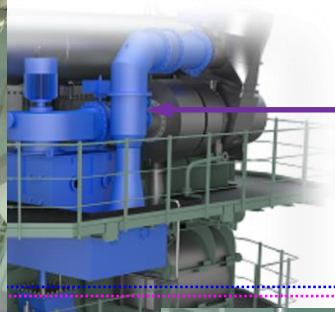
In LP-EGR system, scrubber water is circulated and used, and the scavenging drain is also collected and replenished and reused as scrubber water.

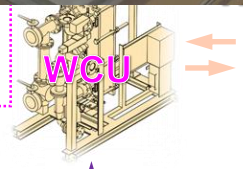
Even above, add fresh water only if the scrubber water is insufficient.

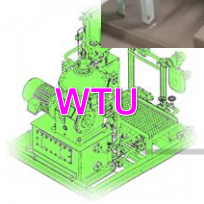
Scrubbing water system	Function
①Scrubbing water receiver (SCWR)	Collecting scrubber water stored in demister and transferring it to ③CTU
②Drain water chamber (DWC)	**Collecting of air cooler drain and reusing it as scrubbing water.**
③Collecting tank unit (CTU)	Storing the scrubbing water
④Water cooling unit (WCU)	Cooling of scrubbing water by heat exchanger using sea water・・・Plate type heat exchanger is equipped
⑤Water treatment unit (WTU)	Removal of residue (waste) particles (soot) from scrubbing water・・・Centrifuge is equipped
⑥Residue (waste) tank	Storing of centrifugal separator residue (waste)（under shipyard's jurisdiction）
⑦Caustic soda aqua solution (NaOH) tank unit	Supplying neutralizer for scrubbing water（ under shipyard's jurisdiction ）

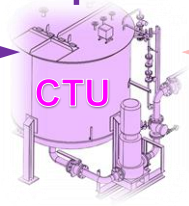
Installed LP-EGR system

EGR gas system









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NaOH tank

E/R

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Scrubbing water system

Thank you

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