

**Tier III NO_x Compliance:
Introduction of SCR On Engine
(iSCR)**

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Contents

1	Information	1
2	Selective Catalytic Reduction (SCR).....	1
3	Integrated SCR (iSCR)	2
4	Scheduling.....	2

Summary

This Technical Information Note announces the integrated Selective Catalytic Reduction (iSCR) system, the future technology of the SCR technology portfolio, applicable for WinGD engines X52, X62-B, X72-B and X82-D.

1 Information

The increasingly stringent emission regulations governing marine applications are driving technology advancement and innovation to develop and design systems to meet the growing demand of emission reduction.

Emission regulations for marine applications are governed by the IMO, International Maritime Organization within MARPOL Annex VI. The first NO_x regulations in the marine industry were introduced in 2000 (Tier I) followed by Tier II in 2011 and Tier III in 2016.

Tier III, applying only to ships operating in Nitrogen Oxide Emission Control Area (NECA) zones, equalling a reduction of 80% NO_x in comparison with Tier II, which applies outside of these NECA zones. While Tier II could be reached by means of internal engine adjustments, Tier III requires post combustion measures. Selective Catalytic Reduction (SCR) is considered the most effective technology on the market, largely meeting Tier III requirements independently.

2 Selective Catalytic Reduction (SCR)

Selective Catalytic Reduction is a well-established, mature and commercial technology for post combustion NO_x abatement. While the technology has been in full scale stationary industrial use since the late 1970s, it was first introduced to mobile applications in the early 2000s, due to a general lack of legal requirements. As its name implies, SCR converts NO_x (NO and NO₂) in the presence of a catalyst to selectively form elementary N₂ and H₂O by the means of a reagent, typically ammonia (NH₃) or urea (NH₂CONH₂).

Despite its renowned advantages of being a high performing and robust technology, it also imposes certain operation limitations due its relatively narrow temperature window, high installation cost and additional foot print requirements. This has also been recognised for the SCR off-engine solutions (HP- and LP-SCR), which are current part of the WinGD portfolio offering.

3 Integrated SCR (iSCR)

The integrated SCR (iSCR) is installed completely 'on engine'. It has been developed due to the growing demand for a smaller, more compact solution to fulfil the Tier III emission regulations.

The principle concept of the iSCR programme is to integrate the SCR reactor directly to the exhaust manifold of the engine, upstream of the turbocharger. This provides high-pressure operation (HP-SCR), while promoting higher operation temperatures (favoured by the SCR reactions). Furthermore, this is achieved in a compact overall design with little external piping.

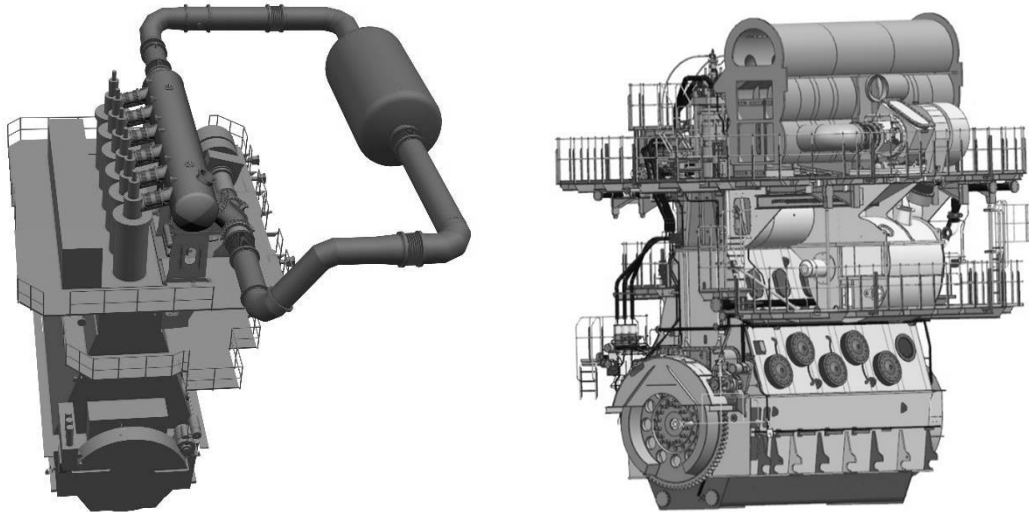


Figure 1: HP-SCR off engine vs. integrated SCR (iSCR)

4 Scheduling

Factory testing is currently underway and is expected to conclude in 2020. After which, the iSCR product will be scaled up and the design extended onto larger test stands as part of the products commercialisation.

Timeline

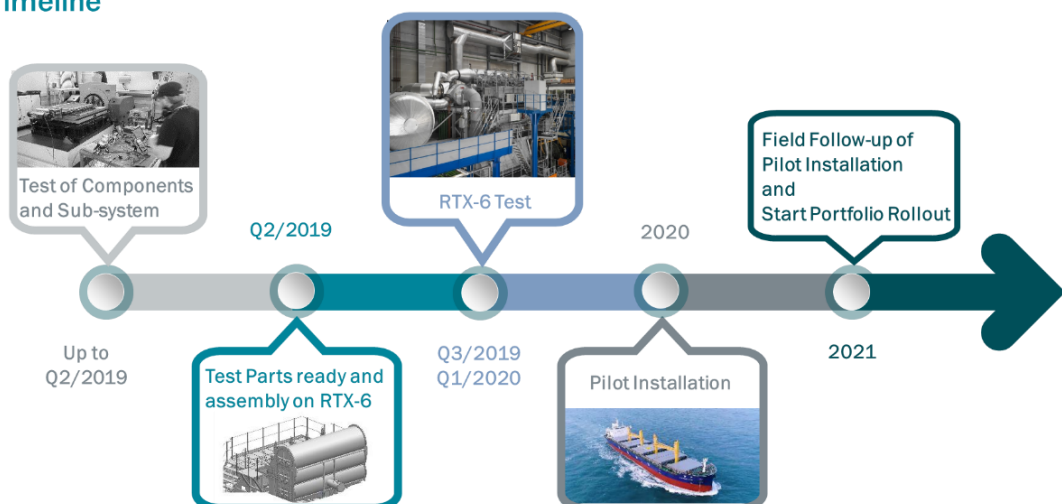


Figure 2: Introduction timeline

Further details will be announced in 2020. The already published GTD data for engines with HP-SCR remain valid also for engines with iSCR. However, for any further information or questions about this Technical Information Note, please contact your WinGD representative or WinGD directly.