DETERMINING NO-PASSING ZONES IN ARIZONA WITH SAFETY AND ACCURACY

David R. Olivarez

Traffic control devices that adequately communicate with motorists on highways are a key factor in maintaining safety. As signs forewarn of potential hazards, the no-passing zone forewarns of stretches of highway that contain sight restrictions and therefore should not be used for passing. Surveying areas that require no-passing zones has been a difficult task because of the amount of time necessary to locate the zones and the hazard involved in working on the highway in the presence of moving traffic.

Various methods for measuring sight distances have been employed in Arizona. The original method involved "eye-balling" the distance with little, if any, measurement. Needless to say, this method resulted in gross inconsistencies in the placement of no-passing zone signs on the highways. Many places had too many restrictive signs, and a large number of curves where passing should have been prohibited were not marked at all.

A second method required a vehicle to tow a target on the end of a cable, which was the same length as the required minimum passing sight distance. When the target disappeared, the vehicle was stopped and a mark was placed on the road to indicate the beginning of a zone. The vehicle then continued through the curve until the target came into view. The vehicle was then stopped again, and a mark was placed on the pavement to indicate the end of a zone.

A third method involved 2 vehicles connected with a length of rope equal to the minimum passing sight distance. When one was out of sight from the other, a no-passing zone was established. This method is known as the target method.

A fourth method used during the late 1950s required 2 vehicles equipped with 2-way radios and calibrated odometers. The vehicles stopped at each potential sight restriction and measured backward and forward until the available sight distance was determined. Location marks were placed on the pavement, and the crew moved to the next curve. This method was quite time-consuming and somewhat dangerous to perform on the highway.

The latest method used from 1960 to 1973 was much more efficient and could be performed more safely than the methods noted above. This last method involved 2

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1 The latest method of determining no-passing zones incorporates 2 Arizona Transportation Department pickup trucks.

2 Bill Batten, no-passing-zone supervisor, at the wheel of the front vehicle. A magnetic sensor mounted a fraction of an inch from the rim of the front tire transmits signals from 8 magnets mounted on the wheel rim to measure elapsed distance.

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1 Author David Olivarez is driving while Kohn Blackledge operates the printer to record no-passing-zone data. The distance-measuring and range-tracking instruments can be seen on the dashboard.

2 Old method of highway striping had built-in deficiencies.

3 Modern striping equipment is efficient, fast, and safe to operate.

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vehicles using 2-way radios, calibrated odometers, a sight target mounted at proper height on the lead vehicle, and a stamping odometer that was in the rear vehicle and used to record the location of each no-passing zone on a tape.

This method permitted measuring sight distances on the highway at speeds ranging from 20 to 40 mph and required stopping on or adjacent to the highway only to mark the beginning and ending of zones on the pavement. These marks are necessary for proper striping of no-passing zones by paint crews. Although this method was a substantial improvement with respect to accuracy, safety, and efficiency, some aspects still needed improvement. These included the following.

1. Two people must physically relocate and mark the new zones on the roadway. One person leans out of the car and paints arrows on the pavement with an aerosol can. This requires the vehicle to be stopped frequently in the middle of the road.

2. The survey procedure requires intense concentration, particularly by the drivers of the vehicles. The drivers must maintain a constant speed, which requires intense concentration on the speedometer, and listen to the clicking sound of the short-wave radio, which clicks every tenth of a mile. The driver of the front vehicle actuates the radio transmitter to create the clicking sound and must concentrate on the odometer to perform this function. The driver of the rear vehicle checks the odometer reading at reference points selected by the front vehicle driver. Both drivers must perform their driving tasks safely.

3. The recorder-operator in the rear vehicle not only must keep an eye on the lead vehicle to determine when the target disappears from view but also must record various data on the stamping odometer tape. The writing of data, such as begin no-passing zone, end no-passing zone, and reference points, is necessary because the odometers only stamp the accumulated mileage reading.

4. The size, location, and weight of the stamping odometer are awkward and pose a hazard to vehicle occupants in case of an accident.

Because of these deficiencies and our desire to develop a safe, reliable, and simple system, we arranged with an instrumentation company to develop a distance-measuring instrument (DMI), a range transmitter, and a pavement marker for use in establishing no-passing zones. The only apparatus needed that was not available at the time was a data printer that could print out various types of information such as the beginning and ending of no-passing zones.

The DMI is a computer-like measuring device that is more precise and efficient than the calibrated odometers that were used. The DMI can be adjusted to any type of measuring increment such as feet or miles; for our purpose, it was adjusted to increments of one-thousandth of a mile. This device operates from a 12-V dc power source. Distances are displayed by a digital readout on the face of the dashboard-mounted DMI unit. The digital readout is actuated by signals from a magnetic sensor mounted a fraction of an inch away from the tire rim. Eight beryllium ferrite magnets are attached to the lip of the wheel rim. Each time one of the magnets passes the sensor, the sensor signals the DMI, which converts the signals to a digital display of distance.

The range-tracking instrument takes a signal from the vehicle recording that has the DMI and one from the DMI in the front vehicle, compares them continually, and displays the distance between the 2 vehicles.

The printer has a keyboard with 12 different symbols, any one of which, when actuated, prints 4 columns of information on a tape. The first column is the reading of the DMI in the recording vehicle, the second is the distance between the 2 vehicles, the third is a 3-digit number that can be used to code any information desired, and the fourth is the symbol as it appears on the button punched.

The pavement marker is used to mark the beginning and ending of zones merely by pushing a button that actuates a spray paint marker.

Some 5,000 miles of highways in Arizona are constantly reviewed for no-passing zones as conditions along these highways change. Three people and 2 trucks equipped with the electronic distance-measuring and range-tracking devices operate year-round to accurately establish no-passing zones.

The front vehicle is equipped with a speed-control device, the distance-measuring instrument, and a range transmitter. It travels at constant speed and is tracked by the rear vehicle traveling at a constant distance and speed. In the rear vehicle, 1 person drives and the other actuates the recorder. That vehicle also has a speed-control device, a range tracker, a data printer, and a pavement marker. The distance traveled by the front vehicle is measured by the DMI, and this information is transmitted by the range transmitter (the operation of this transmitter is in conformance with Part 95, Rules and Regulations of the Citizen Radio Service for Class C Operation) to the rear vehicle on 1 of 5 control frequencies. The receiver in the rear vehicle receives distance information from the front vehicle. Data from the front vehicle are transmitted as a positive count and data from the rear vehicle as a negative count. These data are then channeled through a 4-digit numeric display that automatically calculates the separation distance. This distance is then displayed on the digital readout and is the actual distance between vehicles. The data printer logs events by symbolic notation and records information relating to distances. A 14-count format permits the recording of 12 characters to mark events such as left horizontal curve, right horizontal curve, intersections, or traffic controls. The symbolic characters are operated from a 12-key panel located on the printer.

The pavement marker consists of a paint sprayer, a pressurized stainless steel tank, and a solenoid-operated adjustable spray nozzle mounted on the front bumper of the recording vehicle. Events, such as the beginning or ending of a no-passing zone, can be marked on the road by the driver actuating a button that releases a spray of paint.

No-passing zones are established in accordance with the general guidelines set forth in the 1971 Manual on Uniform Traffic Control Devices. One of these is that the passing sight distance be based on the 85th percentile speed. Before a route is surveyed, speed resolutions on file (the legal document establishing a speed limit) are checked to be certain that the posted speed limits closely agree with the 85th percentile speed. Spot speed checks are used to verify the 85th percentile speed when it is necessary. After this preliminary preparation, there are 3 steps in our procedure of establishing no-passing zones: travel the route, mark the zones on the highway, and document the information and send it to the engineering districts.

The section is traveled in the direction of increasing mileposts while a constant separation between trucks is maintained. A target light, mounted on the front vehicle 3.75 ft above the ground is viewed by a person in the rear vehicle with an eye level at the same height. When the light disappears, a button is pushed to indicate the beginning of a no-passing zone. When the light appears again, the button is pushed to indicate the end of a no-passing zone. The tape now has a record of the milepost location of the zone's beginning and end and the separation between vehicles at the time the buttons were punched. The route is then traveled in the same manner against the milepost. At the end of a day's run these tapes are checked for various items. For example, the minimum length of opening left to pass, under any conditions, is a tenth of a mile, and the separation between vehicles must be within tolerance (±0.005 mile) at the time the zone location was recorded. This corrected information is then transferred to field sheets, which are used by the striping crew to locate the paint marks on the road where the no-passing zones are to be painted. To this point, everything is done in the field.

After they are returned to the office, the field sheets are copied by hand onto final log sheets, and all sheets that pertain to one route are filed in permanent files. Copies are sent to the appropriate striping crews for their records.

The new system began operation in August 1973. Accuracy and safety have greatly increased.

Previously, no-passing zone locations were recorded by using a converted traffic counter as a stamping odometer. There was no way to be sure that the interval between vehicles was right at the time the zone location was stamped on the tape. The old way of maintaining the proper separation distance was to have the driver of the front vehicle click the radio microphone at each tenth mile. The driver of the rear vehicle, hearing this click, would glance at the odometer to see whether the vehicle had just passed a tenth of a mile mark.

With the new system, a person in the rear vehicle now can see on the range tracker what the separation is at any time and adjust accordingly. Also, a permanent record of the separation is made each time a zone is marked.

The stamping odometer used earlier was mounted (at face level) in front of the person recording zones. In case of an accident, this arrangement would surely have caused some injuries. The new printer is a compact box mounted at waist level just to the right of the recorder.

Zone locations used to be marked with spray cans by a person leaning out of the back window. That would also result in injuries in the event of a rear-end collision. Now marking is done simply by pushing a button in the truck while it is in motion. This activates a solenoid in the spray nozzle mounted on the front of the truck.

When the equipment is not being used to establish no-passing zones, it is employed for other functions such as putting in mileposts on new alignments, logging features on high-speed urban facilities, and checking field measurements.

Old method of determining no-passing zones depended on an odometer and a radio to maintain the proper separation distance.