



ARCO Products Company
Fuels Development

ARCO Clean Fuel Projects

- 1989 EC-1 led to CBG 1996
- PNGV
- Fuel Cell Alliances

- 1999 EC-D leads to



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EC-D

- Urban Diesels
- Limited Production
- Non Catalyst Vehicles
- Enables Retro-Fit of Non Catalyst Vehicles
- Enables Future Vehicles Equipped with Catalyst



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EC-D Specifications

<u>Property</u>	<u>Target</u>	<u>Limit</u>
Sulfur, ppmw	<10	15 Max
Aromatics. %v	<10	12 Max
PNA, %wt	0.5	1.0 Max
Natural Cetane Number	60	57 Min
Nitrogen, ppmw	5	10 Max
API Gravity	37-42	42.5 Max
Distillation IBP (D-86), deg. F	375	350 Min
Cloud Point, deg. F	32	
ASTM 975	✓	



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Initial Fuels Tested

<u>Property</u>	<u>EC-D</u>	<u>CARB Fuel</u>
Sulfur, ppmw	<2	120
Aromatic %v	8.8	18.9
PNA, %wt	0.5	2
Natural Cetane Number	61.7	53.2
Nitrogen ppm	1	98
API Gravity	41.5	36.3
Distillation IBP (D-86), deg. F	386	358
Cloud Point, deg. F	32	10.4



Initial Engines Tested

Chassis Tests

- Six “Urban” Trucks/Buses
 - USPS Box Truck (Ford)
 - OCTA Transit Bus (DDC Series 50)
 - ARCO Tractor (Cummins L10)
 - Anaheim School Bus (DDC 6L)
 - Beneto Tractor (Cummins M11)
 - WVU Tractor (Cat 3406)
- Engines:
 - 7-14 Liter, 210-350 hp
- EPA Urban Dynamometer Driving Schedule for Heavy Duty Vehicles
- WVU Mobile Dynamometer

Engine Tests

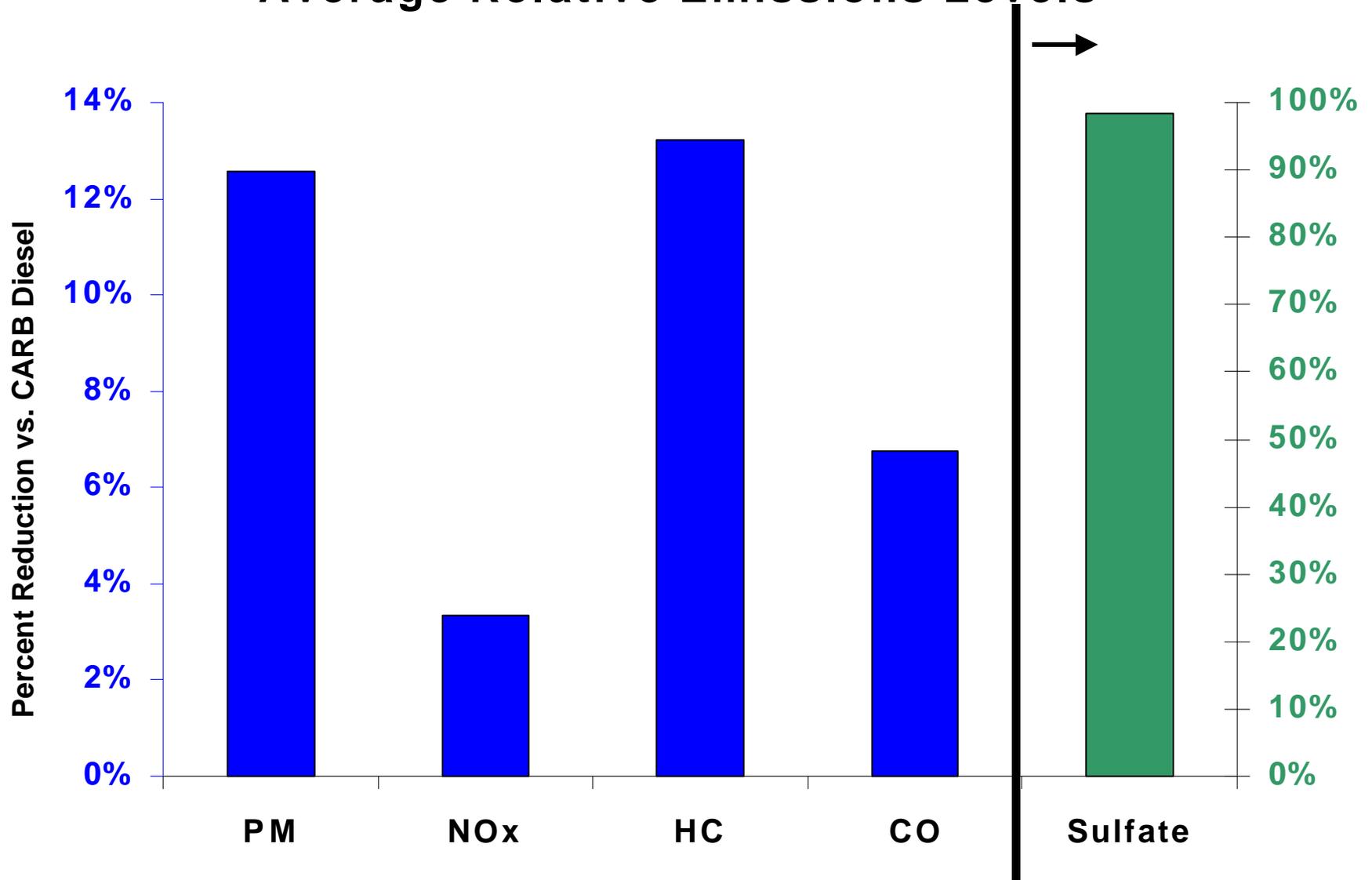
- Southwest Research Institute
 - Two Heavy Duty Engines
 - DDC Series 60
 - (CARB Cert.)
 - Cummins L10
 - Two Driving Cycles
 - EPA Transient
 - Central Business District
- Ethyl Corporation
 - One Heavy Duty Engine (DDC Series 60)
 - EPA Transient Cycle



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Initial EC-D Test Results

Average Relative Emissions Levels

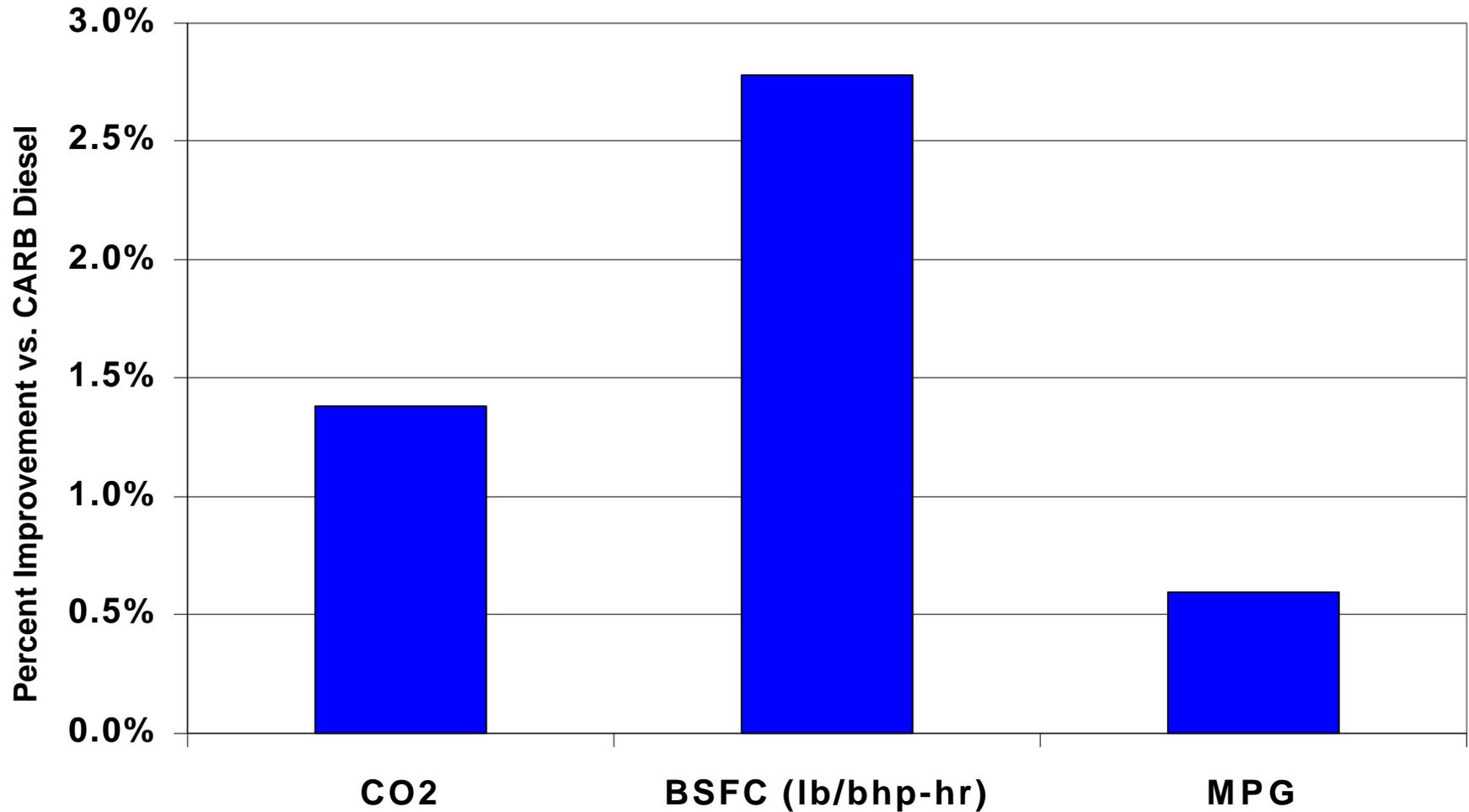




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Initial EC-D Test Results

CO₂ / Fuel Efficiency





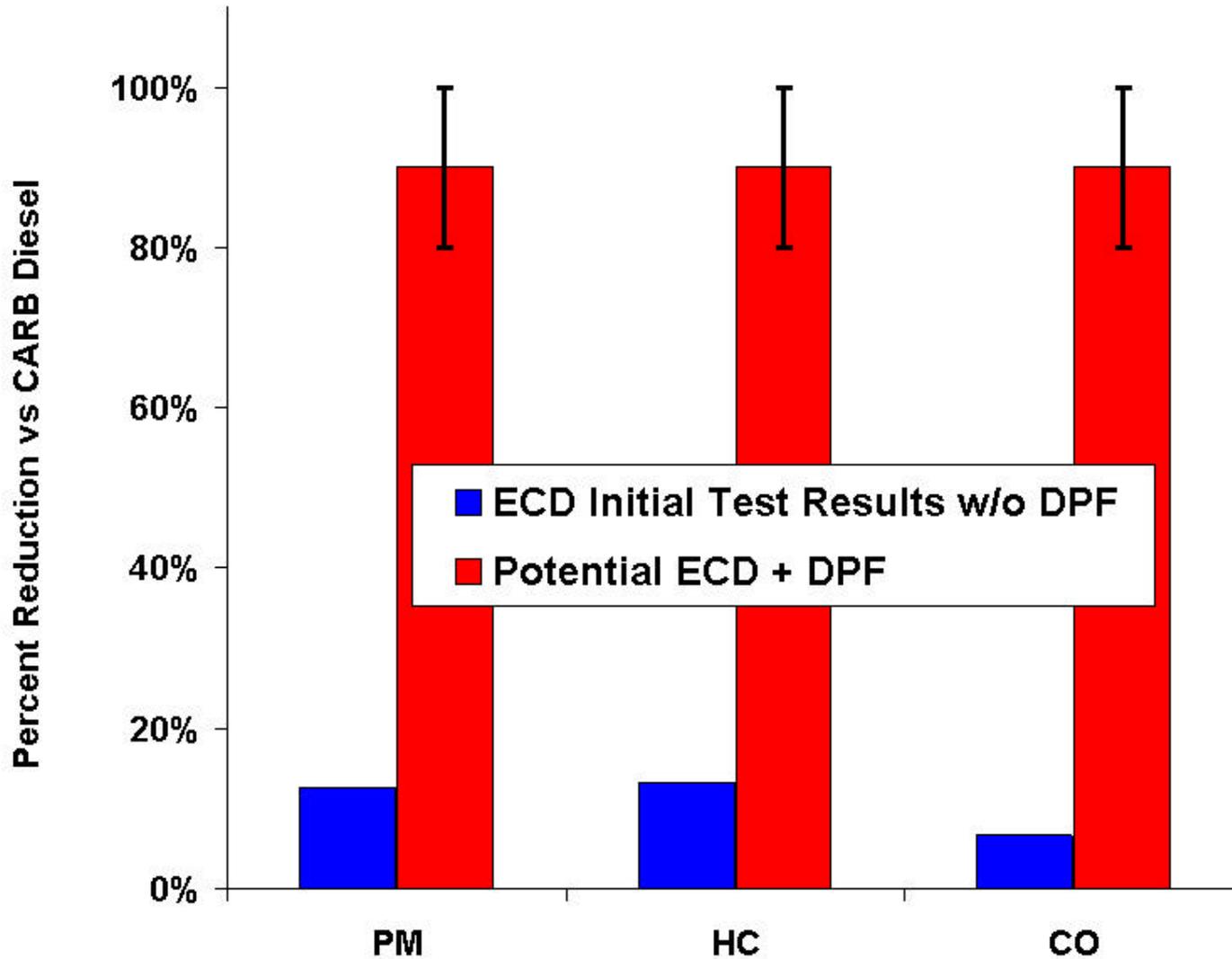
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Catalytic Diesels

- Passive Regenerating Particulate Filters (DPF)
 - Johnson-Matthey, Engelhard
- Sulfur Sensitivity
- Low sulfur fuel may enable high efficiency
NO_x aftertreatment



Catalytic Diesels





Program Deliverables

- Emission data
 - reduction from fuel change
 - reduction from fuel change and passive regenerating particulate filters
- Toxic, speciation and sizing data
 - with and without catalyst
- Durability information
 - low sulfur/aromatic high cetane fuel
 - passive regenerating particulate filters



Program Participants

Fleet Managers	Fleets Participating	Fleet Participation	Operating on ECD		Operating on ECD Only	Operating on CARB Diesel	Total Vehicles
			Johnson-Matthey	Engelhard			
ARCO	ARCO Distribution	Confirmed	5	5	9	10	29
Navistar	San Diego School District	Confirmed	5	5	10	10	30
Cummins	LA City Sanitation	Confirmed	5	5	2	3	15
Detroit Diesel	Santa Monica Big Blue Bus	Confirmed	5	5	10	10	30
Detroit Diesel		Confirmed	5	5	10	0	20
ARCO	Los Angeles MTA	Confirmed	2	2	8	8	20
Ford	Hertz Equipment Rental (LA)	Confirmed	5	5	5	5	20
NREL	Ralphs Grocery	Confirmed	5	5	5	5	20
Total Vehicles			37	37	59	51	184

Note: Corning and NGK are supplying the ceramic filters at a substantial discount and Fleetguard Nelson is assisting with the packaging of the filters.



Emission Testing

Chassis Dyno Test Matrix per Fleet

- Emissions CARB fuel
 - common baseline fuel for testing only
- Criteria Pollutants
 - Chassis Dyno supplemented with engine dyno work
- Toxic/Speciation Plan

	10 vehicles operating on Commercial CARB		10 vehicles operating on ECD & DPF	
	1	2	3	4
Test Vehicles				
Initial				
Emissions CARB	X	X	X	X
ECD			X	X
ECD + DPF			X	X
End				
ECD + DPF			X	X
ECD			X	X
Emission CARB	X		X	X



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Program Timing

- 1st Batch of Fuel Produced in July 99
- ARCO August 99
- San Diego Fleet September 99
- Other fleets currently starting
- Emission testing
 - Initial late 99/early 00
 - Final November 00
- Final report late 00/early 01