Anti-Lock Brakes - Some good news, some bad news and something on drag factors, too.

by Joseph E. Badger

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Many years ago, various manufacturers installed antilock brake systems (ABS) on trucks. Although the idea was a good one, there was a problem. The people who maintained the trucks had little or no training on such systems. Consequently, after several apparent failures, the devices were considered unreliable. Some owners of vehicles with ABS either removed the systems or disabled them. Time passed and manufacturers began installing ABS in cars. Exactly what is ABS?

Time-Life Book of the Family Car [1973] succinctly defined ABS this way: "ANTISKID BRAKING. Tiny computers built into every brake system will sense impending wheel lock-up, and then will cause the brakes to be released and immediately reapplied -- in a lightning-fast version of the stab braking that skilled drivers undertake in trying to avoid a skid on a slippery surface."

The trouble is, most people aren't skilled enough to do that. According to Mitchell Information Services of San Diego, "Antilock braking systems work on the principle that a rolling tire can place more drag on a surface that a skidding or sliding tire. When the brakes are applied sharply, especially in reduced-traction circumstances such as wet or slippery roads, the brakes can lock up the wheels, preventing their rotation altogether. Improved braking will result if the tires are brought near the point of lockup and then released. It was found that the advice of pumping the brakes during an emergency stop just could not be followed by most drivers in a panic stop." [Automotive Electrical Systems, Prentice-Hall, 1987.]

This method of braking is often called threshold braking. It works favorably when operating motorcycles as well as cars and trucks.

Another of Mitchell's publications explains that "Many things happen almost simultaneously when a driver applies the car's brakes in an emergency situation -- and the driver may not be aware of any of them. For instance, a different level of hydraulic pressure is applied to the front brakes than that applied to the rear brakes, because up to 75% of the braking is done by the front brakes." [Automotive Technology Today, Prentice-Hall, 1989.]

The same publication adds that "The system operates differently on rain-slick pavement than on a dry gravel surface. Antilock/antiskid brake systems work because the computer has better information and can react more quickly than the driver could ever hope to."

Eventually, many user-unfriendly components were designed out of the systems, more information became available about ABS, and the devices found their way into several luxury vehicles. It used to be that safety was not much of a factor in selling vehicles. There were no seat belts, dashboards were metal, and there were all manner of protuberances inside.

Apparently, after thousands of motorists and passengers flew through windshields, banged into dashboards, and received wounds from various knobs and pointed doohickeys, the auto

industry began equipping vehicles with seatbelts, padded dashes, shoulder harnesses, air bags and eventually rear seat shoulder harnesses. The industry, reluctant to make changes because of added costs, were finally coaxed, cajoled and occasionally mandated to implement those safety features.

The latest focus is ABS and most people who have cars with ABS swear by it. No longer is the system available only on the most expensive cars; it's standard equipment on many economy cars. However, the trucking industry hasn't been as quick to follow suit.

A group called Citizens for Reliable and Safe Highways (CRASH) have some recommendations for an omnibus truck safety bill. Item one of their recommendations is as follows: (It is all one sentence, so take a deep breath...)

"ANTILOCK BRAKES: Provide that NHTSA conduct rulemaking to require installation of antilock brake systems along with slack adjusters, adjustment indicators, load-proportioning valves, engine/drive-line and other retarders, and increase front steering axle brake size on all commercial vehicles to achieve shorter stopping distances, increase reserve brake capacity, prevent wheel lock-up, and maintain steering control in emergency stopping, especially on roads with poor skid resistance and in grade descents."

According to the Insurance Institute for Highway Safety (IIHS), in its Status Report [Vol. 25, No. 5], the following data on component costs suggests what ABS can do to the price of a new vehicle:

Cable & Connector: $40 per wheel
Sensor: $100 per wheel
Tone Ring: $20 per wheel
Solenoid: $250-$1,500 per vehicle
Electronic Control Unit: $250-$1,800 per vehicle

More and more cars are coming equipped with ABS as standard or optional equipment, and efforts are being made to get ABS into more and more trucks. A while back, the National Highway Traffic Safety Administration (NHTSA) conducted a two-year, $4.5 million study of antilock brakes on 200 tractor trailers. Suppliers of ABS devices used in the testing included Bendix, Bosch, Midland, Rockwell and WABCO. IIHS reported in June 1991: "Ninety-three percent of the 280 operators who have driven the test vehicles report they like the systems. And 20 drivers say the antilocks on their rigs were crucial in averting a crash."

Since then, there has been a concerted effort to convince vehicle manufacturers to install the devices as regular equipment and purchasers have been encouraged to add ABS to vehicles already on the road. Japan requires ABS on heavy tractor trailers (manufactured after 1991) that are used to transport hazardous materials and buses over 12 tons must be equipped with ABS. The European Community has a regulation mandating ABS on heavy trucks, trailers, and buses. That's the good news.

Prior to February 1992, six add-on antilock brake systems sold in the automotive aftermarket apparently did not work and may make braking performance worse - and five other ABS systems were under investigation, according to NHTSA [IIHS Status Report Vol. 27, No. 3.] Tim Hurd of NHTSA's Office of Public Affairs said that the agency "is concerned about the claimed versus the actual performance of these products and the partial brake failure that may result from their installation."

Many police departments have encountered situations involving antilock brakes that resulted in disaster. Some agencies cite instances where the ABS simply didn't work. Other departments, with identical cars -- except that some are equipped with ABS, some without -- report that the ones without ABS stop quicker than those with ABS. A few officers tested their issued ABS-installed vehicles and found if they disabled the system, stopping performance was better. I cannot substantiate the accuracy of any of the tests nor explain how the officers drove the cars, under what conditions, and so forth. I understand that many vehicles went back to the shop for ABS adjustment(s), replacement, or removal. But that is just part of the bad news.

A mainstay of accident reconstruction in general and speed determination in particular is the distance a vehicle skidded prior to, during, or after impact with something. That distance, obviously, is based on measurements made of SKIDMARKS. Skidmarks, for the most part, occur when the driver of a vehicle slams on the brakes and the tires lock. Tires lock because the brake cylinder has been energized by fluid from the master cylinder and so on. When a motorist crams on the brake pedal, all the brakes lock. And they stay locked, generally, until the car smashes into something - like another vehicle or an oak tree. And the investigating officer, quickly and meticulously measures the skidmark(s), shadow and all.

But alas, what if the offending vehicle is equipped with an ABS system? [By the way, it is just as redundant to say "ABS system" as it is to say "HIV virus," but no one likes "AB system" any more than "HI virus."] If the ABS system supposedly prevents the brakes from locking, how then can anyone measure skidmarks since there shouldn't be any. Right?

Not necessarily. Investigators must know what to look for -- and do it early in the investigation. When one applies full force to the brake pedal in an ABS-equipped car, the brakes do actually lock up; however, no sooner are they locked than they're unlocked. This cycle of off-on braking occurs several times a second. The brakes are actually being "pumped" on and off. These pulsations interact with the pavement through the tires.

For those readers who haven't seen the popular video tape put out by a "major automobile manufacturer" on the subject of ABS, yes Virginia, there are skidmarks. They just don't look like the typical and traditional-looking skidmarks. Imagine a length of "skip skids," the kind put down when brakes lock on an empty semi trailer. Now, mentally squeeze the visible parts of the skip skids toward each other so the spaces between are shorter. Next, erase almost everything. The result is a barely discernible mark but it is there and it is possible you'll have to practically stand on your head to see it. Keep in mind these marks may be evident only on dry pavement. ABS was developed for wet roads so that the stopping (braking) distance would be shorter AND the steering control could also be maintained.

Since the ABS tire mark is not one of those magnificent juicy ones that leap out at you when you arrive at the accident scene, don't assume the driver never hit the brakes. And don't forget about looking for ABS-produced marks. Granted, if the vehicle is old or if you simply know that such-and-such isn't equipped with ABS, never mind. Many new, smaller, non-luxury cars have ABS.

Of station wagons and passenger vans, the following 1993 vehicles have antilock brakes as standard equipment:

Buick Roadmaster and Century, Chevrolet Caprice, Chrysler Town & Country, Jeep Grand Cherokee, Volvo 240, and Oldsmobile Cutlass Ciera Cruiser. With others, like the Toyota Previa

and Corolla, and Dodge Caravan, and Plymouth Voyager, antilocks are optional. And some, such as the Ford Aerostar and Clubwagon, and Mazda MPV have antilocks only on the rear.

Of regular two- and four-door cars, ABS comes standard on the Chrysler Concorde, Mazda 929, Pontiac Bonneville, Buick's LaSabre and Park Avenue, Olds 88 and 98, Chevrolet's Beretta and Corsica, Lexus ES300, Toyota Camry and Volvo 240. You should also find antilock brakes on the VW Jetta III GLX and Saab 900. They are optional on the Dodge Daytona, Shadow, and Stealth, the Geo Prism, the Isuzu Impulse, Mitsubishi 3000 GT, Nissan NX and Sentra, Plymouth Sundance, Subaru Impreza and Toyota's Celica, Corolla, Paseo and Tercel. There are no antilock brakes on the Geo Metro Convertible or Storm, nor on Isuzu's Stylus or VW Cabriolet.

The list of luxury cars with ABS includes the Acura Legend, most models of BMW and Mercedes. Lincoln's Town Car and Mark VIII have ABS as does the Cadillac Fleetwood Brougham, Seville and Deville. The Chrysler Imperial is so equipped as are the Infinti Q45, Jaguar XJ6 and all models of Rolls-Royce and Bentley.

On sports cars: Acura NSX, Nissan 300ZX, Subaru SVX, Porsches (911, 928, 968), Cadillac Allante, Chevrolet Corvette, Lotus Esprit Turbo, Mazda RX-7 (optional on the MX-5 Miata). They are also optional on the Toyota MR2. Some late-in-the-year models of Camaro and Firebird will have ABS.

Now, how do you know if you have one of the "optional" vehicles in the accident you're investigating? Ask the driver. If he or she doesn't know (or can't answer), you will have to do some more investigating. If you know what to look for, obviously, examine the brakes; if you don't, ask the service people at a dealership that handles the particular vehicle. But keep in mind to look for the tell-tale signs that ABS manifests, the "close together, skip-skid" marks. Once you've identified and measured the marks, another tricky element enters the picture that affects speed determination: Drag factor.

Calculating speed from skidmarks is another topic in itself, but for those of you already versed in reconstruction, let's address drag factor when ABS is involved. First, some definitions. If an attorney asks you to define "drag factor," several responses are available:

1. A number representing the resistance to sliding of two surfaces in contact.
2. The force parallel to a surface required to keep an object sliding on that surface, divided by the force of the object against the surface.
3. The rate of change of speed loss - or gain - over a period of time.
4. The resistance of one body to another when they are sliding or rubbing against each other.
5. The horizontal force required to cause an object to move in the direction of the force divided by the weight of the object being moved.
6. A number representing the acceleration or deceleration of a vehicle or other body as a decimal fraction of the acceleration of gravity.

I have my own, albeit less scientific-sounding, definition:

A measure of the smoothness or roughness of a surface over which a vehicle slides, rolls, skids, or otherwise moves. At least it's the type of definition most jurors can comprehend.

There is considerable controversy as to how a drag factor should be obtained. Some people lay down test skids, hope they've done it right, measure the skid, factor in the speed and work out

the drag factor mathematically or with a nomograph. Others use various charts that have been around for years. Most of these charts are conservative by nature and keep in mind that tire material and roadway surface aggregates have improved since many of the charts were developed. You can use an electronic accelerometer, a bumper gun or a 5th wheel device.

Regardless of the method, be aware that ABS gives optimum braking efficiency, as it is threshold braking. You can normally stop in a shorter distance, at a given speed, with ABS than without; hence the drag factor should be somewhat higher for an ABS-equipped vehicle than for one whose tires are locked and sliding.

Chances are you will not be able to see (ergo measure) the entire distance over which the car's speed retarded anyway; therefore, the calculated result will definitely be minimum speed.

ABS may be the bane of the accident reconstructionist but hopefully, because they are so equipped, such vehicles will avoid collision and there won't be an accident to investigate.