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C5 Forensic Examination of an Unwanted Seat Belt Release in a Rollover Collision With Occupant Ejection

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After attending this presentation, attendees will have been introduced to a case where a seat belt restrained occupant in a large SUV was ejected and severely injured in a multiple-impact rollover collision. The goals of this presentation are to describe in detail the physical evidence and to clearly explain the mechanism of unwanted seat belt release.

This presentation will impact the forensic science community by illustrating how a detachable anchor design can be susceptible to release.

Collision Overview: A 1999 Ford Expedition with six occupants was traveling in lane #3 of a 3-lane highway when it was struck from the rear by an errant Ford Explorer. The rear impact caused the Expedition to spin out of control, impact the concrete median barrier, and roll over onto its right side. The Expedition was subsequently struck by two vehicles. The latter more severe impact caused structural deformation to the Expedition with the unwanted release of the third row, right outboard occupant's seat belt. The occupant was ejected and sustained a severe closed head injury. This presentation discusses the reconstruction, injury, buckle design, and mechanism of the unwanted belt release.

Materials Reviewed: The traffic collision report provides details of the type and location of physical evidence, and a scaled, hand-drawn diagram. Color digital photographs (29) taken at the scene by police were reviewed. The subject vehicle was inspected. Medical records detailed the occupant injuries.

Collision Reconstruction: In this multi-vehicle collision, there were eight distinct impacts.

- Impact #1: Right front corner of the Explorer rear-ends the left rear corner of the Expedition:** The Expedition was traveling approximately 65 mph when the right front corner of the Explorer struck its left rear corner, evidenced by paint transfers on the Expedition matching the color of the Explorer.
- Impact #2: Explorer rolled on embankment:** The Explorer careened off the right side of the highway and overturned on a landscaped embankment.
- Impact #3: Explorer struck a palm tree:** The Explorer descended the steep slope, struck a palm tree, and continued to its point of rest (POR) on its wheels.
- Impact #4: Right front corner of the Expedition strikes the concrete median barrier:** The Expedition was propelled 174 feet, yawed counterclockwise about 125° (when viewed from above) to an angle of about 18° relative to the concrete median barrier, and struck the barrier at 45 to 47 mph, evidenced by tire friction marks.
- Impact #5: Right rear corner of the Expedition strikes the concrete median barrier:** The Expedition continued to yaw counterclockwise for about 27 feet on its wheels until, at 42 to 44 mph with a principle direction of force of 160° to 180°, its right rear corner collided with the barrier, evidenced by the tire friction marks on the roadway and horizontal scrapes on the Expedition.
- Impact #6: Expedition tripped and rolled in lane #1:** The Expedition continued to yaw counterclockwise, slowed to 34 to 37 mph, tripped, and rolled ¾-turn driver-side leading. Then, the Expedition slid on its right side in lane #1 for about 92 feet, evidenced by metal scrapes to the vehicle exterior.
- Impact #7: Corolla vs. Expedition:** The Toyota Corolla, traveling 65 mph in lane #1, skid into the concrete median barrier, causing left front wheel and suspension damage. Then, the Corolla was redirected, continued skidding for 148 feet, and, traveling approximately 22 mph, struck the front undercarriage of the Expedition, which was stationary on its right side. The Expedition rotated clockwise (when viewed from above) and became aligned within lane #1 with its rear end exposed to approaching traffic.
- Impact #8: RAM vs. Expedition:** The Dodge Ram, traveling 65 mph in lane #1, skid for 46 to 57 feet, slowed to 50 to 53 mph, and hit the right rear corner of the Expedition, which was stationary on its right side, evidenced by a tread imprint from the Ram's left front tire on the Expedition's exhaust pipe and paint chips matching the Ram embedded in the Expedition spare tire bead. The Expedition's velocity change was 28 mph. The Expedition, on its right side, rotated counterclockwise for more than 360° to its POR, ejecting the third row, right outboard passenger.



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Expedition POR: At its POR, the Expedition faced east in the middle of the #1 lane.

Injury Description: The 14 year-old, 135-pound female, 3rd row, right outboard belted passenger sustained severe head trauma (right basal and right frontotemporal skull fractures with right frontal epidural or subdural hematoma, diffuse subarachnoid hemorrhage, and pons diffuse axonal injury with residual right 6th nerve palsy), with blunt right orbital injury, severe frontal laceration, occipital bleeding, nose fracture, and chipped teeth.

Injury Causation: Inspection of the Expedition's interior rear occupant compartment, roof rail and headliner revealed no blood spatter or physical evidence consistent with a forceful head strike. At their POR's, the ejected third row, right outboard occupant was lying on the roadway adjacent to the concrete median barrier approximately five feet from the underside of the Expedition. Therefore, the severe injuries sustained by the victim were likely the result of a forceful impact with the concrete barrier after ejection.

Seat Belt Assembly Inspection:

Third Row Outboard Seat Belt Design: The 3rd row, outboard seat belt assemblies feature continuous loop webbing, a free-sliding latch plate, fixed D-ring and an emergency-locking retractor. The seat belt assemblies contain a seat-fixed, end-release buckle and a lower outboard detachable anchor. These design features facilitate the complete removal of the third row seat assembly to expand cargo volume. The 1998 through 2002 model year Ford Expeditions and Lincoln Navigators contain the same third row detachable anchor design. The detachable anchor resembles a side-release seat belt buckle encased in a plastic boot (photo 01 detachable anchor). The other side of the detachable anchor is called the anchor tongue, and resembles a chrome-plated latch plate tongue that is secured to the vehicle inside a recessed floor pocket. The Expedition Owner's Guide explains how to disengage the lap-shoulder belt from the floor: Insert a key or small screwdriver through a hole in the boot, press on the release button, thereby separating the detachable anchor from the anchor tongue (figure 01 illustration). During the inspection of the subject vehicle, the detachable anchor of the right third row outboard seat belt assembly was found detached from the anchor tongue.



Belt Usage: Physical evidence on the right 3rd row outboard seat belt assembly was conclusive for use at the time of collision. Conspicuous striations to the polymer over mold of the latch plate and D-ring confirmed occupant loading to the seat belt system.

Third Row Outboard Seat Belt Release Mechanism: The impact by the Ram caused the Expedition's right rear floor structure to deform upward toward the headliner (photo 02 rear corner damage). Deformation to the area surrounding the detachable anchor was significant enough to allow the detachable anchor to contact the outboard seat back recline lever. In the undeformed condition, the hole in the boot is approximately four inches from the lower edge of the recline lever when the seat belt is fastened. Scratches consistent with interaction with the recline lever were visible on the side of the boot that conceals the release button facing



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the lever (photo 03 boot evidence). The boot also showed evidence of being compressed in the form of discoloration or lightening of the plastic. The physical evidence indicated that it was most likely interaction between the seat back release lever and the plastic boot that led to an unintended release of the detachable anchor.



Third Row Outboard Seat Belt Detachable Anchor Compression Testing: Compression tests were conducted on the boot- encased detachable anchor assemblies sectioned from two exemplar seat belt assemblies salvaged from 1999 and 2000 model year Expeditions. The 2000 specimen exhibited more oxidation to the metal plating of the detachable anchor, likely a result of exposure to the elements during storage.

First, a force gauge was used to quantify the average minimum force needed to depress the release button and disengage the anchor tongue. Ten tests were conducted on each specimen.



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- The 1999 specimen needed an average 4.1 pounds and approximately 1/8 inch depression to release the anchor tongue, whereas
- The 2000 model needed an average of 5.3 pounds to release the anchor tongue.

Next, a test fixture was designed to hold the detachable anchor in a horizontal orientation (photo 04 fixture). A 1.5-inch diameter ball was used as an impactor centered on the hole in the boot, with a preload of about 20 pounds. The impactor was attached to an Instron model 1123 tension-compression machine with a crosshead speed of 0.5 inches/min. A 5.0-pound weight was secured to the anchor tongue to aid removal from the detachable anchor once sufficient compression force was attained. Data was collected with a 5,000-pound load cell at 20Hz.

- For the 1999 specimen, a compression force of approximately 760 pounds and a displacement of about 0.13 inches was necessary to eject the anchor tongue.
- For the 2000 model specimen, a compression force of about 1,110 pounds and a displacement of about 0.17 inches was necessary to eject the anchor tongue.

The difference in force and displacement values between the specimens may have been the weathered condition of the 2000 specimen, or a result of the eccentricity of the impactor position relative to the release button underneath the plastic boot.

Conclusions: A large SUV was involved in a multiple-impact rollover collision from which a third row, right outboard seat belt restrained occupant was ejected and seriously injured.

Physical evidence on the third row, right outboard seat belt detachable anchor suggested that interaction with the seat back recline lever led to unwanted release of the seat belt.

Compression testing on exemplar detachable anchor specimens showed that latch release can be obtained with 760 to 1,110 pounds

Unwanted Seat Belt Release, Detachable Anchor, Rollover Occupant Ejection