Portland Police Bureau - Training Division - Special Text

DEFENSIVE DRIVING FOR POLICE

PORTLAND METROPOLITAN POLICE ACADEMY

PORTLAND, OREGON

DEFENSIVE DRIVING FOR POLICE

Chapter One

THE "CRISES"

For many years we have heard slogans: "Speed Kills", "Speed Causes Accidents", "Slow Down and Live", and others designed to slow down the motoring public to a speed at which evasive action has a better chance to succeed. And certainly, excessive speed can be a contributing accident cause.

But, speed in and of itself, does not have a harmful effect. As in the case of the old joke about "no one is killed by a fall...it's the sudden stop," there must be some other factor or crisis added to speed to create the accident.

The purpose of this chapter, then, will be to discuss those "crises" which, when added to speed, become causative factors in motor vehicle accidents.

In this chapter, we must consider the three elements of the traffic accident....the environment, the machine and the driver. Speed, with a failure in any one of these elements, or in a combination of them, can result in an accident. While some of the situations we will describe are a result of only one of the above elements, most will have resulted from a failure in two or more of them.

The suggested actions when the "point of no return" has been reached will be, for the most part, generalizations. It would be virtually impossible to suggest an appropriate reaction to every conceivable driving situation. The following are principles and should not be considered as being the only way to take evasive or corrective action.

SKIDS

An automobile is supported on a cushion of air contained in flexible rubber tires. The only connection between the vehicle and the roadway surface are four small patches of rubber, each about the size of a man's hand. Any change of direction or velocity is made by twisting these four rubber patches. When this twisting force exceeds the friction between the tire and the pavement, then skidding occurs. Skidding may be defined as the sliding of one or more of these patches or rubber over the roadway surface.

The simple skid of a single wheel may be compounded by skidding of other wheels and manifest itself in various vehicle movements. Since the four patches of rubber, which control the automobile, are located at the outer limits of the vehicle, the braking effort and cohesion between tire and roadway is different of each wheel. This is compounded by weight shift and a coupling of forces. These various factors may cause the vehicle to deviate from a straight line, rotate around one front wheel or a point between the front wheels, or rotate around any line along the longitudinal axis of the vehicle. These factors can also cause the front wheels to stop steering while the vehicle continues in a straight line.

There must be acceleration, either rectilinear or curvilinear to cause skidding. This means simply that there must be a change in the vehicle's velocity or in its path. These accelerations are caused by brake, throttle, or steering movements. The three factors may be further complicated by a change in the coefficient of friction during the movements. Skidding can also be aggravated by the inherent handling characteristics of the vehicle.

For the purposes of discussion, skidding may be classified into five categories:

1. Acceleration
2. Braking
3. Four-wheel Drift
4. Oversteer
5. Understeer

Each of these categories is discussed in the following paragraphs:

Acceleration Skids

Although a skid involving all four wheels may sometimes occur during rapid acceleration (especially in a turn), the acceleration skid usually involves only the rear wheels. To bring the vehicle back under control, it is necessary only to decrease the torque at the rear wheels by easing up on the throttle. This will stop the wheel slippage and bring the vehicle back under control.

If, in a turn, this solution fails, the front wheels must be steered in the direction that the rear wheels are skidding.

Remember! Spinning rear wheels do not increase the acceleration rate of the patrol car. You run the risk of creating the bad public image of the "hot rodder" without even the justification of getting started on your emergency run faster than by smooth acceleration.

Braking Skids

Wheels steer by rolling friction only. Sliding rubber resists motion and direction of momentum. If all four wheels lock at the same time and there is equal cohesion, braking alone will not cause rotation of the vehicle, if headed in a straight line on level pavement. On a high-crowned road, however, the rear end will tend to move to the low side of the pavement and the car will rotate around the front wheels.

Brakes are designed to compensate for weight differential between axles. This compensation must necessarily include the weight transfer caused by hard braking. Because the amount of weight shifted is related to the degree of deceleration, this compensation can be an approximation only. Maximum deceleration occurs when just enough pedal pressure is applied to almost lock the wheels. Unfortunately, no one is expert enough to sustain this maximum except under the most ideal of conditions. One or more wheels may encounter an area of low coefficient of friction, or a wheel may bounce off the pavement, either of which will cause that wheel or wheels to lock. When this occurs, a braking skid is induced.

Of course, the most obvious solution would seem to be to avoid the situation requiring a panic stop. But, there are situations, for example, when a child darts in front of the vehicle, where a simple panic may be the only solution. If, during such a panic stop, one wheel locks or the car deviates from a straight line for some other reason, ease off the brake pedal pressure until all wheels rotate again and the car should straighten out. If a wheel should lock and because of mechanical failure refuse to release, the only answer may be to increase pedal pressure and lock all four wheels to avoid a spin.

Knowledge of stopping distance can often avert tragedy in a situation like the one described above. If, for example, the vehicle is traveling only 30 m.p.h. when a child suddenly darts into its path 50 feet in front of the vehicle, the driver cannot possibly avoid collision with the child by using the brakes alone. But, even at speeds of 70 m.p.h. with the same 50 feet in which to maneuver the vehicle, the driver can displace the vehicle 14 feet off a collision course. Remember, a collision requires that two objects occupy the same place at the same time. If you can't avoid the timing by use of the brakes, you may be able to avoid reaching the place by steering around the collision area.

Four-Wheel Drift

The term "four-wheel drift" means different things to different people. For our purposes, however, four-wheel drift describes that situation when a vehicle in a turn is traveling at a velocity high enough to cause the tires to slide sideways as the vehicle negotiates the turn. The vehicle is pointed in the direction it is traveling and all four wheels are following a line of the curve. The car is just above the maximum limits of cohesion and very little reserve power is available to control the vehicle. IF THERE IS ADEQUATE ROADWAY AVAILABLE, THE VEHICLE MAY NEGOTIATE THE TURN WITHOUT EVENT.

To get the vehicle back under complete control, reduce speed GENTLY until complete cohesion is regained. Remember, however, that any rough movement -- even getting off the throttle suddenly-- may cause the vehicle to go out of control. Be aware also that a slippery stretch of pavement or foreign material on the roadway encountered under these conditions may cause the vehicle to go out of control.

Oversteer

A natural progression from the four-wheel drift as speed increases, or the result of a sudden rough movement or encountering slippery pavement during a four-wheel drift, is oversteer. This condition is often described as "crossed-up". Oversteer means simply that the vehicle has a tendency to tighten up its turning radius. The back end of the car breaks loose first and begins to move toward the outside of the turn, when, in a turn, the maximum limit of cohesion has been exceeded. This can be caused by sudden application or withdrawal of the throttle during a turn or by sudden, rough movements during a turn.

To overcome this situation, the front of the vehicle is pointed into the apex of the turn, front wheels are turned to the outside of the turn in the direction the rear wheels are trying to move. The throttle is used to balance forces so that engine torque applied to the rear wheels forces the car toward the inside of the turn and control is regained. Care must be exercised in use of the throttle to avoid applying too much torque and spinning the vehicle out in the opposite direction.

Understeer

Most automobiles built in the United States are designed to produce understeer. This means simply that the vehicle is so designed that it wants to go in a straight line. If something disturbs its path, it has a tendency to straighten itself out and return to the original direction of travel.

While this may be of benefit to the average motorist, who wants to exert minimum effort in controlling the vehicle, it does introduce problems in vehicle handling. A greater effort is required to move the car from a straight line.

Some natural forces aggravate the understeer problem. When a vehicle approaches a turn at relatively high speed, the front wheels may be turned and still the car tends to go in a straight line. This characteristic may be further complicated by slippery pavement or foreign materials on the roadway surface.

When this situation occurs, your objective should be to get weight on to the front wheels in order to cause the tires to "stick" or "grab" the pavement and begin turning the vehicle. Sometimes,

getting off the throttle suddenly will transfer enough weight to do the job. In some instances, it may be necessary to apply the brakes in order to increase the weight transfer to the front wheels. But, when this is done, great care must be exercised not to over-control and thus throw the vehicle into a condition of oversteer. Use the controls smoothly and keep in mind what reaction in the vehicle your action will create.

Things to Remember

Probably the biggest factor which makes skids a significant accident cause is the aura of mystery and misinformation regarding their cause, effect, and correction. The driver who is "caught off guard" by a skid, and who knows little or nothing about the forces involved, suffers momentary panic and hence does either nothing or the wrong thing.

Ideally, no force will affect the vehicle's motion unless that force is placed there by the driver. While outside forces often aggravate the situation, usually the initial force is provided by the operator of the vehicle. When the driver is aware of this, he can anticipate the effect, the action, and the reaction of the vehicle. Under such circumstances, it may be sometimes desirable even to induce skidding in order to better control the vehicle.

Some additional factors to keep in mind are:

1. When a vehicle skids, or even is turned sharply in one direction or another, energy is stored in the chassis through displacement of the springs. The driver must anticipate the release of this energy. If he is not aware of its existence, he may over-correct to the point where the force he places on the vehicle's movement, added to this stored energy, will cause a skid in the opposite direction at a higher velocity than the skid that he is trying to correct!

2. In a turn, the vehicle may run onto a patch of ice or other slippery matter on the pavement. If the patch is short, no correction should be attempted since the vehicle will be off the slippery area and back on good traction just as the correction is established thus throwing the vehicle out of control in the opposite direction.

3. Beware of "too much--too late". Over-control, delayed past the point of no return, is the most common error in controlling a skid. Take corrective action smoothly, quickly, and with full knowledge of what effect that action will have on the vehicle and its movement.

4. Remember that all speed is relative. Even 90 m.p.h. in a 100 m.p.h. turn is slow, while 30 m.p.h. in a 20 m.p.h. turn is extrememly high speed.

OTHER ROAD EMERGENCIES

Blowouts

Modern tires are not so subject to complete loss of air as tires were some years ago. Still, under the proper circumstances, tires can and do blow out. This is a kind of driving emergency for which it is really impossible to be completely prepared since it comes with shocking suddenness and with no advance clue that it is about to happen. As in all other emergencies, what you do will depend on circumstances. Some general principles apply, however:

1. Don't get on the brakes. It will be difficult enough to steer with one tire completely flat. Hard breaking will only complicate matters at this point.

2. Don't exert a sudden, hard jerk on the wheel. This can put you in a spin.

3. If traffic conditions are such that you can, you should continue bearing in the same direction the blowout pulls you. (Generally, the car will pull toward the side of the car where the blowout occurred.) Alert other drivers with hand signals or turn signals and steer the car off the roadway at the first safe spot to do so.

4. Don't try to stop as quickly as possible in order to "save the tire". It's already ruined. Save your life, and maybe lives of others.

Brake Failure

The sudden realization that your automobile's brakes are nct working properly can be a terrifying experience. This is particularly true when you discover this condition at the precise moment you most desperately need the brakes! We will be concerned here with two types of brake failure: brake fade and complete loss of braking.

Brake Fade

Brakes, when overused, and consequently overheated, will begin to lose their braking efficiency. This situation will usually occur on a steep down-grade or in a high-speed run requiring frequent hard brake applications. When fade occurs, you may find yourself gaining momentum even though the brakes are applied.

Your first consideration should be to get in a lower gear. If there is time, gently increase engine speed before shifting down to more closely match engine speed to wheel speed. Apply the parking brake as hard as possible. This engages the rear wheel brakes only, and since they usually run cooler than the front wheel brakes, they may still have some braking power left. Meanwhile, your front brakes can be cooling somewhat (provided you resist the urge to use the brake pedal).

Above all, don't panic! Don't get so engrossed in finding a way to brake the car that you forget you are still able to -- and may be required to -- steer away from contact or hazards. When speed is reduced to a level safe enough to do so, get off the road. Allow the brakes to cool before attempting to move the car again.

Brake Loss

This is the one to turn your hair white! A mechanical malfunction occurs without your knowledge so that when you step on the brake pedal, nothing happens!

Here again, the situation will dictate what you must do first. If you are approaching an obstruction, a pedestrian, another vehicle, or a busy intersection, you will have to make an almost instantaneous decision.

It may be best to concentrate on your steering and the power of your engine to get out of the situation and to a spot where you can try to stop the vehicle.

On the other hand, it may be that you will be best advised to apply the parking brake as hard as possible, drop to the lowest gear available to you, and look for the nearest escape route. You may even have to decide which of several obstructions you wish to hit!

In any event, once the car is stopped, do not even consider driving it further -- for any distance -- until the brakes are repaired.

Wheel Off the Road

On any roadway you may find yourself with your right wheels off the pavement and on a soft or low shoulder. This seemingly harmless situation has been the immediate cause of countless automobile accidents.

Don't jerk the car back on to the pavement! This all-too-frequent, nearly instinctive reaction is deadly. You stand an excellent chance of coming back onto the hard surface sideways and going into a spin or tripping the vehicle and rolling over.

Don't jam on the brakes! Instead, ease off the accelerator pedal, keep a firm grip on the wheel, and straddle the edge of the road as the car slows down. When your speed has reduced considerably,

use the brakes LIGHTLY to further control your speed. Then -- and only then -- get back on the road -- after checking to be sure that traffic will permit.

Stuck Gas Pedal

Suppose you're traveling on a busy highway and have accelerated to pass another vehicle. You complete the pass and ease up on the gas pedal as you swing back into the proper lane. But the gas pedal doesn't return! You're picking up more and more speed, and your repeated kicks and stomps on the pedal have no apparent effect. What do you do?

Well, obviously you will apply your brakes. But, equally important, turn off the ignition, and if possible get in a lower gear. The drag of the engine will aid in slowing you down, and you can safely leave the road.

Emergency Stop in Traffic

Good drivers, such as we are, never follow too close in traffic. But all drivers, unfortunately, are not so good as we. Let's assume you are driving a comfortable 10 car lengths behind another automobile at about 60 m.p.h. on a two-way highway. Another car is following you at an uncomfortable 2 car lengths distance. As you start to move up to get away from the "bumper-hugger" behind you, a third vehicle passes you both and pulls in ahead of you. Just as he gets in and starts to accelerate away from you, something happens ahead of him and his brake lights flash as he brakes hard, losing speed rapidly.

If there's time, hand signal and "feather" your brake pedal rapidly to warn the car behind you. Then apply the brakes as hard as is practicable. Remember, however, that if you decelerate too rapidly, the car behind may plow into you.

Choose an escape route to the right since at some point during the brief seconds in which this situation is developing, you may have to make a decision to leave the road. You will probably not want to try passing to the left since this will expose you to a possible head-on collision, and it would probably be preferable to bump the back of the vehicle ahead of you. Here again, however, you must consider the car behind you, since the prospect of being sandwiched in between two vehicles is not a particularly happy one. There is risk in going off the right shoulder too, of course, but it may be the only alternative left to you.

If you do leave the road, remember:

1. Get both right wheels off at the same time, if possible.

2. Keep a firm grip on the steering wheel.

3. Once you've committed yourself to leaving the road, use the brakes only if you have to during the higher speed portion of the maneuver. Remember, sliding front wheels will not steer!

4. When your speed has been reduced, use brakes to complete bringing your car under control and return to the road when it is safe to do so.

Blinding Headlights

It's a common enough occurrence to come over the crest of a hill or around a turn while driving at night and be greeted with blinding high beams of an oncoming vehicle. Usually the driver will lower the beams almost immediately. At other times, however, he will apparently pay no attention to your repeated blinking and will keep the high beams burning brightly into your eyes.

First of all, don't lose your temper. While this is easy to advise and often difficult to comply with, your safety may depend on keeping your full attention on getting past the oncoming vehicle without incident. So, DON'T fight him with your lights, don't look at his lights (you can best avoid this by keeping your attention focused on the right shoulder of the road), and give him all the room you can. Don't be concerned about not seeing the other vehicle if you watch the right shoulder. Tests have shown that, if you have normal peripheral vision, you will be able to "see" the oncoming car even with your eyes thus averted.

"SENSE-ABLE" DRIVING

Thus far, in this chapter, we have talked about what can be done after the emergency situation has developed. And, since we are concerned here with immediate accident causes, it is fitting and proper that we should. However, there are some actions which a driver may take just prior to the development of such emergencies which can ameliorate, if not prevent, the situation. Obviously, evasive action stands a better chance of success if we have some slight clue of what is about to happen. We get this through feed-back.

Feed-back is that information we receive which enables us to interpret what is going on around us. Feed-back is brought to us through the various senses and this is what we mean when we say, "sense-able" driving -- full and purposeful use of the driver's human senses.

The sense of sight

Use your eyes to their maximum capacity. Keep them moving and look for:

1. Foreign material on the roadway

   Avoiding a patch of ice or oil may make it unnecessary to apply the skills involved in getting out of a dangerous skid.

2. Type of roadway

   Four lanes can become two; one-way can become two-way. Know it ahead of time, keep your emergency skills in reserve.

3. Changes in pavement surface

   Look for difference in coefficient of friction. Is pavement surface rough or smooth, concrete or oil?

4. Percentage of grade

   Is there an upgrade? A downgrade? When things happen fast, you may need to know!

5. Obstacles

   See them ahead of time -- before they become an emergency hazard.

6. The immediate environment

   Pedestrians, livestock, disabled vehicle, or anything that is extra to the roadway situation may change the driving environment. Know where these things are and be prepared for the change that is most likely to occur.

7. Dips and rises

   These can kill you if you don't know they are there.

8. Weather conditions

   When you see a little fog, look for more. Don't allow yourself to come around a turn or over a rise and without warning run into a blanket of it hugging the roadway. Is there a strong wind blowing? It may not affect your vehicle, but what about the little slab-sided foreign sedan meeting you on the narrow two-lane roadway?

The sense of hearing

The world is full of sounds; you are "hearing" them all the time you are driving. But, the trick is to separate out the sounds that are meaningful to you as a driver. Listen particularly to such things as:

1. Sounds indicating incipient malfunction

   That steady "bump-bump-bump" that wasn't there a moment before -- could it be a wheel bearing going bad? And that growling noise coming from the rear end.....such sounds can be life-saving clues that something is about to go wrong.

2. Voices

   The sound of children playing on a playground (or, worse, playing in the roadway). The yell of a pedestrian. The quiet warning of your partner in the passenger seat. All these, too, are feed-back.

3. Machinery

   The sound of a compressor running or the ear-splitting chatter of an air-hammer may mean street or highway repairs ahead.

4. Traffic noises

   A horn honking. The unmistakeable sound of rubber sliding over pavement. The chirp of tires followed by the roar of a high-performance engine. The grinding crash of metal against metal and the tinkle of broken glass. All familiar sounds.....and all can mean different things depending upon the circumstances.

The sense of smell

It may seem a bit facetious at first blush to say that you can "smell" an emergency situation developing. But, how many times have each of us discovered a fire starting by the simple expedient of smelling the smoke? The same holds true in a motor vehicle. There are the normal smells and odors, and then there are others that set off a little warning signal somewhere in our consciousness that something is not exactly right. In driving, pay specific attention to:

1. Fire

   Is it outside or inside the vehicle? What is burning? Rubber...Wood....Paint....Overheated metal....Brakes.... all of these have odors peculiar to their source.

2. Diesel Exhaust

   If you smell a truck or bus and don't see one, it should be a clue that one is nearby, perhaps concealed by a turn, crest of a hill, or a subway.

The sense of touch

Good drivers drive by "feel". After you have operated a certain vehicle for a period of time you say that you have gotten the "feel" of it. And when something "doesn't feel right", you're probably getting feed-back that something is not right.

Be aware of such sensations as:

1. Steering feel

   When less effort is required to turn the wheel and steering feels lighter, cohesion is probably less.

2. Incipient mechanical failure

   A change in the vehicle's attitude can be felt. Shimmy or brake chatter can be felt through the receptive controls. A brake pedal that feels spongy is a warning that something probably is not functioning properly.

3. Changes in the pavement

   Washboard surface, slick surface, or other pavement conditions often first come to our attention through the sensation of feeling the ride change in some way.

The "sixth" sense

There will be times when something just doesn't feel right. You can't isolate what it is, but you know that something is amiss. Don't ignore such feelings. The fact that you can't trace it immediately to one of the other senses does not necessarily mean that it is not a valid feeling. Probably, several of your senses are sending you signals, but they are all just below your threshhold of consciousness. Start preparing yourself for it's likely that the signals may get stronger quite suddenly and you'll find yourself in an emergency situation. Later, you'll realize why you had the feeling of unrest and incipient disaster. And, should nothing materialize....what have you lost? You've merely been a little "extra careful" for a few moments. And it's entirely possible that it was just this extra caution that kept the situation from happening.

Chapter Two

STOPPED - BACKING

ZERO SPEED - STOPPED

In our previous discussion about the necessity of additional factors being present with speed in order to cause an accident, it might appear paradoxical to list "zero speed" as an accident potential situation. While there must be movement before the accident occurs, the movement can be a vehicle other than the one you are driving. Just because your vehicle is at rest is no guarantee that it will not become involved in an accident.

The location, manner, and position in which you stop your vehicle can be of importance in preventing an accident while your vehicle is at "zero speed".

Location will not always be a matter of choice. But, whenever possible, choose a spot OFF THE ROADWAY. The most dangerous place to stop a car is, of course, in the traffic lane itself. While such stops are often made during stress situations and emergency circumstances, avoid stopping the vehicle in a traffic lane whenever possible. The shoulder of the roadway is far more preferable although hazards still exist there. When parking on the shoulder, try to find a wide spot that will enable you to get the vehicle completely off the roadway. Select a location that allows traffic in both directions and clear visibility of the patrol car. When feasible, avoid parking just over the crest of a hill or in close proximity to a blind curve. Give other drivers a chance to see you in time so they may take necessary evasive action.

You have more control over the techniques of making the stop than you do in choosing the location. Try to plan far enough ahead so that your stop will not create a hazard for following traffic. Give an adequate signal of your intentions and get off the road smoothly and quickly. Always keep in mind the traffic behind you and what their reaction to your stop may be.

The position of the parked vehicle can also be important in reducing hazards. Place the vehicle off the roadway when possible. If driving an enforcement vehicle, and if there is sufficient room to do so safely, angle the vehicle slightly so that the white door is visible to traffic approaching from the rear.

Do not attempt "bumper-to-bumper" stops. You have more protection when maintaining a distance from preceding vehicles. You can make slower, easier stops and permit yourself room for maneuvering if necessary.

When parking the vehicle on city streets or parking lots, position the car carefully to avoid being a hazard or sustaining damage. Do not rely on the fact that because it is an enforcement vehicle, this prevents the other driver from inadvertently colliding with it. Don't leave the rear end of the vehicle sticking out of a small parking space or leave it half-in-half-out while you're out of the vehicle for "only a minute". There will be occasions when circumstances dictate this type of unsafe positioning. Avoid doing so when it is not necessary.

Develop good stopping and parking habits. Even at "speed = 0", it is possible to become involved in a traffic accident.

MINUS SPEED - BACKING

By minus speed we are not speaking of speed which is less than zero, but of speed in reverse. Many of the same dynamics which combine with speed to produce accidents as previously described will also affect the vehicle moving in reverse. However, since backing speed is usually slow, severity normally is not great.

Backing on the roadway is not good practice. There are times, however, when it becomes necessary. If you must back on the roadway, avoid use of the traffic lane when possible. Use the shoulder of the road if it is firm and wide enough. When backing, try to avoid erratic movements which will confuse drivers approaching from the rear. Back slowly and smoothly, stopping as necessary to let traffic clear. Also, be aware of signs and markers posted along the road edge. They may be in your line of travel but below your line of sight.

Be aware of the existence of such hazards as:

1. Moving traffic

   Remember it is more difficult to see and evaluate traffic when operating the vehicle in reverse.

2. Pedestrians

   There are more "blind spots" to the rear of your vehicle than to the front. Pedestrians are not conditioned to vehicles moving backwards and may fail to get out of your way.

3. Ditches, banks and abutments

   They are low and out of your line of vision if they are close behind your vehicle. Look carefully before backing and utilize your senses to recognize warning signals that such hazards are being approached.

4. Hillcrests, curves and grades

Backing around a curve or over the crest of a hill is hazardous. You cannot see approaching traffic and the sudden appearance of a vehicle coming over the crest of a hill backwards could very well cause momentary panic in approaching drivers.

Backing in parking areas brings some different dynamics into play. For one thing, since you are on private property, the Motor Vehicle Code is not applicable. Speeds are normally slow and erratic and unexpected movements are common. Traffic patterns are many times chaotic.

It is necessary to be aware of these factors and be prepared for the unexpected when backing in a parking lot or similar area. Other vehicles may also be backing, and usually with no fixed pattern. There will be more fixed objects to conflict with your vehicle's movement and considerably more pedestrian traffic from persons parking their vehicles and walking away.

Backing out of carports, driveways, etc., is somewhat different since you are on your own or your agency's property; familiarity breeds carelessness. In enforcement work, you will often be leaving under stress conditions and backing out of such an area will customarily be done hurriedly. Consider the practice of doing your backing when you arrive at these locations rather than when ready to leave. If you back into the carport when you park the vehicle, you are doing so without stress; you are backing into a defined, fixed, and familiar area and there is no pressure of time. Then, when the time comes to leave -- possibly in a hurry -- you need only drive forward, and the dangers of backing are eliminated. Do your backing -- if possible -- when you are not in a hurry.

Chapter Three

HIGH SPEED DRIVING TECHNIQUES

FORCES

The Emergency Vehicle Operations Course (high speed driving) is predicated on the assumption that in the safe operation of a fast moving police vehicle, those physical laws which govern any body in motion must be considered. Further, that those laws over which the driver does have control are simple and readily understandable. These laws can be controlled or channeled in order to retain control of the vehicle and, in those instances when control is lost, to take positive action to minimize injury and damage. Physical laws discussed include those concerning kinetic energy, and friction. In discussing these various forces, it is not intended to present a course in physics. We discuss the forces as they apply to the vehicle.

1. Kinetic Energy

This is probably the most important of all the forces. It can be described as energy a body has because of its motion. A 4000-pound vehicle traveling at 130 mph develops over 2,000,000 foot pounds of energy. This is enough energy to lift a 2,000,000-pound building one foot in the air if this energy could be so channeled. By using the formula $KE = 1/2 \frac{WV^2}{32}$, we find that a vehicle traveling 130 mph develops over 2,500,000 foot pounds of energy. It is not necessary that the student know the formula. It should be noted in the formula that velocity in feet per second is squared. This has direct and important meaning to each driver. As speed doubles, kinetic energy and braking distance increases by four times. As speed triples, they increase nine times.

Energy can be neither created nor destroyed; it can be converted to another form. Kinetic energy must be converted into Btu's (British thermal units) of heat by friction in the brakes and between the tires and the roadway. As an example of how much heat is generated at high speeds, the brakes will generate identical amounts of heat when slowing from 90 mph to 70 mph as when slowing from 70 mph to stop.

2. Momentum

A body in motion tends to remain in motion in a straight line and at a constant velocity unless acted upon by an external unbalanced force. Vehicles are built to run in a straight line, and at this time, the least amount of stress is generated. Unfortunately, there are always unbalancing forces in effect: wind, grade in the roadway, varying roadway surfaces, and friction within the vehicle. A vehicle out of control, although spinning, will travel in a straight line until acted upon by some other force (uneven surface, brakes, steering, etc.). Picture a vehicle spinning on ice. It continues in a line

although spinning. If the tires could somehow grip the surface of the ice, it would create an unbalancing force that would interrupt the path of travel. The vehicle would then attempt to follow the line of the vehicle construction, straight ahead, until acted upon by another force. This is the cause of the erratic skid marks and path of travel indicated at many accident scenes.

3. Centripetal and Centrifugal Force

In order to negotiate a turn at any speed, it is necessary to establish and use centripetal force. This force can be thought of as a cornering or center-seeking power. As mentioned above, a vehicle in motion tends to remain in a straight line until acted upon by an unbalancing force. Centripetal and centrifugal forces are always equal and opposite. The moment cohesion to the front wheels is lost or lessened, centrifugal force is also lost or lessened and the vehicle begins to go in a straight line. Momentum has taken over and the vehicle runs straight until an unbalancing force is recreated. The degree of cornering power is directly dependent upon the amount of centripetal force that is created. The driver has a definite control on this force; however, many variables must be considered. The speed of the vehicle is, of course, the most important. It can be demonstrated that centripetal force may be increased by the angle at which the front wheels are turned up to a certain point or slip angle. At this point, cornering power falls off to zero; and, when centrifugal force disappears, the vehicle will run off the road on the outside of a turn. If excessive amounts of centripetal force are applied, the vehicle will run off the road on the inside of the turn. In the case of excessive centrifugal force, control of the vehicle may be retained by the throttle application, transference of vertical weight distributions, and proper corrective steering. This practice should not be attempted by the untrained individual.

Other factors which affect centripetal and centrifugal forces are roadway surface, tires, vehicle weight distribution, and air turbulence.

4. Potential Energy

A vehicle simply parked on a hill with its parking brake on has potential energy in its mass by its very position. If the brake is released, the potential energy is likewise released and becomes kinetic.

A vehicle in motion while in a turn has potential energy because of displacement. The compression of springs on one side and the stretching of springs on the other create an energy which when direction of turn is reversed, releases kinetic energy which has a direct effect on the vehicle. A vehicle negotiating a "S" turn or one swerving to miss an obstacle illustrates potential energy graphically. The energy

released by the displacement of the vehicle can cause loss of control, throwing the rear of the vehicle to the outside of the turn. If controlled by throttle and steering, this energy can be used to make a nearly square corner. Again, this should be attempted only by the trained driver.

5. Coefficient of Friction

The student should understand the direct effect coefficient of friction has on the handling characteristics of a vehicle.

As the cohesive qualities of the roadway surface vary (water, ice, oil, sand, etc.) so varies the handling qualities of the vehicle. The only control a driver has over his vehicle is transmitted to the roadway by the tires. Each tire has an area about the size of the palm of a hand in contact with the roadway. When the surface area to any one of these "footprints" is changed, it has a direct effect on the vehicle. Most drivers have experienced striking a water puddle on the right shoulder of the roadway which tended to pull the vehicle further to the right. Essentially, this is the result of an uneven distribution of coefficient of friction to the "footprints".

It has been discussed that to negotiate a curve thus creating centrifugal force, the driver must develop centripetal force with the front tires. As the coefficient of friction to either or both front tires decreases, so does centripetal force and momentum takes over causing the vehicle to run straight until cohesion is regained.

Coefficient of friction is necessary between tires and roadway to slow or stop a vehicle. It is also necessary that friction be present between the brake lining and drum. Water saturation of lining and drum will cause lack of braking power or if saturation is uneven will cause the vehicle to swerve when brakes are applied. Extreme heat generated by this friction between lining and drum often causes an expansion of the metal drum to the point that the lining is unable to reach the drum with adequate pressure to create braking power, causing brake "fade".

CORNERING - Speed and position are the two basic considerations in cornering a vehicle. A driver should always enter a turn at a speed below his maximum. At maximum speed, the front end will wash, understeer, or mush. Centripetal force cannot be obtained because the kinetic energy of the mass has exceeded cohesion limitations. Proper position is impossible to attain at maximum speed except for the most proficient and experienced driver. It definitely isn't the quickest or safest way through a turn even for the expert. In this situation, all the driver can do is hope to keep the car on the roadway. Throttle application at this point will cause additional problems. The rear wheels push only in the direction they are heading and will in all probability cause the vehicle to leave the turn on the outside. Hard application of the brakes can prove disastrous. If the brakes are locked, the vehicle will slide straight off the roadway. (This will be discussed later.) If a driver inadvertently enters a turn too fast, a general rule

of thumb might be - stay away from both throttle and brakes.

If braking is done prior to entering the turn and the driver enters the turn at a proper speed, the vehicle will tend to oversteer a predictable amount. That is, adequate centripetal force is present and due to resultant centrifugal force, the rear end begins to come around as in a skid. This skid may or may not be detectable to the driver depending on the degree of movement. When this movement occurs, the throttle may be applied to maintain vehicle attitude in the curve while also taking corrective steering measures. Excessive movement of the rear end can, to a degree, be controlled this way. The transfer of weight to the rear wheels by judicious throttle application causes increased cohesion at that point; however, it also decreases cohesion to the front end during the transfer. Remember, the rear wheels push straight ahead and hard throttle application should not be attempted until the vehicle is in a position of leaving or being pointed out of the turn. This is the quickest way through the turn with a maximum degree of safety.

Excessive skidding in a turn defeats all other good techniques. As the tires slide partially sideward on the pavement, it creates the same effect as applying the brakes while traveling in a straight line. The driver should be able to leave the turn faster than he went in.

Race spectators often marvel at the sudden, apparently reserved, burst of speed some drivers have just after leaving a turn behind a pack of other cars. Quite often this car will pass all the others in a short distance after the turn. This is due to the driver's ability to pick his own speed and proper position for the turn.

In selecting position for a turn, the driver is merely attempting to drive the car through on the straightest line possible, the line of least resistance or stress to the vehicle. The curve should be approached from the high side or top of the turn. While attempting to locate the straightest line through, the driver must laterally scan the curve using his peripheral vision. The path of travel should bring the vehicle to the apex or inside of the turn just prior to that time when the vehicle is pointed out of the turn. The length of time and distance at the apex depends on the radius of the turn negotiated. On a long sweeping turn it may be a matter of several hundred feet; in tight turns, possibly very few feet. The vehicle should be as close as possible to this apex at a point dependent on the radius to allow room when exiting the turn to release the stress built up in the apex. This is done by moving back out to the high side when leaving the turn.

A VEHICLE GOING INTO A FLAT TURN

ROLLING FRICTION - A vehicle steers only by rolling friction. If the front wheels are not rotating, it is not possible to steer. The vehicle will slide in a straight line regardless of the position of the wheels. Many police accidents are caused by the driver's lack of understanding or awareness of this fact. Often a unit rolling down the freeway on an emergency run of some nature at 85 - 90 mph approaches an off ramp and begins to reduce speed. As the driver enters the off ramp, he suddenly realizes that he is traveling at 65 - 70 mph, slower than his previous speed but too fast for the curve at the end of the off ramp. Through past experiences the driver knows that nobody in the world can make that curve in excess of 30 mph. In panic, he applies the brakes, locks all four wheels, and starts sliding. When he reaches the curve, he is only traveling 25 mph but still sliding with his front wheels turned in the direction he wishes he could go. The vehicle does not go around the curve but straight ahead, sliding over the curbing, and into a strategically placed light standard. It doesn't matter if the vehicle was going 20, 15, or 5 mph when it reaches the curve, it will continue to skid in a straight line until it stops--or until the driver eases off the brakes and permits the front wheels to rotate.

BRAKING

It is recommended that the driver use his right foot for all braking. It is true that the use of the left foot could, if positioned on the brake pedal at all times, slightly cut the normal reaction time. Unless the left foot is poised over or upon the pedal, it takes no longer to brake with the right foot. By lifting the right foot, the driver is assured of complete engine deceleration and also reduces the chance of jamming the throttle down upon impact in case of a glancing or sideswipe collision.

The driver who rides his brakes with his left foot increases friction at the brake drums unnecessarily and causes a constant illumination of the stop lamps which negates their value.

Maximum deceleration is best obtained when the brakes are applied just below the point of skidding or locking the wheels. The driver who brakes with his right foot is nearly always better able to achieve this point more accurately.

The driver with his left foot firmly planted on the floor is in a better balanced and braced position. He has two points of support and is less apt to be pulled or knocked away from the steering wheel in the event of side impact or during a violent maneuver.

DEFENSIVE ENFORCEMENT DRIVING

Problems

One of the paramount problems of our job as working highway patrolmen is that of high speed emergency vehicle operation.

Emergency vehicle operation (Code 3) through traffic adds special hazards; therefore; we must be familiar with highspeed driving techniques. The key is planning and being prepared and you must be thoroughly familiar with your vehicle.

Our job demands split-second timing, instant reactions, and the use of good judgment at all times.

Plan necessary moves to cope with various situations, analyze the moves, then when a similar situation arises, you won't waste valuable time in momentary panic or indecision.

Many times on our job, we become involved in stress situations. However, stress often is engendered not by all the work, but by an individual being apprehensive about getting into a situation he can't get out of. While a small degree of tension may cause him to operate more efficiently, an excessive amount of tension can hamper judgment.

The patrolman must know about the physical laws which govern a body in motion. He must think about the physical forces of a body in motion and have a thorough knowledge of his vehicle and what he can and cannot do with it.

If he sets up hypothetical situations and preplans his moves, then with the addition of common sense, he should be able to act rationally in an emergency.

Observation

The Bureau is engaged in a type of enforcement known as visible patrol. Even though the patrol vehicle is in plain view, it may not be seen. A violator driving 90 mph could overtake a patrol vehicle driving 65 mph on the freeway and possibly never recognize the patrol vehicle. Normally, the violator's vision will be limited to the width of the roadway and his eye will be focused on the horizon. As he gets closer to the patrol unit, it moves out of his cone of identification (portion of the eye that identifies is only one of two degrees either side of center). He will see the unit with his fringe vision, but it is merely an object. He may very likely continue on by without slackening speed.

Many times optical illusions are created by moving vehicles or by moving vehicles and stationary objects. You may be parked, observing traffic, or working on reports. If the patrol unit is at a right angle to the roadway, and you observe a distant vehicle approaching, the line of sight and the path angle of the approaching vehicle is very acute.

As the vehicle nears and passes at a right angle, it may appear that the vehicle is speeding -- which may be the fact -- but as the vehicle pulls away, the visual path angle decreases until you are looking at the rear of the car. The illusion then is that the vehicle has slowed way down and may even appear to have stopped. This is very likely not the case, the vehicle is still continuing down the road and probably at the same rate of speed.

Identification

When you observe a violator, you must not only recognize that he is a violator, but you must be able to identify him farther down the road. Knowing the make, color, and model of the car helps; but there may be quite a few cars in the same vicinity that fit the same description. Therefore, look for the difference. Get a look at the driver if possible; note how many people are in the car. Look for primer spots, dents, stickers in the windows, and anything that will identify the particular vehicle from others like it.

To be unable to identify a violator after a pursuit run is inexcusable. The officer has taken risks and imposed hazards on the motoring public for no purpose.

Pursuit

When starting a pursuit, join the flow of traffic smoothly and watch the motorists. Some of them get flustered when they see a patrol car and don't know what to do - and you don't know what they will do. You don't want to pile up a dozen cars before you get started. Once you've joined the traffic flow smoothly and safely, don't dawdle around, accelerate rapidly, get your speed check, and stop the violator quickly in order to make your pursuit run as brief as possible thus reducing the accident exposure time to a minimum.

Keep in mind that the heat of the chase is very consuming. Don't get so involved in the pursuit that you become oblivious to everything except the violator. When this occurs, you are flirting with disaster. You must be conscious of the traffic around you at all times.

Stopping the violator is the most hazardous part of your job. Up to this point you've been driving your own vehicle. Now you are going to take control of the violator's vehicle as well as your own. You don't know what you've got, but it is your responsibility to get him to stop safely. Choose a place where you can get the violator off the road safely and where you can park the patrol car safely. <u>You choose the stopping place</u>.

SELECTING A SAFE LOCATION FOR A STOP

Stopping the Violator

After making your check, the safest technique for making your stop is to:

1. Accelerate 2/3 the separating distance between the vehicles.

2. Get off the throttle and place your foot over the brake pedal.

3. Offset the patrol vehicle slightly to the left of the violator's vehicle. (From there, with your foot over the brake pedal, you have control of the situation.)

4. Snap on the red light and sound the horn or the siren.

5. The moment the violator looks back and identifies you, get on your brakes. No matter how fast his reflexes are, you can get stopped behind him.

   If at all possible, don't go beyond the left rear bumper of the violator's car. If he happens to dislike policemen, all he has to do is pull left and apply a little pressure to leading edge of your right front wheel and he'll put you off the road, and there may not be any marks on either vehicle. Always give yourself room to take evasive action.

   If traffic forces you to make your stop directly to the rear of the violator, don't overlook the possibility that he may have been watching your approach. He knows it is useless to try to run and pointless to slow down because he's already been identified, so he continues down the road watching you. You pull right in behind him, foot on the throttle, and you snap on the red light and sound the siren. The violator may very likely take this opportunity to show you that, although he was speeding, he has excellent brakes. It is most difficult to convince a motorist that he was violating the law when you just buried three feet of the patrol car in his trunk. Again, give yourself room to take evasive action.

   If you overshoot the violator and you make a U-turn to come around and get behind him (which you should do), be certain you have plenty of clearance from opposing and following traffic.

   There are times, that due to anxiety, enthusiasm, or determination, a quick look is not sufficient to allow for proper judgment of distance. These misjudgments sometimes result in mishaps. If however, you must make your stop from in front of the violator, keep in mind that you are vulnerable in this position. Alight from the patrol car on the passenger side and make your approach on the passenger side when at all possible. DON'T GET CAUGHT BETWEEN THE CARS.

Emergency Runs

When traveling Code 3, keep in mind that the high pitched sound of a siren is very directional, it travels in a straight line, and will bounce off solid objects, one of which is the rounded deck of an automobile. The sound will hit and go up to be lost. Where there are buildings, parked cars, or other surrounding objects for the sound to reflect off of, the siren can be heard much better than in sparsely populated or open areas. Also, the fluctuation of the siren attracts attention better and is more readily recognized than a steady high pitched scream. The change in pitch will assure audibility for persons who hear only certain tones.

When running Code 3, use the siren to attract the attention of people along side the roadway as well as those you want to warn ahead of you. In the event of complications down the road, you have people who witnessed that you were using your siren and red light. Another way to attract attention, especially at night, is to flash your headlights up and down. But do not run Code 3 at night with steady burning high beams. High beams wash the red light out completely and it cannot be seen. Although it sounds elementary, watch your red light. Be sure it is pointing down the roadway and not up into the heavens. A Code 3 is hazardous enough when the other motorists and pedestrians can see you coming.

How fast do you drive on a Code 3 run? There are many schools of thought on this subject, the best of which is: you can't help anyone if you don't get there. Emergencies vary in seriousness and you have to be the judge. You are familiar with your area and you know your limitations and the limitations restricted by your surroundings. You must consider the safety of yourself, your partner (if at night), the other traffic, and the victims needing help or the violator you are pursuing. The use of good judgment is imperative at all times. Passing traffic on the right when the red light and siren are operating is foolhardy and dangerous. Don't feel incensed if while you are passing, the motorist pulls to the right to allow you to pass and runs you off the road. He is only complying with the law by moving to the right and stopping for an emergency vehicle. Give him a chance to get out of your way.

If the weather is bad or traffic is congested, you may prefer to respond to an emergency without the use of red light and siren at the legal speed limit. Many times it is faster and traffic does not get confused or flustered.

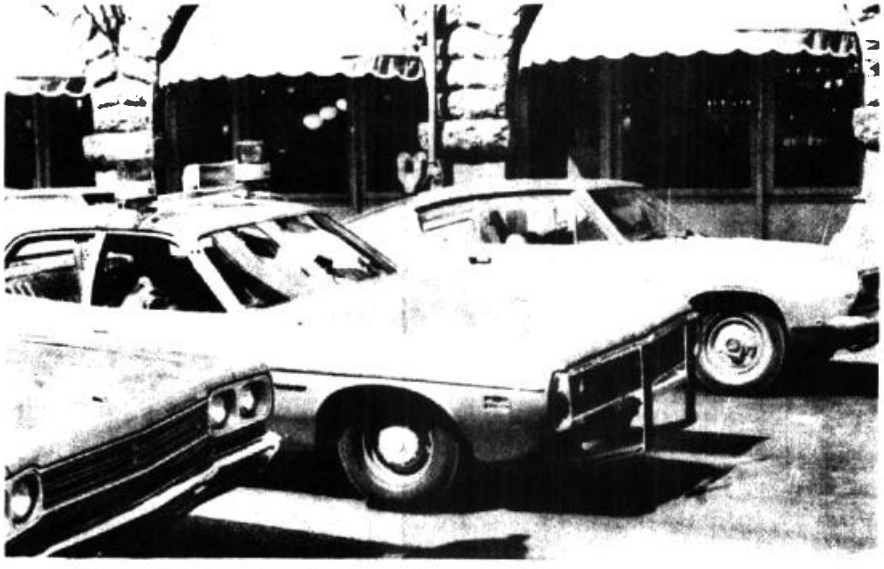
During a pursuit, don't let your pride overshadow your good judgment. When you see a hazardous situation is building or a violator is pulling you into a situation you may not be able to cope with, use your radio and get some assistance ahead. Don't be caught in a bind you can't get out of.

Chapter Four

THE DEFENSIVE DRIVER

The defensive driver is a driver who drives in a manner to prevent accidents regardless of the other fellow's faulty driving or non-observance to traffic laws. He is one who is careful to commit no driving errors himself and who makes allowance for the lack of skill or judgment, or for an improper attitude on the part of the other fellow. He is one who does not allow hazards of weather, road conditions, absence of signs or signals to involve him in a collision. He is prepared for the unexpected from intersections, parked cars, backing, sudden stops by others, or darting pedestrians. The defensive driver is not caught in that last minute, futile attempt to avoid an accident. He is the driver with a plan, a plan for his own safety. The plan involves himself, his car, and the ever changing situations he faces on the road. The defensive driver learns first to overcome the inadequacies in himself and his vehicle. Then he studies the environment for hazards which he cannot eliminate but for which he must compensate. In essence, a good driver is a safe driver, one who can arrive safely at his destination having experienced a minimum number of incidents.

Improving the driving habits of the members will reduce accidents, reduce operating costs, and at the same time, enhance the organization's position in the community. We must not forget that this Bureau exists through public permission and good driving habits do much to create a good public attitude toward the organization. A high percentage of accidents in which officers are involved occur under non-emergency operating conditions. Causes of accidents are basically the same for police officers as for other members of the public. When the officer has improved his on-the-job driving habits he will also bring about a reduction of off-the-job accidents.



A HIGH PERCENTAGE OF ACCIDENTS OCCUR UNDER NON-EMERGENCY OPERATING CONDITIONS

Preparing to Drive

It is important to check equipment before leaving the office. This fast visual and physical inspection can be completed in less than three minutes and will provide the operator with a sense of security. In the final analysis, responsibility for the mechanical safety of his vehicle rests with the operator. He must protect himself and the motoring public from the hazards of an unsafe vehicle. This inspection includes but is not limited to the following:

Attitude of the Vehicle - A simple visual inspection of the vehicle when it is parked alongside another vehicle will indicate defective suspension, broken springs or torsion bars. Lowering the front end 1-1/2 inches may reduce maximum safe speed in a 65 mph turn to 55 mph or less.

Tires - These are one of the cheapest items that the Bureau uses safety wise. Don't endanger yourself and the public by permitting vehicles to be operated on worn tires. On smooth, dry pavement, smooth tires provide a small amount of additional traction over tires with tread design. On wet, otherwise slippery pavement, tread design provides an additional traction. Tires which have worn smoothly have only a thin layer of rubber over the plys and will puncture easily. While checking tires for tread depth, also check for casing breaks.

Wheels - While checking tires, look at wheels, especially adjacent to hub caps. This is the weakest point of the wheels, and breakage usually starts here as a hairline crack.

Lights - Walk around the vehicle. If it is daylight, don't forget the shift may extend into hours when lights are required; turn them on, also check stoplights. At night this check may be made from inside the car. While walking around the car, see that the doors are closed.

Entering the Vehicle - Check for dirt on the floor; dirt blown suddenly into the eyes at high speed is painful and dangerous. Pull on the seat belt to be certain it is fastened to the floor and that it does not have a bind anywhere over its full length. Fasten the seat belt and adjust snuggly under your holster. Start the engine; while it is receiving a fast warm-up, adjust the seat and be sure it is locked in position. Check the brake pedal height. Observe instruments to be certain the vehicle has oil pressure, the alternator is working, and the gas tank is full. It is embarrassing to run out of fuel on the way to an accident or while chasing a violator. Adjust both mirrors if necessary. Examine the windshield and rear window for cleanliness; dirt or other foreign material can cause headaches through eye strain.

Placing the Vehicle in Motion - Avoid backing whenever possible. A large percentage of chargeable accidents occur during backing movements. Be certain parking brake is off; check steering for excessive play, vehicle wandering, or pulling to one side.

Apply brakes to be certain that they are working properly and that they don't grab or lock up. Brakes must be equal at all four wheels; the brake pedal should never be close to the floor. The vehicle should not be driven if it is necessary to pump the pedal to produce braking action. Listen for loose wheel lug nuts indicated by a clanking sound as the wheels rotate. Listen for worn wheel bearings which may cause a scraping noise as the drum rubs on the backing plate or the brake shoes drag.

We have the best available equipment for our type of work. It is our job and responsibility to report any defects; this protects not only ourselves but our brother officers as well. We must always work as a team.

Common Errors in Driving - Most motor vehicle accidents are caused by a failure of one or more drivers. The driver-caused accidents fall into these groups:

Failure to Concentrate on Driving Job - Day-to-day driving has many distractions such as looking for a parking space, street numbers, or road signs. Other distractions are home life, bills, boredom, irritation at another driver.

Physical Condition - This is important. Some detrimental factors are fatigue from lack of sleep, moonlighting, or recreational activities. Every person has a natural blind spot. As fatigue sets in, objects will seem farther away to the driver. The operator should be aware of possible limitations imposed by effects of loss of hearing or a vision impairment. We cannot let our vanity prevent the wearing of needed corrective lenses or hearing aids.

Failure to Maintain Control of the Vehicle at all Times - Correct steering habits. Look well ahead. Make smooth stops. Execute turns slowly. Keep a safe distance from the vehicle ahead.

Failure to Foresee and Analyze Traffic Situations - See all of the traffic situations well ahead and analyze them to determine your actions. Don't trust the other drivers to do the right thing. Be ready to stop, change direction, or accelerate as may be necessary.

Failure to Concede the Right of Way - Concede the right of way if it is in question or disputed. Do not demand your legal rights if it would set up a conflict.

Failure to be Courteous - Courteous driving does not mean we are hesitant, undecided, or erratic drivers scraping and bowing as we drive down the road. Give the other driver a chance to avoid an accident. Don't rely on the white door; always be ready to yield right of way even if it legally is yours. The driver must always consider the other traffic: aged and infirm, foolhardy juveniles, or intoxicated drivers.

A driver can be taught to develop skills and coordination of mind and body. The eyes see, the brain transmits, and the body reacts;

but good judgment comes from experience and good attitude.

The officer's lack of job interest by letting his mind wander may cause him trouble. He must be able to drive his vehicle, observing traffic ahead, watching his mirrors, reading road signs, and checking his speed while he is constantly being observant for traffic violations to front, rear, and both sides.

Chapter Five

THE PROBLEMS AHEAD

The Roadways

The potential causes encountered in the roadway generally occur either in the original design or as a result of deterioration through extensive use or misuse.

Design factors in relation to the safe and rapid movement of traffic have been constantly improved. This fact in itself indicates that many existing highways are of obsolete design and contain built-in, long-range accident causes. This condition will undoubtedly persevere due to economic pressures and the virtual impossibility of changing all roadways at any given time.

Built-in accident potential often exists due to such conditions as roadways that are too narrow. Many thousands of miles of roads with nine- and ten-foot lanes exist and provide little tolerance of maneuvering at high speed.

Bridges and structures may provide hazards due to restricted size and misalignment. Horizontal curves are often too short a radius and vertical curves are many times unmarked.

The actual surface of the roadway often provides potential for mishap. Asphalts which deteriorate through use or extreme weather conditions often have such a low coefficient of friction that when an intermediate cause such as rain is added, there is little need for any further contributing factor other than speed.

Use of dark, light absorbing materials for paving surfaces also adds to the hazard of poor or no lighting on many roads.

The shoulder of the highway is a common contributor to accidents. Sharp drop-offs from the edge of the pavement set the scene for many serious "ran off roadway" accidents. Sandy, muddy, or rutted conditions establish a fertile ground for loss of control once the vehicle leaves the roadway. Probably one of the greatest contributors to potential accident causation is the lack of a shoulder or a shoulder too narrow to allow disabled vehicles a safe, off-the-roadway parking area. A percentage of the Bureau's accidents involve patrol vehicles struck from the rear while stopped or parked.

The environment immediately adjacent to roadways can be a built-in causative factor. Signs, light standards, and other structures are often placed so close to the main traveled portion of the roadway that a slight straying from traffic lanes may result in a damaging impact.

Factors which increase the difficulty of avoiding an accident are found in such impairments to vision as houses, trees, shrubs, and signboards. These, when existing close to intersections,

provide a ready cause for impact when two vehicles approach from right angles.

The requirement that all vehicles traverse the same roadway can be an accident causing factor. When the speed potential of these vehicles is varied either by legal requirement, nature of the vehicle, or whim of the driver, conflict potential is created.

The Drivers

The drivers of the vehicles around you range from 16 to 80 years in age, from top athletes to paraplegics, from morons to geniuses, and from healthy individuals to victims of all chronic diseases.

In dealing with potential causes a logical base can be established by assuming that existing elements that affect driving behavior can be classified as either physiological or psychological.

The physiological aspects are undoubtedly easier to analyze to the extent that our medical knowledge can reveal their effects.

Such conditions as impaired vision, hearing, or motor response certainly set the scene for many accidents involving warning signals, stopping distances, or lack of depth perception. These are a few of the causes which to an extent can be compensated.

Other physiological causes are more obscure but may have more significant effect than the easily recognized ones. Chronic diseases, in many cases unknown to the victim, provide a constant threat. Even in cases where such diseases as diabetes, cardiac conditions, or hypertension have been diagnosed by medical authority, the prescribed treatment often does not include abstinence from driving.

Probably the most significant example of this is alcoholism. When the number of alcoholics is related to the fact that the age groups that drive are almost the same as those subject to alcoholism, it becomes alarming.

Another built-in accident potential in the physiological make-up of drivers that is a little more complex than the actual deterioration of physical ability through chronic disease is the individual's performance under stress. It has become apparent in analyzing accidents that there are different stress thresholds for each individual and these thresholds can be described as the point where physiological reaction so impairs the functioning of the senses that the driver departs from the effects of his immediate environment.

When a driver is startled by a red light and siren or discovers he is on a collision course, often the resultant increase in such things as blood pressure, injection of adrenaline into the blood stream, and impaired breathing so reduce normal functioning of the nervous system that the individual is incapable of intelligent action. It has long been believed that this stress threshold is lower in women than in men drivers. Certainly there is a great

variance in this level in male drivers.

There is a great deal of evidence of this reaction to stress found in such accidents as involvement of an automobile with a railroad train. Many of the victims of such an accident state that there was no train approaching the crossing even though the engineer of the train states the driver looked right at him, that the whistle was blowing, and the flashing headlight was working as the train bore down upon the driver.

Other instances are found when in questioning drivers after an intersection collision, they only recall what happended prior to the time that the other driver entered the intersection and presented an immediate threat.

The physiological conditions described border very closely on the edge of traumatic shock, but the cause is not the shock to the nervous condition caused by the damage or injury, rather in the mental stress of the exteme threat found in the many hazardous accident situations. We see the effects of this condition when we recognize that many drivers, in fact, all drivers who traverse the highways, enter into hazardous situations almost daily, sometimes hourly. Yet we know in many instances there is no ill effect from these situations. The drivers react, make good decisions, and emerge from the situation without harm.

On the other hand, we know that some drivers can be accident prone; and when these drivers encounter a hazardous situation, they are not capable of making the last second decision which would allow them to escape the collision.

Moving into the field of mental aspects of accident causes, we can again divide the field into two categories for the purpose of examination.

1. Mental incompetence as far as making sound decisions is concerned.

    a. There is ample evidence that some people do not have the capability of making wise decisions under a given set of circumstances. Sometimes this is caused by people misevaluating facts or acting without sufficient information. It may just be a lack of the ability to weigh the facts that are revealed to them. In a recent study of ran-off-the-roadway drivers, this inability to make a wise decision is a significant cause. Also correlated with this were other instances that indicated poor decisions on the part of the same individual. For example, the same drivers who had become involved in accidents because of poor decision-making ability also had become involved in a number of problems in their personal lives. High correlation existed in such situations as their being involved in criminal acts. There was a high correlation between the accident prone driver and the driver who was a poor credit risk and

and couldn't pay his bills. True significance of this factor could not be evaluated, but certainly there are many evidences that an unwise decision when related to an immediate or intermediate accident cause resulted in an accident.

2. The persisting attitudes which appear to be a result of lack of maturity on the part of the individual driver.

    a. Lack of maturity is not so clear-cut. Unfortunately, we do not have precise standards for mature behavior in an automobile. We do have admonitions such as "be courteous," "respect the rights of others," or "slow down and live," which indicate the general conception of what mature behavior should be.

It appears that one approach to the definition of mature behavior is to decide what it is not. This we can do by defining immaturity to the extent of listing some of its recognized symptoms.

In this approach, we open an aspect that is unpleasant to contemplate. Observation of the behavior of small children as they demonstrate unlimited capacity for destruction in the living room or flower bed causes us to shudder at the possibility of their having the capability to carry out all of their destructive ambitions. In the case of the adult driver who has never grown up, this capability is realized to the extent of giving him the strength of three hundred or more horses and the ability to so coordinate their efforts that the resulting velocities closely resemble the power of Zeus' thunderbolt.

As shocking as this thought may be, we will still attempt to demonstrate that those existing behavior patterns of drivers sometimes called "attitudes" are really manifestations of immaturity.

For the purpose of illustration and comparison we will assume that the following behavior patterns are those of the child who is mentally, emotionally, or socially undeveloped.

1. Lack of knowledge.
2. Lack of sense of responsibility.
3. Selfishness.
4. Lack of consideration for others.
5. Lack of concern for the property of others.
6. Desire to cause pain.
7. Recklessness.
8. Vicarious thrill in speed.
9. Desire to excel.
10. Will lie to avoid consequence of an act.
11. Day dreaming or preoccupation.
12. Influence of sex drive.
13. The need to belong to the group.
14. Failure to realize the significance of time.

These child-like qualities, when present in the operation of a high-performance vehicle, are individually and collectively potential causes of accidents.

We have seen that both factors, the roadway and the driver, contribute to the potential accident.

The purpose in discussing potential accident causes has not been to offer solutions, but merely to recognize their existence.