European Maritime Safety Agency

Air Emissions – Air Pollution and GHG Emissions

	Air Pollution	Greenhouse Gas Emissions
Emitted substances	Sulphur Oxides (SOx), Nitrogen Oxides (NOx), Particulate Matter	Carbon Dioxide (CO_2), Methane (CH_4).
Origin of Emissions	Combustion processes, either in Internal Combustion engines on-board, boilers, incinerators, gas turbines. **SOx** – emitted when fuels containing sulphur are consumed. **NOx** – Result of endothermic reaction between Nitrogen and Oxygen during combustion processes, at high temperatures. **PM** - Sum of all solid and liquid particles suspended in air many of which are hazardous. Combustion of fossil fuels such as coal, oil, and petrol can produce: • **coarse particles** from the release of non-combustible materials such as fly ash, • **fine particles** from the condensation of materials vaporized during combustion, and • **Secondary particles** through the atmospheric reactions of sulphur oxides and nitrogen oxides initially released as gases.	**CO_2 -** Result from combustion processes where oxidation of carbon occurs. Carbon dioxide and water is the results of complete combustion of fossil fuels where carbon molecules undergo an oxidation process. Carbon Monoxide (CO), a toxic poisonous gas, is the result of incomplete combustion processes where full oxidation of carbon molecules did not occur. **CH_4** – potential emissions of methane resulting from the use of natural gas as fuel in dual-fuel engines. Methane can be emitted through methane leakage during fuel production, storage, transportation and bunkering and through methane slip, unburned methane emissions released during vessel operation due to incomplete fuel combustion in the engine.
Environmental Impact	**SOx** - Local/regional impact. SO_2 contributes to acid deposition which, in turn, affects the quality of soils and water. SOx are known as precursors for Particulate Matter formation. **NOx** – reacts with ammonia to form nitric acid vapour and related particles that can penetrate deeply into sensitive lung tissue and damage it, causing premature death in extreme cases. From the reaction with Volatile Organic Compounds (VOC), in the presence of sunlight, Ozone can cause adverse effects such as damage to lung tissue and reduction in lung function mostly in susceptible populations (children, elderly, and asthmatics). Ozone can be transported by wind currents and cause health impacts far from the original sources.	**CO_2 –** increase of anthropogenic CO2 to the atmosphere with consequential contribution to Greenhouse Gas effect and Global Warming. Climate Change, amongst other direct effects of global temperature increase. **CH_4 –** the same effects of CO2, but with a Greenhouse Gas Potential 25 time higher than CO2 over 100 yrs.

	Air Pollution	Greenhouse Gas Emissions
International instruments regulating/addressing emissions from ships	IMO MARPOL Annex VI	IMO MARPOL Annex VI
EU instruments regulating/addressing emissions from ships	**Sulphur Directive** (Directive (EU) Directive 1999/32/EC of the European Parliament and of the Council of 11 May 2016 *relating to a reduction in the sulphur content of certain liquid fuels*). As amended by Directive 2012/33/EU and codified by 2016/802/EU.	**MRV Regulation** (Regulation (EU) 2015/757 of the European Parliament and of the Council of 29 April 2015 on the monitoring, reporting and verification of carbon dioxide emissions from maritime transport, and amending Directive 2009/16/EC).
Potential mitigating measures	**SOx** - Reduction of SOx emissions implies either the use of fuels with a reduced (compliant) level of sulphur (low sulphur diesels or alternative fuels), or the adoption of Emission Abatement Methods such as an EGC system. **NOx** – NOx emissions from combustion sources can be reduced by two major techniques: • **Combustion modification**, addressing the stoichiometric conditions of combustion process • **Flue-gas treatment** (Exhaust Gas Recirculation – EGR, Selective Catalytic Reduction – SCR). **PM –** Use of fuels containing a lower amount of higher carbon molecules (i.e. cleaner fuels, alternative fuels) or Exhaust Gas Cleaning (scrubber or filtering).	**CO_2 –** Reduction of CO2 emissions from ships can be achieved in two different possible levels: • **Design level**, with the adoption of energy efficient measures in the design of the ship. • **Operational level**s, with different measures possible regarding the operation of the ship (slow speed steaming or any other measures with potential effect in energy efficiency and fuel consumption optimization). **CH_4 –** Reduction of methane emissions from ships is a subject specifically relevant for those ships using LNG as fuel. Methane release mitigation to be addressed in two levels: • **Dual-Fuel Engine design**, for minimization of methane slip phenomenon. • **Adequate handling, storage and distribution procedures,** for mitigation of the risk of LNG leakages/methane releases.