

Emissions from Tractors and Non-Road Mobile Machinery Engines

Hearing on “Agricultural and forestry vehicles: a new regulatory
framework”, European Parliament IMCO Committee
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Cécile Favre, AECC

www.aecc.eu



Association for Emissions Control by Catalyst (AECC) AISBL

AECC members: European Emissions Control companies



Technology for exhaust emissions control on all new cars
(OEM and Aftermarket) and an increasing number of
commercial vehicles, non-road applications and motorcycles.

Tractors Emissions are regulated by 97/68/EC for NRMM Engines

- COM(2010)395 in line with current Directive 2000/25/EC

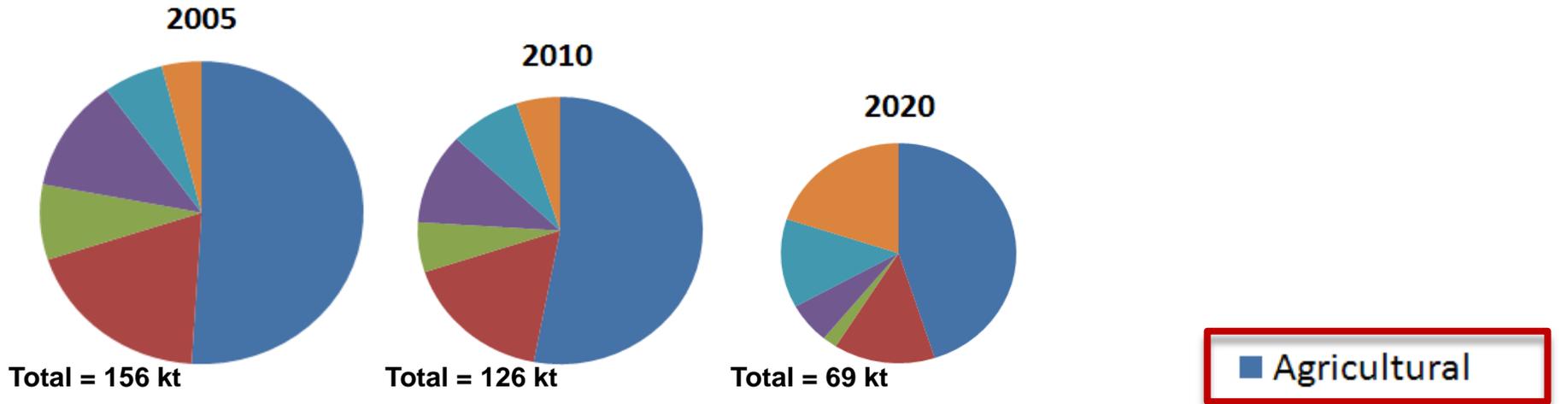
Article 9

Requirements on environmental performance

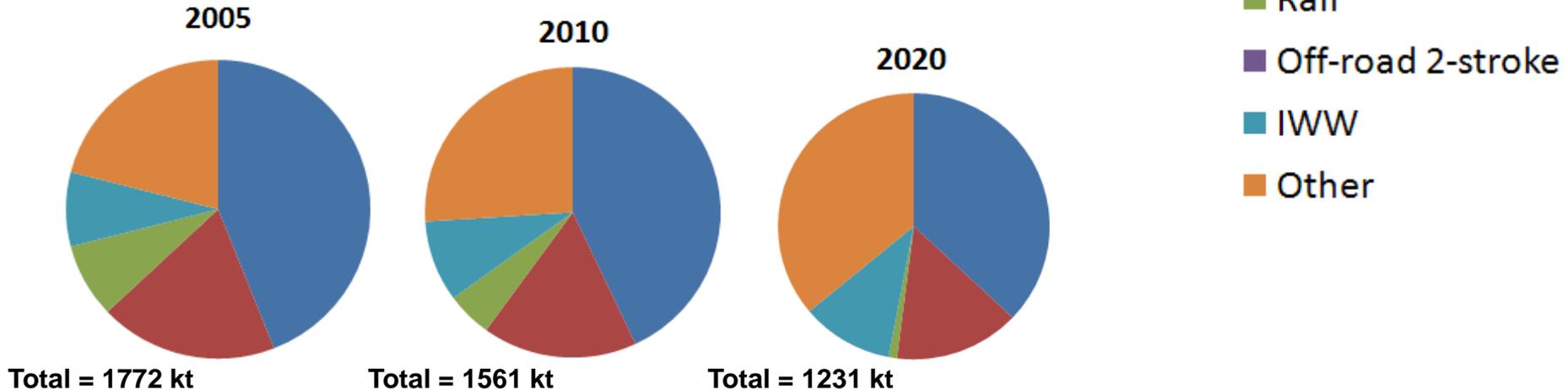
1. Manufacturers shall ensure that vehicles are designed, constructed and assembled so as to minimise the impact to the environment.
2. Manufacturers shall ensure that vehicles, systems, components and separate technical units comply with the relevant requirements set out in this Regulation, including the requirements relating to:
 - (a) pollutant emissions;
 - (b) external sound level.
3. The specific limit values, procedures and test requirements for pollutant emissions laid down for mobile machinery in Directive 97/68/EC³⁵ shall apply.
4. The requirements referred to in paragraphs 1 and 2 shall apply to vehicles, systems, components and separate technical units intended therefor, insofar as they are declared applicable to the relevant vehicle category by this Regulation.
5. The Commission shall be delegated powers to adopt in accordance with Article 57 a delegated act laying down the detailed technical requirements including test procedures and limit values, where applicable, on the external sound level as described in paragraph 2(b) and the installation of approved engines in a vehicle and the related provisions for flexibility as described in paragraphs 2(a) and 3 in order to ensure that a high level of environmental performance will be obtained.

Tractors Contribution to Non-Road Emissions

PM₁₀ emissions from non-road mobile machinery in EU27



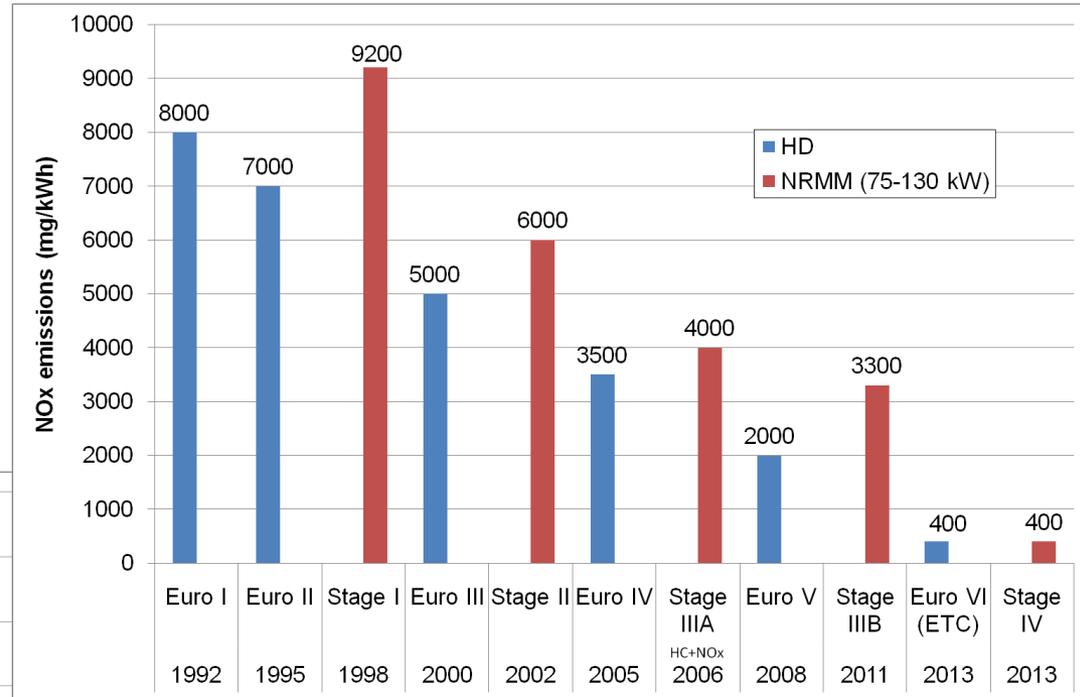
NOx emissions from non-road mobile machinery in EU27



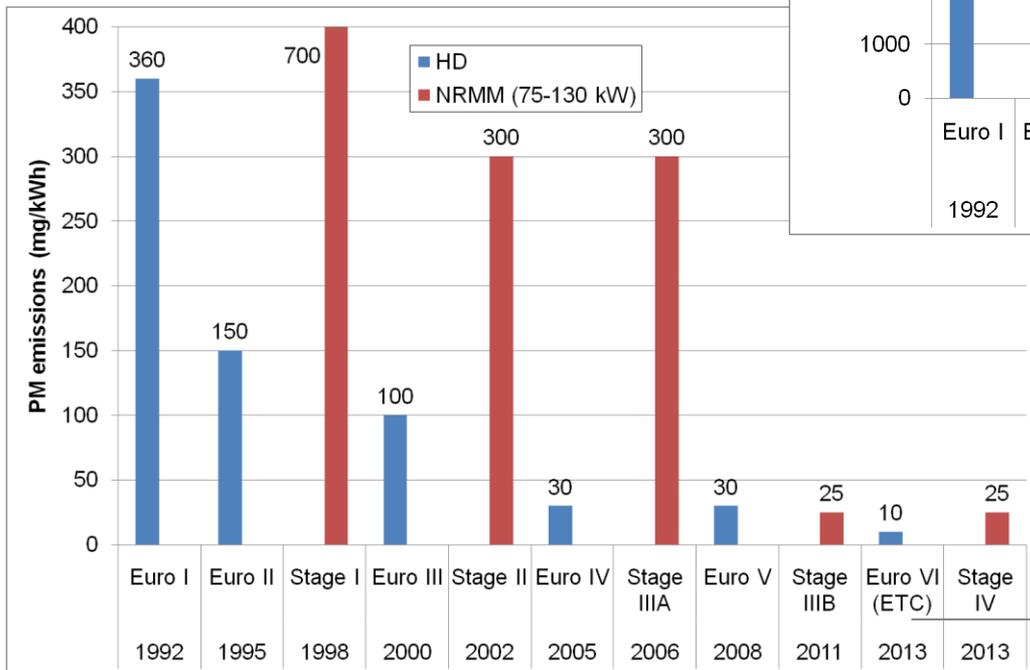
Source: data from Arcadis-TML, Impact Assessment Study – Reviewing Directive 97/68/EC-Emissions from non-road mobile machinery, Final Report 30 January 2009.

NRMM vs. Heavy-Duty Emission Limits

NOx



PM



- No DPF is required for NRMM Stage IV.

HD Euro VI includes a particle number limit

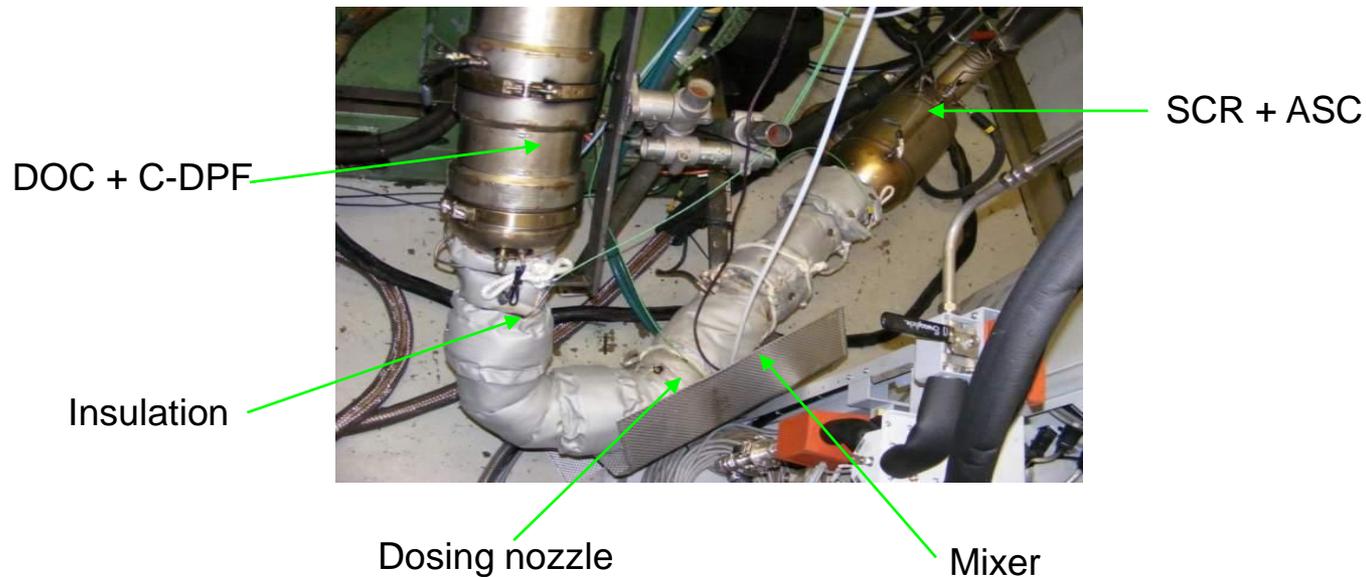
AECC NRMM Demonstration Program

- Industrial prototype engine developed for Stage IIIB, provided by OE manufacturer.
 - 4 cylinder, 4.4 litre engine, 93 kW at 2200 rpm.
 - High Pressure Common Rail, Variable Geometry Turbocharger, cooled EGR.
 - No emission control system supplied with the engine.
- Engine calibration.
 - Engine-out emissions: PM ~35 mg/kWh and NOx ~3.0 g/kWh.
- All calibration and test work used Carcal Reference 725A diesel fuel, low ash 15w-40 engine lubricant and AdBlue[®] aqueous urea to ISO.



Emissions Control System

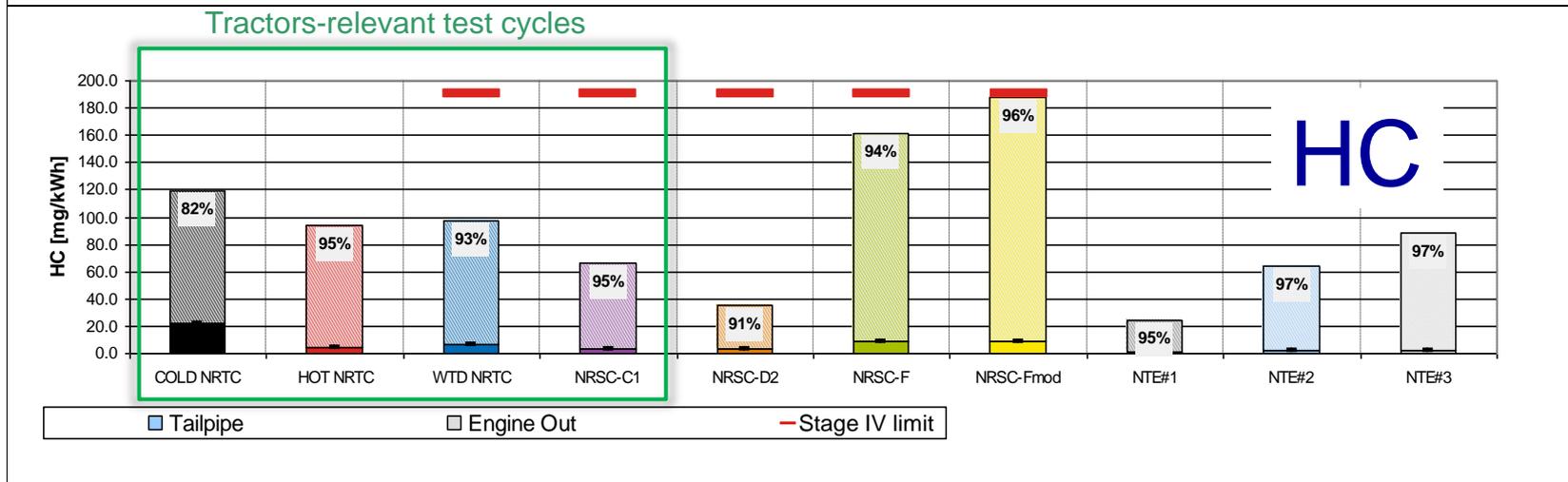
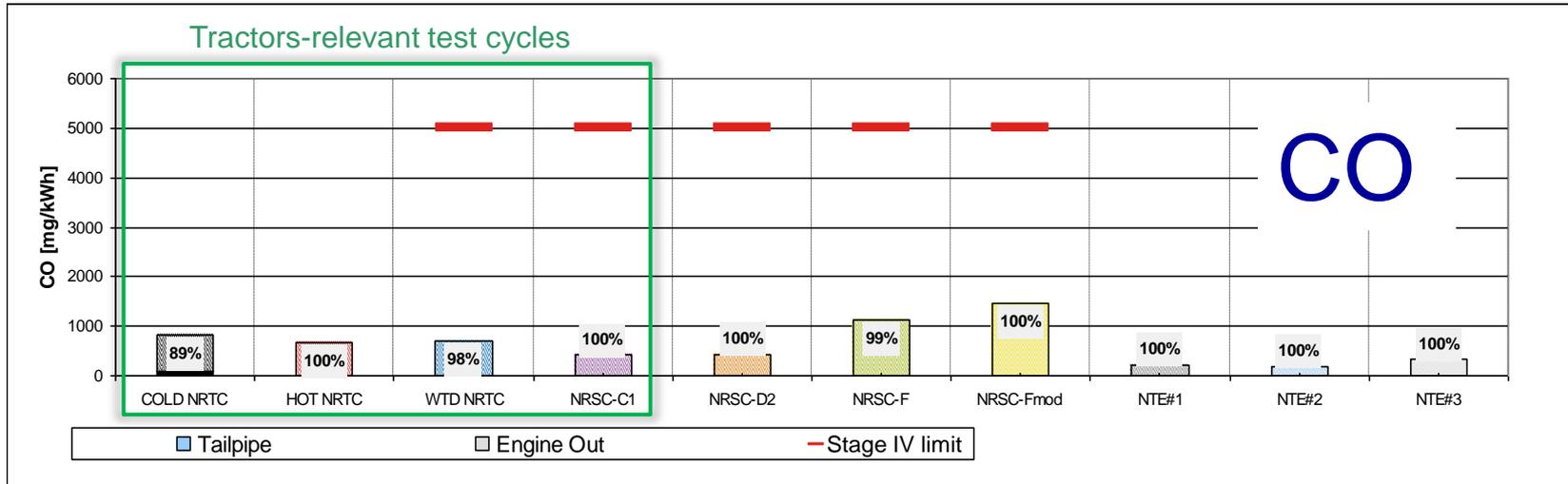
- Complete Emissions Control System supplied by AECC.
- Oxidation catalyst (DOC), catalysed particulate filter (C-DPF) and urea-SCR with ammonia slip catalyst (ASC).
- Exhaust system lengths chosen to be representative of space available in typical industrial machine.



- System hydrothermally aged for 200hours at 600 C.

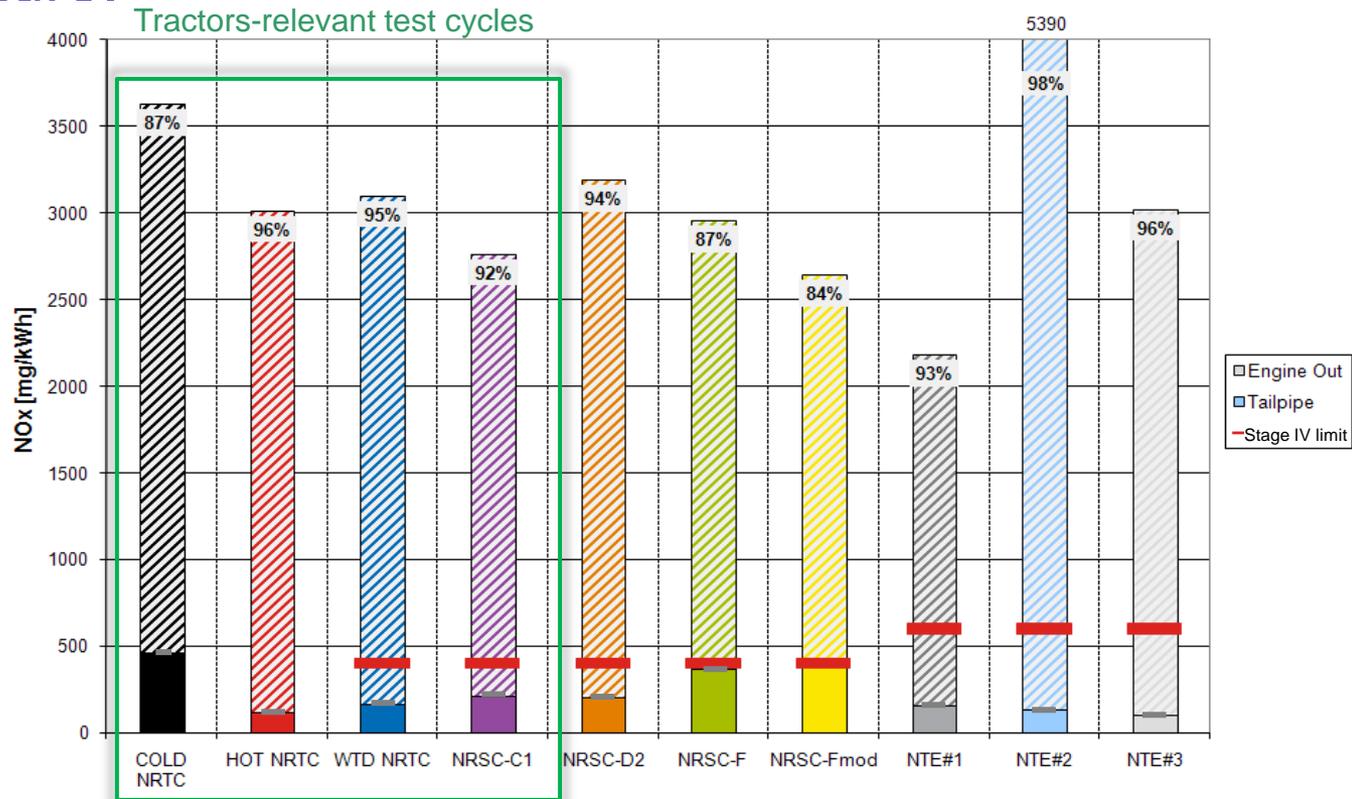
CO and HC Emissions

- Engine-out emissions are already below Stage IV limit for most cycles.



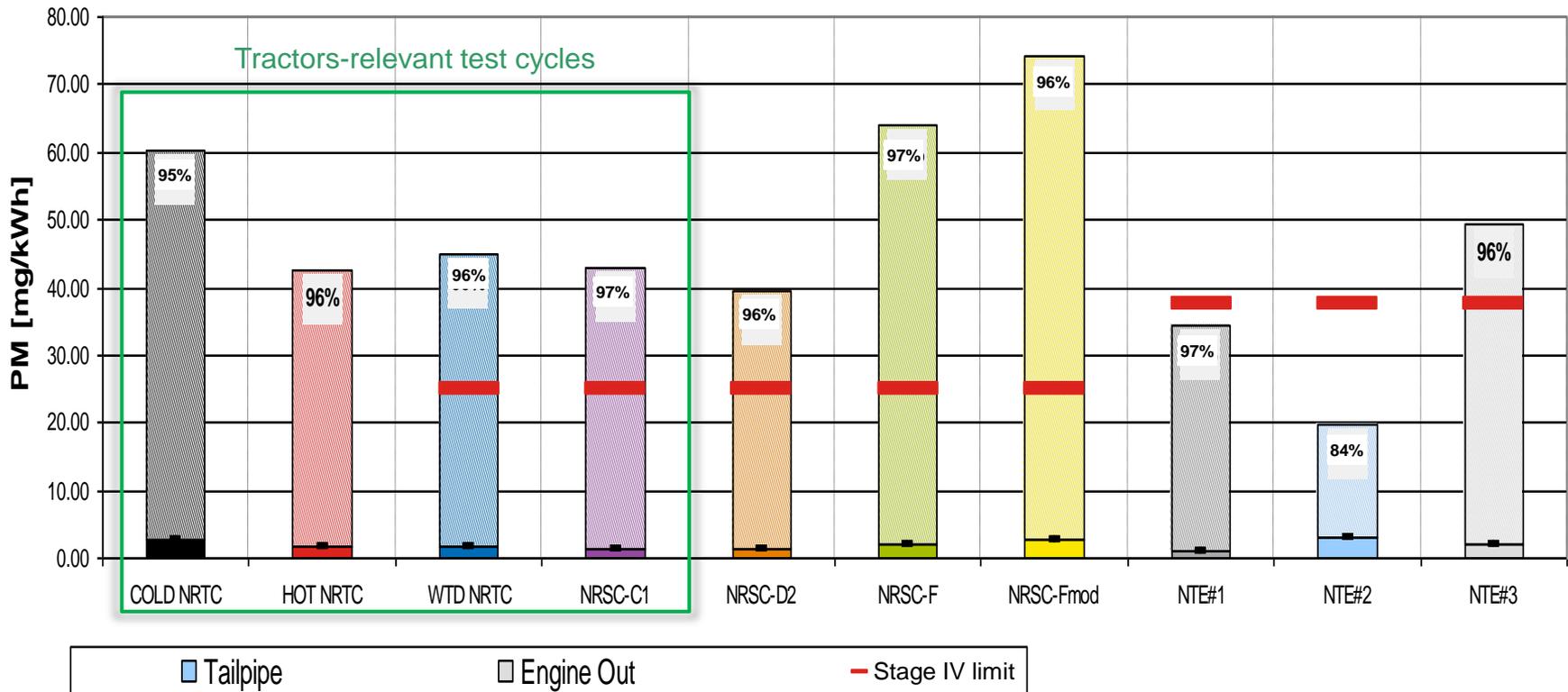
NOx Emissions

- NOx conversion is high (85-95%) over most test cycles, Stage IV limits are readily met (with the exception of NRSC F and F-mod).
- NOx conversion efficiency highly dependent on test cycle temperature.



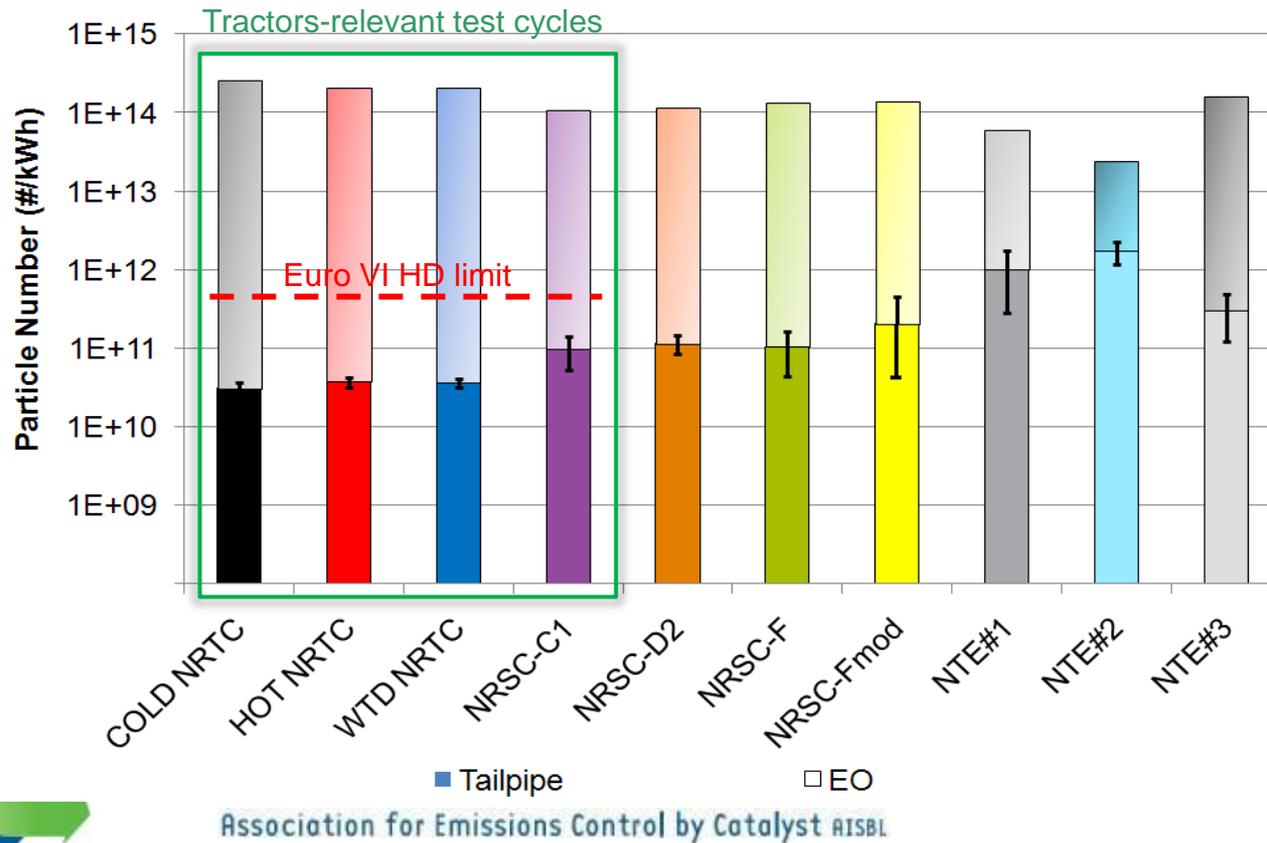
PM Emissions

- PM reduction across DPF meets limits with considerable margin over all cycles.
- PM conversion efficiencies are 96% and 97% over the NRTC and NRSC C1 cycles respectively, resulting in tailpipe PM levels of 1 to 2 mg/kWh.



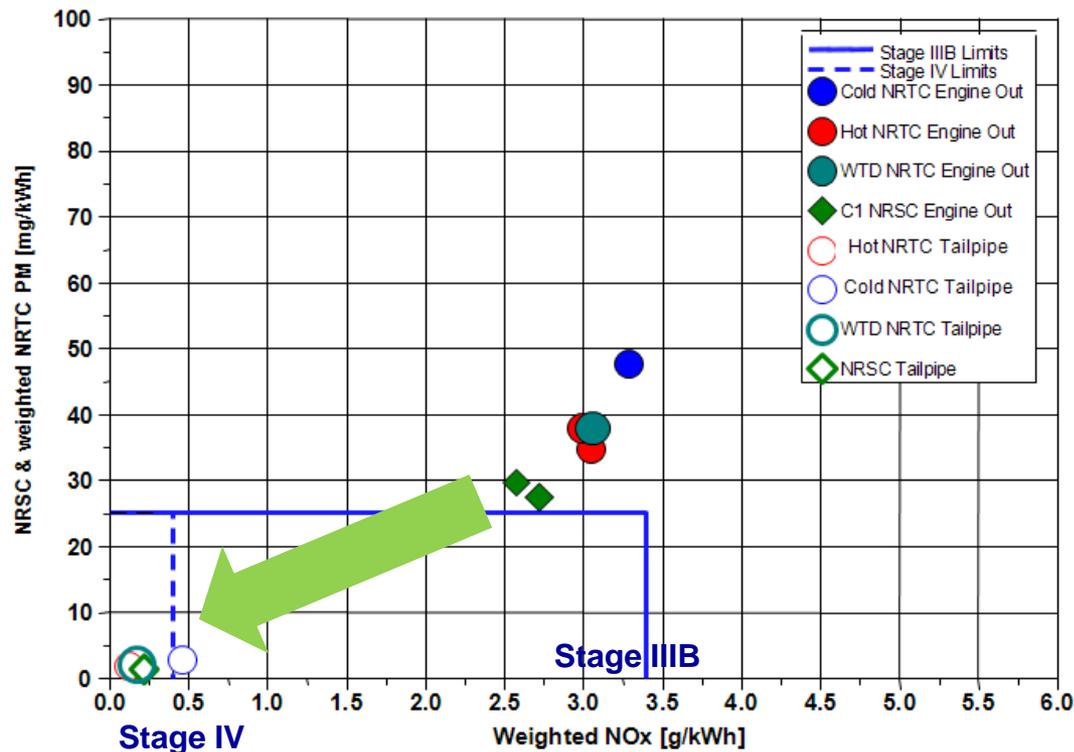
Particle Number Results (PMP)

- Cold and hot transient cycle tailpipe PN results well below 10^{11} /kWh.
- Steady state cycles (NRSC variants) all at PN levels $\sim 10^{11}$ /kWh or below.
- Engine-out PN from all cycles range from $\sim 6 \times 10^{13}$ to $\sim 3 \times 10^{14}$ /kWh.
- ECS efficiency for PMP Particle Numbers is $>99.8\%$ for all transient and steady state cycles.



Summary and Conclusions

- A state-of-the-art engine system comprising a low emissions industrial engine designed for Stage IIIB and an Emissions Control System produced substantial reductions in all regulated pollutants over a range of test cycles.



- The engine system was not fully optimised; there was no thermal management to assist with warm-up from cold starts.

Some Considerations on COM(2010)395

- PM and NOx emissions from agricultural and forestry vehicles will continue to represent a large share of total non-road PM and NOx in the EU.
- Agricultural and forestry vehicles should continue to align with NRMM legislation for emissions, not only at Stage IV but also beyond.
- The introduction of a limit for Particle Number would ensure benefits in terms of both air quality and occupational health of farmers and workers.
- Consideration on a new Stage V started, including the need for a PN standard.



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Who are AECC and what do we do ?

AECC is an international non-profit scientific association of European companies making technologies for automobile exhaust emissions control.

**Thank you
for your attention.**

Their products are the ceramic and metallic substrates for catalysts and filters; autocatalysts (substrates with catalytic materials incorporated or coated); adsorbers; filter-based technologies to control particulate emissions from diesel and other lean burn engines; and speciality materials incorporated into the catalytic converter or filter.

Catalyst-equipped cars were first introduced in the USA in 1974 but only appeared on European roads in 1985 and in 1993 legislation forced their use on cars. Now more than 275 million of the world's 500 million cars and over 85% of all new cars produced worldwide are equipped with autocatalysts. Catalytic converters and filters are also fitted to heavy-duty vehicles, motorcycles and non-road engines and vehicles.

What are the emission control technologies?

Exhaust gas contains carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NOx) and particulate matter (PM). The main technologies used to treat exhaust to remove harmful gases and particles are:

- autocatalysts
- adsorbers (traps)
- filters

There are more details on the technology pages.

