D26 The Time Needed to Exit a Stationary Vehicle and the Forces Required, at Highway Speed, for a Passenger to Open a Vehicle Door Wide Enough to Exit

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After attending this presentation, attendees will better understand how to quantify exit time from a stationary vehicle and the forces required to open the door of a vehicle that is traveling at highway speed.

This presentation will impact the forensic science community by providing quantitative data regarding the time for a passenger to exit a stationary vehicle as well as providing quantification of the force required to hold an automobile door open wide enough to allow a person to exit while traveling at highway speeds.

In an accident sequence, a pickup truck occupied by two adult males lost control and rolled over. The passenger sustained fatal injuries. Rather than being ejected during the rollover, it was alleged that the passenger elected to jump out of the pickup truck while it was traveling in excess of 60mph just as it began losing control immediately before the rollover. Because the scenario allowed for only a very short time interval between the beginning of the rollover event and the passenger's claimed egress, both the length of time required to accomplish this type of maneuver and the magnitude of force that must be simultaneously applied to the door to keep it open to exit were the objective of this study.

The time and effort required to force a door open and hold it open in order to exit a vehicle traveling at highway speeds could not be directly measured due to the requirement to ensure human subject safety and well-being. As such, the problem was addressed in two parts: measure the time to exit a stationary vehicle, then measure the force it takes to overcome the aerodynamic tendency for the wind to close the door, while traveling at highway speeds. Since that force must be overcome and maintained to hold the door open in the dynamic situation, it was important since it would hinder a passenger from exiting the vehicle by increasing both the complexity and effort required. As such, the exit times acquired in the static vehicle situation would be expected to represent the lower bound for the actual time for a passenger to self-eject from a moving vehicle.

The dynamic test involved driving an exemplar pickup on the freeway and opening the door at various speeds. The vehicle was instrumented to measure vehicle speed, door-opening force, and door-opening angle. The passenger was seat belted and the action of opening the door was also videotaped. Since the force to hold the door open should not depend on the specific subject, only one subject opened the door in the moving vehicle test. Seven instrumented runs were performed at speeds ranging from 37mph to 63mph. The door was opened to approximately 50 degrees, with the range from 49 to 57 degrees. The maximum force at 37mph was 20 lbs. and the force at 63mph was approximately 75 lbs. Generation of the force required to keep the door open required some form of occupant interior bracing. Of course, for a stationary vehicle, the force required to hold the door open is essentially zero.

For the static vehicle door open timing, the exemplar pickup was instrumented with a contact switch on the dash for time zero and a contact switch was placed on the ground where the subject opening the door would initially step to represent the end of the maneuver. These trials were also videotaped. Four adult male subjects ranging from 40 to 68 years of age were recruited to participate. The physical characteristics of the participants are summarized in the table below.

Subject	Height (in)	Weight (lbs.)	Age (years)
1	70	213	68
2	72	215	58
3	67	200	46
4	71	260	40

Rather than attempt to replicate the physical characteristics of the passenger in the case, it was decided to use a variety of subjects with different ages, heights, and weights to arrive at a range of times that could be considered realistic.

The subjects were instructed to contact the switch on the dash, open the door, and exit as fast as possible, landing on the ground contact switch. The time between switch contacts was recorded. Each subject performed the task at least three times and there were a total of 18 recorded runs. For each subject, the first attempt at exiting the vehicle was typically their longest time, followed by generally decreasing times as they became more practiced. All the exit times ranged from 1.4 seconds to 3.0 seconds and, by their last attempt, all subjects were able to bring the time down to 1.7 seconds or less.

Besides presumably not having practiced rapidly self-ejecting from a moving vehicle, in addition to opening the door and moving to exit the vehicle, as in the static vehicle condition, exiting a moving vehicle would require the passenger to find a way to brace to force the door open, then maintain that level of force while positioning to exit the vehicle. As such, it can safely be concluded that the time required to exit a moving vehicle would be longer than those times obtained in the static vehicle trials since such a maneuver would be both more complex and require greater effort to complete.

It is concluded that without pre-planning or practice, it would be challenging to successfully exit a vehicle traveling at highway speeds, and it would be extremely unlikely that such could be accomplished quickly.

Accident Reconstruction, Door Opening, Egress Time