C38 Discrepancy Between Dummy Measured Injury Criteria During Static Out-of- Position Airbag Deployments and Actual Human Injury Outcome

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After attending this presentation, attendees will understand what the limitations are when utilizing injury criteria values obtained from anthropomorphic test devices (ATSs) in static airbag deployment test settings.

This presentation will impact the forensic community and/or humanity by demonstrating that the established means for evaluating injury potential from being in close proximity to a deploying airbag has shortcomings and should be viewed with an eye of caution.

This presentation will help attendees understand that there are limitations when utilizing injury criteria values obtained from anthropomorphic test devices (ATDs) in static airbag deployment test settings. A real world, low-speed frontal collision will be presented where extensive (fatal) injury was produced, but the injury measures obtained from out-of-position (OOP) ATDs in static airbag testing were low and grossly inconsistent with the real world outcome.

When conducting vehicle crash testing with ATDs, accelerations, displacements, and forces can be measured for various parts of the dummy during the crash event. The National Highway Traffic Safety Administration (NHTSA) has established injury threshold values that must be met for a vehicle to pass Federal Motor Vehicle Safety Standard (FMVSS) 208, allowing the vehicle to be sold in the United States. Acceleration at the dummy head's center of gravity (cg) is used to calculate the head injury criterion (HIC). Neck loads and moments are used to calculate a neck injury tolerance called Nij. Neck tension, chest g's, and chest deflection are measured directly. In order for a vehicle to be in compliance with FMVSS, the values for these parameters must be below certain established threshold values, called injury assessment reference values (IARVs). The HIC (15 msec) value must not exceed 700 (for the 95th percentile male, the 50th percentile male, or the 5th percentile female). The Nij must not exceed 1.0 for these three dummies; however, critical intercept values used to calculate the Nij are different for the 95th percentile male, the 50th percentile male, and the fifth percentile female. The chest acceleration must not exceed 55 g's for the 95th percentile male, and must not exceed 60 g's for the 50th percentile male and fifth percentile female. The chest deflection should not exceed 2.8 inches for the 95th percentile male, 2.5 inches for the 50th percentile male, and 2.0 inches for the 5th percentile female. If all injury measures for a dummy in a given test are below the IARVs described, it is generally concluded that the chance of sustaining a serious injury to the head, neck, or chest of a human would be very low.

For vehicles manufactured after September 1, 2003, FMVSS also has requirements for an out-of-position (OOP) driver for which the fifth percentile female dummy is used. Even though no federal requirement existed for vehicles manufactured prior to that date, manufacturers were conducting static out-of position airbag deployment testing on the fifth percentile female and child dummies. The Nij for the fifth percentile female for OOP testing uses different intercept values for calculating the Nij than for an "in position" fifth percentile female dummy.

The injury measures obtained from ATDs in static airbag deployment tests are not necessarily representative of the injury sustained by a human in a similar event.

Bench tests for the front driver's side airbag for a 1996 Ford pickup were conducted to determine the forcefulness of the airbag relative to other vehicles. Results showed that the airbag tested was typical of other driver airbags in terms of reaction force at the hub.

Additionally, static airbag deployment tests were conducted on the driver's side of a 1996 Ford pickup with 50th percentile male and fifth percentile female dummies. With the dummies' chests in close proximity to the deployment doors, the measured injury criteria were all below the established IARVs for the 50th percentile male dummy, indicating that serious injury would be unlikely. For the fifth percentile female dummy, the peak neck tension IARV of 2070 N was exceeded in both tests. In the first test, the measured value was 3,693 N and in the second test it was 2,330 N. The Nij in tension and extension, N_{TE}, for an out-of-position fifth percentile female exceeded the IARV of 1.0 in one of the two tests. The remaining measures for the fifth percentile female were below threshold values. Thus, one could conclude that a small-statured human would be at risk for a serious neck injury from the deployment event, but other serious injuries would be unlikely.

Finally, these results were then compared to a real world case involving a 1996 Ford pickup. A 41 year-old male (5'7" and 170 lbs.) was involved in a low-velocity frontal collision. As a result of the low- speed frontal impact, he was on or very close to the deployment doors of the driver's airbag when it deployed. He consequently sustained extensive injuries to his head, neck, and chest including a transverse "hinge" fracture extending through the occipital bone; crush and multiple lacerations of the pons, midbrain, brainstem and cerebellum; multiple bilateral rib fractures; partial transaction of the proximal descending aorta; multiple intimal lacerations of the thoracic aorta; and laceration of the posterior pericardial sac. His fatal injuries were extremely severe and clearly not predicted by the static airbag deployment tests with ATDs. It is hypothesized that the obvious discrepancy between the dummy injury measures and the actual injuries sustained is due to inaccuracies in the IARVs, reliability of the dummy measurements, and/or the failure to include any effect the vehicle velocity change may have on the injury measures.

In conclusion, injury measures from ATDs during static, out-of- position airbag deployment tests do not necessarily accurately reflect the actual injury outcome for a human.

This information helps humanity by demonstrating that the established means for evaluating injury potential from being in close proximity to a deploying airbag has shortcomings and should be viewed with an eye of caution. It is also felt that further research to isolate the reasons for this discrepancy should be conducted to help eliminate this problem.

Airbag Deployment, Out-of-Position, Injury Measures