

# PART5

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- ◆ Differences from old Particulate Model
- ◆ Emission Factor Development
- ◆ Input, Sensitivities
- ◆ Trends

# PART5

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- ◆ FORTRAN Program
- ◆ Calculates particulate emission factors in gram/mile for 12 vehicle classes
- ◆ On-road vehicles, trucks, motorcycles
- ◆ Particle sizes less than or equal to 1.0 - 10.0 microns
- ◆ Name indicates consistency with MOBILE5a in format and fleet characterization data

# New From 1985

## Particulate Model/AP42

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- ◆ Low sulfur fuel regulation of October 1993
- ◆ Lower particulate emission standards
- ◆ Carbon portion of exhaust PM now includes both:
  - Soluble Organic Fraction (SOF)
  - Remaining Carbon Portion (RCP),  
elemental carbon

# New From 1985 Particulate Model/AP42 (Con't)

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- ◆ Expansion of heavy duty diesel vehicle classification into 5 sub-categories
- ◆ Separation of light duty cars and trucks by gasoline and diesel
- ◆ Three additional bus usage categories:
  - Transit
  - Central Business District
  - Heavy Urban

# **New From 1985 Particulate Model/AP42 (Con't)**

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- ◆ Option to print gaseous SO<sub>2</sub> emission factors
- ◆ Option to print idle emission factors
- ◆ Fugitive dust for paved and unpaved roads

# Diesel Vehicle Emission Factors

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- ◆ Direct Sulfate ( $\text{SO}_4$ )
- ◆ Soluble Organic Fraction (SOF)
- ◆ Remaining Carbon Portion (RCP)
- ◆ Exhaust Particulate Matter (PM)

# Gasoline Vehicle Emission Factors

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- ◆ Lead
- ◆ Direct Sulfate (SO<sub>4</sub>)
- ◆ Carbon
- ◆ Exhaust Particulate Matter (PM)

# All Vehicle Types

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- ◆ Indirect Sulfate ( $\text{SO}_4$ )
- ◆ Brake-wear
- ◆ Tire-wear
- ◆ Total Particulate Matter (PM), includes:  
Exhaust PM, Indirect Sulfate,  
Brake-wear, Tire-wear
- ◆ Fleet average Unpaved Road Dust
- ◆ Fleet average Paved Road Dust



# Optional

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- ◆ Idle emissions for heavy-duty diesel vehicle classes
- ◆ Gaseous Sulfur Dioxide (SO<sub>2</sub>)

# Diesel Vehicle Emission Factors

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- ◆ “Regulatory Impact Analysis: Control of Sulfur and Aromatics Contents of On-Highway Diesel Fuel”, 1990
- ◆ “Heavy-Duty Vehicle Emission Conversion Factors II 1962-2000”, EPA-AA-SDSB-89-01
- ◆ “Development of Conversion Factors for Heavy-Duty Bus Engines g/bhp-hr to g/mile”, EPA-AA-EVRB-92-01

# Heavy-Duty Diesel Emission Factors

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- ◆ G/bhp-hr to g/mi conversion factors are calculated by:

$$CF = \rho / BSFC * FE$$

where:

CF = conversion factor in bhp-hr/mi

$\rho$  = fuel density in lb/gal

BSFC = brake-specific fuel

consumption in lb/bhp-hr

FE = fuel economy in mi/gal

# Sulfate Emission Factors

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- ◆ sulfur --> exhaust --> direct sulfate ( $\text{SO}_4$ )  
in fuel OR  
--> gaseous sulfur  
dioxide ( $\text{SO}_2$ )  
and --> indirect sulfate ( $\text{SO}_4$ )  
in atmosphere

# Low Sulfur Fuel Effects

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- ◆ Calendar years preceding 1993 assume .25 weight % sulfur fuel
- ◆ Calendar years 1993 and later assume .05 weight % sulfur fuel

# Diesel Carbon Portions

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- ◆ Soluble Organic Fraction (SOF)

$$\text{fraction}_{\text{SOF},v} = \frac{\text{SOF}_{m,v}}{\text{EF}_{m,v} - \text{DSULF}_{m,v}} *$$

- ◆ Remaining Carbon Portion (RCP)

$$\text{RCP}_{m,v} = \text{EF}_{m,v} - \text{DSULF}_{m,v} - \text{SOF}_{m,v}$$

# Gasoline Vehicle Emission Factors

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- ◆ “Size-Specific Total Particulate Emission Factors for Mobile Sources”,  
EPA-460/3-85-005
- ◆ “Motor Vehicle-Related Air Toxics Study”,  
EPA-420-R-93-005

# Direct Sulfate for Catalyst Equipped Gasoline Vehicles

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- ◆  $DSULF_{m,v} = [FRAC_{cat/no\ air}(.005) + FRAC_{cat/air}(.016)],$   
for speeds at or  $< 19.6$  mph
- ◆  $DSULF_{m,v} = [FRAC_{ox/no\ air}(.005) + FRAC_{3w/no\ air}(.001) + FRAC_{ox/air}(.02) + FRAC_{3w/air}(.025)],$   
for speeds at or  $> 34.8$  mph



# Input

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- ◆ Control Section
- ◆ One-time Data Section
- ◆ Scenario Section

# Control Section

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- ◆ Controls the input, output and execution of the program
- ◆ Determines whether additional input required
- ◆ Controls whether certain options should be included in calculations

# IMFLAG

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- ◆ Legal values:
  - 1 = no I/M program
  - 2 = I/M program
- ◆ No user-supplied data required for this flag
- ◆ Will only affect lead and sulfate particulate emission factors for GASOLINE vehicles
- ◆ Only of any significance if substantial fraction of fleet is pre-1985 model years

# RFGFLG

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- ◆ Legal values:
  - 1 = no reformulated gasoline
  - 2 = reformulated gasoline
- ◆ Affects gasoline vehicles only
- ◆ Sulfur weight %
  - .034 for calendar years preceding 2000
  - When RFGFLG = 2, set to .0138 for calendar years 2000+
- ◆ Exhaust PM reductions consistent with MOBILE5 HC reductions

# BUSFLG

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- ◆ Legal values:
  - 1 = do not print alternative bus cycle efs
  - 2 = print Transit and Central Business District (CBD) bus cycle efs
  - 3 = print Heavy Urban bus cycle efs
- ◆ Based on conversion factors (g/Bhp-hr to g/mi) developed from various test cycles
- ◆ The lower the fuel economy, the more severe the conversion factor

# One-time Data Section

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- ◆ Allows user-supplied information to override internal values in PART5 as specified by the control flags
- ◆ Enter in the same order as specified by the control flags
- ◆ Expects input data when VMFLAG and MYMRFG set to other than “1”, or OUTFMT set to “5”

# Scenario Section

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- ◆ Details individual scenarios for which efs are to be calculated
- ◆ Region; 1 = low altitude, 2 = high altitude  
- no affect currently in the model
- ◆ Calendar year of evaluation; enter year 1960 through 2020
- ◆ Speed cycle; 1 = transient, 2 = steady (cruise) driving - minimal affect on lead efs
- ◆ Speed; average speed in mph - minimal affect on lead and sulfate efs only

# Fugitive Dust Related Inputs

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- ◆ Unpaved road silt%
- ◆ Paved road silt loading
- ◆ Fleet average number of wheels
- ◆ Number of precipitation days with  $> .01$  inches of rain per year
- ◆ Fleet average vehicle weight



# Particle Size Cutoff (PSC)

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- ◆ Maximum aerodynamic diameter of particles included in the emission factor
- ◆ User input:
  - minimum 1.0  $\mu\text{m}^*$
  - maximum 10.0  $\mu\text{m}$

\*exception: fugitive dust fleet average emission factors, minimum PSC is 2.5  $\mu\text{m}$

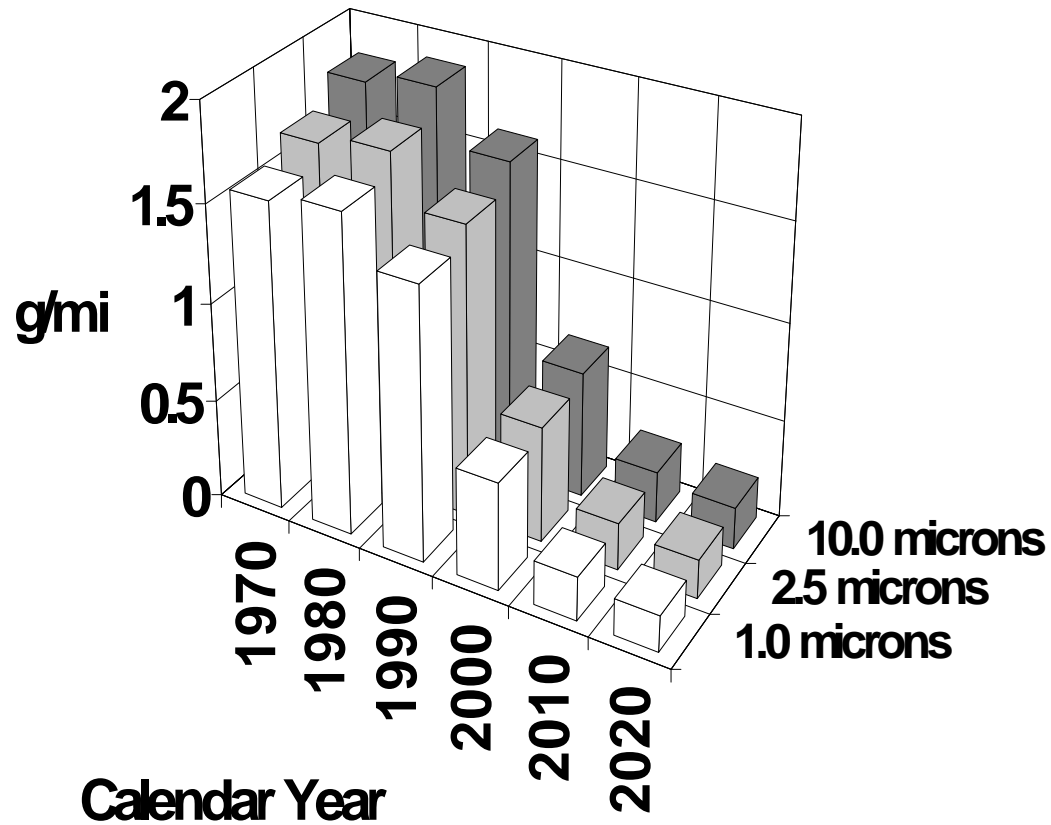
## Particulate Emission Standards

Vehicle Type	Model Year Group	Particulate Standard
LDDV	1982-1986	0.60 g/mi
	1987-1993	0.20 g/mi
LDV	1994+	0.10 g/mi
LDDT	1982-1986	0.60 g/mi
LDDT, <3750 lbs.*	1987	0.26 g/mi
LDDT, >3750 lbs.	1987	0.50 g/mi
LDDT	1988-1993	0.26 g/mi
LDT1	1994+	0.10 g/mi
LDT2, <5750 lbs.	1994+	0.10 g/mi
LDT2, >5750 lbs.	1994+	0.12 g/mi
HDDV	1988-1990	0.60 g/bhp-hr
	1991-1993	0.25 g/bhp-hr
	1994+	0.10 g/bhp-hr
Buses	1988-1990	0.60 g/bhp-hr
	1991-1992	0.25 g/bhp-hr
	1993	0.10 g/bhp-hr
	1994-1995	0.07 g/bhp-hr
	1996+	0.05 g/bhp-hr, Cert. 0.07 g/bhp-hr, in-use

# PART5 Exhaust Particulate Emission Factors

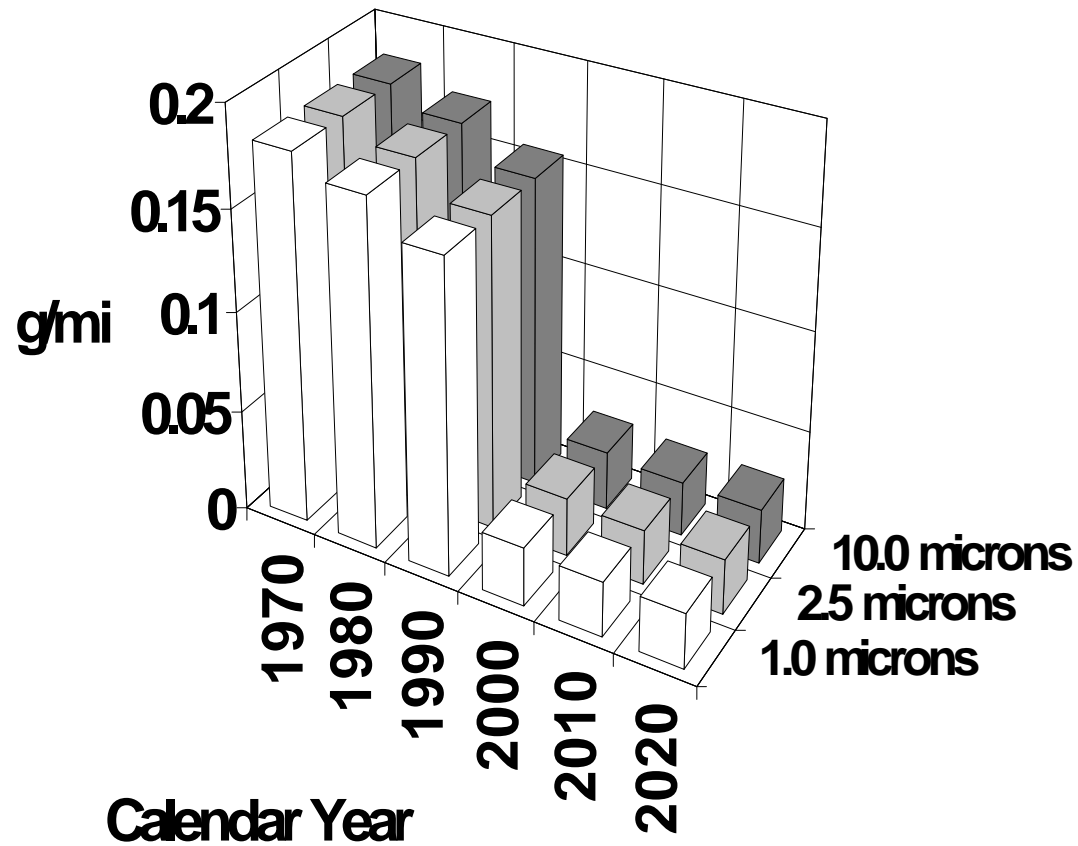
## Medium Heavy-Duty Diesel Vehicles

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# PART5 Direct Sulfate (SO<sub>4</sub>) Emission Factors Medium Heavy-Duty Diesel Vehicles

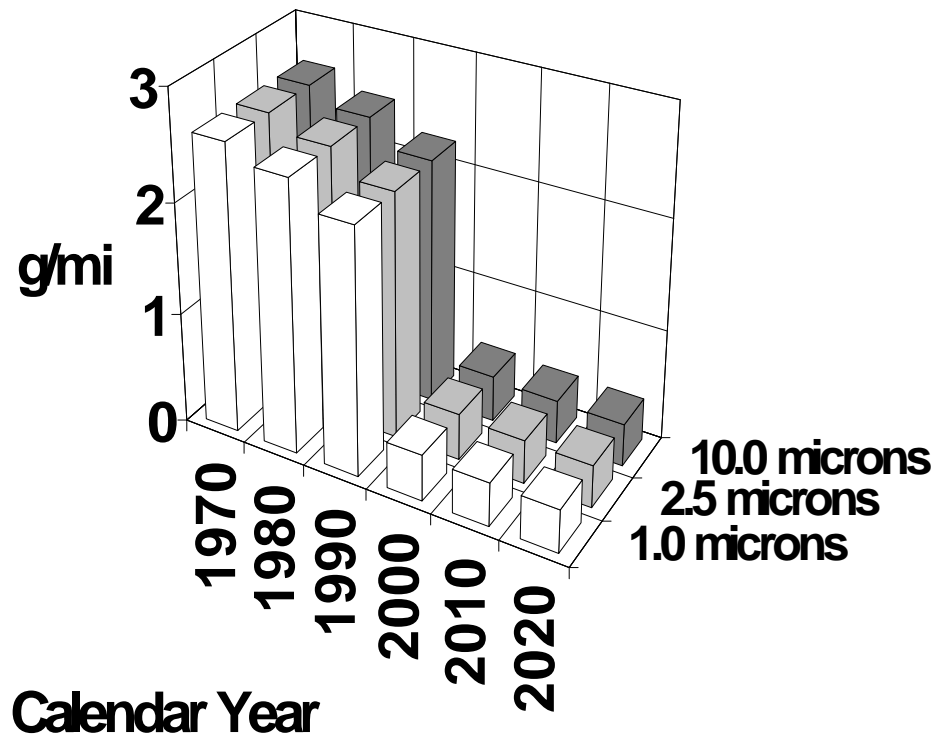
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# PART5 Gaseous Sulfur Dioxide (SO<sub>2</sub>) Emission Factors

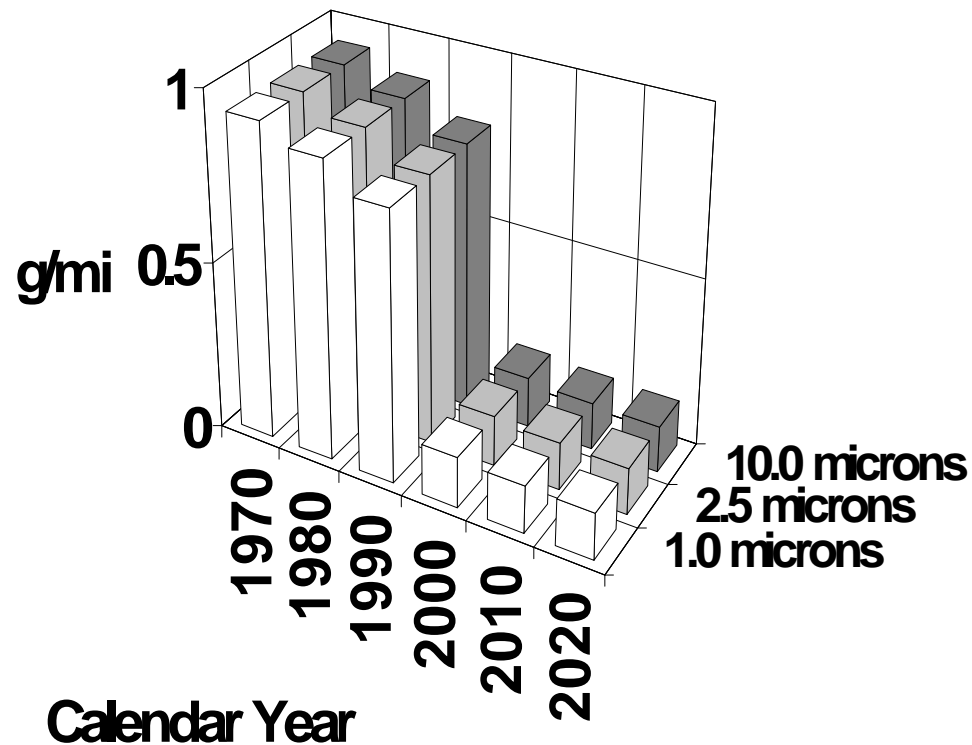
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## Medium Heavy-Duty Diesel Vehicles



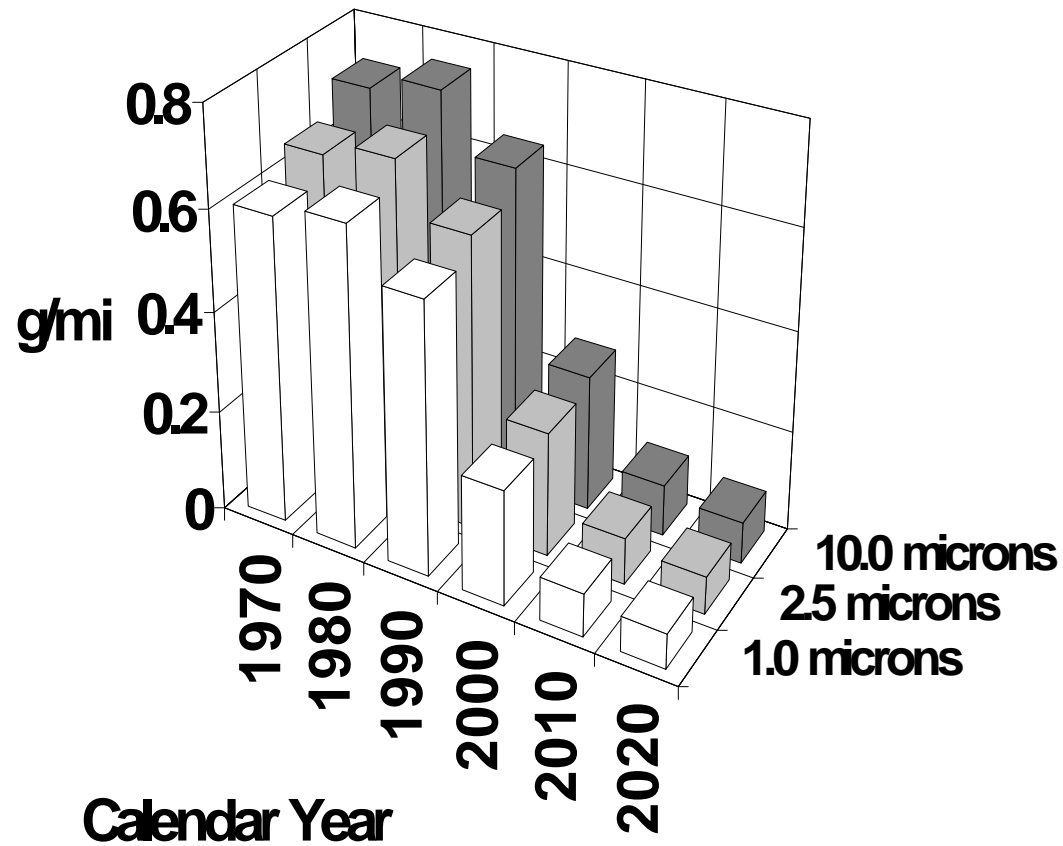
# PART5 Direct and Indirect Sulfate (SO<sub>4</sub>) Emission Factors

## Medium Heavy-Duty Diesel Vehicles



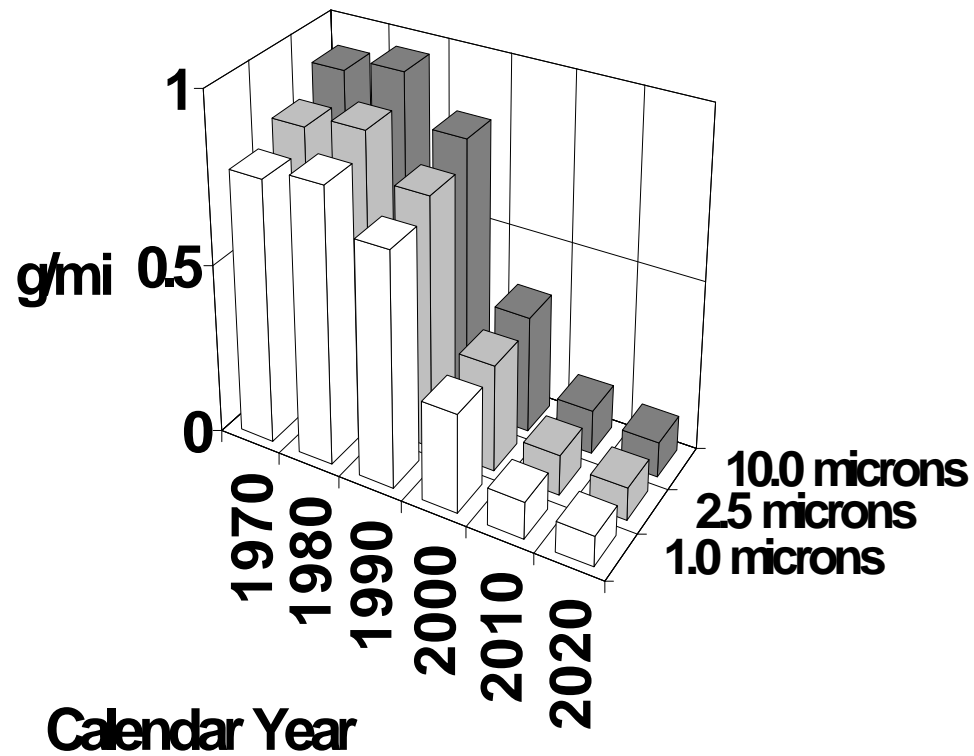
# PART5 Soluble Organic Fraction Emission Factors Medium Heavy-Duty Diesel Vehicles

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# PART5 Remaining Carbon Portion Emission Factors

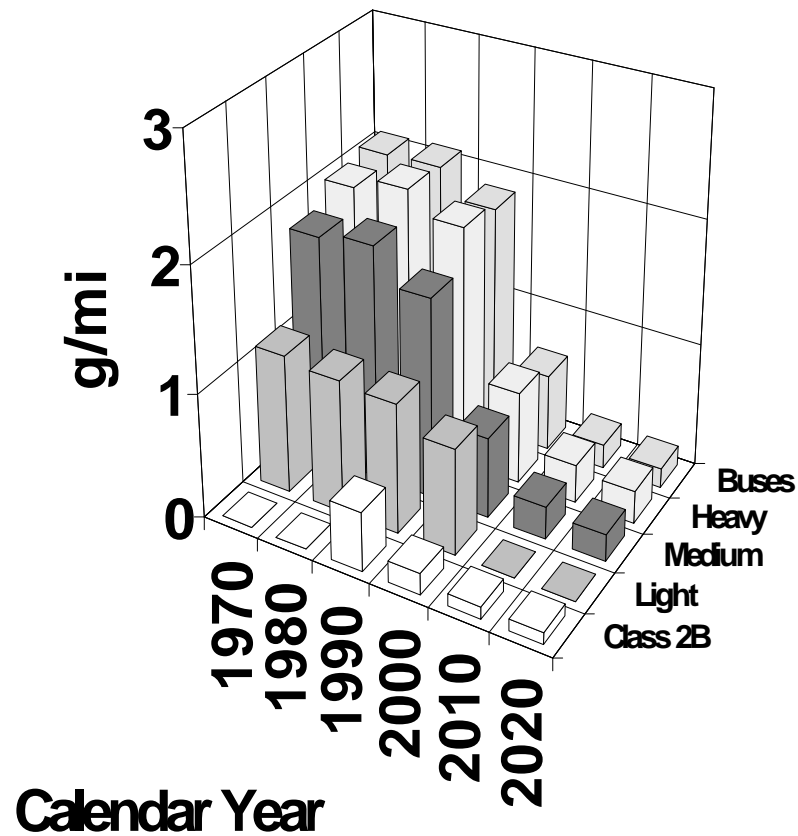
## Medium Heavy-Duty Diesel Vehicles





# PART5 Exhaust Particulate Emission Factors Heavy-Duty Diesels, Max Particle Size 10.0 um

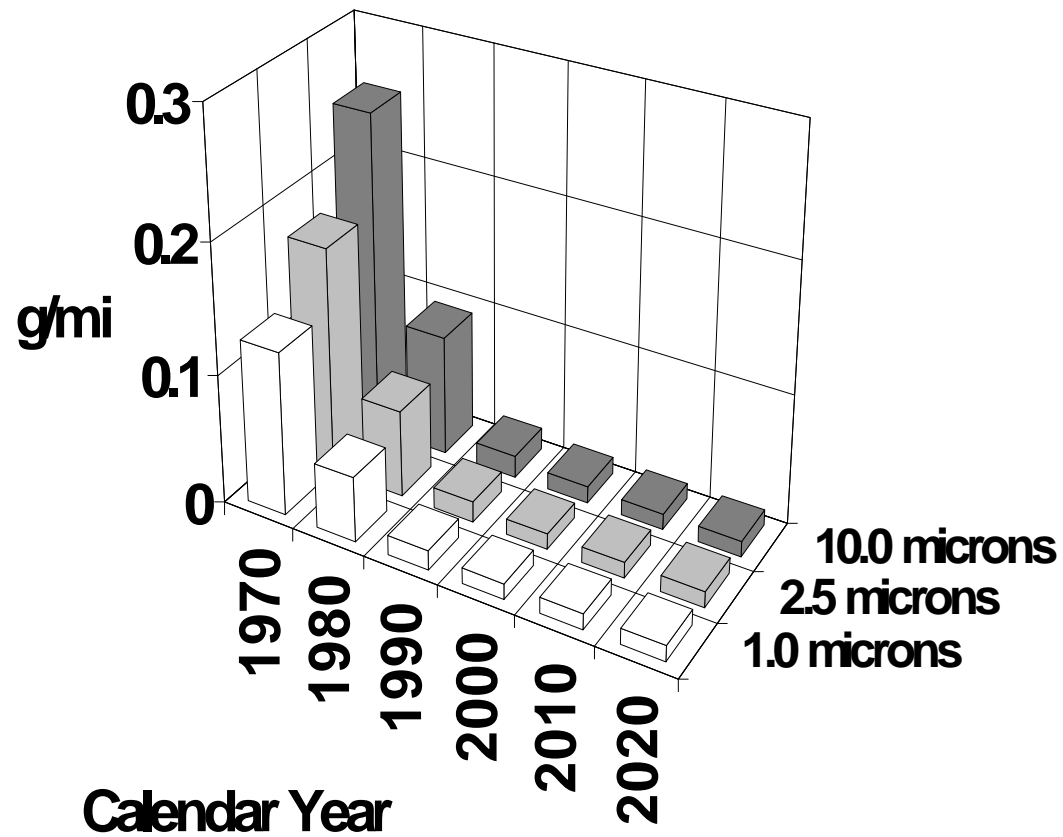
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# PART5 Exhaust Particulate Emission Factors

## Passenger Cars

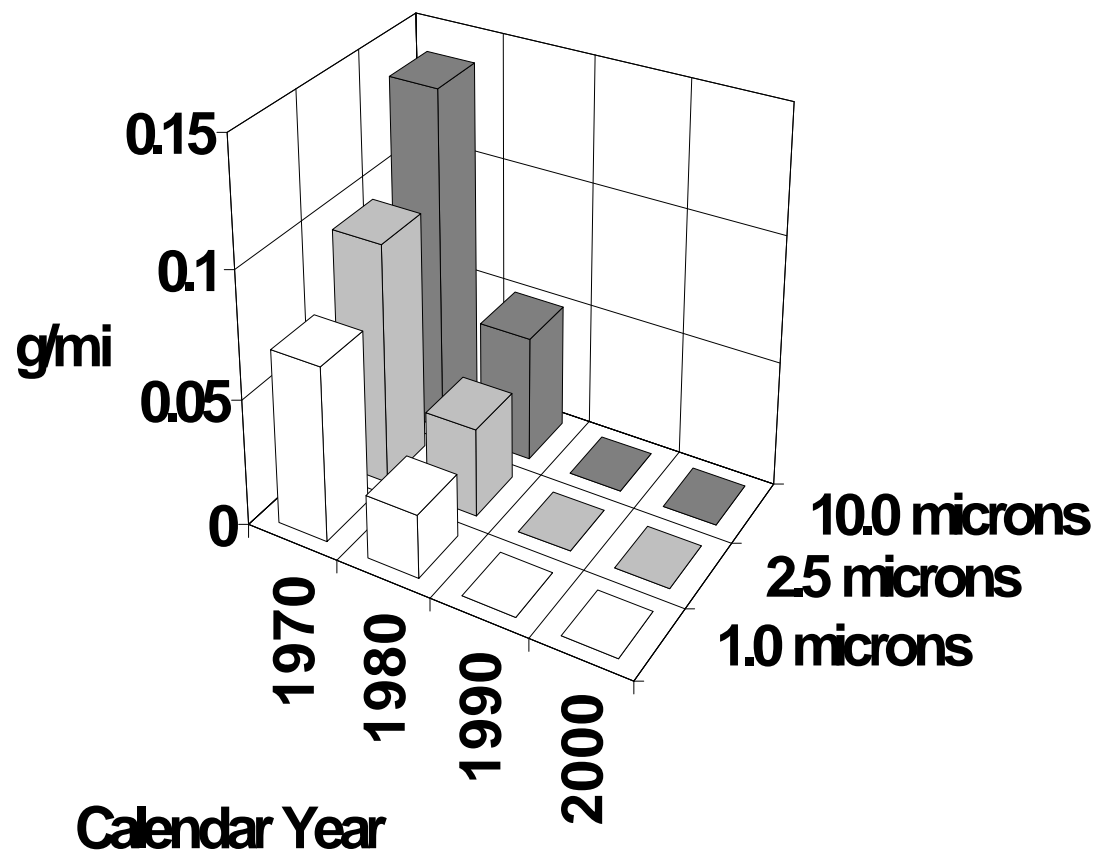
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# PART5 Lead Emission Factors

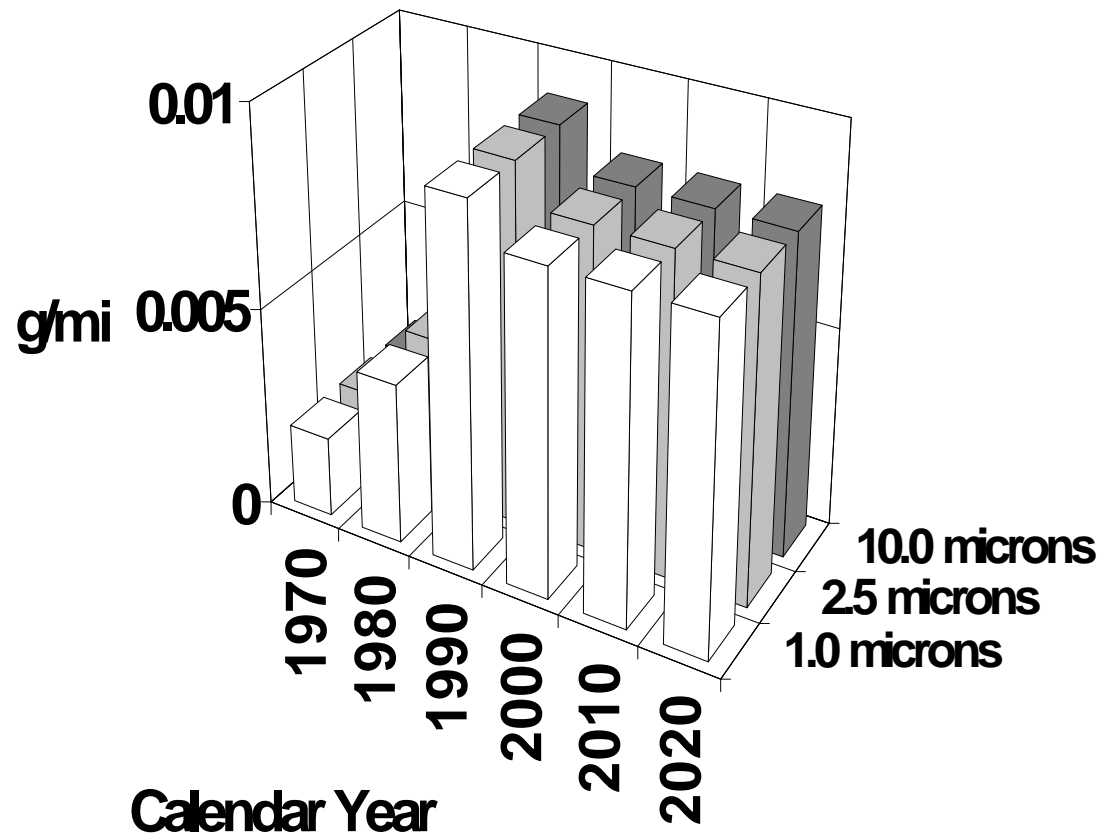
## Passenger Cars

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# PART5 Direct Sulfate Emission Factors Passenger Cars

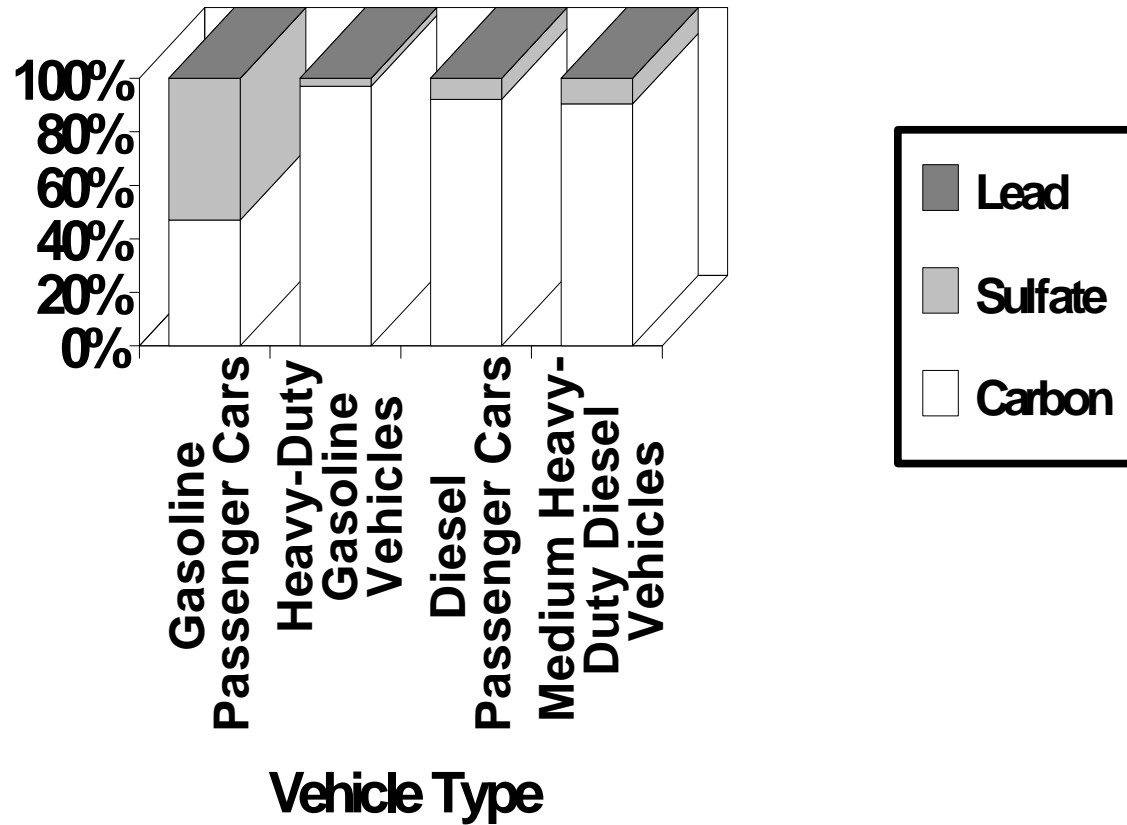
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# PART5 Exhaust Particulate Composition

## Max Particle Size 10.0 um, Calendar Year 1990

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# PART5 Exhaust Particulate Composition

## Max Particle Size 10.0 $\mu$ m, Calendar Year 2000

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