DEQ in the Classroom:
Clean Air Zone: Putting it to the Test

IDAHO DEPARTMENT OF ENVIRONMENTAL QUALITY

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www.deq.idaho.gov

Grade Level:
7 - 12

Time Required (to conduct with an entire class):
To complete the project as written (in-depth study): All or parts of three to four class periods (or more, if students do some of the work in class), plus 20 - 30 hours per student (less if students take turns timing vehicles [different students time on different days]).

However, the project can easily be modified or shortened to accommodate different schedules or levels of involvement, which can result in less of a time commitment.

Objective:
Students bring the *Clean Air Zone* (CAZ) program into schools and study its effects.

Meets Idaho State Standards:
Grade 7: 7.M.5.3.1, 7.S.1.2.2, 7.S.1.6.1, 7.S.1.6.2, 7.S.1.6.3, 7.S.1.6.4, 7.S.1.6.5, 7.S.1.6.6, 7-8.H.1.1.9

Grade 8: 8.M.5.3.1, 8-9.PS.1.6.1, 8-9.PS.1.6.2, 8-9.PS.1.6.3, 8-9.PS.1.6.4, 8-9.PS.1.6.5, 8-9.PS.1.6.6, 8-9.PS.1.6.7, 8-9.ES.1.2.1, 8-9.ES.1.6.5, 8-9.ES.1.6.3, 8-9.ES.1.6.6, 8-9.ES.5.1.1, 7-8.H.1.1.9

Grade 9: 9.M.5.3.1, 8-9.PS.1.6.1, 8-9.PS.1.6.2, 8-9.PS.1.6.3, 8-9.PS.1.6.4, 8-9.PS.1.6.5, 8-9.PS.1.6.6, 8-9.PS.1.6.7, 8-9.ES.1.2.1, 8-9.ES.1.6.5, 8-9.ES.1.6.3, 8-9.ES.1.6.6, 8-9.ES.5.1.1,9-10.B.1.2.1, 9-10.B.1.6.3, 9-10.B.1.6.5, 9-10.B.1.6.6, 9-10.B.5.1.1, 9-12.H.1.1.6

Grade 10: 9-10.B.1.2.1, 9-10.B.1.6.3, 9-10.B.1.6.5, 9-10.B.1.6.6, 9-10.B.5.1.1, 9-12.H.1.1.6

Grade 11: 9-12.H.1.1.6

Grade 12: 9-12.H.1.1.6

Focus:
Air; *Clean Air Zone Idaho*; statistics/math; scientific method. Students study the effect of the CAZ program by timing idling on school property before and after the CAZ program is implemented. Good for an in-depth class project or for a smaller group of students wanting a hands-on project (e.g., a senior project or a "project-based learning" activity). The activity is written assuming an entire class is doing the project together.

Materials:
Digital watches (1 per student)
CAZ toolkits (1 per school being studied), with signs
Data sheets (minimum of 1 sheet/session/student) (copy from page 10, or modify to match different needs/sampling methods)
Clipboard with pen/pencil (1 per student)

Background:

Clean Air Zone Idaho is a statewide program aimed at reducing children's exposure to school bus diesel exhaust and other vehicle exhaust by discouraging the idling of vehicles and encouraging the use of alternative fuels in school buses. While dropping off or picking students up from school and waiting, idling buses and vehicles emit fine particulate matter and other air pollutants, which can impact air quality and public health. Bus idling and bus queuing can further increase the concentrations of particulates both inside school buses and inside nearby buildings.

Diesel exhaust and other vehicle exhaust contain fine particulate matter and other air pollutants. These can adversely impact air quality (cause air pollution) and public health. Recent studies demonstrate that particulate pollution can impair the development of lungs in children. Diesel exhaust (e.g., from school buses) aggravates asthma, emphysema, and bronchitis, according to the U.S. EPA, and exacerbates allergies. EPA has also concluded that diesel exhaust is a probable carcinogen.

Children standing in bus/car queuing areas receive greater exposure to pollutants from exhaust than the general population because the pollutants are emitted from the vehicles right where children are standing, and at the children's height.

Vocabulary:

Alternative Fuel	A fuel that takes the place of traditional petroleum gasoline or diesel fuels.
Biodiesel (B20)	A mixture of diesel fuel with soybean or vegetable oil-based products. B20 (20% biodiesel and 80% petrodiesel) is the most common blend.
Clean Air Zone Idaho	A statewide program aimed at reducing children's exposure to school bus diesel exhaust and other vehicle exhaust by discouraging the idling of vehicles and encouraging the use of alternative fuels in school buses.
Combustion	The process of burning.
Compressed Natural Gas (CNG)	Natural gas used to fuel vehicles. CNG vehicles may run exclusively on natural gas or on both natural gas and gasoline.
Diesel Retrofit Technology	Equipment that can be added to diesel engines to reduce emissions.
Emission	The act or instance of discharging (emitting) something into the air, such as by an internal combustion engine (e.g., a vehicle).
Ethanol (E10 and E85)	Alcohol, commonly derived from corn, that can be blended with traditional petroleum fuel. Common blends include E10 (10% ethanol and 90% petroleum) and E85 (85% ethanol and 15% petroleum).
Exhaust	The fumes or gases released from an engine.
Ozone (O_3)	A gas that forms in the atmosphere when three atoms of oxygen are combined. It is not emitted directly into the air, but is created at ground level by a chemical reaction between oxides of nitrogen and volatile organic compounds in the presence of sunlight. Ozone close to the earth's surface is an air pollutant and is a key ingredient of urban smog. Ozone more than about 10 miles into the atmosphere protects the earth from the sun's harmful ultraviolet rays.
Particulate Matter (PM)	Small particles in the air including dust, dirt, soot, smoke, and liquid droplets.
$PM_{2.5}$	Particulate matter ("PM" or particles) in the air less than 2.5 micrometers in diameter. Often referred to as "fine" particulate matter.

Pollutant	Any substance introduced into the environment that adversely affects the usefulness of a resource or the health of humans, animals, or ecosystems.
Pollution	The act or process of polluting or the state of being polluted, especially the contamination of soil, water, or air by the discharge of harmful substances.

Procedure, Teacher:

Step 1. Visit http://www.deq.idaho.gov/air/educ_tools/clean_air_zone_idaho/index.cfm to **learn about the Clean Air Zone (CAZ) program**. Contact your local DEQ regional office (see list on page 9). Regional office staff will know which local schools are already participating in the CAZ program and be able to help you identify good candidates (not currently participating) for your study[1]. The regional office can also provide you with a CAZ sign to use as a sample to show schools, may be able to provide you with presentation materials to use, and can provide you/your students with toolkits to provide to principals (toolkits can also be downloaded at http://www.deq.idaho.gov/air/educ_tools/clean_air_zone_idaho/index.cfm). Schools will receive their own CAZ signs to post when then enroll in the program.

Step 2. Pick one or more local schools that have not implemented the CAZ program[1]. Elementary schools are best, followed by middle/junior high schools, as they have a higher percentage of parents driving children to/from school than high schools. If all schools in your area have already implemented CAZ, consider conducting the study in other places where idling is common: sports fields, preschools, day care facilities, etc. Conducting the study at an alternate location may require some changes in study protocol.

Step 3. Contact the principal of each school you have picked and explain CAZ and the study. Get the school's agreement to participate. Your students will also need to meet with the principal of each school to "sell" the program and explain the study, but it is best to have initial buy-in from the schools to allow your students to focus on the study and not on finding schools to participate.

Step 4. Discuss air quality and the CAZ program in class. If you wish, someone from your local DEQ office can come to your school to give a presentation on air quality and the CAZ program to your students. Use the information given in "Background," above and found on DEQ's Web site (see page 8) to assist with the discussion. Some questions for discussion are provided on page 7.

Step 5. Have students visit http://www.deq.idaho.gov/air/educ_tools/clean_air_zone_idaho/index.cfm for more **information about the program and to download toolkits** (if you didn't get them from DEQ). The students will need toolkits to give to the principals of the schools they approach about participating.

Step 6. Discuss the study in class. Go over the procedure; discuss scientific method, observation, and data collection; and discuss the students' meetings with school principals.

Step 7. Practice. Have students prepare for their meetings with principals (see Step 1 for Students with Teacher Assistance, page 4, for more information on meetings). Role-play for practice, if necessary. Be sure the students can accurately explain the program and what is expected of the schools. Visit a school to watch traffic flow as a class. Discuss the best ways to observe cars, record results on data sheets, etc.

Step 8. Assign four to eight students per school. If you have more students or not enough schools, assign twice as many students per school and have half the students do a before-school study and half to an after-school study at each school. Another alternative if you have too many students or not enough schools is to divide the class by days—some students observe cars on Monday, others on Tuesdays, etc.

[1] In some cases, entire school districts may be participating. However, if individual schools within a district are not active participants (e.g., they do not display signs and have not informed bus drivers/parents of the program) they are still good candidates for the study.

Procedure, Students with Teacher Assistance:

Step 1. Meet with appropriate principals. At the meetings, explain the CAZ program and the study. Get a commitment from school principals that the school will actively and fully participate in the CAZ program (half-hearted participation by the school will not yield accurate results). Schools need to agree to fill-out and turn in their CAZ paperwork (to DEQ), post signs on the requested date (signs will come from DEQ once the school has enrolled), and provide information to parents and bus drivers. Information on how to do this, as well as sample letters to parents, etc., is found in the toolkits (http://www.deq.idaho.gov/air/educ_tools/clean_air_zone_idaho/index.cfm).

Step 2. Decide if you will time school buses or just cars. If you will time buses (especially good if you have a lot of students), follow the same basic steps as outlined below for cars.

Step 3. After you have a school's commitment, but before the school has communicated the program to parents or bus drivers, **visit the school** during the 40 minutes immediately preceding and following school to observe traffic flow and the drop-off/pick-up process and to establish a sampling method. (Discuss potential sampling methods before you visit the school and at least tentatively decide on a method, as it will affect what information you will need to collect at the school.)

A. **Get a "lay of the land."** Watch where cars and busses stop to drop off and pick up students. Determine the best locations for observing cars. Be sure the locations you choose not only provide a good view of the area, but are also safe and out of the way. Students must be close enough to cars to be able to determine whether or not an engine is running and to read the license plate.

B. **Determine peak drop-off/pick-up times**. Count the number of cars present at the school in the pick-up/drop-off area every five minutes to determine when the peak traffic flow occurs (within 15 minutes of start time? Within 35 minutes of end time?). Keep in mind that parents often arrive before school is let out, so students may need to start timing before school is dismissed. Determine when you need to arrive in the morning and how long you need to stay in the afternoon to record data during the peak times.

C. **Record information that will help students divide cars to be timed**. (Do this step in combination with Step 4, below.) One method for doing this is by dividing by color: Record the colors of cars visiting the school on your visit and the number of cars of each color. Based on the most common car colors, have each student be responsible for recording idling times for only a specific color of car. (Students can also do more generalized research by finding the most common car colors from auto manufacturers or from counting car colors at some place other than the school.) Dividing by car color is just one method of dividing cars, but is the method used as an example throughout this exercise. Other methods may be used; the goal is to time the maximum number of cars without any car being timed by more than one student simultaneously.

Step 4. Based on the results of Step 3, and on the number of students in each group, students **determine a sampling scheme** that includes:

- ✓ Where students will position themselves for timing.
- ✓ When students will begin and end timing idling each day (how long they will need to stay on school grounds each day to observe the majority of the traffic).
- ✓ How students will divide cars to maximize cars timed and ensure no car is timed by more than one student. Use a plan that allows each student to time multiple cars at once, as this will give a clearer

picture of idling habits and keep students from getting "stuck" on a car that arrives first and idles a long time before leaving. A sample plan:

- → Each student picks one color of car to time, based upon the most common car colors determined in Step 3.
- → Each student records the first three letters/numbers of the license plate of each car of that student's assigned color as it arrives, along with the time the car arrives. Students then record the time the car leaves or stops idling. Note that some drivers may turn their engines off then on again while waiting (especially in hot or cold weather).
- → Each student computes and records idling times on a data sheet.

(Students are encouraged to investigate alternative sampling methods and use the method that best suits them. If an alternative sampling method is used, please including the sampling method when submitting results to DEQ [see Step 11]).

Step 5. Using the methods established in Step 4, **record idling times daily** for one week (or longer, if necessary to get all students a chance to record). This establishes an average base idling time, before the CAZ program has been implemented.

Example: School starts at 8:00 am and is dismissed at 3:00 pm. Students have determined that most traffic at the school arrives within 20 minutes of school starting in the morning and departs within 30 minutes of school ending in the afternoon. However, many parents arrive early for pick-up, so the flow of traffic actually begins at 2:50.

There are four students on the team. The most common car colors were determined to be (in order) pink, purple, orange, yellow, and green. As there are four students, they pick the top four car colors to count (therefore, no one counts green). Each student is assigned one car color for the duration of the experiment.

- ✓ All students in the group arrive at the school at 7:35 am.
- ✓ Each student stands in his/her pre-determined location to time cars and uses the same location each day.
- ✓ At the appointed time (7:40 am), students begin timing idling of cars. Each student picks the first car of his assigned color to arrive after the start time and records the time the car arrived, along with the first three digits of the license plate number. The student watches for next car of his color to arrive and does the same thing for it and for each car of his color. As cars are turned off or leave, the student records the off/departure time and whether the car was turned off or left. The student notes if any cars are turned off/on multiple times or idle after being turned off and then on again. The student continues the process until the pre-specified time has ended (8:00 am), then computes and records each car's idling time(s).
- ✓ Students repeat the process after school, arriving at 2:45 pm and beginning timing at 2:50 pm (because they determined that parents arrive early). They continuing timing until 3:30 pm.
- ✓ Students repeat the process daily for a minimum of one week to establish a baseline.

See a sample, completed data sheet on page 11.

Step 6. Ask the school(s) to implement the CAZ program. Parents, teacher, bus drivers, and others should be informed about the program through letters, newsletters, parent meetings, etc. (See toolkit for ideas.). "No Idling" signs need to be posted at appropriate places. You may want to volunteer to help the school in its marketing efforts. Request that the school keep you apprised of marketing efforts and provide you with copies of any letters, etc. used.

Step 7. **Wait one month** after implementation for the program to become established.

Step 8. Repeat the timing procedure used in Step 5.

Step 9. Analyze your results. Determine average drop-off and pick-up times before and after the program. Many different comparisons can be made. Older students who are studying statistics could also determine if any of the differences are significant (if there are differences). Some suggested comparisons include:

- ✓ Was there a difference between average idling times before and after the program? (Drop-off and pick-up combined.)
- ✓ Was there a difference between drop-off (morning) and pick-up (afternoon) idling times before the program? After the program?
- ✓ Did weather conditions affect idling times? (Decide if you are going to examine this ahead of time, as it will affect how precisely students need to record weather conditions.)
- ✓ If more than one school was studied, were there differences among schools before the program? After the program?

Step 10. Scrutinize your results. Consider individually or discuss in small groups or as a class.

- ✓ Were differences seen among schools or between mornings and afternoons? If so, why do you think there were differences?
- ✓ Were there differences between the pre- and post-CAZ idling times? If not, why do you think the program didn't appear to have an effect?
- ✓ Did different schools have different results regarding the "success" of the CAZ program? If so, why do you think that happened?
- ✓ In hindsight, what (if anything) would you have done differently in your study? Could any of your study methods have affected results?
- ✓ In hindsight, what (if anything) could the school(s) have done differently to market the CAZ program? Would different approaches have helped?

Step 11. Report the results of your data *and* the results of your consideration of that data (from Step 10). Ideas for reporting include:

- ✓ Give a presentation to classmates.*
- ✓ Give a presentation to administrators, teachers, bus drivers, parents, or others associated with the school(s) studied.*
- ✓ Write a report to provide to the schools studied.*
- ✓ Prepare a poster or display. The poster/display could be displayed at your school, the schools studied, your local DEQ office, the school district offices, city hall, etc*.
- ✓ **Provide your results to your local DEQ regional office. Results will be pooled with those of other schools in Idaho. Please do this regardless of other presentation methods. If an alternative sampling method was used, please include an explanation of the method used when submitting results to DEQ.**

***Be sure to include background information on air pollution, vehicle/diesel exhaust, and the *Clean Air Zone* program in your presentations/reports and provide tips on what individuals can do to help.**

Questions for Discussion:

1. Why should we care about air pollution?

   Hurts the environment, is unhealthy, blocks views, stinks, can cause economic issues if air quality doesn't meet national standards (see http://www.deq.idaho.gov/air/data_reports/monitoring/overview.cfm), etc. Point out that many of these issues exist even in places with relatively clean air.

2. What causes air pollution?

   Vehicle exhaust, industry, fires (wildfires, agricultural burning, fireplaces/wood stoves), blowing dust, volcanoes, chemical fumes (e.g., from paint or cleaning supplies), gas-powered lawn tools (e.g., lawn mowers), etc.

3. How can we reduce (limit) air pollution?

   Limit vehicle emissions
   - *Limit driving: carpool, walk, combine errands, take the bus*
   - *Turn off engines while waiting (e.g., don't idle in drive though or while waiting to pick up kids)*
   - *Retrofit existing diesel engines (e.g., school buses) with emissions reduction technology*
   - *Keep vehicles well-maintained (get better gas mileage, so produce fewer emissions pre mile driven)*
   - *Purchase and use low emission vehicles (e.g., Toyota Prius)*
   - *Use alternative fuels (e.g., biodiesel [B20], ethanol [E85], and compressed natural gas [CNG]).*

   Take care with fires
   - *Comply with burn bans*
   - *Don't burn garbage*

   Cover dirt if carrying in a truck (to keep it from blowing out)

   Follow directions when using chemicals (paint, cleaning supplies, etc.)

   Use an electric lawn mower and trimmer

   Plant a tree

4. Why is limiting idling important?

   Idling buses and vehicles emit fine particulate matter and other air pollutants that can impact air quality and public health. Bus idling and bus queuing can increase the concentrations of particulates not only in the ambient air, but also inside school buses and inside nearby buildings.

   Recent studies demonstrate that particulate pollution can impair the development of lungs in children. Diesel exhaust (e.g., from school buses) aggravates asthma, emphysema, and bronchitis, according to the U.S. EPA, and exacerbates allergies. EPA has also concluded that diesel exhaust is a probable carcinogen.

   Children standing in bus/car queuing areas receive greater exposure to pollutants from exhaust than the general population because the pollutants are emitted from the vehicles right where children are standing, and at the children's height.

Expansion and Follow-Up Ideas:

- ✓ Have students write letters to the editor to educate citizens and explain the project and their results.
- ✓ Have students conduct an educational campaign at their school or in their city to encourage activities that reduce air pollution (don't idle, carpool, etc.). Write letters to the editor, make posters, etc.
- ✓ Create tables, graphs, and charts to show results and trends.
- ✓ Conduct the same study at a different time of the year. Does this make a difference? Why or why not?
- ✓ Have future students complete the same or similar projects to bring *Clean Air Zone* to more schools.
- ✓ Have future students re-study the same schools to determine if the effects remain the same over time (the future students would only do the "post-implementation" part of the study).
- ✓ Expand the project to include day cares, athletic fields, etc where people pick up and drop off. While some of these areas will not lend themselves to a full educational campaign like a school, signs can still be posted to get the message across. Signs are available from your local DEQ regional office that show a car instead of a school bus.
- ✓ Conduct a study at one place where a full educational campaign is possible (e.g., a school) and another where signs are posted, but no other education is made available (e.g., a soccer field). Compare the results.
- ✓ Learn which pollutants come from vehicle exhaust, then track the levels of those pollutants in your area on DEQ's Web site (http://www.deq.idaho.gov/air/aqindex.cfm).
- ✓ Visit an auto dealership that sells low emission vehicles and/or vehicles that use alternative fuels or visit a gas station that sells alternative fuels to learn more about these technologies.
- ✓ Contact DEQ to learn about diesel retrofit technologies, which are available to reduce emissions from school buses (and other vehicles). Your school district may be able to apply for a grant for retrofit technologies for its buses[2].
- ✓ Pick one type of air pollutant, alternative fuel, or retrofit technology, research it, and prepare a report on it.

Additional Resources on DEQ's Web Site:

Air Quality Educational Tools (includes information for students and teachers, activities, and more!)
http://www.deq.idaho.gov/air/educ_tools.cfm

Air Quality: How it is Measured (includes a discussion of attainment and nonattainment areas)
http://www.deq.idaho.gov/air/data_reports/monitoring/overview.cfm

Air Quality Index (Check your air quality) http://www.deq.idaho.gov/air/aqindex.cfm

Clean Air Zone Idaho http://www.deq.idaho.gov/air/educ_tools/clean_air_zone_idaho/index.cfm

Nitrogen Dioxide http://www.deq.idaho.gov/air/prog_issues/pollutants/health.cfm#nitrogen

Ozone http://www.deq.idaho.gov/air/prog_issues/pollutants/health.cfm#ozone

Particulate Matter http://www.deq.idaho.gov/air/prog_issues/pollutants/health.cfm#pm

Sulfur Dioxide http://www.deq.idaho.gov/air/prog_issues/pollutants/health.cfm#sulfur

Vehicle Emissions http://www.deq.idaho.gov/air/prog_issues/pollutants/vehicles.cfm

[2] For information on retrofit grants, call DEQ at (208) 373-0502.

DEQ Regional Offices, Air Quality Contacts:

Boise Regional Office
Mike Dubois
1445 N. Orchard
Boise, ID 83706
ph: (208) 373-0550
fx: (208) 373-0287

Coeur d'Alene Regional Office
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2110 Ironwood Pkwy.
Coeur d'Alene, ID 83814
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fx: (208) 769-1404

Idaho Falls Regional Office
Aaron Swift
900 N. Skyline, Suite B
Idaho Falls, ID 83402
ph: (208) 528-2650
fx: (208) 528-2695

Lewiston Regional Office
Clayton Steele
1118 "F" Street
Lewiston, ID 83501
ph: (208) 799-4370
fx: (208) 799-3451
toll free: (877) 541-3304

Pocatello Regional Office
Melissa Gibbs
444 Hospital Way, #300
Pocatello, ID 83201
ph: (208) 236-6160
fx: (208) 236-6168

Twin Falls Regional Office
Steve VanZandt
1363 Fillmore St.
Twin Falls, ID 83301
ph: (208) 736-2190
fx: (208) 736-2194

CAZ Idling Study Data Sheet

Use one sheet per session per student. If more than one sheet is needed, staple sheets together. Do not record multiple sessions on one sheet.

Student Name: _____

School Name (where study is occurring): _____

Date: _____ Recording time: Start: _____ Stop: _____

Car color (or other method of determining which cars to time): _____

Total number of cars recorded on this sheet: _____

Weather Conditions: _____

Car Number	First 3 digits of license plate*	Arrive Time	Depart/ Engine Off Time	Idle Time(s)	Depart or Off?**	Observations/Notes
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						

*Do not include county designation (e.g., 1A for Ada County)

** Indicate when you stopped timing. If driver turns vehicle off, write "Off" or "O" and record time. Do not start timing again when vehicle is re-started to leave unless the driver does not leave right away (e.g., gets hot and turns car back on for air conditioner). If driver does not turn vehicle off, write "Depart" or "D" and record the time the vehicle left.

-Sample-

CAZ Idling Study Data Sheet

Use one sheet per session per student. If more than one sheet is needed, staple sheets together. Do not record multiple sessions on one sheet.

Student Name: Gail H.

School Name (where study is occurring): Blue Sky Elementary

Date: 9/18/06 Recording time: Start: 2:50 pm Stop: 3:30 pm

Car color (or other method of determining which cars to time): Blue

Total number of cars recorded on this sheet: 10

Weather Conditions: Hot and Sunny

Car Number	First 3 digits of license plate*	Arrive Time	Depart/ Engine Off Time	Idle Time(s)	Depart or Off?**	Observations/Notes
1	F17	2:50	3:05	15	D	
2	G36	2:50	2:50	0	O	
3	C27	2:51 3:00	2:51 3:05	0 5	O D	Turned car off for a while, then turned back on
4	G88	2:52	2:54	2	O	
5	H92	2:53	3:23	30	D	
6	HAL	2:55	3:00	5	O	
7	Q76	2:55	2:57	2	O	
8	S74	3:05	3:10	5	D	
9	679	3:07	3:10	3	D	
10	123	3:08	3:26	18	D	
11						
12						
13						

*Do not include county designation (e.g., 1A for Ada County)

** Indicate when you stopped timing. If driver turns vehicle off, write "Off" or "O" and record time. Do not start timing again when vehicle is re-started to leave unless the driver does not leave right away (e.g., gets hot and turns car back on for air conditioner). If driver does not turn vehicle off, write "Depart" or "D" and record the time the vehicle left.