

Inspection and Maintenance of Vehicles

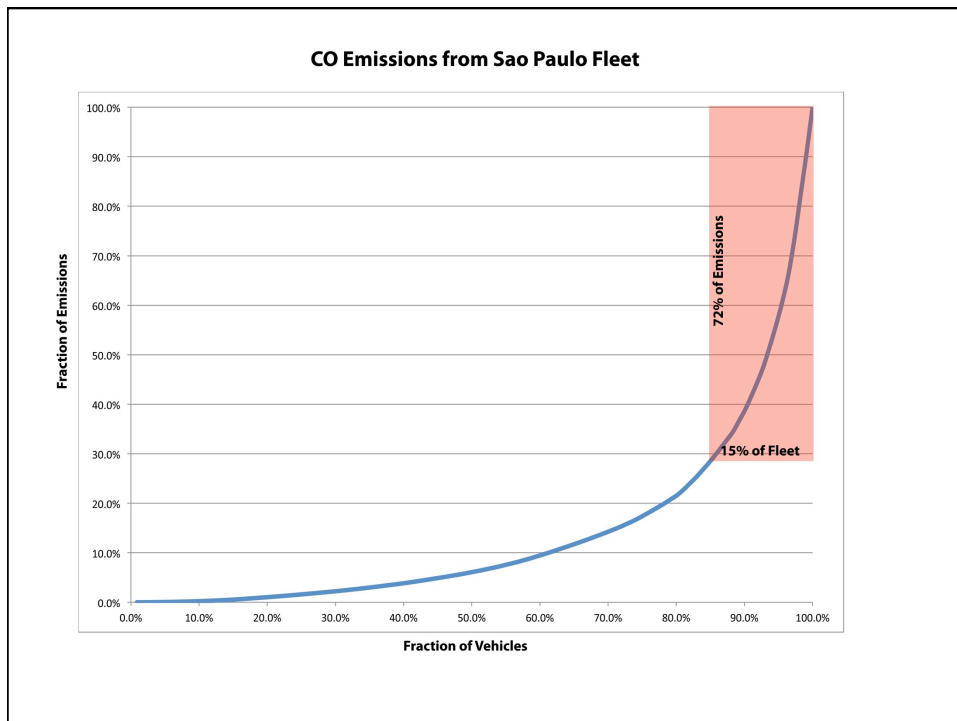
The U.S. Experience

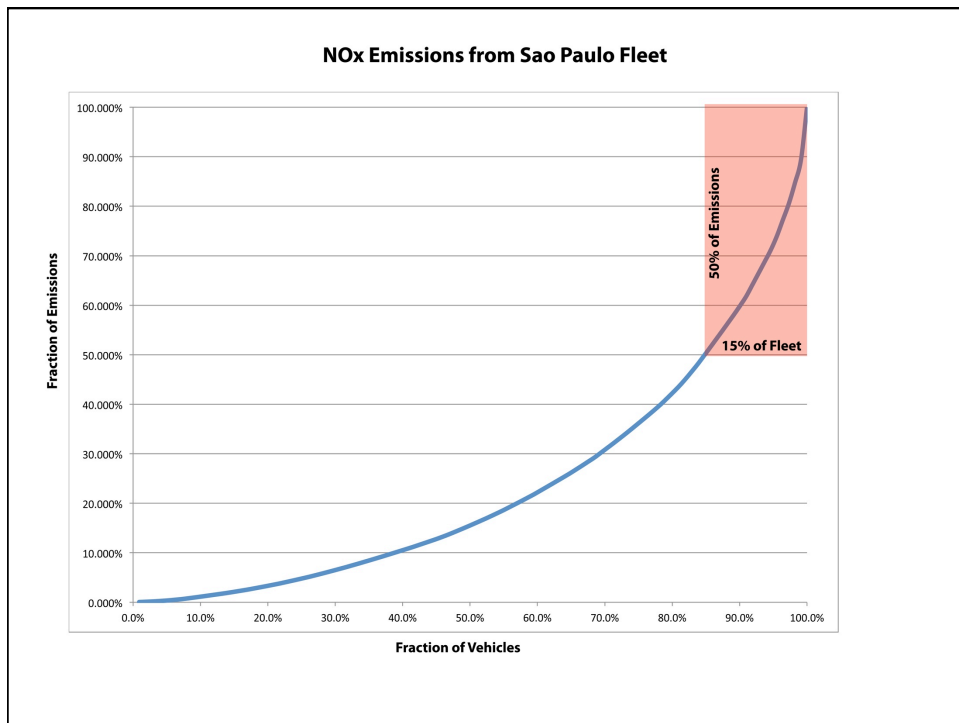
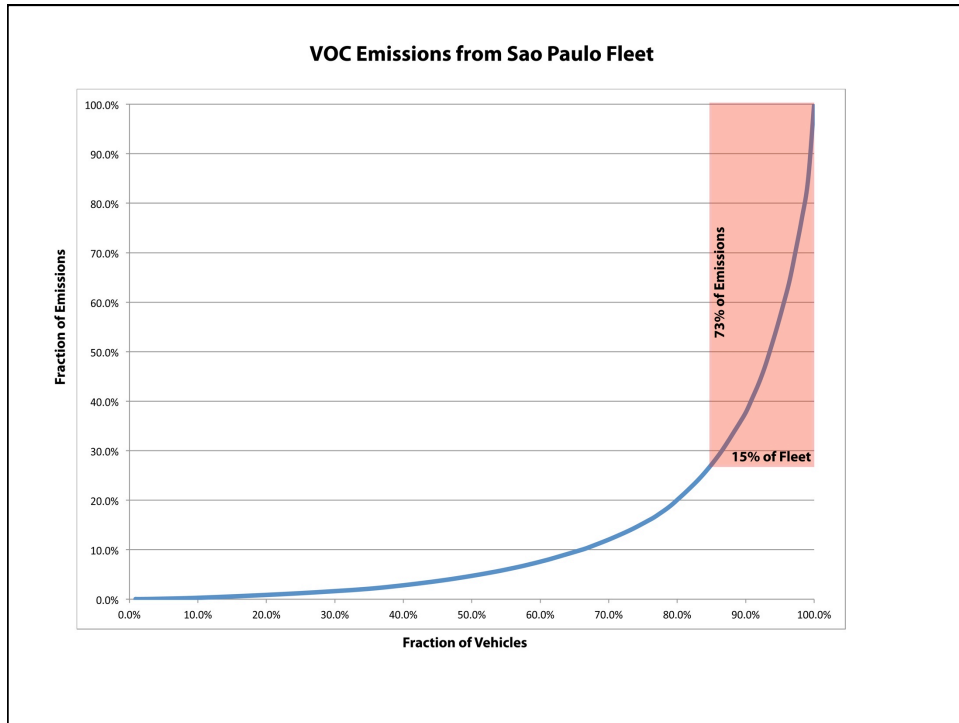
Inspection and Maintenance (I/M)

- Recognized as an important way to reduce mobile source emissions in mid-1970s.
- 1977 U.S. Clean Air Act required cities with unhealthy air to establish an I/M program.
- The I/M program was tightened up in early-1990s.
- The I/M requirement was unpopular at first. The U.S. federal government withheld highway funds from a number of U.S. states to force adoption of an I/M program.
- Today, most major cities in the U.S. have successful I/M programs.

What is the basis for I/M?

Look at some vehicle data collected in Sao Paulo in 2005 for illustration





What were the high emitting vehicles?

Vehicle	Model Year	Failure	Vehicle	Model Year	Failure
Fiat Uno	1990	CO, VOC	GM Chevy	1998	CO, VOC, NOx
Ford Courier	1991	CO, NOx	VW Gol	1998	CO, VOC
GM Chevette	1991	CO, VOC, NOx	Fiat Uno	1999	CO, VOC
Land Rover	1991	CO, VOC	Ford Ka	1999	CO, VOC
GM Vectra	1993	NOx	Ford Escort	2000	CO, VOC
VW Gol	1993	CO, VOC	GM Corsa	2000	NOx
Ford Escort	1995	CO, VOC, NOx	Fiat Palio	2001	NOx
Ford Ka	1995	NOx	Fiat Fiorino	2002	CO, VOC
Ford Pampa	1995	NOx	GM Manza	2002	VOC, NOx
Land Rover	1995	CO	GM Omega	2003	NOx
GM Kodat	1996	CO, VOC	VW Gol	2004	NOx
Fiat 147	1997	CO, VOC	VW Paraty	2004	VOC
VW Gol	1997	CO, NOx	Ford Fiesta	2005	NOx
VW Gol	1997	CO, VOC	VW Gol	2005	NOx
VW Paraty	1997	CO, VOC, NOx	VW Paraty	2005	VOC, NOx
VW Paraty	1997	NOx			

To capture all of the high emitting vehicles requires addressing 27% of the fleet.

Initial Conclusion and Questions in the U.S.

- **Conclusion:**
 - It is possible to significantly reduce emissions by addressing a small fraction of the fleet. (In theory on-road CO and VOC emissions could be reduced by ~60% and NOx emissions by ~40%)
 - Vehicle fuel economy and operation life may also be improved by an I/M program.
- **Questions to Make and I/M Program Work:**
 - How do we identify the high polluters?
 - What do we do with the high polluters once we identify them?

Identifying High Polluters

- Want a test that finds the true high emitters.
 - Do not want to fail clean cars (error of commission--**EoC**)
 - Do not want to pass dirty cars (error of omission-**EoO**)
- Want a test that is low cost.
- Want a test that is as easy for the public to participate in and easy for government to implement.

Potential Approaches to Identify High Emitters

Approach	Errors	Ease of Application	Approximate Cost*
Full CVS Emissions Test	Very Low EoC, Very Low EoO	Carried out at complex central facilities, takes 40 minutes, all vehicles involved	\$1500 / vehicle
Loaded Mode Concentration Test	Low EoC, Low EoO, Needed for NOx	Carried out at a central facility, takes 15 minutes, all vehicles involved	\$45 / vehicle
Idle Concentration Test	Medium EoC, Medium EoO, does not work well for NOx	Carried out at local gasoline stations, takes 15 minutes, all vehicles involved	\$25 / vehicle
Remote Monitoring	Medium EoC, Medium EoO	Carried out on roadways, only failed vehicles involved. Second test required for failed vehicles	Effective \$15 per vehicle
On-Board Diagnostics	Low EoC, Low EoO	Carried out at local stations, all vehicles involved	Effective \$100 per vehicle

Costs are for comparison purposes only, cost vary considerably in various parts of the U.S.

Initial Choices in the U.S.

- On-Board diagnostics not available before 1995.
- Remote monitoring not available before 1990.
- Initial choice in most locations was Idle concentration test addressed to CO/VOC.
- Loaded mode concentration test added mostly in the 1990s as NO_x concern grew.
- Remote monitoring has primarily been used to check on effectiveness of I/M programs.

Testing Today in U.S.

- 35 of 50 states have I/M program.
- Typical program uses:
 - Idle concentration for Pre-1981 vehicles
 - Loaded mode testing for 1981-1995
 - OBD check for Post-1995 vehicles
- 15 states have annual checks, 17 states have every other year checks, 3 states have annual checks for pre-1985 vehicles and every other year for the rest
- 26 states require vehicles from 1967 or 1977 + to get tested. 8 states require 24 or 25 year old and newer vehicles to get tested. 1 state requires 1984 + vehicles to get tested.
- 24 states exempt cars that are 1, 2, 3, 4 or 5 years old.

Selection of Failure Rate

- Depending on the standards set, 0%-100% of vehicles can be made to fail the test.
- Initially, the failure rates were chosen to fail the worst ~20% of the vehicles.
- Today in Phoenix, Arizona, an average of 14% of the total vehicles fail while in Tucson, Arizona an average of 38% fail.
- In California, 12% of total vehicles fail the test (29% of pre 1996 vehicles fail)

Cheating on the I/M Test

- Studies in California indicate that many test stations are passing vehicles that should be failed. (this is the opposite of the early predictions about I/M)
- In a 2009 study where randomly selected vehicles were stopped and tested on the road, there is a large disparity between vehicles checked on the roadside and those checked at the test stations (see next slide).

Results of California Roadside Study

Manufacturer	Station Failure Rate	Roadside Failure Rate	Ratio
GM	14%	26%	1.86
Toyota	12%	22%	1.83
Ford	10%	21%	2.10
Honda	13%	26%	2.00
Nissan	11%	20%	1.82
Chrysler	14%	32%	2.29
Other	15%	31%	2.07
Overall	13%	25%	1.97

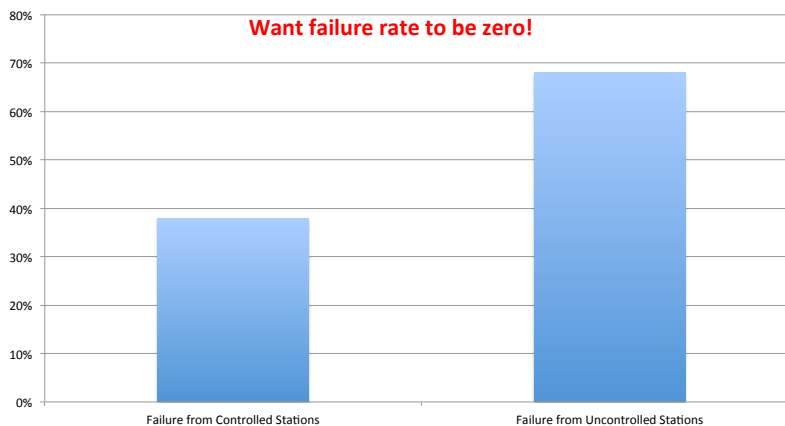
Dealing with the High Emitter

- Repair or Remove
- If Repair approach is used the issues are:
 - Getting the vehicle repaired
 - Keeping the vehicle repaired
 - Retesting the vehicle
- If the Removal approach is used the issues are:
 - Keeping the vehicle out of the fleet
 - Providing transportation in place of the removed vehicle

The Repair Approach

- Used in all locations because of the lack of alternate transportation options.
- About half of U.S. states separate the repair and testing function. The other half allow the testing station to also repair vehicles they have failed.
- Retest vehicle: Most states require repaired vehicles to be re-tested.
- California carried out a study of vehicle status one year after failing the I/M test (next slide).

Check of Vehicles Failed and Then Repaired by Controlled Stations Compared to Uncontrolled Stations after One Year*



*All California I/M Facilities are Privately Owned

Removal of Vehicles from Fleet

- California and other states operate voluntary removal programs.
- In California, vehicle owners are given \$1000 (\$1500 for low income persons) for vehicles that fail the I/M program or are pre-1990 (in Los Angeles). This program has limited funding.
- Engine blocks of vehicles are destroyed immediately after vehicle is surrendered

Conclusion

- Vehicle inspection and maintenance offers great potential to reduce emissions from on-road vehicles (50%-73% emission reduction).
- Actual programs have sustained some measureable cheating and incompetence that reduces the effectiveness of the program.
- With reasonable safeguards and training, I/M programs are achieving half or more of their potential.