Euromot

Canada – Ministry of Environment, Ontario

Concerns and recommendations to the regulation proposal "Emission limits for Internal Combustion Engines used for Non-Emergency Power Generation" (February, 2008)

Position Paper – February 2008

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EUROMOT
Engine-in-Society

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 (UNECE), 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 2003 or pay us a virtual visit at **http://www.euromot.org** – your bookmark for engine power worldwide.

Summary of main concerns and recommendations:

- Definition of engines´/gensets´ power range in the proposal is not suffifient.
  - **Recommendation:** As there is a worldwide emission legislation harmonization process going on especially for smaller diesel high speed engines the power range of the engines that shall fulfil the proposed emission limit values have to defined more exact. A definition if also bigger stationary engines (>>560 kW) shall be affected by the Ontario Proposal is necessary.
- No distinction of different engine types.
  - **Recommendation:** Given engine type specific characteristics should be considered and expressed by different emission limit values.
- No distinction of different fuel types.
  - **Recommendation:** Different fuel types are used in different engine types. As there is no exact definition if also bigger stationary engines will be affected by the Ontario emission proposal for example cheaper fuels of Canada's own extraction like oil from tar sands cannot be used with the proposed limits. Therefore different fuels for different engine applications should be expressed by different emission limit values in the Ontario proposal.
- The Proposed 2007-2010 limits for smaller diesel engines (with 130-560 kW) are not state-of-the-art for nonroad high speed diesel engines (that are often used in gensets) due to harmonized emission legislation between US and EU. Those engines are currently not available on the off-highway market.
  - **Recommendation:** align the introduction time of different emission limit values for smaller diesel high speed engines with EPA or EU limits (see Annex 2) in order to avoid double and unnecessary design work for the engine industry
- **Further recommendations:**
  - **Different engine power categories should be defined. Bigger stationary diesel engines (>>560 kW) should be regulated aligned with the US NSPS CI regulation (see /2/) under the condition that the Ontario proposal includes those big stationary diesel engines.**
  - **For lean-burn (SG, DF) stationary engine units we recommend the US SI NSPS ruling (see /3/).**

1 Introduction

The Ministry of Environment in Ontario has published on 31 January 2008 an emission ruling proposal “Emission Limits for Internal Combustion Engines used for Non-Emergency Power Generation” (EBR Registry Number 010-2463.

This Position Paper includes the general concerns and recommendations of the Euromot Working Group Stationary on the regulation proposal mention above. Euromot would highly appreciate if the following statemens would be taken into account.

Background for the regulation proposal is the grown recent interest to use emergency standby generators to produce electricity in non-emergency situations in order to avoid power-black-outs during periods with high power demand. The proposal affects “generator sets” (internal combustion engines) using fuels such as diesel, bio-diesel, natural gas or bi-fuel (natural gas/diesel) for non-emergency electricity generation. The proposed emission limits are said to ensure the protection of air quality and to be consistent with the direction to replace electricity generation from coal with cleaner and renewable sources. Additionally it is stated that the proposal will assure that emissions from generator sets are similar to those from natural gas combustion turbines.

The proposed emission limits for non-emergency use engines are said to be based on US EPA Tier 3 or Tier 4 (dependent on implementation year) for non-road and stationary emissions with exception of NOx (which is taken from the Ontarian Ministry of Environment (MOE) Guideline for peaking combustion turbine operating on natural gas). The fuel oil is required to be Ultra Low Sulfur Diesel (ULSD) with a maximum sulphur content of 15 parts per million and where other fuels are used, maximum allowable equivalent sulphur emission levels are required. The emission limits are said to refer to 130 – 560 kW generator sets, as these gensets are typically used in Ontario.

However, the proposal leaves it open how the emission limits should be for bigger units.

The engine industry welcomes the above emission standard implementation process and we think it is necessary for the whole power industry to contribute to the efforts for a better future and environment. However, a legislation should be realistic, giving the industry a chance to comply.

Unfortunately in this respect the proposed emission limits in the proposal does not cover:

- different engine types
- emission impacts of different fuels
- information about emission limit values for stationary engines >560 kW

Some of the emission limits are far beyond BAT (Best Available Technique) used widely in emission ruling around the world. BAT is defined as using established techniques (practical, suitable) which are the most effective in achieving a high level of environmental protection as a whole and which can be implemented in the relevant sector under economically and technically viable conditions taking into account the costs and advantages. Some of the proposed limits are even beyond the **L**owest **A**chievable **E**mission **R**ate (LAER), limits are not possible to fulfil with a proven technology.

The proposed emission limits should in practise make use of some fuels prohibitive in Ontario e.g. emulsified fuel oils (even with moderate sulphur contents) due to the unrealistic sulphur dioxide reduction demand and use of lean burn gas engine types due to the low future NMHC limit which are beyond BAT.

Our Position Paper includes some counterproposals in order to get a cost-effective ruling taking both the environment, technical development status and cost aspects into account.

2 Different Engine Types

The Ontario diesel engine emission proposal seems to focus only on the non-road derived high speed diesel engine type applied for stationary applications. The big diesel engines (big single stationary engines can have up to 80 MW) used in stationary plant applications are however different, they are marine derived.

Furthermore the emission limit proposal seems not to consider the gas engine types at all. In below text some common stationary engine types are shortly described, for more information, please see document /1/ page 4.

Some decades ago engine driven power plants were mostly used for short time running applications like emergency & peaking and small scale power production, but today, however reciprocating engines are widely popular also for continuous power production. The market for reciprocating engines was during 2006 – 2007 worldwide in total about 24700 MW (for units bigger than 1 MWoutput) /18/. Large base load engine driven plants with an output up to 150 MWe or more, grid stabilization and peaking plants up to 120 MWe, oil and gas applications (pumping, compression in pipelines) and dezentralized smaller industrial self-generation combined heat and power (CHP) type applications & plants are common today.

The advantages of the reciprocating engine for this kind of applications are numerous as: high thermal efficiency (low fuel consumption and thus lower specific CO2 emissions per produced power, see Annex 1), optimal matching at different load demands (short start-up/shut down times, fast load response, good part load efficiency), flexible fuel choice, easy maintenance and a robust design.

Different types of reciprocating engines exist on the market. They are operating according to various principles and the fuel choice is flexible. The most common engine types and fuel alternatives are:

- Diesel engines operating on diesel oil, heavy fuel oil, crude oil, natural gas, associated gases, biofuels (gas and oils), emulsified fuels, etc.
- Spark-ignited (SG) Otto-type engines operating on gas fuels
- Dual fuel (DF) low gas pressure engines which are fuel versatile, the primary fuel is natural gas and the back-up fuel is a liquid fuel such as diesel oil, bio-oil, etc. The dual fuel engine can operate at full load in both fuel modes. The engine is working according to the otto principle in gas mode and in liquid fuel operation according to the diesel principle.

3 International technique specific emission regulations

In the Ontario proposal is stated that the proposal will assure that emissions from generator sets are similar to those from natural gas combustion turbines. According to the proposal same emission limits should also be used for different fuels such as diesel, bio-diesel, natural gas, etc. This is not according the widely used international principle of technique specific own emission limits for the different prime movers such as boilers, gas turbines and stationary reciprocating engines (see also /1/). Usually own technique specific emission limits are also fuel dependent for the different prime movers. This is the case around the world e.g. in USA (/2/, /3/), Japan /4/, France /5/, UK /6/, Finland /7/, Italy /8/, India /9/, EU BREF /10/, IFC/WB /11, 12/, Portugal /13/, etc.

Below are some examples of technique specific fuel dependent emission legislation shown in following order;

- US EPA NSPS (natural gas or landill/digester gas)
- Finland (liquid, natural gas)

- Japan (liquid, natural gas)
- EU BREF (Guideline).

US EPA published on 18 January 2008 a federal emission regulation for Spark Ignited (SI) engines. Please note that a SI engine is either a gasoline-fuelled engine; or any other type of engine, with a spark-plug (or other sparking device) and with operating characteristics significantly similar to the theoretical Otto combustion cycle.

Dual-fuel engines in which a liquid fuel (typically diesel fuel) is used for compression ignition and gaseous fuel (typically natural gas) is used as primary fuel at an annual average ratio of less than 2 parts diesel fuel to 100 parts total fuel on an energy equivalent basis are considered SI. The US SI NSPS ruling is based on BDT (**B**est **D**emonstrated **T**echnology) considering costs and environmental impacts and energy requirements. EPA considers BDT for SI lean burn engines as following: it is the low emitting level achieved by design and on-engine controls and optimization techniques employed in new stationary lean-burn engines.

Thus BDT is the level achieved by new lean burn engines.

The following tables show different international stationary engine regulations.

Table 1: US EPA SI NSPS /3/ non-emergency natural gas/LPG lean-burn engines HP > 500. Units are g/HP-hr and in brackets ppmvd at 15 vol-% O2, plant to comply with either or of the limits. Engine sizes: 500 > HP < 1350 has later implementation dates (see standard /3/).

	NOx	CO	VOC*
From July 1 2007	2.0 (160)	4.0 (540)	1.0 (86)
From July 1 2010	1.0 (82)	2.0 (270)	0.7 (60)

* VOC is excluding methane, ethane and formaldehyde, see standard for more information. VOC ppmvd expressed as propane.

Biogases might contain components such as siloxanes, chlorinated compounds, hydrogen sulphide, etc. These components are known to foul systems, combustion chambers and post-combustion catalysts. Therefore these fuels have own emissions limits, see below.

Table 2: US EPA SI NSPS /3/ landfill/digester gas lean burn engines HP > 500. Units are g/HP-hr and in brackets ppmvd at 15 vol-% O2, plant to comply with either or of the limits. Engine sizes: 500 > HP < 1350 has later implementation dates (see standard).

	NOx	CO	VOC*
From July 1 2007	3.0 (220)	5.0 (610)	1.0 (80)
From July 1 2010	2.0 (150)	5.0 (610)	1.0 (80)

* VOC is excluding methane, ethane and formaldehyde, see standard for more information. VOC ppmvd expressed as propane.

In Finland all plants have to apply the BAT approach. Below in table 3 are given the Finnish BAT Guideline for stationary reciprocating engine plants 5 – 50 MWth.

Table 3: Emission levels allowed by BAT for new diesel and gas engines. Emission unit mg/Nm3 at 15 vol-% O2. Nm3 given at 0 degree C and 101.3 kPa.

Engine type	NOx	SO_2**	Particulate
Oil diesel engine	1600/750*	600	60
Gas Diesel engine (GD)	1600/750*	-	-
Spark Ignitioon (SG)	175	-	-
Dual Fuel (DF) (gas mode)	175	-	-

*Normal area/Special area. In special areas such as cities a secondary method such as SCR might be needed. In normal areas engine primary abatement methods are usually enough such as water emulsion, Miller concept, etc.
** SO2-limit is related to EU Directive 1999/32/EC, according to which max. 1 wt-% S is allowed in Heavy Fuel Oil (HFO).

The Japanese "Nationwide General limits" are applied in rural areas outside the big cities. In Japan the cost-effective environmental quality need driven approach is used and thus leaner limits are allowed outside cities and stricter in cities, e.g. the NOx limit for a gas engine in Yokohama is equivalent to about 85 ppm-v (15 % O2)

Table 4: "Nationwide General" limits in Japan for diesel and gas engines. Emissions in table are normated to 15 vol-% O2 conditions. Nm3 is defined at 273 K, 101.3 kPa.

	NOx	Particles (as dry dust)****
Diesel engine (> 50 l/h fuel oil)	About 710 ppm-v* About 900 ppm-v **	75 mg/Nm^3 (all areas) 60 mg/Nm^3 (special areas)
Gas engine (> 35 l/h at fuel oil equivalent)	About 170 ppm-v ***	20 mg/Nm^3 (all areas) 11 mg/Nm^3 (special areas)

* Cylinder diameter < 400 mm
** Cylinder diameter > 400 mm
*** After 01.04 1994
**** Japanese particulate measurement standard JIS Z8808 is principally similar to the ISO 9096 or German VDI 2066 Blatt 1 particulate measurement standards.

The allowed SOx level is regulated by a total quantity approach (max SO2 quantity per time unit (Nm^3/h)).

European Union has published **B**est **A**vailable **T**echnique (BAT) documents for different sectors. In 2006 the BREF for Large Combustion Plant installations /10/ was approved. According to the European Directive 96/61/EC **I**ntegrated **P**ollution and **P**revention **C**ontrol (IPPC) big combustion plants >50 MWth are to apply BAT techniques. In order to help the authorities in their work when granting operation licenses EU has worked out EU BREF documents for different sectors. The BREF emission spans are for guidance only (not mandatory)! Below is presented first the liquid fired engine plant and then for the gas fired plant.

3.1 Liquid fired engines

Particulate emission:

According to the BREF document secondary cleaning devices for the particulate reduction is under development for larger diesel engines and thus use of low ash and sulphur fuel can be considered as BAT.

Table 5A: EU Large Combustion Plant (LCP) BREF particulate Guideline values for the liquid fired diesel engine. Emissions in table are mg/Nm3 at 15 vol-% O2 conditions. Nm3 is defined at 273 K, 101.3 kPa.

Engine type	Dry Dust*	Monitoring	Comments
Diesel engine	< 30 (Light fuel oil) < 50 (Heavy fuel oil)	Discontinuous once every 6 months	Steady state 85 to 100 % load of engine
Note !	A member state proposed for HFO limit value of 100 due to fuel composition		

Note: Dust emissions from engines up to 1.3 MW fuel input can be reduced down to values of 20 mg/Nm3 (15 % O2).
* Measurement method ISO 9096 or principally similar

SO2 emission:

According to the BREF document:
At the moment only a few diesel power plants exist with FGD systems. Therefore use of low sulphur fuel oil or natural gas, whenever commercially available is regarded as the first choice of BAT. Secondly, if low sulphur fuel oil or gas are not available the use

of a secondary FGD (Flue gas desulphurization) system is considered as BAT for reducing emissions of SO2.
Please note: According to EU Directive 1999/32/EC /16/ for combustion plants (without use of flue gas desulphurization (FGD)) not falling under the Large Combustion Plant Directive (LCPD) (for big boiler and gas turbine plants) the maximum sulphur content of heavy fuel oil is since January 1 2003 1.00 wt-%. For light fuel oil the limit is 0.2 wt-% S since July 2000 and after January 1 2008 it drops to 0.1 wt-% S. In some member states stricter limits might apply.

NOx-emissions:
According to the BREF document:
Application of primary methods and secondary measures in particular application of SCR is regarded as BAT to reduce NOx emissions from liquid-fuel-fired engine plants. SCR is an applied technique for diesel engines, but can not be seen as BAT for engines with frequent load variation, including frequent start up and shut down periods due to technical constraints. A SCR unit would not function effectively when operating conditions and the consequent catalyst temperature are fluctuating frequently outside the necessary effective temperature window. As a result, SCR is part of BAT, but no specific emission levels are associated with BAT in a general case.
Please note that according to the LCP BREF for boiler plants <100 MWth the use of different low NOx primary measures is considered to be BAT.

CO and hydrocarbon emissions:
According to the BREF document:
For the minimization of air emissions, good maintenance of the engine is regarded as BAT. Oxidation catalysts are not recommended in context with liquid fuels containing sulphur.

3.2 Gas fired engines
According to the BREF document:
For gas-fired stationary engine plants, the lean-burn approach is BAT analogous to the dry low NOx technique used in gas turbines. This is an inbuilt method and no extra reagents or water need to be supplied to the site for NOx reduction. Because gas engines are sometimes equipped with an SCR these techniques can also be considered as part of BAT. To reduce CO emissions, the application of oxidation catalysts is BAT. In case of burning other gaseous fuels such as biogas and landfill gases, the CO emissions can be higher due to the specific fuel used. The NMVOC (Non Methane Volatile Organic Compounds) emissions from spark ignited lean burn gas (SG) engines and dual fuel (DF) engines in gas mode depend on the composition of natural gas. NMVOC secondary emission reduction techniques might in some cases be needed and an oxidation catalyst for simultaneous CO and NMVOC reduction can be applied. But please note that not for all NMHC-components catalysts are available or suitable. CO values kept below 100 mg/Nm3 (15 % O2) and formaldehyde values below 23 mg/Nm3 (15 % O2) are considered BAT for a gas-fired engine equipped with an oxidation catalyst.

In below table 5B NOx and CO BAT levels are shown for the lean-burn gas-fired engine.

Table 5B: BAT levels for NOx and CO emissions for lean-burn engine combustion plants. Emissions in table are mg/Nm3 at 15 vol-% O2 conditions. Nm3 is defined at 273 K, 101.3 kPa. (lower values with treatment technology)

Engine type	NOx	CO	BAT options
New lean burn gas engines	20 – 190*	30 – 380*	Lean burn concept and oxidation catalyst for CO **or** SCR + CO catalyst

* Split views in document table considered !

3.3 Comparison

A conversion of the proposed Ontario non-emergency emission limits is given below:

- Ontario NOx limit values:
- 1.0 kg/MWh (2007)/0.4 kg/kWh (2010) is equal to about (depends on engine efficiency): 140 mg/Nm3 (15 % O2) / 55 mg/Nm3 (15 % O2)

- SO2: 15 ppm S is equil to about 0.9 mg/Nm3 (15 % O2) SO2. Furthermore a clear definition of sulphur is needed (in the fuel or in the exhaust gases?).

- NMHC: 1.3 kg/MWh (2007)/0.19 kg/MWh equal to about (depends on engine efficiency)(as CH4) 170 mg/Nm3 (15 % O2) / 25 mg/Nm3 (15 % O2)

- Particulate: 0.2 kg/MWh / 0.02 kg/MWh equal to about (depends on engine efficiency): 26 mg/Nm3 (15 % O2) / 2.7 mg/Nm3 (15 % O2)

When comparing these to the EU BREF guidance values following can be seen:

- SO2 about limit **about 660 times stricter** (comparison to 1 wt-% HFO). An about 99.9 % efficient FGD should be applied in order to fulfil the rule with a 1 % S HFO. This is technically not possible and beyond BAT and LAER.

- Paticulate (assumed ISO 9096 measurement standard used): 2-19 times stricter. (BEYOND BAT AND LAER). No technique exists in order to fulfil the latter value (can not even be guaranteed with natural gas).

- NMHC: Much stricter than the EU BREF guideline (where only formaldehyde component was mentioned of HC). The future value will be very difficult to fulfil with a gas engine. The NMHC emissions from spark ignited lean burn gas (SG) engines and dual fuel (DF) engines in gas mode depend also on the composition of natural gas. Catalysts for all NMHC-components are not available or suitable. This has to be considered.

Conclusion:

Above has been shown that proposed limits for non-emergency stationary engine applications in the Ontarian ruling are beyond BAT and even LAER for some emission components. We propose adoption of a cost-effective environmental quality need driven approach as used in e.g. Japan and Finland and in the US SI NSPS. In cases of a sudden interruption in the supply of gas and in order to avoid the need of the plant to be equipped with a excessive waste gas purification facility for this exceptional case a derogation from the obligation to comply with the emission limit values should be granted for a period e.g. 10 days in general except for longer periods where there is an overriding need to maintain energy supplies (as is the case in the EU LCP 2001/80/EC Directive for big boiler/gas turbine planst). The proposed emission limits are exceeding even the EU BREF BAT Guidelines for big combustion sources. Today the CO2 emissions and thus efficient fuel usage is in focus due to the Kyoto Protocol. Therefore introduction of efficiency bonuses for the emissions in order to enhance fuel efficiency and bio-fuel usage should be promoted, on page 8 in /17/ a bonus approach is proposed.

For smaller high speed engines up to 560 kW unit size designed for ULSD fuel the US CI NSPS /2/ is recommended. For bigger engines (> 30 liters cylinder displacement volume the US CI NSPS is beyond BAT, see industry feedback /14/.

4 Monitoring

Periodic source testing is in the Ontario proposal said to be conducted with measurement method ISO 8178 C1, 8-mode steady-state test cycle.

The ISO 8178 C1 test cycle implies testing at rated speed, intermediate speed and low-idle speed at torques varying from 100 % to 0 %. These testing conditions are used for small high-speed diesel engines used in small gensets but they are far from the normal usage of bigger stationary engine plants, e.g. in US a gas engine plant consisting of a lean burn gas engines is to be tested at steady load “within 10 percent of 100 percent peak (or the highest achievable load) /3/.

In CIMAC document /14/ annex 2 are “CIMAC recommended emission measurement methods and standards for land based diesel power plants” listed and in appendix 3 CIMAC recommended emission measurement methods and standards for gas engines – Marine engines and Land based Power Plants” given. From these can be seen that in case of bigger stationary reciprocating engines the used measurement standards are the same as in the rest of the power plant industry (used for boilers and gas turbines) such as ISO 9096, US EPA 17, etc.

In above chapter 3 has been shown that in EU and USA measurements are performed at steady state loads at 85-100 % MCR of the bigger reciprocating engines. ISO 8178 test cycles are used mainly on small high speed non-road type engines.

Conclusion: For the bigger reciprocating engine plants similar measurement standards as in the rest of the power industry should be used. Emission measurements should be conducted at high steady state loads (85-100% MCR of the engine) annually or biannually.

5. Conclusions and recommendations

The fundament of the Ontario proposal seems to be to impose similar emission limits on all prime movers and all fuels gaseous or liquid. Modern emission legislation worldwide today is built on technique specific emission limits depending also on the used fuel. This approach is totally missing in the Ontarian proposal. By applying the same low NOx-limit for all prime movers and fuels the consequence will be that certain fuels can not be used and the optimum technique for a certain case will be “locked out”. All techniques have pros and cons.

In above text has been shown that the proposed emission limits for non-emergency bigger (> 0.8 MWe units) stationary engines are beyond BAT AND LAER. Important to note is the strict LAER approach used in US in degraded air-sheds.

Also the proposed limits for the independent electricity system operator emergency load reduction program is very strict. The particulate and especially SO2 limits are beyond BAT when comparing to the EU BREF document. The NOx emission can be fulfilled only by applying an efficient SCR on a diesel engine. This is not a cost-effective approach, SCR has high installation and operating costs.

The proposal is mainly based on US EPA NSPS ruling for non-road engines but with a stricter NOx-limit (taken from a gas turbine standard). In US stationary engines are regulated in the CI NSPS ruling /2/ which contains different emission values (depending on engine sizes) than the proposed ones. The proposal seems to primarily focus on unit sizes 130 – 560 kW but it is unclear how bigger units will be regulated.

For lean-burn (SG, DF) stationary engine units we recommend the US SI NSPS ruling. In cases of a sudden interruption in the supply of gas and in order to avoid the need of the plant to be equipped with an excessive waste gas purification facility for this exceptional case a derogation from the obligation to comply with the emission limit values should be granted for a period e.g. 10 days in general except for longer periods

where there is an overriding need to maintain energy supplies (as is the case in the EU LCP 2001/80/EC Directive for big boiler/gas turbine planst). Biogas fuel fired plants should have own emission limits in order to promote the use of sustainable fuels. For smaller diesel plants up to 50 MWth the Japanese or Finnish approach is recommended and for bigger ones the EU BREF Guideline with usage of the IPPC principle. Energy bonuses should in general be granted for efficient fuel (high efficiencies) and bio-fuel usage in order to decrease CO2 emissions.

6. Sources

/1/ Position of the CIMAC WG 5 exhaust Emissions Control on "Prime Mover technique Specific Emission Limits Need Stationary Reciprocating Engine Plant" at http://www.cimac.com/workinggroups/Index1-working-groups-exhaustemission.htm

/2/ 40 CFR Parts 60, 85 et al. Standards of Performance for Stationary Compression Ignition Internal Combustion Engines; Final Rule; US EPA July 11, 2006 at http://www.epa.gov/EPA-AIR/2008/January/Day-18/a25394.pdf

/3/ 40 CFR parts 60, 63, 85 et al. Standards of Performance for Stationary Spark Ignition Internal Combustion Engines and National Emission Standards for Hazardous Air Pollutants for Reciprocating Internal Combustion Engines; Final rule; US EPA January 18 2008, see http://www.epa.gov/EPA-AIR/2008/January/Day-18/a25394.pdf

/4/ "Nationwide general limits"

/5/ France: "Arrete Ministeriel 2910, 1999"

/6/ The Environmental Protection Act 1990, part 1 (1995 Revision) Engine 20 to 50 MWth)

/7/ Finland: "Best Available Techniques (BAT) in Small 5 – 50 MW Combustion Plants in Finland", at http://www.ymparisto.fi/download.asp?contentid=3708 , see page 102 emission limits in English.

/8/ Decreto Ministeriele del 12/07/1990

/9/ "Emission Standards for Diesel Engines (Engine Rating more than 0.8 MW (800 kW) for Power Plant, Generator Set Applications and other Requirements", Environment (Protection) third Amendment Rules 2002; Ministry of Environment and forests New Delhi the 9th July 2002. See internet: http://www.envfor.nic.in/legis/eia/epr_amd_489.html

/10/ Integrated Pollution Prevention and Control (IPPC) Reference Documents on Best Available Techniques for Large Combustion Plants, available at http://www.jrc.es/pub/english.cgi/d1254325/19%20Reference%20Document%20on%20Best%20Available%20Techniques%20for%20Large%20Combustion%20Plants%20%28adopted%20July%202006%29%20-%2022%20Mb

/11/ IFC/ World Bank General EHS Guidelines at http://www.ifc.org/ifcext/enviro.nsf/AttachmentsByTitle/gui_EHSGuidelines2007_GeneralEHS/$FILE/Final+-+General+EHS+Guidelines.pdf ; dated April 30, 2007

/12/ Bank Guidelines ("Thermal Power – Guidelines for New Plants 1998" at http://www.ifc.org/ifcext/enviro.nsf/AttachmentsByTitle/gui_thermnew_WB/$FILE/thermnew_PPAH.pdf

/13/ Governmental resolution no 1058/94 and resolution 286/93

/14/ CIMAC Recommendation – standards and Methods for sampling and Analysing emission Components in Non-Automotive Diesel and gas Engine Exhaust Gases – Marine and land baserd Power Plant Sources"; CIMAC Working Group on Exhaust Emissions February 2005. Document can be ordered from http://www.cimac.com/services/Index1-techpaperdatabase.htm

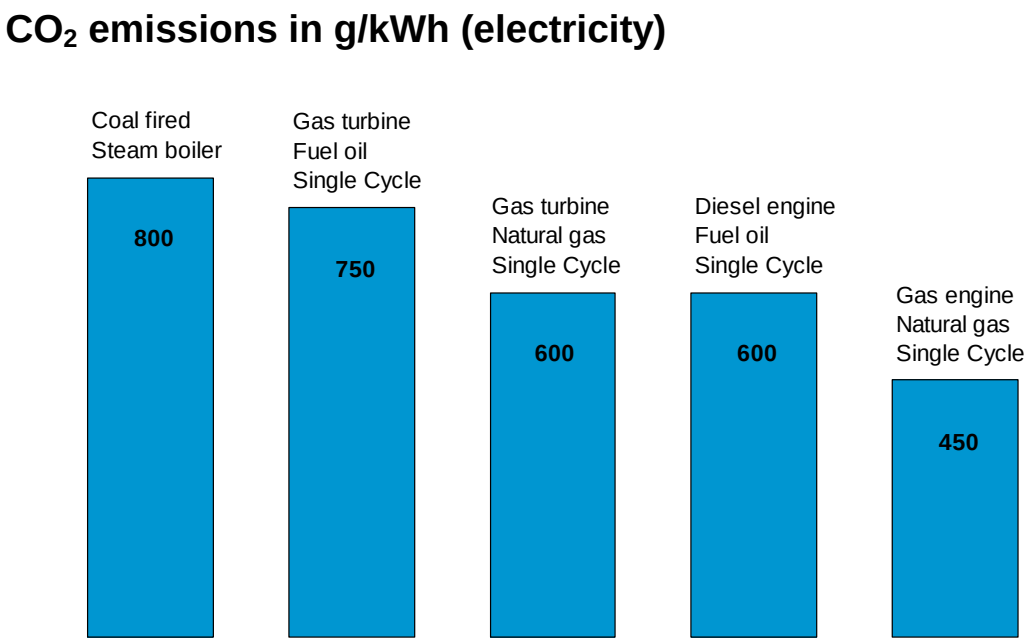
/15/ "US EPA Standard of Performance for Stationary Compression Ignition Internal combustion Engines Position Paper – September 2006". Available at internet: http://www.euromot.org/download/news/positions/stationary_engines/US_EPA_NSPS_diesel_Euromot_position_final_060906.pdf

/16/ Directive 1999/32/EC "Reduction in the sulphur content of certain liquid fuels and amending Directive 93/12/EEC"

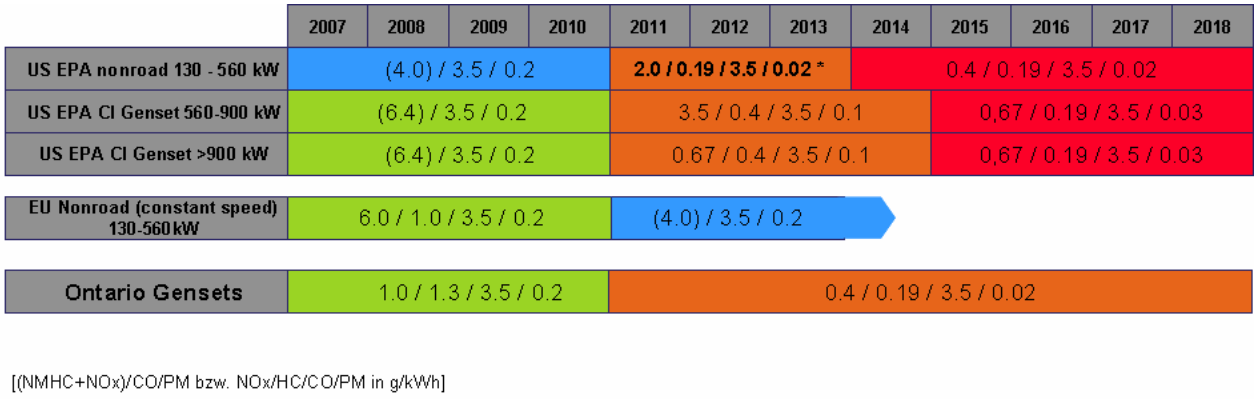
/17/ "Stationary Engine emission Legislation – Diesel and Gas (Euromot November 2004)" at http://www.euromot.org/download/news/positions/stationary_engines/Future_stationary_engine_emission_legislation_Nov04.pdf

/18/ Diesel and gas Turbine Worldwide yearly survey 1992 - 2007

ANNEX 1: Specifiv CO2 emissions



Annex 2: Overview of current emission regulation EU/US vs. Ontario proposal



[(NMHC+NOx)/CO/PM bzw. NOx/HC/CO/PM in g/kWh]

Vaasa - Frankfurt/M, 2008/02/29

Johan Boij
WG Chairman

Panagiotis Daskalopoulos
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