TRANSPORTATION SCIENCES
Crash Data Research Center

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VERIDIAN ON-SITE AIR BAG RELATED/ADULT PASSENGER FATALITY INVESTIGATION

VERIDIAN CASE NO. CA97-007
VEHICLE: 1995 CHRYSLER NEW YORKER
LOCATION: PENNSYLVANIA
CRASH DATE: FEBRUARY 1997

Contract No.
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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 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.

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16. *Abstract* This on-site crash investigation focused on the injury mechanisms and cause of death of a 66 year old female front right passenger of a 1995 Chrysler New Yorker. The Chrysler was equipped with frontal air bags for the driver and right passenger positions that deployed as a result of a center frontal impact with a tree. The driver lost control of the vehicle on a slush covered roadway and initially sideswiped a W-beam guardrail with the left side of the New Yorker. The vehicle was redirected across the roadway initiating a clockwise yaw prior to departing the right road edge. The center frontal area of the New Yorker impacted a 30 cm (12") tree then rebounded back onto the travel lanes. The driver was not restrained by the manual belt system. He contacted the left roof side rail, steering wheel rim, knee bolster, and the deployed front left air bag. He sustained multiple soft tissue contusions and was transported to a local hospital where he was treated and released. The front right passenger was not restrained by the manual belt system. She was displaced forward into the path of the deploying front right air bag. The expanding air bag membrane abraded the anterior aspect of her neck and hyper-extended the head resulting in a cervical fracture with transection of the spinal cord. She expired immediately from the injury and was pronounced dead at the scene.			
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BACKGROUND

This on-site crash investigation focused on the injury mechanisms and cause of death of a 66 year old female front right passenger of a 1995 Chrysler New Yorker. The Chrysler was equipped with frontal air bags for the driver and right passenger positions that deployed as a result of a center frontal impact with a tree. The driver lost control of the vehicle on a slush covered roadway and initially sideswiped a W-beam guardrail with the left side of the New Yorker. The vehicle was redirected across the roadway initiating a clockwise yaw prior to departing the right road edge. The center frontal area of the New Yorker impacted a 30 cm (12") tree then rebounded back onto the travel lanes **(Figure 1)**. The driver was not restrained by the manual belt system. He contacted the left roof side rail, steering wheel rim, knee bolster, and the deployed front left air bag. He sustained multiple soft tissue contusions and was transported to a local hospital where he was treated and released. The front right passenger was not restrained by the manual belt system. She was displaced forward into the path of the deploying front right air bag. The expanding air bag membrane abraded the anterior aspect of her neck and hyper-extended the head resulting in a cervical fracture with transection of the spinal cord. She expired immediately from the injury and was pronounced dead at the scene.

Figure 1. Lookback view of the New Yorker's frontal air bag deployment crash.

The crash occurred in February 1997 during daylight hours. The crash was initially identified by a NHTSA Regional Office through a media search for air bag related crashes. The notification was forwarded to the Veridian Special Crash Investigation team and assigned as an on-site investigation on Thursday, February 20, 1997, at 1053 hours.

SUMMARY

Crash Site

The crash occurred on a rural two-lane state route **(Figure 2)** in February 1997, during daylight hours. The asphalt road surface was slush covered from mixed precipitation. In the vicinity of the crash scene, the roadway was straight with a one-percent positive grade to the east and a posted speed limit of 89 km/h (55 mph). The travel lanes were bordered by stone shoulders with a W-beam guardrail system paralleling the left (north) shoulder. The right shoulder was bordered by an embankment with a mixture of trees.

Figure 2. Overall view of the crash scene.

Subject Vehicle

The subject vehicle in this crash was a 1995 Chrysler New Yorker that was manufactured on 10/94 and identified by vehicle identification number (VIN): 2C3HC46F4SH. The odometer reading at the time of the inspection was 17,319 km (10,762 miles). In addition to the frontal driver and passenger side air bags, the Chrysler New Yorker was equipped with a 50/50 split bench front seat with separate back cushions, adjustable head restraints, a tilt steering column, power windows, power door locks, a six-way power driver's seat, and manual 3-point continuous loop lap and shoulder belt systems for the four outboard seated positions. The front seat belt systems had adjustable upper anchorages (D-rings).

Crash Sequence

Pre-Crash

The driver and his wife were en route to a delivery of flowers and were traveling in an easterly direction on the state route. The weather conditions were changeable from an accumulation of several inches of wet snow on the road surface to a mixture of freezing rain which produced a slushy surface. As the driver traveled on the poor road conditions at an estimated speed of 56-64 km/h (35-40 mph), the vehicle broke traction and drifted across the westbound travel lane. The vehicle crossed the 2.4 m (8.0') wide south stone shoulder in a near tracking orientation.

Crash

The front left corner area of the New Yorker impacted the W-beam guardrail resulting in minor damage to the vehicle. The 12 o'clock impact force redirected the vehicle in a clockwise (CW) direction which allowed the left rear area of the New Yorker to engage with the guardrail. The W-beam guardrail system consisted of a single rail with weak post I-beam supports spaced on 3.7 m (12.0') centers. The contact damage on the guardrail system was continuous with a maximum lateral displacement of 27.9 cm (11.0") to the corrugated beam **(Figure 3)**.

Figure 3. Deflection of the W-beam guardrail.

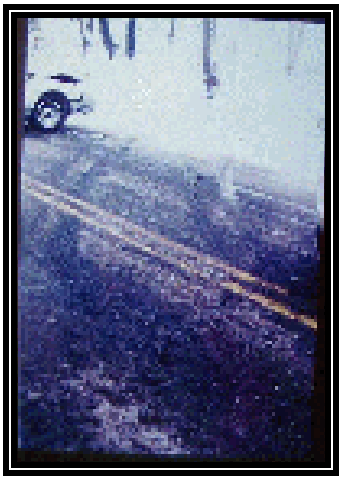

Figure 4. On-scene police photograph of the vehicle's CW yaw skid pattern.

The Chrysler separated from the guardrail and traversed the travel lanes of the roadway, initiating a slight CW yaw estimated at 8-10 degrees. This yaw pattern was evident by the vehicle's tire marks depicted in the on-scene police photographs **(Figure 4)**. The vehicle departed the right (north) stone shoulder and mounted the base of an earth embankment with the front tires. The center frontal area of the New Yorker impacted a 30.4 cm (12.0") diameter tree that was located 3.2 m (10.5') outboard of the north edge line. The damage and trajectory algorithm of the WinSMASH program computed an impact speed of 22.4 km/h (13.9 mph). The 12 o'clock direction of force impact crushed the frontal structure of the vehicle, inclusive of the energy absorbing bumper system, radiator support panel, and the hood. The vehicle underwent a velocity change of 16.7 km/h (10.4 mph) with a longitudinal component of -16.6 km/h (-10.3 mph) and a lateral component of 2.3 km/h (1.4 mph). As a result of the tree impact, the frontal air bag system deployed. The vehicle rotated approximately 40 degrees CW as it rebounded from the tree impact and came to rest straddling the eastbound travel lane perpendicular to the roadway.

Post-Crash

The driver remained in his seated position as the vehicle came to rest on the roadway. The front right passenger was displaced rearward and to the left coming to rest slumped in the center of the front seat, leaning against the driver. At rest, her legs were extended under the instrument panel with her back resting on the center seat cushion. The driver exited the vehicle through the left front door and waited for emergency personnel to arrive on-scene. The local police department arrived within minutes of the call with subsequent arrival of the emergency medical technicians (EMTs). The EMTs checked for vital signs on the passenger and determined she had expired. The County Coroner was called to the scene and the body was removed from the vehicle and transported to a local hospital for an autopsy.

Vehicle Damage

Exterior

The initial contact damage with the W-beam guardrail system involved the front left corner area of the Chrysler New Yorker. The direct contact damage began on the corner of the bumper fascia and extended 26.0 cm (10.25") inboard. The contact abraded the bumper fascia and displaced the corner area of the fascia with no residual crush to the bumper structure **(Figure 5)**. As the contact deflected the guardrail, the leading edge of the left front fender engaged against the rail. The contact displaced the left headlamp assembly, abraded the side aspect of the wrap-around bumper fascia, and fractured the composite left front fender. The damage extended 71.1 cm (28.0") longitudinally onto the left front fender and side aspect of the fascia.

Figure 5. Front left bumper damage from the initial guardrail impact.

The guardrail system redirected the vehicle in a clockwise (CW) direction as it separated from the barrier. Due to this CW deflection, the left rear quarter panel subsequently impacted the W-beam in a sideswipe configuration, resulting in an impact force within the 12 o'clock sector. The direct contact damage began on the left rear door (21.4") forward of the left rear axle and extended 108.6 cm (42.75") rearward onto the left quarter panel, terminating at the rear bumper corner **(Figure 6)**. A crush profile was documented for this impact and was as follows: C1 = 0.6 cm (0.25"), C2 = 3.2 cm (1.25"), C3 = 3.8 cm (1.5"), C4 = 1.0 cm (0.4"), C5 = 0.2 cm (0.1"), C6 = 0 cm.

Figure 6. Secondary guardrail impact damage to the left rear quarter panel.

The center frontal area of the Chrysler subsequently impacted a 30.5 cm (12.0") diameter tree resulting in a 12 o'clock direction of force. Maximum bumper crush was 39.1 cm (15.375"), located on the bumper reinforcement bar immediately left of the vehicle's centerline. The direct contact damage began 5.1 cm (2.0") right of center and extended 19.1 cm (7.5") to the left. The narrow impact deformed the full frontal width of the vehicle resulting in a combined induced and direct damage width of 134.6 cm (53.0"). The impact crushed the bumper fascia, the styro-foam filler panel, and the bumper reinforcement bar. A crush profile was documented at the level of the reinforcement bar and was as follows: C1 = 5.7 cm (2.25"), C2 = 17.8 cm (7.0"), C3 = 32.4 cm (32.4"), C4 = 24.8 cm (9.75"), C5 = 6.4 cm (2.5"), C6 = 0 cm [-12.1 cm (-4.75")].

Figure 7. Frontal damage resulting from the tree impact.

Figure 8. Profile view documenting the depth of frontal crush.

Components damaged by the frontal impact included the bumper system, grille, hood, radiator support panel, radiator, and the air conditioning condenser.

Collision Deformation Classification (CDC)

Event No.	Object Contacted	CDC
1	W-beam guardrail	12-FLEE-3
2	W-beam guardrail	12-LZES-1
3	30 cm (12") diameter tree	12-FCEN-2

Interior

The interior of the Chrysler New Yorker sustained minor severity damage that was associated with frontal air bag deployment and occupant contact. The frontal air bags deployed as designed from the respective module assemblies. There was no related damage to adjacent components. The passenger compartment was not reduced in size by intrusion and there was no damage associated with the exterior deformation.

The driver initiated a forward trajectory in response to the tree impact sequence. His left hand scuffed the steering wheel rim at the 9 o'clock position and deflected off the rim continuing forward. His left hand then impacted and fractured the turn signal stalk, further evidenced by a tissue transfer on the fractured component. The left hand impacted the top surface of the left upper instrument panel directly forward of the turn signal and steering wheel contact points. The left hand scuff was located 59.7-63.2 cm (23.5-24.9") left of center. A similar right hand scuff mark was noted to the right side of the steering wheel rim, located 29.2-44.4 cm (11.5-17.5") left of center.

The driver's head impacted and scuffed the sun visor located 34.3-38.7 cm (13.5-15.25") left of center and 6.1-11.4 cm (2.4-4.5") rearward of the leading edge. There was no deformation to the visor or fracture to the integral vanity mirror. A secondary head scuff mark was present on the left roof side rail 27.9-32.4 cm (11.0-12.75") rearward of the windshield header. The driver's left knee contacted and scuffed the plastic knee bolster panel 45.7-54.6 cm (18.0-21.5") left of center and 30.4-34.3 cm (12.0-13.5") below the top surface of the instrument panel. Additionally, the driver loaded the deployed driver air bag and compressed the bag against the steering column. His loading force was transmitted through the bag and into the column which compressed approximately 2.5 cm (1.0").

The front right passenger of the New Yorker was impacted by the expanding passenger air bag membrane. A faint make-up transfer was present on the bag surface located 6.4-10.8 cm (2.5-4.25") inboard of the right vertical seam and 11.4-19.1 cm (4.5-7.5") below the leading edge of the cover flap. Her knees contacted the glove box door and the mid instrument panel, however, there was no direct contact evidence or damage to support this contact sequence.

Frontal Air Bag System

The 1995 Chrysler New Yorker was equipped with a frontal air bag system for the driver and right passenger positions **(Figure 9)**. The system consisted of two radiator support mounted electro-mechanical crash sensors, the console mounted control module, and the conventionally mounted driver air bag module within the two-spoke steering wheel rim, and the top mounted passenger air bag module assembly. The system deployed as a result of the tree impact with no failures or defects noted.

The driver air bag was contained within H-configuration module cover flaps that were nearly symmetrical in shape. The upper flap was 7.4 cm (2.9") in height and 16.3 cm (6.4") in width at the horizontal tear seam with a hinge width of 14.0 cm (5.5"). The lower flap was 6.4 cm (2.5") in height with a hinge width of 15.9 cm (6.25"). The lower flap contained the acronym SRS (Supplemental Restraint System) and AIRBAG on the lower aspect.

Figure 9. Deployed frontal air bags.

The driver air bag membrane measured 61.0 cm (24.0") in diameter and was tethered by two internal straps. The tethers were sewn to the face of the bag with three rows of external stitching that formed a circle 15.9 cm (6.25") in diameter. The membrane was constructed of two fabrics sewn with an internal peripheral seam. The back side of bag was lighter in color than the face of the bag that was exposed to the driver. The membrane was not directly vented by ports. Venting was probably achieved through a porous membrane or back vented through the module assembly. Although no distinct driver contact points were prevalent on the air bag, the bag was dirty from post-crash handling of the bag by fire and tow personnel.

The driver air bag was labeled with a tag that was sewn and bonded to the 12 o'clock position, adjacent to the inflator. The bar coded label identified the following sequences:

PUT12324-01C
TBN424110743

The front right passenger air bag was mounted in the top of the upper right instrument panel and concealed by a single cover flap. The flap was rectangular in shape and was hinged at the forward aspect. The overall dimensions of the flap were 38.1 cm (15.0") laterally and 19.4 cm (7.625") fore and aft. Again the acronym SRS and AIRBAG were molded into the lower right corner of the flap. The cover flap was reinforced internally and was rigid in design. In its deployed state, the leading edge of the flap protruded 2.3 cm (0.9") above the instrument panel. There was no damage or contact evidence to the cover flap.

The front right passenger air bag was rectangular in shape in its deflated state with measure dimensions of 53.3 cm (21.0") in width and 63.5 cm (25.0") in height. The bag membrane was tethered internally by a wide band tether sewn to the face of the bag approximately 52.7 cm (20.75") below the top of the bag. The maximum excursion of the bag was 25.4 cm (10.0") from the mid instrument panel with a restricted excursion of 23.5 cm (9.25") occurring at the tether location. There were no vent ports in the fabric of the bag.

The top panel of the passenger air bag yielded evidence of a restricted deployment based on transfers to the membrane. These black vinyl transfers extended 31.1 cm (12.25") laterally across the width of the bag at the inflator and extended 27.9 cm (11.0") rearward on the top panel, radiating to a width of 31.8 cm (12.5"). Within this transfer pattern was a faint make-up transfer that was located 6.4-10.8 cm (2.5-4.25")

inboard of the right seam and 11.4-19.1 cm (4.5-7.5") below the leading edge of the cover flap. There was no additional contact evidence or damage to the passenger side air bag.

Driver Demographics

Age/Sex:	70 year old male
Height:	182.9 cm (72.0")
Weight:	81.6 kg (180.0 lb)
Manual Restraint Usage:	None, 3-point lap and shoulder belt was available
Usage Source:	Vehicle inspection
Eyeware:	Unknown
Mode of Transport From Scene:	Ambulance
Type of Medical Treatment:	Treated at a local hospital for minor injuries and released

Driver Injuries

Injury	Injury Severity (AIS Update 98)	Injury Mechanism
Minor laceration, NFS	Minor (990600.1,9)	Unknown, body area not specified
Lower extremity pain	N/A, not a codeable injury	Knee bolster

Driver Kinematics

The driver of the Chrysler New Yorker was seated in a presumed upright posture with the power seat track adjusted 2.5 cm (1.0") forward of the full rear position. The seat back support was adjusted to 18 degrees rearward of vertical and the adjusted head restraint was in the full down position. With the seat adjusted to this position, the horizontal distance between the mid point of the driver air bag module and the seat back support was 57.2 cm (22.5"). [This is inclusive of 2.5 cm (1.0") of steering column compression.] **Figure 10** is a profile view of the driver's seated position with respect to the frontal air bag. He was not wearing the 3-point manual lap and shoulder belt system. The belt system was fully retracted against the B-pillar with the D-ring adjusted to a point that was 2.5 cm (1.0") below the top adjustment position. The lack of belt usage was supported by kinematics of the driver and his interior contact points. Additionally, the belt system was in new condition with no evidence of belt loading or routine usage indicators.

Figure 10. Driver's seated position.

The initial impacts with the W-beam guardrail did not result in a significant velocity change that would have

displaced the driver. Therefore, all contact with interior components resulted from his response to the tree impact sequence. At impact with the tree, the frontal air bag system deployed. The driver responded to the 12 o'clock direction of force impact by initiating a forward trajectory. His left hand loaded the steering wheel rim at the 9 o'clock sector. A tissue transfer was noted to the rim. His hand subsequently separated from the steering wheel rim and impacted the turn signal stalk. The contact fractured the plastic stalk, also evidenced by a tissue transfer. His left hand continued forward into the left upper instrument panel producing a scuff mark to the top of the padded panel. The driver's right hand contacted the right upper instrument panel as evidenced by a scuff mark located 59.7-63.2 cm (23.5-24.9") left of center. No injury resulted from these contacts.

The driver's left knee contacted and scuffed the left side of the knee bolster at the protrusion for the steering column, located 45.7-54.6 cm (18.0-21.5") left of center and 30.5-34.3 cm (12.0-13.5") below the top of the upper instrument panel. The driver complained of leg pain, however, no injury resulted from this contact sequence.

The driver's torso loaded the deployed front left air bag and compressed the expanded bag against the steering column. As a result of the thoracic loading, the energy absorbing steering column compressed approximately 2.5 cm (1.0"). There was no deformation of the steering wheel. The air bag provided the driver with a sufficient ride down of the crash forces and mitigated potential thoracic injury. His scalp contacted and scuffed the left sun visor 34.3-38.7 cm (13.5-15.25") left of center. There was no deformation to the visor and the integral vanity mirror remained intact. A scuff mark was noted to the side rail 27.9-32.4 cm (11.0-12.75") rearward of the windshield header. The driver's head probably impacted the left roof side rail as he rebounded from his initial trajectory during the post-crash spin-out of the vehicle. **Figure 11** is an overall view of the driver's trajectory and contact points.

Figure 11. Driver's trajectory and contact points.

The driver sustained an unspecified laceration and was transported by ambulance to a local hospital where he was treated for his injuries and released.

Front Right Passenger Demographics

Age/Sex:	66 year old female
Height:	157.4 (62.0")
Weight:	63.5 kg (140.0 lb)
Manual Restraint	
Usage:	None, 3-point lap and shoulder belt was available
Usage Source:	Vehicle inspection, on-scene observations of the first responders
Eyeware:	None reported
Medical Treatment:	None, expired at scene

Front Right Passenger Injuries

Injury	Injury Severity (AIS Update 98)	Injury Mechanism
Cervical spine fracture with cord transection	Maximum (640246.56)	Expanding front right passenger air bag membrane
Abrasion anterior neck	Minor (390202.1,5)	Expanding front right passenger air bag membrane

** Source of Injuries - Medical Examiner*

Front Right Passenger Kinematics

The right front passenger of the Chrysler New Yorker was a 66 year old female. The passenger was wearing a blue pullover-type sweater, denim jeans, and a leather-type jacket that was opened across the front of her body. In addition, the passenger was wearing a white knit scarf draped around her neck. She was not wearing the manual 3-point lap and shoulder belt system. Belt non-usage was confirmed by the lack of loading evidence on the system and the lack of routine usage indicators. Additionally, the first responders to the crash scene observed the passenger slumped in the center front position of the vehicle with the front right belt system stowed against the B-pillar. The upper D-ring was adjusted to the full-down position. The manually adjusted right front seat was positioned to a full rear track position with the seat back set to an angle of 18 degrees **(Figure 12)**.

Figure 12. Adjusted seat track position with respect to the front right air bag.

The initial impacts with the guardrail did not result in a sufficient deceleration to displace the unrestrained passenger. However, the subsequent braking and CW yaw displaced the unrestrained passenger in a forward direction. The frontal air bag system deployed as a result of the frontal impact with the tree as the unrestrained passenger initiated a forward trajectory in response to the 12 o'clock impact force. The deploying front right passenger air bag expanded from the top mount module assembly and contacted the underside of the passenger's chin and the anterior aspect of her neck. An large abrasion extended across the anterior neck and onto the underside of the passenger's chin from air bag contact. The scarf partially protected the anterior neck and probably minimized the severity and extent of the abrasion pattern. Her forward position restricted the deployment path of the expanding air bag as evidence by expansion transfers to the top surface of the air bag membrane from against the inner aspect of the module cover and assembly. The air bag interaction against the passenger's neck/face resulted in a faint make-up transfer to the top right aspect of the bag membrane. The transfer was located 6.4-10.8 cm (2.5-4.25") inboard of the right seam and 11.4-19.1 cm (4.5-7.5") below the leading edge of the cover flap. The passenger was not contacted by the top mounted cover flap.

The expanding air bag hyper-extended her neck which resulted in a C-spine fracture and complete transection of the cervical spinal cord. She was subsequently displaced upward and rearward by the bag toward the center front seated position.

She came to rest slumped on the center area of the split bench front seat against the driver with her jacket deflected off her shoulders. EMTs arrived on-scene and failed to detect vital signs. The county coroner was called to the scene where he pronounced her deceased. The body was removed from the vehicle and transported to a local hospital for an autopsy.