TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION

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REDESIGNED AIR BAG SPECIAL STUDY (RABSS)
SCI TECHNICAL SUMMARY REPORT

NASS RABSS CASE NO. 1998-09-802C

RABSS VEHICLE - 1998 HONDA CIVIC EX

LOCATION - STATE OF MARYLAND

CRASH DATE - AUGUST, 1998

Contract No. DTNH22-94-D-07058

Prepared for:

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points are coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems.

TECHNICAL REPORT STANDARD TITLE PAGE

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16. *Abstract* This investigation focused on a two vehicle crash involving a 1998 Honda Civic EX 4-door sedan (subject vehicle) and a 1985 International tractor-trailer. The Honda Civic was equipped with redesigned frontal air bags that deployed as a result of a frontal collision with the rear of the tractor-trailer. The International tractor-trailer was disabled and facing north in the #2 outboard lane of a multi-lane divided highway when the front right area of the (northbound) Honda struck the rear left area of the tractor-trailer resulting in moderate damage. The Honda underrode the trailer as engagement continued into the greenhouse (windshield/roof) area. At this point, the Honda rotated clockwise and traveled into the center (west) median strip where it impacted a guardrail which resulted in minor rear damage. The Honda came to rest against the guardrail facing southeast. The 35 year old male driver of the Honda Civic was unrestrained (3-point manual lap and shoulder belt available) and seated in an upright posture with the seat track adjusted to the rear most position. At impact with the tractor-trailer, he initiated a forward trajectory in response to the 12 o'clock impact force and loaded the deployed air bag resulting in multiple abrasions to the forehead. The lower extremities loaded the knee bolster and center instrument panel which resulted in a fracture of the right acetabulum. His torso subsequently bottomed out the air bag and contacted the lower portion of the steering wheel rim as the right forearm/hand fractured the center mid-instrument panel area. These contacts resulted in a contusion to the right lower chest and multiple abrasions/lacerations to the right forearm/hand. The driver was transported by helicopter to a nearby trauma unit for treatment and hospitalized for 6 days.			
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BACKGROUND

This investigation focused on a two vehicle crash involving a 1998 Honda Civic EX 4-door sedan (subject vehicle) and a 1985 International tractor-trailer. The Honda Civic was equipped with redesigned frontal air bags that deployed as a result of a frontal collision with the rear of the tractor-trailer. The International tractor-trailer was disabled and facing north in the #2 outboard lane of a multi-lane divided highway when the front right area of the (northbound) Honda struck the rear left area of the tractor-trailer resulting in moderate damage. The Honda underrode the trailer as engagement continued into the greenhouse (windshield/roof) area. At this point, the Honda rotated clockwise and traveled into the center (west) median strip where it impacted a guardrail which resulted in minor rear damage. The Honda came to rest against the guardrail facing southeast. The 35 year old male driver of the Honda Civic was unrestrained (3-point manual lap and shoulder belt available) and seated in an upright posture with the seat track adjusted to the rear most position. At impact with the tractor-trailer, he initiated a forward trajectory in response to the 12 o'clock impact force and loaded the deployed air bag resulting in multiple abrasions to the forehead. The lower extremities loaded the knee bolster and center instrument panel which resulted in a fracture of the right acetabulum. His torso subsequently bottomed out the air bag and contacted the lower portion of the steering wheel rim as the right forearm/hand fractured the center mid-instrument panel area. These contacts resulted in a contusion to the right lower chest and multiple abrasions/lacerations to the right forearm/hand. The driver was transported by helicopter to a nearby trauma unit for treatment and hospitalized for 6 days.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as case number 98-09-802C for the Redesigned Air Bag Special Study. The Field Operations Branch of the National Highway Traffic Safety Administration (NHTSA) assigned the Special Crash Investigation (SCI) team at Veridian/Calspan the task of case review and final report preparation.

SUMMARY

Crash Site

This two vehicle crash occurred during the morning hours of August, 1998. At the time of the crash, it was daylight with no adverse conditions as the roads were dry. The crash occurred in the northbound lanes of an multi-lane north/south (asphalt) highway **(see Figure 9 - page 6)** which is divided by a median strip and guardrail. The speed limit at the crash scene was 89 km/h
(55 mph).

Pre-Crash

The 35 year old male driver of the 1998 Honda Civic EX was operating the vehicle northbound in the #2 outboard lane when the driver failed to notice the tractor-trailer (distracted looking into the rear-view mirror) disabled in the same lane ahead. Upon recognition of the impending harmful event, the driver braked and steered left in avoidance remaining in the same lane prior to the collision.

Crash

As the Honda Civic traveled northbound in the #2 outboard lane of the multi-lane divided highway, the front right area struck the rear left area of the 1985 International tractor-trailer (shipping container) resulting in moderate damage. The impact induced deceleration was sufficient to deploy the Honda's redesigned frontal air bag system. Although the impact was classified as out of scope (heavy trucks beyond the scope of the program), the damage algorithm of the WinSMASH program computed a (barrier equivalent) velocity change of 29.2 km/h (18.1 mph). The specific longitudinal component was -29.2 km/h (-18.1 mph). The Collision Deformation Classification (CDC) for the initial impact to the Honda Civic was 12-FRAA-7. At this point, the Honda underrode the trailer as engagement continued into the greenhouse area with subsequent penetration through the windshield and into the passenger compartment. The vehicle rotated clockwise and traveled into the center median strip where it impacted a guardrail resulting in superficial rear damage. The Collision Deformation Classification (CDC) for the secondary impact to the Honda was 05-BREE-3. The Honda came to rest against the guardrail facing southeast **(Figure 1)**.

Figure 1. Look back (south) from vehicle final rest showing overview of crash site.

Post-Crash

The driver of the Honda Civic was removed from the vehicle with perceived serious injuries. Treatment was rendered at the scene by fire department personnel and emergency medical technicians (EMT's). The driver was transported by helicopter to a nearby trauma center for treatment and admitted for 6 days. The vehicle was towed from the scene.

RABSS VEHICLE

The1998 Honda Civic EX was identified by the Vehicle Identification Number (VIN): 2HGEJ8545WH (production sequence deleted). The vehicle was a 4-door sedan equipped with front wheel drive and a 1.6 liter, 4 cylinder engine. The vehicle's odometer reading was 22,209 km (13,801 miles) at the time of the crash. Air bag warning labels were affixed to each front sunvisor. The seating was configured with front bucket seats and a folding (back) rear bench. The NASS researcher reported no cutoff switch for the redesigned passenger air bag. The driver reported no previous crashes or maintenance on the Honda's air bag system (original equipment). A portable cell phone was present but not in use at the time of the collision.

Figure 2. Frontal damage to the 1998 Honda civic EX.

VEHICLE DAMAGE

Exterior Damage

The 1998 Honda Civic EX sustained moderate frontal damage as a result of the impact with the tractor-trailer **(Figure 2)**. The direct contact damage began at the front right bumper corner and extended 40.0 cm (15.7 in) inboard. The impact deformed the full frontal width resulting in a combined direct and induced damage length (Field L) of 110.0 cm (43.3 in). Six crush measurements were documented at the level of the lower radiator support (the bumper fascia and reinforcement bar separated from the mounting assembly): C1 = 2.0 cm (0.8 in), C2 = 2.0 cm (0.8 in), C3 = 13.0 cm (5.1 in), C4 = 23.0 cm (9.1 in), C5 = 29.0 cm (11.4 in), C6 = 38.0 cm (15.0 in). Damage was noted to the right front wheel/tire which was restricted and deflated from both lateral and rearward displacement of the right fender. The right windshield header, A-pillar and roof area were deformed from the trailer underride **(Figures 3 & 4)**. The windshield was fractured and holed from the trailer penetration into the passenger compartment area. Extrication damage was also noted at the outer seams of the windshield which was removed post-crash. Induced buckling restricted the right front door opening and shattered the side glazing. Superficial damage was noted to the rear right bumper corner and quarter panel from the guardrail impact.

Figure 3. Underride damage to the greenhouse area.

Figure 4. Underride damage to the greenhouse area.

Figure 5. 1998 Honda Civic EX redesigned driver air bag.

Interior Damage

Interior damage to the Honda Civic identified through the NASS vehicle inspection was moderate and was attributed to occupant contact. No transfers or loading marks were noted to the available 3-point manual lap and shoulder belt system. No wear marks to the latch plate of the manual restraint were noted which would be an indication of frequent use. No contacts were identified on the exterior surface of the driver air bag module cover flaps, but blood transfers were documented at the (right) upper and lower quadrants of the redesigned driver air bag. The lower portion of the steering wheel rim was deformed forward 2.0 cm (0.8 in) with the tilt column adjusted between the full up and center position. The center instrument panel **(Figure 5)** and left knee bolster were fractured and scuffed. The rear view mirror was fractured and separated from the windshield. No contacts were identified to the exterior surface of the front right air bag module cover flaps, but blood spattering was noted to upper left quadrant of the redesigned passenger air bag. Intrusions into the driver space included 4.0 cm (1.6 in) of longitudinal toepan intrusion and 3.0 cm (1.2 in) of longitudinal instrument panel intrusion. Intrusions into the front right seating area included 14.0 cm (5.5 in) of toepan intrusion, 21.0 cm (8.3 in) of instrument panel intrusion and an (approximated) exterior object intrusion (trailer) of 30.0 cm (11.8 in).

REDESIGNED AIR BAG SYSTEM

The 1998 Honda Civic EX was equipped with redesigned frontal air bags for the driver and front right passenger positions. The air bags deployed as a result of the crash. The driver air bag was housed in the center of the steering wheel with a horizontally oriented flap tear seam (H-configuration). The upper flap measured 14.5 cm (5.7 in) in width and 6.5 cm (2.6 in) in height while the lower flap measured 14.0 cm (5.5 in) in width and 5.0 cm (2.0 in) in height. There was no contact evidence on the exterior surface of the module cover flaps, but blood spattering was identified at the (right) upper and lower quadrants of the air bag associated with the driver's forehead injury. The NASS researcher measured the diameter of the driver air bag at 66.0 cm (26.0 in) in its deflated state **(Figure 6)**. The bag was tethered by two internal straps and vented by two ports located at the 11 o'clock and 1 o'clock sectors on the rear aspect of the air bag.

Figure 6. Damage to the center instrument panel.

Figure 7. 1998 Honda Civic EX redesigned passenger air bag.

The front right passenger air bag deployed from a top mount module in the right instrument panel with a horizontally oriented flap tear seam (H-configuration). The cover flaps opened in an upward direction toward the windshield. Flap contact to the right windshield was unknown given the extrication damage to the windshield. The cover flaps were symmetrical and rectangular in shape which measured 23.0 cm (9.1 in) in width and 5.0 cm (2.0 in) in height. There was no contact evidence noted to the exterior surface of the module cover flaps, but blood spattering was identified to the left upper quadrant of the air bag associated with the driver's right forearm/hand injury. The NASS researcher measured the passenger air bag at 49.0 cm (19.3 in) in width and 54.0 cm (21.3 in) in height in its deflated state **(Figure 7)**. No internal tether straps were present. The bag was vented by two ports located at the 3 o'clock and 9 o'clock sectors on the side aspect of the air bag. Several cuts were noted to the air bag material from rescue efforts post-crash **(Figure 8)**.

Figure 8. Air bag cut by rescue during driver extrication.

DRIVER DEMOGRAPHICS

Age/Sex:	35 year old male
Height:	178 cm (70 in)
Weight:	90 kg (198 lb)
Seat Track Position:	Rear most position
Manual Restraint Use:	None
Usage Source:	NASS vehicle inspection, medical reports
Eyeware:	Non-prescription sunglasses
Type of Medical Treatment:	Transported to a local hospital and admitted (6 days)

Driver Injuries

Injury	*Severity (AIS 90)*	*Injury Mechanism*
Fracture right acetabulum (with dislocation at femoral head)	Serious (852604.3,1)	Center instrument panel (indirect contact injury)
Abrasion right/left forehead	Minor (290202.1,7)	Front left air bag
Abrasion posterior right hand	Minor (790202.1,1)	Center instrument panel
Abrasion posterior right forearm	Minor (790202.1,1)	Center instrument panel
Laceration posterior left forearm	Minor (790602.1,2)	Left side interior surface
Laceration posterior right forearm	Minor (790602.1,1)	Center instrument panel
Contusion right thorax	Minor (490402.1,1)	Steering wheel rim
Laceration right forehead	Minor (290602.1,7)	Rear view mirror

Driver Kinematics

The unrestrained 35 year old male driver of the Honda Civic was seated in an upright posture with the seat track adjusted to the rear most position. The police report noted that the driver was not belted, further evidenced by the lack of loading marks to the belt webbing and extent of occupant contact deformation to the vehicle interior. The rapid counterclockwise steering input (avoidance maneuver) put the driver slightly out of position to the right.

At impact with the trailer, the driver initiated a forward trajectory in response to the 12 o'clock impact force and loaded the deployed air bag resulting in abrasions to the right and left forehead. His torso subsequently bottomed out the air bag and contacted the lower portion of the steering wheel rim resulting in a contusion to the right lower thorax, evidenced by the (pre-crash) placement of the tilt column in conjunction with the 2.0 cm (0.8 in) of deformation to the lower portion of the steering wheel rim. His right lower extremity loaded the knee bolster and center instrument panel. The energy was transmitted through the femur which resulted in a fracture of the right acetabulum (with a dislocation at the femoral head). Although no injuries to the right lower extremity were reported as a result of direct contact to the knee bolster/center instrument panel, this injury mechanism was evidenced by the fractured panels relative to the type of injury sustained. At this point, the driver continued the kinematic response pattern into the center mid-instrument panel area as the forehead struck the rear-view mirror. Contact to these components resulted in multiple lacerations and abrasions to the posterior aspect of the right forearm/hand and a laceration to the right forehead as evidenced by the deformation to these components in relation to the existing kinematic pattern. The driver was transported by helicopter to a nearby trauma unit for treatment and admitted for 6 days.

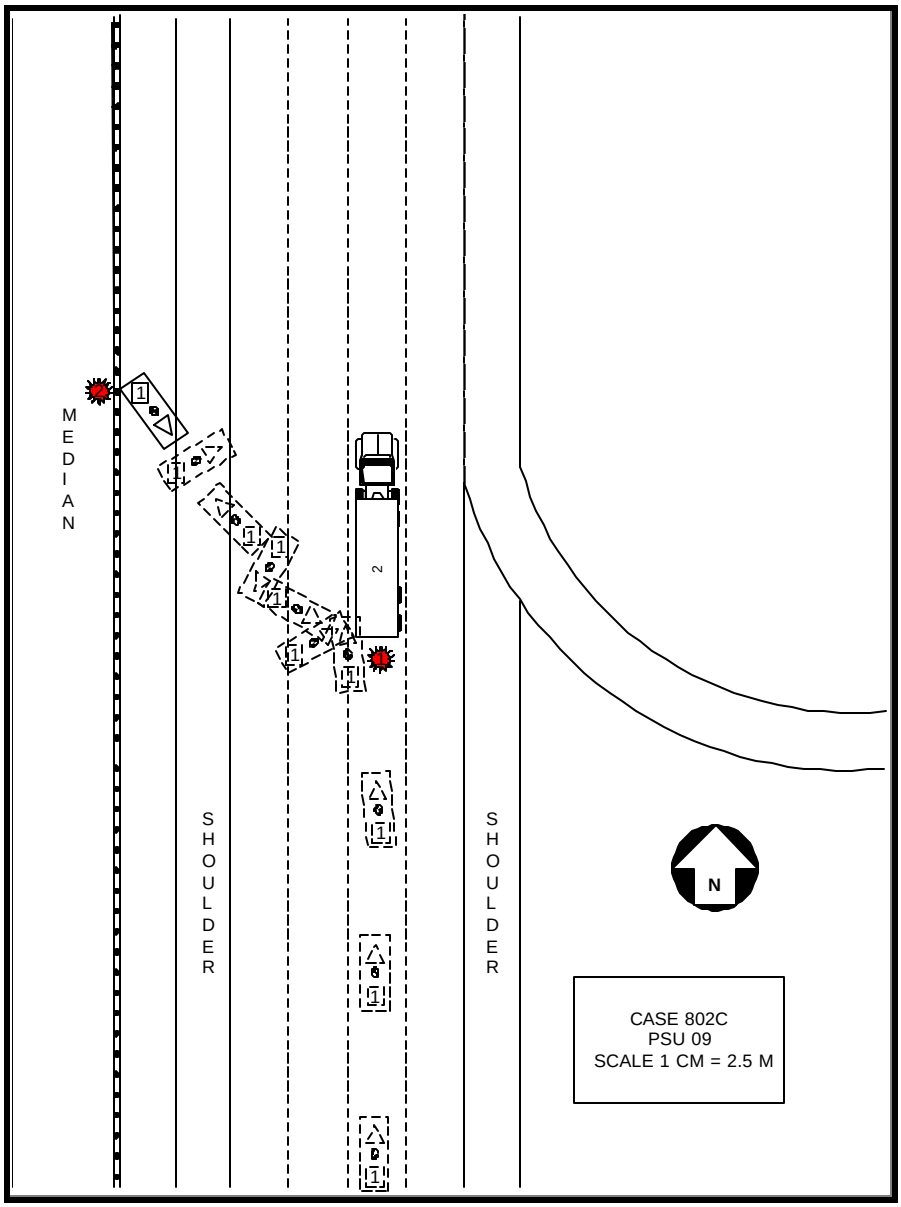

Figure 9. NASS Scene Diagram