
POSITION PAPER

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Proposal to include Smaller Stationary CI Engines (<5MWth) in the Non-road Mobile Equipment Directive

1 BACKGROUND

Many European Union (EU) member states have challenges in fulfilling the national emissions ceilings Directive (2001/81/EC) and the air quality directive (2008/50/EC). This has led them to take a closer view of their emission inventory in order to find further means to comply.

Mass produced, non-road, high speed, liquid fuelled type diesel engines are commonly the basis for the constant speed engines used in mobile applications such as rental generators. The same engines are often used in small scale, constant speed stationary power generation applications. Unlike mobile engines there are no common exhaust emission limit regulations for constant speed stationary engines today at a European Union level. These engines are regulated by national emission regulations that vary from country to country or even location to location, whereas non-road mobile diesel (CI) engines with a shaft power output of 19 to 560 kW (kW_{shaft}) are regulated by the non-road mobile machinery exhaust emissions (NRMM) directive 97/68/EC.

As part of a further amendment to the NRMM directive the European Commission (EC) has initiated an impact assessment study with a view to aligning constant speed mobile engine emission limits with variable speed engine emission limits during the 2016-2020 time period. The study also includes expanding the scope of 97/68/EC to CI engines below 19 kW_{shaft} and above 560 kW_{shaft} . The likely result of this will be that most of the power categories will be at stage IV emissions limits by the end of the process. This amendment of 97/68/EC is currently being prepared for the Ordinary Legislative Process (OLP, previously Co Decision). The

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legislative proposal and impact assessment is expected to be ready for transmission to the European Parliament and Council of the European Union at the end of 2011.

As a result of this, and taking account of the fact that many companies are selling the same engine for mobile and smaller stationary applications anyway, the EC stated at the GEME¹ meeting held on 13th September 2010 that they are currently evaluating a change to the scope of the NRMM directive to include stationary engines which are similar in design and size to non-road type diesel engines. They noted that the upper power limit and emission limits need to be decided. It was also noted that to align with the approach taken in the USA, engines that are only intended for emergency use (and thus only intended to operate infrequently and for short durations) should not be required to comply with after-treatment-forcing standards.

The stage IV emissions limits are at very low levels for the regulated species requiring the best available technology. Regulating smaller stationary liquid-fired diesel engines at EU level in directive 97/68/EC will contribute to an improvement in air quality and at the same time remove barriers to trade. It would create a single market and avoid varying national regulations for such non-road engines.

As a further development of the regulations for liquid-fired diesel engines in the future, the EC sees the potential for the revised Gothenberg protocol being transposed to cover approximately 5 - 50 MW thermal power (MW_{th}), and the future EU Industrial Emissions Directive (IED) applying for $\geq 50 MW_{th}$ plant categories. Note that $5 MW_{th}$ is equal to about $2100 kW_{shaft}$.

The US carried out a similar exercise, resulting in 2006 with the “standards of performance for new stationary sources” rule². US EPA recognized that there are different types of diesel engines and therefore one set of emission limits could not take account of the technical differences between the categories in a correct way. In the CIMAC document³ some further information about the differences between different engine types are given. The US EPA developed separate emission limits appropriate to the type of engine. In the US ruling requirements for new stationary liquid fired diesel engines with a small cylinder displacement volume < 10 litres/cylinder (currently under review and may go to 7 litres per cylinder) are aligned with the non-road rule. A different approach is used for larger displacement engine types (see below Table 1). Emergency engines are only required to meet non-aftertreatment forcing standards.

¹ Expert Group on Emissions from non-road mobile machinery engine established under Directive 97/68/EC.

² US EPA 40 CFR Parts 60, 1039, 1042, 1065, and 1068, “Standards of Performance for Stationary Compression Ignition and Spark Ignition Internal Combustion engines”, Proposed Rule, June 8, 2010 available at <http://www.epa.gov/ttn/atw/nsps/sinsps/fr08jn10.pdf>. In June 2010 US EPA proposed some updates to this ruling, process is still under progress.

³ Position of the CIMAC WG 5 Exhaust Emissions Control about: “Requirements for Prime Mover Technique Specific Emission Limits Stationary Reciprocating Engine Plant”, February 2001; available at internet: <http://www.cimac.com/workinggroups/Index1-working-groups-exhaustemission.htm>

For Europe an additional upper limit on power is proposed at 5MW thermal input to avoid conflict with the Gothenburg Protocol. However, if, as seems likely, the new Gothenburg protocol limits are equivalent to, or lower than the NRMM values it should be allowed to optionally certify to the NRMM for higher than 5MW thermal rated thermal input engines that meet the other criterion of being a non-road type engine (cylinder displacement of less than 10[7] litres per cylinder. This would allow a consistent certification (laboratory rather than site) of engine families that crossed this threshold as well as aligning with the US (see Table 1 below)

TABLE 1: US CI NSPS 2006 Ruling

(US EPA 40 CFR Parts 60, 85, 89, 94, 1039,1065, and 1068, “Standards of Performance for Stationary Compression Ignition Internal Combustion Engines”):

Engine Displacement	Type of Rule
<10 (likely to change to 7) Litres/cyl	Identical to non-road mobile engine
≥10, <30 litres/cylinder	Specific for size of engine
≥30 litres/cylinder	Specific for size of engine

2 PROPOSAL

Apply the NRMM directive to smaller stationary engine plants using engines based on non-road engines. Included stationary engines would have the same limits, certification procedure and type approval as their variable or constant speed mobile equivalents. The exception to this would be engines for emergency use only which would not be taken to aftertreatment forcing limits. This will align the EU rule for non-road type engines with a power output of less than 5 MWth and with displacement of less than 10[7] litres/cylinder with the US CI NSPS rule.

Needed actions:

1. Remove the word mobile from the title of directive 97/68/EC and remove references to mobile as required throughout the directive
2. Add to scope of NRMM directive:

Stationary engines of non-road type; these engines defined as having both:

1. a maximum of less than or equal to 5MW thermal input; and
2. a displacement of less than 10 [7] litres per cylinder.

Optionally, at the choice of the engine manufacturer, stationary engines with a displacement of less than 10[7] litres per cylinder and a maximum of greater than 5 MW thermal input

3. Re-define current and potential new stage IV categories to include above type non-emergency variable speed and constant speed stationary engines
4. Add new categories for above type variable speed and constant speed engines for emergency use. Engines in these categories to be limited to stage IIIA emissions levels, US T2 for > 560 kW.
5. Create new definition for emergency use engine:

Emergency internal combustion engine shall mean any internal combustion engine whose operation is intended to be limited to emergency situations and required testing and maintenance.

[Stationary CI ICE used to supply power to an electric grid or that supply power as part of a financial arrangement with another entity, other than for emergency purposes only, are not considered to be emergency engines.]

Emergency Engines will need to be labelled as such.

6. The proposed standard for above type non-emergency engine type would drive technology that requires a fuel sulphur level harmonised with the existing non-road requirements (<10mg/kg at production and <20 mg/kg at point of final distribution). Therefore the fuels directive 98/70/EC should be amended to reflect this requirement for engines in scope.
7. Future stationary engine regulations for >5 MW thermal input to allow optional certification to the NRMM for engines of less than 10[7] litres per cylinder.

ANNEX 1 – Comparison of test and certification techniques

The non-road directive provides for engine certification on a test bed under given test protocols. These are based on the ISO 8178 series of standards. Most stationary rules are site based at real conditions using measurement protocols developed for industrial processes. However in many cases (in small scale power production based on non-road type engines) laboratory data on a test cycle is accepted as evidence of compliance by the relevant authorities and no further site testing is required. If field tests are conducted allowances are often granted for the emission limits. The table below lists some of the differences between mass produced non-road high speed (NRMM) type engine and the lower production volume medium/slow speed engine types used in larger stationary applications.

TABLE 2

Parameter	NRMM (mass produced)	Typical stationary
Emission test conditions	Laboratory certification at specified standard conditions: <ul style="list-style-type: none"> - Specified ambient test conditions - Reference test fuel - Test cycles with weighting factors (emission average value obtained) 	Measurement at site conditions <ul style="list-style-type: none"> - Steady state conditions - Normal operation loads: typically 85 to 100 % of MCR (Maximum Continuous Rating) - Site fuel used
Emissions units	Brake specific (g/kW.hr)	Exhaust volume specific (mg/m ³ N or ppm-v at a given vol-% O ₂)
Gaseous measurement	Raw or diluted	Direct measurements: Raw (power plant industry measurement standards)
Particulate measurement	Diluted (ISO 8178)	Direct measurements: Raw (power plant industry measurement standard such as ISO 9096, US EPA 17, JIS 8808, EN13284-1)
Fuel quality	Specified test fuel - Distillate (10 ppm Sulphur need for stage IV) <ul style="list-style-type: none"> - Bio fuels 	Bigger diesel engines: <ul style="list-style-type: none"> - Distillate fuel (> 500 ppm S) - Residual oils (HFO 0.5 to 5 wt-% S, etc.) - Crude oil - Bio fuels

Note: The design of medium/slow speed engines capable of operating on HFO, untreated biofuels etc. besides distillate fuel oils are different to that of distillate fuel only operated non-road type engines, i.e. engines developed for e.g. HFO operation are NOT based on non-road engines (also taken into account in the US CI NSPS ruling).

ANNEX 2 – Comparison of NOx limits in different units

Non-road limits use units that are specific to shaft power, namely g/kWh. Many stationary rules use units of normalised exhaust volume corrected to a given oxygen content (although there are sometimes other national references). There is not a direct conversion between the two as it is dependent on the specific fuel consumption of the different engines i.e. of the engine efficiency. For a diesel (CI) engine shaft efficiency is typically between 40 and 45%. An approximate conversion is given in table 3 below, showing how some existing stationary emission limits compare with the proposed limits for the smaller (non-road type) engines.. Figure 1 shows this graphically for some categories.

TABLE 3

Approximate conversion between existing stationary engine limit values and proposed limits for the smaller (non-road type) engines

Application	Category	NOx g/kW.hr	HC g/kW.hr	CO g/kW.hr	PM g/kW.hr
Proposed Emergency	0-8 kW (proposed new stage)	7.5*		8	0.6
	8-19 kW (proposed new stage)	7.5*		6.6	0.6
	19-37 kW (stage IIIA)	7.5*		5.5	0.6
	37-75 kW (stage IIIA)	4.7*		5	0.4
	75-130 kW (stage IIIA)	4*		5	0.3
	130-560 kW (stage IIIA)	4*		3.5	0.2
	[560-2237 kW] (new stage IIIA)	6.4*		3.5	0.2
Proposed non- emergency	0-8 kW (proposed new stage)	7.5*		8	0.6
	8-19 kW (proposed new stage)	7.5*		6.6	0.4
	19-56 kW (proposed stage IIIB)	4.7*		5.5	0.035
	56-130 kW (stage IV)	0.4	0.19	3.5	0.025
	130-560 kW (stage IV)	0.4	0.19	3.5	0.025
	[560-2237 kW (proposed stage IV)]	0.67	0.19	3.5	0.035
Current Stationary Examples	Italy <3MWth (~350 kW-1250 kW)	11.5 ⁽¹⁾			0.28 ⁽⁵⁾
	Italy >3MWth (~>1250 kW)	5.75 ⁽²⁾			0.28 ⁽⁵⁾
	Germany <3MWth (~350 kW-1250 kW)	2.88 ⁽³⁾			0.06 ⁽⁶⁾
	Germany >3MWth (~>1250 kW)	1.44 ⁽⁴⁾			0.06 ⁽⁶⁾

* Combine NOx and HC

(1) Approximation based on 1500mg/m_n³@15%O₂ (=4000mg/m_n³@5%O₂)

(2) Approximation based on 750mg/m_n³@15%O₂ (=2000mg/m_n³@5%O₂)

(3) Approximation based on 375mg/m_n³@15%O₂ (=1000mg/m_n³@5%O₂)

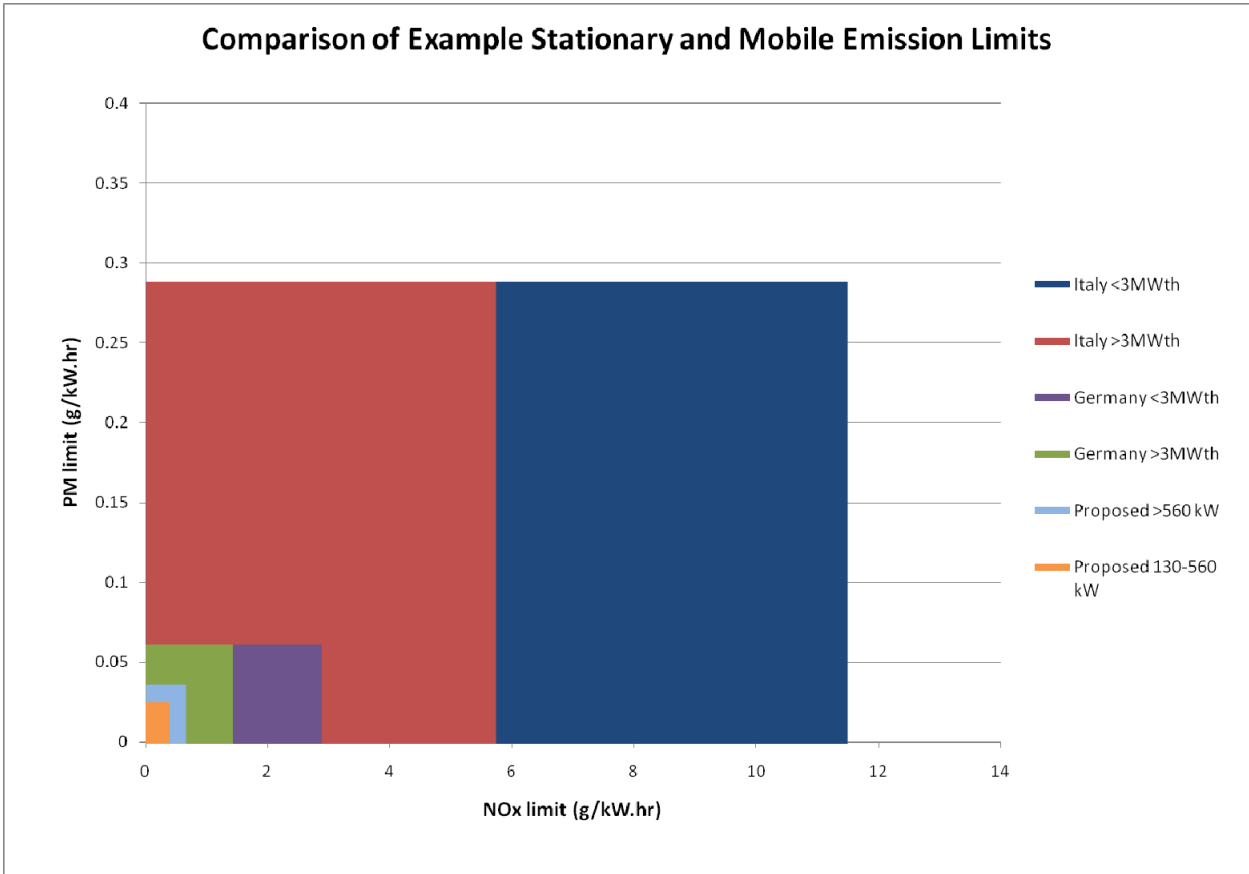
(4) Approximation based on 187mg/m_n³@15%O₂ (=500mg/m_n³@5%O₂)

(5) Approximation based on 49mg/m_n³@15%O₂ (=130mg/m_n³@5%O₂)

(6) Approximation based on 7.5mg/m_n³@15%O₂ (=20mg/m_n³@5%O₂)

Note: m_n³ means a cubic meter at normalised conditions of 273.15K and 101.3 kPa after subtraction of humidity content of steam

FIGURE 1



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