NRMM EU Regulation

Testing within Stage V regulation

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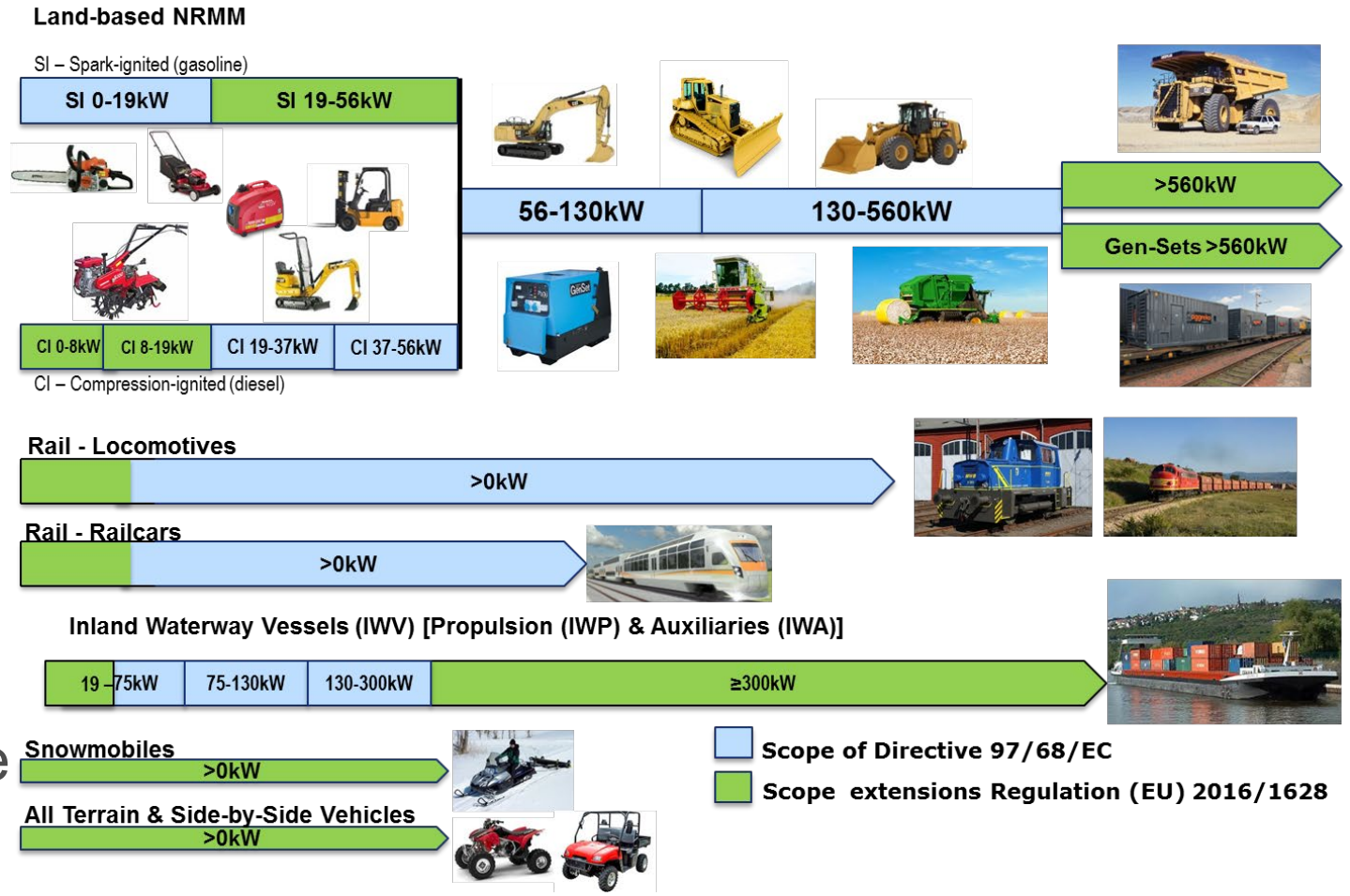
NRMM Stage V: Scope of application

- The regulation places all the engines in STAGE V. Each engine category must comply with a given set of emission limits.
- Aligns with (higher) US EPA standards, where appropriate
- Aligns the emission limits, where possible, to those in the on-road sector.



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NRMM Stage V: new elements (PN)

Rail - Railcars

Regulation (EU) 2016/1628					
Railcars Engines (RLR)	CO	NO_x	HC	PM	PN
	[g/kWh]				[#/kWh]
P > 0 kW	3.50	2.00	0.19	0.015	$1x10^{12}$

Inland Waterway Vessels (IWV) [Propulsion (IWP) & Auxiliaries (IWA)]

Inland waterway vessels (propulsion& Auxiliaries) emisssions in g/kWh	
Engines 19 ≤ P < 75 kW	variale & constant
Engines 75 ≤ P < 130 kW	variale & constant
Engines 130 ≤ P < 300 kW	variale & constant
Engines P ≥ 300 kW	variale & constant

Regulation (EU) 2016/1628				
CO	NO_x	HC	PM	PN
5.00	4.70		0.30	-
5.00	5.40		0.14	-
3.50	2.10	1.00	0.10	-
3.50	1.80	0.19	0.015	$1x10^{12}$

NRMM Stage V: new elements (PN)

CI Engines < 56 kW & All Engines >56 kW		Regulation (EU) 2016/1628				
Emissions in g/kWh		CO	NOx	HC	PM	PN
0 < P < 8 kW	var & const	8.00	7.50		0.40/0.60	-
8 ≤ P < 19 kW		6.60	7.50		0.40	-
19 ≤ P < 37 kW		5.00	4.70		0.015	$1 \cdot 10^{12}$
37 ≤ P < 56 kW		5.00	4.70		0.015	$1 \cdot 10^{12}$
56 ≤ P <130 kW		5.00	0.40	0.19	0.015	$1 \cdot 10^{12}$
130 ≤ P ≤ 560 kW		3.50	0.40	0.19	0.015	$1 \cdot 10^{12}$
P > 560 kW		3.50	3.50	0.19	0.045	-
P > 560 kW Genset		3.50	0.67	0.19	0.035	-

Limit values in line with US legislation

Limit values more stringent than US legislation

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NRMM Stage V: new elements (Monitoring of emissions of in-service NRMM engines*)

- The emissions of engine types or engine families in service shall be monitored by testing engines installed in Non-Road Mobile Machinery operated over their normal operating duty cycles.
- Such testing shall be conducted on engines that have been correctly maintained and required to comply with the provisions on the selection, procedures and reporting of results for the different engine categories laid down in the delegated act.
- Monitoring of emissions of in-service NRMM engines (ISM)

** Art. 19 of Regulation (EU) 2016/1628*

Monitoring of emissions of in-service NRMM engines (ISM)

- **Goals**
  - To define the compliance limits for pollutant emissions of engine types or engine families in-service operations: the so-called in-service conformity (ISC); and
  - to ensure that the designed procedure, which is based on a reduced set of data, is appropriate to ensure the limitation of the emissions of engines installed in NRMM over their normal operation.
- **Status**
  - Currently the procedure in force are for variable speed engines in the 56 to 560 kW power range (i.e. NRE-v-5 and NRE-v-6).
  - Extension to all other engine categories are nearly completed

Engines of category NRSh (SI engines P<19kW)

- ISM pilot programme
- Conclusions/Recommendation:

- An In-service Monitoring procedure should not be applied (NRSh-v-1a, NRSh-v-1b, and NRS-vr-1a), because:
  - Emissions are measured over the whole emission durability period in order to pass the type-approval
  - Equivalence between ageing at the test bench and in the field.
  - Every five years, in cooperation with manufacturers, conduct a pilot programme involving the most recent engine types in order to ensure that the durability procedure remains suitable and effective to control pollutant emissions over the useful life of engines.

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Monitoring of emissions of in-service NRMM engines (ISM) - Methodology

- Test procedure applicable to: gaseous emissions of variable and constant speed engines;
- Includes reporting of the results for the different engine categories;
- Based on Pilot Programs performed by Commission + stakeholders;
- Compulsory use of PEMS (Portable Emission Measurement System) measuring NOx, HC, CO and CO2 (testing in engine-dyno is allowed in some circumstances/categories);
- Data Evaluation: “Averaging window approach“ WBW and CO2-BW

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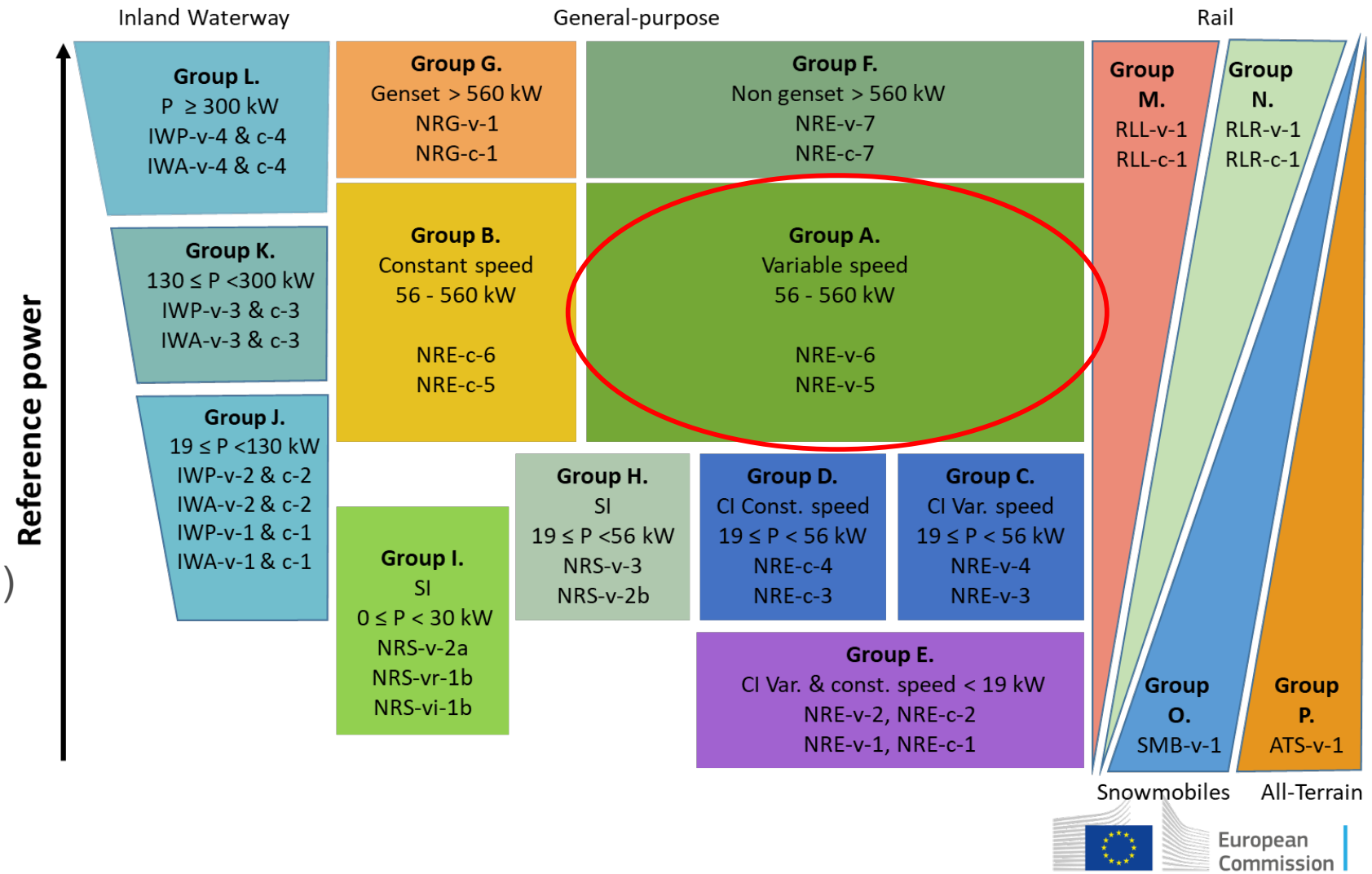
Monitoring of emissions of in-service NRMM engines (ISM)

- NRE & NRG (all sub-categories);
- NRS-vr-1b, NRS-vi-1b NRS-v-2a; NRS-v-2b & NRS-v-3;
- IWP & IWA (all sub-categories),
- RLL & RLR (all sub-categories)
- Snowmobiles (SMB-v-1)
- All-Terrain Vehicles (ATS-v-1)

ISM engine groups



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ISM: general

- Use the same principles/methodology (technical requirements) for all categories (except NRSh) and for both variable and constant speed engines.
- The ISM test can be carried out by following the normal/usual operations the NRMM undergoes in the field.
- The test duration will be:
  - ISM groups A , C and H: between 5-7 times the reference work or reference CO_2 (NRTC/ LSI-NRTC)
  - ISM groups E, I, O and P: between 3-5 times the reference work or reference CO_2. Due to the power range of these NRMM engines (this still ensures statistical robustness).
  - All other groups: between 5-7 times the reference work or reference CO_2.

The reference work in kWh or CO2 reference mass in g/cycle determined from the type-approval test result using the method set out in Appendix 9 (NRSC rather than NRTC)

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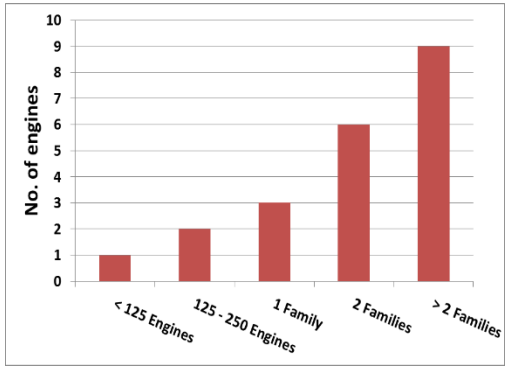
Testing scheme for ISM

- Two testing schemes for ISM (general):
  - Testing scheme based on the Emission Durability Period (EDP)
  - Testing scheme based on a 4 years' period
- For some categories is possible to use:
  - Testing scheme based on the age of non-road mobile machinery (without an operation hour indicator)
  - Testing scheme based on the odometer reading of non-road mobile machinery (machines with an odometer)
- Small volume manufacturers: the number of engines tested are adapted

ISM group A

% of EDP values		
Reference power of selected engine (kW)	a	b
56 ≤ P < 130	20	55
130 ≤ P ≤ 560	30	70



Other ISM groups

Reference power of selected engine (kW)	c	d
P < 56	10	40
56 ≤ P < 130	20	55
P ≥ 130	30	70

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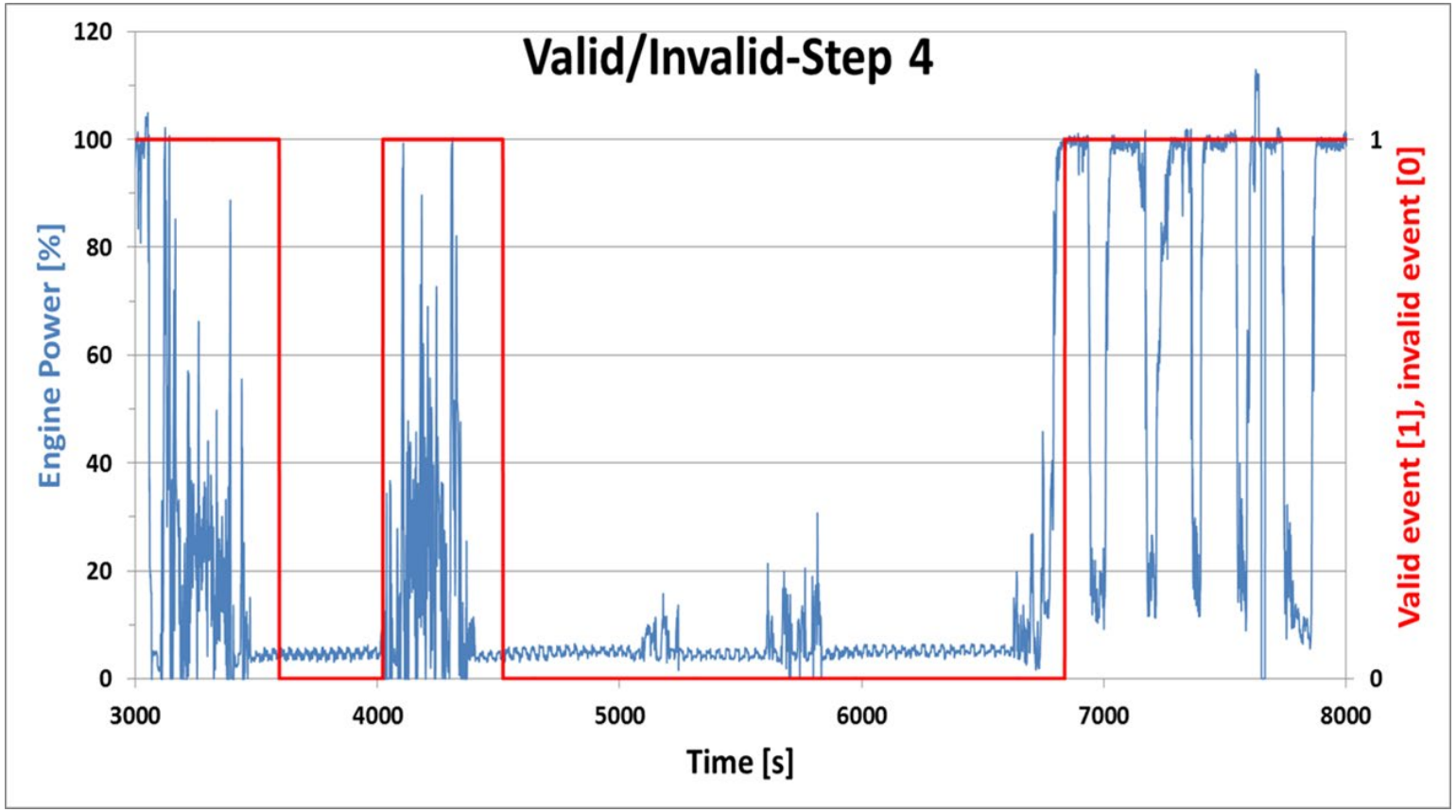
ISM - “Marking algorithm”

- **Definition of working and non-working events:**
- Using a power or idling criterion [engine power is lower than <10% → non-working situation]
- Based on duration parameters D0, D1, D2, D3

D0	*2 minutes*
D1	*2 minutes*
D2	*10 minutes*
D3	*4 minutes*



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Expectations towards stage V

- Larger coverture of engines considered in the NRMM emissions regulation:
  - extension of power band and inclusion of previously unregulated engines.
- Reach the same emission performance as in on-road applications:

Test on In-service Engines

Summary/Conclusions

- NRMM Stage V is a building block in the European Green Deal ambitious goal of climate neutrality.
- It covers nearly all the machinery that are used and operated in many cases in densely inhabited areas.
- By implementing the ISM, most of the machinery's pollutant emissions will be tested in their normal operating conditions.
- With the introductions of the ISM, this regulations contributes to curb the actual pollutant emissions under real everyday operating conditions to which European citizens and the environment are exposed.
- It aspires to reach the same emission performance as in on-road applications

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Thank you

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