Roadmap to strengthen the implementation and enforcement of the Baltic Sea NECA

Adopted in December 2023 by the Heads of Delegation of the EU and the Contracting Parties to HELCOM that are also Member States of the EU

Background information

Nitrogen oxides (NOx) is a collective term for nitrogen oxide gases, primarily composed of nitric oxide (NO) and nitrogen dioxide (NO_2), which are significant components of harmful air pollution. Regulating NOx emissions in shipping is crucial and aims at mitigating the following adverse impacts:

1. **Environmental impact**: NOx emissions contribute to air pollution and have detrimental effects on the environment[1]. When released into the atmosphere, NOx reacts with other pollutants to form ground-level ozone, which is a key component of smog.[2] Ozone is harmful to human health and also damages vegetation and ecosystems. NOx emissions also add to the nutrient pollution of the Baltic Sea[3], in which eutrophication due to excess nitrogen and phosphorous is one of the most significant environmental problems[4]. Additionally, NOx emissions are a major contributor to acid rain, which negatively impacts the marine environment[5].
2. **Human health**: NOx emissions from shipping activities pose a significant risk to human health, especially in densely populated coastal areas and port cities. The inhalation of NOx can lead to respiratory problems such as bronchitis and asthma, particularly in susceptible individuals. NOx also contributes to the formation of fine particulate matter (PM2.5), which can penetrate deep into the lungs and cause various health issues, including cardiovascular and respiratory diseases.[6]
3. **Climate impact**: While NOx emissions do not directly contribute to global warming, they play a role in indirect climate change effects. When burned, fossil fuels generate greenhouse gases such as nitrous oxide (N_2O), a potent greenhouse gas with a significantly higher global warming potential than carbon dioxide (CO_2). This is particularly relevant for the use of Selective Catalytic Reduction (SCR) technology, as they could potentially result in significant emission of N_2O.[7]

At international level, the International Maritime Organization (IMO) established **MARPOL Annex VI Regulation 13**, which sets limits on NOx emissions from marine diesel engines to reduce the overall environmental impact from shipping. Regulation 13 contains the control requirements in relation to NOx,

1 Pérez Velasco, Jarosinska: Update of the WHO global air quality guidelines: Systematic reviews – An introduction, published in Environment International 170 (2022) 107556 (https://www.sciencedirect.com/science/article/pii/S0160412022004834)

2 WHO, https://www.who.int/teams/environment-climate-change-and-health/air-quality-and-health/health-impacts/types-of-pollutants (retrieved on 28 Aug 23)

33 HELCOM MARITIME Assessment 2018, Maritime activities in the Baltic Sea, Baltic Sea environment proceedings no. 152, p. 38

4 HELCOM MARITIME Assessment 2018, Maritime activities in the Baltic Sea, Baltic Sea environment proceedings no. 152, p. 51, 148

5 Nunez: What is acid rain? published on 28 Feb 2019 (https://www.nationalgeographic.com/environment/article/acid-rain)

6 WHO global air quality guidelines 2021, Particulate matter (PM2.5 and PM10), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide, p. 111.

7 M. Zhu, J.-K. Lai, I.E. Wachs, Formation of N2O greenhouse gas during SCR of NO with NH3 by supported vanadium oxide catalysts, Appl Catal B. 224 (2018) 836–840, https://doi.org/10.1016/j.apcatb.2017.11.029

which apply to installed marine diesel engines of over 130 kW output power[8]. It provides limits on NOx emissions depending on the rated engine speed for three different emission levels, known as "Tiers", subject to the keel laying date. The regulation also designates the Emission Control Areas where stricter Tier III NOx limits apply for new build ships after 2016 (US/CAN area) and since 2021 for North and Baltic Sea area.[9] In accordance with regulation 13.5.2, certain small ships would not be required to install Tier III engines.

Regulation 13 is complemented by the **NOx Technical Code** 2008 (resolution MEPC.177(58)), providing mandatory guidance on the control of NOx emissions from marine diesel engines by establishing technical standards and requirements. It provides guidance to shipbuilders, engine manufacturers, and ship operators on the design, construction, and operation of engines to achieve the NOx emission limits. The NOx Technical Code applies to new marine diesel engines installed on ships constructed on or after 1 January 2000, with a power output of more than 130 kW. It covers both propulsion engines and auxiliary engines used on board ships. Shipbuilders and engine manufacturers must ensure that engines meet the NOx emission limits specified in the NOx Technical Code. Compliance is verified through certification processes, which involve testing and measuring the engine's emissions most commonly at manufactures site. Ships equipped with engines meeting the required standards receive an Engine International Air Pollution Prevention (EIAPP) Certificate to be carried on board for Port State Control.

The Baltic Sea is particularly sensitive to pollution due to its shallow depth and slow water circulation, making it more susceptible to the negative effects of NOx emissions. When it comes to regulating **NOx emissions in the Baltic Sea area**, specific targets have been set to address the unique environmental challenges in that region. The IMO designated the Baltic Sea as a NOx Emission Control Area (**NECA**) effective from 1 January 2021 onwards, meaning that ships with a keel laying date after this date have to comply with Tier III. The achievement of good environmental status in relation to eutrophication in the Baltic Sea by 2030 relies inter alia on the reduction of 16,803 tonnes of airborne nitrogen from shipping due to the implementation of this NECA regulation[10]. The following measures support the implementation of the NECA regulation:

1. **HELCOM Baltic Sea Action Plan**: the Baltic Sea Action Plan (BSAP), adopted by the HELCOM Contracting Parties in 2007 and updated in 2021, is HELCOM's strategic programme of measures and actions for achieving good environmental status of the sea, ultimately leading to a Baltic Sea in a healthy state.[11]
2. **National and Regional Initiatives**: in addition to international agreements, countries and regional bodies in the Baltic Sea area have also implemented their own measures to regulate NOx emissions. For example, HELCOM Contracting Parties like Denmark, Estonia, Finland, Germany, and Sweden have introduced **financial incentives** to promote the use of cleaner technologies and alternative fuels, thereby reducing NOx emissions from shipping activities.[12]

The regulations on NOx emissions drive the development and implementation of emission control **technologies** in the shipping industry such as Selective Catalytic Reduction (SCR) systems and Exhaust Gas Recirculation (EGR) systems. It generates investments of the industry in cleaner and more efficient technologies, leading to improved air quality and environmental sustainability.

8 Other than those used solely for emergency purposes
9 IMO-Norway GreenVoyage2050 Project: Clause-by-Clause analysis of MARPOL Annex VI, September 2022, p. 8.
10 HELCOM: Baltic sea Action Plan, 2021 update, October 2021, p. 26.
11 https://helcom.fi/baltic-sea-action-plan/
12 https://www.environmentalshipindex.org/public/ports

State of play

All HELCOM Contracting Parties have ratified MARPOL Annex VI and are therefore required to implement and enforce those regulations as well as the provisions of the NOx Technical Code nationally.

Currently, none of the HELCOM Contracting Parties has found a way to **prosecute NOx Tier III-violations successfully**. NOx inspections on ships are generally limited to documentation verification: a certificate check, e.g. that the serial number on the certificate matches the one on the emission control unit, and inspections of logbooks to ensure all required switch overs (Tier II to Tier III) as well as maintenance has been carried out. A joint meeting of two Bonn Agreement working groups for the North Sea, the MARPOL Annex VI Strategic Operational Working Group (MAVI SOWG) and the MARPOL Annex VI Technical Working Group (MAVI TWG), concluded on 7 February 2023 that "Various remote sniffer measurements (airborne, shipborne and land based) have the potential to identify possible violations on NOx emissions from ships. However, compliance assessment is complex due to numerous factors: Keel Laying Date and Specific Fuel Consumption (SFC) is required, remote measurement gives a snapshot at a certain (unknown) engine load but the limits are based on a weighted average from four different engine loads. Furthermore, it was stated that no limit is in place for engine loads below 25% (e.g., slow steaming, port approach) where generally NOx emissions are higher.

Currently two approaches are used to get to know some ship operation parameters:

1) modelling approach, estimating SFC and engine load for the vessels speed;
2) communication via VHF to request SFC and engine load from the vessels operator."[13]

These results from the technical and strategic discussions are also applicable to the Baltic Sea area. Both approaches, the SFC estimation and the VHF (Very High Frequency) radio communication, are currently not considered court-proof. Hence, none of the Bonn Agreement nor the HELCOM Contracting Parties have sanctioned NOx emissions violations so far.

Experiences and lessons learnt

The following projects and studies have addressed NOx measurements:

1. **SCIPPER project**: funded by EU Horizon 2020, the project ran from May 2019 until January 2023. The consortium included 78 scientists from Denmark, Finland, France, Germany, Greece, the Netherlands, Sweden and the United Kingdom. Data from six measurements campaigns (1,000 plumes) and from long-term measurements (17,000 plumes) were considered. The project covered a cost effectiveness of monitoring methods analysis, quality assurance of remote monitoring systems and harmonised reporting, SOx and NOx Tier III compliance rates and trends, as well as model based investigation on the effectiveness of current and future emission regulations and compliance rates. The output includes recommendations for closing gaps in current international legislations, identification of upcoming risk areas based on future technology use in shipping and improving effectiveness of monitoring and enforcement efforts.
2. **Aer-Nostrum project**: Funded by Interreg, launched in May 2020 and ended in April 2023, the project aimed to help preserve or improve the air quality in port areas while promoting sustainable growth of port activities. Its components included monitoring using smart sensors analysing peaks, modelling considering when ships are stationary and moving in the port and mitigation scenarios.

[13] Bonn Agreement: Minutes of the 1st NOx Joint Session, 7 February 2023, para. 2.1

3. **Starcrest study / IMO MEPC 80 submission by Canada**: Environment and Climate Change Canada contracted Starcrest Consulting Group, LLC, to conduct a study to assess the performance of IMO NOx Tier III technologies.[14] The key conclusions cover the following statements:
    - IMO Tier III regulation certification testing does not include testing for NOx levels at low loads (below 25 Maximum Continuous Rating – MCR),
    - low loads (below 25% MCR and often below 10% MCR) are observed in reduced speed transit and manoeuvring modes which typically occur around port, coastal, and inland areas which are vessel speed reduction zones,
    - while SCR systems are a primary method for engines to reach Tier III NOx standards, they require a certain so called "light-off temperature" to function. At loads below 25%, low exhaust temperatures are typically seen, which necessitates a switch off of these catalysers,
    - tests done with EGR systems suggest that low NOx levels could be achieved down to 10% MCR.

    Canada submitted the study to MEPC 80 (3 – 7 July 2023, MEPC 80/5) and proposed a potential new test cycle for NOx Tier III corresponding to a low-load condition (10% or 15% of engine power). Canada also invited input from engine designers, Original Equipment Manufacturers (OEMs), EUROMOT, and regulators on its findings. Canada is currently working on another document with NOx modelling to be submitted to MEPC 81 in April 2024.

Apart from that, a SCIPPER-follow-up project has been applied for under the Horizon Europe programme: **ATERMON** (Advanced Transport Emission Reporting and MOnitoring Networks).

Technical experts involved in Belgian coastguard NOx measuring have published their experiences with the development of a **methodology to evaluate ship's compliance to NOx emission limits** in 2022.[15] One of the experts also submitted a doctoral dissertation on the "Application of remote measurements for compliance monitoring and enforcement of SOx and NOx emissions under MARPOL Annex VI" in 2023, providing further insight.[16]

Conclusion: a step wise approach

The experience amongst the HELCOM Contracting Parties shows that NOx enforcement is currently limited to documentation inspections. Any NOx measurements require real-time information on the actual engine load. For reliable, court-proof enforcement it would be necessary to combine on-board Continuous Emissions Monitoring Systems (CEMS) with reporting requirements for e.g., engine load and fuel flow. The concerns about regulatory gaps, e.g., at engine loads below 25% MCR, are shared between HELCOM Contracting Parties and have also been recognized at IMO level. The discussion at the IMO started at MEPC 80 and will likely take several Marine Environmental Protection Committee (MEPC) and Pollution Prevention and Response Sub-Committee (PPR) meetings until possible solutions are found and implemented in MARPOL Annex VI as well as the NOx Technical Code.

This draft Roadmap therefore takes a step-wise approach and focuses primarily on supporting actively the needed policy change and regulatory amendments at IMO level, while at the same time supporting remote

[14] Starcrest Consulting Group, LLC: Assessment of low-load performance of IMO NOx Tier III technologies, February 2023; Annex to MEPC 80/5/1 (Canada)

[15] Van Roy, Scheldeman et al.: Airborne monitoring of compliance to NOx emission regulations from ocean-going vessels in the Belgian North Sea, Atmospheric Pollution Research 13(2022)

[16] Ward Van Roy, Application of remote measurements for compliance monitoring and enforcement of SOx and NOx emissions under MARPOL Annex VI, dissertation submitted to Ghent University, 2023

and on-board measurements of NOx emissions and creating incentives for NOx reductions for existing ships, if technically and/or economically feasible.

Taking the recent developments as described above into account, the following steps are proposed:

1. continuously gather information between HELCOM Contracting Parties on compliance monitoring and enforcement gaps;
2. report and discuss the gathered information regularly at WG Maritime meetings;
3. actively support the discussions to be held at IMO meetings in favour of closing technical and enforcement gaps with regard to, in particular, NOx Tier III;
4. initiate a discussion and exchange information with the Bonn Agreement on this issue;
5. noting the challenges for remote measurements, conduct or initiate remote measurements and/or on-board monitoring campaigns of NOx emissions from ships, if feasible, and communicate results to the ongoing policy processes in different fora taking into account but not limited to ongoing discussions at the IMO on NOx-technical code;
6. gather and disseminate information on possible incentives for real NOx emission reductions for existing ships, and create these incentives, if technically and economically feasible; and
7. reconsider the state of play as soon as new IMO regulations have been adopted and revise the draft Roadmap as needed.