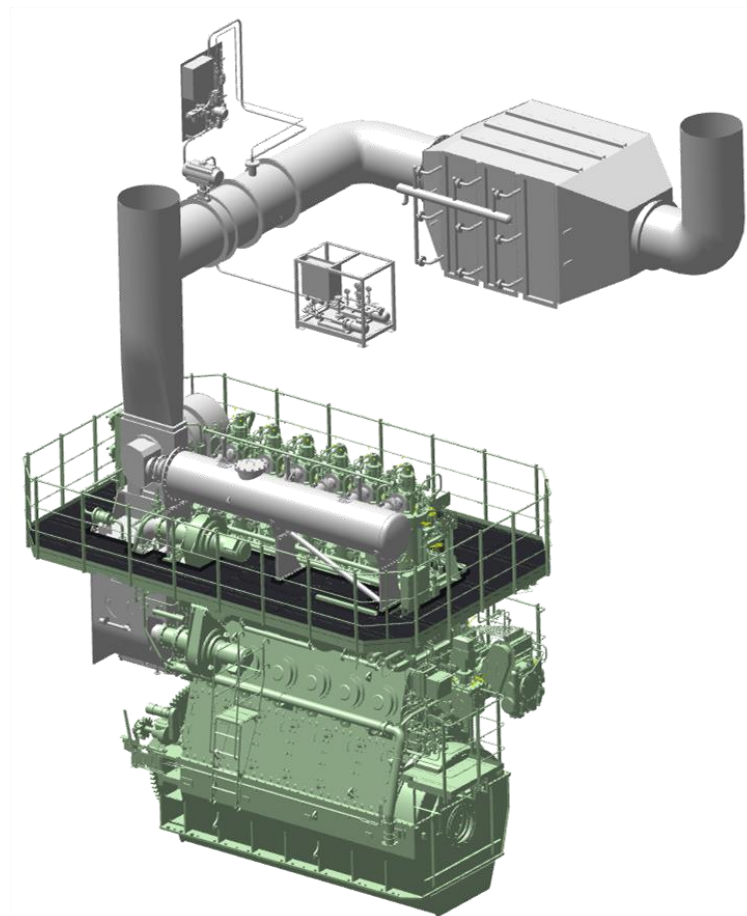


IMO NOx Tier III technology for UE Engine **LP-SCR system**

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~)



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)

1 Design Concepts

2 Development and delivery records of LP-SCR

3 Actual Arrangement for Shop Test

4 Maintenance in Service

Design Concept of Low Pressure-SCR (LP-SCR)

➤ Simple configuration and operation

- ✓ Switching the SCR operation does not affect the engine and turbocharger performance, but **it switch the valves only.**
- ✓ **Simple configuration:**
For engine optimized operation, only one valve is controlled.
- ✓ **Good response and stability** in the maneuvering and for load fluctuation in heavy weather

➤ Good performance and high reliability

- ✓ Minimum SFOC penalty to achieve the exh. gas temperature required for denitration
- ✓ **Kept and verified high reliability**
in fundamental and full-scale on-board tests, started from national project.

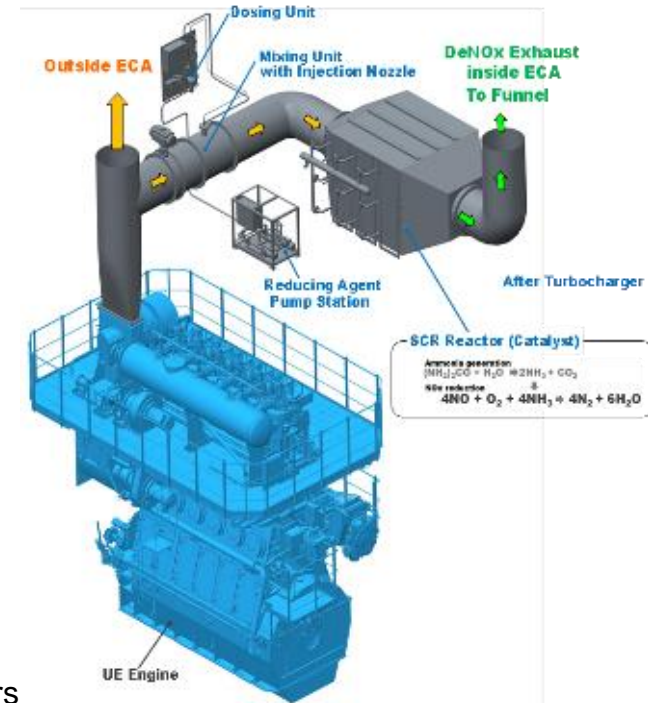
➤ Reduction of CAPEX / OPEX

- ✓ **Low maintenance cost**, due to simple configuration
- ✓ **Contribute the low fuel cost**, due to SFOC advantage over competitors

➤ **No black-box: SCR control system is developed by J-ENG.**

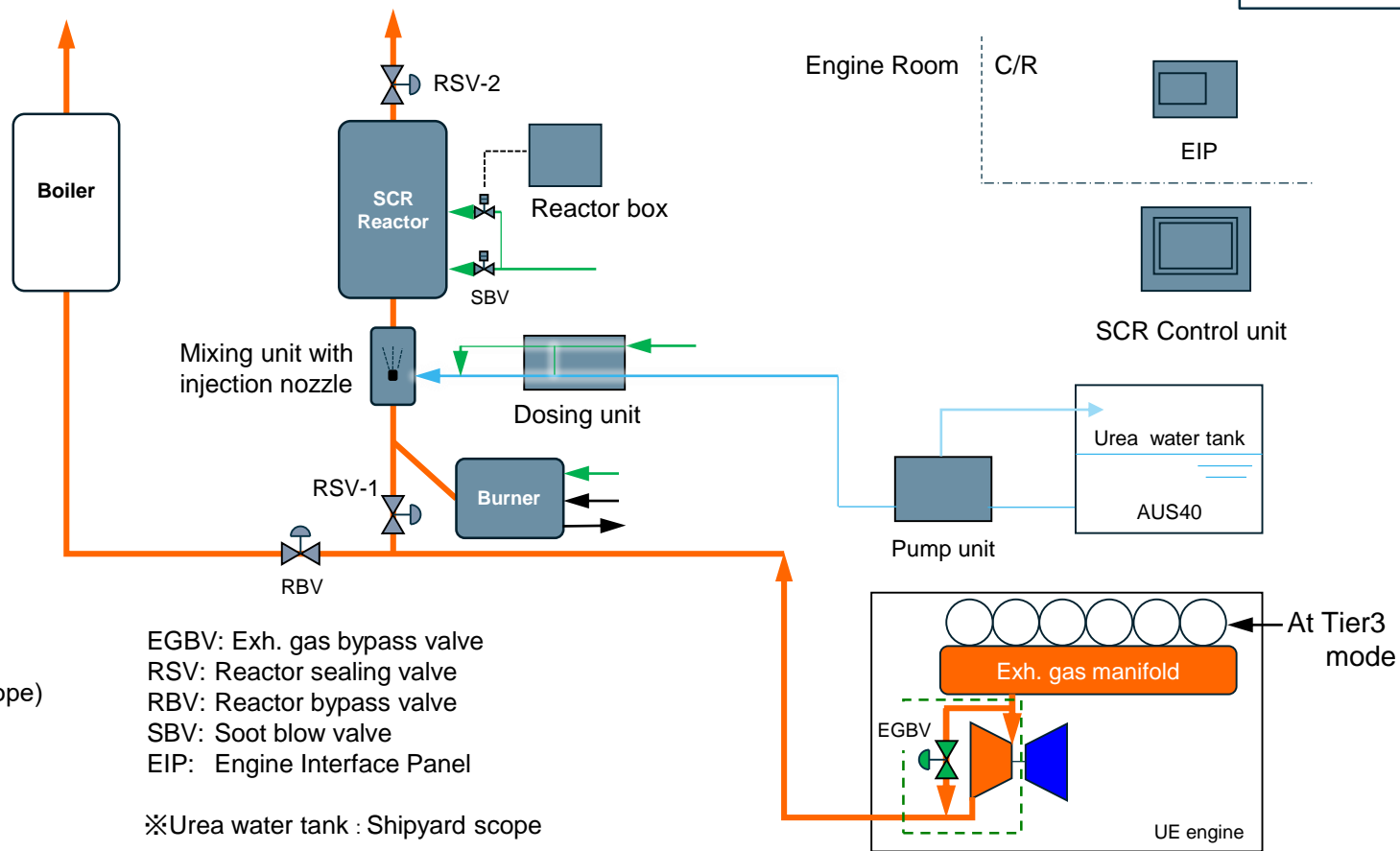
➤ **Smooth switching of SCR operation**

➤ **Optimized operation for compatible performance and reliability**



[Outline of 6UEC33LSE-C2-SCR]

Configuration of LP-SCR System



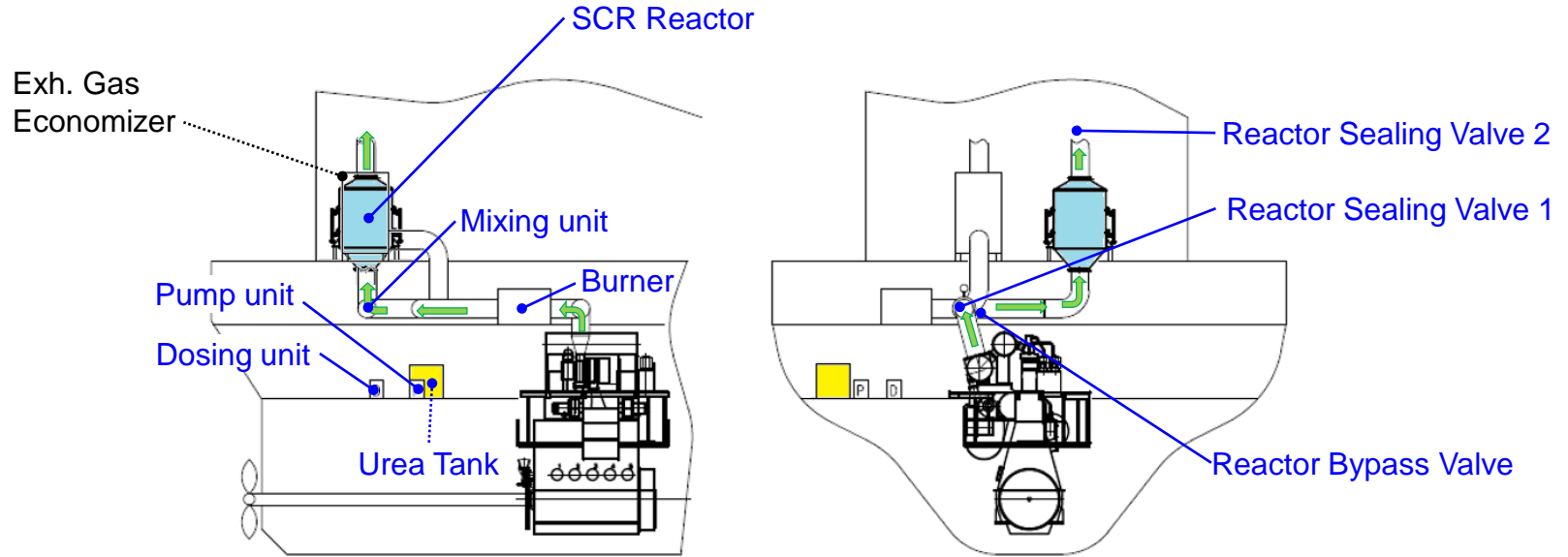
- : Engine Builder scope
- : Integrated in Engine (Engine builder's scope)
- : Compressed air line
- : Urea water line
- : Fuel oil (max.0.1%S)

EGBV: Exh. gas bypass valve
 RSV: Reactor sealing valve
 RBV: Reactor bypass valve
 SBV: Soot blow valve
 EIP: Engine Interface Panel

※Urea water tank : Shipyard scope

Example Arrangement on board

→ Arrow shows Exh. gas flow during SCR operation.



View from Stbd. side

View from Fore side

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LP-SCR Development / Delivery Record

2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------

Prototype full-scale test



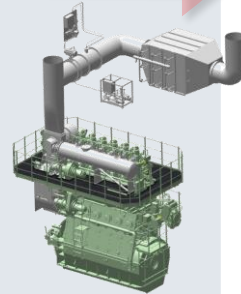
Research De-NOx performance with exh gas of 2st engine

Design Test

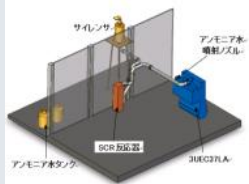
In Service

Scheme A

- ★ 2018-4/ 6-33LSE
- ★ 2020-2/ 6-35LSE-Eco
- ★ 2020-5/ 6-35LSE-Eco
- ★ 2020-9/ 6-33LSE
- ★ 2020-10/ 6-33LSE
- ★ 2021-3/ 6-35LSE-Eco
- ★ 2021-7/ 6-35LSE-Eco
- (2023-4) 6-50LSH-Eco ★
- (2023-4) 6-42LSH-Eco ★★
- (2023-4) 6-35LSE ★
- (2023-5) 6-50LSH-Eco ★★
- (2023-5) 6-42LSH-Eco ★
- (2023-5) 6-33LSE ★★
- (2023-5) 6-35LSE ★
- (2023-6) 6-50LSH-Eco ★
- (2023-6) 6-42LSH-Eco ★★
- (2023-6) 6-35LSE ★
- (2023-7) 6-50LSH-Eco ★
- (2023-7) 6-42LSH-Eco ★
- (2023-7) 6-33LSH ★★
- (2023-8) 6-42LSH-Eco ★★
- (2023-8) 6-33LSH ★★
- (2023-9) 6-42LSH-Eco ★★
- (2023-9) 6-33LSH ★
- (2023-9) 6-33LSE ★
- (2023-10) 6-50LSH-Eco ★
- (2023-10) 6-42LSH-Eco ★
- (2023-10) 6-35LSE ★★
- (2023-10) 6-33LSH ★
- (2023-11) 6-50LSH-Eco ★
- (2023-11) 6-42LSH-Eco ★
- (2023-11) 6-35LSE ★
- (2023-11) 6-33LSH ★
- (2023-12) 6-50LSH-Eco ★
- (2023-12) 6-35LSE ★★
- (2023-12) 6-33LSH ★
- (2024) ★★★★★★★★★★



Fundamental test



Endurance test for catalyst



Long-term Deterioration test on board

1 Design Concepts

2 Development and delivery records of LP-SCR

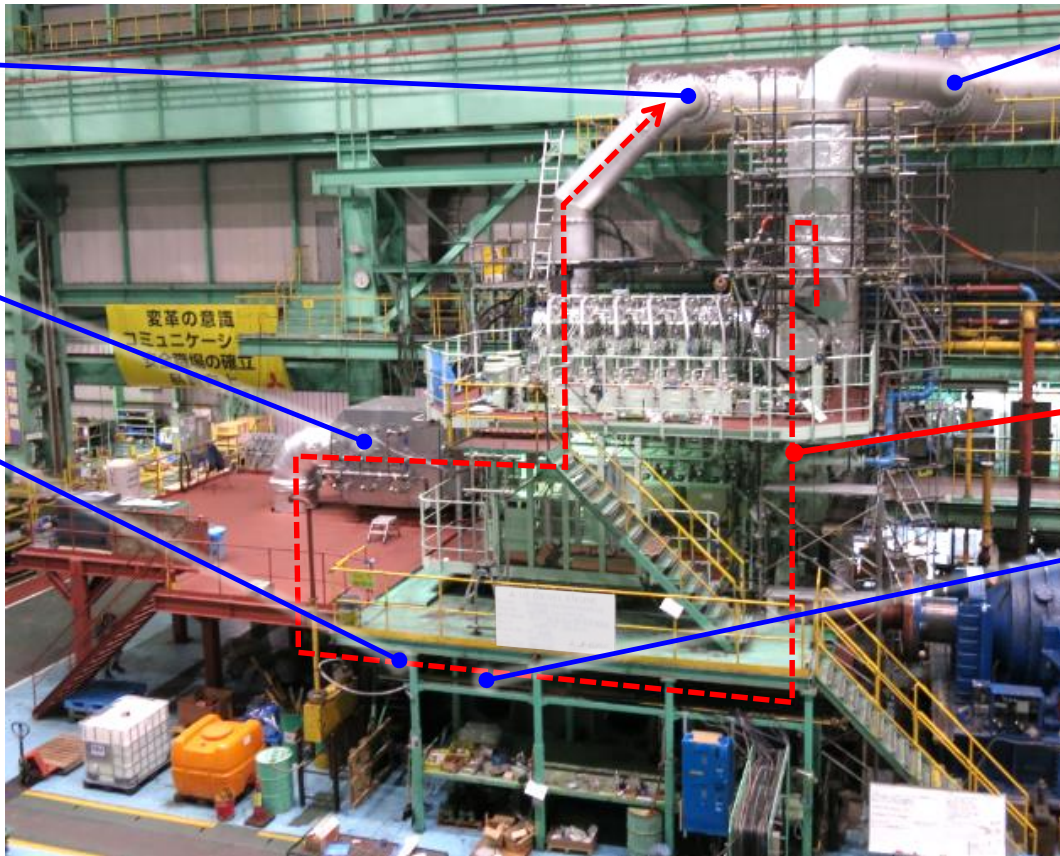
3 Actual Arrangement for Shop Test

4 Maintenance in Service

Overview of LP-SCR system in Shop test



RSV-2

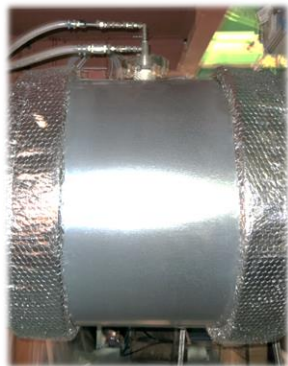


RBV



SCR Reactor

Mixing Unit
Injection Nozzle
(Urea water spray)

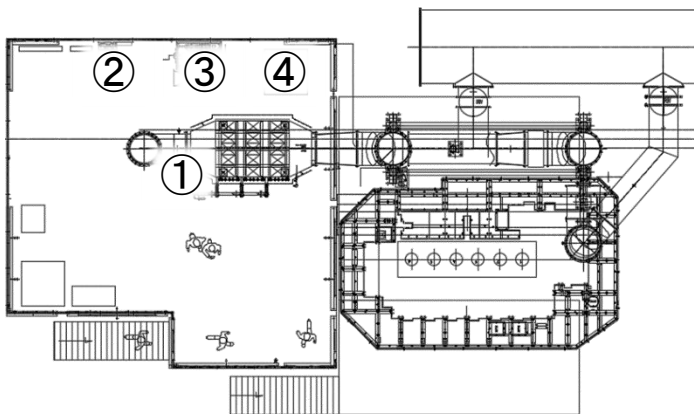


Exhaust
gas flow

RSV-1



SCR Equipment arrangement in Shop test



②Dosing unit and SCR control panel



③Pump unit



①SCR Reactor with Soot blower



④Urea tank

- 1 Design Concepts
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Maintenance of LP-SCR in service

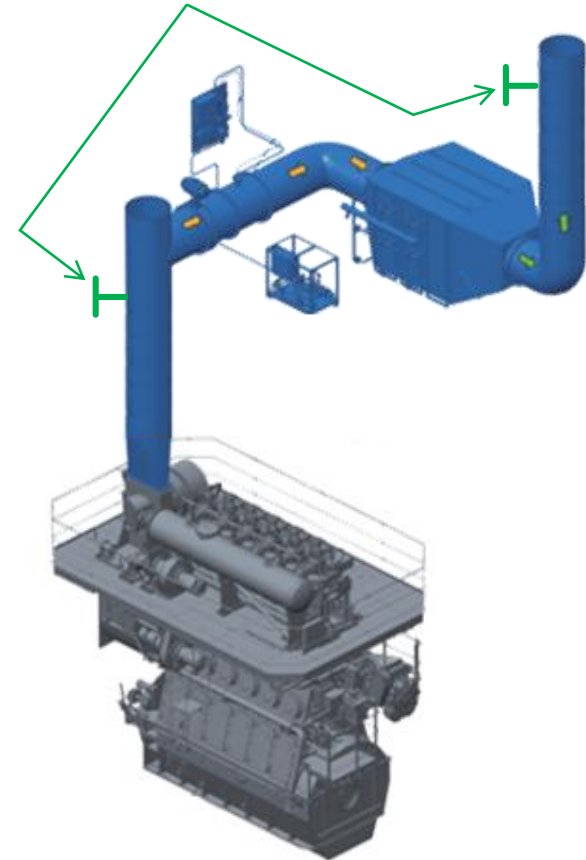
		Maintenance interval						Remarks
		3 months	6 months	12 months	18 months	36 months	60 months	
De-nitration Performance	(Spot Check)			✓				NOx measurement every 12 months
Catalyst	(Replacement of Catalyst)					✓		Replaced when SCR operating time reaches 10,000hrs or 3 years after first use, whichever comes first
Dosing unit	(Replacement of Solenoid Valve, etc.)						✓	
VCP	(Replacement of Board)						✓	For mechanical engines

In addition to the above, there are inspections of electrical components and filters, but it is not always necessary to replace them, and they will be replaced according to the inspection status.

Sampling connection

- ❑ Because of denitration performance in service, SCR should be carried out **annual spot check**. It is described in Resolution MEPC. 291 (71) Chapter

- ❑ The NOx emission will be measured / analyzed in two sampling connections of exh. gas piping.
 - 1) NOx emission after engine outlet
 - 2) NOx emission after SCR reactor



□ For spot check of LP-SCR, the below items should be prepared and used.

- 1) Low sulfur fuel oil under S 0.1% and less (LSMDO, LSMGO)
- 2) 32 or 40% Urea solution* (AUS32 or 40)
- 3) NOx analyzer

Portable NOx analyzer is available for spot check.

(e.g. Testo350 Maritime, etc)

*: The concentration of usable urea solution depends on SCR specification.

〈 Representative portable NOx analyzer (Testo350 Maritime) 〉



Source: photo supplied by Testo K.K

Thank you

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