U.S. Department
of Transportation
National Highway
Traffic Safety
Administration

NHTSA

DOT HS 812 606

August 2018

# Special Crash Investigations On-Site Crash Avoidance Forward Collision Warning Investigation Vehicle: 2014 Honda Accord Location: Kansas Crash Date: April 2016

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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 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.

This report and associated case data are based on information available to the Special Crash Investigation team on the date the report was published.

Suggested APA Format Citation:

Special Crash Investigations Team 2 Indiana University, Transportation Research Center (2018, August). *Special Crash Investigations On-Site Crash Avoidance Forward Collision Warning Investigation; Vehicle: 2014 Honda Accord; Location: Kansas; Crash Date: April 2016* (Report No. DOT HS 812 606). Washington, DC: National Highway Traffic Safety Administration.

***Technical Report Documentation Page***

| 1. Report No. | 2. Government Accession No. | 3. Recipient's Catalog No. | |
|---|---|---|---|
| DOT HS 812 606 | | | |
| 4. Title and Subtitle<br>Special Crash Investigations On-Site Crash Avoidance Forward Collision Warning Investigation<br>Vehicle: 2014 Honda Accord<br>Location: Kansas<br>Crash Date: April 2016 | | 5. Report Date:<br>August 2018<br>6. Performing Organization Code | |
| 7. Author<br>Special Crash Investigations Team 2 | | 8. Performing Organization Report No.<br>IN16019 | |
| 9. Performing Organization Name and Address<br>Transportation Research Center Indiana University<br>501 South Madison Street, Suite 105<br>Bloomington, Indiana 47403-2452 | | 10. Work Unit No. (TRAIS)<br>11. Contract or Grant No.<br>DTNH22-12-C-00270 | |
| 12. Sponsoring Agency Name and Address<br>National Highway Traffic Safety Administration<br>1200 New Jersey Avenue SE.<br>Washington, DC 20590 | | 13. Type of Report and Period Covered<br>Technical Report<br>Crash Date: April 2016<br>14. Sponsoring Agency Code | |
| 15. Supplementary Notes<br>On-site crash avoidance forward collision warning investigation involving a 2014 Honda Accord. | | | |
| 16. Abstract<br>The report documents the on-site investigation of a crash involving a 2014 Honda Accord that was equipped with forward collision warning (FCW) and lane departure warning (LDW) safety features. This crash occurred on a curved, two-lane, undivided, rural State highway. The Honda was a 4-door sedan equipped with FCW and LDW safety features, multi-stage frontal air bags, front-seat-mounted side-impact air bags, and rollover/side impact inflatable curtain air bags. An unbelted 68-year-old male driver occupied the vehicle. The Honda was eastbound in a right curve and a 2006 GMC Sierra 1500 crew cab pickup truck was westbound in a left curve. The Honda entered the GMC's travel lane and the two vehicles struck in a head-on configuration. The impact resulted in deployment of the Honda's driver's frontal, left seat-mounted side impact, and left IC air bags. The driver of the Honda sustained fatal injuries and was pronounced deceased at the crash scene. An unbelted 40-year-old male driver occupied the GMC. He sustained fatal injuries and was pronounced deceased at the crash scene. Both vehicles were towed from the crash scene due to damage. | | | |
| 17. Key Words<br>crash avoidance<br>forward collision warning<br>lane departure warning<br>motor vehicle traffic crash<br>fatal injury | | 18. Distribution Statement<br>This document is available to the public through the National Technical Information Service, www.ntis.gov. | |
| 19 Security Classif. (of this report)<br>Unclassified | 20. Security Classif. (of this page)<br>Unclassified | 21. No. of Pages<br>16 | 22. Price |

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# TABLE OF CONTENTS

# Indiana University
# Transportation Research Center
# On-Site Crash Avoidance
# Forward Collision Warning Investigation
# Case Number - IN16019
# Location - Kansas
# Vehicle - 2014 Honda Accord
# Crash Date - April 2016

## BACKGROUND

The report documents the on-site investigation of a crash involving a 2014 Honda Accord (**Figure 1**) that was equipped with forward collision warning (FCW) and lane departure warning (LDW) safety features. This crash investigation was initiated by the National Highway Traffic Safety Administration in July 2016, through a review of Fatality Analysis Reporting System (FARS) reports and assigned to the Special Crash Investigation (SCI) team at the Indiana University, Transportation Research Center. The crash occurred in Kansas in April 2016 one afternoon and was investigated by a local police agency. The crash involved the Honda and a 2006 GMC Sierra 1500 crew cab pickup truck. The Honda, GMC, and crash scene were inspected in July 2016.

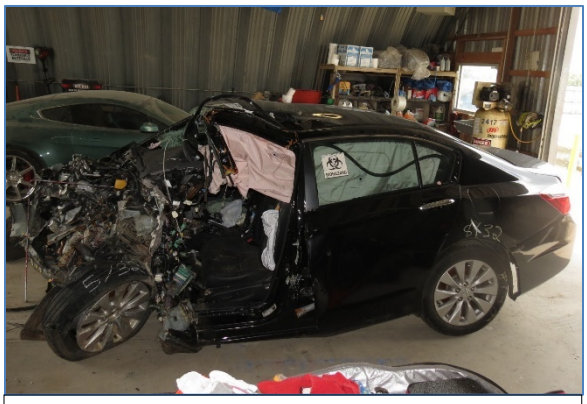


**Figure 1:** The damaged 2014 Honda Accord

This crash occurred on a curved, two-lane, undivided, rural State highway. The Honda was a 4-door sedan equipped with FCW and LDW safety features, multi-stage frontal air bags, front-seat-mounted side impact air bags, and rollover/side impact inflatable curtain (IC) air bags. An unbelted 68-year-old male driver occupied the vehicle. The Honda was eastbound in a right curve and the GMC was westbound in a left curve. The Honda entered the GMC's travel lane and the two vehicles struck in a head-on configuration. The impact resulted in deployment of the Honda's frontal, left seat-mounted side impact, and left IC air bags. The driver of the Honda sustained fatal injuries and was pronounced deceased at the crash scene. An unbelted 40-year-old male driver occupied the GMC. He sustained fatal injuries and was pronounced deceased at the crash scene. Both vehicles were towed from the crash scene due to damage.

## CRASH SUMMARY

### *Crash Site*

This crash occurred during day time hours on a curved, two-lane, undivided, rural State highway. The weather conditions were light rain with 16 kilometers (10 miles) visibility, northerly winds at 23 km/h (14 mph), a temperature of 16.1 °C (61 °F), and a dew point of 10.6 °C (51 °F), according to local weather reports. The roadway traversed in an east/west direction and had one 3.5 m (11.5 ft) wide bituminous lane in each direction. Each lane was bordered by a 3.2 m (10.5 ft)

wide bituminous shoulder. The roadway pavement markings consisted of solid white edge lines and a broken yellow center line on the approach of each vehicle. The roadway surface was wet. The speed limit was 105 km/h (65 mph). The Crash Diagram is included at the end of this report on page 11.

***Pre-Crash:*** The Honda was northeast-bound in a right curve (**Figure 2**). The GMC was southwest-bound in a left curve and was traveling behind an uninvolved vehicle. According to the statement to police by the driver of the uninvolved vehicle, the Honda drifted into her lane and passed directly behind her vehicle and into the path of the GMC. It is not known if the Honda's LDW system issued a warning prior to the vehicle crossing the centerline or if the FCW system issued a warning prior to the crash. See the Crash Avoidance Features discussion in this report.

**Figure 2:** Northeast-bound approach of the Honda

***Crash:*** The front plane of the Honda (**Figure 3**) struck the front plane of the GMC (**Figure 4**). The force direction on the Honda was in the 12 o'clock sector and the impact resulted in deployment of the driver's frontal, left-seat- mounted side impact, and left IC air bags. The damage and trajectory algorithm of the WinSMASH program calculated the total delta-V for the Honda as 104 km/h (65 mph). The longitudinal and lateral velocity changes were -104 km/h (-65 mph) and 0 km/h, respectively. The calculated impact speed was 100 km/h (62 mph).

**Figure 3:** Damage to the front plane of the Honda from the impact with the front plane of the GMC

The force direction on the GMC was also in the 12 o'clock sector and WinSMASH calculated its total delta-V as 84 km/h (52 mph). The longitudinal and lateral velocity changes were -84 km/h (-52 mph) and 0 km/h, respectively. The vehicle's calculated impact speed was 68 km/h (42 mph). The crash fit the reconstruction model and the delta-V results appeared high for the Honda and reasonable for the GMC.

**Figure 4:** Left side view of the damage to the GMC from the impact with the Honda

The impact caused the Honda to rotate counterclockwise 205 degrees as it was redirected rearward 6.0 m (20.0 ft) in a southwesterly direction, coming to final rest in the eastbound lane headed southwest. The GMC rotated counterclockwise 85

degrees as it traveled 8.8 m (28.9 ft) in a northwesterly direction, coming to final rest on the north roadside heading southeast with the front portion of the vehicle on the shoulder and the rear portion on the grass.

***Post-Crash***

The driver of an uninvolved vehicle called 9-1-1 and reported the crash. The investigating police officer was notified of the crash at 1619 hours and arrived on scene at 1631 hours, according to the police crash report. Other police personnel were at the crash scene upon his arrival and informed him that the drivers of the Honda and GMC were deceased. Local emergency medical service was notified at 1626 hours and arrived on scene at 1638 hours. Emergency responders used a hydraulic rescue tool to cut the Honda's left A-pillar and remove the vehicle's left front door. The damage to the interior of the Honda (**Figure 5**) suggested that a hydraulic rescue tool was also used to displace the steering assembly and instrument panel to extricate the deceased driver from the vehicle. Emergency responders also used a hydraulic rescue tool to remove both left side doors of the GMC to extricate the deceased driver from the vehicle. The deputy county coroner arrived on scene at 1644 hours and pronounced both drivers deceased. The drivers were then removed by non-emergency vehicle to a private autopsy facility for examination. Both vehicles were towed from the crash scene due to damage.

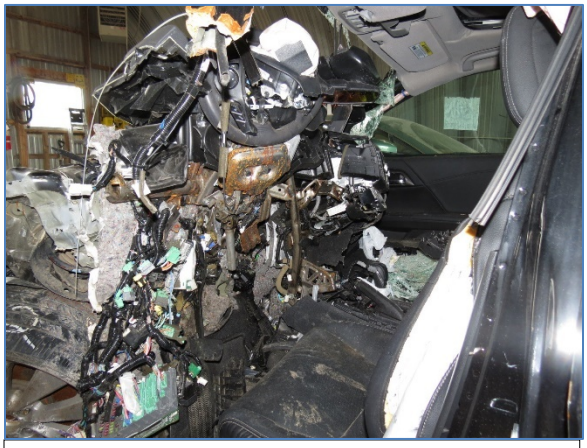


**Figure 5:** Damage to the Honda's instrument panel and steering assembly

**2014 HONDA ACCORD DESCRIPTION**

The Honda was a front-wheel-drive, 5-occupant, 4-door sedan with the VIN 1HGCR2F86EAxxxxxx that was manufactured in March 2014. The vehicle was equipped with a 2.4-liter I-4 engine, continuously variable automatic transmission, 4-wheel antilock brakes with electronic brake force distribution, brake assist, traction control, tire pressure monitoring system (TPMS), and electronic stability control (ESC). The vehicle was also equipped with multi-stage frontal air bags, front seat-mounted side impact air bags, rollover/side impact IC air bags, FCW without auto braking, LDW without lane keeping, blind spot detection, and a rearview camera. The vehicle was also equipped with a tilt/telescoping steering column. The column adjustments could not be determined since the steering assembly was damaged and displaced by both occupant contact and rescue activities. The specified wheelbase was 278 cm (109.4 in).

The vehicle manufacturer's recommended tire size was P215/55R17. The vehicle was equipped with Goodyear Assurance tires of the recommended size. The vehicle manufacturer's recommended cold tire pressure for the front and rear tires was 228 kPa (33 psi). The front tire tread was in fair condition and the rear tire tread was in good condition prior to the crash.

The front row was equipped with driver and front passenger leather-covered bucket seats with adjustable head restraints. The second row was equipped with a leather-covered bench seat with folding back and adjustable head restraints. The driver's seat track was adjusted between the

middle and rear-most positions and the seat back was upright. The top of the head restraint was located 26 cm (10.2 in) above the top of the seat back. The remaining seats were unoccupied at the time of the crash.

## EXTERIOR DAMAGE

The Honda sustained direct damage to the front plane during the impact with the front plane of the GMC. The direct damage began at the left corner of the Honda's front bumper and extended 121 cm (47.6 in) across the front plane. The Field L was 107 cm (42.1 in) and began at the same location as the direct damage. Two sets of crush measurements were taken since the crush at the upper radiator frame level exceeded that at the bumper level. The maximum residual crush at the upper radiator frame level was 121 cm (47.6 in) occurring at the left corner of the radiator frame. The maximum residual crush at the bumper level was 83 cm (32.7in) occurring at the left bumper corner. The crush values at both levels were averaged as required by the crush measurement protocol and the averaged crush values were: $C_1$ = 102 cm (40.1 in), $C_2$ = 90 cm (35.4 in), $C_3$ = 75 cm (29.5 in), $C_4$ = 62 cm (24.4 in), $C_5$ = 57 cm (22.4 in), $C_6$ = 44 cm (17.3 in).

### *Damage Classification*

The Collision Deformation Classification (CDC) was 12FDEW5 (0 degrees).

## EVENT DATA RECORDER

Attempts to image the Honda's EDR via direct connection to the ACM using version 16.6 of the Bosch Crash Data Retrieval software were unsuccessful since the ACM was severely damaged (**Figure 6**) in the crash. The damaged ACM was found during the SCI vehicle inspection separated from its electrical connection and anchor bolts. It was located under the center instrument panel, on the floor pan, near the cowl in the area where it would normally be bolted to the vehicle. The ACM's metal casing was fractured and the bolt mounting brackets were fractured and missing. The electrical connectors were also fractured. The deformation of the vehicle's cowl and floor pan in this area indicated that the ACM was damaged during the crash.


**Figure 6:** The Honda's damaged ACM

## INTERIOR DAMAGE

The interior of the Honda sustained severe damage from 11 intrusions. The most severe intrusions in the driver's seating area involved the toe pan, instrument panel, and left A-pillar. The toe pan intruded longitudinally 54 cm (21 in). The left A-pillar and instrument panel were displaced by emergency responders to extricate the driver, so the extent of their intrusion was estimated to be 65 cm (26 in) based on the appearance of the damage. The steering wheel was completely collapsed from the unbelted driver's chest loading through the deployed frontal air bag and contacting the steering wheel. The center and left instrument panel were also deformed by contact from the driver's knees. The windshield glazing was cracked and largely displaced from the ve-

hicle due to rescue activities and weathering. The left front door had been removed by emergency responders using a hydraulic rescue tool and the door was not present at the SCI vehicle inspection. The damage to the vehicle indicated that the left front glazing was disintegrated by impact forces. The remaining glazing was undamaged. The left rear door was jammed shut. The right front and right rear doors remained closed and operational.

**MANUAL RESTRAINT SYSTEMS**

The front and second rows were equipped with three-point lap and shoulder seat belts. The front row seat belts had sliding latch plates and adjustable upper anchors and were equipped with retractor-mounted pretensioners. The driver's upper anchor was adjusted to the full-down position. The driver's seat belt was drawn tautly into the retractor by pretensioner actuation, indicating that the driver was not restrained at the time of the crash.

**SUPPLEMENTAL RESTRAINT SYSTEMS**

The Honda was equipped with multi-stage frontal air bags, driver and front row passenger seat-mounted side impact air bags, and rollover/side impact IC air bags. The driver's frontal, left seat-mounted side impact, and the left IC air bags deployed during the frontal impact with the GMC.

The driver's frontal air bag module was located within the steering wheel hub and the module cover was a three-flap configuration constructed of pliable vinyl. Each bottom flap was 6 cm (2.4 in) wide and 7 cm (2.8 in) high. The top flap was entrapped under the top of the deformed instrument panel and could not be measured. The deflated air bag was 50 cm (19.7 in) in diameter. The top portion of the air bag had a few small holes with melted edges, suggesting the air bag material was damaged by gas or particles from the inflator. There were what appeared to be deployment related scuff marks on the air bag, but no discernable scuff marks from occupant contact were observed.

The driver's seat-mounted side impact air bag was located in the outboard side of the seat back and deployed through a tear seam. The deflated air bag was 56 cm (22.0 in) high and 22 cm (8.7 in) wide and had three vent ports. There was no discernable evidence of occupant contact to the air bag. The air bag had been cut on both the inboard and outboard sides, possibly during the extrication of the driver.

The IC air bags were located along the roof side rail inside the headliner and extended from the A- pillar to the C-pillar. An accurate length measurement of the deflated left IC was not possible since the IC was displaced rearward along with the left A-pillar and roof side rail as a result of the impact.

The length of the displaced IC was 154 cm (60.6 in) and the height was approximately 41 cm (16.1 in). Inspection of the IC revealed no discernable evidence of occupant contact and no crash-related damage.

**CRASH AVOIDANCE FEATURES**

The Honda's FCW system was designed to prevent a rear-end collision by providing a visual and audible warning if the system detects that a rear end crash is possible. The FCW system does not automatically apply the brakes. The visual warning includes a heads-up warning that flashes

twice on the windshield and an "FCW" warning light located in the instrument cluster directly in front of the driver blinks. The system is camera-based and designed to recognize the rear surface of a vehicle that is in front of the Honda. The camera is located behind the rearview mirror. The system is designed to operate at speeds of 15 km/h (10 mph) or above and can be turned off. The ability of the system to detect a vehicle can be affected by bad weather such as rain, fog, or snow.

The LDW system was also camera based and is designed to provide a visual and audible warning if the vehicle is getting too close to a right or left lane marker and the turn signal is not activated. The system is not designed with a lane keeping feature. The system begins to search for lane markings under the following conditions: the vehicle's speed is from 64 to 145 km/h (40 to 90 mph), the vehicle is on a straight or slightly curved roadway, the turn signals are off, and the brake is not depressed. An audible alert will sound and the "LDW" indicator on the instrument cluster directly in front of the driver will blink if a lane marker is detected. The ability of the system to detect a lane marker can be affected by speed, weather, and lane marker condition.[1] The system can be turned on or off via the "LDW" button that is located on the lower instrument panel left of the steering wheel.

In this crash, the Honda crossed the center line of the roadway, which consisted of broken yellow lines adjacent to the Honda's travel lane and a solid yellow line adjacent to the GMC's travel lane. While the conditions existed for possible activation of both the LDW and FCW warnings, it is not known if such warnings occurred for the following reasons:

1. It could not be determined if either system was turned on. The vehicle's electrical system was destroyed during the crash, so it was not possible to power up the vehicle and determine the status of either system.

2. It was not possible to conduct an SCI interview with the driver to determine the status of either system since he was killed in the crash.

3. While the vehicle was equipped with an EDR, it was not possible to determine if any data relative to the vehicle's FCW and LDW systems were recorded since the air bag control module (ACM) was severely damaged in the crash and the EDR data could not be imaged.

## 2014 HONDA ACCORD OCCUPANT

### *Driver Demographics*

| | |
|---|---|
| Age/Sex: | 68 years/male |
| Height: | 175 cm (69 in) |
| Weight: | 142 kg (312 lbs) |
| Eyewear: | Unknown |
| Seat Type: | Bucket |
| Seat Track Position: | Between middle and rear-most |
| Manual Restraint Usage: | None |
| Usage Source: | Vehicle inspection |

[1] It was raining lightly at the time of the crash, and the centerline of the roadway was in good condition.

Air Bags: Frontal, IC, and seat-mounted side impact deployed
Alcohol/Drug Involvement: None
Egress From Vehicle: Removed by emergency responders
Transport From Scene: Non-emergency vehicle to autopsy facility
Medical Treatment: Pronounced deceased at crash scene

***Driver Injuries***

| Injury No | Injury | AIS 2015 | Involved Physical Components (IPC) | IPC Confidence Level |
|---|---|---|---|---|
| 1 | Hematoma, subdural, not further specified | 140650.3 | Front (windshield) header, driver's | Probable |
| 2 | Injury spinal cord associated with fracture at $C_7$, not further specified | 610224.5 | Front (windshield) header, driver's | Probable |
| 3 | Laceration (transection) of aorta at $C_7$ area (arch[2]) and descending aorta at $T_5$ area, not further specified | 420210.5 | Tandem IPC configuration air bag, driver's frontal steering wheel hub and/or spokes and rim | Possible Certain |
| 4 | Injury spinal cord associated with fracture at $T_5$, not further specified | 610424.5 | Tandem IPC configuration air bag, driver's frontal steering wheel hub and/or spokes and rim | Possible Probable |
| 5 | Lacerations, about 2.5 to 7.6 cm (1-3 in) of heart, not further specified | 441008.3 | Tandem IPC configuration air bag, driver's frontal steering wheel hub and/or spokes and rim | Possible Certain |
| 6 | Lacerations, about 2.5 to 7.6 cm (1-3 in) of lungs, not further specified | 441450.4 | Tandem IPC configuration air bag, driver's frontal steering wheel hub and/or spokes and rim | Possible Certain |
| 7 | Fractures of ribs: 3rd through 10th anteriorly and posteriorly and posterior right ribs 3rd through 5th, not further specified | 450203.3 | Tandem IPC configuration air bag, driver's frontal steering wheel hub and/or spokes and rim | Possible Certain |

[2] The arch of the aorta is near T -T , so this anatomical reference seems unusual.

| Injury No | Injury | AIS 2015 | Involved Physical Components (IPC) | IPC Confidence Level |
|---|---|---|---|---|
| 8 | Lacerations of urinary bladder, about 2.5 to 10.2 cm (1-4 in), not further specified | 540620.2 | Steering wheel rim | Probable |
| 9 | Lacerations of intestine,[3] about 2.5 to 5.1 cm (1-2 in), not further specified | 541420.2 | Steering wheel hub and/or spokes and rim | Certain |
| 10 | Lacerations of liver, about 2.5 to 7.6 cm (1-3 in), not further specified | 541820.2 | Steering wheel hub and/or spokes and rim | Certain |
| 11 | Lacerations of spleen, not further specified | 544220.2 | Steering wheel hub and/or spokes and rim | Certain |
| 12<br>13<br>14<br>15 | Fractures, open,[4] bilateral tibia and fibula, not further specified | 854001.3<br>854112.3<br>854442.2<br>854471.2 | Left lower instrument panel (includes knee bolster) | Certain |
| 16 | Fractures of pelvis, not further specified | 856100.2 | Tandem IPC configuration steering wheel rim left lower instrument panel (includes knee bolster) | Probable |
| 17 | Hematoma, subgaleal, not further specified | 110402.1 | Front (windshield) header, driver's | Probable |
| 18 | Abrasion, 1.9 cm (0.75 in), right upper forehead at hairline, not further specified | 210202.1 | Front (windshield) header, driver's | Probable |
| 19 | Abrasion, 5.1 cm (2 in), on right lateral flank, not further specified | 510202.1 | Steering wheel rim | Probable |
| 20<br>21 | Abraded (irregular) contusion, 10.2 to 12.7 cm (4-5 in), right lower lateral abdominal wall, not further specified | 510202.1<br>510402.1 | Steering wheel hub and/or spokes and rim | Probable |

[3] It is assumed this reference is to the small bowel.
[4] Lacerations, 10.2 (4 in), over right tibia exposing bone and fractures and 10.2 cm (4 in) on left upper proximal tibia, exposing bone, not further specified.

| Injury No | Injury | AIS 2015 | Involved Physical Components (IPC) | IPC Confidence Level |
|---|---|---|---|---|
| 22 | Abrasion, 2.5 to 7.6 cm (1-3 in) on left flank, not further specified | 510202.1 | Steering wheel rim | Probable |
| 23 | Abrasions, 7.6 to 10.2 cm (3-4 in), on posterior (back) of right upper arm, not further specified | 710202.1 | Seat back, driver's | Certain |
| 24<br>25 | AAbraded contusions, multiple, of about 5.1 cm (2 in), on posterior (back) of right forearm, not further specified | 710202.1<br>710402.1 | Center instrument panel | Certain |
| 26<br>27 | Abraded contusion, 1.9 cm (0.75 in), posterior (back of) left elbow, not further specified | 710202.1<br>710402.1 | Left instrument panel | Certain |
| 28<br>29 | Abraded contusion, 10.2 cm (4 in) on posterior (back of) left forearm and wrist, not further specified | 710202.1<br>710402.1 | Left instrument panel | Certain |
| 30 | Laceration, 10.2 cm (4 in) on posterior (back of) left forearm, not fur- ther specified | 710602.1 | Left instrument panel | Certain |
| 31<br>32 | Abraded contusion, 7.6 to 12.7 cm (3- 5 in), on left groin, not further specified | 510202.1<br>510402.1 | Steering column and/or tilt adjustment lever | Probable |
| 33<br>34 | Laceration, 15.2 (6 in), right medial upper thigh and 10.2 cm (4 in), left medial thigh, not further specified | 810602.1<br>810602.1 | Left instrument panel | Certain |

Sources: Autopsy records and coroner records. Injury numbers 1 to 34 came only from autopsy records.

***Driver Kinematics***

The driver was not restrained by the lap and shoulder seat belt. The seat track was adjusted between the middle and rear-most positions and the seat back was upright. The top of the head restraint was located 26 cm (10.2 in) above the top of the seat back. The front plane impact to the Honda resulted in deployment of the driver's frontal, left seat-mounted side impact, and left IC air bags. The driver was displaced forward and his chest loaded through the frontal air bag and contacted the steering wheel, which collapsed the steering wheel and displaced the steering column forward and upward. The driver's head also contacted the windshield header and his upper and lower extremities contacted the instrument panel. The chest contact with the steering wheel resulted in lacerations of the aorta, heart, lungs, bladder, liver, intestine, and spleen. Contact with the steering wheel also resulted in an unspecified thoracic spinal cord injury, fractures of right ribs 3 - 10, and fractures of the pelvis. The head contact with the windshield header resulted in

subdural and subgaleal hematomas and an unspecified cervical spine injury. Lower leg contact with the lower left instrument panel resulted in multiple fractures of the tibia and fibula in both legs. The driver also sustained multiple abrasions and lacerations. Emergency responders used a hydraulic rescue tool to cut the left A-pillar and remove the left front door to extricate the driver from the vehicle. He was pronounced deceased at 1644 hours by the deputy county coroner and transported by a non-emergency vehicle to an autopsy facility.

### 2006 GMC SIERRA 1500

#### *Description*

The GMC was a rear-wheel drive, 5-occupant, 4-door, crew cab pickup truck with the VIN 2GTEC13T161xxxxxx that was manufactured in August 2005. The vehicle was equipped with a 5.3-liter, V-8 engine, 4-speed automatic transmission, and 4-wheel antilock brakes with electronic brake force distribution. The vehicle was also equipped with multi-stage frontal air bags that were certified compliant to Federal Motor Vehicle Safety Standard 208.

#### *Exterior Damage*

The GMC sustained direct damage to the front plane during the impact with the front plane of the Honda. The direct damage began at the left corner of the front bumper and extended 153 cm (60.2 in) across the front plane. The Field L was also 153 cm (60.2 in) The bumper was displaced from the vehicle, so the crush measurements were taken at the lower radiator support level and the maximum residual crush was determined to be 153 cm (60.2 in) occurring at the left bumper corner. The crush values were: $C_1$ = 153 cm (60.2 in), $C_2$ = 113 cm (44.5 in), $C_3$ =92 cm (36.2 in), $C_4$ = 76 cm (29.9 in), $C_5$ = 60 cm (23.6 in), $C_6$ = 47 cm (18.5 in).

#### *Damage Classification*

The CDC was 12FDEW6 (0 degrees).

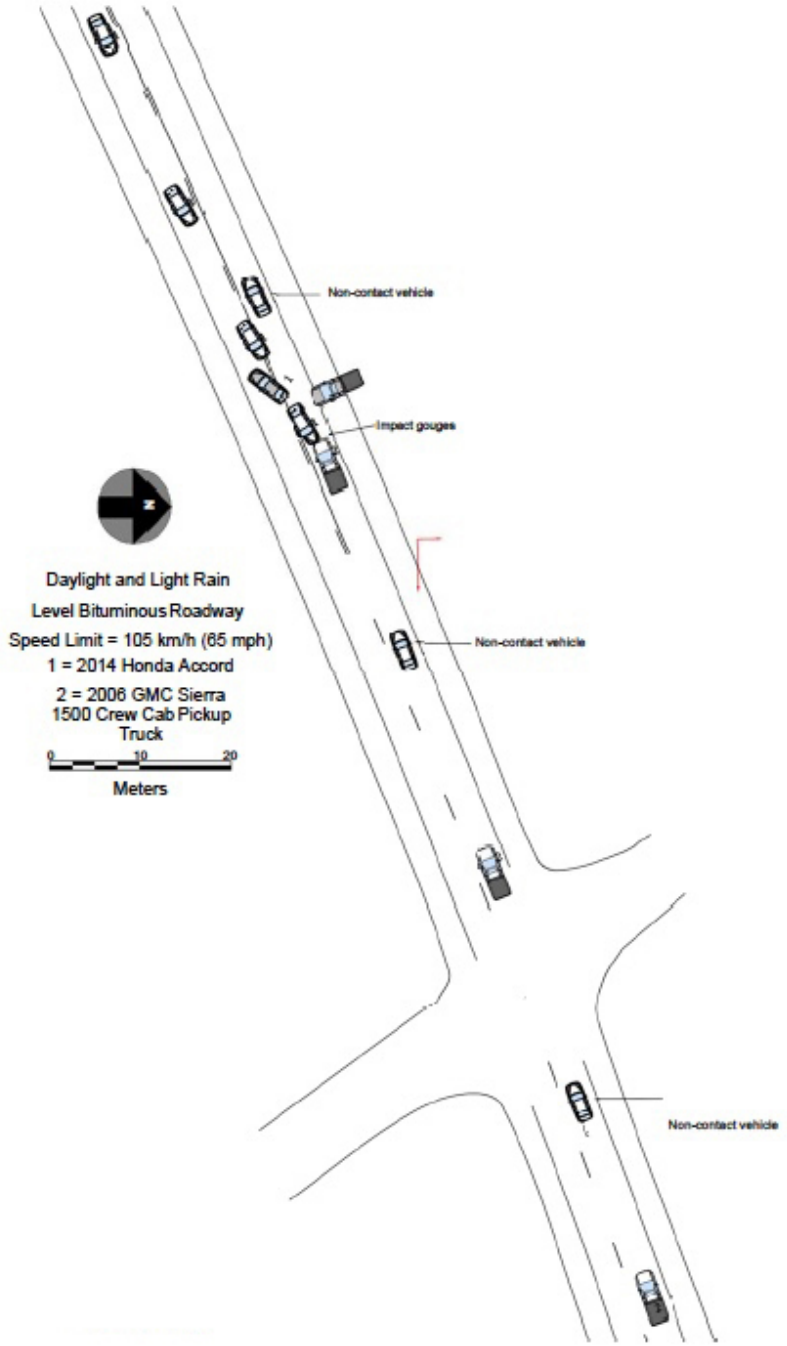
#### *Event Data Recorder*

It was not possible to image the vehicle's EDR since the extensive damage to the vehicle prevented access to the ACM. Imaging the data via the fuse block method was not possible since the fuse block was destroyed in the crash, as was the vehicle's electrical system.

#### *Occupant Data*

The driver (a 40-year-old male) was not restrained by a lap and shoulder seat belt according to the police crash report. The driver sustained fatal injuries and was pronounced deceased at the crash scene. He was transported by non-emergency vehicle to a private autopsy facility. His injuries are not known.

## CRASH DIAGRAM

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13857-082718-v1c