Update on Experimental Locomotive Emissions Technologies (R&D Projects)

SD59MX 3000 HP locomotives with experimental Exhaust Gas Recirculation (EGR)

Genset switchers with experimental Diesel Particulate Filter (DPF) applications

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West Coast Collaborative conference call
February 07, 2012
SD59MX locos. w/ experimental EGR

- Joint project between Union Pacific RR and EMD
- UP paid for re-powering (10) SD60Ms into SD59MXs
- EMD made R&D investment into developing EGR
- SD60Ms were built in late-1980s/early-1990s
- UP has no need for more 3000 HP units, done for R&D
- 3800 HP 16-cyl. T0 engine > 3000 HP 12 cyl. T2 engine
- Reducing engine size 25% “made” space inside carbody
- Exhaust Gas Recirculation (EGR) developed & installed
- Developmental proof-of-concept of EGR for future T4 locos.
- Alternative to urea/DEF and Selective Catalyst Reduction aft.
What is “EGR” on SD59MXs?

- Exhaust Gas (~10% of total volume) is cleaned in DOC+DPF
- … cooled (in a gas-to-water cooler)
- … and then Recirculation takes treated gases back into the engine’s air intake
- Recirculated gas has lower oxygen ($O_2$) content
- … which reduces NOx content of entire exhaust volume

- Experimental (12 cyl.) EGR package weighs >4,000 pounds and occupies space roughly 4’ x 6’ x 5’ (~120 cubic feet*) + ducting
  - * Roughly the size of seven (7) telephone booths
- Size of the EGR was basis for re-powering with smaller engine
- Again … this is emissions technology under development
Initial results: SD59MX w/ EGR for R&D

- (9) units now operating inside Los Angeles basin
- “Hauler service” between W. Colton & rail yards at/near coast
- Qualify as ULELs (ultra-low emitting locos.) per ’98 MOU

EPA line-haul emissions, Federal Test Procedure:

- NOx reduced 41% to 3.23 g/bhp-hr (v Tier 2 = 5.5)
- PM reduced 36% to 0.14 g/bhp-hr (v Tier 2 = 0.22)
- Fuel increased 0.5% (very low fuel penalty)

- First test locos. in revenue service w/ experimental EGR as a possible Tier 4 NOx technology w/out urea/DEF SCR
- Revenue service experience now needed to determine reliability and durability of the technology
SD59MX w/ developmental EGR

3800 HP SD60Ms being surveyed for project in July 2009

First 3000 HP experimental SD59MX with EGR installed

16 cylinder T0 “710” engine

12 cylinder T2 “710” engine
Experimental DPF on Genset Switchers

- Experimental application of Diesel Particulate Filters (DPF)
- (2) 2100 HP multi-engine Genset switchers
- UPY 2737, Johnson-Mathey DPF on (1) engine, CARB baseline
- UPY 2755, J-M DPFs on (3) engines, AB118 & Ports funding

Compared to Gensets as-built (2007) EPA line-haul FTP:
- PM reduced 84-91% (to ~0.011 g/bhp-hr)  1/3rd of Tier 4 limit
- NOx unchanged
- CO reduced 99+% and HC all but eliminated
Experimental DPFs on Genset switchers

Johnson-Mathey DPFs on UPY 2755 roofline