Diesel Emission Control Strategy Verification

Retrofit Assessment Section

August, 2005

California Environmental Protection Agency
Air Resources Board

Objectives of Verification

- Support the Diesel Risk Reduction Plan Goals, and Support the Fleet rules
  - Determine if Emission Reductions are Real and Durable
  - Quantify Emission Reductions
  - Ensure Emissions Performance Through In-Use Compliance Program

Verification Process

- Provide “Pre-Application”
  - Description of Strategy
  - Desired Emission Control Group
- Determine a Test Plan
- Submit Completed Application Including all Data/Testing
- Staff Review of Application
- Verification

Diesel Emission Control Strategy Verification Procedure

- Required PM Reduction - 25% Minimum
- Optional NOx Reduction - 15% Minimum
- Emission Testing
- Durability Demonstration
- Multimedia Evaluation for Fuel Based Strategies
- Warranty Requirements
- In-Use Compliance Testing
  - Reciprocity with U.S. EPA Verification for Select Systems

Emissions and Durability Testing

- To Quantify Actual Emissions Reductions
- Test at Beginning and End of the Durability Demonstration
- Durability Demonstration Designed to Show Performance Under Real-World Conditions
- Measurements
  - PM, NOx, NO_2, HC, CO, and CO_2
  - Backpressure and Exhaust Temperature
  - Additional Analysis May be Required as Needed: Toxics

Minimum Warranty Periods

Engine Type	Engine Size	Min. Warranty Period
On-Road	Light Heavy-Duty	5 years or 60,000 miles
	Medium Heavy-Duty	5 years or 100,000 miles
	Heavy Heavy-Duty	5 years or 150,000 miles; or 2 years, unlimited miles*
Off-Road (incl. Portable Engines) and Stationary	Under 25 Hp	3 years or 1,600 hours
	Between 25 Hp and 50 Hp	4 years or 2,600 hours
	Above 50 Hp	5 years or 4,200 hours

*difference is dependant on use and mileage

In-Use Compliance Testing

- Required for 50 Units or More
- Manufacturer Conducts Testing Under ARB Supervision
- Two Phases of Testing:
  - End of First Year or First Maintenance
  - 60 to 80 percent of Warranted Life
- Four to Ten Units to be Tested at Each Phase
- Consistent With U.S. EPA

Fuel Based Strategies

- Require Multimedia Assessment
- Fuel Additives
  - Must be Used with Diesel Particulate Filter Unless Proven Safe to Use Alone
  - Additional Tests at High Dose
  - Require Review of Environmental and Health-Related Data Every Two Years

EPA Reciprocity

- Facilitate the Verification Process
  - Applicant Involves both EPA and ARB at Start of the Verification Process
  - Allows for Simultaneous Review by Both Programs
  - Potentially Allows Testing and Data to be Appropriate for Both Programs
- For Hardware Based Strategies Like DOCs and DPFs
- No Agreement for Fuel Based or SCR Technologies
- EPA Requires SOF Testing, ARB Requires NO_2 Testing

Verified Technologies

- Level 3 (85+% PM reduction or 0.01 g/bhp-hr)
  - **Cleaire**: DPF + Lean NOx Catalyst, 1993-2003, On Road, ULSD, 25% NOx
  - **Cleaire**: Reflash + DPF, 1994-98 Cummins M11, On Road, ULSD, Quasi-Steady State Applications, 25% NOx
  - **Clean Air Partners**: DPF, Natural Gas/Bi-Fuel, 1996-2002, On Road, ULSD/CARB
  - **CleanAIR Systems**: DPF, 1996-2005, Stationary Emergency Generators
  - **Donaldson**: DPF, 1994–2002, On Road, ULSD
  - **Johnson Matthey**: DPF, 1994-2006, Select EGR, non-EGR, On Road, ULSD
  - **Johnson Matthey**: EGR + DPF, Select 2000/2001 Cummins, International, DDC, On Road, ULSD, 40% NOx
  - **Lubrizol ECS**: DPF, 1994-2003, On Road, ULSD
  - **Lubrizol ECS**: DPF, 1996-2004, Off Road, ULSD/CARB

Verified Technologies

- **Level 2 (50+% PM Reduction)**
  - **Environmental Solutions Worldwide**: Flow Through Filter, 1991-1993, On Road, ULSD/CARB
  - **Lubrizol**: PuriNOx, 1988-2003, On Road, 15% NOx
  - **Lubrizol**: DOC + PuriNOx, 1996-2002, Off Road, 20% NOx

Verified Technologies

- Level 1 (25+% PM Reduction)
  - **Cleaire**: DOC + Lean NOx Catalyst, 1993-1998 Cummins M11, On Road, Quasi Steady State, ULSD/CARB, 25% NOx
  - **Donaldson**: DOC, 1988-1990, On Road, ULSD/CARB
  - **Donaldson**: DOC + Crankcase Filter Systems (several), 1988-2002, On Road, ULSD/CARB
  - **Donaldson**: DOC + Crankcase Filter, Select 1996-2003, Off Road
  - **Extengine**: DOC + SCR, Select 1991-1995 Cummins, Off Road, ULSD/CARB, 80% NOx
  - **Lubrizol ECS**: DOC, 1991-2003 Cummins/Navistar, On Road, ULSD
  - **Lubrizol ECS**: DOC, 1973-1993 DDC, On Road, 2 Stroke, ULSD/CARB
  - **Lubrizol ECS**: DOC, 1996-2002, Off Road, USLD

NO_2 Emission Limit Background

- Originally Adopted 20% Cap (May 2002)
  - Cap Included Engine-Out NO_2
  - Effective Jan 1, 2004
- Delayed Limit to Jan 1, 2007 (Feb 2004)
  - No Verified Filters were Compliant
  - Found Some Engines have High NO_2
- NO_2 Working Group Reevaluated Limit
  - Emphasis on Microscale Exposure

NO_2 Emission Limit Current Proposal

- Board Date of December 2005
- Limit Incremental Increase of NO_2 to 20% of the Total Baseline NOx Emissions
- Use Engine-Out NO_2 as Criterion for Approval of Test Engine
- Effective January 1, 2007

FOR MORE INFORMATION

Verification Procedure:

http://www.arb.ca.gov/regact/dieselrv/dieselrv.htm

Verified Retrofits:

http://www.arb.ca.gov/diesel/verdev/verdev.htm