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GENERAL DYNAMICS ON-SITE CHILD SAFETY SEAT CRASH INVESTIGATION SCI TECHNICAL SUMMARY REPORT

CASE NO: CA03-029

VEHICLE: 2001 CHRYSLER PT CRUISER

LOCATION: STATE OF MICHIGAN

CRASH DATE: MAY 2003

Contract No. DTNH22-01-C-17002

Prepared for:

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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.

TECHNICAL REPORT STANDARD TITLE PAGE

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15. Supplementary Note On-site investigation that focused on the performance of a rear-facing Child Safety Seat (CSS) that was installed in the center rear position of a 2001 Chrysler PT Cruiser. The PT Cruiser was involved in a severe frontal crash and the child did not sustain injury. The detachable base of the CSS fractured as a result of the impact.			
16. Abstract This on-site investigation focused on the installation and performance of a rear-facing child safety seat (CSS) with a detachable base that was installed in the rear center position of a 2001 Chrysler PT Cruiser. The PT Cruiser was occupied by a 35-year-old restrained female driver and an 8-month-old female child passenger who was restrained in the rear-facing CSS. The CSS was an Evenflo Discovery infant CSS that was installed using the detachable base. The PT Cruiser was involved in a severe head-on crash with a 1992 Ford Escort. The impact was sufficient to deploy the frontal air bag system in the PT Cruiser and the loading of the CSS against the 3-point lap and shoulder belt caused multiple fractures in the CSS base at the belt path. The driver initiated a forward trajectory and loaded the manual restraint and deployed driver's air bag. Due to pre-impact bracing and steering column/instrument panel intrusion, the driver sustained a right radius fracture. She sustained a left neck abrasion, left shoulder abrasions and contusions, and an abdominal contusion as a result of safety belt loading. The driver also sustained tears to her right anterior cruciate ligament and right medial meniscus, and a right lower leg laceration from contact with the knee bolster. The child passenger loaded the rear aspect of the CSS in response to the frontal impact, and the base of the CSS fractured at the belt path. The PT Cruiser was subsequently struck in the rear by a 2003 Pontiac Vibe that was traveling in the same direction as the PT Cruiser. The occupants and CSS were redirected rearward and the driver of the PT Cruiser sustained a C5 fracture. The CSS rotated in a counterclockwise (CCW) direction and came to rest on the rear seat of the PT Cruiser. The driver was transported by ambulance to a local hospital and was admitted for treatment for seven days. The child passenger did not sustain injury and was transported by ambulance to a local hospital for evaluation of possible injury and released.			
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BACKGROUND

This on-site investigation focused on the installation and performance of a rear-facing child safety seat (CSS) with a detachable base that was installed in the rear center position of a 2001 Chrysler PT Cruiser. The PT Cruiser was occupied by a 35-year-old restrained female driver and an 8-month-old female child passenger who was restrained in the rear-facing CSS. The CSS was an Evenflo Discovery infant CSS that was installed using the detachable base. The PT Cruiser **(Figure 1)** was involved in a severe head-on crash with a 1992 Ford Escort. The impact was sufficient to deploy the frontal air bag system in the PT Cruiser and the loading of the CSS against the 3-point lap and shoulder belt caused multiple fractures in the CSS base at the belt path. The driver initiated a forward trajectory and loaded the manual restraint and deployed driver's air bag. Due to pre-impact bracing and steering column/instrument panel intrusion, the driver sustained a right radius fracture. She sustained a left neck abrasion, left shoulder abrasions and contusions, and an abdominal contusion as a result of safety belt loading. The driver also sustained tears to her right anterior cruciate ligament and right medial meniscus, and a right lower leg laceration from contact with the knee bolster. The child passenger loaded the rear aspect of the CSS in response to the frontal impact, and the base of the CSS fractured at the belt path. The PT Cruiser was subsequently struck in the rear by a 2003 Pontiac Vibe that was traveling in the same direction as the PT Cruiser. The occupants and CSS were redirected rearward and the driver of the PT Cruiser sustained a C5 fracture. The CSS rotated in a counterclockwise (CCW) direction and came to rest on the rear seat of the PT Cruiser. The driver was transported by ambulance to a local hospital and was admitted for treatment for seven days. The child passenger did not sustain injury and was transported by ambulance to a local hospital for evaluation of possible injury and released.

Figure 1. Damaged 2001 PT Cruiser

This crash was identified by the General Dynamics SCI team through an Internet news website. The crash information was forwarded from the General Dynamics SCI team to the Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA) due to the presence of the CSS. An on-site investigation was assigned on May 30, 2003 and initiated on June 2, 2003.

VEHICLE DATA – 2001 Chrysler PT Cruiser

The 2001 Chrysler PT Cruiser was identified by the Vehicle Identification Number (VIN): 3C8FY4BB31T (production sequence omitted). At the time of the vehicle inspection, the vehicle did not have power, and the odometer reading was unknown. The driver stated that the vehicle was purchased new approximately two years prior to the crash, and the vehicle's odometer read approximately 72,418 km (45,000 miles). The PT Cruiser was a front-wheel-drive, five-door, station wagon with the Limited Edition trim package. It was equipped with a 2.4 liter, 4-cylinder engine, a four-speed automatic transmission, power steering, a tilt steering wheel, front disc/rear drum power-assisted brakes (no ABS), power windows, and a power moonroof. The PT Cruiser was equipped with Goodyear Eagle 205/55R16 tires and aluminum/alloy wheels. The vehicle manufacturer recommended front and rear tire pressure was 234 kPa (34 PSI). The specific tire data is as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	0.0 kpa	5 mm (6/32")	Yes	None
LR	255.1 kPa (37.0 PSI)	6 mm (7/32")	No	None
RF	286.1 kPa (41.5 PSI)	5 mm (6/32")	No	None
RR	289.6 kPa (42.0 PSI)	6 mm (7/32")	No	None

The front seating positions in the PT Cruiser were configured with bucket seats with adjustable head restraints. The driver's power seat track was jammed at the time of the inspection and was located 9.5 cm (3.8") forward of the full-rear position and 13.3 cm (5.3") rear of the full-forward position. The driver's head restraint was positioned 7.0 cm (2.8") above the seat back. The front right passenger's seat was located in the mid-track position and the front right passenger's head restraint was completely separated from the seat back at the time of the inspection. The rear seating positions were configured with a three-person 60/40 split-bench seat with forward-folding back rests. The rear seats also folded forward and were removable to facilitate cargo.

VEHICLE DATA – 1992 Ford Escort

The 1992 Ford Escort was identified by the VIN: 1FAPP10J1NW (production sequence omitted). The vehicle was a two-door hatchback that was equipped with a 1.9 liter, 4-cylinder engine. The Escort was configured with a front-wheel drive, a 5-speed manual transmission and power brakes. The seating was configured with front bucket seats and a rear bench seat with a folding back. The Escort was equipped with Ultimate Metric P175/70R13 tires and steel wheels. At the time of the vehicle inspection, the Escort's odometer read 214 km (133 miles), and due to the age of the vehicle, the odometer was interpreted to read 161,144 km (100,133 miles).

VEHICLE DATA – 2003 Pontiac Vibe

The 2003 Pontiac Vibe was identified by the VIN: 5Y2SM62893Z (production sequence omitted). The Vibe was a four-door, all-purpose-vehicle that was equipped with a 1.8 liter, 4-cylinder engine, a four-speed automatic transmission, all-wheel-drive, power brakes with ABS, power steering, and a tilt steering wheel. The seating was configured with front bucket seats and

a rear bench seat with folding backs. The Vibe was equipped with Goodyear Eagle RS-A P205/55R16 tires and aluminum/alloy wheels. The Vibe was configured with an electronic odometer, and the current mileage was unknown at the time of the vehicle inspection.

CRASH SITE

Figure 2. Southbound view of crash site

This three-vehicle crash occurred during the daylight hours of May 2003 in the state of Michigan. At the time of the crash, the weather was clear and the asphalt roadway surface was dry. The crash occurred on a two-lane north/south state roadway **(Figure 2)**. The roadway was configured with one travel lane in each direction separated by a solid yellow centerline for northbound traffic and a broken yellow centerline for southbound traffic. The roadway was bordered by gravel shoulders and the roadside environment consisted of wooded areas. At the crash site, the roadway was straight and exhibited a slight negative northbound grade with a small hillcrest located approximately 30 m (98') south of the crash site. A four-leg intersection was present 30 m (98') north of the crash site. The posted speed limit for the north/south roadway was 80 km/h (50 mph). The scene schematic is included as **Figure 23** of this report.

CRASH SEQUENCE

Pre-Crash

The female driver of the 2001 PT Cruiser was operating the vehicle in a southbound direction on the two-lane roadway on approach to the crash site **(Figure 3)**. A 40-year-old female driver was operating a 2003 Pontiac Vibe in the same direction behind the PT Cruiser. The distance between the vehicles was not known. A 32-year-old male driver was operating a 1992 Ford Escort in a northbound direction on the same roadway **(Figure 4)**. Police reported that the driver of the Escort might have fallen asleep, which caused him to relinquish control of the vehicle. The Escort drifted over the centerline and into the opposite travel lane in a tracking mode. The driver of the PT Cruiser stated that she was following approximately two car-lengths behind a van traveling in the same direction in front her. She noted that the van swerved slightly right, and subsequently detected the Escort encroaching into the southbound lane. The driver steered right

Figure 3. Southbound approach for the PT Cruiser

Figure 4. Northbound approach for the Ford Escort

and removed her foot from the accelerator pedal in an attempt to avoid the collision. She further stated that she braced her arms against the steering wheel rim. There was no physical evidence (i.e. skid marks) at the crash site to support pre-crash braking.

Crash

The PT Cruiser impacted the Ford Escort in an angled head-on configuration. The frontal impact resulted in severe damage to both vehicles and was sufficient to deploy the redesigned frontal air bag system in the PT Cruiser. The direction of force was in the 12 o'clock sector for both vehicles. The damage algorithm of the WinSMASH program computed a delta-V of 56.0 km (34.8 mph) for the PT Cruiser and a delta-V of 72.0 km/h (44.7 mph) for the Escort based on the documented frontal crush profiles. The front of the PT Cruiser pitched downward as the vehicles engaged.

Prior to vehicle stabilization, the PT Cruiser was struck in the rear left aspect by the 2003 Pontiac Vibe that was traveling in the same lane behind the PT Cruiser. The impact resulted in minor damage to both vehicles. The damage algorithm of the WinSMASH program computed a delta-V of 13.0 km/h (8.1 mph) for the PT Cruiser and a delta-V of 15.0 km/h (9.3 mph) for the Pontiac Vibe based on the documented crush profiles. The impact was not sufficient to deploy the frontal air bag system in the Pontiac Vibe. The PT Cruiser was displaced forward and rotated CCW to final rest while still engaged with the Escort.

Post-Crash

Rescue personnel completely removed the left front door of the PT Cruiser and removed the driver from the vehicle. Police reported that the driver of the Pontiac Vibe was a nurse who evaluated the child and removed her from the CSS. Both occupants of the PT Cruiser were transported by ambulance to a local hospital. The driver was admitted for seven days and the child was evaluated and released. The driver of the 1992 Ford Escort was trapped in the vehicle due to intrusion. He expired at the scene during a lengthy extrication process. The driver of the Pontiac Vibe was transported by ambulance to a local hospital for treatment. Her admission status was not reported.

VEHICLE DAMAGE

Exterior Damage – 2001 Chrysler PT Cruiser

The 2001 Chrysler PT Cruiser sustained severe frontal damage **(Figures 5 and 6)** as a result of the frontal impact with the 1992 Ford Escort. The direct damage began at the front left corner and extended 148.6 cm (58.5") across the bumper to 64.1 cm (25.3") right of the centerline. White paint transfers from the Escort were present on the bumper, grille, and hood from direct contact. The left front fender was crushed rearward. The hood was buckled rearward and displaced slightly right. The bumper was crushed rearward, most severely on the left aspect. The left front wheel was displaced rearward and restricted

Figure 5. View of frontal damage to the PT Cruiser

against the base of the left A-pillar, which resulted in the reduction of the left wheelbase by 30.0 cm (11.8”). The left A-pillar was displaced 12.0 cm (4.6”) rearward at the base. The left A-pillar was also deflected outward 6.4 cm (2.5”). The maximum lateral deflection was located 5.1 cm (2.0”) above the beltline. The combined direct and induced damage involved the entire frontal width of the vehicle and measured 132.1 cm (52.0”) parallel to the established reference line.

The left rear door was displaced rearward and buckled from induced damage. The left side rail was buckled 86.4 cm (34.0”) rear of the windshield header and the right roof side rail was buckled slightly 61.0 cm (24.0”) rear of the windshield header. The moonroof was displaced slightly, however, the glass was not shattered. The roof sustained buckling aft of the B-pillars. The Collision Deformation Classification (CDC) for the frontal impact with the Ford Escort was 12-FDEW-3. Six crush measurements were documented across the front bumper and were as follows: C1 = 54.9 cm (21.6”), C2 = 45.1 cm (17.8”), C3 = 39.4 cm (15.5”), C4 = 32.7 cm (12.9”), C5 = 11.8 cm (4.6”), C6 = 0.0 cm.

Figure 6. Left side view of the damaged PT Cruiser

The 2001 PT Cruiser sustained minor rear damage **(Figure 7)** as a result of the secondary impact with the Pontiac Vibe. The direct contact damage on the rear bumper began 5.1 cm (2.0”) left of the centerline and extended 73.7 cm (29.0”) to the rear left corner of the bumper. The bumper exhibited abrasions and paint transfers from contact with the Pontiac Vibe. Direct contact and paint transfers on the rear hatch began 18.4 cm (7.3”) left of center and extended laterally 43.8 cm (17.3) to the rear left aspect. The entire bumper was deflected slightly to the right. The left rear brake light lens was fractured. The combined direct and induced damage involved the entire rear width of the vehicle and measured 138.4 cm (54.5”). The CDC for the rear impact to the PT Cruiser was 06-BYEW-1. Six crush measurements were documented across the rear bumper and were as follows: C1 = 8.9 cm (3.5”), C2 = 7.3 cm (2.9”), C3 = 7.9 cm (3.1”), C4 = 4.8 cm (1.9”), C5 = 2.5 cm (1.0”), C6 = 0.6 cm (0.3”).

Figure 7. View of rear damage from the Pontiac Vibe

Exterior Damage – 1992 Ford Escort

The 1992 Ford Escort **(Figure 8)** sustained severe frontal damage as a result of the impact with the PT Cruiser. The direct damage began at the right front

Figure 8. View of frontal damage to the Ford Escort

corner and extended 139.7 cm (55.0”) across the entire frontal width, measured parallel to the damaged profile. The front bumper fascia and grille were fractured and completely separated from the vehicle as a result of the impact. The severe crush resulted in moderate deformation of the upper and lower radiator support. The radiator core sustained contact damage from displaced frontal components and was also crushed rearward. The hood was severely buckled rearward and direct contact abrasions and paint transfers were present on the hood. The combined direct and induced damage also involved the entire frontal width and measured 121.9 cm (48.0”), parallel to the established reference line.

Figure 9. Left side view showing wheelbase reduction

The frontal crush resulted in the severe outward buckling of both front fenders. The left front sill was buckled and deflected outward in a CCW direction aft of the left A-pillar. The lateral outward deflection measured 22.9 cm (9.0”). The left A-pillar was deflected rearward. The frontal crush also resulted in the reduction of the left wheelbase by 70.0 cm (27.6”) and the reduction of the right wheelbase by 28.0 cm (11.0”). **Figure 9** illustrates the reduction of the left wheelbase and left A-pillar deflection. The maximum crush measured 103.0 cm (40.5”) at the front left corner. Six crush measurements were documented across the upper radiator support and were as follows: C1 = 95.0 cm (37.4”), C2 = 93.2 cm (36.7”), C3 = 91.9 cm (36.2”), C4 = 84.9 cm (33.4”), C5 = 70.3 cm (27.7”), C6 = 50.0 cm (19.7”). The CDC for the frontal collision with the PT Cruiser was 12-FDEW-5.

Exterior Damage – 2003 Pontiac Vibe

Figure 10. Damaged 2003 Pontiac Vibe

The 2003 Pontiac Vibe **(Figure 10)** sustained minor frontal damage as a result of the impact with the PT Cruiser. The direct damage began 31.8 cm (12.5”) left of the centerline and extended 94.0 cm (37.0”) laterally to the right across the front bumper. Paint transfers and abrasions were present on the front bumper fascia. A circular imprint of the PT Cruiser’s exhaust pipe was present on the lower aspect of the bumper fascia and was located 23.5 cm (9.3”) to the right of the centerline. The combined direct and induced damage involved the entire frontal width of the Pontiac Vibe and measured 141.0 cm (55.5”). The hood was buckled rearward and both head lamps were displaced. The left side aspect of the bumper fascia was displaced and the right front fender was deflected slightly rearward. The maximum crush on the front bumper measured 14.3 cm (5.6”) and was located 8.3 cm (3.3”) to the right of the centerline. Six crush measurements were documented along the front bumper and were as follows: C1 = 0.0 cm, C2 = 1.3 cm (0.5”), C3 = 4.8 cm (1.9”), C4 = 10.5 cm

(4.1”), C5 = 9.8 cm (3.9”), C6 = 9.7 cm (3.8”). The CDC for the impact with the PT Cruiser was 12-FZEW-1.

Interior Damage -2001 Chrysler PT Cruiser

The 2001 Chrysler PT Cruiser sustained moderate interior damage as a result of passenger compartment intrusion and occupant contact. Rescue personnel removed the left front door and the left rear door was jammed shut. The remaining doors were operational. The windshield was fractured as a result of impact forces and displacement of the left A-pillar and separation of the windshield gasket was noted on the bottom left aspect. The windshield laminate was torn adjacent to the left A-pillar **(Figure 11),** possibly a result of the left A-pillar displacement or post-crash extrication efforts. The tear was vertical in nature, and was located 12.7 cm (5.0”) below the windshield header. The tear measured 21.6 cm (8.5”) in length and the maximum width measured 3.2 cm (1.3”). The remaining vehicle glazing was not damaged.

Figure 11. View of torn windshield laminate and left A-pillar displacement

Figure 12 illustrates the interior damage to the front seating positions. The steering wheel rim was deflected forward 2.5 cm (1.0”) at the 8 o’clock aspect and was deflected forward 1.9 cm (0.8”) at the 2 o’clock aspect. The steering rim deflection resulted in a gap at the spoke located at the 3 o’clock position that measured 1.6 cm (0.6”) and a gap at the spoke located at the 7 o’clock position, which measured 0.3 cm (0.1”) from the steering wheel hub. During the frontal impact, the steering column shear capsules in the PT Cruiser sustained complete separation, probably a combination of the driver’s loading through the deployed air bag the rearward intrusion of the steering column. The steering wheel rim was found resting on the driver’s seat cushion at the time of the inspection. NHTSA New Car Assessment Program (NCAP) test results for the PT Cruiser were reviewed for a 56 km/h (35mph) frontal barrier test, and there was no reported shear capsule separation in the test. However, similar deformation was seen on the steering wheel rim as a result of the driver loading through the deployed air bag. The knee bolster was deformed from occupant contact over an area that measured 10.2 cm (4.0”) in width and 15.2 cm (6.0”) in height. The deformation began 2.5 cm (1.0”) right of the centerline of the steering column and extended to the left. A blue scuff, possibly a fabric transfer was present on left instrument panel, below the outside mirror controls that measured 7.6 cm (3.0”) in height and

Figure 12. View of collapsed steering column, rim deflection, and interior damage to the driver's seating position

6.4 cm (2.5”) in width. The plastic instrument panel was also fractured and slightly pocketed at the location of the scuff. A blue linear abrasion that measured 6.4 cm (2.5”) in height was located on the instrument panel to the right of the knee bolster. The front left “grab” handle sustained a scuff from possible occupant contact. The center instrument panel was displaced to the right and rotated slightly CCW. The center console was fractured and the round plastic controls on the center instrument panel were separated.

The rear aspects of the front seat backs exhibited minor damage **(Figure 13)**. The driver’s seat back sustained a scuff on the rear inboard corner of the head restraint. Abrasions and a faint blue plastic transfer were located on the left aspect of the plastic seat back frame from contact with the CSS. Abrasions and scuffs were also present on the right aspect of the seat back from CSS contact.

Figure 13. View of damage to the front seat backs

Abrasions were also present on the left aspect of the right front seat back, and a linear blue plastic transfer was located on the left upper aspect of the seat back. Abrasions were present on the right aspect of the front right seat back but were not related to this crash.

Multiple intrusions of the passenger compartment were documented as follows:

Position	Intruded Component	Magnitude of Intrusion	Direction
FL	Toe pan	19.1 cm (7.5”)	Longitudinal
FL	Left instrument panel	7.0 cm (2.8”)	Longitudinal
FL	Left A-pillar	5.7 cm (2.3”)	Longitudinal
FR	Toe pan	15.2 cm (6.0”)	Longitudinal
RL	Floor pan	10.2 cm (4.0”)	Vertical

MANUAL RESTRAINT SYSTEMS – 2001 Chrysler PT Cruiser

The 2001 Chrysler PT Cruiser was equipped with manual 3-point lap and shoulder belts for all outboard positions. The front seat safety belts were configured with continuous loop webbing, cinching latch plates, and belt-sensitive, and Emergency Locking Retractors (ELR’s) with retractor pretensioners. The front seat safety belts were also configured with adjustable D-rings that were located in the full-down positions.

The driver's safety belt **(Figure 14)** was restricted in the used position at the time of the vehicle inspection as a result of pretensioner actuation. Stretch marks and cupping on the lap belt and shoulder belt webbing were present from occupant loading. An abrasion on the webbing from the latch plate was located 78.7 cm (31.0") from the lower anchor. A heavy plastic transfer from the D-ring was located 144.8 cm (57.0") above the lower anchor and measured 8.3 cm (3.3") in length. The cover for the cinch mechanism on the driver's latch plate came apart **(Figure 15)** as a result of occupant loading and abrasions were present on the latch plate from engagement against the safety belt webbing, but did not affect the performance of the safety belt.

Figure 14. View of driver's safety belt

Figure 15. Close-up of cinch mechanism cover

The rear center lap and shoulder belt **(Figure 16)** was cut by rescue personnel 64.8 cm (25.5") above the anchor and a second cut was made 98.4 cm (38.8") above the anchor. Three blue plastic transfers were present on the lap belt section from engagement against the CSS base. The first plastic transfer was located 22.9 cm (9.0") from the anchor and extended across the entire width of the webbing. The two remaining transfers were located 43.8 cm (17.3"), and 53.8 cm (24.0") from the lower anchor and measured 2.5 cm (1.0") and 1.9 cm (0.8"), respectively. The safety belt webbing exhibited stretch marks from the CSS loading and a crease from the latch plate was located 49.5 cm (19.5") from the anchor. The second section of webbing (cut) also exhibited stretch marks from loading and a slight crease from the CSS locking clip.

Figure 16. View of rear center lap and shoulder belt and the position of the locking clip

The 2001 PT Cruiser was equipped with Lower Anchors and Tethers for Children (LATCH) anchors for each rear seating position. Tether anchors were present on the rear aspects of the rear seat backs for each position.

Two labels (visible in **Figure 16**) were located 25.4 cm (10.0”) and 29.2 cm (11.5”) above the safety belt anchor that identified the presence of the switchable ELR/Automatic Locking Retractor (ALR) for use with CSS’s.

CHILD SAFETY SEAT – Evenflo Discovery Rear-Facing Infant CSS

The Evenflo Discovery rear-facing CSS **(Figure 17)** was identified by the model number: 4791255P1. The date of manufacture was 03 Jul 02. The CSS instruction manual was located on the rear aspect of the CSS at the time of the inspection. The CSS was designed for rear-facing use for infants who weighed between 2.3 – 9.0 kg (5.0 – 20.0 lb) and measured 48 – 66 cm (19 – 26”) in height. The CSS was designed for use with or without the detachable base. The CSS was configured with a single-loop, 3-point harness system and a two-piece snapping harness retainer clip. The harness adjustment was located on the upper rear aspect of the CSS. A spring-loaded release handle was located on the top rear aspect of the CSS to release the CSS from the base. The CSS did not have an angle adjustment indicator, however, labels were located on the circular base of the carrying handle, which stated that the colored arrows must point up when used in the vehicle.

Figure 17. Evenflo Discovery CSS

CHILD SAFETY SEAT INSTALLATION

The Evenflo Discovery CSS was installed in the rear center position of the 2001 Chrysler PT Cruiser. **Figure 18** depicts the approximate position of the CSS in the PT Cruiser. The driver stated that the CSS manual was consulted for the installation, as well as the vehicle’s owner’s manual. She stated that both manuals were confusing.

The CSS was installed with the center position 3-point lap and shoulder belt. The 3-point lap and shoulder belt was routed through the rear-facing belt path on the CSS base. The driver’s spouse stated that the base was installed by pre-loading the base with his knee to compress it into the seat, and pulling on the safety belt webbing to remove the slack and tighten. The driver stated that after installation, the CSS base was not tight enough, and a locking clip was placed on the safety belt (opposite side from the buckle) to tighten the installation and limit lateral movement to less than 2.5 cm (1.0”). During the interviews with the driver and spouse, neither ever indicated any attempt to engage the ALR. Based on the description of the installation by the parents, the ALR was probably not engaged. The CSS was checked on a daily basis to ensure tightness in the vehicle. The driver stated that nothing was used under the CSS to adjust

Figure 18. Pre-crash position of the CSS in the PT Cruiser

the recline angle in the PT Cruiser (they noted that a rolled towel was necessary for use in another family vehicle). The driver said that the carrying handle was positioned forward and the harness retainer clip was positioned at the infant's armpits, per the CSS instructions. The driver stated that the shoulder harnesses were slightly above the child's shoulders in the top slots. Although the driver's spouse stated that the CSS was checked at a local car dealer a few months prior to the crash where local fire and police personnel perform periodic CSS checkpoints, the driver stated that the CSS had not been inspected and that the parents were unable to attend any checkpoints.

At the time of the vehicle and CSS inspection, the rear center lap and shoulder belt webbing was found to have been cut by rescue personnel in two places and the sliding latch plate was engaged in the buckle. A locking clip was present on the webbing and was located 81.9 cm (32.3") above the restraint anchor. The locking clip **(Figure 19)** was deflected forward on the center aspect 0.4 cm (0.2") from loading and the surrounding safety belt webbing was stretched. The position of the locking clip and deflection supported that the locking clip was positioned on the right side of the CSS (relative to the vehicle), opposite the side where the latch plate was located. The shoulder harnesses were routed through the top slots on the CSS and the harness retainer clip was found snapped together near the latch plate at the time of the inspection.

Figure 19. View of deflected locking clip

CHILD SAFETY SEAT DAMAGE

The Evenflo Discovery rear-facing CSS sustained severe damage to the detachable base and minor damage to the CSS. The detachable base sustained significant fractures at the forward aspect of the belt path (in a rear facing orientation) and at the forward panel of the base. **Figure 19** documents the fracture at the belt path, which began on the right side of the base (relative to the front of the vehicle) 3.8 cm (1.5") below the top aspect of the belt path opening on the inboard aspect and continued laterally and downward in a jagged fashion. The fracture extended to the left belt path opening and radiated longitudinally toward the front aspect of the base. The longitudinal fracture extended vertically to the floor of the base and extended forward 10.2 cm (4.0") in a jagged fashion. The termination point of the longitudinal fracture was the point that prevented the base from completely separating into two pieces and allowed the front aspect of the base to rotate CCW from the rear aspect. A second fracture was located on the forward panel of the CSS

Figure 20. View of fractured CSS base

base. The fracture began on the floor of the base, 2.5 cm (1.0”) aft of the front panel on the left side. It radiated laterally along the floor of the base and extended forward onto the front panel from the centerline and terminated on the front panel 3.8 cm (1.5”) inboard of the right side.

In addition to the fractures, multiple stress marks were present on the plastic CSS base. Both the left and right aspects of the belt path were abraded from engagement with the vehicle’s safety belt webbing. The left outboard aspect displayed an abrasion that measured 7.6 cm (3.0”) in height and 1.3 cm (0.5”) in width. A 5.1 cm (2.0”) linear abrasion was present on the left inboard aspect of the belt path. The outboard aspect of the right belt path exhibited an abrasion that measured 6.4 cm (2.5”) in height. The right inboard aspect sustained an abrasion that measured 10.2 cm (4.0”) in length. An area of abrasion was present on the face of the rear aspect of the CSS base (in the rear-facing orientation) that measured 9.5 cm (3.5”) and was located 10.2 cm (4.0”) left of the centerline.

The CSS also sustained damage as a result of the crash. The bottom aspect of the CSS exhibited abrasions consistent with historical use. The right side aspect (in the rear-facing orientation) exhibited stress marks in the plastic channel area that engages with the CSS base. The carrying handle sustained a 6.4 cm (2.5”) stress mark 1.9 cm (0.8”) to the right of the handle’s centerline. The handle also sustained abrasions on the left aspect from engagement against the driver’s seat back. The fabric canopy sustained a 3.8 cm (1.5”) long laceration on the forward left aspect. Although the harness straps did not exhibit any stretch marks from occupant loading, the CSS latch plate was deflected forward (toward the front of the vehicle) as a result of the infant loading the harness system during the initial impact. The latch plate exhibited abrasions consistent with historical use. At the time of the inspection, the latch plate would only engage with the buckle when the release mechanism was pulled prior to inserting the latch plate.

SUPPLEMENTAL RESTRAINT SYSTEMS – *2001 Chrysler PT Cruiser*

The 2001 Chrysler PT Cruiser was equipped with redesigned frontal air bags for the driver and front right passenger positions, which deployed as a result of the frontal impact. The driver’s air bag deployed from the steering wheel hub and was configured with a single cover flap design. The circular cover flap measured 11.4 cm (4.5”) in diameter. The driver’s air bag measured 61.0 cm (24.0”) in diameter and was vented by two circular ports at the 11 and 1 o’clock positions. The vent ports measured 3.2 cm (1.3”) in diameter. The driver’s air bag was tethered by two 12.7 cm (5.0”) wide internal straps that were located at the 3 and 9 o’clock positions. An area of flesh-tone makeup transfer was located on the face of the air bag **(Figure 21)**. The transfer measured 16.5 cm (6.5”) in height at 14.0 cm (5.5”) in width. It began 4.4 cm (1.8”) left of vertical centerline and 7.0 cm (2.8”) above the horizontal centerline, and extended downward and to the right. Two lipstick transfers were located within the makeup transfer and

Figure 21. Deployed redesigned driver's air bag showing makeup transfer

measured 6.4 cm (2.5”) in width. The center of the lipstick transfers was located 8.3 cm (3.3”) right of the vertical centerline and 7.6 cm (3.0”) above the horizontal centerline.

The front right redesigned air bag **(Figure 22)** deployed from a mid-mount module configured with a single plastic cover flap. The cover flap measured 17.8 cm (7.0”) in height and 47.0 cm (18.5”) in width. The air bag measured 40.6 cm (16.0”) in width and 61.0 cm (24.0”) in height. The air bag was tethered by two full-width internal straps and vented by two circular ports that were positioned on the top panel of the air bag and located 10.8 cm (4.8”) from the inflator. The ports measured 6.4 cm (2.5”) in diameter and were spaced 4.4 cm (1.8”) apart. There was not contact evidence to the front right passenger’s air bag.

Figure 22. Redesigned front right passenger's air bag

The PT Cruiser was equipped with retractor pretensioners for the driver and front right passenger positions, which actuated in conjunction with the frontal air bag system as a result of the frontal impact. The driver’s safety belt was restricted in the used position at the time of the vehicle inspection as a due to the actuation of the retractor pretensioner. The front right passenger’s safety belt was restricted in the stowed position, taught against the right B-pillar, as a result of the pretensioner actuation.

The PT Cruiser was also equipped with side impact air bags for both front seat positions. The side impact air bags were located in the outboard aspects of the front seat backs. The side impact air bags did not deploy in this crash.

OCCUPANT DEMOGRAPHICS – 2001 Chrysler PT Cruiser

Driver

Age/Sex:	35-year-old female
Height:	160 cm (63”)
Weight:	66 kg (145 lb)
Seat Track Position:	1.9 cm (0.8”) rear of mid-track
Manual Restraint Use:	Manual 3-point lap and shoulder belt
Usage Source:	Vehicle inspection, driver interview
Eyewear:	Prescription contact lenses
Type of Medical Treatment:	Transported by ambulance to a local hospital and admitted for seven days

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
C5 fracture, NFS	Moderate (650216.2,6)	Head motion as a result of the secondary rear impact
Right radius fracture (at wrist)	Moderate (752800.2,1)	Bracing against steering wheel, steering column intrusion
Torn right anterior cruciate ligament	Moderate (840404.2,1)	Knee bolster
Torn right medial meniscus	Moderate (850822.2,1)	Knee bolster
Left neck abrasion	Minor (390202.1,2)	Safety belt webbing
Left neck contusion	Minor (390402.1,2)	Safety belt webbing
Left shoulder abrasion	Minor (790202.1,2)	Safety belt webbing
Left shoulder contusion	Minor (790402.1,2)	Safety belt webbing
Abdominal contusion	Minor (590402.1,0)	Safety belt webbing
2.5 cm (1.0”) laceration right lower leg below the knee	Minor (890602.1,1)	Bottom edge of knee bolster

Injury source: Driver interview

Driver Kinematics

The 35-year-old driver of the PT Cruiser was seated in an upright posture with the seat track adjusted slightly rear of the mid-track position. The seat back was reclined 10 degrees from vertical, and the distance between the seat back and the steering wheel hub measured 40.6 cm (16.0”). As the driver detected the impending impact, she steered right and extended her arms against the steering wheel rim in an effort to brace. At impact with the Ford Escort, the redesigned frontal air bag system deployed and the safety belt pretensioners actuated. The driver initiated a forward trajectory and loaded the manual restraint. The instrument panel was displaced rearward with the steering wheel. The combination of the instrument panel intrusion and the crash forces loading through her right arm resulted in a right radius fracture near the wrist. Her loading against the safety belt resulted in a left neck abrasion, left shoulder abrasions and contusions, and an abdominal contusion. As the front of the PT cruiser pitched downward, the driver’s head flexed forward and her face loaded the deployed driver’s air bag. Based on the makeup transfers on the driver’s air bag, her face contacted the center aspect of the fully inflated air bag and had no lateral movement across the face of the air bag. Her legs struck the knee bolster and left instrument panel, evidenced by deflection of the knee bolster, fabric transfers, and fracture of the left instrument panel. She sustained a torn right anterior cruciate ligament, and a torn right medial meniscus as a result of contact with the knee bolster. She also sustained a right lower leg laceration from contact with the bottom edge of the bolster. The driver continued to move forward and her torso loaded through the driver’s air bag and engaged the steering wheel rim. Even though she was restrained, the steering wheel deformation through the driver’s

air bag was consistent with the NCAP test results at a comparable delta-V, mentioned previously in this report. Her loading through the air bag combined with the rearward intrusion of the steering column resulted in steering column compression and complete separation of the shear capsules.

The PT Cruiser was subsequently struck in the rear by the Pontiac Vibe, which redirected the driver in a rearward direction. She sustained a C5 fracture. Due to the lack of official medical records, the specific fracture type was not known, and the specific source could not be identified. Rescue personnel removed the driver from the vehicle. She was transported by ambulance to a local hospital where she was admitted for treatment. She was discharged seven days following the crash.

Rear Child Passenger

Age/Sex:	8-month-old female
Height:	53 cm (21”)
Weight:	8 kg (18 lb)
Seat Track Position:	Fixed
Manual Restraint Use:	Rear-facing infant CSS installed with a detachable base, with the vehicle 3-point lap and shoulder belt
Usage Source:	Vehicle inspection, CSS inspection, driver interview
Eyewear:	None
Type of Medical Treatment:	Transported by ambulance to a local hospital for evaluation and released

Rear Child Passenger Kinematics

The 8-month-old female child passenger was restrained in the rear-facing infant CSS that was installed in the rear center position of the PT Cruiser. Based on the CSS installation described by the parents, it was assumed that the switchable ELR/ALR retractor was not engaged to the ALR mode. At impact with the Escort, the safety belt’s ELR engaged and the child and CSS initiated forward trajectories. The CSS loaded the base; the base loaded the vehicle’s 3-point lap and shoulder belt, and the child loaded the seat back and harness system of the CSS. As the CSS and base loaded the safety belt, the lap and shoulder belt attempted to separate on the side of the CSS opposite the buckle, as the CSS pulled the lap belt downward and the shoulder belt upward. Due to the position of the locking clip on the opposite side of the buckle, the belt separation was limited and the loading to the base was distributed across the CSS base. The attempted separation of the lap and shoulder belt resulted in the deflection of the locking clip. The loading to the CSS base resulted in a lateral fracture of the base at the belt path. The loading of the CSS against the base resulted in a second base fracture across the front panel of the base. The belt path fracture of the CSS base allowed the CSS and base to travel forward and rotate slightly CCW, which provided a “ride-down” for the child passenger. The CSS struck the driver’s seat back and rebounded rearward and slightly CCW in response to the secondary rear impact. The child was redirected rearward and CCW and loaded the harness system of the CSS. The parents stated that the CSS did not disengage from the base and the CSS and base were found rotated CCW relative to the rear seat after the vehicle came to rest. The child passenger did not sustain injury, but was transported by ambulance to a local hospital for evaluation and later released.

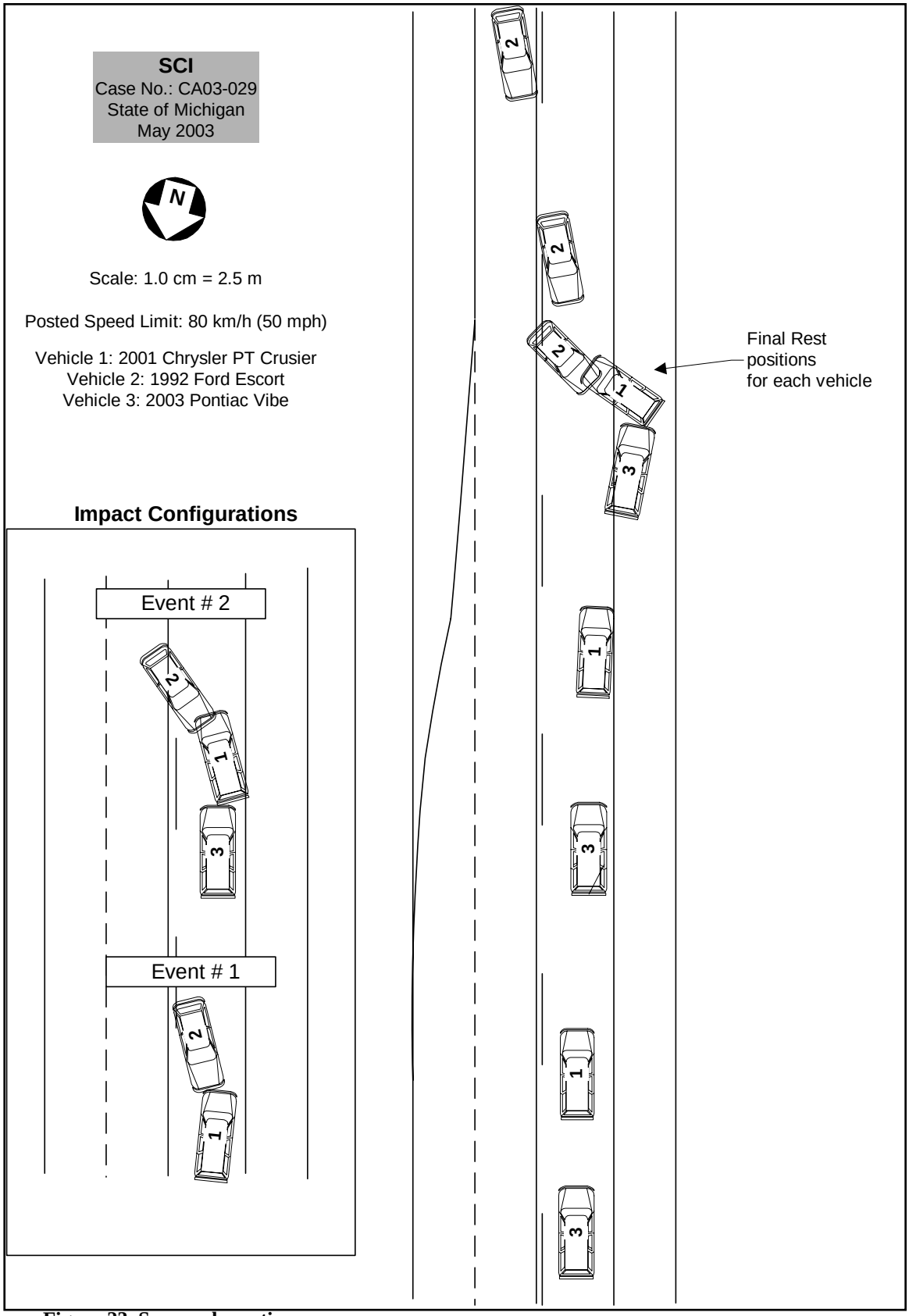

Figure 23. Scene schematic