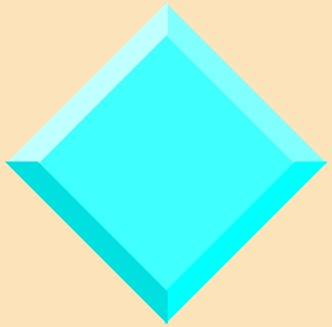


EPA's Proposal for MOBILE6

Exhaust Emissions Due to Engine Starts

Definition of Engine Start Emissions

- Modeled as grams per start
- Basic start defined as 12 hour soak
- Defined as the difference between identical driving cycles with and without an engine start
- Adjusted for soak times less than 12 hours

Data Sources

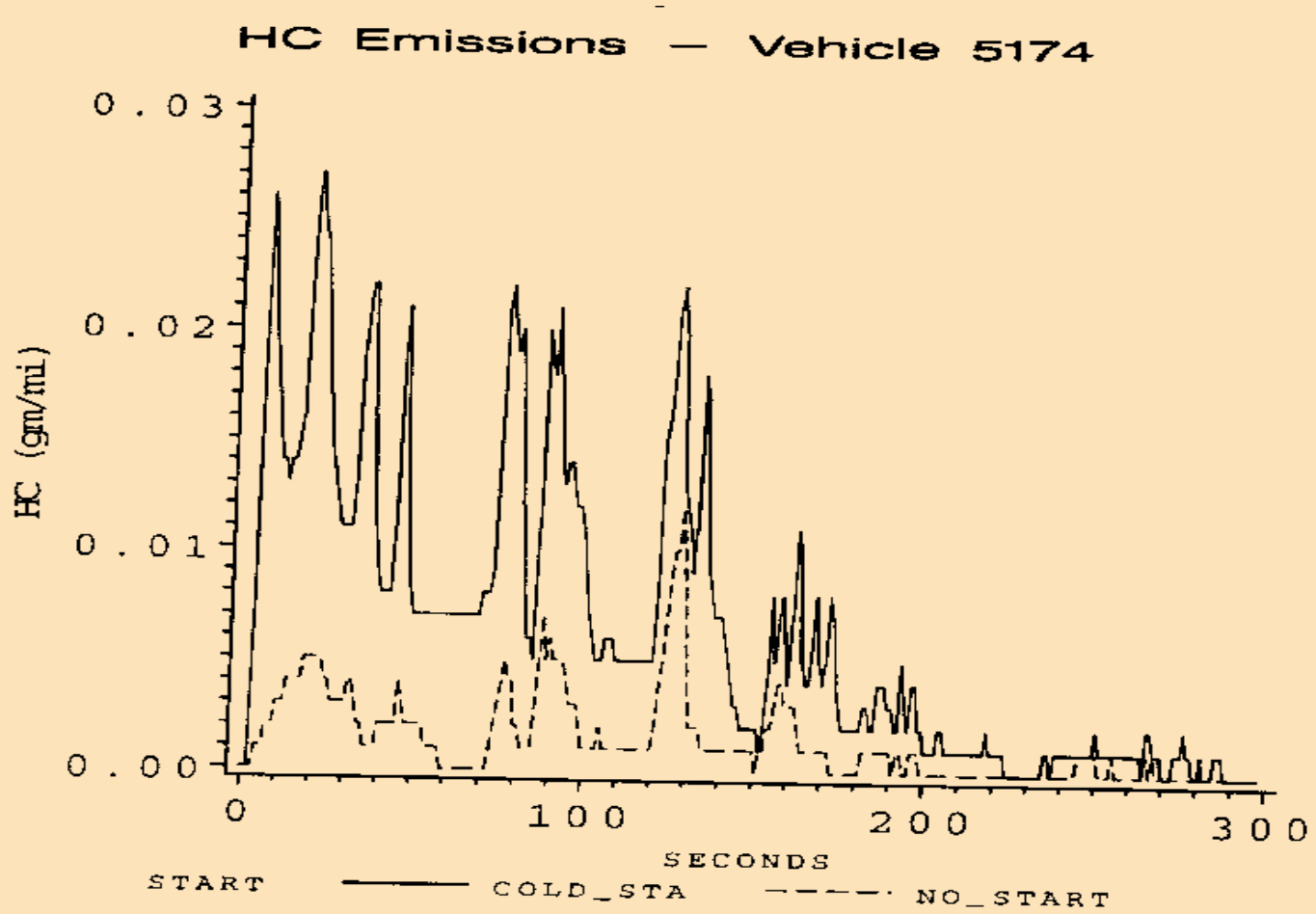
- Federal Test Procedure (FTP)
  - Large Sample of Emission Factor Tests
  - Coverage of Standards, Vehicle Types, Technologies
- California study on effects of soak time
- Instrumented Vehicles
  - Starts Per Mile
  - Soak Time Distribution

Extracting Starts from the FTP

- 505 Cycle used for FTP Bag 1 & 3
- vehicles tested using 505 cycle with no engine start

Basic Start = FTP Bag 1 - Hot Running 505

Example of Data



Data Sample Description

- 77 vehicles
- Cars and Light Trucks
- 1983 through 1996 model years

Data Sample Description

Table 2

Sample Descriptive Statistics

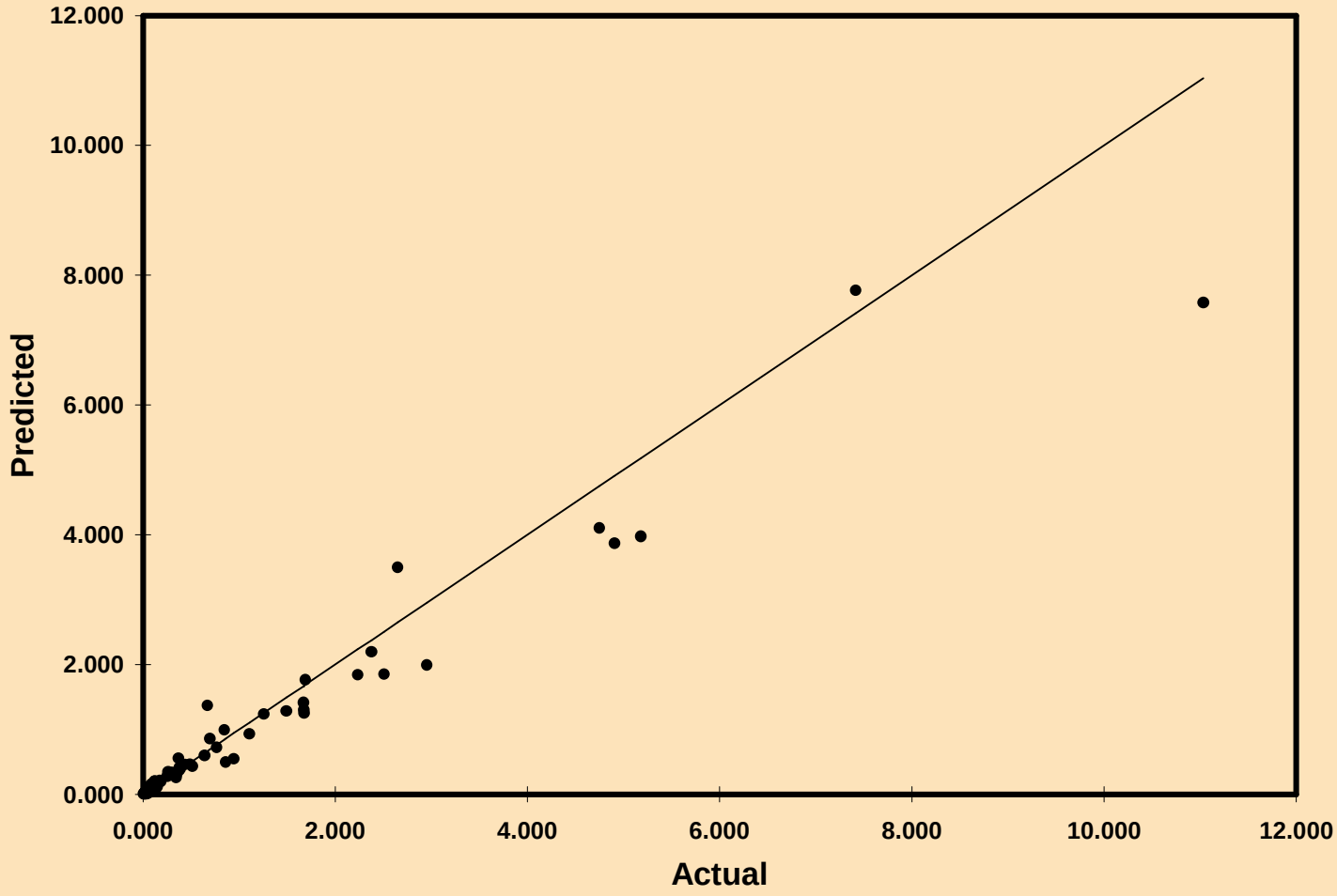
	Sample without vehicle #16				Full Sample (77 cases)			
	Mean	Std Dev	Min	Max	Mean	Std Dev	Min	Max
FTP HC	1.35	2.19	0.07	11.55	1.34	2.18	0.07	11.55
FTP CO	19.66	39.90	0.58	203.43	19.43	39.68	0.58	203.43
FTP NOx	1.16	1.17	0.08	5.58	1.15	1.16	0.08	5.58
Bag 1 HC	1.83	2.03	0.29	10.78	1.82	2.02	0.29	10.78
Bag 2 HC	1.29	2.51	0.01	14.37	1.27	2.50	0.01	14.37
Bag 3 HC	1.11	0.22	0.01	10.77	1.10	0.21	0.01	10.77
Running 505 HC	0.91	1.80	0.01	11.04	0.92	1.79	0.01	11.04
Bag 1 CO	23.57	34.68	2.54	150.03	23.33	34.52	2.54	150.03
Bag 2 CO	20.02	47.22	0.00	253.71	19.76	46.96	0.00	253.71
Bag 3 CO	16.02	32.55	0.04	162.32	15.86	32.37	0.04	162.32
Running 505 CO	15.88	37.24	0.04	224.70	16.37	37.24	0.04	224.70
Bag 1 NOx	1.56	1.23	0.22	5.76	1.55	1.22	0.22	5.76
Bag 2 NOx	0.92	1.09	0.01	5.63	0.91	1.09	0.01	5.63
Bag 3 NOx	1.32	1.38	0.04	5.79	1.30	1.37	0.04	5.79
Running 505 NOx	1.19	1.33	0.01	5.47	1.17	1.33	0.01	5.47
(Bag 1 HC - Running 505 HC)	0.92	1.02	-3.17	5.99	0.90	1.03	-3.17	5.99
(Bag 1 CO - Running 505 CO)	7.70	20.01	-93.98	120.22	6.96	20.90	-93.98	120.22
(Bag 1 NOx - Running 505 NOx)	0.37	0.64	-3.62	1.88	0.37	0.63	-3.62	1.88

Calculation of Hot Running 505

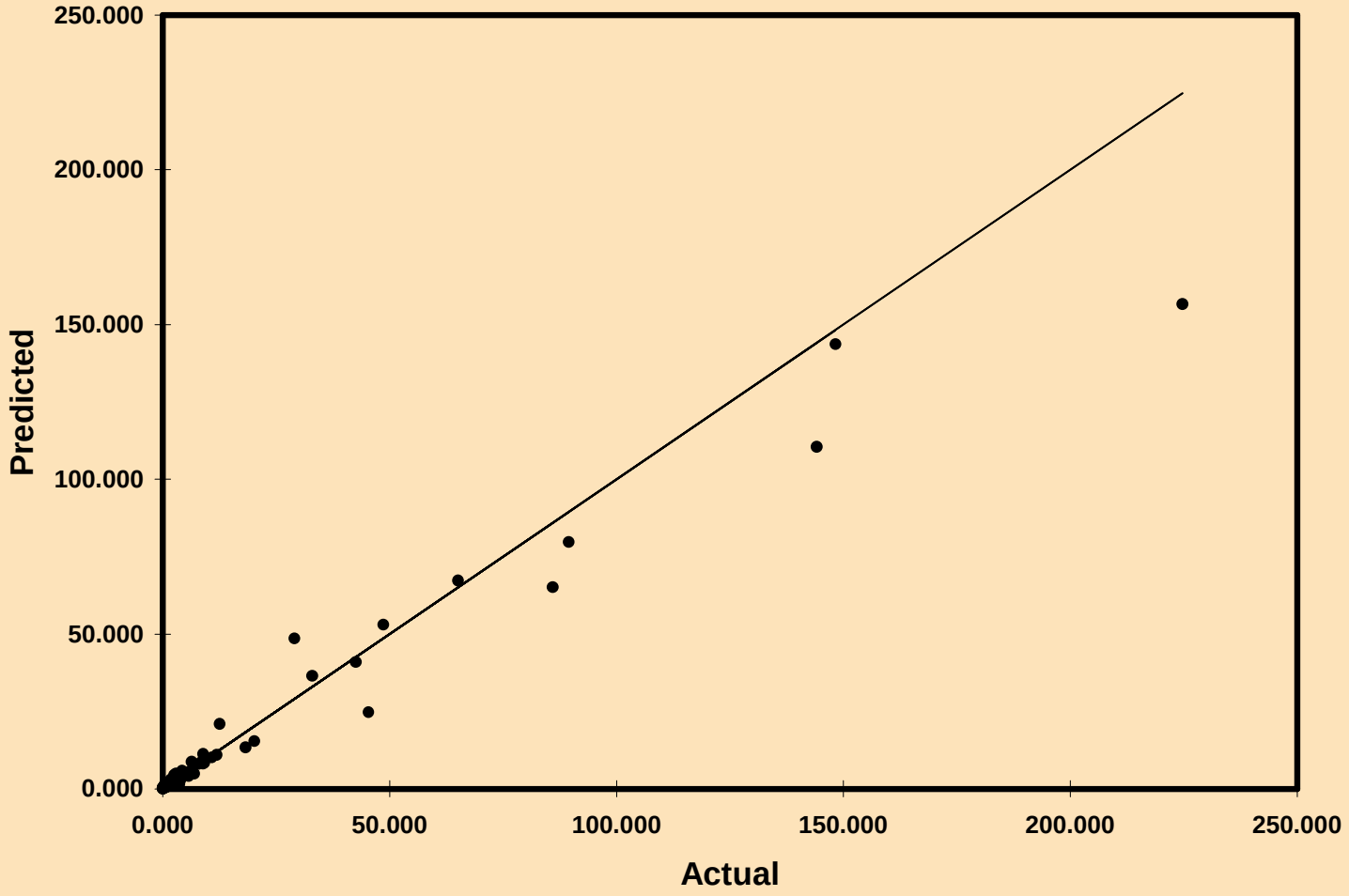
- Bag 1, 2 & 3 from the FTP
- Constant “D” includes adjustment to reduce Log translation bias

HR505 = Exp(A*LN(Bag1)+B*LN(Bag2)+C*LN(Bag3)+D)

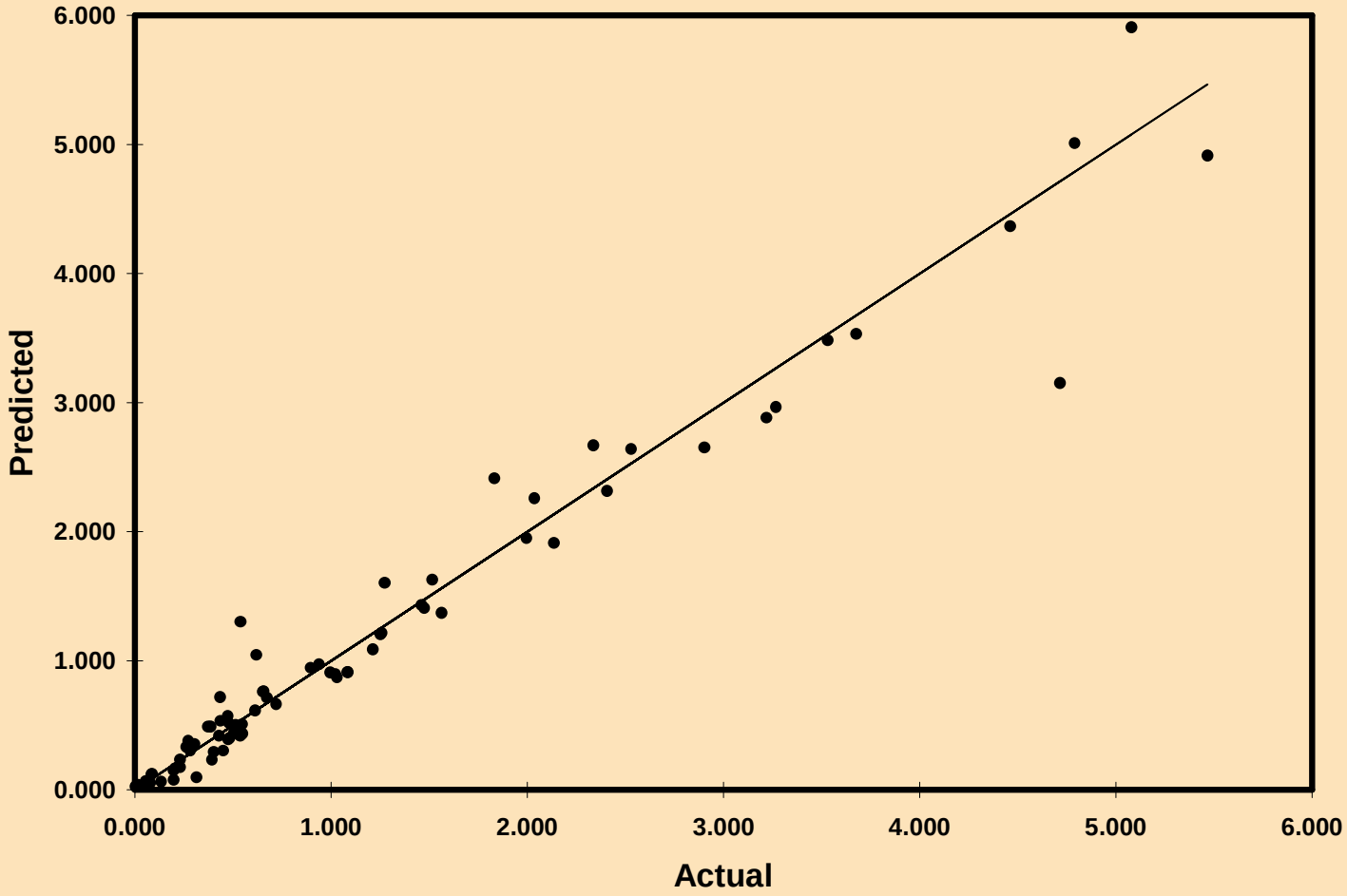
Calculated vs Actual Hot Running 505 HC Emissions



Calculated vs Actual Hot Running 505 CO Emissions



Calculated vs Actual Hot Running 505 NOx Emissions



Using Hot Running 505 in MOBILE6

- Calculate basic (12 hour soak) start emission rate
- Calculate basic running (non-start) emission rate

Basic Start = (FTP Bag 1 - Hot Running 505) * 3.59 miles

Basic Running = Hot Running 505 * 0.479 + FTP Bag 2 * 0.521

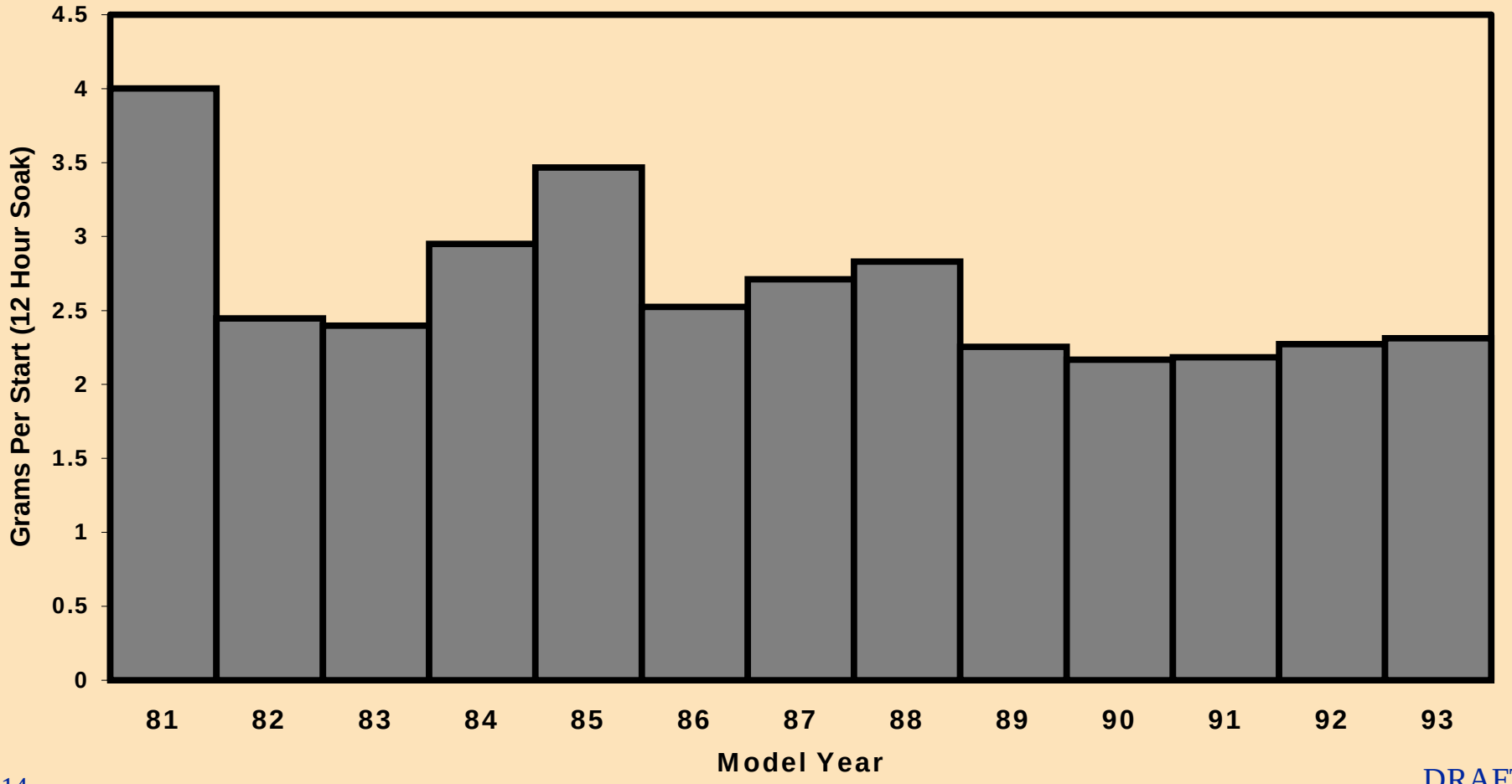
Passenger Car Data Sample

Distribution of Vehicles by Model Year and Technology*

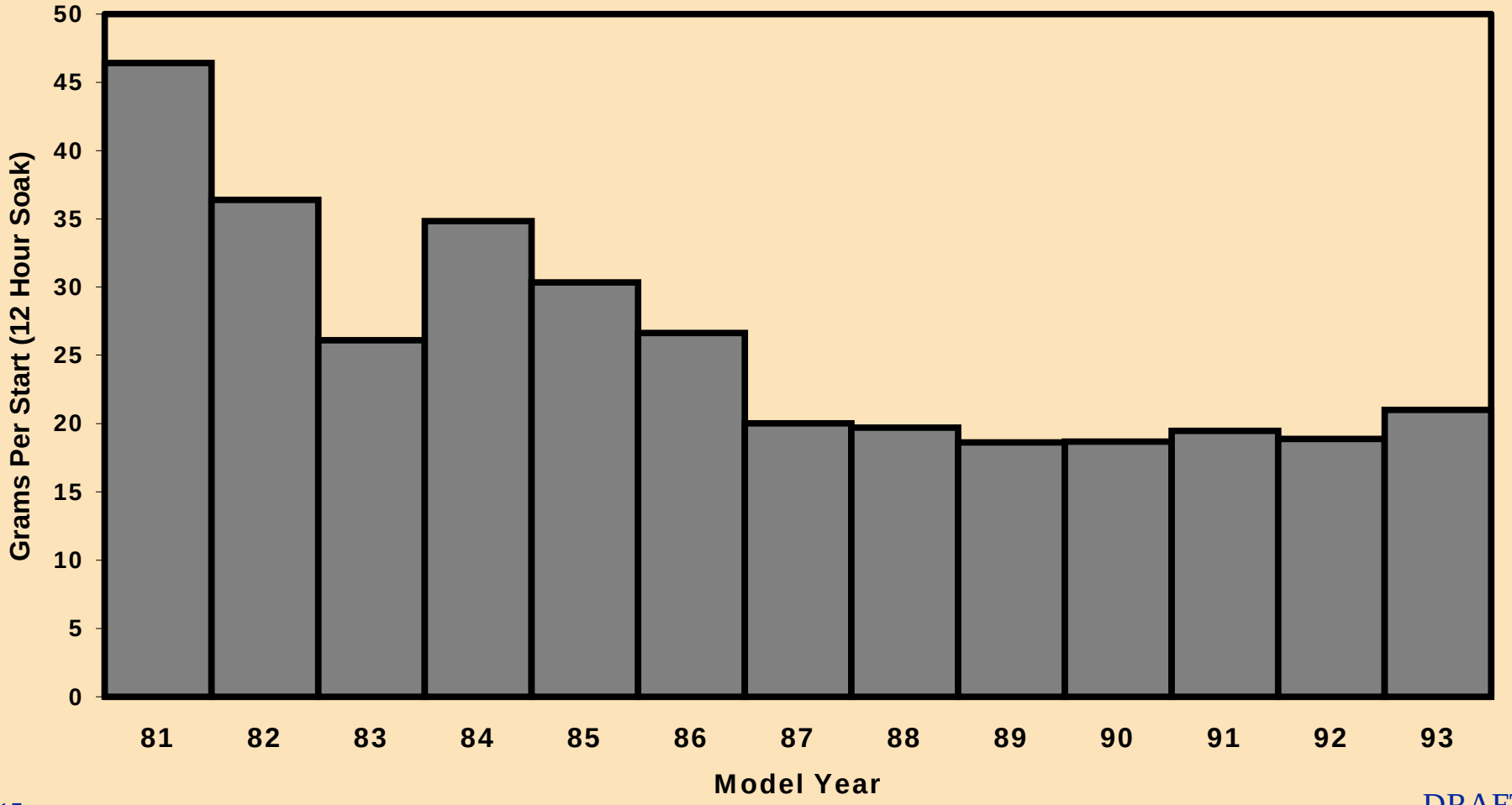
MYR	Cars OPLP	Cars CL CARB	Cars TBI	Cars PFI	Cars ALL
81	367	657	15	29	1068
82	71	71	74	8	224
83	63	57	127	62	309
84	5	30	46	35	116
85	24	74	56	66	220
86	7	34	60	92	193
87	1	17	76	106	200
88		15	69	113	197
89		22	38	103	163
90			160	250	410
91			91	426	517
92			57	347	404
93			29	366	395
ALL	538	977	898	2003	4416

* No entry indicates no data available for that model year/technology type in the FTP dataset used for this analysis.

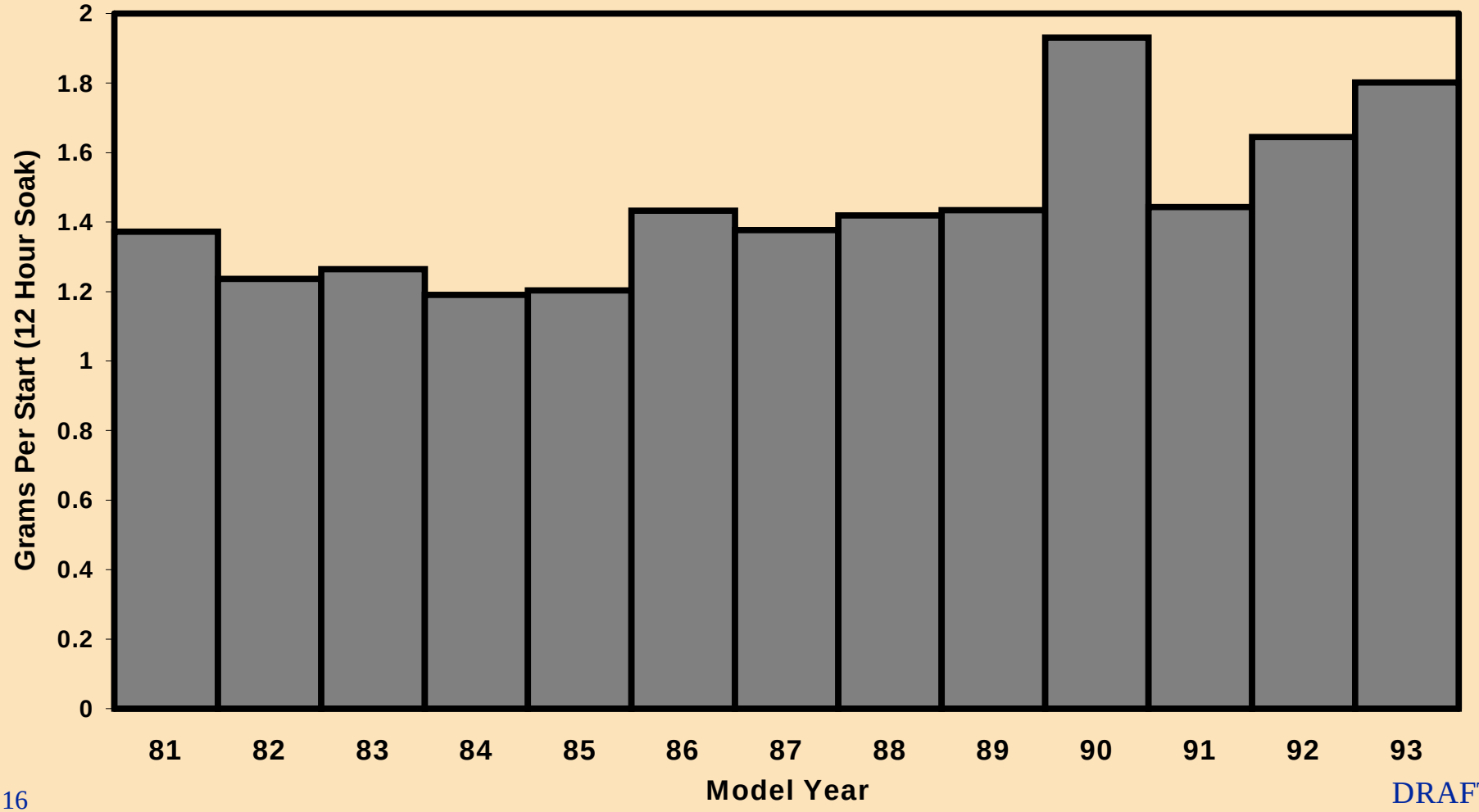
Average HC Start Emissions



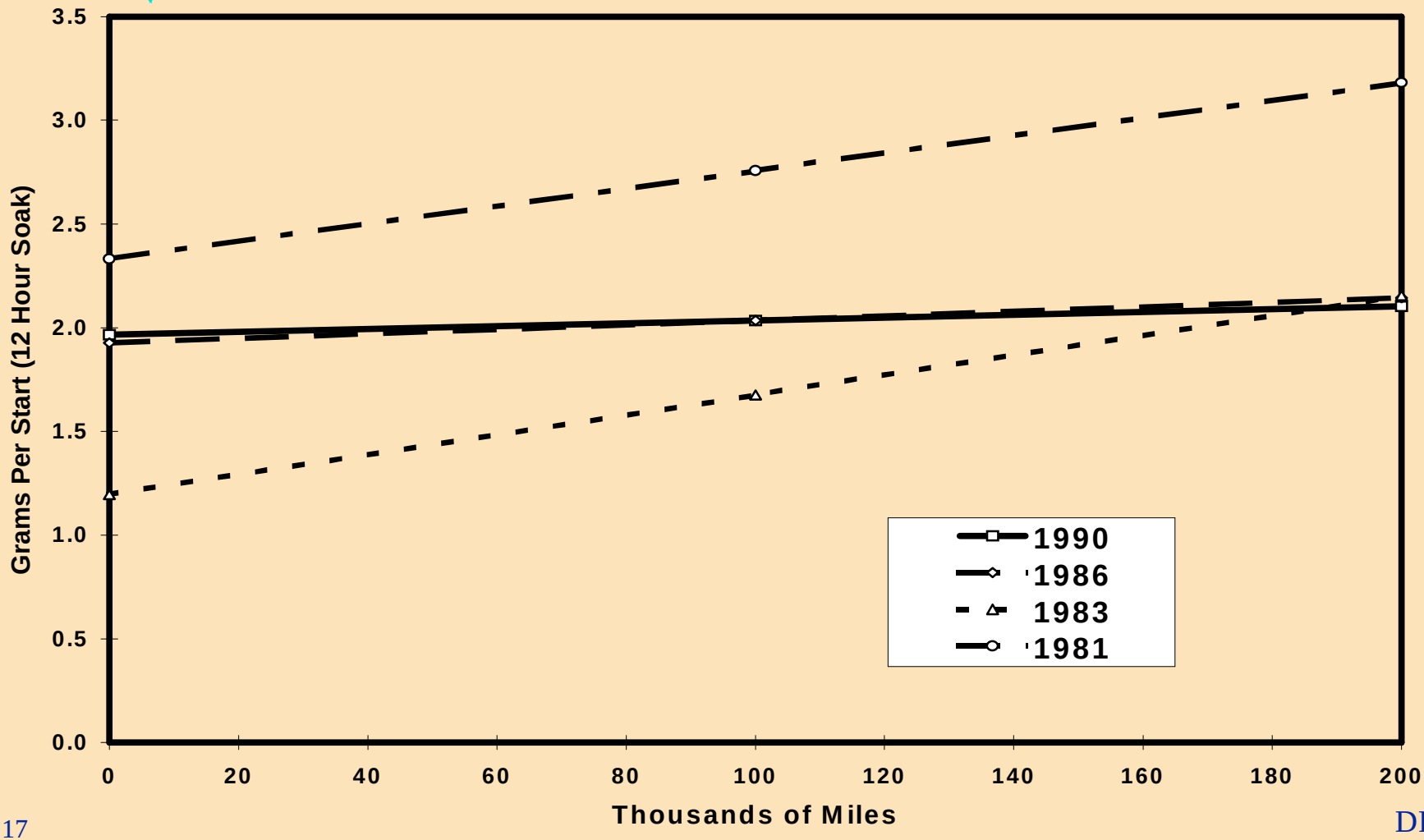
Average CO Start Emissions



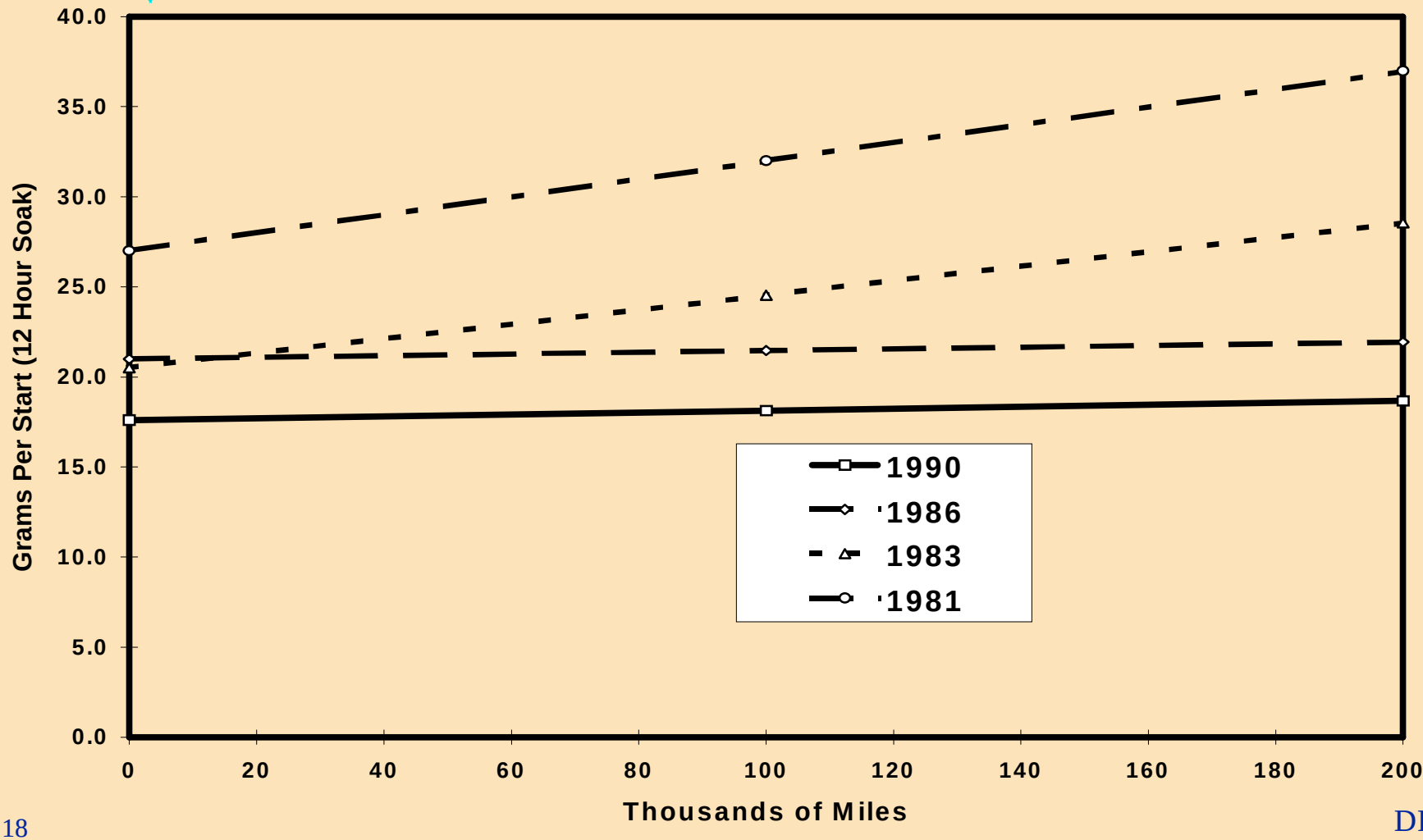
Average NOx Start Emissions



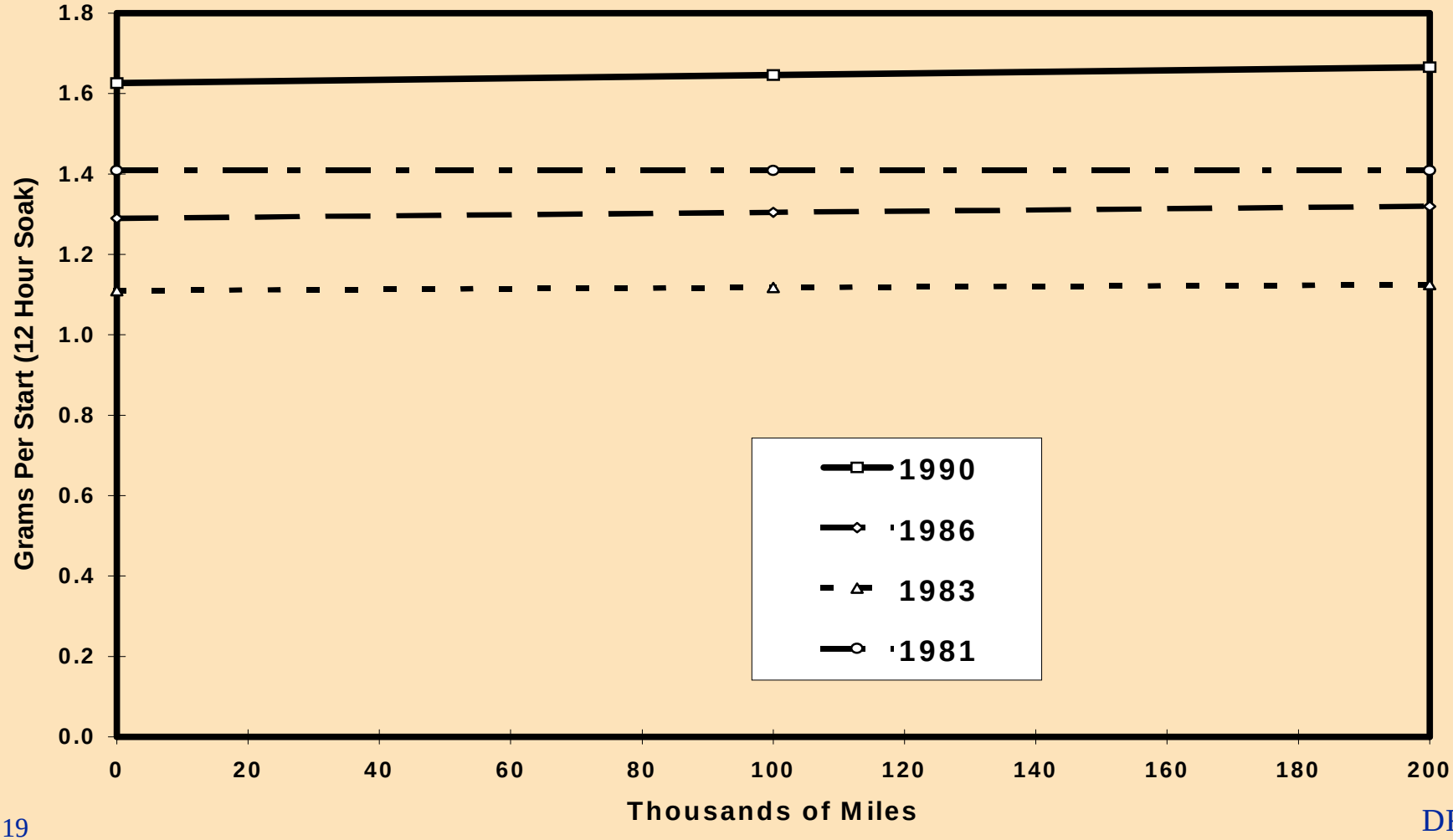
HC Start Emissions Versus Mileage (Corrected)



CO Start Emissions Versus Mileage (Corrected)



NOx Start Emissions Versus Mileage (Corrected)



Modeling Issues

- Should start emissions depend on mileage?
- What are start emissions for Tier 1 and LEV?

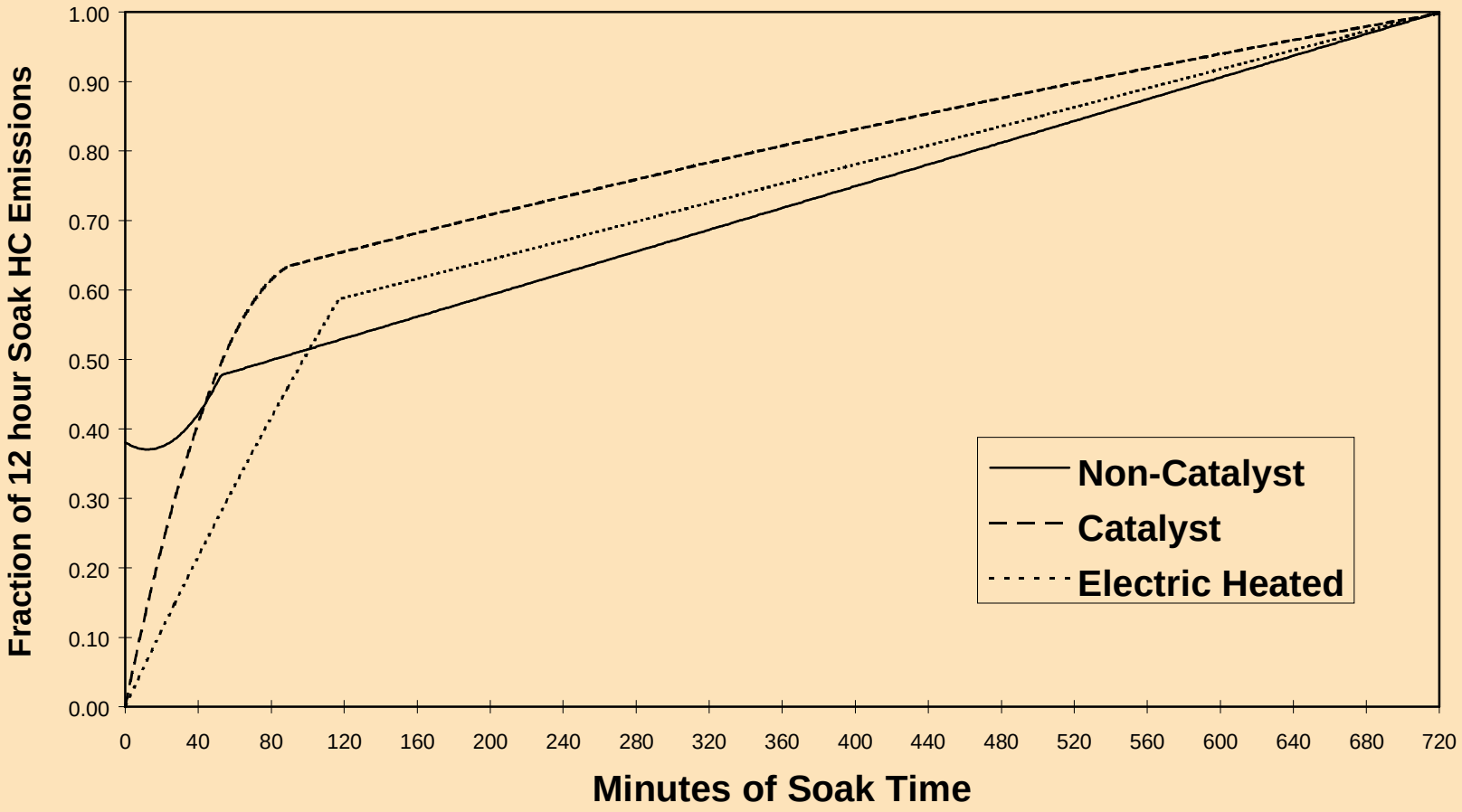
Light Duty Trucks

- Similar methods and issues as passenger cars
- Less data
- Will borrow from cars if necessary

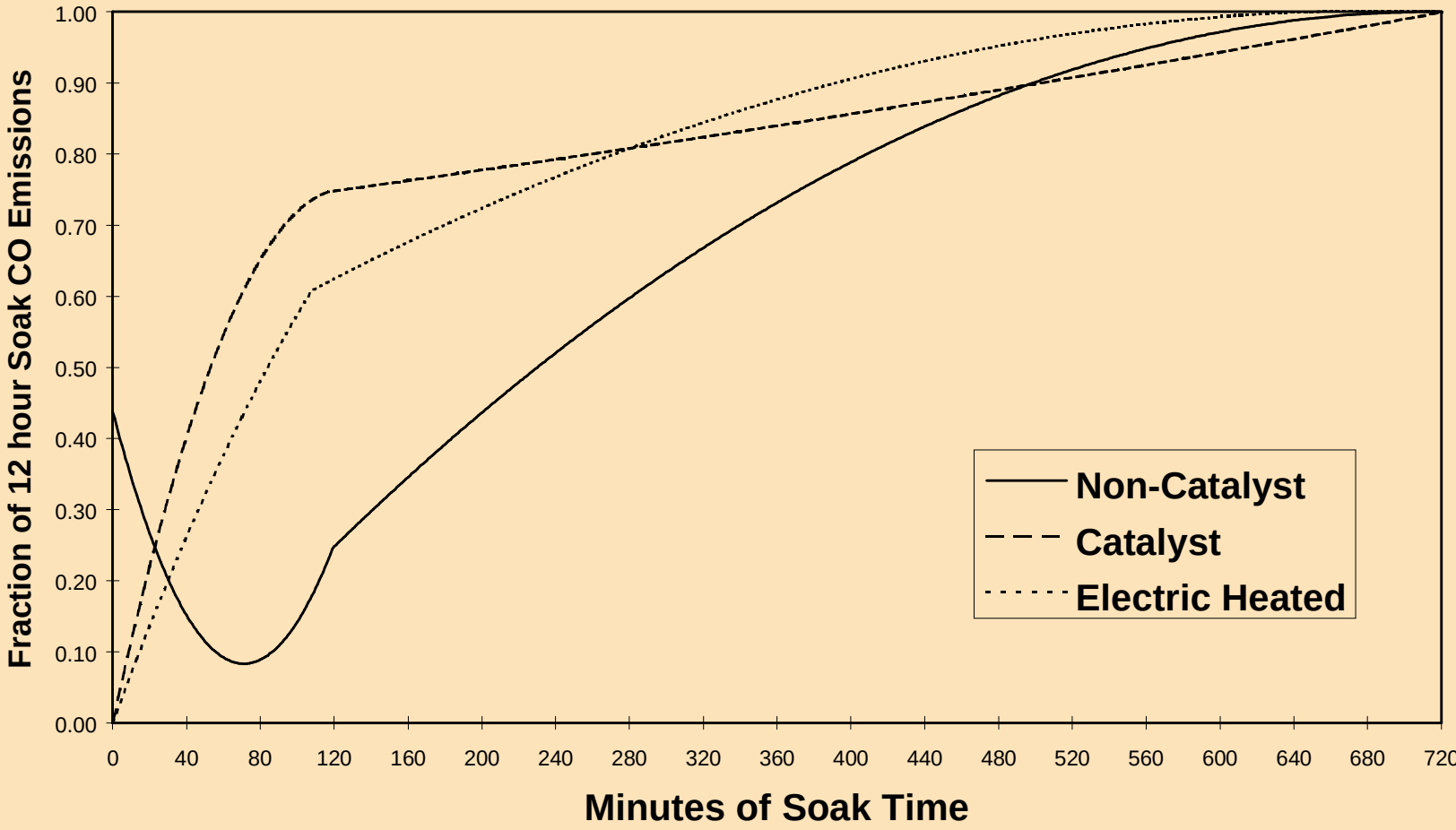
Start Emissions Versus Soak Time

- California has developed relationship
- EPA proposes to use those relationships
- Normalized to EPA data emission levels

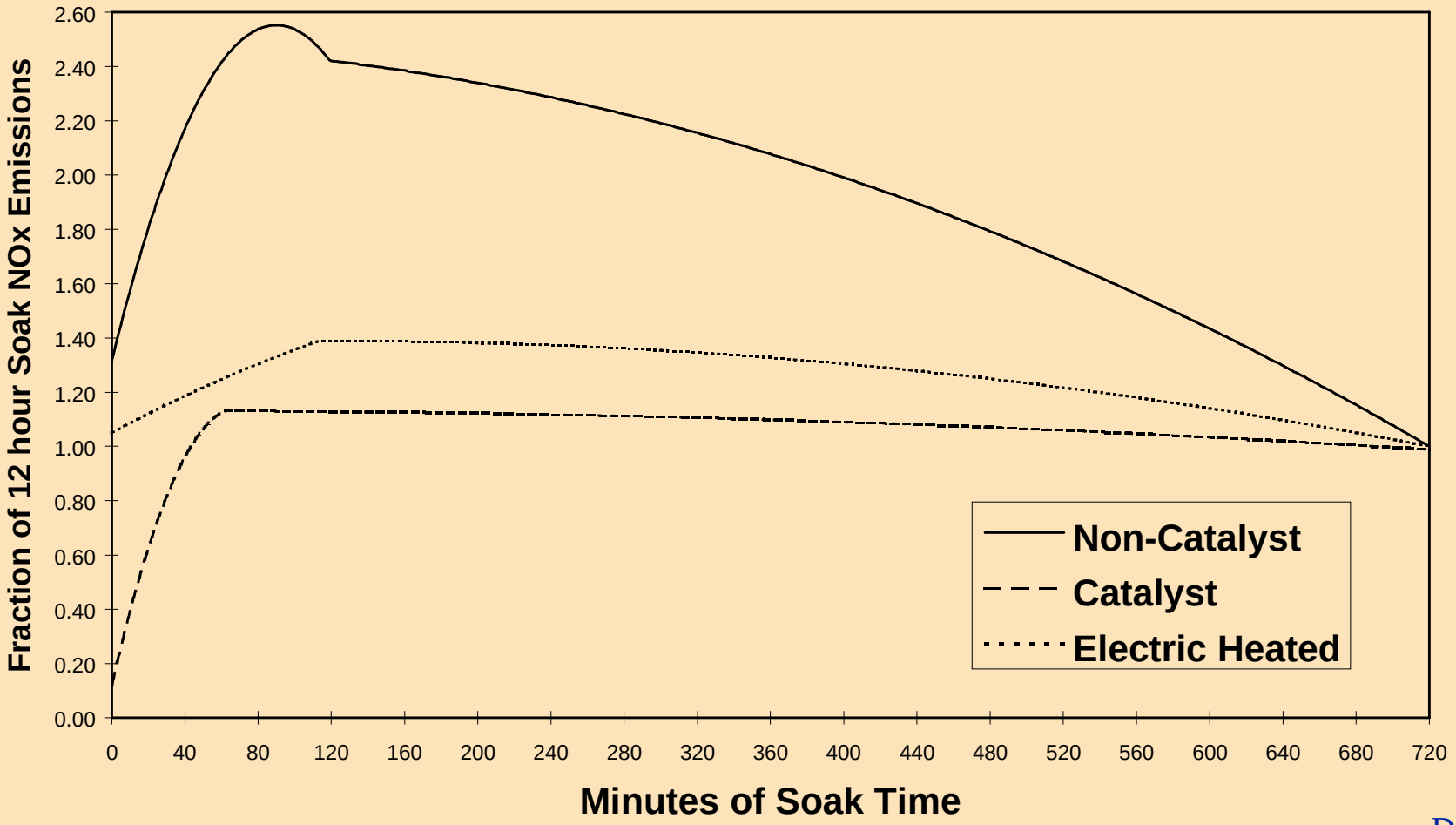
Effect of Soak Time on Start HC Emissions



Effect of Soak Time on Start CO Emissions



Effect of Soak Time on Start NOx Emissions



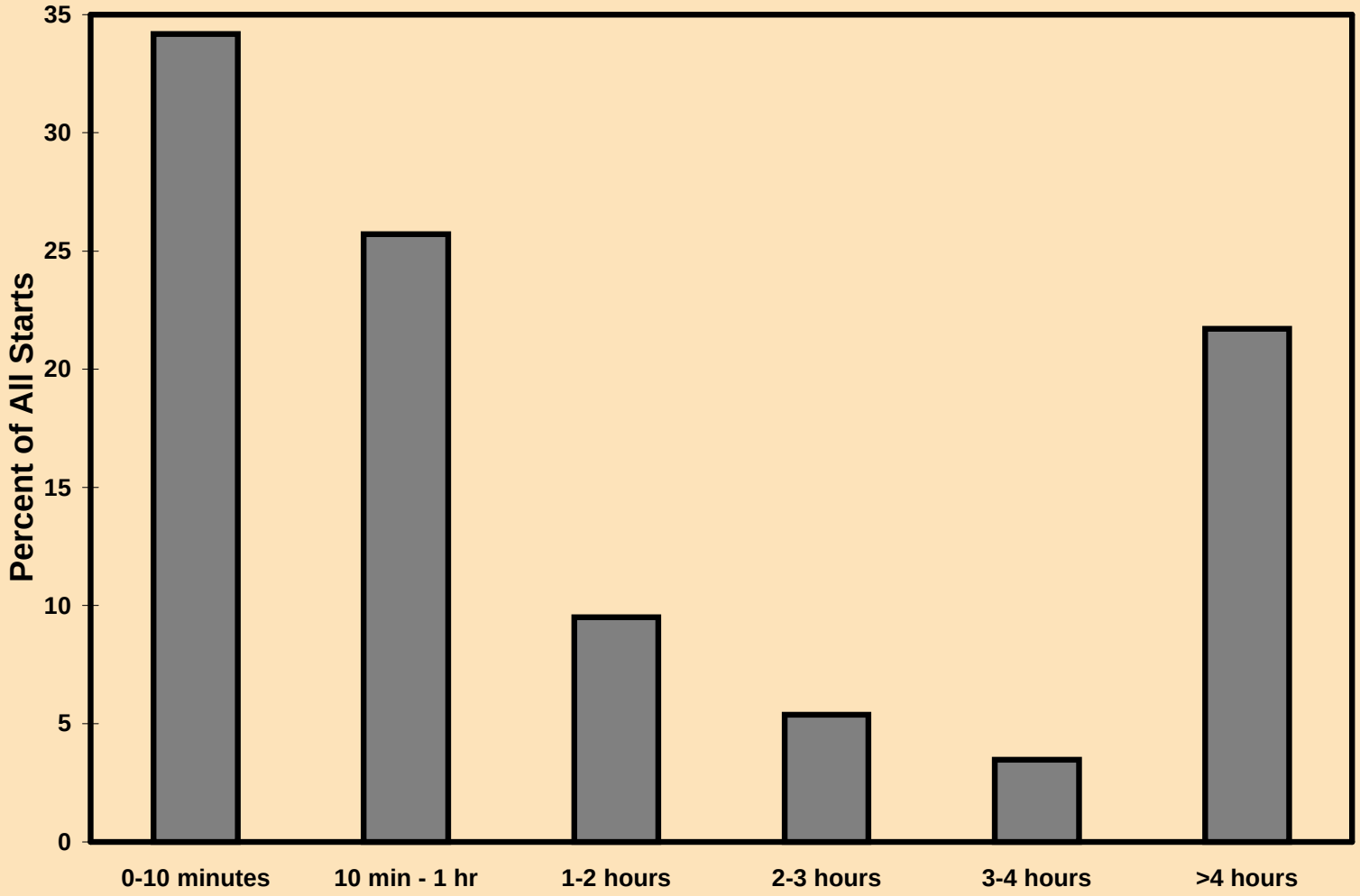
Adjustments to Engine Start Emissions

- Default soak time distribution
- Default number of engine starts per mile of vehicle operation
- Methane, Fuel and Temperature Corrections

Travel Trip Characteristics Analysis

- 1994 EPA Report based on instrumented vehicles
- Will be used as the basis for engine starts per mile and soak time distributions

Distribution of Engine Start Soak Time



Engine Starts Per Mile

Starts Per Mile = Starts Per Day / Miles Per Day

- Used to calculate Start Emissions in grams per mile
- Will have optional output of grams per start

User Adjustments to Engine Starts

- Default output will include start emissions in the emission rate
- Output option for engine start emissions in grams per start
- Optional user input of engine starts per mile of vehicle operation

Issues

- Heavy Duty Vehicles
- Starts per mile by roadway type
- Special handling for engine stalls