

## **MOBILE3 Sensitivity Analysis**

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June 1985

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Office of Air and Radiation  
U.S. Environmental Protection Agency

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## 1.0 Introduction

MOBILE3, a computerized emission factor model for use in the estimation and projection of hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NO<sub>x</sub>), was released to the public in June 1984. Methodologies and data used in this model are presented in the 4th Edition of AP-42, Volume II: Mobile Sources, to be released in July, 1985.

The purpose of this sensitivity document is to display by way of a series of graphs the sensitivity of MOBILE3 emission estimations to changes in some of the key input variables for the low altitude region vehicles. The eight vehicle types include: Light-duty gasoline powered vehicles (LDGVs), light-duty gasoline powered Class 1 trucks (LDGT1s), light-duty gasoline powered Class 2 trucks (LDGT2s), heavy-duty gasoline powered vehicles (HDGVs), light-duty diesel powered vehicles (LDDVs), light-duty diesel powered trucks (LDDTs), heavy-duty diesel powered vehicles (HDDVs), and motorcycles (MCs).

Since MOBILE3 is an update of its predecessor MOBILE2, some areas of the calculations remain unchanged due to the fact that there has been no new test data available in those areas since MOBILE2 was completed. Examples of those areas include the exhaust emission rates for pre-1975 light-duty gasoline-powered vehicles and Class 1 trucks, and the speed correction factor coefficients for pre-1978 light-duty gasoline-powered vehicles and for pre-1979 light-duty gasoline-powered Class 1 and Class 2 trucks. For those areas, the sensitivity of MOBILE3 estimations is not examined so that the sensitivity of MOBILE3 to the changes of the updated portions of the input variables can be more explicitly displayed in the graphs. To see the sensitivity of MOBILE3 estimations to the changes of those nonupdated areas, readers should refer to the document entitled "MOBILE2 Sensitivity Analysis," prepared by Energy and Environmental Analysis, Inc., March 1981.

The graphs in this document are divided into three groups. The first group (Figures 1-24) illustrates MOBILE3 basic emission rates by vehicle type at different mileage points. The second group (Figures 25-39) displays MOBILE3 speed correction factors at various vehicle speeds. The third group (Figures 40-78) shows MOBILE3 temperature correction factors for each of the gasoline-powered vehicles at different ambient temperatures. In general, separate graphs are included for each vehicle type and each pollutant. However, for the speed correction factors, all three pollutants are combined in a single graph for some vehicle types.

Brief discussions on differences between MOBILE3 and MOBILE2, highlights and trends are outlined in the following paragraphs.

## 2.0 Basic Emission Rates

Figures 1 through 24 show how the MOBILE3 basic emission rates change with mileage for each of the three pollutants and each of the eight vehicle types. The HC emissions are total HC emissions, which includes both methane and nonmethane HC emissions, and also includes evaporative and crankcase emissions. The evaporative HC emissions are based on tests on a representative commercial fuel.

The basic emission rates at various mileage points are calculated under the FTP operating mode, which includes 20.6% cold start, 27.3% hot start, and 52.1% stabilized. The tampering effects are also calculated and included in these rates.

For 1975 and later model years, some model year groups are combined as one group if there is a minimal difference (0.02 grams/mile for HC and NO<sub>x</sub> emissions, and 1.00 grams/mile for CO emissions) in the emission rates at all mileages. Therefore, the model year groups in this document may differ slightly from those presented in other documents (such as in AP-42, in which the model year groups are primarily based on emission standards and/or emission control technology groups).

The basic emission rates for the two heavy-duty vehicle classes (HDGVs and HDDVs) have been updated for all model year groups in MOBILE3, due to new factors used to convert emissions in g/bhp-hr to emissions in grams/mile.

## 3.0 Speed Correction Factors

Figures 25 through 39 show the MOBILE3 speed correction factors at various vehicle speeds (in mph) for each of the three pollutants and each of the eight vehicle types. For the two heavy-duty vehicle classes (HDGVs and HDDVs), all three pollutants are included in one plot. The two light-duty diesel-powered vehicle and truck classes (LDDVs and LDDTs) are combined into one vehicle group with all three pollutants included in one graph.

The general trend of the speed correction factors on HC and CO emissions is that the lower the vehicle speed the larger the numerical value of the speed correction factor (which



represents higher emissions). The trend of the NO<sub>x</sub> speed correction factors is similar to that of HC and CO emissions up to a certain vehicle speed (for example, at 40 miles per hour for 1981 and later model year LDGVs). With higher speeds, (e.g., 40+ mph for 1981+ LDGVs), the NO<sub>x</sub> speed correction factors increase. The speed correction factor is 1.0 at vehicle speed 19.6 mph for all vehicle classes.

#### 4.0 Temperature Correction Factors

Figures 40 through 78 present the MOBILE3 temperature correction factors at various ambient temperatures (in degrees Fahrenheit) for each of the three modes of operation, three pollutants, and four light-duty gasoline-powered vehicle types (LDGVs, LDGT1s, LDGT2s, and MCs). The three modes represent the three test segments of the FTP driving cycle: cold start, stabilized, and hot start. For HDGVs, the graphs are presented for each of the three pollutants only. For diesel-powered vehicles and trucks, the temperature correction factor is always 1.0.

In MOBILE2, the temperature correction factor was set to be 1.0 at the temperature ranges of 68° to 86°F. This approach was viewed as inappropriate since the emissions from in-use vehicles outside the laboratory are expected to show some sensitivity even within the temperature ranges between 68° and 86°F. For this reason, the temperature correction factor for MOBILE3 is 1.0 only at 75°F.

Another deviation from MOBILE2 is that at low temperatures (less than 75°F) for 1981 and later LDGVs, and 1984 and later LDGT1s and LDGT2s the cold start CO emissions use an additive rather than a multiplicative correction factor. Data from in-use vehicles/trucks of those model years have shown that the multiplicative correction factor methodology does not give as good a fit for low temperature cold start CO emissions as an offset model.

Note that some model year groups are combined as one group if their correction factors at various temperatures are very similar, so that the graphs can be more clearly presented. For this reason, the model years in this document may differ slightly from those presented in other documents.

The general trend of the temperature correction factors on cold start HC and CO emissions and all three modes of NO<sub>x</sub> emissions is that the lower the ambient temperature the larger the numerical value of the temperature correction factor (which represents higher emissions). For the other two modes of HC and CO emissions, the trend depends upon the model year group, or the technology group, of the vehicle.

FIGURE 1

BASIC EMISSION RATES  
LIGHT DUTY GASOLINE POWERED VEHICLES  
HYDROCARBONS  
Low Altitude

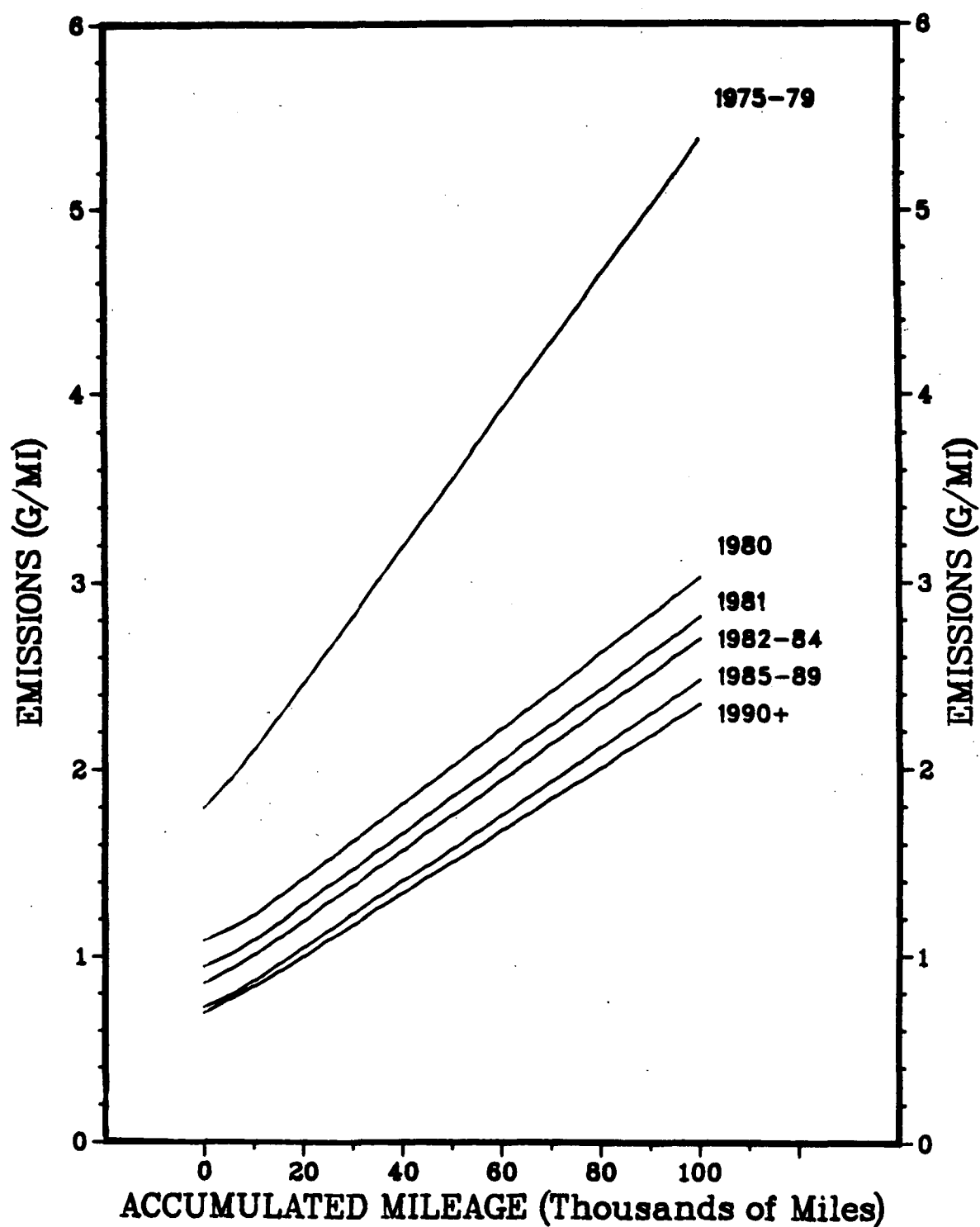


FIGURE 2

BASIC EMISSION RATES  
LIGHT DUTY GASOLINE POWERED VEHICLES  
CARBON MONOXIDE  
Low Altitude

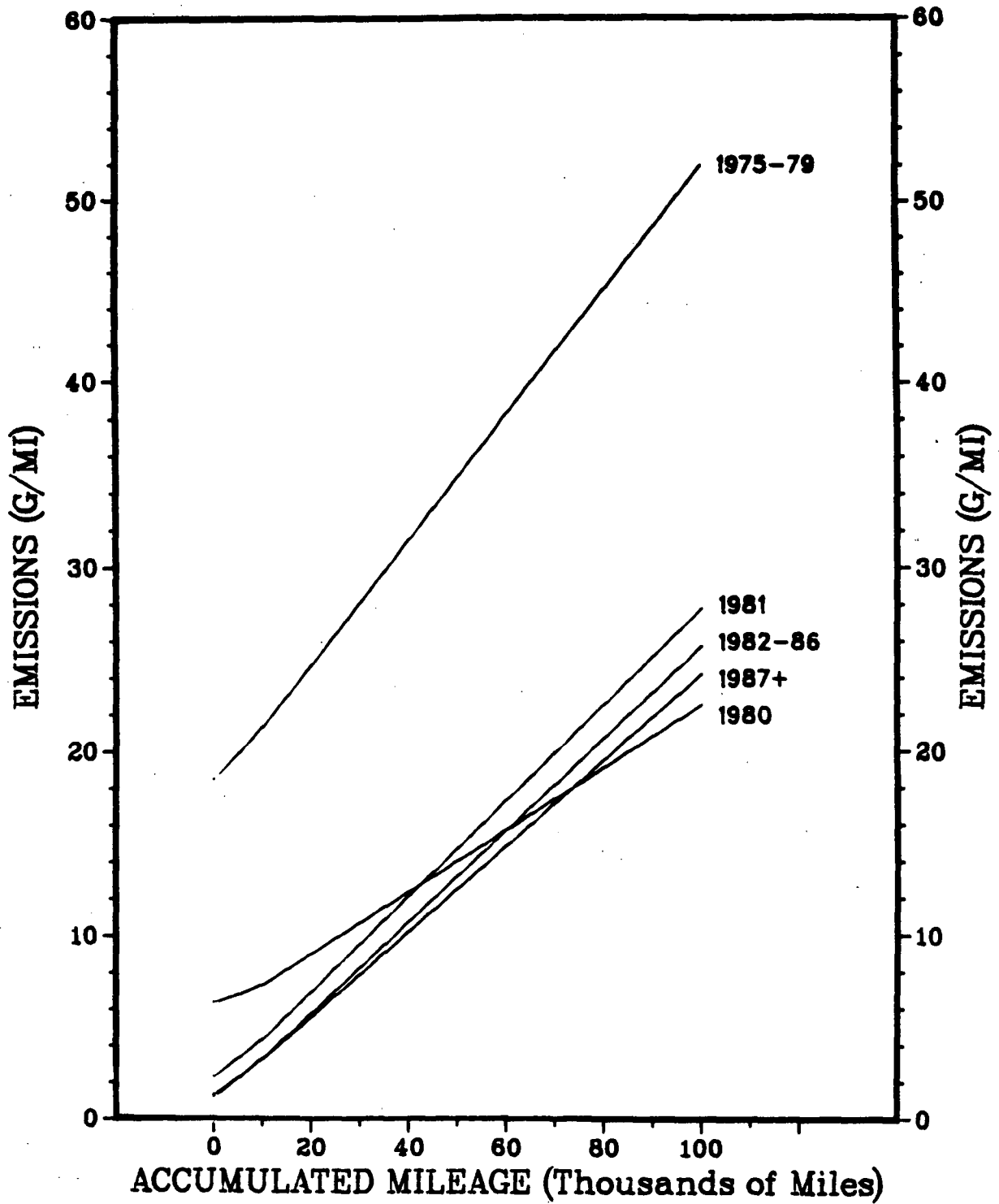


FIGURE 3

BASIC EMISSION RATES  
LIGHT DUTY GASOLINE POWERED VEHICLES  
OXIDES OF NITROGEN  
Low Altitude

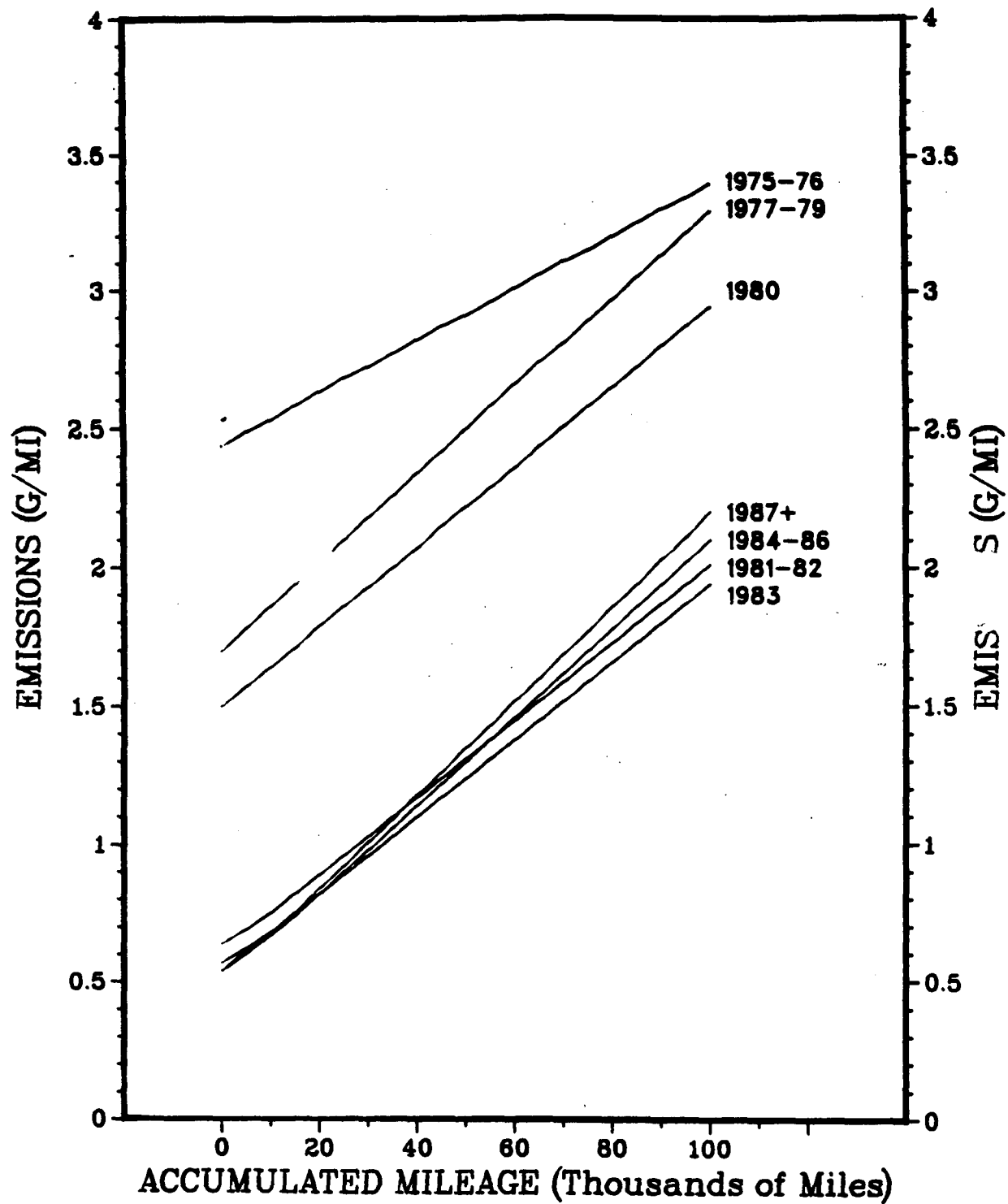


FIGURE 4

BASIC EMISSION RATES  
LIGHT DUTY GASOLINE POWERED TRUCKS I  
HYDROCARBONS  
Low Altitude

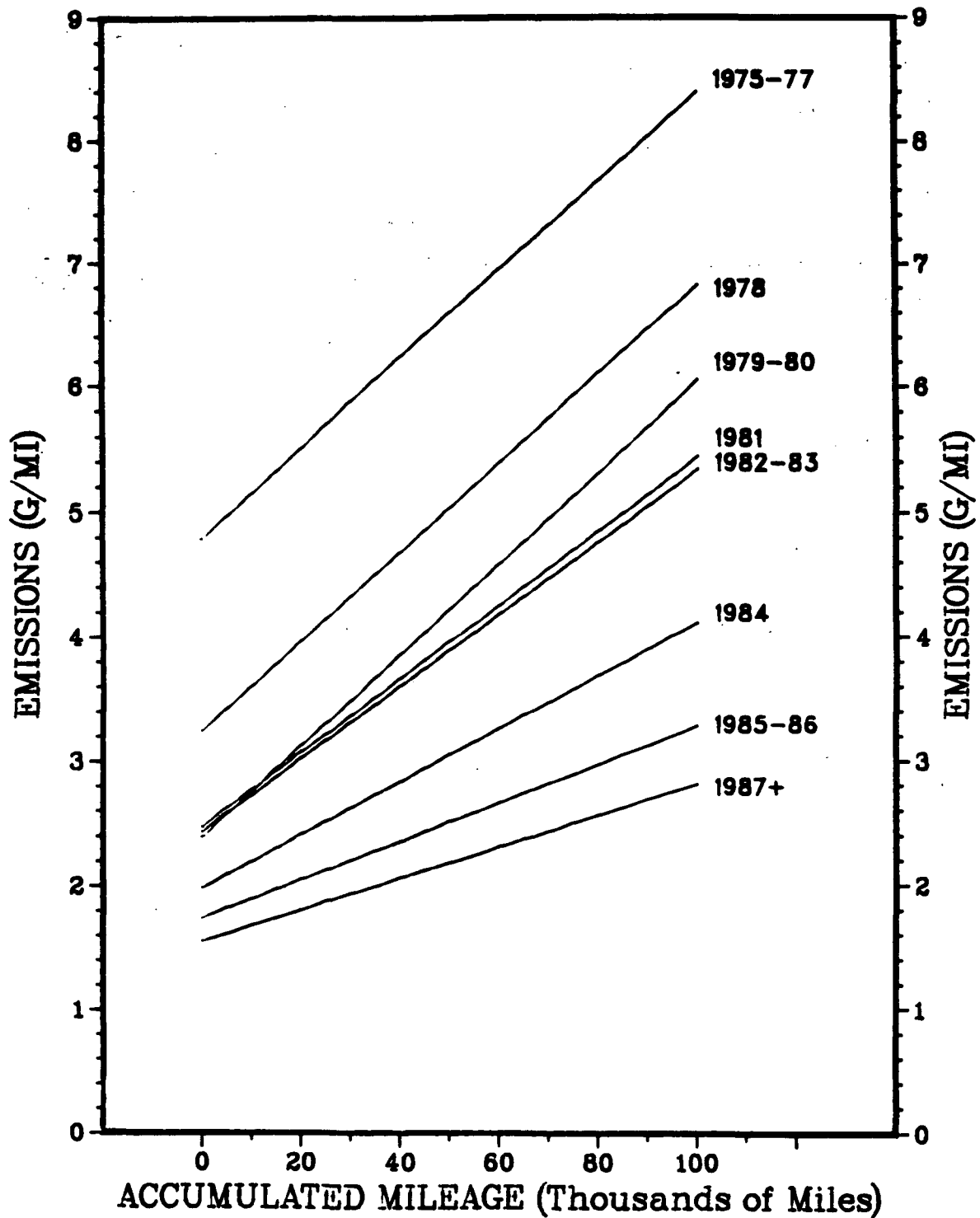


FIGURE 5

BASIC EMISSION RATES  
LIGHT DUTY GASOLINE POWERED TRUCKS I  
CARBON MONOXIDE  
Low Altitude

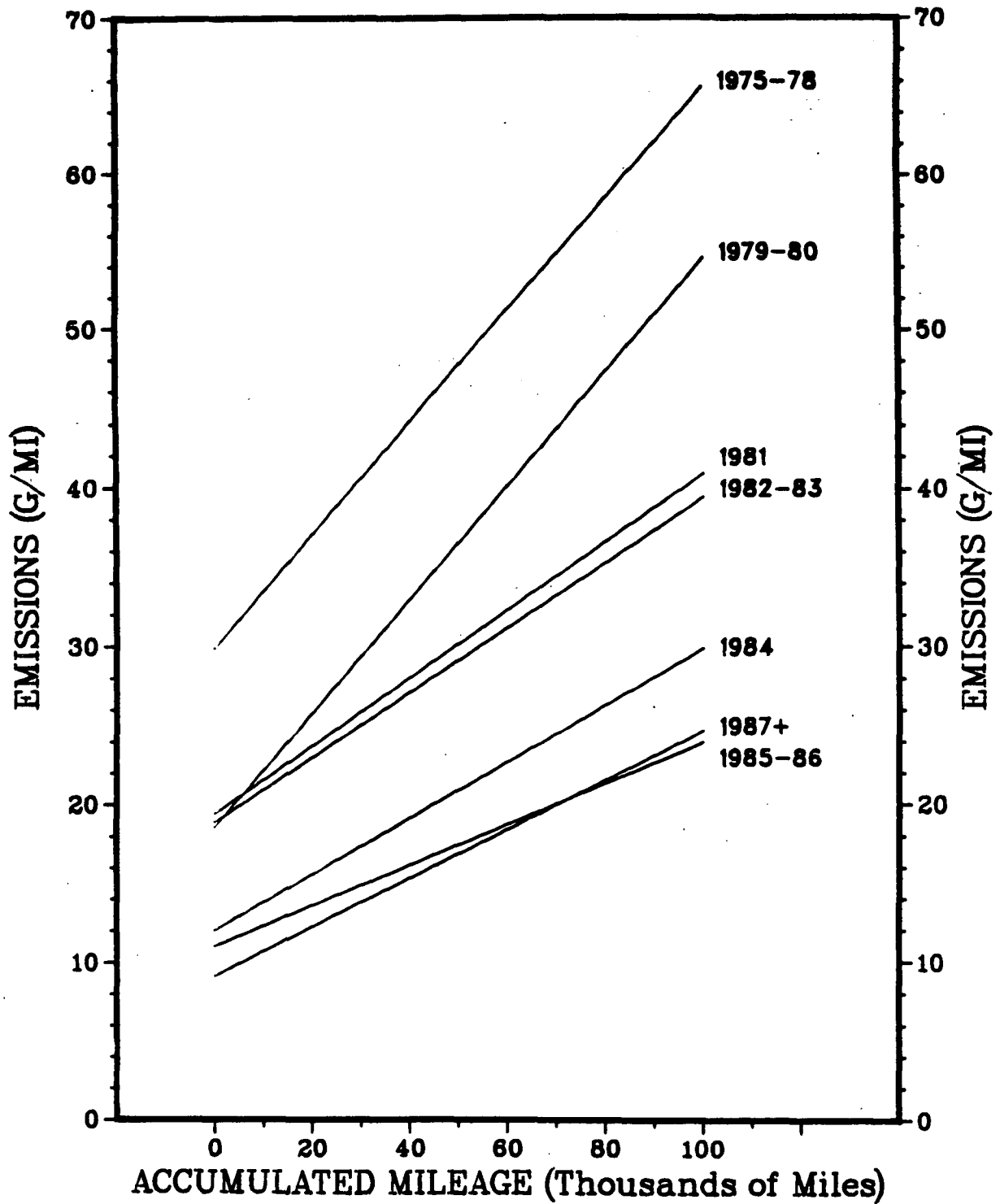


FIGURE 6

BASIC EMISSION RATES  
LIGHT DUTY GASOLINE POWERED TRUCKS I  
OXIDES OF NITROGEN  
Low Altitude

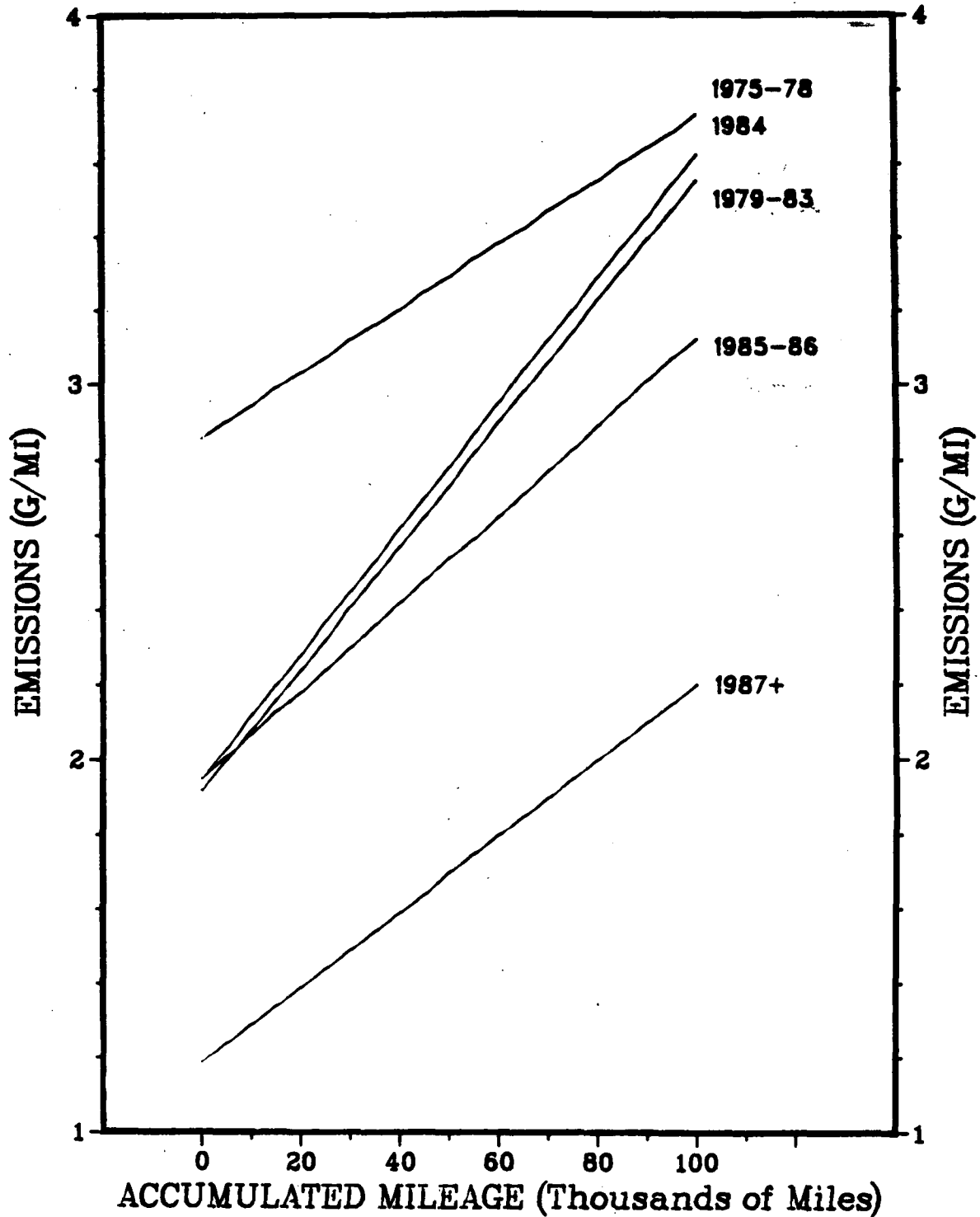


FIGURE 7

BASIC EMISSION RATES  
LIGHT DUTY GASOLINE POWERED TRUCKS II  
HYDROCARBONS  
Low Altitude

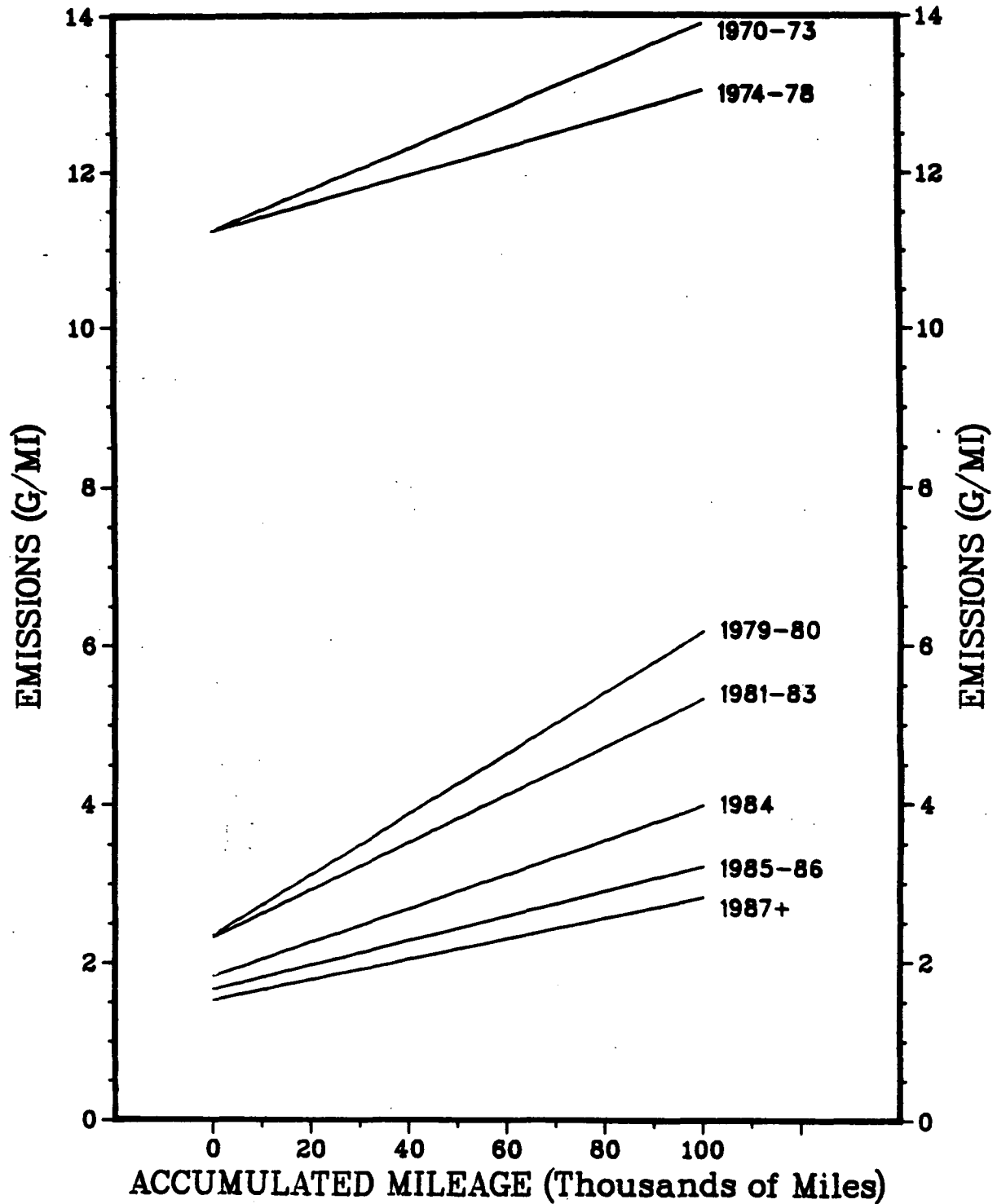




FIGURE 8

BASIC EMISSION RATES  
LIGHT DUTY GASOLINE POWERED TRUCKS II  
CARBON MONOXIDE  
Low Altitude

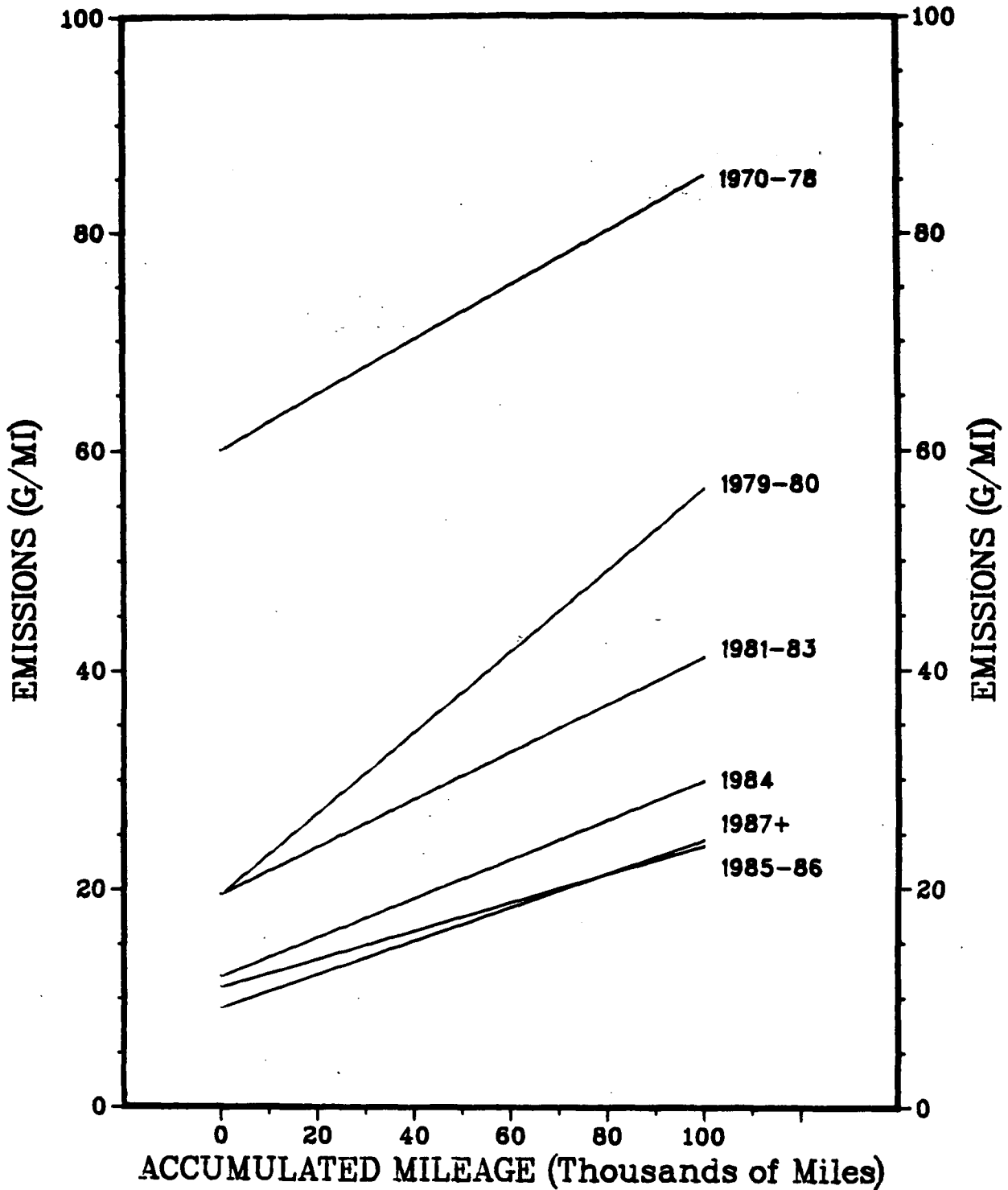


FIGURE 9

BASIC EMISSION RATES  
LIGHT DUTY GASOLINE POWERED TRUCKS II  
OXIDES OF NITROGEN  
Low Altitude

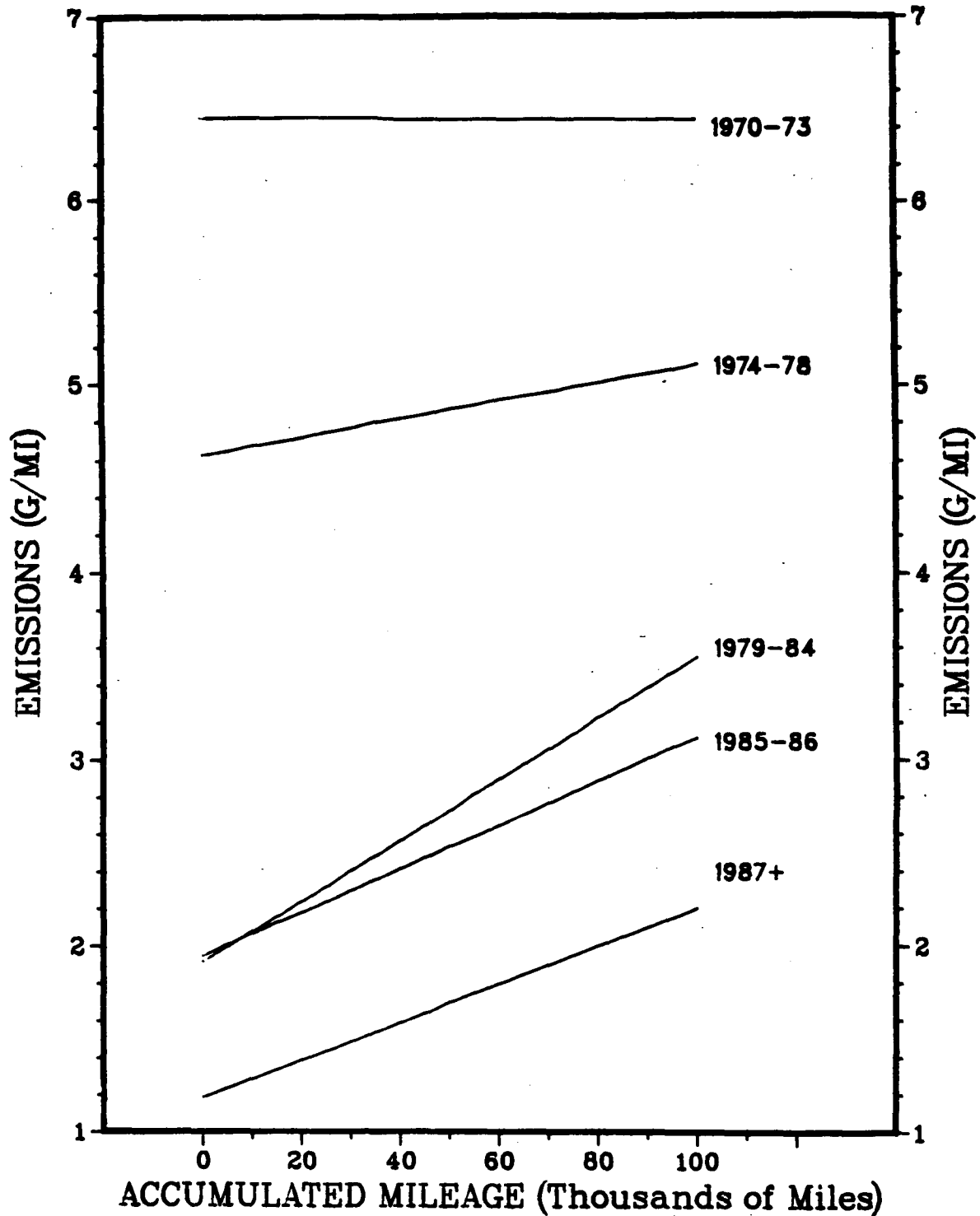


FIGURE 10

BASIC EMISSION RATES  
HEAVY DUTY GASOLINE POWERED VEHICLES  
HYDROCARBONS  
Low Altitude

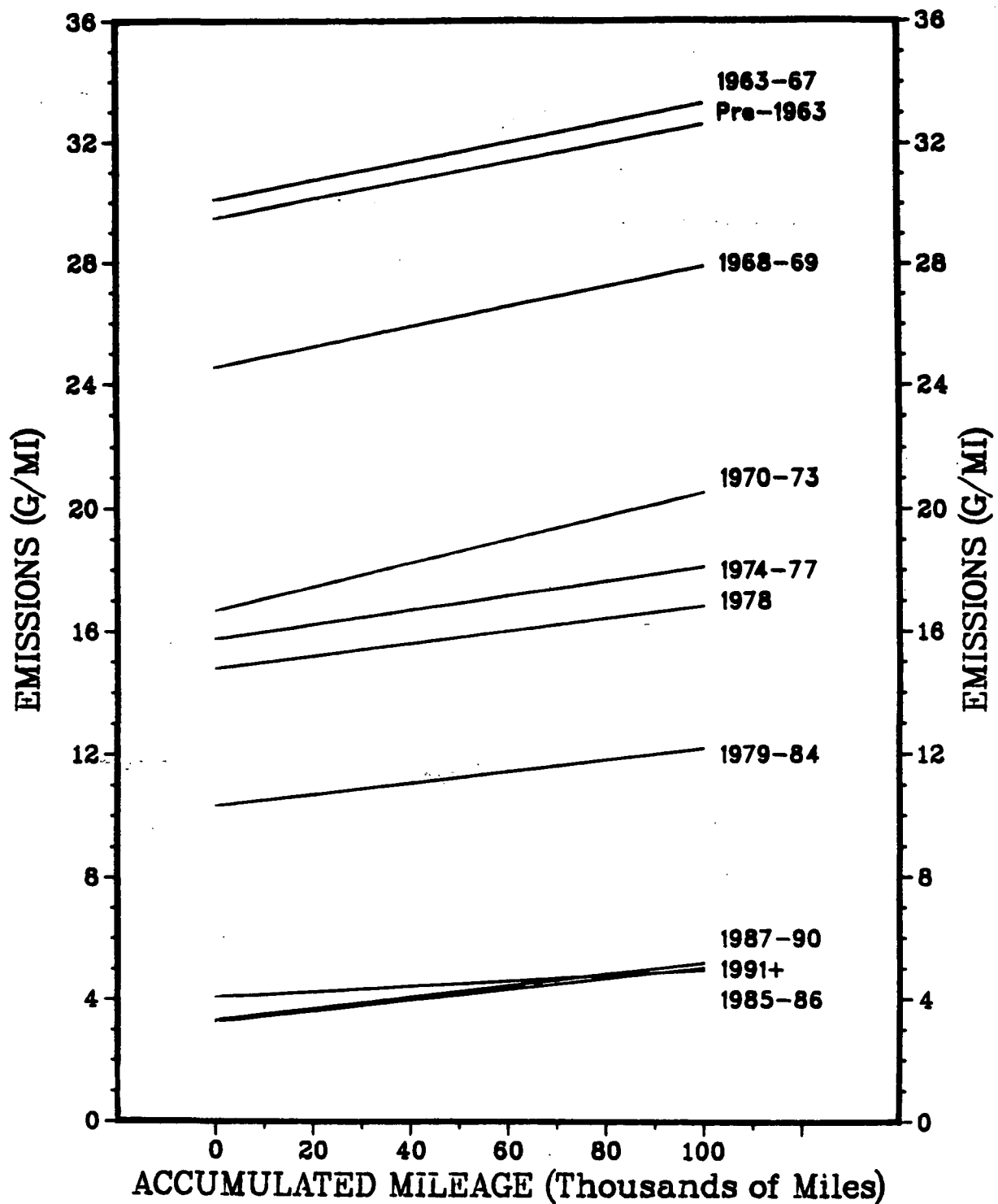


FIGURE 11

BASIC EMISSION RATES  
HEAVY DUTY GASOLINE POWERED VEHICLES  
CARBON MONOXIDE  
Low Altitude

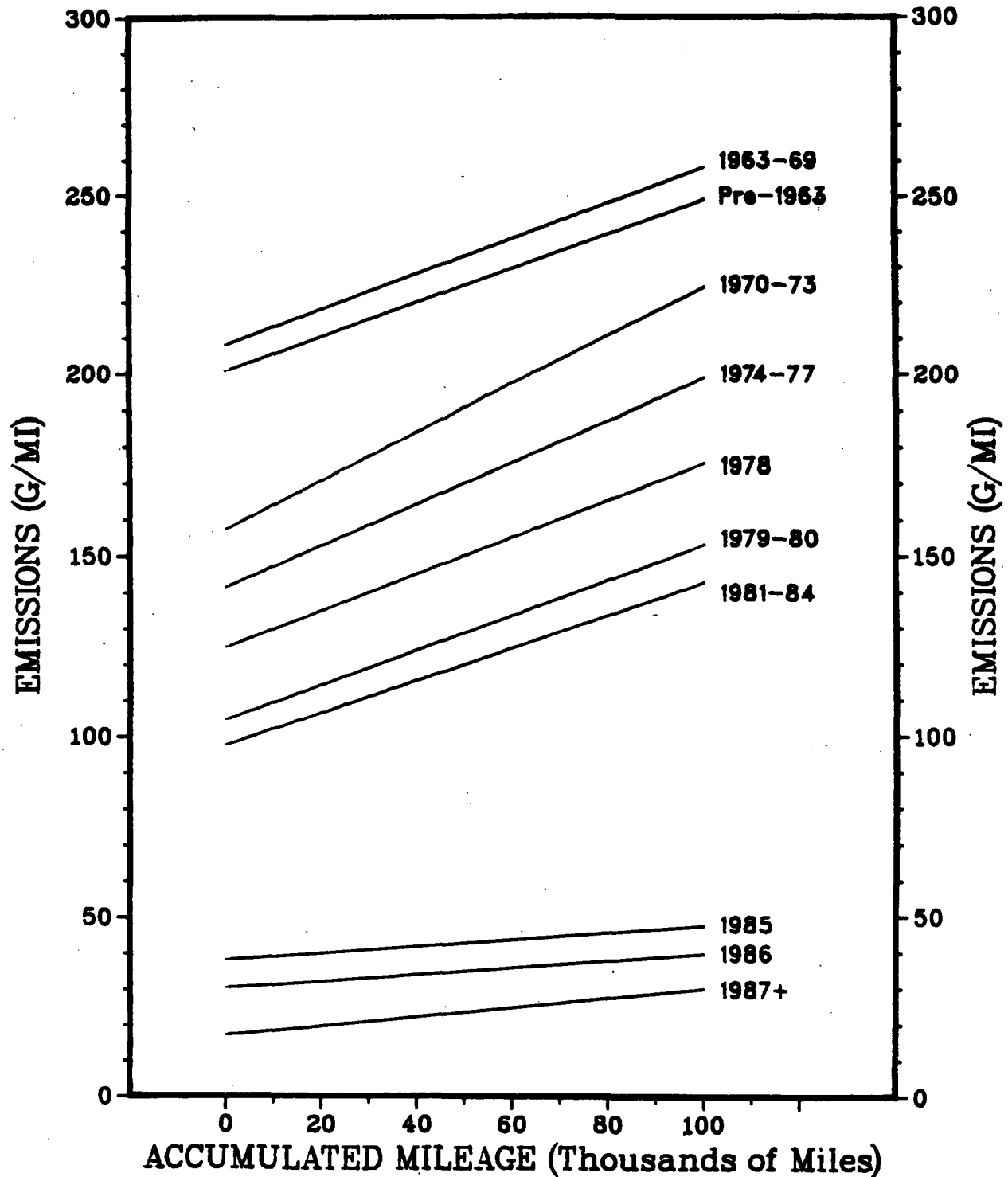


FIGURE 12

BASIC EMISSION RATES  
HEAVY DUTY GASOLINE POWERED VEHICLES  
OXIDES OF NITROGEN  
Low Altitude

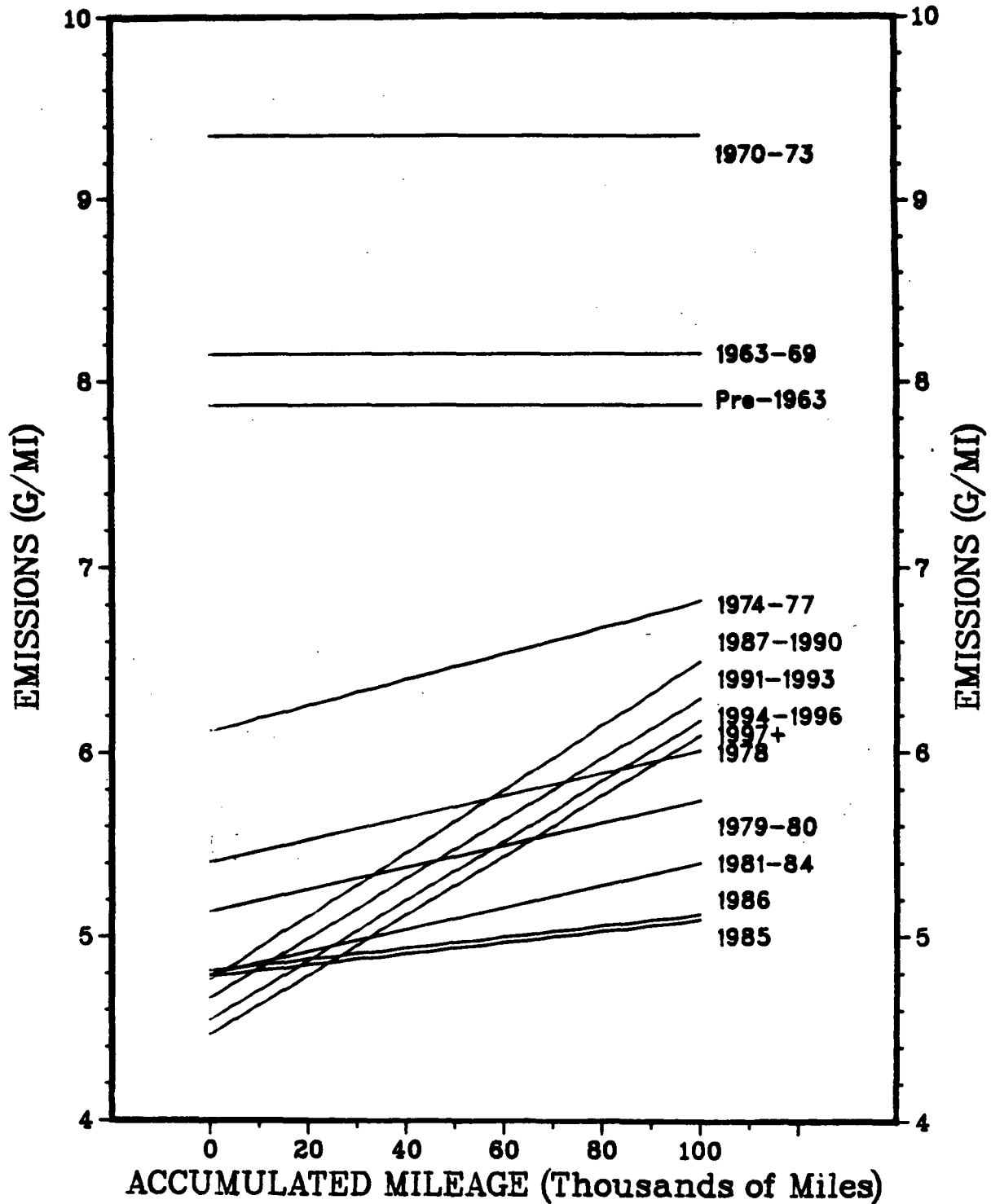


FIGURE 13

BASIC EMISSION RATES  
LIGHT DUTY DIESEL POWERED VEHICLES  
HYDROCARBONS  
Low Altitude

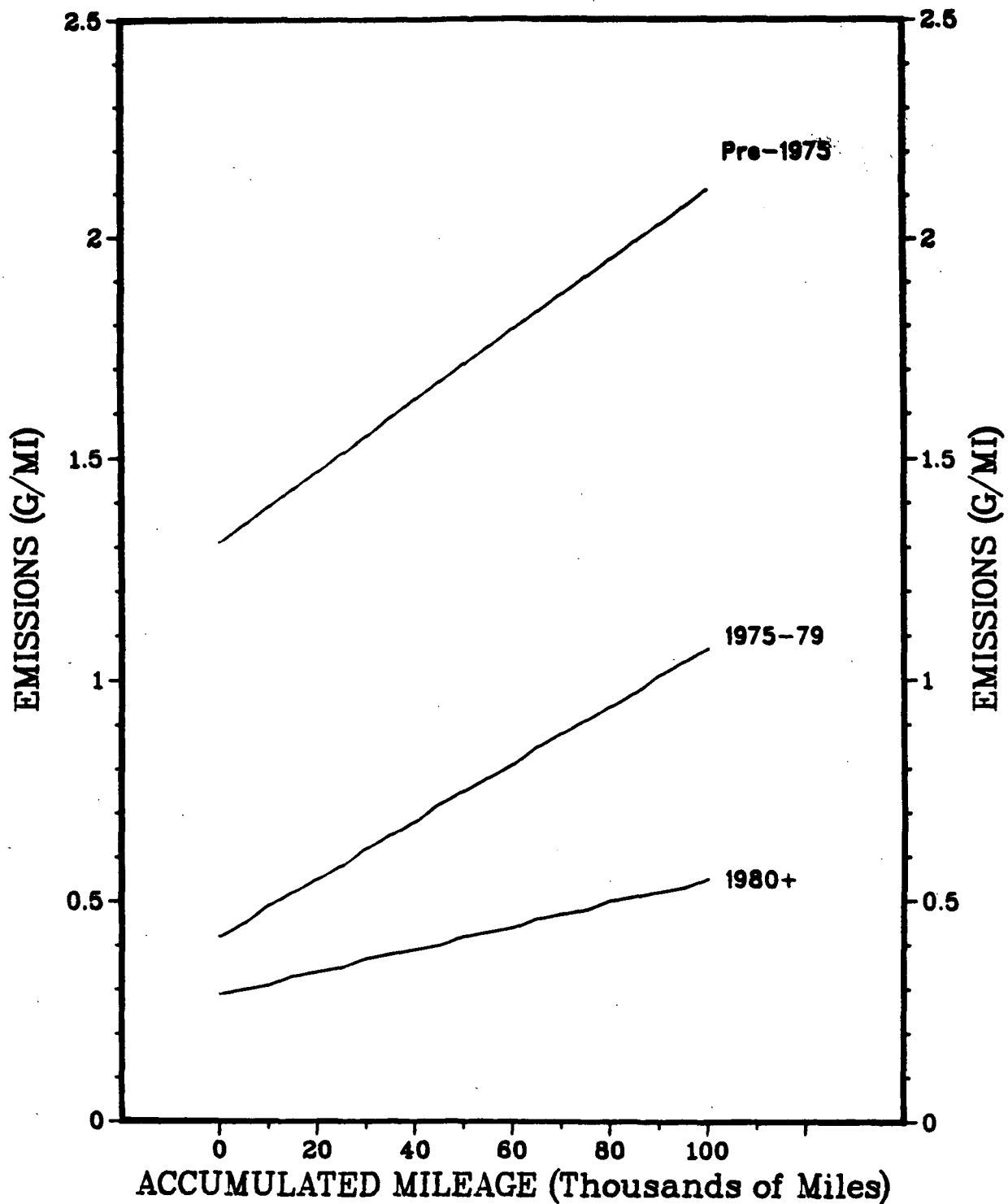


FIGURE 14

BASIC EMISSION RATES  
LIGHT DUTY DIESEL POWERED VEHICLES  
CARBON MONOXIDE  
Low Altitude

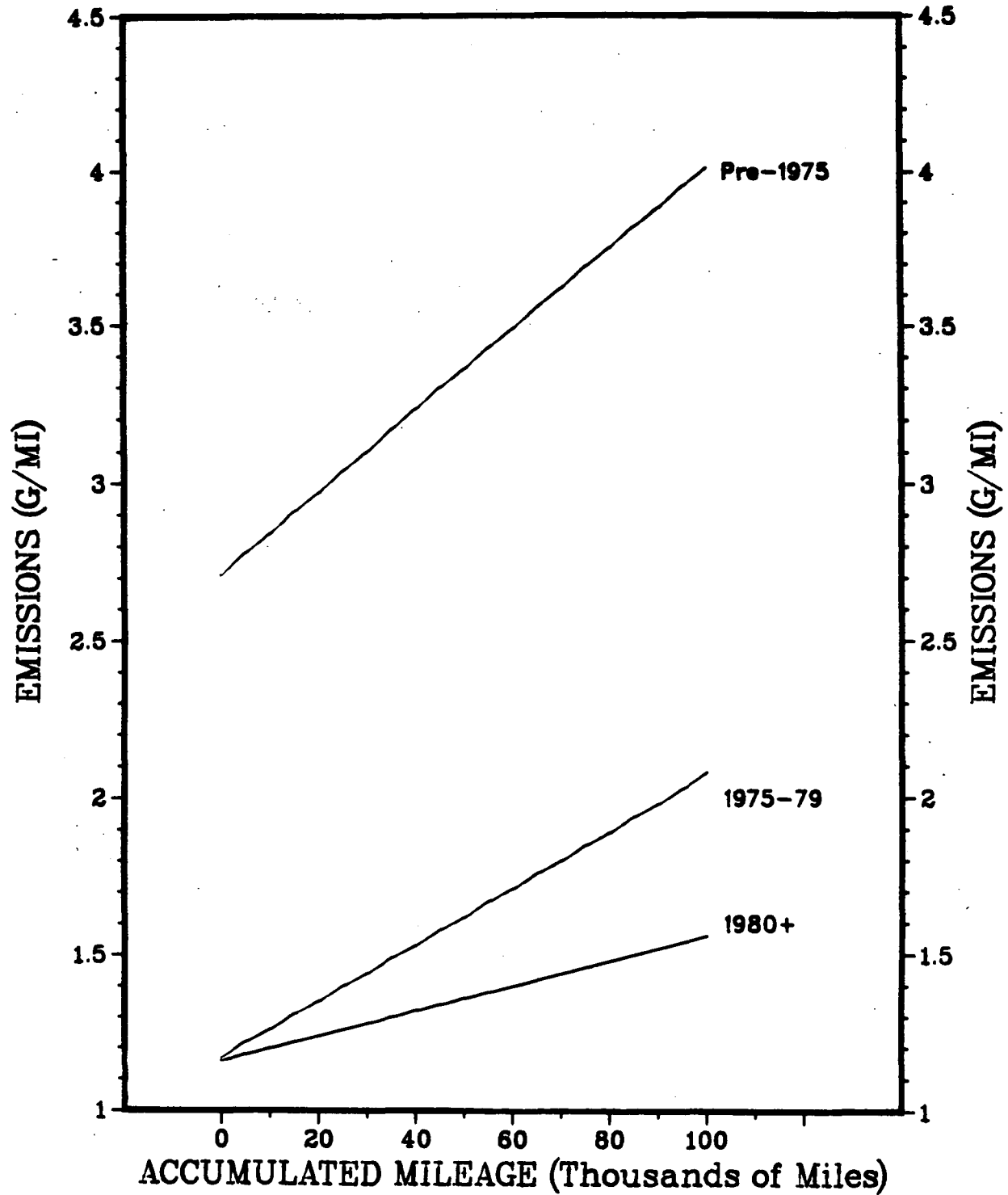


FIGURE 15

BASIC EMISSION RATES  
LIGHT DUTY DIESEL POWERED VEHICLES  
OXIDES OF NITROGEN  
Low Altitude

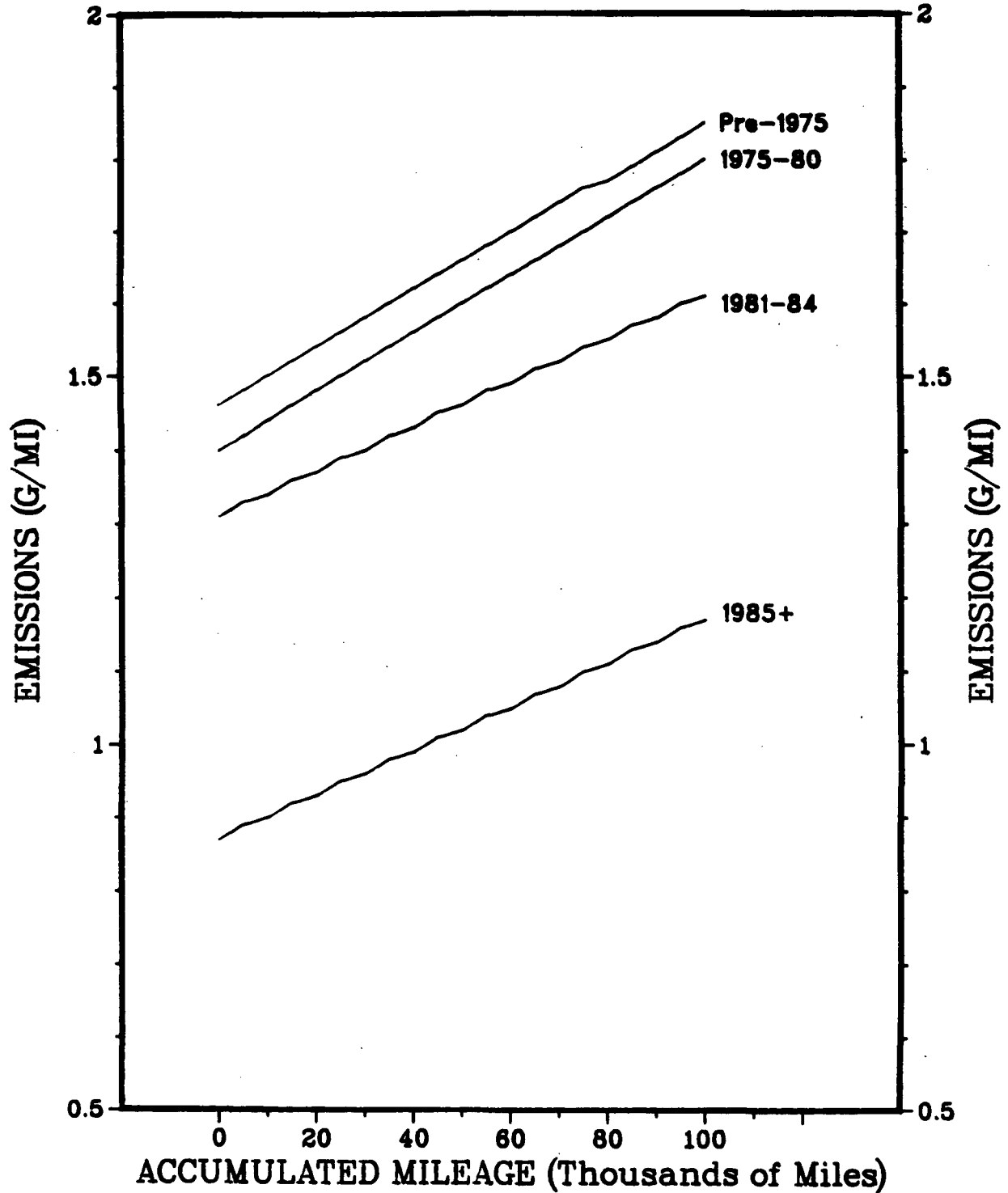




FIGURE 16

BASIC EMISSION RATES  
LIGHT DUTY DIESEL POWERED TRUCKS  
HYDROCARBONS  
Low Altitude

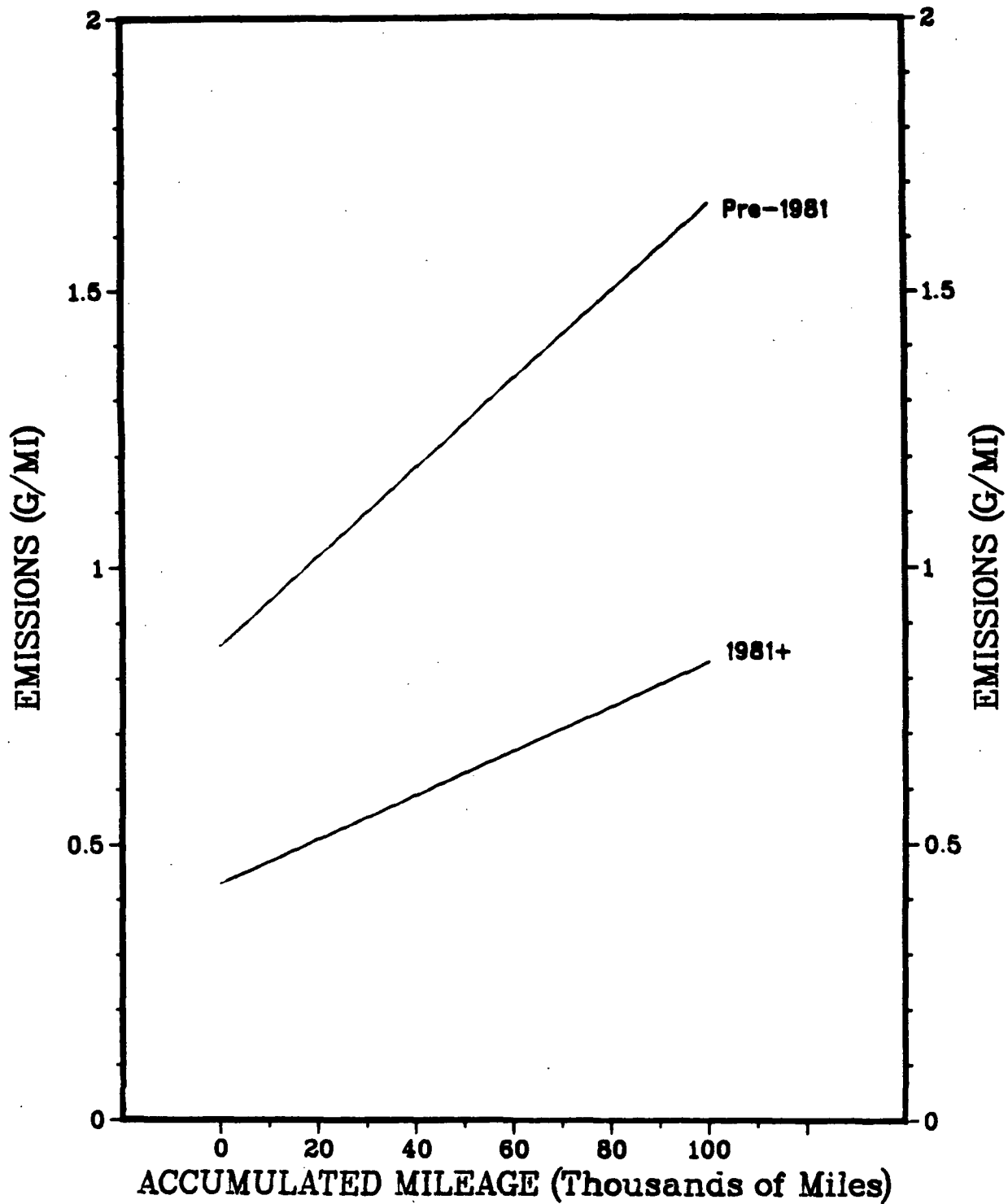


FIGURE 17

BASIC EMISSION RATES  
LIGHT DUTY DIESEL POWERED TRUCKS  
CARBON MONOXIDE  
Low Altitude

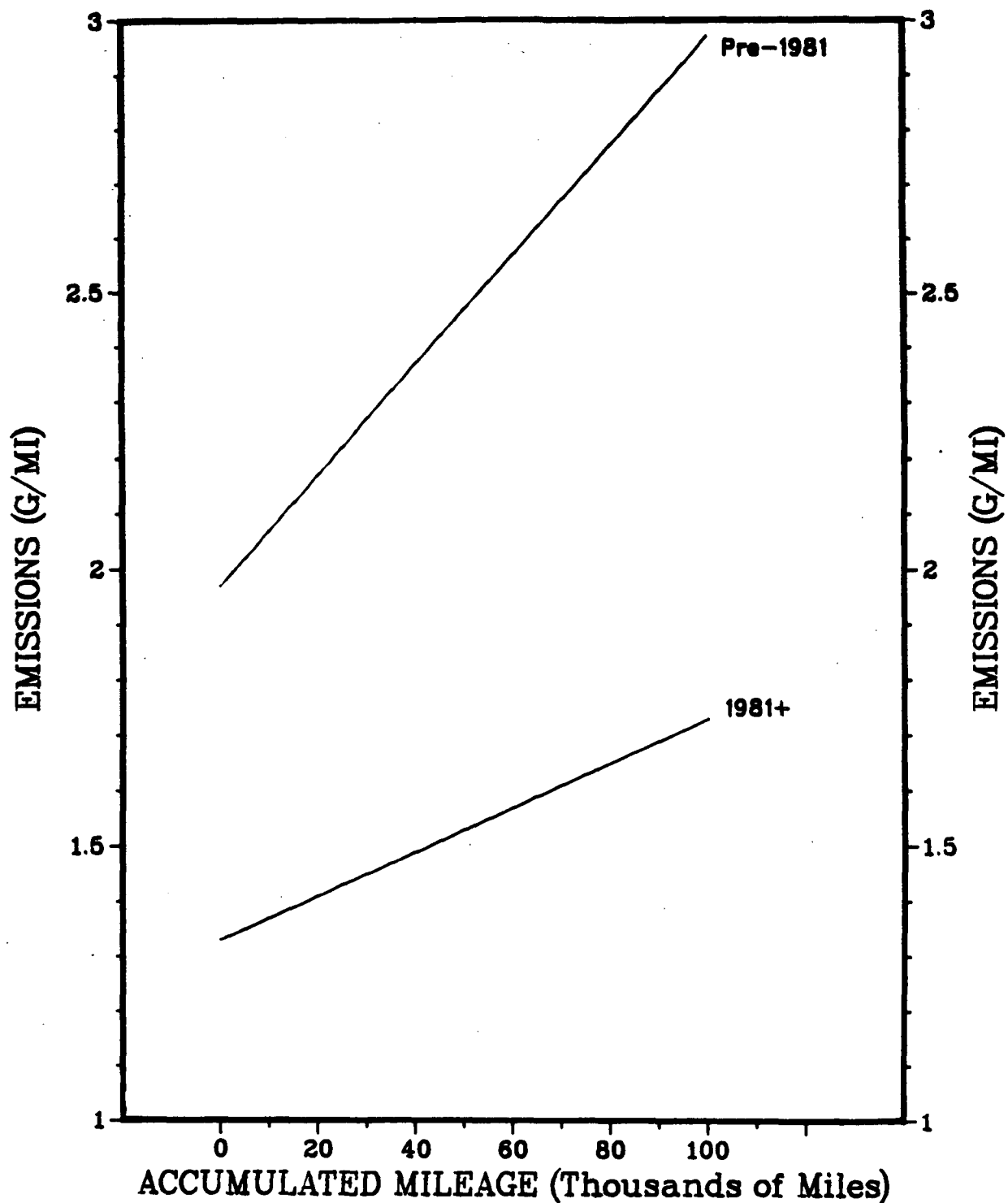


FIGURE 18

BASIC EMISSION RATES  
LIGHT DUTY DIESEL POWERED TRUCKS  
OXIDES OF NITROGEN  
Low Altitude

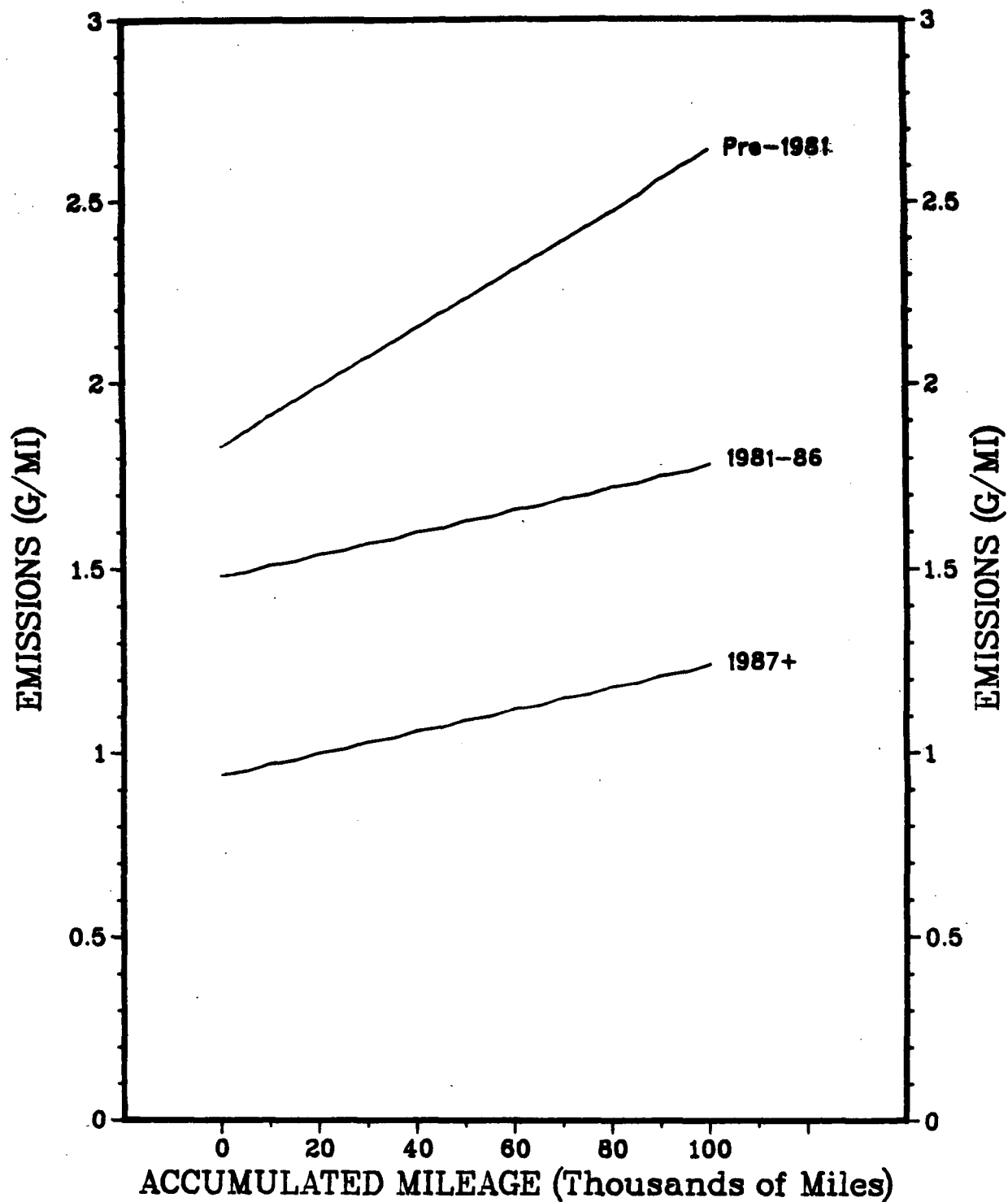


FIGURE 19

BASIC EMISSION RATES  
HEAVY DUTY DIESEL POWERED VEHICLES  
HYDROCARBONS  
Low Altitude

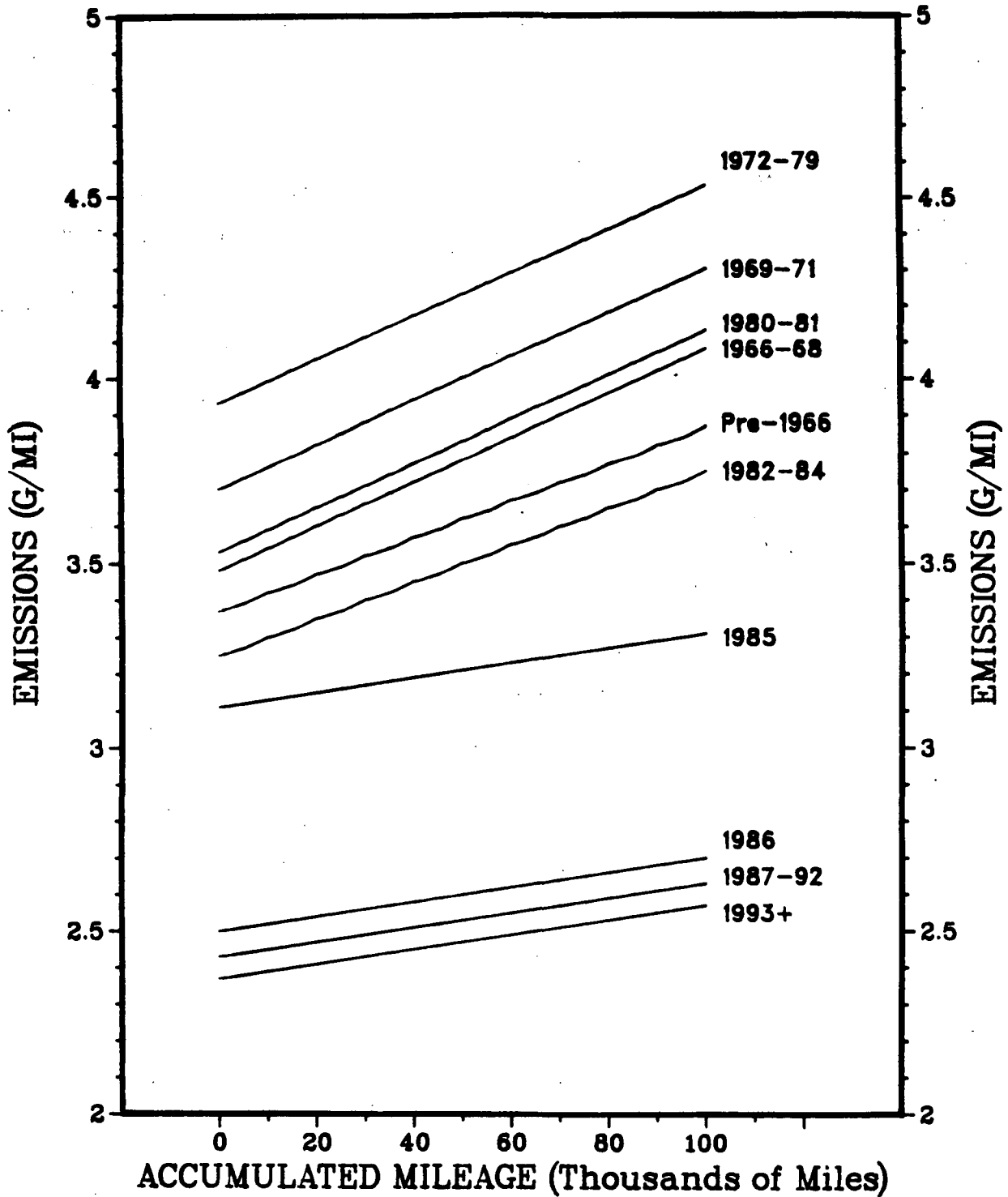


FIGURE 20

BASIC EMISSION RATES  
HEAVY DUTY DIESEL POWERED VEHICLES  
CARBON MONOXIDE  
Low Altitude

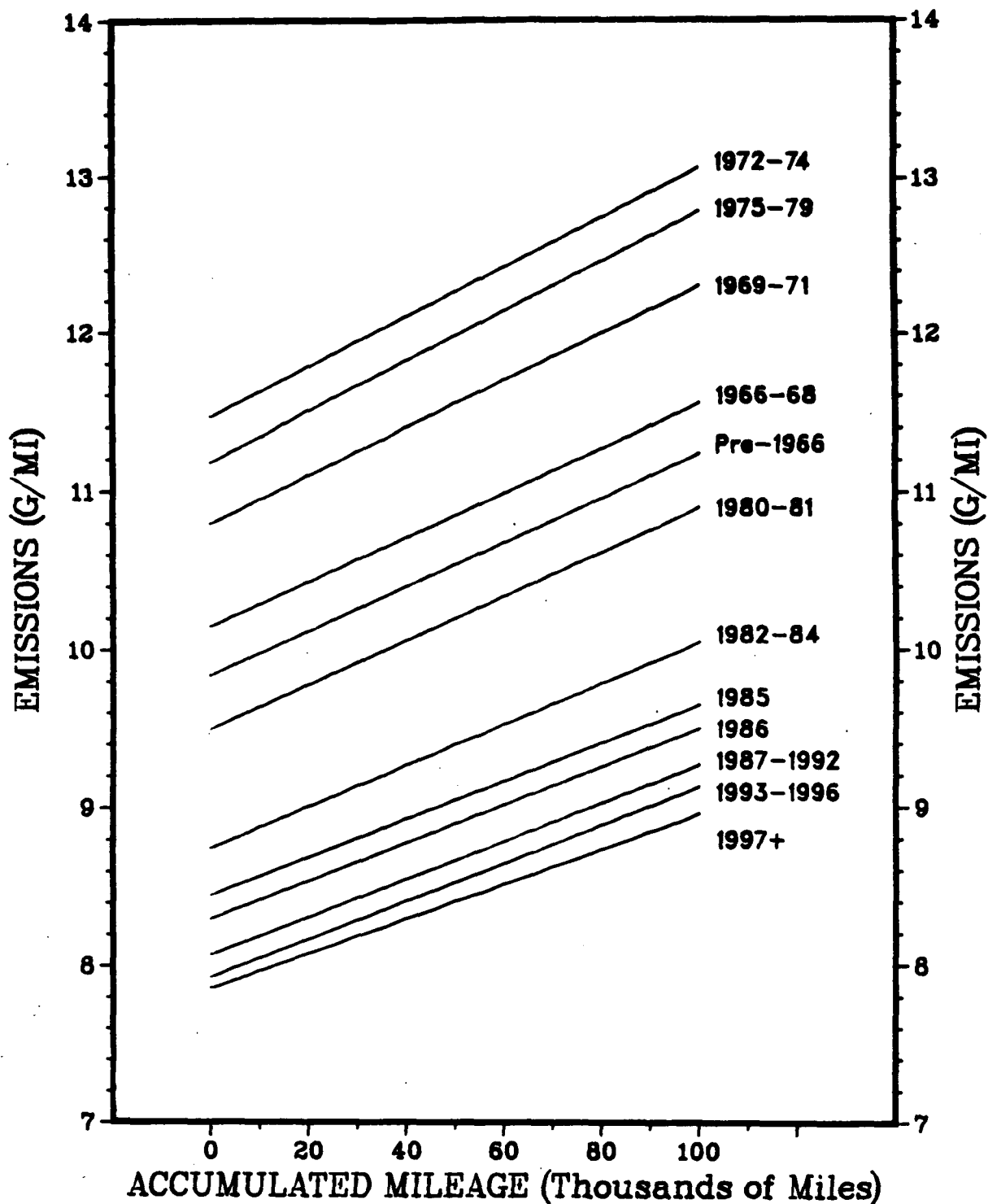


FIGURE 21

BASIC EMISSION RATES  
HEAVY DUTY DIESEL POWERED VEHICLES  
OXIDES OF NITROGEN  
Low Altitude

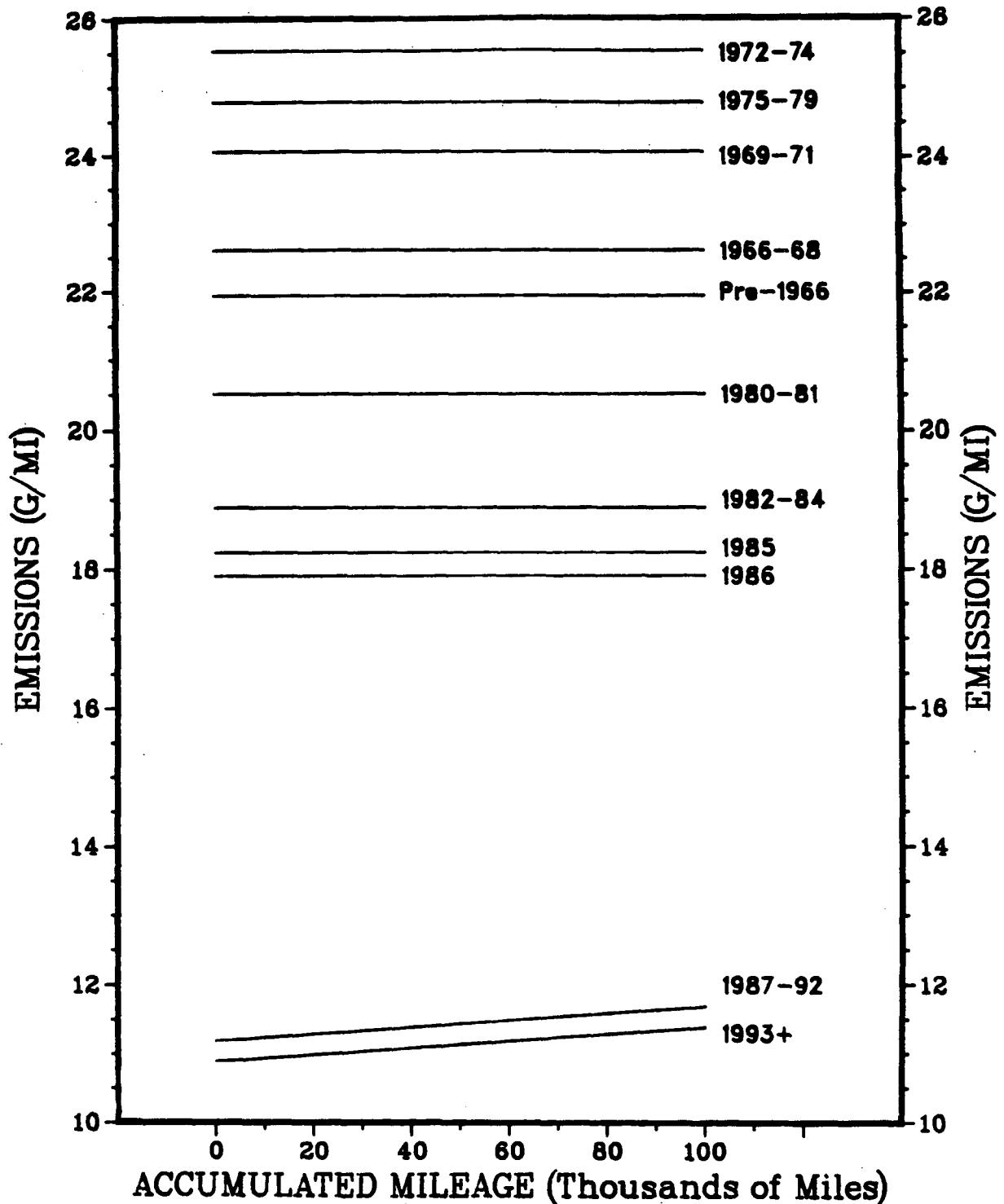


FIGURE 22

BASIC EMISSION RATES  
MOTORCYCLES  
HYDROCARBONS  
Low Altitude

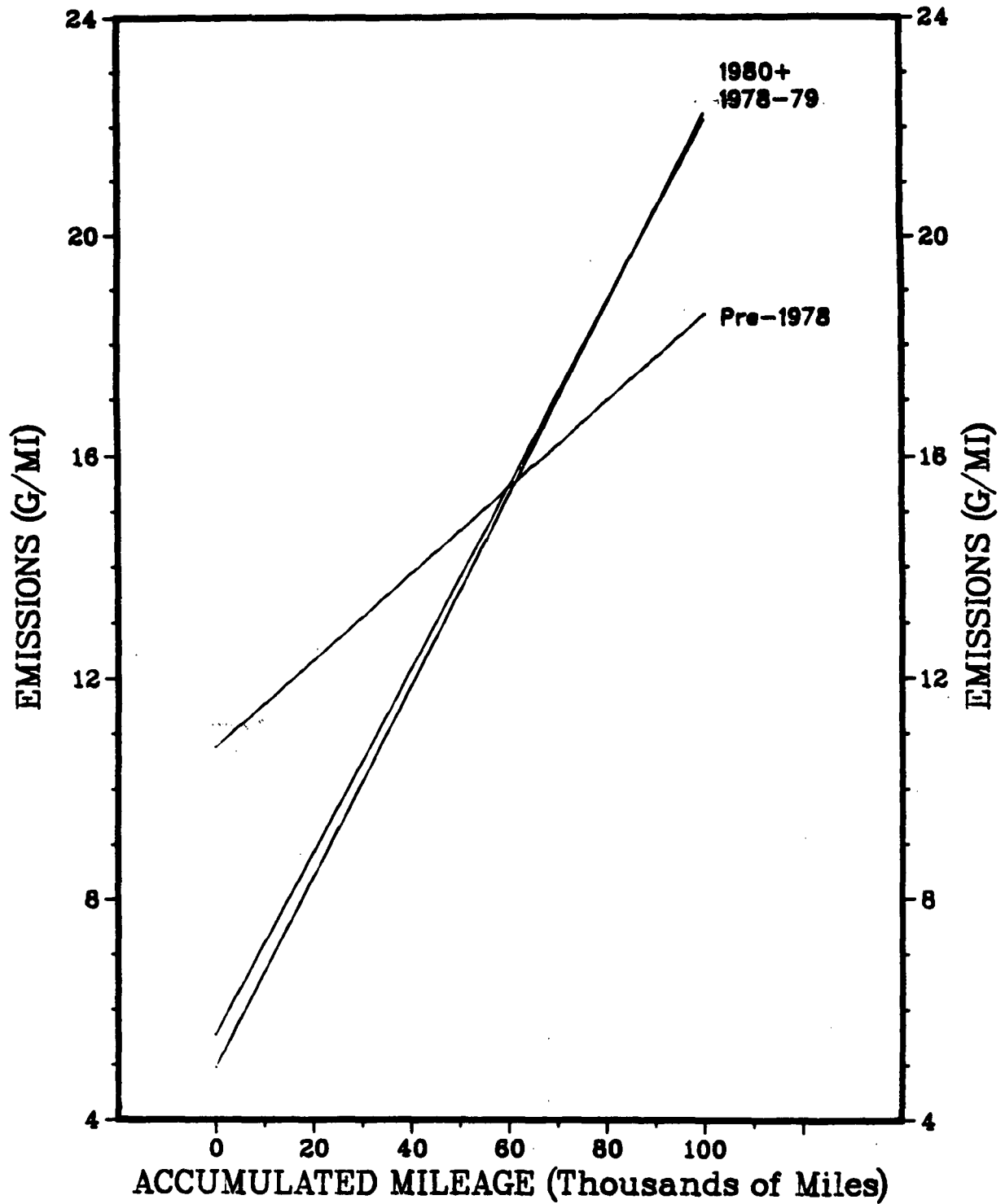


FIGURE 23

BASIC EMISSION RATES  
MOTORCYCLES  
CARBON MONOXIDE  
Low Altitude

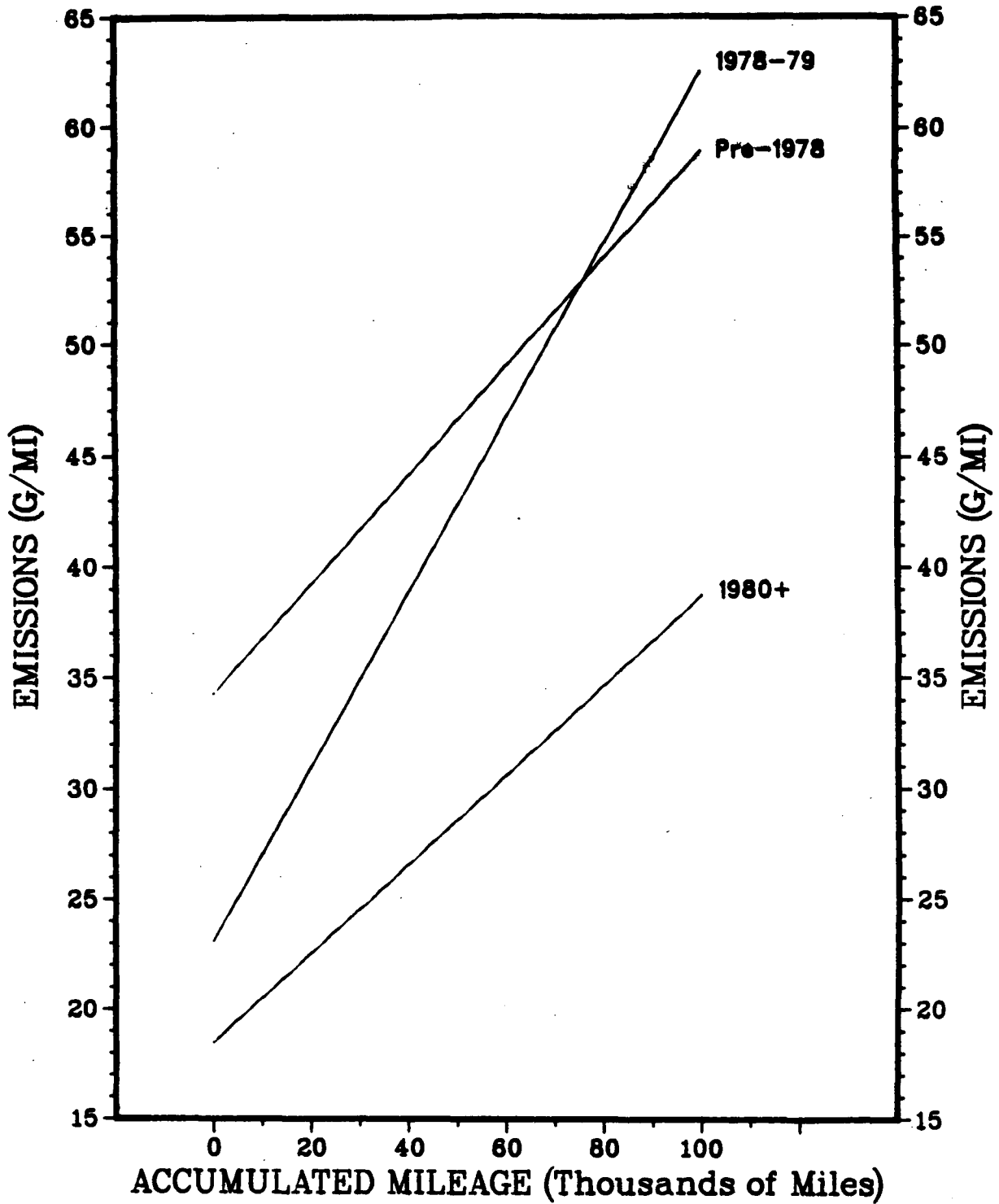




FIGURE 24  
BASIC EMISSION RATES  
MOTORCYCLES  
OXIDES OF NITROGEN  
Low Altitude

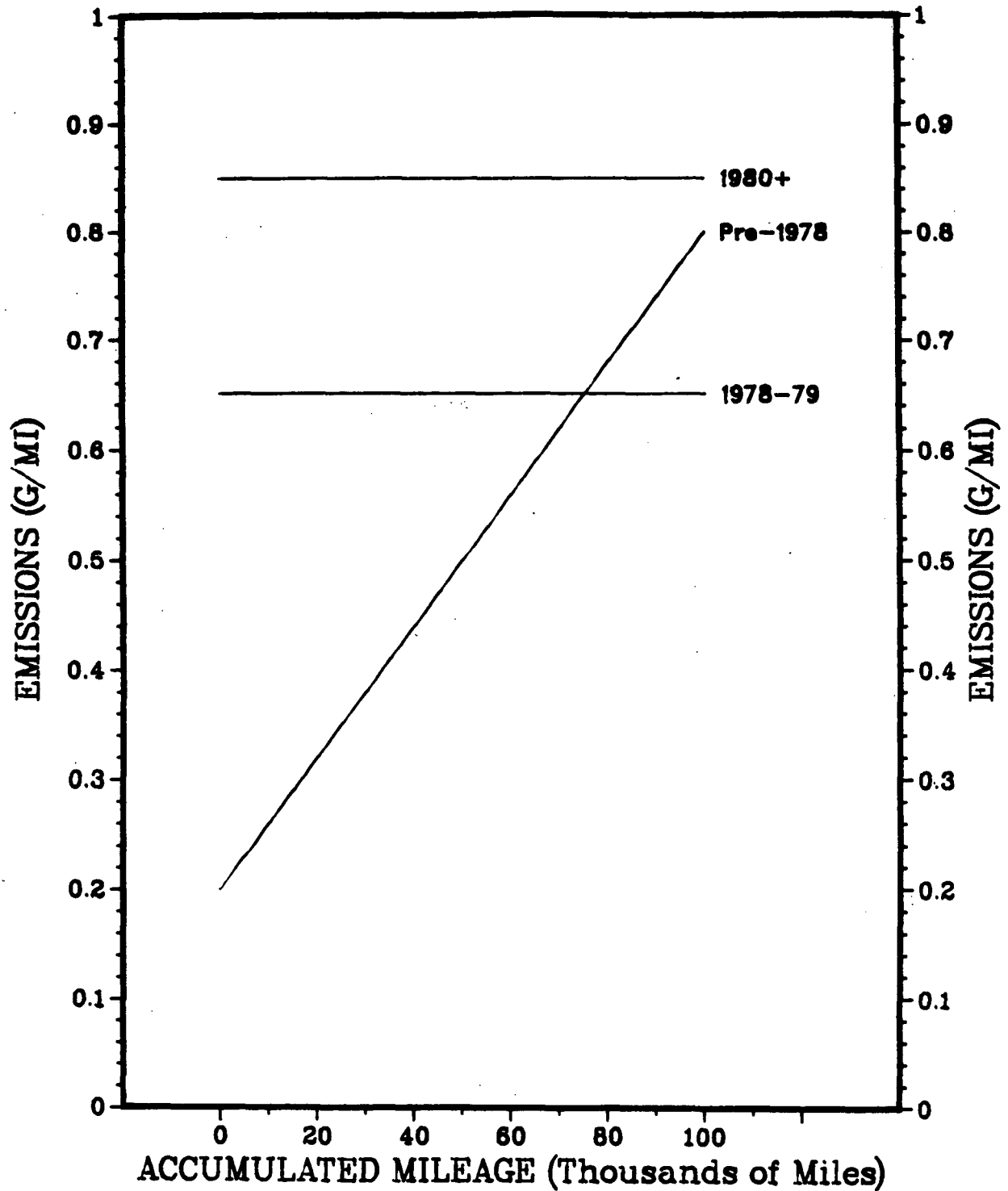


FIGURE 25

SPEED CORRECTION FACTORS  
LIGHT DUTY GASOLINE POWERED VEHICLES  
HYDROCARBONS  
Low Altitude

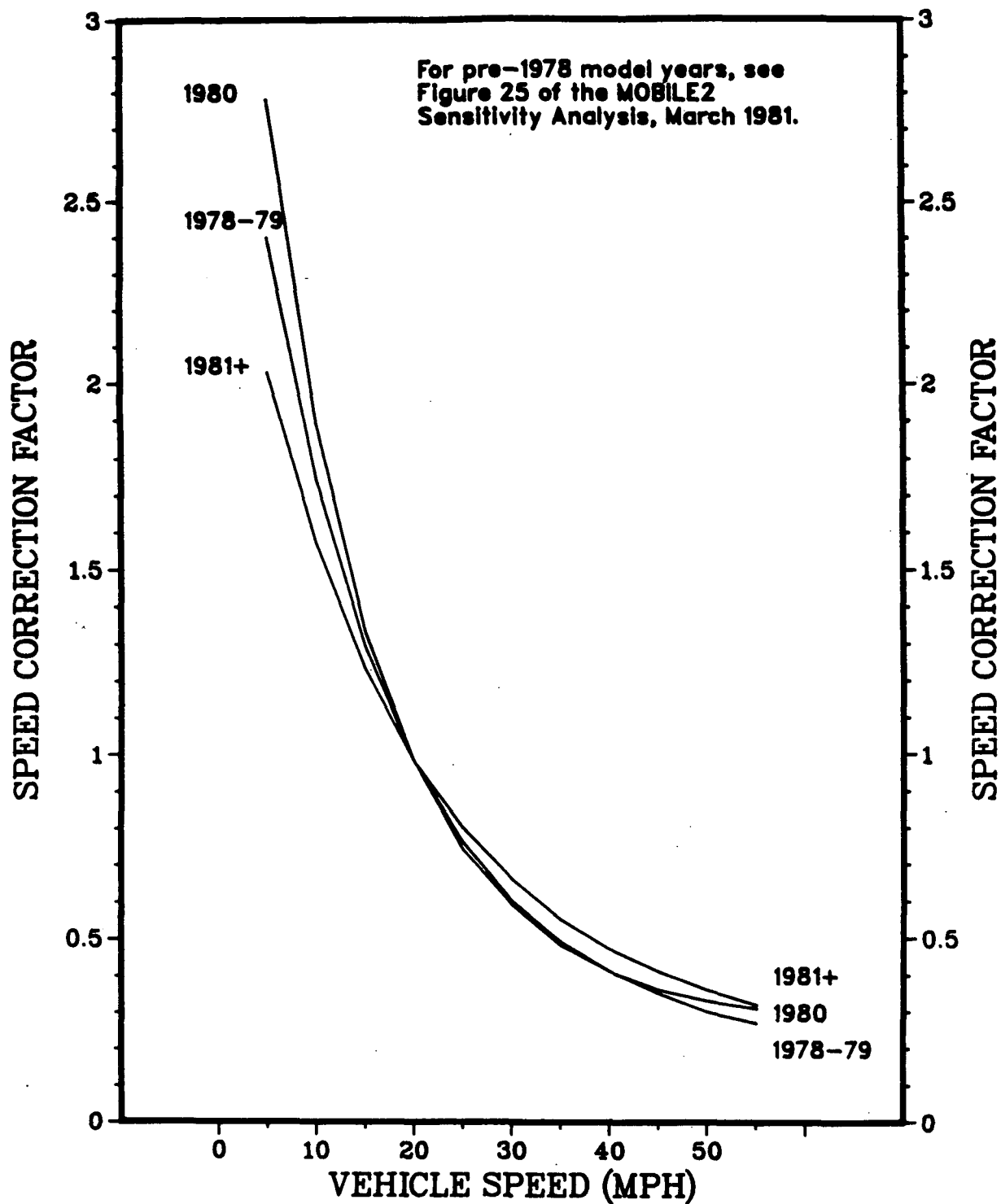


FIGURE 26

SPEED CORRECTION FACTORS  
LIGHT DUTY GASOLINE POWERED VEHICLES  
CARBON MONOXIDE  
Low Altitude

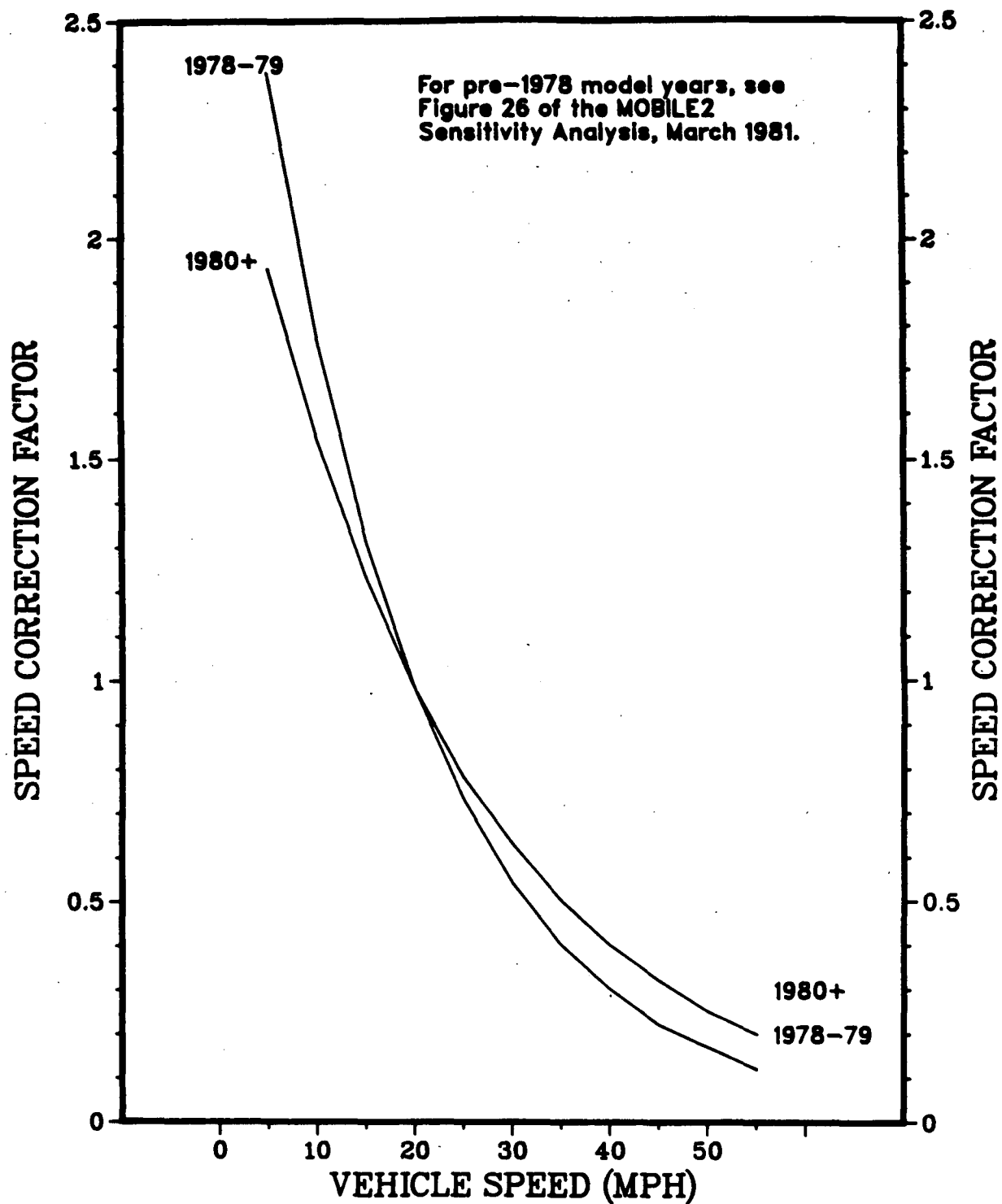


FIGURE 27

SPEED CORRECTION FACTORS  
LIGHT DUTY GASOLINE POWERED VEHICLES  
OXIDES OF NITROGEN  
Low Altitude

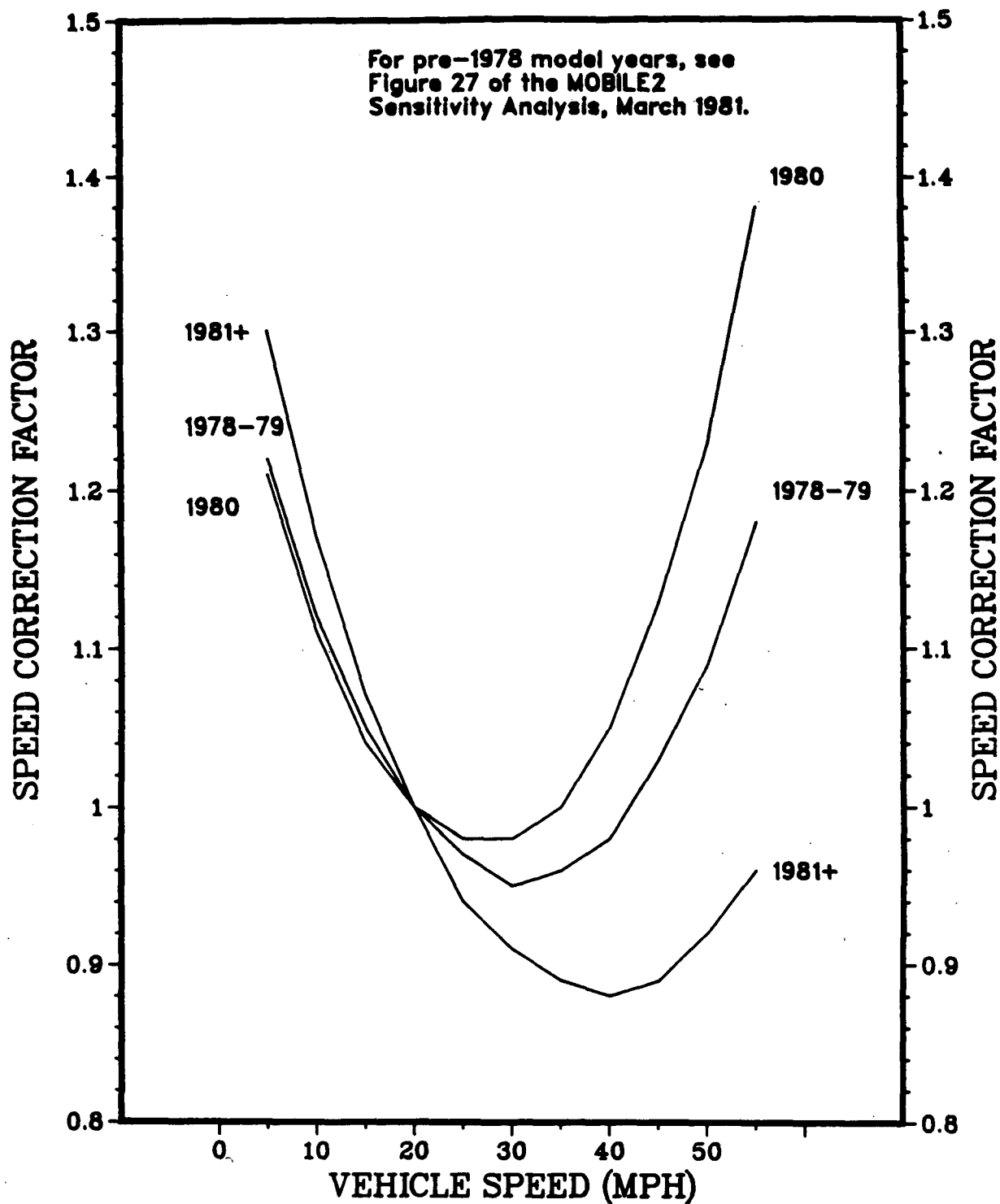


FIGURE 28

SPEED CORRECTION FACTORS  
LIGHT DUTY GASOLINE POWERED TRUCKS I  
HYDROCARBONS  
Low Altitude

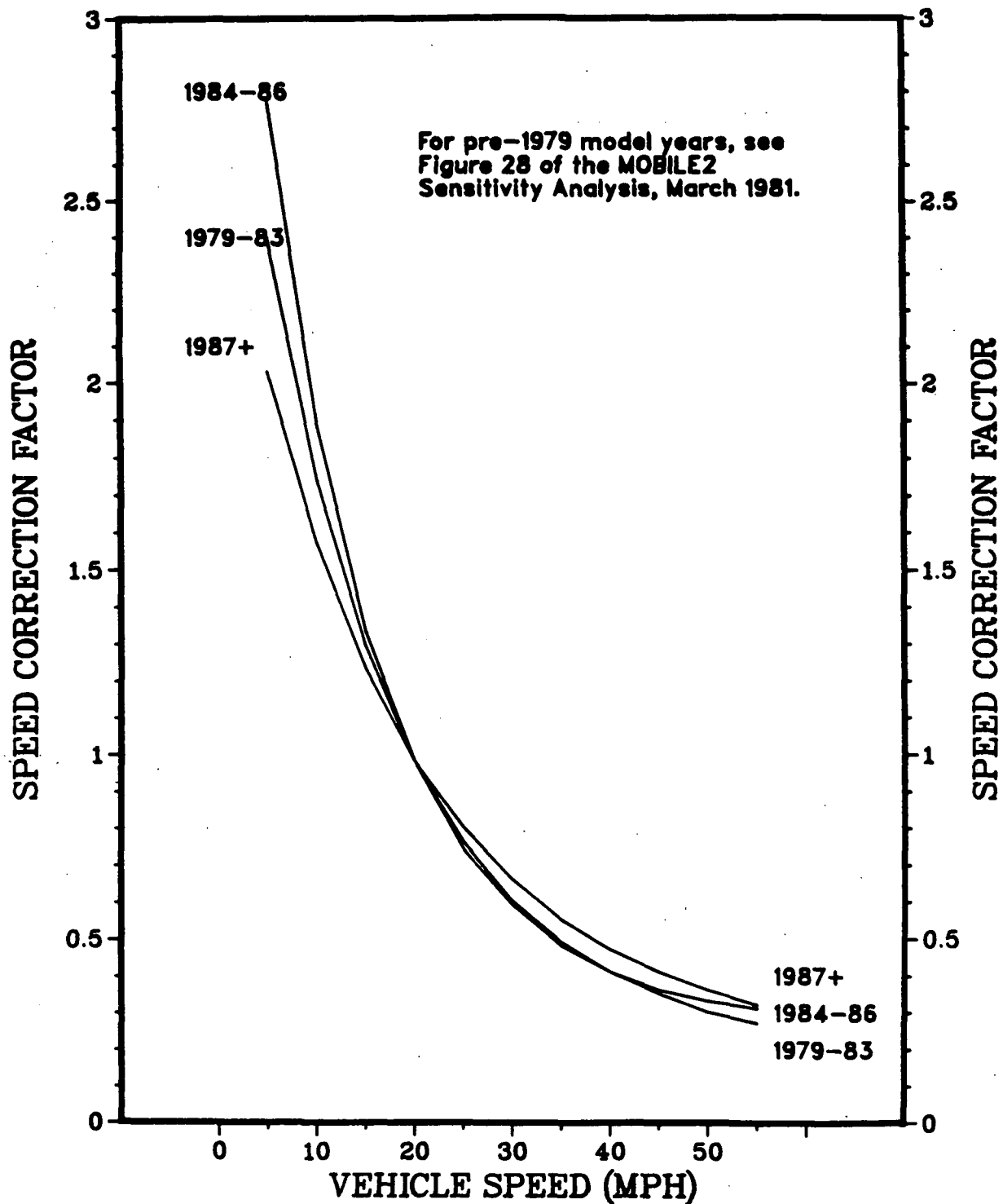


FIGURE 29

SPEED CORRECTION FACTORS  
LIGHT DUTY GASOLINE POWERED TRUCKS I  
CARBON MONOXIDE  
Low Altitude

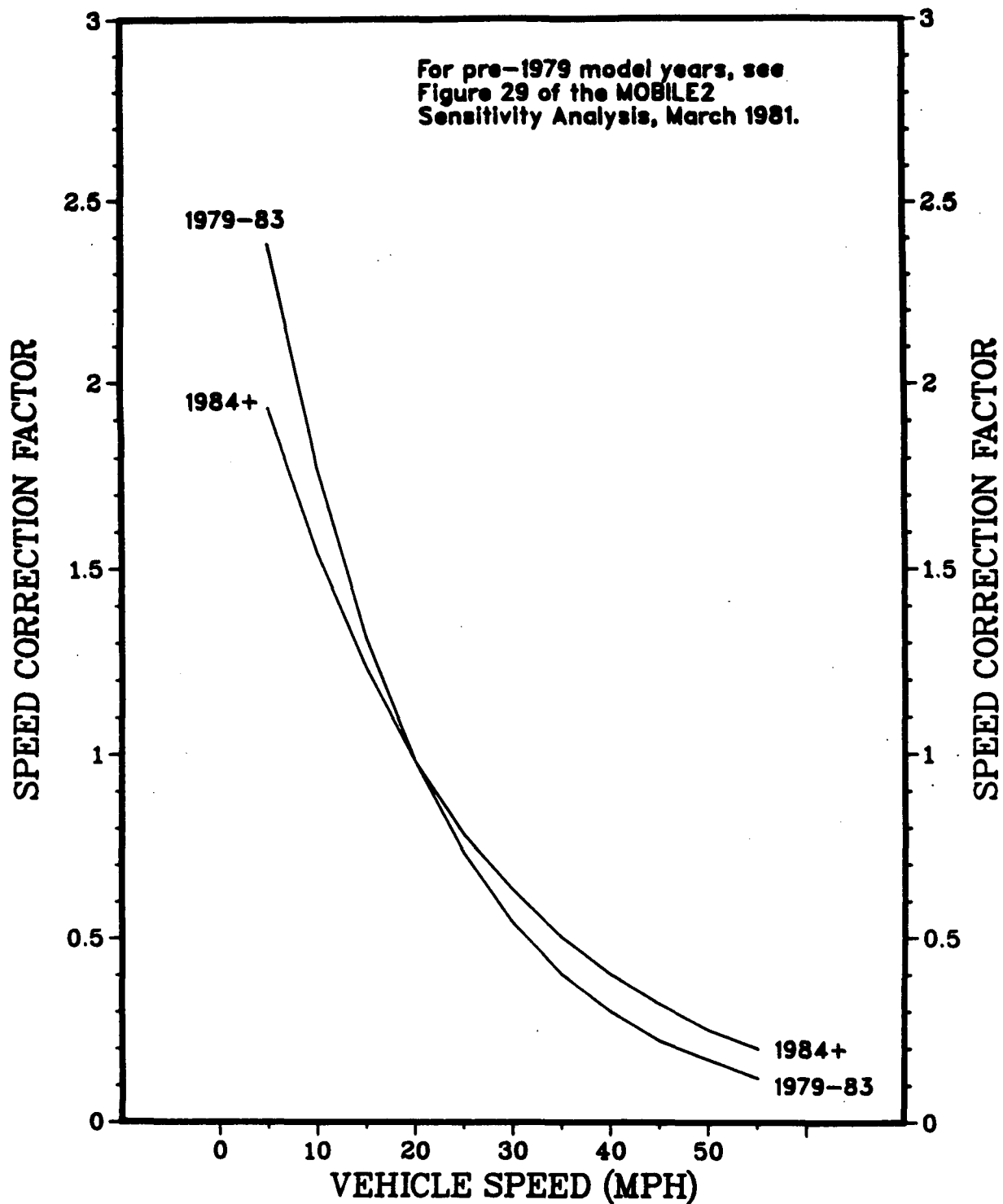


FIGURE 30

SPEED CORRECTION FACTORS  
LIGHT DUTY GASOLINE POWERED TRUCKS I  
OXIDES OF NITROGEN  
Low Altitude

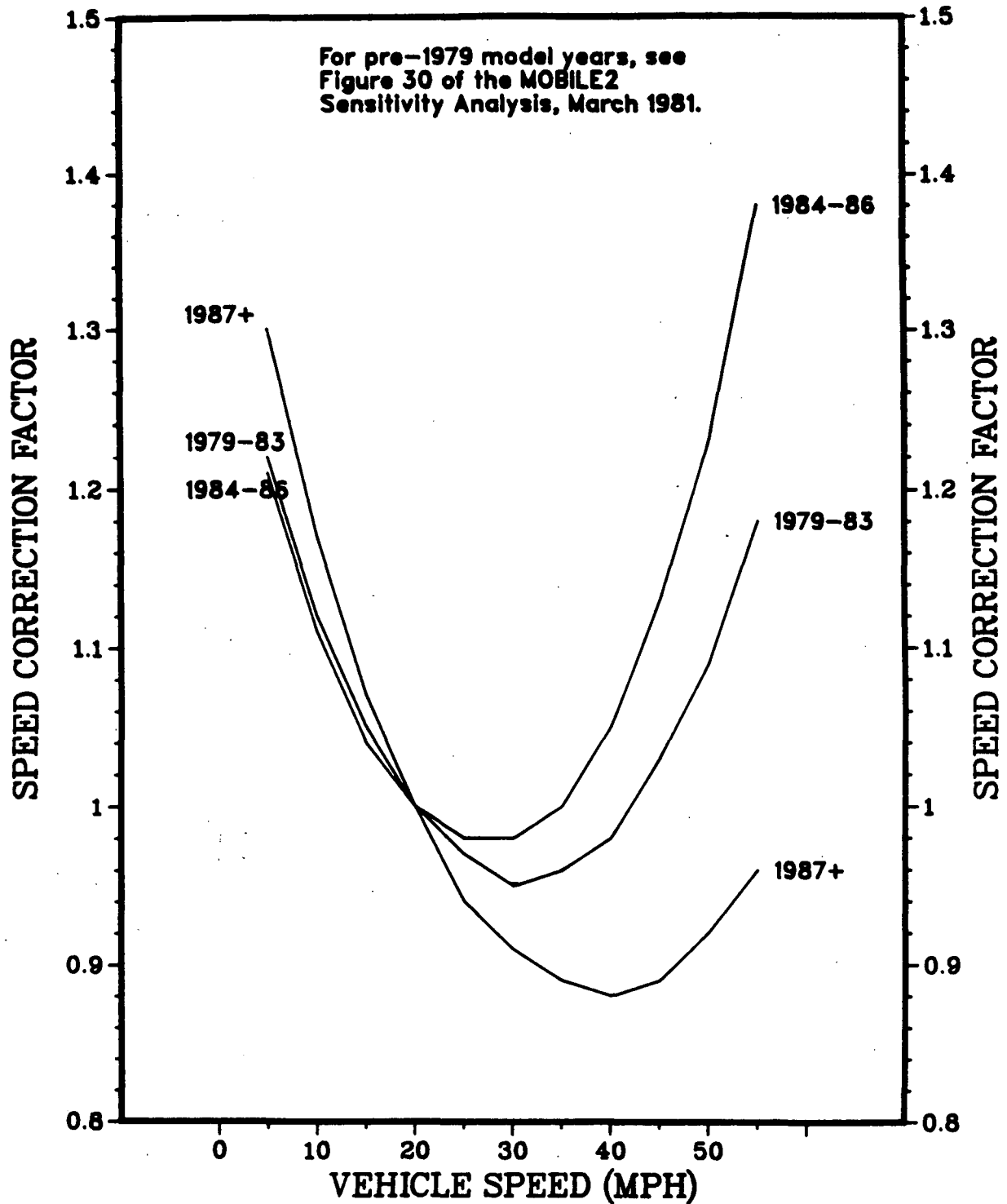


FIGURE 31

SPEED CORRECTION FACTORS  
LIGHT DUTY GASOLINE POWERED TRUCKS II  
HYDROCARBONS  
Low Altitude

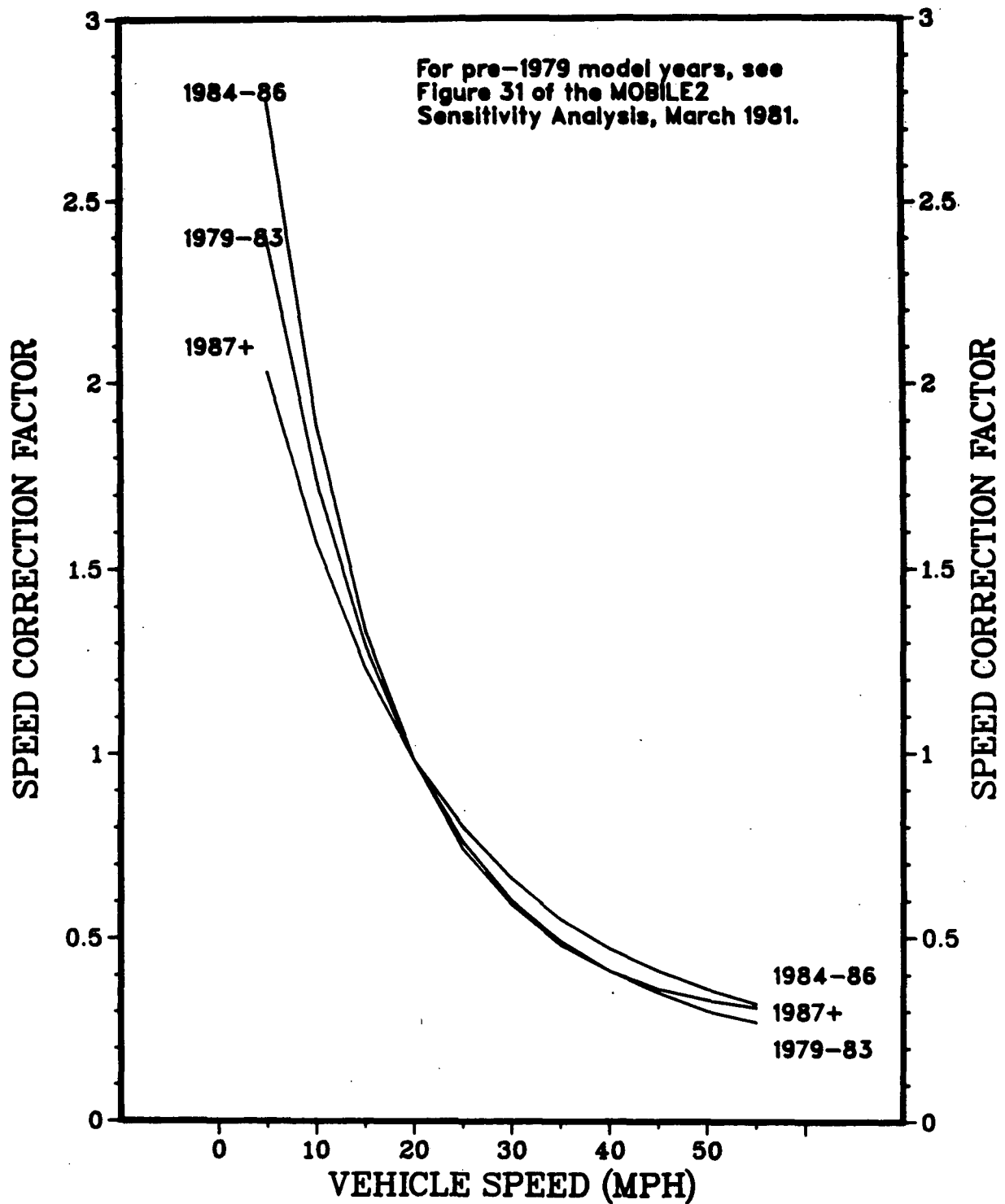




FIGURE 32

SPEED CORRECTION FACTORS  
LIGHT DUTY GASOLINE POWERED TRUCKS II  
CARBON MONOXIDE  
Low Altitude

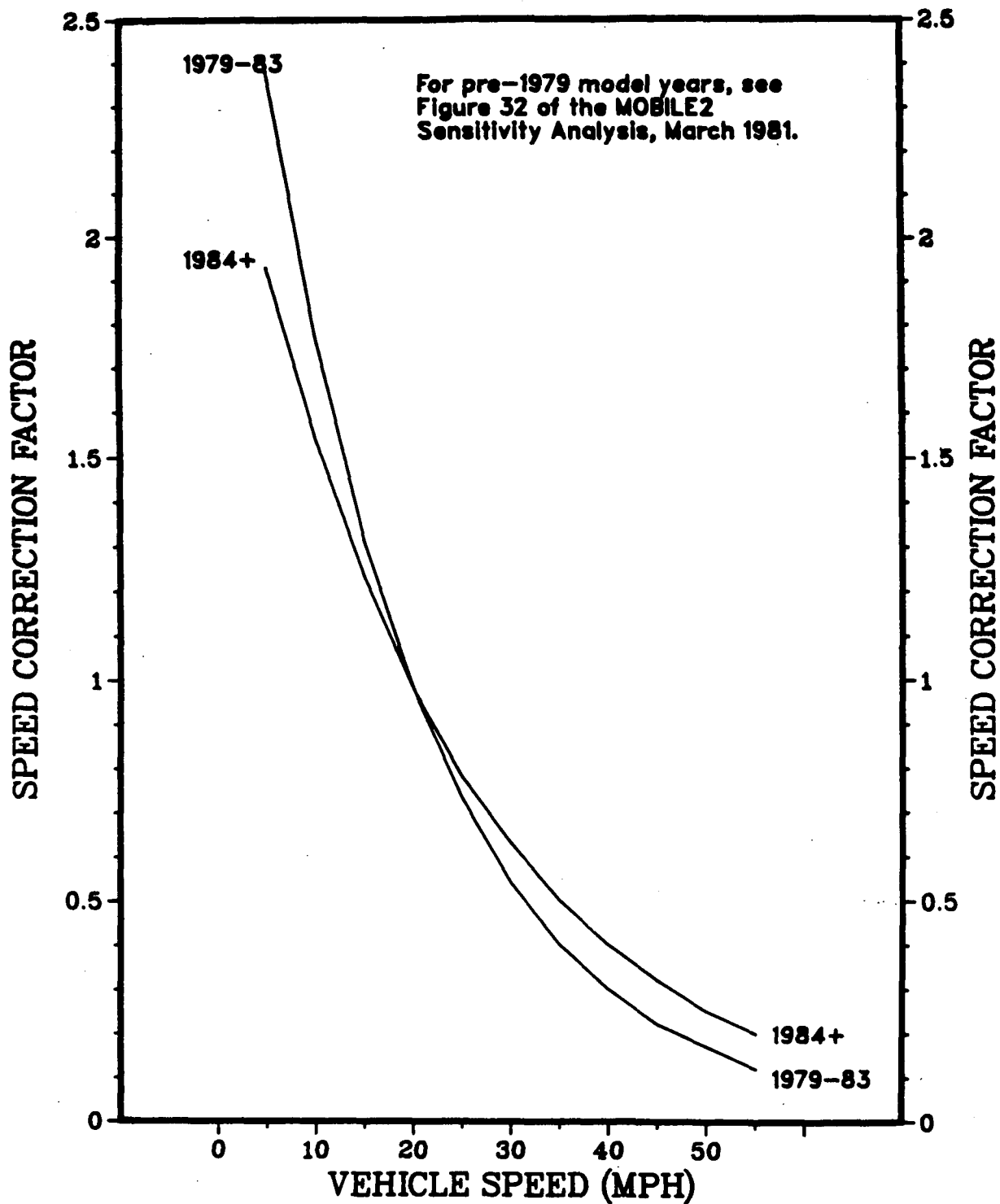


FIGURE 33

SPEED CORRECTION FACTORS  
LIGHT DUTY GASOLINE POWERED TRUCKS II  
OXIDES OF NITROGEN  
Low Altitude

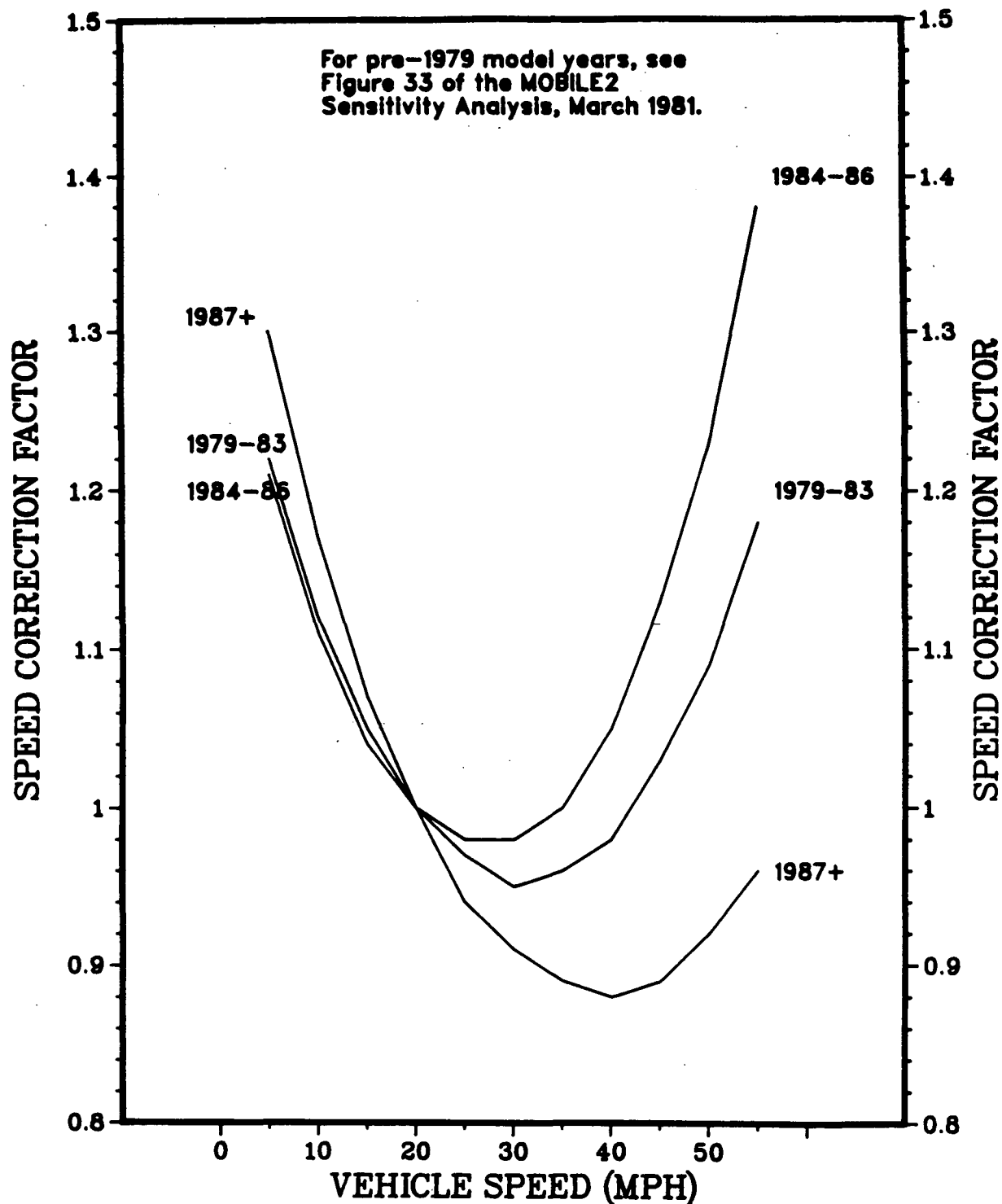


FIGURE 34

SPEED CORRECTION FACTORS  
HEAVY DUTY GASOLINE POWERED VEHICLES  
ALL POLLUTANTS  
Low Altitude

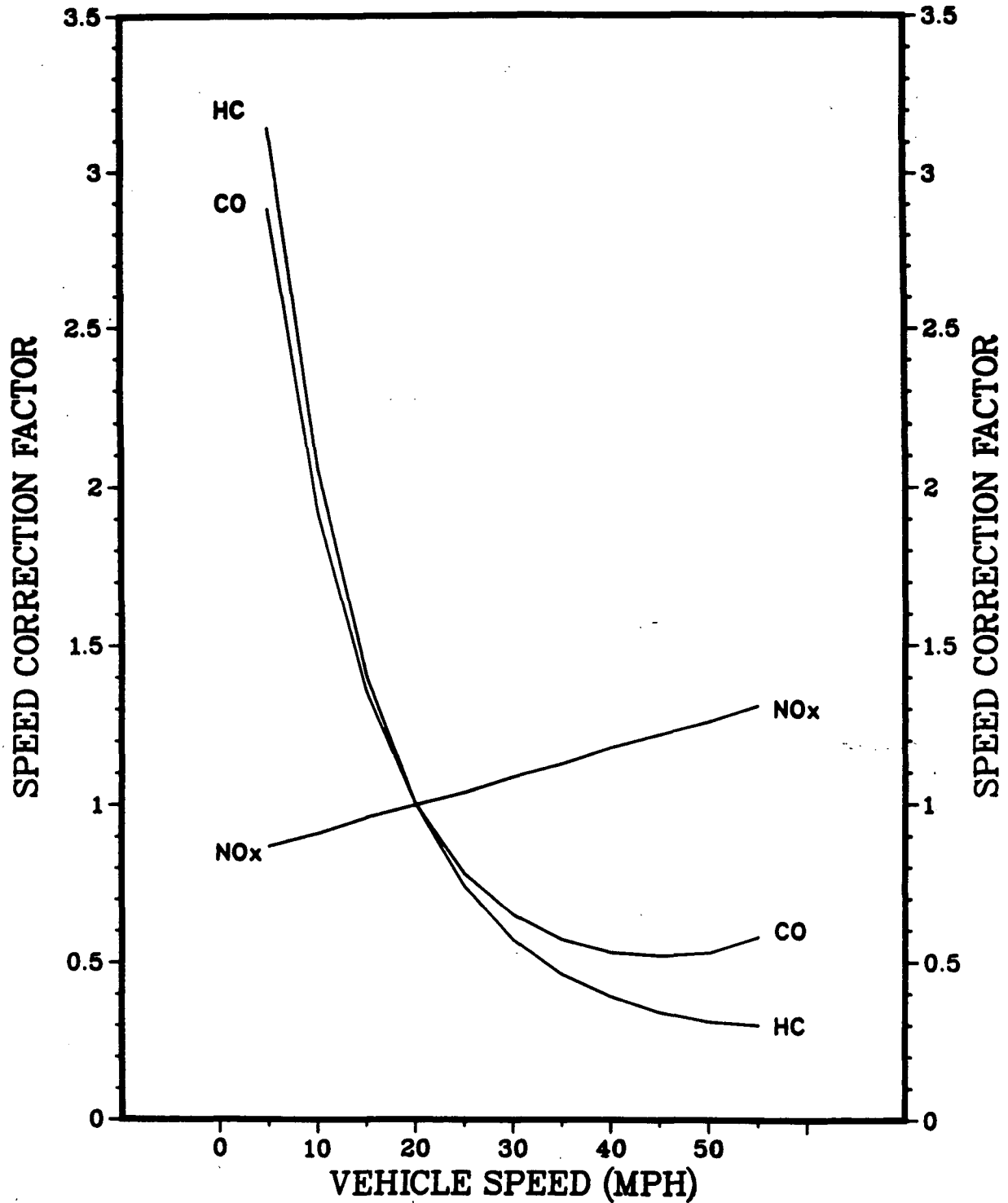


FIGURE 35

SPEED CORRECTION FACTORS  
LIGHT DUTY DIESEL POWERED VEHICLES AND TRUCKS  
ALL POLLUTANTS  
Low Altitude

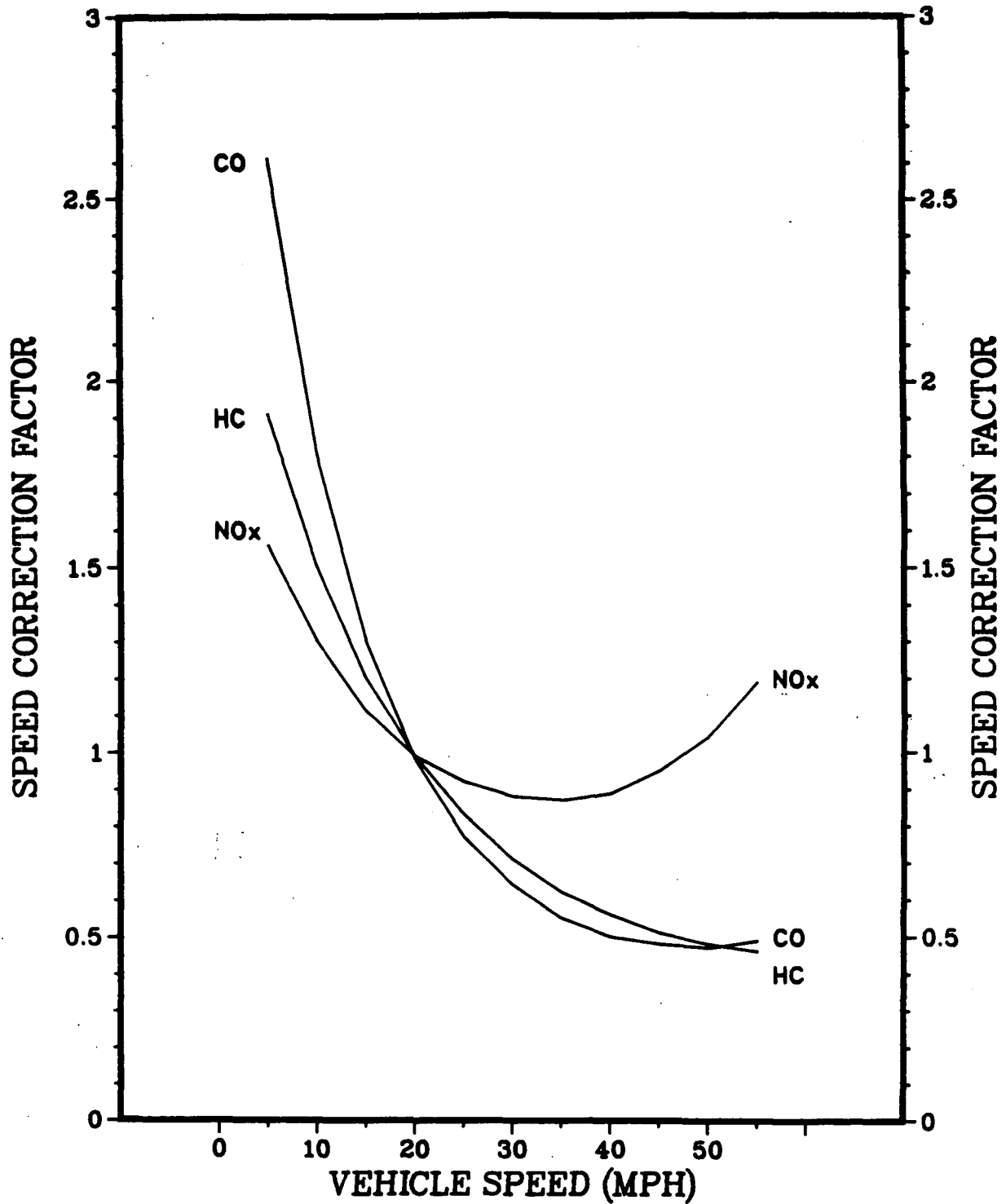


FIGURE 36

SPEED CORRECTION FACTORS  
HEAVY DUTY DIESEL POWERED VEHICLES  
ALL POLLUTANTS  
Low Altitude

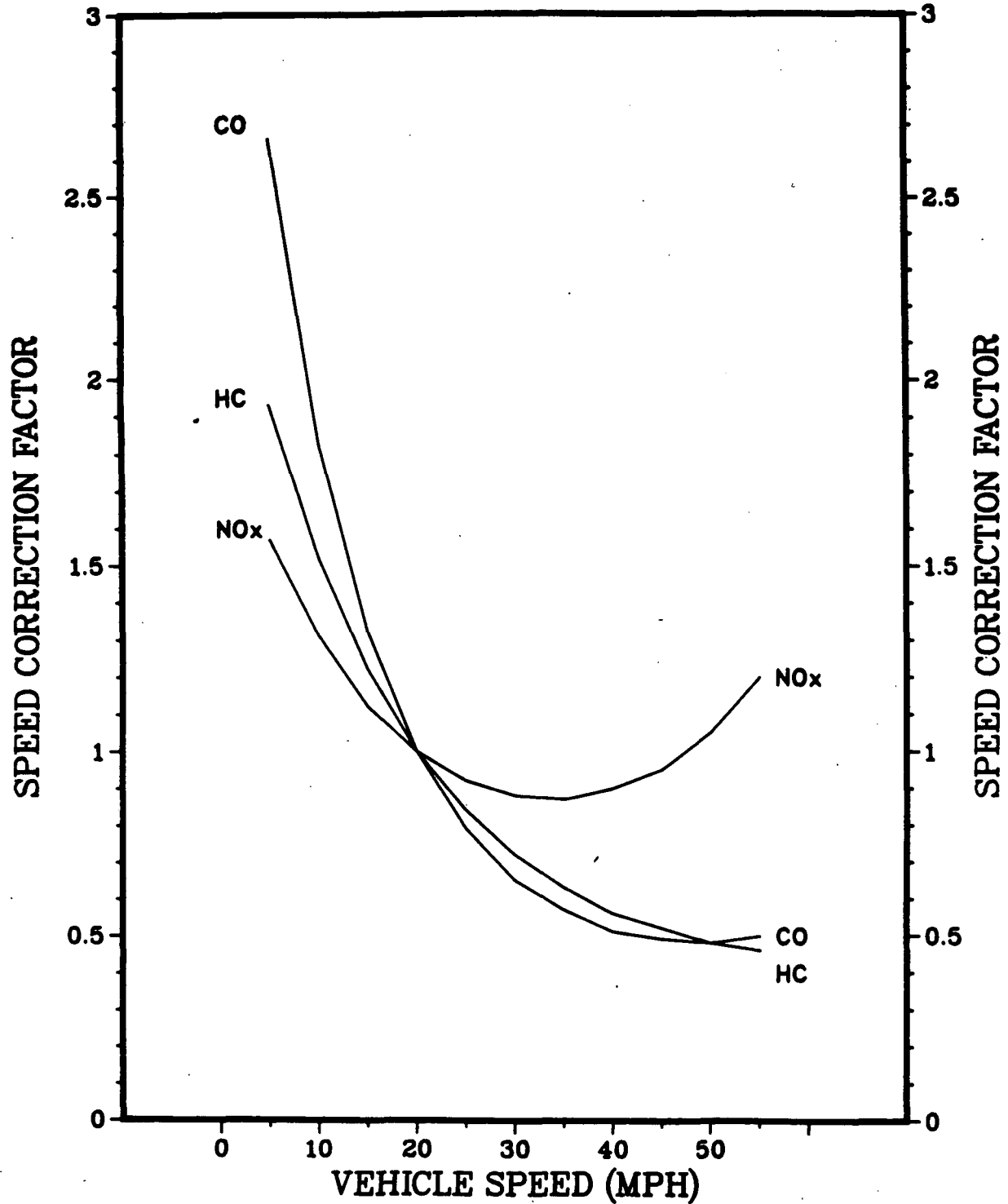


FIGURE 37

SPEED CORRECTION FACTORS  
MOTORCYCLES  
HYDROCARBONS  
Low Altitude

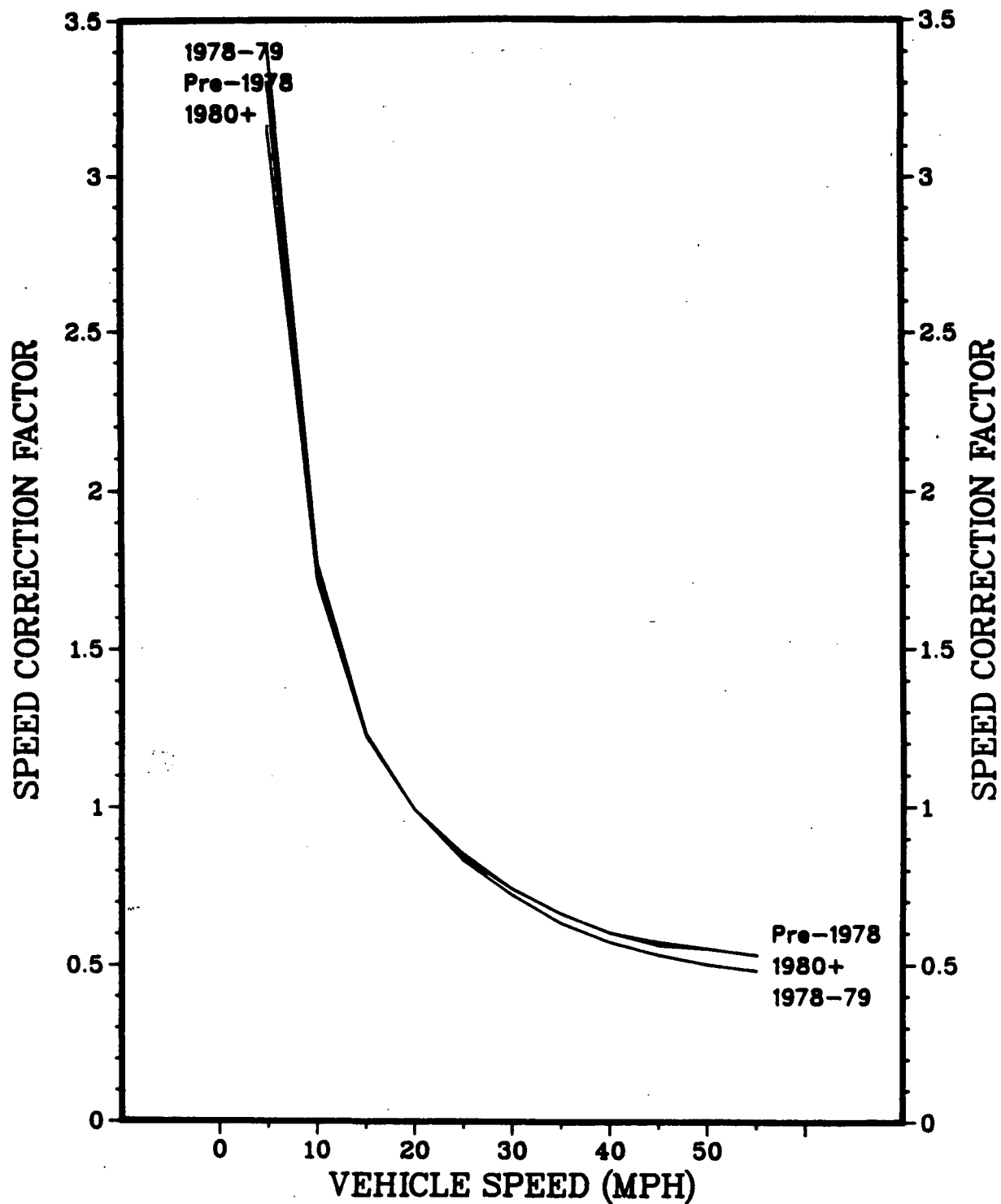


FIGURE 38

SPEED CORRECTION FACTORS  
MOTORCYCLES  
CARBON MONOXIDE  
Low Altitude

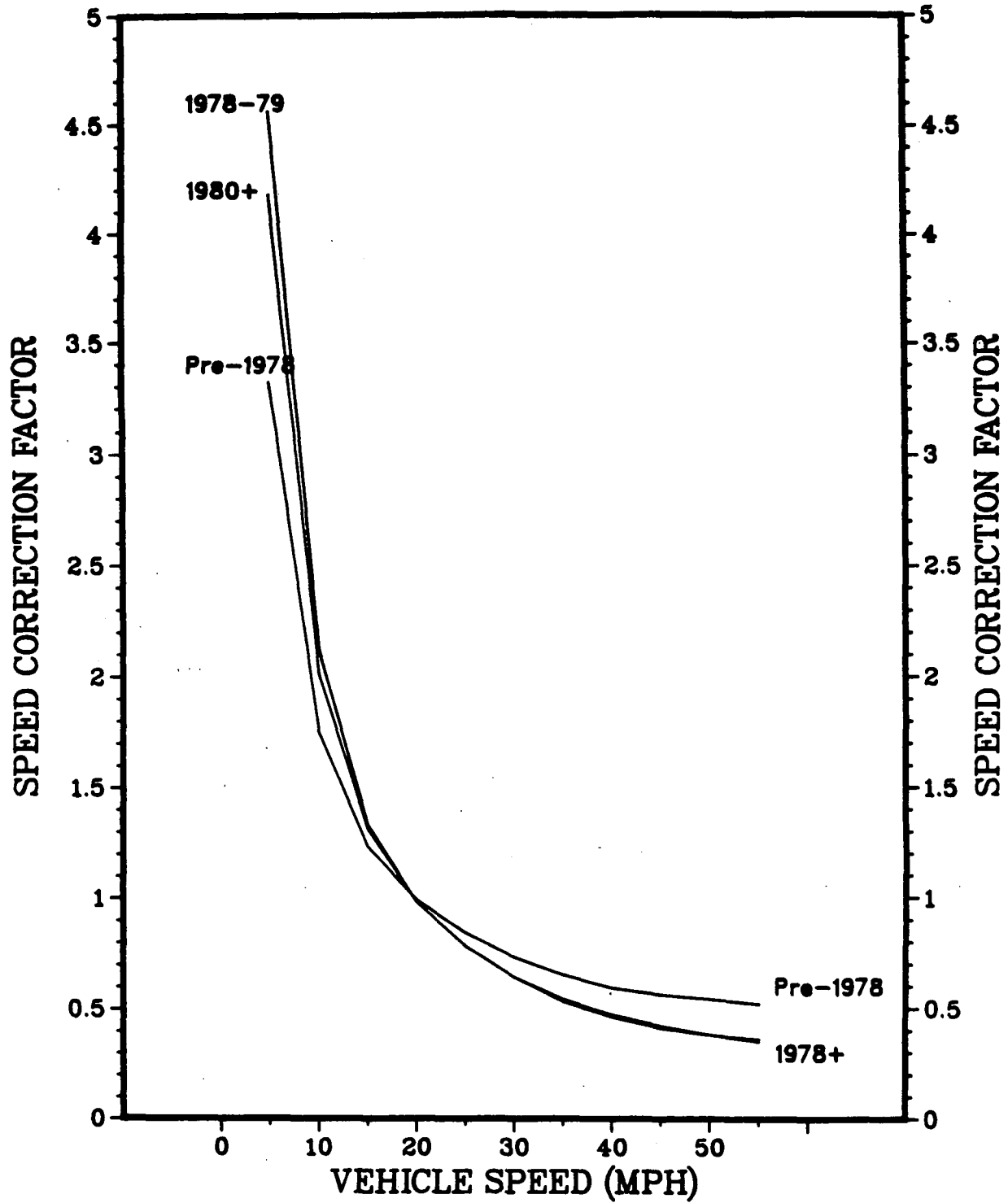


FIGURE 39  
SPEED CORRECTION FACTORS  
MOTORCYCLES  
OXIDES OF NITROGEN  
Low Altitude

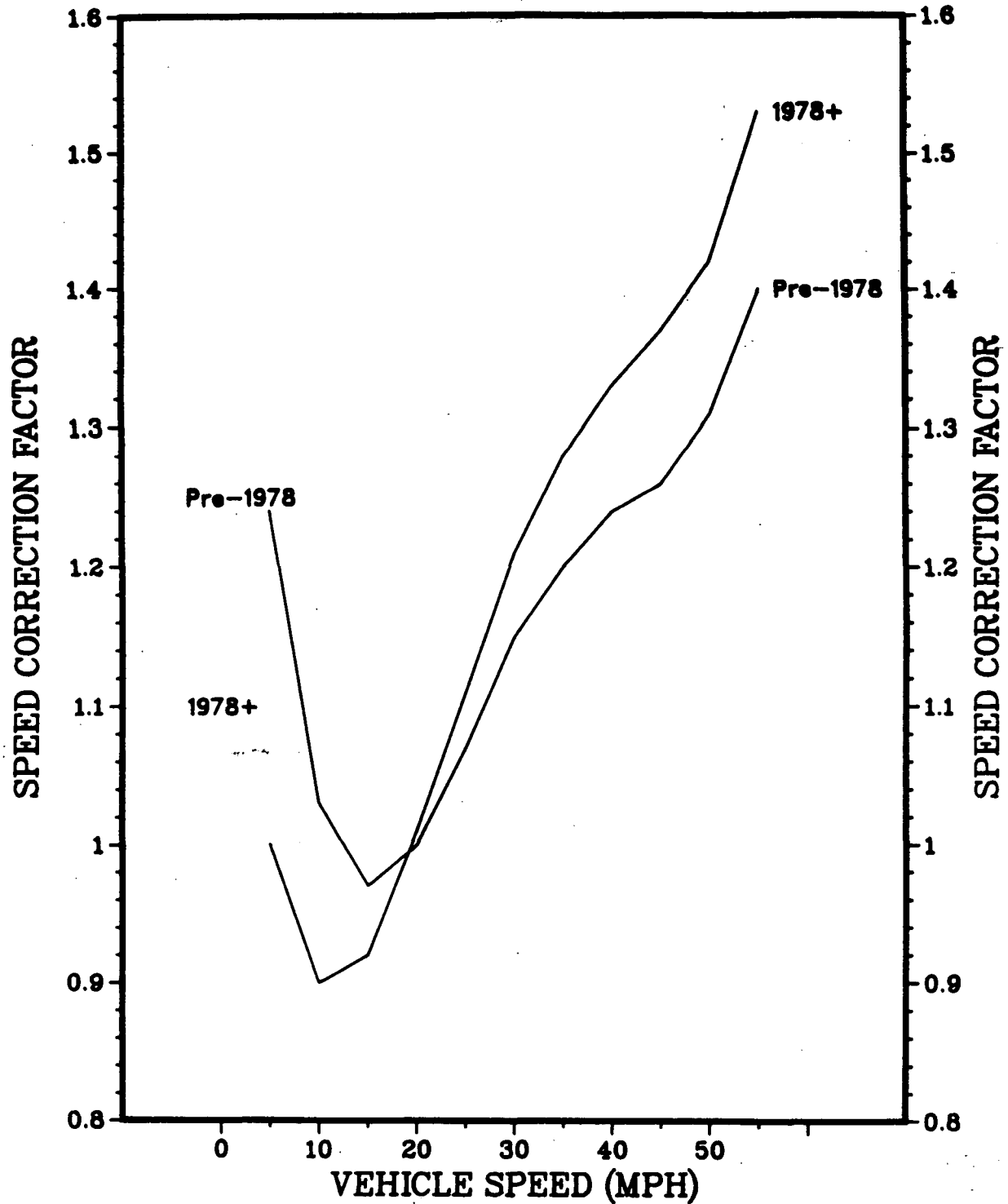




FIGURE 40

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

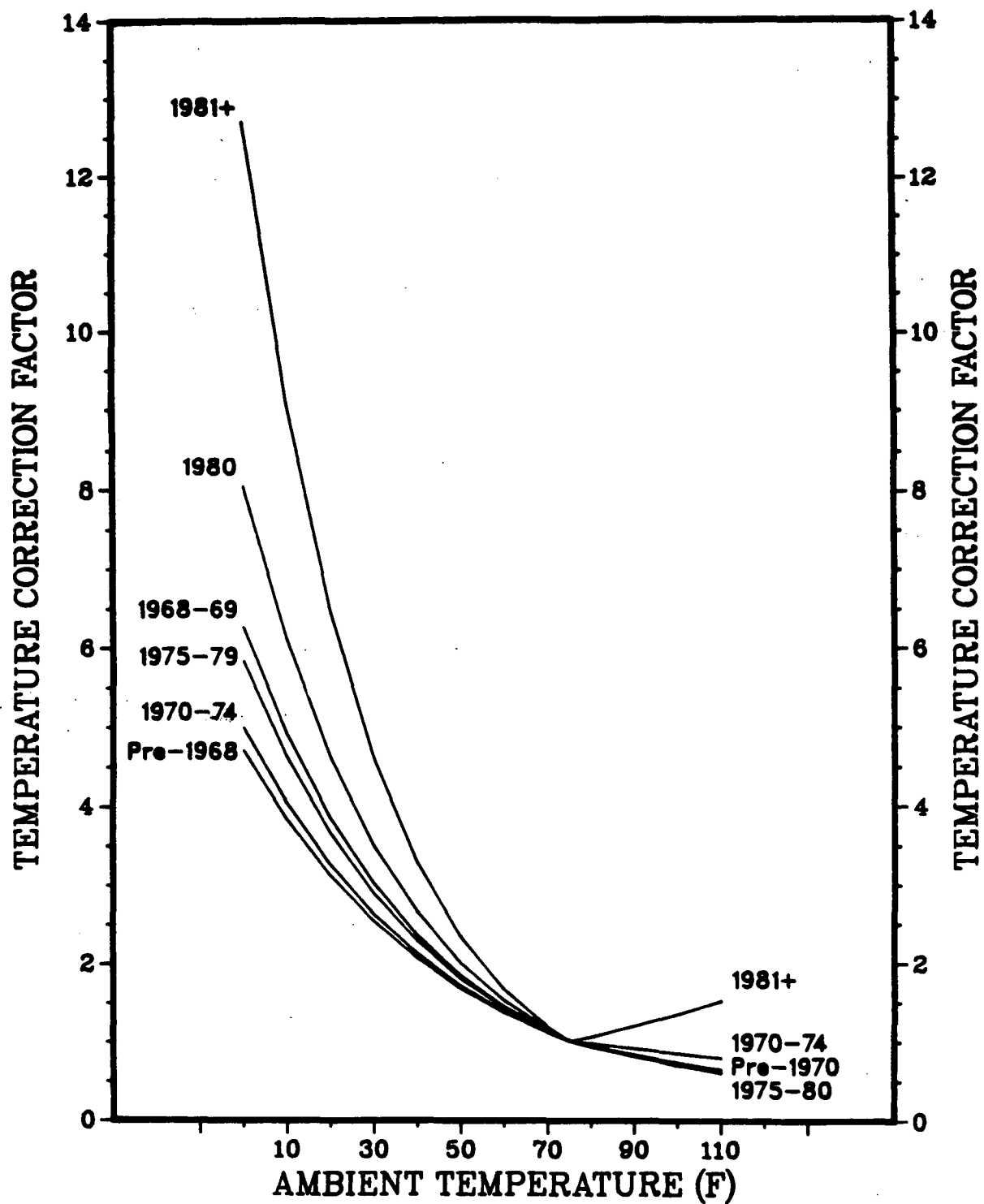


FIGURE 41

TEMPERATURE CORRECTION FACTORS  
LIGHT DUTY GASOLINE POWERED VEHICLES  
BAG 2 - HYDROCARBONS  
Low Altitude

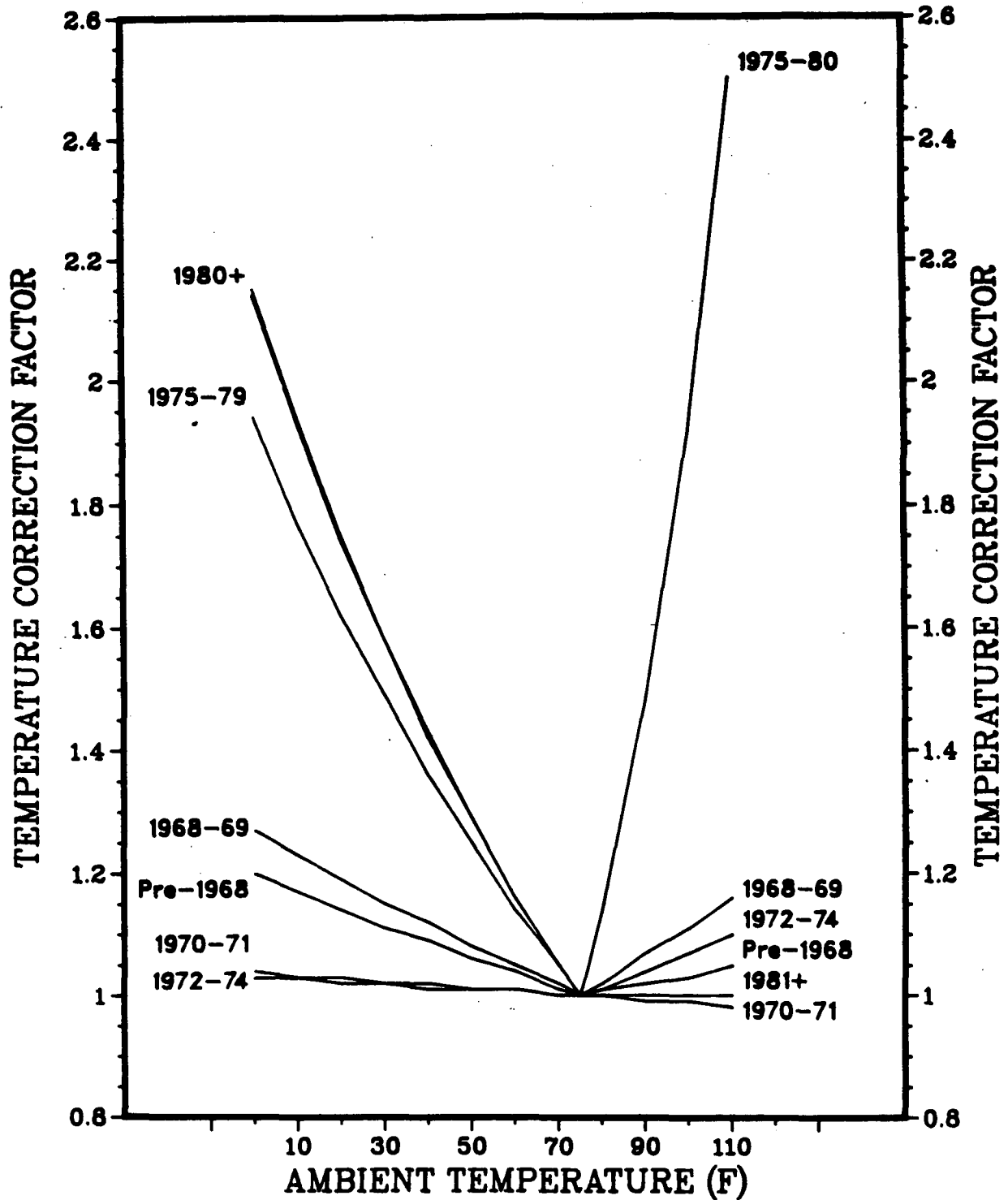


FIGURE 42

TEMPERATURE CORRECTION FACTORS  
LIGHT DUTY GASOLINE POWERED VEHICLES  
BAG 3 - HYDROCARBONS  
Low Altitude

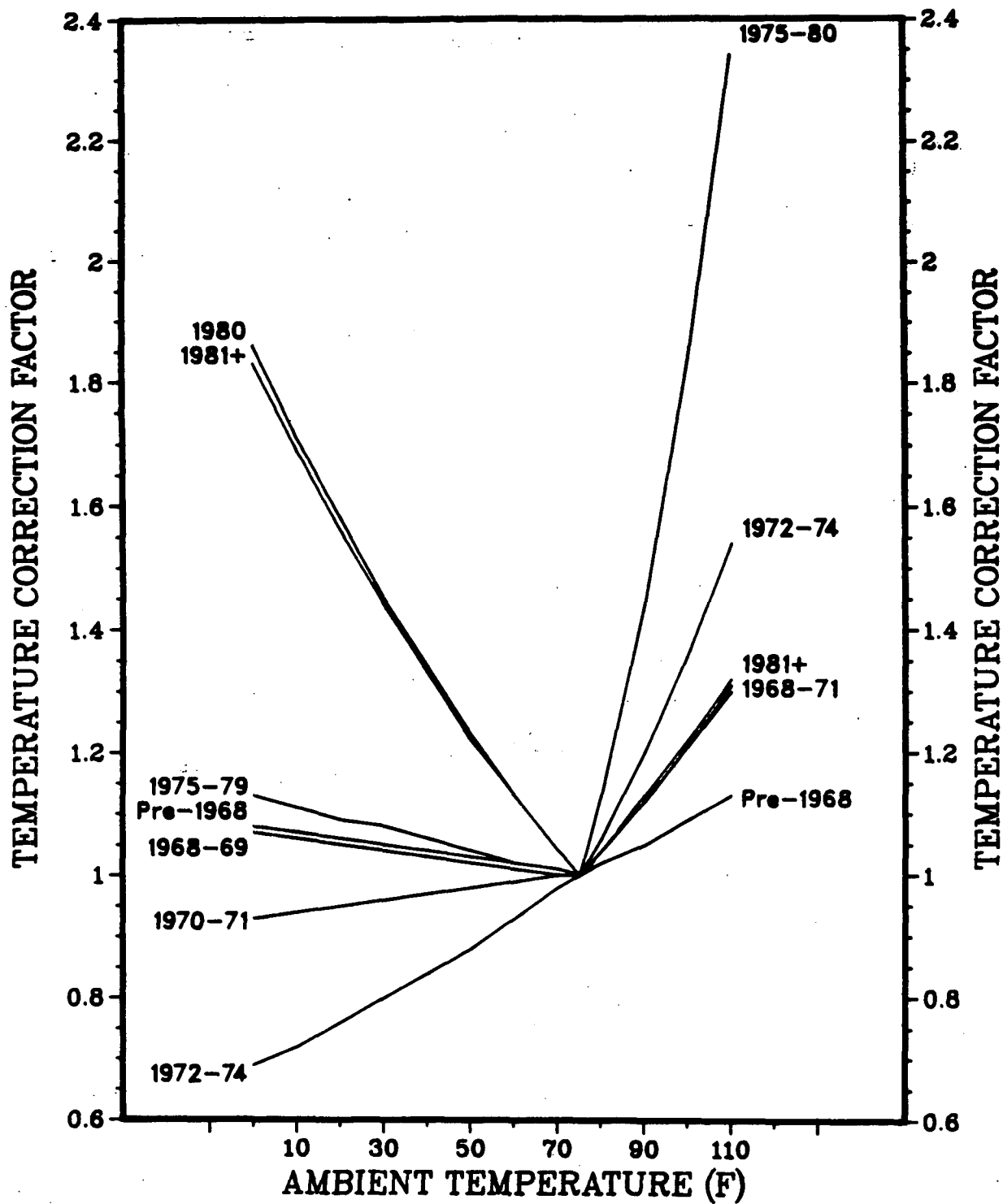


FIGURE 43

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

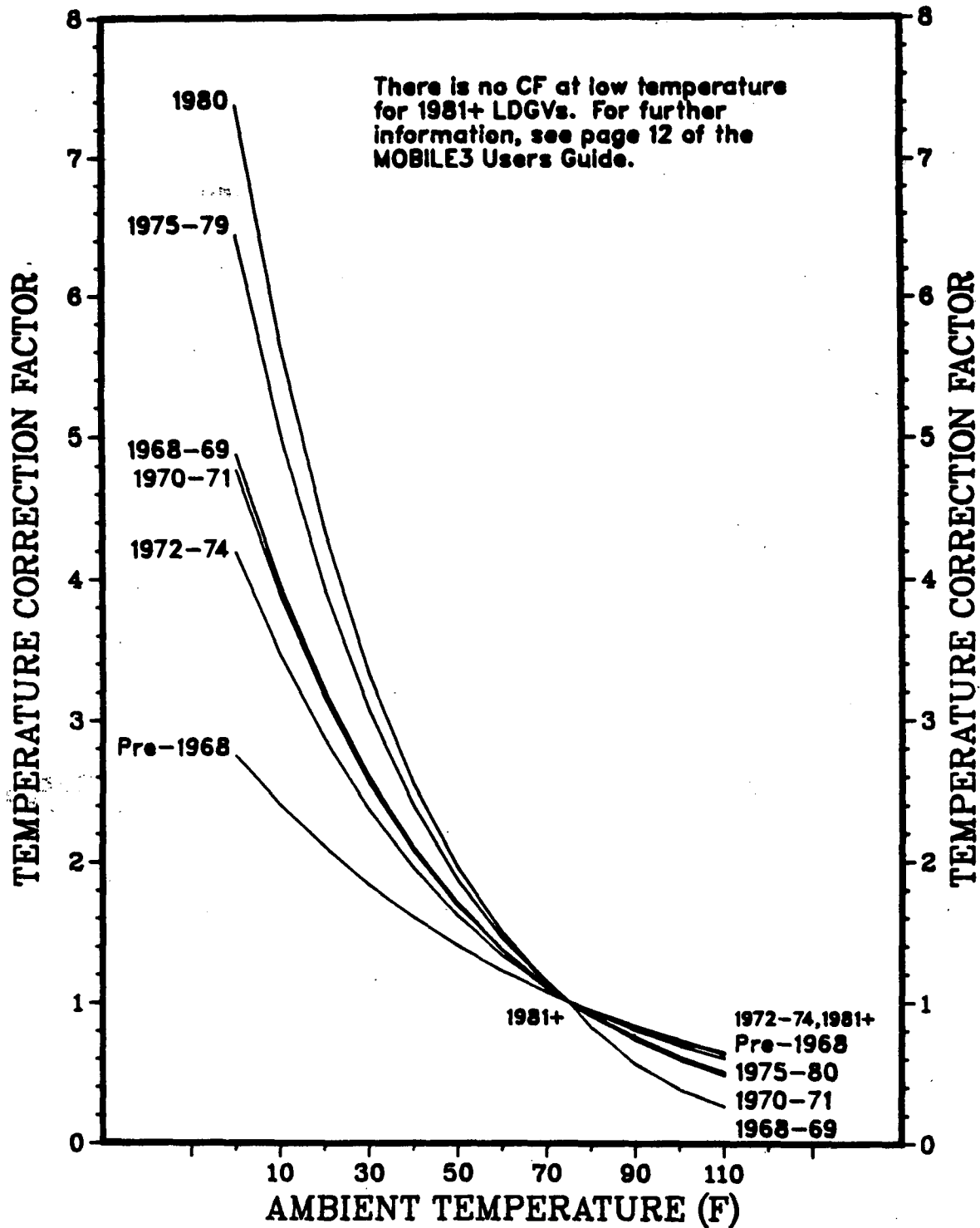


FIGURE 44

TEMPERATURE CORRECTION FACTORS  
LIGHT DUTY GASOLINE POWERED VEHICLES  
BAG 2 - CARBON MONOXIDE  
Low Altitude

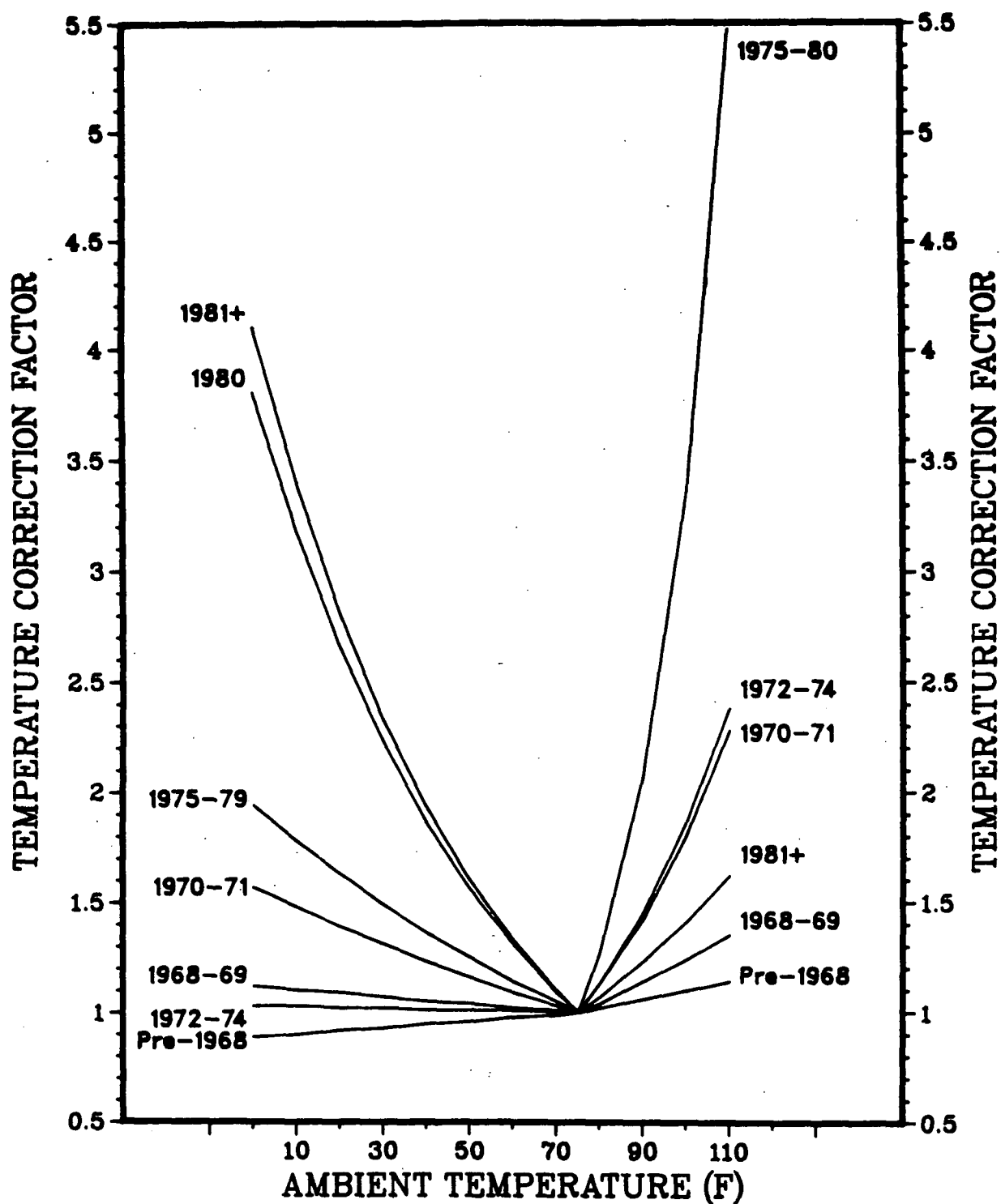


FIGURE 45

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

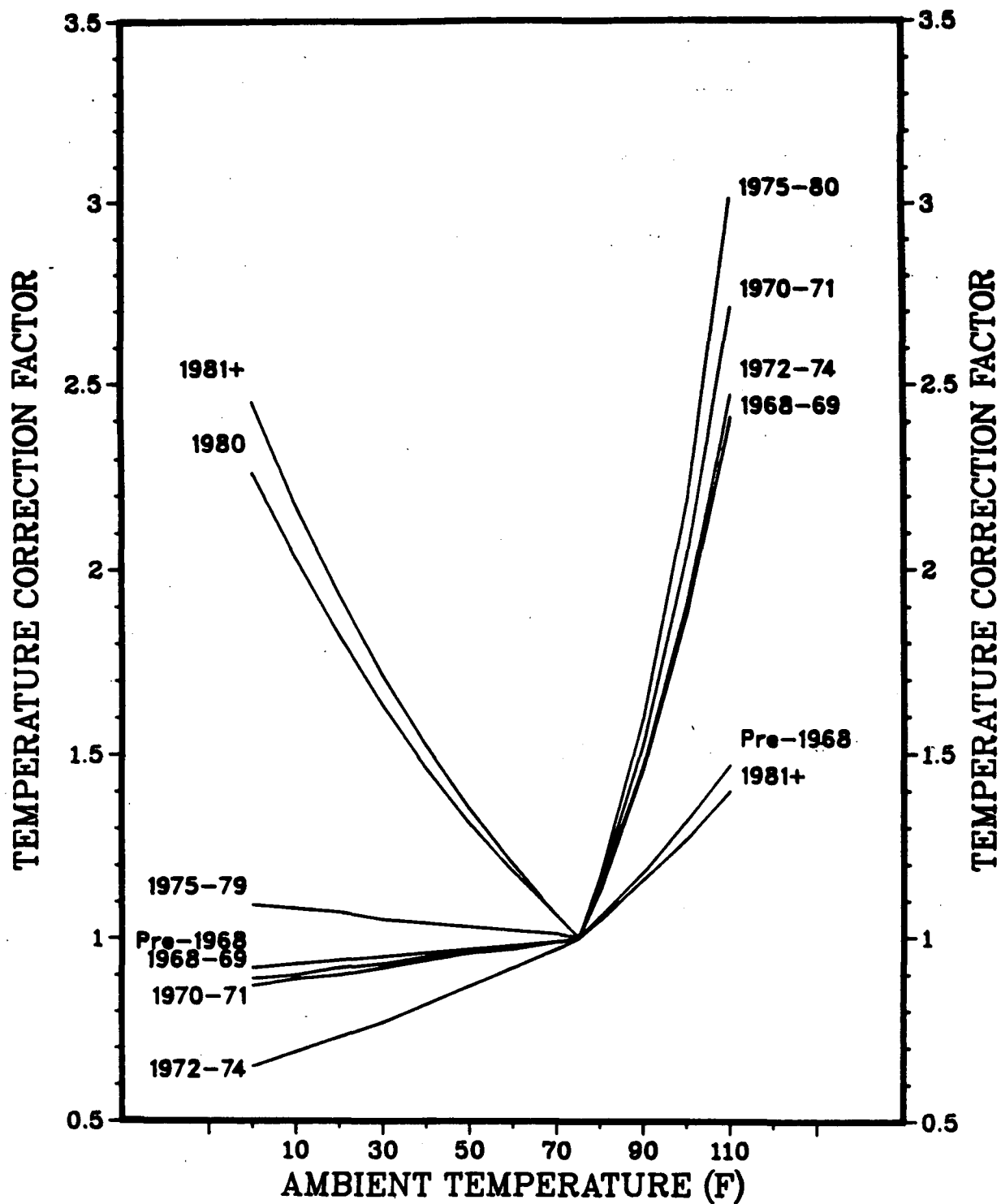


FIGURE 46

TEMPERATURE CORRECTION FACTORS  
LIGHT DUTY GASOLINE POWERED VEHICLES  
BAG 1 - OXIDES OF NITROGEN  
Low Altitude

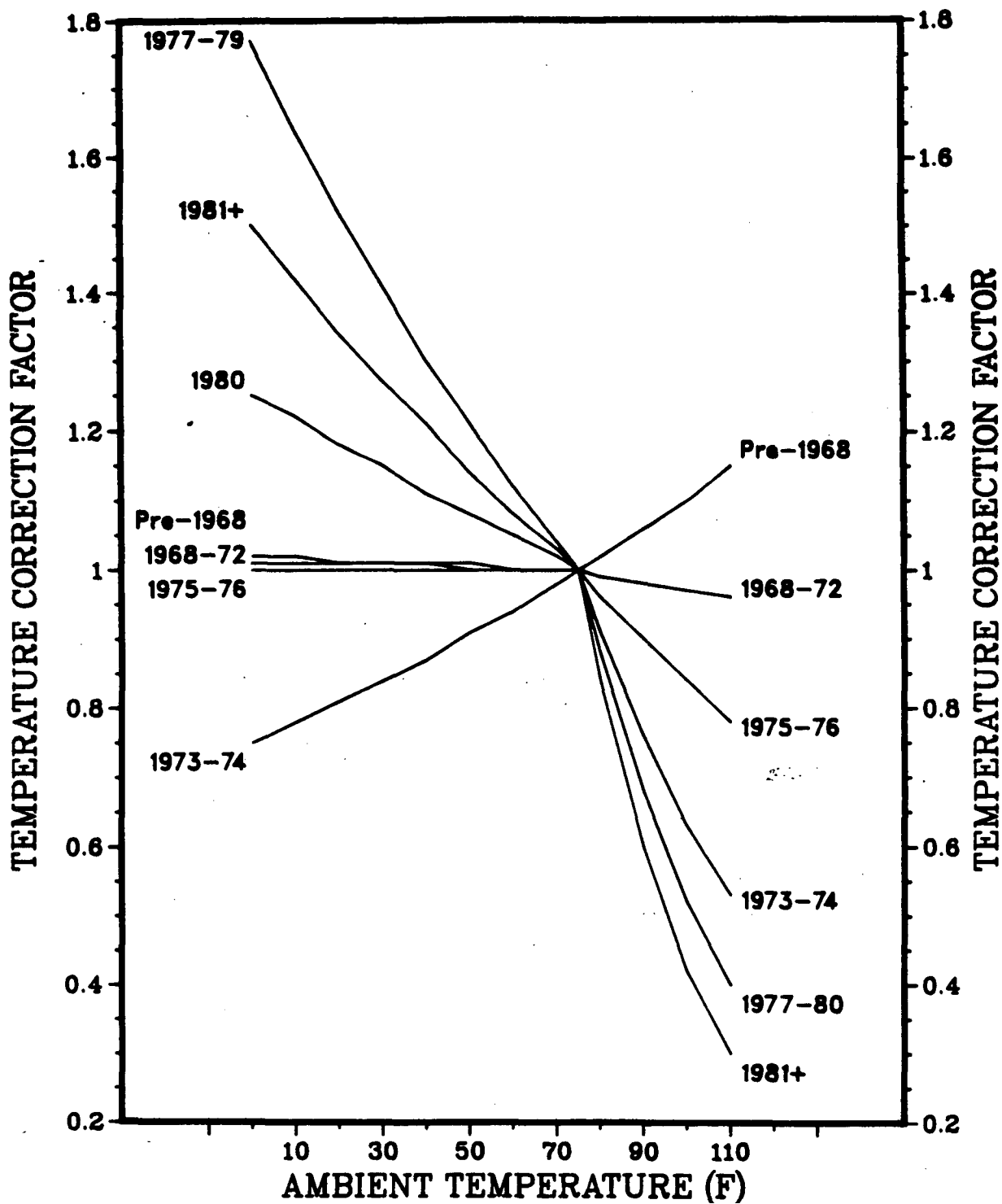


FIGURE 47

TEMPERATURE CORRECTION FACTORS  
LIGHT DUTY GASOLINE POWERED VEHICLES  
BAG 2 - OXIDES OF NITROGEN  
Low Altitude

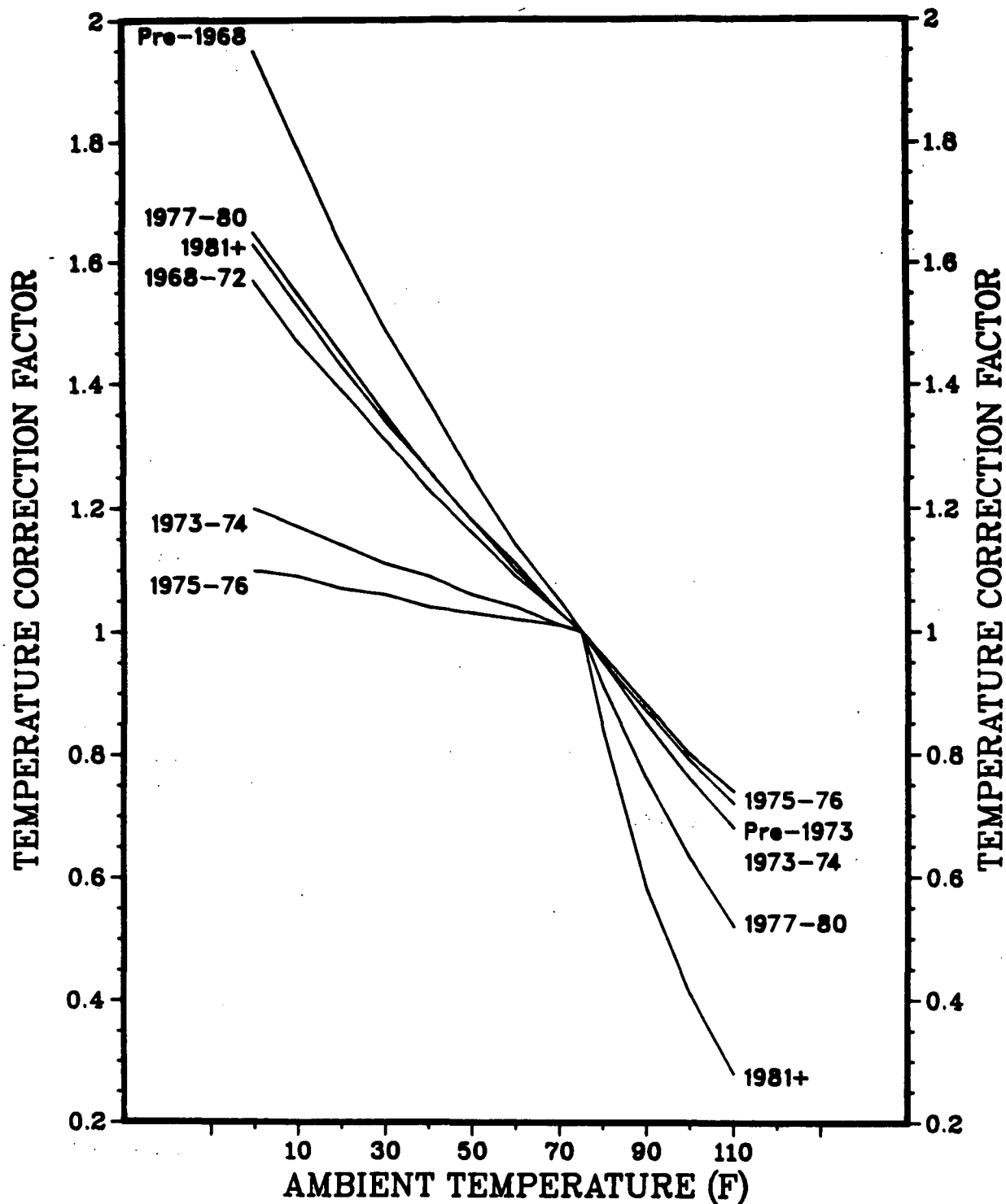




FIGURE 48

TEMPERATURE CORRECTION FACTORS  
LIGHT DUTY GASOLINE POWERED VEHICLES  
BAG 3 - OXIDES OF NITROGEN  
Low Altitude

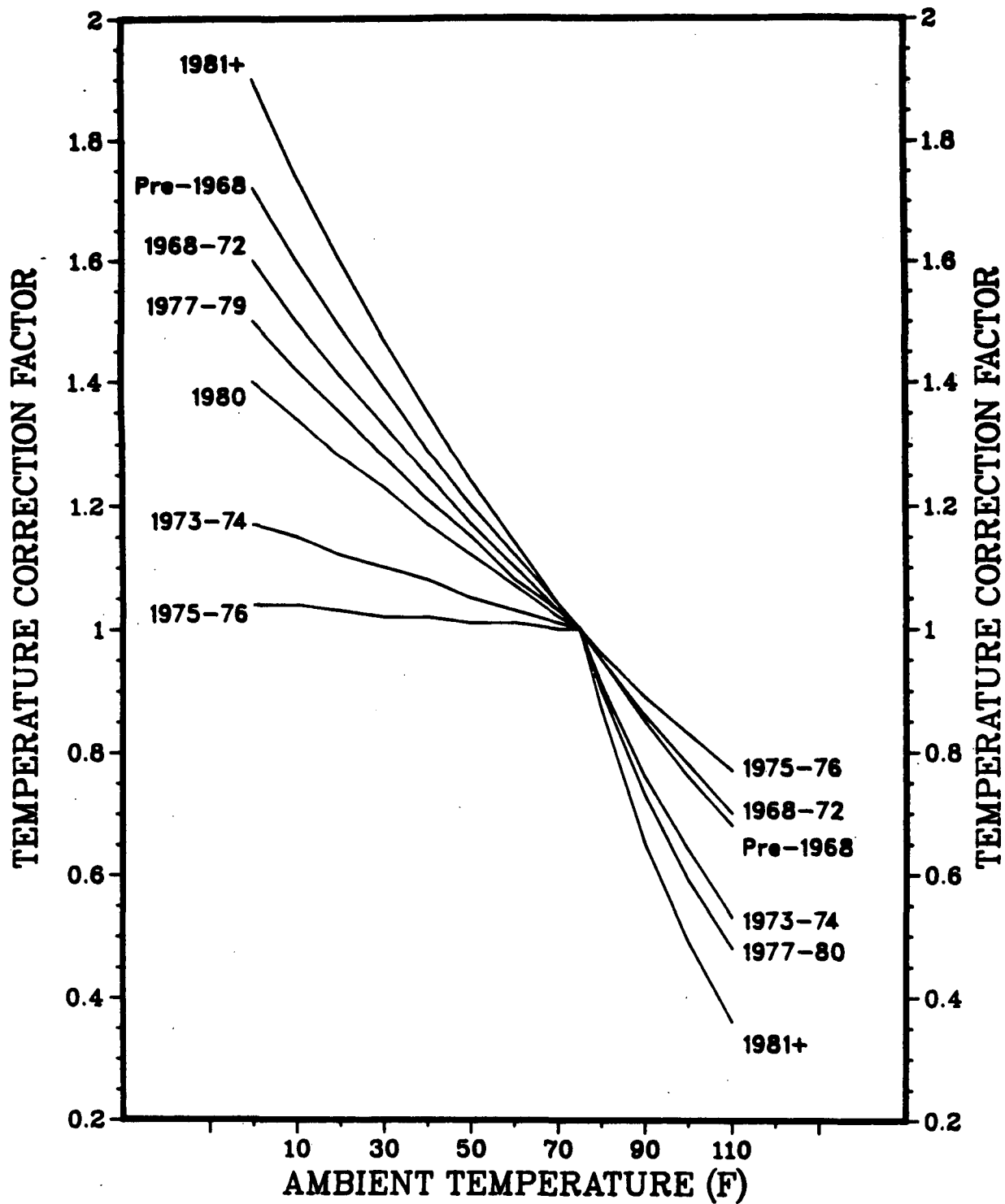


FIGURE 49

TEMPERATURE CORRECTION FACTORS  
LIGHT DUTY GASOLINE POWERED TRUCKS I  
BAG 1 - HYDROCARBONS  
Low Altitude

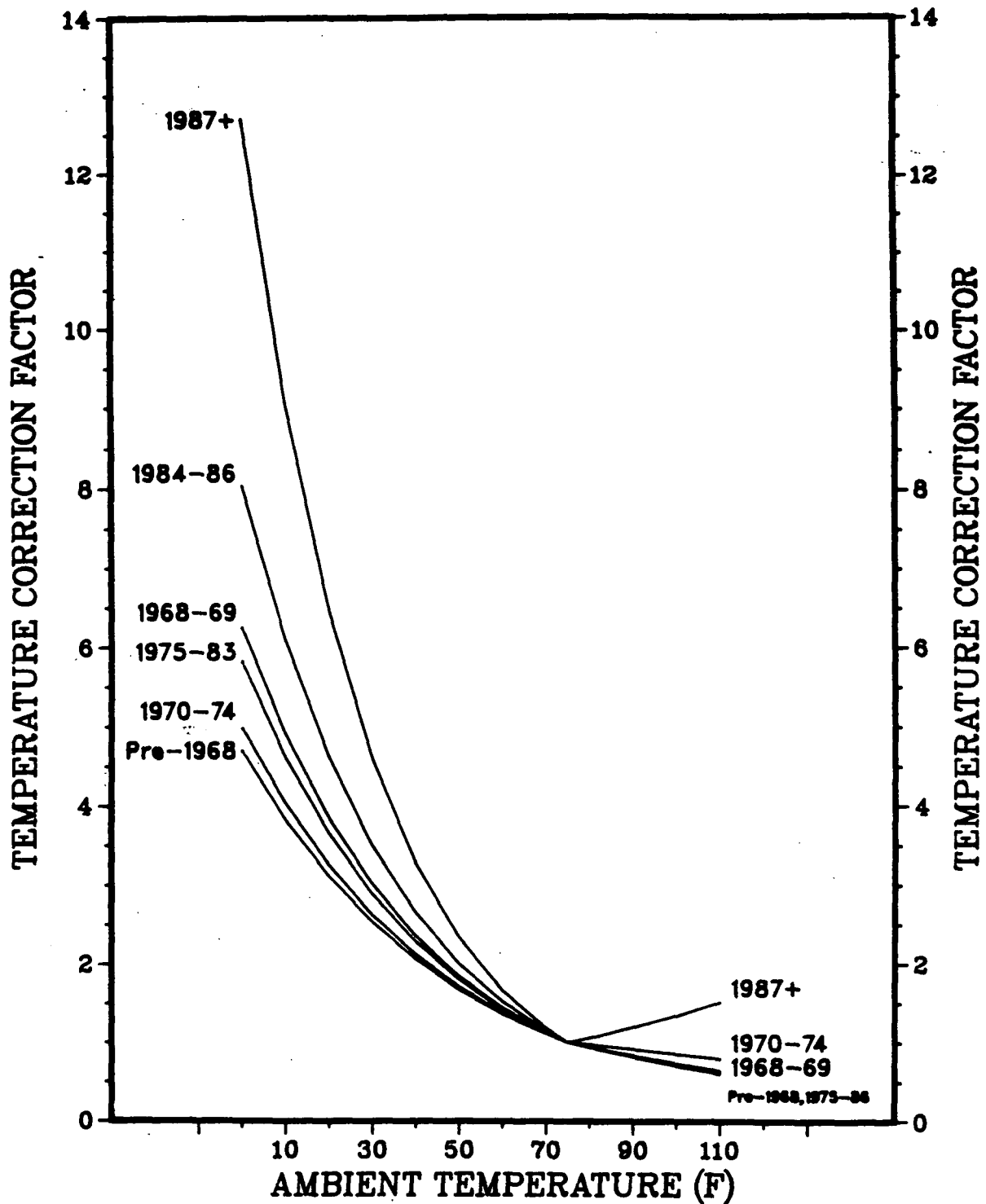
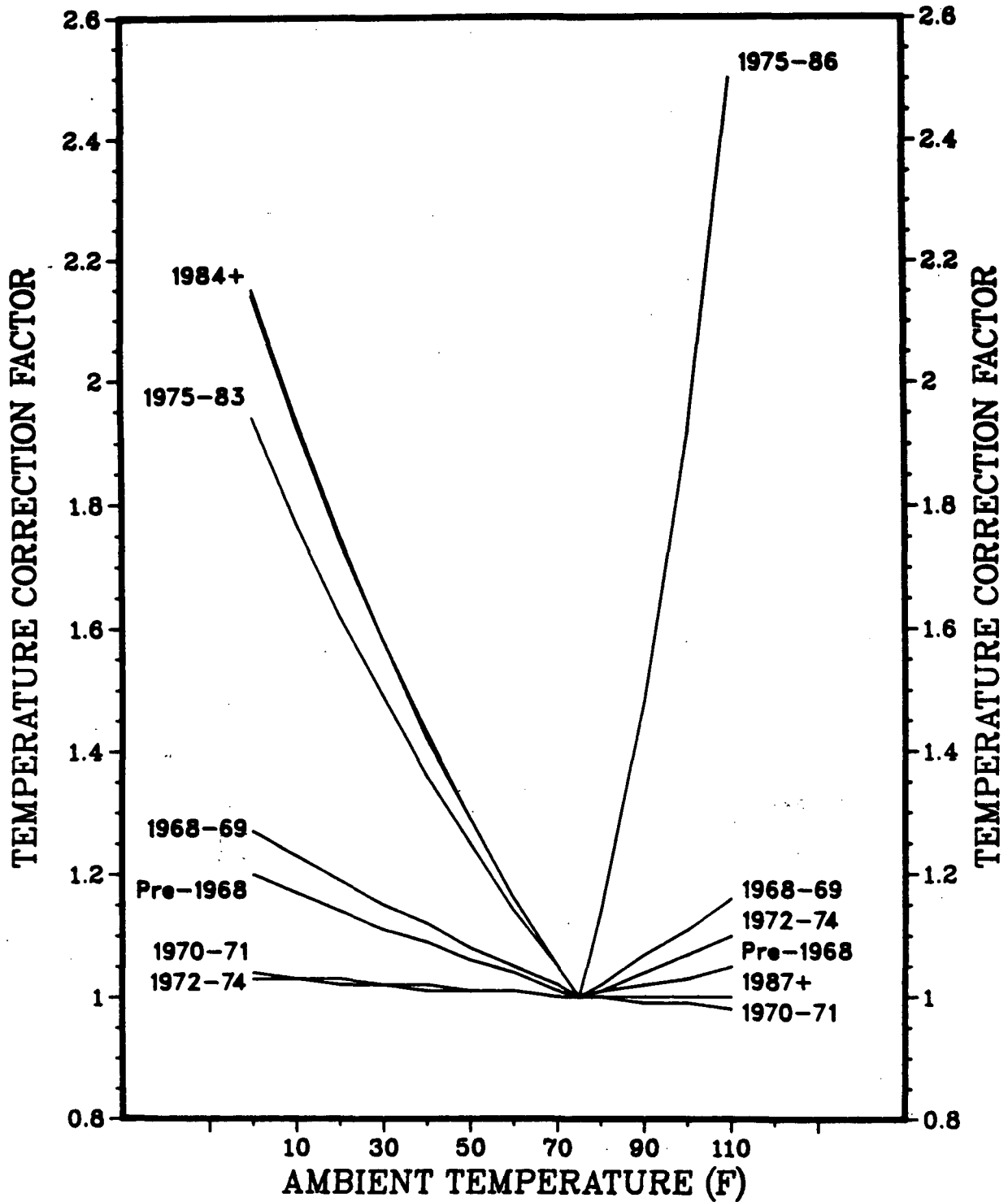


FIGURE 50

TEMPERATURE CORRECTION FACTORS  
LIGHT DUTY GASOLINE POWERED TRUCKS I  
BAG 2 - HYDROCARBONS  
Low Altitude



TEMPERATURE CORRECTION FACTORS  
LIGHT DUTY GASOLINE POWERED TRUCKS I  
BAG 3 - HYDROCARBONS  
Low Altitude

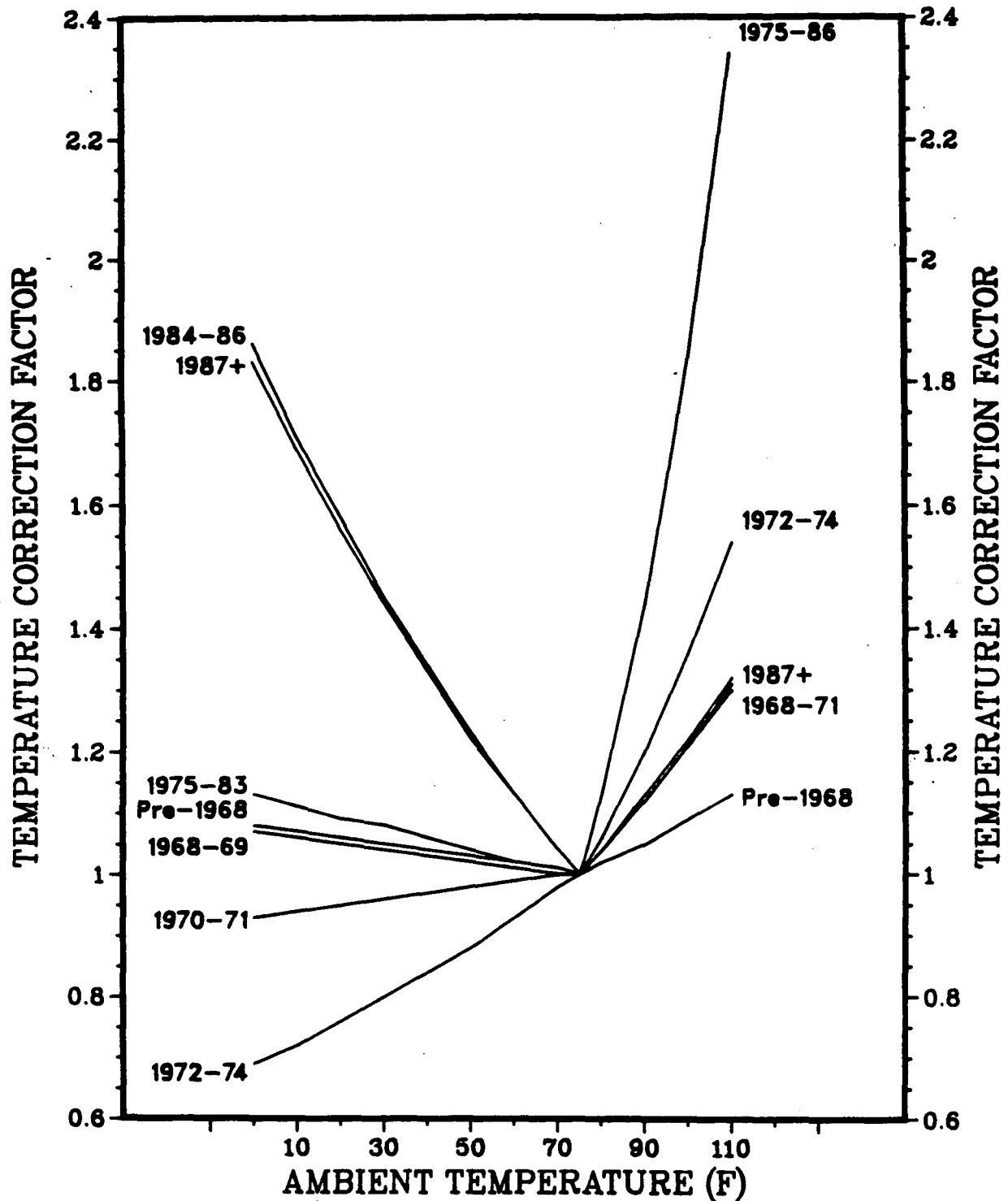


FIGURE 52

TEMPERATURE CORRECTION FACTORS  
LIGHT DUTY GASOLINE POWERED TRUCKS I  
BAG 1 - CARBON MONOXIDE  
Low Altitude

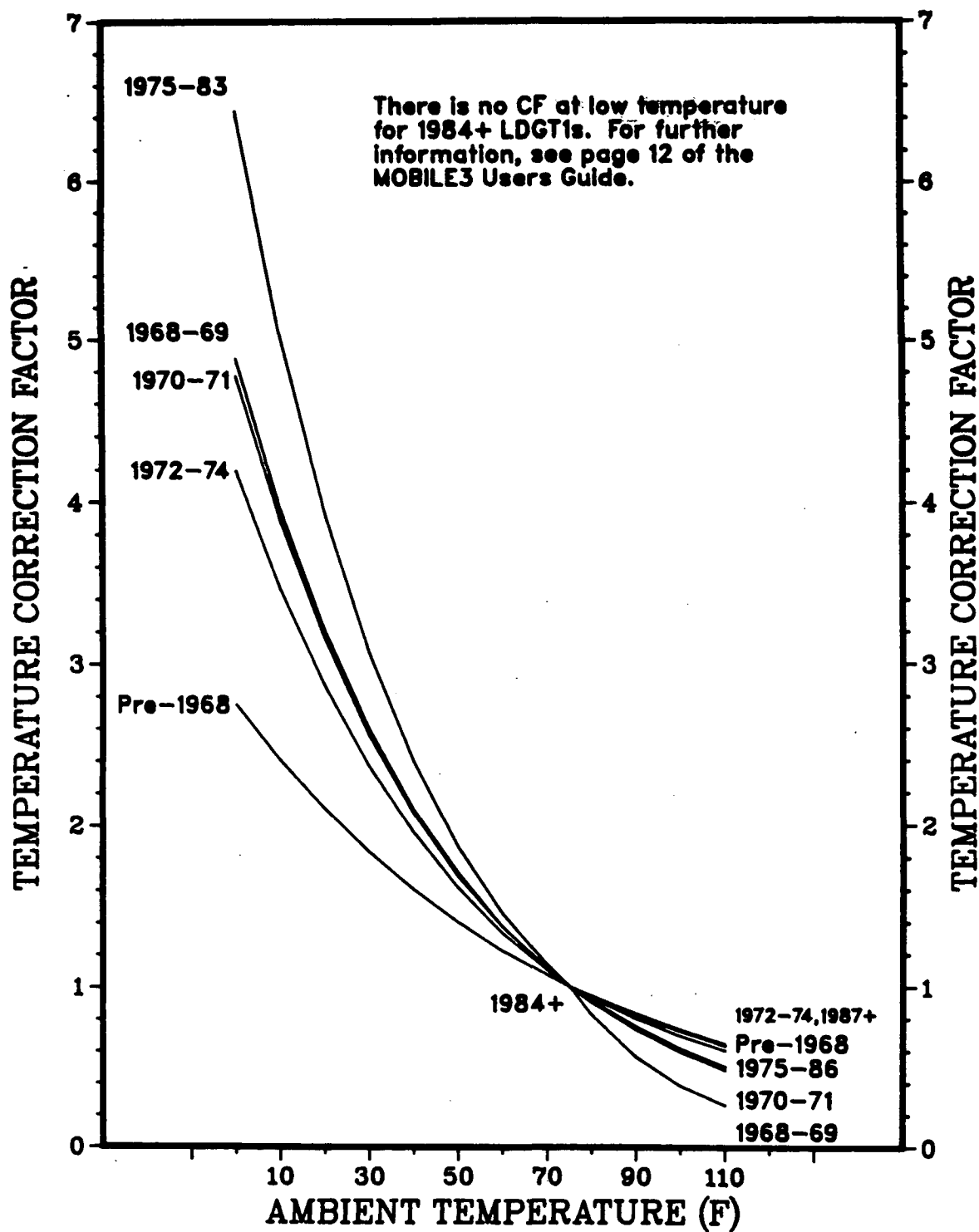


FIGURE 53

TEMPERATURE CORRECTION FACTORS  
LIGHT DUTY GASOLINE POWERED TRUCKS I  
BAG 2 - CARBON MONOXIDE  
Low Altitude

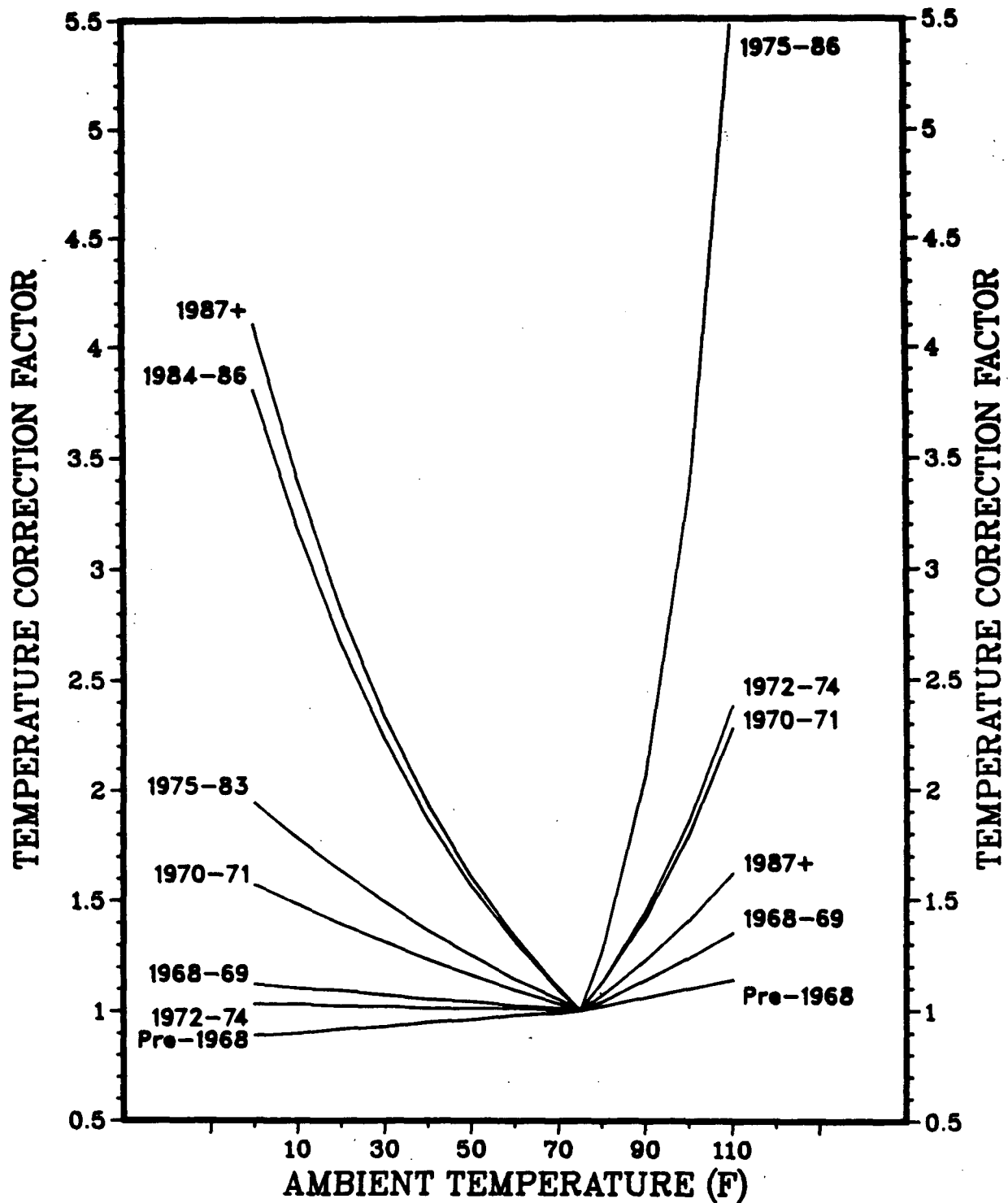


FIGURE 54

TEMPERATURE CORRECTION FACTORS  
LIGHT DUTY GASOLINE POWERED TRUCKS I  
BAG 3 - CARBON MONOXIDE  
Low Altitude

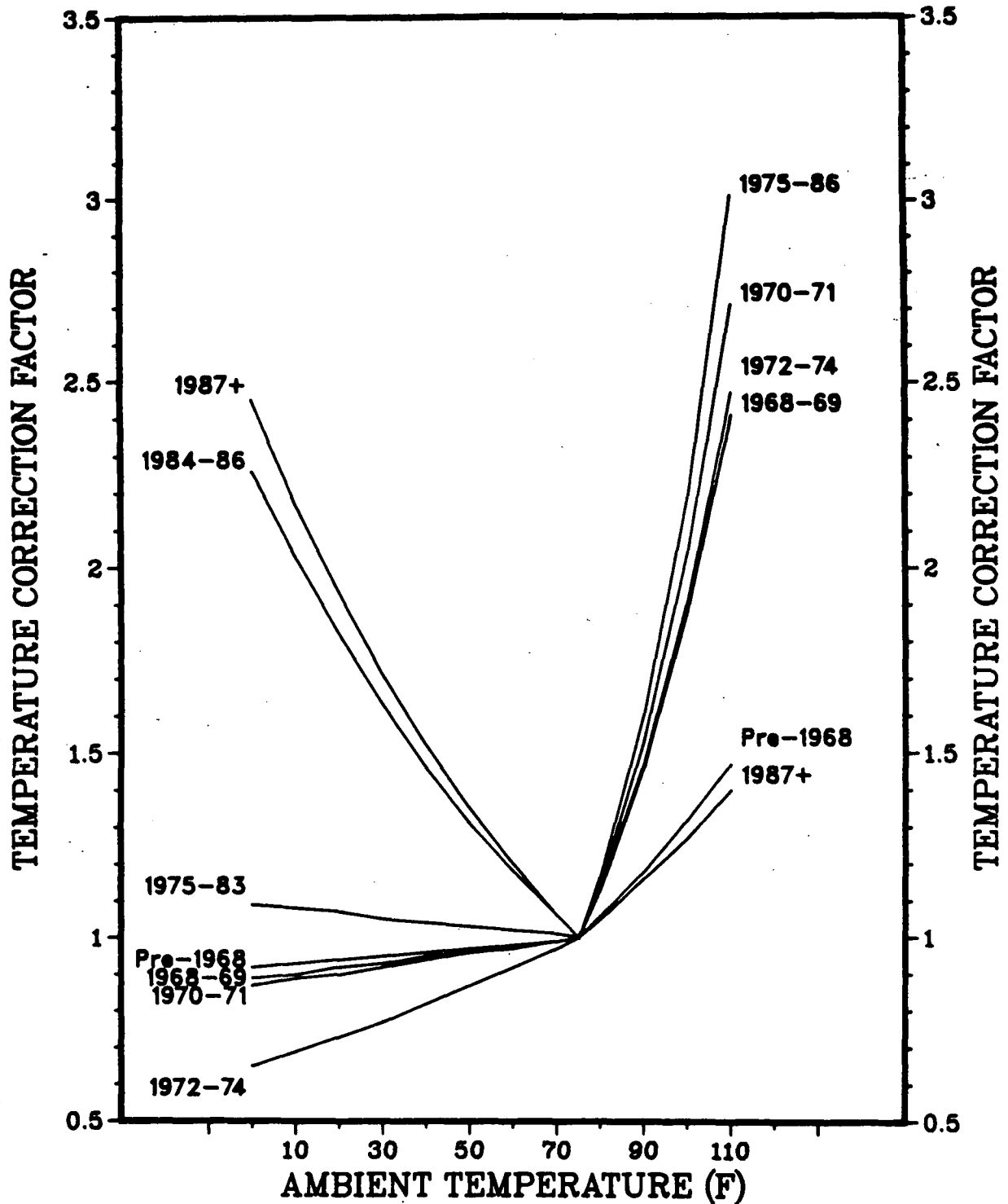


FIGURE 55

TEMPERATURE CORRECTION FACTORS  
LIGHT DUTY GASOLINE POWERED TRUCKS I  
BAG 1 - OXIDES OF NITROGEN  
Low Altitude

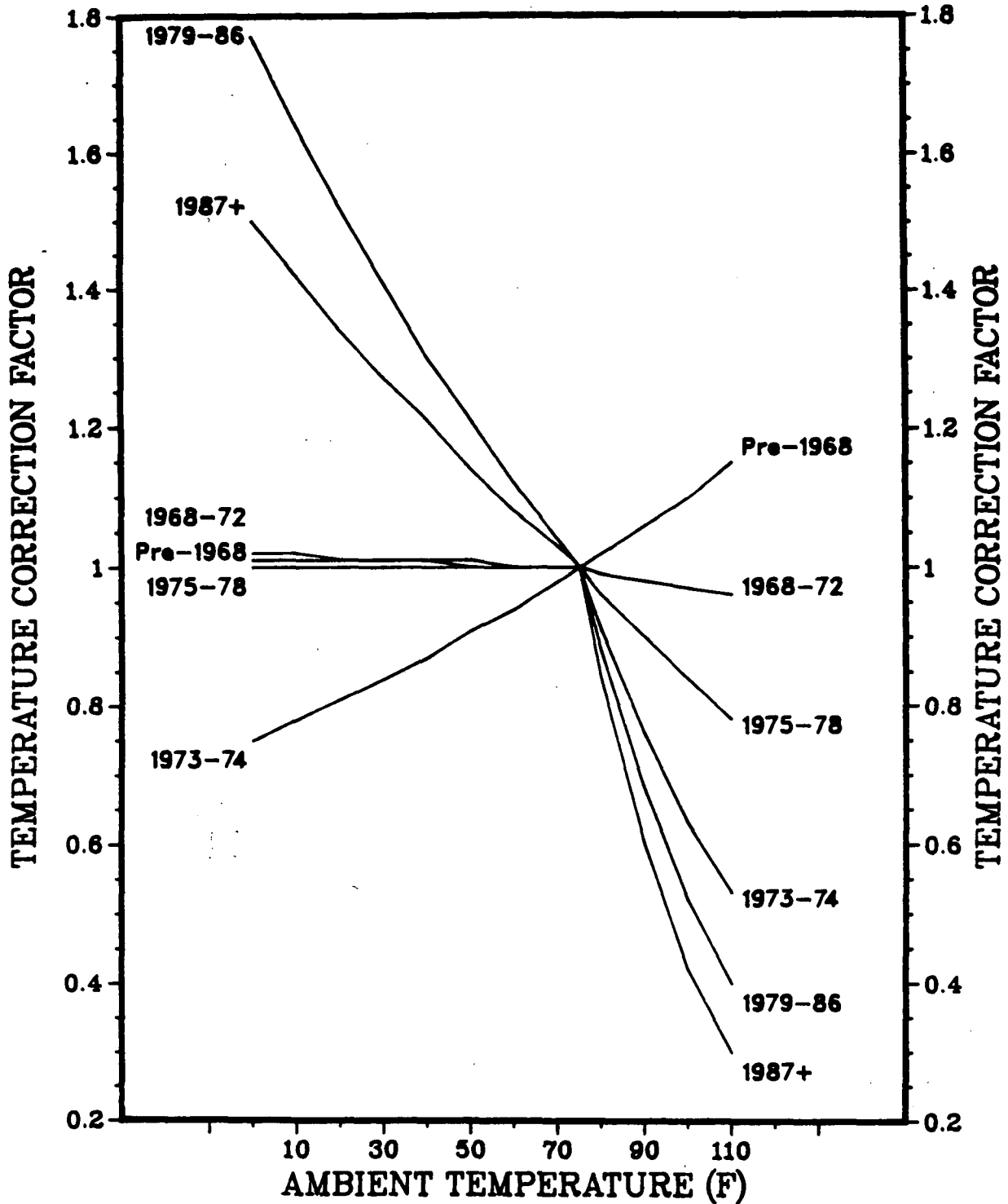




FIGURE 56

TEMPERATURE CORRECTION FACTORS  
LIGHT DUTY GASOLINE POWERED TRUCKS I  
BAG 2 - OXIDES OF NITROGEN  
Low Altitude

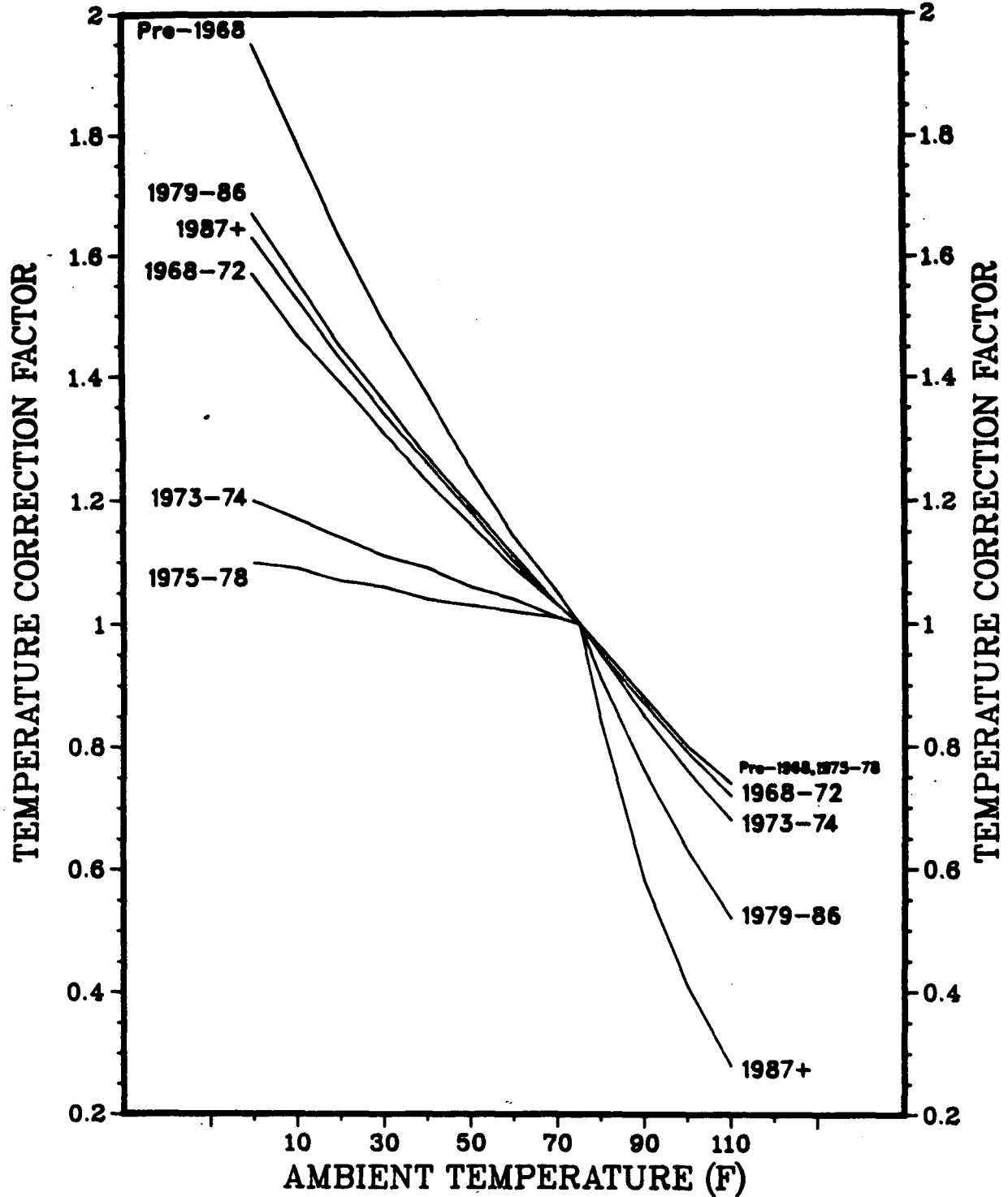


FIGURE 57

TEMPERATURE CORRECTION FACTORS  
LIGHT DUTY GASOLINE POWERED TRUCKS I  
BAG 3 - OXIDES OF NITROGEN  
Low Altitude

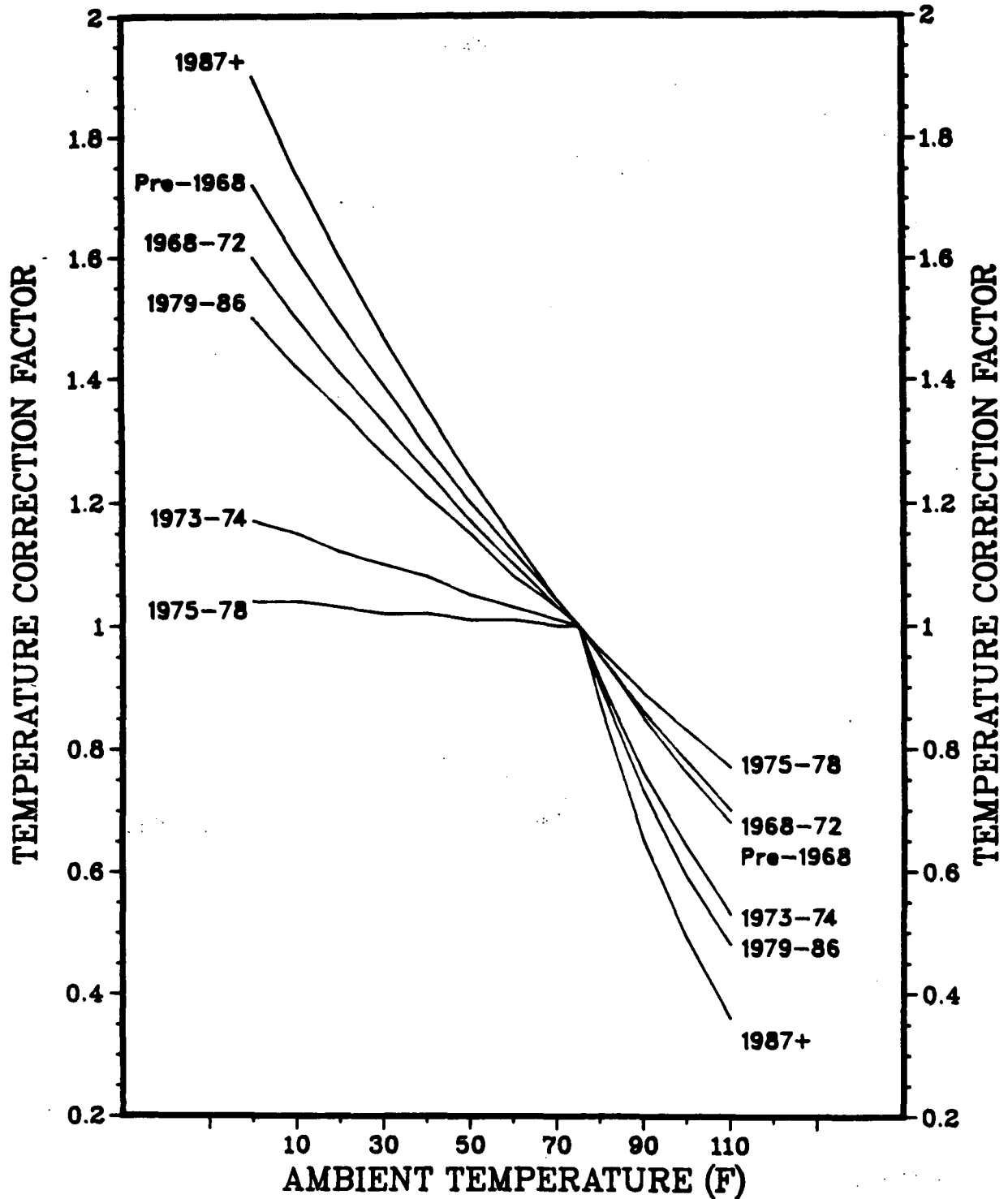


FIGURE 58

TEMPERATURE CORRECTION FACTORS  
LIGHT DUTY GASOLINE POWERED TRUCKS II  
BAG 1 - HYDROCARBONS  
Low Altitude

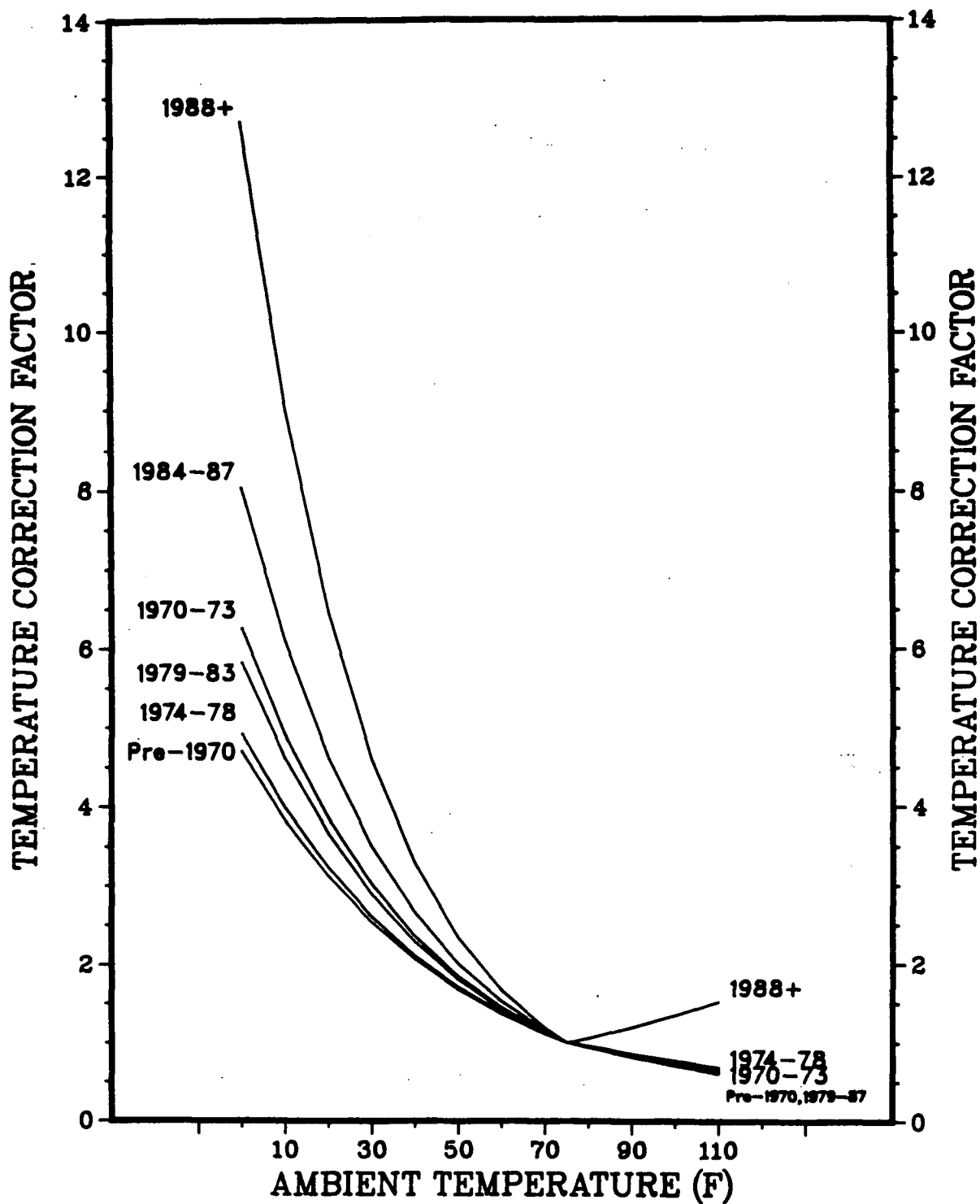


FIGURE 59

TEMPERATURE CORRECTION FACTORS  
LIGHT DUTY GASOLINE POWERED TRUCKS II  
BAG 2 - HYDROCARBONS  
Low Altitude

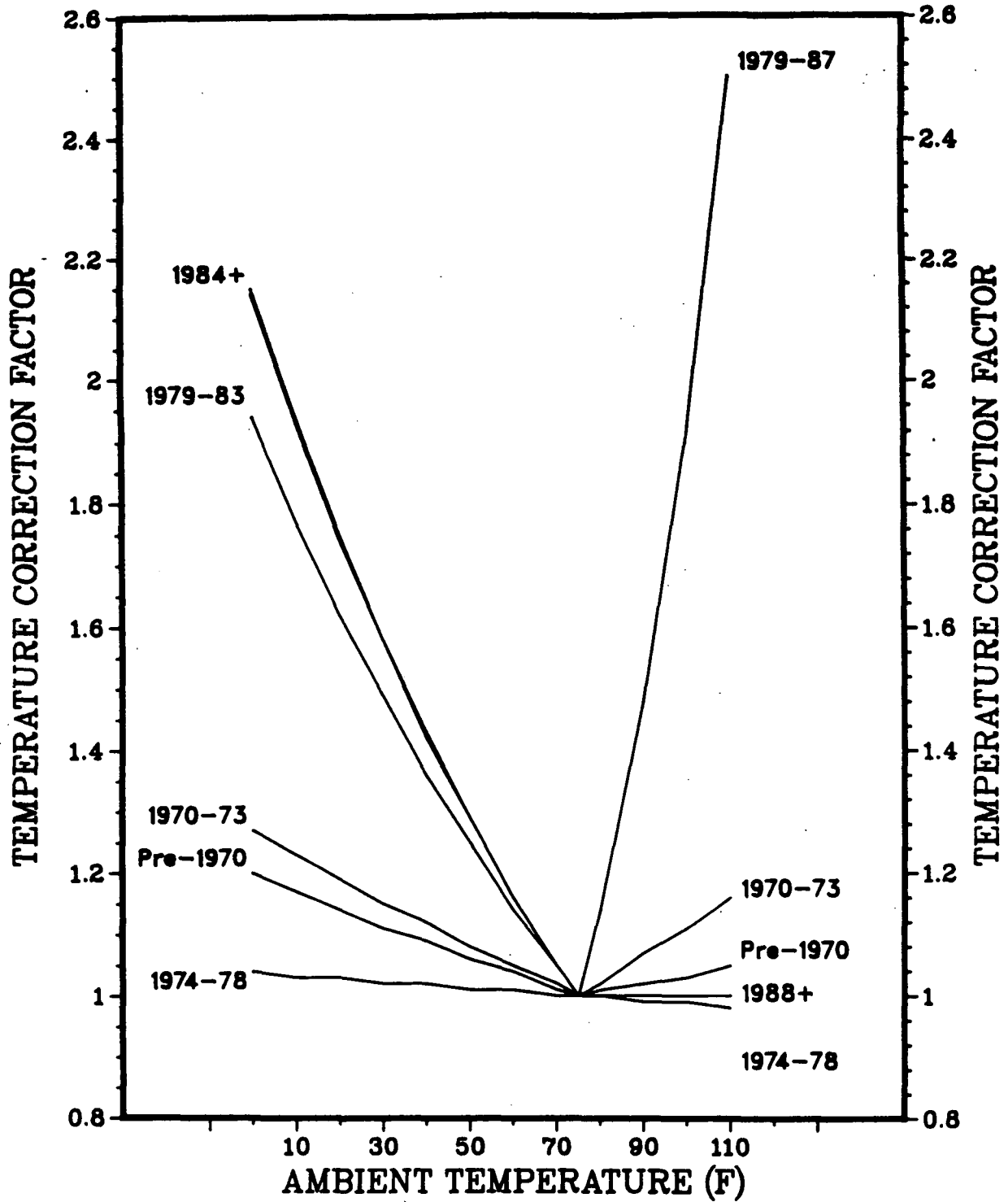


FIGURE 60

TEMPERATURE CORRECTION FACTORS  
LIGHT DUTY GASOLINE POWERED TRUCKS II  
BAG 3 - HYDROCARBONS  
Low Altitude

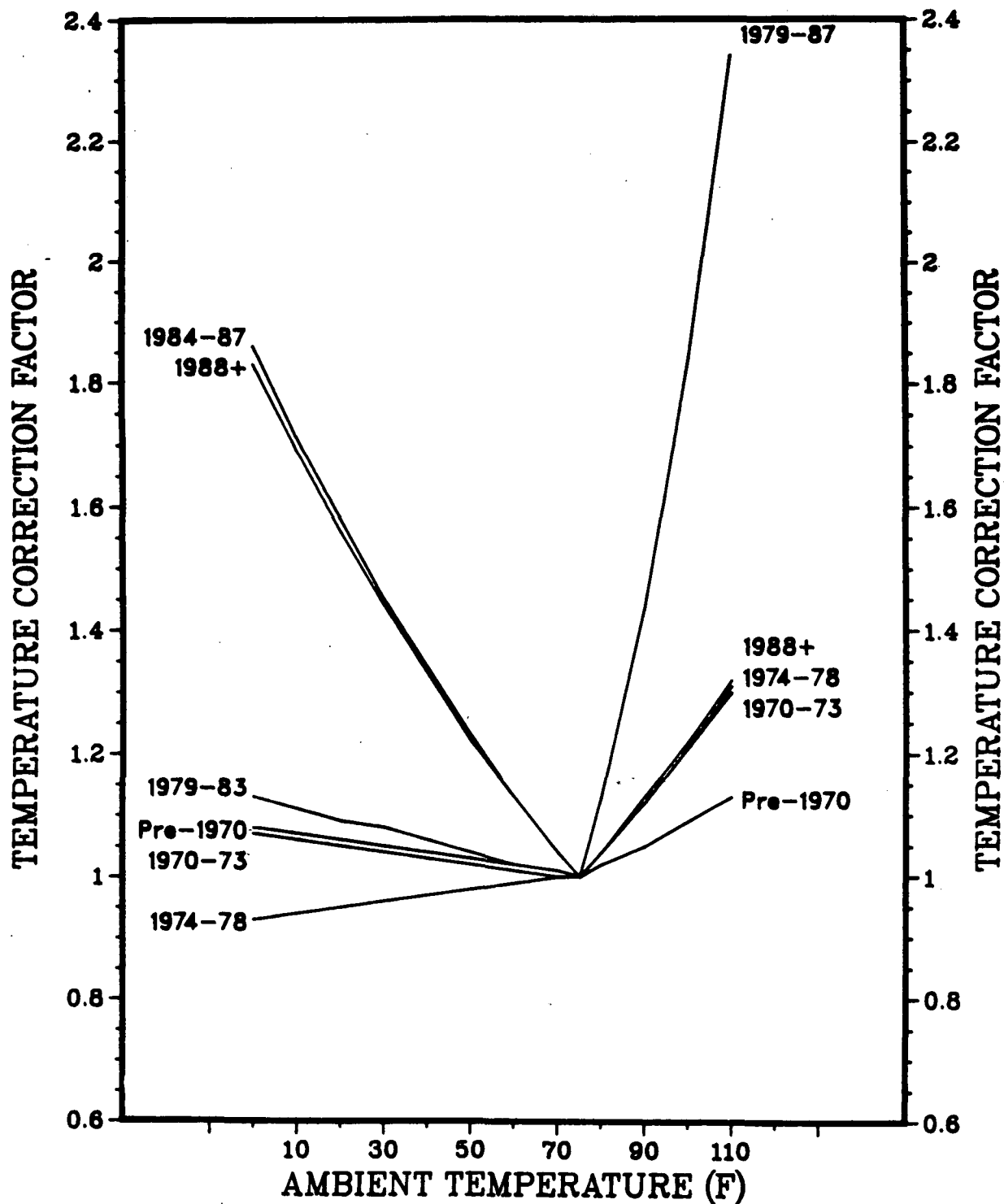
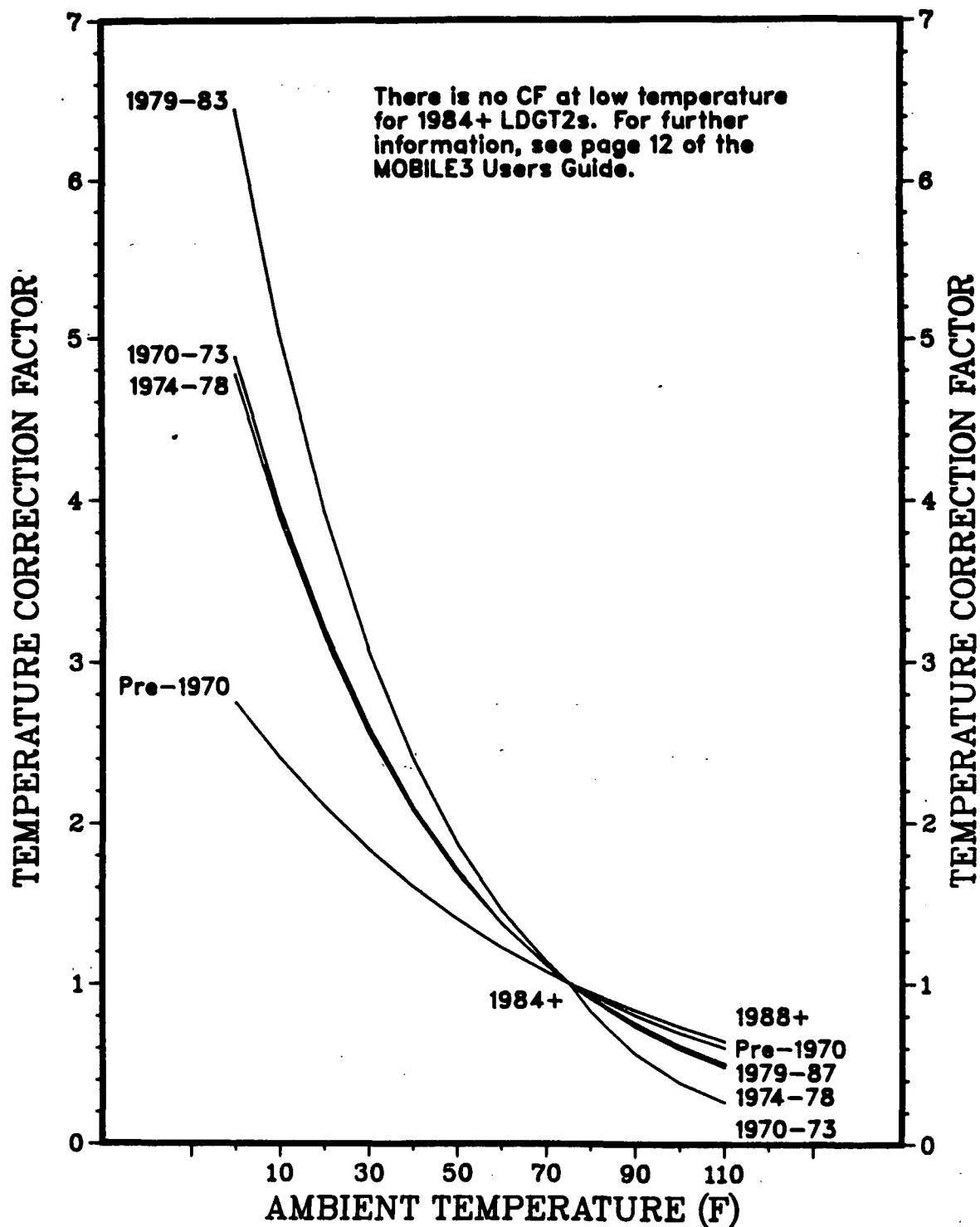


FIGURE 61

TEMPERATURE CORRECTION FACTORS  
LIGHT DUTY GASOLINE POWERED TRUCKS II  
BAG 1 - CARBON MONOXIDE  
Low Altitude



**TEMPERATURE CORRECTION FACTORS  
LIGHT DUTY GASOLINE POWERED TRUCKS II  
BAG 2 - CARBON MONOXIDE  
Low Altitude**

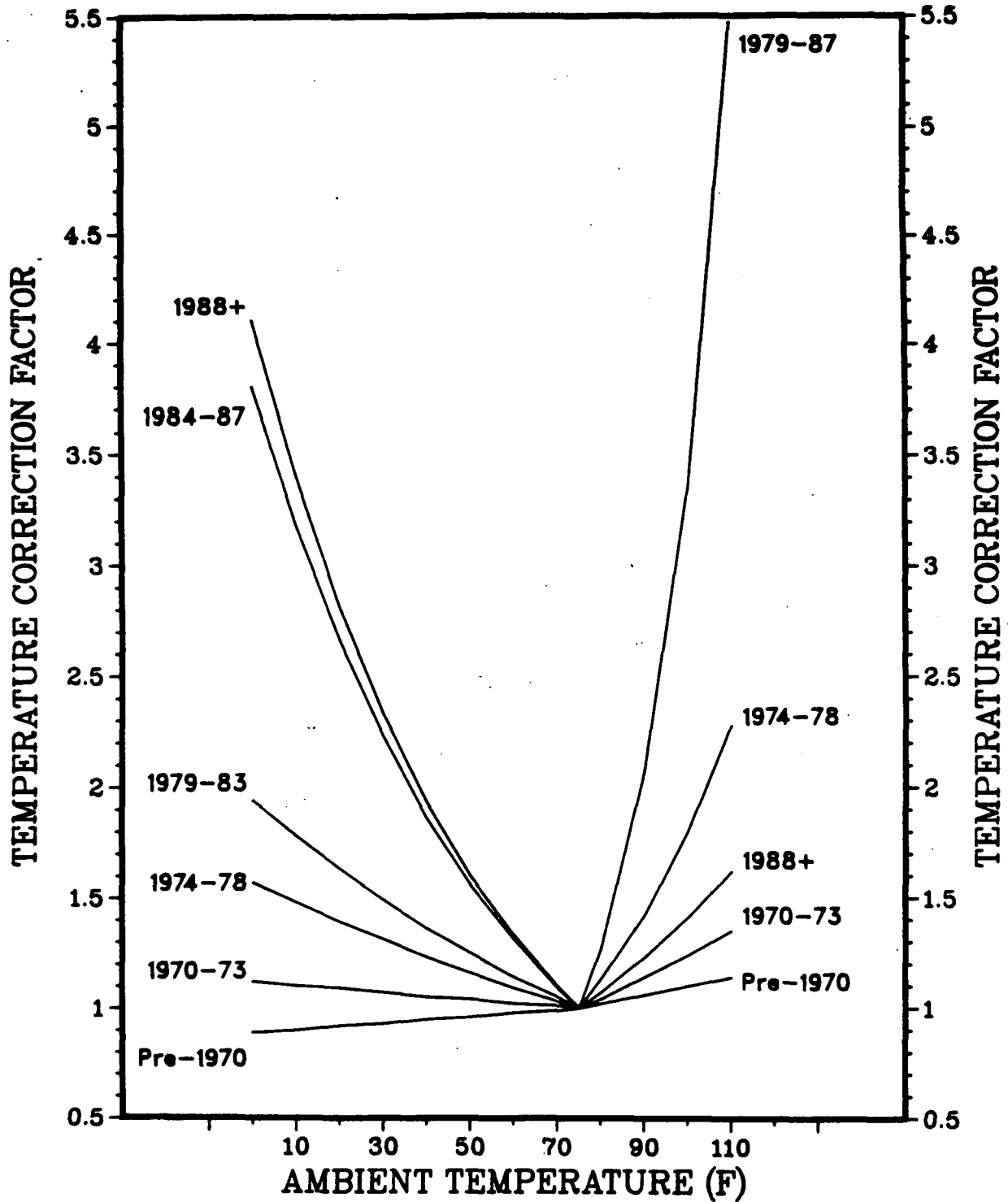
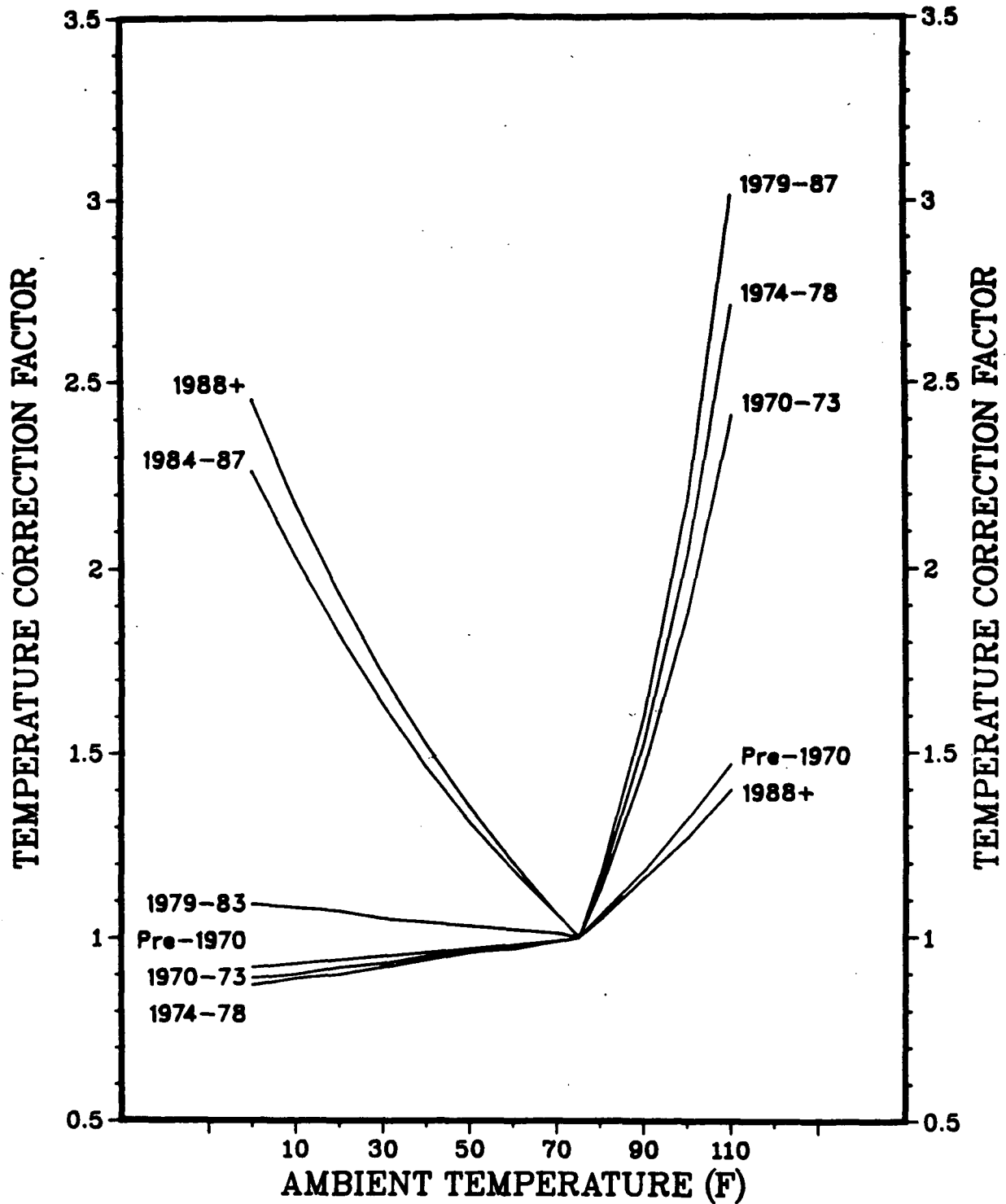


FIGURE 63

TEMPERATURE CORRECTION FACTORS  
LIGHT DUTY GASOLINE POWERED TRUCKS II  
BAG 3 - CARBON MONOXIDE  
Low Altitude





TEMPERATURE CORRECTION FACTORS  
LIGHT DUTY GASOLINE POWERED TRUCKS II  
BAG 1 - OXIDES OF NITROGEN  
Low Altitude

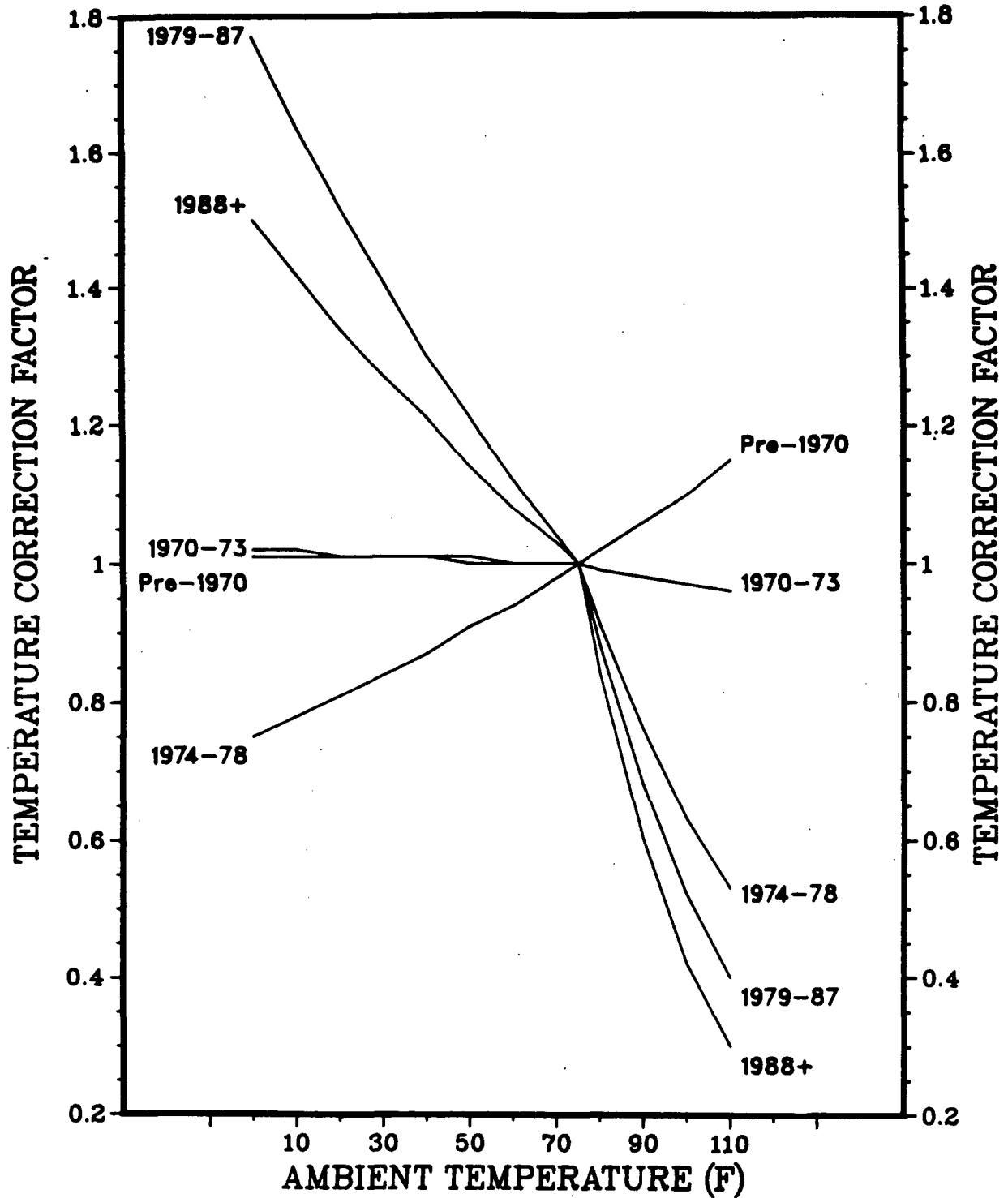


FIGURE 65

TEMPERATURE CORRECTION FACTORS  
LIGHT DUTY GASOLINE POWERED TRUCKS II  
BAG 2 - OXIDES OF NITROGEN  
Low Altitude

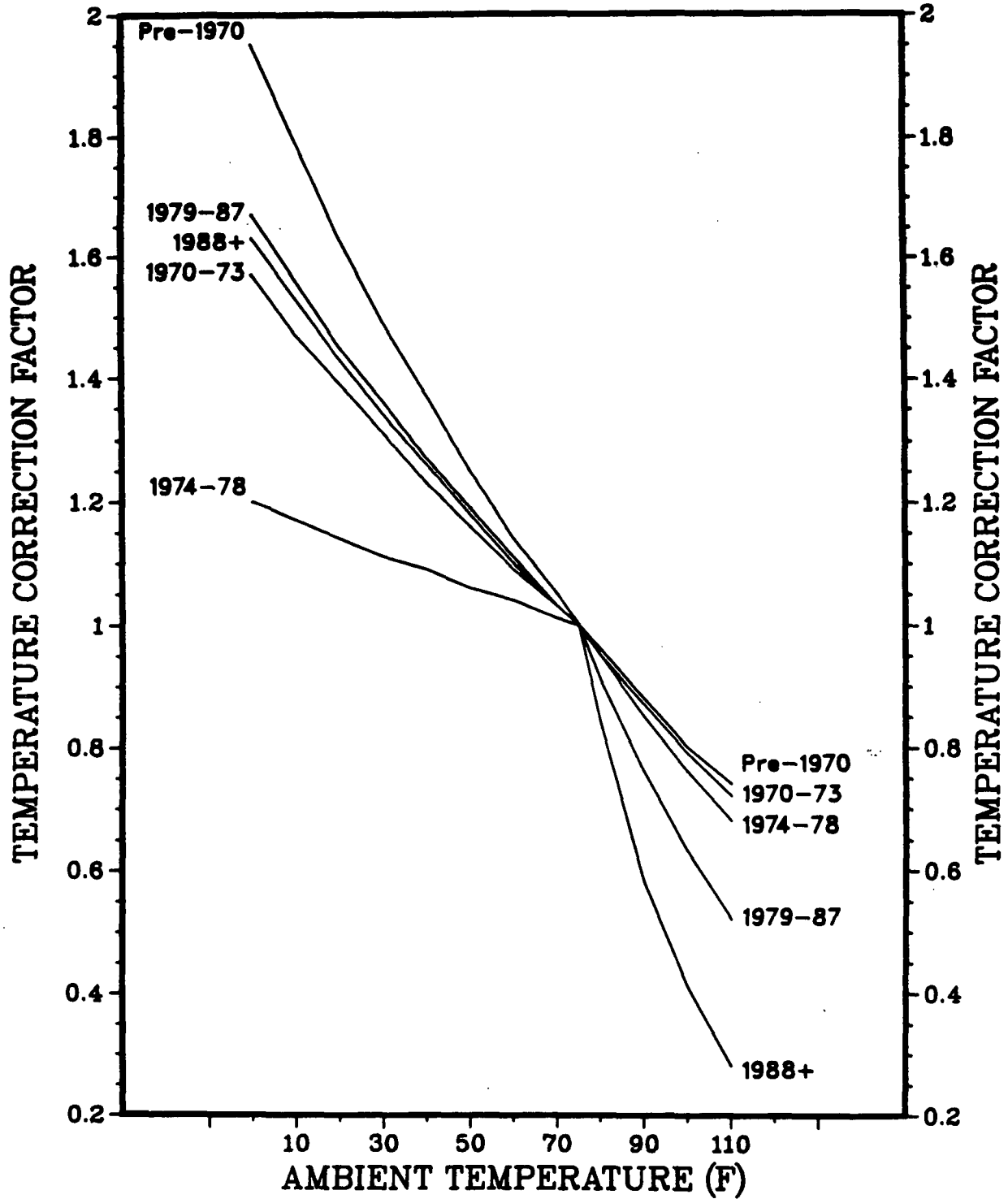


FIGURE 66

TEMPERATURE CORRECTION FACTORS  
LIGHT DUTY GASOLINE POWERED TRUCKS II  
BAG 3 - OXIDES OF NITROGEN  
Low Altitude

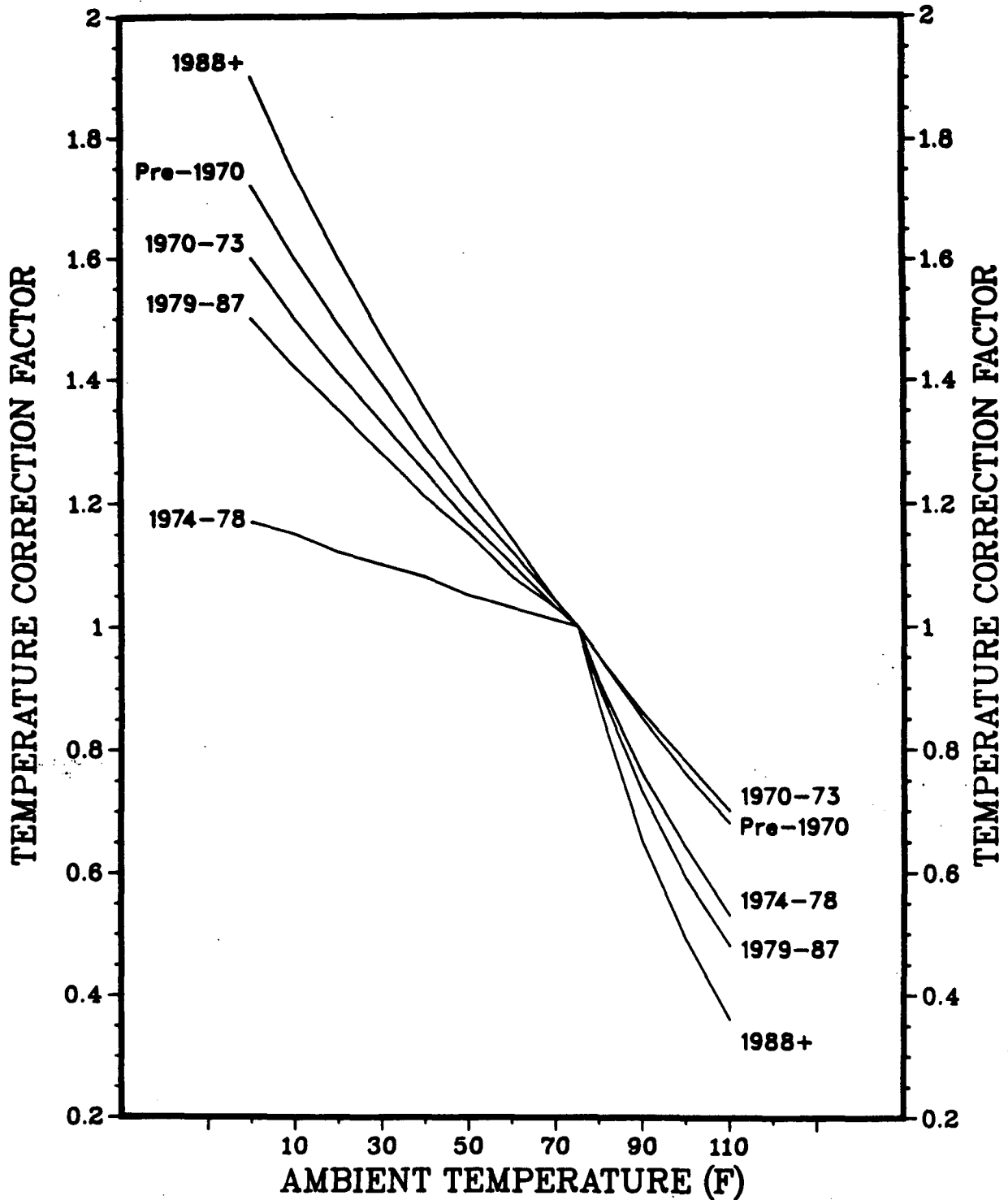


FIGURE 67

TEMPERATURE CORRECTION FACTORS  
HEAVY DUTY GASOLINE POWERED VEHICLES  
HYDROCARBONS  
Low Altitude

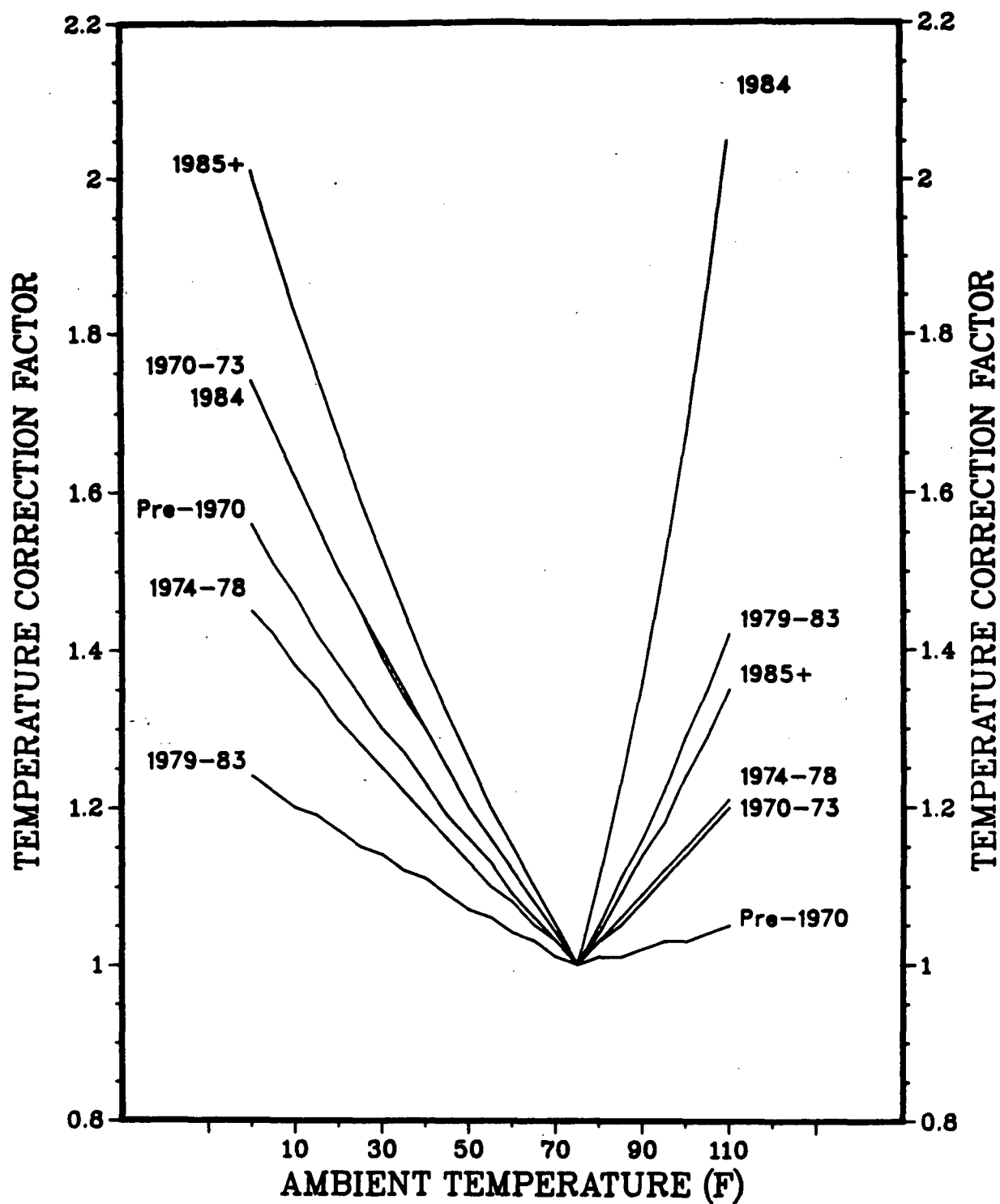


FIGURE 68

TEMPERATURE CORRECTION FACTORS  
HEAVY DUTY GASOLINE POWERED VEHICLES  
CARBON MONOXIDE  
Low Altitude

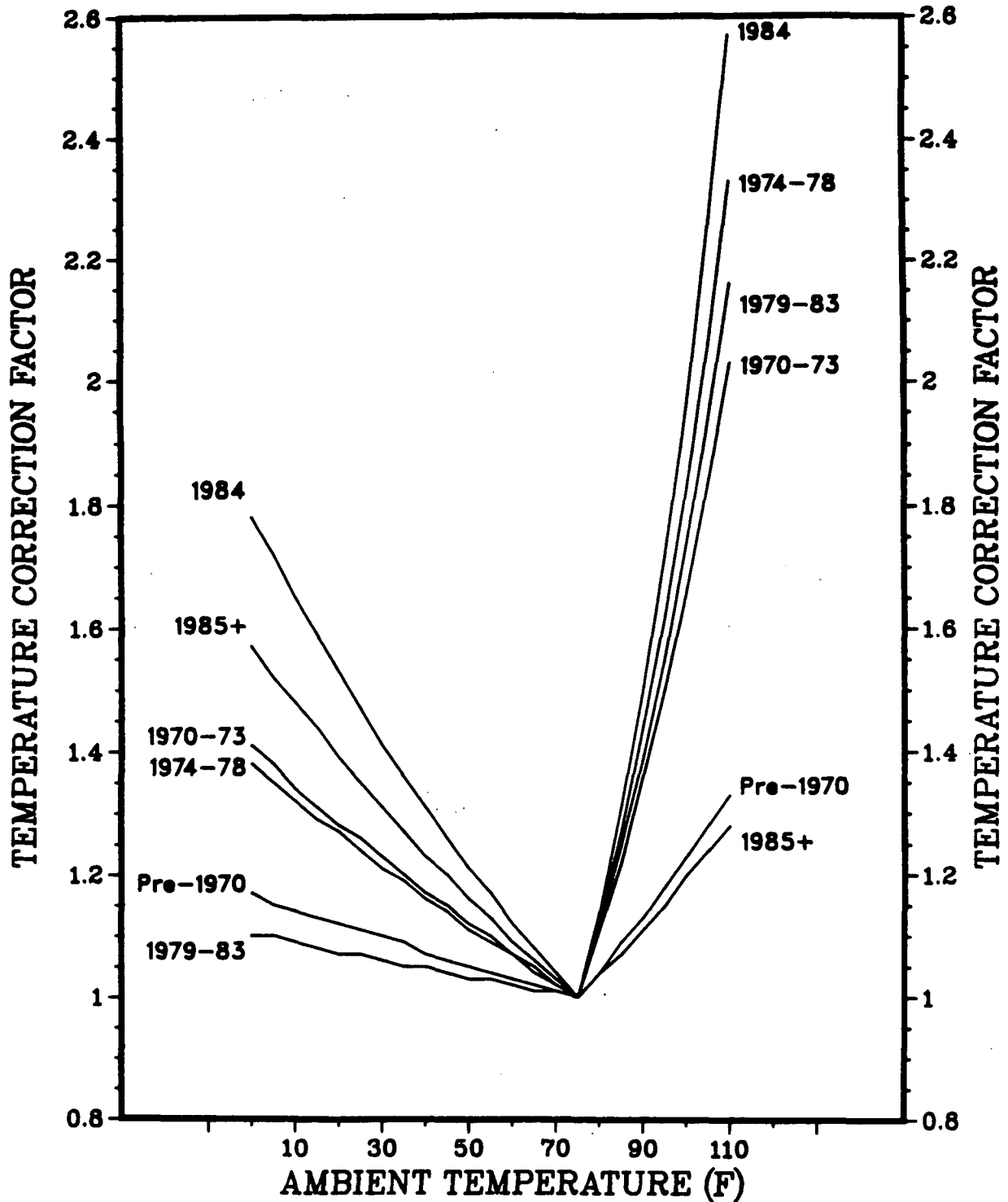


FIGURE 69

TEMPERATURE CORRECTION FACTORS  
HEAVY DUTY GASOLINE POWERED VEHICLES  
OXIDES OF NITROGEN  
Low Altitude

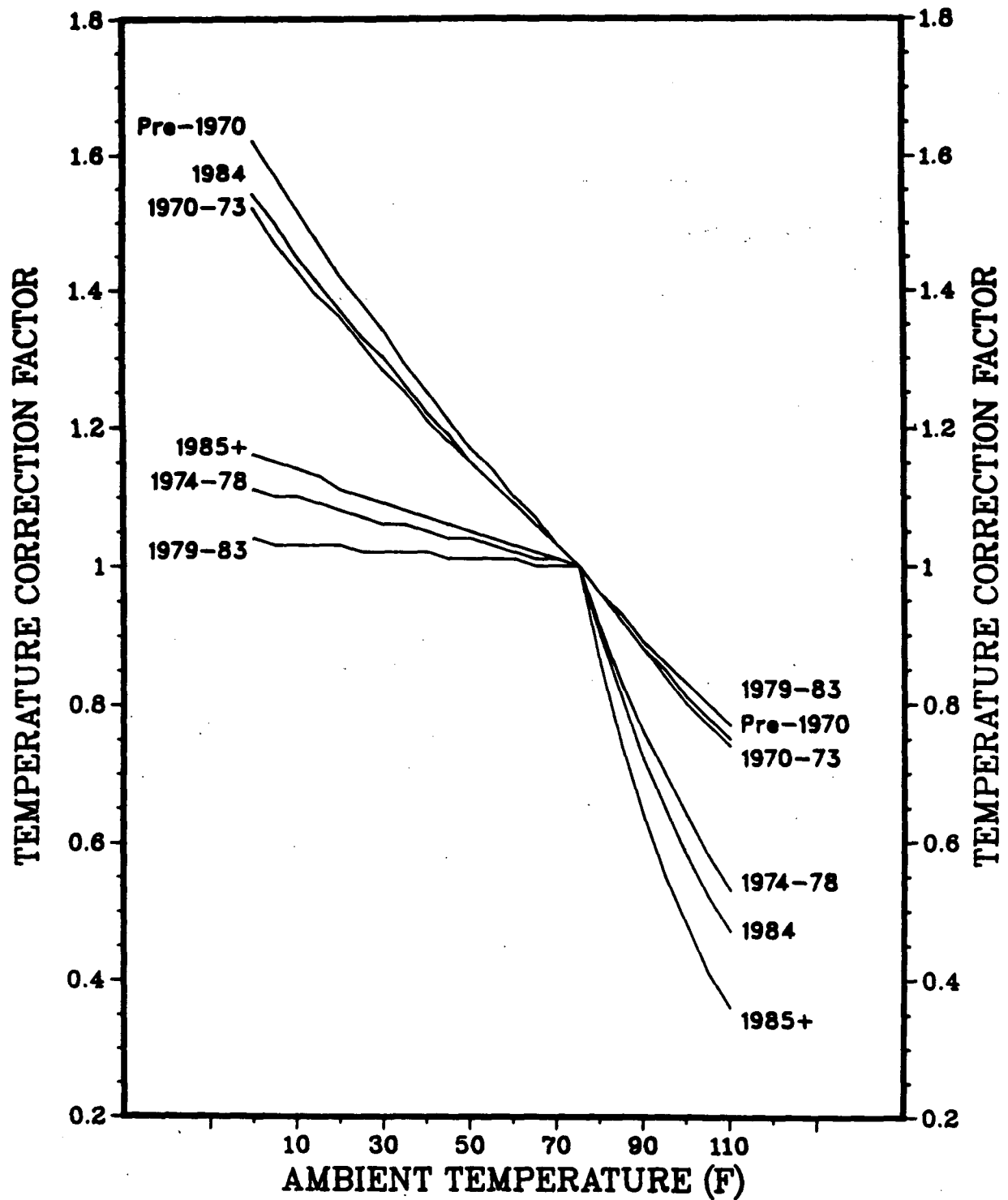


FIGURE 70

TEMPERATURE CORRECTION FACTORS  
MOTORCYCLES  
BAG 1 - HYDROCARBONS  
Low Altitude

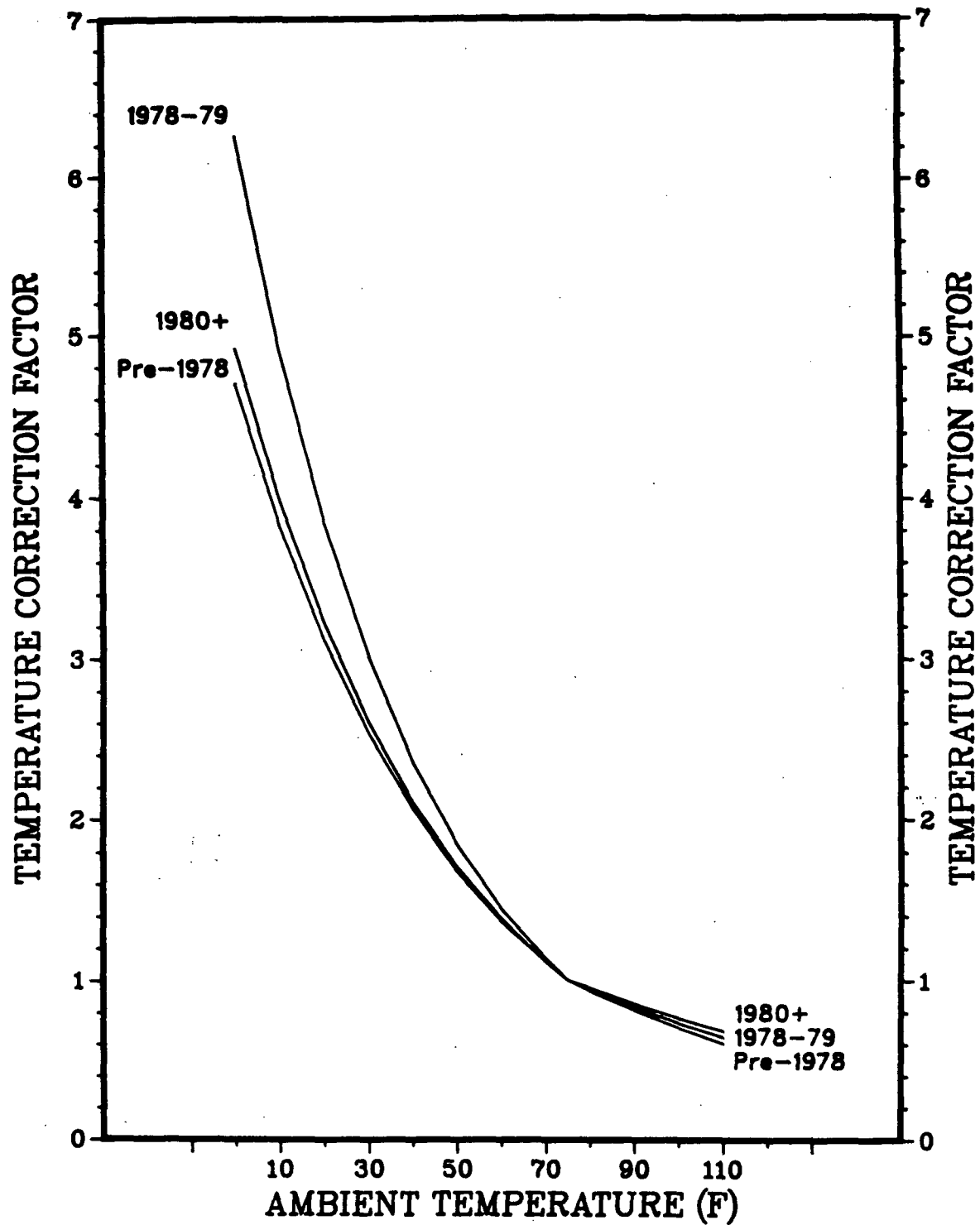


FIGURE 71

TEMPERATURE CORRECTION FACTORS  
MOTORCYCLES  
BAG 2 - HYDROCARBONS  
Low Altitude

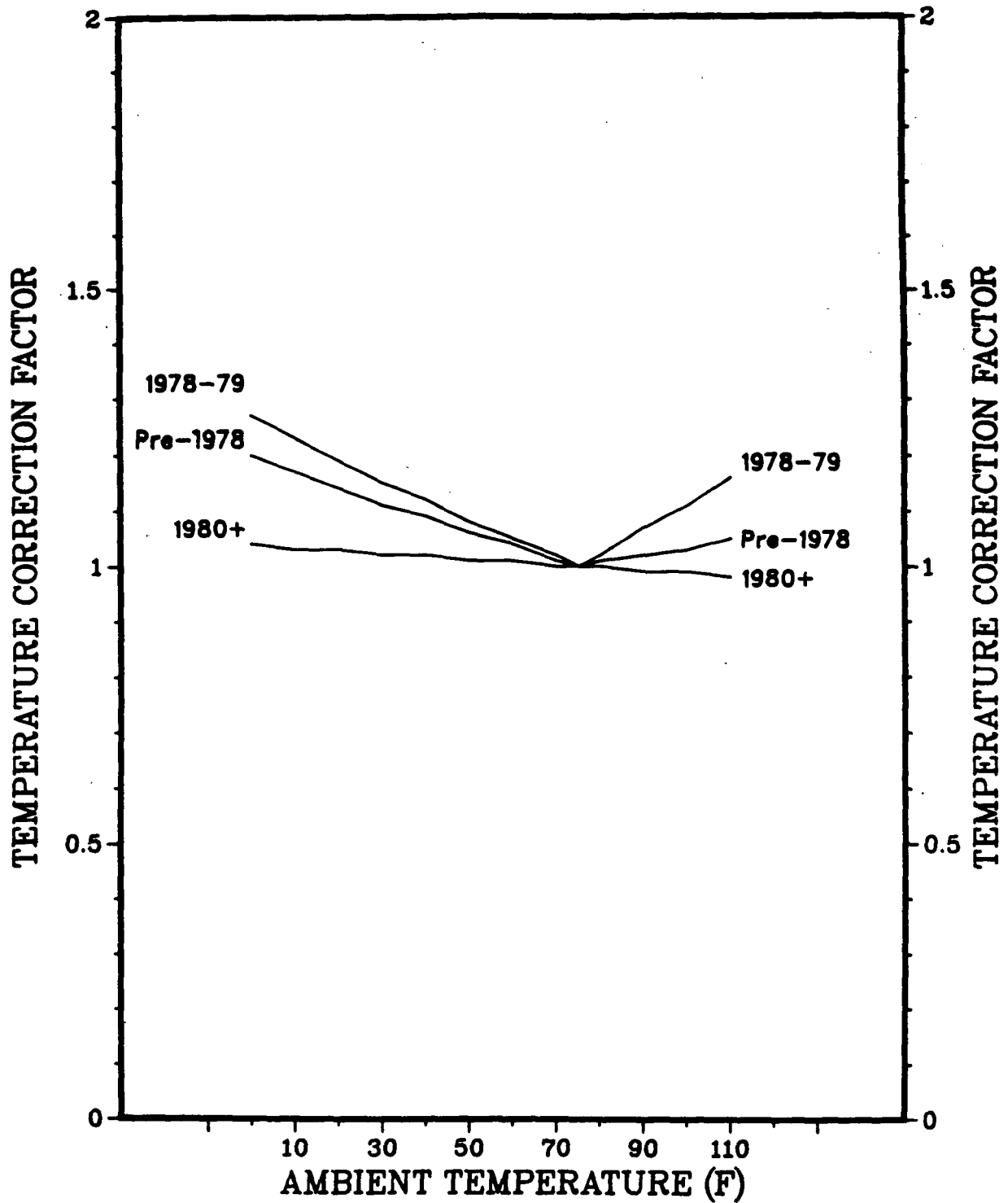




FIGURE 72

TEMPERATURE CORRECTION FACTORS  
MOTORCYCLES  
BAG 3 - HYDROCARBONS  
Low Altitude

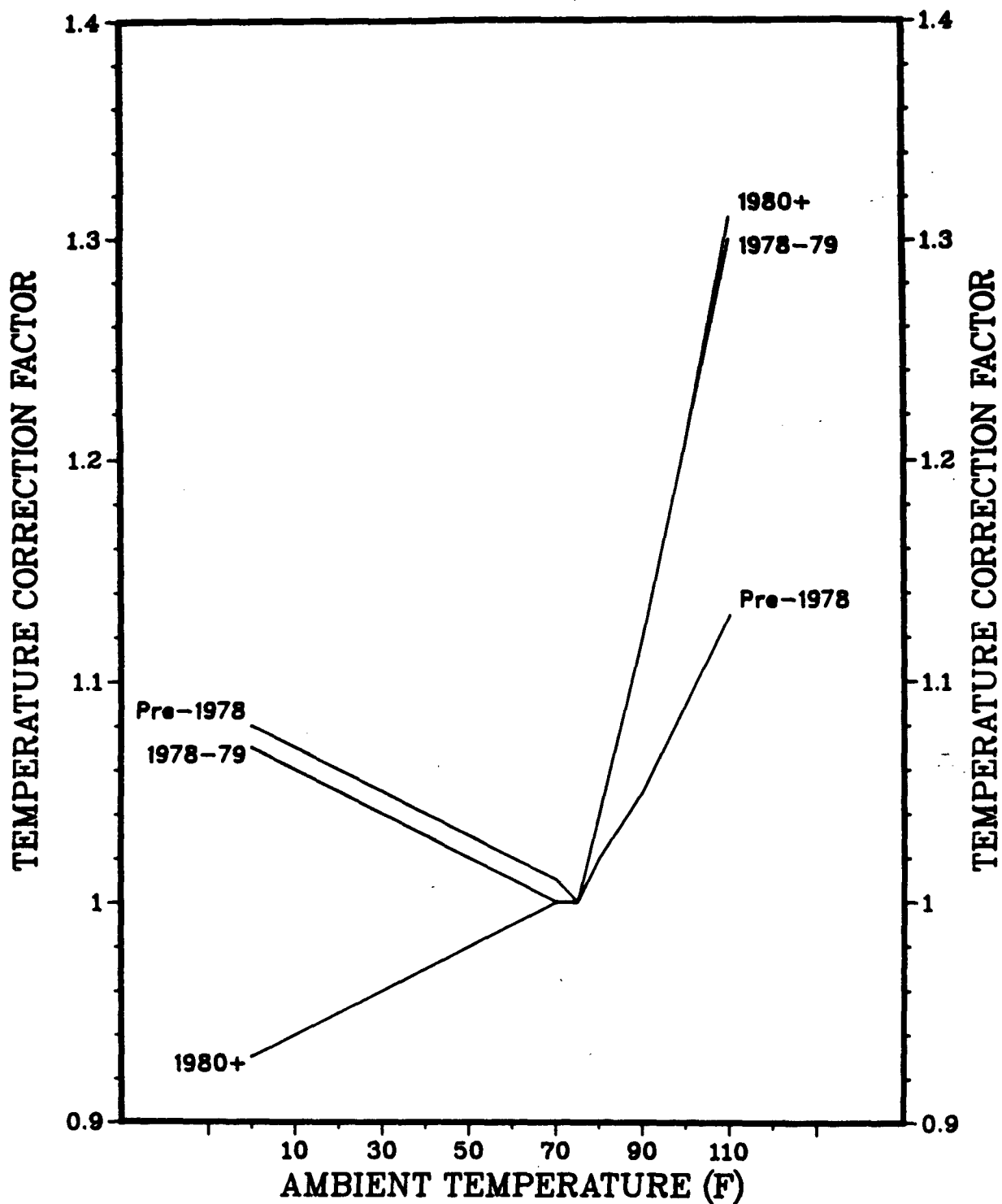


FIGURE 73

TEMPERATURE CORRECTION FACTORS  
MOTORCYCLES  
BAG 1 - CARBON MONOXIDE  
Low Altitude

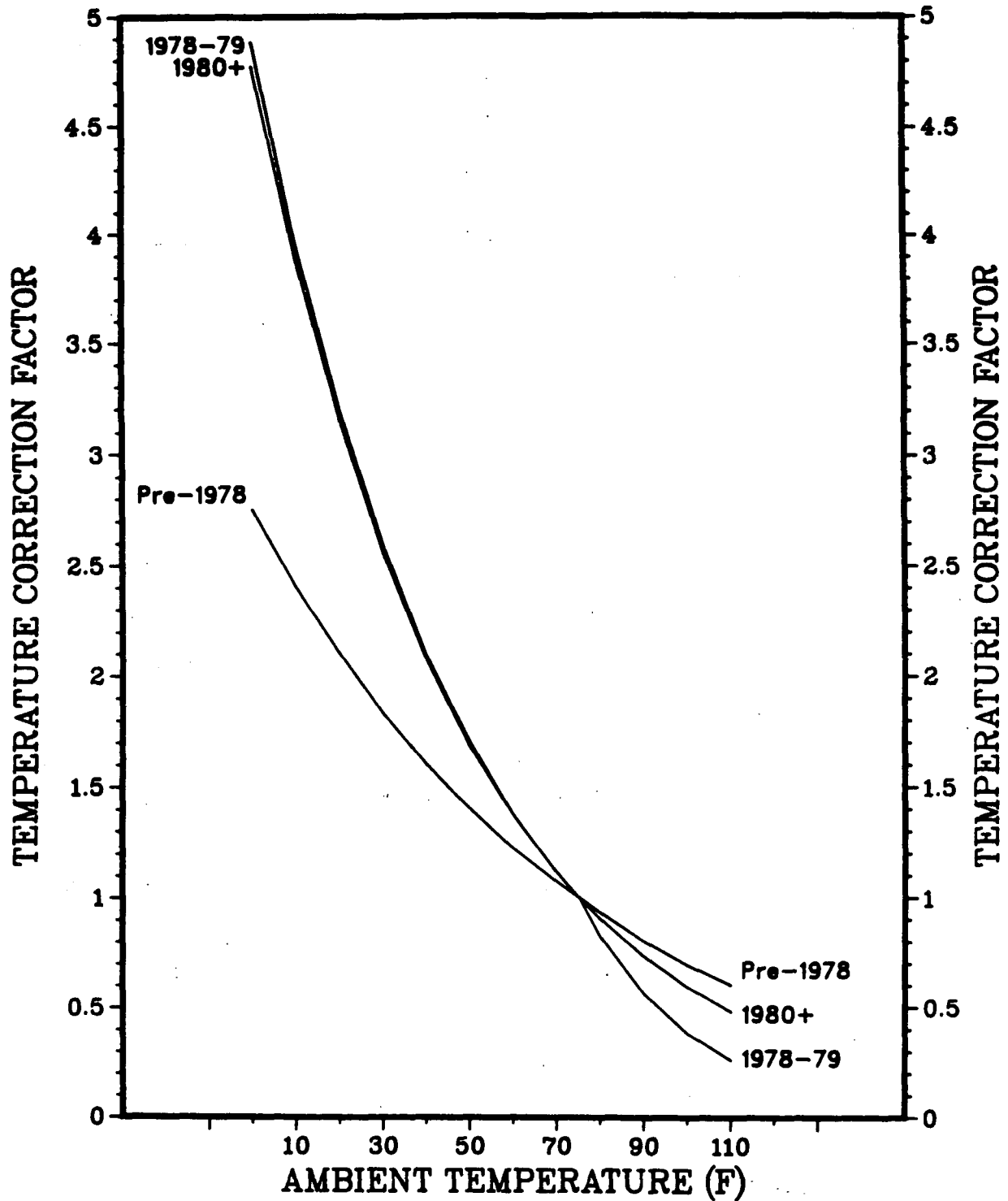


FIGURE 74

TEMPERATURE CORRECTION FACTORS  
MOTORCYCLES  
BAG 2 - CARBON MONOXIDE  
Low Altitude

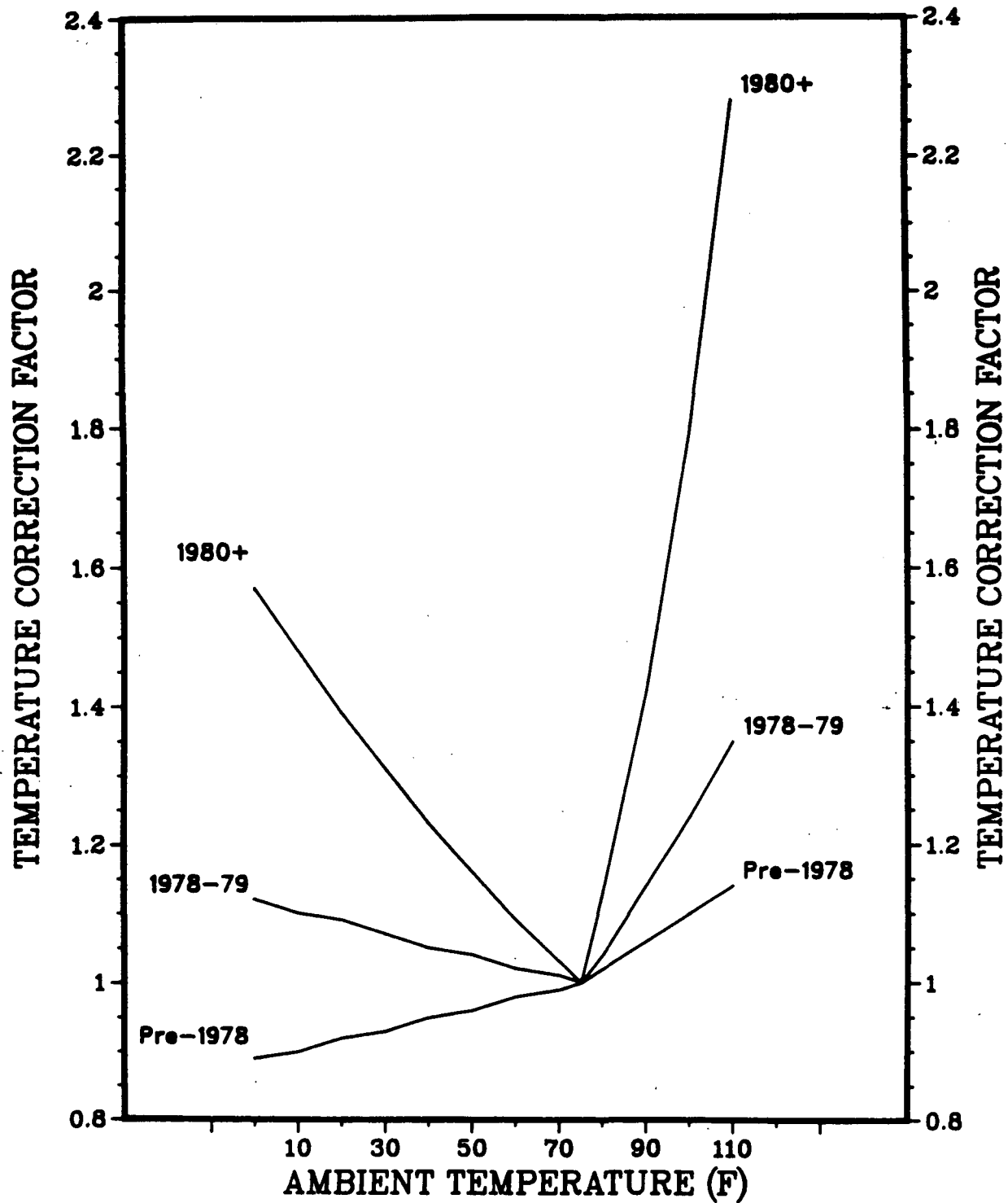


FIGURE 75

TEMPERATURE CORRECTION FACTORS  
MOTORCYCLES  
BAG 3 - CARBON MONOXIDE  
Low Altitude

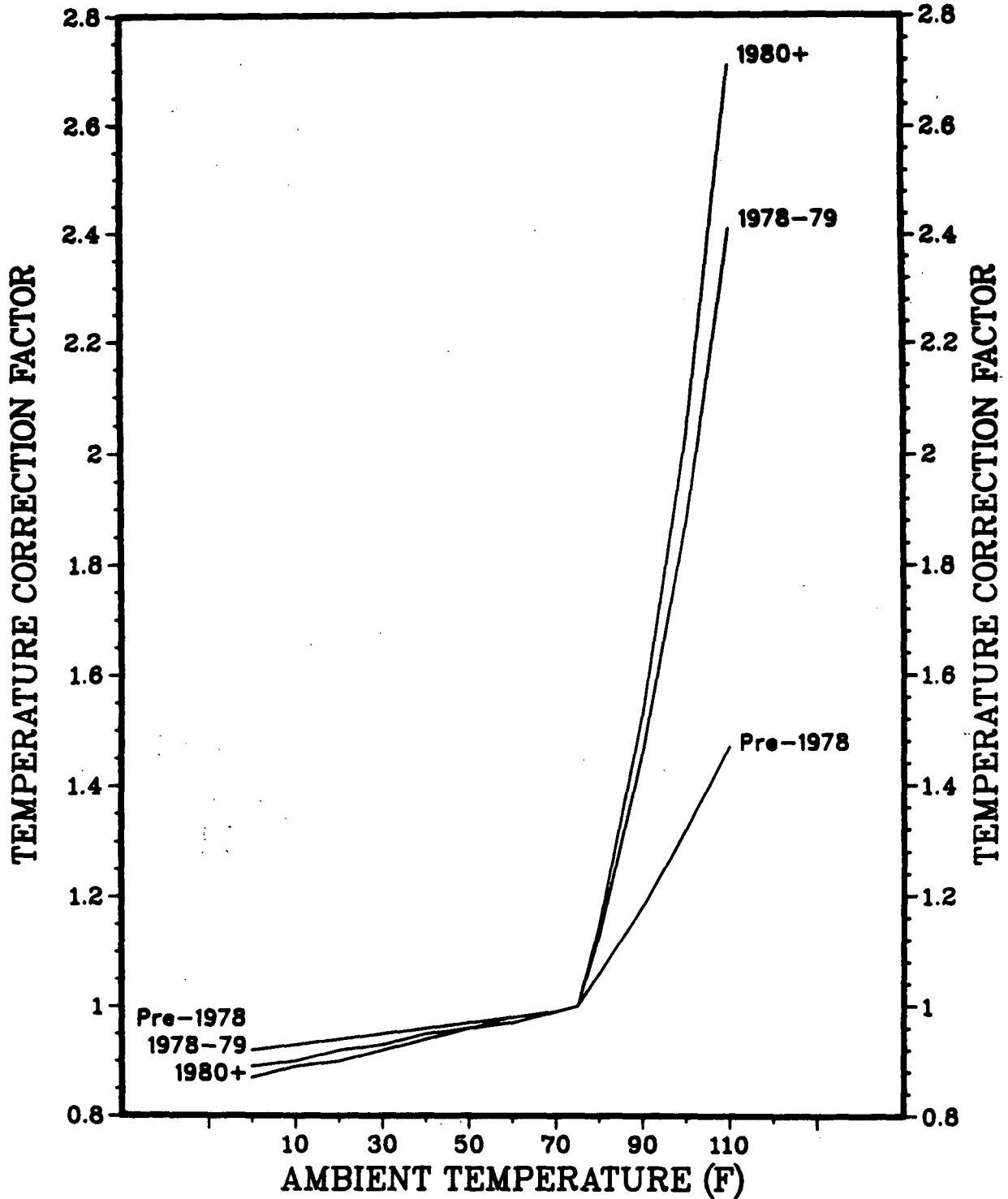


FIGURE 76

TEMPERATURE CORRECTION FACTORS  
MOTORCYCLES  
BAG 1 - OXIDES OF NITROGEN  
Low Altitude

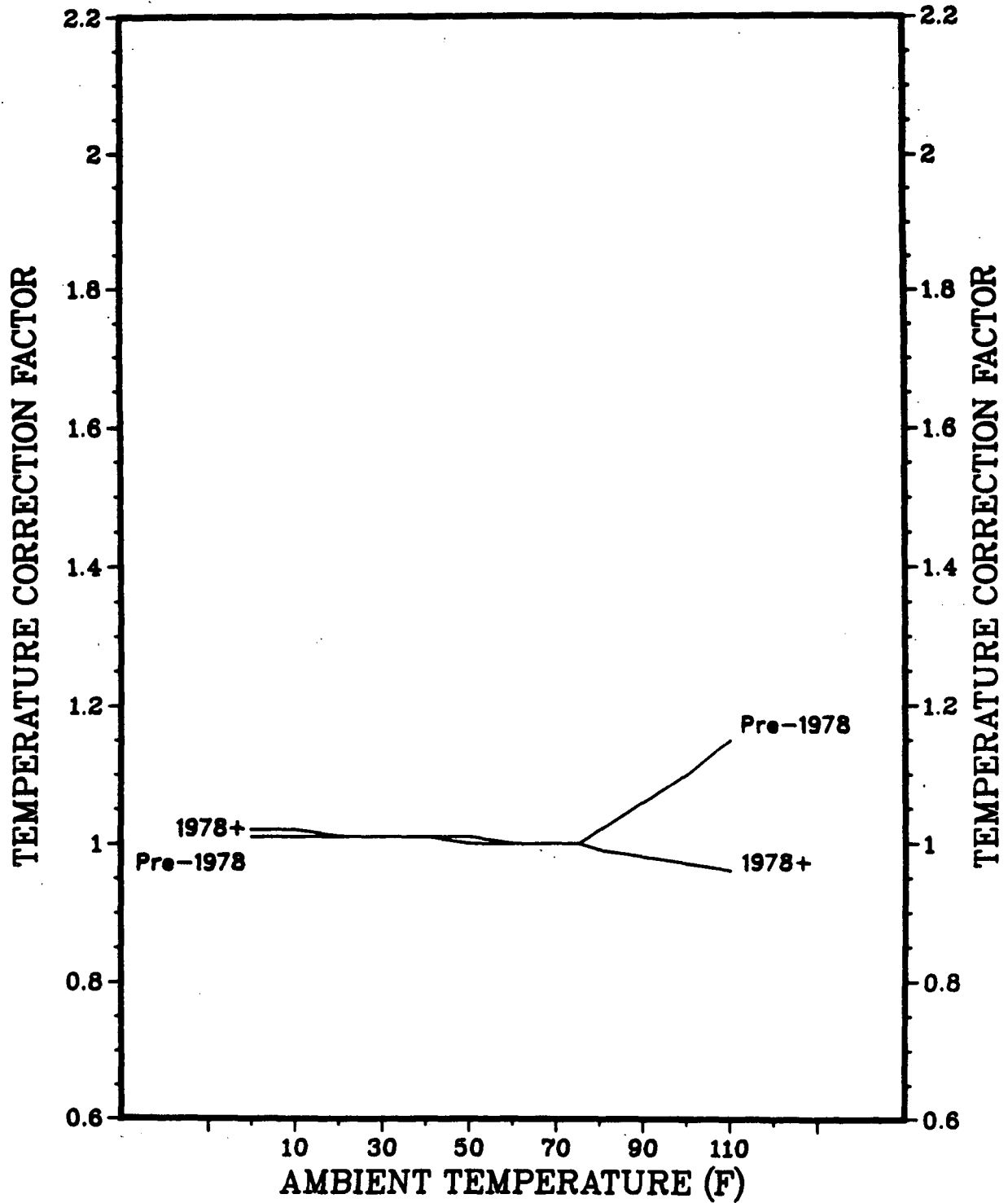


FIGURE 77

TEMPERATURE CORRECTION FACTORS  
MOTORCYCLES  
BAG 2 - OXIDES OF NITROGEN  
Low Altitude

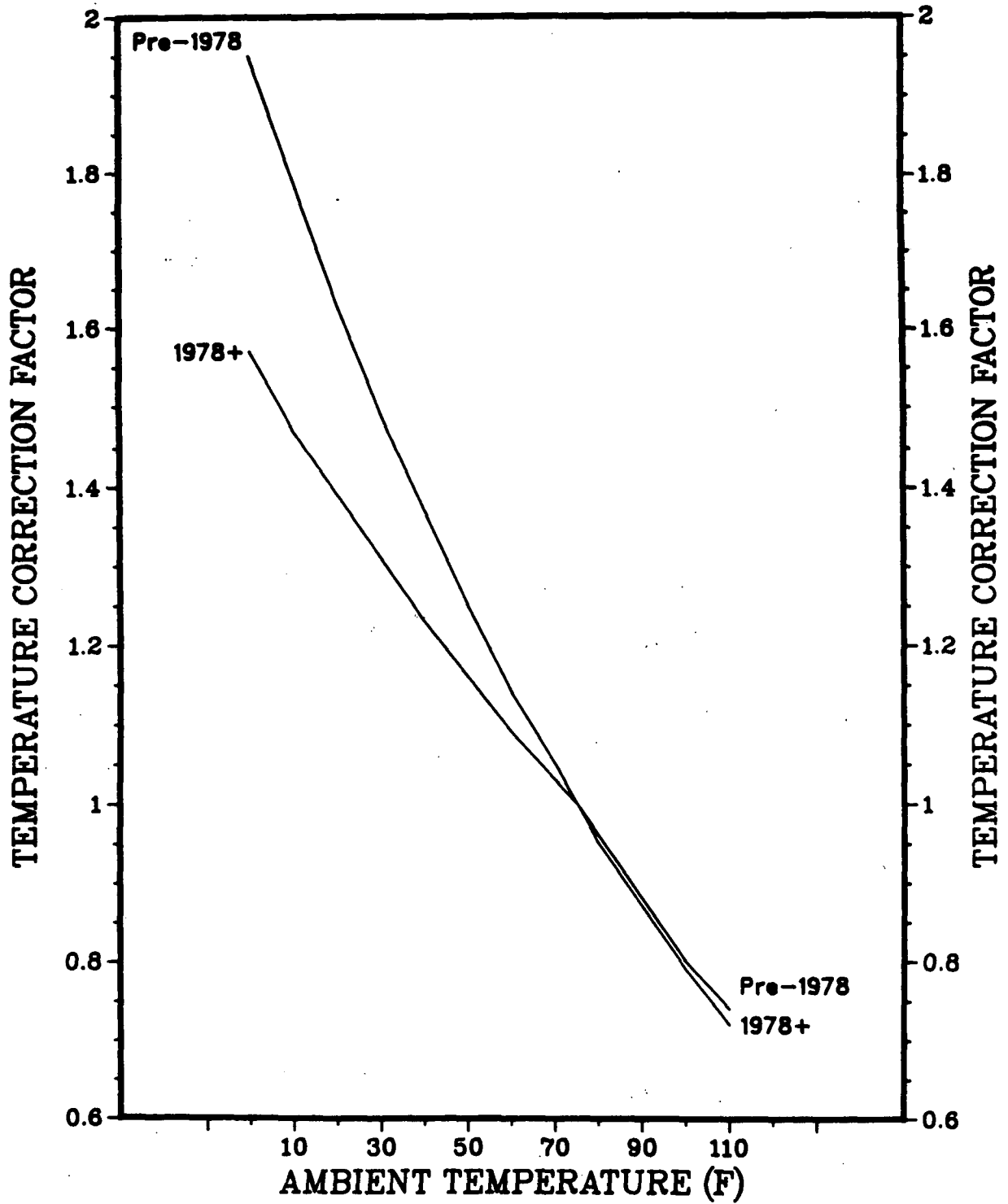


FIGURE 78

TEMPERATURE CORRECTION FACTORS  
MOTORCYCLES  
BAG 3 - OXIDES OF NITROGEN  
Low Altitude

