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**RADAR / LIDAR OPERATOR CERTIFICATION COURSE**

**EXPANDED COURSE OUTLINE**

**DAY 1**

I. Welcome and Introduction

A. Instructor Introduction & Background

B. Course Objectives

C. Benefits of Effective Speed Enforcement

 1. Excessive speed

 a. Speed increases chance of a crash

 b. Increase chance of death/injury

D. Association between Speed Offenses & Vehicle Accidents

 1. Safety benefits of speed reduction

 a. Review charts

II. RADAR Pre-test

III. History & Theory (Video: Part 1)

A. Doppler Principle

 1. Car horn example

 B. RADAR Frequencies

 1. X Band

 a. 10.525 Ghz

 b. 10,525,000,000 cps

 2. K Band

 a. 24,150 Ghz

 b. 24,150,000,000 cps

 3. Ka Band

 a. 34.7 Ghz

 b. 34,700,000,000 cps

C. RADAR Beam Length

 1. Infinite unless:

 a. Reflected

 b. Absorbed

 c. Refracted

 D. Review

 1. Doppler Principle

 2. Wave / cycle

 3. Hertz

 4. Frequency

 5. RADAR

 a. Radio

 b. Detection

 c. And

 d. Ranging

 6. Doppler frequency / shift

 7. Approaching vehicles

 8. Receding Vehicles

IV. Laws and Court Decisions

 A. Speed Laws

 1. 22350 CVC – basic speed law

 2. Prima facie

 3. 22349 CVC – absolute speed law

 4. Speed traps – 40801 CVC / 40802 CVC

 5. Speed surveys

 B. Case Law

 1. State v. Dantonio (New Jersey)

 2. State v. Tomanelli (Connecticut)

 3. Honeycutt v. Commonwealth (Kentucky)

 4. State v. Wilcox (Ohio)

 5. State v. Shelt (Ohio)

 6. State v. Halopoff (California)

 7. State v. Hanson (Wisconsin)

 8. State v. Miller (California)

 9. State v. Aguilera (Florida)

 10. Judge Nesbit’s Ruling (Florida)

 11. State v. Krueger (California)

 12. State v. DiFiore (California)

V. Stationary RADAR

 A. Components

 1. Antenna

 2. Counting unit

 3. Power source

 B. Mounting

 1. Use brackets

 2. Clear of obstructions

 3. Power cord free of counting unit

 4. Secure with straps, Velcro, springs, etc.

 5. Mount in a position to not affect counting unit

 C. Testing the Unit

 1. Light segment test

 2. Internal circuitry test

 3. External test (tuning fork)

 D. RADAR Settings

 1. Audio setting

 2. Auto-Locks

 a. No longer acceptable

 3. Alarms

VI. Stationary RADAR Operation

 A. RADAR Beam

 1. Shape and characteristics

 B. Side Lobes Defined and Explained

 C. Zone of Influence

 1. Area outside the primary beam width (15%)

 D. Beam Width Formula

 E. Beam Range

 F. Range Control Techniques

 G. Cosine Effect

 H. Cosine Calculation

 1. Calculation worksheet

 I. Target Identification

 J. Tracking History Checklist

 1. Visual observation

 a. Identify Target

 b. Estimate Speed

 c. Confirm target is in range

 d. Check environment

 2. Audio confirmation

 a. Pitch

 b. Clarity

 3. RADAR verification

 a. Continuous / stable reading, 3-5 seconds

 b. Manual lock (optional)

 K. Site Selection and Operation

 L. Review Day 1 Material

 M. Day 1 Quiz

 N. Review of Day 1 Quiz

**DAY 2**

VII. Moving RADAR Operation

 A. Basic Principles

 1. CS-PS = TS

 B. Low and High Doppler

 1. Low Doppler (PS)

 2. High Doppler (CS)

 C. Internal and external testing

 1. Light segment test

 2. Internal circuitry test

 3. External (tuning fork) test

 D. Installation

 1. Use brackets

 2. Clear of obstructions (airbag, shotgun, etc.)

 3. Power cord free of counting unit

 4. Secure with straps, Velcro, springs, etc.

 5. Mount in position to not affect counting unit

 6. Antenna must be aligned straight ahead and parallel

VIII. Moving RADAR

 A. Cosine Effect

 1. Low Doppler cosine

 2. High Doppler cosine

 3. Double cosine effect

 B. Shadowing

 1. Identification

 a. Patrol speed will not verify with speedometer

 b. Audio pitch will not be unusually high

 c. No tracking history will be available

 2. Elimination

 a. Move away from large vehicle

 b. Adjust patrol speed

 C. Tracking History Checklist

 1. Visual observation

 a. Identify target

 b. Estimate speed

 c. Confirm target is in range

 d. Check environment

 2. Audio confirmation

 a. Pitch

 b. Clarity

 3. RADAR verification

 a. Verify patrol speed

 b. Continuous / stable reading, 3-5 seconds

 c. Manual lock (optional)

 D. RADAR Detectors

 1. Legal in California

 a. RADAR detectors are radio receivers

 b. Newer models 2-3 times the range of RADAR unit

 c. Defeated by using the “Hold” function

 d. Illegal in some sates

 E. RADAR Jammers

 1. FCC violation (ILLEGAL IN ALL STATES)

 a. Some are transmitter / receiver devices

 b. RADAR in “Hold” mode will display speed-reading

 from a transmitted signal of jamming device

IX. RADAR Effects

 A. Ghost Readings

 1. Readings not understood by untrained persons

 B. External Mechanical Interference

 1. Large signs / rooftop air conditioners

 a. Elimination of Effect

 (1) Use Doppler audio

 (2) Use tracking history checklist

 C. RFI – Random Radio Frequency

 1. Microwave relay tower

 a. Elimination of effect

 (1) Use Doppler audio

 (2) Select appropriate location

 (3) Use tracking history checklist

 D. Interference from Inside the Patrol Vehicle

 1. Police radios

 2. AM radios

 3. Fan motors

 4. Ignition system

 5. Computers

 6. Cell phones

 a. Elimination of effect

 (1) Use Doppler audio

 (2) Use tracking history checklist

E. RFI Through Power and Antenna Leads

 1. Patrol vehicle’s electrical system

 2. Poor connections

 3. Leads not shielded

 4. Leads tangled

 a. Elimination of effect

 (1) Separate antenna and power leads

 (2) Install a “Direct” battery to RADAR hook-up

 (3) Use tracking history checklist

 F. RFI Citizens Band Radios

 1. CB radio during transmission

 a. Elimination of effect

 (1) Do not use CB while using RADAR

 (2) Disregard RADAR reading within 100’ of any

 Transmitting CB radio

 (3) Use tracking history checklist

 G. RFI Police and Business Band Radios

 1. Can cause interference when transmitting

 a. Elimination of effect

 (1) Do not use PD radio while using RADAR

 (2) Disregard RADAR reading if police or business

 band radios are known to be used in close

 proximity

 (3) Use tracking history checklist

 H. RFI Lights

 1. RADAR units may be affected by other devices with multiples of

their operating frequency

 2. Mercury vapor, neon and fluorescent lights are capable of creating

erroneous reading

 a. Elimination of effect

 (1) Select appropriate location

 (2) Use tracking history checklist

 I. RFI Power Lines

 1. High tension lines

 2. Power generating and power substations

 a. Elimination of effect

 (1) Select appropriate location

 (2) Use Doppler audio

 (3) Use tracking history checklist

 J. Harmonic Signal Interference

 1. A multiple base frequency

 2. Caused by electrical devices

 a. Elimination of effect

 (1) Use Doppler audio

 (2) Use tracking history checklist

 K. Own Speed Captures

 1. Only in moving mode

 2. Patrol speed appears simultaneously

 3. Fixed in 1980

 a. Elimination of effect

 (1) Disregard identical readings

 (2) Use tracking history checklist

 L. Pulsating Signal Amplitude

 1. Only in moving mode

 2. Irregular surface with consistent pattern (chain link fence)

 3. Signal returned may be interpreted as a multiple irregular Doppler

 shift

 a. Elimination of effect

 (1) Use Doppler audio

 (2) Observe environment

 (3) Use tracking history checklist

 M. Feedback

 1. Only possible with two-piece RADAR unit

 2. Antenna pointed at counting unit

 a. Elimination of effect

 (1) Use approved mounting procedures

 (2) Do not point antenna at counting unit

 (3) Keep antenna and counting unit separated

 (4) Use tracking history checklist

 N. Audio

 1. Extremely loud commercial radios

 a. Elimination of effect

 (1) Shut off commercial radio when using RADAR

 (2) Use tracking history checklist

 O. Antenna Vibration

 1. RADAR detects motion

 a. Elimination of effect

 (1) Use approved mounting procedures

 (2) Avoid unsuitable locations

 (3) Use tracking history checklist

 P. Motorcycle Considerations

 1. RADAR detects motion

 a. Elimination of effect

 (1) Use approved mounting procedures

 (2) Shut off motorcycle engine

 (3) Store securely in well padded case

 (4) Use tracking history checklist

 Q. Dented Antenna Horn

 1. May cause distortion of the beam propagation

 a. Elimination of effect

 (1) Replace or repair antenna horn

 R. Windshield Obstruction

 1. Dirty or obstructed windshield may reduce range

 2. RADAR signal may be distorted by damaged or obstructed

 windshield

 a. Elimination of effect

 (1) Keep windshield clean and free of obstructions

 (2) Aim antenna properly

 (3) Use tracking history checklist

 S. Weather

 1. Adverse weather tends to reduce range

 2. Also makes it difficult to obtain patrol speed

 a. Elimination of effect

 (1) Avoid using RADAR in adverse weather

 T. Heat Build Up

 1. Excessive heat may cause components to change values

 2. Extreme heat or cold may cause circuitry damage

 a. Elimination of effect

 (1) Maintain a moderate temperature

 (2) If RADAR unit becomes too hot or cold, allow to

 “adjust” for at least 15 minutes

 U. Power Surge

 1. Moving or stationary mode

 2. When first turned on, surge may cause spurious reading

 3. May be caused by hold function

 a. Elimination of effect

 (1) Obtain stable reading for 3-5 seconds

 (2) Use tracking history checklist

 V. Automatic Locks and Alarms

 1. Alarm function can be activated by an effect

 2. Automatic lock can lock a reading caused by an effect

 a. Elimination of effect

 (1) Do not use automatic locks

 (2) Use tracking history checklist

 W. Automatic Gain Control

 1. Sensitivity increases when no target signal is present

 2. As sensitivity increases, so does the possibility of effects

 a. Elimination of effect

 (1) Use tracking history checklist

 X. Panning

 1. Stationary mode

 a. Antenna is moved in a sweeping or panning motion

 2. Moving mode

 a. Antenna sweeps during a U-turn

 b. Elimination of effect

 (1) Use approved mounting procedures

 (2) Stationary mode-antenna remain motionless

 (3) Disregard reading obtained while turning

 (4) Use tracking history checklist

 Y. Batching

 1. Only occurs in moving mode

 2. RADAR device does not update low Doppler and high Doppler

 simultaneously

 3. Occurs when patrol vehicle changes speed while using moving

 RADAR

 a. Elimination of effect

 (1) Maintain constant speed when using moving

 RADAR (only problem for pre-1982 units)

 (2) Use tracking history checklist

 Z. Shadowing

 1. Easily recognizable because of exceptionally high target speed

 and exceptionally low patrol speed

 a. Elimination of effect

 (1) Check RADAR’s indicated patrol speed with

 Patrol vehicle’s speedometer

 (2) Use tracking history checklist

 AA. Multi-Path Signal

 1. Rarely encountered

 2. RADAR signal reflects off target, strikes another vehicle, and

 bounces off the target a second time before returning to the

 RADAR unit

 3. Rapid shift in audio tone

 4. Multiple Doppler shifts have occurred

 a. Elimination of effect

 (1) Use Doppler audio

 (2) Use tracking history checklist

 BB. Review Various Effects

X. Lidar Operation (Video Part II)

 A. Discuss various parts of video

 B. History of LIDAR

 1. July 1960, Theodore H. Maiman created fir Laser

 C. LASER

 1. Light Amplification by Stimulated Emission of Radiation

 D. LIDAR

 1. Light Detection And Ranging

 E. Types of Lasers

 1. Semiconductor

 2. Gas

 3. Chemical

 4. Excimer

 5. Free electron

 F. Operational Considerations

 1. Visual inspection of instrument

 2. Accuracy check

 G. Factors Affecting LIDAR

 1. Radio Frequency Interference (RFI)

 2. Random RFI

 3. Law enforcement radio RFI

 4. Light devices RFI

 5. Electrical lines RFI

 6. Panning

 7. Sweep effect

 8. Windshield obstruction

 9. Weather

 10. Low voltage

 11. Cosine angular effect

 H. Elimination of Effect

 1. Use Doppler audio

 2. Observe environment

 3. Use tracking history checklist

 I. Review of Day 2 Material

 J. Day 2 Quiz / Review of Day 2 Quiz

**DAY 3**

XI. Practical Exercises

 A. Visual Speed and Range Determination

 1. Must be able to establish two elements

 a. What is the range of the unit used?

 b. Was the target within that range?

 B. Range Formula

 1. (Stationary) Distance = S \* 1.47\*T

 2. (Moving) Distance = (S’ = S”) \* 1.47\*T

 C. Speed Determination Techniques

 1. Exhaust

 2. Suspension floating or dipping

 3. Passing other vehicles

 4. Brake lights

 5. Sound of engine

 6. Stirring up road debris / increased air turbulence

 D. Speed Determination Techniques

 1. Practice, practice, practice

 2. Cover display

 E. Practical Exercises

 1. Visual speed estimations

 a. 10 vehicles: stationary

 b. 10 vehicles: moving

 2. Range estimations

 a. 10 vehicles: stationary

 b. 10 vehicles: moving

 3. Demonstrate and explain

 a. Fan motor interference

 b. Police and CB radio interference

 c. Cosine error

XII. RADAR Evidence Kit

 A. Certification of Operator

 B. Vehicle Calibration (moving)

 C. Vehicle Maintenance Records

 D. RADAR Operator’s Manual

 E. RADAR Certification

 F. Tuning Fork Calibration

 G. RADAR Log (Maintenance and Service)

 H. Officer’s Daily Log

 I. Radio Interference Suppression Documentation

XIII. Review Course Material

 A. Final Exam

 B. Class Critique Form