

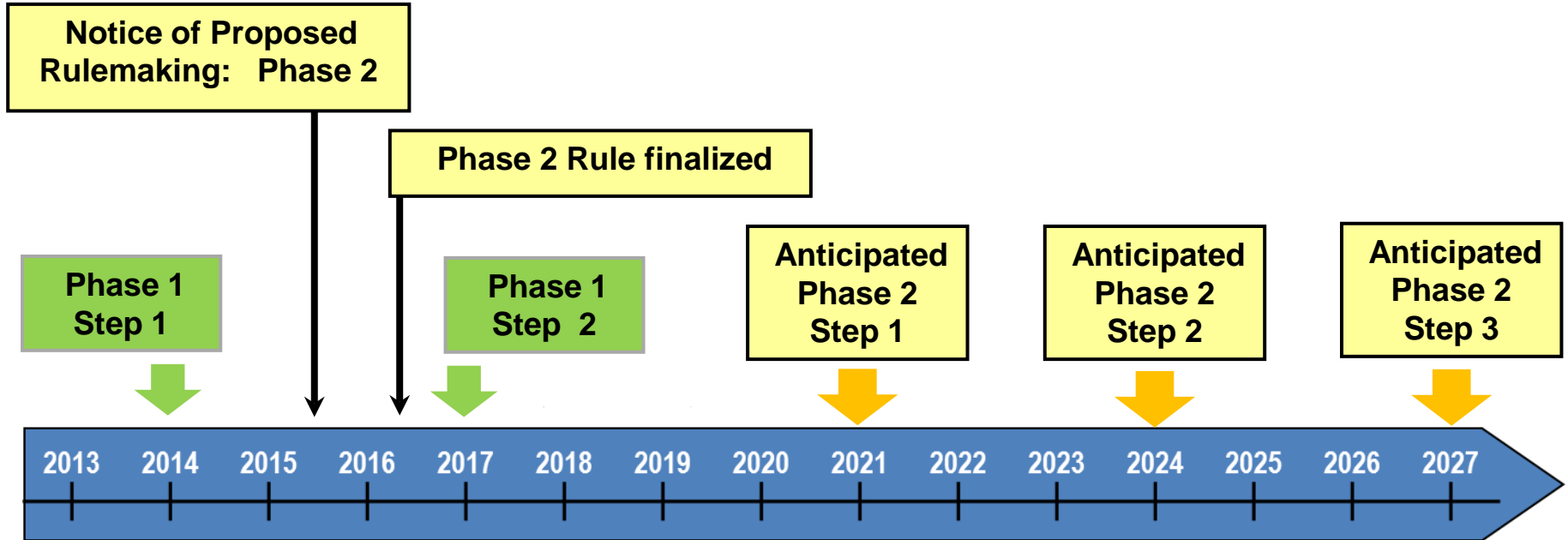
MACK TRUCKS GHG17 UPDATE EMTSP / AASHTO



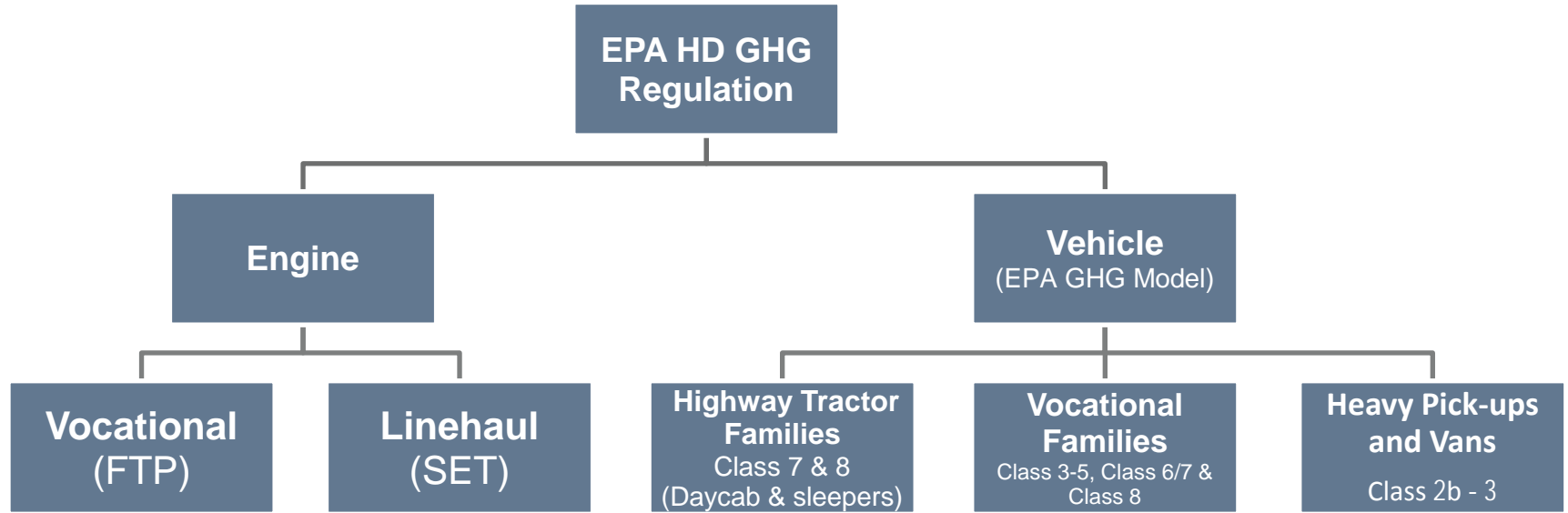
Stu Russoli
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HEAVY-DUTY DIESEL GHG REGULATIONS TIMELINE

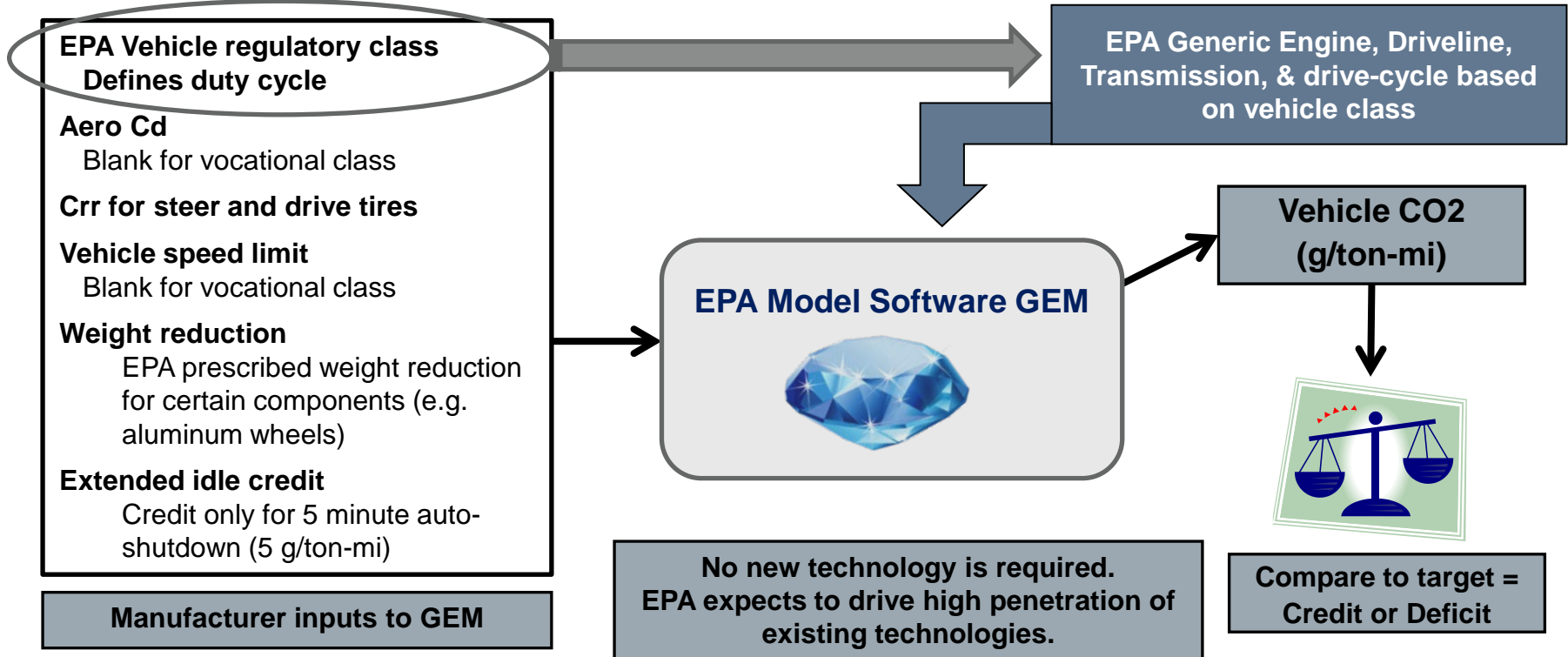


EPA & NHTSA GHG/FE REGULATIONS



Engine and vehicles are separately regulated, except class 2b-3

GHG & EFFICIENCY VEHICLE MODEL: RUN MODEL FOR EACH VEHICLE SPECIFICATION



U.S. GHG REGULATION OVERVIEW

- **Phase 1 GHG starts with 2014 production**
- **Increased engine stringency**
- **Applies to line-haul tractors, vocational trucks, pickup trucks, vans and engines.**
 - Vehicles and engines regulated separately
- **The regulation is intended to reduce CO2 emissions**
 - The only way to reduce CO2 emission is to consume less fuel for a given route / application
 - Hence the regulation drives industry to produce and sell more fuel efficient vehicles
- **Prior NOx and particulate levels are unchanged.**

ENGINE STANDARDS

Model Year 2014

- Up to 3% fuel economy improvement compared to 2010 baseline
- No significant hardware changes

Model Year 2017

- Up to 3% additional fuel economy improvement
- More significant hardware changes likely but too early to name specifics

GHG 2014 ENGINE IMPROVEMENTS

Engine Updates

Fuel economy related

- Engine hardware modifications for improvements in fuel economy
- Updated engine calibrations to optimize fuel economy improvements from the hardware changes

SCR optimization (no reduction in DEF consumption)

Non-fuel economy related (but included as part of project)

- Additional hardware changes to incorporate design updates and improved serviceability
- Hardware changes for chassis installation

GHG 2014 ENGINE IMPROVEMENTS

Engine	Improvement *
MP7	Up to 1.4%
MP8	Up to 2.4%
MP10	0.1%

- Maximum expected improvement versus EPA 2010 / OBD 2013 shown; dependent on duty cycle
- MP7 improvement greatest under load
- MP8 improvement regardless of load
- No significant, visible hardware changes

GHG 2017 MACK

- **Combustion system improvements**
 - Improved combustion
 - Reduced friction
- **Fuel system improvements**
- **Redesigned aftertreatment system**
- **Fuel economy improvement**

RECENT SERVICE INTERVAL IMPROVEMENTS CARRYOVER FOR GHG17 ENGINES

MP7, MP8, MP10 Engines EPA 2010 compliant engines and newer		Heavy Haul Less than 5 mpg Greater than 50 L / 100km	Regional Haul Greater than 5 mpg Less than 50 L / 100km	Long Haul Greater than 6 mpg Less than 39 L / 100km
Engine Oil & Filters, Fuel Filters VDS-4 and EO-O Premium Plus quality If idle time greater than 30%, use the next lower drain interval.	Miles	25,000	35,000	45,000
	Km	45,000	60,000	75,000
	Hours	625	1,000	1,300

Exhaust Aftertreatment Systems		Heavy Haul	Regional Haul	Long Haul
Diesel Particle Filter (DPF) Either clean the ash from the DPF or replace DPF.	Miles	250,000	400,000	
	Km	400,000	650,000	
	Hours	4,500	10,000	

ENGINE OIL

PC11: Performance Category 11

CJ-4 oil spec: Introduced in 2007, meets Mack spec EO-O Premium Plus

CK-4 replacing CJ-4 in 2017:

- today's viscosity & improvements in oil oxidation & oil aeration performance.
- Improvement in oxidation – many cases today limiting factor
- Backwards compatible with earlier engines
- Running oil hotter, time and temperature improvement in aeration

C11B: Same performance as PC11, but with lower viscosity for FE

- PC 11B (FA-4) Low HTHS viscosity & improvements in oil oxidation & oil aeration performance

GHG REGULATION EXPECTED REAL WORLD IMPACT

- **In general, a positive impact in reducing fuel consumption**
- **Impact may vary depending on the actual vehicle duty cycle**
 - Engine certified to prescribed duty cycle which may or may not be representative of the customer duty cycle
- **Measured improvement highly dependent on the baseline vehicle spec**
 - A vehicle already well spec'd to maximize fuel economy has less room for improvement than one not well spec'd



MACK®

VEHICLES STANDARDS

- CO₂ value calculated via GEM (Greenhouse gas Emissions Model) simulation model
- Baseline is conventional truck with minimal aero aids
- Generic engine model is part of simulation

Vocational Family Vehicle GEM Inputs

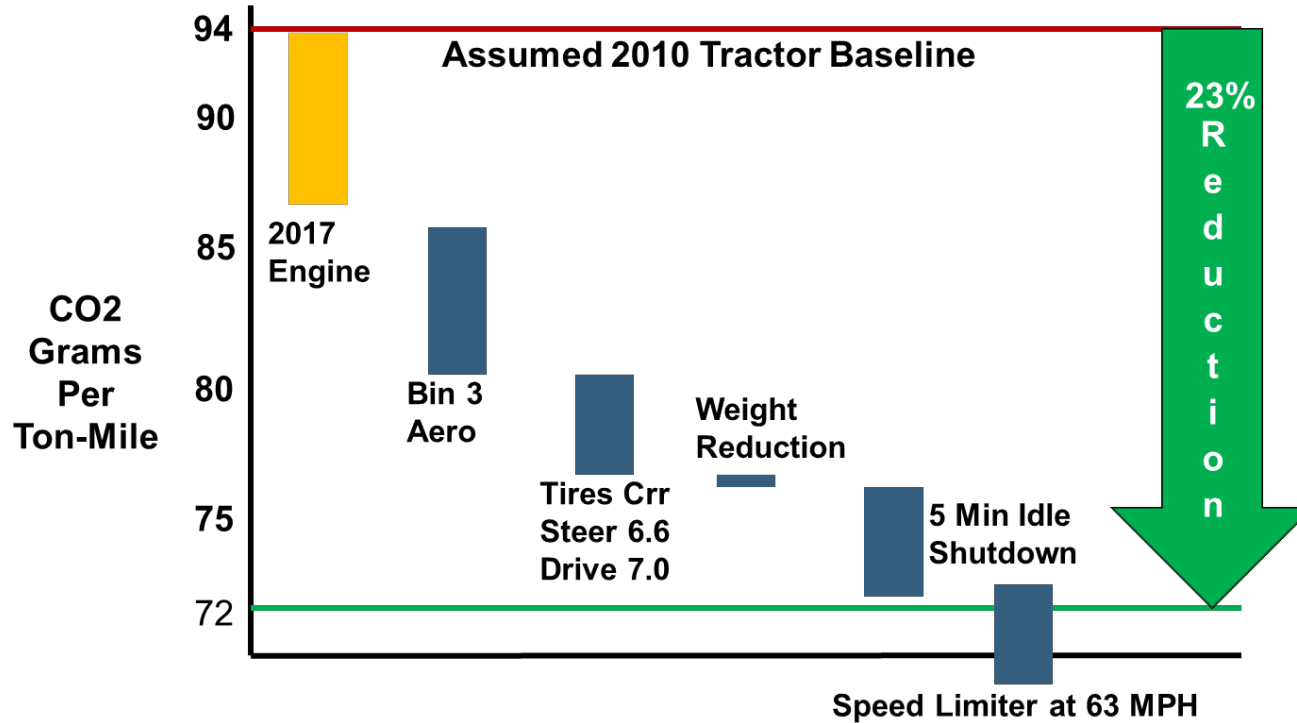
- tire rolling resistance
- The only vehicle concern for is to offer low rolling resistant tires.

Highway Family Vehicle GEM Inputs

- Aerodynamics
- Tire rolling resistance
- Weight reduction
- Idle reduction
- Speed limiters
- value, weight reductions, tire rolling resistance, idle-reduction, speed limiters
- Highway Family vehicle OEMs may need to be conscious, to varying degrees, of all of the above parameters.

HIGH RISE SLEEPER:

How to reach target (EPA assumption)



HIGH RISE SLEEPER: How to reach target (alternative)

