



U.S. Department  
of Transportation  
**National Highway  
Traffic Safety  
Administration**

# Basic Training Program in RADAR Speed Measurement

---

## Instructor's Lesson Plan





U.S. Department  
of Transportation

**National Highway  
Traffic Safety  
Administration**

# **Basic Training Program in RADAR Speed Measurement**

---

## **Instructor's Lesson Plan**

## Foreword

The National Highway Traffic Safety Administration (NHTSA) is responsible for developing training programs responsive to the Uniform National Standards established by the Highway Safety Act of 1966. These programs provide guidelines and exemplary instructional materials for agencies and individuals charged with implementing traffic safety training on the State or local level. The NHTSA identifies those training areas that offer the greatest potential traffic safety benefit. The training programs that NHTSA develops are compatible with local adaptation and use.

RADAR speed measurement is a high-priority training need. Excessive speed is a major cause of motor vehicle accidents, deaths, and injuries. Effective regulation of speed through rigorous enforcement and other control mechanisms can result in enormous benefits through lives saved and injuries prevented. This fact was demonstrated with special clarity during the fuel shortage of the early 1970's: The numbers of traffic deaths declined significantly as drivers reduced their speed.

Today, drivers do not seem as strongly motivated to conserve; the number of speeding vehicles is again on the rise. This places a correspondingly greater demand on the proper enforcement of speed limits. State, county, and local police officers responsible for speed control must be well versed in speed measurement. Without accurate speed measurement, it is difficult to catch speed violators and even more difficult to secure the convictions that can deter future violations.

The NHTSA has developed two separate but closely related programs of instruction in order to present this material. The first program, which is the subject of this Manual, focuses exclusively on RADAR speed measurement. The second covers all non-RADAR methods and devices.\*

RADAR technology has been applied to speed measurement and enforcement for more than 30 years. Now more than ever before, however, police officers need extensive and sophisticated training in order to be able to operate RADAR accurately and in full compliance with evidentiary requirements. This model training program is designed to serve that need, and ultimately to improve traffic safety in America.

---

\* *Basic Training Program in Time-Distance Speed Measurement*

# Preface

This *Instructor's Lesson Plans Manual* was prepared to assist the teacher(s) of the basic course in RADAR speed measurement. The goal of this course is to improve the effectiveness of speed enforcement through the proper and efficient use of RADAR speed measurement devices.

Sound enforcement decisions and successful prosecution of speed violations depend upon the officer's having measured the violator's speed accurately. RADAR technology represents only one method for obtaining these accurate measurements; but it is an especially important method, since in recent years RADAR devices have become increasingly convenient and cost-effective.

Both instruction and training are required to ensure the proper use of RADAR equipment. Training must address the operation of the specific RADAR instrument used by a trainee's agency. Each trainee must learn the purpose of his or her instrument's switches, displays, and components. The trainee must learn how to set up the instrument, how to test it, and how to operate it in the field. Ample hands-on practice is needed to acquire operating skill, not just knowledge.

Instrument-specific training forms a substantial portion of this course, but the focus of the course extends well beyond the particular RADAR instruments. Speed enforcement involves much more than mere RADAR operation. It also demands that the officer know and understand the association between speed violations and traffic safety, and, especially, the enormous contribution of excessive speed to fatal injuries. This knowledge and understanding provide the *motivation* that a traffic officer must have in order to do an effective job.

Speed enforcement also demands a thorough knowledge of the laws and regulations governing motor vehicle speed. No officer can adequately enforce the law unless he or she *knows* the law. This means knowing the elements of offense that have to be established before an officer may accuse someone of a speed violation.

It also means knowing what evidence bears on each element and how this evidence can be collected. It is important that the officer know how to organize and present testimony in court. It is true that only a small percentage of accused speed violators contest their charges; but some do, and the officer must be prepared in case an accused speeder does go to court. It is certainly part of the officer's speed enforcement job to collect and prepare evidence in each case as thoroughly and carefully as if each case were definitely going to court.

Since speed enforcement entails RADAR operation, it is important that the officer have some understanding of the scientific principles and theory on which this technology is based. This is necessary to give the operator confidence in the equipment and the willingness and motivation to use it. The officer must also understand what factors limit RADAR's accuracy and effectiveness so that she or he can put

into practice operating procedures that circumvent or minimize these factors.

Thus, comprehensive training in speed enforcement is necessary. This training must properly emphasize hands-on RADAR instrument operation, but not at the expense of other needed skills and knowledge. The goal of this course will be achieved if each trainee can:

- Describe the association between excessive speeds and accidents, injuries, and deaths as well as the highway safety benefits of effective speed control.
- Describe the basic principles of RADAR speed measurement.
- Demonstrate basic skill in testing and operating the specific RADAR instrument(s).
- Identify the specific RADAR instruments used by the trainee's agency and describe the instrument's major components and functions.
- Identify and describe the laws, court rulings, regulations, 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.

Trainees are expected to meet these objectives; it is up to the instructor to conduct the course so that they do. In order to do this, the instructor must thoroughly understand the subject matter. The instructor assigned to teach Unit 5 and/or Unit 7, for example, must be skilled in the setup, inspection, testing, and operation of the RADAR units used by the trainees' departments. Likewise, the teacher of Unit 4 and/or Unit 6 must be both familiar with all laws and court decisions affecting speed enforcement and experienced with the adjudication of speed violations.

This *Instructor Lesson Plans Manual* does not provide the teacher who is unfamiliar with RADAR speed measurement or enforcement with the necessary background knowledge, skills, or experience. Should a qualified instructor need to refresh his or her memory on any point, references accompany each unit; but an instructor will not be able to use this manual effectively, however, without solid background in the subject matter. Expertise is required.

The instructor must also know how to teach. A wide variety of instructional methods—lecture, skill demonstration, simulation, role-playing, and others—are required during the teaching of this course. The instructor must be able to use various teaching aids effectively and to evaluate the trainees' performance and understanding of the subject matter. This *Instructor's Lesson Plans Manual* does not, and could not, give teaching skills to those who do not possess them.

This Manual, then, does not provide expertise in either subject matter or teaching techniques. What

does it provide? Principally, it provides the lesson plans around which the course is organized. These lesson plans consist of detailed teaching notes that the instructor may use to conduct each unit. The notes are divided into two parts: the course content (or subject-matter outline) tells what is to be taught; the techniques outline tells how it is to be taught and how much time is to be spent in the teaching. This Manual frees the instructor from preparing teaching notes from scratch while providing the basis for a standard course. It guarantees that no matter who does the teaching, the same topics will be covered in essentially the same way.

Training can be standardized, however, without being rigidly restrictive. It is intended that the lesson plans in this Manual be tailored to the training requirements of individual departments and to the teaching styles of individual instructors. The course developers have made the plans suitable to the general training needs of any law enforcement agency, rather than attempting to meet the specific needs of every department. Trainees from one department may already be well versed in some topics but less knowledgeable in others, depending on their previous experience and training. Tailoring the lesson plans to such a class, for example, could require deleting or substantially shortening certain lessons and devoting additional time and attention to others.

Major portions of this course are devoted to operational *procedures*—those methods prescribed by individual police departments for setting up and testing RADAR units, preparing written records and testimony, etc. Obviously this Manual's lesson plans can offer only general coverage of these topics; input by the instructor will be necessary to ensure that the exact procedures established by the local department are taught.

Other opportunities for adaptation will be found in those segments of the lesson plans dealing with traffic safety statistics and key court decisions affecting RADAR speed measurements. The lesson plans for these segments are national in scope: The statistics provided reflect nationwide trends and the cases cited have established significant national precedents. It is also important that local and regional statistics and court rulings should be included for the sake of relevance and credibility. The trainees, after all, will be doing their speed enforcement work in some particular city, county, or State. The instruction the trainees receive should cover thoroughly the peculiarities of their own jurisdiction if the trainees are to be adequately prepared to face their own speeders.

Each instructor has a wealth of personal experience to bring to this course, as well as strengths and weaknesses as a teacher: a particular "style." The instructor will naturally wish to add this experience and style to the lesson plans, and should do so. The instructor, after all, is the one who has to use the plans. It is hoped that every instructor will find these lesson plans not only useful but useable, and to this end modifications are encouraged.

From the instructor's viewpoint, then, the lesson plans should be thought of as "first drafts." They contain all the material that is essential to conduct

every lesson. What they lack are the finishing touches, the slight modifications of content, emphasis, and style that will enrich the lessons and provide more than just puppet words. These modifications will not change the training objectives, but will make it easier for each instructor to help each class of trainees achieve them. It is up to each instructor to add his or her own finishing touches.

The instructor's first task is to prepare or obtain the instructional aids to be used. Illustrations suitable for conversion into overhead transparencies or handouts follow Units 1, 2, 4, and 6 of this *Instructor's Lesson Plan Manual*. In addition, a full set of 35mm slides is available for use with Unit 3, "Basic Principles of RADAR Speed Measurement." The illustrations and 35mm slides are numbered to indicate exactly where in the unit they may be used.

It is the instructor's responsibility to determine what instructional aids to use for each lesson. All, some, or none of the supplied visual aids can be used; aids acquired from other sources can be used as well. An instructor might even elect to prepare his or her own homemade audiovisuals. Any approach is acceptable if the instructional aids contribute to the lesson.

The course requires three full (8-hour) training days, or the equivalent. A suggested schedule appears on page vii. That schedule allows for classroom training, hands-on field practice with the devices, and a period of moot court practice testimony and cross-examination.

This schedule shows a number of break periods at natural division points in the material. The instructor is expected to provide breaks during the lengthier Units 6 and 7 as it is convenient to do so.

The suggested schedule indicates that at least some preparation for the moot court will be required as homework at the end of the second day. If this is not possible, it is suggested that the first part of Unit 6 be scheduled an hour earlier in the second day and that the instructor allow case preparation time during class. An hour of the hands-on field practice shown for Unit 7 would then be forfeited. The instructor could, alternatively, leave the second day's schedule intact and allow an hour at the beginning of the third day for case preparation; in that case, an hour of active moot court would be lost.

The exact schedule for any presentation of this training will, of course, reflect the specific needs of the trainees, the emphasis required by the individual agency, and the practical considerations of trainee and facility availability. Conceivably, training could be divided into hour-long sessions if that would suit an agency's schedule. Whatever other considerations affect the schedule, three factors should be emphasized:

- The units must be presented in a logical sequence.
- The whole course must be given in a reasonably compact period of time to retain the flow of the material.
- Each unit must be allocated enough time for effective presentation.

Figure 1

# A Suggested Course Schedule

FIRST DAY	SECOND DAY	THIRD DAY
0800 UNIT <b>1</b> Introduction; Pretest	0800 UNIT <b>4</b> Legal and Operational Considerations (General Operation Procedures) Unit 4 Review/Summary	0800 UNIT <b>6</b> Moot Court
<i>10-minute break</i>		
0900 UNIT <b>2</b> Speed Enforcement in Relation to Highway Safety; Types of Speed Offenses; Unit 2 Review/Summary	0900 UNIT <b>5</b> Operation of Specific RADAR Instruments; Classroom Segment	
<i>10-minute coffee break</i>		
1000 UNIT <b>3</b>	1000 UNIT <b>7</b> Operation of Specific RADAR Instruments; Hands-on Practice	
<i>10-minute break</i>		
1100 UNIT <b>3</b> Basic Principles of RADAR Speed Measurement	<i>(Breaks as appropriate)</i>	<i>(Breaks as appropriate)</i>
<b>1200 LUNCH BREAK</b>		
1300 UNIT <b>3</b> Continued	1300 UNIT <b>7</b> Operation of Specific RADAR Instruments; Hands-on Segment (continued)	1300 UNIT <b>8</b> Post-test
<i>10-minute break</i>		
1400 UNIT <b>3</b> Continued		1400 UNIT <b>8</b> Course Summary
UNIT <b>3</b> Review/Summary	<i>(Breaks as appropriate)</i>	<i>10-minute break</i>
<i>10-minute coffee break</i>		
1500 UNIT <b>4</b> Legal and Operational Considerations (RADAR Case Law)	1500 UNIT <b>6</b> Introduction to Moot Court Sample Case; Case Assignments*	1500 UNIT <b>8</b> Course Closing Remarks and Trainee Evaluation of Instructors and Content

*The Trainee Instructional Manual* that is part of the RADAR training package is the text of the course. It includes the basic content required for each of the classroom units.

- Unit 1. Introduction
- Unit 2. Speed Offenses and Speed Enforcement
- Unit 3. Basic Principles of RADAR Speed Measurement
- Unit 4. Legal and Operational Considerations
- Unit 5. Operation of Specific RADAR Instruments
- Unit 6. Moot Court

Unit 5 in the *Trainee Instructional Manual* relates to specific instructions for testing and operating the particular RADAR units used by the trainees' department. This segment of the course must be developed directly from the manufacturer's instruction manual for that RADAR. Many makes and models of police traffic RADAR are available and used in the field. All are equipped with a number of options and features and are continually being improved by the manufacturers. Thus it is impossible to provide the instructor with a complete set of training materials that would apply to every RADAR device currently in use. A suggested format for preparing a set of instructions for a typical two-piece RADAR device is provided in both the *Trainee Instructional Manual*

and *Instructor's Lesson Plans*. The instructor must prepare and present to the trainees a set of specific instructions for the operation of each RADAR device used in class. *It is not advisable to assign the reading of the manufacturer's materials to the trainee as a substitute for this task.*

Not all of the material supplied for this course will be presented every time the course is given. Each instructor must review the *Trainee Instructional Manual* and edit and revise it to meet the individual needs of the trainees' agency. The next step would be for the instructor to read each relevant unit of the *Trainee Instructional Manual* and to supplement and enrich the material in class with his or her own first-hand knowledge and other sources.

While preparing for this course, the instructor should decide exactly how to use the *Trainee Instructional Manual* classroom presentations. Ideally, the Manual will be distributed to the trainees for a preliminary reading well before the first class meeting is held. During the course presentation, the instructor may want to refer to specific items noted in the lesson plans. The trainees are to be encouraged to reread parts of the manual, perhaps as homework assignments, if the instructor deems it necessary.

The instructor should be thoroughly familiar with the contents of the Manual, but should not restrict classroom presentation to its contents.

# Contents

	<b>Page</b>
Unit 1	
Overview and Introduction.....	1-1
Unit 2	
Speed Offenses and Speed Enforcement.....	2-1
Unit 3	
Basic Principles of RADAR Speed Measurement.....	3-1
Unit 4	
Legal and Operational Considerations.....	4-1
Unit 5	
Operation of Specific RADAR Devices: Classroom Segment.....	5-1
Unit 6	
Moot Court.....	6-1
Unit 7	
Operation of Specific RADAR Devices: Field Practice Segments.....	7-1
Unit 8	
Course Summary.....	8-1

# Unit 1

## Overview and Introduction

*Total Time:*  
*50 minutes*

---

### Objectives

Provide sufficient information for the trainee to:

- Describe the objectives of the basic course in RADAR speed measurement.
- Describe the technical scope and schedule of the course.

Execute course administrative procedures:

- Instructor introduction.
- Trainee introduction.
- Enrollment forms, etc.
- Other administrative matters.
- Execute the pretest.

### Requirements

Handout Materials:

- Trainee Instructional Manuals (one per trainee and instructor). *NOTE:* If practical, it is preferable that these manuals be issued to trainees approximately 2 weeks before the course to permit the trainees to preview the material.
- Course enrollment forms (if applicable).

Suggested Illustrations:

- Statement of overall course goal.
- List of specific training objectives.
- Course schedule and content.

### Instructor Tasks

The instructor must be familiar with the structure and contents of this unit, which contains the following segments:

1. Introduction (5 minutes).
2. Overall Course Goal (5 minutes).
3. Specific Training Objectives (7 minutes).
4. Course Content and Schedule (8 minutes).
5. Administrative Matters (10 minutes).
6. Pretest (15 minutes).

The lesson plans prepared for "Course Content and Schedule" presume that all eight units will be presented without major modifications. If whole units or parts of units are deleted or substantially reduced, or if additional material is inserted, the instructor must revise the lesson plans for this offering of the course to reflect those modifications.

The instructor must prepare or obtain all visuals and instructional aids specified in the lesson plans. Feel free to use any additional instructional aids that will enhance learning.

If trainee enrollment forms, pretests, or similar forms are required, the instructor must obtain enough copies of each form and have them available for distribution during the final segment of this unit.

The instructor must prepare the *Trainee Instructional Manual* for distribution and see that the material provided under Unit 5 applies to the specific RADAR instruments for which students are to be trained. Any supplemental information obtained from local sources should be inserted into the Manual before it is distributed to trainees.

The instructor must obtain notebooks, writing instruments, and any other supplies to be issued to trainees.

# Unit 1 – Contents

---

## Introduction

**“Welcome to the Basic Course in RADAR Speed Measurement:**

- “The overall goal is for you to become more effective in detecting and apprehending speed violators.
  - “This will be accomplished by training you to operate police traffic RADAR.”
- 

## Instructor Introduction

- Principal Instructor(s) [name, relevant background, etc.]
  - Instructor’s Aide(s) [name, etc.]
- 

## Trainee Introduction

- Names.
  - Departments/districts represented.
  - Relevant experience.
- 

## Trainee Instructional Manual

- Basic reference source for the trainee.
  - Contains extensive information on the topics to be covered.
  - Will serve as a valuable reference after course is completed.
- 

## Unit Title and Objectives

- Unit Title—“Overview and Introduction”
  - “This is the first of [specify number] units, or lessons, that constitute the course.
  - “The purpose of this unit is to ‘set the stage’ by previewing what we hope to cover and accomplish.”

# Unit 1 – Notes

---

*Introduction*  
*Approximate time required:*  
*5 minutes.*

*Welcoming remarks.*

---

*Name(s) on chalkboard or*  
*flip-chart.*

---

*Have trainees briefly*  
*introduce themselves if*  
*diverse departments,*  
*districts, or backgrounds are*  
*represented. If the class*  
*members know each other*  
*already (i.e., same*  
*department, similar levels of*  
*experience), it is possible to*  
*dispense with Trainee*  
*Introduction.*

---

*Trainee Instructional*  
*Manuals should ideally have*  
*been distributed 2 weeks*  
*prior to the first class; in*  
*which case, make sure each*  
*trainee still has his or her*  
*copy and issue replacements*  
*if necessary. If the Manuals*  
*have not yet been*  
*distributed, do so now.*

---

*Unit title on chalkboard or*  
*flip-chart.*

*Indicate the number of units*  
*to be conducted during this*  
*offering of the course.*

---

---

---

---

---

# Unit 1 – Contents

---

- *Unit Objectives*
  - Describe the objectives of the course.
  - Describe the technical scope and schedule.
  - Complete certain administrative requirements.

---

## Unit Content

- State the overall goal of the course and review the relationship of RADAR speed measurement to that goal.
- State the specific training objectives, i.e., exactly what will be expected of each trainee upon completion of the course.
- Preview the material that will be covered in subsequent units.

---

## Overall Course Goal

### Statement of Overall Goal

- "To improve the effectiveness of speed enforcement through the proper and efficient use of RADAR speed measurement instruments."
- The purpose of improved speed enforcement is *to prevent accidents, save lives, and reduce injuries*:
  - As speed increases, the risk of having an accident also increases.
  - As speed increases, the severity of accidents also increases.
  - The numbers of fatalities decrease when speeds are lowered.
- To improve the effectiveness of enforcement, we must:
  - Observe more speeding violations.
  - Apprehend more violators.
  - Secure more convictions.
- Achieving these goals will secure better compliance with speed laws, will lead to a safer average speed on our roads, and will ultimately mean fewer accidents, deaths, and injuries.

# Unit 1 – Notes

---

*Unit Objectives.  
Refer trainees to list of Unit  
1 objectives in the Trainee  
Instructional Manual*

---

*Relate content to the unit  
objectives.*

---

*Approximate time required:  
5 minutes.  
(Prior elapsed time: 5  
minutes.)*

*Write on chalkboard or  
flipchart:  
"Prevent accidents—save  
lives—reduce injuries."*

*Write on chalkboard or flip-  
chart:  
"Better observation—more  
apprehensions—more  
convictions."*

*Write on chalkboard or flip-  
chart below the preceding  
display:  
"Lead to better compliance  
and safer speeds."*

# Unit 1 – Contents

---

## **The role of RADAR in Speed Enforcement (Discussion)**

- To detect a speeding violation, some means of measuring a vehicle's speed is needed.
- RADAR provides one method of measuring speed:
  - It is not the only method,
  - But it is a useful and effective method.
- The key point is that RADAR is used as a means to an end:
  - “We don't want to train you to become simply RADAR operators,
  - “We want to train you to become *better speed enforcers.*”
- To be effective speed enforcers, traffic officers must do many things besides operating RADAR units.

---

## **Specific Training Objectives**

**“The course is designed to achieve specific training objectives:**

- “Each objective expresses what will be expected of you once the course is completed.
- “If you can do these things, you should do an effective job in speed enforcement.”

---

## **Specific Objectives**

**“There are six things you should be able to do once we are finished here:**

1. “Describe the association between excessive speed and accidents, deaths, and injuries, as well as the highway safety benefits of effective speed control.
2. “Describe the basic principles of RADAR speed measurement.
3. “Identify and describe the laws, court rulings, regulations, policies, and procedures affecting RADAR speed measurement and speed enforcement in general.



# Unit 1 – Contents

---

4. “Identify the specific RADAR instrument(s) used by your department and describe their major components and functions.
5. “Acquire and demonstrate basic skills in testing and operating the specific RADAR instrument(s).
6. “Acquire and demonstrate basic skills in preparing and presenting records and courtroom testimony relating to RADAR speed measurement and enforcement.”

---

## Course Content and Schedule

In addition to this introduction, the course consists of seven other units:

- Unit 2—Speed Offenses and Speed Enforcement:
  - Speed in relation to highway safety.
  - Origin, development, and types of speed regulation.
  - Benefits of speed regulation (especially safety benefits).

# Unit 1 – Notes

*department's policy, and that the trainees must know the elements of the offense with which they are dealing before enforcement action can be taken.*

*4. The trainees first must learn what the various switches, pushbuttons, etc., are for before they can use their RADAR instrument.*

*5. Although RADAR is fairly easy to handle, some practice is required before an operator is skillful enough to use it accurately and meet the court's requirements.*

*6. The officer's responsibility doesn't end with issuing a speeding citation; the charge must stand up to help bring about better compliance with speed laws. Although few speeding citations are adjudicated in court, an officer must always prepare evidence and testimony because a court appearance is always possible.*

*Approximate time required:  
8 minutes.*

*(Prior elapsed time: 17  
minutes.)*

*Project slide 2.*

*Point out that:*

*Unit 2 will address the  
necessity of speed*

# Unit 1 – Contents

---

- Unit 3—Basic Principles of RADAR Speed Measurement:
  - Origin and brief history of RADAR.
  - Fundamental concepts (wave concept and Doppler Principle).
  - Principles of stationary RADAR.
  - Principles of moving RADAR.
  - Target identification factors.
  - Factors affecting RADAR.
- Unit 4—Legal and Operational Considerations:
  - Laws, policies, and case law affecting RADAR speed measurement.
  - Instrument licensing, certification, and maintenance.
  - General operating procedures.
  - Case preparation and testimony.
- Unit 5—Operation of Specific RADAR instruments:
  - Instrument components and their functions.
  - Basic operating steps.
  - Operational demonstrations.
  - Hands-on practice.
- Unit 6—Moot Court:
  - Preparation of testimony for sample court cases involving speed enforcement.
  - Presentation of testimony.
  - Cross-examination.
  - Critique.
- Unit 7—Operation of Specific RADAR Instruments:
  - Hands-on practice.
- Unit 8—Course Summary:
  - Review of topics covered.
  - Trainee evaluation.
  - Course evaluation.

# Unit 1 – Notes

---

*enforcement in relation to the job the trainee is being taught to perform.*

*Unit 3 will not make the trainees scientists or technical experts in the design of RADAR. It will help them understand how RADAR works and why they can have confidence in it as a law enforcement tool. It is not enough to know how to turn RADAR on and measure a vehicle's speed. In Unit 4 the trainees will learn how to operate the instrument in strict compliance with all applicable rules and regulations and how to obtain, document, and present all evidence to ensure its relevance and admissibility in court.*

*In Unit 5 the trainees will become familiar with the particular RADAR device(s) they will later use on patrol.*

*In Unit 6 each trainee will have an opportunity to prepare testimony for a sample case. Trainees will subsequently observe or participate in case presentations, cross-examinations, and critiques of their testimony.*

*In Unit 7 the trainees will get practical hands-on training in RADAR operation and begin to develop the necessary skills for effective speed enforcement.*

*In Unit 8 the trainees will demonstrate what they have*

# Unit 1 – Contents

---

Schedule of units, breaks, lunch, etc.

---

## Administrative Matters

Trainee enrollment forms.

Point out locations of cafeteria, rest rooms, etc.

Solicit trainees questions concerning course procedures or the contents of this unit.

Administer pretest.

# Unit 1 – Notes

---

*learned and comment on the course itself. Emphasize that they must achieve all the performance objectives in order to qualify for a RADAR operator certificate that is scheduled for this offering of the course.*

---

*Approximate time required: 25 minutes.  
(Prior elapsed time: 25 minutes.)*

*Distribute whatever forms the trainees must complete for the documentation of this course. Make sure the trainees are comfortable with the class environment and that they understand the course procedures and contents of this unit. If you are pretesting the level of knowledge and skills, administer the pretest.*

# Unit 2

## Speed Offenses and Speed Enforcement

Total Time:  
50 minutes

---

### Objectives

Provide sufficient information for the trainee to be able to:

- Describe the association between speed offenses and motor vehicle accidents and injuries.
- Describe the major types of speed regulations, including the origin, development and scope of these regulations.
- Describe the safety benefits of effective speed enforcement in general and the 55 mph limit in particular.

### Requirements

References:

- Fisher, Edward C. (Reeder, R., revision author), *Vehicle Traffic Law*. Revised Edition, 1974, Northwestern University Traffic Institute (1974).
- *Speed Offenses*. Northwestern University Traffic Institute (1966).
- Roper, W. L. "Why Traffic Control is a Must," *California Highway Patrolman*, Vol. 39, No. 8; pp. 23-25, 28-29, 32-33 (October 1975).
- Cerrelli, E. C. *Safety Consequences of Raising the National Speed Limit From 55 mph to 60 mph*. Report No. DOT-HS-802-382. U.S. Department of Transportation, Secretary of Transportation (October 1977).
- Adams, Brock. *Report to the President on Compliance with the 55 mph Speed Limit*. U.S. Department of Transportation, Secretary of Transportation (October 1977).
- *55 mph Fact Book*. U.S. Department of Transportation, National Highway Traffic Safety Administration (1979).

### Illustrations

- Stopping distance as a function of vehicle speed.
- Association between speed and crash likelihood.
- Association between speed and fatality likelihood.
- Historical trends in vehicle speed and motor vehicle fatalities.
- Safety implications of motor vehicle speeds.
- Safety benefits of 55-mph enforcement.
- Definition and elements of Basic Speed Law.
- Concept of *prima facie* speed limits.
- Concept and elements of absolute speed law.

### Instructor Tasks

The instructor must be familiar with the structure and contents of this unit, which contains the following segments:

1. Introduction (5 minutes).
2. Speed in Relation to Traffic Safety (10 minutes).
3. Speed Enforcement in Relation to Traffic Safety (10 minutes).
4. Types of Speed Offenses (15 minutes).
5. Review and Summary (10 minutes).

The instructor must be familiar with the speed regulations, statutes, and ordinances and the department policies that are in force within the trainees' jurisdictions(s) and must be prepared to relate these regulations, statutes, etc., to the major types of speed regulation covered in this unit.

The instructor should obtain the most recent regional and national data available on average traffic speeds and motor vehicle accidents and fatalities. The information provided in the Manual is from the spring of 1979 and may be out of date as you prepare to conduct the course. Updated information will enhance the relevance and credibility of your presentation and can be found in publications of the U.S. Department of Transportation, the National Safety Council, and State departments of public safety, motor vehicles, etc.

The instructor should review the listed references and similar sources of technical information to refresh and expand his or her knowledge of this unit. The instructor should augment the lesson plans, as appropriate, using information drawn from these references and personal experience.

The instructor must prepare or obtain all visuals and instructional aids specified in the lesson plans, as well as any additional instructional aids that will enhance learning.



## Unit 2 – Contents

---

### Introduction

#### Unit Title and Objectives:

- Unit Title—“Speed Offenses and Speed Enforcement.”
- Unit Objectives:
  - Describe the role of speed offenses, motor vehicle accidents, fatalities, and injuries.
  - Describe types of speed regulations and their origins, development, and scope.
  - Describe the benefits of effective speed enforcement.

---

#### Unit Content:

- Examine the evolution of increased motor vehicle speed and the related evolution of highway accidents.
- Examine how effective speed enforcement has helped diminish the number of highway accidents and lessen their consequences.
- Examine the need for continuing effective enforcement.
- Examine types of speed offenses and their elements.

---

### Speed Relation to Traffic Safety

#### Excessive speed overwhelms driver's capabilities:

- Although vehicles and roadways can be designed to withstand high-speed traffic, human beings cannot be re-designed to handle increasingly higher speeds.
- A driver's capability is limited by speed.
  - The faster a car is driven, the less real control the driver has over it.
  - No matter how good a driver may be, some loss of control over the car will result if the driver goes fast enough.
- One factor affecting a driver's capability is *reaction time*:
  - Reaction time can determine whether an accident will occur.
  - The shorter the reaction time, the sooner the driver starts maneuvering the car to avoid a hazard.
  - During the time it takes the driver to react, the car continues moving toward the hazard.
- Reaction time becomes more critical as speed increases:
  - At slow speeds, the car does not move far during the time it takes the driver to react.
  - At high speeds, the car will move farther during the same reaction time interval, and so even fractions of a second become important.

## Unit 2 – Notes

---

*Introduction.*

*Approximate time required:  
5 minutes.*

*Unit title on chalkboard or  
flip-chart.*

*Refer trainees to list of Unit  
2 objectives in the Trainee  
Instructional Manual.*

---

*Emphasize that the goal of  
this unit is to convey some  
solid reasons why the  
trainees should try to do the  
best job possible in speed  
enforcement.*

*Relate content to unit  
objectives.*

---

*Approximate time required:  
10 minutes.*

*(Prior elapsed time: 5  
minutes.)*

*Emphasize that human  
beings are more  
fallible and more fragile  
than machines are.*

*Write on chalkboard or flip-  
chart:*

*"Reaction Time."*

*Point out that a driver's  
ability to avoid a roadway  
hazard often depends on  
how quickly the car can be  
stopped or steered away  
from the hazard—on how  
quickly the driver reacts.*

## Unit 2 – Contents

---

- How reaction time and speed can limit a driver's capability can be found by applying a car's brakes:
  - The average driver requires approximately three-fourths of a second to react and apply the brakes.
  - During that three-fourths of a second, the brakes are *not* being applied, and the car continues to move at a steady speed.
- How far the car will move during the three-fourths of a second depends on its speed when the hazard was sighted:
  - At 20 miles per hour, the car will move 22 feet during the three-fourths of a second before the driver brakes.
  - At 50 mph, the car will move 55 feet during the same time it takes to apply the brakes.
  - And at 80 mph, 88 feet.
  - In each example, the reaction time is the same, three-fourths of a second, but the distance traveled while the driver is reacting increases steadily as speed increases.
- Reaction time is only the beginning of the problem: Once the brakes are applied, some time elapses before the car comes to a complete halt.
- The faster the car is moving, the longer it will take to stop:
  - Cars moving at higher speeds have more *momentum* than cars at lower speeds.
  - More braking force must be applied to cars traveling at high speeds.
  - At 20 mph, the average car will travel an additional 20 feet after the brakes are applied for a total stopping distance of 42 feet.
  - At 50 mph, the car will travel an additional 133 feet—a total stopping distance of 188 feet.
  - At 80 mph, the car will travel an additional 410 feet—a total stopping distance of 498 feet.
- The total stopping distance increases greatly with just a slight increase in speed:
  - Sixty mph is only 20 percent faster than 50 mph,
  - But the stopping distance at 60 mph (272 feet) is more than 44 percent longer than the stopping distance at 50 mph (188 feet).
- Hazards may appear that can be avoided at low speeds but are unavoidable at higher speeds:
  - Human reaction time limits cannot cope with excessive speeds.

## Unit 2 – Notes

---

*Write on chalkboard or flip-chart:*

*"Reaction time for applying brakes: three-fourths of a second"*

*Point out that this reaction time includes seeing the hazard, recognizing the need to apply the brakes, and finally moving the foot onto the brake pedal.*

*Project slide 3.*

*Emphasize that the reaction time "gap" is more critical at higher speeds than at lower speeds.*

*Write on chalkboard or flip-chart:*

*"Momentum"*

*Project slide 4.*

## Unit 2 – Contents

---

### **Excessive speed increases accident severity:**

- When the driver's capability is overwhelmed by excessive speed, the chances of a collision are increased.
- The excessive speed also increases the chances of death or serious injury.
- The extent of collision damage depends upon the amount of energy present:
  - Energy depends upon speed: The faster a vehicle is moving, the more energy it puts into a collision.
  - The amount of energy increases substantially with only slight increases in speed.
- As the amount of energy increases, the chances of a fatality increase sharply:
  - A collision at 60 mph is twice as likely to result in a fatality as one at 45 mph.
  - A collision at 70 mph is four times as likely to result in a fatality as a crash at 45 mph.

---

### **Historical trends have always linked speed with highway fatalities.**

- The annual highway death totals climbed steadily for the first 75 years of the automobile's history:
  - In 1957, approximately 37,000 people died in American automobile crashes.
  - Six years later (1963), the annual number of deaths had increased to nearly 47,000.
  - Six years later (1969), the number of deaths climbed to more than 55,000 per year.
- During this same period, the average speed on roadways was climbing as well:
  - On free-flowing rural roadways, the average traffic speed was 50 mph in 1957.
  - Six years later (1963), the average speed had jumped to 55 mph.
  - Six years later (1969), the average speed reached more than 57 mph.
- These trends do not prove that increased speeds were the *sole* cause of the increased death toll:
  - The average speeds applied only to certain roads at certain times.
  - The apparent relationship between the increased speeds and the increased numbers of deaths could have been coincidental.
- The trends *do* suggest, however, that high speeds contribute to an increased death toll and that lives can be saved if speeds are reduced.

# Unit 2 – Notes

---

*Project slide 5.*

*Example: A car moving 60 mph carries 44 percent more energy than the same car moving 50 mph.*

*Project slide 6.*

---

*Project slide 7.*

*Project slide 8.*

*Project slide 9.*

*Emphasize the similarity of the two graphs.*

## Unit 2 – Contents

---

### Speed Enforcement in Relation to Traffic Safety

Historical trends in traffic deaths and speeds were interrupted abruptly in 1974:

- The average speed on free-flowing rural roads dropped to approximately 54 mph in 1974:
  - A decrease of nearly 12 percent in a single year, bringing the average speed back to where it was in 1962.
- At the same time, the annual number of highway deaths dropped to approximately 45,000:
  - A 1-year decrease of nearly 17 percent, bringing the number of traffic deaths back to the 1962 level.
- Since 1974, average speeds and the total number of deaths have resumed their upward climb:
  - Though not yet reaching their previous high levels, they are heading back in that direction.
- These trends suggest that:
  - There is a definite relationship between highway speeds and traffic death tolls:
  - As speeds increase, the number of fatalities rises.
  - Speeds can be reduced. When they are, the number of fatalities drops.

---

**The sharp reduction in average speeds was a result of a severe fuel shortage.**

- The petroleum embargo that began in late 1973 led to a major reduction in fuel supplies:
  - Lack of fuel reduced total driving.
  - Many emergency measures aimed at fuel conservation were taken.
- One emergency measure was the adoption of a national speed limit of 55 mph:
  - Engineers and researchers found that motor vehicles operated more efficiently at 55 mph than they did at higher speeds.
- *The public for the most part accepted the new speed limit as a reasonable conservation measure.*
- *Traffic law enforcement agencies supported the new limit with rigorous enforcement.*
- *Good compliance with the limit resulted in a reduction of average highway speeds.*

## Unit 2 – Notes

**Approximate time required:**  
*10 minutes.*

*(Prior elapsed time: 15 minutes.)*

*55 mph saves lives.*

**Project slide 10.**

*Speed cut back to 54 mph.  
(1962 level)*

*Deaths cut back to 45,000.  
(1962 level)*

*Ask the trainee: "What caused the abrupt drop in speeds in 1974? Elicit that the original motive for speed reduction was conservation, not safety."*

*Emphasize the efficiency of the 55 mph speed limit.*

**Project slide 11.**

## Unit 2 – Contents

---

- As the engineers and researchers had predicted, substantial fuel savings occurred:
  - Conservative estimates indicate that the 55 mph limit now saves about *3.6 billion gallons of fuel per year nationwide*.
  - One bus company (Continental Trailways) documented a savings of 1.2 million gallons of fuel during 1976 as a result of compliance with the 55 mph limit.
  - Research suggests that trucks and buses on the average use about 2 percent less fuel for every mile per hour they drive below 60 mph.
- It is important to note that *the initial acceptance of the 55 mph limit* was based on its economic benefits:
  - Much of the public felt the limit *was acceptable as long as the fuel emergency lasted*.
  - Many believed the limit would be lifted once fuel became available again.

---

**The *safety* benefits of the new speed limit were discovered to be even more important than the economic benefits:**

- At first, some believed that the reduction in traffic death tolls occurred only because people were driving much less.
- But research made it clear that the drop in speed was directly improving traffic safety:
  - In 1974, the traffic death rate dropped by 15 percent— from 4.2 deaths per 100 million miles to 3.6.
  - The number of disabling injuries dropped 10 percent.
  - Driving has become safer since the 55-mile limit was imposed.



## Unit 2 – Contents

---

### **Rigorous enforcement is essential to maintain these safety benefits:**

- The public seems to recognize the benefits of the 55-mile limit and gives lip service to the limit:
  - Recent polls indicate that about 75 percent of the public favors keeping the 55-mile limit.
- However, much of the public does not comply with the limit:
  - More than half the vehicles monitored on the Nation's highways exceed the 55-mile limit.
  - The average traffic speed has again climbed, approaching the level attained before the 1974 fuel shortage.
- It appears that the public no longer believes that conserving fuel is reason enough for complying with the limit:
  - The public no longer believes that a fuel emergency exists.
  - The absence of an immediate emergency appears to have diminished voluntary compliance.
- Firm enforcement is the only practical way to improve compliance on the short term.

---

### **We must maintain the 55-mile limit to retain the safety benefits:**

- It has been suggested that the limit be raised to 60 mph, *but research indicates that even so slight an increase in the speed limit would wipe out most of the safety benefits.*
  - The number of accidents would increase by only about 1 percent.
  - But the number of fatalities would increase by about 9 percent.
- The 55-mile limit must be retained, and it must be supported by strong and effective enforcement:
  - Otherwise annual death and injury tolls will return to their previous high levels.

---

### **Speed enforcement is not only for major State highways and interstates:**

- The discussion until now was devoted to the 55-mile speed limit:
  - The 55 mph limit has attracted much attention recently.
  - Fifty-five-mph programs offer evidence that increased enforcement leads to compliance and ultimately to a reduction in the fatality rate.

## Unit 2 – Notes

---

*Point out that compliance improved briefly during the 1979 fuel shortages, but that when the gas lines shrank, the average speed again increased.*

---

*Why not a 60-mph limit?*

*Note the possible advantages of such an increase:  
Better compliance.*

*More respect for law enforcement.*

***Project slide 13.***

*Ask trainees: "Why so many more fatalities when there is such a small increase in the number of crashes?" Explain how even a slight increase in speed means a geometric increase in the energy involved in the crash.*

*Emphasize that rigorous speed enforcement saves lives.*

---

## Unit 2 – Contents

---

- A larger percentage of reported fatalities occur on local or county roads than on interstates. For example, fatality statistics by road type for 1978 show that:
  - Only 8.8 percent of fatal accidents occurred on interstates.
  - But 19.7 percent of reported fatalities occurred on local streets.
  - And 15.9 percent of reported fatalities occurred on county roads.
- Traffic safety and speed enforcement are concerns for *all* police agencies—State, county, city, or any other type.

---

### Types of Speed Offenses

Effective speed enforcement demands familiarity with speed offenses.

- Traffic law enforcement requires knowledge of traffic laws.
- Every violation of the law contains certain elements:
  - Elements cover behaviors, conditions, circumstances, etc., that make up the legal definition of the offense.
  - The offense is not committed unless all elements are present.
  - It must be proven that all elements are present in order to obtain a conviction.
- Speed offenses also have their specific elements.
  - The elements are not always as simple as they might first appear.
  - In all cases, proof of the offense requires more than a speed measurement.

---

Speed regulation and enforcement has developed from the basic speed law, which states that:

- It is unlawful to drive a vehicle on public roadways at a speed greater than is reasonable and prudent under existing conditions. Existing conditions include both actual and potential hazards.
- The intent of the law is simply to prohibit unsafe speeds.



## Unit 2 – Contents

---

- The law contains many elements:
  - *Driver*: The accused violator must in fact have been the driver when the offense was committed.
  - *Vehicle*: Except for certain public service vehicles under emergency circumstances, all vehicles are subject to the basic speed law—not just motor vehicles.
  - *Public roadways*: Streets, roads, highways, and any other areas to which the public has right of access for vehicular use are considered public roadways.
  - *Reasonable and prudent under the conditions*: This is the speed that accounts for all conditions that may affect present hazards, including conditions of the:
    - (1) Road.
    - (2) Visibility.
    - (3) Vehicle.
    - (4) Present pedestrian and vehicular traffic.
  - *Actual and potential hazards*: These include observable hazards (such as other vehicles, debris, etc.) and factors that may contribute to hazards (such as sharp bends, blind corners, etc.).
- The basic speed law makes no mention of any specific speed limit.
  - A driver cannot be convicted of a basic speed law violation simply because he or she was going faster than some particular speed limit.
  - By the same token, the accused cannot avoid conviction simply by showing that she or he was going slower than some particular limit.
- To obtain a conviction for a basic speed law violation, it is necessary to show that *the vehicle's speed was too fast for the conditions that were present*.
  - It is not always easy to show this.
  - *Conditions* can refer to many factors.
  - It is not always clear whether a particular speed is unreasonable or imprudent under existing conditions.
- The basic speed law does not give clear or specific guidance to either the motorist who is trying to decide how fast to drive or to the police officer who is trying to enforce the law.

---

**Many States and communities have attempted to provide better guidance for speed enforcement by adopting *prima facie* speed limits.**

- A *prima facie* speed limit does not change the basic speed law.
  - Even when a *prima facie* speed limit has been established, it is still necessary to show that the accused was traveling too fast for existing conditions.

# Unit 2 – Notes

---

***Project slide 16.***

*List places in trainees' jurisdiction where the speed law applies and does not apply.*

*Ask trainees: "What is the slowest speed that might be considered unlawful under the basic speed law?" Point out that there is no minimum: Any speed may be lawful, depending on conditions.*

---

***Prima Facie Speed Limits.***

***Project slide 17.***

## Unit 2 – Contents

---

- A *prima facie* speed limit is an *indication* of what speed would be considered “reasonable and prudent” in a particular setting:
  - The limit states what would *ordinarily* be the highest reasonable and prudent speed under *generally favorable conditions*.
  - If the accused is traveling faster than that speed, the implication is that even if the existing conditions are favorable, the accused is probably going too fast.
- Exceeding the *prima facie* speed limit is important evidence of a basic speed law violation. However, it is not incontrovertible evidence.
  - *Prima facie* means “at first sight” or “on the face of it.”
  - A driver exceeding the *prima facie* limit appears *at first glance* to have been traveling too fast, no matter how good the conditions.
  - But it is possible that other evidence will cause a “second glance” that will change this appearance.
  - The accused can introduce evidence to show that driving conditions were very highly favorable and that his or her speed was “reasonable and prudent” even though it was above the *prima facie* limit.
  - If the court finds the accused’s evidence to be sufficiently convincing, it will acquit the accused even though the *prima facie* limit was exceeded.
  - Therefore, it is possible under certain circumstances to exceed a *prima facie* limit without violating the basic speed law.
- The opposite is also true: Under certain circumstances it is possible to violate the basic speed law without exceeding the *prima facie* limit:
  - The *prima facie* limit is an indication of the *maximum reasonable speed under favorable conditions*.
  - If conditions are unfavorable, it is reasonable and prudent to drive more slowly.
- A *prima facie* speed limit is only a *guide*. It indicates a safe and prudent speed under typically favorable conditions.

---

### A completely different speed regulation is based on an *absolute speed law*:

- An absolute speed law is different from the basic speed law and has different *elements*.
- An absolute speed law states that it is:
  - Unlawful to drive a vehicle on public *roadways* at a speed in excess of the absolute limit “X” miles per hour.

## Unit 2 – Notes

---

*Project slide 18.*

*Project slide 19.*

---

*Project slide 20.*

*Important: Cite the precise wording of the absolute speed law as it applies to the trainees' jurisdiction.*

## Unit 2 – Contents

---

- The elements of a violation of an absolute speed law are:
  - *Driver*: The accused has to have been driving when the offense was committed.
  - *Vehicle*: The law applies to all types of vehicles except for certain authorized vehicles under emergency conditions.
  - *Public Roadways*: Any place where the public has right of access for vehicular use (streets, roads, alleys, highways, etc.) is a public roadway.
  - *Speed in excess of the absolute limit*: The accused speeder's vehicle must be shown to have traveled faster than the specified absolute limit ("X" mph).
- Under the absolute speed law, circumstances, conditions, and actual or potential hazards don't matter.
  - Those conditions are not elements of the offense and have no bearing on whether or not the offense was committed.

---

### **The absolute speed law does *not* eliminate the basic speed law.**

- Both basic and absolute speed laws are usually needed to provide effective speed control.
- The two laws usually coexist and apply equally to the same public roadways.
- *For example*:
  - A State may have enacted an absolute speed limit of 55 mph and applied it on every public roadway in the State.
  - The basic speed law also applies to every public roadway in the State.
  - At a particular location, a *prima facie* limit of 35 mph may have been posted as guidance for compliance with and enforcement of the basic speed law.
  - At such a location, enforcement action can be taken under either law, depending on the situation.

---

### **Review and Summary**

**As the average traffic speed increases, so do traffic accidents and fatalities:**

- High speed places severe strain on human capabilities and increases the difficulty of controlling the vehicle.
- High speed introduces more energy into a collision, making it more severe.

## Unit 2 – Notes

---

*Point out that the first three elements are identical to those of the basic speed law.*

---

*Point out that even if a driver is obeying the posted speed limit, he or she may still be going at an unreasonable or imprudent speed—for example, driving at 50 mph in a 55 mph zone, but on solid ice in a blizzard.*

---

**Approximate time required:**  
*10 minutes.*  
*(Prior elapsed time: 40 minutes.)*

## Unit 2 – Contents

---

### Reducing speeds saves lives:

- In 1974, a 12 percent speed reduction on rural roads corresponded with a 17 percent reduction in the number of deaths.

---

### To preserve these safety benefits, effective speed enforcement is essential:

- In 1974, a need to conserve fuel resulted in lower speed limits.
- The public's perception of the need for fuel conservation has not always guaranteed compliance with speed limits.
- The public gives lip service to the 55-mph limit, but drivers do not necessarily comply with it.
- Effective enforcement and increased enforcement presence are needed to achieve compliance.

---

### Speed enforcement is based on two types of law:

- The basic speed law prohibits speeds that are unreasonable and imprudent for the prevailing conditions.
- An absolute speed law categorically prohibits speed above a specified limit.
  - Both types of laws can coexist. Both should be enforced.

---

### Evaluation.

- Sample evaluation questions:
  - A vehicle's total stopping distance is:
    1. Approximately *doubled* for every 10 mph increase in speed.
    - \* 2. Affected by the vehicle's speed *and* the driver's reaction time.
    3. About three times more at 65 mph than it is at 55 mph.
    4. How far it will travel during three-fourths of a second.
  - A fatality is more likely to occur in a 60-mph crash than it is in a 45-mph crash. How many times more likely?
    - \* 1. Twice as likely.
    2. Three times as likely.
    3. Five times as likely.
    4. Seven times as likely.

## Unit 2 – Notes

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

*Ask trainees to name and describe each type of law.*

---

---

---

---

---

---

---

---

*Use these or similar questions to assess the trainees' knowledge of Unit 2. This evaluation may be conducted orally or in writing. (The correct answers are indicated by asterisks.)*

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

## Unit 2 – Contents

---

- In 1974, the average traffic speed dropped back to where it had been in 1962. The total number of traffic deaths dropped to where it had been in:
  - \* 1. 1962.
  - 2. 1969.
  - 3. 1953.
  - 4. 1957.
- Research indicates that if the national speed limit were to be raised to 60 mph:
  - 1. The number of accidents and fatalities would probably increase by 25 percent.
  - 2. Speed limit compliance would improve appreciably.
  - \* 3. The total number of accidents would not increase very much, but the total number of fatalities would increase sharply.
  - 4. The numbers of accidents and fatalities would stay about the same, but virtually all fuel savings would disappear.
- The term *prima facie* means:
  - \* 1. "At first glance."
  - 2. "Not to exceed."
  - 3. "Open and shut."
  - 4. "In accordance with conditions."
- *Prima facie* speed limits:
  - 1. Are always lower at night.
  - 2. Are superceded by absolute speed limits.
  - 3. Are based on generally unfavorable driving conditions.
  - \* 4. Always apply to the basic speed law.
- Solicit and answer trainees' questions concerning the contents of this unit.



# Unit 3

## Basic Principles of RADAR Speed Measurement

Total Time:  
3 hours and 30 minutes

---

### Objectives

Provide sufficient information for the trainee to:

- Explain the term RADAR and describe the origin and history of RADAR equipment.
- Explain what is meant by frequency and wavelength of a RADAR signal and describe the relationship governing frequency, wavelength, and RADAR signal speed.
- Explain the Doppler Principle by describing how a RADAR signal is changed when reflected off a moving object.
- Describe the basic operation of a stationary RADAR instrument.
- Describe the basic operation of a moving RADAR instrument.
- Describe the factors that can affect RADAR's accuracy and effectiveness.

### Requirements

References:

- *Police Traffic RADAR: Issue Paper*. National Highway Traffic Safety Administration. February 1980. (Appended to this manual.)
- *Police Traffic RADAR*. New York State Division of Criminal Justice Services, Bureau for Municipal Police.
- Christy, John. "Gotcha! RADAR and the Detectors—the Battle of the Microwaves." *Motor Trend*, August, 1976, pp. 27–31.
- Bedard, Patrick. "Smoking Out Old Smokey." *Car and Driver*, February, 1979, pp. 68–79.
- Ward, K. L. *Techniques for RADAR Speed Detection*. Northwestern University Traffic Institute, 1967.
- *Traffic RADAR Operator's Manual*. Michigan State Police Traffic Services Division. Oct. 1980.

Suggested Illustrations:

- 35mm slides (provided) or suitable alternative training aids.

### Instructor Tasks

The instructor must be familiar with the structure and contents of this unit.

1. Introduction (5 minutes)
2. RADAR's Development and Fundamental Concepts (15 minutes)
3. The Doppler Principle (30 minutes)
4. Principles of Stationary RADAR (30 minutes)
5. Principles of Moving RADAR (20 minutes)
6. Target Vehicle Identification (40 minutes)
7. Factors Affecting RADAR Operation (40 minutes)
8. "Jamming" and Detection of Police Traffic RADAR (15 minutes)
9. Review and Summary (15 minutes)

The instructor should review the listed references and sources of technical information augmenting the lesson plans, as appropriate, using information drawn from the references and from previous personal experience.

The instructor must prepare or obtain all visuals and other instructional aids specified in the lesson plans. In particular, the suggested audio tape illustrating the Doppler Principle via sound waves should be prepared if possible. This can be done by stationing a tape recorder/microphone at the edge of a roadway and driving a vehicle past the recorder with its horn blaring: The vehicle should be driven at a reasonably high speed (40-50 mph) to produce a substantial Doppler shift, and the horn should be sounded continuously for roughly 300 feet on either side of the recorder. For best results, a stereophonic tape should be made, so that the trainees can sense the direction of the vehicle's motion. And, finally, the instructor should use any additional instructional aids that will enhance learning.



# Unit 3 – Contents

---

## Introduction

### Unit Title and Objectives

- Unit Title—“Basic Principles of RADAR Speed Measurement”
- Unit objectives:
  - Explain RADAR and describe the origin and brief history of RADAR equipment.
  - Explain what is meant by frequency and wavelength of a RADAR signal, and describe the relationship governing frequency, wavelength, and RADAR signal speed.
  - Explain the Doppler Principle by describing how a RADAR signal is changed when reflected off a moving object.
  - Describe the basic operation of a stationary RADAR instrument.
  - Describe the basic operation of a moving RADAR instrument.
  - Describe the factors that can affect RADAR accuracy and effectiveness.

---

### Unit Content

- Examine how RADAR instruments use radio signals to determine a vehicle's speed.
- Examine some physical characteristics of radio signals and explore how these characteristics help us measure speed.
- Examine how certain circumstances can affect the accuracy of RADAR speed measurements.
- Examine moving RADAR and explore its particular strengths and weaknesses.

---

## RADAR's Development and Fundamental Concepts

### RADAR's Origin

- The word RADAR is an acronym of the phrase “Radio Detection and Ranging.”
- RADAR technology was first developed by the British shortly before World War II.
- Originally RADAR was used by the Navy to detect enemy ships and planes and to determine their range.
  - Some RADAR instruments are still used for detection and ranging today.

Our concern in this course is with RADAR instruments that measure motion or *speed*, not distance or direction.

# Unit 3 – Notes

---

*Introduction.*

*Approximate time required:  
5 minutes.*

*Unit title on chalkboard or  
flip-chart.*

*Project slide 21.*

*Refer trainees to list of Unit  
3 objectives in the Trainee  
Instructional Manual.*

*Emphasize that the goal of  
this unit is to convey a  
general knowledge of  
fundamental RADAR  
principles, not a thorough  
technical knowledge.*

---

*Relate content to unit  
objectives.*

---

*Approximate time required:  
15 minutes.  
(Prior elapsed time: 5  
minutes.)*

*Project slide 22.*

*Project slide 23.*

*Project slide 24.*

*Impress on trainees that  
police traffic RADAR can  
gauge only relative motion  
between objects, not distance  
or direction.*

## Unit 3 – Contents

---

### Basic Method of RADAR Speed Measurement

- Speed-measuring RADAR units transmit radio signals.
- When radio signals strike a solid object, some of the signal is reflected, or bounced back, toward the RADAR.
- If there is *relative motion* between the RADAR and the solid object, the reflected signal will be different from the transmitted signal:
  - The motion *changes* the reflected signal.
  - The faster this motion, the more the signal changes.
- The RADAR instrument measures how much the reflected signal has changed:
  - The amount of change indicates the speed of the relative motion.

---

### The Wave Concept of Radio Signals

- To understand how RADAR measures speed, we have to understand how radio signals can be changed.
- Radio signals are made of *waves*:
  - We can't see radio waves.
  - But we *can* see other kinds of waves, such as waves on water.
- Each wave is made of a *peak* and a *valley*.
- Waves travel along, one behind another, in a steady stream of peak-valley-peak-valley etc.
- Every radio signal consists of a stream of waves. Two different radio signals have two different streams:
  - Every radio signal has its own characteristic wave.
  - If the signal is changed, then the wave is changed.

---

### Wavelength and Frequency

- Every radio signal has two characteristics that distinguish it from every other signal.
  - One characteristic is the *wavelength*—the distance from the beginning of the peak to the end of the valley.
  - The other is the *frequency*—the number of waves sent out in the signal during 1 second of time.

# Unit 3 – Notes

---

**Project slide 25.**

*Explain the concept of relative motion.*

*Emphasize that it makes no difference whether the object, the RADAR, or both are moving. As long as the object and the RADAR are not both standing still or both moving in exactly the same direction at exactly the same speed, there will be relative motion.*

---

**Project slide 26.**

*Ask trainees:  
Describe waves. Guide the discussion to bring out the notion of crests and troughs or peaks and valleys.*

---

**Project slide 27.**

## Unit 3 – Contents

---

- All radio signals travel at a constant speed—the speed of light:
  - The speed of light is about 186,000 miles per second, or 30 billion centimeters per second.

---

### Fundamental Relationship Between Frequency and Wavelength

- Every radio signal has its own particular frequency and wavelength.
- The relationship can be thought of in terms of a mathematical formula: wavelength times frequency = speed of light.
- Whenever a radio signal is changed, its speed stays the same, but its frequency and wavelength change.
  - As the number of waves per second (frequency) increases, the length of the waves (wavelength) *must* decrease.
  - As the frequency decreases, the wavelength *must* increase.
  - The speed never changes (186,000 miles per second).

---

### Police Traffic RADAR Assigned Frequencies

- Police traffic RADAR transmits in the microwave frequency band:
  - This means billions of waves per second, with very short wavelengths.
- There are two primary FCC-assigned RADAR frequencies, called the X-band and the K-band.
  - The X-band RADAR frequency is the most common, transmitting about 10,525,000,000 waves per second (10.525 gigahertz), with a wavelength of about 1½ inches (3 centimeters).
  - The K-band RADAR frequency transmits about 24,150,000,000 waves per second (2.415 gigahertz), with a wavelength of about ½ inch (1¼ centimeters).



## Unit 3 – Contents

---

- Compared to other types of radio transmissions, RADAR waves are very short.

---

### The Doppler Principle

The scientific principle on which RADAR speed measurement is based is called the Doppler Principle.

- The principle is named for its discoverer, Austrian physicist Christian Johann Doppler.
- The Doppler Principle states that when there is relative motion between two objects, one of which is emitting energy in waves, the frequency of the energy wavelength will be changed because of that relative motion.
- The Doppler Principle applies to *all* waves—waves on water, sound waves, beams of light, radio signals, etc.
  - Example: If a car or truck with a blaring horn is speeding toward you, the horn will have a high-pitched sound. Once it passes by you and is moving away from you, there will be an immediate drop in pitch.
  - The driver of the vehicle would hear no such change in pitch, because there is no change in relative motion between the driver and the vehicle.

---

### Illustration of the Doppler Principle:

- If two objects remain exactly the same distance from each other (i.e., no relative motion), the frequency that one perceives the other as transmitting remains the same as that actually transmitted.
- If the relative motion brings the objects closer together, the frequency will be increased and the pitch heard will sound higher.
- If the relative motion takes the objects farther apart, the frequency will be decreased and the pitch heard will sound lower.
- The amount (speed) of relative motion between the two objects determines how great the frequency change will be. Relative motion will occur if:
  - The object receiving the energy stands still and the transmission source moves.
  - The transmission source stands still and the object receiving the energy moves.



## Unit 3 – Contents

---

- Both objects are moving, but they move at different speeds or in different directions, so that the distance between them changes.

---

### The RADAR Beam

- RADAR wave energy is transmitted by the antenna in a cone-shaped pattern resembling a flashlight's beam.
- The amount of energy decreases the further away from or off to the side one gets from the RADAR unit.
- The length of the RADAR beam is infinite unless it is reflected, absorbed, or refracted by an object in its path.
  - Reflected (metal, concrete, stone).
  - Absorbed (grass, dirt, leaves).
  - Refracted (glass, plastic).

---

### RADAR Range

- The range, or maximum distance, at which a reflected signal can be interpreted by RADAR depends on the sensitivity of the antenna receiver.
- The operational area of the RADAR beam looks much like an elongated cigar.
- The effective range for most RADARs exceeds half a mile.
- The much smaller beams close to the antenna, called *side lobes*, are:
  - A byproduct of RADAR antenna design.
  - So weak in strength that they normally don't affect RADAR operation.

# Unit 3 – Notes

---

*(NOTE: Assure the trainees that the Doppler principle will be discussed again.)*

---

***Project slide 33.***

*This decrease of energy in relation to distance from the RADAR will be important when we later talk about target identification.*

***Project slide 34.***

***Project slide 35.***

*Obviously, cars (being made of metal) reflect well.*

***Project slide 36.***

***Project slide 37.***

*Bent is another word for refracted.*

---

***Project slide 38.***

*Note that range is cone-shaped, like the transmission beam itself.*

*Emphasize that the cigar shape is only a rough representation of the area from which the RADAR will most effectively receive and process reflected signals.*

*Note that there can be many more than two side lobes, depending on the RADAR antenna. Remember that these side lobes are cone-shaped, just as the main beam is.*

---

## Unit 3 – Contents

---

### **RADAR Beam Width**

- The width of the RADAR beam is determined by the initial angle at which it is emitted:
  - This initial angle varies between 11° and 18°, depending on the brand of the particular RADAR unit.
  - Because of the width of the beam, RADAR cannot focus on one single traffic vehicle at any significant distance.
- Not all of the transmitted RADAR signal is contained within the specified beam width:
  - Some of it is emitted at a much greater angle.
  - Vehicles outside the main beam can be displayed.
  - Usually vehicles inside the main beam are dominant over vehicles outside the main beam.
- The operator must understand that current police traffic RADAR units *are not lane-selective*.

---

### **Principles of Stationary RADAR**

#### **Stationary RADAR is based on the Doppler Principle.**

- The Doppler Principle was illustrated earlier with a moving automobile horn (transmission source) and a stationary wave energy receiver (human listener).
- Stationary RADAR involves a transmission source that is also a receiver of a reflected signal from a moving object.

# Unit 3 – Notes

---

***Project slide 39.***

*Ask trainees:  
What do 11° and 18° mean in  
terms of the width of the  
beam at various distances?*

***Project slide 40.***

***Project slide 41.***

***Project slide 42.***

***Project slide 43.***

***Project slide 44.***

***Project slide 45.***

***Project slide 46.***

*Note that with certain  
RADARs, the angle involved  
can be even wider.*

*Stress that the operator  
cannot simply point the  
RADAR at a car and expect  
to receive reflections from  
only that car.*

---

***Approximate time required:  
30 minutes.  
(Prior elapsed time: 50  
minutes.)***

***Project slide 47.***

## Unit 3 – Contents

---

### How the Doppler Principle is applied to stationary RADAR:

- A stationary RADAR signal that strikes a motionless target will return a reflected signal at the same frequency that is being transmitted.
  - If the target is moving toward the RADAR unit, the frequency is increased.
  - If the target is moving away from the RADAR unit, the frequency is decreased.
- 

In each case, the stationary RADAR measures the frequency change and converts it into miles per hour on the display screen.

- With X-band RADAR, an increase or decrease in frequency of 31.4 waves per second occurs for each mile per hour of difference in speed between the transmitter and the reflected object.
  - With K-band RADAR, an increase or decrease in frequency of 72 waves per second occurs for each mile per hour of difference between the transmitter and the reflected object.
  - These frequency changes are small, but still measurable by the RADAR unit.
- 

### Stationary RADAR Examples

- A stationary RADAR beam transmitted into empty space will go on forever—no reading will be obtained.
- A stationary RADAR beam transmitted down a roadway on which no objects are moving will also obtain no reading.
- With a stationary RADAR beam transmitted down a roadway on which vehicles are either approaching or moving away:
  - If the target vehicle is approaching, the reflected signal will be *increased* in frequency, equal to the target vehicle's speed.
  - If the vehicle is moving away, the reflected signal will be decreased in frequency, again equal to the target vehicle's speed.

# Unit 3 – Notes

---

***Project slide 48.***

*Ask trainees: Why is there  
no frequency change?*

*Answer: No relative motion.*

---

***Project slide 49.***

***Project slide 50.***

***Project slide 51.***

*Remember, police traffic  
RADAR transmits at  
billions of waves per second.*

---

***Project slide 52.***

***Project slide 53.***

***Project slide 54.***

***Project slide 55.***

***Project slide 56.***

***Project slide 57.***

---

## Unit 3 – Contents

---

**Remember that Doppler RADAR can only measure the motion of the target vehicle relative to that of the RADAR.**

- Doppler RADAR cannot tell whether the target, the RADAR, or both are moving.
  - Doppler RADAR cannot tell if the target is approaching or retreating.
  - All that can be determined is how fast the target and RADAR unit are moving relative to each other.
- 

### **Stationary RADAR Angular (Cosine) Effect**

- RADAR can only measure the exact speed of a target vehicle when it is approaching *directly* or retreating straight from the RADAR device.
- If any significant angle exists, an angular or cosine effect will occur.
- The (stationary) angular effect can *only* result in a stationary RADAR unit's perceiving a speed *less* than the target vehicle's true speed. This will always be to the motorist's advantage.
- The angular (cosine) effect is not significant as long as the angle remains small:
  - It starts becoming a factor at about 8°.
  - At a 90° angle, the RADAR cannot see any of a target vehicle's speed.
  - A vehicle driving in circles around a RADAR would not be displayed at all, because the angular effect would make it effectively invisible—the RADAR unit would see no *relative* motion.
- The angular (cosine) effect commonly affects stationary RADAR operation in two ways:
  - With the RADAR antenna pointed straight down the adjacent roadway, when approaching vehicles get close enough to produce a significant angle, the result is a recognizably reduced RADAR perception of their speed.
  - When the antenna is pointed at a severe angle across the roadway, the RADAR's perception of the target vehicle is delayed until the vehicle is relatively close. Because of the significant angle, the RADAR will, again, perceive a reduced speed in the target vehicle (this is an immediate, and less recognizable, example).

# Unit 3 – Notes

---

*Project slide 58.*

---

---

---

---

---

---

*Project slide 59.*

*Project slide 60.*

*Ask trainees:*

*What will happen to a stationary RADAR's perception of target vehicle speed if a significant angle exists?*

*Answer:*

*A reduced perception of target speed.*

---

---

---

---

---

---

---

---

---

---

*Project slide 61.*

*Note:*

*Have trainees refer to the cosine table in Unit 3 of the Trainee Instructional Manual.*

---

---

---

---

---

---

---

---

---

---

*Project slide 62.*

*Project slide 63.*

*Ask trainees:*

*Why would no speed be displayed?*

*Answer:*

*The vehicle is not getting closer to or farther away from the RADAR unit. Therefore there is no relative motion.*

---

---

---

---

---

---

---

---

---

---

*Project slide 64.*

*Project slide 65.*

*Project slide 66.*

*Project slide 67.*

---

---

---

---

---

---

---

---

---

---

## Unit 3 – Contents

---

- The RADAR operator should be cautioned against “giving away” too much speed because of the angular effect.
  - Set up the RADAR as close to the roadway as possible. Point the antenna straight down the road.

---

### **Principles of Moving RADAR**

**Moving RADAR is simply a police traffic RADAR unit that can be operated from a moving patrol car.**

- Moving RADAR, just like stationary RADAR, works on the basis of the Doppler Principle.
- Moving RADAR is subject to all the physical limitations affecting any other RADAR (e.g., the angular effect).
- Moving RADAR does involve additional complexities, however, and has some unique limitations.

---

**The most important characteristic of a moving RADAR unit is that it measures two speeds at the same time:**

- The speed of the patrol vehicle relative to the stationary terrain (the roadway).
- The relative speed at which a target vehicle is closing with or approaching the moving patrol car.
- Moving RADAR uses those two speeds to determine the target vehicle’s true speed.

# Unit 3 – Notes

---

**Project slide 68.**

*Note:*

*Stress that it is not that the antenna is pointed across the roadway that causes the angular effect. How the antenna is pointed in stationary RADAR is relevant only because it may delay the RADAR unit's perception of the target.*

*Note:*

*Query the trainees and ensure that an adequate understanding of the principles of stationary RADAR and the angular (cosine) effect exists.*

---

**Approximate time required:**  
*20 minutes.*

*(Prior elapsed time: 1 hour and 20 minutes.)*

**Project slide 69.**

---

*Point out that the speed at which a target vehicle approaches a moving RADAR unit is not its true speed. For example, if the patrol car is doing 30 mph and the target is approaching the patrol car at 40 mph, the closing speed is 75 mph. The closing speed is the speed of relative motion between the moving target and the moving patrol car.*

---

## Unit 3 – Contents

---

**Moving RADAR automatically measures the patrol car's speed relative to the stationary terrain.**

- Part of the beam strikes the ground and reflects back to the RADAR.
  - The RADAR perceives the terrain as approaching *it*, rather than it as approaching the terrain.
  - That reflected signal undergoes a “low Doppler” shift.
  - The amount of Doppler shift indicates the relative speed of the moving RADAR and the stationary ground.
- 

**The speed at which the target vehicle is approaching the patrol vehicle is also determined through the Doppler Principle:**

- A RADAR beam transmitted from the moving patrol vehicle strikes the approaching target vehicle.
  - The RADAR beam is reflected from the moving target to the moving patrol vehicle.
  - The signal returned to the RADAR receiver has undergone a “high Doppler” shift.
  - The RADAR device translates the Doppler shift into a speed measurement:
    - This speed measurement represents the *relative* speed of the two vehicles.
    - With the vast majority of moving RADARs now in use, this will occur only if the target is moving toward the patrol car.
    - The magnitude of the high Doppler shift depends on the relative (approaching or closing) speed of the two vehicles.
- 

**Basically, we want to learn the target vehicle's speed:**

- The target vehicle's speed is computed as: Closing speed minus patrol speed ( $TS = CS - PS$ ).
- We learn the closing speed through the Doppler shift.
- Thus, if we can determine the patrol car's speed, we can compute the target's speed ( $CS - PS = TS$ ).
- The target speed is computed continuously and automatically by the RADAR unit.
- All the newer RADAR devices display not only the target speed but also the patrol speed.



## Unit 3 – Contents

---

### Moving RADAR Angular (Cosine) Effect

- Sometimes the angular effect on *moving* RADAR may result in a *high* as well as the more usual *low* perception of the target vehicle speed.
- But most often, the moving angular effect will result in a *low* target vehicle speed, just as in the stationary angular effect. For example:
  - When an approaching vehicle gets close enough to the RADAR to create a significant angle.
  - Or when a curve in the road may cause the target vehicle to approach the RADAR at a significant angle.
  - This low target speed reading can result only if the patrol car speed is being computed *correctly*.
- Sometimes, though, conditions can exist or be created that will lead to a *high* target vehicle speed being perceived by the RADAR unit:
  - If a less-than-true patrol speed is perceived by the RADAR, the computation of the target speed could be high.
- An improper target speed can result if the patrol speed signal is received from some roadside object at an angle to the patrol car (not from the stationary terrain ahead of it), for example, a fence by the side of the road.
  - The apparent target speed signal will be incorrectly high because the RADAR's reading of the patrol car's speed is incorrectly low.
  - Roadways lined with large buildings or fences and wet and icy roads are most susceptible to creating this problem.
  - This condition usually occurs only for a *brief* period.
- Improper RADAR operation, however, can make this a severe and continuous factor:
  - Misaligning the RADAR antenna at a significant angle from the patrol vehicle's direction of travel will cause problems.
  - A low Doppler patrol car speed signal will be *continuously* perceived as less than actual, resulting in a *continuous* higher-than-actual target speed reading.
- Therefore, straight-ahead antenna alignment is strongly encouraged:
  - Alignment very close to 0° can be achieved by “eyeballing” the RADAR antenna's adjustment.
  - A deliberate misalignment of the antenna, no matter how slight, will increase the possibility of a high target speed reading.
  - In court, the burden of proof on the operator is less weighty if testimony to pointing the antenna “straight ahead” is all that has to be given.

# Unit 3 – Notes

---

***Project slide 73.***

*Stress that, because this effect exists, careful consideration and discussion are necessary for the trainees to assimilate it.*

***Project slide 74.***

*Note:*

*This is most significant on four-lane roads.*

***Project slide 75.***

***Project slide 76.***

***Project slide 77.***

***Project slide 78.***

***Project slide 79.***

## Unit 3 – Contents

---

- Because unavoidable conditions can create a wrongly high target speed, some means of recognizing when the reading displayed is inaccurate must be available.
    - All newly-manufactured moving RADAR units have both target speed displays and patrol speed displays.
    - Comparing the patrol speed display with the calibrated speedometer allows an operator to make sure that the RADAR is measuring the patrol car's speed accurately.
- 

### Summary of Moving RADAR

- Moving RADAR and stationary RADAR both rely on the Doppler Principle.

Moving RADAR—like stationary RADAR—transmits a single beam, but moving RADAR processes *two* reflected signals rather than the stationary RADAR's one.

---

**Target Vehicle Identification** All the discussion up to now has involved only a single target vehicle.

---

When there is more than one target, accurate target identification depends on the operator's understanding of:

- How a RADAR unit "decides" which target vehicle's speed to display.
- The role of the RADAR operator in interpreting all the supportive evidence available into a tracking history.



## Unit 3 – Contents

---

### **RADAR “Decisionmaking”**

- The RADAR beam is such that it can be several hundred feet wide at its maximum range.
  - The RADAR receives signals from any and all vehicles within range.
  - The speed displayed on the RADAR usually results from the *strongest* signal received.
- RADAR “decision”-making is affected by three factors—reflective capability, position, and speed.
- Reflective capability depends on the vehicle’s size and what it’s made of—all vehicles are not the same:
  - A large truck will reflect a stronger signal than a passenger car will.
  - The shape and makeup (composition) of the target vehicle will also affect the signal reflected. Fiberglass, for example, does not reflect as well as metal does.
- *Position* refers to the location of the target vehicles relative to each other and to the RADAR unit.
  - Normally, the nearer a target vehicle is to the antenna, the stronger the reflected signal will be.
  - The target vehicle closest to the RADAR unit is usually the one displayed, particularly when the vehicles in the RADAR’s range are of comparable reflective capability. This is because the closer the target, the larger it appears to the unit relative to the other vehicles on the road.
- The actual *speed* of the target vehicle is usually the least dominant of the three factors.
  - Remember that most RADARs are designed to display the strongest signal received, not the fastest.
  - Speed, however, can be a factor under certain circumstances that will be described shortly.

# Unit 3 – Notes

---

**Project slide 82.**

*Remember, RADAR is not lane-selective, and you can't "focus" it on one particular car.*

**Project slide 83.**

**Project slide 84.**

*The reflective capability of any particular target vehicle is constant; it can't change its size, shape, or makeup. However, when more than one target is in the beam, it can become a variable.*

**Project slide 85.**

**Project slide 86.**

*All this means is that somewhat fewer signals will be reflected to the RADAR from vehicles with little frontal metal makeup. They will reflect a signal, however, contrary to popular belief.*

**Project slide 87.**

*Position is a variable factor with any particular target vehicle. It can get closer to and farther away from the RADAR, and thereby will affect the strength of its reflected signal.*

**Project slide 88.**

*Note:  
Speed as a decisionmaking factor will be discussed soon. Speed is also a variable with any particular target vehicle or group of target vehicles.*

## Unit 3 – Contents

---

### Understanding the RADAR Decisionmaking Process

- Of the three factors, reflective capability and position are the primary forces in the RADAR's determining which vehicle's speed will be displayed.
  - Multiple targets of unequal size create the most frequent problems in target identification.
- To understand when and why either factor may be dominant, it is necessary to understand what actually happens to the RADAR beam energy after it leaves the antenna.
  - When first transmitted by the antenna, almost all the radio wave energy is concentrated in a circle a few inches in diameter.
  - At 250 feet from the antenna, most of the energy is spread over an area *70 feet in diameter*.
  - At 500 feet, the diameter of the circle is *four times* as large as at 250 feet *and it contains about the same amount of energy, spread much thinner*.
  - At 1,000 feet, *the same amount of energy* spread over a circle four times as large as the circle at 500 feet—and *16 times* as large as the circle at 250 feet.
  - This relationship between energy and distance from energy source is called the inverse square rule.
- The inverse square rule affects RADAR decisionmaking:
  - To understand the possible effect of *reflective capability* on RADAR decisionmaking, imagine a car approaching the RADAR unit, 500 feet away, and a truck approaching from 1,000 feet away. If the truck has five times more reflective capability than the car does, then, all other factors being equal, the truck will be the vehicle displayed on the RADAR's screen.
  - *Position*: If the same car and truck move forward to positions that are 250 feet and 750 feet away from the RADAR unit, respectively, the car will have four times the reflective capacity it had at 500 feet, but the truck will only have about twice the reflective capacity it had at 1,000 feet. Now the car has about eight times more reflective capacity than the truck does, and the car will normally be the vehicle displayed on the RADAR screen.
- *Speed*: Speed does not follow the inverse square rule.
  - Depending on the RADAR used, speed becomes a factor when comparably-sized vehicles are approaching close to one another.
  - Obviously, this is usually a factor on four-lane roads rather than on two-lane roads.
  - Speed is usually the least important of the three factors.

# Unit 3 – Notes

---

*Stress that these are completely different factors.*

**Project slide 89.**

*Note:  
This example assumes an 18° beam width.*

---

**Project slide 90.**

*The beam width widens to about 160 feet.*

**Project slide 91.**

*The beam width is now about 315 feet.  
The inverse square rule applies to all kinds of wave energy.*

**Project slide 92.**

*Ask trainees:  
How can the truck's speed be displayed?*

*Answer:  
The truck is twice as far from the RADAR transmitter, and therefore receives four times less energy than the car does.*

**Project slide 93.**

*But the truck has five times the reflective capacity the car does.*

*Note:  
Some RADAR units are more speed-sensitive than others. Generally, speed sensitivity is not considered desirable.*

## Unit 3 – Contents

---

---

### The Role of Supportive Evidence—The Tracking History

- The supportive evidence used by the operator in the valid identification of a target vehicle is called the tracking history.
  - The most important supportive elements are visual and audio evidence.
- *Visual* identification of target speed:
  - Is the most critical piece of supportive evidence.
  - Requires that the operator be able to independently estimate speed without the use of a RADAR unit.
  - Is something everyone can do to some degree. Police officers become particularly adept with practice and experience.
  - Is a skill operators are strongly encouraged to practice and develop.
- Audio tracking (if available):
  - An audio feature is common now on most police traffic RADAR units.
  - This feature allows the operator to monitor the actual sound of a Doppler shift produced by a target vehicle's speed.
  - The audio unit emits a high-pitched tone for a high speed and a low-pitched tone for a low speed.
  - Operators can become competent at estimating speed based on the Doppler audio.
  - A clear and stable audio tone indicates that the RADAR unit is receiving a good signal from a single vehicle.
  - A fluttery or inconsistent audio tone indicates the presence of interference affecting RADAR or that the RADAR is switching back and forth among several targets.
- Target speed display:
  - A target speed must be displayed on the RADAR.
  - This target speed *must* correlate with the visual (and audio, if available) estimations of speed made by the operator.
  - It is *not* mandated that the target speed be locked onto the RADAR display. It is not even a particularly good idea.

## Unit 3 – Notes

---

**Project slide 94.**

*Vehicles in front usually block the beam, keeping it from "seeing" following vehicles.*

**Project slide 95.**

*Usually, reflective capability or position will be the dominant factors.*

---

**Project slide 96.**

*When single or multiple targets are present, a tracking history must be compiled.*

**Project slide 97.**

*Note that the RADAR-displayed target speed is not considered the most important.*

**Project slide 98.**

*Note:*

*Without the officer's having made a visual estimation of speed, no speed citation may be issued.*

**Project slide 99.**

*Note:*

*The term "audio" should not be confused with "audio alert" or "audio alarm."*

*Suggested training aid:*

*The instructor may wish to record the audio Doppler tone of the RADAR used in training as it reflects several different speeds, and have the trainees listen to it and try to make their own auditory estimations.*

*Note:*

*Emphasize that the audio signal should not be turned off when RADAR operations are being conducted.*

## Unit 3 – Contents

---

- These three elements—visual, audio, and target speed display—come into play in a stationary RADAR tracking history.
- For moving RADAR enforcement, an additional element is necessary.
  - It is essential to obtain verification that the patrol speed displayed by the RADAR is correct by comparing it with the calibrated speedometer.
  - An accurate patrol speed perception by RADAR is necessary in the RADAR's target speed computation.
  - Making this comparison is now mandated by case law and critical to the moving RADAR tracking history.
- A tracking history *must* be obtained for each RADAR speed enforcement action.
  - The speed displayed on the RADAR is only one piece of the necessary supportive evidence.
  - The RADAR speed measurement must comply with applicable case law.
  - An instantaneous speed measurement should not be accepted.
- The automatic locking feature available on many units should *not* be used for enforcement.
  - This feature is designed to freeze automatically when it registers any speed at or over a preset limit.
  - The autolock's disadvantages far outweigh its advantages.
  - The autolock prohibits the operator from tracking, over the most appropriate period of time, the target vehicle speed appearing on the RADAR, and correlating it with visual and auditory estimations of speed.
- When multiple targets are present, it is best to track them out of the RADAR beam, without using the autolock.
- To meet case law, the target vehicle should at some point in the tracking history be "out front, by itself, and closest to the RADAR unit."
- If traffic gets too heavy for target identification, no RADAR enforcement action should be taken.
- If any doubt exists, do not take enforcement action.

## Unit 3 – Notes

---

### ***Project slide 100.***

### ***Project slide 101.***

*Stress that the trainee should think of the target reading as supporting the visual and audio evidence, rather than the other way around.*

### ***Project slide 102.***

*Ask trainees:  
What other element is necessary for a moving RADAR tracking history?  
Answer:  
Comparison of patrol speed displayed against calibrated speedometer.*

### ***Project slide 103.***

*Note:  
Other legal requirements inherent in all traffic violations—vehicle make, model, license, and driver identification—will be covered in Unit 4.*

### ***Project slide 104.***

*The autolock feature was originally devised as a convenience feature.*

*Recommend strongly to the trainees that autolocks and alerts not be used.*

*Point out that no significant case law demands that the speed be locked in.*

### ***Project slide 105.***

*Heavy is largely a subjective evaluation. Operators must also consider terrain, ease of pursuit, etc.*

## Unit 3 – Contents

---

### The Effect of Terrain on Target Identification

- The optimum terrain for RADAR enforcement is straight, level roadway.
- Police traffic RADAR works on a line-of-sight basis, and will not normally display vehicles around a curve or over a hill.
- Hills cause the greatest problem in target identification.
  - RADAR can overshoot lead vehicles and strike vehicles far behind.
  - Operator discretion in the selection of a working area is necessary.

---

### Operational Range Control

- Some RADAR devices allow the adjustment of the operational range of the unit.
  - This feature adjusts the sensitivity of the antenna to the strength of the reflected signal.
  - It does not affect the strength of the RADAR beam that is being transmitted—this remains steady.
- Operational range control can be used to reduce target identification problems.
  - A low setting will cause the RADAR to be sensitive only to strong signals, thereby reducing its effective range.
  - A high setting will cause the RADAR to be sensitive to very weak signals, thereby increasing its effective range.
- Experimentation at each enforcement location is necessary to obtain the optimum range.
  - First, set the sensitivity level at a low setting. Increase the sensitivity while watching vehicles until the optimum range is found for the location.
  - The range setting must be high enough to allow a significant tracking history to be obtained.
  - For moving RADAR, the sensitivity setting must be higher.
- The operational range control is only approximate.
  - The control is usually designed to account for the “average” car.
  - Terrain can affect the sensitivity of the RADAR.
  - Rain or snow will decrease the RADAR’s range *slightly*.



## Unit 3 – Contents

---

- Do *not* tilt the RADAR up or down to control its operational range:
  - This promotes interference.
  - It also distorts the RADAR beam.
- Adjusting the RADAR's range control, which affects only the sensitivity of the unit's antenna, will not fool RADAR detectors, which monitor the unaffected transmission.

---

### Factors Affecting All RADAR Operation

Charges have been made that false readings can be displayed on a RADAR unit. This is true, but:

- Most of these instances are avoidable with proper understanding of the RADAR unit.
- Some are a result of natural causes and are avoidable.
- *All of them are recognizable to the trained operator.*
  - RADAR has limitations, and the operator must know them.
  - If a RADAR's limits are unavoidably exceeded, the operator must recognize it.

---

### Interference

- Interference encompasses a wide range of natural and artificial phenomena that can affect RADAR. The prevalent types are:
  - Harmonics—random radio signals mistakenly processed by the RADAR (airport RADAR, mercury and neon lights, power lines, other radio transmissions, etc.).
  - Moving objects other than motor vehicles—RADAR can receive a Doppler shift from *any* moving object (vibrating or rotating signs, fan blades, etc.).
- In order for interference to affect RADAR, it must be:
  - Very strong and close by; or
  - Present in the absence of a bona fide target signal.
- A strong target vehicle signal will almost always override an interference signal.

## Unit 3 – Notes

---

**Project slide 110.**

*A straight-ahead alignment is strongly encouraged.*

---

---

---

---

---

---

**Approximate time required:**  
*30 minutes.*

*(Prior elapsed time: 2 hours and 20 minutes.)*

**Project slide 111.**

*Emphasize that nothing can cause a RADAR device to display an improper reading that a trained, alert operator cannot recognize.*

---

---

---

---

---

---

---

---

---

---

---

**Project slide 112.**

**Project slide 113.**

*Explain how harmonics may cause a false reading when the RADAR processes a signal that is a multiple of its own frequency.*

---

---

---

---

---

---

**Project slide 114.**

*Outside the car, motion-related interference is rare.*

---

---

---

---

---

---

**Project slide 115.**

*Inside the car, both motion and harmonic interference may occur.*

---

---

---

---

---

---

## Unit 3 – Contents

---

- It is important to understand that interference can make it *appear* that a RADAR device is not working properly.
  - A well-publicized court ruling in Dade County, Florida, in the spring of 1979 cast considerable doubt on RADAR's accuracy.
  - The case cited examples where RADAR devices clocked a tree moving at over 80 mph and a house moving at 28 mph.
  - The cause of the strange readings was *interference*, coupled with improper operating procedures.
  - Knowing how to avoid or cut down on interference can greatly reduce problems of this type.
- Most interference that can affect RADAR originates *within* the patrol car—for example, from:
  - Air conditioning and heater fans;
  - Radio transmissions (police band and CB); and
  - Occasionally, faulty ignition wiring.
- Interference that originates *outside* the patrol car is less likely to affect RADAR.
  - Vibrating or rotating signs will cause a reading if no stronger signal is present.
  - Proximity to harmonic sounds—airport RADAR, high-tension power lines, etc.—may cause a false reading.
- A Doppler audio feature, which emits fluttering or buzzing sounds when interference is present, is very useful in identifying the presence of interference.
- The well-trained operator will ignore readings caused by interference because:
  - Usually there is no bona fide target vehicle present.
  - A bona fide target-vehicle signal will almost always replace the usually weak interference reading.
  - The Doppler audio will be inconsistent and impure.
  - Most interference readings are momentary, prohibiting the establishment of a valid tracking history.
  - All of the elements of a tracking history will not be present.
- Operators still should avoid:
  - Operating the RADAR in areas of known interference.
  - Transmitting on police or CB RADIO while obtaining a tracking history.
- Adverse weather conditions—rain, snow, etc.—can make the RADAR more susceptible to interference.
  - But *does not* affect RADAR accuracy as often alleged.
  - It *does* tend to *decrease* the effective range of the RADAR.

# Unit 3 – Notes

---

*Point out that the Dade County case involved a district court and had no legal impact outside that court's jurisdiction. But the case caught the media's attention, and therefore had an indirect nationwide effect.*

*Project slide 116.*

*Project slide 117.*

*Suggested training aid: Prepare a sample tape illustrating various types of audio interference. Also, a RADAR unit can be brought into the classroom and pointed at the overhead lights (usually fluorescent lamps) to create a buzzing audio.*

*Project slide 118.*

*Project slide 119.*

*Project slide 120.*

*Project slide 121.*

*Project slide 122.*

*Project slide 123.*

## Unit 3 – Contents

---

### **Multipath Beam Cancellation Effect**

- An 180 “phase inversion” of the RADAR signal causes the reflected signals to interfere with each other.
- This results in RADAR blind spots—locations where vehicles simply cannot be “seen” by the RADAR even though visible with the naked eye.
- Blind spots are created at places where the RADAR beam is reflected off many surfaces, such as roadway, fenceposts, buildings, trees, etc.
- The reflected beams, in effect, cancel each other out.
- The operator must be alert to the possibility of the RADAR displaying a vehicle well behind the target vehicle in the blind spot.
- There is no remedy to multipath beam cancellation besides avoiding such areas and obtaining a complete tracking history.

---

### **Scanning Effect**

- This is caused by the rapid swinging of a RADAR antenna near a fixed object.
  - The relative motion creates a Doppler shift.
  - It is extremely difficult to produce.
- The simple remedy: Hold the antenna steady while tracking target vehicles and obtain a complete tracking history.

---

### **Panning Effect**

- This occurs when the antenna is panned through its own counting unit, creating feedback and, subsequently, a false signal.
  - It can occur only with two-piece RADARs.
  - The Doppler audio emits an inconsistent squeal.
- The remedy is to mount or point carefully the antenna so that it doesn’t affect its own counting unit and to follow a complete tracking history.

---

### **Turn-On Power Surge Effect**

- May occur when the electrical power is rapidly turned from off to on, resulting in a momentary improper reading.
  - It results from a sudden surge of voltage to the RADAR.
  - This occurs when the officer attempts to defeat RADAR detection devices.
- A similar allegation made against the antenna “transmission hold” switch has no basis in fact.

# Unit 3 – Notes

---

*Project slide 124.*

*Project slide 125.*

*Project slide 126.*

---

*Project slide 127.*

*Note:  
This effect is also alleged to  
affect moving RADAR when  
the patrol car turns a corner  
sharply.*

*Project slide 128.*

---

*Project slide 129.*

*Project slide 130.*

*Project slide 131.*

---

*Project slide 132.*

## Unit 3 – Contents

---

- Switching the power from off to on and immediately taking a speed reading constitutes improper operation and is to be avoided; it is not conducive to obtaining a complete tracking history.

---

### Mirror Switching Effect

- Some handheld RADARs are capable of displaying speeds backwards.
  - This allows the operator to view the RADAR display through a rearview mirror.
  - The operator may mistake an “18” for an “81,” for example.
- An alert operator will not have this problem.

---

### Factors Only Affecting Moving RADAR Operation

Moving RADAR is susceptible to problems that do not affect stationary RADAR.

- An accurate computation of the target-vehicle speed depends upon the RADAR accurately perceiving the patrol car's speed.
- Other factors may affect the patrol speed as perceived by the RADAR.

---

### Patrol Speed Shadow Effect

- This effect can occur if the RADAR stops using the stationary terrain as its reference in gaining patrol speed and uses instead a moving vehicle going in the same direction in front of the RADAR.
- The patrol speed perceived by the RADAR is less than true, causing the target speed of oncoming vehicles to be displayed as improperly high.
  - A large truck often causes shadowing.
  - The patrol car must be close to the truck.
  - A significant difference in speed (10 mph or more) must exist between patrol car and truck for shadowing to occur.
  - This effect rarely occurs.
- In most cases, the patrol speed shadow effect is unavoidable but easily recognizable.
  - The visual estimation of target speed will not coincide with the target speed on the RADAR.

# Unit 3 – Notes

---

*Project slide 133.*

---

---

---

---

---

---

*Project slide 134.*

---

---

---

---

---

---

*Approximate time required:  
10 minutes.  
(Prior elapsed time: 2 hours  
and 50 minutes.)*

*Project slide 135.*

---

---

---

---

---

---

*Project slide 136.*

---

---

---

---

---

*Project slide 137.*

*Point out that some  
RADARs are more  
susceptible to shadowing  
than others. The limitations  
of the device to be used  
should be examined.*

---

---

---

---

---

## Unit 3 – Contents

---

- When the operator compares his/her RADAR display patrol speed with his/her calibrated speedometer (as required), they will not agree.
- While generally unavoidable, this effect is negated by the operator's use of a complete moving RADAR tracking history.

---

### Batching Effect

- The batching effect may occur when the patrol car's speed changes rapidly while sharply accelerating or decelerating.
  - The computer portion of the moving RADAR system may fail to keep pace with the sudden changes in the patrol car's speed.
  - As a result, the computer may use an incorrect patrol-speed value when it performs the subtraction:
$$TS = CS - PS$$
- To avoid the batching effect, the operator need only hold the patrol car's speed fairly steady while obtaining a tracking history.

---

### Conclusions

- Of all the factors affecting RADAR operation:
  - Many are a result of blatant misoperation.
  - Some have no basis in fact.
  - The potential for many to occur is low with proper operation.
  - Most have only a momentary effect.
  - All lack the necessary supportive evidence for a valid target reading.
- The proper operation of RADAR requires:
  - A significant period of visual (and audio) tracking of the target vehicle.
  - Comparison of the displayed patrol car speed with the calibrated speedometer.
- With a proper understanding of RADAR's capabilities and limitations, most problems can be avoided or, if avoidance is not possible, at least recognized.

# Unit 3 – Notes

---

*Project slide 138.*

---

---

---

---

---

---

---

*Project slide 139.*

---

---

---

---

---

---

*Project slide 140.*

---

---

---

---

---

---

---

---

---

*Project slide 141.*

*Project slide 142.*

*Project slide 143.*

*Project slide 144.*

*Project slide 145.*

---

---

---

---

---

---

---

---

*Project slide 146.*

*Stress again that the target speed is only one element of several that makes up a valid RADAR-based speed citation.*

---

---

---

---

---

---

---

---

## Unit 3 – Contents

---

### Jamming and Detection of Police Traffic RADAR

Attempting to create false or distorted RADAR signals is known as jamming.

- Jamming is rarely encountered, but can be a severe problem when it is.
- The primary types of jamming devices are RADAR frequency transmitters.
- The RADAR frequency transmitter sends out a strong signal with a frequency close to that of the police RADAR.
  - The RADAR “sees” that signal instead of the waves reflected off the vehicle.
  - The RADAR registers either no speed measurement at all or an obviously false measurement.
- The RADAR frequency transmitter, when used as a jamming device, violates FCC regulations and is therefore illegal.
  - Notify the nearest FCC office immediately if you should encounter a transmitter.
  - Make sure of your legal ground before confiscating one.
- The presence of a RADAR jammer is recognizable:
  - The Doppler audio may be uneven and inconsistent.
  - If the RADAR has a “transmission hold” switch, the operator may receive a signal when on hold.
- Other methods sometimes tried to jam RADAR border on the ludicrous and are totally ineffective:
  - Strips of metal foil on vehicle.
  - Hanging chains.
  - Metal objects in hubcaps.
  - Horn-honking.

---

### RADAR Detection Techniques

- Sometimes violators can detect RADAR before it detects them.
- Early warning allows violators to temporarily slow down to a legal speed to avoid apprehension.
- Three major methods of RADAR detection/early warning:
  - Flashing headlights.
  - CB radio.
  - Electronic detection (RADAR receivers).
- The flashing-headlights method relies on cooperation among drivers.
  - Those drivers who have passed by the scene of RADAR operations flash their vehicles’ headlights to alert traffic coming from opposite direction.
  - Violators among the oncoming traffic slow down until they pass the RADAR.

# Unit 3 – Notes

Approximate time required:  
15 minutes.  
(Prior elapsed time: 3  
hours.)

Write on chalkboard or flip-  
chart:

“Jamming.”

Point out that this involves a  
deliberate distortion of  
RADAR speed  
measurements by elements of  
the motoring public.

Suggested training aid:  
Demonstrate a confiscated or  
manufactured jamming  
device.

Point out that some States  
outlaw such devices,  
eliminating the need to  
prosecute through the FCC.

This applies only to those  
devices that have a  
transmission hold switch  
option.

Point out that this is the  
oldest method of RADAR  
detection/warning.

## Unit 3 – Contents

---

- Because flashing headlights cannot convey the exact location of RADAR operations, violators must maintain legal speeds for at least several miles.
- CB radio is a more modern method relying on cooperation among violators.
  - Its advantage to violators is that it becomes possible to learn of the exact location of the RADAR.
  - Its disadvantage is that the warning is available only to violators equipped with CB's.
- CB helps speed-violators evade apprehension, but benefits highway safety as well. CB:
  - Allows motorists to be informed of roadway hazards (accidents, slippery conditions, debris on road, etc.).
  - Helps keep motorists awake and alert.
  - Permits more rapid police and emergency response to accidents, stranded motorists, and similar situations.
  - Permits motorists to notify police of law-breakers (drunk drivers, flagrant speeders, etc.).
- Electronic RADAR detectors are simply radio receivers tuned to the frequencies of police RADARs.
  - When a RADAR signal is picked up, the detector sounds a buzzer or lights up an indicator lamp, warning the driver.
- Late-model RADAR detectors are quite effective.
  - They can provide ample advance warning of RADAR.
  - They rarely produce false alarms.
- It is possible to design and operate RADAR to limit the effectiveness of detectors.
  - The basic idea is for you to delay transmitting until the suspected violator is within the effective range of the RADAR, preventing the violator from obtaining advance warning.
  - You should delay transmitting until it is too late for the violator to slow down, but allow enough time to obtain an accurate speed measurement.
- You *cannot* defeat RADAR detectors simply by shortening the range control.
  - Even if the range set is short, the RADAR energy goes on infinitely.
  - Detectors can pick up that energy well beyond the operational range.

## Unit 3 – Notes

*Point out that this actually helps to bring about compliance with the speed regulations.*

*Violators need to slow down only in the actual neighborhood of the RADAR.*

*Point out that the CB's benefits far outweigh the harm caused through RADAR detection or warning.*

*Suggested training aid: Display one or more commercially available RADAR detectors.*

*Point out that earlier models were not always effective.*

*Remember that the operator needs time to obtain a significant tracking history—~~an instantaneous reading is not acceptable.~~*

*Ask trainees: Why does the RADAR detector work beyond the RADAR's range?*

*Answer: The radar signal must be sent and reflected. The RADAR detector only has to read the original signal going out.*

# Unit 3 – Contents

---

## Review and Summary

The basis of RADAR speed measurement is the transmission and reception of radio signals.

- Every radio signal has its own characteristic *frequency*.
- When a signal strikes a moving object, its frequency is changed.
- The amount of frequency change depends on how fast the object is moving.

---

Stationary RADAR measures directly the frequency change between the transmitted signal and the signal reflected from a moving target vehicle.

- The target vehicle may be moving toward or away from the stationary RADAR.
- Due to the angular effect, the measured speed may be less than the true speed.

---

Moving RADAR operates by measuring *two* speeds.

- The two measured speeds are:
  - *Closing speed* of the patrol vehicle and target vehicle.
  - *Patrol vehicle's speed* relative to ground.
- The target vehicle's speed is *computed*, not measured directly.
- Under certain circumstances, a moving RADAR might produce a measurement of patrol speed that is too low.
  - This may produce, in turn, a computed target speed that is too high.

# Unit 3 – Notes

*Approximate time required:  
15 minutes.  
(Prior elapsed time: 3 hours  
and 15 minutes.)*

*Ask trainees:  
What is frequency?*

*Ask trainees:  
What is the basic principle of  
frequency change called?*

*Ask trainees:  
How does this differ from  
the original Doppler  
Principle?*

*Ask trainees:  
When does RADAR measure  
the true speed of the target  
vehicle?*

*Ask trainees:  
What does the angular effect  
do to stationary RADAR?*

*Ask trainees:  
What two speeds does  
RADAR measure?*

*Ask trainees:  
In simple terms, describe the  
target speed calculation.*

*Ask trainees:  
What conditions cause a low  
patrol speed?*

## Unit 3 – Contents

---

**Proper target-vehicle identification requires an understanding of RADAR decisionmaking and the role of supportive evidence.**

- The reflective capability, position, and speed of a target vehicle may each affect the RADAR.
- The separate elements of supportive evidence make up the tracking history.

---

**There are factors that can affect RADAR operation.**

- These factors are due to logical limitations of the RADAR instrument.
- Some are avoidable; others are recognizable to the trained operator.
- When these factors are present, the necessary supportive evidence is not.
- That RADAR can be jammed or detected by motorists does not significantly affect its usefulness.

---

### **Evaluation**

- Sample evaluative questions:
  1. A RADAR signal's *wavelength* is:
    - (a) Approximately 10 billion per second.
    - \*(b) The distance from the beginning of the wave peak to the end of the wave valley.
    - (c) Approximatey 186,000 miles.
    - (d) Infinite.

# Unit 3 – Notes

---

*Ask trainees:  
Valid target identification  
requires a basic  
understanding by the  
operator of two concepts.  
Explain them.*

*Ask trainees:  
What are the basic elements  
in a stationary RADAR  
tracking history? A moving  
RADAR tracking history?*

*Ask trainees:  
What three factors affect  
RADAR decision-making?*

---

*Ask trainees:  
What factors affect stationary  
and moving RADAR  
operation?*

*Ask trainees:  
How does one avoid or  
recognize each factor?*

*Ask trainees:  
How can a jammer be  
detected?*

## Unit 3 – Contents

---

2. A RADAR signal's *frequency* is:
    - \*(a) The number of waves sent out during 1 second.
    - (b) Approximately 186,000 miles per second.
    - (c) About 3 centimeters, or 1-1/5 inches.
    - (d) Infinite, unless it strikes a solid object.
  3. When a RADAR signal is reflected off a moving object:
    - (a) Its wavelength, frequency, and speed all change.
    - \*(b) Its signal speed stays the same.
    - (c) Its signal speed increases if the object is moving toward the RADAR, and decreases if the object is moving away.
    - (d) Its frequency always increases.
  4. When you adjust a RADAR's operational range, you change its:
    - (a) Power output.
    - (b) Beam length *and* wavelength.
    - (c) Beam length only.
    - \*(d) Sensitivity.
  5. The angular effect:
    - (a) Only applies to stationary RADAR.
    - \*(b) Is always in the violator's favor when stationary RADAR is used.
    - (c) Can be reduced by lengthening operation range.
    - (d) Is always against the violator's favor when stationary RADAR is used.
  6. If a RADAR beam is reflected off an object and does *not* experience any Doppler shift, then:
    - (a) The object must not be moving at all.
    - (b) The object must be beyond the operational range setting.
    - \*(c) The object must not be getting any closer to or any farther from the RADAR.
    - (d) The object must be using a radio frequency jammer.
  7. When one is operating a *moving* RADAR:
    - \*(a) The computed target speed might be higher than the true target speed.
    - (b) The patrol vehicle's speed must be kept *absolutely* steady.
    - (c) The patrol vehicle and the target vehicle must be heading in the same direction.
    - (d) The patrol vehicle's speedometer must be calibrated precisely.
- Solicit and answer trainees' questions concerning the contents of this unit.



# Unit 4

## Legal and Operational Considerations

*Total Time:*  
*1 hour and 40 minutes*

---

### Objectives

The trainee should be able to:

- Identify and describe the fundamental case law affecting the use of RADAR for speed measurement and enforcement.
- Demonstrate basic skills in preparing and presenting evidence and testimony concerning speed enforcement and RADAR speed measurement.
- Describe the accepted testing procedures and general operating considerations for police traffic RADAR.

### Requirements

Handout Materials:

- Copies of court rulings relevant to RADAR speed measurement and enforcement stemming from cases within trainees' jurisdictions(s) (if any). Copies of RADAR operations forms, logs, etc. used within trainees' jurisdiction(s).

References:

- Fisher, Edward C. (Reeder, R., Revision author). *Vehicle Traffic Law*, 1974, Revised Edition. Northwestern University Traffic Institute (1974).
- Fisher, Edward C. *Legal Aspects of Speed Measuring Devices*. Northwestern University Traffic Institute.
- Ward, Kenneth L. *Techniques for RADAR Speed Detection*. Northwestern University Traffic Institute.

Suggested Illustrations:

- Basic issue concerning validity of RADAR speed measurement.
- Four specific questions pertaining to RADAR validity.
- Principle of judicial notice.
- Key points of *State v. Dantonio*.
- Principle of "before and after" testing.
- Key points of *State v. Tomanelli*.
- Key points of *Honeycutt v. Commonwealth*.
- Key points of *State v. Hanson*.

Summary of Testimonial Requirements for RADAR:

- Examples of valid needs for RADAR.
- RADAR site selection considerations.
- RADAR assembly considerations.
- Tests for calibration used for RADAR.

Additional training aid:

- Audio tape or videotape of sample testimony concerning RADAR speed measurement.

Instructor Tasks

The instructor must be familiar with the structure and contents of this unit. The unit contains the following segments:

1. Introduction (5 minutes).
2. Fundamental case law affecting RADAR speed measurement (30 minutes).

3. Case preparation and presentation (25 minutes).
4. General operating requirements and procedures (30 minutes).
5. Review and summary (10 minutes).

The instructor must be familiar with judicial decisions affecting RADAR speed measurement that have been handed down in courts within the trainees' jurisdictions and prepared to incorporate the key points of these decisions into this unit's lesson plans. The instructor must be familiar with the RADAR speed measurement policies and procedures adopted by the trainees' department(s) and to incorporate these policies and procedures into this unit's lesson plans.

The instructor should review the listed references and similar sources of information. Feel free to augment the lesson plans, as appropriate, using information drawn from the references and from previous personal experience.

The instructor must prepare or obtain all instructional aids specified in the lesson plans. Feel free to use any additional instructional aids that will enhance learning.

The instructor should prepare an audio tape of a sample testimony pertaining to a RADAR speed measurement case. The text provided as Figure 4-1 of the *Trainee Instructional Manual* should be used as a *guide* for that tape. Whenever appropriate, the text should be modified to reflect the policies of the trainees' jurisdiction(s).

# A Model of Testimony Concerning RADAR Speed Measurement

"My name is John B. Smith. I am a trooper assigned to the Traffic Unit of the Connecticut State Police Department. As part of my duties for the past year, I have operated police traffic RADAR for this department. I have successfully completed a basic training program for RADAR speed measurement, and I currently hold a Certificate of Competency issued by my department.

"On the afternoon of June 2, 1981, I was operating a stationary RADAR unit on Post Road at the corner of Old Kings Highway. The RADAR unit, a model manufactured by Acme RADAR Instruments, was operating in a normal manner. Tests for calibration had been performed when the unit was first set up at 2:15 p.m., and again at the end of my duty tour at 6:20 p.m.

"At approximately 4:25 p.m. a 1978 Alfa Romeo, Connecticut Registration Number 1A-1750 (later found to be driven by the defendant, Paul A. Branless), was observed approaching from the south at what appeared to be a high rate of speed. From visual observation, I judged the speed to be approximately 60 mph. The audio pitch emitted by the RADAR correlated with this speed estimate.

"At the corner of Post Road and Old Kings Highway, when the defendant's vehicle was out front of other traffic, a stable RADAR target speed reading was obtained. The speed reading obtained was 55 mph. The posted speed limit on Old Kings Highway at the intersection of Post Road is 35 mph. [At this point, if the basic speed law applies the officer should state that the speed was unreasonable in light of the conditions of the roadway, traffic, and/or visibility. If a prima facie limit or absolute speed law applies, the officer should also state that RADAR warning signs were in place as required by law.]

"I pursued the suspect for about a block, at which point the suspect's vehicle pulled to the curb. When I approached the vehicle, I discovered the defendant, Mr. Branless [here the officer should point out the defendant], to be the operator of the vehicle."

# Unit 4 – Contents

---

## Introduction

### Unit Title and Objectives

- Unit Title—"Legal and Operational Considerations"
- Unit Objectives—Trainees should be able to:
  - Identify and describe the fundamental case law affecting RADAR speed measurement.
  - Acquire and demonstrate basic skills in preparing and presenting evidence and testimony concerning speed enforcement and RADAR speed measurement.
  - Describe the accepted testing procedures and general operating considerations for police traffic RADAR.

---

### Unit Content

- In order to use RADAR legally for traffic law enforcement, the RADAR operator must comply with certain prerequisites and procedures that have evolved from court decisions.
  - Courts have established guidelines for RADAR use that are designed to ensure that RADAR speed measurements are accurate and valid.
  - Failure to comply with those guidelines can result in the court's refusal to admit the speed measurement into evidence.
- The evidence obtained through RADAR speed measurement is only as good as the person who presents it.
  - It is the RADAR operator's duty to provide records and testimony in court.
  - Overlooking some key point or failing to cover it adequately may jeopardize the entire case.
- Although every RADAR instrument has its own operating characteristics, all devices have certain operating procedures in common.
  - These general procedures cover how to determine where and when to use the RADAR, how to prepare the instrument and oneself for speed surveillance operations, and what information to obtain as evidence.
  - Following these general procedures will help ensure the admissibility of one's evidence in court.

# Unit 4 – Notes

---

*Introduction*

*Approximate time required:  
5 minutes.*

*Unit title on chalkboard or  
flip-chart.*

*Refer trainees to list of Unit  
4 objectives in the Trainee  
Instructional Manual.*

---

*Relate content to objectives.*

*Point out that these  
guidelines are called case  
law—rulings that come from  
the adjudication of a  
particular case and affect all  
subsequent cases.*

*Point out that case law  
applies directly only within  
the jurisdiction of the  
particular court that handed  
down the decision, but that  
it can, and often will, be  
cited as precedent in any  
other court in the country.*

## Unit 4 – Contents

---

### Fundamental Case Law Affecting RADAR Speed Measurement

Speed-measuring RADAR is used by traffic law enforcement to acquire evidence.

- To be useful to the case, the evidence 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 a 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?*

- The word *accurate* in this question is somewhat vague.
  - Certainly the measurement could miss the true speed by an accepted tolerance and still be considered accurate.
  - The measurement could even miss by several mph and still be reasonably accurate, *as long as the miss was in the suspect's favor*.

---

RADAR measurement accuracy requires answering *four specific questions*:

- 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?

# Unit 4 – Notes

---

*Approximate time required:  
30 minutes.  
(Prior elapsed time: 5  
minutes.)*

---

*Project slide 147.*

---

*Project slide 148.*

*Point out that these  
questions apply to all types  
RADAR instruments. Note  
that questions that apply  
specifically to moving  
RADAR will be covered  
later in the unit.*

## Unit 4 – Contents

---

Ever since RADAR was first introduced into traffic law enforcement, these questions have been raised in court.

- In several cases, the courts handed down rulings affecting how these questions can be answered.
  - By and large, these landmark rulings have made it simpler to introduce RADAR speed measurements as evidence.
  - But the rulings have imposed some specific operating procedures that must always be followed.
- 

The question of the validity of the Doppler Principle has been resolved through *judicial notice*.

- Judicial notice is an elementary principle of law.
    - The principle applies to facts that are common knowledge and states that it is not necessary to introduce evidence to prove what is common knowledge.
  - When traffic RADAR was first used, judicial notice had not been taken of the Doppler Principle.
    - This did not mean that the Doppler Principle had not been discovered or that it was doubted by the scientific community, but that the courts did not consider the principle to be so well known as to be common knowledge.
  - The lack of judicial notice meant that in every court case involving RADAR, expert witnesses had to testify to the validity of the Doppler Principle.
  - In June 1955, this requirement ended in the State of New Jersey.
    - The landmark case was *State v. Dantonio*.
    - The New Jersey Supreme Court took judicial notice of the Doppler Principle.
    - Other States quickly followed suit.
  - It is no longer necessary to establish the validity of the Doppler Principle as the scientific basis for RADAR speed measurement.
    - Its validity is now accepted.
    - But the court will not necessarily accept Doppler speed measurements made by a particular RADAR device.
- 

The question of the accuracy of a particular RADAR instrument cannot be resolved through judicial notice.

- The courts will not and cannot accept the accuracy of every traffic RADAR instrument.
  - The courts cannot even accept the accuracy of every instrument of a particular make and model.
  - Nor can they give blanket acceptance to a single instrument every time it is used.

# Unit 4 – Notes

---

---

---

---

---

---

---

---

***Project slide 149.***

*Remind trainees that the Doppler Principle was discovered in the nineteenth century.*

---

---

---

---

---

---

---

---

***Project slide 150.***

*Cite case(s) affirming judicial notice of the Doppler Principle in the trainees' own State.*

---

---

---

---

---

---

---

---

---

---

***Project slide 151.***

*Ask trainees: Why can't the courts take judicial notice of the accuracy of a particular RADAR instrument?*

---

---

---

---

---

---

## Unit 4 – Contents

---

- A RADAR device, like any other scientific instrument, is liable to break down.
  - Because the instrument is working properly today does not mean it will work properly tomorrow.
  - The courts insist on evidence that the instrument was working properly at the time the speed measurement was made.
- The courts *can* take judicial notice of certain *methods and techniques* for determining whether the RADAR instrument is working properly.
  - These methods then become part of the proper operating procedure for RADAR speed measurement.
- Courts have long accepted the principle of “before and after” testing.
  - Before-and-after testing requires that the instrument be shown to be working properly both shortly before and soon after the measurement is made of the suspect vehicle’s speed.
  - The implication is that when the measurement was taken, the instrument was working properly.
- The next step was to have the courts accept some method of checking how well the instrument works.
- The first checking method to be accepted required the use of a test vehicle equipped with a calibrated speedometer.
  - The test vehicle is driven past the RADAR at a constant speed.
  - The RADAR speed measurement is compared with the reading on the test vehicle’s speedometer.
  - If the measurements agree, the instrument will be known to be working properly.
- Although the test vehicle method works reasonably well, it has some disadvantages:
  - It is cumbersome and time-consuming.
  - Other traffic can affect the test vehicle’s ability to maintain a fixed speed as well as the RADAR’s speed measurements.
  - The check is only as accurate as the test vehicle’s speedometer.
  - And it requires a test vehicle.
- A more convenient and effective method of checking RADAR instrument accuracy uses a *tuning fork*.
  - A tuning fork is a precision-engineered metal device that vibrates at some specific frequency when struck.
  - The RADAR interprets the fork’s frequency as a Doppler shift.
  - The Doppler shift corresponds to a particular speed measurement.
  - Each tuning fork is designed to produce some particular speed measurement.

# Unit 4 – Notes

---

***Project slide 152.***

*Point out that before-and-after testing requires the vehicle check to be performed at the beginning and end of operations at a particular location.*

***Project slide 153.***

*Note that the chase car usually serves as the test vehicle.*

***Ask trainees:***

*Suggest some possible disadvantages of the test vehicle method.*

*Point out that because most RADAR instruments are more accurate than speedometers are, the test vehicle method reduces the RADAR's accuracy to the speedometer's level. The test vehicle method is not suited to one-car RADAR operation.*

***Project slide 154.***

*Demonstrate a standard tuning fork. Show that although the vibrating tines produce a sound, this sound has nothing to do with the*

## Unit 4 – Contents

---

- Judicial notice of the tuning fork method as a reliable test of RADAR instrument accuracy was first taken by the Connecticut Supreme Court.
  - The landmark case was *State v. Tomanelli*.
  - The court pointed out, however, that while the tuning fork method is acceptable, the result of the test is only as good as the tuning fork used.
  - Most manufacturers certify their tuning forks. Law enforcement agencies usually test the forks periodically to ensure that they produce the proper frequency.

---

**The question of RADAR operator qualifications was addressed by the Kentucky Court of Appeals in the landmark case *Honeycutt v. Commonwealth*.**

- *Honeycutt v. Commonwealth* established that a speed-measurement RADAR operator *need not* be able to explain the internal workings of the RADAR instrument.
  - Knowledge of the Doppler Principle is irrelevant to the operation of RADAR.
  - The defense cannot question the operator's knowledge of the Doppler Principle or other scientific principles.
  - The operator should not attempt to describe or explain these principles in courtroom testimony.
- In *Honeycutt v. Commonwealth* the court ruled that it is sufficient to have enough knowledge and training to properly:
  - Set up the RADAR instrument.
  - Test its accuracy.
  - Read the instrument to obtain the speed measurement.
- In its ruling, the court stated that a few hours' instruction normally provides a RADAR operator with the necessary knowledge and skill.
- The impact of this ruling on an officer's testimony means:
  - You must establish that you have the necessary qualifications and training for a RADAR operator.
  - You must establish that the instrument was set up properly and working normally.
  - You must establish that the RADAR's accuracy was verified with a proper test.

## Unit 4 – Notes

---

*RADAR speed measurement. The fast-moving metal causes the frequency shift, not the sound.*

***Project slide 155.***

*In other words, the court wants proof that the tuning fork actually produced the desired frequency.*

---

***Project slide 156.***

***Project slide 157.***

*The certificate the trainees receive at the end of the course will establish their qualifications.*

*The ability of a qualified and experienced operator to tell whether RADAR works properly is accepted in court.*

## Unit 4 – Contents

---

---

**How can we verify that the RADAR speed measurement actually came from the accused's vehicle?**

- *Honeycutt v. Commonwealth* was also the landmark ruling for this issue.
- The court cited conditions under which it can reasonably be assumed that a speed measurement applies to a particular vehicle:
  - The target vehicle must be the vehicle closest to the RADAR unit.
  - It must be out in front of any other vehicles and well separated from them.
  - The officer must make a visual estimate of the vehicle's speed.
  - The RADAR speed measurement must be relatively close to the initial visual estimate.

---

**The landmark cases already cited have stemmed from the use of *stationary* RADAR instruments.**

- These cases also apply to moving RADAR.
- Moving RADAR has important characteristics, however, that did not affect any of the aforementioned key decisions.

# Unit 4 – Notes

---

*Using a certified tuning fork is accepted as making a proper test.*

---

---

---

---

---

---

---

*Project slide 158.*

---

---

---

---

*If another vehicle is closer to the RADAR than is the suspected violator's vehicle, the RADAR measurement must be delayed until the lead vehicle has cleared the scene.*

---

---

---

---

---

---

*The degree of separation depends on the types of vehicles involved (e.g., a motorcycle must be quite far ahead of a large truck in order to obtain an acceptable measurement of the motorcycle's speed).*

---

---

---

---

---

---

*An officer must see the violation, estimate the speed of the vehicle, and obtain a confirming RADAR measurement. The enforcement action cannot be based solely on the RADAR speed measurement.*

---

---

---

---

---

---

---

*Ask trainees:  
What characteristic of moving RADAR most concerns the courts?*

---

---

---

*Point out that moving RADAR can produce a high target speed reading under certain circumstances.*

---

---

---

---

## Unit 4 – Contents

---

**One important question concerning moving RADAR is: How do we know that the target speed calculation was not based on a patrol speed measurement that was too low?**

- This question and other issues involving moving RADAR were addressed in the landmark case of *State v. Hanson*.
- In *State v. Hanson*, the court decreed that the officer must be able to testify:
  - To having had adequate training and experience in the operation of the moving RADAR.
  - That the moving RADAR instrument was in proper working order and that its testing had followed suggested methods.
  - That the instrument was used in an area where road conditions presented only the minimum possibility of distortion.
  - *That the patrol car's speed was verified.* This is especially important when unfavorable road conditions (e.g., presence of large trucks, congested traffic, or the roadside being heavily covered with trees and large signs) may have distorted the accuracy of the reading.
  - That the instrument was expertly tested soon after the arrest and that the testing did not rely on the instrument's own internal calibrations.

---

### Case Preparation and Presentation

**The elements that are common to all speeding offenses are *driver, vehicle, and location.***

- Successful prosecution of any speeding violation requires that all elements of the offense be established. You must:
  - Prove that the accused was in fact the driver.
  - Identify the vehicle in question and establish that any speed measurements taken were based on that vehicle and no other.
  - Establish that the alleged offense took place where the public has right of vehicular access and identify the absolute or *prima facie* speed limit in force at that location.
- If the offense is a violation of an absolute speed law, it must be established that the accused's vehicle was in fact exceeding the specified limit.

# Unit 4 – Notes

---

*Project slide 159.*

*Project slide 160.*

*State v. Hanson: Landmark case concerning moving RADAR.*

*That is, the absence of known sources of interference and other negative factors.*

*The officer must also be able to testify to keeping the vehicle's speed fairly steady while making the speed measurement and verifying patrol speed.*

*A tuning fork or calibrated speedometer must have been used to verify the RADAR's accuracy.*

---

*Approximate time required: 25 minutes.  
(Prior elapsed time: 35 minutes.)*

*Write on chalkboard or flip-chart:*

*"Driver—Vehicle—Location."*

*Remind the trainees that this can sometimes be difficult (e.g., if the driver and other passengers are not carefully observed as they exit the vehicle once it is stopped).*

*Write on chalkboard or flip-chart:*

*"If absolute speed violation, prove speed exceeded specified limit."*

## Unit 4 – Contents

---

- If the offense is a violation of the basic speed law, it must be established that the violator's speed was unreasonable for the existing conditions:
  - The officer must describe the conditions and the actual or potential hazards.
  - Any speed in excess of the *prima facie* limit is important evidence.

---

If the prosecution offers a RADAR speed measurement as evidence of an offense, it must be proven that the RADAR speed measurement was obtained in compliance with applicable case law by establishing that:

- The RADAR was operating properly.
- The instrument's accuracy was verified with an appropriate method both before and after the incident.
- The operator was properly qualified and trained.
- There was a visual observation of the violation and an initial speed estimate based on that observation.
- The RADAR speed measurement was taken when the vehicle was out in front of other traffic and closest to the RADAR.
- If a moving RADAR was used, the patrol vehicle's speed measurement was verified at the time the target's speed was noted.

---

**Sample courtroom testimony in RADAR speed measurement.**

---

**Discussion of sample testimony:**

- Did the testimony establish that the accused was the driver?
- Were the officer's qualifications as a RADAR operator established?
- Did the officer identify the vehicle?
- Did the officer establish that the RADAR was operating properly?

# Unit 4 – Notes

---

*Write on chalkboard or flip-chart:  
If basic violation, prove speed was unreasonable and imprudent.*

---

---

---

---

---

---

---

*Ask trainees:  
What specifically must be established to prove compliance with RADAR operations case law?*

*Project slide 161.*

*Note: If the RADAR device is equipped with a Doppler audio feature, that evidence should be introduced at this point.*

---

---

---

---

---

---

---

---

---

---

---

---

---

*Introduce sample testimony to show how the necessary facts can be establish. Play the tape recording of the testimony, advising the trainees to follow along with the transcript given as Figure 4-1 of the Trainee Instructional Manual.*

---

---

---

---

---

---

---

*Ask the class the indicated questions. Elicit discussion:  
How were the facts established? Were any important points missed?  
Could the officer have done a better job of establishing the facts?*

---

---

---

---

---

---

## Unit 4 – Contents

---

- Did the officer establish that the instrument's accuracy was properly verified?
- Was it established that a visual observation of the violation was made?
- Was it adequately established that the vehicle driven by the accused was the subject of the RADAR speed measurement?

---

### General Operating Requirements and Procedures

**A RADAR instrument used for traffic law enforcement must be properly licensed.**

- The necessary license is issued by the Federal Communications Commission (FCC).
- Speed-measurement RADAR is classified as a *pushbutton* instrument and requires a *station license*.
  - The license is issued to the police station that owns the instrument(s), not to the individuals who operate it.
  - In the case of speed measurement RADAR, the law enforcement agency is the station.

---

**General setup procedures must be carefully followed before RADAR operations can begin.**

- Setup procedures include component assembly, antenna mounting, and instrument testing.
- The first step, component assembly, applies only to two-piece RADAR instruments.
  - Two-piece instruments consist of an antenna and a counting unit that must be connected.
  - One-piece instruments have the permanently connected antenna and counting unit housed in the same component.
- *Remember to connect the antenna to the counting unit BEFORE plugging the RADAR into the power source.*
  - Plugging the unit into the power source before the antenna is connected can damage it.

## Unit 4 – Notes

---

*Approximate time required:  
30 minutes.*

*(Prior elapsed time: 1 hour.)*

*Write on chalkboard or flip-  
chart:*

*“RADAR Licensing.”*

*Write on chalkboard or flip-  
chart:*

*“Station license.”*

---

*Write on chalkboard or flip-  
chart:*

*“Component assembly.”*

*Project slide 162.*

## Unit 4 – Contents

---

- An easy way to remember the order of assembly is: “A-B-C.”
  - A—Antenna
  - B—Box (counting unit)
  - C—Current (power source)
- The second step of setting up is antenna mounting. Describe your agency’s policy. There are three general guidelines:
  - Avoid mounting positions that unnecessarily expose the operator or passengers to microwave radiation.
  - Do not pan the antenna through the display console (this of course only applies to two-piece units).
  - Avoid directing the RADAR beam at nearby large metallic surfaces, such as a car door, to minimize potential damage.
- The third step is testing, which verifies that the RADAR instrument is working properly and accurately.
- For every RADAR, two tests are performed—*internal circuit testing* and *external testing*.
  - The internal circuit test checks *only* the circuitry inside the RADAR counting unit.
  - The procedure for conducting an internal circuit test varies from one RADAR instrument to another. This matter will be covered in Unit 5.
- The external test is performed with a *tuning fork* and measures the accuracy of both the antenna and the counting unit.
  - Each tuning fork is designed to produce a specific speed measurement; it is manufactured to exacting specifications and certified by the maker as reliable.
- When using a tuning fork for external testing of a RADAR instrument, remember:
  - *Never use a fork designed for one RADAR model to test another model*; every fork is designed for use with only one type of RADAR instrument.
  - Avoid striking the fork on an extremely hard surface; this could cause the fork to break.
  - Point the antenna skyward when testing the calibration to reduce the chances of picking up a stronger signal from a passing vehicle.
  - Hold the fork parallel to the antenna face at a distance of 1 to 2 inches, with only one tine facing the antenna.
- In order to pass the external test, the speed measurement obtained must be within 1 mph of the rated value of the tuning fork.
  - A deviation of no more than 1 mph is acceptable.
  - If the deviation is over 1 mph, perform the test a second time.
  - If the deviation is again over 1 mph, *do not use the RADAR unit*.



## Unit 4 – Contents

---

- Conducting the internal circuit and external tuning fork tests is sufficient preparation for the operation of stationary RADAR.
- But moving RADAR requires an additional test—the comparison of the patrol speed displayed by the RADAR with the speed measured by the patrol car calibrated speedometer.
  - This test ensures that the RADAR properly perceives the patrol car's true speed—a necessary factor in the computing of the target's speed.
  - The operator accelerates the patrol car to a steady speed, noting the patrol speed displayed by the RADAR and comparing it with the speed displayed by the calibrated speedometer.
  - If a significant deviation exists, the RADAR must not be used.
  - It must then be determined whether the RADAR, the speedometer, or both are in error.
  - This test can also be conducted on stationary RADAR.
- The failure of a RADAR unit to pass *any* required test is grounds for its immediate removal from service.
- Subsequent tests for accuracy: How soon before and after a speed measurement should the RADAR be tested?
  - The minimum requirements are established by departmental policy and local court requirements.
  - The suggested minimum is at the beginning and end of each shift, *at least*.
  - Many agencies require their RADAR operators to test the devices each time they set up and tear down.

---

### **A number of key factors govern RADAR site selection.**

- First and foremost, there must be a valid *need* for RADAR speed measurement.
  - Never set up RADAR operations at a particular site simply because it is convenient.
  - Instead, choose a location that presents or is suspected of presenting a speed traffic safety problem:
    - a. Locations where speed has been a factor in a number of accidents.
    - b. Locations that have been the subjects of citizen complaint.
    - c. Locations where general speed violations frequently occur.
    - d. Locations having unusual speed regulations (school zones, construction sites, etc.).
    - e. Locations selected for special speed surveys (to determine compliance, to establish limits, etc.).

## Unit 4 – Notes

---

*RADAR display should show no less than 64 mph and no more than 66 mph. The operator must take into consideration the known mph discrepancy of the speedometer, if there is a discrepancy.*

*Testing a stationary RADAR in this fashion is an additional test.*

*Note:  
How often these tests are performed varies widely among different enforcement jurisdictions.*

---

*Write on chalkboard or flip-chart:  
"Site Selection."*

*Write on chalkboard or flip-chart:  
"Need."*

**Project slide 166.**

*Briefly describe each type of need.*

## Unit 4 – Contents

---

- The *traffic and road conditions* must also be considered when selecting a location for RADAR operations.
  - Vehicles passing the site should be spaced apart rather than bunched.
  - The roadway should not be excessively hilly or curved; this terrain makes good visual observation difficult.
  - There should be a clear and unobstructed view of oncoming traffic.
  - If moving RADAR is used, the traffic and road conditions must permit only the minimum possibility of distortion.
- *Safety* is also a factor.
  - Position the patrol vehicle and RADAR unit so that they do not impede or endanger pedestrian or vehicular traffic.
  - It must be possible to enter the traffic stream and conduct pursuit and apprehension safely.
- There are other considerations that can affect the site selection for RADAR operations.
  - Operations should not be conducted where there is too much natural or artificial interference.
  - Operations at a particular location should not be continued too long or repeated too often; with time, violators will come to know the locations.
  - If the RADAR operations involve a spotter car and a chase car, the location should permit the operators of the two vehicles to maintain visual contact to ensure that enforcement actions are taken against the proper vehicles.

---

### **RADAR speed measurement operations demand:**

- An accurate record be kept for preserving key evidence to support a charge in court.
- Departmental RADAR operations forms.

# Unit 4 – Notes

---

***Project slide 167.***

*Write on chalkboard or flip-chart:*

*“Traffic/Road Conditions.”*

*Remind trainees that target identification can be a problem and that they must be able to testify that the violator’s vehicle was alone and out in front when the RADAR speed measurement was made.*

*Remind trainees that they must be able to testify that they observed the violation and made a visual estimate of speed before obtaining the RADAR speed measurements.*

*Write on chalkboard or flip-chart:*

*“Safety.”*

***Project slide 168.***

*Remind trainees that by obtaining a tracking history they can ensure that interference did not affect speed measurement.*

*A similar arrangement can work in an urban environment where RADAR operation might involve a foot patrol officer and a chase car.*

---

*Distribute copies of the RADAR operations form used by the trainees’ department and display a slide of the form. Explain each entry on the form.*

# Unit 4 – Contents

---

## Review and Summary

Several landmark court decisions deal with the accuracy and admissibility of RADAR speed measurements.

- In one fundamental case, judicial notice was extended to the Doppler Principle.
- In another, the tuning fork was accepted as a valid means of verifying the accuracy of a RADAR instrument.
- In a third, the essential qualifications of a RADAR operator were established, as well as the requirements for verifying that the RADAR speed measurement comes from the accused's vehicle.
- In the fourth case, key requirements for moving RADAR operations were defined.

---

To obtain a conviction for a speed violation all elements of the alleged violation must be established and all evidence supporting these elements must be gathered in strict accordance with the relevant court rulings.

- The elements of a violation of the basic speed law include: driver; vehicle; location; and speed that is unreasonable or imprudent in light of existing conditions.
- The elements of a violation of an absolute speed law include: driver; vehicle; location; and speed that is in excess of the specified limit.
- In order for a RADAR speed measurement to be admitted as evidence, it must be established that:
  - The RADAR device was operating properly.
  - The operator was properly qualified and trained.
  - The instrument's accuracy was properly verified.
  - The officer saw the violation being made and made a visual estimate of the violator's speed.
  - The RADAR measurement was made when the accused's vehicle was out in front of other traffic and closest to the RADAR.

# Unit 4 – Notes

---

*Approximate time required:  
10 minutes.  
(Prior elapsed time: 1 hour  
and 30 minutes.)*

*Ask trainees to cite the  
applicable cases.*

---

*Ask trainees:  
What are the elements of a  
basic speed law violation?*

*Ask trainees:  
What are the elements of an  
absolute speed law violation?*

*Ask trainees:  
What must be specifically  
established for a valid,  
admissible RADAR speed  
measurement?*

*Ask trainees:  
What other supportive  
evidence can be introduced,  
if available?*

*Answer:  
Doppler audio.*

## Unit 4 – Contents

---

The principal factors governing selection of a location for RADAR operations are need, traffic and road conditions, and safety.

---

The general procedures for setting up a typical RADAR instrument consist of:

- Component assembly and installation.
  - Testing and calibration.
- 

### Evaluation

- Sample evaluation questions:

1. The landmark case of *State v. Dantonio* established:
  - (a) The right of police agencies to use Doppler RADAR.
  - \*(b) Judicial notice of the Doppler Principle.
  - (c) The fact that a RADAR operator need not be licensed.
  - (d) Judicial notice of the tuning fork method of calibration.
2. The "A-B-C" of setting up a RADAR instrument means:
  - (a) Connect the Antenna to the Battery and then to the Counting Unit.
  - (b) Aadjust the aim Before Calibrating.
  - (c) Aim the Beam Carefully.
  - \*(d) Connect the Antenna to the Box (counting unit) and then to the Current (power source).
3. When testing a RADAR device using a tuning fork, it is good practice to:
  - \*(a) Point the antenna upwards to avoid picking up unwanted signals.
  - (b) First adjust the beam aim in the direction of the traffic so the antenna does not have to be moved after testing is completed.
  - (c) Hold the tuning fork about one foot from the antenna face.



## Unit 4 – Contents

---

- (d) Keep the antenna pointed as far away from your body as possible to avoid the radiation hazard.
- 4. The courts cannot accept every RADAR instrument as being accurate at all times; but they *can* take judicial notice of:
  - (a) The accuracy of RADAR instruments that are repaired by technicians holding a second class radio-telephone license.
  - \* (b) The validity of certain methods of testing RADAR accuracy.
  - (c) The accuracy of those RADAR instruments that have been approved by the FCC.
  - (d) The accuracy of every RADAR instrument that uses the Doppler Principle.
- 5. When called upon to testify in court, a police RADAR operator has to be able to provide:
  - (a) Only a brief, simple explanation of the Doppler Principle.
  - (b) A clear explanation of how speed affects frequency shift, though without going into scientific detail.
  - (c) Only a description of the fundamental relationship among speed, frequency, and wavelength.
  - \* (d) No explanation of the Doppler Principle.
- Solicit and answer trainees' questions concerning the contents of this unit.

Unit 4 – Notes



A series of horizontal lines for writing notes, consisting of 25 evenly spaced lines.

# Unit 5

## Operation of Specific RADAR Devices Classroom Segment

Total time:

---

### Objectives

Provide sufficient information for the trainee to:

- Describe the functional components of the RADAR unit(s) to be used.
- Describe and apply the unit's setup, testing, and operative procedures.
- Be prepared to operate the device and meet all procedural requirements of actual patrol.

### Requirements

#### Special Equipment

- A portable power converter (1100 to 1200) or 12-volt battery pack for classroom demonstration of testing and equipment display.
- At least one complete working unit (and all necessary peripheral equipment) of each RADAR device used in instruction.

#### Recommended Illustrations

- Specific study materials for setup, testing, and operation of each RADAR device.

### Instructor Tasks

The instructor must be familiar with the structure and contents of this unit, which contains the following segments:

1. Introduction to the RADAR device(s). (5 minutes)
2. The basic functions of the RADAR device(s). (20 minutes)
3. Presentation and classroom demonstrations of setting up, testing, and operating the RADAR device(s). (25 minutes)

NOTE: If a number of RADAR devices are used, more than the times noted above may be needed.

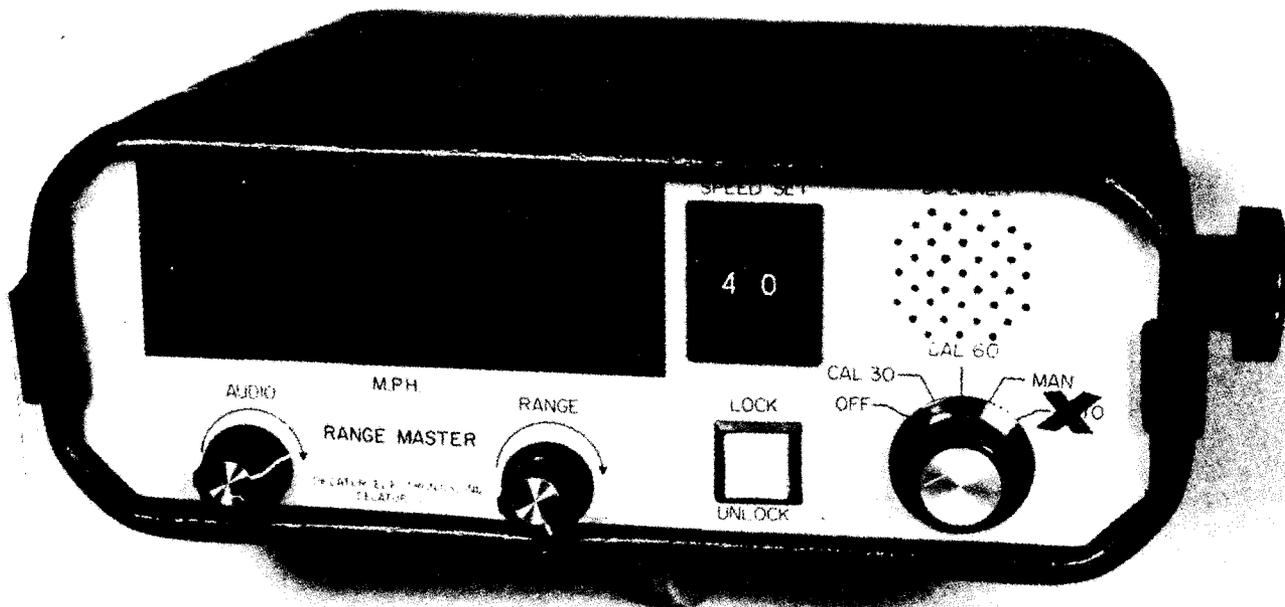
#### Operation of specific RADAR device(s).

The study materials for this unit must be obtained through the direct examination of instructions provided by the manufacturer of each RADAR device. Specific information on component assembly, nomenclature, power supply, testing, etc., must be gleaned from materials supplied by the manufacturers. Because modifications are constantly being made to both new and existing RADAR devices, it would be impossible to provide up-to-date operating materials with this course.

It is possible that the terminology and operating procedures supplied by the manufacturer may conflict with the instruction trainees in this course receive. Wherever possible, terminology and procedures should conform with those used in this program.

A synopsis of the specific operating instructions should be provided to each trainee by the trainees' department. Such an outline will provide an overview of the specific features, characteristics, and limitations of the RADAR to be used.

This sample format may be used to prepare the outline, but it need not restrict you. Make any necessary modifications or dispense with it altogether if some other format is more suitable.



ART No. MV-A RANGEMASTER 715



# Unit 5 – Contents

---

## Introduction

### Unit Title and Objectives

- Unit Title—"RADAR Operation."
  - Unit Objectives:
    - Identify your RADAR unit.
    - Identify and describe instrument components and their functions.
    - Describe the procedures for setting up, testing, and operating the RADAR unit.
- 

### Unit Content

- Introduction to the MV-A RANGEMASTER 715.
  - The operating principles of the MV-A RANGEMASTER 715, its major components, and its design features.
  - The procedures for setting up, testing, and operating the MV-A RANGEMASTER 715.
- 

## MV-A RANGEMASTER 715: General Description

**MV-A RANGEMASTER 715 is a moving RADAR unit operating within the X-frequency band (10.525 GHz).**

- The instrument consists of an antenna and a counting unit; both are dash-mounted.
  - This unit will monitor traffic while either stationary or moving.
- 

### Major Components

- Target window.
- Speed set (inoperative).
- Patrol window.
- Speaker.
- Selector switch.
- Moving/Stationary switch.
- Low-Power indicator.
- Dim control.
- Lock/Release switch.
- Range control.
- Audio control.
- Power-On switch.

# Unit 5 – Notes

---

*Introduction.*  
*Approximate time required:*  
*5 minutes.*

*Write unit title on  
chalkboard or flip-chart.*

*Refer trainees to unit  
objectives in the Trainee  
Instructional Manual.*

---

*Relate unit content to  
objectives.*

---

*Approximate time required:*  
*45 minutes.*  
*(Prior elapsed time: 5  
minutes.)*

*Display sketch of unit. Write  
on chalkboard or flip-chart:*  
*"X-band—10.525 GHz."*

---

*Hold up the unit and point  
out the location of each  
component.*

*If the class is large, use  
slides or overhead projectors  
to display the components.*

*Demonstrate each switch  
position.*

*Emphasize that the manual  
lock function has been  
modified to only allow the  
locking of a target speed—  
even temporarily—with the  
press of a button.*

# Unit 5 – Contents

---

## Component Functions

- The target window, labeled MPH, displays target vehicle speeds with lighted seven-segment Numitrons (0-199 mph).
- Speed set thumbwheels.
  - These were originally designed to allow the selection of speeds to be monitored.
  - A two-digit thumbwheel control allows the setting of speeds up to 99 mph.
  - This speed selection control has been made inoperative on all MSP departmental MV-A RADARs.
- The patrol window, labeled VERIFY SPEED, displays the patrol vehicle's speed with lighted seven-segment Numitrons (0-199 mph).
- The speaker provides an audio reproduction of the Doppler signal being monitored.
- The selector switch has the following settings:
  - OFF—no power supplied to the unit.
  - SEG CK (segment check)—checks the lighted Numitron segments mentioned above.
  - CAL 60—performs an internal circuit test.
  - MAN—allows the officer to manually lock in target vehicle speeds.
  - AUTO—automatically locks in target vehicle speed exceeding that set on "speed set." (Disconnected on all departmental RADARs.)
- The MOV/STA rocker switch allows the operator to select whether the unit will be used as moving or stationary RADAR.
- The low-power indicator is a lighted dot in the lower left corner of the patrol speed (VERIFY) window that appears when the power drops below the manufacturer's specifications.
- The dim control allows the officer to adjust the brightness of the readouts.
- The LOCK/REL switch allows the officer to lock in or release (clear) readings manually.
- The range control allows the officer to adjust the sensitivity of the RADAR receiver (not of the transmission).
- The audio control allows the officer to adjust the audio volume of the monitored Doppler signals.
- The power-on indicator is a small lighted dot in the lower left of the target speed window that shows that the unit is receiving at least some operational power.

# Unit 5 – Notes

---

*Because both the autolock and the audio tone alert have been disconnected, the speed set thumbwheels now serve no function.*

*Emphasize that use of the AUTO mode is not allowed. The autolock has been disconnected on all departmental equipment.*

*Emphasize that the audio volume should always be turned up to a comfortable level to help with target identification, and alert the operator to possible sources of interference.*

## Unit 5 – Contents

---

### Setup and Test Procedures

- Connect power and antenna cords to rear of unit.
    - Ensure that the selector switch is in the OFF position.
    - Plug the power cord into the cigarette lighter or a battery pack.
    - Mount the unit (in the classroom, mount it on a desk).
  - Perform the light test:
    - Set the MOV/STA switch to MOV.
    - Set the selector switch to the SEG CK position. The number “188” will appear in the target (MPH) window and the number “88” will appear in the patrol (VERIFY) window. This checks all displays by lighting all segments of the Numitrons.
    - Adjust the brightness of the displays with the dim switch.
  - Perform internal circuit test:
    - Set the MOV/STA switch to STA.
    - Set the selector switch to the CAL 60 position. The number “60” should appear in the target window.
    - Set the MOV/STA switch to MOV. The number “60” should now appear in the patrol window.
  - Perform external tuning fork test:
    - Set the selector switch to MAN.
    - Set the MOV/STA switch to STA. Select the low-speed fork, strike it, and quickly hold it in front of the antenna. The appropriate reading should appear in the target window. Repeat the test with the high-speed fork. An appropriate reading should again appear in the target window.
    - Set the MOV/STA switch to MOV.
    - Repeat the individual high- and low-speed fork tests. The appropriate speed readings should now appear in the patrol window.
    - Strike the *low-speed* fork and hold it in front of the antenna. The appropriate speed will again be displayed in the patrol window.
  - Patrol speed verification test:
    - This will be demonstrated during the *Unit 7: Field Practice* segment of this course.
    - The test involves a comparison of the patrol speed displayed on the RADAR against the calibrated patrol car speedometer.
- 

If the RADAR unit fails to perform *any* of the prescribed test in accordance with the prescribed parameters, the unit is not to be used.



# Unit 6

## Moot Court

Approximate time required:  
4 hours and 50 minutes

---

<b>Objectives</b>	Provide sufficient information and opportunity for the trainee to: <ul style="list-style-type: none"><li>● Prepare complete and effective direct testimony for RADAR cases.</li><li>● Respond properly and effectively to cross-examination.</li></ul>
<b>Requirements</b>	<b>Handout Materials</b> <ul style="list-style-type: none"><li>● Sample case description: "John Jones" (see pages 6–16 to 6–37 of this unit).</li><li>● Sample case direct testimony.</li><li>● Sample case cross-examination transcript.</li></ul> <b>Additional Training Aid:</b> <ul style="list-style-type: none"><li>● Audio tape (or videotape) presentation of sample case direct testimony and cross-examination.</li></ul>
<b>Instructor Tasks</b>	<p>The instructor must be familiar with the structure and contents of this unit, which contains the following segments:</p> <ol style="list-style-type: none"><li>1. Introduction (5 minutes).</li><li>2. Sample Case (30 minutes).</li><li>3. Case Assignments (15 minutes).</li><li>4. Case Preparation (1 hour).</li><li>5. Conduct of Moot Course (3 hours).</li></ol> <p>The trainees must be given ample time, following the case assignments, to prepare for their roles in the moot courts. If the course is conducted during 3 full days, the trainees can ready themselves during class time. If a compressed training schedule is necessary, however, then the individual preparation must be assigned as homework.</p> <p>The text of some typical direct testimony and subsequent cross-examination for a court case involving RADAR speed measurement has been prepared for the sample case segment. This text will be found on page 6–32 of this Manual, following a descriptive outline of the sample case on 6–30.* Feel free to modify this text to ensure that it conforms to statutes, case law, policy, or procedures that apply to the trainees' jurisdiction(s). Once the necessary modifications have been made, the text should be recorded, with various qualified personnel playing the roles of prosecutor, arresting officer, and defense attorney. For the best results, a videotape recording made in a courtroom-like atmosphere should be prepared. At the very least, an audiotape recording will be required. Seven sample case descriptions have been prepared for the "Case Assignments" segment. They begin on page 6–13 of this Manual and are in Unit 6 of the <i>Trainee Instructional Manual</i>. You may want to develop other sample case descriptions to supplement or replace those provided.</p> <p>The instructor must prepare or obtain all specified instructional aids. Feel free to use any additional aids that will enhance learning.</p>

---

\* Two separate versions have been prepared for the direct testimony portion of the sample case: One is labeled "dialogue," the other "monologue." The latter has an active prosecutor, who elicits the officer's testimony through a series of questions. In the former, the officer, after some general introductory questions, describes in his own words what happened. Use the version that is most compatible with the courtroom procedures familiar to the trainees.

The longest and most important segment of this unit is the "Conduct of Moot Courts." A key role will be played by the individual (or individuals) serving as the defense attorney. The defense attorney must have a good bit of knowledge and experience in the adjudication of speeding cases involving RADAR measurements in order to conduct realistic and enlightening moot cross-examinations. An experienced prosecuting attorney should be recruited to play the defense attorney, but if this is not possible, the instructor who plays the role should get some pointers about cross-examination from a knowledgeable prosecutor.



# Unit 6 – Contents

---

## Introduction

### Unit Title and Objectives

- Unit Title—“Moot Court.”
- Unit Objectives. The trainees should be able to:
  - Prepare complete and effective direct testimony for a sample speed enforcement case involving RADAR speed measurement.
  - Respond properly and effectively to sample cross-examination.
  - Critique both direct testimony and cross-examination testimony provided by other trainees.

---

### Unit Content

- In Unit 4, trainees heard and read a sample statement of direct testimony for a typical RADAR speed measurement case.
  - The sample testimony provided evidence in support of all of the elements of the speeding offense and showed that the RADAR instrument was used in full compliance with all relevant court rulings.
- In this unit, trainees will have an opportunity to prepare a statement of direct testimony based on specific case descriptions.
- Some trainees will present testimony before a moot court (i.e., the hypothetical situation will be that they have accused someone of a speeding violation, and that that person has contested the charge).
- The trainees selected to present direct testimony will also submit to cross-examination.
- At the end of each moot court session, the trainees will discuss the good and bad points of the direct testimony and cross-examination.

---

## Sample Case: John Jones

### Case Description

- To clarify what is expected of each trainee in this unit, we will conduct a sample demonstration of a moot court.
- This sample case is based on the items outlined in the handout:
  - The alleged speed violator is Mr. John Jones, 25 years old.

# Unit 6 – Notes

---

## *Introduction*

*Approximate time required:  
5 minutes.*

*Write the unit title on a  
chalkboard or flip-chart.*

*Refer the trainees to the list  
of Unit 6 objectives in the  
Trainee Instructional  
Manual.*

---

*Relate the content to the unit  
objectives.*

*Emphasize that the purpose  
of the group evaluation is  
not to find fault or to  
embarrass the participants,  
but to offer constructive  
criticism that will help  
improve the skills necessary  
to prepare and present  
testimony in speeding cases.*

---

*Approximate time required:  
30 minutes.*

*(Prior elapsed time: 5  
minutes.)*

*Hand out the "Sample Case:  
John Jones" description to  
each trainee.*

---

## Unit 6 – Contents

---

- He is alleged to have committed the violation while driving a 1978 American Motors Pacer, registered to him.
- The violation is alleged to have occurred at 11:15 a.m., Saturday, July 18, on Interstate Highway 827.
- At the time of the alleged violation, Mr. Jones is said to have been traveling in the westbound lane of Interstate 827, approximately at milepost 57.5.
- The traffic then was light and free-flowing in both directions.
- It was, of course, daytime. The weather was clear; there was essentially no wind.
- One person other than Mr. Jones is alleged to have been in the car, namely Mr. Thomas Smith, 26 years old.
- The police officer who made the speed measurement and took the enforcement action claims that the vehicle was traveling at 65 mph. The speed limit at that location on Interstate 827 is 55 mph, and that is an absolute, rather than *prima facie*, speed limit.
- The officer also claims that the subject vehicle was in the left-hand westbound lane and had passed a pickup truck when the speed measurement was obtained.
- The officer claims to have observed two persons in the front seat of the subject vehicle.
- This outline only summarizes what the officer claims has happened; these are *not* established facts.
- The officer must provide direct testimony to establish all necessary facts.
- The officer then must submit to cross-examination, during which the defense attorney will attempt to discredit the direct testimony or at least create doubt concerning some portions of the testimony.

---

### Testimonial Requirements

- The testimonial requirements of this sample case are no different from any speeding case involving RADAR speed measurement.
- The officer's testimony must establish:
  - That all elements of the offense were present.
  - That the RADAR speed measurement was obtained in full compliance with applicable case law.



## Unit 6 – Contents

---

- In this sample case, establishing the elements of the offense requires that the officer be able to show that:
  - The vehicle stopped was the same vehicle that had its speed measured.
  - Mr. John Jones was the driver of that vehicle.
  - The location was where the public has right of vehicular access.
  - The vehicle's speed exceeded the 55-mph absolute limit.
- Establishing that the RADAR speed measurement was obtained in compliance with case law requires the officer to show that:
  - The RADAR was operating properly.
  - The RADAR's accuracy was verified using an appropriate method.
  - The officer is properly qualified and trained to operate the RADAR.
  - The officer observed the violation and made a visual estimate of the violator's speed based on that observation.
  - The RADAR speed measurement was taken when the violator's vehicle was out in front of other traffic and closest to the RADAR.

---

### Sample Testimony

- What you are about to hear (and see, if videotaped) is a statement of direct testimony intended to establish the above points.
- Discussion:
  - Was the accused shown to be the driver?
  - Was the stopped vehicle identified as the violating vehicle?
  - Did the location permit vehicular access by the public?
  - Was the violator's speed in excess of the specified absolute limit?
  - Was the RADAR operating properly?
  - Was the RADAR's accuracy verified appropriately?
  - Was the officer qualified and trained?
  - Did the officer make a visual observation of the violator's speed as well as an estimate of that speed based on that observation?



## Unit 6 – Contents

---

- Was the RADAR measurement taken with the violator out in front and closest to the RADAR unit?
- Direct testimony must establish each of these points as clearly as possible.
- You can be sure that any points left unclear will be noted by the defense attorney and used to discredit the testimony.

---

### Sample Cross-Examination

- What you are now about to hear (and see, if videotaped) is a typical cross-examination that might follow the direct testimony we have just heard.
- Discussion:
  - Was the accused shown to be the driver?
  - Was the stopped vehicle identified as the violating vehicle?
  - Did the location permit vehicular access by the public?
  - Was the violator's speed in excess of the specified absolute limit?
  - Was the RADAR operating properly?
  - Was the RADAR's accuracy verified appropriately?
  - Was the officer qualified and trained?
  - Did the officer make a visual observation of the violator's speed as well as an estimate of that speed based on that observation?
  - Was the RADAR measurement taken with the violator vehicle out in front and closest to the RADAR unit?

---

### Summary of Sample Case

- Your direct testimony must always be based strictly on the facts.
- It is your job to prepare your testimony carefully, so that all the facts are brought out clearly and completely.
- When preparing your testimony, try to anticipate the points that the defense will challenge during cross-examination, so that you are prepared to respond effectively to any likely questions.

---

### Case Assignments

Sample case descriptions are contained in the *Trainee Instructional Manual* beginning on page 6–13.

- Each of you will be assigned your own case.
- Your job is to prepare a *written* statement of direct testimony for your assigned case.
  - The testimony you prepare must be consistent with the items outlined in the case description. You may not change any of the given facts.

# Unit 6 – Notes

---

*Play the audio tape (or videotape) of the cross-examination for the John Jones case.*

*Ask the trainees:  
Did the cross-examination discredit or seriously weaken any of the indicated points?  
Did the officer's response to cross-examination strengthen the case?*

---

*Refer the trainees to pages 6-28 and 6-32 of their Trainee Instructional Manual for guidance in preparing their sample direct testimony.*

---

*Approximate time required:  
15 minutes.  
(Prior elapsed time: 35 minutes.)*

*Point out that two or three trainees may be assigned the same case, but that they are expected to work independently.*

## Unit 6 – Contents

---

- You *are* expected to add any facts, circumstances, etc. pertinent to the case that do not contradict the given facts.
  - After preparing your written testimony, try to anticipate the questions the defense might ask during cross-examination.
    - Write out these questions and the responses you would give.
- 

When all the writing is completed, some of you will be selected to present your testimony in court.

- If you are asked to present testimony, you will join the prosecuting attorney in reading aloud your prepared script.
  - Following your testimony, you will be cross-examined.
  - At the completion of the cross-examination, the class will evaluate the direct testimony and the cross-examination.
- 

### Case Preparations

Trainees must work independently to prepare the text of direct testimony for their assigned sample cases.

---

### Conduct of Moot Courts

Selection of trainee to present testimony.

---

Presentation of direct testimony.

---



# Unit 6 – Contents

---

Cross-examination.

---

Class evaluation.

---

Repeat above four steps, as time permits and training needs dictate.



# Sample Case Direct Testimony

*(Monologue Version)*

**Q: Officer Brown, where are you employed?**

"I am employed by the Lakeville Sheriff's Department, as a patrol officer."

**Q: In the course of your work, do you have occasion to conduct RADAR speed measurements?**

"Yes, that is a routine part of my patrol duties."

**Q: Could you describe for the court the qualifications and experience you have in the area of RADAR speed measurement?**

"I have successfully completed the Basic Training Program in RADAR Speed Measurement conducted by the Municipal Police Training Council of this State, and I hold a valid certificate of competency in RADAR instrument operation issued by the Lakeville Sheriff's Department. Since I completed my basic RADAR training I have conducted more than 200 hours of RADAR speed measurement operations."

**Q: On Saturday, the 18th of July, did you issue a summons for a speed violation to Mr. John Jones?**

"Yes, I did."

**Q: Do you see that same Mr. John Jones here in the courtroom?**

"Yes. That is he seated next to Mr. Bailey, the defense counsel."

**Q: Officer Brown, please describe in your own words the circumstances leading up to and involving your issuance of that summons to Mr. Jones.**

"On the morning of Saturday, July 18, I was conducting the stationary surveillance of traffic in the westbound lanes of Interstate Highway 827. I had parked my patrol vehicle on the grassy median divider, alongside the shoulder of the left-hand westbound lane, approximately at milepost 57.4. I was operating my assigned RADAR instrument as part of my traffic surveillance. The instrument is a Doppler RADAR device manufactured by Acme Scientific Instruments, Inc. The instrument was operating in a normal manner. I had conducted tests of calibration on the instrument when I first set up for stationary surveillance at 10:50 a.m. The external tests were performed using a certified tuning fork. The checks indicated that the instrument was working properly.

"At approximately 11:15 a.m., I observed a 1978 American Motors Pacer approaching my position in the left-hand westbound lane. When the subject vehicle was approximately at milepost 57.5, one-tenth of a mile from my position, I saw it pass a pickup truck that was traveling westbound in the right-hand lane. Based on my visual estimate, the subject Pacer appeared to be traveling at about 65 to 70 miles per hour after it had passed the pickup truck. The speed limit posted on Interstate 827 is 55 miles per hour. The subject vehicle remained in the left-hand lane after it had completed passing the pickup truck. When the subject vehicle was approximately 300 feet from my position, I obtained a stable reading of 65 mph on my RADAR instrument. The Doppler audio tone emitted by my RADAR instrument was steady and clear. The pitch of the audio correlated with that of a vehicle traveling at an excessive speed. At the time I made my observations and reading, the subject vehicle was the closest vehicle to my position and was out in front of other traffic. As the subject vehicle passed my position, I saw two people in the front seat. The driver appeared to be wearing a baseball-type cap and eyeglasses. The passenger appeared to be without glasses or hat.

"I pursued the subject vehicle and signaled it to stop, using my dome lights. The driver responded quickly and pulled the subject vehicle to the right-hand shoulder. Using the loudspeaker on my patrol car, I instructed the occupants to remain inside their car. As I approached the subject vehicle, I again noted the cap and eyeglasses on the driver.

"I requested that the driver furnish his operator's license and vehicle registration. The operator's license was that of Mr. John Jones, the defendant. The photograph and descriptive information on the license matched the driver. I noted that Mr. Jones' operator's license requires him to wear corrective lenses while driving. The registration certificate was that of an American Motors Pacer, Registration No. 318537, registered to Mr. John Jones. The registration number and other description information matched the subject vehicle.

"I informed Mr. Jones that I had apprehended him for speeding and that I had clocked him at 65 miles per hour on my RADAR instrument. I then issued the summons to him and notified him of his obligations and rights concerning the summons.

"After Mr. Jones drove from the scene I returned to my original position to resume stationary surveillance. Before resuming surveillance, I repeated the calibration checks on my RADAR instrument and verified that it was working properly.

**Q: Thank you, Officer Brown.  
Your witness, Mr. Bailey.**

# Sample Case Direct Testimony

(Dialogue Version)

**The Prosecutor, Ms. Parks:** "Officer, would you state your name and occupation, please?"

**Officer Brown:** "I am Officer Richard H. Brown. I am a patrol officer with the Lakeview Sheriff's Department."

---

**Parks:** "Officer, how long have you been with the sheriff's department?"

**Brown:** "For the past two and a half years."

---

**Parks:** "In the course of your work, do you have occasion to conduct RADAR speed measurements?"

**Brown:** "Yes, ma'am, that is a routine part of my patrol duties."

---

**Parks:** "And were you conducting RADAR speed measurements in your capacity as a patrol officer on the morning of Saturday, the 18th of July?"

**Brown:** "Yes, ma'am, I was."

---

**Parks:** "Please tell the court, Officer, what kind of RADAR instrument you were using on that morning?"

**Brown:** "It was a Doppler RADAR instrument, manufactured by Acme Scientific Instruments, Inc."

---

**Parks:** "Had you used that type of instrument prior to that morning, Officer Brown?"

**Brown:** "Yes, ma'am, many times."

---

**Parks:** "Officer, have you had any special training or qualification for conducting RADAR speed measurements?"

**Brown:** "Yes, ma'am, I have."

---

**Parks:** "Would you please describe your qualifications and experience in RADAR speed measurement to the court?"

**Brown:** "I have successfully completed the Basic Training Program in RADAR Speed Measurement conducted by the Municipal Police Training Council of this State, and I hold a valid certificate of competency in RADAR instrument operation issued by the Lakeville Sheriff's Department."

---

**Parks:** "And, Officer, did you complete that Basic Training Program prior to the 18th of July?"

**Brown:** "Yes, ma'am, I took the course last December."

---

**Parks:** "And your certificate of competency in RADAR operation was completely valid on the morning of that Saturday, the 18th of July; is that right?"

**Brown:** "Yes, ma'am, completely valid."

---

**Parks:** "Officer Brown, between the time that you completed your basic RADAR training and this July 18th, approximately how much time have you spent conducting RADAR speed measurements?"

**Brown:** "I'd say more than 200 hours, ma'am, from last December when I had the course until Saturday, July 18."

---

**Parks:** "And were all these 200-plus working hours spent with the Acme-manufactured RADAR instrument?"

**Brown:** "Yes, ma'am."

---

**Parks:** "All right, Officer Brown, it certainly sounds as if you were very well experienced with the RADAR instrument by Saturday, July 18th. Can you tell us where you were operating the RADAR on that morning?"

**Brown:** "Ma'am, I was conducting stationary surveillance of traffic in the west-bound lanes of Interstate Highway 827 on that morning. I had parked my patrol vehicle on the grassy median divider, alongside the shoulder of the left-hand westbound lane. My vehicle was parked approximately at milepost 57.4."

---

**Parks:** "Thank you, Officer. Can you tell us now when it was that you began to conduct stationary surveillance at that location?"

**Brown:** "Yes, ma'am, it was at 10:50 a.m. that I first set up at that location."

---

**Parks:** "Officer, can you tell us what you did when you set up your RADAR at that time?"

**Brown:** "Yes, ma'am. The Acme Scientific RADAR instrument that I was using is a one-piece unit that mounts on a bracket which can be attached to the patrol vehicle's window. When I set up the RADAR at milepost 57.4 of Highway 827 on the morning of July 18th, I attached the RADAR to the passenger-side window. I then performed internal and external tests of calibration to verify that the instrument was working properly. These tests showed that the instrument was, in fact, working properly."

---

**Parks:** "You mentioned both internal and external tests. How did you perform the internal test?"

**Brown:** "The internal circuit test is performed by pushing a button on the instrument. After the button is pushed, the circuits inside the instrument are tested automatically, and a number appears on the instrument's readout window. If the internal circuit test is performed properly, or if no number appears, then the instrument is not working properly."

---

**Parks:** "At that time, at Highway 827, did you press the button and did the number '37' appear in the readout window?"

**Brown:** "Yes, ma'am."

---

**Parks:** "So the instrument passed the internal circuit test?"

**Brown:** "Yes, ma'am, it passed."

---

**Parks:** "Very good. Now, how about the external test: Is that the tuning fork test?"

**Brown:** "That's correct. That test is performed using a certified tuning fork."

---

**Parks:** "And did you, at that time and place, use the certified tuning fork to test the RADAR, and did the test give a correct answer?"

**Brown:** "Yes, ma'am."

---

**Parks:** "So when you set up on the morning of July 18th, your RADAR instrument passed both the internal *and* the external tests, is that right?"

**Brown:** "Yes, ma'am. Both tests were passed."

---

**Parks:** "Officer Brown, in the RADAR training program you had completed, were you taught that if both the internal and external tests are passed then the RADAR instrument is working properly?"

**Brown:** "Yes, ma'am."

---

**Parks:** "Very good. And on that Saturday, at Highway 827, you performed those tests, and the RADAR passed those tests, at 10:50 a.m., is that right?"

**Brown:** "Yes, ma'am."

---

**Parks:** "What did you do then, Officer?"

**Brown:** "I then began to observe westbound traffic from my stationary position near milepost 57.4."

---

**Parks:** "While you were observing traffic, did you have occasion to notice a 1978 American Motors Pacer approaching your position while it was traveling in the left-hand westbound lane?"

**Brown:** "Yes, I did."

---

**Parks:** "About what time did you notice that vehicle?"

**Brown:** "It was approximately 11:15 a.m., about 25 minutes after I had first set up."

---

**Parks:** "Officer, will you please tell us what you observed concerning that particular vehicle?"

**Brown:** "Ma'am, I observed that the subject Pacer was traveling in the left-hand westbound lane at what appeared to be a high rate of speed, faster than the normal flow of traffic. When the subject vehicle was approximately at milepost 57.5, one-tenth of a mile from my position, I watched it pass a pickup truck that was traveling westbound in the righthand lane."

---

**Parks:** "And based upon your observations, Officer Brown, as well as your experience in conducting traffic surveillance, were you able to make a visual estimate of the Pacer's speed?"

**Brown:** "Yes, ma'am."

---

**Parks:** "Well?"

**Brown:** "The subject Pacer appeared to be traveling approximately 65-70 miles per hour after it had passed the pickup truck."

---

**Parks:** "Were you able to obtain RADAR speed measurement, Officer?"

**Brown:** "Yes, ma'am. When the subject vehicle was approximately 300 feet from my position, I obtained a stable reading of 65 miles per hour on my RADAR instrument. At that time, the subject vehicle was the closest vehicle to my position, and was out front of other traffic."

---

**Parks:** "Officer, did you have any other supportive evidence of excessive speed in regard to the suspect vehicle?"

**Brown:** "Yes, ma'am. My RADAR is equipped with a Doppler audio feature which is capable of providing an audible tone or pitch correlating to the speed of the vehicle being displayed. As the suspect vehicle approached, the audio was clear and steady and emitted a pitch indicating a vehicle traveling at excessive rate of speed."

---

**Parks:** "What is the speed limit at the location of Highway 827, Officer?"

**Brown:** "Fifty-five miles per hour."

---

**Parks:** "So the RADAR confirmed your own visual estimate that the Pacer was exceeding the speed limit by some 10 miles per hour?"

**Brown:** "Yes, ma'am."

---

**Parks:** "After you obtained the RADAR speed measurement, did the Pacer continue to head toward your position, and did you continue to observe the vehicle and its occupants?"

**Brown:** "Yes, ma'am. As the subject vehicle passed my position, I observed two persons in the front seat. The driver appeared to be wearing a baseball-style cap and eyeglasses. The passenger appeared to be without glasses or a hat."

---

**Parks:** "What did you do then, Officer?"

**Brown:** "I pursued the subject vehicle and used my dome lights to signal it to stop. The driver responded quickly and pulled the subject vehicle to the right-hand shoulder."

---

**Parks:** "Did the vehicle occupants leave the vehicle at any time?"

**Brown:** "No, ma'am. As the subject vehicle came to a stop, I used the loudspeaker on my patrol car to tell them to stay inside the car. Then I got out of my patrol car and approached the Pacer to observe and interview the driver."

---

**Parks:** "Please tell us about the observation and interview of the driver."

**Brown:** "As I approached the subject vehicle, I noted again that the driver was wearing a baseball cap and eyeglasses. I requested the driver to furnish

his operator's license and vehicle registration. The operator's license was that of Mr. John Jones. The photograph and descriptive information on the license matched the driver. I noted that Mr. Jones' operator's license requires him to wear corrective lenses while driving. The registration certificate was that of a 1978 American Motors Pacer, registration number 318537, registered to Mr. John Jones. The registration number and other descriptive information matched the subject vehicle."

- Parks:** "Officer Brown, do you see that same Mr. John Jones, whom you observed to be the driver of the Pacer, seated in this room?"
- Brown:** "Yes, ma'am. That is he seated next to Mr. Bailey, the defense counsel."
- Parks:** "Very good, Officer. And did you inform Mr. Jones as to why you had stopped him?"
- Brown:** "I informed Mr. Jones that I had apprehended him for speeding and that I had clocked him at 65 mph on my RADAR instrument. I then issued the summons to him and notified him of his obligations and rights concerning the summons. I then assisted him in returning to the traffic lane."
- Parks:** "What did you do after Mr. Jones had left the scene?"
- Brown:** "I returned to my original position to resume stationary surveillance. Before resuming surveillance, I repeated the tests of calibration on my RADAR instrument and verified that it was still working properly."
- Parks:** "You repeated those same internal and external tests that you described earlier, is that right?"
- Brown:** "Yes, ma'am."
- Parks:** "And did the instrument once again pass those tests?"
- Brown:** "Yes, ma'am, both tests."
- Parks:** "Thank you, Officer Brown. Your witness, Mr. Bailey."
- The Defense Attorney, Mr. Bailey:** "Officer Brown, you've stated that you were stopped alongside Highway 827 working with your RADAR machine. There are a lot of telephone and power lines running along that highway, aren't there?"
- Brown:** "Sir, I recall that telephone lines run parallel to the highway's eastbound lanes."
- Bailey:** "Yes. Well, isn't it true that those lines give off some electrical or electronic signals that could be picked up by a RADAR instrument?"
- Brown:** "I don't know whether telephone lines could cause RADAR interference under certain circumstances. I do know that I saw no evidence of any interference while I was operating my RADAR instrument at that time and place."
- Bailey:** "You say you 'don't know' whether there could have been any interference from the lines. Didn't they cover that in the RADAR training course you claim to have had?"
- Brown:** "Sir, our training taught us how to check for the presence of interference and how to recognize it. One way is to monitor the Doppler audio for evidence of buzzing or other inconsistent audio tones. Another is to monitor the RADAR display screen for speed readings when there is no target present. I checked for interference as I was taught to do, and I found none to be present."
- Bailey:** "But how do you know there wasn't any electrical interference at the moment when you supposedly were clocking Mr. Jones' speed? You couldn't have been checking for interference then. Isn't it possible that someone started to talk on the telephone about that time, and the lines sent out some electrical energy that messed up your machine?"
- Brown:** "Sir, as I've indicated, I found no evidence at all that there was any interference present. Also, my RADAR instrument and my patrol vehi-

cle were quite far away from the telephone lines. I doubt that there could have been any interference—”

**Bailey**  
(interrupting): “You ‘doubt’ it, Officer Brown? But you’re not really sure, are you?”

**Brown:** “Sir, I operated the RADAR instrument exactly as I had been trained to do. I obtained a speed measurement that agreed with my own visual estimate of the defendant’s vehicle’s speed.”

**Bailey:** “All right, Officer, let’s just leave it that there *may* have been some interference. Let’s get back to this so-called visual estimate you’ve mentioned. How did you arrive at this *guess* of 65 to 70 miles per hour as Mr. Jones’ speed?”

**Brown:** “Observing traffic is a large part of my job, sir, and I’ve spent a lot of time doing it. I’ve seen a good deal of traffic moving along Highway 827, and I’ve come to be able to judge pretty accurately how fast vehicles are moving.”

**Bailey:** “Well, at the particular time that you were ‘judging’ Mr. Jones, was there a lot of other traffic moving along the highway?”

**Brown:** “No, sir. Traffic was fairly light.”

**Bailey:** “If traffic was light, there couldn’t have been many other vehicles whose speeds you could have compared to Mr. Jones’. Didn’t that make it a bit more difficult to estimate Mr. Jones’ speed?”

**Brown:** “Not really, no. I could still tell pretty well how fast the Jones vehicle was moving along the road.”

**Bailey:** “And as you said in your direct testimony, you saw Mr. Jones’ car passing a pickup truck about that time, isn’t that right?”

**Brown:** “That’s right.”

**Bailey:** “And I suppose you used your vision and your experience to estimate the pickup’s speed, too?”

**Brown:** “It appeared to me that the pickup was moving at just about the speed limit, around 55 miles per hour.”

**Bailey:** “I see. So would you say that it was the fact that Mr. Jones’ car was passing the pickup truck that led you to conclude that he must have been speeding?”

**Brown:** “It was one of several factors and observations that confirmed my estimate of the Jones vehicle’s speed.”

**Bailey:** “Officer, isn’t it possible that the pickup was going a bit more slowly, say about 45 miles per hour, and that Mr. Jones passed it at a legal speed and that it was just because you saw a vehicle being passed that you thought you had a speeder?”

**Brown:** “Sir, as I’ve said, I estimated that the Jones vehicle was moving at 65 to 70 miles per hour and that my RADAR instrument confirmed a speed of 65. I didn’t base my estimate just on the fact that he was passing the pickup truck.”

**Bailey:** “Well, did you use your RADAR device to confirm your estimate of the pickup’s speed?”

**Brown:** “No, sir. You see, the RADAR—”

**Bailey**  
(interrupting): “Aha! You say, ‘no, you didn’t.’ Well, did you stop the pickup and ask the driver how fast he was going when you claim Mr. Jones passed him?”

**Brown:** “No, certainly not. There wasn’t any need to, and I was starting to pursue—”

**Bailey**  
(interrupting yet again): “So there was no confirmation of your estimate of the pickup’s speed. About how far from your position was the pickup when you say it was passed by Mr. Jones?”

**Brown:** “Roughly one-tenth of a mile, probably a bit less.”

**Bailey:** "One-tenth of a mile—so about 500 feet, you'd say?"

**Brown:** "Just about."

---

**Bailey:** "And would it be fair to say that, after the car passed the pickup, you pretty much concentrated your attention on the car?"

**Brown:** "Certainly, that's when I estimated his—"

---

**Bailey:** "So, your estimate of the pickup's speed was based on a pretty brief look when it was still pretty far away, wouldn't you say?"

**Brown:** "No. I'd observed both vehicles well enough to estimate their speeds. Anyway, the pickup has nothing to do with how fast the Jones vehicle was going."

---

**Bailey:** "Okay, Officer. I think I've asked enough about your speed estimates. I've just a few more questions about some other points you mentioned. You say you turned on your dome lights to signal the vehicle to stop. How did the driver respond to your signal?"

**Brown:** "As I believe I stated, he responded promptly and crossed over to the right-hand shoulder and stopped his car."

---

**Bailey:** "No screeching of tires or jamming of brakes or skid marks or anything like that?"

**Brown:** "No, it was a normal stop."

---

**Bailey:** "Did you see him jam on his brakes or do anything of the sort *before* you signaled him to pull over?"

**Brown:** "No, sir."

---

**Bailey:** "So, he didn't do anything that would indicate to you that *he* thought he had been going excessively or recklessly fast?"

**Brown:** "Well, I can't say what he might have been thinking."

---

**Bailey:** "Okay, well . . . . After you stopped him and you walked up to him, did he say anything to you to indicate that he believed or was admitting that he was speeding?"

**Brown:** "No."

---

**Bailey:** "Then did he say anything to suggest that he thought he had not been speeding?"

**Brown:** "I recall that he made some such remarks, yes."

---

**Bailey:** "Just what did he say to you?"

**Brown:** "I don't recall his exact words, just something to the effect that he was certain he hadn't been going more than 55. The same kind of remarks I hear all the time."

---

**Bailey:** "Didn't he say to you, 'Officer, I was only doing 55 when I passed that truck, it was just creeping along?'"

**Brown:** "I don't know if that was it exactly, I mean, he may have said something like that."

---

**Bailey:** "And was he referring to that same pickup truck that you estimated was moving at, quote, 'just about the speed limit' when you saw it about 500 feet away?"

**Brown:** "As I say, I don't remember his exact remarks."

---

**Bailey:** "No further questions, your honor."

---

# Unit 7

## Operation of Specific RADAR Instruments Field Practice Segments

Total time:  
3 hours and 30 minutes

---

<b>Objective</b>	Provide the trainee with an opportunity to acquire indepth hands-on practice in the operation of specific RADAR instrument(s).
<b>Requirements</b>	Special Facilities: <ul style="list-style-type: none"><li>● Facility for conducting actual RADAR speed measurements (Facility may be a <i>controlled</i> or restricted area such as a test track, large parking lot, or some other location isolated from unauthorized traffic or, conversely, a <i>public access</i> roadway. Alternatively, both types of facilities may be used, with each serving for a portion of this unit).</li><li>● Note: If a controlled test facility is used, it will also be necessary to provide target vehicles, target vehicle drivers, and related support equipment.</li></ul>
<b>Instructor Tasks</b>	<p>This unit is devoted exclusively to trainee practice on assigned RADAR devices. The instructor's task is to monitor each trainee's performance, provide additional instruction and demonstrations when necessary, and determine whether each trainee has achieved a satisfactory level of proficiency.</p> <p>If the practice is conducted at a controlled test facility, one instructor or instructor's aide must coordinate the target vehicle(s). It is recommended that trainees practice in groups of three or four, with an instructor or instructor's aide assigned to each group. Group members will take turns in setting up, testing for calibration, and operating the RADAR instrument(s).</p> <p>Each trainee group must be furnished with at least one RADAR unit and all necessary peripheral equipment (tuning forks, power supplies, etc.).</p> <p><b>HANDS-ON PRACTICE:</b></p> <ol style="list-style-type: none"><li>1. Setup.</li><li>2. Tests of Calibration.</li><li>3. Operation.</li></ol>

# Practice Segment

During the practice segment, the class will be broken up into small groups, giving students the opportunity for hands-on practice with the RADAR unit(s) they will be using in their departments. It is recommended that the groups be composed of three or four (but not more than four) students, under the supervision of one instructor or instructor's aide. The purpose of the small group is to allow each student to set up, test for calibration, and operate a RADAR unit.

The selection of a site for the practice sessions is left to the discretion of the course administrator; an empty parking lot will often suffice. The major consideration in site selection is that the chosen site be large enough so that a RADAR-equipped police car can monitor the speed of a target vehicle as it makes passes through the area. The practice sessions can also be run on actual roadways. If the practice segments are to be run on a highway or back road, the selection of the site should be made in accordance with the criteria discussed in Units 3 and 4. For practice purposes, the most important criterion is the safety of the student. When operating RADAR at a particular location, the instructors must notify the police agency normally charged with the patrol of the area. This will keep the police agency from becoming confused over the presence of the student patrol car and will ensure that the student patrol car does not interfere in any way with the normal patrol procedures for that area.

The student RADAR operator should take the driver's seat; to get the best view of the operator, the other students should take the back seat, while the instructor sits in the front passenger's seat. Each student will take a turn as the driver/operator, beginning by setting up the unit and running through its various testing procedures. The student should follow all approved operating procedures as he or she would in actual patrol situations.

After setting up and testing a stationary RADAR unit, the student should be allowed enough time for at least 20 target readings. With a moving RADAR unit, each student should be allowed enough time for, again, at least 20 readings while the patrol car is both stationary and moving. The students should be encouraged to ask questions during the course of their hands-on training (e.g., about spurious or "ghost" readings, interference, the panning effect, and so on).

The trainees must also keep in mind, and should point out to the instructor as they arise, the various elements of supportive evidence—visual estimate, audio Doppler, RADAR reading, and speedometer verification—needed to construct a tracking history for each target vehicle.

Each student should try to bring about the factors affecting RADAR discussed in Unit 3. This will give the student some idea of the particular tendencies and limitations of RADAR regarding each of the effects it can produce. By knowing what specific actions are needed to produce an improper reading, the student will be better able to *avoid* such readings on actual patrol.

The trainees should evaluate each other for any actions they consider inappropriate or erroneous—as for example, not using the proper procedures to test the RADAR unit or improperly aligning the RADAR antenna. At the end of each turn, the driver/operator should disassemble and dismount the unit. When all of the students have had turns as driver/operator, the groups will return to the classroom.

Attached is a set of work exercises that may be used in this field practice segment. It contains a series of experiments that a student or group of students can conduct to determine the tendencies and limitations of a particular RADAR device. The format may be used as written or modified to meet the instructor's specific needs.

# Police Traffic RADAR

## Project Work Exercises

**Objective:** This unit of instruction is designed to provide the student with a structured field experience that will provide firsthand knowledge of traffic RADAR operational characteristics.

### Experiments

#### A. Tuning Fork

Hold an oscillating (struck) tuning fork approximately 3 feet from the face of the traffic RADAR antenna. Is there an appropriate display on the readout? **YES\_\_\_\_\_ NO\_\_\_\_\_**

Slowly move the oscillating tuning fork towards the face of the RADAR antenna. Approximately how close to the face of the antenna does the tuning fork have to come before an appropriate reading appears on the readout display? \_\_\_\_\_**INCHES**

Holding an oscillating tuning fork approximately 1 inch from the antenna face, slowly move the tuning fork away. Approximately how far away from the face of the antenna must the tuning fork be moved before the appropriate reading appears on the readout display? \_\_\_\_\_**INCHES**

Are the two above measurements approximately the same (within 1 or 2 inches of each other)? **YES\_\_\_\_\_ NO\_\_\_\_\_**

If the answer is "no," then explain why there would be a difference. \_\_\_\_\_

---

---

---

Hold an oscillating tuning fork directly in front of the face of the antenna at a distance of approximately 1 foot. Slowly move the fork out of the main lobe of the antenna beam. Approximately how many degrees can the tuning fork be moved to the side of the beam before the display on the readout disappears? \_\_\_\_\_**DEGREES**

#### B. Antenna Alignment

##### 1. Vertical Alignment

Aim the RADAR antenna beam so that it is parallel with the surface of the roadway. Approximately how far down the roadway can the unit now first detect a full-sized passenger vehicle? \_\_\_\_\_**FEET**

Aim the antenna beam up at approximately 20° from the surface of the roadway. In this position, how far down the roadway can the unit now first detect a full-sized passenger vehicle? \_\_\_\_\_**FEET**

Aim the antenna beam up at approximately 40° from the surface of the roadway. In this position, how far down the roadway can the unit now first detect a full-sized passenger vehicle? \_\_\_\_\_**FEET**

Aim the antenna beam *down* at approximately 20° to the surface of the roadway. In this position, how far down the roadway can the unit now first detect a full-sized passenger vehicle? \_\_\_\_\_**FEET**

##### 2. Horizontal Alignment—Stationary RADAR

This experiment requires the use of both the RADAR instrument and a motor vehicle. The RADAR instrument is to be operated as stationary RADAR. The antenna is to be aimed straight down the road. The target vehicle is to be accelerated to 50 mph (according to that vehicle's speedometer). At this point, record the reading on your display. \_\_\_\_\_**MPH**

Now repeat this experiment with the RADAR antenna misaligned approximately 10° out-of-true. What is the reading displayed? \_\_\_\_\_**MPH**

Keep repeating the experiment, successively misaligning the RADAR antenna 10° further out-of-true until the antenna is aimed 90° (at a right angle) to the oncoming target vehicle. The target vehicle, meanwhile, should make each pass at 40 mph. What are the readings (if any) for each successive misalignment?

20° \_\_\_\_\_ MPH

60° \_\_\_\_\_ MPH

30° \_\_\_\_\_ MPH

70° \_\_\_\_\_ MPH

40° \_\_\_\_\_ MPH

80° \_\_\_\_\_ MPH

50° \_\_\_\_\_ MPH

90° \_\_\_\_\_ MPH

**C. Panning**

With the RADAR turned on, pan or point the antenna beam at the readout module. (Note: This can only be accomplished with a two-piece unit, unless you pan a hand-held unit at another hand-held unit.) Record the reading that was obtained: \_\_\_\_\_ MPH

**D. Scanning**

Holding the antenna of a two-piece unit or holding a one-piece unit, scan the horizon in a fast, sweeping motion and record the effects this has on the readout in your display window. \_\_\_\_\_ MPH

**E. Power Surge**

With the RADAR unit turned off, apply power to the unit (turn it on). Note any display that occurs as the power is applied. \_\_\_\_\_ MPH

**F. Audio Use**

Describe the audio (if your unit has this feature) as a target vehicle approaches your RADAR operating position and suddenly decelerates. Does the sound frequency increase or decrease, and how does it sound?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Does a truck have a RADAR audio sound different from a motorcycle when both are going 50 mph? YES \_\_\_\_\_ NO \_\_\_\_\_

Describe the difference, if any: \_\_\_\_\_

Does the Doppler audio register a person walking past or a rippling flag? YES \_\_\_\_\_ NO \_\_\_\_\_

Describe the sound, if any: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_

**G. Interference Readings**

With the RADAR antenna held in your hands, check around the interior of the patrol vehicle and attempt to find areas that will produce interference or "ghost" readings. Vary the speed of your heater or defroster fans, your engine speed, etc. Watch the readout and record the readings displayed together with what caused them.

REVVED ENGINE: \_\_\_\_\_

HEATER AT LOW: \_\_\_\_\_

HEATER AT HIGH: \_\_\_\_\_

DEFROSTER: \_\_\_\_\_

OTHERS: \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**H. Citizen's Band Radio Effect**

With someone else helping you, have a CB radio "keyed up" while its antenna is in your RADAR's beam. Have the CB set moved through the beam while keyed and observe the effects, if any, on your readout.

RESULTS: \_\_\_\_\_

\_\_\_\_\_

**I. Police Band Radio Effect**

While using the RADAR to track a target vehicle, key in the police radio in your patrol car. Record the effect, if any.

RESULTS: \_\_\_\_\_

\_\_\_\_\_

**J. Whistling on Citizen's Band Radio**

Have an assistant whistle into the microphone of a CB set that has its antenna in your RADAR's beam.

RESULTS: \_\_\_\_\_

\_\_\_\_\_

**Experiments Specific to RADAR**

The following three experiments require the use of a moving RADAR device, a patrol vehicle, and a target vehicle.

**A. Horizontal Antenna Alignment--Moving RADAR**

- With the antenna pointed straight down the road, establish a patrol-car speed of 30 mph and an approaching target-vehicle speed of 40 mph. Record the reading on your RADAR displays.

0° Patrol speed: \_\_\_\_\_ mph. Target speed: \_\_\_\_\_ mph.

- Repeat the experiment with the antenna misaligned approximately 10°. What are the readings displayed?

10° Patrol speed: \_\_\_\_\_ mph. Target speed: \_\_\_\_\_ mph.

- Keep repeating the experiment, successively misaligning the RADAR antenna 10° or more until the antenna is aimed 90° (at a right angle) to the approaching target vehicle. The target vehicle should make each pass at 40 mph. What are the readings, if any, for each successive misalignment?

20° Patrol speed: \_\_\_\_\_ mph. Target speed: \_\_\_\_\_ mph.

30° Patrol speed: \_\_\_\_\_ mph. Target speed: \_\_\_\_\_ mph.

40° Patrol speed: \_\_\_\_\_ mph. Target speed: \_\_\_\_\_ mph.

50° Patrol speed: \_\_\_\_\_ mph. Target speed: \_\_\_\_\_ mph.

60° Patrol speed: \_\_\_\_\_ mph. Target speed: \_\_\_\_\_ mph.

70° Patrol speed: \_\_\_\_\_ mph. Target speed: \_\_\_\_\_ mph.

80° Patrol speed: \_\_\_\_\_ mph. Target speed: \_\_\_\_\_ mph.

90° Patrol speed: \_\_\_\_\_ mph. Target speed: \_\_\_\_\_ mph.

**B. Batching Effect**

Because of the stress placed on the motor vehicle and the fuel required to produce the batching effect, it is recommended that this experiment be conducted only once. It would also be helpful in this experiment to have a partner to assist you. Rapidly accelerate the patrol car and continuously monitor the speedometer reading. Note the difference in speeds between the vehicle speedometer and the patrol ("VERIFY") display on a moving RADAR unit as you "floor it." [Note: This exercise can be duplicated using a stationary RADAR unit, but the batching effect concerns only moving RADARs.] As you "floor it," record the readouts on the RADAR display as your calibrated speedometer shows 25 mph and 40 mph.

25 MPH: \_\_\_\_\_ 40MPH: \_\_\_\_\_

While batching can occur under heavy *deceleration*, you will not be experimenting with this effect. However: If batching *did* occur while you were slamming on the brakes, what would be the effect on the target speed displayed by the RADAR? Check one:

HIGHER-THAN-TRUE SPEED: \_\_\_\_\_

LOWER-THAN-TRUE SPEED: \_\_\_\_\_

Explain your reasoning: \_\_\_\_\_

---

---

---

**C. Shadowing**

Individual RADAR units will vary in their susceptibility to this effect. Attempt to create the shadowing effect with your department's RADAR. A shadowing effect can sometimes be achieved by accelerating up to or past a large vehicle, such as a truck, that is moving in the same direction you are. Describe the circumstances that create a shadowing effect and the effect that was produced: \_\_\_\_\_

---

---

---

---

# Unit 8

## Course Summary

Total time:  
2 hours and 40 minutes

---

### Objectives

- Recapitulate course contents to ensure that trainees retain their newly-acquired knowledge, skills, and attitudes in RADAR speed measurement.
- Evaluate each trainee's knowledge, skills, and attitudes.
- Ask the trainees to evaluate the course and to suggest possible improvements.
- Instructor Tasks
- The instructor's principal tasks in this unit are to determine whether the training objectives have been met; to identify and correct deficiencies in the trainees' knowledge, skills, and attitudes; and to assess the effectiveness of the course and the instructor's own performance as a teacher.

Evaluation is the principal focus of this final unit. The Course Recapitulation segment provides a means for *informally* assessing how much the trainees have learned and how well they have been taught. This assessment can be made while reviewing the major topics. Rather than having the instructor restate these topics, the lesson plan calls for the instructor to ask the class questions and, thus, have *the trainees* conduct the review. By the time the recapitulation is complete, the instructor should have a reasonably accurate idea of how well the class achieved the training objectives.

The Examination segment of this unit offers a more formal evaluation of the trainees. A written examination will provide a better reflection of each trainee's knowledge. Such an examination could be based on the sample questions provided in the summary segments of Units 2, 3, and 4. A sample written examination, made up of 20 multiple-choice and 20 true-or-false questions, is included in this unit. Of course, other similar questions can be used to replace or supplement those provided.

The Course Evaluation provides the trainees an opportunity to assess the course and instructors. Trainee participation should be encouraged. A sample questionnaire that can be used to obtain the trainees' comments follows this unit.

# Unit 8 – Contents

---

## Introduction

### Unit Title and Objectives

- Unit title—“Course Summary”
  - Recapitulate course contents to ensure trainees retain the knowledge, skills, and attitudes desired.
  - Evaluate trainees’ knowledge, skills, and attitudes.
  - Provide opportunity for trainees to evaluate this course and to suggest possible improvements.

---

### Unit Contents:

- A review of the material covered in the previous units.
  - The review is intended to summarize what has been learned by touching on the major points covered.
  - The instructor will pose questions concerning the major points covered; each of you will be called upon to answer some of these questions.
- The evaluation will focus on both the trainees and the course itself.
  - The trainees will be tested to determine how well the training objectives were met and will be asked to evaluate the course and suggest ways of improving it.

---

## Course Recapitulation

### Overall Course Goal

- Statement: To improve the effectiveness of speed enforcement through the proper and efficient use of RADAR speed measurement instruments.
- In order to improve the effectiveness of enforcement, police officers must:
  - Observe more speeding violations.
  - Apprehend more violators.
  - Secure more convictions.
- RADAR can help improve speed law enforcement by providing an accurate measurement of a violator’s speed.
  - It improves the ability to detect violations.
  - It helps us secure convictions.

# Unit 8 – Notes

---

## Introduction

Approximate time required:  
5 minutes,

Write title on chalkboard or  
flip-chart.

---

Review—Point out that the  
trainees themselves will  
conduct the review by  
responding to the instructor's  
questions.

Note:

The training format governs  
when the trainees are to be  
tested on their ability to  
operate police traffic  
RADAR. See the **Course  
Administration Manual** and  
the attached section, **Field  
Testing**, for guidance.

---

Approximate time required:  
45 minutes.  
(Prior elapsed time: 5  
minutes.)

Ask trainees:  
State the overall course goal.

Ask trainees:  
What three things must we  
do to improve speed law  
enforcement?

Ask trainees:  
How can RADAR help us  
improve speed law  
enforcement?

## Unit 8 – Contents

---

### Speed and Highway Safety

- Excessive speed makes it more likely that an accident will occur.
  - Excessive speed overwhelms a driver's capability by limiting his or her reaction time.
  - It increases the time required to stop a vehicle.
- Excessive speed increases the severity of any accident.
  - The higher the speed, the more energy is present.
  - The amount of energy increases dramatically as speed increases.
  - The more energy, the more damage done.
- Evidence proves that lives can be saved if speed is reduced.
  - In 1974, the highway death toll was 17 percent lower than in 1973.
  - During the same period, the average highway speed dropped 12 percent.
  - As the average speed has climbed since 1974, so have the numbers of deaths.
- Rigorous enforcement of the 55-mph speed limit is essential for saving lives.
  - A substantial majority of the public gives lip service to the desirability of a 55-mph speed limit.
  - But the public's compliance with the 55-mph limit is poor.
  - Without rigorous enforcement, traffic speeds will increase to excessive levels—and so will the numbers of accidents, injuries, and deaths.
- The national speed limit must be maintained at 55 mph in order to preserve the safety benefits that have already been achieved.
  - Increasing the limit to 60 mph would probably not result in many more accidents.
  - But it would probably result in several thousand additional *deaths* each year.
- The emphasis on 55-mph enforcement reflects the many speed-related accidents and deaths that occur on our Nation's highways.
- But many occur on rural roads and city streets as well.
- The need for effective speed enforcement exists *everywhere* the public's vehicles are found.

---

### Types of Speed Regulations

- The two types of speed laws are the basic speed law and the absolute speed law.
- The basic speed law states: It is unlawful to drive a vehicle on public roadways at a speed greater than is reasonable and prudent under existing conditions. Existing conditions encompass both actual and potential hazards.

# Unit 8 – Notes

---

*Ask trainees:  
Why does excessive speed  
increase the chances that an  
accident will occur?*

---

---

---

*Ask trainees:  
Why are high-speed  
accidents, as a rule, more  
severe than low-speed  
accidents?*

---

---

---

*Ask trainees:  
When did the national  
highway death toll drop  
significantly?  
Why?*

---

---

---

---

*Ask trainees:  
What justifies maintaining a  
national speed limit of 55  
mph?*

---

---

---

---

*Ask trainees:  
What would happen if the  
national speed limit were  
raised from 55 mph to 60  
mph?*

---

---

---

---

*Ask trainees:  
Why emphasize the 55-mph  
limit? What about other  
roads than highway?*

---

---

---

---

---

*Ask trainees:  
Name the two types of law  
that govern speed.*

---

---

*Ask trainees:  
What does the basic speed  
law state?*

---

---

---

## Unit 8 – Contents

---

- An absolute speed law states: It is unlawful to drive a vehicle on public roadways at a speed greater than \_\_\_\_ (the specified limit).
- An absolute speed law always refers to some absolute speed limit.
  - It is always unlawful to drive faster than the absolute speed limit, regardless of conditions.
  - It is impossible to violate an absolute speed limit.
- The basic speed law does not refer to an absolute speed limit. It may refer to a *prima facie* speed limit.
  - A *prima facie* limit is an indication of the highest speed that ordinarily would be considered reasonable and prudent for a particular location. Most *prima facie* speed limits assume generally favorable conditions.
  - If conditions are unfavorable, it may be possible to violate the basic speed law while driving more slowly than the *prima facie* limit.
  - If conditions are highly favorable, it may be possible to drive faster than the *prima facie* limit without violating the basic speed law.

---

### Principles of RADAR Speed Measurement

- The word RADAR is an acronym of: Radio Detection and Ranging.
- Modern traffic RADAR instruments apply the Doppler Principle to measure vehicle speed.
- The Doppler Principle states that when there is relative motion between two objectives, one of which is transmitting wave energy of any sort, the frequency of the signal as received by the other object changes due to that relative motion.
  - The faster the transmitting object is moving, the greater will be the change in frequency perceived by the other object.
  - The term “frequency” refers to the number of waves emitted by the transmitting object each second. “Wavelength” refers to the length of each of these waves.
  - Frequency and wavelength have an inverse relation: The higher the frequency, the shorter the waves; the lower the frequency, the longer the waves.
- Stationary RADAR transmits a steady beam of radio waves that are reflected back to the antenna from objects in the beam.
  - If none of the objects are moving, there is no change in frequency and no speed reading is obtained.
  - If a target vehicle is moving *toward* the RADAR, the frequency reflected back to the RADAR is *increased* and the RADAR exhibits that upward frequency as a number of miles per hour.

# Unit 8 – Notes

---

*Ask trainees:  
What does an absolute speed law state?*

*Ask trainees:  
Can someone break an absolute speed law while driving more slowly than the posted speed?*

*Ask trainees:  
What kind of speed limit may be established for the basic speed law?*

---

*Ask trainees:  
What the acronym "RADAR" is derived from.*

*Ask trainees:  
Upon what scientific principle is RADAR speed measurement based?*

*Ask trainees:  
In simple terms, explain the Doppler Principle.*

*Ask trainees:  
Define frequency.*

*Ask trainees:  
When a signal's frequency is changed, what else is changed?*

*Ask trainees:  
How does stationary RADAR work?*

## Unit 8 – Contents

---

- If a target vehicle is moving *away* from the RADAR, the frequency reflected back is *decreased* and the RADAR exhibits that downward frequency, again, in terms of miles per hour.
  - The angular, or cosine, effect occurs because stationary RADAR doesn't actually measure how fast an object is moving, but only how fast it is moving toward or away from the RADAR.
    - If an object is moving directly toward or directly away from the RADAR, its actual speed will be measured by the RADAR.
    - If an object is moving toward or away from the RADAR at any angle, the RADAR will reflect a speed that is less than the object's true speed.
- 

### Moving RADAR

- A moving RADAR instrument supplies two speed measurements at the same time:
  - The speed of the patrol car.
  - The closing speed, or the speed difference between the speeds of the patrol car and the target vehicle.
- Moving RADAR automatically subtracts the patrol speed from the closing speed to determine the target speed. ( $TS = CS - PS$ )
- Moving RADAR can overestimate the target vehicle's speed if its patrol speed measurement is too low.
  - The angular effect can produce a low patrol speed if the patrol signal is being reflected off a nearby object that is at an angle to the patrol car's direction of travel, rather than off of the stationary terrain ahead.
  - The counting unit will in turn compute a high target speed. (Closing speed minus false patrol speed equals false target speed.)
  - The angular effect on moving RADAR can be avoided for the most part by careful straight-ahead antenna alignment. It can be recognized when it does occur by comparing the patrol speed displayed by the RADAR with the patrol speed displayed by the patrol car's calibrated speedometer.

# Unit 8 – Notes

---

*Ask trainees:*

*Why is the angular or cosine effect important in RADAR speed measurement? What is the angular effect?*

*Ask trainees:*

*What will happen if an object is moving toward or away from the RADAR at an angle? What impact does the angular effect have on stationary RADAR?*

---

*Ask trainees:*

*In simple terms, explain moving RADAR.*

*Ask trainees:*

*How is the target speed computed?*

*Ask trainees:*

*How might the angular effect cause a moving RADAR to produce a high target speed measurement?*

*Ask trainees:*

*How do you avoid or at least recognize an improper reading caused by the angular effect on moving RADAR?*

# Unit 8 – Contents

---

## Target Identification

- Target identification consists of recognizing what vehicle is causing a displayed RADAR speed. It depends on the operator understanding:
  - How the RADAR unit “decides” which vehicle’s speed to display.
  - The role supportive evidence plays in establishing a complete tracking history.
- RADAR decisionmaking depends on three factors:
  - Reflective capability—a vehicle’s size, shape, and composition.
  - Position—the relation between a target vehicle and other vehicles and their distance from the RADAR.  
A transmitted RADAR beam covers a larger area the further it gets from its source. The inverse square law states that each time the distance from the antenna is doubled, the beam spreads out over an area four times as large and its strength is therefore four times weaker.
  - Speed—the relative speed of multiple targets. Speed is usually the least important factor in RADAR decision-making. *Some* makes of RADAR can distinguish between target vehicles of comparable reflective capability and position, but if the vehicles are markedly different in size or if one vehicle is blocking another from the RADAR’s perception, differences in speed will not affect a RADAR’s “decision” as to which target vehicle’s speed to display.
- The primary elements of supportive evidence contained in a RADAR tracking history are:
  - The visual estimate of target vehicle excess speed is the most critical element in any speed enforcement action. The officer must *see* the target vehicle speeding.
  - A clear, steady Doppler audio estimate of the target vehicle’s speed (if available) can be very valuable.
  - A steady RADAR reading supporting the visual and audio evidence is essential.
  - For moving RADAR, the patrol car speed must correlate with the speed displayed by the calibrated speedometer.
  - The tracking history *may not* be a “snap judgment.” All of the above estimates of a target vehicle’s speed must be made over a long enough time to rule out interference or any other effect that might cause a false reading. This rules out the use of any autolock or audio-alert features.
- The range control adjusts the sensitivity of the RADAR to reflected signals.
  - The *transmitted* signal is not affected and remains steady.
  - “Fuzzbusters,” or RADAR detectors, are tuned to the transmitted beam. Turning down the range control will not fool a RADAR detector.

# Unit 8 – Notes

Ask trainees:

*What two factors must the RADAR operator understand to properly identify a target vehicle?*

Ask trainees:

*What three factors affect RADAR decisionmaking?*

Ask trainees:

*What effect does reflective capability have on a RADAR unit's "decision"?*

Ask trainees:

*What effect does position have on a RADAR unit's "decision"?*

Ask trainees:

*Which factor is usually the least important? Why?*

Ask trainees:

*What are the primary elements in a RADAR tracking history?*

Ask trainees:

*Which element is most critical in any speed-enforcement action?*

Ask trainees:

*Why is it strongly recommended that the use of autolocks and audio alerts be avoided?*

Ask trainees:

*How does the range control affect RADAR detectors?*

## Unit 8 – Contents

---

- In the past, operators tried to control RADAR's sensitivity by tilting the antenna. This is *not* recommended, because it may promote interference.
  - Police traffic RADAR works on a line-of-sight basis. It cannot "look" around corners or over hills.
    - The operator must be careful not to overshoot the lead vehicles and display vehicles far to the rear.
- 

### **RADAR Effects**

- Many factors are alleged to affect police traffic RADAR.
  - Most are avoidable with proper operation.
  - Some come from natural causes and are unavoidable.
  - All are recognizable.
- *Interference* can be both natural and artificial.
  - Harmonics result from other radio frequency sources (airport RADAR, mercury and neon lights, power lines, etc.) being received by the RADAR.
  - Moving objects other than motor vehicles (vibrating or rotating signs, fans, etc.) can cause readings.
  - To be displayed, interference must be very strong or the only movement in the RADAR's beam.
  - Most interference originates within the patrol car (police and CB radios, fans, etc.).
  - Interference from outside the patrol car is less likely to cause problems.
  - The operator must avoid operating RADAR in areas of known interference.
  - Interference is easy to recognize on the Doppler audio: It is heard as a buzzing or an unsteady tone.
- The *multipath beam cancellation effect* is caused by reflected signals cancelling one another out and creating blind spots that cause the RADAR display to blank out.
  - The operator must be sure that the RADAR does not display a vehicle that is *behind* the target vehicle.
  - The operator can avoid this effect by staying away from known problem areas and by always obtaining a complete tracking history.
- The rarely produced *scanning effect* occurs when a RADAR antenna is rapidly swung about; this relative motion creates a false reading.
  - It can be avoided by not swinging the antenna around and by always obtaining a complete tracking history.
- The *panning effect* may occur with two-piece RADAR units when the antenna is pointed or panned at its own counting unit.

# Unit 8 – Notes

---

*Ask trainees:  
Why not just tilt the antenna  
to control the RADAR's  
range?*

*Ask trainees:  
How does terrain affect  
target identification?*

---

*Ask trainees:  
Isn't it true that most  
sources of RADAR errors  
are beyond the operator's  
control?*

*Ask trainees:  
What causes interference?*

*Ask trainees:  
What is the biggest source of  
interference, and how does  
an operator avoid it?*

*Ask trainees:  
When you cannot avoid  
interference, how do you  
recognize it?*

*Ask trainees:  
What is the multipath beam  
cancellation effect?  
How is it recognized or  
avoided?*

*Ask trainees:  
What is the scanning effect?  
How is it recognized or  
avoided?*

*Ask trainees:  
What is the panning effect?  
How is it recognized or  
avoided?*

## Unit 8 – Contents

---

- This effect can be recognized by the resulting highpitched squeal on the Doppler audio.
- It can be avoided by not pointing the antenna at the counting unit and by always obtaining a complete tracking history.
- The *turn-on power surge effect* occurs when the RADAR unit's power is first turned on; the surge in voltage may cause a false reading.
  - The allegation that this effect can also be caused by the use of the antenna hold switch is not generally supported.
  - The effect can be avoided by not taking a reading immediately after turning on the RADAR and by always obtaining a complete tracking history.
- The *mirror switching effect* occurs when the numerals on certain makes of hand-held RADAR are reversed for the RADAR's use in tracking vehicles behind the patrol car and then not returned to normal for forward tracking.
  - A normal amount of alertness in obtaining a complete tracking history will avoid this effect. It is difficult to make a visual estimate of 18 mph correlate with a RADAR reading of 81, or vice versa.

---

### Moving RADAR Effects

- Moving RADAR is susceptible to some effects that cannot occur with stationary RADAR. These factors primarily affect the computation of the patrol car's speed.
- The *patrol car shadow effect* occurs when patrol speed is computed from a vehicle moving in the same direction in front of the patrol car instead of from the stationary terrain.
  - Usually this vehicle is a truck fairly close to the patrol car.
  - There must be a significant difference in speed between the patrol car and the other vehicle.
  - Though largely unavoidable, this effect is easy to recognize: When you are obtaining your complete tracking history, you will check your calibrated speedometer and discover the difference in readings.
- The *batching effect* occurs when a patrol car is sharply accelerated or decelerated. This causes the patrol car speed computation to lag behind the patrol car's true speed change, which in turn causes a false target vehicle reading.

# Unit 8 – Notes

---

*Ask trainees:  
What is the turn-on power surge effect?  
How is it recognized or avoided?*

*Ask trainees:  
What is the mirror switching effect?  
How is it recognized or avoided?*

---

*Ask trainees:  
Does moving RADAR suffer from all the above effects?  
Does it suffer from other effects that cannot occur with stationary RADAR?*

*Ask trainees:  
What is the patrol car shadow effect?  
How is it recognized or avoided?*

*Ask trainees:  
What is the batching effect?  
How is it recognized or avoided?*

## Unit 8 – Contents

---

- If the patrol car is accelerating, the target vehicle reading will be falsely high.
- If the patrol car is decelerating, the target vehicle reading will be falsely low.
- This effect can be avoided by holding a relatively steady patrol speed while obtaining a complete tracking history and by not driving recklessly.

---

### Conclusions on Factors Affecting RADAR

- Blatant misoperation of RADAR can be blamed for many problems.
- Some of what people allege are problems, aren't.
- Proper operation of RADAR will eliminate almost all chance of error.
- Most of the factors that can cause false readings only occur momentarily.
- None of them will be accompanied by the supportive evidence necessary to obtain a valid target reading and a complete tracking history.

---

### Jamming and Detection of Police Traffic RADAR

- Purposeful attempts to interfere with RADAR signals are called jamming.
  - Jamming usually takes the form of someone transmitting a radio signal on a RADAR frequency.
  - Such action is a violation of FCC regulations.
- Detection reduces RADAR's effectiveness by giving a violator advance warning to slow down temporarily and thus avoid getting caught.
- Examples of detection methods include:
  - Flashing headlights.
  - CB radio.
  - RADAR frequency receivers (electronic detectors).
- On the other hand, slower speeds help prevent accidents, injuries, and deaths. The person who uses a detector to get advance warning of RADAR operation avoids getting ticketed—and also avoids getting killed.

# Unit 8 – Notes

---

---

---

---

---

---

---

---

---

---

*Ask trainees:  
What can be concluded  
about these factors and  
RADAR?*

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

*Ask trainees:  
How do RADAR jamming  
devices and RADAR  
detection devices differ?*

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

*Ask trainees:  
How do violators detect  
RADAR operations?*

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

*Ask trainees:  
Does this mean CB radios  
should be outlawed?*

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

## Unit 8 – Contents

---

### Fundamental Case Law

- Four landmark court cases have had major influence on the use of RADAR speed measurement instruments:
  - *State v. Dantonio* (New Jersey).
  - *State v. Tomanelli* (Connecticut).
  - *Honeycutt v. Commonwealth* (Kentucky).
  - *State v. Hanson* (Wisconsin).
- In *State v. Dantonio*, judicial notice was first taken of the Doppler Principle.
  - This eliminated the need to have experts testify to the fundamental basis of RADAR speed measurement during every prosecution that involved RADAR.
- In *State v. Tomanelli*, judicial notice was first taken of the tuning fork method as a reliable test of RADAR instrument accuracy.
- *Honeycutt v. Commonwealth* dealt with the qualifications a RADAR operator must have to produce admissible speed measurements. An operator must be able to:
  - Set up the RADAR instrument properly.
  - Test the instrument properly to verify that it is working accurately.
  - Read the instrument properly to obtain a true speed measurement.
- *Honeycutt v. Commonwealth* also addressed the question of how it can be verified that the RADAR speed measurement came from the target vehicle:
  - The vehicle in question must be that closest to the RADAR.
  - It must be out in front of other vehicles and well separated from them.
  - The operator must have made a visual estimate of the vehicle's speed, and the RADAR speed measurement must be close to this estimate.
- *State v. Hanson* was the first significant case to address the issue of moving RADAR operation. It established that:
  - As with stationary RADAR, the operator must have sufficient experience and training; the RADAR must be in proper working order.
  - The RADAR is to be used in an area where road conditions create a minimal possibility of distortion.
  - The patrol car's speed must be verified.
  - The instrument's accuracy must be tested within a reasonable time both before and after the arrest.

# Unit 8 – Notes

---

*Ask trainees:  
Name four landmark court cases.*

*Ask trainees:  
What was the key issue of State v. Dantonio?*

*Ask trainees:  
What was the key issue of State v. Tomanelli?*

*Ask trainees:  
What qualifications did the court require of RADAR operators in Honeycutt v. Commonwealth?*

*Ask trainees:  
According to the court, under what conditions is it reasonable to assume that a speed measurement applies to a particular vehicle?*

*Ask trainees:  
What are the key issues of State v. Hanson?*

## Unit 8 – Contents

---

### Case Preparation and Testimony

- Any speed offense has four elements. It is essential to establish every element in order to obtain a conviction.
  - *Driver*: It must be established that the accused was the driver of the speeding vehicle.
  - *Vehicle*: The vehicle that was used to commit the violation must be properly identified; it must be established that the speed measurements obtained came from that vehicle.
  - *Location*: It must be established that the violation occurred where the public has right of vehicular access. It must also be established whether the speed limit in force at that location was an absolute limit or a *prima facie* limit.
  - *Speed*: It must be established that the vehicle's speed was unlawful within the specific definition of the type of speed limit in force at the location of the offense:
    - a. If the basic speed law, that the speed was unreasonable or imprudent considering the existing conditions.
    - b. If the absolute speed law, that the speed was greater than the specified speed limit.
- RADAR supplies evidence in support of the *speed* element.
- In order to be admissible, the RADAR speed measurement must have been obtained in full compliance with the applicable case law. It must be established that:
  - The RADAR was operating properly.
  - The instrument's accuracy was verified using an appropriate and acceptable method.
  - The operator was properly qualified and trained.
  - The violation was seen by the RADAR operator and that the operator made a visual estimate of the target vehicle's speed.
  - (The use of Doppler audio is strongly recommended in this course and is a valuable piece of supportive evidence; but it is not now required by significant case law.)
  - The RADAR speed measurement was made when the violating vehicle was out front, alone, and closest to the RADAR.

---

### General Operating Requirements and Procedures for RADAR

- In order to be used legally, a speed-measuring RADAR must be properly licensed.
  - The necessary licenses are issued by the FCC.
  - A station license is required for the police department.

# Unit 8 – Notes

**Ask trainees:**  
*Name the four elements of any speed offense.*

**Ask trainees:**  
*When is a speed in violation of the basic speed law?*

**Ask trainees:**  
*When is speed in violation of the absolute speed law?*

**Ask trainees:**  
*What facts must be established in order to ensure that the RADAR speed measurement is admissible?*

**Ask trainees:**  
*Is the use of Doppler audio mandated by significant case law?*

**Ask trainees:**  
*Does use of RADAR require a license?*

**Ask trainees:**  
*What agency issues RADAR licenses?*

**Ask trainees:**  
*What type of license is needed?*

## Unit 8 – Contents

---

- The individual RADAR operators do not need individual licenses.
- Three key factors must be considered when choosing a place to conduct RADAR speed measurements:
  - Need.
  - Traffic and safety conditions.
  - Safety.
- Examples of legitimate need:
  - Places where numerous speed-related accidents have occurred.
  - Places where there have been frequent complaints of speeding.
  - Places where violations are known to occur frequently (often the same as the first example).
  - Places having unusual speed regulation characteristics, such as construction sites, school zones, etc.
  - Places chosen for special speed survey.
- RADAR operation sites should have the following traffic and road characteristics:
  - Traffic should be free-flowing, with vehicles reasonably well apart.
  - The roadway should not be excessively hilly or curved; hills and curves can cause target identification problems.
  - The operator should have a clear, unobstructed view of oncoming traffic for a reasonable distance.
- The principal safety considerations are to make sure that it is:
  - Possible to position the patrol car and the RADAR unit so that they do not impede or endanger pedestrian or vehicular traffic.
  - Possible to enter the traffic stream and conduct pursuit and apprehension safely.
- Setting up a RADAR unit in general involves:
  - Component assembly and installation.
  - Tests of calibration.
- Always follow the "A-B-C" rule when assembling a two-piece RADAR unit's components:
  - Connect Antenna to Box (or counting unit) and then to the Current (or power source).
- Both internal and external tests of RADAR accuracy are required:
  - The tuning fork method is the most common for the external test of calibration.
  - The internal circuit test checks only the counting unit, *not* the antenna.
  - Testing should be done *at the very least* at the beginning and end of each shift.

# Unit 8 – Notes

---

*Ask trainees:  
Does each police officer need  
an individual license to  
operate RADAR?*

*Ask trainees:  
Name the three key factors  
in choosing a site for  
RADAR operation.*

*Ask trainees:  
Give some examples of places  
that show legitimate need for  
RADAR speed  
measurement.*

*Ask trainees:  
What traffic and road  
characteristics should a  
RADAR speed measurement  
site possess?*

*Ask trainees:  
What are the principal safety  
considerations of site  
selection?*

*Ask trainees:  
What steps must be taken  
when setting up a RADAR  
unit?*

*Ask trainees:  
What is the "A-B-C" rule of  
component assembly?*

*Ask trainees:  
What two types of tests for  
calibration are required?*

## Unit 8 – Contents

---

### **Specific RADAR Device Operating Procedures**

Make sure that trainees are familiar with the particular make(s) of RADAR they will be using in their departments.

---

### **Examination**

Written test.

---

### **Course Evaluation**

- Hand out evaluation form(s).
  - Have trainees complete forms.
  - Collect the forms.
    - a. Written evaluation.
    - b. Solicit final questions and comments from trainees.
    - c. Distribute course completion certificates (if appropriate).
    - d. Closing remarks.
-



# Sample Written Test

In the box (  ), write in the letter (A, B, C, or D) corresponding to the answer that is most appropriate for the question.

1. A vehicle's total stopping distance is \_\_\_\_.
  - A. Approximately doubled for every 10-mph increase in speed.
  - B. Affected by the vehicle's speed and the driver's reaction time.
  - C. The distance it will travel during three-fourths of a second.
  - D. About three times as great at 65 mph as it is at 55 mph.
2. A RADAR signal's frequency is \_\_\_\_.
  - A. The number of waves sent out in one second.
  - B. Approximately 186,000 miles per second.
  - C. About 3 centimeters, or 1-1/5 inches.
  - D. Infinite, unless it strikes a solid object.
3. Traffic RADAR instruments determine vehicle speeds by measuring changes in the \_\_\_\_ of the RADAR signal.
  - A. Doppler.
  - B. Strength.
  - C. Frequency.
  - D. Speed.
4. If several vehicles are all "in range," the RADAR unit will always pick out the speed of the vehicle that is \_\_\_\_.
  - A. Largest.
  - B. Closest.
  - C. Fastest.
  - D. None of the above is always true.
5. The fundamental relationship of RADAR is \_\_\_\_.
  - A. Wavelength multiplied by frequency equals closing speed.
  - B. Wavelength divided by frequency equals the speed of light.
  - C. Wavelength multiplied by frequency equals the speed of light.
  - D. Wavelength divided by frequency equals closing speed.
6. A crash at 60 mph is \_\_\_\_ as likely to result in a fatality as is a crash at 45 mph.
  - A. Not as likely.
  - B. Five times as likely.
  - C. Three times as likely.
  - D. Twice as likely.
7. When you want to adjust a RADAR unit's \_\_\_\_, you change its sensitivity setting.
  - A. Power.
  - B. Operational range.
  - C. Beam length.
  - D. Wavelength.
8. When you test a RADAR unit using a tuning fork, it is good practice to \_\_\_\_.
  - A. Hold the tuning fork about one foot from the antenna face.
  - B. Strike the fork on a good, hard metal surface so that it will vibrate smoothly.
  - C. Strike the fork against something less hard than the fork is.
  - D. Adjust the RADAR power control to the mid-range position before testing.
9. In the case of \_\_\_\_, the tuning fork became a primary means of externally testing the RADAR device.
  - A. *Honeycutt v. Commonwealth.*
  - B. *State v. Tomanelli.*
  - C. *State v. Dantonio.*
  - D. *State v. Hanson.*

10. The "A-B-C" of setting up a RADAR unit means \_\_\_\_.
- Connect Antenna to Battery and then to Counting unit.
  - Adjust Aim Before Calibrating.
  - Aim the Beam Carefully.
  - Connect Antenna to Box (Counting Unit) and then to Current (power source).
11. When choosing a place to conduct RADAR speed measurements, a valid criterion is \_\_\_\_.
- A demonstrated need.
  - Traffic and road conditions.
  - Safety.
  - All of the above.
12. A RADAR signal's wavelength is \_\_\_\_.
- Approximatey 10 feet long.
  - The distance from the beginning of the wave peak to the end of the wave valley.
  - Approximately 186,000 miles.
  - Infinite (unless it strikes a solid object).
13. When you are operating a moving RADAR, you should remember that \_\_\_\_.
- The computed target speed could be higher than the true target speed under some conditions.
  - The patrol vehicle's speedometer must never be used to verify a RADAR patrol speed.
  - The patrol vehicle and the target vehicle must be heading in the same direction.
  - All of the above.
14. The case of \_\_\_\_ vs \_\_\_\_ established what qualifications that RADAR operators must have.
- Honeycutt v. Commonwealth.*
  - State v. Tomanelli.*
  - State v. Dantonio.*
  - State v. Hanson.*
15. The basic computation involved in using a moving RADAR is \_\_\_\_.
- Target Speed = Patrol Speed minus Closing Speed.
  - Target Speed = Patrol Speed plus Closing Speed.
  - Target Speed = Closing Speed minus Patrol Speed.
  - Target Speed = Ground Speed minus Patrol Speed.
16. The \_\_\_\_ of the RADAR unit is the factor usually considered to be the *least* dominant in the RADAR unit's "decision" as to which vehicle's speed to display.
- Reflective Capability.
  - Position.
  - Speed.
  - All of the above are equal.
17. To be a qualified RADAR operator, you are required by the courts to have enough knowledge and training to be able to \_\_\_\_ the RADAR device.
- Assemble, aim, and adjust.
  - Calibrate, tune, and connect.
  - Set range, aim, and read.
  - Set up, test, and operate properly.
18. The case of \_\_\_\_ vs \_\_\_\_ established that we must verify that the RADAR patrol speed was computed properly by checking it against the patrol car calibrated speedmeter.
- Honeycutt v. Commonwealth.*
  - State v. Tomanelli.*
  - State v. Dantonio.*
  - State v. Hanson.*
19. In the case of \_\_\_\_ vs \_\_\_\_ the courts took judicial notice of the Doppler Principle for the first time.
- Honeycutt v. Commonwealth.*
  - State v. Tomanelli.*
  - State v. Dantonio.*
  - State v. Hanson.*

20. According to case law, in order to "pass" the external test of calibration, the RADAR instrument must measure the tuning fork's speed \_\_\_\_.
- A. *Exactly.*
  - B. *Within one-quarter of one mph.*
  - C. *Within one-half of one mph.*
  - D. *Within one mph.*

Circle "T" if the statement is true and "F" if the statement is false.

- |  |                                    |                                    |
|--|------------------------------------|------------------------------------|
| 21. The word "RADAR" stands for <i>RADio Doppler And Ranging.</i>  | T                                  | <input checked="" type="radio"/> F |
| 22. A signal reflected from an object that is moving <i>toward</i> a stationary RADAR is <i>increased</i> in frequency.  | <input checked="" type="radio"/> T | F                                  |
| 23. Whenever a radio signal's frequency changes, its wavelength also changes.  | <input checked="" type="radio"/> T | F                                  |
| 24. The speed of a RADAR signal is always equal to the speed of light.   | <input checked="" type="radio"/> T | F                                  |
| 25. A RADAR signal's beam length is infinite unless reflected, refracted, or absorbed by some object in its path.  | <input checked="" type="radio"/> T | F                                  |
| 26. A moving RADAR unit uses the Doppler Principle to measure the patrol car's own speed.  | <input checked="" type="radio"/> T | F                                  |
| 27. Accelerating a patrol car too rapidly might cause the moving RADAR's counting unit to make a mistake.  | <input checked="" type="radio"/> T | F                                  |
| 28. The traffic death rate dropped slightly more than 25 percent from 1973 to 1974.  | T                                  | <input checked="" type="radio"/> F |
| 29. Research suggests that traffic deaths would increase very sharply (about 9 percent) if the national speed limit were raised to 60 mph.                         | <input checked="" type="radio"/> T | F                                  |
| 30. A visual estimate of a violator's excess speed is an optional element of the tracking history.   | T                                  | <input checked="" type="radio"/> F |
| 31. A good place to strike a tuning fork is on a padded steering wheel.  | <input checked="" type="radio"/> T | F                                  |
| 32. <i>State v. Hanson</i> was a landmark court case involving moving RADAR.   | <input checked="" type="radio"/> T | F                                  |
| 33. A RADAR instrument is considered to "pass" the <u>internal</u> circuit test if the <b>test result</b> is within 1 mph (plus or minus) of the prescribed value. | T                                  | <input checked="" type="radio"/> F |
| 34. A moving RADAR actually has two separate transmitters.   | T                                  | <input checked="" type="radio"/> F |
| 35. Obtaining a tracking history is mandatory in every RADAR enforcement action.   | <input checked="" type="radio"/> T | F                                  |
| 36. The beam width of an X-band RADAR is only about 10 feet wide at a distance of 200 feet.  | T                                  | <input checked="" type="radio"/> F |
| 37. "Batching" is a type of problem that may happen to stationary RADAR.   | T                                  | <input checked="" type="radio"/> F |
| 38. In the case of moving RADAR, the angular effect could cause the target speed measurement to be <u>higher</u> than the actual speed.                            | <input checked="" type="radio"/> T | F                                  |
| 39. Target identification problems can usually be avoided by always using the RADAR's automatic locking feature.   | T                                  | <input checked="" type="radio"/> F |
| 40. The RADAR's Doppler audio feature can help identify sources of interference as well as provide supplementary evidence of excess speed.                         | <input checked="" type="radio"/> T | F                                  |

DOT HS 900 071  
September 1982