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REPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL

on the technical feasibility for further reducing the emissions of marine propulsion engines, introducing requirements for evaporative emissions and the impact of the watercraft design categories on consumer information and on manufacturers as set out in Article 52 of the Directive 2013/53/EU of the European Parliament and of the Council of 20 November 2013 on recreational craft and personal watercraft and repealing Directive 94/25/EC of the European Parliament and of the Council

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1. INTRODUCTION

Directive 2013/53/EU on recreational craft and personal watercraft[1] 'the RCD') was adopted on 20 November 2013, replacing Directive 94/25/EC as amended by Directive 2003/44/EC[2]. The RCD aims to ensure a high level of protection of human health and safety and the environment while guaranteeing the smooth functioning of the internal market. To ensure the latter, it sets harmonised requirements for recreational craft and personal watercraft ('watercraft') and minimum requirements for market surveillance.

Article 52 of the RCD requires that the Commission submit to the European Parliament and the Council, by 18 January 2022, a report on: (a) the technical feasibility for further reducing the emissions of marine propulsion engines and introducing requirements for evaporative emissions and fuel systems that apply to propulsion engines and systems taking into account the cost efficiency of technologies and the need to agree globally harmonised values for the sector, taking into account any major market initiatives; and (b) the impact on consumer information and on manufacturers, in particular small and medium-sized enterprises, of the watercraft design categories listed in Annex I of the RCD, which are based on resistance to wind force and significant wave height, taking into account developments in international standardisation. Additionally, it is required to include an evaluation of whether the watercraft design categories require additional specifications or subdivisions.

In this report, the Commission has assessed the technological and economic feasibility of further reducing the exhaust emissions produced by recreational craft, and introducing limits for evaporative emissions produced by recreational craft's fuel systems. The Commission also evaluated the appropriateness of the current watercraft design categories in light of different weather conditions and the impact of this categorisation on manufacturers and end-users. The report describes the current state of the art of sectoral technologies and associated costs, regardless of future regulatory and technological developments.

1 Directive 2013/53/EU of the European Parliament and of the Council of 20 November 2013 on recreational craft and personal watercraft and repealing Directive 94/25/EC, OJ L 354, 28.12.2013, p. 90-131, Corrigendum to Directive 2013/53/EU of the European Parliament and of the Council of 20 November 2013 on recreational craft and personal watercraft and repealing Directive 94/25/EC (OJ L 354, 28.12.2013).

2 Directive 2003/44/EC of the European Parliament and of the Council of 16 June 2003 amending Directive 94/25/EC on the approximation of the laws, regulations and administrative provisions of the Member States relating to recreational craft, OJ L 214, 26.8.2003, p. 18-35.

In support of this report, the Commission conducted a review study[3] to take stock of the available technologies to reduce emissions from the engines and fuel systems of recreational crafts. The study proposed several options to reduce emissions, presenting an assessment of the economic impact of each of them in the form of a cost/benefit analysis. The study also evaluated the watercraft design categories, focusing on the impact of such categorisation on manufacturers and final users or consumers.

For this report the Commission also analysed Member States' input for the report on the RCD's application (as required by its Article 51). A targeted consultation of the relevant sectoral stakeholders (such as the Member States' public authorities, manufacturers' and end-users' associations and notified bodies) was also carried out as a part of the study.

2. THE CURRENT LEGAL FRAMEWORK ON EXHAUST EMISSIONS, EVAPORATIVE EMISSIONS AND WATERCRAFT DESIGN CATEGORIES

2.1 Exhaust emissions

The exhaust emissions produced by recreational craft and their engines are currently regulated at EU level by the RCD (Article 4 and Annex I, Part B, Point 2), which sets limits on air pollutants that can be emitted by recreational marine engines. In addition, Member States, on the basis of Article 5 of the RCD and subject to the conditions therein, may restrict the use and speed of the motorised recreational craft in certain waters to prevent the accumulation of air pollutants.

Directive 2003/44/EC[4] amending Directive 94/25/EC introduced exhaust emission limits (for nitrogen oxides (NO_x), hydrocarbons (HC), carbon monoxide (CO) and particulate matters (PT)) for combustion propulsion engines of recreational craft that are newly placed on the EU market.

The exhaust emission limits were further reduced by the RCD to a level that reflected the technical development of cleaner marine engine technologies and that allowed progress towards harmonisation of exhaust emission limits with the main trading partners. The CO limits, however, were raised in order to allow the significant decrease of other air pollutants, to reflect technological feasibility and to achieve the fastest possible implementation, while ensuring that the socio-economic impacts on this economic sector were acceptable.

2.1.1 Greenhouse gas (GHG) emissions / CO_2 emissions

GHG emissions from domestic navigation are already covered by the Effort Sharing Regulation (EU) 2018/842[5]. However, no testing procedure exists for recreational craft to determine a representative limit of either CO_2 emissions or of other GHG emissions. In

[3] Review study on the Recreational Craft Directive 2013/53/EU, TNO & Panteia & Emisia, September 2021.

[4] Directive 2003/44/EC of the European Parliament and of the Council of 16 June 2003 amending Directive 94/25/EC on the approximation of the laws, regulations and administrative provisions of the Member States relating to recreational craft (text with EEA relevance), OJ L 214, 26.8.2003, p. 18-35.

[5] Regulation (EU) 2018/842 of the European Parliament and of the Council of 30 May 2018 on binding annual greenhouse gas emission reductions by Member States from 2021 to 2030 contributing to climate action to meet commitments under the Paris Agreement and amending Regulation (EU) No 525/2013, OJ L 156, 19.6.2018, p. 26-42.

particular, the CO_2 emissions are not determined only by engine performance, but also by other aspects such as propeller design, boat shape, positioning of propeller(s) and by handling of the boat. To come up with CO_2 emission limits for recreational craft, a 'boat energy consumption calculation tool'[6], which combines the above mentioned factors, would have to be developed. The introduction of renewable fuels for recreational craft could also contribute to reducing CO_2 emissions.

2.2 Evaporative emissions

Evaporative emissions are not currently regulated by the RCD. In the EU, these emissions are only addressed in the automotive sector[7]. However, evaporative emissions from recreational craft are regulated in some non-EU countries, for example the United States. The US regulations[8] set out the limits for allowed permeation of evaporative emissions from fuel tanks, fuel systems and diurnal emissions. These three types of emissions are responsible for 98% of fuel evaporation.

2.3 Watercraft design categories

Directive 94/25/EC divided watercraft into design categories in order to indicate the areas where a watercraft can operate (category A – ocean, category B – offshore, category C – inshore, category D – sheltered waters).

The ability of a watercraft to operate in certain waters was measured by the capacity to withstand certain combinations of wind force and wave height. The ability to withstand more severe weather conditions also determined the particular conformity assessment module to be applied.

To provide clear information about the acceptable operating environment of watercraft, the RCD removed the references to the types of waters and based the watercraft design categories only on the essential environmental conditions for navigation, namely wind force and significant wave height.

3. TECHNICAL FEASIBILITY FOR FURTHER REDUCING THE EXHAUST EMISSIONS OF MARINE PROPULSION ENGINES

3.1 Types of propulsion engines

The recreational craft using the traditional combustion engines are fitted with either **spark ignition (SI)** propulsion engines (using petrol as the fuel) or **compression ignition (CI)** propulsion engines (using diesel as the fuel).

Another differentiation stems from the positioning of the propulsion engine on the watercraft. In the **outboard propulsion systems** the engine is a separate unit that can be attached to the

6 Similar to the vehicle energy consumption calculation tool (VECTO) used in the automotive industry.

7 Regulation (EC) No 715/2007 of the European Parliament and of the Council of 20 June 2007 on type approval of motor vehicles with respect to emissions from light passenger and commercial vehicles (Euro 5 and Euro 6) and on access to vehicle repair and maintenance information (Text with EEA relevance) OJ L 171, 29.6.2007, p. 1-16.

8 40 Code of Federal Regulations Part 1060 -- Control of Evaporative Emissions from New and In-Use Non-road and Stationary Equipment, US Environmental Protection Agency, 10.8.2008.

rear of recreational craft. In the **inboard propulsion systems**, the engine is positioned inside the craft.

Furthermore, in the **water jet propulsion** system the engine is not connected to a propeller but to a powerful rotating pump. This pump takes the water in and spews it out at great speed, thus generating the move. Such propulsion systems are typically used in personal watercraft.

Recently, two other types of propulsion system have appeared on the market, namely the pure **electric propulsion system** (where the sole source of energy supply is an electric battery that feeds an electric motor) and the **hybrid propulsion system** where a combustion engine works together with an electric motor (with energy stored both in a fuel tank and a battery).

3.2 Existing technologies that can be used to reduce exhaust emissions from propulsion engines

3.2.1 SI outboard engines and personal watercraft propulsion engines

The study indicates that the real-world CO emissions generated by SI outboard and personal watercraft engines currently on the market are well below the RCD limit values. Furthermore, the NO_x+HC emissions generated by best-in-class engines (i.e. the cleanest engines across the power range) are also significantly below the limit values. The study concludes that further restriction of emission limits is possible at lower power ranges, thanks to the optimisation of these engines, achieved by applying electronically-controlled (sequential) multi-point injection technology.

The proposed technology for further reducing the emissions generated by four-stroke SI outboard engines is the application of three-way catalytic aftertreatment. This would require the redesigning of cylinder block and the adaptation of thermal management of the exhaust system.

Using this technology would also result in a 10% decrease in fuel consumption and a 70% reduction in NOx+HC emissions.

3.2.2 SI inboard engines

New SI inboard engines installed in recreational craft are all four-stroke engines. They already apply advanced per-cylinder fuel injection in combination with electronic lambda control and three-way catalytic aftertreatment.

Emissions could be reduced further by avoiding fuel enrichment calibration, which would require using more expensive alloys for valves and turbines. Emissions can also be reduced by limiting the maximum brake mean effective pressure (bmep)[9] of these engines. Limiting bmep would require increasing the total displacement volume of these engines in order to retain the same rated engine power. It would also increase the engine's volume and weight and possibly also its fuel consumption due to the higher impact of friction losses.

[9] Brake mean effective pressure is proportional to the ratio of engine torque and engine total displacement volume.

3.2.3 CI inboard engines

The two new technologies that could further reduce exhaust emissions from CI engines are exhaust gas recirculation (EGR) and selective catalytic reduction (SCR). Both technologies entail the catalytic exhaust gas aftertreatment of CI engines. Applying these technologies reduces the NO_x and HC pollutants. Experience from the Non road mobile machinery sector shows that NO_x-reductions of respectively 50% (EGR technology) and 85% (SCR technology) can be achieved, with the extent of the reduction depending on the engine power. Similarly, PT emissions could be further reduced by using the diesel oxidation catalyst and/or diesel particulate filter technologies.

EGR technology would require the widespread use of low sulphur diesel (max 500 ppm of sulphur) for recreational craft to avoid the risk of corrosion and the fouling of metal parts of the engine when cooling the recirculating exhaust gas. Currently, high sulphur gas (up to 1 000 ppm of sulphur) is predominantly used in the sector. EGR technology would result in a 50% reduction of NO_x and a slight increase (2-3%) in fuel consumption.

SCR technology is also sensitive to sulphate salts, whose deposition may even block the catalyst function. To avoid these issues, ultra-low-sulphur diesel (less than 15 ppm of sulphur content) should be used. If ultra-low-sulphur diesel were not used, a considerable increase (up to 50%) in volume and weight of the catalyst would be required. To apply the SCR technology, reagent fluid (urea-water mixture) needs to be stored on-board in a dedicated tank.

3.2.4 Electric engines

Electric propulsion engines do not produce exhaust emissions except in connection with the production of electricity charged from the grid. The vast majority of current electric engines for recreational craft are small outboard engines with power up to 5 kW. However, some manufacturers are starting to offer more powerful engines.

The faster uptake of electric engines in the marine sector is mainly hampered by the capacity, size, weight and price of the batteries propelling the electric motor. Recreational craft need a sufficient storage of electricity to be able to operate for several hours, for example when navigating at sea. The need of longer boat's autonomy[10] requires that bigger and heavier lithium-ion batteries are installed. These bigger batteries limit storage space in boats and affect their stability and buoyancy. Therefore, a clear limitation of current battery technology is that electric engines are able to operate for a shorter period of time and have a shorter range compared to their internal combustion counterparts in the same engine power class.

3.2.5 Hybrid engines

Hybrid engine applications combine a combustion engine, an electric motor and a battery pack. This combination enables a boat's kinetic energy to be recuperated and stored in a battery for later use. This practice may allow the engine to operate (either in electric or combustion mode) under conditions that enable the lowest possible fuel consumption.

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10 More hours of operation without need to recharge.

4. TECHNICAL FEASIBILITY FOR INTRODUCING REQUIREMENTS FOR EVAPORATIVE EMISSIONS

Evaporative emissions refer to the sum of fuel-related volatile organic compounds' emissions not deriving from fuel combustion. Specifically, these evaporative emissions emanate from petrol fuel. Evaporative emissions from diesel fuel are negligible due to presence of heavier hydrocarbons and low vapour pressure of diesel fuels.

4.1 Types of evaporative emissions

Diurnal emissions are emitted in line with variations in temperature over the course of the day. An increase in ambient temperature results in thermal expansion of the fuel and vapour in the fuel tank.

Fuel hose permeation emissions concern fuel hoses, and their formation mechanism is similar to the fuel tank permeation mechanism. The fuel hose permeation phenomenon is more significant for rubber hoses.

Fuel tank permeation occurs when fuel escapes through the permeable walls of a fuel tank. The outer surfaces of the tanks are exposed to ambient air, so the petrol molecules permeate through them and are emitted directly into the air. Permeation is most common through plastic fuel tanks.

4.2 Existing technologies that can be used to reduce evaporative emissions from fuel systems

(a) Diurnal emissions control

Diurnal evaporative emissions occur when the fuel warms up and passes through a vent into the atmosphere. When the vent is closed, evaporative emissions cannot escape. Even though the pressure rises with the generated vapour, it subsides once the fuel cools back down. An effective way to control these emissions is to integrate a **pressure relief valve** to seal the fuel tank.

Another way to reduce diurnal emissions is to install a **carbon canister** to absorb the vapour generated in the fuel tank. The carbon canisters work by activating the carbon which then collects and stores the hydrocarbons. . The carbon canister can also be connected to the engine through a purge valve, which allows ambient air to flow through the canister' when the engine is running. Purged fuel vapours are thus routed through the engine where they are burned along with the fuel mixture.

(b) Fuel hose permeation control

Fuel hose permeation could be controlled by using **barrier materials** which decrease the rate of permeation. The barrier materials constitute an inner layer that is fixed to the inside of the vent, fill neck and supply/return hoses. .

Typical solutions include:

- thermoplastic barriers for small outboard engines and personal watercraft;
- nylon barriers for boats with installed fuel tanks;
- fluor elastomer used in fuel line applications.

(c) Fuel tank permeation control

Similar to fuel hose permeation control technologies, fuel tank barrier materials are used to reduce tank permeation rates. Typical methods include:

- creating a barrier layer using the sulfonating or fluorination method;
- creating non-continuous barrier platelets by blending a low permeable resin;
- inserting a thermoplastic layer between two rubber layers;
- using fibreglass fuel tanks, with clay nanocomposites as a barrier material;
- inserting a layer of epoxy barrier coating.

5. EVALUATION OF THE WATERCRAFT DESIGN CATEGORIES AND ITS IMPACT ON CONSUMER INFORMATION AND ON MANUFACTURERS

5.1 Impact of watercraft design categories on manufacturers

Manufacturers use watercraft design categories to calculate a boat's stability and structure. The design categories are divided according to conditions for navigation, namely wind force (expressed as a number or 'grade' on the Beaufort scale) and significant wave height[11].

A boat in a specific design category must be able to withstand cracks, damage and flooding caused by waves. Integrating the above two criteria into each design category ensures that the watercraft is designed and built to withstand the combined effects of any meteorological condition, no matter which of the two criteria is the dominant one.

NATO's standardised methodology[12] to measure sea conditions also uses combinations of significant wave height and sustained wind speed. The World Meteorological Organisation (WMO) [13] uses identical methodology.

11 Value of one third of the highest wave height. The statistical value that approximates the visually observed wave height.

12 NATO Standard STANAG 4194 NAV: Standardised wave and wind environments and shipboard of sea conditions (NATO, 1983).

13 Sea states according to WMO, Doc. No 306 Volume I.1, Annex II page A-379 (WMO, 2019).

A comparison between the RCD methodology and the WMO methodology reveals that for the significant wave height $H_s \leq 4$ m (set out for design category B), the RCD limits the wind force (measured on the Beaufort scale) to grade 8, whereas the WMO methodology states that Beaufort grade 7 would be scientifically more precise. The WMO methodology also sets lower Beaufort grades than the RCD for other significant wave height limits. In other words, the steps or increments between the RCD design categories are larger and more unequal than would have been the case had the WMO methodology been applied. However, the current division of watercraft design categories and the choice of criteria is considered to be in line with the most recent knowledge of the WMO and their methodology on the states of sea.

The European Maritime Safety Agency (EMSA) has not reported any accident where the weather or environmental conditions would be the causal factors for accidents when a watercraft was sailing within the limits of its assigned design category.

Note that design category A, as set out in the RCD, does not set upper limits for wind force or significant wave height. Instead, it just states that abnormal conditions such as storms, hurricanes and tornados are excluded, implicitly limiting the design category A to exclude wind force of Beaufort grade 10 and significant wave heights of 8 m. However, harmonised standards for the design categories explicitly set upper limits for design category A.

5.2 Impact of watercraft design categories on end-users/consumers

Watercraft design categories, as set out in the RCD, do not inform the end users (consumers) about the actual state of the sea. The actual state of sea is indicated in the WMO's sea states forecasts (calm, smooth, slight, moderate, rough, very rough, etc.). It is the responsibility of users to know about the actual state of the sea before their departure. The WMO's forecasts include information on the prevailing direction of wind and waves, wind force in terms of Beaufort grade, wind gusts, significant wave height, and maximum wave height and wave period.

Some users may mix up wind force in terms of Beaufort grade (which is an average value) with the wind gust speed (which indicates the maximum possible wind). Wind gust may be up to 40% stronger than the referred wind speed.

Furthermore, users must have a correct understanding of the concept of significant wave height, otherwise they may underestimate the safety risk by real physical conditions that will be encountered. For example, maximum wave height can be up to double the significant wave height (a value implying a range of possible wave heights rather than a single value).

In short, end users may confuse the **watercraft's construction capability** (indicated by the design category) to withstand certain meteorological conditions, with the **actual weather and water conditions** communicated by marine forecasts.

6. KEY RESULTS OF THE ASSESSMENT

6.1. Exhaust emissions – options and impact of emission reduction

The review study mentioned earlier that the exhaust emissions produced by recreational craft and their engines can be reduced by two different means. The first one is restricting the use and speed of the motorised recreational craft by the national authorities in certain places and at certain times. Such restriction is an efficient way for national authorities to decrease health and environmental risks in adverse weather conditions or in the areas sensitive to high accumulation of exhaust emissions at certain peak times. The method is efficient to meet an immediate, short-term need to decrease air pollutants.

The second means is to set stricter limits on the amounts of air pollutants that can be emitted by the recreational marine engines. However, such limits will apply only to new products placed on the market and will not affect the old (more polluting) engines already in service. More than 80% of recreational craft's engines currently in service were placed on the market before the current exhaust emission limits set out in Directive 2013/53/EU came into force.

The study proposed several options for imposing stricter exhaust emission limits on new combustion engines placed on the market. These options differ in the severity of emission limit reductions and associated economic and environmental impacts.

The first possibility considered in the study is engine optimisation of low-powered engines[14], which would enable NO_x, HC and CO limits to be reduced by 30%. In fact, many engines in this category already reach this level. Therefore, it is assumed that real-world exhaust emission decrease would be lower than the decrease of limit values. The monetised environmental benefits would break even with the investment and manufacturing costs in 9 years.

The second possibility would be to impose stricter limits on all engine power ranges. This would require the application of new technologies[15] that restrict NO_x and HC limits by 70% for SI outboard engines as well as by 40% (EGR technology) and by 64% (SCR technology) for CI inboard engines.

Despite the greater environmental gains, these two options would require high investment and manufacturing costs which would be paid back respectively in 16 years (EGR technology) and in 20 years (SCR technology). In addition, the second option would also demand the wide availability of ultra-low sulphur diesel for recreational craft as well as the change in testing procedures in order to apply 'not to exceed zone' testing methodology[16].

The scope of reduction of exhaust emissions from new engines will also depend on the extent of electrification and hybridisation of engines in the sector.

Electric engines are currently competitive only in small power ranges. Engines with limited battery capacities do not provide sufficient electric range to meet boat's need for autonomy at sea. The inadequacy of battery recharging infrastructure in marinas and the high investment

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14 For SI engines: those of P<75kW, for CI engines, those of P<37kW.

15 In particular, the application of three-way catalyst after treatment system for SI outboard engines and application of EGR or SCR technology for CI inboard engines.

16 Testing of emissions over the full range of speed and load combinations commonly experienced in use.

cost of electric engines are two factors that currently prevent effective market penetration. A larger usage of electric engine applications in the recreational craft sector is not possible without further technological development in energy density[17] of current battery technologies. Furthermore, a sufficient network of charging stations in marinas is needed. The uptake of electrification in the sector could be accelerated by introducing ‘emission-free’ zones, tax alleviations for electric applications and higher taxes on combustion engines or fossil fuels.

Hybrid engine applications[18], when combustion parts are used in certain conditions[19], may help reduce fuel consumption by 10% compared to traditional combustion engines (with similar reductions in CO and CO_2 as well as a 37% reduction in $HC+NO_x$).

However, current test cycles, which have been developed purely for testing CI engines, are not suited to test emissions of hybrid applications[20].

The hybridisation of engines affects the volume and weight of the entire application. Therefore, hybrid solutions will probably only be widely used for outboard engines if technological development makes the electromotor and batteries suitably small in the future.

For inboard engines, the study states that hybridisation could account for up to 10% of the market. The main obstacle to a wider uptake of hybrid solutions is that they are expected to cost more than combustion engines. However, the report restricts itself to the current state of the art of available technologies, without considering future regulatory and technological developments.

6.2. Evaporative emissions – options and impact of introducing limits

6.2.1. Options to introduce evaporative emission requirements in the RCD

The review study indicates that emissions from fuel tanks, fuel hoses and diurnal emissions are responsible for 98% of all evaporative emissions. It also estimates that emission limits on evaporation through fuel tanks, fuel hoses and diurnal emissions can reduce annual evaporative emissions produced by recreational craft by up to 30%. This would mean a reduction of 16 thousand tonnes of HC emissions/year[21]. Lower evaporative emissions would also reduce the loss of fuel and therefore decrease overall fuel consumption.

The study concluded that the most appropriate option to reduce evaporative emissions would be to introduce the limits used in the United States for recreational craft[22]. The technologies for reducing the evaporative emissions in the recreational boating sector have already been developed and a decade of experience with those limits has proved that they are feasible and realistic. Harmonisation of the evaporative emission limits between the EU and the US is supported by stakeholders.

17 kWh per kg of battery.

18 When the hybrid application comprises an electric motor and a catalysed SI engine.

19 An electric propulsion engine is used at low speeds (such as when drifting away from the marina), and combustion propulsion takes over when the engine operates between 25% and 80% of its rated power range.

20 When the hybrid application comprises an electric motor and a CI engine.

21 It presents approximately 0.15% of HC emissions produced by all EU sectors.

22 Fuel hose and fuel tank permeation emission control, control of diurnal emissions, control of hot soak emissions and control of running losses during re-fuelling.

Another alternative would be to reduce the evaporative emissions in line with the limits used in the EU automotive sector. However, it is questionable to what extent the limits set for this sector would be appropriate for the specific characteristics of the boating sector (such as different times of engine activity during usage, or operation in wet and salty conditions).

Because technologies have already been developed for boating environments, the evaporative emissions control requires less expenditure on research & development. Nevertheless, EU manufacturers would have to take into account additional fixed expenses for tooling and certification, as well as higher variable manufacturing costs due to the need to apply additional protective layers in fuel tanks and hoses.

According to the study, the benefits of reducing HC emissions and lowering fuel consumption would offset the costs of adopting the technologies after 22 years[23].

A faster payback period of 17 years would also be possible if the technology adopted involves permeation control from fuel hoses alone. This solution would involve lower implementing costs, however the reduction of annual evaporative emissions would also be lower (11% reduction compared to a 30% reduction if all emission control measures are implemented).

6.3. Watercraft design categories – key findings, options for modifying design categories and impact of possible modifications

6.3.1. Key findings for manufacturers

The public consultation shows that the choice of criteria[24] and the watercraft design categories are well understood by boat manufacturers.

The upper limits of wind force and wave height for design category A are set implicitly (by excluding stormy weather) rather than explicitly like in the relevant harmonised standard. Setting explicit upper limits for design category A may improve the clarity of information provided to manufacturers.

6.3.2. Key findings for end users/consumers

The public consultation shows that the choice of criteria and the watercraft design categories are well understood by end-users/consumers. The issues that seem to need a more detailed technical explanation are: significant wave height definition, maximum average wind speeds, gust speeds and maximum wave height. If these terms are explained in the owner's manual as well as in the RCD, end-users should be better able to understand the relation between their watercraft's maximum construction capabilities and marine forecasts.

[23] As measured according to the current level of technology knowledge and current expenses.

[24] Combination of wind force and wave height.

6.3.3. Options for modifying design categories

The first option is to divide design categories C and D into two. New sub-categories C1/C2 and D1/D2 would introduce modifications to the limits for maximum wind force and significant wave height. According to WMO sea state methodology, this could better correspond to weather conditions found in sheltered waters (mainly category D boats) and some areas of non-sheltered waters (mainly category C boats). However, the available accident reports do not provide evidence that the design category assigned for certain meteorological conditions would be a factor contributing to accidents. According to the review study, this option does not appear to bring any tangible safety benefits and would generate costs amounting to several millions of euro.

The second option is a subdivision of category C and the specification of new ranges in all categories in order to improve scientific and technical soundness. It would approximate the RCD design categorisation with the methodology of sea state used by the WMO. According to the study, although this option might bring about some improvements such as clearer information for end-users, the benefits would not outweigh the costs.

A new division of the watercraft design categories would involve costs for manufacturers as well as for standardisation bodies. Manufacturers would need to re-design certain boat models that were previously assigned to a different category, re-certify those boats and communicate the changes to their customers. The study also notes that the cost of revising 23 harmonised standards, which contain references to the current boat design categorisation, could run up to several hundreds of thousands of euro.

The third option does not involve modifying the design categories. Instead, it provides the possibility to increase legal clarity in the RCD by adding the explicit definition of the upper limit values for design category A as defined in the relevant harmonised standard. This option appears to be the most advantageous economically because it does not generate manufacturing or certification costs due to the modification of design categories. Instead, the explicit statement, together with explanations of the terms ‘wind force’, ‘gust wind force’ and ‘significant wave height’, may improve the clarity of information provided to manufacturers as well as to end-users.

7. CONCLUSIONS AND WAY FORWARD

7.1 Exhaust emissions

Conclusions

As explained in Chapter 6.1, approximately 80% of recreational craft currently in service are not covered by the exhaust emissions limits introduced by the RCD (applicable since 2016).

Therefore, the real-world exhaust emissions from recreational craft will fall as the fleet is gradually replaced and equipped with modern, clean engines, including an increasing share of zero-emission technologies.

A further reduction of exhaust emissions from recreational craft engines is technically feasible with the installation of advanced catalyst technologies. Catalyst technologies cannot be simply carried over from the on-road sector, but need to be adjusted to the salty marine environment. The engine manufacturers can therefore take advantage of economies of scale only to a limited extent. The use of catalyst technologies on SI outboard engines and CI engines of recreational craft requires a high and long-term investment (the payback period is 16-20 years). It also requires the availability of specific diesel fuels with a low level of sulphur for recreational craft.

Exhaust emissions could also be reduced by using electric and hybrid engines. Although this is technologically possible, it would still pose a challenge due to battery storage constraints, the cost of electric and hybrid applications and the lack of charging infrastructure. Currently, these applications are competitive only for low-powered motor boats and some sailing boats, but their uptake will increase when the above mentioned limitations are tackled.

Further reducing exhaust emission limits from recreational craft engines in future legislation will not solve the immediate need to improve the ambient air in some heavily-polluted zones (such as certain ports). The immediate reduction of pollutants in sensitive areas is already possible under the current legal framework, as Member States are free to adopt specific rules of navigation according to Article 5 of the RCD (for example limitation of use in certain hours, limitation of speed, way of navigating).

Way forward

The Commission will continue to closely monitor technological and market developments as well as major market initiatives to reduce exhaust and greenhouse gas emissions from recreational craft and make, where appropriate, legislative proposals to set more ambitious emission standards, including the support of low-emission propulsion technologies (such as electrification) used on recreational craft and personal watercraft.

7.2 Evaporative emissions

Conclusions

Evaporative emissions from recreational craft are not currently regulated under the RCD. They are mostly HC emissions and account for a very small proportion of HC emissions from the transport sector. However, they can accumulate in ports and boat storage spaces when recreational craft are left idle.

Introducing evaporative emission limits would be feasible, as the technologies to control these emissions from recreational craft exist and are already used in the United States. It would, however, require a significant financial investment by European suppliers of fuel tanks and hoses to adopt the technologies for controlling evaporative emissions (as indicated in Chapter 4.2). Assuming that the costs will spill over, resulting in higher prices for fuel system components, the payback period for implementing evaporative emissions' control measures on recreational craft would be approximately 20 years for the EU recreational craft manufacturers. Evaporative emissions will naturally decrease alongside the progressive electrification of the engines of recreational craft.

Way forward

The Commission will monitor the electrification process of the engines of recreational craft and its impact on exhaust as well as evaporative emissions from recreational craft. The Commission will also consider introducing evaporative emission limits as part of a future revision of the RCD. In this regard, it will take into account the existing US standards as well as the other major market initiatives.

7.3 Watercraft design categories

Conclusions

As explained in Chapters 5 and 6.3, the current division of the watercraft design categories based on meteorological criteria (combination of wind force and wave height) is appropriate and supported by manufacturers as well as by end-users/consumers.

A modification of these categories would have a significant economic impact on manufacturers, end-users/consumers, and standardisation bodies, and would not improve the safety of recreational craft.

Way forward

Within the current legal framework, the Commission will continue to monitor the implementation of the watercraft design categories.

In a future revision of the RCD, the Commission may consider explicit stating upper limits for design category A and including explanations of the terms 'wind force', 'gust wind force' and 'significant wave height' in the Explanatory Notes of Annex I.A.