

# Control Measure to Reduce Emissions from Forklifts and Other Industrial Equipment



May 25-26, 2006: Sacramento, California

# What are “Large Spark-Ignition Engines”?

- Gasoline and LPG
- Older automotive technology
- Greater than 25 hp and 1 liter
- Typical life of 7-11 years

# Examples of LSI Equipment

- Forklifts



# Examples of LSI Equipment

- Forklifts
- Airport ground support



# Examples of LSI Equipment

- Forklifts
- Airport ground support
- Sweepers/scrubbers



# Examples of LSI Equipment

- Forklifts
- Airport ground support
- Sweepers/scrubbers
- Industrial tow tractors



# Examples of LSI Equipment

- Forklifts
- Airport ground support
- Sweepers/scrubbers
- Industrial tow tractors
- Generator sets



# Examples of LSI Equipment

- Forklifts
- Airport ground support
- Sweepers/scrubbers
- Industrial tow tractors
- Generator sets
- Turf care equipment



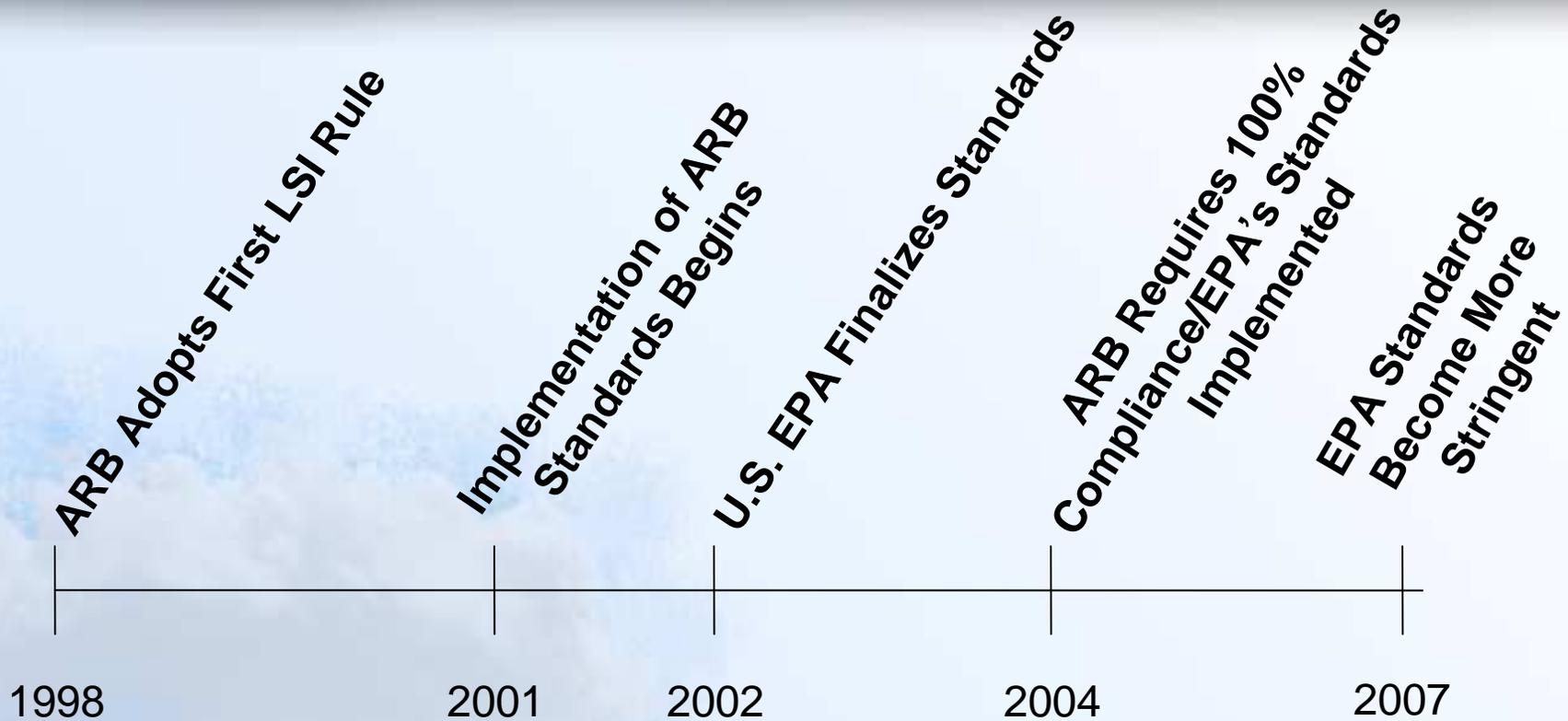
# Examples of LSI Equipment

- Forklifts
- Airport ground support
- Sweepers/scrubbers
- Industrial tow tractors
- Generator sets
- Turf care equipment
- Other non-preempted industrial, construction, and agricultural equipment

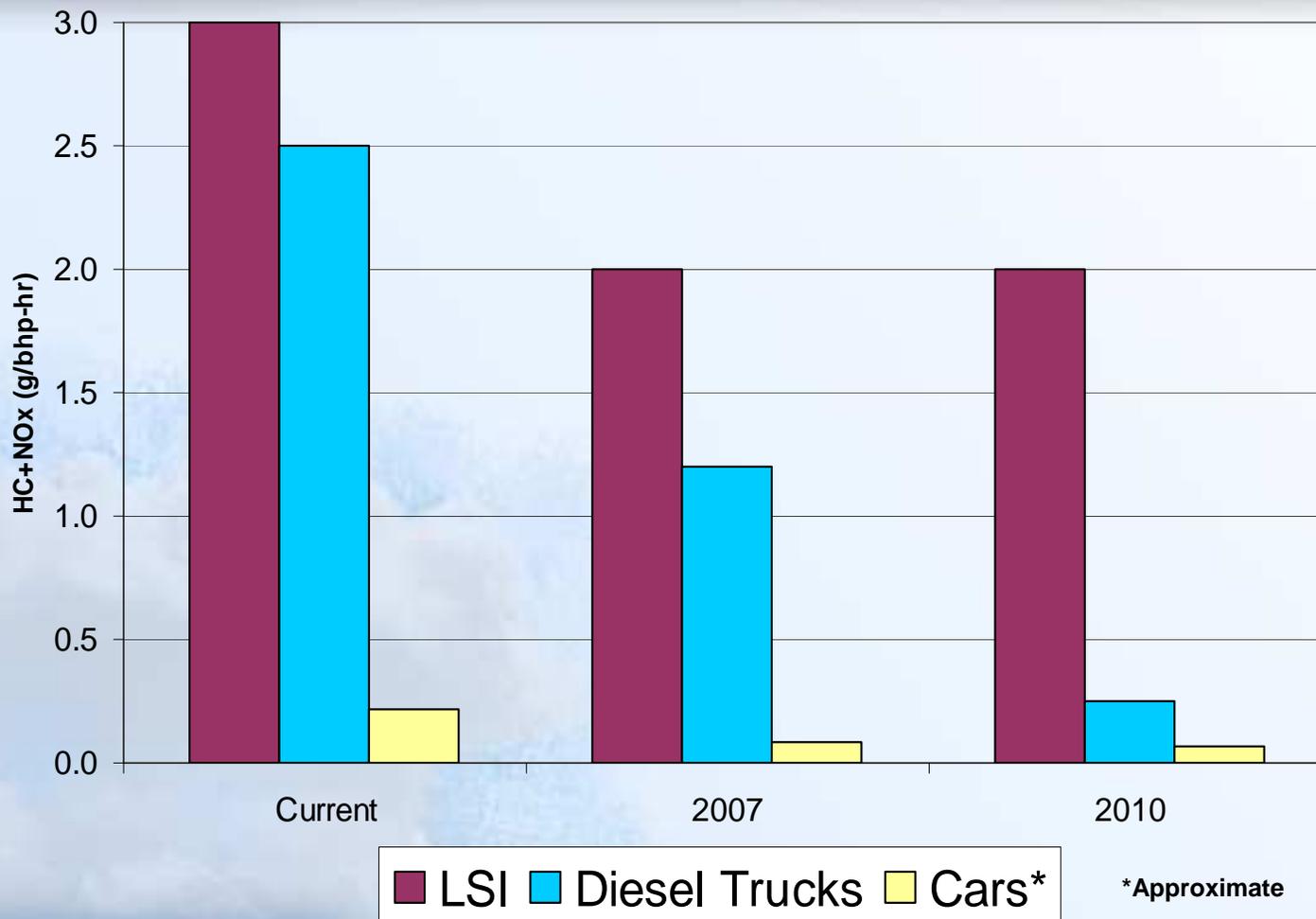
# LSI Emissions

- 88,000 LSI engines
  - 40,000 forklifts
- HC+NO<sub>x</sub> emissions:
  - 70 tons per day in 2004
  - about 5 percent of off-road mobile source emissions

# History of Control



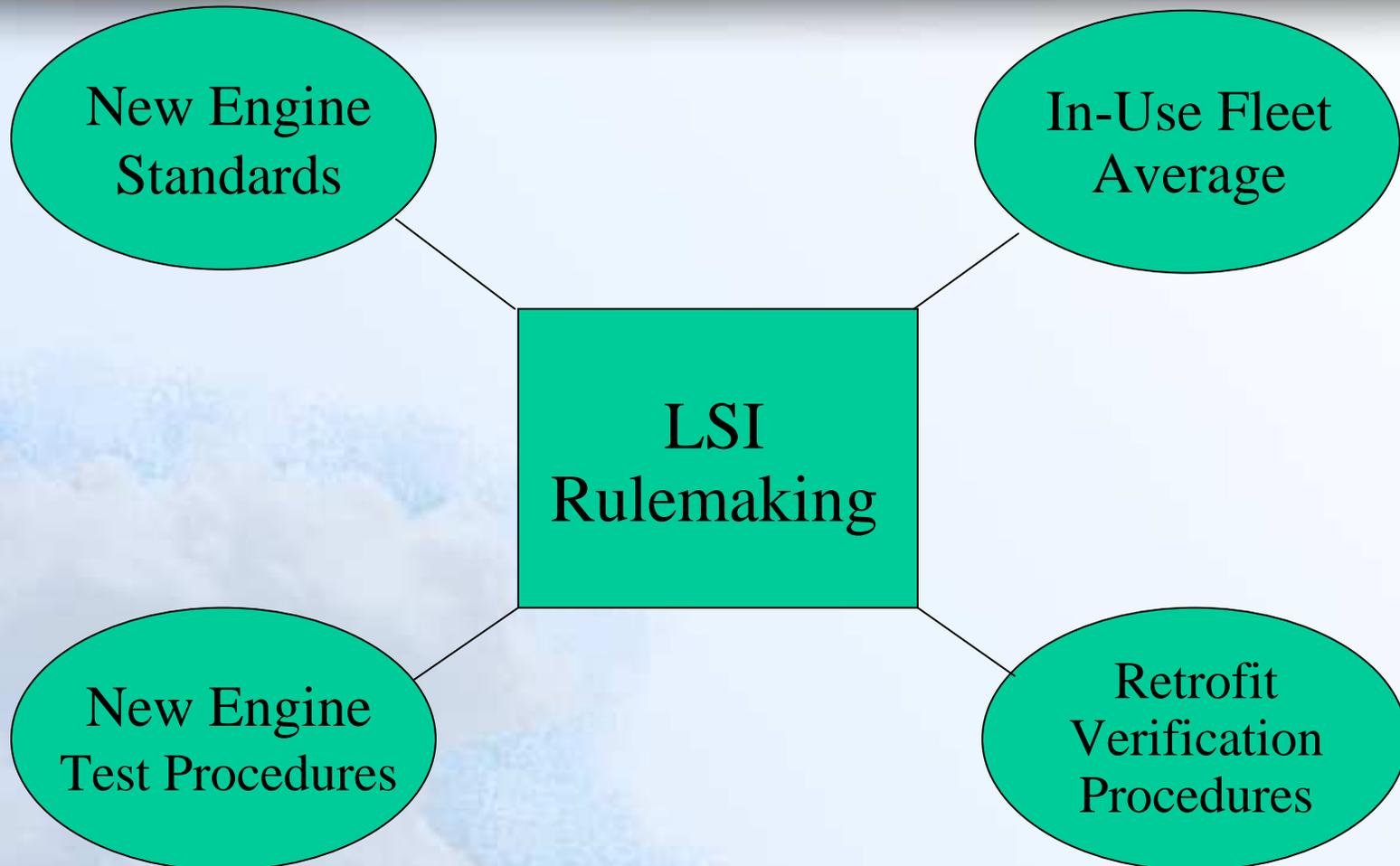
# Comparative Emissions



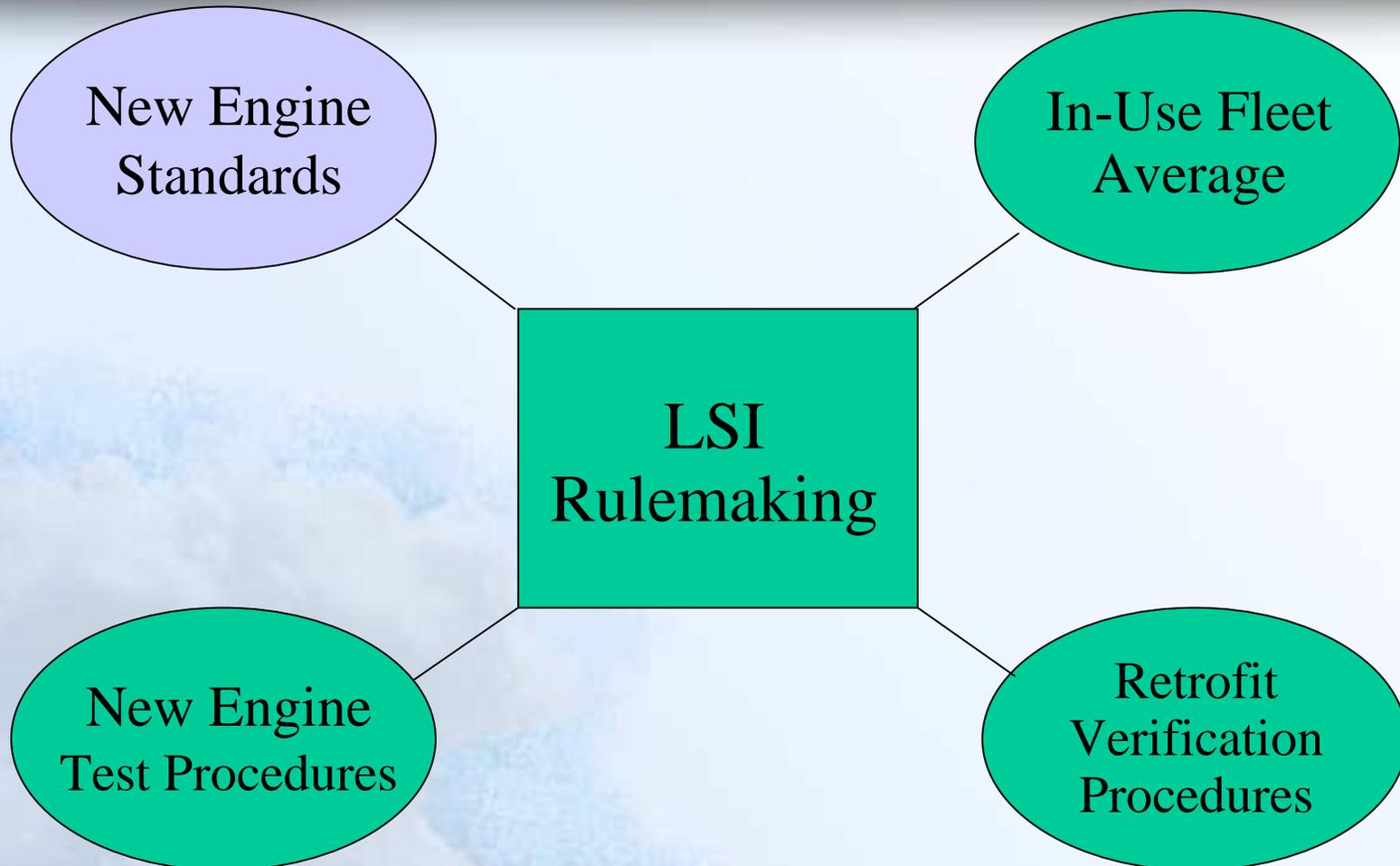
# 2003 State Implementation Plan Commitment

- SIP Measure LSI-1
  - harmonize with 2007 EPA new engine standards
- SIP Measure LSI-2C
  - Existing engines - reduce emissions by 80%
  - Incorporate zero- and near-zero-emission technologies
- Reduce statewide HC+NO<sub>x</sub> emissions
  - 6 to 13 tons per day by 2010

# Elements of the Proposal



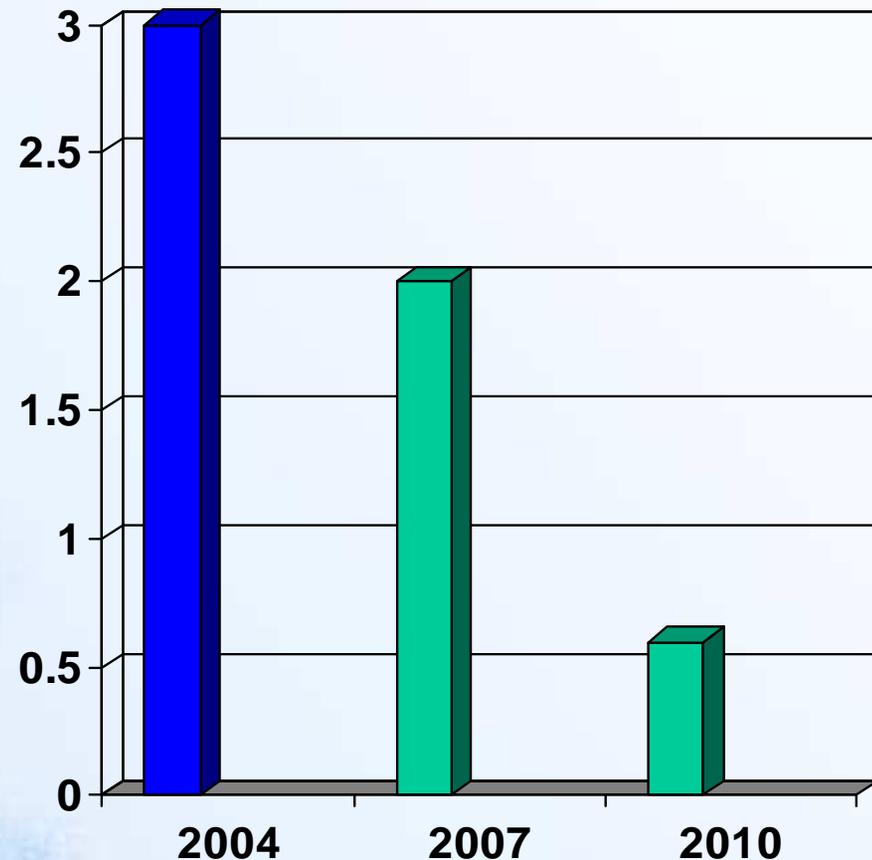
# Elements of the Proposal



# Proposed New Engine Standards

- 2.0 g/bhp-hr HC+NO<sub>x</sub> in 2007
  - Aligns with EPA
- 0.6 g /bhp-hr HC+NO<sub>x</sub> in 2010
  - Draw upon automotive emission control technology

HC + NO<sub>x</sub> Standards



# Technology Comparison

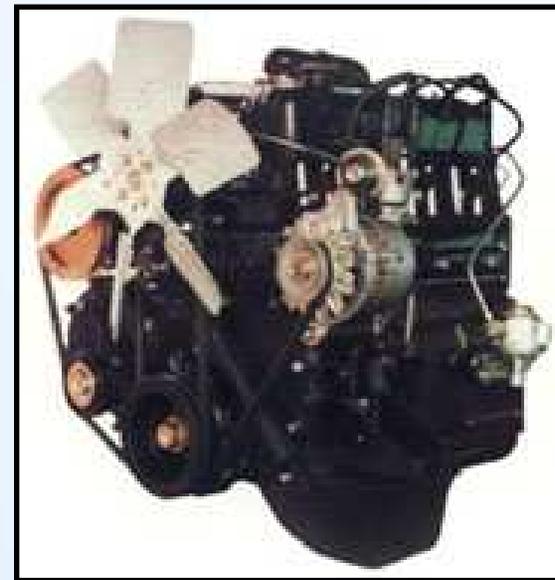
	2004 Forklift	2010 Forklift*	Typical 2004 Car
Fuel System	Carb/TBI	TBI/SMPI	SMPI
Catalyst Volume (% of engine)	40%	80%	100%
Grams of Pt	0.77	> 2	> 2
Grams of Rh	0.19	> 0.4	~ 2
Cert. Emissions (HC+NOx g/bhp-hr)	1	0.1 – 0.3	0.06**
Emission Std. (HC+NOx g/bhp-hr)	3.0	0.6	0.15**

\*Based on cleanest model available today

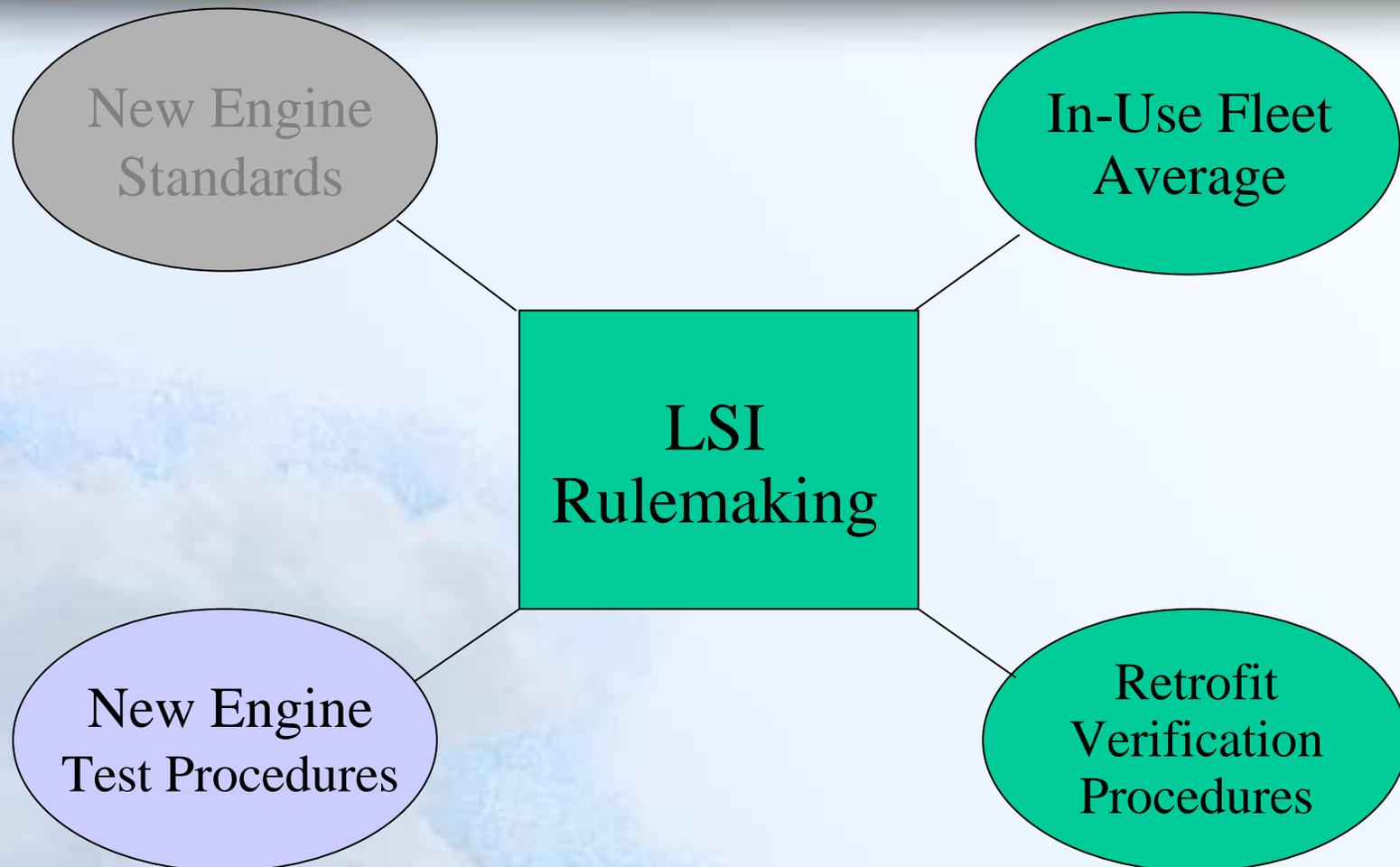
\*\*Approximate

# Optional Manufacturer Lower Emission Standard

- Optional Tiered Certification
  - Model year 2007 and later
  - Early use of available clean technologies
  - Certify to 1.5, 1.0, 0.6, 0.4, 0.2 and 0.1 g/bhp-hr
  - Credits



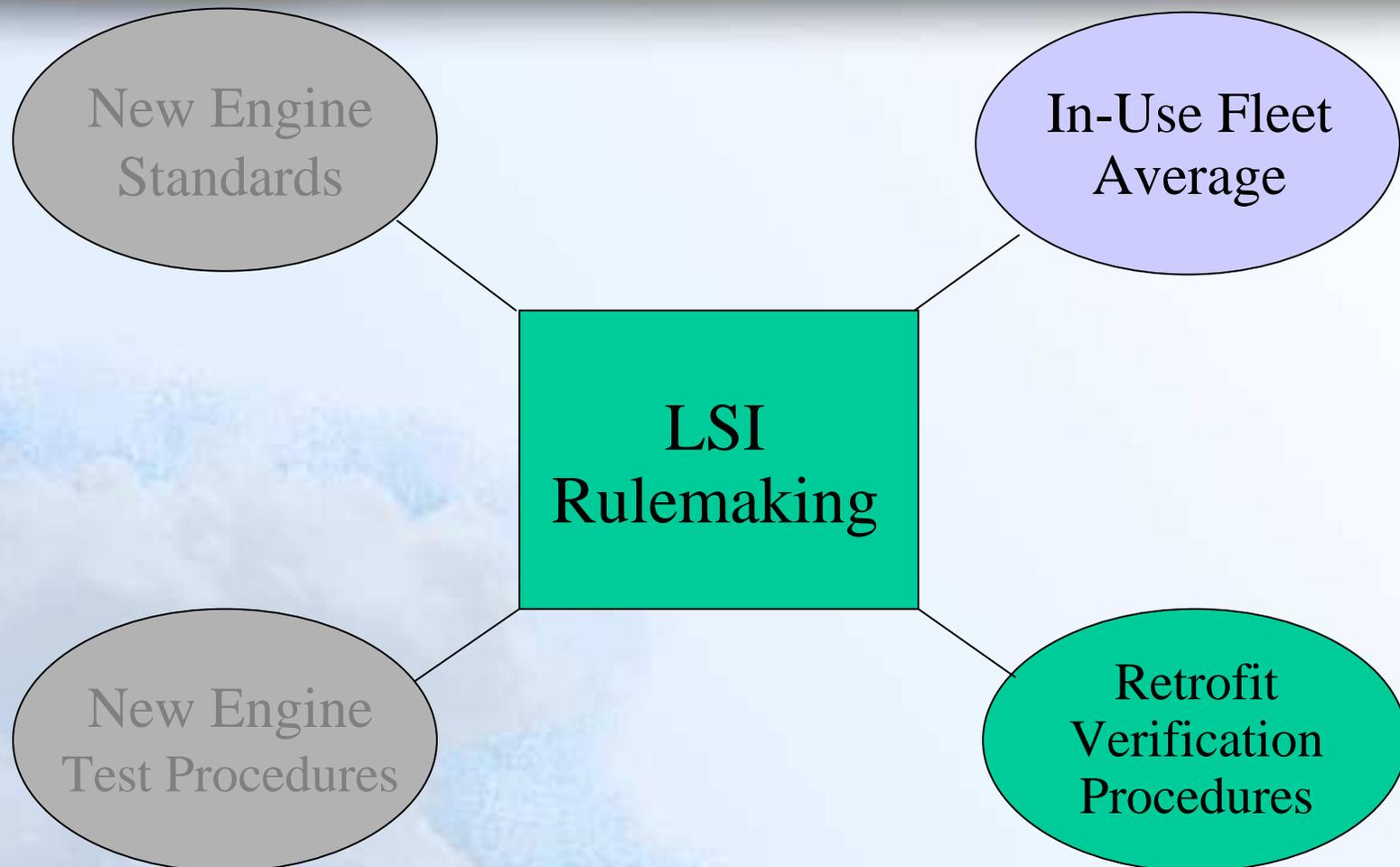
# Elements of the Proposal



# New Engine Test Procedures Beginning in 2007

- New EPA test procedures in 2007
- Proposal aligns with federal test procedures and compliance provisions:
  - Transient test procedure in 2007
  - Near complete alignment from 2007 - 2009
  - Typical differences in 2010 and beyond
  - Keep more stringent or protective ARB language
    - In-use compliance and auditing
    - Warranty and labeling

# Elements of the Proposal



# In-Use Fleet Average Concept

- **Uncontrolled Equipment = High Emissions**
  - All pre-2001 and about half of 2001-2003 engines
  - An uncontrolled forklift operating three shifts = cleanest certified car over its entire life
- **Retrofit, replace, or retire**
  - Ensures turnover
  - Control or replacement of uncontrolled engines

# In-Use Fleet Average Proposal

- Establishes declining fleet average levels
  - Retrofit or replace uncontrolled equipment by 2009
  - Replace some LSI with zero or near-zero emission equipment
- Applies to
  - operators of forklifts, sweepers/scrubbers, tow tractors, and airport ground support equipment
  - owned equipment; rental/lease greater than one year

# In-Use Fleet Average Standards

(Fleet Average Emission Level in Grams HC+NOx)

LSI Fleet Type	Number of units	By 1/1/2009	By 1/1/2011	By 1/1/2013
Large fleet – forklift component	26 +	2.4	1.7	1.1
Mid-size fleet – forklift component	4-25	2.6	2.0	1.4
Non-forklift fleet	N/A	3.0	2.7	2.5

# In-Use Fleet Average Compliance Strategy

- Clean up uncontrolled equipment
  - Retrofit control technology exists
    - Available since mid-1990's
  - Two systems verified
    - ~ 90 percent emission reduction
  - Applicable to most 1990 and newer LSI engines
  - ~ \$3,500 installed
  - Improved fuel economy
- Purchase lower-emission equipment
  - New or used equipment certified to optional lower-emission standards



# In-Use Fleet Average Compliance Strategy

- **Electric**
  - Commercially available
  - Increasingly capable
  - \$2,000 – \$5,000 more than a comparable LSI lift
  - Lower life cycle costs
- **Fuel Cell**
  - Commercialization has begun
  - Eliminates battery issues



# In-Use Fleet Average Modifications

- June 2005 Board feedback
  - Reduce economic impact on dealers and agricultural businesses
  - Find funds to reduce compliance cost
  - No external funding secured
- Staff works with stakeholders to modify proposal
- Modifications identified
  - Significantly lower compliance cost
  - Some loss of emission benefit
  - Consistent with Board direction



# Modifications to Staff Proposal

(made since June 2005)

- Forklift dealers
- Agricultural operations
- Airport ground support equipment (GSE)
- Engines less than 1 Liter

# Dealers - Revised Proposal

- Original Proposal
  - Dealers could be responsible for clean-up of vehicles coming off current leases
  - Costs high – not planned - not recoverable
- Revised proposal
  - Exempt small fleets from reg. (1-3 units)
  - Provides dealers with a sales outlet for used equipment coming off lease
  - Reduces costs to dealers
  - 1 ton/day less emission reduction (2010)

# Agricultural Operations – Revised Proposal

- Original Proposal
  - Reduce emissions of 10% of fleet per year
  - 3 g/bhp-hr level
  - Many old forklifts – only option is replacement at higher cost
- Revised Proposal
  - Only 1990+ forklifts that can use a retrofit kit subject to rule
  - Delayed implementation
  - Cost reduced by 90-98%
  - 0.4 ton/day less emission reduction

# Airport GSE Equipment Revised Proposal

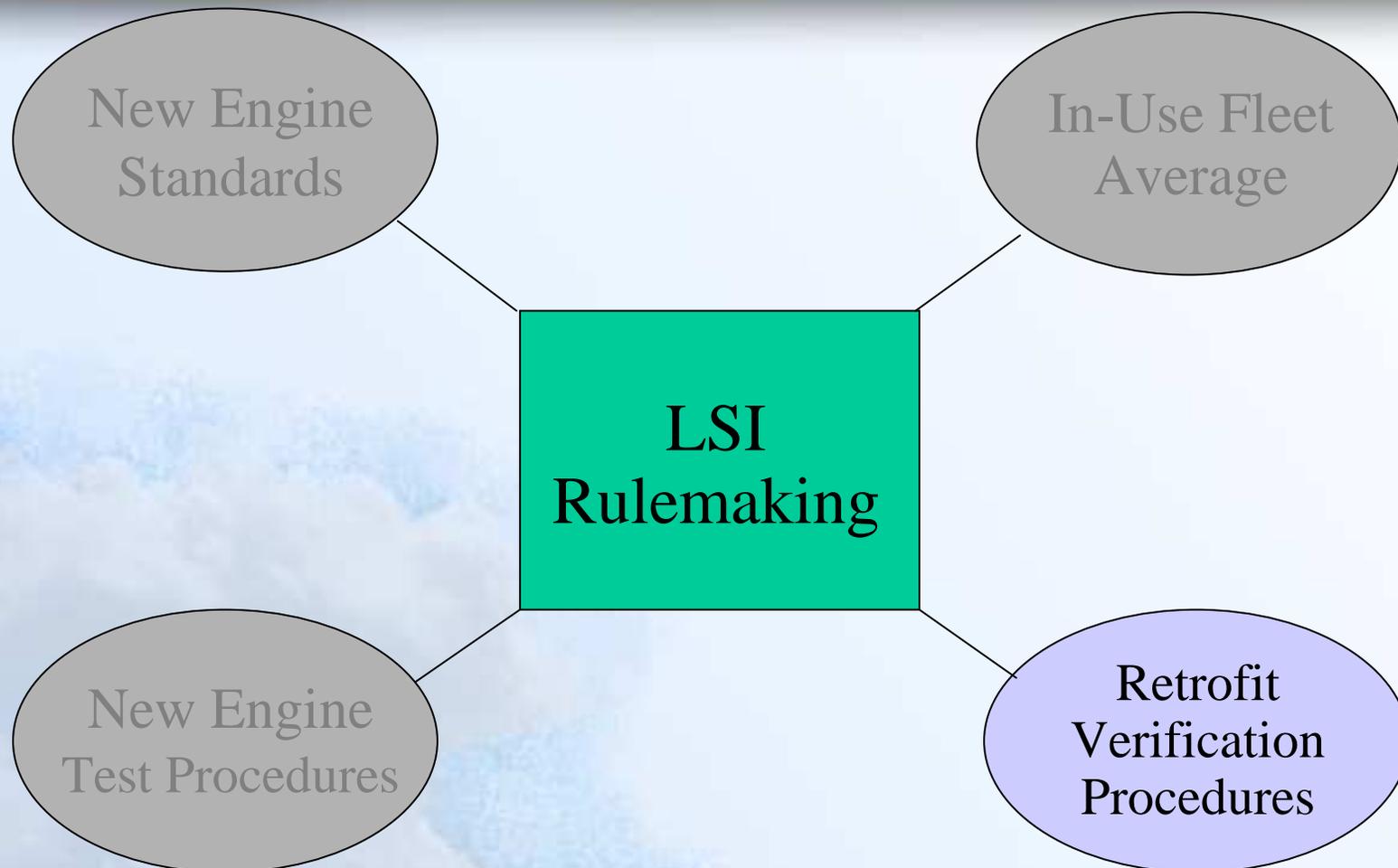
- Original Proposal
  - Airlines in LA must have 30% of fleet zero emission (e.g. electric baggage carts)
  - Proposed regulation replaces MOU terminated by airlines in 2005
- Revised Proposal
  - Eliminate zero emission requirement
  - Airline recently demonstrated they already comply



# Engines Less Than 1 Liter Revised Proposal

- Original Proposal
  - Not subject to proposed new standards or fleet requirements
  - Allow optional compliance with lawn and garden standards and procedures
  - Simpler test
- Revised Proposal
  - Defer until determined if further emission reductions possible
  - Return to Board with proposal

# Elements of the Proposal

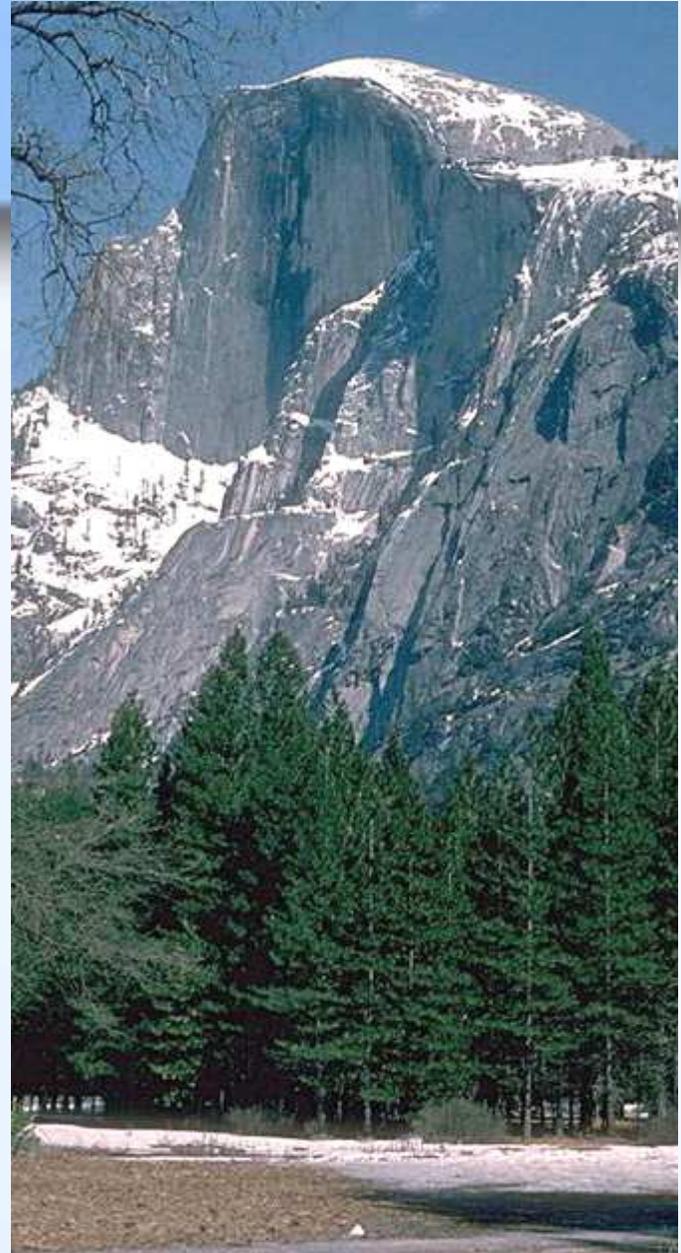


# Retrofit Verification

- Verify emission reductions
  - Percentage reduction
  - Absolute emission level
    - Ranges from 0.5 to 3.0 g/bhp-hr
- Field demonstration
- In-use compliance testing
- Installation and performance warranty
  - 3 years or 2,500 hours
- Labeling requirement
- Two retrofit kits verified



# Estimated Benefits and Cost Effectiveness of the Proposal



# Emission Benefit

## Emission Reductions (HC+NOx)

<b>Benefit (tpd)</b>	<b>2010</b>	<b>2020</b>
<b>Original Proposal</b>	7.2	6.6
<b>New Proposal</b>	5.6	6.2
<b>SIP Commitment</b>	6.1 –13.0	3.3 to 11.1

# Cost-Effectiveness

Proposal Element	Dollars per Pound
New Engine Standards	0.13
In-Use Requirements:	
Retrofit	0 – 1.00
Zero-Emission	0 – 1.40 <sup>1</sup>

1. Cost-effectiveness based on replacement of both controlled and uncontrolled equipment.

# Issues

- 2010 standards for new engines
- Fuel quality

# Issue – 2010 New Engine Standards

- Issue: Feasibility of the 2010 standards
  - Stringency
  - Lead time
- ARB staff response:
  - 2010 standards achievable:
    - Better emission controls available
    - One engine tested at 0.7 g/bhp-hr
    - Cars currently emit at  $\frac{1}{4}$  the 2010 standard

# Issue – Fuel Quality

- Issue: Manufacturer concern with LPG fuel quality
  - Impact of poor fuel quality on engine performance
- ARB staff response: Continue to evaluate
  - Data collection
  - Contract in process
  - Report to Board as necessary

# Conclusions

- Significant emission reductions
- Proposed modifications:
  - Reduce costs
  - Result in some loss in emission benefit
- Standards are attainable with existing technologies
- Staff recommends Board adoption with proposed modifications