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REVIEW OF MARPOL ANNEX VI AND THE NO_x TECHNICAL CODE

Control of NOx emissions from existing marine diesel engines

Submitted by the United States

SUMMARY

Executive summary:	This document outlines a proposal to control NOx emissions from certain marine diesel engines that are not subject to the current Regulation 13 NOx limits (those with a swept volume displacement of 30 liters or more installed on vessels built prior to 1 January 2000 and have not undergone a major modification since that date). The approach is based on the availability of emissions upgrade systems that will reduce emissions to the regulation 13 NOx limits
Action to be taken:	Paragraph 18
Related documents:	BLG 11/5/15 and BLG 11/16

Introduction

1 In document BLG 11/5/15, the United States proposed to limit NOx emissions from certain marine diesel engines that are not currently subject to the regulation 13 NOx limits. Specifically, the United States requested the Sub-Committee to consider a new provision that would require all engines with a per-cylinder swept volume displacement of 30 liters or more on board a vessel built between [1985] and 2000 to achieve a NOx reduction of at least 20%. The United States proposed an effective date of [2012]. Alternatively, the United States suggested that the standard may be expressed as a specified action (e.g., injector change) that would be known to achieve a particular reduction; in this case, verification would be limited to the completion of the action as opposed to measuring a specified emission reduction.

2 At the second intersessional meeting of the BLG Working Group on Air Pollution (BLG-WGAP 2) in Berlin (29 October – 2 November 2007), there was additional discussion of emission standards for existing engines. During that discussion, concerns were raised about those cases where retrofit of certain engines is not practical. There was also discussion about how vessels with engines that cannot comply should be treated, with some parties proposing that such vessels be derated or denied port entry. Recognizing the desire to keep any existing engine standard simple and practical, the United States proposed that retrofits to pre-2000 engines would

only apply to large displacement engines where commercial retrofit "kits" are made available. This paper provides additional information on the "kit"-based approach discussed at BLG-WGAP 2.

Background: Rebuilding Engines in Large Commercial Vessels

3 Very large marine diesel propulsion engines have several characterisitics that affect the options available for emission-reducing modifications.

4 First, these engines are often designed to be a key component of the structure of the vessel. The location of the engine as well as its fuel and control systems is important both in terms of the stability of the vessel and in terms of vessel operation. These constraints make the engine difficult, if not impossible to remove. As a result, the engines are designed to last the life of the vessel, which can be upwards of 30 years. This also means that the engine must be designed to be serviced on the vessel, since removal of major components such as cylinder blocks or crankshafts would often mean cutting into the hull of the vessel. The engines are designed for easy in-situ repairs so that those parts subject to wear can be replaced without difficulty, to minimize the time that the unit is out of service for repair or rebuild. This includes power assemblies, which consists of the pistons, piston rings, cylinder liners, fuel injectors and controls, fuel injection pump(s) and controls, and valves. The power assemblies are generally rebuilt to bring them back to as-new specifications, or they can be upgraded to incorporate the latest design configuration for that engine. As part of the routine rebuilding process, many types of power assemblies and key engine components can be disassembled and replaced or requalified (i.e., determined to be within original manufacturing tolerances).

5 Second, the engines on trans-oceanic and inter-coastal vessels develop very high power compared to inland waterway vessels, exceeding several thousand kilowatts, and in cruise mode they are typically operated at high load factors (80% of power or more) for extended periods of time. This type of operation, as well as the safety implications of operating such large vessels close to shore and in port, requires durable, dependable power plants. Consequently, these engines typically undergo regular and specific maintenance, including periodic overhauls. Regular maintenance also minimizes fuel and lubrication oil consumption losses from poorly operating engines.

6 Third, the long lifespan of these vessels also means that the existing fleet of vessels encompasses a wide variety of propulsion engines, built by different manufacturers, with different engine platforms, different design concepts, and different types of emission-related components (e.g., fuel injectors, cooling systems, piston designs). In some cases, engines may be based on older original designs that may not have been updated for decades prior to the regulation 13 NOx limits, making some older engines different than those engines built from more recent design concepts. These variations in engine design must be considered when developing a programme for existing engines, in terms of both the number of models that can be addressed by the effective date of the requirements and the number of engine manufacturers that can design appropriate emission reduction strategies. In addition, while control technologies that are being used to achieve the current regulation 13 NOx limits may be easily applied to some engines, they may not be applicable to others, even those built in relatively recent model years. Therefore, it may be necessary to limit the engines that would be subject to existing engine standards.

7 One approach to limit the applicability of existing engine standards is to apply the standards only to those engines installed on a ship constructed after a certain date (e.g., 1 January [1980][1985][1990]) but before 1 January 2000. In this approach, all engines that fall within those two dates would be required to be modified to meet the NOx limit for

existing engines. However, such an approach may not readily address the variety of engines in the existing fleet. For example, the choice of beginning date may be difficult to determine due to differences in base engine platforms between manufacturers. A start year that makes sense for one manufacturer may not make sense for another, for example if one engine manufacturer adopted electronic fuel controls later than another. Specifying a set of engines based on the date of construction also runs the risk of excluding engines that may, in fact, easily accommodate engine modifications that would reduce emissions.

Marine Engine Emission Upgrade "Kits" – An Alternative Approach

8 An alternative approach to a provision that would require all engines built on or after a certain date to achieve NOx reductions would be a programme that relies on engine manufacturers to provide emissions upgrade systems, or "kits," and require the owner to install such systems if they are available. This approach is described in the remainder of this paper.

9 In this alternative approach for existing engines, the owner/operator of a covered vessel would be required to use a certified marine emissions upgrade kit when servicing an engine on that vessel if such a kit is available at that time. If there is no certified kit available for the relevant engine at the time the engine servicing is performed, there would be no requirement to upgrade the engine. It will be necessary to clarify the type of servicing event that triggers the requirement, such as a physical inspection of the relevant components as part of an engine survey or when a component is actually replaced. It will also be necessary to specify how the requirement would apply for engines that are serviced on a continual basis, with a subset of power units being replaced on a rolling schedule. Finally, it may be useful to specify a date by which an available emission upgrade kit would be required to be installed, for example by the time of the next vessel re-certification survey pursuant to regulations 5 and 6 or the next intermediate survey, whichever is later.

10 Availability would mean not only that a kit has been certified, but also that it can be obtained and installed in a timely manner consistent with normal business practices. For example, a kit would not be considered to be available if the component parts are not available for purchase in the period normally associated with servicing an engine prior to the re-certification or intermediate survey. If a certified kit is not available at the time of normal engine servicing, there is no requirement to comply with this programme until the next re-certification or intermediate survey, whichever is later, at which time this availability determination will again be made.

11 Emissions upgrade kits are not expected to require significant vessel design changes. Instead, they are expected to consist of more advanced versions of existing engine components. Engine manufacturers will generally apply the same technologies that were used to achieve the current regulation 13 standards, including combustion optimization through fuel injection timing, combustion chamber geometry, compression ratios, and valve timing; improved charge air through better turbochargers and aftercoolers; better fuel injection through fuel injection pressure, nozzle geometry, and controlling the timing and rate of injection; and strategies to reduce lube oil consumption.

12 In this type of programme, engine manufacturers would likely begin by supplying emissions upgrade kits for the engines that are most similar to their engines certified to the existing regulation 13 standards and/or those that can easily accept those control technologies. Depending on the engine manufacturer, these may have original built dates as early as 1980 or as late as 1990. Engine manufacturers would also likely develop emissions upgrade kits for those engine models that had large sales in the past, enabling them to recover the costs of development

over a larger number of engines. In essence, the programme would be driven by the market in terms of the development of systems. System (kit) availability would track the relative share of models to the total population of specific engine designs, as manufacturers make kits for the most popular engine models first.

13 To ensure the expected emission reductions, emissions upgrade kits would be required to be certified as meeting the existing regulation 13 standards. As noted in BLG 11/5/15, certification should be as streamlined as possible and allow:

.1 Simplified certification for an emissions upgrade kit for any engine for which a parent engine of the family has already received certification to the exiting IMO NO_x limit, provided the engines employ the same emission control hardware and calibration;

.2 Use of portable emission measurement equipment, if available, for certifying emissions upgrade systems, with appropriate consideration for any necessary deviations in the engine test cycle;

.3 Broad use of the engine family concept for emissions upgrade systems, to minimize and where appropriate eliminate emissions testing requirements; and

.4 Development of alternatives to the NO_x Technical File to simplify the certification burdens for engines with emissions upgrade systems while ensuring that the modified engines and/or emission components may be surveyed and inspected.

14 At the second intersessional meeting of the BLG Working Group on Air Pollution (BLG-WGAP 2), several delegations suggested that it would also be appropriate to consider ways to reduce the number of separate certifications an emission upgrade kit would need to have to be accepted by all Administrations. The concern raised was that the costs of requiring certification by each Administration could overwhelm the emission benefits of this programme. Therefore, methods should be considered to reduce these costs, perhaps by allowing that an emission upgrade system would be considered to be available if it has been certified by a specified subgroup of Administrations.

15 Because of the technologies involved, the cost of using an emission upgrade kit will be a small increase over the current cost of replacing the relevant engine components. At the same time, because the owner/operator would be required to use a certified emissions upgrade system if it is available, it may be appropriate to consider some constraints on the programme to discourage certification of emissions upgrade systems that are unreasonable, impractical, or excessively costly. Adoption of such constraints would reduce the need for special exemptions and policies that govern how exempted vessels would be treated by port states. One option would be to set a cost cap in terms of the cost per ton of NOx reduced over the expected life of the emissions upgrade system. Alternatively, it may be possible to use the monetized health and welfare benefits of NOx reductions in terms of ozone and secondary PM benefits, to create a cost cap. Another option would be to set limits on the technologies that can be used, such as prohibiting technologies that require vessel redesign or the use of aftertreatment. The cost or technology constraint would be considered at the time the emission upgrade kit is certified.

16 To maximize the benefits of an emissions upgrade system programme, certification of systems should be open to anyone who wishes to develop and certify an emission reduction kit, including original engine manufacturers, ship owners and operators, shipyards, and other third parties. To address any concerns about the potential for unintended adverse effects on engine performance durability or reliability that could occur if another entity (than the original engine

manufacturer) develops an emissions upgrade system for their engines, the programme should require that any person who wishes to certify an emissions upgrade system for an engine not produced by that person or entity be required to notify the original engine manufacturer and obtain their approval on the proposed system, to ensure that the use of the system does not affect the durability or reliability of the engine. Any comments or technical notes than the original engine should be included in the certification application, as well as a description of how those comments were addressed.

17 Finally, the emissions upgrade programme can easily apply to all engines on a vessel powered by an engine with a swept volume displacement of 30 liters or more. Including all engines on covered vessels will help ensure the maximum benefits of the programme. While including auxiliary engines in the programme will increase the number of engines covered, it is not expected to unduly complicate the programme since those engines will only be required to use an emissions upgrade system if one is available at the time of overhaul.

Action requested of the Sub-Committee

18 The Sub-Committee is invited to consider the information provided above and take action as appropriate.

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