

FLETCHER

**EC-X REFORMULATED  
GASOLINE TEST PROGRAM  
STATUS REPORT**

**DAVE PAULSEN  
CLEAN FUELS TASK FORCE  
ARCO**

**In the Matter of Union Oil  
Company of California  
Docket No. 9305**

**RX 180**

**CALIFORNIA AIR RESOURCES BOARD  
JUNE 7, 1991**

CARB-FTC 0058829

# ARCO EC-X TEST PROGRAM GENERAL OVERVIEW

- Auto/Oil Participation
- ARCO Data Correlation
- Refinery Planning Model Development
- EC-X Test Blend Formulations
- EC-X Vehicle Testing
- Data Evaluation

## ARCO EC-X TEST PROGRAM TEST BLEND ANALYSES SUMMARY

Fuel -----	Base -----	1 ---	2 ---	3 ---	4 ---
RVP, psi	8.6	7.9	6.7	7.7	7.0
Arom, Vol%	34.4	21.2	21.6	12.2	12.0
Olef, Vol%	9.7	5.1	5.5	5.2	5.0
Oxy, Wt%	0.0	2.8	2.7	2.5	2.7
T50 (190-200)					
T90, F	323	289	293	278	274
Sul, ppm	349	39	41	31	33
(R+M)/2	86.8	90.1	90.0	90.0	90.0
ARCO DI*	53.4	52.1	54.3	43.0	43.6
(RVP, T50, O <sub>2</sub> )					
ARCO DI, %*	-	(-2)	(+2)	(-19)	(-18)

*Demonstration  
Fuels  
Not optimized  
fuels.*

*2<sup>nd</sup> Batch RFA*

\* Lower ARCO DI Means Better Cold Start Drivability  
Professional Drivers Variation is Approximately 15%

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## ARCO EC-X TEST PROGRAM VEHICLE SUMMARY

<u>1990 CA Vehicles*</u>	<u>No</u>	<u>Eng Type</u>	<u>Eng Size</u>	<u>Fuel Syst</u>	<u>Emissions System</u>
Ford Taurus	350	V-6	3.0	PFI	EGR, TWC
Toyota Camry	351	L-4	2.0	PFI	EGR, TWC
Plymouth Sundance	352	L-4	2.5	TBI	EGR, TWC
Honda Accord	353	L-4	2.2	PFI	EGR, TWC
Nissan Stanza	354	L-4	2.4	PFI	EGR, TWC, PA
Pontiac Grand Am	355	L-4	2.3	PFI	TWC
Ford Crown Vic	356	V-8	5.0	PFI	EGR, 2TWC&2OC, AP
Plymouth Voyager	357	V-6	3.3	PFI	EGR, TWC
Nissan Pickup	358	V-6	3.0	PFI	EGR, TWC
Buick LeSabre	359	V-6	3.8	PFI	EGR, TWC

- Vehicle Mileage Varies from 13,000 to 25,000 Miles  
With a Fleet Average of 18,000 Miles

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# ARCO EC-X TEST PROGRAM - STATUS REPORT

## FTP HC and OZONE - 7 CARS (2 CARS)

Fuel	Base	1	2	3	4
RVP, psi	8.6	7.9	6.7	7.7	7.0
Arom, Vol%	34.4	21.2	21.6	12.2	12.0
Olef, Vol%	9.7	5.1	5.5	5.2	5.0
Oxy, Wt%	0.0	2.8	2.7	2.5	2.7
T90, F	323	289	293	278	274
Sul, ppm	349	39	41	31	33

*Two tests/vehicle  
20% Criteria for  
third test.*

### Predicted Emissions

HC Mass (Exhaust)	Base	-24%	-28%	-29%	-33%
COPM <i>Criteria ozone per mile.</i>	Base	-28%	-31%	-36%	-40%

### Fleet Test Results

HC Mass (Exhaust)	Base	-35%	-29%	(-37%)	-30%
COPM	Base	-43%	-36%		-45%

*Consider Landing  
Hard Starters*

### Plymouth Sundance Test Results

HC Mass (Exhaust)	Base	-44%	-44%		-22%
COPM	Base	-55%	-55%		-43%

*AROMATICS KICK  
ON REACTIVITY  
T90 ON MASS*

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## ARCO EC-X TEST PROGRAM - STATUS REPORT

### FTP CO and NOX - 7 CARS (2 CARS)

Fuel	Base	1	2	3	4
RVP, psi	8.6	7.9	6.7	7.7	7.0
Arom, Vol%	34.4	21.2	21.6	12.2	12.0
Olef, Vol%	9.7	5.1	5.5	5.2	5.0
Oxy, Wt%	0.0	2.8	2.7	2.5	2.7
T90, F	323	289	293	278	274
Sul, ppm	349	39	41	31	33

#### Predicted Emissions

CO Mass	Base	-25%	-27%	-28%	-30%
NOX Mass	Base	-10%	-10%	-10%	-11%

#### Fleet Test Results

CO Mass	Base	-25%	-18%	(-39%)	-18%
NOX Mass	Base	-22%	-23%	(-39%)	-21%

#### Plymouth Sundance Test Results

CO Mass	Base	-44%	-33%		-38%
NOX Mass	Base	-23%	-30%		-23%

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*Assumed Linear*

→ *Sulfur/Olefins  
May be chemistry vs catalyst!*

## ARCO EC-X TEST PROGRAM - STATUS REPORT

### FTP TOTAL TOXICS - 7 CARS

Fuel	Base	1	2	3	4
RVP, psi	8.6	7.9	6.7	7.7	7.0
Arom, Vol%	34.4	21.2	21.6	12.2	12.0
Olef, Vol%	9.7	5.1	5.5	5.2	5.0
Oxy, Wt%	0.0	2.8	2.7	2.5	2.7
T90, F	323	289	293	278	274
Sul, ppm	349	39	41	31	33

#### Fleet Test Results Adjusted\*

Toxics Mass	Base	-50%	-46%	-56%
Risk Wtd**	Base	-48%	-45%	-54%

#### Plymouth Sundance Test Results Adjusted\*

Toxics Mass	Base	-66%	-60%	-64%
Risk Wtd**	Base	-67%	-62%	-66%

\* Adjusted to 1.6% Benzene in Base and 0.8% in Test Blends

\*\* Based on 12/90 Cancer Risk Factors

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# ARCO EC-X TEST PROGRAM SUMMARY

- EC-X Test Program in Progress
- Testing Realistic Reformulated Gasolines
- Achieving Substantial Reductions in HC, CO, NOX
- Achieving Substantial Reductions in Ozone
- Achieving Substantial Reductions in Toxics
- Emissions Reductions Equal/Better Than M85

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Next steps  
- Public Announcement of results at  
press conference  
- Want Jan to participate in press conf.  
- July 9 date for press conf.

## EC-X Program Overview

- **EC-X vs. Industry Average Gasoline**
  - \* **ARCO Data in 10 Car 1990 Fleet of Dedicated Gasoline Vehicles**
  
- **M85 vs. Industry Average Gasoline**
  - \* **Auto/Oil Data:**

**Industry Average Gasoline in 20  
Car 1989 Fleet of Dedicated  
Gasoline Vehicles**

**- VS -**

**M85 in 19 Car "State of Art"  
Fleet of FFV's**

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# EC-X Program Results: Tailpipe

10 Vehicle Data Set

*Auto/Oil limits*

Fuel	EC-X Blends				
	M85	1	2	3	4
RVP		8	7	8	7
% Aromatics		21	21	12	12
<b>% Reduction:</b>					
Hydrocarbon Mass	-38	33	28	37	32
Hydrocarbon Ozone Potential	35	41	37	52	46
NO <sub>x</sub>	"15"	26	26	31	25
CO	"31"	27	25	33	25
<b>Toxics</b>					
- Mass	11	53	47	59	58
- Risk Wtd (12/90 Factors)	60	50	45	58	56
- Risk Wtd (Likely 12/91 Factors)	30	46	42	53	51

\*Based on 10 vehicles for mass and 3 for reactivity.

*EC-X ≈ 5% less  
BTU/gallon*

*Farm. more potent  
than 12/90.*

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## EC-X Program Results: Rough Est\* Total Car

Fuel	M85	EC-X Blends			
		1	2	3	4
RVP		8	7	8	7
% Aromatics		21	21	12	12
<b>% Reduction:</b>					
- Hydrocarbon Mass	-19	35	32	36	34
- Ozone Potential	41	43	40	48	46
<b>Toxics</b>					
- Mass	20	59	56	69	67
- Risk Wtd 12/90 Factors	69	57	54	67	65
- Risk Wtd Likely 12/91 Factors	42	54	51	64	62

\*Assume 50/50 Evap/Tailpipe Base Case

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## EC-X Program Fuels

- Auto/Oil Industry Average (USA) Gasoline "Baseline"
  
- EC-X Fuels (4 Total)
  - \* All @ low sulfur, low T90, low olefins, and high MTBE (2.7%)
  
  - \* Two @ very low RVP (7 psi) and two @ low RVP (8 psi)
  
  - \* Two @ very low aromatics (12%) and two @ low aromatics (22%)

*Light olefins C3-C5  
max. 8 NOx ↑*

*Fuels are commercially producible*

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## Example EC-X "Cost/Benefit" Analysis: EC-X Impact on Non LEVs

Program	Deltas in Base Gasoline 1995-2005 Totals		
	Fuel Cost ¢/Gal.	Thousands of Tons #	\$/Ton
<b>EC-X #4 Effects:</b>			
- Reduce RVP 2 PSI	2	1,000	3,300
- Add 15% MTBE	4	300	23,000
- Reduce sulfur	2	200	22,500
- Reduce T90 and Aromatics	14	300	83,200
<b>- TOTAL</b>	<b>22</b>	<b>1,800</b>	<b>19,400</b>

\*Base = Industry Average Gasoline in all vehicles assuming no introduction of LEV's, etc.

*15 Apr. 87*

*12% Aromatics  
for 20% aromatics in 7¢/gal.*

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\*Base = Industry Average Gasoline in all vehicles assuming no introduction of LEV's, etc.

Program		Fuel Cost ¢/GAL	Vehicle Cost \$/CAR	MS/TON
ARB LEV's etc. if Fuel =				
- Conventional Gasoline	0	170 to 340	24.8 to 36.6	
- EC-X #4	22	70	39.4	
- M85	25 to 40	470	71.8 to 95.3	
Deltas to Base Case*		1995-2005 Totals		

**Example EC-X "Cost/Benefit" Analysis:**  
**ARB LEV Program**  
 1995-2005 Equivalent THC Reduction = 236,000 Tons\*