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# SCI/NASS COMBINATION CASE REPORT

CASE NUMBER - NASS-2001-73-041B
LOCATION - Indiana
VEHICLE - 1994 GMC SAFARI
CRASH DATE - March 2001

Submitted:

September 9, 2002

Revised:
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Contract Number: DTNH22-94-D-17058

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
National Center for Statistics and Analysis
Washington, D.C. 20590-0003

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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.

**Technical Report Documentation Page**

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SCI/NASS combination child safety seat investigation involving a 1994 GMC Safari XT, three-door minivan, with manual three-point safety belts and a driver-only air bag, and a 1988 White GMC Volvo truck tractor with one semi-trailer

16. *Abstract*
This report covers a SCI/NASS combination investigation of a fatal crash that involved a 1994 GMC Safari XT minivan van (case vehicle) and a 1988 White/GMC Volvo truck-tractor with one semi-trailer. This crash is of special interest because the case vehicle's second seated left and second seated right passengers (4-year-old female and 2-year-old male, respectively), who were restrained in forward facing child safety seats, sustained only minor injuries. The case vehicle was traveling south in the outside southbound lane of a two-lane roadway that was part of a four-lane, divided Interstate trafficway and intended to continue southward. The tractor-trailer combination had been traveling south on the same roadway, ahead of the case vehicle, and the driver lost control on the snow covered, icy roadway. The rig rotated counterclockwise and came to rest perpendicular to the roadway, blocking both travel lanes and both shoulders, with the tractor in the median. The case vehicle's driver braked, attempting to avoid the crash. The crash occurred in the outside through lane of the southbound roadway. The front of the case vehicle impacted and underrode the left side of the semi-trailer, resulting in massive crush and intrusion into the case vehicle's front seat row. Because of the severe underride, the case vehicle's driver-only air bag did not deploy. The case vehicle's driver (37-year-old male) and front right passenger (36-year-old female) were both restrained by their available, active, three-point, lap-and-shoulder safety belt systems. They were both killed instantly. The two children in the second seat row were both seated in an upright posture, with their backs against the back of their Forward Facing Child Safety Seats, their feet hanging down over the front edge of the seat's cushion. They both sustained minor injuries and were treated and released.

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Additional photographs are available in the coded NASS case

## BACKGROUND

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This on-site combination was first brought to the NHTSA's attention on March 21, 2001 from a newspaper article. The case was later selected for inclusion in the NASS/CDS sample via normal PSU case selection activities. This crash involved a 1994 GMC Safari minivan (case vehicle) and a 1988 White GMC Volvo truck-tractor with one semi-trailer (other vehicle). The crash occurred in March 2001, at 4:18 a.m., in Indiana and was investigated by the applicable state police department. This crash is of special interest because the case vehicle's second seated left and right passengers (4-year-old female and 2-year-old male, respectively), who were restrained in forward facing child safety seats, sustained only minor injuries. The case vehicle's driver and front right passenger (i.e., parents) were pronounced dead at the scene of the crash. This contractor contacted the investigating police agency on March 21, 2001 and inspected the scene and vehicles on March 22, 2001. The investigating officer and an eyewitness were interviewed on March 27, 2001. This summary is based on the Police Crash Report, interviews with the investigating police officer and an eyewitness, scene and vehicle inspections, occupant kinematic principles, occupant medical records, and this contractor's evaluation of the evidence.

## SUMMARY

The case vehicle was traveling south in the outside southbound lane of a two-lane roadway that was part of a four-lane, divided Interstate trafficway and intended to continue southward. The tractor-trailer combination had been traveling south on the same roadway, ahead of the case vehicle. The tractor-trailer's driver braked due to a braking noncontact vehicle further south and lost control on the snow covered, icy roadway. The rig rotated counterclockwise and came to rest perpendicular to the roadway, blocking both travel lanes and both shoulders with the tractor in the median. The case vehicle's driver braked, attempting to avoid the crash. Based on statements by an eye witness and on-scene firefighters, because of the snow covered roadway, the color of the trailer, and possibly driver fatigue, the case vehicle's driver most likely didn't see the trailer and didn't apply his brakes until immediately prior to impact. The crash occurred in the outside through lane of the southbound roadway.

The front of the case vehicle impacted the left side of the semi-trailer in a perpendicular configuration and underrode it. Because of the severe underride, the case vehicle's driver only air bag did not deploy. The case vehicle came to rest heading south, with the tractor-trailer heading east.

The case vehicle was an all wheel drive 1994 GMC Safari XT, eight-passenger, three-door minivan (VIN: 1GKEL19W8RB------). The case vehicle was equipped with four-wheel anti-lock brakes and was towed due to damage.

Based on the vehicle inspection, the CDC for the case vehicle was determined to be: **12-FDHW-9 (360)**. No reconstruction program was used on this crash because the struck vehicle was out-of-scope. The crash was severe for the case vehicle.

The case vehicle's initial contact with the side of the semi-trailer involved the entire front end above the grille, starting at the leading edge of the hood. The direct damage width was 179 centimeters [70.5 inches]. The severe underride damage extended from the front edge of the hood rearward through the windshield and A-pillars to the B-pillars. Maximum crush was measured as 224 centimeters [88.2 inches]. The case vehicle's front overhang, wheelbase, and rear overhang remained unchanged. The case vehicle's hood, windshield, left and right A-pillars, left and right front window glazing, left and right second row window glazing, left and right front doors, roof, and instrument panel were directly damaged and crushed rearward. None of the case vehicle's tires were physically restricted nor deflated from the crash. There was integrity loss through the windshield, both front door windows, both second row seating area windows, and both front doors. The integrity loss to both front doors was from failures of both A-pillars which were separated from the front fenders. Several photographs documenting the rivet holes in both front fenders, where both front door structures were pulled/torn rearwards, are presented.

The case vehicle was equipped with a driver (only) air bag which was located in the steering wheel hub. The case vehicle's driver air bag did not deploy. An inspection of the case vehicle's interior failed to reveal any obvious visible evidence of occupant contact on the interior surfaces of the case vehicle.

Both of the child safety seats used by the case vehicle's second seated left and right passengers were forward facing-only child safety seats (FFCSS) manufactured by Graco Children's Products on February 15, 2001, identified by Model number 8480HG and model name "Cherished CarGo". Each seat was equipped with a five-point harness with three different sets of slots to adjust the height of the shoulder straps. In addition, each seat was designed with two different slots for the buckle, on the seating portion (i.e., between the toddler's legs). Each seat was equipped with an optional tether, which was not in use for either seat. The two seats had been purchased at the same time, approximately one week prior to the crash.

Only the left-seated 4-year-old female's FFCSS was available to be inspected, because she got out of the seat when she was removed from the case vehicle and the seat stayed in the minivan. (The right-seated 2-year-old male was removed from the case vehicle and was transported to the hospital in his FFCSS, which was discarded by the hospital). The 4-year-old's seat showed no wear and tear to the padding or shell because it was so new. There were, however, numerous areas of crash-induced stress evidence on the plastic shell of the FFCSS. The primary areas of stress were at both of the side openings used for the seat belt path. The right side opening also showed a squared indentation/stress mark from the corner of the case vehicle's safety belt buckle assembly. The buckle also showed corresponding stress evidence. The other stress areas were towards the base of the FFCSS near the front right. This most likely occurred when this portion of the FFCSS was being compressed against the seat cushion as it was lifted/tilted forward at maximum engagement.

The other vehicle was a 1988 White GMC Volvo 6x4 cab-behind-engine (conventional) truck-tractor (VIN: 4V1WDBJH7JN------), hauling a Great Dane 16.2 meter [53 feet], two-axle semi-trailer (VIN: 1GRAA062XXB------). There was no cargo in the trailer at the time of the crash. Inspection of the trailer revealed damage to the left side and undercarriage from the impact

with the case vehicle. The tractor also had damage on the front bumper, front axle and fuel tanks from striking and running over the median guardrail. The tractor and semi-trailer were both towed due to damage.

Immediately prior to the crash the case vehicle's second seated left passenger (4-year-old female, white, non-Hispanic, 99 centimeters, 16 kilograms [39 inches, 35 pounds]) was probably seated in an upright posture with her back against the back of her FFCSS, her feet hanging down over the front edge of the seat's cushion, and both hands on her lap. Her seat track and seat back were not adjustable.

The case vehicle's second seated left passenger was restrained in her FFCSS which was secured by her available, active, continuous loop, three-point, lap-and-shoulder, safety belt system with locking latch plate. The inspection of her FFCSS and the seat belt webbing, D-ring, and latch plate showed significant evidence of loading, with evidence of stress at several areas on the plastic shell of the FFCSS.

The case vehicle's driver braked at the last second. As a result of this attempted avoidance maneuver along with the use of the FFCSS, the second seated left passenger most likely moved slightly forward against her safety harness just prior to impact. The case vehicle's impact with the semi-trailer caused the second seated left passenger to continue forward and slightly upward as the case vehicle decelerated. According to an eye witness, at final rest the second seated left passenger was in the upright position, still secured in her forward facing child safety seat.

The FFCSS has an upper height recommendation of 102 centimeters [40 inches] and the harness straps were in the middle set of slots for this child who was 99 centimeters [39 inches]. The harness straps were likely below the shoulder area which may have allowed the child to "ramp up" to some degree, contributing to the injuries on her back/lower back area.

The case vehicle's 4-year-old, second seated left passenger was transported by ambulance to a hospital. She sustained minor injuries and was treated and released. According to her medical records, she sustained minor contusions on her chin, her posterior thorax (i.e., upper to middle back), and on her shins, bilaterally.

Immediately prior to the crash the case vehicle's 2-year-old, second seated right passenger (2-year-old male, white, non-Hispanic, 93 centimeters, 15 kilograms [37 inches, 33 pounds]) was probably seated in an upright posture with his back against the back of his FFCSS, his feet hanging down over the front edge of the seat's cushion, and both hands on his lap. His seat track and seat back were not adjustable.

The case vehicle's second seated right passenger was restrained by his FFCSS which was secured by his available, active, continuos loop, three-point, lap-and-shoulder, safety belt system with locking latch plate. In addition, the inspection of the second seated right passenger's seat belt webbing, D-ring, and latch plate showed definite evidence of loading.

According to the eyewitness, this occupant's FFCSS had tipped over onto its right side.

This observation suggests that the FFCSS was improperly installed by not having the seat belt with locking latch plate cinched down tight enough. The FFCSS was subsequently disposed of by hospital personnel prior to this investigator's on-site investigation. According to the eyewitness, the FFCSS showed visible evidence of stress from the crash.

According to the eyewitness, the case vehicle's driver braked at the last second. As a result of this attempted avoidance maneuver along with the use of the forward facing child safety seat, the second seated right passenger most likely moved slightly forward against his safety harness just prior to impact. The case vehicle's impact with the semi-trailer caused the second seated right passenger to continue forward and slightly upward as the case vehicle decelerated. According to the eyewitness, at final rest the child was still secured in his forward facing child safety seat but the seat had tipped over onto its right side and the child was crying because he was afraid of falling out.

The case vehicle's second seated right passenger was transported by ambulance to a hospital. He sustained minor injuries and was treated and released. According to his medical records, he sustained minor periorbital abrasions and an abrasion just below his lower lip.

The exact posture of the case vehicle's driver (37-year-old male, white, non-Hispanic, 170 centimeters, 84 kilograms [67 inches, 185 pounds]) just prior to the crash is unknown, but he was probably seated in an upright posture with his back against the seat back, his left foot on the floor, his right foot on the brake, and both hands on the steering wheel. His seat track was located in its rearmost position with his seat back sightly reclined. The severe underride resulted in the driver's seat back being bent rearward to an angle of approximately 40 degrees above horizontal. He was pinned in his seat by the intruding steering assembly and the steering column was cut by rescue personnel in order to get his body out of the vehicle. The position of his tilt steering wheel is unknown. The driver-only air bag did not deploy.

The case vehicle's driver was restrained by his available, active, three-point, lap-and-shoulder, safety belt system. He sustained fatal injuries, was pronounced dead at the scene and was transported by ambulance to the county morgue. Based on the autopsy report, the case vehicle driver's injuries included: fracture of cervical vertebrae C5 and C6; compression of the chest with chest wall contusion hemorrhage; bilateral lung contusions; fracture of left ribs 5 and 6; laceration of the liver; and numerous contusions and abrasions over his entire body.

The exact posture of case vehicle's front right passenger (36-year-old female, white, non-Hispanic, pregnant in the second trimester,165 centimeters, 58 kilograms [65 inches, 128 pounds]) is unknown, but she was probably seated in a reclined posture with her back against the seat back, her feet on the floor, and both her hands on her lap. Her seat track was located in its rearmost position and the seat back was reclined. The severe underride impact resulted in the front right passenger's seat back being bent rearward to an angle of approximately 30 degrees above horizontal.

The case vehicle's front right passenger was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. She sustained fatal injuries, was pronounced dead at the

scene and was transported by ambulance to the county morgue. Based on the autopsy report, the case vehicle's front right passenger's injuries included: fracture and dislocation of the cervical spine at C1; acute subdural hemorrhage; compression of the chest with chest wall contusion hemorrhage; bilateral lung contusions; numerous contusions and abrasions over her entire body.

## CRASH CIRCUMSTANCES

The case vehicle was traveling south in the outside southbound lane of a two-lane roadway that was part of a four-lane, divided, Interstate trafficway and intended to continue southward. The tractor-trailer combination was traveling south in the outside lane of the same southbound roadway. The tractor-trailer's driver braked due to a braking noncontact vehicle further south and, as a result, lost control on the snow covered, icy roadway. The rig rotated couterclockwise and the truck-tractor climbed onto and partially over the guardrail along the east shoulder (**Figure 1**) while the semi-trailer swung across both southbound lanes (**Figure 2**). The case vehicle's driver braked, attempting to avoid the crash. Based on statements by an eye witness and on-scene firefighters, because of the snow covered roadway, the color of the trailer, and possibly driver fatigue, the case vehicle's driver most likely didn't see the trailer and didn't apply his brakes until immediately prior to impact. The crash occurred in the outside through lane of the southbound roadway.

**Figure 1:** Southeast view of southbound roadway and median guardrail damaged by tractor-trailer

**Figure 2:** On-scene long view of case vehicle and tractor-trailer at final rest positions; Note: snow packed roadway conditions

The southbound roadway was straight with a $<2\%$ negative slope at the area of impact. The pavement was bituminous, and the width of the outside southbound lane was 3.2 meters [10.7 feet]. The width of the inside southbound lane was 3.4 meters [11.3 feet]. The outside southbound lane was bordered on the west side by a painted solid white line which was adjacent to the 3.2 meter [10.5 feet] wide paved shoulder with a rumble strip immediately adjacent to a W-beam guardrail. The inside southbound lane was bordered on the east side by a painted solid yellow line which was adjacent to the 2.1 meter [7 feet] wide paved shoulder and a W-beam guardrail. Pavement markings consisted of a painted broken white line separating the two southbound travel lanes. The estimated coefficient of friction was 0.45. There were no traffic controls in the area of impact. The legal speed limit was 105 km.p.h. [65 m.p.h.] for vehicles with a gross weight of less than 11,794 kilograms [26,000 pounds] and 97 km.p.h. [60 m.p.h.] for vehicles in excess of 11,794 kilograms [26,000 pounds].

At the time of the crash the light condition was darkness without street lights, the atmospheric condition was cold and snowing, and the roadway pavement was snow covered and icy. Traffic density was light to moderate and the site of the crash was rural.

The front (primarily greenhouse) of the case vehicle impacted, in a perpendicular orientation, the left side of the semi-trailer and underrode it (**Figures 3** and **4**). Because of the severe underride, the case vehicle's driver air bag did not deploy. The case vehicle came to rest heading south while the tractor-trailer was heading east.

**Figure 3:** On-scene view of case vehicle at final rest lodged underneath semi-trailer's left side

**Figure 4:** On-scene view of case vehicle's final rest position lodged under semi-trailer's left side

## CASE VEHICLE

The case vehicle was an all wheel drive 1994 GMC Safari XT, three-door mini-van (VIN: 1GKEL19W8RB------) equipped with a 4.3 liter V6 engine and an automatic transmission with a column-mounted selector lever. Braking was achieved by a power-assisted hydraulic, front disc and rear drum four-wheel anti-lock system. The wheelbase was 282 centimeters [111 inches]. The recorded mileage is unknown due to damage.

The interior of the case vehicle was equipped with a four-way power adjustable driver bucket seat and manually adjustable front right passenger bucket seat with adjustable head restraints, three-point lap-and-shoulder belts in the six outboard seated positions, and lap belts in the second and third center seat positions. The second and third rows had bench seats with no head restraints. The front safety belt systems were equipped with manually operated height adjusters for the D-rings. There was an air bag for the driver position only.


**Figure 5** Front overhead view of deformation to case vehicle's greenhouse area; Note: no direct damage to bumper or grill

The case vehicle's contact with the side of the semi-trailer involved the entire front end above the bumper, starting at the leading edge of the hood (**Figure 5**). The direct damage width was 179 centimeters [70.5 inches]. The severe underride damage extended from the front edge of the hood rearward through the windshield and A-pillar to the B-pillar (**Figure 6**). Maximum crush was 224 centimeters [88.2 inches]. The case vehicle's front overhang, wheelbase, and rear overhang remained unchanged. The case vehicle's hood, windshield, left and right A-pillars, left and right front window glazing, left and right second seating area window glazing, left and right front doors, and roof were crushed rearward. None of the case vehicle's tires were physically restricted and/or deflated from the crash. There was integrity loss through the windshield, both front door windows, both second seating area windows, and both front doors. The integrity loss to both front doors was from failures of both A-pillars which were separated from the front fenders. Both front door structures were pulled/torn rearwards, with rivets torn out (**Figures 7** and **8**).

**Figure 6**: Case vehicle's greenhouse area; Note: A-pillar failure and top of dash torn away

**Figure 7:** Additional view of case vehicle's left A-pillar failure and integrity loss; Note: rivet holes (highlighted) in sheet metal

Based on the vehicle inspection, the CDC for the case vehicle was determined to be: **12-FDHW-9 (360)**. No reconstruction program was used on this crash because the struck vehicle was out-of-scope. The crash was severe for the case vehicle.

Inspection of the case vehicle's interior failed to reveal any obvious visible evidence of occupant contact on the interior surfaces of the case vehicle. The roof certainly contacted the driver and front right passenger as it folded inward but there was no obvious visible evidence.

**Figure 8:** Right A-pillar pushed rearward against right B-pillar; Note: rivet holes (highlighted) in sheet metal

## AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with a driver (only) air bag which was located in the steering wheel hub. The case vehicle's driver air bag did not deploy.

Both of the child safety seats used by the case vehicle's second row left and right passengers were forward facing-only child safety seats (FFCSS) manufactured by Graco Children's Products on February 15, 2001, identified by model number 8480HG and model name "Cherished CarGo". Each seat was equipped with a five-point harness with three different sets of slots to adjust the height of the shoulder straps. In addition, each seat was designed with two different slots for the buckle, on the seat portion (i.e., between the toddler's legs). Each seat was equipped with an optional tether, which was not in use for either seat. The two seats had been purchased at the same time, approximately one week prior to the crash.

Only the left-seated 4-year-old female's FFCSS was available to be inspected, because she got out of the seat when she was removed from the case vehicle and the seated stayed in the minivan (**Figures 9** and **10**). (The right-seated 2-year-old male was removed from the case vehicle and was transported to the hospital in his FFCSS, which was discarded by the hospital.)


**Figure 9:** Front of Graco FFCSS used by case vehicle's second seated left passenger

**Figure 10:** Back of Graco FFCSS used by case vehicle's second seated left passenger; Note: stress (highlighted) marks

The 4-year-old's FFCSS showed no wear and tear on the padding or shell because it was so new. There were numerous areas of stress evidence on the plastic shell of the FFCSS. The primary areas of stress were to both of the side openings used for the seat belt path (**Figure 11**). The right side belt opening also showed a squared indentation/stress mark from the corner of the seat belt tongue. The seat belt tongue also showed corresponding stress evidence. The other stress areas were toward the base of the FFCSS near the front right. This most likely occurred when this portion was being compressed against the seat cushion as the FFCSS lifted/tilted forward at maximum engagement.

## CASE VEHICLE DRIVER KINEMATICS

The case vehicle driver (37-year-old male, white, non-Hispanic, 170 centimeters and 84 kilograms [67 inches, 185 pounds]) was restrained by his available, active, three-point, lap-and-shoulder, safety belt system. The inspection of the driver's seat belt webbing, D-ring, and latch plate showed definite evidence of loading. The seat belt webbing was subsequently cut during the extrication process.

The driver's exact posture just prior to the crash is unknown, but he was probably seated in an upright posture with his back against the seat back, his left foot on the floor, his right foot on the brake, and both hands on the steering wheel. His seat track was located in its rearmost position with his seat back sightly reclined. The severe underride resulted in the driver's seat back being bent rearward to an angle approximately 40 degrees above horizontal. The position of his tilt steering wheel is unknown because the steering wheel was cut off to extricate the driver.

The driver braked at the last second. As a result of this attempted avoidance maneuver along with the use of his safety belt, he most likely moved slightly forward against his seat belt webbing as it locked-up just prior to impact. The case vehicle's impact with the semi-trailer resulted in the driver continuing forward and slightly upward as the case vehicle decelerated, subsequently loading his seat belt. Based on police on-scene photographs, at final rest the driver was in a slightly reclined position from the intrusion folding the roof into his upper torso, bending the seat back further rearward.

## CASE VEHICLE DRIVER INJURIES

The driver sustained fatal injuries and was pronounced dead at the scene. His body was transported by ambulance to the county morgue, where a complete autopsy was performed.

| Injury Number | Injury Description (including Aspect) | NASS Injury Code & AIS 90 | Injury Source (Mechanism) | Source Confidence | Source of Injury Data |
|---|---|---|---|---|---|
| 1. | Contusions, lungs, bilateral | 441410.4 severe | Belt restraint webbing | Probable | Autopsy |
| 2. | Fractures, left 5th and 6th ribs | 450220.2 moderate | Belt restraint webbing | Probable | Autopsy |

| Injury Number | Injury Description (including Aspect) | NASS Injury Code & AIS 90 | Injury Source (Mechanism) | Source Confidence | Source of Injury Data |
|---|---|---|---|---|---|
| 3. | Fracture, cervical vertebrae C5-C6, NFS | 650230.2 moderate | Front header | Probable | Autopsy |
| 4. | Laceration, liver, capsular surface and right lobe | 541822.2 moderate | Belt restraint webbing | Probable | Autopsy |
| 5. | Contusion, scalp, over the right temporal area | 190402.1 minor | Front header | Probable | Autopsy |
| 6. | Laceration, right forehead near the eyebrow | 290602.1 minor | Front header | Probable | Autopsy |
| 7. | Multiple abrasions, forehead, right cheek, nose, upper lip, chin | 290202.1 minor | Front header | Probable | Autopsy |
| 8. | Lacerations, right side of neck | 390202.1 minor | Front header | Probable | Autopsy |
| 9. | Abrasions, right side of neck | 390602.1 minor | Front header | Probable | Autopsy |
| 10. | Abrasions, right shoulder | 790202.1 minor | Front header | Probable | Autopsy |
| 11. | Abrasions, left upper arm | 790202.1 minor | Noncontact: flying glass | Probable | Autopsy |
| 12. | Laceration, left upper arm | 790602.1 minor | Noncontact: flying glass | Probable | Autopsy |
| 13. | Contusion, right thigh | 890402.1 minor | Steering wheel rim | Probable | Autopsy |
| 14. | Abrasion, left thigh | 890202.1 minor | Left instrument panel | Probable | Autopsy |

## CASE VEHICLE FRONT RIGHT PASSENGER KINEMATICS

The case vehicle front right passenger (36-year-old female, white, non-Hispanic, pregnant in the second trimester, 165 centimeters, 58 kilograms [65 inches, 128 pounds]) was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. The inspection of the front right passenger's seat belt webbing, D-ring, and latch plate showed definite evidence of loading. The seat belt webbing was subsequently cut during the extrication process.

The exact posture of case vehicle front right passenger is unknown, but she was probably seated in a reclined posture with her back against the seat back, her feet on the floor, and both her hands on her lap. Her seat track was located in its rearmost position and the seat back was reclined. The severe underride impact resulted in the front right passenger's seat back being bent rearward to an angle approximately 30 degrees above horizontal.

The case vehicle's driver braked at the last second. As a result of this attempted avoidance maneuver along with the use of her safety belt, the front right passenger most likely moved slightly forward against her seat belt webbing as it locked-up just prior to impact. The case vehicle's impact with the semi-trailer resulted in the front right passenger continuing forward and slightly upward as the case vehicle decelerated, loading her seat belt. Based on police on-scene photographs, at final rest the front right passenger was in a slightly reclined position from the intrusion folding the roof into her upper torso, bending the seat back further rearward.

## CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

The front right passenger sustained fatal injuries and was pronounced dead at the scene. Her body was transported by ambulance to the county morgue, where a complete autopsy was performed.

## CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

| Injury Number | Injury Description (including Aspect) | NASS Injury Code & AIS 90 | Injury Source (Mechanism) | Source Confidence | Source of Injury Data |
|---|---|---|---|---|---|
| 1. | Subdural hemorrhage over the left convexity of the brain | 140650.4 severe | Front header | Probable | Autopsy |
| 2. | Contusions, lungs, bilateral | 441410.4 severe | Belt restraint webbing | Probable | Autopsy |
| 3. | Fracture with dislocation, cervical vertebra C1 | 650230.2 moderate | Front header | Probable | Autopsy |
| 4. | Focal hemorrhage in the scalp and galea, right side of head | 190402.1 minor | Front header | Probable | Autopsy |
| 5. | Abrasion, right forehead and eyebrow area | 290202.1 minor | Front header | Probable | Autopsy |
| 6. | Abrasions, right side of face and chin | 290202.1 minor | Front header | Probable | Autopsy |
| 7. | Abrasion, right side of neck | 390202.1 minor | Belt restraint webbing | Probable | Autopsy |
| 8. | Multiple small abrasions, right arm | 790202.1 minor | Noncontact: flying glass | Probable | Autopsy |
| 9. | Contusion, left hand | 790402.1 minor | Right instrument panel | Probable | Autopsy |
| 10. | Abrasions, knees bilateral and left leg | 890202.1 minor | Right instrument panel | Probable | Autopsy |
| 11. | Contusion, right ankle | 890402.1 minor | Floor | Probable | Autopsy |
| 12. | Laceration, right lower leg (9 x 3 centimeters [3.5 x 1 inches]) | 890602.1 minor | Right instrument panel | Probable | Autopsy |

The case vehicle second seated left passenger (4-year-old female, white, non-Hispanic, 99 centimeters, 16 kilograms [39 inches, 35 pounds]) was restrained in her forward facing child safety seat (FFCSS) which was secured by her available, active, continuous loop, three-point, lap-and-shoulder, safety belt system with locking latch plate. The inspection of the her FFCSS and the seat belt webbing, D-ring, and latch plate showed significant evidence of loading, and there were several areas of stress on the plastic shell of the FFCSS (**Figure 12**).

Immediately prior to the crash the case vehicle second seated left passenger was probably seated in an upright posture with her back against the back of her FFCSS, her feet hanging down over the front edge of the seat's cushion, and both hands on her lap. Her seat track and seat back were not adjustable.

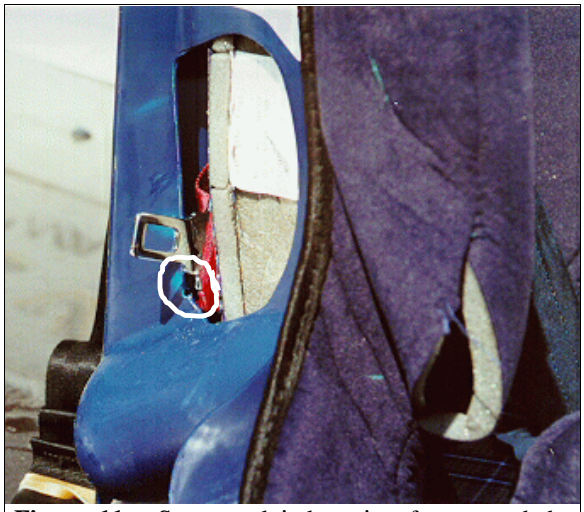


**Figure 11:** Stress and indentation from seat belt buckle on plastic shell of FFCSS used by case vehicle's second seated left passenger

The case vehicle's driver braked at the last second. As a result of this attempted avoidance maneuver along with the use of the forward facing child safety seat, the second seated left passenger most likely moved slightly forward against her safety harness just prior to impact. The case vehicle's impact with the semi-trailer enabled the second seated left passenger to continue forward and slightly upward as the case vehicle decelerated. According to an eye witness, at final rest the second seated left passenger was in the upright position, still secured in her forward facing child safety seat.

The FFCSS has an upper height recommendation of 101.6 centimeters [40 inches] and the harness straps were in the middle set of slots for this child who was 99 centimeters [39 inches]. The harness straps were likely below the shoulder area which may have allowed the child to "ramp up" to some degree contributing to the injuries to the back/lower back area.

**Figure 12:** On-scene view of case vehicle's second seated left passenger area showing FFCSS in post-crash position; Note: identical FFCSS in right position removed along with toddler to hospital

The case vehicle's 4-year-old, second seated left passenger was transported by ambulance to a hospital. She sustained minor injuries and was treated and released. She was subsequently seen by a private physician who confirmed the minor injuries.

| Injury Number | Injury Description (including Aspect) | NASS Injury Code & AIS 90 | Injury Source (Mechanism) | Source Confidence | Source of Injury Data |
|---|---|---|---|---|---|
| 1. | Small contusion, chin | 290402.1 minor | Child Safety Seat | Probable | Emergency Room |
| 2. | Contusion, posterior thorax | 690402.1 minor | Child Safety Seat | Probable | Emergency Room |
| 3. | Contusions, shins, bilateral[1] | 890402.1 minor | Front seat back | Probable | Private Physician |

**CASE VEHICLE BACK RIGHT PASSENGER KINEMATICS**

The case vehicle's second seated right passenger (2-year-old male, white, non-Hispanic, 93 centimeters, 15 kilograms [37 inches, 33 pounds]) was restrained by his FFCSS which was secured by his available, active, continuos loop, three-point, lap-and-shoulder, safety belt system with locking latch plate. The inspection of the second seated right passenger's seat belt webbing, D-ring, and latch plate showed definite evidence of loading.

Immediately prior to the crash the case vehicle second seated right passenger was probably seated in an upright posture with his back against the back of his FFCSS, his feet hanging down over the front edge of the seat's cushion, and both hands on his lap. His seat track and seat back were not adjustable.

According to the statement by the eye-witness, this occupant's FFCSS had tipped over onto its right side. This statement suggests that the FFCSS was improperly installed by not having the seat belt with locking latch plate cinched down tight enough. The FFCSS was subsequently disposed of by hospital personnel prior to this investigator's on-site investigation. According to the eye-witness (who cared for the second seated right passenger until the EMTs arrived), the FFCSS showed visible evidence of stress from the crash.

The case vehicle's driver braked at the last second. As a result of this attempted avoidance maneuver along with the use of the forward facing child safety seat, the second seated right passenger most likely moved slightly forward against his safety harness just prior to impact. The case vehicle's impact with the semi-trailer enabled the second seated right passenger to continue forward and slightly upward as the case vehicle decelerated. According to the eye-witness, at final

[1]These two injuries are not included in the coded NASS case.

rest the child was still secured in his forward facing child safety seat but the seat had tipped over onto its right side and the child was crying because he was afraid of falling out.

## CASE VEHICLE BACK RIGHT PASSENGER INJURIES

The case vehicle's 2-year-old, second seated right passenger was transported by ambulance to the hospital. He sustained minor injuries and was treated and released. He was subsequently seen by a private physician who confirmed the minor injuries.

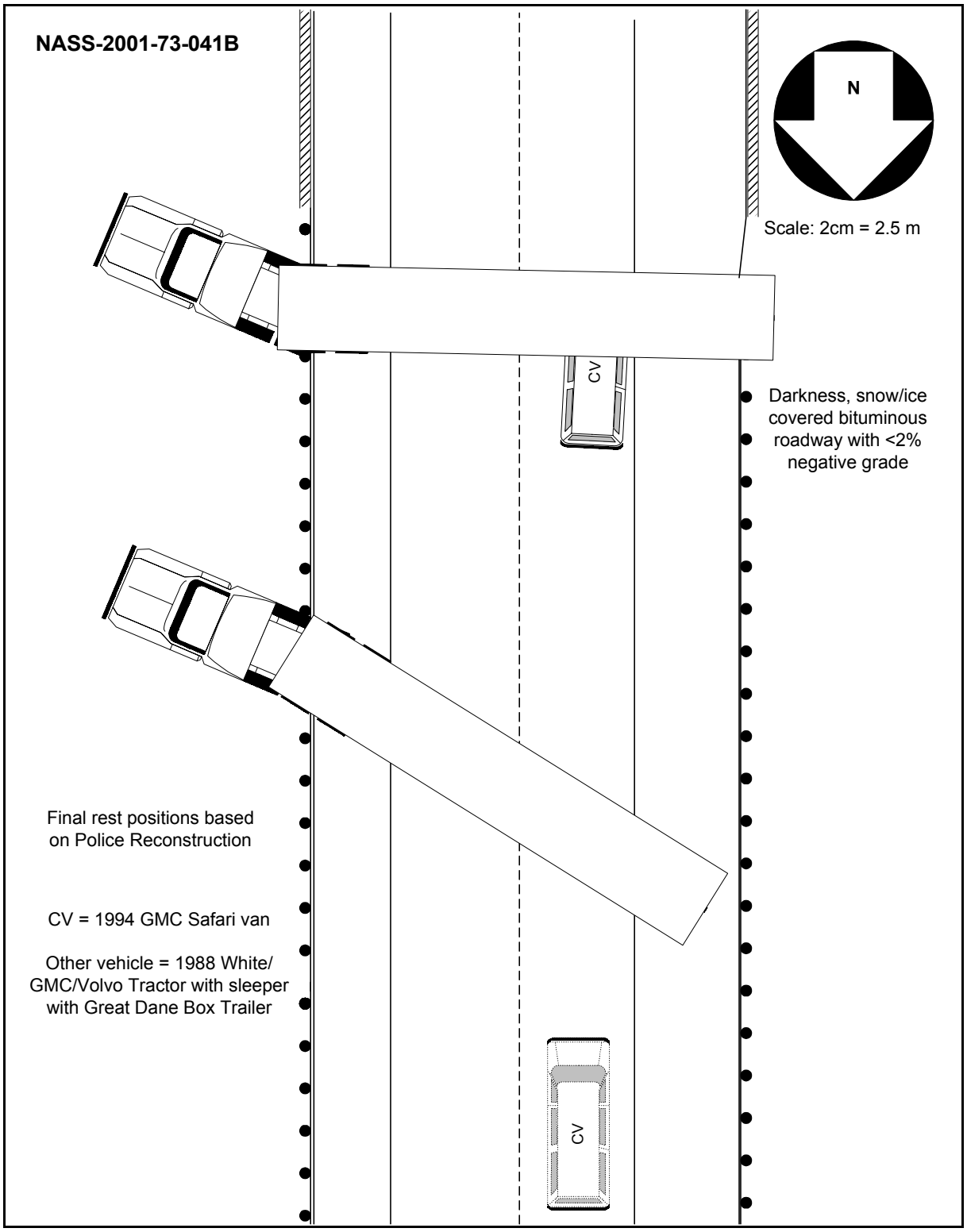
| Injury Number | Injury Description (including Aspect) | NASS Injury Code & AIS 90 | Injury Source (Mechanism) | Source Confidence | Source of Injury Data |
|---|---|---|---|---|---|
| 1. | Small abrasion just below lower lip | 290202.1 minor | Noncontact: flying glass | Probable | Emergency Room |
| 2. | Small abrasions, right periorbital area | 297202.1 minor | Noncontact: flying glass | Probable | Emergency Room |
| 3. | Small abrasions, left periorbital area | 297202.1 minor | Noncontact: flying glass | Probable | Emergency Room |

## OTHER VEHICLE

The other vehicle was a 1988 White GMC Volvo 6x4 truck-tractor (VIN: 4V1WDBJH7JN------), hauling a 16.1 meter [53 feet] in length, Great Dane trailer (VIN: 1GRAA062XXB------). Inspection of the Great Dane trailer revealed damage to the trailer's left side (**Figure 12**) and undercarriage from impact with the case vehicle. The White GMC tractor and the Great Dane trailer were both towed due to damage.

**Figure 13:** Tractor, front bumper damage due to guardrail impact

**Figure 14:** Left side of trailer showing area of direct contact from case vehicle


NASS-2001-73-041B
N
Scale: 2cm = 2.5 m
CV
Darkness, snow/ice covered bituminous roadway with <2% negative grade
Final rest positions based on Police Reconstruction
CV = 1994 GMC Safari van
Other vehicle = 1988 White/ GMC/Volvo Tractor with sleeper with Great Dane Box Trailer
CV