

Diesel emissions standards in North America and worldwide are difficult to understand for technicians, students and teachers alike. At ConsuLab, we continue to develop our expertise in teaching diesel emissions. Our OEM relationships with Caterpillar, Cummins and John Deere, keep us at the leading edge of aftertreatment systems and emissions control technologies. Schools are challenged to refresh their engine fleet and faced with difficult purchasing choices choosing between technology of emission standards that best fit their program.

To help clarify these choices we wish to share our expertise and demystify some of the nomenclature and standards without going into minutiae.

Standards

EPA - Environmental Protection Agency sets standards for all vehicle emissions in the United States. When discussing an EPA standard, we use a reference year in a format of EPA following the reference year (example: EPA2007). This standard is used discussing on-highway class 8 trucks with diesel engines in Canada and the United States. This standard measures engine exhaust emissions at the tailpipe.

Tier level – while still governed by the EPA, we refer to a Tier standard (example: Tier 3). The Tier standards apply to off-road vehicles like heavy equipment, they are set by the EPA in the United States. Canadian standards are aligned to the US and use the same terminology. This standard measures engine exhaust emissions.

Stage – European Union standards that are harmonized to US EPA. This standard measures engine exhaust emissions at the tailpipe. (example: Stage V)

GHG – Green House Gas CO₂ emissions standards set forth by NHSTA (National Highway Traffic Safety Administration). These standards are measures of the whole vehicle. Measurements within these standards may be improved by aerodynamics, transmission, and other improvements to overall operating efficiencies.

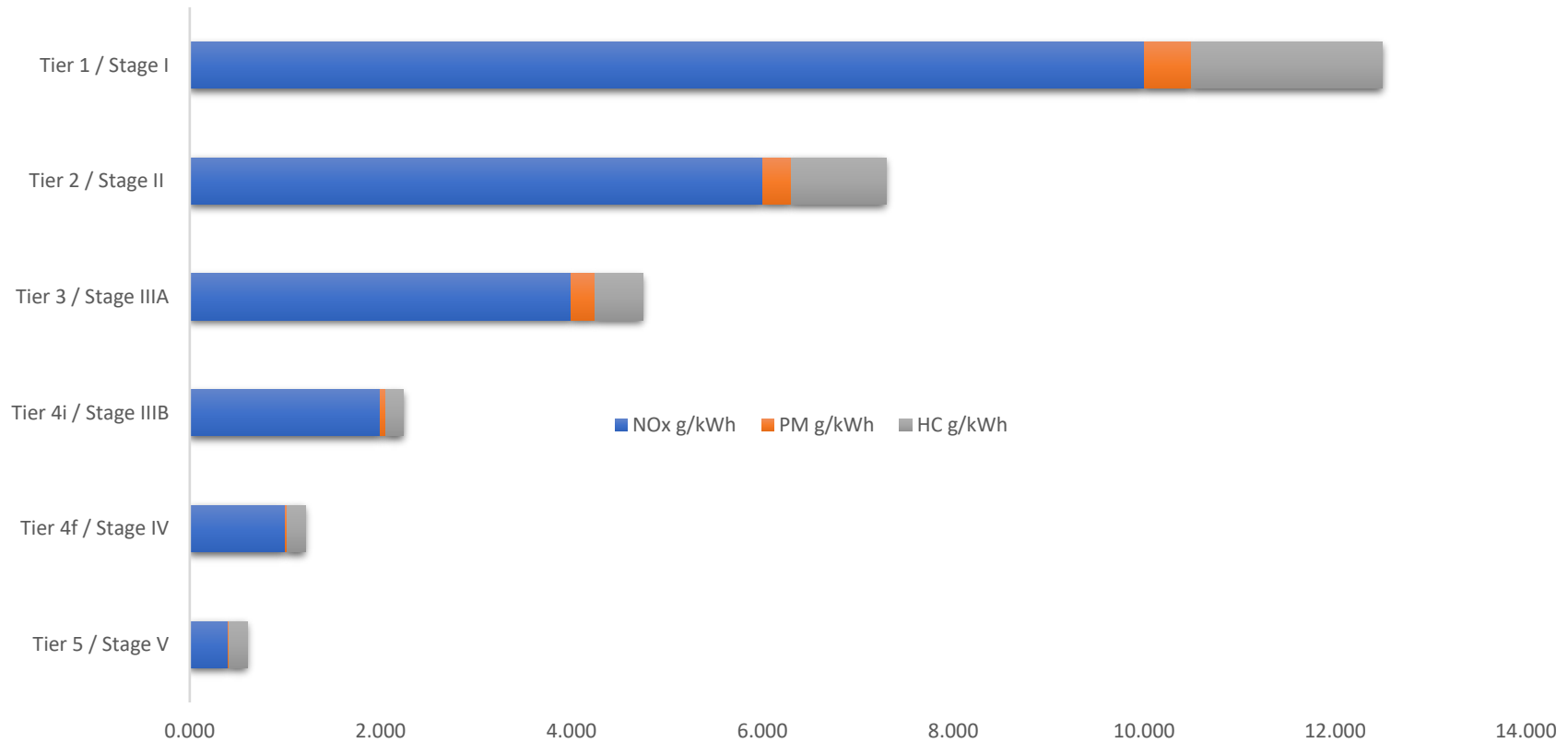
Major Milestones:

2007 – this was one of the most important years in diesel technology in North America since it is when we moved to ULSD (ultra low sulfur diesel) fuel with less than 15ppm sulphur content. This change allowed us to implement advanced diesel aftertreatment systems and reduce emissions.

2010 - the introduction of SCR (Selective Catalytic Reduction) with DEF injection systems to reduce NO_x output.

Year	On-road standard	Off-road standard (USA/CAN)	Off-road standard (EU)	EGR	C-EGR	DPF	DOC	SCR	General notes
<1996		Tier 0							Mostly unregulated
1999		Tier 1	Stage I	YES					HC unregulated
2002		Tier 2	Stage II	YES					HC unregulated, PM and NO _x regulated
2006		Tier 3	Stage IIIA		YES				HC, PM and NO _x regulated
2007	EPA2007	Tier 3	Stage 3		YES	YES			Drastic reduction in PM and NO _x
2010	EPA2010				YES	YES		YES	Another drastic reduction in HC, PM and NO _x , arrival of SCR and DEF injection systems
2011		Tier 4 interim	Stage IIIB		YES	YES		YES	
2013	EPA2013				YES	YES	YES	YES	
2014		Tier 4 final	Stage IV		YES	YES	YES	YES	Arrival of SCR and DEF injection systems
2017	EPA2017				YES	YES	YES	YES	Incremental improvements over EPA2013 standard
2019		Tier 5	Stage V		YES	YES	YES	YES	Incremental improvements over Tier 4 / Stage IV

diesel emissions



* exact standards vary by engine size and jurisdiction; this chart demonstrates the order of magnitude of the improvements. Prior to Tier3/Stage IIIA HC was unregulated so actual emissions are unknown.

Glossary

C-EGR	Cooled Exhaust Gas Recirculation
CO	Carbon Monoxide
CO ₂	Carbon Dioxide
DEF	Diesel Exhaust Fluid
DOC	Diesel Oxidation Catalyst
DPF	Diesel Particulate Filter
EGR	Exhaust Gas Recirculation
EPA	Environmental Protection Agency
GHG	Green House Gas
HC	Hydrocarbons
LSD	Low Sulphur Diesel (<500 ppm)
NHSTA	National Highway Traffic Safety Administration
NO _x	Oxides of Nitrogen Emissions (NO ₂ , NO ₃ , NO ₄ , NO ₅)
OEM	Original Equipment Manufacturer
PM	Particulate Matter
SCR	Selective Catalytic Reduction
ULSD	Ultra Low Sulphur Diesel (<15 ppm)
g/kWh	Grams per kilowatt hour

Exceptions:

This document has been created to give a high-level overview of the standards and their impact; broad assumptions have been made. There may be some exceptions to many of the generalities presented within. Specifically, once we analyse each standard and look at the various power ratings and the emissions requirements per power rating, the complexity magnifies exponentially. To meet the various standards each diesel engine manufacturer has chosen to implement technologies at different times, and in different ways.

References:

https://en.wikipedia.org/wiki/European_emission_standards

<https://www.dieselnet.com/standards/ca/nonroad.php>

<https://www.epa.gov/emission-standards-reference-guide>

<https://www.canada.ca/en/environment-climate-change/services/canadian-environmental-protection-act-registry/publications/guidance-document-engine-emission-regulations/chapter-6.html>

<https://www.forestry.com/editorial/equipments/eu-us-emission-standards-diesel-engines-forest-machines/>

<https://www.cjdigital.com/it-aint-easy-being-green-how-emission-control-has-changed-trucking/>