



YANMAR

Selective Catalytic Reduction system



SCR System

Selective Catalytic Reduction System

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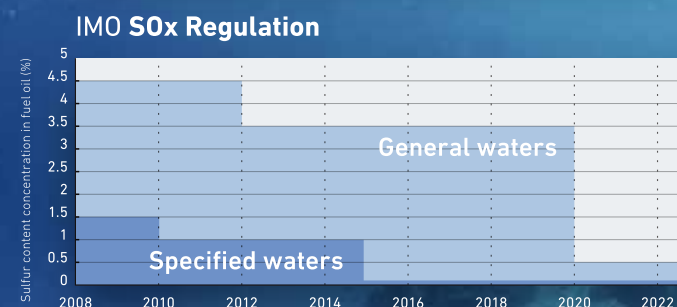
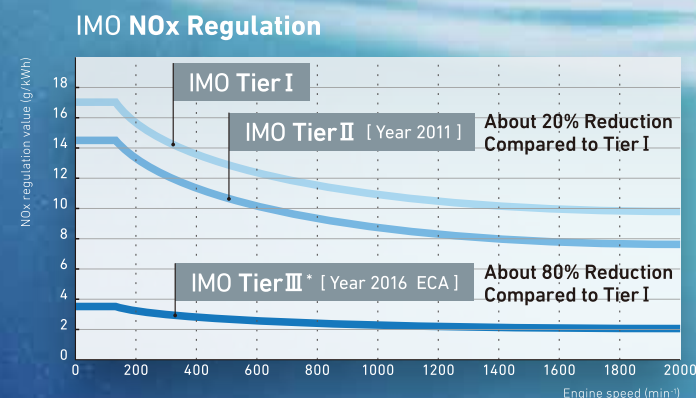
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Cleaner exhaust gas for ocean and sky More convenience for vessels

Recently, from the point of caring the environment, emission requirements around the world is becoming stricter.

Tier III* of IMO applied from 2016 says to reduce 80% of NOx exhaust compared to Tier I, in North American Emission Control Area (ECA).

In Yanmar, we have developed an SCR system that can solely clear this new environmental regulation requiring this strict NOx reduction. With our unique technology and experience, we have created designs and functions that perfectly fit for vessel use. We provide this SCR system that best matches the engine specification as a high quality solution to customers, that is human-friendly and eco-friendly at the same time.



* Tier III is applied in general waters
ECA = Emission Control Area IMO = International Maritime Organization
NOx = Nitrogen Oxides SOx = Sulfur Oxides

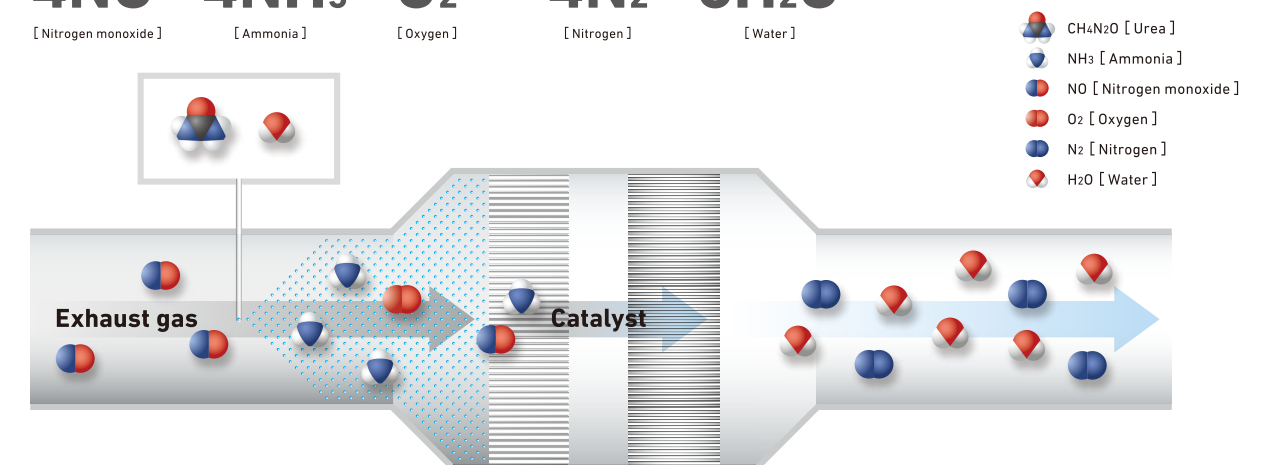
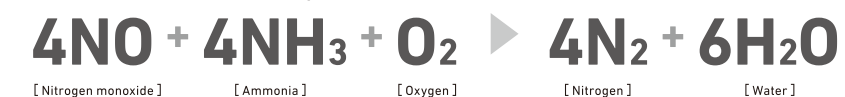
NOx is converted into nontoxic “nitrogen” and “water” through chemical reactions.

Urea solution (safe to be used as reducing agent) is injected into exhaust gas, and hydrolyzed at high temperature. By this, the generated ammonia reacts with NOx through catalyst, resulting in nontoxic nitrogen and water being discharged into open air.

■ Ammonia is generated from urea solution.



■ Ammonia reduces NOx to nitrogen and water.

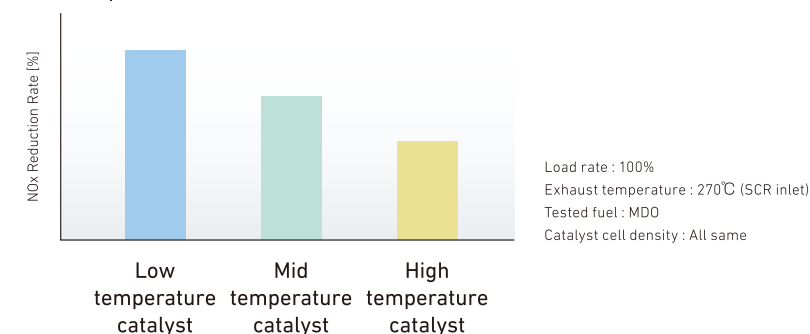


Adjusting to the engine performance, this system exerts excellent NOx reduction even in low exhaust temperatures.

We have adopted the best catalyst type considering high activeness in low temperature, trade-off of pressure loss and NOx reduction rate, and durability.

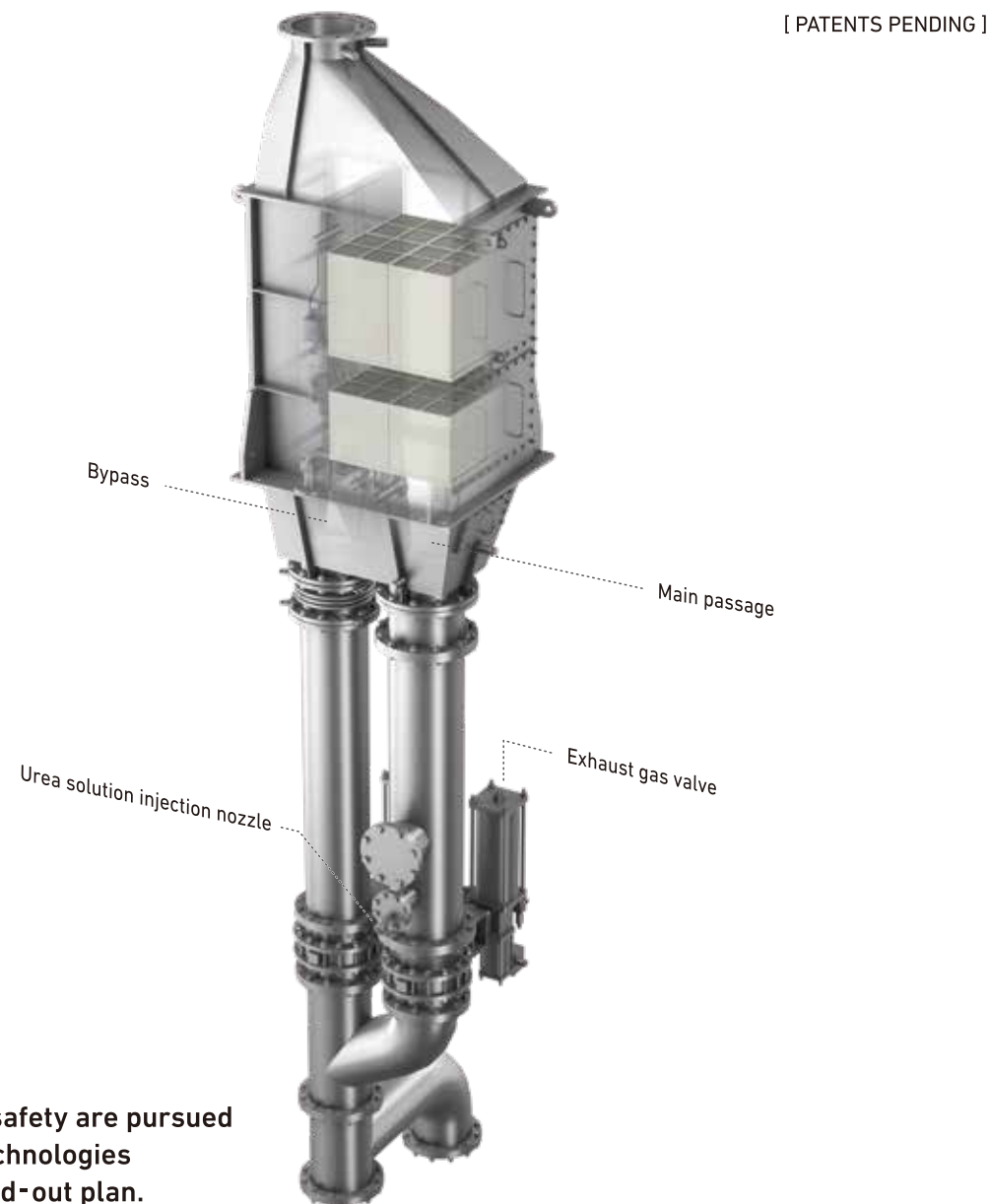
* However, the fuel used for the engine during SCR operation is either MGO or MDO with sulfur content concentration of 0.1% or lower.

Effect on NOx reduction rate under low temperature
(Example of actual test result)



Compact design : Unified catalyst line and bypass

The newly installed bypass operation, which does not allow exhaust gas to pass through the catalyst, contributes to longer catalyst lifetime and achieves optimum operations adjusting to every marine water. The integrated catalytic reactor facilitates the installation and reduces designing burden at shipyards.

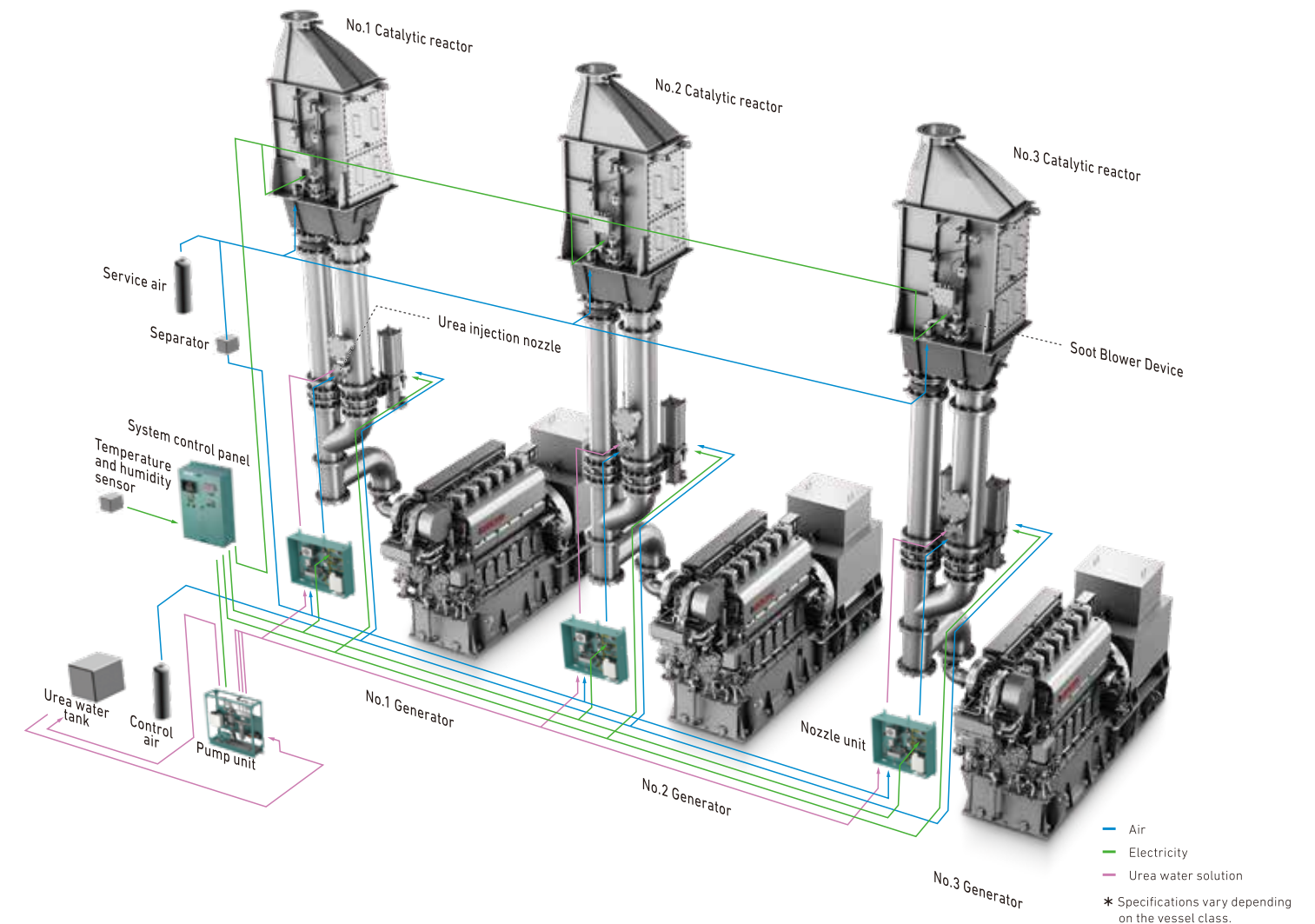


Efficiency and safety are pursued with various technologies and fully worked-out plan.

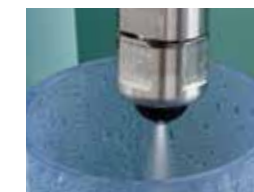
- By adopting a straight pipe from the urea solution injection nozzle through the catalytic reactor, high denitrification performance is ensured without affecting the piping layout predetermined by shipyards. This design also contributes to ensuring the acquisition of the Scheme-A certificate.
- The installation of the urea solution injection nozzle downstream of the bypass branching prevents ammonia from leaking to the bypass pipe in case the exhaust valve is broken.
- The automatic soot blow device prevents soot deposition and catalyst deterioration, and suppresses pressure loss from increasing.
- The air-assisted urea solution injection improves the denitrification efficiency.
- The injection of urea solution is automatically controlled to the best amount to prevent generating excess ammonia.

Saving space for multiple generator engines as well

All devices including the catalytic converters installed in individual engines are controlled integrally.



Nozzle unit



Urea solution injection nozzle



Control panel monitor



Pump unit

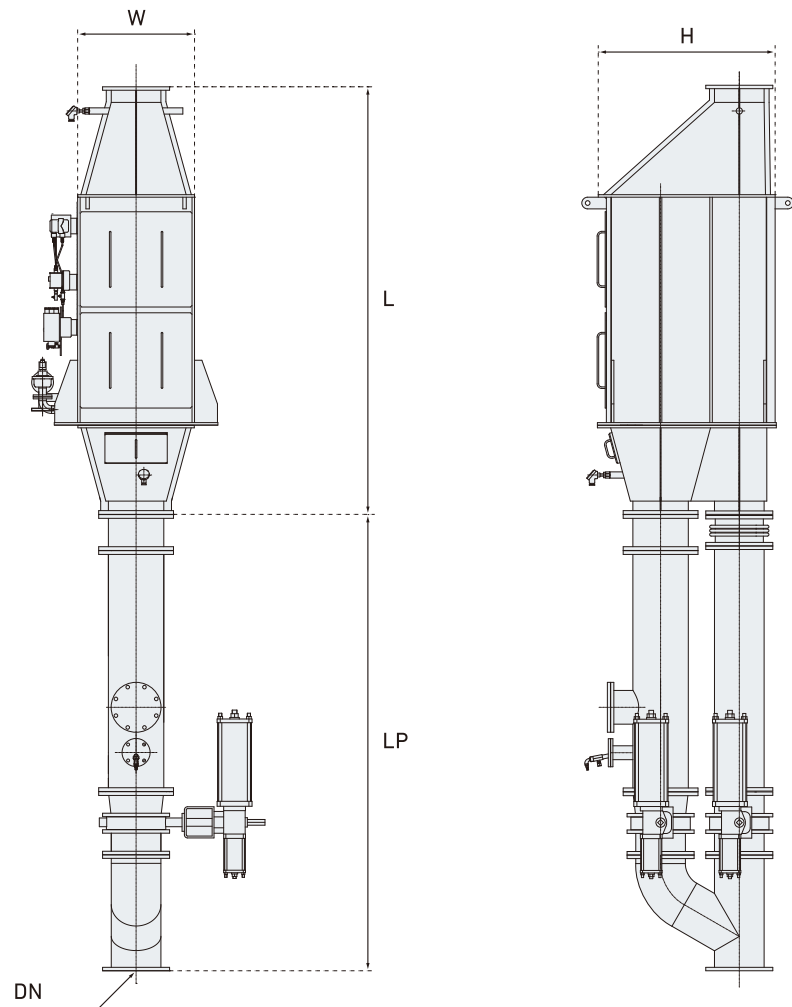


System control panel

SCR System

- ☐ Nozzle unit
- ☐ System control panel
- ☐ Urea solution injection nozzle
- ☐ Pump unit
- ☐ Catalytic reactor
- ☐ Urea solution tank
- ☐ Air tank
- ☐ Soot blow pipe
- ☐ Air treatment unit
- ☐ Temperature and humidity sensor

Full view



| SCR model | Catalytic reactor dimension (mm) | | | Exhaust pipe dimension (mm) | | | Engine model | Power (kW) |
|--------------------|----------------------------------|------|------|-----------------------------|--------|------|--------------------|------------|
| | H | W | L | DN-in | DN-out | LP | | |
| Y155SCR-L | 1080 | 750 | 2530 | 250A | 300A | 2760 | 6AYLS | 438~491 |
| Y16SCR-L | 1080 | 750 | 2390 | 250A | 250A | 2080 | 6NY16LWS | 353~441 |
| Y165SCR-L | 1140 | 750 | 2465 | 300A | 300A | 2325 | 6N165LWS | 485 |
| | 1140 | 750 | 2615 | 300A | 300A | 2325 | | 530 |
| Y18SCR-(A)L | 1140 | 750 | 2615 | 300A | 300A | 2930 | 6EY18(A)LWS | 455~615 |
| | 1140 | 750 | 2765 | 300A | 300A | 2930 | | 660~800 |
| Y21SCR-AL | 1480 | 1050 | 2760 | 350A | 400A | 3330 | 6EY21ALWS | 880~1020 |
| Y22SCR-(A)L | 1480 | 1070 | 2760 | 400A | 400A | 3620 | 6EY22(A)LWS | 880~1100 |
| | 1480 | 1070 | 2910 | 400A | 400A | 3620 | | 1180~1370 |
| Y22SCR-AL | 1480 | 1070 | 2910 | 400A | 500A | 3620 | 6EY22ALWS | 1500 |
| Y26SCR-6L | 1700 | 1430 | 3465 | 500A | 500A | 4300 | 6EY26LWS | 1400~1840 |
| Y26SCR-8L | 1920 | 1430 | 3330 | 550A | 600A | 4400 | 8EY26LWS | 1900~2130 |
| | 1920 | 1430 | 3480 | 550A | 600A | 4400 | | 2245~2450 |
| Y33SCR-6L | 2135 | 1750 | 3850 | 650A | 650A | 5335 | 6EY33LWS | 2400~3360 |
| Y33SCR-8L | 2430 | 1750 | 3900 | 750A | 750A | 6100 | 8EY33LWS | 3600~4500 |

SCR system scheduled inspection table

| Component | Maintenance items [What to do] | Inspection period (in SCR Operating time) | | | | |
|---------------------------------|---|---|-------------------------------|--------------------------------|----------------------------------|-------------------|
| | | 2 months or 300 | 2 years or 4000 to 5000 | 5 years or 8000 to 12000 | 10 years or 16000 to 20000 | 16000 to 20000 |
| Catalytic reactor | Catalytic converters, catalyst [Inspect / Clean* ¹] | | ■ | | | |
| | Catalyst [Replace] | | | | | ■ |
| | Solenoid valve for soot blow [Replace] | | | ■ | | |
| Urea solution injection nozzle | Urea injection nozzle tip [Clean] | ■ | | | | |
| | Air cap [Replace] | | ■ | | | |
| | Cap nut [Replace] | | ■ | | | |
| | Fluid cap [Replace] | | | ■ | | |
| Pump unit | Pump head [Replace] | | | ■ | | |
| | Pump motor [Replace] | | | | ■ | |
| | Y strainer element (before the pump) [Clean] | | ■ | | | |
| | Filter element (after the pump) [Replace] | | | ■ | | |
| Nozzle unit | Strainer element [Clean] | | ■ | | | |
| NOx sensor * ² | Metal filter [Clean] | | ■ | | | |
| | Sensor [Replace] | | ■ | | | |
| Calibration unit * ² | Span/zero gas filter [Clean] | | ■ | | | |

| Inspection period (in Engine operating hours) | | |
|---|--|-------------------------------|
| Exhaust Gas Valve | Seat ring, sheet gasket, gland packing [Replace] | 2 to 3 years or 8000 to 12000 |
| | Filter regulator element [Replace / Clean * ¹] | |
| Air treatment unit | Filter element [Replace] | |
| | Water separator element [Replace] | |
| | Micro-mist separator element [Replace] | |

| Replacement cycle | | |
|-----------------------------------|--|---|
| Temperature and humidity sensor | Sensor [Replace] | 2.5 years |
| All SCR System | Electronic devices [Replace] | 7 years (in general) |
| Control Panel | Controller backup battery [Replace] | 3 years (in general) or when alarm goes off |
| | Backup battery for touch panel [Replace] | |
| Urea solution concentration meter | Battery [Replace] | 3 years (in general) |
| NH3 alarm unit * ³ | Battery (detection part) [Replace] | 1 year (in general) |

*1: After inspection, clean or replace if necessary.
 *2: When the NOx sensor is equipped (optional)
 *3: When NH3 leak alarm unit is equipped (optional)

A reliable engine manufacturer's quality and support



IMO TierⅢ for NOx cleared.

Certificates of conformity to the TierⅢ regulation for NOx are being obtained from IMO and nine major Classification Societies. We took a certification test conducted under Scheme A*, in which engines are tested together with the SCR system.

* This omits on-board certification test.



Engines and SCR system provided together

Through our in-house development taking advantages as an engine manufacturer, such as the technology to control exhaust gas temperature to facilitate reduction reactions, are fully utilized to provide a total SCR system best suited for your engines.



After-sales service

Even after delivery, total support will be given to your engines and SCR system. Spot-check service is also available and we will provide you a wide range of services from on-board NOx measuring to reporting the Classification Society.



Reliable technologies based on multiple testing to actual vessels

Under the joint research scheme of ClassNK in cooperation with Mitsui O.S.K. Lines and Namura Shipbuilding Co., Ltd., sea trials on three generator engines equipped with the SCR system were completed in October 2014. The SCR system for ocean-going vessels was established with a high degree of perfection.

Integrated manufacturing of high-quality large engines at Yanmar's Amagasaki factory.

Amagasaki factory started in 1936 as world's first factory to produce small sized diesel engines. Today, the factory mass produces large-sized diesel engines for marine and generator use, and also produces diesel and gas engines for land use and general power source. From 1983, the factory also produces gas turbines, and continues to produce high quality products ever since.

Highly accurate and efficient production system

Amagasaki factory uses its unique, high performance devices and advanced machines for automatic and laborsaving operation. Furthermore, a suitable order-entry system matching each product is applied and controlled with an accurate quality management system. Therefore, we are able to produce highly reliable products to customers. Yanmar is the only company that produces the entire engine integrally within one factory.



11 awards in the engine industry

Amagasaki factory is a certified factory of the 11.prestigious Classification Societies in the world. The world's first factory to qualify the self-inspection system in all 11 Classes.



Certificate of the 11 major Classification Societies

- | | | |
|-----------------------|-----------------------|-----------------------|
| NK [Japan] | RINA [Italy] | GL [Germany] |
| ABS [US] | BV [France] | IRS [India] |
| LR [UK] | KR [Korea] | RS [Russia] |
| DNV [Norway] | CCS [China] | |

Research and development with advanced technology

Yanmar continues to research and develop environmental-friendly technology in a higher degree, such as developing cleaner emission gas, low fuel consumption, and less vibration and noise, based on our unique engine technology.



Internationally qualified quality management and environmental friendliness

In June 1992, acquired "ISO9001*1" from the British certification organization LRQA. With early adaption to environmental problems, by June 1997, we received the "ISO14001*2" qualification as a first manufacturing factory for land-and-marine-use large diesel engines. Furthermore, we were the first engine manufacturer in Japan to acquire a certificate (NK) of"IMO exhaust gas regulation (NOx emission control value)" (TierI in 2001 and TierII in 2011). We are highly evaluated in advanced technology considering environmental protection.

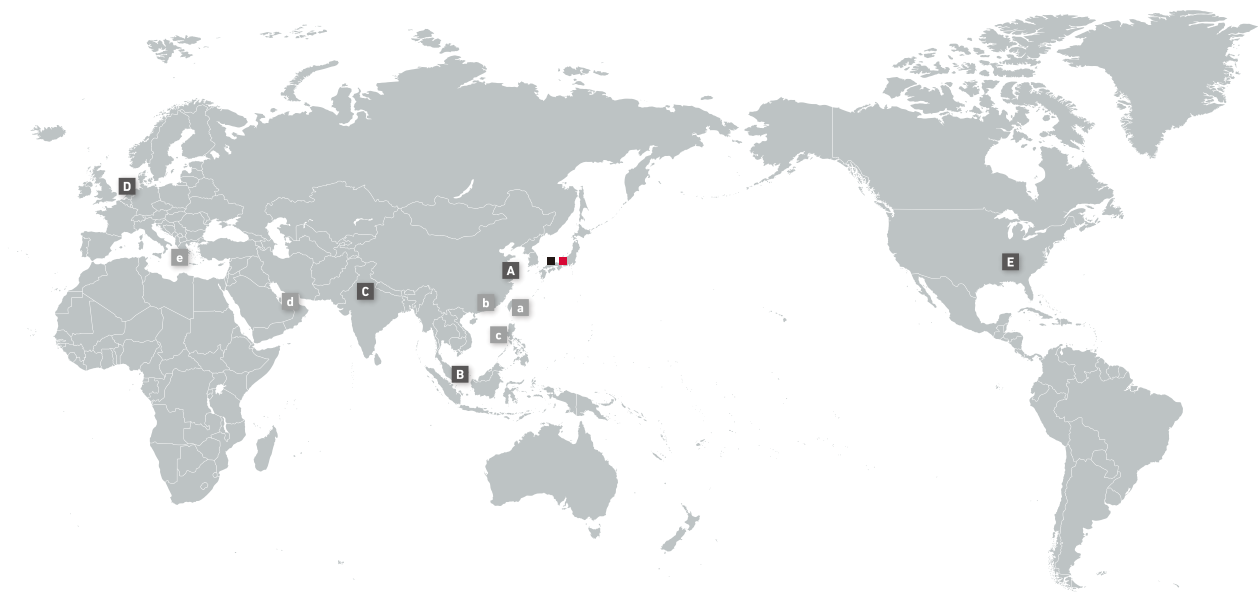


*1 ISO9001
(International Organization for Standardization):
International standard for Quality Management System
(Confirmation number: 912208)



*2 ISO14001
(International Organization for Standardization):
International standard for Environmental Management System
(Confirmation number: 770250)

Service Network



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