TRAFFIC RADAR HANDBOOK

To the Officers who have dedicated their
time and effort to the Radar program

Thank You

Uniformed Support Division,

BASIC PRINCIPLES OF RADAR

INTRODUCTION

PURPOSE AND OBJECTIVES

The radar operator must be able to:

* Explain the Doppler Principle.

* Describe the association between excessive speed and accidents, injuries, and deaths, as well as the highway safety benefits of effective speed control.

* Explain what Tracking History means and why it's so important to the radar operator.

* Explain why the use of the Audio Doppler feature is important.

* Explain proper radar device set-up and testing procedures.

* How to properly identify target vehicles.

* Describe the basic principles of Stationary and Moving radar speed measurement.

* Demonstrate basic skills in proper set-up and testing procedures and operation of devices owned and utilized by their respective agency.

* Identify the specific radar device(s) used by their agency and describe their major components.

* Identify and describe the laws, court rulings (National and State), regulations, agency policies, and procedures affecting radar speed measurement and speed enforcement in general.

* Demonstrate the ability to prepare and present records and courtroom testimony relating to radar speed measurement and enforcement.

* Understand radar jamming and be able to identify Audio Doppler readings generated by a jamming device.

* Respect for people

DEDICATION

This book is dedicated to all of those officers who have lost their lives keeping the highways safe to drive.

“We will strive to achieve the highest level of quality in all aspects of Traffic Enforcement. WE can never be satisfied with the “Status Quo.” We must aim for continuous improvement in serving the people in our communities.”

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BASIC PRINCIPLES OF RADAR

INTRODUCTION

In recent years, radar has been attacked as being an unreliable device for effective speed detection and enforcement. Comprehensive training in the operation of Police Traffic Radar is no longer optional, but mandatory.

Because of the persistent criticism on the "reliability" of radar and with the attacks on the "poorly trained operators" and their competency, we must obtain the optimum in proficiency in the operation of radar. This requires standardized presentations, insuring that each operator will receive the same quality training. This way each operator will have the benefit of the latest "state-of-the-art" information. This training program should give each operator a basic understanding of the functions of radar and their operational characteristics.

By following the procedures set forth in the National Highway Traffic Safety Administration's (NHTSA), Basic Radar Operator Program and by working closely with our judges and prosecutors, we can strengthen our radar cases and project a professional image to the public.

This handbook if used in conjunction with a comprehensive training program will prove that radar devices, if used properly, with supportive evidence are not only reliable, but extremely effective as a speed detection and enforcement tools. The material contained in this handbook should give the operator the most up to date information on Police Traffic Radar and should be a reference source for court testimony, thus aiding in the successful prosecution of speed violators.

It is not the intent of the radar operator school to have officers exclusively enforce speed regulations. Officers should enforce all of those sections of the vehicle code that constitute an immediate hazard to pedestrians, bicyclists and vehicular traffic. Also, officers should be aware and enforce those sections that deal with the vehicle operation, soundness, stability and maintenance to insure that the highways are safe to drive.

*** Integrity is our standard. We are proud of our profession and will conduct ourselves in a manner that merits the respect of all people.

CHAPTER I

We have been given the honor and privilege of enforcing the law. We must always exercise integrity in the use of the power and authority that have been given to us by the people. Our personal and professional behavior should be a model for all to follow. We will obey and support the letter and spirit of the law.

HISTORY

Traffic controls and enforcement have been around since ancient times. The best examples are from ancient Egypt and from ancient Rome. The Egyptians needed a method of controlling traffic for the transportation of the building materials for the Pyramids.

Ancient Rome had one of the most extensive road systems in the world some were so well constructed that they are still used today. Probably a Centurion was assigned to traffic duties and had to regulate the speed of the various types of vehicles being utilized. He was probably assigned the duty shortly after the first traffic accident occurred between one or more of those ancient vehicles, or after the first traffic jam when members of the Roman Senate couldn't get out of the city to go to their favorite holiday location. It is likely that one of the first laws that the Roman Senate passed and required the Centurions to enforce dealt with traffic regulations. These first traffic laws probably regulated the size and weight of vehicles, and how traffic should travel.

In our modern fast paced society things haven't changed much in regard to the overall traffic flow problems. However, there have been great strides in the construction of our roads, vehicles and traffic control devices. The three "E's" were born from those early Roman regulations. We now refer to "**E**ducation", "**E**ngineering" and "**E**nforcement" as the three "E's" of traffic. Each is independent and interdependent of the other two. They remain the as the basic principles of traffic control.

Before the turn of the Century, people were accustomed to vehicles primarily drawn by animals. Those vehicles traveled at 6 to 7 miles per hour maximum. This is about 10 feet per second. Today's modern vehicles can travel at speeds above 100 miles per hour and over 150 feet per second.

Conversion Formula for miles per hour to feet per second:

Note: *To determine feet per second multiply the speed in miles per hour by 1.466*

Since the earliest days of the automobile, speed has been its most controversial feature. Historically, manufacturers have had little trouble finding a ready market for fast cars. Consider what has been the most popular vehicles year after year: Corvettes, Porches, or any other sports car that advertises "zero to sixty in eight seconds.
Concern over the public's fascination with speed was voiced by the Supreme Court of Pennsylvania as early as 1906. In affirming a conviction under a city ordinance for speeding, the Court said:

> ***"It is only necessary to resort to the most cursory observation to find evidence that many drivers of automobiles in their desire to put their novel and rapid machines to a test of their capacity, drive such vehicles through the streets with a reckless disregard of the rights of others."*** **(Brazier vs. City of Philadelphia, 215 Pa. 297, 64A. 508, 510, 1906).**

According to the National Safety Council, 72.2 Billion dollars were spent because of automobile accidents in 1989. Of the 94,500 persons that died an accidental death in 1989, 46,900 of these were killed in an automobile accident, or 49.6% of accidental deaths. Traffic accidents are the single leading cause of accidental deaths in the United States.

Some memorable moments in the world of driving and traffic control aren't very well known and happened early in our nations history.

The year was 1757. The place: Boston in the Massachusetts Colony. At a meeting of the Board of Selectmen, one of the first speed laws in America was enacted. The ordinance stated that coaches and carriages should not be driven at a "greater rate than a foot pace." One hundred five years earlier (1652), New Amsterdam (now New York City) passed its first traffic law and probably the first in America. This law prohibited riding horses at a gallop inside the city limits.
In New York City, on May 30, 1896, Mr. Henry Wells of Springfield, Massachusetts, while driving a Duryea Motor Wagon collided with a bicycle ridden by Miss Evelyn Thomas. It was the first accident involving a motor vehicle in the United States. Miss Thomas went to the hospital with a broken leg. Mr. Wells spent the night in jail.

The public's preoccupation with speed seems to be even more prevalent today, with our highly-mechanized society. People rush to work and rush to play. The automobile provides the means to maintain this harried existence.

For some, it also serves as a means to relieve the tensions brought about by living at so rapid a pace. Individuals turn their automobiles into weapons, or tools of aggression. This is not to say that most drivers are obsessed with speed. It is important, however, not to lose sight of the dangers inherent in high speeds. High speeds affect all three elements of driving:

The Operator:

Increased speeds tax the drivers basic capabilities, such as reaction time (the time required to perceive a danger and respond to it.)

The Vehicle:

Increased speeds tax the automobile's capabilities, such as brakes and steering.

The Roadway:

Higher speeds increase the potential hazards of any deficiencies in the road surface, (potholes, construction, etc.) or situational conditions resulting from weather (rain, snow or ice).
High, speeds interacting with one or more of these elements can result in an accident. To grasp the dramatic impact excessive speed can have, let's examine a simple task, stopping a vehicle. This simple task incorporates the three elements above and is, therefore, greatly affected by increased speed.

Studies over the years have shown that the average person has a perception time of three-fourths of a second (time required to perceive a danger). This same person's average reaction time is also three fourths of a second (time required to react to the danger). Now suppose our average motorist is proceeding along a typical road, clear of any surface problems. Driving at about 20 miles per hour, the motorist notices a hazard ahead and reacts normally. At 20 miles per hour, the vehicle will travel 44 feet during this second and one-half perception and reaction time. Assuming that the vehicle is in proper working order, an additional 20 feet of braking distance is required to bring the vehicle to a complete stop. In total it has taken 64 feet to stop the vehicle. That's not too bad but lets change the initial speed to 30 miles per hour and see what happens. The perception and reaction distance now becomes 66 feet and the braking distance is 44 feet for a total stopping distance of 110 feet.

Suppose a driver was proceeding at 40 miles per hour. The perception reaction distance becomes 88 feet and the braking distance becomes 77 feet for a total of 165 feet. Remember these examples are under favorable conditions where the driver perceives the hazard, reacts to it, the vehicle is in good mechanical condition and the roadway has no defects.

On the following page there are two graphs, one showing stopping distances for automobiles and the other one with stopping distances for air brake equipped vehicles.

TECHNICAL ADVANCES CAN INCREASE AN AUTOMOBILE'S CAPABILITIES OR IMPROVE THE DESIGN OF ROADWAYS TO ALLOW FOR GREATER AND GREATER SPEEDS. IT IS MUCH MORE DIFFICULT TO "REDESIGN" OR IMPROVE A DRIVER'S CAPABILITIES !

A SHORT HISTORY OF SPEED REGULATION

Various types of legislation to control speed have been introduced throughout our nation's history. The primary purpose of these regulations has not been to restrict the flow of traffic, but to make traffic movement more efficient with minimum danger to persons and property.

According to Joseph Nathan's Famous Firsts, the first automobile speed regulation was enacted in Hartford, Connecticut, in 1901. The law limited automobile speeds to 12 miles per hour in the country and 8 miles per hour within the city limits.

As the number of automobiles increased, the number of laws governing their use also increased. These statutes and ordinances were based on the assumption that no one should drive a vehicle at a speed greater than is reasonable and prudent under existing conditions. This assumption became known as the "basic speed law."

SPEEDING OFFENSES

The Uniform Vehicle Code and Model Traffic Ordinance lists speed restrictions in Article VII. Most of the states have adopted laws that are based upon these "Model Laws." We will concern ourselves with the definitions of the three basic types of speed regulations: basic speed law, prima facie limits and maximum or absolute limits.

Basic Speed Law: It is unlawful to drive a vehicle on a public roadway at a speed greater than is reasonable and prudent under existing conditions. Existing conditions include both actual and potential hazards.

The intent of this type of law is simply to prohibit unsafe speeds. Enforcing the basic speed law involves procedures different from enforcing speed limits. Under the basic speed law, it must be shown that the violator's speed was unreasonable or imprudent given the existing conditions. This is not easy, since any "basic speed law" includes such ambiguous terms as:

Reasonable: What is "reasonable"?

Prudent: Just what is a "prudent" speed?

Under existing conditions: This term can refer to the condition of the road, the condition of the vehicle, the condition of the driver, or the environment.

Early efforts to enforce this somewhat ambiguous law resulted in some confusion. These enforcement efforts caused two major schools of thought regarding speed enforcement to emerge:

Those advocating "Prima Facie" speed limits and those advocating "absolute" speed limits.

Prima Facie Limits: An indication of the highest speed that would be considered "reasonable and prudent" at some given location under generally favorable conditions.

Prima Facie means "at first glance" or "in the absence of further proof." Prima facie speed limits are those stated as a specific rate and posted on the highway. An example would be a speed posting of 35 miles per hour. However, the "basic speed law" is that which has to be enforced and adjudicated. In other words, a speed limit is posted to tell the motorist what is considered a reasonable speed for that area. If a motorist exceeds this speed, the motorist is said to have violated the basic speed law "prima facie."

However, speed in excess of the prima facie limit is only an indication that the speed was unreasonable and imprudent. The accused is entitled to produce evidence in court to show that the speed was reasonable and prudent for the conditions and circumstances at the time in question. A court or jury provides the final decision.
Proponents of this type of law insist that it permits greater flexibility in practice. Not every speed exceeding the stated limits should be considered dangerous. Prima facie limits are not arbitrary and it is contended that most drivers use good judgment and adjust their speed according to the conditions encountered.

Maximum or Absolute limits: It is unlawful to drive a vehicle on a public roadway at a speed greater than ***"X"*** miles per hour(***"X"***

is the absolute speed limit).

Maximum or Absolute speed limits are based on laws that simply prohibit driving faster than a specified speed, no matter what "the existing conditions". This school of thought insists that the basic speed law alone leaves too much room for individual interpretation by motorists - many of whom aren't reliable enough to make correct decisions as to reasonable speeds. It is also maintained that prima facie limits are practically unenforceable, since questions arise in almost every case as to the rate of speed in relation to environmental conditions and what a reasonable speed really is for those conditions. Driving in excess of that absolute limit, regardless of conditions, is a violation. The only proof required is that the motorist exceeded the limit; circumstances and conditions have no bearing on the driver's guilt or innocence.

Speed limits can include both maximum and minimum speed restrictions. Different limits can be set for different conditions, such as:

Time of day: Speeds are sometimes lowered during night or rush hours;
Type of roadway: Highway or urban routes can have different limits than roads in residential areas; and

Type of vehicle or equipment: Lower maximum are often set for buses or trucks.

In the early versions of the Uniform Vehicle Code, "prima facie" limits were recommended, and a majority of states adopted prima facie speed provisions.

Meanwhile, the absolute type of law fell into disfavor. In the 1950's more and more states began to adopt absolute limits and abandon the prima facie approach. In fact, the 1956 Uniform Vehicle Code was revised to provide absolute maximum limits and all mention of prima facie was eliminated.

The International Association of Chiefs of Police at its 70th annual conference in Houston, Texas, in October of 1963, adopted a resolution approving a formal presentation of policy as guidelines for police administrators in the enforcement of traffic laws and ordinances and providing for the safe and expeditious flow of traffic. The following is a portion of the position statement on police traffic management:

"The police do not feel that the ultimate in safe speed for motor vehicle transportation has been reached. They recognize that increased safe speed for every form of transportation is a means of progress. Regularity of vehicular movement, however, must be recognized as an essential of efficient transportation.

Comparatively low speeds are as disruptive as high speeds. Varying conditions such as traffic, road and visibility affect the safe speed. The wide range of skills and capabilities of individual operators is a factor to be considered.

In light of these several factors and the need for reasonable, specific, understandable speed regulations it is, therefore, believed that the following considerations should be given in the formulation and enforcement of legislation designed to control undesirable effects of too great or too little speed for existing conditions.

a. Absolute maximum speeds should be established for rural and urban driving after consultation of police and engineers.

b. Empower the appropriate agency, after consultation with police, to legally raise or lower these limits in specific zones after engineering and traffic accident studies establish that the proposed changed limit is reasonable and safe for that zone provided that the zone affected is properly and adequately signed.

c. Make it incumbent upon drivers to drive at speeds lower than the absolute maximums when consideration of existing conditions indicates a safe speed is lower than that of the existing maximums.

d. Legislation based on a prima facie limits which allow the individual driver to exceed these limits when within his judgment it is safe to do so, is undesirable.

e. Minimum speed laws based on consideration of the speed for most rapid, lawful, and efficient movement of traffic should be formulated after appropriate surveys determine the relationship of the need for rapid movement to its effect on the safe movement of traffic.

f. Review to determine the need for establishing or adjusting speed regulations should constitute a continuing program."

Current systems of speed control acknowledge that the speed control system must permit motorists to reach their destinations as rapidly as possible while giving all due consideration to safety, reason, and prudence. Rapid and safe movement of vehicular traffic is essential to efficient highway transportation.

ELEMENTS OF THE OFFENSE

Successful enforcement of speed regulations-whether prima facie limit, basic speed limit, or absolute speed limit involves more than simply detecting and apprehending violators. Speeding, just as any other offense, can only be successfully prosecuted when certain specific elements of the offense stipulated in each statute are established. The elements of the speeding offense are driver identification, location, speed, and conditions. These elements are specified in general in Table 1. It should be noted that the different types of regulations are essentially the same, except for "speed" which is defined differently under each type of law. The "location" element in some jurisdictions may include only public highways and roads. In others, it may include parking lots, public driveways and private roads.

Thus far we have discussed speed and enforcement. A look at the role of enforcement is needed to add perspective to the total traffic picture.

The three **E's** of traffic are **Education**, **Engineering** and **Enforcement**. The three terms describe an interaction between these agencies as well as the approach to achieve a safe traveling environment. The most important of the three is education. Education includes but is not limited to, how drive safely, wearing seat belts, being aware of the environment (pedestrians, construction zones, etc.) and informing the public and others about the use of radar.

Engineering is primarily directed toward the union of highway design and automobile construction, and the traffic controls that make that union a successful one. Then, there is "Enforcement" by either police officers and/or a parking enforcement group.

Enforcement is viewed by police officers as primarily an opportunity to give one-on-one education on how to safely drive. Unfortunately, some cities see this as an opportunity to collect revenue and some insurance companies see it as a means of raising insurance premiums. WE SHOULD TREAT VIOLATORS OF THE LAW WITH FAIRNESS AND DIGNITY. BY DEMOSTRATING RESPECT FOR OTHERS, WE WILL EARN RESPECT FOR THE LOS ANGELES POLICE DEPARTMENT. IT IS OUR DUTY TO REPORT MISCONDUCT AND FACTS RELEVANT OF SUCH CONDUCT.

Over the years, education has been shown to be the most effective way to get the public to obey the law and drive with care. This education is ongoing and is usually provided by the press or other media as part of public service programs. Some insurance companies are very active in this area and have had a great impact in changing poor driving habits. Most police departments have education programs directed toward crime prevention, or traffic safety.

In California the three largest agencies in the state (Los Angeles Police Department, Los Angeles Sheriff Department and the California Highway Patrol) are constantly vying for public service time to educate the public in the area of traffic safety. Seen as leaders in the areas of traffic safety, public awareness and on-going education of its officers. They all have POST certified courses for radar operation.

In April 1990, the United States Department of Transportation/National Highway Traffic Safety Administration held a Traffic Safety Summit, in Chicago. A portion of the summit covered speed, speeding offenses and technology to detect speeding vehicles, as well as radar detection devices. Part of the final report states:

"The National Transportation Policy emphatically makes "safety... the top priority for the Department of Transportation." Our aim must be...to cut the death rate and reduce the traffic death toll... through the next decade."

It is Federal transportation policy to:

* Conduct a coordinated national campaign to increase public awareness of traffic safety issues, promote improved driver training, achieve more effective driver licensing and driver records, build support for traffic safety laws, and change unsafe driving behavior.

This emphasis, coupled with engineering and enforcement efforts, can significantly impact the amount of deaths and injuries on our highways.

Inherent in the use of radar is the need to understand the various speed laws. The elements involved in these laws are covered in the next portion of the book.

ELEMENTS OF THE SPEEDING OFFENSE

ELEMENTS

ABSOLUTE SPEED LAW

BASIC SPEED LAW

PRIMA FACIE

Driver I.D.
Accused must be SAME. SAME shown to have been the driver at time of the infraction

Location
Any place to which the public has right of

access for vehicular use

Speed
In excess of Unreasonable or In excess of specified limit imprudent posted limit and thus presumed unreasonable or imprudent

TABLE 1.

Driver Identification

There are two aspects to driver identification. The officer must be able to quickly identify the driver of the vehicle at the time of the initial stop and then later identify the same driver in court.

Upon making the initial stop, the officer should make an immediate visual identification of the driver. Other vehicle occupants may attempt to change places with the driver in an effort to confuse the investigation. An alert officer can counter these activities by initially noting driver characteristics such as clothing, facial hair, or other distinguishing characteristics that can be observed at a quick glance.

When the officer has completed this first identification of the driver, more specific details can be noted that will aid the officer in identifying the suspect in court.

Location

Establishing where the defendant's vehicle was being driven when the infraction occurred is usually not difficult. The officer's testimony that the violation was observed to have taken place on a certain street or highway is sufficient. If there is doubt as to whether the location of a particular roadway is considered public or private, look it up under state statutes or check with a supervisor. If the offense occurred off-highway and is included under the statute, the location can be defined by reference to permanent landmarks.

Speed

Establishing a defendant's speed has differing degrees of importance depending on which type of speed law covers the location of the infraction.

National Maximum Speed Law

As indicated in previous sections, safety officials have long been aware of the relationship between speed and safety. They have also been aware of the relationship between speed and fuel consumption. It took a national emergency in the form of an energy shortage to provide the impetus for lowering highway speeds nationwide.

Relationship Between Speed and Safety

When the 55 mph speed limit was enacted, its sole purpose was to save fuel and help reduce our dependence on foreign fuel sources. At the end of 1974 a more important effect was noticed: There were 9,109 fewer fatalities than in 1973. shows yearly increases in speeds, which reached a high point in 1973 and then dropped sharply after passage of the 55 mph speed limit. shows yearly traffic fatalities. When compared, the two graphs appear almost identical. Whenever speeds have increased significantly, so have fatalities. Conversely, whenever speeds decreased, so did fatalities.

In fact, in 1974 the first year of the 55 mph speed limit, traffic fatalities decreased 16.8 percent - the largest annual absolute reduction since 1942. ("Absolute" indicates the total number of fatalities reported.)

At first, one might argue that the dramatic reduction in fatalities in 1974 were simply a result of a reduction in travel during the fuel shortage - the less time in traffic, the less chance of being in a traffic accident. This argument can be refuted with one look at the "fatality rate." The fatality rate measures the number of fatalities reported against the number of miles actually traveled (fatalities per 100 million miles).

Since the early 1970's, the fatality rate had been declining by about three percent a year because of better engineering and such other safety factors as increased use of seat belts. However, the fatality rate plunged from 4.2 in 1973 to 3.6 in 1974. This represented a very significant decrease of 14 percent. Obviously, reduced speed has saved lives.

Not only has the 55 mph speed limit reduced the number of fatalities, it has also reduced the number of significant injuries. The reported number of spinal cord injuries caused by auto accidents has dropped as much as 60 to 70 percent in some parts of the country. In all, disabling injuries resulting from traffic accidents dropped 10 percent after 1973, when two million people were severely injured.

That speed has such a tremendous effect on fatality and accident severity rates should come as no great surprise. As discussed earlier, increased speeds tax the operating limitations of both vehicle and driver. Speeding increases the stress on tires, steering, and braking systems. It also stresses a drivers physical limitations, such as vision and reaction time. Moreover, when collisions occur, the higher the speed the greater the structural damage to the automobile and the more tragic the consequences for the occupants. The probability of a fatality in a crash roughly doubles from 45 to 60 mph, and doubles again at 70 mph.

Until January of 1989, the 55 mile per hour speed limit stayed in force. It was predicted that if it was relaxed that collisions would increase by about 1% and fatalities would increase about 9%. The first year's results are in and those highways that were allowed to increase the speed limit to 65 m.p.h. have had a 9% increase in fatalities.

CHAPTER II

RADAR'S EARLY BEGINNINGS

The word "RADAR" is an acronym for RAdio Detection And Ranging. Police Radar is only one type of a small family of radar devices that provide no "range" information. This means that radar devices used by police do not provide the distance to the targeted vehicle. This also means that these radar devices do not fit the true definition of the acronym. However, the term radar is still used to describe these devices.

What is a radar device? Simply, its just a radio transmitter and receiver, tuned to a specific frequency with a focused antenna. This device during operation doesn't have a "voice" circuit, or "key" circuit to transmit information like a regular radio, but it does give us information. That information is the speed of a moving object (usually some type of vehicle).

It has a speaker, the speaker emits a tone or other sounds (RFI noise, also known as "white noise"), it gives us information from these sounds, whether, or not we are tracking a true target. This push-button device transmits a great deal of information to the operator and the operator's job is to interpret that information.

Radar owes its existence to development during World War II, The British Government and the United States Navy were both working on devices to detect enemy planes and ships in late 1938. The development was cloaked in secrecy and extreme measures were taken to protect the technology and the frequencies being used. The letters "S", "K", and "X" were chosen for the frequency bands because they were nonconsecutive. These same bands are used today for police radar devices.

The "long-wave" radar systems that were used to defend Great Britain from the German aircraft during 1940-41 measured range accurately but were much less accurate in measuring direction, because the radiated beams were very wide. By reducing the wavelength (increase the frequency) of the radio waves it became possible to build antennas to form narrow beams that could be rotated like a lighthouse beacon. Only when the enemy aircraft were within the beam would a radar echo be received; thus with such a narrow beam system the bearing could be observed directly. These new narrower beams were "S-Band" and "X-Band" devices.

Police radar devices have been used to measure vehicle speed since 1948. Those early police radar units left much to be desired. Most required a quarter mile hike just to set up.

It is important to know that many types of Radar exist. Some are very simple like police units, while others are very complex. There are two basic types of radar: "Pulse" and "Continuous Wave." Police radar devices operate on "Continuous Wave," whereas, commercial and military radar operate on "Pulse."

Digital traffic radar made a significant breakthrough in 1970 with the development of hand held devices. These instruments have continually been technically refined with the introduction of "Moving" Radar, in 1972.

TYPES OF SPEED MEASURING DEVICES

STOPWATCH

Probably the first mechanical device to measure vehicular speed; this device was accepted by courts as early as 1906. In one form or another, this device is still utilized today.

PHOTO-SPEED RECORDER:

Developed prior to 1910; this device consisted of a camera synchronized with a stopwatch. By taking photographs at a measured time interval, vehicular speed could be calculated mathematically by comparing image sizes.

SPEEDOMETERS:

Utilized since approximately 1916; this device has remained the "standard" for vehicular speed measurement for over fifty years. Modern moving radar still relies upon the speedometer reading for patrol speed verification.

SPEED WATCH:

Basically an electric timer; this device required two rubber tubes stretched the width of the road. As the vehicle crossed the first tube, the electronic timer started. When the vehicle crossed the second tube, the electronic timer stopped. From the final reading, the vehicle's speed was computed.

VASCAR:

The Visual Average Speed Computer And Recorder is basically a time distance computer. The unit is used to calculate the time required for a motorist to cross two fixed reference points and from that information, it converts the data into miles per hour.

RADAR:

Based upon the Doppler Principle, police traffic radar has become the most common device utilized to measure vehicular speed. Sophisticated police radar can determine the speed of vehicles while the patrol unit is stationary and while the patrol unit is moving in the opposite direction of the target vehicle.

BILLBOARD RADAR:

This is not a new technology only a combining of technology and advertising. This radar device usually sits inside a box trailer with a sign that reads: "Your Speed is." Below this is a large digital readout sign that displays the speed captured by the radar device. It has been reported as very effective in slowing traffic and is an outstanding education tool.

PHOTO-RADAR:

This device is also based on the Doppler principle. It is simply a radar device connected through a portable computer to a camera. The device is set-up with a preset "tolerance speed" and when a vehicle exceeds that speed a photograph is taken. The photograph shows the vehicle, it's license, the actual speed of the vehicle and usually a recognizable occupant driver.

LASER DEVICES:

These are the latest devices in modern technology to be developed to detect the speed of vehicles. These devices work on a pulse system of laser light. The device emits a series of pulses and measures the speed of the object from the returned reflected laser light. The word LASER is actually an acronym that stands for "Light Amplification by Stimulated Emission of Radiation". LASER devices are not currently detectable by the general public like Radar through the use of "Radar Detectors".

THE DOPPLER PRINCIPLE

Christian Johann Doppler, (1803-1853), an Austrian physicist and mathematician. Although Doppler wrote only one book, he was the author of dozens of scientific papers. The most important of these, published in 1842 explains what is now known as the **Doppler Effect**. This paper, postulated the theory that connects the frequency of a wave with the relative motion between the source of the wave and the observer. Or to put it another way, he discovered that relative motion causes a signal's frequency to change. We now honor his memory by referring to this basic scientific fact as the Doppler Principle.

This phenomenon, the Doppler effect, applies to all types of waves. He actually studied sound waves but it was later found that the principle applies to all wave energy, including light waves and radio waves.

Doppler postulated the effect although he did not test nor prove it. It was tested experimentally and proven in 1845 by Buys Ballot, another mathematician and physicist, in Holland, "using a locomotive drawing an open car with several trumpeters."

Perhaps the most familiar example of the Doppler effect is the decrease in pitch of a locomotive whistle as the train passes by the listener. When the train approaches, the frequency of the sound measured by a stationary observer is higher than the rest frequency that he would measure if the train were standing still. As the train recedes the observer measures the sound of the whistle at a frequency lower than the rest frequency. similar results are obtained when the listener approaches or recedes from a stationary source of sound. an example would be heard alongside a road listening to the sounds of passing cars and trucks. His original postulate or theory also stated that the color of a luminous body would change in a similar manner, due to the relative motion of the body and the observer.

Applications:

The Doppler effect has perhaps found its most spectacular applications in astronomy. By examining the frequency of the shift of spectroscopic lines in the light from the stars, astronomers have determined the velocities of these stars relative to our sun, and by measuring the frequency shifts of radio waves emitted by clouds of hydrogen gas in our galaxy, they have been able to analyze the motions of these clouds. It has also been used to measure the speed of a pitched baseball the fastest recorded was thrown by Ryne Duran of the California Angels at a speed of 106 mph.

The Doppler Principle states:

When an energy, be it light, radio, or sound energy is transmitted from a and reflected from a stationary object or transmitted from a stationary object and reflected from a moving object, or both, it increases or decreases in frequency in direct proportion to the speed of the object.

Simply stated, the Doppler effect works this way:
When a source of sound approaches the listener, the waves in front of the source are crowded together so that the listener receives a larger number of waves in the same time than would have been received from a stationary source. This process raises the pitch that the listener hears. Similarly, when the source moves away from the listener, the waves spread farther apart and the observer receives fewer waves per unit of time, resulting in a lower pitch. When used in conjunction with Radar, the Doppler Principle can be expressed as follows:

* When there is relative motion between a Radar and a solid object, the frequency of the transmitted signal will be different than the frequency of the reflected signal.

* If the solid object is in motion towards the Radar, the reflected signal will have a higher frequency than the transmitted signal.

* If the solid object is moving away from the Radar, the reflected signal will have a lower frequency.

* The speed of a moving object will determine exactly how much higher or lower the reflected signal's frequency will be. It must be remembered that the frequency change occurs when there is relative motion between the Radar and a solid object.

If the Radar and a solid object are both standing absolutely still, there is no relative motion; hence, the received signal will have the same frequency as the transmitted signal.

What is most important about the Doppler Principle is that the frequency change happens <u>only</u> when there is <u>relative motion between the objects.</u> If both objects are standing still, there is no relative motion, and the received signal has the same frequency as the transmitted signal. There is also no relative motion between two objects if they are moving in the same direction at the same speed. Relative motion requires that the distance between the transmission source and the receiver of the wave energy must be changing in some way.

Relative motion will occur:

* If the object receiving the energy stands still and the transmission source moves.

* If the transmission source stands still and the object receiving the energy moves.

* Or, if both the transmission source and the object receiving the energy move, as long as they do so at different speeds or in different directions (so that the distance between them changes).

The Doppler effect is of great importance in optics (light waves). Since the velocity of light is so large, pronounced effects can be observed only for astronomical (stars) or atomic bodies that have velocities, which are large, compared to ordinary speeds. The effect is seen in the shift in the wavelengths of light emitted by moving astronomical bodies. The shift to longer wavelengths (blues) of light emitted from distant galaxies indicates that they are receding and, hence, supports the concept of an expanding universe.

The Doppler effect has many uses in science and a variety of practical applications as well. Measurements of shifts of radio waves from orbiting satellites, for example, are used in maritime navigation and the effect is also employed in the radar surveillance of various types of vehicles, boats and aircraft. Medically, the effect is used for ultrasonic diagnosis.
In order to operate police traffic Radar, you don't need a complete understanding of how or why the Doppler Principle works. It is enough for you to be aware that there is a valid scientific basis for Radar speed measurement.

THE WAVE THEORY

Two of the ways to get in touch with a friend in a distant city are: You can write a letter, or you can pick up the telephone. The second choice (the telephone) is in the spirit of the "wave." In a wave, information and energy move from one point to another but no material object makes that journey.

In your telephone call, sound wave carries your message from your vocal cords to the telephone. From there, the wave is electromagnetic, passing along a copper wire or an optical fiber or through free space, possibly by way of a communications satellite. At the receiving end there is another short acoustic path to your friend's ear. Although the message is passed, nothing that you have touched reaches your friend. Leonardo Da.. Vinci understood about waves when he wrote of water waves: "It often happens that the wave flees the place of its creation while the water does not; like the waves made in a field of grain by the wind, where we see the waves running across the field while the grain remains in place." The dictionary defines a wave in physics as: Any series of advancing impulses set up by a vibration, etc., as in the transmission of light, sound, etc. The "etc." in this situation also includes radio waves.

A flag waving in the breeze is so familiar that, when the astronauts planted the American flag on the windless moon, they used a flag with built-in ripples so that it would look "natural." There are also water waves, in bodies of water ranging from an ocean to a wash basin. There are sound waves, in the air and in water, and seismic waves, in the earth's crust, mantle and core. The central feature of all these *mechanical* waves is that they are governed by Newton's Laws and they require a mechanical medium, such as air, water a stretched string, or a steel rod for their propagation.

ELECTROMAGNETIC WAVES

The most familiar of these waves is visible light. Also part of the *electromagnetic spectrum* to which visible light belongs are x-rays, microwaves, and the waves that activate our radios and television sets. Unless you are reading this book in an electrically shielded room (or perhaps underwater!), many such waves will be passing through you at this moment.

The x-rays, sunlight, and long radio waves behave quite differently when studied in the laboratory. At root, however, they are very similar, their different behaviors being traceable to their differences in wavelength.

Electromagnetic waves require no medium for their propagation, traveling freely to us from the distant quasars through the near vacuum of deep space. They all travel through free space at the same speed, "the speed of light".

Speed of Light = 299,792,458 meters per second, or
Speed of Light = 186,000 miles per second

To examine how reflected radio signals are changed by relative motion requires an understanding of their wave nature. Everyone is familiar with waves occurring in water:

Each water wave consists of a peak and a valley. Sound, light and radio energy can each be described as a distinctive form of wave. Each police Traffic Radar device transmits a continuous series of radio waves, which have three characteristics:

* The signal speed - constant

All Radar signals travel at the speed of light. This is equivalent to 186,000 miles per second, or 30 billion centimeters per second. Both transmitted and received Radar signals always travel at that speed.

* The wavelength - variable

  The distance from the beginning of the peak to the end of the valley of wave may vary.

* The frequency - variable

  The number of waves transmitted in one second of time may vary.

Frequency is usually measured in cycles per second. A cycle is the same as a wave. Scientists and engineers often use the term "hertz" (abbreviated - Hz) instead of cycles per second. All these terms have the same meaning: One hertz equals one cycle per second, which is the same as one wave per second.

"Waves per second" will be the term most often used, since this will help you keep in the wave nature of Radar signals.

NOTE: *Hertz= 1 to 999 cycles per second*
Kilohertz = 1,000 to 999,999 cycles per second (Thousands)
Megahertz = 1,000,000 to 999,999,999 c.p.s. (Millions)
Gigahertz = 1,000,000,000 or more c.p.s. (Billions)

Because the speed of radio waves is constant at 186,000 miles per second, wavelength and frequency have an inverse relationship. As the number of radio waves transmitted each second (frequency) increases, the length of the waves (wavelength) must decrease. The reverse is also true. If frequency decreases, wavelength must increase.

NOTE: The words **waves**, **cycles** or **Hertz** are interchangeable, or synonymous, they mean the same thing.

THE RADAR BEAM

It must be understood from the outset that a radar device is actually a radio transmitter-receiver tuned to a particular frequency. It only transmits on that frequency and only receives a "true signal" on that frequency. The radar transmitter produces high-frequency radio energy. This signal generated by the police traffic radar falls within the range of microwave. This energy is also known as Electromagnetic Energy. The microwave signal has all the properties of light except one; it cannot be seen.

The radio wave energy transmitted by police traffic radar is concentrated in the form of a beam that cannot be seen or felt. If it were visible, it would resemble a long cigar-shaped beam enclosed in a cone. Most of the energy transmitted remains in the central core of the beam. The concentration of energy drops off quickly as one gets farther away from, or off to the side of the main beam.

The radar beam, like a light beam, travels in a straight line. Once transmitted, the length of the beam is infinite unless it is **reflected** or bounced back, **refracted** or bent passing through one substance another, or **absorbed** by certain materials in its path or transmitted by other materials.

Opaque objects such as metal, stone, wood, and concrete reflect the radar beam. Because almost all vehicles are primarily made of metal it makes them an ideal reflector.

The term refraction refers to the radio waves that may pass completely through some substances and continue on infinitely. As they do, though, their direction may be changed slightly.

Transparent material, such as glass and certain plastics, permit practically all of the beam to pass through, reflecting only a small amount.

An example of light waves being refracted can be seen when a straight object that's been put partway into water appears suddenly to be bent. Other substances (such as tall grass, leaves, loose sand, gravel) and certain fibrous materials may absorb the beam, with little energy being reflected back to the radar unit.

Radar functions in a line of sight manner. It cannot be used to monitor traffic around curves, over hills, or through parked cars.

BEAM PROPAGATION

Before the speed of a vehicle is measured by the Radar it must be understood how a target vehicle is measured and why it is measured. The Radar beam can be best described as radio energy being focused in a cigar shaped manner. There are several factors that determine whether or not a target vehicles speed will be measured by the radar unit. These are Reflective capability, Position, and Speed. More than one factor can be present and are treated equally.

Reflective capability refers to what the target vehicle is made of and what shape it has. Most vehicles are made of metal, but there are some that are made of fiberglass. Even the fiberglass vehicles, though, have metal components. The shape of the target vehicle plays an integral part. A large square truck versus a sports car would be examples, or a passenger car versus a motorcycle. In the first situation the truck has a larger flatter reflective area and in the second situation the passenger vehicle has larger flatter reflective surface. The sports car might be made of fiberglass and the motor cycle has very little reflective surface. Where these vehicles are in relation to each other and the radar can determine which vehicle will be measured by the radar unit. Size, larger versus smaller, relates to reflective capability. Speed is considered to be the least dominant of these characteristics, but it is a factor to be considered. These factors work in conjunction with the amount of energy the target vehicle receives.

The main portion of the beam is sometimes referred to as the main lobe. A small portion of the electromagnetic energy escapes outside the main beam, in what is known as the side lobes. These side lobes are caused by minor imperfections in the Radar antenna. They usually are insignificant in power. Within the central core of the beam, the concentration of energy or beam strength, drops off the farther we go from the transmitter. If an object is far from the transmitter, it will be struck by relatively little energy, therefore, it will reflect relatively little energy back toward the Radar unit. If an object is close to the transmitter and directly in the path of maximum beam strength, it will receive and reflect more energy.

The beam length transmitted is infinite unless it is reflected, refracted or absorbed by an object in its path. The beam may be reflected by metal or concrete, absorbed by grass or plastic or refracted by glass. When the waves are refracted, their direction is changed.

RADAR WILL ONLY "SEE" A TARGET IF THE REFLECTED SIGNAL IS SUFFICIENTLY STRONG

The strength of a reflected signal depends on:

* The size of the target.

* What the target is made of (composition).

* How much transmitted energy target receives.

* What Shape target has.

Targets that are a great distance away will be in the minimum beam strength.

A target closer in the medium beam strength will generally be picked up before a target in the minimum area, and a target in the maximum beam strength will generally be picked up before a target in the medium beam area.

Being mindful that all vehicles are not all the same shape and size, the reflective area of a large truck is greater than a motorcycle. Consequently, a large truck in close proximity to a motorcycle will probably create the stronger signal. However, it the motorcycle is in the maximum strength area and the truck in the minimum area, the motorcycle will more than likely reflect the strongest signal even though it has the smaller reflective area.

Normally, when vehicles of comparable size are within the influence of the beam, the vehicle nearest to the antenna creates the strongest signal.

BEAM WIDTH

We already know that the length of the beam is infinite unless it is reflected, refracted or absorbed, but often officers are asked "How wide is the beam"? The width depends on two factors, first at what degree (angle) is the beam projected and second at what distance from the face of the antenna. Typically "X"-Band radar is projected at 18 degrees and "K"-Band is projected at 12 degrees. Some of the vintage devices projected beams as wide as 32 degrees.
The beam width in degrees is measured from the center of axis to the first half power point. That means if you looked down from above at a radar beam you would look down the center of the beam and with a signal strength meter determine where the beam strength is only equal to one half of the power that the device is projecting from the face of the antenna.

Still the question is "How wide is the beam"? To determine the width in feet the distance from the device is needed once that is provided and you already know how many degrees the width can be calculated as follows:

FORMULA: Beam Width = **2 d tan ∠ ½** or **X = 2 d tan ∠ ½**

2 = constant

d = distance from radar device

tan ∠½ = tangent of the half angle

This formula comes to us from trigonometry and can be found in any standard trigonometry text book. You will find a trigonometry table in the back of this book.
Lets work through a problem and see how it does work. The question has been asked, "How wide is the beam"?, And we need some basic information, or "givens", the givens are as follows: "X"-BAND 18 degree radar and 950 feet. We now need to determine what the tangent of the half angle is. so we divide 18 by 2 and receive a answer of 9.

We then go to the trigonometry table and look up the tangent for 9 degrees; which is 0.1583. We can now substitute in the values and determine the width of the beam at 950 feet.

Calculation: **X = 2 d tan ∠ ½**
Givens: distance **d** = 950

angle / = 18
tan / ½ = .1583
X = (2) (d) (tan / ½)

X = (2) (950) (.1583)
X = (1900) (.1583)
X = 300.77 feet

So the answer is for an "X"-Band device that projects an 18 degree beam at 950 feet the width of the beam will be 300.77 feet.

Now lets do the same problem for a "K"-Band device. The distance will remain the same only the angle will change. "K"-Band devices usually project a 12 degree beam. So half would be 6 degrees. Looking to the trigonometry table again for the tangent of 6 degrees we find .1051.

Calculation: **X = 2 d tan / ½**

Givens:
distance **d** = 950
angle / = 12
tan / ½ = .1051
X = (2) (d) (tan / ½)
X = (2) (950) (.1051)
X = (1900) (.1051)
X = 199.69 feet

The answer for a "K"-Band device is that at 950 feet the width of the beam is 199.69 feet.

PRINCIPLES OF STATIONARY RADAR

Presently all traffic Radar operates on four bands, "S" Band, "X" Band, "K" Band and "Ka" Band. The difference between the four bands is the operating frequency. The "S" Band transmits on a frequency of 2,455,000,000 Hz (2.455 Gigahertz). The "X" Band transmits on a frequency of 10,525,000,000 Hz. (10.525 Gigahertz). The "K" Band at 24,150,000,000 Hz. (24.150 Gigahertz) and the "Ka" Band at 34,300,000,000 Hz (34.3 Gigahertz).

For a source of radio waves, radar has a sophisticated solid state device called a Gun Oscillator which generates radio energy at a specific frequency. This high frequency radio energy is focused into a narrow beam and directed at the target vehicle at the speed of light, the universal constant.

A small portion of the beam is reflected back to the transmitter where a device compares the frequency of the reflected beam to the transmitted frequency. The difference is the Doppler frequency.

NOTE: Doppler Shift or Doppler Frequency:

Doppler Shift and Doppler Frequency are synonymous terms and refer to the difference between the transmitted frequency and returned signal frequency.

The older "S"-Band radar is not utilized very much and has fallen out of favor as operating band for police radar. In fact most microwave ovens in use today use this frequency to heat food in our homes.
The two most popular bands in use today are "X"-Band and "K"-Band. "Ka"-Band is utilized primarily by the photo-radar devices.

It can be shown mathematically, that at a transmitted frequency of 10.525 Ghz.("X"-Band), a Doppler frequency of 31.4 Hz. will be produced for each mile per hour of target ground speed.

For example: 31.4 Hz. x 60 mph = 1884 Hz. Knowing this relationship we are able, by means of modern electronic circuitry, to convert the Doppler frequency into a digital presentation of the target's speed in miles per hour. Some appreciation of the accuracy required of the complete system may be gained by looking at the very small numerical value of the Doppler frequency as compared to the transmitted and received frequencies.

Example: Vehicle Approaching 60 M.P.H.
Reflected Frequency 10,525,001,884 cycles per second

Transmitted Frequency -10,525,000,000 cycles per second

Doppler Frequency -1,884 cycles per second

In the X-Band radar, the Doppler shift occurs at the rate of 31.4 cycles per second for each mile per hour. The Doppler shift for K-Band is 72.023 cycles per second for each mile per hour.

NOTE: The Doppler shift for "S"-Band for one mile per hour is 7.2 cycles per second.

At 50 miles per hour the Doppler shift in X-Band is 1570 cycles per second. At 100 miles per hour the Doppler shift in X-Band is 3139 cycles per second.

At 50 mph the Doppler shift in K-Band is 3601 cycles per second. At 100 mph the Doppler shift in K-Band is 7202 cycles per second.
The above is derived from the formula
F = 2V DOP C

Where F (DOP) is frequency of the returning waves

Where 2 is a constant

Where V is the speed of the target vehicle

Where F is the frequency of the transmitted signal

Where C is the speed of light in miles per hour

DOPPLER SHIFTS FOR TYPICAL SPEEDS

SPEED	X-BAND SHIFT	K-BAND SHIFT
1 m.p.h.	31.4 c.p.s.	72.02 c.p.s.
5 m.p.h.	157.0 c.p.s.	360.10 c.p.s.
10 m.p.h.	314.0 c.p.s.	720.20 c.p.s.
25 m.p.h.	785.0 c.p.s.	1800.50 c.p.s.
40 m.p.h.	1256.0 c.p.s.	2880.80 c.p.s.

Now that we have an understanding of the Doppler Principle as applied to velocity measurement let us examine how it is used in traffic radar.

You will recall in the example of the train that the frequency of the train tone and its rate of travel through the air were assumed to be constant; so that the only factor effecting the tone from the observers standpoint was the change in position of the train. With radio waves we are able to assume this with much greater confidence.

For a source of radio waves manufacturers have selected a sophisticated solid state device called a Gun Oscillator which generates radio energy in the microwave region, specifically at frequency of 10.525 Ghz, (X-Band). This high frequency radio energy is focused into a narrow beam and directed a the target vehicle at the speed of light; the universal constant. A small portion of the beam is reflected back to the transmitter where a second solid state device called a mixer diode compares the frequency of the reflected beam to the transmitted frequency. The difference is our old friend the Doppler frequency, or Doppler shift.

LOCATIONS FOR OPERATING RADAR

When choosing a location or area to operate radar, considerations should be made with reference to the following:

1. Areas where the operator has a clear field of vision.

2. Areas where there is a minimum possibility of external interference. (RFI, EMI, etc.).

3. Areas or locations where vehicles are well within the speed zone. (Bulk of traffic.).

4. Areas where vehicles have relatively good spacing, not bunched, or congested.

5. Areas with easy access to the violators with regard to pursuit of the vehicle, while taking into account the safety of other motorists.
6. Areas that allow safe set-up by the officer without interfering with the traffic flow.

7. A need for operating radar at the location:
   a. Complaints by citizens or local officials of excessive speed.

   b. Accident records.

   c. Traditional methods have been ineffective or they are unsafe for the particular location.

OTHER RADAR APPLICATIONS

Radar is utilized primarily by law enforcement to detect speed violators. There are some other applications that radar is utilized. It has been used to detect the speed of boats in our nations waterways in an enforcement mode. It has also been used to check the speed of pitchers in professional baseball as well as in little league baseball.

There is one field where it is used by law enforcement. That is in the field of accident reconstruction. It is used to determine the speed of a vehicle in a controlled skid situation to not only measure the speed, but correlate the measured speed with the resulting skid marks to determine the coefficient of friction of the roadway. It is also utilized to conduct spot speed studies to determine prevailing speeds at traffic accident locations. These of course are in conjunction with civil law suit cases and on occasion in conjunction with a vehicular homicide case.

In a newspaper report from the San Francisco Chronicle dated July 20, 1991, a new and different application in the area of radar is being investigated:

NEW RADAR DEVICE MAY HELP MOTORISTS PREVENT CRASHES

SAN FRANCISCO - Secretary of Transportation Samuel Skinner, gripping the wheel of a high-tech Lincoln, hurtled toward a parked car on an abandoned stretch of Interstate 280 and hoped the automatic brakes would work. They did - in a demonstration of potentially life-saving radar technology that experts say could save thousands of lives on American highways. If drivers could spot road hazards just half a second earlier, studies show, more than 50 percent of all rear-end collisions and 30 percent of head-on crashes could be prevented.

IVHS Technologies Inc.'s, first product emits a series of warning beeps in the event of sudden hazards - when a car ahead slams on its brakes, for example, or when a dozing driver is heading for a tree.

Skinner, attracting a large media contingent during a visit to San Francisco this week, test-drove the Lincoln Town car equipped with an IVHS system known as VORAD, or Vehicular On-board Radar. The radar is connected to a braking system that automatically stopped the swiftly moving vehicle, just in time to avoid what might well have been one of the most publicized crashes in history.

The IVHS system is based on a radar antenna in a vehicles grill. Among its other capabilities, the technology can make a computerized record of the events leading up to a crash. Investigators are enthusiastic about this feature, particularly because anti-lock brakes eliminate many skid marks that could be used to reconstruct accident scenes.

RADAR SET-UP AND TEST

ABC METHOD

Although Radar instruments are manufactured by various companies, most units fall into the categories: "One Piece" or "Two Piece" units. A One Piece unit has the antenna and counting unit (computer unit) housed in one single component and obviously, requires no assembly. One piece units are also referred to as "hand held units". Two Piece units require some component assembly. It is imperative that this assembly procedure be followed in the below sequence.

The basic method of setting up or connecting a radar device is called the "ABC" Method. This refers to connecting the **A**ntenna to the **B**ox (counting unit) and connecting the Box to a **C**urrent source (usually a cigar lighter receptacle). This is the basic method for setting up all radar devices and it simply means that all cables should be connected to the counting unit before plugging the unit into a power source.

NOTE: After you have connected all the cables to the counting unit make sure that the device is turned off before plugging it into the power source. If you don't a spark could jump at the point of connection, or a power surge could occur. If a spark, or power surge does occur with the device on, it could damage the internal components.

Also, do not coil, twist, or wrap the power cord around the antenna cord as it will act as an induction coil or a transformer and could cause possible interference with the operation of the device.

Once the device is connected **A** to **B** to **C**, then turn it on and a power indicator light should illuminate. Align the antenna properly (See section on antenna alignment page 46). For two piece units make sure that the counting unit is secured properly (refer to manufacturer's manual for proper installation).

INSTRUMENT TESTING

Testing procedures are to be followed in accordance with the manufacturer's manual. Circuitry tests vary from instrument to instrument but, in all cases, internal and external tests must be conducted. If for any reason the proper results fail to appear during testing, the Radar device should be taken out-of-service and be repaired.

Radar operators do not calibrate the radar unit. The operator merely tests the calibration of the equipment. The basic calibration testing is two part. An external test, by use of tuning forks, is done. Secondly, an internal calibration check is done.

NOTE: Both internal and external tests are done in both the stationary and moving modes.

FOLLOW THE OPERATOR'S MANUAL FOR THE SEQUENCE OF THE CHECKS

INTERNAL TEST(S)

The internal test checks the calibration of the counting mechanism in the readout unit.

Most modern devices have a Lamp Segment Test (L/S) and an Internal Calibration Test (ICT). The lamp segment test illuminates all of the lamps and number segments verifying that they function. If any of the lamps or segments fail to illuminate the device should not be used and turned in for repair.

The internal calibration test will check the inner circuitry of the device and a preset number should be displayed in the readout window If this preset number is not displayed the device should not be used and turned in for repair. Refer to the manufacturers manual to determine which lamps and segments should illuminate and the preset number during the tests. Neither of these tests verify that the device is sending out a signal that is verified by the external test.

Starting with the stationary mode, the internal calibration switch or button is activated. A predetermined number, by design, will appear in the target display (refer to Operator's Manual). Release the button or switch and place the unit in moving mode and again activate the internal calibration switch or button. You should now receive a predetermined number in both displays. Consult the Operator's Manual for the predetermined calibration numbers.

NOTE: There is no acceptable tolerance in the internal calibration test!

A verification test is done, comparing the Patrol Display with the police vehicle's calibrated speedometer when the police vehicle is moving, to ensure that the correct patrol speed is being used in the computation of the target vehicle speed. This test is not required, but is recommended.

Another test may be performed is that of having a second vehicle, generally another police vehicle, traveling at a known speed, read by the radar unit. Notation of the known speed and the radar readout may be put on the officers log.

EXTERNAL TEST

The external test basically checks the functions of the antenna. The external test is done by using a tuning fork. The fork is designed to oscillate, or vibrate, at a known frequency. This represents the equivalent speed with relation to the Doppler shift. On the tuning fork certification of accuracy, the information given is the cycles per second of oscillation of each tuning fork, and its corresponding mile per hour. Each fork should be stamped with a serial number which also appears on the certification of accuracy.

X-BAND AND K-BAND FORKS ARE NOT INTERCHANGEABLE

Although two forks may each be marked with 35 mph, at 35 mph an X-Band fork will not produce a 35 mph readout on a K-Band radar (15.25 mph). After the installation of the radar unit per the Operator's Manual, the actual testing should be done as follows:

To use the tuning fork, simply grasp the fork firmly by the handle and strike one of the tines against a reasonably firm surface. The heel of your shoe or a padded steering wheel are good surfaces. Striking the fork against a very hard surface such as metal or concrete damages the fork and should be avoided. Also, the forks should never be tapped or struck together. It is also a good practice to warm or cool the forks to a comfortable temperature before striking them.

Even though there have been independent tests conducted using cold tuning forks with no adverse affects, to avoid any questions at all, it is a good practice to spend a few minutes to allow the tuning forks to adjust to a comfortable operating temperature range.

During testing, it is a good procedure to point the antenna upwards to avoid any interference. After striking the tuning fork, it should be held between one-half inch and two inches from in front of the face of the antenna as shown in Figure #?. It is recommended that the fork be held with one tine exposed to the antenna face for the most efficient method. Failure to obtain the proper speed reading as stamped on the tuning fork (plus or minus one mile per hour) is grounds for checking the Radar with another set of forks or placing the Radar unit out-of-service and have it repaired.

NOTE: If a tuning fork is stamped 50 m.p.h. and it shows either 49, 50, or 51 in the readout window the device is working properly.

Using tuning forks from one manufacturer to check the instrument of another manufacturer is not recommended. (Mixing "X" band forks with "K" band Radar or vice versa is also not recommended). The tuning forks should be kept in a location which will keep them free from damage.

In the external test Stationary Mode, the forks are tapped and placed in front of the antenna separately, (approximately ½" to 2" from the face of the antenna) one at a time. In the external test Moving Mode, the forks are tapped and placed in front of the antenna together. The slower speed of the two forks will be displayed in the Patrol Display Window, while the difference of the two forks will be displayed in the Target Display Window.

EXAMPLE (moving mode):

Fork #1 - 35 mph....Patrol Display 35 mph

Fork #2 - 65 mph....Target Display 30 mph

AUTOMATIC LOCK

The automatic lock is designed to lock in a radar target reading. The unit automatically locks upon a target vehicle reaching a preselected speed set by the radar operator.

Due to case law in several states operating in the Automatic Lock mode is prohibited. However, the officer has the capability of manually locking in the speed by depressing the lock/release button. Locking in the speed after obtaining a tracking history is not required by case law, nor is it mandated that the officer show the target speed indicated to the violator. Safety and discretion would dictate allowing the violator to view the Radar speed.

TRACKING HISTORY

The "Tracking History" is probably the most important subject in a radar operators course. This one area will assist the operator in virtually eliminating the possibility of issuing an undeserved citation. If each step is followed the operator eliminate the possibility of any errors in determining which vehicle the radar targeted. There are three main parts to the stationary tracking history. They are:

VISUAL ESTIMATION, AUDIO ESTIMATION, RADAR CONFIRMATION, SPEEDOMETER VERIFICATION (Moving Radar operations)

These areas are further broken down as follows:

VISUAL ESTIMATION:
Identify Violator
Estimate Speed In Range Check Environment

AUDIO ESTIMATION:
Pitch and Clarity

RADAR CONFIRMATION:
Obtain "Stable" Reading
Manual Lock/No Lock (Optional)

SPEEDOMETER VERIFICATION:
Verify that the radar patrol speed and speedometer match (Moving Radar).

The tracking history should take three (3) to five (5) seconds to complete.
As you know if you have ever been in a courtroom, officers must provide supplemental evidence, usually in the form of testimony, to prove the case. If you follow the steps in the tracking history, as explained below you should have little, if any, difficulty with the courtroom testimony in a radar case.

VISUAL ESTIMATION

Identify violator: Observe traffic at all times and watch for that vehicle that's traveling faster than the norm, or that's passing other vehicles. You have to identify the vehicle that is traveling too fast, as well as, the driver. The driver identification is usually made after you stop the vehicle.

Estimate Speed: As you observe traffic continually estimate the speed of the vehicles that are approaching your location and those vehicles that are going away from your location. Typically your device has an effective range of about 2,000 to 2,500 feet.

Try to estimate and monitor the vehicles completely through this zone of influence. Make a mental note of the ***range*** and ***location*** of the vehicle so you can testify it was within your ability to estimate its speed.

In Range: Your radar device has an approximate range of 2,000 to 2,500 feet, but depending on conditions present it could be greater or shorter. To determine the range of your device you can compute it quite simply by following these steps:

1. After you complete the required tests assure that your device is working properly.

2. You observe traffic and pick a vehicle coming toward you (hopefully traffic will be light enough so that you have a lone vehicle target) and as soon as the radar picks up the target. Monitor the speed and start a timing how long before the vehicle passes your position.

3. With the information of a known speed and the time in seconds it took for the vehicle to traverse the zone of influence you can calculate your effective range using the following formula:

d = t s 1.47 d = distance
t = time in seconds
s = speed in m.p.h.
1.47 = conversion from miles per hour to feet per second

Example problem:

A vehicle enters the zone of influence and your radar device gives you a speed reading of 35 m.p.h. (the vehicle maintains the speed completely through the zone of influence) and it takes the vehicle 21 seconds to traverse from when you first picked up the vehicle with the radar to when it passes by your location.

Givens: t = 21 seconds
s = 35 m.p.h. Formula: **d = t s 1.47**

d = (21) (35) (1.47)

d = (735) (1.47)

d = 1080.45 feet

The effective range in this situation is 1080.45 feet. The effective range for a device can change due to many factors hills, curves, atmospheric conditions, etc.

Check Environment: This should be done before you set up in a location to eliminate the possibility of external interference (explained later in the book). You should also constantly monitor the environment not only for the possibility of interferences, but the traffic pattern and what vehicles are within the zone of influence of the radar. How convenient it has become for a violator to say that you the officer didn't have him in the radar but another vehicle (usually a truck).

Visual estimation is a continual on-going process of monitoring traffic and estimating speeds of vehicles traveling through the radar's zone of influence.

AUDIO ESTIMATION

The audio feature incorporated in a radar system is a feature that allows the operator to audibly detect the change in frequency between the transmitted and returned signal. It tells the operator that there is in fact a true Doppler "shift" in the frequency occurring. For this reason, the use of the audio is a must.

The audio signal is an essential aid to the operator in four ways:

1. In determining interference from the environment.

2. In determining interference from the police vehicle.

3. Distinguishing higher/lower speed targets.

4. Determining that multiple targets are influencing the radar signal.

Referring to the Doppler Principle, the greater the difference between the transmitted frequency and the returned frequency, the higher the pitch or tone of the audio signal. When the radar signal is examining multiple targets, the audio pitch may jump from high to low to high several times until there is a dominant signal from a single target vehicle.

Two examples of more than one audio tone would be as follows:

EXAMPLE #1.

A - A strong high pitched audio signal
B - A weaker low pitched audio signal

Conclusion: The possibility exists that the faster vehicle is out in front while a slower target may be a vehicle at a further distance from the radar.

EXAMPLE #2.

A - A strong low pitched audio signal
B - A weaker high pitched audio signal

Conclusion: The possibility exists that the larger or slower vehicle is closer to the radar, while the faster vehicle is further down the road, gaining on the first vehicle.

Remember the audio system will tell you what type of signal you are receiving. You can easily distinguish a Doppler signal from a "noise" or "secondary" signal as they are sometimes called. It is also important to know that the radar unit processes the audio signal in real time. That means it does not process it through the computer-calculation process and there is no delay of the audio signal. This is not true of the radar read out as it has to process and compare the return signal (usually 200 or more returns), calculate the Doppler shift, verify that the signal being received is a true signal and then display the targets speed in the readout window. This process can take up as much as a eighth to a fifth of a second, depending on the individual device and manufacturer.

Pitch: This refers to the audible frequency of return signal from a target vehicle. The radar unit processes the return signals and emits a tone for a moving object the higher the pitch the faster the speed. Over a short period of time you will be estimate the speed of a target vehicle by this audio tone. This audio estimation should be close to your visual estimation and help confirm it.

Clarity: The audio tone that is being emitted for a given target vehicle should be a clear and steady tone without interference. As stated earlier on occasion you will be able to hear multiple tones and examples were given as to what they could be. However, with experience you will learn how to determine what is occurring by using both your visual and audio estimations. To determine a true target (one that you would issue a citation to) it is best to receive a single uninterrupted tone.

RADAR CONFIRMATION

Stable Reading: This is done for obvious reasons; primarily because if the reading is caused by one of the possible effects, (most will be ruled out by the audio estimation) covered later, it usually will not be a reading that stays on the radar readout more than a second or two. The stable reading referred to doesn't mean the same reading for a full 3 - 5 seconds. Many violators upon seeing the patrol vehicle will reduce their speed. This can be observed by continually watching the vehicle and you will see the front of the vehicle dip and you should visually note a reduction in speed as well as hear a change in the audio pitch to a lower tone. If your visual and audio estimations confirm this slowing, you still have a "stable reading."

The 3 - 5 seconds are necessary to allow the radar unit to up-date itself at least twice. Many units take 1 - 2 seconds to perform this update sequence. You will have plenty of time to complete your tracking history if you recall the "in-range" distance calculation it took a vehicle 21 seconds at 35 m.p.h. to travel 1080 feet. Subtracting the 5 seconds from the 21 gives you 16 seconds to monitor and prepare to apprehend the violator.

Manually Lock/No Lock: After your stable reading you may manually lock in the target vehicle's speed. There is no requirement either in law or case law that requires you to lock in the reading. You could lock it in to show the reading to the violator as a way of alleviating a later court trial.

However, if you allow the target vehicle to pass through the radar beam and you check to see if you lose the reading, you have confirmed that the vehicle that passed trough the zone of influence was the target vehicle.

You might also pick up a new reading from another target that you could observe visually as well as with the audio that would confirm your violation reading. If there are no other target vehicles present and you get no reading that confirms it also.

If, however, the reading continues, the radar is receiving a reflected signal from another target.

It is important to visually reconfirm the target vehicle. Get a positive identification so you can reconfirm in your own mind that this is the target vehicle you estimated and from which you obtained the radar reading.

SPEEDOMETER VERIFICATION

This step in the tracking history is for moving mode operations. The radar operator in moving mode has to verify that the reading on the radar for the patrol speed matches the speed on the speedometer. This one step in moving mode will eliminate the possibility of several operator induced errors (See effects). The only error(s) in using radar is the operator's interpretation or misuse of the device.

APPREHENSION

Lastly, apprehend the violator. As you catch up to the violator preparing to make the stop, pace the target vehicle if you can. If his speed is the same as the earlier radar reading, you have that much more evidence for a conviction. While issuing the citation, be alert for any spontaneous statements made by the violator regarding the incident.

ANTENNA ALIGNMENT

Before the radar is placed in operation, proper antenna alignment must be addressed. Positioning the Radar's antenna as straight as possible toward an approaching target is imperative.

The Radar's perception of a target's speed is affected as a result of any angle at which the reflected waves are measured.
Vertical antenna alignment or "tilt" would have no bearing on angular effect; however, to avoid interferences associated with tilt, a "level" alignment of the antenna is advisable. (See Cosine Error, and Radar Effects.)

Probably the most important operational aspect performed by the Radar operator is obtaining the Tracking History of the violator. The Tracking History contains a number of supportive elements involved in the radar identification of a target vehicle made by the operator.

* VISUAL, INDEPENDENT DETERMINATION OF EXCESSIVE SPEED.

* DOPPLER AUDIO, DETERMINATION OF THE SPEED.

* TRAFFIC SURVEY OF THE TOTAL ENVIRONMENT INCLUDING PRIMA FACIE ELEMENTS OF THE SPEEDING OFFENSE.

* VERIFICATION OF THE SPEED USING THE RADAR UNIT.

* COMPARISON OF RADAR TO SPEEDOMETER (MOVING MODE)

What better way to try to beat a radar citation than to simply present the argument that the radar was reading a vehicle other than the defendant's vehicle.

TARGET MIS-IDENTIFICATION

Target mis-identification is a common defense in a radar trial. The important thing to remember here is that the operator is the one who makes the decision to stop or not stop a vehicle. The radar device merely indicates to the operator the speed of a vehicle. An obvious conclusion? Yes, but stopping the vehicle and taking some type of enforcement action is the culmination of several steps that the operator has gone through to be sure that the vehicle being stopped <u>is</u> the correct target vehicle that was read.
The officer has been monitoring the traffic flow.

a. The target enters the operational portion of the Radar Beam.

b. Officer gets a visual observation of speed estimation.

c. Doppler audio speed estimation is obtained.

d. Radar speed reading in target window is observed.

e. Speedometer comparison with patrol speed is a necessity in the moving mode.

The second way to identify a target vehicle occurs:

a. The officer visually observes an apparent speed violation.

b. The target vehicle then enters the Radar Beam.

c. The officer continues to monitor the Doppler audio for speed estimation.

d. The speed is indicated in the target window.

e. Patrol speed must correspond with the certified speedometer.

The first four (4) elements are necessary for both stationary and moving radar. The last element, comparison of patrol speed with speedometer, is necessary only for a moving radar reading. The actual sequence in which the elements occur is unimportant. It is vital that all of the necessary elements be present.

<u>COSINE OR ANGLE EFFECT</u>

A radar unit measures velocity in a direct line, either toward or away from the transmitter. With road design, elevation, curves, etc., this direct line with the radar signal is not always possible. Thus, if we have a target vehicle entering the radar beam and there is an angle between the direction of the target vehicle and the transmitted signal, some component of the target's velocity will go undetected by the radar.

In the stationary mode, the greater this angle, the greater the loss in velocity. The Cosine of the angle is equivalent to the percent of velocity.
Example:

Angle between target vehicle and radar beam = 10 degrees.
The cosine of 10 degrees is .984

The actual speed of a target vehicle = 60 mph.

Indicated speed on the radar: 60 x .984 = 59.04 or 59 mph.

NOTE: Any angle effect in stationary mode is always in favor of the violator.

CHAPTER III

<u>PRINCIPLES OF MOVING RADAR</u>

To this point, the reading of target vehicles has been done while the patrol vehicle or officer is in a stationary position. Through modern technology, radar has been developed with the capability of "reading" vehicles while the patrol vehicle is in motion. Moving radar is nothing more than a "refinement" of stationary radar.

To understand the working of moving radar, it is necessary that we elaborate on the Doppler Principle as described earlier. In addition to the points previously stated, it is now necessary to develop the concept of relative motion. Quite simply, what this means is that for two objects in motion in the same direction, a Doppler Shift will result from the difference in their relative speeds; and for two objects in motion in opposite directions, a Doppler Shift will result equivalent to the sum of their speed. Considering this, we can see that we are already very close to our objective, which is, of course, a method of determining a target vehicle speed while the patrol vehicle is in motion.

If a conventional stationary radar will supply us with the combined or closing rate of speed of the two vehicles, all that remains is to accurately determine the patrol vehicle speed and subtract it from the combined speed. Algebraically the problem looks like this:

Target Vehicle Speed = Closing Rate Speed (-) Patrol Vehicle Speed, or (TS = CS - PS)

It is possible to determine the patrol speed using radar. Actually, the radar cannot sense its own movement but rather it sees the physical terrain moving toward it. The radar beam is reflected back off the roadway, hills and roadside objects and because the transmitter is moving, a Doppler Shift equal to the speed of the patrol vehicle results. This is commonly referred to as <u>Low Doppler</u>. Summarily, it is possible to determine the closing rate of speed of two vehicles with radar, and it is possible to determine the patrol vehicle speed with radar. If we next modify our unit by adding a second receiving channel, we can make both these determinations simultaneously. The addition of a calculation circuit allows us to subtract the patrol speed from the closing rate of speed and we have our moving radar. The closing rate is referred to as <u>High Doppler</u>.

PATROL SPEED CAPTURE

Patrol speed capture is an absolute necessity in moving radar. Any loss of correct patrol vehicle speed capture will cause inaccurate readings. The subtractor in the radar counting unit relies on a correct patrol speed capture in order to give a correct target speed. This characteristic can easily be recognized by getting a tracking history. Loss of correct patrol speed capture can occur because of improper antenna positioning, such as the antenna being too high to get a return signal from the roadway. In this case the radar will fail to have a patrol reading at all. This is readily apparent to the radar operator.

There are other instances where the radar can have an incorrect patrol speed capture and have inaccurate readings, but none that the certified operator cannot recognize. (Verify with your speedometer.)

Don't confuse this with the "Own Speed Capture effect" in the Chapter IV. You need your patrol speed as part of your tracking history.

TRACKING HISTORY

The Tracking History for both moving and stationary radar operations has already been covered in Stationary Operations. It is still Visual, Audio, Radar, Speedometer (VARS) with the emphasis on the "S" for Speedometer Verification. There is one exception to this and that is how the range is determined in moving operations.

In Range: The moving radar device has an approximate range of 2,000 to 2,500 feet, but depending on conditions present it could be greater or shorter. To determine the range of your device you can compute it quite simply by following these steps:

1. After you complete the required tests to assure that your device is working properly.

2. You observe traffic and pick a vehicle coming toward you (hopefully traffic will be light enough so that you have a lone vehicle target) and as soon as the radar picks up the target. Monitor the speed and start a timing how long before the vehicle passes your position.

3. With the information of a known speed and the time in seconds it took for the vehicle to traverse the zone of influence you can calculate your effective range using the following formula:

$\mathbf{d = t\ (S_1 + S_2)\ 1.47}$

d = distance
t = time in seconds

$\mathbf{S_1}$ = speed of patrol veh. in m.p.h.
$\mathbf{S_2}$ = speed of target veh. in m.p.h.
1.47 = conversion from miles per hour to feet per second

Example problem:

You are traveling 35 m.p.h. on a roadway. A vehicle enters the zone of influence and your radar device gives you a speed reading of 35 m.p.h. (the vehicle maintains the speed completely through the zone of influence) and it takes the vehicle 16 seconds to traverse from when you first picked up the vehicle with the radar to when it passes by your location.

Givens: t = 16 seconds
S_1 = 35 m.p.h. Formula: $\mathbf{d = t\ (S_1 + S_2) \times 1.47}$
S_2 = 35 m.p.h.

d = (16) (35 + 35) (1.47)

d = (16) (70) (1.47)

d = (1120) (1.47)

d = 1646.4 feet

The effective range in this situation is 1646.4 feet. The effective range for a device can change due to many factors hills, curves, atmospheric conditions, etc.

LOCATIONS FOR OPERATING RADAR

When choosing a location or area to operate radar, considerations should be made with reference to the following:

1. Areas where the operator has a clear field of vision.

2. Areas where there is a minimum possibility of external interference. (RFI, EMI, etc.)

3. Areas or locations where vehicles are well within the speed zone. (Bulk of traffic.)

4. Areas where vehicles have relatively good spacing, not bunched, or congested.

5. Areas with easy access to the violators with regard to pursuit of the vehicle, while taking into account the safety of other motorists.

6. Areas that allow safe set-up by the officer without interfering with the traffic flow.

7. A need for operating radar at the location:

   a. Complaints by citizens or local officials of excessive speed.

   b. Accident records.

   c. Traditional methods have been ineffective or they are unsafe for the particular location.

RADAR SET-UP AND TEST

ABC METHOD

Although Radar instruments are manufactured by various companies, most units fall into the categories: "One Piece" or "Two Piece" units. A One Piece unit has the antenna and counting unit (computer unit) housed in one single component and obviously, requires no assembly. One piece units are also referred to as "hand held units". Two Piece units require some component assembly. It is imperative that this assembly procedure be followed in the below sequence.

The basic method of setting up or connecting a radar device is called the "ABC" Method. This refers to connecting the **A**ntenna to the **B**ox (counting unit) and connecting the Box to a **C**urrent source (usually a cigar lighter receptacle). This is the basic method for setting up all radar devices and it simply means that all cables should be connected to the counting unit before plugging the unit into a power source.

NOTE: After you have connected all the cables to the counting unit make sure that the device is turned off before plugging it into the power source. If you don't a spark could jump at the point of connection, or a power surge could occur. If a spark, or power surge does occur with the device on, it could damage the internal components.

Also, do not coil, twist, or wrap the power cord around the antenna cord as it will act as an induction coil or a transformer and could cause possible interference with the operation of the device.

Once the device is connected A to B to C, then turn it on and a power indicator light should illuminate. Align the antenna properly (See section on antenna alignment page #45). For two piece units make sure that the counting unit is secured properly (refer to manufacturer's manual for proper installation).

INSTRUMENT TESTING

Testing procedures are to be followed in accordance with the manufacturer's manual. Circuitry tests vary from instrument to instrument but, in all cases, internal and external tests must be conducted. If for any reason the proper results fail to appear during testing, the Radar device should be taken out-of-service and be repaired.

Radar operators do not calibrate the radar unit. The operator merely tests the calibration of the equipment. The basic calibration testing is two part. An external test, by use of tuning forks, is done. Secondly, an internal calibration check is done.

NOTE: Both internal and external tests are done in both the stationary and moving modes.

FOLLOW THE OPERATOR'S MANUAL FOR THE SEQUENCE OF THE CHECKS

INTERNAL TEST(S)

The internal test checks the calibration of the counting mechanism in the readout unit. Most modern devices have a Lamp Segment Test (L/S) and an Internal Calibration Test (ICT). The lamp segment test illuminates all of the lamps and number segments verifying that they function. If any of the lamps or segments fail to illuminate the device should not be used and turned in for repair.

The internal calibration test will check the inner circuitry of the device and a preset number should be displayed in the readout window If this preset number is not displayed the device should not be used and turned in for repair. Refer to the manufacturers manual to determine which lamps and segments should illuminate and the preset number during the tests. Neither of these tests verify that the device is sending out a signal that is verified by the external test.

Starting with the stationary mode, the internal calibration switch or button is activated. A predetermined number, by design, will appear in the target display (refer to Operator's Manual). Release the button or switch and place the unit in moving mode and again activate the internal calibration switch or button. You should now receive a predetermined number in both displays. Consult the Operator's Manual for the predetermined calibration numbers.

NOTE: There is no acceptable tolerance in the internal calibration test!

A verification test is done, comparing the Patrol Display with the police vehicle's calibrated speedometer when the police vehicle is moving, to ensure that the correct patrol speed is being used in the computation of the target vehicle speed. This test is not required, but is recommended.

Another test may be performed is that of having a second vehicle, generally another police vehicle, traveling at a known speed, read by the radar unit. Notation of the known speed and the radar readout may be put on the officers log.

EXTERNAL TEST

The external test basically checks the functions of the antenna. The external test is done by using a tuning fork or forks. The fork is designed to oscillate, or vibrate, at a known frequency. This represents the equivalent speed with relation to the Doppler shift. On the tuning fork certification of accuracy, the information given is the cycles per second of oscillation of each tuning fork, and its corresponding mile per hour. Each fork should be stamped with a serial number which also appears on the certification of accuracy.

X-BAND AND K-BAND FORKS ARE NOT INTERCHANGEABLE

Although two forks may each be marked with 35 mph, at 35 mph an X-Band fork will not produce a 35 mph readout on a K-Band radar (15.25 mph). After the installation of the radar unit per the Operator's Manual, the actual testing should be done as follows:

To use the tuning fork, simply grasp the fork firmly by the handle and strike one of the tines against a reasonably firm surface. The heel of your shoe or a padded steering wheel are good surfaces. Striking the fork against a very hard surface such as metal or concrete damages the fork and should be avoided. Also, the forks should never be tapped or struck together. It is also a good practice to warm or cool the forks to a comfortable temperature before striking them.

Even though there have been independent tests conducted using cold tuning forks with no adverse affects, to avoid any questions at all, it is a good practice to spend a few minutes to allow the tuning forks to adjust to a comfortable operating temperature range.

During testing, it is a good procedure to point the antenna upwards to avoid any interference. After striking the tuning fork, it should be held between one-half inch (½) and two (2) inches from in front of the face of the antenna as shown in. It is recommended that the fork be held with one tine exposed to the antenna face for the most efficient method. Failure to obtain the proper speed reading as stamped on the tuning fork (plus or minus one mile per hour) is grounds for checking the Radar with another set of forks or placing the Radar unit out-of-service and have it repaired.

NOTE: If a tuning fork is stamped 50 m.p.h. and it shows either 49, 50, or 51 in the readout window the device is working properly.

Using tuning forks from one manufacturer to check the instrument of another manufacturer is not recommended. (Mixing "X" band forks with "K" band Radar or vice versa is also not recommended).

The tuning forks should be kept in an area which will keep them free from damage.
In the external test Stationary Mode, the forks are tapped and placed in front of the antenna separately, one at a time. In the external test Moving Mode, the forks are tapped and placed in front of the antenna together. The slower speed of the two forks will be displayed in the Patrol Display Window, while the difference of the two forks will be displayed in the Target Display Window.

EXAMPLE (moving mode):

Fork #1 - 35 mph....Patrol Display 35 mph

Fork #2 - 65 mph....Target Display 30 mph

POINTS TO REMEMBER IN OPERATING MOVING RADAR

While the accuracy specifications of moving radar equipment are equal to those of stationary radar sets, it must be remembered that the equipment is being operated over a wide variety of terrain in situations rarely, if ever, encountered in stationary, or conventional radar operations. Because of this, it is necessary that we address situations that affect moving radar.

Cosine Angle Effect can be made in one of two ways either naturally or inadvertently. The advantage may or may not be to the motorist while moving.

* Angle error occurs naturally in different ways. One way, the most common way, occurs as with stationary radar. When the vehicle approaching is a significant distance from the antenna the angle created is insignificant. As the target vehicle approaches the radar, a greater angle is created; hence, a target speed less than actual will be displayed.

* A curve in the road is another way moving angular effect may display a target speed less than actual. If a target vehicle approaching a moving patrol vehicle from around a curve, the reflected relative motion will not be straight at the antenna.

* In the previous situations, the cosine or angle error in the moving mode will always be to the

advantage of the motorist only if the radar unit is correctly computing the patrol car speed.

If the radar operator inadvertently aligns the antenna with a significant angle (in excess of 10 degrees) with respect to the direction of travel of a patrol vehicle, then a patrol speed less than true speed will result in a target speed higher than the target is actually moving.

NOTE: If we have a low patrol speed measurement, the calculation of TS = CS - PS will produce an erroneously high target speed.

For **example**,

If the target vehicle's true speed is 55 mph and the patrol vehicle's true speed is 50 mph, the true closing speed between the two vehicles would be 105 mph. However, if the angular effect produces a low patrol speed measurement: In this case 45 mph, then, the computation would be as follows:

TS = CS - PS

TS = 105 - 45

TS = 60 mph

Our target speed result would be 5 mph higher than the targets true speed. Under some circumstances, we might take an enforcement action when there actually has been no violation. The effect of improper antenna alignment is immediate and is more significant on the patrol car speed than on the target speed. However, when the incorrect patrol speed is displayed and compared with the calibrated speedometer, the operator will see that the two speeds are not equal; therefore, the reading will be disregarded.

It is of the utmost importance that the operator align the radar antenna as close as possible to zero degrees. With proper antenna alignment, any angle created by an approaching target in the moving mode will be in favor of the motorist. It must be remembered that the radar beam is fairly wide; therefore, lane selectivity is almost impossible; hence, the antenna should not be angled for better range.

ARITHMETIC RELATIONSHIP

One additional point concerning moving radar needs to be clarified: The arithmetic relationship, TS = CS - PS, works only when the patrol vehicle and target are moving in opposite directions. It is only in that case that the vehicles' closing speed (CS) is equal to the sum of their individual speeds. If the target vehicle were traveling in the same direction as the patrol vehicle, we could still point the moving radar at it and obtain a Doppler Shift. But in this case, the Doppler Shift would be caused by the difference between the patrol vehicle's speed and the target vehicle's speed.

You should be mindful that the "computer" portion of the moving radar operation has to perform a different calculation when the target is moving opposite to the patrol car as opposed to when it is moving in the same direction as the patrol car. The moving radars that were developed were capable of performing only one calculation (namely, TS=CS-PS), and so could be used only for targets moving opposite to the patrol car. Recently, some instruments have become available that are capable of operation for targets moving in the same direction Always be sure that you are aware of the capabilities of the instrument you use to ensure and accurate, valid speed measurement.

APPLICATION OF COSINE EFFECT TO MOVING RADAR

The same principle holds true in the moving mode, provided that there is no cosine or angle effect relative to the patrol vehicle speed. See. The antenna should be aimed straight down the hood of the police vehicle, in the direction that the police vehicle will be traveling and parallel with the roadway. The only cosine effect that will exist in this position, when the police vehicle is moving, will be on the target vehicle speed. The operator will experience this mainly while working four lane divided highways. As a vehicle approaches, the indicated speed on the radar may read 60, 59, 58 mph. The closer the target vehicle gets to the position of the police vehicle, the greater the angle between the direction of the target vehicle and the radar signal.

An area of concern is where there is improper aiming of the antenna, and a cosine effect is induced on the patrol vehicle speed. As the antenna is turned right or left from a straight ahead aiming position (the direction of travel of the patrol vehicle), the cosine effect will present itself with relation to the patrol vehicle speed. to the radar, it will appear as if the patrol vehicle is traveling slower than it actually is, due to the angle that exists between the direction of travel of the patrol vehicle and the radar signal. In this instance, some component of the patrol vehicle velocity is lost.

The combined speed of the police vehicle and a target vehicle may vary slightly due to the cosine effect on the "closing rate" but the main concern with moving radar cosine effect is the reduction of the patrol speed as seen by radar. The result is a slower than actual patrol speed being subtracted from the combined speed. Subsequently, the readout on the target vehicle would be higher than the actual speed of the target.

NOTE: If the angle is small (less than 10 degrees), the effect of any angle error will be insignificant. As the angle increases form 10 degrees, the error will be increased proportionately. Remember, in the stationary mode, the angle error is always to the advantage of the motorist. However in moving mode if the cosine is on the patrol speed the radar will not subtract out enough from the closing rate thus showing a higher than actual speed for the target vehicle.

The closer the target vehicle gets to 90 degrees, the lower the indicated speed on the radar.

NOTE: The straight ahead and parallel aiming of the radar antenna is recommended while in the moving mode of operation.

ANY COSINE EFFECT WILL ALWAYS BE IN FAVOR OF THE VIOLATOR, IF THE PATROL SPEED IS COMPUTED CORRECTLY REMEMBER ALWAYS VERIFY THE PATROL SPEED!

CHAPTER IV

RADAR EFFECTS

RECOGNITION AND ELIMINATION OF RADAR EFFECTS

In early 1979, the use of radar on our nations highways was challenged in Dade County (Miami), Florida. A great deal of publicity surrounded the proceedings. Radar, itself, was put on trial. Some of the publicity was directed by so called "experts" showing radar making what were termed mistakes or errors. These "experts" showed a house supposedly moving at 26 m.p.h. when in actuality the house was standing still. The radar was probably receiving a reflected signal. The "experts" also showed a tree that gave a reading, on a radar device, of 56 m.p.h. This situation was actually caused by traffic on a road that the camera did not show. This media radar bashing did much to smear the reputation of radar, its manufacture and operator training. Some of the media stories were presented honestly and tried to show both sides of the situation, but as the old saying goes, "what sells newspapers"? The answer, of course, is sensationalism. So, we have been stuck with this suspicion that radar is not reliable. There are anomalies, "glitches", phenomena and other things in the environment that can and will affect a radar's operation. You as an operator need to know about these anomalies, phenomena, or effects to be efficient and able to counteract them.

The trained radar operator has to view the operation of his unit in the context of the total environment. Unfortunately, that environment includes natural, manmade and operator effects. The Natural effects are primarily weather, things in nature (trees, grass, etc.), or the physical environment such as hills and curves in the roadway, buildings, etc.
Manmade effects include electrical and mechanical sources that may interfere with the radar unit's operation. Lastly, there are Operator effects that are operator induced situations, or the operator not properly interpreting the information from the device. Radar reads the speed at which objects move, and in a traffic environment we find many things in the total environment that may interfere with, or hamper operations. The operator needs to know of these "possible interferences" and utilize the device in the prescribed manner. The majority of these are eliminated by using the "Tracking History" and some have been eliminated through advances in technology in the manufacture of the devices.

Interference by definition is an "opposing or hampering action". Interference is one of the most common defenses used against police traffic radar. In some of the older radar units, it was possible for a "spike" or secondary signal to be processed and counted and displayed, or would show up as a "blip" on the graph (old "S"-Band device). Realizing this, radar manufacturers have built in suppression systems, filtering systems, verification circuits and detector circuits to deal with readouts from "noise" signals, although under certain circumstances a readout may occur as a result of an overabundance of interference. These readings are very distinguishable to the trained operator.

NATURAL EFFECTS

Weather effects include rain, snow, moisture in the atmosphere, high temperatures and other such types of natural phenomena. These things do not affect the accuracy of the radar. They may affect the ability of the radar to read a target vehicle, as they may absorb, or possibly scatter the radar signal. These types of interference hamper the sensitivity of the radar, but they do not affect the accuracy of the radar. In moving operations, rain and snow have the same effect of decreasing the sensitivity (range), but there is an added problem. The cracks, and crannies in the roadway fill with water, or ice. The "hot spot" where the radar receives the patrol vehicle speed does not reflect back to the radar and the patrol speed can be lost. This increases the possibility of the device using a shadowing target for the ground speed. It increases the possibility of the radar using a cosine target, off the side of the road, for the ground speed which could show a lower than actual patrol speed. When using radar in moving mode be sure to verify the patrol speed.

In some rare cases fog can increase the unit's range. However, operating radar in foggy conditions is not a good idea. It decreases the operator's ability to identify the target vehicle and the overall environment. Because of a "tunneling" effect the radar beam could increase beyond its normal range. This coupled with the decreased visibility makes for very poor radar operation. In stationary mode, check your location and be definitely sure of your effective range. Most of all pay extra attention to your total tracking history. Special care should be taken to avoid turning the antenna and creating a cosine error in an effort to increase lane selectivity or range during inclement weather.

MANMADE EFFECTS OR INTERFERENCE

Interference is classified as:

* Radio Frequency Interference. (RFI), or

* Electro-Magnetic Interference (EMI).

When discussing RFI or EMI, we refer to them as being either internal or external, meaning they originate from within the police vehicle or from a source outside the police vehicle.

Examples of possible sources of internal interference (also referred to as "secondary" signals) are:

* Patrol radio
* Mobile Digital Terminals
* Cellular Telephones
* CB radio
* Heater fan (motor and/or fan blades), also air conditioner
* Vehicle ignition
* Alternators
* Electric windows
* Electrical interference
* Etc.

Radar units equipped with suppression circuits or filters will eliminate low grade interferences such as; alternator, ignition, fan motor and like interference should they exist.

NOTE: Some of the "effects" are referred to as errors by the defense at time of trial. If possible correct them in their use of terminology and educate them that the radar device is interacting with the total environment.

PROPER USE OF EQUIPMENT

Before we go into the specific effects it should be emphasized that you as the operator should know the function of all the switches, buttons and lights on your device. While using the device you should check it continually and know what position each switch is in, so that you do not induce an "Operator Error". An example would be setting stationary and have the unit in the "moving mode". The question is what kind of readings will you get? and who is making the error, RADAR OR YOU?

RFI NOISE EFFECTS AND SOURCES

As mentioned above, there is a constant flow of radio signals in our environment no matter where the patrol vehicle is positioned. Under certain circumstances, that ambient "noise" may be read by the radar unit. Specific sources of Radio Frequency Interferences are discussed later in this chapter.

Interference inside of the patrol vehicle

Even within the patrol vehicle, there are a surprising number of devices which may interact with a radar unit. Most have been listed previously, however, one of the keys to locating and eliminating this type of interference lies with the recurrence of such readings under similar conditions. As an example; If you start receiving "ghost" readings in the 50-60 m.p.h. range every time you run the air conditioner you can learn to either run without the air conditioner or reject all readings under those conditions. **None of these sources of interference will sound like a car on the audio Doppler, and <u>the audio remains the key</u> to valid interpretation of the radar reading.**

Electrical Interference

A major source of electrical effect occurs from within the police vehicle. Radio frequency interference or RFI comes from a number of sources. If there is a poor connection between the Radar and the vehicle, RFI may occur. It is therefore recommended that a direct source of electrical current be used rather than a cigarette lighter receptacle in order to reduce a potential source of RFI. Radio transmissions at time of reading a target should not be conducted.

This will avoid any question of RFI at the time a tracking history was received. (It must be noted that a radio microphone must generally be held very close to the radar to cause any RFI.)

Operating PATROL RADIOS, MOBILE DIGITAL TERMINAL, or a CB RADIO within the patrol car could cause a reading to be displayed. Radar units equipped with a radio frequency (RF) detector will pick up the presence of RFI and in turn will cause the display or displays to blank out. To determine whether, or not your unit is equipped with an RF detector, simply key your patrol microphone while you have a reading on the screen(s). The display should go blank. If you should receive a reading under these circumstances it is now due to EMI. The reading(s) and audio signal from this type of interference are easily distinguishable from a true target readout and audio signal.

NOTE: To eliminate any questions as to this type of interference, DO NOT TRANSMIT on radios while reading vehicles.

The HEATER or AIR CONDITIONING motor and fan could provide a source of interference. Filters in the radar system should take care of the electrical "noise" from the motor itself. Your AUDIO signal will indicate what kind of signal you are receiving.

When the operator is utilizing the heater or air conditioning unit and is receiving a constant reading (generally low), and is receiving a corresponding Doppler audio, the reading is coming from the fan blades in the heater, or A/C system. Because of the movement, a Doppler "shift" is occurring. The question now is whether a 23 mph reading from the fan blades would produce the same audio signal as a target vehicle traveling at 23 mph. The answer is two part. First, the audio signal would be at the same pitch. Twenty-three mph is 23 mph with regard to speed or velocity. Secondly and most important, is that the audio signal from the fan blades is at a constant level or strength. The audio signal from a target vehicle starts weak and gets stronger as the vehicle gets closer to the radar, or vice versa if the vehicle is traveling away from the radar.

NOTE: If use of the heater or A/C is necessary, use them in the lowest setting.

RFI Interference through power and antenna leads

The power connection between the radar unit and the vehicle is a major potential source of interference. Electrical devices on the vehicle all produce a certain amount of feed-back into the system which may be read by the radar unit, much the same as a blender or vacuum cleaner will effect a nearby television, or radio.
A poor connection through a dirty cigarette lighter socket may interrupt the unit's power, causing "ghost" readings because of power surge or low volt power. This type of effect can be easily eliminated by connecting the radar unit directly to the vehicle battery.

In some radar units, the lead(s) to the antenna(s) are poorly shielded and are susceptible to interference through "induction". Particular care should be taken with how the cable is routed in the patrol vehicle. Keep the cable as far away as possible from all radios and other electrical devices. Do not intertwine the antenna and power leads, or wrap the cables in a coil, this produces an induction or a "coil" and could cause false readings.

EXTERNAL INTERFERENCE

There are two types of external interference, External Radio Frequency Interference and External Mechanical Interference.

Examples of possible sources of external Radio Frequency interference would be:

* Police radios from other police vehicles.
* CB radios.
* Amateur Radio operators (HAM).
* Microwave transmissions, telephone, satellite, etc.
* Power generating stations or sub-stations.
* High tension wires.
* Neon lights.
* Mercury vapor lights.
* Fluorescent lights.
* Harmonics (also may be included as an internal interference).

Police Radios

Some radar devices are influenced by police radio transmissions from a patrol vehicle in close proximity of the radar device. The furthest distance according to test results (testing done by the National Highway Traffic Safety Administration) is thirty (30) feet from the radar device. The transmissions during testing were from 100 watt transmitters in the police vehicle. Most police vehicle transmitters are of a low power usually five to ten watts.

NOTE: Audio signal indicator and possible fleeting high speed readings when a transmission is made from a police vehicle in close proximity of the radar.

CB Radio

Of seven radar units tested by NHTSA, one was affected by transmissions from a CB radio up to 175 feet. The other units were not affected by transmissions as close as three (3) feet from the radar.

Amateur Radio

These signals would fall into the same category as a CB Radio.

Microwave transmissions

Microwaves transmissions for telephone communications, satellite communications, or other sources are not on the same frequency as the radar devices and the device would either blank, or the Audio would be inconsistent with a true target. These types of transmissions would include Military or Commercial radar transmissions. These devices produce a powerful microwave signal. Close proximity can cause interference with police radar. These devices use a rotating antenna that has a directional antenna. They transmit bursts of microwave energy but for nano seconds (Millionths of a second). Rarely will you encounter any problems because of the short time periods involved, but areas with this type of equipment should be checked very carefully before using radar. In most cases you will not be close enough to affected by these devices.

In this same area falls the commercial broadcast stations. These include television, AM radio and FM radio stations. All of these stations put out strong signals up to 50,000 watts of power (AM 640, KFI Los Angeles), and can be heard when conditions are good halfway across the country. Because they do put out a lot of power and a higher frequency they might cause interference. There have been reports of voice or music being picked up over the radar audio speaker. This type of interference will rarely give a reading, but you will readily detect that you should change locations. Again check your location before you start using the radar and be aware of these types of situations.

High Tension Wires/Transformers

Electrical interference from high tension wires and/or transformers in commonly used as a defense, the contention being that the reading came from the wires or transformer and not from the target vehicle. The fact that the radar was influenced by this type of interference can be ruled out simply by the use of the audio system. Also, the circuitry used in police traffic radar today is designed so that "noise" cannot be counted along with Doppler signals. Therefore, instead of receiving a spurious (not genuine) the presence of electrical noise which would be strong enough to affect the radar.

The operator may however, hear a cracking, popping sound from the audio system, as this system generally precedes the verification circuits. This constant crackling/popping sound is usually referred to as "ambient", or "white" noise. The above information deals with electrical "noise". Should the operator receive a readout from wires or transformers it would be a harmonic signal of 60 cycles per second alternating current leaking form a faulty high tension wire or transformer. (See harmonic interference.)

Neon Lights - Mercury Vapor Lights - Fluorescent Lights

These lights generally operate on a frequency of 60 cycles per second, alternating current. Should you receive a reading from one of these types of lights (IN THE ABSENCE OF TARGET VEHICLES), you would be receiving a harmonic signal of the basic 60 cycle per second frequency. Although "noise" is not acceptable to the radar, it is possible for a harmonic of a low frequency to be processed.

Harmonic Interference

A harmonic is a multiple of a fundamental or basic frequency. For instance, a neon light operating at 60 cycles per second alternating current would produce harmonic signals of:

* 1st Harmonic = 60 cycles per second

(fundamental)

* 2nd Harmonic = 60 x 2 = 120 cycles per second
* 3rd Harmonic = 60 x 3 = 180 cycles per second
* 4th Harmonic = 60 x 4 = 240 cycles per second
* etc.
* etc.

The higher the frequency of the harmonic signal, the lower the amplitude or strength of the signal. For this reason, a Doppler signal will override the weaker harmonic signal.

NOTE: Again, the audio signal will inform the operator as to what type of signal is being received by the radar.

EXTERNAL

RFI, EMI, Alternating Current Interference, including power lines, transformers, neon lights, mercury vapor lights. RFI, Radio Frequency Interference consists of interference caused by other radio transmitters near enough to the frequency of the radar, read erroneously. Some radars contain a circuit which recognizes this condition and causes the radar to shut down its counting circuits and go blank.
However, since the levels of this interference may reach a "saturation condition" called electrical mechanical interference (EMI), the operator should be aware that strong, near radio signals either in the radio or radar frequencies may cause interference. These are readily recognized as they are inconsistent to the speed of traffic, usually being inordinately high in nature or not stable, but erratic and rapidly changing. They are accompanied by a squeal in the audio instead of the familiar clear Doppler tone the operator has become familiar with. Daily operation of the radar device by the operator in his assigned patrol area will familiarize him with any permanent installations which cause this problem. Transient transmitters exhibit the same characteristics.

Any readings on the radar while the patrol car radio is in use would certainly be disregarded. The operator may leave the radar on during the time of radio use, as it will not harm the radar and is helpful in teaching him to recognize this interference.

Defroster, heater, and air conditioner fans, when the radar is pointing directly at the outlets, may cause the radar to read a number consistent with the speed of the fans. These readings are useful to show speeding trees and buildings.

These are readily recognized and will be of such a weak nature that they will be displaced at once by primary target in the central portion of the beam. It is a good practice to run these fans in the lower speed positions anyway as one of their actions is to shorten the range of the radar. In the moving mode of operation with the antenna looking into the clear, ahead of the vehicle, this interference is at its minimum and of such a low order that it causes no problems when the fan are run at their lower speeds.

The ignition, alternator, AC alternating current interference is generally of such a low order that it causes a degradation of the performance of the radar and a loss of range rather than a false reading. A way to recognize this interference is to put the radar in the stationary mode, turn up the audio, and listen. The operator will soon become familiar with the hum caused by alternating current, street lights, etc., the whine of the alternator or the tapping noise of ignition interference.

If these levels of interference appear to get stronger and the radar appears to shorten in range it would bear investigation as to whether it is a particularly noisy location, a particularly noisy vehicle, or a fault of the suppression circuits failing, or the vehicle suppression failing. The radar should be tried in another vehicle to see if the condition still exists. If it does continue, then it is the fault of the suppression circuits in the radar. If it does not continue, then the vehicle should be checked.

External Mechanical Interference

This is one of the most common types of radar effect, and has been demonstrated several times on television. Typically, the radar is picking up a signal from some mechanical device. A rotating sign as an example, as the sigh rotates it revolves at a set speed and the radar device measures the speed of its rotation. The rotation speed is very low and some defendants try to say that the radar "added" the additional speed of the rotation to his speed. Since, radar only measures the change in frequency (Doppler Shift) of one object and does not add speeds this scenario cannot happen. The trained operator will recognize through the audio that this is not a "true target".

OPERATOR EFFECTS

Operator effects are simply those situations where the operator induces a false reading either by misuse of the device, or lack of training or knowledge in the proper operation. Through the rest of the chapter the "named" effects are listed in alphabetical order, you might want to read through them and note the ones that are operator induced and the ones that occur and could be missed by an untrained operator.

OPERATIONAL AND NON-OPERATIONAL "EFFECTS"

A.D.S. EFFECT

The Anti-Defeat switch (A.D.S. also known as Anti-Detector Switch) silences the transmitter so that radar detectors are useless against the radar. It leaves the rest of the circuitry on and "idling". It is also called the "turn on" error and describes what was called high opening back in the days of needle-type radar. It purports that the radar may open (display) on a number higher than the speed of the target and then settle back. In old radars, that was possible as the signal processing circuits were capable of reading electrical noise. It was pointed out to the manufacturers and the operators were trained to adjust the radar to eliminate it. In the new digital radars, the verification circuitry prohibits the radar reading at all, until a sampling is done over a period of time sufficient to analyze the signal to make certain it is a Doppler signal rather than electrical noise (time in nano seconds). This precludes that radar from reading a high number, any number in fact, until the signal is stable. If the A.D.S. switch caused a "spike" which it does not, the radar would simply delay the reading until the spike disappeared. This "error" may be disproved by using the switch and noting that the first reading displayed by radar is always consistent with those that follow. There is no A.D.S. error.

AUTOMATIC GAIN CONTROL

Radar units are generally equipped with an automatic gain control which increases the sensitivity of the radar unit causing the radar to see the strongest signal. Therefore, an on-coming vehicle will override any interference or ghost. In the absence of any on-coming vehicle, the radar could pick up a spurious reading. The device continues to look for signals that are weaker and weaker in an attempt to provide the operator with information.

The information displayed will only be as good as the information received. The skilled operator must always be aware that the reading being displayed is the result of the correct input. Therefore, the radar operator must always obtain a tracking history and verify the patrol speed with the certified speedometer while moving and always listen to the Doppler audio.

AVERAGING

This is similar to the A.D.S. error claim, that the radar could look at a car going perhaps 50 mph, look at another target going 70 mph, and average the two at 60 mph. The verification circuits deal with only one signal at a time and by their nature and design cannot average. In reality, if two similar size targets of dissimilar speed are present, it reads neither and blanks the display until it has only one clear signal. There is no averaging error.

NOTE: This cannot happen. The radar will only process one signal at a time, that being the dominant signal.

BATCHING EFFECT

Another special problem that only applies to moving radar is known as the batching effect. This is caused by slight time lags in the moving radar's sensing/computing cycle. Like the angular effect (cosine), the batching effect can lead to either low or high target speed results, depending upon the exact circumstances.

The batching effect might happen if the patrol car is substantially changing its speed (i.e., rapidly accelerating or decelerating) while the radar speed measurements are being made. In simple terms, the computer may not be able to keep up with these drastic speed changes. Instead of using the actual patrol speed at the instant that the closing speed is measured, the computer may use the speed that the patrol car was traveling a few fractions of a second earlier.

If the patrol car is rapidly accelerating, its previous speed was lower than its present true speed, and the target speed calculation may be higher than the target's true speed.

If the patrol car is rapidly decelerating, then the speed a fraction a second ago was higher than its present speed, and the target speed calculation may be lower than the true speed. The batching effect can be avoided by maintaining a relatively steady speed when taking speed measurements and by monitoring your patrol speed (speedometer).

In summary, the moving radar angular effect, shadowing effect and batching effect are particularly significant because they might lead us to think that a motorist is traveling faster than he really is. We need to do everything that we possibly can to avoid these effects. In particular, we should strive to keep the patrol car's speed reasonably steady to eliminate the batching problem; it is particularly important to avoid any sudden acceleration and/or decelerations. We must aim the moving radar as closely as possible to the patrol car's direction of motion. We should keep a large distance between the patrol car and any other vehicle that could produce the shadowing effect.

In general, we should be aware that it usually is not advisable to conduct moving radar operations in congested traffic where selectivity problems and shadowing are most likely to occur. In all cases where we use moving radar, we should verify that the correct patrol speed has gone into the target speed calculation. Many of the latest-model moving radars have two display windows so that both the target speed and patrol speed measurements can be seen simultaneously. Finally, you must verify that the radar and speedometer agree on the patrol speed before accepting the target speed result as valid.

NOTE: To avoid any question as to the possibility of batching effect, do not accelerate, or decelerate while reading a target vehicle. Testifying to a maintained speed of the police vehicle during a reading will put to rest any question as to batching.

BLOWING DUST EFFECT

The blowing dust, tree leaves, swinging sings, wind, rain, bats' wings, etc., are purely from imagination. They have no effect other than reducing the range of radar

COMPUTERS

Computers or mobile digital terminals and stolen vehicle tracking systems are the latest thing in the police vehicles. Some of these devices are capable of emitting RFI over a wide spectrum of the radio frequencies and might cause interference with the radar device. The radar audio Doppler will be the most apparent indicator of interference from these devices. It will more than likely be very distinct sounding like movie sound effects and not sound like a true target.

COSINE EFFECT

See Cosine effect(s) in Chapters II and III and **8.**

COSINE OWN SPEED

This is an effect that the radar in moving mode could produce, since it obtains the speed of the patrol car from the roadway (Low Doppler), it could look off to the side at a road sign with sufficient angle to perhaps obtain a low reading, thus not subtracting a number sufficiently high to get the correct patrol speed; this to the detriment of the motorist.

The fact is that eighty-five percent of the signal strength is in a cigar shaped beam, approximately six degrees wide on each side. The area illuminated by this signal is some six hundred thousand square feet and contained in it is nearly all the beam strength.

To suppose that the radar would read a sign or other target, even a large one, completely outside that shape in the remainder of the fifteen percent of the strength, when that fifteen percent encompasses another 344 degrees, is not possible. Even if the aforementioned were not true, and the laws of electromagnetic wave propagation were repealed, there are other circuit characteristics in the verifiers which prevent the reading of targets exhibiting the kind of cosine derived deceleration characteristics of targets of such angles. Last, but not least, the officer proves the absence of such error all day by simply observing the stability of patrol speed readings as he drives around and at the time he locks the violation, any instability or "jumping around" of numbers on patrol speed would not be tolerated. There is no cosine on own speed error.

NOTE: To eliminate any possibility of this occurring the verification of patrol speed via the speedometer eliminates this effect.

DOUBLE BOUNCE

There is one additional shadowing-type phenomenon of which you should be aware. It is called "Double Bounce" The radar could use Truck 1 as a reflector and cause the difference speed (20 mph) to be added to Truck 2, thereby causing the readout to display 80 mph. The Radar operator would normally attribute this reading to the target vehicle. It is important to note that the Radar has not "seen" the target vehicle yet. Also, if there was no difference in speed (if Truck 1 and the patrol car were traveling at the same speed of 50 mph), Truck 1 could reflect the patrol speed (50 mph) and add it to Truck 2, thus producing a reading of 110 mph. It is important to be aware of this potential problem if you are in an area of heavy truck traffic. This problem can also be avoided by obtaining a tracking history. Do not lock in on the first reading. Remember 3 to 5 seconds. See Figure #?

EMERGENCY LIGHTS

The electronic circuits in some of the newer police emergency lighting systems are capable of producing strong RFI causing interference with the radar device. These systems are usually equipped with "strobes" and the audio will produce an erratic tone or strong pulses as the strobe activates. This really should not be a problem as most officers would not be utilizing radar while the emergency lights are in operation. Only the lights installed in the police vehicle will have this effect because of the proximity to the radar.

EXCESSIVE AUDIO

A loud audio in close proximity to the radar can cause the radar to react as if the sound were a Doppler shift. Some traffic radar devices can display false signals due to this phenomenon. The volume of the audio required to cause this effect is easily noticeable. This can be shown by whistling directly into the antenna. Unless the audio is loud and a single pure tone, the radar's signal circuitry will ignore the sound. This is rarely a problem, however, keep the AM and FM radios away from the radar.

FEEDBACK

Assuming we have a two-piece radar unit consisting of the antenna and counting unit, feedback effect occurs when the antenna is panned through or aimed at the readout unit and the signal being transmitted travels into the readout unit. Another illustration of this is when a microphone is keyed in front of the speaker of a radio, or public address system and a high frequency squeal is emitted.

HEAT BUILD-UP EFFECT

Heat tests done on police traffic radar at 140 degrees Fahrenheit showed a variance of .019 mph. However, heat does play a significant factor in component life. Heat over time will weaken transistors and diodes and thus cause a failure in the circuitry. Whenever possible keep devices out of the heat.

NOTE: Heat build-up is not a factor in actual readings.

IMPROPER CONTROL SETTINGS

This is definitely an operator error. You as the operator should know every switch, button and light on the device and their function. Before, during and after, or to put it another way continually check your radar switches and settings to insure that you are operating it properly.

If you operate in the moving mode with the radar controls set for stationary, you readings are going to be different than what you are observing. The radar will display the closing rate and you will receive NO patrol speed reading.

If you set your self in a stationary position and the device is set for moving again you will receive some strange readings. Suppose you do this and you have two vehicles approaching from your front. One is traveling at 30 mph and the other is traveling at 55 mph. Your radar would probably indicate a patrol speed of 30 mph and a target speed of 25 mph (TS = CS - PS, or 25 = 55 - 30).

In both of these situations you have told the radar that its doing the opposite of what you are really doing.

LOW TEMPERATURE EFFECT

Results of testing at -22 degrees Fahrenheit indicated no error existing due to low temperature.

LOW SPEED COMBINING EFFECT

In moving radar, it depends on manufacturers design as to the speed a police car has to be traveling or cannot exceed in order to reading oncoming traffic. That is, if the police car is moving slower than a certain speed or over a certain speed, the radar will not track targets. This is due to the filtering systems in the radar unit. As mentioned earlier in the section on the application of the Doppler Principle to moving radar, High and Low Doppler occurs. We will use the following example to explain the "low speed combining effect". The effective range of police car speeds for reading oncoming traffic is 16 to 69 miles per hour.

This would be considered the Low Doppler range, as the part of the radar that deals with the Low Doppler is looking for low differences in frequencies as opposed to the High Doppler portion of the radar, which is looking for high differences in frequencies as in the combined speeds of the police and a target vehicle. The Low Speed Combining Effect takes place when the police vehicle is near the 16 mph area. If the police vehicle is approaching a stop sign and is traveling 14 mph and there is an oncoming vehicle traveling at 23 mph, the combined speed is 37 mph. This 37 mph is processed as Low Doppler and the 37 mph is displayed in the <u>PATROL DISPLAY WINDOW.</u>

NOTE: This effect is easily recognized by a trained operator, and will be disregarded, as only target speeds in the target display window are of concern to the operator.

LOW VOLTAGE EFFECT

This occurs when the power supply to the radar has been reduced to a level at which the radar will no longer function. Some units are equipped with an indicating feature which informs the operator that a low voltage situation exists. Readings do not occur as a result of a low voltage situation, the display is blanked.

MOVING COSINE EFFECT

See explanation in test of Chapter III.

MULTIPLE REFLECTED SIGNAL EFFECT

This effect occurs when the radar antenna is aimed in the general direction of an object which may reflect the radar signal at an angle. For Example: We are in the stationary mode. We are parked along the roadside and in front of the police vehicle (down the road) and off to one side, is a large billboard. The radar signal strikes the sign, it is reflected at an angle (which is dependent on the positioning of the sign), strikes a target vehicle approaching the sign from an intersecting road, returns to the sign and back to the radar. What do we have now? The

"GHOST" reading. Is there Doppler audio? Obvious answer..., Doppler audio, corresponding to the speed of the target. Now, a vehicle approaches your location moving straight at the radar, and you now have a visible target. Which signal will be stronger?

The vehicle on the intersecting road may be closer, but each time the signal is reflected, it loses strength. The vehicle traveling directly at the radar will produce the strongest or dominant signal.

NICHOLS EFFECT

This purports that a moving radar traveling along a road with fences, or whatever alongside, will set up an oscillation due to repetitive signal returns from those objects and read a distorted signal. This claim ignores the fact that eight-five percent of the beam strength lies in the main body of the beam and these weak signals, even though present, are thousands of times weaker than the main signals from the roadway. The radar completely ignores them.

OWN SPEED CAPTURE EFFECT

Own speed capture effect is a moving radar effect. When this effect occurs, the radar displays a target speed that is the same as or a multiple of the patrol speed. A common cause is a double reflection of the radar beam from a bridge or other object.
The radar receives a Doppler shift return from a bridge . The radar measures the amount of shift and processes it as a patrol speed (PS = 30). A portion of that return bounces off of the front of the police vehicle and returns to the bridge. The signal bounces off of the bridge and is shifted again to a higher frequency (double the original amount of shift, remember though that this signal is getting weaker as it travels over distance), this signal now returns to the radar with this "double" shift. The second return is received by the radar and processed as the closing rate of speed (CS = 60). Thus:

TS = CS (60) - PS (30)

30 = 60 - 30

PHASE LOCKED LOOP EFFECT

The Phase Locked Loop (P.L.L.) is widely used in everything from life support systems to components in the instrumental landing systems for airliners. It is a significant contribution of the space-age and so common and reliable, it has perfect application in traffic radar. Its function is to discriminate between electrical noise and signal, and act on only true signals. It makes possible communication with the planet Venus, pictures of the Moon, and a police radar, which can read with dead certain accuracy at great distances.

PANNING EFFECT

This effect is more appropriately known as "feedback". See Feedback.

NOTE: You may receive a high pitch but without the clarity of a true main beam target. A very strong audio tone, but inconsistent, or scratchy. Care should be taken not to aim or point the antenna at the readout unit.

POWER SURGE EFFECT

This is also known as "POP" and can occur when the device is turned on and then plugged in, or when it is turned on and the vehicle ignition is turned on a power surge could occur. If it does occur the device could be damaged internally from the resulting power surge. If it is damaged it could give inaccurate or false readings (See "ABC" set up procedure). It is also claimed that when a radar unit is on, but the signal is being "held", that upon activating the radar, "taking it off hold", there will be a sudden surge of power which could produce an erroneous reading (See A.D.S. Effect).

NOTE:

* The power supply to the circuitry is limited by design.

* If power limiting components fail, the displays are blanked due to the interruption of the verification system.

* Any error in the target display would also be evident in the patrol display in the moving mode and would be recognized by the operator, as the patrol display is compared with the calibrated speedometer. In the stationary mode, the initial speed is not automatically locked. Also, the first speed readout that appears is not immediately locked by the operator. A monitoring of speed(s) is done prior to manual locking, if locking of the readout(s) is preferred. (Tracking History.)

PULSATING AMPLITUDE EFFECT

Pulsating amplitude effect can occur when a moving radar unit meets a repeated patterned object along the side of the road. This has usually been described as a picket fence. It could be any relatively closely and evenly spaced objects that are along the roadside. This rarely happens and is extremely hard to produce. When it does occur the radar operator will notice a pulsation of the audio Doppler or a buzzing sound. If you are aware of your environment you will recognize this situation immediately.

REFLECTED SIGNAL

This goes by several names; mostly it is the technique used to show so-called "ghosting" or trees and mailboxes or other inanimate objects moving. The radar beam, which if we could see it, looks like a fat cigar, it looks at targets in its strongest part, to the detriment of targets in the weaker areas. However, in the absence of targets in the "main beam", it can bounce and read very weak targets outside the main beam.

Let it be said emphatically that these "bounce" or "side" targets will be immediately displaced by primary targets in the main beam. Interestingly, those target strengths may be on an order of five thousand times as weak or more to one in the main beam. The "bounce" signal will not displace the main target. See Multiple Signal, Double Bounce and Own Speed Capture. See

SHADOWING EFFECT

You should also be aware that moving radar may be susceptible to some special problems that do not affect stationary radar. One of these problems is known as the shadowing effect. Like the angular effect, it can produce a lower-than-actual patrol speed measurement and lead to a higher-than-actual target speed calculation.

There is a large moving truck ahead of the patrol vehicle. The radar beam that we intend to strike the ground is striking the truck and the truck reflects a stronger signal than the ground (Remember, the truck is large, metallic and close to the patrol vehicle and is thus an efficient reflector.). The radar uses the signal reflected from the truck and indicates a lower-than-actual patrol speed. This occurs because the truck and patrol car are moving in the same direction and the relative speed of the patrol car to the truck is less than the patrol car's actual over-the-road speed. For example, if the patrol car is moving at 50 mph and the truck at 30 mph, the speed of the patrol car relative to the truck is only 20 mph, and the moving radar would mistakenly measure the patrol cars speed at 20 mph (Low Doppler). In effect, the radar would "think" that the truck is the ground, and the "ground happens to be moving at 20 miles per hour.

Meanwhile, what is happening with the "other" radar beam that is striking the target vehicle? It is continuing to undergo a Doppler Shift caused by the combined speeds (High Doppler) of the target and patrol car, and so the radar measures this combined speed. (Patrol speed of 50 plus the target speed of 55.) Now the computer goes into action:

TS = CS (105) - PS (20)

85 = 105 - 20

But unfortunately, the computer believes that the patrol speed is only 20 mph. So, as far as the radar is concerned, the target is traveling at 85 mph (105-20). Obviously, this is a very large deviation from the target's actual speed of 55 mph. Even worse, from a legal standpoint, the deviation is not in the defendant's favor. Fortunately, this type of problem does not occur all the time because usually the signal reflected back from the ground is stronger than that reflected back from roadside objects or from other vehicles in the patrol car's lane. However, if the situation should occur, it can easily be detected by monitoring your patrol speed. This problem can be avoided by obtaining a tracking history before manually locking the target speed and/or taking enforcement action.

SIDE LOBE EFFECT

Radar side lobes are accused of causing a radar to read a vehicle as much as 45 degrees outside of the main beam. By its very nature, the radar cannot do this because the reflected signal from the main beam is 1,000 to 5,000 times stronger than any side lobe. See figure ?

SCANNING OR SWEEPING EFFECT

This is a theoretical effect which relates to a sweeping motion of a radar antenna and the receiving of a speed readout from one of two things.

* It is theorized that the motion of the antenna could result in a speed reading being produced, as the Doppler Principle relates to movement.

* It is theorized that if a radar beam is swept or panned across a flat plane, such as sweeping the antenna across a moving target vehicle (for example, from the rear to the front of the vehicle), that speed could be added to the actual speed of the target vehicle. Again, radar does not add signals.

NOTE: Radar antennas mounted in a stationary position eliminate any question as to the "sweeping effect".

WINDOW OBSTRUCTIONS

You should keep the windshield clean and free of obstructions. The beam will be refracted slightly as it passes through the glass, but it doesn't affect the operation of the device. A dirty windshield though can block, absorb,

AUTOMATIC LOCK AND ALARM SYSTEMS

Although the automatic lock and alarm is not an effect it is included in this chapter because of the problems encountered in the past by use of this feature.

The automatic locking of speed readouts has come under sharp criticism, and justifiably so. The automatic lock feature on a radar device works in conjunction with the alarm system.

If the radar alarm is programmed at 56 mph, then the first readout of 56 mph or greater is automatically locked in and displayed, and the operator is informed by a "beeping" sound from the alarm system that a 56 mph reading (or greater) has taken place. The AUTO-LOCK lends itself to questions from radar critics to defense attorneys as to the automatic locking in of a spurious reading from interference, power surge effect, etc. Locking in the readout MANUALLY, or not locking them at all, eliminates any question as to what type of reading the operator was receiving. Devices equipped with this feature did not allow for a tracking history to be developed.

For this reason, most of the automatic lock mechanisms have been removed on radar units produced recently, officers are instructed NOT TO USE the auto-lock feature. Some radar manufacturers are not offering the automatic lock feature on their newer units.

On radar units with alarm systems, the problem covered in the preceding paragraph could be eliminated by setting the alarm high. For example, an 88 or 99 setting would avoid the so-called "alarming" of the operator, and there would be no interference of the audio signal, except at the very high speeds.

BEAM INTERRUPTER SWITCH

Older K-55 radar devices have been modified with a beam interrupter switch. New models are manufactured with the switch as original equipment. The beam interrupter switch simply stops the transmission of the microwaves but allows the computer component to remain functional.

Upon visually observing an apparent speed violation, the officer turns the switch to the "On" position allowing the transmission of the microwaves to strike the target vehicle.

Remember, the officer must continue to obtain the Tracking History after visually observing the target vehicle. This is the Anti-Defeat Switch.

1. **READOUT UNIT** - The readout unit should be mounted in a location in plain view of the operator. The readout unit should be mounted in a secure position to avoid damage to the equipment. The readout unit should be mounted so that the operator has easy access to it for testing, locking in of speed readout(s), if desired, changing of modes, etc.

2. A**NTENNA** - The antenna should be mounted in a secure manner, whether it is to be mounted inside or outside of police vehicle. Only weatherproof antennas should be mounted outside of the police vehicle. Antennas designed to be mounted inside the police vehicle should not be mounted outside of the police vehicle unless either position is recommended by the manufacturer.

Positioning and aiming of the antenna should be done in accordance with the following:

a. POSITIONING

1). Easy access to the operator for testing.

2). Positioned to avoid panning effect.

3). In an area that the antenna can be

secured.

b. AIMING

1). direction and tilt of the antenna:

a). Stationary mode: As close to the direction of travel of the target vehicles as possible, and parallel with the ground.

b). Moving mode: Straight ahead (in the direction that the police vehicle is traveling) and parallel with the ground. (SEE MOVING MODE COSINE EFFECT.)

3. **POWER SOURCE** - The power cord should be plugged into the auxiliary cigarette lighter provided in police vehicles. It is recommended, as the source is hooked up directly with the battery. Make sure of good power connection.

4. **ANTI-DETECTION SWITCH** - Care should be taken to avoid damage to this part of the equipment (should it be part of the unit). The unit may be positioned on the seat next to the operator, between the seats (with access to the operator), or secured to the radio stack, or other convenient locations.

5. **CONNECTIONS** - Make sure that if the equipment being used requires the operator to connect certain parts of the equipment, that care is taken to ensure that the parts are correctly secured and that good connections are made.

CHAPTER VI

CALIFORNIA VEHICLE CODE SECTIONS

The Sections of the Vehicle Code contained in this handbook are excerpts from the 1990 edition of the California Vehicle Code. The particular

Sections that apply to the use of radar include the speed laws and several other Sections that affect radar operations and use. These Sections are listed as follows:

* 165 C.V.C. Authorized Emergency Vehicle
* 440 C.V.C. Official Traffic Control Device
* 445 C.V.C. Official Traffic Control Signal
* 627 C.V.C. Engineering and Traffic Survey
* 22348 C.V.C. Excessive Speed and Designated Lane Use
* 22349 C.V.C. Maximum Speed Limit
* 22350 C.V.C. Basic Speed Law
* 22351 C.V.C. Speed Law Violations
* 22352 C.V.C. Prima Facie Speed Limits
* 22354 C.V.C. Decrease of State Highway Limits
* 22355 C.V.C. Variable Speed Limits
* 22356 C.V.C. Increase of Freeway Limit
* 22357 C.V.C. Increase of Local Limits
* 22357.1 C.V.C. Decrease near Children's Playgrounds
* 22358 C.V.C. Decrease of Local Limits
* 22358.3 C.V.C. Decrease on Narrow Street
* 22358.4 C.V.C. Decrease of Local Limits Near Schools or Senior Centers
* 22358.5 C.V.C. Downward Speed Zoning
* 22359 C.V.C. Boundary line Streets
* 22362 C.V.C. Speed Limit where Persons at Work
* 22364 C.V.C. Lane Speed Limits
* 22400 C.V.C. Minimum Speed Law
* 22405 C.V.C. Unsafe speed for bridge, structure, tube, or tunnel
* 22406 C.V.C. Maximum Speed for designated vehicles
* 22407 C.V.C. Truck Speeds on downgrades
* 22409 C.V.C. Solid tire vehicle, speed restricted by weight
* 22410 C.V.C. Metal tire, vehicle exceeding 6 m.p.h.
* 40500 C.V.C. Notice to appear
* 40503 C.V.C. Speed Charge
* 40508 C.V.C. Violation of promise to appear or pay fine
* 40800 C.V.C. Vehicle and Uniform Used by Officer
* 40801 C.V.C. Speed Trap Prohibition
* 40802 C.V.C. Speed Trap
* 40803 C.V.C. Speed Trap Evidence
* 40804 C.V.C. Testimony based on Speed Trap
* 40805 C.V.C. Admission of Speed Trap Evidence
* 41100 C.V.C. Speed Restriction Signs
* 41600 C.V.C. Arrest Quota Defined
* 41601 C.V.C. Citation Defined
* 41602 C.V.C. Arrest Quota Prohibited
* 41603 C.V.C. Evaluation of Peace Officers Performance

It is strongly suggested that officers enforcing the traffic laws become extremely well versed in the previously listed sections as well as those other sections of the Vehicle Code pertaining to the movement of pedestrians, bicycles and traffic. The bulk of these are found in Divisions 10 and 11 of the California Vehicle Code. As stated in the introductory chapter there are three basic types of speed laws; basic speed law, prima facie law and maximum speed law. There are of course others, but radar is usually deployed to detect those vehicles exceeding the three basic types of speed laws mentioned above. In this book we will not completely write out all of the laws that are listed on the previous page, just those that are necessary to know in day-to-day use by the operator.

<u>SECTION 440 V.C.</u> ***Official Traffic Control Device***

An "official traffic control device" is any sign, signal, marking, or device, consistent with Section 21400, placed or erected by authority of a public body or official having jurisdiction, for the purpose of regulating, warning, or guiding traffic, but does not include islands, curbs, traffic barriers, or other roadway design features.

<u>SECTION 445 V.C.</u> ***Official Traffic Control Signal***

An "official traffic control signal" is any device, weather manually, electrically or mechanically operated, by which traffic is alternately directed to stop and proceed and which is erected by authority of a public body or official having jurisdiction.

<u>SECTION 627 V.C.</u> ***Engineering and Traffic Survey***

(a) "Engineering and Traffic Survey", as used in this code, means a survey of highway and traffic conditions in accordance with methods determined by the Department of Transportation for use by the state and local authorities.

(b) An engineering and traffic survey shall include, among other requirements deemed necessary by the department, consideration of all of the following:

(1) Prevailing speeds as determined by traffic engineering measurements.

(2) Accident records.

(3) Highway, traffic, and roadside conditions not readily apparent to the driver.

<u>SECTION 22349 V.C.</u> ***Maximum Speed Limit***

Except as provided in Section 22356, no person shall drive a vehicle upon a highway at a speed greater than 55 miles per hour.

NOTE: Compare to Uniform Vehicle Code Maximum limits in Chapter I.

<u>SECTION 22350 V.C.</u> ***Basic Speed Law***

No person shall drive a vehicle upon a highway at a speed greater than is reasonable or prudent having due regard foe weather, visibility, the traffic on, and the surface and width of, the highway, and in no event at a speed which endangers the safety of persons or property.

NOTE: Compare to Uniform Vehicle Code Basic Speed Law in Chapter I.

<u>SECTION 22351 V.C.</u> ***Speed Law Violations***

(a) The speed of any vehicle upon a highway not in excess of the limits specified in Section 22352 or established as authorized in this code is lawful unless clearly proved to be in violation of the basic speed law.

(b) The speed of any vehicle upon a highway in excess of the prima facie speed limits in Section 22352 or established as authorized in this code is prima facie unlawful unless the defendant establishes by competent evidence that the speed in excess of said limits did not constitute a violation of the basic speed law at the time, place and under conditions then existing.

SECTION 22352 V.C. ***Prima Facie Speed Limits***

The prima facie limits are as follows and shall be applicable unless changed as authorized in this code and, if so changed, only when signs have been erected giving notice thereof:

(a) Fifteen miles per hour.

(1) When traversing a railway grade crossing, if during the last 100 feet of the approach to the crossing the driver does not have a clear and unobstructed view of the crossing and of any traffic on the railway for a distance of 400 feet in both directions along the railway. This subdivision does not apply in the case of any railway grade crossing where a human flagman is on duty or a clearly visible electrical or mechanical railway crossing signal device is installed but does not then indicate the immediate approach of a railway train or car.

(2) When traversing any intersection of highways if during the last 100 feet of the driver's approach to the intersection the driver does not have a clear and unobstructed view of the intersection and of any traffic upon all of the highways entering the intersection for a distance of 100 feet along all those highways, except at an intersection protected by stop signs or yield right-of-way signs or controlled by official traffic control signals.

(3) On any alley.

(b) Twenty-five miles per hour.

(1) On any highway other than a state highway, in any business or residence district unless a different speed is determined by local authority under procedures set forth in this code.

(2) When passing a school building or the grounds thereof, contiguous to a highway and posted with a standard "SCHOOL" warning sign, while children are going to or leaving the school either during school hours or during the noon recess period. The prima facie limit shall also apply when passing any school grounds which are not separated from the highway by a fence, gate or other physical barrier while the grounds are in use by children and the highway is posted with a standard "SCHOOL" warning sign.

(3) When passing a senior center or other facility primarily used by senior citizens, contiguous to a street other than a state highway and posted with a standard "SENIOR" warning sign. A local authority is not required to erect any sign pursuant to this paragraph until donations from private sources covering those costs are received and the local agency makes a determination that the proposed signing should be implemented. A local authority may, however, utilize any other funds available to it to pay for the erection of those signs.

NOTE: Compare 22351 and 22352 VC to Uniform Vehicle Code definition of Prima facie limits in Chapter I.

SECTION 22357 V.C. ***Increase of local limits***

Whenever a local authority determines upon the basis of an engineering and traffic survey that a speed greater than 25 miles per hour would facilitate the orderly movement of vehicular traffic and would be reasonable and safe upon any street other than a state highway otherwise subject to a prima facie limit of 25 miles per hour, the local authority may by ordinance determine and declare a prima facie speed limit of 30, 35, 40, 45, or 50 miles per hour or a maximum speed limit of 55 miles per hour, whichever is found most appropriate to facilitate the orderly movement of traffic and is reasonable and safe. The declared prima facie or maximum speed limit shall be effective when appropriate signs giving notice thereof are erected upon the street and shall not thereafter be revised except upon the basis of an engineering and traffic survey.

The provisions of this section does not apply to any 25 mile-per-hour prima facie limit which is applicable when passing a school building or the grounds thereof or when passing a senior center or other facility primarily used by senior citizens.

SECTION 22358 V.C. ***Decrease of local limits***

Whenever a local authority determines upon the basis of an engineering and traffic survey that the limit of 55 miles per hour is more than is reasonable or safe upon any portion of any street other than a state highway where the limit of 55 miles per hour is applicable, the local authority may by ordinance determine and declare a prima facie speed limit of 50, 45, 40, 35, 30 or 25 miles per hour, whichever is found most appropriate to facilitate the orderly movement of traffic and is reasonable and safe, which The declared prima facie limit shall be effective when appropriate signs giving notice thereof are erected upon the street.

SECTION 22358.5 V.C. ***Downward Speed Zoning***

It is the intent of the Legislature that physical conditions such as width, curvature, grade and surface conditions, or any other condition readily apparent to a driver, in the absence of other factors, would not require special downward speed zoning, as the basic rule of Section 22350 is sufficient regulation as to such conditions.

SECTION 22359 V.C. ***Boundary Line Streets***

With respect to boundary line streets and highways where portions thereof are within different jurisdictions, no ordinance adopted under Sections 22357 and 22358 shall be effective as to any portion until all authorities having jurisdiction of the portions of the street concerned have approved the same. This section shall not apply in the case of boundary line streets consisting of separate roadways within different jurisdictions.

SECTION 40800 V.C. ***Vehicle and Uniform Used by Officers***

Every traffic officer on duty for the exclusive or main purpose of enforcing the provisions of Division 10 or 11 of this code shall wear a full distinctive uniform, and if the officer while so on duty uses a motor vehicle, it must be painted a distinctive color specified by the commissioner.

This section does not apply to an officer assigned exclusively to the duty of investigating and securing evidence in reference to any theft of a vehicle or failure of a person to stop in the event of an accident or violation of Section 23109 or in reference to any felony charge, or to any officer engaged in serving any warrant when the officer is not engaged in patrolling the highway for the purpose of enforcing the traffic laws.

SECTION 40801 V.C. ***Speed Trap Prohibition***

No peace officer or other person shall use a speed trap in arresting, or participating or assisting in the arrest of, any person for any alleged violation of this code nor shall any speed trap be used in securing evidence as to the speed of any vehicle for the purpose of an arrest or prosecution under this code.

SECTION 40802 V.C. ***Speed Trap***

A "speed trap" is either of the following:

(a) A particular section of a highway measured as to distance and with boundaries marked, designated, or otherwise determined in order that the speed of a vehicle may be calculated by securing the time it takes the vehicle to travel the known distance.

(b) A particular section of a highway with a prima facie speed limit provided by this code or by local ordinance pursuant to paragraph (1) of subdivision (b) of Section 22352, or established pursuant to Section 22354, 22357, 22358, or 22358.3, which speed limit is not justified by an engineering and traffic survey conducted within five years prior to the alleged violation, and where enforcement involves the use of radar or other electronic devices which measure the speed of moving objects. The provisions of this subdivision do not apply to local streets and roads.

For purposes of this section, local streets and roads shall be defined by the latest functional usage and federal-aid system maps as submitted to the Federal Highway Administration. When these maps have not been submitted, the following definition shall be used: A local street or road primarily provides access to abutting residential property and shall meet the following three conditions:

(1) Roadway width of not more than 40 feet.

(2) Not more than one-half mile of uninterrupted length. Interruptions shall include official traffic control devices as defined in Section 445.

(3) Not more than one traffic lane in each direction.

This section shall remain in effect only until January 1, 1993, and as of that date is repealed, unless a later enacted statute, which is enacted before January 1, 1993, deletes or extends that date.

NOTE: This section remains in effect only until January 1, 1993, at which time it is repealed and the following section becomes effective.

SECTION 40802 V.C.

A "speed trap" is either of the following:

(a) A particular section of a highway measured as to distance and with boundaries marked, designated, or otherwise determined in order that

the speed of a vehicle may be calculated by securing the time it takes the vehicle to travel the known distance.

(b) A particular section of a highway with a prima facie speed limit provided by this code or by local ordinance pursuant to paragraph (1) of subdivision (b) of Section 22352, or established pursuant to Section 22354, 22357, 22358, or 22358.3, which speed limit is not justified by an engineering and traffic survey conducted within five years prior to the alleged violation, and where enforcement involves the use of radar or other electronic devices which measure the speed of moving objects.

NOTE: The original speed trap laws were enacted in 1923 under Sections 751 and 752. These laws were the result of unscrupulous cities or agencies setting up locations where speed zone (postings) changes were unwarranted or not justified! The officers working these locations were usually a small town police officer or sheriff that did not have a uniform and he usually utilized his own vehicle. So in essence he "blended into the background" he was visible but not recognized as the police. These officers would sit at the roadside at a measured distance from the beginning of the lower speed zone and timed vehicles over the measured, or known distance and calculate the speed. It has to be remembered that this occurred shortly after World War I and the economy was in sad shape. The officers and local courts usually split the fines that were generated as part of their salary.

EXCEPTIONS TO 40802 (b) V.C. SPEED TRAP

The use of radar in the following locations is legal and not considered to be a violation of 40802 (b) V.C.

* Streets that are posted with a speed limit certified by an Engineering and Traffic Survey conducted within five years prior to the alleged violation.

* Local Streets and Roads as defined in Section 40802 (b) V.C.

* Within 100 feet of a railroad crossing that has a visual obstruction along its right of way for within 400 feet in both directions.

* Within 100 feet of an intersection that has a visual obstruction of the intersection and any traffic upon all of the highways entering the intersection for a distance of 100 feet.

* To any alley.

* To a distinctly marked "School Zone" when children are present going to or coming from and at the lunch break, also at any time if there is no fence to protect the students.

* To a distinctly marked "Senior Zone" when passing a senior center or other facility primarily used by senior citizens, contiguous to a street other than a state highway and posted with a standard "SENIOR" warning sign.

* Where the speed limit is 55 miles per hour or above.

SECTION 40803 V.C. ***Speed Trap Evidence***

(a) No evidence as to the speed of a vehicle upon a highway shall be admitted in any court upon the trial of any person for an alleged violation of this code when the evidence is based upon or obtained from or by the maintenance or use of a speed trap.

(b) In any prosecution under this code of a charge involving the speed of a vehicle, where enforcement involves the use of radar or other electronic devices which measure the speed of moving objects, the prosecution shall establish, as a part of its prima facie case, that the evidence or testimony presented is not based upon a speed trap as defined in subdivision (b) of Section 40802. Evidence that a traffic and engineering survey has been conducted within five years of the date of the alleged violation or evidence that the offense was committed on a local street or road as defined in subdivision (b) of Section 40802 shall constitute a prima facie case that the evidence or testimony is not based upon a speed trap as defined in subdivision (b) of Section 40802.

SECTION 40804 V.C. ***Testimony Based on Speed Trap***

(a) In any prosecution under this code upon a charge involving the speed of a vehicle, any officer or other person shall be incompetent as a witness if the testimony is based upon or obtained from or by the maintenance or use of a speed trap.

(b) Every officer arresting, or participating or assisting in the arrest of, a person so charged while on duty for the exclusive or main purpose of enforcing the provisions of Divisions 10 and 11 is incompetent as a witness if at the time of such arrest he was not wearing a distinctive uniform, or was using a motor vehicle not painted the distinctive color specified by the commissioner.

This section does not apply to an officer assigned exclusively to the duty of investigating and securing evidence in reference to any theft of a vehicle or failure of a person to stop in the event of an accident or violation of Section 23109 or in reference to any felony charge, or to any officer engaged in serving any warrant when the officer is not engaged in patrolling the highway for the purpose of enforcing the traffic laws.

SECTION 40805 V.C. ***Admission of Speed Trap Evidence***

Every court shall be without jurisdiction to render a judgment of conviction against any person for a violation of this code involving the speed of a vehicle if the court admits any evidence or testimony secured in violation of, or which is inadmissible under this article.

CHAPTER V

FEDERAL CASE LAW, LEGAL ASPECTS AND NATIONAL CASE LAW

FEDERAL COMMUNICATIONS COMMISSION RULES

Before going into the National Case Law and individual cases and the decisions the radar operator should know that to date the Federal requirements related to the operation and use of police traffic radar have been very minimal. The Federal government does require that the individual agencies that operate radar must have a Federal Communications Commission Station License. There is no license required for the individual operator.

On October 26, 1976, The Federal Communications Commission (FCC), amended its rules to eliminate the required annual measurement of transmitter power, frequency and modulation, and to specify transmitter power in terms of output power for licenses in the Public Safety, Industrial, and Land Transportation Radio Services.

Under the rules, which amend part 89, 91, and 93, licenses will continue to be required to operate their transmitters within the specified technical parameters.

For the sake of convenience and simplicity of transmitter power measurement, the FCC specified that in the future, transmitter output power, rather than the direct current input power to the final radio frequency stage, be the standard parameter used to indicate transmitter power. The FCC defined transmitter output power as that power measured at the transmitter output terminals when connected to a load of the impedance recommended by the equipment manufacturer.

On February 1, 1983, The Federal Communications Commission amended its rules (Part 90) to eliminate the requirement for local governmental entities licensed in the Public Safety Radio Services to obtain separate authorization for radar speed detection devices.

This change reduced paperwork for the Commission's licensing staff and for police and other government units, which will no longer have to apply for new radar authorizations or modify or renew existing licenses and may operate speed detection devices as part of their base/mobile communications systems.

To provide the Commission with a record of such units in use, licenses will be required to list the number of speed detection units and the frequencies on which they operate at the time of renewal of their land mobile authorizations. Ordinarily, this would be once every five years and would not be a significant addition to the renewal process.

Recently, the Federal Government has become more involved in radar's use. The National Highway Traffic Safety Administration (NHTSA), has developed minimum standards for operator training in the use of radar. The International Association of Chiefs of Police (IACP), in conjunction with NHTSA, has set-up testing standards for radar devices (Model Performance Specifications For Police Traffic Radar Devices, 1984).

LEGAL ASPECTS

Radar has been used to measure the speed of vehicles since 1948. Since that time there have been many challenges in the courts regarding the use of these devices. To gain a successful prosecution the radar operator must know, not only how the radar device functions, but what the precepts or rules that govern its operation. These rules are found in the codified laws and in case law decisions.

Basically, it has to be shown that the device is accurate and reliable so evidence obtained from its use can be trusted and that evidence when presented is then admissible. How do we establish this accuracy and reliability? There are several steps required in allowing the admissibility of evidence.

1. Laying a foundation for the evidence.

   a. Sound scientific principle.

   b. Judicial Notice.

2. The device was checked to determine that it was functioning properly.

   a. Before operation - Test to insure it functions properly.

   b. During operation - minimize the possibility of outside interference.

   c. After operation - test again if it worked before and no malfunction during and works after it is assumed by courts that it was functioning properly during operation.

3. Operator was trained and experienced in the use of the device.

SCIENTIFIC PRINCIPLES

When a device first comes on the market an expert witness (or witnesses) is needed to explain the scientific theory or principle to the court (State vs. Moffitt, 9 Terry (48 Del.) 210, 100A. 2d 778, 1953,). The witness or witnesses need to establish that the device uses a sound scientific method of measuring whatever it is that the device is designed to measure. Just because the device is "new,", "electronic," solid state, or just modern is not sufficient to persuade the courts to accept evidence obtained by the device. It is the burden of the prosecution to show that the device is capable of doing what it purports to do and that its scientific principles are sound.

JUDICIAL NOTICE

When a court takes judicial notice of a fact or principle, the court is saying that it is so widely known and accepted that the court does not need to have them proven again.

Without judicial notice, the prosecution would have to produce expert testimony to prove every single scientific fact, including basic mathematics. Judicial notice allows the court to accept, without proof, those facts that are well known and undisputed. This saves time and expense in the prosecution of cases.

Judicial notice usually applies to the scientific principle involved, but will not usually extend to any particular instrument. This means that the courts may take judicial notice of the Doppler principle, or the principles of moving radar, but judicial notice does not extend to the scientific workability of a particular instrument, or model (e.g., Ace Radar Mfg., Model A-1).

THE DEVICE MUST BE WORKING PROPERLY

It must be proven that the device was functioning properly at the time that it was used. The proof is usually a test against some type of accepted standard. With radar there are several methods that are accepted as proof that the device was functioning properly. These methods are:

1. Checking the speed reading of a vehicle traveling at a known speed, usually another patrol vehicle with a calibrated speedometer.

2. Checking the speed reading of the patrol vehicle traveling at a known speed with a calibrated speedometer (moving mode).

3. Using calibrated and certified tuning forks and comparing the speed stamped on the fork against the reading on the device.

4. Using the internal calibration and lamp segment tests built into the device.

Not all of these checks are required. Usually numbers 3 and 4 will suffice to prove that the device was functioning properly. These checks should be performed before and after use. If the device was working properly before the reading was obtained and was working properly after the reading was obtained; then it has to be concluded that it was working properly when the reading was obtained. The operator must also demonstrate that the reading obtained was valid and that there was no possibility of outside distortion or other source(s) causing the reading.

OPERATOR TRAINING AND EXPERIENCE

Before any scientific evidence can be admitted, it must be shown that the operator of the instrument was properly trained and has sufficient experience operating it. The amount of training depends on the type of device and how complex it is. In one case the court said:

"... it is sufficient to qualify the operator that he have such knowledge and training as enables him to properly set up, test and read the instrument; it is not required that he understand the scientific principles of radar or be able to explain the internal workings; a few hours instruction normally should be enough to qualify the operator..."

The court further quoted:

"As one Missouri court said, "One need not be qualified to manufacture a clock in order to wind, set and read it.""

OTHER SPEED CHECK ISSUES AT TRIAL

Driver Identification: It is necessary to put the driver behind the wheel. The identification of the driver and vehicle is made by the officer or officers upon careful observation and taking notes at the time of the arrest.

Opinion Evidence: The opinion evidence rule is that ordinary witnesses (not experts) cannot give opinions, however, there are some exceptions to this rule. Examples are: the ordinary witnesses description of a suspect, the sobriety of a person, or visibility.

The speed of a vehicle is also, one of the exceptions. The opinion of the speed of a vehicle can be used in two ways. One is to corroborate the reading on the speed measuring device (Speed estimation). The other one is where the courts have upheld convictions solely on the opinion evidence (Speed estimation) of the officer where the speed was excessively over the speed limit.

Hearsay Rule: Hearsay evidence is testimony in court, or written evidence, of a statement made out of court, the statement being offered as an assertion to show the truth of matters asserted therein, and thus resting for its value upon the credibility of the out-of-court asserter.

The Hearsay Rule bars the admission into evidence of hearsay testimony, oral or written, unless it is admissible under one of the exceptions to the rule.

Statutory Limits on the use of radar or other speed measuring instruments: Some states have required that warning signs be posted where the devices are used. "Speed trap" states restricting the use of the devices unless certain guidelines are met. Licensing of radar by the state for local government use. Officer required to be in uniform and if in a vehicle it must be marked if he is enforcing traffic laws.

Discovery or inspection of instrument by defendant: No right of the driver to inspect or have radar tested at the side of the road at the time of arrest, no state law or court decision requires this.

However, some courts have held that defendant does have the right to file a motion asking the court to order the prosecution to produce the instrument so that the defendant can have his expert test and inspect the instrument. Defendant also may request that certification records, maintenance records and training records be brought to court or copies given to him so he may adequately prepare his defense.

DEFENSES IN SPEEDING CASES

All of the traditional defenses of a criminal case apply to traffic laws. Some of the defenses are humorous at best, but some of the more common ones are listed below.

Entrapment: Conceivable it could happen in a traffic case, but the fact that motorists are quite capable of speeding and the idea is not planted by an officer makes it a rather remote possibility.

Speeding to pass: It is no defense that the driver was speeding only when passing another vehicle (State vs. Kilpatrick, 184 a 2d 191 (Conn. Cir. 1962).

Defective Speedometer: A defective speedometer is no defense to speeding since intent or knowledge is not an element of the offense (People vs. Caddy, 540 P.2d 1090, Colo., 1975).

"Cruise Control": It is no defense to a charge of speeding that the driver had placed the "cruise control" in operation. He was still driving; lack of intent to violate is irrelevant (State vs. Packin, 257 A.2d 120, N.J.Super, 1969). The "cruise control" stuck in the "acceleration" position and driver could not kill the cruise control for a short distance during which time officer clocked speed of 78 mph in a 55 mph zone. Court held it was no defense to speeding that the driver was not able momentarily to control his speed (state vs. Baker, 571 P.2d 65 Kan.App., 1977).

NOTE: It would have taken 21 seconds to accelerate from 55 mph to 78 mph.

Unsafe to brake: Where the driver was moving in heavy traffic and the stream of traffic entered a reduced speed zone, it was not a defense to the driver when he argued that if he had braked to reduce his speed for the zone he was afraid that he would cause an accident with the vehicles behind him (City of Creve Coeur vs. Pelletier, 358 N.E.2d 1355, Ill.App, 1977).

Safer passing: A driver cannot exceed the speed limit in passing on a two-lane road just because it might it might be safer to pass rapidly (State vs. Creaser, 365 A2d 421, Maine, 1976).

Exactitude: The precise amount by which the speed limit was exceeded is not an essential element of the offense of speeding (Melanson vs. Dept. of Motor Vehicles, 197 N.W.2d 401, Neb., 1972).

Impossibility of Compliance: Anything which would make it impossible for a driver to comply with a traffic regulation and over which he has no control, or an emergency not of his own making is a valid defense. However, where driver speeded up over the limit where he thought the driver ahead might turn into his lane it is an emergency of his own making (just as easily could have slowed down) and hence this defense was not available to him (City of Des Moines vs. Davis, 214 N.W.2d 199, Iowa, 1974).

NATIONAL CASE LAW

To be useful to the case, any evidence obtained must be ruled admissible. For the evidence to be admitted, there must be sufficient reason to believe that it is valid. The question concerning the validity of radar speed measurement is:

Is this measurement an accurate representation of the speed of the actual vehicle driven by the accused at the time of the alleged violation?

To answer it four specific questions have to be asked and answered:

* *How do we know that the Doppler Principle is valid?*

* *How do we know that the radar instrument was working properly at the time of the alleged violation?*

* *How do we know that the operator has the necessary qualifications and performed properly at the time of the alleged violation?*

* *How do we know that the speed measurement came from the vehicle driven by the accused?*

It has already been discussed In the "Legal Aspects" portion of this chapter what is necessary to answer some of these questions. These questions have been asked over and over again in the courts and the answers are in the case law decisions. Lets examine the significant or "Landmark Cases" that affect radar operations.

Although transcripts and opinions on radar case law are available, the following information is presented in basic form merely to show the results of these landmark cases regarding radar. These case law examples reflect the progression of requirements for the use of radar and for testimony in a radar trial, including expert testimony.

We will examine several cases, including the circumstances, the judgments, the issues and the significance of each case. Some of the cases are quite simple, some are extremely complex. The operator should be familiar with the significance of the cases because they effect the overall operation of radar in the field and dictate what is necessary to successfully prosecute a radar speeding case.

State vs. Moffitt, 9 Terry 210, 100A. 2d 778, 48 Del., (1953).

Circumstances:

The defendant was issued a citation by two State Troopers using an electronic speed meter for traveling 63 miles per hour in a 50 mile per hour zone. An expert witness testified to the Doppler Principle and the functioning of the device. The defendant objected to any testimony being introduced concerning the operation of the speed meter or its admission into evidence for two reasons:

1. The speed meter ("S-BAND" Radar) has never been recognized as being a reliable instrument to record speed of vehicles upon the highway.

2. The speed meter, even if admitted into evidence, standing alone should not be held to constitute conclusive evidence of the speed of the defendant's vehicle.

Judgment:

The electronic radar speed meter, if properly functioning and properly operated at the time of use was sufficient to support a conviction.

Issues:

Validity of the Doppler Principle.

Significance:

It is necessary for the prosecution to produce expert testimony to prove the reliability of radar.

Question(s) answered by this case:

NONE

State of New Jersey vs. Dominic D'Antonio, 18 N.J. 570, 115 A. 2d 35 (1955).

Circumstances:

State Troopers operating radar speed meter equipment (S-Band device) along the New Jersey Turnpike charged the defendant with having violated its 60-mile speed limit. The court took judicial notice of the Doppler Principle. The defendant was found guilty in the Municipal Court of Milltown and after trial *de novo* (case was reviewed) in the Middlesex County Court, he was again found guilty. The defendant appealed to the Appellate Division and the Judgment was affirmed.

Judgment:

The State Supreme Court, held that evidence of radar speed meter readings could be received in evidence on a showing that speed meter was properly set up and tested by police officers, without any need for independent expert testimony by electrical engineers as to its general nature and trustworthiness.

"...members of the public have become generally aware of the widespread use of radar methods in detecting... speed and while they may not fully understand their intricacies, they do not question their general accuracy and effectiveness."

Issues:

* Judicial notice of the Doppler Principle.

* Proper set up and testing of the device.

* Police officers trained in the use of the device.

Significance:

Judicial notice taken on the reliability of radar, eliminating requirement of expert testimony (Moffitt case) for prosecution in each radar trial.

Question(s) answered by this case:

* *How do we know that the Doppler Principle is valid?*

State of Connecticut vs. Michael R. Tomanelli, 153 Conn. 365, 216 A. 2d 625 (1966).

Circumstances:

The defendant was charged with the crime of speeding and was brought to the Circuit Court in the Eleventh Circuit and tried to the jury before Judge J. Alexander. The defendant was found guilty and the case was taken to the Appellate Division of the Circuit Court, which affirmed the judgment of the Appellate Division. The defendant, upon granting of certification, appealed to the Supreme Court.

Where police radar registered the speed of the target vehicle by visual speed meter, it also made a graphic record by a line traced on a roll of paper graduated to make a permanent record of the speed. This graphic recording process was operated continuously for the entire three and one-half hour period. The radar operator testified to the defendant's speed which he had observed on the speed meter.

The accuracy of the radar device was established by the operator's testimony that he had made tuning fork tests before and after the defendant (motorist's) speed was recorded. These tests were made by activating what were described as forty-, sixty- and eighty-mile-per-hour tuning forks and by observing, in each test, that the speed meter and graphic recorder of the radar instrument indicated corresponding readings.

Judgment:

The Supreme Court held that the scientific accuracy of the Doppler-shift Principle for measurement of speed, if principle is correctly applied, is, in the discretion of court, a proper subject of judicial notice so that, especially where no evidence attacking it is proffered, expert testimony in explanation of principle is not necessary prelude to introduction of police radar evidence.

Judicial notice can extend only to scientific accuracy of Doppler-shift Principle as a means of measuring speed if the principle is correctly applied; judicial notice does not extend to accuracy or efficiency of any given police radar instrument designed to employ the principle; whether the instrument itself is accurate and is accurately operated must necessarily be demonstrated to satisfaction of the trier in order to render evidence produced by it admissible.

There may be outside influences which may affect the accuracy of the recording by a police radar set sufficient to raise a doubt as to the reliability of speed recorded through the use of the set; conflicts in the evidence concerning existence of interference of this nature would, when they arise, require additional consideration by the trier.

The record in the speeding case disclosed that the radar operator was qualified to testify as to the accuracy and operation of the police radar instrument which was used.

Accuracy of police radar unit was established by the operator's testimony that the had made tuning fork tests before and after defendant-motorist's speed was recorded, that these tests were made by activating what were described as forty-, sixty- and eighty-mile-per-hour tuning forks and by observing, in each test, that the speed meter and graphic recorder of the radar instrument indicated corresponding readings of forty, sixty and eighty miles per hour, and no effort was made by defendant to attack accuracy of tuning forks.

The tuning forks themselves must be shown to be accurate if they are to be accepted as valid test of accuracy of police radar instruments.

Issues:

* Judicial notice of Doppler Principle
* Outside influences may affect accuracy of readings
* Operator qualifications
* Use of tuning forks as a method of testing accuracy

Significance:

Accepted use of tuning forks to test the accuracy of a radar device. Forks assumed accurate if no challenge by defense.

Question(s) answered by this case:

** How do we know that the radar instrument was working properly at the time of the alleged violation?*

Honeycutt vs. Commonwealth of Kentucky, 408 S.W. 2d 421 (1966).

Circumstances:

Erna Elijah Honeycutt was charged with exceeding the speed limit, in the City of Henderson, traveling 50 miles per hour in a 35-mile-per-hour-zone. The trial court allowed a police officer to testify that a radar device was being operated by him, and registered the fact that a vehicle was approaching from the rear at 50 miles per hour. Upon visual observation the police officer identified the vehicle as being one operated by Honeycutt. The police officer testified that the accuracy of the radar unit had been tested, earlier in the same day, by use of a calibrated tuning fork and by a speedometer check with another police vehicle driven through the radar field. The evidence was admitted over the appellant's objections.

Honeycutt appealed arguing:

1. There was no expert testimony of the scientific validity of the principles of radar speed detection or that radar is capable of accurately measuring speed of motor vehicles.

2. The accuracy of the particular instrument used in this case was not proved.

3. The policeman was not shown to be qualified to properly operate and interpret the instrument.

4. There was insufficient proof that his car was the one that caused the radar speedometer to show a reading of 50 miles per hour.

Judgment:

This court has not previously been presented with a case involving the use of evidence from a radar detector (radar instrument), but a number of such cases recently have reached the courts of sister states. Those courts have written at some length on the question raised and we there is no need for us to add to the literature on the subject. It will be sufficient for us to indicate our agreement with what appears to be the uniform view of all of the other courts in the cases that have arisen in the last few years.

First, the courts will take judicial notice of the fact that a properly constructed and operated radar device is capable of accurately measuring the speed of motor vehicles.

Second, the courts will not take judicial notice of the accuracy of the particular instrument employed on a specific occasion, but will treat, as sufficient evidence of accuracy, uncontested testimony that the instrument was tested within a few hours of its specific use, and found to be accurate, by use of a calibrated tuning fork and by a comparison with a speedometer of another vehicle driven through the traffic field.

It is indicated (by other cases "Tomanelli") that the tuning fork test alone may be sufficient. It is pointed out in that case that the accuracy of the tuning for itself may be assumed in the absence of an attack by the defendant.

Third, it is sufficient to qualify the operator that he have such knowledge and training as enables him to properly set up, test, and read the instrument; it is not required that he understand the scientific principles of radar or be able to explain its internal workings (Wind, set and read a clock, State v. Graham, Mo.); a few hours' instruction normally should be enough to qualify an operator. In the instant case the policeman had received 13 weeks training as a radar repairman and had operated radar equipment for almost two years. We think this was sufficient qualification to make his testimony competent. A reading of his testimony indicates that he understood how to operate the instrument (in original trial the officer testified at length about how to set up - **A**ntenna to **B**ox to **C**urrent, test and properly operate the radar instrument).

The appellant argues that there was insufficient evidence that his car was the one which caused the radar unit to show a 50 m.p.h. reading; that a south-bound car in the other lane could have caused it. In our opinion the reasonable import of the policeman's testimony (in original trial the officer testified to the estimation of the speed, the immediate environment at the location, the range of the device, the reading received and the loss of reading when the defendant's vehicle left the radar field -TRACKING HISTORY) is that he observed the appellant's car passing others at the same time the radar dial showed a fluctuating reading with a 50 m.p.h. maximum. When the dial stabilized at 50 m.p.h. the car was in front by itself, nearest to the unit. The policeman's estimate of its speed, from visual observation alone, was from 40 to 45 m.p.h.. This evidence reasonable points to the appellant's car as the offending vehicle, and so we do not think that the evidence is reduced to worthlessness by the remote chance of coincidence that a southbound vehicle broke clear from a passing situation, at 50 m.p.h., at the same moment that the appellant's car got out in front in the north-bound lanes. In our opinion the radar evidence in this case was competent. The judgment is affirmed.

In rendering the opinion the court cited the following cases:

* State v. D'Antonio
* Everight v. Little Rock
* State v. Graham
* State v. Tomanelli

Issues:

* Judicial notice of the Doppler Principle.

* Accuracy of the device used and how it functioned (out-front and closest).

* Set-up (A to B to C rule), test (Tuning fork, or vehicle) and read.

* Training of operator (A few hours sufficient).

* Identification of suspected vehicle (Tracking History).

Significance:

Although judicial notice was taken on the reliability of radar, the prosecution must establish the accuracy of the radar device on the date and time of the reading of the accused. Proper set-up, and testing methods to be followed. Antenna to Box to Current - A to B to C rule established. The operator need not be an expert in the internal workings, but should know how to operate properly. Also, correct target vehicle identification.

Question(s) answered by this case:

* *How do we know that the radar instrument was working properly at the time of the alleged violation?*

* *How do we know that the operator has the necessary qualifications and performed*

properly at the time of the alleged violation?

* *How do we know that the speed measurement came from the vehicle driven by the accused?*

State of Wisconsin vs. Lawrence I. Hanson, 270 N.W. 2d 212 (1978).

Circumstances:

On January 4, 1975 at 1:18 p.m., the defendant was ticketed for speeding on U.S. Highways 18-151, in the town of Verona. He was cited for a violation of Section 346.57(4), Stats., for allegedly traveling at a speed of 68 m.p.h. in a 55 m.p.h. zone. Hanson's speed on the highway was measured by a speed radar device.

The device utilized by the police was a Kustom Electronics, Model MR-7, "moving"radar device. During the trial, the state trooper testified that he had one hour of classroom instruction and practical experience. There was no testimony about tracking history, nor any about how the radar unit was set up or tested (before and after the citation was issued). The defendant was originally found not guilty due to conflicting expert testimony on the accuracy of the device. The prosecution filed an appeal seeking a judicial notice ruling on the accuracy and reliability of the moving radar device (MR-7).

Judgement:

Supreme Court ruled that Courts may take judicial notice of the reliability of underlying principles of speed radar detection that employs the Doppler Effect as a means of determining the speed of moving objects.

Prima facie presumption of accuracy sufficient to support a speeding conviction will be accorded to moving radar upon testimony by a competent, operating police officer that:

* Officer operating the device had adequate training and experience in its operation,

* That the radar device was in proper working condition at the time of arrest,

* that the device was used in an area where road conditions were such that there is a minimum possibility of distortion,

* That the input speed of patrol car was verified, and the police vehicle's speedometer was expertly tested within a reasonable proximity following arrest and that such testing was done by means which did not rely on radar device's own internal calibrations.

* The radar unit was tested using two tuning forks before and after the alleged violation took place.

Issues:

* Judicial notice of the Doppler Principle.

* Accuracy of the device used and how it functioned (Moving mode and only one readout window, switch back and forth from target to verify speed).

* Set-up and test (two tuning forks - moving device).

* Experience and training of operator.

* Operate the device in an area free of distortion (Interference).

Significance:

Verification of patrol speed on radar device with the police vehicles calibrated speedometer while operating in the moving mode, to ensure that correct calculation of the target vehicle speed has taken place (Tracking History).

1) The officer must have adequate training and experience in radar operation.
2) The officer must testify to the setting up of the equipment and the conditions under which it was used.
3) The equipment was operated with a minimum possibility of distortion from external interference.
4) An external test was performed either by the use of tuning forks or by an actual test run by a vehicle with an accurately calibrated speedometer.

Caused manufacturer's to redesign future equipment to have two readout windows one for verify speed (Patrol veh ground speed) and one for target vehicle's speed.

Question(s) answered by this case:

* *How do we know that the radar instrument was working properly at the time of the alleged violation?*

* *How do we know that the operator has the necessary qualifications and performed properly at the time of the alleged violation?*

* *How do we know that the speed measurement came from the vehicle driven by the accused?*

The next few cases are important in the area of case law, but are not as significant as the four previous briefed cases. They are significant to how the courts have perceived radar and its use by officers.

State of Minnesota vs. David Gerdes, 191 N.W. 2d 428, (1971).

Circumstances:

The Defendant was convicted of speeding 40 mph in a 30 mph prima facie zone. The only evidence of his precise speed was the reading of a radar unit operated by a Bloomington police officer. At the trial, the officer testified that he checked the device by means of an internal mechanism ("Internal Calibration Check") and that no external testing was performed. The defendant appealed.

Judgement:

"Courts may take judicial notice of underlying principles and reliability of properly tested and operated radar devices for determining speed of motor vehicles without requiring expert testimony concerning theory and mechanics of a particular device." "To prove accuracy of a particular instrument for measuring speed of automobiles, the officer reading the device must have adequate training and experience in operation, the officer should testify to the manner in which the unit was set up, and conditions under which it was used, and a showing must be made that the machine was operated with minimum possibility of distortion and that, on occasion when machine was set up, its accuracy had been tested in some external manner."

"Where only means of testing accuracy of radar device which indicated that defendant was speeding was an internal mechanism which was an integral part of device itself, defendant could not be convicted of speeding, in absence of evidence other than radar reading that he was driving at a speed in excess of the limit." "... We are not satisfied that this or any other radar device is infallible. To test the machine by the machine itself seems to be bootstrapping. In two leading cases the New York Court of Appeals has underscored the need for adequate testing...."

Issues:

* Judicial notice of the Scientific Principles (Doppler Principle).

* Accuracy of the device used and how it functioned.

* Set-up and test (Internal but no tuning forks).

* Experience and training of operator.

* Operate the device in an area free of distortion (Interference).

Significance:

When operating a radar device it should be tested by adequate means to insure that it is functioning properly, recommended by tuning fork before and after as well as other available test(s) such as internal tests.

State of Ohio vs. Wilcox, 40 Ohio App. 2d 380, (1974).

Circumstances:

The defendant was convicted of speeding 56 mph in a 40 mph prima facie zone. At the trial the officer testified that he had his radar device set for automatic operation and that it "locked in" at 56 mph. He stated he observed the traffic and decided that the defendant's vehicle was the one which had activated the radar device. The defendant presented the testimony of a former police officer who testified that he was familiar with the device in question and that an order had been issued not to utilize the device on automatic in a moving vehicle because of discrepancies resulting from such use. He also testified as to other frailties of the radar device.

NOTE: No testimony was given as to tracking history or simple estimation of the defendants speed. Obviously the radar was working the operator instead of the operator working it.

Judgment:

The court ruled that judicial notice could be taken of the Doppler Principle without the need for expert testimony. The court stated further that stationary radar could also be given this same judicial notice presumption. The court refused to allow judicial notice of the moving radar unit without some expert testimony as to its operation and ability to determine target speed by subtracting the patrol speed from the closing speed.

"In the case at hand, the prosecution has failed to properly prove that this radar device was capable of making that determination. Without some expert testimony as to the reliability and function of the radar unit, there is insufficient evidence upon which to base a conviction on the charge of speeding."

NOTE: The court was confused about how the device (Kustom MR-7) functioned and could not clearly understand the principle of moving operations that a moving radar device sent out one signal (base frequency) and processed two return signals (High Doppler and

Low Doppler to calculate TS = CS - PS).

Issues:

* Whether there was sufficient evidence to convict defendant.

* Operation of moving radar devices specifically MR-7's.

Significance:

Expert testimony needed to explain the principles of moving radar operation.

State of Ohio vs. Shelt, 46 Ohio App. 2d 115, (1976).

Circumstances:

The defendant was convicted of speeding 69 mph in a 55 mile per hour zone. The speed of the defendant's vehicle was obtained by the use of a moving radar device known as an MR-7, which enabled the patrol car equipped with such a device to be in motion while tracking the speed of vehicles approaching from the opposite direction. Defendant entered testimony that at the location of the offense his speed was not unsafe for the conditions present.

Judgment:

"A person may be convicted of speeding solely upon evidence obtained from an MR-7 moving radar device mounted on a moving patrol vehicle where the record contains (1), expert testimony of construction of the device and its method of operation in determining the speed of the approaching vehicle from the opposite direction, and (2), evidence that the device is in good condition for accurate work, and (3), evidence that the officer using the device is one qualified for its use by training and experience."

"Upon publication of this opinion, it may be judicially noticed that the MR-7 moving radar device, using the Doppler effect, is acceptable as dependable for its proposed purpose."

"Condition and width of highway at the time defendant's speed was clocked at 69 miles per hour was sufficient to support finding by trial court that speed was greater than reasonable or proper and that by reason thereof defendant violated statute. R.C. Section 4511.21."

Issues:

* MR-7 radar devices.

* Judicial Notice of moving radar principles and of all MR-7 radar devices.

* Operator training and experience.

* Elements of speeding offense(s).

Significance:

The court took "blanket" judicial notice of the accuracy and reliability of all MR-7 radar devices and their use as long as the operator testified to his/her training and experience and that the device was working properly. A showing of testing before and after is necessary to assure that the device is functioning properly.

State of Florida vs. Ana Aquilera, et. al., Dade County (1979)

<u>THIS IS NOT A CASE LAW CASE</u>

Circumstances:

This case came to the attention of the Dade County Court on a motion to suppress evidence. It was heard in an administrative court by Administrative Law Judge Alfred Nesbitt. There were eighty defendants. Some thirty experts from the fields of engineering, radar manufacture, radar detector manufacture, mathematics, physics and police testified. There were thirty-three exhibits and over two thousand pages of documentation.

No arguments against the Doppler Principle were presented. However, there was a common belief that radar devices could and should be improved. The improvements that were suggested were to make the instruments more accurate in target identification. The court commented that agencies purchased radar units based on economy, (low bid) not on quality. Therefore, all defendants had suffered additional penalties or higher insurance rates and the possibility of losing their driver's license.

The court held that in depth studies of the "alleged errors" (effects)should be conducted. These suggested studies included:

* Cosine error.
* Batching error.
* Panning error (feedback).
* Shadowing error.
* Scanning error.
* Passing Citizens Band Radios (CB's).
* Radio Frequency Interference (RFI).
* Air conditioners - heaters.

The major criticism during the trial was inadequate training of operators.

Judgement:

"... Admittedly more of these errors pertain to radar in the moving mode than in the stationary mode. Certainly, some of these problems are minimal in degree but their potential has been attested to not only in scientific theory but many have been perceived in actual tests by the witnesses. The state's witnesses have denied these problems but in doing so have expressed a reliance on adequately trained officers recognizing same and not issuing tickets. However, the defense witness, Dr. Nichols, whose expertise and objectivity have been conceded by Mr. Drucker (prosecutor)[1], has prescribed an intensive course of training in both classroom (80 hours)[1] and in the field (40 hours)[1] with written examinations for proof of qualification, conducted by an independent, highly skilled radar operator and not by a manufacturer's agent or his students.

Such program has not apparently been pursued. Even with this type of curriculum, Dr. Nichols seems to imply that there would only be a lessening of the problems.

All of this resolves itself into one main issue, to wit: the reliability of radar speed measuring devices as used today.

Based upon all of the testimony, exhibits, and argument of counsel, I find that the reliability of the radar speed measuring devices as used in their present modes and in particular in these cases, has not been established and to the exclusion of every reasonable doubt and it is therefore,

ORDERED AND ADJUDGED that the Motions to Suppress and/or Exclude herein be and they are hereby granted."

Issues:

* Training of operators.

* Radar Errors (effects).

* Reliability of devices (even though all of the eighty cases involved, M.P.H. Industries, Inc., Model K-55 radar devices).

Significance:

This case because of the notoriety in national news (CBS 60 - Minutes) caused the National Highway Traffic Safety Administration (NHTSA) to set up a certification program for radar operators (24 hour course). NHTSA and the International Association of Chiefs of Police (IACP) also set up a testing program for radar devices. This case has no Case Law effect even in Florida, however, it did bring radar usage to the public eye and in Florida an operator has to complete a forty hour course every two years to maintain certification. A radar instructor has to qualify as an operator and attend a Radar Instructor Course every two years in that state.

The radar manufacturer's have been more responsive to proposed changes to their devices and have upgraded them to a point where they are less apt to give false readings even though the "propound errors" are used as defenses quite often in speeding citation trials.

This case pointed out the real significance of a TRACKING HISTORY as evidence and that a radar device only supports the officers observations.

Question(s) answered by this case:

NONE per se, However, a significant case in that it set in motion the standardization for minimum training (NHTSA 24 hours), and the continual improvement and standards of testing of speed detection equipment (NHTSA/IACP).

This last case is included because of the personage involved. Ms. Janice Lee is an employee of Electrolert, Inc (Fuzzbuster), she is the current President of the Radio Association Defending Airwave Rights, Incorporated (RADAR, Inc), she has been the only president since it was first formed. RADAR Inc., is a non profit organization dedicated to the defense of the use of radar detectors. This organization lobbies professionally to inhibit legislation banning radar detectors. The organization has several publications dedicated to defending citizens that receive citations where radar has been utilized. During this case the full resources of Fuzzbuster including the paid witnesses Dr. Lee Nichols, Mr. Andy Soccio and Mr. Rod Dornsife were marshalled on her behalf.

Commonwealth of Kentucky vs. Janice Lee, Gallatin Circuit Court, NO. 80-X-003, 1981.

This cause was tried in the Gallatin District Court, The Honorable Robert L. Hall, Judge presided.

From a judgment of guilty of speeding in violation of K.R.S. 189.390 and .391, and a sentence of a fine of $34.00 and costs of $20.00, this appeal has been taken.

The facts of the charge of speeding were not disputed. What is in issue is the admissibility of the evidence obtained by Trooper Michael Steward by the use of a K-55 mobile traffic radar device. Specifically, Appellant contends that such traffic radar device is susceptible to influence by various forces, and that by lack of training Tpr. Steward lacks sufficient knowledge of the device, its workings, and its misfunctions, so as to be able to accurately testify as to information obtained through its use.

Although testimony related to a motion to suppress was received over five days as to the principles of radar and their specific application to the workings of the K-55 mobile traffic radar device, much of it misses the mark. Tpr. Steward testified, on trial of the issue of guilt or innocence, that the conditions that various defense witnesses testified would produce erroneous readings were not present. While such evidence may educate one concerning mobile traffic radar, it has no application to this case, inasmuch as such conditions were shown to not exist.

Tpr. Steward told the trial court of his classroom instruction and years of experience using such a device. He demonstrated a knowledge of such problems as Appellant's evidence tended to establish, although his answers were not always articulated in phrases used by Appellant's counsel and witnesses. Tpr. Steward testified to the absence of such problems in connection with Appellant.

Since 1966, the courts of this state have recognized the principle of radar as a reliable means of measuring the speed of motor vehicles, if operated properly by a qualified operator. *Honeycutt v. Commonwealth, Ky., 408 S.W. 2d 421 (1966).*

The Court in *Honeycutt* enumerated the conditions under which radar readings would be received in evidence:

1. The instrument must have been tested prior to its use in the instant case;

2. The operator have knowledge and training, not of the scientific principles of radar or its internal workings, but to enable him to properly set up, test and read the instrument; and

3. As to identifying, relating a target vehicle to the readout, it would be sufficient if the defendant's vehicle was by itself, away from other traffic, and closest to the radar unit.

The evidence herein is clear and convincing that the K-55 unit used in the instant case was tested at the beginning of Tpr. Steward's shift by using tuning forks to test the diverse speeds of the target and patrol-vehicle speeds, with a differential readout. No testimony was given as to the driving of a designated target vehicle through the radar field, but Tpr. Steward testified that comparison of the "patrol-vehicle" speed readout with the certified calibrated speedometer of his vehicle was repeated and continuing exercise, and that such comparison was immediately made upon receiving the target-vehicle readout of defendant's vehicle. This court finds that this meets or exceeds the standards of the *Honeycutt* case.

Tpr. Steward testified as to his training, his experience and his ability to accurately and legitimately use his K-55 radar unit. His qualifications are beyond cavil.

Not only did Tpr. Steward testify that defendant's vehicle was out in front, by itself and away from other traffic, but he did so in clear terms; the Court also notes that by application the principle of "the inverse fourth-order" the disparity in the size of vehicles must be unusually substantial, even in relatively close situations.

Lastly, Tpr. Steward testified conclusively, in terms of time and distance from the radar-reading to apprehension, as to the identity of defendant as the operator of the vehicle.

This court finds that the requirements of *Honeycutt vs. Commonwealth* have been met or exceeded.

IT IS THEREFORE ORDERED AND ADJUDGED that the judgment and sentence of the trial court are affirmed.

THE CONVICTION STOOD AND THERE WERE NO FURTHER APPEALS !

OTHER SIGNIFICANT NATIONAL CASES

Arizona:

Villegas vs. Bryson, 494 P. 2d 61 (1972). (Tachograph)

Colorado:

City of Aurora vs. McIntyre, 719 P 2d 727 (1986).

People vs. Walker, 610 P 2d 496 (1980).

People vs. Stribel, 609 P 2d 113 (1980). (Speedometer)

People vs. Gallegos, 553 P.2d 1140 (1975). (Vascar)

Nevada:

NONE FOUND

New Mexico:

NONE FOUND

Oregon:

Salem vs. Franz, Or. June 22, 1954, (unpublished).

People vs Spada, 576 P. 2d 33 (1978).

Texas:

Masquelette vs. State, 579 S.W.2d 479 (1979).

Gano vs. State, 466 S.W.2d 730 (1971).

Knott vs. State, 648 S.W.2d 20 (1983). (Radar Detection)

Continental Bus System, Inc vs. Biggers, 322 S.W.2d 1 (1959). (Tachograph)

Cromer vs. State, 374 S.W. 2d 884 (1964).

Holley vs. State, 366 S.W. 2d 570, (1963).

Wilson vs. State, 168 Tex. Cr. 439, 328 S.W. 2d 311 (1959).

Utah:

NONE FOUND

Washington:

City of Bellevue vs. Mociulski, 756 P.2d 1320 (1988).

City of Seattle vs. Peterson, 693 P.2d 757 (1985)

City of Spokane vs. Knight, 96 Wash. 403, 165 P.105 (1917). (Speedometer)

State vs. Ryan, 48 Wash. 2d 304, 293 P.2d 399 (1956).

ADDITIONAL INFORMATION

As stated in the beginning of this chapter: To be useful to the case, any evidence obtained must be ruled admissible. For the evidence to be admitted, there must be sufficient reason to

believe that it is valid. There have been many challenges in the courts regarding the use of radar devices. To gain a successful prosecution the radar operator has to know, not only how the radar device functions, but what the precepts, or rules are that govern its operation. These rules are found in the codified laws and in case law decisions. We have shown you only a few of the more significant cases. Each state has had its share of challenges regarding the use of radar. Some of the cases are quite interesting in how the public had tried to defeat the use of this law enforcement tool. If you have an interest in this area further research on your part will yield some interesting reading. The next section of the handbook is specific to California Case Law and how it has affected the use of radar.
You will find that there are some additional considerations and rules when utilizing radar in California.

CHAPTER VII

CALIFORNIA CASE LAW

From the original enactment of the "Speed Trap" law in 1923, through the end of World War II, there was little significant case law regarding speed traps. Since 1953, there have been several cases that have involved speed and the "speed trap" sections of the Vehicle Code. Some of these cases have involved the use of radar devices. The significant cases in this area are contained in this handbook. This section of the hand book also covers other cases and the issues involved that have already been discussed in National Case Law.

PEOPLE vs. HAEUSSLER 41 C.2d 252; 260 P .2d 8, 1953

Circumstances:

The defendant while, driving under the influence, drove on the wrong side of the roadway and collided head on with another vehicle causing death to a passenger in the other vehicle.

After the collision, it was noted that the speedometer needle on the other vehicle (not defendant's) was stuck at 78 m.p.h.. The defendant argued that the other driver was speeding which caused the accident.

The investigating officer testified to the location of the point of impact, the violation of wrong side of roadway and the "under-the-influence" charge.

A speedometer mechanic with several years of experience testified as an expert for the People. No attempt was made to cross-examine the mechanic regarding his qualifications. He testified that a severe impact might cause the needle of a speedometer to become fixed at any point, regardless of the speed at which the car had been traveling.

The defendant was convicted of manslaughter and appealed.

Judgment:

In prosecution for driving a vehicle while intoxicated, there was no prejudicial error in permitting a mechanic to testify that a severe impact might cause the needle of a speedometer to become fixed at any point, regardless of the speed at which the car had been traveling, where the witness was qualified as an expert by evidence that he had been a speedometer mechanic for several years, and no attempt was made by defendant to cross-examine him concerning his qualifications.

Issues:

* Expert testimony

* Speedometer operation

Significance:

This is the only case that addresses any expert testimony on the operation of a speedometer.

PEOPLE vs.BEAMER 130 C.A. 2d Supp. 874; 279 P .2d 205, 133 C.A. 2d 63: 283 P. 2d 356, (1955).

Circumstances:

Oakland - Piedmont Municipal Court. The defendant was convicted of driving 35 m.p.h. in a 25 m.p.h. prima facie speed zone (School zone) as indicated on an electromagnetic radar device.

The defendant appealed arguing that the officer that stopped him was not properly attired (Section 751 V.C.). The court held that Speed Trap Law (Veh. Code S. 751) is not violated by a method whereby police officers dressed in uniform measure motorist's speed with radar unit located in properly painted automobile parked at curb of highway in plain view and, on discovery of speed violation cause motorist's arrest by motorcycle officer openly patrolling highway.

BEAMER filed a second appeal contending that the radar unit was a speed trap as defined in Section 751 and 752 V.C. (Now Sections 40800 through 40802 (a) V.C.).

Judgment:

The Court upheld the conviction based on the fact that electromagnetic radar does not measure the time the vehicle traveled a distance, nor was there a known distance measured, marked or otherwise designated. Radar did measure the speed of an object by the change in the reflected electromagnetic wave (Doppler Principle). Therefore, radar is not a speed trap.

The court stated that a "Speed Trap" must have the following characteristics:

* A particular section of highway,

* Measured as to distance,

* With boundaries marked, designated, or otherwise determined,

* In order that the speed of a vehicle may be calculated, by securing the time it takes said vehicle to travel such known distance.

The court also looked at the operation of a vehicle speedometer and said: even though a speedometer does measure time over distance it was not the intent of the legislature to restrict police officers so severely as to disallow the use of this device and in a "pure sense" a speedometer did not measure a known distance with boundaries marked or otherwise designated.

Issues:

* Uniform and vehicle used by officers.

* Speed Trap definition.

* Electromagnetic wave reflections (Doppler Principle).

Significance:

The court held Radar was not a speed trap because radar determines speed through space without reference to the highway. (Doppler Frequency.)

* No recognized Radar device is a speed trap per 40802 CVC.

PEOPLE vs. JOHNSON 29 C.A. 3d. Supp. 1; 105 Cal. Rptr. 212, 1972

Circumstances:

Lodi Municipal Court - The officer, using VASCAR (Visual Average Speed Computer and Recorder), measured the distance between the crosswalks at two intersections of the street. He parked and measured, by means of a time switch, the time it took the defendant's vehicle to travel the previously measured distance.

The defendant was convicted and appealed.

Judgment:

The appellate court reversed the conviction citing that VASCAR computes speed by measuring the time it takes a vehicle to travel a known distance. Evidence and testimony obtained by the use of VASCAR constitutes a speed trap and is inadmissible under the provisions of the Vehicle Code.

Issues:

* Speed Trap evidence.

* Vehicle Code Sections 40801, 40802 (a), 40803 and 40804.

Significance:

Evidence obtained by use of "VASCAR", **Visual Averaging Speed Computer and Recorder** constituted **"Speed Trap Evidence"** and was inadmissable under provisions of Vehicle Code Sections 40801, 40802 (a), 40803, 40804 and 40805 V.C.

NOTE: Fruit of the poison tree doctrine (Mapp vs. Ohio, U.S. Supreme Court Decision).

PEOPLE vs. MACLAIRD 264 C.A. 2d 972; 71 Cal. Rptr. 191, 1969

Circumstances:

Sonoma Municipal Court - The defendant was cited for 22350 V.C., exceeding the posted prima facie speed limit as indicated by radar.

At trial, the prosecuting attorney advised the court that the matter at hand was a radar case and he intended to prove the installation, operation and accuracy of the radar machine through testimony of the arresting officer. The lower court then inquired whether the People proposed to present an expert witness to establish the validity and accuracy of radar devices. The prosecuting attorney replied that they would not produce such a witness, whereupon the court, upon its own motion, dismissed the action, stating that the court would refuse to take judicial notice of the use, validity and accuracy of radar devices.

The prosecution appealed.

Judgment:

"In weighing whether the trial court committed error in refusing to take judicial notice of the "use, validity and accuracy of radar devices," we interpret this to mean taking judicial notice of the principle of radar as an electronic device which scientifically and accurately measures speed of a moving object. This is altogether different from judicially noticing the accuracy and operating efficiency of the particular radar device used to measure the speed of the defendant's vehicle in the case before the court."

"Radar has developed many uses since its introduction in the 1930's, not the least of which is the highly simple, precise and accurate radar device for measuring the speed of a moving vehicle."

"Although the legal issue presented to this court stands as a case of first impression in California, the precise question has been litigated in a number of other jurisdictions. While there is some conflict of authority on whether the principle of radar should be judicially noticed, the better-reasoned cases hold that it should."

The court cited from several cases from other states including:

State v. D'Antonio, N.J.
People v. Magri, N.Y.
Cleveland v. Ferell, Oh.

State v. Graham, Mo.
U.S. v. Dreos

"The writings on the subject assert that when properly operated they accurately record speed and nothing to the contrary has been brought to our attention; under the circumstances it would seem that the evidence of radar speed meter readings should be received in evidence upon a showing that the speed meter was properly set up and tested by the police officers without any need for independent expert testimony by electrical engineers as to its general nature and trustworthiness." "The New York and New Jersey holdings are likewise supported by leading legal writers, including California's B.E. Witkin, who says: "The scientific accuracy of the device, properly handled, is scarcely open to question." (Witkin, Cal. Evidence (2d ed. 1966), SS. 663, p. 662)."

"California Evidence Code, section 451 (mandatory Judicial notice) provides in part: "Judicial notice shall be taken of:. . . (f) Facts and propositions of generalized knowledge that are so universally known that they cannot reasonably be the subject of dispute."

"We have concluded that the validity and accuracy of radar devices is a proposition of such common and universal knowledge that it must be judicially noticed and there is no necessity to call an expert witness to establish this commonly known and accepted proposition."

"The judgment dismissing the complaint is reversed, and the cause is remanded to the trial court for further proceedings in accordance with the views herein expressed."

Issues:

* Judicial notice of the Doppler Principle.

* Accuracy of the device used and how it functioned.

* Set-up, test and read.

* Training of operator.

NOTE: Compare this case to the National case of Commonwealth vs. Honeycutt.

Significance:

The court must take Judicial notice of:

1. The use.
2. The validity.
3. The accuracy of radar devices (Doppler Principle)

NOTE: It is still necessary for the officer to testify that the device was properly set up, tested, and the officer using the device was qualified to properly use it.

PEOPLE vs. HALOPOFF 60 C.A. 30 Supp. 1;131 Cal. Rptr. 531, 1967

Circumstances:

Los Cerritos Municipal Court - The defendant was convicted of violating the basic speed law, 22350 V.C., by driving 55 m.p.h. in a 40 m.p.h. posted prima facie speed zone as indicated on radar.

In the prosecution of the case, the defendant asserted that he was the victim of a speed trap. The defendant objected to permitting a deputy sheriff to testify that he had observed defendant's speed on a radar unit and that, in his opinion, 40-miles-per-hour was a safe speed on that particular street. The ground for the objection was that there had been no preliminary showing of the Engineering and Traffic Survey as required under Vehicle Code Section 40802, defining a speed trap as a section of a highway with a prima facie speed limit not justified by such a survey and enforced by the use of radar. The trial court overruled the objection and entered a judgment convicting defendant of violating the basic speed law.

Judgment:

"The legislature has declared a strong public policy against the use of speed traps. It has provided (1) that no peace officer or other person shall use a speed trap to enforce the Vehicle Code or to secure evidence of speeding for the purpose of arrest or prosecution (Vehicle Code Section 40801; (2) that where evidence is obtained as a result of a speed trap it shall be inadmissible (V.C. Sec. 40803); (3) that witnesses are incompetent to testify in such cases (V.C.Sec. 40804 (a)); and (4) that courts are without jurisdiction to render judgments of conviction in such cases (V.C. Sec. 40805)."

"Here we determine that defendant's conviction was improper under these sections and we declare the obligation of the prosecutor to establish that a speed trap was not involved in those cases where radar is used to apprehend a defendant."

"The defendant objected to the introduction of radar testimony because there had been no preliminary showing that the engineering study referred to had been conducted and there was no showing that the radar machine was calibrated, tuned, or maintained properly."

"The deputy sheriff testified that in his opinion 40 miles per hour was a safe speed on the particular street. The People urge that this testimony justifies the posted speed limit of 40 miles per hour.

Were we to accept such testimony in place and in stead of the engineering and traffic survey, any need for such surveys would be eliminated; the officer would simply testify that he thought a particular speed was safe and that would suffice to satisfy the speed trap statute (V.C. Sec. 40804 (a)). That surely was not the intent of the Legislature. Only proof of the *survey* can take this case out of section 40802, subdivision (b)."

Issues:

* Engineering and traffic surveys

* Vehicle Code Sections 40801, 40802 (b), 40803, 40804 and 40805.

Significance:

Court held that the prosecution has the responsibility to show no speed trap exists and provide the Traffic Engineering Survey to the court when radar is used. The prosecution must show the radar machine was tuned, calibrated and operated properly.

PEOPLE vs. STERITT 65 C.A. 30 Supp. 141 Cal. Rptr. 522, 1976

Circumstances:

The defendant was convicted of speeding (22350, 45 m.p.h. in a posted 25 m.p.h. zone) in the Municipal Court for the Beverly Hills Judicial District of Los Angeles County. The arresting officer testified that an engineering and traffic survey had been conducted within the past 18 months and that he personally not conduct it because it was not the responsibility of the police department. No evidence was presented as to the scope, findings or recommendations of the survey mentioned by the officer. Defense motions to strike his testimony pursuant to Vehicle Code sections 40803 and 40804 were denied. A motion based on section 40805 of the Vehicle Code was also denied.

Judgment:

In trial of speeding cases where radar is involved, it is incumbent on the People, in absence of stipulation by defendant, to physically produce in the courtroom the engineering and traffic survey required by statute and to establish that the survey justified the posted speed limit.

Issues:

* Engineering and traffic surveys

* Vehicle Code Sections 40801, 40802 (b), 40803, 40804 and 40805.

Significance:

The court held that when radar is used the people must, without request disclose that not only a Traffic Survey was conducted but that the survey justified the posted speed.

PEOPLE vs. FLAXMAN 74 C.A. 3d Supp. 16; 141 Cal. Rptr. 799, 1977

Circumstances:

Santa Monica Municipal Court. In a prosecution for driving at a speed greater than 55 miles per hour in an area posted 40 miles per hour (Veh. Code, Section 22348 (a)), the Peoples evidence consisted of the testimony of a single police officer who relied totally on a reading from a radar device. A certified copy of an engineering and traffic survey of the area was received into evidence. The officer testified that he had calibrated[1.] the radar device in accordance with instructions he had received, but could not explain the functioning of the machine. The trial court entered judgment of conviction.

The defendant appealed on the grounds of: (a) that any evidence as to a radar reading was inadmissible as incompetent because there was no justification of the posted speed limit by means of an engineering and traffic survey as required by Vehicle Code section 40802, subdivision (b), (defendant stated the engineer that conducted the survey did not appear in court and explain it); (b) there was no showing as to the radar machine's accuracy (defendant wanted an expert or electrical engineer to testify as to the accuracy or inaccuracy of the device).

Judgment:

The court discussed People vs. Halopoff, Vehicle Code Section 40802 (b), Rules of evidence in regard to "Public records exceptions under Section 1280 of the Evidence Code: "Section 1280. *"Evidence of a writing made as a record of an act, condition, or event is not made inadmissible by the hearsay rule when offered to prove the act, condition or event if: (a) The writing was made by and within the scope of duty of a public employee: (b) The writing was made at or near the time of the act, condition, or event: and © The sources of information and method and time of preparation were such as to indicate its trustworthiness."*" "It follows then that a court may admit a certified copy of an engineering and traffic survey provided it satisfies Evidence Code sections 1530 (Copy of writing in official custody) and 1453 (Domestic official signatures)[2.], by way of taking judicial notice. The trial judge must be persuaded that its identity and trustworthiness, as evidenced by its mode of preparation as described in the survey, satisfy the requirements of Evidence Code section 452, subdivision (h) (Matters which may be judicially noticed)."

In the case before us, it appears that the court did in fact take judicial notice of the underlying foundational facts, consistent with the views expressed herein, which thereupon rendered the survey admissible pursuant to Evidence Code section 1280.

The Court also discussed People vs. MacLaird in regard to the use, validity and accuracy of radar devices as a scientific method of measuring speed. "It is sufficient that the operator of a radar machine be familiar with the device and its operation and recognizing that the device might not be properly functioning upon occasion, take a reasonable amount precautionary measures to assure that it is properly operating.

The measures taken in this case were sufficient to establish a prima facie showing that the machine was suitably functioning. Accordingly, we hold that the police officer's testimony was sufficient to establish the accuracy of the radar reading."

Issues:

* Judicial notice

* Engineering and traffic surveys

* Vehicle Code Section 40802 (b), 40803, 40804 and 40805.

* Police officer's competency to testify.

Significance:

The court held that a certified copy of the Traffic and Engineering Survey is admissible under Evidence Code (Section 1280) and the court may take judicial notice of the survey.

Testimony of the operator of the machine is sufficient if the operator is familiar with the device and its operation. Its not necessary for the operator to know the internal workings of the device.

PEOPLE vs. MILLER 90 C.A. 3d Supp. 35; 153 Cal. Rptr. 192, 1979

Circumstances:

Pomona Judicial District. Defendant was convicted for driving on a highway at a speed greater than 55 miles per hour (Veh. Code, section 22348, subd. (a)), on the basis of radar evidence. The People's witness, a City of Pomona police officer, testified that he observed appellant on State Highway 71 and that a printout on his radar unit, verified for accurate calibration 10 minutes before, showed appellant to be traveling 74 miles per hour. A 55 mile per hour state speed limit was in effect for that area of Highway 71.

In appealing his conviction, appellant's primary contention is that evidence of his alleged violation was inadmissible under sections 40803, 40804 and 40805 which exclude speed trap evidence. At the time of the alleged violation a speed trap was defined by section 40802.

Appellant further contends that a Pomona police officer did not have authority to issue a citation in the area in question, but such contention, if proved would not affect the validity of his conviction.

Judgment:

Appellant does not contend that the area in question was a speed trap under subdivision (a) but asserts that subdivision (b) applies and that no engineering and traffic survey was presented to justify the use of radar evidence as required by that subdivision and in our opinions in People vs. Flaxman, People vs. Sterritt and People vs. Halopoff.

The court held under 40802(b) that a **"speed trap"** is a particular section of highway with a **prima facie** speed limit that is not justified by an Engineering and Traffic Survey. Thus, in a prosecution for driving on a highway at a speed greater than 55 miles per hour (22348(a) CVC), the trial court properly admitted radar evidence to establish that the defendant had been speeding, even though speed trap evidence is inadmissible (40803 CVC), where the 55 mile per hour speed limit in effect on the area of highway in question was not a **prima facie** speed limit.

The court also held that the opportunity to prove that the basic speed law (22350 CVC), has not been violated **<u>is not available</u>** to a person charged with driving in excess of 55 miles per hour on a highway with such a speed limit, since Vehicle Code Section 22348(a), prohibits driving at a speed greater than 55 miles per hour notwithstanding...any other provision of this chapter.

The court went on to say that this would also apply to any **<u>maximum</u>** speed limit.

The court ruled that his contention as to the police officer's authority on a State Highway was without merit.

Issues:

* Maximum speed limits.
* Prima facie limits.
* Engineering and traffic surveys.
* Vehicle Code Section 40802 (b), 40803, 40804 and 40805.
* Police officer's authority on a State Highway.

Significance:

No engineering and traffic survey is required when operating radar in an area that is controlled by a "maximum" speed limit.

A peace officer (836 P.C.) may enforce the Vehicle Code within the boundaries of his jurisdiction (782 P.C. jurisdiction, within 500 yards of boundary).

PEOPLE vs. ECHOLS 46 C.A. 3d Supp. 1; 120 Cal. Rptr. 375, 1975

Judgment:

The only type of **"Speed Trap"** prohibited by Vehicle Code Section 751 (now 40802), is one possessed of four characteristics: a particular section of highway, measured as to distance, with boundaries marked, designated or otherwise determined, and the speed of the vehicle calculated by computing the time it takes the vehicle to travel the known distance. In the absence of any of these elements, the device does not fall within the prohibition of Section 751.

Hence, the use of a **helicopter** by the police to establish the speed of a defendant in a prosecution for speeding, did not constitute a speed trap where no particular section" of the highway was used by the helicopter pilot, and where the officer did not calculate the speed of the defendant by computing the time it took him to travel a known distance, but instead, after determining the ground speed of the helicopter, noted the defendant's vehicle was traveling at the same speed as the helicopter.

NOTE: The pilot used a conversion chart to determine the correct ground speed from air speed, as he paced the defendant's vehicle: He did not use a **Time - Distance** calculation in this case.

Issues:

* Speed Trap (40802 (a) V.C.).

Significance:

* Use of a helicopter and converting "air speed" to ground speed is not a speed trap.

PEOPLE vs. KRUEGAR (case #887092), PANTOS (#DP44339), PAYNE (#DP54571), et. al., (This case is not an Appeals Court Case)

Circumstances:

Sixteen separate speeding cases charging 22350 V.C. were joined into one hearing. Two agencies were involved in the prosecution; The California Highway Patrol and the Sacramento Police Department. The court selected three of the sixteen cases for review with the understanding that the evidentiary record would apply to all sixteen cases.

There were eight separate issues that the defendants wanted the court to rule on, as follows:

1. Unreliability of RADAR's design, construction and component parts.

2. Use in "today's" environment and target uncertainty making the readings unreliable.

3. Inadequate training of operators rendering unreliable readings.

4. The possibility of various errors making the devices unreliable.
5. Intentional operator misuse yielding fraudulent readings.

6. Improperly maintained units giving false readings.

7. Admissibility of radar readings would violate Due Process of Law given no legislative or administrative guidelines in California.

8. Admissibility of radar is prohibited under the "Separation of Powers" Clause, in that the Legislature has abdicated its responsibility to the Executive Branch.

One officer from each agency testified. The California Highway Patrol officer testified on two cases.

Judgment:

The court decided:

1. Reliability - The court took judicial notice of the scientific principles of radar (Doppler Principle) by reviewing past cases involving radar. The court referenced the following cases D'Antonio vs. New Jersey, People vs.MacLaird, and People vs. Flaxman. The court also reviewed State of Florida vs. Aquilera.

2. Error Recognition - The court discussed potential errors and their effect on the admissibility of radar evidence. Foremost was the target identification (Tracking history and target verification). The court reviewed radar effects and phenomenon to include Scanning, External interferences, Power Surge, Batching, Ghosting and Cosine effect. The court also reviewed the use of radar devices that did not have an audio Doppler feature and the difficulty in developing a tracking history or differentiating false readings from true readings.

3. Admissibility of radar evidence - The court decided that the evidence must show that internal and external testing was completed and the operator must be competent and adequately trained in the use of speed radar and in error recognition.

4. Operator training and testimony - The **California Highway Patrol** follows the NHTSA 1982 guidelines:

a. 16 - 20 hours of classroom training.
b. 4 hours of controlled situational experiments.
c. Visual estimates of speed confirmed by radar.
d. Annual recertification through written test and visual estimations.

Sacramento Police Department:

a. 3 hours of instruction, including a test.
b. 6 hours of in-field training (visual estimation and effects).
c. Reading the operator's manual provided by the manufacturer.

The court noted, there was "no meaningful training of radar operators within the Sacramento Police Department."

Sacramento P.D. was using pre-NHTSA guideline devices and limited training. "If it weren't for the general radar knowledge that the citing officer displayed (18 years of in-field experience with radar) while testifying, this case would have returned with a defense verdict."

5. The court found no intentional misuse by operators.

6. The court examined maintenance and calibration records and found that all devices owned by both departments were well maintained and calibrations were kept current.

7. Due Process - The court found no merit to this argument.

8. Separation of Powers - Again the court found no merit to this argument as the Executive Branch (includes Police) enforce the laws of the land.

Issues:

Stated above.

Significance:

Although this particular case is not case law, the court felt there should be statewide standards set in the area of Doppler Radar and the California Commission on Peace Officer Standards and Training (P.O.S.T.), should set minimum standards for radar operator training.

This case, like the Florida vs. Aquilera case, does not mandate the Legislature or P.O.S.T. to set guidelines. However, the courts have realized the importance of standardized training.

Footnote to this case: In January of 1988 POST put together a Radar Instructor Course in Sacramento. Twenty-two agencies sent thirty-five students to the training, including two from the Los Angeles Police Department and three from the California Highway Patrol. The instructors for the course were from the Utah Highway Patrol, and they had also taught for Northwestern University's Traffic Institute. One of the students was the Sacramento police officer that testified in the case.

OTHER CALIFORNIA CASES

People vs. Darby, 95 Cal. App. 3d 662, 1979 (Aircraft case).

People vs. Smith, Cal. App. 3d Supp. 7; Super., 173 Cal. Rptr. 659, 1981.

People vs. Peterson, 181 Cal. App. 3d Supp. 7, 1986.

People vs Stone, Segesman, 190 Cal. App. 3d supp. 1, 1987.

People vs. DiFiore, 88 Daily Journal, D.A.R. 277, 1988.

CHAPTER VIII

TRAFFIC AND ENGINEERING SURVEYS

BACKGROUND

Since the beginning of the "motor era," society has been concerned with effectively tempering the behavior of the unreasonable vehicle operator. Driving behavior has long been recognized as a product of individual attitude. Most citizens can be relied upon to behave in a reasonable manner as they go about their daily activities. Many of our laws reflect how reasonable people behave under most circumstances. Traffic laws are based on the behavior of groups of motorists under various conditions. Generally traffic laws that reflect the behavior of the majority of motorists are found to be successful. Laws that are arbitrary, restrict the majority of drivers, lack public support and fail to bring about changes in driver behavior usually encourage wholesale violations to occur.

It is necessary to first identify a fundamental purpose for speed zoning (setting speed limits). Speed zoning is the application of engineering and traffic survey methods for developing specific speed regulations. The purpose of speed regulations, in turn is to provide realistic guidance to the driving public and to provide equitable enforcement against the excessive speed violator. Effective speed zoning and speed control are among the top traffic management concerns of local officials.
The principal aim of engineering and enforcement efforts in realistic speed zoning is to improve safety and to improve traffic flow conditions. The review of established principles for effective and equitable speed zoning and enforcement is intended to improve confidence in this greatly misunderstood and often controversial aspect of traffic management. In addition to reviewing the fundamental steps in completing an Engineering and Traffic Survey, specific guidelines for improving the quality of the survey are provided.

There is a need to strengthen overall confidence in proven speed zoning methods and equally important to promote the credibility of those methods with elected officials, enforcement agencies, and with the general public.

It is necessary to first identify a fundamental purpose for speed zoning.

Definition from California Department of Transportation:

"Speed zoning is the application of engineering and traffic survey methods for developing specific speed regulations. The purpose of speed regulations, in turn, is to provide realistic guidance to the driving public and to provide equitable enforcement against the occasional excessive-speed violator."

The principal aim of engineering and enforcement efforts in realistic speed zoning is to improve safety and to improve traffic flow conditions.

Realistic speed zones are of public importance for a variety of reasons:

* They satisfy the requirements for establishing prima facie speed limits.

* They invite public compliance by conforming to the behavior of the majority and by giving a clear reminder to non-conforming violators.

The basic intent of speed zoning is to influence as many drivers as possible to operate at or near the same speed, thus reducing conflicts created by wide differences in operating speeds.

The enforcement of excessive speed is not a question of posted limits and enforcement of "**tolerance**." It is a matter of correlating physical roadway and roadside features with variable traffic conditions to arrive at a reasonable and prudent speed for a given period. Any set "**tolerance**" that is adopted and applied as routine for enforcement purposes is both improper and in conflict with the basic speed law of most states.

The majority of our national traffic regulations recognize that traffic laws, as other laws, cannot be effectively enforced without the consent and compliance of the public. Speed laws can be classed into three basic types:

1. Maximum Speed - Relates to absolute speed limits (Natl. 55)

2. Prima Facie Speed - Refers to posted or statute speed limits intermediate between 25 - 55 mph.

3. Basic Speed - General requirement that drivers not exceed a "safe" speed under any circumstances.

All of the States utilize engineering and traffic surveys to establish speed limits on the "intermediate" locations. Washington and California have some special laws concerning "speed traps"

While the basic speed law always applies, review focuses on prima facie or posted speed regulations intermediate between legally defined 25 mile per hour business, residence, School zones, and Senior zones and with the maximum speed limit.

California State law provides that intermediate zones be established "on the basis of an engineering and traffic survey". The California Vehicle Code defines Engineering and Traffic Survey as:

Vehicle Code Section 627: Engineering and Traffic Survey, as used in this code, means a survey of highway and traffic conditions in accordance with methods determined by the Department of Transportation (Cal-Trans) for use by state and local authorities.

An Engineering and Traffic Survey shall include, among other requirements deemed necessary by the Department, consideration of the following:

1. Prevailing speeds as determined by traffic engineering measurements.
2. Accident records.
3. Highway, traffic, and roadside conditions not readily apparent to the driver.

ENGINEERING AND TRAFFIC SURVEY (E&TS) GUIDELINES

The administrative provisions outlined in the California Department of Transportation Traffic Manual, Section 8.03, include specific guidelines for selecting proper speed limits. The following additional guidelines are intended to supplement Traffic Manual (E&TS) provisions and thereby facilitate the speed zoning process as well as to more completely satisfy the provisions of Section 627 of the California Vehicle Code:

Prevailing Speed:

Prevailing speed is often referred to as the "critical speed" or "85th percentile speed." Speed limits set higher than the 85th percentile are generally not considered reasonable and safe and speed limits set below the 85th percentile do not facilitate the orderly movement of traffic. The California Department of Transportation has set guidelines to measure this "85 th percentile" speed stated as follows:

Traffic Manual Guidelines:

"Speed limits should be established preferably at or near the 85th percentile speed,... speed measurements should be taken during off-peak hours on weekdays. The weather should be fair with no unusual conditions prevailing."

It is only the top fringe of drivers (15 %) that are inclined to be reckless and unreliable, or who have faulty judgment that must be controlled by enforcement. The speed limit should be established at the first five mile per hour increment below the 85th percentile speed. However, in matching existing conditions with the traffic safety needs of the community, engineering judgment may indicate the need for a further reduction of five miles per hour.

The above guidelines are based on experience that shows, the great majority of drivers will normally travel at a speed that is reasonable and prudent. The engineering concept known as the 85th percentile has time and again substantiated this basic assumption.

How is the 85th percentile determined? Speed measurements are taken of 100 vehicles, 50 in each direction and the 15 fastest speeds are basically thrown out.

The speed of the 16th fastest vehicle sets the prevailing speed.

Prevailing speed investigations should include the following:

1. Proper selection of spot-check locations (free-flow areas).

2. Free flowing vehicles - care should be exercised to avoid recording either too many "fast" or too many "slow" vehicles.

3. Representative sample vehicles (proper ratio of trucks, buses, and autos).

4. Adequate sample size (usually 50 for each direction at the location).

The survey of prevailing speeds at spot locations simply provides a speed profile. A selected numerical speed limit represents the straight line which best fits this profile. Prevailing speeds may, at various locations, occur above or below the selected limit. The objective of realistic zoning therefore is to offer that numerical limit which is most representative of a running section of roadway.

Accident Records:

Traffic Manual Guidelines:

"As a check on the validity of the proposed speed limit, an analysis should be made of the two-year accident record for the section of roadway under consideration. If this record shows an abnormally high percentage of accidents normally associated with excessive speeds, the proposed speed limit should be further reduced. This is a judgment situation, and will not usually be a factor."

The term accidents, normally associated with excessive speeds should suggest that corrective action be by the way of selective enforcement of a realistic speed limit rather than by adopting unrealistic regulation. Arbitrary, unrealistic speed zones cannot be expected to reduce accidents and may in fact adversely affect traffic safety by confusing drivers and increasing speed dispersions. Accidents should not be used as a casual justification for posting arbitrary speed limits. Where appropriate, such as along sections of major thoroughfares, accident rates should be computed and then be compared to rates on similar roadways. Abnormally high rates should alert the engineer to identify point-concentration (curves, intersection, etc.) accidents and to develop corrective measures and programs for accident reduction. Identification of appropriate engineering corrective measures may include traffic control devices (signs, signals, markings, etc.) or roadway construction improvements.

Roadway Characteristics (conditions not readily apparent to the driver):

Traffic Manual Guideline:

"Only when roadside development results in traffic conflicts and unusual conditions which are not readily apparent to drivers, are speed limits somewhat below the 8585 percentile warranted."

Perhaps the most misunderstood element in Engineering and traffic survey definition is the consideration of roadway and roadside characteristics "not readily apparent to the driver." This statement appears to suggest that physical roadway elements should be "weighed" to justify speed zones below the observed prevailing speeds. The traffic engineer, however, must keep two basic survey elements in mind:

1. Free flow locations, driver can see and analyze.

2. Physical characteristics, cannot see, such as hidden intersections, dips, curves, lane-drops, etc.

Sample surveys and Federal Aid and Urban System Maps

Included in the next few pages are examples of Engineering and Traffic Surveys from several sources. Some are self explanatory and others may seem hard to understand at first, however, if you study them carefully they will become easier to read and understand. Also included is a portion of a Federal Aid and Urban System (FAU) map.

CHAPTER IX

COURTROOM PREPARATION AND TESTIMONY

INTRODUCTION

Through most of this handbook you have been preparing for the most important part of the training program and that is to prepare and present a radar case with the professional demeanor, confidence and with the knowledge to obtain a conviction, or prove your case. As a witness your credibility and integrity are on the line whenever you testify. This is discussed in greater detail later in this chapter.

OBJECTIVES

The objectives of this portion of the handbook is assist you in the courtroom this will be accomplished by giving you information on the following:

1. How to write the radar citation.

2. The four important factors in presenting a radar case.

3. When does case preparation begin.

4. How to lay a foundation for radar evidence and testify.

5. The radar court packet or "evidence kit."

WRITING A RADAR CITATION

Writing a radar citation differs only in the "notes" portion of the citation. This difference is that you have to include the estimation of the violators speed (EST 55+/35), the radar indicated speed (IND 57 mph), the radar device serial number (RR4600) and the tuning fork serial number (FK#12345). As usual on the last copy of the citation you would include other notes in regard to your tracking history, the prima facie conditions present and when the internal and external checks were performed. Some of the prima facie conditions should be included on the face of the citation in the notes.

In California, as discussed previously there are some exceptions to the speed trap law and these situations should be noted on the face of the citation in the notes. These would include "School zone", "Senior zone", a local street or road, or one of the other locations.

Examples of citation notes:

SURVEYED STREET

22350 VC - N/B-1 POVS (3) EST 50+/35 RADAR# RR4777 IND 53 MPH DOWNGRADE, CURVES, PRI DRVS, SIDE ST, PKD VEHS, PEDS, (CLEAR AUDIO), 3122 LC, FK# 17322

LOCAL STREET OR ROAD

22350 VC - W/B EST 45/25, LOCAL STREET, RADAR RR# 4777 FK# 17322, IND 44 MPH, RES DIST, PKD VEHS, SIDE ST, NO SIDEWALKS, PEDS, SPD COMPLAINT

SCHOOL ZONE

22350 VC - E/B-2 EST 40+ 25 MPH SCHOOL ZONE, CHILDREN PRESENT (30+) RADAR RR# 4777 IND 42 MPH FK# 17322

MAXIMUM SPEED

22349 VC - S/B-1 EST 70/55 RADAR RR# 4777 FK# 17322 IND 70 MPH EXCEEDING MAX STATE SPD

MOVING RADAR CITATION

22350 VC - E/B-2 EST 60/35 MOVING RADAR IND 62 MPH. POVS(3) PEDS DRVWYS PKD VEHS SIDE STS MOV RADAR HR-12 #AA4612 FKS 17312/4663

As you can see the citation notes are quite simple and to the point. They also should be as complete as possible to help you recall the traffic stop and issuance of the citation. In the Surveyed Street example there is a notation of "3122 LC" this is an indication of where the officer was set up operating stationary radar and it stands for the address of 3122 Laurel Canyon Boulevard. This type of notation can only make your memory more clear about the incident and assist you in your testimony.

PRESENTING A RADAR CASE

There are four important factors in presenting a radar case in court. These are demeanor, a commitment to radar's accuracy and reliability, your experience and training and your preparation prior to the trial.

DEMEANOR

You are looked at from the time you enter the courthouse until you leave. You are judged by some by how you appear, your attire, your attitude, your courtesy and your professionalism. There is an old saying about first impressions lasting a long time and you only get one chance to make that "first impression." If your overall demeanor is that of a professional you will gain the respect of the court, jury, your peers and the public from that first impression.

That first impression is all important and cannot be underestimated. You should be in appropriate business attire or in uniform to present a professional businesslike appearance.

If you appear in uniform, it should neat and clean. Even if you have to keep a "court" or "inspection" have it ready (clean and pressed). If you appear in civilian attire, it should be a "conservative" business suit that presents a neutral but professional appearance. Whether in uniform or civilian attire , avoid a "flashy" or sloppy appearance.

Show respect for the court, as a police officer or expert witness you are subject to constant scrutiny. You should display respect in all dealings with the court. You should display a quiet, reserved and dignified demeanor in court. Your role as a witness is to present a factual account of the incidents associated with a particular case or situation. This should be accomplished as professionally as possible. Nervous anxiety sometimes causes people to do things before, during and after a court appearance that would not otherwise do. You must recognize the possible effects of this anxiety and guard against its effects. Be quiet and reserved. Don't become involved in "horseplay" or other type of "locker room" humor or anything that would be considered in bad taste. The court is a serious place and its functions and activities are to be respected.

While testifying maintain a neutral attitude. You are to testify to the facts of the case as a "trained observer" skilled in relating a factual account of the incident or situation. As a witness you should present an unbiased attitude in your testimony. Avoid any display of a bias of any kind toward any part of, or principle involved in the court proceeding. Some have said "Put on a professional face" while in court and you will be respected for it by all involved.

Avoid showing any emotion or "disbelief" if other witnesses are not testifying as you recall the situation. The judge or jury doesn't need your "coaching" from the side lines. Our form of government is based on separation of powers your job was to gather evidence, make the arrest and testify to the facts as you know them, not to prosecute, or to be judge and jury.

While on the witness stand continue to conduct yourself in a professional manner. The judge or jury will be looking at all of the witnesses. Their job is to decide who and what to believe and who did not tell "the truth, the whole truth and nothing but the truth." If your bearing is sloppy, unkempt, you slouch or show an otherwise unprofessional appearance, it will be easier for the jury to put less weight than it deserves on your testimony than other witnesses. Try to be modest, unassuming and reserved.

Don't be in a hurry to answer questions think over what was asked. Answer all questions deliberately, slowly and clearly. Show respect for not only the judge and the prosecutor, but for the defense lawyer as well. If you answer the defense questions "with an attitude", it will be seen by the judge and/or jury. Avoid this as it shows bias toward the defense and is unprofessional. Direct your answers to the judge and/or jury.

Don't be afraid to say "I don't Know" if you are asked a question that you don't know the answer to. You are not expected to know the answers to everything. Answer those questions that you do know the answer to, but if you can't answer a question say so. Also, don't be afraid to ask for clarification or have the question restated if you don't understand it. This also holds true for those things that you honestly don't remember.

Don't volunteer anything answer only the question asked. This applies to the questions posed by the prosecution as well as those posed by the defense. If you are asked a question and it is indicated that the attorney only wants a "yes or no" answer and you can not answer the question in that form, then tell the court that you can not answer it that way.
The court will usually allow you to phrase your answer, or have the attorney rephrase the question.

Your actions in and around the court may have a bearing on the case outcome. Your actions are constantly under observation, one of the observers could be the judge, a member of the jury, or the defense. If the defense observes you doing something that you shouldn't they might and usually will make a comment during the trial. If you have acted in a professional manner while at the court there will be no problems in this area.

COMMITMENT TO RADAR'S ACCURACY AND RELIABILITY

Thus far in the training it has been shown that radar is an accurate and reliable device if used properly by a trained operator. The steps required for setting up, testing and using have been explained in great detail. The "tracking history" and what is required has also been explained in great detail. If you utilize the information received and utilize the device properly at all times you shouldn't have a problem in testifying. Remember that as part of your testimony you have to explain the set up (A to B to C), the internal checks (lamp/segment and Internal Calibration) and the external (tuning fork(s) or vehicle with a calibrated speedometer) test(s) performed. The "tracking history" should include the minimum of VARS and hopefully be more detailed to include the complete "tracking history."

TRACKING HISTORY (3 to 5 seconds)

VISUAL ESTIMATION
* Identify target
* Estimate Speed
* In range
* Check environment

AUDIO ESTIMATION
* Pitch and clarity

RADAR CONFIRMATION
* Stable reading
* Manual lock/no lock (your option)

SPEEDOMETER VERIFICATION
(moving mode)
* Verify indicated patrol speed with speedometer

EXPERIENCE AND TRAINING

Your experience and training started long before you became a police officer. Some of it goes back to your youth. Some of it stems from your education up through high school and some of it stems from your first introduction to the rules of the road as a pedestrian in elementary school. You have been building on that experience and training ever since. Upon completion of the radar operator school you will have been exposed to some scientific and technical information.

You will also have had the opportunity to estimate speeds from a stationary position and from a moving vehicle. Hopefully you will have had some hands on experience with a device and had the opportunity to try and induce and experience some of the effects of radar interacting with the environment.

In the court you should tell them about some of this training and experience, or as the saying goes "lay it on them." Your experience and training makes you somewhat of an expert in the field of radar once you complete the radar school. The court, however, will reserve the right to declare you an expert, but when the court does declare you an expert, note it down and keep track of it so it can be commented on in future cases. It would also be wise to keep track of the number of radar citations written, this adds to your credibility in the area of experience.

PRESENTING YOUR CASE IN COURT

When does your preparation begin? Well, honestly it started on your first day in the academy to become a police officer, or in the case of radar your first day in radar school. Realistically, it starts from the moment that morning when you first set up the device and run the required tests. When you are issuing the citation don't say or do anything that you wouldn't want discussed in court. Think of yourself as being in the court room during your traffic stop.

How do you present your case, well you take some time to prepare before you go to court. Review the citation and if you aren't familiar with the location go by and look it over. Make appropriate notes on a separate sheet of paper. Study the engineering and traffic survey. Review all of the times and distances involved. Defense attorneys will try to trip you up using the time and distance calculations range, speed in feet per second, etc. Below are some sample questions that you should be prepared to answer:

1. How far away was the target when you first observed it?

2. How far away was the target when it first registered on your radar?

3. For how long did you observe the vehicle before it registered on your radar?

4. How far away was the target when you locked in the radar reading?

5. For how long did you observe the radar before you locked in the reading?

6. How fast was the vehicle traveling?

7. How fast were you traveling?

Work out these questions prior to trial. In fact you should have these noted on your copy of the citation at the time you issued the citation. If not calculate the answers using a calculator before court, don't try to answer these off the top of your head while on the stand its too easy to get tripped up. All of these are simple, but if you are not prepared you can end up looking like a fool on the stand and if that happens your credibility is shot. The judge or jury might perceive that you are lying or just plain stupid.

Rehearse in your mind your testimony prior to court. In court make a diagram on the chalk board or white board. Include the vehicle description, date, time, day of week, radar unit and fork numbers and any other pertinent notes you feel you might need and don't be afraid to use them. Don't forget to indicate which way North is for you and for the court.

Your actual testimony should include the following:

* Introduction of the survey, or that the location is one of the exceptions.

* State your qualifications, training and experience.
* In uniform, on duty with a marked vehicle.

* Set-up and testing of the device.

* If appropriate complaint location, high accident location, etc.

* Prima facie elements (why was it unsafe).

  ** Clear and unobstructed view.
  ** Tracking history (3 to 5 seconds).
  ** Identify the defendant as the driver.

* All events occurred in your jurisdiction (City of Los Angeles).

You should assume that each and every citation that you issue will result in you appearance in court and that you will have to testify. With this in mind, a thorough job will be done with regard to each and every radar citation.

You should also have your radar court packet, or evidence kit with you and it should include:

* Your radar certificate of training or a copy.

* Vehicle speedometer calibration (moving).

* Operator's manual for the radar device.

* Radar certificate (copy).

* Tuning fork(s) certificate(s) (copy(s)).

* Certified copy of the survey (if applicable).

Any maintenance records for the vehicle or the radar device has to be subpoenaed by the defense prior to trial. If they are requested in court at the time of trial inform the court that the records are maintained by the department's keeper of records and a ***Subpoena Duces Tecum*** should have been sought by the defendant for those records or documents.

If the court dismisses the case because these records are not in court contact the court liaison officer, or the prosecutor (City Attorney, County Attorney, etc.) to file a formal protest, or to have the case refiled.

Familiarize yourself with the courtroom be aware of where things are, this is two fold, if you are familiar with the layout you will know where you belong and you might be asked to estimate the distance from one location of the room to another location. You should know the courtroom well enough to be within a few feet on distance estimations.

Listed below are some of the elements of a radar citation which should be considered in the preparation of your case. These elements arise out of the law itself and the rules of evidence.

1. The basic elements.

   a. Date, time and location of the alleged violation.

   b. The fact that the officer was on duty.

c. Officer was operating radar.

d. It was legal to operate radar at that location and that any required signs were posted and any required surveys had been conducted.

e. A speed reading was present on the radar unit.

f. That the speed registered was a violation of law.

2. The fact that the radar was operating properly.

a. Device set up properly.

b. The device tested before and after violation.

c. Testing was performed as prescribed (ICT/LS - Tuning Fork).

d. Tuning fork was accurate (certificate if necessary).

3. The fact that the radar was operated properly.

a. The officer's qualifications were adequate.

b. The radar unit was in the proper operating mode (moving/stationary).

c. The radar was responding to the target vehicle and not to electronic interference.

d. The radar unit was properly aimed.

e. Operator did not move the unit prior to reading (to prevent scanning/panning effect).

f. There were no fans in operation, or windblown objects which could generate a false radar signal.

g. There was no traffic adjacent to the path of the radar beam (frontage or service roads along highway).

h. There were no other interferences present.

4. Reliability of the officer's visual testimony.

a. Established whether the officer's view was direct or reflected in a mirror (possible distortion in glass).

b. Establish whether the officer observed the alleged speed first visually, or by radar.

c. Establish officer's ability to judge speed and distance.

5. That it is valid to assume that the speed shown on the radar unit was the speed of the target vehicle.

a. Radar beams cannot be seen by the unit's operator; was the radar unit properly aimed?

b. Establish the connection between the speed of the target vehicle and the speed shown on the radar unit.

HERE IS A SHORT LIST OF THE MANY QUESTIONS AN OPERATOR COULD BE ASKED IN COURT

The questions could be asked by the prosecutor, the judge, the defense attorney, or the defendant depending on the type of court situation. Please read through the questions you will find that they will greatly assist you in your testimony not only for a radar case, but for almost any case.

* Please state your name, place of employment, and present assignment?

* How long have you been employed by that law enforcement agency?

* What type of positions and experience have you had as a law enforcement officer?

* When did you graduate from the training academy?

* While employed by your department, what, if any specialized training have you been given in the operation of __________ radar device?

* Would you describe to the court the specific nature, extent and depth of this training?

* Who were the instructors?

* What were their qualifications to train?

* Did they give you a proficiency test at the end of your training?

* What was your proficiency?

* How is your proficiency today?

* Do you have a record of your radar training?

* Do you have the record with you?

* Were you given a diploma or anything to indicate that you are qualified to operate a radar unit?

* Did you bring it with you to court?

* Where did this training take place?

* What was the nature and length of their experience and training in the use of this radar?

* How long have you employed radar in traffic control (Years, Months, Days)?

* How many citations have you written using radar?

* How many radar citations do you write on an average day?

* Do you know if that is about average for all the radar officers?

* How many motorists did you cite on the day of the alleged violation?

* Calling your attention to (date), will you explain what official duties, if any, you were performing relative to this case?

* What time did you begin your tour of duty on that date?

* What time did you begin conducting traffic control radar activity?

* Where was your patrol vehicle/motorcycle in relation to traffic being monitored?

* Were you hidden from traffic?
If Yes:

** Would you agree that your purpose was to slow traffic down?

** Don't you feel hiding defeats your purpose?

** Does hiding allow you to catch a lot of motorists?

* When did you first observe the defendant's

motor vehicle?

NOTE: The answer to this question should reflect a visual observation by the officer which indicated that the vehicle being read by radar was exceeding the speed limit and observed as such prior to radar confirmation of that fact (Tracking History).

* Will you establish the time, place, and location of the subject vehicle?
* What was the direction of traffic being read at this time?

* Will you please identify the subject vehicle by make, model, and color if possible?

* Can you identify the driver? Please identify the driver for the court.

* After having visually observed the subject vehicle, what enforcement action, if any, did you take?

* Where was the defendant's vehicle in relation to other traffic?

* What was your estimate of his/her speed?

* What speed did the radar indicate?

* What speed were you traveling (if moving unit used) when you observed and cited the defendant?

* What is the name, model number, and manufacturer of the radar unit used to make this arrest?

* Could you describe to the court what the device looks like and how it functions?

* Did you receive any on-the-job training using this instrument while working with a more experienced operator?

* Approximately how many hours did you have working with this specific piece of equipment?

* Did you perform any tests to check the accuracy of this unit prior to going out on patrol?

* Would you explain the nature and extent of these tests?

* What effect does testing, as you testified, have on the accuracy of this instrument?

* What is an external calibration? Did you perform this test prior to going out on patrol?

NOTE: Old "S-Band" radar devices were "externally calibrated." This terminology is no longer correct for "modern" devices. Correct the person asking the question by stating that you tested the calibration externally utilizing a tuning fork.

* What is an internal calibration test? Did you perform this test prior to going out on patrol?

* What is an lamp segment test? Did you perform this test prior to going out on patrol?

* Did you test this unit using a tuning fork?

* How many forks did you use?

* Would you explain why you conducted these three calibration tests prior to going out on patrol?

* Are these required by departmental

procedure? (No, Tuning fork by case law and the other tests as per the manufacturers handbook).

* Did the defendant ask to see the radar unit and the speed result? Was he shown the speed he was "clocked" by you?

* I show you what has been marked as state's exhibit #1 for identification (radar maintenance records). Would you identify it for the court?

* Did you calibrate and test the radar unit after defendant's arrest? Why?

* When you clocked the defendant for the speed check, please describe how the radar performed?

NOTE: The answer should reflect an audio estimation (tone) from the unit, as well as the readout window reading of the speed.

* How did this audio tone compare in regard to other motor vehicles being clocked?

* Did you use an automatic mode? (No, feature not available).

* How many radar signals can this radar unit pick up at one time? (Stationary - one, moving - two, high doppler (CS) and low doppler (PS).

* When was the last time this radar unit was calibrated by a technician having an FCC license?

* What is a ghost image (reading)? Would you describe how this effects the operation of radar?

NOTE: The answer here should emphasize your tracking history and that there is really no such thing as a "ghost image" and that they are erratic or improper descriptions of radar interacting with the environment. These phenomenon are weak interferences that are ignored because there is no tracking history. Radar only measures moving objects.

* Is it possible to get a speed reading from a tree or sign off of the highway?

* What happens when a moving object enters the radar beam path?

* What are sources of interference for a radar unit?

* What effect does a "Fuzzbuster", "Whistler", or Citizens Band Radio have on radar?

* Can police radar be jammed? Why not?

* What, if any sources of interference, were present on the date of the defendant's arrest?

* Would you again state the defendant's speed on the date in question?

* How did you arrive at this speed determination?

* Did this speed violate the posted lawful speed limit?

* Was that speed unsafe? Why?

* Again what is the average number of citations written by radar officers?

* How many officers does your department employ?

* That would mean roughly (number of citations) per day for your agency?

* If you write (number of citations) per day then you have written several hundred since writing this particular citation?

* Do you feel you can clearly remember the defendant's vehicle out of all those cars?
* Officer, is it legal to use radar in Los Angeles? By what authority?

* Is it required by law to have signs posted informing the public you are using radar?
* Were there signs posted at the time of the alleged violation?

* Where are these signs located?

* Does California require a traffic survey on all highways where radar is in use?

* Was a survey conducted at the location of this alleged violation?
  If Yes:
  ** When was the survey conducted?

  ** What did the survey show as a safe speed?
  ** Who conducted the survey?

  ** Do you have a copy of the survey in court with you?

* Did you show the defendant the speed reading at the time you stopped his vehicle?

* How do we know the speed displayed was the defendant's?

* What speed is posted on that street?

* Can you preserve any violator's speed by pushing the unit's lock button?

* What was the speed you cited on the ticket just before the defendant's?

* Do you have a copy of that ticket in court today?

* Could you describe to the court basically how radar works?

* Are you the only officer who uses that radar unit?
* How many other officers use the same unit?

* Has you radar unit ever malfunctioned or required repair of any type?

* How many times in the last year has that particular unit required repair?

* Do you keep maintenance records for your unit? (NO, the department keeper of records maintains those records).

* What band or frequency does your radar transmit on?

* Your radar device sends out a beam of electromagnetic energy doesn't it?

* How would you describe the width of the beam, narrow or wide?

* Officer, isn't it true that at a thousand feet the beam is as wide as a football field?
* What is the width in degrees of your radar beam? How many lanes will it cover, say 1/2 block away?

* How wide is the beam at a thousand feet?

* How do you know which vehicle is in the radar beam?

* What was the weather like on the day of the

citation?

* Are you aware sunlight and temperature can effect the radar reading?

* Is your radar unit equipped to allow you to check all of the segments of the speed display?

* Are you aware that an unlit segment could mislead the operator by showing a 6 to look like a 5 or a 7 to look like a 1?

* Did you check the segments on the day of the violation?

* Did you check immediately before or after this alleged violation?

* Do you know what a harmonic frequency is?

* Are you aware that you can clock trains or aircraft with radar?

* Is it true your radar tends to track the strongest signal?

* Are you aware that a large vehicle behind a smaller will be read when the smaller car could be much closer?

* Does your agency have a license to broadcast on ___________ frequency?

* Is the use of your unit authorized by the FCC?

* How many units does your license authorize your agency to use?

* How many units does your agency have?

* What is the unit number of your radar unit?

* Is that number listed on the FCC license?

* Was the unit aimed directly at traffic or a few degrees off center?

* Are you aware of the "cosine angle error" as it applies to radar?

* Did you know a cosine error can cause an error in speed readings?

THIS LIST IS ONLY A FEW OF THE QUESTIONS THAT COULD BE ASKED. KEEP IN MIND, MOST ARE DESIGNED TO CAST DOUBT ON THE UNIT OPERATOR !

CHAPTER X

RADAR DETECTORS AND JAMMING DEVICES

DETECTION METHODS

There are numerous methods utilized by the public to detect and warn other motorists that radar is being utilized by the police. Some of these methods are very simple, some are complicated and require a great deal of cooperation among motorists and some could be classed as ridiculous in their attempt to avoid officers using radar.

Because of the unpopularity of the 55 mile per hour speed limit in 1973, it has become almost a national pastime to find a means of eluding the long range capabilities of modern radar devices in moving and stationary situations. To meet and satisfy this demand, a growing business of significant financial magnitude has evolved, providing new and imaginative means of eluding detection through a myriad of gadgets and mechanical devices. While there seems to be no end to the parade of claims that certain devices can detect or confuse radar in traffic enforcement, there is one fact of which there is no dispute. None of these devices, regardless of cost, is totally capable of meeting all claims made by its manufacturer. Many of these devices are illegal and carry sanctions if used to avoid detection by radar units.

Its true that motorists that violate the speed laws can detect radar before it detects them. This early warning allows violators to temporarily slow down to a legal speed to avoid apprehension. There are three major methods of radar detection or early warning:

1. Flashing headlights.

2. Citizens Band Radios

3. Electronic Detection by use of "Radar Detectors".

Flashing Headlights

The flashing headlight method relies on cooperation among drivers. Those drivers who have passed by a location where radar is being utilized flash their headlights to alert traffic coming from the opposite direction. This assumes that the drivers that see the flashing lights understand what it means and slow down until they pass beyond the radar location. Because flashing lights cannot convey the exact location of the radar, motorists must maintain legal speeds for several miles.

Citizens Band Radios

A Citizens Band Radio (CB) is a more modern method relying on cooperation among motorists. Its advantage is that the warning to other motorists pinpoints the exact location of the radar. The disadvantage is that it is only available to those motorists that have a CB radio in their vehicle. Also, the CB radio has to be on and tuned to the station when the broadcast(s) are made warning them of the radar location. CB's do help speed-violators evade apprehension, but they benefit highway safety as well.
CB's inform motorists of roadway hazards such as accidents, slippery conditions, debris on the roadway as well as many other hazards. They have helped keep motorists awake and alert by the constant conversation between radio operators. On many occasions CB operators have notified police via the "REACT" channel of law breakers, accidents, intoxicated drivers and stranded motorists.

CB radios have captured the fancy of the public because of their ability to permit conversations between traveling motorists on highways and interstates. CB'ers are under the mistaken notion that in addition to providing advance warning of radar in a given area, that whistling into the CB radio will result in the creation of a false return signal to the radar device that will "confuse" or jam the radar unit. While this was true some years ago with the older less sophisticated radar devices, whistling will no longer give a reading on a radar device. The "RFI" light will come on and the window display will blank. The older devices were not filtered and would and the whistling would cause a harmonic signal. When this was tested scientifically it was found that this was only effective on one radar device at a distance of 75 feet and on the other radar devices within 30 feet. This was used as a defense during the mid to late 1970's. It hasn't been used recently due to the improvement in radar devices.

Radar Detectors

The most notable is the modern electronic "radar detector". There are several electronics firms that market this device. The most famous is the "Fuzzbuster" manufactured by Electrolert, Inc., This device became famous nationally because of the publicity surrounding the Dade County case (Ana Aquilera, et.al.) in 1979. An electronic radar detector is simply a radio receiver tuned to the police radar frequencies. When a radar signal is picked up, the detector sounds an alarm and/or lights up an indicator lamp, warning the driver that radar is being utilized nearby. Late model radar detectors are quite effective and can provide ample advance warning that radar is being utilized. Some of the newer models can detect the use of radar up to five miles away. The older detectors were only able to detect "X-Band" and the radar manufacturers started producing "K-Band" radar. This prompted the development of multi-band radar detectors and more recently devices called heterodyne radar detectors. The heterodyne devices are less apt to give false alarms but are more expensive to manufacture and buy. More recently the "Super-heterodyne" radar detectors have been developed and they are again expensive to purchase. In late 1988 several states and municipalities started investigating "Photo-radar" devices. These devices operated on the "Ka-Band" and so the newest radar detectors on the market can now detect this band as well as the two more conventional police radar bands.

Radar detectors are subject to the same interferences and effects that police radar devices experience. However, these radar detectors do not have an Audio-Doppler return so the operator can determine what is being detected, so there are many false alarms given to the operator. Some of these are caused by police radar and many are caused by garage door openers, television remote controls, grocery store automatic doors to name just a few of the problems radar detector have. Remember these devices are set up to be more sensitive than a police radar device and as such process much weaker signals because the owner of the device is guaranteed that he will not receive a ticket "if he uses the device properly." Part of this proper operation is to always slow to the speed limit whenever the device gives an alert.

Since the mid 1970's there have been numerous magazine articles about radar detectors, generally these articles have been in the "automotive" magazines like "Road & Track", "Hot Rod", or other like magazines. Most of the articles have been performance comparisons of various radar detectors available on the market. The comparisons include sensitivity tests for front and rear detection, audibility of the alert signal, sensitivity for the different bands and price comparisons. Some of the devices can be purchased for under a $100 and some can cost over $400. The latest devices are advertising how small or compact they are and still "out perform" police radar.

As one of the radar detector industry said some time back "you can't build a space ship to go to the moon for $300, nor can you build an accurate radar device to do what it is supposed to do at that price either." What he was saying was that the radar devices on the market at that time were not living up to their advertisement; well the price tag on most of the radar detectors do not support their claim that they will always detect a radar device in operation if the radar detector is used properly and save the radar detector's owner a citation. The modern traffic radar devices are able to be utilized via the "anti-detection" switch which means you will get your visual estimation and then activate your radar device, the radar signal will reach the target vehicle and detector virtually at the same time, returning to the radar at the same rate. Before the radar detector will be of concern to the radar operator, a device will have to be created that works in conjunction with the detector which can move a drivers foot from the gas pedal to the brake pedal faster than the speed of light, which incidently is 186,282.3960 miles per second. The time required to receive a stable audio and stable reading is usually just more than one second. The amount of deceleration that could be applied by the driver of the target vehicle by braking is negligible. So you will be reading the actual speed of the target vehicle with less than a mile per hour change in speed.

If you have the opportunity search out some of the articles published about radar detectors some of it is interesting reading and very informative. Usually these articles contain the current defenses being advised by the radar detector industry and this will keep you up to date on what you might be asked in court.

There is an organization that defends the use of radar detectors and fights the use of radar devices the organization is called RADAR, Inc., or Radio Association Defending Airwave Rights, Incorporated. RADAR Inc., publishes a monthly newsletter and has published pamphlets and books defending the use of radar detectors and attacking the use of police traffic radar. In some of the published material a great deal can be learned about radar and how it was either abused or misused in the past. RADAR, Inc., does admit that radar in the hands of a trained operator is an effective enforcement tool. RADAR, Inc., has conducted surveys where they have reported that owners of radar detectors:

"... have lower accident rates than non-owners, and belong to one of the safest class of drivers on the road: typically, high mileage with above-average education and incomes. Many of these drivers found that radar can lead to arrests for speed "infractions" too minor to be seen by the naked eye; that radar speed traps jeopardize their wallets, their driver's license and sometimes their livelihood; and that the only practical protection from false speed readings and incorrect target identification is knowing when they're under surveillance, and taking added precautions. Which is what radar detectors are for."

What RADAR, Inc., doesn't say is that the survey was of its membership only that numbers less than 10,000 out of a nation of drivers of over 125,000,000. RADAR, INC.., is backed by the radar detector industry and its membership. However, some of its members only join to receive the printed literature so they may be better informed as to the defenses that are being used by owners of radar detectors. Yes, these members are police officers and educators in the field of police traffic radar.

There are a couple of organizations that are opposed to the use of radar detectors one is GUARD, Group United Against Radar Detectors and the other is the Insurance Institute for Highway Safety (IIHS). GUARD is primarily financed by GEICO Insurance, but it is backed by the National Safety Council and the International Association of Chiefs of Police. Geico has been denying insurance to citizens that own radar detectors and because of this stand they have been in various state courts defending their position. Their corporate position is stated as follows:

"Geico believes that it is unfair to ask its law-abiding policyholders to foot the bill for high-risk drivers who use radar detectors to speed. As a responsible corporate citizen, Geico cannot condone the use of devices which are used only to break the law and threaten highway safety."

The IIHS is continually conducting surveys on the highways in trying to determine just who the speeding driver is. A new device has been developed to assist in these surveys it is called the radar detector detector or RDD. The RDD used in a recent survey discovered that those owning and using a radar detector were speeding more than those that did not have radar detectors. These surveys were conducted in the States of Maryland, where detectors are legal and Virginia where detectors are illegal by state law. Connecticut, the District of Columbia and the State of New York either ban the use of these devices altogether or have a limited ban on the use of these devices.

This information is provided only to show that there are two sides to the radar/radar detector controversy that has raged since the mid to late 1970's.

Other methods used to counter radar

Some of the other methods tried to counter the use of radar border on the ludicrous and are totally ineffective:

* Strips of metal foil on the vehicle. This came from the Air Force using thousands of tin foil strips dropped from aircraft during World War II. The foil was called "Chaff" and would reflect back thousands of signals to German and Japanese radar installations thus confusing them and decoying them to areas where no aircraft were. With police radar this only enhances the reflective capability of the vehicle and makes it a better target.

* Hanging chains, or metal to the ground. Some people thought that they could divert the radar signal into the ground like you would electricity. Again this only adds to the reflective capability of the vehicle. You cannot "ground" radar signals by hanging chains or metal from a vehicle.

* Metal objects in hubcaps. Again a similar belief to the "Chaff" idea, but it only adds weight to the vehicle. It will not affect the radar signal.

* Horn honking. It was believed by parts of the population that the sound would set up a frequency that would be read by the radar similar to the tuning fork test. Radar does use a tuning fork, but within very close proximity of the device (one-half to two inches) the radar reads the frequency not the sound. This will not work because radar reads the change in frequency of a radio signal not a sound wave. Also sound only travels 1,095 feet per second as compared to186,000 miles per second for a radio wave.

* Driving with the headlights on. This is similar to the horn honking in that those that tried this believed that radio waves and light travel at the same speed and that the radar would read the headlights and not their speed. However, visible light has other characteristics that will not allow it to be measured by a radar device.

* "Stealth Bra" - The "Stealth Bra" is a new device on the market and it will not cause the radar to give a false reading, but it will be harder to receive a return signal because this device will absorb some of the radar signal. This only covers up part of the hood and grill and there is still more surface area than the hood and grill on a vehicle, so this device is only partially effective.

* Windshield wipers - This was a defense in an Alabama court the defendant tried to convince the judge that his windshield wipers caused a reading of 56 miles per hour on the State Troopers radar device. The judge asked the trooper if it was possible the Trooper's reply was "I've never seen windshield wipers travel that fast, besides

your honor the windshield wipers were moving across the windshield not toward the radar." needless to say the judge believed the Trooper and found the defendant guilty as charged.

RADAR JAMMING

"Jam" or "Jamming" according to Webster's: "is to obstruct or to make unintelligible by sending out interfering signals or messages. To make ineffective by jamming signals or by causing reflection of radar waves to become blocked..." Jamming is rarely encountered, but can be a problem when it is. The primary types of jamming devices are radar frequency transmitters. The jammer sends out a strong signal on a frequency close to that of the police radar. Because of the strength of the signal the radar "sees" that signal instead of the waves reflected off of the target vehicle. The radar will register either no speed measurement (blank out) or an obviously false measurement. Some jammers may be quite crude in their construction as compared to some that are more sophisticated. Some jammers will send out a signal at a predetermined or fixed frequency. This type of jammer cannot be adjusted with regard to multiple frequencies. Others can be adjusted to a desired output or speed.

The jammer could be designed or programmed to produce very high, unrealistic numbers on the radar device, or it could be designed to produce a reasonable or believable number (speed).

The presence of a radar jammer is recognizable. The Audio Doppler will be quite strong but uneven and inconsistent with your visual observation. If the radar is in the "hold" mode and a signal is received it is more than likely a jammer in use.

The radar frequency transmitter, when used as a jamming device violates the Federal Communications Commission (FCC) Regulations and is therefore illegal. If you discover one of these devices in use notify the nearest FCC office immediately. Be sure that you are on legal ground before you attempt to confiscate the device. The minimum fine for illegal transmission is $750.00, the maximum fine is $10,000.00.

In a published article, it was suggested that the ideal system for jamming police traffic radar and not setting off radar detectors would be to first equip a vehicle with a highly sensitive radar detector. This detector would be hooked up to two jammers, one to the front of the vehicle and the other one to the rear. When the detector "smelled" or detected the presence of radar, it would close a relay, firing up the jammers for a predetermined length of time, enough to get through the "ordinary radar trap." The jammers would then stop and the detector would "sniff" for radar again.

CHAPTER XI

FIELD EXPERIMENTS

The field experiments are designed so that each student has the opportunity to get some "hands on" experience with various radar devices. The students will spend approximately four hours with an instructor(s) conducting various experiments with radar. Also, experimentation will include estimation of speed for stationary targets and moving targets. Each student will set up, test and use the various devices available. The Field Experiment Worksheet and Speed Estimation worksheets are included in this handbook. The experiments include the following exercises:

* Beam Propagation - Radar devices of "X" and "K" bands will be set up and the beam widths will be determined and compared by using a radar detector.

* Set up, test and operate - Each student will set up, test and operate at least one stationary and one moving radar device, performing all of the recommended tests and demonstrations on how to properly control the radar range.

* Speed estimation - estimation of speed in both stationary and moving mode will be conducted by each student to determine proficiency.

* Distance or range estimation - The student will determine the range of various radar devices in both stationary and moving mode.

* Radar effects - The instructor(s) will try to demonstrate as many radar effects as possible in stationary and moving modes depending on the conditions present. The different effects include:

Interferences

* Heater/A.C. Fan
* RFI - Police radio
* Emergency lights
* High voltage power lines
* Mechanical interference
* Fluorescent or neon lights
* Feedback
* Panning/Scanning
* Beam Reflection
* Multi-beam path
* Excessive Audio
* Improper control settings
* Power surge

Moving radar effects

* Batching
* Shadowing
* Moving Cosine effect
* Moving multi-beam path
* Own speed capture
* Pulsating amplitude

MOCK COURT

The object of Mock Court, or Moot Court as it is sometimes called, is give the student the opportunity to practice giving testimony in a radar trial. This is accomplished by staging mock trials in the classroom. Whenever possible the instructor cadre should obtain the services of a bench officer to sit as judge in the mock trials. Sometimes Juvenile Court bench officers are available they can sit as the judge.

The "Bench Officer" in the classroom adds to the credibility of the school and it assists keeping the decorum necessary to have this phase of the school run smoothly.

The students need to prepare sample citations for a couple of scenarios to testify. The instructors should act as the defendants for the various cases presented. The overall class should act as the jury and critique the testimony to help improve it. It will be noticed that as more testimony is given by the students, the students that testify later in the class will improve by not making the mistakes of the earlier students. The instructor should make it clear that this is a learning experience and not intended to belittle or harass any of the students.

After the judgment is rendered each case should be discussed and alternate strategies looked at and analyzed. The object is for the student to prove his or her case beyond a reasonable doubt. If any doubt exists then the defendant is found not guilty. This exercise is not only educational it can be a lot of fun for all involved. The role playing is one of the most effective methods of teaching/learning.

MEDICAL ASPECTS OF RADAR

Many rumors have been circulated linking radar microwave radiation to cancer, cataracts, sterility, loss of hair, etc. These rumors are without merit, as this type of radiation does not initiate or aggravate medical problems. Although there are no absolute tolerance levels with reference to microwave radiation (as there are with nuclear activity), there are general guidelines regarding levels of microwave radiation.

It is not important that the operator know what the symbols below mean, nor be able to relate the information, but it will give the operator general information on police traffic radar microwave radiation and its relation to the general guidelines. This will also aid the operator in knowing that he/she is not being bombarded with radiant energy. The Occupational Safety and Health Act (OSHA) contains a Radiation Protection Guide, which applies to exposure to electromotive radiation at various frequencies. Our area of concern is with the frequencies that police traffic operates on.

General Standard is: 10 mW per cm^2 (ten milliwatts per square centimeter, or one ten-thousandth of a watt per square centimeter).

The Radio Frequency Guide recommends: 5 Mw per cm^2

At the opening of the antenna (the aperture) the microwave radiation level is well below the maximum exposure level. If we use the lowest recommended standard of 5 Mw per cm^2 as a reference, we can relate the radiation levels below this standard. The results of testing indicate that the highest level of radiation at the antenna opening was 2.82 mW per cm^2. The level of microwave radiation is reduced drastically as the distance from the antenna increases. The level of radiation in the area of the driver is approximately $\frac{1}{1000}$ mW per cm^2.

It is recommended that particularly eyes and skin are not exposed to the microwave radiation at the opening of the antenna for prolonged periods of time.

In our modern society we are exposed to microwave energy daily. The tops of most buildings in the larger cities are covered with microwave antenna dishes, we use microwave ovens to heat our food, we have computers in our police vehicles and on our desks, we carry microwave radios on our hips and we have an energy source in the sky that produces an enormous amount of microwave energy. All of the facts are not in as yet, but the amount of energy produced by radar units is considerably less than some of these other devices and well below the allowable standard.

Power Level Examples:

Amana "Radarrange"	1200 watts
Packard Bell VGA Monitor	80 watts
MPH Industries, K-55, radar unit	0.08 mW/cm^2
Kustom Signals, "Roadrunner", radar unit	

0.34 mW/cm^2

Kustom Signals, HR-12, radar unit
1.35 mW/cm^2

There is no hard evidence that these devices cause cancer and recent articles have mentioned types of cancers that have been linked to exposure to the Sun.

As further investigation by qualified experts in this area are brought to light some hard answers whether radar causes cancer may come to light. However, officers involved nationally in the use of radar number well into the thousands and radar has been used by police since 1948. The number of cases reported in these recent articles is very very low.

In March of 1991, The Institute of Police Technology and Management (IPTM), at the University of North Florida, sent out an information paper on "Traffic RADAR Power Density Health Concerns Fact Sheet." The fact sheet stated pretty much what has already been stated in this handbook with additional technical information. The last paragraph of the fact sheet reads as follows:

"A 1987 study by the New Jersey Department of Environmental Protection showed that, with the antenna mounted on the dash of the vehicle, radiation readings at the driver and passenger positions were undetectable. Another study just completed in Ohio showed similar results. Testing of RADAR units in a vehicle environment tested by IPTM confirm that, with the antenna mounted on the dash, no detectable radiation could be found in the passenger compartment."

ESTABLISHMENT OF DEPARTMENTAL POLICY AND PROCEDURE

For a traffic enforcement program using radar as its primary speed measurement tool to be successful, the law enforcement agency must commit itself to such use. Preparing policy and procedures for training personnel in the use of new radar equipment, periodically giving in-service refresher courses in the use of older units, providing practical training and theoretical classroom education and establishing a departmental standard of expertise in radar use help present the use of traffic radar units as a professional approach to enforcement.

It is also fundamentally sound for a law enforcement agency to establish written policies and procedures on the maintenance and care of radar equipment and the supervision of personnel involved in the program. Written policies set the standards to be followed and help maintain a fair and impartial enforcement program. Routine inspections should also be conducted to insure that departmental standards in these areas are met by both uniformed and civilian personnel in the Department.

Standard operating procedures should also be developed for recording required enforcement-related information by an arresting officer. Officers should also be trained in the underlying scientific principles of radar and proper radar terminology, so as to insure proper court preparation and testimony.

Finally, a policy statement should be prepared by the law enforcement agency utilizing radar in enforcement activity. This statement should define the purpose, goals, and legitimate interests to be served by the use of radar. Such a statement will help in promoting public acceptance as an enforcement tool. It will also indicate a professional approach in which reliable operators and accurate scientific equipment are to be used in a fair and objective speed limit enforcement program.

The Los Angeles Police Department Radar Policies can be found in the Department Manual, Volume 4, Section 305.10 and in the Traffic Manual Volume 5, Sections 109, and 220 through 226.

CHAPTER XII

PHOTO-RADAR AND LASER DEVICES

PHOTO RADAR SYSTEMS

Photo Radar is a term that has been assigned to a group of radar units that use a Radar unit, a computer and a camera together. There are several different types. Some are placed on poles or other fixed object and allowed to operate without an officer or technician to monitor the operation. Units of this type are used extensively in other countries.

Product names and types:

Orbis - This product uses a hose timer to trigger the camera above a preset speed. It does not record the actual speed the vehicle was travelling.

Photo-Radar - As used in Europe, operates on an automatic system, when a violator goes beyond a preset speed the camera is triggered for that speed only !

Multinova-Radar 6F - This unit is also triggered if a vehicle exceeds a preset (Photo-Radar) speed, however, it records the speed that the vehicle was actually travelling.

LeMarquis-Micro speed - This is also a Photo-Radar device, however, it can be utilized very much like a conventional radar device because it will photograph the suspected violator vehicle when the operator triggers the device. It records on the photograph the speed of the vehicle, the date and the time. It can also be used in other types of enforcement:

* Right of way violations.

* Failure to obey traffic signals or signs.

* Failure to stop at stop signs.

Recently, the City of Pasadena started a test program on one of the Photo-radar units (Multinova-Radar 6F). The unit being tested is mounted in the rear of a vehicle and is set up and operated by a police officer. The radar portion of the unit operates on an assigned frequency of 34.3 Gigahertz, (K-Alpha Band). The equipment still operates on the Doppler Principle. The unit has a small computer attached to assist in the analysis of incoming signals and to trigger the attached camera. The camera is set up to photograph the violator vehicle as well as recording the speed of the vehicle, and the time that the photograph was taken. The system is extremely accurate and can record up to 60 violators per hour.

The Photo Radar system tested does not send a beam parallel to approaching or receding traffic. The beam is aimed at an angle across traffic and the computer computes the correct speed from the returned signal adding back in the speed lost due to the cosine effect.

The Photo-Radar, unit has the following component parts:

1. Camera, mounted in vehicle

2. Operating unit, hand held input device to program "tolerance" speed.

3. Central Control Unit - Computer.

4. Flash unit with battery pack.

The beam width of this unit is only five (5) degrees. Because of the range and the geometry of deployment this unit can determine which vehicle is being measured.
By comparing the beam patterns from one of these units to a conventional radar unit the possibility of error is reduced greatly. A unit of this type goes through several steps before the camera is activated. These are the Measurement Phase and the Verification Phase.

All of the above information about Photo-Radar Systems is informational only. As an operator you are not, as yet, required to know about these systems!

LASER DEVICES

Light is a form of electromagnetic radiation the same as radio and microwaves. The difference is that light has a much higher frequency than either radio or microwaves. The light emitted by laser is no different from that emitted by any other light source, but a laser has a unique method of generating light.

The word LASER is actually an acronym that stands for "**L**ight **A**mplification by **S**timulated **E**mission of **R**adiation". The LASER determines speed by measuring the time of flight of very short pulses of infrared light. **Figure 12-3**

In theory, it is possible to make a speed measurement using only two pulses as described above. In practice this would be prone to errors, such as a shift of the aiming point between pulses. To eliminate the possibility of such errors, the LASER uses as many as sixty pulses to measure the speed of the target. Seven independent tests are applied to the pulse data and a failure of any one of the tests results in an error message being displayed on the readout window. The actual speed calculation that the LASER uses is not a simple distance divided by time formula. The distance to the target is not used and the target speed is calculated as a fraction of the speed of light. Also, the target speed is derived from the entire data set using the method of least squares.

The laser device emits a narrow cone of radiation (LASER light), that is directed into a vary narrow beam that gives the LASER its pin-point targeting ability. The beam is 3 feet wide at 1,000 feet. The effective range is about 2,000 feet as compared to radar's 2,500 to 3,000 feet, still plenty of time to develop a tracking history. The LASER can only be used from a stationary position. Because of the nature of the LASER it is not prone to the interferences that a radar device experiences. However, it is still prone to operator misuse or mis-operation due to lack of training.

Currently, there are two seperate devices on the market one from Kustom Signals and the other from Laser Technology Incorporated. The price of the devices is still somewhat high, but like any other new technology as time passes and more are purchased the price will get lower.

The manufacturers claim that the LASER's are superior to radar because of the following factors:

* Simplified training and operation.

* Positive target identification.

* Instantaneous readings.

* Non-detectable by a "LASER Detector" (No such device exists).

* Fewer court challenges because erroneous readings are eliminated.

* Low maintenance.

OPERATION OF SPECIFIC RADAR DEVICES

INTRODUCTION

This section of the book will introduce you to several different types of radar devices. This will assist you in being able to describe the different components available on the different units that are manufactured in the United States. Also, it will assist you in setting up testing and operating the various units available. Currently in the United States there are four major manufacturers of radar equipment. They are as follows:

C.M.I. Industries, Inc., Minturn, Colorado

Decatur Electronics, Decatur, Illinois

Kustom Quality Electronics, Lenexa, Kansas

M.P.H. Industries, Inc., Chanute, Kansas

C.M.I. Industries Equipment:

1. Speedgun One (formerly Speedgun JF100), hand-held device, stationary mode.

2. Speedgun Magnum, hand-held or vehicle mounted device, moving or stationary mode.

3. Enforcer, vehicle mounted device, moving or stationary mode.

Decatur Electronics Equipment:

1. RA-Gun, hand-held device, stationary mode.

2. Hunter, vehicle mounted device, stationary or moving mode.

3. Hunter II, hand-held or vehicle mounted device, stationary or moving mode.

Kustom Quality Electronics:

1. HR-4, hand-held device, stationary mode.
2. HR-8, hand-held device, stationary mode.
3. Roadrunner, hand-held device, stationary mode.
4. Falcon, hand-held device, stationary mode.
5. HR-12, hand-held or vehicle mounted device, stationary or moving mode.
6. TR-6 (older unit no longer manufactured), vehicle mounted, stationary mode.
7. MR-7, vehicle mounted, stationary or moving mode.
8. Trooper, dual antenna capabilities, vehicle mounted stationary or moving mode.
9. KR-10SP, dual antenna capabilities, vehicle mounted stationary or moving mode.
10. HAWK, dual antenna capabilities also can operate and work moving going away as well as approaching from front and rear, vehicle mounted, stationary or moving mode.

M.P.H. Industries Equipment:

1. K-15, hand-held device, stationary mode.
2. K-15-II, hand-held device, stationary mode, has a second window for continual tracking.
3. K-55, dual antenna capabilities, vehicle mounted stationary or moving mode.
4. S-80, vehicle mounted, stationary or moving mode.
5. Bee-36, Dual antenna capabilities, vehicle mounted, stationary or moving mode.

TRI-BAR Industries (Canada)

1. Muni-quip KGP, hand-held, stationary device.

If you are not familiar with a specific device refer to the manufacturer's operator manual for that device.

Features Common to All Units:

1. Target Vehicle Display Screen - Displays target vehicle speeds via lighted segment numitrons or L.E.D.

2. Speaker - Provides an audio reproduction of the Doppler signal being monitored.

3. Off-On Switch - Turns the unit on or off.

4. Low-Power Indicator - A lighted dot on the display panel of the unit, placement is different depending on manufacturer. Displays (comes on) when power drops below the manufacturers specifications.

5. Lock/Release - Trigger on hand-held units, a

button on vehicle mounted units. Permits the lock-in or release of readings on the display screens.

6. Audio - Permits adjustment of the volume of the audio reproduction of the Doppler signals being monitored.

7. Power-On Indicator - A lighted dot on the display panel of the unit, placement is different depending on manufacturer. Displays (comes on) when unit is receiving operational power.

CARE AND MAINTENANCE OF RADAR EQUIPMENT

The care and maintenance of radar devices is actually quite simple. Most of the devices are fairly sturdy and durable. The device should be kept clean by wiping it off with a clean cloth. You should also avoid letting it set in direct sunlight on hot summer days and avoid getting it wet. Excessive heat and excessive moisture both play havoc on electrical components. Some devices have a plastic covering over the end of the antenna horn this should be kept clean and free of excessive scratches.

the most frequent damage to devices is the power cord this is due to use. However, the life of the power cord can be prolonged by not over stretching, or over bending the cord where it enters the device. Whenever there is excessive cord that may get in the operator's way the extra cord should be secured out of harms way loosely and not coiled (See Effects). Broken wires in the power cord are a common cause of intermittent operation or indications of low voltage problems.

Be guided by the manufacturers operation manual for the device. Whenever the device does not function properly it should be checked by either a department expert or sent to an authorized repair facility.

APPENDIX

DOCUMENT LIST

U.S. Department of Transportation, National Highway Traffic Safety Administration, Basic Training Program in RADAR Speed Measurement, "Course Administrator's Manual".

U.S. Department of Transportation, National Highway Traffic Safety Administration, Basic Training Program in RADAR Speed Measurement, "Trainee Instructional Manual".

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MPH Industries, Inc., "K-55 Operator Manual", Chanute, Kansas.

MPH Industries, Inc., "S-80 Operator Manual", Chanute, Kansas.

MPH Industries, Inc., "Bee-36 Operator Manual", Chanute, Kansas.

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CMI Industries, Inc., "Magnum Operator Manual", Minturn, Colorado.

CMI Industries, Inc., "Enforcer Operator Manual", Minturn, Colorado.

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GLOSSARY

A.B.C. OF RADAR - Term used to teach how to connect two piece or moving radar in a vehicle. Antenna to box (counting unit) to current.

ACCIDENT - A traffic accident is an unintentional occurrence, in which the movement of a conveyance causes death, injury, or property damage.

ACCIDENT CITATION - A traffic ticket given to the driver who caused or contributed to an accident by violating the law.

ACQUITTAL - A court verdict of not guilty.

ALARM SYSTEM - A feature on some radar units which allows the operator to "program" a certain number into the system. When a reading of that number or higher is obtained, the system will "alarm" the operator, generally with a beeping sound.

ANA AGUILERA - Florida case in Dade County, 1979, made famous by publicity received ET. AL. on "60 Minutes" television program.

ANNOTATED VEHICLE CODE - Vehicle Code which contains updates on the most current court decisions and definitions by the Attorney General in addition to the complete text of the Law.

ANTENNA - That part of a radar unit which sends out the radar signal.

APPEAL - A request by a person, who has been found guilty, to a higher court to review the correctness of the lower court's decision.

AUDIBLE SIGNAL - The tone emitted by a radar unit to alert its operator to the speeds of

vehicles the unit is tracking.

AUDIO DOPPLER - The same as audible signal above also known as audio tone.

AUTHORIZED - Defined in the California Vehicle Code under Section 165. Generally

EMERGENCY VEHICLE - A publicly owned vehicle used by the Police, Fire, or any other department that responds to an emergency. Also includes private ambulance companies.

AUTOMATIC LOCK SYSTEM - Works in conjunction with the alarm system to automatically lock in the first readout at or over a certain "programmed" speed. Under no circumstances should this feature be used.

BACKLOBE - A weak portion of the radar beam emitted to the rear, see Sidelobe.

BAND - In radar there are three "Bands" or frequencies authorized for use by police agencies. S-Band, X-Band, K-Band and Ka-Band.

BASIC SPEED LAW - A law which forbids the operation of a motor vehicle at a speed that is not prudent or safe. Consideration is given to existing conditions, such as, weather, lighting, etc.

BATCHING EFFECT - When a sudden increase or decrease in patrol speed has an effect on the target vehicle speed readout. (Also referred to as target speed bumping.)

BATTERY PACK - Portable power source.

BEAM - Main portion of electromagnetic energy emitted by the device (85%), also known as main lobe or main beam.

BEAM WIDTH - The horizontal distance between half-power points at a given distance from the antenna.

BEAMER - People vs. Beamer, 1955 California case that accepted radar use because of Doppler Principle.

BLIND SPOT - The area on the right rear of most vehicles where the driver cannot see with his mirrors.

BUNCHING - Closely spaced vehicles on the highway.

BURDEN OF PROOF - The legal principle that is the duty of the prosecution to present sufficient proof (facts) to establish the validity of the charges.

CALIBRATE MODE - When an operator has selected the internal calibration switch to determine if the radar unit is functioning properly. This does not actually calibrate the unit, it only <u>tests</u> the internal circuits.

CALIBRATED SPEEDOMETER – A speedometer which has had its accuracy verified by external means.

CALIBRATION - Process to insure that the device is functioning properly. There are several types of calibration; Internal, external and certified. Internal and external are performed by the operator in the field. Certified is done by either the manufacturer, or a certified repair/calibration facility, certificates of accuracy are issued by either of these certification stations.

CALIBRATION TESTS - A sequence of testing of a radar unit to assure the operator that the unit is functioning properly.

CARRIER FREQUENCY - The frequency of the microwave beam emitted by the radar device, also known as Carrier Wave.

CERTIFICATE OF CALIBRATION - A document from the manufacturer of a radar unit or radar tuning fork certifying its specifications and accuracy. Radar unit to be renewed annually, tuning forks renewed along with its companion radar device.

CERTIFIED TUNING FORK - A tuning fork that has been certified and is used to check the accuracy of a radar unit.

CITIZENS BAND RADIO - Also referred to as CB. Any class D, 27 megahertz transceiver used by individuals to communicate with each other.

CHAFF - Any number of scattered materials used to interfere with radar. (Applies only to aircraft or military radar.)

CLOCK - Can be done by two methods: a) Using a stop watch to determine the amount of time a vehicle travels a known distance b). Pacing a vehicle to determine its speed using another vehicle to maintain the pace.

CONTINUOUS WAVE (CW) - Uninterrupted microwave energy used in police radar.

COSINE OR ANGLE EFFECT (STATIONARY) - The loss of some component of velocity, or speed of a target vehicle if any angle exists between the direction of the target vehicle and the radar signal. In the stationary mode, the greater the angle, the amount lost is in the violator's favor and not indicated on the radar.

COSINE OR ANGLE EFFECT(MOVING) - This occurs when there is improper aiming of the radar antenna and an excessive angle exists between the direction of travel of the police vehicle and the direction of the radar signal. This can cause an indicated loss in patrol vehicle speed as seen by the radar, and a subsequent higher than actual target speed reading.

COUNTING UNIT - That part of a radar unit that processes the return Doppler signals, calculates and displays the speed.

CYCLES - An international unit of frequency, "one cycle per second". Also referred to as Hertz or waves. See also WAVE THEORY.

D'ANTONNIO - Refers to the case "State vs. D'Antonnio", where the Doppler Principle was accepted and Judicial Notice of the Principle was established.

DETECTOR DEFEAT MODE - An option available on some radar units that allows the operator to selectively control when the unit sends out a signal. Also referred to as the Anti-Defeat Switch (ADS), see ADS EFFECT in text.

DIGITAL READOUT - Numerical display of either vehicle speed or patrol speed.

DOPPLER - Refers to Johann Christian Doppler, see DOPPLER PRINCIPLE.

DOPPLER AUDIO - A feature of the radar unit which makes audible the change in frequency.

Also, helps to detect the presence of interference.

DOPPLER EFFECT - The change in the frequency of a reflected radio wave, which varies with the speed of the source. See WAVE THEORY.

DOPPLER FREQUENCY - The difference between the frequency of the radio waves projected by a radar unit, and the waves reflected by a moving object.

DOPPLER PRINCIPLE - The radar transmits a signal at a known frequency. The motion of a target vehicle changes the frequency of the signal. The amount of change in frequency depends on the speed of the target. The returned "Doppler" frequency is then converted to miles per hour.

DOPPLER TONE - The audible tone produced by some radar units which represents the speed of the vehicle being read. See DOPPLER AUDIO.

ECHO - Signal reflected back to the device by a radar target.

85TH PERCENTILE SPEED - The speed represented by the 85 slowest out of 100 vehicles measured during a speed survey as done by the Department of Transportation. The survey being done as set forth in 627 CVC.

EFFECTIVE RANGE - The distance that a radar device can accurately target a moving object. (See range in text)

ELECTROMAGNETIC RADIATION - Type of energy emitted by the radar device. Also, same as radio wave.

ELECTRONIC COUNTER MEASURE (ECM's) - Any electronic device used to defeat radar, includes detectors and jamming devices.

EQUIPMENT VIOLATION - Any violation of the Vehicle Code that requires mechanical repair of the vehicle.

EXTERNAL CALIBRATION - Test of radar device using a calibrated tuning fork, or test vehicle.

FEDERAL COMMUNICATIONS - The federal agency responsible for the licensing and regulations governing the use of radio and police radar.

COMMISSION
(F.C.C.)

FIELD INTENSITY - Strength of microwave beam, measured with a signal strength meter.

FIFTH AMENDMENT - The amendment to the United States Constitution that gives a person the right not to testify against himself.

FLAXMAN - A California case in 1977, where the court held that a certified copy of the Traffic and Engineering Survey is admissible under the Evidence Code.

FLEETING SPEED READING - A speed readout that appears and disappears in the same instant. Also called ghost readings.

FREQUENCY - The number of waves that leave the radar antenna in one second. Designated in "cycles per second" Hertz, or waves.

FOUNDATION - Preliminary evidence necessary to establish the admissibility of other evidence.

FREQUENCY SHIFT - Also called Doppler Shift. The change that occurs in the frequency of the broadcast radar beam and the beam reflected back to the radar unit from a moving object.

GHOST READING - A fleeting signal or reading, apparently from a "Ghost Vehicle", usually of a very short duration and audio does not verify reading.

GIGAHERTZ - A frequency of a billion waves per second.

HALOPOFF - A California case, in 1967, where the court said that the prosecution has the responsibility to show that no speed trap exists and provide a current Traffic and Engineering Survey (within last five years). Prosecution must also show that the radar was tuned, calibrated and operated properly.

HANSON - A Wisconsin case in 1978, where the court stated that verification of the patrol speed on a radar device be checked against the police vehicle speedometer, while operating in moving mode, to ensure that the target speed was calculated correctly.

HARMONICS - A multiple of a fundamental or basic frequency. (see text)

HERTZ - A measurement of frequency equal to one cycle per second, or one wave per second.

HIGH DOPPLER - The frequency used by a moving radar unit to track the speed of a target vehicle. The counting unit processes the signal from the closing speed for "High Doppler". "Low Doppler" is from the return signal from the ground. "Low Doppler" is subtracted from "High Doppler" to determine the target vehicle speed (TS = CS - PS).

HOLD SWITCH - A feature of a radar unit which upon being activated, causes the radar signal to be generated. In the "hold" or "squelch" position, no signal is leaving the antenna. (Anti-detection switch.)

HONEYCUTT - Refers to the case of Honeycutt vs. The commonwealth of Kentucky. The case determined that a radar operator's visual observation of a vehicle was sufficient to identify it as the one read by the radar unit (out front and closest to the radar).

HYDROPLANING - A phenomena which occurs when the tires of a car lose contact with the road and rides up on a layer of water.
IGNORANCE OF THE LAW - Something suffered by the public when stopped for a traffic violation. Also, used as a defense in court.

IMPLIED CONSENT - A provision of law that says you agree to take a chemical test for alcohol automatically by the fact that you have a driver’s license.

IN PRO PER - Short for In Propria Persona, meaning appearing in person on your own behalf.

INTERFERENCE - An opposing or hampering action, affecting the performance of a radar unit. Classified as natural or man-made.

INTERNAL CALIBRATION - A check of a radar unit's accuracy through the use of a crystal, or other electronic means. More accurately, it only checks the unit's ability to analyze a frequency ratio, and does not use the radar itself.

JOHNSON - A California case, in 1972, the court held that VASCAR was illegal because it constituted a "speed trap" because it recorded time and distance.

JUDICIAL NOTICE - A legal principle where a court can take notice of a fact without evidence being presented to prove the fact.

K-BAND - A frequency of 24.150 Gigahertz, one of the three bands currently authorized for police radar by the Federal Communication Commission.

KILOHERTZ - A frequency of a thousand cycles per second.

LANDMARK CASE - A case that is so important that it establishes a precedent for future cases.

LOBE(S) - The main beam or spill over side beams, also referred to as the main lobe and side lobes.

NOTE: There can be more than one side lobe on each side of the main lobe, and there is usually a rear lobe. This term indicates a zone of radar influence around the radar unit. The side lobes are of a much weaker strength than the main beam or main lobe.

LOCAL STREET OR ROAD - Term derived from the California Vehicle Code, Section 40802 (b). Defined two ways; first, any street noted on a Federal Aid and Urban Usage Map as a "local street or road". Secondly, as a street 40 feet in width, not more than one-half mile of uninterrupted length by traffic control signals as defined in 445 C.V.C., and only one lane in each direction.

LOCKED READING - Speed reading in the radar manually locked in by the operator.

LOW DOPPLER - The frequency used by a moving radar unit to track the ground speed of the police vehicle or patrol vehicle. This signal is processed in the counting unit. "Low Doppler" is subtracted from "High Doppler" to determine the target vehicle speed (TS = CS - PS).

LOW SPEED COMBINING EFFECT - In the moving mode, the combined or "closing speed" of a slow moving police vehicle and a slow moving oncoming vehicle (target) may be displayed in the patrol display window. Nothing appears in the target display window.

MAC LAIRD - A California case, in 1968, where the court held that judicial notice must be taken of, the use, validity, and accuracy of a radar device. Also, there was no need to call an expert witness to establish commonly known prepositions (Doppler Principle).

MAIN BEAM OR MAIN LOBE - The main beam or main lobe of a radar unit is that zone of influence that the radar is being projected. Usually, 18-22 degrees for X-Band and 12 degrees for K-Band. Also, see LOBES.

MAXIMUM SPEED LIMIT - The highest speed that a vehicle may legally travel, even if it is safe to go at a faster speed.

MEGAHERTZ - A frequency of a million cycles per second.

MILLER - A California case, in 1979, where the court held that an Engineering and Traffic Survey was not necessary where the Vehicle Code defined maximum speed limits.

MIRROR SWITCH - Switch on some older devices that reversed the numerical display so it could be pointed out the rear of the vehicle and the readout read in the rear view mirror.

MOVING RADAR - Any radar unit capable of reading a target while the vehicle that the radar is mounted in is in motion.

MOVING MODE - The mode which allows a moving radar to operate while the vehicle is in motion.

MOVING VIOLATION - Violations of the Vehicle Code that involve movement of a vehicle or pedestrian.

MULTIPLE REFLECTED EFFECT SIGNAL -

Associated generally with the stationary mode. The signal strikes an object and is reflected away from the radar. A target at an angle to the radar may be read, as the returning signal from the target would strike the object which initially reflected the signal, and then travel back to the antenna. A vehicle traveling directly at the radar will produce a much stronger signal and will override the multiple reflected signal.

N.C.I.C. - The National Crime Information Center, the nation's clearing house for information on all criminal activities.

NEW VASCAR - A term erroneously used to describe moving radar.

NEW JERSEY VS. D'ANTONIO - The landmark case on radar, in which the court accepted the fact of radar's accuracy (Doppler Principle) and set the guidelines for the operator's training and understanding.

NO FAULT INSURANCE - Insurance where each party bears responsibility for the repairs to their own vehicle after a traffic collision.

NOISE - Natural mixture of randomly generated signals which prevent electronic equipment from receiving weak signals. Also known as "white" noise and the "scratchy, rushing" sound heard through when no target is present.

NOLO CONTENDERE - A plea of NO CONTEST (guilty), however, the evidence cannot be used in a civil trial, it has to be proven again.

NUMITRON GAS TUBE - A device that electronically displays any digit from 0 through 9. Two or three tubes are used in some radar units to display the speed.

OFFICIAL TRAFFIC CONTROL DEVICE - Any sign, signal, marking or device designed to regulate warn or guide traffic and placed in accordance with the law

OFFICIAL TRAFFIC CONTROL SIGNAL - Any device that alternately signals vehicles to stop and proceed, may be mechanical or electrical.

ORBIS - A sophisticated hose-timer system which photographs offenders and automatically processes citations. Also called Photo Speed Recorder.

PANNING EFFECT - With a two piece unit, aiming the antenna at the readout unit may produce a spurious reading. Fleeting numbers and audio squeal accompany the panning effect. Can also produce a reading possibly higher than a violator's speed. It is better described as a "Feedback", See Feedback.

PATROL SPEED - See LOW DOPPLER, the speed of the patrol vehicle.

PHOTO SPEED - Same as an ORBIS device.
RECORDER

POSTED LIMIT - The speed limit which appears on signs near or on the roadway. Also Prima Facia Limit.

POWER SURGE EFFECT - A claimed effect which purports that when a radar unit is on but the signal is being "held", upon activating the radar, a surge of power could cause an erroneous reading. Also known as POP.

PRIMA FACIA - Same as POSTED LIMIT.
SPEED LIMIT

PROBABLE CAUSE - Reasonable grounds or suspicion that a person has committed a crime.

RADAR - **Ra**dio **D**etection **A**nd **R**anging. An electronic device used by law enforcement agencies to determine the speed of vehicles on the highway.

RADAR BEAM - Refers to the signal within and following a given course. The course or path is determined by the radar antenna.

RADAR DETECTORS - Radio receivers capable of receiving a radar signal and alarming the driver of vehicle that radar is being used in the area.

RADAR EFFECTS OR ERRORS - There are many effects, referred to as errors by defendants, that are reported to cause improper readings, refer to text for a complete explanation. The effects are as follows:

a). Cosine or Angle Effect
b). A.D.S. Effect
c). Averaging
d). Batching Effect
e). Cosine on Own Speed
f). Double Bounce
g). Low Speed Combining Effect
h). Low voltage Effect
I). Multiple Reflected Signal Effect
j). Nichols Effect
k). P.L.L. Error
l). Patrol Speed Capture
m). Panning Effect
n). Power Surge Effect
o). Reflected Signal
p). Shadowing Effect
q). Side Lobe Effect
r). Scanning or Sweeping Effect
s). Weather Effects
t). Automatic Gain Control

RADAR EVIDENCE KIT - Radar related documents maintained and kept by each officer which may be used as evidence in a radar trial.

RADAR JAMMING DEVICE - A transmitting device capable of producing readings on a radar unit. They are illegal as transmitters, must be licensed by the Federal Communications Commission
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RANGE CONTROL KNOB - A feature available on some radar units. It controls the sensitivity of the unit, not the range, See Automatic Gain Control.

READOUT UNIT (COMPUTER) - That part of a radar unit that computes the speed of the target vehicle (moving mode).

REFLECTED FREQUENCY - The frequency of the radio wave reflected from a moving object, See Doppler Shift. (Approaching - higher, receding - lower).

REFLECTIVE CAPABILITY - Refers to how strong a signal will be reflected back to the radar unit based upon how well a given target reflects the signal (size, composition and shape). Usually the closest target will reflect best, however, a large truck may have more reflective area and give back a better reflection. The process depends on reflective capability, position and speed.

RUDE RULE - A basic principle of most traffic laws. Generally, if an act or action is rude, it's probably against the law.

S-BAND - A frequency of 2.455 Gigahertz, one of the three bands currently authorized for police radar. It was the first frequency used by police radar, and is rarely used today. It can be found in the microwave ovens used in the kitchen.

SCANNING DETECTOR - A radar detector that scans all the bands used by police radar, rather, than being tuned to one specific frequency.

SHADOWING EFFECT - In the moving mode, this effect can occur when the radar uses a moving vehicle traveling in the same direction as the police vehicle as a reference for the patrol speed. The differential speed between the police vehicle and moving vehicle ahead is displayed in the Patrol Window. A higher than actual target speed appears in the Target Window.

SIDE LOBES - Refers to a zone of influence near the radar unit where the radar can be detected outside the main beam or main lobe by a signal strength meter.

SNAKES - A hose timer.

SPEED TRAP - Defined by Section 40802 (a) and (b) of the California Vehicle Code. Also defined as a location that is designed to catch motorists, either by the design and posted speeds on the highway or the manner that the laws are enforced.

SPEED OF LIGHT - Generally 186,300 miles per second. This is the speed a radar signal travels.

SPEEDOMETER - A device connected to a vehicle to measure the speed that the vehicle is traveling. On a police vehicle, this instrument is checked for calibration every six months.

SPEEDWATCH - An electric timer used to measure a vehicle's speed.

SPURIOUS READING - Not a true genuine target speed reading. Usually for no apparent reason. See GHOST READING.

STERITT - A California case, in 1976, where the court held that the prosecution must, without request, disclose that not only a Traffic and Engineering Survey was conducted, but that the survey justified the posted speed.

STATE VS. TOMANELLI - The court case that established the tuning fork as a recognized method of testing for a radar unit.

STATIONARY MODE - The mode that allows a moving radar unit to operate while the vehicle it is mounted in is stationary.

STATIONARY RADAR - A radar unit that works only in a stationary mode, or does not have the the capability of reading vehicles while the patrol vehicle is in motion.

STEREODYNE - Term used by some manufacturers to describe the operation of radar detector capable of receiving two frequencies.

STOPPING DISTANCE - The distance required to stop a vehicle at a given speed and includes the reaction time.

STOPWATCH - A device used to measure the time a vehicle takes to travel a known distance. Use illegal in California under 40802 C.V.C.

SWEEPING OR SCANNING EFFECT - A speed reading due to relative motion when the antenna is moved or swept during a speed measurement.

TARGET - The vehicle being read by radar.

TARGET SPEED - The speed of the vehicle being read by radar.

TIME DISTANCE COMPUTER - An electronic device that determines the speed of a vehicle based on the amount of time required for a vehicle to travel a known distance.

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TRACKING HISTORY - A combination of the following factors:

a). Visual estimation of speed.
b). Audio estimation (pitch of audio Doppler signal).
c). Radar Confirmation (Target speed display).
d). Speed verification (moving radar only).

TRAFFIC CONDITIONS - Usually refers to the number, density and speed of vehicles in an area, on a highway.

TRAFFIC SAFETY INDEX - The ratio between fatal and injury traffic accidents and issued citations. Indicates traffic enforcement impact or efficiency.

TRAFFIC SAFETY RADAR - Radar used by law enforcement agencies to enforce speed laws.

TRAFFIC SURVEY - An engineering and traffic survey completed by the Department of Transportation (City or Cal-Trans). Also referred to as a Engineering and Traffic Survey (627 C.V.C.).

TUNING FORK - A device, when tapped, will oscillate at a known frequency and is used to test the calibration of a radar unit.

VASCAR - Acronym for "Visual Average Speed Computer And Recorder". Simply, a time-distance computer.

VISUAL ESTIMATE - Observation of a vehicle's speed by merely seeing the vehicle and estimating its speed. See TRACKING HISTORY.

VISUAL OBSERVATION - A visual determination, independent of the radar, that the target vehicle was traveling in excess of the speed limit or faster than the norm. (TRACKING HISTORY.)

WAVE OR WAVE THEORY - A wave is measured from the beginning of the peak to the end of the valley. The wave theory explained in detail in the text. See HERTZ, CYCLE, FREQUENCY.

WHISTLER - A method of cheating radar by whistling into a C.B. radio, attempting to generate a false signal. This does not work with the newer radar units due to filtering of the return signals.

WORKING RANGE - The distance where the use of radar is practical, usually about 2,500 feet K-Band, 3,000 feet X-Band. Also known as the effective range.

X-BAND - A frequency of 10.525 Gigahertz, one of the three bands authorized by the F.C.C. for police use.