Technical Support Document

Carbon Monoxide Maintenance Plan Revision For the Denver-Boulder Attainment Area

September 2005

Prepared by the Technical Services Program
Air Pollution Control Division
Colorado Department of Public Health and Environment

Table of Contents

Tables

Figures

1.0 Introduction

Ambient carbon monoxide levels have dropped dramatically over the past 10 years in the Denver metro area. Maximum 8-hour ambient concentrations are near half the 8-hour NAAQS for carbon monoxide. In addition, MOBILE6.2-based estimates for I/M 240 and oxygenated fuel program benefits in the current State Implementation Plan (SIP) are less than in the past since the post-'1996 fleet of vehicles is clean and the deterioration rate is low. Consequently the I/M 240 program and the oxygenated fuel program are no longer necessary to maintain the carbon monoxide NAAQS in the Denver-Boulder attainment area. This document describes the technical analysis that will be utilized to demonstrate that the I/M 240 and oxygenated fuel programs are no longer necessary to assure that the Denver-Boulder carbon monoxide attainment area will meet the CO NAAQS.

The 2001 attainment year inventory is based on the actual control levels in place at that time. For purposes of the demonstration of maintenance of the CO NAAQS, the I/M 240 program and the oxygenated fuel program are assumed to terminate on January 1, 2008. The phase-out of residual I/M 240 program benefits is estimated in the 2009 and 2010 analysis years. January 1, 2009 will have half the benefit of a biennial I/M 240 program and January 1, 2010 will have no residual benefit due to the I/M 240 program.

The attainment demonstration for this SIP revision is based on three components:

1. Attainment area inventory analysis (all future years emissions inventory total is less than the 2001 inventory.

2. A gridded emission inventory analysis

    - Evaluate a nine-grid cell area around the CAMP monitoring site to assure that all future emission levels are less than the 2001 emissions level
    - Evaluate the entire attainment area for areas of high growth. Assure with a roll forward analysis that the CO NAAQS will not be exceeded

3. Hot-spot/intersection modeling analysis for at the CAMP monitoring location, the three most congested and the three highest volume intersections.

Section 3 of this documents describes these three components in detail.

2.0 Emissions Inventory Summary

Carbon monoxide emissions were developed for the 2001 base-attainment year, the 2009 and 2010, 2015, 2020 and 2025 interim years. The 2021 maintenance year emission inventories were a linear interpolation between the 2020 and 2025 interim year inventories.

The 2001 base inventory incorporates the estimated actual emissions and control measures in place at that time. The 2009, 2010, 2015, 2020, and 2025 inventories incorporate control measures described in sections pertinent to each emissions source category (Section 3.0 Emission Inventories)

All of the inventories are for the Denver attainment maintenance boundary and provide emissions estimates consistent with December 5, 1988 (design day from the UAM dispersion modeling demonstration). The attainment area modeling domain area is also used to establish the motor vehicle emissions budgets for the region as discussed in subsequent sections of this plan.

The inventories were developed using EPA-approved emissions modeling methods and updated transportation and demographics data from DRCOG. This technical support document contains detailed information on model assumptions and parameters for each source category.

The emissions inventories include forecasted estimates from Denver International Airport (DIA) operations and construction. The Technical Support Document contains a table of DIA-specific emissions for purposes of general conformity demonstrations. The entirety of DIA's emissions estimates documentation is included in Appendix C.

The Table 2.1-1 summarizes the emission inventories to support the Denver Maintenance plan transportation budget revision. All inventories have been apportioned to the geographical area bounded by the Denver-Boulder attainment area boundaries.

Table 2.0-1 - Emission Inventory Summaries

Area Sources	**2001**	**2009**	**2010**	**2013**	**2015**	**2020**	**2021**	**2025**
Aircraft	13.8	17.6	18.0	19.1	19.9	21.7	22.0	22.8
Commercial Cooking	1.0	1.0	1.1	1.1	1.2	1.3	1.3	1.4
Fuel Combustion	8.2	9.2	9.4	9.8	10.1	11.0	11.0	11.8
Railroads	0.6	0.8	0.8	0.9	0.9	1.0	1.0	1.1
Structure Fires	0.4	0.5	0.5	0.5	0.5	0.5	0.5	.6
Woodburning	50.2	51.4	51.5	52.0	52.3	53.2	53.4	54.2
Total Area Sources	**74.1**	**80.5**	**81.2**	**83.4**	**84.9**	**88.7**	**89.4**	**91.9**
NonRoad Sources								
Agricultural Equipment	0.2	0.2	0.2	0.1	0.1	0.1	0.1	.1
Airport Equipment	27.4	34.0	35.3	37.3	38.9	42.9	43.6	46.7
Commercial Equipment	116.0	148.2	151.1	159.6	165.2	174.8	176.8	184.7
Construction and Mining Equipment	14.4	15.1	15.0	14.1	13.4	12.0	11.9	11.6
Industrial Equipment	21.4	15.7	13.5	7.3	4.9	3.2	3.1	2.7

Area Sources	**2001**	**2009**	**2010**	**2013**	**2015**	**2020**	**2021**	**2025**
Lawn and Garden Equipment (Commercial)	17.4	22.1	22.4	23.3	24.0	25.5	26.0	27.7
Lawn and Garden Equipment (Residential)	1.0	0.8	0.9	0.9	0.9	1.0	1.0	1.1
Other Oil Field Equipment	0.4	0.5	0.5	0.5	0.5	0.5	0.5	.5
Railroad Equipment	0.2	0.2	0.2	0.2	0.2	0.2	0.2	.2
Recreational Equipment	1.3	2.2	2.3	2.4	2.4	2.4	2.4	2.5
Total NonRoad Sources	**199.4**	**239.0**	**241.3**	**245.6**	**250.4**	**262.6**	**265.6**	**277.8**
Point Sources								
Stack>=25	4.9	5.6	5.8	6.3	6.8	7.9	8.1	8.7
Stack<25	10.4	12.5	12.7	13.5	13.6	15.0	15.2	16.1
Total Points	**15.3**	**18.1**	**18.5**	**19.8**	**20.4**	**22.9**	**23.3**	**24.8**
Mobile Sources	**1708.1**	**1476.8**	**1523.9**	**1429.2**	**1416.0**	**1362.7**	**1372.1**	**1409.9**
Grand Total	**1997.0**	**1814.5**	**1864.9**	**1778.1**	**1771.7**	**1736.9**	**1750.3**	**1804.3**

2.1 Mobile Source Emission Inventory

2.1.1 Travel Demand Model based Mobile6.2 Inputs

The basis for mobile source activity level is the DRCOG the 2030 Regional Transportation Plan (RTP) travel demand modeling. The 2001, 2005, 2015, 2020 and 2030 networks from the 2030 RTP will be used for VMT estimates. The 2009, 2010, 2013 and 2025 VMT and network speed estimates were determined from interpolations between the appropriate 2030 RTP networks.

The following Mobile6.2 inputs parameters for 2001, 2009, 2010 and 2013, 2015, 2020 and 2030 were derived from the 2030 RTP:

- Vehicle speeds (SPEED VMT command)
- Diurnal distribution of VMT (VMT BY HOUR command)
- Distribution of VMT by Facility class (VMT BY FACILITY)

A FORTRAN program was written to convert the speeds and VMT as a function of 10 peak periods, facility type and area type into the proper formats for the Mobile6.2 command files. This FORTRAN program, m6inputa.f, is included in Appendix A.

The temporal basis of the DRCOG 2030 RTP is 10 peak periods: three a.m. and p.m. peak periods and four off peak periods. Each link in the network has a traffic volume and speed associated with each of the 10 peak periods. The length of each peak period and where it occurs

during the day is dependent on the level of congestion during the peak period. A FORTRAN processing program, link_to_area1.f, utilizes congestion level/peak period definition information from DRCOG to allocate the VMT and speed to the appropriate hour(s) in the day. Finally, the VMT for each area type is normalized to unity, resulting in the files referenced by the VMT BY HOUR command. The SPEED VMT files are processed similarly, although the speeds are weighted by the VMT across the freeway and arterial classes. Freeway and Major Regional speeds from the DRCOG 2030 RTP comprise the Mobile6.2 'freeway' speed. Likewise the RTP speeds for Major Arterials, Minor Arterials and Collectors comprise the Mobile6.2 'arterial' speed. Mobile6.2 'ramps' and 'locals' speeds are defined internal by the Mobile6.2 model. SPEED VMT files for 2009, 2010, 2013 and 2025 were interpolated from the appropriate RTP model years.

Each link in the DRCOG networks is also designated with a facility class (freeway, expressway, principal and minor arterial, collector, ramp and local) and area type (CBD, fringe, urban, suburban and rural). The file referenced by the VMT BY FACILITY command results from a summary of VMT by facility type for each area type.

Finally, the FORTRAN processing program writes a text file of five scenarios, one for each area type. The text for each scenario references the appropriate files through the SPEED VMT, VMT BY FACILITY and VMT BY HOUR commands. The scenarios text is then appended to the 'header' and 'run' sections to complete the Mobile6.2 input file.

2.1.2 Local Vehicle Mix and Vehicle Registration Distribution

Colorado data on VMT mix and vehicle registration distribution has been was updated recently based on the year 2001. These new local data sets were included in this SIP revision. This information results from a survey of VMT mix across the state of Colorado during 2001. To estimate the VMT mix for years other than 2001, the 2001 VMT mix is 'aged' using the trend in the default Mobile6.2 VMT fraction between 2009 and 2030. The VMT mix is included as part of the scenario description for each area type in the Mobile6.2 'scenario section'. The reference to the registration distribution is included in the 'RUN DATA' section of the Mobile6.2 input files. The VMT mix information and registration distribution is included in the Appendix A as part of the Mobile6.2 input streams.

2.1.3 Control Strategy Parameterization

For purposes of this technical demonstration, it is assumed that the I/M 240 program and the oxygenated fuel program will terminate on December 31, 2007. Consequently, the year 2009 (January 1, 2009) is proposed as the first interim year for an emissions inventory estimate to recognize the reduced emissions benefits of the I/M 240 program. The year 2010 is proposed as the second interim year for an emissions inventory estimate to recognize the elimination of emissions benefits of the I/M 240 program in the SIP. The 2009 emissions inventory estimate will recognize the elimination of the oxygenated fuel program in the SIP.

2.1.4 Mobile Source Emission Inventories

The mobile source emission factors were calculated using the Mobile6.2 executable. Tables summarize the VMT, emissions factors and resulting emissions inventories:

Table 2.1-2 - VMT, Emissions Factors and Resulting Emissions Inventories

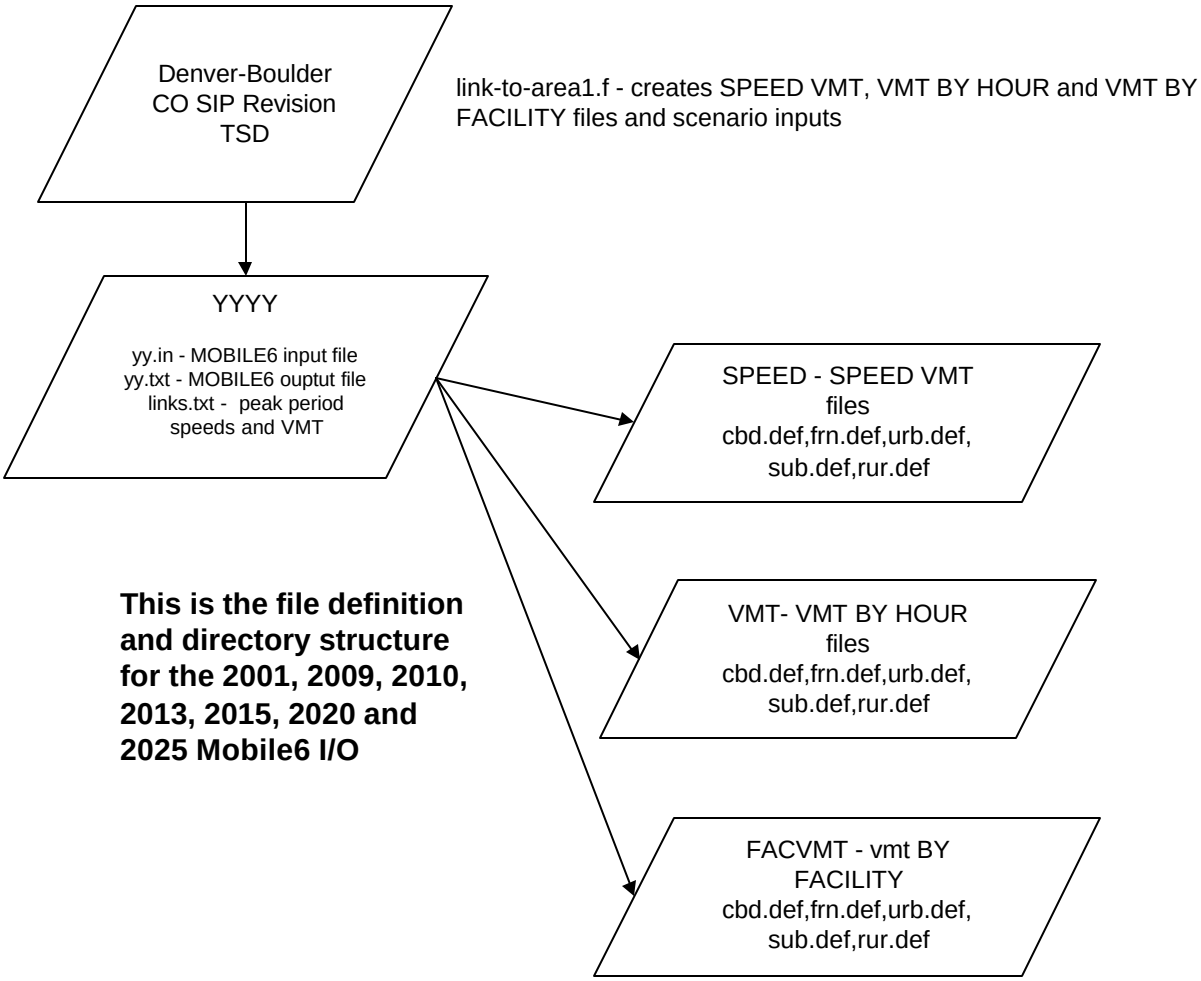
2001	**VMT**	**g/mi**	**tons/day**
CBD	1,100,835	26.205	31.798
Fringe	5,104,078	26.719	150.326
Urban	20,674,046	25.961	591.621
Suburban	22,980,944	27.015	684.337
Rural	8,124,682	27.922	250.063
Total	57,984,585	26.725	1708.146
2009	**VMT**	**g/mi**	**tons/day**
CBD	666,035	19.085	14.012
Fringe	7,393,596	19.535	159.208
Urban	29,803,647	19.270	633.065
Suburban	22,693,337	19.915	498.168
Rural	7,571,395	20.655	172.384
Total	68,128,010	19.666	1476.837
2010	**VMT**	**g/mi**	**tons/day**
CBD	672,665	19.370	14.362
Fringe	7,487,461	19.780	163.252
Urban	30,301,624	19.460	649.989
Suburban	23,294,606	20.050	514.833
Rural	7,901,439	20.840	181.510
Total	69,657,794	19.847	1523.946
2013	**VMT**	**g/mi**	**tons/day**
CBD	691,004	17.043	12.981
Fringe	7,787,120	17.383	149.210
Urban	31,816,343	17.103	599.818
Suburban	25,155,374	17.529	486.054
Rural	8,998,636	18.265	181.173
Total	74,448,477	17.416	1429.237
2015	**VMT**	**g/mi**	**tons/day**
CBD	705,954	16.153	12.570
Fringe	7,963,210	16.506	144.886
Urban	32,824,105	16.242	587.664
Suburban	26,395,011	16.709	486.149
Rural	9,656,366	17.359	184.772
Total	77,544,645	16.566	1416.041
2020	**VMT**	**g/mi**	**tons/day**
CBD	738,533	14.327	11.663
Fringe	8,985,561	14.570	144.312

Urban	35,917,174	14.309	566.511
Suburban	28,045,230	14.674	453.633
Rural	11,079,125	15.277	186.569
Total	84,765,624	14.584	1362.688
2021	**VMT**	**g/mi**	**tons/day**
CBD	749,780	14.214	11.742
Fringe	9,432,336	14.446	149.956
Urban	36,478,792	14.185	570.093
Suburban	28,276,491	14.550	453.389
Rural	11,215,781	15.128	186.941
Total	86,153,180		1372.122
2025	**VMT**	**g/mi**	**tons/day**
CBD	794,769	13.764	12.058
Fringe	11,219,435	13.951	172.533
Urban	38,725,263	13.691	584.422
Suburban	29,201,534	14.055	452.411
Rural	11,762,405	14.533	188.429
Total	91,703,406	13.947	1409.854

2.1.5 Mobile6.2 Input/Output File Documentation

Due to the volume and complexity of files utilized in the emission processing for this SIP revision, the Mobile6.2 input and output files as well as all ancillary input files are included on the Technical Services Program Technical Documents web site, http://apcd.state.co.us/documents/techdocs.html, as Appendix A. The subdirectory structure of the files on this CD is described in the following diagram.

Diagram 1: Directory structure of digital files for Denver-Boulder CO SIP Revision TSD



2.2 Area, Non-road and Point Source Emission Inventories

Area Source Emissions for 2001 were based on The February 2005 Version of the 2002 EPA National Emissions Inventory (NEI) and were apportioned to the Denver CO Grid by households or employment using the Denver Regional Council of Governments (DRCOG) Land Use and Transportation Plan (LUTP) demographic data. The LUTP and census data were used to adjust emissions for growth. Daily Residential and Commercial Heating Emissions were obtained from annual emissions by multiplying by the ratio of heating degree days in the high CO season (November, December and January) to the entire year (0.517161, based on National Weather Service data for Denver for 1948 to 2004 with a base of 60 degrees F)) and dividing by 92 (the number of days in the season). Daily Emissions for Other area sources (Commercial Cooking, Structural Fires) were obtained by dividing annual emissions by 365. Projections to other years were based on population and employment projections from the land use and transportation plan.

The Non-Road emissions were based on the EPA Non-road model. Non-road Emissions were apportioned to the Denver CO Grid by households or employment using the DRCOG demographic data. The railroad and agriculture Non-road Emissions are an exception to this apportionment methodology. Railroad related Non-road Emissions were apportioned to the attainment area by the miles of track. Agricultural Non-road Emissions were apportioned to the Denver CO Grid by land area, and airports were apportioned according to airport location. For Commercial Equipment, Emissions were calculated for 2001 using the Non-road Model, but were grown to future years using the growth in Production and Distribution Employment from the DRCOG LUPT. The following equipment categories were excluded from the Lawn and Garden categories in computing the winter emissions: Commercial Turf Equipment, Front Mowers, Lawn & Garden Tractors, Lawn mowers, Other Lawn & Garden Eqp., Rear Engine Riding Mowers, Rotary Tillers < 6 HP, Trimmers/Edgers/Brush Cutter. The following lawn and garden equipment winter emissions were included: Chippers/Stump Grinders, Chain Saws < 6 HP, Leafblowers/Vacuums, Shredders < 6 HP, Snowblowers.

The City and County of Denver provided emissions for Denver International Airport (DIA) for the base and future years. Table 2.2-1 summarizes the Denver International Airport emissions Inventory Estimates. The totals in this table are includes Table 2.2-1 summaries for aircraft, aircraft equipment, structural fires, point sources and construction. DIA serves as a regional firefighting training site, and the Division has included the airport's firefighting training emissions under the structural fire category.

Table 2.2-1 - Carbon Monoxide Emissions Summary – Denver International Airport

	Carbon Monoxide (tons/year)							
Inventory Sub-Category	**2001**	**2009**	**2010**	**2013**	**2015**	**2020**	**2025**	**2030**
Operational Emissions								
Aircraft[1/]	2,470.74	3,555.65	3,649.35	3,922.99	4,101.69	4,528.47	4,936.28	5,393.86
Airport Equipment[2/]	9,977.79	12,394.42	12,852.57	13,604.77	14,195.39	15,645.22	17,053.79	18,624.43
Firefighting Training	0.44	0.86	0.94	1.22	1.22	1.22	1.22	1.22
Minor Point Sources	40.33	54.21	55.80	60.31	62.69	71.40	79.61	87.67
Unpaved Roads	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Construction Emissions								
Construction	19.01	19.01	19.01	19.01	19.01	19.01	19.01	19.01
Construction Equipment	125.78	65.37	61.71	44.08	33.51	16.64	9.38	6.02
Total	12,634.09	16,089.52	16,639.38	17,652.38	18,413.51	20,281.96	22,099.29	24,132.21

	Carbon Monoxide (tons/day) [3/]							
Inventory Sub-Category	**2001**	**2009**	**2010**	**2013**	**2015**	**2020**	**2025**	**2030**
Aircraft[1/]	6.7692	9.7415	9.9982	10.7479	11.2375	12.4068	13.5241	14.7777
Airport Equipment[2/]	27.3364	33.9573	35.2125	37.2733	38.8915	42.8636	46.7227	51.0258
Firefighting Training	0.0012	0.0024	0.0026	0.0033	0.0033	0.0033	0.0033	0.0033
Minor Point Sources	0.1105	0.1485	0.1529	0.1652	0.1718	0.1956	0.2181	0.2402
Unpaved Roads	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Construction Emissions								
Construction	0.0521	0.0521	0.0521	0.0521	0.0521	0.0521	0.0521	0.0521
Construction Equipment	0.3446	0.1791	0.1691	0.1208	0.0918	0.0456	0.0257	0.0165
Total	34.6140	44.0809	45.5874	48.3626	50.4480	55.5670	60.5460	66.1156

Notes:
1/ The "Aircraft" source category includes emissions produced by aircraft operations and auxiliary power units.
2/ "Airport equipment" includes emissions produced by ground support equipment and city support equipment.
3/ Tons per day were calculated by dividing the tons per year data by 365 days per year.
n.a. = not applicable

The Division estimated airport emissions for all other metropolitan area airports separately.

Railroad Locomotive Emissions for 2001were based on The February 2005 Version of the 2002 EPA National Emissions Inventory (NEI) and were apportioned to the nonattainment area by miles of track. Projections from 2002 to 2001 and to future years were based on the change in population.

Wood burning emissions for 2001 and future years were developed by calculating per-household wood burning rates from the the 2002 Wood Burning Survey, and multiplying by the appropriate AP-42 emission factors. The number of households for each year was taken from the DRCOG LUTP. Daily emissions were obtained from annual emissions by multiplying by the ratio of heating degree days in the high CO season (November, December and January) to the entire year (0.517161, based on National Weather Service data for Denver for 1948 to 2004 with a base of 60 degrees F) and dividing by 92(the number of days in the season).

2001 Point Source Emissions were taken from the Colorado Air Inventory System which is based on the stationary source permit data. Point Source Emissions were grown to future years using the EPA's Economic Growth and Analysis System (EGAS) model.

Denver Regional Council of Governments (DRCOG) Land Use and Transportation Plan (LUTP) demographic data:

CO Grids YEAR	2001	2008	2013	2015	2020	2025	2030
Population	2,450,129	2,754,010	2,990,322	3,084,846	3,373,388	3,661,930	3,950,472
Households	969,739	1,104,691	1,202,289	1,241,329	1,362,896	1,484,462	1,606,029
Employment	1,364,673	1,474,233	1,640,636	1,707,198	1,830,825	1,954,452	2,078,079

2.2.1 Non-road Model Input File For 2001

The "Non-road Model Input File for 2001 " was produced automatically by the NonRoad Model. There is no High Altitude Option available for the Model. The inputs to the model that are reflected in this file are those within the */NAME/…/END/* delimiters such as:

/OPTIONS/
Title 1 : DENVER CO SIP REVISION
Title 2 : 2001
Fuel RVP for gas : 12.5
Oxygen Weight % : 3.4
Gas sulfur % : 0.034
Diesel sulfur % : 0.0500
CNG/LPG sulfur % : 0.003
Minimum temper. (F): 27
Maximum temper. (F): 52
Average temper. (F): 39
Altitude of region : LOW
/END/

Written by Nonroad interface at 12/16/2004 3:17:19 PM
This is the options file for the NONROAD program.
The data is sperated into "packets" bases on common
information. Each packet is specified by an
identifier and a terminator. Any notes or descriptions
can be placed between the data packets.

10/8/1999 changed default RVP from 9.0 to 8.0

PERIOD PACKET

This is the packet that defines the period for
which emissions are to be estimated. The order of the
records matter. The selection of certain parameters
will cause some of the record that follow to be ignored.
The order of the records is as follows:

1 - Char 10 - Period type for this simulation.
Valid responses are: ANNUAL, SEASONAL, and MONTHLY
2 - Char 10 - Type of inventory produced.
Valid responses are: TYPICAL DAY and PERIOD TOTAL
3 - Integer - year of episode (4 digit year)
4 - Char 10 - Month of episode (use complete name of month)
5 - Char 10 - Type of day
Valid responses are: WEEKDAY and WEEKEND

/PERIOD/
Period type : Seasonal
Summation type : Typical day
Year of episode : 2001
Season of year : Winter
Month of year :
Weekday or weekend : Weekday
/END/

OPTIONS PACKET

This is the packet that defines some of the user options that drive the model. Most parameters are used to make episode specific emission factor adjustments. The order of the records is fixed. The order is as follows.

1 - Char 80 - First title on reports
2 - Char 80 - Second title on reports
3 - Real 10 - Fuel RVP of gasoline for this simulation
4 - Real 10 - Oxygen weight percent of gasoline for simulation
5 - Real 10 - Percent sulfur for gasoline
6 - Real 10 - Percent sulfur for diesel
7 - Real 10 - Percent sulfur for LPG/CNG
8 - Real 10 - Minimum daily temperature (deg. F)
9 - Real 10 - maximum daily temperature (deg. F)
10 - Real 10 - Representative average daily temperature (deg. F)
11 - Char 10 - Flag to determine if region is high altitude
Valid responses are: HIGH and LOW
12 - Char 10 - Flag to determine if RFG adjustments are made
Valid responses are: YES and NO

/OPTIONS/
Title 1 : DENVER CO SIP REVISION
Title 2 : 2001
Fuel RVP for gas : 12.5
Oxygen Weight % : 3.4
Gas sulfur % : 0.034
Diesel sulfur % : 0.0500
CNG/LPG sulfur % : 0.003
Minimum temper. (F): 27
Maximum temper. (F): 52
Average temper. (F): 39
Altitude of region : LOW
/END/

REGION PACKET

This is the packet that defines the region for which emissions are to be estimated.

The first record tells the type of region and allocation to perform.

Valid responses are:
US TOTAL - emissions are for entire USA without state breakout.

50STATE - emissions are for all 50 states and Washington D.C., by state.

STATE - emissions are for a select group of states
and are state-level estimates

COUNTY - emissions are for a select group of counties
and are county level estimates. If necessary,
allocation from state to county will be performed.

SUBCOUNTY - emissions are for the specified sub counties
and are subcounty level estimates. If necessary,
county to subcounty allocation will be performed.

The remaining records define the regions to be included.
The type of data which must be specified depends on the
region level.

US TOTAL - Nothing needs to be specified. The FIPS
code 00000 is used automatically.

50STATE - Nothing needs to be specified. The FIPS
code 00000 is used automatically.

STATE - state FIPS codes

COUNTY - state or county FIPS codes. State FIPS
code means include all counties in the
state.

SUBCOUNTY - county FIPS code and subregion code.

/REGION/
Region Level : COUNTY
Adams County CO : 08001
Arapahoe County CO : 08005
Boulder County CO : 08013
Denver County CO : 08031
Douglas County CO : 08035
Jefferson County CO: 08059
Weld County CO : 08123
/END/

or use -
Region Level : STATE
Michigan : 26000

SOURCE CATEGORY PACKET

This packet is used to tell the model which source
categories are to be processed. It is optional.
If used, only those source categories list will
appear in the output data file. If the packet is
not found, the model will process all source
categories in the population files.

All Equipment - just put semicolon at start of packet name line
or use the following SCC list -

:2260000000
:2265000000
:2267000000
:2268000000
:2270000000
:2282000000
:2285000000

Diesel Only -
:2270000000
:2282020000
:2285002015
Spark Ignition Only -
:2260000000
:2265000000
:2267000000
:2268000000
:2282005010
:2282005015
:2282010005
:2285004015
:2285006015

This is the packet that lists the names of output files
and some of the input data files read by the model. If
a drive:\path\ is not given, the location of the
NONROAD.EXE file itself is assumed. You will probably
want to change the names of the Output and Message files
to match that of the OPTion file, e.g., MICH-97.OPT,
MICH-97.OUT, MICH-97.MSG, and if used MICH-97.AMS.

/RUNFILES/
ALLOC XREF : c:\nonroad\data\allocate\allocate.xrf
ACTIVITY : c:\nonroad\data\activity\activity.dat
TECHNOLOGY : c:\nonroad\data\tech\tech.dat
SEASONALITY : c:\nonroad\data\season\season.dat
REGIONS : c:\nonroad\data\season\season.dat
MESSAGE : c:\nonroad\outputs\denco01.msg
OUTPUT DATA : c:\nonroad\outputs\denco01.out
EPS2 AMS :
/END/

This is the packet that defines the equipment population
files read by the model.

/POP FILES/
Population File : c:\nonroad\data\pop\co.pop
/END/

POPULATION FILE : c:\nonroad\data\POP\MI.POP

This is the packet that defines the growth files
files read by the model.

/GROWTH FILES/
National defaults :C:\nonroad\data\growth\nation.grw
/END/

This is the packet that defines the spatial
allocation files read by the model.

/ALLOC FILES/
Air Transportation :c:\nonroad\data\allocate\co_airtr.alo
Coal mining empl. :c:\nonroad\data\allocate\co_coal.alo
Allocation File :c:\nonroad\data\allocate\co_con.alo
Allocation File :c:\nonroad\data\allocate\co_conbr.alo
Construction empl. :c:\nonroad\data\allocate\co_const.alo
Allocation File :c:\nonroad\data\allocate\co_farbr.alo

Harvested acres :c:\nonroad\data\allocate\co_farms.alo
Allocation File :c:\nonroad\data\allocate\co_golbr.alo
Golf course estab. :c:\nonroad\data\allocate\co_golf.alo
Allocation File :c:\nonroad\data\allocate\co_holbr.alo
Wholesale estab. :c:\nonroad\data\allocate\co_holsl.alo
Allocation File :c:\nonroad\data\allocate\co_houbr.alo
Family housing :c:\nonroad\data\allocate\co_house.alo
Loggin empl. :c:\nonroad\data\allocate\co_loggn.alo
Landscape empl. :c:\nonroad\data\allocate\co_lscap.alo
Allocation File :c:\nonroad\data\allocate\co_lscbr.alo
Allocation File :c:\nonroad\data\allocate\co_metal.alo
Allocation File :c:\nonroad\data\allocate\co_mnfbr.alo
Manufacturing empl.:c:\nonroad\data\allocate\co_mnfg.alo
Oil & Gas employees:c:\nonroad\data\allocate\co_oil.alo
Allocation File :c:\nonroad\data\allocate\co_oil~1.alo
Census population :c:\nonroad\data\allocate\co_pop.alo
Allocation File :c:\nonroad\data\allocate\co_pop~1.alo
RV Park establish. :c:\nonroad\data\allocate\co_rvprk.alo
Snowblowers comm. :c:\nonroad\data\allocate\co_sbc.alo
Allocation File :c:\nonroad\data\allocate\co_sbcbr.alo
Snowblowers res. :c:\nonroad\data\allocate\co_sbr.alo
Allocation File :c:\nonroad\data\allocate\co_sbrbr.alo
Allocation File :c:\nonroad\data\allocate\co_snmbr.alo
Snowmobiles :c:\nonroad\data\allocate\co_snowm.alo
Allocation File :c:\nonroad\data\allocate\co_water.alo
Rec marine inbrd :c:\nonroad\data\allocate\co_wib.alo
Rec marin outbrd :c:\nonroad\data\allocate\co_wob.alo
/END/

This is the packet that defines the emssions factors
files read by the model.

/EMFAC FILES/
THC exhaust : c:\nonroad\data\emsfac\exhthc.emf
CO exhaust : c:\nonroad\data\emsfac\exhco.emf
NOX exhaust : c:\nonroad\data\emsfac\exhnox.emf
PM exhaust : c:\nonroad\data\emsfac\exhpm.emf
BSFC : c:\nonroad\data\emsfac\bsfc.emf
Crankcase : c:\nonroad\data\emsfac\crank.emf
Spillage : c:\nonroad\data\emsfac\spillage.emf
Diurnal : c:\nonroad\data\emsfac\diurnal.emf
/END/

This is the packet that defines the deterioration factors
files read by the model.

/DETERIORATE FILES/
THC exhaust : c:\nonroad\data\detfac\exhthc.det
CO exhaust : c:\nonroad\data\detfac\exhco.det
NOX exhaust : c:\nonroad\data\detfac\exhnox.det
PM exhaust : c:\nonroad\data\detfac\exhpm.det
/END/

Optional Packets - Add initial slash "/" to activate

/STAGE II/
Control Factor : 0
/END/
Enter percent control: 95 = 95% control = 0.05 x uncontrolled
Default should be zero control.

MODELYEAR OUT/
by-model-year out : C:\nonroad\outputs\template.bmy

/END/

SI REPORT/
SI report file-CSV :C:\NONROAD\OUTPUTS\NRPOLLUT.CSV
/END/

3.0 Maintenance Demonstration

The maintenance demonstration for this SIP revision is based on three components:

1. Attainment area inventory analysis (all future years emissions inventory total is less than the 2001 inventory).

2. Hot-spot/intersection modeling analysis for at the CAMP monitoring location, the three most congested and the three highest volume intersections.

3. A gridded emission inventory analysis

    a. Evaluate a nine-grid cell area around the CAMP monitoring site to assure that all future emission levels are less than the 2001 emissions level
    b. Evaluate the entire attainment area for areas of high growth. Assure with a roll forward analysis that the CO NAAQS will not be exceeded

The following sections describes these three components in detail.

3.1 Attainment Area Carbon Monoxide Emission Inventory Trend

Table 2.0-1 clearly indicates that carbon monoxide emissions levels for all years through 2021 are less than the 2001 base year emissions inventory.

3.2 Intersection Modeling Analysis

As described in the modeling protocol, a CAL3QHC intersection modeling analysis was performed on the three 'most-congested' intersections and the three 'highest-volume' intersections. The Denver Regional Council of Governments provided a list of the intersections meeting these criteria. The three 'most-congested' intersections are:

- 28th Street and Arapahoe Road (Boulder)
- University Boulevard & Belleview Ave
- Foothills Parkway & 28th Street (Boulder)

The three 'highest-volume' intersections are:

- University Avenue & 1st Avenue,
- Wadsworth Boulevard & Alameda Avenue
- University Boulevard & Belleview Avenue

In addition to the intersections listed above, the CAMP intersection will also be included in the intersection modeling analysis to maintain consistency with previous Denver-Boulder attainment/maintenance technical demonstrations.

Since the base year for this analysis is 2001, the same background concentrations apply to the intersection analysis as were used in the previous SIP revision (2004). Table 3.2-1 summarizes the ambient monitoring data that was used as the basis for the background concentrations.

Table 3.2-1 - 2000-2002 Ambient Carbon Monoxide Max and 2nd

Location	Area Type	2000	2001	2002
CAMP	CBD	8.5 / **5.4**	4.4 / 4.1	3.7 / 3.7
Speer & Auraria	CBD	5.0 / 4.6	4.6 / 4.0	3.9 / 3.6
Carriage	Fringe	4.1 / 3.4	3.8 / 3.7	3.7 / 2.7
National Jewish Hospital	Fringe	4.8 / **4.7**	4.0 / 3.9	3.5 / 3.1
Arvada	Urban/Suburban	3.9 / **3.8**	3.1 / 3.0	3.0 / 2.6
Boulder	Urban/Suburban	6.8 / **4.3**	4.5 / 3.4	3.5 / 3.0

2001 Background Concentrations Estimates for Intersection modeling:

The highest-volume and most-congested intersections were assigned background concentrations from Table 3.2-1 on the basis of intersection location, area type and intersection roadway class similarities. Table 3.2-2 shows the background assumptions and rationale for each intersection.

Table 3.2-2 - Background CO concentrations for CAL3QHC Intersections

Intersection	Background Assignment	Rationale
28th & Arapahoe (Boulder)	Boulder; 4.3 ppm	Monitor Location
University & Belleview	Arvada; 3.8	Urban/major arterials
University and 1st Ave.	NJH; 4.7 ppm	Fringe/major arterials
Foothills & Arapahoe	Boulder; 4.3 ppm	Monitor location
Wadsworth & Alameda	Arvada; 3.8	Urban/major arterials
CAMP	CAMP; 5.4 ppm	Monitor location

The CAL3QHC model input and output is included in the Appendix C. The mobile6.2 input and output files for the emissions factors used in the intersection modeling are included in the subdirectory structure as described in Section 2.1.5. The Mobile6.2 input/output files have the text 'cal3' as the leading portion of the filenames.

Table 3.2-3 summarizes the results of the CAL3QHC modeling. The 2009-2021 carbon monoxide background concentration is estimated by adjusting the 2001 background concentration is adjusted by the ratio of the future year to the 2001 carbon monoxide emission loading in a one mile radius around the intersection (in the '1 km CO (t/d)' column). The intersection modeling results indicates that ambient concentration of carbon

monoxide is expected to be below the NAAQS for all years in the future between 2001 and 2021.

Table 3.2-3 - CAL3QHC Modeling Results Summary

CAMP 2001 Background: 5.4 ppm	1 km CO (t/d)	CAL3QHC	Background (ppm)	Total CO (ppm)
2001	28.8			
2009	26.3	1.3	4.9	6.2
2010	26.4	1.4	5.0	6.4
2013	24.2	1.2	4.5	5.7
2015	23.3	1.2	4.4	5.6
2020	22.6	1.1	4.2	5.3
2021	22.7	1.1	4.3	5.4

Arapahoe Rd & 28th St. Background: 4.3 ppm	1 km CO (t/d)	CAL3QHC	Background (ppm)	Total CO (ppm)
2001	14.3			
2009	11.5	3.8	3.4	7.4
2010	11.4	4.1	3.4	7.5
2013	10.2	3.5	3.1	6.6
2015	9.7	3.3	2.9	6.2
2020	9.1	3.0	2.7	5.7
2021	9.1	3.0	2.7	5.7

Wadsworth Blvd & Alameda Ave. Background: 3.8 ppm	1 km CO (t/d)	CAL3QHC	Background (ppm)	Total CO (ppm)
2001	8.4			
2009	6.4	2.9	2.9	5.8
2010	6.5	3.1	2.9	6.0
2013	5.8	2.7	2.6	5.3
2015	5.4	2.5	2.5	5.0
2020	5.2	2.2	2.3	4.5
2021	5.2	2.2	2.3	4.5

Belleview Ave & University Blvd. Background: 3.8 ppm	1 km CO (t/d)	CAL3QHC	Background (ppm)	Total CO (ppm)
2001	5.4			
2009	4.4	3.8	3.2	7.0
2010	4.5	3.9	3.2	7.1
2013	3.9	3.3	2.8	6.1

Belleview Ave & University Blvd. Background: 3.8 ppm	1 km CO (t/d)	CAL3QHC	Background (ppm)	Total CO (ppm)
2015	3.7	3.3	2.7	6.0
2020	3.4	3.0	2.4	5.4
2021	3.4	3.0	2.4	5.4

University Blvd. & 1st Avenue Background: 3.8 ppm	1 km CO (t/d)	CAL3QHC	Background (ppm)	Total CO (ppm)
2001	15.1			
2009	12.0	3.0	4.0	7.0
2010	12.1	3.3	4.0	7.3
2013	10.8	2.8	3.6	6.4
2015	10.3	2.6	3.4	6.0
2020	9.5	2.4	3.2	5.6
2021	9.6	2.3	3.2	5.5

3.3 Gridded Emissions Analysis

3.3.1 CAMP/CBD Area Emissions Analysis

Table 4.2-1 shows the emissions inventory trend in the nine grid-cell neighborhood surrounding the CAMP carbon monoxide monitoring site.

Table 3.3-1 - CAMP/CBD Emission Inventory Trend

Year	Tons/day
2001	67.9
2009	58.7
2010	59.2
2013	53.9
2015	51.9
2020	49.8
2021	50.0

The Central Business District grid analysis clearly indicates that we should not exceed the 2001baseline emission inventory at any time in the future out to 2021. Since ambient carbon monoxide concentrations at the CAMP location were measured at a maximum concentration of 8.5 and a second-high maximum of 5.4 ppm for the 2000 through 2002 ambient period (see Table 4.2-1), it can be inferred all concentrations between 2001 and 2021 will be at or below these levels.

3.3.2 High-Growth Area Analysis

The high-growth urban area analysis is a search for areas that might approach the CO NAAQS in the future because high levels of growth may suggest that background concentrations may approach levels that suggest a hot spot analysis would be required. This analysis found that there are no areas of concern due to high growth. In fact, the urban/suburban area background values even when adjusted for growth in 2010 are less than those estimates for the hot spot locations. And since none of the suburban areas met the criteria for the highest volume or the most congested intersections it can be reasonably assume that a CAL3QHC modeling demonstration at a suburban location would result in lower CO concentrations than the six intersections described in the intersection modeling.

The intersections/areas chosen for the high growth areas analysis are shown in Figure 4.3-2 and the roll forward results are shown in Table 4.3-1.

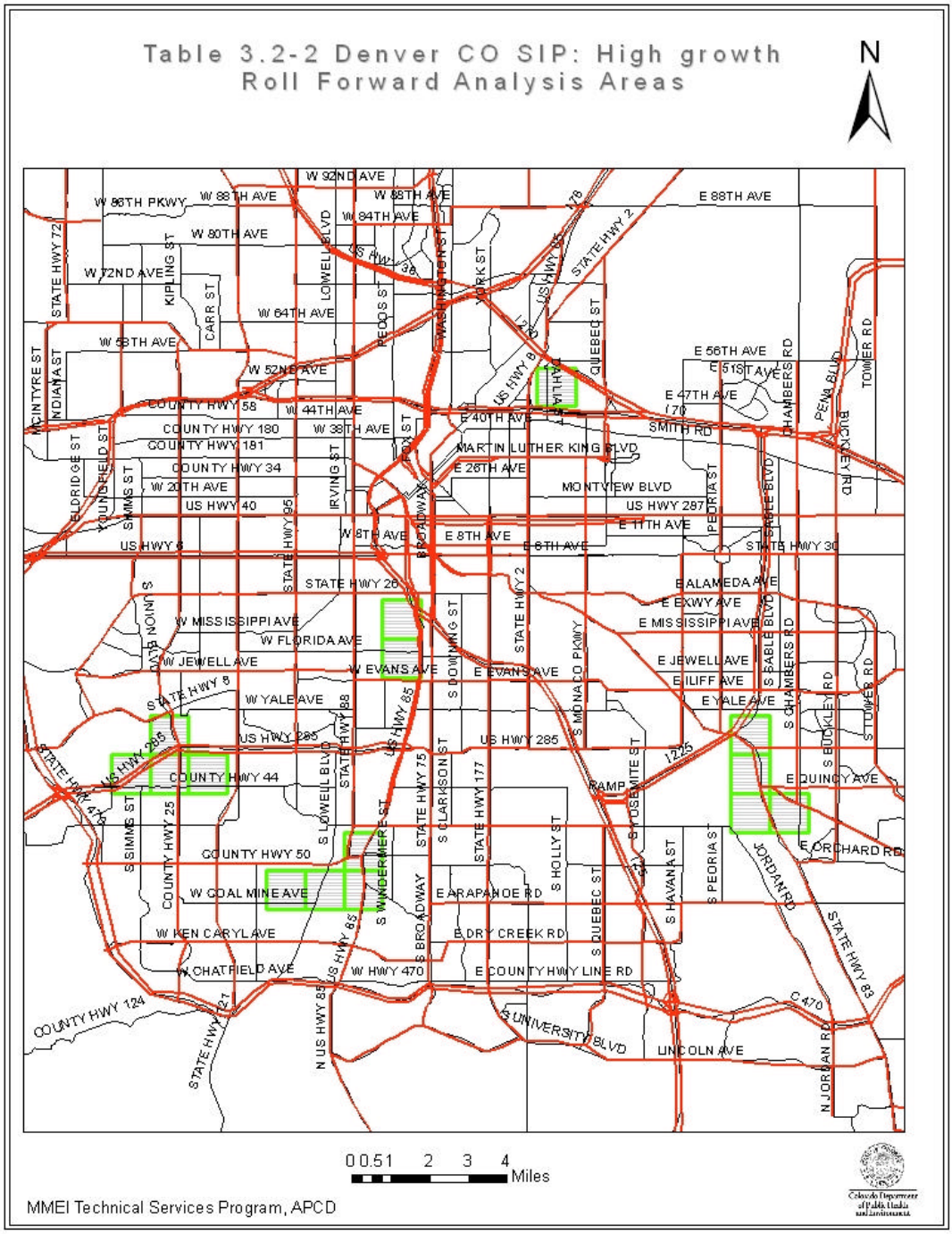


Figure 3.3-1 High Growth Roll Forward Analysis Areas

Table 3.3-2 High Growth Area Roll Forward Analysis

Parker Rd and I-225 2001 UAM background = 2.1 ppm			
	grams/day	tons/day	CO ppm
2001	10029123	11.055	2.1
2009	12554152	13.838	2.6
2010	12641649	13.935	2.6
2013	11128769	12.267	2.3
2015	10525080	11.602	2.2
2020	9788474	10.790	2.0
2021	9818742	10.823	2.1
2025	9939813	10.957	2.1
S. Sante Fe corridor 2001 UAM background = 2.3			
	grams/day	tons/day	CO ppm
2001	9313896	10.267	2.3
2009	9535935	10.511	2.4
2010	9613389	10.597	2.4
2013	8656220	9.542	2.1
2015	8270117	9.116	2.0
2020	7591029	8.368	1.9
2021	7591960	8.369	1.9
2025	7595683	8.373	1.9
S. Sante Fe corridor & Bowles/Littleton Blvd 2001 UAM background = 1.1			
	grams/day	tons/day	CO ppm
2001	6507586	7.173	1.1
2009	7008290	7.725	1.2
2010	7044345	7.765	1.2
2013	6304995	6.950	1.1
2015	6008275	6.623	1.0
2020	5602122	6.175	0.9
2021	5593622	6.166	0.9
2025	5559622	6.128	0.9
Hwy 285 and Kipling Pkwy 2001 UAM background = 1.0 ppm			
	grams/day	tons/day	CO ppm
2001	5411140	5.965	1
2009	6309821	6.955	1.2
2010	6420378	7.077	1.2
2013	5960112	6.570	1.1
2015	5823224	6.419	1.1
2020	5888493	6.491	1.1
2021	5974797	6.586	1.1
2025	6320010	6.967	1.2
Parker Rd corridor & I225 2001 UAM background = 2.3			
	grams/day	tons/day	CO ppm

2001	8532311	9.405	2.3
2009	10515450	11.591	2.8
2010	10590942	11.674	2.9
2013	9335827	10.291	2.5
2015	8837628	9.742	2.4
2020	8181893	9.019	2.2
2021	8207486	9.047	2.2
2025	8309859	9.160	2.2

Appendix A - Mobile6.2 I/O files

Appendix B – Denver International Airport Emission Inventory Documentation

Appendix A – CAL3QHC I/O files

Note: These appendices can be found at the following website:

http://apcd.state.co.us/documents/techdocs.html

They are also available in CD format upon request.