APPENDIX A

Acronyms Used in Staff Report

A/C	Air Conditioning
ACCF	Air Conditioning Correction Factor
AIRS	Aerometric Information Retrieval System
ARB	California Air Resources Board
ARC/INFO	ARC/INFO GIS software by ESRI, Inc.
ASTM	American Society for Testing and Materials
BAR	California Bureau of Automotive Repair
BERs	Base Emission Rates
Board	The Air Resources Board Members
BSFC	Brake-Specific Fuel Consumption
CA	California
CALIMFAC	California I/M and Emission Factors Model
CALTRANS	California Department of Transportation
CBD	Central Business Cycle
CCF	Cycle Correction Factor
CCR	California Code of Regulations
CDEC	California Data Exchange Center
CDF	California Department of Forestry
CE-CERT	College of Engineering, Center for Environmental Research and Technology of University of California, Riverside
CFR	Code of Federal Regulations
CIFER	Colorado Institute for Fuels and High Altitude Engine Research
CIMIS	CA Irrigation Management Information System
COGs	Councils of Government
CRC	Coordinating Research Council
CSM	Colorado School of Mines
ΔEF	Change in Emissions Factor due to tampering
D2	Federal Reformulated Diesel Fuel
DEM	Digital Elevation Model
districts	Air pollution control or management districts
DMV	California Department of Motor Vehicles
DOF	California Department of Finance
DR	Deterioration Rate
DWR	California Department of Water Resources
EEA	Energy and Environmental Analysis, Inc.
EFEE	Engine, Fuel and Emissions Engineering, Inc.
EGR	Exhaust Gas Recirculation
EMFAC2000	Emission Factor Model 2000
ETW	Equivalent Test Weight

EVAP	Evaporative
FCF	Fuel Correction Factor
FID	Flame Ionization Detector
FTP	Federal Test Procedure
GAI	Geographic Area Index
GIS	Geographic Information Systems
g/mi	Grams Per Mile
GPS	Global Positioning System
GUI	Graphical User Interface
GVW	Gross Vehicle Weight
HDVEM	Heavy-Duty vehicle Emissions Modeling
HPMS	Highway Performance Monitoring System
HSL	ARB's Haagen-Smit Laboratory
ID	Identification
I/M, I&M	Inspection and Maintenance Program
LA4	Modes 1 and 2 of the FTP
LA92	Los Angeles 1992 Cycle (Unified Cycle)
lb.	Pounds
Mfgr.	Manufacturer
MIC	Motorcycle Industry Council
MIL	Malfunction Indicator Light
MOBILE	The Federal On-Road Emission Factor Model
MPOs	Metropolitan planning organizations
MVDAS	Motor Vehicle Data Acquisition System
MVEI Models	Motor Vehicle Emission Inventory Models
MVEI7G1.0c	The most recent MVEI version
MVSTAFF	Motor Vehicle Stock, Travel and Fuel Forecast
MY	Model Year
NCDC	National Climatic Data Center
NFRAQS	Northern Front Range Air Quality Study
NOAA	National Oceanographic and Atmospheric Admin.
NREL	National Renewable Energy Laboratory
NWS	National Weather Service
NYBC	New York Bus Composite Cycle
NYSDEC	New York State Department of Environmental Conservation and Energy
OBD	On-Board Diagnostics
PES	Pacific Environmental Services
PKE	Positive Kinetic Energy
POP	Population of Vehicles
PROC GLM	General Linear Model Procedure in SAS
Radian	Radian Corporation
RCE	Repair Correction Efficiency
RPM	Revolutions per Minute
REG	Registration
RLHP	Road Load Horsepower

RVP	Reid Vapor Pressure
SAE	Society of Automotive Engineers
SAS	Statistical Analysis Software by SAS, Inc.
SCAB	South Coast Air Basin
SCAQMD	South Coast Air Quality Management District
SCF	Speed Correction Factors
SC03	Air Conditioning Cycle #3
Sierra	Sierra Research, Inc.
SIP	State Implementation Plan
SHED	Sealed Housing Evaporative Determination
SSD	Stationary Source Division
Start	Vehicle starts
StCF	Start Correction Factor
TCF	Temperature Correction Factors
TDC	Teale Data Center
TDMs	Travel Demand Models
TIUS	Truck Inventory Usage Survey
TPD	Tons Per Day
UC	Unified Cycle (same as LA92)
UCC	Unified Correction Cycle
UDDS	Urban Dynamometer Driving Schedule for heavy-duty vehicles
U.S. EPA/EPA	United State Environmental Protection Agency
VMT	Vehicle Miles Traveled
WSPA	Western States Petroleum Association
WVU	University of West Virginia
ZM	Zero Mile Value

Pollutants

CO	Carbon monoxide
CO2	Carbon dioxide
HC	Total hydrocarbons
NMOG	Non-methane Organic Gases
NO_X	Oxides of Nitrogen
O3	Ozone
Pb	Lead
PM	Total particulate matter
PM_{10}	Particulate matter 10 microns in diameter or smaller
ROG	Reactive organic gases
SOx	Oxides of Sulfur
TOG	Total organic gases

Vehicle Classes

HDT	Heavy-Duty Trucks
HDDT	Heavy-Duty Diesel Trucks
HDGT	Heavy-Duty Gas Trucks

HHDT	Heavy-Heavy Diesel Trucks
LDA	Light-Duty Autos
LDT	Light-Duty Trucks
LDV	Light-Duty Vehicles
LHGT	Light-Heavy Gas Trucks
LHDT	Light-Heavy Diesel Trucks
MDT/MDV	Medium-Duty Trucks/Vehicles
MHGT	Medium-Heavy Gas Trucks
MHDT	Medium-Heavy Diesel Trucks
MCY	Motorcycles
PC	Passenger Cars
Tn	Truck subcategory n
UBD	Urban Transit Buses

Vehicle Technology Groups

AFC	Adaptive Fuel Control
AIR	Air Injection
DSL	Diesel-fueled vehicles
CARB	Carbureted Fuel Delivery
CAT	Catalyst-equipped vehicles
GCL	Greater Catalyst Loading
LEV	Low Emission Vehicle
LEVII	Low Emission Vehicle Program II
MEX	Mexican Vehicle
MFI/MPFI/PFI	Multipoint/Multiport Fuel Injection
NCAT	Non-catalyst-equipped vehicles
OXCAT	Oxidation catalyst
SULEV	Super ULEV (see ULEV)
SULEVII	SULEV Program II
TBI	Throttle Body Injection
TWC	Three-way Catalyst
TLEV	Transitional Low Emission Vehicle
ULEV	Ultra Low Emission Vehicle
ZEB	Zero Emission Bus
ZEV	Zero Emission Vehicle

Appendix B - EMFAC2000 Technology Groups

Tech Group	MY Group	Description
1	<75	LDV no AIR
2	<75	LDV with AIR
3	75+	LDV noncatalyst
4	75-76	LDV OxCat with AIR
5	75-79	LDV OxCat no AIR
6	80+	LDV OxCat no AIR
7	77+	LDV OxCat with AIR
8	77-79	LDV TWC TBI/CARB
9	81-84	LDV TWC TBI/CARB 0.7 NOx
10	85+	LDV TWC TBI/CARB 0.7 NOx
11	77-80	LDV TWC MPFI
12	81-85	LDV TWC MPFI 0.7 NOx
13	86+	LDV TWC MPFI 0.7 NOx
14	81+	LDV TWC TBI/CARB 0.4 NOx
15	81+	LDV TWC MPFI 0.4 NOx
16	1980	LDV TWC TBI/CARB
17	93+	LDV TWC TBI/CARB .25 HC
18	93+	LDV TWC MPFI .25 HC
19	96+	LDV TWC TBI/CRB .25 OBD2
20	96+	LDV TWC MPFI .25HC OBD2
21	94-95	LDV TLEV MPFI .25HC
22	96+	LDV TLEV OBD2 GCL
23	96+	LDV LEV OBD2 GCL CBC AFC
24	96+	LDV ULEV OBD2 GCL CBC AFC
25	ALL	ZEV
26	96+	LDT TWC MPFI OBD2 .7NOx
27	96+	LDV TWC TBI/CARB OBD2
28	04+	LDV LEV II
29	04+	LDV ULEV II
30	04+	LDV SULEV II
40	Mex	LDV NoCat/NoAir
41	Mex	LDV OxCat with AIR
42	Mex	LDV TWC TBI/CARB 0.7 NOx
43	Mex	LDV TWC MPFI 0.7 NOx
50	<77	LHD1 gas
51	77-84	LHD1 gas
52	85+	LHD1 gas
53	94+	LHD1 gas MDV
54	94+	LHD1 gas LEV
55	94+	LHD1 gas ULEV
60	pre-77	LHD1 dsl
61	1977-79	LHD1 dsl
62	1980-83	LHD1 dsl
63	1984-86	LHD1 dsl
64	1987-90	LHD1 dsl
65	1991-93	LHD1 dsl

66	1994	LHD1 dsl
67	1995	LHD1 dsl
68	1996-2001	LHD1 dsl
69	2002-03	LHD1 dsl
70	2004+	LHD1 dsl
80	<77	LHD2 gas
81	77-84	LHD2 gas
82	85+	LHD2 gas
83	94+	LHD2 gas MDV
84	94+	LHD2 gas LEV
85	94+	LHD2 gas ULEV
90	pre-77	LHD2 dsl
91	1977-79	LHD2 dsl
92	1980-83	LHD2 dsl
93	1984-86	LHD2 dsl
94	1987-90	LHD2 dsl
95	1991-93	LHD2 dsl
96	1994	LHD2 dsl
97	1995	LHD2 dsl
98	1996-2001	LHD2 dsl
99	2002-03	LHD2 dsl
100	2004+	LHD2 dsl
110	<77	MHDV gas
111	77-84	MHDV gas
112	85+	MHDV gas
120	pre-1977	MHDV dsl
121	1977-79	MHDV dsl
122	1980-83	MHDV dsl
123	1984-86	MHDV dsl
124	1987-90	MHDV dsl
125	1991-93	MHDV dsl
126	1994-97	MHDV dsl
127	1998-2001	MHDV dsl
128	2002-2003	MHDV dsl
129	2004+	MHDV dsl
140	<77	HHDV/LHV gas
141	77-84	HHDV/LHV gas
142	85+	HHDV/LHV gas
150	pre-1977	CA HHDV/LHV dsl
151	1977-79	CA HHDV/LHV dsl
152	1980-83	CA HHDV/LHV dsl
153	1984-86	CA HHDV/LHV dsl
154	1987-90	CA HHDV/LHV dsl
155	1991-93	CA HHDV/LHV dsl
156	1994-97	CA HHDV/LHV dsl
157	1998-2001	CA HHDV/LHV dsl
158	2002-2003	CA HHDV/LHV dsl
159	2004+	CA HHDV/LHV dsl
170	65-74	LDA dsl
171	75-79	LDA dsl
172	80	LDA dsl

173	81-83	LDA dsl
174	84-85	LDA dsl
175	86	LDA dsl
176	87-95	LDA dsl
177	96+	LDA dsl
178	65-78	LDT dsl
179	79-80	LDT dsl
180	81-83	LDT dsl
181	84-85	LDT dsl
182	86	LDT dsl
183	87-93	LDT dsl
184	94-96	LDT dsl
185	97+	LDT dsl
186	65-78	MDT dsl <8500LBS
187	79-80	MDT dsl
188	81-82	MDT dsl
189	83-84	MDT dsl
190	85-86	MDT dsl
191	87-90	MDT dsl
192	91-93	MDT dsl
193	94-96	MDT dsl
194	97+	MDT dsl
200	pre-1979	Federal HHDV/LHV dsl
201	1979-83	Federal HHDV/LHV dsl
202	1984-87	Federal HHDV/LHV dsl
203	1988-90	Federal HHDV/LHV dsl
204	1991-93	Federal HHDV/LHV dsl
205	1994-97	Federal HHDV/LHV dsl
206	1998-2001	Federal HHDV/LHV dsl
207	2002-2003	Federal HHDV/LHV dsl
208	2004+	Federal HHDV/LHV dsl
220	<73	UB dsl
221	73-83	UB dsl
222	84-90	UB dsl
223	91-93	UB dsl
224	94-95	UB dsl
225	96+	UB dsl
230	<77	SBUS gas
231	77-84	SBUS gas
232	85+	SBUS gas
240	pre-1977	SBUS dsl
241	1977-79	SBUS dsl
242	1980-83	SBUS dsl
243	1984-86	SBUS dsl
244	1987-90	SBUS dsl
245	1991-93	SBUS dsl
246	1994-97	SBUS dsl
247	1998-2001	SBUS dsl
248	2002-2003	SBUS dsl
249	2004+	SBUS dsl
	Motorcycles	

260	2 stroke/6g evap
261	Pre-1978/6g evap
262	78-79Carb/6g evap
263	80-81Carb/6g evap
264	82-84Carb/6g evap
265	85-87Carb/2g evap
266	88-2003Carb/2g evap
267	88-2003FI/2g evap
268	88-2003Carb+cat/2g evap
269	88-2003FI+cat/2g evap
270	2003-08carb/2g evap
271	2003-08FI/2g evap
272	2003-08 Caer+cat/2 evap
273	2003-08FI+cat/2g evap
274	2008+carb/2 evap
275	2008+fi/2 evap
276	2008+Carb+Cat/2g evap
277	2008+FI+Cat/2 g evap

Section ES EXECUTIVE SUMMARY

The emissions inventory is the foundation upon which the Air Resources Board regulatory strategy rests. Prior to the consideration of any new vehicle standard or in use emissions control program, an inventory assessment is made of that source's contribution to the overall inventory, and what properties and process lead to excess emissions. The inventory is used as one gauge by which progress toward attainment is measured, and by which each estimate of the cost effectiveness of control measures is assessed.

Over the years, the increasing stringency of emissions standards was met with technological solutions of greater complexity. In response, the emissions estimation models have grown in size and complexity. What hasn't changed, however, is the reliance on the accuracy of the inventory in making those decisions which ultimately effect all of California and in some instances, the entire nation. Given how critical an accurate inventory is to the regulatory process, staff was charged to review and incorporate the latest emissions modeling information available, and to undertake research and test projects where this information was found to be lacking.

Methodologies that had previously been reviewed and approved were re-evaluated and in many instances, revised or eliminated. In this revision of the model, staff performed hundreds of analyses, some proving to have a large impact on the inventory, some having very little impact. Some analyses lead to a decrease in estimated emissions, many lead to increases. No goal or emissions "target" was established except to produce as functional, flexible and accurate an emissions calculation tool possible.

The staff of the Air Resources Board is seeking Board approval of the inventory of pollutants from on-road mobile sources as calculated by the latest version of inventory estimation model, EMFAC2000. EMFAC2000 estimates the total emissions for the entire state, subtotals for each of the seventeen air basins, thirteen districts and fifty-eight counties. The model produces emission rates and inventories of exhaust and evaporative hydrocarbons, carbon monoxide, oxides of nitrogen and particulate matter associated with exhaust, tire-wear and brake-wear. Hydrocarbon emissions estimates are produced for total hydrocarbon, total organic gases, and reactive organic gases. Particulate matter estimates are made for total suspended particulate, particulate ten microns in diameter or less, and particulate 2.5 microns in diameter or less. The model also estimates emissions of oxides of sulfur, lead, and carbon dioxide. The carbon dioxide inventory is used to estimate fuel consumption. Although the estimation of toxic air contaminants is currently performed outside of EMFAC2000, efforts are underway to include this capability in the next version of the model.

In addition to current year inventories, the model is capable of estimating back-cast and forecasted inventories for calendar years 1980 to 2040. Temperature and humidity profiles are used to produce month specific, annual average and episodic inventories. Staff is also seeking approval of these ancillary products of the estimation model.

Section 1.0 BACKGROUND

The on-road motor vehicle emission inventory can be summarized as the product of an emission rate (e.g., grams/mile) and an associated vehicle activity (e.g., miles/day). Emission rate data are collected on individual vehicles in a laboratory setting. These tests are performed primarily by the ARB and U.S. EPA[1]. Activity data are available from many sources, including the DMV, CALTRANS, and MPOs.

For planning purposes, it is necessary to predict emission rates, activity, and inventories for the future this necessitates the development of mathematical models. These models can then be used to develop emission inventories for conditions, places, and times that cannot be measured directly.

A list of the various acronyms used in this report is included in the Appendix.

Section 3.3 GEOGRAPHIC AREAS

The EMFAC2000 model can generate emission inventories for fifteen air basins[1], fifty-eight counties and thirty five-air pollution control districts. This section lists these geographic areas; the area-specific activity files, and details how the data are used in calculating area specific emissions.

3.3.1 Introduction

The MVEI7G model generates emission inventories for fourteen air basins and fifty-eight counties. Table 3.3-1 summarizes how the emission inventories are calculated by county, air basin, and the state.

Table 3.3-1 How Emission Inventories Are Calculated In MVEI7G

Area	Methodology
County	The model does not explicitly generate county specific emission inventories. Instead it calculates the portion of the county's emissions within an air basin. The model contains county specific estimates of vehicle population and vehicle miles traveled (VMT) by vehicle class. The model also contains period specific temperature and speed distributions. The class specific population and registration distribution are used to calculate the model year specific population estimates. The model year specific population estimates are then used in calculating "per vehicle" emissions, i.e., hot soak, diurnal and resting loss emissions. The class specific VMT estimate is also disaggregated into a model year specific basis using travel fractions. The model year specific VMT estimates are then used in calculating emissions on a "per mile" basis, i.e., exhaust emissions.
Air Basin	The emissions inventory for an air basin is calculated by summing the emissions from counties or parts of counties that reside within an air basin. Emissions from counties that span two or more air basins (sub-counties) are estimated by applying appropriate VMT splits to county specific emission estimates.
Statewide	The statewide emissions inventory is calculated by summing the emission estimates from each air basin.

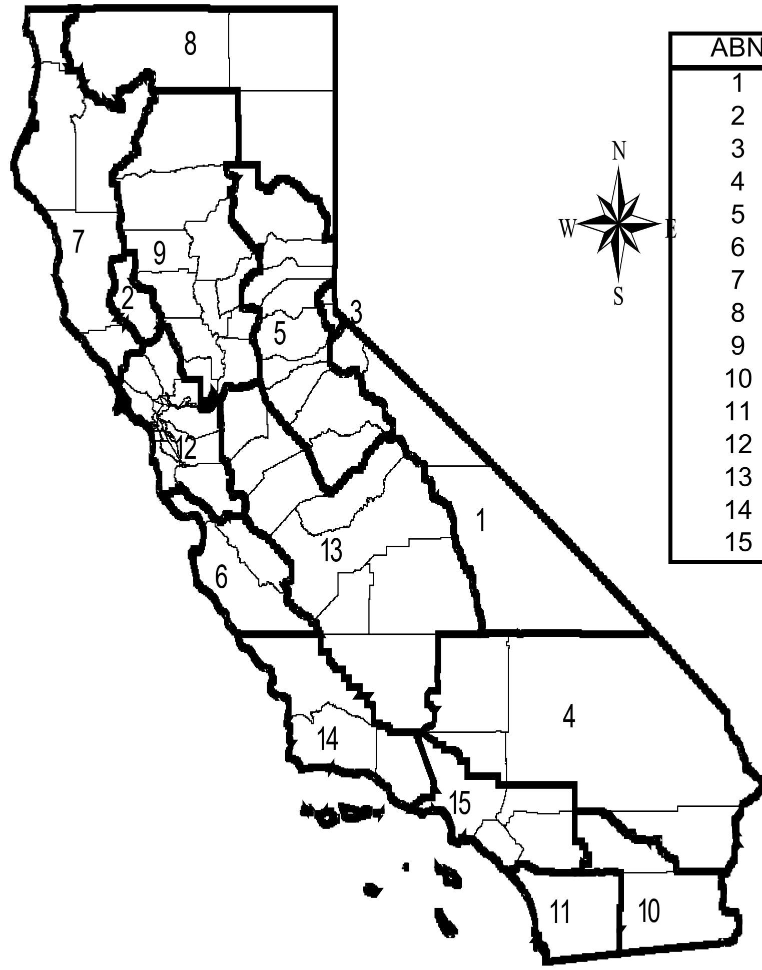
The EMFAC2000 model contains activity data for sixty-nine geographic areas. These sixty-nine areas include counties that overlap several air basins and air pollution control districts. Figure 3.3-1 shows the air basin and county boundaries. Table 3.3-2 lists the geographic areas modeled in EMFAC2000.

[1] The South East Desert air basin was redesignated into the Salton Sea and Mojave Desert air basins.

The EMFAC2000 model contains the following area specific data files:

1. Poprdata.for. This file contains the number of registered vehicles by age, vehicle class, fuel type and geographic area.
2. Cunrdata.for This file contains the number of chronically unregistered vehicles by age, vehicle class, fuel type and geographic area.
3. Popgdata.for This file contains the population growth rates by calendar year, vehicle class, fuel type, and geographic area.
4. Tempdata.for This file contains averaged monthly, summer and winter episodic diurnal temperatures for each geographic area.
5. Rh_data.for This file contains averaged monthly relative humidities for each geographic area.
6. Accrdata.for This file contains accrual rates by age, vehicle class, fuel type and geographic area.
7. Rvp_data.for This file contains the monthly, summer and winter gasoline fuel Reid Vapor Pressures for each geographic area and calendar year.
8. Area_im.for This file contains default Inspection and Maintenance options for each geographic area.

The EMFAC2000 model more accurately estimates the emissions for each geographic area than the MVEI7G model primarily due to the usage of area specific activity data. However, this increase in accuracy results in longer execution times. To compensate for this, the user has an option of calculating the emissions using either the "Simple-Average" or "Do-each-sub-area" options. The "Simple-Average" option provides emission estimates faster than the "Do-each-sub-area" option however some simplifying assumptions are made resulting in less accuracy. The latter option provides the most accurate emission estimates. The "Simple-Average" option calculates emissions that are within 0.5% of the emission estimates obtained using the "Do-each-sub-area" option.



ABN	Air Basin
1	Great Basin Valleys
2	Lake County
3	Lake Tahoe
4	Mojave Desert
5	Mountain Counties
6	North Central Coast
7	North Coast
8	Northeast Plateau
9	Sacramento Valley
10	Salton Sea
11	San Diego
12	San Francisco Bay Area
13	San Joaquin Valley
14	South Central Coast
15	South Coast

Figure 3.3-1 **Air Basin and County Boundaries**

Table 3.3-2 List of Geographic Areas Modeled in EMFAC2000

ABN	APCD	County	Area	AB_Code	Air Basin	Air Pollution District	County
1	10	2	1	GBV	Great Basin Valleys	Great Basin Unified APCD	Alpine
1	10	14	2	GBV	Great Basin Valleys	Great Basin Unified APCD	Inyo
1	10	26	3	GBV	Great Basin Valleys	Great Basin Unified APCD	Mono
2	13	17	4	LC	Lake County	Lake County APCD	Lake
3	7	9	5	LT	Lake Tahoe	El Dorado County APCD	El Dorado
3	23	31	6	LT	Lake Tahoe	Placer County APCD	Placer
5	1	3	7	MC	Mountain Counties	Amador County APCD	Amador
5	5	5	8	MC	Mountain Counties	Calaveras County APCD	Calaveras
5	7	9	9	MC	Mountain Counties	El Dorado County APCD	El Dorado
5	15	22	10	MC	Mountain Counties	Mariposa County APCD	Mariposa
5	21	29	11	MC	Mountain Counties	Northern Sierra AQMD	Nevada
5	23	31	12	MC	Mountain Counties	Placer County APCD	Placer
5	21	32	13	MC	Mountain Counties	Northern Sierra AQMD	Plumas
5	21	46	14	MC	Mountain Counties	Northern Sierra AQMD	Sierra
5	33	55	15	MC	Mountain Counties	Tuolumne County APCD	Tuolumne
6	19	27	16	NCC	North Central Coast	Monterey Bay Unified APCD	Monterey
6	19	35	17	NCC	North Central Coast	Monterey Bay Unified APCD	San Benito
6	19	44	18	NCC	North Central Coast	Monterey Bay Unified APCD	Santa Cruz
7	20	8	19	NC	North Coast	North Coast Unified AQMD	Del Norte
7	20	12	20	NC	North Coast	North Coast Unified AQMD	Humboldt
7	16	23	21	NC	North Coast	Mendocino County APCD	Mendocino
7	22	49	22	NC	North Coast	Northern Sonoma County APCD	Sonoma
7	20	53	23	NC	North Coast	North Coast Unified AQMD	Trinity
8	14	18	24	NEP	Northeast Plateau	Lassen County APCD	Lassen
8	17	25	25	NEP	Northeast Plateau	Modoc County APCD	Modoc
8	30	47	26	NEP	Northeast Plateau	Siskiyou County APCD	Siskiyou
9	4	4	27	SV	Sacramento Valley	Butte County AQMD	Butte
9	6	6	28	SV	Sacramento Valley	Colusa County APCD	Colusa
9	9	11	29	SV	Sacramento Valley	Glenn County APCD	Glenn
9	23	31	30	SV	Sacramento Valley	Placer County APCD	Placer
9	24	34	31	SV	Sacramento Valley	Sacramento Metropolitan AQMD	Sacramento
9	29	45	32	SV	Sacramento Valley	Shasta County AQMD	Shasta
9	35	48	33	SV	Sacramento Valley	Yolo/Solano AQMD	Solano
9	8	51	34	SV	Sacramento Valley	Feather River AQMD	Sutter
9	32	52	35	SV	Sacramento Valley	Tehama County APCD	Tehama
9	35	57	36	SV	Sacramento Valley	Yolo/Solano AQMD	Yolo
9	8	58	37	SV	Sacramento Valley	Feather River AQMD	Yuba
11	25	37	38	SD	San Diego	San Diego County APCD	San Diego
12	3	1	39	SF	San Francisco Bay Area	Bay Area AQMD	Alameda
12	3	7	40	SF	San Francisco Bay Area	Bay Area AQMD	Contra Costa
12	3	21	41	SF	San Francisco Bay Area	Bay Area AQMD	Marin
12	3	28	42	SF	San Francisco Bay Area	Bay Area AQMD	Napa
12	3	38	43	SF	San Francisco Bay Area	Bay Area AQMD	San Francisco
12	3	41	44	SF	San Francisco Bay Area	Bay Area AQMD	San Mateo
12	3	43	45	SF	San Francisco Bay Area	Bay Area AQMD	Santa Clara
12	3	48	46	SF	San Francisco Bay Area	Bay Area AQMD	Solano
12	3	49	47	SF	San Francisco Bay Area	Bay Area AQMD	Sonoma
13	26	10	48	SJV	San Joaquin Valley	San Joaquin Valley Unified APCD	Fresno
13	26	15	49	SJV	San Joaquin Valley	San Joaquin Valley Unified APCD	Kern
13	26	16	50	SJV	San Joaquin Valley	San Joaquin Valley Unified APCD	Kings
13	26	20	51	SJV	San Joaquin Valley	San Joaquin Valley Unified APCD	Madera
13	26	24	52	SJV	San Joaquin Valley	San Joaquin Valley Unified APCD	Merced
13	26	39	53	SJV	San Joaquin Valley	San Joaquin Valley Unified APCD	San Joaquin
13	26	50	54	SJV	San Joaquin Valley	San Joaquin Valley Unified APCD	Stanislaus
13	26	54	55	SJV	San Joaquin Valley	San Joaquin Valley Unified APCD	Tulare
14	27	40	56	SCC	South Central Coast	San Luis Obispo County APCD	San Luis Obispo
14	28	42	57	SCC	South Central Coast	Santa Barbara County APCD	Santa Barbara
14	34	56	58	SCC	South Central Coast	Ventura County APCD	Ventura
15	31	19	59	SC	South Coast	South Coast AQMD	Los Angeles
15	31	30	60	SC	South Coast	South Coast AQMD	Orange
15	31	33	61	SC	South Coast	South Coast AQMD	Riverside
15	31	36	62	SC	South Coast	South Coast AQMD	San Bernardino
10	11	13	63	SS	Salton Sea	Imperial County APCD	Imperial
10	31	33	64	SS	Salton Sea	South Coast AQMD	Riverside
4	12	15	65	MD	Mojave Desert	Kern County APCD	Kern
4	18	33	66	MD	Mojave Desert	Mojave Desert AQMD	Riverside
4	31	33	67	MD	Mojave Desert	South Coast AQMD	Riverside
4	2	19	68	MD	Mojave Desert	Antelope Valley APCD	Los Angeles
4	18	36	69	MD	Mojave Desert	Mojave Desert AQMD	San Bernardino

Where:
ABN = Air Basin Number APCD = Air Pollution Control District
County = County Specific Identification Number
Area = Geographic Area Index AB_Code = Air Basin Abbreviation

3.3.2 Emissions Estimated Using the Simple-Average Option

This section details how the county, air basin, air pollution control district and statewide inventories are calculated using the “Simple-Average” option. The methodology described below for calculating the emissions and activity for an air basin is also used in calculating emission inventories for the air pollution control districts and the state.

County: The EMFAC2000 model explicitly calculates emissions for any county using the “Simple-Average” option.

Air Basin: The model first calculates appropriate averages for: vehicle miles traveled, temperature, relative humidity, fuel RVP, Inspection and Maintenance and speed. For example, the model calculates the vehicle population in the air basin by summing the model year specific populations across all areas within the air basin (AB).

$$POPULATION_{AB} = \sum_{i=1}^{area} POP_{area} \qquad (3.3-1)$$

The area specific VMT is calculated by multiplying the area specific population by the area specific cumulative mileage and then summing across all areas.

$$VMT_{AB} = \sum_{i=1}^{area} (POP_{area} * Cumulative\_Milage_{area}) \qquad (3.3-2)$$

The averaged diurnal temperature profile is calculated by appropriately weighting the area specific temperatures by the area specific VMT.

$$TEMPERATURE_{AB} = \frac{\sum_{i=1}^{area} (VMT_{area} * Temp_{area})}{VMT_{AB}} \qquad (3.3-3)$$

The basin specific relative humidity, fuel RVP and the percent of travel in each speed bin are also calculated by weighting with the area specific VMT.

The basin specific with and without I&M emissions are also weighted by the portion of travel that occurs in with I&M areas. The emissions (in tons per day) are weighted to account for areas that are and are not subject to an I&M program. The I&M weighting factor is a ratio of the (VMT in I&M Areas)/(Total VMT in AB). Equation 3.3-4 shows how the basin specific emissions are calculated.

$Emissions_{AB}$ = With_IM_tons_per_day * I&M_Weighting_Factor + Without_I&M_tons_per_day * (1 – I&M_Weighting_Factor) (3.3-4)

3.3.3 Emissions Estimated Using the Sub-Area Option

The following section details how the emissions are calculated by county, air basin, air pollution district and the state using the "Sub-Area" option. The methodology described below for calculating an inventory for the air basin is also used in calculating an inventory for the state, and air pollution control districts.

County: The EMFAC2000 model explicitly calculates emissions for any county using the "Simple-Average" option.

Air Basin The EMFAC2000 model first calculates the emissions for each area and sub-areas within the air basin. These emissions are then summed to calculate the emissions inventory for the air basin.

Section 8.0 METHODOLOGY USED TO MODEL INSPECTION AND MAINTENANCE (I&M) PROGRAMS

This section describes how inspection and maintenance (I&M) or smog check programs effect basic exhaust emission rates, and how these effects were simulated in the CALIMFAC[1] (preprocessor to the MVEI7G model) and EMFAC2000 models.

8.1 Introduction

The basic exhaust and evaporative emission rates increase as a function of vehicle age and/or mileage. This deterioration in emissions control occurs as a result of vehicle defects and/or malmaintenance, which includes tampering by the vehicle owner. Historically, two strategies have been employed to reduce emissions from motor vehicles; the first approach relied on lowering the emission standards from new vehicles, the second was to lower emissions from in-use vehicles. The primary goal of an I&M program is to reduce emissions from in-use vehicles by identifying and repairing malperforming vehicles during periodic inspections. In California, the first statewide biennial inspection program was introduced in 1984. In this program raw exhaust concentrations of hydrocarbon and carbon monoxide emissions were measured at idle from gasoline fueled passenger cars (PC), light-duty trucks (LDT) and medium trucks (MDV). These raw measurements were then compared to emission cutpoints to determine the pass/fail status of the vehicle. In addition, the mechanic would perform a visual and functional check of the air injection system, exhaust gas re-circulation system, oxygen sensor and the catalyst. The vehicle owner was required to spend up to $50 for repair if the vehicle failed either the exhaust or the visual/functional test. The owner was issued a repair waiver if the total cost of repairs exceeded $50. The 1984 program was first revised by the State legislature in 1990 (1990 I&M) and then again in 1996 (enhanced program) with the goal of improving the identification and repair rates. As a result, some vehicles have been subject to three different I&M programs in their lifetime. For example, a 1980 model year vehicle has been subject to the 1984, 1990 and enhanced I&M programs. Table 8-1 provides detail on the type of inspections, repair cost limits, and visual/functional checks performed in each program.

Figure 8-1 shows a comparison of how emissions from vehicles increase, with the same model year and technology that undergo a biennial inspection versus those that bypass the inspection program. The first inspection is represented by point A in figure 8-1. The change in emissions from point A to point B reflects the fact that some vehicles are identified and repaired at smog check. The emissions then increase due to vehicle deterioration, and are reduced again at the next inspection. The mid-point of the saw tooth represents the average emissions increase for vehicles subject to an I&M program. In Figure 8-1 further changes to the I&M program, i.e. changing to ASM testing are reflected by points C and D. Figure 8-1 illustrates three key components necessary for modeling an I&M program. These are:

[1] CALIMFAC: California's I&M Benefits Model, developed in June 1990 by Sierra Research under contract to the Air Resources Board.

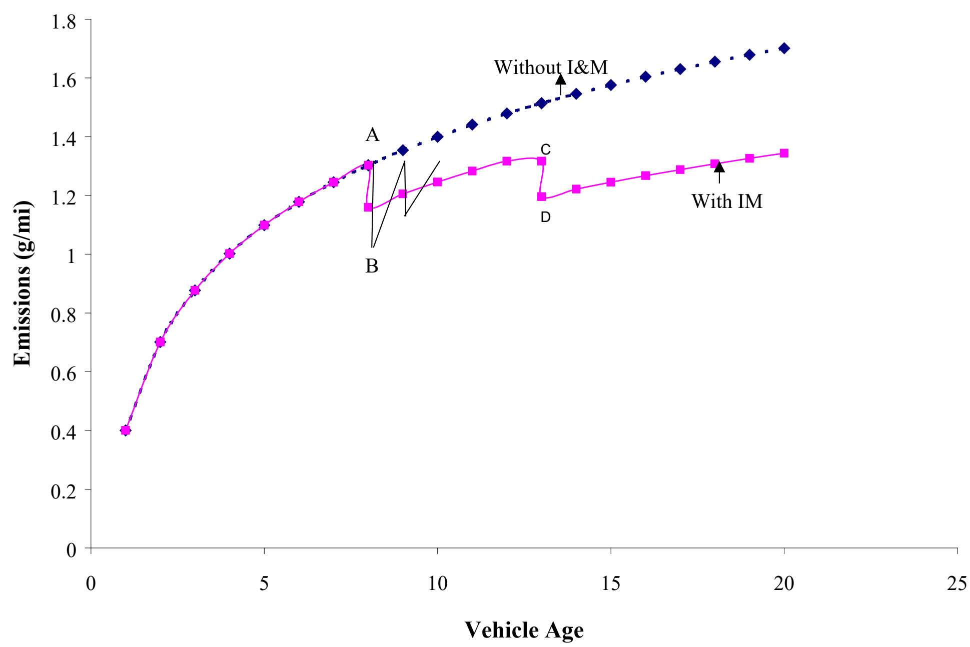
Table 8-1 California's Inspection and Maintenance Programs

I&M Program	Start date	Vehicle Type	Model Year Group	Test Type	Emissions Measured	Repair Cost Limit ($)	Type of Visual & Funcational	Evap. System Check	New Vehicle Exemptions
1984 or	March, 1984	PC-MDV	1965-79	Idle Only	HC, CO	50	Air/EGR/O2-sensor/Cat	None	1 Year
BAR 84		PC-MDV	1980+	Idle+2500		50	Air/EGR/O2-sensor/Cat	None	1 Year
1990 or	July, 1990	PC-MDV	Pre-1972	Idle+2500	HC, CO	50	Full Visual & Functional	None	1 Year
BAR 90		HDV	1972-74	Idle+2500		90	Full Visual & Functional	None	1 Year
			1975-79	Idle+2500		125	Full Visual & Functional	None	1 Year
			1980-89	Idle+2500		175	Full Visual & Functional	None	1 Year
			1990+	Idle+2500		300	Full Visual & Functional	None	1 Year
Enhanced Basic	August, 1997	PC-MDV + HDV	1974+	Idle+2500	HC, CO,	450	Full Visual & Functional	Gas Cap	4 Years
Enhanced	June, 1998(*)	PC-MDV	1974+	ASM	HC, CO, NOx	450	Full Visual & Functional	Gas Cap	4 Years

(*) Although ASM testing began in June, 1998 it is assumed that the required cutpoints will not be in place until sometime in 2001.

Figure 8-1 Illustration of How I&M Programs Lower Vehicle Deterioration Rates

1. Identification Rate: This is the number of vehicles at point A that fail the inspection

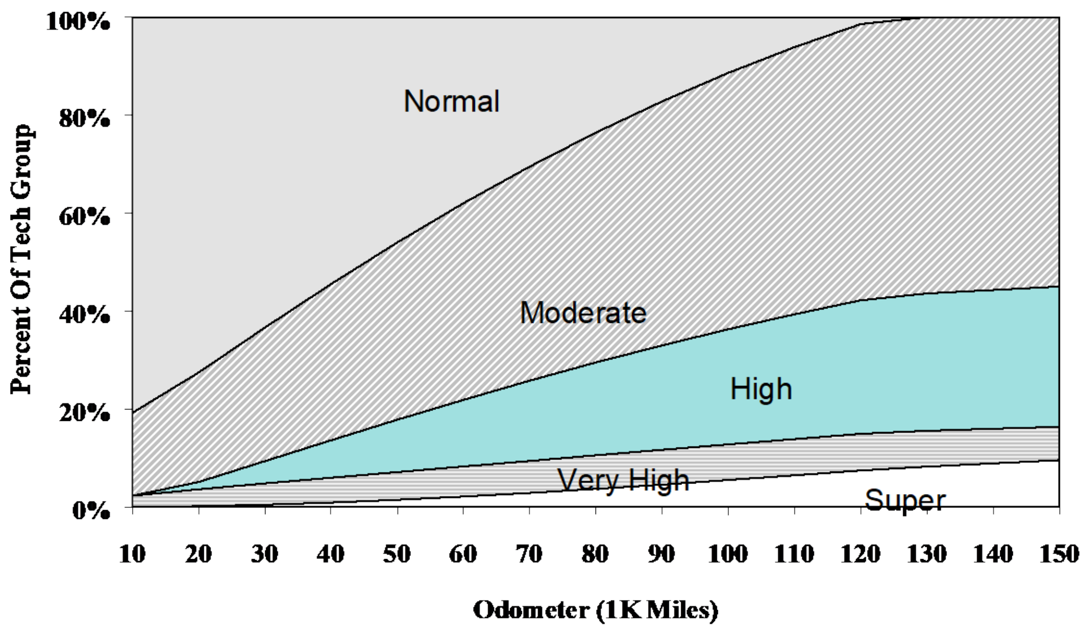


program.
2. Repair Effectiveness: This is a measure of how well the failing vehicles are repaired as indicated by the reduction in emissions from points A to B.
3. Vehicle Deterioration: What is the deterioration rate for vehicles that have undergone an I&M program.

8.2 Background

This section describes how I&M programs were simulated in the CALIMFAC model, and how they are modeled in EMFAC2000. Following is a sample calculation of how one I&M cycle is simulated. This illustrates some of the similarities and differences in how I&M is modeled in both models. Both models start by calculating the populations of each regime as a function of vehicle mileage. Figure 8-2 shows an example of the regime sizes for Oxides of Nitrogen (NOx) for vehicles in technology group 12.

Figure 8-2 <u>Regime Sizes for Vehicles in Technology Group 12</u>



Assuming that the first inspection occurs at 100,000 miles, the model calculates that 5.5%, 7.3%, 23.5%, 52.3% and 11.4% of the vehicles in technology group 12 are supers, very highs, highs, moderates and normal[1] emitters for NOx, respectively. This regime specific population distribution is then multiplied by the regime specific identification rates (Table 8-1) to calculate the number of passing and failing vehicles. The identification rate is the percentage of vehicles, by regime, that will fail a given I&M program. The failing vehicles are repaired as indicated by the movement towards lower emitting regimes. For example, of the 4.5 supers that were repaired; 1.3 remained as supers, 2.6 became very high emitters and 0.6 became high emitters. This distribution of vehicles after repair is known as the "post-repair move matrix." The distribution of vehicles after repair is then added to the distribution of passing vehicles to calculate the "post-repair matrix." After one I&M cycle 2.8%, 10.3%, 22.8%, 51.5% and 12.6% of the vehicles in technology group 12 are super, very high, high, moderate and normal emitters, respectively. The after-repair regime specific populations then grow (or deteriorate) according to the after-repair regime growth rates.

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[1] Section 4.5 details how vehicles within a particular technology group are classified into the normal, moderate, high, very high and super emission regimes.

Table 8-1 Example of One I&M Cycle

	100K	ID_rate	Passed	Failed	Post Repair Move Matrix N	M	H	VH	S		Post Repr + Passing
S	5.5	0.82	1.0	4.5	0.0	0.0	0.6	2.6	1.3		2.8
V	7.3	0.66	2.5	4.8	0.1	0.2	1.0	3.2	0.3		10.3
H	23.5	0.69	7.3	16.2	0.6	1.2	12.1	2.1	0.2		22.8
M	52.3	0.39	31.9	20.4	0.9	17.7	1.8	0.0	0.0		51.5
N	11.4	0.3	8.0	3.4	2.9	0.5	0.0	0.0	0.0		12.6
				Total	4.6	19.6	15.5	7.9	1.8		100.0

S=*Super* V=*Very High*, H=*High,* M=*Moderate*, N=*Normal*

The example described above shows in general terms how an I&M cycle is simulated in both the CALIMFAC and EMFAC2000 models. The following sections provide more detail on the data sources, identification rates, repair move matrices and how deterioration is modeled in both models.

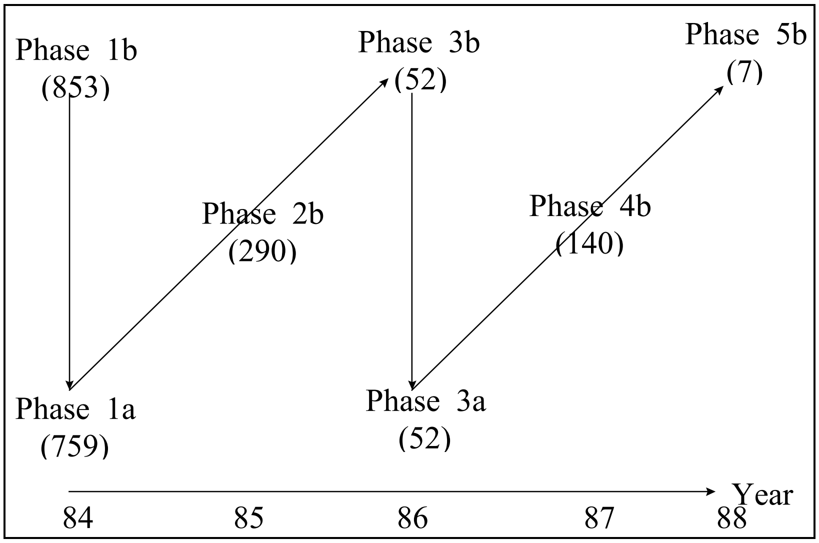
8.3 Data Sources

1984 I&M Program

The 1984 I&M evaluation program consisted of five phases carried out over a period of five years, beginning in 1984. Figure 8-3 shows the number of vehicles tested during each phase. The same group of vehicles was tested during phase_1b, phase_1a, phase_2b and phase_4b. Another group of vehicles, mainly 1980 and newer, was tested during other phases of the program.

During phase_1b, 853 vehicles failing the BAR 84 test were procured and given a baseline FTP and a BAR 84 test at CARB’s Haagen-Smit Laboratory (HSL). These vehicles were then sent randomly to smog check stations in the South Coast Air Basin (SCAB). Repairs performed at these stations were noted in a database. These vehicles were then given a confirmatory BAR 84 test and an after-repair FTP test at HSL. In the second phase, vehicles were brought in and given a baseline FTP and a BAR 84 test. In phase_3, another group of vehicles was procured and subjected to the same sequence of tests as vehicles in phase_1. A subset of vehicles tested in phase_1 were procured for baseline FTP tests during phase_4. During phase_5, a subset of vehicles tested in phase_3 were procured and given a baseline FTP test.

Figure 8-3 **Vehicles Tested During The 1984 I&M Evaluation Program**



Where:
The letters "b" and "a" refer to baseline and after-repair tests.

The 1984 I&M evaluation program data was used to:

1. Calculate identification rates for vehicles tested in phase_1b.
2. Calculate repair move matrices for vehicles tested in phase_1 and phase_3.
3. Calculate move matrices that describe the movement of vehicles between inspection cycles.
4. Calculate deterioration rates for vehicles tested in phase_2 and phase_4, and compare them to each other, to vehicles tested in the 1990 I&M program, and to vehicles not subject to an I&M program.

1990 I&M Program

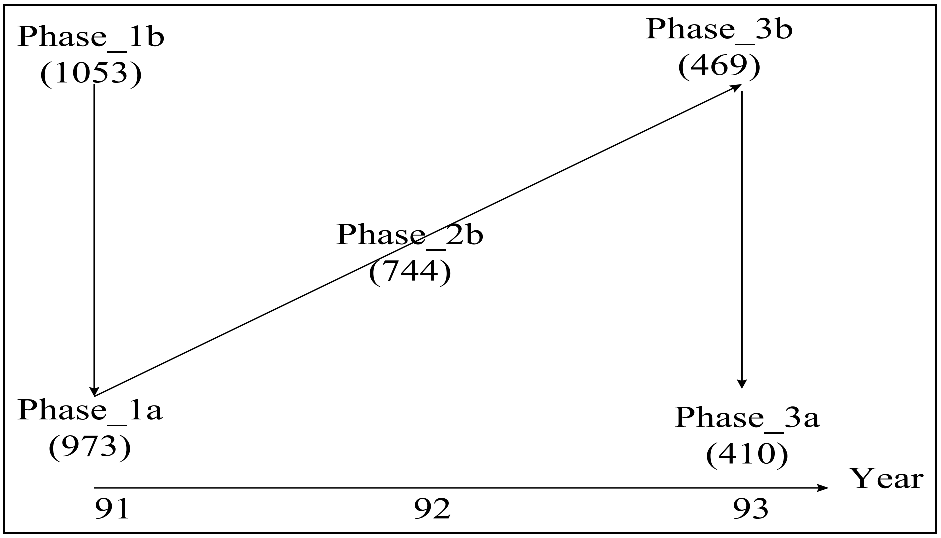
The 1990 I&M evaluation program consisted of three phases (Figure 8-4) carried out over a period of three years beginning in 1991. Figure 8-4 shows the number of vehicles tested during each phase. The same group of vehicles was tested during the various phases.

Vehicles in the 1990 I&M evaluation program were subject to the same testing sequences as vehicles in the 1984 I&M evaluation program, with the exception that they were tested using the BAR 90 inspection test. The data from the 1990 I&M evaluation program was used to:

1. Calculate identification rates for vehicles tested in phase_1b.
2. Calculate repair move matrices for vehicles tested in phase_1 and phase_3.
3. Calculate move matrices that describe the movement of vehicles between inspection cycles.

4. Calculate deterioration rates for vehicles tested in phase_2 to vehicles tested in the 1984 I&M program, and for vehicles not subject to an I&M program.

Figure 8-4 <u>Vehicles Tested During The 1990 I&M Evaluation Program</u>



Where:
The letters "b" and "a" refer to baseline and after-repair tests.

1998 I&M Program

CARB's 1994 Pilot program data was analyzed to calculate repair move matrices for vehicles subject to a $450-500 repair cost limit. In the Pilot program, 199 vehicles were sent for repair to an off-site repair facility. Of these, 34 vehicles were removed because they "ping-ponged" between CARB's HSL and the repair facility. Staff believe that with proper preconditioning, which is allowed in the enhanced I&M program, these vehicles would have passed the initial screening test. Further, these vehicles did not receive any repairs because they passed at the repair facility. Five vehicles that did not receive repairs due to cost limitations were kept in the data set.

Staff believe that this 165 vehicle data set is insufficient to adequately populate the model year group specific repair move matrices. For this reason, data from the light-duty vehicle surveillance 13 program were also used in calculating the move matrices. Vehicles in this program were also subject to the $450-500 repair cost limit and were tested using the same ASM cutpoints. Combined, the data set contained 323 vehicles.

Without I&M Data

The without I&M data set contains data from CARB's light-duty surveillance programs 1 through 9. This data was used to generate the "master data set" for use in the

CALIMFAC model. In addition, this data set was supplemented with U. S. EPA's without I&M data. Combined, test data from 3,361 vehicles were used in calculating the deterioration rates for vehicles not subject to an I&M program.

8.4 Identification Rates

The identification rates (ID) represent the percent of vehicles in a given technology group and emissions regime that fail an I&M program with particular cutpoints, visual and functional checks, and mechanic performance.

In the CALIMFAC model the ID rate was calculated by adding two probabilities. Vehicles failing the exhaust test were assigned a probability of one, whereas, vehicles failing only the visual/functional test were assigned a probability that was dependent on the mechanic's ability to identify malperforming components. It is important to note that the CALIMFAC model was developed in 1990; hence assumptions were made regarding mechanic repair effectiveness and performance especially in modeling the benefits from the 1990 and loaded mode testing programs. In the CALIMFAC model, the ID rates were calculated for two emission stringency levels for three I&M programs (1984, 1990 and loaded mode), and by three levels of visual/functional checks (Table 8-2).

Table 8-2

Program Type	No Visual & Functional Checks	Check AIR, EGR, O2S and CAT	Check AIR, EGR, O2S, CAT, EVAP, Crankcase, Fillpipe
1984	3-Levels of M.P.	3-Levels of M.P.	3-Levels of M.P.
1990	3-Levels of M.P.	3-Levels of M.P.	3-Levels of M.P.
Loaded Mode	3-Levels of M.P.	3-Levels of M.P.	3-Levels of M.P.

Where: M.P. is Mechanic Performance

In addition, the ID rates were also calculated for three levels of mechanic performance (basic, enhanced and best). The basic level corresponds to the mechanic training in the 1984 program. For a given technology group the ID rates for each cell in Table 8-2 were calculated by first determining how many vehicles failed the exhaust test. These vehicles were then assigned a probability of one. The probability that the remaining vehicles would be identified by the visual/functional checks was based on mechanics ability in identifying the malperforming components. These probabilities were calculated based on an analysis of the 1984 I&M evaluation data. Additional assumptions were made to increase these ID rates for improvements in mechanic training. For example, it was assumed that enhanced mechanic performance would increase the identification rates by 50%, up to the level achieved with OBD2 vehicles.

In EMFAC2000, the ID rates are only calculated for three I&M programs (1984, 1990 and enhanced), and are not a function of mechanic performance. In EMFAC2000, the ID rates were simplified because of the availability of test data from the 1990 and enhanced I&M evaluation programs. The ID rates, by model year group and emissions regime, for vehicles failing either the exhaust emissions test only or the visual/functional test only were calculated as:

$$ID_{exhaust} = \frac{\text{Number of vehicles failing the emissions test during smog check}}{\text{Total number of vehicles}}$$

$$ID_{visual/functional} = \frac{\text{Number of vehicles only failing for V/F defects during smog check}}{\text{Total number of vehicles}}$$

In phase_1b of the 1984 I&M program, 853 vehicles failing the BAR 84 test were given a baseline FTP and a BAR 84 test at HSL. These vehicles were then sent for smog checks to randomly selected smog check stations in the SCAB. Vehicles from phase_1b were first classified into the EMFAC2000 emission regimes. The ID rates were then calculated as shown above. The overall ID is the sum of the individual rates. Table 8-3 shows the ID rates for vehicles subject to the 1984 I&M program. The approach described above was also used in calculating the ID rates (Table 8-4) for vehicles subject to the 1990 I&M program. Please note the ID rates from lower emission regimes that have more vehicles were used in instances where the number of vehicles is too small for a valid estimate of the ID rate.

Using data from the 1994 I&M Pilot program staff calculated the ID rates for vehicles subject to the new 1998 enhanced I&M program. The ID rates were calculated for vehicles subject to either CARB's or BAR's ASM standards. These ID rates only represent the probability of identifying a vehicle based solely on it failing the exhaust test. The probability of identifying vehicles that only fail the visual/functional portion of the new enhanced test cannot be assessed from the Pilot program data. It was assumed that the overall ID rate will be the same as the exhaust emissions ID rate since mechanics are more likely to perform the emissions test first, and only check for visual/functional defects once the vehicle has failed the emissions test. This may preclude them from finding vehicles that only fail the visual/functional portion of the test. However, to model the possibility that some vehicles may be identified as only failing the visual/functional portion of the test, staff believe that visual/functional ID rate should be set to zero in the model. This provides an opportunity to change these ID rates when more data becomes available.

The question that remains is, what will the ID rate be for vehicles equipped with an OBDII system (mainly for 1996 and newer model year vehicles)? In the CALIMFAC model, it was assumed that 95 percent of the failures for vehicles in the high to super emission regimes would be identified by the OBD II system. Staff has reviewed some preliminary data collected by CARB's Advanced Engineering section, which indicates that the OBDII system is correctly identifying failures occurring in TLEV vehicles emitting at or below the normal emissions regime. On this basis, staff believes that the interim OBDII identification rates should be set to identify 95 percent of vehicles in the high to super emissions regime. This ID rate will be revised when more data become available. Upon repair these vehicles move evenly to the normal and moderate emission regimes. This assumes an almost perfect repair, and this may be the case since only a proper repair will deactivate the MIL.

8.5 Repair

Once the failing vehicles have been tagged in each emission regime, repair is simulated by moving vehicles from higher to lower emission regimes (see Table 8-1). In the CALIMFAC model the maximum movement of vehicles from before-repair to after-repair is based on an analysis of CARB's in-use vehicle surveillance data. The baseline FTP data and the final (after-extensive ARB repairs) FTP data were used in determining the number of vehicles in each regime at baseline and after perfect repairs. This information was used in constructing the pre-repair and post repairs move matrices. The difference between these two regime distributions represented the maximum movement of vehicles when there are no repair cost limits and assumed perfect repairs. Mitigating the maximum movement of these vehicles via correction efficiencies (Table 8-5) then simulated the repairs performed at smog check stations. The correction efficiencies varied according to the I&M program being simulated and were a function of the repair cost limits and the level of mechanic repair effectiveness. The correction efficiencies for the 1984 Level (option 1) were based on data from the 1984 I&M evaluation program. For the same option, the correction efficiencies for enhanced mechanic training were determined by examining vehicle diagnostic information and deciding if additional repairs could have been done under the $50 repair cost limit with additional mechanic training. The remaining correction efficiencies were estimated either by interpolation or by assessing the cost of additional repairs.

Table 8-5 Correction Efficiencies Used In The CALIMFAC Model

	Model Year Group	Cost Limit ($)	1984 Level	1990 Level	Enhanced Training
Option 1	Pre-1975	50	0.69*	0.79	0.89**
1984 I&M	1975-79	50	0.64*	0.72	0.80**
	1980+	50	0.46*	0.56	0.66**
Option 2	Pre-1972	50	0.69	0.79	0.89
1990 I&M	1972-74	90	0.73	0.83	0.94
	1975-79	125	0.70	0.79	0.88
	1980-89	175	0.59	0.72	0.84
	1990+	300	0.64	0.78	0.92
Option 3	Pre-1975	no limit	0.78	0.89	1.00
	1975-79	no limit	0.80	0.90	1.00
	1980+	no limit	0.70	0.85	1.00

* Determined from 1984 I&M Evaluation Program

** Determined from 1984 I&M Evaluation Program by examining ARB diagnostic information and deciding what could have been repaired under the $50 cost limit.

Table 8-3 Identification Rates For Vehicles Subject To The 1984 I&M Program

	Pre-1975 Vehicles				1975-79 Model Year Vehicles				1980 and Newer Vehicles				All Vehicles			
HC	Regime	Emissions	Vis/Func	Overall	Regime	Emissions	Vis/Func	Overall	Regime	Emissions	Vis/Func	Overall	Regime	Emissions	Vis/Func	Overall
pre-1975	Totals	Idrate	Idrate	Idrate	Totals	Idrate	Idrate	Idrate	Totals	Idrate	Idrate	Idrate	Totals	Idrate	Idrate	Idrate
Norm																
	69	0.2029	0.3478	0.5507	22	0.0455	0.2273	0.2727	28	0.1786	0.2500	0.4286	119	0.1681	0.3025	0.4706
Modr																
	79	0.5190	0.1266	0.6456	77	0.1558	0.2338	0.3896	83	0.3735	0.1084	0.4819	239	0.3515	0.1548	0.5063
High																
	21	0.7143	0.0952	0.8095	143	0.4965	0.1538	0.6503	63	0.5238	0.0952	0.6190	227	0.5242	0.1322	0.6564
V_High		***0.7143***	***0.0952***	***0.8095***												
	6	0.8333	0.0000	0.8333	37	0.7568	0.0541	0.8108	22	0.9091	0.0455	0.9545	65	0.8154	0.0462	0.8615
Supr																
	11	0.8182	0.0909	0.9091	18	0.7778	0.1111	0.8889	10	0.9000	0.1000	1.0000	39	0.8205	0.1026	0.9231
CO	Regime	Emissions	Vis/Func	Overall	Regime	Emissions	Vis/Func	Overall	Regime	Emissions	Vis/Func	Overall	Regime	Emissions	Vis/Func	Overall
pre-1975	Totals	Idrate	Idrate	Idrate	Totals	Idrate	Idrate	Idrate	Totals	Idrate	Idrate	Idrate	Totals	Idrate	Idrate	Idrate
Norm																
	75	0.3733	0.2267	0.6000	64	0.1406	0.2031	0.3438	63	0.2540	0.1587	0.4127	202	0.2624	0.1980	0.4604
Modr																
	68	0.4412	0.2353	0.6765	98	0.2857	0.2143	0.5000	66	0.4848	0.0909	0.5758	232	0.3879	0.1853	0.5733
High																
	30	0.6000	0.0667	0.6667	70	0.5429	0.1571	0.7000	48	0.5208	0.1042	0.6250	148	0.5473	0.1216	0.6689
V_High																
	10	0.7000	0.2000	0.9000	36	0.7222	0.0556	0.7778	12	0.8333	0.0833	0.9167	58	0.7414	0.0862	0.8276
Supr		***0.7000***	***0.2000***	***0.9000***												
	3	0.3333	0.0000	0.3333	30	0.8333	0.0667	0.9000	16	0.8750	0.1250	1.0000	49	0.8163	0.0816	0.8980
NOx	Regime	Emissions	Vis/Func	Overall	Regime	Emissions	Vis/Func	Overall	Regime	Emissions	Vis/Func	Overall	Regime	Emissions	Vis/Func	Overall
pre-1975	Totals	Idrate	Idrate	Idrate	Totals	Idrate	Idrate	Idrate	Totals	Idrate	Idrate	Idrate	Totals	Idrate	Idrate	Idrate
Norm																
	99	0.4848	0.1717	0.6566	76	0.5132	0.1711	0.6842	75	0.5600	0.1067	0.6667	250	0.5160	0.1520	0.6680
Modr																
	45	0.5111	0.1778	0.6889	76	0.4079	0.1184	0.5263	72	0.4444	0.1250	0.5694	193	0.4456	0.1347	0.5803
High																
	28	0.2857	0.3571	0.6429	109	0.3670	0.2202	0.5872	36	0.5278	0.0833	0.6111	173	0.3873	0.2139	0.6012
V_High		***0.2857***	***0.3571***	***0.6429***												
	9	0.5556	0.2222	0.7778	30	0.3667	0.1000	0.4667	18	0.2778	0.1111	0.3889	57	0.3684	0.1228	0.4912
Supr		***0.2857***	***0.3571***	***0.6429***		***0.3667***	***0.1000***	***0.4667***		***0.2778***	***0.1111***	***0.3889***				
	5	0.0000	0.0000	0.0000	7	0.7143	0.0000	0.7143	5	0.0000	0.4000	0.4000	17	0.2941	0.1176	0.4118

Table 8-4 Identification Rates For Vehicles Subject To The 1990 I&M Program

	Pre-1975 Vehicles				1975-79 Model Year Vehicles				1980 and Newer Vehicles				All Vehicles			
	Regime	Emissions	Vis/Func	Overall	Regime	Emissions	Vis/Func	Overall	Regime	Emissions	Vis/Func	Overall	Regime	Emissions	Vis/Func	Overall
pre-1975	Totals	Idrate	Idrate	Idrate	Totals	Idrate	Idrate	Idrate	Totals	Idrate	Idrate	Idrate	Totals	Idrate	Idrate	Idrate
Norm						***0.0645***	***0.3226***	***0.3871***								
	60	0.3833	0.2500	0.6333	6	0.1667	0.0000	0.1667	30	0.1333	0.1667	0.3000	96	0.2917	0.2083	0.5000
Modr																
	67	0.5075	0.1791	0.6866	31	0.0645	0.3226	0.3871	109	0.2110	0.1835	0.3945	207	0.2850	0.2029	0.4879
High																
	21	0.5238	0.0952	0.6190	145	0.3724	0.1793	0.5517	184	0.5598	0.1304	0.6902	350	0.4800	0.1486	0.6286
V_High																
	11	0.7273	0.0000	0.7273	57	0.5263	0.1228	0.6491	130	0.6154	0.0462	0.6615	198	0.5960	0.0657	0.6616
Supr																
	14	0.7143	0.0714	0.7857	40	0.7250	0.0750	0.8000	39	0.7949	0.0256	0.8205	93	0.7527	0.0538	0.8065
	Regime	Emissions	Vis/Func	Overall	Regime	Emissions	Vis/Func	Overall	Regime	Emissions	Vis/Func	Overall	Regime	Emissions	Vis/Func	Overall
pre-1975	Totals	Idrate	Idrate	Idrate	Totals	Idrate	Idrate	Idrate	Totals	Idrate	Idrate	Idrate	Totals	Idrate	Idrate	Idrate
Norm																
	70	0.4286	0.2286	0.6571	40	0.2000	0.2500	0.4500	77	0.2208	0.0909	0.3117	187	0.2941	0.1765	0.4706
Modr																
	70	0.5143	0.1429	0.6571	87	0.2414	0.2644	0.5057	121	0.3967	0.2149	0.6116	278	0.3777	0.2122	0.5899
High																
	21	0.5714	0.1429	0.7143	62	0.4839	0.0968	0.5806	183	0.5519	0.0929	0.6448	266	0.5376	0.0977	0.6353
V_High																
	12	0.6667	0.0000	0.6667	50	0.6200	0.0800	0.7000	57	0.5789	0.0877	0.6667	119	0.6050	0.0756	0.6807
Supr		***0.6667***	***0.0000***	***0.6667***												
	0	0.0000	0.0000	0.0000	40	0.6500	0.0750	0.7250	54	0.7778	0.0185	0.7963	94	0.7234	0.0426	0.7660
	Regime	Emissions	Vis/Func	Overall	Regime	Emissions	Vis/Func	Overall	Regime	Emissions	Vis/Func	Overall	Regime	Emissions	Vis/Func	Overall
pre-1975	Totals	Idrate	Idrate	Idrate	Totals	Idrate	Idrate	Idrate	Totals	Idrate	Idrate	Idrate	Totals	Idrate	Idrate	Idrate
Norm																
	112	0.4911	0.1607	0.6518	79	0.4810	0.1139	0.5949	102	0.5784	0.0490	0.6275	293	0.5188	0.1092	0.6280
Modr																
	46	0.4783	0.1522	0.6304	76	0.4079	0.1711	0.5789	150	0.4800	0.1000	0.5800	272	0.4596	0.1287	0.5882
High		***0.6000***	***0.2667***	***0.8667***												
	8	0.3750	0.5000	0.8750	86	0.3837	0.1512	0.5349	100	0.4100	0.1500	0.5600	194	0.3969	0.1649	0.5619
V_High		***0.6000***	***0.2667***	***0.8667***												
	3	1.0000	0.0000	1.0000	24	0.4167	0.2917	0.7083	82	0.4634	0.1707	0.6341	109	0.4679	0.1927	0.6606
Supr		***0.6000***	***0.2667***	***0.8667***												
	4	0.7500	0.0000	0.7500	14	0.2857	0.2857	0.5714	58	0.5345	0.1207	0.6552	76	0.5000	0.1447	0.6447

Table 8-6 shows the actual correction efficiencies determined from an analysis of the 1990 I&M evaluation program. Comparison of the actual versus projected correction efficiencies (Tables 8-5 & 8-6) from the 1990 I&M program indicate that the projected improvements to the mechanic repair effectiveness level, from higher repair cost limits and enhanced training, were overly optimistic.

Table 8-6 <u>Correction Efficiencies Based On 1990 I&M Program</u>

Model Year Group	Repair Cost Limit ($)	1990 Level
Pre-1972	50	0.70
1972-74	90	0.67
1975-79	125	0.71
1980-89	175	0.66

Table 8-7 shows the correction efficiencies that were originally used in earlier versions of EMFAC2000. The correction efficiencies for option 3 represent those from an enhanced ASM testing program with a $450 repair cost limit.

Table 8-7 <u>Correction Efficiencies Used in one version of EMFAC2000</u>

	Model Year Group	Cost Limit ($)	1984 Level	1990 Level	Enhanced Training
Option 1	Pre-1972	50	0.69	0.69	0.76
1984 I&M	1972-74	50	0.69	0.69	0.77
	1975-79	50	0.64	0.64	0.70
	1980-89	50	0.46	0.51	0.61
	1990+	50	0.46	0.51	0.61
Option 2	Pre-1972	50	0.69	0.69	0.76
1990 I&M	1972-74	90	0.70	0.70	0.78
	1975-79	125	0.71	0.71	0.77
	1980-89	175	0.59	0.66	0.80
	1990+	300	0.64	0.72	0.82
Option 3	Pre-1972	450	0.77	0.77	0.85
1998 I&M	1972-74	450	0.76	0.76	0.85
	1975-79	450	0.78	0.78	0.85
	1980-89	450	0.66	0.73	0.87
	1990+	450	0.66	0.74	0.87
Option 4	Pre-1972	No Limit	0.78	0.78	1.00
	1972-74	No Limit	0.78	0.78	1.00
	1975-79	No Limit	0.80	0.80	1.00
	1980-89	No Limit	0.70	0.78	1.00
	1990+	No Limit	0.70	0.78	1.00

Even after improving the accuracy of the repair correction efficiencies, the early versions of EMFAC2000 were predicting higher emission benefits than observed in the I&M evaluation programs. One of the main reasons behind the higher emission benefits was how the repair correction efficiencies were applied to the post-repair move matrix. The post-repair move matrix is based on near perfect repairs performed by CARB mechanics with unlimited resources. This represents the maximum movement (or perfect repairs) of vehicles with no limits on the repair costs. This movement is mitigated by the repair correction efficiencies. However, the movement of vehicles is still predicated on perfect repairs, which is fundamentally wrong. For example, with unlimited resources the mechanics are able to repair two super emitters to moderate and normal emission regimes. If the same mechanics were constrained by a $50 repair cost limit it is unlikely that these vehicles will be moved to the lower emission regimes. However, the methodology of using repair correction efficiencies to mitigate the movement of vehicles assumes that some fraction of these two vehicles would still be moved to the lower emission regimes. Given this, it was decided to base repairs directly on data collected during various I&M evaluation programs.

In the 1984 I&M evaluation program, should fail vehicles were given a baseline FTP test and a BAR 84 test at CARB's HSL facility. These vehicles were then sent for a smog check, including repair, to randomly selected stations in the SCAB. Upon their return, these vehicles were given an after-repair FTP test and a BAR 84 test. This data was used in calculating the repair move matrices used in EMFAC2000. Table 8-8 shows the repair move matrices for vehicles subject to the 1984 I&M program. Tables 8-9 and 8-10 shows the repair move matrices for vehicles subject to the 1990 I&M and enhanced I&M programs, respectively.

Table 8-8 <u>Repair Move Matrices For Vehicles Subject to the 1984 I&M Program</u>

<1975	Baseline	HC Norm	HC Modr	HC High	HC Vhigh	HC Supr	Baseline	CO Norm	CO Modr	CO High	CO Vhigh	CO Supr	Baseline	NOx Norm	NOx Modr	NOx High	NOx Vhigh	NOx Supr
Norm	73	0.8356	0.1644	0.0000	0.0000	0.0000	74	0.8919	0.0811	0.0270	0.0000	0.0000	101	0.8911	0.1089	0.0000	0.0000	0.0000
Modr	79	0.2785	0.6962	0.0253	0.0000	0.0000	69	0.3188	0.6087	0.0580	0.0145	0.0000	48	0.3333	0.5417	0.1042	0.0208	0.0000
High	17	0.2353	0.4706	0.2941	0.0000	0.0000	32	0.0313	0.6875	0.2188	0.0625	0.0000	27	0.1111	0.3333	0.5556	0.0000	0.0000
Vhigh	6	0.3333	0.5000	0.0000	0.0000	0.1667	9	0.0000	0.1111	0.3333	0.5556	0.0000	9	0.2222	0.1111	0.3333	0.2222	0.1111
Supr	11	0.0909	0.2727	0.2727	0.0000	0.3636	2	0.0000	0.0000	0.0000	0.5000	0.5000	1*	0.0000	0.0000	1.0000	0.0000	0.0000
	186						186						186					

MY Group 1975-79	Baseline	HC Norm	HC Modr	HC High	HC Vhigh	HC Supr	Baseline	CO Norm	CO Modr	CO High	CO Vhigh	CO Supr	Baseline	NOx Norm	NOx Modr	NOx High	NOx Vhigh	NOx Supr
Norm	18	0.7222	0.2778	0.0000	0.0000	0.0000	57	0.7719	0.1930	0.0175	0.0175	0.0000	82	0.8415	0.1220	0.0366	0.0000	0.0000
Modr	70	0.1000	0.7143	0.1857	0.0000	0.0000	91	0.1319	0.7143	0.1209	0.0220	0.0110	80	0.2750	0.5625	0.1500	0.0125	0.0000
High	139	0.0072	0.1727	0.7914	0.0288	0.0000	69	0.0435	0.2029	0.6377	0.1159	0.0000	92	0.0978	0.0978	0.7609	0.0435	0.0000
Vhigh	37	0.0000	0.0270	0.4054	0.4595	0.1081	34	0.0588	0.2353	0.3235	0.3529	0.0294	23	0.0870	0.1304	0.3913	0.3913	0.0000
Supr	18	0.0000	0.0556	0.2778	0.2778	0.3889	31	0.0000	0.0645	0.1935	0.2581	0.4839	5*	0.0000	0.0000	0.0000	0.2000	0.8000
	282						282						282					

1980-85	Baseline	HC Norm	HC Modr	HC High	HC Vhigh	HC Supr	Baseline	CO Norm	CO Modr	CO High	CO Vhigh	CO Supr	Baseline	NOx Norm	NOx Modr	NOx High	NOx Vhigh	NOx Supr
Norm	55	0.7091	0.2727	0.0182	0.0000	0.0000	92	0.8587	0.1304	0.0109	0.0000	0.0000	115	0.8435	0.1391	0.0174	0.0000	0.0000
Modr	119	0.0840	0.8319	0.0840	0.0000	0.0000	100	0.2100	0.7000	0.0900	0.0000	0.0000	108	0.1667	0.7315	0.0926	0.0000	0.0093
High	76	0.0526	0.1711	0.7500	0.0263	0.0000	63	0.0794	0.2381	0.6667	0.0000	0.0159	38	0.0526	0.1842	0.6316	0.1053	0.0263
Vhigh	25	0.0000	0.2400	0.2800	0.4800	0.0000	12	0.0833	0.1667	0.4167	0.3333	0.0000	18	0.1111	0.0556	0.1667	0.5000	0.1667
Supr	11	0.0000	0.0909	0.3636	0.0909	0.4545	19	0.1579	0.1053	0.1579	0.0526	0.5263	7*	0.0000	0.1429	0.1429	0.1429	0.5714
	286						286						13	*0.0000*	*0.0770*	*0.1540*	*0.1540*	*0.6150*

1986+	Baseline	HC Norm	HC Modr	HC High	HC Vhigh	HC Supr	Baseline	CO Norm	CO Modr	CO High	CO Vhigh	CO Supr	Baseline	NOx Norm	NOx Modr	NOx High	NOx Vhigh	NOx Supr
Norm	55	0.7091	0.2727	0.0182	0.0000	0.0000	92	0.8587	0.1304	0.0109	0.0000	0.0000	115	0.8435	0.1391	0.0174	0.0000	0.0000
Modr	119	0.0840	0.8319	0.0840	0.0000	0.0000	100	0.2100	0.7000	0.0900	0.0000	0.0000	108	0.1667	0.7315	0.0926	0.0000	0.0093
High	76	0.0526	0.1711	0.7500	0.0263	0.0000	63	0.0794	0.2381	0.6667	0.0000	0.0159	38	0.0526	0.1842	0.6316	0.1053	0.0263
Vhigh	25	0.0000	0.2400	0.2800	0.4800	0.0000	12	0.0833	0.1667	0.4167	0.3333	0.0000	18	0.1111	0.0556	0.1667	0.5000	0.1667
Supr	11	0.0000	0.0909	0.3636	0.0909	0.4545	19	0.1579	0.1053	0.1579	0.0526	0.5263	7	0.0000	0.1429	0.1429	0.1429	0.5714
	286						286						286					

The arrows indicate substitutions for elements with insufficient data.

Table 8-9 Repair Move Matrices For Vehicles Subject to the 1990 I&M Program

		HC	HC	HC	HC	HC		CO	CO	CO	CO	CO		NOx	NOx	NOx	NOx	NOx
<1975	Baseline	Norm	Modr	High	Vhigh	Supr	Baseline	Norm	Modr	High	Vhigh	Supr	Baseline	Norm	Modr	High	Vhigh	Supr
Norm	63	0.8571	0.1270	0.0000	0.0000	0.0159	70	0.7429	0.2429	0.0143	0.0000	0.0000	115	0.9652	0.0348	0.0000	0.0000	0.0000
Modr	66	0.4394	0.5000	0.0606	0.0000	0.0000	73	0.3151	0.6301	0.0548	0.0000	0.0000	46	0.4130	0.4783	0.0870	0.0217	0.0000
High	21	0.0476	0.4286	0.4762	0.0476	0.0000	21	0.0000	0.4762	0.5238	0.0000	0.0000	8	0.2500	0.5000	0.1250	0.0000	0.1250
Vhigh	15	0.3333	0.2667	0.1333	0.0667	0.2000	12	0.0833	0.0833	0.3333	0.4167	0.0833	3	0.3333	0.0000	0.3333	0.0000	0.3333
Supr	11	0.3636	0.0909	0.0909	0.1818	0.2727	0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	4	0.0000	0.2500	0.0000	0.5000	0.2500
176	176						176						176					
		HC	HC	HC	HC	HC		CO	CO	CO	CO	CO		NOx	NOx	NOx	NOx	NOx
1975-79	Baseline	Norm	Modr	High	Vhigh	Supr	Baseline	Norm	Modr	High	Vhigh	Supr	Baseline	Norm	Modr	High	Vhigh	Supr
Norm	6	0.5000	0.5000	0.0000	0.0000	0.0000	41	0.6829	0.2927	0.0244	0.0000	0.0000	79	0.8228	0.1392	0.0380	0.0000	0.0000
Modr	32	0.0313	0.5625	0.3438	0.0625	0.0000	87	0.1034	0.7126	0.1379	0.0345	0.0115	77	0.2468	0.5844	0.1558	0.0000	0.0130
High	145	0.0207	0.0897	0.8000	0.0897	0.0000	63	0.0794	0.2857	0.5397	0.0635	0.0317	86	0.2907	0.2326	0.4419	0.0349	0.0000
Vhigh	58	0.0345	0.0000	0.3276	0.5690	0.0690	50	0.0200	0.1400	0.3600	0.3600	0.1200	25	0.3600	0.0800	0.4000	0.1600	0.0000
Supr	40	0.0000	0.0000	0.3000	0.2000	0.5000	40	0.0000	0.0750	0.1000	0.2750	0.5500	14	0.0714	0.2857	0.0714	0.2857	0.2857
281	281						281						281					
		HC	HC	HC	HC	HC		CO	CO	CO	CO	CO		NOx	NOx	NOx	NOx	NOx
1980-85	Baseline	Norm	Modr	High	Vhigh	Supr	Baseline	Norm	Modr	High	Vhigh	Supr	Baseline	Norm	Modr	High	Vhigh	Supr
Norm	21	0.7143	0.2857	0.0000	0.0000	0.0000	57	0.7719	0.2105	0.0175	0.0000	0.0000	70	0.7571	0.2000	0.0429	0.0000	0.0000
Modr	84	0.0833	0.8095	0.1071	0.0000	0.0000	96	0.1771	0.6563	0.1667	0.0000	0.0000	127	0.1811	0.7087	0.0945	0.0079	0.0079
High	154	0.0390	0.0909	0.7468	0.1169	0.0065	160	0.0313	0.1500	0.7375	0.0750	0.0063	88	0.1023	0.3977	0.3636	0.1136	0.0227
Vhigh	118	0.0085	0.0678	0.2627	0.6186	0.0424	50	0.1000	0.0200	0.3000	0.4000	0.1800	76	0.0395	0.1711	0.2237	0.5263	0.0395
Supr	37	0.0000	0.0000	0.1892	0.4054	0.4054	51	0.0784	0.0784	0.2745	0.1765	0.3922	53	0.0377	0.1887	0.1132	0.2642	0.3962
414	414						414						414					
		HC	HC	HC	HC	HC		CO	CO	CO	CO	CO		NOx	NOx	NOx	NOx	NOx
1986+	Baseline	Norm	Modr	High	Vhigh	Supr	Baseline	Norm	Modr	High	Vhigh	Supr	Baseline	Norm	Modr	High	Vhigh	Supr
Norm	9	0.7778	0.2222	0.0000	0.0000	0.0000	21	0.8571	0.0952	0.0476	0.0000	0.0000	33	0.8182	0.1818	0.0000	0.0000	0.0000
Modr	29	0.1034	0.7586	0.1379	0.0000	0.0000	28	0.3571	0.4643	0.1786	0.0000	0.0000	27	0.2222	0.7407	0.0370	0.0000	0.0000
High	33	0.0303	0.2121	0.6667	0.0909	0.0000	24	0.0417	0.1667	0.6667	0.0833	0.0417	13	0.0000	0.3846	0.6154	0.0000	0.0000
Vhigh	12	0.1667	0.0000	0.1667	0.4167	0.2500	4	0.0000	0.0000	0.0000	0.2500	0.7500	7	0.0000	0.4286	0.2857	0.2857	0.0000
Supr	2	0.0000	0.0000	0.0000	0.0000	1.0000	8	0.0000	0.1250	0.1250	0.0000	0.7500	5	0.0000	0.0000	0.2000	0.2000	0.6000

The arrows indicate substitutions for elements with insufficient data.

Table 8-10 Repair Move Matrices For Vehicles Subject to the Enhanced I&M Program

Pre-1974		HC	HC	HC	HC	HC	CO	CO	CO	CO	CO	CO	NOx	NOx	NOx	NOx	NOx	NOx
HC	Phase_1b	Norm	Modr	High	V_High	Supr	Phase_1b	Norm	Modr	High	V_High	Supr	Phase_1b	Norm	Modr	High	V_High	Supr
Norm	14	0.857	0.143	0.000	0.000	0.000	16	0.938	0.063	0.000	0.000	0.000	21	0.952	0.048	0.000	0.000	0.000
Modr	9	0.556	0.444	0.000	0.000	0.000	9	0.444	0.556	0.000	0.000	0.000	5	1.000	0.000	0.000	0.000	0.000
High	5	0.400	0.200	0.400	0.000	0.000	4	0.000	0.500	0.500	0.000	0.000	3	0.000	0.333	0.333	0.333	0.000
V_High	1	0.000	0.000	0.000	1.000	0.000	1	0.000	0.000	0.000	1.000	0.000	2	1.000	0.000	0.000	0.000	0.000
Supr	2	0.000	1.000	0.000	0.000	0.000	1	0.000	0.000	0.000	0.000	1.000	0	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Total	31						31						31					

1975-79		HC	HC	HC	HC	HC	CO	CO	CO	CO	CO	CO	NOx	NOx	NOx	NOx	NOx	NOx
HC	Phase_1b	Norm	Modr	High	V_High	Supr	Phase_1b	Norm	Modr	High	V_High	Supr	Phase_1b	Norm	Modr	High	V_High	Supr
Norm	2	0.000	1.000	0.000	0.000	0.000	6	0.500	0.500	0.000	0.000	0.000	25	0.960	0.040	0.000	0.000	0.000
Modr	6	0.500	0.167	0.333	0.000	0.000	21	0.333	0.524	0.143	0.000	0.000	16	0.750	0.250	0.000	0.000	0.000
High	37	0.189	0.108	0.676	0.027	0.000	13	0.231	0.231	0.385	0.154	0.000	15	0.333	0.600	0.000	0.000	0.067
V_High	14	0.071	0.286	0.429	0.143	0.071	15	0.267	0.400	0.200	0.067	0.067	4	0.750	0.000	0.000	0.000	0.250
Supr	8	0.000	0.125	0.250	0.500	0.125	12	0.083	0.250	0.333	0.083	0.250	7	0.429	0.429	0.000	0.000	0.143
Total	67						67						67					

1980+		HC	HC	HC	HC	HC	CO	CO	CO	CO	CO	CO	NOx	NOx	NOx	NOx	NOx	NOx
HC	Phase_1b	Norm	Modr	High	V_High	Supr	Phase_1b	Norm	Modr	High	V_High	Supr	Phase_1b	Norm	Modr	High	V_High	Supr
Norm	27	0.741	0.259	0.000	0.000	0.000	49	0.816	0.143	0.020	0.020	0.000	49	0.673	0.286	0.041	0.000	0.000
Modr	72	0.264	0.639	0.097	0.000	0.000	63	0.429	0.492	0.079	0.000	0.000	64	0.469	0.516	0.016	0.000	0.000
High	76	0.171	0.342	0.434	0.053	0.000	71	0.254	0.380	0.324	0.014	0.028	50	0.340	0.460	0.180	0.020	0.000
V_High	40	0.200	0.350	0.300	0.150	0.000	18	0.333	0.167	0.389	0.056	0.056	36	0.250	0.583	0.083	0.083	0.000
Supr	10	0.100	0.400	0.100	0.200	0.200	24	0.250	0.417	0.125	0.042	0.167	26	0.269	0.385	0.077	0.038	0.231
Total	225						225						225					

All Vehicles		HC	HC	HC	HC	HC	CO	CO	CO	CO	CO	CO	NOx	NOx	NOx	NOx	NOx	NOx
HC	Phase_1b	Norm	Modr	High	V_High	Supr	Phase_1b	Norm	Modr	High	V_High	Supr	Phase_1b	Norm	Modr	High	V_High	Supr
Norm	43	0.744	0.256	0.000	0.000	0.000	71	0.817	0.155	0.014	0.014	0.000	95	0.811	0.168	0.021	0.000	0.000
Modr	87	0.310	0.586	0.103	0.000	0.000	93	0.409	0.505	0.086	0.000	0.000	85	0.553	0.435	0.012	0.000	0.000
High	118	0.186	0.263	0.508	0.042	0.000	88	0.239	0.364	0.341	0.034	0.023	68	0.324	0.485	0.147	0.029	0.015
V_High	55	0.164	0.327	0.327	0.164	0.018	34	0.294	0.265	0.294	0.088	0.059	42	0.333	0.500	0.071	0.071	0.024
Supr	20	0.050	0.350	0.150	0.300	0.150	37	0.189	0.351	0.189	0.054	0.216	33	0.303	0.394	0.061	0.030	0.212
Total	323						323						323					

The arrows indicate substitutions for elements with insufficient data.

8.6 Deterioration Rates

One of the major assumptions in the CALIMFAC model was that after vehicles have been redistributed among the emission regimes, they deteriorate at the same rate as other vehicles in that emission regime. This implies that vehicles in a particular emission regime have a deterioration rate that on a mileage basis is same with or without I&M.

In modeling the benefits from a vehicle scrappage program, staff noted that the emission benefits from the 1990 I&M program in calendar year 2010 were higher than indicated by data. They compared deterioration rates predicted by the model for an average 1987 model year vehicle to the deterioration rates from "should fail" vehicles in the 1990 I&M evaluation program and observed that the after-repair deterioration rates from the should fail vehicles were different than the without I&M deterioration rates. This implied a need for a separate set of deterioration rates for vehicles subject to an I&M program. In order to test the hypothesis that vehicle deterioration rates are the same regardless of whether or not they are subject to an I&M program, staff compared deterioration rates for vehicles subject to the 1984 (phase_2b) and 1990 programs (phase_2b) to vehicles not subject to an I&M program. In addition, staff wanted to ascertain if vehicles subject to the same I&M program deteriorate at the same rate when examined two years later. This involved comparing the deterioration rates for vehicles in phase_2b to phase_4b of the 1984 I&M program. In summary, this analysis indicated that vehicles that are not subject to an I&M program have deterioration rates that are different from vehicles subject to either the 1984 or 1990 I&M programs. Further, this analysis indicated that vehicles subject to the 1984 and 1990 I&M programs have similar deterioration rates.

Two methodologies were used to model the deterioration between inspection cycles. The first method involved determining the move matrices between inspection cycles for vehicles tested during the 1984 and 1990 I&M evaluation programs. These move matrices were then applied to the post-repair move matrix to redistribute the vehicles among the regimes thereby simulating deterioration over the two-year inspection cycle. The second method involved determining the vehicle's after-repair emissions and determining the age when the vehicle's emissions were first at this rate. This age is then used to calculate the migration rate, which on a regime basis is the difference between the regime sizes at (age+1)-(age). This difference in regime sizes is the deterioration rate for the next year.

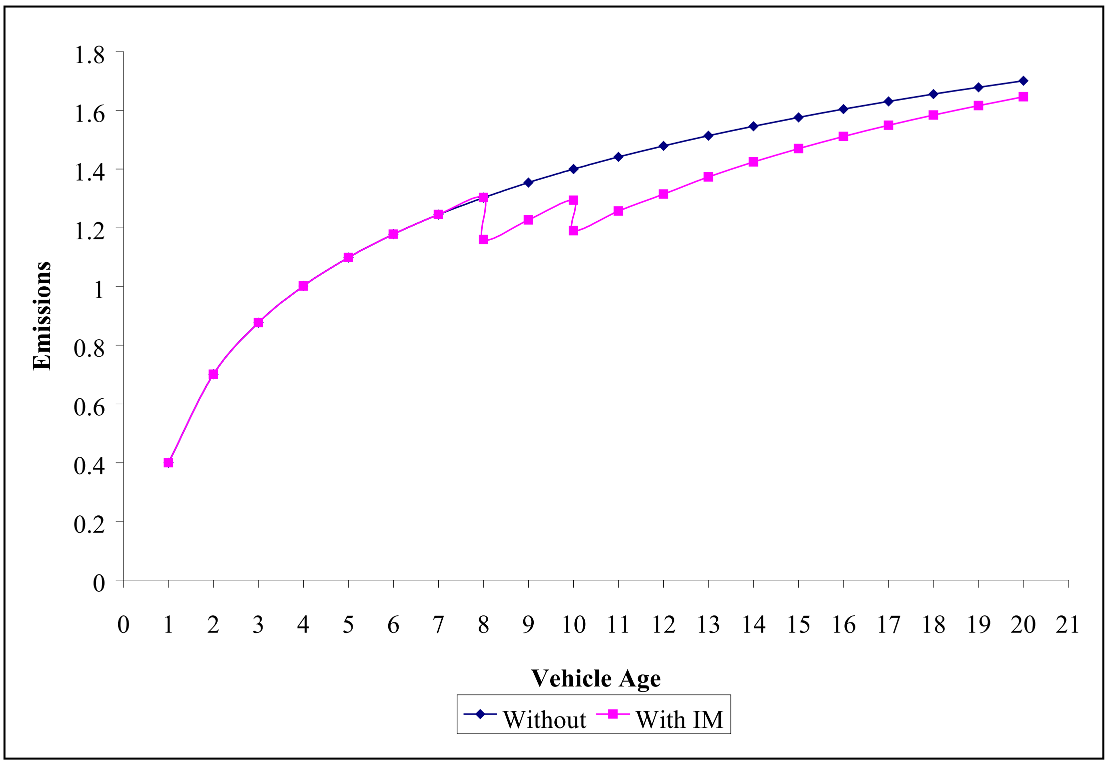
The first method was modeled in an earlier version of EMFAC2000. This was done by calculating the movement of vehicles from Phase_1a to Phase_3b for vehicles tested in the 1984 and 1990 I&M evaluation programs. In the absence of data, staff assumed that vehicles subject to the enhanced I&M program will deteriorate at the same rate as vehicles subject to the 1990 I&M program. This method was eventually dropped because it predicted very high emission benefits for the 1990 I&M program; more than indicated by a previous study[2]. In addition the model predicted higher emission rates for vehicles subject to an I&M program than those not subject to an I&M program. These two results

[2] Evaluation of the California Smog Check Program and Recommendations for Program Improvements, Fourth Report to the Legislature, February, 1993, by Sierra Research

were contradictory, and were a direct result of the data used in calculating the move matrices. The move matrices indicated a very high deterioration rate with more super emitters being created after two years of deterioration. This resulted in I&M emission rates that in some instances were higher than the without I&M emission rates. However, at the next inspection the super emitters were promptly identified and repaired; hence the high emission benefits. In the I&M evaluation data only 34% and 35% of the vehicles were tested in subsequent phases of the 1984 and 1990 I&M evaluation programs, respectively. Staff believes that basing the deterioration move matrices on this subset of vehicles introduced a bias towards more malperforming vehicles.

Figure 8-5 conceptualizes how the second method calculates the with I&M emission rates. In this example, the vehicle undergoes its first inspection at age 8. This reduces the after-repair emissions as indicated by the step reduction in the emissions rate. The model then determines the age (age=6) when the vehicle first displayed this after-repair emission rate. The model then uses the deterioration rate from ages 6-7 as the next deterioration rate. What this figure illustrates is that the with this methodology, the with and without I&M deterioration rates are not the same.

Figure 8-5 Example of how the With I&M Deterioration Rates are Calculated



The second method was used in calculating the with I&M deterioration rates. This method was selected because it allows for the fact that with I&M deterioration rates can be higher than the without I&M rates.

8.7 Discussion

Currently, the CALIMFAC model uses move matrices that describe the maximum movement of vehicles from baseline to after-perfect-repair. This movement of vehicles is then mitigated via correction efficiencies (Table 8-5) to simulate I&M repairs. The correction efficiencies are a function of the I&M program repair cost limit and the level of mechanic repair effectiveness. Once the vehicles have migrated to (mainly) the lower emission regimes it is assumed that these vehicles deteriorate at the same rate as other vehicles in the emissions regime that they now occupy. Instead of using the correction efficiencies to calculate the repair move matrices, staff recommends using the repair move matrices in Tables 8-8, 8-9 and 8-10 to model repairs performed during the 1984, 1990 and 1998 I&M programs, respectively. The mechanic repair correction efficiencies should be set to 1.0. This means that the user will no longer have the option of doing "what if" analyses on the 1984, 1990 and enhanced programs. For example, in CALIMFAC the users could estimate the improvements in emission benefits in the 1984 I&M program as a result of enhanced mechanic training. This improvement was modeled via the repair correction efficiencies.

The CALIMFAC model assumed that vehicles, on an age basis, undergoing I&M program have the same deterioration rates as those vehicles avoiding an I&M. In EMFAC2000 the deterioration rate should be based on the after-repair emissions, and subsequent deterioration should be based on the vehicle's historical deterioration rates.

Section 2.0 MODEL HISTORY

Staff is continually improving the on-road vehicle emission inventory, which has become more complex and data driven as computer technology has advanced. The series of improvements in EMFAC, BURDEN and WEIGHT culminated in a relatively modern version called EMFAC7D. The major improvements in the MVEI Models, commencing with EMFAC7D, are listed below:

EMFAC7D (January 1988)

- Improved Basic Emission Rates
- Improved Deterioration Rates
- Improved mileage accumulation rates
- Improved travel fraction (VMT by age)
- Improved methodology documentation
- Improved source code/users guide documentation

EMFAC7E (July 1990)

- Addition of evaporative running losses
- Adjusted HDT emission rates to account for federal HDTs operating in California
- Modeled Urban Buses separate from HDTs
- Used CALIMFAC for I/M benefits
- Increased speed domain from 5-55 MPH to 3-65 MPH
- Disaggregated Diurnals into Partial and Multiple Day estimates
- Added evaporative resting loss emissions
- Addition of evaporative emission temperature correction factors
- Added Planning Inventory capability for non-attainment areas

EMFAC7EP (December 1990)

- Expanded Planning Inventories to attainment areas
- Added Phase I Gasoline benefits
- Added LEV emission rates
- Redefined MDT and adjusted emission rates
- Adjusted evaporative emission rates for a new certification standard/test procedure
- Updated SCFs

EMFAC7F (September 1993)

- Modeled evaporative emissions by period of the day
- Updated BERs, TCFs and SCFs
- Improved cumulative mileage curves and travel activity
- Added Phase II Gasoline and Oxygenates benefits

MVEI7G1.0 (October 1996)

- Added Cycle Correction Factors
- Added High Emitter Correction Factors

- Added CO_2 to the model
- Improved Starts Methodology
- Improved Starts Activity
- Added BERs for Enhanced I/M and Basic 96 I/M
- Added Clean Diesel Fuel benefits
- Improved VMT by speed distributions
- GUI Interface

MVEI7G1.0c (July 1997)

- Corrected program to set PM and fuel flag.
- Corrected program for model year runs.
- Changed logic in front end for option to run EMFAC only and standard report.
- Corrected BRCOUNTY file which had error in LA SEDAB.
- Revised activity data for SFAB per District's submittal.
- Revised activity data for SD per SANDAG submittal.
- Revised activity data for Fresno (SJV) per COG's submittal.
- Revised activity data for Kern (SJV) per COG's submittal.
- Corrected pre-66 model year base rates.
- Corrected BRCOUNTY to correct I/M phase-in for some counties that have start dates of
- 1991 or 1992.
- Corrected light - duty trucks (LDT) evaporative emission rates.
- Adjusted evaporative emission rates for zero emission vehicles (T2).
- Modified cycle correction factors.
- Modified high emitter correction factors.
- Adjusted I/M implementation dates.
- Corrected minor errors in the BURDEN output.
- Corrected temperature correction factors for winter rates (50 deg F).

MVEI7G1.0c (October, 1998)

- EMFAC report table 8 -- Evaporative Running Losses -- Revised to include light heavy gas
- (LHG) and medium heavy gas (MHG) (dated June 10, 1998)
- Revised activity data for classes 7 and 8 (HDG and HDD) for years 1981-89 (July 23, 1998)
- Smooth out the 1980-1990 heavy duty truck activity to better reflect the diesel fuel sales.

MVEI7G1.0c (February 2000)

- New data for SJVAB (Fresno, Kings, Stanislaus and Tulare) (December 1998)
- SACOG (MCAB-El Dorado, MCAB-Placer, SVAB-Placer, SVAB-Sacramento, SVAB-Yolo)
- 1994-2015 data for SCCAB-Santa Barbara
- Same data as 7G (July, 1998) for SDAB, SFAB, SCAB, SJVAB (Kern, Madera, Merced, San Joaquin)

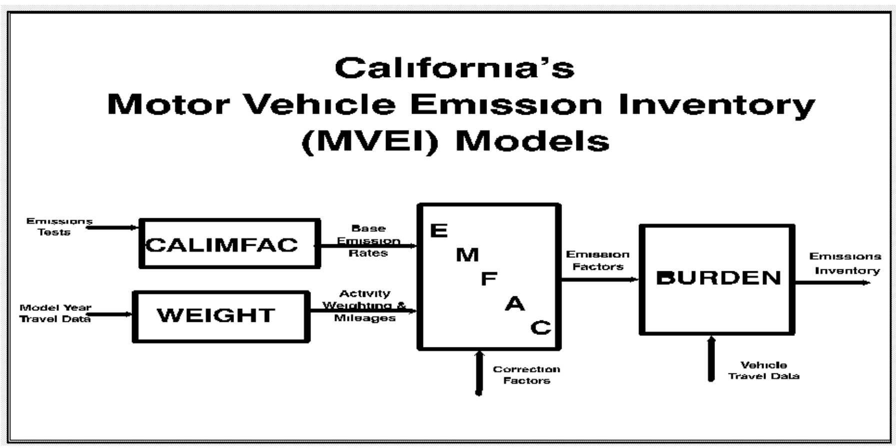
- For the Rest of Counties:
  VMT=MVSTAFF,
  STARTS=VEH*START RATE
- HDT VMT (1980-2020) based on Caltrans Truck Kilometers of Travel Reports and MVSTAFF
- Corrections to the "Fuel Consumption"
- Corrected "no I/M" option when running the model.

Section 3.0 Overview

Staff previously estimated on-road motor vehicle emissions using a series of computer models called the MVEI models. The following discussion provides an overview of the emission estimating process and the computer models used. Although some technical detail is included, this discussion is intended to provide more of a qualitative understanding of the overall process. For a more comprehensive discussion of the workings of the MVEI7G model, documentation is available in "***Methodology for Estimating Emissions from On-Road Motor Vehicles (Volumes 1-6),*** *and* ***Derivation of Emission and Correction Factors for MVEI7G."*** These documents are available on the ARB's Web Page at: http://www.arb.ca.gov/msei/mvei/mvei.htm.

Figure 3-1 is a block diagram of the four computer models utilized in MVEI7G. A brief description of the four models follows:

Figure 3-1 – MVEI7G



The primary function of the **CALIMFAC** model was to provide basic emission rates (BERs) to EMFAC. CALIMFAC also simulates various vehicle inspection and maintenance (I/M) program (smog check) scenarios, and adjusts the BERs, accordingly. These BERs are based on dynamometer tests of randomly selected vehicles driven over a specific driving pattern called the U.S. EPA Federal Test Procedure (FTP). CALIMFAC estimates BERs for model years 1965 through 2003 and four broad I/M scenarios.

EMFAC adjusted the BERs for non-standard driving conditions. These adjustments are generally referred to as correction factors. Correction factors include, but are not limited to, speed, temperature, fuel, and driving cycle.

The **WEIGHT** model estimated the contribution each model year makes to a given calendar year's activity. Because the BERs and correction factors are model year-specific, it is critical that the appropriate model year activity assigned to each model year's emission factor is properly weighted.

BURDEN used county-specific activity data to estimate emissions at the county and air basin level. The three main types of activity data are: the population of vehicles (POP), the number of vehicle miles traveled (VMT), and the number of vehicle starts (Starts). The corresponding emission rates are expressed as grams per vehicle, grams per mile, and grams per start. An inventory is then calculated by multiplying the emission factor by its associated activity.

The first three models used statewide data. In contrast, the BURDEN model produced emission inventories for the entire state, an air basin, or county. The models incorporate emission impacts of only those regulations adopted prior to the model release date and not regulations proposed for adoption. The MVEI Models estimated emissions for calendar years 1970 through 2020.

Vehicle Classes and Technology Groups

The MVEI7G model provided emission estimates for ten different vehicle classes and three technology groups that were combined to form 19 class/technology groups. The technology groups are non-catalyst equipped (NCAT), catalyst equipped (CAT), and diesel powered (DSL) vehicles. The nineteen class/technology groups, and the abbreviations used are listed in Table 3-1.

TABLE 3-1. - 19 VEHICLE CLASS/TECHNOLOGY GROUPS IN MVEI7G

CLASS#	Class	Tech Groups	Vehicle Class (spelled out)
1	LDA	NCAT, CAT, DSL	Light-Duty Autos
2	LDT	NCAT, CAT, DSL	Light-Duty Trucks
3	MDT	NCAT, CAT, DSL	Medium-Duty Trucks
4	LHGT	NCAT, CAT, DSL	Light-Heavy Gas Trucks
5	LHDT	DSL	Light-Heavy Diesel Trucks
6	MHGT	NCAT, CAT	Medium-Heavy Gas Trucks
7	MHDT	DSL	Medium-Heavy Diesel Trucks
8	HHDT	DSL	Heavy-Heavy Diesel Trucks
9	UBD	DSL	Urban Transit Buses
10	MCY	NCAT	Motorcycles

Exhaust Emission Sources

Emissions that emanate from the vehicle's tailpipe are called exhaust emissions. Incomplete combustion of the fuel is the primary cause of HC, CO, and PM emissions. These emissions occur at all times, but especially when the air/fuel ratio is richer than stoichiometric (14.7-to-1) conditions, such as during a hard acceleration. NO_X is produced during combustion at high temperatures and pressures, but especially under lean air/fuel ratio conditions. Properly working catalysts reduce tailpipe emissions from gasoline vehicles by over 90 percent when combined with electronic systems that monitor the air/fuel ratio. Due to higher combustion temperatures, excess air and high pressures, a diesel-fueled vehicle emits comparatively more NO_X than a comparable gasoline-fueled vehicle. PM is the by-product of incomplete combustion. The lean overall air/fuel ratios used by diesel vehicles preclude the use of conventional reduction catalysts for emissions control.

There are two vehicle operation modes that contribute to exhaust emissions: the stabilized running mode and the start mode. The stabilized running mode occurs when the engine and/or catalyst are at normal operating temperature. As defined for modeling purposes, the start mode occurs during the first 100 seconds of operation after the engine has been started. Since the engine and/or catalyst may not have achieved their optimal operating temperature, the emissions during starts are generally higher.

Most of the PC, LDT and MDT exhaust data used for modeling are collected in ARB Surveillance programs. In developing MVEI7G, data from approximately 2600 vehicles were available. Most vehicles were tested on a dynamometer, which simulates on-road driving. Because HDT engines may be sold independent of the chassis, HDT engines are tested on engine dynamometers, which simulate the load experienced by the engine. Individual vehicle parameters such as axle ratio, aerodynamics and gross vehicle weight are represented rather crudely by the engine dynamometer test.

<u>Evaporative Emissions Sources</u>

Gasoline readily leaks or evaporates from the fuel storage and delivery system. This occurs whether the vehicle is running or not and whether the ambient temperature is increasing or decreasing. The evaporative emission processes are described below:

1) Diurnal

Diurnal emissions result from evaporation in the fuel system and breakthrough of vapors from the carbon canister, hoses and connectors when the vehicle is not being operated and the ambient temperature is rising.

2) Hot Soak

Hot soak emissions result when vapors escape within one hour after the engine is turned off. These emissions are caused by high under-hood and fuel temperatures.

3) Resting Losses

Resting loss emissions are defined as losses due to permeation of fuel through rubber and plastic components when the vehicle has not been operated for at least an hour and the ambient temperature is either constant or decreasing.

4) Running Losses

Running losses occur when hot fuel vapors escape from the fuel system or overwhelm the carbon canister while a vehicle is being operated.

Evaporative emissions are measured using a Sealed Housing Evaporative Determination (SHED) Test. This test is performed by placing a vehicle in an airtight enclosure, also referred to as a shed, to capture the evaporating gases. The temperature inside the shed is varied to simulate changes in ambient temperature. A running loss enclosure, a dynamometer within a shed, is used to gather emissions while a vehicle is being driven.

Activity

The BURDEN model utilized a variety of motor vehicle activity data developed from a variety of sources. Since MVEI7G produced county-specific and vehicle class-specific emission inventories, county-specific and vehicle class-specific activity data were needed. Activity data forecasting methods were also needed to project activity from a baseline year to 51 calendar years, 1970 to 2020. The sources of baseline activity data were often different than the sources of forecasting data. In many cases, data needed to be disaggregated from a statewide to county-specific level, or disaggregated from the entire motor vehicle fleet to specific vehicle classes. The most relevant activity data and their primary sources are summarized in Table 3-2.

TABLE 3-2. - COUNTY-SPECIFIC ACTIVITY DATA AND SOURCES

Data Type	Primary Data Sources
Populations	DMV, DOF
Vehicle Miles Traveled	CALTRANS, TDMs, ARB
Vehicle Starts	U.S. EPA, ARB
Ambient Temperatures	NWS, ARB, Districts, DWR
VMT by Speed Distribution	CALTRANS, TDMs
Soak Distribution	U.S. EPA, ARB
Activity Distribution	U.S. EPA, ARB

Population

For MVEI7G, vehicle registration data from the DMV were used for vehicle population estimates for calendar years 1970 through 1993. Since the DMV uses different classifications and vehicle weight-classes, the data from these reports were first converted to match ARB's vehicle classes. Projections of light-duty vehicle population for future years were made using the DOF growth rates of people population for each county.

Projections for HDTs were based on CALTRANS' truck growth rates from the MVSTAFF report.

Vehicle Miles Traveled (VMT)

In MVEI7G, VMT on state highways and other roadways was estimated for the total motor vehicle fleet by CALTRANS and published in its yearly MVSTAFF Report. 1980 to 1993 reports were used. Since BURDEN required VMT data by vehicle class, other sources of information (such as DMV registration data) were used in conjunction with the MVSTAFF report to estimate travel by vehicle class. VMT estimates were first made for HDTs, UBDs, and MCYs. This subtotal was then subtracted from the total VMT in the MVSTAFF Report and the remainder was split among LDAs, LDTs, and MDTs using vehicle population data for these classes. The COGs in most urbanized areas have developed TDMs. As part of the transportation planning process, these models estimate VMT for their regions for some classes of vehicles. When available, VMT estimates from these local TDMs were used in place of MVSTAFF.

All HDT VMT was estimated using two sources: CALTRANS' yearly report, "Truck Miles of Travel on the California State Highway System" and Pacific Environmental Services' (PES) "Assessment of Heavy-Duty Gasoline and Diesel Vehicles in California: Population and Use Patterns." The PES Report contains data regarding travel on local roads. The VMT for all HDTs were then split for gasoline and diesel HDTs using data from the PES Report.

Projections for future years are also given in the MVSTAFF Report and from the TDMs. Since these sources may not have included projections for all of the years needed by the MVEI Models, staff interpolated and/or extrapolated the data as needed.

Vehicle Starts

In MVEI7G, the on-road emission inventory used an estimated number of starts to calculate trip emissions for all gasoline-powered vehicle classes except heavy-duty trucks and motorcycles. The total number of vehicle starts was calculated as the product of a per-vehicle start rate (starts per vehicle per day) and the fleet population. Data from the U.S. EPA's 3-City Instrumented Vehicle Study, along with estimates of trips from CALTRANS travel surveys, were analyzed by staff to estimate the statewide, per vehicle start rates for light-, and medium-duty vehicles. Vehicles in the U.S. EPA's study were instrumented to record the number of times the vehicles were started each day. This study was conducted in 1992 and included 1978 to 1992 vehicles. Since 35 model years were used in the MVEI Models for LDAs (25 model years for the other vehicle classes), CALTRANS' travel survey data were used to fill in for the remaining model years.

CALTRANS periodically conducts a statewide travel survey in which people record their driving habits in diaries. Because CALTRANS is interested in the number of *trips* people make, non-destination trips are not recorded. These non-destination trips include short side trips, and starts associated with shuffling cars at home or moving a car in a parking lot. Since emissions are produced whenever a vehicle is started, the CALTRANS survey data were adjusted to include these starts. The analysis resulted in the distribution of starts by vehicle age used in MVEI7G. When combined with the population distribution by vehicle age, a fleet average start rate was produced. For LDAs, the statewide average number of starts per vehicle per day was estimated as 6.35. Previously, (EMFAC7F), this rate was assumed to be 3.76 trips per vehicle per day using only the CALTRANS Survey Data. Therefore, the ratio of MVEI7G "starts" to EMFAC7F "trips" for LDAs was estimated at 1.69 and this ratio was used as the "trips-to-starts" adjustment factor.

Some regions use TDMs to provide the ARB with alternative estimates of the total number of trips, independent of the total number of vehicles, so that a per vehicle trip rate was not used. For these regions, the total number of trips predicted by the TDMs was multiplied by the 1.69 adjustment factor to produce the total number of starts. Therefore, the rate of starts per vehicle varied from year-to-year for regions that have TDMs. For regions that did not use TDMs, the survey data were used to determine the region-to-statewide relative trip rates. These regional differences were used to adjust the total number of starts for each region.

Ambient Temperatures

Because emissions from motor vehicles are sensitive to temperature, profiles of ambient temperatures are used to estimate seasonal inventories. Staff analyzed ambient temperature data from the following sources: ARB and district monitoring stations, the National Weather Service, and two databases which are maintained by the California Department of Water Resources - CIMIS and CDEC. A single temperature distribution was created by averaging the hourly temperatures from the 10 days with the worst air quality during the period of 1987 to 1989.

For non-attainment areas, the ten worst days were determined for each pollutant. For ozone, the ten worst days were determined for the entire basin (i.e., all the counties within the basin have the same ten worst days). For CO, NO_2, and SO_2, the ten worst days were determined for each county or a portion of a county within an air basin.

Because attainment areas do not have exceedance days, the ten days were based on the worst air quality readings (basin-wide for O_3, countywide for CO). For the unclassified areas (areas with limited or no air quality data), the ten days were based on a neighboring county within the same air basin that had available data.

VMT by Speed Distribution

The primary sources of VMT by speed distribution are CALTRANS and, where available, regional TDMs. Speed distribution data from TDMs were used in BURDEN without further adjustment. For areas that did not use TDMs, staff used CALTRANS traffic count data and information from the HPMS database to estimate VMT by speed. The same VMT by speed distribution was used for all vehicle classes except buses. Travel data were provided by the TDMs for a base year and usually several future years, each with different speed distributions. Staff used these speed distributions for those analysis years, and interpolated for the years between. Areas without TDMs used the same speed distributions for all calendar years.

For urban diesel transit buses, the VMT by speed distribution was based on a study performed for the ARB by Valley Research Corporation titled "On-Road Motor Vehicle Activity Data, Volume 1-Bus Population and Activity Pattern." The study analyzed the driving patterns of transit buses and school buses using chase cars equipped with data loggers. Although the study was done in the SCAB, the resultant speed distributions were used for all counties in the state after adjusting for each county's urban and small urban classifications.

Starts by Soak Time Distribution

A "soak" is defined as the time during which a vehicle is turned off, to the time it is restarted. Start emission rates differ according to how long a vehicle has been "soaking" and MVEI7G produced start emission factors for a variety of pre-start soak times. Staff analyzed data from the U.S. EPA's Instrumented Vehicle Study to group starts by soak duration for 12 pre-start intervals. Since the U.S. EPA data included the time of day the vehicles were started, the analysis produced a different soak distribution for each of six periods. However, the same soak distributions by period were used for all calendar years, for light-, and medium-duty vehicles, and for all counties.

Period Splits

Because BURDEN estimated emissions for each of six time periods, the activity data used by BURDEN was estimated for each period. While the ambient temperature data were derived by time of day, other activity data (VMT, starts, and VMT by speed) were derived for an average day and then disaggregated into six time periods. These divisions were based on CALTRANS or COG estimates of VMT for certain periods of the day (for VMT), miles of roadway by functional classification, and vehicle speed profiles by functional classification for VMT by speed distribution. Driver trips-in-motion by region of the State were used to allocate trips to period of the day.

3.1 **Annual Average Inventory**

EMFAC2000 produces a number of seasonal inventories for different purposes. Seasonal adjustments in the model include ambient temperature, humidity and the Reid Vapor Pressure of dispensed fuel.

Episodic inventories are needed to assess worst case conditions for ozone, high ambient temperature and low relative humidity, and carbon monoxide, low ambient temperature and high relative humidity, in order to estimate how effective adopted or proposed emission reductions strategies will be in reducing peak concentrations of pollutants. EMFAC2000 produces both episodic and month specific inventories, however, an annual average inventory is best suited for assessing emission trends over time.

MVEI7G did not produce an annual average emissions inventory, rather ozone and carbon monoxide episodic estimates were weighted together for this purpose. A two thirds weighting for ozone and one third weighting for carbon monoxide was used in MVEI7G for all air basins with the exception of the South Coast, where a 7/12, 5/12 weighting was used for ozone and carbon monoxide, respectively. The weighting of episodic inventories may have led to an overestimation of annual average emissions.

In EMFAC2000, annual average inventories are derived by weighting each month of emissions for the year equally for a specific area. It is believed that this modification in methodology yields a more realistic basis for tracking emission reductions and assessing the cost of effectiveness.

California Environmental Protection Agency

AIR RESOURCES BOARD

PUBLIC MEETING
TO CONSIDER
APPROVAL OF
REVISIONS TO THE STATE'S
ON-ROAD
MOTOR VEHICLE EMISSIONS
INVENTORY

TECHNICAL SUPPORT DOCUMENT

May 2000

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Appendix A - Acronyms Used in Staff Report
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