ATTACHMENT I

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ATTACHMENT II

Overview of the Proposed SMA Cycle

Types of Operation	**COMMENTS**
Vehicle Speed - 35% increase in average speed	Reduces time duration to complete 100K miles Higher power requirements and engine exhaust temperatures. Reduced AF control would contribute to richer mixtures and more catalyst activity.
Accelerations - number of higher rate accelerations increases significantly	Fuel enrichment as a function of A/F control Raise power requirements Engine wear
Decelerations - Closed throttle from higher speeds	Fuel shut off/lean operation - higher catalyst temperature. All deceleratons are light to prolong acceleration mode and reduce tire wear.
Engine RPM - downshift operation	Potential for increased oil consumption/contaminate catalyst (reduces catalyst efficiency) Lean operation Engine wear
Idles (Key on) and Stops (Key off)	Hot starts/vapor problems/fuel metering. Canister purging Exercise computer memory/time delays
City Driving concept retained from current (AMA approx. 50% of driving time)	Provides operation for many engine emission components at an increased rate of frequency and low stress (low power requirements). An attempt to not put all our emphasis on just catalyst thermal deterioration.
Specific load requirements - ALVW	Increases power requirements (F = mass X accel.) at all rates of acceleration and speed. Increases engine exhaust temperatures.
Cold Soaks	Not included in current AMA. Proposed on the basis that higher emission levels during cold start operation will contribute to emission system deterioration.
Specify a quantitative measure for acceleration rates	Should contribute to improved test program repeatability.

Results of Our On-Road Testing

•Parameter	Effect on Catalyst Temperature
• Engine RPM	Major effect; high RPM promoted high catalyst temps
• Downshifts	Major effect; (same as engine RPM)
• Vehicle speed	Major effect; high speeds promoted high catalyst temps
• Acceleration rate	Major effect; high accels promoted high catalyst temps
• Idles	Major effect; usually promoted the lowest catalyst temps
• Closed throttle decels	Variable; promoted higher catalyst temps on 2 vehicles
• Vehicle test load	Moderate effect; high loads promoted high temps
• Cold starts	Moderate effect; higher catalyst temps on warm-ups
• Throttle fluctuations	Moderate effect
• Hot starts	Very little effect
• *Ambient Conditions*	Very little effect
• Fuel	Very little effect

•• No operational or overheating problems were encountered with any of the vehicles.

Certification Division Slide No. 5

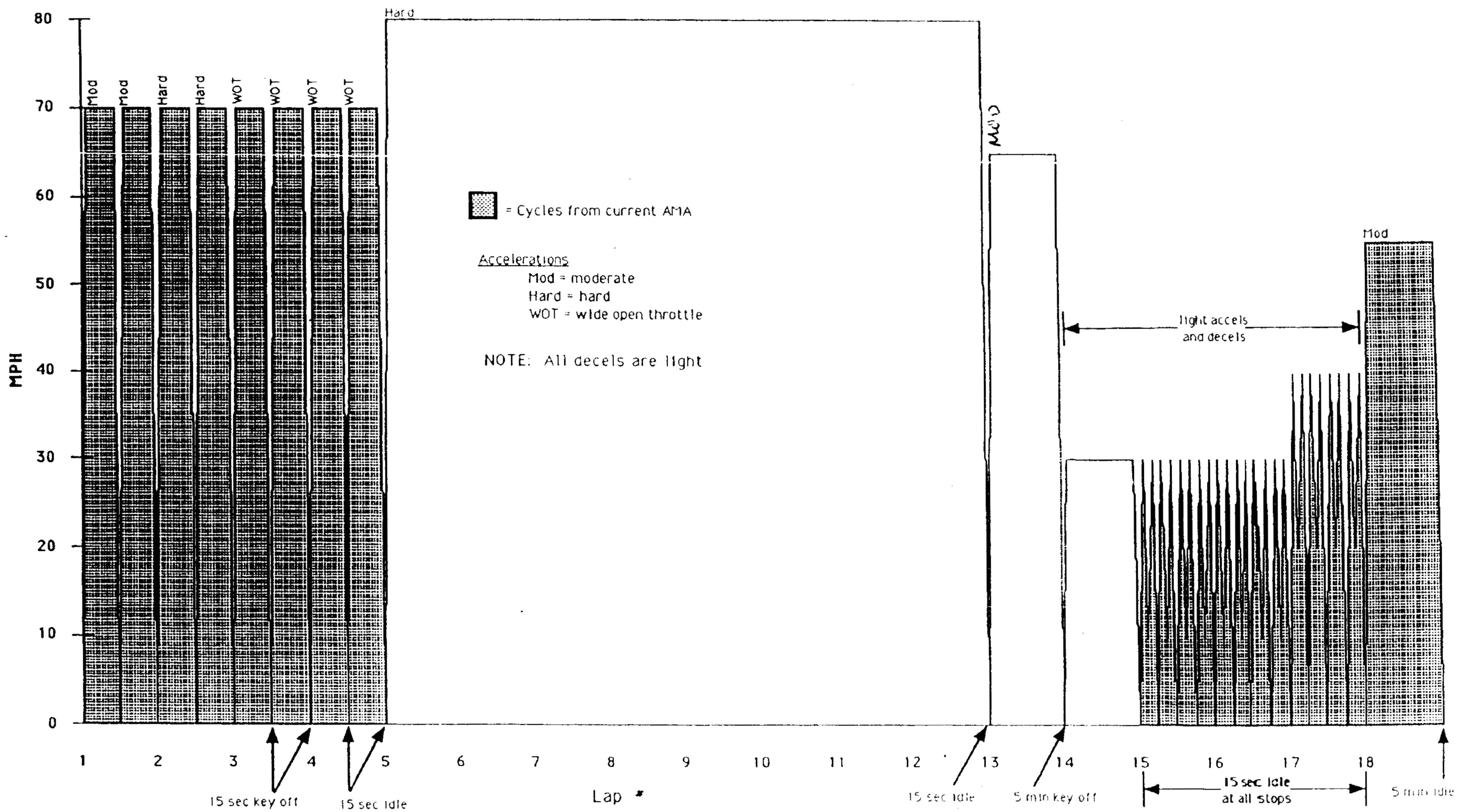
The Proposed Cycle

Lap	Base Speed	No. of Stops	Time/ Stop	Accel Rate	Ave. Speed*	Comments
1	70	2	0 sec	Mod	55 mph	
2	70	2	0 sec	Hard	56 mph	
3	70	2	15 sec	WOT	48 mph	Key off for stops
4	70	2	15 sec	WOT	48 mph	
5	80	0	NA	Hard	74 mph	
6	80	0	NA	NA	80 mph	
7	80	0	NA	NA	80 mph	
8	80	0	NA	NA	80 mph	
9	80	0	NA	NA	80 mph	
10	80	0	NA	NA	80 mph	
11	80	0	NA	NA	80 mph	
12	80	1	15 sec	NA	66 mph	
13	65	1	5 min	Mod	58 mph	Key off 5 minutes
14	30	1	15 sec	Light	28 mph	
15	30	4	15 sec	Light	21 mph	5 Decels to 10 mph
16	30	4	15 sec	Light	21 mph	5 Decels to 10 mph
17	40	4	15 sec	Light	25 mph	5 Decels to 20 mph
18	55	1	5 min	Mod	51 mph	Idle for 5 minutes

*Includes 15 sec stops but not 5 min. idle or 5 min. key off.

Certification Division Slide No. 6

SMA ... E



MPH
80
70
60
50
40
30
20
10
0
Mod
Mod
Hard
Hard
WOT
WOT
WOT
WOT
Hard
Mod
Mod
= Cycles from current AMA
Accelerations
Mod = moderate
Hard = hard
WOT = wide open throttle
NOTE: All decels are light
light accels and decels
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
Lap #
15 sec key off
15 sec idle
15 sec idle
5 min key off
15 sec idle at all stops
5 min idle

A-6

II-3

ATTACHMENT III

Distribution of Balt. Data Over 65 MPH

low	high	bin mid	# vehicles	%	cum. %
65	**70**	67.5	66,826	76.4%	76.4%
70	**75**	72.5	17,485	20.0%	96.4%
75	**80**	77.5	2,803	3.2%	99.6%
80	**85**	82.5	253	0.3%	99.9%
85	**90**	87.5	91	0.1%	100.0%
90	**95**	92.5	11	0.0%	100.0%
		Totals	87,469	100%	
		Avg Speed	68.89		

From EPA 420-R-93-007 Table 6-9

Distribution of Accels (mph/sec), Baltimore

low	high	bin mid	# vehicles	%	cum. %
0	**1**	0.5	899,795	63.9%	63.9%
1	**2**	1.5	267,355	19.0%	82.9%
2	**3**	2.5	133,587	9.5%	92.4%
3	**4**	3.5	62,415	4.4%	96.8%
4	**5**	4.5	27,375	1.9%	98.8%
5	**6**	5.5	10,639	0.8%	99.5%
6	**7**	6.5	3,712	0.3%	99.8%
7	**8**	7.5	1,649	0.1%	99.9%
8	**9**	8.5	776	0.1%	100.0%
9	**10**	9.5	325	0.0%	100.0%
10	**11**	10.5	187	0.0%	100.0%
11	**12**	11.5	62	0.0%	100.0%
12	**13**	12.5	20	0.0%	100.0%
13	**14**	13.5	8	0.0%	100.0%
14	**15**	14.5	2	0.0%	100.0%
15	**16**	15.5	1	0.0%	100.0%
		Totals	1,407,908	100%	
		Avg Accel	1.16		

From EPA 420-R-93-007 Table 6-10

ATTACHMENT IV

IV-1

Draft Strawman Durability Proposal

Eldert Bontekoe, EPA

January 29, 2003

IV-2

Durability Procedure Options

- Manufacturers may use the EPA-defined whole vehicle or bench aging procedures.
- Manufacturers may choose to calculate an additive or multiplicative deterioration factor (DF) or use aged components on EDVs to develop certification compliance levels.

IV-3

Whole Vehicle Aging

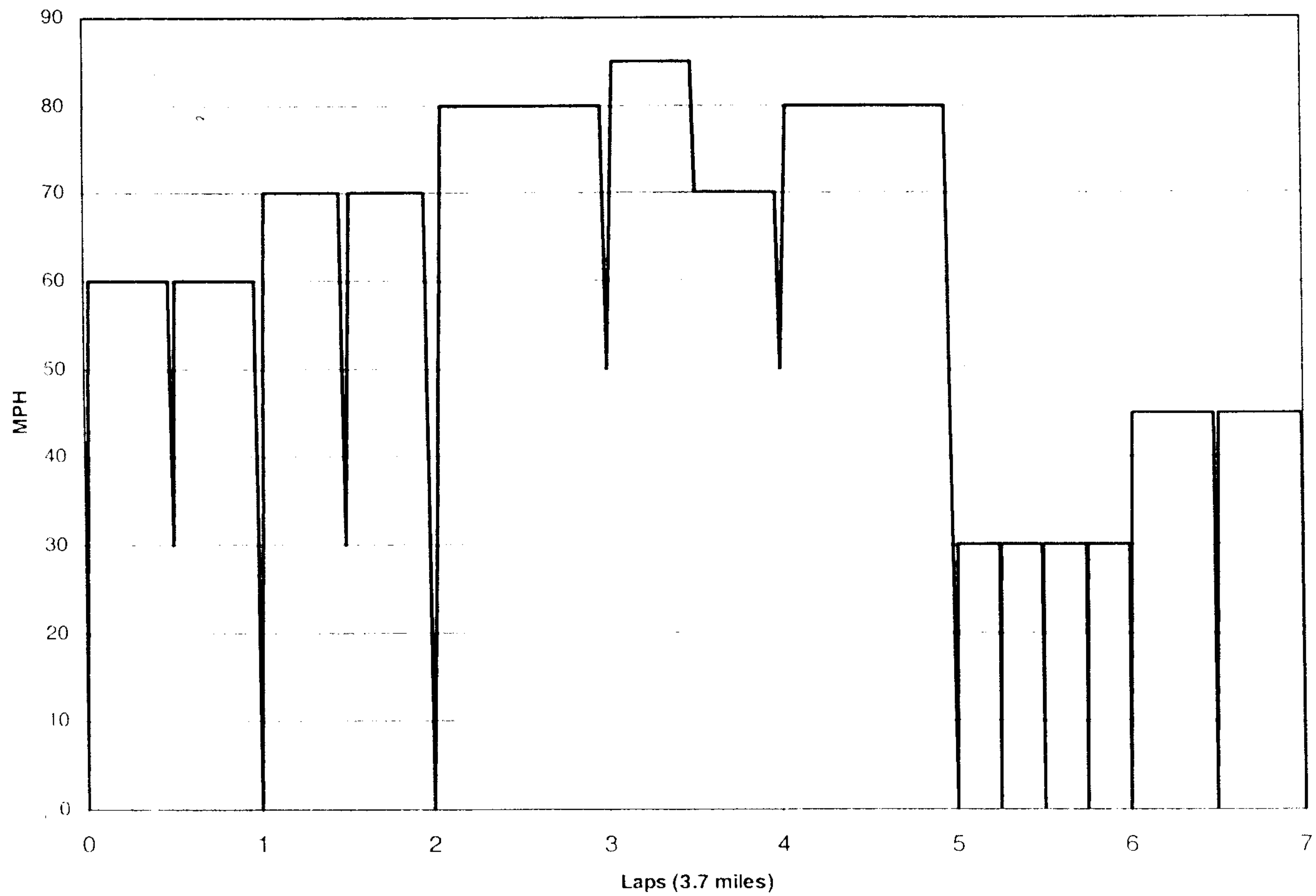
IV-4

EPA's Whole Vehicle Aging Cycle

- A whole vehicle is run on a track (or dyno) following the EPA cycle.
- The cycle consists of seven, 3.7-mile laps.
- The average speed of the cycle is 51.3 mph, the high speed is 85 mph.
- The cycle shall be repeated as necessary to complete each portion of the service accumulation between testing points.
- Optionally, the full useful life deterioration factors may be projected (using the upper 80% statistical confidence limit) from a minimum of 75 percent of the full useful life service accumulation.
- Loading and test weight
  - Cars: Test weight is loaded vehicle weight (LVW=curb + 300)
  - Trucks: Test weight is ALVW (ALVW = (curb wt + GVWR) / 2
  - Road load horsepower determined using GEJ
- DDV selection ; Worst case; Component selection: mid-50% or random.
- Testing: For df, Every 25,000 miles and before/after maintenance. When using aged components on EDV, no testing is required on the DDV.

IV-5

Whole Vehicle Aging Cycle



Draft EPA Strawman Proposal

Whole Vehicle Aging Cycle Specifics

Lap	Description	Cumulative Cycle (Mi)	No. of Laps	Ending MPH	Distance (Miles)	Typical Accel Rate (MPH/s)	Lapsed Time (s)	Cumulative Cycle Time (s)
1	(start engine) Idle 5 sec	0.00	0.00	0	0.00	0	5	5
1	Hard accel to 60 MPH	0.13	0.03	60	0.13	4	15	20
1	Cruise at 60 MPH for 1/2 lap	1.78	0.48	60	1.65	0	99	119
1	Mod decel to 30 MPH	1.85	0.50	30	0.08	-5	6	125
1	Hard accel to 60 MPH	1.94	0.53	60	0.09	4	8	133
1	Cruise at 60 MPH for 1/2 lap	3.60	0.97	60	1.66	0	99	232
1	Mod decel to stop	3.70	1.00	0	0.10	-5	12	244
2	Idle 5 sec	3.70	1.00	0	0.00	0	5	249
2	WOT accel to 70 MPH	3.84	1.04	70	0.14	5	14	263
2	Cruise at 70 MPH for 1/2 lap	5.44	1.47	70	1.60	0	82	345
2	Mod decel to 30 MPH	5.55	1.50	30	0.11	5	8	353
2	WOT accel to 70 MPH	5.66	1.53	70	0.11	5	8	361
2	Cruise at 70 MPH for 1/2 lap	7.26	1.96	70	1.60	0	82	444
2	Mod decel to stop	7.40	2.00	0	0.14	5	14	458
3	Idle 5 sec	7.40	2.00	0	0.00	0	5	463
3	Hard accel to 80 MPH	7.62	2.06	80	0.22	4	20	483
3	Cruise at 80 MPH for 1 lap	10.99	2.97	80	3.37	0	152	634
3	Mod decel to 50 MPH	11.10	3.00	50	0.11	5	6	640
4	WOT Accel to 85 MPH	11.26	3.04	85	0.16	4	9	649
4	Cruise at 85 MPH for 1/2 lap	12.95	3.50	85	1.69	0	71	721
4	Mod decel to 70 MPH	13.01	3.52	70	0.06	5	3	724
4	Cruise at 70 MPH for 1/2 lap	14.73	3.98	70	1.72	0	88	812
4	Mod decel to 50 MPH	14.80	4.00	50	0.07	5	4	816
5	WOT Accel to 80 MPH	14.94	4.04	80	0.14	4	7	823
5	Cruise at 80 MPH for 1 lap	18.32	4.95	80	3.39	0	152	976
5	Mod decel to stop	18.50	5.00	0	0.18	5	16	992
6	Idle 30 sec	18.50	5.00	0	0.00	0	30	1022
6	Mod Accel to 30 MPH	18.53	5.01	30	0.03	5	6	1028
6	Cruise at 30 MPH for 1/4 Lap	19.41	5.25	30	0.88	0	106	1134
6	Light decel to stop	19.43	5.25	0	0.02	8	4	1138
6	Idle 5 sec	19.43	5.25	0	0.00	0	5	1143
6	Mod Accel to 30 MPH	19.45	5.26	30	0.03	5	6	1149
6	Cruise at 30 MPH for 1/4 lap	20.33	5.50	30	0.88	0	106	1255
6	Light decel to stop	20.35	5.50	0	0.02	8	4	1259
6	Idle 5 sec	20.35	5.50	0	0.00	0	5	1264
6	Mod Accel to 30 MPH	20.38	5.51	30	0.03	5	6	1270
6	Cruise at 30 MPH for 1/4 Lap	21.26	5.75	30	0.88	0	106	1376
6	Light decel to stop	21.28	5.75	0	0.02	8	4	1379
6	Idle 5 sec	21.28	5.75	0	0.00	0	5	1384
6	Mod Accel to 30 MPH	21.30	5.76	30	0.03	5	6	1390
6	Cruise at 30 MPH for 1/4 lap	22.18	6.00	30	0.88	0	106	1497
6	Light decel to stop	22.20	6.00	0	0.02	8	4	1500
7	Idle 5 sec	22.20	6.00	0	0.00	0	5	1505
7	Mod accel to 45 MPH	22.27	6.02	45	0.07	4	11	1517
7	Cruise at 45 MPH for 1/2 lap	24.01	6.49	45	1.74	[illegible]	140	1656
7	Mod decel to stop	24.05	6.50	0	0.04	8	6	1662
7	Mod accel to 45 MPH	24.12	6.52	45	0.07	4	11	1673
7	Cruise at 45 MPH for 1/2 lap	25.86	6.99	45	1.74	0	140	1813
7	Mod decel to stop	25.90	7.00	0	0.04	8	6	1818

IV-7

Time to Run Useful Life Miles

Useful Life Mileage 100,000

Testing Intervals	
No of Tests	**Mileage**
2	4,000
1	25,000
1	50,000
1	75,000
2	100,000

Work Day (hrs/day)	**22**
Cycle time	**88**
7 Tests (2 days/test)	**14**
Total (days)	**102**

Adjusting Whole Vehicle DF's for IUVP data

- Apply IUVP data to the appropriate durability groups and associated test groups.
  - Any carry-over durability group
  - Other durability groups based on GEJ
- Criteria for required adjustment: The df must be adjusted when:
  - Family specific: Calculated df for any constituent for a test group 25%, or more, different for two years
  - General trend: Statistically significant overall offset
  - Manufacturer may adjust more frequently based on GEJ
- How to correct the offset
  - Mathematically adjust the df by at least half the difference, or
  - Increase the miles run by at least half the percentage offset (e.g. if UL is 100,000 miles and the offset is 20%, than increase the miles run by 10% and run 110,000 miles to represent the UL deterioration)

IV-G-11

Bench Aging

EPA's Bench Aging Concept

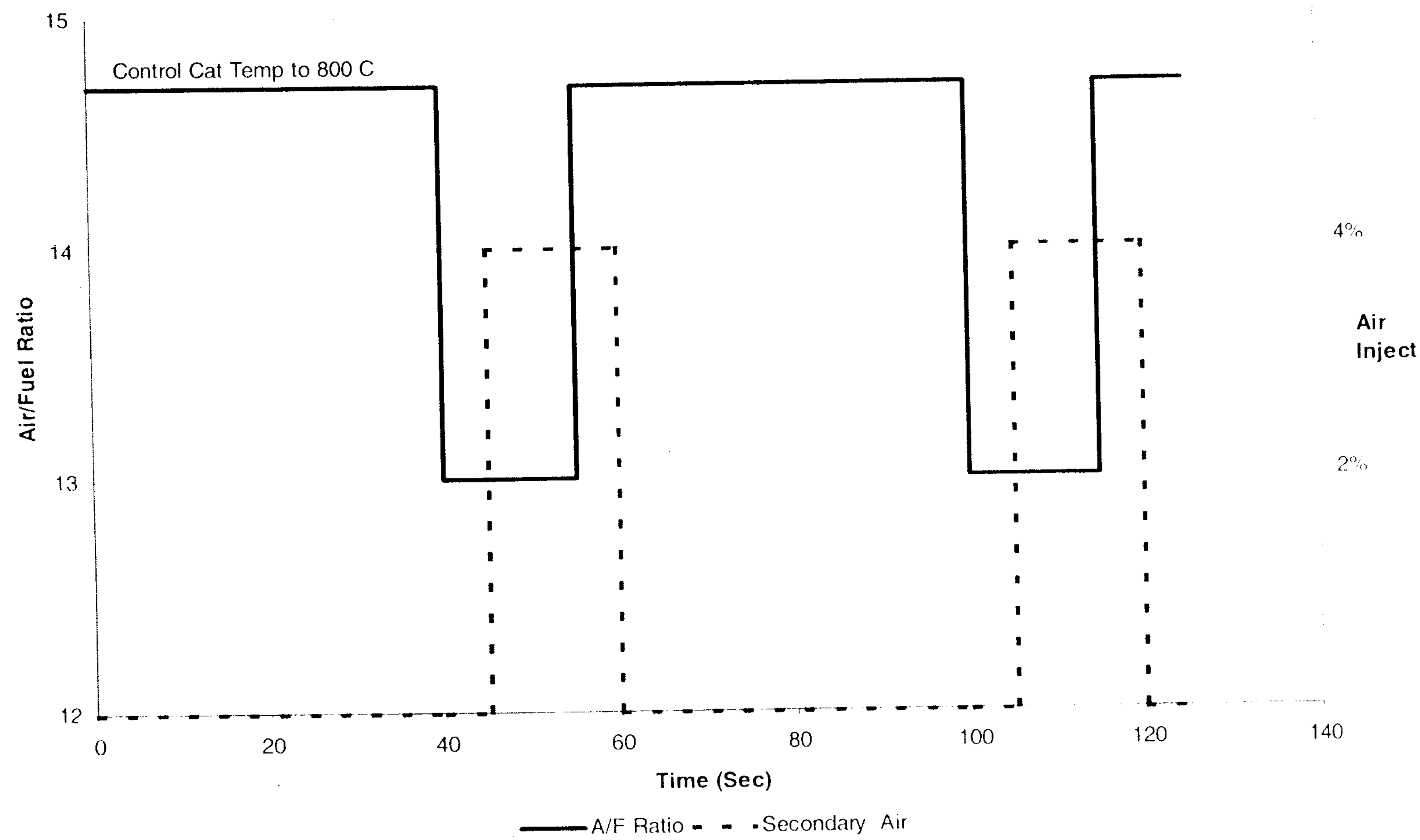
- EPA's Bench Aging Cycle attempts to replicate the total thermal exposure of the catalyst over the full useful life of the worst case vehicle in the durability group (the DDV) by aging the catalyst for a shorter period of time at a much higher temperature.
- EPA believes that most deterioration comes from the catalyst and most catalyst deterioration is due to thermal exposure. However, to account for the aging that does not come from catalyst thermal exposure, EPA uses an adjustment factor (A = 1.1) to increase the aging time.

Bench Aging Procedure

- Each bank of the exhaust system (including all catalysts and oxygen sensors) is installed on a "bench" which consists of an slave engine mounted on a engine dynamometer. (Optionally, each in-line catalyst may be aged separately on the bench)
- The exhaust flow rate of the bench is set to simulate the engine flow rate at the rpm/load selected for the bench.
- The average commercial fuel will be used for testing (optionally worst case).
- The speed, load and spark retard of the engine are controlled to maintain a desired reference catalyst temperature (800°C) during stoichiometric operation on the EPA cycle.
- The engine dynamometer controller will vary the air/fuel ratio of the engine from stoich. to rich (13 A/F [≅ 4% CO]) according to the EPA cycle.
- Shop air (4% [enough to oxidize exhaust]) is added before the catalyst for 15 seconds as specified by the EPA cycle. The extra air overlaps the rich air/fuel by 10 seconds which causes a exothermal reaction that increases the catalyst temperature while the catalyst is in a lean air/fuel ratio regime.
- This catalyst temperature spike is monitored so assure that it does not exceed the maximum temperature for rapid thermal damage of the catalyst (1000 °C). If it does, the reference temperature at stoich is reduced.

IV - 12

EPA Bench Cycle



IV-13

Data Required for Bench Aging

- Collect catalyst temperature histogram on EPA road cycle for the vehicle in question.
  - Hottest catalyst at location of maximum temperature
  - Minimum number of miles: 100 miles
  - Bin temperatures in 25° C temperature bands

- Collect a catalyst temperature histogram on the EPA catalyst bench aging cycle for the catalyst/exhaust system in question.
  - Hottest catalyst at location of maximum temperature
  - Minimum of 20 minutes of aging
  - Bin temperatures in 10° C temperature bands

- Testing: For df, two tests before and after bench aging. For aged components on EDVs, no testing is required on the DDV.

IV-14

Calculating Bench Aging Time

(based on Arrhenius' Equation for Chemical Kinetics)

t_e for a temperature bin = $t_h\, e^{((R/Tr) - (R/Tv))}$

Total t_e = Sum of t_e over all the temperature bins

Bench Aging Time = A (Total t_e)

Where:

- A = 1.1 or a value determined by the mfr using in-use data and GEJ to adjust the catalyst aging to include deterioration comes from sources other than thermal aging of the catalyst
- R = For tier 2 vehicles use 17500, for all other vehicles use 18500. Alternatively, the manufacturer may determine the R-factor experimentally
- t_h = The time (in hours) measured within the prescribed temperature bin of the vehicle's temperature histogram adjusted to be on a full useful life basis (if the histogram represented 400 miles, and full useful life was 100,000 miles; all histogram time entries would be multiplied by 250 (100000/400))
- Total t_e = The equivalent time (in hours) to age the catalyst at the temperature of T_r on the catalyst aging bench using the catalyst aging cycle to produce the same amount of deterioration experienced by the catalyst due to thermal deactivation over the vehicle's full useful life.
- t_e for a bin = The equivalent time (in hours) to age the catalyst at the temperature of T_r on the catalyst aging bench using the catalyst aging cycle to produce the same amount of deterioration experienced by the catalyst due to thermal deactivation at the temperature bin of T_v over the vehicle's full useful life.
- T_r = The effective reference temperature (in °K) of the catalyst on the catalyst bench
- T_v = The mid-point temperature (in °K) of the temperature bin of the vehicle on-road catalyst temperature histogram

IV-15

Calculating the Effective Cat Bench Aging Temp

		Instructions
Catalyst Temp Sensitivity (R)	18500	
Reference Temp °C (T_r)	800.3	Change the Ref Temp value Until the Actual Time = Calc Time
Actual Time	0.3333	
Calc Time	0.3328	

Temperature Interval (°C)	T_v	Time (hrs)	Head Load $\exp((R/Tr)-(R/T_v))$	Equivalent Hrs at Tr	Raw Histogram of Cat Aging Cycle V Time (sec) V
651 - 660	655	0.0000	0.07	0.00	0
661 - 670	665	0.0000	0.08	0.00	0
671 - 680	675	0.0000	0.10	0.00	0
681 - 690	685	0.0000	0.13	0.00	0
691 - 700	695	0.0000	0.15	0.00	0
701 - 710	705	0.0000	0.19	0.00	0
711 - 720	715	0.0000	0.23	0.00	0
721 - 730	725	0.0000	0.27	0.00	0
731 - 740	735	0.0000	0.33	0.00	0
741 - 750	745	0.0000	0.39	0.00	0
751 - 760	755	0.0000	0.47	0.00	0
761 - 770	765	0.0017	0.56	0.00	6
771 - 780	775	0.0100	0.66	0.01	36
781 - 790	785	0.0589	0.78	0.05	212
791 - 800	795	0.1125	0.92	0.10	405
801 - 810	805	0.0853	1.08	0.09	307
811 - 820	815	0.0567	1.26	0.07	204
821 - 830	825	0.0067	1.47	0.01	24
831 - 840	835	0.0017	1.72	0.00	6
841 - 850	845	0.0000	1.99	0.00	0
851 - 860	855	0.0000	2.31	0.00	0
861 - 870	865	0.0000	2.66	0.00	0
871 - 880	875	0.0000	3.07	0.00	0
881 - 890	885	0.0000	3.53	0.00	0
891 - 900	895	0.0000	4.05	0.00	0
901 - 910	905	0.0000	4.63	0.00	0
911 - 920	915	0.0000	5.28	0.00	0
921 - 930	925	0.0000	6.01	0.00	0
931 - 940	935	0.0000	6.83	0.00	0
941 - 950	945	0.0000	7.75	0.00	0
	Total	0.3333		0.33	

Enter Cat Temp Histogram Data from Road Route

Enter Values Below	V	Instructions
Miles represented in Histogram	400.0	Enter the miles run on the test track
Useful Life Miles	100,000	*Enter the useful life mileage*
In-Use Correction Factor	1.10	Enter the Adjustment factor from in-use data
Reference Temp °C (T_r)	800	Enter appropriate control value for bench aging
Tier 2?	N	Enter Y or N for Tier 2
Catalyst Temp Sensitivity (R)	18500	Auto Entered 18500 Non-Tier 2, 17500 Tier 2

Enter Your Data In This Column V Below V

Temperature Interval (°C)	Tv (°C)	Raw Histogram (hrs)	Raw Histogram Seconds
less than 200	100	0.05	180
200 - 224	212	0	0
225 - 249	237	0	0
250 - 274	262	0	0
275 - 299	287	0	0
300 - 324	312	0.001	4
325 - 349	337	0.001	4
350 - 374	362	0.002	7
375 - 399	387	0.003	11
400 - 424	412	0.004	14
425 - 449	437	0.007	25
450 - 474	462	0.01	36
475 - 499	487	0.01	36
500 - 524	512	0.03	108
525 - 549	537	0.04	144
550 - 574	562	0.476	1714
575 - 599	587	1.194	4298
600 - 624	612	2.014	7250
625 - 649	637	2.056	7402
650 - 674	662	1.036	3730
675 - 699	687	0.34	1224
700 - 724	712	0.226	814
725 - 749	737	0.208	749
750 - 774	762	0.066	238
775 - 799	787	0.06	216
800 - 824	812	0.02	72
825 - 849	837	0.001	4
850 - 874	862	0	0
875 - 899	887	0	0
900 - 924	912	0	0
925 - 949	937	0	0
950 - 974	962	0	0
975 - 999	987	0	0
1000 - 1024	1012	0	0

IV-17

Draft EPA Strawman Proposal

Converting Histogram Hours to Catalyst Aging Hours

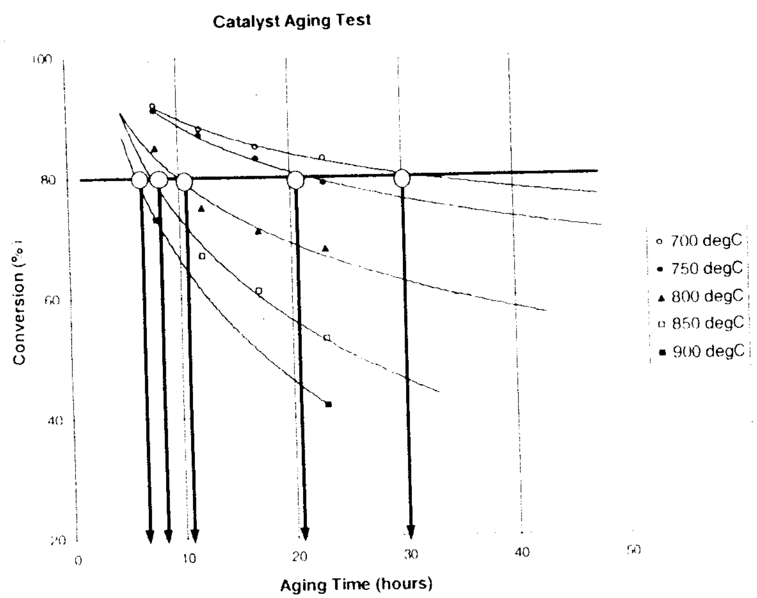
Miles represented in Histogram	400
Useful Life Miles	100,000
Reference Temp °C (T_r)	800
In-Use Correction Factor	1.10
Tier 2?	N
Catalyst Temp Sensititivy (R)	18500

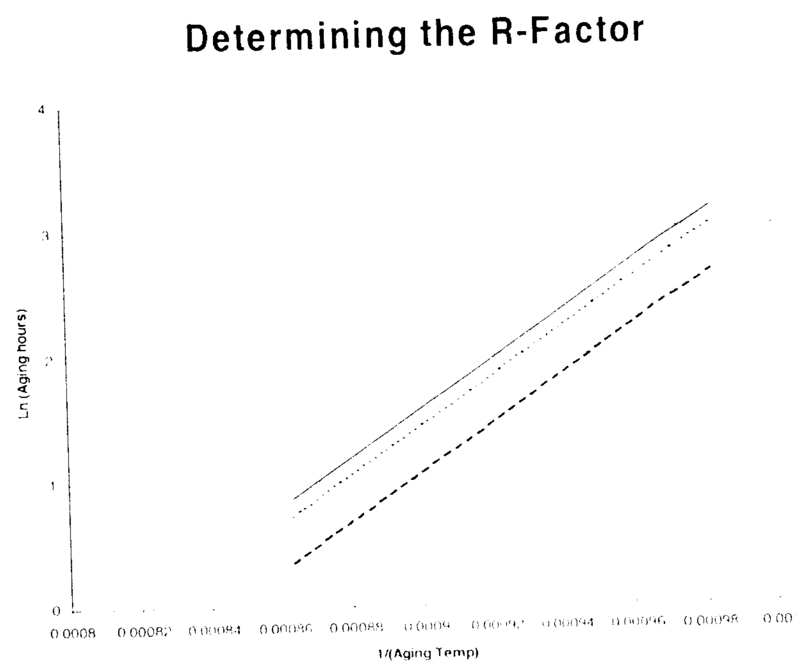
Bench Aging Hours at Ref Temp	**129.6**
Adjusted to include In-Use Factor	**142.5**

Temperature Interval (°C)	T_v	Heat Load exp((R/Tr)-(R/T_v))	Equivalent Hrs at T_r	Histogram (hrs) Based on UL	Raw Histogram (hrs)
less than 200	100	0.00	0.0	12.50	0.05
200 - 224	212	0.00	0.0	0.00	0
225 - 249	237	0.00	0.0	0.00	0
250 - 274	262	0.00	0.0	0.00	0
275 - 299	287	0.00	0.0	0.00	0
300 - 324	312	0.00	0.0	0.25	0.001
325 - 349	337	0.00	0.0	0.25	0.001
350 - 374	362	0.00	0.0	0.50	0.002
375 - 399	387	0.00	0.0	0.75	0.003
400 - 424	412	0.00	0.0	1.00	0.004
425 - 449	437	0.00	0.0	1.75	0.007
450 - 474	462	0.00	0.0	2.50	0.01
475 - 499	487	0.00	0.0	2.50	0.01
500 - 524	512	0.00	0.0	7.50	0.03
525 - 549	537	0.00	0.0	10.00	0.04
550 - 574	562	0.01	0.9	119.00	0.476
575 - 599	587	0.01	4.2	298.50	1.194
600 - 624	612	0.03	12.9	503.50	2.014
625 - 649	637	0.05	23.3	514.00	2.056
650 - 674	662	0.08	20.2	259.00	1.036
675 - 699	687	0.13	11.1	85.00	0.34
700 - 724	712	0.21	12.1	56.50	0.226
725 - 749	737	0.34	17.7	52.00	0.208
750 - 774	762	0.53	8.7	16.50	0.066
775 - 799	787	0.81	12.1	15.00	0.06
800 - 824	812	1.20	6.0	5.00	0.02
825 - 849	837	1.77	0.4	0.25	0.001
850 - 874	862	2.55	0.0	0.00	0
875 - 899	887	3.63	0.0	0.00	0
900 - 924	912	5.08	0.0	0.00	0
925 - 949	937	7.01	0.0	0.00	0
950 - 974	962	9.55	0.0	0.00	0
975 - 999	987	12.86	0.0	0.00	0
1000 - 1024	1012	17.11	0.0	0.00	0
				Hours in Sample run	7.855
				Ave Miles per Hour	50.92

IV-18

Experimentally Determining the R-Factor





- Age several catalysts at different temperatures; measure efficiency periodically for each constituent
- Plot the percent catalyst conversion efficiency versus aging time in hours for each of the catalysts. Draw a logarithmic best fit line for each aging temperature.
- At several different constant values of conversion efficiencies, draw a horizontal line on the chart and read the aging time at the intercepts with the constant temperature aging curves.
- Plot the natural log (ln) of the aging time in hours versus (1/Aging temperature (in °K)) for several constant-catalyst-efficiencies for each constituent. Calculate a least-squared best-fit line though the constant-efficiency data. The slope of the line is the R factor. Use the smallest R-factor (worst case).

IV-19

Customizing EPA's Bench Aging Procedures

- Customized EPA Procedures: Mfr can change (subject to GEJ):
  - The T_r temperature of EPA's rapid aging
  - The R-factor (catalyst sensitivity to temperature exposure)
  - The A-factor (how much extra catalyst thermal aging is necessary to reflect the sum of all catalyst deterioration experienced in- use)
  - Use fuel with additional lead/phosphorous, etc to include more poisoning deactivation and thereby reduce the A factor
- Approval criteria (TBD)
- Required disclosure (TBD)

IV-20

Adjusting Bench Procedures for IUVP data

- Apply IUVP data to the appropriate durability groups and associated test groups.
  - Any carry-over durability group
  - Other durability groups based on GEJ
- Criteria for required adjustment: The df must be adjusted when:
  - Within a Durability Group: Calculated df for any constituent for a test group X% [25%?], or more, different for two years
  - General trend: Statistically significant overall offset
  - Manufacturer may adjust more frequently based on compelling evidence [GEJ]
- How to correct the offset
  - Mathematically adjust the df by at least half the difference,
  - Adjust the A-factor in the aging time equation for that family by at least half the percentage of the offset (e.g. if the offset was 20%, then increase the A factor by 10%, so 1.1 becomes 1.21), or
  - Calculate a new R-factor

IV-21

Prove-Out Testing Program

- Select vehicles to participate. SFTP compliant and CAP 2000 bench aged.
- Instrument the vehicle with catalyst thermocouples - hottest catalyst at location of maximum catalyst temperature (e.g., 1" behind the front face on the axis)
- Run the vehicle over the EPA-whole vehicle cycle (at least 100 miles) while collecting catalyst temperature data
- For a typical EPA seven-lap cycle, plot temperature and vehicle speed vs time. Provide a histogram of catalyst temperatures in 25°C intervals. Also provide similar information for the Mfr's CAP 2000 cycle.
- Determine the effective temperature-load for EPA's cycle and the Mfr CAP 2000 cycle using both the EPA's and the Mfr's methods.
- Determine the effective temperature of the bench aging cycle that you currently use and also the the effective temperature of EPA's bench cycle on your catalyst aging bench.
- Compute aging time for both Mfr cycle and EPA Cycle using both EPA's method and the CAP 2000 Mfr method
- Compare aging time used in CAP 2000 vs Mfr Cycle and EPA Cycle time

ATTACHMENT V

I - 1

Alliance OF AUTOMOBILE MANUFACTURERS

AIAM

February 21, 2003

Gregory A. Green, Director
Certification and Compliance Division
Office of Transportation and Air Quality
United States Environmental Protection Agency
National Vehicle and Fuel Emissions Laboratory
2565 Plymouth Road
Ann Arbor, Michigan 48105-2498

Dear Mr. Green,

This letter is in response to EPA's request for comments on its "Strawman Proposal" for new durability procedures presented at the industry meeting on February 5, 2003.

The Alliance of Automobile Manufacturers[1] ("Alliance") and the Association of International Automobile Manufacturers (AIAM)[2] agree with EPA that a default durability protocol is needed as one option for your upcoming regulatory proposal on durability procedures. Furthermore, we are committed to working with you over the next few months to identify and analyze existing relevant data and to collect and analyze new data as necessary to support the development of a default protocol. However, we are unable to support EPA's Strawman Proposal. We believe that the procedures set forth in that proposal are not representative of real world driving conditions and create a much too severe cycle for durability purposes. Some of our concerns include but are not limited to the following points:

- The whole vehicle cycle, as proposed, likely exceeds 99^{th} percentile customer driving in terms of the amount of time at high speeds, as well as the frequency and duration of severe accelerations.
- Extensive in-use driving behavior surveys conducted during the SFTP rulemaking showed that only 6.4% of operation was over 60 mph, 2.6% over 65 mph, and 0.6% over 70 mph.
- Wide-open throttle (WOT) accelerations observed in the customer surveys were not as frequent as represented in the EPA cycle and seldom exceeded 4 – 5 mph/sec.

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[1] Alliance members include; BMW Group, DaimlerChrysler, Ford Motor Company, General Motors, Mazda, Mitsubishi Motors, Nissan, Toyota, and Volkswagen.

[2] AIAM members include American Honda Motor Co., American Suzuki Motor Corp., Aston Martin Lagonda of North America, Inc., Ferrari North America, Inc., Hyundai Motor America, Isuzu Motors America, Inc., Kia Motors America, Maserati North America, Inc., Mitsubishi Motors North America, Nissan North America, Peugeot Motors of America, Saab Cars USA, Renault, SA, Subaru of America, and Toyota Motor Sales, U.S.A.

- A one-size, worst case road or bench protocol (with no alternative) has the practical effect of increasing the stringency of applicable emissions standards and drives incremental hardware/system changes that are otherwise not required. Such an outcome is not the intended result of either the Clean Air Act (CAA) or the Court's order in Ethyl Corporation v. EPA. Section 206 merely states that durability procedures are meant to determine if the vehicle or engines *conform* to the §202 standards—not to raise those standards. To do otherwise would be improper under these circumstances.
- Unlike existing manufacturer cycles, the EPA cycle has not been correlated with data to real world experience.

We request that EPA revise its Strawman Proposal with the following points in mind. However, these points are raised now to allow EPA to craft a more representative *initial* proposed cycle for evaluation during the NPRM review process. We believe that the best approach for developing representative default procedures for the NPRM is for a joint EPA/industry work group to analyze existing data and new data that may be generated quickly in order to develop a representative cycle. This technical effort could be completed well in advance of the planned release of your NPRM in August, and would not prevent EPA from moving ahead with the development of the preamble and necessary draft regulations. The default protocol could be inserted once it is completed. Unless we develop representative default procedures in this type of work group, we anticipate that there *will remain a significant need* to further refine the proposed procedures during the comment period.

- The EPA cycle should be representative of existing drive cycles and the extensive in-use driving behavior surveys conducted by EPA and Industry during the SFTP rulemaking.
- We believe that the relative stringency of any proposed cycle should be based on an aggregate of overall Industry cycles.
- Manufacturers invested significant time and resources to develop their own accelerated aging cycles, correlated them to real world experience, and obtained EPA approval. This invaluable real-world experience is not currently captured in EPA's Strawman Proposal.
- It is essential that EPA reassess any proposed cycle based on information from the Industry comparative/prove-out data.

Several manufacturers intend to meet with EPA as soon as possible (to accomodate the EPA deadlines) to discuss specific proposals for revising any proposed cycle. Those manufacturers will contact EPA directly in order to make appropriate arrangements.

As you requested, the Alliance and AIAM are committed to work with EPA to generate comparative data between existing manufacturer cycles and an EPA cycle.

V-3

As we work through this process, it is imperative that all parties approach this issue with the broadest possible perspective, and be open to viable alternative approaches. As EPA has previously acknowledged, individual manufacturers have gained considerable experience over the years and have produced representative cycles, as validated with substantial in-use data. EPA must include reasonable and flexible provisions in the NPRM that allow manufacturers to submit their own proprietary cycles for approval in lieu of any standard cycle that EPA may adopt. EPA should also refrain from narrowly defining a bench procedure, and instead, should simply provide general criteria by which manufacturers can use their own bench procedures. We believe that such an approach is completely permissible under both the CAA and the Court's order.

CAA Section 206(d) directs the Administrator to, "by regulation establish methods and procedures for making tests under this section." Yet the Administrator is provided broad discretion in crafting regulations governing durability protocols. Under Section 206(a)(1), the Administrator is directed to "test, or require to be *tested in such a manner as he deems appropriate*, any new motor vehicle or new motor vehicle engine submitted by a manufacturer to determine whether such vehicle or engine conforms with the regulations prescribed under section 202 of this Act." (Emphasis added.)

Rather than restricting the broad discretion given the Administrator, the D.C. Circuit acknowledged the appropriateness of deferring to the Administrator on such issues. Citing prior cases, the Court acknowledged that in its prior decisions interpreting statutes similar to the Clean Air Act, where "Congress has not specified the level of specificity expected of the agency, we held that the agency was entitled to broad deference in picking the suitable level." The Court also noted that "vaguely articulated test procedures" would be "reviewed deferentially under such cases as American Trucking."

The Court found fault with CAP 2000 simply because EPA did not "articulate even a vague durability test." The Court went on to say that "All that is required is that [EPA] establish its procedures, no matter how variegated, 'by regulation'."

EPA has the discretion to establish by regulation varying means of demonstrating durability under the Clean Air Act, and these can include an option for manufacturers to utilize proprietary testing protocols. The Court expressly acknowledged that a "one-size fits all" test method was not required.

Citing MST Express v. Department of Transportation, 108 F.3d 401 (1997), the Court also acknowledged that regulated parties can use various means to demonstrate their compliance with established regulations so long as those alternative means are evaluated by the agency vis-à-vis a properly promulgated set of criteria.

Finally, nothing in the Court's opinion prohibits the use of Confidential Business Information (CBI) as part of the manufacturer's demonstration of compliance. In fact, the Court expressly acknowledged that CBI is protected under Section 208. The Court simply noted that EPA could not use CBI as a reason for failing to promulgate regulations. We believe that EPA must include such an option for manufacturers to utilize proprietary testing protocols in the NPRM, and that the failure to provide an opportunity to comment on the merits of this approach would be unreasonable.

The Alliance and AIAM believe that EPA must include such an option (i.e. alternative approaches for durability protocols), as set forth above, in the NPRM. To eliminate such an option without an opportunity for a more thorough review during the comment period would be unreasonable

We appreciate the opportunity to provide this feedback. Please contact us if you should have any questions.

Sincerely,

Casimer J. Andary

Casimer Andary
Director, Regulatory Programs
Alliance of Automobile Manufacturers

John M Cabaniss Jr.

John Cabaniss
Director, Environment & Energy
Association of International Automobile Manufacturers

Cc: Eldert Bontekoe
John Hannon
Dan Harrison
Linda Hormes
Lori Stewart

ATTACHMENT VI

Ford Motor Company

Ford/EPA Meeting on Durability Aging Procedures

January 22, 2003

Confidential Slides/Materials are Marked Appropriately

1-1A

Ford Motor Company

Presentation Outline

- **ADP Program Overview**
  - Whole Vehicle (HSC a.k.a. Fast AMA or "FAMA")
  - Fuel Specifications
  - Bench Cycle Development
- **Catalyst Bench Aging Procedures & Equipment**
  - Engine Selection
  - Engine Dynamometer
- **Ford 4-Mode & TCAC Bench Aging Cycle Descriptions**
  - Aging Cycle Targets
  - Current Aging Cycles & Applications
  - Stoich/Rich/Lean Operational Modes
  - Engine/System Controls & Other Parameters
  - Aging Severity

VI-2

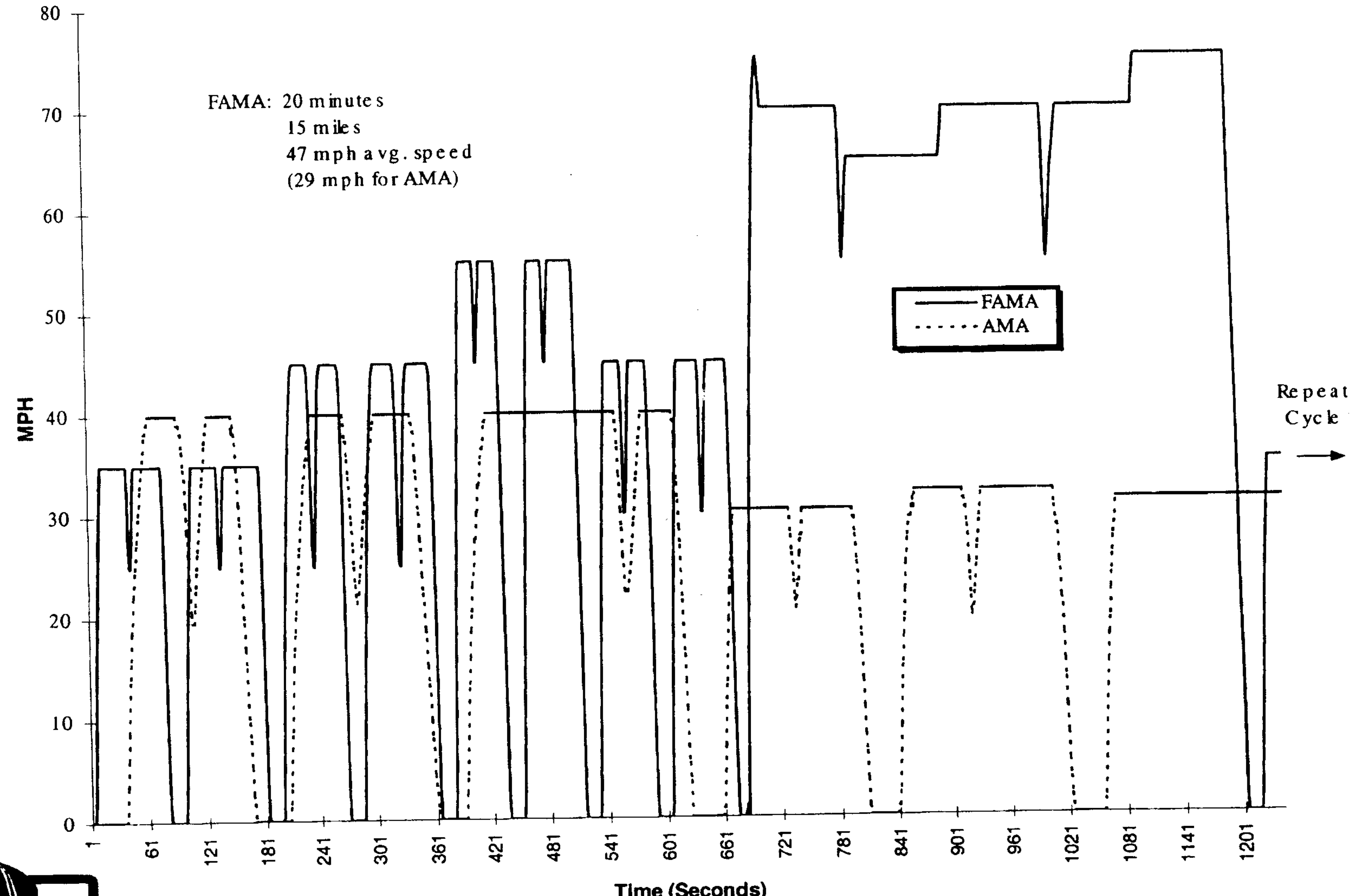
Ford Motor Company

Whole-Vehicle Fast AMA Cycle

- Developed through field experience and modified to accommodate track mileage accumulation facilities.
- Consists of a 15 mile sequence with a top speed of 75 mph and average speed of 47 mph.
- Contains greater percentage of high speeds and correspondingly higher catalyst temperatures vs. customer in-use driving patterns.
- Ford has agreed to publicly disclose the Fast AMA procedure (see separate letter dated 1/21/03).

Ford Motor Company

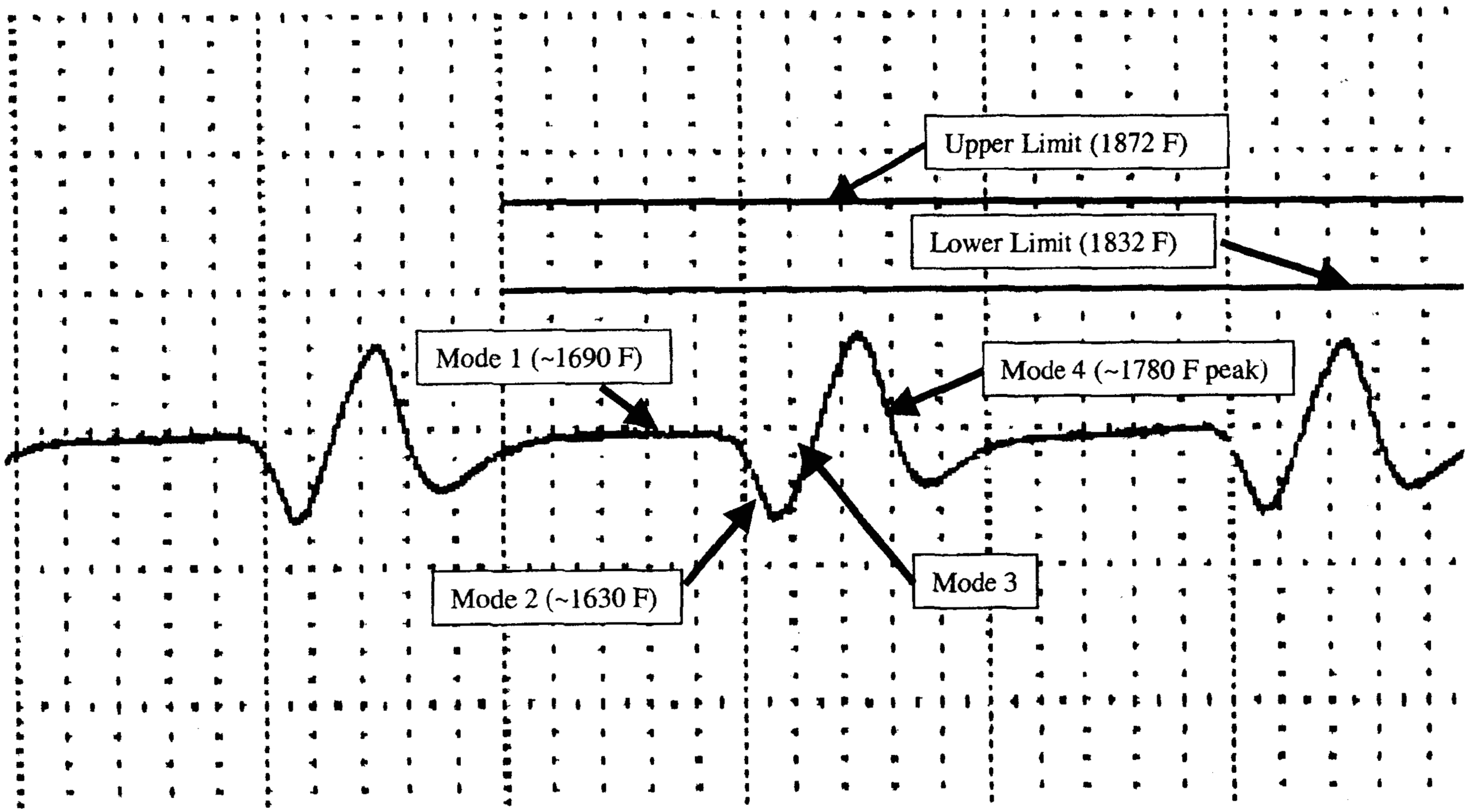
Whole-Vehicle Fast AMA Cycle



III-4

pp 4-15
Confidential

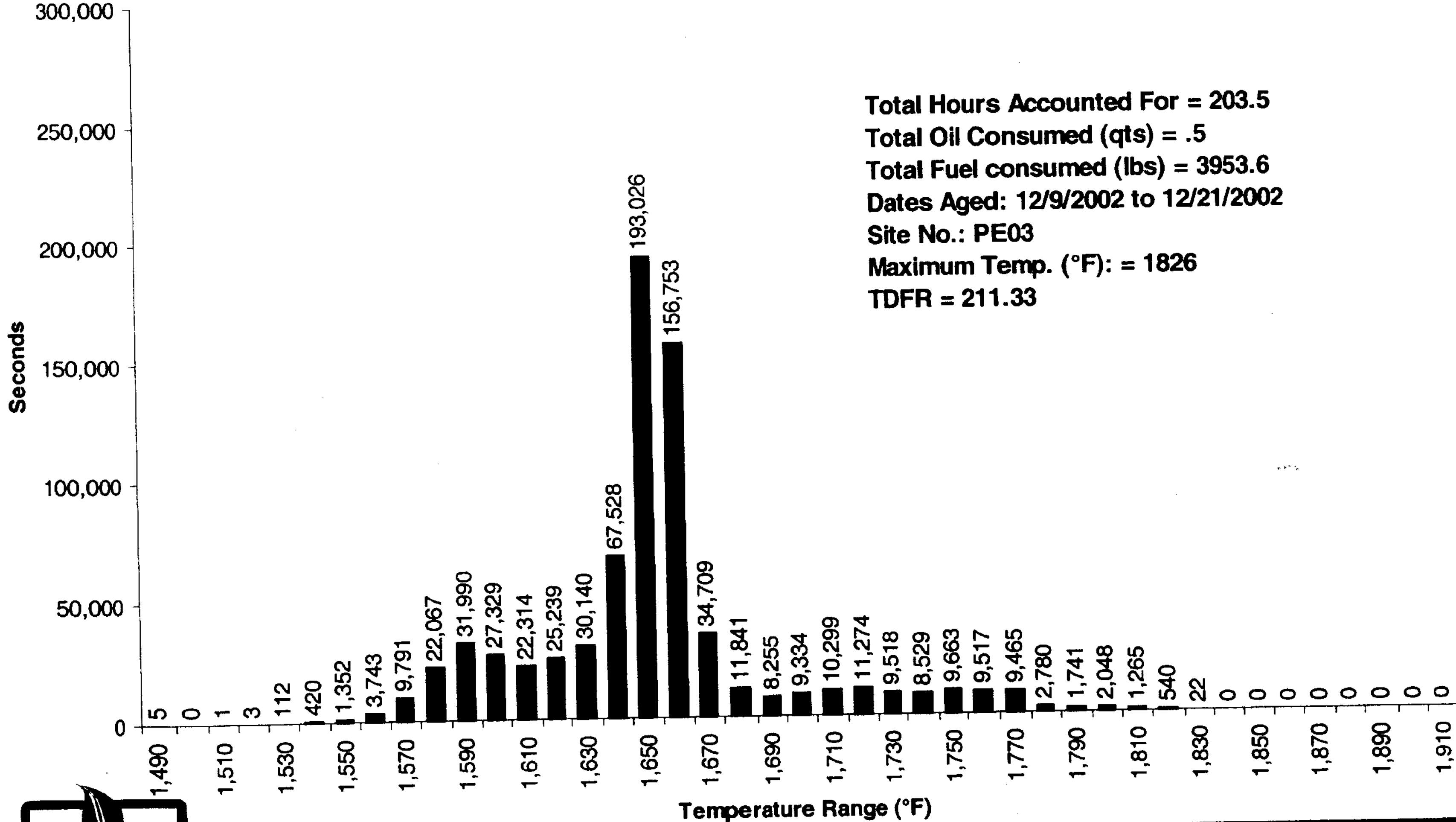
Ford 4-Mode & TCAC
Typical Temperature Trace



VI - 6

Ford Motor Company

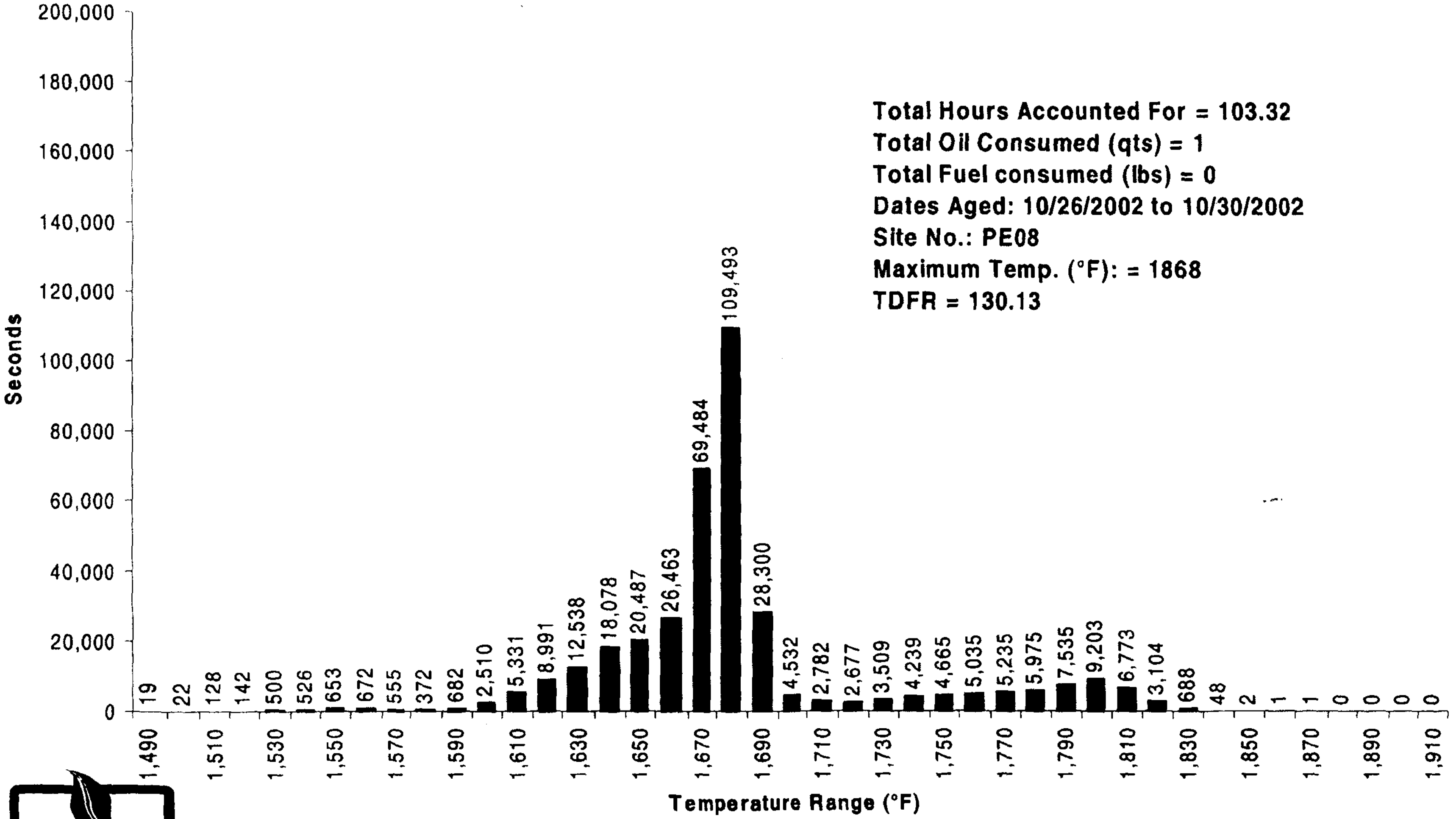
2.3L Focus1560°F 4-Mode 200 Hrs. JB9924-1 RB Midbed Cat Aging Temperature Histogram



VI-7

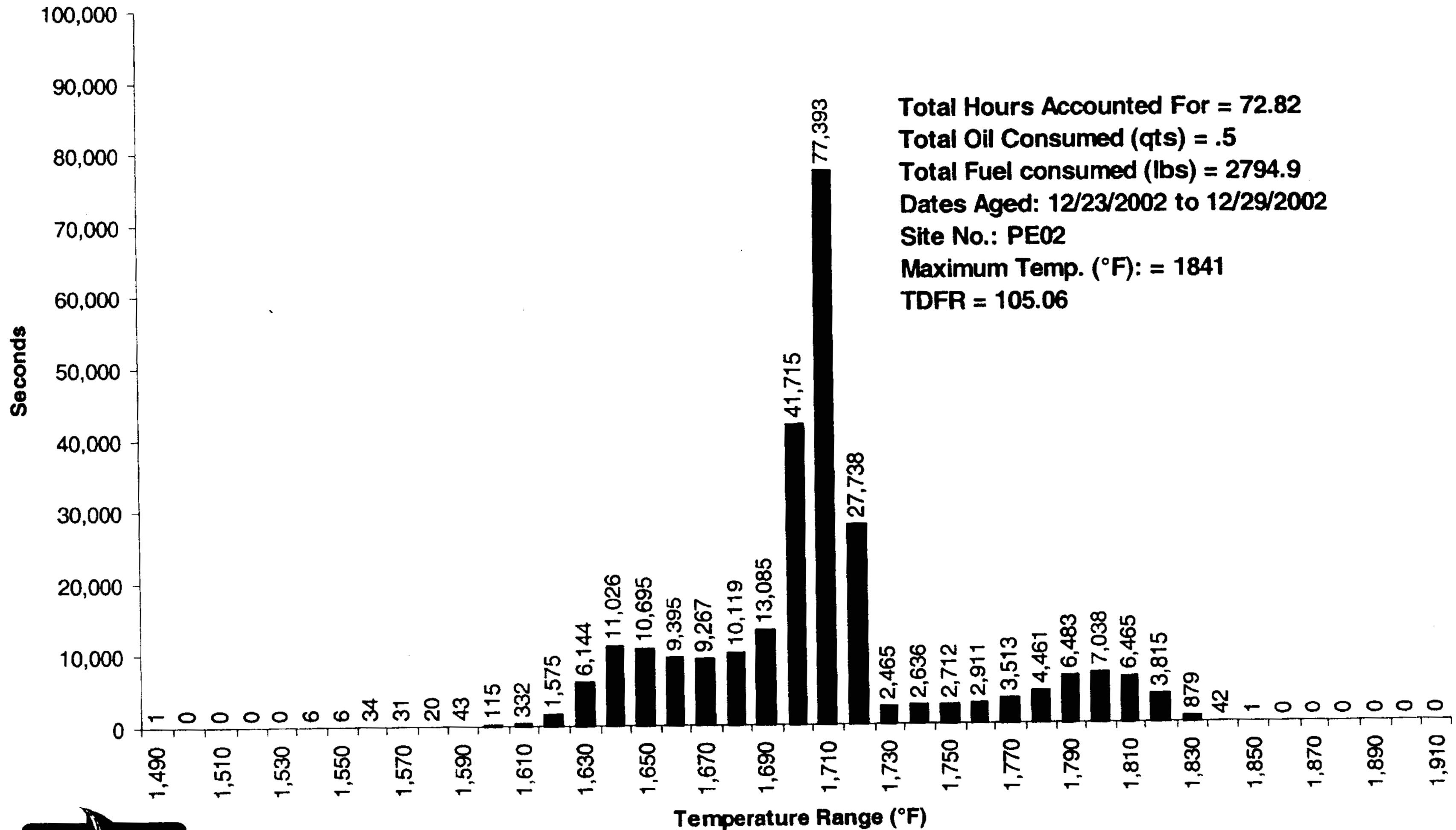
Ford Motor Company

3.0L Vulcan Ranger 1560°F 4-Mode 100 Hrs. JB 8905-4 RB Midbed Cat Aging Temperature Histogram



8-IA

4.6L Explorer 1560°F TCAC 73 Hrs. JB9972-4 RB Midbed Cat Aging Temperature Histogram



Ford Motor Company

Aging Severity

- **Effect of Temperature**
  - Thermally Activated Processes

    Rate ~ AExp [- E / RT]

- **Importance of Exhaust Stream Constituents**
  - Poisons in the exhaust stream may interact with the catalyst washcoat and cause significant, irreversible deterioration (reference: SAE Paper 2000-01-188)
  - Degradation rate may be accelerated by excess O2 (reference SAE Paper 982706)
  - Some poisons do not chemically interact but physically coat the catalyst and can affect performance

VI-10

ATTACHMENT VII

Ford Motor Company

Vehicle Environmental Engineering
Ford Motor Company

1500 Enterprise Drive
Suite 3W-200
Allen Park, MI 48101

January 21, 2003

Mr. E. Bontekoe
Certification Division
Mobile Sources Pollution Control
U.S. Environmental Protection Agency
2000 Traverwood
Ann Arbor, MI 48105-2498

Dear Mr. Bontekoe:

Subject: **Disclosure of Ford's High-Speed Cycle for Emissions Durability**

Reference: (1) EPA comments made at the December 5, 2002 EPA/Industry Compliance Meeting held at EPA's NVFEL office building, Ann Arbor, MI.
(2) Letter to D. Kulp (Ford) from D. Good (EPA), "Approval of Alternate Durability Protocol (ADP)," dated December 23, 1994.
(3) Letter to C. Tyree (EPA) from D. Kulp, "Freedom of Information Act (FOIA) Request Concerning Ford's Alternative Durability Program," dated December 8, 1998.

In recognition of changing circumstances and to aid EPA's proposed rulemaking to establish new emissions durability regulations (Ref. 1), Ford Motor Company (Ford) hereby agrees to disclose its High Speed Cycle (HSC) for emissions durability. The attachment to this letter contains a description of Ford's HSC, along with a description of the part it can play in assessing emissions deterioration.

Ford uses the HSC (a.k.a., Fast AMA or FAMA) to demonstrate durability of emissions components and either a) to generate a deterioration factor for emissions performance or b) to provide a basis for engine-dynamometer aging processes from which deterioration factors may be derived. Using the FAMA cycle, emissions performance assessments occur, at minimum, at the 5K milestone and at a milestone representative of full useful life. There is a one-to-one correspondence between HSC mileage and the mileage it represents – durability assessments do not presume that a mile of HSC mileage represents more than a mile of actual vehicle usage and uses no adjustment factors to map HSC mileage to effective vehicle mileage. Also, Ford's HSC is not necessarily structured to assess the effects of any new fuel or fuel additive beyond that currently available commercially in the U.S. New additives may have deleterious effects for customer operating modes not fully represented in the HSC. Therefore, new fuels or fuel additives may require re-examination of the suitability of the HSC to represent emissions control performance for a substantial majority of in-use vehicles.

As indicated above, Ford uses its HSC to establish a basis for engine-dynamomter aging processes. When developing bench-aging requirements, Ford initially targets to produce the same full-useful life effect on bench cycles as produced by emissions control systems exposed to HSC mileage. Ford then increases bench-aging requirements by a safety factor in order to provide more robustness in meeting full useful life emissions standards. As an alternative to the HSC, Ford may use data obtained from captive fleets operated over public roads for establishing bench-aging targets.

EPA approved HSC as part of its ADP process in 1994 (Ref. 2). At that time Ford believed that disclosure of the HSC would substantially harm the Company's competitive position, conferring on interested parties proprietary information about a process developed at great expense. Accordingly, Ford asserted specific claims of business confidentiality regarding the HSC in its response to EPA's FOIA request (Ref. 3). Based on publically available information, it would appear that other manufacturers have developed similar high-speed cycles that substantially diminish the competitive advantage originally assigned to Ford's HSC. Thus, Ford believes that it may disclose its HSC in order to facilitate EPA's upcoming rulemaking on emissions durability requirements. It should be noted, however, that as to other information beyond the HSC disclosed herein, Ford maintains its claims of business confidentiality.

If you have any questions regarding this disclosure, please contact me at (313) 323-8937 or Bob Holycross at (313) 594-0738.

Sincerely,

David L. Kulp, Manager
Certification Engineering Department
Vehicle Environmental Engineering

Attachment

.cc Duc Nguyen (CARB)

FORD HIGH SPEED EMISSIONS DURABILITY CYCLE

The following describes Ford's High Speed Cycle (HSC) used to demonstrate emissions durability performance. Emissions data generated from exhaust systems exposed to HSC driving may either be used to calculate an emissions deterioration factor or provide a basis for configuring engine-dynamometer exhaust system aging from which a deterioration factor may be derived.

HSC Whole Vehicle Aging Procedure

Ford's HSC was adapted from a target accelerated whole vehicle aging cycle that was developed through evaluation of field experience. This target cycle was then modified such that it could accommodate our mileage accumulation facilities. The HSC consists of a 15 mile sequence with a top speed of 75 mph and an average speed of 47 mph. It contains a greater percentage of high speeds and correspondingly higher catalyst temperatures when compared to customer in-use driving patterns. Cycle severity and comparisons to customer usage were described in a letter from Mr. D. L. Kulp to Mr. T. M. Ball dated December 10, 1993, and updated in a letter dated December 20, 1993. This information was supplemented with individual catalyst temperature profiles from the customer usage study and catalyst temperature comparisons between the AMA and HSC in letters to Mr. E. Bontekoe dated January 24, 1994, and February 24, 1994.

Testing Sequence for Deriving DFs Using Ford's HSC

1. The durability data vehicle (DDV) is be selected in accordance with the standard procedure described in 40 CFR § 86.1822-01
2. The DDV accumulates 100,000/120,000/150,000 miles using the HSC as described in the HSC Drive procedure, below.
   - For FFVs, mileage accumulation fuel alternates between alcohol and gasoline every 1,000 miles.
3. Emissions tests is either be conducted at intervals consistent with the criteria set forth in 40 CFR § 86.094-26(a)(4)(i) or at intervals that, at minimum, characterize emissions performance at 5K and at full useful life. Testing also occurs at scheduled maintenance milestones, which vary by vehicle program.
   - For FFVs, tests are conducted at each test point using both alcohol and gasoline fuels.
4. Emissions tests for before and after scheduled maintenances are conducted in accordance with the criteria set forth in 40 CFR § 86.094-25.
5. Mileage accumulation may be halted at three quarters (3/4) of useful life consistent with the criteria set forth in 40 CFR § 86.094-26(a)(4)(i)(B). The 4K, 50K, and 100/120/150K intercepts will be taken off the line of deterioration which will be calculated using the method of least squares.
6. The 4K to 50K and 4K to 100/120K/150K DFs will be represented by the arithmetic difference between the respective intercepts.
   - For FFVs, DFs are determined on both gasoline and on the alcohol fuel.
7. Catalyst temperature profiles of the primary DDVs are generated on the HSC.

HSC Drive Procedure

The HSC drive procedure consists of the following:

1. Execute the low-speed cycle.
2. Execute the high-speed cycle.
3. Repeat.

Low Speed Cycle (Consists of 4 phases)

Phase 1:

a) Accelerate at a normal rate from a stop to 35 mph.
b) Hold at 35 mph to 0.3 miles.
c) Decelerate at a normal rate to 25 mph.
d) Accelerate at a normal rate to 35 mph.
e) Hold at 35 mph to 0.3 miles.
f) Decelerate at a normal rate to a stop and idle for 15 s.
g) Accelerate to a normal rate from a stop to 35 mph.
h) Hold at 35 mph to 0.3 miles.
i) Decelerate at a normal rate to 25 mph.
j) Accelerate at a normal rate to 35 mph.
k) Hold at 35 mph to 0.4 miles.
l) Decelerate at a normal rate to a stop and idle for 15 s.

Phase 2:

a) Accelerate at a normal rate from a stop to 45 mph.
b) Hold at 45 mph to 0.25 miles.
c) Decelerate at a normal rate to 25 mph.
d) Accelerate at a normal rate to 45 mph.
e) Hold at 45 mph to 0.25 miles.
f) Decelerate at a normal rate to a stop and idle for 15 s.
g) Accelerate to a normal rate from a stop to 45 mph.
h) Hold at 45 mph to 0.35 miles.
i) Decelerate at a normal rate to 25 mph.
j) Accelerate at a normal rate to 45 mph.
k) Hold at 45 mph to 0.35 miles.
l) Decelerate at a normal rate to a stop and idle for 15 s.

Phase 3:

a) Accelerate at WOT from a stop to 55 mph.
b) Hold at 55 mph to 0.3 miles.
c) Decelerate at a normal rate to 45 mph.
d) Accelerate at a normal rate to 55 mph.
e) Hold at 55 mph to 0.3 miles.
f) Decelerate at a normal rate to a stop and idle for 15 s.
g) Accelerate at WOT from a stop to 55 mph.
h) Hold at 55 mph to 0.3 miles.
i) Decelerate at a normal rate to 45 mph.
j) Accelerate at a normal rate to 55 mph.
k) Hold at 55 mph to 0.4 miles.
l) Decelerate at a normal rate to a stop and idle for 15 s.

Phase 4:

a) Accelerate at a normal rate from a stop to 45 mph.
b) Hold at 45 mph to 0.25 miles.
c) Decelerate at a normal rate to 30 mph.
d) Accelerate at a normal rate to 45 mph.
e) Hold at 45 mph to 0.25 miles.
f) Decelerate at a normal rate to a stop and idle for 15 s.

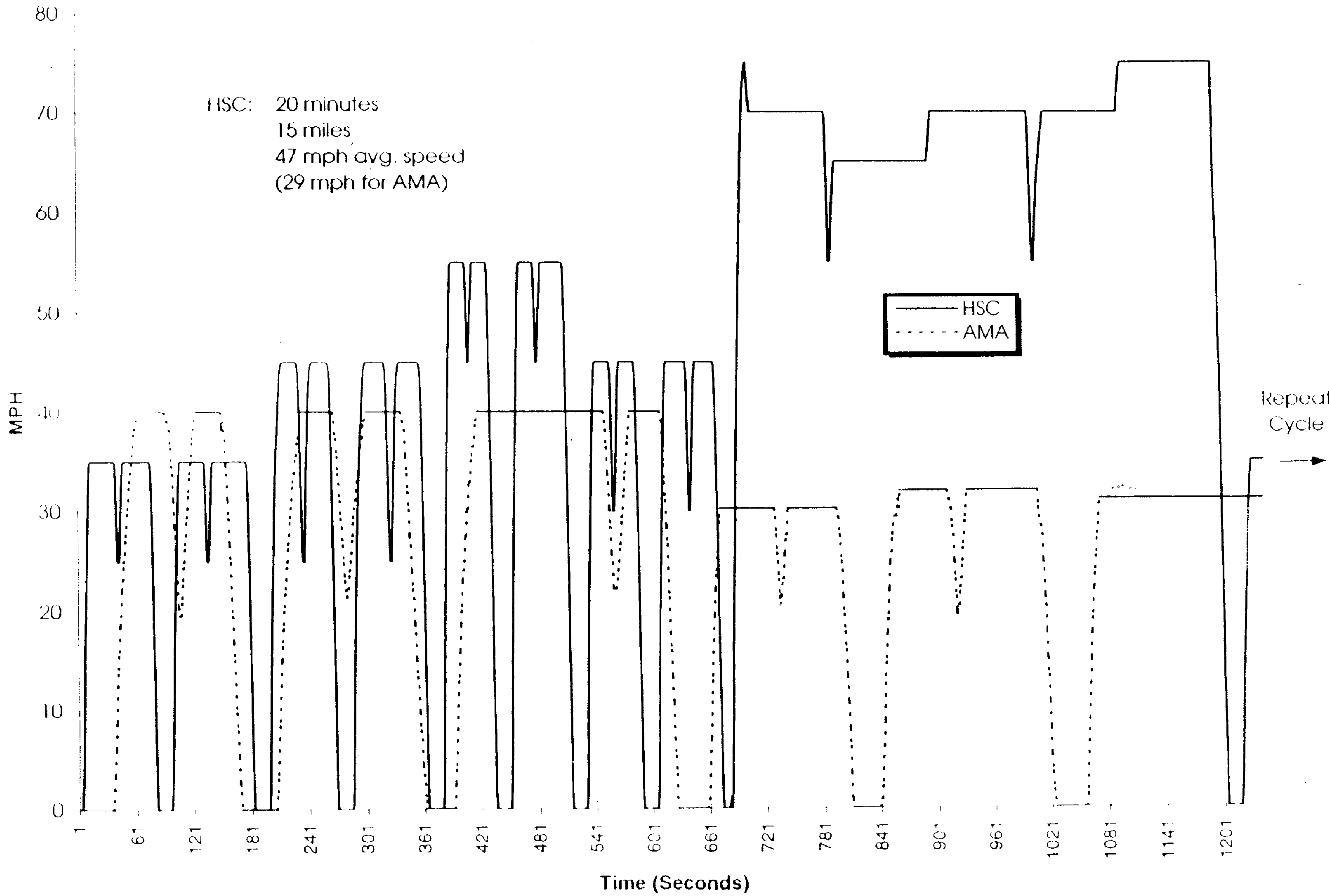
g) Accelerate to a normal rate from a stop to 45 mph.
h) Hold at 45 mph to 0.35 miles.
i) Decelerate at a normal rate to 30 mph.
j) Accelerate at a normal rate to 45 mph.
k) Hold at 45 mph to 0.35 miles.
l) Decelerate at a normal rate to a stop and idle for 15 s.

High-Speed Cycle

a) Accelerate at WOT from a stop to 75 mph.
b) Decelerate at a normal rate to 70 mph.
c) Hold at 70 mph to 1.8 miles.
d) Decelerate at a normal rate to 55 mph.
e) Accelerate at a normal rate to 65 mph.
f) Hold at 65 mph to 2.0 miles.
g) Accelerate at a normal rate to 70 mph.
h) Hold at 70 mph to 2.1 miles.
i) Decelerate at a normal rate to 55 mph.
j) Accelerate to a normal rate to 70 mph.
k) Hold at 70 mph to 1.9 miles.
l) Accelerate at a normal rate to 75 mph.
m) Hold at 75 mph to 2.2 miles.
n) Decelerate at a normal rate to a stop.

Note: Mileage accumulation may occur at lower speeds if weather conditions or other factors generate situations where driving at the specified speeds would be unsafe.

High Speed Mileage Accumulation Cycle (HSC)
(Partial AMA cycle included -- for same time frame)



VIII - 9

ATTACHMENT VIII

Comparison of EPA Aging Cycle with Real-World Driving Behavior

- Used California Unified Cycle, Weighted Average[1] of EPA cycles and customer surveys from SFTP rulemaking as a basis
- EPA Aging Cycle drives at higher speeds for longer duration than real-world

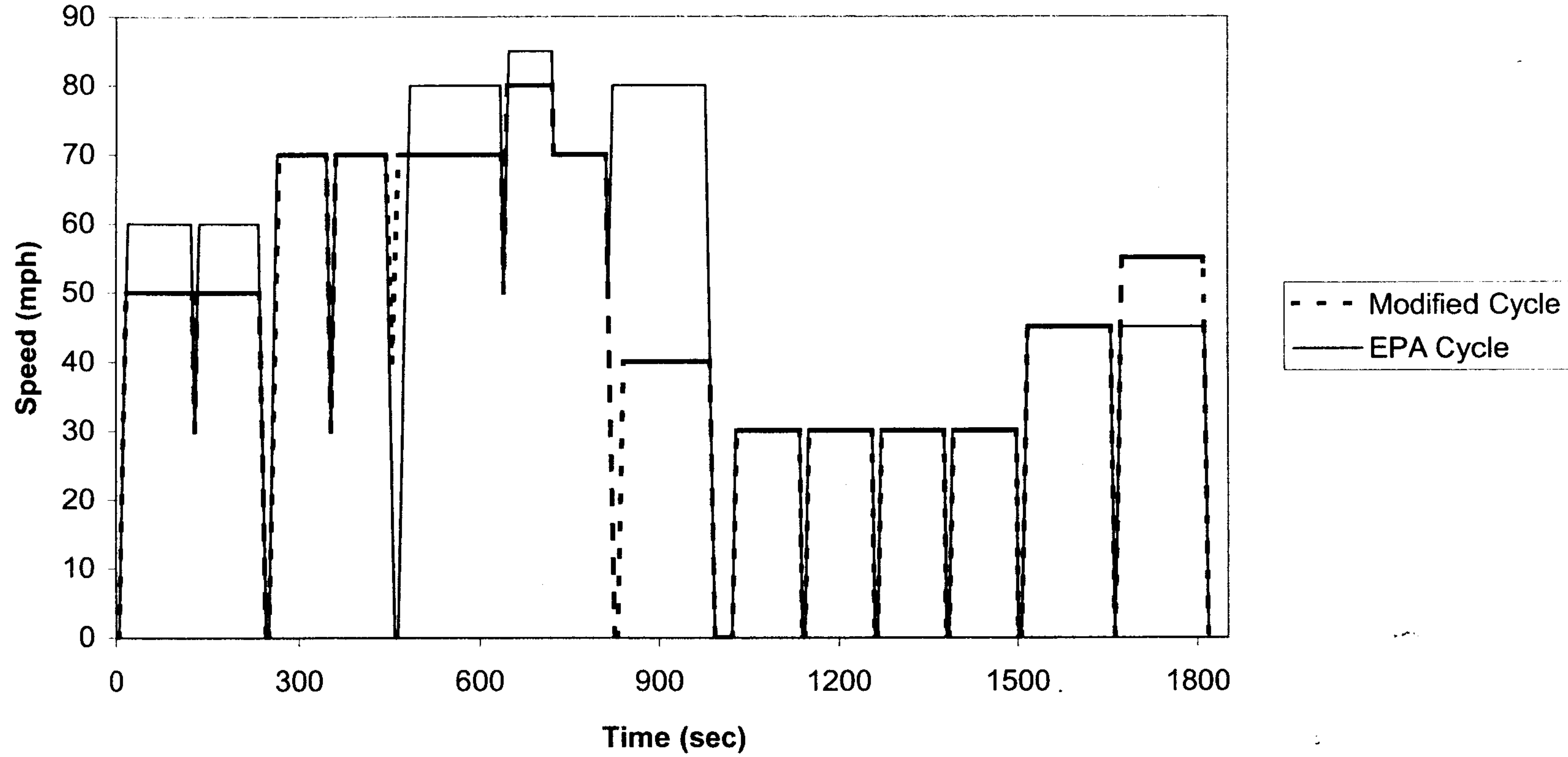
Drive Cycle	% Time above 70 MPH
Unified	2.6%
Weighted EPA Emissions Cycles	4.2%
EPA Aging Cycle	21.6%

- EPA Aging Cycle has sustained WOT (5 mph/sec) accelerations
  - Longest average sustained acceleration over entire accel mode in US06 Cycle is 4.6 mph/sec (546 to 552 seconds on trace)
  - Customer driving surveys[2] show that while high rates of acceleration exist, accelerations above 3 mph/sec compose only about 3% of total driving time
  - Studies used in development of Low-Powered Vehicle Adjustment suggest that duration of WOT accelerations seldom exceed 4 to 5 seconds
- MOD1 Revision
  - Reduces time above 70 MPH to 4.3%
  - Reduces WOT accelerations from six to three, and moves them to accelerations beginning at speeds greater than zero
  - Still may exceed 90th percentile and further refinements may be necessary

[1] Weighted average calculated from FTP, US06 and SC03 as specified for the composite option for emissions - 35:28:37 percent respectively.
[2] From EPA Preliminary Technical Report 420-R-93-007

Prepared: February 19, 2003
Ford Motor Company

MOD1 Whole Vehicle Aging Cycle



Acceleration Rate (mph/sec):

MOD1	4	5	4	5	3	5	4	4	4	4	4	4	4
EPA	4	4	5	5	4	4	4	5	5	5	5	4	4

Reasons to change acceleration rates:

Change accelerations starting at idle from WOT (5 mph/sec) to hard (4 mph/sec) to minimize wheel spin and excess wear

Change accelerations starting at 30 mph and from 50 mph from hard to WOT to preserve element of WOT accelerations

Highest ave acceleration rate over entire acceleration mode within US06 is 4.6 mph/sec from approx 0 to 30 mph at 546 to 552 sec

Prepared: February 18, 2003
Ford Motor Company

Drive Cycle Speed Distributions

	FTP (4 bags)	US06	SC03	REP05	UNIF01	EPA	Weighted	MOD1
Average Spd (mph)	19.5	48.0	21.7	51.5	25.6	51.3	28.3	46.5
St Dev	14.7	24.6	15.3	20.1	22.1	23.2	17.7	20.0
Max	56.7	80.3	54.8	80.3	74.1	85.0	62.6	80.0

	FTP (4 bags)	US06	SC03	REP05	UNIF01	EPA	Weighted	MOD1
Idle	19.2	7.5	18.7	3.3	24.1	4.1	15.7	4.4
0 - 5 mph	5.5	3.7	5.0	1.8	5.1	0.8	4.8	0.9
5 - 10 mph	5.7	2.8	4.7	1.9	3.6	0.9	4.5	1.0
10 - 15 mph	5.5	2.3	5.0	2.1	4.4	0.9	4.5	1.0
15 - 20 mph	10.0	3.0	12.1	2.3	5.9	0.9	8.8	1.1
20 - 25 mph	18.6	3.2	6.7	2.6	6.8	0.9	9.9	1.0
25 - 30 mph	18.5	4.2	10.8	3.7	9.4	24.2	11.6	24.4
30 - 35 mph	5.8	1.7	17.8	3.6	10.1	0.7	9.1	0.8
35 - 40 mph	3.1	3.2	10.9	3.1	7.0	1.0	6.0	9.0
40 - 45 mph	0.6	2.8	2.5	4.0	5.0	16.0	1.9	8.4
45 - 50 mph	2.2	2.7	2.2	1.9	2.0	0.7	2.3	12.0
50 - 55 mph	3.6	6.5	3.5	4.2	2.1	0.8	4.4	8.0
55 - 60 mph	1.7	7.3	0.0	10.6	3.6	11.7	2.7	0.5
60 - 65 mph	0.0	20.5	0.0	32.9	3.3	0.5	5.7	0.4
65 - 70 mph	0.0	13.6	0.0	15.7	5.0	14.5	3.8	22.8
70 - 75 mph	0.0	11.5	0.0	5.2	2.6	0.3	3.2	0.1
75 - 80 mph	0.0	3.3	0.0	1.0	0.0	17.0	0.9	4.2
80 - 85 mph	0.0	0.3	0.0	0.1	0.0	4.1	0.1	0.0

Note: Weighted column represents the weighted average of 35% FTP, 28% US06, and 37% SC03.

VIII - 3

Prepared: February 19, 2003
Ford Motor Company

ATTACHMENT IX

EPA/GM Meeting – March 17, 2003

Comparison of GM and EPA Strawman ADP Processes

GM POWERTRAIN Global Engineering

Topic Outline

- GM's Perspective
- GM Process – A Quick Recap
- Process Severity Comparison
  - » EPA Strawman vs GM Protocol
- The Implications of Arbitrary Severity
- What's Next

GM's Perspective – The Big Picture

- Our Sense of Where this is Headed:
  - » Several Decades of Solid GM Science
    - – Unequalled and Exhaustive Studies of Customer Use
    - – Vehicle Road Schedules at Targeted Severity Level
    - – Catalyst Stress Mechanism & Matched Bench Processes
    - – Statistically Based Process for Development Targeting
    - – These are an Integrated Process to Produce Compliance
  - » May be Replaced with an Arbitrary EPA Guess
    - – With NO Foundation in Customer Usage Data
  - » To Placate Ethyl
    - – Whose Motives aren't Robust Compliance & Air Quality

GM's Perspective – The Big Picture

- We Agree EPA Needs an ADP Process
  - » To Close the Ethyl Litigation
  - » Your Severity Target must be Appropriate
    - – Regulations Require Passing the Standard on Average
      - ➢ Absent a Defect in a Significant Failing Subset
    - – We Think our Process Puts the Fleet Avg. ~60% of Std.
  - » GM Internal, Reality Check & IUVP Data Confirms
    - – GM has Provided EPA with Thousands of In-Use Tests
- EPA ADP Process should NOT:
  - » Be the Arbitrary Severity Standard
  - » Be Required for Certification

GM's Perspective – The Big Picture

- GM's Priorities Going Forward
  - » Work with EPA to Resolve Ethyl Impass
  - » Imperative - No Arbitrary Increase in Severity
  - » Seek Further Improvements to the Cert Process
    - – Cert Durability Testing an <u>Entirely</u> Redundant Activity
    - – No Compliance Value Added by this Exercise
    - – Compliance Statement Appropriate Long-Term Approach

Caveat

- To Meet EPAs Timeline this Test Work:
  - » was Done Fast
  - » was Analyzed Fast
  - » was Summarized Fast
- We Think the Analysis is Accurate
- We will Double Check & Advise of any Issues

GM ADP Process

- Process is Derived from Customer Data
  - » Hundreds of Vehicles with 2 Years of Driving Each
- Vehicle Driven over MPG Road Schedules
  - » North Loop, South Loop, Gravel, Belgian Blocks, Extended Trip, City, High Speed, Ride and Handling, Performance, Straight-away
    - – 2 Ballast conditions
    - – Total Driving Time is 4 Hours per Ballast Condition
  - » Record Catalyst Time in Temperature Bins
  - » Time@Temp Histogram is Analyzed
    - – To Determine "GMAC" Bench Aging Hours
      - Each Sub-Schedule Time@Temp Histogram Weighted at Fraction of Total Miles
      - Histogram Fed into Exponential Equation
  - » Defines Aging Hours on a Particular GMAC Bench Aging Schedule

IX-7

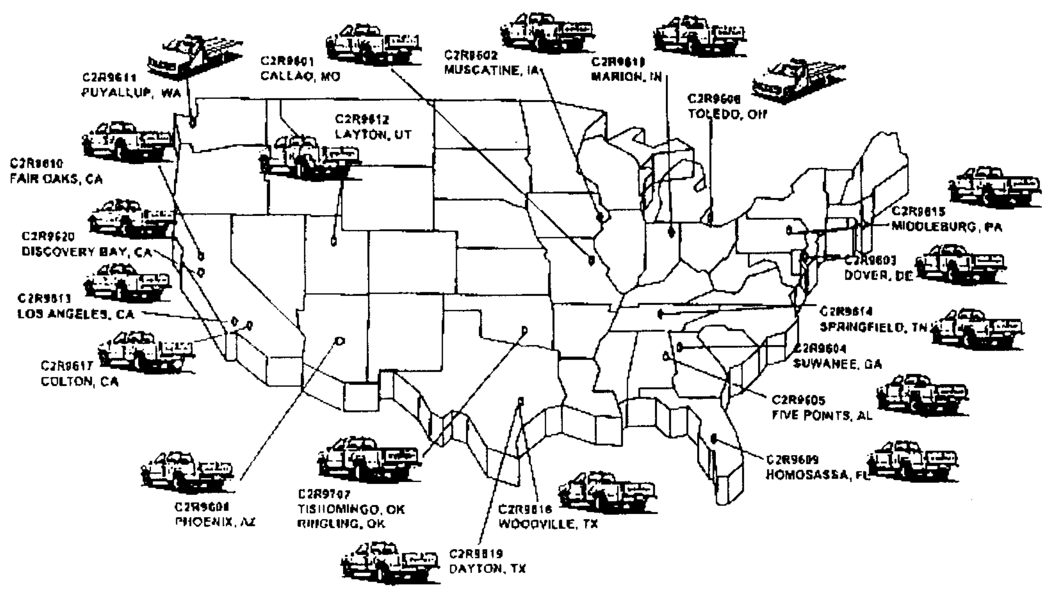
The Critical Input – Customer Usage

10/11/99

1996 C30 7.4L 4L80E Truck
Customer Vehicle Measurement Program

2nd Interim Data Report
Validation/QRD Center

VEHICLE LOCATION MAP



9

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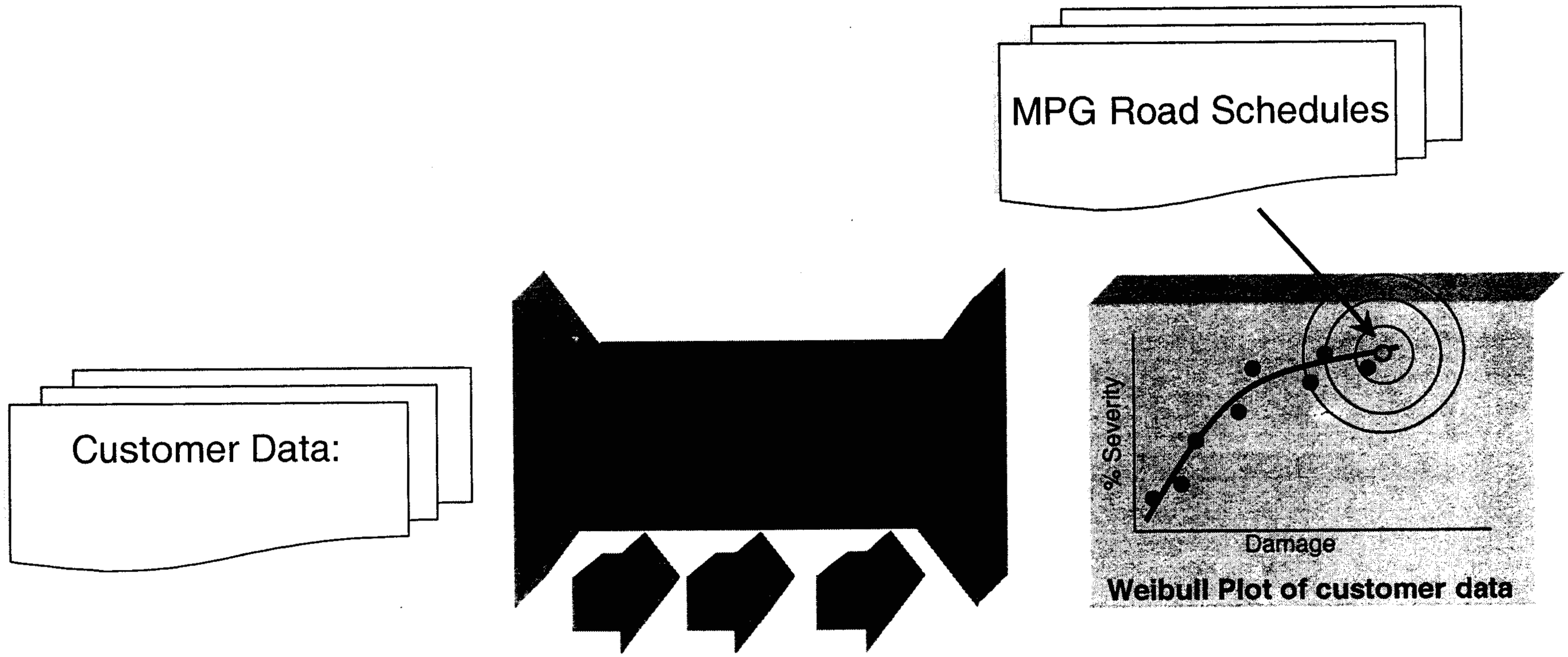
Figure 3

Severity Assessment Process



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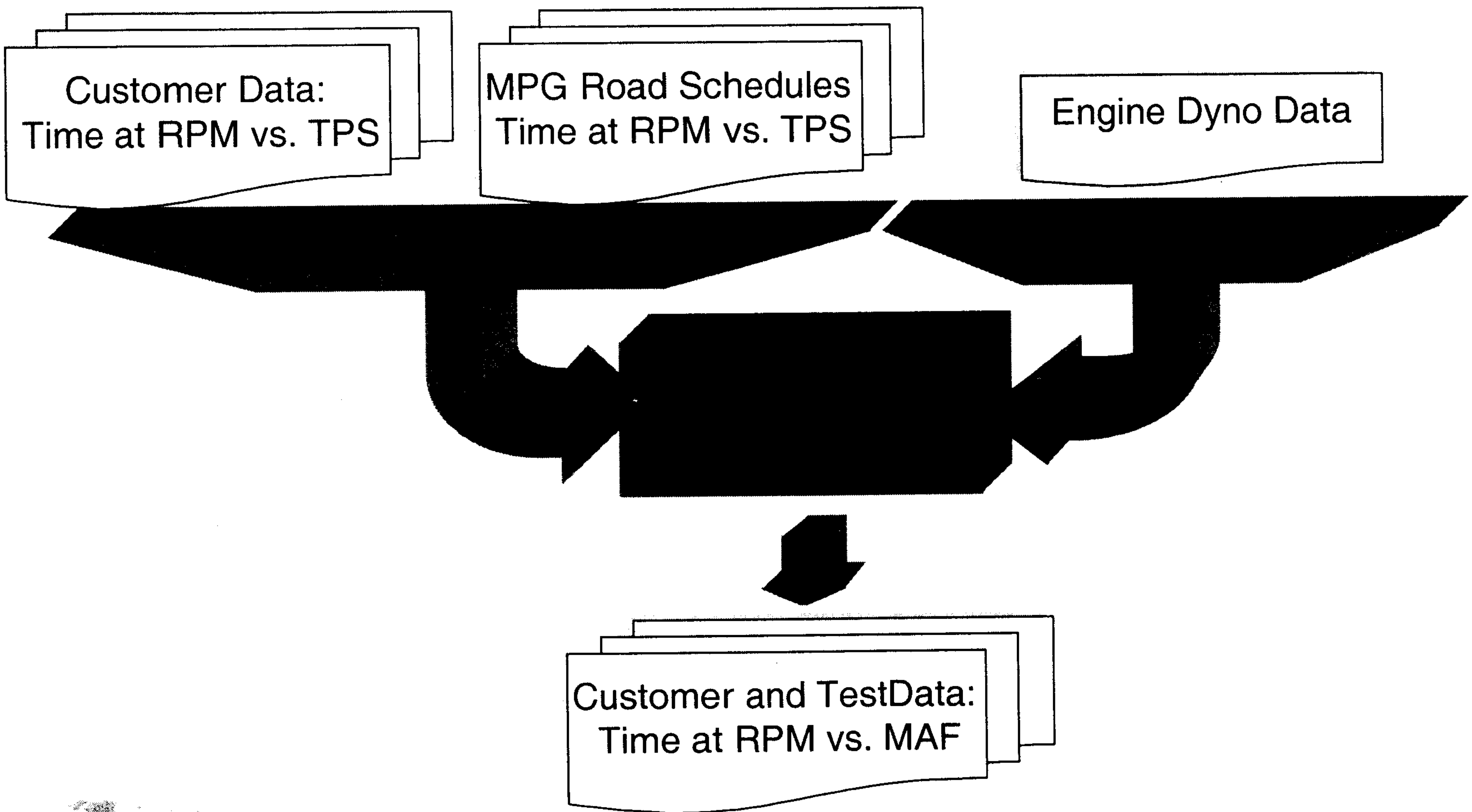
Severity Assessment Process



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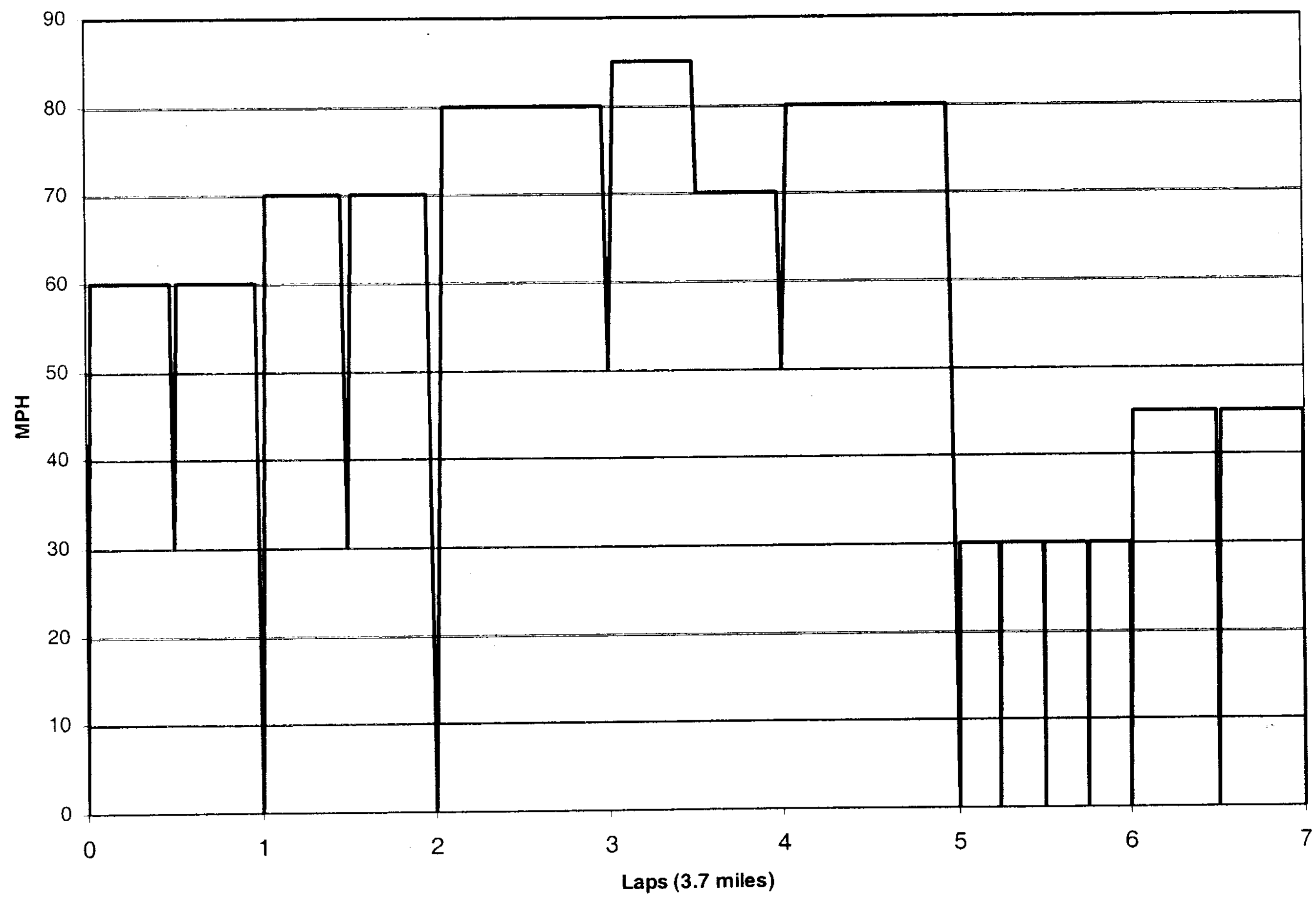
GM Analysis to Evaluate Severity

- Selected Four GM Vehicles
  - » Cross Section of Fleet
    - – Cars & Trucks
    - – Several of the Hottest
    - – 2004-08 Architectures
  - » Collected Histograms over EPA Road Schedule
  - » Calculated Equivalent GMAC "A" Aging Hours
    - – GM Road Histogram with GM Bench Hour Calculator
    - – GM Road Histogram with EPA Bench Hour Calculator
    - – EPA Road Histogram with GM Bench Hour Calculator
    - – EPA Road Histogram with EPA Bench Hour Calculator

EPA's Whole Vehicle Road Aging Cycle



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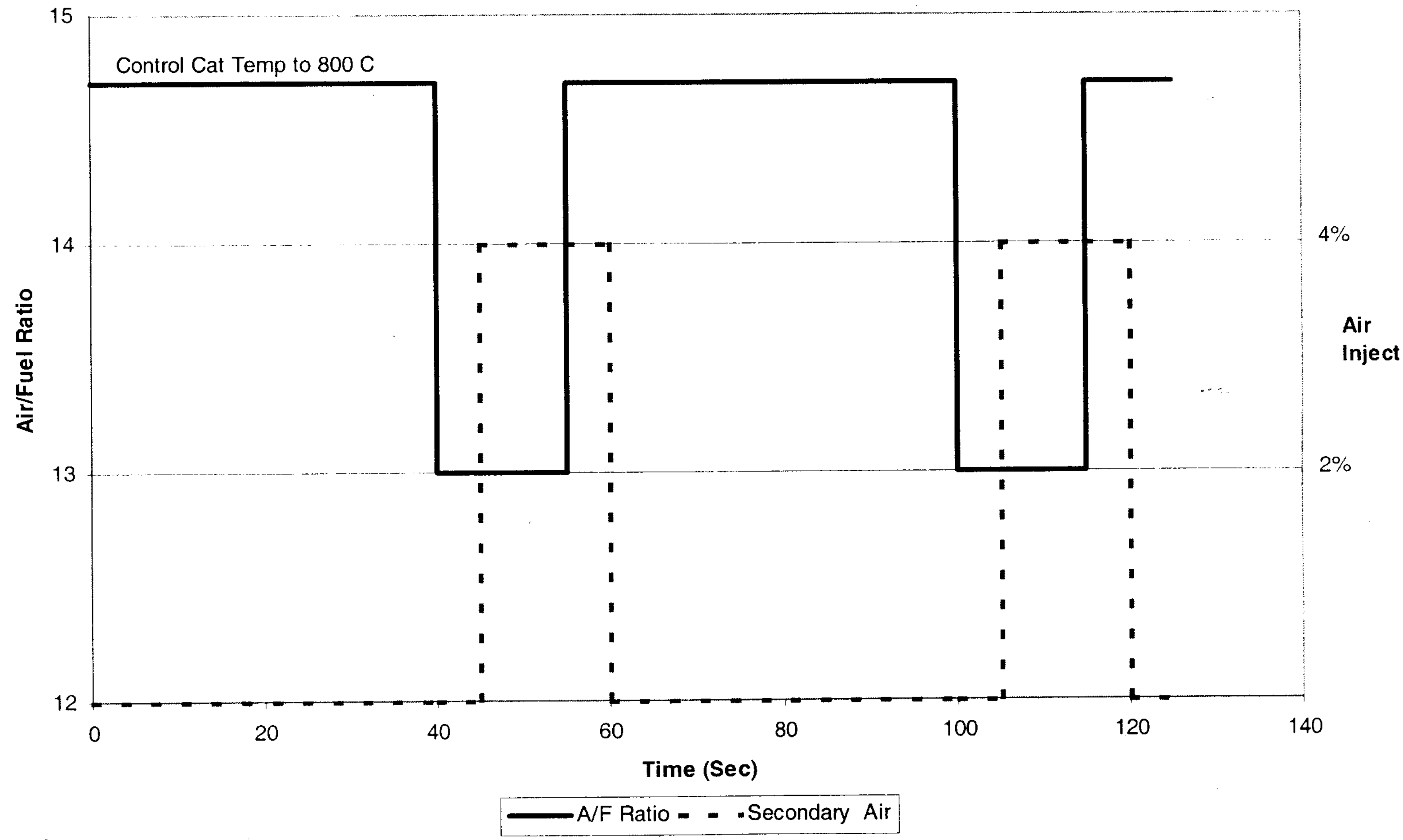
IX · 12

GM Analysis to Evaluate Severity

- Unable to Calculate EPA Bench Hours
  - » EPA Bench Protocol:
    - – Control Stoich Phase to 800°C
    - – Slew A:F to 13:1
    - – Add 4% Air, Hot Lean Temp Excursion Unknown
  - » GM's Bench Protocol Controls to Hot Lean Temp
  - » Our Impression – EPA Protocol could Overtemp
  - » We will need Temp Data from EPA Protocol to Assess Hours

EPA Bench Cycle



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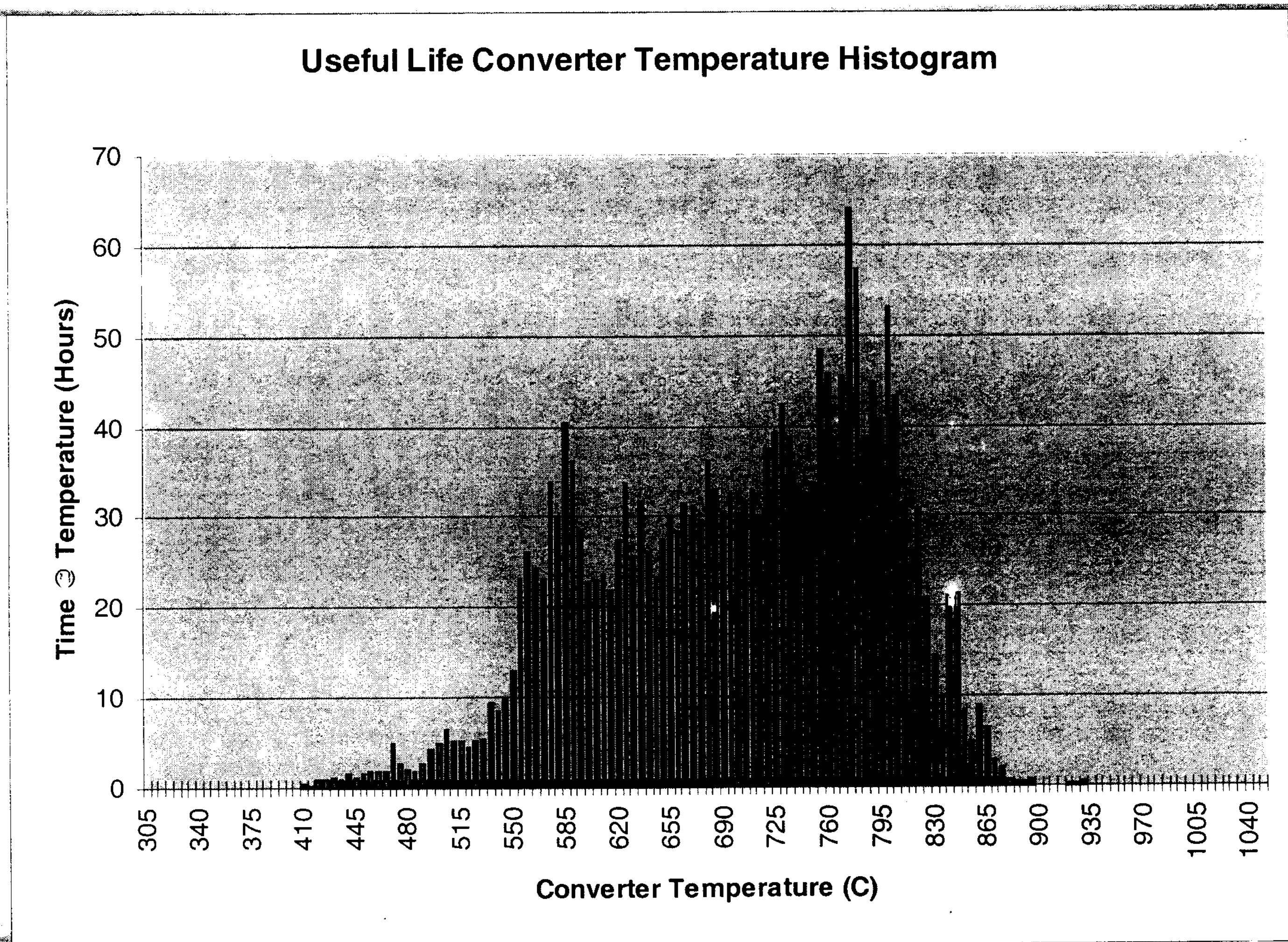
IX-14

Large SUV Histogram: GM Road Cycle



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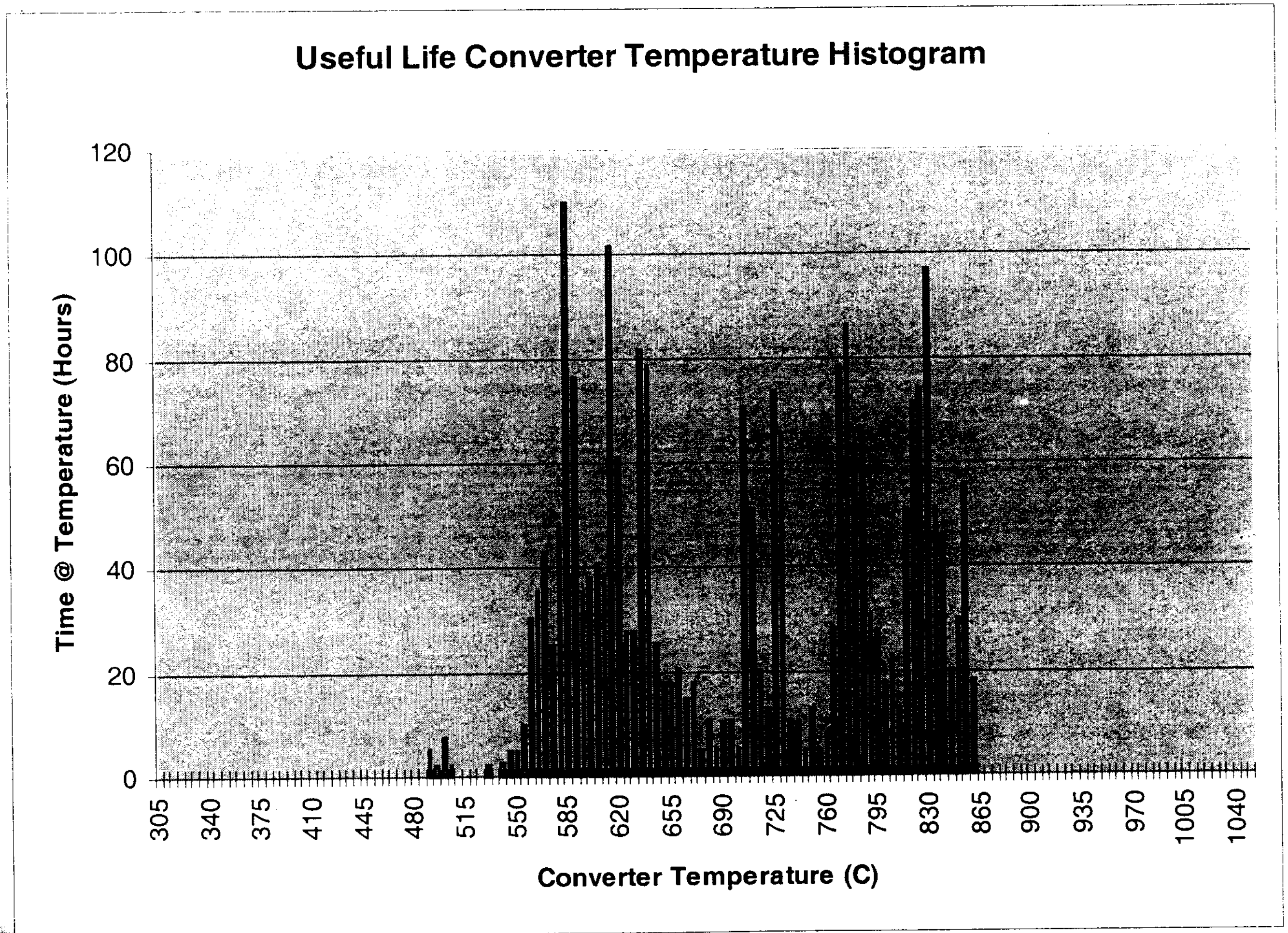
IX - 15

Large SUV Histogram: EPA Road Cycle



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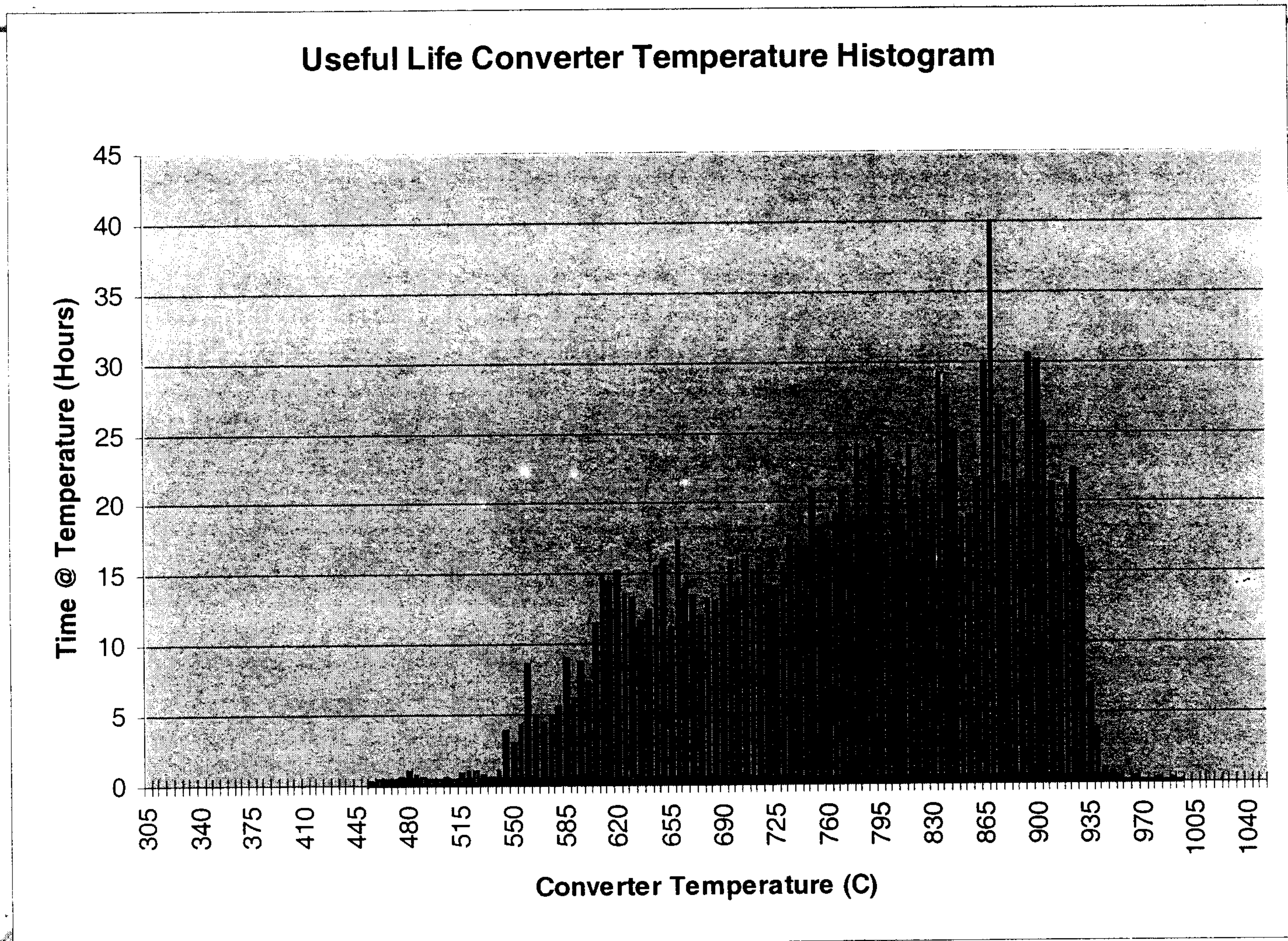
IX - 16

Midsize P/U Histogram: GM Road Cycle



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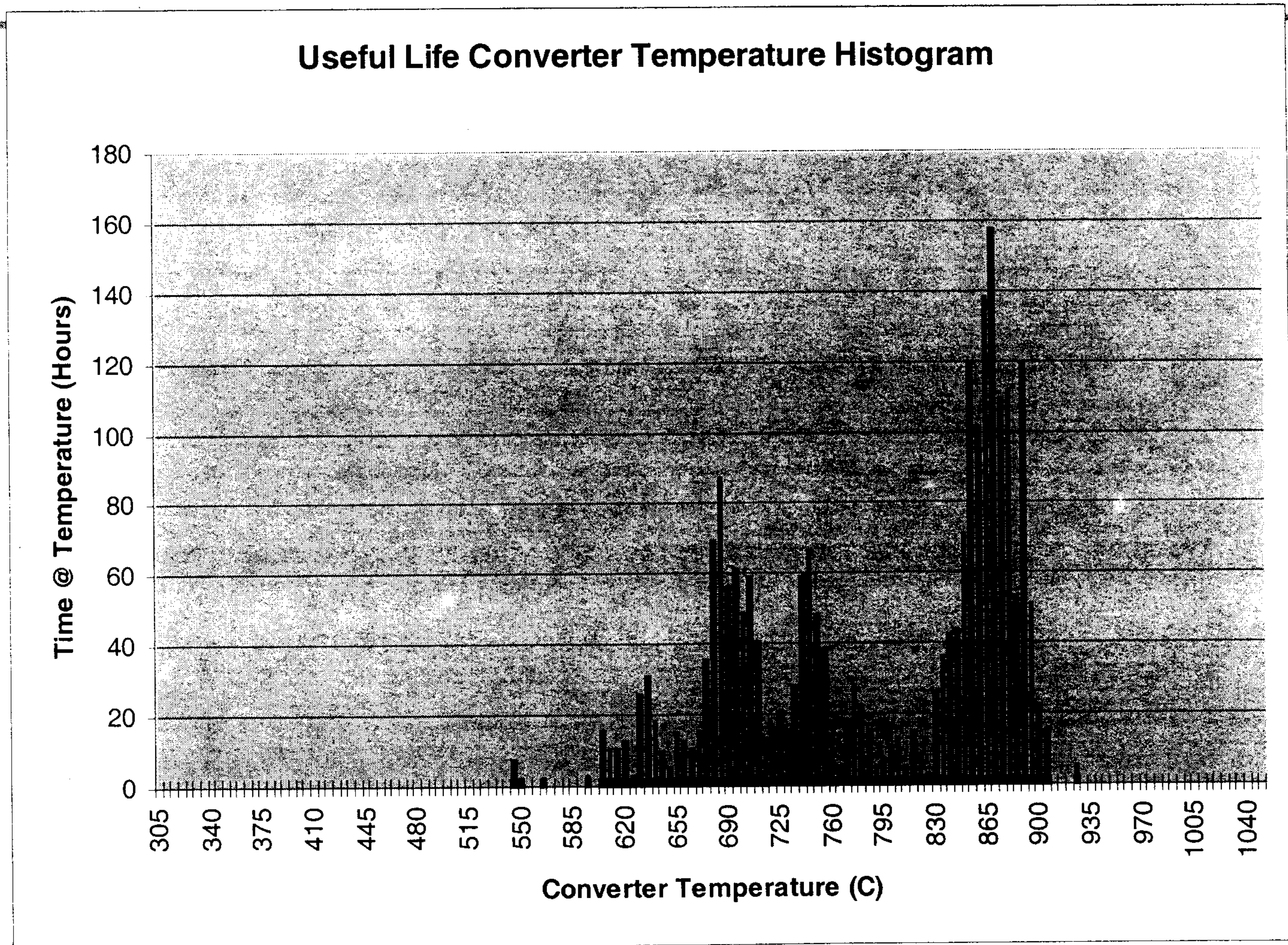
IX-17

Midsize P/U Histogram: EPA Road Cycle



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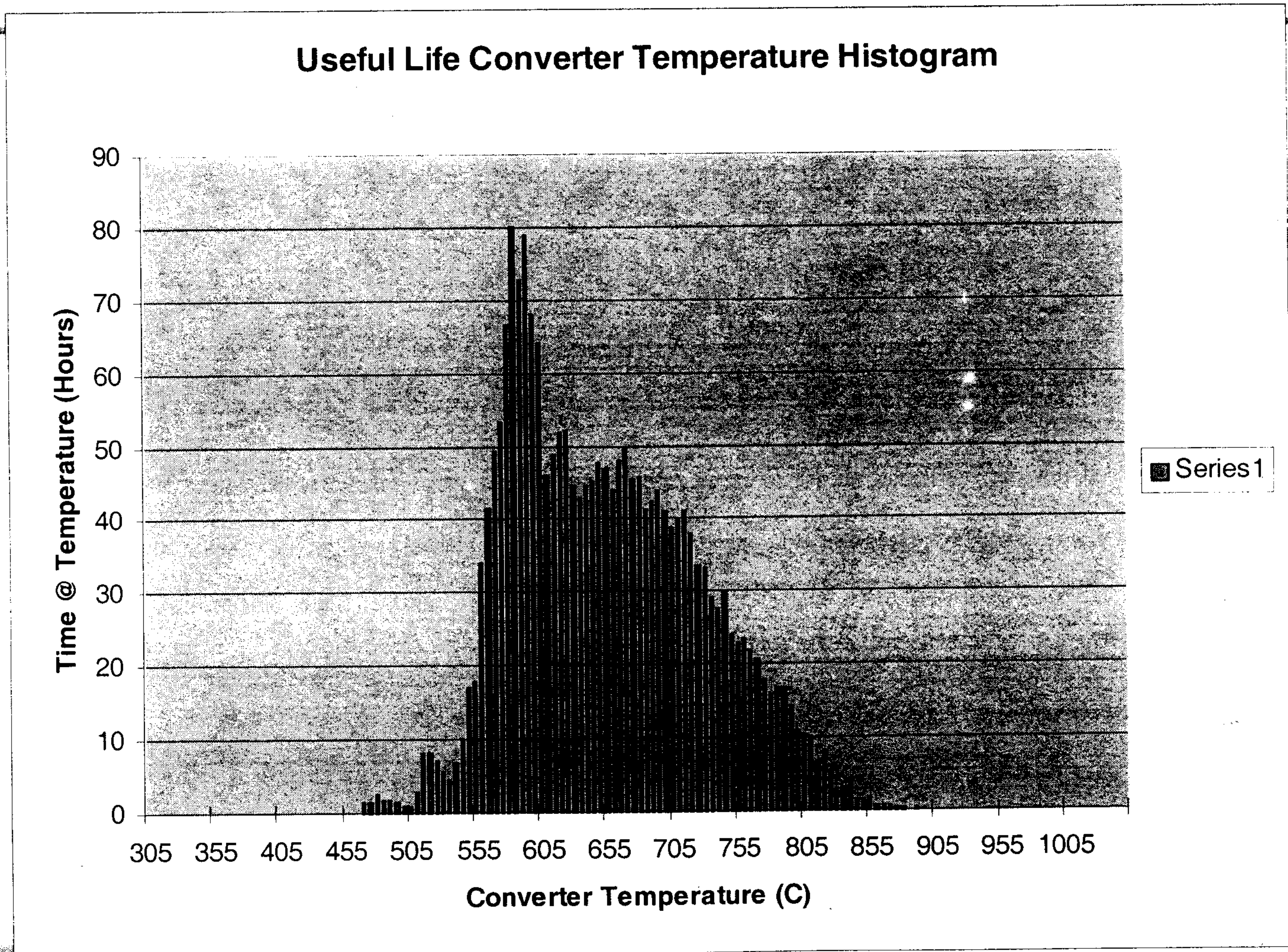
IX - 18

Large PC Histogram: GM Road Cycle



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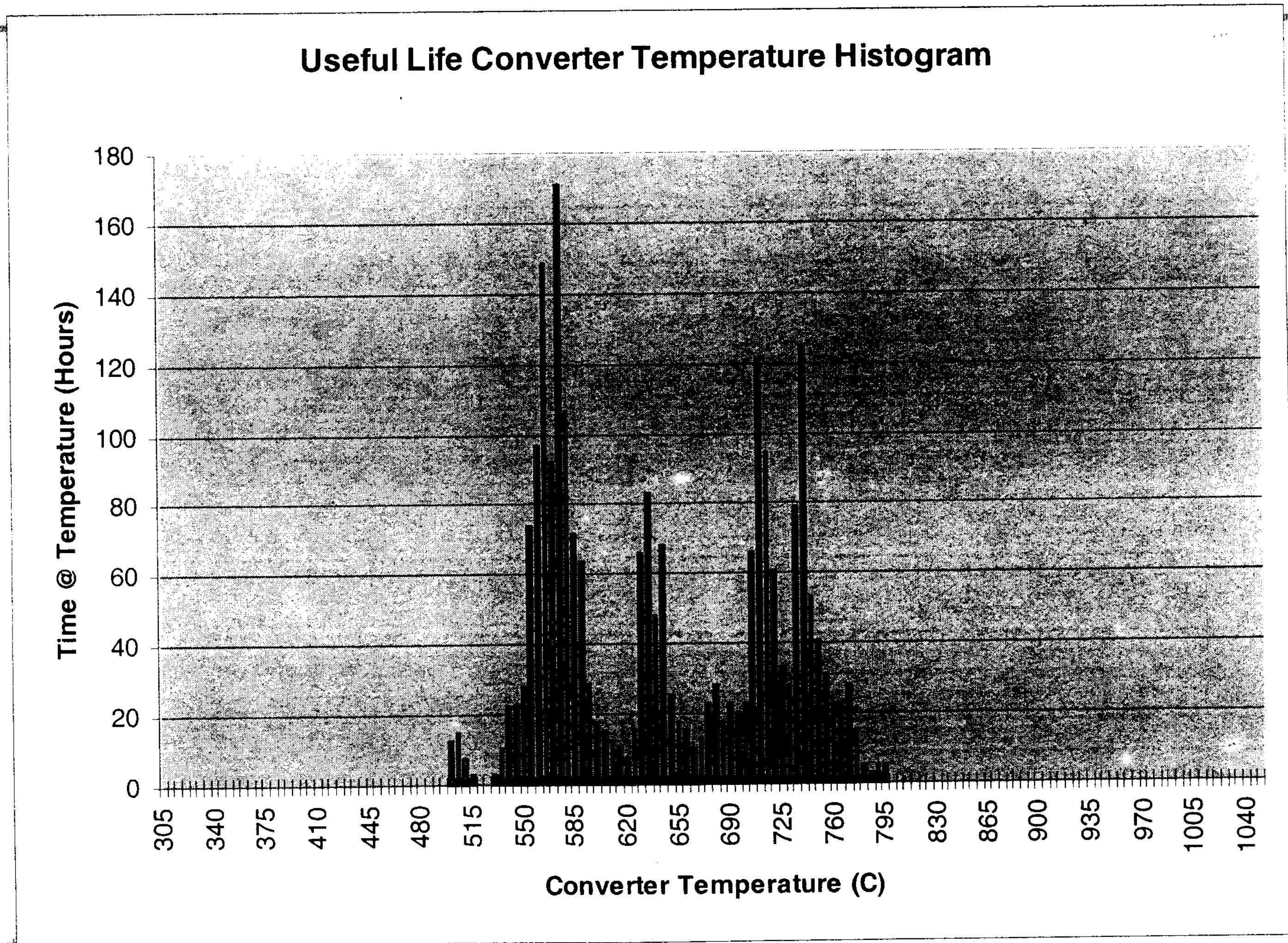
IX-19

Large PC Histogram: EPA Road Cycle



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IX-20

Histogram Observations

- GM's Road Schedules
  - » Produce Smooth Continuous Histograms
    - – Properly Balance the Mix of Severe Operation
    - – The Schedules are not Absolute Speed vs Time
      - ➢ Event Severities are Tuned to Vehicle Characteristics
- EPA Road Schedule
  - » Produce Discontinuous Narrow Band Histograms
    - – Focused on a Few Operating Modes
    - – The Schedule is Absolute Speed vs Time
      - ➢ Severity Level Increases on Lower Powered Vehicles
      - ➢ Many Acceleration Events are Unachievable

Road x Bench Cycle Severity

Vehicle	GMAC A 120K Bench Hours			EPA 120K Bench Hours	
	GM Road Histogram	EPA Road Histogram		EPA Road Histogram	
	GM Calc	GM Calc	EPA Calc	GM Calc	EPA Calc
Full Size SUV: V8 LDT4 Bin 5 Architecture	238	531	528	-	1414*
Mid-Size PU: L4 LDT2 Bin 9 Architecture	950*	1620	1485	-	3975*
Small Car: L4 PC Bin 5 Architecture	266	439	438	-	1173*
Large Car: V6 PC SULEV Architecture	112	119	126	-	338*

*** Data from Earlier Development to be Verified - Expect Actual Hours to be Somewhat Lower**

*** Note - EPA Calculated Hours Suspect - Do not Comprehend Likely Temps on EPA Bench Cycle**

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3/17/03

TX-22

Severity Observations

- EPA's Road Schedule Severity
  - » Varies based on Vehicle Characteristics
  - » Roughly 1.5 to 2X Severity of GM Road Schedule
    - – For Close-Coupled and/or Lower Powered Vehicles
  - » Comparable Severity
    - – For Medium Coupled Adequately Powered Vehicles
- EPA's Bench Aging Cycle
  - » Calculated Hours Likely Erroneous
    - – Lean-Hot Temperature Unknown
    - – EPA Calculator Assumes Wrong Temperature

Impact of EPA ADP Protocol

- If GM used EPA Road Schedule for Cert
  - » Significant Additional Content would be Required
  - » Cost would Increase
  - » Some Close-Coupled Applications Might not Work
- None of these Changes needed to Comply
  - » Our Process produces Robust Compliance Now
- This is the Consequence of:
  - » Arbitrary Level of Severity in Road Schedule
  - » Unconnected to Overall Development Process

GM's Bottom Line

- GM's the Most Evolved Compliance Process
  - » More Customer Usage Data
  - » More In-Use Emissions Data
  - » Evolved and Refined over 20 Years
- It would be Wholly Inappropriate to:
  - » Add Costs to Our Vehicles Arbitrarily
  - » Certify with a Less Well Developed Protocol
- EPA Must:
  - » Properly Tune Severity of their Process
  - » Allow Manufacturer's Proven Processes to Stand
- EPA should Retain Compliance Statement Option

ATTACHMENT X

X-1

March 31, 2003

John German
American Honda Motor Co.
3947 Research Park Drive
Ann Arbor, MI 48108

Eldert Bontekoe
U.S. Environmental Protection Agency
2000 Traverwood
Ann Arbor, MI 48105

Eldert,

As you requested, attached is Honda's catalyst temperature data.

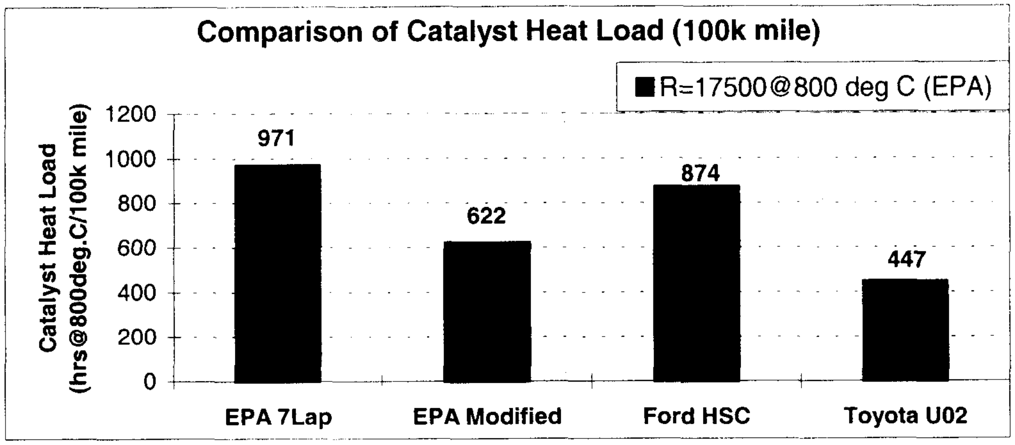
Attachment 1 contains the overall heat load for four different cycles on our Accord 4-cylinder. The four cycles are the original EPA proposed 7-lap cycle, the EPA cycle with suggested modifications from Ford (MOD1), the Ford HSC, and the Toyota U02 cycle. This chart is non-confidential and you may use it as you see fit.

John German

X-2

Attachment 1

2004MY Honda Accord 2.4L - Bin5



ATTACHMENT XI

→ Linda Hormes

XI - 1

TOYOTA

TOYOTA TECHNICAL CENTER, USA, INC.

RECEIVED
FEB 21 2003
VPCD

February 21, 2003

Mr. Greg Green, Director
Certification and Compliance Division
Office of Transportation and Air Quality
United States Environmental Protection Agency
National Vehicle and Fuel Emissions Laboratory
2000 Traverwood
Ann Arbor, MI 48105

Re: Draft Strawman Durability Proposal

Dear Mr. Green,

Toyota has reviewed EPA's "Draft Strawman Durability Proposal." Toyota would like to avoid running two kinds of durability cycles, one being Toyota's for development and the other being the EPA required or partially modified procedure for certification. Therefore:

1. Toyota strongly desires manufacturers to be allowed to have their own durability cycle and bench aging methods.
2. Toyota believes the new durability cycle, the U02 cycle, is representative of actual deterioration. This new cycle is described below. If only one cycle is allowed, the U02 should be the cycle selected.

Toyota believes that we will be injured, or harmed if we are not allowed to use the durability cycle Toyota has developed since this would result in requiring significant emission control system change in order to meet the applicable standards with the unrepresentative durability cycle.

Whole vehicle durability:

Toyota believes that the whole vehicle cycle should be representative of in-use. EPA proposed 7-Lap cycle, however, seems to be not representative of in-use from the aspects of the maximum vehicle speed, acceleration and deceleration rate.

1588 Woodridge, RR #7, Ann Arbor, Michigan 48105 Telephone: (734) 995-2600

Toyota has been using the 9-Lap cycle since 1983 in development. Then Toyota adopted the 9-Lap cycle for certification, with EPA, approval in April 1994. Toyota has made the 9-Lap durability cycle publicly available in 1992 with our comments to EPA regarding MMT. Toyota believed this cycle was representative of in-use deterioration based on in-use data, including reality check results. Now, Toyota has developed a new durability cycle, the U02 cycle, to be similar to the 9-Lap cycle, attachment 1. We were planning to adopt the U02 cycle for the 2005MY.

The U02 cycle was designed to consider the impact of lean A/F conditions (i.e. fuel cut) on catalyst deterioration. The U02 cycle is considered to represent in-use since it simulates the in-use frequency of fuel cut and retains the thermal and fuel cut stress equal to 9-Lap.

Attachment 2 shows our road temperature data on two Toyota models, comparing EPA 7-Lap and Toyota's U02 cycle. These graphs show that EPA cycle has higher temperature profile than U02 and has less fuel cut conditions than U02. Toyota found customers more often experience acceleration-off in the actual market as fuel cut activates. Then Toyota updated the heat stress balance between feedback and fuel cut. This means that some engines may have severe deterioration with U02 and some may not. It depends on the fuel cut frequency.

Depending on the vehicle calibration, and how much a vehicle is facing fuel cut, there will be some models which the EPA cycle will be more severe, and some models that the Toyota cycle will be more severe. But it does not matter which is more severe. Toyota believes the U02 cycle is more representative to actual market conditions, especially in the viewpoint of the balance of heat stress conditions.

Bench Aging

The Bench aging cycle should be flexible to allow the manufacturer's own bench cycle rather than the EPA's Rapid Aging Test. As the proposal was made, EPA will permit some customization of EPA standard cycle within certain bounds. This is limited to the change of catalyst sensitivity factor, the in-use adjustment factor, etc.

Toyota wants to ensure the EPA does not intend to require uniform bench aging cycle as well as whole vehicle durability cycle. We believe it is possible for manufactures to have their own bench aging cycle because the whole vehicle durability cycle will be established and the thermal stress during the whole vehicle cycle is simulated equally on the bench cycle. This does not conflict with the Clean Air Act.

Toyota is concerned about having a uniform bench aging cycle for all engines. Toyota believes that catalyst deterioration is accelerated under the lean A/F condition. However, the EPA cycle adds secondary air with constant time for all engines, ignoring the actual vehicle's fuel cut frequency. Some engines would experience severe durability conditions while some would be advantaged.

Toyota believes our bench aging cycle is the most suitable procedure for individual models because it accurately simulates fuel cut conditions experienced during the whole vehicle cycle.

Offering Options:
Toyota believes the EPA should offer different durability options to manufacturers. This may mean that each manufacturer has their own whole vehicle procedure published as a regulation. The Clean Air Act section 206 directs, "establish methods and procedures for making tests." This clearly has the meaning of allowing more than one test.

The US District Court of Appeals in their October 22, 2002 opinion states:

> Nothing in our opinion requires that EPA use only a "one-size-fits-all" test method. All that is required is that it establish its procedures, no matter how variegated, "by regulation."

Therefore, manufacturer specific options are legal.

Conclusion:
1. Toyota strongly desires manufacturers to be allowed to have their own durability cycle. It is legal to allow many procedures as options.
2. Toyota believes the U02 cycle is representative of actual deterioration. It represents actual market conditions. If only one cycle is allowed, the U02 should be the cycle selected.

Sincerely,

Matt Kevnick
General Manager, Environmental Engineering Dept. - AA

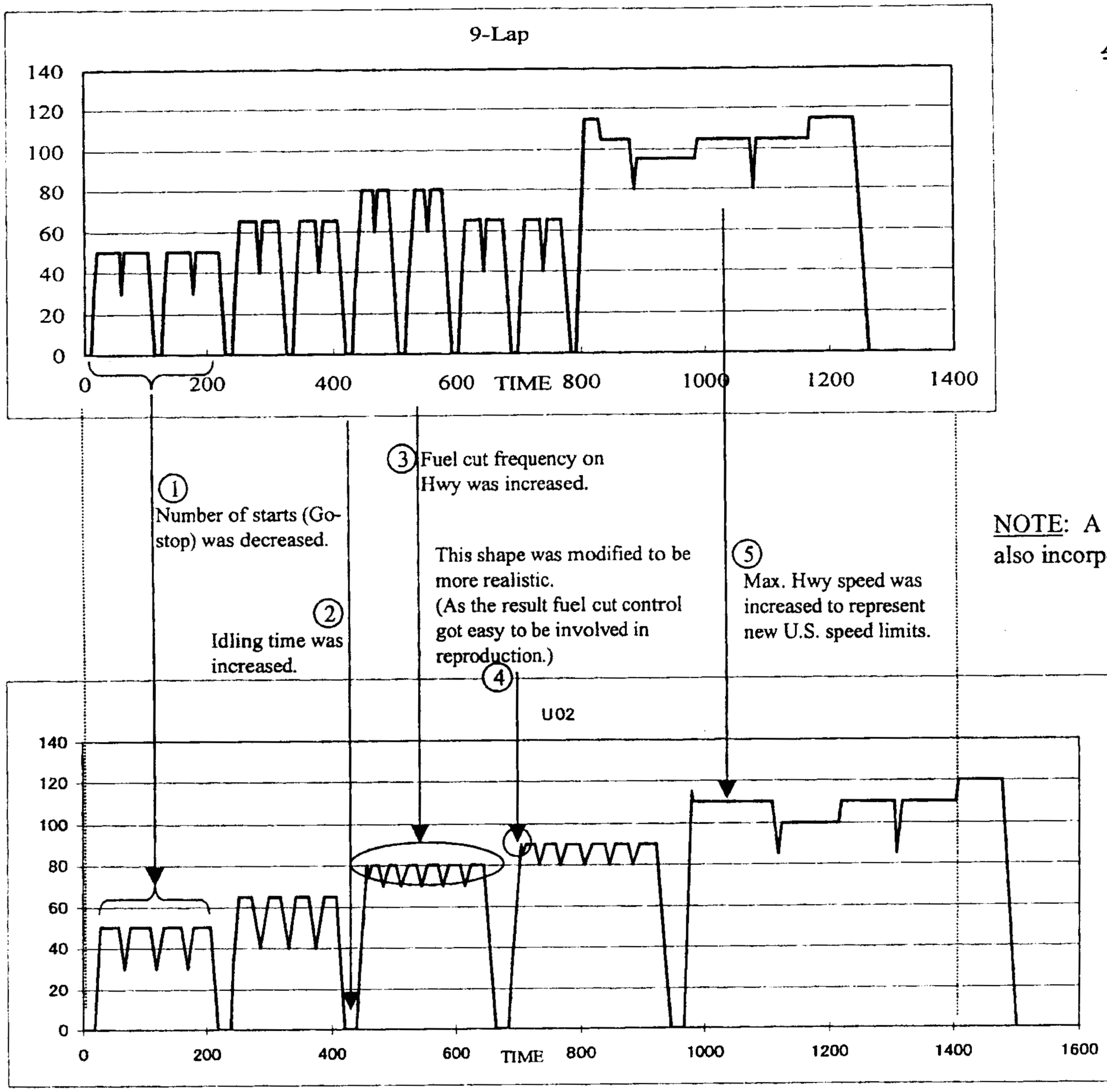
Cc: Eldert Bontekoe
Dan Harrison
Linda Hormes
Lori Stewart
John Hannon

Differences Between Toyota's Previous (9-Lap) and New (U02) Cycles

Attachment 1

Toyota 9-LAP

Toyota U02

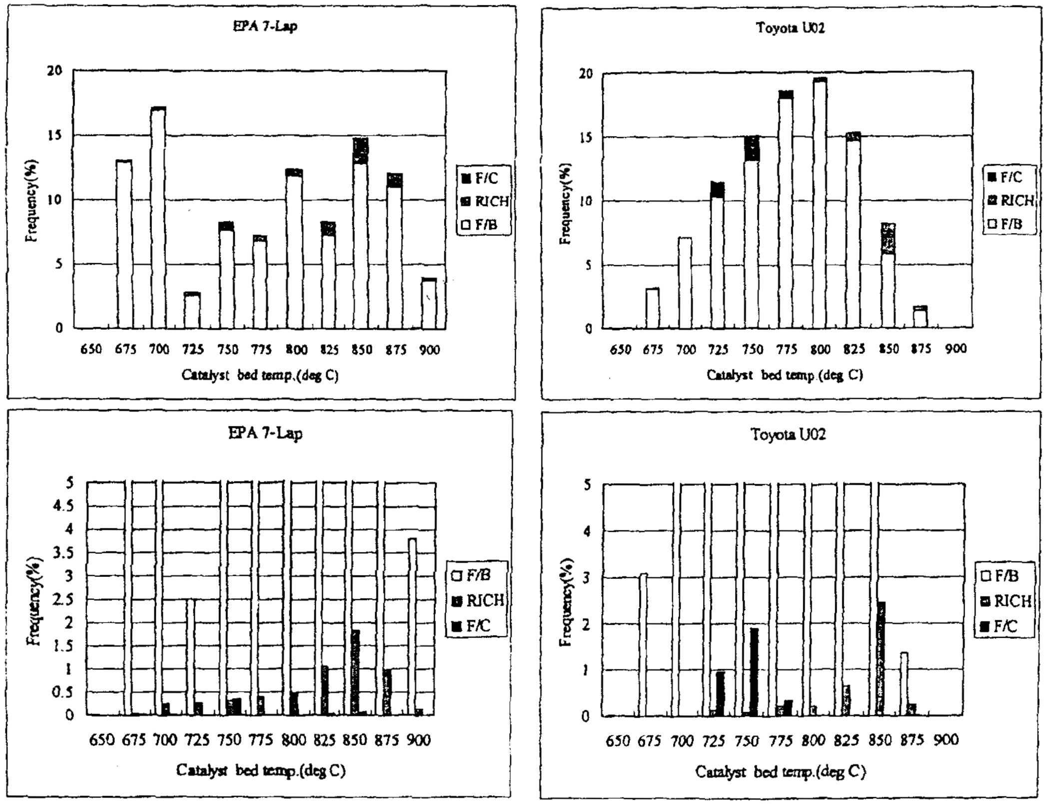


NOTE: A 4% hill/slope condition was also incorporated into this cycle.

Attachment 2

The total heat stress of the EPA proposed cycle is generally similar to Toyota's U02 cycle. However, a majority of heat stress in the EPA cycle occurs under the feedback condition as shown below.
In the actual market, Toyota found customers more often experience acceleration-off as fuel cut activates and modified the heat stress balance between the feedback condition and fuel cut condition accordingly.

Depending on the vehicle's fuel cut calibration, EPA's cycle will be more severe on some models than Toyota's U02 cycle and less severe on other models. Therefore, we do not feel this is simply a matter of which cycle is more severe.
Toyota believes the U02 cycle is more representative to actual U.S. market conditions, especially from the viewpoint of the balance of total heat stress on the catalyst.

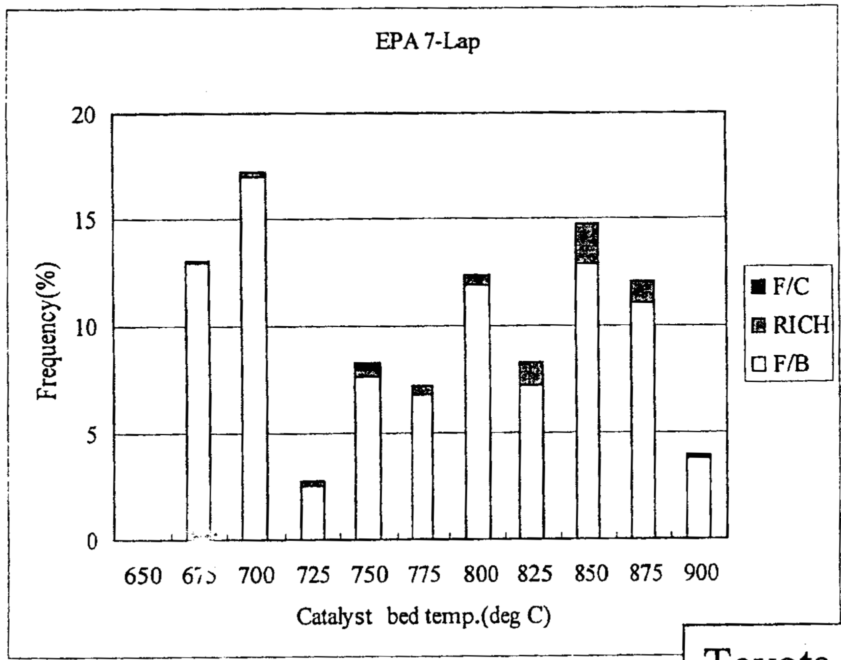


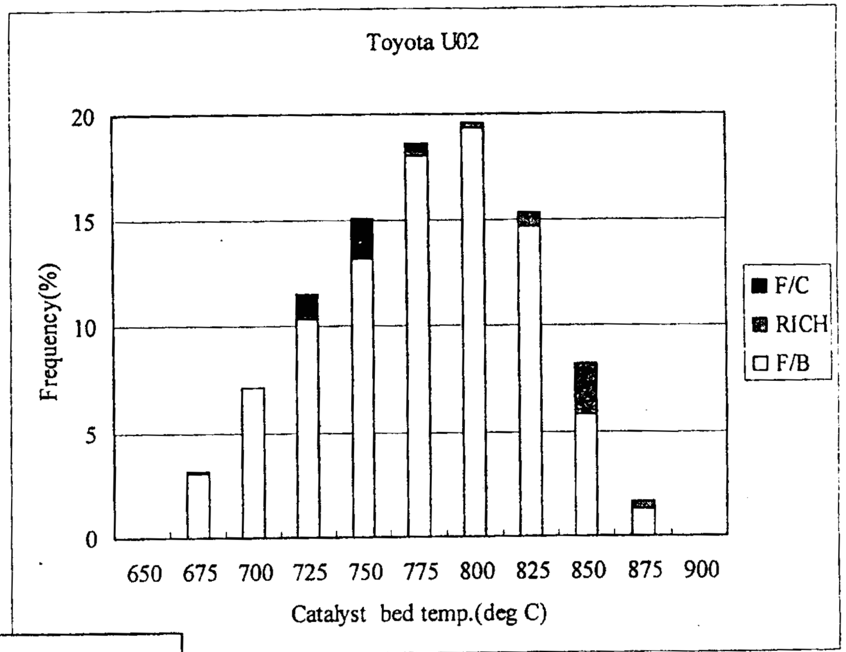
Total heat stress = FB + Rich + FC

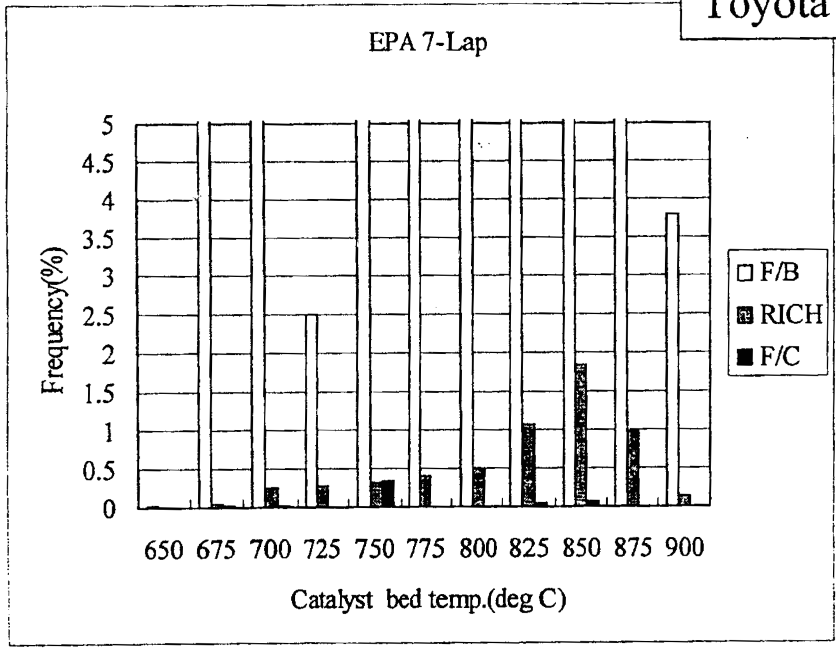
FB: Heat stress under the feedback condition
Rich: Heat stress under the rich condition
FC: Heat stress under the fuel cut condition

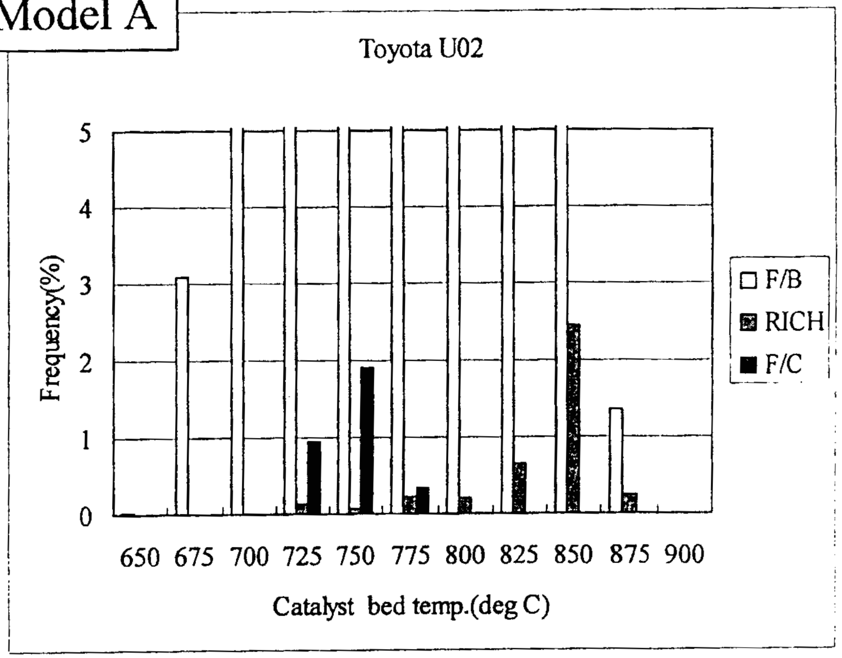
Fuel cut and Rich condition frequency are scaled up.

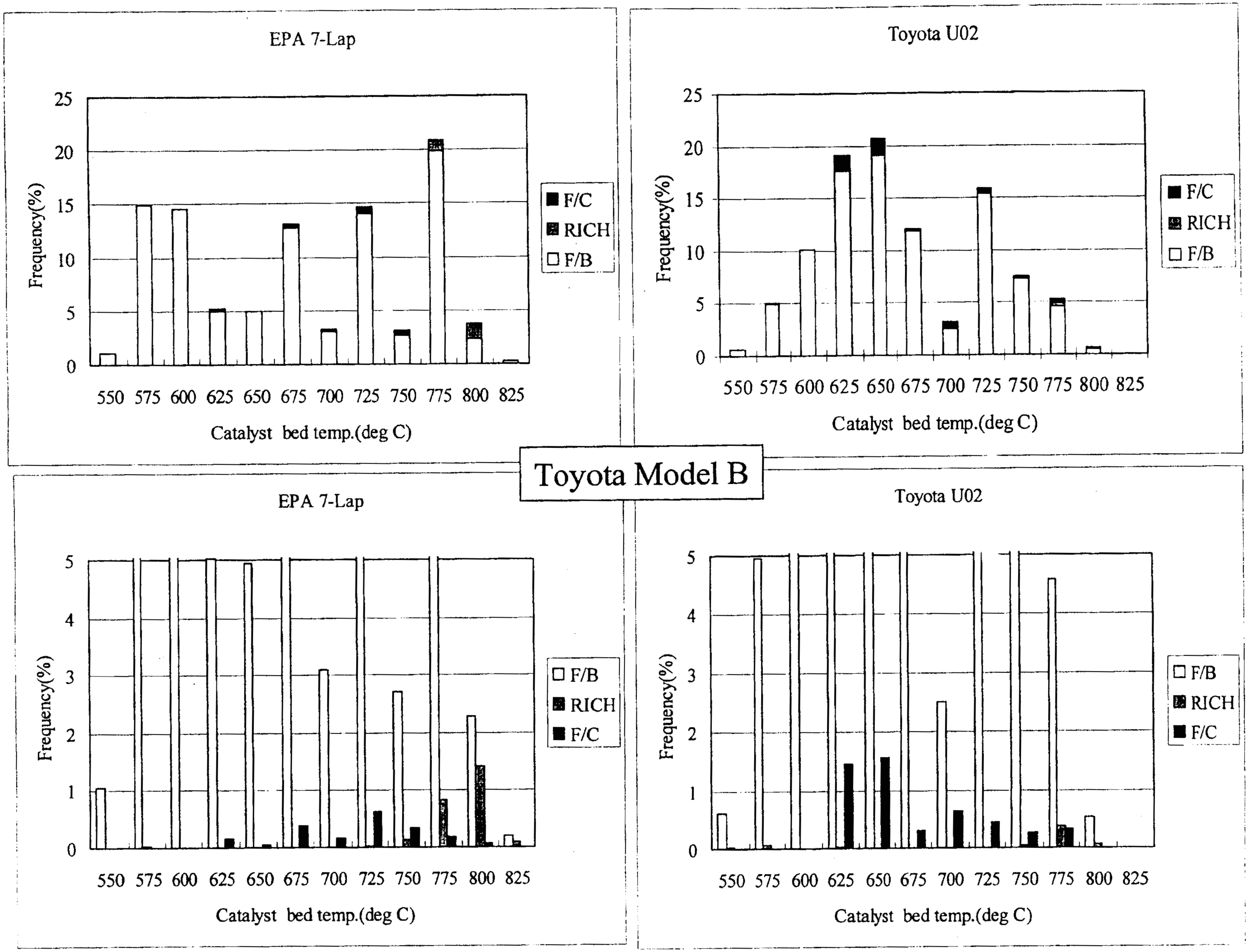
Toyota Model A










Toyota Model B
EPA 7-Lap
Toyota U02
Frequency(%)
Catalyst bed temp.(deg C)
550 575 600 625 650 675 700 725 750 775 800 825
0 5 10 15 20 25
0 1 2 3 4 5
F/C
RICH
F/B

ATTACHMENT XII

XII - 1

New Durability Procedures

March 14, 2003

XII-2

Summary

- Durability Procedures should be established from the feedback of in -use driving conditions and emission performance.
- The durability procedures currently used by manufacturers have been developed for a long time with investing significant manpower and resources.
- EPA standardized cycle imposes new burden on manufacturers in aspects of both the verification of cycle's appropriateness and the evaluation of compliance of the emission control system.
- We will explain our comments on EPA's strawman durability proposal and the appropriateness of our whole vehicle durability cycle and bench aging procedure.

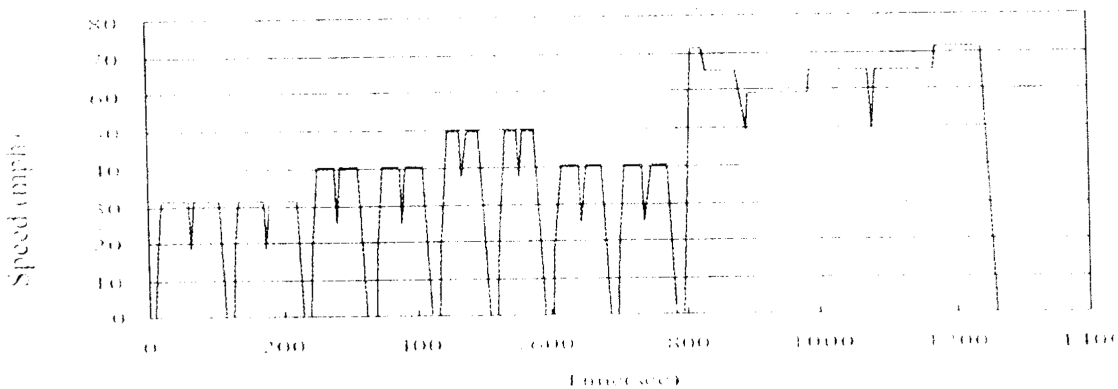
XII-3

Toyota's Comments on EPA Strawman Durability Proposal

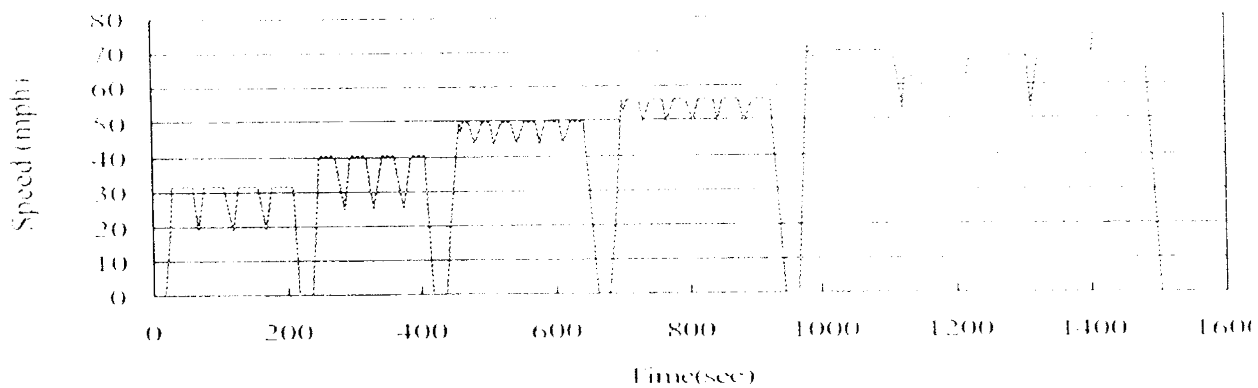
1. EPA proposed whole durability cycle is not representative of in-use from the aspects of the maximum vehicle speed, acceleration and deceleration rate.
2. Toyota strongly desires manufacturers to be allowed to have their own durability cycle and bench aging methods. Especially, it is important for bench aging method to simulate whole vehicle cycle accurately. Promulgating the procedure negates manufacturer's efforts.
3. If only one cycle is allowed, the U02 should be the cycle selected.
4. Toyota opposes the adjustment of the durability procedures for the IUVP data.

Toyota's New Whole Vehicle Durability Cycle "U02"

Toyota 9Lap



Toyota U02



XII-3

Background of New Durability Cycle "U02"

1. Toyota has been using the 9-Lap cycle since 1983 in development and since 1994 for certification with agencies approval.
2. The representative of 9-Lap has been proved from in-use data including reality check results.
3. We have evaluated if 9-Lap is still valid for the recent emission control system complying the stringent emission standards.
4. The point of the evaluation was to determine if the 9-Lap still represented in-use driving.
5. We have changed part of 9-Lap to make the U02 cycle to improve it, making it more representative of in-use driving.
6. In this improvement Toyota judged that the total durability stress itself does not need to be changed based on the in-use emission performance.

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XII-10

Investigation of driving condition of the U.S.market (5)

Summary of in-use driving investigation results

Comparing with in-use driving, the condition of 9-Lap is :

1. less vehicle speed frequency around 55 and 65 MPH (see ④ and ⑤ next page).
2. less frequency for low acceleration and low deceleration. Especially, low deceleration that is high frequency in-use generates fuel cut (④ and ⑤).
3. larger number of acceleration from start, and less frequent and shorter trip (①).
4. shorter idling time (②).
5. less margin for maximum vehicle speed in freeway driving (⑤).
6. less fuel cut frequency and hence less fuel cut stress in the catalyst total durability stress, to the contrary, more severe thermal stress (① - ⑤).

⇩

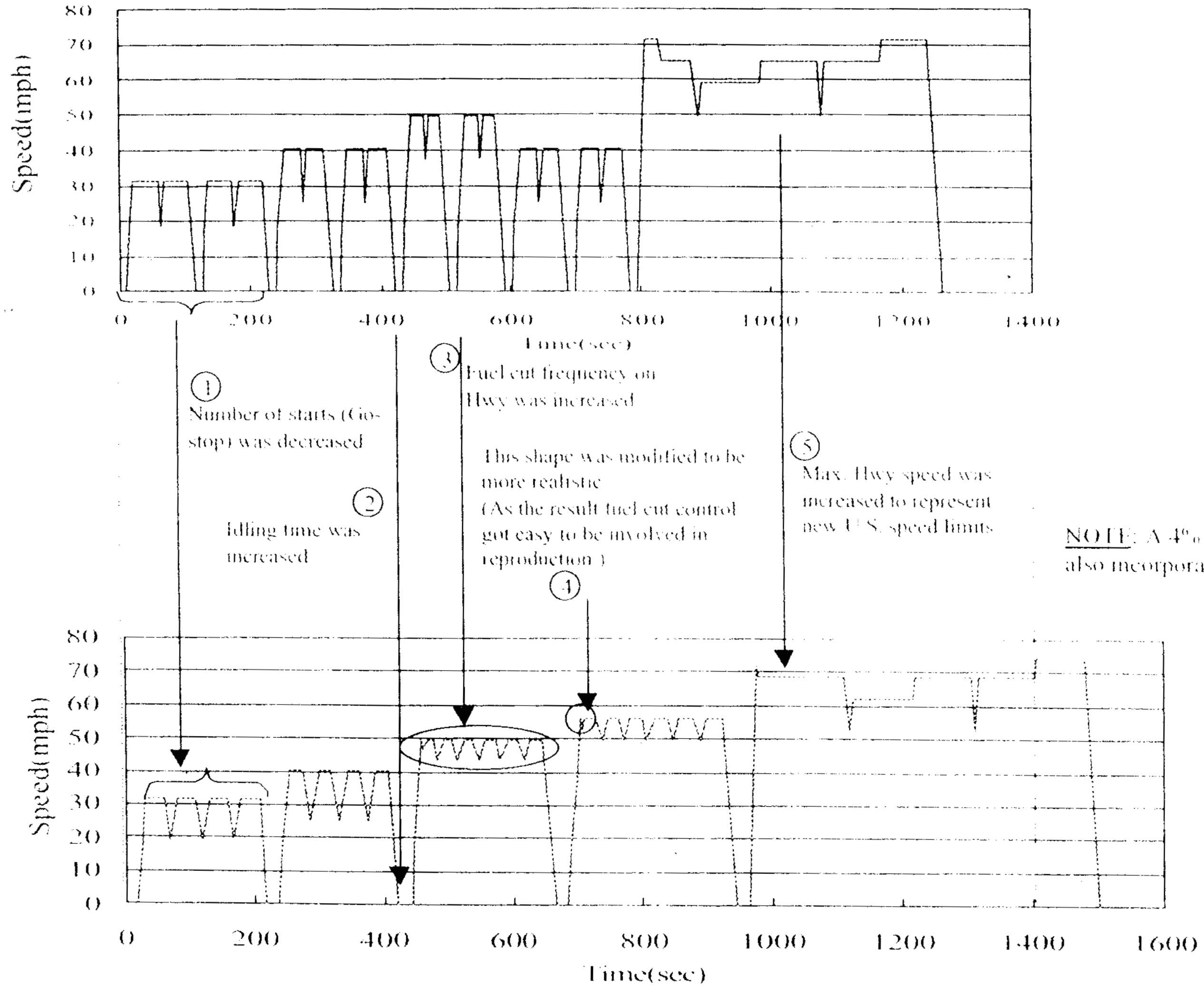
Toyota has modified 9-Lap cycle as "U02" cycle considering these points.

XII - 11

Modifications from 9-Lap to U02 cycle

Toyota 9-LAP

Toyota U02



NOTE: A 4% hill/slope condition was also incorporated into this cycle.

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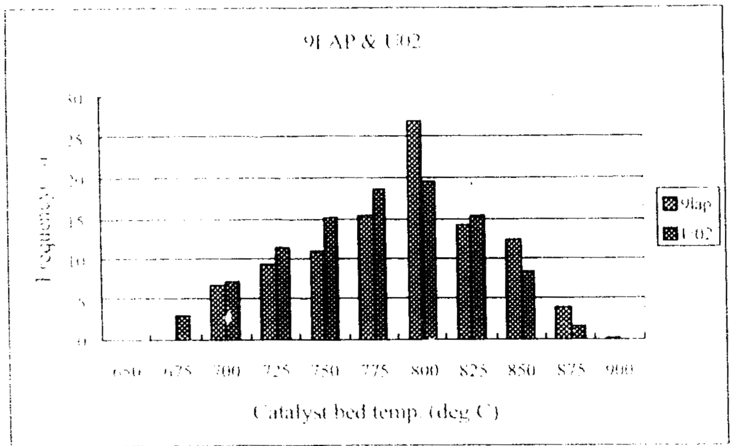
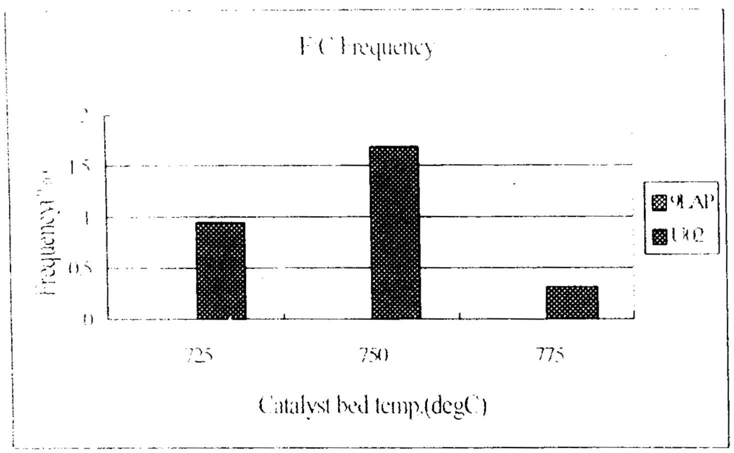
XII-13

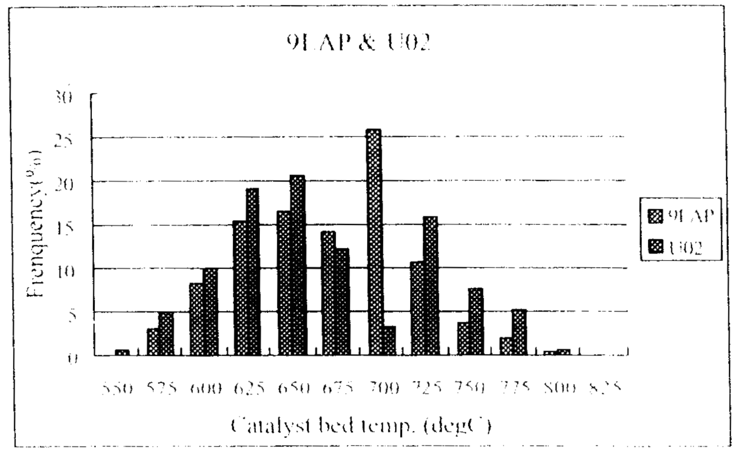
Catalyst stress of U02 (v.s. 9Lap)

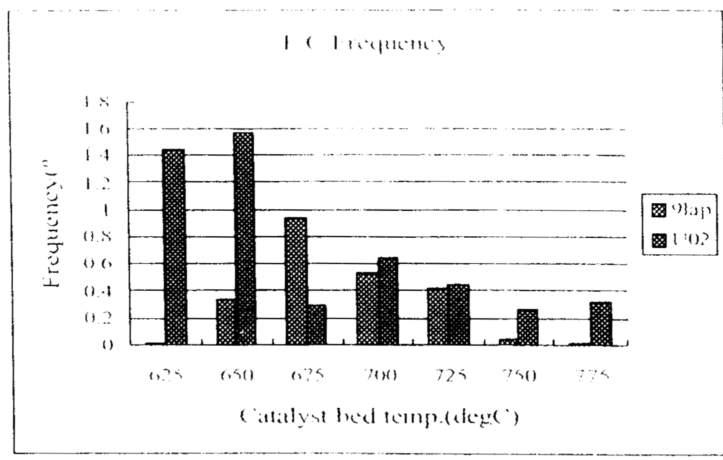
Corolla





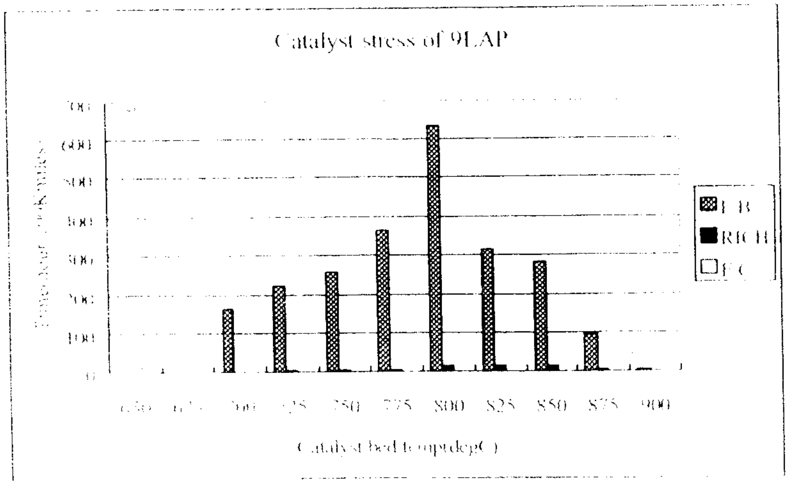
Camry (V6-engine)

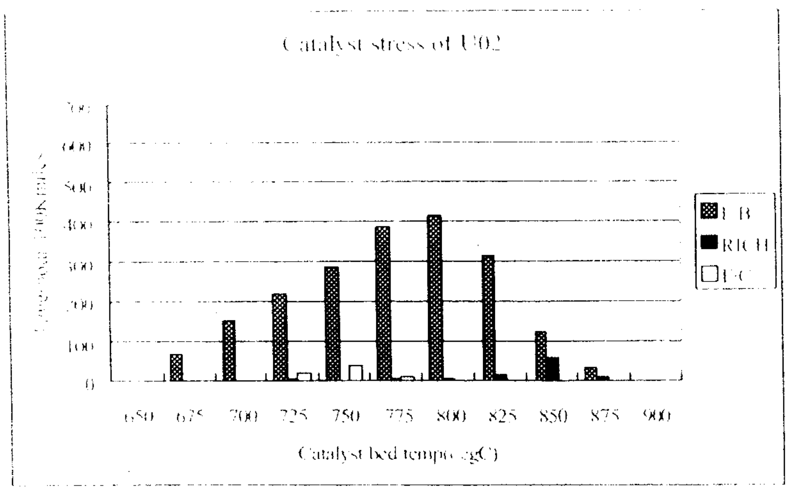




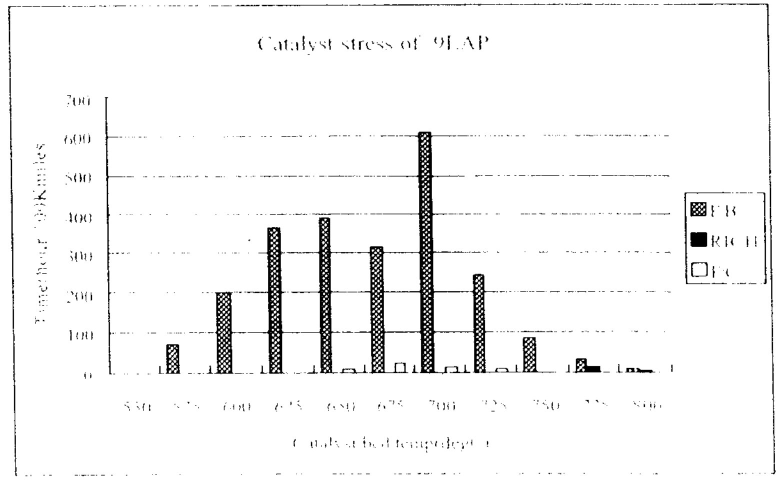
XII-14

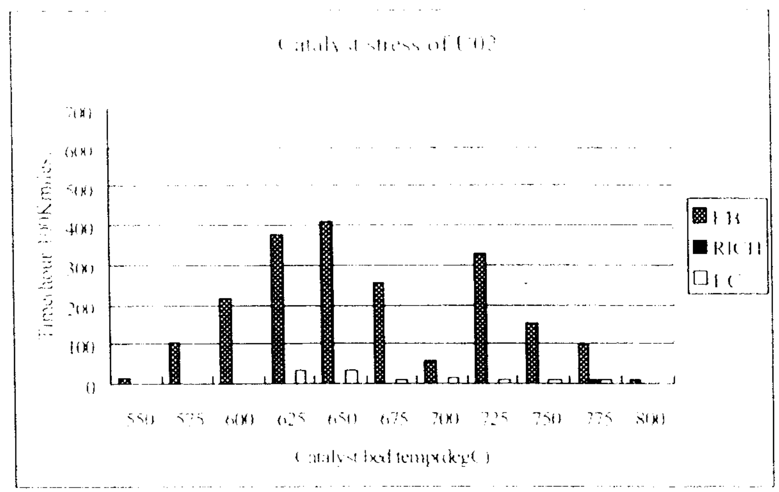
Corolla



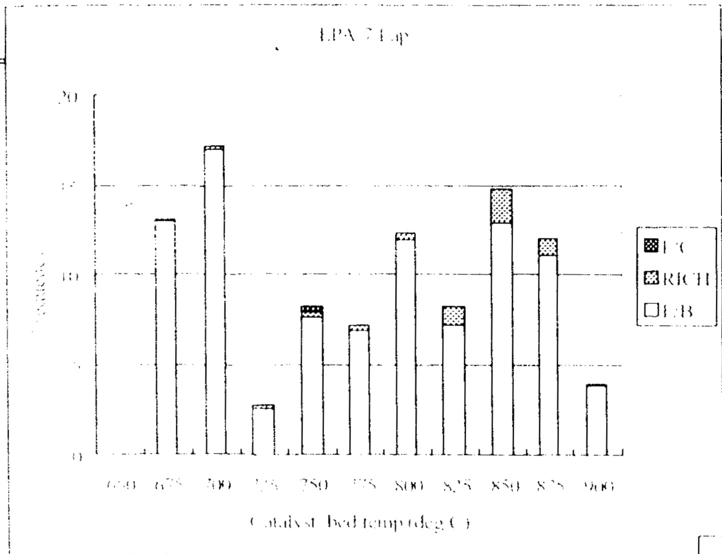


Camry (V6-engine)

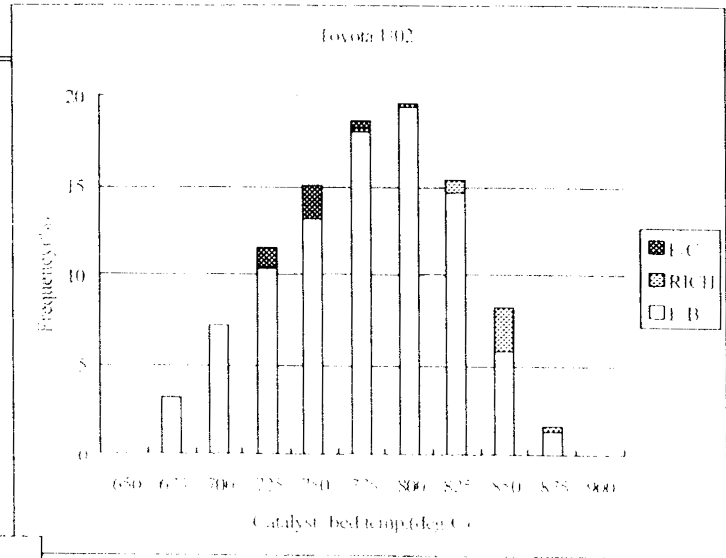




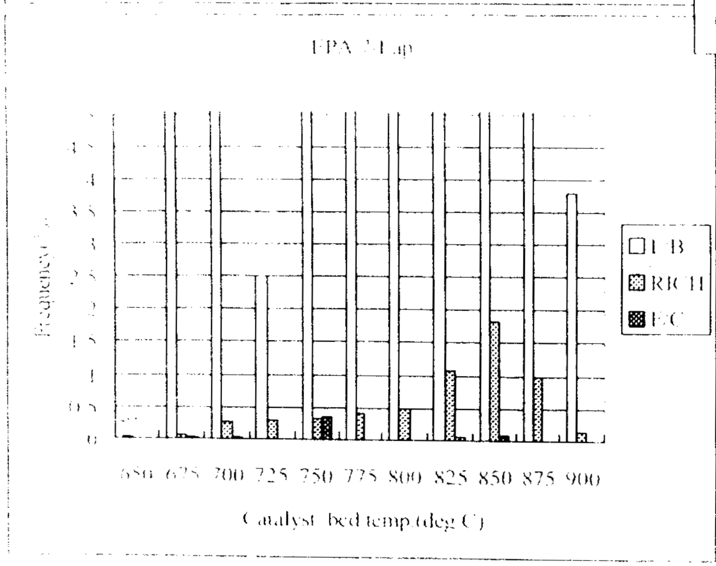
Corolla



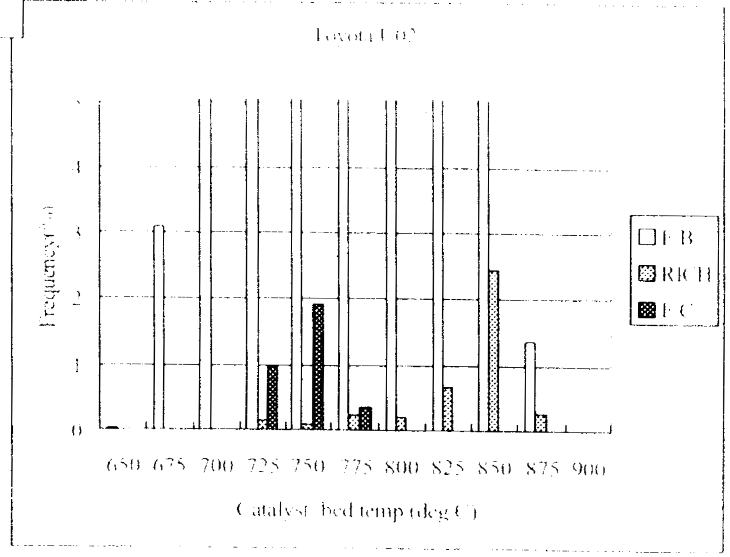
20
15
10
5
0
RICH
Catalyst bed temp (deg C)



20
15
10
5
0
650
700
800
850
900
RICH
Frequency
Catalyst bed temp (deg C)



4
3
1
0
675 700 725 750 775 800 825 850 875 900
RICH
Frequency
Catalyst bed temp (deg C)



4
3
2
1
0
650 675 700 725 750 775 800 825 850 875 900
RICH
Frequency
Catalyst bed temp (deg C)

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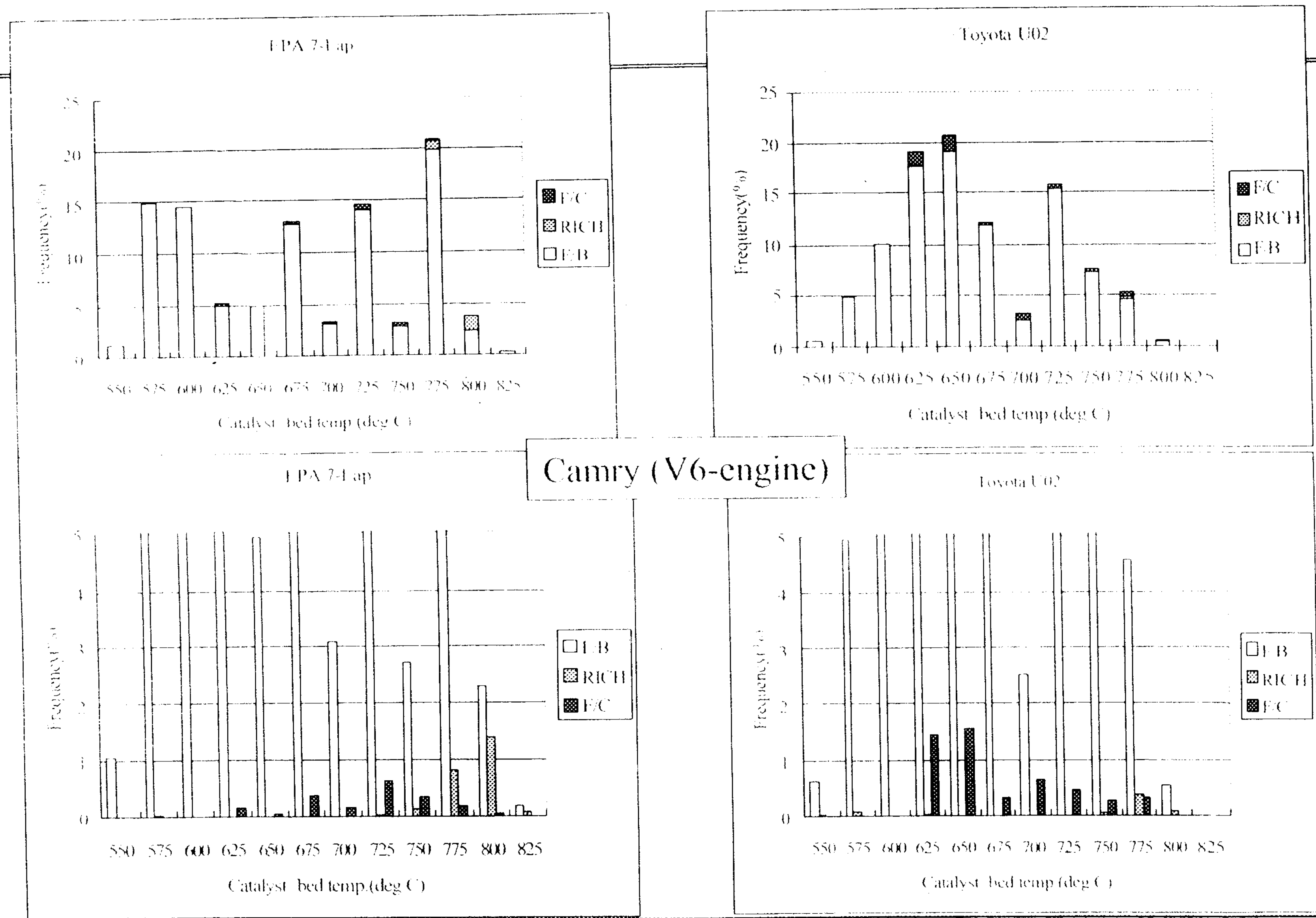
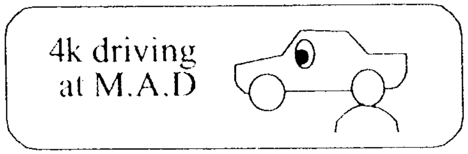


EPA 7-Lap
Toyota U02
Frequency(%)
F/C
RICH
F/B
550 575 600 625 650 675 700 725 750 775 800 825
Catalyst bed temp (deg C)
Camry (V6-engine)

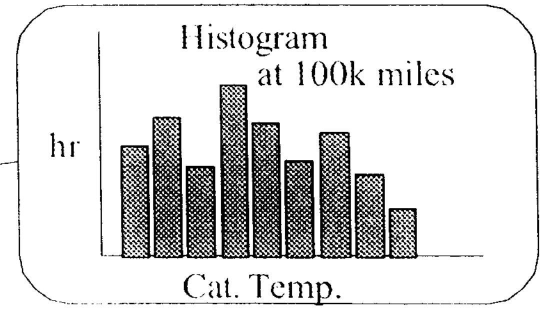
XII-17

Toyota Bench Aging Procedure

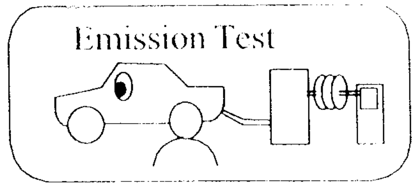
Vehicle Stabilized



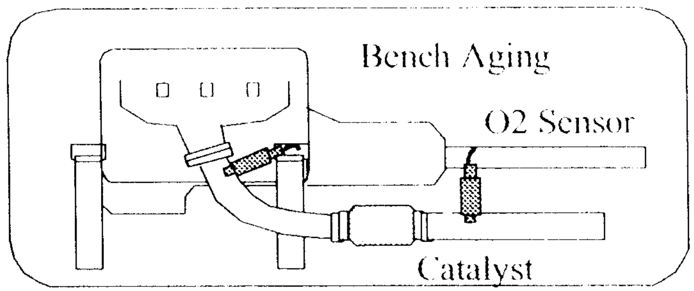
Collect Histogram of Catalyst Temperature



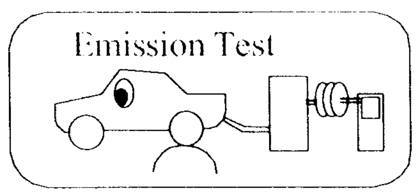
4k miles Emission Test (n=3)



Component Bench Aging



100k miles Emission Test (n=3)



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Toyota Bench Aging Procedures

- Toyota has been using bench aging procedures approved by Agencies in development and certification.
- Toyota believes that it is important to simulate durability stress during actual vehicle durability on bench aging process.
- It is common knowledge that the A/F condition has important meaning in catalyst deterioration.
- The major characteristic of Toyota bench aging process is to reflect the durability stress during whole vehicle durability cycle separately for closed loop, fuel cut, and rich A/F condition.
- On the other hand, EPA proposed bench cycle does not reflect the difference in fuel cut frequency of individual vehicles since the durability stress during actual vehicle cycle is only treated as thermal histogram.

XII-20

Adjusting Durability Procedure for IUVP Data

- EPA is proposing to adjust the DF derived from whole vehicle cycle or bench cycle considering the tendency of in-use deterioration.
- Toyota thinks that this method has the following problems:
  1. As discussed in the RDP II rulemaking process, the deterioration tendency derived from IUVP data is of only different vehicles, but not a tendency of a vehicle.
  2. Modification of durability procedures should be conducted by manufacturers in order to assure in-use emission compliance. Therefore, the procedure of adjusting DF should not be regulated.
- Toyota strongly opposes the adjusting DF for IUVP data on durability procedures.

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Conclusion

- Toyota strongly desires manufacturers to be allowed to have their own durability cycle.
- Toyota believes that our U02 cycle modified from 9-Lap that is representative of in-use should be allowed.
- Important point of bench aging procedure is to accurately simulate the durability stress of actual vehicles, and manufacturer's own procedure should be also allowed.
- Toyota's bench aging procedure is one accurately simulating fuel cut stress that significantly contribute to the catalyst deterioration, and therefore it should be approved to be used.
- Toyota strongly oppose the reflection of IUVP results to durability procedures due to the lack of confidence. The procedure should be left to manufacturers.

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ATTACHMENT XIII

図-1

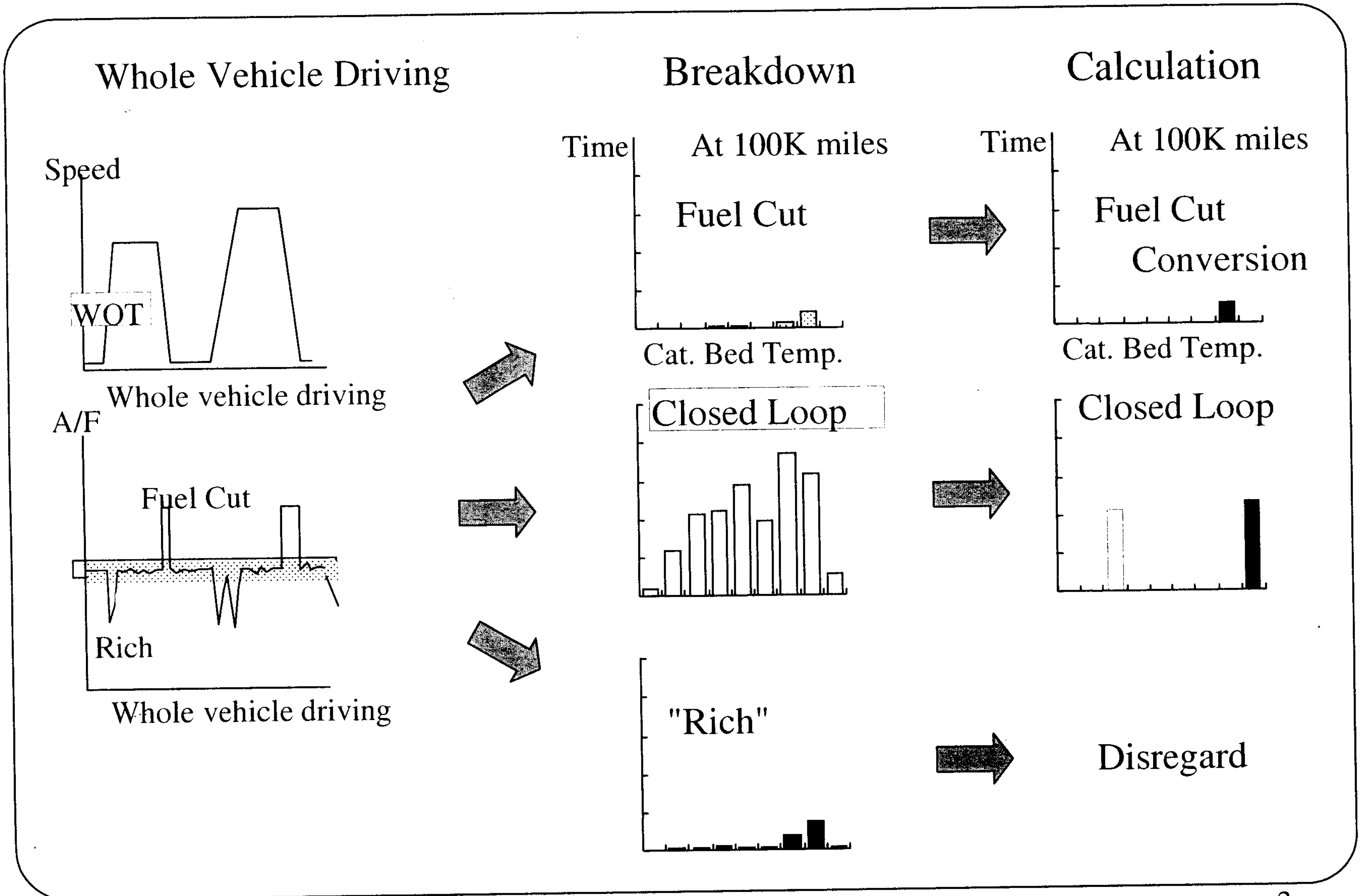
Comparison of Durability Stress

March 27, 2003

Toyota Motor Corporation

XIII - 2

Image of Durability Stress Calculation



XIII - 3

Calculation of Durability Stress

In Closed Loop and Fuel Cut Condition

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XIII-4

Calculation method:

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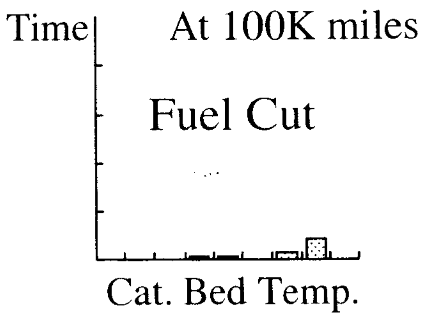
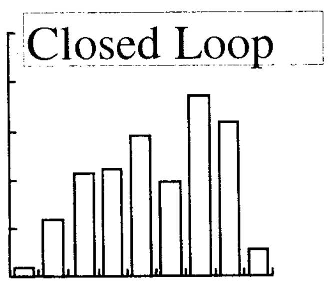
XIII-5

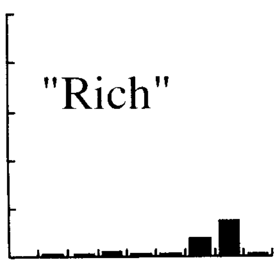
In Rich Condition

Calculation of Durability Stress (U02 cycle)

Breakdown

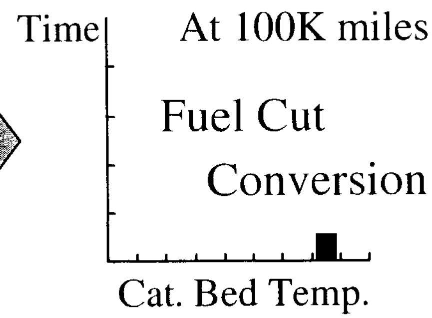


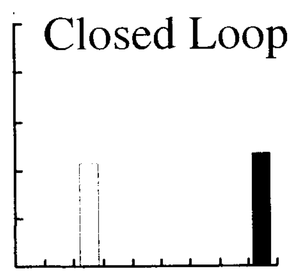




	Corolla	Camry
Fuel Cut	63h (2.9%)	107h (5.0%)
Closed Loop	1994h (93.1%)	2023h (94.4%)
"Rich"	86h (4.0%)	13h (0.6%)

Calculation

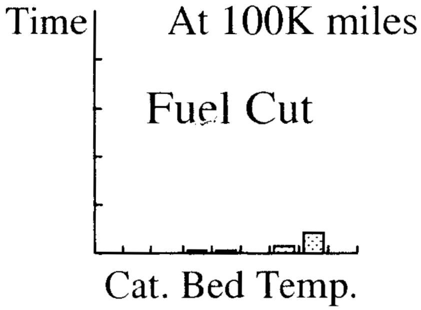


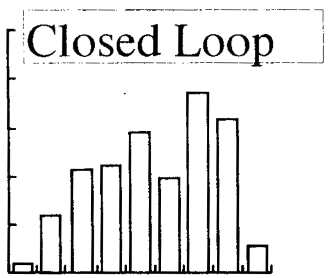


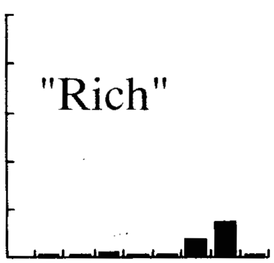
	Corolla	Camry
Fuel Cut Conversion	50h (46h) /765'C	35h (22h) /780'C
Closed Loop	261h (393h) /900'C	243h (266h) /810'C
"Rich"	Disregard	

Calculation of Durability Stress (EPA cycle)

Breakdown

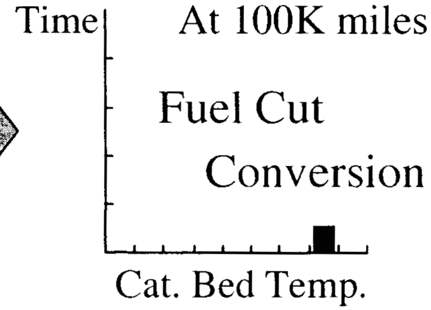


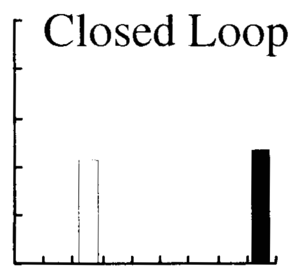




	Corolla	Camry
Fuel Cut	8h (0.4%)	33h (1.7%)
Closed Loop	1829h (93.8%)	1868h (95.8%)
"Rich"	113h (5.8%)	49h (2.5%)

Calculation





	Corolla	Camry
Fuel Cut Conversion	7h (5h) /765'C	22h (15h) /780'C
Closed Loop	414h (511h) /900'C	366h (397h) /810'C
"Rich"	Disregard	Disregard

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Durability stress comparison

		U02 cycle	EPA cycle	U02/EPA
F/C Time %	Corolla	2.9%	0.4%	
	Camry	5.0%	1.7%	
F/C Stress	Corolla	50h/765'C	7h/765'C	7.1
	Camry	35h/780'C	22h/780'C	1.6
C/L Time %	Corolla	93.1%	93.8%	
	Camry	94.4%	95.8%	
C/L Stress	Corolla	261h/900'C	414h/900'C	0.63
	Camry	243h/810'C	366h/810'C	0.66

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Durability stress comparison

Use EPA r-Factor		U02 cycle	EPA cycle	U02/EPA
F/C Time %	Corolla	2.9%	0.4%	
	Camry	5.0%	1.7%	
F/C Stress	Corolla	46h/765'C	5h/765'C	9.2
	Camry	22h/780'C	15h/780'C	1.5
C/L Time %	Corolla	93.1%	93.8%	
	Camry	94.4%	95.8%	
C/L Stress	Corolla	393h/900'C	511h/900'C	0.77
	Camry	266h/810'C	397h/810'C	0.67

Conclusion

1. The oxygen density in exhaust gas gives big influence to deterioration of a catalyst.
2. Therefore, Toyota thinks that breakdown of condition of C/L and F/C is necessary to judge severity of durability cycle.
3. Calculation method of durability stress of F/C and C/L can use durability time calculation method in the bench durability method.
4. And those durability stress can compare durability stress with criterion cycle.
5. In comparison of EPA cycle and U02 cycle, as for the EPA cycle, stress of C/L condition is excessive, and stress of F/C condition is too little.
6. Toyota thinks that balance of stress of C/L and F/C of EPA cycle needs to revise it.

ATTACHMENT XIV

Toyota's Fuel Cut Information

From Toyota

Percentage of time in each F/C (fuel cut) , F/B (feed-back control) and Rich for bench durability.

U02 = Toyota's new road cycle
EPA = EPA's strawman road cycle

		Corolla		Camry	
		U02	EPA	U02	EPA
Toyota	F/C	15.3%	1.4%	29.5%	7.3%
	C/L	63.7%	77.4%	66.9%	81.7%
	Rich	21.0%	21.2%	3.5%	11.0%
EPA*	F/C	11.6%	1.2%	27.7%	6.9%
	C/L	72.5%	80.9%	68.9%	82.8%
	Rich	15.9%	17.9%	3.3%	10.3%

*:Using EPA's r-factor

ATTACHMENT XV

Summary Sheet

Comparision of 9lap and U02 to EPA Strawman Cycle

TR=810
Hours on bench

	COROLLA	CAMRY
9LAP	2394.75	311.46
U02	1776.20	314.25
EPA	2272.25	485.89
9LAP/EPA	1.05	0.64
U02/EPA	0.78	0.65

Corolla on EPA Strawman Road Cycle

Enter Data in the "Enter Histogram Data" Worksheet

Miles represented in Histogram	100000
Useful Life Miles	100,000
Reference Temp °C (T_r)	810
In-Use Correction Factor	1.10
Tier 2?	N
Catalyst Temp Sensititivy (R)	18500

EPA CYCLE
COROLLA

Bench Aging Hours at Ref Temp	**2065.7**
Adjusted to include In-Use Factor	**2272.2**

Temperature Interval (°C)	T_v	Heat Load exp((R/Tr)-(R/T_v))	Equivalent Hrs at T_r	Histogram (hrs) Based on UL	Raw Histogram (hrs)
	650	0.05	0.0	0.34	0.344145982
	675	0.09	22.3	253.50	253.497937
	700	0.14	48.8	336.27	336.2650458
	725	0.23	12.7	54.27	54.27182152
	750	0.37	59.4	161.65	161.6453679
	775	0.57	79.4	140.51	140.5148101
	800	0.85	205.8	241.32	241.3151661
	825	1.26	204.4	161.85	161.8518605
	850	1.84	530.0	288.43	288.4287539
	875	2.63	618.8	235.22	235.22378
	900	3.71	284.2	76.64	76.64131136
	925	5.15	0.0	0.00	0
				Hours in Sample run	1950
				Ave Miles per Hour	51.28

Corolla on Toyota's U02 Cycle

Enter Data in the "Enter Histogram Data" Worksheet

Miles represented in Histogram	100000
Useful Life Miles	100,000
Reference Temp °C (T_r)	810
In-Use Correction Factor	1.10
Tier 2?	N
Catalyst Temp Sensititivy (R)	18500

U02 CYCLE
COROLLA

Bench Aging Hours at Ref Temp	**1614.7**
Adjusted to include In-Use Factor	**1776.2**

Temperature Interval (°C)	T_v	Heat Load exp((R/Tr)-(R/T_v))	Equivalent Hrs at T_r	Histogram (hrs) Based on UL	Raw Histogram (hrs)
	650	0.05	0.0	0.33	0.33157975
	675	0.09	5.8	66.51	66.50542608
	700	0.14	22.0	151.48	151.4845778
	725	0.23	57.3	245.42	245.4163945
	750	0.37	118.7	323.20	323.1955291
	775	0.57	225.4	398.80	398.7957269
	800	0.85	357.5	419.16	419.164189
	825	1.26	413.5	327.41	327.4113261
	850	1.84	323.6	176.12	176.1162187
	875	2.63	91.0	34.58	34.57903204
	900	3.71	0.0	0.00	0
	925	5.15	0.0	0.00	0
				Hours in Sample run	2143
				Ave Miles per Hour	46.66

Corolla on the Toyota 9 Lap Cycle

Enter Data in the "Enter Histogram Data" Worksheet

Miles represented in Histogram	100000
Useful Life Miles	100,000
Reference Temp °C (T_r)	810
In-Use Correction Factor	1.10
Tier 2?	N
Catalyst Temp Sensititivy (R)	18500

9LAP CYCLE
COROLLA

Bench Aging Hours at Ref Temp	**2177.0**
Adjusted to include In-Use Factor	**2394.7**

Temperature Interval (°C)	T_v	Heat Load $\exp((R/Tr)-(R/T_v))$	Equivalent Hrs at T_r	Histogram (hrs) Based on UL	Raw Histogram (hrs)
	650	0.05	0.0	0.00	0
	675	0.09	0.1	1.01	1.011164942
	700	0.14	23.3	160.52	160.52244
	725	0.23	52.5	224.92	224.9210024
	750	0.37	95.9	261.20	261.1965442
	775	0.57	208.9	369.52	369.5175928
	800	0.85	551.2	646.32	646.3240016
	825	1.26	424.1	335.83	335.8331501
	850	1.84	550.1	299.37	299.3680171
	875	2.63	255.5	97.14	97.1350314
	900	3.71	15.5	4.17	4.171055416
	925	5.15	0.0	0.00	0
				Hours in Sample run	2400
				Ave Miles per Hour	41.67

Camry on the EPA Strawman Road Cycle

Enter Data in the "Enter Histogram Data" Worksheet

Miles represented in Histogram	100000
Useful Life Miles	100,000
Reference Temp °C (T_r)	810
In-Use Correction Factor	1.10
Tier 2?	N
Catalyst Temp Sensititivy (R)	18500

EPA CYCLE
CAMRY

Bench Aging Hours at Ref Temp	**441.7**
Adjusted to include In-Use Factor	**485.9**

Temperature Interval (°C)	T_v	Heat Load exp((R/Tr)-(R/T_v))	Equivalent Hrs at T_r	Histogram (hrs) Based on UL	Raw Histogram (hrs)
	550	0.00	0.1	20.86	20.86445876
	575	0.01	2.6	291.12	291.1172454
	600	0.02	4.7	284.96	284.9599455
	625	0.03	2.9	97.99	97.98906679
	650	0.05	5.1	99.01	99.00941865
	675	0.09	21.9	249.49	249.4938836
	700	0.14	9.5	65.55	65.54887951
	725	0.23	66.4	284.47	284.4673658
	750	0.37	22.5	61.36	61.36191315
	775	0.57	233.2	412.61	412.6096112
	800	0.85	65.5	76.81	76.80794585
	825	1.26	7.3	5.77	5.770271672
				Hours in Sample run	1950.000006
				Ave Miles per Hour	51.28

Camry on Toyota's 9-Lap Cycle

Enter Data in the "Enter Histogram Data" Worksheet

Miles represented in Histogram	100000
Useful Life Miles	100,000
Reference Temp °C (T_r)	810
In-Use Correction Factor	1.10
Tier 2?	N
Catalyst Temp Sensititivy (R)	18500

9LAP CYCLE
CAMRY

Bench Aging Hours at Ref Temp	**283.1**
Adjusted to include In-Use Factor	**311.5**

Temperature Interval (°C)	T_v	Heat Load $\exp((R/Tr)-(R/T_v))$	Equivalent Hrs at T_r	Histogram (hrs) Based on UL	Raw Histogram (hrs)
	550	0.00	0.0	0.00	0
	575	0.01	0.6	71.33	71.3317818
	600	0.02	3.3	200.59	200.5928452
	625	0.03	10.9	369.62	369.6167591
	650	0.05	20.5	395.60	395.5960228
	675	0.09	29.8	339.57	339.5723059
	700	0.14	90.2	622.49	622.4857053
	725	0.23	59.5	255.09	255.0921077
	750	0.37	32.5	88.55	88.54541657
	775	0.57	25.7	45.48	45.47956884
	800	0.85	10.0	11.69	11.68748696
	825	1.26	0.0	0.00	0
				Hours in Sample run	2400
				Ave Miles per Hour	41.67

XI-6

Camry on Toyota's U02 Cycle

Enter Data in the "Enter Histogram Data" Worksheet

Miles represented in Histogram	100000
Useful Life Miles	100,000
Reference Temp °C (T_r)	810
In-Use Correction Factor	1.10
Tier 2?	N
Catalyst Temp Sensititivy (R)	18500

U02 CYCLE
CAMRY

Bench Aging Hours at Ref Temp	**285.7**
Adjusted to include In-Use Factor	**314.2**

Temperature Interval (°C)	**T_v**	**Heat Load $exp((R/Tr)-(R/T_v))$**	**Equivalent Hrs at T_r**	**Histogram (hrs) Based on UL**	**Raw Histogram (hrs)**
	550	0.00	0.1	13.50	13.50139092
	575	0.01	0.9	107.63	107.6294658
	600	0.02	3.5	215.21	215.2112307
	625	0.03	12.1	409.76	409.7648494
	650	0.05	22.9	443.02	443.0173931
	675	0.09	22.7	258.77	258.7687121
	700	0.14	9.8	67.65	67.65008142
	725	0.23	79.3	339.59	339.5862293
	750	0.37	59.6	162.26	162.2552355
	775	0.57	63.7	112.78	112.7819396
	800	0.85	10.9	12.83	12.83347778
	825	1.26	0.0	0.00	0
				Hours in Sample run	2143.000006
				Ave Miles per Hour	46.66

ATTACHMENT XVI

Comparision of Thermal Severity of the Strawman Cycle to Various Mfr's Cycles

Source of Data	Mfr Cycle Used	Description of Vehicle tested	Relative severity MFR/EPA	Relative severity EPA/MFR
GM	GM	Large SUV, V8, LDT4, Bin5	45%	222%
GM	GM	Mid-size PU, L4, LDT2, Bin 9	64%	156%
GM	GM	Small Car, L4, LDV, Bin 5	61%	165%
GM	GM	Large Car, V4, LDV, SULEV	89%	113%
Toyota	Toyota 9 Lap	Corolla	105%	95%
Toyota	Toyota U02	Corolla	78%	128%
Toyota	Toyota 9 Lap	Camry V6	64%	156%
Toyota	Toyota U02	Camry V6	65%	154%
Honda	MOD1	Accord 2.4l ,L4, LDV, Bin 5	64%	156%
Honda	Ford HSC	Accord 2.4l ,L4, LDV, Bin 5	90%	111%
Honda	Toyota U02	Accord 2.4l ,L4, LDV, Bin 5	46%	217%
		Ave:	70%	152%

ATTACHMENT XVII

Evaporative DFs
(2002 and 2003 MYs)

Manufacturer	Model Year	Evap Family	Sys	Fuel	Emission Name	Standard	Evap DF
ASTON MARTIN	2002	2ASXR0121V03	2	G	HC-TEV-2D	2.5	0
ASTON MARTIN	2002	2ASXR0284DB7	1	G	HC-TEV-2D	2.5	0
ASTON MARTIN	2003	3ASXR0121V03	1	G	HC-TEV-2D	2.5	0
Baytech Corporation	2003	3BYTE0000217	1	CNG	HC-TEV-2D	2.5	0
BMW	2002	2BMXR0158E65	1	G	HC-TEV-2D	2.5	0
BMW	2003	3BMXR0128E85	1	G	HC-TEV-2D	2.5	0
BMW	2003	3BMXR0134M56	1	G	HC-TEV-2D	2.5	0
BMW	2003	3BMXR0158E65	1	G	HC-TEV-2D	2.5	0
BMW	2003	3BMXR0158N73	1	G	HC-TEV-2D	2.5	0
DaimlerChrysler	2002	2CRXE0101GCS	1	G	HC-TEV-2D	2.5	0
DaimlerChrysler	2002	2CRXR0101GBA	1	G	HC-TEV-2D	2.5	0
DaimlerChrysler	2002	2CRXR0130GBA	1	G	HC-TEV-2D	2.5	0
DaimlerChrysler	2002	2CRXR0133GBH	1	G	HC-TEV-2D	2.5	0
DaimlerChrysler	2002	2CRXR0155GCH	1	G	HC-TEV-2D	2.5	0
DaimlerChrysler	2002	2CRXR0165GCA	1	G	HC-TEV-2D	2.5	0
DaimlerChrysler	2003	3CRXR0101GBA	1	G	HC-TEV-2D	2.5	0
DaimlerChrysler	2003	3CRXR0130GBA	1	G	HC-TEV-2D	2.5	0
DaimlerChrysler	2003	3CRXR0155GBH	1	G	HC-TEV-2D	2.5	0
DaimlerChrysler	2003	3CRXR0155GCH	1	G	HC-TEV-2D	2.5	0
DaimlerChrysler	2003	3CRXR0177GCA	1	G	HC-TEV-2D	2.5	0
Ford Motor Company	2002	2FMXR0230BBE	1	E	OMHCE-TEV-2D	2.5	0
Ford Motor Company	2002	2FMXR0230BBE	1	G	HC-TEV-2D	2.5	0
Ford Motor Company	2003	3FMXR0230BBE	1	E	OMHCE-TEV-2D	2.5	0
Ford Motor Company	2003	3FMXR0230BBE	1	G	HC-TEV-2D	2.5	0
FUJI HEAVY IND	2002	2FJXR01251BB	1	G	HC-TEV-2D	2.5	0
FUJI HEAVY IND	2002	2FJXR01251BD	1	G	HC-TEV-2D	2.5	0
FUJI HEAVY IND	2002	2FJXR01251CC	1	G	HC-TEV-2D	2.5	0
FUJI HEAVY IND	2003	3FJXR01251BB	1	G	HC-TEV-2D	2.5	0
FUJI HEAVY IND	2003	3FJXR01251BD	1	G	HC-TEV-2D	2.5	0
GENERAL MOTORS	2003	3GMXR0175922	1	G	HC-TEV-2D	2.5	0
GENERAL MOTORS	2003	3GMXR0212923	1	G	HC-TEV-2D	2.5	0
HONDA	2002	2HNXR0130AAB	1	G	HC-TEV-2D	2.5	0
HONDA	2002	2HNXR0130AAF	1	G	HC-TEV-2D	2.5	0
HONDA	2002	2HNXR0160AAA	1	G	HC-TEV-2D	2.5	0
HONDA	2002	2HNXR0160AAD	1	G	HC-TEV-2D	2.5	0
HONDA	2003	3HNXR0130AAA	1	G	HC-TEV-2D	2.5	0
HONDA	2003	3HNXR0140AAA	1	G	HC-TEV-2D	2.5	0
HONDA	2003	3HNXR0160AAA	1	G	HC-TEV-2D	2.5	0
HONDA	2003	3HNXR0160AAB	1	G	HC-TEV-2D	2.5	0
HYUNDAI	2002	2HYXR0105PEA	1	G	HC-TEV-2D	2.5	0
HYUNDAI	2002	2HYXR0134PEX	1	G	HC-TEV-2D	2.5	0
HYUNDAI	2002	2HYXR0150PEE	1	G	HC-TEV-2D	2.5	0
HYUNDAI	2002	2HYXR0150PEG	1	G	HC-TEV-2D	2.5	0
HYUNDAI	2002	2HYXR0175PES	1	G	HC-TEV-2D	2.5	0
HYUNDAI	2003	3HYXR0105PEA	1	G	HC-TEV-2D	2.5	0
HYUNDAI	2003	3HYXR0134PEX	1	G	HC-TEV-2D	2.5	0
HYUNDAI	2003	3HYXR0150PEE	1	G	HC-TEV-2D	2.5	0
HYUNDAI	2003	3HYXR0150PEG	1	G	HC-TEV-2D	2.5	0
HYUNDAI	2003	3HYXR0175PES	1	G	HC-TEV-2D	2.5	0
JAGUAR CARS INC	2002	2JCXR0121M2X	1	G	HC-TEV-2D	2.5	0
JAGUAR CARS INC	2002	2JCXR0140P1X	1	G	HC-TEV-2D	2.5	0
JAGUAR CARS INC	2003	3JCXR0121M2X	1	G	HC-TEV-2D	2.5	0
JAGUAR CARS INC	2003	3JCXR0140P1X	1	G	HC-TEV-2D	2.5	0
KIA MOTORS CORPORATION	2002	2KMXE0105B05	1	G	HC-TEV-2D	2.5	0

MERCEDES BENZ	2003	3MBXR0155LFZ	1	E	OMHCE-TEV-2D	2.5	0
MITSUBISHI MOTORS AUSTRAL	2002	2MLXR0175A1A	1	G	HC-TEV-2D	2.5	0
MITSUBISHI MOTORS AUSTRAL	2003	3MLXR0175A1A	1	G	HC-TEV-2D	2.5	0
Mitsubishi Motors Corporation	2002	2MTXE0130A1A	1	G	HC-TEV-2D	2.5	0
Mitsubishi Motors Corporation	2002	2MTXR0140A1A	1	G	HC-TEV-2D	2.5	0
Mitsubishi Motors Corporation	2002	2MTXR0175A1A	1	G	HC-TEV-2D	2.5	0
Mitsubishi Motors Corporation	2002	2MTXR0200A1A	1	G	HC-TEV-2D	2.5	0
Mitsubishi Motors Corporation	2003	3MTXR0140A1A	1	G	HC-TEV-2D	2.5	0
Mitsubishi Motors Corporation	2003	3MTXR0175A1A	1	G	HC-TEV-2D	2.5	0
Mitsubishi Motors Corporation	2003	3MTXR0200A1A	1	G	HC-TEV-2D	2.5	0
Mitsubishi Motors North America	2002	2DSXR0165A1F	1	G	HC-TEV-2D	2.5	0
Mitsubishi Motors North America	2003	3DSXR0165A1F	1	G	HC-TEV-2D	2.5	0
NEW UNITED MOTOR MFG INC	2002	2NTXR0115AK1	1	G	HC-TEV-2D	2.5	0
NEW UNITED MOTOR MFG INC	2003	3NTXR0115AK1	1	G	HC-TEV-2D	2.5	0
Nissan	2002	2NSXR0085RCA	1	G	HC-TEV-2D	2.5	0
Nissan	2002	2NSXR0110RCA	1	G	HC-TEV-2D	2.5	0
Nissan	2002	2NSXR0110RCB	1	G	HC-TEV-2D	2.5	0
Nissan	2002	2NSXR0110RCC	1	G	HC-TEV-2D	2.5	0
Nissan	2002	2NSXR0120RCA	1	G	HC-TEV-2D	2.5	0
Nissan	2002	2NSXR0120RCB	1	G	HC-TEV-2D	2.5	0
Nissan	2002	2NSXR0130RCA	1	G	HC-TEV-2D	2.5	0
Nissan	2003	3NSXR0085MAA	1	G	HC-TEV-2D	2.5	0
Nissan	2003	3NSXR0085MAB	1	G	HC-TEV-2D	2.5	0
Nissan	2003	3NSXR0110MAA	1	G	HC-TEV-2D	2.5	0
Nissan	2003	3NSXR0120MAA	1	G	HC-TEV-2D	2.5	0
Nissan	2003	3NSXR0120MAB	1	G	HC-TEV-2D	2.5	0
Nissan	2003	3NSXR0120PAA	1	G	HC-TEV-2D	2.5	0
Nissan	2003	3NSXR0120PAB	1	G	HC-TEV-2D	2.5	0
Nissan	2003	3NSXR0130MAB	1	G	HC-TEV-2D	2.5	0
Nissan	2003	3NSXR0130MAC	1	G	HC-TEV-2D	2.5	0
Nissan	2003	3NSXR0130PAA	1	G	HC-TEV-2D	2.5	0
Nissan	2003	3NSXR0145MAA	1	G	HC-TEV-2D	2.5	0
SUZUKI MOTOR CORPORATION	2002	2SKXR0120164	1	G	HC-TEV-2D	2.5	0
SUZUKI MOTOR CORPORATION	2003	3SKXR0120164	1	G	HC-TEV-2D	2.5	0
TOYOTA	2002	2TYXE0145AE0	1	G	HC-TEV-2D	2.5	0
TOYOTA	2002	2TYXE0145AF0	1	G	HC-TEV-2D	2.5	0
TOYOTA	2002	2TYXE0190AF0	1	G	HC-TEV-2D	2.5	0
TOYOTA	2002	2TYXR0030PK1	1	G	HC-TEV-2D	2.5	0
TOYOTA	2002	2TYXR0115AK1	1	G	HC-TEV-2D	2.5	0
TOYOTA	2002	2TYXR0135AK0	1	G	HC-TEV-2D	2.5	0
TOYOTA	2002	2TYXR0135AK1	1	G	HC-TEV-2D	2.5	0
TOYOTA	2002	2TYXR0150AK1	1	G	HC-TEV-2D	2.5	0
TOYOTA	2002	2TYXR0160AK1	1	G	HC-TEV-2D	2.5	0
TOYOTA	2003	3TYXE0190AF0	1	G	HC-TEV-2D	2.5	0
TOYOTA	2003	3TYXR0030PK1	1	G	HC-TEV-2D	2.5	0
TOYOTA	2003	3TYXR0115AK1	1	G	HC-TEV-2D	2.5	0
TOYOTA	2003	3TYXR0135AK0	1	G	HC-TEV-2D	2.5	0
TOYOTA	2003	3TYXR0135AK1	1	G	HC-TEV-2D	2.5	0
TOYOTA	2003	3TYXR0150AK1	1	G	HC-TEV-2D	2.5	0
TOYOTA	2003	3TYXR0160AK1	1	G	HC-TEV-2D	2.5	0
TOYOTA	2003	3TYXR0190A20	1	G	HC-TEV-2D	2.5	0
TOYOTA	2003	3TYXR0190P20	1	G	HC-TEV-2D	2.5	0
VOLVO	2002	2VVXR0133AAA	1	G	HC-TEV-2D	2.5	0
VOLVO	2003	3VVXR0133AAA	1	G	HC-TEV-2D	2.5	0
BMW	2003	3BMXR0093R50	1	G	HC-TEV-2D	2.5	0.0019
Ford Motor Company	2002	2FMXR0115FAE	1	E	OMHCE-TEV-2D	2.5	0.01
Ford Motor Company	2002	2FMXR0115FAE	1	G	HC-TEV-2D	2.5	0.01
Ford Motor Company	2003	3FMXR0115FAE	1	E	OMHCE-TEV-2D	2.5	0.01
Ford Motor Company	2003	3FMXR0115FAE	1	G	HC-TEV-2D	2.5	0.01
HONDA	2003	3HNXR0135BCA	1	G	HC-TEV-2D	1.2	0.01

HONDA	2003	3HNXR0140BBA	1	G	HC-TEV-2D	0.65	0.01
HONDA	2003	3HNXR0140BBA	1	G	HC-TEV-2D	1.2	0.01
HONDA	2003	3HNXR0140BBA	1	G	HC-TEV-2D	2.5	0.01
KIA MOTORS CORPORATION	2002	2KMXR0160F01	1	G	HC-TEV-2D	2.5	0.016
KIA MOTORS CORPORATION	2003	3KMXR0160F02	1	G	HC-TEV-2D	2.5	0.016
BMW	2002	2BMXR0093R50	1	G	HC-TEV-2D	2.5	0.019
Ford Motor Company	2002	2FMXE0110MBA	1	G	HC-TEV-2D	2.5	0.02
HONDA	2002	2HNXR0083AAE	1	G	HC-TEV-2D	2.5	0.02
HONDA	2003	3HNXR0083AAA	1	G	HC-TEV-2D	2.5	0.02
HONDA	2003	3HNXR0096BCA	1	G	HC-TEV-2D	1.2	0.02
Nissan	2002	2NSXE0110MBA	1	G	HC-TEV-2D	2.5	0.02
MERCEDES BENZ	2002	2MBXR0155LNA	1	G	HC-TEV-2D	2.5	0.027
MERCEDES BENZ	2002	2MBXR0193LNZ	1	G	HC-TEV-2D	2.5	0.027
MERCEDES BENZ	2002	2MBXR0218LNZ	1	G	HC-TEV-2D	2.5	0.027
MERCEDES BENZ	2003	3MBXR0155LNA	1	G	HC-TEV-2D	2.5	0.03
MERCEDES BENZ	2003	3MBXR0168LNC	1	G	HC-TEV-2D	2.5	0.03
MERCEDES BENZ	2003	3MBXR0168LNZ	1	G	HC-TEV-2D	2.5	0.03
MERCEDES BENZ	2003	3MBXR0218LNZ	1	G	HC-TEV-2D	2.5	0.03
TOYOTA	2002	2TYXR0075AK1	1	G	HC-TEV-2D	2.5	0.03
TOYOTA	2003	3TYXR0075AK1	1	G	HC-TEV-2D	2.5	0.03
KIA MOTORS CORPORATION	2002	2KMXR0160B05	1	G	HC-TEV-2D	2.5	0.04
MERCEDES BENZ	2002	2MBXR0155LNZ	1	G	HC-TEV-2D	2.5	0.04
MERCEDES BENZ	2002	2MBXR0155MNZ	1	G	HC-TEV-2D	2.5	0.04
MERCEDES BENZ	2003	3MBXR0155MNZ	1	G	HC-TEV-2D	2.5	0.04
BMW	2003	3BMXR0136E46	1	G	HC-TEV-2D	2.5	0.0493
HONDA	2002	2HNXR0099AAH	1	G	HC-TEV-2D	2.5	0.06
HONDA	2003	3HNXR0099AAA	1	G	HC-TEV-2D	2.5	0.06
Ford Motor Company	2002	2FMXR0080BAE	1	G	HC-TEV-2D	2.5	0.07
Ford Motor Company	2002	2FMXR0080BBE	1	G	HC-TEV-2D	2.5	0.07
Ford Motor Company	2003	3FMXR0080BAE	1	G	HC-TEV-2D	2.5	0.07
Ford Motor Company	2003	3FMXR0080BBE	1	G	HC-TEV-2D	2.5	0.07
HONDA	2002	2HNXR0152AAC	1	G	HC-TEV-2D	2.5	0.07
HONDA	2003	3HNXR0152AAA	1	G	HC-TEV-2D	2.5	0.07
MERCEDES BENZ	2002	2MBXR0155MYZ	1	G	HC-TEV-2D	2.5	0.07
ISUZU	2002	2SZXE0095ME0	1	G	HC-TEV-2D	2.5	0.08
ISUZU	2002	2SZXE0095PE0	1	G	HC-TEV-2D	2.5	0.08
ISUZU	2002	2SZXE0095PE1	1	G	HC-TEV-2D	2.5	0.08
ISUZU	2002	2SZXR0175ME0	1	G	HC-TEV-2D	2.5	0.08
ISUZU	2002	2SZXR0175PE0	1	G	HC-TEV-2D	2.5	0.08
ISUZU	2003	3SZXR0175PE0	1	G	HC-TEV-2D	2.5	0.08
DaimlerChrysler	2003	3CRXR0130XAA	1	E	OMHCE-TEV-2D	2.5	0.09
DaimlerChrysler	2003	3CRXR0177XAA	1	E	OMHCE-TEV-2D	2.5	0.09
DaimlerChrysler	2002	2CRXR0165XAA	1	G	HC-TEV-2D	2.5	0.1
Ford Motor Company	2002	2FMXR0160BBE	1	G	HC-TEV-2D	2.5	0.1
Ford Motor Company	2003	3FMXR0160BBE	1	G	HC-TEV-2D	2.5	0.1
JAGUAR CARS INC	2002	2JCXR0160P2X	1	G	HC-TEV-2D	2.5	0.1
JAGUAR CARS INC	2003	3JCXR0160P1X	1	G	HC-TEV-2D	2.5	0.1
MAZDA MOTOR CORP.	2002	2TKXR0120PMA	1	G	HC-TEV-2D	2.5	0.1
MAZDA MOTOR CORP.	2002	2TKXR0150PPA	1	G	HC-TEV-2D	2.5	0.1
MAZDA MOTOR CORP.	2003	3TKXR0120PMA	1	G	HC-TEV-2D	2.5	0.1
VOLVO	2002	2VVXR0133C70	1	G	HC-TEV-2D	2.5	0.1
VOLVO	2003	3VVXR0133C70	1	G	HC-TEV-2D	2.5	0.1
MAZDA MOTOR CORP.	2002	2TKXR0125PMA	1	G	HC-TEV-2D	2.5	0.11
MAZDA MOTOR CORP.	2002	2TKXR0125PMB	1	G	HC-TEV-2D	2.5	0.11
MAZDA MOTOR CORP.	2003	3TKXR0125PMA	1	G	HC-TEV-2D	2.5	0.11
MAZDA MOTOR CORP.	2002	2TKXR0125PMC	1	G	HC-TEV-2D	2.5	0.12
KIA MOTORS CORPORATION	2002	2KMXR0150D02	1	G	HC-TEV-2D	2.5	0.1254
KIA MOTORS CORPORATION	2003	3KMXR0150D03	1	G	HC-TEV-2D	2.5	0.1254
Ford Motor Company	2002	2FMXR0155FBE	1	E	OMHCE-TEV-2D	2.5	0.13
Ford Motor Company	2003	3FMXR0155FBE	1	E	OMHCE-TEV-2D	2.5	0.13

HONDA	2002	2HNXR0130AAB	1	G	HC-TEV-2D	2.5	0.13
HONDA	2003	3HNXR0130AAB	1	G	HC-TEV-2D	2.5	0.13
KIA MOTORS CORPORATION	2003	3KMXR0160G01	1	G	HC-TEV-2D	2.5	0.136
VOLVO	2003	3VVXR0130EV2	1	G	HC-TEV-2D	2.5	0.15
Ford Motor Company	2002	2FMXR0175BAE	1	G	HC-TEV-2D	2.5	0.153
VOLKSWAGEN	2002	2VWXR0140233	1	G	HC-TEV-2D	2.5	0.17
VOLKSWAGEN	2003	3VWXR0140233	1	G	HC-TEV-2D	2.5	0.17
AUDI	2002	2ADXR0140232	1	G	HC-TEV-2D	2.5	0.18
AUDI	2002	2ADXR0140233	1	G	HC-TEV-2D	2.5	0.18
AUDI	2002	2ADXR0170252	1	G	HC-TEV-2D	2.5	0.18
AUDI	2003	3ADXR0140232	1	G	HC-TEV-2D	2.5	0.18
AUDI	2003	3ADXR0140233	1	G	HC-TEV-2D	2.5	0.18
AUDI	2003	3ADXR0170252	1	G	HC-TEV-2D	2.5	0.18
BENTLEY MOTORS LTD.	2003	3BEXR0200E96	1	G	HC-TEV-2D	2.5	0.18
DaimlerChrysler	2002	2CRXR0165XAA	1	E	OMHCE-TEV-2D	2.5	0.18
DaimlerChrysler	2003	3CRXR0130XAA	1	G	HC-TEV-2D	2.5	0.18
DaimlerChrysler	2003	3CRXR0177XAA	1	G	HC-TEV-2D	2.5	0.18
FERRARI	2002	2FEXR0203360	1	G	HC-TEV-2D	2.5	0.18
FERRARI	2002	2FEXR0203575	1	G	HC-TEV-2D	2.5	0.18
FERRARI	2002	2FEXR0203C00	1	G	HC-TEV-2D	2.5	0.18
FERRARI	2003	3FEXR0203140	1	G	HC-TEV-2D	2.5	0.18
FERRARI	2003	3FEXR0203360	1	G	HC-TEV-2D	2.5	0.18
FERRARI	2003	3FEXR0203575	1	G	HC-TEV-2D	2.5	0.18
FERRARI	2003	3FEXR0203C00	1	G	HC-TEV-2D	2.5	0.18
Ford * 70%-tile point***	**2002**	**2FMXR0115BAE**	**1**	**G**	**HC-TEV-2D**	**2.5**	**0.18**
Ford Motor Company	2003	3FMXR0115BAE	1	G	HC-TEV-2D	2.5	0.18
HYUNDAI	2002	2HYXR0134PER	1	G	HC-TEV-2D	2.5	0.18
HYUNDAI	2003	3HYXR0134PER	1	G	HC-TEV-2D	2.5	0.18
LAMBORGHINI	2002	2NLXR0203DBR	1	G	HC-TEV-2D	2.5	0.18
LAMBORGHINI	2003	3NLXR0203DBR	1	G	HC-TEV-2D	2.5	0.18
LOTUS	2002	2LTXR0124OVR	1	G	HC-TEV-2D	2	0.18
LOTUS	2003	3LTXR0124OVR	1	G	HC-TEV-2D	2.5	0.18
MASERATI	2002	2MAXR0198138	1	G	HC-TEV-2D	2.5	0.18
MASERATI	2003	3MAXR0198138	1	G	HC-TEV-2D	2.5	0.18
Morgan Motor Company, L.t.d.	2002	2MMYR0124ML1	1	G	HC-TEV-2D	2.5	0.18
Morgan Motor Company, L.t.d.	2003	3MMYR0124MA3	1	G	HC-TEV-2D	2.5	0.18
PORSCHE	2003	3PRXR0230RE1	1	G	HC-TEV-2D	2.5	0.18
ROLLS-ROYCE MOTOR CARS L	2002	2RRXR0200E96	1	G	HC-TEV-2D	2.5	0.18
SALEEN PERFORMANCE INC.	2002	2S3XR0105JDA	1	G	HC-TEV-2D	2.5	0.18
SALEEN PERFORMANCE INC.	2003	3S3XR0105EAA	1	G	HC-TEV-2D	2.5	0.18
VOLKSWAGEN	2002	2VWXR0140234	1	G	HC-TEV-2D	2.5	0.18
VOLKSWAGEN	2003	3VWXR0140234	1	G	HC-TEV-2D	2.5	0.18
LAND ROVER GROUP LTD.	2002	2LRXR0124002	1	G	HC-TEV-2D	2.5	0.2
MAZDA MOTOR CORP.	2002	2TKXR0150PMA	1	G	HC-TEV-2D	2.5	0.2
MAZDA MOTOR CORP.	2003	3TKXR0150PMA	1	G	HC-TEV-2D	2.5	0.2
MAZDA MOTOR CORP.	2003	3TKXR0150PPC	1	G	HC-TEV-2D	2.5	0.2
Baytech Corporation	2002	2BYTE0095ULV	1	CNG	HC-TEV-2D	2.5	0.22
Baytech Corporation	2002	2BYTE0095ULV	1	G	HC-TEV-2D	2.5	0.22
Baytech Corporation	2003	3BYTE0095ULV	2	CNG	HC-TEV-2D	2.5	0.22
Baytech Corporation	2003	3BYTE0095ULV	2	G	HC-TEV-2D	2.5	0.22
Baytech Corporation	2003	3BYTR0175ULV	3	CNG	HC-TEV-2D	2.5	0.22
Baytech Corporation	2003	3BYTR0175ULV	3	G	HC-TEV-2D	2.5	0.22
GENERAL MOTORS	2002	2GMXE0095904	1	G	HC-TEV-2D	2.5	0.22
GENERAL MOTORS	2002	2GMXR0080902	1	G	HC-TEV-2D	2.5	0.22
GENERAL MOTORS	2002	2GMXR0124919	1	G	HC-TEV-2D	2.5	0.22
GENERAL MOTORS	2002	2GMXR0175922	1	G	HC-TEV-2D	2.5	0.22
GENERAL MOTORS	2003	3GMXR0124919	1	G	HC-TEV-2D	2.5	0.22
Quantum Technologies	2002	2TJXR0124919	1	CNG	HC-TEV-2D	2.5	0.22
Quantum Technologies	2002	2TJXR0124919	1	G	HC-TEV-2D	2.5	0.22
Quantum Technologies	2003	3TJXR0124919	1	CNG	HC-TEV-2D	2.5	0.22

Quantum Technologies	2003	3TJXR0124919	1	G	HC-TEV-2D	2.5	0.22
AUDI	2002	2ADXR0140262	1	G	HC-TEV-2D	2.5	0.24
AUDI	2003	3ADXR0140262	1	G	HC-TEV-2D	2.5	0.24
KIA MOTORS CORPORATION	2002	2KMXR0100A05	1	G	HC-TEV-2D	2.5	0.25915
KIA MOTORS CORPORATION	2003	3KMXR0100A06	1	G	HC-TEV-2D	2.5	0.25915
AUDI	2002	2ADXR0110234	1	G	HC-TEV-2D	2.5	0.26
AUDI	2002	2ADXR0130242	1	G	HC-TEV-2D	2.5	0.26
AUDI	2003	3ADXR0110234	1	G	HC-TEV-2D	2.5	0.26
AUDI	2003	3ADXR0130242	1	G	HC-TEV-2D	2.5	0.26
VOLKSWAGEN	2002	2VWXR0110234	1	G	HC-TEV-2D	2.5	0.26
VOLKSWAGEN	2003	3VWXR0110234	1	G	HC-TEV-2D	2.5	0.26
LAND ROVER GROUP LTD.	2003	3LRXR0124002	1	G	HC-TEV-2D	2.5	0.27
KIA MOTORS CORPORATION	2002	2KMXR0100C02	1	G	HC-TEV-2D	2.5	0.275
KIA MOTORS CORPORATION	2003	3KMXR0100C01	1	G	HC-TEV-2D	2.5	0.275
Ford Motor Company	2002	2FMXE0115BBE	1	G	HC-TEV-2D	2.5	0.35
Ford Motor Company	2002	2FMXE0120BAE	1	G	HC-TEV-2D	2.5	0.35
Ford Motor Company	2002	2FMXR0105BAE	1	G	HC-TEV-2D	2.5	0.35
Ford Motor Company	2002	2FMXR0115BBE	1	G	HC-TEV-2D	2.5	0.35
Ford Motor Company	2003	3FMXR0105BAE	1	G	HC-TEV-2D	2.5	0.35
Ford Motor Company	2003	3FMXR0115BBE	1	G	HC-TEV-2D	2.5	0.35
MAZDA MOTOR CORP.	2002	2TKXE0115PPA	1	G	HC-TEV-2D	2.5	0.35
MAZDA MOTOR CORP.	2002	2TKXR0115PPB	1	G	HC-TEV-2D	2.5	0.35
MAZDA MOTOR CORP.	2003	3TKXR0115PPB	1	G	HC-TEV-2D	2.5	0.35
PANOZ AUTO-DEVELOPMENT (	2002	2P3XR010500A	1	G	HC-TEV-2D	2	0.35
PANOZ AUTO-DEVELOPMENT (	2002	2P3XR010500A	1	G	HC-TEV-2D	2.5	0.35
PANOZ AUTO-DEVELOPMENT (	2003	3P3XR010500A	1	G	HC-TEV-2D	2	0.35
PANOZ AUTO-DEVELOPMENT (	2003	3P3XR010500A	1	G	HC-TEV-2D	2.5	0.35
Roush Industries, Inc.	2002	2RIIR0105BAE	1	G	HC-TEV-2D	2.5	0.35
Roush Industries, Inc.	2003	3RIIR0105BAE	1	G	HC-TEV-2D	2.5	0.35
SALEEN PERFORMANCE INC.	2003	3S3XR0105JDA	1	G	HC-TEV-2D	2.5	0.35
Ford Motor Company	2002	2FMXR0155BBE	1	G	HC-TEV-2D	2.5	0.36
Ford Motor Company	2002	2FMXR0160BBE	1	G	HC-TEV-2D	2.5	0.36
Ford Motor Company	2002	2FMXR0160FBE	1	E	OMHCE-TEV-2D	2.5	0.36
Ford Motor Company	2002	2FMXR0160FBE	1	G	HC-TEV-2D	2.5	0.36
Ford Motor Company	2003	3FMXR0155BBE	1	G	HC-TEV-2D	2.5	0.36
Ford Motor Company	2003	3FMXR0160BBE	1	G	HC-TEV-2D	2.5	0.36
Ford Motor Company	2003	3FMXR0160FBE	1	E	OMHCE-TEV-2D	2.5	0.36
Ford Motor Company	2003	3FMXR0160FBE	1	G	HC-TEV-2D	2.5	0.36
MERCEDES BENZ	2002	2MBXR0155LNZ	2	G	HC-TEV-2D	2.5	0.397
MERCEDES BENZ	2003	3MBXR0155LFZ	1	G	HC-TEV-2D	2.5	0.4
MERCEDES BENZ	2003	3MBXR0155LNZ	1	G	HC-TEV-2D	2.5	0.4
DAEWOO	2002	2DWXR0095A0L	1	G	HC-TEV-2D	2.5	0.457
DAEWOO	2003	3DWXR0095A0L	1	G	HC-TEV-2D	2.5	0.457
GENERAL MOTORS	2002	2GMXE0111906	1	E	OMHCE-TEV-2D	2.5	0.46
GENERAL MOTORS	2002	2GMXE0111906	1	G	HC-TEV-2D	2.5	0.46
GENERAL MOTORS	2002	2GMXR0133910	1	G	HC-TEV-2D	2.5	0.46
GENERAL MOTORS	2002	2GMXR0212923	1	G	HC-TEV-2D	2.5	0.46
GENERAL MOTORS	2003	3GMXR0133910	1	G	HC-TEV-2D	2.5	0.46
Alpina Burkard Bovensiepen + Co	2003	3ABBR0136E46	1	G	HC-TEV-2D	2.5	0.493
BMW	2002	2BMXR0136E46	1	G	HC-TEV-2D	2.5	0.493
BMW	2002	2BMXR0160E39	1	G	HC-TEV-2D	2.5	0.612
BMW	2003	3BMXR0160E39	1	G	HC-TEV-2D	2.5	0.612
PORSCHE	2002	2PRXR0110R96	1	G	HC-TEV-2D	2.5	0.643
PORSCHE	2003	3PRXR0110R96	1	G	HC-TEV-2D	2.5	0.643
RUF AUTOMOBILE GMBH	2002	2RAXR0110RGT	1	G	HC-TEV-2D	2.5	0.643
202.3					Average	2.5	0.124

Refueling DFs

(2002 and 2003 MYs)

Manufacturer	Model Year	Evap Family	Sys	Fuel	Emission Name	Standard	Refuel DF
Alpina Burkard Bovensiepen + Co. (	2003	3ABBR0136E46	1	G	HC-ORVR	0.2	0
ASTON MARTIN	2002	2ASXR0121V03	2	G	HC-ORVR	0.2	0
ASTON MARTIN	2002	2ASXR0284DB7	1	G	HC-ORVR	0.2	0
ASTON MARTIN	2003	3ASXR0121V03	1	G	HC-ORVR	0.2	0
AUDI	2002	2ADXR0110234	1	G	HC-ORVR	0.2	0
AUDI	2002	2ADXR0130242	1	G	HC-ORVR	0.2	0
AUDI	2002	2ADXR0140262	1	G	HC-ORVR	0.2	0
AUDI	2002	2ADXR0170252	1	G	HC-ORVR	0.2	0
AUDI	2003	3ADXR0110234	1	G	HC-ORVR	0.2	0
AUDI	2003	3ADXR0130242	1	G	HC-ORVR	0.2	0
AUDI	2003	3ADXR0140262	1	G	HC-ORVR	0.2	0
AUDI	2003	3ADXR0170252	1	G	HC-ORVR	0.2	0
BENTLEY MOTORS LTD.	2003	3BEXR0200E96	1	G	HC-ORVR	0.2	0
BMW	2002	2BMXR0136E46	1	G	HC-ORVR	0.2	0
BMW	2003	3BMXR0134M56	1	G	HC-ORVR	0.2	0
BMW	2003	3BMXR0136E46	1	G	HC-ORVR	0.2	0
BMW	2003	3BMXR0158N73	1	G	HC-ORVR	0.2	0
DAEWOO	2002	2DWXR0095A0L	1	G	HC-ORVR	0.2	0
DAEWOO	2003	3DWXR0095A0L	1	G	HC-ORVR	0.2	0
DaimlerChrysler	2002	2CRXR0101GBA	1	G	HC-ORVR	0.2	0
DaimlerChrysler	2002	2CRXR0133GBH	1	G	HC-ORVR	0.2	0
DaimlerChrysler	2002	2CRXR0155GCH	1	G	HC-ORVR	0.2	0
DaimlerChrysler	2003	3CRXR0101GBA	1	G	HC-ORVR	0.2	0
DaimlerChrysler	2003	3CRXR0130GBA	1	G	HC-ORVR	0.2	0
DaimlerChrysler	2003	3CRXR0155GBH	1	G	HC-ORVR	0.2	0
DaimlerChrysler	2003	3CRXR0155GCH	1	G	HC-ORVR	0.2	0
DaimlerChrysler	2003	3CRXR0177GCA	1	G	HC-ORVR	0.2	0
Ford Motor Company	2002	2FMXR0115FAE	1	E	OMHCE-ORVR	0.2	0
Ford Motor Company	2002	2FMXR0115FAE	1	G	HC-ORVR	0.2	0
Ford Motor Company	2002	2FMXR0160BBE	1	G	HC-ORVR	0.2	0
Ford Motor Company	2002	2FMXR0230BBE	1	E	OMHCE-ORVR	0.2	0
Ford Motor Company	2002	2FMXR0230BBE	1	G	HC-ORVR	0.2	0
Ford Motor Company	2003	3FMXR0115FAE	1	E	OMHCE-ORVR	0.2	0
Ford Motor Company	2003	3FMXR0115FAE	1	G	HC-ORVR	0.2	0
Ford Motor Company	2003	3FMXR0160BBE	1	G	HC-ORVR	0.2	0
Ford Motor Company	2003	3FMXR0230BBE	1	E	OMHCE-ORVR	0.2	0
Ford Motor Company	2003	3FMXR0230BBE	1	G	HC-ORVR	0.2	0
FUJI HEAVY IND	2002	2FJXR01251BB	1	G	HC-ORVR	0.2	0
FUJI HEAVY IND	2002	2FJXR01251BD	1	G	HC-ORVR	0.2	0
FUJI HEAVY IND	2003	3FJXR01251BB	1	G	HC-ORVR	0.2	0
FUJI HEAVY IND	2003	3FJXR01251BD	1	G	HC-ORVR	0.2	0
GENERAL MOTORS	2002	2GMXR0124919	1	G	HC-ORVR	0.2	0
GENERAL MOTORS	2002	2GMXR0133910	1	G	HC-ORVR	0.2	0
GENERAL MOTORS	2003	3GMXR0124919	1	G	HC-ORVR	0.2	0
GENERAL MOTORS	2003	3GMXR0133910	1	G	HC-ORVR	0.2	0
HONDA	2002	2HNXR0083AAE	1	G	HC-ORVR	0.2	0
HONDA	2002	2HNXR0130AAB	1	G	HC-ORVR	0.2	0
HONDA	2002	2HNXR0160AAA	1	G	HC-ORVR	0.2	0
HONDA	2002	2HNXR0160AAD	1	G	HC-ORVR	0.2	0
HONDA	2003	3HNXR0083AAA	1	G	HC-ORVR	0.2	0
HONDA	2003	3HNXR0096BCA	1	G	HC-ORVR	0.2	0
HONDA	2003	3HNXR0130AAB	1	G	HC-ORVR	0.2	0
HONDA	2003	3HNXR0135BCA	1	G	HC-ORVR	0.2	0
HONDA	2003	3HNXR0140BBA	1	G	HC-ORVR	0.2	0

HONDA	2003	3HNXR0160AAA	1	G	HC-ORVR	0.2	0
HONDA	2003	3HNXR0160AAB	1	G	HC-ORVR	0.2	0
HYUNDAI	2002	2HYXR0105PEA	1	G	HC-ORVR	0.2	0
HYUNDAI	2002	2HYXR0134PER	1	G	HC-ORVR	0.2	0
HYUNDAI	2002	2HYXR0134PEX	1	G	HC-ORVR	0.2	0
HYUNDAI	2002	2HYXR0150PEE	1	G	HC-ORVR	0.2	0
HYUNDAI	2002	2HYXR0150PEG	1	G	HC-ORVR	0.2	0
HYUNDAI	2002	2HYXR0175PES	1	G	HC-ORVR	0.2	0
HYUNDAI	2003	3HYXR0105PEA	1	G	HC-ORVR	0.2	0
HYUNDAI	2003	3HYXR0134PER	1	G	HC-ORVR	0.2	0
HYUNDAI	2003	3HYXR0134PEX	1	G	HC-ORVR	0.2	0
HYUNDAI	2003	3HYXR0150PEE	1	G	HC-ORVR	0.2	0
HYUNDAI	2003	3HYXR0150PEG	1	G	HC-ORVR	0.2	0
HYUNDAI	2003	3HYXR0175PES	1	G	HC-ORVR	0.2	0
JAGUAR CARS INC	2002	2JCXR0121M2X	1	G	HC-ORVR	0.2	0
JAGUAR CARS INC	2002	2JCXR0140P1X	1	G	HC-ORVR	0.2	0
JAGUAR CARS INC	2002	2JCXR0160P2X	1	G	HC-ORVR	0.2	0
JAGUAR CARS INC	2003	3JCXR0121M2X	1	G	HC-ORVR	0.2	0
JAGUAR CARS INC	2003	3JCXR0140P1X	1	G	HC-ORVR	0.2	0
JAGUAR CARS INC	2003	3JCXR0160P1X	1	G	HC-ORVR	0.2	0
LAND ROVER GROUP LTD.	2002	2LRXR0124002	1	G	HC-ORVR	0.2	0
LAND ROVER GROUP LTD.	2003	3LRXR0124002	1	G	HC-ORVR	0.2	0
MERCEDES BENZ	2002	2MBXR0155LNA	1	G	HC-ORVR	0.2	0
MERCEDES BENZ	2002	2MBXR0193LNZ	1	G	HC-ORVR	0.2	0
MERCEDES BENZ	2002	2MBXR0218LNZ	1	G	HC-ORVR	0.2	0
MERCEDES BENZ	2003	3MBXR0155LFZ	1	E	OMHCE-ORVR	0.2	0
MERCEDES BENZ	2003	3MBXR0155LNA	1	G	HC-ORVR	0.2	0
MERCEDES BENZ	2003	3MBXR0168LNC	1	G	HC-ORVR	0.2	0
MERCEDES BENZ	2003	3MBXR0168LNZ	1	G	HC-ORVR	0.2	0
MERCEDES BENZ	2003	3MBXR0218LNZ	1	G	HC-ORVR	0.2	0
MITSUBISHI MOTORS AUSTRALI/	2002	2MLXR0175A1A	1	G	HC-ORVR	0.2	0
MITSUBISHI MOTORS AUSTRALI/	2003	3MLXR0175A1A	1	G	HC-ORVR	0.2	0
Mitsubishi Motors Corporation	2002	2MTXR0140A1A	1	G	HC-ORVR	0.2	0
Mitsubishi Motors Corporation	2002	2MTXR0175A1A	1	G	HC-ORVR	0.2	0
Mitsubishi Motors Corporation	2002	2MTXR0200A1A	1	G	HC-ORVR	0.2	0
Mitsubishi Motors Corporation	2003	3MTXR0140A1A	1	G	HC-ORVR	0.2	0
Mitsubishi Motors Corporation	2003	3MTXR0175A1A	1	G	HC-ORVR	0.2	0
Mitsubishi Motors Corporation	2003	3MTXR0200A1A	1	G	HC-ORVR	0.2	0
Mitsubishi Motors North America	2002	2DSXR0165A1F	1	G	HC-ORVR	0.2	0
Mitsubishi Motors North America	2003	3DSXR0165A1F	1	G	HC-ORVR	0.2	0
Morgan Motor Company, L.t.d.	2002	2MMYR0124ML1	1	G	HC-ORVR	0.2	0
Morgan Motor Company, L.t.d.	2003	3MMYR0124MA3	1	G	HC-ORVR	0.2	0
NEW UNITED MOTOR MFG INC	2002	2NTXR0115AK1	1	G	HC-ORVR	0.2	0
NEW UNITED MOTOR MFG INC	2003	3NTXR0115AK1	1	G	HC-ORVR	0.2	0
Nissan	2002	2NSXR0085RCA	1	G	HC-ORVR	0.2	0
Nissan	2002	2NSXR0110RCA	1	G	HC-ORVR	0.2	0
Nissan	2002	2NSXR0110RCB	1	G	HC-ORVR	0.2	0
Nissan	2002	2NSXR0110RCC	1	G	HC-ORVR	0.2	0
Nissan	2002	2NSXR0120RCA	1	G	HC-ORVR	0.2	0
Nissan	2002	2NSXR0120RCB	1	G	HC-ORVR	0.2	0
Nissan	2002	2NSXR0130RCA	1	G	HC-ORVR	0.2	0
Nissan	2003	3NSXR0085MAA	1	G	HC-ORVR	0.2	0
Nissan	2003	3NSXR0085MAB	1	G	HC-ORVR	0.2	0
Nissan	2003	3NSXR0110MAA	1	G	HC-ORVR	0.2	0
Nissan	2003	3NSXR0120MAA	1	G	HC-ORVR	0.2	0
Nissan	2003	3NSXR0120MAB	1	G	HC-ORVR	0.2	0
Nissan	2003	3NSXR0120PAA	1	G	HC-ORVR	0.2	0
Nissan	2003	3NSXR0120PAB	1	G	HC-ORVR	0.2	0
Nissan	2003	3NSXR0130MAB	1	G	HC-ORVR	0.2	0
Nissan	2003	3NSXR0130MAC	1	G	HC-ORVR	0.2	0

Nissan	2003	3NSXR0130PAA	1	G	HC-ORVR	0.2	0
Nissan	2003	3NSXR0145MAA	1	G	HC-ORVR	0.2	0
Quantum Technologies	2002	2TJXR0124919	1	G	HC-ORVR	0.2	0
Quantum Technologies	2003	3TJXR0124919	1	G	HC-ORVR	0.2	0
ROLLS-ROYCE MOTOR CARS LT	2002	2RRXR0200E96	1	G	HC-ORVR	0.2	0
TOYOTA	2002	2TYXR0030PK1	1	G	HC-ORVR	0.2	0
TOYOTA	2002	2TYXR0115AK1	1	G	HC-ORVR	0.2	0
TOYOTA	2002	2TYXR0135AK0	1	G	HC-ORVR	0.2	0
TOYOTA	2002	2TYXR0135AK1	1	G	HC-ORVR	0.2	0
TOYOTA	2002	2TYXR0150AK1	1	G	HC-ORVR	0.2	0
TOYOTA	2003	3TYXR0030PK1	1	G	HC-ORVR	0.2	0
TOYOTA	2003	3TYXR0115AK1	1	G	HC-ORVR	0.2	0
TOYOTA	2003	3TYXR0135AK0	1	G	HC-ORVR	0.2	0
TOYOTA	2003	3TYXR0135AK1	1	G	HC-ORVR	0.2	0
TOYOTA	2003	3TYXR0150AK1	1	G	HC-ORVR	0.2	0
VOLKSWAGEN	2002	2VWXR0110234	1	G	HC-ORVR	0.2	0
VOLKSWAGEN	2002	2VWXR0140233	1	G	HC-ORVR	0.2	0
VOLKSWAGEN	2002	2VWXR0140234	1	G	HC-ORVR	0.2	0
VOLKSWAGEN	2003	3VWXR0110234	1	G	HC-ORVR	0.2	0
VOLKSWAGEN	2003	3VWXR0140233	1	G	HC-ORVR	0.2	0
VOLVO	2002	2VVXR0133AAA	1	G	HC-ORVR	0.2	0
VOLVO	2002	2VVXR0133C70	1	G	HC-ORVR	0.2	0
VOLVO	2003	3VVXR0133AAA	1	G	HC-ORVR	0.2	0
VOLVO	2003	3VVXR0133C70	1	G	HC-ORVR	0.2	0
BMW	2003	3BMXR0093R50	1	G	HC-ORVR	0.2	0.00052
DaimlerChrysler	2002	2CRXR0130GBA	1	G	HC-ORVR	0.2	0.001
VOLVO	2003	3VVXR0130EV2	1	G	HC-ORVR	0.2	0.001
AUDI	2002	2ADXR0140232	1	G	HC-ORVR	0.2	0.002
AUDI	2002	2ADXR0140233	1	G	HC-ORVR	0.2	0.002
AUDI	2003	3ADXR0140232	1	G	HC-ORVR	0.2	0.002
AUDI	2003	3ADXR0140233	1	G	HC-ORVR	0.2	0.002
VOLKSWAGEN	2003	3VWXR0140234	1	G	HC-ORVR	0.2	0.002
BMW	2003	3BMXR0158E65	1	G	HC-ORVR	0.2	0.00227
MERCEDES BENZ	2002	2MBXR0155LNZ	1	G	HC-ORVR	0.2	0.004
MERCEDES BENZ	2002	2MBXR0155MNZ	1	G	HC-ORVR	0.2	0.004
MERCEDES BENZ	2002	2MBXR0155MYZ	1	G	HC-ORVR	0.2	0.004
MERCEDES BENZ	2003	3MBXR0155MNZ	1	G	HC-ORVR	0.2	0.004
BMW	2002	2BMXR0093R50	1	G	HC-ORVR	0.2	0.0052
Ford Motor Company	2002	2FMXR0080BAE	1	G	HC-ORVR	0.2	0.007
Ford Motor Company	2002	2FMXR0080BBE	1	G	HC-ORVR	0.2	0.007
Ford Motor Company	2003	3FMXR0080BAE	1	G	HC-ORVR	0.2	0.007
Ford Motor Company	2003	3FMXR0080BBE	1	G	HC-ORVR	0.2	0.007
TOYOTA	2003	3TYXR0190P20	1	G	HC-ORVR	0.2	0.007
SUZUKI MOTOR CORPORATION	2002	2SKXR0120164	1	G	HC-ORVR	0.2	0.007531
SUZUKI MOTOR CORPORATION	2003	3SKXR0120164	1	G	HC-ORVR	0.2	0.007531
KIA MOTORS CORPORATION	2002	2KMXR0160B05	1	G	HC-ORVR	0.2	0.008
KIA MOTORS CORPORATION	2003	3KMXR0160G01	1	G	HC-ORVR	0.2	0.008
KIA MOTORS CORPORATION	2002	2KMXR0160F01	1	G	HC-ORVR	0.2	0.0095
KIA MOTORS CORPORATION	2003	3KMXR0160F02	1	G	HC-ORVR	0.2	0.0095
Baytech Corporation	2003	3BYTR0175ULV	3	G	HC-ORVR	0.2	0.01
GENERAL MOTORS	2002	2GMXR0175922	1	G	HC-ORVR	0.2	0.01
GENERAL MOTORS	2003	3GMXR0175922	1	G	HC-ORVR	0.2	0.01
HONDA	2002	2HNXR0130AAF	1	G	HC-ORVR	0.2	0.01
HONDA	2003	3HNXR0130AAA	1	G	HC-ORVR	0.2	0.01
HONDA	2003	3HNXR0140AAA	1	G	HC-ORVR	0.2	0.01
LOTUS	2002	2LTXR0124OVR	1	G	HC-ORVR	0.2	0.01
LOTUS	2003	3LTXR0124OVR	1	G	HC-ORVR	0.2	0.01
MAZDA MOTOR CORP.	2002	2TKXR0125PMA	1	G	HC-ORVR	0.2	0.01
MAZDA MOTOR CORP.	2002	2TKXR0150PMA	1	G	HC-ORVR	0.2	0.01
MAZDA MOTOR CORP.	2003	3TKXR0125PMA	1	G	HC-ORVR	0.2	0.01

MAZDA MOTOR CORP.	2003	3TKXR0150PMA	1	G	HC-ORVR	0.2	0.01
MAZDA MOTOR CORP.	2003	3TKXR0150PPC	1	G	HC-ORVR	0.2	0.01
TOYOTA	2002	2TYXR0160AK1	1	G	HC-ORVR	0.2	0.01
TOYOTA * 70%-tile point*** **	**2003**	**3TYXR0160AK1**	**1**	**G**	**HC-ORVR**	**0.2**	**0.01**
MAZDA MOTOR CORP.	2002	2TKXR0120PMA	1	G	HC-ORVR	0.2	0.012
MAZDA MOTOR CORP.	2002	2TKXR0125PMB	1	G	HC-ORVR	0.2	0.012
MAZDA MOTOR CORP.	2002	2TKXR0125PMC	1	G	HC-ORVR	0.2	0.012
MAZDA MOTOR CORP.	2003	3TKXR0120PMA	1	G	HC-ORVR	0.2	0.012
Ford Motor Company	2002	2FMXR0155FBE	1	E	OMHCE-ORVR	0.2	0.013
Ford Motor Company	2002	2FMXR0155FBE	1	G	HC-ORVR	0.2	0.013
Ford Motor Company	2002	2FMXR0155FBE	1	G	OMHCE-ORVR	0.2	0.013
Ford Motor Company	2003	3FMXR0155FBE	1	E	OMHCE-ORVR	0.2	0.013
Ford Motor Company	2003	3FMXR0155FBE	1	G	HC-ORVR	0.2	0.013
Ford Motor Company	2002	2FMXR0175BAE	1	G	HC-ORVR	0.2	0.015
ISUZU	2002	2SZXR0175ME0	1	G	HC-ORVR	0.2	0.015
ISUZU	2002	2SZXR0175PE0	1	G	HC-ORVR	0.2	0.015
ISUZU	2003	3SZXR0175PE0	1	G	HC-ORVR	0.2	0.015
PORSCHE	2002	2PRXR0110R96	1	G	HC-ORVR	0.2	0.015
PORSCHE	2003	3PRXR0110R96	1	G	HC-ORVR	0.2	0.015
RUF AUTOMOBILE GMBH	2002	2RAXR0110RGT	1	G	HC-ORVR	0.2	0.015
TOYOTA	2003	3TYXR0190A20	1	G	HC-ORVR	0.2	0.017
DaimlerChrysler	2002	2CRXR0165XAA	1	E	OMHCE-ORVR	0.2	0.018
DaimlerChrysler	2002	2CRXR0165XAA	1	G	HC-ORVR	0.2	0.018
BMW	2003	3BMXR0128E85	1	G	HC-ORVR	0.2	0.02
DaimlerChrysler	2002	2CRXR0165GCA	1	G	HC-ORVR	0.2	0.02
Ford Motor Company	2002	2FMXR0115BAE	1	G	HC-ORVR	0.2	0.02
Ford Motor Company	2003	3FMXR0115BAE	1	G	HC-ORVR	0.2	0.02
FUJI HEAVY IND	2002	2FJXR01251CC	1	G	HC-ORVR	0.2	0.02
GENERAL MOTORS	2002	2GMXR0212923	1	G	HC-ORVR	0.2	0.02
GENERAL MOTORS	2003	3GMXR0212923	1	G	HC-ORVR	0.2	0.02
KIA MOTORS CORPORATION	2002	2KMXR0100C02	1	G	HC-ORVR	0.2	0.02
KIA MOTORS CORPORATION	2003	3KMXR0100C01	1	G	HC-ORVR	0.2	0.02
MAZDA MOTOR CORP.	2002	2TKXR0150PPA	1	G	HC-ORVR	0.2	0.02
BMW	2002	2BMXR0158E65	1	G	HC-ORVR	0.2	0.0227
FERRARI	2002	2FEXR0203360	1	G	HC-ORVR	0.2	0.03
FERRARI	2002	2FEXR0203575	1	G	HC-ORVR	0.2	0.03
FERRARI	2002	2FEXR0203C00	1	G	HC-ORVR	0.2	0.03
FERRARI	2003	3FEXR0203140	1	G	HC-ORVR	0.2	0.03
FERRARI	2003	3FEXR0203360	1	G	HC-ORVR	0.2	0.03
FERRARI	2003	3FEXR0203575	1	G	HC-ORVR	0.2	0.03
FERRARI	2003	3FEXR0203C00	1	G	HC-ORVR	0.2	0.03
LAMBORGHINI	2002	2NLXR0203DBR	1	G	HC-ORVR	0.2	0.03
LAMBORGHINI	2003	3NLXR0203DBR	1	G	HC-ORVR	0.2	0.03
MASERATI	2002	2MAXR0198138	1	G	HC-ORVR	0.2	0.03
MASERATI	2003	3MAXR0198138	1	G	HC-ORVR	0.2	0.03
BMW	2002	2BMXR0160E39	1	G	HC-ORVR	0.2	0.031
BMW	2003	3BMXR0160E39	1	G	HC-ORVR	0.2	0.031
KIA MOTORS CORPORATION	2002	2KMXR0150D02	1	G	HC-ORVR	0.2	0.032
KIA MOTORS CORPORATION	2003	3KMXR0150D03	1	G	HC-ORVR	0.2	0.032
KIA MOTORS CORPORATION	2002	2KMXR0100A05	1	G	HC-ORVR	0.2	0.03225
KIA MOTORS CORPORATION	2003	3KMXR0100A06	1	G	HC-ORVR	0.2	0.03225
Ford Motor Company	2002	2FMXR0105BAE	1	G	HC-ORVR	0.2	0.035
Ford Motor Company	2002	2FMXR0115BBE	1	G	HC-ORVR	0.2	0.035
Ford Motor Company	2003	3FMXR0105BAE	1	G	HC-ORVR	0.2	0.035
Ford Motor Company	2003	3FMXR0115BBE	1	G	HC-ORVR	0.2	0.035
MAZDA MOTOR CORP.	2002	2TKXR0115PPB	1	G	HC-ORVR	0.2	0.035
MAZDA MOTOR CORP.	2003	3TKXR0115PPB	1	G	HC-ORVR	0.2	0.035
PANOZ AUTO-DEVELOPMENT CC	2002	2P3XR010500A	1	G	HC-ORVR	0.2	0.035
PANOZ AUTO-DEVELOPMENT CC	2003	3P3XR010500A	1	G	HC-ORVR	0.2	0.035
Roush Industries, Inc.	2002	2RIIR0105BAE	1	G	HC-ORVR	0.2	0.035

Roush Industries, Inc.	2003	3RIIR0105BAE	1	G	HC-ORVR	0.2	0.035
SALEEN PERFORMANCE INC.	2003	3S3XR0105JDA	1	G	HC-ORVR	0.2	0.035
Ford Motor Company	2002	2FMXR0155BBE	1	G	HC-ORVR	0.2	0.036
Ford Motor Company	2002	2FMXR0160BBE	1	G	HC-ORVR	0.2	0.036
Ford Motor Company	2002	2FMXR0160FBE	1	E	OMHCE-ORVR	0.2	0.036
Ford Motor Company	2002	2FMXR0160FBE	1	G	HC-ORVR	0.2	0.036
Ford Motor Company	2003	3FMXR0155BBE	1	G	HC-ORVR	0.2	0.036
Ford Motor Company	2003	3FMXR0160BBE	1	G	HC-ORVR	0.2	0.036
Ford Motor Company	2003	3FMXR0160FBE	1	E	OMHCE-ORVR	0.2	0.036
Ford Motor Company	2003	3FMXR0160FBE	1	G	HC-ORVR	0.2	0.036
DaimlerChrysler	2003	3CRXR0130XAA	1	E	OMHCE-ORVR	0.2	0.04
DaimlerChrysler	2003	3CRXR0130XAA	1	G	HC-ORVR	0.2	0.04
DaimlerChrysler	2003	3CRXR0177XAA	1	E	OMHCE-ORVR	0.2	0.04
DaimlerChrysler	2003	3CRXR0177XAA	1	G	HC-ORVR	0.2	0.04
GENERAL MOTORS	2002	2GMXR0080902	1	G	HC-ORVR	0.2	0.04
HONDA	2002	2HNXR0099AAH	1	G	HC-ORVR	0.2	0.04
HONDA	2003	3HNXR0099AAA	1	G	HC-ORVR	0.2	0.04
MERCEDES BENZ	2002	2MBXR0155LNZ	2	G	HC-ORVR	0.2	0.044
MERCEDES BENZ	2003	3MBXR0155LFZ	1	G	HC-ORVR	0.2	0.044
MERCEDES BENZ	2003	3MBXR0155LNZ	1	G	HC-ORVR	0.2	0.044
TOYOTA	2002	2TYXR0075AK1	1	G	HC-ORVR	0.2	0.086
TOYOTA	2003	3TYXR0075AK1	1	G	HC-ORVR	0.2	0.086
HONDA	2002	2HNXR0152AAC	1	G	HC-ORVR	0.2	0.13
HONDA	2003	3HNXR0152AAA	1	G	HC-ORVR	0.2	0.13
SALEEN PERFORMANCE INC.	2002	2S3XR0105JDA	1	G	HC-ORVR	0.2	0.18
SALEEN PERFORMANCE INC.	2003	3S3XR0105EAA	1	G	HC-ORVR	0.2	0.18
					Average	**0.2**	**0.012**