2.6.2 Premaneuver Time

Premeuver time is the time required for a driver to process information relative to a hazard. It consists of the times to detect and recognize the hazard, and to decide on proper maneuvers and initiate required action. This process thus includes both reaction and response initiation.

Detection and recognition times: These two elements of the information-handling process include time periods for latency (the delay between the time a hazard is presented and the time that the eyes begin to move), eye movement to hazard, eye fixation, and finally recognition or perception of the hazard. Times for these elements increase with the complexity and number of signals (hazards) and with increasing speed.

Decision and response initiation times: Once the hazard is perceived, the next steps in the process are to identify the alternative maneuvers, select one, and the initiate the required action. Because the required maneuver is likely to be a lane change, the time to decide on this maneuver, search for gaps, and initiate the action can range from 2.0 to 7.1 seconds, or even longer under heavy traffic volumes.

Maneuver time: The final component is the time required accomplishing a vehicle maneuver. Because the intent of decision sight distance is to allow drivers time to take an evasive action other than a quick stop, the assumption is made that a lane change is representative of maneuvers that would be performed. On the basis of data derived for
passing sight distance, this time is assumed to be between 3.5 and 4.5 seconds, decreasing with increasing speed.

2.7 Passing Sight Distance

Most roads are considered to qualify as two lane highways on which vehicles frequently overtake slower moving vehicles, the passing of which must be accomplished on lanes regularly used by opposing traffic. If passing is to be accomplished with safety, the driver should be able to see a sufficient distance ahead, clear of traffic, to complete the passing maneuver without cutting off the passed vehicle in advance of meeting an opposing vehicle appearing during the maneuver. When required, a driver can return to the right lane without passing if he sees opposing traffic is too close when maneuver is only partially completed. Many passing are accomplished without driver seeing a safe passing section ahead, but design based on such maneuvers does not have the desired factor of safety. Because many cautious drivers would not attempt to pass under such conditions, design on this basis would reduce usefulness of the highway.

Passing sight distance for use in design should be determined on the basis of the length needed to safely complete normal passing maneuvers. While there may be occasions to consider multiple passing, where two or more vehicles pass or are passed, it is not practical to assume such conditions in developing minimum design criteria. Instead, sight distance is determined for a single vehicle passing a single vehicle. Longer sight
distances occur in design and these locations can accommodate an occasional multiple passing.

When computing minimum passing sight distances on two-lane highways for design use, certain assumptions for traffic behavior are necessary; some of which offer a wide choice. The assumed control for driver behavior should be that practiced by a high percentage of drivers, rather than the average driver. Such assumptions follow:

1. Overtaken vehicle travels at uniform speed
2. The passing vehicle has reduced speed and trails the overtaken vehicle as it enters a passing section.
3. When the passing section is reached, the driver requires a short period of time to perceive the clear passing section and to react to start his maneuver.
4. Passing is accomplished under what may be termed a delayed start and a hurried return in the face of opposing traffic. The passing vehicle accelerates during the maneuver, and its average speed during the occupancy of the left lane is 10 mph higher than the overtaken vehicle.
5. When the passing vehicle returns to its lane, there is a suitable clearance length between the passing vehicle and an oncoming vehicle in the other lane.

Some drivers accelerate at the beginning of a passing maneuver to a comparably higher speed and then continue at a uniform speed until the passing is completed. Many drivers accelerate at a fairly high rate until just beyond the vehicle being passed and then complete the maneuver either without further acceleration or at reduced speed. For
simplicity, extraordinary maneuvers are ignored and passing distances are developed with the use of observed speeds and times that fit the practices of a high percentage of drivers.

The minimum passing sight distance for two-lane highways is determined as the sum of the four distances (Figure-A.1)

\[ d_1 \] – Distance traversed during perception and reaction time and during the initial acceleration to the point of encroachment on the left lane.

\[ d_2 \] – Distance traveled while the passing vehicle occupies the left lane.

\[ d_3 \] – Distance between the passing vehicle at the end of its maneuver and the opposing vehicle.

\[ d_4 \] – Distance traversed by an opposing vehicle for two-thirds of the time the passing vehicle occupies the left lane, or 2/3 of \( d_2 \) above.

**Initial maneuver distance (\( d_1 \)).** The initial maneuver period has two components, a time for perception and reaction, and an interval during which the driver brings his vehicle from the trailing speed to the point of encroachment on the left or passing lane. To a great extent the two overlap. As a passing section of highway comes into view of a driver desiring to pass, he may begin to accelerate a maneuver his vehicle toward the centerline of the highway while deciding whether or not to pass. Studies show that average passing vehicle accelerates at less than its maximum potential, indicating that the initial maneuver period contains an element of time for perception and reaction. However some drivers may remain in normal lane position while deciding to pass. The exact position of the
vehicle during initial maneuver is unimportant because differences in resulting passing
distances are insignificant.

The distance \( d_1 \) traveled during the initial maneuver period is computed from the
following formula:

\[
d_1 = 1.47 \ t_1 \ ( v - m + ( a \ t_1 / 2 ))
\]

where: \( t_1 \) = time of initial maneuver (seconds);

\( a \) = average acceleration (mph/sec);

\( v \) = average speed of passing vehicle (mph);

\( m \) = difference in speed of passed vehicle and passing vehicle.

The acceleration, time, and distance traveled during the initial maneuver periods in
passing are given in Table-A.5.

**Distance while passing vehicle occupies the left lane** \((d_2)\). The distance \( d_2 \) traveled in
the
left lane by the passing vehicle is computed by the following formula:

\[
d_2 = 1.47 \ v \ t_2
\]

where: \( t_2 \) = time passing vehicle occupies the left lane (seconds);

\( v \) = average speed of passing vehicle (mph).
The time and distance traveled while passing vehicle occupies the left lane are given in Table-A.5.

**Clearance length (d₃).** The clearance length between opposing vehicle and passing vehicle at the end of the maneuvers usually varies from 110 to 300 ft. This length, adjusted for practical consistency, is shown as the clearance length d₃ in Table-A.5.

**Distance traveled by opposing vehicle (d₄).** Passing sight distance includes the distance traversed by an opposing vehicle during the passing maneuver to minimize the chance of passing vehicle meeting an opposing vehicle while in the left lane. Conservatively, this distance should be the distance traversed by an opposing vehicle during the entire time it takes to pass or during the time the passing vehicle is in the left lane, but such distance is questionably long. During the first phase of the passing maneuver, the passing vehicle has not yet pulled abreast of the vehicle being passed, and even though the passing vehicle occupies the left lane, its driver can return to the right lane if he sees an opposing vehicle. This time interval, which can be computed from the relative positions of passing and passed vehicle, is about one-third the time the passing vehicle occupies the left lane, so that the passing sight distance element for the opposing vehicle is the distance it traverses during two-thirds of the time the passing vehicle occupies the left lane. The opposing vehicle is assumed to be travelling at the same speed as the passing vehicle, so $d₄ = 2 \, d₂ / 3$. The distance $d₄$ is given in Table-A.5.