

The Ship Operator's Guide To NO_x Reduction

*The Comprehensive Resource For NO_x Emissions
Reduction & Abatement*



GUIDE SPONSORS



SUPPORTING SPONSOR



The Ship Operator's Guide To NO_x Reduction

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SCR Systems & Providers

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WÄRTSILÄ

Wärtsilä NOx Reducer (NOR)

The Wärtsilä NOx Reducer (NOR) SCR system reduces the level of NOx in the exhaust gas from the engine by means of catalyst elements and a reducing agent. The system is intended for four-stroke diesel engines, operating on both LFO and HFO fuels. Tailor-made NOx Reducers can be designed upon request, e.g. for NOx reduction levels other than IMO Tier III or for meeting specific space requirements.

Overview	
Ship Types	All
Newbuild/Retrofit	Both
Engine Types	Four-stroke medium-speed engines, optimised for Wärtsilä four-stroke engine portfolio. NOR can be also offered to other engine brands
Fuel Types	MGO, MDO, HFO

Performance	
NOx Removal	80-90%, other NOx reduction levels upon request
Removal Of Other Pollutants	SCR systems typically have small or moderate hydrocarbons and soot reduction capabilities.
Silencing Function	Typical noise reduction for the NOR reactor: 8-10 dB(A). Possibility to integrate NOR reactor with silencers when 35 dB(A) noise reduction is achieved.

System Components & Installation		
System Components	The main components that are included in the standard scope of supply are: <ul style="list-style-type: none"> • Reactor housing • Catalyst elements • Soot blowing unit • Urea injection and mixing unit • Urea dosing unit • Control and automation unit • Urea pump unit • Air unit 	The standard scope of supply may also be extended with the following: <ul style="list-style-type: none"> • NOx monitoring system • Mixing duct • Compressor station (compressed air for urea injection and soot blowing system)
	Other components that are essential for the system are: <ul style="list-style-type: none"> • Urea tank • Insulation • Expansion bellows incl. counter flanges • Support for ducting and reactor • Piping between the NOR units <p>Various kinds of customer specific solutions are possible, e.g. integrating the SCR reactor with a silencer, a combined SCR and compact silencer systems, a heater for outside installation in cold climate, and additional oxidation catalyst for CO removal.</p>	
Bypass Requirement	The NOR reactor can be run dry (soot blowing remains in operation), thus no bypass is required, although classification societies may have their generic bypass requirements for SCR. Soot blowing ensures efficient cleaning of the whole element surface area.	
Footprint	Typical dimensions for a two catalyst layer reactor (LFO/MDF): <ul style="list-style-type: none"> • 5MW engine: 3.2 x 2.1 x 2.0m • 10MW engine: 3.5 x 2.8 x 2.8m • 20MW engine: 4.1 x 3.9 x 3.7m 	
Installation Considerations	One NOR reactor is installed per engine and exhaust gas pipe. The standard reactor is designed in a flexible way for the initial loading of two or three catalyst layers depending on the ship structure. It can be installed either vertically or horizontally onboard the ship.	

Practical Considerations	
Temperature Range	~300-450 °C
Power Requirements	~1 kW per NOR unit
Type Of Reducing Agent	Aqueous urea solution (40% recommended, 32% possible)
Consumption Of Reducing Agent	~15 litres/MWh, at full engine load, from Tier II to Tier III level, can be optimised in certain circumstances. The consumption follows the used engine power.
Tank Capacity For Reducing Agent	Should depend on operating profile in NOx ECAs.
Ammonia Slip	<10 ppm
Operational Considerations	Wärtsilä NOR operation mode is automatically controlled and based on common automation platform with Wärtsilä engines. In case requested, the urea injection can be additionally started and stopped based on the Global Positioning System (GPS) signal from the ship system which tells when the ship is operating inside the NOx ECA. Warming up period depends on the operation load (exhaust gas temperature) and reactor size to reach sufficient exhaust gas temperatures for urea injection start and deNOx reactions.
Emissions Monitoring	A NOx analyser is an optional device and provides NOx emission measurement after the SCR reactor. The analyser can be stationary or alternatively portable for spot check measurements.
Catalyst Lifetime	Typically 4-6 years
Maintenance Requirements	<p>Typical maintenance intervals:</p> <ul style="list-style-type: none"> • Every six months, the urea pumps should be overhauled, the urea filters should be inspected and the urea injector lance and nozzle should be cleaned and inspected. • Every year, the reactor and catalyst should be cleaned and inspected, the piping and flexible hoses should be inspected and the gauges, transmitters, switches and other instrumentation should be inspected and tested. • Every two years or 5,000 running hours, the urea pump drives should be lubricated. • As required, the dosing unit, including the pipe connections and cables, should be inspected and the soot blowing valves should be inspected and cleaned.
Compatibility With Exhaust Gas Cleaning Systems	The Wärtsilä NOR can be operated together with other exhaust gas treatment units, such as SOx scrubber systems.

Costs	
Operational Costs	€3-6/MWh

System Maturity	
Class Society Approval	Wärtsilä NOR has been delivered to projects under several class societies (as typical examples DNV, GL, ABS, LR, BV, NK).
Technological Maturity	Wärtsilä deliveries include over 700 SCR systems.

FATHOM COMMENT

As an engine manufacturer, Wärtsilä knows engine behaviour and performance in various operating conditions and thus can optimise SCR units to be effective and reliable for long-term use. Pre-certified engine and SCR packages offered by the company can cut customers' costs.