In an automotive collision where the velocity of a car is rapidly changed, an empty space between the occupant and the interior of the vehicle will result in a difference in velocity between the occupant and the car in the direction of travel. The deceleration of the vehicle and the distance of unrestrained relative motion will determine the occupant's impact velocity against the vehicle interior at the end of travel. Since such impacts often result in occupant injury, restraint systems are used to control this relative motion. The basic principle for such systems is the interposition of load-carrying, deformable elements between the vehicle interior and the occupant.

In some restraint systems these elements are in contact with the occupant's body already during normal driving. This type of restraint system does to some extent control the occupant's posture and thereby also the spatial relation between the human body and the restraint system during the collision sequence.

One characteristic of the airbag restraint system is that the deformable element -- the airbag itself -- is not inflated during normal driving, but remains stored, usually in the instrument panel. This is an important characteristic of this system, because it leaves a seated occupant more freedom to move and change position than do most other systems. In order to obtain this advantage, however, the system must be activated at an early stage of a collision. Thus the airbag must inflate and be placed in position between the vehicle interior and the occupant very quickly. The spatial relation between the occupant and the restraint cannot be controlled in the same manner in airbag restraint systems as it can in most other systems.

The current requirements of US FMVSS 208 take into consideration only the normally seated "grown up" car passenger. It may seem quite possible that a grown up passenger only very seldom is out of position to such an extent that this would cause any serious problems. If, however, the occupant is not only out-of-position but also has other body dimensions and weight that differ too much from that of an adult occupant, these problems may become more intricate. A child standing by the dashboard in front of the seat during an accident would fit this description quite well.

In this investigation the influence of three different inflation pulses on the risk of injury to a standing child was inferentially studied. Pigs weighing 14-15 kilograms were used as test animals. When anesthetized and kept in an upright position in a rear-facing child seat these animals were able to withstand a simulated car-barrier impact at 48.2 km/h (30 mph) without any sign of injury. When anesthetized in the same way and suspended in a vertical position with their right side 10-15-cm (4-6 inc.) from the airbag outlet area in the instrument panel and subjected to an acceleration pulse with a peak of 12 g and a velocity change of 28 km/h (17.5 mph) these animals were injured whether or not the airbags were inflated with any of the inflation pulses. Injury severity was rated from severe (AIS 3) to fatal (AIS 6) in the Abbreviated Injury Scale. Two types of injuries were seen: Tears in the liver and large bleeding in the heart or lungs as seen in impacts with displacement of the organs due to body deformation and multiple petechial bleedings mainly under the pleurae and the endocardium as seen in experimental air blasts.