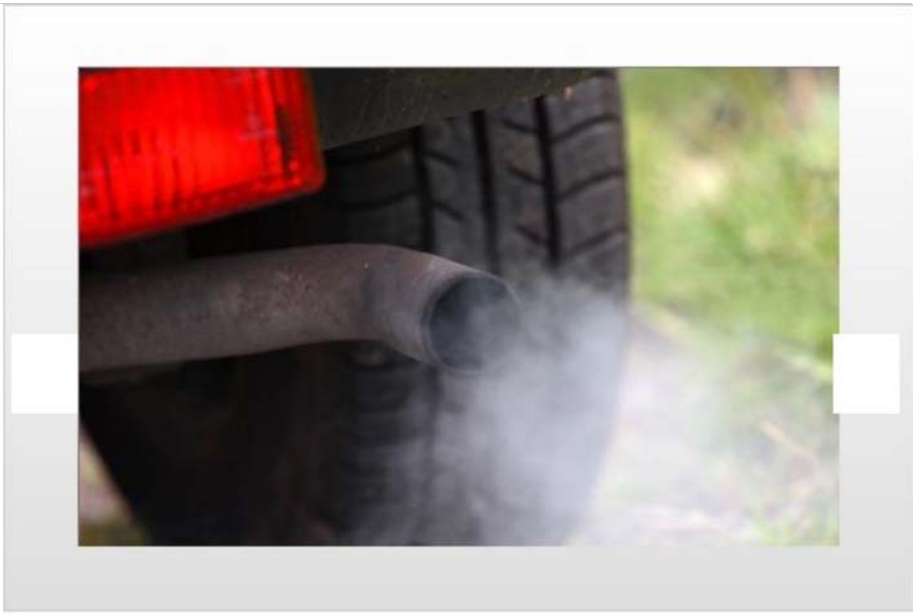
# Untangling U.S. Vehicle Emissions Regulations

Updated: 05/12/2009 - by Jason Kavanagh, Engineering Editor





**Exhaust Smoke**

Automotive emissions standards have grown so increasingly stringent since the introduction of Tier 2 and LEV 2 standards that sooty black exhaust pipes are becoming a thing of the past. | March 18, 2010 | iStockPhoto

1 of 4

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If you're confused by the alphabet soup of automotive emissions acronyms, you're not alone. The regulation of automotive tailpipe emissions is an exceedingly complex subject, rife with legal definitions, caveats and jargon.

Tier 2, CARB, EPA.... What does it mean, and how does it all work?

To better understand the acronyms, we've provided some background on the primary organizations overseeing automotive emissions regulation. We'll look at what the regulations do and do not allow in Part II.

**The Background**

Every passenger car and light-duty truck (SUV or pickup) sold in the United States must comply with emissions regulations set forth by the Environmental Protection Agency (EPA). This regulatory entity, established in 1970, implements federal laws intended to protect the environment.



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It appears to be working, as longtime residents of Southern California have observed — smog, while still a major problem, is nowhere near the eyeball-searing levels it was 20 years ago.

There's one large problem with the EPA's standards: They aren't the same as everyone else's standards. Japan, the European Union and the U.S. have historically enforced different regulations for automobile emissions. This worldwide disparity in regulations creates headaches for automakers attempting to produce one basic vehicle for international sale and increases the cost of bringing vehicles to market.

Today, the emissions standards in the U.S. are more stringent than anywhere else in the world, and will remain so for the foreseeable future.

**Tier 1 and Tier 2**

In 1990, the Clean Air Act was amended to define federal emissions standards that took full effect in model-year 1996. These were known as Tier 1 standards. The days of Tier 1 are now behind us, so let's focus on the present.

Today, Tier 2 defines the current set of federal emissions regulations. Tier 2 slashes allowable emissions to much lower levels than Tier 1, but more significantly it requires that vans, pickups and large SUVs be subject to the same emissions regulations as passenger cars.

Tier 2's phase-in period was from model years 2004-'07 for cars and trucks. Every successive model year within this period required that an additional 25 percent of an automaker's fleet be Tier 2 compliant. This phase-in period gave automakers some breathing room in meeting the regulations. Technologically speaking, it's easier to step into a lukewarm shower and gradually turn up the heat versus jumping right into a scalding spray.

The rules and regulations surrounding the phase-in period of Tier 2 are hugely convoluted. Basically, all vehicles up to 8,500 pounds GVWR (Gross Vehicle Weight Rating) are now subject to Tier 2 standards, which are "fuel neutral," meaning the standards are the same whether a vehicle uses gasoline, diesel or any other fuel.

The next step in emissions regulation will no doubt be referred to as Tier 3, though no details have yet been announced by the EPA. So from now until the foreseeable future, Tier 2 is the emissions standard that all cars must meet.

**Individual States Can Enforce California's Standards**

As the acting federal authority, the EPA lays down the law, literally, on any type of emissions standards in the U.S. The Clean Air Act has provisions that allow California to implement its own automotive emissions standards and other states to adopt California's standards at their own discretion.

You've probably heard the expression "California emissions." This is simply shorthand for the state standards defined by California's Air Resources Board (CARB).

Today, CARB's level of enforcement, known as LEV (Low-Emission Vehicle) 2, makes the EPA's standard look like an easy Sunday drive.

Ever notice that certain vehicles are not available in all states? LEV 2 is almost always the reason. Automakers must comply with LEV 2 if they wish to sell vehicles in those states that have adopted CARB's LEV 2 standards as their own. Maine, Massachusetts, New York and Vermont are among the states that have done so. By 2009, a total of 11 states (including California) will have followed suit.

**Which Emissions Are Regulated?**

No matter the vehicle type, Tier 2 regulates the emissions of five tailpipe pollutants:

- **Non-Methane Organic Gases** (NMOG) — this category accounts for alcohols and other pollutants that are not hydrocarbons but can lead to production of ozone, a principal smog-related compound
- **Carbon Monoxide** (CO) — toxic to humans when inhaled
- **Oxides of Nitrogen** (NOx) — can react and produce ozone, a toxin, and contributes to acid rain formation
- **Particulate Matter** (PM) — when inhaled, can cause lung and bronchial problems; thought to be carcinogenic; also a contributor to smog

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On April 2, 2007, Congress ruled that greenhouse gases are considered pollutants and as such the EPA has the authority to regulate them. The ruling is recent enough that the EPA hasn't yet put forth any proposals pertaining to greenhouse gas regulation.

**Summary**

At a minimum, all automakers must comply with the EPA's Tier 2 emissions standards if they want to sell new cars or SUVs in the U.S. Certain states take this a step further and demand that the cars meet an even tighter standard known as CARB LEV 2.

In Part II, we'll describe the nuts and bolts of Tier 2 and LEV 2 in more detail.

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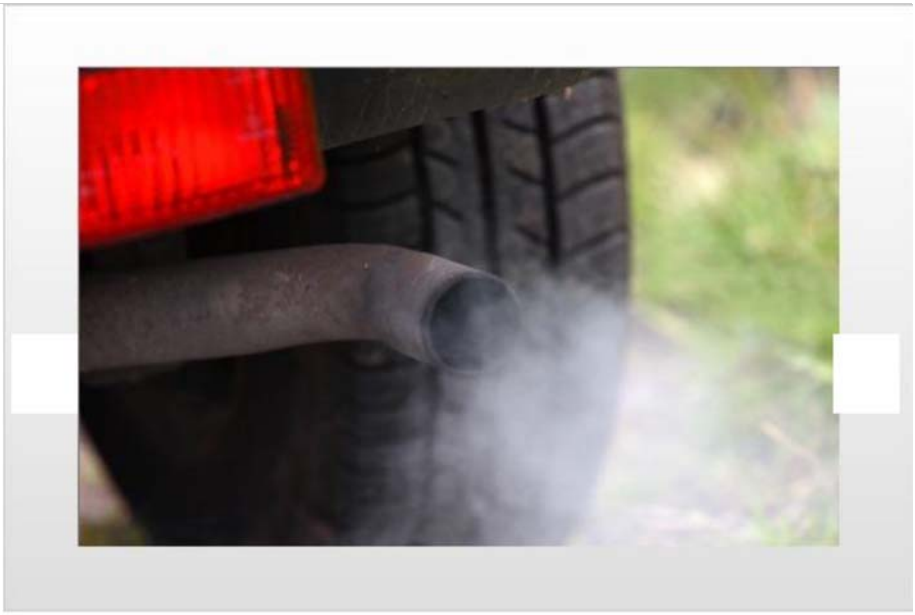

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In Part I we described the five major automotive emissions categories and U.S. governmental agencies responsible for the regulation of exhaust by-products. Now let's take a closer look at the allowable limits of those emissions.

To recap, Tier 2 is the set of federal emissions regulations set forth by the Environmental Protection Agency, and LEV 2 describes the regulations prescribed by California's Air Resources Board (CARB).

**The Bins That Comprise Tier 2**

Eight "permanent" certification levels, known as bins, define the Tier 2 regulations associated with the control of each of the five pollutants. Each bin allows for different degrees of acceptance of those pollutants — bin 8 allows the most emissions; bin 1 allows none.

| | | Higher Emissions | | | Lower Emissions | | | |
|---|---|---|---|---|---|---|---|---|
| | | Bin 8 | Bin 7 | Bin 6 | Bin 5 | Bin 4 | Bin 3 | Bin 2 |
| NMOG | 50k | 0.100 | 0.075 | 0.075 | 0.075 | | | |
| | 120k | 0.125 | 0.090 | 0.090 | 0.090 | 0.070 | 0.055 | 0.010 |
| CO | 50k | 3.4 | 3.4 | 3.4 | 3.4 | | | |
| | 120k | 4.2 | 4.2 | 4.2 | 4.2 | 2.1 | 2.1 | 2.1 |
| NOx | 50k | 0.14 | 0.11 | 0.08 | 0.05 | | | |
| | 120k | 0.20 | 0.15 | 0.10 | 0.07 | 0.04 | 0.03 | 0.02 |
| PM | 120k | 0.02 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 |
| HCHO | 50k | 0.015 | 0.015 | 0.015 | 0.015 | | | |
| | 120k | 0.018 | 0.018 | 0.018 | 0.018 | 0.011 | 0.011 | 0.004 |

**How These Different Bins Work**

A tier is a fleet-averaged emissions standard. Once Tier 2 is fully implemented in 2009, an automaker's fleet must average no more than 0.07 gram per mile of NOx. (This is equivalent to the NOx level of bin 5.)

Automakers can sell as many "dirty" bin 8 cars as they choose, provided they are balanced by sales of an appropriate number of bin 4 (or cleaner) vehicles in order to achieve the required average. It's like being able to use an "A" in gym class to offset the "C" you got in math since they average to a "B."

"Dirty" is a relative term. Bin 8 — again, the "dirtiest" of all Tier 2 bins — allows only a fraction of the emissions permitted just 10 years ago under Tier 1.

These requirements allow plenty of room for carrying NOx credits over from previous years and for trading or selling credits to other manufacturers within this paradigm. We could devote an entire Web site to explaining that, but suffice it to say that the ultimate intent of the credit program is to ensure that air quality meets an overall standard on a yearly basis.

**Emissions Measured on Two Driving Schedules**

Different driving conditions produce different amounts of emissions, so the EPA measures the above pollutants during two very specific driving schedules intended to represent city driving and highway conditions.

Well, sort of. The EPA is rethinking those driving cycles, as they were originally created decades ago and do not accurately reflect today's driving conditions.

**Where CARB's LEV 2 Regulations Fit in**

Conceptually, CARB's LEV 2 standards — the current standards — use Tier 2 as a starting point and then tighten the screws down further.

Most LEV 2 categories are more stringent than the corresponding Tier 2 limit. In fact, the most lenient of LEV 2's categories, Low Emission Vehicle (LEV), is equivalent to Tier 2, bin 5.

**LEV 2 Emissions Limits for Passenger Cars and Light-Duty Trucks (grams/mile)**

| | | Higher Emissions | | Lower Emissions | |
|---|---|---|---|---|---|
| | | LEV | ULEV | SULEV | ZEV |
| NMOG | 50k | 0.075 | 0.040 | | 0 |
| | 120k | 0.090 | 0.055 | 0.010 | 0 |
| CO | 50k | 3.4 | 1.7 | | 0 |
| | 120k | 4.2 | 2.1 | 1.0 | 0 |
| NOx | 50k | 0.05 | 0.05 | | 0 |
| | 120k | 0.07 | 0.07 | 0.02 | 0 |
| PM | 50k | 120k | 0 | 0.01 | 0.01 | 0 |
| | | | | | | 0 |

A manufacturer wishing to sell vehicles in the states that abide by California's emissions standards can certify to any of the above LEV 2 categories they choose, provided that their entire fleet meets prescribed average NMOG limits. The allowable NMOG is an ever-stricter target, finally bottoming out at 0.035 gram per mile in 2010. This idea parallels Tier 2's fleet-averaged NOx limit.

**But Wait, There's More**

LEV 2 originally required 10 percent of new cars to be classifieds as ZEVs, which were intended to be essentially battery-powered electric vehicles (EVs). When it became apparent the limitations of existing battery technology would not allow a marketable electric vehicle to be produced, CARB revised its ZEV mandate to include non-battery EVs.

Within the ZEV category above, there are six subcategories. All of these entitle an automaker to receive credits toward the ZEV requirement:

- **PZEV** (Partial Zero Emission Vehicle) — a rating reserved for cars that meet both SULEV standards and a near-zero evaporative emissions standard and is warranted for 15 years/150,000 miles.
- **AT-PZEV** (Advanced Technology Partial Zero Emission Vehicle) — these are PZEVs that also utilize alternative fuel, electric drives or other advanced technology
- **NEV** (Neighborhood Electric Vehicle) — think "golf cart on steroids"
- **FFEV** (Full-Function Electric Vehicle) — larger than an NEV and capable of normal-car duties, but with limited range
- **CEV** (City Electric Vehicle) — sized between an NEV and an FFEV but legal to run on freeways

PZEV and AT-PZEV have emissions equivalent to or less than the power plant emissions associated with battery EVs. Thus, they can be used to fulfill up to 60 percent of an automaker's ZEV requirement. The remainder of an automaker's ZEV requirement must be comprised of "pure" ZEVs.

PZEVs are typically gasoline-fueled vehicles equipped with comprehensive emissions controls. Most AT-PZEVs are hybrids or alternative-fuel vehicles. In model-year 2008, a total of 56 models are classified as PZEV and six of them are AT-PZEVs.

**Ever-Changing Paradigm**

Emissions regulations are always evolving as automakers and the enforcing entities learn more about health, weather and the impact of emissions on both. These regulations keep everyone on their toes, advance the state of the art in vehicle technology, and help keep the air cleaner.

Now if we could all agree on a worldwide standard, we'd be making real progress. A reduction in the number of acronyms wouldn't hurt, either.

| 2008 Model | Emissions Ratings |
|---|---|
| BMW 328i Sedan | PZEV |
| BMW 328i Coupe | PZEV |
| BMW 328i Convertible | PZEV |
| BMW 328xi Sedan | PZEV |
| BMW 328xi Coupe | PZEV |
| Chrysler Sebring | PZEV |
| Dodge Avenger | PZEV |
| Ford Focus | PZEV |
| Ford Fusion | PZEV |
| Mercury Milan | PZEV |
| Ford Escape Hybrid 2WD/4WD | AT-PZEV |
| Mercury Mariner Hybrid 2WD/4WD | AT-PZEV |

| | |
|---|---|
| Ford Taurus AWD | PZEV |
| Ford Taurus X | PZEV |
| Ford Taurus AWD | PZEV |
| Mercury Sable | PZEV |
| Mercury Sable AWD | PZEV |
| Buick Lucerne | PZEV |
| Buick Lacrosse | PZEV |
| Pontiac Grand Prix | PZEV |
| Chevrolet Impala | PZEV |
| Chevrolet Cobalt | PZEV |
| Pontiac G5 | PZEV |
| Honda Civic Hybrid | AT-PZEV |
| Honda Civic GX | PZEV |
| Honda Accord 2.4-liter | PZEV |
| Honda Accord 3.5-liter | PZEV |
| Hyundai Elantra | PZEV |
| Kia Spectra | PZEV |
| Mazda Mazda3 2.0-liter | PZEV |
| Mazda Mazda3 2.3-liter | PZEV |
| Mazda Mazda6 2.3-liter | PZEV |
| Mercedes-Benz E350 | PZEV |
| Mercedes-Benz C350 | PZEV |
| Mitsubishi Lancer | PZEV |
| Mitsubishi Outlander | PZEV |
| Mitsubishi Galant | PZEV |
| Nissan Altima 2.5L | PZEV |
| Nissan Altima Coupe 2.5L | PZEV |
| Nissan Altima Hybrid | PZEV |
| Subaru Forester 2.5X | PZEV |
| Subaru Forester 2.5XS Ltd. | PZEV |
| Subaru Legacy Wagon 2.5i | PZEV |
| Subaru Outback Wagon Base | PZEV |
| Subaru Outback Wagon Ltd | PZEV |
| Toyota Camry 2.4L | PZEV |
| Toyota Prius | AT-PZEV |

| | |
|---|---|
| Volkswagen Jetta Sportswagon | PZEV |
| Volkswagen Rabbit | PZEV |
| Volkswagen New Beetle | PZEV |
| Volkswagen New Beetle Convertible | PZEV |
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