

INDUSTRY LOW-SULFUR TEST PROGRAM

- **AUTOMOBILE-INDUSTRY LEV/ULEV
VEHICLE TEST PROGRAM
(The Alliance, AIAM and Honda)**
- **PERFORMED AT REQUEST OF CARB
IN CONJUNCTION WITH MTBE-BAN
AND NEW CBF3 REGULATIONS**
- **PERFORMED WITH COOPERATIVE
ASSISTANCE OF OIL INDUSTRY**

GOAL #1:

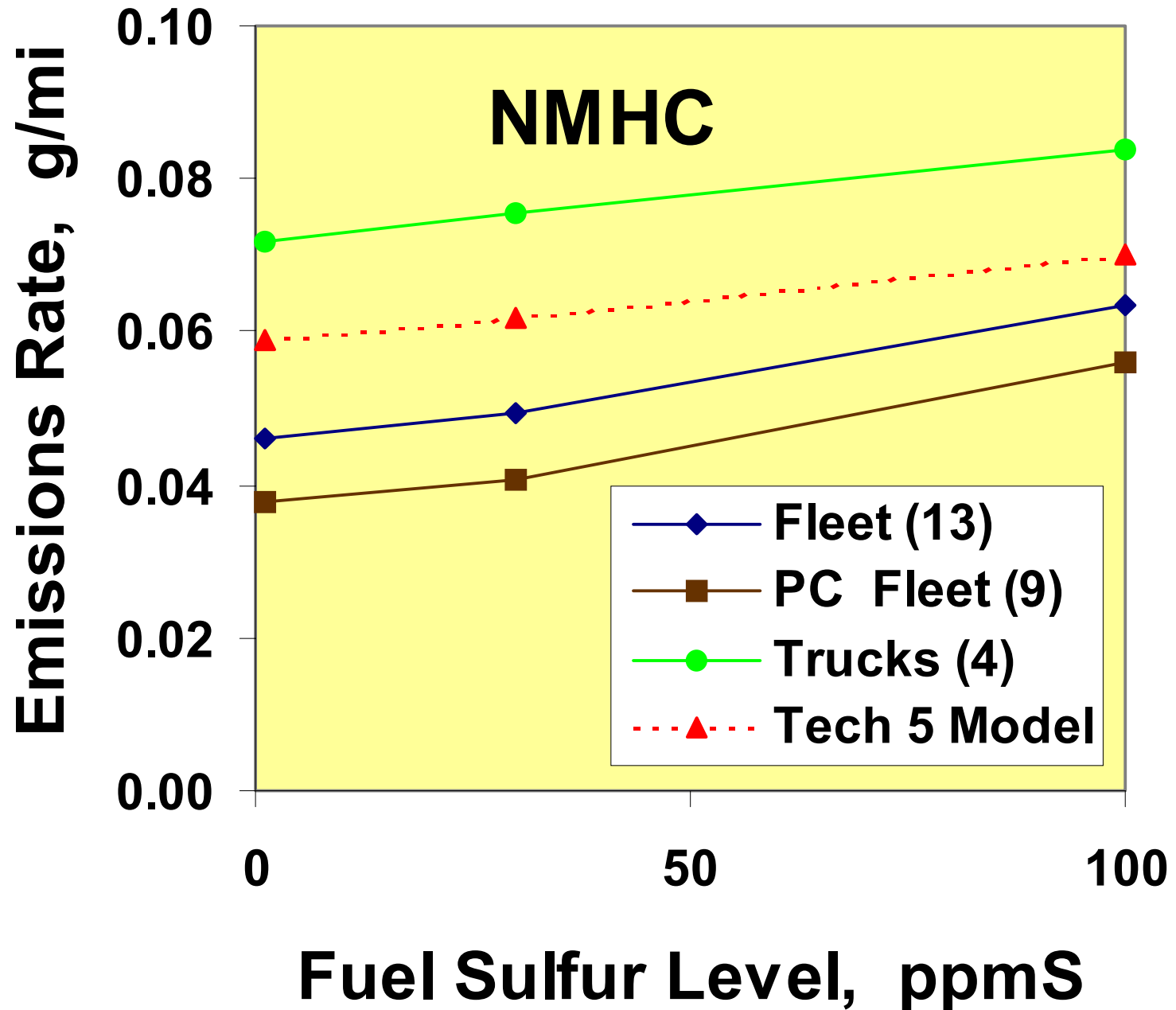
- **EVALUATE VERY-LOW SULFUR FUEL IN TECH-5 VEHICLES**
- **KEEP OTHER FUEL PARAMETERS CONSTANT**
- **USE 1, 30 AND 100 ppm S FUEL SULFUR LEVELS**
- **START WITH 1 ppm S FUEL, DOPE TO 30 AND 100 ppm S w MULTI-MIX**

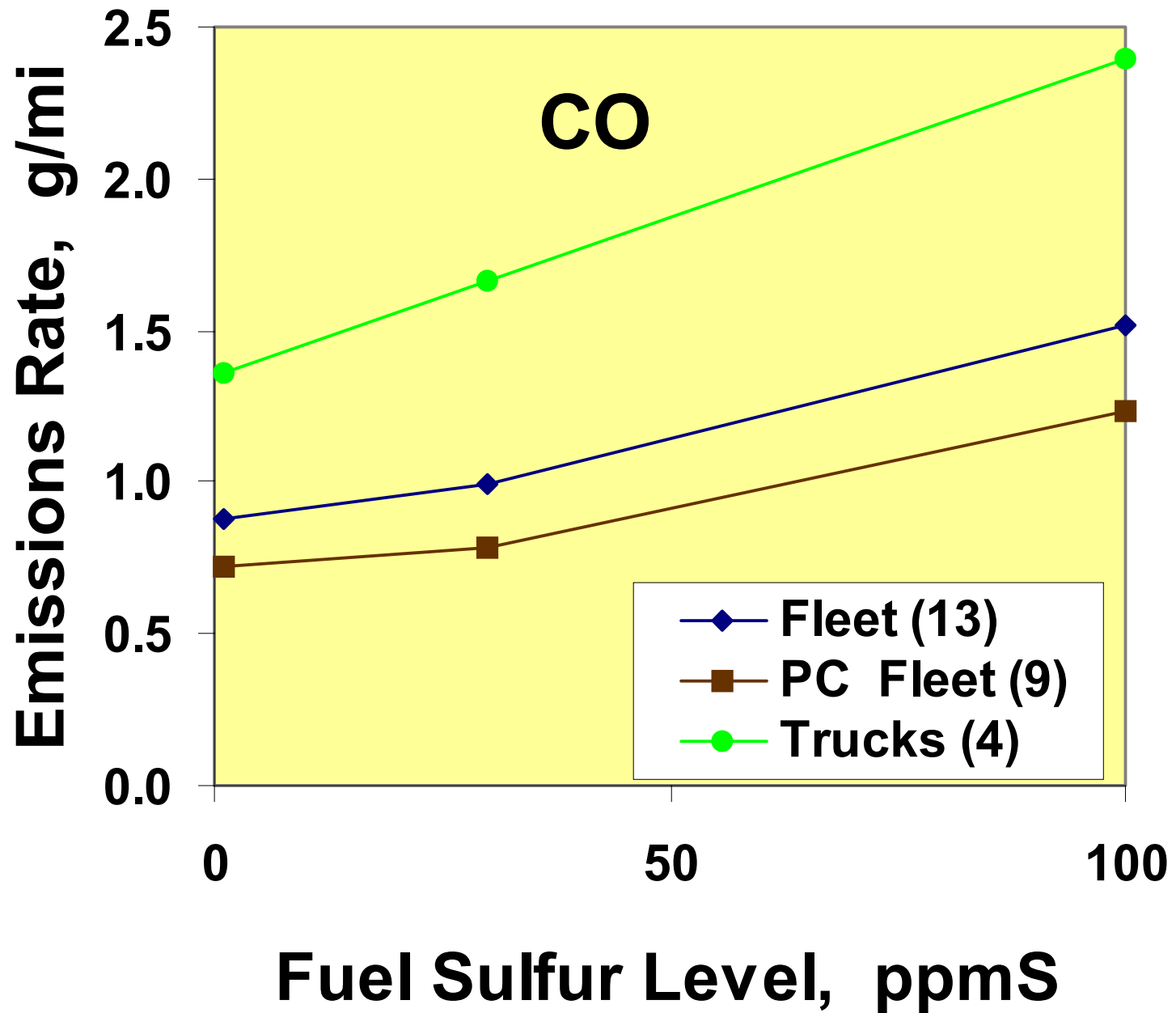
GOAL #2:

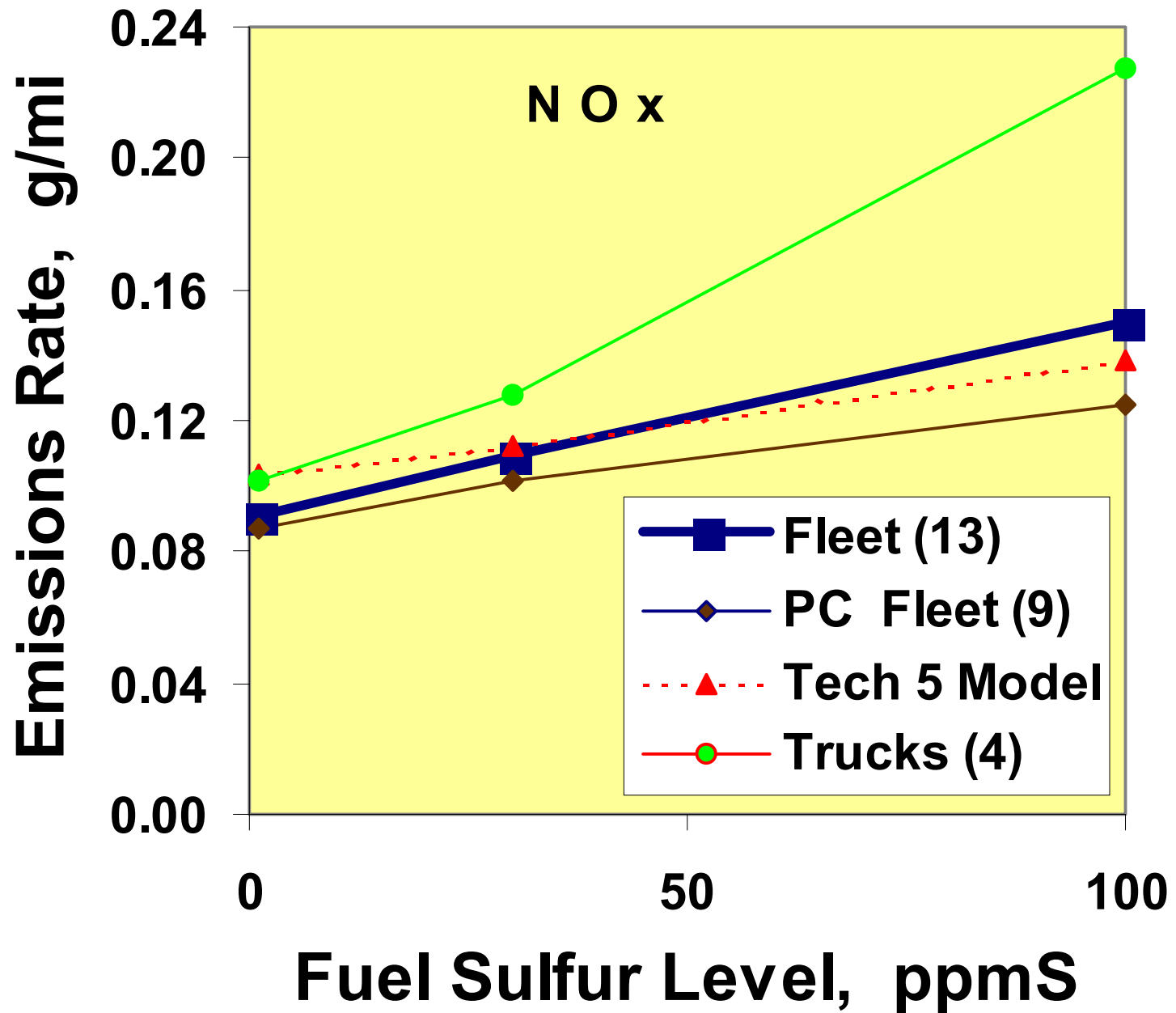
- **EVALUATE FUEL OXYGENATE EFFECT ON EMISSIONS**
- **USE MTBE-CONTAINING CBF2 FUEL AND COMPARE TO ETHANOL FUEL AT 4% OXYGEN,**
- ***AND TO OXYGENATE-FREE FUEL, ATTEMPTING TO HOLD KEY FUEL PARAMETERS CONSTANT***

Status of Industry CBF3 Low Sulfur Data Set:

	Summary Information:		
Emissions Class	1 TLEV	9 LEV	3 ULEV
Vehicle Class	9 LDV	2 LDT2	2 MDV2
Body Class	9 PC	4 T	
SFTP Chip	3 Yes	10 No	
Engine-Out Data	5 Yes	8 No	
Catalyst Inefficiency	7 Yes	6 No	
Bags 1, 2, 3 of FTP	9 Yes	4 No	
Methane	11 Yes	2 No	
Sulfur Fuels	"1"	13 Yes	
	"30"	13 Yes	
	"100"	13 Yes	
Emissions Class-Oxy	0 TLEV	8 LEV	2 ULEV
Vehicle Class-Oxy	8 LDV	1 LDT2	1 MDV2
Body Class-Oxy	8 PC	2 T	
Ethanol Fuel	"E"	10 Yes	3 No
Clear Fuel	"C"	10 Yes	3 No
Reversibility	Standard	12 Yes	1 No
	Extra	8 Yes	5 No
US06	"U"	2 Yes	11 No
Other	2 w Species	4 w/o FE	







Tech 5



Linear

Emissions Reduction 30 ppmS			
g/mi	Species	30 to 1	Zero Lube
0.09	NOx	16%	55% 0.05 g/mi
0.90	CO	12%	69% 0.61 g/mi
0.06	HC	11%	58% 0.02 g/mi

13-Vehicle Fleet Geometric
MeansTLEV, LEV & ULEV PC & T

CONCLUSIONS - SULFUR

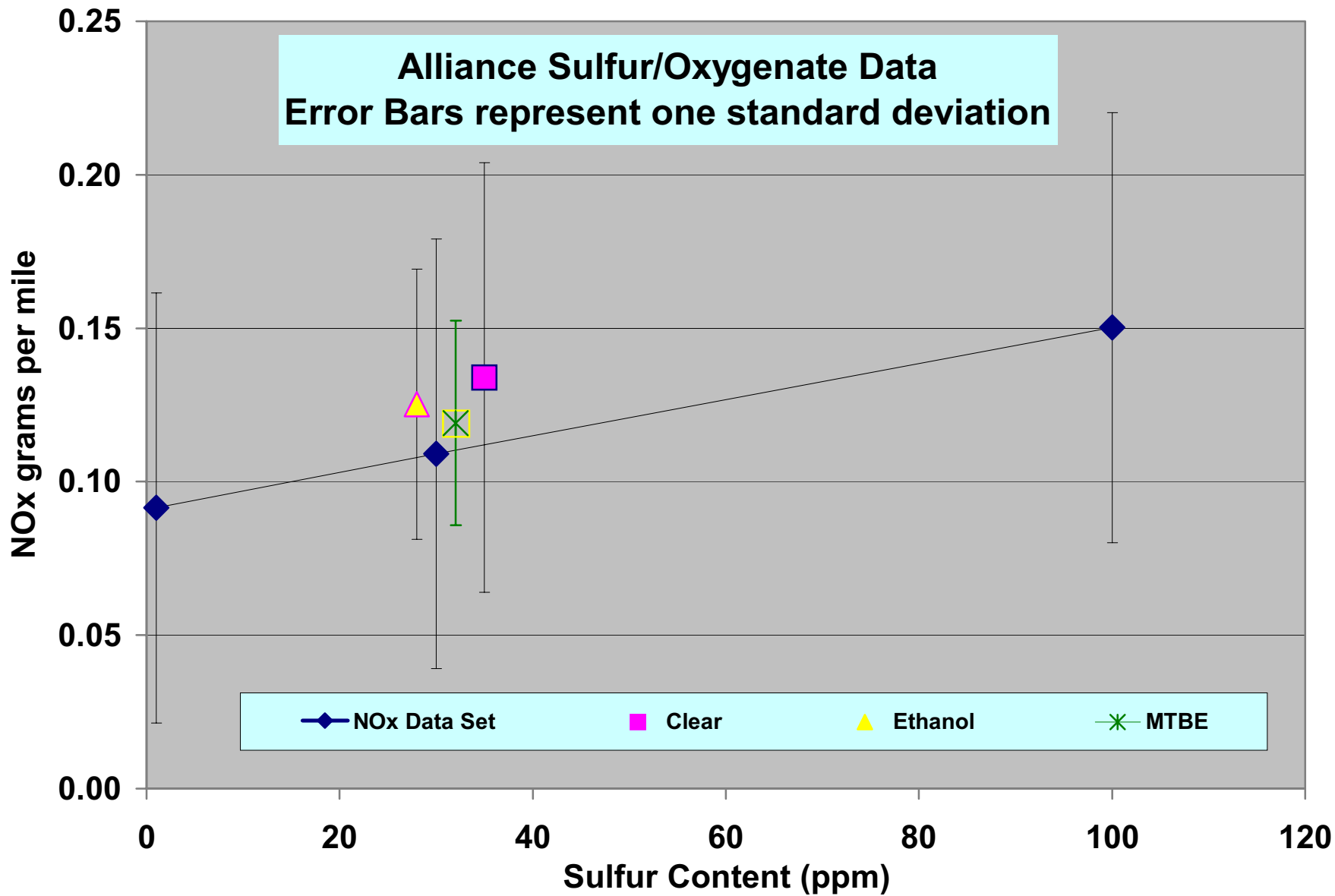
- **LINEAR $\ln(\text{EMISSIONS})$ vs. SULFUR ppm**
- **FUEL SULFUR REDUCTIONS STILL NEEDED FOR HC, CO & NO_x**
- **REDUCTIONS LESS THAN AUTO/OIL LOG-LOG PREDICTION AT 1 ppm S**
- **DIFFERENCE PRESUMABLY LUBRICANT-SULFUR CONTRIBUTION**
- **DATA SUPPORTS MAKING CARB TECH 5-MODEL UPDATES**
 - **Effects observed are greater than ARB model prediction**

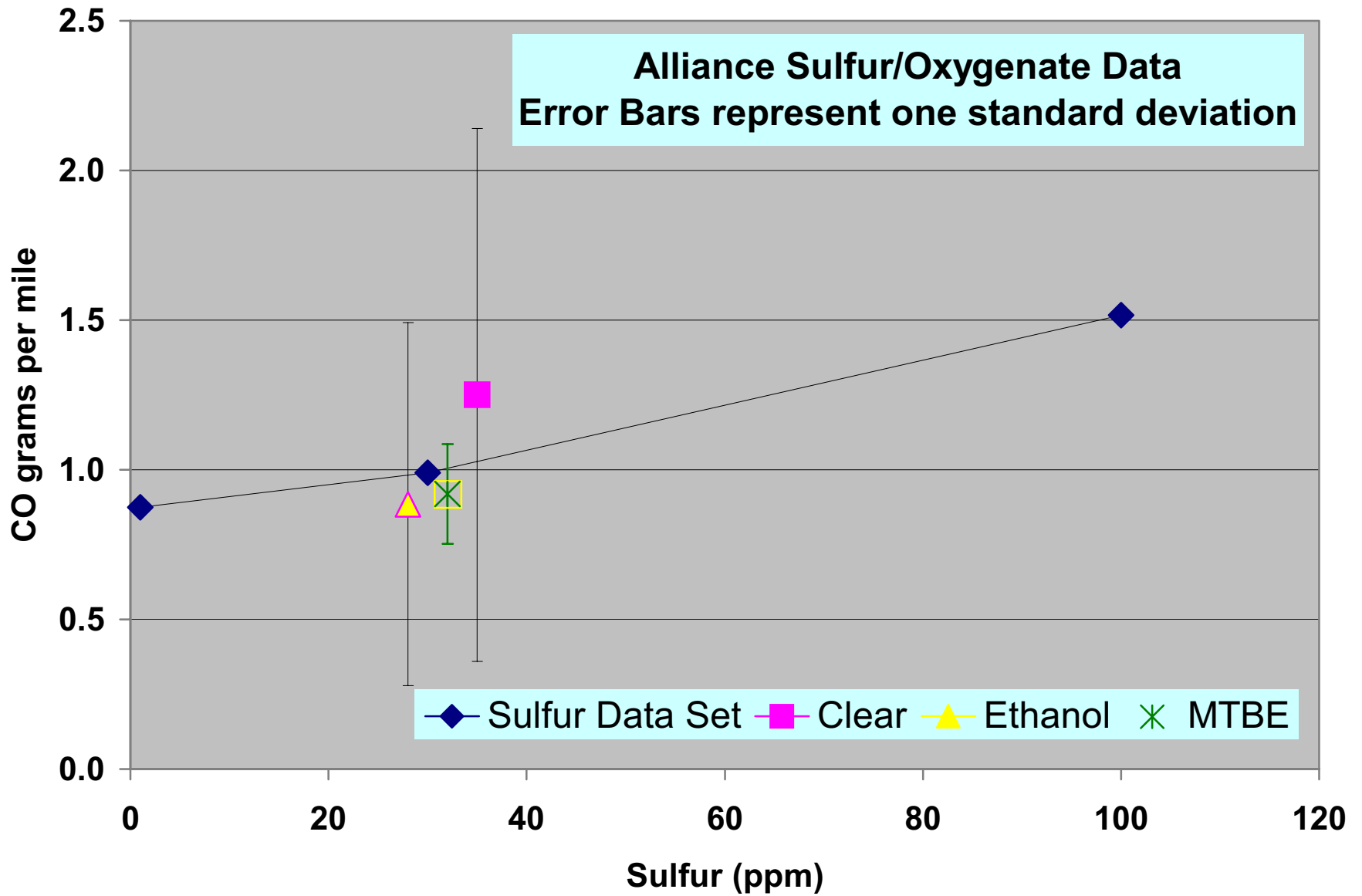
OXYGENATE CONCERNS

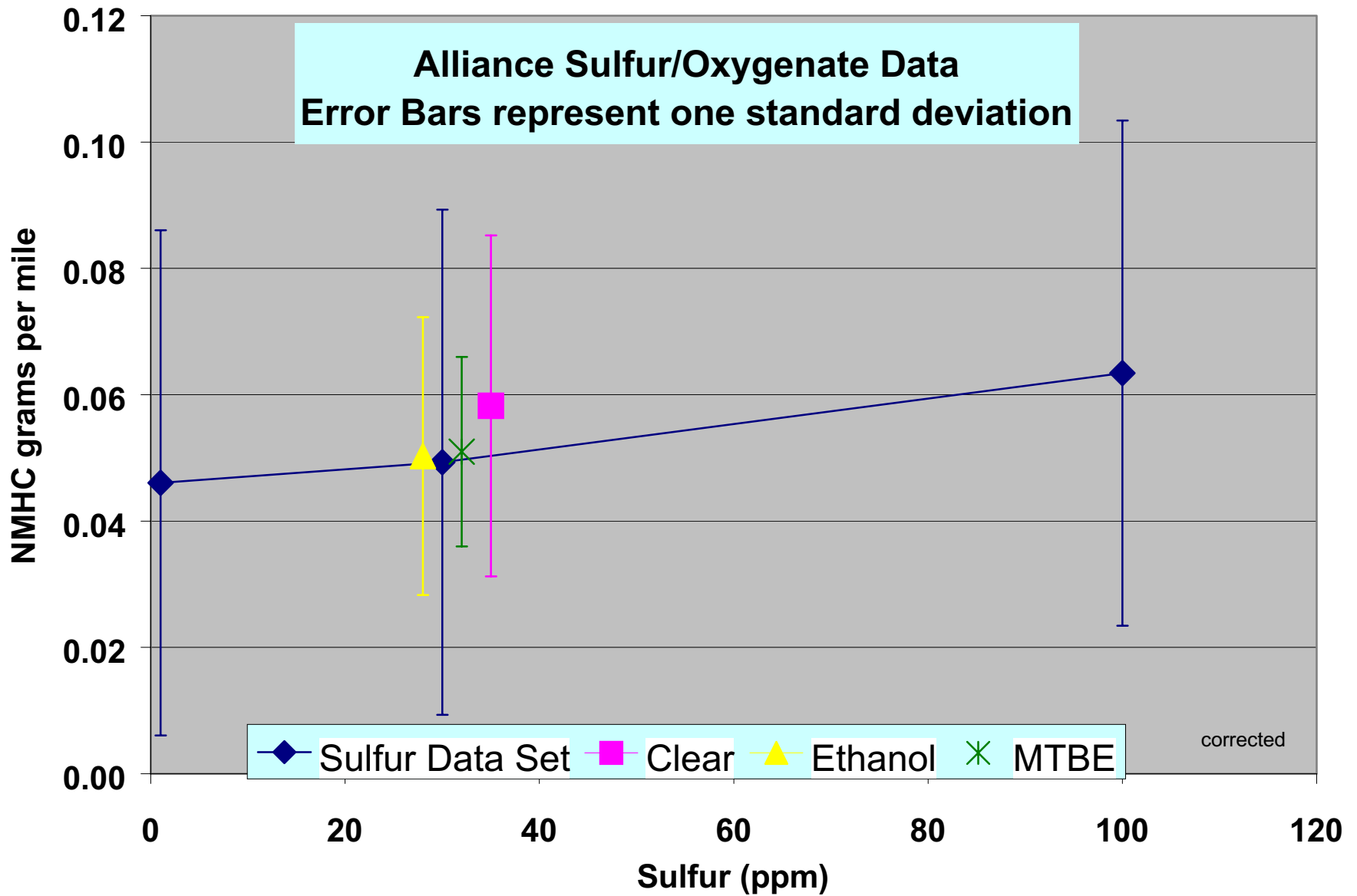
- **IMPOSSIBLE TO BLEND IDENTICAL FUELS AT 0, 2 & 4% OXYGEN LEVELS**
- **OIL INDUSTRY MADE GALLANT EFFORT, MUCH BETTER THAN COULD BE EXPECTED**
- **OXYGENATE EFFECT CAN RESULT IN CONFOUNDING ENGINE-OUT DIFFERENCES - LIMITED DATA**

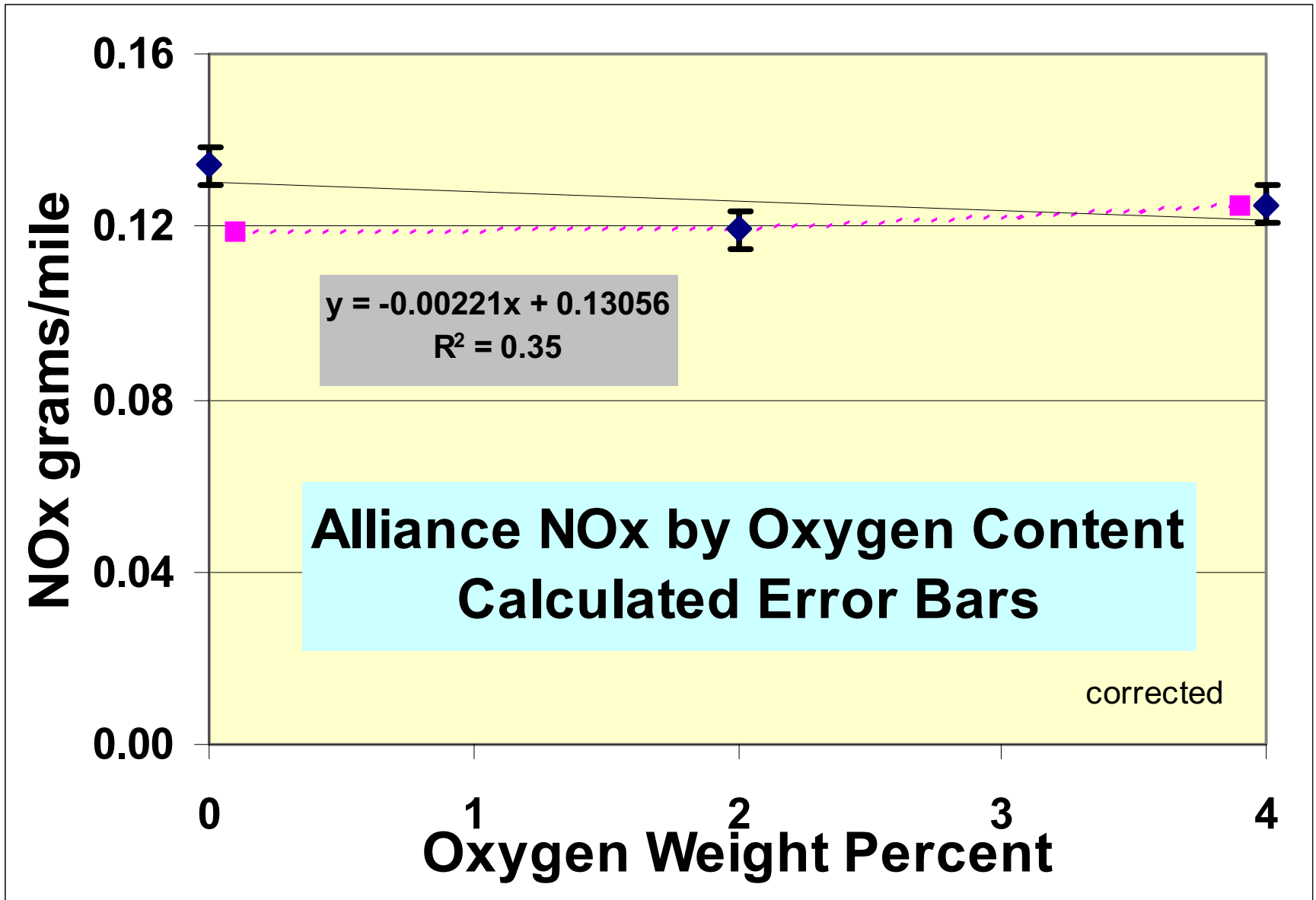
Fuel Analysis Data

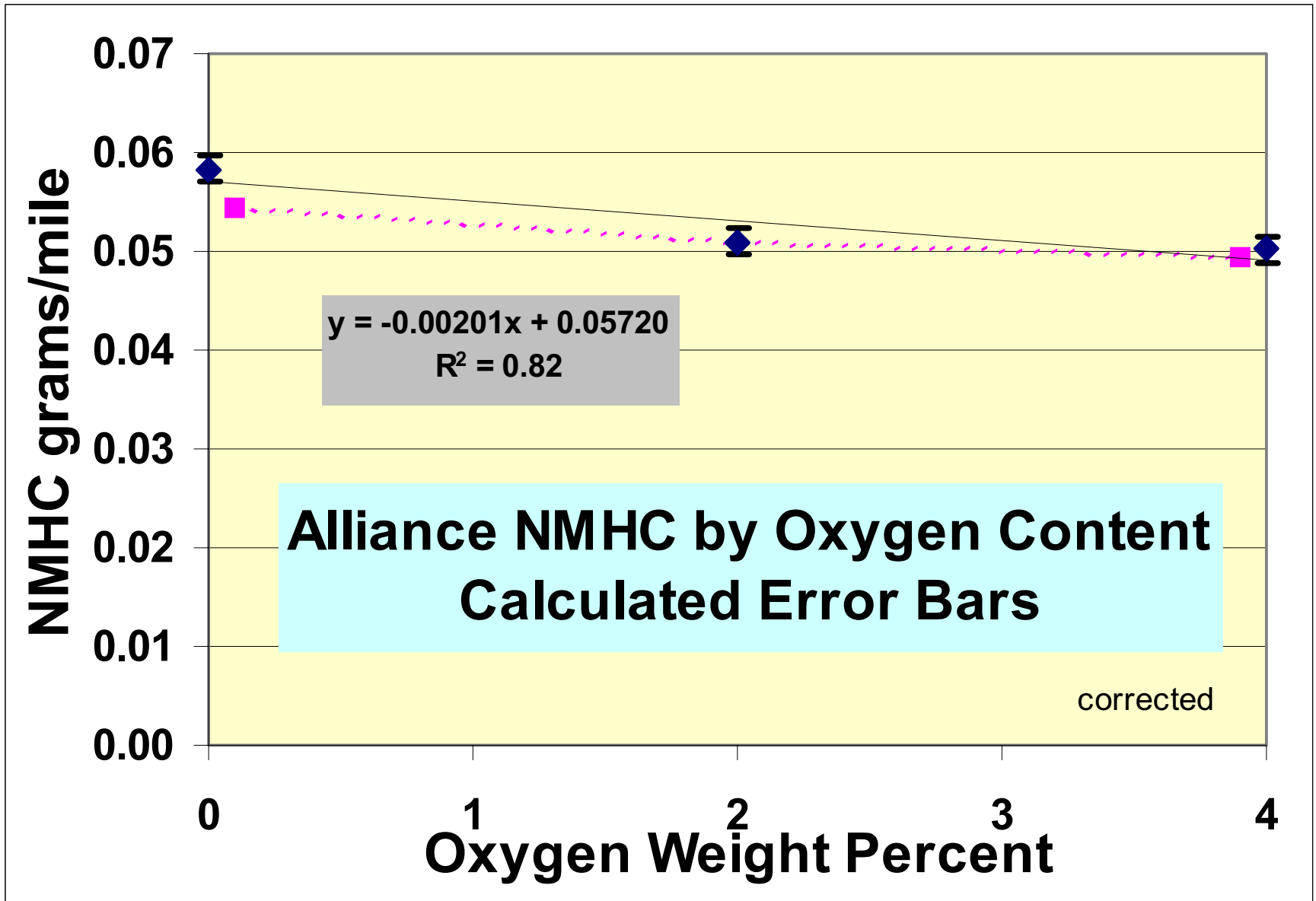
Test	Units	<Non-Oxy>	MTBE	<EtOH>
10%	°F	145	141	136
50%	°F	210	202	205
90%	°F	297	294	291
Gravity	°API	61.4	61.9	60.2
Reid Vapor Pressure	psi	7.1	6.91	7.1
Carbon	wt. fraction	0.851	0.834	0.824
Hydrogen	wt. fraction	0.141	0.139	0.142
Hydrogen/Carbon Ratio	mole/mole	1.98	1.99	2.05
Sulfur	ppm	35	31	28
Ethanol	vol %	0.0	0.0	11.5
MTBE	vol %	0.0	11.3	0.0
Composition, aromatics	vol %	24.6	22.0	21.6
Composition, olefins	vol %	4.6	3.4	4.1
Composition, saturates	vol %	70.9	63.3	62.8
(R+M)/2		91.4	95.0	95.7
Net Heat of Combustion	btu/lb	18347	18468	17776

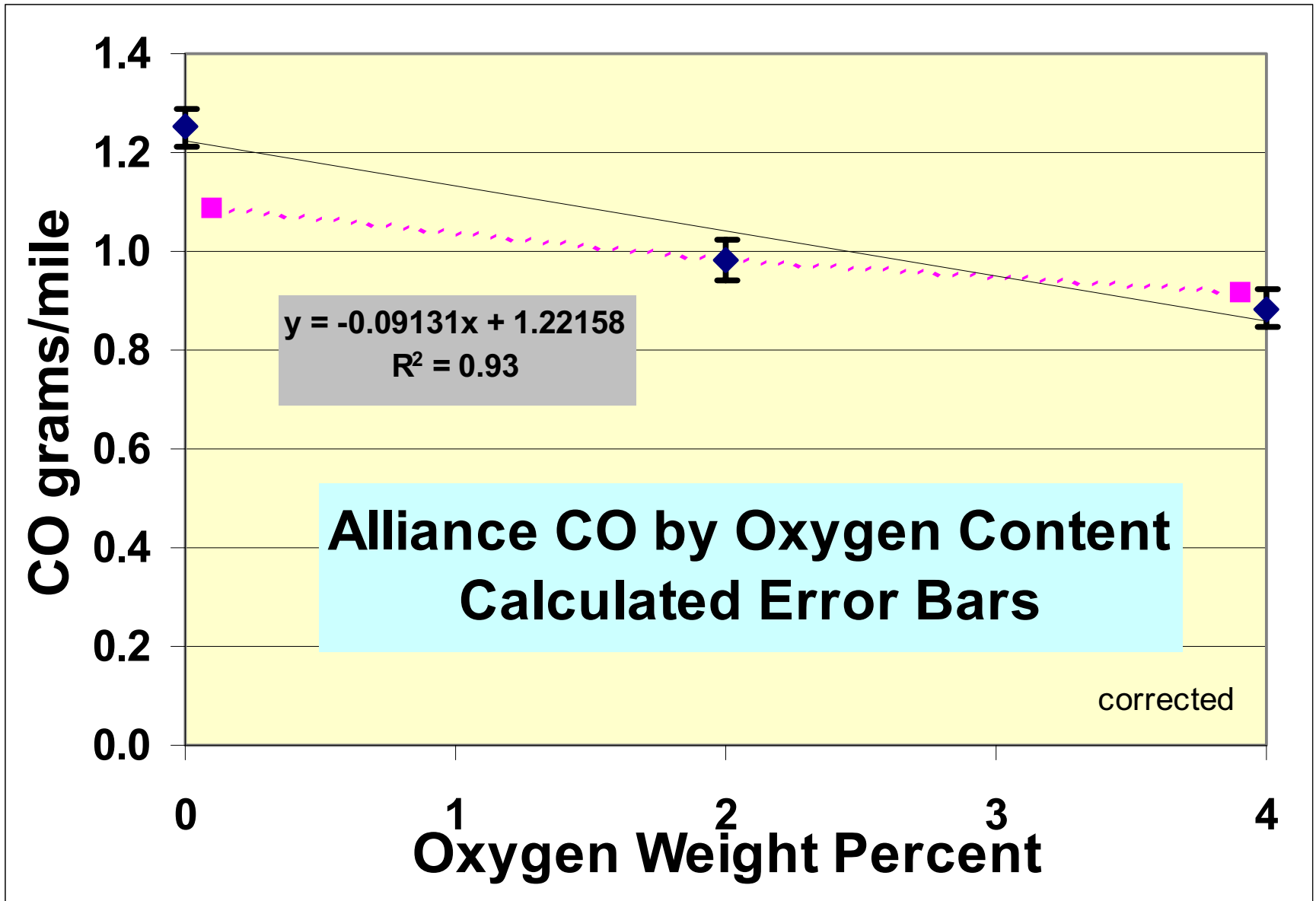












CONCLUSIONS - OXYGENATE

- **SOME, BUT NOT ALL, OXYGENATE DIFFERENCES ARE STATISTICALLY SIGNIFICANT**
- **NOT CLEAR THAT MODEL CHANGES WARRANTED BASED ON THIS DATA**