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Emission Factor Testing Needs in the Latter 1980s

by

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1.0 Summary

Emission Factor testing is important because of its use in MOBILE3, which is in turn used to prepare State Implementation Plans (SIPs), Environmental Impact Statements (EISs), and develop real world benefits for EPA regulatory proposals. Many others (auto manufacturers, CARB) use the emission factor data directly for many different purposes.

There are a variety of current and future emission factor testing needs which are enumerated below. EPA should consider increasing its commitment to emission factor testing so that these needs are adequately addressed.

Summary of EF Testing Needs

- Carbureted Cars - at higher mileages (70+K)
- Fuel injected cars - at higher mileages (50+K)
- Continued or increased testing at alternate sites
- Older cars (10-15 years old)
- Future cars/trucks with onboard systems or systems certified with higher volatility fuels
- More emphasis on LDGTs
- Chassis testing of heavy duty trucks
- Continued testing of transit bus engines
- Continued testing of heavy duty gasoline engines, if feasible
- Some testing of LDDTs
- Continued testing of temperature effects on evaporative emissions
- Characterization of evaporative HC running losses
- High altitude evaporative HC testing
- Low temperature testing of carbureted and fuel injected cars with wintertime fuels
- Modal testing of new technology cars to aid in CO modeling at intersections
- Effectiveness of certain repairs
- FTP effects of pattern case fixes

2.0 Background

EPA's emission factor data base, which contains emission tests on over 12,000 in-use light-duty vehicles and trucks tested since 1971, is EPA's best source of information on how cars and trucks actually perform on the road. As a data set on in-use car performance with respect to emissions and fuel economy, it is second to none in size and completeness of information on each car tested. It is used primarily by the Emission Control Technology Division of EPA's Office of Mobile Sources (OMS) to update its in-use emissions' models such as MOBILE3, and to estimate the benefits of certain regulatory proposals, for example, volatility controls. States and local areas are relying on the data through the use of MOBILE3 to estimate emission inventories, determine the effects of I/M and antitampering programs, and determine the effects of transportation control measures and construction projects. Others are given free access to the data, and use it on a periodic or as-needed basis. For example, most of the major auto manufacturers have requested access to the data, and some review the new data on a weekly or monthly basis to determine the in-use performance of their cars. The potential benefits of their concern with in-use performance should not be underestimated. Another example user is the California Air Resources Board (CARB), which has an ongoing in-use testing program of its own. CARB is currently using the EPA data to compare their estimates of light-duty vehicle emission factors to EPA's. Other OMS divisions have also used the emission factor data base on numerous occasions.

With all of its current merits, in order for the data base to remain useful, EPA must have a high commitment to continued emission factor testing, and should consider increasing that commitment. There is, and will be, a great need to test new technology vehicles at a wide range of mileages and ages (to assess durability); vehicles with new fuel delivery systems (fuel injection), new emission standards, and perhaps new evaporative control hardware (onboard systems). Additionally, there are many special emission factor testing needs which have not yet been addressed. All of these needs, both present and future, will be discussed in this paper.

3.0 General Testing Needs by Vehicle Type

3.1 Light-Duty Gasoline Vehicles (LDGVs)

Carbureted Cars - Although fuel injected cars are rapidly becoming more common, carbureted closed loop cars will continue to dominate the in-use fleet in the late 1980s. The emission factors for these cars are based on quite a few cars tested at low mileages and some cars tested at the higher mileages (see Figure 1). The emission data indicated that cars could be divided into three groups by emission levels - normal emitters, high emitters, and super emitters. The high emitting cars usually have one or two problems which make them emit above the normal cars. The super emitters have extraordinary problems, either in numbers or type, that make them emit far above the high emitters. As the fleet of new technology cars grows older, more are expected to migrate from the normal category into the high and super emitter categories. The emission rates of the fleet of carbureted closed-loop cars are very dependent on how quickly this migration occurs. In turn, the emission rates of all LDGVs are quite dependent on the high mileage cars, since 50% of the LDGV VMT is from cars with odometer values above 50,000 miles. Therefore, it is important to be able to predict the rate of growth of the high and super emitter categories with confidence, and also their average emission levels. To do this effectively, EPA needs more data on carbureted cars tested at mileages above 70K miles.

Another point with respect to the high mileage data we do have is that it is from cars that accumulated the mileage quickly, since most of the tests were performed two or three years ago on 1981 cars when they were only about two to three years old. Most cars accumulate mileage slower than that, for example, a 1981 car sold in January of 1981 would be expected to have about 55,000 miles on it at this time. Emissions from normally accumulated mileage cars could be somewhat higher than advanced accumulated mileage cars since they may experience more cold starts and more severe stop-and-go driving than the advanced mileage cars.

Fuel Injected Cars - Manufacturers are introducing fuel injection on new and existing engines at a rapid pace. EPA's emission factor program has been focusing on these cars in the last two years for evaporative as well as exhuast emission reasons, but we clearly have little high mileage data on fuel injected cars (see Figure 2). Generally, our experience to date has been that fuel injected cars are cleaner than carbureted cars. We have not found a fuel injected car in the super emitter category yet, and those in the high and normal categories have lower average emissions than their carbureted counterparts. However, a somewhat new development with fuel injected cars may change this outlook. Many fuel injected cars are experiencing injector plugging from deposits that are building up in the nozzles of the injectors. These deposits come from in-use gasolines with little or no detergent additives. (Higher detergent gasolines supposedly can clear away these deposits.) In a multipoint fuel injected car, the deposits can disturb the distribution of gasoline into the cylinders, causing driveability problems potentially resulting in incomplete combustion and higher HC emissions. We plan to monitor this situation by inspecting and testing injectors on EF cars that have HC emissions in excess of about 0.6 g/mi, and have few or no other apparent problems (such as a three-way system failure or faulty ignition system). In the last few months we have seen very few fuel injected cars above 0.6 g/mi (most are 0.2-0.3 g/mi HC); however, these have been mostly lower mileage (20K-30K) cars.

<u>All Cars</u> - For the last few years our primary emission factor testing has been conducted in Ann Arbor (other smaller and specialized programs have taken place in Denver and East Liberty, Ohio). Resource considerations have been the motivating factor in consolidating the testing at the Ann Arbor site. We do not fault the testing here in any way, but we are concerned about the risks of basing nationwide vehicle emission factor estimates on testing primarily at one site. We have seen differences in evaporative emissions between samples tested in Ohio and Ann Arbor. Most of the difference we have been able to attribute to minor test procedure differences, but the potential exists for different evaporative emissions between different sites because of the wide differences in in-use fuels used. It is possible that some fuels cause more rapid deterioration in evaporative systems than other fuels.

Another consideration is the severity of weather in the Detroit area. Detroit cars undoubtedly experience more low temperature cold starts than the national average, and these conditions are well known for producing engine wear. There is also more possibility of choke malfunctions. These factors would make the Detroit sample a higher emitting sample than the national average.

An ideal solution would involve a return to the multicity EF programs of the past. As an alternative, it is imperative that we maintain and perhaps increase our commitment to the off-site testing we are doing in Ohio and possibly at other contractor facilities. In addition to studying specialized concerns at these sites, we can continue to make comparisons between the as-received tests on cars at the different sites.

<u>Future Cars</u> - Due to the need for ozone control and control of air toxics, it is almost a certainty that EPA will require auto manufacturers to control excess evaporative

emissions, refueling emissions, or both. This could occur with the 1989 or 1990 model year. The manufacturers will have to develop new hardware and alter purge system management to accomplish this. Naturally, there will be a need to test how these systems perform in use. A continued and consistent commitment to EF testing will allow us to perform this critical testing when the time comes.

Older Cars - The data in Figure 3 illustrate that age 0-5 cars accumulate 50% of the fleet VMT, but only contribute 16-22 percent of the fleet emissions because of their relatively low emission levels. The most emissions come from the age 11-15 group, which contributes 35-37 percent of the fleet emissions. These values take into account the fact that many of these 11-15 year old cars have been scrapped. The dominance of the fleet emission factor by these cars can be traced to the deterioration rate, or increase in emissions with age/mileage.

This concept is illustrated further in Figure 4 which shows the yearly emissions of a 1985 car which lasts for 20 years. Each year's emissions are estimated as the product of the annual VMT and the average emission factor (at year midpoint) for that year. For 1985 cars that last 20 years, they produce the most emissions in their twelfth year, the reason being that their emission rates have increased much faster than their yearly VMT has dropped.

The implications of these concepts are that if EPA has missed the mark at all in estimating emission rates of the 1970-75 cars by extrapolating low mileage data to higher mileages, the current fleet emission rates could be significantly affected. We suggest that at least 50 twelve year old cars be tested each year to check the older emission rates. If the average emissions of these cars are significantly higher than the equations predict, then some adjustment could be made.

It should be noted that it will be more expensive to test 50 older cars than 50 newer cars. With newer cars, our current rejection rate is about 12 percent. These cars are rejected for being too expensive to repair prior to testing on the dynamometer. Where a car needs minor nonemission control repairs such as new brake linings or a new exhaust pipe, we do make those repairs so the cars can be tested. To conserve resources we do not, however, replace expensive items such as faulty transmissions unless they fail during testing.

On older cars there is a greater likelihood that we will have to reject more cars as too expensive to repair, and that cars will fail while we are testing them. This will increase the recruitment and repair costs over what we now pay for newer cars.

3.2 Light Duty Gasoline Trucks (LDGTs)

Light duty gasoline trucks, which are all gasoline trucks under 8500 lbs gross weight, make up roughly 20% of the total VMT of all vehicles combined. However, because their emission rates are higher than light-duty vehicles, they account for about 32% of the HC and CO emissions of the fleet (see Table 1), and therefore it is important that their emission factors are accurately characterized.

Light duty truck manufacturers use very similar emission control equipment on their cars and light trucks. Many light trucks are currently equipped with closed loop fuel controls and 3-way catalysts, even though the current NOx standard is 2.3 gpm, which in many cases probably does not require closed loop fuel control to attain. Because of the similarities between light trucks and cars, the emission factors of trucks are in part developed from the emission factors of cars, for which there are much more data. However, there are indications that the resulting emission factors for trucks are too low. Recently we tested 50 1981 LDTs in Ohio, and found that the CO emissions of the untampered trucks were 20% higher than what MOBILE3 would predict for untampered 1981 trucks. Therefore, we have started testing trucks again in the current EF program, and since the emission standards of trucks are still changing, this effort should continue. (The 1985 trucks have a full useful life definition, 1987 trucks will have a particulate standard of 0.26 g/mile, and 1988 and later trucks will have a NOx standard of 1.2 and 1.7 g/mile for 0-6000 pounds and 6000-8500 pound trucks, respectively). Although we do not think it is necessary or feasible to devote equal resources to light trucks and cars, there will be a continuing need to support EF testing of trucks.

3.3 Heavy Duty Trucks (Gasoline and Diesel), and Buses

EPA's data base on in-use emissions for gasoline and heavy duty trucks has been greatly augmented through cooperative testing with MVMA and EMA of in-use truck engines. The cooperative testing program is complete, and the emissions of these 1979-82 engines will be used in a future update of model year 1979-1986 emission rates for heavy duty trucks.

The emission rates of trucks tested in this program are quite similar to MOBILE3 emissions with the exception of HC emissions from heavy-duty gasoline vehicles, which from the test data are around 8.7 g/bhp-hr, where MOBILE3 predicts around 3.7 g/bhp-hr. The HC emissions for the test engines are driven by one truck with HC emissions of 43.8 g/bhp-hr, while the rest of the engines ranged from 3-8 g/bhp-hr. Many of the gasoline engines were poorly maintained and had evidence of being tampered.

The heavy-duty gasoline engine market is dominated by GM and Ford. Only Ford and Chrysler, however, contributed engines to the in-use emissions project. If they could be encouraged to continue sending a few engines each year, we may be able to refine our emission estimates, particularly for HC.

For both diesel and gasoline engines, it would make sense to encourage EMA and MVMA to continue the cooperative in-use testing program on a more limited basis, for example, each member agreeing to send one or two engines per year. This way we could have a continuing program, as with light-duty vehicles and light-duty trucks.

The emission factors for trucks have also been improved with further attention to the development of the heavy duty conversion factors which translate engine emissions in g/bhp-hr to on-road emissions in g/mile. While the emissions in g/mile have been improved through this analysis, there is still a need to do further chassis testing of heavy duty trucks as a check to see that the converted engine emissions are realistic. Several trucks from each truck class from light-heavy to heavy-heavy (both gas and diesel) would be needed in this analysis.

Looking ahead, heavy duty truck HC and CO standards are made more stringent in 1987, and the NOx and particulate standards are more stringent in 1988. The NOx and particulate standards are further tightened in 1991 and 1993. The next major cooperative in-use program on heavy duty engines should occur when the 1988 and 1989 model year engines have accumulated some mileage.

EPA has recently begun to test some transit bus engines on bus duty cycles, which are significantly different than the truck transient test, and yield higher levels of some emissions. Only one bus engine has been tested so far, and to adequately characterize emissions a few more are probably needed. Although bus emissions are probably not a large part of any urban inventory, they are important from an exposure standpoint.

3.4 Light Duty Diesel Vehicles and Trucks (LDDVs and LDDTs)

Although the manufacturers have significantly pulled back in their effort to develop diesel cars, there has been continued development and demand for diesel engines in light duty trucks. In 1980 the percent of light truck VMT that was attributed to diesel trucks was less than 1%. It is expected to grow to about 10% in 1990 and 28% by the year 2000.

The zero mile levels of light diesel trucks are based on certification levels and the deterioration rates are borrowed from light diesel vehicles. This, coupled with the fact that the particulate standard for diesel trucks was lowered in 1985 to 260 mg/mile, underscores the need to test a few (perhaps 20-30) 1985 and 1986 light diesel trucks in the next two years.

3.5 Off-Highway Vehicles

There are four main types of off-highway vehicles: locomotives, construction equipment, aircraft and ships (vessels). New data are being compiled for locomotives and aircraft, and the current AP-42 emissions factors for construction equipment are based on a recent California study. The off-highway source that needs additional attention is ships. Although there are some new data, the applicability is limited. For example, the new data available are for large diesels used in commercial ships. However, most of the emissions in a harbor area come from the smaller and newer diesel powerplants found in tugs and construction barges. There are very little data for this size engine (around 1500 hp). Testing of a few of these engines on representative duty cycles is needed for cities like San Diego, Houston and New York.

4.0 Specialized Needs

4.1 Evaporative Emissions

As it has become more apparent that many areas of the nation will not attain the ozone standard by the end of 1987, EPA has searched for additional HC control measures. Evaporative emissions from mobile sources have come under close scrutiny because the volatility of in-use fuels has increased dramatically over the last decade, thereby leading to higher vehicle evaporative HC emissions.

EPA has concentrated its testing efforts in quantifying the "first order" effects on evaporative emissions, namely, fuel volatility and ambient temperature. EPA now has a substantial volatility data base with which to estimate volatility effects and the benefits of volatility controls. Characterizing the effects of temperature, however, has thus far proved to be more elusive. The temperature testing is resource intensive on a per car basis, therefore, only 20 fuel injected and 20 carbureted cars have received temperature testing. Furthermore, evaporative emissions are very sensitive to temperature, leading to high variability in the data. This underscores the need for continued temperature testing so that the temperature effects can be reasonably estimated.

Quantifying the temperature effects is also a very important issue from the standpoint of controls. Ozone exceedences are known to be associated with hotter summer weather. The maximum diurnal temperature in EPA's Federal Test Procedure is 84°F. EPA needs to be sure that whatever evaporative controls are put in place, that they are effective for most situations. Accurately characterizing the effects of temperature on evaporative emissions, and also the ambient temperatures associated with most ozone exceedences, will enable us to do that.

High ambient temperatures and extended vehicle driving can also produce an evaporative emission from cars known as "running losses." When cars are driven, fuel in the tank is heated by the exhaust system, and in fuel injected cars is also heated by unused fuel recirculated from the injection system. The increase in tank fuel temperature produces additional vapor which is normally purged into the engine while the car is operating. Under some conditions, however, the rate of vapor generation can overwhelm the purge system, leading to a rapid buildup of pressure in the fuel tank. All fuel tanks are designed to release that pressure through the fuel cap at about 1.5 psi for safety reasons, and that release is a "running loss." Running losses can also occur during periods of engine operation where purge is not taking place, such as extended idle operation. Here the losses may not vent through the cap, but instead build-up and overwhelm the canister, since the canister is not being purged.

At this time there are very little data on the conditions under which running losses occur. EPA has initiated a small scale test program on one fuel injected and one carbureted car to characterize the extent of driving which would trigger running losses. However, the occurrence of running losses is probably also very system dependent, and so a larger scale effort on more cars is needed in the very near future.

A third area where EPA needs more evaporative data is at high altitude. Starting with the 1985 model year the high and low altitude evaporative standard is the same (2g). Since atmospheric pressure is lower at high altitude, more HC is produced during a given diurnal at high altitude than at low altitude. For the same reason, vapor lock is more of a problem at high altitude than at low altitude, so the oil companies typically market lower volatility fuels at high altitude during the summer than are marketed at low altitudes with similar temperatures.

In EPA's High Altitude Report to Congress, it was stated that the manufacturers might need to increase canister capacity to meet the 2g standard at high altitudes. It is known, however, that some companies are using exactly the same systems at high as well as low altitude, either because they feel that their low altitude systems have enough capacity for high altitude, or that there is a lack of EPA enforcement effort at high altitude, or both.

The current MOBILE3 high altitude evaporative emission factors for 1985+ LDGVs are set equal to the low altitude levels because the standards are the same. But if the systems are not different, the in-use high altitude evaporative rates may be higher than at lower altitudes. Therefore, there is a clear need for in-use evaporative testing of 1985 and later cars at high altitude. This testing should utilize a representative in-use high altitude fuel.

4.2 Exhaust Emissions at Different Temperatures

Exhaust HC and CO emissions are very sensitive to temperature. During a cold start at cold temperatures choke operation in carbureted cars produces very rich mixtures at a time when the catalyst is not operating, thereby producing high HC and CO emissions. Fuel injected cars need rich mixtures during cold starts also, but these systems achieve tighter control of fuel/air ratios, thereby producing less HC and CO at cold temperatures than carbureted cars.

The primary needs in the area of cold temperature data are for additional testing of carbureted cars at cold temperatures on typical wintertime fuels of 13+ psi (most tests have been done on Indolene, at 9 psi), and for fuel injected cars tested at low temperatures. The fuel injected testing should also utilize typical wintertime fuels. We currently have about 30 fuel injected cars which have been tested at 20° and 50°, and we need a minimum of 30-40 more cars to accurately characterize the behavior of these cars separately from carbureted cars. Also, there may be substantial differences between throttle-body and multiport fuel injection that need to be identified. The cold temperature testing is currently being done by TEB, drawing on the pool of fuel injected emission factor cars that we are recruiting.

As previously discussed, HC and CO emissions are high at very low temperatures. As the temperature is increased, these emissions decrease because less choke operation is needed. Emissions find a low point around 70° to 80°. This is not surprising because it is the test temperature range in which cars are certified, therefore, manufacturers have designed cars for low emissions in this range. At temperatures above 85°, however, HC and CO emissions start to increase again. This increase is due to a change in the density of air as the temperature rises. As it rises, the air becomes less dense, causing an increase in the fuel/air ratio since there are less oxygen molecules per unit volume of air than at a lower temperature.

The temperature correction factors for the different model year groups for HC and CO are shown in Figures 5-10. There is a separate figure for each bag of the FTP. Figure 6 shows the HC correction factors for the stabilized bag. The 1975-80 cars display significantly more emission sensitivity to higher temperatures than the other cars. (CO correction factors for these cars display a similar sensitivity in Figure 9.) These correction factors are based on four 1977-78 cars tested in the 1979 Gulf Study of emissions versus temperature. Of the four cars, three were very sensitive to temperature, i.e., the stabilized HC emissions of a 1978 Buick (V6) were 1.93 g/mi at 80F°, and 26.01 g/mi at 110°F with the air conditioning on.

The high temperature correction factors for 1981 and later cars are based on a few prototype and California cars tested in the same (Gulf Research) test program. Therefore, there appears to be a need for more high temperature testing of newer fuel injected and carbureted cars. Some of this testing has already been done as a part of our evaporative emissions versus temperature and RVP program (exhaust emissions were collected at 75, 85, and 95°F). This most recent testing also includes heat builds (diurnal evap emissions), which the previous Gulf Research testing did not. These data will be analyzed, and additional new technology emission factor cars may be tested at high temperatures.

The effects of higher temperature on fleet HC and CO emissions of LDGVs are shown in Table 2. MOBILE3 predicts for calendar year 1985 that LDGV CO emissions are 82% higher at 100° than 75°, and that HC emissions are 20% higher. The magnitude of these differences decrease significantly in the year 2000, when all cars are assumed to have closed loop fuel control, and can better compensate for the change in fuel/air ratio brought about by the less dense air.

4.3 CO Emissions at Low Speeds

One of the most persistent problems facing air quality modelers today is how to estimate low speed CO emissions. The applications are numerous since most states require that an Environmental Impact Statement (EIS) be prepared for any new construction in a downtown area. The EIS must assess the impacts of changes in traffic behavior on local or "hot spot" CO emissions.

EPA provided states with a low speed version of MOBILE3 which is capable of predicting CO emissions in g/mi down to about 2.5 mph. These are transient emissions, which involve stops, idle periods, acceleration and deceleration modes. While this seems to have met the needs of some, there are problems with this approach. The emissions in g/mi are very sensitive to low speeds, as evidenced by the emissions at 3, 4, and 5 mph presented in Table 3. In an effort to study CO emission sensitivity at low speeds, EPA developed three low speed cycles under 5 mph from the GM chase car data, and will soon be testing all emission factor cars on these and other speed cycles.

An alternative to transient modeling at low speeds is modal modeling, where a given cycle is broken down into its various modes (idle, accel, decel, cruise) and emissions are estimated for each mode. These estimates are then placed in an indirect source model such as HIGHWAY or CALINE, which predict CO concentrations around the area of interest. EPA has published modal factors which can be used to convert transient emissions into modal emissions. The limitation with these factors is that they were developed eight years ago on 1972-1976 cars, and therefore do not account for the behavior of new technology closed loop fuel control cars. Updating these factors to include newer technology cars is vital to indirect source modeling, and therefore vital in order to accurately prepare EISs. EPA should give high priority to developing an intersection-type modal testing program for newer technology cars.

Another concern with low speed CO emissions is the interaction with temperature. The speed correction factors for MOBILE3 were developed from cycles which were run in the hot stabilized (as opposed to cold start) mode at about 75°F. Alternately, the temperature correction factors were developed with tests at different temperatures using the FTP cycle with an average speed of 19.6 mph. No other cycles were used.

When a MOBILE3 user specifies that they want emissions at 7 mph and 25°, the speed and temperature correction factors are estimated separately and applied independently. If the speed correction factor is 3.0 and the temperature correction factor is 3.5, the resulting combined factor is 10.5, which can result in very high emissions.

There are a great many factors which can affect the amount of CO emissions produced under these low speed and low temperature conditions, such as choke action, extent of choke pull-off, idle speed, rate of engine warm-up, catalyst light-off time, etc. Since CO emissions are sensitive to both speed and temperature, EPA should test some cars at low speeds and temperatures to determine the interactions.

4.4 Effects of Repairs

Cars with the highest as-received emission levels generally receive maintenance (called restorative maintenance, or "RM") and an after maintenance FTP test. The historical objective for RM is to confirm our diagnosis of the malfunctioning systems: once repaired, the car's emission levels should significantly drop. If they do not, we know we have not yet made the complete diagnosis and further RM is generally performed, depending on the continued availability of the car and/or other resource considerations.

Recently, however, two other objectives for RM have emerged. One has been the need to characterize the emission reductions associated with specific three-way system repairs. This is in support of a preliminary effort to estimate the benefits of requiring on-board diagnostics on all cars. These systems are probably most readily integrated with the three-way system and computer.

Emission benefits on cars receiving 3-way system repairs are clearly higher than on those receiving only non-3-way system repairs as the data in Table 4 demonstrate. The limitations of these data are that many of the cars receiving 3-way repairs also received some non-3-way repairs simultaneously, so it is difficult to determine the emission benefits of specific 3-way repairs. For this reason we are implementing a step-wise RM procedure with cars which qualify for RM. Preference will be given to repair 3-way items first.

A retest will be performed, and then additional non-3-way repairs if necessary. We are also using a short test (the restart idle test) as a "flash" estimate for evaluating whether repairs have been effective.

The second new objective in RM is to determine effects of field fixes on "pattern case" failures. Pattern case cars are those that experience an abnormally high I/M failure rate, usually because of a common problem. These cars may or may not have high FTP emissions. In some cases, the manufacturers have suggested field fixes for these cars so they won't continue to fail I/M tests. Currently, we do not know what the FTP effects of these field fixes are. EPA should do some testing on cars which have received field fix repairs.

4.5 Disablement/Misfueling Testing

EPA does disablement and misfueling testing to determine the effects of tampering on in-use emissions. The analysis of the effects of tampering that was performed prior to the release of MOBILE3 identified areas where additional testing was needed. This testing included disablement testing (primarily catalyst removal) at high altitude, and additional misfueling studies. That testing is nearly complete and the results should be summarized in the next few months. This may identify additional disablement or misfueling testing that is needed for cars.

The effects of tampering on truck emissions were borrowed from cars with some modifications. However, disablement testing should be extended at least on a limited basis to light-duty trucks, particularly in light of the fact that tampering rates are higher for trucks than for cars.

Table 1

MOBILE3 Fleet VMT and Emission Fractions:
1990 Calendar Year

Vehicle Type	Fleet VMT Fractions	Emission Factors (g/mi) HC	Emission Factors (g/mi) CO	Emission Fractions HC	Emission Fractions CO
LDGVs	0.635	2.28	18.44	0.50	0.52
LDGTs	0.201	4.67	35.93	0.32	0.32
HDGVs	0.041	6.95	66.48	0.09	0.12
LDDVs	0.046	0.40	1.32	0.01	0.0
LDDTs	0.021	0.62	1.53	0.0	0.0
HDDVs	0.049	3.51	11.11	0.06	0.03
MCs	0.007	6.01	19.73	0.02	0.01
	1.000			1.00	1.00

Note: Emission fractions are estimated by multiplying emission factors by fleet VMT fractions, adding these products together to get the fleet emission factor, and dividing the weighted emission factor of each vehicle type by the fleet emission factor.

Table 2

LDGV Fleet HC and CO Emissions at Varying Temperatures

Calendar Year	Pollutant	50°	75°	100°
1985	HC (g/mi)	4.32	3.48	4.21
	CO (g/mi)	40.39	27.52	50.09
2000	HC (g/mi)	2.31	1.60	1.79
	CO (g/mi)	26.40	13.66	15.51

Source: *MOBILE3*, default operating mode percentages, speed = 19.6 mph

Table 3

CO Emissions in g/mi of LDGVs
at Low Speeds

Speed	CO, g/mi	
	75°F	30°F
3 mph	159	305
4 mph	121	231
5 mph	96	181

Source: Low-speed MOBILE3. Default operating mode percentages used.

Table 4

HC and CO Emission Benefits of 3-Way System and Non-3-Way System Repairs

Category	N	HC gmi Before Repair	HC gmi After Repair	HC gmi Reduc.	CO g/mi Before Repair	CO g/mi After Repair	CO g/mi Reduction
Carbureted Cars							
No 3-way System Repair	144	1.36	0.81	0.55	18.32	10.49	7.83
3-way System Repair	48	2.43	1.28	1.15	47.78	23.76	34.02
Fuel Injected Cars							
No 3-way System Repair	26	0.95	0.76	0.19	11.50	8.80	2.70
3-Way System Repair	21	2.68	0.91	1.78	51.86	10.16	41.70

NOTE: No 3-way system repairs: could have received multiple repairs, but none to 3-way system.
3-way system repairs: could include some non-3-way system repairs also.

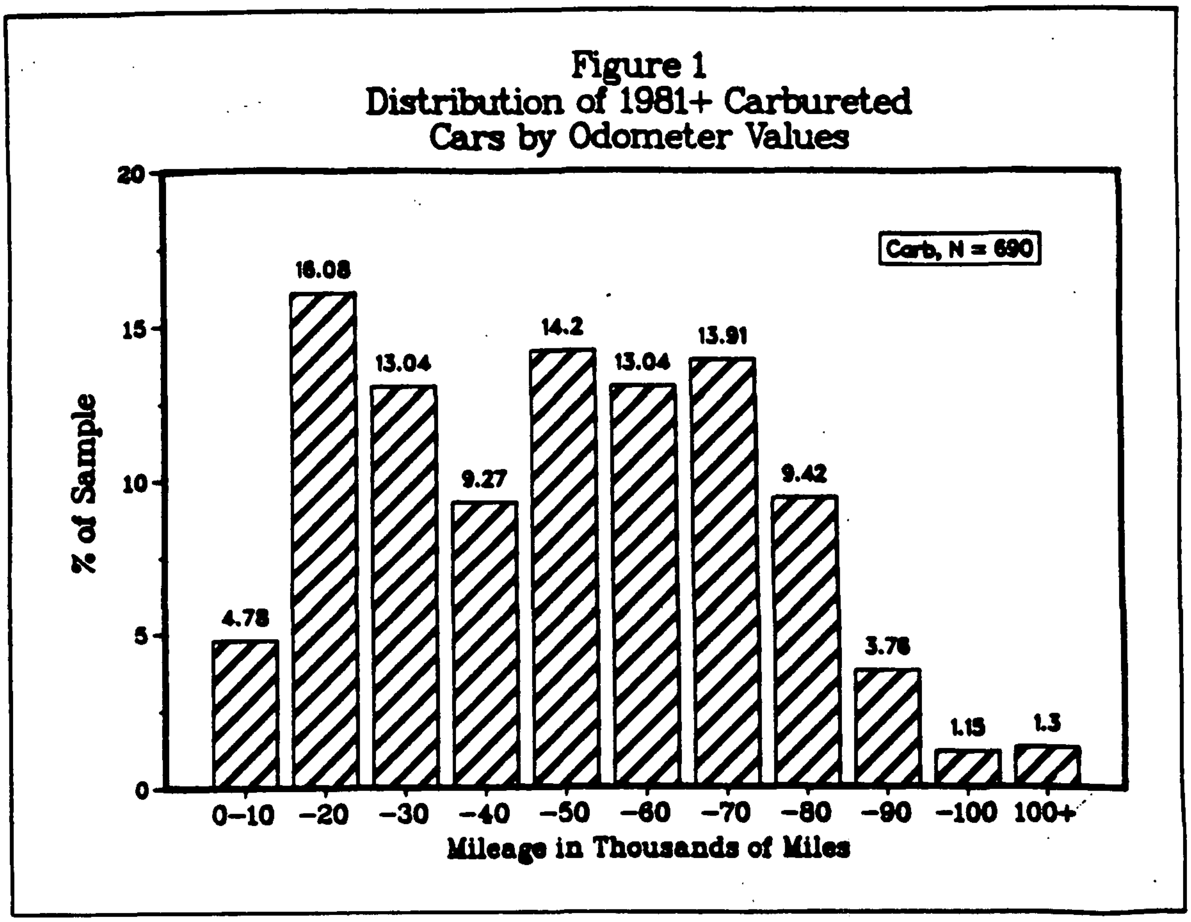


Figure 1
Distribution of 1981+ Carbureted
Cars by Odometer Values
Carb, N = 690
% of Sample
20
15
10
5
0
16.08
13.04
14.2
13.04
13.91
9.27
9.42
4.78
3.78
1.15
1.3
0–10
-20
-30
-40
-50
-60
-70
-80
-90
-100
100+
Mileage in Thousands of Miles

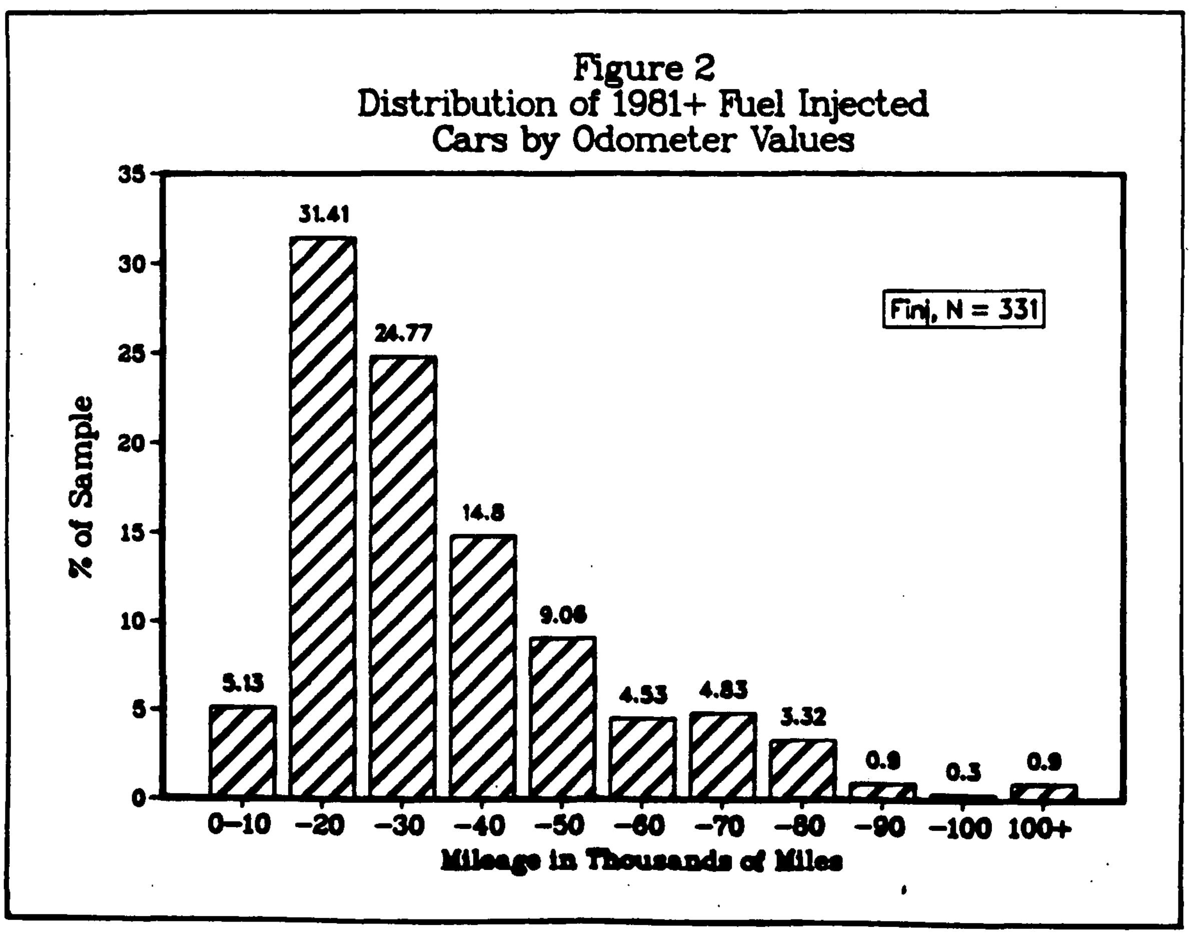


Figure 2
Distribution of 1981+ Fuel Injected
Cars by Odometer Values
Finj, N = 331
% of Sample
35
30
25
20
15
10
5
0
31.41
24.77
14.8
9.06
5.13
4.53
4.83
3.32
0.9
0.3
0.9
0–10
-20
-30
-40
-50
-60
-70
-80
-90
-100
100+
Mileage in Thousands of Miles

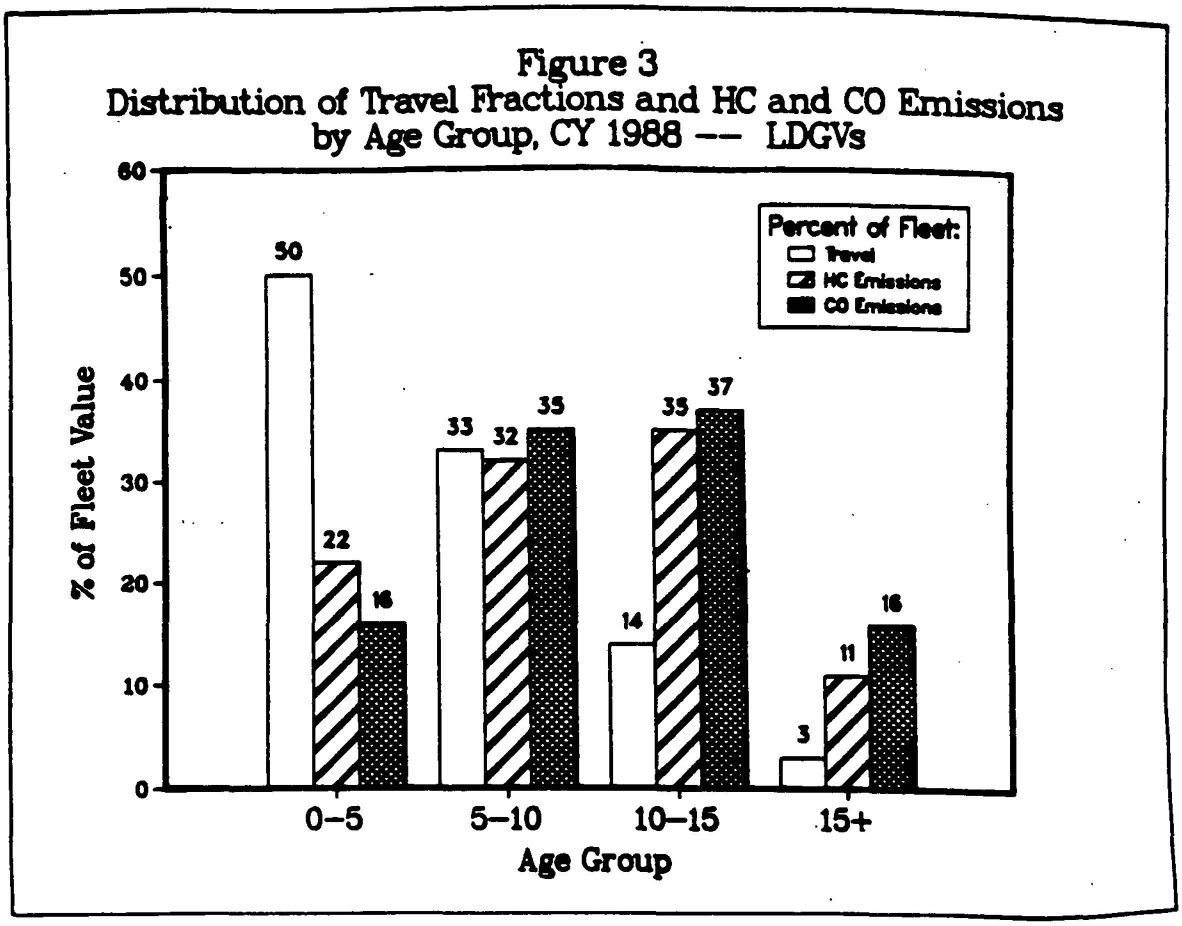


FIGURE 4
CO YEARLY EMISSIONS vs. AGE

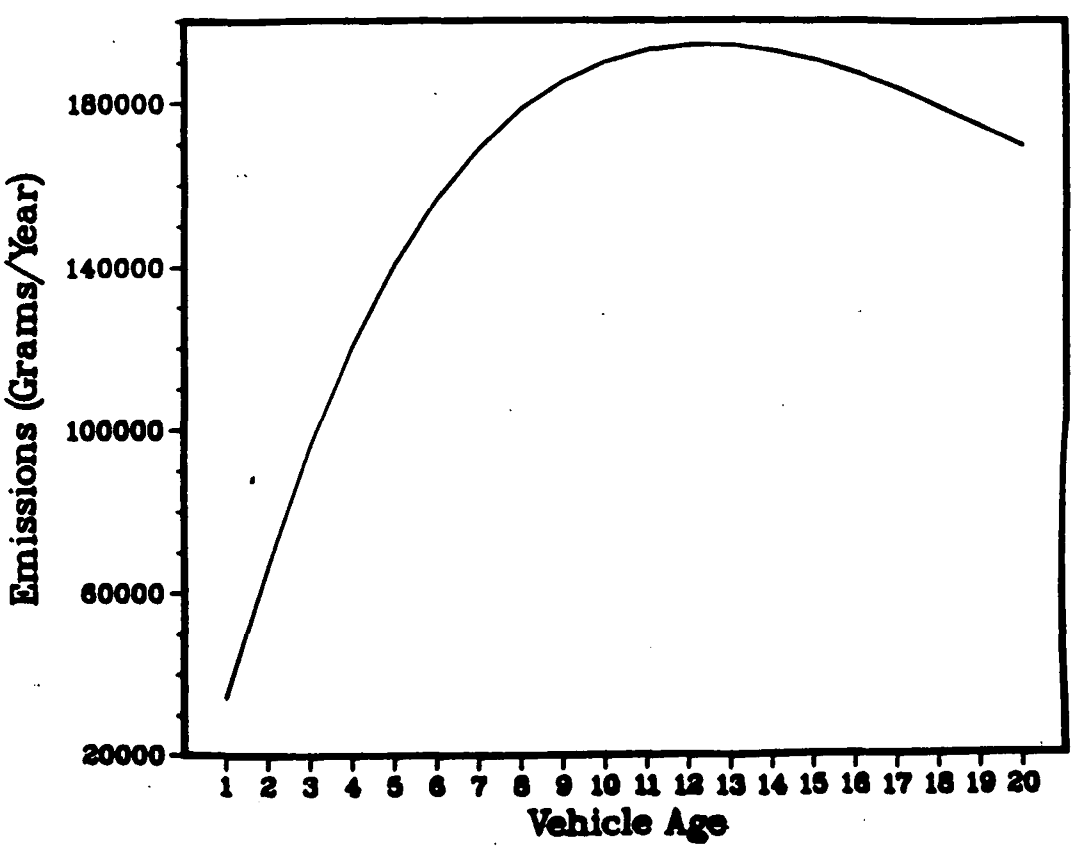


FIGURE 5

TEMPERATURE CORRECTION FACTORS
LIGHT DUTY GASOLINE POWERED VEHICLES
BAG 1 – HYDROCARBONS
Low Altitude

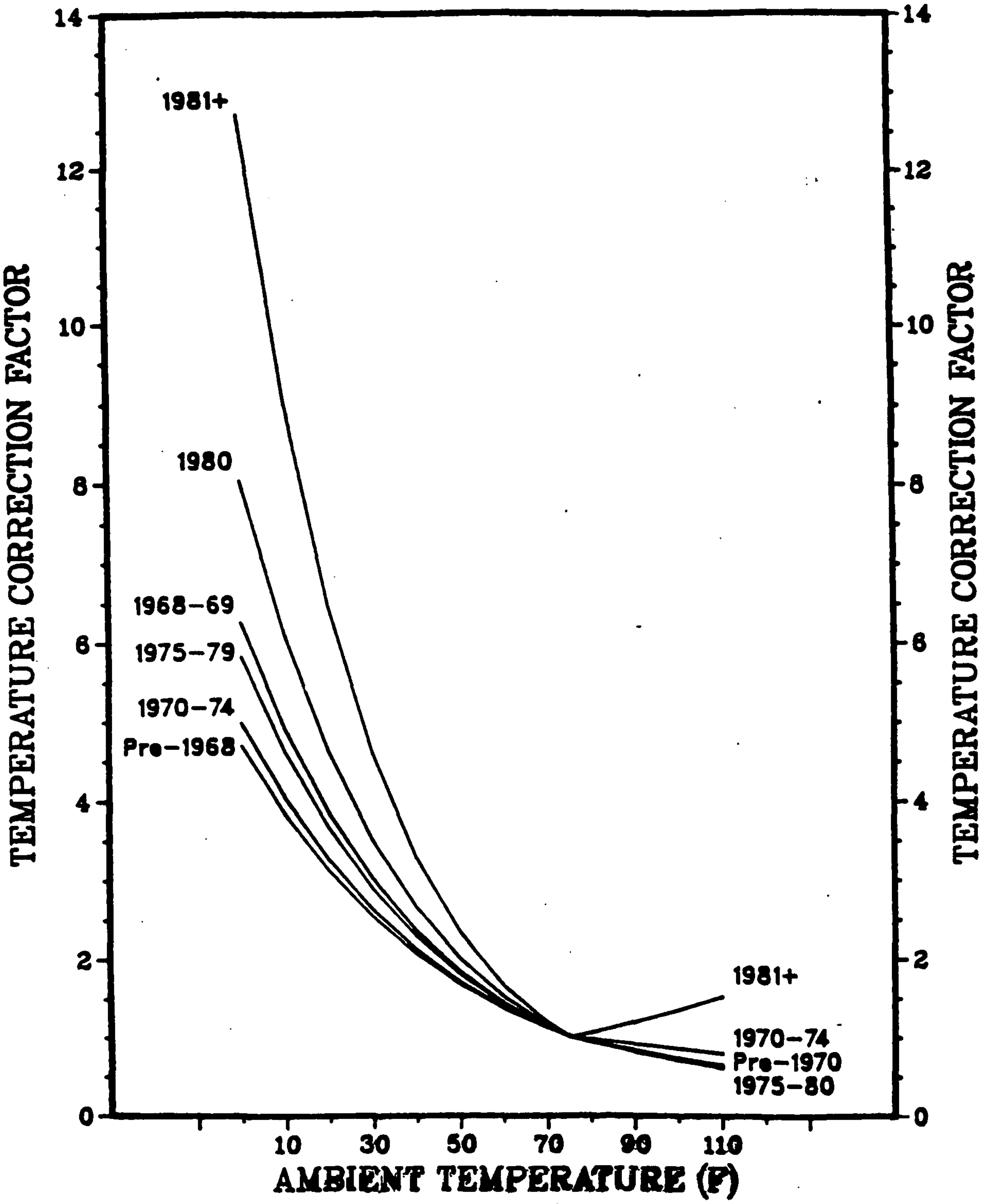
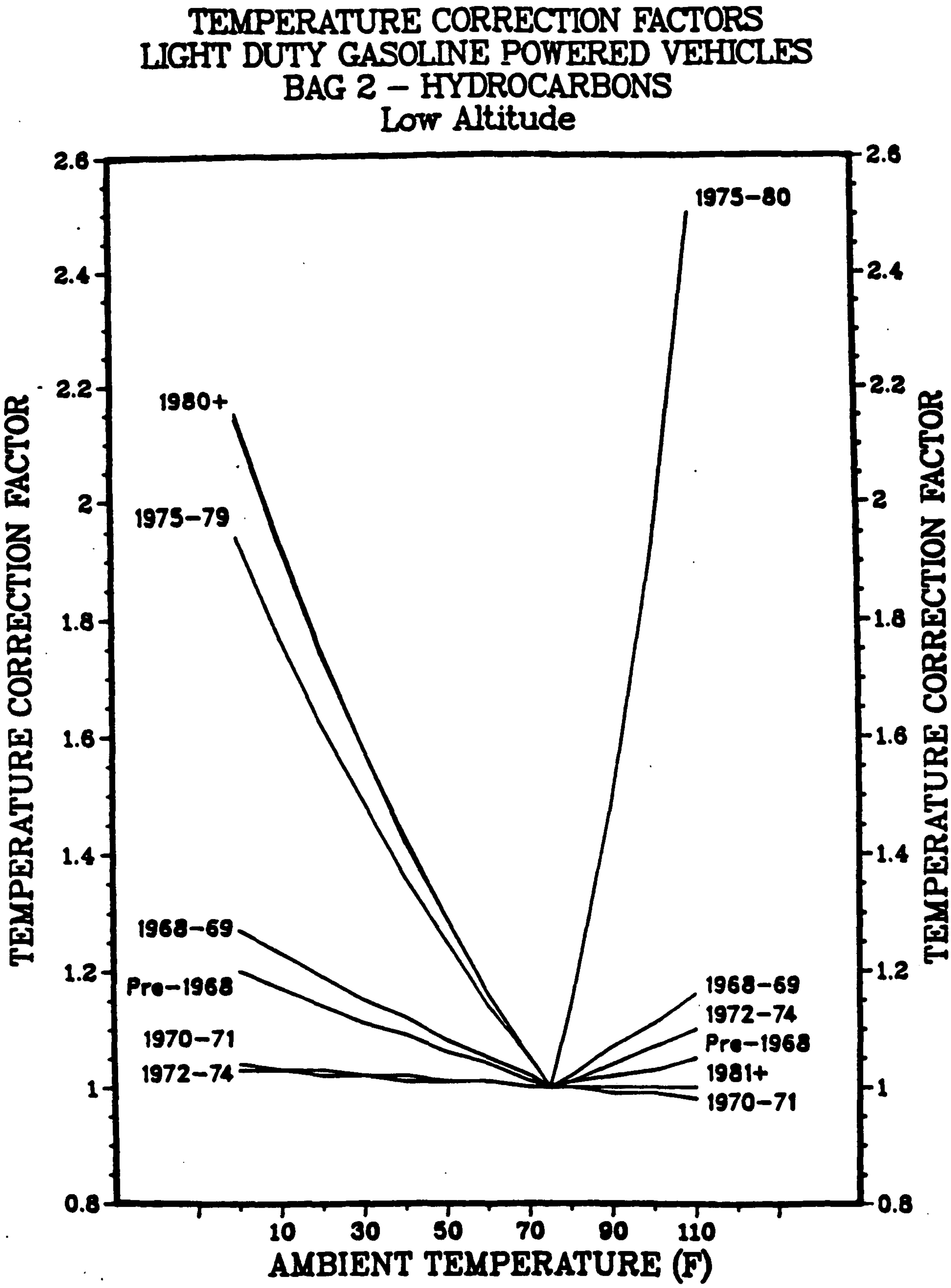


FIGURE 6



TEMPERATURE CORRECTION FACTORS
LIGHT DUTY GASOLINE POWERED VEHICLES
BAG 2 - HYDROCARBONS
Low Altitude
TEMPERATURE CORRECTION FACTOR
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
1975-80
1980+
1975-79
1968-69
Pre-1968
1970-71
1972-74
1968-69
1972-74
Pre-1968
1981+
1970-71
10
30
50
70
90
110
AMBIENT TEMPERATURE (F)

FIGURE 7

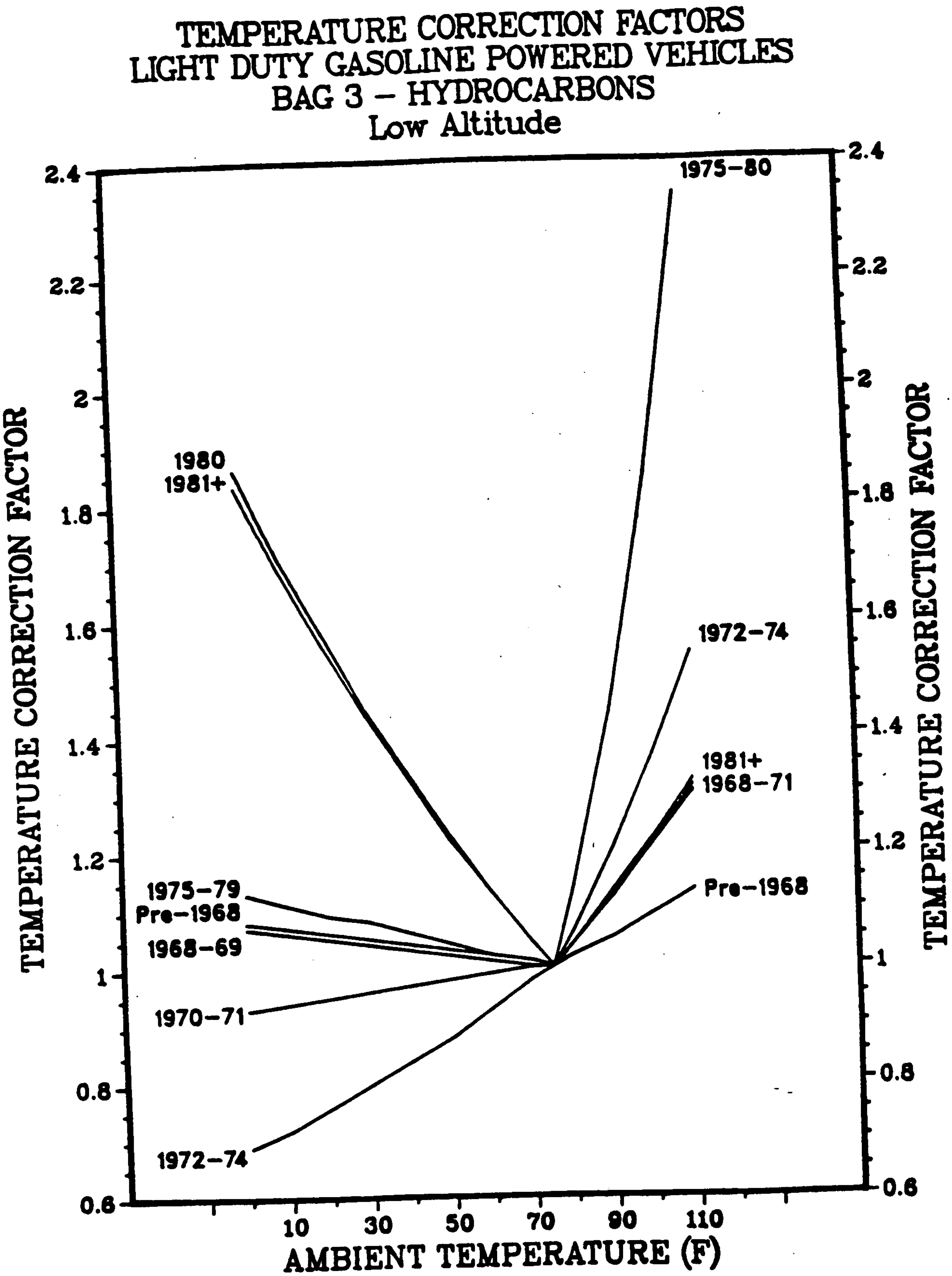

TEMPERATURE CORRECTION FACTORS
LIGHT DUTY GASOLINE POWERED VEHICLES
BAG 3 – HYDROCARBONS
Low Altitude
TEMPERATURE CORRECTION FACTOR
TEMPERATURE CORRECTION FACTOR
AMBIENT TEMPERATURE (F)
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
10
30
50
70
90
110
1975-80
1980
1981+
1972-74
1981+
1968-71
1975-79
Pre-1968
1968-69
1970-71
Pre-1968
1972-74

FIGURE 8

TEMPERATURE CORRECTION FACTORS
LIGHT DUTY GASOLINE POWERED VEHICLES
BAG 1 – CARBON MONOXIDE
Low Altitude

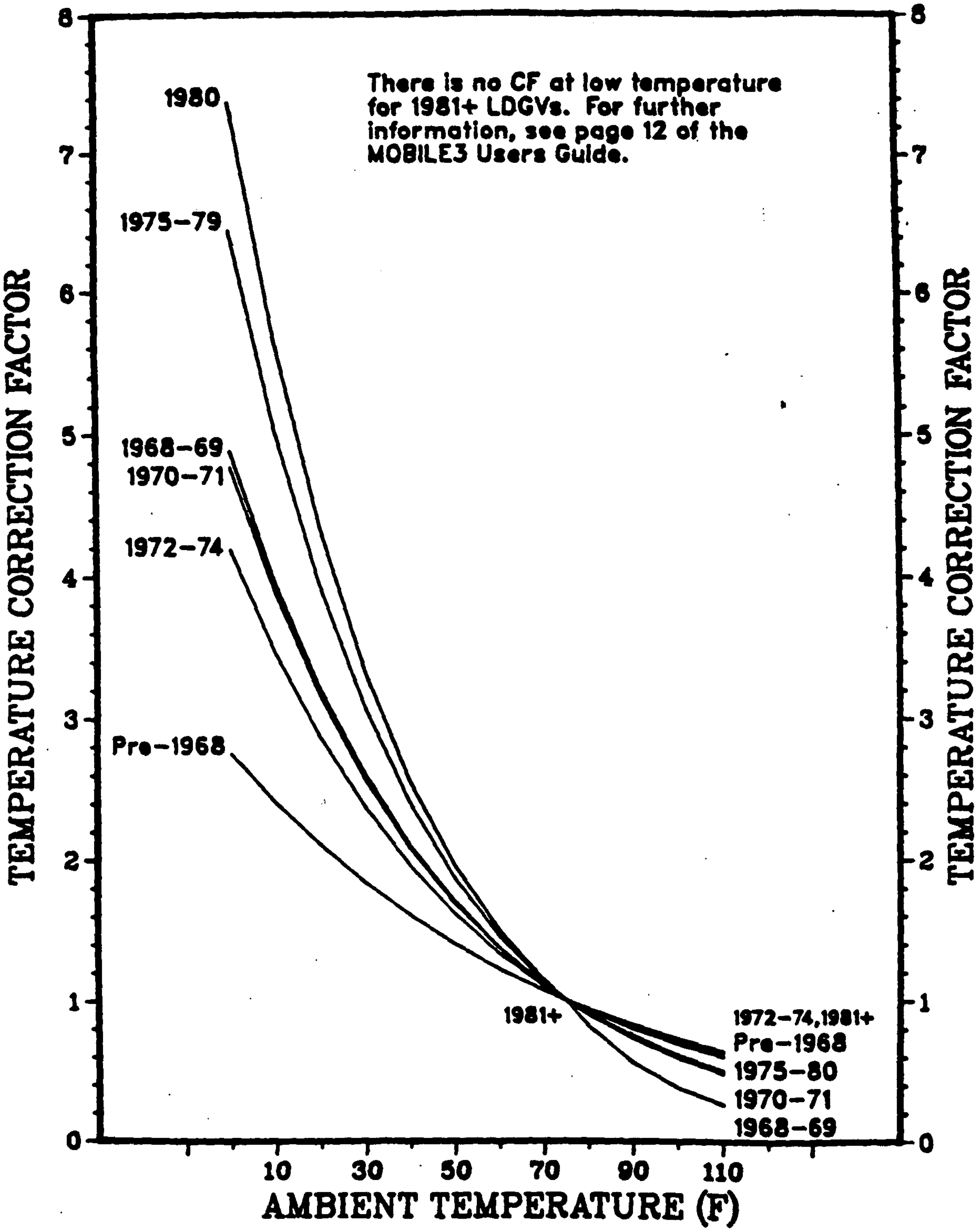


FIGURE 9

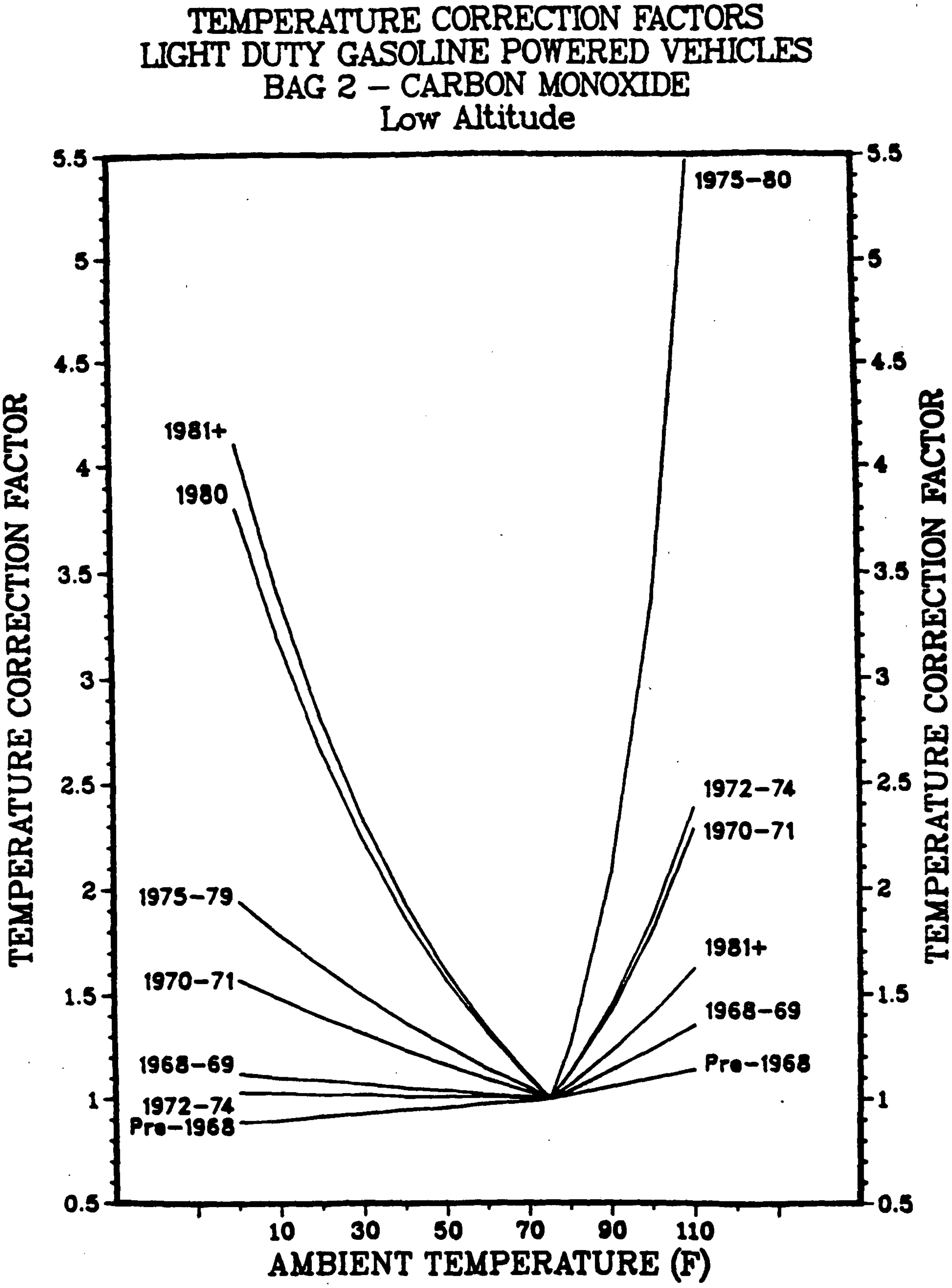

TEMPERATURE CORRECTION FACTORS
LIGHT DUTY GASOLINE POWERED VEHICLES
BAG 2 – CARBON MONOXIDE
Low Altitude
TEMPERATURE CORRECTION FACTOR
AMBIENT TEMPERATURE (F)
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
10
30
50
70
90
110
1981+
1980
1975-79
1970-71
1968-69
1972-74
Pre-1968
1975-80
1972-74
1970-71
1981+
1968-69
Pre-1968

FIGURE 10

TEMPERATURE CORRECTION FACTORS
LIGHT DUTY GASOLINE POWERED VEHICLES
BAG 3 – CARBON MONOXIDE
Low Altitude