Cummins

Maintenance and Operation Presentation

Cummins Inc.

- Sales of $19.8 billion in 2020
- Over 1,300,000 engines built in 2020
- 58,000 global employees
- Headquarters – Columbus, Indiana

CMI
LISTED
NYSE

Summary of Cummins benefits

- **Premium driving experience with less fatigue**
  - Much lower noise levels, less downshifting in rolling terrain
  - 50% more torque…where you drive (highest torque wherever you cruise)
  - Supplemental engine braking for downhill grades
  - Air suspension and air brakes for better ride and handling

- **Cost of ownership**
  - Up to 50% better fuel economy for lower operational cost
  - Longer warranty period
  - Better fuel economy than gasoline

- **Convenience and Support**
  - Longer range for fuel stops
  - Less maintenance visits – annual (or 18 months) vs. semi-annual
  - 3500 service locations – engine and generator with 60 RV focused coach care locations
  - 800-CUMMINS, Shows/Rallies, PowerClub

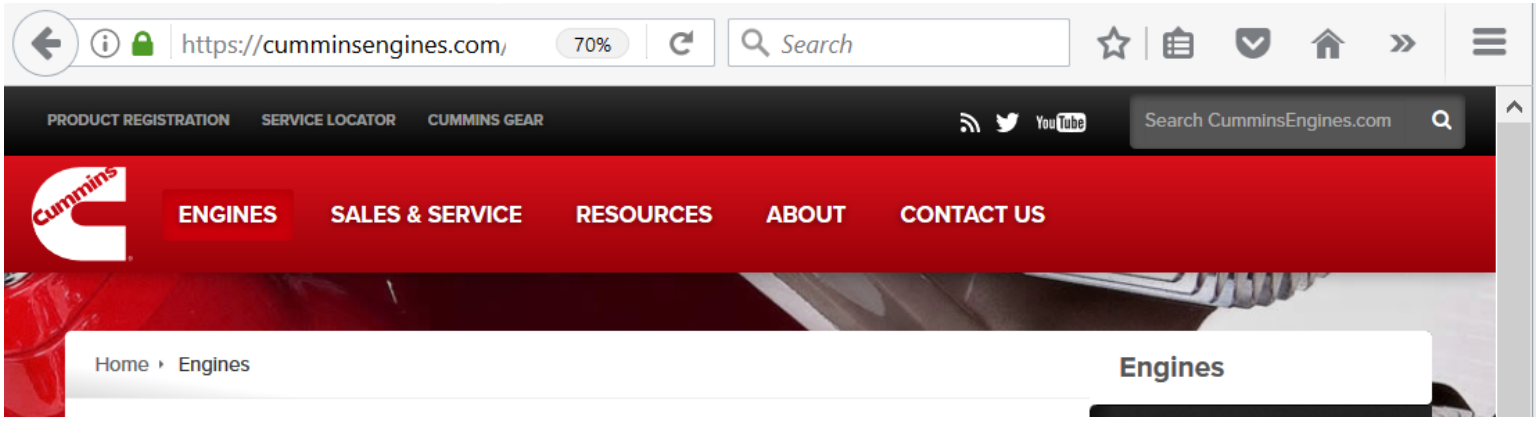
Agenda

- Product Information
  - Emissions history and technology
- Operation
  - Pre-Trip, Dash Lamps, Fuel Economy
- Maintenance
  - Fluids – Fuel, Coolant, Oil, DEF
  - Maintenance intervals
- Support
  - Cummins Care, Coach Care

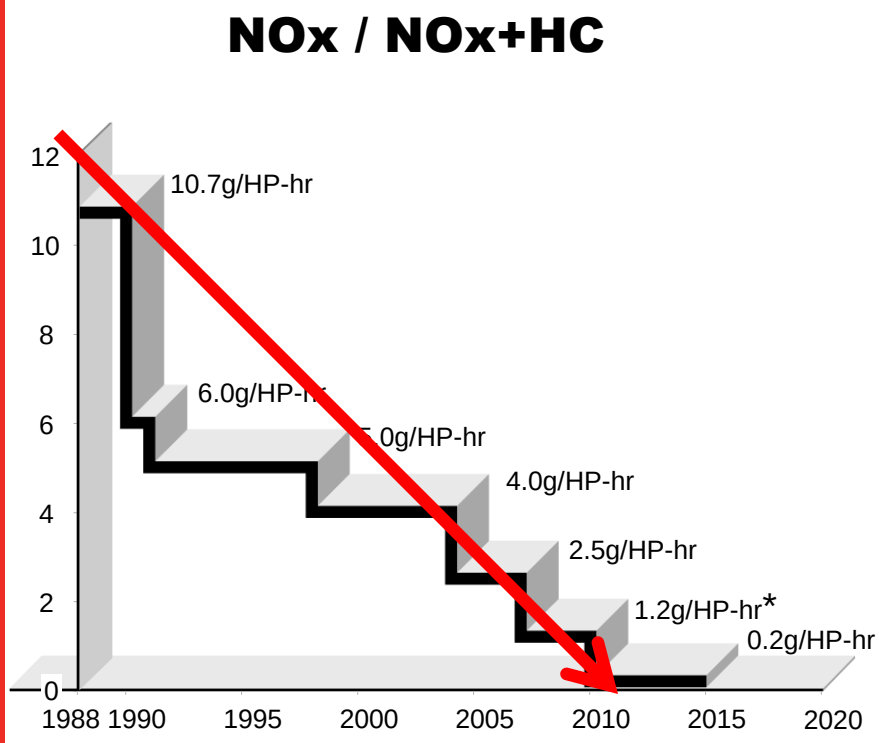
Handouts

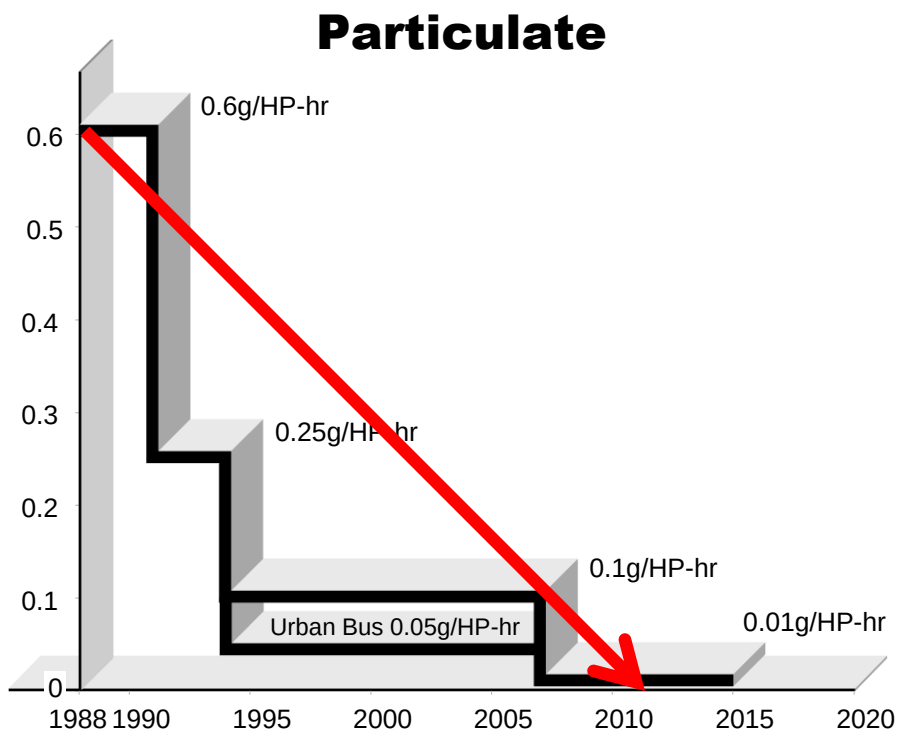
- Presentation is available online

- www.cummins.com
  - Search for FMCA



EPA Emissions – Clean Diesel

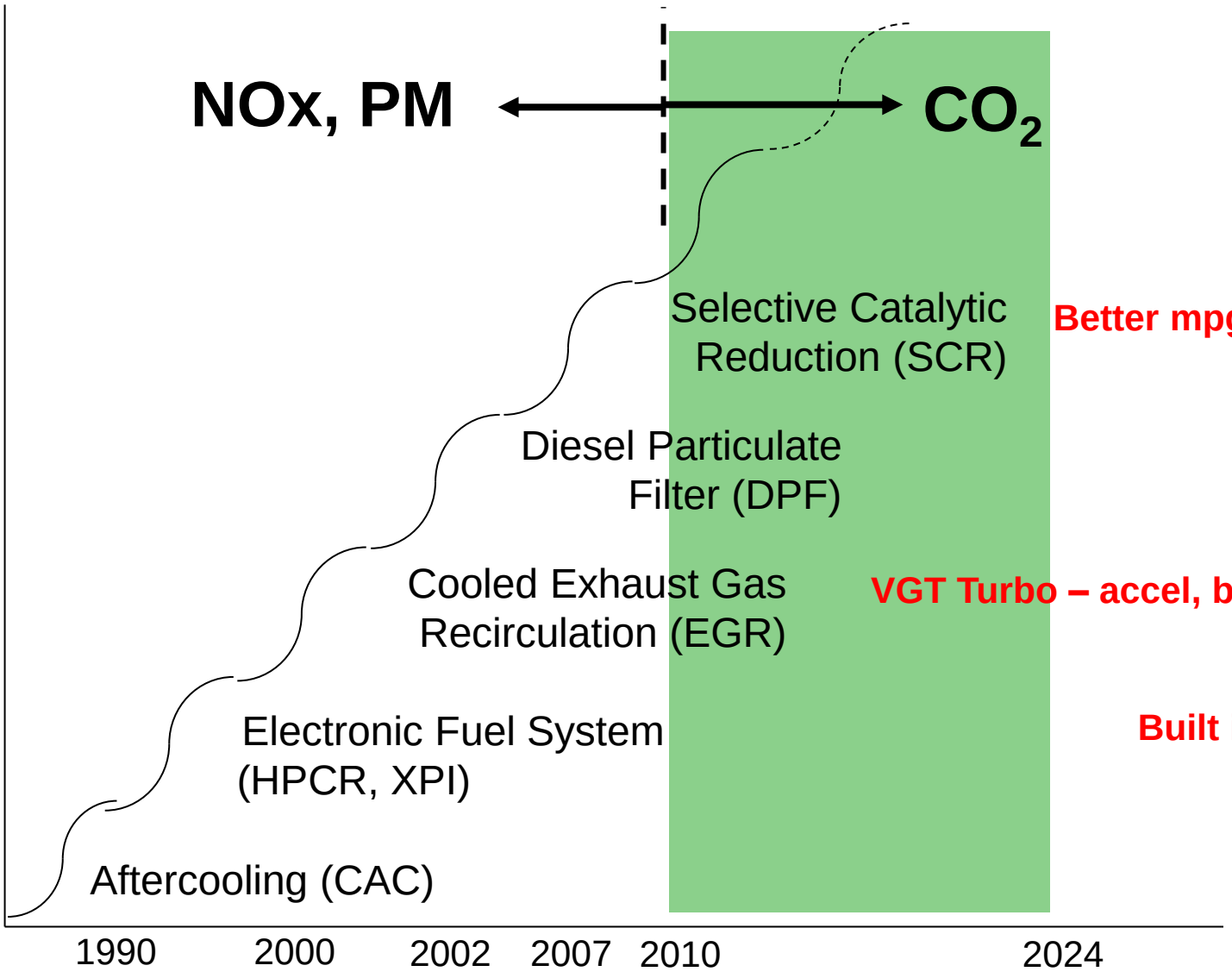




* Phase-In Average

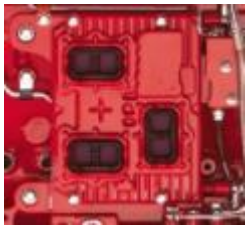
Near Zero Emissions

Technology for Emissions Helps Customers



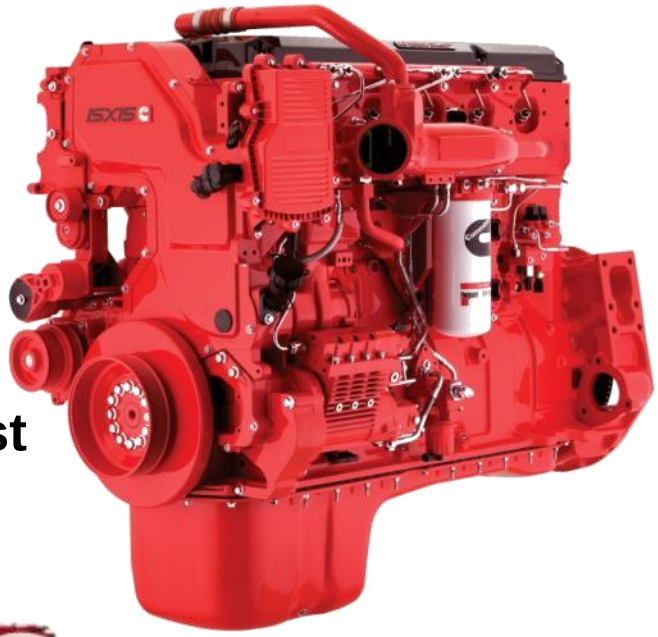
Cummins Owns its Own Technology

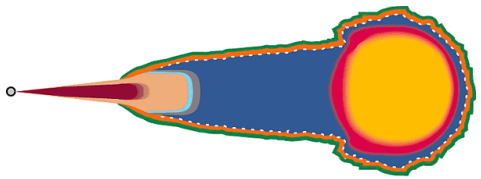
Filters and fluids



Electronic Controls

SCR catalyst and DPF





Combustion Technology

Variable Geometry Turbo (VGT)

Fuel Systems (XPI, HPCR)

Operation

Pre Trip Inspection

Before Starting

- **Check fluid levels – Oil, Coolant**
  - Level surface, wait 15 minutes for oil to drain to pan
  - Never remove radiator cap if coolant is hot (>120 degrees)
- **Air Intake**
  - Check Restriction indicator

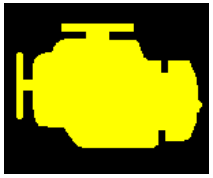
After Starting – walk around coach

- **Check gage levels** (DEF, fuel, air pressure)
- **Water in Fuel lamp?**
- **Look for leaks, smoke**
  - Should be no smoke from exhaust on 2007 and newer
- **Listen for air leaks or other unusual noises**

Operation – Dash Lamps

HEST (High Exhaust System Temperature) lamp
Elevated exhaust temperature. **Don't drive over leaf pile.**

DPF (Diesel Particulate Filter) lamp – soot is present in exhaust filter. **Increase system temperature by doing a highway drive for 30-40 minutes.**



Check Engine Lamp – check fluid levels, gages, sounds, and smells – **make a plan to get service**. Can be coupled with De-Rate

Stop Engine Lamp – **pull over as soon as it is safely possible.** This will require a visit to a Cummins service center.

Diesel Exhaust Fluid (DEF) lamp – indicates when DEF level in tank is low. **Correct with refilling DEF tank.**

Malfunction Indicator Lamp (MIL) – OBD and emissions control system related – **make a plan to get service.**

Two lamps on dash? make a plan to get service

Do you speak engine?

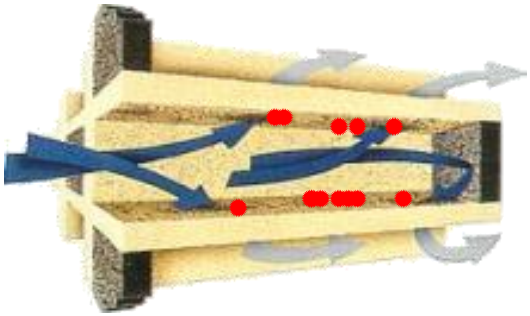
- Cummins Guidanz – 2007 and newer
  - Read your check engine light from your smart phone
  - App is free

- Inline Mini adapter (part number 5299909)
  - Bluetooth datalink adapter
  - Plugs under dash near steering wheel
  - Can move from vehicle to vehicle

- Process
  - If CEL comes on, plug in and read code
  - Call local Cummins service location
  - Click “share” to open email to send your ECM data

Operation: What is Regeneration?

- Soot accumulates in the DPF
- Without regeneration, DPF can plug
- We oxidize the soot by regeneration
  - Passive – any time exhaust system is hot
  - Active – extra fuel creates extra heat
- All that is left is ash (minerals)



Similar to how your self cleaning oven works

Fuel Economy

- What consumes horsepower?
  - **Aerodynamics (>50 mph)**
    - Air drag is a function of speed (10 mph = 1 mpg)
    - Customer control – **slow down**
  - **Rolling Resistance (<50 mph)**
    - Function of weight, road surface, tires, tire pressure
    - Customer control – **proper inflation and tire selection**
  - **Accessories**
    - cooling fan/alternator/freon compressor (40-60 hp)
    - Customer control – **clean radiator and keep dash a/c system charged**
  - **Changes in Speed**
    - Customer control **– use cruise control**

Engine braking

- Two types of auxiliary braking
  - **VGT Exhaust brake –** restricts exhaust
    - Switch ON/OFF on dash (B6.7/L9)
  - **Compression brake –** releases compression
    - Switch ON/OFF and SwitchHI/LOW or HI/MED/LOW (L9/X12/X15)
- Benefits
  - Better vehicle control
  - Eliminates brake fade downhill
  - Service brake life – but not a factor in motorhomes

Compression brake usage

- Maximum braking at higher engines speeds – this is why the transmission downshifts
- Allison will not force a downshift that will overspeed
- Do not use during icy or slick road conditions
- Okay to leave switch in on position
- Won't engage unless accelerator pedal is at 0%
- Works in cruise control but hysteresis 7-10 mph over set speed

- **Low vs. High**
  - Typically use low for supplemental around town driving
  - Downhill with 3 stage brake
    - Start on high – if you slow too much, simply switch to medium
    - If medium slows you too much, switch to low
    - If low isn't enough for you to hold speed, switch back up to medium

Other operating tips

- **Warm-up –** operate with light throttle until coolant temperature reaches 150 degrees
- **Cooldown –** light load – idle for 3-5 minutes
- **Monthly engine exercise**
  - You are exercising the generator monthly, why not the engine?
  - Good – run engine at high idle (use the cruise set switch) until reaching operating temperature
  - Better – run engine at high idle and move coach forward and back
  - Best – go for a 20-30 minute drive at highway speed
- **Idle Speed** - Engine may automatically increase speed to warm up or reduce soot in DPF

Maintenance

Motorhome Maintenance Intervals

	B6.7 (200-360hp)	C8.3/L9 (330-450hp)	ISX12 (500hp)	ISX15/X15 (550-605hp)
Coolant testing	6 months	6 months	6 months	6 months
Oil and oil filter*	12-18 months 15,000 miles	12-18 months 20,000 miles	6 months 25,000 miles	12 months 30,000 miles
Fuel filter*	12-18 months 15,000 miles	12-18 months 20,000 miles	6 months 30,000 miles	12 months 30,000 miles
Coolant Filter*	n/a	n/a (optional)	n/a	12 months 50,000 miles
Overhead* Adjustment	150,000 miles	150,000 miles	24 months 250,000 miles	500,000 miles
Crankcase Breather Element+	Every 3rd or 4th oil change	Every 3rd or 4th oil change	150,000 miles	125,000 miles
DEF filter	200,000 miles	300,000 miles	300,000 miles	300,000 miles
DPF cleaning	200,000 miles	200,000 miles	200,000 miles	200,000 miles

*Whichever occurs first ‘

+2021 engines do NOT have a crankcase breather element

Chassis Builder – Coolant, Air Filter, Air Dryer Cartridge, Radiator Belts – 5 year inspection

Air System

- **The most expensive mistake you can make**
  - Only takes a teaspoon of dust to create major damage
  - Dirt can damage turbo, cylinder head, power cylinders

- Maintenance
  - Follow chassis manufacturer recommendation (12-24 mos)
  - Check restriction indicator when fueling
  - Pay attention when installing the filter
  - Check for loose or broken clamps

Fluids – Fuel

- Buy from high volume location (truck stop)
- Cummins does NOT require fuel additives
  - Two special cases where fuel additives can be useful:
    - Black “slime” in fuel filter
      - Biocide and fuel filters
    - Cold weather operation
      - Fuel can gel at temperatures below 15 degrees
      - PowerService Diesel Fuel Supplement +Cetane Boost (white bottle)
- Biodiesel
  - Suggest not storing long term with Biodiesel
  - EPA2002 and later – OK to B20; All OK up to B5

Fluids – Oil

- Use a name brand oil

- API Classification
  - Preferred: **CK-4** (don't use FA-4)
  - **Pre2021 – 15w40**
  - **2021 and later – 10w30; 15w40 acceptable**

- Synthetic Oils
  - More expensive than mineral based oils
  - Do NOT extend oil drain intervals
  - Main benefit – very low temperatures (-13 deg F) or very high temps

- Oil analysis
  - Can be useful to detect contaminants
  - Should NOT be used to extend drain intervals

Fluids – Coolant

- Coolant has many jobs
  - Protect against corrosion and liner pitting
  - Cool engine and transmission, lubricate seals
- Know what coolant you have
  - Top off only with the same brand
  - Tell your service provider what coolant you want
- Test
  - 2x per year for freeze point (CC2806)
  - Annually for proper chemistry (CC8997 – OAT)
    - If coolant fails – drain, flush, refill
  - Especially Freightliner chassis prior to 2017!
- Drain and refill after 5 years

Fluids - DEF

- Freezes at 11°F (does not degrade)
- ISO spec 22241-1 – 32% Urea, 68% deionized water
- Shelf life 1 – 2 years depending on temperature
  - Avoid direct sunlight and temperature above 78°F
- Non-toxic, non-polluting, non-flammable
- 2-6 gallons DEF for 100 gallons of diesel
  - Most motorhome DEF tanks are 10-15 gallons
  - Sized for about 2-3 complete fuel tank fill ups

DEF Lamp Sequence

or

- Just like your car
  - There is a DEF level gage on dash, a gage on tank, and warning lamps
  - Lamp comes on if you don't pay attention to gage
- Lamp sequence

1. Solid

2. DEF Solid
CEL Solid

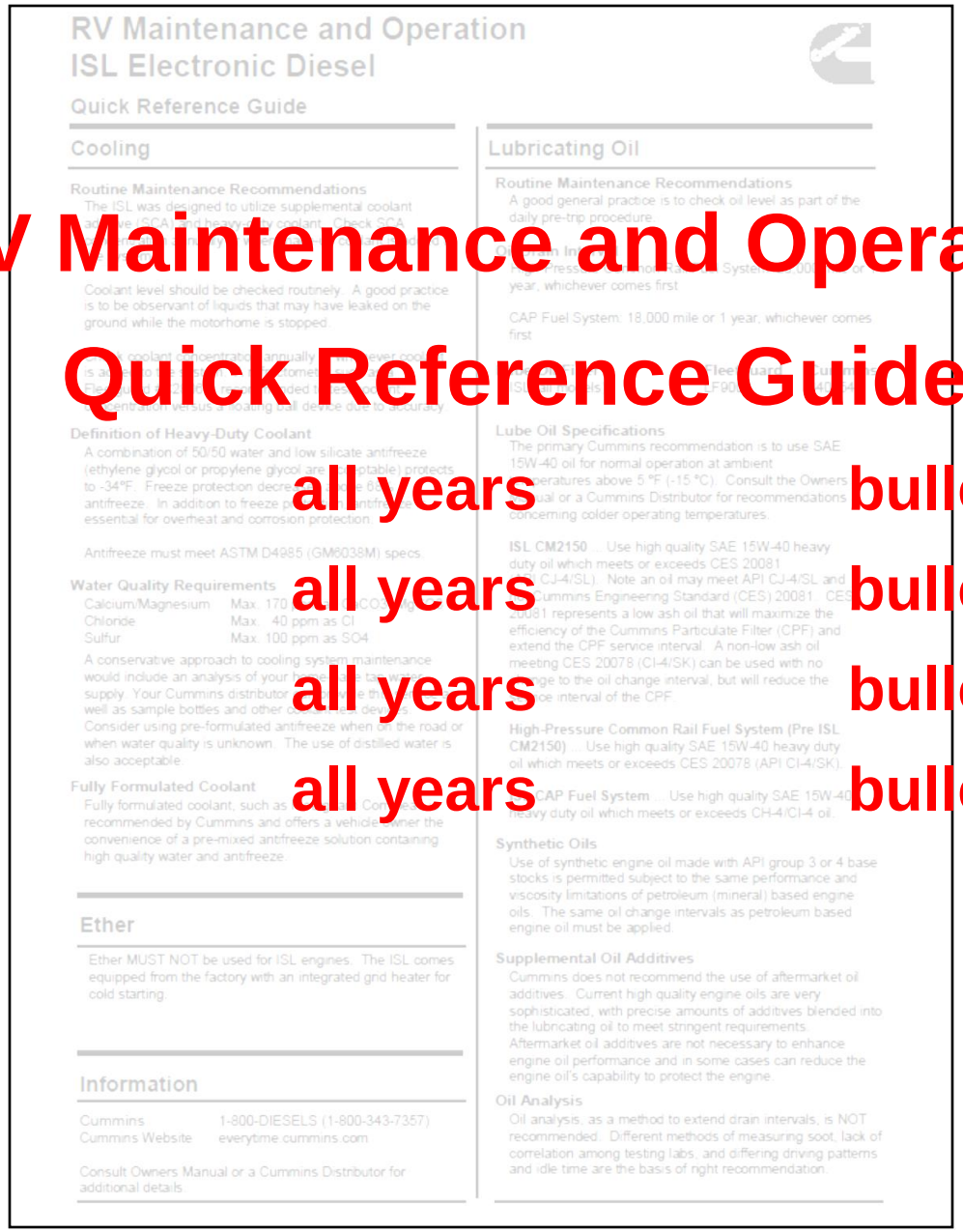
3. DEF Blinking
CEL Solid

4. DEF Blinking, CEL Solid and Stop Engine

- If you ignore the lamps, there are consequences
  - Torque derate (Step 2 – 25% derate, Step 3 – 45% derate)
  - Step 4 – limited to 5 mph – "inducement"
    - If Step 4 - don't idle >1 hour, don't fill fuel without DEF, don't key off

Long term storage (6 months) suggestions

- Better to change oil/filters before storage than after
- Fill fuel tank (prevent condensation)
- Don’t store with Biodiesel or use the exercise program
- A monthly exercise program is good
  - Operating temperature, lubricate parts, charge batteries
- Tighten DEF cap – prevent the “brick”
- Check coolant freeze protection (northern states)



RV Maintenance and Operation

Quick Reference Guides

B6.7	all years	bulletin 4971286
L9	all years	bulletin 4971288
ISX12	all years	bulletin 4971384
X15	all years	bulletin 5410810

Customer Support

Types of Cummins service locations

- Cummins Coach Care locations (60+)
  - RV friendly repair locations
  - Meet certain criteria (tools, facilities, amenities)
  - **Top of the line locations**
- Cummins Distributor locations (200)
  - Names start with Cummins (e.g. Cummins Sales & Service, etc)
  - Parts and service for both engines and generators
  - **Specialists**
- Cummins Dealer locations (3500)
  - Have a Cummins sign
  - Typically dealers of a truck OEM (Navistar, Freightliner, etc)
  - Parts and service for chassis and engine
  - **General Practitioners**

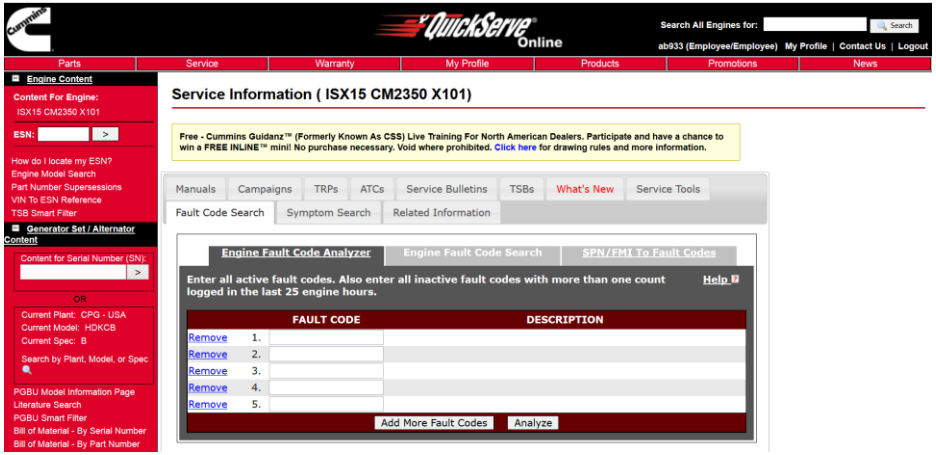
Cummins Care

- 1-800-CUMMINS™
  - Engines, generators, parts, service information – “One Cummins”
  - 24/7/365

- Cummins Care representative
  - Will ask for information (Engine s/n and location)
  - Can help locate closest authorized repair location
  - Can assist you with scheduling the unit into the repair location
  - Can answer questions you might have

Service Information

- Cummins QuickServe Online
  - Quickserve.cummins.com
  - Free for up to 5 ESNs (limited owners plan)

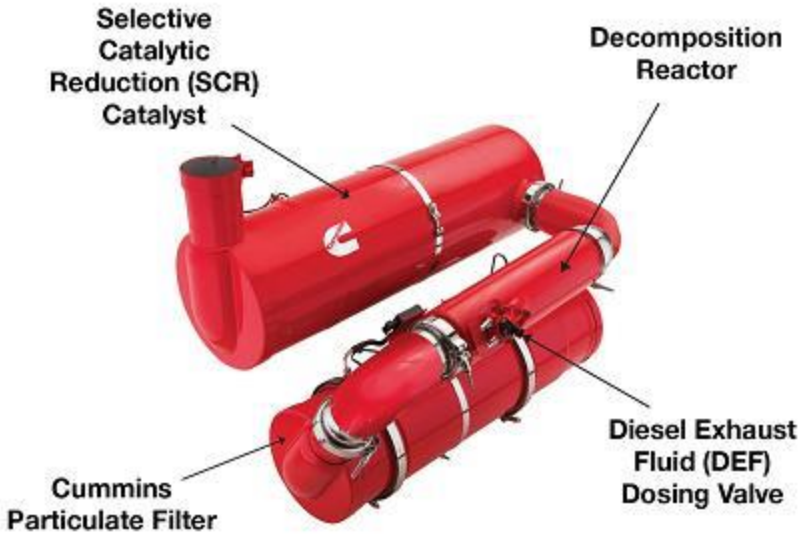


- QuickServe Mobile – for your handheld device

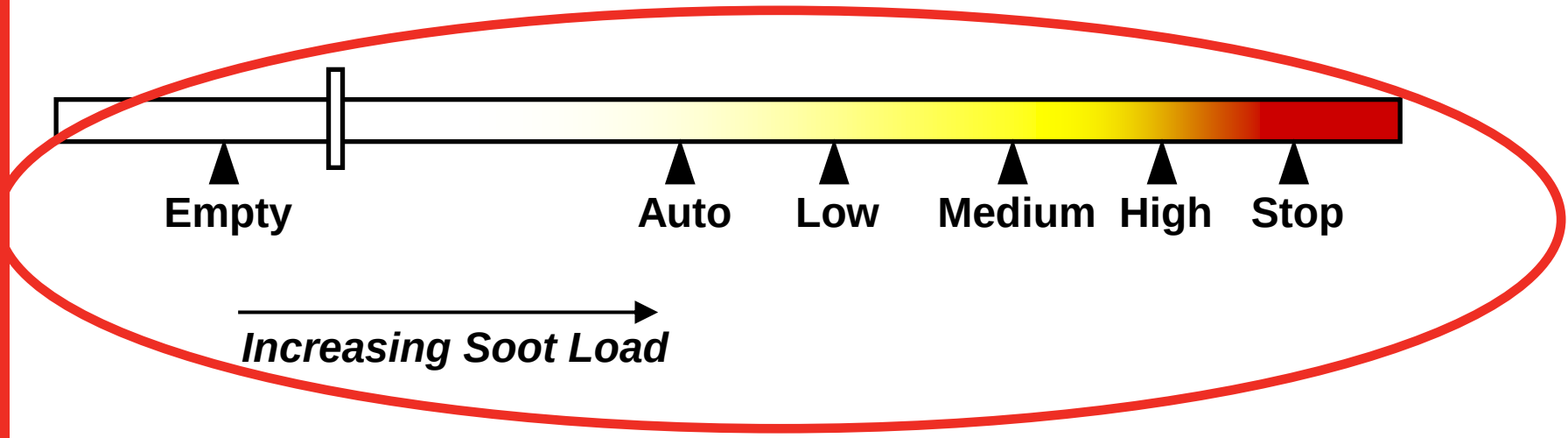
Appendix

2010 - SCR

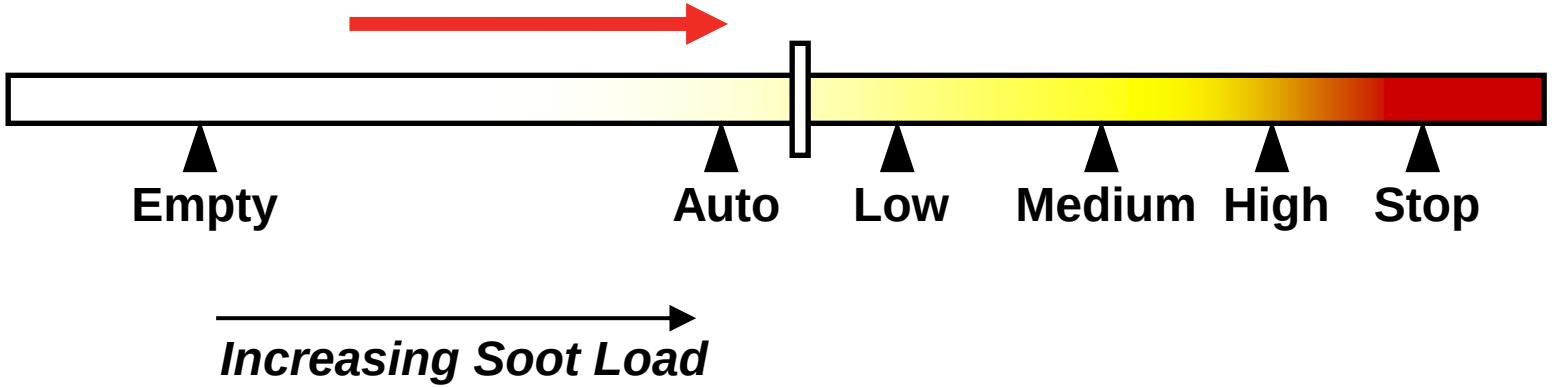
- **SCR** – Selective Catalytic Reduction
- DEF (urea) is injected to make ammonia
- Ammonia + NOx react to form nitrogen and water
- Allows better engine tuning – mpg, power, maintenance



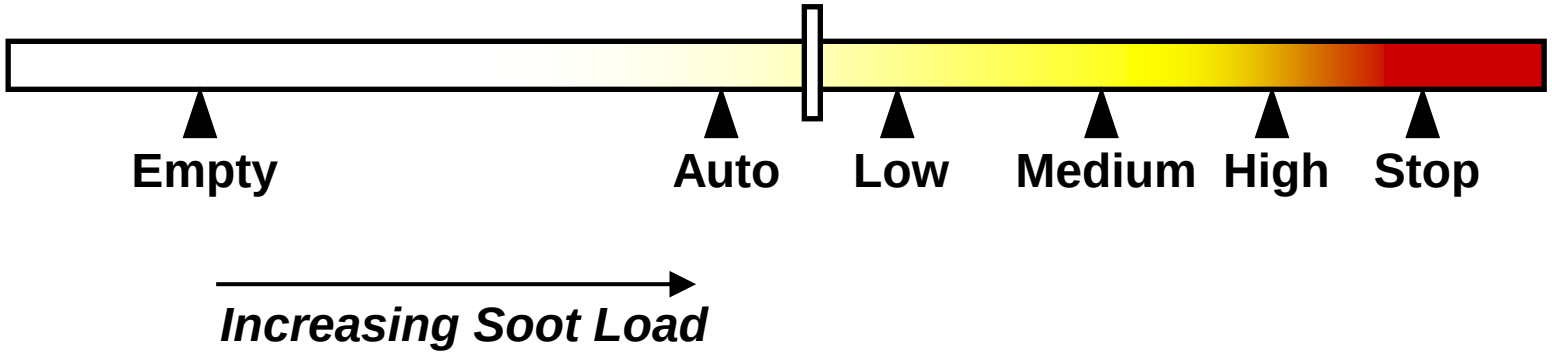
Regeneration Lamp Sequence



No lamps on
System is filtering exhaust
Soot is collecting in the DPF
Enjoy the ride

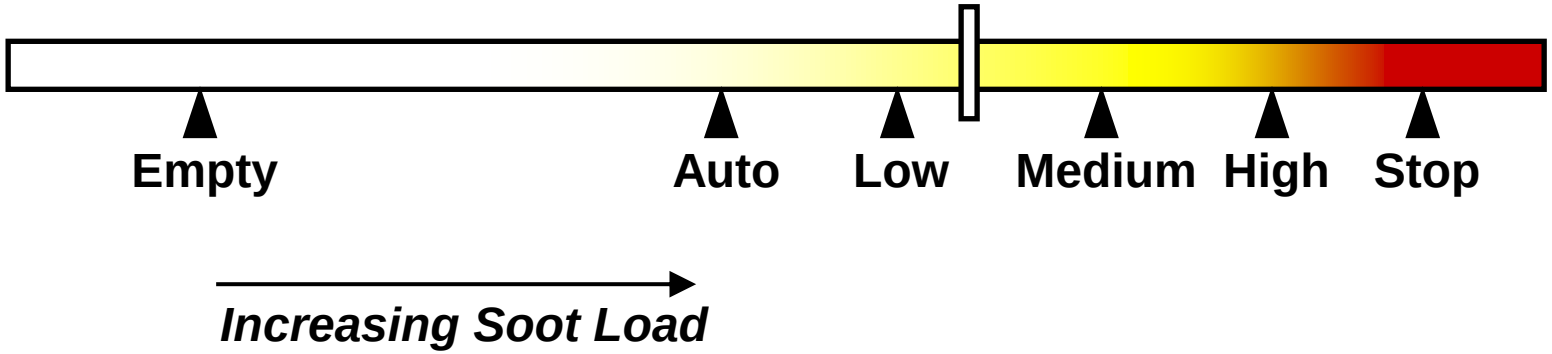


No lamps on
Passive regen is occurring
System may actively regenerate
Might hear different noise from turbo
Enjoy the ride

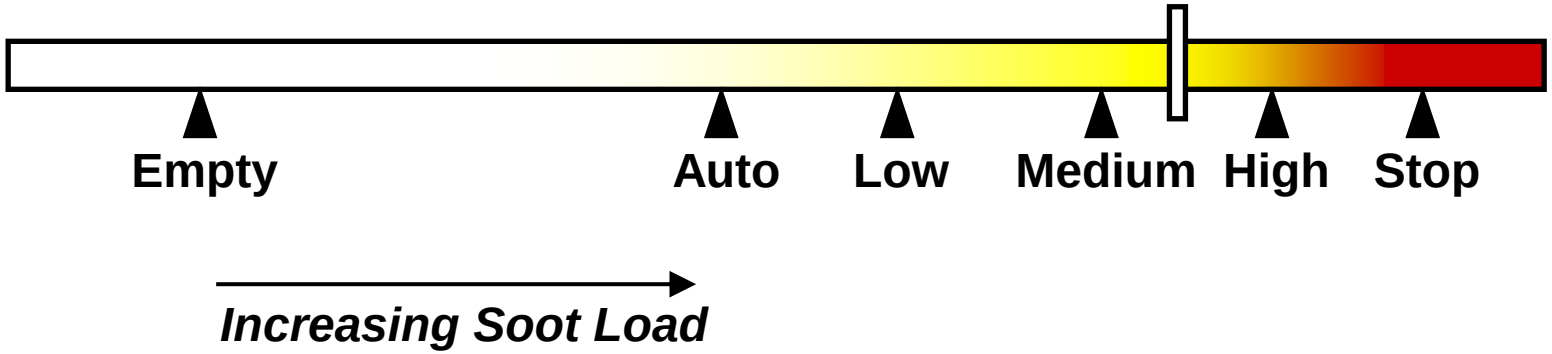


Exhaust temperatures are high

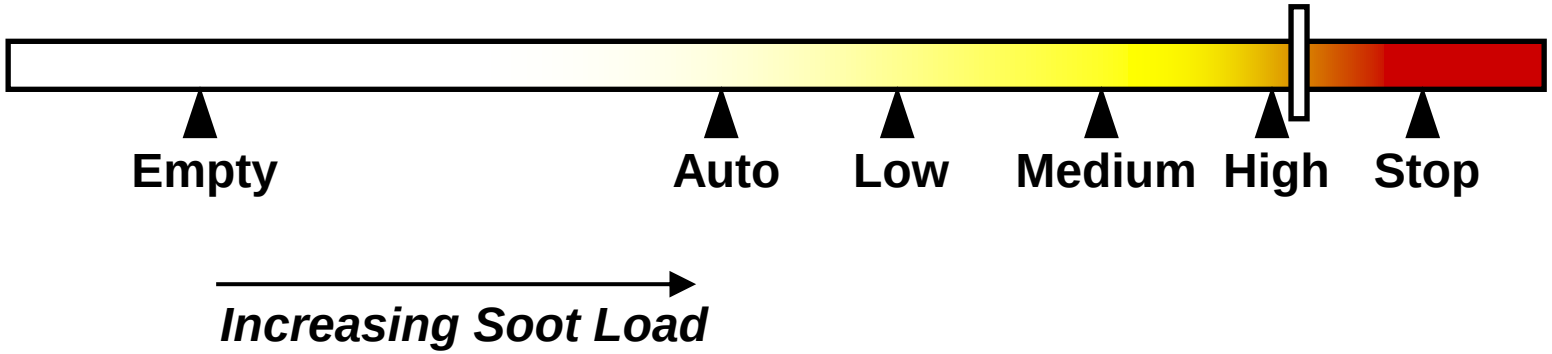
Don’t drive over a dry leaf pile



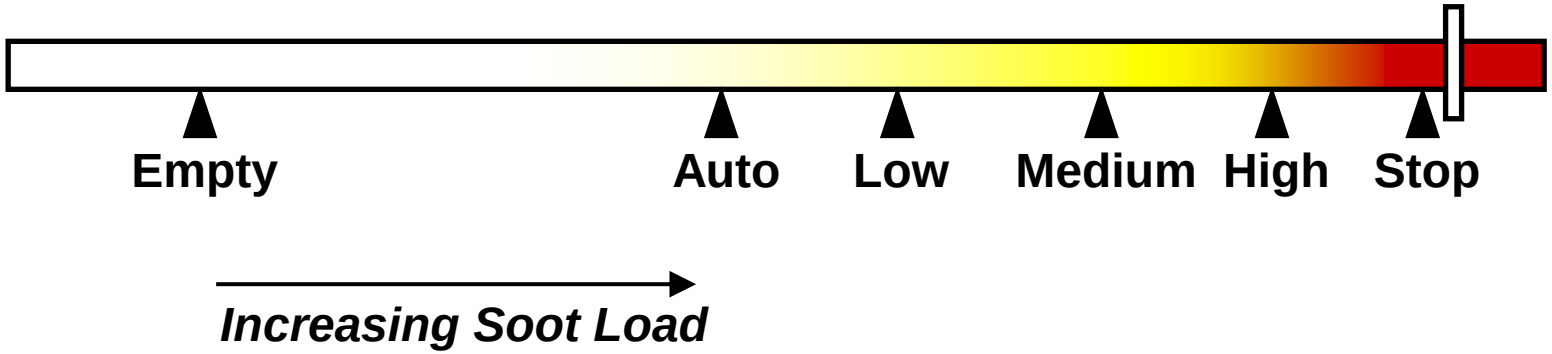
DPF lamp on solid
Low level of soot in DPF
Go for a highway speed drive



DPF lamp flashing
Medium level of soot in DPF
Go for a highway speed drive



DPF lamp flashing – Check Engine Light on
High level of soot in DPF
Go for a highway speed drive
Or make plans to visit Cummins shop



DPF lamp flashing – STOP Engine Light on
Stop operation as soon as it is safely possible
Will require a visit to Cummins shop