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California Air Resources Board
Public Meeting Regarding Revisions
to
Lower Emission School Bus Program Guidelines

Donaldson Company Comments

Julian Imes

February 23, 2006



Agenda

- Introduction
- Opposition to School Bus Retrofit Guidelines
 - NO₂ Control Limits
 - ARB Staff Guidance
 - BACT Determination
- Technology Alternatives
 - Total PM Emissions (Tailpipe + Crankcase)
- Summary/Recommendations



The Company at a Glance



- Founded in 1915
- Over 10,000 employees
- 46 distribution & manufacturing locations worldwide
- Sales of \$1.6 billion
- Technology leader in filtration sciences



Current Donaldson Portfolio

- DOC Mufflers
- DMF Mufflers
- DPF Mufflers
- Spiracle Crankcase Filter System
- DPF Cleaning Systems



Retrofit Program Requirements Eligible Retrofit Devices

- 2005 – 2006 FY State Budget Funding Eligible Device Requirements

– Budget Language (Senate Bill 77, Stats. 2005, Ch. 38)

“(a) have at least a Level 3 verification from the Board

“ ...

“(e) produce the lowest possible NO_x across the device.”



Retrofit Program Requirements Eligible Retrofit Devices Cont'd

- ARB Staff Report Guidance:

“... based on the budget language requirements, air districts shall fund grant applicants choosing Level 3 technologies that inherently produce less NO_x than other candidate devices provided that the technologies and their required maintenance are practically applicable to the buses to be retrofitted and the corresponding bus fleet operations, and that the costs of the device and related infrastructure are reasonable. Air districts may use all available specifications and data in determining which retrofit technologies produce the lowest possible NO_x.”

“For practical implementation, this means that air districts shall give priority to applications from school districts requesting funds to install uncatalyzed active particulate filters on eligible school buses, even if they are more expensive than a catalyzed passive particulate filter. If school bus retrofit funding is still available after all reasonable applications for uncatalyzed active Level 3 devices and any necessary infrastructure are funded, then an air district may fund other Level 3 devices.” [Emphasis added.]



Opposition to School Bus Retrofit Guidelines

- **NO₂ Control Limits**
 - ARB staff interpretation of lowest possible NO₂ is at odds with ARB's proposed limits for NO₂ increase of 30% NO₂/NOx (by 1/1/07) and 20% NO₂/NOx (by 1/1/09)
 - All existing and future ARB NO₂/NOx requirements should be within the framework of ARB Verification regulations for NO₂/NOx limitations. Lowest possible NO₂ increase should not be equated to no increase without adequate assessment of practicality.
 - The short time for implementation of the 2005-2006 FY retrofit program does not allow competitive supplier development and delivery of ARB verified products with no NO₂ increase.



Opposition to School Bus Retrofit Guidelines

- **ARB Staff Guidance**
 - ARB staff assessment of eligible retrofit devices with practical application and reasonable costs is wrong to focus and give priority direction to uncatalyzed active particulate filters at an estimated total cost/system of \$18,500. This allows only 675 school bus retrofits for \$12.5 million for FY 2005 - 2006.
 - ARB staff assessment should be technology neutral and within the framework of ARB's proposed Verification limits for NO₂ increase and with adequate assessment and clarification of BACT determination.



Opposition to School Bus Retrofit Guidelines

- **BACT Determination**
 - Improved guidance is needed from ARB staff on industry inputs to BACT determination.
 - **Technical criteria**
 - % emission reduction
 - NO₂ level limits
 - Temp criteria
 - **Operational compatibility**
 - Fleet operation
 - Fuel Use
 - **Cost acceptance**
 - Initial
 - Operational/Maintenance
 - **Exemption requests**
 - Each operation/fleet has independent criteria/needs
 - What reasonable volume for ARB staff assessment



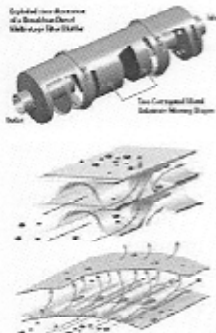
Technology Alternatives

- ARB staff should further explore and solicit alternative retrofit device technologies for the Lower Emission School Bus Program as opposed to the present focus/guidance to one technology approach (uncatalyzed active DPF's at \$18,500/system).
- Donaldson Company recommendation for ARB staff to explore and utilize additional PM reduction strategies for lower emission school buses (all within EPA/ARB Verification program regulations).
 - **TOTAL PM Control**
 - Tailpipe PM control
 - Crankcase PM control



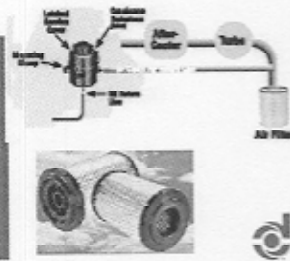
Flow Through Diesel Multi-Stage Filter (DMF)

- Offers CARB Level 2 performance (≥ 50% reduction)
 - Between DOC and DPF
- Exhaust temperature sensitive
- Requires ULSD fuel
- Resistant to plugging
- Meets NO₂/NOx regulation



Closed Crankcase Filtration System

- Eliminates emissions from crankcase
- Two stage filter protects engine
- Filter change required every 500 hr
- 2.5-3.0 hr installation



Donaldson DECS Summary

	DOC	DMF	DPF	Spiracle
Technology	Flow-thru	FTF	Wall Flow	Barrier
Efficiency (%)	20-30	71-75	90	100
w/ Spiracle (%)	25-49	75-80	90-95	--
Temp Sensitivity	None	Low	Medium	None
Fuel	Any	ULSD	ULSD	Any
Install Time (hr)	1-1.5	1-2	2-3	2-3
Cost (\$)	\$2-4K	\$5-6K	\$7-10K	~\$1.0K
Maintenance	None	None	Ash Clean	Replace Filter



Crankcase PM Measurements

- Baseline Crankcase PM
 - Measured at same time/operating modes as tailpipe PM (e.g., On-road - Cold + 3 Hot over FTP)
 - SwRI SOP 07-043, Blow-by Emissions Measurement of HD Diesel Engines, Dec 2002. Approved by EPA/RTI for ETV Program
 - EPA Section 1065.130(h) for open crankcase measurement
- Total PM = Tailpipe PM + Crankcase PM
 - Crankcase either open or closed-loop
 - EPA07 must account for total PM; same for EPA Non-road 2011
- ISO Standard Development for Crankcase Measurement
 - Engine Test Procedures: ISO 03192004, ISO 10132004
 - Lab Test Procedure: ISO 01012006



Crankcase PM Contribution

On-Road Engine MY	Tailpipe PM g/bhp-hr Regulation	Crankcase PM g/bhp-hr .025 Avg.	Total PM g/bhp-hr Avg.	Crankcase to Total PM Avg. %
1988 - 1990	0.60	0.01 - 0.04	.625	4%
1991 - 1993	0.25	0.01 - 0.04	.275	11%
1994 - 2006	0.10	0.01 - 0.04	.125	20%
2007 +	0.01	0.01 - 0.04	.035	71%



Level 3 Technology Options

- Engine/Vehicle MY Tailpipe PM (g/bhp-hr) Crankcase PM/g/bhp-hr
 - 1994 - 2006 Baseline .10 .025 Avg
- DPF Tailpipe PM Control (85%+)
 - $.85 (.10) = .085$ g/bhp-hr reduced
- DMF Tailpipe PM Control (70%+) + Spiracle Crankcase Control (100%)
 - $.70 (.10) + 1.00 (.025) = .095$ g/bhp-hr reduced
- DMF Tailpipe PM + Spiracle Crankcase PM Technology
 - Meets CARB's proposed NO₂/NO_x requirements (< 20%)
 - Improves in-cabin air quality
 - Cost effective technology solution



Summary/Recommendations

- Donaldson is opposed to present ARB staff conclusions and guidance for technology acceptance criteria to meet California 2005 - 2006 State Budget Funding Eligible Device Requirements for the Lower Emission School Bus System.
- The ARB Board is requested to delay final approval of the Proposed Guideline Revisions for Retrofit Program funding and to direct ARB staff to provide additional assessment and recommendations for retrofit technology alternatives along with resulting BACT impacts.
- The ARB Board is requested to direct ARB staff to provide an assessment and recommendations of the impact and benefit of specific Crankcase PM control measures, both used alone and in combination with other Tailpipe aftertreatment control measures.



Questions/Comments?

Thank you for your time

