E10 Operator-Induced Errors in Speed Measurement of Motor Vehicles

Roger L. Boyell, BEE, MS, MBA, PE, 416 Parry Drive, Moorestown, NJ 08057-2877*

After attending this presentation, attendees will understand the accuracy and reliability of vehicle speed measurement devices for law enforcement are adversely affected by operator-induced error. Devices subject to these errors are hand-held timers, radar, and lidar. Operator error is manifested through improper target sighting or inappropriate display interpretation. Available literature focuses on intrinsic equipment accuracy rather than operator-induced errors. Potential operator errors are here presented, specific to each device.

This presentation will impact the forensic community and/or humanity by demonstrating operator-induced errors which have been acknowledged by the relevant community, but they are minimized or ignored during operator training in order to avoid questioning the perceived accuracy or reliability of the test results.

The accuracy and reliability of vehicle speed measurement devices for law enforcement are adversely affected by operator-induced error. Devices subject to these errors are hand-held timers, radar, and lidar. Operator error is manifested through improper target sighting or inappropriate display interpretation. Available literature focuses on intrinsic equipment accuracy rather than operator-induced errors. Potential operator errors are here presented, specific to each device.

Errors induced by the operator include parallax viewing, inept button- pressing, unrecognized statistical fluctuations, target mis-identification, failure to field-calibrate, and imprecise target tracking. These errors are difficult to quantify, and they are minimized in operator training and related equipment manuals.

Digital readout of hand-held timers has an error of 10% - 20% through operator performance. A timer is an inexpensive electronic stopwatch designed for generic measuring of time intervals. It can be used to measure the time interval for a vehicle traveling between two fixed reference points, for speed calculation. The operator manually operates the timer as the vehicle crosses two reference points. Since the lines of sight do not remain parallel, the operator's view is subject to perspective distortion or parallax.

Another problem with timers is the manual starting and stopping of the timer, or button-pushing, requiring consistent hand-eye coordination. Activation of the button either early or late affects the accuracy of timing, thereby causing an erroneous speed calculation.

Both parallax compensation and accurate button-pushing are critical to effective timer employment. To avoid parallax errors the reference dis- tance is typically shortened to 30 meters. However, an operator cannot nor- mally respond to a 30-meter distance with accurate hand-eye motor coor- dination when a target vehicle is moving faster than 30 miles/hour. Operators can perform at tenths of a second, not hundredths or thousandths of a second as performed by automatic sensors.

Hand-held timers can be purchased which automatically calculate speed in miles or kilometers per hour. However, they still use a manually operated start-stop switch. Single-test accuracy and precision cannot be reproduced.

Traffic radar (radio detection and ranging) speed measurements are affected by statistical fluctuations in radio signals, and by the presence of unidentified targets. Operators are not familiar with electronic principles of vehicle speed measurement or equipment designs which are peculiar to traffic radar devices.

For operator convenience, the radar updates its display frequently, typ- ically twice a second, which sacrifices speed measurement accuracy. This is because signal distortions and fluctuations occur, and any single split-second reading by itself may be a statistical outlier. The operator must visually observe the intended target over an unimpeded line of sight, and must take multiple readings. This is to compensate for fluctuating signals and to assure the radar is responding to only the intended target. Merely flicking the off/on switch and accepting a single displayed speed number is inadequate.

Target identification problems occur when (1) more than one moving object is present in the radar beam, (2) the radar unit is subjected to physical motion or vibration, or (3) in moving radar, the patrol vehicle does not maintain accurate ground track during the measurement. Appropriate target identification and continuous ground tracking is necessary for a proper reading.

Traffic lidar (light detection and ranging) uses a laser light source or an infrared-emitting diode to illuminate a moving target. Nominal training is required for an operator to "point and shoot" a lidar. The major problems are absence of speed calibration in the field, and unsteady target tracking by the operator. Errors of 5 – 10 miles/hour occur in these situations.

The device is factory calibrated, not field recalibrated, thereby making all field results suspect due to hardware and software problems. The cursory operator field check on a stationary, high-contrast object is inade- quate, because it does not verify speed calculation.

Another error is the operator's facility in sighting and tracking. The bulky hand-held device must be held steady on a reflective part of the intended target vehicle, similar to operating a rifle without wavering or flinching. The operator needs to conduct multiple confirmatory readings in order to substantiate the displayed result.

 ** Presenting Author*

These operator-induced errors have been acknowledged by the relevant community, but they are minimized or ignored during operator training in order to avoid questioning the perceived accuracy or reliability of the test results.

Speed-Timing, Radar, Lidar

 ** Presenting Author*