BASIC VEHICLE BRAKING INFO

A wide receiver darts down the football field deftly dodging and spinning his way past his opponents stopping and turning on a dime. Would you say your vehicle can do the same, or would you equate your vehicle more with the substantial, weighty, and strong defensive end or linebacker? Fire apparatus are not loved because of their speed and agility, but more for their size and strength. Unlike a defensive end, a vehicle does not have the luxury of crashing to a stop. When it comes to safely stopping a vehicle, the operator needs to be acutely aware of speed, road conditions, and the additional time and space needed to safely stop due to the vehicles size and weight. Other factors playing a significant role are your physical condition, how tired you are, any medication, your attitude, and your concentration.

Maintaining a Defensive Space:
When operating any vehicle the operator must be aware of the location and speed of all vehicles in front of him as well as those to the side and rear to set up the best situations for braking his vehicle. This is accomplished by sweeping your vision thru the range of the space around your vehicle. First looking in front of the vehicle at the closest traffic and then ten or more cars further down the road to see what they are doing. By doing this you will be able to slow down, stop, or change lanes long before a problem becomes critical in front of you. Look in the side and rear mirrors on a regular basis to know what vehicles are alongside and to the rear of your vehicle so that you can rapidly maneuver to the side or stop, if the situation should require. Looking in the side mirror before a lane change maneuver is a major contributing factor to accidents, as the vehicle in front may be rapidly stopping, especially when you are following closer than defensive driving recommendations. Making this situational awareness a part of your driving skills will allow for evasive maneuvers or safe stopping with out endangering your vehicle, passengers, and the other vehicles on the road.

Keep Your Distance:
It is recommended that all vehicles, especially large vehicles, maintain at least six to eight seconds distance from the vehicle in front of them. To judge this distance, watch when the vehicle in front of you passes a sign or a mile-marker and count the seconds until your front bumper passes that same landmark. After learning this skill, your mind will help you to automatically assume a safe following distance. Following too closely jeopardizes your safety because you are forced to focus all your attention on the vehicle in front of you and may be unaware of situations arising elsewhere. Ask yourself the following questions to determine if you are maintaining a safe following distance.

- Am ‘I” able to consistently look a good distance up the road and still focus enough attention on the vehicle in front of me?
- Is it safe to take my eyes off the vehicle in front of me long enough to check my mirrors?
- Do I have an out in case an emergency occurs?

***** Answering "no" to any of these questions is an indicator that you are following too closely.

Covering the Brakes:
Covering the brakes is a safety procedure taught in the defensive driving courses. When you approach a situation that makes you uneasy or that you know has a potential hazard condition, place your foot over the brake pedal without actually touching it. This reduces reaction time if your hunch or the hazard conditions proves to be correct and you need to quickly apply the brakes.

Equipment Factors Effecting Braking:
Many equipment factors are also involved in how quickly a vehicle can make a complete stop. Size and weight are the obvious and biggest considerations; but tire size and condition, the foundation brake system’s size and type, aerodynamic design and rolling resistance, and the type of engine each play a role in the vehicle’s stopping capability. In addition to these factors many large vehicles employ the use of auxiliary braking systems, like engine brakes (Jake Brake), transmission retarders, exhaust retarders, and

driveline retarders (such as a Telma) singly or in combination to get additional stopping power and control for both normal driving, stops, and emergency stops.

Foundation Brake System:
The foundation brake system is the fundamental braking system on the vehicle. There are many component manufacturers, but only two types of brake actuation systems and two types of brake friction systems in common use. The activation systems fundamentally have the same design and component structure; only the delivery methods for the stop activation information are different in each system. Activation energy is delivered either by air pressure or hydraulic oil to the friction system, with air pressure being the primary method used, and required by law and engineering, on large and heavy vehicles. Friction systems are either drum or disc type brakes and each may be used with either type of activation system and installed in combination with each other on the same vehicle. The size of the brake shoe or disc brake pads play an important role, as does the size of the brake drum or braking surface of the rotor that the disc brakes rub against in stopping capability. Each system must be checked for proper adjustment, damage, and wear on a scheduled basis, normally daily, to ensure proper stopping ability. Due to the friction of this type brake systems a large amount of heat is generated when they are used. The heat produced will reduce the effectiveness of braking; causing possible problems ranging from fading brake efficiency, to broken components, or even to the brakes catching on fire. The efficiency of foundation brake system is improved if the speed of vehicle operation can be reduced to a low level; the brake system components are made large and massive in construction to absorb heat; the brake system components have good air flow around them to reduce heat; or the load on the brake system is reduced by operation of secondary braking devices.

Tire Size and Condition:
Tires must be matched to vehicle size and weight as well as to use and roadway conditions. Tire air pressure is extremely important and must be maintained at the proper pressure for the load carried by the vehicle and roadway conditions. There is also a ballooning effect from a tire that is to large for the vehicle, or has to low of an air pressure. This effect causes the vehicle to bounce and lose control when braking and / or going through bumps or dips. The size of tires can make a significant difference in stopping distance as narrow tires don't offer as much roadway surface contact with the roadway which will result in less braking efficiency. The correct number of cord ply's in the tire effect the tire's overall stability, the vehicle load bearing capability, turning ability, heat capacity, and stopping ability. A tread depth of greater than 2/32" must also be maintained for a tire to function effectively, without skidding, when brakes are applied on the various roadway conditions encountered in all weather driving.

Engines:
Diesel engines are more versatile than gasoline engines due to the different operating principles and design of each engine type. A gasoline engine has a butterfly valve in the carburetor or intake manifold, which controls the air supply to the engine. When the accelerator (throttle) is released the closing butter fly valve creates a vacuum and reduces the air supplied to the engine and signals the electronic engine control to reduce fuel supply. The reduced fuel supply causes a subsequent engine power reduction. This reduction in engine power uses the resulting engine compression to absorb speed energy through the power train from the wheels to slow the vehicle. Diesel engines achieve compression effect from the fuel being reduced and /or the compression released by the exhaust valves opening just before ignition occurs at each engine cylinder. This is accomplished in the diesel engine when the accelerator (throttle) is released by adding a retarding device (Jake Brake, etc.). However, once a large amount of vehicle weight is factored into any stopping situation other retarding devices and / or auxiliary brake systems must be installed and operating.

Retarders and Auxiliary Brake Systems:
The California Commercial Drivers License (CDL) Study Guide states that some vehicles are equipped with "retarders." Retarders help to slow a vehicle, reducing the need for using your vehicles brakes. Retarders reduce brake wear and give you another way to slow down. There are many types of retarders (exhaust, engine, hydraulic, electric). All retarders can be turned on or off by the driver. On some retarder types, the retarding power can be adjusted. When turned "on," retarders apply their braking power (to the drive wheels only) whenever you let up on the accelerator pedal all the way or apply the brakes ever so slightly. Caution. When your drive wheels have poor traction, the retarder may cause them to skid. Therefore, you should turn the retarder off whenever the road is wet, icy, or snow covered.

There are several types of auxiliary braking devices available for diesel powered engines to provide braking assistance. The most popular is the exhaust brake followed by the engine brake, the transmission brake or retarder, and the driveline retarder. When driving in terrain with any type of a decline, it is essential to use some form of braking assistance for safety and efficiency. There are currently two types of supplemental brakes available for gasoline-powered vehicles. One operates on a butterfly principle, very similar to the diesel-engine exhaust brake, while the other operates exactly as the driveline retarder. All auxiliary brake systems extend the life of the foundation brake system and its components, improve operating safety, and increase operating the efficiency of the vehicle. To be effective all auxiliary braking systems require that the vehicle be operated in a lower gear to get maximum results. Best results are achieved by maintaining the engine's rpm at the lower end of engine's power range, generally around 1400 to1600 rpm. The power range is also the best overall fuel efficiency and operating response range for the engine.

Exhaust Brake System:
Sometimes called a retarder; the exhaust brake system is normally used on medium duty diesel engines and vehicles. This device mounts in the exhaust system of the vehicle, and restricts exhaust flow when activated. The system works by the activation of a shutter valve in the exhaust system just behind the turbo charger restricting the flow of exhaust gasses. It is virtually silent when in operation, and provides retarding power that is proportional to engine rpm (Always stay within engine manufacturer's rpm recommendations). The closed valve causes a buildup of pressure in the exhaust system that passes back through the turbo and engine exhaust valves and into the combustion chamber of the engine cylinders. The pressure buildup in the cylinders from the backed up exhaust gas creates a power loss by reducing the fuel / air mixture delivered to the cylinders. This increased backpressure creates resistance against the pistons in the engine, slowing the crankshaft's rotation and reduced engine power. Reduced power means that engine compression is used to absorb road speed energy through the power train from the wheels slowing the vehicle. The exhaust brake system is quite efficient because the same energy that used to keep the vehicle in motion can now help to slow it down if it is connected to an engine that offers the some type of direct interface with the transmission. The exhaust brake's maximum efficiency is reached at the maximum engine rpm for which the exhaust brake is rated. It is important to note that if this braking device is not used frequently; the air cylinder shaft that operates the butter fly valve can freeze up, making the device inoperable.

Engine Brake System:
Often referred to as the Jake brake, the engine brake is used on the heavy duty larger diesel engines commonly found in fire apparatus. The engine brake was actually invented by Clessie M. Cummins the founder of Cummins Engine Company; however, nickname refers to the Jacobs Vehicle Systems Engine Brake or extarder, one of the first and major providers of this type of brake system. The engine brake is a hydraulic engine attachment that alters the diesel engine exhaust valve operating sequence, which converts the diesel engine into an air compressor. This conversion is accomplished by prematurely opening the exhaust valves near the top of the piston stroke (TDC) which releases the compression pressure to exhaust and by reducing fuel injection into the cylinder. This operation provides a no power

cycle to the engine allowing road speed energy to be dissipated by compressing air without fuel ignition. The resulting retarding power is up to 90% of engine horsepower and is proportional to engine rpm (always stay within engine manufacturer's rpm recommendations). The system may have a manual on off switch and variable power level switch. When the switch is "ON" this system is energized by the absence of throttle demand. The engine brake reacts quickly to throttle positioning and will activate or deactivate in less than 1/4 of a second. The engine creates a distinctive sound while in operation, but this sound is barely noticeable if Original Equipment Manufacturer (OEM)-quality exhaust mufflers are maintained on the vehicle. There is no limit to the length of operating time of an engine brake system. The engine's cooling system will continuously absorb and dissipate the heat generated by the use of the engine brake. The engine brake is more expensive than an exhaust brake and cannot be used on every type of engine because an engine brake system requires higher valve covers and there may be limited space on the engine or in the engine compartment.

Engine Bleeder Brake System:
This new type of engine brake system is used on medium duty diesel engines to give heavy duty engine retarding performance to the medium duty engine. The bleeder brake is based on a system of creating very slight exhaust valve lift, either through all four strokes or some duration of those strokes, as compared to the nearly instant compression-release event of an engine brake on the compression stroke. The volume of air traveling through the engine is restricted by the slightly open exhaust valve and this allows exhaust gasses to "push" against the incoming fuel / air mixture. This backpressure is created by and enhanced by an exhaust brake butterfly valve or the variable vanes of a turbocharger. By bleeding off the compression energy in the cylinder during the various engine strokes and by creating backpressure in the engine with that airflow the engine is doing work through the entire four-stroke process. Without the normal creation of combustion chamber air compression and the diesel expansion effect, the engine and vehicle slow down. Another advantage of the bleeder brake system is that the air release is continuous, which prevents the distinct 'staccato' sound as is associated with engine exhaust during use of a normal engine brake system (particularly on unmuffled or poorly muffled engines).

Transmission Retarder:
The transmission (hydraulic) retarder utilizes the transmission fluid to create backpressure in the transmission to slow the vehicle. This system is very efficient, is a relatively noise free, and can be operated manually or automatically. The backpressure system can be applied in one of two ways. Some vehicles have a selector control stick mounted in the driver's area that can be moved into several positions. The further down you pull the selector control lever the greater the braking action applied by the system. This system requires that you manually downshift your transmission to help the device operate more efficiently. If you do not down shift, and instead rely only on the selector control stick, you may overheat your transmission fluid as the transmission is not turning at a high enough rpm to aid the effort to slow down. The brake pedal may also be used to activate this type of retarder system. Usually this system has three sensors that detect the amount of brake pedal pressure being applied and engage the retarder accordingly. The transmission retarder avoids engine damage, but if the transmission fluid is overheated, major transmission damage can result. This system dissipates the heat of the fluid through a air cooler behind or below the main engine radiator. It is essential that proper maintenance of the transmission and transmission fluid be maintained.

Driveline Retarder:
The most efficient but most expensive means of slowing a vehicle is a driveline retarder (Telma). When engaged, the electromagnet around the driveshaft creates an opposing magnetic field around the driveshaft that causes the driveshaft to resist turning, thereby slowing the vehicle. The driveline retarder is engaged by pulling down on a control stick similar to the transmission retarder and or by use of the brake pedal. This system may also be installed on a non-drive axle position.

Automatic Braking System (ABS):
The Automatic Braking System (ABS) is an electronic system that monitors all wheels on the vehicle to determine if a wheel(s) is starting to skid or is skidding during brake application, and then momentarily releases some or all brake action to that wheel(s) until the skid stops. ABS will also interrupt the operation of any auxiliary braking devices that may be causing a rear wheel(s) to skid but will not effect the retarding device if only a front wheel(s) is skidding. The vehicle operator may turn off some systems, while others remain on continuously. When the vehicle is started, the ABS system goes through a test sequence and will show a warning indicator of some kind if the system is not working. The correct operating procedure for stopping a vehicle with ABS is to apply continuous steady pressure and never pump the brakes in a normal or emergency stop condition. Should the ABS system disengage a retarding device you may perceive this as a loss of braking; however, this is not the case just apply more foot pressure to the brake pedal, do not stop applying the brakes!
For **Emergency Situations Only:**

STOMP - the brake pedal to the floorboard!
STAY - on the brake pedal, do not let up!; as releasing the brake pedal resets the ABS computer, **INCREASING** the stopping distance.
STEER - around the hazard(s) as the vehicle will still handle very well with ABS system working.

Automatic Traction Control System (ATC):
The Automatic Traction Control System (ATC) is an electronic sensor and control system that monitors and controls wheel slip when throttle is applied to the engine increasing output power or roadway conditions cause slippage. The system will reduce power to the slipping wheel(s) until traction is regained. This system may be combined with ABS but both systems will work independently. The vehicle operator may turn off some systems, while others remain on continuously. When the vehicle is started, the ATC system goes through a test sequence and will show a warning indicator of some kind if the system is not working.

Remember:
Do not take chances with your ability to stop the vehicle that you are operating as the safety of your passengers, the public, and yourself may depend on it! Be sure to maintain a minimum following distance of six to eight seconds from other vehicles so you have the maximum amount of stopping time. Fire apparatus are not as agile as automobiles and do not stop on a dime, so-you need all the time you can get. Use the supplemental braking devices **AT ALL TIMES** as they can be helpful in decreasing your vehicles stopping distance, which may be crucial to avoiding an accident.

sensor and control