Advanced Occupant Protection System (AOPS) Investigation / Vehicle to Object
Dynamic Science, Inc. / Case Number: 2005-79-139B
2000 Honda Accord
California
November, 2005

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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 be 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.

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16. Abstract

This Remote/Combination Investigation focused on the Advanced Occupant Protection Investigation System (AOPS) that was present in a 2000 Honda Accord. This single vehicle crash occurred in November 2005 at 1220 hours. The subject vehicle was being driven by a 74-year-old female. The driver was wearing the manual 3-point lap and shoulder belt. The Honda was equipped with a steering wheel mounted driver air bag and a top mount front right passenger air bag. The crash occurred in the southwest corner of a three leg intersection. The speed limit was 56 km/h (35 mph). The Honda Accord was traveling southbound in the first lane from the right. The driver veered to the right. As the vehicle approached the concrete curb at the southwest corner of the intersection, the driver began braking. The case vehicle struck the curb and mounted it. The case vehicle continued in a southwest direction and struck a metal light pole with its front end. The pole was sheared off at its base. The driver's air bag deployed at this time. The case vehicle came to rest partially off road, facing southwest. The driver was unconscious when the police arrived. She sustained a heart laceration, rib fractures, and multiple contusions/abrasions. She was transported from the scene to a local hospital where she was pronounced dead at 1406 hours.

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**Dynamic Science, Inc.**
**Crash Investigation**
**Case Number: 2005-79-139B**

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## BACKGROUND:

### Description

This Remote/Combination Investigation focused on the Advanced Occupant Protection Investigation System (AOPS) that was present in a 2000 Honda Accord. (**Figure 1**). The AOPS consisted of dual-stage frontal air bags. This single vehicle crash occurred in November 2005 at 1220 hours. The subject vehicle was being driven by a 74-year-old female. The driver was wearing the manual 3-point lap and shoulder belt. The crash occurred in the southwest corner of a three leg intersection. The speed limit was 56 km/h (35 mph). The Honda was traveling southbound in the first lane from the right. The driver failed to negotiate the right hand curve and the vehicle went to the right. As the vehicle approached the concrete curb at the southwest corner of the intersection, the driver began braking. The Honda struck the curb and mounted it. The Honda continued in a southwest direction and struck a metal light pole with its front end. The pole was sheared off at its base. The driver's air bag deployed at this time. The Honda came to rest off road, facing south. The driver was unconscious when the police arrived. She sustained a heart laceration, rib fractures, and multiple contusions/abrasions. She was transported from the scene to a local hospital where she was pronounced dead at 1406 hours.

**Figure 1**. 2000 Honda Accord

This case was identified by the local National Automotive Sampling System, Primary Sampling Unit. The case was reported to DSI on February 22, 2006.

The NASS case was published based on the best available information at file closeout. Based on additional information that was later obtained from the SCI investigation, the air bag could not be confirmed as the source of the driver's fatal injuries. The case was then changed from a driver air bag fatality case to an advanced occupant protection case.

## SUMMARY

### Crash Site

The crash occurred in the southwest corner of a three leg intersection (**Figure 2**). The southern leg of the intersection is comprised of two southbound travel lanes, a two way turn lane, and two northbound travel lanes. The intersecting eastbound roadway was private. There was a 1.5% downhill grade for southbound travel. There were no adverse driving conditions and the roadway was dry. The speed limit was 56 km/h (35 mph).

**Figure 2**. Approach to area of impact, south

**Pre-Crash**

This single vehicle crash occurred in November 2005 at 1220 hours. The 2000 Honda Accord that was being driven by a 74-year-old female (163 cm/64 in, 61 kg/134 lbs). The driver was wearing the manual 3-point lap and shoulder belt. The case vehicle was equipped with a steering wheel mounted driver air bag and a top mount front right passenger air bag. The Honda was traveling southbound in the first lane from the right at a minimum speed of 41.3 km/h (25.7 mph)[1].

**Crash**

The driver failed to negotiate the right hand curve and the vehicle went to the right. As the Honda approached the concrete curb at the southwest corner of the intersection, the driver began braking and deposited a 4.3 m (14.0 ft) left wheel skid. The Honda struck the curb and mounted it (**Figure 3**). The Honda continued in a southernly direction and struck a metal light pole with its front end. The pole was sheared off at its base. The barrier routine of the WinSmash program computed a delta V of 31 km/h (19.3 mph), based on the Honda's front crush profile. This collision is beyond the WinSmash program due to the yielding object; the barrier equivalent speed is for reference only. The driver's air bag deployed at this time. The Honda came to rest off road, facing south.

**Figure 3**. Area of impact with pole, pre-impact skidmarks

**Post-Crash**

One of the citizen first responders to the crash stated that the driver was found upright in her seat, was still wearing her seat belt and was staring straight ahead. He indicated that it appeared that the driver was having trouble breathing. He broke out the right rear window to allow the dust from the air bag out. He stated that the driver removed her own seat belt. He attempted to speak to her, but she responded in an unknown language (Farsi).

The driver was unconscious when the police arrived. She had a Glasgow Coma Scale (GCS) score of 3 at the scene. She was transported by ground ambulance to a local hospital. On route she became slightly alert complaining of right-sided rib pain. In the emergency room she was found to be alert, awake and hypotensive. CPR was initiated in the operating room. A sternotomy was performed and it was determined that the driver had a significant tear at the junction of the inferior vena cava and the right atrium. Efforts to stop the bleeding were unsuccessful and the driver was pronounced dead at 1406 hours. According to the autopsy report, the cause of death was "...from blunt injuries."

A time line of rescue efforts is shown in the following table.

[1]See Attachment 2 for speed calculations

| Activity | Time |
|---|---|
| Time of crash | 1220 |
| Ambulance notified | 1220 |
| Ambulance arrived | 1229 |
| Ambulance departed | 1241 |
| Ambulance arrived at hospital | 1254 |
| Driver pronounced dead | 1406 |

The Honda Accord was towed from the scene due to damage.

**VEHICLE DATA -2000 Honda Accord**

The 2000 Honda Accord LX four door sedan was identified by the Vehicle Identification Number (VIN): 3HGCG6655Yxxxxxx. The Accord was equipped with a 2.3 liter, four-cylinder engine, a five speed automatic transmission, front wheel drive, front disc/rear drum brakes, hydraulic power-assist rack-pinion steering, and a tilt steering wheel. The 2000 Honda Accord was equipped with Michelin Energy P195/65R15 tires. The specific tire data is as follows:

| Tire | Tread | Pressure | Recommended cold pressure |
|---|---|---|---|
| LF | 5 mm (0.19 in) | 200 kPa (29 psi) | 207 kPa (30 psi) |
| LR | 6 mm (0.23 in) | 193 kPa (28 psi) | 207 kPa (30 psi) |
| RF | 5 mm (0.19 in) | 200 kPa (29 psi) | 207 kPa (30 psi) |
| RR | 6 mm (0.23 in) | 186 kPa (27 psi) | 207 kPa (30 psi) |

The seating in the Honda Accord was configured with front bucket seats with adjustable head restraints and a rear bench seat with a folding back. The driver's seat track position is not known. The front right seat was adjusted to the rear most track position. Both front seat backs were in the upright position and retained that position post crash.

## VEHICLE DAMAGE

### Exterior Damage - 2000 Honda Accord

| | | |
|---|---|---|
| Damage Description: | The 2000 Honda Accord sustained moderate front end damage as a result of the impact with the pole **(Figures 4-5)**. The direct damage began 80 cm (31.4 in) left of the right front bumper corner and extended 40 cm (15.7 in) along the front plane. The combined direct and induced damage included the entire front end. The left front tire was restricted. | |
| CDC: | 12FYEN3 | |
| Delta V: | Total | Unknown |
| | Longitudinal | Unknown |
| | Latitudinal | Unknown |
| | Energy | Unknown |
| | Barrier Equivalent Speed | 31.0 km/h (19.3 mph) |

Six crush measurements were documented at the bumper level as follows: C1 = 3 cm (1.1 in), C2 = 45 cm (17.7 in), C3 = 31 cm (12.2 in), C4 = 18 cm (7.0 in), C5 = 5 cm (1.9 in), C6 = 0 cm.

**Figure 4**. 2000 Honda Accord, left side

**Figure 5**. 2000 Honda Accord, front end damage

**Interior Damage - 2000 Honda Accord**

The Honda sustained moderate interior damage as a result of passenger compartment intrusion and occupant contacts. The left instrument panel and left floor pan sustained longitudinal intrusion. The top of the steering wheel was slightly deformed forward (**Figure 6**). The left knee bolster was deformed from occupant contact (**Figure 7**).

There was no integrity loss due to impact forces. The right rear side glass was broken out by bystanders. The doors remained closed and operational. The windshield glazing was cracked due to impact forces.

The specific passenger compartment intrusions were documented as follows:

**Figure 6**. Deformed steering wheel rim

| Position | Intruded Component | Magnitude of Intrusion | Direction |
|---|---|---|---|
| FL | Instrument panel, left | 5 cm (1.9 in) | Longitudinal |
| FL | Floor pan | 6 cm (2.4 in) | Longitudinal |

**Figure 7**. Left knee contact to knee bolster

**Manual Restraint Systems - 2000 Honda Accord**

The 2000 Honda Accord was configured with manual 3-point lap and shoulder belts for all five seating positions. Both front seat belts were equipped with adjustable D-rings; the driver's belt was in the mid position and the front right passenger's belt was in the full up position. The driver's safety belt was configured with a sliding latch plate and an Emergency Locking Retractor (ELR). The remaining safety belts were configured with sliding latch plates and switchable ELR/Automatic Locking Retractors (ALR).

**Supplemental Restraint System - 2000 Honda Accord**

The 2000 Honda Accord was equipped with dual-stage frontal air bags that deployed as a result of the longitudinal deceleration of the Accord during the impact with the pole.

The driver's air bag deployed from the center of the steering wheel hub through H-configuration module cover flaps (**Figure 8**). The deployed driver's air bag measured 55 cm (21.6 in) in its deflated state. The air bag was circular in shape and was equipped with two internal tethers and two vent ports. Neither the air bag nor the cover flaps were damaged. There was a scuff located in the center of the deployed air bag that may have been due to occupant contact.

The front right passenger air bag deployed from a top-mounted module (**Figure 9**). The air bag was rectangular in shape and was equipped with two internal tethers. The air bag had no vent ports. There was no damage or occupant contact noted to either the module cover or the deployed passenger air bag.

Additional information on the driver and front right passenger air bags was not available.

**Figure 8**. Deployed driver's air bag

**Figure 9**. Deployed front right passenger's air bag

**OCCUPANT DEMOGRAPHICS - 2000 Honda Accord**

| | Driver |
|---|---|
| Age/Sex: | 74/Female |
| Seated Position: | Front left |
| Seat Type: | Fabric covered bucket seat |
| Height: | 163 cm (64 in) |
| Weight: | 61 kg (134 lbs) |
| Occupation: | Retired |
| Pre-existing Medical Condition: | Mild degenerative disease at C4-C5 and C5-C6 |
| Alcohol/Drug Involvement: | None |
| Driving Experience: | Presumed to be > 10 years |
| Body Posture: | Normal, upright. Per witnesses. |
| Hand Position: | Unknown |
| Foot Position: | Right foot presumed to be on brake. |
| Restraint Usage: | Lap and shoulder belt available, used |
| Air bag: | Steering wheel mounted air bag, deployed |

**OCCUPANT INJURIES - 2000 Honda Accord**

Driver: Injuries obtained from autopsy report, radiology reports, and post emergency room medical records. A portable supine chest x-ray was taken. According to the report..."the visualized osseous structures appear intact."

| Injury | OIC Code | Injury Mechanism | Confidence Level |
|---|---|---|---|
| Heart (myocardium) laceration perforation | 441012.5,4[2] | Unknown | Unknown |
| Multiple rib fractures, left (aspect per autopsy report) | 450210.2,2[2] | Unknown | Unknown |
| Chest contusions | 490402.1,0[2] | Unknown | Unknown |
| Abrasion, right elbow | 790202.1,1 | Left instrument panel and below | Certain |
| Contusion, right elbow and left hand | 790402.1,3 | Left instrument panel and below | Certain |
| Contusion, right ankle | 890402.1,1 | Floor | Certain |
| Abrasions, bilateral knees | 890202.1,3 | Knee bolster | Certain |
| Abrasion, mid left thigh, right thigh | 890202.1,3[3] | Steering wheel rim | Certain |
| Contusions, bilateral knees | 890402.1,3 | Knee bolster | Certain |
| Abrasion, left lower leg | 890202.1,2[4] | Left instrument panel and below | Probable |

**OCCUPANT KINEMATICS - 2000 Honda Accord**

The 74-year-old female driver was seated in an upright posture[5] and was restrained by the 3-point manual lap and shoulder belt. Restraint usage was based mainly on witness information, the CDS vehicle inspection, and photographs. The seat track position is not known. Based on her stature (163 cm, 64 in) it is likely that the track was somewhere between full forward and the middle position. The seat back was upright. Prior to impact, the driver began braking. Her right foot was

[2]Injury mechanism changed because object contacted could not be confirmed. Aspect for the rib fractures changed based on information located in the autopsy report.

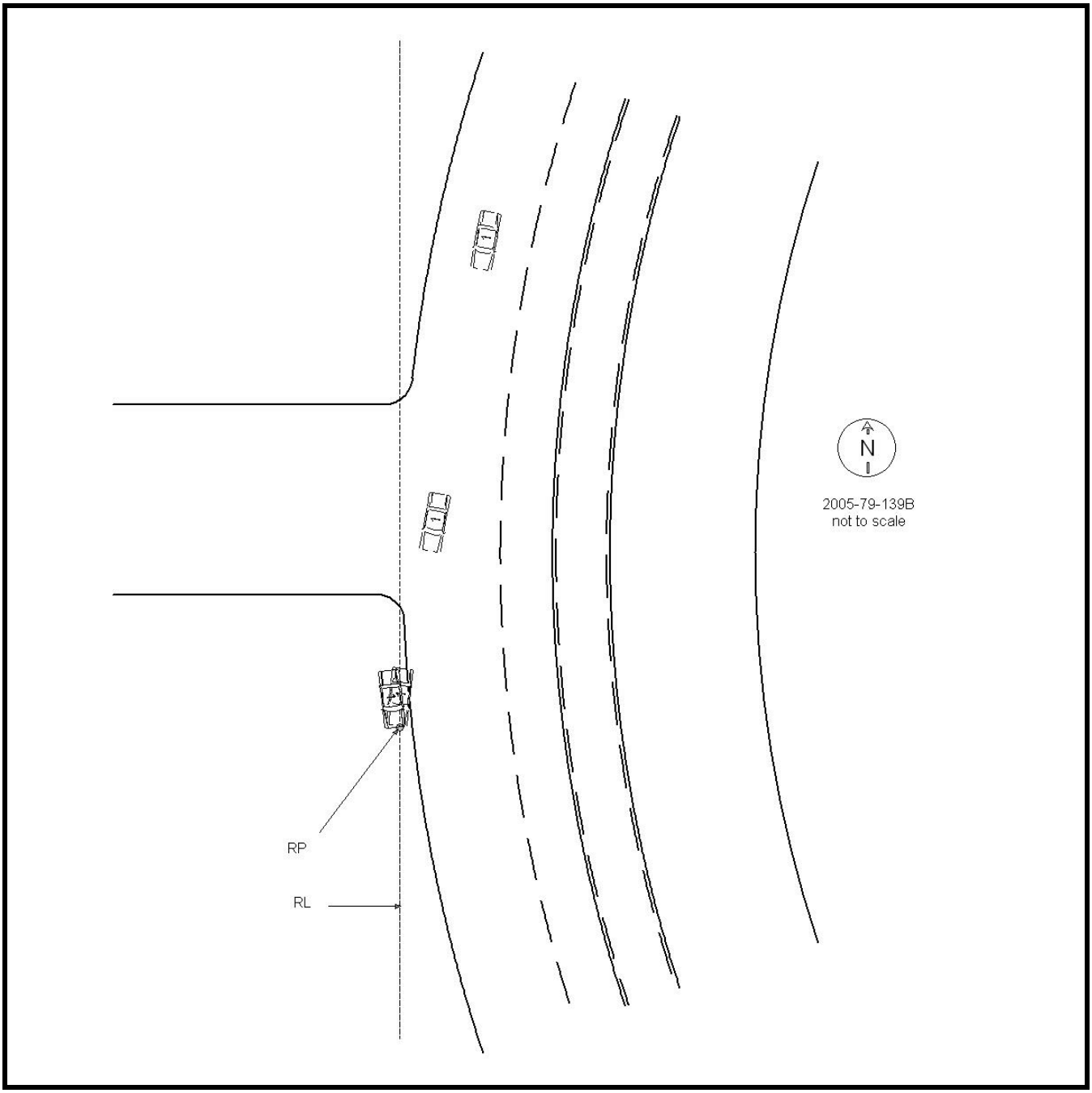
[3]SCI change. Located an abrasion to the right thigh in medical report. Aspect changed to bilateral.

[4]SCI addition. Located abrasion to left lower leg in medical report.

[5]SCI change based on witness account

on the brake, the left on the floor. Both hands were likely on the steering wheel at this point. The case vehicle struck the curb–primarily with the left front tire. The driver pitched forward and up to some degree–possibly engaging the steering wheel rim with her left thigh. At impact with the pole, the frontal air bags deployed. The driver initiated a forward trajectory. She loaded the seat belt and engaged the deployed driver's air bag with her chest. Both knees engaged the knee bolster, causing the bilateral knee abrasions/contusions. The driver was unconscious when the police arrived. She had a Glasgow Coma Scale (GCS) score of 3 at the scene. She was transported by ground ambulance to a local hospital. On route she became slightly alert complaining of right-sided rib pain. In the emergency room she was found to be alert, awake and hypotensive. CPR was initiated in the operating room. A sternotomy was performed and it was determined that the driver had a significant tear at the junction of the inferior vena cava and the right atrium. Efforts to stop the bleeding were unsuccessful and the driver was pronounced dead at 1406 hours. According to the autopsy report, the cause of death was "...from blunt injuries."

**Attachment 1. Scene Diagram**



## Attachment 2. Calculations

**CASE NUMBER: 2005-79-139B**

*** * MINIMUM SPEED W/ KNOWN DRAG FACTOR * ***

$S = \sqrt{30 \times D \times f}$

$S = \sqrt{30 \times 14.00 \times 0.70}$

$S = \sqrt{294.00}$

$S = 17.14$

S = The Speed in MPH.
30 = A Constant.
D = The Distance in Feet.
$f$ = The Adjusted Accel/Drag Factor.

| INPUTS: | |
|---|---|
| The Acceleration/Drag Factor is: | 0.70 |
| The Distance in Feet is: | 14.00 |

| RESULTS: | |
|---|---|
| The Speed in MPH is: | 17.14 |
| The Velocity in FPS is: | 25.13 |

7.50.24

**CASE NUMBER: 2005-79-139B**

Comments: Combined speed, barrier and pre impact skid

*** * COMBINED MINIMUM SPEEDS W/ KNOWN SPEEDS * ***

$S = \sqrt{S^2(1) + S^2(2) + \ldots S^2(n)}$

$S = \sqrt{(17.14)^2 + (19.20)^2 + (0.00)^2 + (0.00)^2 + (0.00)^2 + (0.00)^2 + (0.00)^2 + (0.00)^2}$

$S = \sqrt{293.77 + 368.64 + 0.00 + 0.00 + 0.00 + 0.00 + 0.00 + 0.00}$

$S = \sqrt{662.41}$

$S = 25.73$

S = The Speed in MPH.
$S^2$ = The Individual Min. Speed.
(1), (2), (n) = The # of the individual speed.

| INPUTS: | |
|---|---|
| Speed # 1 in MPH is: | 17.14 |
| Speed # 2 in MPH is: | 19.20 |

| RESULTS: | |
|---|---|
| The Speed in MPH is: | 25.73 |
| The Velocity in FPS is: | 37.73 |

7.50.24