MODIFICATIONS TO THE PUBLIC TRANSIT BUS FLEET RULE AND NEW INTERIM CERTIFICATION PROCEDURES FOR HEAVY-DUTY HYBRID-ELECTRIC VEHICLES

Public Hearing
October 24, 2002

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY
Air Resources Board
Today’s Presentation

- Background
- Proposed Fleet Rule Amendments
- Proposed Interim Certification
  Procedure for Hybrid-Electric
  Vehicles in the Urban Bus and Heavy-
  Duty Vehicle Classes
- Conclusions & Recommendations
Background

- Goal is to reduce both NO\textsubscript{X} and PM through:
  - New technology forcing standards, and
  - A fleet rule designed to promote advanced technology
Urban Transit Bus Standards

- Urban bus standards set for engine manufacturers
- NO\textsubscript{X} and PM standards lowered significantly
- Goal is to move toward Zero Emission vehicles in all areas
Implementation Status

✓ 1/31/01: Fuel path selected
✓ 7/1/02: Started ultra low sulfur fuel
  – All but 4 small transit agencies
✓ 10/1/02: 4.8 g/bhp-hr NO\textsubscript{X} fleet average
  – All but one transit agency, notice of violation
• 12/31/02: Alt. NO\textsubscript{X} strategy demo on schedule
Implementation Status (continued)

• 1/1/03: PM Retrofits
  – No devices verified for engines older than 1994, and some 1994 and newer
  – Board directed staff to modify PM retrofit program

• 7/03: Zero Emission Bus demo

• 7/08: Zero Emission Bus purchases
## Current PM Retrofit Schedule 2003 - 2009

<table>
<thead>
<tr>
<th>Tiers</th>
<th>Fuel Path</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tier 1 Pre-1991</td>
<td>Diesel</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alt. Fuel</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tier 2 1991-1995</td>
<td>Diesel</td>
<td>50%</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alt. Fuel</td>
<td>20%</td>
<td>75%</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tier 3 1996-2002</td>
<td>Diesel</td>
<td></td>
<td></td>
<td></td>
<td>20%</td>
<td>75%</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alt. Fuel</td>
<td></td>
<td></td>
<td></td>
<td>20%</td>
<td>75%</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>

Note: Percentages of buses retrofitted by January 1 of every year.
Today’s Presentation

• Background

• Proposed Fleet Rule Amendments

• Proposed Interim Certification Procedure for Hybrid-Electric Vehicles in the Urban Bus and Heavy-Duty Vehicle Classes

• Conclusions & Recommendations
Overview of Staff’s Proposal

- Diesel PM Emission Reduction Proposal
- Fuel Path Change
- Alternative Fuel Bus Purchase Provision
- Compliance extension request
- Modification to definitions
- Replace PM retrofit certification procedures
- Other
# Diesel PM Emission Reduction Proposal

## Percent Diesel PM Reduction

<table>
<thead>
<tr>
<th>Fuel Path</th>
<th>Percent Diesel PM Reduction Compliance year as of January 1st</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2003</td>
</tr>
<tr>
<td>Diesel</td>
<td>0 %</td>
</tr>
<tr>
<td>Alternative Fuel</td>
<td>0 %</td>
</tr>
</tbody>
</table>

*Note: Percentage reduction based on transit agency’s total diesel PM emission baseline calculated for January 1, 2002.*
Current Versus Proposed Diesel PM Emissions

The graph illustrates the trend of diesel PM emissions from 2001 to 2010. The emissions are depicted in pounds per day (lbs./day) over the calendar years. The line labeled "Baseline" shows a downward trend, indicating a decrease in emissions over time.
Current Versus Proposed Diesel PM Emissions

- **Baseline**
- **Current**

PM emissions (lbs./day) over calendar years from 2001 to 2010.
Current Versus Proposed Diesel PM Emissions

[Graph showing the comparison of Diesel PM emissions over calendar years.]
Cost-Effectiveness ($/lb)

- Proposed amendments - average $25 per pound (range $11 - $45)
- Original rulemaking - average $18 per pound
New PM Proposal Flexible

- Ensures that every diesel fleet will reduce diesel PM by 85% as of 2007 and 2009
  - Consistent with February 2000 Rulemaking

- Options available to transit agencies
  - Replacement with newer buses
  - Repower with cleaner engines
  - Retire
  - Retrofit
Fuel Path Change Background

- Benefits for selecting alternative fuel path:
  - Same NO$_X$/more PM benefits than diesel path
  - Later compliance with PM retrofit schedule
  - No ZEB demonstration
  - ZEB purchase requirement 2 years later

- Statewide change from diesel path to alternative fuel path impacts anticipated benefits
Fuel Path Change Evaluation

- Fuel Path Change Statewide Not Necessary
  - All transit agencies solicited
  - Only transit agencies in SCAQMD responded

- Very little impact if allowed in SCAQMD
  - Rule 1192 - Alternative fuel purchase required since July 1, 2001
  - Seven transit agencies on diesel path
Fuel Path Change Requirements

- Applicable to transit agencies in the SCAQMD
- Diesel to alternative fuel ONLY
- Change declared by 1/31/04
  - Coincides with scheduled reporting
  - After final rule approval
- Letter of intent must certify compliance with fleet rule provisions
Alternative Fuel Bus Purchase
Current Provision

- Diesel path: 2004 - 2006 MY engines must meet 0.5 g/bhp-hr NO\textsubscript{X}
- Transit Agencies with Alternative NO\textsubscript{X} Exemption approval may purchase 2.5 g/bhp-hr NO\textsubscript{X} + NMHC engines
- No alternative fuel engine projected to meet 0.5 g/bhp-hr NO\textsubscript{X} by 2004
Alternative Fuel Bus Purchase
Proposed Revision

- Allow alternative fuel engines on the diesel path at $2.5 \text{ g/bhp-hr } \text{NO}_x + \text{NMHC}$
  - Encourages transit agencies on the diesel path to purchase alternative-fueled bus engines
Compliance Extension for Small Transit Agencies

- Fleet size less than 20 buses
- Financial hardship implementation delay
  - Apply at least 30 days prior to the implementation date
  - Provide documentation as specified
  - Approval by Executive Officer 90 days after receipt
  - Applicant responsible for compliance until application approved
Heavy-Duty Pilot Ignition Engines
15 Day Change

- Retain current alternative fuel definition
- Allow engines that use diesel as a pilot ignition source only
  - Natural gas is the primary fuel, diesel is less than 10 percent of total fuel usage
  - Engine cannot idle or operate solely on diesel
- Engine may be certified to same levels as alternative fuel engines
Emissions Comparison
(g/bhp-hr)

- NOx:
  - ISX Diesel: 3.65
  - ISX HPDI: 2.36

- PM:
  - ISX Diesel: 0.08
  - ISX HPDI: 0.032

Legend:
- ISX Diesel
- ISX HPDI
Other Changes

- Modify ultra low sulfur requirement
  - Allow any fuel verified by EO as a diesel emission control strategy

- Update certification procedures for retrofits with new procedure approved in May 2002
Other Changes (continued)

- Modify the definition of “Active Fleet”
  - indicates buses operated by or under contract to transit agency
- Two new definitions
  - Emergency Contingency
  - Spare Bus
- Reporting Requirements
Proposed Interim Certification Procedure for Hybrid-Electric Vehicles Used in the Urban Bus and Heavy-Duty Vehicle Classes
Hybrid-Electric Buses (HEBs)

- Urban buses: frequent stop and go
- HEBs reduce high polluting episodes
- HEBs use Two motive power sources
  - Battery pack/ultra-capacitors & electric motor
  - APU (internal combustion engine, microturbine)
Types of HEBs
Steps in Developing Proposed Procedure

- Staff worked closely with U.S. EPA and stakeholders
- Recommended practice approved by SAE in April 2002
- Tested several hybrid electric buses following SAE J2711
NOx Testing Results

![Diagram showing NOx testing results for various types of vehicles. The graph compares g/mile for diesel and CNG vehicles, including typical 1999 diesel, Allison ED 1999 diesel hybrid, Allison ED 2000 diesel hybrid, BAE SYSTEMS 1998 diesel hybrid, BAE SYSTEMS 2001 diesel hybrid, E-bus 2000 turbine LPG hybrid, and ISE Research 2001 gasoline hybrid. The diagram highlights the lower NOx emissions for CNG vehicles compared to diesel vehicles.](image-url)
PM Testing Results

![Graph showing PM testing results for various vehicles.](image)

- **Diesel**
  - Typical 1999 Diesel
  - Allison ED 1999 diesel hybrid
  - Allison ED 2000 diesel hybrid
  - BAE SYSTEMS 1998 diesel hybrid
  - BAE SYSTEMS 2001 diesel hybrid

- **CNG**
  - Typical 1999 CNG

- **Non-Diesel**
  - E-bus 2000 turbine LPG hybrid
  - ISE Research 2001 gasoline hybrid
Proposed Interim Certification Procedure

- Procedure is Quantifiable
  - Incorporates a chassis test procedure
  - SAE J2711 modified for clarity
  - Test results correlated to g/bhp-hr cert.

- Procedure is Enforceable, APU and Hybrid-electric System...
  - Would be ARB-certified and labeled
  - Would have useful life, durability, warranty, record keeping, and information requirements
Proposed Interim Certification Procedure (continued)

- Procedure is flexible, manufacturers may:
  - Follow current engine certification
  - Claim a 25% reduction, in lieu of testing
  - Case-by-case certification for emerging technology
  - Split certification
## Responsibility

<table>
<thead>
<tr>
<th></th>
<th>Current Requirements</th>
<th>Proposed for HEBs - Interim</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Engine Manufacturer</strong></td>
<td></td>
<td><strong>Two Party Responsibility</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Engine Manufacturer</td>
</tr>
<tr>
<td><strong>NOx+NMHC/PM Certification Standard of APU</strong></td>
<td>2.5/0.01 g/bhp-hr</td>
<td>2.5/0.01</td>
</tr>
<tr>
<td><strong>Useful Life</strong></td>
<td>10 years, 290,000 mi.</td>
<td>5 yrs, 150,000 mi.</td>
</tr>
<tr>
<td><strong>Durability Demonstration</strong></td>
<td>For Full Useful Life</td>
<td>Under 50 Exempt</td>
</tr>
<tr>
<td><strong>Warranty</strong></td>
<td>5 years, 100,000 mi.</td>
<td>Existing</td>
</tr>
</tbody>
</table>
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Conclusions & Recommendations

- Proposed amendments are flexible and necessary to achieve PM reductions
- Interim certification procedure for hybrid-electric vehicles is necessary to promote new promising technology
- Recommend Board approval of amendments and interim procedure