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ON-SITE ADVANCE OCCUPANT PROTECTION SYSTEMS INVESTIGATION

CASE NUMBER - IN01-006
LOCATION - ILLINOIS
VEHICLE - 2001 FORD TAURUS SEL
CRASH DATE - March, 2001

Submitted:

March 13, 2003

Contract Number: DTNH22-94-D-17058

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 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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On-site air bag deployment investigation involving a 2001 Ford Taurus SEL, four-door sedan, with manual safety belts and advanced occupant protection systems, and a 1995 Mazda Protege LX, four-door sedan

16. *Abstract*

This report covers an on-site investigation of an air bag deployment crash that involved a 2001 Ford Taurus SEL (case vehicle) and a 1995 Mazda Protege LX (other vehicle). This crash is of special interest because the case vehicle was equipped with multiple, advanced, occupant protection systems and the case vehicle's driver (25-year-old male) survived a high speed, head-on, offset frontal crash in which three of the five occupants of the other vehicle died as a result of the collision. The case vehicle was traveling north in the inside through lane of a three-lane, southbound roadway (i.e., the wrong way) that was part of a six-lane, divided, Interstate trafficway (i.e., both the north and southbound roadways had two through lanes and the southbound roadway had an entrance ramp while the northbound roadway had an exit ramp). The Mazda was traveling south in the inside, through lane of the southbound roadway. The crash occurred in the inside southbound through lane of the southbound roadway. The front left half of the case vehicle impacted the front left corner of the Mazda, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The case vehicle rotated approximately 180 degrees counterclockwise post-crash. As a result, the case vehicle departed the road, entered the grass median, contacted the median's "W"-beam guardrail with its back left quarter panel, and came to rest facing south. The Mazda also rotated counterclockwise after its initial impact, crossed two travel lanes, departed the west side of the roadway, and struck a guardrail before rebounding back onto the roadway. The Mazda came to rest diagonally across the southbound roadway, straddling the outside southbound through lane and the acceleration lane (i.e., the entrance ramp). The case vehicle's driver was seated with his seat track in its rearmost position, and the tilt steering wheel was located between its middle and upmost positions. He was restrained by his available, active, three-point, lap-and-shoulder, safety belt system and sustained, according to the Police Crash Report, "A" (incapacitating-evident) injuries, but the exact injuries he sustained are unknown.

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TABLE OF CONTENTS IN01-006

Page No.

SELECTED PHOTOGRAPHS (Continued)

BACKGROUND

IN01-006

This on-site investigation was brought to NHTSA's attention on March 21, 2001, by a law enforcement officer. The crash involved a 2001 Ford Taurus SEL (case vehicle) and a 1995 Mazda Protege LX (other vehicle). The crash occurred in March, 2001, at 1:06 a.m., in Illinois, and was investigated by the applicable state police department. This crash is of special interest because the case vehicle was equipped with multiple, advanced, occupant protection systems and the case vehicle's driver [25-year-old, White (unknown if Hispanic) male] survived a high speed, head-on, offset frontal crash in which three of the five occupants of the other vehicle died as a result of the collision. This contractor inspected the scene and vehicles on 27-28 March, 2001. This contractor was finally able to contact the attorney representing the case vehicle's driver on February 5, 2002, but the driver declined to participate in this research. This report is based on the Police Crash Report, conversations with the investigating police officer, scene and vehicle inspections, occupant kinematic principles, and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle was traveling north in the inside through lane of a three-lane, southbound roadway that was part of a six-lane, divided, Interstate trafficway (i.e., both the north and southbound roadways had two through lanes and the southbound roadway had an entrance ramp while the northbound roadway had an exit ramp). The case vehicle's driver most likely intended to continue traveling north in the inside southbound lane (i.e., the wrong way). The Mazda was traveling south in the inside, through lane of the southbound roadway that was part of the same six-lane, divided, Interstate trafficway and most likely intended to continue traveling southward. According to the investigating officers, the case vehicle's driver made no known avoidance maneuvers prior to the crash. As the case vehicle was nearing completion of a left-hand curve and the Mazda was just entering the same curve from the opposing direction (a right-hand curve for the Mazda), an optical illusion created by the roadway curvature and darkness may well have delayed each driver's awareness that another vehicle was occupying the same travel lane. Based on the narrow front corner engagement and subsequent penetration into the driver's space that the Mazda sustained and based on the police investigation, the Mazda's driver braked and attempted to steer rightward just prior to the crash. The crash occurred in the inside southbound through lane of the southbound roadway; see **CRASH DIAGRAM** below.

The front left half of the case vehicle impacted the front left corner of the Mazda, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The case vehicle rotated approximately 180 degrees counterclockwise post-crash. As a result, the case vehicle departed the road, entered the grass median, contacted the median's "W"-beam guardrail with its back left quarter panel, and came to rest facing south. The Mazda also rotated counterclockwise after its initial impact, crossed two travel lanes, departed the west side of the roadway, and struck a guardrail before rebounding back onto the roadway. The Mazda came to rest diagonally across the southbound roadway, straddling the outside southbound through lane and the acceleration lane (i.e., the entrance ramp).

The 2001 Ford Taurus SEL was a front wheel drive, four-door sedan (VIN: 1FAFP56S21G------). The case vehicle was equipped with four-wheel, anti-lock brakes.

Additionally, the case vehicle was equipped with electronically adjustable brake and accelerator pedals and safety belt pretensioners. Based on the vehicle inspection, the CDCs for the case vehicle were determined to be: **12-FYEK-6 (350)**, **11-LZEW-2 (340)**, and **06-BLES-5 (170)**. The WinSMASH reconstruction program, damage only algorithm, was used on the case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 41.0 km.p.h. (25.5 m.p.h.), -40.4 km.p.h. (-25.1 m.p.h.), and +7.1 km.p.h. (+4.4 m.p.h.). In this contractor's opinion, these WinSMASH reconstruction results appear to be low. The case vehicle was towed due to damage.

The case vehicle's contact with the Mazda involved the front left half. Direct damage began 62 centimeters (24.4 inches) to the left of the front right bumper corner and extended an additional 65 centimeters (25.6 inches) to the front left bumper corner. Maximum crush was measured as 166 centimeters (65.4 inches) from the front bumper to the post-crash left front axle end (i.e., at C_1). Residual maximum crush was measured as 87 centimeters (34.3 inches) at C_1. Direct contact damage along the case vehicle's left side ended just rearward of the left "B"-pillar's forward seam, a distance of 247 centimeters (97.2 inches). Direct damage along the case vehicle's left side included separating the left front wheel at the axle end, deflecting the forward end of the left rocker panel inboard 35 centimeters (13.8 inches), and shoving the bottom portion of the left upper "A"-pillar rearward 38 centimeters (15.0 inches). The wheelbase on the case vehicle's left side was shortened 63 centimeters (24.8 inches) while the right side was extended 12 centimeters (4.7 inches).

The front bumper fascia, air dam, and front bumper reinforcement bar were separated from the case vehicle. The front grille and the front left headlamp assembly are missing and the left side of the radiator is folded rearward. Also impacted was the left side of the frame's forward cross-member. The left fender was pushed into the lower left "A"-pillar, separating the left front wheel assembly and a portion of its suspension system. The hood was rotated to the left and its left half was displaced rearward and tented near its left side mid-point. Sheet metal covering of the left front door was separated. The right headlight and turn signal assemblies, the hood, the right fender and the right front and rear doors all sustained induced damage as well. Remote buckling was also found on the left roof near the left "B"-pillar. The windshield's glazing was cracked and both left side window glazings were disintegrated. The right front window glazing was broken out by rescue personnel.

The second impact to the case vehicle occurred from contact with the median's "W"-beam guardrail and resulted in sideswipe-type direct damage to the left quarter panel at the height of the rear bumper fascia. Direct damage began at the back left bumper corner and extended 10 centimeters (3.9 inches) along the back bumper toward the right. Maximum crush was measured as 6 centimeters (2.4 inches). The direct contact damage associated with this impact also began at the back left bumper corner and extended a measured distance of 64 centimeters (25.2 inches) forward toward the left rear wheel. The case vehicle's back bumper fascia and left fender were directly contacted.

Both the case vehicle's driver and front right passenger air bags were cut out by the investigating police officer and shipped to a laboratory for analysis. The case vehicle's driver air

bag was located in the steering wheel hub. An inspection of the air bag module's cover flaps revealed that the cover flaps opened at their designated tear points and there appeared to be neither damage nor contact evidence on the surface of either flap. The module cover flaps were in an asymmetrical, trapezoidal configuration, with the upper cover flap measuring 17.0 centimeters (6.7 inches) horizontally along its lower horizontal seam, 15.5 centimeters (6.1 inches) along its top horizontal seam, and 8 centimeters (3.1 inches) vertically. The lower cover flap measured 17.0 centimeters (6.7 inches) along its top horizontal seam, 12.5 centimeters (4.9 inches) along its bottom horizontal seam, and 5 centimeters (2.0 inches) vertically. This contractor discovered what appeared to be remnants of two tethers, each 6 centimeters (2.4 inches) in width, located inside the steering wheel hub. With the air bag fabric removed, the existence, number, and size of vent ports could not be assessed nor could the shape or size of the driver's air bag be described. Comments by the investigating police officer indicated that there were blood stains on the fabric of the driver's air bag, but their exact locations are unknown.

The front right passenger's air bag was located in the top of the instrument panel. An inspection of the front right air bag module's cover flap revealed that it opened at the designated tear points, and there appeared to be neither damage nor contact evidence on the flap's surface. There was a single, essentially rectangular, modular cover flap. The cover flap was made of a thick vinyl over a thick cardboard type frame. The flap's dimensions were: 27.5 centimeters (10.8 inches) at the lower horizontal seam and 12.0 centimeters (4.7 inches) along both vertical seams. The profile of the case vehicle's instrument panel resulted in an 8 centimeter (3.1 inch) setback of the leading edge of the cover flap relative to the protruding right instrument panel. With the air bag's fabric removed, the existence, number, and size of tethers or vent ports could not be assessed nor could the shape or size of the front right passenger's air bag be described. The investigating police officer made no mention of any evidence of contact or damage to the air bag's fabric.

The Restraints Control Module (RCM) was removed from the case vehicle and sent to the manufacturer for data download. The data downloaded from the case vehicle's **RCM** included the vehicle's diagnostic codes active when the event occurred, driver and passenger seat belt buckle status, time from algorithm wake-up to pretensioner deployment, time from algorithm wake-up to deployment (i.e., air bag deployments) and longitudinal and lateral velocity change (i.e., Delta V). According to the manufacturer: "…it appears the power to the module was lost before any recording could take place." and "The crash severity data came up 'No data'." See the section entitled **RESTRAINTS CONTROL MODULE DATA** below. Included in this section are the Summary Page, the Longitudinal Cumulative Delta-V Chart, and the Lateral Cumulative Delta-V Chart.

Inspection of the case vehicle's interior revealed eight additional locations of occupant contact and/or injury evidence. The left instrument panel contained a scrape mark and body fluid. The top left corner of the left instrument panel had blood splatters, while the underneath side of the steering column and the right side of the left instrument panel displayed scrapes. Furthermore, a long scrape mark was discovered on the lower portion of the interior panel of the driver's door, and a small body fluid smear was detected on the left side of the steering wheel rim. In addition, the roof fabric above the driver's seat had a scrape mark and hair strands. There was extensive intrusion to the driver's seating area including toe and floor pans, left front door panel and rocker

panel, and left instrument panel area. Finally, the steering column was loose, post-crash, indicating shear capsule separation.

The electronically adjustable brake and accelerator pedals were examined as well as the pretensioners. Post-crash, the brake pedal was extended towards the driver's seat by 9 centimeters (3.5 inches) and the accelerator pedal by 7 centimeters (2.8 inches). Given the height [185 centimeters (73 inches)] of the case vehicle's driver, it is highly unlikely he would have found it necessary to have extended the pedals. Rather, the severe lateral intrusion to the driver's toe pan and floor pan areas likely lifted and shifted (to the right) the pedals with sufficient force to expand the arm travel of both. An attempt was made to examine the safety belt pretensioners; however, because of the severe intrusion, the likely actuation of the driver's pretensioner was not verified or measured.

The 1995 Mazda Protege LX was a front wheel drive, four-door sedan (VIN: JM1BA1412S0------). The Mazda was not equipped with four wheel, anti-lock brakes. Based on the vehicle inspection the CDCs for the Mazda were determined to be: **12-FLAE-9 (350)** and **02-RZEW-3 (50)**. The WinSMASH reconstruction program, damage only algorithm, was used on the Mazda's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 45.0 km.p.h. (28.0 m.p.h.), -44.3 km.p.h. (-27.5 m.p.h.), and + 7.8 km.p.h. (+ 4.8 m.p.h.). The Mazda was towed due to damage.

The Mazda's contact with the case vehicle involved its front left corner. Direct damage began at the front left bumper corner and extended, a measured distance of 18 centimeters (7.1 inches), along the front bumper toward the right. The Field L extended from bumper corner to bumper corner, a measured distance of 128 centimeters (50.4 inches). Residual maximum crush was measured as 73 centimeters (28.7 inches) at C_1. Direct contact damaged extend down the Mazda's left side, beyond the left rear wheel, and was measured as 387 centimeters (152.4 inches). The wheelbase on the case vehicle's left side was shortened 57 centimeters (22.4 inches) while the right side was unaltered from the crash. The left front tire was missing and the left front wheel and suspension were driven backwards into the driver's seating area. The left rear tire was physically restricted and deflated.

The exact posture of the case vehicle's driver [185 centimeters and 79 kilograms (73 inches, 175 pounds)] immediately prior to the crash is unknown, but he was most likely seated, approximately upright, with his back against or near the seat back, his left foot on the floor, his right foot on the accelerator pedal, and at least one hand on the steering wheel rim. In addition, the exact position of his hands is unknown. However, with the case vehicle completing a left curve, at a speed that witnesses reported to the police as high [i.e., greater than 113 km.p.h. (70 m.p.h.) and maybe as high as 145 km.p.h. (90 m.p.h.)], and where the adjacent curve on the northbound roadway had numerous CURVE warning signs, the driver's weight may have shifted slightly to his right. Although the driver's seat cushion, seat back, and seat track were deformed by the intruding left front door panel and left rocker panel, his seat back seemed to be aligned with the front right passenger's seat back that was measured at its rearmost track position. Considering the driver's seat deformity, the driver's seat back was slightly reclined, and the tilt steering wheel

was located between its middle and upmost positions. According to the police investigation, the driver's blood alcohol at the time of admission to the hospital was measured as 0.252 g/dl (0.252).

According to the Police Crash Report, the case vehicle's driver was restrained by his available, active, three-point, lap-and-shoulder, safety belt system. Missing from the case vehicle was the driver's safety belt, which had been cut and removed by the investigating officer. Missing as well was the driver's safety belt latch plate and both frontal air bags. According to the police investigation, they noted loading evidence on the driver's safety belt webbing and buckle and concluded that he had been restrained.

The case vehicle's driver made no known pre-crash avoidance maneuvers. As a result and independent of the use of his available safety belts, his pre-impact body position did not change just prior to impact. The case vehicle's offset frontal impact with the Mazda enabled the driver to continue forward and slightly upward toward the case vehicle's **350** degree Direction of Principal Force as the case vehicle decelerated. The case vehicle's driver loaded his safety belt system and contacted his deploying driver air bag. The force of the collision caused the steering column to be loaded, collapsing the shear capsules. In fact, intruding components from the instrument panel were pushed over the steering wheel rim. In addition, the case vehicle's driver contacted the instrument panel left and right of the steering column. The counterclockwise rotation caused the case vehicle's driver to move slightly to his right initially, but his safety belts and driver air bag restricted his movement. As the case vehicle continued to rotate counterclockwise, the driver rebounded backwards off of his deploying driver air bag and safety belts, slightly leftward (due to the rotation), upward where he contacted the roof–left of the dome light, and finally backwards into his seat back. The case vehicle's impact with the median's "W"-beam guardrail had little, if any, affect on the driver's movement within the vehicle. According to the police investigation, the driver's foot was pinned in the vehicle under the brake pedal by the intruding left toe pan and he was still in the driver's seat at final rest. Rescue personnel broke out the right front window glazing in order to get to the driver.

The driver was transported by ambulance to a medical facility. According to the Police Crash Report, he sustained "A" (incapacitating-evident) injuries. According to media accounts, he was hospitalized for 7 days post-crash. Conversations with the investigating police officer indicated that the case vehicle's driver was hospitalized with facial lacerations and fractures to both ankles. Because of the lack of medical records and the fact that the case vehicle's driver and front right passenger air bags were cut out of the vehicle and sent to a police laboratory for analysis, this contractor cannot link the driver's air bag to any potential contacts by the driver's face or torso.

As indicated by the Police Crash Report, three of the five occupants of the Mazda were fatally injured in this crash [i.e., the driver (19-year-old male), the back left passenger (20-year-old female), and the back center passenger (19-year-old female)]. Both the front right passenger (20-year-old male) and the back right passenger (19-year-old male) sustained "A" (incapacitating) injuries) and survived. All five occupants were restrained.

The case vehicle was traveling north in the inside through lane (**Figure 1**) of a three-lane, southbound roadway that was part of a six-lane, divided, Interstate trafficway (i.e., both the north and southbound roadways had two through lanes and the southbound roadway had an entrance ramp while the northbound roadway had an exit ramp). The case vehicle's driver most likely intended to continue traveling north in the inside southbound lane (i.e., the wrong way). The Mazda was traveling south in the inside, through lane of the southbound roadway that was part of the same six-lane, divided, Interstate trafficway and most likely intended to continue traveling southward (**Figure 2**). According to the investigating officers, the case vehicle's driver made no known avoidance maneuvers prior to the crash. As the case vehicle was nearing completion of a left-hand curve (**Figure 1**) and the Mazda was just entering the same curve from the opposing direction (a right-hand curve for the Mazda–**Figure 3**), an optical illusion created by the roadway curvature and darkness may well have delayed each driver's awareness that another vehicle was occupying the same travel lane. Based on the narrow front corner engagement and subsequent penetration into the driver's space that the Mazda sustained and based on the police investigation, the Mazda's driver braked and attempted to steer rightward just prior to the crash. The crash occurred in the inside southbound through lane of the southbound roadway; see **CRASH DIAGRAM** below.

Figure 1: Case vehicle's northerly travel path in inside, southbound lane of southbound roadway; Note: southbound roadway has a curve right horizontal alignment (case photo #03)

Figure 2: Mazda's southerly travel path in inside southbound lane prior to entering right-hand curve; Note: crash occurred just south of first overpass (case photo #11)

Figure 3: Case vehicle's final rest position heading southward; Note: case vehicle rotated counter-clockwise post-crash and contacted median guardrail before coming to rest (case photo #09)

The interstate highway was curved to the right [i.e., 2,438.4 meter (8,000 foot) radius] for southbound traffic and level (i.e., actual slope was 0.17%, negative to the south for the inside southbound lane, and 0.35%, negative to the south for the outside southbound lane), at the area of impact. The pavement was bituminous, but traveled, and the pre-crash width of the inside southbound through lane was 3.5 meters (11.4 feet), the outside through lane was 3.8 meters (12.3 feet), and the acceleration lane was 4.2 meters (13.7 feet). At the point of maximum engagement the acceleration lane and the outside through lane had merged and the width of the combined lanes

was 7.9 meters (26.0 feet). The east side of the southbound road had a 1.5meter (4.9 foot) paved shoulder and the west side had a 1.3 meter (4.2 foot) paved shoulder, prior to the 10.1 meter (33 feet) wide grassy median. Pavement markings consisted of dashed white line that separated the inside and outside through lanes. In addition, the roadway was bordered by a solid yellow edge line on the east side and a solid white edge line on west side. Although a solid white lane line was used to separate the outside through lane from the acceleration lane, the line disappeared as the two lanes merged toward the immediate area of the crash. The estimated wet coefficient of friction was 0.70. There were no visible traffic controls in the immediate area of the crash. The posted speed limit was 105 km.p.h. (65 m.p.h.). At the time of the crash the light condition was dark, but illuminated by overhead street lamps at the area of impact, the atmospheric condition was light snow, and the road pavement was wet. Traffic density was light, and the site of the crash was rural undeveloped.

Figure 4: Case vehicle and damaged components; Note: direct frontal damage was primarily offset toward front left (case photo #13)

Figure 5: Case vehicle's front left damage with contour gauge present (case photo #14)

Figure 6: Mazda's narrow front left corner damage viewed from front; Note: front bumper fascia missing and driver's door toward right of photo (case photo #56)

Figure 7: Mazda's frontal impact showing narrow end engagement and extensive damage and penetration to left side (case photo #62)

The front left half of the case vehicle (**Figures 4** and **5**) impacted the front left corner of the Mazda (**Figures 6** and **7**), causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The case vehicle rotated approximately 180 degrees counterclockwise post-crash (**Figure 3** above). As a result, the case vehicle departed the road, entered the grass median, contacted the median's "W"-beam guardrail with its back left quarter

panel (**Figure 8**), and came to rest facing south (**Figure 9**). The Mazda also rotated counter-clockwise after its initial impact, crossed two travel lanes, departed the west side of the roadway, and struck a guardrail before rebounding back onto the roadway. The Mazda came to rest diagonally across the southbound roadway, straddling the outside southbound through lane and the acceleration lane (i.e., the entrance ramp–**Figure 10**).

Figure 8: Case vehicle's back left sideswipe damage from contact with the median guardrail (case photo #24)

CASE VEHICLE

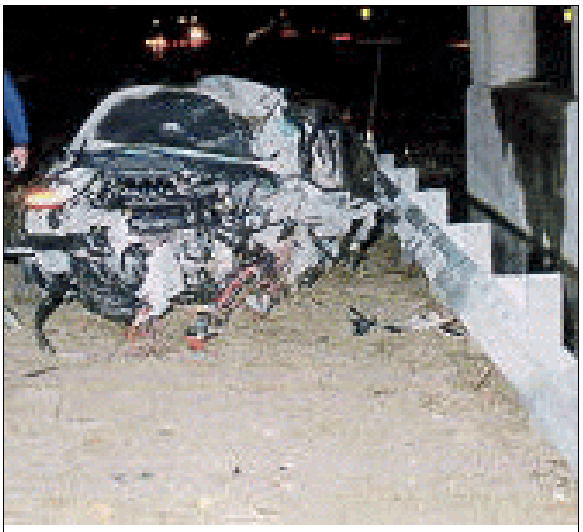


Figure 9: On scene view of case vehicle's final rest position, heading south, near median guardrail underneath overpass (case photo #89)

Figure 10: On-scene view of Mazda's final rest position, heading east-southeast, straddling acceleration lane, showing proximity to west guardrail (case photo #90)

The 2001 Ford Taurus SEL was a front wheel drive, six-passenger, four-door sedan (VIN: 1FAFP56S21G------) equipped with a 3.0L, V-6 engine and a four-speed automatic transmission with the selector lever on the steering column. Additionally, the case vehicle was equipped with electronically adjustable brake and accelerator pedals and safety belt pretensioners. Braking was achieved by a power-assisted, front disc and rear drum, four-wheel, anti-lock system. The case vehicle's wheelbase was 276 centimeters (108.5 inches), and the odometer reading at inspection is unknown because the vehicle was equipped with an electronic odometer.

Inspection of the vehicle's interior revealed a split bench seat with separate back cushions and adjustable head restraints for the outboard seating positions; a non-adjustable back bench seat without head restraints for the back seating positions; continuous loop, three-point, lap-and-shoulder, safety belt systems at the front outboard positions and all three back positions; and a two-point, lap belt system at the front center position. The front seat belt systems were equipped with manually operated, upper anchorage adjusters for the "D"-rings. Both the driver and front

right passenger positions had their upper anchorage adjusters located in the upmost positions. The vehicle was equipped with knee bolsters for both the driver and front right passenger, and there was scuffing on the driver's knee bolster to the right of the steering column. Automatic restraint was provided by a Supplemental Restraint System (SRS) that consisted of a frontal air bag for the driver and front right passenger seating positions. Both frontal air bags deployed as a result of the case vehicle's frontal impact with the Mazda.

CASE VEHICLE DAMAGE

Figure 11: Damage extends down case vehicle's left side as a result of frontal impact; Note: arrow locates lower portion of left upper "A"-pillar (case photo #21)

The case vehicle's contact with the Mazda involved the front left half (**Figures 4** and **5** above). Direct damage began 62 centimeters (24.4 inches) to the left of the front right bumper corner and extended an additional 65 centimeters (25.6 inches) to the front left bumper corner. Maximum crush was measured as 166 centimeters (65.4 inches) from the front bumper to the post-crash left front axle end (i.e., at C_1). Residual maximum crush was measured as 87 centimeters (34.3 inches) at C_1. Direct contact damage along the case vehicle's left side ended just rearward of the left "B"-pillar's forward seam (**Figure 11**), a distance of 247 centimeters (97.2 inches). Direct damage along the case vehicle's left side included separating the left front wheel at the axle end, deflecting the forward end of the left rocker panel inboard 35 centimeters (13.8 inches), and shoving the bottom portion of the left upper "A"-pillar rearward 38 centimeters (15.0 inches). The wheelbase on the case vehicle's left side was shortened 63 centimeters (24.8 inches) while the right side was extended 12 centimeters (4.7 inches).

The front bumper fascia, air dam, and front bumper reinforcement bar were separated from the case vehicle (**Figure 4** above). The front grille and the front left headlamp assembly are missing and the left side of the radiator is folded rearward. Also impacted was the left side of the frame's forward cross-member. The left fender was pushed into the lower left "A"-pillar, separating the left front wheel assembly and a portion of its suspension system. The hood was rotated to the left and its left half was displaced rearward and tented near its left side mid-point. Sheet metal covering of the left front door was separated. The right headlight and turn signal assemblies, the hood, the right fender and the right front and rear doors all sustained induced damage as well. Remote buckling was also found on the left roof near the left "B"-pillar. The windshield's glazing was cracked and both left side window glazings were disintegrated. The right front window glazing was broken out by rescue personnel.

The second impact to the case vehicle occurred from contact with the median's "W"-beam guardrail and resulted in sideswipe-type direct damage to the left quarter panel at the height of the rear bumper fascia (**Figure 8** above). Direct damage began at the back left bumper corner and extended 10 centimeters (3.9 inches) along the back bumper toward the right. Maximum crush was measured as 6 centimeters (2.4 inches). The direct contact damage associated with this impact

also began at the back left bumper corner and extended a measured distance of 64 centimeters (25.2 inches) forward toward the left rear wheel. The case vehicle's back bumper fascia and left fender were directly contacted.

Inspection of the case vehicle's interior revealed eight additional locations of occupant contact and/or injury evidence. The left instrument panel contained a scrape mark and body fluid. The top left corner of the left instrument panel had blood splatters, while the underneath side of the steering column and the right side of the left instrument panel displayed scrapes. Furthermore, a long scrape mark was discovered on the lower portion of the interior panel of the driver's door, and a small body fluid smear was detected on the left side of the steering wheel rim. In addition, the roof fabric above the driver's seat had a scrape mark and hair strands. There was extensive intrusion to the driver's seating area including toe and floor pans, left front door panel and rocker panel, and left instrument panel area (**Figure 12**). Finally, the steering column was loose, post-crash, indicating shear capsule separation.

Figure 12: Case vehicle's front seating area viewed from right showing distortion of instrument panel and intrusion into driver's seating area; Note: contact evidence on driver's door and remnant of front right passenger air bag (case photo #42)

The electronically adjustable brake and accelerator pedals were examined (**Figure 13**) as well as the pretensioners. Post-crash, the brake pedal was extended towards the driver's seat by 9 centimeters (3.5 inches) and the accelerator pedal by 7 centimeters (2.8 inches). Given the height [185 centimeters (73 inches)] of the case vehicle's driver, it is highly unlikely he would have found it necessary to have extended the pedals. Rather, the severe lateral intrusion to the driver's toe pan and floor pan areas likely lifted and shifted (to the right) the pedals with sufficient force to expand the arm travel of both. An attempt was made to examine the safety belt pretensioners; however, because of the severe intrusion, the likely actuation of the driver's pretensioner was not verified or measured.

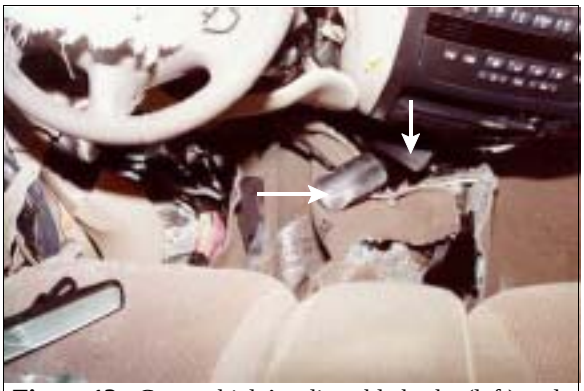


Figure 13: Case vehicle's adjustable brake (left) and accelerator (right) pedals; Note: severe toe and floor pan deformation and arrows locating pedals (case photo #40)

Based on the vehicle inspection, the CDCs for the case vehicle were determined to be: **12-FYEK-6 (350)**, **11-LZEW-2 (340)**[1], and **06-BLES-5 (170)**. The WinSMASH reconstruction

[1] This CDC is associated with the first CDC (i.e., **12-FYEK-6**) by means of the "K" designation in the 6th column of the first CDC. Currently because of data entry issues, the second CDC from a "K"-conversion is not entered in the NASS Electronic Data Collection System (EDCS). In the EDCS for this case, an annotation has been entered on the first CDC to alert readers of its presence.

program, damage only algorithm, was used on the case vehicle's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 41.0 km.p.h. (25.5 m.p.h.), -40.4 km.p.h. (-25.1 m.p.h.), and +7.1 km.p.h. (+4.4 m.p.h.). In this contractor's opinion, these WinSMASH reconstruction results appear to be low. The case vehicle was towed due to damage.

AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with a Supplemental Restraint System (SRS) that contained redesigned frontal air bags at the driver and front right passenger positions. Both frontal air bags deployed as a result of the frontal impact with the Mazda. Both the case vehicle's driver and front right passenger air bags were cut out by the investigating police officer and shipped to a laboratory for analysis. The case vehicle's driver air bag was located in the steering wheel hub (**Figure 14**). The module cover flaps were in an asymmetrical, trapezoidal configuration, with the upper cover flap measuring 17.0 centimeters (6.7 inches) horizontally along its lower horizontal seam, 15.5 centimeters (6.1 inches) along its top horizontal seam, and 8 centimeters (3.1 inches) vertically. The lower cover flap measured 17.0 centimeters (6.7 inches) along its top horizontal seam, 12.5 centimeters (4.9 inches) along its bottom horizontal seam, and 5 centimeters (2.0 inches) vertically. An inspection of the air bag module's cover flaps revealed that the cover flaps opened at their designated tear points and there appeared to be neither damage nor contact evidence on the surface of either flap. This contractor discovered what appeared to be remnants of two tethers, each 6 centimeters (2.4 inches) in width, located inside the steering wheel hub. With the air bag fabric removed, the existence, number, and size of vent ports could not be assessed nor could the shape or size of the driver's air bag be described. Comments by the investigating police officer indicated that there were blood stains on the fabric of the driver's air bag, but their exact locations are unknown.

Figure 14: Fabric remnants of case vehicle's steering wheel-mounted driver air bag; Note: air bag cut out by investigating police officer (case photo #39)

The front right passenger's air bag was located in the top of the instrument panel. There was a single, essentially rectangular, modular cover flap. The cover flap was made of a thick vinyl over a thick cardboard type frame. The flap's dimensions were: 27.5 centimeters (10.8 inches) at the lower horizontal seam and 12.0 centimeters (4.7 inches) along both vertical seams. The profile of the case vehicle's instrument panel resulted in an 8 centimeter (3.1 inch) setback of the leading edge of the cover flap relative to the protruding right instrument panel. An inspection of the front right air bag module's cover flap revealed that it opened at the designated tear points, and there appeared to be neither damage nor contact evidence on the flap's surface. With the air bag's fabric removed, the existence, number, and size of tethers or vent ports could not be assessed nor could the shape or size of the front right passenger's air bag be described. The investigating police officer made no mention of any evidence of contact or damage to the air bag's fabric.

The Restraints Control Module (RCM) was removed from the case vehicle and sent to the manufacturer for data download. The data downloaded from the case vehicle's **RCM** included the vehicle's diagnostic codes active when the event occurred, driver and passenger seat belt buckle status, time from algorithm wake-up to pretensioner deployment, time from algorithm wake-up to deployment (i.e., air bag deployments) and longitudinal and lateral velocity change (i.e., Delta V). According to the manufacturer: "…it appears the power to the module was lost before any recording could take place." and "The crash severity data came up 'No data'." See the section entitled **RESTRAINTS CONTROL MODULE DATA** below (i.e., **Figures 19** through **21**). Included in this section are the Summary Page, the Longitudinal Cumulative Delta-V Chart, and the Lateral Cumulative Delta-V Chart.

CASE VEHICLE DRIVER KINEMATICS

The exact posture of the case vehicle's driver [185 centimeters and 79 kilograms (73 inches, 175 pounds)] immediately prior to the crash is unknown, but he was most likely seated, approximately upright, with his back against or near the seat back, his left foot on the floor, his right foot on the accelerator pedal, and at least one hand on the steering wheel rim. In addition, the exact position of his hands is unknown. However, with the case vehicle completing a left curve, at a speed that witnesses reported to the police as high [i.e., greater than 113 km.p.h. (70 m.p.h.) and maybe as high as 145 km.p.h. (90 m.p.h.)], and where the adjacent curve on the northbound roadway had numerous CURVE warning signs, the driver's weight may have shifted slightly to his right. Although the driver's seat cushion, seat back, and seat track were deformed by the intruding left front door panel and left rocker panel, his seat back seemed to be aligned with the front right passenger's seat back that was measured at its rearmost track position. Considering the driver's seat deformity, the driver's seat back was slightly reclined, and the tilt steering wheel was located between its middle and upmost positions. According to the police investigation, the driver's blood alcohol at the time of admission to the hospital was measured as 0.252 g/dl (0.252).

According to the Police Crash Report, the case vehicle's driver was restrained by his available, active, three-point, lap-and-shoulder, safety belt system. Missing from the case vehicle was the driver's safety belt, which had been cut and removed by the investigating officer. Missing as well was the driver's safety belt latch plate and both frontal air bags. According to the police investigation, they noted loading evidence on the driver's safety belt webbing and buckle and concluded that he had been restrained.

The case vehicle's driver made no known pre-crash avoidance maneuvers. As a result and independent of the use of his available safety belts, his pre-impact body position did not change just prior to impact. The case vehicle's offset frontal impact with the Mazda enabled the driver to continue forward and slightly upward toward the case vehicle's **350** degree Direction of Principal Force as the case vehicle decelerated. The case vehicle's driver loaded his safety belt system and contacted his deploying driver air bag. The force of the collision caused the steering column to be loaded, collapsing the shear capsules. In fact, intruding components from the instrument panel were pushed over the steering wheel rim. In addition, the case vehicle's driver contacted the instrument panel left and right of the steering column. The counterclockwise

rotation caused the case vehicle's driver to move slightly to his right initially, but his safety belts and driver air bag restricted his movement. As the case vehicle continued to rotate counterclockwise, the driver rebounded backwards off of his deploying driver air bag and safety belts, slightly leftward (due to the rotation), upward where he contacted the roof–left of the dome light (**Figure 15**), and finally backwards into his seat back. The case vehicle's impact with the median's "W"-beam guardrail had little, if any, affect on the driver's movement within the vehicle. According to the police investigation, the driver's foot was pinned in the vehicle under the brake pedal by the intruding left toe pan and he was still in the driver's seat at final rest. Rescue personnel broke out the right front window glazing in order to get to the driver.

Figure 15: Contact evidence on case vehicle's roof deposited by driver's head during rebound from initial impact with Mazda (case photo #41)

CASE VEHICLE DRIVER INJURIES

The driver was transported by ambulance to a medical facility. According to the Police Crash Report, he sustained "A" (incapacitating-evident) injuries. According to media accounts, he was hospitalized for 7 days post-crash. Conversations with the investigating police officer indicated that the case vehicle's driver was hospitalized with facial lacerations and fractures to both ankles. Because of the lack of medical records and the fact that the case vehicle's driver and front right passenger air bags were cut out of the vehicle and sent to a police laboratory for analysis, this contractor cannot link the driver's air bag to any potential contacts by the driver's face or torso.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Fracture right ankle, not further specified	852002.2 moderate	Toe pan	Probable	Police {conversation}
2	Fracture left ankle, not further specified	852002.2 moderate	Foot controls	Probable	Police {conversation}
3	Lacerations face, not further specified	290600.1 minor	Unknown contact mechanism	Unknown	Police {conversation}

OTHER VEHICLE

The 1995 Mazda Protege LX was a front wheel drive, five-passenger, four-door sedan (VIN: JM1BA1412S0------) equipped with a 1.5L, I-4 engine and a five-speed, manual transmission with the shift lever on the console. The Mazda was also equipped with driver and front right passenger supplemental restraints (air bags) that deployed as a result of the frontal

collision with the case vehicle (**Figure 16**). The Mazda was not equipped with four wheel, anti-lock brakes. The Mazda's wheelbase was 261 centimeters (102.6 inches), and the odometer reading at inspection is unknown.

Figure 16: Mazda's deployed driver and front right passenger air bags viewed from right near "B"-pillar (case photo #85)

The Mazda's contact with the case vehicle involved its front left corner (**Figures 6** and **7** above). Direct damage began at the front left bumper corner and extended, a measured distance of 18 centimeters (7.1 inches), along the front bumper toward the right. The Field L extended from bumper corner to bumper corner, a measured distance of 128 centimeters (50.4 inches). Residual maximum crush was measured as 73 centimeters (28.7 inches) at C_1. Direct contact damaged extend down the Mazda's left side, beyond the left rear wheel (**Figure 17**), and was measured as 387 centimeters (152.4 inches). The wheelbase on the case vehicle's left side was shortened 57 centimeters (22.4 inches) while the right side was unaltered from the crash. The left front tire was missing and the left front wheel and suspension were driven backwards into the driver's seating area (**Figure 7** above). The left rear tire was physically restricted and deflated (**Figure 17**).

Figure 17: Mazda's very narrow frontal impact and extensive left side damage viewed from left; Note: vertical line marks end of direct contact (case photo #67)

Based on the vehicle inspection the CDCs for the Mazda were determined to be: **12-FLAE-9 (350)** and **02-RZEW-3 (50)**. The WinSMASH reconstruction program, damage only algorithm, was used on the Mazda's highest severity impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 45.0 km.p.h. (28.0 m.p.h.), -44.3 km.p.h. (-27.5 m.p.h.), and +7.8 km.p.h. (+4.8 m.p.h.). The Mazda was towed due to damage.

Figure 18: Mazda's driver seat viewed from left, showing deployed driver air bag; Note: driver was declared dead at the scene (case photo #82)

As indicated by the Police Crash Report, three of the five occupants of the Mazda were fatally injured in this crash [i.e., the driver (19-year-old male–**Figure 18**), the back left passenger (20-year-old female), and the back center passenger (19-year-old female)]. Both the front right passenger (20-year-old male) and the back right passenger (19-year-old male) sustained "A" (incapacitating) injuries) and survived. All five occupants were restrained.

Investigation Data

File Name:	IN01-006.ABS	File Save Date:	04-Apr-2001
File Read-out Date:	N/A	Report Date:	05-Apr-2001
Report Version:	1.6		

EDR Control Module Data

Data Validity Check:	Valid	EDR Model Version:	141
Time From Side Safing Decision to Left (Driver) Side Bag Deployment:			Not Deployed
Time From Side Safing Decision to Right (Passenger) Side Bag Deployment:			Not Deployed
Passenger Airbag Switch Position During Event:			N/A
Diagnostic Codes Active When Event Occurred:			0

Algorithm Times — Actual initiation depends on restraint system status (below).	ms
Time From Algorithm Wakeup to Pretensioner:	0
Time From Algorithm Wakeup to First Stage - Unbelted:	0
Time From Algorithm Wakeup to First Stage - Belted:	0
Time From Algorithm Wakeup to Second Stage:	0

Algorithm Times — Actual initiation depends on restraint system status (below).	ms
Time From Algorithm Wakeup to Pretensioner:	0
Time From Algorithm Wakeup to First Stage - Unbelted:	0
Time From Algorithm Wakeup to First Stage - Belted:	0
Time From Algorithm Wakeup to Second Stage:	0

Restraint System Status

Driver Seat Belt Buckle:	Not Engaged
Passenger Seat Belt Buckle:	Not Engaged
Driver Seat Track In Forward Position:	No
Passenger Seat Weight Switch Position:	N/A

Deployment Initiation Attempt Times	Driver	Passenger
Time From Algorithm Wakeup to Pretensioner Deployment Attempt:	Not Deployed	Not Deployed
Time From Algorithm Wakeup to First Stage Deployment Attempt:	Not Deployed	Not Deployed
Time From Algorithm Wakeup to Second Stage Deployment Attempt:	Not Deployed	Not Deployed

Figure 19: Control module data, algorithm times, and restraint system data

Longitudinal Cumulative Delta-V

Time (ms)	0	10	20	30	40	50	60	70	78
Delta-V (MPH)	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data

Note: Acceleration data and plots are only valid for frontal impact event recordings.

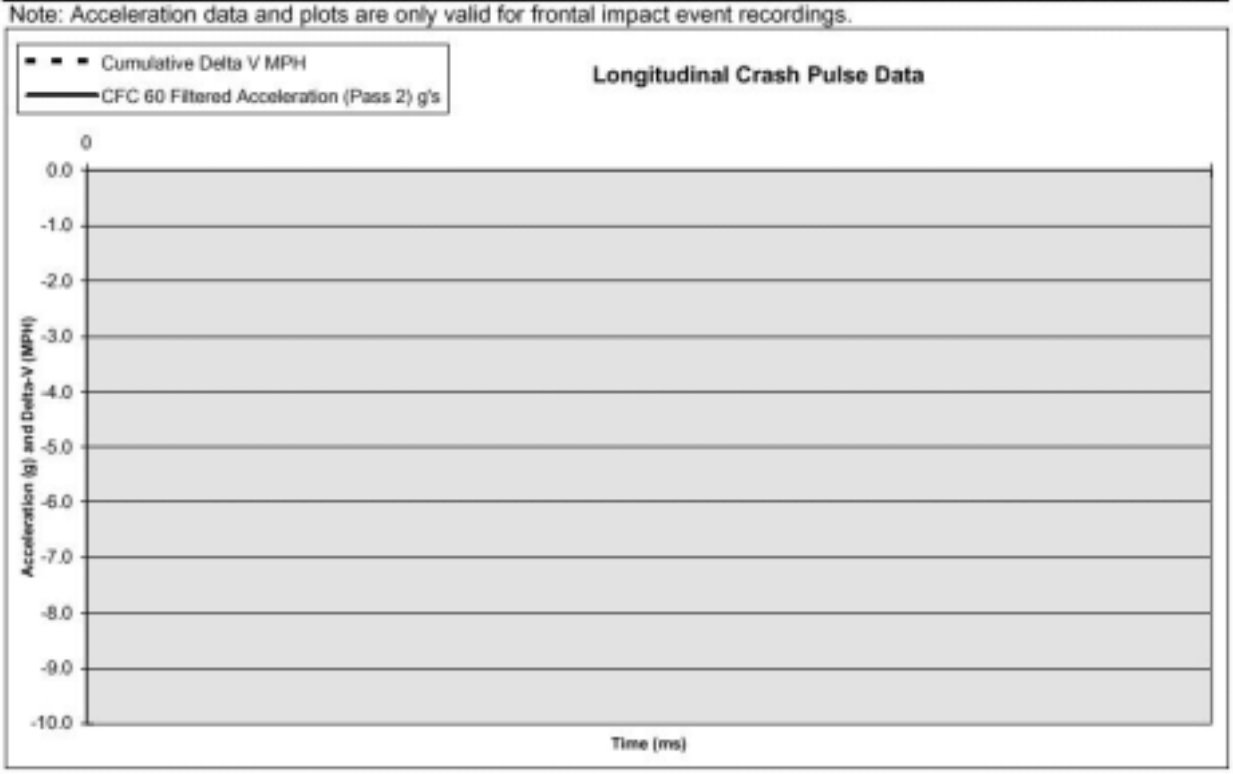


Figure 20: Cumulative Longitudinal Delta V versus Delta T

Lateral Cumulative Delta-V

Time (ms)	0	10	20	30	40	50	60	70	78
Delta-V (MPH)	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data	No Data

Note: Acceleration data and plots are only valid for frontal impact event recordings.

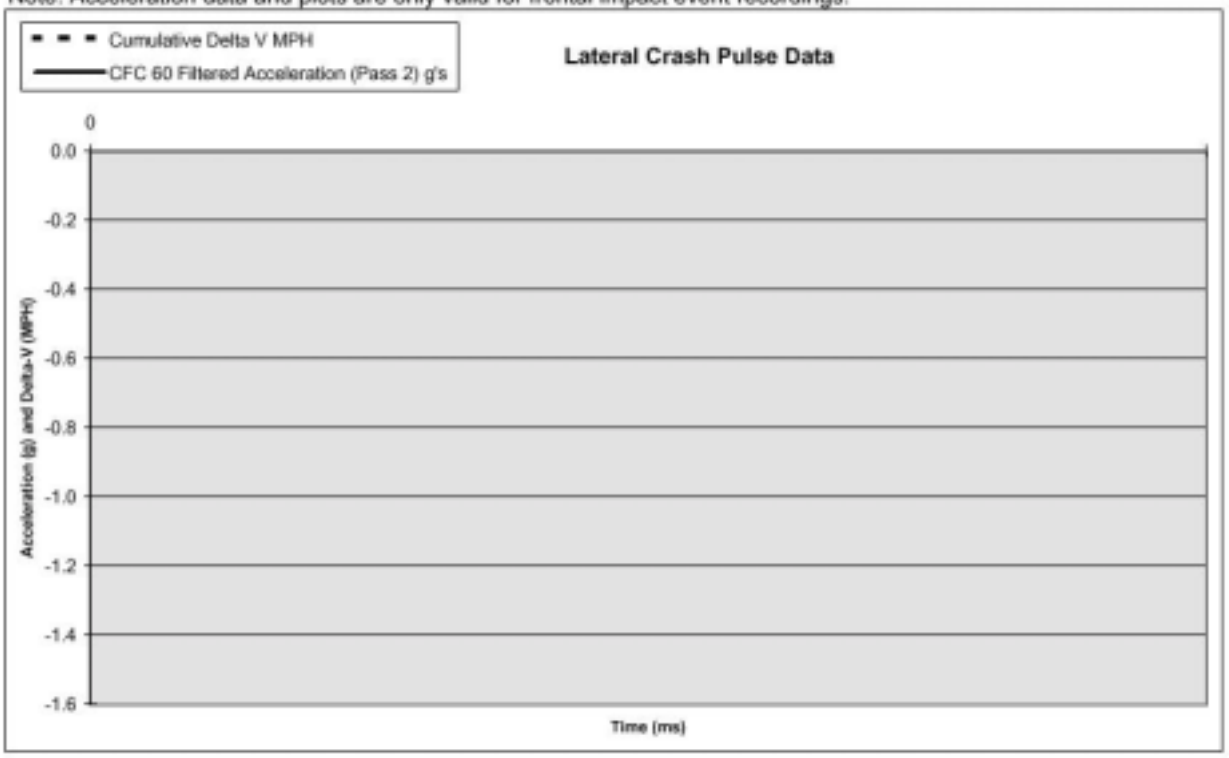
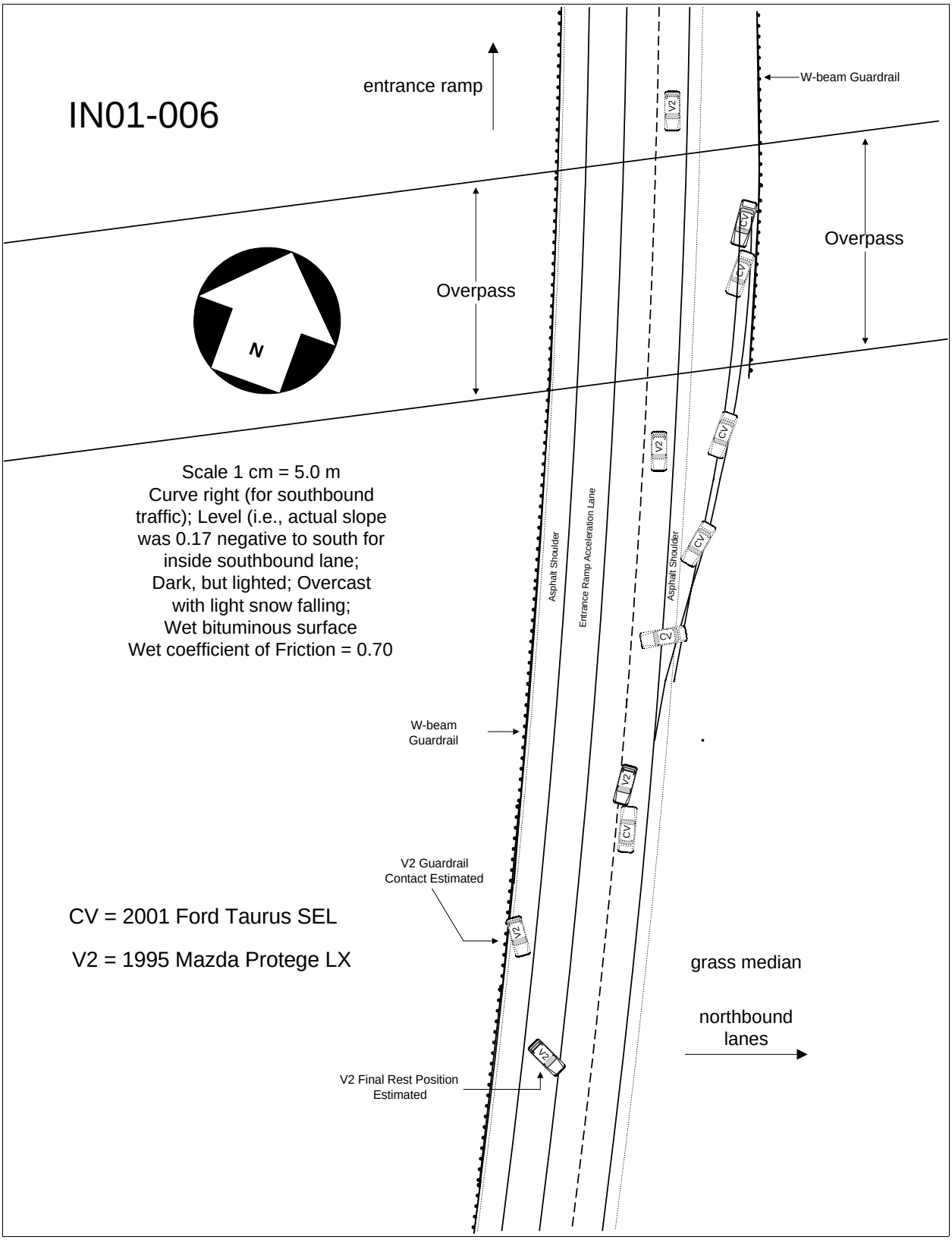


Figure 21: Cumulative Lateral Delta V versus Delta T


IN01-006
entrance ramp
W-beam Guardrail
Overpass
Overpass
N
Scale 1 cm = 5.0 m
Curve right (for southbound traffic); Level (i.e., actual slope was 0.17 negative to south for inside southbound lane; Dark, but lighted; Overcast with light snow falling; Wet bituminous surface
Wet coefficient of Friction = 0.70
Asphalt Shoulder
Entrance Ramp Acceleration Lane
Asphalt Shoulder
W-beam Guardrail
V2 Guardrail Contact Estimated
CV = 2001 Ford Taurus SEL
V2 = 1995 Mazda Protege LX
V2 Final Rest Position Estimated
grass median
northbound lanes
V2
CV