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Technical Report

An Analysis of Carbon Monoxide Emissions As a Function of Ambient Temperature and Vehicle Parameters

by

Larry C. Landman

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U. S. Environmental Protection Agency
Office of Air, Noise and Radiation
Office of Mobile Sources
Emission Control Technology Division
Control Technology Assessment and Characterization Branch
2565 Plymouth Road
Ann Arbor, Michigan 48105

Introduction

Numerous investigators have reported the observations that:

1) Carbon monoxide (CO) exhaust emissions tend to increase as ambient temperature decreases.

2) The "cold-start emissions" (those emitted prior to light-off of the catalyst) are the most sensitive to a drop in the ambient temperature [1,5,6,7]*.

This tendency toward increased CO emissions is suspected as being a major factor causing National Ambient Air Quality Standard (NAAQS) violations for CO during cold weather conditions [1].

To investigate possible functional relationships between cold weather CO emissions and emission control technology or vehicle parameters, we reviewed existing data on eighteen (18) vehicles for which cold-start tests were performed in EPA's Controlled Environmental Test Facility (CETF). These data were generated between February 1980 and October 1981. Since these vehicles were not specifically chosen as a representative sampling of the population of late-model year vehicles, care must be taken in generalizing the results of these analyses.

Results of these analyses may be used in the development of future test programs designed to investigate ways to reduce cold weather CO emissions.

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*Bracketed, [ ], numbers indicate references at the end of this report.

Conclusions and Recommendations

In tne limited data base which was used, we conclude that the most significant vehicle parameter related to CO emissions at low ambient temperature is the type of fuel metering system. The vehicles equipped with electronic fuel injection (EFI) exhibited greater cold weather CO control than did the carbureted vehicles. Of secondary importance is the vehicle's test weight (ETW) and the type of secondary air injection used.

We had limited success in predicting both cold-start CO emissions and the increase in cold-start CO emissions (in grams per mile) relative to FTP ambient temperatures (75°F) as functions of ambient temperature, type of fuel metering system, and ETW. However, the percent of CO increase (relative to 75°F) correlated poorly with the available variables. From this, we infer that an additive rather that multiplicative "correction factor" for cold weather CO emissions may be a more appropriate form.

We did find a high positive correlation, at low ambient temperatures, between the increase in fuel consumed (Bag 1 fuel consumption minus Bag 3 fuel consumption) and the corresponding increase in CO emissions. This is further indication that the cold-start fuel enrichment systems are responsible for much of the low ambient temperature CO emissions.

It is difficult to determine, from the data set used for this report, how important eacn design parameter is, since the data set does not include every possible combination of all the parameters. It is obvious, however, that the important parameters to concentrate on in future investigations are those related to the fuel metering, air injection, and cold-start fuel enrichment systems. In an ideal sense, further cold room testing would involve test vehicles that had the following characteristics:

(1) Vehicles representing all combinations of fuel metering systems (e.g., 1, 2, and 4 barrel carburetion; throttle-bodied fuel injection (TBI); multipoint fuel injection) and secondary air systems (e.g., no air injection, pulse air injection, air pump) used in late-model vehicles and/or likely to be used in future vehicles, and

(2) Vehicles representing various types of cold-start fuel enrichment systems. (We could then search for readily identifiable vehicle parameters which correlate with the cold start effects of these systems, and quantify the effects on cold weather CO emissions.)

Test Vehicles & Test Results

The 18 test vehicles are described in Table 1. As indicated in that table, data from the first ten (10) vehicles were used in reference 1, the next five (5) appeared in reference 2, and the last vehicle appeared in reference 3. Data generated by vehicle D160 (1981 Chrysler K-Car Wagon) and vehicle 1009 (Ethyl's lean-burn concept car) have not appeared in any previous EPA technical report.

It should be noted that both the Ethyl lean-burn car (a 1978 Ford Fairmont with a modified Peugeot V-6 engine and an Asian-Warner A4(OD) transmission) and the Dresser Nova (a modified 1977 Chevrolet Nova equipped with a Dresser sonic carburetor) are prototype vehicles which embody hardware that is not used on production cars. Thus, some of the regression analyses were done both with and without these two vehicles. Additionally, vehicle FB289 (the turbocharged Datsun 280ZX) was an experimental prototype and, thus, not necessarily representative of either the 1981 or 1982 model year Nissan vehicles.

Table 1

Test Vehicle Descriptions

	MFR	VID	YEAR/ STANDARD		MODEL	CID(ℓ) / No. of Cyl
1	Ford	9S1-5.8M-H-400	1979	CA	T-BIRD	351(5.8)/8
2	Nissan	FB223	1980	49	280ZX	168(2.8)/6
3	Nissan	FB178	1980	CA	280ZX	168(2.8)/6
4	GM	P0948	1981	49	GRAND PRIX	265(4.3)/8
5	GM	03H2-94472C	1980	CA	CUTLASS SUPREME	260(4.3)/8
6	Ford	8R10Y131366	1978	CA	PINTO	140(2.3)/4
7	GM	4M47AAH202725	1980	50	REGAL	231(3.8)/6
8	Nissan	FB289	N/A		280ZX TURBO	168(2.8)/6
9	Plymouth	D162	1981	49	RELIANT	135(2.2)/4
10	Toyota	MA46100183	1980	50	CELICA SUPRA	156(2.6)/6
11	Chry	B3BK26B4BC184143	1981		K-CAR	135(2.2)/4
12	Ford	1FABP082XBW20356	1981		ESCORT WAGON	98(1.6)/4
13	Ford	1FABP21B3BK15310	1981		FAIRMONT	200(3.3)/6
14	GM	1G1AX68X7B621755	1981		CITATION	173(2.8)/6
15	GM	2G1AW69J6B144479	1981		MALIBU	267(4.4)/8
16	Chry	D160	1981		K-CAR (WGN)	135(2.2)/4
17	Ethyl	1009	N/A		ETHYL LEAN-BURN	163(2.6)/6
18	Dresser	1X69L7L104103	N/A		DRESSER '77 NOVA	350(5.7)/8

Table 1 (Continued)

Test Vehicle Descriptions

	ETW (lb)	TRAN	EGR	AIR	CATALYST ‡	A/F	FUEL METR.	REF
			----- EMISSION CONTROL SYSTEM -----					
1	4500	A3	YES	PUMP	OXD(M)	OPEN	2 bbl	[1]
2	3250	A3	YES	PULSE	OXD(M)	OPEN	EFI	[1]
3	3125	M5	NO	NO AIR	3WY(M)	CLOSED	EFI	[1]
4	3875	L3	YES	PUMP	3WY(P)+OXD(P)	CLOSED	2 bbl	[1]
5	3500	A3	YES	PUMP	3WY(P)	CLOSED	2 bbl	[1]
6	2750	A3	YES	PUMP	3WY(M)+OXD(M)	CLOSED	2 bbl	[1]
7	3750	A3	NO	PUMP	3WY(P)	CLOSED	2 bbl	[1]
8	3250	A3	YES	NO AIR	3WY(M)	CLOSED	EFI	[1]
9	2750	M4	YES	PUMP	3WY(M)+OXD(M)	CLOSED	2 bbl	[1]
10	3000	A4-OD	YES	NO AIR	3WY(M)+3WY(P)	CLOSED	EFI	[1]
11	2750	A3	YES	PUMP	3WY(M)+OXD(M)	CLOSED	2 bbl	[2]
12	2500	M4	YES	PUMP	3WY(M)+OXD(M)	OPEN	2 bbl	[2]
13	3375	A3	YES	PUMP	3WY(M)+OXD(M)	OPEN	1 bbl	[2]
14	3000	A3	YES	PULSE	3WY(M)+OXD(M)	CLOSED	2 bbl	[2]
15	3625	A3	YES	PUMP	3WY(P)+OXD(P)	CLOSED	2 bbl	[2]
16	2625	M4	YES	PUMP	3WY(M)+OXD(M)	CLOSED	2 bbl	None
17	2750	A4-OD	YES	PUMP	NONE	OPEN	3 bbl	[4]
18	4000	A3	YES	NO AIR	3WY(P)	OPEN	SONIC	[3]

‡ 'P' designates a Pelleted catalytic converter, and 'M' designates a Monolith.

The CO exhaust emissions from those test vehicles, over the FTP driving cycle, appear in Appendix 1. The emissions, in grams per mile, are given for the cold start (Bag 1), hot transient (Bag 2), and the hot start (Bag 3) portions of the FTP cycle. Those data are presented graphically, for each vehicle, in Appendix 2.

Data Analyses

As the 18 graphs in Appendix 2 illustrate, the CO emissions during the hot transient (Bag 2) and hot start (Bag 3) portions of the FTP are relatively low and relatively insensitive to the ambient temperature. The only possible exception to this observation could be the performance of three of the four Ford vehicles (see Figures 07, 12, and 13 of Appendix 2). These three vehicles exhibit a trend in low temperature Bag 2 and Bag 3 CO emissions that appear somewhat different from the other vehicles. For the purposes of this report, no special analysis based on this observation was made. However, it may be necessary and appropriate to consider the low temperature Bag 2 and Bag 3 results of vehicles in future test programs, based on this observation.

For this report, the analysis was divided into the following five areas:

1) Analysis of the cold start (Bag 1) CO emissions only. This results in analysis of Bag 1 emissions in grams per mile.

2) Analysis of the amount by which the Bag 1 CO emissions exceeded the Bag 3 CO emissions (i.e., the difference of Bag 1 and Bag 3 emissions). This results in analysis of grams per mile differences.

3) Analysis of the amount by which the Bag 1 CO emissions exceeded the average Bag 1 CO emissions at 75°F for each vehicle. This results in analysis of grams per mile differences.

4) Analysis of the ratio of the Bag 1 CO emissions to the average Bag 1 CO emissions at 75°F. This results in analysis of dimensionless quantities equivalent to percent increases in CO emissions.

5) Analysis of the ratio of the Bag 1 CO emissions to the corresponding Bag 3 emissions. This results in analysis of dimensionless quantities equivalent to percent increase in CO emissions.

For each vehicle, equations were generated to approximate CO emissions by using a "best fit" first-degree and a "best fit" second-degree polynominal in ambient temperature (Appendix 3). The best fit was obtained using the least-squares-fit method, which smoothed the data, and provided an insight into the shape of the CO emissions versus ambient temperature curve. A second set of equations was generated by using results from tests for which the ambient temperature was below 90°F. Selection of a quadratic equation in ambient temperature to model CO emissions was based on a visual observation of the data. That is, the quadratic is tne simplest function that is concave upwards and decreases as temperature increases. In addition, modeling the CO emissions with such a function has been used in the past.[5] For each of the 64 least-squares-fit equations for Bag 1 CO in Appendix 3, we calculated:

1) predicted CO emissions at 20°, 40°, and 75°F,

2) predicted slope of the equation at 20°, 40°, and 75°F,

3) predicted sensitivity of the equation at 20°, 40°, and 75°F, where sensitivity is the per cent change in CO emissions divided by the per cent change in temperature,

4) ratio of the predicted CO emissions at 20°F to those at 75°F.

For each of the four combinations of temperature interval and polynominal degree, we computed correlation coefficients between each of those calculated values and the following eleven (11) vehicle parameters:

1) secondary air (air pump, pulse air, or no air)

2) number of catalysts (0, 1, or 2)

3) equipped with an oxidation catalyst only (yes or no)

4) equipped with a three-way catalyst only (yes or no)

5) equipped with both a three-way and oxidation catalyst (yes or no)

6) type of catalyst (pelletted or monolith)

7) fuel metering system (fuel injected or carbureted)

8) control of air/fuel ratio (open or closed loop)

9) equipped with EGR (yes or no)

10) equivalent test weight (ETW) (in pounds)

11) number of cylinders (4, 6, or 8)

Conspicuous by its absence from the preceding list is a vehicle design parameter directly relating to cold-start fuel enrichment (e.g., choke angle as functions of time and temperature). Thus, this important factor was omitted from the list because no variable was found to consistently represent it for each of the test vehicles. However, some of the characteristics of cold-start fuel enrichment may be inferred from the amount of additional fuel consumed to perform the cold-start relative to the corresponding hot-start (i.e., Bag 1 minus Bag 3 fuel consumption). This difference in total fuel consumed (in grams) appears in Appendix 1.

The matrices of the calculated correlation coefficients appear in Appendix 4. Each correlation coefficient, r, between pairs of variables is the standard product-moment correlation coefficient.* This value is used to describe the strength of the linear relationship (<u>if</u> any) between the two variables being correlated. The tables in Appendix 4 give the correlation coefficients between pairs of actual data (from Appendix 1) and vehicle parameters, between pairs of model predicted data (from Appendix 3) and vehicle parameters, and between pairs of vehicle parameters. The selection of model predicted values was made to allow us to correlate the shape of the CO values was made to allow us to correlate the shape of the CO emission curves (i.e., slope and sensitivity) with the various vehicle parameters.

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*For example, see <u>Introduction to the Theory of Statistics</u> by Yale, G.U., and Kendall; M.G. Hafner Publishing Company, New York 1968, p. 216.

Choice of numerical values on which to base a judgment about whether or not there is a relationship of the type being investigated is always a matter of choice. For this analysis we judged the variables to be linearly related, if we can accept that null hypothesis of linear dependence at the 0.01 significance level. The only vehicle parameters thus defined which correlated highly (either positively or negatively) with the low temperature CO values (either actual or calculated) were those related to the fuel metering system, secondary air system, ETW, and possession of only a three-way catalyst. Unexpectedly, the ratio of the CO emissions at 20°F to CO emissions at 75°F (or equivalently, the percent of increase in the CO emissions at lower temperatures) did not correlate highly with any of those eleven vehicle parameters. Possession of only a three-way catalyst was dropped as a significant variable because of its high correlation with secondary air systems.

The increase in Bag 1 relative to Bag 3 CO emissions (i.e., Bag 1 minus Bag 3 emissions) correlated highly with the corresponding increase in fuel consumption at ambient temperatures below the FTP temperature range (68°F to 86°F). (Appendix 4) It, therefore, appears likely that the temperature-related increases in CO emissions are due to the cold-start fuel enrichment system.

We then used both stepwise forward and stepwise backward regression analyses to model the actual cold-start CO emissions as a function of the three (3) continous variables: TEMP (ambient temperature), TEMP.2 (square of the ambient temperature), and ETW. The TEMP variables were chosen because of the success in modeling individual car CO results (see Appendix 3). ETW was chosen because, in the correlation matrices in Appendix 4, ETW was almost always the next most highly correlated variable in the linear sense after the three following categorical variables which were previously determined to be (linearly) related to cold weather CO at the 0.01 level of significance:

PMP (0 = No air pump, 1 = Has air pump)
PLS (0 = No pulse air, 1 = Has pulse air)
FS (0 = EFI, 1 = Carbureted)

It is important to note that, in this sample of 16 cars, those six variables are not independent. The variables PMP and PLS are, of course, always mutually exclusive (i.e., no car is equipped with both an air pump system and a pulse air injection system). However, in this study, the type of secondary air injection system (PMP or PLS) correlates highly with the type of fuel metering system (FS): all the test vehicles with air pumps were carbureted, while all the vehicles without secondary air were fuel injected. Thus, for this sample of 16 cars, the combinations of the categorical variables produce only four, rather than six, subsets with data in them.

Stepwise forward regression analyses were performed using those variables, products of those variables with the categorical variables, and with products of the categorical variables. Stepwise backward regression analyses had to be performed with a reduced set of variables because the matrix of coefficients used by the MIDAS statistical program became singular when all the variable and product terms were used.

The end results of those regression analyses are given in Appendix 5. Those results indicate that the CO emissions can be modeled using those variables, and those models yield multiple-Rs of about 88 percent for the vehicles in this sample. In light of the high degree of correlation among what should be independent variables, the final regression equations are not vital. What is important, however, is the fact that the most critical variable (after "temperature") in modeling cold-start CO emissions is the fuel metering system (FS) and possibly air systems. This observation is illustrated in Figures 1 to 3.

Equally important is the fact that attempts to model the ratio of increase in CO emissions from 75°F resulted in multiple Rs of 0.66 to 0.68. Thus, the proportion of the variability (the square of R) in that ratio of CO emissions that is explained by temperature, ETW, and the categorical variables is less than 46 percent. This seems to indicate that use of a multiplicative form of "correction factor" to calculate cold weather CO may not be as good as an additive form.

If we use the results of the regression analyses in Appendix 5, not to predict CO emissions, but rather to predict the <u>difference</u> in CO emissions between the carbureted and fuel injected vehicles at low ambient temperatures (i.e., 20°F), the equations predict:

1) Cold-start CO emissions of the carbureted vehicles exceed those of the fuel injected vehicles by 72 grams per mile. (The actual data indicate 79.6 grams per mile.)

2) The increase in cold-start CO emissions from 75°F to 20°F for the carbureted vehicles exceeded by 65 grams per mile the corresponding increase for the fuel injected vehicles. (The actual data indicate 74.2 grams per mile.)

These predictions are borne out by Figures 1 and 2.

Figure 1

Average Bag 1 CO Emissions Versus Ambient Temperature
(Means of Actual Data from Appendix 1)
Stratified by Fuel Metering & Secondary Air Systems

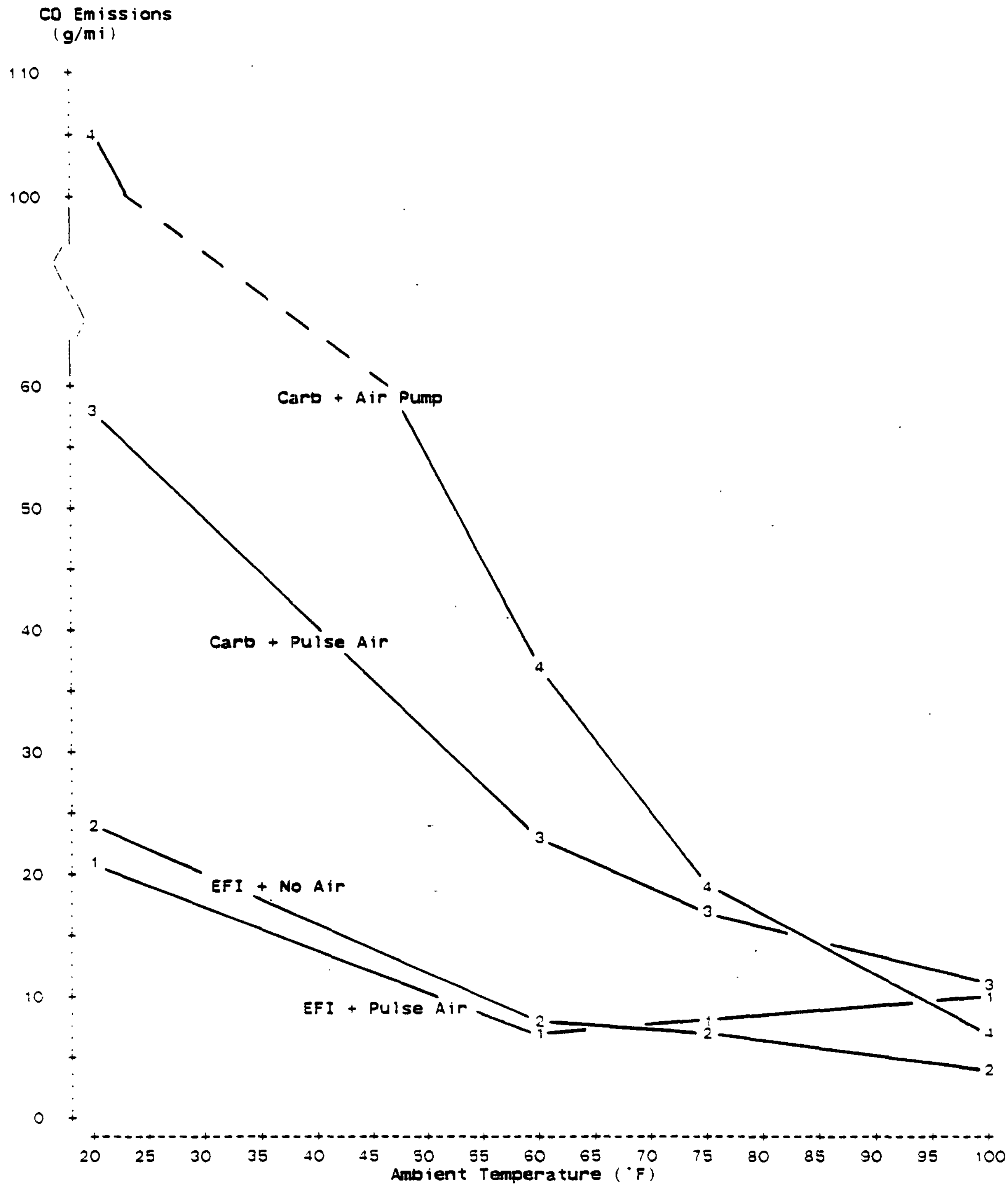


Figure 2

Average Difference between Bag 1 CO Emissions and Bag 1 CO Emissions at 75°F Ambient Temperature
(Means of Actual Data from Appendix 1)
Versus Ambient Temperature
Stratified by Fuel Metering & Secondary Air Systems

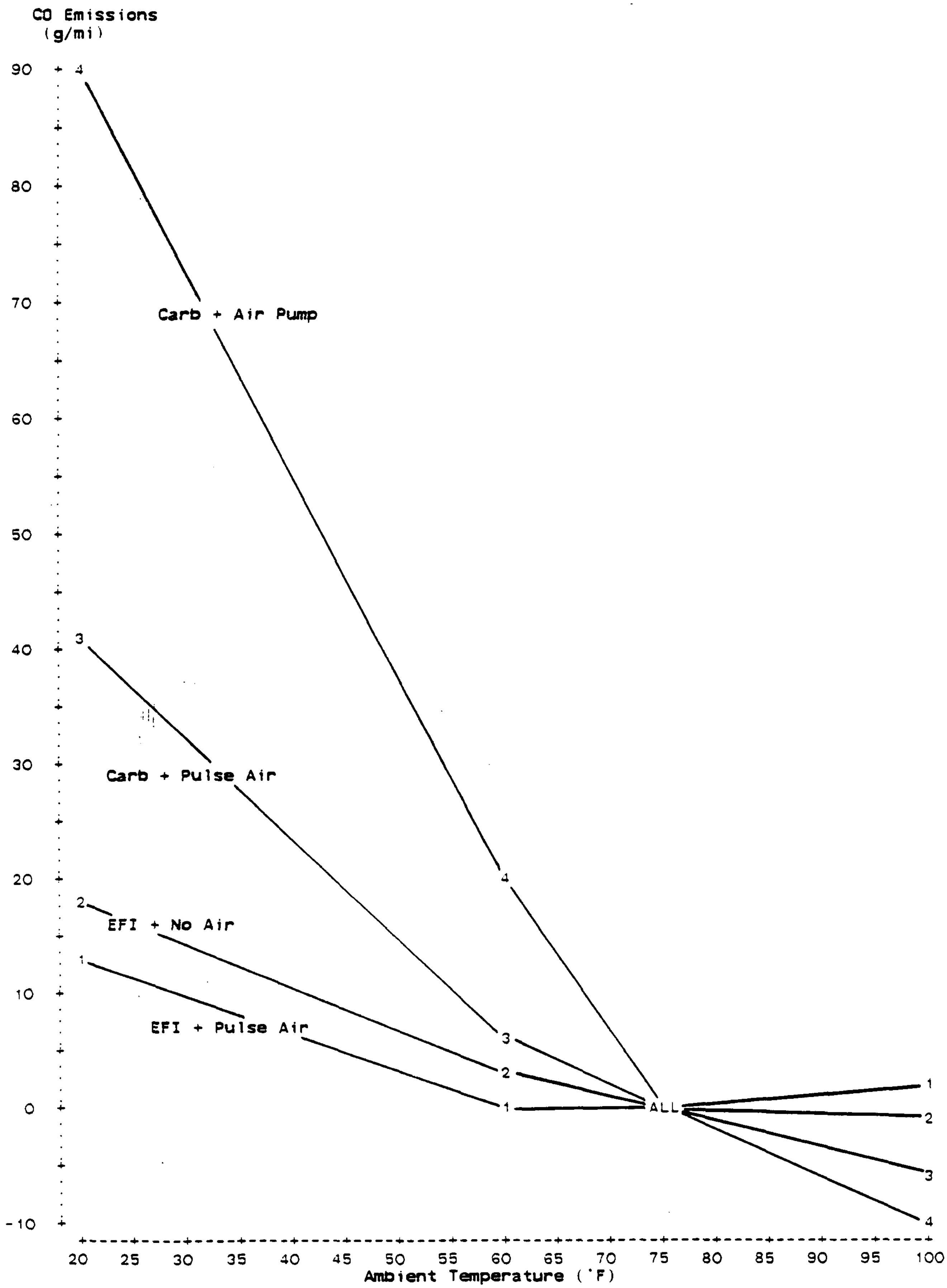
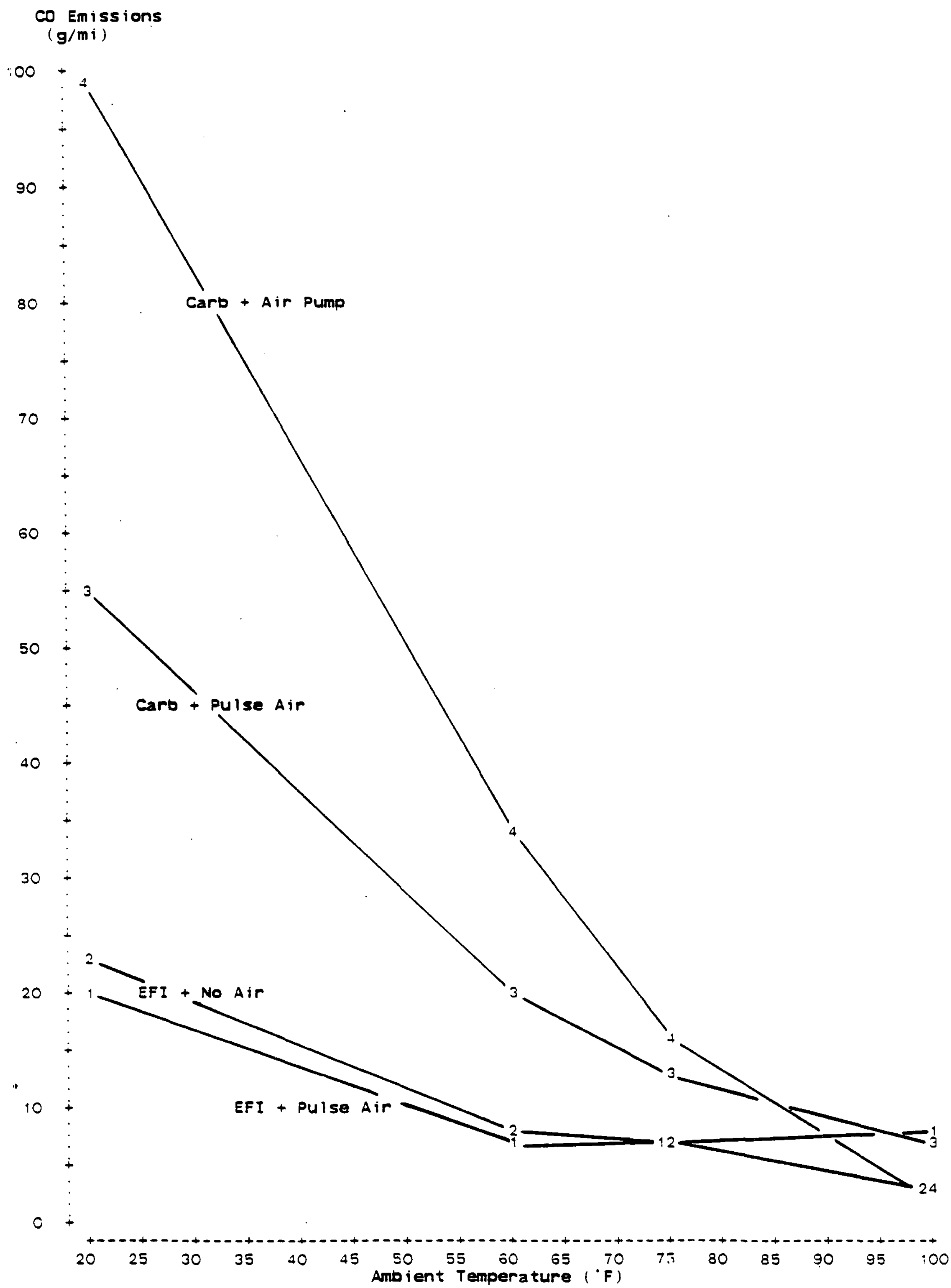


Figure 3

Average Difference between Bag 1 CO Emissions and Bag 3 CO Emissions Versus Ambient Temperature
(Means of Actual Data from Appendix 1)
Stratified by Fuel Metering & Secondary Air Systems



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APPENDIX 1

CO Emission Data from FTP Driving Cycle

Appendix 1

CO Emissions Data from FTP Driving Cycle

Vehicle I.D.	Temp (°F)	Test Number	--- CO Emissions (g/mi) --- Bag 1	Bag 2	Bag 3	ΔFuel Used*
9S1-5.8M-H-400	20.0	801423	201.919	4.318	9.989	313.1
1979 Ford T-Bird	60.0	801424	105.835	0.601	9.409	227.5
	60.0	801427	106.355	2.201	7.220	194.6
	74.0	801454	46.897	0.632	7.761	158.4
	75.0	801632	47.816	0.921	9.352	151.3
	75.0	801648	53.442	0.709	5.725	170.4
	100.0	801579	13.369	3.259	20.331	84.7
	101.0	801580	10.528	3.127	13.388	59.0
FB223	21.0	802513	22.348	0.0	0.072	202.6
1980 49-State	22.0	802514	19.172	0.0	0.537	173.4
Datsun 280ZX	60.0	801642	7.280	-0.007	0.567	114.5
	60.0	801644	7.173	0.019	0.019	126.6
	74.0	801641	6.219	0.019	1.569	34.9
	75.0	801640	9.375	0.014	0.513	90.8
	75.0	802414	6.253	0.012	1.283	203.5
	75.0	802578	8.661	0.005	0.969	41.2
	99.0	801639	9.571	0.025	1.444	55.6
	100.0	801643	8.088	0.029	1.270	60.7
	100.0	802413	11.101	0.0	2.360	50.4
FB178	20.0	802687	30.701	1.239	1.520	173.5
1980 California	20.0	802810	27.514	1.342	1.434	164.0
Datsun 280ZX	60.0	802586	10.797	0.960	0.966	97.1
	60.0	802589	10.375	1.042	0.901	97.6
	75.0	802434	11.102	1.044	0.871	87.4
	75.0	802435	7.010	1.143	0.852	77.6
	75.0	802681	13.953	1.250	1.342	97.8
	75.0	802684	7.666	0.737	1.201	75.2
P0948	20.0	803474	141.126	0.221	0.812	441.6
1981 Grand Prix	20.0	803476	159.249	0.096	1.189	456.8
	60.0	803098	77.532	0.116	0.678	272.4
	60.0	803101	69.041	0.106	1.030	246.5
	75.0	803092	9.597	0.321	2.803	132.0
	75.0	803095	10.308	0.184	3.060	130.0
	100.0	803404	5.162	0.096	1.784	92.0
	101.0	803479	3.604	0.062	0.709	89.3
03H2-94472C	20.0	803783	98.346	0.702	0.648	265.2
1980 Cutlass Sup	20.0	803786	107.345	0.400	0.655	271.3
	60.0	803597	39.290	0.326	0.622	139.5
	62.0	803590	38.939	0.323	0.892	126.9
	74.8	803777	10.487	0.229	0.590	96.6
	75.0	803593	12.910	0.284	0.658	96.5
	75.0	803776	14.462	0.314	0.849	90.9
	100.0	803779	7.305	0.649	2.411	27.0
	100.0	803781	6.653	0.275	1.266	36.3

* ΔFuel Used is the amount of fuel (in grams) consumed during Bag 1 minus the amount consumed during Bag 3. (Fuel consumption was calculated using carbon balance equations.)

Appendix 1 (Continued)

CO Emissions Data from FTP Driving Cycle

Vehicle I.D.	Temp (°F)	Test Number	--- CO Emissions (g/mi) --- Bag 1	Bag 2	Bag 3	ΔFuel Used
8R10Y131366	20.0	803933	97.613	5.910	17.919	184.8
1978 Ford Pinto	20.0	803936	88.559	5.554	23.145	154.8
	60.0	803674	27.947	0.066	0.611	116.3
	60.0	803676	27.297	0.329	0.460	81.9
	75.0	803663	22.836	0.178	1.077	91.6
	75.0	803665	17.875	0.122	1.127	76.3
	100.0	803668	2.238	1.098	3.157	27.3
	100.0	803671	6.124	1.600	3.413	14.0
4M47AAH202725	20.0	804131	64.178	4.942	5.065	312.5
1980 Buick Regal	20.0	804134	56.155	5.601	4.898	282.6
	60.0	804120	17.679	5.000	5.320	110.7
	60.0	804121	21.757	6.136	5.458	142.7
	75.0	804114	19.690	4.978	6.991	106.1
	100.0	804124	10.289	8.589	9.873	46.1
	100.0	804126	8.762	7.101	9.148	42.3
FB289	20.0	805435	12.440	0.567	0.532	188.5
1981.5 Datsun	20.0	805438	20.557	0.548	0.501	221.6
280ZX Turbo	20.0	805441	10.744	0.633	1.467	190.2
	20.0	806124	14.897	0.564	1.319	205.8
	60.0	805432	4.366	0.487	0.488	106.6
	60.0	805451	4.661	0.537	0.538	105.9
	60.0	805821	5.282	0.614	0.533	106.7
	60.0	806114	7.690	0.681	1.853	106.3
	75.0	805377	3.458	0.528	0.529	82.0
	75.0	805380	2.853	0.667	0.566	86.3
	100.0	805372	3.891	0.625	0.697	61.7
	100.0	805375	5.369	0.527	0.838	57.9
D162	20.0	806250	54.110	0.599	2.258	214.7
1981 Ply Reliant	20.0	806253	48.207	0.373	2.886	191.3
	60.0	806241	14.062	0.631	2.472	74.0
	60.0	806244	15.979	0.652	2.447	86.0
	75.0	806232	7.408	0.619	2.496	52.6
	75.0	806235	9.771	0.656	2.909	55.8
	100.0	806239	6.313	0.658	2.525	34.1
	100.0	806247	7.217	1.594	2.247	41.7
	100.0	806402	6.838	0.789	0.862	23.3

Appendix 1 (Continued)

CO Emissions Data from FTP Driving Cycle

Vehicle I.D.	Temp (°F)	Test Number	--- CO Emissions (g/mi) --- Bag 1	Bag 2	Bag 3	ΔFuel Used
MA46100183	20.0	806710	36.404	0.486	0.455	236.6
1980 Celica Supra	20.0	806713	36.169	0.469	0.644	241.7
	60.0	806704	10.590	0.436	0.281	123.5
	60.0	806707	13.954	0.490	0.290	122.7
	71.5	805387 ‡	70.073	61.705	55.500	109.7
	72.5	805537	6.873	0.217	0.167	98.1
	73.0	806359	6.685	0.113	0.129	87.2
	74.5	805383	5.234	0.207	0.203	115.2
	74.5	806357	6.490	0.324	0.229	98.6
	75.0	805385	6.887	0.292	0.332	107.4
	75.0	806361	5.440	0.417	0.573	68.5
	75.0	806698	10.784	0.678	0.494	95.9
	75.0	806701	5.987	0.416	0.235	98.9
	100.0	806690	3.137	0.339	0.455	50.0
	100.0	806693	3.163	0.394	0.340	49.0
B3BK26B4BC184143	22.0	810713	125.399	0.383	6.093	256.1
1981 Chry K-Car	59.0	810711	23.944	0.363	5.055	64.2
	72.5	810697	22.938	0.369	2.545	79.2
	97.0	810734	12.355	0.961	2.552	48.2
1FABP082XBW20356	23.0	810849	78.402	1.093	16.846	135.6
1981 Escort Wagon	58.5	810826	14.142	0.645	4.084	88.0
	75.0	810822	11.206	1.256	5.376	62.8
	98.0	810824	10.620	2.117	7.376	44.6
1FABP21B3BK15310	22.2	810575	136.083	78.495	5.434	208.8
1981 Fairmont	59.0	810573	3.578	0.012	0.453	134.3
	74.0	810569	3.980	0.029	1.362	89.7
	100.0	810571	3.853	0.069	1.943	81.9
1G1AX68X7B621755	22.0	810752	58.147	0.091	3.144	219.1
1981 Citation	60.5	810750	23.018	0.176	2.750	92.0
	75.0	810746	17.174	0.059	3.965	76.6
	101.5	810748	11.036	0.156	3.564	62.0
2G1AW69J6B144479	18.7	811194	133.036	0.182	1.900	421.8
1981 Chev Malibu	60.0	811188	8.836	0.049	2.908	139.5
	73.6	811180	9.080	0.059	1.780	107.2
D160	20.0	807526	97.453	0.722	2.459	317.9
1981 Chry K-Wagon	60.0	807528	21.637	0.329	2.699	106.8
	75.0	807389	12.710	0.392	2.780	85.8
	75.0	807392	13.355	0.584	2.469	84.2
	100.0	807381	7.043	0.460	2.277	53.2
	100.0	807386	6.646	0.876	2.153	53.8

‡ Designates a questionable test result which was omitted from the analyses. (A result was deleted if it differed from the corresponding mean for that vehicle at that temperature by more than two standard deviations.)

Appendix 1 (Continued)

CO Emissions Data from FTP Driving Cycle

Vehicle I.D.	Temp (°F)	Test Number	--- CO Emissions (g/mi) --- Bag 1	Bag 2	Bag 3	ΔFuel Used
1009	20.0	809475	150.003	3.322	7.184	339.5
Ethyl Lean-Burn	20.0	809476	158.684	3.953	7.598	381.0
	21.0	809345	154.993	3.313	7.385	340.5
	33.5	809332	107.788	3.482	7.635	257.2
	40.0	809474	105.557	3.176	7.686	253.3
	40.0	809571	115.058	2.934	7.966	296.6
	40.0	809572	108.803	3.324	7.534	285.9
	60.0	809477	36.001	3.570	8.609	129.2
	60.0	809478	63.548	3.206	8.757	199.4
	60.0	809479	59.767	2.479	7.610	172.4
	70.0	809205	15.382	3.838	7.382	83.0
	73.5	809006	48.858	3.281	5.670	133.9
	75.0	809209	16.260	3.316	8.558	78.2
	75.0	809349	19.304	2.527	8.317	103.7
	75.0	809350	19.817	2.699	7.491	92.2
	75.0	809573	14.389	2.799	8.327	119.9
	75.0	809582	15.860	2.626	10.614	122.9
1X69L7L104103	20.0	808193	37.131	0.398	0.776	298.8
Dresser '77 Nova	20.0	808199	29.861	0.098	0.645	264.4
	28.0	808195	18.898	0.044	0.344	207.9
	40.0	808189	9.574	1.003	1.229	186.6
	40.0	808191	12.543	0.804	0.959	156.8
	40.0	808200	5.241	0.816	0.979	180.7
	40.0	808202	12.264	1.277	1.125	182.6
	60.0	808185	4.464	1.511	4.701	87.9
	60.0	808187	4.325	1.555	1.095	102.8
	60.0	808205	5.679	1.836	2.757	89.8
	60.0	808455	4.046	1.935	1.849	170.3
	60.0	808464	4.059	2.729	2.119	133.2
	72.0	808112	3.527	1.291	1.785	106.7
	75.0	808149	3.618	1.105	1.735	104.0
	75.0	808181	2.320	1.151	1.108	70.9
	75.0	808183	2.230	1.012	0.858	59.7
	75.0	808463	3.022	1.417	1.164	121.6

APPENDIX 2

Plots of CO Emissions for Each Test Vehicle

(Bag-by-Bag)

(Note: All CO scales are not the same.)

Figure 01

Scatter Plot of Bag-1 (1), Bag-2 (2), Bag-3 (3) CO Emissions versus Ambient Temperature

Vehicle No. 9S1-5.8M-H-400, Ford 1979 California T-BIRD (351 cid)

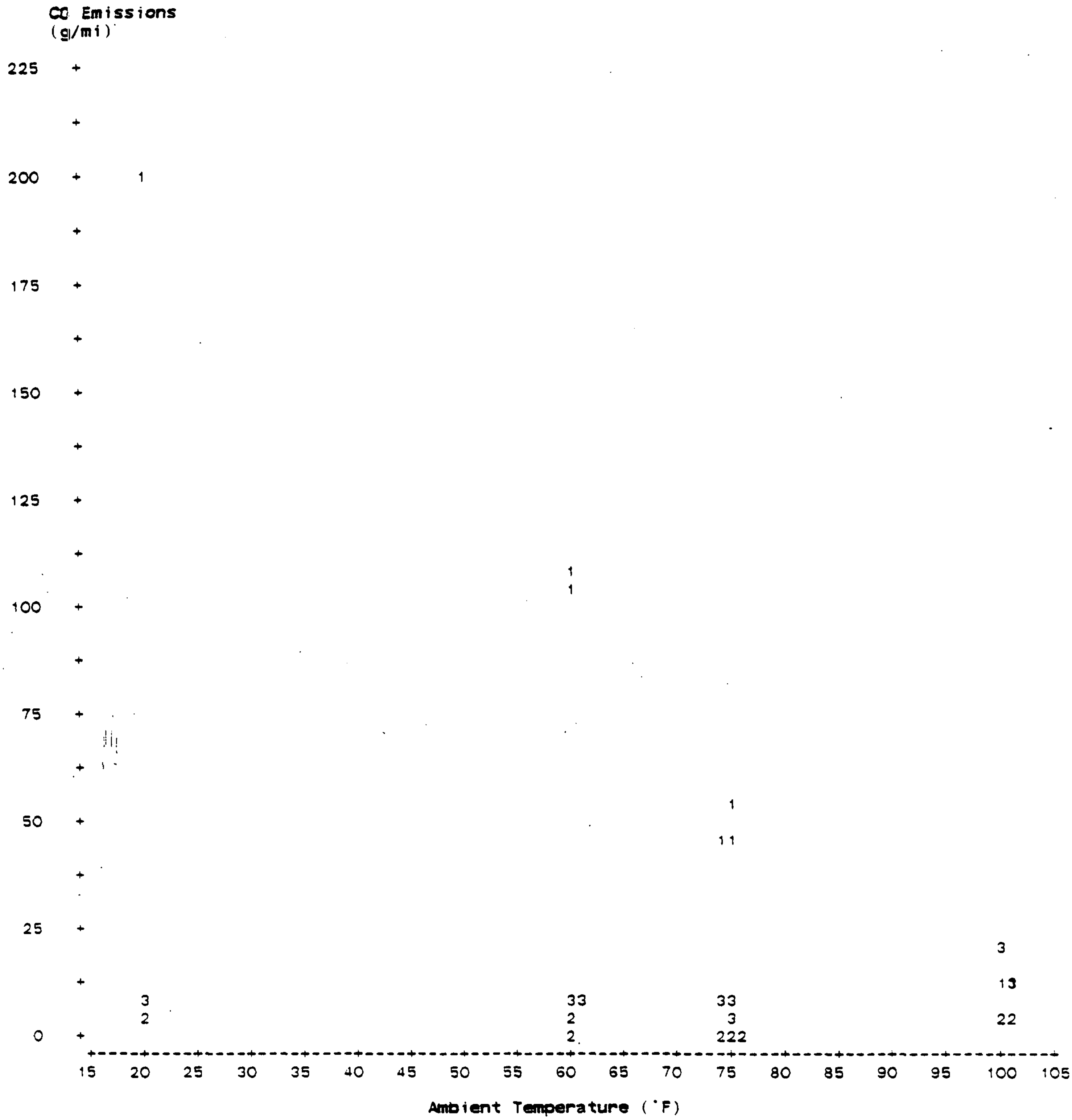


Figure 02

Scatter Plot of Bag-1 (1), Bag-2 (2), Bag-3 (3) CO Emissions versus Ambient Temperature

Vehicle No. FB223, Nissan 1980 49-State 280ZX (168 cid)

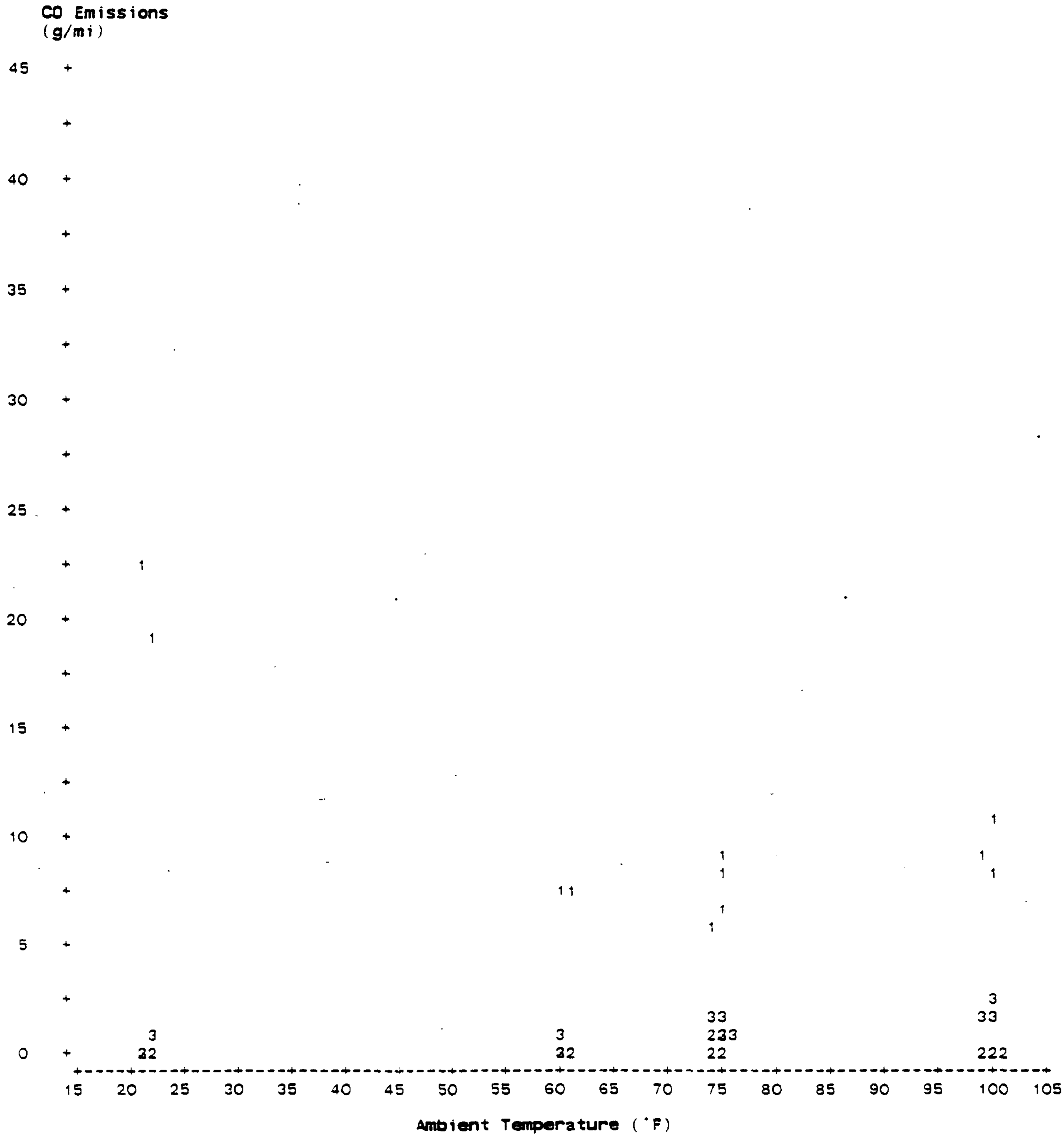


Figure 03

Scatter Plot of Bag-1 (1), Bag-2 (2), Bag-3 (3) CO Emissions versus Ambient Temperature

Vehicle No. FB178, Nissan 1980 California 280ZX (168 cid)

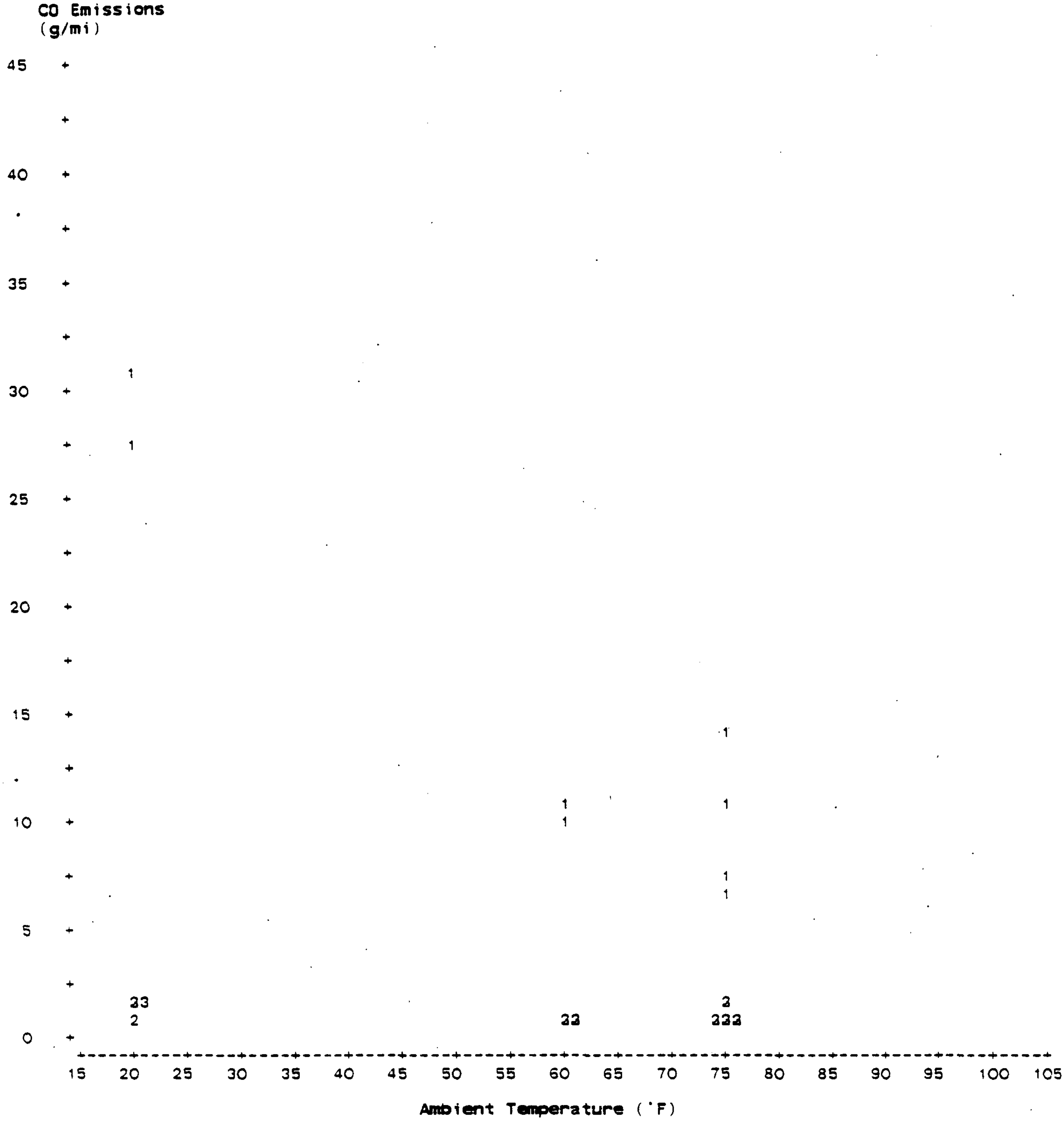
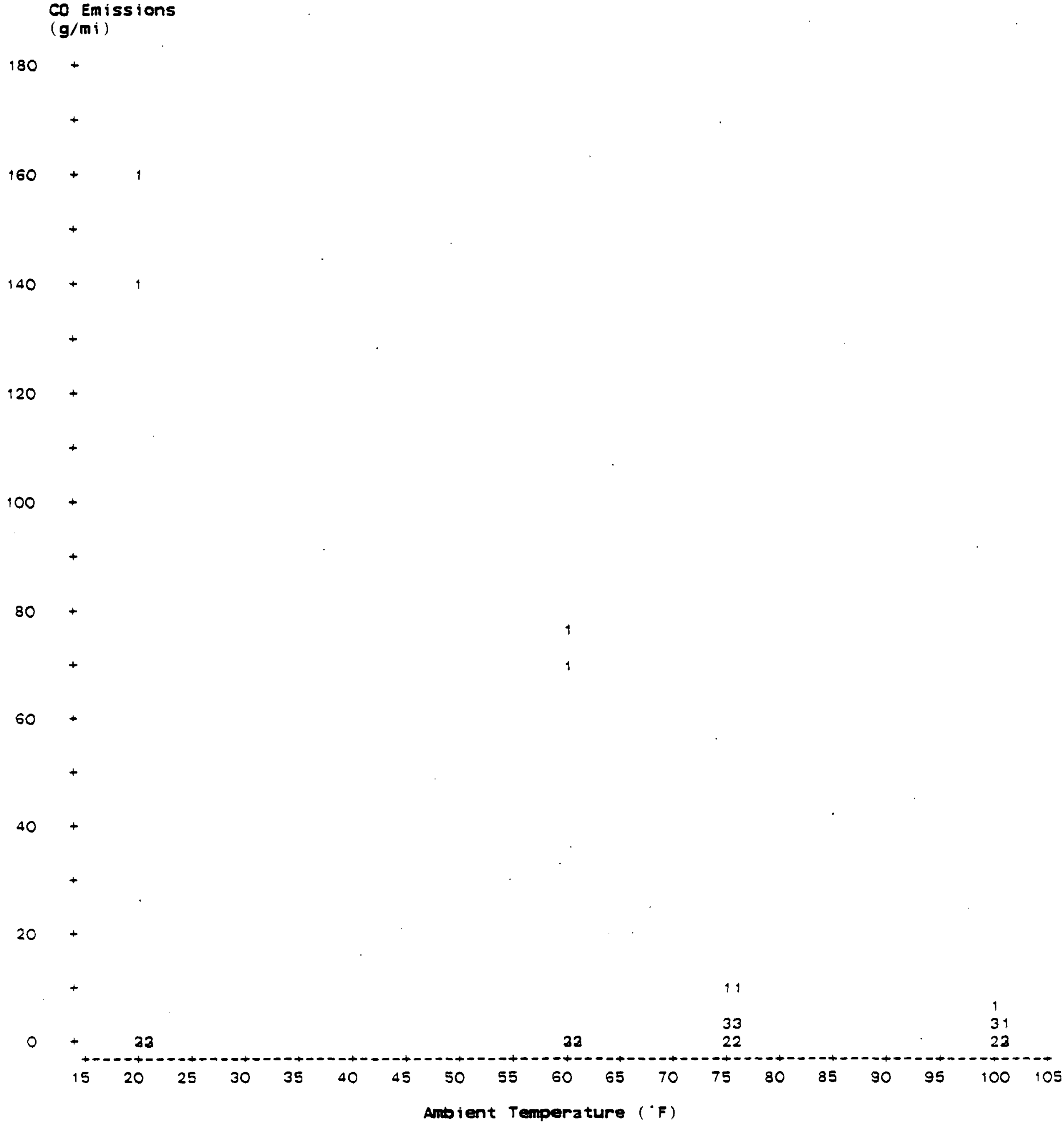


Figure 04

Scatter Plot of Bag-1 (1), Bag-2 (2), Bag-3 (3) CO Emissions versus Ambient Temperature

Vehicle No. P0948, GM 1981 49-State GRAND PRIX (265 cid)



. Figure 05

Scatter Plot of Bag-1 (1), Bag-2 (2), Bag-3 (3) CO Emissions versus Ambient Temperature

Vehicle No. 03H2-94472C, GM 1980 California CUTLASS SUPREME (260 cid)

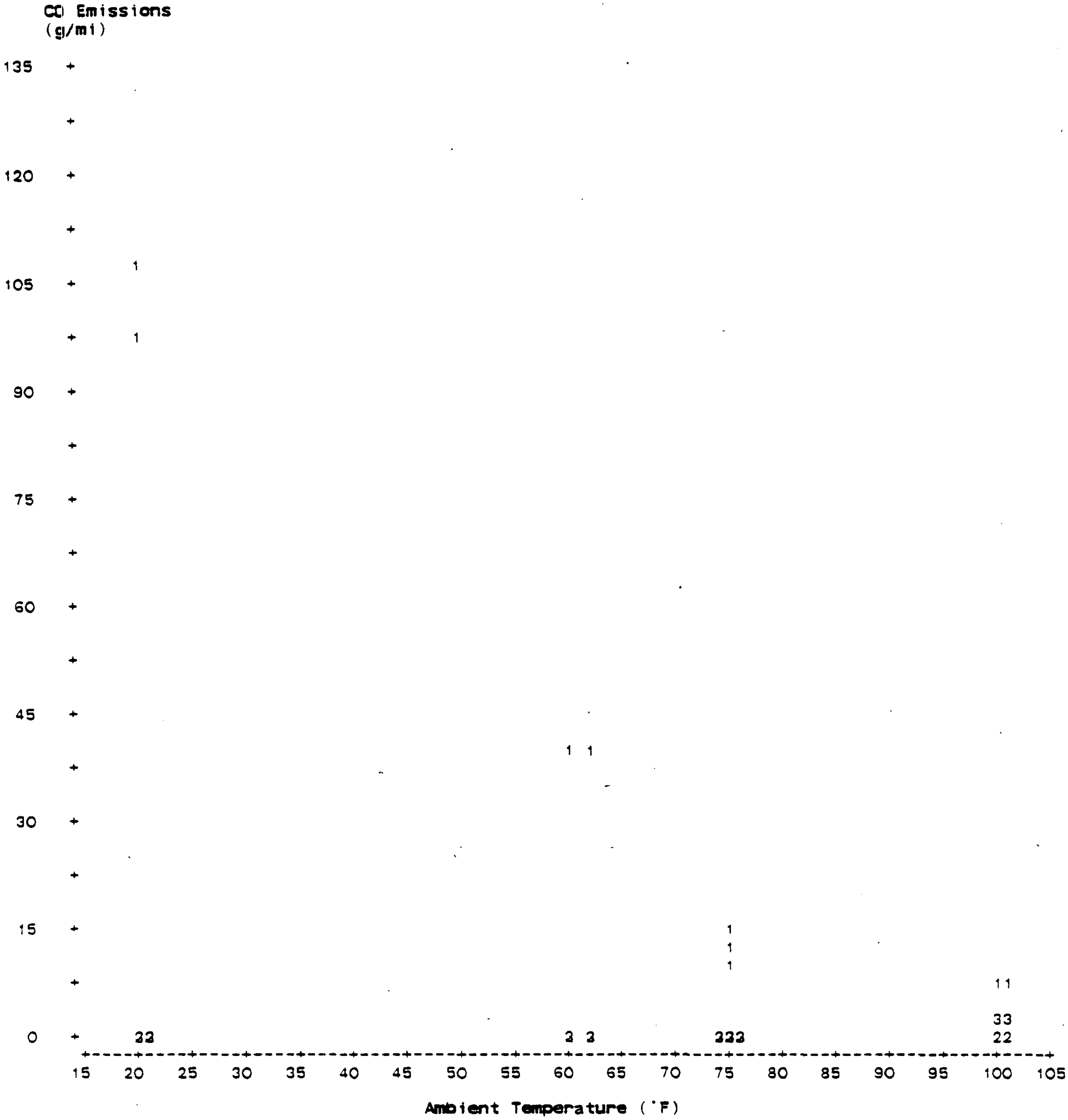


Figure 06

Scatter Plot of Bag-1 (1), Bag-2 (2), Bag-3 (3) CO Emissions versus Ambient Temperature

Vehicle No. 8R10Y131366, Ford 1978 California PINTO (140 cid)

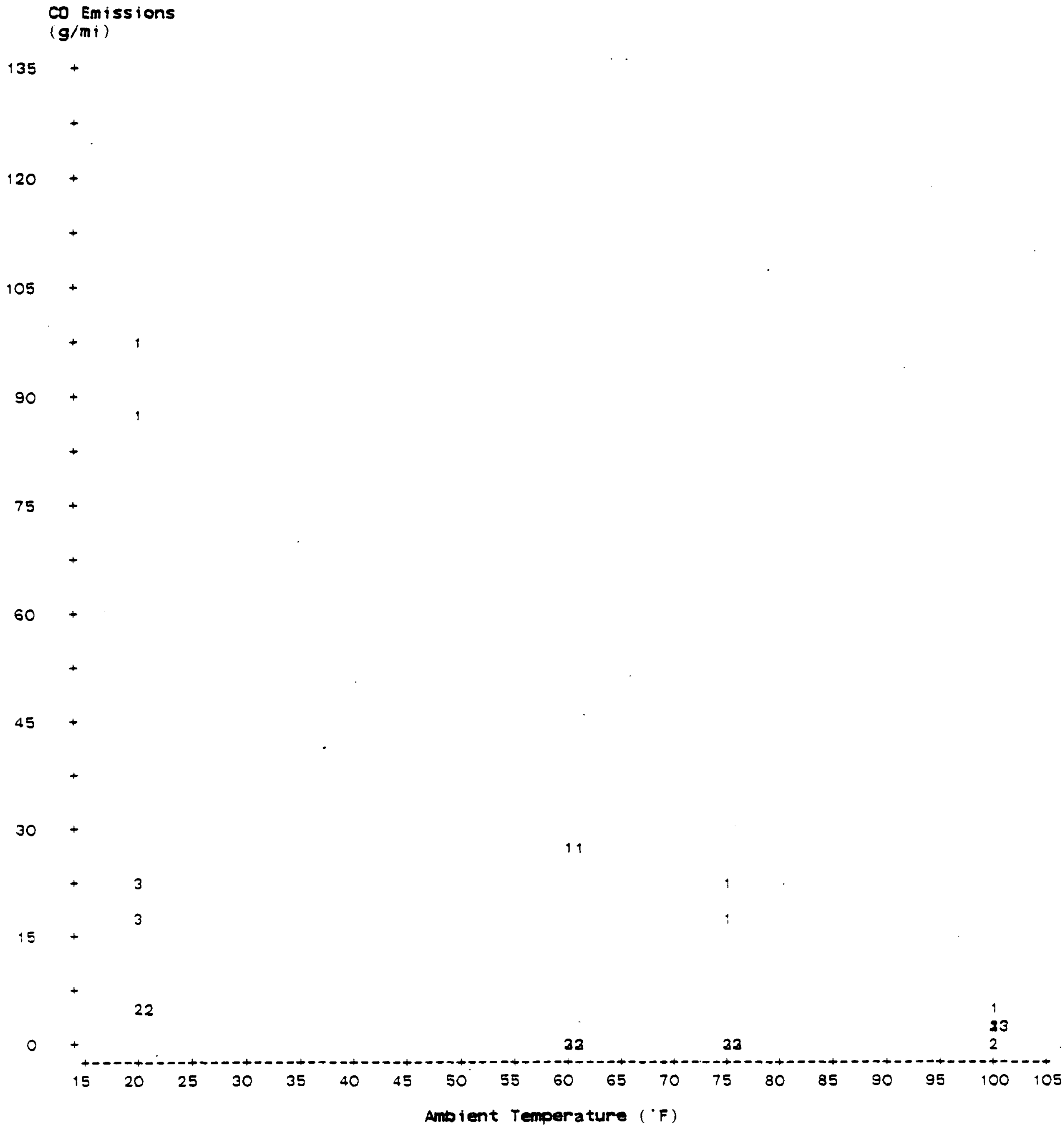


Figure 07

Scatter Plot of Bag-1 (1), Bag-2 (2), Bag-3 (3) CO Emissions versus Ambient Temperature

Vehicle No. 4M47AAH202725, GM 1980 50-State REGAL (231 cid)

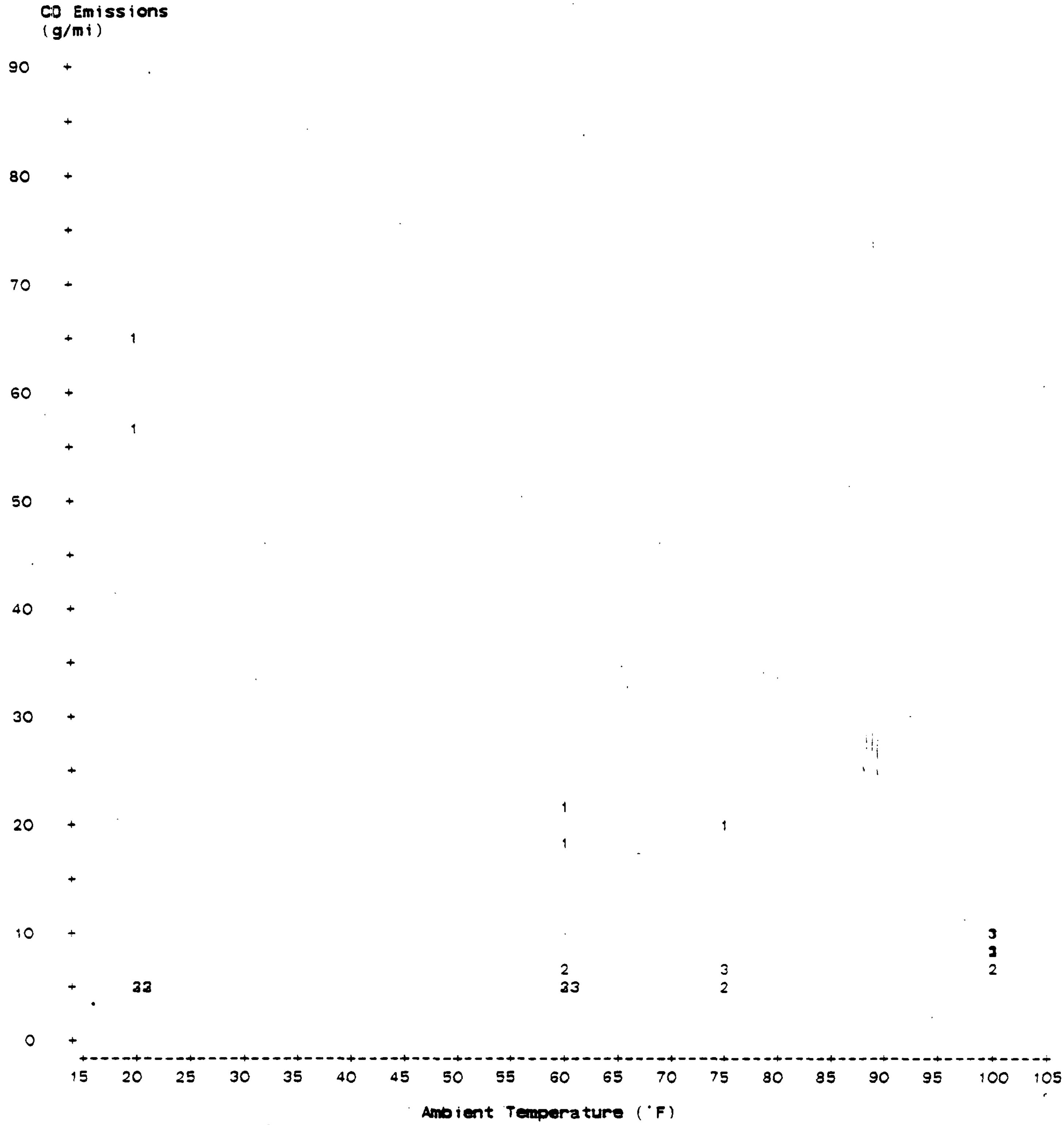


Figure 08

Scatter Plot of Bag-1 (1), Bag-2 (2), Bag-3 (3) CO Emissions versus Ambient Temperature

Vehicle No. FB289, Nissan 1981.5 49-State 280ZX TURBO (168 cid)

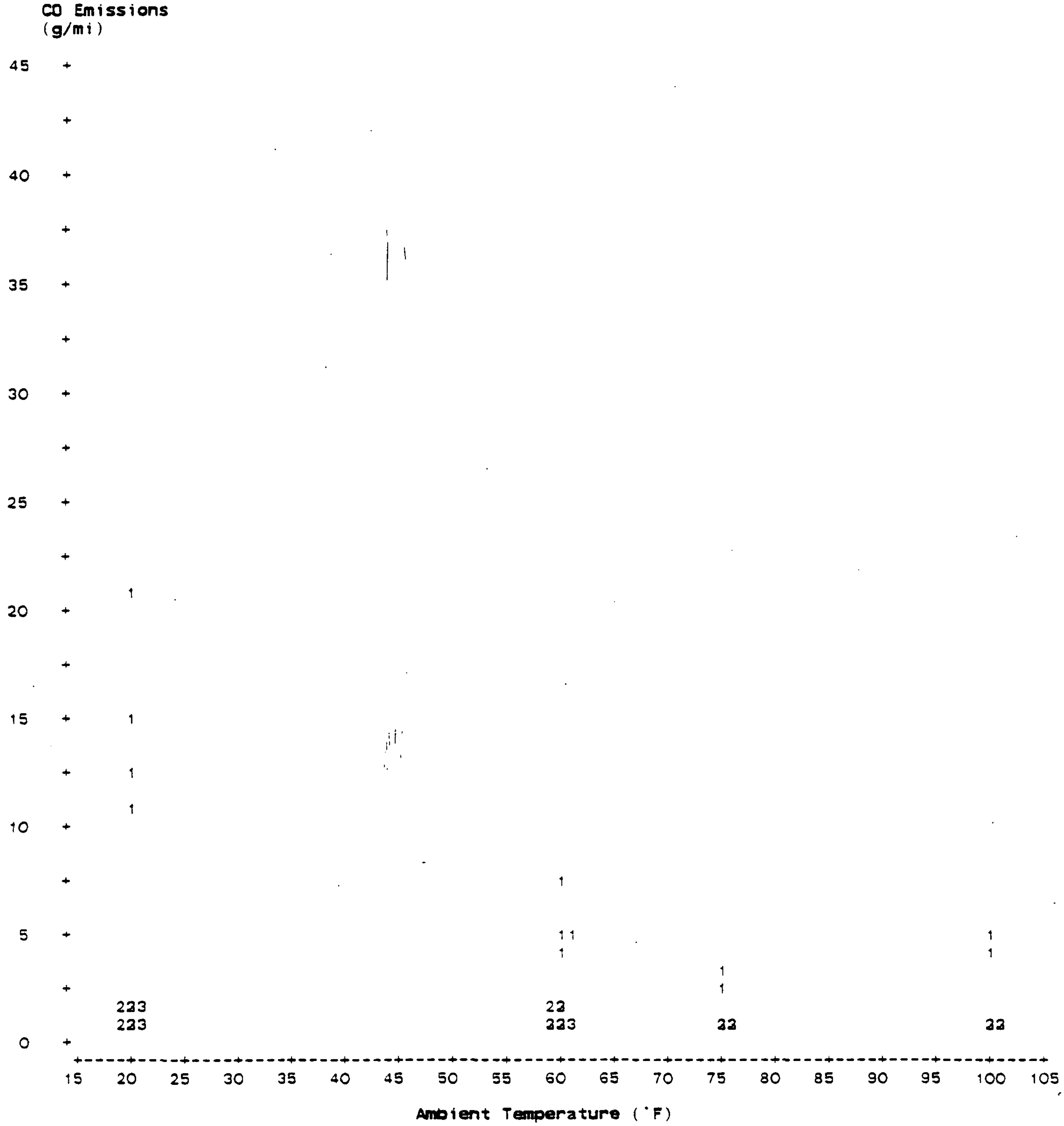


Figure 09

Scatter Plot of Bag-1 (1), Bag-2 (2), Bag-3 (3) CO Emissions versus Ambient Temperature

Vehicle No. D162, Plymouth 1981 49-State RELIANT (135 cid)

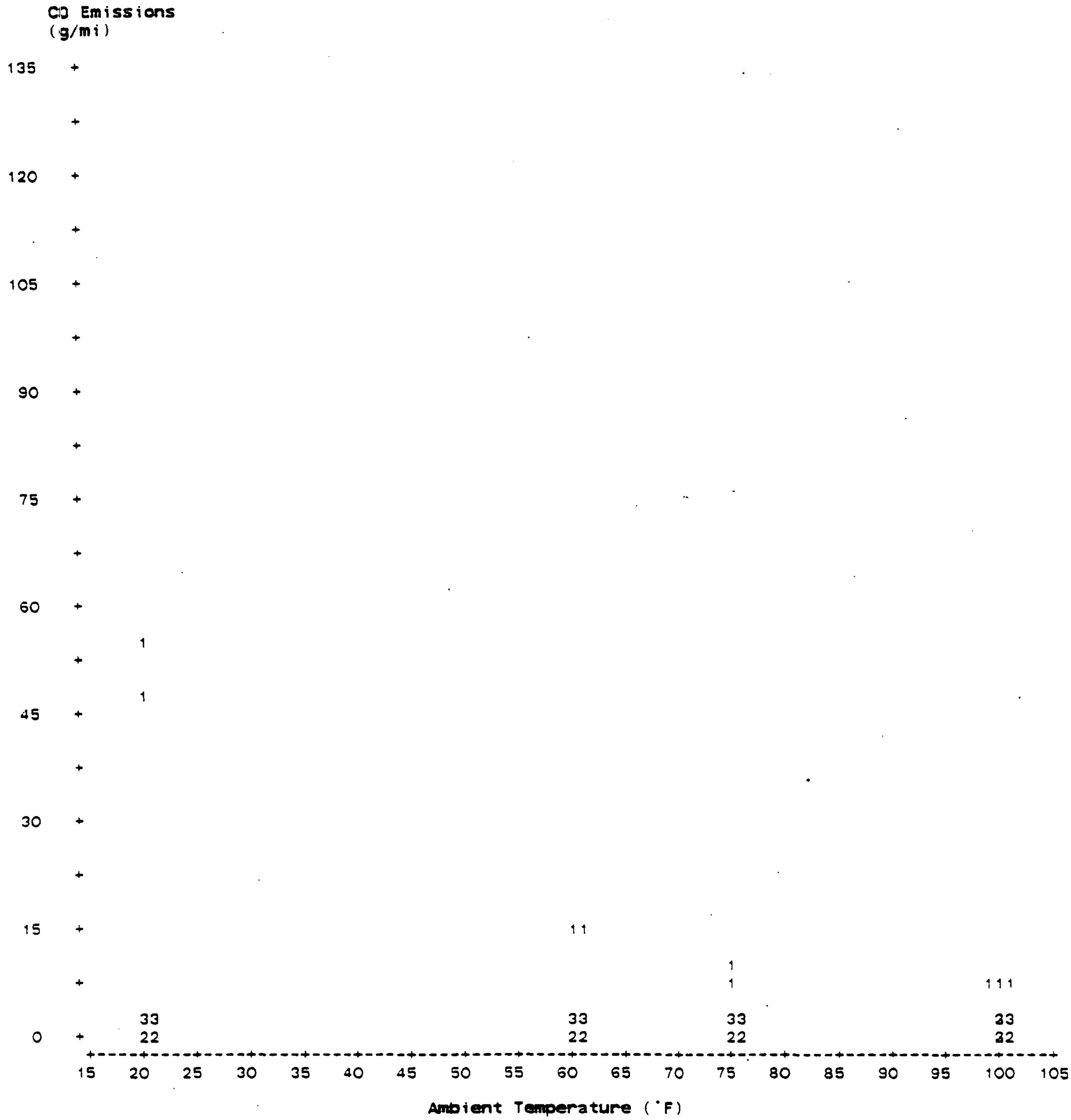


Figure 10

Scatter Plot of Bag-1 (1), Bag-2 (2), Bag-3 (3) CO Emissions versus Ambient Temperature

Vehicle No. MA46100183, Toyota 1980 50-State CELICA SUPRA (156 cid)

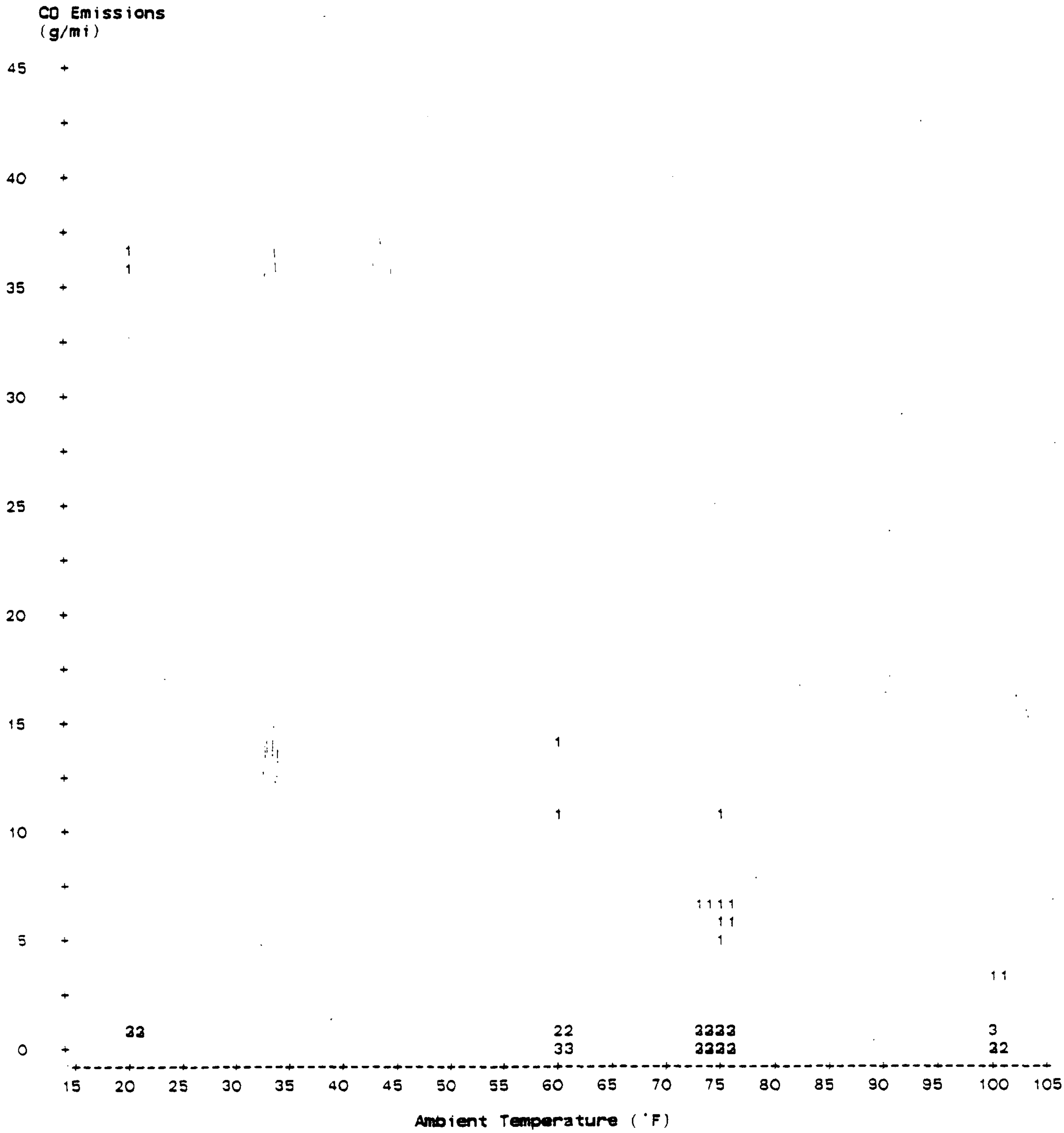


Figure 11

Scatter Plot of Bag-1 (1), Bag-2 (2), Bag-3 (3) CO Emissions versus Ambient Temperature

Vehicle No. B3BK26B4BC184143, Chrysler 1981 K-CAR (135 cid)

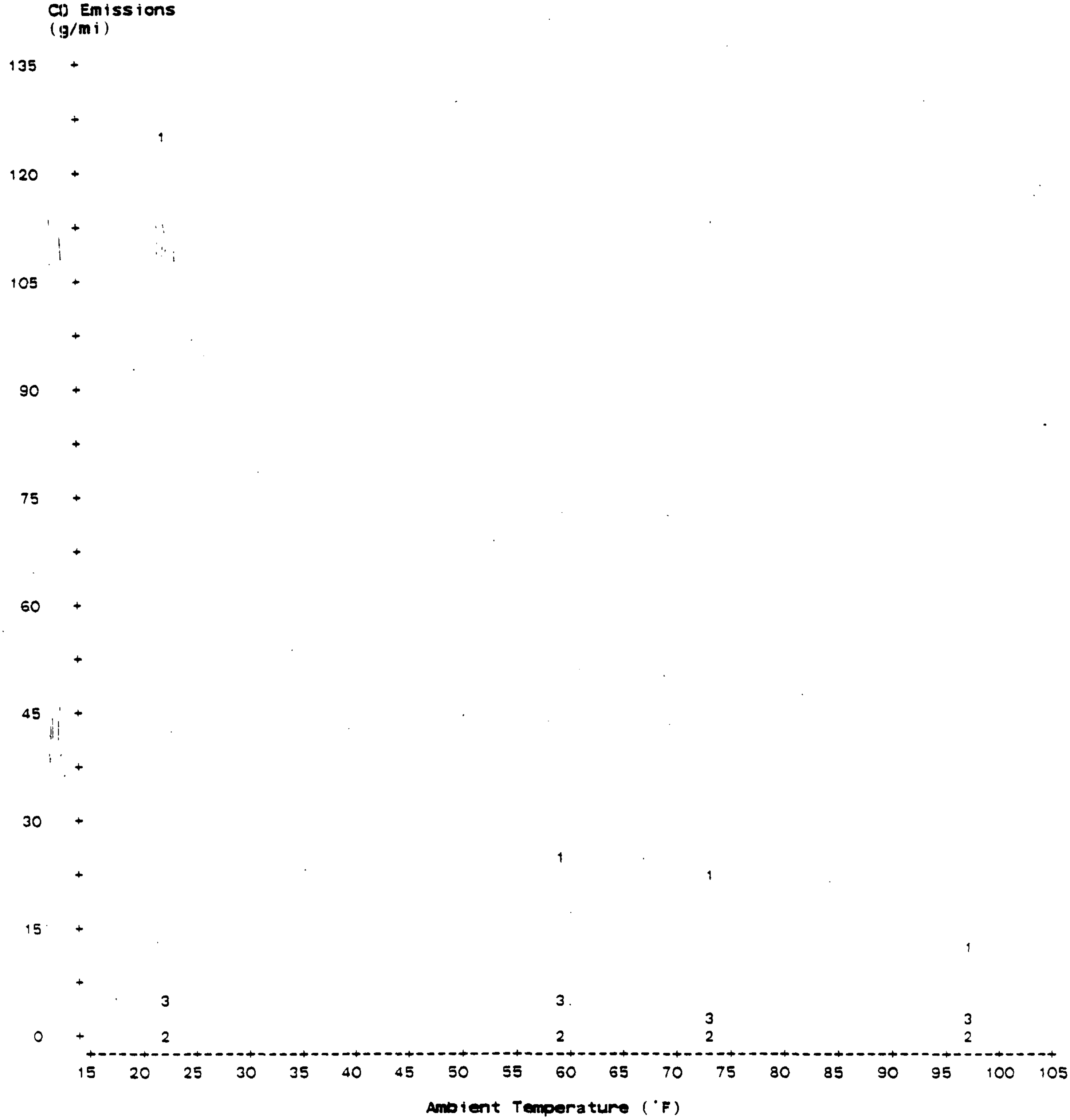


Figure 12

Scatter Plot of Bag-1 (1), Bag-2 (2), Bag-3 (3) CO Emissions versus Ambient Temperature

Vehicle No. 1FABP082XBW20356, Ford 1981 ESCORT WAGON (98 cid)

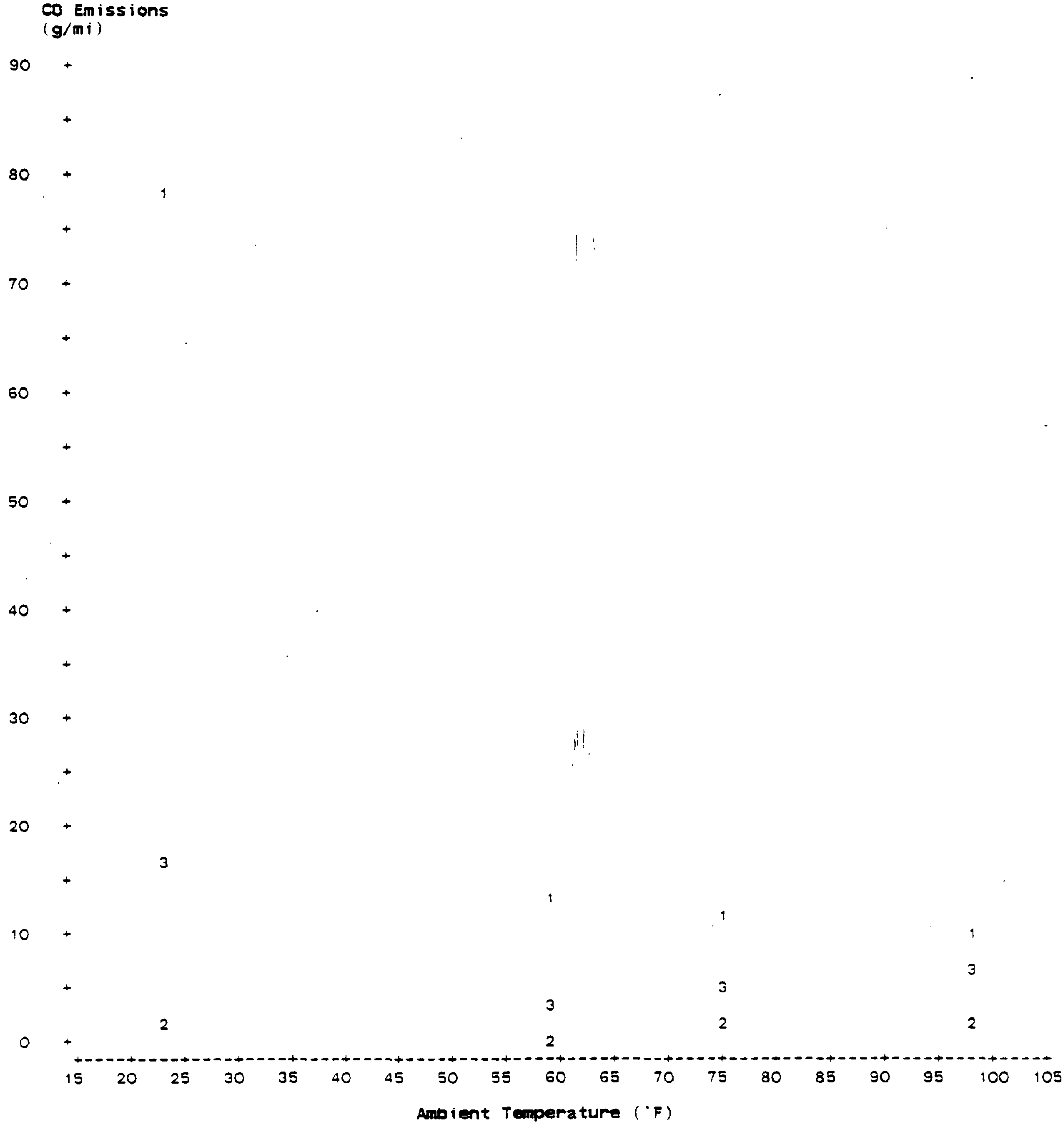


Figure 13

Scatter Plot of Bag-1 (1), Bag-2 (2), Bag-3 (3) CO Emissions versus Ambient Temperature

Vehicle No. 1FABP21B3BK15310, Ford 1981 FAIRMONT (200 cid)

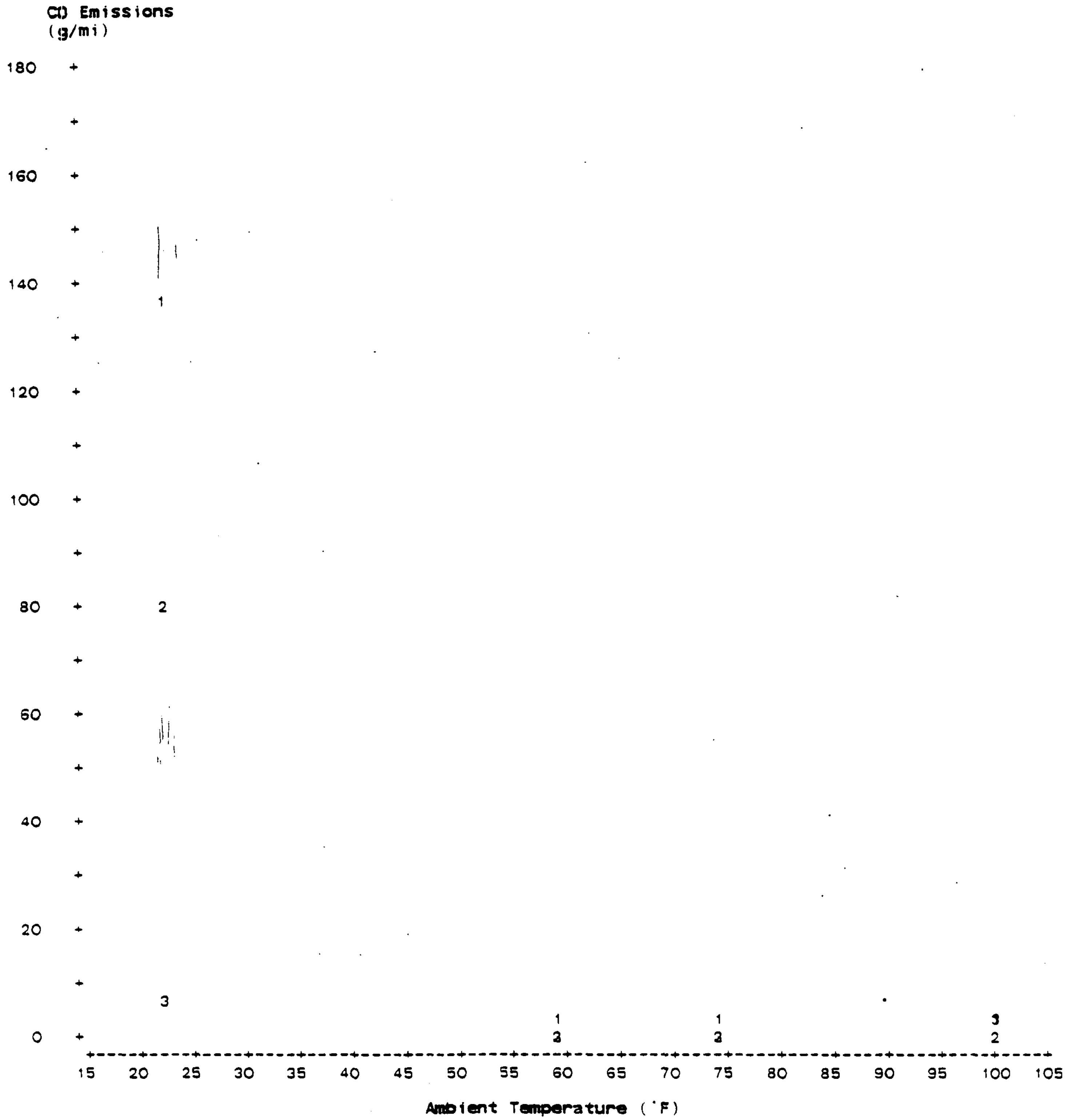


Figure 14

Scatter Plot of Bag-1 (1), Bag-2 (2), Bag-3 (3) CO Emissions versus Ambient Temperature

Vehicle No. 1G1AX68X7B621755, GM 1981 CITATION (173 cid)

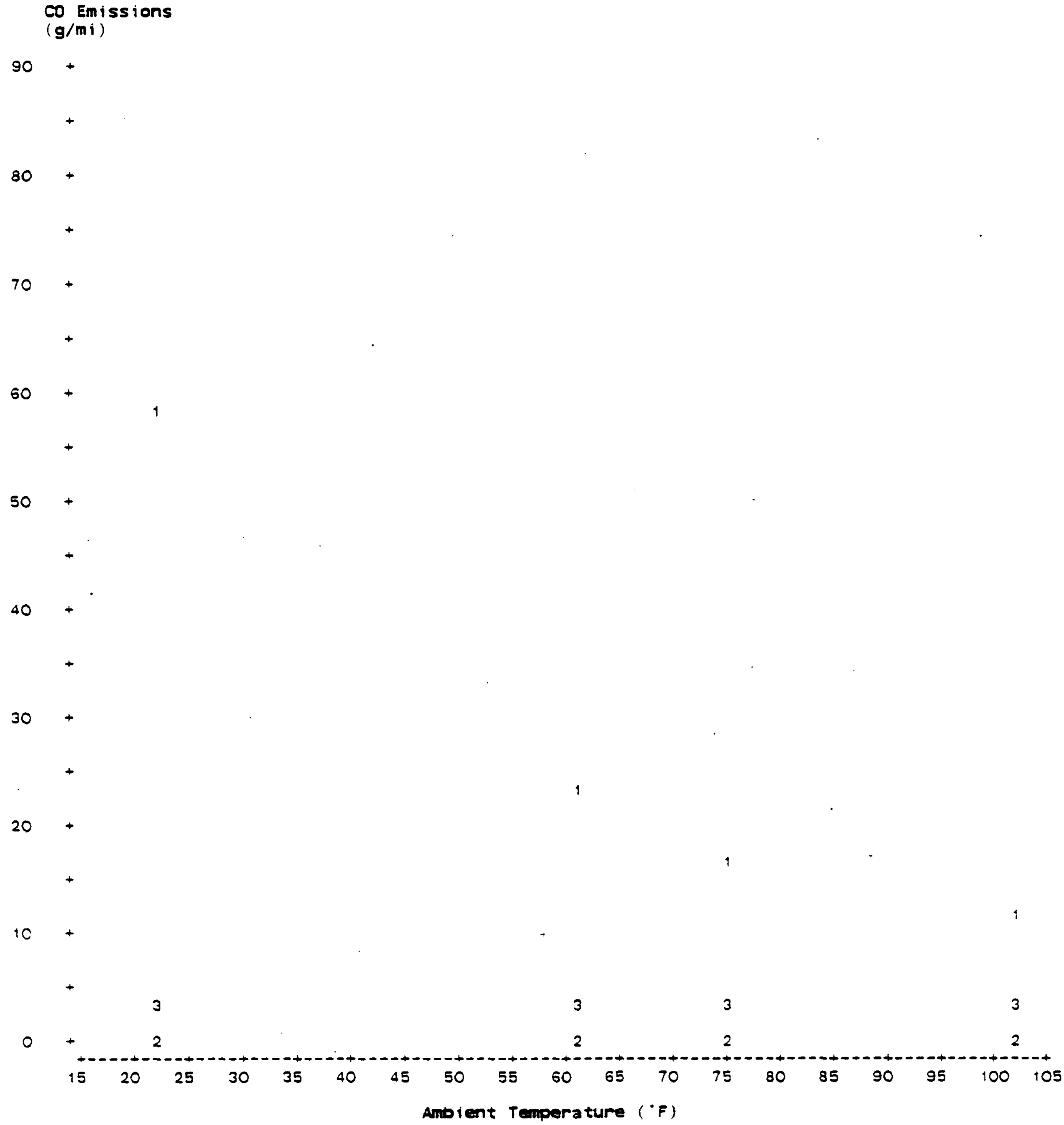


Figure 15

Scatter Plot of Bag-1 (1), Bag-2 (2), Bag-3 (3) CO Emissions versus Ambient Temperature

Vehicle No. 2G1AW69J6B144479, GM 1981 MALIBU (267 cid)

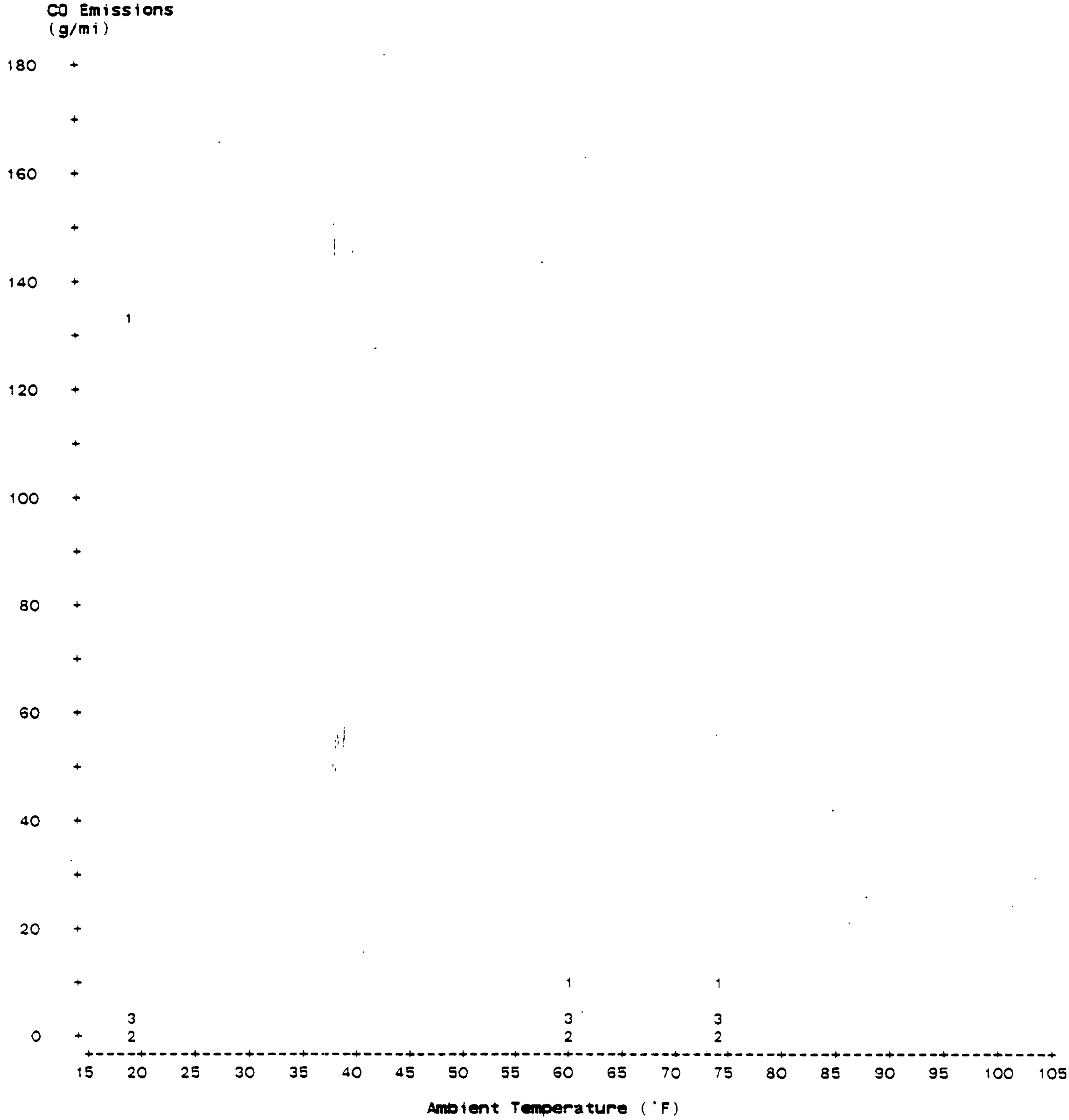


Figure 16

Scatter Plot of Bag-1 (1), Bag-2 (2), Bag-3 (3) CO Emissions versus Ambient Temperature

Vehicle No. D160, Chrysler 1981 K-CAR (WGN) (135 cid)

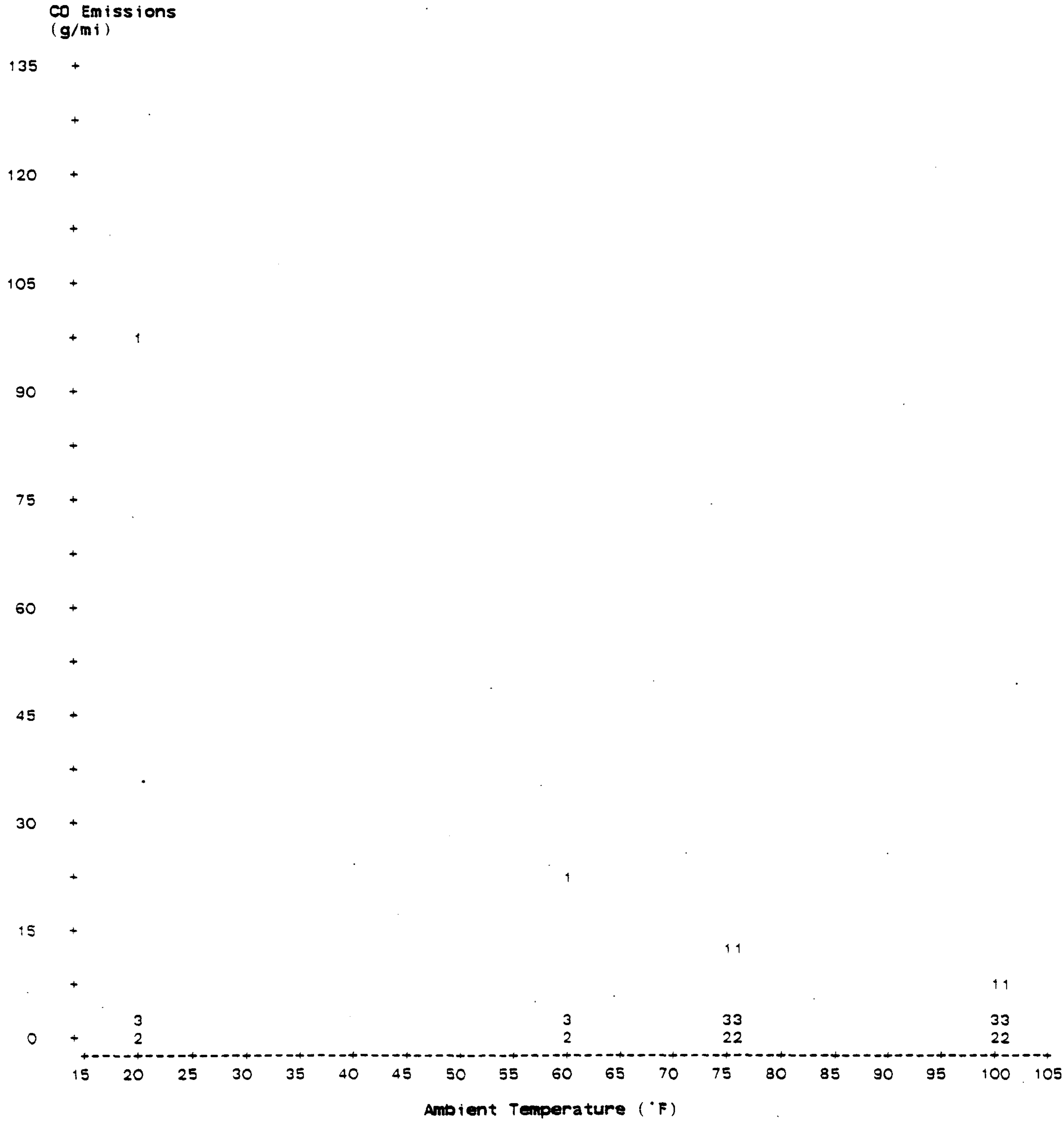


Figure 17

Scatter Plot of Bag-1 (1), Bag-2 (2), Bag-3 (3) CO Emissions versus Ambient Temperature

Vehicle No. 1009, Ethyl Lean-Burn Car (163 cid)

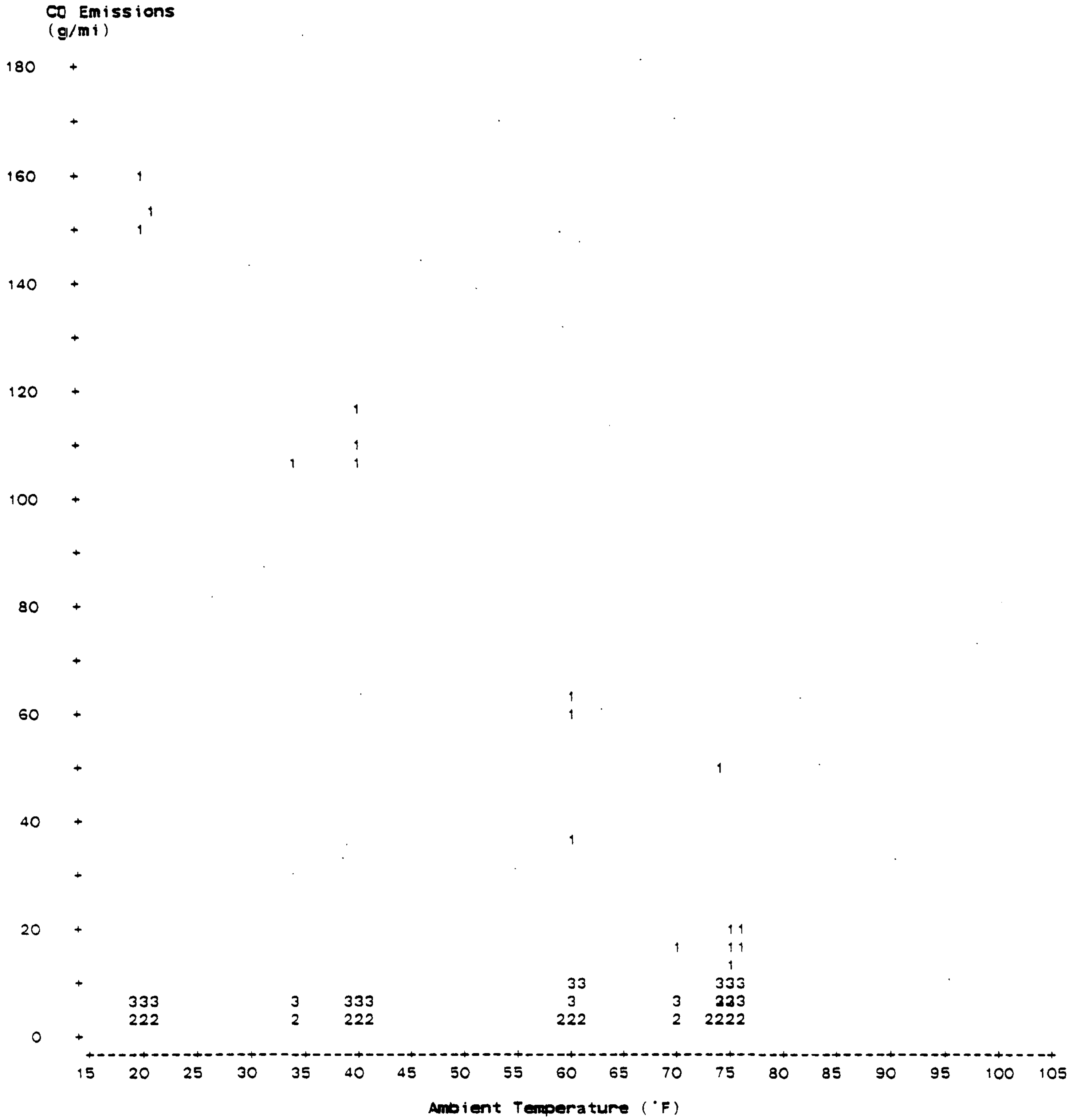
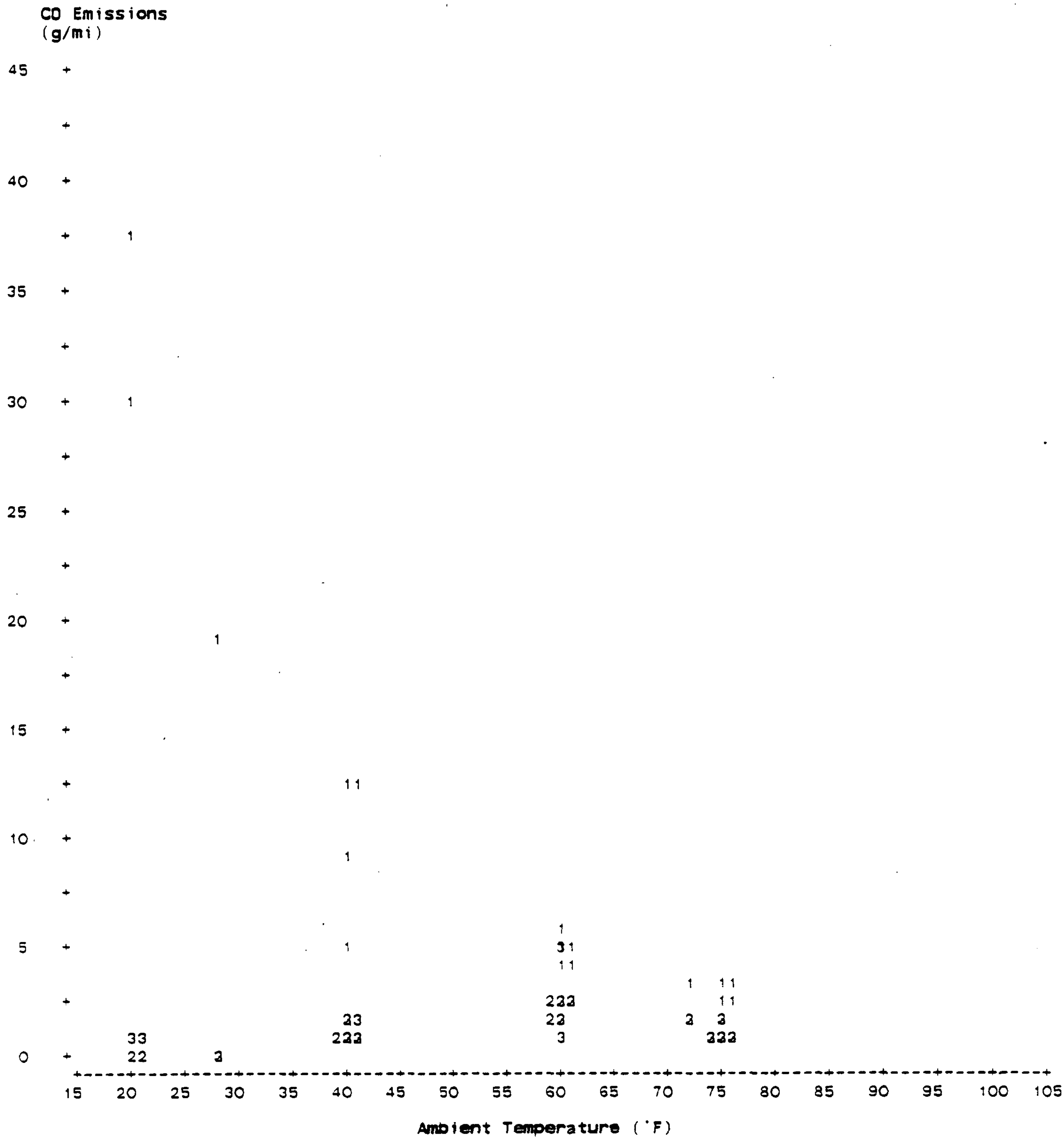


Figure 18

Scatter Plot of Bag-1 (1), Bag-2 (2), Bag-3 (3) CO Emissions versus Ambient Temperature

Vehicle No. 1X69L7L104103, Dresser 1977 NOVA (350 cid)



APPENDIX 3

Equations Modeling CO Emissions for Each Vehicle

Models Predicting Cold-Start CO Emissions for Vehicle 9S1-5.8M-H-400, Ford 1979 California T-BIRD (351 cid)

N	Temp Interval	Equation	R-SQR	SE
8	20.0 - 101.0	BAG1 CO = 243.77 - 2.4142(TEMP)	96.361%	13.024
8	20.0 - 101.0	BAG1 CO = 271.94 - 3.5045(TEMP) + 0.008775(TEMP.2)	97.513%	11.795
8	20.0 - 101.0	(BAG1 - BAG3) CO = 239.69 - 2.5036(TEMP)	97.643%	10.798
8	20.0 - 101.0	(BAG1 - BAG3) CO = 255.04 - 3.0978(TEMP) + 0.004781(TEMP.2)	97.965%	10.990
6	20.0 - 75.0	BAG1 CO = 263.44 - 2.7977(TEMP)	97.901%	9.7014
6	20.0 - 75.0	BAG1 CO = 218.47 - 0.3004(TEMP) - 0.026278(TEMP.2)	99.675%	4.4069
6	20.0 - 75.0	(BAG1 - BAG3) CO = 252.55 - 2.7541(TEMP)	97.670%	10.073
6	20.0 - 75.0	(BAG1 - BAG3) CO = 207.80 - 0.2685(TEMP) - 0.026155(TEMP.2)	99.480%	5.4965

Models Predicting Cold-Start CO Emissions for Vehicle FB223, Nissan 1980 49-State 280ZX (168 cid)

N	Temp Interval	Equation	R-SQR	SE
11	21.0 - 100.0	BAG1 CO = 20.14 - 0.1397(TEMP)	52.248%	3.8891
11	21.0 - 100.0	BAG1 CO = 33.63 - 0.7044(TEMP) + 0.004667(TEMP.2)	93.198%	1.5568
11	21.0 - 100.0	(BAG1 - BAG3) CO = 20.49 - 0.1586(TEMP)	60.513%	3.7312
11	21.0 - 100.0	(BAG1 - BAG3) CO = 33.20 - 0.6910(TEMP) + 0.004400(TEMP.2)	93.214%	1.6406
8	21.0 - 75.0	BAG1 CO = 25.33 - 0.2514(TEMP)	86.508%	2.4969
8	21.0 - 75.0	BAG1 CO = 37.97 - 0.9578(TEMP) + 0.007391(TEMP.2)	96.081%	1.4742
8	21.0 - 75.0	(BAG1 - BAG3) CO = 25.44 - 0.2653(TEMP)	87.676%	2.5013
8	21.0 - 75.0	(BAG1 - BAG3) CO = 36.49 - 0.8832(TEMP) + 0.006466(TEMP.2)	94.344%	1.8562

Models Predicting Cold-Start CO Emissions for Vehicle FB178, Nissan 1980 California 280ZX (168 cid)

N	Temp Interval	Equation	R-SQR	SE
8	20.0 - 75.0	BAG1 CO = 35.26 - 0.3543(TEMP)	88.253%	3.3581
8	20.0 - 75.0	BAG1 CO = 47.52 - 1.0732(TEMP) + 0.007627(TEMP.2)	93.684%	2.6973
8	20.0 - 75.0	(BAG1 - BAG3) CO = 33.68 - 0.3465(TEMP)	88.711%	3.2115
8	20.0 - 75.0	(BAG1 - BAG3) CO = 45.28 - 1.0270(TEMP) + 0.007219(TEMP.2)	93.824%	2.6022

Models Predicting Cold-Start CO Emissions for Vehicle P0948, GM 1981 49-State GRAND PRIX (265 cid)

N	Temp Interval	Equation	R-SQR	SE
8	20.0 - 101.0	BAG1 CO = 183.30 - 1.9388(TEMP)	91.386%	20.055
8	20.0 - 101.0	BAG1 CO = 216.13 - 3.4312(TEMP) + 0.012672(TEMP.2)	94.005%	18.328
8	20.0 - 101.0	(BAG1 - BAG3) CO = 182.37 - 1.9479(TEMP)	90.798%	20.893
8	20.0 - 101.0	(BAG1 - BAG3) CO = 216.19 - 3.4853(TEMP) + 0.013054(TEMP.2)	93.533%	19.186
6	20.0 - 75.0	BAG1 CO = 202.86 - 2.4204(TEMP)	95.054%	15.698
6	20.0 - 75.0	BAG1 CO = 138.46 + 1.4226(TEMP) - 0.041813(TEMP.2)	98.994%	8.1756
6	20.0 - 75.0	(BAG1 - BAG3) CO = 202.67 - 2.4475(TEMP)	94.710%	16.446
6	20.0 - 75.0	(BAG1 - BAG3) CO = 134.29 + 1.6330(TEMP) - 0.044398(TEMP.2)	99.038%	8.0966

Models Predicting Cold-Start CO Emissions for Vehicle 03H2-94472C, GM 1980 California CUTLASS SUPREME (260 cid)

N	Temp Interval	Equation	R-SQR	SE
9	20.0 - 100.0	BAG1 CO = 121.04 - 1.2843(TEMP)	91.485%	12.239
9	20.0 - 100.0	BAG1 CO = 154.50 - 2.8024(TEMP) + 0.013078(TEMP.2)	98.049%	6.3276
9	20.0 - 100.0	(BAG1 - BAG3) CO = 120.88 - 1.2965(TEMP)	92.102%	11.859
9	20.0 - 100.0	(BAG1 - BAG3) CO = 153.25 - 2.7651(TEMP) + 0.012652(TEMP.2)	98.170%	6.1660
7	20.0 - 75.0	BAG1 CO = 136.06 - 1.6304(TEMP)	99.273%	3.8044
7	20.0 - 75.0	BAG1 CO = 126.57 - 1.0654(TEMP) - 0.006063(TEMP.2)	99.441%	3.7300
7	20.0 - 75.0	(BAG1 - BAG3) CO = 135.42 - 1.6315(TEMP)	99.299%	3.7373
7	20.0 - 75.0	(BAG1 - BAG3) CO = 126.09 - 1.0761(TEMP) - 0.005960(TEMP.2)	99.461%	3.6634

Models Predicting Cold-Start CO Emissions for Vehicle 8R10Y131366, Ford 1978 California PINTO (140 cid)

N	Temp Interval	Equation	R-SQR	SE
8	20.0 - 100.0	BAG1 CO = 108.14 - 1.1267(TEMP)	92.636%	10.645
8	20.0 - 100.0	BAG1 CO = 137.33 - 2.4607(TEMP) + 0.011384(TEMP.2)	98.843%	4.6213
8	20.0 - 100.0	(BAG1 - BAG3) CO = 87.23 - 0.8985(TEMP)	95.672%	6.4039
8	20.0 - 100.0	(BAG1 - BAG3) CO = 99.72 - 1.4695(TEMP) + 0.004872(TEMP.2)	97.519%	5.3116
6	20.0 - 75.0	BAG1 CO = 118.69 - 1.3872(TEMP)	96.128%	7.9148
6	20.0 - 75.0	BAG1 CO = 150.96 - 3.3125(TEMP) + 0.020948(TEMP.2)	99.173%	4.2231
6	20.0 - 75.0	(BAG1 - BAG3) CO = 91.49 - 1.0037(TEMP)	95.020%	6.5325
6	20.0 - 75.0	(BAG1 - BAG3) CO = 108.69 - 2.0305(TEMP) + 0.011172(TEMP.2)	96.656%	6.1817

Models Predicting Cold-Start CO Emissions for Vehicle 4M47AAH202725, GM 1980 50-State REGAL (231 cid)

N	Temp Interval	Equation	R-SQR	SE
7	20.0 - 100.0	BAG1 CO = 67.77 - 0.6342(TEMP)	88.452%	8.3322
7	20.0 - 100.0	BAG1 CO = 88.62 - 1.6013(TEMP) + 0.008171(TEMP.2)	97.336%	4.4691
7	20.0 - 100.0	(BAG1 - BAG3) CO = 64.55 - 0.6899(TEMP)	91.975%	7.3988
7	20.0 - 100.0	(BAG1 - BAG3) CO = 82.66 - 1.5298(TEMP) + 0.007096(TEMP.2)	97.883%	4.2490
5	20.0 - 75.0	BAG1 CO = 75.70 - 0.8469(TEMP)	92.307%	7.1699
5	20.0 - 75.0	BAG1 CO = 102.41 - 2.4794(TEMP) + 0.018352(TEMP.2)	97.980%	4.5000
5	20.0 - 75.0	(BAG1 - BAG3) CO = 71.37 - 0.8728(TEMP)	93.724%	6.6236
5	20.0 - 75.0	(BAG1 - BAG3) CO = 95.53 - 2.3490(TEMP) + 0.016595(TEMP.2)	98.158%	4.3943

Models Predicting Cold-Start CO Emissions for Vehicle FB289, Nissan 1981.5 49-State 280ZX TURBO (168 cid)

N	Temp Interval	Equation	R-SQR	SE
12	20.0 - 100.0	BAG1 CO = 16.41 - 0.1503(TEMP)	66.350%	3.3588
12	20.0 - 100.0	BAG1 CO = 22.75 - 0.4571(TEMP) + 0.002740(TEMP.2)	80.695%	2.6817
12	20.0 - 100.0	(BAG1 - BAG3) CO = 15.40 - 0.1469(TEMP)	65.076%	3.3760
12	20.0 - 100.0	(BAG1 - BAG3) CO = 21.63 - 0.4487(TEMP) + 0.002696(TEMP.2)	79.344%	2.7368
10	20.0 - 75.0	BAG1 CO = 18.90 - 0.2172(TEMP)	79.359%	2.8127
10	20.0 - 75.0	BAG1 CO = 20.83 - 0.3348(TEMP) + 0.001322(TEMP.2)	79.744%	2.9788
10	20.0 - 75.0	(BAG1 - BAG3) CO = 17.81 - 0.2117(TEMP)	77.404%	2.9051
10	20.0 - 75.0	(BAG1 - BAG3) CO = 20.21 - 0.3581(TEMP) + 0.001646(TEMP.2)	78.016%	3.0633

Models Predicting Cold-Start CO Emissions for Vehicle D162, Plymouth 1981 49-State RELIANT (135 cid)

N	Temp Interval	Equation	R-SQR	SE
9	20.0 - 100.0	BAG1 CO = 56.10 - 0.5492(TEMP)	88.577%	7.5771
9	20.0 - 100.0	BAG1 CO = 79.74 - 1.6038(TEMP) + 0.008742(TEMP.2)	99.194%	1.9352
9	20.0 - 100.0	(BAG1 - BAG3) CO = 53.21 - 0.5412(TEMP)	84.323%	7.8418
9	20.0 - 100.0	(BAG1 - BAG3) CO = 77.57 - 1.6277(TEMP) + 0.009006(TEMP.2)	98.989%	2.1513
6	20.0 - 75.0	BAG1 CO = 66.29 - 0.8007(TEMP)	97.392%	3.7251
6	20.0 - 75.0	BAG1 CO = 79.59 - 1.5939(TEMP) + 0.008631(TEMP.2)	98.964%	2.7112
6	20.0 - 75.0	(BAG1 - BAG3) CO = 63.78 - 0.8020(TEMP)	97.380%	3.7397
6	20.0 - 75.0	(BAG1 - BAG3) CO = 76.54 - 1.5635(TEMP) + 0.008286(TEMP.2)	98.824%	2.8933

Models Predicting Cold-Start CO Emissions for Vehicle MA46100183,
Toyota 1980 50-State CELICA SUPRA (156 cid)

N	Temp Interval	Equation	R-SQR	SE
14	20.0 - 100.0	BAG1 CO = 41.60 - 0.4448(TEMP)	89.463%	3.7156
14	20.0 - 100.0	BAG1 CO = 54.46 - 1.0045(TEMP) + 0.004906(TEMP.2)	98.207%	1.6008
14	20.0 - 100.0	(BAG1 - BAG3) CO = 41.09 - 0.4424(TEMP)	89.813%	3.6264
14	20.0 - 100.0	(BAG1 - BAG3) CO = 53.65 - 0.9889(TEMP) + 0.004790(TEMP.2)	98.273%	1.5594
12	20.0 - 75.0	BAG1 CO = 46.53 - 0.5392(TEMP)	97.287%	1.9615
12	20.0 - 75.0	BAG1 CO = 53.56 - 0.9494(TEMP) + 0.004314(TEMP.2)	98.028%	1.7629
12	20.0 - 75.0	(BAG1 - BAG3) CO = 45.91 - 0.5347(TEMP)	97.416%	1.8974
12	20.0 - 75.0	(BAG1 - BAG3) CO = 52.62 - 0.9259(TEMP) + 0.004113(TEMP.2)	98.101%	1.7144

Models Predicting Cold-Start CO Emissions for Vehicle B3BK26B48C184143, Chrysler 1981 K-CAR (135 cid)

N	Temp Interval	Equation	R-SQR	SE
4	22.0 - 97.0	BAG1 CO = 142.56 - 1.5394(TEMP)	82.481%	27.213
4	22.0 - 97.0	BAG1 CO = 216.85 - 4.8156(TEMP) + 0.028103(TEMP.2)	98.769%	10.201
4	22.0 - 97.0	(BAG1 - BAG3) CO = 135.25 - 1.4874(TEMP)	81.237%	27.419
4	22.0 - 97.0	(BAG1 - BAG3) CO = 209.36 - 4.7563(TEMP) + 0.028040(TEMP.2)	98.345%	11.516
3	22.0 - 72.5	BAG1 CO = 168.98 - 2.1801(TEMP)	93.755%	20.805
3	22.0 - 72.5	BAG1 CO = 254.28 - 7.0206(TEMP) + 0.052822(TEMP.2)	100.00%	0.000
3	22.0 - 72.5	(BAG1 - BAG3) CO = 161.27 - 2.1188(TEMP)	92.668%	22.036
3	22.0 - 72.5	(BAG1 - BAG3) CO = 251.63 - 7.2458(TEMP) + 0.055948(TEMP.2)	100.00%	0.000

Models Predicting Cold-Start CO Emissions for Vehicle 1FABP082XBW20356, Ford 1981 ESCORT WAGON (98 cid)

N	Temp Interval	Equation	R-SQR	SE
4	23.0 - 98.0	BAG1 CO = 87.48 - 0.9255(TEMP)	77.191%	19.444
4	23.0 - 98.0	BAG1 CO = 144.79 - 3.3876(TEMP) + 0.020716(TEMP.2)	99.136%	5.3520
4	23.0 - 98.0	(BAG1 - BAG3) CO = 70.74 - 0.7947(TEMP)	81.790%	14.494
4	23.0 - 98.0	(BAG1 - BAG3) CO = 113.56 - 2.6341(TEMP) + 0.015476(TEMP.2)	99.388%	3.7578
3	23.0 - 75.0	BAG1 CO = 106.30 - 1.3747(TEMP)	92.520%	14.689
3	23.0 - 75.0	BAG1 CO = 162.27 - 4.3683(TEMP) + 0.031388(TEMP.2)	100.00%	0.000
3	23.0 - 75.0	(BAG1 - BAG3) CO = 84.87 - 1.1320(TEMP)	93.998%	10.749
3	23.0 - 75.0	(BAG1 - BAG3) CO = 125.83 - 3.3226(TEMP) + 0.022969(TEMP.2)	100.00%	0.000

Models Predicting Cold-Start CO Emissions for Vehicle 1FABP21B3BK15310, Ford 1981 FAIRMONT (200 cid)

N	Temp Interval	Equation	R-SQR	SE
4	22.2 - 100.0	BAG1 CO = 147.60 - 1.7355(TEMP)	72.709%	42.317
4	22.2 - 100.0	BAG1 CO = 262.10 - 6.6433(TEMP) + 0.040848(TEMP.2)	98.626%	13.427
4	22.2 - 100.0	(BAG1 - BAG3) CO = 142.40 - 1.6900(TEMP)	73.521%	40.366
4	22.2 - 100.0	(BAG1 - BAG3) CO = 251.74 - 6.3769(TEMP) + 0.039009(TEMP.2)	98.724%	12.533
3	22.2 - 74.0	BAG1 CO = 190.04 - 2.7480(TEMP)	91.939%	30.670
3	22.2 - 74.0	BAG1 CO = 307.74 - 9.2870(TEMP) + 0.070029(TEMP.2)	100.00%	0.000
3	22.2 - 74.0	(BAG1 - BAG3) CO = 183.01 - 2.6587(TEMP)	92.267%	29.013
3	22.2 - 74.0	(BAG1 - BAG3) CO = 294.35 - 8.8445(TEMP) + 0.066246(TEMP.2)	100.00%	0.000

Models Predicting Cold-Start CO Emissions for Vehicle 1G1AX68X7B621755, GM 1981 CITATION (173 cid)

N	Temp Interval	Equation	R-SQR	SE
4	22.0 - 101.5	BAG1 CO = 66.61 - 0.6064(TEMP)	90.813%	7.8367
4	22.0 - 101.5	BAG1 CO = 87.55 - 1.5036(TEMP) + 0.007404(TEMP.2)	99.922%	1.0192
4	22.0 - 101.5	(BAG1 - BAG3) CO = 63.76 - 0.6142(TEMP)	91.245%	7.7294
4	22.0 - 101.5	(BAG1 - BAG3) CO = 84.49 - 1.5026(TEMP) + 0.007332(TEMP.2)	99.996%	0.2334
3	22.0 - 75.0	BAG1 CO = 74.87 - 0.8017(TEMP)	98.171%	4.2385
3	22.0 - 75.0	BAG1 CO = 91.01 - 1.7054(TEMP) + 0.009612(TEMP.2)	100.00%	0.000
3	22.0 - 75.0	(BAG1 - BAG3) CO = 72.12 - 0.8119(TEMP)	98.807%	3.4562
3	22.0 - 75.0	(BAG1 - BAG3) CO = 85.28 - 1.5488(TEMP) + 0.007837(TEMP.2)	100.00%	0.000

Models Predicting Cold-Start CO Emissions for Vehicle 2G1AW69J6B144479, GM 1981 MALIBU (267 cid)

N	Temp Interval	Equation	R-SQR	SE
3	18.7 - 73.6	BAG1 CO = 173.81 - 2.4327(TEMP)	94.264%	24.263
3	18.7 - 73.6	BAG1 CO = 251.10 - 7.3439(TEMP) + 0.055104(TEMP.2)	100.00%	0.000
3	18.7 - 73.6	(BAG1 - BAG3) CO = 171.82 - 2.4367(TEMP)	93.894%	25.124
3	18.7 - 73.6	(BAG1 - BAG3) CO = 253.35 - 7.6276(TEMP) + 0.058399(TEMP.2)	100.00%	0.000

Models Predicting Cold-Start CO Emissions for Vehicle D160, Chrysler 1981 K-CAR (WGN) (135 cid)

N	Temp Interval	Equation	R-SQR	SE
6	20.0 - 100.0	BAG1 CO = 104.27 - 1.0856(TEMP)	84.355%	15.564
6	20.0 - 100.0	BAG1 CO = 154.28 - 3.2073(TEMP) + 0.017371(TEMP.2)	99.785%	2.1075
6	20.0 - 100.0	(BAG1 - BAG3) CO = 101.55 - 1.0821(TEMP)	83.913%	15.773
6	20.0 - 100.0	(BAG1 - BAG3) CO = 152.23 - 3.2326(TEMP) + 0.017606(TEMP.2)	99.784%	2.1128
4	20.0 - 75.0	BAG1 CO = 125.57 - 1.5527(TEMP)	96.913%	8.8177
4	20.0 - 75.0	BAG1 CO = 164.20 - 3.8180(TEMP) + 0.024032(TEMP.2)	99.996%	0.4561
4	20.0 - 75.0	(BAG1 - BAG3) CO = 123.15 - 1.5559(TEMP)	96.871%	8.8977
4	20.0 - 75.0	(BAG1 - BAG3) CO = 162.10 - 3.8399(TEMP) + 0.024232(TEMP.2)	99.991%	0.6760

Models Predicting Cold-Start CO Emissions for Vehicle 1009, Ethyl Lean-Burn Car (163 cid)

N	Temp Interval	Equation	R-SQR	SE
17	20.0 - 75.0	BAG1 CO = 203.48 - 2.4633(TEMP)	96.158%	10.905
17	20.0 - 75.0	BAG1 CO = 208.03 - 2.6914(TEMP) + 0.002318(TEMP.2)	96.175%	11.263
17	20.0 - 75.0	(BAG1 - BAG3) CO = 196.30 - 2.4769(TEMP)	95.890%	11.357
17	20.0 - 75.0	(BAG1 - BAG3) CO = 201.20 - 2.7219(TEMP) + 0.002490(TEMP.2)	95.909%	11.728

Models Predicting Cold-Start CO Emissions for Vehicle 1X69L7L104103, Dresser 1977 NOVA (350 cid)

N	Temp Interval	Equation	R-SQR	SE
17	20.0 - 75.0	BAG1 CO = 33.47 - 0.4513(TEMP)	74.603%	5.2759
17	20.0 - 75.0	BAG1 CO = 63.05 - 1.8657(TEMP) + 0.014350(TEMP.2)	93.274%	2.8104
17	20.0 - 75.0	(BAG1 - BAG3) CO = 33.03 - 0.4711(TEMP)	74.506%	5.5207
17	20.0 - 75.0	(BAG1 - BAG3) CO = 65.31 - 2.0145(TEMP) + 0.015659(TEMP.2)	94.889%	2.5586

APPENDIX 4

Correlation Coefficients between:

1. Difference in (actual) CO emissions from Bag 3 to Bag 1 and the corresponding differences in fuel consumption. (Stratified by temperature)

2. Actual CO emissions (from Appendix 1) and vehicle parameters.

3. Predicted CO emissions (from Appendix 3) and vehicle parameters.

4. Pairs of vehicle parameters.

KEY:

AIR:	0 = No secondary air; 1 = Has secondary air.
PMP/PLS:	0 = Pulse air; 1 = Air pump. (Missing = No air.)
OXD:	1 = Has only oxidation catalyst; 0 = Otherwise.
3WY:	1 = Has only three-way catalyst; 0 = Otherwise.
BOTH:	1 = Has both oxidation and three-way catalysts; 0 = Otherwise.
#CAT:	Number of catalyst(s) (0, 1, or 2)
TYPE:	0 = Monolith Catalyst; 1 = Pelleted Catalyst.
FS:	0 = EFI; 1 = Carbureted. (FS: Fuel Metering System)
A/F:	0 = Open-loop air/fuel (A/F) control; 1 = Closed-loop A/F.
EGR:	0 = No Exhaust Gas Recirculation (EGR); 1 = Has EGR.
ETW:	Equivalent Test Weight (pounds)
#CYL:	Number of cylinders (4, 6, or 8)

Correlation Matrices for ACTUAL Emission & Fuel Consumption Data (from Appendix 1).

Correlation Coefficients between the Increase in Bag 3 to Bag 1 CO Emissions and the Corresponding Increase in Fuel Consumed for All 18 Vehicles.

Temp	Correlation Coefficients				
20°F	0.7159	(N= 33	DF= 31	R@ .0500= .3440	R@ .0100= .4421)‡
30°F	N/A	(TOO FEW CASES FOR ANALYSIS)			
40°F	0.9638	(N= 7	DF= 5	R@ .0500= .7545	R@ .0100= .8745)
60°F	0.7799	(N= 36	DF= 34	R@ .0500= .3291	R@ .0100= .4238)
75°F	0.4721	(N= 50	DF= 48	R@ .0500= .2787	R@ .0100= .3610)
100°F	-0.1991	(N= 26	DF= 24	R@ .0500= .3882	R@ .0100= .4958)

Correlation Coefficients between the Increase in Bag 3 to Bag 1 CO Emissions and the Corresponding Increase in Fuel Consumed for 16 Vehicles (All Cars Except the Ethyl and Dresser Cars)

Temp	Correlation Coefficients				
20°F	0.6972	(N= 27	DF= 25	R@ .0500= .3809	R@ .0100= .4869)
60°F	0.8038	(N= 28	DF= 26	R@ .0500= .3739	R@ .0100= .4785)
75°F	0.5006	(N= 38	DF= 36	R@ .0500= .3202	R@ .0100= .4128)
100°F	-0.1991	(N= 26	DF= 24	R@ .0500= .3882	R@ .0100= .4958)

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‡ 'N' is sample size, 'DF' is degrees of freedom.

'R@ .0500= .3440' indicates that the correlation coefficient which corresponds to the '.0500' significance level is '.3440'

Correlation Coefficients between Pairs of Actual Data (Appendix 1) and Vehicle Parameters, Stratified by Ambient Temperature:

Correlation Matrices for All Vehicles Except the Ethyl & Dresser Cars

ACTUAL VARIABLE	AIR	PMP/PLS	OXD	3WY	BOTH	#CAT	TYPE	FS	A/F	EGR	ETW	#CYL
Temperature = 20°F, N= 27 DF= 25 R@ .0500= .3809 R@ .0100= .4869:												
Bag 1 CO	.6330	.7436	.0554	-.5329	.4979	.3873	.4114	.7570	-.1727	.2346	.4438	.3417
Delta Fuel*	.3372	.4151	-.0696	-.1787	.2227	.2091	.7375	.4257	.2251	.0649	.6916	.6149
Delta CO	.6096	.7152	.0620	-.5014	.4622	.3597	.4484	.7275	-.1551	.2334	.4925	.4087
Temperature = 60°F, N= 28 DF= 26 R@ .0500= .3739 R@ .0100= .4785:												
Bag 1 CO	.4024	.4687	.4385	-.3364	.0263	-.0455	.2585	.4808	-.2656	.1629	.6484	.5392
Delta Fuel	.2372	.2798	.3220	-.1983	-.0293	-.0398	.4847	.2426	-.2193	.1223	.8043	.7459
Delta CO	.3869	.4509	.4265	-.3304	.0289	-.0363	.2653	.4604	-.2498	.1853	.6451	.5547
Temperature = 75°F, N= 38 DF= 36 R@ .0500= .3202 R@ .0100= .4128:												
Bag 1 CO	.4007	.4649	.4991	-.3672	-.0213	-.2561	-.0377	.4895	-.3946	.0468	.5275	.2826
Delta Fuel	.1069	.1393	.3675	-.0924	-.2031	-.1884	.1812	.1236	-.2623	.0818	.6042	.5323
Delta CO	.3525	.4166	.4938	-.3221	-.0645	-.2620	-.0602	.4395	-.3635	.0625	.5025	.2906

Correlation Matrices for All 18 Vehicles:

ACTUAL VARIABLE	AIR	PMP/PLS	OXD	3WY	BOTH	#CAT	TYPE	FS	A/F	EGR	ETW	#CYL
Temperature = 20°F, N= 33 DF= 31 R@ .0500= .3440 R@ .0100= .4421:												
Bag 1 CO	.6781	.7728	.0271	-.6195	.3505	-.0139	-.1472	.6561	-.1961	.2206	.0596	.1497
Delta Fuel	.3372	.4146	-.1042	-.2426	.0919	-.1186	.2259	.4562	-.0308	.1069	.4104	.5143
Delta CO	.6575	.7490	.0320	-.5928	.3218	-.0301	-.1184	.6373	-.1917	.2217	.1007	.2082
Temperature = 60°F, N= 36 DF= 34 R@ .0500= .3291 R@ .0100= .4238:												
Bag 1 CO	.5098	.5647	.3998	-.4594	.0430	-.1464	-.1595	.3918	-.1412	.1342	.2423	.2771
Delta Fuel	.2730	.3130	.2760	-.2572	-.0541	-.1614	.1005	.2359	-.2013	.1250	.4659	.5502
Delta CO	.4994	.5509	.4004	-.4506	.0616	-.1044	-.1320	.3634	-.1031	.1472	.2473	.2866
Temperature = 75°F, N= 50 DF= 48 R@ .0500= .2787 R@ .0100= .3610:												
Bag 1 CO	.4829	.5341	.4120	-.4568	-.0223	-.2782	-.3198	.3860	-.2635	.0422	.1539	.0807
Delta Fuel	.1318	.1617	.3224	-.1244	-.1970	-.1810	.0050	.1276	-.2198	.0852	.3983	.4229
Delta CO	.3987	.4403	.4315	-.3644	-.0131	-.1533	-.2177	.2877	-.1545	.0303	.1809	.0880

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* Delta Fuel = Total fuel consumed (in grams) during Bag 1 minus total fuel consumed during the corresponding Bag 3.

Delta CO = CO Emissions (grams per mile) during Bag 1 minus corresponding Bag 3 CO Emissions.

Correlation Matrices for PREDICTED Bag 1 CO (Appendix 3) for All 18 Vehicles

Correlation Coefficients for Linear Model with No Data from Tests Over 90°F

N= 17 DF= 15 R@ .0500= .4821 R@ .0100= .6055

PREDICTED VARIABLE	AIR	PMP/PLS	OXD	3WY	BOTH	#CAT	TYPE	FS	A/F	EGR	ETW	#CYL
CO @ 20°F	.5981	.7155	.2035	-.5435	.2351	-.0197	-.0467	.6088	-.1580	.2736	.2833	.2491
CO @ 40°F	.5843	.6925	.2536	-.5255	.1897	-.0510	-.0686	.5848	-.1778	.2527	.3140	.2586
CO @ 75°F	.4174	.4600	.4792	-.3462	-.0813	-.2089	-.1738	.3642	-.2540	.1014	.4269	.2679
Slope@20°F	-.6097	-.7434	-.0864	.5658	-.3277	-.0500	-.0030	-.6423	.1095	-.3110	-.2065	-.2202
Slope@40°F	-.6097	-.7434	-.0864	.5658	-.3277	-.0500	-.0030	-.6423	.1095	-.3110	-.2065	-.2202
Slope@75°F	-.6097	-.7434	-.0864	.5658	-.3277	-.0500	-.0030	-.6423	.1095	-.3110	-.2065	-.2202
RATIO*	.0663	.1392	-.1919	-.1460	.2926	.2297	.4146	.2561	.0455	.1780	.1721	.3109
Sen* @ 20°F	-.0829	-.2707	.5049	.1332	-.4265	-.3057	-.3199	-.5296	.0022	-.3964	.0887	-.0153
Sen @ 40°F	-.0739	-.2522	.4783	.1350	-.4178	-.2996	-.3344	-.5118	.0183	-.3825	.0664	-.0404
Sen @ 75°F	-.0663	-.1392	.1919	.1460	-.2926	-.2297	-.4146	-.2561	-.0455	-.1780	-.1721	-.3109
DIFF*	.6097	.7434	.0864	-.5658	.3277	.0500	.0030	.6423	-.1095	.3110	.2065	.2202
	AIR	PMP/PLS	OXD	3WY	BOTH	#CAT	TYPE	FS	A/F	EGR	ETW	#CYL

Correlation Coefficients for Linear Model with Data from Tests up to 105°F

N= 18 DF= 16 R@ .0500= .4683 R@ .0100= .5897

PREDICTED VARIABLE	AIR	PMP/PLS	OXD	3WY	BOTH	#CAT	TYPE	FS	A/F	EGR	ETW	#CYL
CO @ 20°F	.5867	.7038	.1812	-.5415	.2351	-.0256	-.0642	.6054	-.2111	.2700	.3060	.2804
CO @ 40°F	.5946	.7035	.2250	-.5364	.2195	-.0249	-.0771	.5978	-.2071	.2557	.3166	.2579
CO @ 75°F	.5300	.5835	.3833	-.4236	.1130	-.0176	-.1215	.4636	-.1547	.1485	.3106	.1145
Slope@20°F	-.5379	-.6685	-.0690	.5255	-.2595	.0260	.0308	-.5919	.2094	-.2898	-.2654	-.3184
Slope@40°F	-.5379	-.6685	-.0690	.5255	-.2595	.0260	.0308	-.5919	.2094	-.2898	-.2654	-.3184
Slope@75°F	-.5379	-.6685	-.0690	.5255	-.2595	.0260	.0308	-.5919	.2094	-.2898	-.2654	-.3184
RATIO	.0024	.0603	-.1450	-.0815	.1730	.1219	.4160	.1986	.0342	.1276	.2545	.4115
Sen @ 20°F	.1054	-.0962	.4493	-.0040	-.1696	-.0555	-.2641	-.4374	.1326	-.1950	-.1676	-.3333
Sen @ 40°F	.1079	-.0702	.3993	.0005	-.1492	-.0375	-.2906	-.4065	.1536	-.2001	-.1959	-.3661
Sen @ 75°F	-.0024	-.0603	.1450	.0815	-.1729	-.1218	-.4160	-.1986	-.0341	-.1276	-.2546	-.4115
DIFF	.5379	.6685	.0690	-.5255	.2595	-.0260	-.0308	.5919	-.2094	.2898	.2654	.3184
	AIR	PMP/PLS	OXD	3WY	BOTH	#CAT	TYPE	FS	A/F	EGR	ETW	#CYL

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* RATIO = Bag 1 CO at 20°F divided by Bag 1 CO at 75°F.

DIFF = Bag 1 CO at 20°F minus by Bag 1 CO at 75°F.

Sen (Sensitivity) = $\frac{d(CO)}{CO} / \frac{d(Temp)}{Temp}$

Correlation Matrices for PREDICTED Bag 1 CO (Appendix 3) for All 18 Vehicles

Correlation Coefficients for Quadratic Model with No Data from Tests Over 90°F

N= 18 DF= 16 R@ .0500= .4683 R@ .0100= .5897

PREDICTED VARIABLE	AIR	PMP/PLS	OXD	3WY	BOTH	#CAT	TYPE	FS	A/F	EGR	ETW	#CYL
CO @ 20°F	.6143	.7343	.1506	-.5756	.3105	.0523	-.0798	.6386	-.2495	.2952	.2577	.2077
CO @ 40°F	.4808	.5691	.3106	-.4154	.0551	-.1381	-.0499	.4804	-.1892	.2349	.4086	.3576
CO @ 75°F	.3860	.4236	.4741	-.2905	-.1231	-.2391	-.1088	.3480	-.1303	.0689	.4166	.2675
Slope@20°F	-.4211	-.5101	.2321	.4554	-.5460	-.3570	.0866	-.4697	.1799	-.1811	.2016	.2265
Slope@40°F	-.5912	-.7187	.0706	.5936	-.4981	-.2336	.0733	-.6395	.2500	-.3061	-.0488	-.0338
Slope@75°F	-.2413	-.2968	-.3030	.1830	.1456	.2525	-.0328	-.2351	.0987	-.1923	-.4512	-.4710
RATIO	.1305	.1711	-.1085	-.1823	.2689	.2224	-.0670	.1569	-.3477	.1077	.0673	.0191
Sen @ 20°F	.0606	.0646	.2250	.0483	-.2755	-.2673	-.0503	-.0652	.2017	.0615	.2725	.3265
Sen @ 40°F	-.0086	-.0664	.2554	.1409	-.3684	-.3216	-.1690	-.2514	.3114	-.1310	.0624	.0840
Sen @ 75°F	.0708	.0859	-.0824	-.1421	.2480	.2261	-.0582	.1047	-.3645	.0261	.0367	-.0494
DIFF	.6076	.7396	.0166	-.5942	.4181	.1466	-.0585	.6503	-.2560	.3327	.1661	.1576

Correlation Coefficients for Quadratic Model with Data from Tests up to 105°F

N= 17 DF= 15 R@ .0500= .4821 R@ .0100= .6055

PREDICTED VARIABLE	AIR	PMP/PLS	OXD	3WY	BOTH	#CAT	TYPE	FS	A/F	EGR	ETW	#CYL
CO @ 20°F	.6009	.7207	.1910	-.5509	.2500	-.0108	-.0476	.6272	-.1721	.2818	.2683	.2325
CO @ 40°F	.5470	.6436	.2905	-.4858	.1034	-.1344	-.1463	.5411	-.2279	.2348	.3102	.2393
CO @ 75°F	.4180	.4662	.4693	-.3496	-.0643	-.1933	-.1137	.3791	-.2383	.1145	.4784	.3264
Slope@20°F	-.5454	-.6785	.0543	.5325	-.4897	-.2629	-.1947	-.6322	.0024	-.2948	-.1320	-.1716
Slope@40°F	-.6091	-.7472	-.0345	.5769	-.3943	-.1178	-.0409	-.6694	.0979	-.3197	-.1579	-.1779
Slope@75°F	-.4472	-.5259	-.2328	.3851	.0429	.2965	.3546	-.4119	.2795	-.2139	-.1388	-.1006
RATIO	.0398	.1405	-.2780	-.1478	.3472	.2717	.3742	.3470	-.0804	.2460	.0442	.1644
Sen @ 20°F	.2788	.2237	.2705	-.1319	-.1874	-.2320	-.4381	-.0609	.0559	-.0546	-.0250	-.0915
Sen @ 40°F	.1778	.0916	.2861	-.0439	-.2194	-.2085	-.4438	-.2354	.1175	-.1712	-.0945	-.1800
Sen @ 75°F	-.4098	-.4531	.0669	.2943	-.1477	-.0127	.5490	-.1659	-.0486	-.1303	.4847	.5017
DIFF	.6160	.7522	.0669	-.5775	.3476	.0601	-.0179	.6648	-.1310	.3201	.1632	.1753

Correlation Matrices for PREDICTED Bag 1 CO (Appendix 3) for All Vehicles Except the Ethyl & Dresser Cars

Correlation Coefficients for Linear Model with No Data from Tests Over 90°F

N= 15 DF= 13 R@ .0500= .5140 R@ .0100= .6411

PREDICTED VARIABLE	AIR	PMP/PLS	OXD	3WY	BOTH	#CAT	TYPE	FS	A/F	EGR	ETW	#CYL
CO @ 20°F	.5454	.6797	.2311	-.4737	.2901	.1720	.3156	.6747	-.1826	.2979	.5311	.3867
CO @ 40°F	.5260	.6497	.2847	-.4515	.2327	.1170	.2785	.6488	-.2159	.2756	.5665	.3989
CO @ 75°F	.3325	.3799	.5080	-.2574	-.1030	-.1852	.0391	.4002	-.3473	.1125	.6468	.3902
Slope@20°F	-.5676	-.7202	-.1041	.5046	-.4059	-.2868	-.3854	-.7062	.1024	-.3356	-.4326	-.3450
Slope@40°F	-.5676	-.7202	-.1041	.5046	-.4059	-.2868	-.3854	-.7062	.1024	-.3356	-.4326	-.3450
Slope@75°F	-.5676	-.7202	-.1041	.5046	-.4059	-.2868	-.3854	-.7062	.1024	-.3356	-.4326	-.3450
RATIO	.1886	.2642	-.1837	-.2460	.3576	.3215	.4252	.2455	.1292	.1694	.1017	.2657
Sen @ 20°F	-.3050	-.5106	.5071	.2946	-.6239	-.6180	-.3269	-.5158	-.2391	-.3880	.2474	.1295
Sen @ 40°F	-.3048	-.4998	.4805	.3062	-.6167	-.6041	-.3323	-.4986	-.2186	-.3747	.2308	.1059
Sen @ 75°F	-.1887	-.2642	.1837	.2460	-.3576	-.3215	-.4252	-.2455	-.1291	-.1694	-.1017	-.2657
DIFF	.5676	.7202	.1041	-.5047	.4059	.2868	.3854	.7062	-.1024	.3356	.4326	.3450

Correlation Coefficients for Linear Model with Data from Tests up to 105°F

N= 16 DF= 14 R@ .0500= .4973 R@ .0100= .6226

PREDICTED VARIABLE	AIR	PMP/PLS	OXD	3WY	BOTH	#CAT	TYPE	FS	A/F	EGR	ETW	#CYL
CO @ 20°F	.5390	.6733	.2110	-.4765	.3045	.1883	.3058	.6698	-.2303	.2929	.5659	.4229
CO @ 40°F	.5391	.6643	.2523	-.4659	.2672	.1488	.2646	.6639	-.2484	.2799	.5717	.4007
CO @ 75°F	.4522	.5184	.3876	-.3458	.0647	-.0437	.0463	.5315	-.2854	.1794	.5041	.2414
Slope@20°F	-.5084	-.6570	-.0998	.4749	-.3771	-.2726	-.3875	-.6462	.1738	-.3075	-.5200	-.4524
Slope@40°F	-.5084	-.6570	-.0998	.4749	-.3771	-.2726	-.3875	-.6462	.1738	-.3075	-.5200	-.4524
Slope@75°F	-.5084	-.6570	-.0998	.4749	-.3771	-.2726	-.3875	-.6462	.1738	-.3075	-.5200	-.4524
RATIO	.1301	.1859	-.1288	-.1823	.2562	.2344	.4469	.1750	.1409	.1106	.1932	.3627
Sen @ 20°F	-.1105	-.3444	.4616	.1518	-.4495	-.4953	-.3721	-.4117	-.1743	-.1563	-.0762	-.2193
Sen @ 40°F	-.1255	-.3302	.4054	.1732	-.4321	-.4676	-.3933	-.3772	-.1523	-.1633	-.0995	-.2539
Sen @ 75°F	-.1301	-.1859	.1288	.1823	-.2562	-.2344	-.4469	-.1750	-.1409	-.1106	-.1932	-.3627
DIFF	.5084	.6570	.0999	-.4749	.3771	.2726	.3875	.6462	-.1738	.3075	.5200	.4524

Correlation Matrices for PREDICTED Bag 1 CO (Appendix 3) for All Vehicles Except the Ethyl & Dresser Cars

Correlation Coefficients for Quadratic Model with No Data from Tests Over 90°F

N= 16 DF= 14 R@ .0500= .4973 R@ .0100= .6226

PREDICTED VARIABLE	AIR	PMP/PLS	OXD	3WY	BOTH	#CAT	TYPE	FS	A/F	EGR	ETW	#CYL
CO @ 20°F	.5708	.7074	.1684	-.5176	.3714	.2509	.2351	.6997	-.2953	.3190	.4821	.3300
CO @ 40°F	.4171	.5156	.3452	-.3364	.0842	-.0059	.2727	.5186	-.2050	.2491	.6518	.4918
CO @ 75°F	.3100	.3508	.5007	-.2054	-.1419	-.2208	.1111	.3740	-.1636	.0742	.6163	.3755
Slope@20°F	-.4116	-.5086	.2412	.4417	-.5735	-.4889	.0182	-.4904	.2332	-.1893	.1638	.2014
Slope@40°F	-.5592	-.7009	.0732	.5517	-.5643	-.4505	-.1649	-.6818	.2960	-.3225	-.1928	-.1106
Slope@75°F	-.1732	-.2308	-.3336	.1030	.1261	.1597	-.3165	-.2326	.0625	-.1913	-.6410	-.5720
RATIO	.1419	.1888	-.1178	-.1980	.2635	.2339	-.1208	.1727	-.4401	.1170	.0691	.0306
Sen @ 20°F	-.1298	-.1176	.2309	.2180	-.3576	-.3206	.2243	-.0511	.1893	.0803	.4964	.4902
Sen @ 40°F	-.2471	-.3054	.2600	.3498	-.5002	-.4519	.0631	-.2466	.2911	-.1223	.2703	.2410
Sen @ 75°F	.1258	.1443	-.0913	-.1981	.2459	.2068	-.1971	.1190	-.4590	.0339	-.0112	-.0699
DIFF	.5718	.7204	.0229	-.5454	.4944	.3786	.2414	.7030	-.2946	.3548	.3566	.2606

Correlation Coefficients for Quadratic Model with Data from Tests up to 105°F

N= 15 DF= 13 R@ .0500= .5140 R@ .0100= .6411

PREDICTED VARIABLE	AIR	PMP/PLS	OXD	3WY	BOTH	#CAT	TYPE	FS	A/F	EGR	ETW	#CYL
CO @ 20°F	.5572	.6925	.2183	-.4878	.3122	.1915	.3032	.6875	-.1881	.3027	.5013	.3570
CO @ 40°F	.4867	.5959	.3382	-.4055	.1527	.0475	.2067	.6001	-.2530	.2536	.5807	.3781
CO @ 75°F	.3411	.3947	.4936	-.2681	-.0830	-.1705	.1029	.4131	-.3245	.1255	.6912	.4469
Slope@20°F	-.5364	-.6819	.0588	.5103	-.5223	-.4034	-.4077	-.6613	.0182	-.3056	-.2283	-.2339
Slope@40°F	-.5802	-.7340	-.0448	.5286	-.4690	-.3465	-.3734	-.7179	.0879	-.3366	-.3367	-.2738
Slope@75°F	-.3764	-.4660	-.3293	.2781	-.0384	.0244	-.0550	-.4728	.2458	-.2352	-.4673	-.2351
RATIO	.2520	.3570	-.2689	-.3207	.4862	.4553	.3224	.3307	.0613	.2341	-.1059	.0526
Sen @ 20°F	-.0215	-.0877	.3185	.1539	-.3624	-.3186	-.1562	-.0234	-.1028	-.0343	.3319	.1306
Sen @ 40°F	-.1623	-.2617	.3133	.2544	-.4538	-.4217	-.2710	-.2210	-.1062	-.1646	.2036	.0233
Sen @ 75°F	-.1683	-.2409	.1185	.0610	-.1385	-.1976	.2837	-.2711	.0594	-.2051	.3144	.4569
DIFF	.5848	.7384	.0856	-.5241	.4369	.3157	.3511	.7245	-.1140	.3415	.3729	.2837

Correlation Matrices for All 18 Vehicles

Correlation Coefficients between pairs of Vehicle Parameters:

N= 18 DF= 16 R@ .0500= .4683 R@ .0100= .5897

VARIABLE												
AIR	1.0000											
PMP/PLS	.9286	1.0000										
OXD	.1890	.0236	1.0000									
3WY	-.7559	-.6614	-.2500	1.0000								
BOTH	.5345	.5345	-.3536	-.7071	1.0000							
#CAT	.2224	.2224	-.2942	-.3922	.8321	1.0000						
TYPE	-.0279	.0279	-.1474	.3686	0.	.1735	1.0000					
FS	.6786	.7679	-.2362	-.4725	.5345	.2224	.2229	1.0000				
A/F	-.0945	-.0472	-.5000	.2500	.2357	.3922	.2949	-.0945	1.0000			
EGR	.2362	.1890	.1250	-.5000	.3536	.2942	-.1843	.2362	-.2500	1.0000		
ETW	-.1013	-.0716	.4207	.2589	-.4053	-.2937	.5944	.0874	-.2034	-.1294	1.0000	
#CYL	-.1793	-.1793	.2372	.3162	-.4472	-.3721	.5595	0.	-.1581	0.	.8596	1.0000
	AIR	**PMP/PLS**	**OXD**	**3WY**	**BOTH**	**#CAT**	**TYPE**	**FS**	**A/F**	**EGR**	**ETW**	**#CYL**

Correlation Matrices for 16 Cars (All Vehicles Except the Ethyl & Dresser Cars)

Correlation Coefficients between pairs of Vehicle Parameters:

N= 16 DF= 14 R@ .0500= .4973 R@ .0100= .6226

VARIABLE												
AIR	1.0000											
PMP/PLS	.9115	1.0000										
OXD	.1816	0.	1.0000									
3WY	-.7125	-.5970	-.2548	1.0000								
BOTH	.5447	.5578	-.4286	-.7645	1.0000							
#CAT	.2894	.3266	-.4880	-.5919	.8783	1.0000						
TYPE	.2774	.3651	-.2182	.2335	-.0727	-.1491	1.0000					
FS	.8321	.9129	-.2182	-.5449	6547	.4472	.3333	1.0000				
A/F	-.2774	-.1826	-.6547	.3892	.0727	.1491	.3333	0.	1.0000			
EGR	.3026	.2390	.1429	-.5606	.4286	.4880	-.2182	.2182	-.2182	1.0000		
ETW	.0946	.1245	.4752	.1287	-.4370	-.5045	.5159	.0787	-.2011	-.1546	1.0000	
#CYL	-.0402	-.0529	.2845	.2368	-.4109	-.4102	.6276	-.0483	-.0483	-.0316	.8676	1.0000
	AIR	**PMP/PLS**	**OXD**	**3WY**	**BOTH**	**#CAT**	**TYPE**	**FS**	**A/F**	**EGR**	**ETW**	**#CYL**

APPENDIX 5

Regression Analyses Modeling Cold-Start CO Emissions

The results from forward and backward selection indicate that relationships can be determined which have R-squared values that exceed 0.7. The relationships are summarized below.

Results From Backward Selection

	-----Value of the Coefficient of the Term-----						
Dependent Variable	Constant	Temp	FS	ETW	FS*TEMP	$FS*TEMP^2$	R-Sq.
Bag 1 CO	-134.310	0.852	109.59	0.021	-1.800	0.006	0.78
Bag 1 CO-Bag 1 CO @75°	-97.936	0.855	102.01	0.010	-1.846	0.007	0.76

Results From Forward Selection

	---Value of the Coefficient of the Term--					
Dependent Variable	Constant	$Temp^2$	ETW	FS*TEMP	FS*ETW	R-Sq.
Bag 1 CO	73.719	0.009	-0.041	-1.131	0.031	0.77
Bag 1 CO-Bag 1 CO @75°	93.998	0.009	-0.047	-1.153	0.029	0.76

FS is a categorical variable. If a vehicle has fuel injection, FS = 0. If a vehicle is carbureted, FS = 1.0.

SELECT OPTIONS=STEPWISE,BACKWARD VAR=03;2,20,7,12,17,71,72,74,81,82
MAXIM=100 LEVELS=.05,.10>

Selection of Regression of Bag 1 CO (BONE) Using All Vehicles Except
Ethyl & Dresser Cars (16 Cars)

ANALYSIS AT STEP 0 (Initial Step) FOR 3.BONE N= 119 OUT OF 119

SOURCE	DF	SUM OF SQRS	MEAN SQUARE	F-STAT	SIGNIF
REGRESSION	10	.13340 +6	13340.	37.606	.0000
ERROR	108	38312.	354.74		
TOTAL	118	.17172 +6			

MULTIPLE R= .88141 R-SQR= .77689 SE= 18.835

VARIABLE	PARTIAL	COEFFICIENT	STD ERROR	T-STAT	SIGNIF
CONSTANT		-196.08	.61971 +8	-.31641 -5	1.0000
2.TEMP	.09395	1.9510	1.9894	.98070	.3289
20.TEMP.2	-.05871	-.10570 -1	.17294 -1	-.61117	.5424
7.PLS	.00000	43.252	.61971 +8	.69794 -6	1.0000
12.FS	.00000	164.36	.61971 +8	.26522 -5	1.0000
17.ETW	.49705	.20961 -1	.35212 -2	5.9529	.0000
71.PLS*TEMP	-.01431	-.17138	1.1523	-.14873	.8820
72.PLS*TEMP.2	.02097	.20800 -2	.95443 -2	.21794	.8279
74.FS*PLS	-.00000	-44.638	.61971 +8	-.72030 -6	1.0000
81.FS*TEMP	-.31725	-2.3125	.66518	-3.4766	.0007
82.FS*TEMP.2	.18052	.11077 -1	.58077 -2	1.9073	.0591

ANALYSIS AT STEP 5 (Final Step) FOR 3.BONE N= 119 OUT OF 119

SOURCE	DF	SUM OF SQRS	MEAN SQUARE	F-STAT	SIGNIF
REGRESSION	5	.13309 +6	26617.	77.856	.0000
ERROR	113	38632.	341.88		
TOTAL	118	.17172 +6			

MULTIPLE R= .88036 R-SQR= .77503 SE= 18.490

VARIABLE	PARTIAL	COEFFICIENT	STD ERROR	T-STAT	SIGNIF
CONSTANT		-134.31	18.737	-7.1682	.0000
2.TEMP	.33372	.85150	.22627	3.7633	.0003
12.FS	.72186	109.59	9.8839	11.088	.0000
17.ETW	.49366	.20792 -1	.34457 -2	6.0341	.0000
81.FS*TEMP	-.61885	-1.7998	.21491	-8.3747	.0000
82.FS*TEMP.2	.40289	.64208 -2	.13722 -2	4.6793	.0000

REMAINING	PARTIAL	SIGNIF
20.TEMP.2	-.07818	.4083
7.PLS	-.03940	.6772
71.PLS*TEMP	-.03181	.7369
72.PLS*TEMP.2	-.03738	.6930
74.FS*PLS	-.03940	.6772

REGRESSION OF 3.BONE USING BACKWARD SELECTION

STEP	R-SQR	STD ERROR	# VAR	VARIABLE		PARTIAL	SIGNIF
0	.77689	18.835	10		IN		
1	.77689	18.748	9	7.PLS	OUT	.00000	1.0000
2	.77688	18.663	8	74.FS*PLS	OUT	-.00420	.9651
3	.77648	18.595	7	72.PLS*TEMP.2	OUT	.04247	.6566
4	.77640	18.515	6	71.PLS*TEMP	OUT	-.01894	.8422
5	.77503	18.490	5	20.TEMP.2	OUT	-.07818	.4083

SELECT OPTIONS=STEPWISE,FORWARD VAR=03;2,20,7,12,17,71-74,81-83,91,92,93
MAXIM=100 LEVELS=.05,.10>

Selection of Regression of Bag 1 CO (BONE) Using All Vehicles Except Ethyl & Dresser Cars (16 Cars)

ANALYSIS AT STEP 1 (Initial Step) FOR 3.BONE N= 119 OUT OF 119

SOURCE	DF	SUM OF SQRS	MEAN SQUARE	F-STAT	SIGNIF
REGRESSION	1	68342.	68342.	77.350	.0000
ERROR	117	.10337 +6	883.55		
TOTAL	118	.17172 +6			

MULTIPLE R= .63087 R-SQR= .39799 SE= 29.724

VARIABLE	PARTIAL	COEFFICIENT	STD ERROR	T-STAT	SIGNIF
CONSTANT		84.892	6.9503	12.214	.0000
2.TEMP	-.63087	-.87305	.99268 -1	-8.7949	.0000

REMAINING	PARTIAL	SIGNIF
20.TEMP.2	.23864	.0093
7.PLS	-.15201	.1003
12.FS	.49859	.0000
17.ETW	.40492	.0000
71.PLS*TEMP	-.06789	.4651
72.PLS*TEMP.2	.06538	.4818
73.PLS*ETW	.05522	.5526
74.FS*PLS	.43871	.0000
81.FS*TEMP	.29072	.0014
82.FS*TEMP.2	.26129	.0043
83.FS*ETW	.60202	.0000
91.FS*PLS*TEMP	.27256	.0028
92.FS*PLS*TEMP.2	.26594	.0036
93.FS*PLS*ETW	.55526	.0000

ANALYSIS AT STEP 6 (Final Step) FOR 3.BONE N= 119 OUT OF 119

SOURCE	DF	SUM OF SQRS	MEAN SQUARE	F-STAT	SIGNIF
REGRESSION	4	.13245 +6	33114.	96.147	.0000
ERROR	114	39262.	344.41		
TOTAL	118	.17172 +6			

MULTIPLE R= .87827 R-SQR= .77135 SE= 18.558

VARIABLE	PARTIAL	COEFFICIENT	STD ERROR	T-STAT	SIGNIF
CONSTANT		73.719	13.485	5.4670	.0000
20.TEMP.2	.45367	.85788 -2	.15783 -2	5.4353	.0000
17.ETW	-.53754	-.41108 -1	.60398 -2	-6.8063	.0000
81.FS*TEMP	-.69676	-1.1313	.10908	-10.371	.0000
83.FS*ETW	.77019	.31124 -1	.24141 -2	12.893	.0000

REMAINING	PARTIAL	SIGNIF
2.TEMP	-.09398	.3178
7.PLS	.00901	.9238
12.FS	-.04090	.6643
71.PLS*TEMP	-.02375	.8011
72.PLS*TEMP.2	-.01029	.9131
73.PLS*ETW	.00901	.9238
74.FS*PLS	.00542	.9542
82.FS*TEMP.2	.15276	.1031
91.FS*PLS*TEMP	-.00009	.9992
92.FS*PLS*TEMP.2	.07951	.3983
93.FS*PLS*ETW	.00901	.9238

REGRESSION OF 3.BONE USING FORWARD SELECTION

STEP	R-SQR	STD ERROR	# VAR	VARIABLE		PARTIAL	SIGNIF
1	.39799	29.724	1	2.TEMP	IN	-.63087	.0000
2	.61618	23.836	2	83.FS*ETW	IN	.60202	.0000
3	.67576	22.003	3	81.FS*TEMP	IN	-.39400	.0000
4	.67446	21.952	2	2.TEMP	OUT	-.06331	.4977
5	.71210	20.734	3	17.ETW	IN	-.34005	.0002
6	.77135	18.558	4	20.TEMP.2	IN	.45367	.0000

SELECT OPTIONS=STEPWISE,BACKWARD VAR=18;2,20,7,12,17,71,72,74,81,82 MAXIM=100 LEVELS=.05,.10>

Selection of Regression of the Amount (DIFF) by Which Bag 1 CO Exceeds Bag 1 CO at 75°F for 16 Veh.

ANALYSIS AT STEP 0 (Initial Step) FOR 18.DIFF N= 119 OUT OF 119

SOURCE	DF	SUM OF SQRS	MEAN SQUARE	F-STAT	SIGNIF
REGRESSION	10	.11430 +6	11430.	35.366	.0000
ERROR	108	34905.	323.19		
TOTAL	118	.14921 +6			

MULTIPLE R= .87525 R-SQR= .76606 SE= 17.978

VARIABLE	PARTIAL	COEFFICIENT	STD ERROR	T-STAT	SIGNIF
CONSTANT		-152.92	.59151 +8	-.25853 -5	1.0000
2.TEMP	.08594	1.7021	1.8988	.89639	.3720
20.TEMP.2	-.04937	-.84796 -2	.16507 -1	-.51369	.6085
7.PLS	.00000	39.773	.59151 +8	.67239 -6	1.0000
12.FS	.00000	154.42	.59151 +8	.26107 -5	1.0000
17.ETW	.27953	.10169 -1	.33610 -2	3.0256	.0031
71.PLS*TEMP	-.00545	-.62300 -1	1.0998	-.56645 -1	.9549
72.PLS*TEMP.2	.01299	.12302 -2	.91100 -2	.13504	.8928
74.FS*PLS	-.00000	-44.047	.59151 +8	-.74466 -6	1.0000
81.FS*TEMP	-.32684	-2.2819	.63492	-3.5939	.0005
82.FS*TEMP.2	.18239	.10687 -1	.55434 -2	1.9278	.0565

ANALYSIS AT STEP 5 (Final Step) FOR 18.DIFF N= 119 OUT OF 119

SOURCE	DF	SUM OF SQRS	MEAN SQUARE	F-STAT	SIGNIF
REGRESSION	5	.11404 +6	22808.	73.283	.0000
ERROR	113	35169.	311.23		
TOTAL	118	.14921 +6			

MULTIPLE R= .87424 R-SQR= .76430 SE= 17.642

VARIABLE	PARTIAL	COEFFICIENT	STD ERROR	T-STAT	SIGNIF
CONSTANT		-97.936	17.878	-5.4781	.0000
2.TEMP	.34915	.85508	.21589	3.9608	.0001
12.FS	.71323	102.01	9.4305	10.817	.0000
17.ETW	.27547	.10015 -1	.32876 -2	3.0461	.0029
81.FS*TEMP	-.64637	-1.8464	.20505	-9.0050	.0000
82.FS*TEMP.2	.43369	.66984 -2	.13092 -2	5.1164	.0000

REMAINING	PARTIAL	SIGNIF
20.TEMP.2	-.07237	.4442
7.PLS	-.03987	.6736
71.PLS*TEMP	-.03009	.7506
72.PLS*TEMP.2	-.03470	.7140
74.FS*PLS	-.03987	.6736

REGRESSION OF 18.DIFF USING BACKWARD SELECTION

STEP	R-SQR	STD ERROR	= VAR	VARIABLE		PARTIAL	SIGNIF
0	.76606	17.978	10		IN		
1	.76606	17.895	9	7.PLS	OUT	.00000	1.0000
2	.76606	17.814	8	71.PLS*TEMP	OUT	-.00545	.9547
3	.76578	17.744	7	72.PLS*TEMP.2	OUT	.03467	.7167
4	.76553	17.674	6	74.FS*PLS	OUT	-.03229	.7342
5	.76430	17.642	5	20.TEMP.2	OUT	-.07237	.4442

SELECT OPTIONS=STEPWISE,FORWARD VAR=18;2,20,7,12,17,71-74,81-83,91,92,93 MAXIM=100 LEVELS=.05,.10>

Selection of Regression of the Amount (DIFF) by Which Bag 1 CO Exceeds Bag 1 CO at 75°F for 16 Veh.

ANALYSIS AT STEP 1 (Initial Step) FOR 18.DIFF N= 119 OUT OF 119

SOURCE	DF	SUM OF SQRS	MEAN SQUARE	F-STAT	SIGNIF
REGRESSION	1	72307.	72307.	110.01	.0000
ERROR	117	76901.	657.27		
TOTAL	118	.14921 +6			

MULTIPLE R= .69614 R-SQR= .48461 SE= 25.637

VARIABLE	PARTIAL	COEFFICIENT	STD ERROR	T-STAT	SIGNIF
CONSTANT		73.145	5.9946	12.202	.0000
2.TEMP	-.69614	-.89801	.85618 -1	-10.489	.0000

REMAINING	PARTIAL	SIGNIF
20.TEMP.2	.27473	.0026
7.PLS	-.10272	.2683
12.FS	.37123	.0000
17.ETW	.23127	.0117
71.PLS*TEMP	-.00670	.9426
72.PLS*TEMP.2	.13664	.1401
73.PLS*ETW	.01750	.8508
74.FS*PLS	.33336	.0002
81.FS*TEMP	.14306	.1222
82.FS*TEMP.2	.14778	.1103
83.FS*ETW	.41252	.0000
91.FS*PLS*TEMP	.15279	.0986
92.FS*PLS*TEMP.2	.18404	.0460
93.FS*PLS*ETW	.38121	.0000

ANALYSIS AT STEP 6 (Final Step) FOR 18.DIFF N= 119 OUT OF 119

SOURCE	DF	SUM OF SQRS	MEAN SQUARE	F-STAT	SIGNIF
REGRESSION	4	.11270 +6	28175.	87.983	.0000
ERROR	114	36507.	320.23		
TOTAL	118	.14921 +6			

MULTIPLE R= .86910 R-SQR= .75533 SE= 17.895

VARIABLE	PARTIAL	COEFFICIENT	STD ERROR	T-STAT	SIGNIF
CONSTANT		93.998	13.003	7.2292	.0000
20.TEMP.2	.47347	.87349 -2	.15219 -2	5.7394	.0000
17.ETW	-.60221	-.46906 -1	.58239 -2	-8.0540	.0000
81.FS*TEMP	-.71626	-1.1526	.10518	-10.959	.0000
83.FS*ETW	.75492	.28610 -1	.23278 -2	12.290	.0000

REMAINING	PARTIAL	SIGNIF
2.TEMP	-.11582	.2177
7.PLS	.00387	.9672
12.FS	.01878	.8421
71.PLS*TEMP	-.03368	.7208
72.PLS*TEMP.2	-.01504	.8732
73.PLS*ETW	.00387	.9672
74.FS*PLS	.00519	.9561
82.FS*TEMP.2	.17170	.0665
91.FS*PLS*TEMP	-.00480	.9594
92 FS*PLS*TEMP.2	.08610	.3602
93.FS*PLS*ETW	.00387	.9672

REGRESSION OF 18.DIFF USING FORWARD SELECTION

STEP	R-SQR	STD ERROR	# VAR	VARIABLE		PARTIAL	SIGNIF
1	.48461	25.637	1	2.TEMP	IN	-.69614	.0000
2	.57231	23.455	2	83.FS*ETW	IN	.41252	.0000
3	.62143	22.163	3	81.FS*TEMP	IN	-.33888	.0002
4	.61485	22.258	2	2.TEMP	OUT	-.13071	.1601
5	.68463	20.228	3	17.ETW	IN	-.42566	.0000
6	.75533	17.895	4	20.TEMP.2	IN	.47347	.0000

```
SELECT OPTIONS=STEPWISE,BACKWARD VAR=19;2,20,7,12,17,71,72,74,81,82
   MAXIM=100 LEVELS=.05,.10>
```

Selection of Regression of Quotient (RATIO) of Bag 1 CO Divided by Bag 1 CO at 75°F for 16 Vehicles

ANALYSIS AT STEP 0 (Initial Step) FOR 19.RATIO N= 119 OUT OF 119

SOURCE	DF	SUM OF SQRS	MEAN SQUARE	F-STAT	SIGNIF
REGRESSION	10	891.60	89.160	9.3464	.0000
ERROR	108	1030.3	9.5395		
TOTAL	118	1921.9			

MULTIPLE R= .68112 R-SQR= .46392 SE= 3.0886

VARIABLE	PARTIAL	COEFFICIENT	STD ERROR	T-STAT	SIGNIF
CONSTANT		-2.8227	.10162 +8	-.27776 -6	1.0000
2.TEMP	-.00029	-.96814 -3	.32623	-.29677 -2	.9976
20.TEMP.2	-.00122	-.35951 -4	.28360 -2	-.12677 -1	.9899
7.PLS	.00000	.45237 -1	.10162 +8	.44514 -8	1.0000
12.FS	.00000	9.6308	.10162 +8	.94769 -6	1.0000
17.ETW	.11350	.68549 -3	.57742 -3	1.1872	.2378
71.PLS*TEMP	.01778	.34911 -1	.18896	.18476	.8538
72.PLS*TEMP.2	-.00563	-.91602 -4	.15651 -2	-.58527 -1	.9534
74.FS*PLS	-.00000	-2.3586	.10162 +8	-.23209 -6	1.0000
81.FS*TEMP	-.14079	-.16120	.10908	-1.4778	.1424
82.FS*TEMP.2	.08368	.83111 -3	.95238 -3	.87267	.3848

ANALYSIS AT STEP 7 (Final Step) FOR 19.RATIO N= 119 OUT OF 119

SOURCE	DF	SUM OF SQRS	MEAN SQUARE	F-STAT	SIGNIF
REGRESSION	3	868.04	289.35	31.575	.0000
ERROR	115	1053.8	9.1638		
TOTAL	118	1921.9			

MULTIPLE R= .67206 R-SQR= .45166 SE= 3.0272

VARIABLE	PARTIAL	COEFFICIENT	STD ERROR	T-STAT	SIGNIF
CONSTANT		.62845	.97537	.64432	.5207
12.FS	.56296	6.5177	.89227	7.3046	.0000
81.FS*TEMP	-.43346	-.13936	.27017 -1	-5.1581	.0000
82.FS*TEMP.2	.29451	.74008 -3	.22393 -3	3.3049	.0013

REMAINING	PARTIAL	SIGNIF
2.TEMP	.07341	.4335
20.TEMP.2	.07109	.4483
7.PLS	-.02253	.8103
17.ETW	.10982	.2406
71.PLS*TEMP	.03515	.7080
72.PLS*TEMP.2	.04881	.6028
74.FS*PLS	-.02253	.8103

REGRESSION OF 19.RATIO USING BACKWARD SELECTION

STEP	R-SQR	STD ERROR	# VAR	VARIABLE		PARTIAL	SIGNIF
0	.46392	3.0886	10		IN		
1	.46392	3.0744	9	7.PLS	OUT	.00000	1.0000
2	.46392	3 0604	8	2.TEMP	OUT	-.00029	.9976
3	.46390	3.0467	7	20.TEMP.2	OUT	-.00659	.9450
4	.46382	3.0332	6	72.PLS*TEMP.2	OUT	-.01189	.9005
5	.45879	3.0339	5	71.PLS*TEMP	OUT	.09647	.3072
6	.45828	3.0220	4	74.FS*PLS	OUT	-.03075	.7443
7	.45166	3.0272	3	17.ETW	OUT	.10982	.2406

SELECT OPTIONS=STEPWISE,FORWARD VAR=19;2,20,7,12,17,71-74,81-83,91,92,93
MAXIM=100 LEVELS=.05,.10>

Selection of Regression of Quotient (RATIO) of Bag 1 CO Divided by Bag 1 CO at 75°F for 16 Vehicles

ANALYSIS AT STEP 1 (Initial Step) FOR 19.RATIO N= 119 OUT OF 119

SOURCE	DF	SUM OF SQRS	MEAN SQUARE	F-STAT	SIGNIF
REGRESSION	1	638.94	638.94	58.270	.0000
ERROR	117	1282.9	10.965		
TOTAL	118	1921.9			

MULTIPLE R= .57659 R-SQR= .33246 SE= 3.3114

VARIABLE	PARTIAL	COEFFICIENT	STD ERROR	T-STAT	SIGNIF
CONSTANT		7.9725	.77427	10.297	.0000
2.TEMP	-.57659	-.84416 -1	.11059 -1	-7.6335	.0000

REMAINING	PARTIAL	SIGNIF
20.TEMP.2	.26269	.0041
7.PLS	-.07387	.4266
12.FS	.19936	.0304
17.ETW	.11698	.2071
71.PLS*TEMP	-.00879	.9247
72.PLS*TEMP.2	.11775	.2041
73.PLS*ETW	-.01050	.9102
74.FS*PLS	.16701	.0707
81.FS*TEMP	.08684	.3498
82.FS*TEMP.2	.13610	.1417
83.FS*ETW	.21702	.0183
91.FS*PLS*TEMP	.08943	.3355
92.FS*PLS*TEMP.2	.16164	.0803
93.FS*PLS*ETW	.19046	.0388

ANALYSIS AT STEP 4 (Final Step) FOR 19.RATIO N= 119 OUT OF 119

SOURCE	DF	SUM OF SQRS	MEAN SQUARE	F-STAT	SIGNIF
REGRESSION	4	828.87	207.22	21.613	.0000
ERROR	114	1093.0	9.5877		
TOTAL	118	1921.9			

MULTIPLE R= .65672 R-SQR= .43128 SE= 3.0964

VARIABLE	PARTIAL	COEFFICIENT	STD ERROR	T-STAT	SIGNIF
CONSTANT		7.5243	1.6640	4.5217	.0000
2.TEMP	-.41340	-.22931	.47304 -1	-4.8475	.0000
20.TEMP.2	.32536	.18132 -2	.49354 -3	3.6738	.0004
82.FS*TEMP.2	-.21074	-.34248 -3	.14879 -3	-2.3018	.0232
83.FS*ETW	.29133	.68738 -3	.21140 -3	3.2515	.0015

REMAINING	PARTIAL	SIGNIF
7.PLS	-.06731	.4748
12.FS	.17058	.0684
17.ETW	-.17274	.0649
71.PLS*TEMP	-.02812	.7654
72.PLS*TEMP.2	-.01590	.8661
73.PLS*ETW	-.11539	.2194
74.FS*PLS	.05007	.5951
81.FS*TEMP	.06203	.5101
91.FS*PLS*TEMP	-.00961	.9188
92.FS*PLS*TEMP.2	-.01590	.8661
93.FS*PLS*ETW	-.06731	.4748

REGRESSION OF 19.RATIO USING FORWARD SELECTION

STEP	R-SQR	STD ERROR	# VAR	VARIABLE		PARTIAL	SIGNIF
1	.33246	3.3114	1	2.TEMP	IN	-.57659	.0000
2	.37852	3.2088	2	20.TEMP.2	IN	.26269	.0041
3	.40485	3.1537	3	83.FS*ETW	IN	.20583	.0260
4	.43128	3.0964	4	82.FS*TEMP.2	IN	-.21074	.0232