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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 2005-2015¹ described on-road measurement activities and the vehicles exempted from inspection. This report covers calendar year 2016.

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.

RapidScreen provided benefits to vehicle owners of \$3.66M through reduced time and expense associated with eliminated inspection station visits. The reduction in station inspections also yielded net savings in greenhouse gases and 135,000 gallons of gasoline.

Changes to the I/M program were implemented at the start of 2015:

- The new vehicle exemption was extended from four to seven years;
- Models 8 to 11 years old with functioning OBD-II systems were subject to the OBD I/M test instead of IM240 or Idle tailpipe tests;
- All remote sensing measurements were made using RSD5000 systems monitored remotely from a nearby service van.

Collection Activity

In 2016, four single-unit RSD vans and five vans designed to transport, deploy and monitor three systems each, were used in the DMA and Northern Front Range (NFR). Twenty-four different RSD5000 systems were used as some units were rotated for preventive or corrective maintenance. Units were deployed at 94 locations in the DMA and 30 locations in the NFR for a total of 25,099 active collection hours. A total 5.9 million emission measurements were collected and successfully matched to Colorado registered vehicles. Additional remote sensing productivity information is provided in Section IV.

2015 vs 2016 Collection Comparison

In 2015, 5.0 million emission measurements were collected compared to the 5.9M in 2016. Notices to owners of vehicles qualifying for clean screen in 2016 were marginally higher at 220,052 compared to 219,860 in 2015. Vehicles using the exemption were lower in 2016 at

186,359 compared to 195,778 in 2015. There are timing differences between notices issued and notices used.

Vehicle Exemptions

Over 227,000 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 220,052 vehicles meeting the clean screening criteria were issued notices granting exemption from the I/M test at an inspection station. Of these vehicles, 186,539 (84.7%) owners took advantage of the Clean Screen exemption.

Two methods were used to qualify vehicles, 2-RSD and RSD-LEI. 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 'RSD-LEI' 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 3,648 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

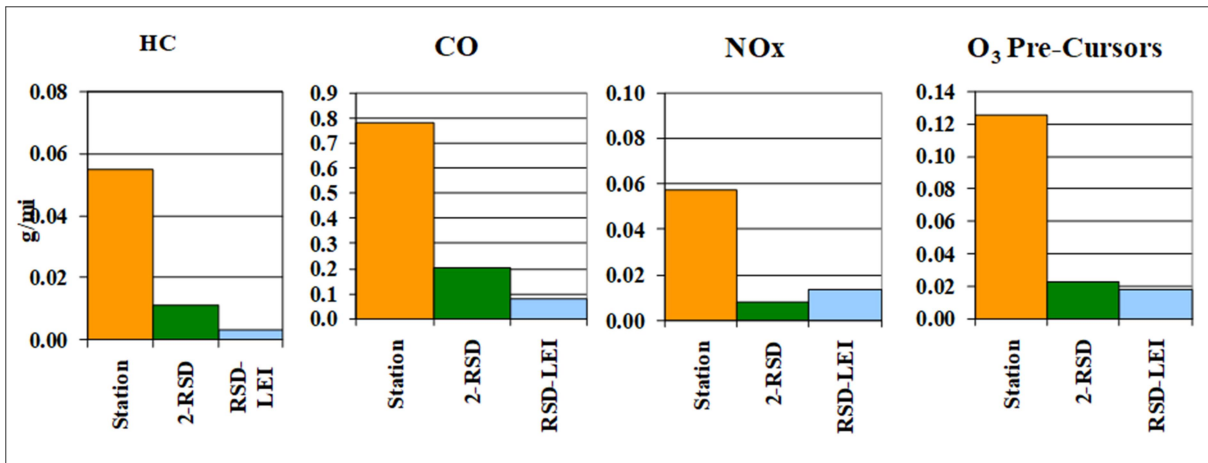
In a Clean Screen program, some vehicles passing the clean screen emissions criteria might have failed if inspected at an inspection station. Therefore, a Clean Screen program, while greatly improving convenience for vehicle owners, can slightly reduce the overall effectiveness of the I/M program.

On May 5th 2008, IM240 Denver Metro Area station test standards were tightened – especially for HC and NO_x – to bring them into closer alignment with EPA final standards. RSD standards were updated in October 2010 with the addition of an RSD NO standard of 1000ppm that first applied to December 2010 registrants. The Low Emitter Index (LEI) is updated annually using inspection results from the prior year. In 2015, the required LEI pass rate was changed to 96% and for 2016 the LEI was updated with fail rates from OBD tests introduced in 2015 for eight to eleven year old vehicles.

For 2016, based on the 2% random audit vehicles, it was projected that 96.6%, 94.6% and 94.3% of HC, CO and NO_x of program exhaust emission reductions were retained. The impact on gas cap related evaporative emissions was projected to be another 1.1% of HC reductions.

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. Ozone precursors were calculated as the sum of HC, NO_x and one sixtieth of CO emissions. The RSD-LEI audit sample showed a smaller impact on ozone precursor reductions than the 2-RSD method.

Figure I-1 Average IM240 Emissions Reductions g/mi



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 was better 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 11². 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 low probability of failing. The requirement for a vehicle group to qualify as a potential low emitter is they must have an I/M240 or OBD pass rate of 96% or greater. Individual vehicles within the group must also pass the RSD measurement cutpoints.

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

Envirotest was contracted to operate the enhanced program by a competitive bid process and Clean Screen is part of the current contract for the Denver Metro Area and the North Front Range. Envirotest uses technology derived from that originally developed at Denver University with whom Envirotest 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, CO₂, 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 AccuScanTM. Successor RSD 4000 units were introduced in 2003. Both systems were based on a technical platform developed at the University of Denver by Dr. Donald Stedman. In 2007, additional RSD4600 units were added. The RSD4600 had a more compact speed and acceleration measurement bar and more diagnostic ports. Functionally, the two systems were the same. RSD 5000's, the latest generation of RSD systems, passed acceptance testing in 2011 and began data collection in December 2011. Five additional 5000 units were added in 2013 and 2014. In 2015 and 2016, RSD5000's were used to perform measurements with up to 22 units deployed at one time. The RSD 5000 is more compact, requires less power, can run on batteries instead of a generator and supports remote wireless operation.

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 CO₂. Dispersive ultraviolet (UV) spectroscopy is used to measure NO_x. 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 standard RSD5000 unit:

- Main box:
 - Enclosed Source/Detector Module (SDM) with Internal Gas
 - Calibration Cell and embedded Weather Station
 - Network Speed/Acceleration System (S/A)
 - Central System Control Unit (SCU)
 - Battery power supply
- Enclosed Corner Cube Mirror (CCM); Sapphire Windows
- Network Video Camera for License Plate Capture
- Remote Sensing Windows based Software
- Tag Editing and Data Processing Software
- Calibration and auditing subsystem consisting of:
 - Calibration gas cell
 - Audit tube

- Audit gas bottle
- Pressure regulator
- Hoses with quick disconnects

Chevy express 3500 cargo vans outfitted with a winch are used to deploy and recover the RSD5000 systems efficiently. Once a unit is lowered to the ground it is placed on a two wheel hand cart and moved to the location where it will test. Deploying the equipment from the smaller cargo van allows operators to be further away from traffic while setup is in progress. Also, not having a van permanently at each test site has improved overall safety. Setup time has been reduced from 45 minutes to thirty minutes or less for each unmanned unit. End of day shutdown of a test site has been reduced from 30 minutes to 10 minutes or less. The reductions in setup and shutdown time leave greater active vehicle measurement time per shift. Up to three RSD 5000 units can be deployed and managed by a single operator.





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 RSD units comply with the CDPHE, "Colorado On-road Vehicle Emissions Remote Sensing System (COVERS) Specifications" Amended July 2010³: The COVERs accuracy specifications are consistent with the California BAR OREMS Specification:¹ and include:

Detector accuracy:

1. The CO₂% reading shall be within $\pm 10\%$ of the Certified Gas Sample, or an absolute value of ± 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 ± 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 ± 250 ppm (whichever is greater). Negative values shall be included and shall not be rounded to zero.
4. The NO_x reading (ppm) shall be within $\pm 15\%$ of the Certified Gas Sample, or an absolute value of ± 250 ppm (whichever is greater). Negative values shall be included and shall not be rounded to zero.

¹ 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.

5. COVERS shall submit readings within the following limits:
CO + CO₂ ≤ 21.0 %, HC ≤ 35,000 ppm hexane, CO₂ ≤ 16.0 %, and NO ≤ 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 CO₂ molecules seen, the average number of CO₂ 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:
CO₂%
CO %
HC ppm hexane
NO ppm

Speed and Acceleration Accuracy:

1. The vehicle speed measurement should be accurately recorded within ± 1.0 mile per hour.
2. The vehicle acceleration measurement should be accurately recorded within ± 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 passing 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.

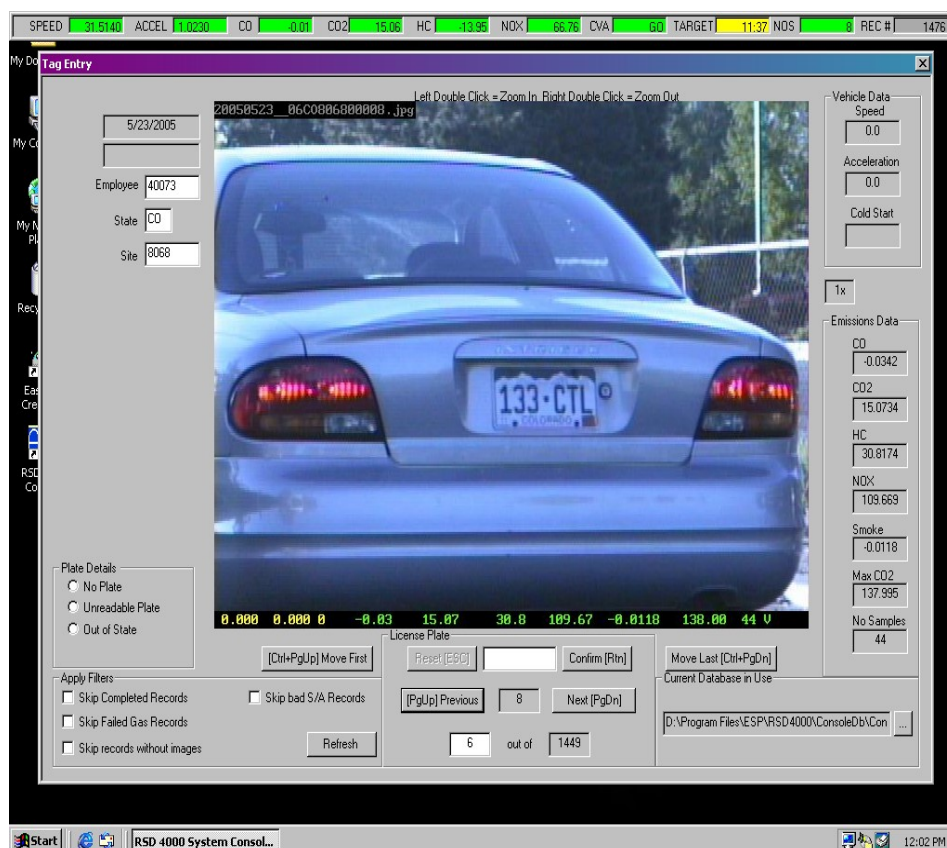
Envirotest's TagEdit™ software is used to transcribe vehicle license plate information. Figure II-1 below shows an example of a TagEdit™ screen. This license plate editing service is superior to an automatic license plate reader because:

- 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 Envirotest 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



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 siting 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 (NFR), 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.

Table II-2 lists the Denver Metro Area (DMA) site locations.

Site locations in the NFR and DMA are illustrated in Figures II-2a and II b. Blue sites are active. 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

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	1	4	546	134
3017	EB TRILBY ROAD EAST OF SHIELDS STREET	FORT COLLINS	14	89	15,527	174
3019	ON RAMP TO NB I-25 FROM 402 (CR-54)	LOVELAND	18	117	13,879	119
3020	ON RAMP TO SB I-25 FROM 402 (CR-54)	LOVELAND	16	110	13,528	123
3508	ONRAMP TO NB I-25 FROM HARMONY RD.	FT. COLLINS	56	333	60,167	181
3509	ONRAMP TO NB I-25 FROM PROSPECT RD.	FT. COLLINS	20	133	5,473	41
3512	SB TIMBERLINE RD. JUST BEFORE WILLOW SPRINGS RD.	FT. COLLINS	20	134	32,612	244
3513	NB SHIELDS RD. AFTER BON HOMME RD.	FT. COLLINS	22	115	5,971	52
3514	NB TAFT HILL RD. AFTER HARMONY RD.	FT. COLLINS	26	182	39,174	215
3515	ONRAMP TO NB I-25 FROM WB US-34	FT. COLLINS	23	143	28,010	196
3516	ONRAMP TO NB I-25 FROM CROSSROADS BLVD.	FT. COLLINS	28	172	25,144	147
3517	ONRAMP TO SB I-25 FROM CROSSROADS BLVD.	FT. COLLINS	29	223	28,274	127
3527	EB 392 AFTER INTERSECTION WITH CR-9	FT. COLLINS	12	69	11,838	173
8042	ONRAMP TO SB I-25 FROM EAST PROSPECT	FT COLLINS	16	109	28,868	266
8049	ONRAMP TO SB I-25 FROM HARMONY RD	FT COLLINS	30	219	60,088	274
2989	EB US 34 BYPASS FROM 23RD AVE	GREELEY	7	46	6,609	144
3506	ONRAMP TO NB US-85 FROM HWY 52	FT. LUPTON	27	204	14,263	70
3507	ONRAMP TO SB US-85 FROM HWY 52	FT. LUPTON	9	69	10,083	145
3518	ONRAMP TO SB I-25 FROM SR-60	LOVELAND	18	133	9,679	73
3519	ONRAMP TO SB I-25 FROM SR-56	BERTHOUD	39	270	11,765	44
3520	ONRAMP TO SB I-25 FROM SR-66	LONGMONT	26	146	16,724	114
3521	ONRAMP TO SB I-25 FROM SR-52	LONGMONT	16	119	29,994	253
3522	ONRAMP TO SB I-25 FROM CR-8	DACONO	6	34	3,081	90
3523	ONRAMP TO NB I-25 FROM CR-8	DACONO	1	5	11	2
3524	ONRAMP TO NB I-25 FROM SR-52	LONGMONT	24	163	15,679	96
3525	ONRAMP TO NB I-25 FROM SR-119	LONGMONT	24	160	26,759	168
8044	ONRAMP TO EB US-34 FROM SH-257	GREELEY	25	195	25,627	131
8045	ONRAMP TO EB US-34 BYPASS FROM SH-257	GREELEY	18	143	17,796	124
Subtotal			571	3,839	557,169	145

Table II-2 Denver RSD Sites

Site Code	Location	City	Active Days	Total Active Hours	Registered Vehicles Measured	Veh's Per Hour
2169	ONRAMP TO NB I-25 FROM 136TH AVE.	THORNTON	4	19	1,860	96
2819	ONRAMP TO SB 121 FROM WB 287	WESTMINSTER	38	299	73,011	244
2821	ONRAMP TO NB I-25 FROM 120TH AVE	WESTMINSTER	8	57	11,350	198
2971	EB DILLON RD EAST OF US-287	BROOMFIELD	42	273	51,899	190
4198	ON RAMP TO NB PARKER ROAD FROM WB ARAPAHOE ROAD	AURORA	18	132	5,844	44
4204	ON RAMP TO WB I-76 FROM US-85	COMMERCE CITY	28	183	40,636	222
4207	ON RAMP TO SB I-25 FROM 144TH AVE	WESTMINSTER	4	31	2,721	86
4209	ON RAMP TO NB US-85 FROM CO-7	BRIGHTON	9	50	4,004	80
4210	EB 160TH AVE (CO-7) PAST RIVERDALE ROAD	THORNTON	7	38	3,712	98
4211	ON RAMP TO SB US-85 FROM CO-7	BRIGHTON	11	63	8,701	137
4313	ONRAMP TO WB I-70 FROM NB I-25	DENVER	51	335	131,089	391
8072	ONRAMP TO NB I-25 FROM 84TH AVE.	THORNTON	7	44	5,786	133
8073	ONRAMP TO NB I-25 FROM 104TH AVE.	NORTHGLENN	14	103	23,125	225
8087	ONRAMP TO WB I-70 FROM AIRPORT BLVD.	AURORA	33	254	41,788	165
8088	ONRAMP TO WB I-76 FROM 88TH AVE	COMMERCE CITY	28	148	11,240	76
8089	ONRAMP TO WB I-76 FROM 96TH AVE	COMMERCE CITY	26	170	25,091	148
8090	ONRAMP TO EB I-76 FROM PECOS ST.	DENVER	3	22	2,194	100
8091	ONRAMP TO WB I-76 FROM BROMLEY LN.	BRIGHTON	4	30	5,067	169
8093	ONRAMP TO WB I-70 FROM NB I-25	DENVER	136	843	415,054	492
8107	ONRAMP TO WB US-36 FROM BROADWAY	DENVER	43	319	106,514	334
8115	ONRAMP TO EB I-76 FROM FEDERAL BLVD	DENVER	6	34	2,494	73
8125	ONRAMP TO NB I-25 FROM THORNTON PKWY	THORNTON	6	34	2,936	86
8129	ONRAMP TO WB I-76 FROM PECOS ST	DENVER	17	92	13,622	149
2170	ONRAMP TO NB I-225 FROM BELLEVIEW AVE.	CHERRY HILLS	6	41	4,245	105
4200	ON RAMP TO NB SANTA FE FROM BELLEVIEW AVE	ENGLEWOOD	69	664	216,825	326
8095	ONRAMP TO SB I-225 FROM ILLIFF AVE.	AURORA	35	285	17,784	62
8098	ONRAMP TO NB I-225 FROM ILLIFF AVE	AURORA	44	381	57,239	150
8120	ONRAMP TO SB I-225 FROM ALAMEDA AVE	AURORA	36	296	45,444	153
2512	ONRAMP TO NB SH-157 FROM PEARL ST.	BOULDER	36	272	18,730	69
2513	ONRAMP TO SB DIAGONAL HWY FROM NB BOULDER RD	BOULDER	2	12	290	23
2514	ONRAMP TO 96TH AVE FROM SH-42.	BOULDER	2	11	1,481	130
8057	ON-RAMP TO SB SH 157 FROM PEARL ST.	BOULDER	31	209	33,550	161
8064	ONRAMP TO NB SH 157 (FOOTHILLS PKAY) FROM EB TABLE MESA	BOULDER	31	264	36,760	139
4205	WB DILLON ROAD BEFORE CO-287	BROOMFIELD	44	228	23,522	103
4206	EB 144TH AVE BEFORE ZUNI	BROOMFIELD	4	27	2,192	80
2171	ONRAMP TO WB I-70 FROM PECOS ST.	DENVER	1	5	154	32
2177	ONRAMP TO NB I-25 FROM EB I-76	DENVER	3	26	4,942	192
2179	ONRAMP TO EB I-70 FROM SB SHERIDAN BLVD	DENVER	3	27	1,845	67
2811	ONRAMP TO I-25 FROM WB SPEER	DENVER	65	469	90,459	193
3503	ONRAMP TO EB I-70 FROM QUEBEC ST.	DENVER	1	8	2,882	368
3505	ONRAMP TO WB I-70 FROM QUEBEC ST.	DENVER	74	534	156,667	293
8059	ONRAMP TO NB SANTA FE FROM US-285 (HAMPDEN AVE)	ENGLEWOOD	10	85	6,430	75
8060	EXIT LOOP TO NB SPEER BLVD FROM NB I-25	DENVER	2	12	2,065	174
8062	ONRAMP TO EB I-70 FROM FEDERAL BLVD	DENVER	56	382	67,907	178
8094	ONRAMP TO SB US-285 (HAMPDEN AVE) FROM FEDERAL BLVD	SHERIDAN	71	589	108,265	184
8096	ONRAMP TO NB US-285 (HAMPDEN AVE) FROM FEDERAL BLVD.	SHERIDAN	55	387	64,910	168
8113	ONRAMP TO SB US-285 (HAMPDEN AVE) FROM SHERIDAN BLVD.	DENVER	23	180	29,159	162
8122	ONRAMP TO NB I-25 FROM PARK AVE	DENVER	74	494	132,139	267
8123	ONRAMP TO NB I-25 FROM 58TH AVE.	DENVER	64	410	85,450	208
2319	ONRAMP TO EB C-470 FROM LUCENT BLVD	HIGHLANDS RANCH	49	448	79,948	178
2320	ONRAMP TO EB C-470 FROM BROADWAY	HIGHLANDS RANCH	107	842	337,841	401
2321	ONRAMP TO EB C-470 FROM UNIVERSITY BLVD	HIGHLANDS RANCH	64	445	128,332	288

Table II-2 Denver RSD Sites continued

Code	Location	City	Days	Active	Vehicles	Per
2322	ONRAMP TO WB C-470 FROM UNIVERSITY BLVD	HIGHLANDS RANCH	37	235	40,607	173
2574	ONRAMP TO NB I-25 FROM WB COUNTY LINE RD.	HIGHLANDS RANCH	5	28	2,638	94
2576	ONRAMP TO SB I-25 FROM EB COUNTY LINE RD.	HIGHLANDS RANCH	51	452	90,982	201
2577	ONRAMP TO NB I-25 FROM EB COUNTY LINE RD.	HIGHLANDS RANCH	90	695	209,900	302
4197	ON RAMP NB I-25 FROM WB RIDGEGATE PKWY	LONE TREE	21	150	26,055	173
8077	ONRAMP TO EB C-470 FROM QUEBEC ST.	HIGHLANDS RANCH	141	1,412	678,020	480
8083	ONRAMP TO SB I-25 FROM FOUNDERS PARKWAY (EXIT 184)	CASTLE ROCK	51	405	78,822	195
8084	ONRAMP TO SB I-25 FROM LINCOLN AVE.	LITTLETON	40	317	44,579	141
8085	ONRAMP TO NB I-25 FROM WOLFENSBERGER RD. (EXIT 182)	CASTLE ROCK	52	381	130,735	343
8086	ONRAMP TO NB I-25 FROM FOUNDERS PARKWAY (EXIT 184)	CASTLE ROCK	32	249	74,096	297
2172	ONRAMP TO EB C-470 FROM BOWLES AVE.	LAKEWOOD	9	61	6,511	107
2173	ONRAMP TO EB C-470 FOM KEN CARYL AVE.	LAKEWOOD	7	53	5,103	96
2174	ONRAMP TO WB C-470 FROM WADSWORTH PKWY	LAKEWOOD	6	54	4,458	83
2175	ONRAMP TO WB C-470 FROM KIPLING ST.	LAKEWOOD	7	67	6,022	90
2176	ONRAMP TO WB C-470 FROM KEN CARYL AVE	LAKEWOOD	7	32	4,775	150
2325	ONRAMP TO EB C-470 FROM QUINCY AVE	LAKEWOOD	7	61	5,426	90
2327	ONRAMP TO WB I-70 FROM WB US-6TH AVE	GOLDEN	29	177	28,468	160
2400	ONRAMP TO WB C-470 FROM NB US-285 (HAMPDEN AVE)	LAKEWOOD	10	69	11,645	168
2457	ONRAMP TO EB US-6TH AVE FROM SIMMS ST	LAKEWOOD	1	6	1,255	228
2458	ONRAMP TO WB US-6TH AVE FROM SIMMS ST	LAKEWOOD	29	215	32,478	151
2460	ONRAMP TO EB US-6TH AVE FROM SB WADSWORTH BLVD	LAKEWOOD	1	6	721	123
2461	ONRAMP TO WB US-6TH AVE FROM NB WADSWORTH BLVD	LAKEWOOD	1	8	1,701	212
2464	ONRAMP TO WB I-70 FROM NB WADSWORTH BLVD	ARVADA	5	33	1,328	41
4199	ON RAMP TO WB C-470 FROM ALAMEDA PKWY	LAKEWOOD	11	52	5,518	107
4201	ON RAMP TO EB I-70 FROM DENVER WEST BLVD	LAKEWOOD	4	26	4,279	166
8058	ONRAMP TO WB I-76 FROM SHERIDAN BLVD.	ARVADA	15	109	20,798	190
8068	ONRAMP TO EB I-70 FROM HARLAN ST.	ARVADA	13	113	17,119	152
8069	ONRAMP TO WB I-70 FROM KIPLING ST.	WHEATRIDGE	30	207	49,713	240
8100	ONRAMP TO WB US-6TH AVE FROM SB KIPLING ST.	LAKEWOOD	3	26	3,395	132
8101	ONRAMP TO WB US-6TH AVE FROM INDIANA ST.	LAKEWOOD	29	188	24,139	128
8104	ONRAMP TO SB US-285 (HAMPDEN AVE) FROM WADSWORTH BLVD.	DENVER	25	215	27,477	128
8105	ONRAMP TO SB US-285 (HAMPDEN AVE) FROM KIPLING BLVD.	DENVER	29	200	31,686	159
8106	ONRAMP TO NB US-285 (HAMPDEN AVE) FROM KIPLING BLVD.	DENVER	27	148	26,801	181
8110	ONRAMP TO EB SH-58 FROM WASHINGTON AVE	GOLDEN	6	46	8,027	173
8112	ONRAMP TO WB C-470 FROM MORRISON RD.	MORRISON	13	78	8,043	103
8130	ONRAMP TO EB I-76 FROM SHERIDAN BLVD	ARVADA	14	78	12,681	162
8131	ONRAMP TO EB I-70 FROM SHERIDAN BLVD.	ARVADA	8	60	5,114	85
Subtotal			2,471	18,320	4,478,310	244

Figure II-2 a: Site Locations Northern Front Range

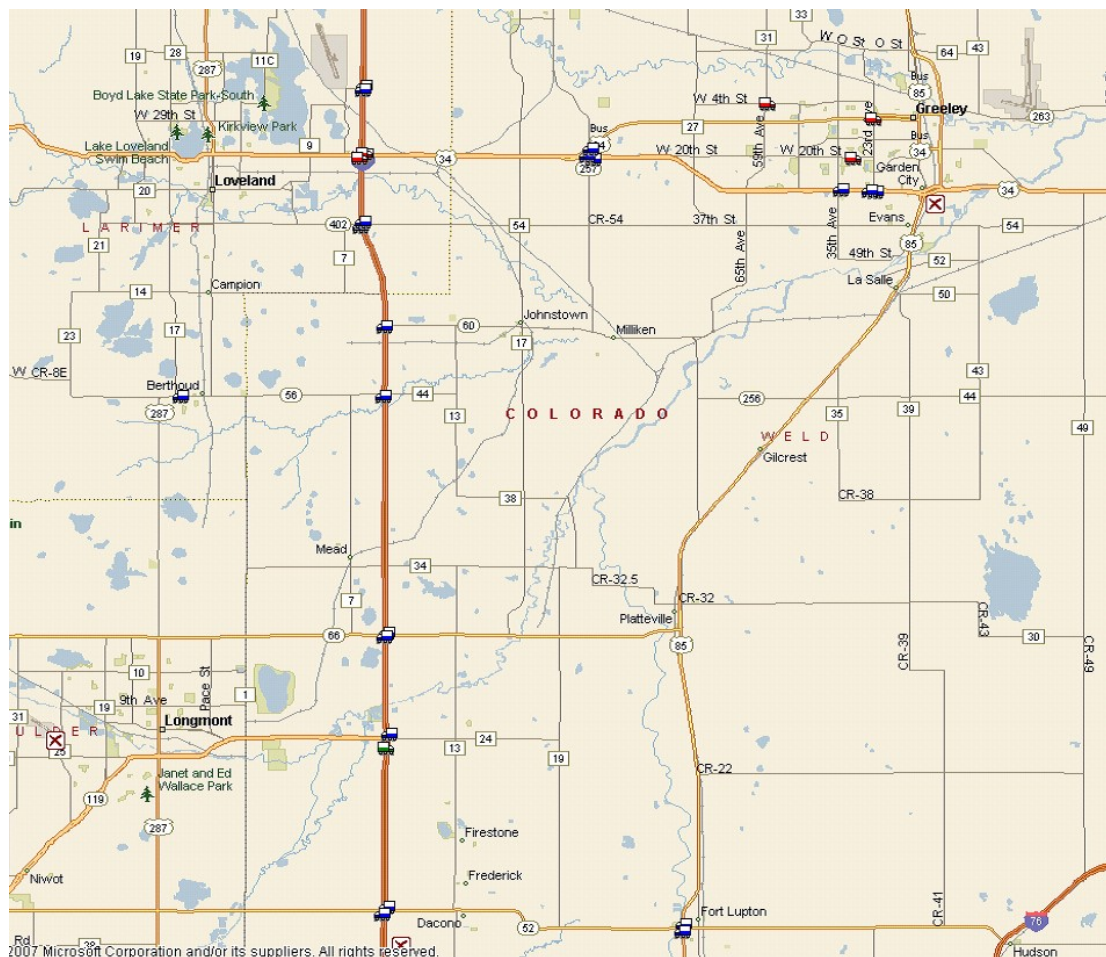
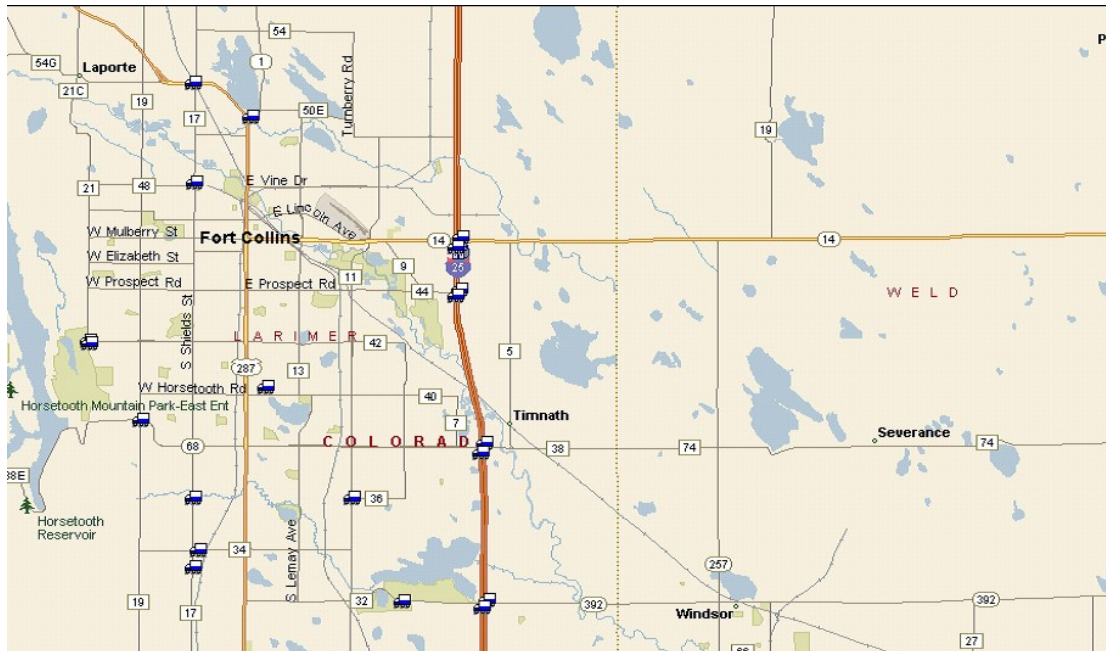
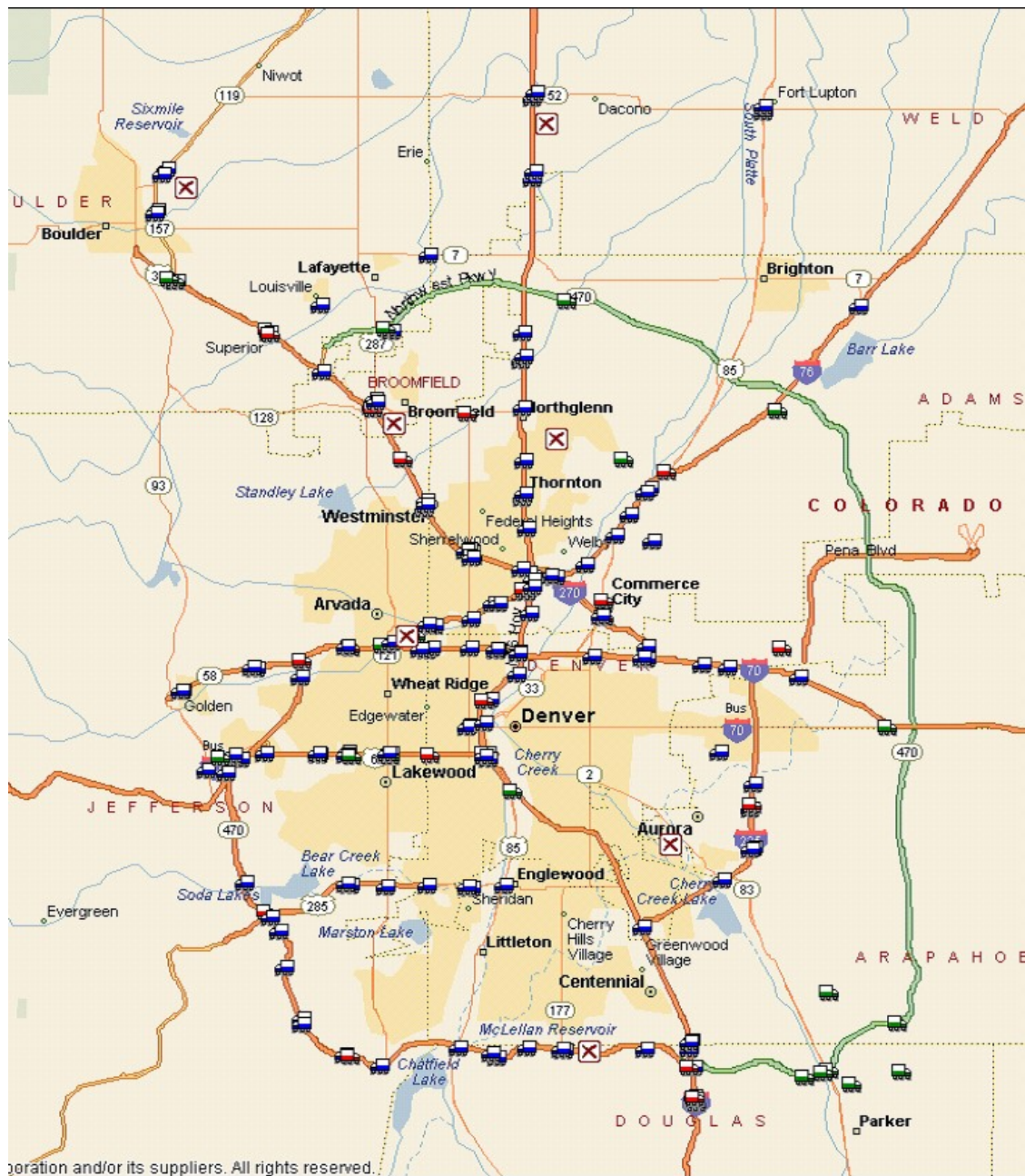


Figure II-2 b: Site Locations – Denver Metro Area



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, Envirotest. Using the vehicle plate identified by RSD, the registration file is accessed to determine the vehicle identification number (VIN) and vehicle registration information. Envirotest uses the Polk VIN Decoder to add additional information about each vehicle. The combined data fields are shown in Table II-4.

Table II-4 Vehicle Measurement Information

Field Name	Description
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

Field Name	Description
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 RSD5000 remote sensing units were deployed for 3,289 days during 2016 to collect 5.9M measurements having a visible plate and valid HC, CO, NO, speed and acceleration values: 5.1M measurements in the Denver metropolitan area (DMA) Metro Area and 0.8M measurements in the Northern Front Range (NFR).

Clean screen exemption notices were issued for 220,052 vehicles scheduled to renew their registration in 2016 and due for emissions testing (Table III-1) comprising 189,618 DMA vehicles and 30,434 NFR vehicles.

Vehicles registered in the DMA accounted for over 4.7M measurements, the NFR for 0.7M, and El Paso County) 0.1M. Another 0.2M measurements were of vehicles registered in other Colorado counties and 0.2M measurements were not matched (Table III-2).

Table III-1 Collection Summary

Collection Summary			
Statistic	Denver Metro Area	Northern Front Range	Total
Sites Used	94	30	124
Collection Van Days	2,603	686	3,289
Active Collection Van Hours	20,541	4,558	25,099
Matched to Registration	5,127,586	752,140	5,879,726
Notices Generated for 2016 renewals	189,618	30,434	220,052

A. Monthly Collection Activity

Figure III-1 shows the monthly RSD measurements. 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 7:00am and 7:00pm.

Figure III-1 Monthly RSD Measurements

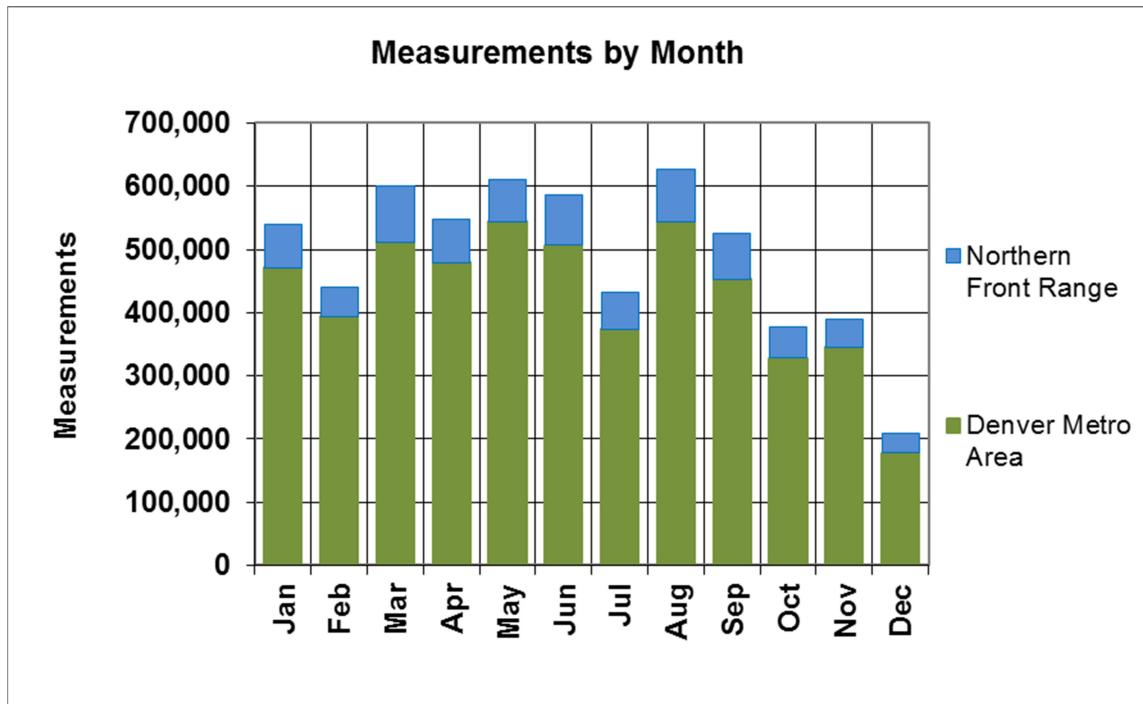
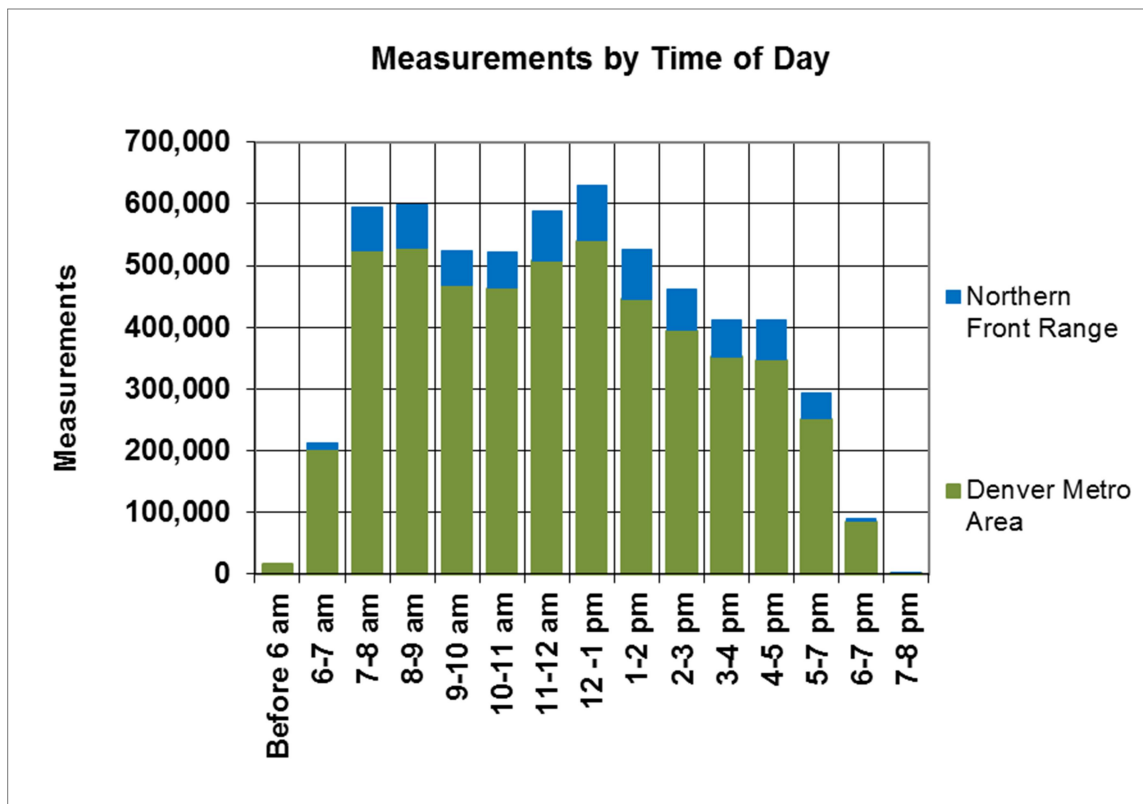


Figure III-2 Measurements by Time of Day



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 (98%) of Denver Metropolitan Area registered vehicles were measured within the DMA. A majority (85%) of Northern Front Range registered vehicles were measured in NFR with the remaining 15% being measured in the DMA.

Table III-3, Type of Vehicles Measured by RSD within Registration Jurisdiction, shows that 79.9% of vehicles measured were registered in the DMA, 11.8% in the NFR, 1.7% in El Paso County (Colorado Springs), 3.3% in other non-I/M counties, and 3.3% 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. Fourteen hundred and nine measurements of motorcycles were also recorded.

Table III-2 Source of Vehicle Registrations Measured by RSD

Program	Registered County	Measured In				Total
		Denver Metro Area		Northern Front Range		
Denver Metro Area	Adams	505,351	95%	28,698	5%	534,049
	Arapahoe	839,585	98%	16,755	2%	856,340
	Boulder	269,569	92%	22,527	8%	292,096
	Broomfield	82,402	96%	3,289	4%	85,691
	Denver	816,725	98%	20,001	2%	836,726
	Douglas	1,146,832	99%	7,290	1%	1,154,122
	Jefferson	897,435	98%	14,804	2%	912,239
	State of Colorado	23,928	88%	3,152	12%	27,080
Subtotal Denver Metro		4,581,827	98%	116,516	2%	4,698,343
Northern Front Range	Larimer	36,983	10%	345,393	90%	382,376
	Weld	69,351	22%	243,238	78%	312,589
Subtotal Northern Front Range		106,334	15%	588,631	85%	694,965
El Paso	El Paso	91,961	94%	6,166	6%	98,127
Non I/M		175,848	91%	17,619	9%	193,467
Not Matched						194,824
Total		4,955,970	84%	728,932	12%	5,879,726

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

Program	County	Pass	Truck	Unknown	Total	%
Denver Metro	Adams	158,372	369,974	5,703	534,049	9.1%
	Arapahoe	261,494	582,555	12,291	856,340	14.6%
	Boulder	99,851	189,712	2,533	292,096	5.0%
	Broomfield	30,148	55,008	535	85,691	1.5%
	Denver	260,345	564,236	12,145	836,726	14.2%
	Douglas	328,096	819,037	6,989	1,154,122	19.6%
	Jefferson	260,361	644,467	7,411	912,239	15.5%
	State of Colorado	4,146	17,286	5,648	27,080	0.5%
Denver Metro		1,402,813	3,242,275	53,255	4,698,343	79.9%
Northern Front Range	Larimer	119,924	259,444	3,008	382,376	6.5%
	Weld	96,731	212,910	2,948	312,589	5.3%
Subtotal North Front Range		216,655	472,354	5,956	694,965	11.8%
El Paso	El Paso	31,193	65,379	1,555	98,127	1.7%
Non I/M		46,993	142,226	4,248	193,467	3.3%
Not Matched					194,824	3.3%
Total		1,697,654	3,922,234	65,014	5,879,726	100.0%

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	126	28	3	10	167
	1982-1990	9,567	1,838	389	841	12,635
	1991-1995	35,396	6,820	920	1,789	44,925
	1996-2000	138,757	24,080	3,545	6,057	172,439
	2001-2005	312,017	51,428	6,781	12,314	382,540
	2006-2010	394,096	59,327	8,419	12,817	474,659
	2011 & newer	512,854	73,134	11,136	13,165	610,289
Light Truck	1981 & older	230	30	14	71	345
	1982-1990	14,595	2,651	456	2,060	19,762
	1991-1995	53,213	9,465	1,336	4,712	68,726
	1996-2000	266,734	40,396	5,881	15,126	328,137
	2001-2005	673,726	99,632	14,950	32,807	821,115
	2006-2010	836,361	120,355	16,429	35,141	1,008,286
	2011 & newer	1,397,416	199,825	26,313	52,309	1,675,863
Unknown	1981 & older	5,574	998	261	1,285	8,118
	1982-1990	620	101	47	178	946
	1991-1995	618	123	45	182	968
	1996-2000	1,444	407	85	353	2,289
	2001-2005	2,470	474	136	449	3,529
	2006-2010	3,017	506	147	502	4,172
	2011 & newer	35,822	3,154	668	990	40,634
Motorcycles		741	193	166	309	1,409
Total		4,695,394	694,965	98,127	193,467	5,681,953

IV. Clean Screening Program Performance

A. Vehicles Selected, Notices and Redemptions

In 2016, there were 227,960 vehicles qualifying for participation in the clean screen program. Table IV-1 summarizes the monthly number of vehicles meeting screening criteria each month, including 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 changing owner were likely to have obtained an earlier station inspection. Compared to the 220,052 vehicles notified in the year, fewer vehicles 186,359 (84.7%) 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
2016	Jan	345	197	16,837	17,379	2.0%
2016	Feb	337	214	16,598	17,149	2.0%
2016	Mar	375	238	18,049	18,662	2.0%
2016	Apr	359	264	17,194	17,817	2.0%
2016	May	364	465	17,165	17,994	2.0%
2016	Jun	382	281	18,339	19,002	2.0%
2016	Jul	418	297	20,231	20,946	2.0%
2016	Aug	413	320	19,774	20,507	2.0%
2016	Sep	409	355	19,492	20,256	2.0%
2016	Oct	416	285	19,991	20,692	2.0%
2016	Nov	352	191	17,326	17,869	2.0%
2016	Dec	395	236	19,056	19,687	2.0%
Total		4,565	3,343	220,052	227,960	2.0%

Table IV-2 lists the number of vehicles by month and city notified via the Department of Revenue. Table IV-3 shows inspection results of the audit sample. Of the total audit sample 0.4% failed their exhaust emissions inspection down from 0.7% in 2015 and 2.2% failed OBD. For audit vehicles of model years 2006 through 2009 subject to the OBD test but tested by IM240, fails were counted if they would have failed the OBD test. Most vehicles had either an IM240 or an OBD inspection but the denominator is the total sample. Rates by test type were therefore higher. Gas cap pressure test failures of 3.2% were up from 3.1% in 2015.

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	2,879	2,741	3,204	3,129	3,199	3,269	3,641	3,432	3,371	3,547	3,168	3,327	38,907
AURORA	1,157	1,221	1,429	1,332	1,296	1,350	1,459	1,433	1,404	1,363	1,200	1,441	16,085
LITTLETON	1,168	1,168	1,263	1,190	1,191	1,293	1,393	1,352	1,321	1,389	1,147	1,324	15,199
HIGHLAND RCH	1,005	992	961	925	866	984	1,063	1,070	1,026	1,067	856	934	11,749
FT COLLINS	833	764	845	799	812	893	1,038	1,079	1,020	1,010	878	958	10,929
ARVADA	864	821	876	781	798	811	930	914	916	916	799	904	10,330
LAKEWOOD	709	675	775	801	751	831	923	886	908	956	842	858	9,915
CENTENNIAL	700	667	707	673	672	711	800	770	783	740	723	749	8,695
THORNTON	648	652	699	652	629	690	764	680	641	626	547	637	7,865
CASTLE ROCK	550	635	623	536	543	556	709	640	628	643	514	540	7,117
PARKER	493	514	505	534	499	544	585	573	612	626	489	554	6,528
BOULDER	386	364	354	336	387	426	491	524	552	559	496	581	5,456
LOVELAND	346	350	325	347	379	430	506	481	458	499	424	483	5,028
BROOMFIELD	386	353	401	358	373	446	448	436	450	445	404	421	4,921
GOLDEN	374	343	386	369	295	352	399	403	381	400	374	357	4,433
ENGLEWOOD	323	335	331	341	322	353	335	369	360	345	332	378	4,124
LONGMONT	282	291	279	279	335	294	367	362	364	417	346	348	3,964
GREELEY	224	252	281	247	244	229	302	274	314	330	252	341	3,290
BRIGHTON	220	226	252	265	236	294	279	255	253	204	190	208	2,882
COMMERCE CITY	232	195	242	257	214	246	252	245	214	232	223	220	2,772
NORTHGLENN	147	156	168	193	168	183	201	168	155	178	153	152	2,022
MORRISON	124	122	136	118	139	144	162	153	154	161	129	136	1,678
LAFAYETTE	101	85	106	98	99	103	130	160	159	150	156	158	1,505
EVERGREEN	129	121	113	104	114	115	120	120	134	144	128	129	1,471
LONE TREE	106	94	106	114	112	111	123	102	112	115	91	111	1,297
LOUISVILLE	78	62	90	62	78	100	111	114	137	135	99	165	1,231
GREENWOOD VLG	108	96	124	82	83	86	118	102	91	94	103	128	1,215
ERIE	92	95	96	108	106	98	115	112	84	107	91	89	1,193
JOHNSTOWN	86	94	107	73	81	84	93	100	80	86	79	106	1,069
FT LUPTON	61	61	87	90	68	92	94	91	90	58	67	75	934
FREDERICK	75	71	73	57	76	89	69	76	57	58	59	70	830
CONIFER	62	55	73	49	61	71	64	63	67	54	56	52	727
HENDERSON	51	58	67	51	73	67	60	62	76	65	48	36	714
BERTHOUD	50	58	59	44	43	64	62	70	73	62	55	62	702
FIRESTONE	49	53	65	57	67	47	69	68	58	62	41	50	686
SUPERIOR	51	31	49	27	36	53	50	62	59	86	86	79	669
FEDERAL HTS	46	55	67	54	53	62	52	48	59	65	51	55	667
LARKSPUR	59	54	62	55	52	46	50	61	47	50	41	46	623
CASTLE PINES	54	46	65	57	65	61	55	41	36	50	40	51	621
OTHER	1,529	1,572	1,598	1,550	1,550	1,661	1,749	1,823	1,788	1,897	1,549	1,743	20,009
Total	16,837	16,598	18,049	17,194	17,165	18,339	20,231	19,774	19,492	19,991	17,326	19,056	220,052

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

Vehicle Type	Vehicles	Fail Tailpipe	Fail OBD	Fail Gas Cap / Pressure	Fail Inspection
Passenger	1,224	3	27	30	61
Light Truck	2,424	13	55	87	157
Total	3,648	16	82	117	218
Percentage		0.4%	2.2%	3.2%	6.0%

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 re-inspections following an initial failure were sought through the end of February 2016. The inspections identified for audit sample vehicles and the inspection 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 2016, 2006 through 2009 models were normally inspected using OBD without a tailpipe emissions measurement and this included about half of the RapidScreen audit vehicles from these years. The method used to estimate emissions and potential emissions reductions from these is described later in this section. In aggregate, 0.4% of the tested audit vehicles failed their tailpipe emissions inspection, 2.2% failed OBD and 3.2% failed the gas cap pressure test².

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

1. Tailpipe Tested Vehicles

Over 97% of the clean screen audit vehicles were tested using either the OBD or IM240 tailpipe inspection. The vast majority of the few clean screen candidates inspected using the Idle test were 2000-and-newer trucks. None of the 91 Idle tested audit vehicles failed inspection. The IM240 test provides a more accurate estimate of in-use vehicle exhaust emissions than the Idle tailpipe test. Therefore, the results of the IM240 tested clean screen audit sample was used to evaluate the exhaust emissions effectiveness of clean screen program for vehicles tested with tailpipe or OBD.

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 there was only a single test result for a particular vehicle. The expected combinations applying 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)
- U – Failed unresolved (F/null, F/F)

² 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.

- W – Failed and Waivered (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 fast-passing the IM240 inspection must be extrapolated. A method for projecting full test emissions was developed and implemented in the I/M program in 1996⁴ 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 having initial tests in late 2015 but completing repair and final test after February of the following year are treated as unresolved. In addition, a vehicle failing an initial test in year one and failing a re-inspection in January and February of year two and not subsequently obtaining a pass in year two would be counted as unresolved in both year one and year two. 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 Arizona⁵ and Colorado⁶ 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 Colorado indicate the percentage leaving the area may be as high as 80%.

To minimize the number of unresolved Clean Screen audit vehicles, retests of audit vehicles were included through the end of February 2017 and the audit vehicles were all assumed to remain in the area.

First and Final Emissions Results

Table IV-4 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 564 1985 model year passenger vehicles tested using the IM240 transient test, 13.6% of vehicles initially failed inspection and were repaired (Pass) with HC, CO and NOx reductions of 59.6%, 64.0% and 2.9%. Another 7.9% of vehicles failed their initial inspection and had not successfully passed a retest by end February 2017 (Unresolved). Reductions from these vehicles are estimated to be approximately 80% for HC, CO and NOx, because follow-up studies have shown that 80% cease operating in the area. Finally, 0.8% of vehicles were waived (Waiver) an increases in HC of 11.4%, an increase in CO of 6.4% and a NOx reduction of 6.1%. In aggregate, including vehicles passing their initial inspection, emission reductions for 1985 passenger vehicles were 31.4% for HC, 33.7% for CO and 6.3% 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.

Table IV-4 Transient Test Emission Reductions for 1982-1985 Passenger Vehicles

Appendix A1 Colorado 2016 OBD & Transient Test Emissions Reductions													
Unresolved fails remaining in area					20%								
Model	First	Last			Initial			Final			Reduction %		
Year/Type	Result	Result	Vehicles	Fail%	HC	CO	NOX	HC	CO	NOX	HC	CO	NOX
1982	Pass	-	182		1.64	19.64	2.01	1.64	19.64	2.01	0.0%	0.0%	0.0%
P	Fail	Pass	40	16.3%	4.13	47.54	2.20	1.72	20.73	2.04	58.5%	56.4%	7.4%
	Fail	Unresolv.	24	9.8%	7.71	87.92	2.24	1.48	16.39	0.47	80.8%	81.4%	78.9%
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		246	26.0%	2.64	30.84	2.06	1.64	19.50	1.86	37.9%	36.8%	9.6%
1983	Pass	-	223		1.22	12.15	2.00	1.22	12.15	2.00	0.0%	0.0%	0.0%
P	Fail	Pass	59	18.9%	4.01	56.13	1.76	1.37	14.27	1.85	65.8%	74.6%	-5.4%
	Fail	Unresolv.	28	9.0%	5.27	83.55	1.83	0.89	15.85	0.35	83.1%	81.0%	80.7%
	Fail	Waiver	2	0.6%	4.17	88.76	0.62	2.55	75.43	0.95	38.9%	15.0%	-53.5%
Total	Fail%		312	28.5%	2.13	27.37	1.93	1.23	13.29	1.82	42.3%	51.4%	5.8%
1984	Pass	-	530		1.22	11.08	1.91	1.22	11.08	1.91	0.0%	0.0%	0.0%
P	Fail	Pass	112	15.9%	2.51	33.33	1.72	1.35	13.49	1.81	46.1%	59.5%	-5.4%
	Fail	Unresolv.	59	8.4%	5.62	78.41	1.85	1.05	15.29	0.38	81.3%	80.5%	79.7%
	Fail	Waiver	5	0.7%	10.53	114.13	0.64	9.08	120.12	0.51	13.8%	-5.3%	19.7%
Total	Fail%		706	24.9%	1.86	20.97	1.86	1.29	12.59	1.76	30.9%	40.0%	5.9%
1985	Pass	-	564		0.99	10.55	1.90	0.99	10.55	1.90	0.0%	0.0%	0.0%
P	Fail	Pass	99	13.6%	2.77	27.02	2.09	1.12	9.72	2.03	59.6%	64.0%	2.9%
	Fail	Unresolv.	57	7.9%	3.73	49.18	1.79	0.71	10.05	0.35	81.0%	79.6%	80.3%
	Fail	Waiver	6	0.8%	3.10	39.26	2.51	3.45	41.76	2.35	-11.4%	-6.4%	6.1%
Total	Fail%		726	22.3%	1.46	16.07	1.92	1.01	10.66	1.80	31.4%	33.7%	6.3%

2. OBD-II Tested RapidScreen Audit Vehicles

Emissions of RapidScreen audit vehicles tested in stations using the OBD-II inspection were estimated:

- First and last inspection results for the 2016 OBD-II tested audit vehicles were determined by type and model year.
- To establish an adequate sample of representative IM240 emissions, average initial IM240 emissions by type, model year were determined from the collection of audit vehicles tested using IM240 in 2014, 2015 & 2016 grouped by their OBD result using the 2015 program rules rather than the reported IM240 test result, i.e.:
 - Vehicles failing for a reason other than IM240 emissions, e.g. gas cap = Fail
 - OBD MIL on = Fail
 - OBD Not Ready per 2015 rules = Reject OBD test and fall back to IM240 unless hybrid
 - MIL Off and Ready per 2015 rules=Pass
- The OBD result oriented average initial emissions above (referred to below as 2014/2015/2016 OBD emissions) were applied to the 2016 OBD-II audit vehicles based on their result groupings:
 - P – Passed initial test (P/null, P/P, P/F, P/W) – initial and last emissions set to 2014/2015/2016 OBD initial pass emissions.
 - R – Failed and successfully repaired (F/P):
 - initial emissions set to 2014/2015/2016 OBD initial fail emissions;
 - last emissions set to 2016 random IM240 OBD initial pass emissions.
 - U – Failed unresolved (F/null, F/F):
 - initial emissions set to 2014/2015/2016 OBD initial fail emissions;
 - last emissions set to 2014/2015/2016 OBD initial fail emissions.
 - W – Failed and wavered (F/W):
 - initial emissions set to 2014/2015/2016 OBD initial fail emissions;
 - last emissions set to 2016 random IM240 OBD initial fail emissions.

IM240 emissions from tests of 2014/2015/2016 RapidScreen audit tests were used to estimate emissions of 2016 RapidScreen audit vehicles tests using OBD-II because:

- There was an insufficient sample of 2016 RapidScreen audit vehicles randomly tested using IM240;

- RapidScreen audit vehicles were known from previous years to have materially lower emissions than the general population of station tested vehicles; and
- Vehicles passing RapidScreen in 2014 and 2015 had to meet the same on-road emissions criteria and were expected to have similar emissions to those passing RapidScreen in 2016.

3. OBD-II RapidScreen Audit Vehicles Tested by IM240

In 2015, virtually all OBD-II audit vehicles were tested using the OBD test. In 2016 the procedure was changed to test audit vehicles with IM240 in order to obtain more complete emissions values. However, vehicles passing IM240 that would have failed OBD were not retested. Even vehicles passing an IM240 retest might have failed an OBD retest. Therefore, final emissions assuming an OBD test regime had to be estimated.

Initial tests were categorized into two groups according to their OBD oriented test result; Pass, Reject or Fail. Initial emissions of these groups were the average of their initial IM240 tests.

Final emissions were assumed to be:

- Pass OBD – last emissions are the same as their initial emissions;
- Fail OBD – last emissions set to 2016 random IM240 OBD initial pass emissions;
- Reject OBD - last emissions set to 2016 random IM240 OBD initial pass emissions, i.e. assumes all would return and complete their emissions test cycle.

Results for these vehicles were added to the results of ‘*OBD-II Tested RapidScreen Audit Vehicles*’ described earlier.

4. Audit Sample Reductions and Projected Impact

Table IV-5 shows the aggregate first and final results for the 97% of inspected audit sample vehicles tested using IM240 and OBD. 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 96.6%, 95.5% and 95.9% of the exhaust HC, CO and NOx reductions respectively. 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 Clean Screen Emissions Impact for Tailpipe Emissions (OBD & IM240)

	IM240 Tailpipe Emissions			
	Vehicles	HC g/mi	CO g/mi	NOx g/mi
Audit Sample	3,405			
Mean Initial		0.083	1.725	0.235
Mean Final		0.074	1.562	0.225
Emissions reduction		0.008	0.162	0.011
Clean Screens	186,359			
Potential Reductions		1,577	30,205	1,973
Station Vehicles	812,947			
Mean Initial		0.233	3.530	0.511
Mean Final		0.179	2.749	0.454
Emissions reduction		0.055	0.782	0.057
In station reductions		44,484	635,487	46,557
Combined CS & Stn	999,306	46,061	665,691	48,530
Clean Screen Impact		3.4%	4.5%	4.1%
Retained Reductions		96.6%	95.5%	95.9%

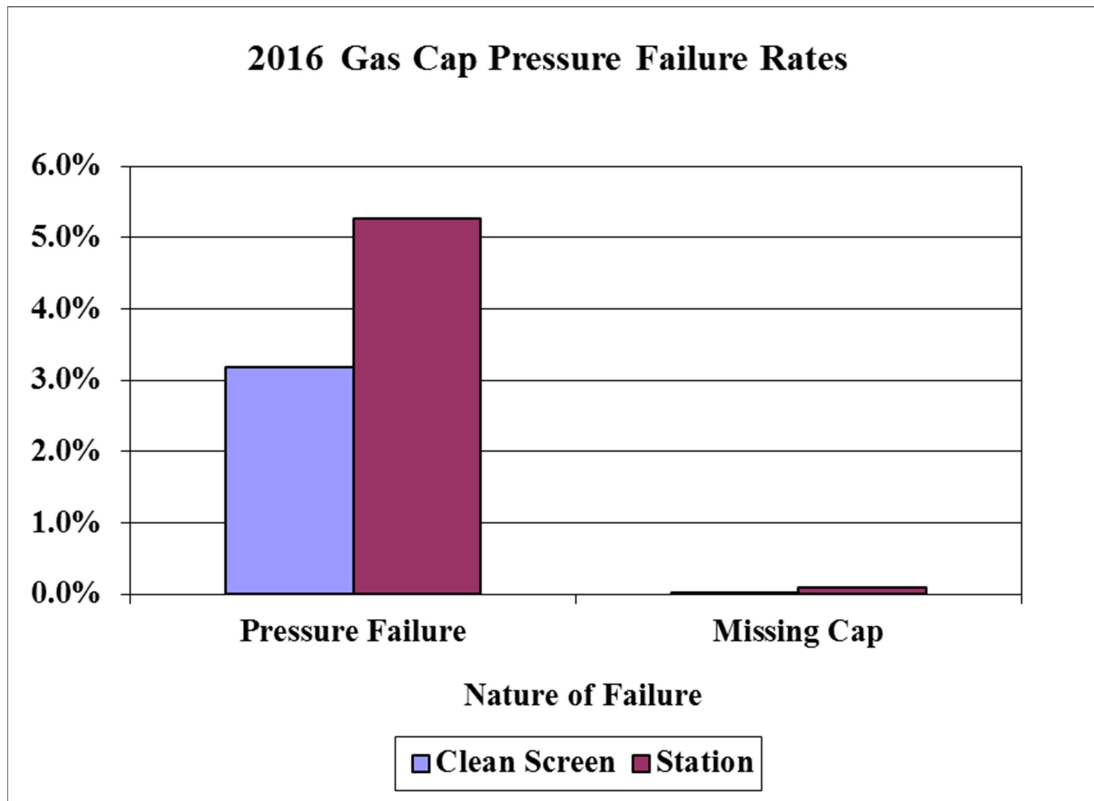
C. Gas Cap Evaporative Emissions

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 reductions³.

Figure IV-1 compares the average gas cap failure rate of the Clean Screen audit sample vehicles (3.2%) to the average failure rate of the non-audit vehicles tested at stations (5.4%). The failure rate of vehicles exempted via Clean Screen methods was 40% lower than the failure rate of vehicles receiving a station-based test (See Figure IV-1). A gas cap evaporative leak has to be quite large to be detected by RSD units. Clean screen models were newer than the overall tested fleet.

³ 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-1 Gas Cap Pressure Failure Rates



Using the fail rates identified in the audit sample, Table IV-6 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. Vehicle counts in Figure IV-6 are higher than IV-5 because they include gas cap tests on vehicles tested using idle tests as well as those tested using IM240 and OBD. Vehicles with a redeemed Clean Screen notice account for 11.2% of the total possible gas cap failures. Therefore, 88.8% 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, MOVES, was used to estimate the fraction of emissions benefits derived from gas cap inspections.

CDPHE provided results from MOVES 2016 models of the benefits of the I/M program for 2016. The projected average reduction in HC emissions of the area fleet was 0.103 g/mi. This was comprised of 0.0928 g/mi resulting from exhaust emissions inspections and 0.0102 g/mi from the Gas Cap testing, i.e. evaporative benefits were 9.9% of total HC benefits. The measured I/M exhaust reductions (see section V) were 395.5 tons and the clean screen exhaust HC impact was estimated to be 15.4 tons. Assuming the 0.0928 g/mi corresponded to 410.9

tons, the Gas Cap related HC reductions were projected to be 45.2 tons. These results are shown in Table IV-7. The RapidScreen impact was projected as 5.1 tons or 1.1% of the I/M program reductions.

Table IV-6 Clean Screen Impact on Evaporative HC Emissions

	Initial Tests	Pressure Failure	Missing Cap	Total Fails
RapidScreen Audit	3,648	116 3.2%	1 0.0%	117 3.2%
Projected RapidScreen	186,359	5,926	51	5,977
Station GC Tests	881,718	46,441 5.3%	876 0.1%	47,317 5.4%
Total Program	1,068,077	52,367	927	53,294
RapidScreen Impact	17.4%	11.3%	5.5%	11.2%
Retained Reductions	82.6%	88.7%	94.5%	88.8%

Table IV-7 Gas Cap Related Benefit Tons

		2016 MOVES g/mi HC	I/M 2016 HC tons
MOVES Estimates (from CDPHE)			
I/M Exhaust emission reductions		0.0928	410.9
Projected Gas Cap Evap Emissions reductions		0.0102	45.2
I/M Program total HC reductions		0.1030	456.1
Gas Cap Evap RapidScreen impact	11.2%	0.001	5.1
% of I/M program HC benefit			1.1%

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

Envirotest 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 2,236 vehicles screened using the 2-RSD method and 1,169 vehicles screened using Hybrid RSD-LEI method. Table IV-8 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. Ozone precursors were calculated as $\text{HC g/mi} + \text{CO g/mi} / 60 + \text{NOx g/mi}$.

The 2-RSD method audit vehicles had initial emissions that were 42%, 55% and 52% of the overall I/M fleet average for HC and CO and NOx respectively. The equivalent percentages in 2015 were 44%, 54% and 60% respectively.

The Hybrid RSD-LEI method audit vehicles had lower initial emissions that were 37%, 50% and 50% of the I/M fleet average for HC and CO and NOx respectively. The 2015 equivalents were 34%, 48% and 46% respectively.

The Hybrid RSD-LEI method had a lower overall impact on ozone precursors than the RSD-2 method., i.e. performed more effectively than the RSD-2 method.

Average reductions in station tested vehicle emissions were 26.7%, 24.5% and 12.5% for HC, CO and NOx respectively – similar to the equivalent percentages in 2015 of 26.0%, 24.1% and 11.6% respectively.

Average I/M emissions reductions for the 2-RSD audit vehicles were 5.4%, 6.4% and 1.8% of fleet average initial emissions for HC and CO and NOx respectively. Comparable percentages in 2015 were 1.7%, 1.9% and 1.7%. Part of the large increase was a 2007 vehicle with normally low NOx of 0.03 g/mi but CO emissions of 209.8 g/mi and HC emissions of 9.4 g/mi – 100’s of times higher than typical vehicles. Emissions upon re-inspection three months later were 0.4 g/mi HC and 0.8 g/mi CO giving reductions of 9.0 g/mi HC and 209.0 g/mi CO, while NOx remained low at 0.09 g/mi. Absent this single vehicle 2-RSD audit vehicle reductions would have been 3.4% for HC and 3.5% for CO with no change in the 1.8% NOx reduction. A second 2007 vehicle with HC reductions of 11.2 g/mi accounted for a majority of the remaining HC impact.

Average emissions reductions for the Hybrid RSD-LEI audit vehicles were 1.6%, 2.5% and 3.0% of fleet average initial emissions for HC and CO and NOx respectively. Comparable percentages in 2015 were 2.5%, 4.5% and 1.9%. The improvement on the LEI screen fail rates may have stemmed from the inclusion of OBD fail rates in the LEI table in 2016.

Table IV-8 Average Emissions per Vehicle

Vehicle Sample	IM240 Tailpipe Emissions				O ₃ Pre-*
	Vehicles	HC g/mi	CO g/mi	NO _x g/mi	
I/M vehicle initial mean emissions		0.205	3.194	0.460	0.718
2-RSD Audits	2,236				
Mean Initial		0.086	1.791	0.239	0.355
Mean Final		0.075	1.586	0.231	0.332
Emissions reduction		0.011	0.205	0.008	0.023
% of I/M vehicle initial mean emission		5.4%	6.4%	1.8%	3.2%
Hybrid Audits	1,169				
Mean Initial		0.075	1.591	0.229	0.331
Mean Final		0.072	1.512	0.216	0.313
Emissions reduction		0.003	0.079	0.014	0.018
% of I/M vehicle initial mean emission		1.6%	2.5%	3.0%	2.5%
All Station Tests	812,947				
Mean Initial		0.233	3.530	0.511	0.804
Mean Final		0.179	2.749	0.454	0.679
Emissions reduction		0.055	0.782	0.057	0.125
% of I/M vehicle initial mean emission		26.7%	24.5%	12.5%	17.4%

* HC + NO_x+CO/60

Figure IV-2 Average Initial IM240 Emissions

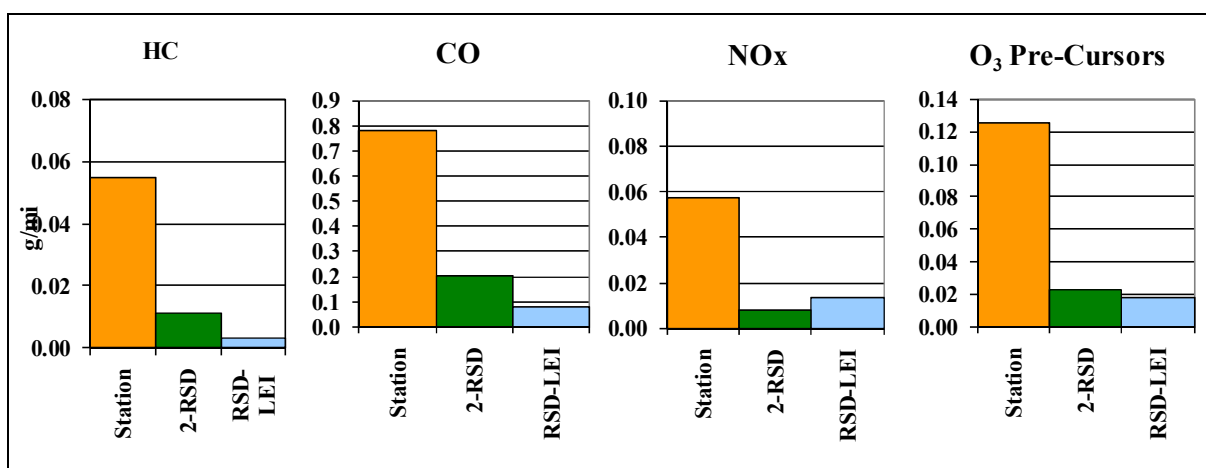
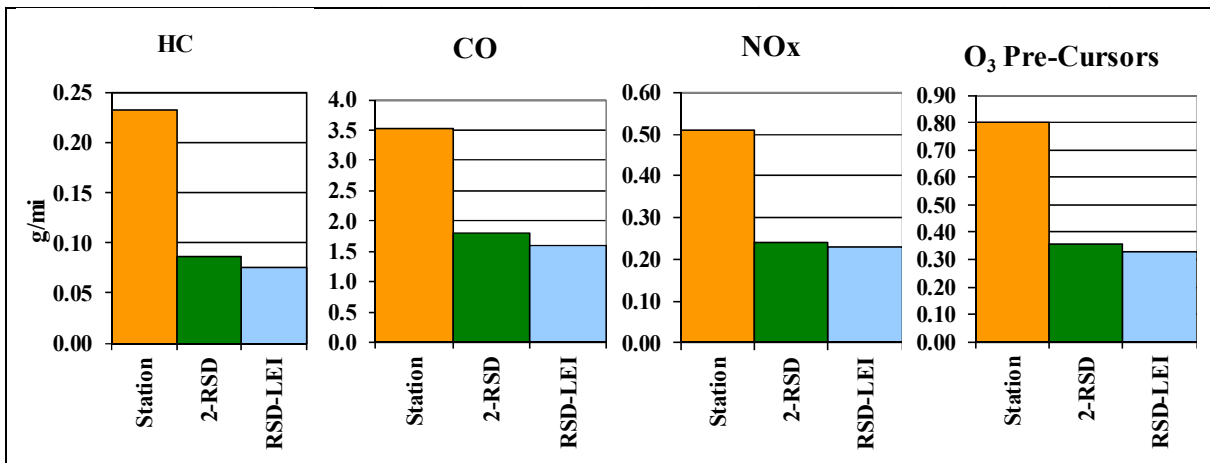


Figure IV-3 Average IM240 Emissions Reductions



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 or vehicle retirement;
- Reductions from repair activities 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, most vehicles tested were equipped with OBD-II malfunction indicator lights and many repairs of these 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 dis-benefit 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 initially failing and 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

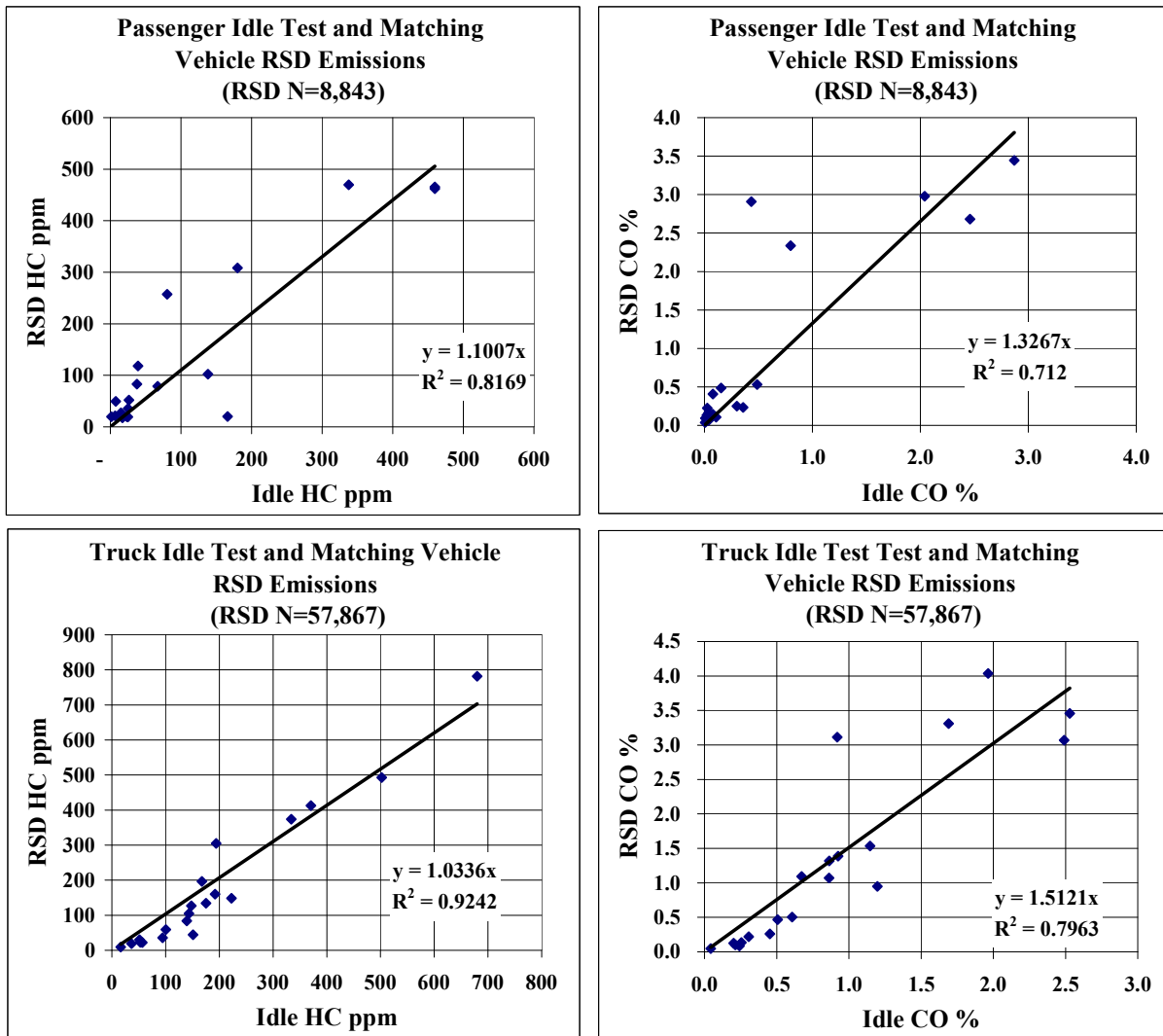


Table V-1 Low Speed Idle to IM240

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

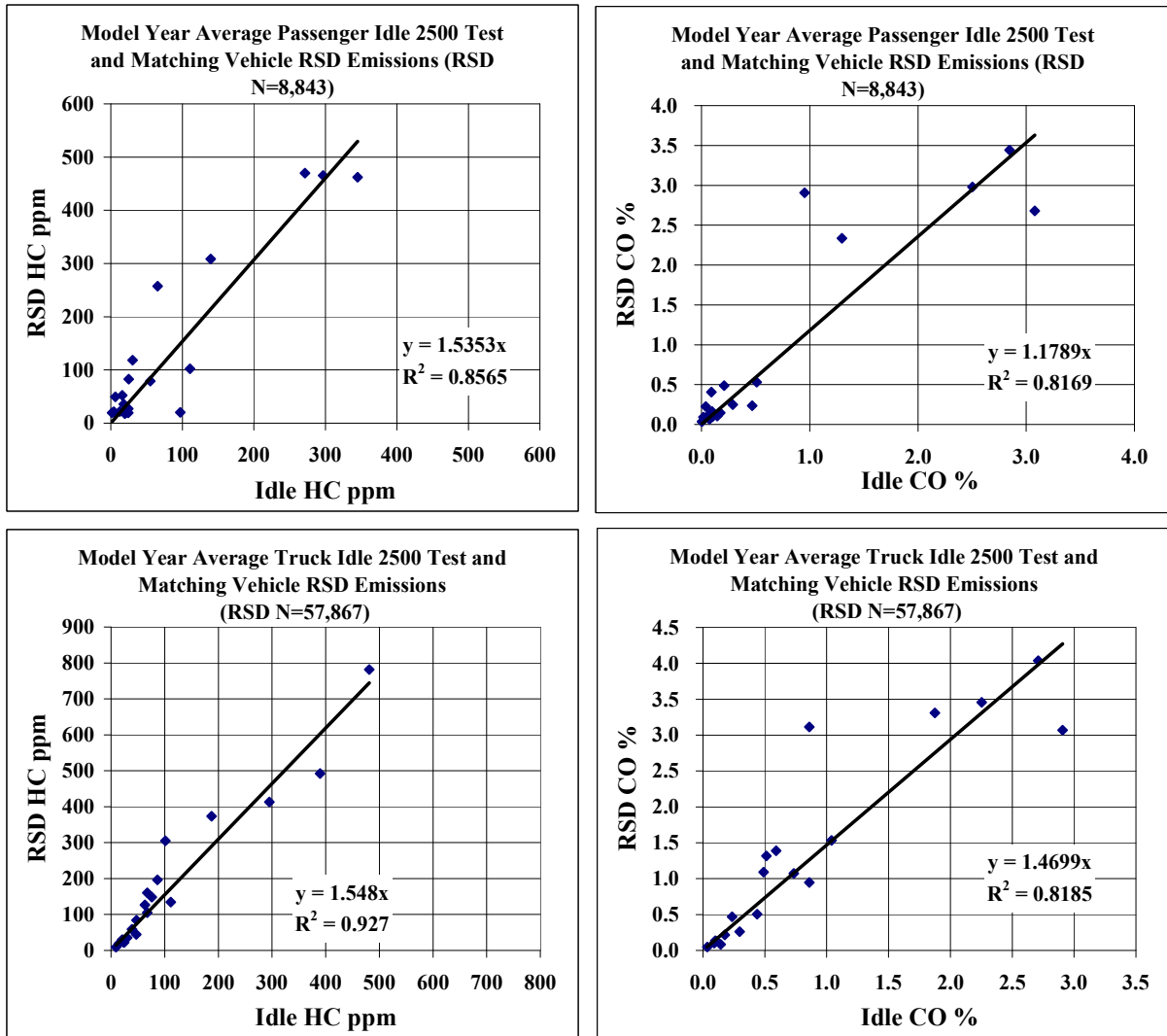
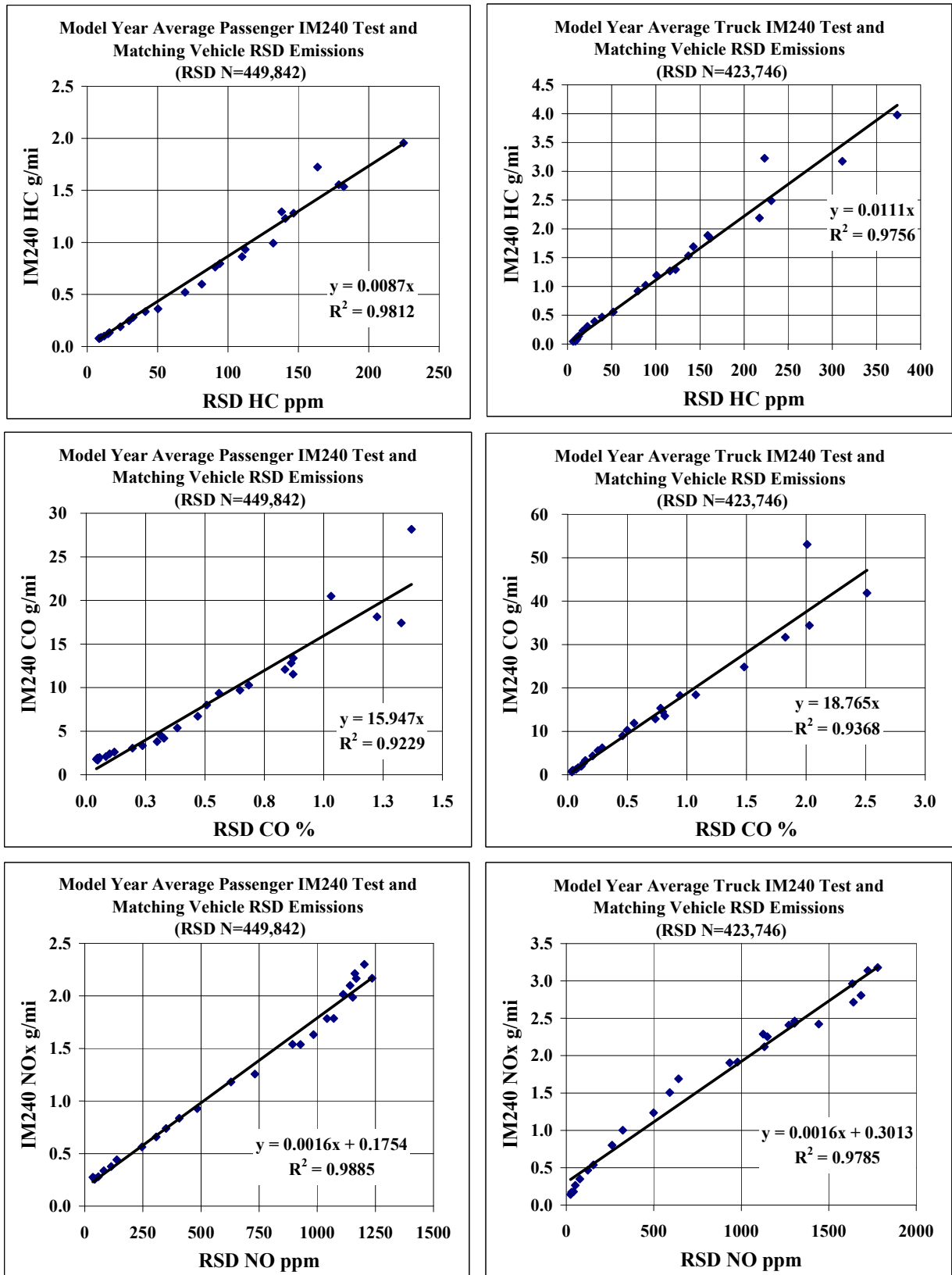


Table V-2 High Speed Idle to IM240

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. IM240 Test Emissions



B. Estimation of OBD Tested Vehicle Emissions

In 2016, a random sample of the general population of vehicles subject to the OBD test was selected for IM240 testing. The IM240 emissions from the sample were used to project the emissions of the general population of models tested using OBD.

Within the random sample, the test result from an OBD perspective (Pass, Fail, Reject) was determined by the Overall result, the Emissions result and the OBD result:

- If the OBD result was null, the vehicle was not considered
- If the vehicle passed emissions but failed for another reason the vehicle failed;
- Otherwise, the result was assumed to be the OBD result

The average initial emissions of the random sample by type, year and OBD result were used to estimate the initial and final emissions of the OBD tested vehicles:

- Initial emissions were set according to the initial result
- Final emissions of repaired vehicles were assumed to be the same as initial pass;
- Final emissions of unresolved vehicles were assumed to be the same as an initial fail;
- Final emissions of vehicles receiving a waiver were assumed to be the same as an initial fail.

The average of 2009, 2010 and 2011 & newer IM240 random test emissions were used to estimate 2012 & newer model emissions having an inadequate random sample.

C. 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 rates⁷.

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. On average, newer model year vehicles are driven more miles annually than older vehicles and, for vehicles less than 15 years old, trucks are driven more than passenger vehicles.

Table V-3 Estimated Annual Mileage in 2016

Year	LDGV	LDGT
1986	4,304	4,550
1987	4,304	4,554
1988	4,304	4,562
1989	4,434	4,583
1990	4,481	4,630
1991	4,502	4,668
1992	4,552	4,741
1993	4,780	4,851
1994	5,088	5,019
1995	5,430	5,256
1996	5,672	5,519
1997	6,002	5,824
1998	6,331	6,135
1999	6,653	6,471
2000	6,974	6,940
2001	7,369	7,437
2002	7,764	7,863
2003	8,188	8,345
2004	8,613	8,900
2005	9,032	9,502
2006	9,450	10,087
2007	9,905	10,727
2008	10,360	11,245
2009	10,746	11,817
2010	11,132	12,303
2011	11,870	12,834
2012	12,023	13,215
2013	12,307	13,433
2014	12,357	13,514
2015	11,600	12,428
2016	9,650	8,995

D. 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 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 Cap⁴ estimates are factored in. During 2016, the Clean Screen program retained 95.5%, 94.6% and 94.3% respectively of potential HC, CO and NOx emission reductions in vehicles subject to testing.

For vehicles initially tested in calendar year 2016, the I/M Program is projected to have eliminated 435.6 tons of HC, 5,475.2 tons of CO and 365.8 tons of NOx 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.

⁴ 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

Audit Vehicle Reductions (IM240 tons/yr)				
Audit Tests	Unique Vehicles	HC	CO	NO_x
Enhanced IM240 & OBD	3,405	0.28	5.73	0.38
Potential from RS Vehicles (IM240 tons/yr)				
RapidScreen	Unique Vehicles	HC	CO	NO_x
Enhanced Area	186,359	15.4	313.8	20.9
Gas Cap estimate from MOVES		5.1		
Station Reductions (IM240 tons/yr)				
Station I/M Vehicles	Unique Vehicles	HC	CO	NO_x
Enhanced IM240 & OBD	812,947	290.1	4,283.7	344.9
Enhanced Idle*	44,497	105.4	1,191.5	
Gas Cap scaled from MOVES		40.1		
	857,444	435.6	5,475.2	344.9
Total Potential Reductions		456.1	5,789.0	365.8
<i>RapidScreen Exhaust Impact</i>		<i>3.4%</i>	<i>5.4%</i>	<i>5.7%</i>
<i>Rapidscreen Gas Cap Impact</i>		<i>1.1%</i>		
Retained Reductions		95.5%	94.6%	94.3%

* NO_x is not reported for idle tests.

During calendar year 2016, 186,359 vehicles were exempted through Clean Screen, and 857,444 vehicles received a station test. Therefore, 17.9% of the 1,043,803 unique vehicles were Clean Screened.

If the fraction of Clean Screen vehicles had been 30% of vehicles subject to inspection there would have been 313,141 Clean Screens and 730,662 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 92.5%, 90.9% and 90.4% respectively of potential HC, CO and NO_x tailpipe emission reductions.

VI.IM240 Projected Emissions by Model Year

Figures VI-1 through VI-6 show the annual emissions inventories and reductions by model year and vehicle type for the vehicles clean screened and tested at stations in 2016. Emissions are based on the IM240 driving cycle. The projected IM240 equivalent 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 2010 and newer models not yet subject to inspection;
- any estimate of pre-inspection emission reductions;
- NO_x emissions for 44,497 vehicles tested with the idle test: 1981 and older models 7,609 (17%), 1982 and newer trucks 36,116 (81%), and 1982 & newer passenger vehicles 772 (2%).

Vehicles 15 years and older (model year 2001 and older), 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 VI-1 LDGV HC Reductions and Remaining Emissions

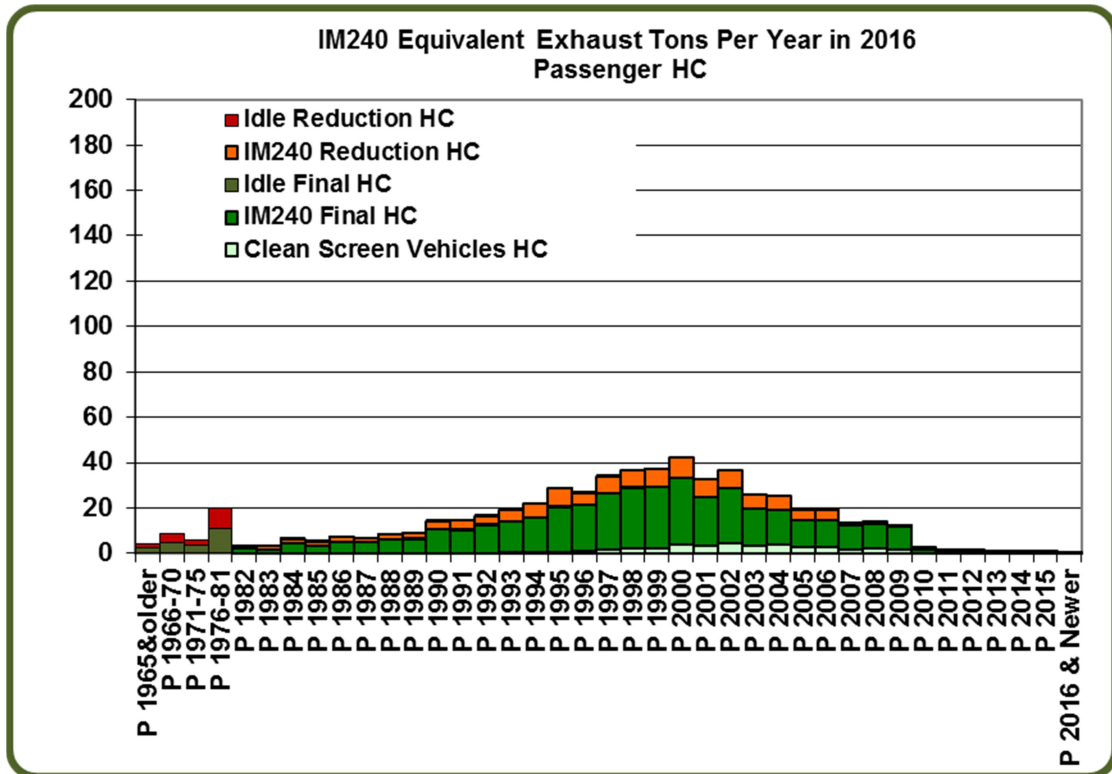


Figure VI-2 LDGT HC Reductions and Remaining Emissions

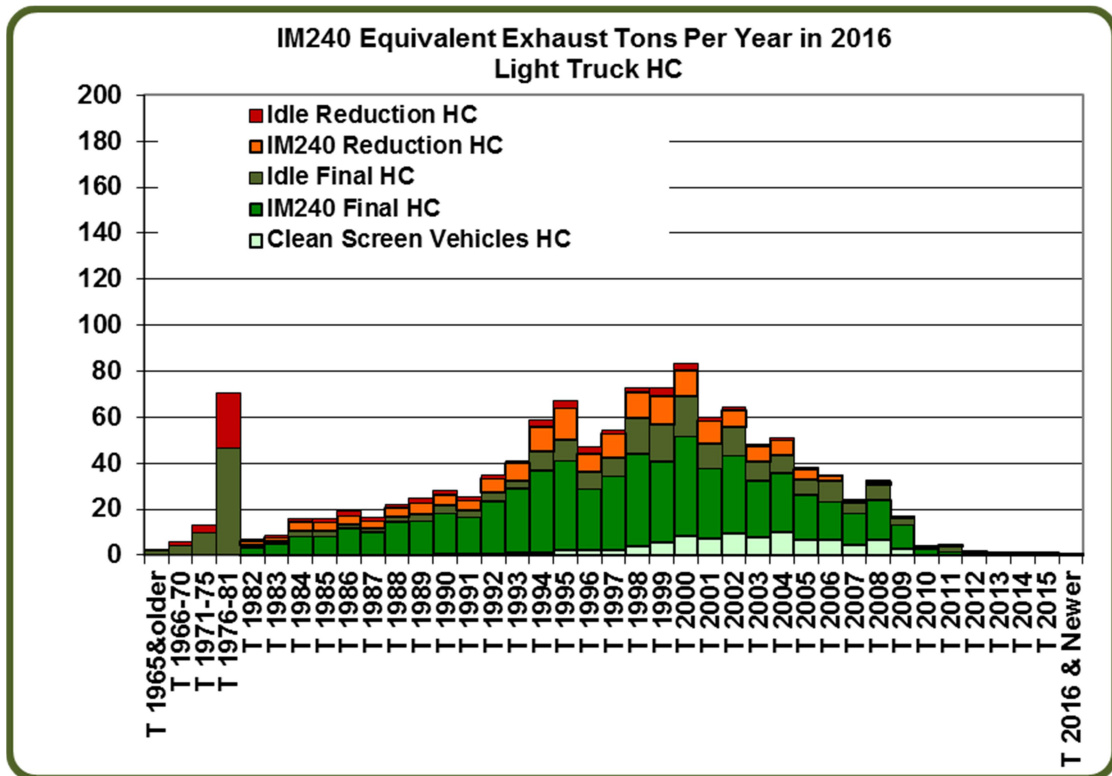


Figure VI-3 LDGV CO Reductions and Remaining Emissions

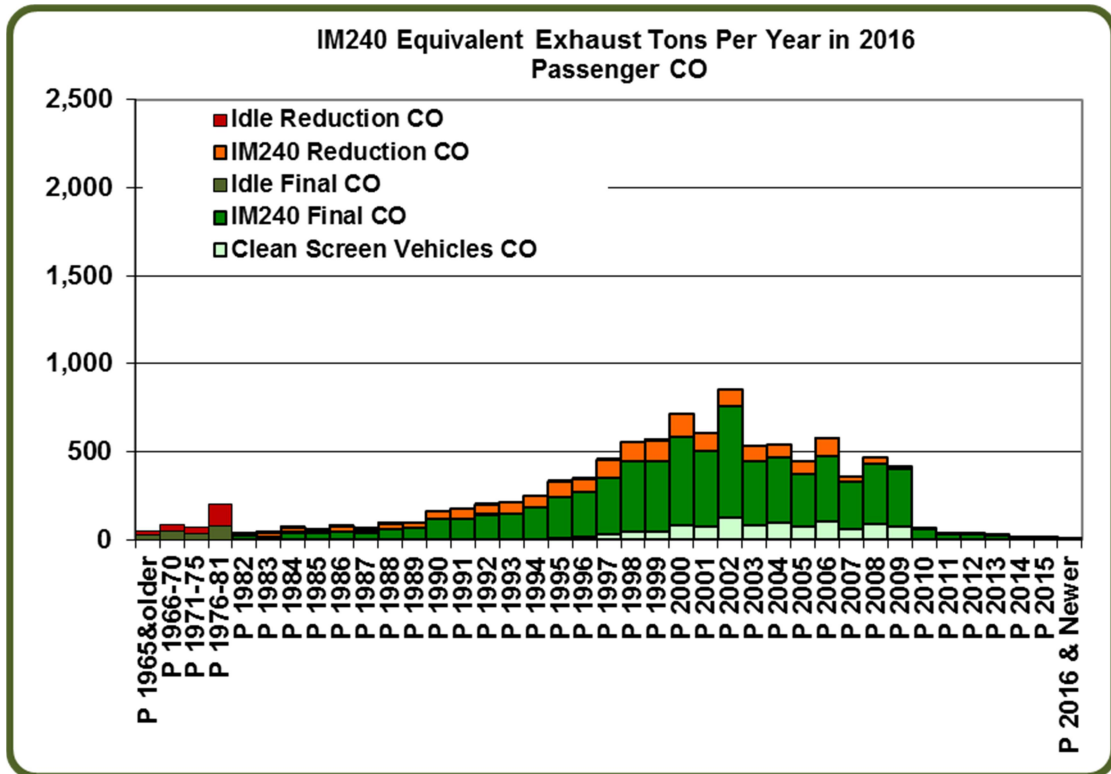


Figure VI-4 LDGT CO Reductions and Remaining Emissions

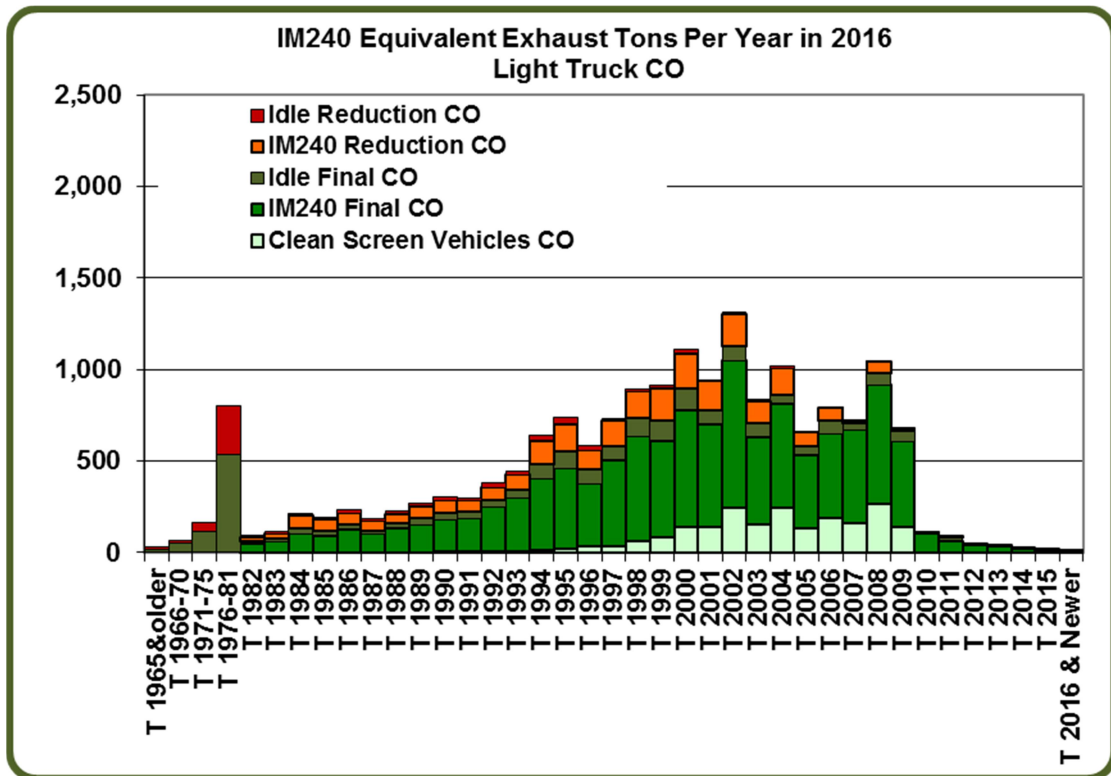


Figure VI-5 LDGV NOx Reductions and Remaining Emissions

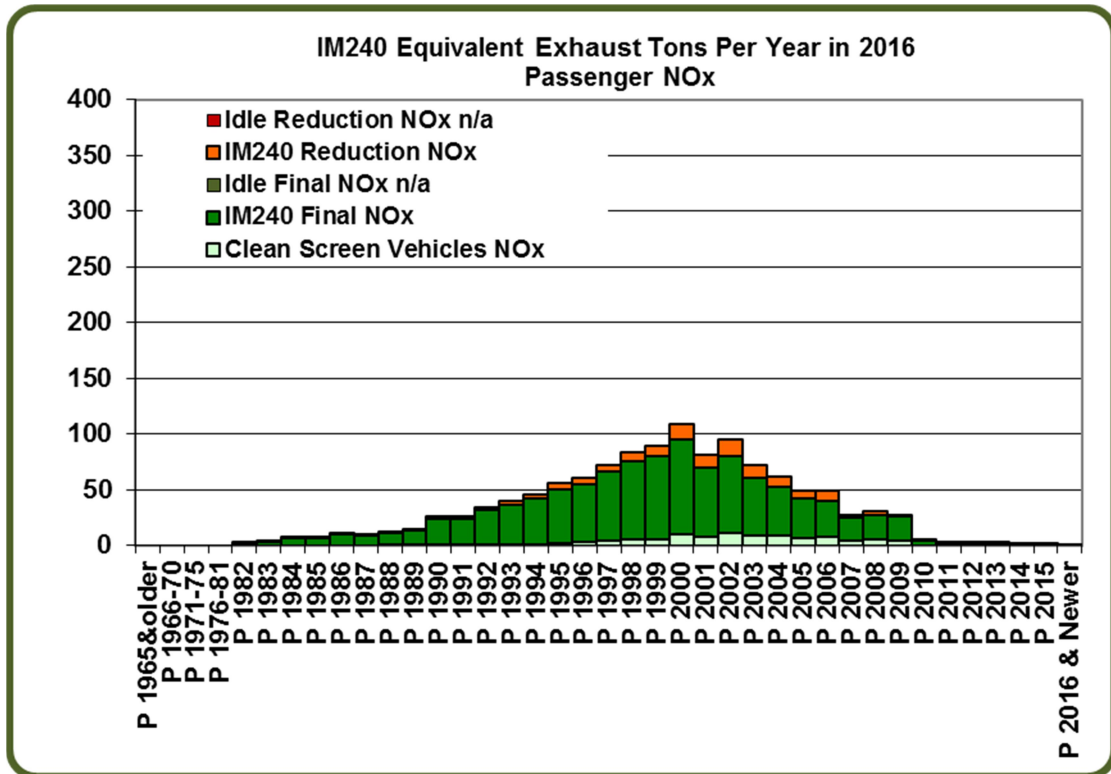
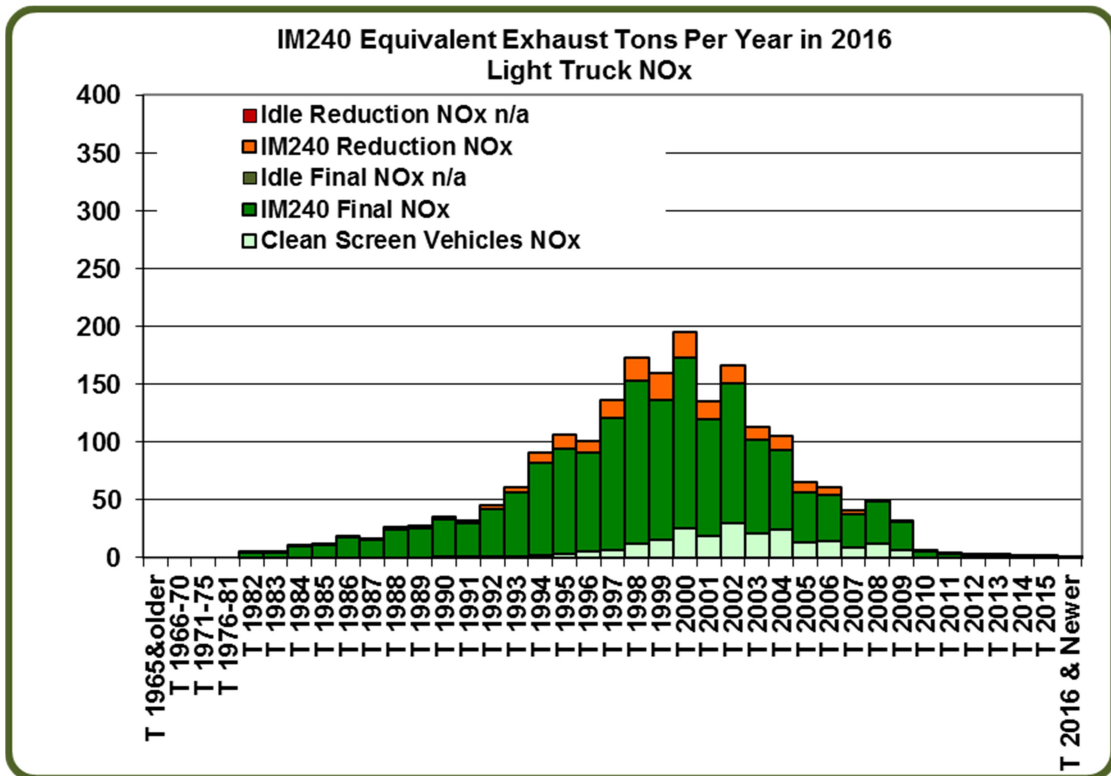


Figure VI-6 LDGT NOx Reductions and Remaining Emissions



VII. RapidScreen Benefits

RapidScreen provided benefits to vehicle owners of \$3.66M through reduced time and expense associated with eliminated inspection station visits. The elimination of station inspections also yielded net savings in emissions, greenhouse gases and 135,000 gallons of gasoline. This section summarizes the operational costs and benefits of the RapidScreen program.

A. Greenhouse Gas and Pollutants from Clean Screen Operations

The following were considered in deriving the net emissions, greenhouse gas and fuel use associated with the RapidScreen program:

- RSD van operations;
- RSD generators;
- RSD unit calibration and audit gases;
- Reductions from eliminated trips to inspection stations.

Table VII-1 summarizes these amounts.

Table VII-1 Reductions in Greenhouse Gases and Pollutants from RapidScreen Operations

Activity	HC t/yr	CO t/yr	NOx t/yr	CO2 t/yr	Fuel gal.
RapidScreen Operations					
RapidScreen operating vehicles (vans, audit trucks, maintenance)	0.220	0.419	0.028	127.7	14,318
Generators	0.071	5.04	0.000	16.0	2,467
Calibration and audit gases	0.005	0.05	0.003	0.5	
Total Rapidscreen operations	0.296	5.52	0.032	144.2	16,785
RapidScreen Vehicle Emission Reductions					
Station trip, waiting & testing	0.287	9.10	1.380	1405.6	157,582
Net benefit (cost)	(0.01)	3.58	1.348	1261.4	140,797

1. RapidScreen Operating Vehicles

Emissions and fuel usage of older RSD vans, audit trucks and maintenance vehicles associated with the RapidScreen program were developed from the average IM240 emissions of each vehicle from the most recent inspections performed from 2010 through 2016. Idle test emissions were converted to IM240 g/mi using the conversion factors described in Section V. IM240 emissions were scaled up to match MOVES estimates of running emissions vs. IM240 using scaling factors of 1.0 for hydrocarbons, 1.92 for CO and 2.23 for NO_x. For new model vans, the Tier2 standards for the G3500

Express V8 6L gasoline certification values were obtained from the EPA certification database. Odometer changes were pro-rated to provide annual mileages. Fuel use was calculated using EPA city fuel economies for the vehicle models or similar models. CO₂ tons were calculated at the rate of 8.92 x 10⁻³ tons per gallon (<http://www.epa.gov/cleanenergy/energy-resources/refs.html>).

2. Generators

The unmanned RSD 5000 units now run off battery power. For the four traditional vans, typical generator emissions and CO₂ grams over a four minute period were obtained by collecting generator emissions using lane IM240 equipment. Emissions and CO₂ grams were then multiplied by 15 to obtain g/hour and by their estimated hourly activity. Fuel gallons were back calculated from CO₂ tons.

3. Calibration and Audit Gases

Calibration and Audit Gas emissions were calculated directly from the use estimates presented in Table VII-2. The liters of calibration and audit gases at 70F and normal pressure were multiplied by the pollutant concentration percentages and by the pollutant mass per liter to obtain tons.

Table VII-2 Calibration and Audit Gas Emissions

RSD VANS	AL Cyls	BL Cyls	CL Cyls	Liters at 70F NP	CO %	CO ₂ %	HC %	NO %	HC PPM	NOX PPM	CO tons	CO ₂ tons	HC tons	NO tons
Calibration	240	30	0	1,028,820	3.00	12.90	0.15	0.15	1500	1500	0.0425	0.2874	0.0033	0.0023
2 Point Audit	80	10		342,940	0.50	14.70	0.04	0.10	400	1000	0.0024	0.1092	0.0003	0.0005
ATP / DOR														
A	12	0		47,916	0.00	15.05	0.00	0.00	0	0	0.0000	0.0156	0.0000	0.0000
F	12	0	16	61,964	5.00	11.55	0.60	0.03	6000	250	0.0043	0.0155	0.0008	0.0000
G	12	0		47,916	0.20	14.91	0.01	0.15	100	1500	0.0001	0.0155	0.0000	0.0001
H	12	0		47,916	0.30	14.84	0.02	0.10	200	1000	0.0002	0.0154	0.0000	0.0001
J	12	0	16	61,964	0.50	14.70	0.04	0.10	400	1000	0.0004	0.0197	0.0001	0.0001
K	12	0		47,916	1.00	14.34	0.05	0.03	500	300	0.0007	0.0149	0.0001	0.0000
L	12	0		47,916	1.50	13.99	0.07	0.01	700	100	0.0010	0.0145	0.0001	0.0000
Q	12	0	16	61,964	3.00	12.92	0.11	0.05	1100	500	0.0026	0.0173	0.0001	0.0000
Total	416	40	48	1,797,232							0.0541	0.5249	0.0048	0.0031

Capacities and g/l	AL Cyls	BL Cyls	CL Cyls		CO %	CO ₂ %	HC %	NO %
Cylinder L @2000psi	29.5	15.7	5.9	Mol. Wt	28	44	44	30
Liters gas at 70F NP	3993	2350	878	g/l	1.3	2.0	2.0	1.3

4. RapidScreen Vehicle Emissions Reductions

The RapidScreen program eliminated the need for 186,359 station inspections that would otherwise require travel, waiting and inspection.

The average round trip to a station was estimated to be 9.5 miles. For every two minutes a car is idling, it uses about the same amount of fuel it takes to go about one mile according to the Consumer Energy Center (<http://www.consumerenergycenter.org/myths/idling.html>). This implies the average waiting time of 9.0 minutes was equivalent to 4.5 miles of driving. The equivalent of another equivalent 2.2

miles of driving was spent moving through the inspection lane for a total equivalent of 16.2 miles per inspection. Eliminated trip/inspection emissions tons were calculated from the inspection mileage multiplied by the average IM240 g/mi emissions of the RapidScreen audit sample and the number of exempted vehicles. As noted above, IM240 emissions were scaled up to match MOVES estimates of running emissions vs. IM240. Gallons of fuel saved were estimated using an average of 20mpg.

B. RapidScreen Vehicle Owner Savings

Table VII-3 quantifies the RapidScreen benefits to vehicle owners. The average round trip to an inspection station was assumed to take an average of 28.5 minutes (9.5 miles at 20mph). Average wait and test times were 9.0 and 11.3 minutes respectively. The waiting and testing fuel consumption was estimated to be the equivalent of driving another 6.7 miles. Vehicle owner time was assumed to be worth half the Denver area average hourly wage of \$26.88 per hour, or \$13.44 per hour.

Travel savings were calculated at the IRS rate of 54c per mile per IRS Notice IR-2016-169, Dec.13, 2016. Total savings were \$3.66M or \$20.37 per vehicle.

Table VII-3 RapidScreen Vehicle Owner Savings

Activity	Vehicles	Minutes	Hours	Unit \$	\$'M
Station round trip @ 20mph	186359	28.5	88521	\$ 13.44	\$ 1.19
Testing	186359	11.3	34994	\$ 13.44	\$ 0.47
Waiting	186359	9.0	27850	\$ 13.44	\$ 0.37
Miles					
Driving miles equiv.	186359	16.2		\$ 0.540	\$ 1.63
Total vehicle owner savings					\$ 3.66

VIII. Recommendations

In 2015, a change was made to Clean screen criteria by increasing the previous 2% RSD-LEI fail cutpoint to 4%. In 2016 the RSD-LEI method had a smaller per vehicle impact on reductions of O₃ pre-cursor emissions reductions than the 2-RSD method. EPA and CDPHE require this to continue, i.e. that the RSD-LEI method should continue to perform at least as well as the 2-RSD method.

In August 2017 the Colorado Air Quality Control Commission approved the following amendments to our Regulation 11:

VI.B.1. On or before July 1st of each year the Air Pollution Control Division shall develop a low emitting vehicle index based on a tabulation of the previous calendar year's inspection program results for specified make, model and model year of vehicles.

VI.B.2. A passing rate for emissions shall be set as the minimum allowable passing criteria for the low emitting vehicle index.

VI.B.3. In developing the low emitting vehicle index, the Division may use passing criteria as necessary to ensure that the use of the low emitting vehicle index is equivalent to or better than the use of a second remote sensing measurement in terms of air quality benefits.

VI.B.4. The passing rate criteria for the low emitting vehicle index shall be submitted to the U.S. EPA on or before July 1 of each year.

Section IV.D. of this report contains a comparison of the 2-RSD and RSD-LEI effectiveness. Next year's annual report should expand this to specifically address the new regulations.

References

¹ “The Colorado Remote Sensing Program January – December 2011”, Envirotech report for the Colorado Department of Public Health and Environment, November 2012

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

³ 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

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

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

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

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

Appendix A1 Colorado 2016 OBD & Transient Test Emissions Reductions

Unresolved fails remaining in area					20%								
Model	First	Last	Vehicles	Fail%	Initial			Final			Reduction %		
Year/Type	Result	Result			HC	CO	NOX	HC	CO	NOX	HC	CO	NOX
1982	Pass	-	182		1.64	19.64	2.01	1.64	19.64	2.01	0.0%	0.0%	0.0%
P	Fail	Pass	40	16.3%	4.13	47.54	2.20	1.72	20.73	2.04	58.5%	56.4%	7.4%
	Fail	Unresolv.	24	9.8%	7.71	87.92	2.24	1.48	16.39	0.47	80.8%	81.4%	78.9%
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		246	26.0%	2.64	30.84	2.06	1.64	19.50	1.86	37.9%	36.8%	9.6%
1983	Pass	-	223		1.22	12.15	2.00	1.22	12.15	2.00	0.0%	0.0%	0.0%
P	Fail	Pass	59	18.9%	4.01	56.13	1.76	1.37	14.27	1.85	65.8%	74.6%	-5.4%
	Fail	Unresolv.	28	9.0%	5.27	83.55	1.83	0.89	15.85	0.35	83.1%	81.0%	80.7%
	Fail	Waiver	2	0.6%	4.17	88.76	0.62	2.55	75.43	0.95	38.9%	15.0%	-53.5%
Total	Fail%		312	28.5%	2.13	27.37	1.93	1.23	13.29	1.82	42.3%	51.4%	5.8%
1984	Pass	-	530		1.22	11.08	1.91	1.22	11.08	1.91	0.0%	0.0%	0.0%
P	Fail	Pass	112	15.9%	2.51	33.33	1.72	1.35	13.49	1.81	46.1%	59.5%	-5.4%
	Fail	Unresolv.	59	8.4%	5.62	78.41	1.85	1.05	15.29	0.38	81.3%	80.5%	79.7%
	Fail	Waiver	5	0.7%	10.53	114.13	0.64	9.08	120.12	0.51	13.8%	-5.3%	19.7%
Total	Fail%		706	24.9%	1.86	20.97	1.86	1.29	12.59	1.76	30.9%	40.0%	5.9%
1985	Pass	-	564		0.99	10.55	1.90	0.99	10.55	1.90	0.0%	0.0%	0.0%
P	Fail	Pass	99	13.6%	2.77	27.02	2.09	1.12	9.72	2.03	59.6%	64.0%	2.9%
	Fail	Unresolv.	57	7.9%	3.73	49.18	1.79	0.71	10.05	0.35	81.0%	79.6%	80.3%
	Fail	Waiver	6	0.8%	3.10	39.26	2.51	3.45	41.76	2.35	-11.4%	-6.4%	6.1%
Total	Fail%		726	22.3%	1.46	16.07	1.92	1.01	10.66	1.80	31.4%	33.7%	6.3%
1986	Pass	-	934		0.87	7.90	1.82	0.87	7.90	1.82	0.0%	0.0%	0.0%
P	Fail	Pass	125	10.9%	2.54	29.68	2.03	1.09	10.23	1.92	57.0%	65.5%	5.5%
	Fail	Unresolv.	75	6.6%	4.01	58.87	2.11	0.68	10.44	0.41	83.0%	82.3%	80.5%
	Fail	Waiver	9	0.8%	3.98	71.39	1.50	3.67	73.21	1.15	7.9%	-2.6%	23.2%
Total	Fail%		1,143	18.3%	1.28	14.13	1.86	0.91	8.84	1.74	29.5%	37.4%	6.8%
1987	Pass	-	921		0.87	7.73	1.78	0.87	7.73	1.78	0.0%	0.0%	0.0%
P	Fail	Pass	122	11.0%	2.02	24.24	2.14	1.02	9.33	1.90	49.6%	61.5%	11.2%
	Fail	Unresolv.	63	5.7%	4.84	49.58	2.02	0.83	9.37	0.42	82.8%	81.1%	79.3%
	Fail	Waiver	3	0.3%	3.74	82.77	2.65	3.42	48.88	2.37	8.5%	40.9%	10.8%
Total	Fail%		1,109	17.0%	1.23	12.13	1.83	0.89	8.11	1.72	27.5%	33.1%	6.4%
1988	Pass	-	1,405		0.71	7.65	1.51	0.71	7.65	1.51	0.0%	0.0%	0.0%
P	Fail	Pass	163	9.9%	1.87	29.10	1.68	0.83	8.28	1.60	55.8%	71.5%	4.7%
	Fail	Unresolv.	75	4.5%	5.45	44.32	1.80	1.12	9.99	0.35	79.5%	77.5%	80.5%
	Fail	Waiver	6	0.4%	1.73	29.16	1.62	1.75	39.61	1.41	-0.9%	-35.8%	13.0%
Total	Fail%		1,649	14.8%	1.05	11.52	1.54	0.74	7.94	1.47	28.7%	31.1%	4.8%
1989	Pass	-	1,449		0.72	7.60	1.61	0.72	7.60	1.61	0.0%	0.0%	0.0%
P	Fail	Pass	201	11.7%	2.08	27.71	1.87	0.82	8.30	1.63	60.7%	70.0%	12.9%
	Fail	Unresolv.	64	3.7%	4.58	39.33	2.11	1.09	8.50	0.40	76.2%	78.4%	81.2%
	Fail	Waiver	5	0.3%	2.35	29.00	2.43	2.75	36.02	2.35	-16.7%	-24.2%	3.2%
Total	Fail%		1,719	15.7%	1.03	11.20	1.66	0.75	7.80	1.57	27.0%	30.3%	5.5%
1990	Pass	-	2,773		0.65	7.32	1.54	0.65	7.32	1.54	0.0%	0.0%	0.0%
P	Fail	Pass	285	9.0%	1.99	25.00	1.93	0.78	7.52	1.57	60.9%	69.9%	18.7%
	Fail	Unresolv.	109	3.4%	3.81	42.79	2.27	0.72	8.58	0.45	81.0%	80.0%	80.2%
	Fail	Waiver	4	0.1%	2.53	13.84	4.43	2.23	9.32	3.24	12.0%	32.7%	27.0%
Total	Fail%		3,171	12.6%	0.88	10.14	1.61	0.66	7.39	1.51	24.5%	27.1%	6.0%

Appendix A1 Colorado 2016 OBD & Transient Test Emissions Reductions

Unresolved fails remaining in area					20%								
Model	First	Last	Vehicles	Fail%	Initial			Final			Reduction %		
Year/Type	Result	Result			HC	CO	NOX	HC	CO	NOX	HC	CO	NOX
1991	Pass	-	2,870		0.57	6.76	1.42	0.57	6.76	1.42	0.0%	0.0%	0.0%
P	Fail	Pass	374	10.9%	1.67	22.47	2.01	0.69	7.33	1.55	58.4%	67.4%	22.9%
	Fail	Unresolv.	164	4.8%	3.17	40.37	2.10	0.64	7.88	0.40	79.9%	80.5%	80.9%
	Fail	Waiver	12	0.4%	3.52	46.09	2.06	3.83	43.26	2.07	-8.8%	6.1%	-0.5%
Total	Fail%		3,420	16.1%	0.83	10.23	1.52	0.60	7.01	1.39	27.4%	31.5%	8.7%
1992	Pass	-	3,942		0.52	5.95	1.37	0.52	5.95	1.37	0.0%	0.0%	0.0%
P	Fail	Pass	463	10.1%	1.51	20.69	1.84	0.66	6.82	1.59	56.3%	67.0%	14.0%
	Fail	Unresolv.	163	3.6%	2.57	35.39	2.02	0.52	7.09	0.39	79.9%	80.0%	80.9%
	Fail	Waiver	15	0.3%	2.22	27.50	1.58	1.95	20.25	1.75	12.1%	26.4%	-11.4%
Total	Fail%		4,583	14.0%	0.70	8.56	1.44	0.54	6.13	1.36	22.9%	28.4%	5.8%
1993	Pass	-	4,185		0.52	5.60	1.43	0.52	5.60	1.43	0.0%	0.0%	0.0%
P	Fail	Pass	462	9.5%	1.55	21.33	2.06	0.61	6.26	1.58	60.5%	70.7%	23.5%
	Fail	Unresolv.	185	3.8%	3.19	33.31	2.31	0.63	6.49	0.47	80.3%	80.5%	79.6%
	Fail	Waiver	9	0.2%	2.64	23.24	2.82	2.39	21.02	2.43	9.5%	9.5%	13.8%
Total	Fail%		4,841	13.6%	0.73	8.19	1.53	0.54	5.72	1.41	25.8%	30.1%	7.7%
1994	Pass	-	5,631		0.40	4.91	1.14	0.40	4.91	1.14	0.0%	0.0%	0.0%
P	Fail	Pass	547	8.5%	1.39	15.91	1.73	0.52	5.48	1.34	62.6%	65.6%	22.6%
	Fail	Unresolv.	228	3.6%	2.94	27.31	2.07	0.58	5.21	0.42	80.1%	80.9%	79.8%
	Fail	Waiver	7	0.1%	8.75	19.93	2.05	6.03	15.27	2.41	31.0%	23.4%	-17.3%
Total	Fail%		6,413	12.2%	0.58	6.66	1.22	0.42	4.98	1.13	27.6%	25.2%	7.5%
1995	Pass	-	7,183		0.39	4.70	1.01	0.39	4.70	1.01	0.0%	0.0%	0.0%
P	Fail	Pass	677	8.3%	1.29	15.59	1.62	0.45	4.80	1.11	65.2%	69.2%	31.5%
	Fail	Unresolv.	293	3.6%	2.98	30.04	1.98	0.53	5.67	0.40	82.2%	81.1%	80.0%
	Fail	Waiver	15	0.2%	1.84	21.64	2.17	2.70	24.79	2.01	-46.6%	-14.6%	7.1%
Total	Fail%		8,168	12.1%	0.56	6.54	1.10	0.40	4.78	1.00	28.0%	27.0%	9.0%
1996	Pass	-	9,581		0.29	3.71	0.79	0.29	3.71	0.79	0.0%	0.0%	0.0%
P	Fail	Pass	778	7.3%	0.93	13.48	1.40	0.36	4.49	0.91	61.3%	66.7%	35.3%
	Fail	Unresolv.	257	2.4%	1.97	22.83	1.91	0.38	4.51	0.39	80.6%	80.3%	79.7%
	Fail	Waiver	10	0.1%	2.12	36.55	1.76	2.03	38.36	1.54	4.2%	-5.0%	12.8%
Total	Fail%		10,626	9.8%	0.38	4.92	0.86	0.30	3.82	0.79	21.1%	22.4%	8.5%
1997	Pass	-	11,007		0.30	3.87	0.76	0.30	3.87	0.76	0.0%	0.0%	0.0%
P	Fail	Pass	1,032	8.4%	0.82	13.44	1.25	0.34	4.46	0.86	58.3%	66.8%	31.5%
	Fail	Unresolv.	294	2.4%	2.54	26.15	1.91	0.45	5.23	0.39	82.4%	80.0%	79.6%
	Fail	Waiver	12	0.1%	0.91	16.54	2.03	0.91	17.80	1.98	-0.1%	-7.6%	2.1%
Total	Fail%		12,345	10.8%	0.39	5.21	0.83	0.30	3.96	0.76	22.8%	23.9%	8.3%
1998	Pass	-	14,575		0.23	3.47	0.62	0.23	3.47	0.62	0.0%	0.0%	0.0%
P	Fail	Pass	1,348	8.3%	0.74	11.84	1.13	0.26	3.96	0.67	64.8%	66.5%	40.8%
	Fail	Unresolv.	344	2.1%	1.57	18.03	1.85	0.31	3.63	0.37	80.5%	79.9%	80.0%
	Fail	Waiver	12	0.1%	1.18	18.45	2.20	1.35	27.68	1.76	-14.1%	-50.0%	19.9%
Total	Fail%		16,279	10.5%	0.30	4.48	0.69	0.23	3.53	0.62	22.1%	21.2%	10.1%
1999	Pass	-	15,392		0.20	3.14	0.59	0.20	3.14	0.59	0.0%	0.0%	0.0%
P	Fail	Pass	1,399	8.2%	0.69	10.54	1.19	0.25	3.49	0.67	64.0%	66.9%	43.4%
	Fail	Unresolv.	361	2.1%	1.68	19.70	1.96	0.33	3.86	0.39	80.3%	80.4%	80.0%
	Fail	Waiver	13	0.1%	1.64	22.01	1.66	1.47	20.27	1.57	10.2%	7.9%	5.8%
Total	Fail%		17,165	10.3%	0.28	4.10	0.66	0.21	3.19	0.59	23.3%	22.2%	11.3%

Appendix A1 Colorado 2016 OBD & Transient Test Emissions Reductions

Unresolved fails remaining in area					20%								
Model	First	Last	Vehicles	Fail%	Initial			Final			Reduction %		
Year/Type	Result	Result			HC	CO	NOX	HC	CO	NOX	HC	CO	NOX
2000 P	Pass	-	22,121		0.15	2.63	0.45	0.15	2.63	0.45	0.0%	0.0%	0.0%
	Fail	Pass	1,692	7.0%	0.60	10.14	1.19	0.20	3.32	0.57	66.2%	67.3%	52.1%
	Fail	Unresolv.	445	1.8%	1.32	16.42	2.07	0.26	3.23	0.43	80.7%	80.3%	79.4%
	Fail	Waiver	18	0.1%	2.74	15.83	1.69	1.15	24.30	1.52	57.9%	-53.5%	10.3%
Total	Fail%		24,276	8.9%	0.21	3.42	0.53	0.16	2.71	0.46	23.6%	20.8%	13.9%
2001 P	Pass	-	20,314		0.11	2.34	0.33	0.11	2.34	0.33	0.0%	0.0%	0.0%
	Fail	Pass	1,452	6.6%	0.56	8.61	1.00	0.16	2.73	0.42	71.6%	68.3%	57.6%
	Fail	Unresolv.	350	1.6%	1.40	16.31	2.02	0.28	3.17	0.41	79.8%	80.6%	79.7%
	Fail	Waiver	11	0.0%	0.62	13.51	1.72	0.54	11.22	1.82	12.7%	17.0%	-6.3%
Total	Fail%		22,127	8.2%	0.16	2.98	0.41	0.12	2.38	0.34	27.1%	20.0%	15.6%
2002 P	Pass	-	26,353		0.09	2.54	0.27	0.09	2.54	0.27	0.0%	0.0%	0.0%
	Fail	Pass	1,799	6.3%	0.49	6.93	1.00	0.14	2.90	0.36	71.8%	58.2%	63.7%
	Fail	Unresolv.	324	1.1%	1.11	16.87	2.22	0.22	3.33	0.45	79.8%	80.3%	79.8%
	Fail	Waiver	14	0.0%	3.08	13.96	2.09	3.35	13.01	2.37	-8.8%	6.8%	-13.2%
Total	Fail%		28,490	7.5%	0.13	2.98	0.34	0.10	2.57	0.28	24.4%	13.7%	17.6%
2003 P	Pass	-	21,844		0.07	1.66	0.24	0.07	1.66	0.24	0.0%	0.0%	0.0%
	Fail	Pass	1,563	6.6%	0.39	6.49	0.82	0.12	2.19	0.31	70.4%	66.3%	61.9%
	Fail	Unresolv.	266	1.1%	0.99	12.43	2.07	0.20	2.45	0.42	80.1%	80.3%	79.8%
	Fail	Waiver	16	0.1%	2.32	11.34	1.43	0.55	10.25	1.55	76.3%	9.6%	-8.4%
Total	Fail%		23,689	7.8%	0.11	2.11	0.30	0.08	1.71	0.24	27.0%	18.8%	17.5%
2004 P	Pass	-	26,257		0.05	1.35	0.16	0.05	1.35	0.16	0.0%	0.0%	0.0%
	Fail	Pass	1,533	5.5%	0.36	5.48	0.66	0.09	1.81	0.22	74.3%	66.9%	66.2%
	Fail	Unresolv.	196	0.7%	1.46	14.21	1.84	0.26	2.88	0.36	82.0%	79.7%	80.6%
	Fail	Waiver	7	0.0%	0.50	10.70	1.04	0.50	10.25	0.87	0.3%	4.1%	16.4%
Total	Fail%		27,993	6.2%	0.08	1.67	0.20	0.06	1.39	0.16	28.3%	16.8%	17.3%
2005 P	Pass	-	22,840		0.05	1.20	0.14	0.05	1.20	0.14	0.0%	0.0%	0.0%
	Fail	Pass	1,405	5.8%	0.33	4.97	0.61	0.07	1.61	0.19	77.5%	67.7%	68.6%
	Fail	Unresolv.	164	0.7%	0.82	14.85	1.43	0.16	2.97	0.29	80.1%	80.0%	79.7%
	Fail	Waiver	22	0.1%	0.38	5.21	0.94	0.41	5.29	0.86	-8.8%	-1.5%	8.2%
Total	Fail%		24,431	6.5%	0.07	1.52	0.18	0.05	1.24	0.14	27.9%	18.0%	18.1%
2006 P	Pass	-	27,818		0.04	1.16	0.10	0.04	1.16	0.10	0.0%	0.0%	0.0%
	Fail	Pass	2,176	7.1%	0.21	4.60	0.43	0.04	1.24	0.11	79.4%	73.1%	73.4%
	Fail	Unresolv.	510	1.7%	0.21	4.72	0.43	0.04	0.94	0.09	80.0%	80.0%	80.0%
	Fail	Waiver	25	0.1%	0.43	4.46	0.45	0.43	4.46	0.45	0.0%	0.0%	0.0%
Total	Fail%		30,529	8.9%	0.05	1.47	0.13	0.04	1.16	0.10	28.1%	20.6%	21.6%
2007 P	Pass	-	22,994		0.04	0.99	0.08	0.04	0.99	0.08	0.0%	0.0%	0.0%
	Fail	Pass	1,512	6.1%	0.10	2.48	0.23	0.04	1.07	0.08	57.8%	56.8%	63.5%
	Fail	Unresolv.	285	1.1%	0.12	2.44	0.28	0.03	0.49	0.06	79.5%	79.9%	79.4%
	Fail	Waiver	23	0.1%	0.04	1.67	0.15	0.04	1.67	0.15	0.0%	0.0%	0.0%
Total	Fail%		24,814	7.3%	0.04	1.10	0.09	0.04	0.99	0.08	10.9%	9.8%	12.9%
2008 P	Pass	-	29,185		0.03	0.97	0.06	0.03	0.97	0.06	0.0%	0.0%	0.0%
	Fail	Pass	1,315	4.3%	0.09	2.95	0.23	0.04	1.05	0.07	61.6%	64.3%	68.2%
	Fail	Unresolv.	217	0.7%	0.11	3.08	0.28	0.02	0.63	0.06	79.5%	79.4%	79.6%
	Fail	Waiver	17	0.1%	0.31	4.56	0.27	1.37	2.76	0.19	-335.6%	39.5%	27.9%
Total	Fail%		30,734	5.0%	0.03	1.08	0.07	0.03	0.98	0.06	7.4%	9.2%	11.7%

Appendix A1 Colorado 2016 OBD & Transient Test Emissions Reductions

Unresolved fails remaining in area					20%								
Model	First	Last	Vehicles	Fail%	Initial			Final			Reduction %		
Year/Type	Result	Result			HC	CO	NOX	HC	CO	NOX	HC	CO	NOX
2009 P	Pass	-	31,154		0.03	0.87	0.06	0.03	0.87	0.06	0.0%	0.0%	0.0%
	Fail	Pass	1,025	3.2%	0.07	2.00	0.21	0.03	0.90	0.07	60.5%	54.9%	68.3%
	Fail	Unresolv.	111	0.3%	0.14	2.32	0.27	0.04	0.46	0.05	71.3%	80.4%	80.4%
	Fail	Waiver	8	0.0%	0.04	1.69	0.11	0.04	1.69	0.11	0.0%	0.0%	0.0%
Total	Fail%		32,298	3.5%	0.03	0.91	0.06	0.03	0.87	0.06	6.2%	4.5%	8.4%
2010 P	Pass	-	6,090		0.02	0.80	0.04	0.02	0.80	0.04	0.0%	0.0%	0.0%
	Fail	Pass	233	3.7%	0.19	1.44	0.52	0.03	0.86	0.05	85.1%	39.9%	90.0%
	Fail	Unresolv.	40	0.6%	0.34	2.57	0.83	0.07	0.51	0.17	80.0%	80.0%	80.0%
	Fail	Waiver	1	0.0%	0.02	0.56	0.49	0.02	0.56	0.49	0.0%	0.0%	0.0%
Total	Fail%		6,364	4.3%	0.03	0.84	0.07	0.02	0.80	0.05	24.4%	4.1%	31.6%
2011 P	Pass	-	2,737		0.03	0.93	0.06	0.03	0.93	0.06	0.0%	0.0%	0.0%
	Fail	Pass	96	3.4%	0.13	2.41	0.39	0.03	1.19	0.08	73.4%	50.6%	78.5%
	Fail	Unresolv.	26	0.9%	0.41	4.27	0.66	0.08	0.85	0.13	80.0%	80.0%	80.0%
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		2,859	4.3%	0.03	1.01	0.07	0.03	0.94	0.06	18.7%	7.1%	20.8%
2012 P	Pass	-	2,808		0.03	0.90	0.06	0.03	0.90	0.06	0.0%	0.0%	0.0%
	Fail	Pass	102	3.5%	0.05	1.80	0.18	0.02	0.94	0.06	54.9%	48.1%	65.3%
	Fail	Unresolv.	28	1.0%	0.18	2.25	0.22	0.04	0.45	0.04	80.0%	80.0%	80.0%
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		2,938	4.4%	0.03	0.94	0.06	0.03	0.89	0.06	8.5%	5.0%	9.3%
2013 P	Pass	-	2,033		0.03	0.89	0.05	0.03	0.89	0.05	0.0%	0.0%	0.0%
	Fail	Pass	54	2.6%	0.04	1.56	0.14	0.02	0.85	0.05	41.1%	45.9%	62.2%
	Fail	Unresolv.	17	0.8%	0.08	2.93	0.14	0.02	0.59	0.03	80.0%	80.0%	80.0%
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		2,104	3.4%	0.03	0.92	0.06	0.03	0.89	0.05	3.5%	4.0%	5.5%
2014 P	Pass	-	1,128		0.02	0.86	0.05	0.02	0.86	0.05	0.0%	0.0%	0.0%
	Fail	Pass	28	2.4%	0.15	2.38	0.47	0.03	1.14	0.06	82.4%	52.0%	88.1%
	Fail	Unresolv.	12	1.0%	0.14	2.47	0.38	0.03	0.49	0.08	80.0%	80.0%	80.0%
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		1,168	3.4%	0.03	0.91	0.07	0.03	0.86	0.05	14.2%	5.5%	19.5%
2015 P	Pass	-	760		0.03	0.85	0.06	0.03	0.85	0.06	0.0%	0.0%	0.0%
	Fail	Pass	27	3.4%	0.04	1.58	0.15	0.03	0.84	0.05	41.0%	46.5%	63.6%
	Fail	Unresolv.	8	1.0%	0.29	4.13	0.50	0.06	0.83	0.10	80.0%	80.0%	80.0%
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		795	4.4%	0.03	0.91	0.06	0.03	0.85	0.06	10.1%	6.4%	11.4%
2016 & Newer P	Pass	-	177		0.03	0.84	0.05	0.03	0.84	0.05	0.0%	0.0%	0.0%
	Fail	Pass	1	0.6%	0.04	1.58	0.15	0.03	0.84	0.05	41.0%	46.5%	63.6%
	Fail	Unresolv.	3	1.7%	0.04	1.58	0.15	0.01	0.32	0.03	80.0%	80.0%	80.0%
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		181	2.2%	0.03	0.86	0.06	0.02	0.83	0.05	2.6%	2.9%	4.5%
Total Passenger Vehicles													
All	Pass	-	349,960		0.13	2.22	0.35	0.13	2.22	0.35	0.0%	0.0%	0.0%
P	Fail	Pass	24,299	6.4%	0.63	9.31	0.94	0.22	3.11	0.53	64.1%	66.6%	43.3%
	Fail	Unresolv.	5,845	1.5%	1.78	20.84	1.65	0.34	4.10	0.33	80.7%	80.3%	79.9%
	Fail	Waiver	307	0.1%	1.89	20.20	1.44	1.71	20.37	1.37	9.7%	-0.8%	4.9%
Total	Fail%		380,411	8.0%	0.19	2.97	0.41	0.14	2.32	0.36	25.0%	22.0%	11.3%

Appendix A1 Colorado 2016 OBD & Transient Test Emissions Reductions

Unresolved fails remaining in area					20%								
Model	First	Last	Vehicles	Fail%	Initial			Final			Reduction %		
Year/Type	Result	Result			HC	CO	NOX	HC	CO	NOX	HC	CO	NOX
1982	Pass	-	218		2.26	29.93	2.84	2.26	29.93	2.84	0.0%	0.0%	0.0%
T	Fail	Pass	76	23.5%	4.30	60.98	2.70	2.36	33.73	2.58	45.2%	44.7%	4.2%
	Fail	Unresolv.	29	9.0%	7.23	104.07	2.13	1.22	19.96	0.42	83.2%	80.8%	80.4%
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		323	32.5%	3.19	43.89	2.74	2.19	29.93	2.56	31.3%	31.8%	6.6%
1983	Pass	-	251		2.66	32.30	2.59	2.66	32.30	2.59	0.0%	0.0%	0.0%
T	Fail	Pass	91	23.4%	4.25	66.35	2.50	2.88	35.71	2.69	32.3%	46.2%	-7.7%
	Fail	Unresolv.	46	11.8%	5.40	73.24	2.36	1.05	15.29	0.46	80.5%	79.1%	80.4%
	Fail	Waiver	1	0.3%	4.71	102.15	0.59	11.10	175.35	0.09	-135.7%	-71.7%	83.8%
Total	Fail%		389	35.5%	3.36	45.29	2.54	2.54	31.46	2.35	24.3%	30.5%	7.2%
1984	Pass	-	575		2.03	23.63	2.70	2.03	23.63	2.70	0.0%	0.0%	0.0%
T	Fail	Pass	174	20.9%	4.05	69.57	2.39	1.95	27.60	2.75	51.8%	60.3%	-15.0%
	Fail	Unresolv.	83	10.0%	6.37	106.29	1.90	1.30	20.71	0.38	79.6%	80.5%	80.0%
	Fail	Waiver	1	0.1%	1.45	62.09	0.07	1.78	79.67	0.11	-22.3%	-28.3%	-49.9%
Total	Fail%		833	31.0%	2.88	41.51	2.56	1.94	24.23	2.48	32.7%	41.6%	3.0%
1985	Pass	-	601		1.85	18.97	2.71	1.85	18.97	2.71	0.0%	0.0%	0.0%
T	Fail	Pass	189	21.2%	3.56	52.96	2.69	1.89	22.65	2.78	46.9%	57.2%	-3.3%
	Fail	Unresolv.	94	10.6%	5.67	93.11	2.37	1.05	18.33	0.53	81.5%	80.3%	77.8%
	Fail	Waiver	6	0.7%	11.28	155.47	0.61	4.50	106.04	0.81	60.1%	31.8%	-32.6%
Total	Fail%		890	32.5%	2.68	34.94	2.65	1.79	20.27	2.48	33.2%	42.0%	6.6%
1986	Pass	-	1,118		1.57	16.31	2.50	1.57	16.31	2.50	0.0%	0.0%	0.0%
T	Fail	Pass	263	17.7%	3.12	42.45	2.52	1.76	18.64	2.55	43.5%	56.1%	-1.5%
	Fail	Unresolv.	94	6.3%	4.93	86.88	2.40	0.99	16.18	0.48	79.9%	81.4%	79.9%
	Fail	Waiver	7	0.5%	3.73	75.55	1.87	4.02	64.10	2.49	-7.9%	15.2%	-33.2%
Total	Fail%		1,482	24.6%	2.07	25.70	2.49	1.58	16.94	2.38	23.6%	34.1%	4.5%
1987	Pass	-	1,043		1.47	14.27	2.42	1.47	14.27	2.42	0.0%	0.0%	0.0%
T	Fail	Pass	227	16.5%	2.83	39.96	2.58	1.55	14.79	2.44	45.3%	63.0%	5.6%
	Fail	Unresolv.	95	6.9%	4.31	64.91	2.39	0.86	12.88	0.48	80.2%	80.2%	79.9%
	Fail	Waiver	7	0.5%	4.68	94.56	2.71	3.84	84.95	1.91	18.0%	10.2%	29.4%
Total	Fail%		1,372	24.0%	1.91	22.43	2.44	1.45	14.62	2.28	23.9%	34.8%	6.6%
1988	Pass	-	1,769		1.30	11.73	2.27	1.30	11.73	2.27	0.0%	0.0%	0.0%
T	Fail	Pass	336	15.2%	2.50	28.03	2.83	1.30	12.21	2.35	48.0%	56.4%	17.2%
	Fail	Unresolv.	94	4.3%	5.16	62.20	2.87	1.07	13.19	0.54	79.2%	78.8%	81.2%
	Fail	Waiver	9	0.4%	4.90	101.22	1.41	2.32	56.34	1.16	52.6%	44.3%	17.9%
Total	Fail%		2,208	19.9%	1.66	16.73	2.38	1.29	12.05	2.20	22.1%	28.0%	7.3%
1989	Pass	-	1,847		1.23	12.24	2.22	1.23	12.24	2.22	0.0%	0.0%	0.0%
T	Fail	Pass	384	16.3%	2.77	32.89	2.69	1.32	12.13	2.27	52.5%	63.1%	15.7%
	Fail	Unresolv.	114	4.8%	4.37	60.44	2.91	0.91	12.40	0.57	79.1%	79.5%	80.3%
	Fail	Waiver	7	0.3%	4.26	87.18	2.14	4.67	101.07	1.56	-9.6%	-15.9%	27.0%
Total	Fail%		2,352	21.5%	1.64	18.17	2.33	1.24	12.49	2.15	24.6%	31.2%	7.9%
1990	Pass	-	2,418		1.17	11.36	2.21	1.17	11.36	2.21	0.0%	0.0%	0.0%
T	Fail	Pass	436	14.7%	2.60	30.21	2.64	1.29	12.09	2.33	50.5%	60.0%	12.0%
	Fail	Unresolv.	115	3.9%	3.83	50.28	3.04	0.74	10.07	0.57	80.6%	80.0%	81.2%
	Fail	Waiver	6	0.2%	4.89	74.99	3.77	2.52	40.90	3.40	48.4%	45.5%	10.0%
Total	Fail%		2,975	18.7%	1.49	15.76	2.31	1.18	11.48	2.16	21.2%	27.2%	6.2%

Appendix A1 Colorado 2016 OBD & Transient Test Emissions Reductions

Unresolved fails remaining in area					20%								
Model	First	Last	Vehicles	Fail%	Initial			Final			Reduction %		
Year/Type	Result	Result			HC	CO	NOX	HC	CO	NOX	HC	CO	NOX
1991	Pass	-	2,481		1.00	11.42	1.88	1.00	11.42	1.88	0.0%	0.0%	0.0%
T	Fail	Pass	480	15.6%	2.10	26.70	2.49	1.11	11.51	2.06	47.3%	56.9%	17.2%
	Fail	Unresolv.	113	3.7%	4.40	55.19	2.71	0.88	11.45	0.54	80.0%	79.3%	80.1%
	Fail	Waiver	3	0.1%	5.30	69.64	3.03	3.18	22.99	4.15	40.1%	67.0%	-37.2%
Total	Fail%		3,077	19.4%	1.30	15.47	2.01	1.01	11.45	1.86	22.0%	26.0%	7.2%
1992	Pass	-	3,515		1.03	10.91	1.92	1.03	10.91	1.92	0.0%	0.0%	0.0%
T	Fail	Pass	551	13.1%	2.38	24.57	2.57	1.14	11.69	2.07	52.3%	52.4%	19.6%
	Fail	Unresolv.	131	3.1%	4.62	50.22	3.06	0.94	10.32	0.57	79.6%	79.5%	81.4%
	Fail	Waiver	13	0.3%	2.70	39.83	1.97	2.77	42.71	2.05	-2.5%	-7.2%	-4.2%
Total	Fail%		4,210	16.5%	1.32	14.01	2.04	1.04	11.09	1.89	21.0%	20.8%	7.0%
1993	Pass	-	4,135		1.04	10.81	2.09	1.04	10.81	2.09	0.0%	0.0%	0.0%
T	Fail	Pass	676	13.6%	2.33	25.05	2.96	1.12	11.09	2.20	51.9%	55.7%	25.8%
	Fail	Unresolv.	166	3.3%	4.49	47.86	3.11	0.91	9.50	0.62	79.8%	80.2%	80.1%
	Fail	Waiver	9	0.2%	3.70	44.93	3.42	2.51	28.81	3.33	32.3%	35.9%	2.6%
Total	Fail%		4,986	17.1%	1.34	14.04	2.24	1.05	10.84	2.06	21.4%	22.8%	8.3%
1994	Pass	-	6,656		0.79	8.71	1.82	0.79	8.71	1.82	0.0%	0.0%	0.0%
T	Fail	Pass	1,122	13.9%	1.93	22.12	2.72	0.88	9.30	1.94	54.6%	57.9%	28.8%
	Fail	Unresolv.	298	3.7%	3.28	37.22	3.12	0.70	7.40	0.63	78.8%	80.1%	79.7%
	Fail	Waiver	13	0.2%	3.53	20.59	5.40	2.60	15.95	4.47	26.5%	22.5%	17.2%
Total	Fail%		8,089	17.7%	1.04	11.64	1.99	0.80	8.75	1.79	23.3%	24.8%	10.1%
1995	Pass	-	7,117		0.75	8.64	1.83	0.75	8.64	1.83	0.0%	0.0%	0.0%
T	Fail	Pass	1,294	14.8%	1.90	21.82	2.80	0.85	9.14	1.88	55.2%	58.1%	33.0%
	Fail	Unresolv.	341	3.9%	3.73	34.18	3.22	0.71	6.61	0.65	80.9%	80.7%	79.9%
	Fail	Waiver	15	0.2%	4.42	38.04	2.23	2.67	27.43	2.27	39.7%	27.9%	-2.1%
Total	Fail%		8,767	18.8%	1.04	11.63	2.03	0.77	8.66	1.79	26.4%	25.5%	11.6%
1996	Pass	-	9,023		0.41	5.32	1.35	0.41	5.32	1.35	0.0%	0.0%	0.0%
T	Fail	Pass	1,153	11.0%	1.04	14.36	2.14	0.42	5.44	1.44	59.6%	62.1%	33.0%
	Fail	Unresolv.	266	2.5%	2.91	32.20	3.07	0.57	5.90	0.62	80.5%	81.7%	79.7%
	Fail	Waiver	20	0.2%	2.15	23.64	2.90	2.09	22.80	2.84	2.9%	3.5%	2.2%
Total	Fail%		10,462	13.8%	0.54	7.03	1.48	0.42	5.38	1.34	23.6%	23.5%	9.4%
1997	Pass	-	11,599		0.35	5.21	1.29	0.35	5.21	1.29	0.0%	0.0%	0.0%
T	Fail	Pass	1,779	12.9%	0.93	13.84	2.22	0.40	5.75	1.38	57.2%	58.4%	37.9%
	Fail	Unresolv.	386	2.8%	2.19	23.70	3.10	0.41	4.52	0.62	81.2%	80.9%	80.0%
	Fail	Waiver	24	0.2%	2.23	30.03	2.97	1.34	26.45	2.91	39.7%	11.9%	2.2%
Total	Fail%		13,788	15.9%	0.48	6.88	1.46	0.36	5.30	1.29	24.8%	23.0%	12.2%
1998	Pass	-	16,830		0.30	4.35	1.08	0.30	4.35	1.08	0.0%	0.0%	0.0%
T	Fail	Pass	2,060	10.6%	0.81	11.84	2.08	0.34	4.68	1.18	58.2%	60.5%	43.4%
	Fail	Unresolv.	437	2.3%	1.81	19.53	3.25	0.35	3.88	0.65	80.4%	80.1%	80.1%
	Fail	Waiver	27	0.1%	3.42	20.38	3.38	1.77	19.94	3.29	48.3%	2.2%	2.5%
Total	Fail%		19,354	13.0%	0.39	5.51	1.24	0.31	4.40	1.08	21.7%	20.2%	12.5%
1999	Pass	-	17,429		0.23	3.52	0.82	0.23	3.52	0.82	0.0%	0.0%	0.0%
T	Fail	Pass	2,370	11.6%	0.71	10.96	1.86	0.29	4.02	0.97	58.7%	63.3%	47.6%
	Fail	Unresolv.	560	2.7%	1.61	18.85	2.67	0.29	3.72	0.54	81.7%	80.3%	79.9%
	Fail	Waiver	31	0.2%	0.95	12.91	3.12	1.10	12.85	2.99	-16.1%	0.4%	4.4%
Total	Fail%		20,390	14.5%	0.33	4.82	0.99	0.24	3.60	0.83	25.8%	25.3%	16.3%

Appendix A1 Colorado 2016 OBD & Transient Test Emissions Reductions

Unresolved fails remaining in area					20%								
Model	First	Last	Vehicles	Fail%	Initial			Final			Reduction %		
Year/Type	Result	Result			HC	CO	NOX	HC	CO	NOX	HC	CO	NOX
2000 T	Pass	-	23,664		0.20	3.02	0.70	0.20	3.02	0.70	0.0%	0.0%	0.0%
	Fail	Pass	2,721	10.1%	0.56	9.64	1.54	0.24	3.57	0.89	57.0%	63.0%	42.2%
	Fail	Unresolv.	556	2.1%	1.27	19.00	2.55	0.27	4.00	0.51	78.7%	79.0%	79.8%
	Fail	Waiver	27	0.1%	1.48	11.58	3.45	1.03	10.44	3.24	30.3%	9.8%	6.2%
Total	Fail%		26,968	12.3%	0.26	4.03	0.83	0.21	3.10	0.72	20.2%	22.9%	13.0%
2001 T	Pass	-	21,589		0.15	2.78	0.49	0.15	2.78	0.49	0.0%	0.0%	0.0%
	Fail	Pass	2,383	9.8%	0.51	8.62	1.14	0.18	3.12	0.60	64.2%	63.8%	47.3%
	Fail	Unresolv.	392	1.6%	1.41	19.67	2.00	0.26	3.77	0.40	81.7%	80.8%	79.8%
	Fail	Waiver	28	0.1%	1.15	12.56	2.00	0.66	12.07	1.66	42.7%	3.9%	16.6%
Total	Fail%		24,392	11.5%	0.20	3.63	0.58	0.15	2.84	0.50	25.0%	21.8%	13.5%
2002 T	Pass	-	29,455		0.12	2.82	0.42	0.12	2.82	0.42	0.0%	0.0%	0.0%
	Fail	Pass	2,454	7.6%	0.37	9.30	1.04	0.16	3.21	0.55	57.7%	65.5%	47.5%
	Fail	Unresolv.	386	1.2%	1.12	19.44	2.10	0.22	3.86	0.42	80.0%	80.1%	79.8%
	Fail	Waiver	19	0.1%	1.03	31.29	2.07	1.10	30.04	2.02	-6.9%	4.0%	2.4%
Total	Fail%		32,314	8.8%	0.15	3.53	0.49	0.12	2.88	0.43	18.2%	18.4%	11.8%
2003 T	Pass	-	23,428		0.10	1.96	0.33	0.10	1.96	0.33	0.0%	0.0%	0.0%
	Fail	Pass	2,075	8.1%	0.37	7.31	0.84	0.14	2.60	0.44	63.7%	64.4%	47.4%
	Fail	Unresolv.	244	0.9%	1.25	18.89	1.90	0.22	3.64	0.39	82.1%	80.8%	79.7%
	Fail	Waiver	9	0.0%	0.09	2.50	1.96	0.09	2.50	1.96	0.0%	0.0%	0.0%
Total	Fail%		25,756	9.0%	0.13	2.55	0.39	0.10	2.02	0.34	21.6%	20.6%	11.9%
2004 T	Pass	-	34,898		0.07	1.49	0.18	0.07	1.49	0.18	0.0%	0.0%	0.0%
	Fail	Pass	2,427	6.5%	0.29	6.58	0.64	0.10	2.11	0.26	67.0%	68.0%	59.5%
	Fail	Unresolv.	232	0.6%	1.08	21.17	1.67	0.21	4.03	0.34	80.1%	81.0%	79.3%
	Fail	Waiver	13	0.0%	5.12	18.94	0.82	4.93	16.89	0.82	3.7%	10.8%	0.3%
Total	Fail%		37,570	7.1%	0.09	1.95	0.22	0.07	1.55	0.19	20.5%	20.3%	14.8%
2005 T	Pass	-	27,330		0.06	1.28	0.14	0.06	1.28	0.14	0.0%	0.0%	0.0%
	Fail	Pass	1,421	4.9%	0.32	5.46	0.68	0.10	1.98	0.24	69.5%	63.8%	64.7%
	Fail	Unresolv.	150	0.5%	1.10	18.13	1.70	0.18	3.25	0.35	84.1%	82.1%	79.6%
	Fail	Waiver	10	0.0%	0.38	6.52	2.16	0.39	8.64	1.53	-3.8%	-32.5%	29.1%
Total	Fail%		28,911	5.5%	0.08	1.58	0.17	0.07	1.33	0.14	19.3%	15.7%	16.6%
2006 T	Pass	-	30,957		0.04	1.22	0.11	0.04	1.22	0.11	0.0%	0.0%	0.0%
	Fail	Pass	2,523	7.4%	0.10	3.08	0.29	0.05	1.29	0.12	51.4%	58.2%	57.2%
	Fail	Unresolv.	393	1.2%	0.17	3.95	0.43	0.04	0.80	0.09	79.8%	79.8%	80.2%
	Fail	Waiver	23	0.1%	0.08	2.75	0.24	0.08	2.75	0.24	0.0%	0.0%	0.0%
Total	Fail%		33,896	8.7%	0.05	1.39	0.12	0.04	1.22	0.11	10.9%	12.2%	13.3%
2007 T	Pass	-	26,950		0.04	1.49	0.08	0.04	1.49	0.08	0.0%	0.0%	0.0%
	Fail	Pass	1,932	6.6%	0.07	2.01	0.20	0.04	1.62	0.10	40.1%	19.4%	52.7%
	Fail	Unresolv.	256	0.9%	0.10	2.32	0.26	0.02	0.57	0.06	78.8%	75.4%	78.6%
	Fail	Waiver	19	0.1%	0.05	1.37	0.15	0.05	1.37	0.15	0.0%	0.0%	0.0%
Total	Fail%		29,157	7.6%	0.04	1.53	0.09	0.04	1.49	0.08	6.2%	2.7%	9.5%
2008 T	Pass	-	37,386		0.04	1.32	0.07	0.04	1.32	0.07	0.0%	0.0%	0.0%
	Fail	Pass	2,002	5.1%	0.08	3.58	0.12	0.04	1.41	0.08	50.2%	60.7%	34.6%
	Fail	Unresolv.	202	0.5%	0.14	5.06	0.27	0.03	1.03	0.05	80.2%	79.6%	80.7%
	Fail	Waiver	7	0.0%	0.06	3.41	0.08	0.06	3.41	0.08	0.0%	0.0%	0.0%
Total	Fail%		39,597	5.6%	0.04	1.45	0.08	0.04	1.32	0.07	6.7%	9.0%	4.2%

Appendix A1 Colorado 2016 OBD & Transient Test Emissions Reductions

Unresolved fails remaining in area					20%								
Model	First	Last	Vehicles	Fail%	Initial			Final			Reduction %		
Year/Type	Result	Result			HC	CO	NOX	HC	CO	NOX	HC	CO	NOX
2009 T	Pass	-	28,628		0.03	1.19	0.06	0.03	1.19	0.06	0.0%	0.0%	0.0%
	Fail	Pass	1,434	4.8%	0.03	1.70	0.15	0.03	1.23	0.07	17.5%	27.6%	56.8%
	Fail	Unresolv.	91	0.3%	0.03	1.65	0.14	0.01	0.33	0.03	80.0%	80.0%	80.0%
	Fail	Waiver	3	0.0%	0.03	1.65	0.14	0.03	1.65	0.14	0.0%	0.0%	0.0%
Total	Fail%		30,156	5.1%	0.03	1.21	0.07	0.03	1.19	0.06	1.3%	2.2%	6.7%
2010 T	Pass	-	6,849		0.03	1.05	0.05	0.03	1.05	0.05	0.0%	0.0%	0.0%
	Fail	Pass	308	4.3%	0.03	1.07	0.05	0.03	1.18	0.06	10.2%	-10.8%	-19.0%
	Fail	Unresolv.	30	0.4%	0.05	1.13	0.16	0.01	0.23	0.03	80.0%	80.0%	80.0%
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		7,187	4.7%	0.03	1.05	0.05	0.03	1.05	0.05	1.1%	-0.1%	0.2%
2011 T	Pass	-	3,615		0.03	1.18	0.06	0.03	1.18	0.06	0.0%	0.0%	0.0%
	Fail	Pass	150	4.0%	0.03	1.57	0.14	0.03	1.19	0.07	8.6%	24.3%	51.6%
	Fail	Unresolv.	25	0.7%	0.03	1.48	0.28	0.01	0.30	0.06	80.0%	80.0%	80.0%
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		3,790	4.6%	0.03	1.20	0.07	0.03	1.17	0.06	1.0%	1.9%	6.7%
2012 T	Pass	-	2,414		0.03	1.17	0.06	0.03	1.17	0.06	0.0%	0.0%	0.0%
	Fail	Pass	86	3.4%	0.03	1.50	0.12	0.03	1.17	0.06	13.3%	22.0%	51.8%
	Fail	Unresolv.	27	1.1%	0.11	2.79	0.30	0.02	0.56	0.06	80.0%	80.0%	80.0%
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		2,527	4.5%	0.03	1.20	0.06	0.03	1.16	0.06	4.0%	2.9%	7.4%
2013 T	Pass	-	1,871		0.03	1.16	0.06	0.03	1.16	0.06	0.0%	0.0%	0.0%
	Fail	Pass	59	3.0%	0.03	1.56	0.13	0.03	1.17	0.06	15.6%	24.7%	53.7%
	Fail	Unresolv.	9	0.5%	0.03	1.56	0.13	0.01	0.31	0.03	80.0%	80.0%	80.0%
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		1,939	3.5%	0.03	1.17	0.06	0.03	1.16	0.06	1.0%	1.5%	4.2%
2014 T	Pass	-	1,254		0.03	1.16	0.06	0.03	1.16	0.06	0.0%	0.0%	0.0%
	Fail	Pass	35	2.7%	0.03	1.56	0.13	0.03	1.17	0.06	15.6%	24.7%	53.7%
	Fail	Unresolv.	11	0.8%	0.03	1.56	0.13	0.01	0.31	0.03	80.0%	80.0%	80.0%
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		1,300	3.5%	0.03	1.17	0.06	0.03	1.15	0.06	1.3%	1.8%	4.4%
2015 T	Pass	-	792		0.03	1.17	0.06	0.03	1.17	0.06	0.0%	0.0%	0.0%
	Fail	Pass	10	1.2%	0.03	1.56	0.13	0.03	1.17	0.06	15.6%	24.7%	53.7%
	Fail	Unresolv.	4	0.5%	0.03	1.56	0.13	0.01	0.31	0.03	80.0%	80.0%	80.0%
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		806	1.7%	0.03	1.18	0.06	0.03	1.17	0.06	0.7%	0.9%	2.3%
2016 & Newer T	Pass	-	322		0.03	1.14	0.06	0.03	1.14	0.06	0.0%	0.0%	0.0%
	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	1	0.3%	0.03	1.56	0.13	0.01	0.31	0.03	80.0%	80.0%	80.0%
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		323	0.3%	0.03	1.14	0.06	0.03	1.14	0.06	0.3%	0.3%	0.5%
Total Trucks													
All	Pass	-	390,027		0.19	2.94	0.50	0.19	2.94	0.50	0.0%	0.0%	0.0%
T	Fail	Pass	35,681	8.2%	0.77	11.40	1.33	0.35	4.61	0.85	54.5%	59.5%	36.3%
	Fail	Unresolv.	6,471	1.5%	2.13	27.61	2.25	0.42	5.45	0.45	80.4%	80.2%	79.9%
	Fail	Waiver	357	0.1%	2.29	28.24	2.30	1.68	23.98	2.16	26.5%	15.1%	5.9%
Total	Fail%		432,536	9.8%	0.27	4.02	0.60	0.21	3.13	0.53	22.5%	22.2%	11.2%
Fleet Total													
All	Pass	-	739,987		0.16	2.60	0.43	0.16	2.60	0.43	0.0%	0.0%	0.0%
All	Fail	Pass	59,980	7.4%	0.71	10.55	1.17	0.30	4.00	0.72	57.9%	62.1%	38.6%
	Fail	Unresolv.	12,316	1.5%	1.96	24.40	1.97	0.38	4.81	0.39	80.5%	80.3%	79.9%
	Fail	Waiver	664	0.1%	2.10	24.52	1.90	1.69	22.31	1.80	19.5%	9.0%	5.5%
Total	Fail%		812,947	9.0%	0.23	3.53	0.51	0.18	2.75	0.45	23.4%	22.1%	11.2%

Appendix A2 Colorado 2016 Clean Screen Audit IM240 & OBD 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	-	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%
1986	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%
1987	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%
1988	Pass	-	1		0.34	3.54	1.73	0.34	3.54	1.73	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%	0.34	3.54	1.73	0.34	3.54	1.73	0.0%	0.0%	0.0%
1989	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%
1990	Pass	-	2		0.30	4.83	0.74	0.30	4.83	0.74	0.0%	0.0%	0.0%
P	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		2	0.0%	0.30	4.83	0.74	0.30	4.83	0.74	0.0%	0.0%	0.0%

Appendix A2 Colorado 2016 Clean Screen Audit IM240 & OBD 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
1991	Pass	-	2		0.36	8.45	0.90	0.36	8.45	0.90	0.0%	0.0%	0.0%
P	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		2	0.0%	0.36	8.45	0.90	0.36	8.45	0.90	0.0%	0.0%	0.0%
1992	Pass	-	1		0.14	0.99	0.01	0.14	0.99	0.01	0.0%	0.0%	0.0%
P	Fail	Pass	1	50.0%	0.21	3.49	0.82	0.52	9.32	1.66	-148.4%	-167.1%	-102.8%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		2	50.0%	0.17	2.24	0.42	0.33	5.15	0.84	-89.8%	-130.3%	-100.9%
1993	Pass	-	4		0.35	5.69	0.64	0.35	5.69	0.64	0.0%	0.0%	0.0%
P	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		4	0.0%	0.35	5.69	0.64	0.35	5.69	0.64	0.0%	0.0%	0.0%
1994	Pass	-	6		0.26	2.53	0.94	0.26	2.53	0.94	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%	0.26	2.53	0.94	0.26	2.53	0.94	0.0%	0.0%	0.0%
1995	Pass	-	7		0.33	3.38	1.00	0.33	3.38	1.00	0.0%	0.0%	0.0%
P	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		7	0.0%	0.33	3.38	1.00	0.33	3.38	1.00	0.0%	0.0%	0.0%
1996	Pass	-	9		0.27	2.70	0.68	0.27	2.70	0.68	0.0%	0.0%	0.0%
P	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		9	0.0%	0.27	2.70	0.68	0.27	2.70	0.68	0.0%	0.0%	0.0%
1997	Pass	-	16		0.22	3.05	0.54	0.22	3.05	0.54	0.0%	0.0%	0.0%
P	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		16	0.0%	0.22	3.05	0.54	0.22	3.05	0.54	0.0%	0.0%	0.0%
1998	Pass	-	26		0.31	4.22	0.63	0.31	4.22	0.63	0.0%	0.0%	0.0%
P	Fail	Pass	1	3.7%	0.05	1.59	0.27	0.05	1.67	0.29	5.4%	-5.2%	-5.1%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		27	3.7%	0.30	4.12	0.62	0.30	4.12	0.62	0.0%	-0.1%	-0.1%
1999	Pass	-	28		0.15	2.49	0.41	0.15	2.49	0.41	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%	0.15	2.49	0.41	0.15	2.49	0.41	0.0%	0.0%	0.0%

Appendix A2 Colorado 2016 Clean Screen Audit IM240 & OBD 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
2000	Pass	-	57		0.10	2.24	0.35	0.10	2.24	0.35	0.0%	0.0%	0.0%
P	Fail	Pass	1	1.7%	0.12	3.61	0.26	0.02	2.20	0.11	83.0%	39.0%	58.2%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		58	1.7%	0.10	2.26	0.35	0.10	2.23	0.34	1.7%	1.1%	0.8%
2001	Pass	-	41		0.07	1.79	0.25	0.07	1.79	0.25	0.0%	0.0%	0.0%
P	Fail	Pass	2	4.7%	0.08	3.83	0.07	0.08	3.90	0.06	1.7%	-1.8%	18.4%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		43	4.7%	0.07	1.88	0.24	0.07	1.89	0.24	0.1%	-0.2%	0.3%
2002	Pass	-	113		0.07	2.02	0.22	0.07	2.02	0.22	0.0%	0.0%	0.0%
P	Fail	Pass	5	4.2%	0.05	2.00	0.32	0.05	1.66	0.15	0.4%	17.1%	52.9%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		118	4.2%	0.07	2.02	0.23	0.07	2.00	0.22	0.0%	0.7%	3.2%
2003	Pass	-	77		0.05	1.35	0.20	0.05	1.35	0.20	0.0%	0.0%	0.0%
P	Fail	Pass	1	1.3%	0.01	0.46	0.09	0.04	0.38	0.14	-173.9%	17.6%	-46.8%
	Fail	Unresolv.	1	1.3%	0.04	3.06	0.07	0.04	3.06	0.07	0.0%	0.0%	0.0%
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		79	2.5%	0.05	1.36	0.20	0.05	1.36	0.20	-0.6%	0.1%	-0.3%
2004	Pass	-	133		0.04	1.24	0.13	0.04	1.24	0.13	0.0%	0.0%	0.0%
P	Fail	Pass	6	4.3%	0.14	7.95	0.45	0.07	3.15	0.18	51.2%	60.4%	59.6%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		139	4.3%	0.05	1.53	0.15	0.04	1.33	0.13	6.7%	13.5%	7.9%
2005	Pass	-	84		0.05	1.03	0.13	0.05	1.03	0.13	0.0%	0.0%	0.0%
P	Fail	Pass	4	4.5%	0.24	11.18	0.10	0.04	0.94	0.20	83.8%	91.6%	-99.7%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		88	4.5%	0.05	1.49	0.13	0.05	1.02	0.14	16.8%	31.3%	-3.4%
2006	Pass	-	128		0.04	1.01	0.09	0.04	1.01	0.09	0.0%	0.0%	0.0%
P	Fail	Pass	15	10.8%	0.06	2.43	0.09	0.03	1.12	0.10	43.2%	54.1%	-15.3%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		143	10.8%	0.04	1.16	0.09	0.04	1.02	0.09	7.3%	12.2%	-1.6%
2007	Pass	-	95		0.03	0.88	0.07	0.03	0.88	0.07	0.0%	0.0%	0.0%
P	Fail	Pass	12	11.6%	0.79	18.58	0.18	0.04	0.96	0.07	95.2%	94.9%	60.6%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		107	11.6%	0.12	2.94	0.09	0.03	0.89	0.07	76.0%	69.8%	15.0%
2008	Pass	-	152		0.03	1.16	0.06	0.03	1.16	0.06	0.0%	0.0%	0.0%
P	Fail	Pass	7	4.1%	0.03	1.60	0.09	0.03	0.95	0.06	7.8%	40.7%	30.0%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		159	4.1%	0.03	1.18	0.06	0.03	1.15	0.06	0.4%	2.3%	1.8%

Appendix A2 Colorado 2016 Clean Screen Audit IM240 & OBD Test Emissions Reductions

Unresolved fails remaining in area

100%

Model	First	Last	Vehicles	Fail%	Initial			Final			Reduction %		
					HC	CO	NOX	HC	CO	NOX	HC	CO	NOX
2009	Pass	-	154		0.02	0.81	0.14	0.02	0.81	0.14	0.0%	0.0%	0.0%
P	Fail	Pass	8	5.2%	0.01	0.65	0.88	0.03	0.85	0.05	-264.8%	-29.8%	93.8%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		162	5.2%	0.02	0.80	0.18	0.02	0.81	0.13	-4.1%	-1.3%	24.3%
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%
2012	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%
2013	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%
Total Passenger Vehicles													
All	Pass	-	1,135		0.06	1.45	0.19	0.06	1.45	0.19	0.0%	0.0%	0.0%
P	Fail	Pass	64	5.3%	0.21	6.33	0.28	0.05	1.48	0.13	78.0%	76.5%	54.0%
	Fail	Unresolv.	1	0.1%	0.04	3.06	0.07	0.04	3.06	0.07	0.0%	0.0%	0.0%
	Fail	Waiver	0	0.0%	0.00	0.00	0.00	0.00	0.00	0.00			
Total	Fail%		1,200	5.4%	0.07	1.71	0.19	0.06	1.45	0.18	12.6%	15.1%	4.2%

Appendix A2 Colorado 2016 Clean Screen Audit IM240 & OBD Test Emissions Reductions

Unresolved fails remaining in area

100%

Model Year/Type	First Result	Last Result	Vehicles	Fail%	Initial			Final			Reduction %		
					HC	CO	NOX	HC	CO	NOX	HC	CO	NOX
1982 T	Pass	-	0		-	-	-	-	-	-	-	-	-
	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 T	Pass	-	0		-	-	-	-	-	-	-	-	-
	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 T	Pass	-	0		-	-	-	-	-	-	-	-	-
	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 T	Pass	-	0		-	-	-	-	-	-	-	-	-
	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%
1986 T	Pass	-	0		-	-	-	-	-	-	-	-	-
	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%
1987 T	Pass	-	0		-	-	-	-	-	-	-	-	-
	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 T	Pass	-	0		-	-	-	-	-	-	-	-	-
	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%
1989 T	Pass	-	1		1.41	11.61	3.07	1.41	11.61	3.07	0.0%	0.0%	0.0%
	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		1	0.0%	1.41	11.61	3.07	1.41	11.61	3.07	0.0%	0.0%	0.0%
1990 T	Pass	-	1		1.15	6.44	1.38	1.15	6.44	1.38	0.0%	0.0%	0.0%
	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		1	0.0%	1.15	6.44	1.38	1.15	6.44	1.38	0.0%	0.0%	0.0%

Appendix A2 Colorado 2016 Clean Screen Audit IM240 & OBD 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
1991	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%
1992	Pass	-	1		1.39	23.49	1.27	1.39	23.49	1.27	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%	1.39	23.49	1.27	1.39	23.49	1.27	0.0%	0.0%	0.0%
1993	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%
1994	Pass	-	3		0.78	10.28	1.28	0.78	10.28	1.28	0.0%	0.0%	0.0%
T	Fail	Pass	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		3	0.0%	0.78	10.28	1.28	0.78	10.28	1.28	0.0%	0.0%	0.0%
1995	Pass	-	6		0.71	7.48	1.86	0.71	7.48	1.86	0.0%	0.0%	0.0%
T	Fail	Pass	1	14.3%	4.05	23.66	0.72	1.22	8.23	0.94	69.9%	65.2%	-31.4%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		7	14.3%	1.19	9.79	1.70	0.78	7.59	1.73	34.0%	22.5%	-1.9%
1996	Pass	-	18		0.34	3.59	0.96	0.34	3.59	0.96	0.0%	0.0%	0.0%
T	Fail	Pass	1	5.3%	0.19	0.54	0.91	0.12	0.32	0.82	34.7%	40.3%	10.1%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		19	5.3%	0.33	3.43	0.96	0.33	3.42	0.96	1.0%	0.3%	0.5%
1997	Pass	-	14		0.31	4.33	1.61	0.31	4.33	1.61	0.0%	0.0%	0.0%
T	Fail	Pass	1	6.7%	1.24	0.75	0.64	0.68	4.86	0.97	44.7%	-550.3%	-51.4%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		15	6.7%	0.38	4.09	1.54	0.34	4.37	1.56	9.8%	-6.7%	-1.4%
1998	Pass	-	37		0.25	2.84	0.91	0.25	2.84	0.91	0.0%	0.0%	0.0%
T	Fail	Pass	2	5.1%	0.43	8.46	1.11	0.26	4.60	1.09	39.2%	45.5%	1.2%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		39	5.1%	0.26	3.13	0.92	0.25	2.93	0.92	3.3%	6.3%	0.1%
1999	Pass	-	63		0.19	2.37	0.71	0.19	2.37	0.71	0.0%	0.0%	0.0%
T	Fail	Pass	4	6.0%	0.23	4.55	1.39	0.22	5.34	1.32	4.6%	-17.4%	5.1%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		67	6.0%	0.19	2.50	0.75	0.19	2.55	0.75	0.3%	-1.9%	0.6%

Appendix A2 Colorado 2016 Clean Screen Audit IM240 & OBD 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
2000	Pass	-	89		0.19	2.68	0.68	0.19	2.68	0.68	0.0%	0.0%	0.0%
T	Fail	Pass	9	9.2%	0.56	8.59	0.85	0.17	2.98	0.62	69.3%	65.3%	26.9%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		98	9.2%	0.22	3.22	0.70	0.19	2.71	0.68	16.1%	16.0%	3.0%
2001	Pass	-	85		0.14	2.36	0.50	0.14	2.36	0.50	0.0%	0.0%	0.0%
T	Fail	Pass	4	4.4%	0.25	3.58	0.92	0.19	2.54	0.81	25.4%	29.1%	11.4%
	Fail	Unresolv.	1	1.1%	0.02	0.13	0.49	0.02	0.13	0.49	0.0%	0.0%	0.0%
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		90	5.6%	0.14	2.39	0.52	0.14	2.35	0.51	2.0%	1.9%	0.9%
2002	Pass	-	181		0.11	2.43	0.41	0.11	2.43	0.41	0.0%	0.0%	0.0%
T	Fail	Pass	10	5.2%	0.36	3.81	0.79	0.16	3.51	0.40	55.6%	7.9%	50.1%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		191	5.2%	0.12	2.50	0.43	0.11	2.48	0.41	8.6%	0.6%	4.8%
2003	Pass	-	120		0.10	2.03	0.32	0.10	2.03	0.32	0.0%	0.0%	0.0%
T	Fail	Pass	9	7.0%	0.14	6.32	1.05	0.16	3.30	0.58	-12.2%	47.9%	45.4%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		129	7.0%	0.10	2.33	0.38	0.11	2.12	0.34	-1.1%	9.1%	8.9%
2004	Pass	-	288		0.06	1.42	0.17	0.06	1.42	0.17	0.0%	0.0%	0.0%
T	Fail	Pass	12	4.0%	0.08	3.47	0.61	0.08	1.55	0.22	3.9%	55.2%	64.7%
	Fail	Unresolv.	1	0.3%	0.03	0.79	0.25	0.03	0.79	0.25	0.0%	0.0%	0.0%
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		301	4.3%	0.06	1.50	0.19	0.06	1.42	0.17	0.2%	5.1%	8.4%
2005	Pass	-	169		0.07	1.46	0.15	0.07	1.46	0.15	0.0%	0.0%	0.0%
T	Fail	Pass	7	4.0%	0.19	2.58	0.25	0.10	2.03	0.20	45.9%	21.3%	19.2%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		176	4.0%	0.07	1.51	0.16	0.07	1.48	0.16	4.8%	1.5%	1.2%
2006	Pass	-	269		0.04	0.86	0.09	0.04	0.86	0.09	0.0%	0.0%	0.0%
T	Fail	Pass	49	15.4%	0.17	2.22	0.19	0.04	1.19	0.10	75.5%	46.5%	46.5%
	Fail	Unresolv.	1	0.3%	0.16	2.29	0.17	0.16	2.29	0.17	0.0%	0.0%	0.0%
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		319	15.7%	0.06	1.07	0.10	0.04	0.91	0.09	35.4%	14.8%	12.8%
2007	Pass	-	179		0.03	1.17	0.07	0.03	1.17	0.07	0.0%	0.0%	0.0%
T	Fail	Pass	22	10.9%	0.06	2.03	0.18	0.04	1.51	0.08	37.0%	25.6%	54.2%
	Fail	Unresolv.	1	0.5%	0.06	1.79	0.13	0.06	1.79	0.13	0.0%	0.0%	0.0%
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		202	11.4%	0.04	1.26	0.08	0.03	1.21	0.07	6.8%	4.5%	12.4%
2008	Pass	-	311		0.03	1.02	0.07	0.03	1.02	0.07	0.0%	0.0%	0.0%
T	Fail	Pass	16	5.0%	0.09	3.50	0.30	0.03	1.32	0.07	61.1%	62.3%	76.2%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		327	5.0%	0.03	1.14	0.08	0.03	1.03	0.07	8.5%	9.6%	13.9%

Appendix A2 Colorado 2016 Clean Screen Audit IM240 & OBD Test Emissions Reductions

Unresolved fails remaining in area

100%

Model Year/Type	First Result	Last Result	Vehicles	Fail%	Initial			Final			Reduction %		
					HC	CO	NOX	HC	CO	NOX	HC	CO	NOX
2009	Pass	-	205		0.04	1.15	0.07	0.04	1.15	0.07	0.0%	0.0%	0.0%
T	Fail	Pass	14	6.3%	0.04	2.44	0.11	0.03	1.18	0.06	30.0%	51.5%	44.8%
	Fail	Unresolv.	0	0.0%	-	-	-	-	-	-	-	-	-
	Fail	Waiver	0	0.0%	-	-	-	-	-	-	-	-	-
Total	Fail%		219	6.3%	0.04	1.23	0.08	0.03	1.15	0.07	2.0%	6.5%	4.1%
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%
2012	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%
2013	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%
Total Trucks													
All	Pass	-	2,040		0.08	1.60	0.25	0.08	1.60	0.25	0.0%	0.0%	0.0%
T	Fail	Pass	161	7.3%	0.20	3.41	0.42	0.09	1.91	0.25	55.8%	44.1%	39.3%
	Fail	Unresolv.	4	0.2%	0.07	1.25	0.26	0.07	1.25	0.26	0.0%	0.0%	0.0%
	Fail	Waiver	0	0.0%									
Total	Fail%		2,205	7.5%	0.09	1.73	0.26	0.08	1.62	0.25	9.2%	6.4%	4.6%
Fleet Total													
All	Pass	-	3,175		0.07	1.55	0.23	0.07	1.55	0.23	0.0%	0.0%	0.0%
All	Fail	Pass	225	6.6%	0.20	4.24	0.38	0.08	1.79	0.22	62.4%	57.8%	42.4%
	Fail	Unresolv.	5	0.1%	0.06	1.61	0.22	0.06	1.61	0.22	0.0%	0.0%	0.0%
	Fail	Waiver	0	0.0%									
Total	Fail%		3,405	6.8%	0.08	1.72	0.24	0.07	1.56	0.22	10.2%	9.4%	4.5%

Appendix B Colorado 2016
Enhanced IM240 and OBD 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	246	3.1	36.0	2.4	1.9	22.8	2.2	1.2	13.2	0.2
P 1983	4,304	312	3.2	40.5	2.9	1.8	19.7	2.7	1.3	20.8	0.2
P 1984	4,304	706	6.2	70.2	6.2	4.3	42.2	5.9	1.9	28.1	0.4
P 1985	4,304	726	5.0	55.4	6.6	3.5	36.7	6.2	1.6	18.6	0.4
P 1986	4,304	1,143	7.0	76.6	10.1	4.9	47.9	9.4	2.1	28.7	0.7
P 1987	4,304	1,109	6.5	63.8	9.7	4.7	42.7	9.0	1.8	21.1	0.6
P 1988	4,304	1,649	8.2	90.1	12.1	5.8	62.1	11.5	2.3	28.0	0.6
P 1989	4,434	1,719	8.6	94.1	14.0	6.3	65.6	13.2	2.3	28.5	0.8
P 1990	4,481	3,171	13.7	158.8	25.2	10.4	115.7	23.7	3.4	43.1	1.5
P 1991	4,502	3,420	14.1	173.7	25.9	10.2	118.9	23.6	3.9	54.7	2.2
P 1992	4,552	4,583	16.0	196.9	33.1	12.4	141.0	31.2	3.7	55.9	1.9
P 1993	4,780	4,841	18.6	208.9	39.0	13.8	145.9	36.0	4.8	62.9	3.0
P 1994	5,088	6,413	20.9	239.6	44.0	15.2	179.1	40.7	5.8	60.5	3.3
P 1995	5,430	8,168	27.2	319.8	53.7	19.6	233.6	48.9	7.6	86.2	4.9
P 1996	5,672	10,626	25.3	326.7	57.3	19.9	253.6	52.5	5.3	73.1	4.9
P 1997	6,002	12,345	32.1	425.7	67.9	24.8	323.8	62.3	7.3	101.9	5.7
P 1998	6,331	16,279	34.1	509.1	78.3	26.6	401.2	70.3	7.5	107.9	7.9
P 1999	6,653	17,165	34.7	516.5	83.6	26.6	402.1	74.1	8.1	114.4	9.5
P 2000	6,974	24,276	38.4	638.0	98.8	29.3	505.3	85.1	9.1	132.7	13.7
P 2001	7,369	22,127	29.3	535.2	72.8	21.4	428.4	61.5	7.9	106.9	11.4
P 2002	7,764	28,490	32.0	727.4	83.2	24.2	627.6	68.5	7.8	99.8	14.7
P 2003	8,188	23,689	22.5	450.5	63.4	16.4	365.6	52.3	6.1	84.9	11.1
P 2004	8,613	27,993	21.5	443.1	52.5	15.4	368.7	43.4	6.1	74.4	9.1
P 2005	9,032	24,431	16.6	368.7	42.7	12.0	302.3	34.9	4.6	66.5	7.7
P 2006	9,450	30,529	16.4	466.6	41.5	11.8	370.3	32.5	4.6	96.3	9.0
P 2007	9,905	24,814	11.8	298.4	23.7	10.5	269.1	20.6	1.3	29.3	3.1
P 2008	10,360	30,734	11.7	377.5	25.4	10.8	342.6	22.4	0.9	34.9	3.0
P 2009	10,746	32,298	10.7	347.7	23.7	10.0	331.9	21.7	0.7	15.8	2.0
P 2010	11,132	6,364	2.5	65.3	5.2	1.9	62.6	3.6	0.6	2.6	1.7
P 2011	11,870	2,859	1.2	37.8	2.7	1.0	35.1	2.2	0.2	2.7	0.6
P 2012	12,023	2,938	1.1	36.6	2.4	1.0	34.8	2.2	0.1	1.8	0.2
P 2013	12,307	2,104	0.7	26.4	1.6	0.7	25.3	1.6	0.0	1.1	0.1
P 2014	12,357	1,168	0.5	14.5	1.1	0.4	13.7	0.9	0.1	0.8	0.2
P 2015	11,600	795	0.3	9.3	0.6	0.3	8.7	0.6	0.0	0.6	0.1
P Total		380,230	501.6	8445.4	1113.3	379.7	6746.4	977.2	122.0	1699.0	136.1
T 1982	4,550	323	5.2	71.1	4.4	3.5	48.5	4.2	1.6	22.6	0.3
T 1983	4,550	389	6.6	88.4	4.9	5.0	61.4	4.6	1.6	27.0	0.4
T 1984	4,550	833	12.0	173.4	10.7	8.1	101.3	10.4	3.9	72.2	0.3
T 1985	4,550	890	11.9	155.9	11.8	8.0	90.5	11.1	4.0	65.5	0.8
T 1986	4,550	1,482	15.4	191.0	18.5	11.8	125.9	17.7	3.6	65.1	0.8
T 1987	4,554	1,372	13.1	154.5	16.8	10.0	100.7	15.7	3.1	53.8	1.1
T 1988	4,562	2,208	18.5	185.7	26.4	14.4	133.8	24.4	4.1	51.9	1.9
T 1989	4,583	2,352	19.5	215.9	27.7	14.7	148.4	25.5	4.8	67.5	2.2
T 1990	4,630	2,975	22.7	239.3	35.0	17.9	174.3	32.8	4.8	65.0	2.2
T 1991	4,668	3,077	20.6	244.9	31.8	16.0	181.3	29.5	4.5	63.7	2.3
T 1992	4,741	4,210	29.1	308.3	44.8	23.0	244.1	41.7	6.1	64.2	3.2
T 1993	4,851	4,986	35.6	374.3	59.8	28.0	289.0	54.8	7.6	85.3	5.0
T 1994	5,019	8,089	46.6	520.8	89.3	35.7	391.7	80.2	10.9	129.0	9.0
T 1995	5,256	8,767	52.9	590.5	103.1	38.9	440.0	91.1	14.0	150.5	12.0
T 1996	5,519	10,462	34.6	447.6	94.4	26.4	342.3	85.5	8.1	105.3	8.9
T 1997	5,824	13,788	42.7	609.2	129.6	32.1	468.8	113.8	10.6	140.4	15.8
T 1998	6,135	19,354	51.3	721.6	161.7	40.1	575.5	141.4	11.1	146.1	20.3
T 1999	6,471	20,390	47.5	701.0	144.6	35.3	523.4	121.1	12.3	177.7	23.5
T 2000	6,940	26,968	54.3	830.8	170.7	43.3	640.3	148.5	11.0	190.5	22.2
T 2001	7,437	24,392	40.6	726.0	115.9	30.5	567.4	100.2	10.2	158.6	15.7
T 2002	7,863	32,314	41.3	988.0	137.1	33.8	806.1	120.9	7.5	181.9	16.1
T 2003	8,345	25,756	31.7	603.5	92.1	24.8	479.4	81.1	6.8	124.1	11.0
T 2004	8,900	37,570	32.3	718.9	81.2	25.7	573.0	69.2	6.6	145.9	12.0
T 2005	9,502	28,911	24.6	477.2	52.5	19.8	402.2	43.8	4.8	75.1	8.7
T 2006	10,087	33,896	18.8	524.3	46.3	16.8	460.2	40.2	2.0	64.1	6.2
T 2007	10,727	29,157	14.9	527.3	32.1	13.9	513.1	29.0	0.9	14.2	3.0
T 2008	11,245	39,597	18.7	712.1	37.6	17.4	648.1	36.0	1.3	64.0	1.6
T 2009	11,817	30,156	10.4	476.9	25.9	10.3	466.6	24.1	0.1	10.3	1.7
T 2010	12,303	7,187	2.8	102.2	5.0	2.7	102.3	5.0	0.0	-0.1	0.0
T 2011	12,834	3,790	1.4	64.1	3.5	1.4	62.9	3.3	0.0	1.2	0.2
T 2012	13,215	2,527	1.0	44.2	2.4	1.0	42.9	2.2	0.0	1.3	0.2
T 2013	13,433	1,939	0.7	33.7	1.8	0.7	33.2	1.7	0.0	0.5	0.1
T 2014	13,514	1,300	0.5	22.8	1.2	0.5	22.3	1.1	0.0	0.4	0.1
T 2015	12,428	806	0.3	13.0	0.7	0.3	12.9	0.6	0.0	0.1	0.0
T Total		432,213	779.9	12858.5	1821.3	611.8	10273.7	1612.4	168.1	2584.7	208.8
Total		812,443	1281.5	21303.9	2934.6	991.4	17020.2	2589.7	290.1	4283.7	344.9

Appendix B - Colorado 2016
RapidScreen Audit IM240 and OBD 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	4,304	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P 1984	4,304	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P 1985	4,304	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P 1986	4,304	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P 1987	4,304	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P 1988	4,304	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P 1989	4,434	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P 1990	4,481	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P 1991	4,502	2	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0
P 1992	4,552	2	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
P 1993	4,780	4	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0
P 1994	5,088	6	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0
P 1995	5,430	7	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0
P 1996	5,672	9	0.0	0.2	0.0	0.0	0.2	0.0	0.0	0.0	0.0
P 1997	6,002	16	0.0	0.3	0.1	0.0	0.3	0.1	0.0	0.0	0.0
P 1998	6,331	27	0.1	0.8	0.1	0.1	0.8	0.1	0.0	0.0	0.0
P 1999	6,653	28	0.0	0.5	0.1	0.0	0.5	0.1	0.0	0.0	0.0
P 2000	6,974	58	0.0	1.0	0.2	0.0	1.0	0.2	0.0	0.0	0.0
P 2001	7,369	43	0.0	0.7	0.1	0.0	0.7	0.1	0.0	0.0	0.0
P 2002	7,764	118	0.1	2.0	0.2	0.1	2.0	0.2	0.0	0.0	0.0
P 2003	8,188	79	0.0	1.0	0.1	0.0	1.0	0.1	0.0	0.0	0.0
P 2004	8,613	139	0.1	2.0	0.2	0.1	1.7	0.2	0.0	0.3	0.0
P 2005	9,032	88	0.0	1.3	0.1	0.0	0.9	0.1	0.0	0.4	0.0
P 2006	9,450	143	0.1	1.7	0.1	0.1	1.5	0.1	0.0	0.2	0.0
P 2007	9,905	107	0.1	3.4	0.1	0.0	1.0	0.1	0.1	2.4	0.0
P 2008	10,360	159	0.1	2.1	0.1	0.1	2.1	0.1	0.0	0.0	0.0
P 2009	10,746	162	0.0	1.5	0.3	0.0	1.6	0.3	0.0	0.0	0.1
P 2010	11,132	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P 2011	11,870	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P Total		1,200	0.7	19.1	2.0	0.6	15.8	1.9	0.1	3.3	0.1
T 1982	4,550	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
T 1983	4,550	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
T 1984	4,550	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
T 1985	4,550	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
T 1986	4,550	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
T 1987	4,554	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
T 1988	4,562	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
T 1989	4,583	1	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0
T 1990	4,630	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
T 1991	4,668	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
T 1992	4,741	1	0.0	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0
T 1993	4,851	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
T 1994	5,019	3	0.0	0.2	0.0	0.0	0.2	0.0	0.0	0.0	0.0
T 1995	5,256	7	0.0	0.4	0.1	0.0	0.3	0.1	0.0	0.1	0.0
T 1996	5,519	19	0.0	0.4	0.1	0.0	0.4	0.1	0.0	0.0	0.0
T 1997	5,824	15	0.0	0.4	0.1	0.0	0.4	0.2	0.0	0.0	0.0
T 1998	6,135	39	0.1	0.8	0.2	0.1	0.8	0.2	0.0	0.1	0.0
T 1999	6,471	67	0.1	1.2	0.4	0.1	1.2	0.4	0.0	0.0	0.0
T 2000	6,940	98	0.2	2.4	0.5	0.1	2.0	0.5	0.0	0.4	0.0
T 2001	7,437	90	0.1	1.8	0.4	0.1	1.7	0.4	0.0	0.0	0.0
T 2002	7,863	191	0.2	4.1	0.7	0.2	4.1	0.7	0.0	0.0	0.0
T 2003	8,345	129	0.1	2.8	0.4	0.1	2.5	0.4	0.0	0.3	0.0
T 2004	8,900	301	0.2	4.4	0.6	0.2	4.2	0.5	0.0	0.2	0.0
T 2005	9,502	176	0.1	2.8	0.3	0.1	2.7	0.3	0.0	0.0	0.0
T 2006	10,087	319	0.2	3.8	0.4	0.1	3.2	0.3	0.1	0.6	0.0
T 2007	10,727	202	0.1	3.0	0.2	0.1	2.9	0.2	0.0	0.1	0.0
T 2008	11,245	327	0.1	4.6	0.3	0.1	4.2	0.3	0.0	0.4	0.0
T 2009	11,817	219	0.1	3.5	0.2	0.1	3.3	0.2	0.0	0.2	0.0
T 2010	12,303	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
T 2011	12,834	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
T Total		2,205	1.8	36.8	5.0	1.6	34.4	4.7	0.2	2.4	0.3
Total		3,405	2.5	56.0	7.0	2.2	50.2	6.6	0.3	5.7	0.4