

The New Federal Program to Control Locomotive Emissions

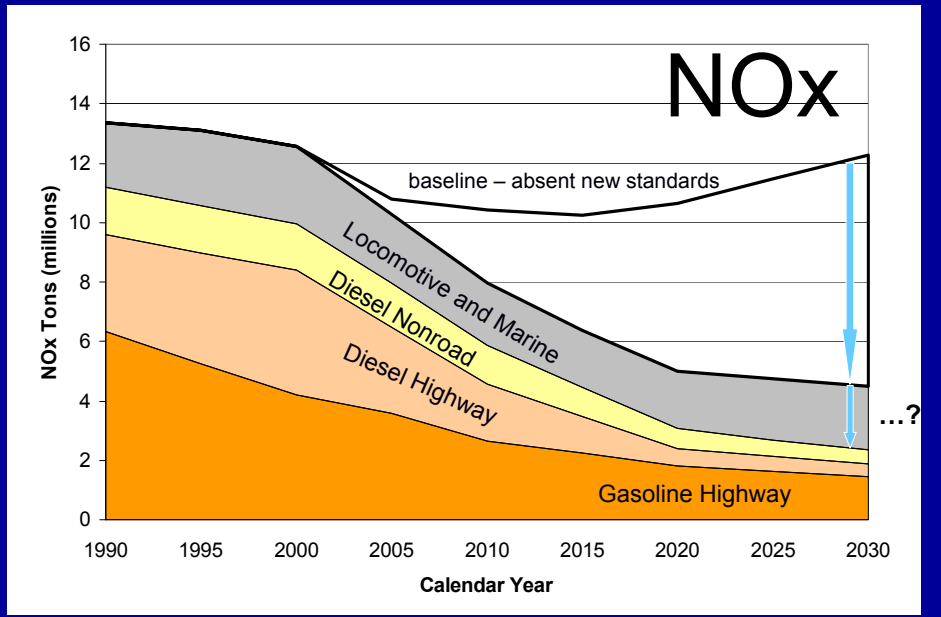
Don Kopinski, U.S. EPA
Faster Freight -- Cleaner Air
Los Angeles
February 25, 2008



Overview

- A fruitful collaborative effort 2004-2007
 - what we proposed
 - major issues we've worked through since
- A Closer Look at One Key FRM Issue –
 - Tier 4 NOx Catalyst Durability

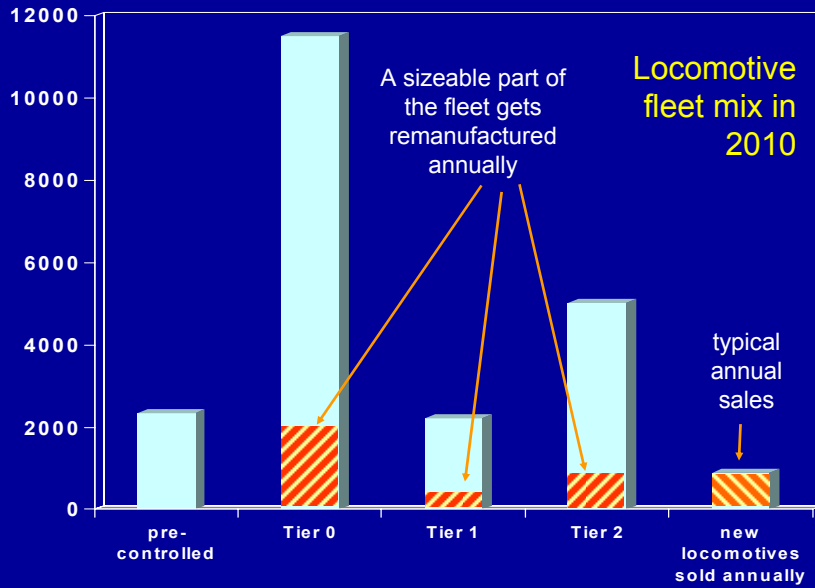
A Slide From a March 2005 MSTRS Briefing



Problems Can Turn Out To Be Opportunities

- **Traditional Agency Approach**– set future standards for new engines and allow natural fleet turnover to effect air quality improvements
- **The Problem**– locomotives can be in service 40 years+
 - rebuilt again and again
- States (and the breathing public) can't wait that long for cleaner air
- **The Opportunity**– Set new standards for remanufactured locomotives
 - And have them take effect asap after final rule is signed
 - Also set shorter- AND longer-term standards for newly-built units
- Extension of approach first used in 1998 locomotive rule

The Significance of Locomotive Remanufacturing



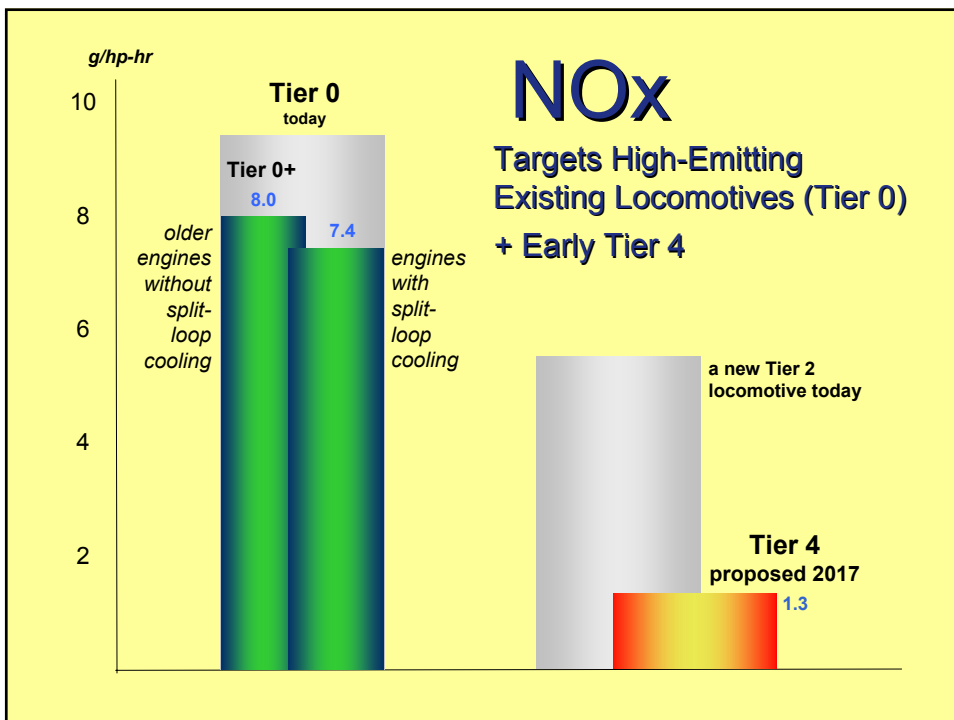
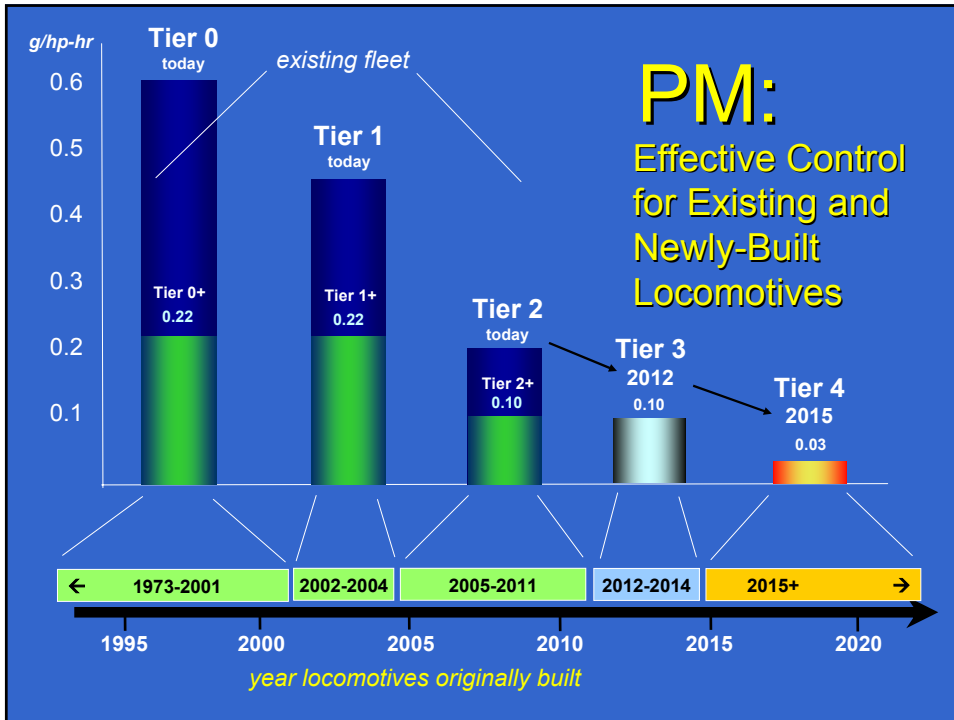
Comprehensive 3-Part Program

remanufactured existing locomotives starts 2008

newly-built Tier 3 starts 2012 engine-based

newly-built Tier 4 starts 2015 aftertreatment-based

Additionally, in all 3 parts of program: Idle emissions control-- automatic engine stop/start



Encouraging Low-Emission Switchers

- Stringent new standards alone could prove counterproductive
 - Added cost could drive RRs to continue maintaining old switchers
- Streamlined certification using “nonroad” engines –unlimited sales
- Standards set to be feasible for traditional “medium-speed” engines too
- Revised credit calculations to properly credit replacing old switchers with refurbished ones



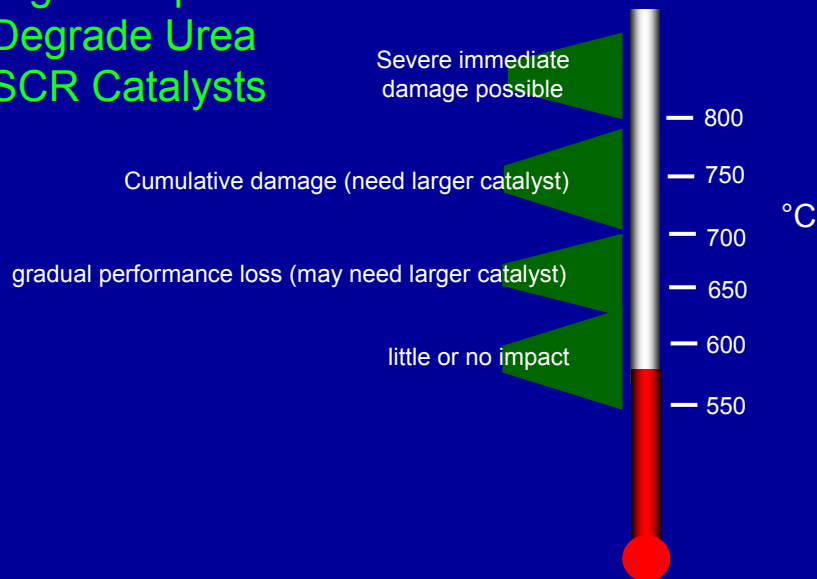
Improving on the March 2007 Proposal

- **Some of the Major Comments--**
 - EPA has taken too long to finish this rulemaking
 - Program doesn't get reductions early enough for SIP targets
 - NOx catalyst durability unproven for high temperature operation
 - Need to include smaller RRs Tier 0+ program
 - Give credit for emission reductions from energy-saving innovations
- **Many constructive meetings** with stakeholders over past year
 - Exploring ways to pull-ahead earlier NOx benefits
 - And address other comments
- **Resulting Final Rule** expected to provide more emission reductions and have broader support than proposal
 - This is crucial because some provisions would start right away

Major FRM Issue Tier 4 NOx Catalyst Durability

- Two mechanisms:
 - High temperature thermal damage
 - Poisoning
 - phosphorous, zinc, other metals in engine oil accumulate on catalysts

High Temperatures Can Degrade Urea SCR Catalysts



2 Research Initiatives

In the Field--

- Collaborative field testing: EPA, GE, EMD, UP, BNSF
 - Tier 2 locomotives in tunnel operation
 - Find hottest exhaust temperatures

In the Lab (NVFEL)--

- Evaluate performance of state-of-the-art exhaust catalyst system over locomotive emissions test cycle
 - Measure NO_x performance at low hours
 - Accelerate exposure to temperature cycling and catalyst contamination from oil consumption
 - Evaluate again at high hours

High Temperature Tunnel Testing

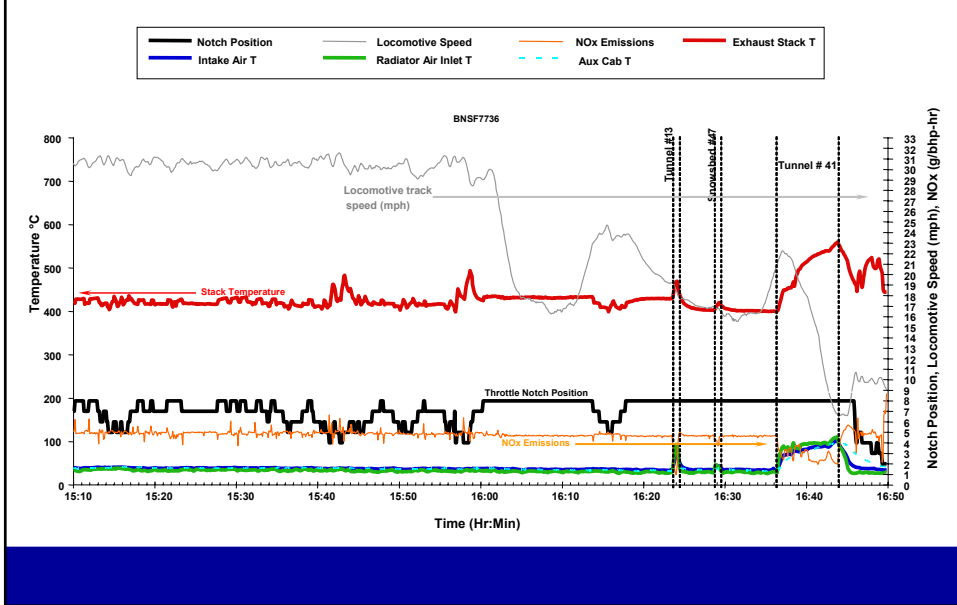
Norden tunnel system
through Donner Pass
August 2007



Worst case conditions

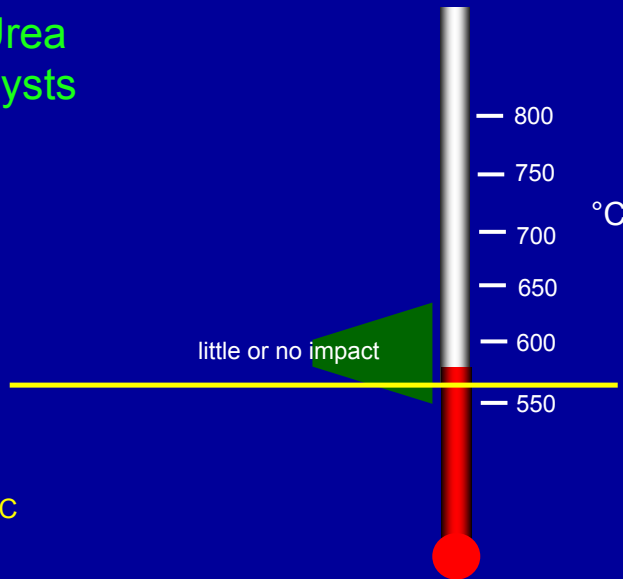
- 95 °F ambient temperature in open air
- Unventilated tunnels-- ~200°F ambient
- Steep grades
- Heavy freight trains (over 8,000 tons)

Example of Data from Tunnel Testing

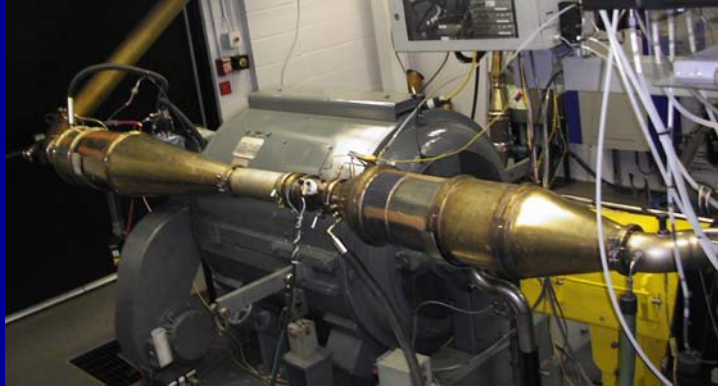


High Temperatures Can Degrade Urea SCR Catalysts

Norden Tunnel Result
Exhaust temperatures remained <560 C



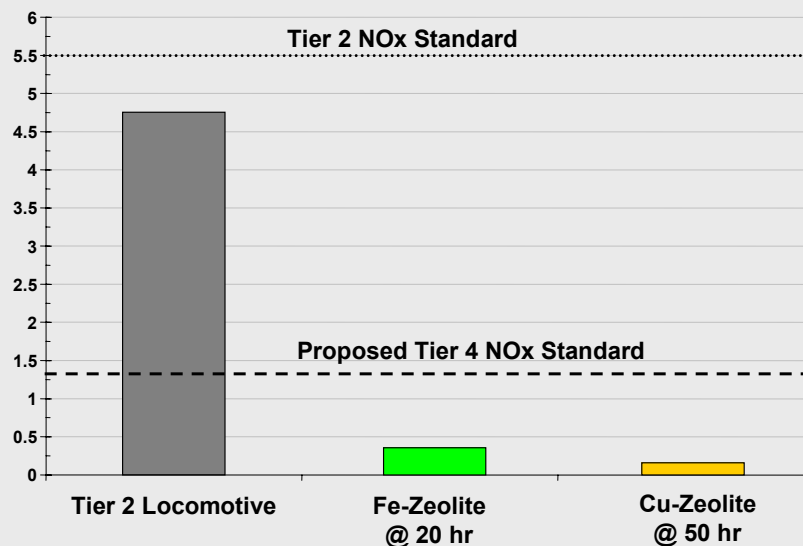
SCR Testing at EPA-NVFEL



- Truck-size engine made to behave like “scaled down” locomotive engine
- Electronic engine management system configured to match exhaust gas of Tier 2 locomotive
- 2010 heavy-duty truck “production intent” components were used for catalysts, urea dosing system, static mixer, sensors and other components

Low Hour NOx Catalyst Performance

NOx (g/bhp-hr)



Accelerated Aging

- **Accelerated Thermal Effects**
 - Operation at Notch 8 equivalent
 - 200 events cycling exhaust temperature to 580 °C
 - Simulation of severe operation in unventilated tunnels
 - Many locomotives would never see this kind of exposure
- **Accelerated Oil Poisoning Effects**
 - High-ash oil dosing
 - ~6 X acceleration of oil poisoning
 - Current LMOA-approved oil additive package

Accelerated Aging Results

