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Airborne Toxic Control Measure for Stationary Compression-Ignition Engines – Staff Report: Initial Statement Of Reasons for Proposed Rulemaking (CARB Stationary Source Division Emissions Assessment Branch, September 2003)

The Euromot Position

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The European Association
of Internal Combustion
Engine Manufacturers
President:
Horst Dekena
General Secretary:
Dr Hartmut Mayer

Lyoner Strasse 18
60528 Frankfurt/Main

fon 0049 69 6603-1354
fax 0049 69 6603-2354
eMail euromot@vdma.org
web www.euromot.org

EUROMOT
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Euromot is the **European Association of Internal Combustion Engine Manufacturers**.

We represent the leading manufacturers of internal combustion engines used in a broad range of nonroad and marine applications (construction, mining and material handling equipment, trucks and buses, agricultural and forestry equipment, commercial marine and seagoing vessels, workboats and pleasure boats, rail traction, lawn/garden and recreational equipment, power generation).

Euromot has been working for many years with international regulatory bodies, eg European Union, the UN Economic Commission for Europe (UN-ECE), the UN International Maritime Organizations (IMO) and the Central Commission for the Navigation on the Rhine (CCNR). In addition, we are seeking an open and fair dialogue with national governments to provide reliable know-how on advanced internal combustion engine technologies in general and, in particular, on the feasibility of environmental as well as cost-effective product regulations. To achieve a pro-active engagement of all stakeholders in international harmonisation of regulations affecting engines and equipment, we coordinate our activities worldwide with trade associations of the non-road and marine industry sector.

For further information about our Association please refer to our Annual Report 2001 or pay us a virtual visit at **http://www.euromot.org** – your bookmark for engine power worldwide.

Introductory remark

California Air Resource Board is planning for implementation of emission standards for stationary diesel-fuelled compression ignition engines. Euromot members are providing technology for such engines and we welcome the emission regulatory process initiated. We believe it is a necessity for the diesel power industry to contribute to the efforts for a better environment.

However, emission standards should be realistic, giving the industry a chance to develop suitable cost-effective technology to comply. Unfortunately, in this respect, the proposed emission limits for bigger diesel-fuelled stationary compression ignition engine plants do not satisfy. This document is intended to draw your attention to and convey our concern about these issues.

Technical and Economic Concerns

1. General observations about Air Resource Board proposal

ARB is proposing an ATCM (Airborne Toxic Control Measure) that will limit the emissions from new and existing stationary diesel-fuelled compression ignition (CI) engines. Requirements are grouped into three general categories: use of cleanest diesel fuels possible, operational requirements and emission standards and record keeping, reporting and monitoring requirements. The proposed ATCM require specified classes of stationary engines to meet the off-road standard in title 13, California Code of Regulations (CCR) section 2423 for other pollutants that contribute to ground-level smog. **It is said that requirements can be met (in consideration of technical and economic feasibility) by use of the cleanest fuels possible, limit unnecessary operation of the engines and by use of secondary emission control equipment (on page 7) such as diesel particulate filters and diesel oxidation catalysts**. It is said on page 11: “Overall, most affected business will be able to absorb the costs of the proposed regulation with no significant adverse impacts on their profitability”.

For diesel fuel sold in California (beginning mid-2006) for stationary source engines, on-road and off-road vehicles the sulphur content limit will be reduced from 500 parts per million by volume (ppm-v) to 15 ppm-v. (page 96). In stationary sources greater than 50 hp only clean fuels such as CARB Diesel Fuel are allowed as of January 1, 2005 (page A-12).

ARB has conducted a stationary diesel fuelled prime engine survey: engines found in the survey ranged from under 50 to over 2000 horsepower (about 37 … 1490 kW). Average horsepower for all of the prime engines was 556 (about 415 kW) (page 45). Many of the engines found in the survey had advanced particulate controls such as diesel particulate filters (DPFs) and diesel oxidation catalysts (DOCs) (page 47). Average number of annual running hours of the prime engines in the survey was 953 (page C-8).

The proposed ATCM identifies several specific engine applications that are **exempt** from all or part of the fuel use, operating requirements, emission standards, or record keeping and reporting requirements (page 57). Exemptions are provided to address specific situations due to high costs, technical issues, etc. associated with controlling diesel PM emissions. In table V-1 on page 58 are among others: marine vessel engines, stationary diesel-fuelled engines on outer continental shelf platforms, etc. belonging to the exempted category.

Diesel PM measurement methods approved are (page 89):

- CARB Method 5 (front half, and in accordance with ISO 8178-4 cycles)
- ISO 8178-1:1996(E); ISO 8178-2:1996(E); and ISO 8178-4: 1996(E)

NOx, CO, HC and NMHC emission testing shall also be done in accordance with ISO 8178-4 cycles).

In the PM air modelling (page E-2) West Los Angeles meteorological data which tend to provide higher estimates of risk than most other meteorological data sets have been used. West Los Angeles weather data give results with less dispersion of pollutants than many other sites. On page E-4 it is said: "…the **smaller horsepower engine (200 hp) typically demonstrated higher near source risk for a given number of operation than the larger engine**s. In addition, the potential cancer risk reached the point of maximum impact more rapidly for the 200 hp engine than the larger engines. The larger engines had the point of maximum impact further from engine due to the greater plume dispersion that occurs with large horsepower engines".

On page 3 it is said that stationary engines account for about four percent of the total diesel PM emissions in California.

2. Drawbacks of the proposal

In this section the issues are listed, why the proposed ATCM is neither economic nor technically feasible for larger stationary liquid fuel fired compression ignition engines:

- Engines in the survey made by CARB are very small, not representing the whole engine spectrum used in liquid-fired stationary power plants.
- Stationary engine driven power plants are operated in other modes than off-road engines. This has an impact on particulate emissions.
- Fuels used in bigger engines might greatly vary and the technique listed in the CARB survey are not technically available for bigger stationary engine driven power plants.
- Stationary power plants (boilers, gas turbines, engines) are usually run at high steady load conditions and different measurement methods such as US EPA Method 5B are often used compared to those for off-road engines. For instance according to European Union (EU) Directive 2001/80/EC for large combustion plants, gas turbines have to fulfil stipulated emission limits only above 70 % load.

Therefore, in Europe and Japan stationary engine driven power plants and off-road engines have their own different specific emission limits.

2.1 Stationary compression-ignition engine – Use and operation

In the 1960s and 1970s engine-driven power plants were mostly used for running short-time applications such as emergency and peaking production and small scale power production, but today reciprocating engines are widely used, especially for continuous running power generation applications in many countries world wide. Decentralized simultaneous heat and power (CHP) production plants with low specific carbon dioxide (CO_2) emissions are increasingly popular in many countries today due to the requirements of the Kyoto Protocol. In most bigger engine driven power plants the medium speed diesel engine type is used. Liquid fired medium speed diesel engines with a fuel input of up to 50 MW_{th} (about 22 MWe output) and gas/diesel engines ("high pressure" and "low pressure (dual fuel) engine types) with a fuel input of up to 40 MW_{th} (about 18 MWe output) are available on the market. Diesel engines are fuel flexible and can use fuels such as diesel oil, heavy fuel oil, gas, crude oil, biofuels and Orimulsion. Nevertheless, in western countries, few such big plants exist in interconnected systems for power generation on liquid fuels. On the other hand bigger liquid fired base load engine-driven plants with an output up to 200 MWe are common in many Asian and Central American countries, due to the existing fuel infrastructure.

2.2 Particulate emission – characteristics of stationary engines

All prime movers such as boilers, gas turbines and engines emit small particulate when burning oil or gas. Also the different running profile (steady state high loads, part loads, transient conditions); is largely affecting the particulate emission. At part loads and transient conditions (with less efficient fuel combustion) the particulate emission is substantially higher than at steady state full load.

Stationary power plants are usually operated in a steady state high load mode (boilers, gas turbines and engine driven plants), thus the situation of particulate emissions is different from that of automotive engines operating at transient conditions. The technique of bigger stationary engines used in power plants differ from that of smaller engines used in trucks, off-road applications, etc. A big stationary engine has higher combustion temperatures and pressures in the cylinders compared to the truck engines. High temperatures and pressures improve the combustion quality and consequently lower the particulate emissions.

Conclusion

Emissions from a stationary power plant versus automotive engines are not comparable due to different test parameters (test cycle, test fuel, measurement procedures). Also the composition of PM differs due to the different fuel used.

2.3 Particulate traps

This technology is developed for **small** diesel engines (exhaust gas flow typically up to 3600 Nm^3/h), i.e. automotive diesel engines, off-road applications, small utility and electric power generators which are burning an ultra fine diesel oil (fuel to be virtually sulphur free, typically 0.001 … 0.005 wt-% S). Otherwise deactivation of the catalyst, clogging and/or sulphate formation might occur. An oxidation catalyst catalyzes a significant portion of the soluble organic fraction and only a small portion of the soot of the particulate.

Experiences show that well over 90% of the solid particulate emitted by small diesel engines consist of elementary carbon/organic fraction, i.e. organic fraction is largely burned away during the regeneration phase of the filter. Bigger stationary engines are usually operating on fuels containing various amounts of ash and sulphur. The soluble organic fraction of particulates originating from heavy fuel oil combustion is low compared to those from burning clean diesel oils. The biggest contributor to the particulate flow of bigger engines in heavy fuel oil mode is the ash content of both the fuel and the burnt lube oil: ash can not be burnt.

Conclusion

Particulate traps as under development for mobile sources will technically not be suitable for bigger engines.

2.4 Particulate reduction techniques for stationary engine driven plants

In bigger liquid fuelled stationary engine driven power plants similar secondary particulate abatement methods are used as in the boiler power plants, e.g. electrostatic precipitators (ESP), and bag filters. Secondary particulate abatement methods are new in context with bigger stationary engine driven power plants. For status of secondary particulate abatement technology see pages 4-7 on the Euromot website

www.euromot.org/download/news/positions/stationary/Stationary_TA_Luft_2002Oct02.pdf

2.5 Legislatory aspects

In Europe and Japan, stationary engine-driven power plant emissions are measured at high steady loads with similar methods as for the rest of the power plant industry (boilers, etc.). In these legislations the size and the location of the power plant often affect the emission limits (bigger power plants in urban areas are strictly regulated and smaller plants in rural areas have leaner limits). Examples of stationary engine driven power plant legislations are e.g. in UK:

- "The Environmental Protection Act 1990, part I (1995 Revision), (PG1/5(95): Secretary of State´s Guidance-Compression Ignition Engines, 20 – 50 MW net rated Thermal Input"

- "Achievable Releases to Air; HM Inspectorate of Pollution; Processes Subject to Integrated Pollution Control; Chief Inspector´s Guidance Note, Series 2 (S2) 1.03 Combustion Processes: Compression Ignition Engines 50 MWth and Over (September 1995)"

Off-road (non-road) engines have own emission limits in Europe and Japan. This approach is logical due to the different running profile, fuels and engine techniques used (small high-speed engines versus big medium/low speed engines) compared to stationary engine driven power plants.

The US EPA has worked out the "Tier 1 Emission Standards for Marine Engines, 40 CFR Part 9 and 94". In the proposed ATCM, smaller engines up to 2.5 liters/cylinder (cylinders displacement) have similar NO_x limits according to the Tier 2 non-road standard and the category for bigger engines the near-term Tier 1. The near-term Tier 1 limits (to be fulfilled from 1 January 2004 a) are similar to the IMO (International Maritime Organisation) NO_x levels. For instance, category 3 engines (size 3000 to 100000 hp equivalent to 2500 to 70000 kW) manufactured after 1 January 2004 have to fulfil the IMO NO_x rule and by 27 April 2007 US EPA will work out new stricter standards for this engine category 1[*)].

The bigger medium speed engine types used in stationary engine driven power plants are usually the category 3 (> 3025 liters/cylinder) engine category.

In the Californian ATCM proposal the power category has been set > 50 hp, no upper power limit is given. Emission limits are given in table 1 below:

Table 1. Standards for New Stationary Prime Diesel-Fuelled CI Engines > 50 bhp (may be locally subject to additional emission limitations)

Diesel PM Standards [g/bhp-hr]	HC, NOx, NMHC + NOx and CO Standards [g/bhp-hr]
Meet more stringent of < 0.01 or Off-road CI Engine Certification Standard for an off-road engine of the same horsepower rating	Off-Road CI Engine Certification Standard for an off-road engine of the same model year and horsepower rating, or Tier 1 standard for an off-road engine of the same horsepower rating.

The particulate emission limit of 0.01 g/bhp-hr equals to < 2 mg/Nm^3 (15 % O_2). For bigger diesel fuelled engines no secondary emission abatement technique exists today to achieve this very strict emission limit.

EMA arrives at the same technical judgement and consequently, Euromot supports the relevant EMA submission.

*) US EPA Regulatory Announcement "Emission Standards Adopted for New Marine Diesel Engines"; EPA420-F-03-001 January 2003

Conclusion and Recommendation

With reference to above we propose the following:

- Stationary diesel fuelled engines with a rated output from 50 (about 37 kW) horse power up to 560 kW output should be subject to the proposed emission rules. For this power range, secondary abatement techniques for particulates exist as mentioned in the study and, depending on the application, might be applied. These engines are also widely used in the off-road industry.

- Larger (above 560kW) stationary diesel fuelled engines should be exempted from the proposed rules and separate rules need to be developed (see e.g. US EPA marine sector approach above). Main reasons are that there exists no commercially available secondary particulate abatement technology in order to reach the proposed limits at the moment and that the limits proposed therefore do not represent BAT of this engine category.

- Euromot members are prepared to actively participate in the proposed new legislative process.