



TECHNICAL CIRCULAR No. 187 of 3RD April 2014

To:	All Surveyors/Auditors
Applicable to flag:	All Flags
Subject:	NOX Emission – Implementation using SCR (Selective Catalytic Reduction)
Reference	IMO Annex VI – Tier III

The International Council on Clean Transportation (ICCT) has recently issued a Working Paper based on a survey of technical literature and industry reports which assess equipment costs, environmental side effects, urea and catalyst availability and disposal, and the overall system costs of SCR in the marine sector

ICCT paper investigates the current status of selective catalytic reduction (SCR), a technology that is key to meeting Tier III requirements. Challenges and costs of the technology, including applicability to various engine and vessel types, potential environmental side effects, urea and catalyst availability and disposal, and anticipated system costs, are discussed. Based on this evaluation of technological capabilities and history of successful application of SCR technology to maritime vessels, no substantial equipment, supply chain, or cost barriers exist that would necessitate the delay of IMO's Tier III requirements.

In 2008 the Marine Environmental Protection Committee (MEPC) of the International Maritime Organization (IMO) agreed upon progressively stricter limitations for nitrogen oxide (NOx) emissions from vessels based on their date of engine installation, with the strictest Tier III requirements to take effect in designated Emission Control Areas (ECA) beginning in 2016. At MEPC-66 in April 2014, an amendment that would delay the introduction of the Tier III standards to 2021 will be considered based on concerns arising from perceived equipment, supply chain, and cost barriers raised at MEPC-65

NOx Limits in MARPOL Annex VI

Tier	Effective Date	NOx Limit (g/kWh)		
		N < 130	130 ≤ N < 2000	N > 2000
Tier I**	2000	17	$45 * n^{-0.2}$	9.8
Tier II	2011	14.4	$44 * n^{-0.2}$	7.7
Tier III***	2016	3.4	$9 * n^{-0.2}$	1.96

Customer Service Center

5201 Blue Lagoon Drive, 9TH. Floor,
Miami, Fl., 33126
Tel: 1 (305) 716 4116,
Fax: 1 (305) 716 4117,
E-Mail:

joel@conarinagroup.com

Technical Head Office

7111 Dekadine Ct.
Spring, Tx., 77379
Tel: 1 (281) 370 9363,
1 (713) 204 6380

E-Mail: tho@conarinagroup.com,
houston@conarinagroup.com

"n" refers to rated engine speed (rpm)

* Excluding ships with marine diesel engines less than 130 kW or ships solely for emergency purposes

** Annex VI entered into force in 2004, but it applies retroactively to new engines larger than 300 kW installed on ships on or after January 1, 2000

*** Tier III applies only in emission control areas

Overview of SCR in marine applications

SCR is the only technology currently available to achieve compliance with the Tier III NOX standards for all applicable engines



Shipping NO_x Reduction potential

IEM: Internal Engine Modification; DWI: Direct Water Injection; HAM: Humid Air Motors; FEW: Fuel-Water Emulsion; EGR: Exhaust Gas Recirculation; SCR: Selective Catalytic Reduction; LNG: Liquefied Natural Gas

Other technologies can either achieve Tier II standard or achieve Tier III standard for only a subset of applicable engines. SCR has been recognized as one of the most promising means of controlling NOX by a variety of countries and regulatory authorities. State-of-the-art SCR systems are capable of reducing NOX emissions by more than 90% under certain conditions. Furthermore, SCR has proven popular with equipment manufacturers because it allows NOx control with little or no fuel efficiency penalty, and sometimes a net benefit. This occurs because manufacturers can tune their engines for maximum fuel efficiency and use SCR to clean up the resulting "engine out" NOX. Today, SCR is a well-proven technology with over 500 applications in the marine sector in 2013.

Customer Service Center

5201 Blue Lagoon Drive, 9TH. Floor,
Miami, Fl., 33126
Tel: 1 (305) 716 4116,
Fax: 1 (305) 716 4117,
E-Mail:

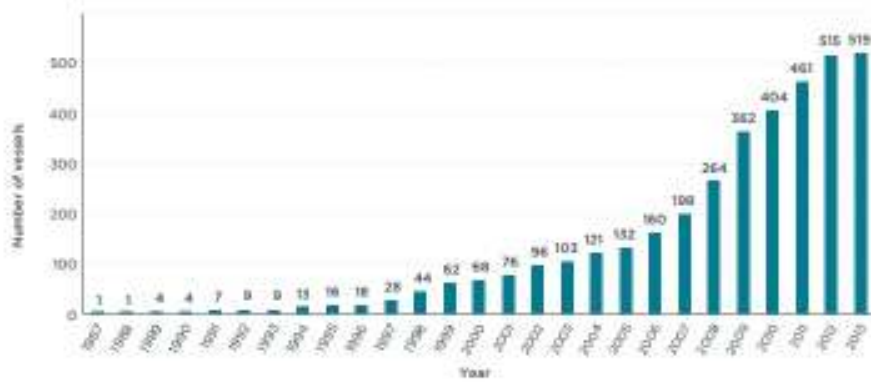
joel@conarinagroup.com

Technical Head Office

7111 Dekadine Ct.
Spring, Tx., 77379
Tel: 1 (281) 370 9363,
1 (713) 204 6380

E-Mail: tho@conarinagroup.com,

houston@conarinagroup.com



Total number of vessels with SCR systems installed by year

A number of manufacturing companies have invested in SCR in the 25 years since it was first applied to marine vessels. A significant number of companies based in Europe, the US and Asia are delivering marine SCR technologies capable of meeting current and future NOX reduction requirements. Table below presents a non- exhaustive list of companies pursuing engine, SCR and catalyst technologies. These companies supply full SCR systems, components, reagent, or some combination of the three. The collaborations between engine designer, builder and catalyst designer facilitate the development and delivery of a complete emissions reduction system

Engine Technologies	SCR and Catalyst Technologies
Wartsila	Haldor Topsoe
MAN	Johnson Matthey
MTU	Hitachi Zosen
ABC	Panasia
Bergen Engines	Tenneco
Yanmar	Cormetech
Hitachi Zosen	Ceram (Ibiden Group)
Mitsubishi Heavy Industry	Nano
Mitsui	Dansk Teknologi
Himsen	Mecmar
Daihatsu	HUG Engineering

Customer Service Center

5201 Blue Lagoon Drive, 9TH. Floor,
 Miami, Fl., 33126
 Tel: 1 (305) 716 4116,
 Fax: 1 (305) 716 4117,
 E-Mail:

joel@conarinagroup.com

Technical Head Office

7111 Dekadine Ct.
 Spring, Tx., 77379
 Tel: 1 (281) 370 9363,
 1 (713) 204 6380

E-Mail: tho@conarinagroup.com,

houston@conarinagroup.com

Conclusions

SCR is a well-proven technology. Those vessels with the longest track records using it have accumulated upwards of 80,000 hours of operation over the past two decades. In the more than two decades in which SCR technology has been fitted to vessels, a number of manufacturing companies have invested in the technology. Today a significant number of companies based in Europe, the US, and Asia are delivering marine SCR technologies to meet current and future NOX reduction requirements. It is notable that many of the applications to date have been retrofits, which can be more costly and difficult to operate than systems installed on new engines. Since IMO's Tier III requirements will drive OEM applications, even fewer problems may be expected in the future.

This review has identified no systematic barriers to meeting Tier III requirements in 2016 through the use of SCR. Vanadium-based SCR systems, supplemented where necessary with strategies to boost exhaust temperature in low-load operations, will be capable of reducing NOx over a sufficient range of operational conditions, particularly when paired with the 0.1% sulfur fuel that will be made available in sulfur emission control areas. Production and distribution of urea to marine vessels should be manageable given the relatively small volumes to be delivered, the limited number of ports that need to be served, and the identification of best practices in Europe. Environmental byproducts, notably ammonia slip and excess CO2 emissions, are not expected to be generated in significant volumes. Finally, the costs of installing and operating SCR are modest and are expected to fall over time as the Tier III requirements generate greater innovation and competition among manufacturers and suppliers.

Based on this evaluation of technological capabilities and history of successful application of SCR technology to maritime vessels, we find no substantial equipment, supply chain, or cost barriers that would significantly inhibit the implementation of MARPOL NOX Tier III regulations for applicable vessels in 2016 as established by the IMO in 2008.

REFERENCES:

- IMO Annex VI – Tier III

ATTACHMENTS: No.

Kindest Regards,

Cosmin Bozenovici
Naval Architect – Conarina Technical Head Office

Customer Service Center

5201 Blue Lagoon Drive, 9TH. Floor,
Miami, Fl., 33126
Tel: 1 (305) 716 4116,
Fax: 1 (305) 716 4117,
E-Mail:

joel@conarinagroup.com

Technical Head Office

7111 Dekadine Ct.
Spring, Tx., 77379
Tel: 1 (281) 370 9363,
1 (713) 204 6380

E-Mail: tho@conarinagroup.com,
houston@conarinagroup.com