UNIT 6: MICHIGAN TRAFFIC RADAR

Unit Overview

6.1 Unit Instructions—Scope and Objectives

A. Instructions

To complete this unit, you will need a VCR.

1) Read the entire unit, and then watch the video *"An Introduction to Radar Speed Measurement,"* following the instructions within each section.
2) Complete the review and instructional activities in Section 6.9 and check your answers using the answer key in Section 6.10.
3) Complete the unit evaluation form and the videotape evaluation form.
4) Complete the ride-along assignment with an MCOLES-approved instructor and return the completed Traffic Radar Ride-Along Checklist to MJI (See Overview, page **XXX**).

B. Scope and Objectives

This unit describes the use of traffic radar by Michigan law enforcement agencies in their issuance of speeding tickets. It discusses the role of traffic radar, its principles, the components and their functions, the process of verification, proper operation, the process for certification of operators, and key case law as it relates to hearing traffic radar citations.

The content of this unit was taken from the instructional training program developed for Michigan Radar Operators. That program was designed by members of the Michigan Speed Measurement Task Force (MSMTF).

Unit 6 covers only traffic radar. For information on laser speed measurement, please see Unit 7. For information on VASCAR, another method of measuring vehicle speed, please turn to the Reference Section.

At the end of this unit, you will be able to:

- Explain the purpose of traffic radar as an effective speed control device.

- Identify the principles on which traffic radar instruments operate.
- Identify the major components of the traffic radar instrument and their functions.
- Explain the procedure needed to verify the proper working order of a traffic instrument.
- Identify the proper techniques to be used in the operation of traffic radar.
- Identify the seven-step process to be used by the magistrate in rendering a decision.
- Accurately determine whether the instrument and the operator meet the standards set.
- Determine whether the evidence presented is sufficient to support a finding of responsibility for the infraction.

6.2 Background

In 1966, the governor of each state was mandated by the National Highway Safety Act to administer the state's federally funded highway safety program. Then, in 1967, the Michigan legislature gave the governor the power to implement the requirements of the National Highway Safety Act. This led to the formation of the Michigan Office of Highway Safety Planning (OHSP). One responsibility of the OHSP is to establish priorities for allocating the federal funds among highway safety activities in Michigan. Consequently, in 1979, OHSP established radar speed enforcement as one important focus within its program of police traffic services.

The basic goal of police traffic work is to protect the lives, property, safety, and well-being of the public. The regulation and enforcement of traffic speed on Michigan highways certainly should be directed to this end. Research has shown that excessive speed is a major contributing factor to highway crashes. High speeds affect all of the three elements of driving, i.e., the operator, the vehicle, and the roadway. Increased speeds strain the driver's basic capabilities such as reaction time, and tax the automobile's capabilities (the brakes, steering, etc.). Additionally, increased speeds increase the potential hazards of any deficiencies in the road surface, such as potholes or construction, or situational conditions resulting from weather, such as ice, snow or rain. Furthermore, excessive speed increases the severity of highway crashes when they do occur, i.e., a high speed crash is more likely to produce death or serious injury than crashes involving lesser speeds. Lastly, there is a direct relationship between speed and stopping distance. As speed doubles, reaction time distance also doubles, but braking distance increases geometrically. For example, when speed doubles from 40 mph to 80 mph, braking distance increases over five times, from 81 feet to 410 feet.

Research studies are equally clear that vigorous selective speed enforcement can reduce vehicle speeds. Traffic radar has proved to be an effective tool for determining vehicle speed. Nonetheless, the use of traffic radar equipment continues to come under public scrutiny. The major concerns are the quality of the traffic radar training received by law enforcement personnel and the

quality of the traffic radar instruments. These concerns reached a peak in a famous 1979 Florida case, in which palm trees and houses were reported as having been clocked at 84 miles per hour by radar. This decision, *Florida v Aquilera*, 48 Fla Supp 207 (1979), achieved nationwide notoriety, so that radar evidence began to be questioned in all states. Because of these concerns, the courts and the law enforcement community have tried to ensure that the radar operators are adequately trained and the traffic radar instruments are performing accurately.

A. History of the Michigan Speed Measurement Task Force

During the late 1970's, following *Aquilera*, several groups within Michigan independently began to develop specific concerns about the future of radar speed enforcement. These groups included members of the law enforcement community and the legal profession, law enforcement trainers and electronics experts. Collectively, these people concluded that while speed laws must be enforced, vehicle speed-measurement methods must be accurate, cost effective, and accepted by the courts and the public.

During the period between 1978 and 1982, OHSP took the following steps:

- Organized the Michigan Speed Measurement Task Force (MSMTF, formerly the Michigan Radar Task Force) to discuss, evaluate and make recommendations to OHSP regarding radar speed enforcement, and to prepare interim guidelines for the use of radar devices in Michigan.
- Issued grants to Michigan State University to establish a radar testing laboratory and to develop course materials needed to train radar operators and radar course instructors.
- Funded the Michigan Judicial Institute in the development of radar and civil infraction case adjudication materials for district court judges and magistrates.

A radar operator training program which trained over 100 radar course instructors was developed and pilot tested. Between 1980 and 1986, these instructors trained over 6,000 law enforcement officers in the sue of radar equipment through the Michigan Commission on Law Enforcement Standards (MCOLES) in-service training program. Radar course instructors were certified to be in compliance with a minimum training standard, but no statewide program to certify radar operators was developed and implemented.

The MSMTF's original position was that individual courts would have to determine what constitutes adequate radar operator training and experience. In 1985, the MSMTF, based on the Michigan Court of Appeals ruling in *People v Ferency*, 133 Mich App 526 (1984), concluded that all radar operators in Michigan must be certified. The MSMTF used this ruling as a basis for developing both operator training and equipment certification programs. The certification program began in 1987 by training over 200 radar instructors to provide update training for all qualified existing radar operators in the state. As a result, approximately 4,100 radar operators had their training updated and were certified by MCOLES in 1987. Finally, the Task Force developed training and testing materials for a statewide basic radar operator training course. All new radar operators are now required to successfully

complete this training course and be certified by MCOLES as a prerequisite to being allowed to testify in any court hearing involving radar.

The MSMTF works closely with the Michigan Judicial Institute (MJI) to assist in the training of district court judges and magistrates on the adjudication of radar speeding cases. Since 1982, all new magistrates have been trained using a self-instructional training package developed by MJI for new magistrates. Furthermore, traffic radar has been a major topic at several traffic adjudication seminars sponsored by MJI. In all, it is estimated that more than 800 judges and magistrates have received MSMTF information through MJI programs.

The MSMTF has been active in studying and evaluating the central issues surrounding the use of radar equipment in traffic speed enforcement. It also developed recommendations regarding the performance of radar equipment, the training of radar operators, and the adjudication of radar speeding cases. Because of MSMTF's responsibilities and level of involvement, it is not surprising that many wonder where the MSMTF gets its authority. The MSMTF's authority derives partially from the OHSP and partially from the Michigan Court of Appeals ruling in *People v Ferency*. In this ruling, the Court of Appeals authenticated the recommendations of OSHP and encouraged its continued involvement in these issues to help ensure due process in the adjudication of radar speeding cases. In response to this ruling, OHSP directed the MSMTF to develop a comprehensive set of recommendations and to review and update these on a regular basis. The document, Michigan Speed Measurement Task Force Recommendations, is the Task Force's response to this request.

B. Basic Principles of Radar Speed Measurement

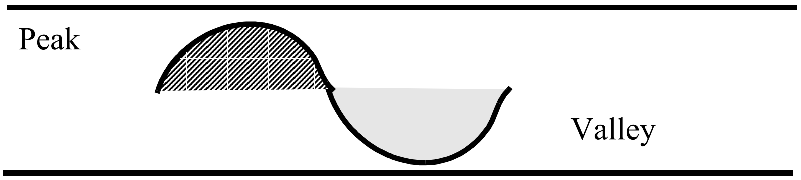
The word "radar" is actually an acronym for "Radio Detection And Ranging." All radars are radios because they transmit and receive radio frequency energy, just like the radios in a patrol unit.

Radar systems were first used just before World War II to detect the presence of moving objects such as aircraft and establish their range (distance) from the radar base. Now, radar systems can do much more, including establishing position, altitude, etc.

Police traffic radar, on the other hand, merely detects the presence of a moving object and determines its speed. Since police traffic radar has such a limited function, it is considerably less complicated and less expensive than other types of radar systems.

C. Scientific Principles

There are physical characteristics to the length and frequency of waves. Like the waves occurring on water, each wave consists of a peak and a valley, as illustrated below:



The waves move along the water, following one another in a steady sequence. If a pebble were dropped into a pond, it would generate a series of waves that would move out in circles from the point where the pebble entered the water. The same wave motion also exists in sound waves, light beams and radio signals. While all radio wave signals travel at the speed of light, every signal has its own distinct characteristics. One signal differs from another in terms of two important wave characteristics, wavelength and frequency.

Wavelength is the physical distance or length from the beginning of the peak to the end of the valley. Traffic radar signals have wavelengths of approximately one inch for “X” band, 0.5 inches for “K” band and 0.3 inches for “Ka” band.

Frequency is the number of waves generated by the signal during one second of time. “X” band is a continuous wave with a frequency of 10, 525,000,000 waves per second, or 10.525 Gigahertz (+ or - .2%). “K” band is a continuous wave with a frequency of 24, 150,000,000 waves per second or 24.150 Gigahertz (+ or - .2%). “Ka” band is a continuous wave within a frequency range of 33,400,000,000 waves per second to 36,000,000,000 waves per second, or 33.4 to 36 Gigahertz.

> **Note:** Frequency usually is measured in cycles-per-second. One cycle is the same thing as one wave. Scientists and engineers often use the term Hertz (abbreviated Hz) instead of cycles-per-second. All of these terms have exactly the same meaning: one Hertz equals one cycle per second, which equals one wave per second. We will continue to use the expression “waves per second,” since this helps to keep in mind the wave nature of radar signals.

In the case of traffic radar, high frequency waves interact between the radar unit and the target vehicle. The radio waves radiate from the antenna in a continuous series of connected peaks and valleys. Every radio signal has its own particular frequency and wavelength. The relationship can be thought of in terms of a mathematical formula: wavelength x frequency = speed of light.

Whenever a radio signal is changed, its speed stays the same, but its frequency and wavelength change.

- As the frequency (number of waves per second) increases, the wavelength (length of waves) must decrease.
- As the frequency decreases, the wavelength must increase.
- The speed never changes (186,000 miles per second which is the speed of light).

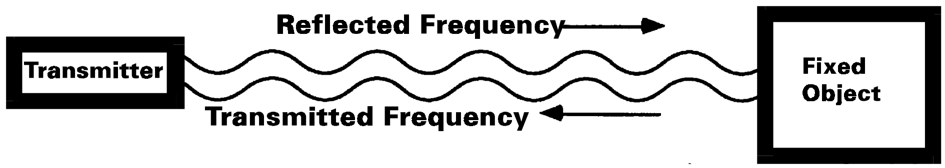
D. Doppler Principle

The radar unit used today by police agencies measures only speed. This type of radar is called Doppler radar and is based on the Doppler principle, named after its discoverer, Christian Johan Doppler. This Austrian physicist defined the principle in 1842, and it is applied to traffic radar as follows:

When energy waves, be they light, radio, or sound waves, are transmitted from a moving object and reflected from a stationary object, or transmitted from a moving or stationary object and reflected from a moving object, they increase or decrease in frequency in direct proportion to the speed of the object.

Doppler noted that sound waves emanating from moving objects seemed to vary in pitch depending on whether the object was moving toward or away from the observer. For example, the pitch of a locomotive's whistle would seem to be constant if both the locomotive and the listener were standing still.

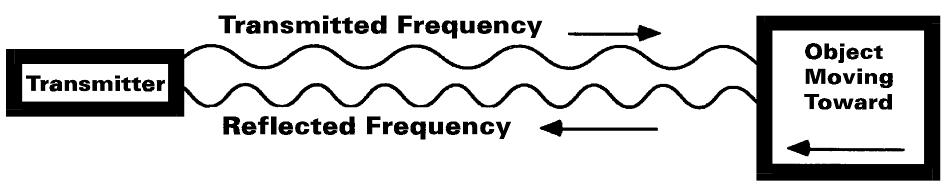
Stationary Objects: Reflect at Same Frequency



However, he noted that if the locomotive was in motion, the pitch of the whistle was higher as it approached the listener and lower as it moved away from the listener. In other words, the speed of the locomotive affected the frequency of the sound waves heard by the stationary listener. Two principles evolved:

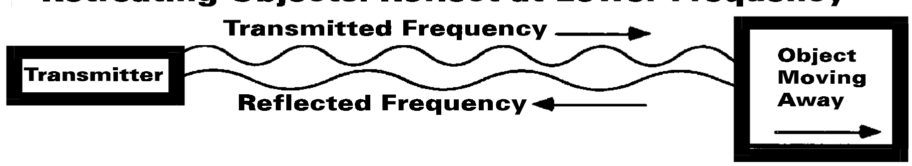
1) If the source of the transmitted signal and target object are moving closer to each other, the frequency of the sound wave will be increased.

Incoming Objects: Reflected at Higher Frequency



2) If the source of the transmitted signal and target object are moving away from each other, the frequency of the wave will decrease.

Retreating Objects: Reflect at Lower Frequency



The Doppler principle scientifically states that the closing speed of an object affects the frequency of the wave that the object reflects.

E. Doppler Shift for Standard Traffic Radar

For each one mile per hour of target speed, the radar wave frequency will shift as follows:

- "X" band will shift 31.4 Hertz or waves per second.
- "K" band will shift 72 Hertz or waves per second.
- "Ka" band will shift approximately 100 Hertz or waves per second.

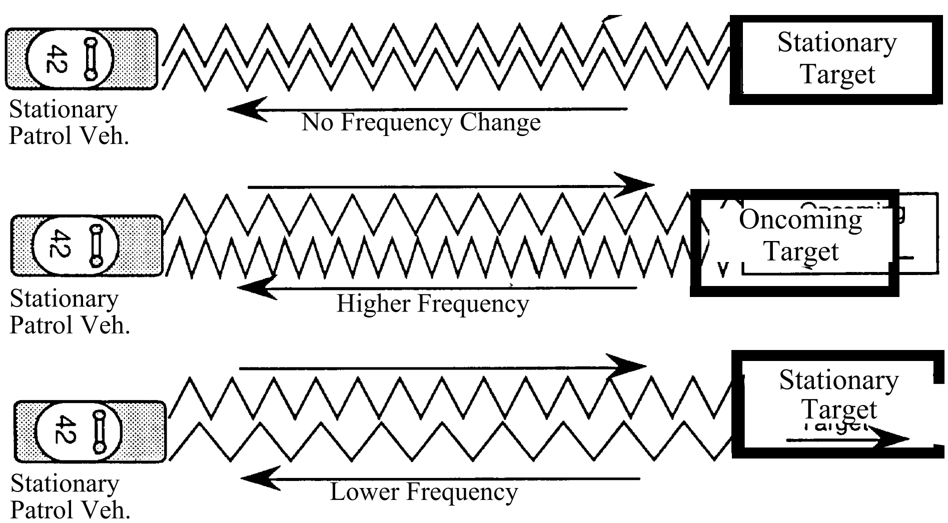
F. Basic Method of Radar Speed Measurement

In the case of radar units, the speed measuring radar transmits a continuous series of radio waves (signals). When a portion of this signal strikes a solid object, some of the signal is reflected, or bounced back to the radar unit.

If the solid or target object is moving, the reflected signal will have a different frequency from the transmitted signal:

- If the traffic radar unit and the target vehicle are both stationary, there will be no change in the frequency of the reflected signal.
- If the traffic radar unit and the target vehicle are moving closer together, there will be an increase in the frequency of the reflected signal.
- If the traffic radar unit and the target vehicle are moving apart, there will be a decrease in the frequency of the reflected signal.
- The faster the closing or departure rate between the radar unit and the target vehicle, the more the signal will be changed.

Traffic radar instruments measure the change in frequency between the transmitted frequency and the reflected frequency.



G. Basic Components of Traffic Radar

Most modern police radar units are composed of two parts — an antenna and a processing-display unit.

- **Antenna.** The antenna transmits a high frequency radio signal out and away from the antenna in a directional beam, receives the reflected signal from the target, and "feeds" that signals to the read-out module. There are currently traffic radar units that have two antennas.
- **Processing-display unit.** The processing-display unit receives the signal from the antenna, executes the desired frequency filtering, determines whether there is an increase or decrease in the reflected signal frequency compared to the transmitted signal frequency, mathematically translates the frequency speed into the target vehicle speed, and displays it. In the moving mode, it also calculates and displays the patrol vehicle's speed. Additionally, the read-out module produces an audio signal that correlates to a target vehicle speed.

6.3 Traffic Radar Beam

This section is concerned with the radar beam, the operational area of the beam, and considerations the operator needs to make when using radar to establish proper target identification. For the magistrate, this section will explain the basic principles of the equipment and how it operates in both ideal and non-ideal situations.

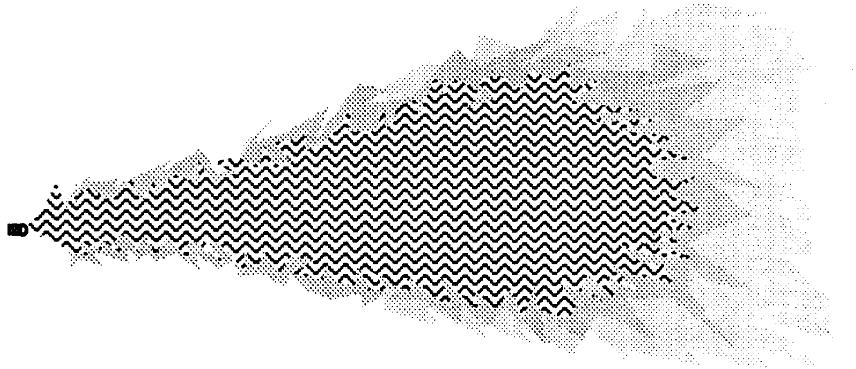
A. General Shape

The traffic radar signal is transmitted from the antenna in a directional beam. The signal's configuration is very similar to the beam of light that is sent out by a spotlight. It is cone shaped and will continue infinitely in a straight line unless it is influenced by one or more of the following factors:

- reflection, e.g., by metal, stone, wood, concrete, etc.
- absorption, e.g., by leaves, grass, loose sand, earth, etc.
- refraction (bent in passing through a substance), e.g., through glass, certain plastics, etc.

The main lobe (referred to in this text as the operational area of the beam) contains approximately 80 percent of the energy of the transmitted signal. While the main lobe does not contain the entire transmitted signal, it is the area from which the reflected signals from target vehicles are most likely to

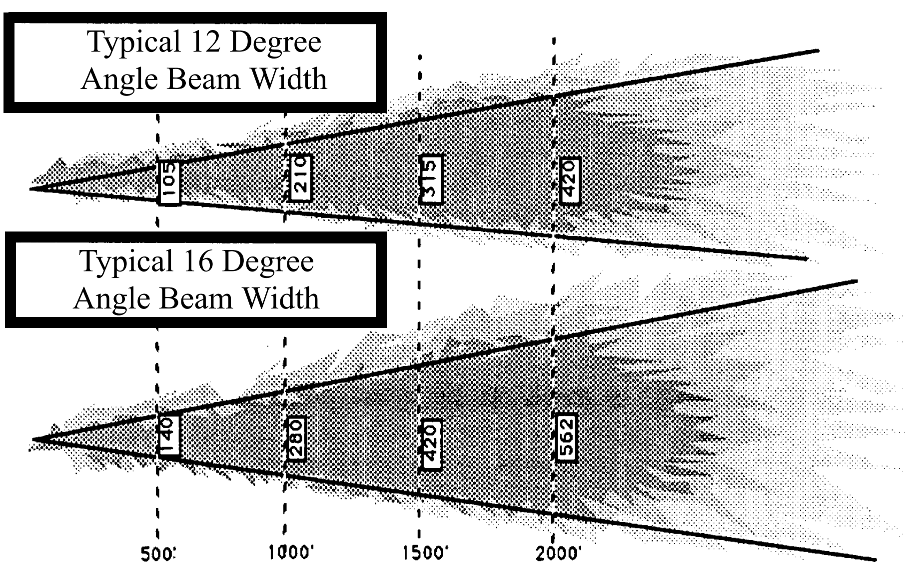
be received and displayed. This is not to imply that the target vehicles outside of this main lobe could not be displayed.



Main lobe contains approximately 80% of the signal's power.

B. Beam Width

Beam width will vary from manufacturer to manufacturer and from model to model. The National Institute of Standards and Technology (NIST), in a laboratory environment, found beam widths to vary from 11.5 to 24.2 degrees. The ability of the radar beam to be lane selective (i.e., focus on one lane and not the other), is virtually nonexistent with current radar. The following illustrations show the width of such beams at various distances.



C. Beam Range

Beam range, unlike beam length, is finite or limited in distance. Beam range is the distance at which the radar can effectively receive and process a target vehicle's reflected signal. Beam range, like width, may vary from manufacturer to manufacturer. However, most models have a maximum

capability of approximately one-half mile. This range will vary based on many factors. The range factor is adjustable on some models for closer distances by use of a range control selector.

D. Operational Area of the Beam

Operational area of the beam is that area of a radar beam in which a valid target reading may be calculated. The operational area of the beam may be influenced by the size, shape, composition and position of the target vehicle in relation to other vehicles, and by environmental factors such as weather and terrain. The radar beam may be only a few inches wide at its origin, but five or six hundred feet wide at its maximum operational range. The antenna receives reflections from any moving objects that are within the beam up to the operational limit. This means that vehicles in different lanes will reflect radio waves as well as vehicles closer to, and farther away from, the radar unit.

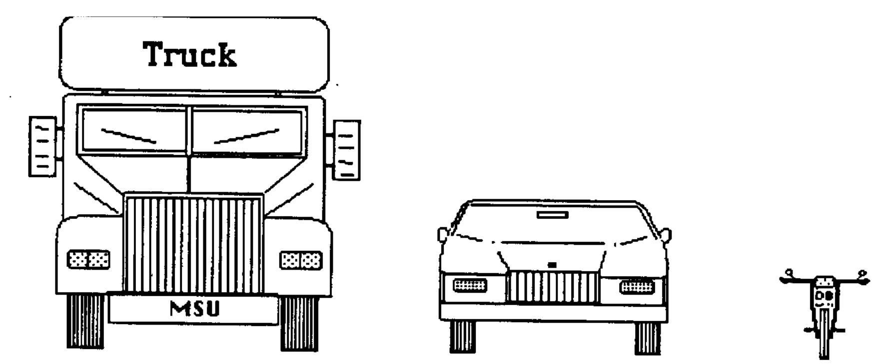
Target identification on a roadway where multiple targets are present is a matter of operator interpretation. Operator interpretation relies heavily on the visual estimate of a target's excessive speed as a primary element with the radar unit being used as important supportive evidence.

E. Radar Sensitivity

Radar sensitivity is determined by the strength of a reflected radar signal. Radar instruments will only respond to those signals that are strong enough to be processed. When there are multiple targets, the following factors may affect which target is being picked up and displayed by the radar instrument.

1. Target Size

The larger the object, the more surface it has to reflect the radar beam. For example, a motorcycle has a very small reflective surface and contains relatively little metal. As a result, a radar unit is not as sensitive to the motorcycle as it is to a car, nor is the radar unit as sensitive to a car when compared to a large truck at a comparable distance.



2. Target Shape

The reflective capability of a target vehicle is affected by the target shape. For example, a vehicle with a large, flat, vertical surface like a truck will tend to

reflect more of the signal back toward the radar, while a streamlined vehicle might scatter much of the reflected signal and reflect less of the signal back toward the radar.

3. Target Composition

Some materials reflect radar signals better than others.

- Metal, concrete and stone are excellent reflectors.
- Leaves, dirt, and loose sand absorb much of the radar signals rather than reflecting them.
- Glass and plastic allow radar signals to pass through without any appreciable reflection. However, the signal may be refracted or bent.

4. Target Position

The energy of the signal that strikes the target will usually depend on where the object is in relation to the beam.

- Most of the beam's energy is contained in the operational area of the beam.
- The concentration of energy drops off quickly as the signal moves farther from the antenna or off into the fringes of the operational area of the beam.
- Objects located in the operational area of the beam receive a high concentration of energy in relation to objects outside this area.

5. Target Speed

The speed of a target vehicle is a final possible determining factor by the radar only in some very specific circumstances.

The radar units used by law enforcement will generally display the one vehicle among many reflecting the strongest signal. This signal is usually a result of the reflective capability (size, shape, composition) or position of the target vehicle.

When multiple targets of unequal size are present, then either reflective capability (size, shape, composition) or position will most often be the determining factor by the radar. It is vital to understand that these are two completely different factors. With this understanding, it is easier to interpret which is coming into play in multiple target situations.

When the strength of reflected signals is relatively equal, the speed of the target vehicle may impact upon the radar's sensitivity. It is possible to clock a faster vehicle that is, in fact, not the lead vehicle in oncoming traffic. For example, if a passenger vehicle traveling at 50 mph on the expressway is being overtaken by a similar size vehicle from the rear at a much greater speed of 70 mph, then the faster vehicle's speed may be displayed. This would not occur until the faster vehicle is in close proximity to the lead vehicle.

This speed selective factor is much less likely to occur on two-lane roadways. The front vehicle generally reduces the number of radar waves that strike the vehicle approaching from the rear.

These examples involving reflective capability, position, and speed are not meant to imply that the operators must attempt to compute the relative size and distance of an approaching vehicle mathematically. However, from these examples, several guidelines on target identification can be drawn. There are exceptions to these guidelines and results may vary depending on the situation.

- If the approaching target vehicles are all about the same size, the vehicle closest in the main radar beam will usually be the one displayed by the radar.
- If the vehicles are not of the same size and a truck is positioned in front of a car, the truck will usually be the vehicle displayed no matter what the distance.
- If a car is in front of a truck and the truck is as close to the car as the car is to the radar antenna, then it is most probable that the truck will be the one displayed.
- If a car is in front of a truck and the car is significantly closer to the radar antenna than to the truck behind it, then the car would usually be displayed by the radar unit.

The closer the target to the radar unit, the greater the potential for positive target identification by the operator.

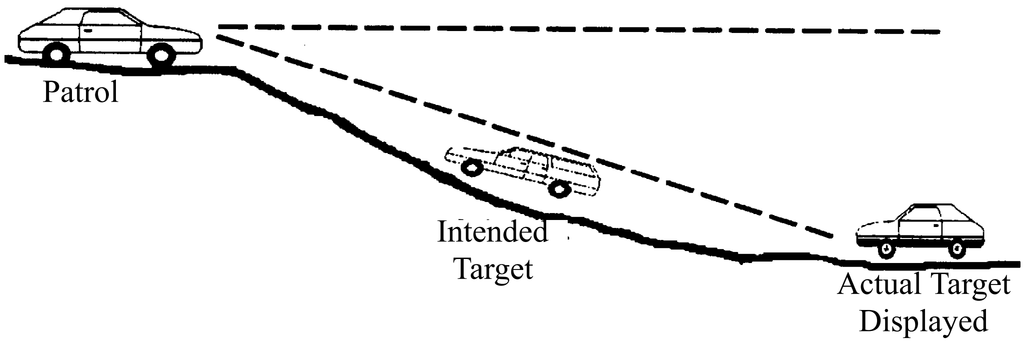
These guidelines are not absolute and may not always hold true due to other factors such as vehicle shape and road terrain. These guidelines emphasize the importance of the operator tracking a suspected violator for as long as practical.

F. Effect of Terrain on Target Identification

The optimum areas for radar operation would be on straight and level roadways. When traffic radar is operated on hilly or curved roadways, the operator must take into account the effect of these variables on the radar unit.

Curves in the road cause fewer problems in target identification than hills. The radar unit functions on a “line of sight” basis and cannot display a vehicle not yet in sight. The operator must be sure that a target vehicle is clearly within the operational area of the radar before a target determination is made.

Hilly terrain may create problems in target identification. For example, if the patrol vehicle is positioned at the crest of a hilltop with the antenna focused straight ahead rather than down the hill, the radar beam may “overshoot” the lead vehicle approaching and display a vehicle to the rear.



A dip in the roadway may also affect the radar's ability to display the lead vehicle. In this case, the roadway itself may shield most of the reflective surface of the lead vehicle, allowing a vehicle to the rear to be displayed.

It is vitally important to stress that the radar reading is only one piece of supportive evidence and not the sole basis for issuing a citation.

If the terrain contains an obstruction, i.e., a sign, a parked vehicle, a bridge abutment, etc., a momentary change in the signal may result. These momentary signals will be dismissed by the operator because they do not take into account all of the factors required for a tracking history.

Discretion on the part of the operator must be used when roadway terrain problems exist. The operator must track the target vehicle as long as possible to be certain of a valid target identification.

It must be remembered that the radar reading is only one piece of the supportive evidence the operator uses in establishing a speed violation. The operator relies heavily on visual clues which indicate a suspected speeder approaching. With the operator's attention focused on a specific vehicle, it is easier to determine when that vehicle is being registered on the readout module. Situations will arise where either the radar will not display or the operator will be unable to confirm a reading. This will occur most often in areas with a heavy traffic volume. The multiple targets presented will limit the operator to interpreting only those vehicles which are easily identifiable, visually.

Light or medium traffic obviously is the easiest for the operator to interpret. In any case, operators are trained that if there is any doubt as to the validity of the reading, they shall not issue a citation.

Weather conditions will not affect the accuracy of a traffic radar instrument. They may lessen the effective range of a radar instrument in that some of the signals may be absorbed or refracted by rain or snow in the air.

6.4 Common Features of Traffic Radar Instruments

A. Features of Traffic Radar Unit

While there are many features on a traffic radar unit, this section covers only those items that are of importance to the magistrate.

1. Light-Segment Test

This test provides a visual verification that all light segments in the radar instrument are capable of illumination.

This test may be manually or automatically activated. This required test feature helps to ensure that the radar device is capable of displaying proper speeds.

2. Internal-Circuit Test

This test provides a means to verify that various portions of the electronic circuitry are properly functioning.

This test may be manually or automatically activated. When activated, a manufacturer's specified speed display will appear in the radar unit's window(s). If the proper speed is not displayed, the unit shall be taken out of service. This required feature helps to ensure that the radar device is in proper working order.

Note: The internal-circuit test does not check the antenna.

3. Low-Voltage Indicator

This indicator provides a visual alert that the radar unit is not receiving sufficient electrical energy to operate properly. The Low Voltage Indicator is:

- Required to activate at or below 10.8 volts.
- Required to activate prior to the display of any spurious speed displays.
- Required to activate prior to any other characteristics being significantly reduced:
  - Target range
  - Doppler audio quality
  - Brightness of the display(s)
- Typically located on the display module.
- When activated, operator must stop display of speeds in the target-speed window (referred to as "blanking").
- Intended to help minimize the number of spurious target-speed displays due to power surges.

4. RFI Indicator

This indicator provides a visual warning of the presence of unwanted radio-frequency interference (RFI) that might result in spurious target-speed displays. The RFI Indicator:

- Is typically located on the display module.
- Is required to activate prior to any spurious speed displays.
- Must be sensitive to spurious signals from:
  - Police radios
  - Citizen-band radios
  - Other AM or FM radio transmitters
- When activated, must stop display of speeds in the target-speed window.
- Is intended to minimize the number of spurious target-speed displays due to RFI effects.

5. Doppler-Audio Function

This function provides an audio output tone which allows an operator to correlate the tone with visual observation and estimation of speed of a target vehicle.

- Audio pitch (frequency) will rise or fall as a target vehicle's closing (or receding) speed increases or decreases, respectively. The audio pitch on a same-direction mode radar may actually increase or decrease in pitch when the target vehicle is slowing or speeding up.
  - Audio output may prove useful to establish:
    - The range of the target since the audio output volume and tone quality may relate to the strength of the reflected Doppler-shifted signal.
    - The presence of potential sources of spurious displays since they may first be recognized by hearing rather than a display reading, e.g., spurious readings due to fans in the patrol vehicle, radio frequency interference, patrol vehicle ignition noises, etc.
    - The presence of multiple targets within the operational area of the radar beam, i.e., multiple tones are heard simultaneously due to multiple targets traveling at varying speeds within the operational area of the radar beam.

6. Standby or Radio Frequency Hold (RF Hold)

This feature provides a means to turn off the microwave transmitter (antenna), and helps to minimize the effectiveness of a radar detector.

Typically, the Standby is activated until such time as an operator is confident the suspected target vehicle is in the operational area of the beam.

This feature, when used properly, will generally allow a radar operator to determine the target vehicle's speed prior to a violator reacting to a radar detector. The typical radar will process and display a target vehicle's speed within 1/10 of a second after the RF Hold is released.

7. Range Control

This feature provides a means to control the operational length of the radar beam through the adjustment of the radar receiver's sensitivity to reflected radar signals.

This feature simply allows for the adjustment of the radar receiver's sensitivity. It does not change the characteristics of the radar's transmitted microwave energy.

This function does not make a radar target selective. All potential targets within the operational area will be equally affected.

This feature assists in target identification by reducing the operational area of the radar beam, thereby decreasing the total number of potential targets within the beam (extremely useful with multiple targets).

8. Target-Speed Display Window

This feature provides a visual display of the target vehicle's speed in mph.

9. Patrol-Speed Display Window

This feature provides a visual display of the patrol vehicle's speed in mph, while being operated in the moving mode.

10. Manual Lock Target Speed Display Window

This feature provides the operator with a means to preserve target-speed displays by locking them in this window.

Locking this window does not affect speeds displayed in other windows, nor does it impact on the Doppler-audio function.

Radar devices with two target-speed display windows may possess the manual lock feature. One display window locks the target vehicle's speed while the second window continues to display the target vehicle's speed while in the operational area of the beam.

Because they preclude proper target tracking history, the following features are not permitted on State certified radar equipment:

- **Autolock:** This feature provides a means to preset a "threshold target-speed" on a radar device. When set, this feature will automatically cause the speed display window(s) to lock and an audible alert tone to sound when the unit senses a target-speed at or above the preset speed.

- **Violator Warning:** When used in conjunction with a preset speed feature, the violator warning feature provides an operator with an audible tone when a target speed is sensed at or above a preset speed. While the violator warning feature does not permanently lock the speed display(s), it does momentarily lock the unit's speed displays for the period of time it is sounding. Also, the Doppler audio is interrupted.

11. Moving/Stationary Mode Switch

This feature provides a means to convert a radar unit from "Moving mode" to "Stationary mode" and vice versa.

12. Same Direction/Opposite Direction Mode Switch

This feature is found only on moving mode models. It provides a means to select same direction or opposite direction tracking capabilities.

13. Slower/Faster Target Vehicle Mode Switch

This feature is found only on same direction moving mode radars. The slower mode is used when the target vehicle speed is lower than the patrol vehicle speed. The faster mode is used when the target vehicle speed is faster than the patrol vehicle speed.

14. Fastest Target Speed Switch

This feature provides a means for an operator to display the speed of the fastest vehicle that is currently in the operational area of the beam.

15. Directional Sensing Radar

This feature provides a means for an operator to select, while the stationary mode, vehicles that are either coming toward the radar device or are receding from the radar device.

B. Inside Antenna Mounting

The radar antenna should be securely mounted and positioned so that:

- Its beam is not directed at the air-conditioning, heating or engine fan (poor positioning will lead to spurious displays.)
- It is mounted as high above the dash as practical because it generally improves range.
- It is mounted as close to the windshield as practical because it generally improves range and reduces interference.
- Its beam is not directed at the rearview mirror or flat metal objects in or around the front of the antenna (these objects may reflect the radar beam and cause the radar to clock moving vehicles other than the one desired).
- It is not a vision obstruction.

- It is not mounted within the deployment footprint of the patrol vehicle's airbag(s).
- Its beam is not directed at patrol vehicle occupants.

A clean windshield will improve the radar's operational range. Smoke film or other foreign material will detract from the unit's performance.

Inside antenna mounting may reduce possibility of damage to equipment. However, inside antenna mounting has the following disadvantages:

- May promote interference.
- May slightly reduce range.
- May alter the shape of the operational area of the beam.

C. Outside Antenna Mounting

The radar antenna should be securely mounted and positioned to avoid excessive vibration.

Outside antenna mounting may eliminate the effects of vehicle interior electrical interference, and increase the range of the instrument. However, outside antenna mounting has certain disadvantages, namely:

- May result in equipment failure due to moisture and dirt causing corrosion within the antenna.
- May result in antenna damage due to accidents or vandalism.
- May alter the shape of the antenna beam from that of inside antenna mounting.

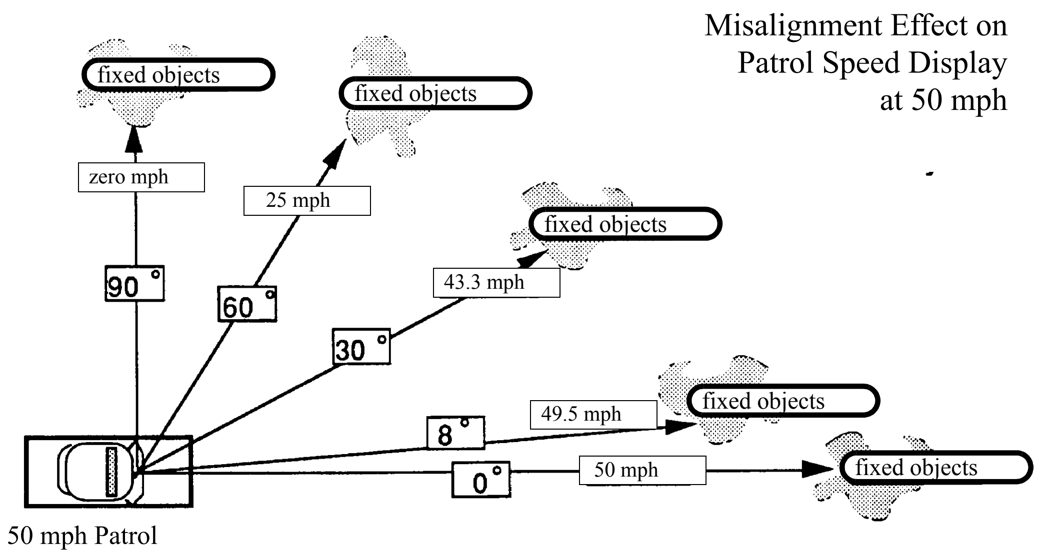
D. Antenna Positioning

1. Horizontal Alignment.

Horizontal or lateral alignment of the traffic radar's antenna is critical for proper clocking of vehicles. Doppler radar measures speed only, not direction. If the target vehicle is not coming directly at or away from the antenna, the radar cannot calculate an accurate vehicle speed. For complete accuracy, the radar unit requires a 0-degree angle between the approaching or departing target vehicle and the antenna. Obviously, this is impractical from a traffic enforcement standpoint and some slight angle almost always exists and is acceptable. Small deviations from zero degree will have an insignificant effect on the accuracy of the display readout. It is strongly agreed that an attempt should be made to position the radar antenna, by visual observation, as close to zero degrees as possible.

An angle greater than eight degrees from zero horizontal alignment may have the following effects:

- In the stationary mode, may decrease the unit's ability to detect target vehicles but will not have an impact on target speed displays.
- In the moving mode, may cause the radar to display higher or lower than actual target speeds.



2. Vertical Alignment

The radar antenna should be mounted so that the radar signal is beamed parallel to the ground (not tilted).

The vertical antenna alignment or tilt is not as critical in relation to receiving a proper target reading as is horizontal alignment.

While tilting the antenna slightly downward may result in limiting the range of the instrument, this procedure is discouraged since it may promote interference.

E. Verification of Proper Radar Operation

Before a radar unit can be used for traffic enforcement purposes, several separate checks must be made. All of the verification tests shall be made at the beginning and end of each shift and documented for possible use in court. If the unit fails any of the tests listed below, it must be removed from service immediately.

1. Display-Segment Test

The display segment check is performed to ensure that all display segments are operating properly. If one or more of these display segments fails to come on, the unit shall be removed from service immediately.

2. Internal Circuit Test

This test procedure will vary from model to model. However, this test feature will result in a display of a pre-determined speed display (set by the manufacturer). If the unit fails this test, it must be taken out of service. The internal circuit test does not verify the proper operation of the unit's antenna.

3. Speed Display Tests

Verification of the patrol speed radar readout against the independently calibrated patrol vehicle speedometer can be accomplished as follows:

- With the radar in stationary mode, drive the patrol unit at various speeds. Ensure that the radar can accurately compute and display the patrol speed in the "target" window.
- With the radar in moving mode (if so equipped), drive the patrol unit at various speeds. Ensure that the radar can accurately compute and display the patrol speed in the "patrol" window.
- Ensure that the radar can acquire and display the speed of a target at normal range. If you perceive a deterioration in the range, this may indicate deterioration of certain components that could increase the likelihood of spurious readings.

4. Audio Output Test

Ensure that the radar has clear Doppler audio output tones during the Speed Display Tests described above and that the audio tones correlate with the displayed speeds.

5. Tuning Fork Test

Tuning fork tests are not necessary or recommended. Very old radar units (constructed in the 1950's before digital electronic circuits were used) had a tendency to fall out of calibration, and tuning forks were necessary to calibrate or adjust them. All radar units used today have digital electronic circuits and tuning forks serve no useful function.

F. Videotape Notetaking Outline for Videotape Section C

View the videotape labeled Radar: Technical Aspects *and follow along with the videotape outline located on this page. Watch only the Section C portion. Do not rewind the tape at this time.*

1. The Radar Device:

- On/Off Power Switch
- Power-On Indicator
- Target-Speed Display Window
- Patrol-Speed Display Window required for all moving mode radar.

- Low-Voltage Indicator provides a visual alert that the radar unit is not receiving sufficient electrical energy. When activated, the target-speed window must stop displaying speeds (referred to as "blanking").
- RFI (Radio Frequency Interference) Indicator provides a visual warning of the presence of unwanted radio-frequency interference that might result in spurious target-speed displays. When activated, the target-speed window must go blank.
- Light-Segment Test provides a visual verification that all light segments are capable of illuminating.
- Internal-Circuit Test provides a means to verify that that various portions of the electronic circuitry are properly functioning.

  Note: This test does not check the operation of the antenna.

- Standby or RF Hold provides a means to turn off the microwave transmitter (antenna). This feature helps to minimize the effectiveness of radar detectors.
- Range Control provides a means to control the operational length of the radar beam through the adjustment of the radar receiver's sensitivity to reflected radar signals.
- Doppler Audio Function provides an audio output tone that allows an operator to correlate the tone with visual observations and estimation of speed in a target vehicle.
- Volume control allows operator to adjust loudness for hearing comfort.
- Pitch correlates with the speed of the target vehicle.
- Clarity correlates with range of target vehicle, presence of multiple targets, and interference.
- Squelch/Squelch-Override Control provides a means to turn off the Doppler Audio output when no target-vehicle speeds are being displayed.

2. Autolock and Violator Warning Features:

Note: These features are NOT PERMITTED in Michigan.

3. Manual Lock Feature:

- Manually locking target speed display disrupts target tracking history.
- Locking a target display is not necessary.
- Manual lock is permitted on radar devices purchased after 1-1-86, only when a second target display window is present. One display window locks the target vehicle's speed while the second window continues to display the target vehicle's speed while in the operational area of the beam.

4. Tuning Forks:

- Were necessary to calibrate older radar devices.
- Are not an adequate test of modern radar because incorrect target speed displays are possible even if radar passes tuning fork test.
- Tuning fork test – (Not recommended by MSMTF.)

5. Mounting Antennas and Display Units:

- Outside antenna mounting *advantages*:
  - May improve patrol vehicle driver's visibility.
  - May increase range of radar.
  - May reduce spurious readings.
- Inside antenna mounting *advantages*:
  - Radar less likely to be affected by rain, dust, etc.
  - Easier to monitor antenna alignment.
  - Reduces possibility of vandalism.
- Inside antenna mounting *disadvantage*:
  - Range may be reduced.
- Range improvement (inside mounting):
  - Clean windshield inside and out.
  - Mount antenna as close to windshield as practical.
  - Mount antenna as high above the dash as practical.
  - Align antenna with direction of patrol vehicle.

6. Verifying Proper Operation of Radar Device:

- Turn on radar.
- Internal-circuit test.
- Light-segment test.
  - Target-speed and patrol-speed displays correlate with the independently calibrated patrol speedometer in the moving mode.
  - Speed display/audio output test—correlate audio output, target and patrol speed display readings with calibrated speedometer at several speeds.

6.5 Stationary/Moving Traffic Radar

Videotape Section D covers the stationary and moving modes of radar and the method of developing a tracking history.

A. Stationary Traffic Radar

Characteristics:

1) Stationary Traffic Radar transmits one signal and receives and monitors many signals, but may not display more than one at a time.
2) Stationary Radar must be operated from a fixed or stationary location.
3) It is capable of accurately recording speeds of objects approaching or moving away from the antenna.
4) If operated improperly from a moving patrol vehicle, it will:
   - Display the patrol vehicle speed in the target window; or
   - Display the closing rate between the patrol vehicle and a moving object.

B. Moving Traffic Radar

There are two types of moving traffic radar: opposite direction mode radar and same direction mode radar.

1. **Characteristics of Opposite Direction Mode Radar**

Doppler Signals: Moving traffic radar, while in the moving mode, transmits one signal, receives and monitors many signals, and then processes two reflected signals simultaneously. These two reflected signals are called patrol speed or low-frequency Doppler and closing speed or high-frequency Doppler.

- **Patrol Speed:** Patrol speed Doppler is typically the strongest signal. When the patrol vehicle is placed in motion, the radar unit immediately begins receiving a Doppler shift signal from the stationary terrain in front of the patrol vehicle. This strong low-frequency shift signal results from the radar unit's perception that the stationary terrain is moving toward it, rather than the unit moving toward the terrain. This patrol vehicle speed signal is sometimes also called the low Doppler.
- **Closing Speed Doppler:** The second Doppler Shift is called the closing speed or high Doppler. This is when the signal received by the radar unit results from a moving vehicle entering the radar beam from the opposite direction. This strong higher frequency shift signal is the closing speed between the patrol vehicle and the approaching target vehicle. It can also be the closing speed between the patrol vehicle and the fastest closing vehicle. The closing speed Doppler is typically the second strongest signal.

Target Speed Formula: The radar unit then computes target speed as follows: the low Doppler patrol vehicle speed is subtracted from the closing speed and the target speed is then displayed by the readout module.

TS = CS – PS.

or

Target Speed = Closing Speed – Patrol Speed

or

Target Speed = Closing Speed (High) Doppler – Patrol Speed (Low) Doppler

Selectivity. Many signals are received and processed but only two signals are selected while in the moving mode, *i.e.,* the closing speed between the target and radar unit and the speed of the patrol vehicle.

2. Characteristics of Same Direction Mode Radar

Doppler Principle: Same direction moving radar uses the same fundamental Doppler Principle that all police traffic radar instruments employ. The manner in which it operates and is operated is different from traditional opposite direction moving radar.

Target Speed Formula: The radar unit computes the target speed, using the following formula: TS = PS ± SS.

- Slower target:

  Target Speed = Patrol Speed – Separation Speed

  or

  Target Speed = Patrol Speed Doppler – Separation Speed Doppler

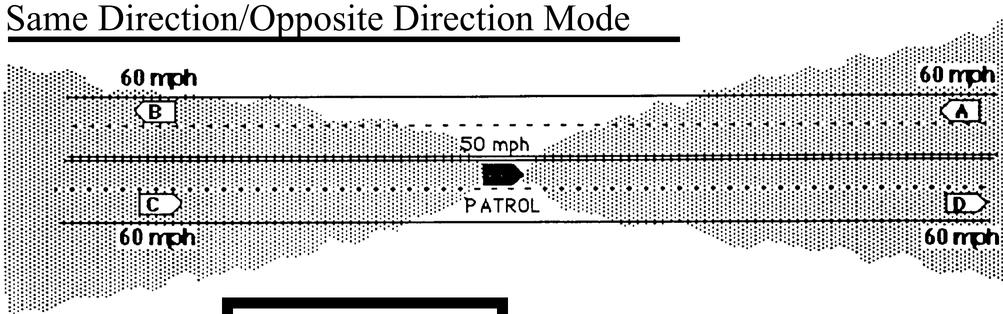
- Faster target:

  Target Speed = Patrol Speed + Separation Speed

  or

  Target Speed = Patrol Speed Doppler + Separation Speed Doppler

Same Direction/Opposite Direction Mode



Vehicle “A”	TS = CS - PS 60 = 110 - 50		
Vehicle “B”	TS = SS - PS 60 = 110 - 50		
Vehicle “C”	TS = PS + SS 60 = 50 + 10	if “C” was slower, e.g., 40 mph	TS = PS - SS 40 = 50 - 10
Vehicle “D”	TS = PS + PS 60 = 10 + 50	if “D” was slower, e.g., 40 mph	TS = PS - SS 40 = 50 - 10

Selectivity: Many signals are received and processed, but only two signals are selected while in the same-direction moving mode. They are the separation speed between the target vehicle and the radar unit and the patrol vehicle speed.

Separation speed is the relative motion between a target vehicle and the patrol vehicle speed. If there is relative motion, the target vehicle is either moving faster or slower than the patrol vehicle. Same-direction moving radar equipment is unable to determine if the target is moving faster or slower than the patrol vehicle (unless it has “Direction Sensing” capabilities). This determination of relative speeds of the patrol and target vehicles is left to the radar operator.

Some same-direction radar units will not process and display target vehicles that are traveling within ±3-6 mph of a patrol vehicle speed. Yet other units will display target vehicles within ±1 mph of the patrol vehicle speed. In short, some same-direction radars may ignore the closer/larger vehicles, that are traveling within ±6 mph of the patrol speed, and display the speed of a more distant smaller vehicle.

However, some same-direction radar will process and display the vehicle that is reflecting the strongest signal, generally the closer/larger vehicle. It is important that an operator be familiar with the capabilities and limitations of the particular same-direction radar unit that is being used.

C. Tracking History

Six supportive elements (audio and visual) are involved in the valid identification of a target vehicle. Together, these supportive elements comprise what is referred to as a complete tracking history. These six elements are:

1) **Visual Observation and Estimation of Speed.** An operator must be able to visually identify the target vehicle, and to estimate its speed at greater than the speed limit.
2) **Doppler Audio.** An operator must correlate the tone of the Doppler audio with visual observations and estimation of speed of a target vehicle.
3) **Target Speed Display.** An operator must establish that the target speed displayed corresponds with the visual estimation of speed and the Doppler audio output.
4) **Within Operational Area of the Beam.** An operator must establish that the target vehicle was within the operational area of the beam at the time the target's speed was displayed.
5) **Patrol Speed Verification (moving mode only).** An operator must establish that the radar's patrol speed display corresponds with the independently calibrated patrol speedometer at the time a target vehicle's speed is being monitored.
6) **Faster/Slower Mode Verification (same-direction mode only).** An operator, while monitoring a target vehicle's speed in the same-direction mode, must establish that the radar is clocking in the proper Faster/Slower mode. By gradually varying the patrol speed up or down a few mph, the operator shall verify that there is no corresponding change in the target speed display. When the radar has correctly computed the target speed, changes in the patrol vehicle speed will not affect the target speed display. If the incorrect Faster/Slower mode is being used, the target vehicle speed will correspondingly go up and down with the acceleration and deceleration of the patrol vehicle. Regardless of the cause, rapid target window fluctuations are not acceptable for enforcement purposes.

The actual sequence in which the elements of the tracking history occur is unimportant. It is vital, however, that all of the necessary elements be present. It is also necessary that the tracking of the target vehicle take place over a reasonable amount of time, so the operator knows it is not a spurious reading.

The following examples represent typical sequences of the elements necessary to establish a valid tracking history for moving radar:

- **Example A:** The radar operator is on patrol on a two-lane roadway. The operator first hears an audio tone which corresponds with excessive speed. The vehicle then comes in a position where the operator can make a visual estimate of its speed. A target reading appears on the display screen of 67 miles per hour. This agrees with the audio and visual estimate of the vehicle's speed by the operator. The operator then quickly compares the

independently calibrated speedometer reading with the patrol vehicle speed shown in the patrol display window. The speedometer and radar readings correspond. The target vehicle was within the operational area of the radar beam when the reading was taken. At this time, the sequence is complete and the officer can take enforcement action.

- **Example B:** The officer observes a vehicle approaching around a curve. While the vehicle is not yet in the radar beam, the officer obtains a visual estimate of the vehicle's apparent excessive speed. The vehicle enters the operational area of the beam, and an audio tone consistent with the visual estimate of speed is heard. A reading of 63 miles per hour is displayed on the radar. The officer verifies the speedometer against the patrol vehicle speed displayed by the radar. At this time, the sequence is complete and the officer can take enforcement action.
- **Example C:** The radar officer is on patrol on a four lane divided expressway (65 mph max.) using moving mode radar with Standby (RF Hold) switch in the off position. A medium size vehicle approaches from the opposite direction, catching up with and beginning to pass another medium size vehicle. The officer visually estimates the target vehicle speed to be 80 mph and turns the Standby (RF Hold) switch "on". A strong audio tone consistent with the estimated 80 speed is heard and a reading of 81 appears in the target window. Immediately thereafter the officer observes the front of the target vehicle dip abruptly, the vehicle appears to brake abruptly, the audio drops quickly and the reading in the target display window drops rapidly from 81 to 65. The patrol window displays 63 and the calibrated speedometer reads 63. The officer notes the obvious visual deceleration of the target vehicle corresponding exactly with the drop in audio and target display window read-out and concludes that the radar was tracking the target vehicle and not the other vehicle. Target identification is complete and the officer can take enforcement action.

6.6 Cosine Effect and Spurious Displays

This section covers the kinds of effects that could alter the accuracy of radar readings. You should be aware of these effects and be able to respond to questions during informal hearings.

A. Cosine (Angular) Effect – Stationary Mode

The cosine effect causes an erroneous reading from a target vehicle. The cosine effect always exists when the target vehicle is not moving directly at or away from the antenna.

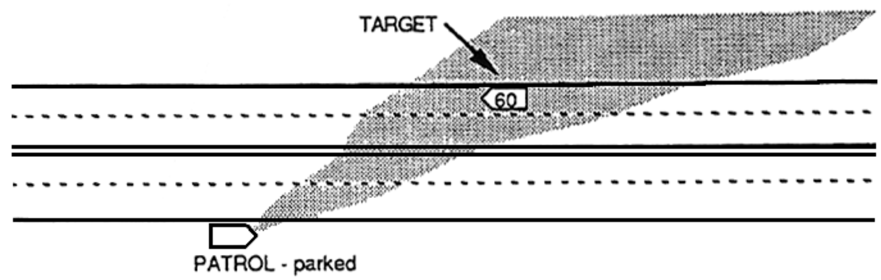
The effect upon the accuracy is insignificant at 8 degrees or less from a direct line between the antenna and the target.

While using traffic radar in a stationary mode, the cosine effect will always cause the readout module to display a speed that is lower than the true target vehicle speed (favors the motorist).

The cosine effect will occur in the following two ways when using radar in a stationary mode:

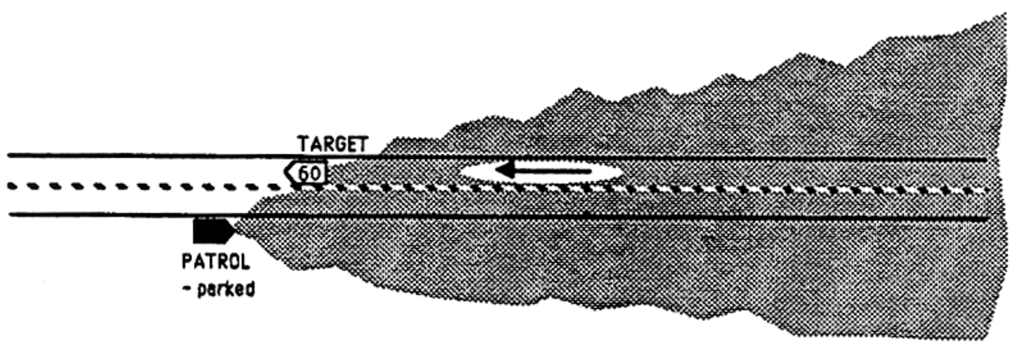
Stationary Example 1

Cosine effect exists because the radar antenna is misaligned. The antenna should be positioned so that the angle between the target vehicle and the antenna is as close as possible to zero degrees.



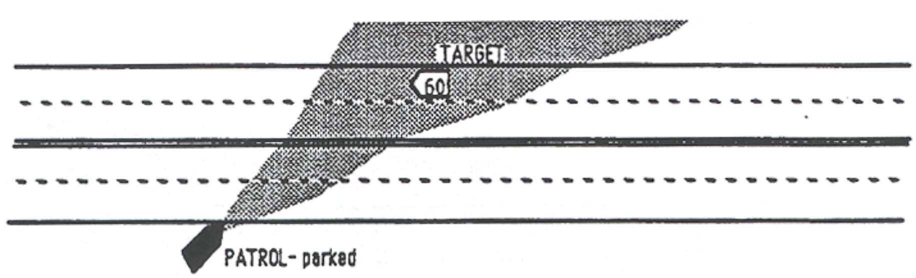
Stationary Example 2

Cosine effect exists because the target vehicle has moved into the fringe of the operational area of the beam, causing a significant angle.



Stationary Example 3

The patrol vehicle and the radar antenna are positioned at an angle so that when the target vehicle is **WITHIN THE OPERATIONAL AREA OF THE BEAM** it is no longer directly approaching the radar antenna.

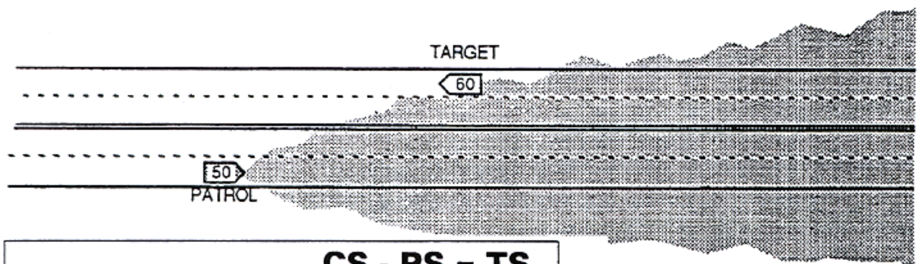


B. Cosine Effect — Moving Mode (Opposite Direction)

While using traffic radar in a moving mode, the cosine effect will cause the readout module to display a target vehicle speed that is either higher or lower than that of the true target vehicle speed. In the following two illustrations, the cosine effect is seen in the target vehicle display, not the patrol speed display. Both illustrations show variances in radar speeds in favor of the motorist.

Moving Example 1

The vehicle is at the fringe of the operational area of the beam, thereby causing the cosine effect in the high Doppler signal. This will result in a less than true target speed which is to the motorist's advantage.

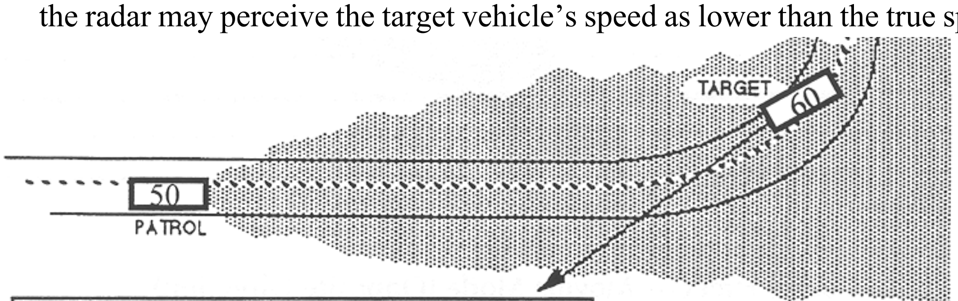


CS - PS = TS
Actual Speeds 110 - 50 = 60
Cosine Effect 100 - 50 = 50

10 mph too LOW

Moving Example 2 (Closing Speed Doppler)

A curve in the road may cause the cosine effect in the closing speed Doppler signal. If the target vehicle is approaching the moving patrol unit from around a curve, its relative motion will not be straight at the antenna. In such a case, the radar may perceive the target vehicle's speed as lower than the true speed.



CS - PS = TS
Actual Speeds 110 - 50 = 60 mph
Cosine Effect 100 - 50 = 50 mph

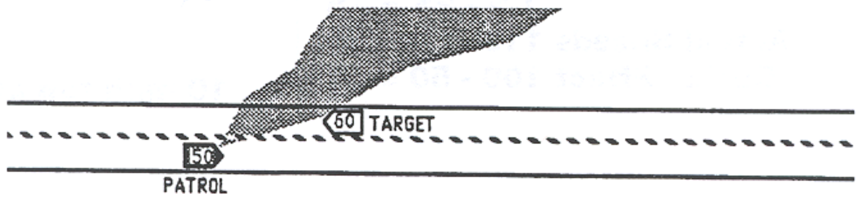
10 mph too LOW

In the moving mode, if the antenna is significantly out of alignment laterally with respect to the direction of travel of the patrol vehicle, then a reverse phenomenon will occur which may not be in favor of the motorist. The patrol speed Doppler cosine effect produced in this case will result in the readout module displaying a false patrol vehicle speed. The effect of improper antenna alignment is immediate and more significant on the patrol vehicle speed than on the target closing speed. The next two illustrations show a higher target

display reading than the true target speed resulting from patrol speed Doppler cosine effect.

Moving Example 3 (Patrol Speed Doppler)

The antenna is misaligned, causing a lower than actual patrol speed, which will add it to the target speed and result in a higher than actual target vehicle display reading.

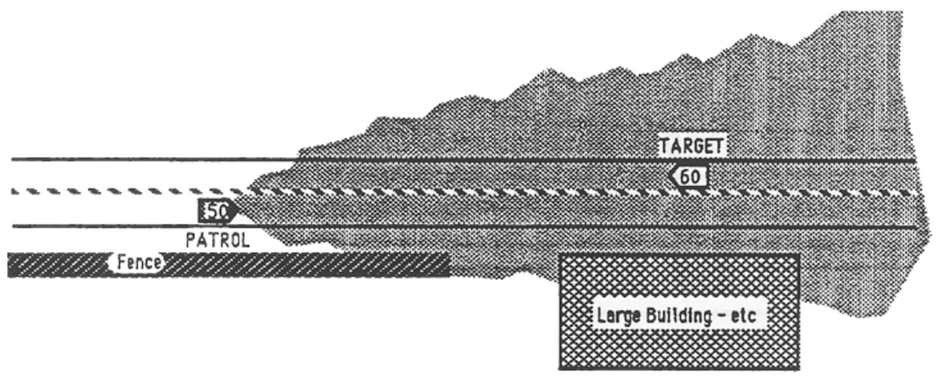


CS - PS = TS
Actual Speeds 110 - 50 = 60 mph
Cosine Effect 110 - 40 = 70 mph

10 mph too HIGH

Moving Example 4 (Patrol Speed Doppler)

The patrol speed is being picked up off the fence, rather than the roadway, which is causing a lower than actual patrol speed. The difference is added to the target speed, causing a higher than actual target vehicle speed display.



CS - PS = TS
Actual Speeds 110 - 50 = 60 mph
Cosine Effect 110 - 40 = 70 mph

10 mph too HIGH

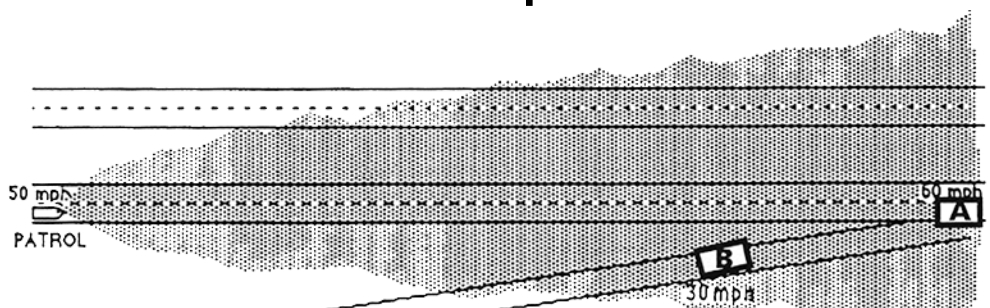
Patrol speed Doppler cosine effect is always detectable by comparing the patrol vehicle speed display with the calibrated speedometer. The patrol vehicle speed display will be lower than the calibrated speedometer reading.

To avoid the cosine effect in the moving mode, mount the antenna as close to straight ahead as is visibly possible, i.e., parallel to the line of travel of the patrol vehicle. Also, verify that the radar patrol speed display is consistent with the independently calibrated speedometer.

C. Cosine Effect — Moving Mode (Same Direction)

The next three examples illustrate variances in radar target speed displays involving same direction radar where target speed may appear to be higher than actual (target speed too high).

Same Direction Radar Example 1



Attempting to clock vehicle "A" in Faster mode, "B" is actually being clocked.

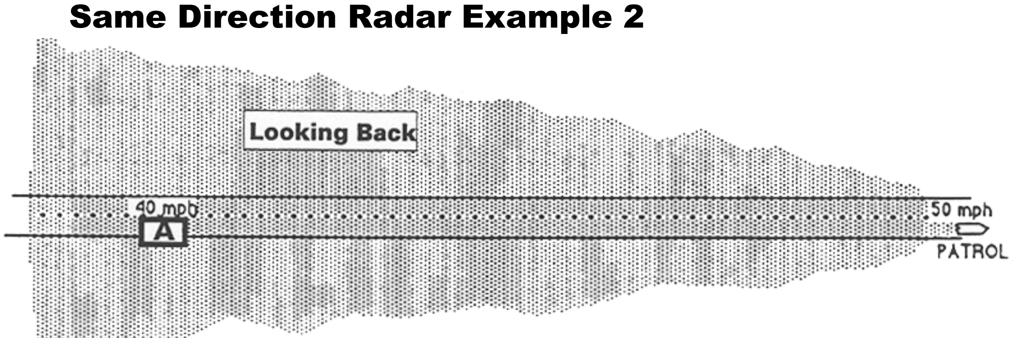
	PS + SS = TS
Actual Speeds:	**50 + 10 = 60 mph**
I.D. Problem:	**50 + 20 = 70 mph**

10 mph too HIGH

The above example illustrates a patrol vehicle traveling 50 mph and an intended target vehicle (A) traveling at 60 mph. The radar unit is positioned in the faster target vehicle mode. Therefore, the radar processes speeds using PS + SS = TS, or in this case, 50 mph + 10 mph = 60 mph.

However, in this example, Vehicle B has entered the operational area of the beam and is being processed as the target vehicle. B is traveling at 30 mph, and has a 20 mph separation speed in relation to the patrol vehicle. This would cause the radar to display a target speed of 70 mph (PS + SS = TS, or 50 mph + 20 mph = 70 mph.) To insure this is not occurring, simply vary the patrol vehicle speed by approximately (3 mph and verify that no corresponding change occurs in the target speed display.

Same Direction Radar Example 2



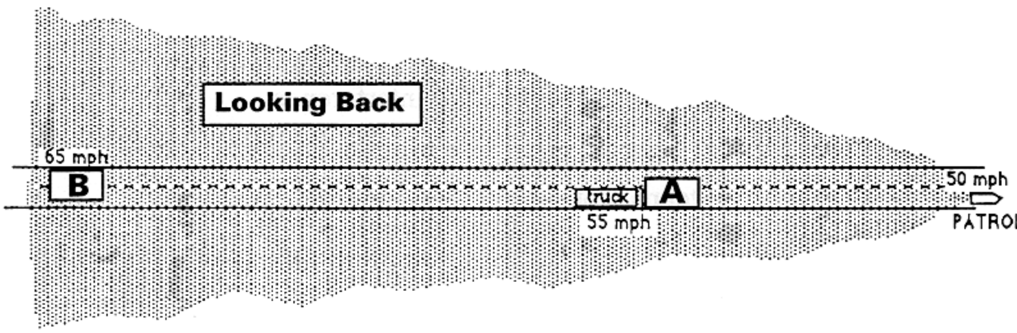
Attempting to clock vehicle "A" in faster mode, "A" is actually SLOWER than the patrol car.

	PS - SS = TS
Actual Speeds:	**50 - 10 = 40 mph**
Mode Problem:	**50 + 10 = 60 mph**

20 mph too HIGH

The same direction radar example 2 illustrates a patrol vehicle traveling 50 mph and an intended target vehicle (A) traveling at 40 mph behind the patrol vehicle in the same direction. The radar unit is incorrectly positioned in the faster target vehicle mode rather than the slower mode. Therefore, the radar processes the target vehicle's (A) speed using PS + SS = TS, or in this case, 50 mph + 10 mph = 60 mph, which is 20 mph too high.

Same Direction Radar Example 3



Attempting to clock vehicle "A" in faster mode, "B" is actually being clocked.

PS + SS = TS
Actual Speeds: 50 + 5 = 55 mph
I.D. Problem: 50 + 15 = 65 mph

10 mph too HIGH

The above example illustrates a patrol vehicle traveling 50 mph and an intended target vehicle (Truck A) traveling at 60 mph. The radar unit is positioned in the faster target vehicle mode. Therefore, the radar processes speeds using PS + SS = TS, or in this case, 50 mph + 5 mph = 55 mph.

However, in this example, Truck A has not been processed by the radar because Vehicle B's speed is very close to the patrol vehicle speed. Vehicle B, which is traveling at 65 mph, is processed by the radar. Vehicle B has a 15 mph separation speed in relation to the patrol vehicle. This would cause the radar to display a target speed of 65 mph (PS + SS + TS, or 50 mph + 15 mph = 65 mph).

To insure this is not occurring, simply vary the patrol vehicle speed so that the separation speed of the intended target vehicle and the patrol vehicle is at least 7 mph. Note that target vehicles traveling very close to the speed of the patrol vehicle may be ignored by some same-direction radar units.

D. Spurious Display Readings

Spurious displays are readings that appear when there is no target causing the reading. There are several causes for spurious displays, such as:

- Electrical interference. Spurious displays from this source are not reflected radar signals, but rather are outside or inside signals that may affect traffic radar, i.e., ignition systems, electronic displays, two-way radios, etc.
- Objects in motion other than the intended target vehicle, i.e., fans, etc.

- Outside interference, i.e., airport radar, neon/fluorescent/ mercury lights, high output radio transmission sources, etc.

Interference causing spurious displays should not be added to target vehicle speeds, i.e., a fan interference of 18 mph is not added to target vehicle speed. Interference is generally overridden by the stronger reflected signal from moving objects in the operational area of the radar.

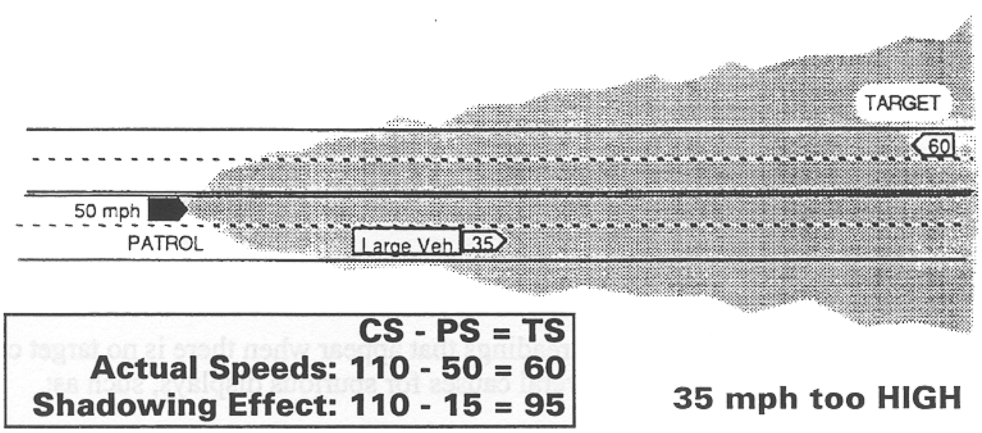
To avoid spurious displays:

- Avoid operation in known areas of interference.
- Avoid radio transmissions while actually tracking a potential violation.
- Adjust the antenna mounting so as to minimize interference.
- Use the radar instrument only as supportive evidence. Interference will lack the necessary elements to be considered a valid reading.
- Use the Doppler audio. Interference will lack the tone quality necessary to be considered a valid reading.

E. Shadowing Effect

The shadowing effect is a rare type of patrol speed Doppler cosine; the newer radar units are designed to minimize this effect. The shadowing effect may result when the traffic radar, in moving mode, fixes onto a large moving object traveling in the same direction as the patrol vehicle. This results in a lower than true speed for the patrol vehicle. Because the patrol vehicle speed is perceived lower than actual, this results in a higher than actual target speed display. (See example below.)

The shadowing effect generally requires significant difference in speed (10 mph or greater) between the radar and large moving object.



To avoid the shadowing effect:

- Verify that both the displayed patrol vehicle speed and actual patrol vehicle speed are the same at the time of the violation. They will not be the same if shadowing has occurred.
- Visually estimate target speed. Shadowing will generally result in extremely high target speed displays.

F. Batching Effect (Target Speed Bumping)

The batching effect results from the inability of some moving-mode radars to maintain a consistent patrol vehicle tracking speed when the patrol vehicle is subjected to sudden extreme changes in speed. The batching effect may cause high or low target speeds.

Today's moving-mode traffic radar instruments combat the batching effect by keeping up with these sudden changes; some radar instruments blank out the LED display if the change in speed is too severe.

G. Scanning Effect

The scanning effect allegedly occurs when the operator scans the horizon with a hand-held stationary radar instrument in a fast, sweeping action. This constitutes improper operation. Modern radar units are designed to minimize this effect. Technical experts have not been able to observe this effect in current radar devices.

To avoid the scanning effect, hold a hand-held radar instrument relatively steady to keep the target vehicle in the beam.

H. Panning Effect

The panning effect may occur when the radar beam is panned across the face of an electronic display, e.g., a watch, calculator, electronic dash displays, etc. This constitutes improper operation. If the electronic display is part of the readout module, the radar unit must be a two-piece model for the panning effect to occur. The panning effect may cause a spurious reading.

To avoid the panning effect, avoid aiming the radar antenna in the direction of the readout module or any other electronic display.

I. Conclusions

- Most of the above-mentioned effects influence the radar unit only momentarily.
- Many of these effects result from improper operation of the radar instrument.
- A properly certified radar operator and certified modern radar equipment minimize the likelihood of these effects occurring.

- If a complete and accurate tracking history exists and other supportive evidence corroborates the radar display, the above effects are negated.

6.7 Case Law Affecting Traffic Radar

Traffic radar is used primarily by traffic law enforcement to acquire evidence. To be used in court, this evidence must be ruled admissible. Two court rulings related to the admissibility of radar evidence are of primary interest in Michigan. The first establishes the validity of the Doppler Principle. The second helps ensure that the due process rights of the defendant are not violated. This case includes the issues of: the accuracy of a particular radar instrument, radar operator testimony, proper target identification, moving radar acceptance, and radar operator training. All of these issues have been previously addressed in separate court cases from around the country.

A. Validity of Doppler Principle

A traffic radar operator is not required to present scientific evidence to prove the validity of the Doppler Principle, because the Michigan Court of Appeals accepted the scientific reliability of the Doppler Principle in *People v Ferency*, 133 Mich App 526 (1984).

B. Due Process

The Michigan Court of Appeals ruled in *People v Ferency*, 133 Mich App 526 (1984*),* that in order to avoid any violation of due process rights of a defendant in a speeding case involving "moving" radar, seven guidelines must be met in order to allow into evidence speed readings from a radar speedmeter. The seven *People v Ferency* guidelines are:

1) The officer operating the device has adequate training and experience in radar operation.
2) The radar device was in proper working condition and properly installed in the patrol vehicle at the time the citation was issued.
3) The radar device was used on a road where there was a minimum possibility of distortion (spurious readings).
4) The input speed of the patrol vehicle was verified. This also means that the speedometer of the patrol vehicle was independently calibrated.
5) The speedmeter (radar) was retested at the end of the shift in the same manner that it was tested prior to the shift and the speedmeter (radar) was serviced by the manufacturer or other professional as recommended.
6) The radar operator was able to establish that the target vehicle was within the operational area of the radar beam at the time the reading was displayed.

7) The radar unit has been certified for use by an agency with some demonstrable expertise in the area.

This Court of Appeals ruling went on to state that these seven guidelines can be met by showing that the issuing officer followed the recommendations established by the Office of Highway Safety Planning (OHSP).

C. Interpretation of the *People v Ferency* Guidelines

The following discussion summarizes how the OHSP, through the Michigan Speed Measurement Task Force (MSMTF), has interpreted the seven *Ferency* guidelines:

1. **The officer operating the device has adequate training and experience in its operation.**

   Interpretation: The radar operator must have successfully completed a Michigan Commission on Law Enforcement Standards (MCOLES) approved operator training program. Effective 1/1/88, all Michigan radar operators must be certified by MCOLES. Periodic recertification may be required by MCOLES.

2. **The radar device was in proper working condition and properly installed in the patrol vehicle at the time of the issuance of the citation.**

   Interpretation: The radar device is in proper working condition and is properly installed if:

   - There is no AUTOLOCK feature.
   - There is no VIOLATOR WARNING (also known as SPEED ALERT).
   - It has a minimum of two windows for moving-mode operation.
   - It has the Doppler audio feature.
   - The antenna is fixed-mounted for moving-mode operation.
   - The antenna is held stationary for stationary-mode operation.
   - The verification tests, as outlined below in Guideline 5, were conducted on the radar device at the beginning and end of each shift.

3. **The radar device was used in an area where road conditions are such that there is a minimal possibility of distortion (spurious readings).**

   Interpretation: The Task Force recognizes that other potential sources for spurious readings exist in addition to those due to road conditions. For example, electrical and mechanical interference effects inside as well as outside the patrol vehicle may give rise to spurious speed display readings. However, the adequately trained operator knows how to differentiate between these spurious readings and bona fide target speed display readings.

4. The input speed of the patrol vehicle was verified. This also means that the speedometer of the patrol vehicle must have been independently calibrated.

Interpretation: The Michigan Speed Measurement Task Force recommends that a patrol vehicle's speedometer be calibrated for accuracy prior to initial speed enforcement use. Thereafter, the speedometer should be recalibrated only if the patrol vehicle has undergone any of the following:

– Transmission repair.

– Major body repair.

– Tire-size or wheel-size change.

Each of the following are accepted methods for calibrating the patrol vehicle's speedometer:

1) Time-distance method.
2) Dynamometer method.
3) Fifth wheel method.
4) LIDAR (laser speed measurement) device method. The speedmeter (radar) was retested at the end of the shift in the same manner that it was tested prior to the shift, and the speedmeter (radar) was serviced by the manufacturer or other professional as recommended.

5. The speedmeter (radar) was retested at the end of the shift in the same manner that it was tested prior to the shift, and the speedmeter (radar) was serviced by the manufacturer or other professional as recommended.

Interpretation: The tests to be conducted on the radar device at the start and end of each shift are as follows:

– Display Segment Test.

– Internal Circuit Test.

– Speed Display Tests.

– Audio Output Test.

6. The radar operator was able to establish that the target vehicle was within the operational area of the radar beam at the time the reading was displayed.

Interpretation: The target vehicle is considered to be within the operational area of the beam when this vehicle is within the normal operational range of the radar speedmeter, and there is an unobstructed straight line between the target vehicle and the front of the radar's antenna.

7. **The particular unit has been certified for use by an agency with some demonstrable expertise in the area.**

    Interpretation: All radar devices in use in Michigan must be certified by MSMTF; recertification is not necessary. As of March 1, 2000, each new radar device purchased for use in Michigan shall meet the standard as set by the International Association of Chiefs of Police.

Although the Court of Appeals ruling only addressed moving-mode radar operation, the MSMTF holds that these guidelines are applicable to both stationary and moving-mode usage.

6.8 Components of Radar Case Testimony

The following list of elements is used by the magistrate to assess the testimony given in a contested radar speeding matter. It is your responsibility to determine the validity and accuracy of the radar operator's testimony, establish a preponderance of the evidence, and render a fair and impartial decision.

A. Reliability of the Radar Device

In Michigan, the reliability of a radar device can be established with operator testimony that the unit was certified for use in Michigan by a procedure adopted by the Michigan Speed Measurement Task Force, *i.e.,* the individual unit had been tested and found to be in compliance with the International Association of Chiefs of Police radar procurement standards.

- If the radar device used is not certified or the operator is not certain as to the device's certification and the court has no record of the device's certification, then the radar speeding case against the defendant should be dismissed.
- If the radar device is certified, then either the magistrate or judge should have a copy of the certificate for the specific radar device on file or the radar operator should be prepared to present it as evidence.

The issue of whether the radar device was operating properly at the time of the test should be established with operator testimony that the device passed the verification tests at the beginning and end of the shift and through observation of the radar during normal operation. In addition, documentation of these tests may be required.

B. Radar Operator's Qualifications

The officer's qualifications to operate radar equipment for enforcement purposes are established by testimony that the officer is MCOLES State-certified as a "radar operator" at the time the speeding infraction occurred. Documentation may be presented at a hearing, i.e., a certification card.

C. Existence of a Valid Speed Limit

The question as to the speed limit in force at the time of the alleged speeding infraction is generally resolved with officer testimony. The officer simply testifies what the speed limit was at the location where the citation was issued. On occasion, a court may require a valid traffic control order or ordinance be presented to the court.

D. Jurisdiction

The court's authority to decide a matter requires that the speeding infraction occur within the court's jurisdiction. If jurisdiction is not established, the case may be dismissed. The complaining officer generally establishes jurisdiction with testimony that the location of the infraction was in the County of _____, Township of _____, or the City of _____ along with the specific highway location.

E. Reliability of the Specific Speed Reading Obtained

The court may require an officer to provide evidence showing the defendant's vehicle caused the radar readout to the exclusion of all other reasonably possible causes. Six points to assure that there was no violation of due process, and that the speeding infraction by the defendant did occur are as follows:

1) Was the radar device being operated in the stationary or moving mode?
2) Was the radar device being used in an area where road conditions or environmental conditions might lead to spurious target display readings due to RF interference effects, shadowing effects, cosine effects, etc.?
3) Was the target vehicle within the operational area of the radar beam when the speed reading was obtained?
4) Did the radar's Doppler audio output correlate with the radar operator's visual observations and estimation of the target vehicle's speed? Consider the following questions:
    - What led the radar operator to believe that this target vehicle was traveling at an excessive speed?
    - Was there a clear line of sight between the radar's antenna and the target vehicle?
    - If other vehicles were moving in the same direction, was this target vehicle moving at the same speed as the others? Or was it travelling at a higher or lower speed than the others?
    - Was the target vehicle the first to come over a hill or around a bend and into the operational area of the radar beam?
    - How long did the radar operator observe the target vehicle?
    - Was the target vehicle moving at a constant speed, speeding up, or slowing down?

5) Were the displayed target speeds consistent with the visual observations and with the Doppler audio output? If in the moving mode, did the patrol speed displayed by the radar device coincide with the speed displayed by the patrol vehicle's speedometer?

6) Was the patrol vehicle's speedometer independently calibrated using an acceptable procedure?

F. Federal Communications Commission Licensing Regulations (FCC)

On occasion there are some questions regarding FCC regulations and the operation of radar units. Individual law enforcement agencies do not need to have FCC licenses for individual radar devices. However, they do need to have a general license to operate their department's radio equipment, and this general license serves as the only license required to operate speed measuring radar devices which are classified as "radios" by the FCC.

G. Checklist of Key Elements

The key elements in radar case testimony revolve around the following points:

- ❑ Was the operator MCOLES-certified?
- ❑ Was the radar device certified for use in Michigan by a procedure adopted by the MSMTF?
- ❑ Was venue established?
- ❑ What was the speed limit in force at the time of the alleged speeding infraction?
- ❑ Was the radar device properly mounted or held while the target vehicle's speed was being determined?
- ❑ Was the operation of the radar device properly verified at the beginning and end of the shift?
- ❑ When the target's speed was displayed, was the target in the operational area of the radar device's beam?
- ❑ Was the target's speed determined in an area that is relatively free from interference (distortion) effects?
- ❑ Was the tracking history sufficient?
- ❑ If moving-mode operation was used, was the patrol speed displayed by the radar in agreement with the patrol vehicle's calibrated speedometer?
- ❑ If more than one target was in the operational area of the radar device's beam, was the target vehicle properly identified?

6.9 Review/Instructional Activities

A. Questions

Please answer the following questions, and correct your answers against the answer key in Section 6.10. Look back in the materials to find answers to any questions you did not understand.

1. Rain, snow or fog will not affect the accuracy of a radar instrument, but may affect a radar operator's ability to obtain an adequate tracking history.

   a. True b. False

2. The Michigan Speed Measurement Task Force does not recommend the use of tuning forks for verifying that the radar device is in proper working condition.

   a. True b. False

3. An FCC license is not required for radar devices; each agency is only required to have a general license to operate their department's radio equipment.

   a. True b. False

4. A basic computation involved in using an opposite-direction moving-mode radar is:

   a. Target Speed = Patrol Speed minus Closing Speed.

   b. Target Speed = Patrol Speed plus Closing Speed.

   c. Target Speed = Closing Speed minus Patrol Speed.

   d. Target Speed = Ground Speed minus Patrol Speed.

5. A basic computation involved in using a same-direction moving-mode radar for a faster target is:

   a. Target Speed = Patrol Speed minus Separation Speed.

   b. Target Speed = Patrol Speed plus Separation Speed.

   c. Target Speed = Closing Speed minus Patrol Speed.

   d. Target Speed = Ground Speed minus Patrol Speed.

6. The reliability of a specific radar instrument is established through judicial notice.

   a. True b. False

7. A record of the date and time the radar unit was verified as operable should be maintained for possible use in court.

   a. True b. False

8. With experience and proper training, it is possible to be lane selective in determining the speed of target vehicles; i.e., the beam can be aimed so as to detect only vehicles in one particular lane of traffic.

   a. True b. False

9. Which of the following is not an element of a moving-mode tracking history?

   a. Visual estimate of speed.

   b. Manually locking in the target speed display.

   c. Verification of displayed patrol speed with speedometer.

   d. All of the above.

10. The Michigan Speed Measurement Task Force recommends that the patrol vehicle speedometer be independently calibrated at least once a year.

    a. True b. False

11. The guidelines in *People v Ferency* do not apply to stationary radar use as interpreted by the Michigan Speed Measurement Task Force.

    a. True b. False

12. Which of the following is required by the *People v Ferency* decision?

    a. The radar operator must have adequate training.

    b. The radar was certified for use in Michigan.

    c. The target vehicle was within the operational area of the beam.

    d. All of the above.

13. Unless a second target speed display window is present, manually locking in the target vehicle speed is:

    a. Recommended by the Michigan Speed Measurement Task Force so that the motorist can be shown the speed upon request.

    b. Not recommended by the Michigan Speed Measurement Task Force since the tracking history is interrupted preventing any further radar evidence.

    c. Required by case law.

    d. None of the above.

14. The guidelines given in the Court of Appeals decision *People v Ferency* must be followed in order to ensure that due process is not violated in a radar speeding case.

    a. True b. False

15. In an informal hearing that involves a radar speeding case, the magistrate may ask the radar operator for proof that the radar device was certified as determined by the Michigan Speed Measurement Task Force.

    a. True b. False

16. The Michigan Speed Measurement Task Force does not recommend that specific radar devices be recertified because:

    a. Radar devices never go bad.

    b. It is acceptable practice to use a radar device that is not in proper working order.

    c. A properly trained radar operator will be able to determine whether or not a certified radar device is in proper working order.

    d. None of the above is true.

17. Which of the following statements is false? The Michigan Speed Measurement Task Force recommends that:

    a. All radar devices used in Michigan be certified.

    b. All radar devices be recertified.

    c. All radar operators be certified.

    d. All radar operators be recertified.

6.10 Answer Key

A. Answers to Questions

1. a
2. a
3. a
4. c
5. b
6. b
7. a
8. b
9. b
10. a
11. b
12. d
13. b
14. a
15. a
16. c
17. b

Before you go to the next unit, turn to the first section of this unit and review the instructions. Make sure you have completed each step before moving on to Unit 7.