PUBLIC TRANSIT BUS FLEET RULE - MODIFICATIONS

Lucina Negrete, Elise Keddie, Juan Osborn

Mobile Source Control Division
California Air Resources Board

Sacramento: May 3, 2002
El Monte: May 9, 2002

California Environmental Protection Agency
Air Resources Board

Today's Agenda

- **Introductions - Lucina Negrete**
  - Background
  - History
  - Public Transit Fleet Rule
  - Implementation status
  - Current direction
- **Morning session - Elise Keddie**
  - Certifying Hybrid-Electric Buses (HEBs)
- **LUNCH 12:00 - 1:00**
- **Afternoon session - Juan Osborn**
  - Public Transit Fleet Rule modifications

Background

- **California's goal is clean and healthful air**
  - Mobile sources = 40% of oxides of nitrogen (NOx)
  - Diesel particulate matter (PM) identified as a Toxic Air Contaminant
  - Since 1980 exceeding ozone has decreased by 60%
  - 8 districts nonattainment with one-hour federal ozone standard
  - 4 districts nonattainment with federal PM standard

History

- **Public Transit Bus Fleet Rule adopted in February 2000**
- **Rule designed to promote advanced technology**
  - PM retrofits, strategies to reduce NOx emissions, HEBs, ZEBs, etc.
  - Implementation pending available technology

Public Transit Fleet Rule

- July 2002 use low sulfur fuel
- October 2002 4.8 g/bhp-hr NOx fleet average
- 2007 NOx standard is 0.2 g/bhp-hr
- PM standard is 0.01 g/bhp-hr
  - Diesel engines by October 2002
  - Alternative fuel engines by 2007
- Transit agencies required to declare a fuel path

Public Transit Fleet Rule (continued)

- Declaring an alternative fuel path:
  - 85% of new purchases must be alternative fuel
  - Phase-in PM retrofit requirements
    - 100% pre-1991 diesel engines by 1/1/03
    - 100% pre-1996 diesel engines by 1/1/05
    - 100% pre-October 2002 diesel engines by 1/1/09
  - Zero Emission Bus (ZEB) purchases for large fleets (>200)
    - 15% by January 2010

Public Transit Fleet Rule (continued)

- **Declaring a diesel fuel path**
  - Interim standard for 2004 - 2006 MY Engines:
    0.5 g/bhp-hr NOx and 0.01 g/bhp-hr PM

    OR

    Implement an alternative NOx strategy approved by ARB's Executive Officer
  - Phased in PM retrofit requirements (2 yrs. earlier)
    - 100% pre-1991 diesel engines by 1/1/03
    - 100% pre-1996 diesel engines by 1/1/04
    - 100% pre-October 2002 diesel engines by 1/1/07

Public Transit Fleet Rule (continued)

- **Declaring a diesel fuel path**
  - ZEB for large fleets (>200)
    - July 2003 - 3 bus demo
    - January 2008 - 15% purchases for large fleets

Public Transit Fleet Rule (continued)

- **ARB reporting requirements to the Board:**
  - Implementation of transit agency programs
  - Implementation of alternative emission reduction strategies and first exemption applications
  - Status of advanced aftertreatment systems
  - Progress and development of HEB test procedures

Implementation Status 9/01

- **Compliance with October 2002 4.8 g/bhp-hr NOx fleet average**
- **Development of PM retrofits**
  - 2 devices verified for later model year engines
  - No devices verified for engines older than 1994
- **HEB test procedures being developed**

Implementation Status 3/02

- **Most transit agencies will comply with the 10/02 fleet average**
- **Compliance with PM retrofit schedule**
  - No devices verified for engines older than 1994
  - Recommend modification schedule

Implementation Status 3/02 (continued)

- **Developing HEB certification proposal**
  - Developed draft SAE J2711 - lead NAVC
  - Tested several hybrid electric buses
  - Allowed transit agencies to claim 25% reduction for HEBs
  - Currently drafting certification proposal

Current Direction

- HEB certification proposal 9/02
- Modify diesel PM retrofit implementation schedule
- Option for transits to change from the diesel path to the alternative fuel path

PROPOSED HEAVY-DUTY HYBRID-ELECTRIC TEST PROCEDURES

Elise Keddie

On Road Controls Branch
California Air Resources Board

Sacramento: May 3, 2002
El Monte: May 9, 2002

California Environmental Protection Agency
Air Resources Board

Hybrid-Electric Propulsion Systems

- **Combine two motive power sources**
  - Renewable Energy Storage System (battery pack, ultra-capacitors)
  - Auxiliary Power Unit (internal combustion engine, microturbine)
- **Electric motor powers wheels**
- **Regenerative braking charges energy storage system**

Hybrid-Electric Propulsion Systems (continued)

- **Series Hybrid-Electric Vehicle (HEV)- APU charges energy storage system and provides power to the electric motor**
- **Parallel HEV- APU provides power directly to drive wheels in addition to energy storage system and electric motor**

Development of Heavy-Duty HEV Test Procedures

- Current certification based on engine testing
- Engine behavior in HEVs different, difficult to mimic in engine testing
  - Less transient engine operation
  - Undersized engine for application
  - Integrated controls, energy storage, and engine

Development of SAE J2711

- Northeast Advanced Vehicle Consortium (NAVC) Heavy-Duty Hybrid Certification workgroup formed with industry, academic, and government members
- Collaborated with SAE to develop chassis test procedure based on light-duty hybrid-electric test procedure

Development of SAE J2711 (continued)

- Testing on chassis dynomometer using drive cycles reflective of transit bus operation (low-, intermediate-, and high-speed)
- SAE J2711 balloted, being prepared for public comment

ARB HEB Testing

- Two hybrid-electric transit buses (HEBs) tested using a modified SAE J2711 at ARB Heavy-Duty Emissions Test Facility in 2001
  - 1999 New Flyer HEB (Allison series hybrid)
  - 2001 Orion HEB (BAE Systems series hybrid)
- Both demonstrated a 50% reduction in NOx and total HC, improved fuel economy

HEB Certification/Verification Proposals

- Verification by chassis testing to qualify for future incentive programs and to meet alternative NOx strategy requirement
- Certification (with sunset date) using an emission factor developed from both engine certification and chassis testing
- Certification through chassis testing
- Other options

Proposal Concepts

- Certification or interim verification
- Responsibility for system dependant on testing procedure selected
  - hybrid-electric drive system manufacturer
  - engine manufacturer
- All proposals allow purchasers to qualify for incentive funds
- All proposals use a modified SAE J2711

Verification To Qualify For Future Incentive Programs And To Meet Alternative NOx Strategy Requirement

- Interim test procedure
- Modified SAE J2711 for testing
- Results allowed for meeting alternative NOx strategy requirement in diesel path
- Emission test results allow purchasers to qualify for incentive funds

Verification To Qualify For Future Incentive Programs And To Meet Alternative NOx Strategy Requirement (continued)

- Additional testing for assessment of durability (after one year) for future certification test procedure
- Electric drive system manufacturers responsible for entire system

Certification Using An Emission Factor Developed From Both Engine Certification And Chassis Testing

- Interim test procedure (sunset date)
- Engine certification and system certification
- ARB calculates emission factor determining emission reductions from hybrid-electric drive system

Certification Using An Emission Factor Developed From Both Engine Certification And Chassis Testing (continued)

- Emission test results allow purchasers to qualify for incentive funds
- Additional testing for assessment of durability (after one year) for future certification test procedure
- Engine and electric drive system manufacturers responsible for durability

Certification Through Chassis Testing

- Certification using a modified SAE J2711
- Drive cycles used in testing dependant on vehicle application
- Emission test results allow purchasers to qualify for incentive funds
- Hybrid-electric drive manufacturer responsible for entire system

HEB Certification/Verification Considerations

- Hybrid-electric drive systems are a new and evolving technology
- Useful life of engine and drive system is not known
- Limited testing on drive systems to date
- Certification or interim verification
- Responsibility for system

Schedule

- Public workshops May 3 and 9, 2002
- Stakeholders Meeting in El Monte June 6, 2002
- Document available to the public August 2002
- Board Hearing September 2002

Contacts

- Elise Keddie (ekeddie@arb.ca.gov)
  916-323-8974
- Lucina Negrete (lnegrete@arb.ca.gov)
  916-327-2938
- Juan Osborn (josborn@arb.ca.gov)
  626-575-6998