



**REPAIR YOUR AIR CAMPAIGN I
INTERIM REPORT (WAVES 1 – 13)**

**Regional Air Quality Council
December 28, 2004**

Executive Summary

1. Introduction

The Repair Your Air Campaign (RYAC) is a partnership between the Regional Air Quality Council (RAQC) and the Colorado Department of Public Health and Environment (CDPHE). This program was designed to reduce ozone-forming hydrocarbons (HC) through the identification and subsidized repair of high hydrocarbon emitting vehicles. It was also intended to investigate the issues surrounding implementation of full-scale remote sensing based high-emitter program. This program is partially funded through a CMAQ grant.

The RYAC program kicked-off in May of 2003. At the start of the program, CDPHE deployed a CDPHE staffed remote sensing van to identify high-emitters. This was done to start the RYAC program as soon as possible to reduce HC for the 2003 summertime ozone season with the intention of utilizing the forthcoming RapidScreen Program to identify high emitters when that program was implemented. The RapidScreen Program officially began in September 2003 with high-emitters being identified through this program since then.

Data gathered from the remote sensing vans is provided to CDPHE to perform registration matches and qualify vehicles into the program. CDPHE then provides the data to the RAQC to mail solicitations to potential program participants. Vehicle owners identified as high-emitters are offered free emissions testing, up to \$500 in emissions related repairs, and a free rental car to participate in the program.

This RYAC Interim Report addresses operational issues and provides repair data through Wave 13 of the program. Further analyses will be developed in the future to investigate aspects of the program not addressed in this report.

2. RSD Analysis

The program has experienced a number of critical delays due to the delayed implementation of the RapidScreen Program. To help compensate for the late start of the RapidScreen Program, the Repair Your Air Program began monitoring motor vehicle emissions with a CDPHE staffed remote sensing van. The number of remote sensing vans on the road increased when the RapidScreen Program was implemented in September 2003. With the addition of more vans, van days and the number of sites being visited increased substantially. This has translated into the identification of more cars eligible for the program.

The number of usable remote sensing records has been of concern. At the present time, 42 percent of the overall records are usable. There are a number of reasons why a record may not be usable but this usable records rate is lower than first anticipated and has reduced the total number of vehicles identified as high-emitters. Further work needs to be done to determine if this is an acceptable rate and, if not, what can be done to increase it.

3. Notification & Participation

Program participation has averaged 13 percent through Wave 13 of the program. This participation rate is due to the completely voluntary nature of the program and is comparable to other voluntary programs. Future efforts will investigate options to increase program

participation. These options range from strengthening the current contact letters to requiring program participation.

Currently, program partners believe that strengthening the letter to include language indicating high-emitting vehicle owners are violating State Statute and may fail their next required emissions test is the option of choice for the proposed RYAC II. This strengthened letter is expected to increase participation but it is uncertain by what amount. Another option to increase participation is to implement a compulsory enforcement program.

4. Outreach Effort

Program outreach has been ongoing. A media kickoff event was held to increase public awareness of the program and was widely covered by the media. However, since then media coverage has decreased. The declining media coverage has contributed to the program's current participation rate.

It is anticipated that future efforts should include a sustained, large-scale media outreach effort to continuously educate and remind citizens in the Denver metro area about the Repair Your Air Campaign. By reaching out to the public through an effective public relations campaign, program awareness will be increased which should result in a corresponding increase in program participation. Additionally, the RAQC and CDPHE must continue their efforts to partner with local governments to notify employees and citizens about the program.

5. Testing Effort

The RYAC has completed testing of 130 vehicles. Of the vehicles tested, 60 have been confirmed as being high-emitters through IM240 emissions testing. As the initial vehicle identification protocol was set to maximize the number of high-emitting vehicles identified and repaired prior to the 2003 ozone season, the 46 percent confirmation rate is adequate.

However, any future program should adopt a more rigorous identification protocol to lower the number of vehicles rejected from the program. Two important issues have been identified as needing further attention and should be investigated in future high-emitter identification efforts. These issues include increasing the number of valid remote sensing readings required to qualify for the program and reducing cold start identifications.

Data indicate that utilizing an identification protocol of two valid remote sensing readings and an index should reduce the false failure rate. This index will opt out vehicles by make and model year that are shown to be historically clean in Envirotest lanes.

To reduce the number of cold start identifications, a site-by-site analysis will need to be performed to determine which sites are marginal for identification of high-emitters. Sites that are found to have a high number of cold start identifications should be eliminated from providing high-emitter data. Other solutions will also be investigated to address the cold start issue.

6. Vehicle Demographic & Repair Statistics

The types of repairs that have been performed on program vehicles can be placed into two categories; tune-ups and emissions equipment repairs. The tune-ups have included changing engine oil, replacing distributor caps and spark plugs, and cleaning engine components. The

emissions equipment repairs primarily include replacement of catalytic converters and oxygen sensors. Some vehicles fall into both categories.

By measuring the emissions reductions of the repaired vehicles, an estimate can be made of the annual emissions reduction received. Based on IM240 results, the program will reduce approximately 2 tons HC, 58 tons of carbon monoxide (CO), and 0.7 tons of oxides of nitrogen on an annual basis.

Program repair costs have averaged approximately \$455. This is lower than the \$500 average estimated at the time of program implementation.

7. Conclusion

Overall, the program is performing within most design parameters and has resulted in demonstrable emissions reductions at a reasonable cost. The average reduction for HC is approximately 3 grams per mile. Repairs have cost an average of \$455 per vehicle, which is below the \$500 average repair cost estimated at the time of program implementation.

Two critical areas must be addressed in the future. The first is increasing participation by strengthening the contact letters and more extensive outreach to improve the public's awareness of the program. The second critical area is reducing the false failure rate through site analysis and a more rigorous identification protocol.

Repair Your Air Campaign Interim Report

1. Introduction

The Repair Your Air Campaign (RYAC) is a partnership between the Regional Air Quality Council (RAQC) and the Colorado Department of Public Health and Environment (CDPHE). This program was designed to reduce ozone forming hydrocarbons (HC) through the identification and subsidized repair of high hydrocarbon emitting vehicles. It was also intended to investigate the issues surrounding implementation of full-scale remote sensing based high-emitter program. This program is partially funded through a CMAQ grant.

This innovative program has used remote sensing efforts from CDPHE, University of Denver, and the State's RapidScreen Program to identify high-emitting vehicles in the Denver metro area. The RYAC program kicked-off in May of 2003. At the start of the program, CDPHE deployed a CDPHE staffed remote sensing van to identify high-emitters. This was done to start the RYAC program as soon as possible to reduce HC for the 2003 summertime ozone season with the intention of utilizing the forthcoming RapidScreen Program to identify high emitters after that program was implemented. The RapidScreen Program officially began in September 2003 with high-emitters being identified through this program since then.

Data gathered from the remote sensing vans is provided to CDPHE to perform registration matches and qualify vehicles into the program. CDPHE then provides the data to the RAQC to mail solicitations to potential program participants. Vehicle owners identified as high-emitters are offered free emissions testing, up to \$500 in emissions related repairs, and a free rental car to participate in the program.

This RYAC Interim Report addresses operational issues and provides repair data through Wave 13. Some data from Wave 14 was used in two instances; however, it is not used throughout the report due to the fact that the full wave cycle (i.e., initial contact mailing, follow-up mailing, and phone call over a 3 week period) was not completed at the time this report was being produced.

2. RSD Analysis

One important factor influencing the RYAC's efficiency and effectiveness is the number of high-emitting vehicles identified through remote sensing efforts. There are three factors that impact the number of vehicles identified. These include the number of vans operating in the RapidScreen Program, the number of days those vans are on the road collecting data, and the number of sites used to collect data.

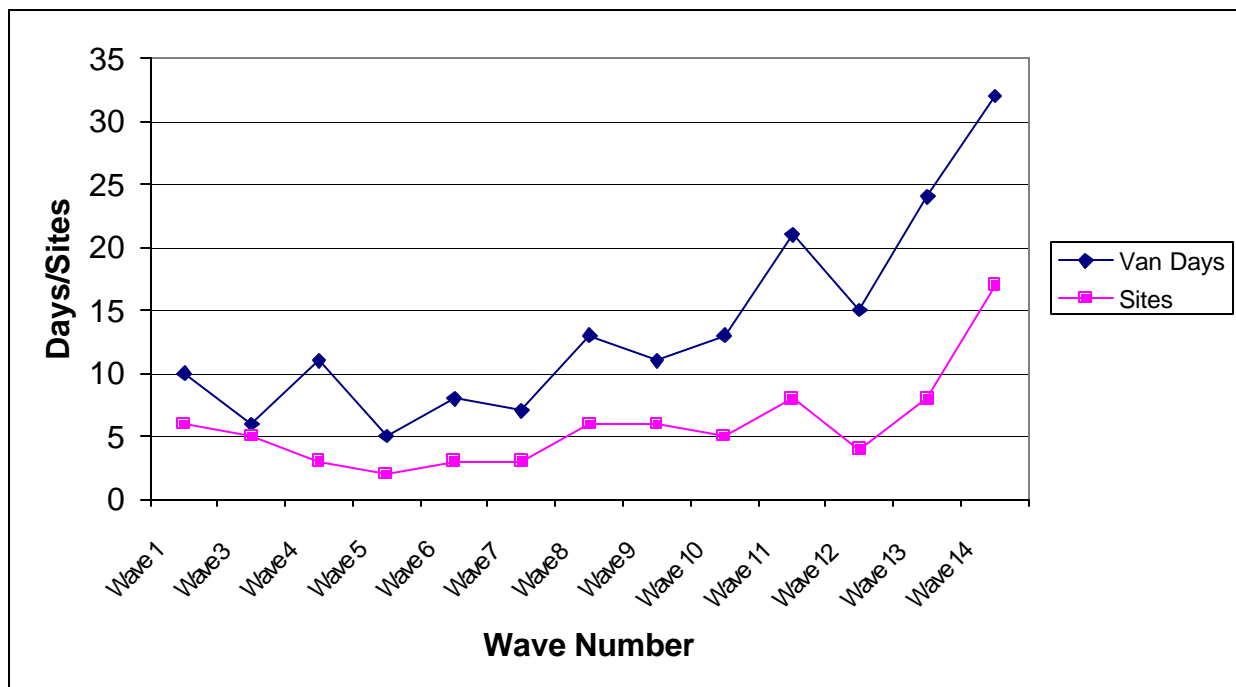
The number of vans on the road and the number of days they are deployed directly impact the number of high-emitters identified for the program. With more vans on the road for more days, more high-emitters are identified.

The number of sites visited by the vans allow for more discrete vehicles to be identified by increasing the remote sensing coverage across the Denver metro area. The more days a van stays at one site over time, the more it begins to identify the same vehicles over and over. By visiting as many sites as possible, the RapidScreen vans identify more discrete vehicles across a wider geographic area.

At the start of the RYAC, the previously listed factors detailed above limited the amount of data collected for the program. At program kickoff, there was one van operated by CDPHE on the road. As the RapidScreen Program was implemented, only 1 – 3 vans were on the road. This slow implementation limited the number of high-emitters identified and reduced program efficiency. In the near future, there will be between 4 and 7 vans collecting data at any one time. When this happens and the program is fully implemented, the number of high-emitters identified will increase. In turn, program efficiency and effectiveness will also increase.

Since RapidScreen implementation has been slower than anticipated, the number of days vans have been in deployed and the number of sites utilized have been limited. However, as Figure 2.1 shows, as the program reaches full implementation, the van days and sites utilized are steadily increasing. The figure does include Wave 14 data to show the strong increase in van deployment and site usage.

Figure 2.1 – Van Days and Sites Utilized



Through Wave 13, the remote sensing vans have been on the road for 114 days. This count includes both full and partial days of operation. The increase in the number of vans on the road has led to an increase in the number of records collected on a per wave basis. Figure 2.2 shows the number of raw records collected through Wave 14. Wave 14 is included in this graph to show the strong increase in raw records due to the increase in van days and sites visited.

Figure 2.2 – Raw Records by Wave

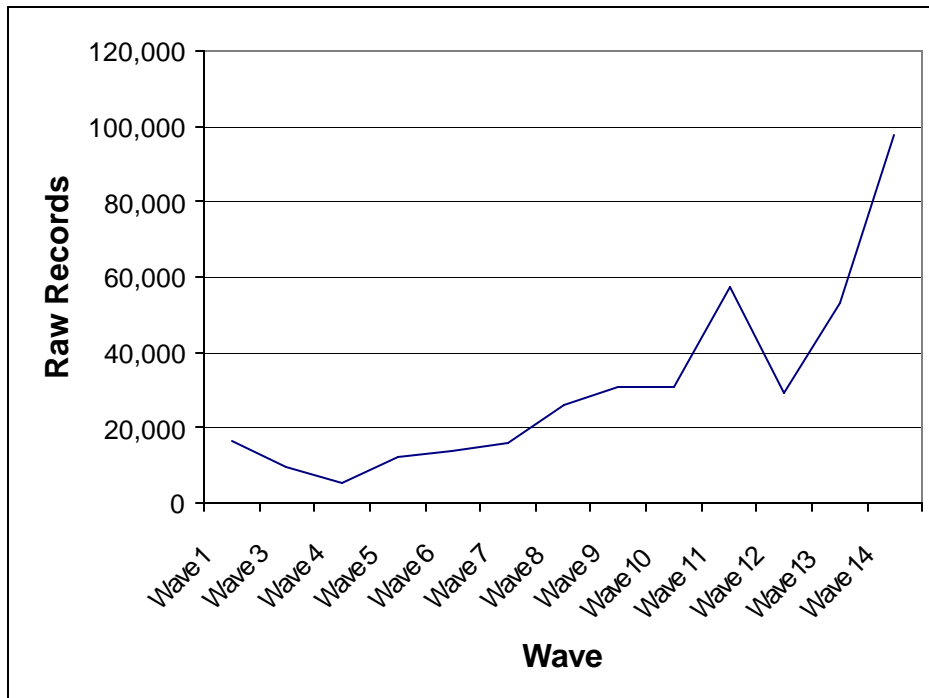


Table 2.3 below shows the number of raw records collected between Wave 1 and Wave 13. This data includes records collected by Dr. Donald Stedman with Denver University, data collected by CDPHE staff with the RSD3000, and data collected through the RapidScreen Program with the RSD4000. Therefore the data in Table 2.3 cannot be used to measure the effectiveness of the RSD4000. In total, the aggregated remote sensing data shows a 39 percent usable records rate.

Table 2.3 – RSD Performance (Waves 1 Through 13)

	Number of Records	Percentage
Raw records	300,137	
Usable records	117,053	39%
HC records meeting criteria	1,463	1.2%

However, the usable record rate for the RSD4000 is 42 percent since Colorado started using the unit in Wave 5. This percentage is lower than anticipated prior to program implementation.

Table 2.4 – RSD4000 Performance (Waves 5 through 13)

	Number of Records	Percentage
Raw records	268,934	
Usable records	112,486	41.8%
HC records meeting criteria	1,196	1%

Overall, the program is moving in the right direction. Van days and the number of sites being visited have increased substantially over the last year. This has translated into more raw records and, therefore, more usable records and more eligible vehicles qualifying for the program.

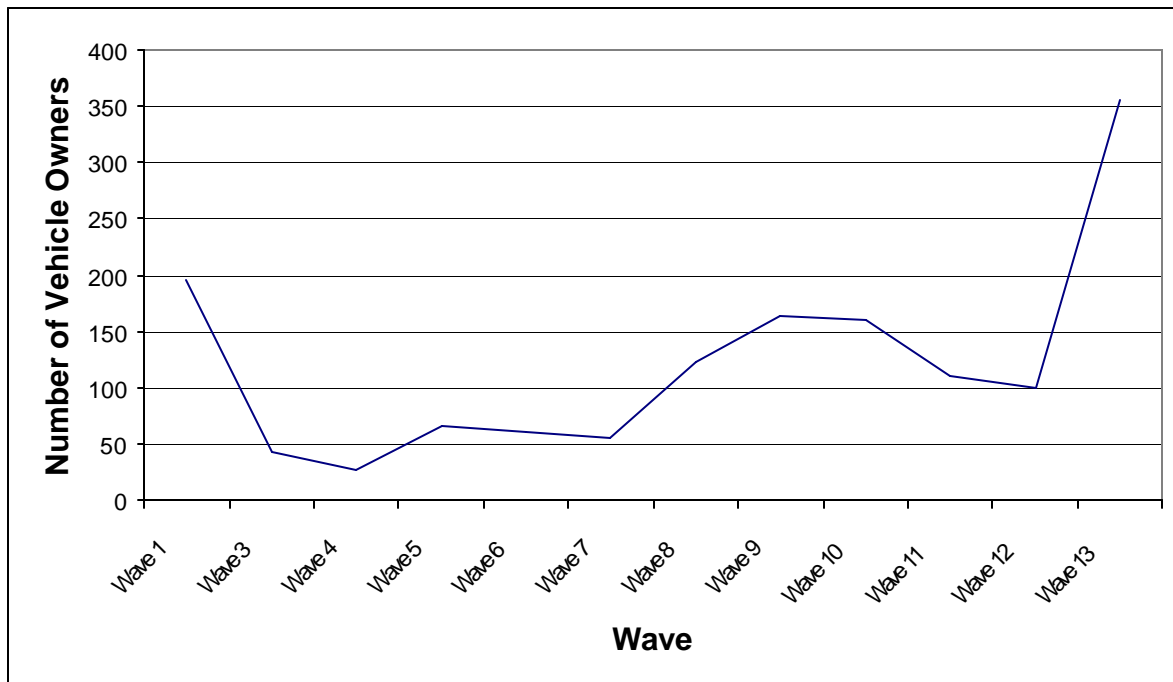
Recommendations

Investigate the RSD4000's usable records rate to determine if the current 42 percent usable records rate is optimal.

3. Notification & Participation

The RYAC currently uses the State Contractor's RapidScreen Program vans to identify high-emitting vehicles in the Denver Metro Area. The data gathered from the vans is provided to CDPHE to perform registration matches and qualify vehicles into the program. CDPHE then provides the data to the RAQC to mail solicitations to potential program participants. Through Wave 13, CDPHE has provided 1,463 qualified participants to the RAQC for notification. Figure 3.1 below shows the number of notifications by wave.

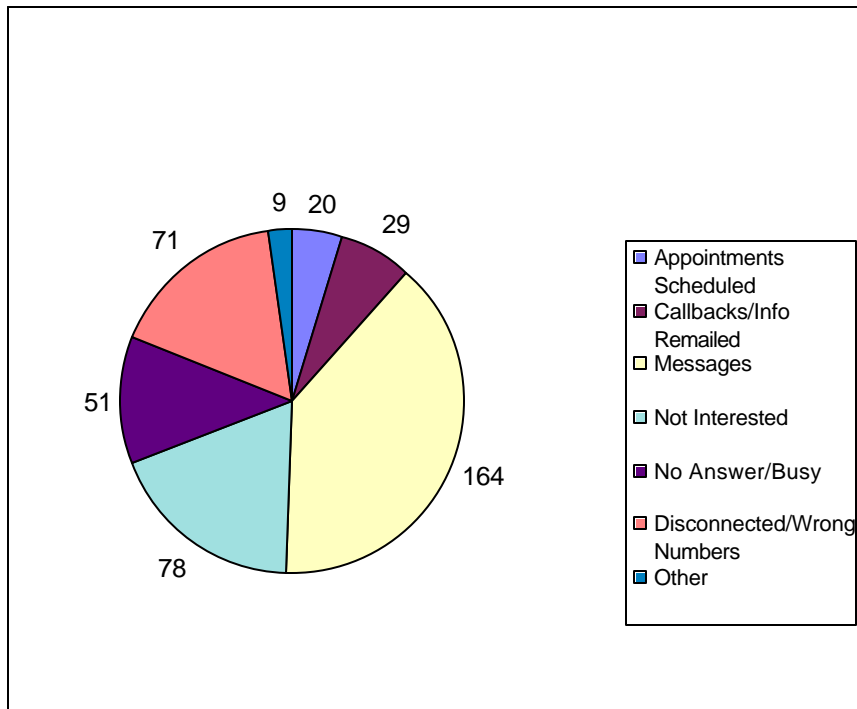
Figure 3.1 – Notifications by Wave



Waves 2 through 13 detailed in Figure 3.1 are each approximately one month's worth of data from either the RSD3000 operated by the CDPHE staff or the RapidScreen Program RSD4000. However, Wave 1 was an accumulation of data from a number of months and different sources. Since the RapidScreen Program had been delayed, program management decided to give the RYAC more momentum at start-up by using data from a number of different sources.

After the initial letter is sent, interested program participants are directed to call the RAQC for scheduling into CDPHE Emissions Technical Centers (ETC). One week after the initial letter is sent to potential participants, a second follow-up letter is sent out as a reminder to all non-respondents. A week after the follow-up letter is sent, RAQC staff calls all non-respondents as a final reminder to participate in the program. Figure 3.2 shows the outcomes of those calls.

Figure 3.2 – Follow-up Call Responses

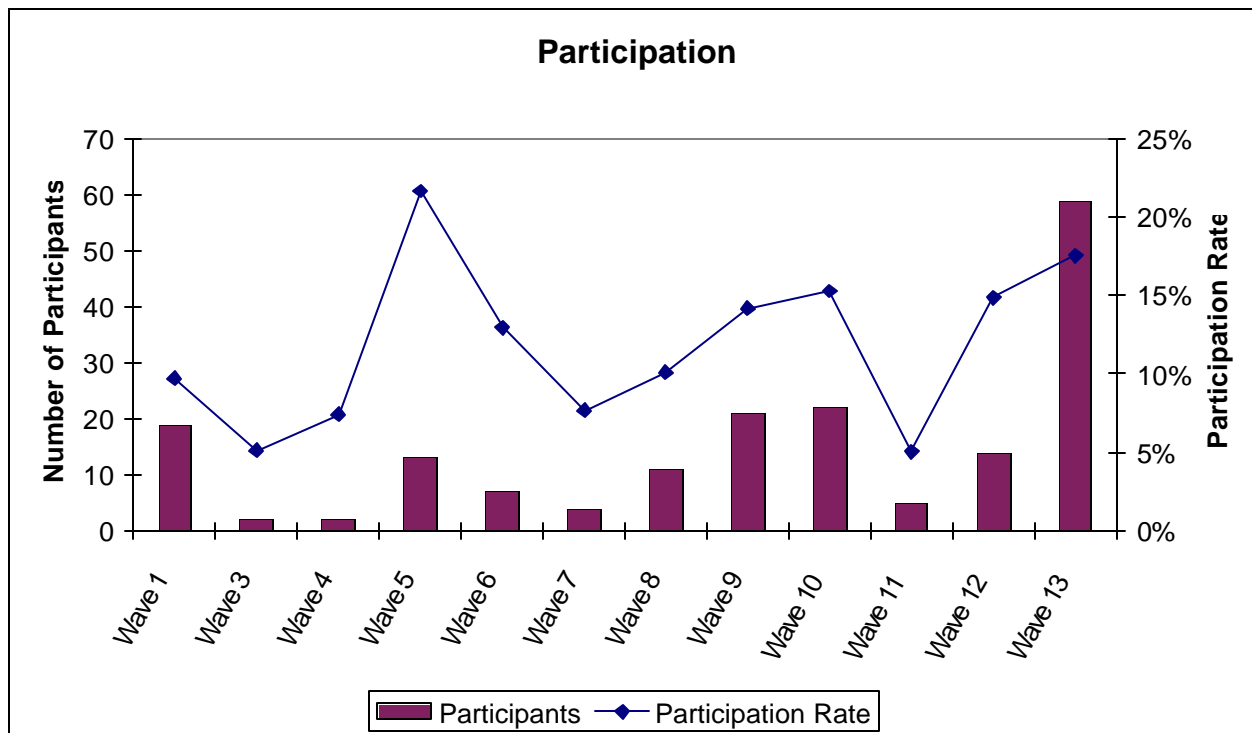


Overall, the call effort has been effective in adding participants to the program. Through Wave 13, 422 calls have been attempted. Twenty-eight of these calls, or 7 percent, have resulted in appointments being made. This effort accounts for approximately 14 percent of the 207 respondents in the program.

A Mid-Program Evaluation, performed for other purposes and based on a sampling of participants, showed that 35 percent of the respondents enrolled in the program after receiving the first letter. The follow-up letter sent a week after the initial contact resulted in 49 percent of enrollments. The final phone call accounted for 16 percent of enrollments. These results show the value of a strong contact strategy and indicate that all points of contact are critical for increasing participation in the program.

Through Wave 13, these efforts have resulted in 207 respondents to the program solicitations. Of the 207 respondents, 28 did not show up for their appointment, sold their vehicle, or had their vehicle break down permanently. Figure 3.3 shows when the remaining 179 participants entered the program and the overall participation rate for each wave.

Table 3.3 – Participation by Wave (n = 179)



As the table shows, the participation rate has been between 5 – 22 percent for all waves with an average of 13 percent through Wave 13. A number of ideas have been implemented to increase this participation rate.

During the beginning waves of the program the initial letter was sent out on RYAC letterhead. This led to many questions from the public regarding the program’s legitimacy. Starting with Wave 9, the initial contact letter was mailed on State letterhead with articles from the Rocky Mountain News about the program included in the packet. This has led to a small increase in the number of participants.

Another issue that has been discussed to increase program participation is moving from a completely voluntary program to a more compulsory program with registration-based enforcement and fines. Currently, program partners believe that strengthening the letter to include language indicating high-emitting vehicle owners are violating State Statute and may fail their next required emissions test is the option of choice for the proposed RYAC II. This strengthened letter will increase participation but it is uncertain by what amount. If program participation does not increase, a compulsory enforcement program could be the next step.

A final area that needs to be addressed in the future is the ability to contact non-English speaking potential participants. If a non-English speaker calls in to participate in the program, staff does have an Envirotest employee that is willing to assist our efforts. However, it is difficult to assist non-English speakers while staff is performing follow-up phone calls.

Recommendations

A number of improvements can be made to increase the effectiveness of future efforts. These include:

- Strengthening the letter sent to potential program participants if the program remains voluntary in RYAC II;
- Potentially requiring program participation through a compulsory program that includes fines and registration based enforcement; and
- Improving the ability to contact non-English speakers.

4. Outreach Effort

Outreach for the program is ongoing but has been limited due to funding. A media kickoff event was held to increase public awareness of the program and was widely covered by the media. However, since then media coverage has decreased. The declining media coverage has contributed to the program's current participation rate.

Subsequent efforts to increase public awareness of the program included advertising on the Internet, at RTD bus stops, and through state and local government employee and citizen newsletters. This effort has been small scale and had little impact on the program.

Recommendations

A number of improvements can be made to increase public awareness of our efforts. These include:

- A sustained, large scale media outreach effort to educate citizens in the Denver metro area to continuously educate and remind citizens about the Repair Your Air Campaign, and;
- A coordinated effort to partner with local governments to notify employees and citizens about the program through local government outreach efforts.

5. Testing Effort

After a vehicle is identified as a high-emitter and the owner calls in to participate, the vehicle is given a series of emissions tests at a CDPHE ETC. All vehicles receive a confirmatory, pre-repair IM240 emissions test. If the vehicle passes, the vehicle does not qualify for the program and the owner is given a \$10 gift certificate from Valero. If the vehicle fails, it qualifies to be repaired under the program. After the vehicle is repaired, it is given a post-repair IM240 test to ensure that the repairs were effective in reducing emissions.

Of the 207 respondents that have signed up to participate in the program, 179 have shown up for testing. Table 5.2 shows the results of the testing efforts to-date. Of the 130 vehicles tested, 60 were confirmed to be high-emitters. This equates to a 46 percent failure rate. This means that 54 percent of the vehicles tentatively identified as high-emitters passed their confirmatory IM240 test and were rejected from the program. These passed confirmatory tests are called false failures. These false failures are a concern that must be investigated.

Table 5.2 – Testing Results

	Number of Participants	Percentage
Failed	60	34%
Passed	70	39%
Rejected	8	4%
Pending	41	23%
Total	179	100%

False failures occur for a number of reasons. These reasons include:

- Cold start identifications which occur when a vehicle is identified by the remote sensor as a high-emitter prior to the engine reaching proper operating temperature;
- The one valid remote sensing reading identification protocol of the pilot program;
- A vehicle owner repairing the vehicle after it is identified as a high-emitter but prior to its confirmatory IM240 test;
- The variability of vehicle emissions and test results; and
- RSD technology software issues related to high-emitter identification that need to be investigated.

Addressing the reasons behind the false failure rate is very important. However, at this time, analytical resources are limited and cannot be allocated to address these issues. This will need to be accomplished through the proposed RYAC II.

If RYAC II is implemented, all the reasons cited for the false failure rate must be analyzed. The most important of the issues listed above are increasing the number of valid readings required to qualify for the program, using an index to screen those vehicles, and reducing cold start identifications.

Data indicate that utilizing an identification protocol of two valid remote sensing readings should lower the false failure rate. By combining two remote sensing readings with an index, a matrix that opts out vehicles by make and model year that are shown to be historically clean in the Envirotec lanes, the false failure rate should be further reduced. As an example, the index could show that newer model year vehicles consistently pass the IM240 test. Since these newer vehicles are historically clean, these vehicles would not be solicited to participate in the program.

To reduce the number of cold start identifications, a site-by-site analysis will need to be performed to determine which sites are marginal and producing the majority of false failures. Experts theorize that siting the RapidScreen vans near neighborhoods results in more cold start identifications because vehicle owners do not properly warm their vehicles up to the correct operating temperature before having their emissions monitored by a remote sensing unit. Those sites that may have high false failure rates could be eliminated from providing high-emitter data. Other solutions will also be investigated to address the cold start issue.

Recommendations

A number of improvements can be made to improve compliance rates and minimize false failure rates in future efforts. These improvements include:

- Changing the current identification strategy from one valid remote sensing reading to two valid readings and an index;
- An in-depth site-by-site analysis to determine where false failures are occurring in the metro area and elimination of those sites as sources of high-emitter data;
- Questioning of participants to determine if they have performed repairs on their vehicle prior to confirmatory testing; and
- Continued improvement of the RSD technology through high-emitter identification.

6. Vehicle Demographic & Repair Statistics

An analysis was performed to determine the demographics of all participating vehicles and those that were repaired through the program. Due to the reporting delay between when the vehicle is repaired and the data is reported to the RAQC, a limited data set was available for analysis. The data set for participating vehicles includes 124 vehicles that both passed and failed their confirmatory emissions test. Participating vehicle demographics show that they are:

- 1991 Median Model Year; and
- Averaging 120,000 miles

To-date 57 vehicles have been repaired. However, due to the same reporting delay, 47 vehicles are included in the repair data set used for this analysis. Repaired vehicle demographics show that they are:

- 1989 Median Model Year; and
- Averaging 150,000 miles

The reporting delay discussed above needs to be resolved. The long delay between when a vehicle is repaired and when the data is reported makes it difficult to conduct ongoing, timely analysis of program results.

The types of repairs that have been performed on program vehicles can be placed into two categories; tune-ups and emissions equipment repairs. Many tune-ups have required changing engine oil, replacing distributor caps and spark plugs, and cleaning engine components. The other repair category, emissions equipment repairs, includes replacement of catalytic converters and oxygen sensors. Some vehicles fall into both categories. A detailed analysis of repairs performed under the program will be done during program evaluation.

Table 6.1 shows the mean and median of pre-repair emissions by HC, CO, NOx. The pre-repair emissions tests for HC show a mean of 4.1 grams per mile and a median of 2.45 grams per mile.

Table 6.1 – Pre-repair Emissions Statistics (n=47)

	Mean	Median
Hydrocarbons	4.10	2.45
Carbon Monoxide	30.63	16.33
Nitrogen Oxide	2.61	2.56

Table 6.2 details the mean and median of post-repair emissions by criteria pollutant. The post-repair emissions tests for HC show a mean of 1.28 grams per mile and a median of 0.67 grams

per mile. This equates to an average 2.81 HC gram per mile reduction after repairs. This is shown in Table 6.3.

Table 6.2 – Post-repair Emissions Statistics (n=47)

	Mean	Median
Hydrocarbons	1.28	0.67
Carbon Monoxide	10.4	4.51
Nitrogen Oxide	1.66	1.08

The table below provides the overall emissions reductions for the program. By measuring the emissions reductions of the 47 vehicles in the data set, an estimate can be made of the annual emissions reductions. On an annual basis, the program results in a reduction of approximately 2 tons HC, 58 tons of CO, and 0.7 tons of NOx.

Table 6.3 – Reduction by Pollutant (n=47)

	Pre-Repair	Post-Repair	Reduction	Tons
Hydrocarbons	4.10	1.28	2.81	1.97
Carbon Monoxide	30.63	10.4	20.22	57.9
Nitrogen Oxide	2.61	1.66	0.95	0.7

Of the 47 vehicles in the data set, the repair costs totaled approximately \$21,000. This total includes ETC technician time, parts costs, and private repair shop technician time. The average repair cost equates to \$455 per vehicle. This is lower than the \$500 average estimated at the time of program implementation.

Recommendations

Recommendations to improve the repair process include:

- Working with the Aurora ETC to provide more timely repair data; and
- Performing analysis during program evaluation to determine the types of repairs performed under the program and assess the resulting emissions reductions by repair type.

7. Conclusions

Overall, the program is performing within most design parameters and has resulted in demonstrable emissions reductions at a reasonable cost. The average reduction for HC is approximately 3 grams per mile. Repairs have cost an average of \$455 per vehicle, which is below the \$500 average repair cost estimated at the time of program implementation.

Two critical areas must be addressed in the future. The first is increasing participation by strengthening the contact letters and more extensive outreach to improve the public's awareness of the program. The second critical area is reducing the false failure rate through site analysis and a more rigorous identification protocol.