Report on the Mid-Atlantic Truck Engine Idle Reduction Technology Demonstration Program

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Project Description, Goals, and Funding

The Mid-Atlantic Regional Air Management Association (MARAMA) working in partnership with the air quality small business assistance programs in Delaware, Pennsylvania, and Virginia developed the Mid-Atlantic Regional Small Business Anti-Idling Initiative. This effort provided support for the purchase and installation of anti-idling technology by independent truckers and small transport companies that qualify as small businesses (operating less than 50 trucks) located within two Environmental Protection Agency (EPA) Region III states, Delaware and Pennsylvania. The project produced data on the effectiveness of auxiliary power units (APU) in reducing idling emissions.

Small trucking companies represent a significant segment of the long haul population, operating vehicles that may pollute more due to vehicle age, abound in major metro areas and have great potential to reduce emissions. The challenge is that small business truckers cannot afford the up-front capital cost of the APU. The financial constraints for independent truckers and small transport companies are real and may prevent them from attempting to address truck idling and the subsequent environmental issues which truck idling creates. This project offered small businesses a non-regulatory opportunity to be a proactive participant in improving air quality.

Anti-idling equipment (generally known as an auxiliary power unit, auxiliary generator, or APU) is a unit that permits a trucker to heat and/or cool the cab of the truck without running the truck's engine. This results in significant savings in fuel usage, wear and tear on the vehicle's engine, and reductions in emissions. Although often utilizing diesel fuel for operation of the generator, APUs burn less fuel than a truck's main engine would consume while idling.

Project Goals

- Build regional capacity of state agencies to replicate an APU assistance program.
- Assist small trucking companies/owner operators to reduce emissions and improve fuel efficiency.
- Install 16 APUs on participant trucks.
- Educate the trucking community about the benefits of APUs.
- Evaluate the effectiveness of APUs to reduce truck emissions.
- Assess the viability of a multi-state initiative and the value of inter-State capacity building.
- Explore the use of program emission reductions for use in State Air Quality Implementation Plans.
- Reduce emissions from the vehicles.
- Leverage and build on existing programs such as SmartWay and State diesel emission reduction efforts.

Work Products

1. Regional Partnership
2. Participant applications, contracts, data collection forms
3. Support for APU Purchase and Installation
4. Outreach Strategy
5. Program Webpage
6. Brochure or Flyer Describing the Partnership
7. Final Report

Because transport companies and independent owner/operators qualify as small businesses, the Delaware and Pennsylvania Small Business Assistance Programs (SBAP) and Ombudsmen assisted in project outreach to target potential recipients of the funds and helped provide the intake, review, and approval of anti-idling equipment purchases. MARAMA was responsible for the administration of the overall program and for financial transactions.

Program Funding

Funding for this project was provided by the U.S. Environmental Protection Agency Region III and the Office of Transportation and Air Quality. The grant was administered by the Office of Transportation and Air Quality.

MARAMA's budget for this project was $60,000, with $48,000 originally budgeted for awards to trucking companies, leaving $12,000 for project administration over the original 23-month grant period. The project period was extended for an additional nine months, and funds were re-allocated so that $42,000 was awarded to trucking companies and $18,000 was used for project administration.

Administrative costs were higher than might be anticipated for this size of a budget because the project involved the processing of numerous applications, offers of 16 contracts, execution of 13 contracts, cancellation of one contract, analysis of three data submissions for each of 14 trucks, and report preparation. A significant part of the staff time and management oversight needed to fully execute the project was donated either by project partners from Delaware and Pennsylvania or by MARAMA.

Future projects of this type should be undertaken with the understanding that managing a large number of contracts with individual trucking companies requires significant project management time.

Marketing

The success of this project depended on finding participants willing to invest their resources in the purchase of an APU and follow through to provide reports to MARAMA. The challenge was to garner enough applications from each participating state (Delaware and Pennsylvania), but not over-market the program and set expectations of funding availability too high. To manage this issue and guide the marketing process the project team developed an Outreach Strategy (Attachment 1).

Strategy Highlights

Partnership:

Coordinate outreach efforts.
Maintain message consistency and avoid confusion.
Ensure potential applicants learned of the program in a timely manner.

Recruitment:

Facilitate the timely and efficient recruitment of program participants.
Balance the need for generating program interest with limited funds.
Use recruitment process as opportunity to generate interest in diesel reduction efforts within the region (e.g. Mid-Atlantic Diesel Collaborative).
Use print and electronic media to reach target audience.

Collateral Materials

To facilitate recruitment the partners (MARAMA, Delaware, and Pennsylvania) used three key mechanisms; brochure, webpage, and advertisements (free advertisement placements). The Program Brochure (Attachment 2) provided a pitch for participation, key contact information, and a small amount of information about auxiliary power units. It was distributed at SBA events via booths and tables. The web page (Attachment 3) was the main mechanism used to educate and disseminate information to applications. All application materials were made available through the site. As with the Brochure the website provided information about why to apply and APUs as well as contact information for partner staff. Information was provided to participating agencies for distribution to relevant publications willing to place free advertisements. MARAMA did not track the actual publication of this material.

Marketing Lessons Learned / Challenges

- It is important to coordinate with all partners, early and often.
- A regional project is possible, but needs a regional body to administer. State led projects can be effective as well.
- Regional projects need local partners. Local partners know their communities the best and often have good contacts.

Application Materials, Data Collection Forms, and Contracts

Applications

Application materials (Attachment 4) were based on the more general materials developed for Pennsylvania's small business program grants. The challenge with developing the application materials was to garner enough information to make an informed decision about eligibility and not to overwhelm potential applicants with paperwork. We wanted our questions to be clear in order to ensure an efficient review process. The ability to get accurate information via the application is essential.

The team developed a list of Manufacturer Approved APU Installers in Delaware and Pennsylvania. This summary table was distributed to the applicants. (See Attachment 5, Contract Materials).

The applications gathered information about the owner, the company, the truck and the engine, truck operations and, the APU and APU installer. This information was sufficient for the selection process; however there was some difficulty in getting all the information from the applicants. Even though applications could have been refused if incomplete, MARAMA and state staff worked with applicants to obtain missing data. If this project were scaled to a larger size such follow-up would be time consuming and perhaps impossible.

Data Collection Forms

The data collection forms were developed to gather information needed to determine fuel savings, emissions reductions, and other qualitative information about the APUs. The purchase, installation, and baseline data report form (Attachment 5, Contract Materials) collected baseline data about the truck for the twelve months before the APU was installed. The baseline data form requested information about the engine and truck, truck operations, APU information, and APU installer information. The baseline form did not request information about the APU's operation since it had not yet been installed. The semi-annual report data form (Attachment 5, Contract Materials) requested information about the main engine and truck, and APU operations. The semi-annual report collected data for two six-month periods after the APU was installed and operational.

The semi-annual report form collected the same data for each time period. The basic data sections included:

- Truck Engine Make,
- Truck Make,
- Truck Engine Model,
- Truck Model,
- Truck Vehicle ID Number (VIN),
- Truck License Plate Number,
- Licensing State,
- Hours the APU Operated over the Period,
- Hours Truck Engine Operated over the Period,
- Hours the Truck Engine Idled over the Period,
- APU Fuel Consumption Rate (gallons/hour),
- Truck Engine Fuel Consumption Rate at Idle (gallons/hour),

- Semi-Annual Mileage (miles traveled during the report period),
- Diesel Fuel Consumed during the period (gallons), Main engine and APU,
- Average price of diesel fuel over the quarter (dollars/gallon),
- Information as to where idling occurred (truck stop, rest area, loading dock, side of road, etc.),
- Comments on APU operation and maintenance,
- Other Comments.

Much of the information was repeated in both the baseline form and each of the semi-annual reports, which provided a means to identify possible anomalies. For example KEC Trucking's VIN number changed on the Task 3 submission. When staff asked about this change KEC Trucking provided a letter stating that the original truck had been involved in an accident and had been replaced. The APU was transferred from one vehicle to the other. (See Attachment 11, data input for KEC Trucking. Data for the first semi-annual report was from one truck, and for the second semi-annual report, from the other truck.) Repeating key information on each of the forms also assisted with tracking participants that had multiple trucks in the project. For example, Patrick had two trucks on one contract and Sindall had three trucks on two contracts; it was important to track each truck by its individual VIN.

The forms requested comments on APU operation and maintenance, and these were also important to the project. For example, during the months of April through September 2007, Johnson experienced an APU breakdown that required him to idle his truck engine as opposed to using his APU, this information was noted in the comments section.

Once data was received it was entered into a Microsoft Excel spreadsheet, similar to the one in Table 1, below, for easy access and data analysis. (See Attachment 11.)

Contracts

MARAMA considered whether to issue sub-grants or contracts with the owner/operator participants. After researching federal regulations, reviewing Office of Management and Budget Circular 110, and considering how best to work with the trucking industry, MARAMA concluded that negotiating contracts with truckers and truck companies would be the most appropriate. The trucking companies were contracted to provide data concerning the use and operation of APUs. (See Attachment 5.)

MARAMA consulted an attorney and modified its standard contract template to develop the contract for this project (Attachment 5). As with the applications, the challenge was to meet MARAMA's needs with a contract that would not be overwhelming for a small business owner. The final product was reviewed by the SBA representatives and a few minor adjustments were made.

Table 1. Data Input Form

Necessary Information			
	Start and End Dates of Period of Operation		
	Baseline (over last 12 months)	April 1-Sept 30, 2007	Oct 1-March 31, 2008
Truck Mileage (miles), during this period			
Hours Truck Engine Operated Over the Period (hours)			
Hours Truck Engine Idled Over the Period (hours)			
Truck Engine Fuel Consumption Rate at Idle (gallons/hour)			
Diesel Fuel Consumed during the period by the engine (gallons)			
Hours APU Operated Over the Period (hours)			
APU Fuel Consumption Rate (gallons/hour)			
Diesel Fuel Consumed during the period by the APU (gallons)			
Average Miles Per Gallon over the Last 12 months (miles)			
Average Price of Diesel Fuel over the Period ($)			

Payment Schedule

In the contracts, MARAMA established the following payment schedule to provide an incentive for continued participation in the project and submittal of complete operating information:

- Task 1: $750 (Purchase and install an APU, submit proof of purchase and receipt for installation, a copy of the warranty, a photo of the APU as installed, and baseline data)
- Task 2: $750 (Semi-annual report for April through September)
- Task 3: Up to $1,500 or a lesser amount that brings the total paid to no more than 50 percent of the total cost of the APU (Semi-annual report for October through March)

Application Materials, Data Collection Forms, and Contracts – Lessons Learned

- Applications:
  - Keep forms short and clearly written.
  - Expect some need for follow-up and allow staff time for questions and answers from applicants.
  - Perhaps post a Q and A page on the web.

- Data Collection Forms:
  - Ask for key identification information on each form. This helps with data entry and with tracking data.
  - Keep forms short. Develop a clear understanding ahead of time about which data is needed and do not ask for more.

- Contracts:
  - Keep the contract conditions simple and obtain legal advice concerning necessary provisions.
  - Be clear about ownership of the APU. You do not want an APU returned to you at the close of the project.
  - A contract was used, rather than a grant, because our purpose was to gather data from the participants concerning the actual operation of the APU. Payments were structured so that the last payment was the largest to provide an incentive to stay with the program and to continue to provide needed data.
  - Allow ample time for securing signatures. This participant group is very mobile and it may take some time to get mail to them and back. Perhaps consider calling to determine their location prior to sending to them. Then follow-up within a week to make sure they actually received the contract.
  - Establish a waiting list. Several trucking companies who applied to participated in the program declined to sign the contract and did not participate in the project.

Project Implementation

Program Design

In June 2005 MARAMA applied for a $500,000 grant to fund a larger version of this program and planned to cover about 20 percent of the cost of installing APUs on about 60 trucks in five states and the District of Columbia. That application was unsuccessful. In September 2005 MARAMA re-applied for $60,000 to cover no more than 50 percent of the cost of purchasing and installing APUs for approximately 16 vehicles in two states—Delaware and Pennsylvania—as a demonstration program and foundation for future efforts to reach out to small business owner/operators within the Mid-Atlantic Region. EPA awarded $60,000 for the project in November 2005.

A project team was formed to design and implement the project, including staff from the Delaware, Pennsylvania, and Virginia small business assistance programs and MARAMA staff. Grant funds supported MARAMA staff participation and the incentive awards to small business owner/operators.

It was essential that project participants would provide data on the operation of the APUs. After extensive discussion, the project team agreed on a payment schedule that encouraged participants to "stay with the program" and to provide a full year of operational data. The project used a "back-end" funded approach that paid $750 after baseline data collection and APU installation, $750 after successful completion of the first semi-annual report, and $1,500 after completion of the second semi-annual report. The initial award was to assist in purchasing an APU, the second was to ensure continued participation and data submission, and the final report was to ensure the final data set was submitted. The total awards to each participant provided no more than, and generally less than, 50 percent of the cost of the APU purchase and installation. MARAMA also built in a penalty of 10 percent per week for submitting late reports.

The payment schedule was a successful approach, since all but one participant who signed a contract (Jaguar LLC) completed all three data reports.[1] The approach may also have discouraged some from participating who could not obtain the necessary up front funds to purchase the APU. Several applicants selected to participate dropped out upon receiving the contract that specified the payment schedule.

At least half of the total cost of the APU and the cost of the installation were provided by the truck owner, and they owned the APU after completion of the project. The owners were able to select the unit of choice but at a minimum the units were to provide heating and

[1] Jaguar LLC did not provide any of the required reports. After numerous calls and emails from both the APU project manager and MARAMA's Executive Director, MARAMA formally terminated the contract with Jaguar LLC. The owner of Jaguar LLC or members of his family also owned other trucking companies and had contracts for three other vehicles under this program. Tasks 1, 2, and 3 were completed for the other contracts.

cooling to the cab of the truck and have a run-time "Hour Meter." One applicant was interested in using a bunk heater option only. After discussion the project team decided to allow this application since there was enough funding to support all the applicants. Although not identified until after data analysis had begun, three trucks had battery operated APUs which did not have hour meters. This was a significant problem for calculating emissions reductions due to the operation of the unit.

Participants were required to provide information on the idling hours and idling fuel consumption for the previous year prior to application and installation of the APU. One participant with new trucks was unable to provide this data but provided data for other trucks operated by the same company. Again, during the data analysis phase, it was determined that the participant had not provided information on hours idled, and efforts were made to obtain this information after the fact.

MARAMA developed a basic data analysis plan identifying how emissions benefits from the project were to be calculated. It is recommended that any other projects of this nature do a more detailed data analysis plan in conjunction with developing the application and reporting forms to ensure that it is clear which elements of information are mandatory for calculating the emissions benefits. As discussed in more detail below, in some cases in this program applicants were afforded flexibility that later made data analysis more difficult.

Selection of Participants

MARAMA's original contract budget was $48,000, which we planned to divide equally between Pennsylvania and Delaware. At $3,000 per participant, 16 APUs were to be installed. As explained below, the project concluded with 14 APUs on three trucks from Delaware and 11 from Pennsylvania.

The request for applications was originally open for December 1-22, 2006. MARAMA received 17 applications by the closing deadline, and four after that, for a total of 21 applications. Each was copied and sent to the small business program representatives in Delaware, Pennsylvania, and Virginia for review. Conference calls were held on January 17 and 24, 2007 with the project team to evaluate the applications. The team also followed up with numerous applicants to obtain information that was either incomplete or missing from the applications.

As part of the application process, staff considered numerous program components including eligibility, payment, and data collection. Participant eligibility was limited to those trucking companies domiciled in either Delaware or Pennsylvania. Proof was required via a state license tag number. However the partners fully understood the nature of the work done by the small trucking companies. Many had routes that took them cross country or at least out of state on a regular basis.

MARAMA and state staff reviewing the applications found that many applicants had already installed an APU, had installed an APU not on the list of suggested APU manufacturers, or had their APU installed at a company not on the list of suggested APU installers. Applicants who had already installed an APU were considered for participation as

long as the APU was fairly recently installed, within its useful life, and under warranty. APUs installed by installers not on the suggested list were also considered eligible for the program as long as the APUs were manufactured by mainstream companies in good standing and were under warranty. Black Rock, Carrier, and Oman were found to be mainstream makers of APUs. Webasto is a mainstream maker of bunk heaters.

After completing the review of applications, the project team selected 16 trucks for participation. Contracts were developed for each company and sent in duplicate for signature and return.

Execution of Contracts

The family of one of the 16 selected participants withdrew from the program due to his death. Another company offered a contract withdrew due to financial issues. (Information about that company was passed along to EPA so they could contact the company about the SmartWay loan program.) Two other selected participants decided not to participate in the program. One of the selected participants signed and returned the contract but never completed any of the data submission forms and was terminated from the project.

Once the applicants were accepted MARAMA sent each selected participant a notification letter and contract for signature. Securing signatures for each participant was time consuming. Most required numerous contact attempts and lengthy delays (two–three weeks) prior to MARAMA receiving a completed contract. This was mainly due to the mobile nature of the participants. Contacting the applicants via phone or e-mail before mailing contracts might have helped speed the signature process.

During the course of the project, it was necessary for MARAMA to consult with the project team and award replacement contracts when selected applicants did not sign their contract and notified MARAMA that they had dropped out or when MARAMA cancelled a contract for lack of participation. A list of the final participants is provided below (Table 2). After discussion, and with the approval of the EPA project officer, the number of trucks participating in the program was eventually reduced to 14 in order to provide resources to cover the costs of administering the program. After consultation with the project team, the contract for the last two trucks was signed late in the project and was awarded to one of the other participants who had originally applied to have five trucks in the program and who had been very responsive in providing information and signing required documents.

Table 2. Project Participants

Company Name	Contact Person	Address	Contract Date
Richard P. Johnson Trucking	Richard Johnson	20640 Mulberry Knoll Road Lewes, DE 19958	3/20/2007
Sindall Transport, Inc. (Truck 1)	Deb Sindall	461 Diller Avenue, Suite 100 New Holland, PA 17557	3/20/2007
Roger A. Stanislaw	Roger Stanislaw	4573 Route 711 Bolivar, PA 15923	3/25/2007
D.G. Pearson, Inc.	Donald Pearson	6150 W. Denny's Road Dover, DE 19901	3/25/2007
KEC Trucking	Kevin Marchuk	21054 Mayhew Drive Lincoln, DE 19960	3/26/2007
Patrick Transportation (Trucks 1 and 2)	Rosemary Gault	2860 Hedley Street Philadelphia, PA 19137	3/27/2007
Lurena, LLC	Lurena Ferguson	108 Carriage Lane Clarks Summit, PA 18411	4/1/2007
Mark K Ferguson Trucking	Mark Ferguson	108 Carriage Lane Clarks Summit, PA 18411	4/1/2007
Jaguar, Inc.	Malcolm Ferguson	108 Carriage Lane Clarks Summit, PA 18411	4/1/2007
Couch Trucking Co.	Floyd Couch, Jr	104 Martin Road Markleysburg, PA 15459	4/10/2007
Crossroad	Fred Caspillo	209 7th Street Weatherly, PA 18255	4/12/2007
Sindall Transport, Inc. (Truck 2 & 3)	Deb Sindall	462 Diller Avenue, Suite 100 New Holland, PA 17558	11/7/2007

Reports from Participants

With contracts signed, the next phase of the project was processing requests for payment for Task 1. Deliverables for this tasks included:

- A signed invoice for the purchase of the APU,
- A signed service receipt showing the APU was installed by a manufacturer-approved or MARAMA-suggested installer,
- A copy of the APU warranty,
- A photo of the APU installed on the owner's truck,
- A completed Attachment C: Baseline Data Collection and Installation of APU Report. (Contract Materials, Attachment 5)

While some of the participants had little difficulty providing all the deliverables most needed either some assistance in completing reports or at the least a few email and/or phone call reminders. As stated in the application section, many did not use a manufacturer-approved or MARAMA-recommended installer. Installers were deemed mainstream and in good standing if they had been in business for at least one year. Some participants had

difficulty completing the Baseline Data report. Some did not complete the form or numbers seemed incorrect. Project staff communicated mostly by email with participants to secure needed information. A few participants requested and were granted extensions for the completion of Task 1 (i.e., the penalty for late submittal was waived). Some needed to coordinate the time their trucks would be available for installation of the APUs. Extensions were normally only a few weeks. The one instance where this was not the case was the company that never completed any of the tasks and had its contract terminated.

The Task 2 deliverable included the completion of Attachment D, semi annual Report for April 1 - September 30, 2007 (Contract Materials, Attachment 5). Most of these reports were submitted in a timely fashion. MARAMA checked the data to ensure that the form was complete and accurate. Some follow-up was needed to clarify handwriting and faxed numbers. In one instance the submitted report did not show decimal points which made the hours idling excessively high. After a few calls to the participant and a recheck of the run time meter the error was found and the data was adjusted. MARAMA also started inputting data into tabular form in preparation for analysis and preparation of the final report.

The Task 3 deliverable was the completion of Attachment D, the semi-annual report for October 1 2007 – March 31, 2008 (Contract Materials, Attachment 5). All of the reports except the one eventually cancelled were submitted in a timely fashion. Staff processed the reports, checked data for accuracy and completeness. While some time was still required for follow-up on missing data, it was much less than needed for Task 2.

Data Analysis Methods

Data analysis was an important part of this project. Two key project outcomes were to decrease emissions of harmful pollutants including particulate matter (PM), nitrogen oxides (NO_x), and carbon dioxide (CO_2) and the reduction of fuel consumption. Using the data collected for the baseline and the two semi-annual reports MARAMA calculated emission reductions and fuel efficiency for the 14 trucks that completed the project.

The original work plan used fairly simple formulae to determine estimated emission reductions. Since the original submission EPA developed the Diesel Emissions Quantifier. This very useful online tool is an effective means to calculate emissions. However, it currently does not handle small fleets well. Adjustments to the model are underway and this may prove to be an efficient and effective calculation means for small fleet projects.

Methods Used for NO_x and PM

The methodology used for this project is detailed in EPA's "Guidance for Quantifying and Using Long Duration Truck Idling Emission Reductions in State Implementation Plans and Transportation Conformity" dated January 2004 (SIP Guidance) (Attachment 6). This document is also available at http://www.epa.gov/smartway/idle-guid.htm. Methods used for CO_2 are different, and are described later in this section.

In order to quantify the emissions reductions for NO_x and PM_{10} MARAMA generally followed EPA's SIP Guidance described above. It provides guidance on quantifying emission reductions from technologies which reduce long duration truck idling emissions from Class 8 trucks (vehicles weighing over 33,001 pounds). The SIP Guidance can be used for idle reduction technologies that are mobile and attach onto the truck (mobile auxiliary power units such as APUs) and other forms of idle reduction technology. According to the document almost all diesel PM is submicron in size. Therefore PM_{10} emissions are equivalent to $PM_{2.5}$ emissions (and the two should not be added together).

Sections A through C of the SIP Guidance provide background information, data on long duration truck idling emissions reductions, information on long duration truck idling emissions reductions, and specific considerations for using long duration truck idling emission reductions. Section D contains the specific steps used to calculate emissions reductions. The steps are listed below followed by an explanation of calculations performed and sources of information.

- Step 1: Determine the historic idling activity of the truck involved in the project.
  - Determine the number of hours the truck idled for the past year, which was given in the baseline report.

- Step 2: Select the emission factor for the criteria air pollutant or precursor.
    - This step involved using Appendix B and C of the SIP Guidance to find the emission factors for NO_x and $PM_{10.}$ For NO_x emissions, the emission factor is 135 g/hr. For PM emissions, the emission factor depends on the model year of the truck. For trucks with a model year of 2006 and earlier the emission factor is 3.68 g/hr and for trucks with a model year of 2007 the emission factor is 0.33 g/hr.

- Step 3: Multiply the emission factor in Step 2 by the number of hours per day the truck is not idling because the idle reduction technology is used.
    - Participants provided the number of hours the idle reduction technology, in this case an APU, was utilized during each half of the project period. This calculation involved summing the hours on the two reports.

- Step 4

  (a): Determine emission factor for the mobile idle reduction technology.
    - Following the guidance, this step involved finding the emission factor for the APU used. Emission factors can be obtained by consulting the certification data on the EPA website at http://www.epa.gov/otaq/certdata.htm. Look under the section entitled, "Non-road Large Compression Engine (CI)" and then "Engine Family General Information." (The spreadsheet is large so it may take some time to download.) The emission factor is on the worksheet entitled "Test info." Find the manufacturer of the APU engine's name and the 12-character EPA engine family number. The certification levels for NO_x and PM are in the "Certification Levels" column.

    - On the baseline data form, MARAMA requested the APU Engine Family Name from each participant. However, MARAMA did not request the APU engine year or the 12-character EPA engine family number, and both are necessary for finding the emissions factor. MARAMA staff attempted to find the 12-character EPA engine family number and engine; however, this proved to be difficult.

    - Paul Bubbosh, our EPA Project Manager, suggested that one APU be used as a general default for each truck in the project since the APUs have similar emissions. To test this MARAMA completed the quantification calculation for an APU with a 2003 Kubota engine (the suggested general default engine and the same engine that was used in the SIP Guidance) and an APU with a 2006 Yanmar engine. The emissions reductions were comparable. (See Tables 3-4.) Therefore, information for this report was calculated using the emission factor for the 2006 Yanmar engine.

Table 3. 2006 Yanmar APU
Emission Factors and Emissions Reductions for NO_x and PM

Emission Factors			
	NO_X	**PM (2006 and earlier)**	**PM (2007 and later)**
Emission Factor for the Truck (grams/hour)	135	3.68	0.33
Emission Factor for an APU with a 2006 Yanmar Engine (grams/hour)	27.00	0.70	0.70
Percent Reduction (%)	80	81	-112

Table 4. 2003 Kubota APU
Emission Factors and Emissions Reductions for NO_x and PM

Emission Factors			
	NO_X	**PM (2006 and earlier)**	**PM (2007 and later)**
Emission Factor for the Truck (grams/hour)	135	3.68	0.33
Emission Factor for the APU with a 2003 Kubota Engine (grams/hour)	28	0.70	0.70
Percent Reduction (%)	80	81	-112

(b): When using a mobile idle reduction technology, multiply the APU emission factors from 4(a) by the average daily horsepower load of the mobile idle reduction technology.
- Appendix E of the SIP Guidance gives an example of how to use the quantification steps and gives 5 horsepower (hp) as a default for the 2003 Kubota engine.

(c): When using a mobile idle reduction technology, multiply the g/hr factor by the number of operating hours it is estimated to be used.
- This step involved calculating the number of hours the APU was utilized, summing the hours from the Task 2 and Task 3 reports.

- Step 5: Determine the net emission reduction.
  - This step is the difference between step 3 (the emissions avoided by not idling the truck engine) and step 4(c) (the emissions added by running the APU).

- Step 6: Sum all emission reductions for the project.
  - Once the quantification calculation was done for each truck the numbers were added together to get the amount of reductions for all the trucks involved.

The methods used for calculating NO_x and PM for the Sindall trucks are different due to the fact that the APUs are battery operated and do not have an hourly meter. The APUs on the Sindall truck use dieselfuel to heat the cab and the battery to cool the cab, so the diesel fuel usage in Task 3 (October 2007 through March 2008) will be higher than Task 2 (April through September 2007). No data was provided on the hours the APU was used. Sindall stated that for the four nights a week the drivers are out, they use the APU an average of ten hours per night. She suggested using the following method to calculate the hours that the APU was used.

- Calculation: 26 weeks per report period X 4 nights per week = 104 nights per report period. 104 nights X the number of hours the APU was used = the number of hours the APU was used in the report period.

The APU only uses diesel to heat the cab, then the APU uses only battery power and no fuel in Task 2, which is during the spring to summer months. It only operates an estimated 5 hours per night in Task 2.

- The calculation for Task 2:
  26 weeks per report period X 4 nights per week = 104 nights per report period. 104 nights X 5 hours = 520 hours that the APU was used in Task 2.

- The calculation for Task 3:
  26 weeks per report period X 4 nights per week = 104 nights per report period. 104 nights X 10 hours = 1,040 hours that the APU was used in Task 3.

The steps for calculating NO_x and PM for the Sindall trucks are the same as stated on page 15, with one exception. In Step 4 (c) only the hours that the APU was used in Task 3 are used, as opposed to the hours of usage in Tasks 2 and 3. This is because the APU is battery operated and uses diesel fuel only when it is heating the cab, which is only necessary in the colder months. Since the APU uses the battery for cooling during the summer months and does not use diesel fuel unless heating, emissions from Task 2 were assumed to be zero.

Calculations for NOx emissions reductions for each truck are presented in Attachment 9. Calculations for PM emissions reductions for each truck are presented in Attachment 10.

In addition to the emissions factors, the activity data needed for these calculations are the following:

- The number of hours the APU operated.
- The manufacturer of the APU engine and the 12-character EPA engine family number of the APU.
- The horsepower of the APU.
- The model year of the truck engine.

Method used for CO_2

In order to quantify the emissions reductions in CO_2 due to this project, MARAMA used EPA's "Emission Facts, Average Carbon Dioxide Emissions Resulting from Gasoline and Diesel Fuel" (EPA420-F-05-001, dated February 2005) (Attachment 7). This document is available on the EPA website at: http://www.epa.gov/oms/climate/420f05001.pdf. It provides a method for calculating CO_2 emissions from using a gallon of diesel fuel based on average carbon content of conventional diesel fuel. The emissions factor of 22.2 pounds/gallon was used. The amount of CO_2 emitted does not depend on whether the fuel was burned in the truck or the APU and does not depend on the age of the truck; it depends only on the amount of diesel fuel used. Because an APU uses less fuel per hour than an idling truck, using the APU will decrease CO_2 emissions.

To calculate the fuel saved by using an APU, subtract the fuel used by the APU from the fuel saved by reducing truck idling, resulting in the overall fuel savings. Multiply the overall fuel savings by the amount of CO_2 emitted per gallon (22.2 lbs/gal) of diesel.

- Step 1: Calculate the fuel saved by reducing truck idling.
  Truck gallon/hour at idle X (Baseline truck hours idled minus project truck hours idled) = gallons saved

- Step 2: Calculate fuel used by APU.
  (Fuel used by APU in Task 2) + (Fuel used by APU in Task 3) = Fuel used by APU

- Step 3: Compute the overall fuel savings.
  (Step 1) - (Step 2) = Overall fuel savings

- Step 4: Multiply overall fuel saved times CO_2 per gallon.
  (The result from step 3) X (22.2 pounds/gallon) = CO_2 reduction

The inputs used for calculating CO_2 for the Sindall trucks is different because the APUs are battery operated and do not have an hourly meter. Since baseline data was not available, Deb Sindall submitted data reports for five other trucks in the fleet that have basically the same motor, transmission, and rear. To calculate the baseline hours the truck idled, the average percent idle time for the other five trucks in the fleet was calculated for a result of 24.40 percent. Assuming the trucks operated the same number of hours in the baseline as in the project period, baseline truck hours idling were estimated at 24.40 percent of the total hours the truck engine operated in Tasks 2 and 3. This gave an assumed hors of operation in the baseline period of 448 for Sindall 1, 598 for Sindall 2, and 778 for Sindall 3 (See Appendices 8 and 11).

The fuel usage of the Sindall APUs also had to be calculated. In the semi-annual reports the APU fuel consumption rate was given as 0.03-0.06 gallons/hour, for a median amount of 0.045 gallons/hour. To calculate the fuel used by the APU, multiply the hours the

APU was used in each task by 0.045 gallons/hour. For Task 2 the APU was used for 520 hours. However since it does not use diesel fuel when cooling the cab, the emissions were zero. For Task 3, the APU was used for 1,040 hours X 0.045 gallons/hour, which equals 46.8 gallons. The steps used to calculate the CO_2 emissions reductions are the same as above.

This quantification was done for CO_2, for each truck that participated in the project. Calculations for each truck are presented in Attachment 8.

Note that in addition to the emissions factor, the activity data needed for these calculations are the following:

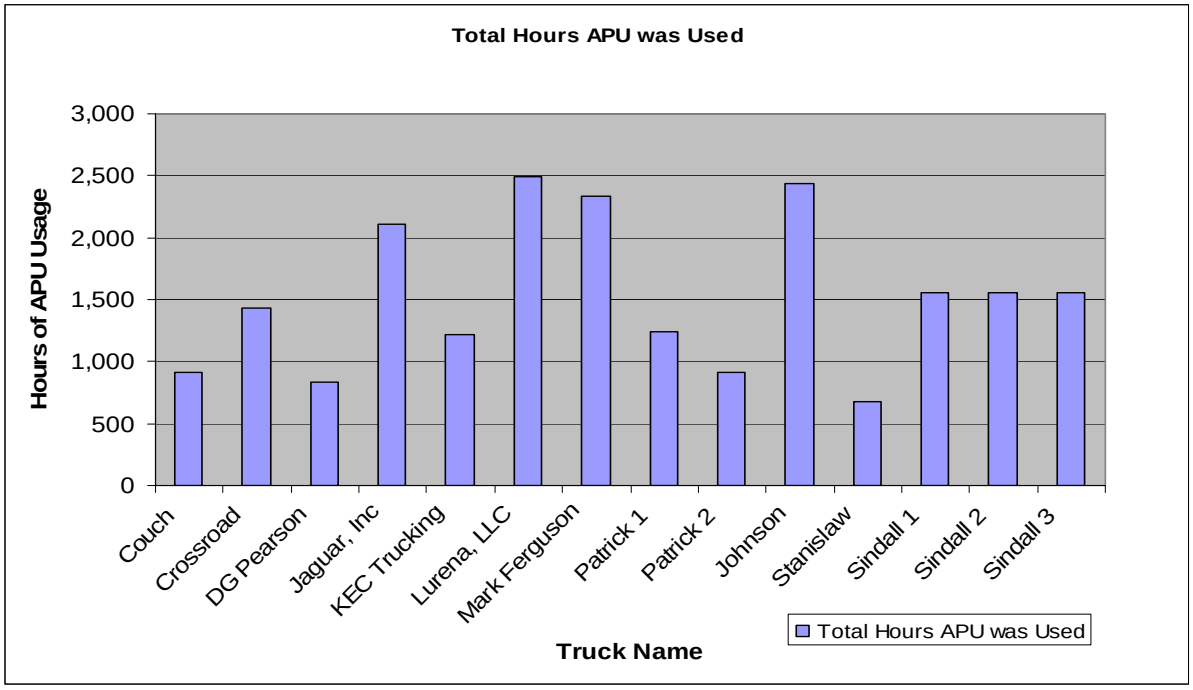
- The gallons per hour of diesel fuel used by the truck at idle.
- The gallons of fuel used by the APU or the gallons per hour of diesel fuel used by the APU.
- The hours the APU was operated.

Emissions Reductions from the Project

The emissions reductions for the entire project were 236 tons per year (tons/yr) of CO_2, 2.5795 tons/yr of NO_x, and 0.0356 tons/yr of PM. The variability in trucks is due to the different hours the APU was operated and the difference in usage between the baseline period and Tasks 2 and 3. The variability in PM is due to the age of the trucks, this is discussed in more detail below. Figures and tables showing the emissions reductions for CO_2, NO_x, and PM are below.

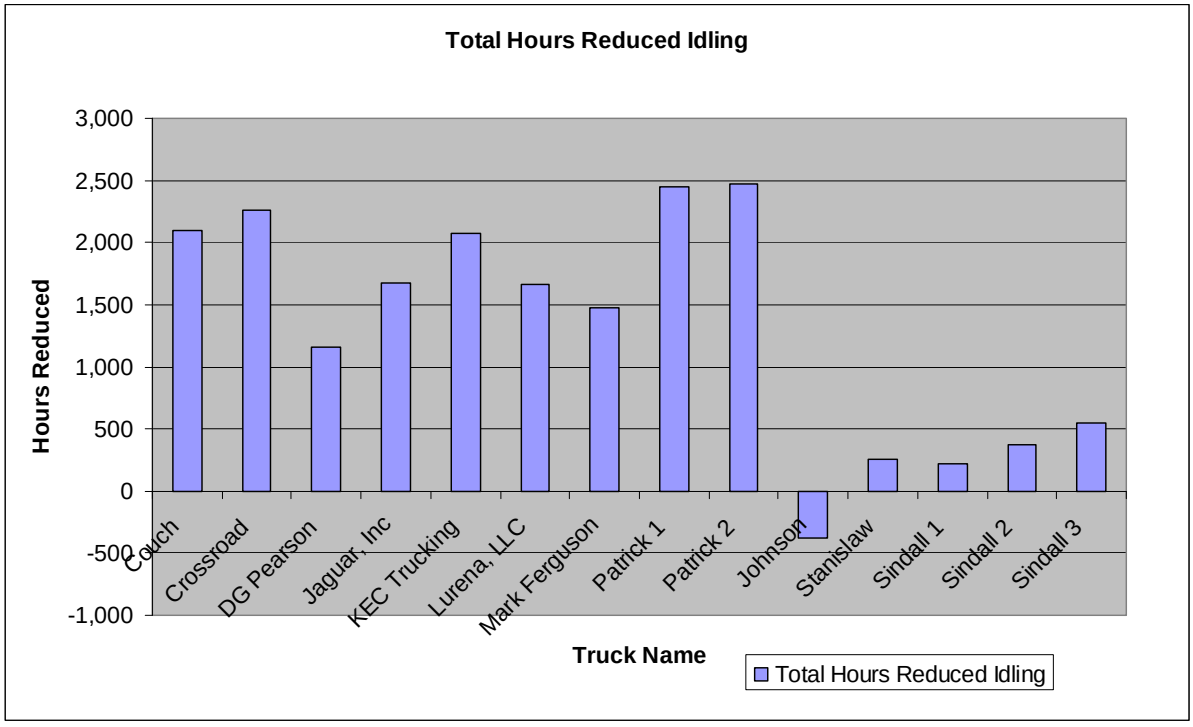
Installing an APU allows the truck operator to reduce the number of hours the truck engine is idling. This produces benefits both in terms of emissions reductions and reduced use of diesel fuel. The figure below shows the number of hours that each truck used its APU. The total hours of APU usage for the entire project is 21,278. Sindall Trucks 1, 2, and 3 used battery-operated APUs that did not have meters to record the number of hours the APU operated. This deficiency was not realized until the data analysis portion of the project. Efforts were made to obtain estimates of the number of hours the APU operated, and various assumptions were used to estimate the hours. This issue, unfortunately, makes estimates of emissions reductions from these three APUs problematic.

Figure 1. Total Hours APU was Used



The figure below shows the number of hours that each truck's idling was reduced, based on the number of hours idling during the baseline minus the number of hours idling during the project. The total hours of idling reduced by the project is 18,312. The number of hours reduced idling varied from truck to truck, and if the truck was operated in a different pattern during the periods, this would not be a good representation of the potential reductions. The number of hours the APU operated during the project period is also indicative of the reduced idling during the period. The idling reduction for Johnson is negative because he had an APU breakdown during Task 2 and he drove more miles during Tasks 2 and 3, than he did during the baseline period.

Figure 2. Total Hours Reduced Idling



The following figures and tables show the total amount of CO_2, NO_x, and PM emissions reductions for each truck in the project and the total amount of reductions in the project. Some figures show increased PM. This is because 2007 and later truck engines have very low PM emissions, and the emissions rate assumed for the APU was higher than the emissions rate for the late model truck engines.

The following figure and the table below show the CO_2 reduced and (in the table) the gallons of overall fuel savings for the entire project. The CO_2 emissions for Johnson are negative because he had an APU breakdown during Task 2 and he drove more miles during Tasks 2 and 3, than he did during the baseline period.

Figure 3. CO_2 Reduced

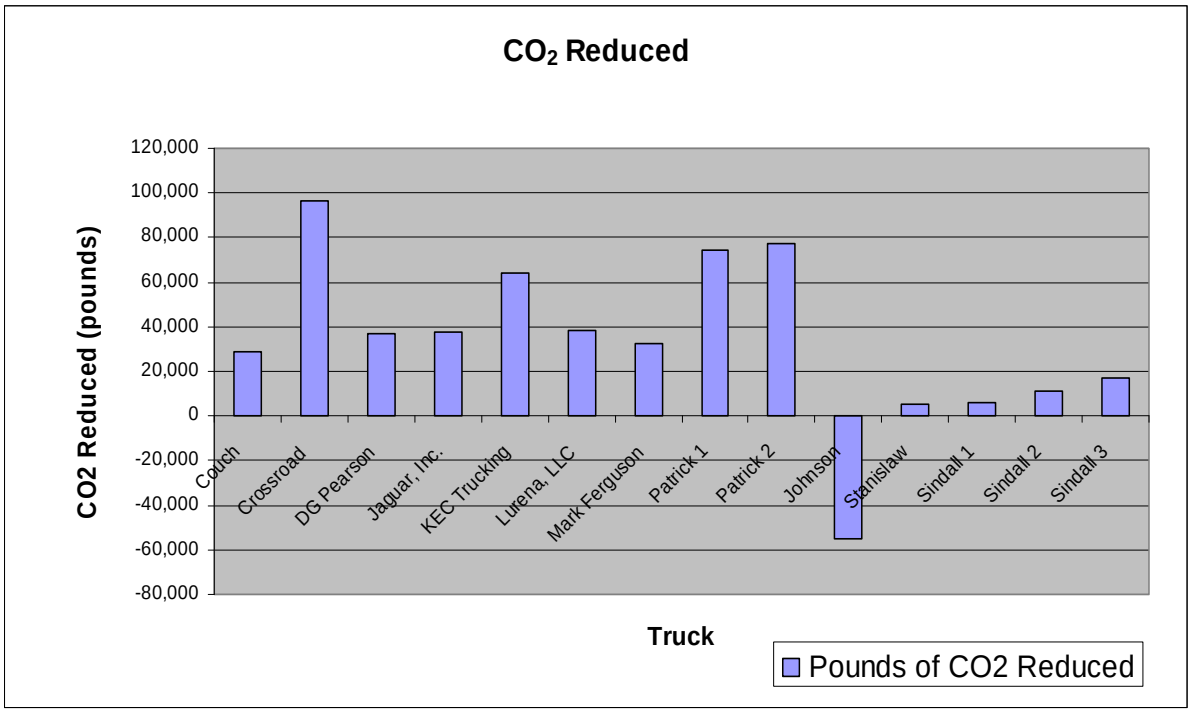


Table 5. CO_2 Reduced and the Gallons of Fuel Saved for the Entire Project

Truck Name	Pounds of CO2 Reduced	Tons of CO2 Reduced	Gallons of Overall Fuel Savings
Couch	28,638	14	1,290
Crossroad	96,792	48	4,360
DG Pearson	36,558	18	1,647
Jaguar, Inc.	37,946	19	1,709
KEC Trucking	64,180	32	2,891
Lurena, LLC	38,533	19	1,736
Mark Ferguson	32,570	16	1,467
Patrick 1	74,614	37	3,480
Patrick 2	77,262	39	3,480
Johnson	-54,968	-27	-2,476
Stanislaw	5,332	3	240
Sindall 1	6,232	3	281
Sindall 2	11,202	6	505
Sindall 3	17,208	9	775
TOTALS	472,099	236	21,385

Note:
To convert pounds to tons, the pounds were divided by 2,000.

The following figure and table show the estimate of NO_x reduced by each truck in the project.

Figure 4. NOx Reduced

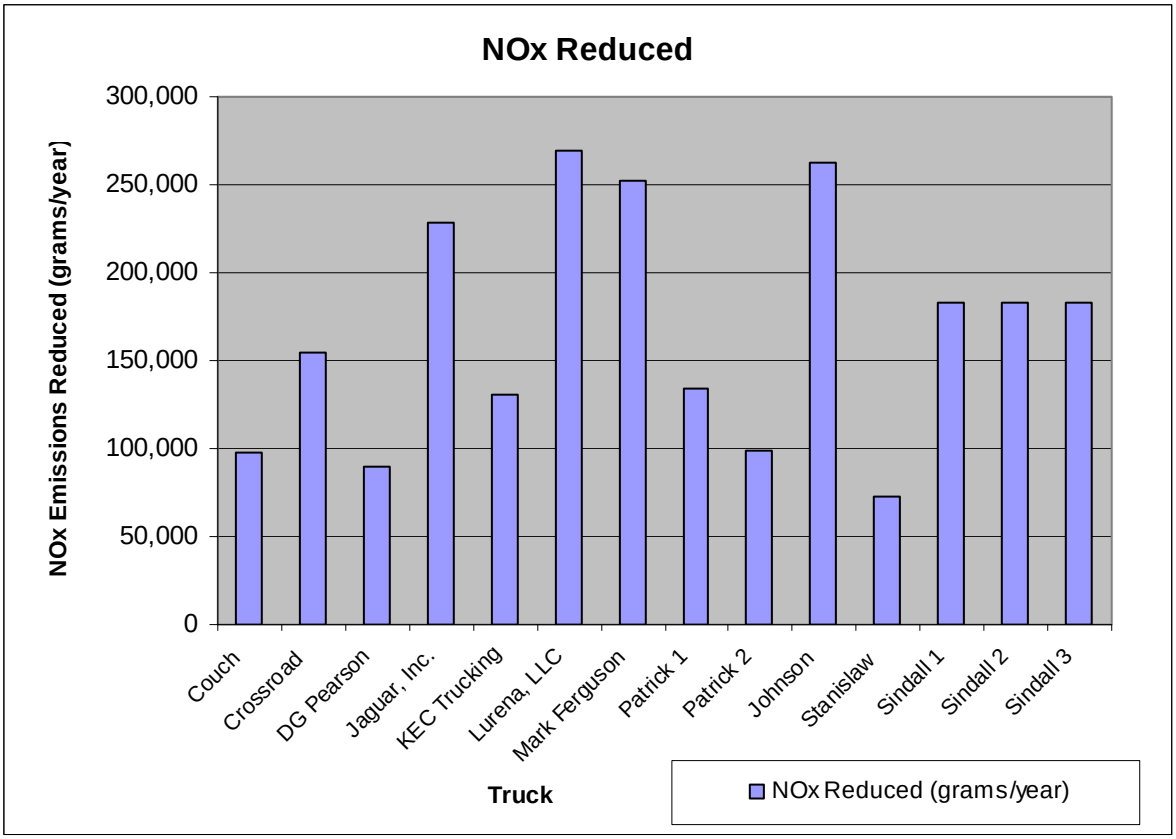


Table 6. NO_x Reduced

Truck Name	NO_x Reduced (grams/year)	NO_x Reduced (tons/year)
Couch	98,064	0.1081
Crossroad	154,980	0.1708
DG Pearson	89,964	0.0992
Jaguar, Inc.	227,880	0.2512
KEC Trucking	131,004	0.1444
Lurena, LLC	269,136	0.2967
Mark Ferguson	252,612	0.2785
Patrick 1	134,352	0.1481
Patrick 2	99,036	0.1092
Johnson	262,764	0.2896
Stanislaw	72,792	0.0802
Sindall 1	182,520	0.2012
Sindall 2	182,520	0.2012
Sindall 3	182,520	0.2012
Emissions Reductions for the Entire Project	2,340,144	2.5795

Note:
To convert grams to tons, the grams were divided by 907,200.

The following figure and table shows the estimated PM reduced by each truck in the project.

Figure 5. PM Reduced

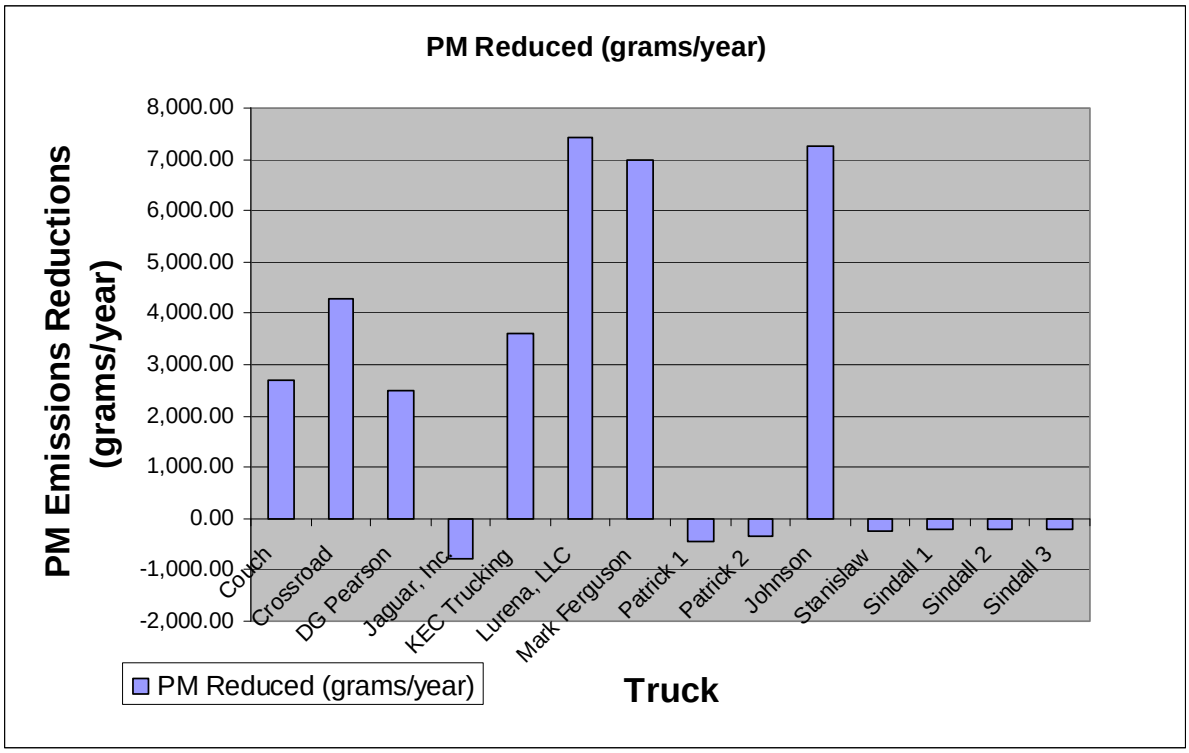


Table 7. PM Reduced

Truck Name	PM Reduced (grams/year)	PM Reduced (tons/year)
Couch	2,705.84	0.0030
Crossroad	4,276.30	0.0047
DG Pearson	2,482.34	0.0027
Jaguar, Inc.	-780.70	-0.0009
KEC Trucking	3,614.74	0.0040
Lurena, LLC	7,426.16	0.0082
Mark Ferguson	6,970.22	0.0077
Patrick 1	-460.28	-0.0005
Patrick 2	-339.29	-0.0004
Johnson	7,250.34	0.0080
Stanislaw	-249.38	-0.0003
Sindall 1	-213.20	-0.0002
Sindall 2	-213.20	-0.0002
Sindall 3	-213.20	-0.0002
Emissions Reductions for the Entire Project	32,257	0.0356

Note:
To convert grams to tons, the grams were divided by 907,200.

In certain cases the PM emissions reductions were negative, indicating an increase in PM emissions. This is because the emissions factors for PM depend on the model year of the vehicle, the emissions factor for trucks with model year 2006 and earlier is 3.68 grams/hour and the emissions factor for trucks that are model 2007 and later is 0.33 grams/hour. Trucks that are model year 2007 and later are much cleaner than trucks that are 2006 and earlier. As a result in newer model trucks the APU engine actually emits more emissions than the truck engine, as seen in the cases of Jaguar Inc, Patrick 1, Patrick 2, Stanislaw and Sindall 1, 2, and 3. Therefore if APUs are going to be installed on trucks for the purpose of reducing PM and NO_x emissions, the most effective scenario would be model year 2006 and earlier or require a PM control on the APU.

Addressing Difficulties during the Project

Program Design

The project began in November 2005. As reported in June 2006 Second Progress Report, it took several months to develop a workable mechanism for disbursement of program funds. Discussions also were necessary with EPA staff and with MARAMA's accountant regarding property ownership. This issue was resolved with agreement that the truck company would own the APU. Development and legal review of contract language and the decision to issue contracts rather than grants also took time.

Staff Vacancies and Reassignments

The project was delayed due to staff vacancies and other project deadlines at MARAMA. However staff were reassigned to provide coverage of the program while the lead staff was on maternity leave and at the end of the project to complete calculations and assist with the final report.

APU Installation

As reported in the December 2006 Progress Report, MARAMA and state staff reviewing the applications found that many applicants had already installed an APU or had installed an APU not on the list of suggested APU manufacturers. Most applicants had their APU installed at a company not on the list of suggested APU installers. The project team decided applicants who had already installed an APU should be considered as long as the APU was fairly recently installed, within its useful life and under warranty. The project team also decided that APUs and APU installers not on the suggested list should be considered for the program as long as they were mainstream companies in good standing. Black Rock, Carrier, and Onan were found to be mainstream makers of APUs. Webasto is a mainstream maker of bunk heaters.

Data Analysis

The data analysis portion of the project proved to be difficult. The December 2006 quarterly report noted that in order make accurate emission reduction calculations, MARAMA would need emission data, by pollutant, for the truck engines and the APU engines in the program. Early attempts to get grams per hour emission rates for truck engines and APU engines were generally unsuccessful. MARAMA investigated methods of calculating emissions reductions and with the help of EPA found and used the EPA SIP Guidance and the EPA Emission Facts, as discussed earlier in this report.

Missing Data

Some of the difficulties encountered on this project were securing contract signatures with truckers who were often on the road, tracking down missing or incomplete information in

order to process task orders, and the time intensive nature of implementing a large number of small contracts.

EPA Engine Family Name and APU Engine Year

The "engine family name" is required to obtain accurate emissions data for an engine. While applicants generally know a great deal about their truck, they are unfamiliar with this important designation on their truck engine. The 12-character EPA engine family number for the APU was requested in the Baseline Report. APU manufacturers vary widely as to what information they will give out about their APU's. Therefore to avoid this extra and potential time-consuming step it is essential to get the APU, 12-character EPA Engine Family Number prior to installation of the APU. The number can be found on the APU engine's emission control label and should be recorded by the installer so that someone who does not know much about APUs is not trying to open the APU to find this information. MARAMA later requested assistance from EPA in obtaining truck and APU emission rates.

Baseline Information

On the baseline report MARAMA did not ask how many hours the truck engine operated. This information would have been useful as a cross check during the data analysis portion of the project so that the numbers in both semi-annual reports could be compared to a baseline number.

Forms that Had Incorrect or Missing Data

Participants were required to fill in forms for the application process, the baseline report, and two semi-annual reports. If information was missing from the forms then MARAMA had to contact the participant and this could be difficult because they are owner/operators and are on the road for large stretches of time.

MARAMA also received a number of forms with incorrect or inconsistent information. Some of the forms ask for the same information, for example the truck make and model and the truck engine make and model. These questions were asked on each form so that inconsistencies would be apparent. However, some participants filled in different information on each form and MARAMA had to contact the participant to find the correct information. This can be time-consuming and difficult due to the nature of their work.

MARAMA also received forms missing entire pages and thus had to contact participants to get the missing information.

Battery Powered APUs

One of the participants, Sindall, who had 3 trucks in the program, used an APU called NITE System (No Idle Thermal Environment) Combo Systems. The NITE APU is battery operated which means that the APU does not have a motor or a meter. Since the APU does not have a motor it does not create emissions of PM, NO_x, or CO_2. Since the APU does not have a meter, they cannot calculate how many hours it operated and this caused problems with the data analysis because we were unable to calculate the hours that the APU operated which influenced the pollutant emission reductions and the diesel consumption reductions.

Data Log Books

One of the program requirements was that if a participant did not have an hourly meter on the truck engine then they were required to submit their log books to MARAMA. However, analyzing these log books can be tedious because there is a page for every day the truck operated, which means MARAMA was sent many pages of detailed information. Also the information is entered by hand on a carbon copied document which can cause smearing to occur and make the documents illegible.

Maintaining Participation

A few of the program participants did not complete the program, although all who submitted the baseline data form completed all required forms.

Couch Trucking Co.'s Freightliner truck was sold after the project began, the owner sent in a letter confirming this information.

Orsino, Kenneth Meredith, Mike Falls Motor Freight, and Ricochet Xpress, Inc. were offered contracts but withdrew from the program for various reasons. When applicable MARAMA forward their contact information to EPA for follow-up about Innovative Financing Options.

Jaguar, LLC did not provide any of the required reports. After numerous calls and emails from both the APU project manager and MARAMA's Executive Director, MARAMA formally terminated the contract with Jaguar LLC.

KEC Trucking's tractor trailer was involved in an accident during Task 2 and was replaced by a new truck. This information was confirmed via fax from KEC Trucking. However both trucks are model 2006 and earlier (the model year of the truck is important for the PM calculations) and have similar engines (both have the same fuel consumption rate and amenities).

Participant Evaluations of APU Performance

Some comments provided on reporting forms allowed MARAMA to assess the effectiveness of the project based on participant comments. Most participants were pleased with the way their APUs operated and were appreciative of the funding that was provided, as noted by the quotes below from data reports submitted:

> Richard P. Johnson, "The program is helpful, it helps to recoup some of the money that we (drivers) are spending."
>
> Sindall, "Thank you for allowing us to take part in your grant program."
>
> DG Pearson, "Thanks for helping me pay for it."
>
> Crossroad, "Thanks again for helping to make it an affordable reality."
>
> Couch Trucking, "Thank you for the grant!"

An important aspect of this project was to assess the participants' views of the effectiveness of the APUs. Project participants installed a number of different APUs on their trucks including Carrier, Black Rock, NITE System, Thermo King, RigMaster, and PowerTech. In most cases the APUs worked well and participants noted that they noticed a reduction in diesel fuel consumption. A few of the participants had problems with their APUs. The form that was used for the Tasks 2 and 3 semi-annual reports requested comments on the APU operation and maintenance as well as any other comments. The following paragraphs contain those comments and information about engine idling reduction.

<u>*Richard P. Johnson*, Black Rock APU with a 2 cylinder Yanmar engine</u>
Task 2 Semi-Annual Report

- "When [the] APU is working properly it is a very useful tool."

Task 3 Semi-Annual Report

- "I was not happy with it at all. It was a lot of money. No one knew anything about it when I went to get it fixed. The first year was fine because it was all paid for. But the first or second month that the warranty is up, I had to pay to get it fixed and no one knew what they were doing…Now that all the bugs are worked out its not bad. In the beginning I had a lot of problems, but once those were sorted out, it was ok."

Insight: It seems that when the APU is working properly it is very useful, however, if it breaks its difficult to get repaired. If this project is to be replicated MARAMA would suggest participants get a list of certified repair facilities that are along their routes from their installers.

Mark Ferguson, Black Rock APU with a 2 cylinder Yanmar engine

Task 2 Semi-Annual Report

- "Effort and money well spent—minor maintenance and one service."

Task 3 Semi-Annual Report

- "Black Rock is durable and provides excellent heating and cooling. The unit was somewhat noisy but was corrected under warranty."

Patrick Transportation Co., ThermoKing TriPac

Task 2 Semi-Annual Report

- "Very low maintenance. Had a fuse problem at first [that was] quickly corrected."

Task 3 Semi-Annual Report

- "One week period—APU inoperative [because of a] mechanical issue."

Lurena LLC, ThermoKing TriPac

Task 2 Semi-Annual Report

- "Excellent – no maintenance except two oil changes."

Task 3 Semi-Annual Report

- "Tri Pac is an excellent unit. When the truck engine is turned off, the APU turns on. If the APU is not calling for heat or cooling the unit goes into a dormant status.

Note: In Task 2 Lurena LLC's truck engine idled for 12 hours and for 31 hours in Task 3, compared to 1,700 in the Baseline period. The truck engine idles because it must air up after sitting and the truck engine operates the compressor.

Sindall Transportation Inc, NITE System

Task 2 Semi-Annual Report

- "The NITE System will maintain a comfortable temperature in summer and winter, but it will not make a cold cab warmer or a hot cab cool. The truck must be run to obtain the comfortable temperature." Sindall went on to state that, "The unit had a computer glitch the first quarter of reporting April-June."

Task 3 Semi-Annual Report

- "The truck must be ran to obtain a comfortable temperature. It also cannot maintain an acceptable temperature in extreme heat or when it is very cold outside."

Note: The NITE System is battery operated, providing significant potential fuel savings and emissions reductions, but the lack of an hour meter makes it nearly impossible to estimate the emissions reductions achieved by the units in this project.

DG Pearson, RigMaster RMC-14-6

Task 2 Semi-Annual Report

- "Did not have to idle [the] truck. Used the APU." During Tasks 2 and 3 his engine did idled a total of zero hours. He went on to say, "Really a good engine. Maintenance cheap. I should have had one years ago. Saves a lot of money on fuel. The RigMaster is a 'Top of the Line' engine."

Task 3 Semi-Annual Report

- "I couldn't ask for a better machine. I have no problems with this. If I knew this I would have had one years ago. Everyone should have one. I like this one because it is a generator. It saved me a lot of money, with the cost of fuel being so high."

Jaguar, *Inc.* PowerTech Genset 5kW APU

Task 2 Semi-Annual Report

- "Money and effort well spent-no breakdowns and one oil change/service."

Task 3 Semi-Annual Report

- "The Power Tech has an excellent air distribution system. It cools and heats well. Any warranty issues have been dealt with promptly."

Note: During Task 2 the truck idled for 12 hours and during Task 3 it idled for 15 hours, compared to 1,700 hours over the baseline period. The truck idles because it must air up after sitting and the truck engine operates the compressor.

Crossroad, Carrier ComfortPro APU

Task 3 Semi-Annual Report

- "The unit operation has been trouble free with minimal maintenance. I strongly feel the unit has been a wise investment and would highly recommend it to anyone."

Couch Trucking, PowerTech, Power Pac APU

Task 3 Semi-Annual Report

- "I feel the APU not only saves money, but adds comfort out on the road. I am very happy with it. I think it saved approximately $3,000.00 this period." Couch also stated the, "Truck does not run while APU is in use."

Note: According to the Baseline report the truck engine idled about 2,100 hours, but in Tasks 2 and 3 the truck engine did not idle at all.

Implications for State Implementation Plans

One of the project goals was to explore the use of program emission reductions for use in State Air Quality Implementation Plans. While emissions reductions from this project are small, the methods used to calculate emissions benefits may be used by planners to assess emissions reductions from ongoing programs that states may pursue in the future.

During the data analysis phase of the project, MARAMA created Microsoft Excel Calculation Sheets for NO_x, PM, and CO_2 for each truck in the project. These sheets may be useful in the future for SIP planners.

Each sheet includes a list of the steps to calculate emissions or diesel use reductions. The NO_x and PM calculations are from a document written by EPA entitled, "Guidance for Quantifying and Using Long Duration Truck Idling Emission Reductions in State Implementation Plans and Transportation Conformity" that provides guidance to state air pollution control agencies on how control measures to reduce truck idling emissions may be used to meet State Implementation Plan (SIP) requirements (January 2004). The CO_2 calculation came from EPA's "Emission Facts: Average Carbon Dioxide Emissions Resulting from Gasoline and Diesel Fuel, " developed to facilitate consistency of assumptions and practice in the calculation of emissions of greenhouse gases from transportation and mobile sources and as a reference for anyone estimating emission benefits of mobile sources air pollution control programs (February 2005).