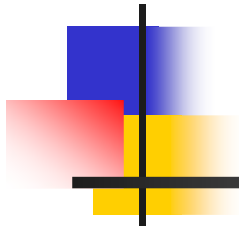


The Predictive Model and EMFAC



Predictive Model Workshop

May 24, 2006

Ben Hancock
PTSD Mobile Source Analysis Branch
Analysis Section



Presentation Outline

- Objectives
- Model Timelines
- EMFAC Changes affecting Predictive Model
- Summary and Next Steps



Objectives

- Predictive Model Revision before the Board
October 19, 2006
- Model depends on EMFAC inputs. Changes to fuel have exhaust and evap effects.
- No inputs at present from OFFROAD. We will only talk about on road gasoline effects here.
- EMFAC 2007 is under development. Extensive changes since 2002. Due in November 2006
- Identify which EMFAC changes can be incorporated in Predictive Model for October.



Model Timelines

Most recent EMFAC to SSD	May 8-10
Revised EMFAC Working Draft	June 8
Draft Predictive Model	June 15
Final Predictive Model	July 15
Board Hearing	October 19
EMFAC 2007 Release	November



EMFAC Updates Provided to SSD

CHANGE ITEM	IMPORTANT TO	
	EXHAUST	EVAP
GUI UPDATES		
FUEL CORRECTION FACTORS	●	
I&M UPDATES	●	
BRAKEWEAR PM		
ACCRUAL RATES	●	
OTHER BUS CATEGORY		
POPULATIONS 00,01,02,03	●	●
HHDDT POPULATION REDIST		
ETHANOL PERMEATION		●
HHDDT EXHAUST RATES		
VMT FORECASTS	●	●
SPEED PROFILE FORECASTS	●	
ANNUAL AVG CORRECTION		
TEMPERATURE PROFILES	●	●
RELATIVE HUMIDITY PROFILES	●	



EMFAC Updates to be Completed by June 8

CHANGE ITEM	IMPORTANT TO	
	EXHAUST	EVAP
UPDATED VMTS	●	●
CEIDARS/CFES FORMATS		
HDV GAS CAPS		●
POPULATIONS 04,05	●	●
REMATCH VMTS	●	●
SCAG VMT UPDATE	●	●
SCAG SPEED UPDATE	●	
PENDING VEHICLE SFS	●	●



EMFAC Updates to be completed by November

CHANGE ITEM	IMPORTANT TO	
	EXHAUST	EVAP
REVISED POPULATIONS	●	●



Significant EMFAC Changes Affecting Predictive Model

- Temperature and Relative Humidity Profiles
- Vehicle Population
- Activity estimates from COGs/MPOs
- Ethanol

Emission Effects Relative to EMFAC 2002

	ROG	CO	NOx
Temperature/RH	↑	↑	↑
Vehicle Population	↑	↑	↑
Activity estimates	↑↓	↑↓	↑↓
Ethanol	↑	—	—

Emission Effects Relative to EMFAC Working Draft

	ROG	CO	NOx
Temperature/RH	—	—	—
Vehicle Population	↓	↓	↓
Activity estimates	↑↓	↑↓	↑↓
Ethanol	—	—	—



Temperature and Humidity

- New and more met data
- Improved choice of candidate days
- Finer extrapolation and weighting

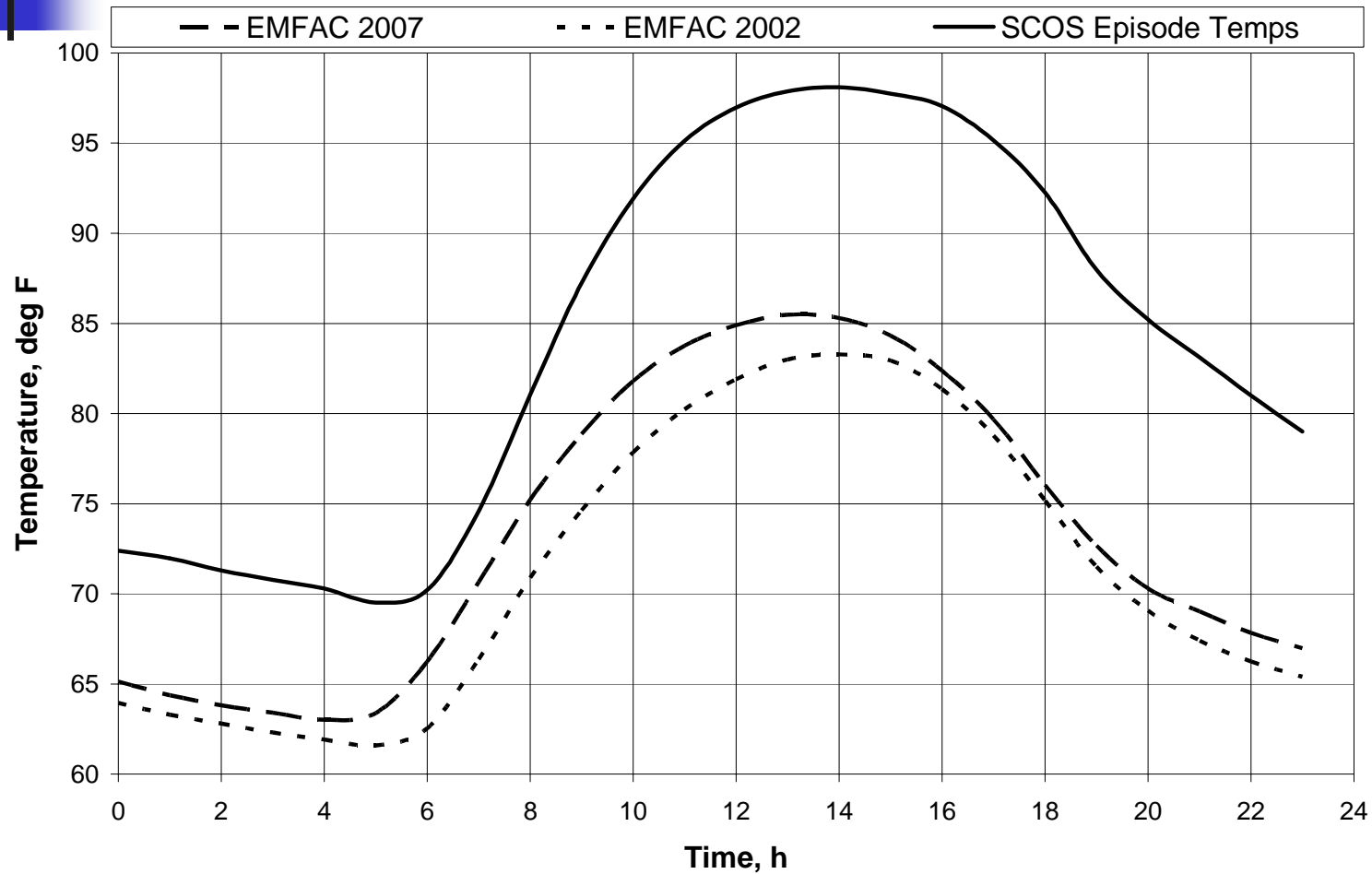


Temperature and Humidity Effects

Region	Temperature	Humidity
Statewide	+5-7°F	-
South Coast Air Basin	+3-5°F	-3 pp*
San Joaquin Valley Air Basin	+7-12°F	-10 pp

*pp is "percentage points". Evaluated at mid day.

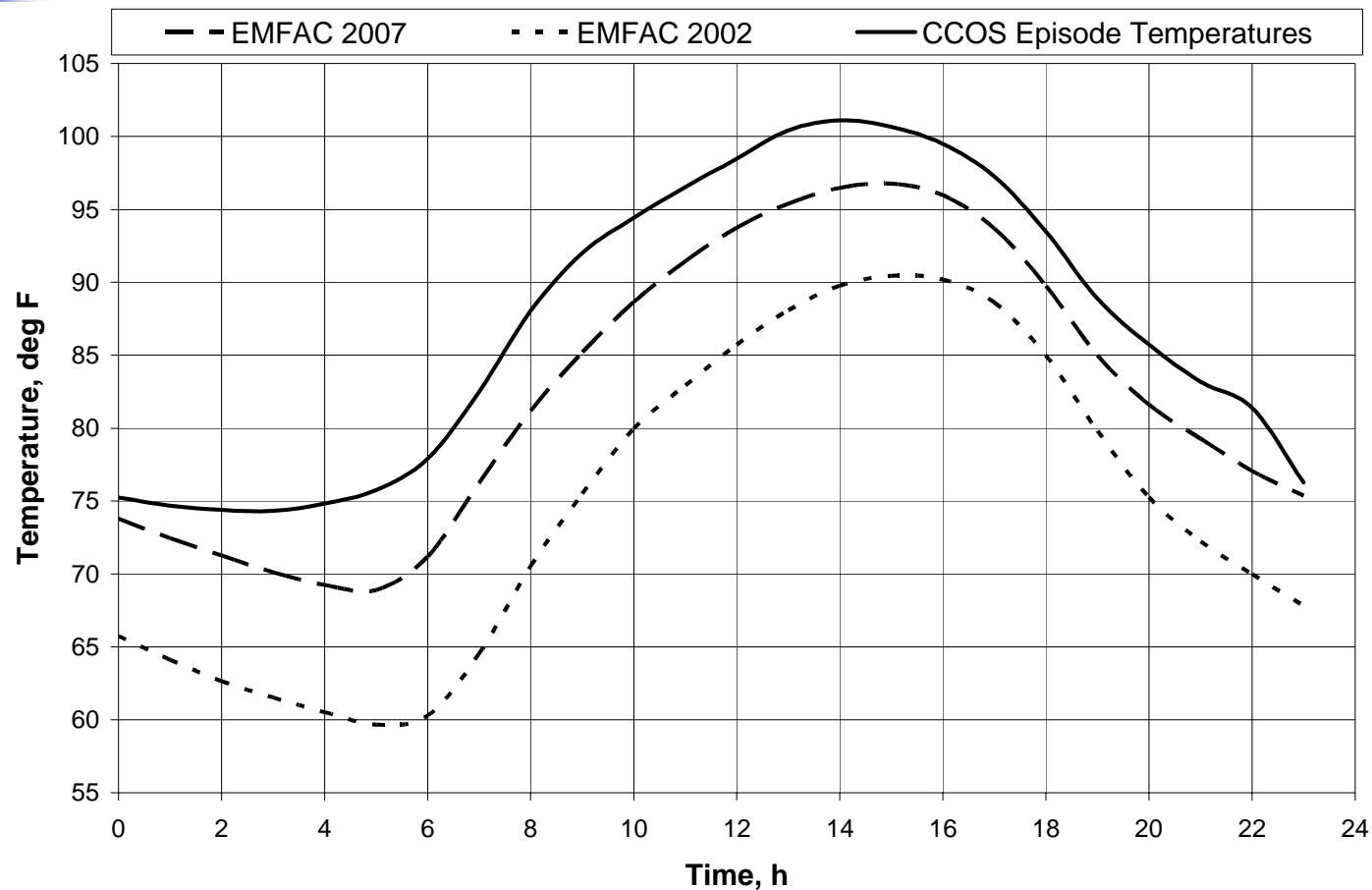
South Coast Temperature Profiles



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San Joaquin Valley Temperatures



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Emission Impact of Temperature and Humidity Change

Region	ROG	CO	NOx
Statewide	+60 tpd (+6%)	+234 tpd (+3%)	+32 tpd (+2%)
South Coast Air Basin	+7 tpd (+2%)	+24 tpd (+1%)	+12 tpd (+3%)
San Joaquin Valley Air Basin	+11 tpd (+10%)	+55 tpd (+6%)	+11 tpd (+4%)

2005 Onroad vehicles. Working draft population (29.6 million)



Vehicle Population

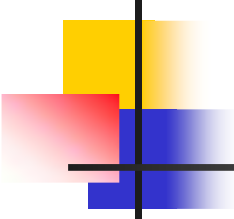
- Proposed Population
- Emission Impact



Proposed Population Changes – Older & Alternative Fuels Vehicles

Population Estimate Based on Calendar Year 2003	Total
Registered	23.4 M
+ Pending (Instantaneous)	1.1 M
= Draft Total Population	24.5 M
+ "Older" Vehicles	1.1 M
+ Alt. Fueled	0.4 M
= Proposed Total Population	26.0 M

***All pending registrations included would correspond to 29.6 million vehicles for CY 2003**



Emission Impact with Revised Population (26.0 million)

Region	ROG	CO	NOx
Statewide	-88 tpd (-8%)	-270 tpd (-3%)	-25 tpd (-1%)

2003 Onroad vehicles

With respect to Working draft population (29.6 million)



Activity Estimates from COGs

- Received VMT and Speed Data from SCAG on May 1
- Staff is reviewing data, will be complete by June 8
- Might receive data from MTC, San Diego, and SaCOG by November
- If COG errors are discovered, we will have to recalculate.



Emission Impact of Ethanol Permeation

	29.6 m	26.0 m
Region	ROG	ROG
Statewide	+42 tpd (+9%)	+37 tpd (+9%)
South Coast Air Basin	+14 tpd (+8%)	+12 tpd (+8%)
San Joaquin Valley Air Basin	+7 tpd (+11%)	+6 tpd (+11%)

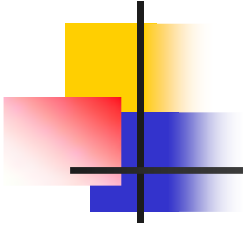
2005 Onroad vehicles, % of Evap Inventory, New Temperature Profiles



Summary and Next Steps

- Create scaling factor for modeling purposes
- Start programming for November update
- On-going coordination and outreach
- All significant changes will be reflected in the Predictive Model by June
- CRC and U.S. EPA studies will provide more data

End of Presentation





EMFAC Basic Structure

$$\textit{Emissions Inventory} = \sum \textit{NoVeh} \times \textit{Act} \times \textit{EmisFact}$$

Emissions Inventory, tons per day

No Veh = number of vehicles

Act = activity in miles per day

Emis Fact = Emission factor in grams per mile

The product No Veh x Act is VMT (vehicle-miles traveled per day)

Comparison of Population Estimates for CY 2003

CY 2003	Notes for Raw Data	Raw (Millions)	Normalized to EMFAC
US Census	All Gas vehicles, 1974+ (2000)	19.0	23.1
Known Registered	All Vehicles, '54-'03	23.4	23.4
BAR	LDT, MDT, no Diesel, MY='74-04	23.4	24.1
Known Registered & Pending	All Vehicles, '54-'03	24.5	24.5
CALTRANS	All Vehicles, All Fuels (2004 MVSTAFFF)	25.1	25.1
California Statewide Household Travel Survey	LDA, T1, T2, T3 (2000-2002 Travel Survey)	21.4	25.7
PROPOSED POPULATION	All Vehicles, '54-'03	26.0	26.0
CEC	Includes Pending, '87-'03	25.9	28.2
All Records	All Vehicles, '54-'03	29.6	29.6



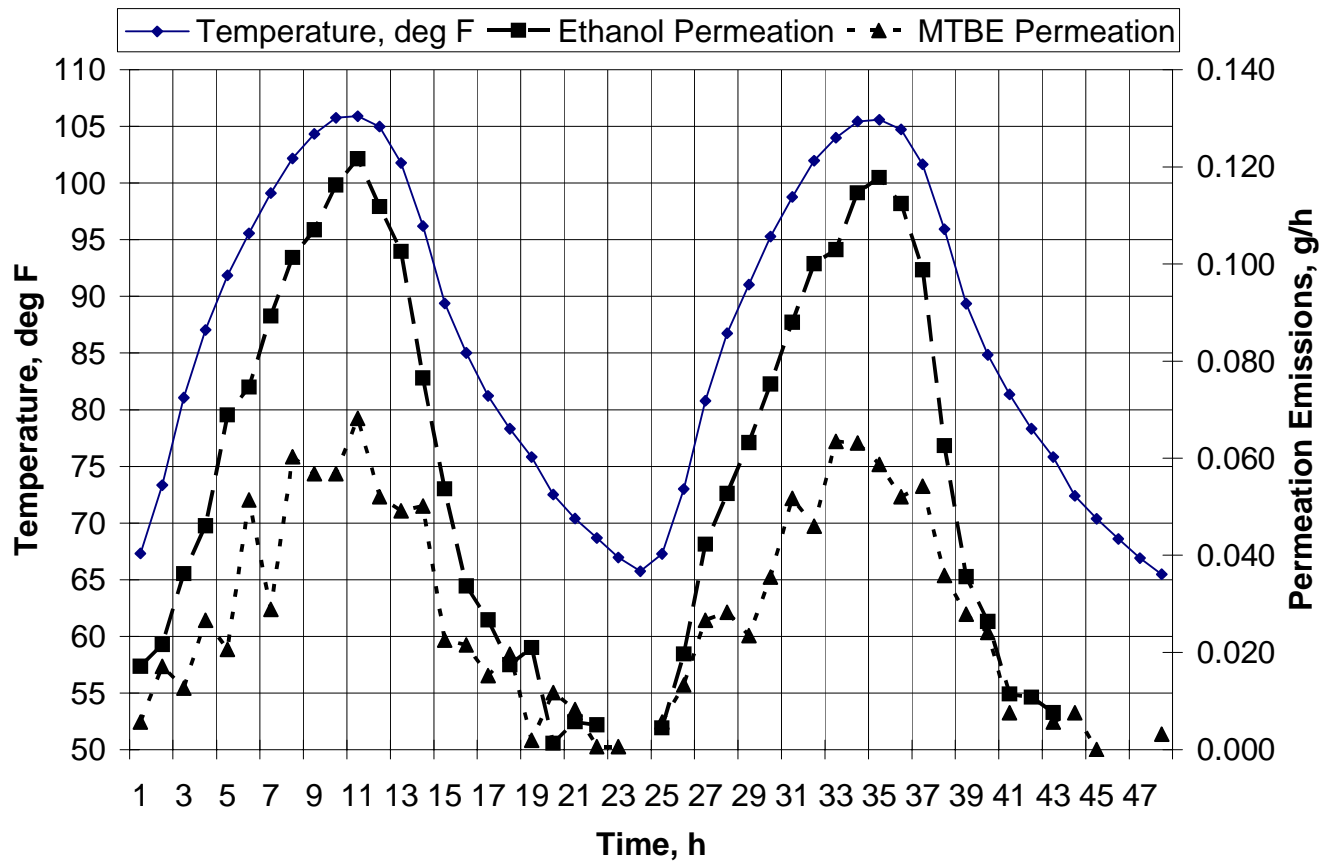
E65 Diurnal Results

- Fleet average 2.1 grams per day emissions on MtBE, 3.6 g/d emissions on EtOH.

MY	MTBE	EtOH	Age		delta	ratio
	g/d	g/d	y		g/d	
2001	0.2	0.76	3		0.52	3.17
2000	0.6	1.43	4		0.79	2.23
1999	0.3	1.37	5		1.08	4.72
1997	0.6	2.25	7		1.62	3.57
1995	9.2	11.65	9		2.45	1.27
1993	*	3.7	4.89	11	1.19	1.32
1991	1.2	2.25	13		1.01	1.81
1989	1.0	2.63	15		1.67	2.74
1985	2.0	4.67	19		2.71	2.38
1978	1.9	3.74	26		1.82	1.95
Total	2.1	3.6	11	g/d avg	1.5	1.72
8 normals	1.0	2.4		g/d avg	1.4	2.42
2 moderates	6.5	8.3		g/d avg	1.8	1.28

E65 Diurnal Permeation Data

- Results for one vehicle over 48 hours



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Method Summary

$$ER_{\text{etoh}} = ER_{\text{mtbe}} * (\text{PERMfr} * \text{EtRFG2r} + 1 - \text{PERMfr})$$

ER = emission rate

- Evaluated at ambient (diurnal) temperature
- EtRFG2r ratios from E65 data

$$\text{EtRFG2r} = \text{diurnal rate on EtOH fuel} \div \text{diurnal rate on MTBE fuel}$$

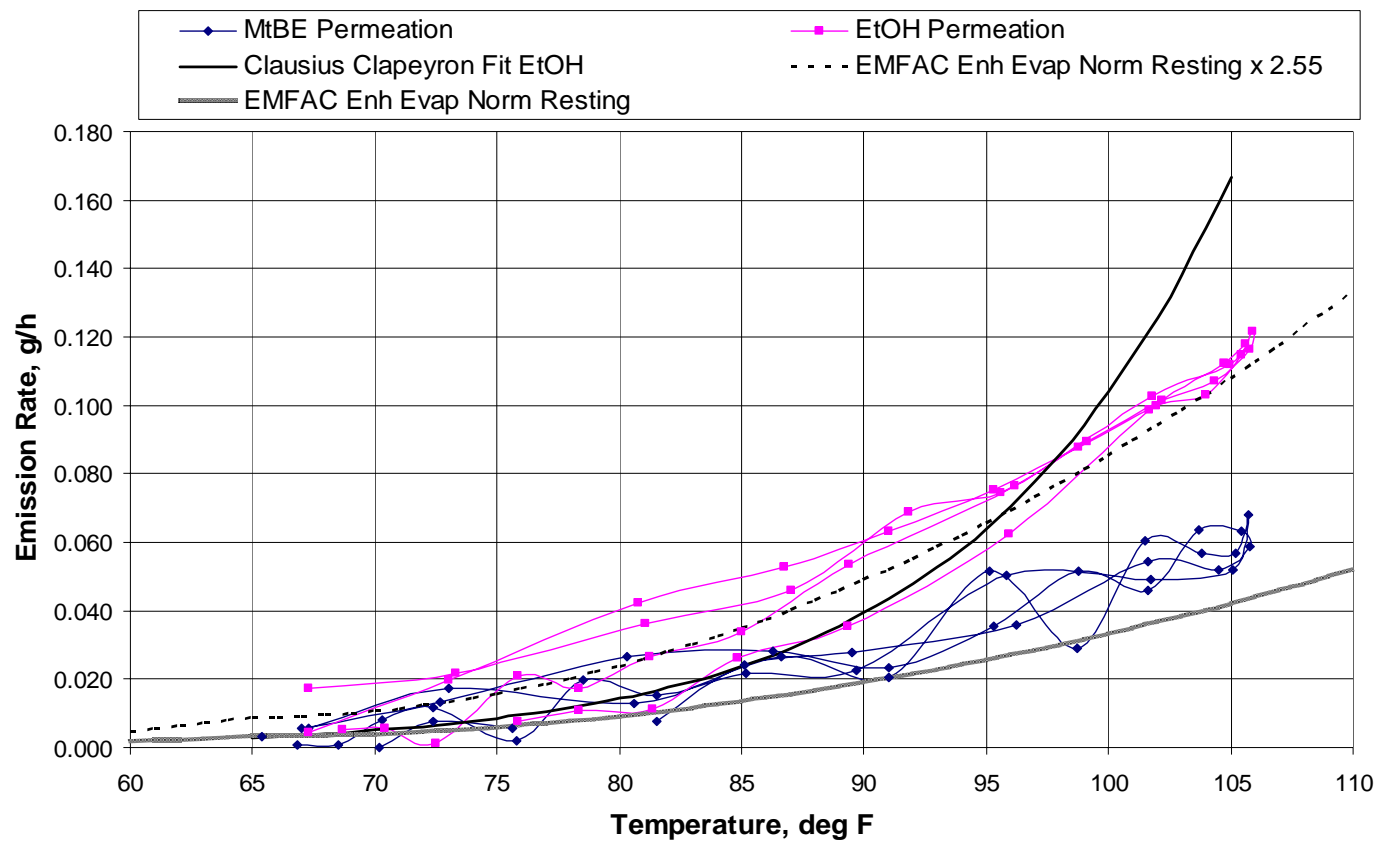
- PERMfr fraction permeation. Resting loss is hypothesized to be surrogate for permeation.

$$\text{PERMfr} = 0.9 * ER_{\text{resting}} * \text{RVPTCF} / (ER_{\text{process}} * \text{RVPTCF})$$

RVPTCF is the RVP/Temperature correction factor

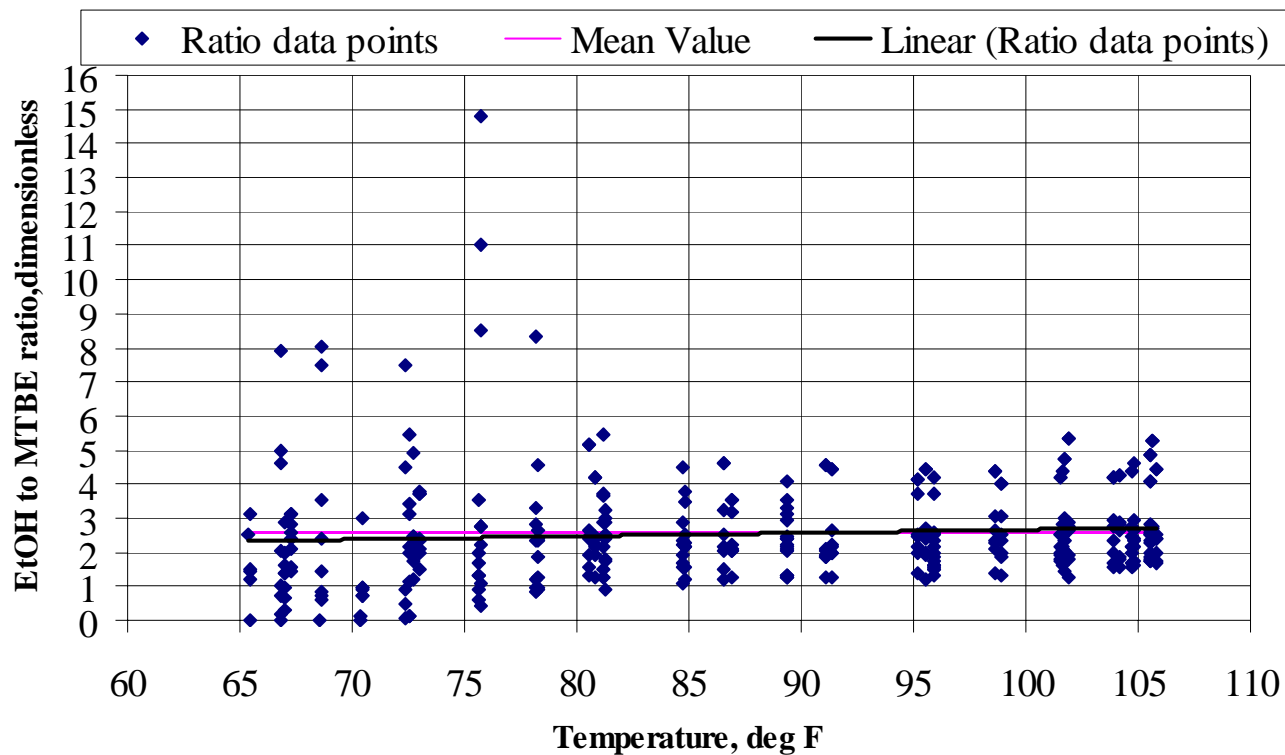
Emissions and Temperature

- EMFAC Model tracks E65 results



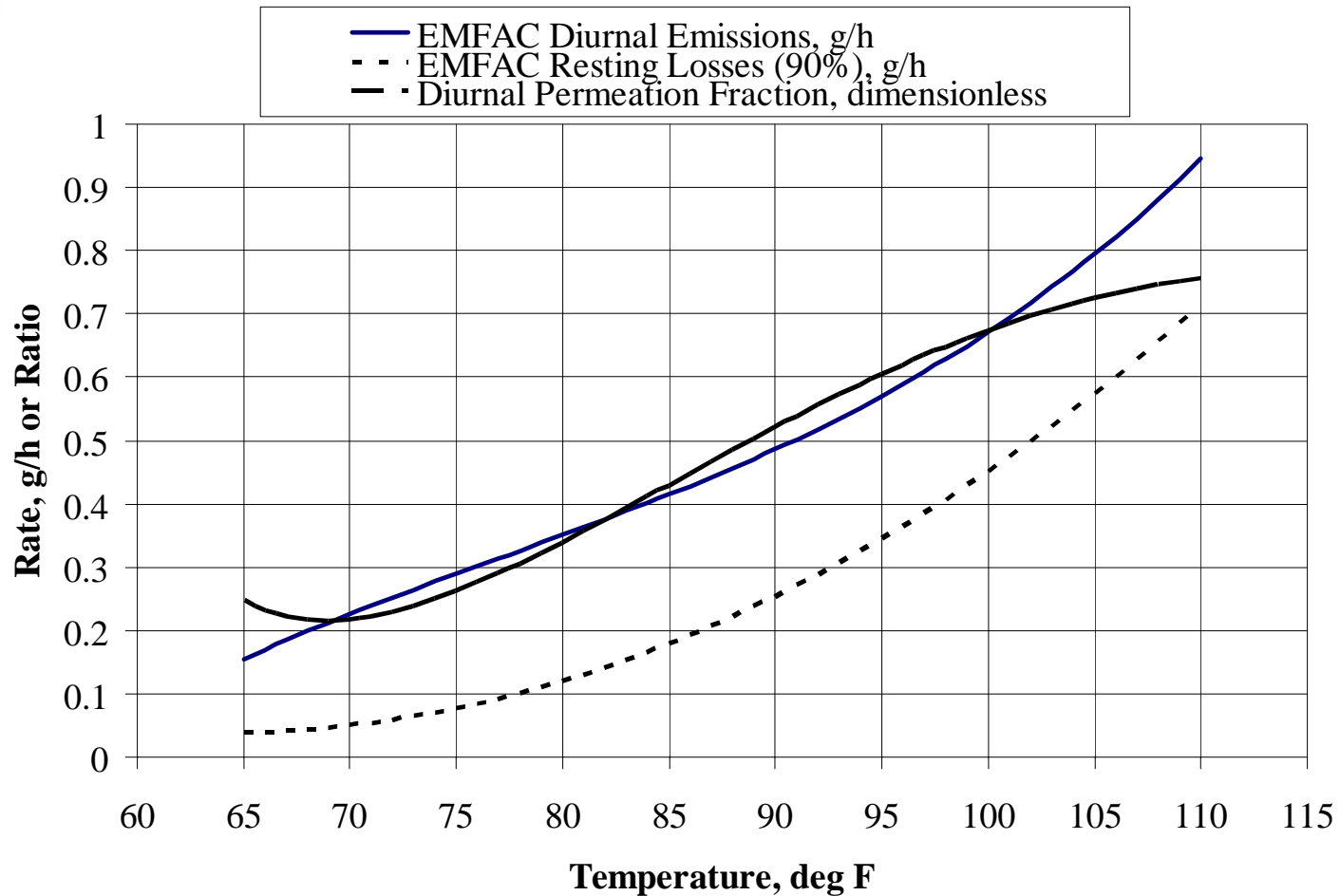
E65 Diurnal Augmentation Ratios

- Ethanol-to-MtBE ratio constant with temperature



Based on E65, 8 normal emitters, 48 hours each

Diurnal Permeation Fraction





Permeation Fractions

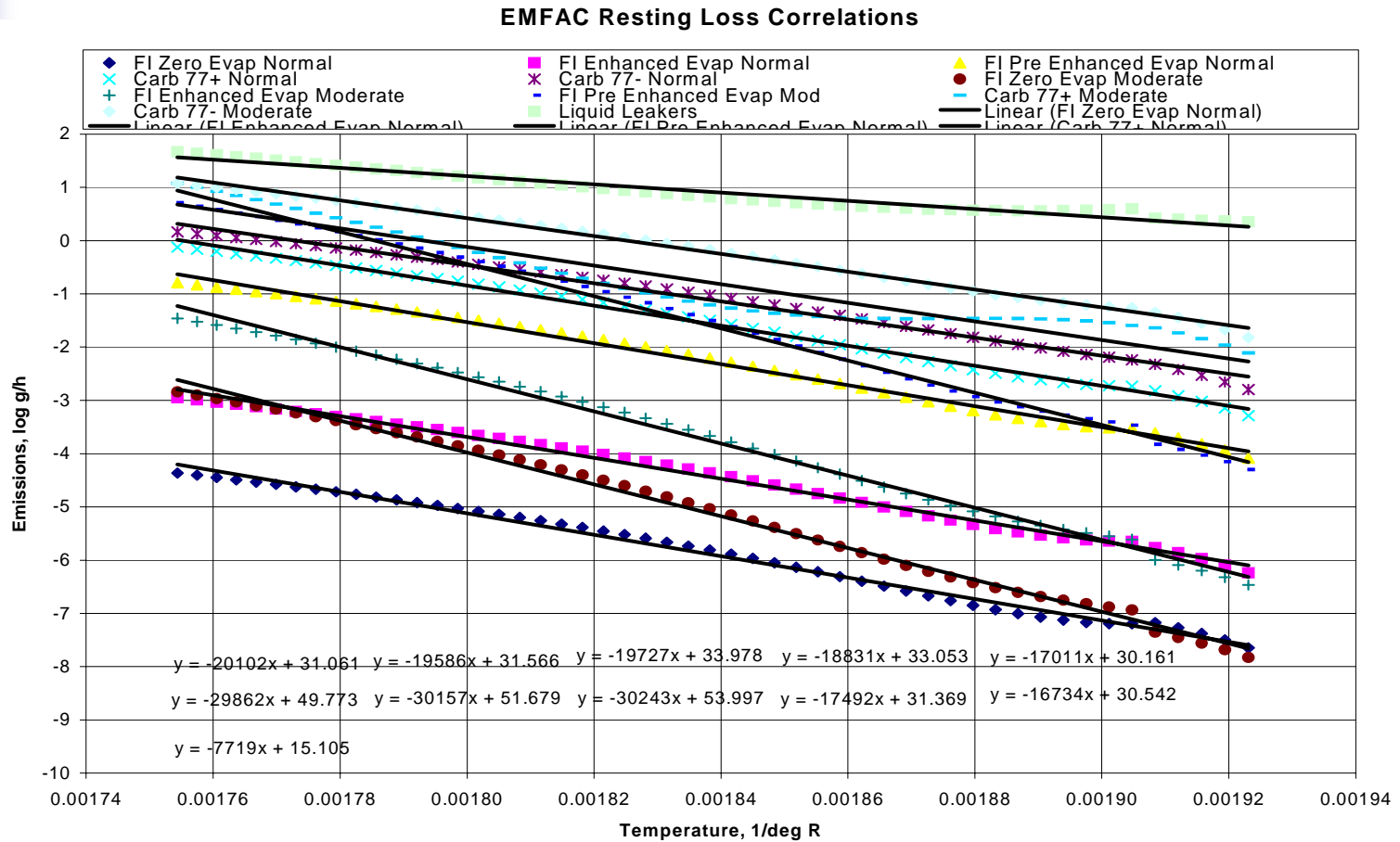
- Resting loss mostly permeation.
- Permeation fraction is 90% of resting loss divided by diurnal rate at temperature.
- Used the temperature dependence of EMFAC resting loss correlations developed from surveillance data in SHED.
- Agrees well in 70s and 80s with other approaches and rules-of-thumb. Higher than “steady-state” approach in 90s and 100s.



EMFAC Resting Loss Correlations

- Correlations for each of 15 tech groups.
- Rise exponentially with temperature.
- Our results for fleets at temperature profiles peaking in the high 90s are greater than E65 fleet results for a 105° day.
- We think this is due to the steepness of the resting loss curves (original BERs in EMFAC).

EMFAC Resting Loss Correlations





EMFAC Resting Loss v Temp

EMFAC Tech Group	Resting Loss del T for 100%		
	deg F	%/deg F	%/deg C
FI Zero Evap Norm	15.9	6.3	11.3
FI Enhanced Evap Normal	16.3	6.1	11.0
FI Pre-Enhanced Evap Normal	16.2	6.2	11.1
Carb 77+ Norm	17.0	5.9	10.6
Carb 77- Norm	18.8	5.3	9.6
FI Zero Evap Moderate	10.7	9.4	16.8
FI Enhanced Evap Moderate	10.6	9.4	17.0
FI Pre-Enhanced Evap Moderate	10.6	9.5	17.1
Carb 77+ Moderate	18.2	5.5	9.9
Carb 77- Moderate	19.1	5.2	9.4
Liquid Leaker	41.4	2.4	4.4



E65 Steady-state Analysis

ln E vs 1/T

age	y		Steady State Results			Hour-by-hour results	
			MTBE dbl deg F	etoh dbl deg F	gaso dbl deg F	Resting deg F	Diurnal HE deg F
3	1	2001 Tacoma P/U	26.0	34.9	32.3	12.6	19.4
4	2	2000 Odyssey Van	21.5	24.6	24.7	10.7	17.2
5	3	1999 Corolla	23.7	24.5	20.0	10.8	18.1
7	4	1997 T&C Van	25.4	24.3	35.3	14.7	17.8
9	5	1995 Ranger P/U	26.4	24.4	24.9	13.7	17.9
11	6	1993 Caprice	21.0	17.0	18.0	11.6	13.2
13	7	1991 Accord	20.5	26.8	25.5	11.3	19.4
15	8	1989 Taurus	26.8	26.4	30.7	15.9	21.1
19	9	1985 Sentra	20.2	32.8	30.8	14.3	23.0
26	10	1978 Cutlass	27.2	33.7	30.5	11.1	25.2
		Population	24.1	25.0	24.8	13.8	19.1
		Hexane	56.1				
		Water	33.4				



Steady-state Estimates

		Diurnal Permeation			SCAB
		MtBE	EtOH		12.4
		g/d/veh	g/d/veh	g/d/veh	M Vehicle
					TPD
Harold E65	65-105	1.9	3.5	1.6	21.9
EMFAC Summer SCAB	62-83	1.4	2.1	0.7	9.6
EMFAC SCAB New Temp	63-86			0.8	11.1
EMFAC SCOS SCAB	70-98	3.1	4.7	1.6	21.9
E65 SS	62-83	0.9	1.6	0.7	9.6
E65 SS	63-86	1.0	1.8	0.8	10.9
E65 SS	70-98	1.6	3.0	1.4	19.1