



National Clean Diesel Campaign

Verification Opportunities

**Verification Workshop
December 13, 2007**

Dennis Johnson, Team Leader
Retrofit Technology Verification Team
National Clean Diesel Campaign
Office of Transportation and Air Quality

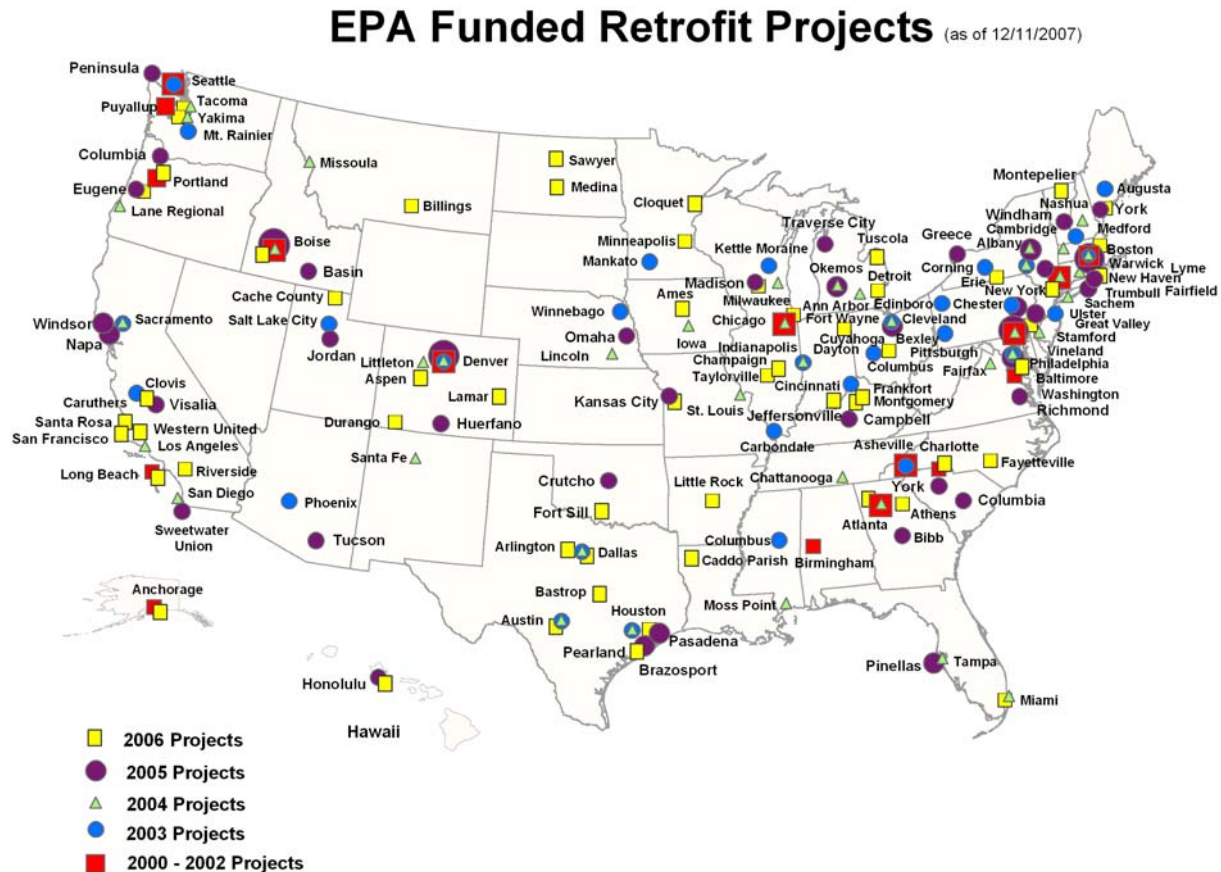


Overview

- Why verify with EPA?
- Verification Process
- Implementing NO₂ Limits
- Technology Priorities & Unique Verification Needs
- Conditional Verification
- Emerging Technologies

Why Verify With EPA?

- Funding Opportunities



Why Verify With EPA?

- **Partnership Opportunities**

- EPA's 7 Diesel Collaboratives competed and awarded \$12 million in grants last year
- Major workshops and conferences in sectors
 - NCDC Summit
 - Clean Ships Conference
 - Pacific Rim Conference
 - Funding forums on Innovative financing, CMAQ opportunities
- Interagency proposal to International Maritime Organization for Ocean Going Vessel emission reductions
- Marketing and Outreach

- **EPA Requires Verified Technologies**

- Historically, EPA grants have required verified technologies
- Future funding will Require EPA or ARB Verified Products

Why Verify With EPA?

- EPA Promotes Verified Technologies
 - EPA staff spoke at numerous events with transportation audiences (AMPO, NARC, AASHTO, etc.)
 - All 10 EPA regions held funding forums or events to educate stakeholders about CMAQ opportunities
 - Manufacturers played a key role
 - Presented an award to Tennessee DOT for being the first CMAQ -funded nonroad retrofit project

Why Verify With EPA?

The President and Congress are Promoting EPA's Retrofit Efforts

EPAct 2005: Diesel Emission Reduction Program:

- President proposed \$35M, nonattainment (NA) areas
- House and Senate Marks: \$50 M
 - Senate mark contains additional \$15M for CA
- Program divided into Federal and State components
 - 70% for federal grant/loan programs
 - 50% to public fleets
 - Funds will be distributed through RFPs by EPA Regions
 - Up to 10% for “emerging technologies”
 - 30% for State programs
- Program funding, allocations, criteria, eligibility, etc. subject to final Congressional appropriation language

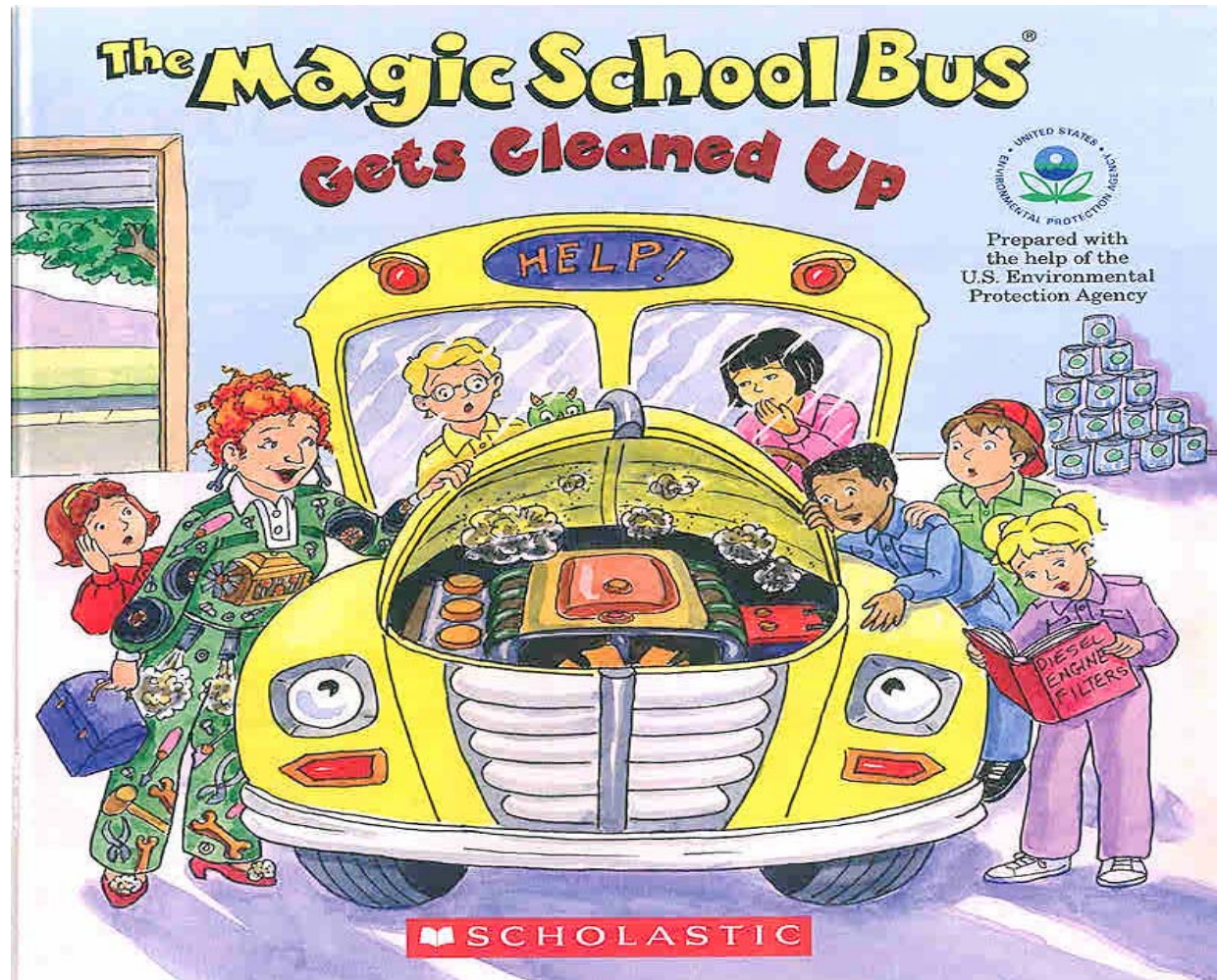
Why Verify With EPA?

EPA Promotes Technologies in Press Events



Why Verify With EPA?

EPA Does Outreach to Promote Diesel Technologies.



Carpenter

DESIGNED & BUILT BY:
FALCON PERSPECTIVES, INC.
45-28 VERNON BOULEVARD
LONG ISLAND CITY, NY 11101
T. 718. 706. 9168
F. 718. 433. 0993



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Emissions
Reduction

Verification Process

- General Verification Description
- Technology Groups
- Steps to Verification & General Process
- ETV Program Coordination
- ARB Coordination
- Common Delays in Getting Verified

General Verification Description

- Objective: Evaluate the emission reduction effectiveness of retrofit technology
 - Verification provides stakeholders with confidence that these technologies will achieve quantifiable emission reductions
- Verification Includes:
 - Application & technology review
 - Testing in accordance with protocols & statistical analysis
 - Durability requirements and manufacturer in-use testing
- Coordinating Verification
 - Manufacturers
 - Testing Organizations
 - Environmental Technology Verification (ETV) Program, Air Pollution Control Technology Center – Research Triangle Institute (RTI) International
 - Testing Protocols & Verification of Devices, SCR, and Fuels & Fuel Additives
 - California Air Resources Board Diesel Risk Reduction Program
 - Memorandum Of Agreement (MOA) for reciprocity in device verification

Technology Groups

- **Devices**
 - Diesel Oxidation Catalysts (DOCs)
 - Partial filters
 - PM filters (DPFs)
 - Engine modifications
 - Other devices
- **Fuels**
 - Alternative fuels (emulsions, biodiesel)
 - Reformulations
 - Fuel additives
 - Lubricants and lubricant additives
- **Selective Catalytic Reduction**
- **Other Technologies & Vehicle Systems**



A FIRST STEPPING STONE BOOK

Junie B. Jones and the **Stupid Smelly Bus**

She'll do anything to get
out of riding that bus!



**BARBARA
PARK**

Author of *Skinnybones*

Devices

- Typically: DOC, DPF or combination of technologies
- Generic Verification Protocol
- Testing with ULSD on the FTP (cold and hot start cycles)
- Typical Testing
 - FTP cycles: cold + hot + hot + hot
 - Supplemental Emission Test (SET) for NO_x technologies
 - Baseline, Degreened Device, Aged Device (≥ 1000 hours)
 - Within one week and without engine or equipment modifications
 - Report all results and voided tests
 - Void testing only for regulatory procedure problems or with EPA approval
 - All test results may be considered in OTAQ analysis
- Important Points
 - Manufacturer is responsible for testing outside of ETV Program
 - All testing & evaluation of devices should be reported
 - All measurements should be described

Fuels, Fuel Additives & Lubricants

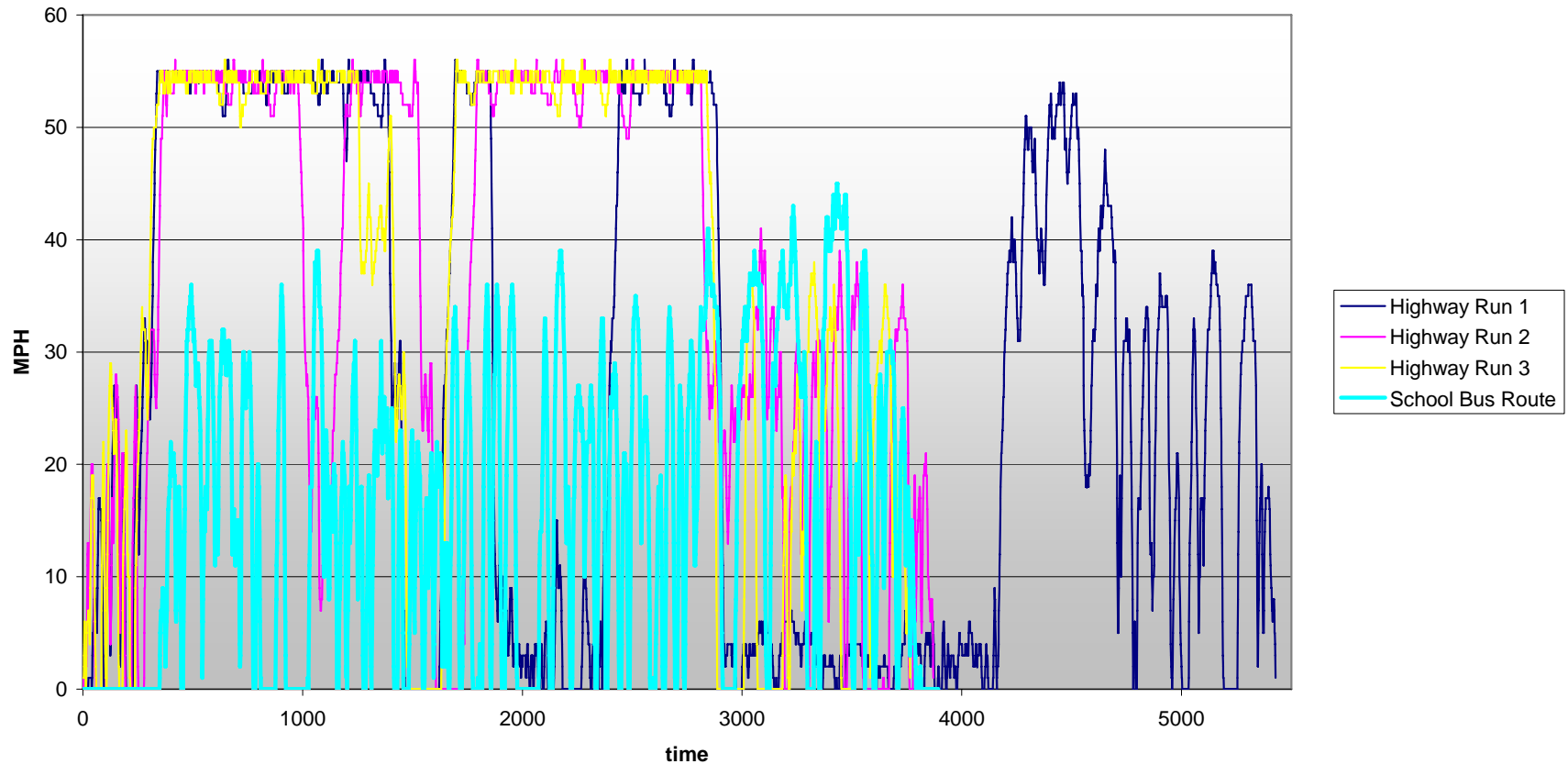
- Fuel registration is required
- Generic verification protocol
- Reduction mechanism must be described
- Typical Sequences
 - FTP (cold and hot start cycles) and SET
 - Immediate effect
 - Cumulative effect
 - Check for engine emissions returning to baseline
- Scope of coverage may be limited with concern for data showing similar performance on different engine technologies

SCR

- Application & detailed technical description
- Generic Verification Protocol
- Reductant (urea) infrastructure concern
- Driver notification & inducements
 - Reference guidance at CISD-07-07,
 - Low tank level – multiple levels of alarm
 - System malfunction
 - Engine no restart
- In-use experience with a representative system
- Testing
 - FTP: C, H, H, H + SET
 - Baseline, degreened & aged
 - Functional Testing
- Scope of coverage will depend on the system

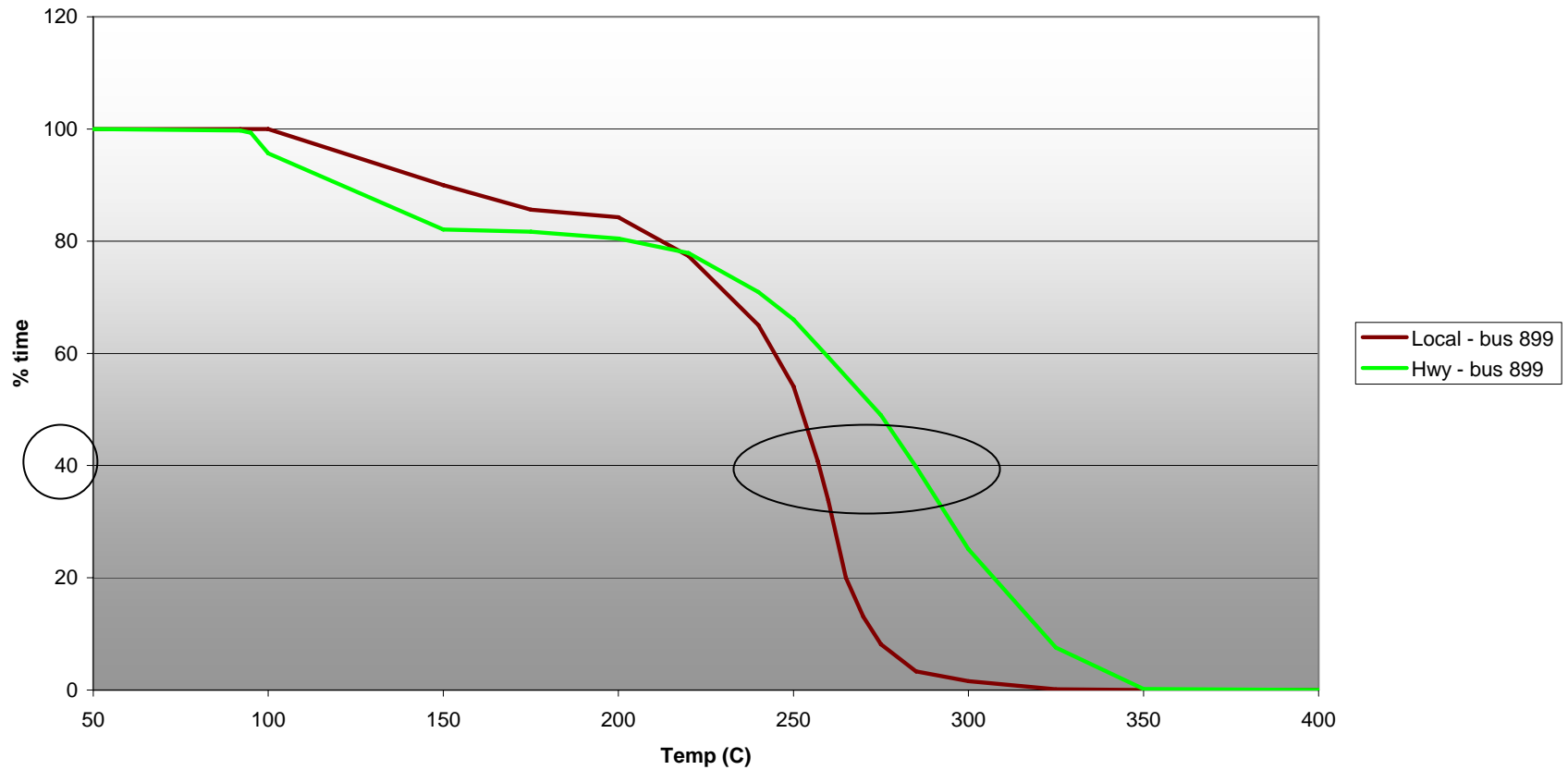
In-use Operation

Vehicle Speed - School Bus 542



Same Engine Different Operation

School Bus Exhaust Temperatures



NCDC Verification Process

Four Steps to Verification

1. Application
2. Test Plan Preparation
3. Testing
4. Data Review & Analysis

NCDC Verification Process

A simple example

Manufacturer Applies To EPA & RTI. Application is reviewed.



EPA, RTI & Manufacturer Develop Test Plan



RTI, Testing Organization & Manufacturer
Develop and Sign Statement of Work



Testing Performed & Documented



RTI Performs Data Analysis & Generates ETV Report(s)

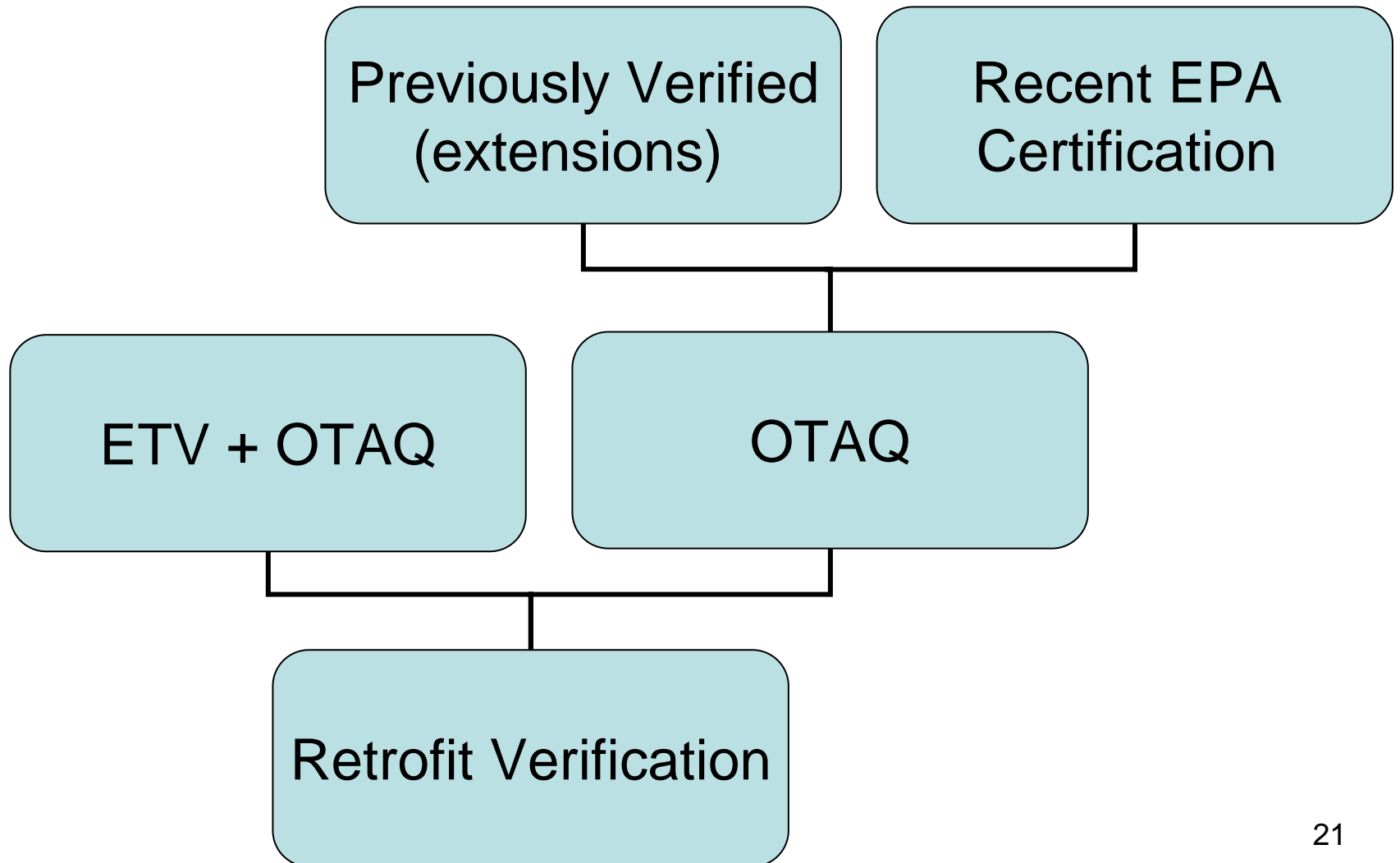


OTAQ Evaluates Results & Includes on Verified Technology List



Explore Expanding Verification to Other Engines

NCDC Verification Process



ETV Program Coordination

- Environmental Technology Verification (ETV)
 - Program develops testing protocols and verifies the performance of innovative technologies that have the potential to improve protection of human health and the environment. ETV was created to accelerate the entrance of new environmental technologies into the domestic and international marketplace. ETV is also verifying monitoring and treatment technologies relevant for water security.

Roles

ETV

- ◆ Coordinates testing between EPA-OTAQ, Lab & Mfr.
- ◆ Prepares test/QA plan
- ◆ Audits ETV test labs
- ◆ Conduct or contract ETV tests
- ◆ Issues ETV verification reports and statements



OTAQ

- ◆ Evaluates total application package & technology
- ◆ Addresses durability & in-use operation
- ◆ Interprets emissions reductions data from ETV
- ◆ Sets emissions reductions for technologies and posts on NCDC Web site
- ◆ Extends applicability and sets requirements for additional data





ARB Coordination

- Similar Program Requirements
 - Application
 - Testing
- In-use Testing
 - Combined program possible
 - More sources for devices
- Verification with EPA & ARB creates more opportunities

Keep it Up-to-Date

- Technologies sold as verified must be manufactured as documented to EPA and ARB
- Application, parts descriptions & technical information must be updated to represent current production
- Product literature must be clear about EPA verified levels
- Criteria in verification must be maintained in representing verified technologies
- Manufacturers are responsible for their verified products when a distributor or installer is their representative
- Failure to meet obligations or misrepresenting technologies may delay future verifications or result in other action by EPA or ARB
- Verification should increase credibility –
Please don't reduce yours.



Points to Consider for a Timely Verification

- Incomplete technical information
- Manufacturer technical experts are not included in the process
- Technical papers and installation instructions should match the application or detailed differences described
- No aged system available
- Aged system does not match production
- Devices not right for the test engine
- Devices do not match the intended scope
- Test engine issues
- Slow response to questions
- Inadequate response to technical question
- Experienced staff move to new positions

Anticipated EPA NO₂ Limits

- January 1, 2009 - Implementing Limits
- 20% increase from baseline
- ARB Test Procedures
- Manufacturers must supply data to EPA for currently verified technologies
- Data and reports required by ARB may be provided to EPA to show compliance
- Future testing must include NO₂ analysis
- EPA testing for NO₂

Technology Priorities & Unique Verification Needs

- Priorities
 - Nonroad
 - Engine Upgrades from Manufacturers
 - Technologies participating in the ARB Showcase
 - NOx
 - SCR needs to address issues in guidance
 - In-use exhaust temperature & performance experience
- Unique Technologies Needs
 - Marine
 - Locomotive
 - Other Technologies

Unique Verification Needs

- Non-traditional Verification Starts with the Manufacturer
 - Flexibilities exist within current verification framework
 - Large engines & unique installations leads to special consideration
 - Detailed technical description & in-use system operation will expedite discussion
 - Special testing needs
- Regulatory Requirements Remain
 - Hybrid vehicles must use appropriately certified engines
 - Rebuild requirements hold if applicable

Conditional Verification

- Used to address shortfalls in available devices / data needs
- Available for highway and nonroad
- NOx and PM technologies
- Need confidence in performance and durability
- Manufacturer must apply and have justification

Conditional Verification

- Used to Address
 - Time for service accumulation and to test an aged system – when there is confidence in durability
 - Scope of coverage
 - Initial testing procedures
- May also be used to:
 - Expedite verification for NR and NOx technologies
 - List technologies that have been demonstrated, but unique applications & system experience leaves some uncertainty

Emerging Technologies

- Note – Depends on final DERA funding & requirements
- Sec. 792. (a)(3)(B) Emerging Technologies
 - (i) In General – The Administrator shall provide not more than 10 percent of funds available for a fiscal year under this section to eligible entities for the development and commercialization of emerging technologies.
 - (ii) Application and Test Plan – To receive funds under clause (i), a manufacturer, in consultation with an eligible entity, shall submit for verification to the Administrator or the California Air Resources Board a test plan for the emerging technology, together with the application under subsection (c).

Implementation Emerging Technologies Provisions

- 10% Funding Limitation
- Requirement ... in consultation with an eligible entity....
 - Only "eligible entities" (governments, non-profits, etc.) can apply for grant funds
- Approvable test plans for verification include/are based on:
 - Completed application for verification
 - Science based technical description
 - Test plan may be comparable to
 - a signed ETV statement of work or
 - ARB approved test plan.

Steps to Approvable Test Plans

- Complete application submitted to EPA
- Complete technical description & electronic strategies detailed
- Electronic strategies & monitoring systems meet necessary requirements
- Accepted reduction mechanism description
- Initial scope of verification appropriately specified
- Fuel Registration or any other regulatory obligations met
- Data logging or other operation monitoring identified, and reporting frequency & format established
- Accepted proposal to address compliance and/or functional testing
- Proposed test engine & devices match and within scope of coverage
- Appropriately described fuel(s), lubricants, additives and/or reductant
- Unregulated/ancillary pollutant concerns addressed
- No outstanding safety or health effects concerns
- Timeframe identified for completing testing
- Other information as identified by EPA

Opportunities

- States are asking for technologies
- EPA is promoting verified products
- Fleets are working with EPA
- Grant recipients want options
- Use existing data to expand verified scope
- EPA answers questions about retrofits with positive feedback on verified products
- More Technologies = More Interest

Summary

- EPA verification creates opportunities
- EPA promotes & requires verified technologies for funding programs
- Technology reduction levels are posted
- Concurrent EPA & ARB verification is possible
- Get in the process to verify now

Thank You

Any Questions?

For More Information

Visit EPA's National Clean Diesel Campaign
Website

www.epa.gov/cleandiesel

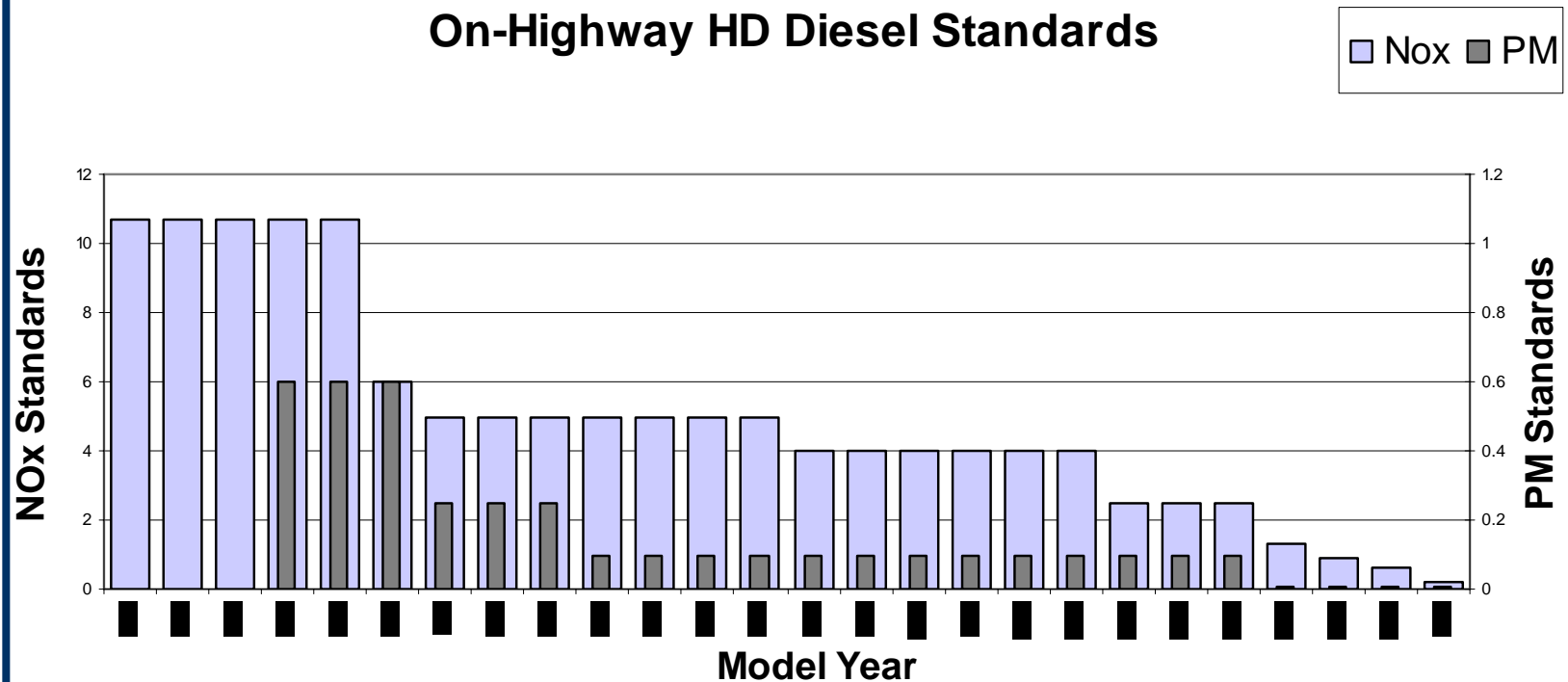


National Clean Diesel Campaign

Reference Materials

- Application form & example application
<http://www.epa.gov/otaq/retrofit/verif-process.htm>
- Verification Protocols
http://www.epa.gov/etv/pubs/05_vp_devrev.pdf
http://www.epa.gov/etv/pubs/05_vp_fuel.pdf
http://www.epa.gov/etv/pubs/05_vp_emissions.pdf
- SCR Certification Guidance, CISC-07-07
http://www.epa.gov/dis/display_file.jsp?docid=16677&flag=1
- Clean School Bus USA
<http://www.epa.gov/otaq/schoolbus/index.htm>
- Magic School Bus Book (via NSCEP)
<http://www.epa.gov/ncepihom/ordering.htm>

Scope of Coverage Depends on Similar Emission Characteristics



Applicability by Verification Boxes

ON HIGHWAY ENGINE FAMILY BOXES

The engine family boxes shown below represent groupings of engine families with similar characteristics (i.e., the emissions standards that the engines were built to) for current and past model years. The boxes are categorized by urban bus or non-urban bus and emissions standards. The number of engine families for each box were tabulated from an EPA engine certification database. Each box consists of six subcategories: 2 or 4 stroke technology and the different categories of engines (LHDDE, MHDDE, HHDDE). An example is shown below the engine family boxes.

EPA considers this framework of engine family boxes to be a guideline only. Manufacturers may demonstrate the appropriateness of extending or limiting the applicability of data, on a case by case basis. EPA will consider analyses based on good engineering judgment and the submission of additional data may, or may not, be required.

<p>PRE MY 1988**</p> <p>BOX OH-1</p>	<p>MY 1988-1989</p> <p>BOX OH-2</p> <table border="1"> <tr><td>HC:</td><td>1.30</td></tr> <tr><td>CO:</td><td>15.50</td></tr> <tr><td>NOx:</td><td>10.70</td></tr> <tr><td>PM:</td><td>0.50</td></tr> <tr><td>No. Of Families:</td><td>288</td></tr> </table>	HC:	1.30	CO:	15.50	NOx:	10.70	PM:	0.50	No. Of Families:	288	<p>MY 1990</p> <p>BOX OH-3</p> <table border="1"> <tr><td>HC:</td><td>1.30</td></tr> <tr><td>CO:</td><td>15.50</td></tr> <tr><td>NOx:</td><td>5.00</td></tr> <tr><td>PM:</td><td>0.50</td></tr> <tr><td>No. Of Families:</td><td>155</td></tr> </table>	HC:	1.30	CO:	15.50	NOx:	5.00	PM:	0.50	No. Of Families:	155										
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<p>MY 1991-1992</p> <p>BOX OH-4</p> <table border="1"> <tr><td>HC:</td><td>1.30</td></tr> <tr><td>CO:</td><td>15.50</td></tr> <tr><td>NOx:</td><td>5.00</td></tr> <tr><td>PM:</td><td>0.25</td></tr> <tr><td>No. Of Families:</td><td>232</td></tr> </table>	HC:	1.30	CO:	15.50	NOx:	5.00	PM:	0.25	No. Of Families:	232	<p>MY 1993 Non-Urban Bus</p> <p>BOX OH-5</p> <table border="1"> <tr><td>HC:</td><td>1.30</td></tr> <tr><td>CO:</td><td>15.50</td></tr> <tr><td>NOx:</td><td>5.00</td></tr> <tr><td>PM:</td><td>0.25</td></tr> <tr><td>No. Of Families:</td><td>165</td></tr> </table>	HC:	1.30	CO:	15.50	NOx:	5.00	PM:	0.25	No. Of Families:	165	<p>MY 1993 Urban Bus</p> <p>BOX OH-6</p> <table border="1"> <tr><td>HC:</td><td>1.30</td></tr> <tr><td>CO:</td><td>15.50</td></tr> <tr><td>NOx:</td><td>5.00</td></tr> <tr><td>PM:</td><td>0.10</td></tr> <tr><td>No. Of Families:</td><td></td></tr> </table>	HC:	1.30	CO:	15.50	NOx:	5.00	PM:	0.10	No. Of Families:	
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<p>MY 1994-1997 Non-Urban Bus</p> <p>BOX OH-7</p> <table border="1"> <tr><td>HC:</td><td>1.30</td></tr> <tr><td>CO:</td><td>15.50</td></tr> <tr><td>NOx:</td><td>5.00</td></tr> <tr><td>PM:</td><td>0.10</td></tr> <tr><td>No. Of Families:</td><td>491</td></tr> </table>	HC:	1.30	CO:	15.50	NOx:	5.00	PM:	0.10	No. Of Families:	491	<p>MY 1994-1995 Urban Bus</p> <p>BOX OH-8</p> <table border="1"> <tr><td>HC:</td><td>1.30</td></tr> <tr><td>CO:</td><td>15.50</td></tr> <tr><td>NOx:</td><td>5.00</td></tr> <tr><td>PM:</td><td>0.07</td></tr> <tr><td>No. Of Families:</td><td>TBD*</td></tr> </table>	HC:	1.30	CO:	15.50	NOx:	5.00	PM:	0.07	No. Of Families:	TBD*	<p>MY 1996-1997 Urban Bus</p> <p>BOX OH-9</p> <table border="1"> <tr><td>HC:</td><td>1.30</td></tr> <tr><td>CO:</td><td>15.50</td></tr> <tr><td>NOx:</td><td>5.00</td></tr> <tr><td>PM:</td><td>0.05</td></tr> <tr><td>No. Of Families:</td><td>TBD*</td></tr> </table>	HC:	1.30	CO:	15.50	NOx:	5.00	PM:	0.05	No. Of Families:	TBD*
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<p>MY 1998-2003 Non-Urban Bus</p> <p>BOX OH-10</p> <table border="1"> <tr><td>HC:</td><td>1.30</td></tr> <tr><td>CO:</td><td>15.50</td></tr> <tr><td>NOx:</td><td>4.00</td></tr> <tr><td>PM:</td><td>0.10</td></tr> <tr><td>No. Of Families:</td><td>673</td></tr> </table>	HC:	1.30	CO:	15.50	NOx:	4.00	PM:	0.10	No. Of Families:	673	<p>MY 1998-2003 Urban Bus</p> <p>BOX OH-11</p> <table border="1"> <tr><td>HC:</td><td>1.30</td></tr> <tr><td>CO:</td><td>15.50</td></tr> <tr><td>NOx:</td><td>4.00</td></tr> <tr><td>PM:</td><td>0.05</td></tr> <tr><td>No. Of Families:</td><td>TBD*</td></tr> </table>	HC:	1.30	CO:	15.50	NOx:	4.00	PM:	0.05	No. Of Families:	TBD*											
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Types of Fuel Effects

Immediate

(e.g., PuriNOx)

- Base, Candidate, Base
- Statistics without Mileage effect
- Expect more testing
 - 6 to 16 Tests for one family
 - 84 Tests for fleet

Types of Fuel Effects (cont'd)

Cumulative

- Reductions over time
- Same Vehicle/Engine
- Account for Deterioration/Service
- More Tests/Analysis
- Carryover Effect

