Combination Hybrid Vehicle Investigation/ Vehicle to Vehicle
Dynamic Science, Inc. / Case Number: 2005-082-083A
2004 Honda Civic
Washington
September, 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

The 2004 Honda Civic Hybrid was traveling southbound on an elevated roadway. The vehicle sideswiped a cement barrier bordering the right side of the one-way expressway. The vehicle was directed to the left, at which time it struck the right side of a 2004 Chrysler Pacifica station wagon. The Civic then was redirected to the right and impacted the same cement barrier. The vehicle then climbed atop the barrier, sustaining some undercarriage damage. The vehicle fell approximately 7.6 m (25.0 ft) to the roadway below. As the vehicle landed on its left side, the restrained driver's head came partially out the left side window. This resulted in the driver sustaining a fatal head trauma. The restrained front-right passenger was transported to a local trauma center, where he was admitted for five days with a fractured pelvis, in addition to other fractures.

The Pacifica sustained minor damage. The restrained driver was uninjured. There were no indications of electrolyte spillage from the propulsion battery or any movement of the battery module.

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Dynamic Science, Inc.
Crash Investigation
Case Number: 2005-082-083A

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BACKGROUND:

Description:

This remote/combination investigation focused on the hybrid electric/gasoline system installed in a 2004 Honda Civic Hybrid. The 4-door Honda sedan struck multiple objects, including a 2004 Chrysler Pacifica, before mounting the cement barrier bordering the right shoulder of the elevated expressway. After falling approximately 7.6 m (25.0 ft) to another roadway below, the restrained driver became partially ejected out the left front window. She sustained fatal head injuries as the left side of the Honda was impacting the pavement. The front-right restrained occupant also sustained serious injuries, including a fractured pelvis, and was consequently transported to a trauma center for treatment.

Figure 1. Front, 2004 Honda Civic Hybrid

The crash occurred in the state of Washington in September 2005 at 0033 hours. DSI was assigned the case on December 1, 2005, after the NASS team had completed their own investigation. The case was assigned because it involved a hybrid vehicle that is in compliance with government standard Sec.571.305 Standard No.305. This compliance standard relates to electric-powered vehicles, electrolyte spillage and electrical shock protection. The following information was provided from the National Highway Traffic Safety Administration website regarding this safety standard: “FMVSS No. 305 requires vehicles that use electricity as propulsion power to meet requirements for limitation of electrolyte spillage, retention of propulsion batteries during a crash, and electrical isolation of the chassis from the high-voltage system”.

SUMMARY

Crash Site

This two vehicle crash occurred in September 2005 at 0033 hours. The crash occurred on a three-lane, one-way elevated expressway. At the time of the crash, there were no adverse weather conditions and the concrete roadway surface was dry and defect free. The southbound roadway at the crash location consisted of a total of three lanes, separated from each other by dashed white lines. The crash site involved a left hand curve and an uphill grade. The roadway was bordered

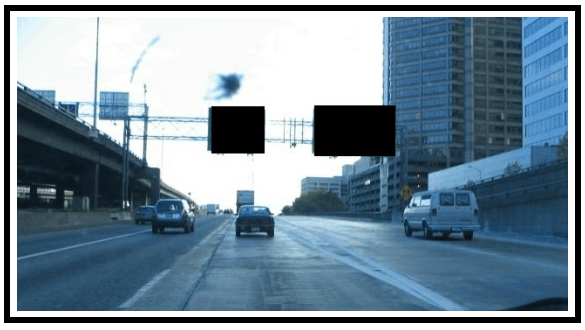


Figure 2. Approach to area of initial impact, south

on the right by a positive cement barrier.

Pre-Crash

The case vehicle is a 2004 Honda Civic Hybrid gasoline-electric hybrid four door sedan driven by a 28 year-old female. The Civic Hybrid uses Honda's Integrated Motor Assist (IMA) technology–a 1.3-liter 4-cylinder gasoline engine coupled with a high output electric motor. The system's nickel metal hydride battery module is automatically recharged during braking and deceleration. The case vehicle was equipped with a driver's air bag, a front right passenger air bag, front seat back mounted side air bags, and front seat belt pretensioners.

Figure 3. Path of vehicle over wall

The case vehicle contained a total of two occupants, the 28 year-old driver, and a 53 year-old male who had been seated in the front-right bucket seat. Both were wearing the 3-point manual lap and shoulder belts, and both were further protected by frontal air bag system.

The Honda had been proceeding southbound in the inside lane of what had initially been a five-lane interstate highway. As the vehicle continued southbound the left three lanes became an elevated continuation of the expressway, while the two right lanes entered an urban area at that point and were no longer a part of the thruway. This three lane, elevated, one-way roadway consisted of a positive grade, which was located in a sweeping left curve. As it was early morning, it was dark outside, but there were street lights present to provide artificial illumination[1].

The other involved vehicle, a 2004 Chrysler Pacifica, was traveling southbound, in the lane immediately to the left of the Honda. It was reported that the Chrysler was slightly forward of the Honda. This vehicle contained one occupant, a 33 year-old male.

Figure 4. Gas tank contact

[1]SCI change based on scene images

Crash[2]

As both vehicles proceeded southbound, the Honda, for an unknown reason, moved toward the right. Upon doing so, it struck the cement barrier which was next to the right paved shoulder with its frontal plane (Event #1). After this initial impact, the case vehicle was redirected to the left, at which point its left side struck the right side of the Pacifica (Event #2). The case vehicle was then redirected to the right, where it once again impacted the cement barrier adjacent to the shoulder with its front end (Event #3). The Honda mounted the cement wall. As it did so, the vehicle sustained some undercarriage damage to the gas tank area (Event #4) prior to rolling off the wall and subsequently rolling over (Event #5). After landing on its left side on the ground of another roadway that was located approximately 7.6 m (25.0 ft) below its original traffic way, the Honda bounced back onto its wheels and came to rest facing in a southerly direction, on a service road adjacent to the elevated roadway. As the Honda fell to the ground below, the restrained driver was partially ejected, at which point she sustained severe head trauma which resulted in her death.

The Pacifica, after the vehicle to vehicle contacts (Event #2), struck the same cement barrier before coming to final rest alongside the barrier. This vehicle sustained minor damage.

Post-Crash

When the emergency medical personnel and fire department arrived at the scene, both occupants were still in the Civic. To aide in their removal, the roof was cut off the car at the A, B and C pillars.

The restrained driver in the Honda was pronounced dead at the scene with severe head trauma. The front-right passenger sustained multiple fractures, including those to his pelvis, and was transported to a trauma center, where he was admitted for a total of five days before being released.

Figure 5. Left side damage, 2004 Honda Civic

The police report coding indicated that the driver in the Pacifica sustained no injuries. This appears to be consistent with the slight amount of damage the vehicle had sustained.

The Honda Civic was subsequently towed from the scene with disabling damage. The Chrysler Pacifica sustained damage that was not severe enough to warrant its having to be towed.

[2]SCI changes made to the number of events and the barrier CDCs

VEHICLE DATA - 2004 Honda Civic

The 2004 Honda Civic was identified by the Vehicle Identification Number (VIN) JHMES96624xxxxxx. The 2004 Honda Civic Hybrid four-door sedan was factory equipped with a continuously variable shiftless automatic transmission, cruise control, a 4-wheel anti-lock braking system, a tilt steering column, power windows, and power door locks. The odometer reading of 61,155 km (38,001 miles) was recorded by the NASS researcher. This data was not obtained from the vehicle inspection, but instead came from an interview.

The 2004 Honda Civic was equipped with Dunlop SP30FE P185/70R14 tires. The specific tire data is as follows:

Tire	Tread	Measured pressure	Manufacturer recommended pressure
LF	6.0 mm (0.2 in)	Flattened	Maximum: 352 kPa (51 psi)
LR	6.0 mm (0.2 in)	228 kPa (33 psi)	Maximum: 352 kPa (51 psi)
RF	5.0 mm (0.2 in)	Flattened	Maximum: 352 kPa (51 psi)
RR	6.0 mm (0.2 in)	234 kPa (34 psi)	Maximum: 352 kPa (51 psi)

The front seating positions in the 2004 Honda Civic consisted of two fabric bucket seats in the outboard seating positions. The rear seat consisted of a total of three seating positions. Each seating position had its own seat belt system.

IMA Discussion - 2004 Honda Civic Hybrid

The IMA is composed of a gasoline engine and an electric motor. Located between the engine and transmission, the electric motor supplies additional power during acceleration. It also functions as a high-speed starter and as a generator for the charging system during regenerative braking. The IMA electric motor works in conjunction with the gasoline engine, and supplies additional torque in assist mode. It is powered by a 144 volt nickel metal hydride (NI-MH) battery pack, which is stowed at the back of the car (behind the rear seat) and consists of 120 cells providing 1.2 volts each. The engine and electric motor operate together under the following modes:

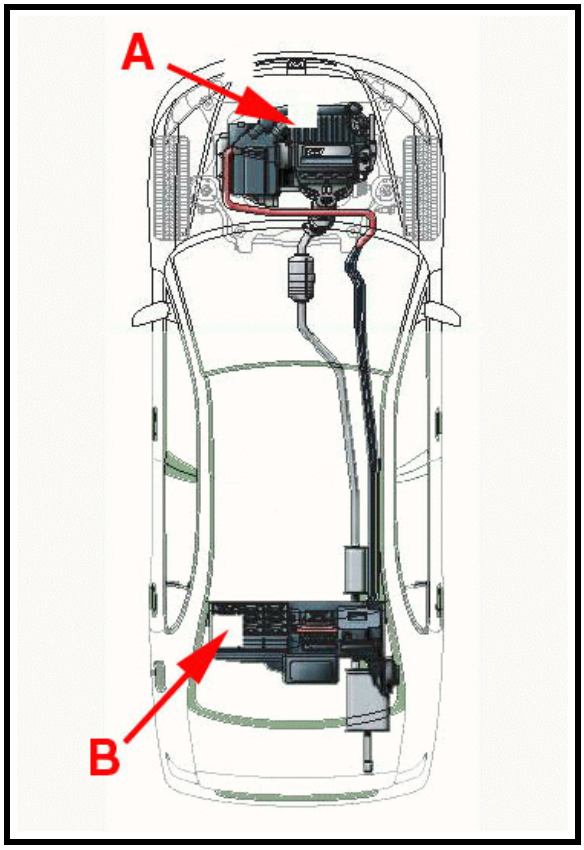


Figure 6. (A) Combination gasoline/electric powerplant, (B) Ni-MH battery pack

- Starting is normally done by the IMA. If the IMA battery pack charge is low, a separate 12-volt battery and starter motor are used.
- When the IMA system detects a demand for additional power, via the throttle position sensor, the electric motor starts and adds horsepower.
- When cruising at a steady speed the gasoline engine works by itself.
- When the driver is using the brakes, the electric motor becomes a generator, recharging the battery.
- At a stop, the engine cuts off automatically thanks to the idle-stop feature. It restarts itself when the vehicle is ready begin moving again.

Compliance with Sec.571.305 Standard No.305; Electric-powered vehicles: electrolyte spillage and electrical shock protection

- There were no indications of electrolyte spillage from the propulsion battery.
- There was no movement of the battery module.
- The electrical isolation test was not conducted. There were no indications, however, of any arcing, fire, or component meltdown. See Attachment 2 for discussion of electrical isolation test.

VEHICLE DAMAGE

Exterior Damage - 2004 Honda Civic

Damage Description:	The vehicle sustained moderate damage to the entire left side. This occurred as the vehicle exchanged forces with the Pacifica (Event #2), then struck the ground as it climbed over the cement right barrier and fell 7.6 m (25.0 ft) to the ground below (Event #6).	
CDC:	Event #1-impact with cement barrier: 12FRE9U[3] Event #2-impact with Pacifica: 09L9999 Event #3-impact with same barrier: 12FREE9 Event #4-impact while atop barrier: 00U9999[4] Event #5-roll/falls to roadway below: 00LDAO3	
Delta V:	Total	Unknown
	Longitudinal	Unknown
	Latitudinal	Unknown
	Energy	Unknown

The Civic had sustained damage to both the frontal and the left side planes from the multiple impacts that it had sustained. Additionally, the gas tank sustained abrasions from the top of the cement barrier as it mounted it (Event #4). This preceded the vehicle falling approximately 7.6 m (25.0 ft) onto its left side, on the paved roadway below (Event #6), which was deemed the most significant impact.

Figure 7. Left rear view, 2004 Honda Civic

Event #1 involved the front of the vehicle as it impacted the cement barrier to the right of the shoulder. This initial front-right impact, which had damage values recorded for Event #1, really was the result of two independent impacts. The researcher had recorded damage measurements for the frontal plane, and duplicated the exact same values for Event #3. However, it is most likely that the more significant of the two frontal impacts occurred during Event #3. Therefore, the first CDC was been changed to reflect unknowns for both Columns 6 and 7.

The third impact occurred as the Honda was deflected toward the right, after it had collided with the Pacifica. As it traveled towards the right cement barrier (same barrier which it had struck

[3]Changed from EDS by SCI

[4]Event added by SCI

initially), the front-right bumper of the vehicle impacted the barrier. This resulted in damage which extended along the right side of the Honda, in the same general contact area which was engaged in Event #1. One final CDC, which reflected both front-right impacts, has been encoded with a value of 12FREE9. This overlapping damage resulted in one recorded Field L of 116.0 cm (45.7 in), which began at the front-right corner. The direct contact extended a distance of 33.0 cm (12.9 in) from the front-right corner toward the front-left corner. The maximum crush, which fell at the front-left corner (C1) was almost identical to what was measured at the C6 location, 4.0 cm (1.6 in) and 3.0 cm (1.2 in), respectively.

After this impact, the Honda climbed up and over the cement barrier. While doing so, a portion of the gas tank was abraded. This event was not initially recorded, but was added as Event #4. The CDC is partially unknown, and has thus been encoded as 00U9999.

After climbing over the barrier, the vehicle fell approximately 7.6 m (25.0 ft) to the paved roadway below. It fell with the left side leading (Event #5), and landed on its left side at final rest. The resulting CDC was encoded as 00LDAO3. Based upon the change in velocity, it appears most likely that this event resulted in the highest delta V to the vehicle.

The A, B and C pillars had been cut in order to facilitate the removal of the front-right occupant and the deceased driver. Afterwards the roof was replaced onto its approximate pre-removal location. Since the roof had been removed, some of the lateral intrusion measurements may have been slightly altered as a direct consequence.

Interior Damage - 2004 Honda Civic

The roof had been removed from the Civic to facilitate the removal of the critically injured front-right seat occupant, and the fatally injured driver. After its removal, the roof had been repositioned in its approximate pre-crash location. Given this fact, the roof side rail and the window's lateral intrusions were placed within the ≥3.0 cm (1.2 in) to < 8.0 cm (3.1 in) range, rather than being assigned specific measurements.

Position	**Intruded Component**	**Magnitude of Intrusion**	**Direction**
Front-left (11)	Door panel	8.0 cm (3.1 in)	Lateral
Front-left (11)	B-pillar	7.0 cm (2.8 in)	Lateral
Front-left (11)	Floor pan/including sill	7.0 cm (2.8 in)	Lateral
Front-left (11)	Roof side rail	≥3.0 cm (1.2 in) to < 8.0 cm (3.1 in)	Lateral
Front-left (11)	Window frame	≥3.0 cm (1.2 in) to < 8.0 cm (3.1 in)	Lateral
2nd seat-left (21)	Door panel	10.0 cm (3.9 in)	Lateral

There were a number of occupant contact points visible inside the interior of the Civic. The left

side hardware/armrest was cracked, and contained visible blood evidence as well. This cracking was attributed to the left lower arm of the partially ejected driver. Additionally the left side panel sustained a dent from the upper arm of the driver. The rigid knee bolster sustained some scuffing, which was determined to be from interaction with her left knee. The steering column area was scuffed and cracked, and this was attributed to her right knee. The fabric of the air bag contained blood evidence, which was attributed to the face of the driver.

The front-right restrained passenger also left numerous signs of occupant interaction with items within that seating position. The front-right knee bolster sustained some scuffing from his right knee. The center console transmission lever sustained some cracking and deformation from what has been determined to be his left thigh and left upper leg. Additionally, the center console was deformed from his left hip. The engine shroud cover sustained some scuffing which may have been from his left foot. The seat belt webbing was deformed from the occupant's loading it. The seat was deformed by what was probably his left elbow. He may have impacted the deploying air bag with his face, as there was blood visible along the fabric. The glove box door and the rigid plastic bolster sustained some visible scuffing which was possibly a result of interaction with this occupant's knees.

MANUAL RESTRAINT SYSTEMS - 2004 Honda Civic

The vehicle was equipped with 3-point manual lap and shoulder belts in the outboard front seating positions. Both of the frontal seat belts performed as expected; there were no signs of any failures to the webbing, the latch plate, or the buckle.

Figure 8. Deployed driver's air bag

FRONTAL AIR BAG SYSTEM - 2004 Honda Civic

The vehicle was equipped with both frontal air bag seat back mounted side air bags.

The driver's air bag deployed from the center of the steering wheel hub through H-configuration module cover flaps. The top flap measured 16.0 cm (6.3 in) in height by 8.0 cm (3.1 in) in width. The bottom flap measured 16.0 cm (6.3 in) in height by 8.0 cm (3.1 in) in width. The deployed driver's air bag measured 50.0 cm (19.7 in) in diameter in its deflated state. Two circular vent ports were located at the 11 and 1 o'clock aspects on the rear of the air bag. Blood was found in the left upper and lower quadrants.

The front right passenger's air bag deployed from a

Figure 9. Deployed front right passenger's air bag

top mount module with an H-configuration cover flap. The top module cover flap measured 22.0 cm (8.7 in) in width and 4.0 cm (1.6 in) on the left and 6.0 cm (2.4 in) on the right. The bottom module cover flap measured 22.0 cm (8.7 in) in width and 6.0 cm (2.4 in) on the left and 4.0 cm (1.6 in) on the right. The deployed front right passenger's air bag measured 50.0 cm (19.7 in) in height and 50.0 cm (19.7 in) in width. Two circular vent ports were located at the 3 and 9 o'clock aspects of each side panel of the air bag. There was a burn mark located in the top left quadrant and blood found in the top right quadrant.

The driver's side air bag deployed from a seat back mounted module with a rectangular cover flap. The flap measured 10.0 cm (3.9 in) in width and 23.0 cm (9.0 in) in height. The deployed side air bag measured 28.0 cm (11.0 in) in width and 32.0 cm (12.6 in) in height. There was blood found on the outside facing portion of the air bag.

VEHICLE DATA - 2004 Chrysler Pacifica

Description:	Minor damage to the right side plane. The vehicle was drivable after sustaining slight, non-disabling damage.	
VIN:	2C8GM68454xxxxxx	
Odometer:	Unknown	
Engine:	3.5 L, V6	
Reported Defects:	None observed	
Cargo:	None observed	
Damage Description:	Minor damage	
CDC:	Unknown	
Delta V:	Total	Unknown
	Longitudinal	Unknown
	Latitudinal	Unknown
	Energy	Unknown

No speed reconstructions were obtained for this vehicle due to the minor damage which was sustained. The plastic bumper cover had been removed from the car, and there was insufficient data to arrive at C values for either of the impacts. The first event this vehicle was involved with occurred as the right side of this vehicle came into contact with the left side of the Honda. The resulting CDC was encoded as 99R9999. The second impact, which involved the right side impacting the cement barrier, was encoded as 12FRES9.

OCCUPANT DEMOGRAPHICS - 2004 Honda Civic

	Driver	Occupant 2
Age/Sex:	28/Female	53/Male
Seated Position:	Front left	Front right
Seat Type:	Bucket seat, adjusted to between forward most and middle track position, seat back upright prior to crash	Bucket seat, adjusted to between rear most and middle track position, seat back upright prior to crash
Height:	155 cm (61 in)	168 cm (66 in)
Weight:	63 kg (139 lbs)	100 kg (220 lbs)
Occupation:	Unknown	Unknown
Pre-existing Medical Condition:	None reported	None reported
Alcohol/Drug Involvement:	Unknown	Did not indicate
Driving Experience:	Unknown	N/A
Body Posture:	Unknown	Normal, upright
Hand Position:	Unknown	Unknown
Foot Position:	Unknown	Unknown
Restraint Usage:	Lap and shoulder belt available, used correctly	Lap and shoulder belt available, used correctly
Air bag:	Both the steering wheel mounted and the driver's seat mounted air bag deployed	Front instrument panel air bag deployed. Seat mounted air bag did not

OCCUPANT DEMOGRAPHICS - Chrysler Pacifica

Age/Sex:	32/Male
Seated Position:	Front-left (driver)
Seat Type:	Bucket seat
Height:	Unknown
Weight:	Unknown
Occupation:	Unknown
Pre-existing Medical Condition:	None reported on the police report
Alcohol/Drug Involvement:	PAR encoded as unknown
Driving Experience:	Unknown
Body Posture:	Unknown
Hand Position:	Unknown
Foot Position:	Unknown
Restraint Usage:	Lap and shoulder belt, per police report

OCCUPANT INJURIES - 2004 Honda Civic

Driver: Injuries obtained from autopsy report.

INJURY	OIC CODE	Injury Mechanism	Confidence Level
Basilar skull fracture	150206.4,8	Ground	Certain
Vault skull fracture, left	150402.2,2	Ground	Certain
Bilateral cerebral contusions	140620.3,3	Ground	Certain
Subarachnoid hemorrhage, left	140684.3,2	Ground	Certain
Subarachnoid hemorrhage, right	140684.3,1	Ground	Certain
Scalp abrasion, left	190202.1,2	Ground	Certain
Facial abrasion, superior	290202.1,7	Ground	Certain
Facial contusion, superior	290402.1,7	Ground	Certain
Chest abrasions, right	490202.1,1	Seat belt webbing	Certain
Neck abrasions, anterior	390202.1.5	Seat belt webbing	Certain
Abdomen abrasion, left	590202.1,2	Seat belt webbing	Certain
Forearm abrasion, left	790202.1,2	Air bag	Certain
Lower leg abrasion, left	890202.1,2	Knee bolster	Certain

Front right occupant: Injuries obtained emergency room records.

INJURY	OIC CODE	Injury Mechanism	Confidence Level
Lumbar spine fracture at L4	650620.2,8	Center console	Certain
Lumbar spine fracture at L5	650620.2.8	Center console	Certain
Posterior sacral fracture	852602.2,6	Center console	Certain
Wrist dislocation, left	751430.2,2	Steering wheel rim	Probable
Displaced radius fracture, left	752804.3,2	Steering wheel rim	Probable
Displaced ulna fracture, left	753204.3,2	Steering wheel rim	Probable
Concussion	160414.2,0	Roof side rail	Probable
Upper extremity contusion, right	790402.1,1	Right side interior surface	Probable

OCCUPANT KINEMATICS - 2004 Honda Civic

Driver kinematics

The restrained driver was wearing a 3-point manual lap and shoulder belt. Additionally, she was further protected by both steering wheel and left seat mounted air bags. During the initial right side impact with the cement barrier (Event #1), the driver may have moved forward slightly. She would have loaded the seat belt webbing, which kept her behind the wheel of her vehicle. The damage that the vehicle sustained during this initial impact was not very significant. The vehicle was deflected toward the left, at which time it impacted the right side of the Pacifica. Based upon the visible damage which the Pacifica sustained, the interaction between the Civic and the Chrysler was fairly negligible and would not have affected any of the passengers significantly. The Civic was then redirected back toward the cement median in a shallow angled impact. The vehicle then climbed up onto the top of the barrier, resulting in undercarriage damage. During this time there would have been both longitudinal and vertical forces affecting the driver.

After the car climbed atop the barrier, it fell, with its left side leading, 7.6 m (25.0 ft) to the pavement below. As the vehicle rolled to the left, the restrained driver moved toward the left door and window area. Although she was restrained, the shoulder belt did little to restrict her movement to the left, in the direction of the non-horizontal force. During this time her head came partially outside the Civic, through the left side window. As the vehicle landed on the roadway below, she sustained a fatal head trauma.

It is unclear as to when the air bags deployed.

The on-scene personnel pronounced her dead at the scene with severe head trauma.

Front-right occupant kinematics

The restrained 53 year-old male moved forward during the initial frontal impact into the rigid barrier. Although the seat belt kept him in his seat, his extremities continued forward, striking the rigid plastic knee bolster and the glove compartment area. As the car was redirected toward the left, the passenger remained in his seat by the manual 3-point lap and shoulder belt system. He did move laterally slightly during the vehicle to vehicle engagement.

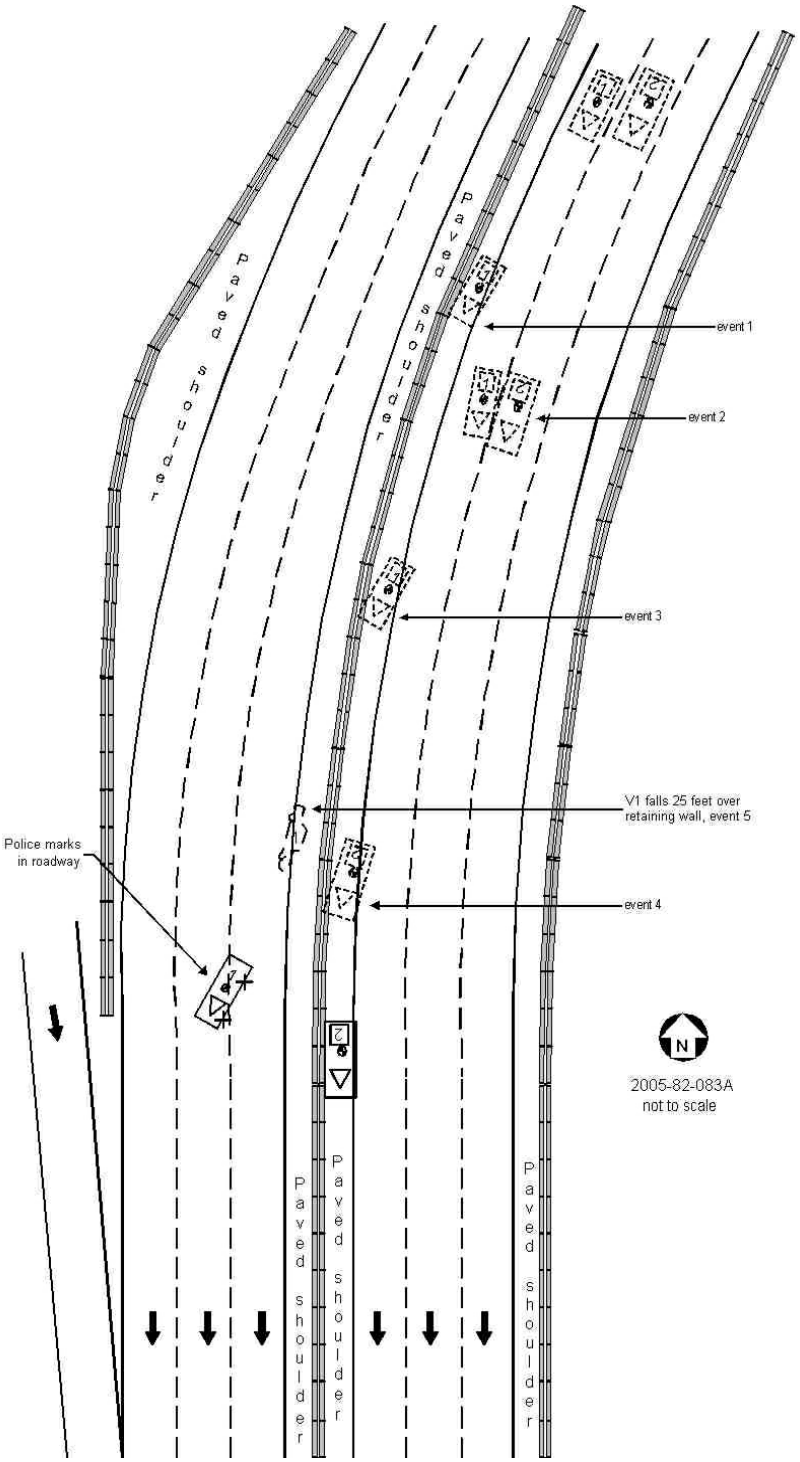
As the Civic once again struck the cement median, the passenger encountered both longitudinal and vertical force components. His extremities once again encountered the rigid knee bolster and the glove compartment area. At some time during the crash sequence he struck the deploying front mounted air bag.

As the vehicle fell off the top of the barrier, with its left side leading, and impacted the ground below, the restrained occupant moved laterally to the left, in the force direction. Upon doing so his lower extremities impacted the center console that separated the two bucket seats, and his

elbow came into contact with a seat back cushion. His left wrist and lower arm contacted the steering wheel rim, causing the wrist dislocation and the radius/ulna fractures. It appears most likely that it was during this fall and subsequent landing that he sustaining a fracture to his pelvis and lumbar spine.

He was extricated from the vehicle by on-scene personnel. After being transported to a trauma center, he was admitted for a total of five days prior to being released.

Attachment 1. Scene Diagram



Attachment 2. Electrical Isolation Test Discussion

This contractor reviewed publicly available manufacturer information regarding the electrical system of the Civic Hybrid to determine likely points to assess vehicle electrical isolation. The system basically consists of the intelligent power unit (IPU) which is located behind the rear seat, the electric motor which is located in the engine compartment, and the motor power cable which is the cable that connects the power unit to the drive unit. The system uses high voltage (144 V) circuits. The high voltage cables and their covers are identified by orange coloring. There are two likely points of electrical exposure: the cable connection to the IPU and the cable connection to the electric motor.

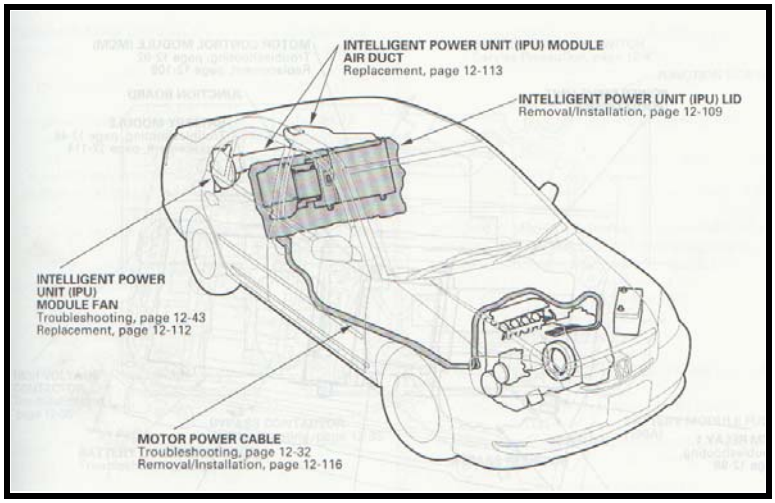


Figure 11. Overview, IMA system

The test for IPU isolation/circuit problems includes the following steps as paraphrased from the Civic Hybrid Service Manual:

- Ignition switch off.
- Remove back seat back.
- Access battery module switch and turn to off.
- Remove IPU lid.
- Measure voltage at the junction board terminals. There should be 30 V or less. If more than 30 V is present, there is a problem in the circuit.

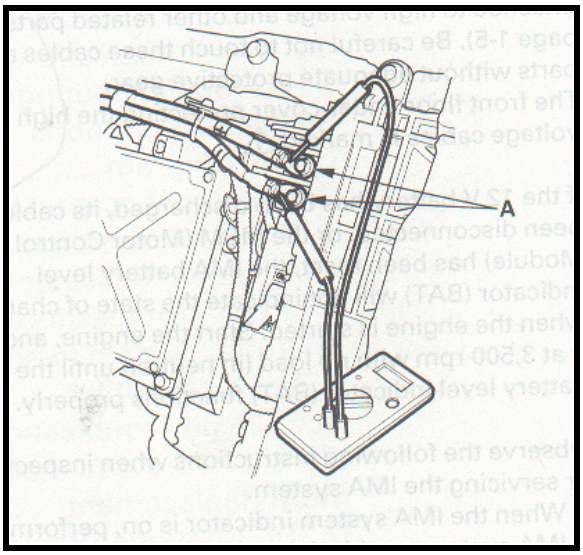


Figure 12. IPU circuit test at battery end of high voltage line

A second test will reveal if there is a short in the high voltage line. This test would involve the following steps:

- Disconnect the high voltage cables from the output terminals on the junction board.
- Measure resistance between high-voltage cables and body ground individually.
- If the resistance is 350 k Ω or lower, there is a short in the high voltage line.

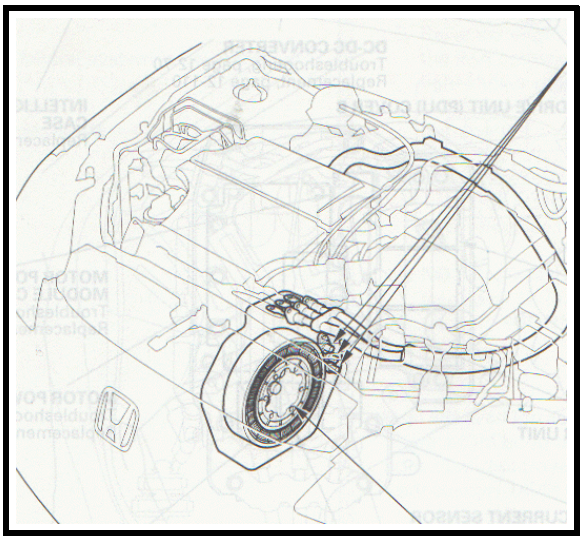


Figure 13. Engine side of high voltage line