Technical Support Document

Carbon Monoxide Maintenance Plan Revision For the Longmont Attainment Area

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

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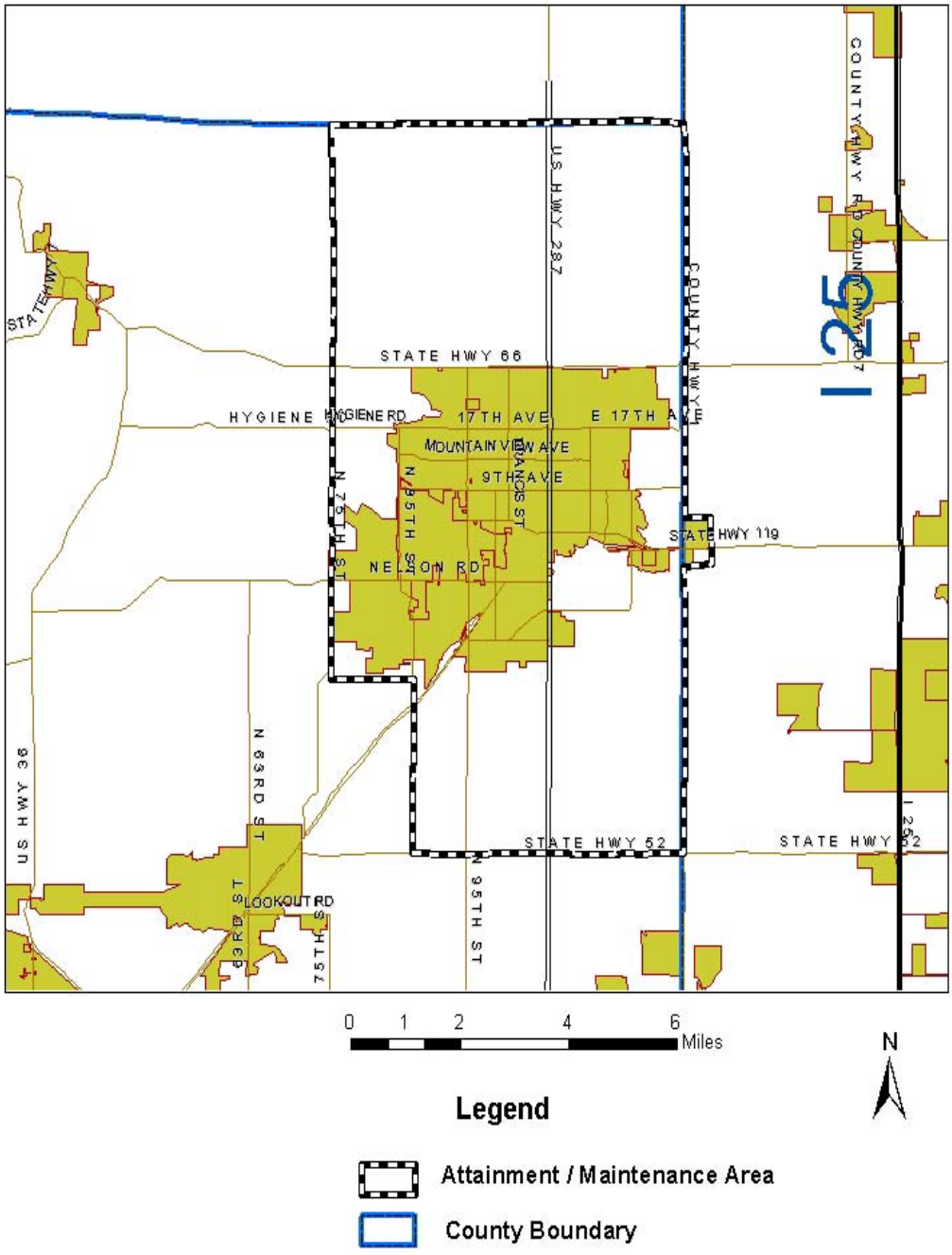
1.0 Background

The Environmental Protection Agency (EPA) approved a carbon monoxide (CO) redesignation request and maintenance plan for the Longmont area on September 24, 1999 (64 FR 51694), which became effective on November 23, 1999. The action, which was adopted by the Colorado Air Quality Control Commission (AQCC) in December 1997, established an attainment year of 1993 and a maintenance year of 2015, provided for the continuation of the State's enhanced inspection and maintenance (I/M) program and the oxygenated gasoline program in the Longmont area, established a carbon monoxide emission budget of 27 tons per day for mobile sources to be utilized in transportation conformity determinations (the EPA subsequently set the budget at 16.76 tons per day due to a calculation error), and established a contingency plan in the event a violation of the CO National Ambient Air Quality Standards (NAAQS) was measured.

This revision to the maintenance plan updates the emissions inventories using the latest EPA-approved tools (including the MOBILE6 on-road mobile sources emissions model), maintains the current enhanced I/M program and the oxygenated gasoline program, and revises the CO emission budget from a MOBILE5-based budget to a MOBILE6-based budget.

Figure 1 shows the geographical area incorporated by the Longmont attainment area boundaries.

Figure 1. Longmont Carbon Monoxide Attainment/Maintenance Area



Map created by the APCD Technical Services Program.
Colorado Department of Public Health and Environment

2.0 Emission Inventories and Maintenance Demonstration

The emission inventories for the 1993 attainment year, the 2005, 2006 and 2010 interim years, and the 2015 maintenance year are presented in Tables 1. Each inventory accounts for the emission control programs effective during that period. As shown in these tables, emissions for all future years are less than emissions for the 1993 attainment year. Therefore, maintenance of the CO NAAQS is demonstrated.

Table 1 - Longmont Carbon Monoxide Maintenance Plan Emission Inventories (tons/day)

Source Category	1993	2005	2006	2010	2015
Aircraft	.504	.533	.535	.545	.557
Heating	.110	.138	.140	.149	.161
Commercial Heating	.036	.044	.045	.048	.051
Commercial Non-road	2.503	3.638	3.732	4.110	4.538
Construction Non-road	.625	.579	.575	.560	.540
Industrial Non-road	1.525	1.502	1.500	1.493	1.483
Com. Lawn & Garden	1.170	1.364	1.380	1.445	1.526
Res. Lawn & Garden	.205	.238	.240	.251	.264
Agriculture Non-road	0	0	0	0	0
Wood Burning	2.537	1.737	1.67	1.403	1.07
Railroad Non-road	.007	.008	.008	.008	.008
Railroad Locomotives	.030	.045	.047	.052	.058
Point Sources	.183	.120	.115	.094	.068
Sub-total non-road	**9.437**	**9.945**	**9.988**	**10.157**	**10.369**
On-Road	43.255	33.969	35.321	28.007	25.992
Grand Total (tons/day)	**52.692**	**43.914**	**45.309**	**38.164**	**25.992**

Note: Results are reported with two decimal place precision to provide representation of smaller source categories. This level of precision is not intended to suggest a level of accuracy. A detailed description of all point sources is shown in Table 4.

The area/non-road inventories provide emissions estimates for a weekday during the winter CO season (November through February). The maximum and minimum temperatures used for the Mobile6 input are consistent with those used in the redesignation request and maintenance plan. The modeling domain consists of the Longmont attainment/maintenance area, which encompasses the City of Longmont and the surrounding area. The inventories were developed using EPA-approved emissions modeling methods, including the MOBILE6.2 emissions model, and the latest transportation and demographic data from the Denver Regional Council of Governments (DRCOG). DRCOG is the "Metropolitan Planning Organization" for transportation in the Longmont area. This technical support document for this maintenance plan contains detailed information on model assumptions and parameters for each source category.

The Denver Regional Council of Governments has provided the demographic and vehicle miles traveled data for use in this technical analysis. Table 2 shows the 1993 – 2015 demographic data used for these inventories.

Table 2 – 1993 – 2015 Demographic Data

	1993	2005	2006	2010	2015
Population	59,340	81,648	83,030	88,560	92,535
Employment	25,725	35,496	36,333	39,680	42,701
Households	22,912	31,116	31,701	34,040	35,518
Vehicle Miles Traveled	750,122	1,073,189	1,107,496	1,261,738	1,372,530

3.0 Mobile Source Emission Inventories

3.1 Vehicle Miles Traveled Activity Estimates

The Denver Regional Council of Government (DRCOG) travel demand modeling provides the base vehicle miles traveled for the mobile source emission inventories. The 2001, 2010 and 2020 networks from the 2025 Regional Transportation Plan (RTP, April 2002) were used to estimate the VMT for 2005, 2006, 2010 and 2015. The 1993 VMT was estimated using the last travel demand modeling DRCOG performed for 1993 (1993DA).

3.2 Travel Demand Model based Mobile6.2 Inputs

The following Mobile6.2 inputs parameters for 1993, 2005, 2006, 2010 and 2015 were derived from the VMT and vehicle speeds resulting from PPACG travel demand modeling:

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

A FORTRAN program was written to convert the speeds and VMT, as a function of AM, PM and Off 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 the Appendix, available upon request. The diurnal distribution of VMT for each area type is normalized to unity, resulting in the files referenced by the VMT BY HOUR command. The Mobile6.2 default VMT BY HOUR distribution was used to distribute the AM, PM and OFF Peak period VMT from the PPACG travel demand modeling into 24 hours. This 24-hour distribution of VMT was than normalized to unity. The SPEED VMT files are processed in a similar manner. The freeway and expressway speeds are VMT weighted for the 'freeway' speeds in the SPEED VMT files. The principal arterial, minor arterial and collector speeds are VMT weighted for the 'arterial' speeds in the SPEED VMT files. 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.

3.3 Local Vehicle Mix and Vehicle Registration Distribution

Colorado data for the fleet mix of vehicle miles traveled or 'VMT mix' (the fractional distribution miles driven by the various vehicle types driven on Colorado roadways) and vehicle registration distribution (vehicle age distribution) was updated based on 2001 data. The previous survey of this information in 1988 indicated that the mobile fleet in Colorado tends to be older than the national average and that the VMT mix is comprised of more heavy duty vehicles than the national average VMT mix. The 2001 registration distribution and VMT mix survey information indicates that this trend of an older fleet and a VMT mix of heavier vehicles continues in Colorado. As a result of these continuing trends, a Colorado fleet of vehicles will have higher emission rates than the national average. These new local data sets were included in this budget revision for 2005, 2006, 2010 and 2015. Since the 1993 base year inventory is closer to the 1988 survey data, the 1993 vehicle mix resulting from the 1988 survey information was used for 1993 (1988 survey data is 'aged' to 1993 using Mobile6.2 default VMT mix). The VMT mix by area type is appended to each area type scenario as described in the previous 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 are included in the Appendix (available upon request) in the Mobile6.2 inputs.

3.4 Control Strategy Parameterization

The mobile source control programs in 1993, an I/M 240 inspection and maintenance (I/M) program and an oxygenated fuel program, are parameterized as they were operating in 1993. The mix of ethanol and MTBE oxygenate additives in 1993 results in a 3.0% oxygenated fuel program. The Mobile6.2 input files for 1993 has the descriptions of these programs. Control strategies for this budget revision analysis are characterized as defined in the Denver Maintenance Plan (December 14, 2001). An I/M 240 inspection and maintenance program and an oxygenated fuel program are scheduled to continue through the 2001 to 2013 time period. In addition, a Clean Screen program is to be implemented for the 2004-2006 timeframe at penetration levels of 40% to 80%, respectively. Since the year-to-year description of these strategies is quite complex, it is not included here. However, the Mobile6.2 input files for each year contains all of the information regarding these strategies and how they are parameterized for the Mobile6.2 runs. These files are located in the Appendix (available upon request).

The Clean Screen Utility provided by the EPA (May 22, 2003) was utilized to estimate the reduction of the I/M 240 benefit resulting from the implementation of Clean Screening during the 2004-2006 time period.

3.5 Mobile Source Emission Inventory Summaries

The mobile source emission factors were calculated using Mobile6.2.

Table 3 summarises the VMT, emissions factors and resulting on-road mobile source emissions inventories:

Table 3 - VMT, Emissions Factors and Resulting On-Road Mobile Source Emissions Inventories

Longmont Attainment Area

Vehicle Miles Traveled, Carbon Monoxide Emission Factors and Inventories

1993

	VMT	Emission Factors g/mile	Emission Inventory tons/day
Urban	22,024	52.3	1.270
Suburban	433,196	52.345	24.995
Rural	294,902	52.265	16.990
Total	750,122	52.312	43.255

2005

	VMT	Emission Factors g/mile	Emission Inventory tons/day
Urban	249,709	27.88	7.674
Suburban	368,696	28.593	11.621
Rural	454,784	29.272	14.674
Total	1,073,189	28.715	33.969

2006

	VMT	Emission Factors g/mile	Emission Inventory tons/day
Urban	217,098	28.181	6.744
Suburban	521,915	28.846	16.595
Rural	368,483	29.5	11.982
Total	1,107,496	28.933	35.321

2010

	VMT	Emission Factors g/mile	Emission Inventory tons/day
Urban	248,248	19.664	5.381
Suburban	594,067	20.078	13.148
Rural	419,423	20.501	9.478
Total	1,261,738	20.137	28.007

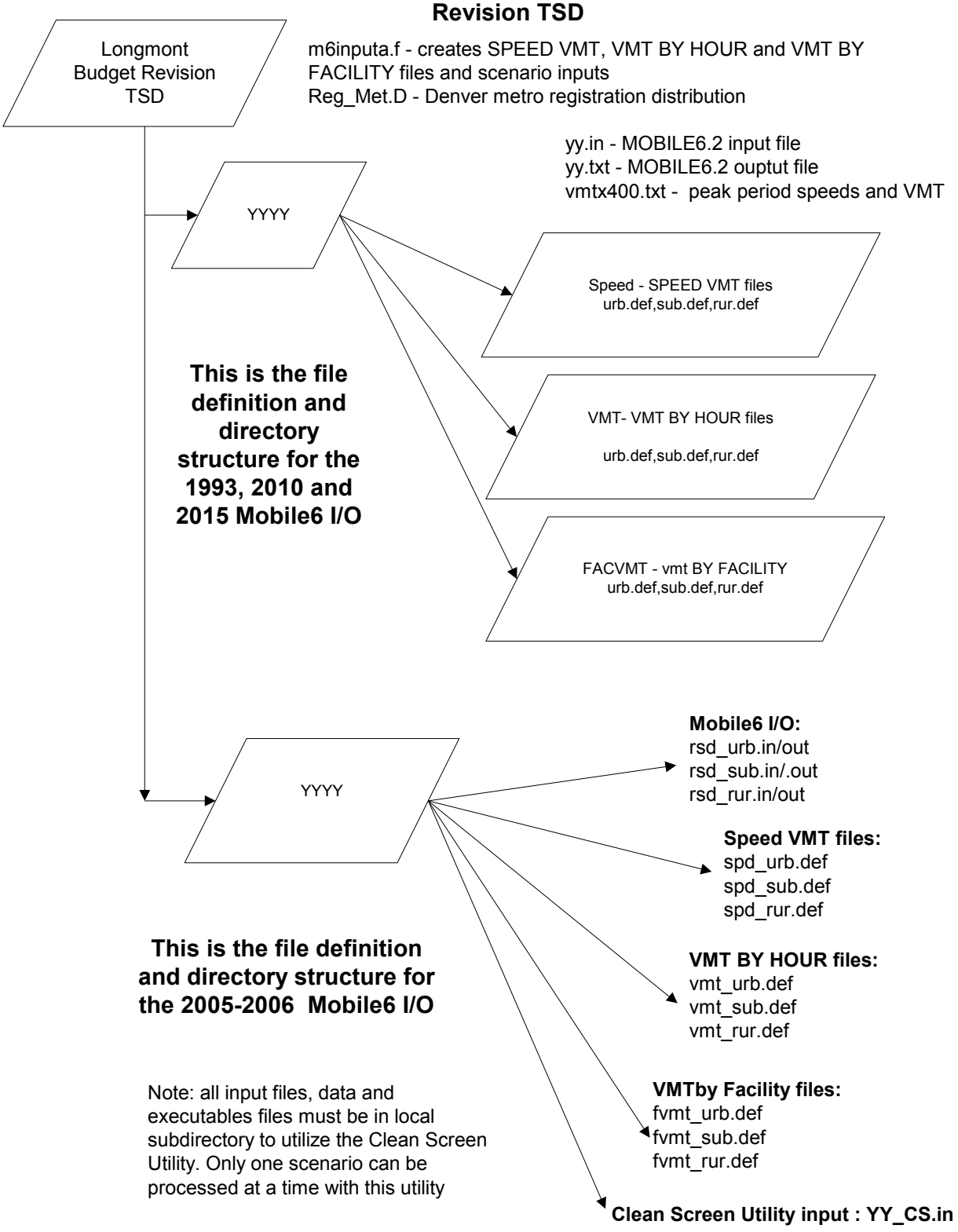
2015

	VMT	Emission Factors g/mile	Emission Inventory tons/day
Urban	361,696	16.66	6.642
Suburban	523,145	17.212	9.925
Rural	487,688	17.531	9.424
Total	1,372,530	17.18	25.992

3.6 Mobile6.2 Input/Output File Documentation

Due to the volume and complexity of files utilized in the emission processing for this budget revision, the Mobile6.2 input and output files as well as all ancillary input files are included on a CD as an Appendix, available on request. The subdirectory structure of the files on this CD is described in the following diagram.

Diagram 1: Directory structure of digital files for Longmont Budget Revision TSD



4.0 Area, Non-road and Point Source Emission Inventories

Residential and Commercial Heating Emissions for 1993 and 2015 were based on Version 1.5 of the 1999 EPA National Emissions Inventory (NEI) for Boulder County and were apportioned to the Longmont attainment area by households 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 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 (0.486936, based on National Weather Service data for Longmont for 1900 to 2000 with a base of 65 degrees F) and dividing by 92(the number of days in the season). 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 Longmont attainment area by households using the 1990 Census. 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 Longmont attainment area by land area. 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. Based on the 1993 Revised Longmont SIP Inventory, the following categories of non-road and area sources were excluded from the Longmont inventory because they are insignificant or nonexistent: airport service equipment, logging equipment, recreational equipment, recreational marine equipment, aircraft/rocket engine testing, charcoal grilling, firefighter training, forest wildfires, managed burning, and orchard heaters.

Railroad Locomotive Emissions for 1993 and 2015 were based on Version 1.5 of the 1999 EPA National Emissions Inventory (NEI) for Boulder County and were apportioned to the nonattainment area by miles of track. Projections from 1999 to 1993 and 2015 were based on the change in population.

Wood burning emissions for 1993 are from the 1993 Revised Longmont SIP. Wood burning emissions for 2015 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 2002 Survey is included in this document at Attachment 3. 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 (0.486936, based on National Weather Service data for Longmont for 1900 to 2000 with a base of 65 degrees F) and dividing by 92(the number of days in the season).

1993 Point Source Emissions were taken from the 1993 Revised Longmont SIP. 2002 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 2015 by the growth in production employment based on the DRCOG LUTP.

Table 4 – 2002 Point Sources Within Nonattainment Area

facility_name	2002 T/Y
ST VRAIN CREMATORY SVC	0.031
LONGMONT FOODS	4.115
WESTERN FOUNDRIES	0.125
LONGMONT WWTP	0.275
LONGMONT UNITED HOSP	0.000
LONGMONT ANIMAL HUMANE SOCIETY	0.038
WOODYS OF COLORADO INC	5.300
AHLBERG FUNERAL CHAPEL INC	0.070
SEAGATE TECHNOLOGY	5.951
U.S. FEDERAL AVIATION ADMINISTRATION	2.520
TOTAL	18.425

Non-road Model Emissions tons per day

Area	Agricultural Equipment	Commercial Equipment	Construction and Mining Equipment	Industrial Equipment	Lawn and Garden Equipment (Com)	Lawn and Garden Equipment (Res)	Rail Equipment
1993							
Boulder County	0.069	13.467	2.396	7.742	6.615	0.788	0.029
Longmont Nonattainment Area	0.00002	2.503	0.626	1.525	1.170	0.206	0.007
2015							
Boulder County	0.065	24.556	2.069	7.426	8.629	1.012	0.034
Longmont Nonattainment Area	0.00002	4.563	0.540	1.463	1.526	0.264	0.008

Non-road Model Input File For 1993

The "Non-road Model Input File for 1993 " was produced automatically by the NonRoad Model. The inputs to the model that are reflected in this file are those within the */NAME/…/END/* delimiters such as:

/OPTIONS/
Title 1 : Longmont 93
Title 2 :
Fuel RVP for gas : 12.4
Oxygen Weight % : 3.0
Gas sulfur % : 0.034
Diesel sulfur % : 0.3300
CNG/LPG sulfur % : 0.003
Minimum temper. (F): 21
Maximum temper. (F): 53
Average temper. (F): 36
Altitude of region : LOW
/END/

Written by Nonroad interface at 3/12/2003 7:57:46 AM
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 : 1993
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 : Boulder 1993 Winter
Title 2 :
Fuel RVP for gas : 12.4
Oxygen Weight % : 0
Gas sulfur % : 0.034
Diesel sulfur % : 0.3300
CNG/LPG sulfur % : 0.003
Minimum temper. (F): 16
Maximum temper. (F): 39
Average temper. (F): 25
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
Boulder County CO : 08013
/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\longco93.msg
OUTPUT DATA       : c:\nonroad\outputs\longco93.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
Contruction empl.  :c:\nonroad\data\allocate\co_const.alo
Havested Cropland  :c:\nonroad\data\allocate\co_farms.alo
Golf Course estab. :c:\nonroad\data\allocate\co_golf.alo
Wholesale establis.:c:\nonroad\data\allocate\co_holsl.alo
Family housing     :c:\nonroad\data\allocate\co_house.alo
Logging empl.      :c:\nonroad\data\allocate\co_loggn.alo
Landscape empl.    :c:\nonroad\data\allocate\co_lscap.alo
Metal mining empl. :c:\nonroad\data\allocate\co_metal.alo
Manufacturing empl.:c:\nonroad\data\allocate\co_mnfg.alo
Oil & Gas employees:c:\nonroad\data\allocate\co_oil.alo
Census population  :c:\nonroad\data\allocate\co_pop.alo
RV Park employees  :c:\nonroad\data\allocate\co_rvprk.alo
Surface water area :c:\nonroad\data\allocate\co_water.alo
Allocation File    :c:\nonroad\data\allocate\co_sbr.alo
Allocation File    :c:\nonroad\data\allocate\co_sbc.alo
Allocation File    :c:\nonroad\data\allocate\co_snowm.alo
Allocation File    :c:\nonroad\data\allocate\co_wob.alo
Allocation File    :c:\nonroad\data\allocate\co_wib.alo
Allocation File    :c:\nonroad\data\allocate\co_coal.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/

Railroad and Rail Service Equipment Emissions

Boulder County Rail									
98	92	98	5	10	15				
total rr	total rse	total rse	total rse	total rse	total rse				
0.0603	0.0213	0.0242	0.0245	0.0265	0.0308				
T_Length	LENGTH	92 rse t/d	92 t/d rr	98 rse t/d	98 t/d rr	05 rse t/d	05 rr t/d	10 rse t/d	10 rr t
111,801	54,239	0.010	0.026	0.012	0.029	0.012	0.030	0.013	0.