Diesel Off-road Equipment Rule Workgroup Meeting: New Regulatory Concepts and Inventory Updates


July 21, 2006
Sacramento and El Monte, California

Heavy-Duty Diesel In Use Strategies Branch

California Environmental Protection Agency

Air Resources Board

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Overview

- **Inventory updates**
  - Construction/mining/industrial equipment
  - Airport ground support equipment
- **Regulatory concepts**
  - Rule structure
  - Changes since January '06 version
  - Response to other comments received
- **Compliance for example fleet**
- **Preliminary cost analysis**
- **Next steps**

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Inventory Updates: Construction/ Mining/ Industrial


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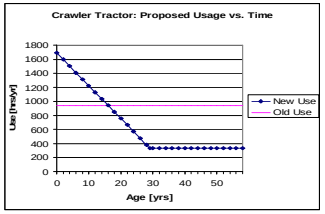
Annual Use

- **Average annual use updated based on:**
  - MacKay construction equipment universe study (2003)
  - 2003 and 2005 ARB surveys
- **Varied annual use vs. age for construction/mining**
  - Annual use declines 30-90% over life



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Equipment Populations

- **Updated based on:**
  - MacKay construction equipment universe study (2003)
  - U.S. EPA NONROAD estimates
- **Construction/mining populations about 8% lower than previous estimates**
- **Industrial populations about 90% higher**
- **New year 2000 populations**
  - ~148,000 construction/mining
  - ~15,000 industrial

Longer Useful Lives

- **Updated based on:**
  - MacKay (2003) average age scrapped
  - Mini-survey of fleet equipment ages
  - 2003 and 2005 survey "average age when scrapped or sold"
- **Construction/ mining lives ~ double**
- **Much more Tier 0 equipment (close to 50% in 2005)**

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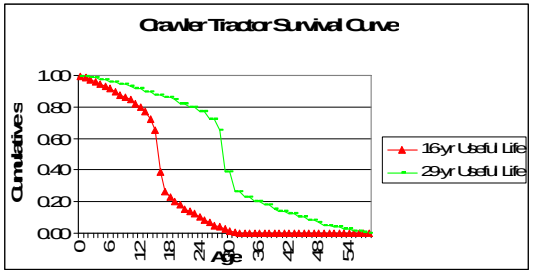
Example Survival Curve Change

- **Crawler tractor – changed median useful life from 16 to 29 years**



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Inventory Updates: Airport Ground Support Equipment

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Annual Use, Equipment Population, and Useful Life

- **Average annual use and equipment population updated based on 2005 ARB survey**
  - Population up about 12%
  - Year 2000: 1,640 pieces
  - Hours of operation constant over equipment life
- **Useful life updated based on 2004 Air Transport Association (ATA) survey**
  - Survey included data on average age of equipment by equipment type
  - Useful lives increased about 40%

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Regulatory Concepts

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Regulatory Concept Changes

- **Summary of rule structure**
- **Definition changes**
- **Fleet average changes**
  - Compliance dates
  - Electric/alternative fuel equipment
  - New Appendix A factors for uncertified engines
  - New targets and how set
- **Technology off-ramp (BACT)**
  - Never require more than 10%/yr turnover
- **Idling changes**
- **Encouraging NOx reductions**
- **No more ban on sale/purchase of Tier 0**
- **Labeling details**
- **Reporting**

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Proposed Rule Structure

- **Must meet fleet average target**
  - Compliance dates start in 2009 (large fleets only), 2010 (medium fleets), and 2015 (small fleets)
  - Separate fleet average targets for Construction/Mining/Industrial and GSE
  - “Technology off-ramp” if fleet average cannot be met at any time (BACT)

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Off-Ramp Provisions

- **If fleet average is not met must demonstrate off-ramp (BACT) provisions were met**

Year	Off-Ramp (BACT)
2009 (large fleets only)	Retrofit equipment older than 5 years with highest level VDECS
2010-12 (2015-17 for small fleets)	Retrofit equipment older than 5 years with highest level VDECS
2013-20 (2018-25 for small fleets)	Same as 2010 and also replace up to 10% of max power per year. Replace engines older than 10 years with no VDECS, and Tier 0/1 engines not certified to a PM standard with no Level 3 VDECS For engines with a Level 1 or 2 VDECS installed more than 6 years before compliance date, if a Level 3 VDECS has been verified, install the Level 3 VDECS

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Definition Changes

- **Agricultural operations**
  - Now includes agricultural crop preparation services
  - Packinghouses, cotton gins, nut hullers and processors, dehydrators, and feed and grain mills
- **Alternative fuel – new definition**
- **Construction/mining/industrial equipment fleet**
  - combined construction/mining and industrial for fleet average purposes
- **Engine/vehicle identification number**
  - not sequential
  - assigned by ARB

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Definition Changes: Fleet Definitions

- **Fleet**
  - Mobile diesel off-road engines 25 hp or greater
  - Owned equipment plus equipment rented or leased for a period of one year or more or reasonably expected to be rented or leased for a period of one year or more
- **Total equipment under common ownership defines fleet size**
- **United States and California agencies may report separately, but must meet the large fleet requirements**
- **Fleet size - defined by total maximum power, not number of pieces; better correlation with emissions**

		Survey Results		
	Total max power [hp]	**% of total hp**	**% of Equipment**	**% of Fleets**
Large	**>20,000**	67	51	5
Medium	**1,500-20,000**	29	37	30
Small	**<1,500**	4	12	65

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Definition Changes: Low-use Equipment

- **Operates less than 100 hours per year, based on a three calendar-year rolling engine-hour average**
- **Proposed at 50 hrs/year in Jan. '06**
- **Will improve cost-effectiveness**
- **Give up <4% of potential emission reductions**
- **Low-use equipment must meet BACT or fleet average in 2020**

	% Population	**% PM Emissions**
<50 hrs/yr	**10.5%**	**<=0.8%**
<100 hrs/yr	**22.7%**	**<=3.3%**
<200 hrs/yr	**47.9%**	**<=13.8%**

Assumptions: Construction/mining equipment, load factor and hp for low-use same as for general population; EF for low-use=0.72 g/bhp-hr, EF for general population = 0.5 g/bhp-hr; Percent emissions are for 50 hrs/yr, 100 hrs/yr, and 200 hrs/yr operation, respectively

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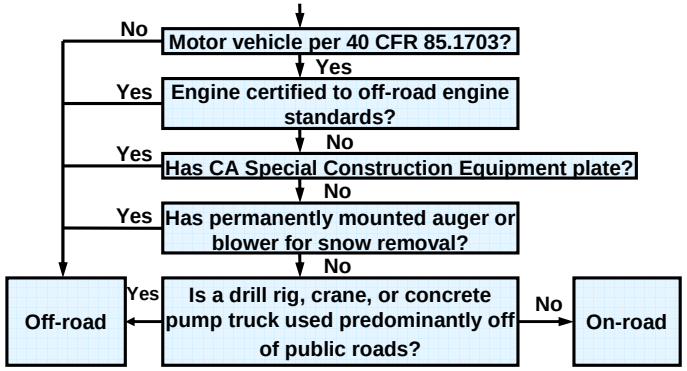
Definition Changes: Off-Road Definition



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Fleet Average Changes

- **Shift compliance dates from January 1 to March 1**
  - Spread out device purchases/installations from those for other diesel ATCMs
  - Allows retrofit installation during winter down-time
- **Fleet average must be met between compliance dates and maintained after 2020**
- **If add equipment to the fleet, have 3 months to meet the previous fleet average target**
- **Must meet the overall fleet average target**
  - Do not have to meet the individual horsepower group fleet average targets

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Electric and Alternative Fuel Equipment in Fleet Average

- **Electric emission factor is 0**
- **If bought 1/1/07 or later, may count in the fleet average if:**
  - Serves same function and performs same work as diesel equipment
  - Is not already counted in large spark ignition fleet average, and
  - Has certified NOx less than the diesel NOx standard for the same model year and horsepower
- **Stationary or portable electric equipment used to replace mobile diesel equipment, such as a conveyor system at a mine, may also count**
- **Electric airport GSE bought before 1/1/07**
  - May count 20% toward fleet average
- **Other electric and alternative fuel equipment bought before 1/1/07 may be counted if it is certain that diesel equipment would have otherwise been purchased to accomplish the same work**

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Fleet Average Emission Factors:

- **Based on engine certification standard or Appendix A**
  - Appendix A factors are surrogates for uncertified engines
    - Represents zero-hour factor plus deterioration to 5,000 or 8,000 hours
- **Carl Moyer Program zero-hour emission factors representative of new equipment**
  - Not appropriate for average fleet
  - May change in next revision
- **Certification values (i.e., test values) are not enforceable and may not be representative of all engines covered in certification EO**

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How Proposed Fleet Average Targets Set

- **Set at level that could be achieved through aggressive turnover and retrofits**
  - For example, could meet through ~20% turn over to new, ~60% Level 3 retrofit
- **But can be no more stringent than fleet average from 5-year turnover with no retrofits**
- **Proposed construction/mining/industrial fleet averages**
  - 2010: Fleet average PM down 66% from 2000 baseline, expect > 50% reduction in PM emissions
  - 2020: Fleet average PM down 93% from 2000 baseline, expect ~85% reduction in PM emissions
- **Proposed airport ground support equipment fleet averages**
  - 2010: Fleet average PM down 69% from 2000 baseline, expect ~60% reduction in PM emissions
  - 2020: Fleet average PM down 95% from 2000 baseline, expect ~90% reduction in PM emissions

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Construction/Mining/Industrial Fleet Averages [g/bhp-hr PM]

Large and Medium Fleet Compliance Date: 3/1 of	Small Fleet Compliance Date: 3/1 of	25-99 hp	100-750 hp	>750 hp
2009 (large fleets only)	Not applicable	0.40	0.25	0.25
2010	2015	0.35	0.20	0.20
2013	2018	0.29	0.16	0.17
2017	2022	0.12	0.06	0.08
2020	2025	0.08	0.04	0.06

* - Combined construction/mining and industrial targets

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Airport GSE Fleet Averages
[g/bhp-hr PM]

Large and Medium Fleet Compliance Date: 3/1 of	Small Fleet Compliance Date: 3/1 of	25-99 hp	100-750 hp	>750 hp
2009 (large fleets only)	Not applicable	0.40	0.25	0.25
2010	2015	0.34	0.19	0.20
2013	2018	0.27	0.15	0.17
2017	2022	0.09	0.05	0.08
2020	2025	0.06	0.03	0.06

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Accelerated Turnover (BACT Off-Ramp)

- **Accelerated Turnover Engines include:**
  - Engines older than 10 years with no VDECS, and Tier 0/1 engines not certified to a PM standard with no Level 3 VDECS
- **Turn over 10% of fleet horsepower each year**
- **Order of Accelerated Turnover:**
  1. All uncontrolled (i.e., not retrofit with a VDECS) pre-1988 model year Tier 0 engines, before
  2. All pre-1988 model year Tier 0 engines retrofit with a Level 1 VDECS, before
  3. Other remaining Tier 0 and Tier 1 engines that must be replaced, before
  4. Other remaining Tier 2 and Tier 3 engines that must be replaced, before
  5. Tier 4 interim engines that must be replaced.

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Expand Idling Exemptions

- **Idle limits remain at <= 5 minutes**
  - Except when queuing, verifying safe operation, testing, servicing, repairing, or when necessary to accomplish work for which equipment designed.
- **Added exemptions for:**
  - Idling to bring machine to operating temperature (CIAQC)
  - Idling to provide for safe operation of the equipment

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Encouraging NOx Reductions

- **Need to place greater emphasis reducing NOx:**
  - Mortality from secondary particulate matter formed from diesel NOx emissions can be as significant as that due to direct diesel PM
  - South Coast and San Joaquin Valley attainment deadlines for PM2.5 and eight-hour ozone in 2015-2025
- **Ways to more strongly encourage NOx reductions in rule:**
  - Include a mandatory level of turnover of all Tier 0 and 1 engines
  - Include a NOx or secondary PM fleet average requirement.
  - Mandate a maximum allowed percentage of Tier 0 and Tier 1 engines in each fleet. The maximum allowed percentage would decline each year until all Tier 0 and 1 engines have been phased out.
  - Other ideas?

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Removed Ban on Sale/Purchase of Tier 0 Equipment

- **Major concerns from stakeholders re: devaluing fleets, inability to "bond" projects**
- **Much more Tier 0 equipment than we originally thought**
- **Would have involved an additional set of stakeholders (auction-houses, dealers)**
- **Still strong incentive to retire Tier 0 equipment to meet fleet average**

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Labeling Changes

- **ARB assigns unique identification number**
- **Identification number stays with equipment no matter who owns it, like a license plate**
- **Permanently affix or paint on left side of vehicle**
- **All equipment, even if low-use or small fleet, must be labeled and reported by 2008**
  - Apply for number by 1/1/08
  - Label within 30 days of receipt

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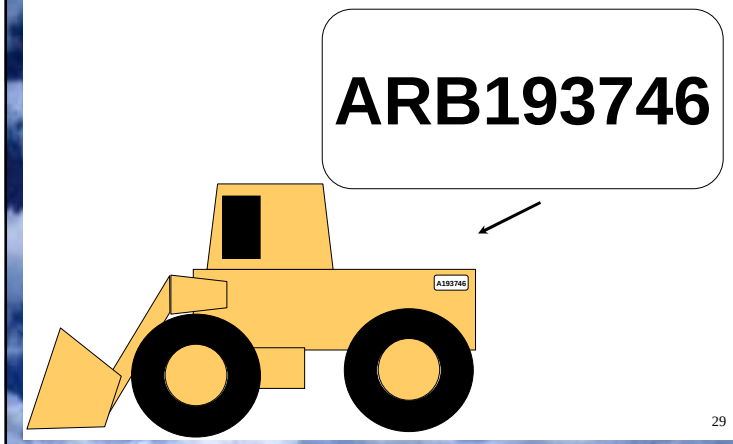
Example Label



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Reporting Changes

- **Report April 1 annually beginning in 2008, not just on compliance dates**
- **If engine family, serial number unknown**
  - No enforcement penalty for reporting "unknown"
  - For fleet average purposes, assign unknowns highest emission factor (same as dirtiest Tier 0)
  - Assume no VDECS if engine family unknown
  - Considered "Accelerated Turnover Engine" under BACT

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Response to Other Comments Received

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No Project Requirements

- **Project Requirements:**
  - Some stakeholders asked for stricter project requirements near sensitive sites (schools, hospitals, etc.)
  - Some asked for option to do project averages only in lieu of owned fleet averages
- **Difficult to enforce**
  - Project duration temporary
  - Equipment rotate in and out of project
  - Many more projects than owned fleets
  - Would require more frequent than annual reporting
- **May shift dirty equipment to smaller projects**
- **Tracking equipment and sensitive sites would significantly add to complexity**
- **CEQA process addresses specific site issues**

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No Hours or Load Factor In Fleet Avg

- **Fleet average =** $$\frac{\sum_{i=1}^{n} bhp_i \times EmissionFactor_i}{\sum_{i=1}^{n} bhp_i}$$

•Stakeholders asked us to include hours of operation and load factor

•<u>Why we did not include hours and load factor:</u>

- •Avoids added complexity, recordkeeping, reporting
- •Avoids risk of mis-reported use
- •Difficult to enforce use, impossible to enforce load
- •Avoids spending time debating appropriate equipment type, load factor
- •Some equipment does not have hour meters
- •Use and load may vary from year to year
- •Overall goal is to have <u>all</u> equipment controlled

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Compliance for Example Fleet:

Actual fleet from 2003 TIAX survey

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Example Fleet: Baseline

Id Number	Equipment	Engine Model Year	Rated HP	Tier	Emission Factor [g/bhp-hr]
< 100 HP GROUP					
2	Backhoe Loader	1986	95	0	1.200
3	Backhoe Loader	1997	96	0	0.980
4	Backhoe Loader	1999	96	0	1.090
5	Backhoe Loader	1999	96	0	1.090
100-750 HP GROUP					
6	Wheel Loader	1986	375	0	0.680
7	Tractor/Dozer	1997	375	1	0.4
8	Wheel Loader	1997	375	1	0.4
Total HP: 1508		**2005 Baseline Fleet Average = 0.65 g/bhp-hr**			

FLEET AVERAGE TARGETS FOR CONSTRUCTION/MINING/INDUSTRIAL EQUIPMENT

HP Group	2010	2013	2017	2020
<100 hp	0.35	0.29	0.12	0.08
100-750 hp	0.20	0.16	0.06	0.04
>750 hp	0.20	0.17	0.08	0.06

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Example Fleet:

Scenario if Lots of Level 3 Retrofits Available

Action by:

ID #	Equipment	Model Year	hp	Tier	2010	2013	2017	2020
2	Backhoe Loader	1986	95	0	Replaced with Tier 3*	**Level 3 Retrofit**	-	-
3	Backhoe Loader	1997	96	0	**Level 3 Retrofit**	-	-	-
4	Backhoe Loader	1999	96	0	**Level 3 Retrofit**	-	-	-
5	Backhoe Loader	1999	96	0	**Level 3 Retrofit**	-	-	-
6	Wheel Loader	1986	375	0	Replace with Tier 3*	**Level 3 Retrofit**	-	-
7	Tractor/Dozer	1997	375	1	**Level 3 Retrofit**	-	-	Replace with Tier 4
8	Wheel Loader	1997	375	1	-	-	Replace with Tier 4	-
	Fleet Average PM:				**0.201**	**0.153**	**0.057**	**0.046**
	Fleet Target PM:				**0.238**	**0.190**	**0.075**	**0.052**

•Assume the 1986 MY equipment was replaced between 2005 and 2010 due to normal turnover. Shading indicates vehicles replaced through normal 20-year turnover (i.e., when >=20 years old).

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Example Fleet:

BACT: Replace 10% HP per Year if Retrofits Not Widely Available

Action by:

ID #	Equipment	Model Year	hp	Tier	2010	2013	2017	2020
2	Backhoe Loader	1986	95	0	Replaced with Tier 3*	-	-	-
3	Backhoe Loader	1997	96	0	-	-	Replace with Tier 4	-
4	Backhoe Loader	1999	96	0	-	-	Replace with Tier 4	-
5	Backhoe Loader	1999	96	0	-	-	Replace with Tier 4	-
6	Wheel Loader	1986	375	0	Replaced with Tier 3*	-	-	Replace with Tier 4
7	Tractor/Dozer	1997	375	1	-	-	Replace with Tier 4	-
8	Wheel Loader	1997	375	1	-	Replace with Tier 4	-	-
	Fleet Average PM:				**0.456**	**0.361**	**0.067**	**0.033**
	Fleet Target PM:				**0.238**	**0.190**	**0.075**	**0.052**

•Assume the 1986 MY equipment was replaced between 2005 and 2010 due to normal turnover.
Shading indicates vehicles replaced through normal 20-year turnover (i.e., when >=20 years old).

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Preliminary Cost and Cost-Effectiveness Analysis

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Cost Analysis Example

- **Example: 1998 Backhoe, 92 hp**
- **New price = $78,000**
- **Used price for 11-year old equipment = $13,000**
- **Used price for 18-year old equipment = $9,300**
- **Equipment useful life = 18 yrs**
  - Retrofit or replace in 2009
  - In 2009, would be replacing 7 years early
- **Interest rate = 7%**
- **VDECS life = 10 years**
- **PM EF = 1.09 g/bhp-hr**
- **Operates 1,346 hrs/year**
- **Load factor = 0.5**
- **Repower at normal rebuild time**

Most Compliance Options Are Cost Effective

	% PM Reduction	% NOx Reduction	Up-front Cost	Annualized Cost in 2006 dollars *	Cost-effectiveness [$/lb PM]
Level 1 Retrofit	25%	0%	$2,000	$232	$6.25
Level 2 Retrofit	50%	0%	$6,000	$697	$9.38
Level 3 Retrofit	85%	0%	$15,000	$1,743	$13.80
Repower to Tier 3	72%	61%	$31,000	$3,603	$33.44
Tier 3 Replacement	72%	61%	$65,000**	$2,502	$30.27

*Cost adjusted by net present value & capital recovery factor
** New equipment cost ($78,000) - Used equipment cost ($13,000)

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Return on Equity Analysis

- **Trying to design rule to not have significant adverse impact on profitability of affected industries**
  - Used 10% change in return on equity (ROE) as threshold for significant adverse impact (ROE=Profit / Equity)
- **Looked at each SIC code affected by rule – various mining, construction, equipment rental SIC codes**
- **Net worth and profit for typical companies in each SIC code from Dun and Bradstreet report (2003)**

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Return on Equity Analysis Cont'd

- **Analyzed "worst-case" scenario where no retrofits are available, and fleets have to turn over whole fleet to brand new**
  - Retrofits highly likely to be available (2013)
    - Less expensive
  - Could upgrade to less expensive used equipment
- **Conclusions:**
  - Majority of companies can absorb cost of 10%/year turnover without exceeding 10% change in ROE
  - Many of those that cannot are likely have small fleets which under proposal can delay compliance

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Next Steps, Contacts, and Further Information

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Next Steps

- **Workshop this fall**
  - **Off-road retrofits**
  - **Regulatory language**
  - **Emission benefits**
  - **Cost and economic impacts**
- **To Board December 2006**

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