**TRANSPORTATION SCIENCES**
**CRASH DATA RESEARCH CENTER**

Advanced Information Engineering Services, Inc.
A General Dynamics Company
Buffalo, NY 14225

# GENERAL DYNAMICS REMOTE SIDE IMPACT INFLATABLE OCCUPANT PROTECTION SYSTEM CRASH INVESTIGATION

## SCI TECHNICAL SUMMARY REPORT

## NASS/SCI COMBO CASE NO. 03-43-270A

## VEHICLE – 2001 BMW 325i

## LOCATION - STATE OF NORTH CAROLINA

## CRASH DATE – DECEMBER 2003

Contract No. DTNH22-01-C-17002

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
Washington, D.C. 20590

## DISCLAIMER

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no responsibility for the contents or use thereof.

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the National Highway Traffic Safety Administration.

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

| | | | |
|---|---|---|---|
| *1. Report No.*<br>03-43-270A | *2. Government Accession No.* | *3. Recipient's Catalog No.* | |
| *4. Title and Subtitle*<br>General Dynamics Remote Side Impact Inflatable Occupant Protection System Crash Investigation<br>Vehicle: 2001 BMW 325I<br>Location: State of North Carolina | | *5. Report Date*:<br>September 2004<br><br>*6. Performing Organization Code* | |
| *7. Author(s)*<br>Crash Data Research Center | | *8. Performing Organization Report No.* | |
| *9. Performing Organization Name and Address*<br>Transportation Sciences<br>Crash Data Research Center<br>Advanced Information Engineering Services<br>A General Dynamics Company<br>P.O. Box 400<br>Buffalo, New York 14225 | | *10. Work Unit No.*<br>C00410.0000.0229<br><br>*11. Contract or Grant No.*<br>DTNH22-01-C-17002 | |
| *12. Sponsoring Agency Name and Address*<br>U.S. Department of Transportation<br>National Highway Traffic Safety Administration<br>Washington, D.C. 20590 | | *13. Type of Report and Period Covered*<br>Technical Report<br>Crash Date: December 2003<br><br>*14. Sponsoring Agency Code* | |
| *15. Supplementary Note*<br>This remote investigation focused on the performance of the Side Impact Inflatable Occupant Protection system in a 2001 BMW 325i and resulting injury mechanism for a 9-year-old female front right occupant. | | | |
| *16. Abstract*<br>This remote investigation focused on the performance of the Side Impact Inflatable Occupant Protection system in a 2001 BMW 325i and the resulting injury mechanism for the 9-year-old female front right occupant. The BMW was equipped with front door panel mounted side impact air bags and a Head Protection System (HPS) that consisted of roof side rail mounted tubular air bags for the front seating positions. In addition, the BMW was equipped with dual stage frontal air bags and buckle mounted safety belt pretensioners. The 2001 BMW 325i was occupied by a restrained 34-year-old female driver, a 9-year-old female front right occupant, and a 5-year-old male rear left occupant. The BMW was involved in an intersection-type crash with a 1999 Honda Passport. The Honda was involved in a subsequent impact with a 1993 GMC Sonoma. The Honda was occupied by a 30-year-old male driver. The GMC was occupied by a 31-year-old male driver. As a result of the impact, the right door panel mounted side impact air bag and right side HPS deployed in the BMW. The driver of the BMW sustained incapacitating injuries and was transported to a local trauma center where she was hospitalized for the three days. The 9-year-old female front occupant was transported to a trauma center where she was pronounced deceased shortly after arrival. The 5-year-old male rear left occupant sustained minor injuries and was not transported. The driver of the Honda sustained minor injuries and was transported to a local hospital where he was treated and released. The driver of the GMC sustained minor injuries and was transported to a local hospital where he was treated and released. The BMW and the Honda sustained severe damage and were towed from the crash site. The GMC sustained moderate damage and was towed from the crash site. | | | |
| *17. Key Words*<br>Right Side Impact Air Bag Deployment Right Side Head Protection System Deployment | | *18. Distribution Statement*<br>General Public | |
| *19. Security Classif. (of this report)*<br>Unclassified | *20. Security Classif. (of this page)*<br>Unclassified | *21. No. of Pages*<br>13 | *22. Price* |

# TABLE OF CONTENTS

**GENERAL DYNAMICS REMOTE SIDE IMPACT INFLATABLE OCCUPANT PROTECTION SYSTEM CRASH INVESTIGATION**
**SCI SUMMARY TECHNICAL REPORT**
**NASS/SCI COMBO CASE NO. 03-43-270A**
**SUBJECT VEHICLE – 2001 BMW 325i**
**LOCATION - STATE OF NORTH CAROLINA**
**CRASH DATE - DECEMBER 2003**

## BACKGROUND

This remote investigation focused on the performance of the Side Impact Inflatable Occupant Protection system in a 2001 BMW 325i **(Figure 1)** and the resulting injury mechanism for the 9-year-old female front right occupant. The BMW was equipped with front door panel mounted side impact air bags and a Head Protection System (HPS) that consisted of roof side rail mounted tubular air bags for the front seating positions. In addition, the BMW was equipped with dual stage frontal air bags and buckle mounted safety belt pretensioners. The 2001 BMW 325i was occupied by a restrained 34-year-old female driver, a 9-year-old female front right occupant, and a 5-year-old male rear left occupant. The BMW was involved in an intersection-type crash with a 1999 Honda Passport. The Honda was involved in a subsequent impact with a 1993 GMC Sonoma. The Honda was occupied by a 30-year-old male driver. The GMC was occupied by a 31-year-old male driver. As a result of the impact, the right door panel mounted side impact air bag and right side HPS deployed in the BMW. The driver of the BMW sustained incapacitating injuries and was transported to a local trauma center where she hospitalized for the three days. The 9-year-old female front occupant was transported to a trauma center where she was pronounced deceased shortly after arrival. The 5-year-old male rear left occupant sustained minor injuries and was not transported. The driver of the Honda sustained minor injuries and was transported to a local hospital where he was treated and released. The driver of the GMC sustained minor injuries and was transported to a local hospital where he was treated and released. The BMW and the Honda sustained severe damage and were towed from the crash site. The GMC sustained moderate damage and was towed from the crash site.

**Figure 1. Subject vehicle 2001 BMW 325i.**

This crash was identified by the National Automotive Sampling System (NASS) PSU 43 during the weekly sampling of Police Accident Reports (PARs). This crash was selected and researched as CDS Case No. 03-43-270A. The NASS PSU performed the vehicle and scene inspections, and conducted the driver/occupant interviews. Due to the deployment of the side impact air bag, Head Protection System, the presence of a child occupant, and the injuries sustained by the child occupant of the BMW, NHTSA assigned

the tasks of case review and report preparation to the General Dynamics SCI team on July 30, 2004.

***Summary***

***Crash Site***

This intersection crash occurred during the morning hours of December 2003 in the state of North Carolina. At the time of the crash, it was raining and the asphalt road surface was wet. The crash occurred at a four-leg signalized intersection. The north/southbound roadway was configured with three travel lanes in each direction, which were delineated by a non-curbed median that consisted of dirt, grass, and traffic signs. Asphalt shoulders and earthen embankments bordered the north/southbound roadway. The east/westbound roadway was a two-lane, two-way roadway that was delineated by a double yellow centerline. The northbound lanes had an uphill grade approaching the intersection. The posted speed limit for the north/southbound roadway was 72 km/h (45 mph).

***Vehicle Data***

***2001 BMW 325i***

The 2001 BMW 325i was identified by the Vehicle Identification Number (VIN): WBAAV334X1 (production sequence omitted). The odometer reading was 32,187 kilometers (20,000 miles) at the time of the NASS inspection. The vehicle was a four-door sedan that was equipped with a 2.5-liter, six-cylinder engine linked to a five-speed automatic transmission, four-wheel disc brakes with ABS, traction control, automatic stability control, daytime running lights, OEM 40.6 cm (16.0") aluminum/alloy rims. The tires on the BMW were Continental Conti Touring Contact, size P205/55R16. The maximum pressure for these tires was 352 kpa (51 psi). The manufacturer recommended tire pressure was 241 kpa (35 psi). The specific tire data was as follows:

| Tire | Measured Pressure | Tread Depth | Restricted | Damage |
|---|---|---|---|---|
| LF | 207 kpa (30 psi) | 8 mm (10/32) | No | None |
| LR | 200 kpa (29 psi) | 5 mm (6/32) | No | None |
| RF | 0 kpa | 8 mm (10/32) | No | Punctured Tread |
| RR | 214 kpa (31 psi) | 6 mm (8/32) | No | None |

The BMW was configured with front leather appointed bucket seats with height adjustable head restraints that were removed at the time of the NASS inspection. The second row was configured with a leather appointed three-passenger bench seat and height adjustable head restraints for the outboard positions. The rear head restraints were adjusted to the full-down positions at the time of the NASS inspection.

***1999 Honda Passport***

The 1999 Honda Passport was identified by the VIN: 4S6CK58W2X (production sequence omitted). The odometer reading was 153,611 kilometers (95,442 miles) at the time of the NASS inspection. The vehicle was a four-door sport utility that was equipped

with a 3.2-liter, six-cylinder engine, four-speed automatic transmission, rear-wheel drive, and four-wheel ABS. The tires on the Honda were Bridgestone Dueler HT, size P245/70R15. The manufacturer recommended front pressure was 179 kpa (26 psi). The specific tire data was as follows:

| Tire | Measured Pressure | Tread Depth | Restricted | Damage |
|---|---|---|---|---|
| LF | 0 kpa | 8 mm (10/32) | Yes | Punctured Tread |
| LR | 221 kpa (32 psi) | 9 mm (11/32) | No | None |
| RF | 228 kpa (33 psi) | 8 mm (10/32) | Yes | None |
| RR | 234 kpa (34 psi) | 9 mm (11/32) | No | None |

The Honda was configured with leather upholstered front bucket seats with height adjustable head restraints that were adjusted to the full-down position at the time of the NASS inspection. The second row was configured with leather upholstered three-passenger bench seat and height adjustable head restraints for the outboard positions. The rear head restraints were adjusted to the full-down position at the time of the NASS inspection.

***1993 GMC Sonoma***

The 1993 GMC Sonoma was identified by the VIN: 1GTCS14R6P (production sequence omitted). The odometer reading was 242,092 kilometers (150,433 miles) at the time of the NASS inspection. The vehicle was a two-door compact pickup truck that was equipped with a 2.8-liter, six-cylinder engine, five-speed manual transmission, and rear-wheel drive. The GMC was equipped with National tires for the LF, RF, and RR, size P215/70/R15. The maximum pressure for these tires was 241 kpa (35 psi). The LR tire was equipped with a Lee tire, size P205/75R14. The maximum pressure for this tire was 303 kpa (44 psi). The manufacturer recommended tire pressure for this vehicle was 241 kpa (35 psi). This specific tire data was as follows:

| Tire | Measured Pressure | Tread Depth | Restricted | Damage |
|---|---|---|---|---|
| LF | 248 kpa (36psi) | 3 mm (4/32) | No | None |
| LR | 234 kpa (34 psi) | 2 mm (3/32) | No | None |
| RF | Unknown | 4 mm (5/32) | Yes | None |
| RR | 234 kpa (34 psi) | 2 mm (3/32) | No | None |

The GMC was configured with a three-passenger bench seat with height adjustable head restraints for the outboard positions. Both head restraints were adjusted to the full-down position at the time of the NASS inspection.

***Crash Sequence***

***Pre-Crash***

The restrained 34-year-old female driver of the BMW was operating the vehicle southbound approaching the four-leg intersection **(Figure 2)** where the driver was intending to turn left. The driver of the GMC was operating the vehicle northbound in the left through lane approaching the same intersection ahead of the Honda. The driver of the Honda was operating the vehicle northbound in the left through lane behind the GMC approaching the same intersection. The Honda changed lanes to the left and entered the left turn lane and passed the GMC. The Honda reentered the inboard through lane prior to the intersection. No pre-impact evidence [i.e. skid marks] were present at the crash site. The NASS scene schematic is included as **Figure 11** of this report.

**Figure 2. BMW's approach to the intersection.**

***Crash***

As the BMW crossed the inboard northbound lane, the front of the Honda impacted the right passenger compartment area of the BMW **(Figure 3)**. The impact resulted in severe damage to the right side of the BMW and severe damage to the front of the Honda. The resultant direction of force was within the 2 o'clock sector for the BMW and 11 o'clock sector for the Honda. The WINSMASH program damage algorithm was used to calculate a delta V for this impact. The total delta V for the BMW was 32.0 km/h (19.8 mph). The longitudinal and lateral components for the BMW were -16.0 km/h (-9.9 mph) and 28.0 km/h (17.3 mph), respectively. The total calculated delta V for the Honda was 34.0 km/h (21.1 mph). The longitudinal and lateral components for the Honda were -29.1 km/h (-18.1 mph) and 17.0 km/h (10.6 mph), respectively. As a result of the impact, the front right side impact air bag and right HPS deployed in the BMW and the frontal air bags deployed in the Honda.

**Figure 3. Area of impact from the Honda's approach.**

As result of the impact, the BMW was deflected to its left and began a northeast trajectory as it traveled off the northeast road edge and came to rest off-road. The Honda began a clockwise rotation and traveled in a northeast trajectory. The front of the GMC subsequently impacted the right aspect of the Honda as the vehicles came to rest.

***Post-Crash***

Police and rescue personnel arrived on scene shortly after the crash. The 34-year-old female driver of the BMW sustained incapacitating injuries and was transported to a local trauma center where she hospitalized for the three days. The 9-year-old female front right occupant sustained serious severity injuries and was transported to a local trauma center where she pronounced deceased approximately 1 hour post-crash. It was noted in the medical report that extrication efforts to remove the front right occupant took approximately 23 minutes; and she had no pulse during extrication. The 5-year-old male rear left occupant sustained minor injuries and was not transported to a hospital. The driver of the Honda sustained minor injuries and was transported to a local hospital where he was treated and released. The driver of the GMC sustained minor injuries and was transported to a local hospital where he was treated and released. The BMW and the Honda sustained severe damage and were towed from the crash site. The GMC sustained moderate damage and was towed from the crash site.

***Vehicle Damage***

***Exterior – 2001 BMW 325i***

The 2001 BMW 325i sustained severe right side damage as a result of the collision with the Honda **(Figure 4)**. The direct contact damage measured 180.0 cm (70.9") and began 56.0 cm forward of the right rear axle and extended forward. The maximum crush was located near of the B-pillar and measured 45.0 cm (17.7"). The damaged components involved the right front fender, A-pillar, right doors, sill, B-pillar, roof side rail, and the right side glazing. Six crush measurements were documented along the mid-door level using a combined direct and induced damage width of 245.0 cm (96.5") and were as follows: C1 = 8.0 cm (3.1"), C2 = 41.0 cm (16.1"), C3 = 16.0 cm (6.3"), C4 = 21.0 cm (8.3"), C5 = 43.0 cm (16.9"), C6 = 3.0 cm (1.2").

**Figure 4. Right side crush profile.**

The Collision Deformation Classification (CDC) for this impact was 02-RYEW-3. The right side and left rear doors were jammed closed by deformation and the left front door remained closed and operational post-crash. The windshield was fractured from the lateral deformation. The right front and right rear glazing were disintegrated at impact. The left side, backlight, and right rear quarter glazing remained intact.

***Interior – 2001 BMW 325i***

The 2001 BMW 325i sustained severe interior damage **(Figure 5, 6 and 7)** as a result of intrusion and occupant contacts. As a result of the impact, the driver initiated a right trajectory and the driver's right hip contact the center console, which deformed by the occupant contact. The driver's right thigh contacted the center console mounted parking brake handle, which was evidenced by lateral deformation. The driver's left knee

contacted the knee bolster that was evidenced by deformation to the knee bolster. As the driver rebounded, her back contacted and deformed the seatback. As a result of the impact forces, the front right passenger initiated a right trajectory and her right hip and flank contacted the intruded right front door panel. The NASS researcher noted that the door panel was deformed and fractured from the occupant contact. The passenger's head contacted the right B-pillar and right front door panel. The NASS researcher noted probable occupant contact points from the front right occupant to the following objects, floor, seatback, right side impact air bag, and right side HPS air bag. However, no occupant contact related evidence was noted to the objects. The documented intrusions were as follows:

**Figure 5. Right front passenger area.**

**Figure 6. Front right seat.**

**Figure 7. Removed right front door panel.**

| Seat Position | Intruded Component | Magnitude | Direction |
|---|---|---|---|
| Front Right | Sill | 33.0 cm (12.9”) | Lateral |
| Front Right | Door Panel | 24.0 cm (9.5”) | Lateral |
| Front Right | B-pillar | 19.0 cm (7.5”) | Lateral |
| Front Right | Seat Cushion | 22.0 cm (8.6”) | Lateral |
| Front Right | A-pillar | 4.0 cm (1.6”) | Lateral |
| Front Right | Roof Side Rail | 48.0 cm (18.9”) | Lateral |
| Front Right | Instrument Panel | 12.0 cm (4.7”) | Lateral |
| Front Center | Center Instrument Panel | Est. 3.0-8.0 cm (1.0-3.0”) | Lateral |
| Rear Right | Door Panel | 21.0 cm (8.3”) | Lateral |
| Rear Right | Seat Cushion | 8.0 cm (3.1”) | Lateral |
| Rear Right | Roof Side Rail | 5.0 cm (1.9”) | Lateral |

***Exterior – 1999 Honda Passport***

The 1999 Honda Passport sustained severe damage as result of the collision with the BMW **(Figure 8)**. The direct damage measured 140.0 cm (55.1”) and extended the full width of the vehicle. Maximum crush was located at the front right bumper corner and measured 49.0 cm (19.3”). The damage involved longitudinal deformation to the frontal structure. The NASS researcher utilized six crush measurements using a combined direct and induced damage width of 140.0 cm (55.1”) to document the residual crush. The crush measurements were as follows: C1 = 38.0 cm (14.9”), C2 = 22.0 cm (8.6”), C3 = 26.0 cm (10.2”), C4 = 35.0 cm (13.7”), C5 = 35.0 cm (13.7”), C6 = 49.0 cm (19.3”). The CDC for this impact was 11-FDEW-3.

**Figure 8. Damaged 1999 Honda Passport.**

The 1999 Honda Passport sustained minor right side damage as a result of the subsequent impact with the 1993 GMC Sonoma.

***Exterior – 1993 GMC Sonoma***

The 1993 GMC Sonoma sustained moderate frontal damage as a result of the subsequent impact with the 1999 Honda Passport.

***Manual Restraint Systems – 2001 BMW 325i***

The 2001 BMW 325i was equipped with manual 3-point lap and shoulder safety belts for the outboard seating positions. The driver's safety belt was configured with a height adjustable D-ring that was adjusted to approximately the full-up position at the time of the NASS inspection, sliding latch plate, and Emergency Locking Retractor (ELR). The driver's safety belt was also equipped with a buckle pretensioner that did not fire in this crash. The driver utilized the safety belt in this crash. The front right safety belt was configured with an adjustable D-ring, which appeared to be adjusted to the mid-position, sliding latch plate, buckle pretensioner, and a switchable ELR/Automatic Locking Retractor. The front right safety belt pretensioner did not fire in this crash. The front right occupant utilized her safety belt in the crash. The NASS researcher noted a transfer on the safety belt webbing, which may have resulted from occupant loading. The rear outboard safety belts were configured with sliding latch plates and switchable ELR/ALR retractors. The rear left safety belt was used by the 5-year-old male rear left occupant. The rear center safety belt was a 2-point manual lap belt and was configured with a locking latch plate and no retractor.

***Side Impact Air Bags – 2001 BMW 325i***

The 2001 BMW 325i was equipped with door panel mounted side impact air bags for the front seating positions. In the subject crash, the front right door panel side impact air bag deployed **(Figure 9)**. The air bag was concealed by a leather cover flap that measured 11.0 cm (4.3") in height and 25.0 cm (9.8") in width. The air bag membrane measured 10.0 cm (3.9") in height at the forward aspect and 20.0 cm (7.8") at the rear aspect and 45.0 cm (17.7") in width. The NASS researcher noted no vent ports or tethers on the air bag. Although, a circular stitch pattern was present on the outboard panel of the air bag, which may have been consistent of a lateral tether. The NASS researcher documented a possible occupant contact to the air bag from the front right occupant, however; no contact related evidence was cited. No damage or failure was noted to the air bag.

**Figure 9. Deployed right side impact air bag.**

***Head Protection System (HPS) – 2001 BMW 325i***

The 2001 BMW 325i was equipped with a Head Protection System (HPS) for the front seating positions. The system included two tubular air bags that deploy from the roof side rails and were designed to protect the occupants in the event of a side impact. In subject crash, the right side HPS deployed **(Figure 10)** from the right roof side rail. The air bag membrane measured 16.0 cm (6.3") diameter (deflated)

**Figure 10. Deployed right side HPS air bag.**

and 111.0 cm (43.7") in length. The HPS was tethered at the right A- and C-pillars and was tensioned by inflation. The NASS researcher documented probable contact to the right HPS air bag; however, no contact related evidence was found. The NASS researcher noted no failures or damage to the air bag. The vehicle did not sustain a left side impact, therefore the left side HPS did not deploy.

***Occupant Demographics– 2001 BMW 325i***

***Driver***

| | |
|---|---|
| Age/Sex: | 34-year-old female |
| Height: | 175.0 cm (69.0") |
| Weight: | 82.0 kg (181.0 lbs) |
| Seat Track Position: | Between mid and full rear |
| Manual Restraint Use: | Manual 3-point lap and shoulder belt |
| Usage Source: | Vehicle inspection |
| Eyewear: | None |
| Type of Medical Treatment: | Transported to a local trauma center where she hospitalized for three days. |

***Driver Injuries***

| Injury | Injury Severity (AIS 90/Update 98) | Injury Mechanism |
|---|---|---|
| Several anterior lateral spleen lacerations to the upper and lower poles | Moderate (544220.2,2) | Left B-pillar (rebound injury) |
| Spleen contusion, NFS | Moderate (544210.2,2) | Left B-pillar (rebound injury) |
| Right kidney contusion, NFS | Moderate (541610.2,1) | Transmission gear selector |
| Right hip contusion, NFS | Minor (890402.1,1) | Transmission gear selector |
| Contusion to upper left anterior chest | Minor (490402.1,2) | Safety belt |
| Left arm contusion | Minor (790402.1,2) | Left B-pillar (rebound injury) |
| Left knee contusion | Minor (890402.1,2) | Knee bolster |
| Left medial knee abrasion | Minor (890202.1,2) | Knee bolster |

Source of injury data – Post-emergency room records and driver interview

***Driver Kinematics***

The 34-year-old female driver of the 2001 BMW 325i was seated in a presumed upright driving posture and was restrained by the manual 3-point lap and shoulder belt. The seat track was adjusted to the mid-to-full rear position. At impact with the Honda, the right side impact air bag and the HPS air bag deployed. The restrained driver initiated a right trajectory in response to the 2 o'clock direction of force. The driver's lower right torso contacted the transmission gear selector, which resulted in the right kidney contusion and

right hip contusion. Her chest loaded the shoulder belt portion of the safety belt system, which resulted in the upper left chest contusion. Her left knee contacted the knee bolster subsequently resulting in the left knee contusion and abrasion. As a result of her lateral right movement, the driver probably contacted the front right passenger. As the driver rebounded into the front left seat her left torso and left arm contacted the left B-pillar. This contact resulted in the spleen lacerations, spleen contusion, and left arm contusion.

***Driver's Medical Treatment***

The driver was transported to a local trauma center where she was hospitalized for the three days. She underwent radiology and was blood work to identify further possible injuries. The driver was started on a regular diet and released three days post-crash.

***Front Right Occupant***

| | |
|---|---|
| Age/Sex: | 9-year-old female |
| Height: | 152.0 cm (60.0") |
| Weight: | 44.0 kg (97.0 lbs) |
| Seat Track Position: | Between mid and full rear |
| Manual Restraint Use: | Manual 3-point lap and shoulder belt |
| Usage Source: | Vehicle inspection |
| Eyewear: | None |
| Type of Medical Treatment: | Transported to a local trauma center where she expired. |

***Front Right Occupant Injuries***

| Injury | Injury Severity (AIS 90/Update 98) | Injury Mechanism |
|---|---|---|
| Comminuted fracture of the right pelvis acetabulum/ischium | Serious (852604.3,1) | Intruding right front door panel |
| **Comminuted fracture of the right inferior pubic ramus | Serious (852604.3,5) | Intruding right front door panel |
| Right femur neck fracture | Serious (851812.3,1) | Intruding right front door panel |
| * High C2-C3 fracture | Moderate (650216.2,6) | Right flexion over shoulder belt |
| Left clavicle fracture | Moderate (752200.2,2) | Driver |
| Right side neck abrasion | Minor (390202.1,1) | Safety belt |
| Inner left elbow abrasion | Minor (790202.1,2) | Center console |
| Right abdomen abrasion | Minor (590202.1,8) | Safety belt |
| Right abdomen contusion | Minor (590402.1,1) | Intruding right front door panel |
| Right inner thigh contusion | Minor (890402.1,1) | Same occupant contact (left knee) |
| Left shin contusion | Minor (890402.1,1) | Intruding right front door panel |

| Injury | Injury Severity (AIS 90/Update 98) | Injury Mechanism |
|---|---|---|
| Left knee abrasion | Minor (890202.1,2) | Intruding right front door panel |
| Right knee abrasion | Minor (890202.1,1) | Intruding right front door panel |
| Contusion to the top of the left foot | Minor (890402.1,2) | Floor |
| Left ankle abrasion | Minor (890202.1,2 | Floor |
| Left calf abrasion | Minor (890202.1,2) | Seat cushion |
| Right hand contusion | Minor (790402.1,1) | Intruding right front door panel |

Source of injury data – Post-emergency room records and medical examiner record

***Front Right Occupant Kinematics***

The 9-year-old female occupant was seating in a presumed upright posture and was restrained by the manual 3-point lap and shoulder safety belt. At impact with the Honda, she initiated a lateral right trajectory toward the front right door panel. She contacted and loaded the intruding front right door which resulted in the comminuted fracture of the right pelvis, comminuted fracture of the right inferior pubic ramus, right femur neck fracture, lower abdomen contusion, left shin contusion, left knee abrasion, right knee abrasion, and the right hand contusion. The passenger's head flexed laterally right over the shoulder belt portion of the belt system as her torso remained restrained by the safety belt. This motion resulted in the high C2-C3 fracture. It was presumed that her head had minimal contact with the HPS. Her head moved laterally under the protection offered by the HPS. The passenger's neck contacted the shoulder belt during the flexion, which caused the right side neck abrasion. Her abdomen loaded the lap belt, which resulted in the lower abdomen abrasion, and her left arm contacted the center console that resulted in an inner left elbow abrasion. Additionally, her left leg was displaced laterally right, which allowed her left knee to contact her inner right thigh resulting in the right inner thigh contusion. As her left leg was displaced to the right it contacted and loaded the floor and as result sustained a contusion to the top of her left foot and a left ankle abrasion. As the passenger rebounded back into the front right seat her left calf contacted the seat cushion thus resulting in the left calf abrasion. She also sustained a left clavicle fracture from probable contact by the driver as the she moved laterally in response to the 2 o'clock impact force.

***Front Right Occupant Medical Treatment***

The 9-year-old female front right occupant sustained fatal injuries and was transported to a local trauma center where she pronounced deceased approximately 1 hour post-crash. It was noted in the medical report that extrication efforts to remove the front right occupant took approximately 23 minutes; she had no pulse during extrication.

* Although not medically diagnosed the front right occupant probably sustained a spinal cord injury that contributed to her death. ** This injury was not coded in the NASS Electronic Data System (EDS).

***Rear Left Occupant***

| | |
|---|---|
| Age/Sex: | 5-year-old male |
| Height: | Unknown |
| Weight: | 18.0 kg (40.0 lbs) |
| Seat Track Position: | Not adjustable |
| Manual Restraint Use: | Manual 3-point lap and shoulder belt |
| Usage Source: | Vehicle inspection |
| Eyewear: | None |
| Type of Medical Treatment: | Transported to a local trauma center where he was treated and released. |

***Rear Left Occupant Injuries***

| Injury | Injury Severity (AIS 90/Update 98) | Injury Mechanism |
|---|---|---|
| Abdomen contusion, NFS | Minor (590402.1,7) | Safety belt |

Source of injury data – Driver

***Rear Left Occupant Kinematics***

The 5-year-old male was seated in the rear left position in a presumed upright posture and was restrained by the manual 3-point safety belt. At impact with the Honda, he initiated a lateral right trajectory and loaded the safety belt system. As a result of the loading, he sustained a contusion to his abdomen. The 5-year-old male was not transported to a hospital for treatment.

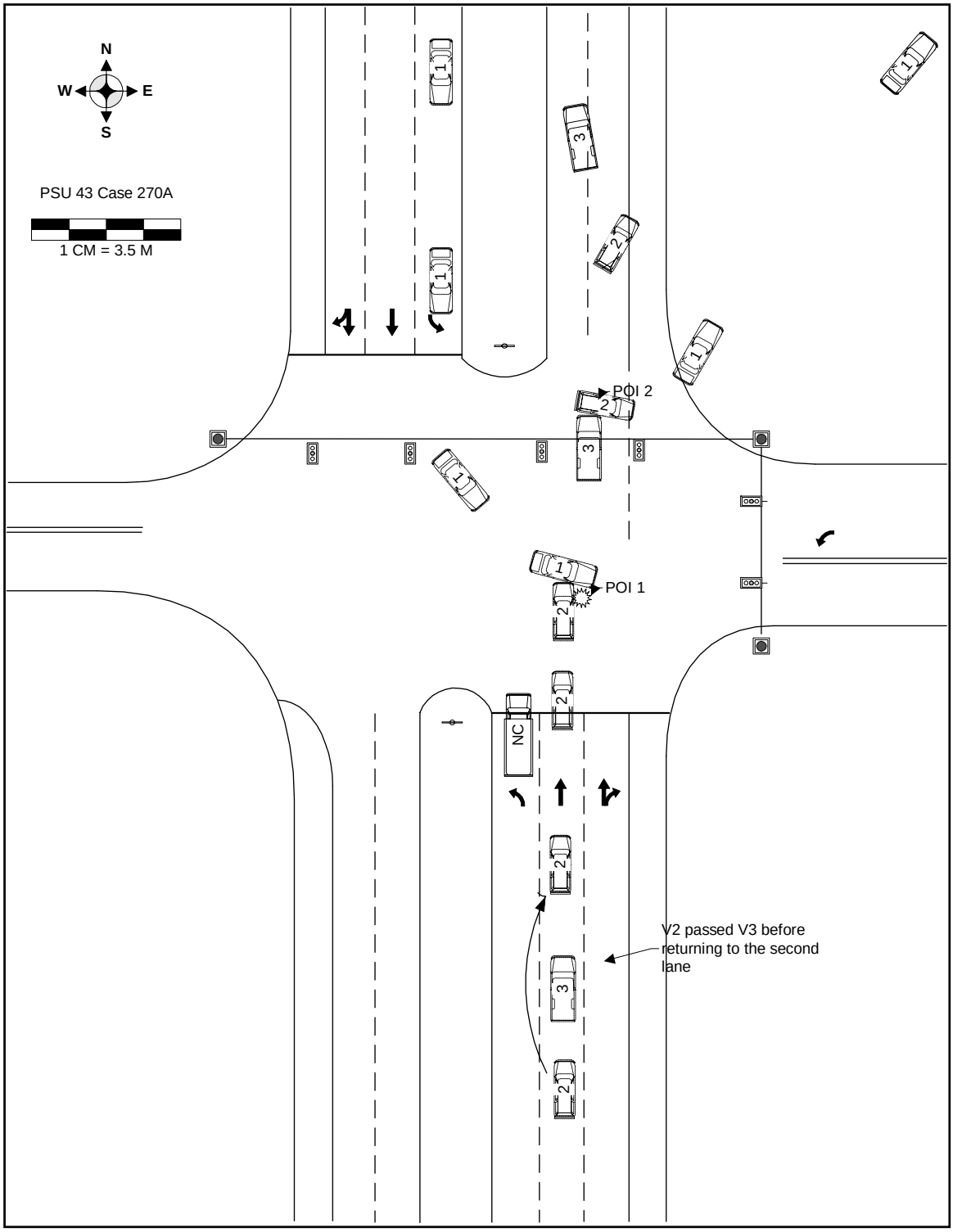


***Figure 11. NASS Scene Schematic***