

# The New Federal Program to Control Locomotive Emissions

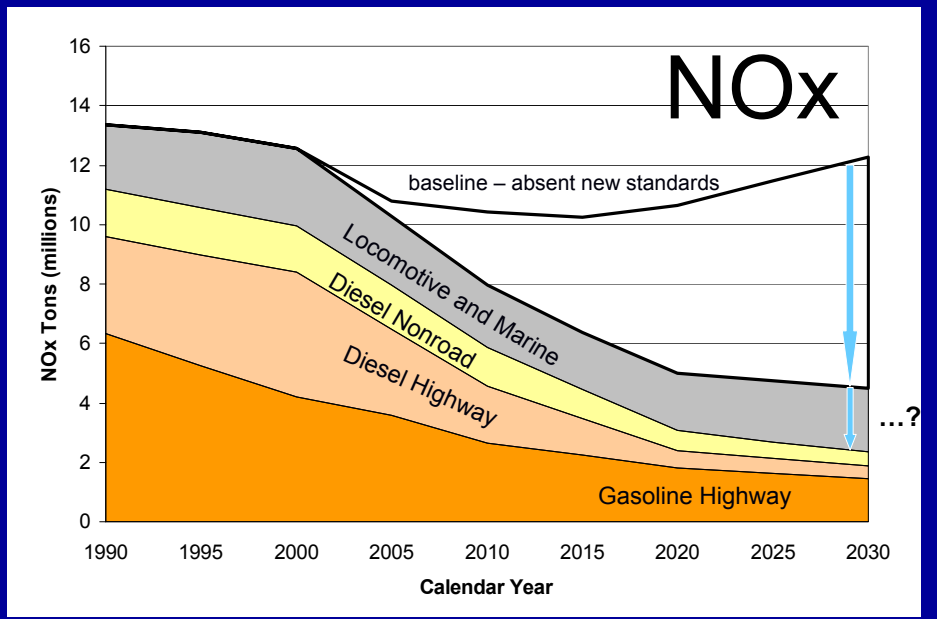
Don Kopinski, U.S. EPA  
Faster Freight -- Cleaner Air  
Los Angeles  
February 25, 2008



## 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

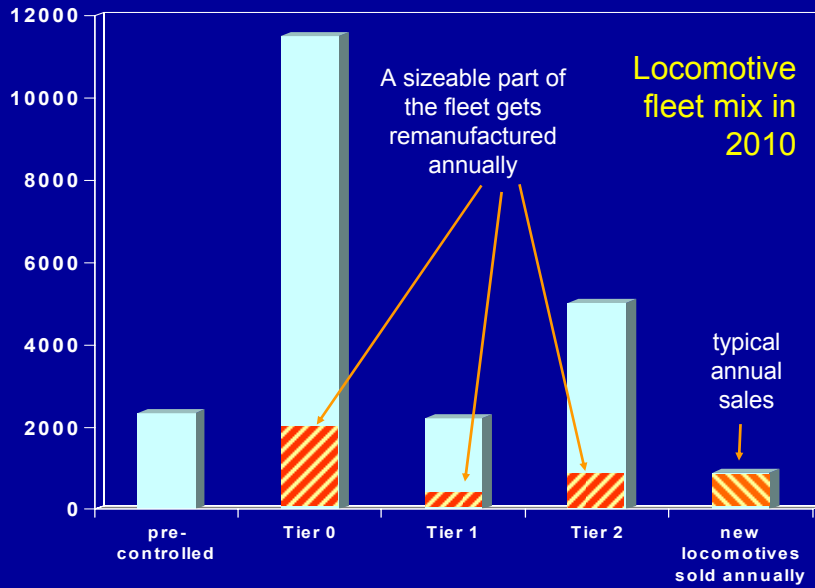
## A Slide From a March 2005 MSTRS Briefing



## 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



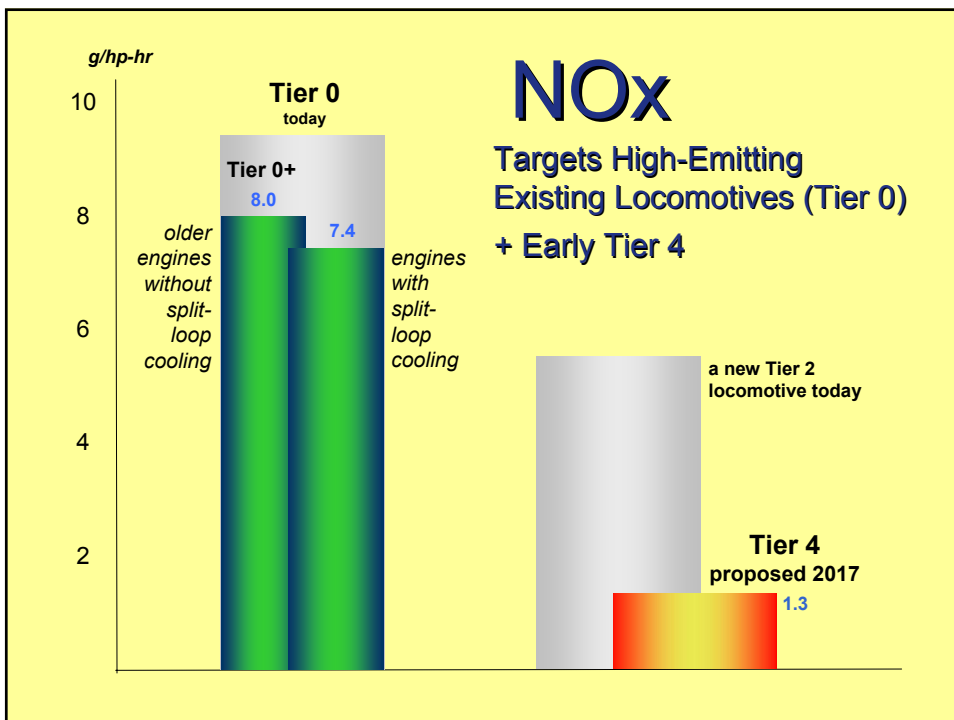
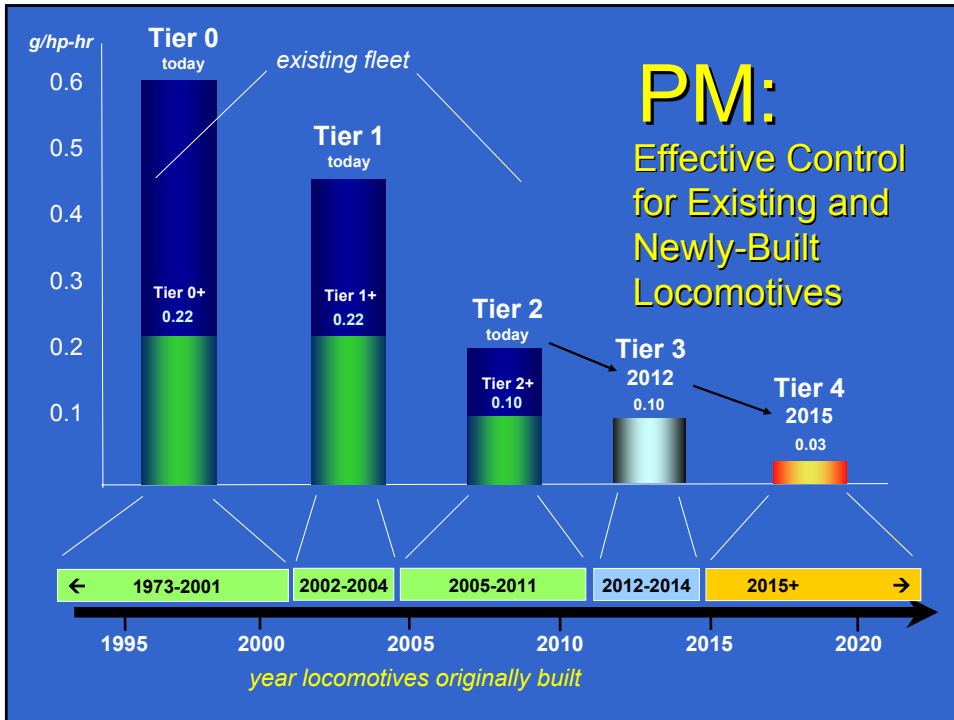
## Comprehensive 3-Part Program

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



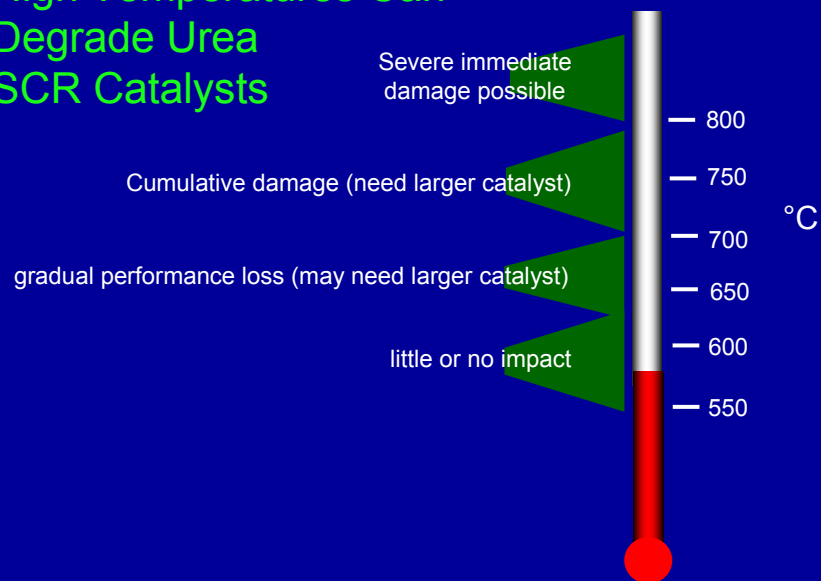
## Improving on the March 2007 Proposal

- **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<sub>x</sub> performance at low hours
  - Accelerate exposure to temperature cycling and catalyst contamination from oil consumption
  - Evaluate again at high hours

## High Temperature Tunnel Testing

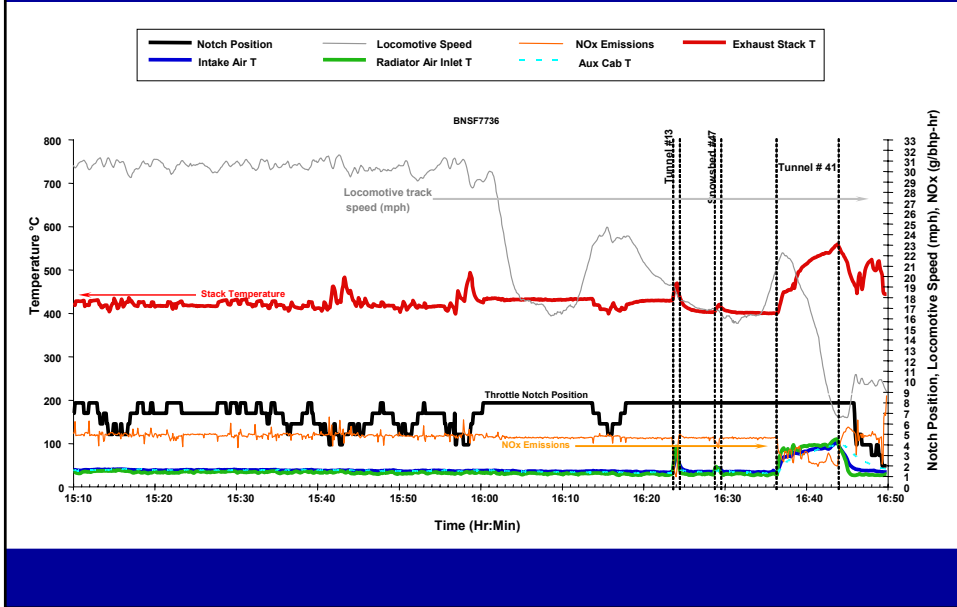
Norden tunnel system  
through Donner Pass  
August 2007



### Worst case conditions

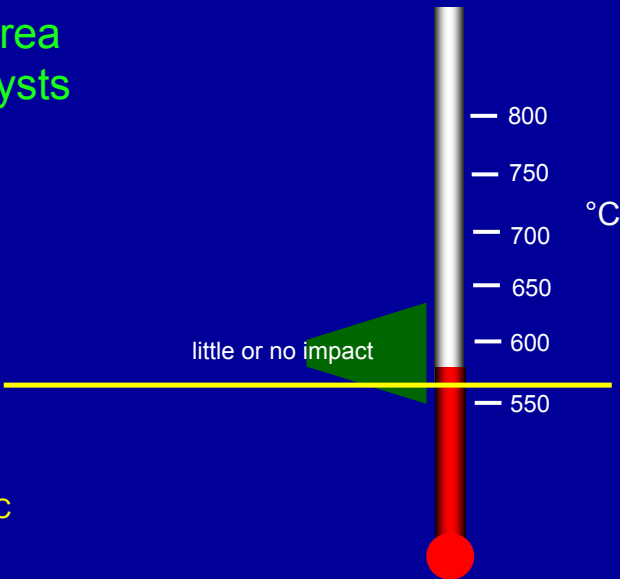
- 95 °F ambient temperature in open air
- Unventilated tunnels-- ~200°F ambient
- Steep grades
- Heavy freight trains (over 8,000 tons)

# Example of Data from Tunnel Testing



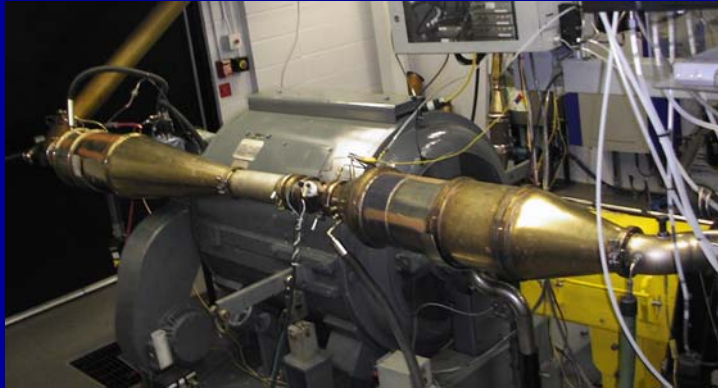
High Temperatures Can Degrade Urea SCR Catalysts

Norden Tunnel Result  
Exhaust temperatures remained <560 C





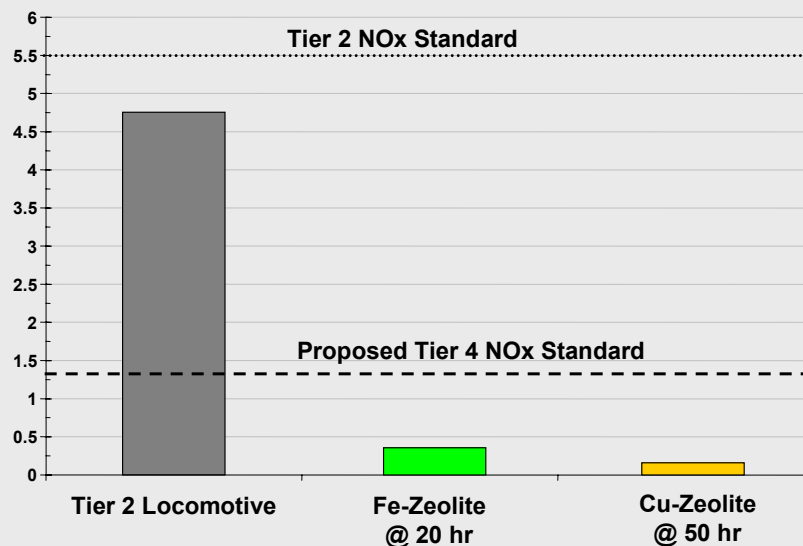
## SCR Testing at EPA-NVFEL



- 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

