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## **The Colorado Remote Sensing Program January – December 2010**

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Prepared for:

**The Colorado Department of Public Health and  
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## **I. Summary**

The Colorado Department of Public Health & Environment (CDPHE) and the Department of Revenue (DOR) have operated an Enhanced Inspection and Maintenance (I/M) program in the Denver metropolitan area (DMA) since 1995. Operations for a remote sensing clean screening element commenced in 2003. Previous reports, “The Colorado Clean Screening Program’ reports for July 2003 – December 2004 and annual reports for 2005-2009<sup>1</sup> described on-road measurement activities and the vehicles exempted from inspection. This report covers calendar year 2010.

The clean screening program uses remote sensing to measure the tailpipe emissions of vehicles as they drive by measuring equipment positioned on the side of the road. Vehicles that are determined to have low tailpipe emissions are granted an exemption from the I/M inspection. Clean screening improves convenience of the I/M program for vehicle owners.

In order to exempt vehicles from inspection, computer systems and procedures are required for administering the program and notifying vehicle owners of their inspection exemption. The I/M program is registration enforced and the administration of the clean screening program requires the transmission of information among the contractor, CDPHE and DOR who manage motor vehicle registrations.

### **Collection Activity**

In 2010, eighteen RSD 4000 series vans were deployed in the DMA with an additional 4 in the Northern Front Range (NFR). Twenty-four different RSD systems were used as some units were rotated for preventive or corrective maintenance. Van’s deployed at 47 locations in the DMA, 16 sites in the NFR and 4 sites in Colorado Springs for a total of 24,000 active collection hours. Over nine million emission measurements were collected and successfully matched to Colorado registered vehicles. Additional remote sensing productivity information is provided in Section IV.

Expanded vehicle emissions testing began in parts of Weld and Larimer counties in late 2010. Vehicle owners with December renewal dates were the first required to get a test. On-road measurements of emissions for the NFR enhanced program were expanded in June 2010 to develop the database of clean screen candidates.

### **Vehicle Exemptions**

Over 250,000 vehicles measured on-road initially met the clean screening exemption criteria. Two percent of these were reserved to provide a program audit sample and others were eliminated during the QA reviews, for example, as a result of vehicle plate changes. The owners of the remaining 242,911 vehicles meeting the clean screening criteria were issued notices granting exemption from the I/M test at an inspection station. Approximately 207,000 (85%) of the 242,911 vehicle owners took advantage of the Clean Screen exemption.

Two methods were used to qualify vehicles, 2-RSD and Hybrid. With the 2-RSD method, vehicles qualified for an exemption if they had two or more on-road measurements and the most recent two measurements both showed emissions within the clean screen standards. With the ‘Hybrid’ clean screening method vehicles measured once by remote sensing

qualified for clean screening if the emissions measurement was within the clean screen standards and the vehicle model had a historically low rate of emissions problems.

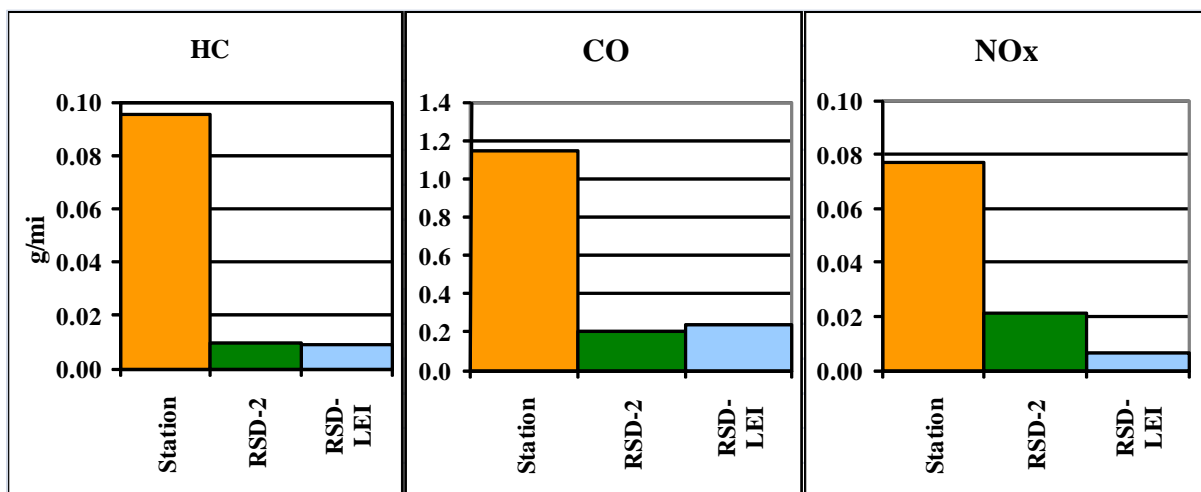
A 2% random sample of vehicles that qualified was not issued exemption notices and 4,343 of these vehicles were subsequently inspected at an enhanced inspection station. The results of the station inspections were used to evaluate the effectiveness of the program. Additional information about vehicles mailed notices is provided in Section IV.

### Clean Screen Program Effectiveness

In a Clean Screen program, some vehicles passing the clean screen emissions criteria might have failed if inspected at an inspection station. Therefore, a Clean Screen program, while greatly improving convenience for vehicle owners, can slightly reduce the overall effectiveness of the I/M program.

On May 5<sup>th</sup> 2008, IM240 Denver Metro Area station test standards were tightened – especially for HC and NO<sub>x</sub> – to bring them into closer alignment with EPA final standards. In December 2008, and periodically during 2009 and 2010, the LEI table was updated with recent IM240 results to reflect the new IM240 standards. The RSD standards, however, remained unchanged until the October introduction of an RSD NO standard of 1000ppm that first applied to December 2010 registrants. The NO standard, therefore, had little impact on overall 2010 results. Figure I-1 compares the average IM240 exhaust reductions per vehicle inspected at stations to those of the 2-RSD audit sample and the Hybrid RSD-LEI audit sample. For HC and NO<sub>x</sub> pollutants the RSD-LEI audit sample showed smaller reductions than RSD-2 indicating the hybrid RSD-LEI method performed better.

**Figure I-1 Average IM240 Emissions Reductions**



In 2010, based on the 2% random audit vehicles tested with IM240, it was projected that 97.4%, 93.8% and 92.4% of HC, CO and NO<sub>x</sub> of program exhaust emission reductions were retained. The impact on gas cap related evaporative emissions was projected to be another 3.9% of HC reductions.

Environmental Systems Products (ESP) ran a 'what-if' analysis to determine the effectiveness of the new RSD NO standard. If the standard had been in place for the full year the retained

exhaust benefits were projected to improve to 98.6%, 95.4% and 96.9% for HC, CO and NO<sub>x</sub> respectively and the gas cap related evaporative emissions impact to improve to 3.6%.

The methodology for estimating clean screen effectiveness only allows for a score of 100% or less and uses the IM240 test as a “gold” standard. Any variations in vehicle performance or the IM240 test procedure that produce an anomalous IM240 test failure are scored against Clean Screen. Therefore, it is possible the Clean Screen effectiveness is greater than projected.

## **II. Description of the Denver Clean Screening Program**

### **A. I/M Program Overview**

The Colorado Department of Public Health & Environment (CDPHE) operates an enhanced Inspection and Maintenance (I/M) program in the Denver metropolitan area (DMA) and the Northern Front Range (NFR). The clean screening component of the IM program uses remote sensing equipment to measure the tailpipe emissions of vehicles as they drive by the measuring equipment. Vehicles that are determined to have low tailpipe emissions are granted an exemption from their I/M inspection.

Operating rules for the Clean Screening program are contained in the Air Quality Control Commission's Regulation 11<sup>2</sup>. The Regulation defines the maximum percentages of vehicles that may be evaluated by the clean screen program in the enhanced I/M area. In 2006, the percentage of vehicles allowed to be evaluated using remote sensing was decreased from 80% to 50% as part of an Early Action Compact (EAC) to achieve an earlier attainment designation for ozone.

Clean Screening regulations were expanded in 2007 to allow use of a single RSD measurement combined with an index of low emitting vehicles to evaluate exemption candidates. The Low Emitter Index (LEI) was developed using I/M240 data to identify vehicle groups that historically have a very low probability of failing. The current requirement for a vehicle group to qualify as a low emitter is they must have an I/M240 pass rate of 98% or greater.

There are multiple requirements and restrictions for vehicles to participate in the Clean Screen program as defined in Regulation 11. The following are the primary elements for vehicles to qualify for a clean screen exemption.

- The applicable observations were within twelve months prior to the individual vehicles registration renewal date,
- The two most recent observation results are below, 200ppm, 0.5%, and 1000ppm for HC, CO, and NOx respectively, (NOx standard implemented October 2010)
- The two most recent observations must have occurred on a different day or on the same day at different site locations,

### **Contractor**

Environmental Systems Products (ESP) was contracted to operate the enhanced program by a competitive bid process and the contract was subsequently amended to include clean screening in the Denver area. ESP uses technology derived from that originally developed at Denver University with whom ESP has a royalty agreement.

### **Theory of operation**

The RSD is a system designed for a non-intrusive measurement of vehicle emissions. It generates and monitors a non-dispersive infrared and dispersive ultra-violet beam emitted and



reflected approximately 10 to 18 inches above ground preferably across a single lane road. Gasoline, diesel, or other fossil fuel powered vehicles drive through this beam and the exhaust interferes with this transmission of the beam. Quantifying the interference enables the calculation of tailpipe concentrations of CO, HC, CO<sub>2</sub>, NO and particulate matter. A camera simultaneously captures a digitized video image of the rear of the vehicle and its license plate.

## **Equipment**

The equipment initially deployed in the Northern Front Range counties were RSD-3000 mobile units also called AccuScan<sup>TM</sup>. Successor RSD 4000 units were introduced in 2003. Both systems are based on a technical platform developed at the University of Denver by Dr. Donald Stedman. In 2007, additional RSD4600 units were added. The RSD4600 is very similar to the RSD4000-L3 system described below. The RSD4600 has a more compact speed and acceleration measurement bar and more diagnostic ports. Functionally, the two systems are the same.

AccuScan measures the exhaust of a passing motor vehicle in less than 0.7 seconds. Non-dispersive infrared (IR) spectroscopy, the same analytical technique used in garage based two-speed idle and ASM equipment is used to measure concentrations of CO, HC, and CO<sub>2</sub>. Dispersive ultraviolet (UV) spectroscopy is used to measure NO<sub>x</sub>. The system is based on the original designs and patents of Dr. Donald Stedman, professor emeritus at the University of Denver.

The following elements comprise a complete RSD4000 unit:

- RSD4000-L3 4-gas analyzer Source Detector Module
- Corner Cubed Mirror Module (CCM)
- Two Alignment stands, one each for SDM and CCM
- Speed/Acceleration subsystem consisting of:
  - Two Speed/Acceleration bars: one emitter and one detector bar with adjunct hardware
  - Speed/Acceleration computer
  - Two spare rechargeable battery packs
- Digital Video camera and speed subsystem
- Computer control console subsystem consisting of:
  - Video monitor
  - Pentium<sup>TM</sup>-based PC
  - Additional PC cards and internal hardware PC cards:
    - Hard drive
    - Removable Mass Storage

- Matrox video
- Serial and COM port
- RSD4000-L3 operation (data collection) software
- RSD4000-L3 compatible license plate tag-editing software
- Calibration subsystem consisting of:
  - Calibration tube
  - Calibration gas bottle
  - Pressure regulator
  - Hoses with quick disconnects
- RSD4000-L3 shipping container for SDM, TMM, quick disconnect and on/off switch fuse

The following elements comprise an upgraded AccuScan™ van:

- Ford one-ton truck
- Triton V-8 engine with 4-speed automatic transmission
- 12 – 14 foot box on bed of truck
- Roof-mounted 13,500 BTU Coleman air-conditioner
- 5 kW Onan generator
- Connector panel for quick connection of external cables and cal gas hoses

The RSD unit takes multiple rapid readings for each vehicle to characterize the exhaust plume profile and evaluate whether a valid measurement of a vehicle's exhaust has been achieved. The criteria include how much vehicle exhaust plume is available for the duration of the sampling period, evaluation of whether plume measurements are consistent with normal plume dissipation, and correction for changes in background concentrations of emissions.

The RSD4000{4600} units comply with the CDPHE, "Colorado On-road Vehicle Emissions Remote Sensing System (COVERS) Specifications" Amended July 2010<sup>3</sup>: The COVERS accuracy specifications are consistent with the California BAR OREMS Specification:<sup>1</sup> and include:

#### Detector accuracy:

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<sup>1</sup> On Road Emissions Measurement System (OREMS) Specifications, Revision L, Bureau of Automotive Repair, Engineering and Technical Research Branch, 10240 Systems Parkway, Sacramento, CA 95827; 2001 California DCA/BAR; p. 5.

1. The CO<sub>2</sub>% reading shall be within  $\pm 10\%$  of the Certified Gas Sample, or an absolute value of  $\pm 0.25$ , or shall be within published manufacturer's specification – whichever is less restrictive. Negative values shall be included and shall not be rounded to zero.
2. The CO% reading shall be within  $\pm 15\%$  of the Certified Gas Sample, or an absolute value of  $\pm 0.25$  (whichever is greater). Negative values shall be included and shall not be rounded to zero.
3. The HC reading (ppm propane) shall be within  $\pm 15\%$  of the Certified Gas Sample, or an absolute value of  $\pm 250$ ppm (whichever is greater). Negative values shall be included and shall not be rounded to zero.
4. The NO<sub>x</sub> reading (ppm) shall be within  $\pm 15\%$  of the Certified Gas Sample, or an absolute value of  $\pm 250$  ppm (whichever is greater). Negative values shall be included and shall not be rounded to zero.
5. COVERS shall submit readings within the following limits:  
CO + CO<sub>2</sub>  $\leq 21.0\%$ , HC  $\leq 35,000$  ppm hexane, CO<sub>2</sub>  $\leq 16.0\%$ , and NO  $\leq 7000$  ppm.
6. The system shall record at least three and display at least two measures of plume characteristics, for example the maximum number of CO<sub>2</sub> molecules seen, the average number of CO<sub>2</sub> molecules seen, and the number of valid samples (measurements) made.
7. Each unit shall demonstrate during controlled acceptance testing the above criteria 98% of the time. Ninety-eight percent (98%) shall mean that one hundred percent (100%) of the valid records shall have the following fields filled correctly with accurate data, ninety-eight percent (98%) of the time:
  - CO<sub>2</sub>%
  - CO %
  - HC ppm hexane
  - NO ppm

Speed and Acceleration Accuracy:

1. The vehicle speed measurement should be accurately recorded within  $\pm 1.0$  mile per hour.
2. The vehicle acceleration measurement should be accurately recorded within  $\pm 0.5$  mile per hour / second.
3. The speed and acceleration system shall demonstrate during controlled acceptance testing the above criteria ninety-five percent 95% of the time. Ninety-five percent (95%) shall mean that one hundred percent (100%) of the valid records shall have the speed and acceleration fields filled correctly with accurate data, ninety-five percent (95%) of the time.

4. VSP shall be calculated during host processing using the most recent CDPHE approved equation.

### **Vehicle Identification**

The system captures emissions readings and rear pictures of vehicles that pass through the RSD infrared beam. The video and emissions readings taken are stored directly on a removable media disk and can be used for future reference.

Environmental Systems Product's TagEdit™ software is used to transcribe vehicle license plate information. Figure II-1 below shows an example of a TagEdit™ screen. This license plate editing service is superior to an automatic license plate reader because:

- All video images associated with valid emissions data get processed. This ensures the highest possible vehicle capture rate.
- Vehicles with special plates are also processed. This is especially important in areas where many unique license plates are issued. Failure to process all plate types can create a statistically skewed database that could be misinterpreted by the public as "targeting" only certain vehicle classes.

A special registration database was created for the Clean Screen program to allow vehicles to be identified (VINs) from Clean Screen license photos captured days prior to their data processing. This Clean Screen registration database is updated nightly with all the changes statewide that affect what VIN is associated with what plate. A lag time interval is incorporated to allow time for updates to get from the County Clerks Offices to the DOR database. The separate Clean Screen Registration Database on the ESP host contains all vehicle registration records statewide, even though only certain counties are expected to participate in the Clean Screen program. The future growth of registration could require some housekeeping, but there is plenty of hardware scalability to handle this growth.

Figure II-1: TagEdit™ Screen

SPEED 31.5140 ACCEL 1.0230 CO -0.01 CO2 15.06 HC -13.95 NOX 66.76 CVA G0 TARGET 11:37 NOS 8 REC # 1476

Tag Entry

Left Double Click = Zoom In. Right Double Click = Zoom Out

20050523 06C0806800008.jpg

5/23/2005

Employee 40073

State CO

Site 8068

Vehicle Data

Speed 0.0

Acceleration 0.0

Cold Start

1x

Emissions Data

CO -0.0342

CO2 15.0734

HC 30.8174

NOX 109.669

Smoke -0.0118

Max CO2 137.995

No Samples 44

Plate Details

☐ No Plate

☐ Unreadable Plate

☐ Out of State

Apply Filters

☐ Skip Completed Records

☐ Skip bad S/A Records

☐ Skip Failed Gas Records

☐ Skip records without images

Refresh

License Plate

[Ctrl+PgUp] Move First

Reset [ESC]

Confirm [Rtn]

[PgUp] Previous

8

Next [PgDn]

6 out of 1449

Move Last [Ctrl+PgDn]

Current Database in Use

D:\Program Files\ESP\RSD4000\ConsoleDb\Con...

Start RSD 4000 System Consol... 12:02 PM

## **B. Measurement Sites**

Good remote sensing sites are critical for obtaining RSD measurements that are representative of vehicle operation. Recommended site attributes include:

- (1) Absence of cold start vehicle operating conditions
- (2) Sites where vehicles will generally be accelerating or driving at a steady speed uphill to ensure adequate engine power and exhaust plumes and avoid the problem of RSD not measuring vehicles that have virtually no exhaust under deceleration
- (3) Absence of enrichment due to high load conditions
- (4) Single lane operation
- (5) High volume traffic
- (6) Unobtrusive citing of the remote sensing equipment
- (7) Adequate median space for safe operation of the RSD equipment.

Table II-1 lists the RSD sites in the Northern Front Range and in El Paso County (Colorado Springs). A small number of measurements were typically made annually in these areas each year. In 2010 the on-road activity in the Northern Front Range was expanded to prepare for the new I/M program. Table II-2 lists the Denver area site locations used for the clean screening program, the number of days each site was used, the total hours during which measurements were collected and the number of vehicles measured per hour. The hours shown do not include travel time to and from the site, equipment set-up and equipment takedown time.

Denver site locations are illustrated in Figure II-2. Blue sites have been approved for more than six months. Green sites are new additions over the last 6 months and Red sites are no longer permitted. The X's represent HQ and other stations where RSD vans are housed.

**Table II-1 Northern Front Range and El Paso RSD Sites**

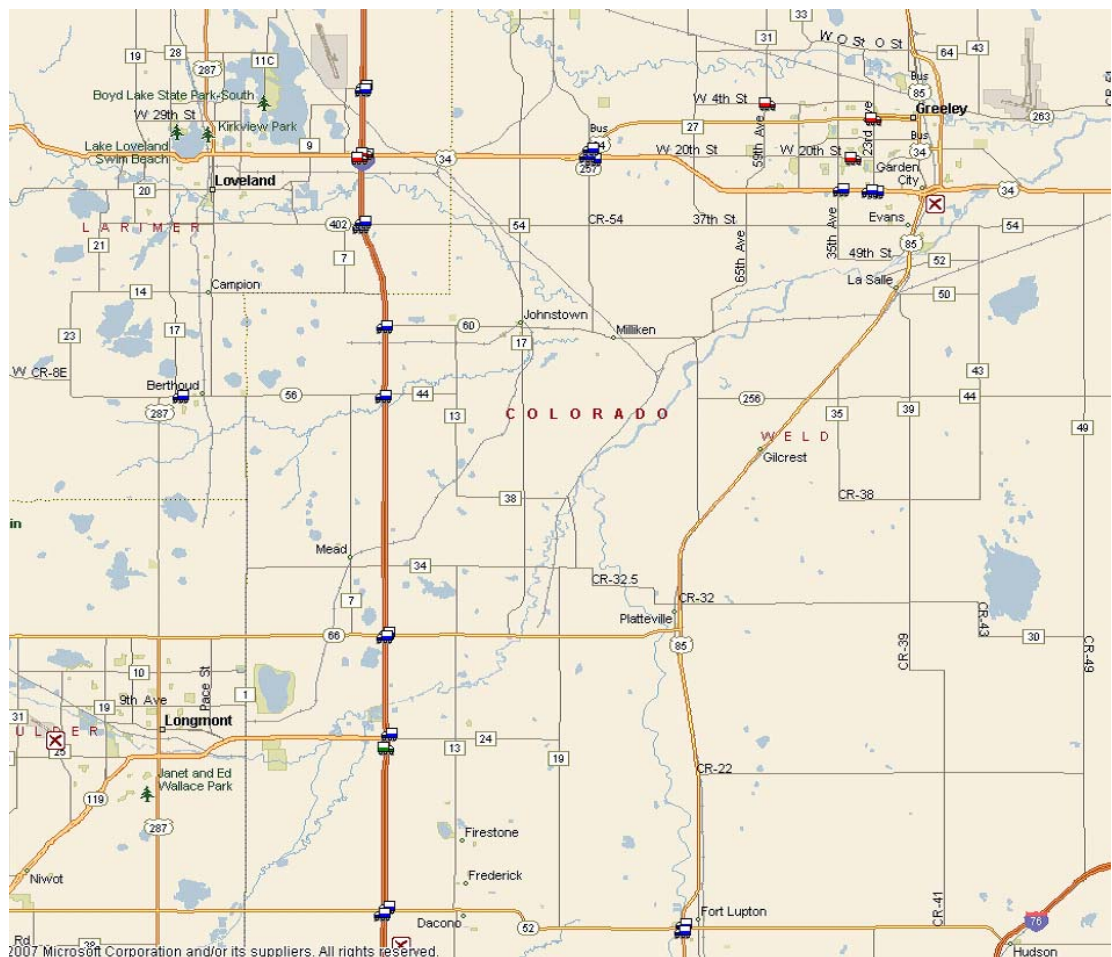
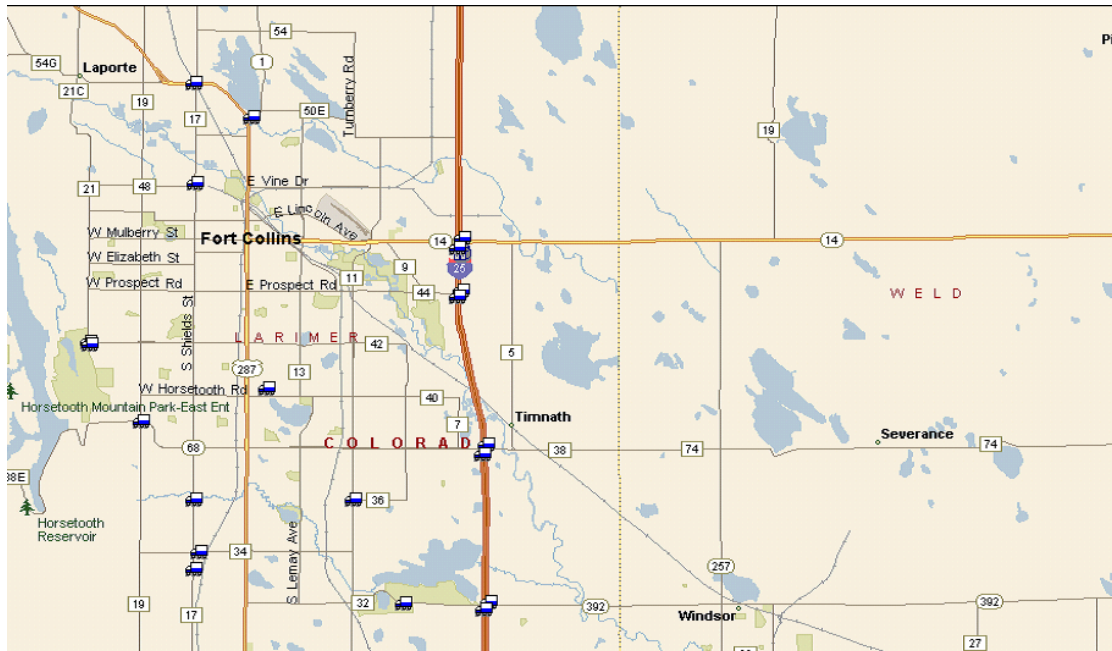
Northern Front Range						
Site Code	Location	City	Active Days	Total Active Hours	Registered Vehicles Measured	Veh's Per Hour
2132	NB SHIELDS 100' PAST VINE DR	FT COLLINS	20	136	15,105	111
2143	NB OVERLAND TRAIL NORTH OF DRAKE	FT COLLINS	24	182	24,434	134
2144	NB STANDFORD FROM MONROE DR	FT COLLINS	4	29	2,146	75
3017	EB TRILBY ROAD EAST OF SHIELDS STREET	FORT COLLINS	102	756	207,735	275
3019	ON RAMP TO NB I-25 FROM 402 (CR-54)	LOVELAND	8	58	7,445	129
3020	ON RAMP TO SB I-25 FROM 402 (CR-54)	LOVELAND	38	252	30,980	123
8041	WB US-287 JUST WEST OF SHIELDS ST.	FT COLLINS	8	65	10,850	168
8042	ONRAMP TO SB I-25 FROM EAST PROSPECT	FT COLLINS	55	388	81,395	210
8046	EXIT LOOP FROM SB I-25 TO EB US-34	LOVELAND	4	31	6,743	214
8049	ONRAMP TO SB I-25 FROM HARMONY RD	FT COLLINS	67	496	115,539	233
8050	ONRAMP TO SB I-25 FROM LCR-32	WINDSOR	61	432	85,153	197
8051	ONRAMP TO NB I-25 FOM LCR-32	WINDSOR	38	229	41,847	183
8052	NB SH-1 JUST EAST OF INTERSECTION WITH US-287	FT COLLINS	15	117	18,888	161
2989	EB US 34 BYPASS FROM 23RD AVE	GREELEY	39	245	32,646	133
8037	EB US-34 BYPASS FRONTAGE ROAD JUST EAST OF 35TH AVE.	GREELEY	12	95	6,345	67
8043	ONRAMP TO WB US-34 FROM 27TH ST	GREELEY	59	381	70,374	185
Subtotal			554	3,894	757,625	195
El Paso County						
Site Code	Location	City	Active Days	Total Active Hours	Registered Vehicles Measured	Veh's Per Hour
2518	ONRAMP TO E.PLATTE AVE FROM NB ACADEMY BLVD	COLORADO SPRINGS	6	34	6,946	205
2519	ONRAMP TO NB I-25 FROM FILLMORE ST	COLORADO SPRINGS	4	29	9,026	309
2520	ONRAMP TO NB I-25 FROM N.ACADEMY BLVD	COLORADO SPRINGS	9	65	11,649	178
2521	ONRAMP TO NB I-25 FROM S.ACADEMY BLVD	COLORADO SPRINGS	3	16	60	4
Subtotal			22	145	27,681	191

**Table II-2 Denver RSD Sites**

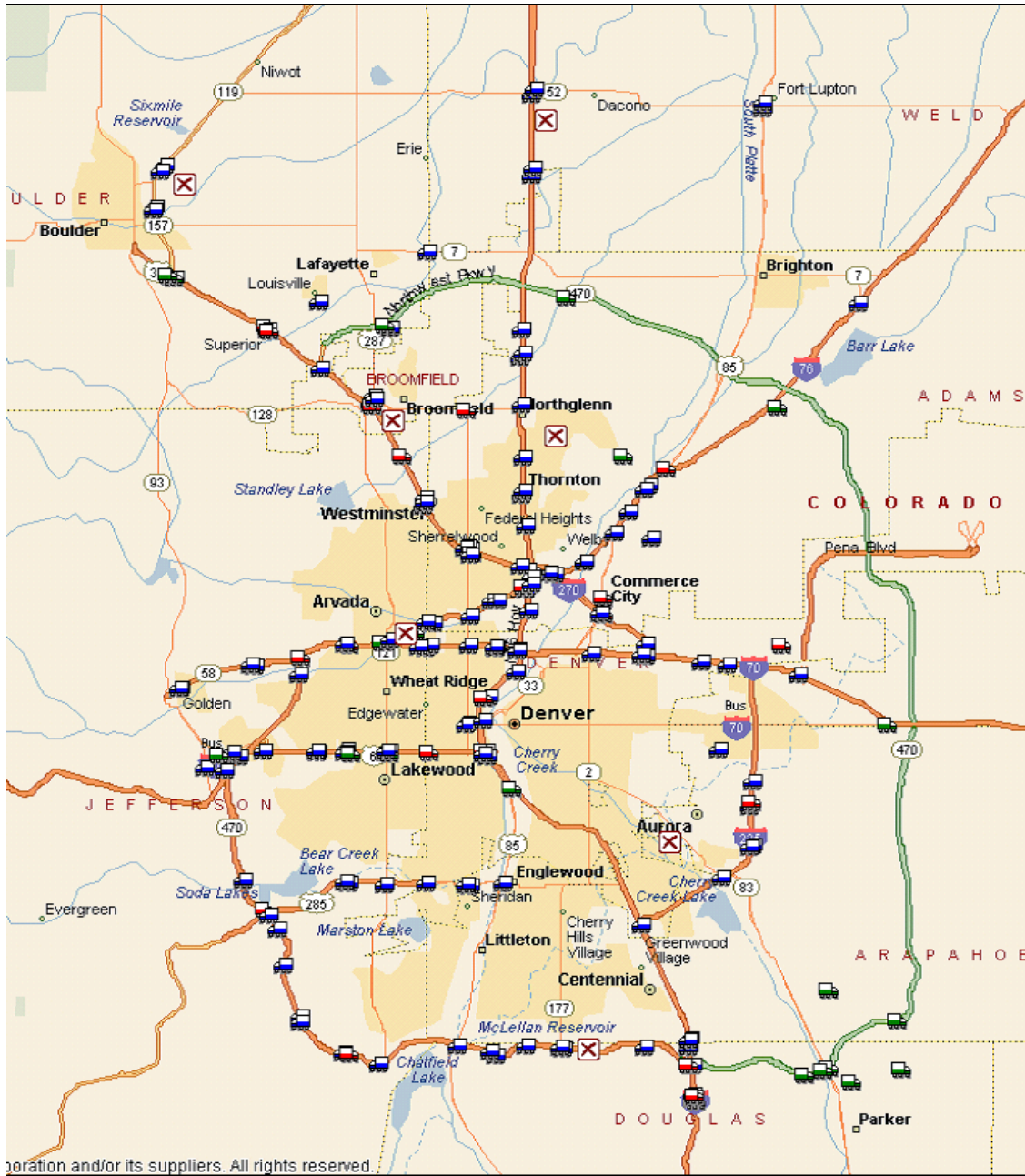
Denver Metro Area						
Site Code	Location	City	Active Days	Total Active Hours	Registered Vehicles Measured	Veh's Per Hour
2808	ONRAMP TO SB I-25 FROM 136TH AVE	THORNTON	12	94	17,448	185
2819	ONRAMP TO SB 121 FROM WB 287	WESTMINSTER	184	946	329,097	348
2821	ONRAMP TO NB I-25 FROM 120TH AVE	WESTMINSTER	15	98	16,427	167
2971	EB DILLON RD EAST OF US-287	BROOMFIELD	55	414	92,721	224
8072	ONRAMP TO NB I-25 FROM 84TH AVE.	THORNTON	7	48	10,377	218
8073	ONRAMP TO NB I-25 FROM 104TH AVE.	NORTHGLENN	1	6	589	94
8090	ONRAMP TO EB I-76 FROM PECOS ST.	DENVER	1	7	469	63
8091	ONRAMP TO WB I-76 FROM BROMLEY LN.	BRIGHTON	4	32	5,055	159
8093	ONRAMP TO WB I-70 FROM NB I-25	DENVER	415	2,466	1,441,230	585
8107	ONRAMP TO WB US-36 FROM BROADWAY	DENVER	64	461	204,562	444
8115	ONRAMP TO EB I-76 FROM FEDERAL BLVD	DENVER	15	72	11,323	157
8129	ONRAMP TO WB I-76 FROM PECOS ST	DENVER	1	3	491	175
8098	ONRAMP TO NB I-225 FROM ILLIFF AVE	AURORA	41	295	35,113	119
8120	ONRAMP TO SB I-225 FROM ALAMEDA AVE	AURORA	7	55	8,835	160
8121	ONRAMP TO SB I-225 FROM MISSISSIPPI AVE	AURORA	31	220	57,432	262
2826	ONRAMP TO EB US-36 FROM MCCASLIN	LOUISVILLE	21	152	32,364	213
8057	ON-RAMP TO SB SH 157 FROM PEARL ST.	BOULDER	44	341	73,166	215
8064	ONRAMP TO NB SH 157 (FOOTHILLS PKAY) FROM EB TABLE MESA	BOULDER	39	295	65,114	221
8079	ONRAMP TO WB US-36 FROM WADSWORTH PKWY	BROOMFIELD	198	1,029	410,111	399
2811	ONRAMP TO I-25 FROM WB SPEER	DENVER	174	867	307,553	355
8059	ONRAMP TO NB SANTA FE FROM US-285 (HAMPDEN AVE)	ENGLEWOOD	11	87	20,002	229
8062	ONRAMP TO EB I-70 FROM FEDERAL BLVD	DENVER	38	250	62,156	249
8097	ONRAMP TO WB US-6TH AVE FROM NB I-25	DENVER	162	1,068	824,184	771
8122	ONRAMP TO NB I-25 FROM PARK AVE	DENVER	173	936	341,274	365
8123	ONRAMP TO NB I-25 FROM 58TH AVE.	DENVER	98	675	257,234	381
2319	ONRAMP TO EB C-470 FROM LUCENT BLVD	HIGHLANDS RANCH	14	95	15,694	165
2320	ONRAMP TO EB C-470 FROM BROADWAY	HIGHLANDS RANCH	163	1,257	652,596	519
2321	ONRAMP TO EB C-470 FROM UNIVERSITY BLVD	HIGHLANDS RANCH	54	374	79,478	213
2322	ONRAMP TO WB C-470 FROM UNIVERSITY BLVD	HIGHLANDS RANCH	49	315	57,281	182
2323	ONRAMP TO WB C-470 FROM LUCENT BLVD.	HIGHLANDS RANCH	5	39	4,055	104
2576	ONRAMP TO SB I-25 FROM EB COUNTY LINE RD.	HIGHLANDS RANCH	48	348	104,173	300
2577	ONRAMP TO NB I-25 FROM EB COUNTY LINE RD.	HIGHLANDS RANCH	182	1,397	688,355	493
8063	ONRAMP TO EB C-470 FROM SANTA FE DR	HIGHLANDS RANCH	130	1,008	460,495	457
8077	ONRAMP TO EB C-470 FROM QUEBEC ST.	HIGHLANDS RANCH	176	1,391	784,616	564
8084	ONRAMP TO SB I-25 FROM LINCOLN AVE.	LITTLETON	1	2	278	164
8085	ONRAMP TO NB I-25 FROM WOLFENBERGER RD. (EXIT 182)	CASTLE ROCK	73	535	161,511	302
8086	ONRAMP TO NB I-25 FROM FOUNDERS PARKWAY (EXIT 184)	CASTLE ROCK	88	650	236,810	364
2175	ONRAMP TO WB C-470 FROM KIPLING ST.	LAKEWOOD	2	15	1,764	115
2458	ONRAMP TO WB US-6TH AVE FROM SIMMS ST	LAKEWOOD	22	131	32,079	245
2813	ONRAMP TO NB I-25 FROM COLFAX	LAKEWOOD	2	5	1,048	206
8058	ONRAMP TO WB I-76 FROM SHERIDAN BLVD.	ARVADA	89	466	116,613	250
8069	ONRAMP TO WB I-70 FROM KIPLING ST.	WHEATRIDGE	58	429	124,801	291
8100	ONRAMP TO WB US-6TH AVE FROM SB KIPLING ST.	LAKEWOOD	11	74	17,199	232
8106	ONRAMP TO NB US-285 (HAMPDEN AVE) FROM KIPLING BLVD.	DENVER	41	293	86,017	293
8110	ONRAMP TO EB SH-58 FROM WASHINGTON AVE	GOLDEN	14	100	19,325	194
8111	ONRAMP TO EB SH-58 FROM MCINTYRE ST.	GOLDEN	3	24	3,639	154
8130	ONRAMP TO EB I-76 FROM SHERIDAN BLVD	ARVADA	38	194	42,131	217
Subtotal			3,074	20,057	8,314,285	415



**Figure II-2 a: Site Locations Northern Front Range**



**Figure II-2 b: Site Locations – Denver Metro Area**



### **C. Sources of Data and Description of Elements**

Data used in the analyses in this report come from three primary sources:

- Remote sensing unit measurements
- The DMV database maintained on the AIR program contractor host computer

- I/M test database maintained on the AIR program contractor host computer

Data from the RSD units are loaded into a database maintained by the centralized contractor, ESP. Using the vehicle plate identified by RSD, the registration file is accessed to determine the vehicle identification number (VIN) and vehicle registration information. ESP uses the Polk VIN Decoder to add additional information about each vehicle. The combined data fields are shown in Table II-3.

*Table II-3 Vehicle Measurement Information*

<b>Field Name</b>	<b>Description</b>
V_DATA_VER	Data version
V_DATE_TIME	Date and time of measurement
V_RSD_UNIT	RSD system number
V_SEQ_NUM	Measurement sequence number
V_SITE_CODE	Site reference
V_PROGRAM_CODE	I/M Program
V_VAN_OPERATOR_ID	
V_CO	Carbon monoxide emissions %
V_CO2	Carbon dioxide emissions %
V_MAX_CO2	Maximum observed CO2
V_CO2_VOLUME	Volume of CO2 observed
V_HC	Hydrocarbon emissions ppm hexane equivalent
V_NOX	Oxides of nitrogen emissions ppm (NOx)
V_NOX_FLAG	Validity of NOx measurement
V_OPAC	Opacity measurement
V_SPEED	Speed MPH
V_ACCEL	Acceleration MPH/S
V_SA_UNITS	Units of speed and acceleration
V_TEMPERATURE	Ambient temperature
V_HUMIDITY	Ambient humidity
V_WIND_SPEED	Ambient wind speed
V_WIND_DIRECTION	Ambient wind direction
V_WEATHER_UNITS	
V_PLATE_CONFIDENCE	Reserved for future use
V_ALPR_VENDOR	Reserved for future use
V_TEST_COUNTY	Reserved for future use
V_CRC	
V_TAG_EDIT_MODE	
V_TAG_EDIT_ID_1	
V_TAG_EDIT_ID_2	
V_TAG_EDIT_ID_3	
V_TAG_EDIT_EMP_1	
V_TAG_EDIT_EMP_2	
V_TAG_EDIT_EMP_3	
V_PLATE	License plate
V_PLATE_STATE	State issuing license plate
V_PLATE_TYPE	Type of plate
V_VIN	Vehicle Identification Number

<b>Field Name</b>	<b>Description</b>
V_LZIP	Zip code for legal owner address
V_STATE_MAKE	Make code
V_STATE_MODEL	Model code
V_COUNTY	County of registration
V_VEH_YEAR	Model year
V_EM_FLAG	Subject to emissions test
V_POLK_VEH_YEAR	Polk decoded model year
V_POLK_MAKE	Polk decoded make
V_POLK_VEH_TYPE	Polk decoded vehicle type (P-pass, T-truck, U-unknown)
V_POLK_MODEL	Polk decoded model
V_POLK_DISP	Polk decoded engine displacement
V_VSP	Calculated vehicle specific power during measurement

### III. Summary of Data Collection

Up to 22 remote sensing units were deployed for 3,650 days during the one-year period to collect 8.3M measurements in the Denver metropolitan area (DMA) Metro Area, 757,000 measurements in the Northern Front Range (NFR) and 27,000 measurements in El Paso County having a visible plate and valid HC, CO, speed and acceleration values.

Plates were matched to registrations to determine model and owner information. Vehicles registered in the DMA accounted for 7.4M measurements, the NFR for 831,000, and El Paso County 145,000. Another 307,000 measurements were of vehicles registered in other Colorado counties.

Clean screen exemption notices were issued for 240,326 DMA vehicles due to renew their registration in 2010. Expanded vehicle emissions testing began in parts of Weld and Larimer counties in late 2010. Vehicle owners with December renewal dates were the first required to get a test and 2,665 were issued clean screen exemption notices. Only half of December renewals were due in 2010, as even model year vehicles are first tested in even years and odd model year vehicles are first tested in odd years.

These results are summarized in Table III-1 to II-3.

*Table III-1 Collection Summary*

Collection Summary				
Statistic	Denver Metro Area	Northern Front Range	Colorado Springs	Total
Sites Used	47	16	4	67
Collection Van Days	3,074	554	22	3,650
Active Collection Van Hours	20,057	3,894	145	24,096
Matched to Registration	8,314,285	757,625	27,681	9,099,591
Notices Generated for 2010 renewals	240,326	2,665		242,991

#### A. Monthly Collection Activity

Figure III-1 shows the monthly RSD measurements. Northern Front Range data collection for clean screening started in June 2010. Collection rates were lower during severe winter months.

#### B. Measurements by Hour of Day

Figure III-2 'Measurements by Hour of Day' shows the number of vehicles measured during each hour of the day. The shape of the curve is indicative of when measurements were collected and does not represent the level of traffic during the day. Most measurements were collected between 8:00am and 6:00pm.

Figure III-1 Monthly RSD Measurements

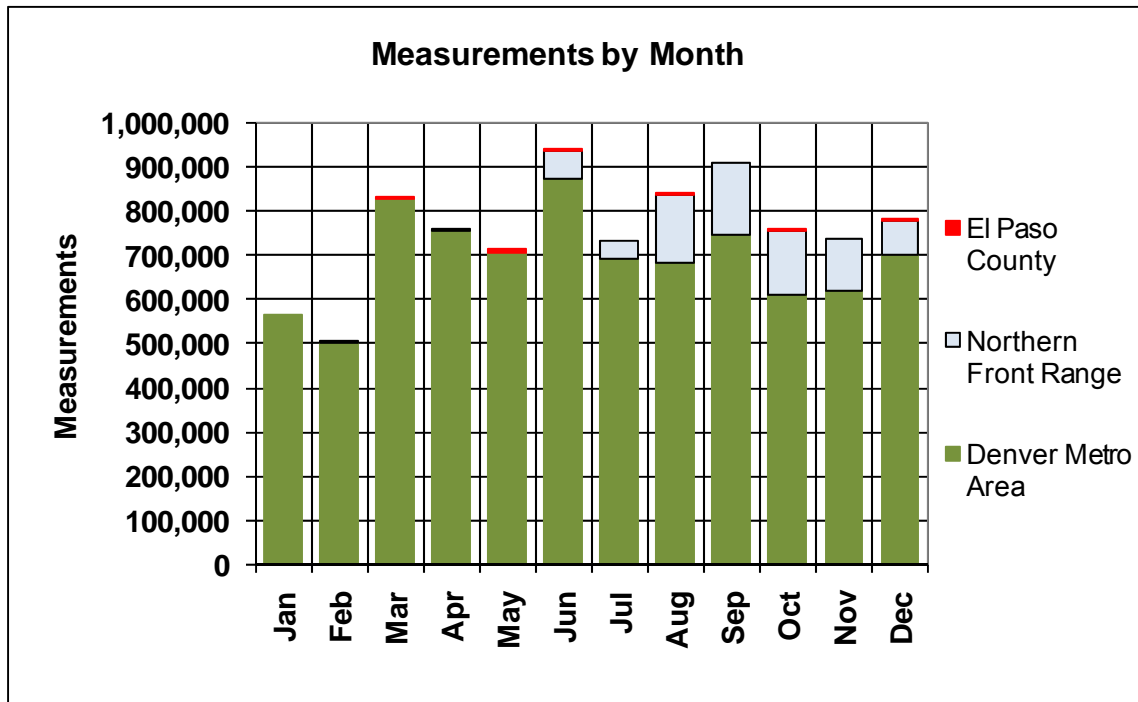
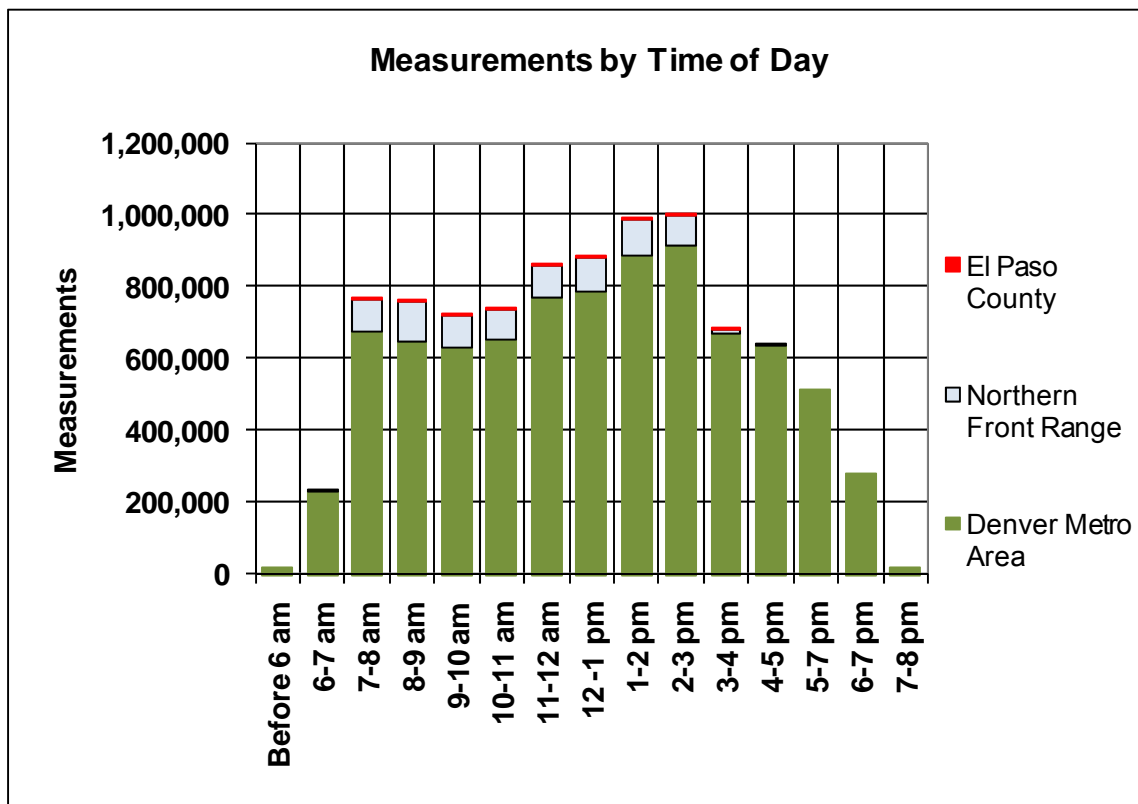


Figure III-2 Measurements by Time of Day



### C. Composition of Vehicles Measured

Table III-2, Source of Vehicle Registrations Measured by RSD, shows the number of vehicles registered in each program area and the area where they were measured. The majority (99%) of Denver metropolitan area registered vehicles were measured in the DMA . A majority (76%) of Northern Front Range registered vehicles were measured in NFR with the remaining 24% being measured in the DMA. The Northern Front Range fleet was actively measured during the second half of 2010. The percentage of NFR vehicles measured in the DMA is expected to be lower in the future as the active measuring in the NFR continues.

Table III-3, Type of Vehicles Measured by RSD within Registration Jurisdiction, shows that 81.7% of vehicles measured were registered in the DMA, 9.1% in the NFR, 1.6% in El Paso County (Colorado Springs), 3.4% in other non-I/M counties, and 4.2% were not matched. This can occur when plates are transferred by an owner to a new vehicle. These numbers are indicative of on-road activity – not unique registrations. The same vehicle may be measured more than once.

Table III-4 shows the distribution of vehicle measurements by vehicle type, age group and registration jurisdiction. The vehicle types were identified by the Polk VIN decoder. The model years of 1980 and older vehicles and some of the newest models were determined from the registration information but the vehicle type was not available. These were classified as Unknown in Table III-3. Five hundred measurements of motorcycles were also included as Unknown.

*Table III-2 Source of Vehicle Registrations Measured by RSD*

Program	Registered County	Measured In						Total
		Denver Metro Area		Northern Front Range		El Paso		
Denver Metro Area	Adams	1,000,431	99%	13,313	1%	256	0%	1,014,000
	Arapahoe	1,199,796	99%	13,826	1%	716	0%	1,214,338
	Boulder	386,120	97%	10,469	3%	85	0%	396,674
	Broomfield	289,358	99%	2,082	1%	25	0%	291,465
	Denver	1,148,888	99%	16,500	1%	694	0%	1,166,082
	Douglas	1,719,902	100%	6,731	0%	719	0%	1,727,352
	Jefferson	1,571,367	99%	13,035	1%	388	0%	1,584,790
	State of Colorado	31,576	87%	4,364	12%	358	1%	36,298
Subtotal Denver Metro		7,347,438	99%	80,320	1%	3,241	0%	7,430,999
Northern Front Range	Larimer	68,956	13%	465,063	87%	101	0%	534,120
	Weld	134,373	45%	162,974	55%	96	0%	297,443
Subtotal Northern Front Range		203,329	24%	628,037	76%	197	0%	831,563
El Paso	El Paso	117,311	81%	6,457	4%	21,751	15%	145,519
Non I/M		285,695	93%	20,241	7%	1,783	1%	307,719
Not Matched								383,791
Total		7,953,773		735,055		26,972		9,099,591



**Table III-3 Type of Vehicles Measured by RSD within Registration Jurisdiction**

Program	County	Pass	Truck	Unknown	Total	%
Denver Metro	Adams	390,854	566,678	56,468	1,014,000	11.1%
	Arapahoe	446,322	642,132	125,884	1,214,338	13.3%
	Boulder	182,191	189,026	25,457	396,674	4.4%
	Broomfield	126,598	143,902	20,965	291,465	3.2%
	Denver	450,081	584,371	131,630	1,166,082	12.8%
	Douglas	571,497	1,009,838	146,017	1,727,352	19.0%
	Jefferson	623,128	864,290	97,372	1,584,790	17.4%
	State of Colorado	9,283	19,509	7,506	36,298	0.4%
<b>Denver Metro</b>		<b>2,799,954</b>	<b>4,019,746</b>	<b>611,299</b>	<b>7,430,999</b>	<b>81.7%</b>
Northern Front Range	Larimer	206,266	284,364	43,490	534,120	5.9%
	Weld	114,679	162,707	20,057	297,443	3.3%
<b>Subtotal North Front Range</b>		<b>320,945</b>	<b>447,071</b>	<b>63,547</b>	<b>831,563</b>	<b>9.1%</b>
El Paso	El Paso	56,508	77,551	11,460	145,519	1.6%
<b>Non I/M</b>		104,379	180,994	22,346	307,719	3.4%
<b>Not Matched</b>					383,791	4.2%
<b>Total</b>		<b>3,281,786</b>	<b>4,725,362</b>	<b>708,652</b>	<b>9,099,591</b>	<b>100.0%</b>

**Table III-4 Registered Jurisdiction and Age of Vehicles Measured by RSD**

Vehicle Type	Model Year	Denver Metro Area	Northern Front Range	El Paso	Non-I/M	Total
Pass	1981 & older	683	175	7	46	911
	1982-1985	8,064	1,496	239	712	10,511
	1986-1990	57,513	9,768	1,181	3,729	72,191
	1991-1995	242,801	33,008	4,992	10,873	291,674
	1996-2000	688,802	82,782	13,579	25,509	810,672
	2001-2005	1,098,508	120,527	22,172	40,255	1,281,462
	2006 & newer	703,583	73,189	14,338	23,255	814,365
Light Truck	1981 & older	562	185	27	130	904
	1982-1985	7,150	1,931	139	958	10,178
	1986-1990	44,188	7,595	1,114	3,510	56,407
	1991-1995	196,458	27,640	4,047	11,972	240,117
	1996-2000	815,041	96,024	15,245	38,425	964,735
	2001-2005	1,713,937	185,366	33,053	73,452	2,005,808
	2006 & newer	1,242,410	128,330	23,926	52,547	1,447,213
Unknown	1981 & older	15,637	3,262	557	2,034	21,490
	1982-1985	330	64	21	64	479
	1986-1990	256	59	8	53	376
	1991-1995	589	206	46	95	936
	1996-2000	2,926	492	56	208	3,682
	2001-2005	2,804	562	153	291	3,810
	2006 & newer	588,213	58,902	10,619	19,601	677,335
<b>Total</b>		<b>7,430,455</b>	<b>831,563</b>	<b>145,519</b>	<b>307,719</b>	<b>8,715,256</b>



## IV. Clean Screening Program Performance

### A. Vehicles Selected, Notices and Redemptions

In 2010, there were 242,991 vehicles that qualified to participate in the clean screen program. Table IV-1 summarizes the monthly number of vehicles meeting screening criteria each month, to include the number withheld for the random sample and the number rejected through QA checks.

A random sample of two percent of vehicles meeting Clean Screen criteria are not mailed notices. These vehicles are required to go to a test station to obtain the station-based emission inspection. This random sample of vehicles is used to evaluate the effectiveness of the Clean Screen program.

Not all vehicles notified for clean screen or withheld in the random sample redeem the clean screen or obtain a test at that time, for example vehicles that changed owner are likely to have obtained an earlier station inspection. Compared to the 242,991 vehicles notified in the year, fewer vehicles 206,790 (85%) obtained a clean screen.

*Table IV-1 Vehicles Qualified As Meeting Clean Screening Criteria by Status*

Reg Year	Reg Month	Random Sample	QA failed	Notified	Total Qualified	Random % of Qualified
2010	Jan	449	313	21,676	22,438	2.0%
2010	Feb	419	319	20,185	20,923	2.0%
2010	Mar	428	342	20,904	21,674	2.0%
2010	Apr	405	255	19,419	20,079	2.0%
2010	May	361	250	17,448	18,059	2.0%
2010	Jun	370	739	17,405	18,514	2.0%
2010	Jul	436	295	21,025	21,756	2.0%
2010	Aug	425	255	20,466	21,146	2.0%
2010	Sep	440	310	21,231	21,981	2.0%
2010	Oct	468	282	22,465	23,215	2.0%
2010	Nov	389	222	19,019	19,630	2.0%
2010	Dec	442	248	21,748	22,438	2.0%
Total		5,032	3,830	242,991	251,853	2.0%

Table IV-2 lists the number of vehicles by month and city that were notified via the Department of Revenue.

**Table IV-2 Notifications Transmitted to DOR**

City	Registration Renewal Month												Total
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
DENVER	4,205	3,901	3,920	3,885	3,551	3,517	4,103	4,027	4,040	4,147	3,562	3,571	46,429
AURORA	1,761	1,761	1,860	1,691	1,535	1,481	1,851	1,656	1,743	1,838	1,608	1,654	20,439
LITTLETON	1,716	1,492	1,634	1,463	1,353	1,322	1,575	1,442	1,550	1,627	1,357	1,333	17,864
ARVADA	1,230	1,175	1,305	1,240	1,105	1,007	1,309	1,258	1,295	1,480	1,194	1,169	14,767
HIGHLAND RCH	1,188	1,079	1,103	1,018	984	937	1,202	1,275	1,325	1,407	1,159	1,192	13,869
LAKEWOOD	1,245	1,103	1,184	1,016	925	892	1,093	994	1,072	1,170	965	964	12,623
WESTMINSTER	1,017	1,003	1,082	951	799	833	1,064	1,069	1,103	1,115	968	931	11,935
CENTENNIAL	979	903	900	900	844	820	1,003	959	1,005	1,115	943	937	11,308
THORNTON	969	882	896	843	699	744	950	881	910	970	826	776	10,346
BOULDER	871	755	707	727	624	669	688	740	808	834	659	720	8,802
PARKER	776	763	768	673	556	558	726	685	744	751	644	681	8,325
BROOMFIELD	691	646	731	633	538	555	765	692	753	785	655	676	8,120
CASTLE ROCK	695	663	652	576	581	580	682	716	729	781	677	637	7,969
GOLDEN	539	540	576	507	444	428	511	532	581	570	482	515	6,225
ENGLEWOOD	460	438	397	427	365	370	406	506	420	445	426	406	5,066
LONGMONT	310	268	262	259	225	256	270	299	287	291	243	302	3,272
WHEAT RIDGE	257	265	265	251	195	235	279	238	268	314	232	237	3,036
NORTHGLENN	271	246	273	232	194	216	272	240	252	267	222	217	2,902
BRIGHTON	261	227	259	220	186	180	233	213	242	246	210	239	2,716
COMMERCE CITY	244	233	243	217	197	182	218	192	205	199	210	192	2,532
LOUISVILLE	151	163	203	148	144	186	172	182	194	225	173	191	2,132
LAFAYETTE	167	178	156	133	124	142	183	177	203	187	181	160	1,991
GREENWOOD VLG	185	158	164	126	128	139	206	183	179	179	163	179	1,989
EVERGREEN	182	165	174	157	136	126	145	133	147	199	139	123	1,826
LONE TREE	139	123	116	102	133	113	139	152	133	152	135	144	1,581
CASTLE PNS N	131	130	93	113	102	105	99	135	124	177	106	138	1,453
SUPERIOR	112	95	118	99	104	96	106	123	108	112	113	112	1,298
MORRISON	130	118	125	126	79	101	105	96	93	113	93	90	1,269
FT COLLINS												1,070	1,070
ERIE	60	44	58	58	42	44	50	47	59	64	48	135	709
CHERRY HL VLG	71	55	51	51	42	46	58	54	63	69	73	50	683
LARKSPUR	66	62	50	65	46	41	57	62	62	58	49	62	680
FEDERAL HTS	59	64	53	59	52	50	58	52	53	51	52	48	651
FRANKTOWN	73	46	53	46	52	56	42	50	55	51	43	51	618
CONIFER	44	53	79	45	44	42	55	48	49	67	38	49	613
SEDALIA	52	48	54	46	44	35	45	53	46	54	58	58	593
HENDERSON	54	45	57	41	40	51	47	50	56	59	43	42	585
LOVELAND												412	412
SHERIDAN	27	33	33	25	28	28	28	39	32	39	25	30	367
OTHER	287	262	249	249	208	222	230	215	243	257	245	1,259	3,926
<b>Total</b>	<b>21,675</b>	<b>20,185</b>	<b>20,903</b>	<b>19,418</b>	<b>17,448</b>	<b>17,405</b>	<b>21,025</b>	<b>20,465</b>	<b>21,231</b>	<b>22,465</b>	<b>19,019</b>	<b>21,752</b>	<b>242,991</b>

**Table IV-3 Clean Screen Audit Test Pass / Fail Statistics**

Vehicle Type	Vehicles	Fail Emissions	Fail Gas Cap / Pressure	Fail Inspection
Passenger	1,892	23	51	75
Light Truck	2,451	27	83	104
Total	4,343	50	134	179
Percentage		1.2%	3.1%	4.1%

## B. Clean Screen Program Effectiveness

The emissions reductions obtained during the station testing of the audit sample vehicles are used to project the total emissions reductions foregone as a result of the Clean Screen program.

### Pass / Fail Statistics

Matching initial tests for audit vehicles were limited to those occurring after the second RSD measurement and before expiration of the assigned Clean Screen period. Matching tests were sought through the end of February 2011. The tests identified for audit sample vehicles and their I/M results are tabulated in Table IV-3. As noted earlier, some of the anticipated random vehicles did not obtain a test within the Clean Screen period. In aggregate, 1.2% of the tested audit vehicles failed their tailpipe emissions inspection, and 3.1% of the tested audit vehicles failed their gas cap pressure test<sup>2</sup>. The 1.2% of emissions failures in 2010 was the same rate as in 2009. The overall rate of gas cap failures in the program was 3.1% in 2010 compared to 3.0% in 2009.

HC and CO RSD clean screening cutpoints for 2010 were unchanged and an RSD cutpoint for NOx was introduced in October 2010, which was not early enough in the year to materially affect 2010 results. The LEI table was updated in 2009 and in January 2010.

Following sections describe in detail how these results are used to evaluate the emissions impact of the Clean Screen program.

### Tailpipe Emissions

The vast majority of vehicles were tested using IM240 tailpipe tests and IM240 testing provides a more accurate estimate of vehicle emissions than the idle tailpipe test. Therefore, the results of the 95% of the clean screen audit sample vehicles tested using IM240 were used to evaluate the exhaust emissions effectiveness of the clean screen program. The emission reductions from vehicles inspected using the idle test procedure have been included in the overall estimate of program benefits. Models inspected using the idle test procedure are 1981-and-older models and 1982-and-newer trucks over 8500 lbs GWR plus some four-wheel drive and traction control vehicles.

Vehicle test results were sorted by VIN and test date. Vehicles were then further classified based on their first and last test result during the period. To avoid potential double counting of emissions reductions, the emissions analysis only considered the first and last result for each vehicle during the year and interim results were ignored.

In the list below, the first and last results are indicated in parenthesis, where P is pass, F is fail, W is waiver and null indicates that there was only a single test result for a particular vehicle. The expected combinations that apply to the vast majority of vehicles are underlined.

- P – Passed initial test (P/null, P/P, P/F, P/W)
- R – Failed and successfully repaired (F/P)

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<sup>2</sup> Note that the number of emissions fails plus the number of Gas Cap / Gas Cap Pressure failures does not always equal the total number of inspection failures. In a few cases a vehicle may fail both Emissions and Gas Cap. In a few cases, vehicles fail for other reasons.

- U – Failed unresolved (F/null, F/F)
- W – Failed and wavered (F/W)

The difference between the initial and final tests is used to determine the percentage of tailpipe emissions reduction of each group. For vehicles with only one test, the final result is the same as the initial result.

### **Adjustment of Fast-Pass Results**

A majority of vehicles tested on IM240 fast pass the test in less than the 240-second driving cycle. To allow for comparison of emissions of vehicles tested over different durations of the IM240 test cycle, the emission results for vehicles that fast-pass the IM240 inspection must be extrapolated. A method for projecting full test emissions was developed and implemented in the I/M program in 1995<sup>4</sup> and the projected full test emissions values are stored in the test records and reported as the emissions results.

### **Unresolved Vehicles**

When vehicles fail their initial inspection, they must obtain a repair and return for re-inspection. This process is normally completed in 30 days, but can take longer. Vehicles that had initial tests in late 2010 but completed repair and final test after February of the following year are treated as unresolved. Thus, the “Fail unresolved” category may be somewhat over-stated.

A number of vehicles never complete the repair/re-inspection process. In most cases, these vehicles are either scrapped or removed from the non-attainment area, which does reduce emissions in the area. Surveys in Arizona<sup>5</sup> and Colorado<sup>6</sup> found that some vehicles continued to operate in the area in violation of the program rules, either with expired license plates or with stolen license plates or license plate stickers. In this report, it is assumed that two-thirds of these unresolved vehicles leave the area and one third continues to operate. Studies in progress in Colorado preliminarily indicate the percentage leaving the area is closer to 80%.

To minimize the number of unresolved Clean Screen audit vehicles, retests of audit vehicles were included through the end of February 2011 and the audit vehicles were all assumed to remain in the area.

### **First and Final Emissions Results**

Table IV-5 contains an example of the initial and final tailpipe results for 1982 to 1985 passenger vehicles inspected using the IM240 test. The table shows the average initial and average final emissions for each group of vehicles together with the percentage reduction.

For example, of the 1,085 1985 model year passenger vehicles tested using the IM240 transient test, 16.9% of vehicles initially failed inspection and were repaired (Pass) with HC, CO and NOx reductions of 61.5%, 73.6% and 10.7% respectively. Another 9.8% of vehicles failed their initial inspection and had not successfully passed a retest by end February 2011 (Unresolved). Reductions from these vehicles are estimated to be approximately 67% for HC, CO and NOx, because follow-up studies have shown that more than two thirds cease operating in the area. Finally, 0.3% of vehicles were waived (Waiver) with HC, CO and NOx reductions of 27.8%, 20.6% and -2.6% respectively. In aggregate, including vehicles that passed their initial inspection, emission reductions for 1985 passenger vehicles were 36.6% for HC, 40.9% for CO and 9.8% for NOx.

Complete tables by model year and vehicle type are provided in Appendix A for vehicles tested using the IM240. Tables are also provided for the Clean Screen audit sample vehicles. The aggregate results from these tables are used to estimate the impact of the Clean Screen program.

#### **Audit Sample Reductions and Projected Impact**

Table IV-6 shows the aggregate first and final results for the 95% of the inspected audit sample vehicles that were tested using IM240. The average per vehicle emissions reductions from the audit sample are multiplied by the number of exempted clean screen vehicles to project the reductions that could have been achieved if the clean screen vehicles had instead been inspected at the stations. This amount is then compared to the total emission reductions from vehicles tested at stations to determine the impact of the Clean Screen program and the percentage of emissions reductions retained.

For vehicles subject to the IM240 test, the Clean Screen program retained 93 to 97% of the exhaust HC, CO and NO<sub>x</sub> reductions. These reductions assume all vehicles are driven the same number of miles each year. Mileage adjusted emission reductions are calculated in section V.

**Table IV-5 Transient Test Emission Reductions for 1982-1985 Passenger Vehicles**

Colorado 2010 Transient Test Emissions Reductions													
Unresolved fails remaining in area					33%								
Model	First	Last			Initial			Final			Reduction %		
Year/Type	Result	Result	Vehicles	Fail%	HC	CO	NOX	HC	CO	NOX	HC	CO	NOX
1982	Pass	-	368		1.54	18.68	2.14	1.54	18.68	2.14	0.0%	0.0%	0.0%
P	Fail	Pass	69	14.7%	2.98	41.26	2.54	1.54	15.93	2.35	48.5%	61.4%	7.1%
	Fail	Unresolv.	32	6.8%	7.12	91.53	1.99	2.84	29.13	0.66	60.2%	68.2%	66.9%
	Fail	Waiver	0	0.0%	0.00	0.00	0.00	0.00	0.00	0.00			
Total	Fail%		469	21.5%	2.13	26.97	2.19	1.63	18.98	2.07	23.7%	29.6%	5.4%
1983	Pass	-	393		1.33	16.46	1.94	1.33	16.46	1.94	0.0%	0.0%	0.0%
P	Fail	Pass	94	16.6%	3.58	41.00	2.10	1.53	15.36	2.08	57.2%	62.5%	0.9%
	Fail	Unresolv.	76	13.4%	5.36	73.94	1.70	1.69	24.35	0.58	68.4%	67.1%	66.2%
	Fail	Waiver	4	0.7%	3.41	74.31	1.73	2.00	44.95	1.59	41.3%	39.5%	8.1%
Total	Fail%		567	30.7%	2.26	28.64	1.93	1.42	17.54	1.78	37.2%	38.8%	8.0%
1984	Pass	-	1,060		1.24	14.47	1.89	1.24	14.47	1.89	0.0%	0.0%	0.0%
P	Fail	Pass	228	16.4%	2.99	36.12	2.23	1.30	12.98	1.95	56.5%	64.1%	12.7%
	Fail	Unresolv.	102	7.3%	4.89	78.11	1.96	1.90	28.35	0.60	61.3%	63.7%	69.3%
	Fail	Waiver	1	0.1%	3.41	16.55	3.80	3.49	11.85	3.31	-2.4%	28.4%	12.8%
Total	Fail%		1,391	23.8%	1.80	22.69	1.95	1.30	15.24	1.81	27.6%	32.8%	7.5%
1985	Pass	-	1,085		1.00	11.13	1.91	1.00	11.13	1.91	0.0%	0.0%	0.0%
P	Fail	Pass	251	16.9%	2.76	34.24	2.20	1.06	9.04	1.97	61.5%	73.6%	10.7%
	Fail	Unresolv.	146	9.8%	4.57	56.45	2.38	1.36	18.48	0.78	70.2%	67.3%	67.4%
	Fail	Waiver	5	0.3%	2.39	45.97	1.78	1.73	36.48	1.83	27.8%	20.6%	-2.6%
Total	Fail%		1,487	27.0%	1.65	19.60	2.00	1.05	11.59	1.81	36.6%	40.9%	9.8%

*Table IV-6 Clean Screen Emissions Impact for Tailpipe Emissions*

	<b>IM240 Tailpipe Emissions</b>			
	<b>Vehicles</b>	<b>HC g/mi</b>	<b>CO g/mi</b>	<b>NOx g/mi</b>
<b>Audit Sample</b>	4,108			
Mean Initial		0.153	2.328	0.485
Mean Final		0.144	2.114	0.468
Emissions reduction		0.010	0.214	0.018
<b>Clean Screens</b>	206,790			
Potential Reductions		2,007	44,236	3,673
<b>Station Vehicles</b>	673,407			
Mean Initial		0.377	4.726	0.772
Mean Final		0.282	3.580	0.695
Emissions reduction		0.095	1.146	0.077
In station reductions		64,110	771,635	51,712
<b>Combined CS &amp; Stn</b>	880,197	66,117	815,871	55,385
Clean Screen Impact		3.0%	5.4%	6.6%
Retained Reductions		97.0%	94.6%	93.4%

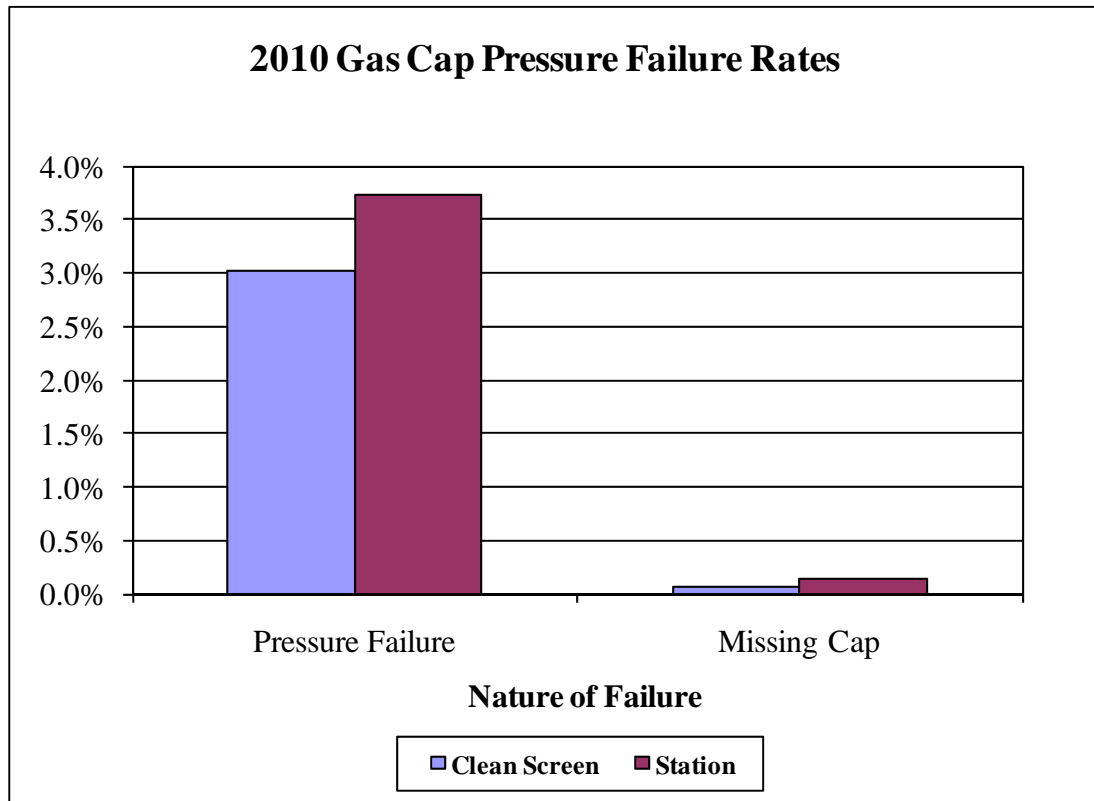
### C. Gas Cap Evaporative Emissions

The evaporative emissions test used in the I/M Program is a gas cap pressure test. Leaking gas caps allow evaporated gasoline (HC) to escape from vehicle gas tanks into the atmosphere. The impact of leaking gas caps on the Clean Screen program is only evaluated in this report in terms of the failure rate, not in terms of repairable gas cap emissions reductions<sup>3</sup>.

Figure IV-7 compares the average gas cap failure rate of the Clean Screen audit sample vehicles to the average failure rate of the non-audit vehicles tested at stations. The failure rate of vehicles exempted via Clean Screen methods was 19% lower than the failure rate of vehicles that received a station-based test (See Figure IV-7). This result is expected because remote sensing is directed towards measuring tailpipe emissions. A gas cap evaporative leak would have to be quite large to be detected by RSD units. Clean screen models were newer than the overall tested fleet.

<sup>3</sup> Although the gas cap leak rates are measured in the I/M Program, it is not clear that leak rates are directly related to the amount of evaporative HC emissions released from the gas tank. A small pressure leak may have the same effect as a large pressure leak, as long as it is sufficient to release internal gas tank pressure over a period of an hour or so.

**Figure IV-7 Gas Cap Pressure Failure Rates**



Using the fail rates identified in the audit sample, Table IV-7 shows the projected gas cap failures that would have been found in the exempted clean screen vehicles. These projected gas cap failures are added to the actual gas cap failures identified in initial inspections at the test stations to provide the total possible gas cap failure rate for the program. Vehicles with a redeemed Clean Screen notice account for 17.9% of the total possible gas cap failures. Therefore, 82.1% of evaporative gas cap HC emission reductions were retained.

In general, it is desirable to use direct measurements of emissions to evaluate program performance rather than a model. Unlike exhaust emissions that are directly measured using tailpipe tests, however, emissions rates from gas caps cannot easily be directly measured. Emissions rates of vapor leaks are typically determined in a test laboratory by enclosing a vehicle in a sealed compartment and measuring the emissions released into the compartment over time, which is impractical for testing many vehicles. Therefore, the EPA mobile source emissions model, Mobile6.2, was used to estimate the fraction of emissions benefits derived from gas cap inspections.

CDPHE provided results from Mobile6.2 models of the benefits of the I/M program for 2010. The projected average reduction in HC emissions of the area fleet was 0.088 g/mi. This was comprised of 0.069 g/mi resulting from exhaust emissions inspections and 0.019 g/mi from the Gas Cap testing. The measured I/M exhaust reductions (see section V) were 606.1 tons. Assuming the 0.069 g/mi corresponded to 691.8 tons, the Gas Cap related HC reductions were projected to be 166.9 tons. These results are shown in Table IV-8. The RapidScreen impact was projected as 29.9 tons or 3.9% of the I/M program reductions.



*Table IV-7 Clean Screen Impact on Evaporative HC Emissions*

	<b>Initial Tests</b>	<b>Pressure Failure</b>	<b>Missing Cap</b>	<b>Total Fails</b>
RapidScreen Audit	4,343	131 3.0%	3 0.1%	134 3.1%
Projected RapidScreen	206,790	6,238	143	6,380
Station GC Tests	752,703	28,135 3.7%	1,056 0.1%	29,191 3.9%
Total Program	959,493	34,373	1,199	35,571
RapidScreen Impact	21.6%	18.1%	11.9%	17.9%
Retained Reductions	78.4%	81.9%	88.1%	82.1%

*Table IV-8 Gas Cap Related Benefit Tons*

		<b>2010 M6 g/mi HC</b>	<b>I/M 2010 HC tons</b>
<b>Mobile6 Estimates (from CDPHE)</b>			
I/M Exhaust emission reductions		0.069	606.1
Projected Gas Cap Evap Emissions reductions		0.019	166.9
I/M Program total HC reductions		0.088	773.0
Gas Cap Evap RapidScreen impact	18%	0.003	29.9
<b>% of I/M program HC benefit</b>			<b>3.9%</b>

#### **D. Hybrid RSD-LEI vs. 2-hit RSD**

Environmental Systems Products compared the effectiveness of the 'Hybrid' and '2-RSD' screening methods. The Hybrid method uses a single RSD measurement and a low emitter index (LEI) table. The 2-RSD method uses two RSD measurements.

The audit sample of vehicles with IM240 tests contained 3,091 vehicles screened using the 2-RSD method and 1,017 vehicles screened using Hybrid RSD-LEI method. Table IV-9 shows the emissions reductions for these two samples and the average for all vehicles inspected at stations. Figures IV-2 and IV-3 show the average initial emissions and emissions reductions for each sample.

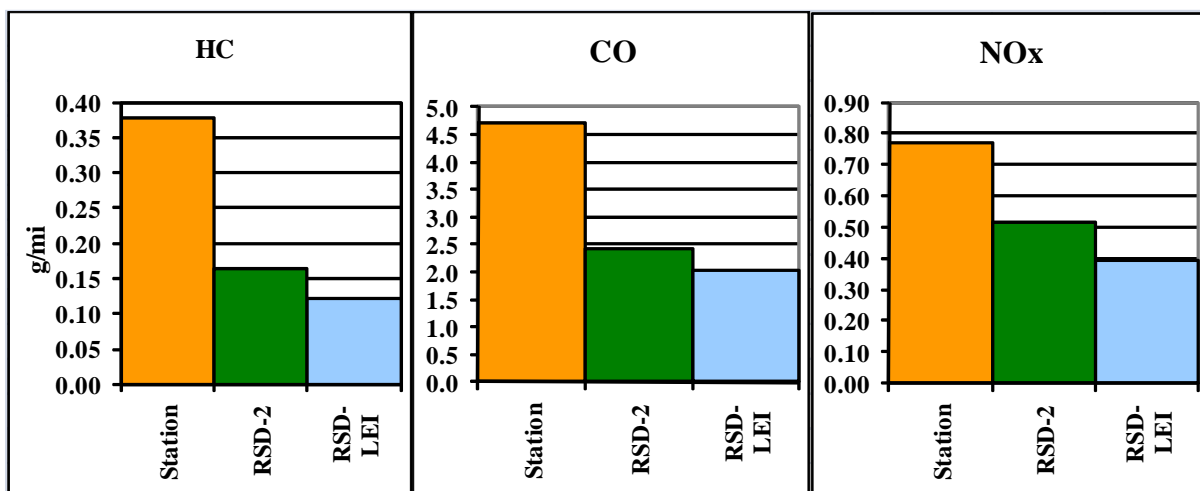
The 2-RSD method audit vehicles had initial emissions that were 52%, 59% and 74% of the overall I/M fleet average for HC and CO and NOx respectively. The relatively higher average for NOx in part reflects the absence of an RSD NO cutpoint. The Hybrid RSD-LEI method audit vehicles had lower initial emissions that were 38%, 50% and 56% of the I/M fleet average for HC and CO and NOx respectively.

Average emissions reductions for the 2-RSD audit vehicles were 3.0%, 5.0% and 3.0% of fleet average initial emissions for HC and CO and NOx respectively. Average emissions reductions for the Hybrid RSD-LEI audit vehicles were 2.9%, 5.7% and 0.9% of fleet average initial emissions for HC and CO and NOx respectively. These compared to station average reductions of 29.3%, 27.5% and 10.9% for HC, CO and NOx respectively. The Hybrid RSD-LEI audit vehicles had lower initial emissions and lower reductions of HC and NOx than the 2-RSD audit vehicles.

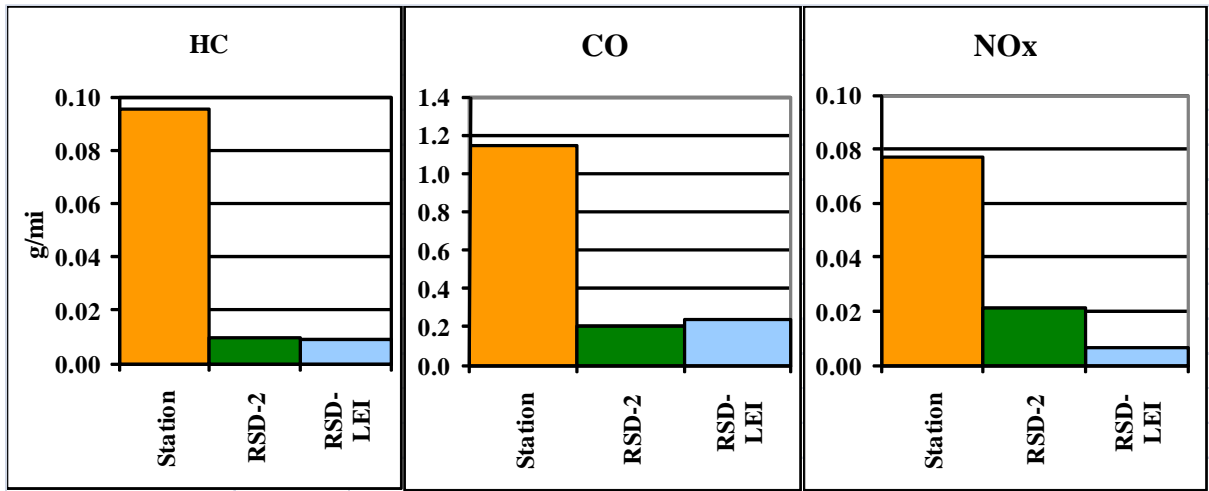
**Table IV-9 Average Emissions per Vehicle**

Vehicle Sample	IM240 Tailpipe Emissions			
	Vehicles	HC g/mi	CO g/mi	NOx g/mi
<b>I/M vehicle initial mean emissions</b>		0.325	4.162	0.705
<b>2-RSD Audits</b>	3,091			
Mean Initial		0.164	2.425	0.516
Mean Final		0.154	2.219	0.495
Emissions reduction		0.010	0.206	0.021
% of I/M vehicle initial mean em		3.0%	5.0%	3.0%
<b>Hybrid Audits</b>	1,017			
Mean Initial		0.121	2.030	0.392
Mean Final		0.112	1.793	0.385
Emissions reduction		0.009	0.237	0.007
% of I/M vehicle initial mean em		2.9%	5.7%	0.9%
<b>All Station Tests</b>	673,407			
Mean Initial		0.377	4.726	0.772
Mean Final		0.282	3.580	0.695
Emissions reduction		0.095	1.146	0.077
% of I/M vehicle initial mean em		29.3%	27.5%	10.9%

**Figure IV-2 Average Initial IM240 Emissions**



**Figure IV-3 Average IM240 Emissions Reductions**



## **V. Estimate of Overall I/M Program Benefits and Clean Screen Impact**

Overall I/M program emission reductions derive from two main components:

- Reductions resulting directly from I/M inspections and consequent repairs;
- Reductions from repair activities that are performed in anticipation of an I/M inspection.

In previous years, it was assumed the vast majority of emissions reductions were directly measurable by comparing the initial and final I/M inspection emissions results, i.e. the first component described above. This report uses the same methodology. However, it is acknowledged that by 2007 most vehicles were equipped with OBD-II malfunction indicator lights. It is believed that some repairs of these newer model vehicles are performed in response to warning lights before the initial inspection. The benefits of these repairs are not directly measurable in the program testing.

The Clean Screen disbenefit can be projected directly from the emissions testing of the audit sample. There may be unmeasured offsetting benefits if the Clean Screen program encourages owners to maintain malfunctioning vehicles sooner than otherwise.

For this report, measured I/M exhaust emissions benefits were projected from the IM240 and Idle emissions tests. In the case of Idle tests, idle test emission concentrations were converted to equivalent IM240 g/mi emissions.

For each model year, the IM240 g/mi emissions values were weighted by the annual vehicle miles traveled to project the emissions inventory for initial and final test and, hence, the direct program benefits.

The following sections project the directly measured tons of emissions and reductions

### **A. Conversion of Idle Tests to IM240 Equivalent emissions**

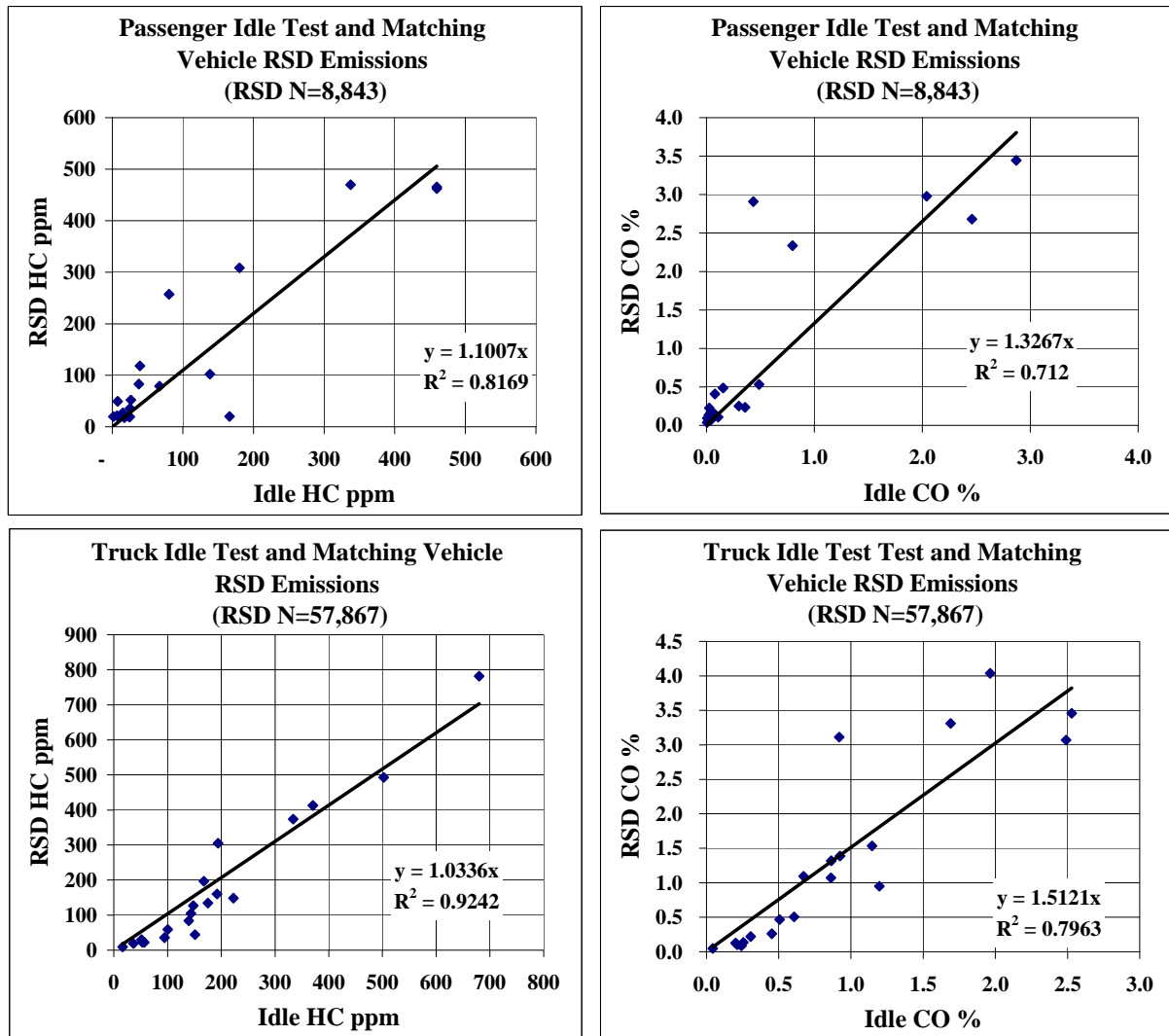
On-road remote sensing emissions of vehicles inspected at I/M stations have been used to project IM240 equivalent values for Idle test emissions.

The idle test procedure includes a low-speed idle and a high speed idle at 2500rpm. Vehicles model year 1980 and older are required to pass the low-speed idle while 1981 and newer models must pass both the low-speed and the high-speed tests.

Figures V-1 and V-2 show the correlation between idle tests and on-road HC and CO emissions of the same vehicles. Results are averaged by model year. Average initial and final test emissions were used for vehicles that initially failed and were retested. Model years were grouped together for 1965-and-older, 1966 to 1970, 1971 to 1975, 1976 to 1981, 1982 to 1985, 1986 to 1990 and 2004-and-newer. Even with these groups, there were less than 100 matching RSD measurements for Passenger vehicles in groups from 1982 to 1998. There were several hundred matching RSD measurements for each truck group. Trend lines were plotted with an intercept of zero to obtain RSD / Idle Test emissions ratios.

Similarly, Figure V-3 shows the correlation between IM240 and on-road emissions. Trend lines were plotted with an intercept of zero for HC and CO emissions to obtain IM240 / RSD emissions ratios. The results are summarized in Tables V-1 and V-2.

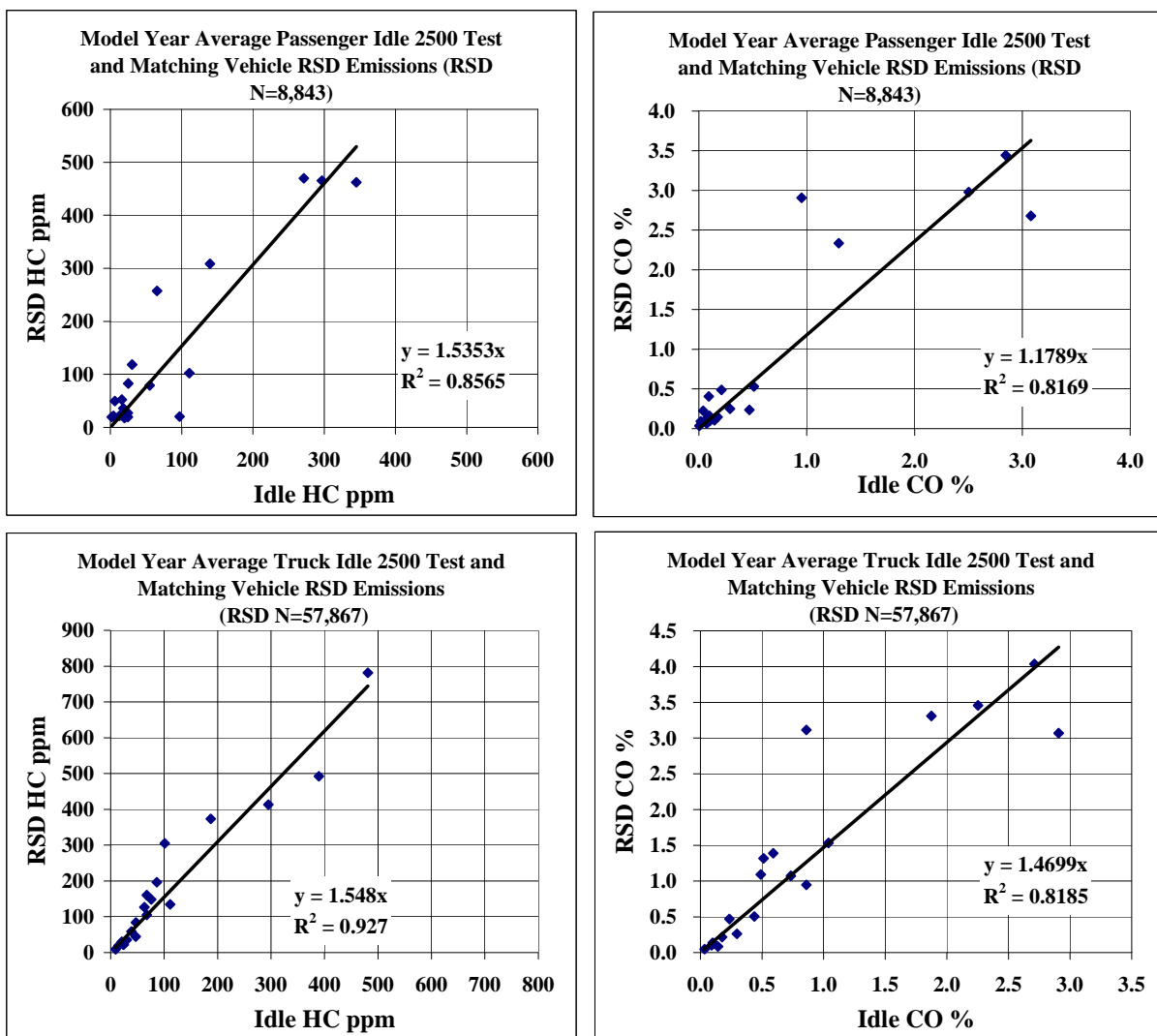
**Figure V-1 RSD vs. Idle Test Emissions**



*Table V-1 Low Speed Idle to IM240*

Low Speed Idle test to IM240 Projection				
Passenger	HC	HC R2	CO	CO R2
RSD / Idle	1.1007	0.81	1.3267	0.71
IM240 / RSD	0.0087	0.98	15.947	0.92
IM240 / Idle	0.0096		21.1569	
Truck	HC	HC R2	CO	CO R2
RSD / Idle	1.0336	0.92	1.5121	0.8
IM240 / RSD	0.0111	0.98	18.765	0.94
IM240 / Idle	0.0115		28.3746	

**Figure V-2 RSD vs. 2500 Idle Test Emissions**

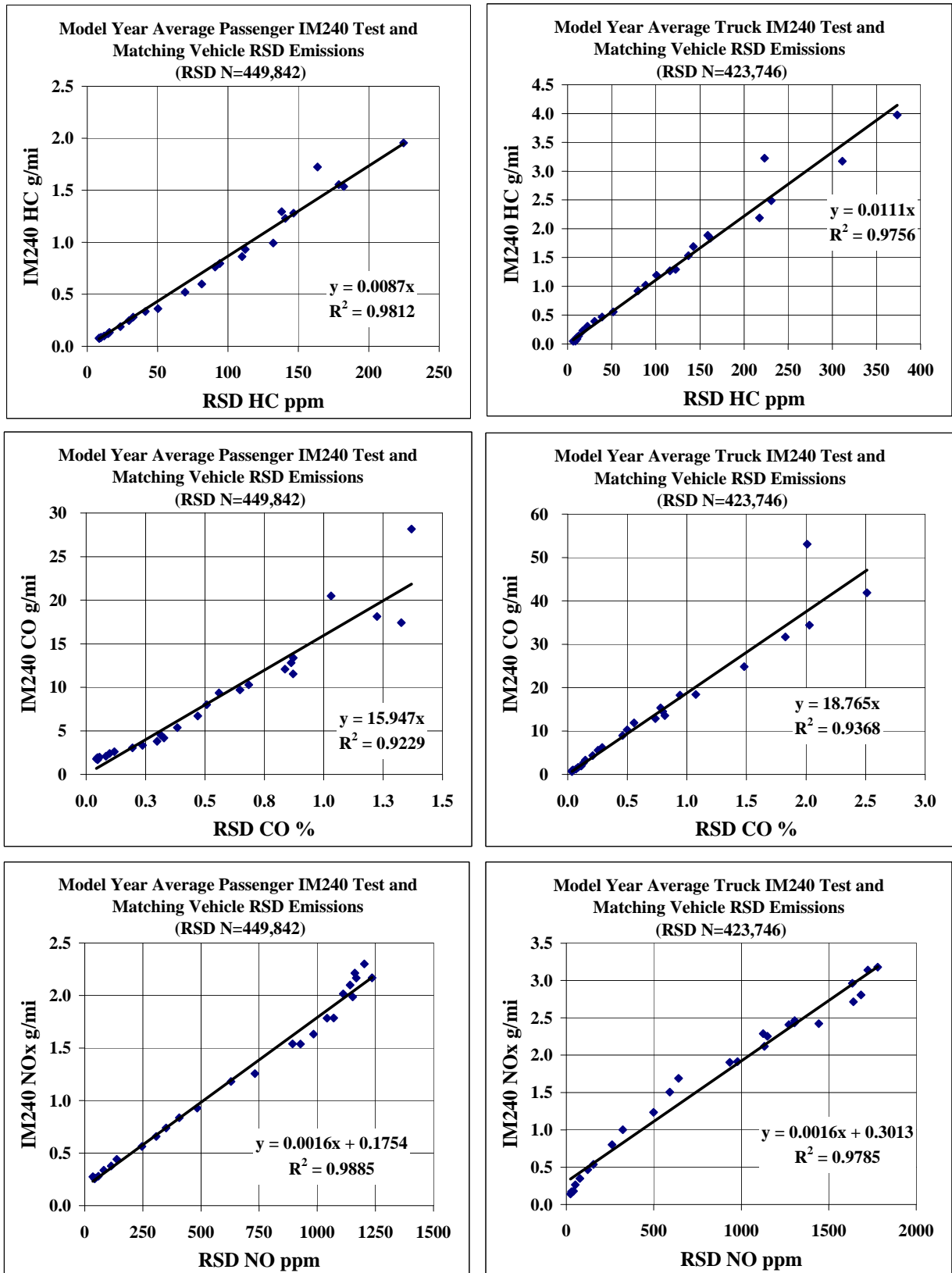


*Table V-2 Low Speed Idle to IM240*

2500 RPM Idle test to IM240 Projection				
Passenger	HC	HC R2	CO	CO R2
RSD / 2500	1.5353	0.86	1.1789	0.82
IM240 / RSD	0.0087	0.98	15.947	0.92
IM240 / 2500	0.0134		18.7999	
Truck	HC	HC R2	CO	CO R2
RSD / 2500	1.548	0.93	1.4699	0.82
IM240 / RSD	0.0111	0.98	18.765	0.94
IM240 / 2500	0.0172		27.5827	

Using the ratios derived above, IM240 g/mi equivalent emissions were projected for the vehicles tested with the idle test procedure. The low speed idle results were used to estimate emissions reductions as all model year vehicles tested at idle were required to pass the low speed idle test.

Figure V-3 RSD vs. 2500 Idle Test Emissions





## B. Annual Mileage Weighting

Because of data entry errors and odometer rollover on older, high mileage vehicles, obtaining estimates of annual mileage from the I/M Program odometer readings for each model year and type of vehicle is not recommended. To avoid these problems, annual mileages for vehicles were taken from the 2008 ERG report on Colorado mileage accumulation rates<sup>7</sup>.

The estimated annual mileages are shown in Table V-3 for LDGVs and LDGTs. In Table VI-3 the mileage accumulation rates for LDGT2, 3 and 4 were weighted together to obtain a single LDGT value. This table indicates that newer model year vehicles are driven more miles annually than older vehicles. It also indicates that 1995 and newer model year LDGTs, which emit greater masses of pollution than LDGVs are driven more miles annually than 1995 and newer model year LDGVs.

*Table V-3 Estimated Annual Mileage in 2010*

Year	LDGV	LDGT
1981	4304	4,554
1982	4304	4,562
1983	4434	4,583
1984	4481	4,630
1985	4502	4,668
1986	4552	4,741
1987	4,780	4,851
1988	5,088	5,019
1989	5,430	5,256
1990	5,672	5,519
1991	6,002	5,824
1992	6,331	6,135
1993	6,653	6,471
1994	6,974	6,940
1995	7,369	7,437
1996	7,764	7,863
1997	8,188	8,345
1998	8,613	8,900
1999	9,032	9,502
2000	9,450	10,087
2001	9,905	10,727
2002	10,360	11,245
2003	10,746	11,817
2004	11,132	12,303
2005	11,870	12,834
2006	12,023	13,215
2007	12,307	13,433
2008	12,357	13,514
2009	11,600	12,428
2010	9,650	8,995

### C. Annual Emissions Reductions

Annual tons of emissions were projected for vehicle type and model year by multiplying the numbers of vehicles by annual mileage and average g/mi emission levels. Results were projected for initial tests and final tests to determine the initial and final tons of emissions and, therefore, the tons of reduction. The results are listed in Appendix B for IM240 and Idle tests.

Table V-4 first shows the reductions from the Clean Screen audit tests. Based on the audit tests, the second part of the table projects the potential reductions from the Clean Screen vehicles if all vehicles with redeemed Clean Screen notices had been tested at a station. The third part of the table shows the reductions from the vehicles that were tested at inspection stations, which includes the Clean Screen audit vehicles. The total potential reductions from the program are the combination of the potential reductions from the Clean Screened vehicles plus the actual reductions from the vehicles tested at stations.

In Table IV-4, Clean Screen effectiveness was expressed without reference to the annual vehicle miles traveled (VMT) by each model year of vehicles. The more complete analysis in Table V-4 shows the Clean Screen program effectiveness when the VMT and Gas Cap<sup>4</sup> estimates are factored in. During 2010, the Clean Screen program retained 93.5%, 93.8% and 92.4% respectively of potential HC, CO and NO<sub>x</sub> emission reductions in vehicles subject to testing.

For vehicles initially tested in calendar year 2010, the I/M Program is projected to have eliminated 723.1 tons of HC, 6,874.6 tons of CO and 462.2 tons of NO<sub>x</sub> for one year of vehicle travel – based on the IM240 driving cycle.

Because the program is biennial, these reductions are approximately half of the reductions that would be measured over a full two-year cycle of the program.

The tons of reductions cited here do not relate directly to the total mobile emissions inventory. The reductions cited are for tailpipe emissions and are in terms of the IM240 driving cycle. State Implementation Plan reductions are based on different driving cycles, are subject to many adjustments for speed, road type, temperature, air conditioning loads, etc., and therefore are larger than the IM240 measured reductions.

As noted earlier, the reductions shown do not include reductions from maintenance actions performed on vehicles before their initial inspection. These may be quite substantial, especially for OBD-II vehicles that turn on the check engine light to alert owners to problems.

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<sup>4</sup> The evaporative emissions have not been adjusted for mileage but the effect of an adjustment would be small. Gas cap failures are more evenly distributed by age than tailpipe failures and only part of the evaporative emissions are running losses dependent on miles traveled.

**Table V-4 Estimated Annual Tons Of Reduction (IM240 and Idle Tested Vehicles**

<b>Audit Vehicle Reductions (tons/yr)</b>				
<b>Audit Tests</b>	<b>Unique Vehicles</b>	<b>HC</b>	<b>CO</b>	<b>NOx</b>
Enhanced IM240	4,108	0.40	9.04	0.75
<b>Potential from RS Vehicles (tons/yr)</b>				
<b>RapidScreen</b>	<b>Unique Vehicles</b>	<b>HC</b>	<b>CO</b>	<b>NOx</b>
Enhanced Area	206,790	19.9	454.9	37.8
Gas Cap estimate from Mobile6		29.9		
<b>Station Reductions (tons/yr)</b>				
<b>Station I/M Vehicles</b>	<b>Unique Vehicles</b>	<b>HC</b>	<b>CO</b>	<b>NOx</b>
Enhanced IM240	673,407	482.8	5,829.1	462.2
Enhanced Idle*	62,219	103.4	1,045.5	
Gas Cap estimate from Mobile6		137.0		
	735,626	723.1	6,874.6	462.2
<b>Total Potential Reductions</b>		<b>773.0</b>	<b>7,329.5</b>	<b>500.0</b>
<i>RapidScreen Exhaust Impact</i>		2.6%	6.2%	7.6%
<i>Rapidscreen Gas Cap Impact</i>		3.9%		
<b>Retained Reductions</b>		<b>93.5%</b>	<b>93.8%</b>	<b>92.4%</b>

\* NOx is not reported for idle tests.

Table V-4 also shows that, during for the calendar year 2010, 206,790 unique vehicles were exempted through Clean Screen, and 735,626 vehicles received a station test. Therefore, 22% of the 942,416 unique vehicles were Clean Screened.

If the fraction of Clean Screen vehicles had been 30% of vehicles subject to inspection there would have been 282,725 Clean Screens and 659,691 Station tests. Assuming this increase was achieved by increasing on-road fleet coverage rather than by relaxing the Clean Screen standards, the projected emissions retained would have been 91.2%, 90.9% and 88.8% respectively of potential HC, CO and NOx tailpipe emission reductions.

#### **D. Projection with RSD NOx Standard**

As noted earlier, the Clean Screening RSD NO standard of 1000 ppm was implemented late in 2010. This section projects 2010 results had the NO standard been in force throughout the year. The calculation steps were:

- 1) Determine the clean screen vehicles meeting the criteria with the NO standard.
- 2) Determine the 2% audit vehicles meeting the criteria with the NO standard.
- 3) Project revised potential reductions from clean screen vehicles that met the NO standard;
- 4) Add back the 2010 clean screen vehicles not meeting the NO standard and their associated emissions and reductions to the station tests;
- 5) Pro-rate the evaporative emissions impact for the smaller number of vehicles clean screened.

Table V-5 shows the revised results in the same format as Table V-4. Vehicles clean screened were reduced by 7% while the potential exhaust reductions from clean screen vehicles were reduced by 46% for HC, 25% for CO and 59% for NOx. The implementation of the RSD NO standard is therefore very effective with positive results for HC and CO as well as NOx.

Vehicles passing the HC and CO clean screen criteria and failing the NO standard tended to be older – 83% were 2001 and older models. It is therefore understandable there would be improvements in the HC and CO results when these older vehicles with higher NO emissions are removed from the clean screen candidates.

With the NO standard in place throughout 2010, , the Clean Screen program would have retained 95.0%, 95.4% and 96.9% respectively of potential HC, CO and NOx emission reductions in vehicles subject to testing.

If the fraction of Clean Screen vehicles had been 30% of vehicles subject to inspection, and, as before, assuming this increase was achieved by increasing on-road fleet coverage, the projected emissions retained would have been 92.7%, 92.6% and 94.9% respectively of potential HC, CO and NOx tailpipe emission reductions.

*Table V-5 Estimated Annual Tons Of Reduction with 1000 ppm RSD NO Standard*

<b>Audit Vehicle Reductions (tons/yr)</b>				
<b>Audit Tests</b>	<b>Unique Vehicles</b>	<b>HC</b>	<b>CO</b>	<b>NO<sub>x</sub></b>
Enhanced IM240	3,820	0.21	6.73	0.31
<b>Potential from RS Vehicles (tons/yr)</b>				
<b>RapidScreen</b>	<b>Unique Vehicles</b>	<b>HC</b>	<b>CO</b>	<b>NO<sub>x</sub></b>
Enhanced Area	192,919	10.8	339.7	15.5
Gas Cap estimate from Mobile6		27.9		
<b>Station Reductions (tons/yr)</b>				
<b>Station I/M Vehicles</b>	<b>Unique Vehicles</b>	<b>HC</b>	<b>CO</b>	<b>NO<sub>x</sub></b>
Enhanced IM240	687,278	491.9	5,944.4	484.5
Enhanced Idle*	62,219	103.4	1,045.5	
Gas Cap estimate from Mobile6		139.0		
	749,497	734.3	6,989.9	484.5
<b>Total Potential Reductions</b>		<b>773.0</b>	<b>7,329.5</b>	<b>500.0</b>
<i>RapidScreen Exhaust Impact</i>		<i>1.4%</i>	<i>4.6%</i>	<i>3.1%</i>
<i>Rapidscreen Gas Cap Impact</i>		<i>3.6%</i>		
<b>Retained Reductions</b>		<b>95.0%</b>	<b>95.4%</b>	<b>96.9%</b>

## **VI. Proposed Review of Clean Screen Standards and Procedures**

The 2008 report<sup>1</sup> contained an extensive ‘what if’ analysis to determine how clean screen standards could be adjusted to match the May 5, 2008 changes in I/M standards. Since then the LEI standards were updated and the RSD NO standard of 1000 ppm was implemented.

As noted earlier in the report, the 1000ppm RSD NOx cutpoint is projected to result in fewer lost emissions reductions in 2011 with some reduction in the number of qualifying clean screen vehicles.

Clean screens using the RSD-LEI method have fallen from 45% of the total in 2008 to 29% in 2009 and 24% in 2010. This reduction is a combination the effective tightening of the LEI to match the new standards and an increase in the fraction of vehicles with two RSD measurements.

In addition, new factors will potentially be coming into play in 2011:

- EPA is scheduled to announce new ozone standards by August 2011 that may affect the Denver Metropolitan Area and Northern Front Range;
- EPA has introduced the MOVES model that will be the basis for future SIP modeling;
- CDPHE will be performing a further study of OBD-II system effectiveness.

Consequently, it would be beneficial to perform further review and modeling of methods and procedures to ensure the clean screen program continues to provide convenience to as many vehicle owners as possible consistent with maintaining air quality goals. The second half of 2011 would be an appropriate time to start this review.

## **VII. IM240 Projected Emissions by Model Year**

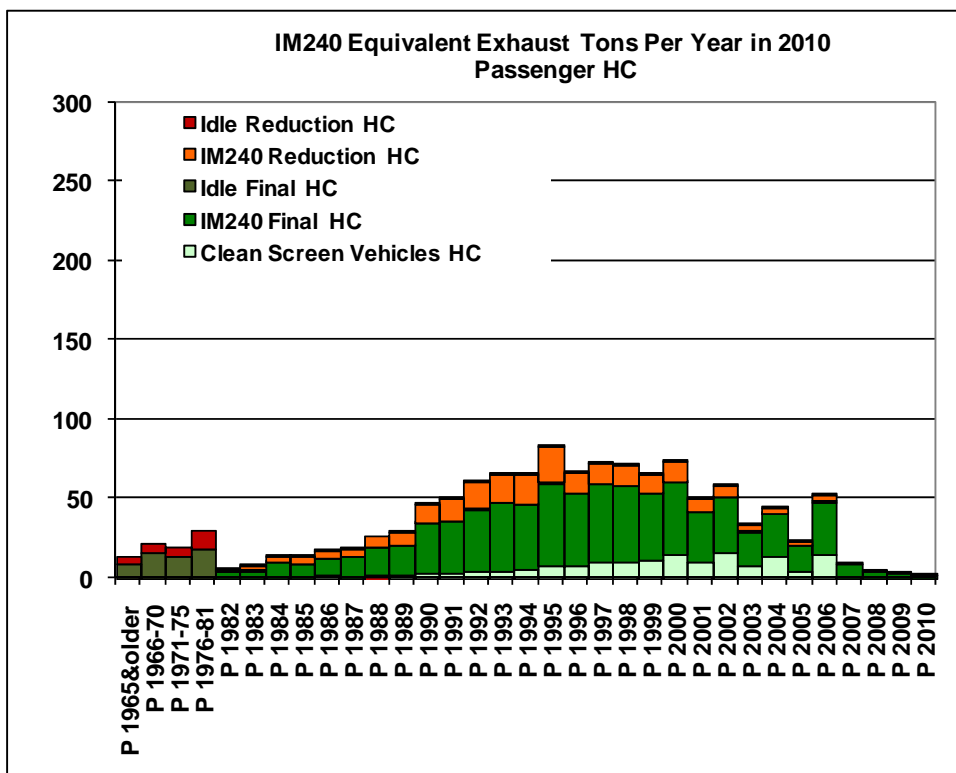
Figures VII-1 through VII-6 show the annual emissions inventories and reductions by model year and vehicle type for the vehicles tested in 2010 at stations, based on the IM240 driving cycle. The projected exhaust emissions inventory for the Clean Screen vehicles and Idle tested vehicles are also shown. The biennial testing cycle of the Enhanced area causes the difference between the sizes of the bars for odd model year vehicles vs. even model year vehicles.

Not included in these charts:

- most 2007 and newer models that had not yet entered the testing program;
- any estimate of pre-inspection emission reductions;
- NOx emissions for 62,200 vehicles tested with the idle test: 1981 and older models 13,700 (27%), 1982 and newer trucks 49,900 (67%), and 1982 & newer passenger vehicles 3,600 (5%).

The Figures VII-1 to 6 illustrate that older vehicles, which are fewer in number and driven fewer miles each year, still contribute many tons of excess emissions in the I/M area – especially old trucks.

**Figure VII-1 LDGV HC Reductions and Remaining Emissions**



**Figure VII-2 LDGT HC Reductions and Remaining Emissions**

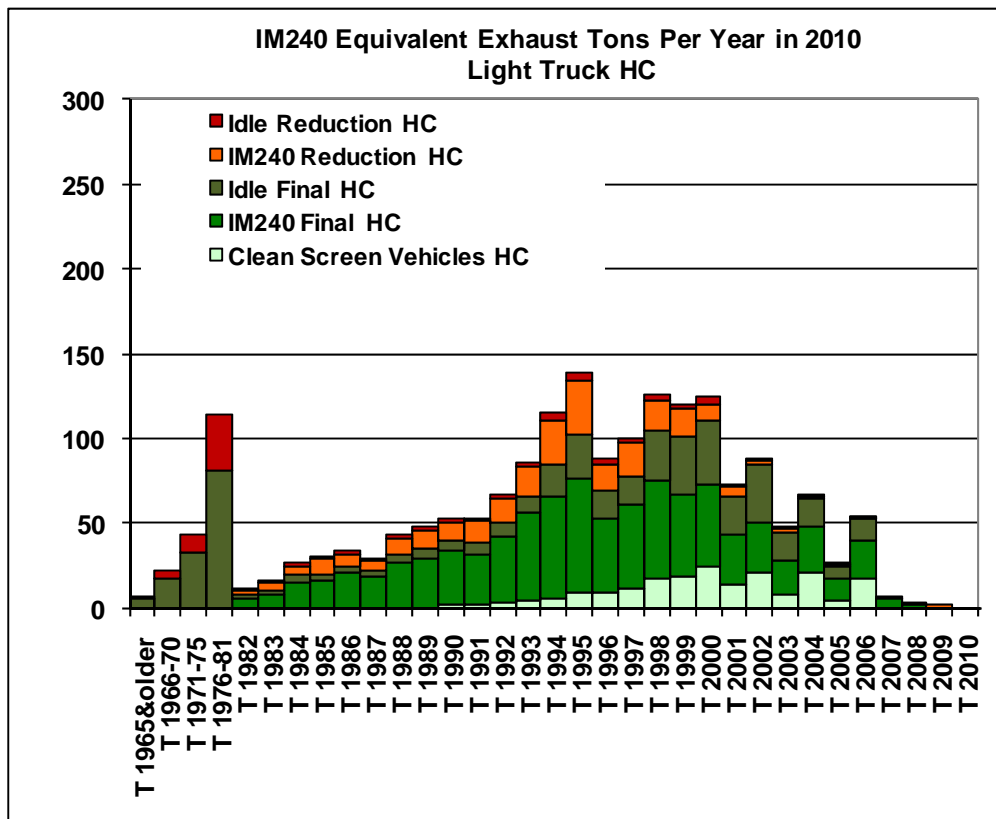




Figure VII-3 LDGV CO Reductions and Remaining Emissions

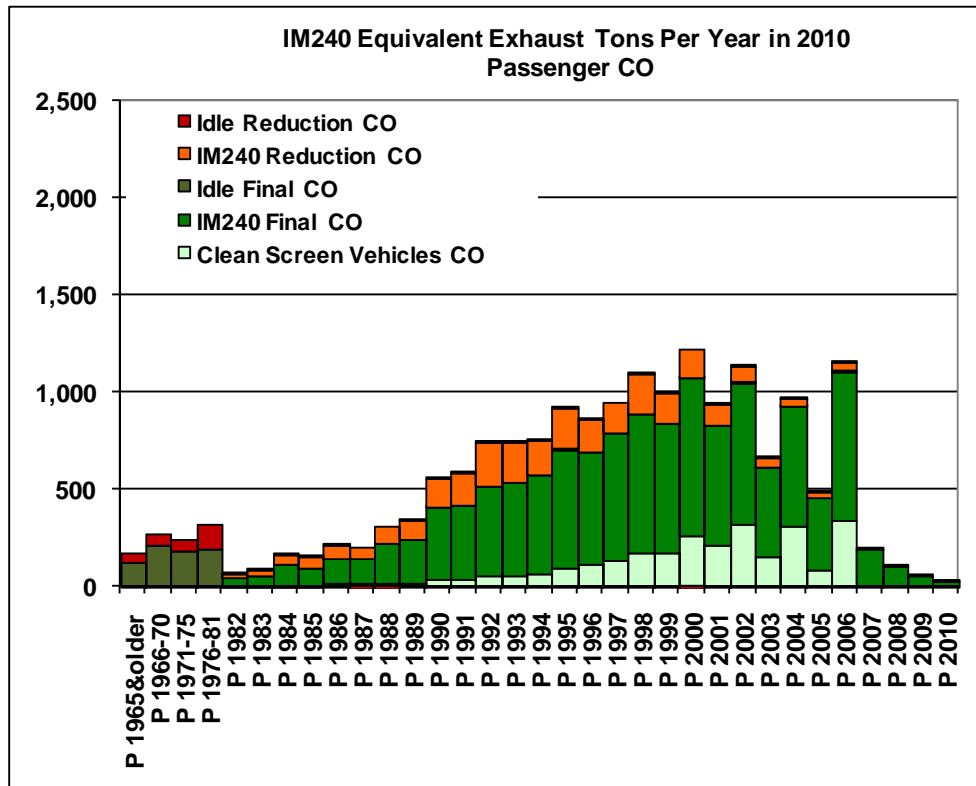


Figure VII-4 LDGT CO Reductions and Remaining Emissions

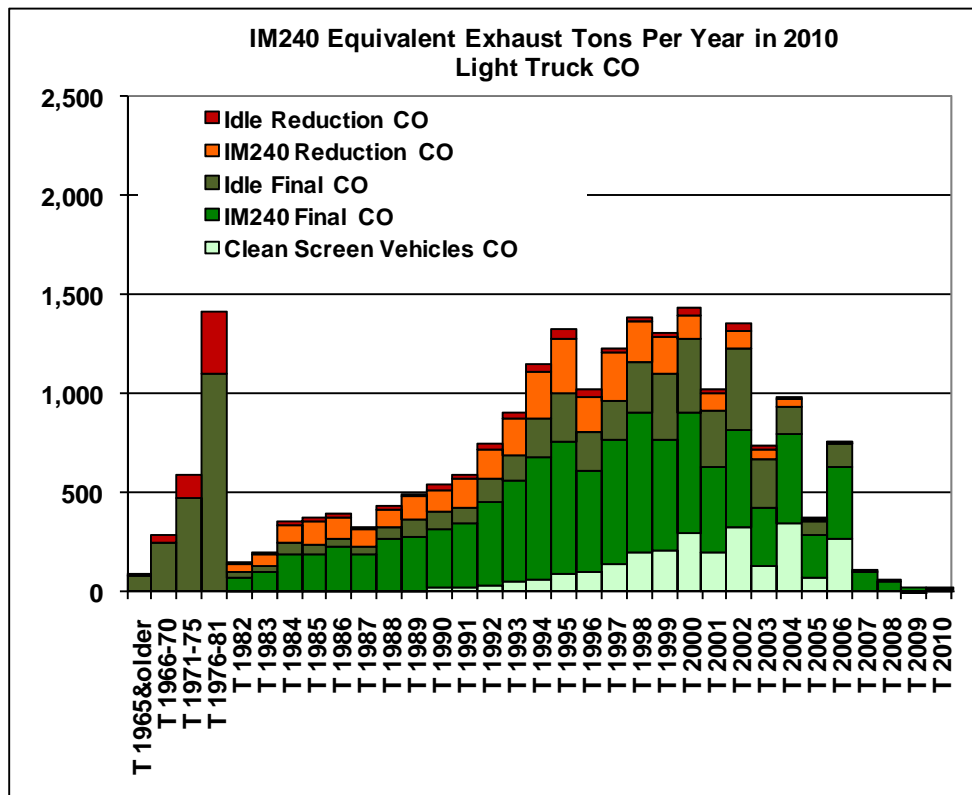


Figure VII-5 LDGV NOx Reductions and Remaining Emissions

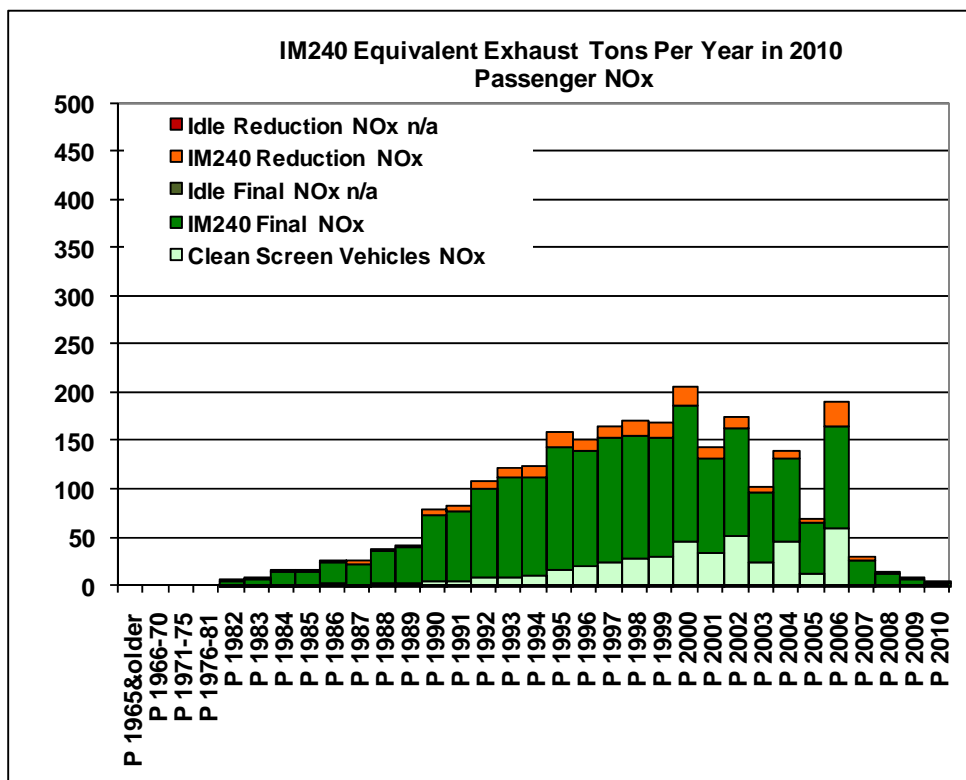
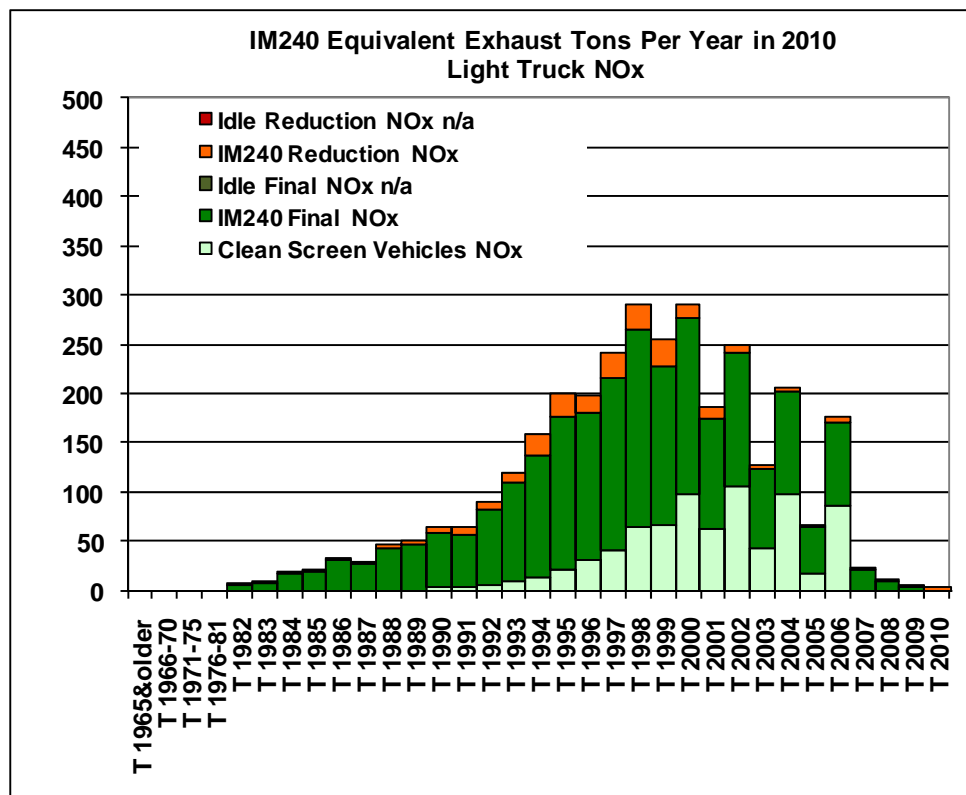


Figure VII-6 LDGT NOx Reductions and Remaining Emissions



## References

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<sup>1</sup> “The Colorado Remote Sensing Program January – December 2009”, ESP report for the Colorado Department of Public Health and Environment, July 2010

<sup>2</sup> Colorado Air Quality Control Commission, “Regulation Number 11, Motor Vehicle Emissions Inspection Program”, <http://www.cdphe.state.co.us/regulations/airregs/5CCR1001-13.pdf>

<sup>3</sup> Colorado Department Of Public Health and Environment, Air Pollution Control Division, Mobile Sources Section, “Colorado On-road Vehicle Emissions Remote Sensing System (COVERS) Specifications” Amended July 2010

<sup>4</sup> Klausmeier R., “Technical Note: Estimating Full IM240 Emissions Based on Fast Pass Emission Results”, November 2005

<sup>5</sup> Wenzel, T. “Evaluation of Arizona’s Enhanced I/M Program”, Presented at the 9th CRC On-Road Vehicle Emissions Workshop. April 1999.

<sup>6</sup> McClintock, P. “The Denver Remote Sensing Clean Screening Pilot”, ESP report for the Colorado Department of Health and Environment, December 1999.

<sup>7</sup> “Colorado Mileage Accumulation Rates from VID Odometer Readings Draft Report” for CDPHE by Eastern Research Group, Inc. June 30, 2008

## Appendix A-1 Colorado 2010 Transient Test Emissions Reductions

Unresolved fails remaining in area					33%								
Model	First	Last	Vehicles	Fail%	Initial			Final			Reduction %		
Year/Type	Result	Result			HC	CO	NOX	HC	CO	NOX	HC	CO	NOX
1982	Pass	-	368		1.54	18.68	2.14	1.54	18.68	2.14	0.0%	0.0%	0.0%
P	Fail	Pass	69	14.7%	2.98	41.26	2.54	1.54	15.93	2.35	48.5%	61.4%	7.1%
	Fail	Unresolv.	32	6.8%	7.12	91.53	1.99	2.84	29.13	0.66	60.2%	68.2%	66.9%
	Fail	Waiver	0	0.0%	0.00	0.00	0.00	0.00	0.00	0.00			
Total	Fail%		469	21.5%	2.13	26.97	2.19	1.63	18.98	2.07	23.7%	29.6%	5.4%
1983	Pass	-	393		1.33	16.46	1.94	1.33	16.46	1.94	0.0%	0.0%	0.0%
P	Fail	Pass	94	16.6%	3.58	41.00	2.10	1.53	15.36	2.08	57.2%	62.5%	0.9%
	Fail	Unresolv.	76	13.4%	5.36	73.94	1.70	1.69	24.35	0.58	68.4%	67.1%	66.2%
	Fail	Waiver	4	0.7%	3.41	74.31	1.73	2.00	44.95	1.59	41.3%	39.5%	8.1%
Total	Fail%		567	30.7%	2.26	28.64	1.93	1.42	17.54	1.78	37.2%	38.8%	8.0%
1984	Pass	-	1,060		1.24	14.47	1.89	1.24	14.47	1.89	0.0%	0.0%	0.0%
P	Fail	Pass	228	16.4%	2.99	36.12	2.23	1.30	12.98	1.95	56.5%	64.1%	12.7%
	Fail	Unresolv.	102	7.3%	4.89	78.11	1.96	1.90	28.35	0.60	61.3%	63.7%	69.3%
	Fail	Waiver	1	0.1%	3.41	16.55	3.80	3.49	11.85	3.31	-2.4%	28.4%	12.8%
Total	Fail%		1,391	23.8%	1.80	22.69	1.95	1.30	15.24	1.81	27.6%	32.8%	7.5%
1985	Pass	-	1,085		1.00	11.13	1.91	1.00	11.13	1.91	0.0%	0.0%	0.0%
P	Fail	Pass	251	16.9%	2.76	34.24	2.20	1.06	9.04	1.97	61.5%	73.6%	10.7%
	Fail	Unresolv.	146	9.8%	4.57	56.45	2.38	1.36	18.48	0.78	70.2%	67.3%	67.4%
	Fail	Waiver	5	0.3%	2.39	45.97	1.78	1.73	36.48	1.83	27.8%	20.6%	-2.6%
Total	Fail%		1,487	27.0%	1.65	19.60	2.00	1.05	11.59	1.81	36.6%	40.9%	9.8%
1986	Pass	-	1,973		0.89	9.87	1.81	0.89	9.87	1.81	0.0%	0.0%	0.0%
P	Fail	Pass	334	13.6%	2.35	34.01	2.09	1.00	9.16	2.00	57.6%	73.1%	4.2%
	Fail	Unresolv.	141	5.8%	4.18	52.78	2.20	1.46	18.26	0.67	65.2%	65.4%	69.5%
	Fail	Waiver	1	0.0%	2.46	78.53	2.32	3.21	123.78	0.67	-30.5%	-57.6%	71.0%
Total	Fail%		2,449	19.4%	1.28	15.66	1.87	0.94	10.30	1.77	26.7%	34.2%	5.4%
1987	Pass	-	2,019		0.85	9.22	1.67	0.85	9.22	1.67	0.0%	0.0%	0.0%
P	Fail	Pass	325	12.9%	2.48	28.43	2.14	0.96	8.31	1.67	61.3%	70.8%	21.7%
	Fail	Unresolv.	162	6.5%	3.86	50.38	2.42	1.28	17.05	0.78	66.9%	66.2%	68.0%
	Fail	Waiver	5	0.2%	3.08	73.38	1.37	3.31	82.37	1.28	-7.4%	-12.2%	6.3%
Total	Fail%		2,511	19.6%	1.26	14.49	1.78	0.89	9.76	1.62	28.9%	32.7%	9.4%
1988	Pass	-	3,272		0.73	8.77	1.55	0.73	8.77	1.55	0.0%	0.0%	0.0%
P	Fail	Pass	443	11.3%	2.43	28.37	1.92	0.87	7.95	1.66	64.0%	72.0%	13.6%
	Fail	Unresolv.	190	4.9%	4.59	48.70	2.21	1.49	15.87	0.72	67.6%	67.4%	67.6%
	Fail	Waiver	4	0.1%	4.16	60.49	2.66	3.33	23.79	3.28	20.0%	60.7%	-23.5%
Total	Fail%		3,909	16.3%	1.12	12.98	1.62	0.79	9.04	1.52	29.4%	30.4%	6.3%
1989	Pass	-	3,506		0.68	8.32	1.47	0.68	8.32	1.47	0.0%	0.0%	0.0%
P	Fail	Pass	494	11.7%	2.29	25.26	2.03	0.88	8.30	1.73	61.6%	67.1%	14.6%
	Fail	Unresolv.	208	4.9%	4.61	50.11	1.93	1.51	16.18	0.66	67.2%	67.7%	65.8%
	Fail	Waiver	6	0.1%	3.31	55.11	1.83	3.34	51.78	2.08	-0.9%	6.0%	-13.5%
Total	Fail%		4,214	16.8%	1.07	12.44	1.56	0.75	8.77	1.46	29.9%	29.5%	6.2%

## Appendix A-1 Colorado 2010 Transient Test Emissions Reductions

Unresolved fails remaining in area					33%								
Model	First	Last	Vehicles	Fail%	Initial			Final			Reduction %		
Year/Type	Result	Result			HC	CO	NOX	HC	CO	NOX	HC	CO	NOX
1990	Pass	-	6,608		0.63	7.60	1.40	0.63	7.60	1.40	0.0%	0.0%	0.0%
P	Fail	Pass	767	10.0%	2.05	26.76	2.16	0.77	7.39	1.70	62.4%	72.4%	21.6%
	Fail	Unresolv.	292	3.8%	3.92	41.63	2.55	1.31	14.03	0.84	66.5%	66.3%	67.1%
	Fail	Waiver	6	0.1%	2.29	20.53	5.32	1.48	15.06	5.12	35.1%	26.7%	3.7%
Total	Fail%		7,673	13.9%	0.90	10.82	1.53	0.67	7.83	1.42	25.4%	27.6%	7.3%
1991	Pass	-	6,863		0.55	6.74	1.31	0.55	6.74	1.31	0.0%	0.0%	0.0%
P	Fail	Pass	938	11.5%	2.05	24.06	2.11	0.72	7.12	1.57	65.1%	70.4%	25.7%
	Fail	Unresolv.	369	4.5%	3.60	37.03	2.41	1.16	11.97	0.80	67.8%	67.7%	66.9%
	Fail	Waiver	9	0.1%	3.87	43.59	2.34	5.01	38.50	2.40	-29.5%	11.7%	-2.6%
Total	Fail%		8,179	16.1%	0.86	10.13	1.45	0.60	7.05	1.31	30.4%	30.4%	9.3%
1992	Pass	-	9,015		0.48	6.01	1.24	0.48	6.01	1.24	0.0%	0.0%	0.0%
P	Fail	Pass	1,155	10.9%	1.85	24.54	1.94	0.64	6.19	1.48	65.2%	74.8%	23.3%
	Fail	Unresolv.	441	4.2%	3.51	34.32	2.40	1.19	11.59	0.79	66.1%	66.2%	66.9%
	Fail	Waiver	3	0.0%	5.72	88.75	2.68	5.44	83.64	1.83	4.9%	5.8%	31.9%
Total	Fail%		10,614	15.1%	0.76	9.22	1.36	0.53	6.28	1.25	30.0%	31.9%	8.5%
1993	Pass	-	9,607		0.47	5.57	1.23	0.47	5.57	1.23	0.0%	0.0%	0.0%
P	Fail	Pass	1,207	10.7%	1.79	21.44	2.05	0.64	6.15	1.54	64.5%	71.3%	24.8%
	Fail	Unresolv.	429	3.8%	3.62	32.52	2.59	1.11	10.34	0.86	69.2%	68.2%	66.7%
	Fail	Waiver	5	0.0%	7.31	84.00	1.99	3.86	96.05	1.34	47.2%	-14.3%	32.6%
Total	Fail%		11,248	14.6%	0.74	8.33	1.37	0.52	5.85	1.25	29.9%	29.8%	8.8%
1994	Pass	-	11,584		0.37	4.83	0.99	0.37	4.83	0.99	0.0%	0.0%	0.0%
P	Fail	Pass	1,146	8.7%	1.75	17.91	1.86	0.50	5.19	1.31	71.4%	71.0%	29.8%
	Fail	Unresolv.	437	3.3%	3.10	28.49	2.41	1.04	9.25	0.79	66.4%	67.5%	67.3%
	Fail	Waiver	12	0.1%	3.38	33.99	2.48	2.99	21.51	2.41	11.7%	36.7%	3.0%
Total	Fail%		13,179	12.1%	0.59	6.78	1.11	0.41	5.03	1.01	30.3%	25.9%	9.2%
1995	Pass	-	14,848		0.35	4.23	0.90	0.35	4.23	0.90	0.0%	0.0%	0.0%
P	Fail	Pass	1,532	9.0%	1.50	14.91	1.77	0.46	4.58	1.19	69.5%	69.3%	33.0%
	Fail	Unresolv.	553	3.3%	3.00	26.48	2.46	0.98	8.95	0.81	67.4%	66.2%	66.9%
	Fail	Waiver	17	0.1%	6.73	42.15	2.42	2.11	25.59	2.05	68.7%	39.3%	15.3%
Total	Fail%		16,950	12.4%	0.54	5.96	1.03	0.38	4.44	0.92	30.4%	25.5%	10.4%
1996	Pass	-	16,891		0.27	3.51	0.73	0.27	3.51	0.73	0.0%	0.0%	0.0%
P	Fail	Pass	1,405	7.5%	1.02	13.68	1.48	0.38	4.05	0.96	62.8%	70.4%	35.1%
	Fail	Unresolv.	372	2.0%	2.00	22.47	2.41	0.64	7.29	0.82	67.9%	67.6%	66.1%
	Fail	Waiver	6	0.0%	4.21	8.13	2.61	2.53	9.74	2.77	39.9%	-19.8%	-6.0%
Total	Fail%		18,674	9.5%	0.36	4.65	0.82	0.29	3.63	0.75	20.9%	22.1%	8.6%
1997	Pass	-	18,239		0.26	3.48	0.70	0.26	3.48	0.70	0.0%	0.0%	0.0%
P	Fail	Pass	1,529	7.6%	0.91	12.37	1.43	0.33	3.96	0.88	64.2%	68.0%	38.1%
	Fail	Unresolv.	342	1.7%	2.20	23.08	2.36	0.72	7.59	0.79	67.3%	67.1%	66.5%
	Fail	Waiver	7	0.0%	0.94	8.14	3.80	1.07	7.86	3.28	-14.7%	3.5%	13.6%
Total	Fail%		20,117	9.3%	0.35	4.49	0.78	0.28	3.59	0.71	20.1%	20.1%	8.7%

## Appendix A-1 Colorado 2010 Transient Test Emissions Reductions

Unresolved fails remaining in area					33%								
Model	First	Last	Vehicles	Fail%	Initial			Final			Reduction %		
Year/Type	Result	Result			HC	CO	NOX	HC	CO	NOX	HC	CO	NOX
1998	Pass	-	21,617		0.21	3.13	0.56	0.21	3.13	0.56	0.0%	0.0%	0.0%
P	Fail	Pass	1,595	6.8%	0.79	13.62	1.34	0.25	3.42	0.69	68.4%	74.9%	49.1%
	Fail	Unresolv.	378	1.6%	1.65	19.92	2.23	0.54	6.84	0.75	67.3%	65.7%	66.6%
	Fail	Waiver	7	0.0%	0.66	7.04	2.91	0.94	11.26	2.69	-42.7%	-60.1%	7.8%
Total	Fail%		23,597	8.4%	0.27	4.11	0.64	0.21	3.21	0.57	20.2%	21.9%	10.7%
1999	Pass	-	20,343		0.19	2.89	0.53	0.19	2.89	0.53	0.0%	0.0%	0.0%
P	Fail	Pass	1,743	7.8%	0.70	10.10	1.27	0.22	3.03	0.65	68.2%	70.0%	48.5%
	Fail	Unresolv.	314	1.4%	1.37	17.55	2.28	0.42	5.66	0.77	69.0%	67.8%	66.3%
	Fail	Waiver	10	0.0%	1.18	19.98	2.69	1.17	18.98	3.08	1.1%	5.0%	-14.4%
Total	Fail%		22,410	9.2%	0.24	3.66	0.62	0.19	2.95	0.55	20.7%	19.6%	11.2%
2000	Pass	-	27,504		0.14	2.60	0.45	0.14	2.60	0.45	0.0%	0.0%	0.0%
P	Fail	Pass	1,837	6.2%	0.61	8.54	1.34	0.18	2.69	0.53	70.7%	68.5%	60.8%
	Fail	Unresolv.	306	1.0%	1.59	15.13	2.48	0.44	4.40	0.84	72.2%	70.9%	66.2%
	Fail	Waiver	7	0.0%	0.41	10.86	3.29	0.29	2.28	3.05	30.7%	79.0%	7.3%
Total	Fail%		29,654	7.3%	0.19	3.10	0.52	0.15	2.63	0.45	20.5%	15.3%	12.9%
2001	Pass	-	22,173		0.12	2.41	0.38	0.12	2.41	0.38	0.0%	0.0%	0.0%
P	Fail	Pass	1,158	4.9%	0.59	9.30	1.19	0.14	2.21	0.41	76.5%	76.2%	65.5%
	Fail	Unresolv.	141	0.6%	1.51	17.38	2.66	0.50	4.82	0.90	66.5%	72.3%	66.0%
	Fail	Waiver	4	0.0%	0.82	5.91	3.76	0.22	3.02	2.72	72.5%	48.8%	27.8%
Total	Fail%		23,476	5.6%	0.15	2.84	0.43	0.12	2.41	0.38	18.8%	15.0%	11.4%
2002	Pass	-	27,751		0.11	2.19	0.33	0.11	2.19	0.33	0.0%	0.0%	0.0%
P	Fail	Pass	1,131	3.9%	0.47	7.51	1.01	0.10	2.06	0.32	78.4%	72.6%	68.7%
	Fail	Unresolv.	122	0.4%	1.65	13.85	2.78	0.39	4.16	0.92	76.3%	70.0%	66.8%
	Fail	Waiver	6	0.0%	1.56	16.48	2.80	1.37	15.64	2.30	12.1%	5.1%	17.8%
Total	Fail%		29,010	4.3%	0.13	2.45	0.37	0.11	2.20	0.34	15.3%	10.3%	9.4%
2003	Pass	-	18,463		0.10	2.03	0.32	0.10	2.03	0.32	0.0%	0.0%	0.0%
P	Fail	Pass	706	3.7%	0.36	6.04	0.80	0.08	1.33	0.25	78.4%	78.0%	68.9%
	Fail	Unresolv.	72	0.4%	1.80	19.52	2.29	0.51	6.04	0.74	71.9%	69.1%	67.6%
	Fail	Waiver	1	0.0%	1.61	10.83	4.13	1.89	8.63	4.73	-17.1%	20.3%	-14.6%
Total	Fail%		19,242	4.0%	0.11	2.25	0.34	0.10	2.02	0.32	13.7%	9.9%	7.6%
2004	Pass	-	24,812		0.09	1.97	0.28	0.09	1.97	0.28	0.0%	0.0%	0.0%
P	Fail	Pass	1,015	3.9%	0.32	4.26	0.64	0.07	1.36	0.16	78.3%	68.1%	75.0%
	Fail	Unresolv.	42	0.2%	1.29	15.27	2.59	0.46	5.18	0.86	64.1%	66.1%	66.6%
	Fail	Waiver	1	0.0%	0.19	2.55	3.54	0.19	2.55	3.54	0.0%	0.0%	0.0%
Total	Fail%		25,870	4.1%	0.10	2.08	0.29	0.09	1.95	0.27	11.5%	6.2%	7.4%
2005	Pass	-	14,480		0.08	1.92	0.27	0.08	1.92	0.27	0.0%	0.0%	0.0%
P	Fail	Pass	617	4.1%	0.28	4.11	0.72	0.05	1.07	0.16	80.1%	74.1%	78.3%
	Fail	Unresolv.	19	0.1%	1.44	13.58	2.92	0.47	4.13	1.03	67.0%	69.6%	64.8%
	Fail	Waiver	0	0.0%	0.00	0.00	0.00	0.00	0.00	0.00			
Total	Fail%		15,116	4.2%	0.09	2.02	0.29	0.08	1.89	0.27	10.9%	6.7%	8.7%

## Appendix A-1 Colorado 2010 Transient Test Emissions Reductions

Unresolved fails remaining in area					33%								
Model	First	Last	Vehicles	Fail%	Initial			Final			Reduction %		
Year/Type	Result	Result			HC	CO	NOX	HC	CO	NOX	HC	CO	NOX
2006	Pass	-	31,282		0.08	1.81	0.25	0.08	1.81	0.25	0.0%	0.0%	0.0%
P	Fail	Pass	1,102	3.4%	0.23	3.36	1.85	0.05	0.93	0.12	79.0%	72.2%	93.6%
	Fail	Unresolv.	42	0.1%	1.78	16.72	3.12	0.53	4.22	1.09	70.2%	74.7%	64.9%
	Fail	Waiver	0	0.0%	0.00	0.00	0.00	0.00	0.00	0.00			
Total	Fail%		32,426	3.5%	0.09	1.88	0.31	0.08	1.78	0.25	9.1%	5.2%	19.9%
2007	Pass	-	7,725		0.08	1.78	0.24	0.08	1.78	0.24	0.0%	0.0%	0.0%
P	Fail	Pass	202	2.5%	0.12	2.36	1.17	0.03	0.77	0.06	73.3%	67.2%	94.5%
	Fail	Unresolv.	18	0.2%	0.71	15.98	2.17	0.19	4.94	0.73	72.6%	69.1%	66.4%
	Fail	Waiver	0	0.0%	0.00	0.00	0.00	0.00	0.00	0.00			
Total	Fail%		7,945	2.8%	0.08	1.83	0.27	0.08	1.76	0.24	4.2%	3.6%	11.7%
2008	Pass	-	3,724		0.08	1.83	0.23	0.08	1.83	0.23	0.0%	0.0%	0.0%
P	Fail	Pass	143	3.7%	0.14	2.76	0.82	0.03	0.77	0.05	81.9%	72.0%	94.0%
	Fail	Unresolv.	10	0.3%	0.28	3.82	2.42	0.09	1.28	0.80	68.3%	66.5%	67.1%
	Fail	Waiver	0	0.0%	0.00	0.00	0.00	0.00	0.00	0.00			
Total	Fail%		3,877	3.9%	0.08	1.87	0.26	0.08	1.79	0.22	6.0%	4.3%	12.7%
2009	Pass	-	2,067		0.07	1.81	0.23	0.07	1.81	0.23	0.0%	0.0%	0.0%
P	Fail	Pass	46	2.2%	0.28	2.07	1.19	0.03	0.53	0.04	90.7%	74.2%	97.0%
	Fail	Unresolv.	5	0.2%	0.32	2.98	2.94	0.10	0.98	1.22	67.5%	67.0%	58.3%
	Fail	Waiver	0	0.0%	0.00	0.00	0.00	0.00	0.00	0.00			
Total	Fail%		2,118	2.4%	0.08	1.82	0.25	0.07	1.78	0.22	7.6%	2.1%	11.6%
2010	Pass	-	660		0.08	1.75	0.22	0.08	1.75	0.22	0.0%	0.0%	0.0%
P	Fail	Pass	2	0.3%	0.07	1.99	0.21	0.02	0.57	0.00	75.6%	71.2%	98.3%
	Fail	Unresolv.	0	0.0%	0.00	0.00	0.00	0.00	0.00	0.00			
	Fail	Waiver	0	0.0%	0.00	0.00	0.00	0.00	0.00	0.00			
Total	Fail%		662	0.3%	0.08	1.75	0.22	0.08	1.75	0.22	0.2%	0.2%	0.3%
2011	Pass	-	20		0.07	1.68	0.21	0.07	1.68	0.21	0.0%	0.0%	0.0%
P	Fail	Pass	0	0.0%	0.00	0.00	0.00	0.00	0.00	0.00			
	Fail	Unresolv.	0	0.0%	0.00	0.00	0.00	0.00	0.00	0.00			
	Fail	Waiver	0	0.0%	0.00	0.00	0.00	0.00	0.00	0.00			
Total	Fail%		20	0.0%	0.07	1.68	0.21	0.07	1.68	0.21	0.0%	0.0%	0.0%
<b>Total Passenger Vehicles</b>													
All	Pass	-	329,952		0.22	3.31	0.59	0.22	3.31	0.59	0.0%	0.0%	0.0%
P	Fail	Pass	23,214	6.5%	1.14	14.56	1.53	0.39	4.21	0.91	66.2%	71.1%	40.8%
	Fail	Unresolv.	5,761	1.6%	2.98	31.84	2.39	0.97	10.48	0.79	67.4%	67.1%	66.8%
	Fail	Waiver	127	0.0%	3.20	35.08	2.71	2.27	29.07	2.54	28.9%	17.1%	6.2%
Total	Fail%		359,054	8.1%	0.33	4.50	0.68	0.25	3.49	0.61	24.8%	22.5%	9.7%

## Appendix A-1 Colorado 2010 Transient Test Emissions Reductions

Unresolved fails remaining in area					33%								
Model	First	Last	Vehicles	Fail%	Initial			Final			Reduction %		
Year/Type	Result	Result			HC	CO	NOX	HC	CO	NOX	HC	CO	NOX
1982	Pass	-	315		2.74	29.47	2.64	2.74	29.47	2.64	0.0%	0.0%	0.0%
T	Fail	Pass	97	21.2%	4.61	62.97	2.88	2.69	29.44	2.79	41.6%	53.3%	3.2%
	Fail	Unresolv.	46	10.0%	8.63	109.85	2.75	2.47	36.40	0.77	71.4%	66.9%	72.2%
	Fail	Waiver	0	0.0%									
Total	Fail%		458	31.2%	3.73	44.64	2.70	2.70	30.16	2.48	27.5%	32.4%	8.1%
1983	Pass	-	352		2.74	30.85	2.71	2.74	30.85	2.71	0.0%	0.0%	0.0%
T	Fail	Pass	167	28.0%	5.16	63.37	3.14	2.55	30.93	2.84	50.6%	51.2%	9.7%
	Fail	Unresolv.	76	12.8%	7.29	108.32	2.38	2.30	35.87	0.75	68.5%	66.9%	68.6%
	Fail	Waiver	1	0.2%	2.26	108.67	1.75	1.48	104.69	0.10	34.5%	3.7%	94.3%
Total	Fail%		596	40.9%	3.99	49.97	2.79	2.63	31.63	2.49	34.3%	36.7%	10.7%
1984	Pass	-	889		2.26	26.76	2.75	2.26	26.76	2.75	0.0%	0.0%	0.0%
T	Fail	Pass	310	23.2%	3.83	57.78	2.92	2.17	26.62	2.81	43.3%	53.9%	3.7%
	Fail	Unresolv.	134	10.0%	5.95	93.25	2.63	1.90	29.21	0.87	68.0%	68.7%	67.0%
	Fail	Waiver	3	0.2%	4.84	107.84	0.79	7.57	76.77	0.99	-56.3%	28.8%	-25.9%
Total	Fail%		1,336	33.5%	3.00	40.81	2.77	2.22	27.08	2.57	26.1%	33.6%	7.3%
1985	Pass	-	970		2.00	22.50	2.66	2.00	22.50	2.66	0.0%	0.0%	0.0%
T	Fail	Pass	358	23.4%	3.85	49.90	3.19	1.88	20.14	2.98	51.1%	59.6%	6.6%
	Fail	Unresolv.	197	12.9%	6.76	93.70	2.72	1.98	29.03	0.92	70.7%	69.0%	66.1%
	Fail	Waiver	2	0.1%	4.51	95.96	0.81	3.91	83.05	0.67	13.3%	13.5%	17.7%
Total	Fail%		1,527	36.5%	3.05	38.21	2.79	1.97	22.87	2.51	35.4%	40.1%	10.1%
1986	Pass	-	1,686		1.67	16.91	2.58	1.67	16.91	2.58	0.0%	0.0%	0.0%
T	Fail	Pass	434	18.8%	3.33	43.92	2.99	1.82	18.65	2.80	45.3%	57.5%	6.4%
	Fail	Unresolv.	183	7.9%	6.10	75.99	2.73	1.97	25.08	0.88	67.8%	67.0%	67.7%
	Fail	Waiver	2	0.1%	2.07	31.73	5.05	2.07	31.73	5.05	0.0%	0.0%	0.0%
Total	Fail%		2,305	26.9%	2.33	26.70	2.67	1.72	17.90	2.49	26.2%	33.0%	6.9%
1987	Pass	-	1,706		1.45	13.92	2.26	1.45	13.92	2.26	0.0%	0.0%	0.0%
T	Fail	Pass	406	17.9%	3.05	35.74	2.75	1.52	13.88	2.48	50.0%	61.2%	10.0%
	Fail	Unresolv.	157	6.9%	5.41	73.46	2.33	1.77	24.25	0.74	67.3%	67.0%	68.4%
	Fail	Waiver	4	0.2%	5.26	71.78	4.77	6.06	75.92	4.65	-15.2%	-5.8%	2.6%
Total	Fail%		2,273	24.9%	2.02	22.03	2.36	1.50	14.73	2.20	25.9%	33.1%	6.8%
1988	Pass	-	2,812		1.24	12.36	2.02	1.24	12.36	2.02	0.0%	0.0%	0.0%
T	Fail	Pass	609	16.8%	2.97	29.75	3.07	1.31	11.62	2.46	56.0%	60.9%	20.0%
	Fail	Unresolv.	206	5.7%	5.16	45.64	3.25	1.71	15.71	1.06	66.9%	65.6%	67.4%
	Fail	Waiver	4	0.1%	2.08	37.30	3.21	2.94	69.12	3.54	-41.3%	-85.3%	-10.2%
Total	Fail%		3,631	22.6%	1.75	17.19	2.26	1.28	12.49	2.04	27.0%	27.4%	10.0%
1989	Pass	-	2,927		1.20	11.67	2.05	1.20	11.67	2.05	0.0%	0.0%	0.0%
T	Fail	Pass	642	16.9%	3.12	31.33	2.73	1.37	11.96	2.37	55.9%	61.8%	13.4%
	Fail	Unresolv.	214	5.6%	4.73	51.97	3.14	1.66	16.95	1.05	65.0%	67.4%	66.5%
	Fail	Waiver	5	0.1%	4.98	74.49	3.50	5.24	60.52	2.43	-5.2%	18.8%	30.5%
Total	Fail%		3,788	22.7%	1.73	17.36	2.23	1.26	12.08	2.05	27.1%	30.4%	8.1%



## Appendix A-1 Colorado 2010 Transient Test Emissions Reductions

Unresolved fails remaining in area					33%								
Model	First	Last	Vehicles	Fail%	Initial			Final			Reduction %		
Year/Type	Result	Result			HC	CO	NOX	HC	CO	NOX	HC	CO	NOX
1990	Pass	-	3,689		1.08	10.31	1.96	1.08	10.31	1.96	0.0%	0.0%	0.0%
T	Fail	Pass	749	16.2%	2.74	29.09	2.96	1.31	11.20	2.39	52.1%	61.5%	19.4%
	Fail	Unresolv.	172	3.7%	4.99	49.83	3.30	1.54	16.55	1.05	69.1%	66.8%	68.1%
	Fail	Waiver	3	0.1%	7.98	62.75	1.61	9.79	67.62	2.46	-22.8%	-7.7%	-52.3%
Total	Fail%		4,613	20.0%	1.50	14.87	2.18	1.14	10.73	2.00	24.0%	27.9%	8.1%
1991	Pass	-	4,071		0.87	9.27	1.61	0.87	9.27	1.61	0.0%	0.0%	0.0%
T	Fail	Pass	773	15.2%	2.65	30.08	2.65	1.04	10.33	2.05	60.6%	65.7%	22.6%
	Fail	Unresolv.	224	4.4%	5.05	50.04	3.30	1.54	17.03	1.03	69.4%	66.0%	68.7%
	Fail	Waiver	2	0.0%	4.91	53.90	2.92	5.55	47.44	2.45	-13.1%	12.0%	16.1%
Total	Fail%		5,070	19.7%	1.32	14.26	1.85	0.93	9.79	1.65	30.2%	31.4%	10.4%
1992	Pass	-	5,294		0.85	9.18	1.74	0.85	9.18	1.74	0.0%	0.0%	0.0%
T	Fail	Pass	888	13.8%	2.51	27.96	2.64	1.03	10.28	2.04	58.9%	63.2%	22.6%
	Fail	Unresolv.	231	3.6%	4.49	42.71	3.43	1.43	14.14	1.16	68.2%	66.9%	66.2%
	Fail	Waiver	9	0.1%	5.39	44.45	4.30	4.41	42.60	3.65	18.2%	4.2%	15.0%
Total	Fail%		6,422	17.6%	1.22	13.03	1.93	0.90	9.55	1.77	26.0%	26.7%	8.5%
1993	Pass	-	6,698		0.83	8.42	1.68	0.83	8.42	1.68	0.0%	0.0%	0.0%
T	Fail	Pass	1,102	13.6%	2.69	27.73	2.99	1.12	10.47	2.23	58.5%	62.2%	25.5%
	Fail	Unresolv.	285	3.5%	4.32	41.38	3.50	1.49	13.90	1.13	65.6%	66.4%	67.6%
	Fail	Waiver	5	0.1%	4.79	85.35	1.50	3.51	63.29	2.42	26.6%	25.8%	-61.1%
Total	Fail%		8,090	17.2%	1.21	12.26	1.92	0.89	8.93	1.74	26.1%	27.2%	9.7%
1994	Pass	-	9,077		0.64	6.88	1.40	0.64	6.88	1.40	0.0%	0.0%	0.0%
T	Fail	Pass	1,633	14.6%	2.26	21.32	2.85	0.87	8.34	1.90	61.7%	60.9%	33.4%
	Fail	Unresolv.	432	3.9%	3.81	33.23	3.71	1.28	11.02	1.22	66.5%	66.8%	67.2%
	Fail	Waiver	9	0.1%	4.06	68.49	4.01	3.15	51.93	3.21	22.4%	24.2%	20.0%
Total	Fail%		11,151	18.6%	1.00	10.06	1.70	0.70	7.29	1.47	30.3%	27.6%	13.9%
1995	Pass	-	10,651		0.58	5.95	1.41	0.58	5.95	1.41	0.0%	0.0%	0.0%
T	Fail	Pass	1,750	13.6%	2.16	21.08	2.84	0.80	8.05	1.86	63.0%	61.8%	34.3%
	Fail	Unresolv.	487	3.8%	4.32	30.12	3.69	1.33	9.86	1.24	69.3%	67.3%	66.4%
	Fail	Waiver	6	0.0%	3.19	29.95	2.99	2.65	32.74	2.13	16.9%	-9.3%	28.9%
Total	Fail%		12,894	17.4%	0.94	8.93	1.69	0.64	6.40	1.47	31.8%	28.4%	13.3%
1996	Pass	-	12,158		0.34	3.95	1.17	0.34	3.95	1.17	0.0%	0.0%	0.0%
T	Fail	Pass	1,688	11.9%	1.15	13.68	2.34	0.41	4.84	1.51	64.0%	64.6%	35.5%
	Fail	Unresolv.	319	2.3%	2.56	26.03	3.70	0.84	8.66	1.23	67.1%	66.7%	66.9%
	Fail	Waiver	6	0.0%	4.82	35.03	2.66	6.61	46.51	2.16	-37.1%	-32.8%	19.0%
Total	Fail%		14,171	14.2%	0.49	5.62	1.37	0.36	4.18	1.21	25.8%	25.6%	11.3%
1997	Pass	-	14,441		0.29	3.76	1.07	0.29	3.76	1.07	0.0%	0.0%	0.0%
T	Fail	Pass	2,121	12.5%	1.09	14.16	2.28	0.39	4.95	1.36	64.6%	65.0%	40.3%
	Fail	Unresolv.	400	2.4%	2.49	27.15	3.45	0.79	8.89	1.14	68.2%	67.2%	67.0%
	Fail	Waiver	6	0.0%	2.02	45.94	4.19	2.04	39.30	4.01	-1.2%	14.4%	4.2%
Total	Fail%		16,968	14.9%	0.44	5.62	1.28	0.31	4.04	1.11	29.0%	28.2%	13.2%

## Appendix A-1 Colorado 2010 Transient Test Emissions Reductions

Unresolved fails remaining in area					33%								
Model	First	Last	Vehicles	Fail%	Initial			Final			Reduction %		
Year/Type	Result	Result			HC	CO	NOX	HC	CO	NOX	HC	CO	NOX
1998	Pass	-	19,718		0.25	3.10	0.90	0.25	3.10	0.90	0.0%	0.0%	0.0%
T	Fail	Pass	1,913	8.7%	1.04	12.17	2.15	0.33	4.09	1.17	68.0%	66.4%	45.7%
	Fail	Unresolv.	333	1.5%	1.88	21.81	3.45	0.59	7.36	1.12	68.5%	66.3%	67.5%
	Fail	Waiver	7	0.0%	8.01	68.12	3.31	6.14	60.25	2.99	23.4%	11.5%	9.7%
Total	Fail%		21,971	10.3%	0.35	4.19	1.05	0.27	3.27	0.93	23.6%	22.1%	11.5%
1999	Pass	-	18,886		0.20	2.42	0.70	0.20	2.42	0.70	0.0%	0.0%	0.0%
T	Fail	Pass	1,931	9.1%	0.88	10.48	1.98	0.27	3.22	0.95	68.7%	69.2%	52.0%
	Fail	Unresolv.	323	1.5%	1.99	19.08	3.27	0.62	5.60	1.09	68.7%	70.7%	66.6%
	Fail	Waiver	10	0.0%	2.41	19.32	3.27	2.30	16.19	3.51	4.8%	16.2%	-7.1%
Total	Fail%		21,150	10.7%	0.29	3.42	0.86	0.22	2.55	0.73	26.0%	25.4%	14.9%
2000	Pass	-	23,415		0.16	2.11	0.62	0.16	2.11	0.62	0.0%	0.0%	0.0%
T	Fail	Pass	1,646	6.5%	0.60	8.00	1.45	0.24	2.97	0.82	60.5%	62.8%	43.6%
	Fail	Unresolv.	164	0.7%	1.99	23.04	2.59	0.60	6.76	0.86	70.1%	70.6%	66.7%
	Fail	Waiver	4	0.0%	1.90	10.01	2.85	2.08	10.51	3.55	-9.7%	-4.9%	-24.8%
Total	Fail%		25,229	7.2%	0.21	2.63	0.68	0.17	2.20	0.63	16.0%	16.5%	7.7%
2001	Pass	-	18,776		0.12	1.73	0.46	0.12	1.73	0.46	0.0%	0.0%	0.0%
T	Fail	Pass	1,305	6.5%	0.41	6.53	1.15	0.15	2.36	0.56	62.4%	63.9%	51.2%
	Fail	Unresolv.	102	0.5%	1.65	22.15	2.76	0.50	5.96	0.96	70.0%	73.1%	65.1%
	Fail	Waiver	4	0.0%	1.91	27.24	4.21	1.80	27.93	3.90	6.1%	-2.5%	7.3%
Total	Fail%		20,187	7.0%	0.14	2.15	0.52	0.12	1.80	0.47	15.5%	16.3%	9.0%
2002	Pass	-	25,544		0.09	1.41	0.40	0.09	1.41	0.40	0.0%	0.0%	0.0%
T	Fail	Pass	1,168	4.4%	0.30	7.28	1.01	0.13	2.20	0.49	57.0%	69.7%	51.5%
	Fail	Unresolv.	68	0.3%	1.06	24.39	2.47	0.42	8.43	0.83	60.6%	65.4%	66.5%
	Fail	Waiver	1	0.0%	0.57	45.83	0.27	0.85	55.19	0.22	-49.4%	-20.4%	18.9%
Total	Fail%		26,781	4.6%	0.10	1.73	0.43	0.09	1.47	0.41	9.1%	15.1%	6.2%
2003	Pass	-	16,356		0.08	1.30	0.36	0.08	1.30	0.36	0.0%	0.0%	0.0%
T	Fail	Pass	730	4.3%	0.27	5.80	0.72	0.11	1.97	0.38	59.1%	66.0%	46.7%
	Fail	Unresolv.	39	0.2%	0.89	16.83	2.30	0.30	5.34	0.78	65.9%	68.3%	66.3%
	Fail	Waiver	1	0.0%	1.07	9.15	4.71	1.07	9.15	4.71	0.0%	0.0%	0.0%
Total	Fail%		17,126	4.5%	0.09	1.52	0.38	0.09	1.33	0.36	8.5%	12.4%	4.7%
2004	Pass	-	29,362		0.07	1.08	0.25	0.07	1.08	0.25	0.0%	0.0%	0.0%
T	Fail	Pass	1,035	3.4%	0.22	4.47	0.50	0.07	1.53	0.19	68.3%	65.9%	62.3%
	Fail	Unresolv.	26	0.1%	0.53	10.88	1.98	0.19	3.71	0.63	65.1%	65.9%	68.2%
	Fail	Waiver	0	0.0%									
Total	Fail%		30,423	3.5%	0.07	1.21	0.26	0.07	1.10	0.25	7.6%	8.8%	4.5%
2005	Pass	-	14,729		0.06	1.01	0.22	0.06	1.01	0.22	0.0%	0.0%	0.0%
T	Fail	Pass	418	2.8%	0.18	2.99	0.58	0.07	1.30	0.17	62.6%	56.5%	70.6%
	Fail	Unresolv.	15	0.1%	0.96	24.73	1.91	0.26	6.23	0.67	73.0%	74.8%	64.8%
	Fail	Waiver	0	0.0%									
Total	Fail%		15,162	2.9%	0.06	1.08	0.23	0.06	1.02	0.22	5.9%	6.0%	5.5%

## Appendix A-1 Colorado 2010 Transient Test Emissions Reductions

Unresolved fails remaining in area					33%								
Model	First	Last	Vehicles	Fail%	Initial			Final			Reduction %		
Year/Type	Result	Result			HC	CO	NOX	HC	CO	NOX	HC	CO	NOX
2006	Pass	-	27,426		0.05	0.88	0.21	0.05	0.88	0.21	0.0%	0.0%	0.0%
T	Fail	Pass	710	2.5%	0.11	1.58	0.75	0.05	0.79	0.13	52.7%	49.9%	82.8%
	Fail	Unresolv.	8	0.0%	0.15	3.13	1.28	0.07	1.75	0.41	53.2%	44.1%	68.0%
	Fail	Waiver	0	0.0%									
Total	Fail%		28,144	2.6%	0.06	0.90	0.22	0.05	0.88	0.20	2.6%	2.2%	7.2%
2007	Pass	-	7,445		0.05	0.84	0.19	0.05	0.84	0.19	0.0%	0.0%	0.0%
T	Fail	Pass	181	2.4%	0.08	2.15	0.34	0.03	0.82	0.08	56.9%	61.9%	75.4%
	Fail	Unresolv.	9	0.1%	0.06	3.47	0.60	0.02	1.18	0.20	64.7%	66.1%	66.9%
	Fail	Waiver	0	0.0%									
Total	Fail%		7,635	2.5%	0.05	0.88	0.19	0.05	0.84	0.19	2.3%	3.9%	3.4%
2008	Pass	-	3,213		0.05	0.88	0.19	0.05	0.88	0.19	0.0%	0.0%	0.0%
T	Fail	Pass	115	3.4%	0.07	2.52	0.36	0.04	1.39	0.08	36.3%	44.7%	79.1%
	Fail	Unresolv.	10	0.3%	0.09	5.08	0.70	0.03	1.68	0.23	67.0%	67.0%	67.0%
	Fail	Waiver	0	0.0%									
Total	Fail%		3,338	3.7%	0.05	0.95	0.19	0.05	0.90	0.18	2.2%	5.2%	5.8%
2009	Pass	-	1,304		0.05	0.84	0.18	0.05	0.84	0.18	0.0%	0.0%	0.0%
T	Fail	Pass	26	2.0%	0.04	0.85	0.35	0.03	1.15	0.08	15.4%	-35.0%	78.1%
	Fail	Unresolv.	2	0.2%	0.03	0.65	5.33	0.01	0.21	1.76	67.0%	67.0%	67.0%
	Fail	Waiver	0	0.0%									
Total	Fail%		1,332	2.1%	0.05	0.84	0.19	0.05	0.84	0.18	0.3%	-0.6%	5.6%
2010	Pass	-	551		0.04	0.79	0.17	0.04	0.79	0.17	0.0%	0.0%	0.0%
T	Fail	Pass	7	1.2%	0.31	0.39	0.67	0.01	0.21	0.02	96.4%	46.1%	96.6%
	Fail	Unresolv.	5	0.9%	0.04	0.60	0.84	0.01	0.20	0.28	67.0%	67.0%	67.0%
	Fail	Waiver	0	0.0%									
Total	Fail%		563	2.1%	0.04	0.78	0.18	0.04	0.78	0.17	8.9%	0.7%	7.1%
2011	Pass	-	19		0.04	0.70	0.15	0.04	0.70	0.15	0.0%	0.0%	0.0%
T	Fail	Pass	0	0.0%									
	Fail	Unresolv.	0	0.0%									
	Fail	Waiver	0	0.0%									
Total	Fail%		19	0.0%	0.04	0.70	0.15	0.04	0.70	0.15	0.0%	0.0%	0.0%
<b>Total Trucks</b>													
All	Pass	-	284,480		0.28	3.25	0.73	0.28	3.25	0.73	0.0%	0.0%	0.0%
T	Fail	Pass	24,912	7.9%	1.51	17.47	2.09	0.62	6.60	1.40	58.7%	62.2%	33.4%
	Fail	Unresolv.	4,867	1.5%	3.87	41.58	3.24	1.24	13.57	1.06	68.1%	67.4%	67.1%
	Fail	Waiver	94	0.0%	4.09	50.80	3.26	4.00	47.08	3.04	2.3%	7.3%	6.6%
Total	Fail%		314,353	9.5%	0.43	4.98	0.88	0.32	3.68	0.79	25.6%	26.0%	10.2%
<b>Fleet Total</b>													
All	Pass	-	614,432		0.25	3.28	0.65	0.25	3.28	0.65	0.0%	0.0%	0.0%
All	Fail	Pass	48,126	7.1%	1.33	16.07	1.82	0.51	5.45	1.16	61.8%	66.1%	36.4%
	Fail	Unresolv.	10,628	1.6%	3.39	36.30	2.78	1.09	11.89	0.92	67.8%	67.2%	67.0%
	Fail	Waiver	221	0.0%	3.58	41.76	2.94	3.01	36.73	2.76	16.0%	12.1%	6.4%
Total	Fail%		673,407	8.8%	0.38	4.73	0.77	0.28	3.58	0.70	25.2%	24.2%	9.9%

## Appendix A2 Colorado 2010 Clean Screen Audit Transient Test Emissions Reductions

Unresolved fails remaining in area					100%								
Model	First	Last	Vehicles	Fail%	Initial			Final			Reduction %		
Year/Type	Result	Result			HC	CO	NOX	HC	CO	NOX	HC	CO	NOX
1982	Pass	-	0		-	-	-	-	-	-	-	-	-
P	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		0	0.0%	0.00	0.00	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%
1983	Pass	-	0		-	-	-	-	-	-	-	-	-
P	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		0	0.0%	0.00	0.00	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%
1984	Pass	-	0		-	-	-	-	-	-	-	-	-
P	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		0	0.0%	0.00	0.00	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%
1985	Pass	-	1		1.12	9.48	2.84	1.12	9.48	2.84	0.0%	0.0%	0.0%
P	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		1	0.0%	1.12	9.48	2.84	1.12	9.48	2.84	0.0%	0.0%	0.0%
1986	Pass	-	1		0.53	9.08	1.31	0.53	9.08	1.31	0.0%	0.0%	0.0%
P	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		1	0.0%	0.53	9.08	1.31	0.53	9.08	1.31	0.0%	0.0%	0.0%
1987	Pass	-	1		0.72	10.40	2.39	0.72	10.40	2.39	0.0%	0.0%	0.0%
P	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		1	0.0%	0.72	10.40	2.39	0.72	10.40	2.39	0.0%	0.0%	0.0%
1988	Pass	-	3		0.41	7.51	1.12	0.41	7.51	1.12	0.0%	0.0%	0.0%
P	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		3	0.0%	0.41	7.51	1.12	0.41	7.51	1.12	0.0%	0.0%	0.0%
1989	Pass	-	5		0.97	6.40	2.21	0.97	6.40	2.21	0.0%	0.0%	0.0%
P	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		5	0.0%	0.97	6.40	2.21	0.97	6.40	2.21	0.0%	0.0%	0.0%

## Appendix A2 Colorado 2010 Clean Screen Audit Transient Test Emissions Reductions

Unresolved fails remaining in area					100%								
Model	First	Last	Vehicles	Fail%	Initial			Final			Reduction %		
Year/Type	Result	Result			HC	CO	NOX	HC	CO	NOX	HC	CO	NOX
1990	Pass	-	6		0.78	6.87	1.62	0.78	6.87	1.62	0.0%	0.0%	0.0%
P	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		6	0.0%	0.78	6.87	1.62	0.78	6.87	1.62	0.0%	0.0%	0.0%
1991	Pass	-	13		0.48	6.61	1.27	0.48	6.61	1.27	0.0%	0.0%	0.0%
P	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		13	0.0%	0.48	6.61	1.27	0.48	6.61	1.27	0.0%	0.0%	0.0%
1992	Pass	-	17		0.45	5.73	1.30	0.45	5.73	1.30	0.0%	0.0%	0.0%
P	Fail	Pass	1	5.6%	0.18	4.17	0.64	0.36	5.33	0.71	-92.4%	-27.9%	-10.4%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		18	5.6%	0.44	5.65	1.26	0.45	5.71	1.26	-2.2%	-1.1%	-0.3%
1993	Pass	-	18		0.40	4.71	1.37	0.40	4.71	1.37	0.0%	0.0%	0.0%
P	Fail	Pass	3	14.3%	1.02	19.30	1.46	0.81	9.42	1.41	20.6%	51.2%	3.6%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		21	14.3%	0.49	6.79	1.39	0.46	5.38	1.38	6.2%	20.8%	0.5%
1994	Pass	-	28		0.33	4.54	0.96	0.33	4.54	0.96	0.0%	0.0%	0.0%
P	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		28	0.0%	0.33	4.54	0.96	0.33	4.54	0.96	0.0%	0.0%	0.0%
1995	Pass	-	35		0.32	3.57	0.80	0.32	3.57	0.80	0.0%	0.0%	0.0%
P	Fail	Pass	3	7.9%	0.67	23.17	0.85	0.33	7.41	0.43	51.3%	68.0%	49.4%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		38	7.9%	0.34	5.12	0.80	0.32	3.87	0.77	7.9%	24.3%	4.1%
1996	Pass	-	53		0.28	3.52	0.64	0.28	3.52	0.64	0.0%	0.0%	0.0%
P	Fail	Pass	4	7.0%	0.57	13.01	0.68	0.33	2.82	0.79	42.4%	78.4%	-16.9%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		57	7.0%	0.30	4.19	0.64	0.28	3.47	0.65	5.6%	17.1%	-1.3%
1997	Pass	-	86		0.28	3.44	0.71	0.28	3.44	0.71	0.0%	0.0%	0.0%
P	Fail	Pass	5	5.5%	0.77	6.86	2.43	0.17	1.03	0.73	78.5%	85.0%	69.9%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		91	5.5%	0.30	3.63	0.81	0.27	3.31	0.71	10.9%	8.8%	11.6%

## Appendix A2 Colorado 2010 Clean Screen Audit Transient Test Emissions Reductions

Unresolved fails remaining in area					100%								
Model	First	Last	Vehicles	Fail%	Initial			Final			Reduction %		
Year/Type	Result	Result			HC	CO	NOX	HC	CO	NOX	HC	CO	NOX
1998	Pass	-	100		0.20	2.79	0.57	0.20	2.79	0.57	0.0%	0.0%	0.0%
P	Fail	Pass	5	4.8%	0.18	3.01	0.99	0.13	2.61	0.69	30.2%	13.5%	30.4%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		105	4.8%	0.20	2.80	0.59	0.20	2.78	0.58	1.3%	0.7%	2.4%
1999	Pass	-	89		0.19	3.05	0.54	0.19	3.05	0.54	0.0%	0.0%	0.0%
P	Fail	Pass	2	2.2%	0.45	6.55	1.92	0.10	0.92	0.22	79.1%	86.0%	88.4%
	Fail	Unresolv.	1	1.1%	0.06	0.86	2.28	1.09	0.04	3.56	-1593.5%	95.8%	-55.9%
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		92	3.3%	0.19	3.10	0.59	0.20	2.97	0.57	-1.7%	4.2%	3.9%
2000	Pass	-	185		0.13	2.46	0.45	0.13	2.46	0.45	0.0%	0.0%	0.0%
P	Fail	Pass	7	3.6%	0.50	8.40	0.32	0.11	1.91	0.25	77.9%	77.3%	22.1%
	Fail	Unresolv.	1	0.5%	0.76	9.87	3.38	0.85	7.13	3.83	-10.6%	27.8%	-13.3%
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		193	4.1%	0.15	2.71	0.46	0.13	2.46	0.46	9.2%	9.2%	0.0%
2001	Pass	-	139		0.10	2.25	0.33	0.10	2.25	0.33	0.0%	0.0%	0.0%
P	Fail	Pass	9	6.1%	0.35	13.14	1.14	0.16	2.73	0.46	53.6%	79.3%	59.5%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		148	6.1%	0.11	2.91	0.38	0.10	2.27	0.34	10.0%	21.8%	10.8%
2002	Pass	-	267		0.10	2.07	0.33	0.10	2.07	0.33	0.0%	0.0%	0.0%
P	Fail	Pass	5	1.8%	0.44	16.34	1.33	0.05	1.39	0.21	89.1%	91.5%	84.4%
	Fail	Unresolv.	3	1.1%	0.16	2.99	4.54	0.31	3.92	3.05	-96.5%	-31.1%	32.8%
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		275	2.9%	0.11	2.34	0.39	0.10	2.08	0.36	5.1%	11.2%	9.3%
2003	Pass	-	124		0.10	2.30	0.34	0.10	2.30	0.34	0.0%	0.0%	0.0%
P	Fail	Pass	2	1.6%	0.05	1.52	0.15	0.05	0.63	0.23	-3.9%	58.5%	-52.0%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		126	1.6%	0.10	2.29	0.34	0.10	2.28	0.34	0.0%	0.6%	-0.4%
2004	Pass	-	264		0.08	1.88	0.28	0.08	1.88	0.28	0.0%	0.0%	0.0%
P	Fail	Pass	12	4.3%	0.08	1.88	0.26	0.04	1.05	0.17	46.0%	44.0%	35.0%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		276	4.3%	0.08	1.88	0.28	0.08	1.84	0.27	2.0%	1.9%	1.4%
2005	Pass	-	77		0.09	1.93	0.23	0.09	1.93	0.23	0.0%	0.0%	0.0%
P	Fail	Pass	5	6.1%	0.08	1.99	0.22	0.04	0.62	0.13	43.4%	68.7%	39.7%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		82	6.1%	0.08	1.94	0.23	0.08	1.85	0.22	2.4%	4.3%	2.3%

## Appendix A2 Colorado 2010 Clean Screen Audit Transient Test Emissions Reductions

Unresolved fails remaining in area					100%								
Model	First	Last	Vehicles	Fail%	Initial			Final			Reduction %		
Year/Type	Result	Result			HC	CO	NOX	HC	CO	NOX	HC	CO	NOX
2006	Pass	-	290		0.08	1.87	0.23	0.08	1.87	0.23	0.0%	0.0%	0.0%
P	Fail	Pass	6	2.0%	0.06	1.27	1.25	0.02	0.81	0.23	74.0%	36.5%	81.7%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		296	2.0%	0.08	1.86	0.25	0.08	1.85	0.23	1.2%	0.5%	8.2%
2007	Pass	-	1		0.07	2.03	0.22	0.07	2.03	0.22	0.0%	0.0%	0.0%
P	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		1	0.0%	0.07	2.03	0.22	0.07	2.03	0.22	0.0%	0.0%	0.0%
2008	Pass	-	0		-	-	-	-	-	-	-	-	-
P	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		0	0.0%	0.00	0.00	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%
2009	Pass	-	0		-	-	-	-	-	-	-	-	-
P	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		0	0.0%	0.00	0.00	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%
2010	Pass	-	0		-	-	-	-	-	-	-	-	-
P	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		0	0.0%	0.00	0.00	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%
2011	Pass	-	0		-	-	-	-	-	-	-	-	-
P	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		0	0.0%	0.00	0.00	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%
<b>Total Passenger Vehicles</b>													
All	Pass	-	1,803		0.14	2.48	0.43	0.14	2.48	0.43	0.0%	0.0%	0.0%
P	Fail	Pass	69	3.7%	0.35	7.94	0.90	0.15	2.23	0.41	57.5%	71.9%	54.5%
	Fail	Unresolv.	5	0.3%	0.26	3.94	3.86	0.57	3.78	3.31	-120.0%	3.9%	14.2%
	Fail	Waiver	0	0.0%	0.00	0.00	0.00	0.00	0.00	0.00			
Total	Fail%		1,877	3.9%	0.15	2.68	0.45	0.14	2.47	0.43	4.3%	7.8%	4.3%

## Appendix A2 Colorado 2010 Clean Screen Audit Transient Test Emissions Reductions

Unresolved fails remaining in area					100%								
Model	First	Last	Vehicles	Fail%	Initial			Final			Reduction %		
Year/Type	Result	Result			HC	CO	NOX	HC	CO	NOX	HC	CO	NOX
1982	Pass	-	0		-	-	-	-	-	-	-	-	-
T	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		0	0.0%	0.00	0.00	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%
1983	Pass	-	0		-	-	-	-	-	-	-	-	-
T	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		0	0.0%	0.00	0.00	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%
1984	Pass	-	0		-	-	-	-	-	-	-	-	-
T	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		0	0.0%	0.00	0.00	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%
1985	Pass	-	1		2.65	19.11	4.24	2.65	19.11	4.24	0.0%	0.0%	0.0%
T	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		1	0.0%	2.65	19.11	4.24	2.65	19.11	4.24	0.0%	0.0%	0.0%
1986	Pass	-	1		1.50	14.78	2.61	1.50	14.78	2.61	0.0%	0.0%	0.0%
T	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		1	0.0%	1.50	14.78	2.61	1.50	14.78	2.61	0.0%	0.0%	0.0%
1987	Pass	-	0		-	-	-	-	-	-	-	-	-
T	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		0	0.0%	0.00	0.00	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%
1988	Pass	-	3		1.00	11.26	1.10	1.00	11.26	1.10	0.0%	0.0%	0.0%
T	Fail	Pass	1	25.0%	2.39	20.84	4.06	2.43	24.99	3.75	-1.5%	-19.9%	7.7%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		4	25.0%	1.35	13.65	1.84	1.36	14.69	1.77	-0.7%	-7.6%	4.2%
1989	Pass	-	1		1.78	16.93	1.58	1.78	16.93	1.58	0.0%	0.0%	0.0%
T	Fail	Pass	1	50.0%	2.21	12.56	2.28	1.85	14.62	1.34	16.4%	-16.4%	41.0%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		2	50.0%	1.99	14.75	1.93	1.81	15.78	1.46	9.1%	-7.0%	24.2%



## Appendix A2 Colorado 2010 Clean Screen Audit Transient Test Emissions Reductions

Unresolved fails remaining in area					100%								
Model	First	Last	Vehicles	Fail%	Initial			Final			Reduction %		
Year/Type	Result	Result			HC	CO	NOX	HC	CO	NOX	HC	CO	NOX
1990	Pass	-	8		1.22	9.67	2.31	1.22	9.67	2.31	0.0%	0.0%	0.0%
T	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		8	0.0%	1.22	9.67	2.31	1.22	9.67	2.31	0.0%	0.0%	0.0%
1991	Pass	-	8		0.77	6.45	1.92	0.77	6.45	1.92	0.0%	0.0%	0.0%
T	Fail	Pass	1	11.1%	0.33	0.40	7.06	1.28	6.85	3.87	-293.0%	#####	45.1%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		9	11.1%	0.72	5.77	2.49	0.83	6.49	2.13	-14.7%	-12.4%	14.2%
1992	Pass	-	6		0.76	7.75	1.40	0.76	7.75	1.40	0.0%	0.0%	0.0%
T	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	1	14.3%	5.17	65.69	11.34	5.17	65.69	11.34	0.0%	0.0%	0.0%
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		7	14.3%	1.39	16.03	2.82	1.39	16.03	2.82	0.0%	0.0%	0.0%
1993	Pass	-	15		0.81	9.48	1.65	0.81	9.48	1.65	0.0%	0.0%	0.0%
T	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		15	0.0%	0.81	9.48	1.65	0.81	9.48	1.65	0.0%	0.0%	0.0%
1994	Pass	-	15		0.80	7.49	1.83	0.80	7.49	1.83	0.0%	0.0%	0.0%
T	Fail	Pass	6	28.6%	1.06	8.15	2.42	1.01	5.74	2.06	4.3%	29.5%	14.8%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		21	28.6%	0.88	7.68	2.00	0.86	6.99	1.89	1.5%	9.0%	5.1%
1995	Pass	-	28		0.69	6.40	1.57	0.69	6.40	1.57	0.0%	0.0%	0.0%
T	Fail	Pass	2	6.7%	1.13	10.97	4.79	0.34	1.69	0.49	70.0%	84.6%	89.8%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		30	6.7%	0.72	6.71	1.79	0.67	6.09	1.50	7.3%	9.2%	16.0%
1996	Pass	-	52		0.29	3.41	0.97	0.29	3.41	0.97	0.0%	0.0%	0.0%
T	Fail	Pass	5	8.8%	2.70	26.13	1.17	0.28	3.50	1.59	89.6%	86.6%	-36.3%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		57	8.8%	0.50	5.40	0.99	0.29	3.42	1.03	42.1%	36.8%	-3.7%
1997	Pass	-	69		0.28	3.48	1.06	0.28	3.48	1.06	0.0%	0.0%	0.0%
T	Fail	Pass	6	8.0%	0.63	7.66	1.93	0.57	4.47	0.89	9.6%	41.7%	53.9%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		75	8.0%	0.31	3.81	1.13	0.30	3.56	1.04	1.6%	6.7%	7.4%

## Appendix A2 Colorado 2010 Clean Screen Audit Transient Test Emissions Reductions

Unresolved fails remaining in area					100%								
Model	First	Last	Vehicles	Fail%	Initial			Final			Reduction %		
Year/Type	Result	Result			HC	CO	NOX	HC	CO	NOX	HC	CO	NOX
1998	Pass	-	108		0.20	2.51	0.82	0.20	2.51	0.82	0.0%	0.0%	0.0%
T	Fail	Pass	5	4.3%	0.57	12.78	1.56	0.20	3.60	1.24	64.8%	71.8%	20.5%
	Fail	Unresolv.	2	1.7%	0.23	10.21	3.02	0.13	5.11	2.56	45.1%	50.0%	15.3%
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		115	6.1%	0.21	3.09	0.89	0.20	2.60	0.87	8.4%	15.8%	2.5%
1999	Pass	-	119		0.20	2.23	0.68	0.20	2.23	0.68	0.0%	0.0%	0.0%
T	Fail	Pass	9	7.0%	0.37	7.45	1.62	0.19	3.32	0.94	48.6%	55.4%	41.8%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		128	7.0%	0.21	2.60	0.74	0.20	2.31	0.70	6.1%	11.2%	6.4%
2000	Pass	-	206		0.13	1.61	0.57	0.13	1.61	0.57	0.0%	0.0%	0.0%
T	Fail	Pass	13	5.9%	0.85	14.82	0.76	0.21	2.59	0.76	75.7%	82.5%	0.2%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		219	5.9%	0.18	2.40	0.59	0.14	1.67	0.59	21.9%	30.3%	0.0%
2001	Pass	-	157		0.12	1.63	0.47	0.12	1.63	0.47	0.0%	0.0%	0.0%
T	Fail	Pass	8	4.8%	0.13	1.37	0.56	0.10	1.52	0.41	21.2%	-11.0%	26.3%
	Fail	Unresolv.	1	0.6%	1.28	58.53	0.17	1.28	58.53	0.17	0.0%	0.0%	0.0%
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		166	5.4%	0.13	1.96	0.47	0.12	1.97	0.47	1.1%	-0.4%	1.5%
2002	Pass	-	294		0.09	1.41	0.41	0.09	1.41	0.41	0.0%	0.0%	0.0%
T	Fail	Pass	10	3.3%	0.12	1.19	0.64	0.08	0.74	0.44	30.2%	37.7%	30.8%
	Fail	Unresolv.	1	0.3%	0.46	10.03	2.44	0.46	10.03	2.44	0.0%	0.0%	0.0%
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		305	3.6%	0.09	1.43	0.43	0.09	1.41	0.42	1.3%	1.0%	1.5%
2003	Pass	-	164		0.07	1.19	0.32	0.07	1.19	0.32	0.0%	0.0%	0.0%
T	Fail	Pass	6	3.5%	0.30	13.57	0.66	0.12	1.00	0.84	59.3%	92.6%	-27.2%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		170	3.5%	0.08	1.63	0.34	0.07	1.19	0.34	8.0%	27.2%	-1.9%
2004	Pass	-	387		0.06	0.93	0.26	0.06	0.93	0.26	0.0%	0.0%	0.0%
T	Fail	Pass	13	3.2%	0.06	1.15	0.37	0.03	0.98	0.12	41.8%	14.5%	67.9%
	Fail	Unresolv.	3	0.7%	0.15	1.04	2.05	0.16	1.11	1.20	-11.2%	-6.9%	41.2%
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		403	4.0%	0.06	0.93	0.28	0.06	0.93	0.26	1.0%	0.5%	5.1%
2005	Pass	-	108		0.06	0.93	0.21	0.06	0.93	0.21	0.0%	0.0%	0.0%
T	Fail	Pass	2	1.8%	0.04	0.72	0.21	0.03	1.21	0.03	36.1%	-68.7%	84.9%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		110	1.8%	0.06	0.92	0.21	0.06	0.93	0.21	0.5%	-1.0%	1.5%

## Appendix A2 Colorado 2010 Clean Screen Audit Transient Test Emissions Reductions

Unresolved fails remaining in area					100%								
Model	First	Last	Vehicles	Fail%	Initial			Final			Reduction %		
Year/Type	Result	Result			HC	CO	NOX	HC	CO	NOX	HC	CO	NOX
2006	Pass	-	373		0.05	0.87	0.20	0.05	0.87	0.20	0.0%	0.0%	0.0%
T	Fail	Pass	6	1.6%	0.10	1.08	0.28	0.10	1.18	0.26	1.5%	-9.4%	6.4%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		379	1.6%	0.05	0.87	0.20	0.05	0.87	0.20	0.0%	-0.2%	0.1%
2007	Pass	-	6		0.05	0.93	0.15	0.05	0.93	0.15	0.0%	0.0%	0.0%
T	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		6	0.0%	0.05	0.93	0.15	0.05	0.93	0.15	0.0%	0.0%	0.0%
2008	Pass	-	0		-	-	-	-	-	-	-	-	-
T	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		0	0.0%	0.00	0.00	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%
2009	Pass	-	0		-	-	-	-	-	-	-	-	-
T	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		0	0.0%	0.00	0.00	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%
2010	Pass	-	0		-	-	-	-	-	-	-	-	-
T	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		0	0.0%	0.00	0.00	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%
2011	Pass	-	0		-	-	-	-	-	-	-	-	-
T	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		0	0.0%	0.00	0.00	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%
<b>Total Trucks</b>													
All	Pass	-	2,129		0.13	1.71	0.47	0.13	1.71	0.47	0.0%	0.0%	0.0%
T	Fail	Pass	94	4.2%	0.57	7.79	1.16	0.28	2.75	0.81	51.5%	64.7%	30.1%
	Fail	Unresolv.	8	0.4%	0.98	19.72	3.27	0.96	18.47	2.83	2.1%	6.3%	13.2%
	Fail	Waiver	0	0.0%									
Total	Fail%		2,231	4.6%	0.16	2.03	0.51	0.14	1.81	0.50	8.0%	10.7%	3.2%
<b>Fleet Total</b>													
All	Pass	-	3,932		0.14	2.06	0.45	0.14	2.06	0.45	0.0%	0.0%	0.0%
All	Fail	Pass	163	4.0%	0.47	7.85	1.05	0.22	2.53	0.64	53.4%	67.8%	39.0%
	Fail	Unresolv.	13	0.3%	0.70	13.65	3.49	0.81	12.82	3.02	-15.3%	6.1%	13.7%
	Fail	Waiver	0	0.0%									
Total	Fail%		4,108	4.3%	0.15	2.33	0.49	0.14	2.11	0.47	6.3%	9.2%	3.7%

**Appendix B Colorado 2010  
Enhanced IM240 Test Reduction Tons**

Type	Annual Miles	Unique Vehicles	Initial Tons/Yr			Final Tons/Yr			Reduction Tons/Yr		
			HC	CO	NOx	HC	CO	NOx	HC	CO	NOx
P 1982	4,304	469	4.7	60.0	4.9	3.6	42.2	4.6	1.1	17.8	0.3
P 1983	4,434	567	6.3	79.4	5.3	3.9	48.6	4.9	2.3	30.8	0.4
P 1984	4,481	1,391	12.4	155.9	13.4	8.9	104.7	12.4	3.4	51.2	1.0
P 1985	4,502	1,487	12.2	144.6	14.8	7.7	85.5	13.3	4.5	59.1	1.5
P 1986	4,552	2,449	15.7	192.4	22.9	11.5	126.6	21.7	4.2	65.8	1.2
P 1987	4,780	2,511	16.6	191.8	23.6	11.8	129.1	21.4	4.8	62.7	2.2
P 1988	5,088	3,909	24.4	284.7	35.6	17.3	198.1	33.4	7.2	86.5	2.2
P 1989	5,430	4,214	26.9	313.7	39.4	18.8	221.2	36.9	8.0	92.5	2.4
P 1990	5,672	7,673	43.0	519.1	73.3	32.1	375.7	67.9	10.9	143.4	5.4
P 1991	6,002	8,179	46.6	548.2	78.4	32.4	381.7	71.1	14.2	166.6	7.3
P 1992	6,331	10,614	56.1	683.3	101.0	39.3	465.3	92.4	16.9	218.0	8.6
P 1993	6,653	11,248	61.0	687.3	113.0	42.7	482.6	103.0	18.2	204.7	10.0
P 1994	6,974	13,179	59.4	687.1	112.5	41.4	509.2	102.2	18.0	177.9	10.3
P 1995	7,369	16,950	74.8	820.4	141.8	52.1	610.9	127.1	22.7	209.6	14.7
P 1996	7,764	18,674	58.0	743.9	131.6	45.9	579.8	120.3	12.1	164.0	11.3
P 1997	8,188	20,117	62.9	815.1	141.7	50.3	651.2	129.3	12.7	163.8	12.4
P 1998	8,613	23,597	60.3	920.0	143.7	48.2	718.8	128.3	12.2	201.2	15.3
P 1999	9,032	22,410	54.1	817.5	137.4	42.9	657.6	122.0	11.2	160.0	15.3
P 2000	9,450	29,654	58.2	958.3	161.3	46.3	811.5	140.5	11.9	146.8	20.9
P 2001	9,905	23,476	38.7	727.3	110.7	31.4	618.2	98.1	7.3	109.1	12.6
P 2002	10,360	29,010	42.6	811.6	123.2	36.0	727.6	111.6	6.5	84.0	11.6
P 2003	10,746	19,242	25.5	511.8	77.8	22.0	460.9	71.9	3.5	50.9	5.9
P 2004	11,132	25,870	31.0	660.9	93.6	27.4	619.6	86.7	3.6	41.3	6.9
P 2005	11,870	15,116	18.5	400.0	57.6	16.5	373.0	52.6	2.0	26.9	5.0
P 2006	12,023	32,426	37.0	807.3	132.7	33.7	764.9	106.3	3.4	42.4	26.5
P 2007	12,307	7,945	8.5	196.8	28.9	8.2	189.8	25.6	0.4	7.0	3.4
P 2008	12,357	3,877	4.2	98.9	13.6	4.0	94.7	11.9	0.3	4.2	1.7
P 2009	11,600	2,118	2.2	49.2	6.8	2.0	48.2	6.1	0.2	1.0	0.8
P 2010	9,650	662	0.5	12.3	1.5	0.5	12.3	1.5	0.0	0.0	0.0
P 2011	9,650	20	0.0	0.4	0.0	0.0	0.4	0.0	0.0	0.0	0.0
P Total		359,054	962.5	13899.0	2142.0	739.0	11109.8	1924.9	223.5	2789.2	217.1
T 1982	4,562	458	8.6	102.8	6.2	6.2	69.5	5.7	2.4	33.3	0.5
T 1983	4,583	596	12.0	150.4	8.4	7.9	95.2	7.5	4.1	55.2	0.9
T 1984	4,630	1,336	20.5	278.3	18.9	15.1	184.7	17.5	5.4	93.6	1.4
T 1985	4,668	1,527	24.0	300.2	21.9	15.5	179.7	19.7	8.5	120.5	2.2
T 1986	4,741	2,305	28.1	321.6	32.2	20.7	215.6	29.9	7.4	106.0	2.2
T 1987	4,851	2,273	24.5	267.8	28.7	18.2	179.1	26.8	6.4	88.7	1.9
T 1988	5,019	3,631	35.2	345.4	45.5	25.7	250.9	40.9	9.5	94.5	4.6
T 1989	5,256	3,788	38.0	381.0	48.9	27.7	265.1	44.9	10.3	115.9	4.0
T 1990	5,519	4,613	42.0	417.3	61.1	32.0	301.0	56.1	10.1	116.2	5.0
T 1991	5,824	5,070	43.1	464.1	60.1	30.1	318.6	53.8	13.0	145.6	6.2
T 1992	6,135	6,422	52.9	565.8	83.8	39.1	414.9	76.7	13.7	150.9	7.2
T 1993	6,471	8,090	69.6	707.4	110.9	51.4	515.0	100.2	18.2	192.3	10.8
T 1994	6,940	11,151	85.4	858.3	145.2	59.5	621.6	125.1	25.9	236.7	20.2
T 1995	7,437	12,894	99.0	943.9	178.8	67.5	676.2	155.1	31.5	267.7	23.8
T 1996	7,863	14,171	59.6	689.9	168.2	44.2	513.3	149.1	15.4	176.7	19.0
T 1997	8,345	16,968	69.1	877.6	200.1	49.0	630.5	173.6	20.0	247.1	26.5
T 1998	8,900	21,971	74.7	904.1	226.2	57.1	704.6	200.1	17.6	199.5	26.1
T 1999	9,502	21,150	64.8	757.1	189.5	47.9	564.4	161.3	16.8	192.6	28.2
T 2000	10,087	25,229	57.6	739.0	192.2	48.4	617.4	177.4	9.2	121.6	14.7
T 2001	10,727	20,187	34.3	513.0	124.4	28.9	429.2	113.1	5.3	83.8	11.2
T 2002	11,245	26,781	33.5	573.7	143.6	30.5	486.9	134.7	3.1	86.9	8.9
T 2003	11,817	17,126	21.0	339.9	85.2	19.2	297.7	81.2	1.8	42.3	4.0
T 2004	12,303	30,423	29.3	497.8	109.0	27.1	453.9	104.1	2.2	43.9	4.9
T 2005	12,834	15,162	13.9	232.4	48.9	13.1	218.5	46.2	0.8	13.9	2.7
T 2006	13,215	28,144	22.8	370.2	90.5	22.3	361.8	83.9	0.6	8.3	6.6
T 2007	13,433	7,635	5.6	99.0	21.8	5.5	95.1	21.1	0.1	3.9	0.7
T 2008	13,514	3,338	2.3	47.2	9.6	2.3	44.8	9.0	0.1	2.4	0.6
T 2009	12,428	1,332	0.8	15.3	3.5	0.8	15.4	3.3	0.0	-0.1	0.2
T 2010	8,995	563	0.2	4.4	1.0	0.2	4.3	1.0	0.0	0.0	0.1
T 2011	8,995	19	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0
T Total		314,353	1072.4	12764.9	2464.2	813.2	9725.0	2219.2	259.2	3039.9	245.0
Total		673,407	2035.0	26663.9	4606.2	1552.2	20834.8	4144.0	482.8	5829.1	462.2

Appendix B - Colorado 2010  
RapidScreen Audit IM240 Test Reduction Tons

Type	Annual Miles	Unique Vehicles	Initial Tons/Yr			Final Tons/Yr			Reduction Tons/Yr		
			HC	CO	NOx	HC	CO	NOx	HC	CO	NOx
P 1982	4,304	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P 1983	4,434	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P 1984	4,481	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P 1985	4,502	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P 1986	4,552	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P 1987	4,780	1	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0
P 1988	5,088	3	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0
P 1989	5,430	5	0.0	0.2	0.1	0.0	0.2	0.1	0.0	0.0	0.0
P 1990	5,672	6	0.0	0.3	0.1	0.0	0.3	0.1	0.0	0.0	0.0
P 1991	6,002	13	0.0	0.6	0.1	0.0	0.6	0.1	0.0	0.0	0.0
P 1992	6,331	18	0.1	0.7	0.2	0.1	0.7	0.2	0.0	0.0	0.0
P 1993	6,653	21	0.1	1.0	0.2	0.1	0.8	0.2	0.0	0.2	0.0
P 1994	6,974	28	0.1	1.0	0.2	0.1	1.0	0.2	0.0	0.0	0.0
P 1995	7,369	38	0.1	1.6	0.2	0.1	1.2	0.2	0.0	0.4	0.0
P 1996	7,764	57	0.1	2.0	0.3	0.1	1.7	0.3	0.0	0.3	0.0
P 1997	8,188	91	0.2	3.0	0.7	0.2	2.7	0.6	0.0	0.3	0.1
P 1998	8,613	105	0.2	2.8	0.6	0.2	2.8	0.6	0.0	0.0	0.0
P 1999	9,032	92	0.2	2.8	0.5	0.2	2.7	0.5	0.0	0.1	0.0
P 2000	9,450	193	0.3	5.5	0.9	0.3	4.9	0.9	0.0	0.5	0.0
P 2001	9,905	148	0.2	4.7	0.6	0.2	3.7	0.5	0.0	1.0	0.1
P 2002	10,360	275	0.3	7.3	1.2	0.3	6.5	1.1	0.0	0.8	0.1
P 2003	10,746	126	0.2	3.4	0.5	0.2	3.4	0.5	0.0	0.0	0.0
P 2004	11,132	276	0.3	6.4	0.9	0.3	6.2	0.9	0.0	0.1	0.0
P 2005	11,870	82	0.1	2.1	0.2	0.1	2.0	0.2	0.0	0.1	0.0
P 2006	12,023	296	0.3	7.3	1.0	0.3	7.2	0.9	0.0	0.0	0.1
P 2007	12,307	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P 2008	12,357	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P 2009	11,600	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P Total		1,877	2.8	52.9	8.7	2.7	49.0	8.3	0.1	4.0	0.4
T 1982	4,562	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
T 1983	4,583	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
T 1984	4,630	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
T 1985	4,668	1	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0
T 1986	4,741	1	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0
T 1987	4,851	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
T 1988	5,019	4	0.0	0.3	0.0	0.0	0.3	0.0	0.0	0.0	0.0
T 1989	5,256	2	0.0	0.2	0.0	0.0	0.2	0.0	0.0	0.0	0.0
T 1990	5,519	8	0.1	0.5	0.1	0.1	0.5	0.1	0.0	0.0	0.0
T 1991	5,824	9	0.0	0.3	0.1	0.0	0.4	0.1	0.0	0.0	0.0
T 1992	6,135	7	0.1	0.8	0.1	0.1	0.8	0.1	0.0	0.0	0.0
T 1993	6,471	15	0.1	1.0	0.2	0.1	1.0	0.2	0.0	0.0	0.0
T 1994	6,940	21	0.1	1.2	0.3	0.1	1.1	0.3	0.0	0.1	0.0
T 1995	7,437	30	0.2	1.6	0.4	0.2	1.5	0.4	0.0	0.2	0.1
T 1996	7,863	57	0.2	2.7	0.5	0.1	1.7	0.5	0.1	1.0	0.0
T 1997	8,345	75	0.2	2.6	0.8	0.2	2.5	0.7	0.0	0.2	0.1
T 1998	8,900	115	0.2	3.5	1.0	0.2	2.9	1.0	0.0	0.6	0.0
T 1999	9,502	128	0.3	3.5	1.0	0.3	3.1	0.9	0.0	0.4	0.1
T 2000	10,087	219	0.4	5.8	1.4	0.3	4.1	1.4	0.1	1.8	0.0
T 2001	10,727	166	0.2	3.9	0.9	0.2	3.9	0.9	0.0	0.0	0.0
T 2002	11,245	305	0.3	5.4	1.6	0.3	5.3	1.6	0.0	0.1	0.0
T 2003	11,817	170	0.2	3.6	0.7	0.2	2.6	0.8	0.0	1.0	0.0
T 2004	12,303	403	0.3	5.1	1.5	0.3	5.1	1.4	0.0	0.0	0.1
T 2005	12,834	110	0.1	1.4	0.3	0.1	1.5	0.3	0.0	0.0	0.0
T 2006	13,215	379	0.3	4.8	1.1	0.3	4.8	1.1	0.0	0.0	0.0
T 2007	13,433	6	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0
T 2008	13,514	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
T 2009	12,428	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
T Total		2,231	3.5	48.5	12.4	3.3	43.4	12.0	0.3	5.1	0.4
Total		4,108	6.4	101.4	21.1	6.0	92.4	20.3	0.4	9.0	0.8