U.S. Department
of Transportation
National Highway
Traffic Safety
Administration

NHTSA

DOT HS 813 045

January 2021

Special Crash Investigations: On-Site ABS Failure Crash Investigation; Vehicle: 2008 Mercury Milan; Location: California; Crash Date: November 2018

DISCLAIMER

Suggested APA Format Citation:

Dynamic Science, Inc. (2021, January). *Special Crash Investigations: On-Site ABS Failure Crash Investigation; Vehicle: 2008 Mercury Milan; Location: California; Crash Date: November 2018* (Report No. DOT HS 813 045). National Highway Traffic Safety Administration.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT HS 813 045		

4. Title and Subtitle	5. Report Date
Special Crash Investigations: On-Site ABS Failure Crash Investigation; Vehicle: 2008 Mercury Milan; Location: California; Crash Date: November 2018	January 2021
	6. Performing Organization Code

7. Author	8. Performing Organization Report No.
Dynamic Science, Inc.	Case Number DS18027

9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Dynamic Science, Inc. 26141 Marguerite Parkway, Suite C Mission Viejo, CA 92692	11. Contract or Grant No. 693JJ918C000012

12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
National Highway Traffic Safety Administration 1200 New Jersey Avenue SE Washington, DC 20590	Technical Report Crash Date: November 2018
	14. Sponsoring Agency Code

15. Supplementary Notes

Each crash represents a unique sequence of events, and generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicles or their safety systems. This report and associated case data are based on information available to the Special Crash Investigation team on the date this report was published.

16. Abstract

This report documents the on-site investigation of an antilock braking system (ABS) failure crash and the injuries sustained by the driver of a 2008 Mercury Milan that was involved in a single-vehicle crash that occurred on a four-lane, undivided, city roadway in California in November 2018. It was morning at the time of the crash and the weather was cloudy. The Mercury was driven by a belted 26-year-old male. The vehicle was traveling southbound at an EDR-reported speed of 96 km/h (60 mph) in the right lane. The driver indicated that a large sport utility vehicle (SUV) was traveling southbound in front of his vehicle in the second lane from the right. He stated that the SUV drifted into his lane of travel. The driver braked and lost control of his vehicle. The Mercury began a clockwise rotation, departed the roadway on the right, struck a curb with the left front tire, and struck a utility pole with the left plane. The left inflatable curtain and seat-mounted side air bags deployed. The driver sustained fractures to his left hip and left shoulder and a splenic laceration. He was trapped in the vehicle and required extrication. He was transported to an area trauma center by ambulance for treatment and was hospitalized for one day. The investigation revealed that the ABS was active at the time of the crash. It appears that one tire did lock up and that the vehicle's loss of control was related to the lock-up.

17. Key Words	18. Distribution Statement
ABS, side impact, antilock, serious injury	The document is available to the public from the National Technical Information Service, ww.ntis.gov.

19 Security Classif. (of this report)	20. Security Classif. (of this page)	21 No. of Pages	22. Price
Unclassified	Unclassified	15	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

Table of Contents

Special Crash Investigations
On-Site ABS Failure Crash Investigation
Office of Defects Investigation
Case Number: DS18027
Vehicle: 2008 Mercury Milan
Location: California
Crash Date: November 2018

BACKGROUND

This report documents the on-site investigation of an antilock braking system (ABS) failure crash and the injuries sustained by the driver of a 2008 Mercury Milan (**Figure 1**) that was involved in a single-vehicle crash. The driver sustained serious injuries. This case was initiated in response to a notification made to the National Highway Traffic Safety Administration. The Special Crash Investigations (SCI) group assigned the case to Dynamic Science, Inc., in November 2018. SCI obtained the police report and contacted the driver's insurance company to secure cooperation. The investigation was intended to determine the crash circumstances and to harvest the ABS control module from the vehicle. The vehicle was not supported by the Bosch Crash Data Retrieval (CDR) system and the air bag module was not imaged on site. The vehicle inspection occurred in December 2018. Present at the inspection were representatives from the Ford Motor Company and NHTSA's Vehicle Research and Test Center (VRTC).

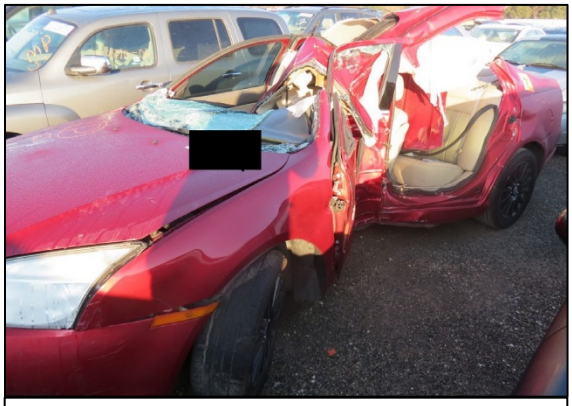


Figure 1. The 2008 Mercury Milan.

During the inspection, the air bag control module (ACM), ABS module, and powertrain control module (PCM) were removed and secured by the VRTC representative. The ACM and PCM modules were imaged at a later date by manufacturer representatives. The data is presented later in this report.

This single-vehicle crash occurred on a four-lane, undivided, city roadway in California in November 2018. The asphalt roadway was straight and level. It was morning at the time of the crash, and the weather was clear. The Mercury was driven by a belted 26-year-old male. The vehicle was traveling southbound at an EDR-reported speed of 96 km/h (60 mph) in the right lane. The driver indicated that a large SUV was traveling southbound in front of his vehicle in the second lane from the right. He stated that the SUV drifted into his lane of travel. The driver braked, and one tire locked up. The driver reported that he tried to correct for the locked wheel by braking and steering right. The Mercury began a clockwise rotation, departed the roadway on the right, struck a curb with the left front tire, and struck a utility pole with the left plane. The left inflatable curtain (IC) and seat-mounted side air bags deployed. The driver sustained fractures to his left hip and left shoulder and a splenic laceration. He was trapped in the vehicle and required extrication. He was transported to an area trauma center by ambulance for treatment, where he was hospitalized for one day. The vehicle was towed from the scene due to damage. The

investigation revealed that the ABS was active at the time of the crash. It appears that one tire did lock up and that the vehicle's loss of control was related to the lock up.

SUMMARY

Crash Site

The crash site was in the southbound lanes of a four-lane, undivided, city roadway (**Figure 2**). The asphalt roadway was straight and level. There were two southbound lanes and two northbound lanes that were separated by double-yellow lines. The southbound lanes were bordered on the right by a solid white fog line, an asphalt shoulder, a 14 cm (5.5 in) concrete curb, and a concrete sidewalk. This crash occurred during the early morning. A wooden utility pole 38 cm (14.9 in) diameter was located to the right of the curb. The posted speed limit was 64 km/h (40 mph). The roadway was dry. The weather at the nearest reporting station was 13 °C (56 °F), 26 percent humidity, and cloudy. The winds were out of the north northwest at 28 km/h (18 mph). A crash diagram is attached at the end of this technical report.

Pre-Crash

The driver reported that, on several occasions before this crash, he had encountered issues with braking for this vehicle. He reported that the issues included having to brake heavily with excessive brake pedal travel before the vehicle would slow down in a normal fashion. He stated that the vehicle had been inspected by a Ford dealership that indicated the issue was related to sticky valves in the ABS control unit. The driver reported that he removed the ABS fuse and the ABS pump fuse and the vehicle had traveled for approximately 16,093 km (10,000 miles) without having the braking issue. At some point prior to the crash, he replaced the fuses. At the time of the vehicle inspection, the fuses were present but were of the incorrect amperage. According to PCM data, the ABS flags were turning on and off, which indicated that the ABS fuses were installed and the system was in an alert state sensing increasing wheel speed differences. It does not mean that the ABS was intervening and actuating valves.

Figure 2. Southbound approach of the 2008 Mercury Milan.

In this crash, the vehicle was traveling southbound at an EDR-report speed of 97 km/h (60 mph) in the right lane at 5 seconds prior to impact. The driver indicated that a large SUV was traveling southbound in front of his vehicle in the second lane from the right. He stated that the SUV drifted into his lane of travel. The driver first braked at four seconds prior to impact and the system reported ABS in progress. As the driver braked, one wheel (likely the left rear) locked up, and he lost control of his vehicle. The driver reported that he tried to correct for the locked wheel by braking and steering right. The Mercury began a clockwise rotation. At two seconds prior to impact, the driver released the brake and the ABS was no longer in progress. The vehicle continued the clockwise rotation until it was roughly 90 degrees from its original orientation. The Mercury's pre-crash speeds and distances covered are shown in the table below. The

reported vehicle speed just prior to impact is not representative of the actual ground speed because the vehicle was in rotation. The speed at time of impact was approximately 56 km/h (35 mph) based on the time at -1 seconds and the WinSMASH results.

Time	Vehicle Speed		Distance Traveled			
			Incremental		Cumulative	
-sec	km/h	mph	m	ft	m	ft
5	97	60	NA	NA	NA	NA
4	86	53.5	25.4	83.2	25.4	83.2
3	72	44.89	22	72.2	47.4	155.4
2	73	45.25	20.1	66.1	67.5	221.5
1	58	36.29	9.1	29.9	76.6	251.4
0	21	13.07	5.5	18.1	82.1	269.5

Crash

The Mercury departed the roadway on the right, and struck the curb with the left front wheel (**Figure 3**). The vehicle traveled an additional 5.1 m (17 ft) before striking a utility pole with the left plane (**Figure 4**). The barrier algorithm of the WinSMASH program calculated a total delta-V of 58 km/h (36 mph). The longitudinal and lateral components were 10 km/h (6 mph) and 57 km/h (35 mph), respectively. The collision fit the model and the results appear reasonable. The left IC and seat-mounted side air bags deployed at 8 milliseconds (ms). The driver seat belt pretensioner actuated at 8 ms.

Figure 3. Struck curb, looking south.

Post-Crash

The Mercury came to rest against the utility pole. The driver sustained fractures to his left hip and left shoulder and a splenic laceration. There was no loss of consciousness. He was trapped in the vehicle and required extrication. The local fire department responded. The call came in two minutes after the crash, and the responders were on scene eight minutes later. They were on scene for 17 minutes, departed, and then arrived at the Level 1 trauma center 12 minutes later. The Glasgow Coma Scale (GCS) score was 15 upon arrival. The driver was hospitalized for one day. The vehicle was towed from the scene due to damage.

Figure 4. Struck utility pole, looking south.

2008 MERCURY MILAN PREMIER

Description

The 2008 Mercury Milan Premier was a 5-passenger, 4-door sedan. The vehicle was identified by the Vehicle Identification Number 3MEHM08148Rxxxxxx. The vehicle was equipped with a 3.0-liter, 6-cylinder, gasoline engine coupled to a 6-speed automatic transmission; a front-wheel drive; 4-wheel disc brakes; and ABS. The vehicle was configured with an after-market sound system in the trunk that was powered by a fused wiring harness that originated at the service battery and ended in the trunk. The interior of the vehicle was configured for five-passenger seating. Each seat position was equipped with a 3-point lap and shoulder restraint. The front seat belts were equipped with retractor pretensioners. The vehicle was equipped with Certified Advanced 208-Compliant front air bags and side impact IC air bags. The vehicle was the corporate twin to the Ford Fusion. The vehicle manufacturer's recommended tire size was P225/70R16 with a cold pressure of 207 kPa (30 psi). The vehicle was equipped with P225/50R17 Douglas Performance tires. The specific tire information at the SCI inspection was as follows:

Position	Measured Tread Depth	Measured Pressure[1]	Restricted	Damage
LF	2 mm (2/32 in)	193 kPa (28 psi)	No	No
LR	4 mm (5/32 in)	193 kPa (28 psi)	No	No
RR	5 mm (6/32 in)	193 kPa (28 psi)	No	No
RF	2 mm (2/32 in)	172 kPa (25 psi)	No	No

Exterior Damage

The Mercury sustained minor left front wheel damage from the impact with the curb (**Figure 5**). The Collision Deformation Classification (CDC) was 09LFWN1. The vehicle sustained severe left side damage from the impact with the wooden utility pole (**Figure 6**). The direct damage measured 40 cm (15.7 in). The direct damage began 100 cm (39.3 in) aft of the front axle and was primarily located at the rearward aspect of the front door and B-pillar. The vertical aspect of the direct damage ranged from the sill to the roof side rail. The Field L began 30 cm (11.8 in) aft of the front axle and measured 163 cm (64.1 in). Nineteen measurements were taken at the mid door level by the Nikon Total Station and the Faro Blitz program computed crush measurement in six

Figure 5. Left wheel damage, the 2008 Mercury Milan.

[1] Pressure measured five weeks post-crash.

increments as follows: C_1 = 16 cm (6.2 in), C_2 = 34 cm (13.3 in), C_3 = 48 cm (18.8 in), C_4 = 64 cm (25.1 in), C_5 = 70 cm (27.5 in), and C_6 = 30 cm (11.8 in). The maximum crush measured 70 cm (27.5 in) and was located 115 cm (45.2 in) aft of the front axle. Both left doors were jammed shut due to the damage. The left rear door was removed during extrication. The height of the maximum crush was 41 cm (16.1 in). The left rear door (and the roof) were removed to extricate the driver. The CDC was 09LPAN4.

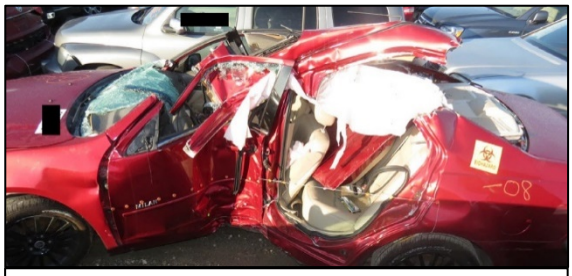


Figure 6. Left plane damage, the 2008 Mercury Milan.

Event Data Recorder (EDR) and Power Control Module (PCM)

The Mercury was equipped with a restraint control module (RCM) that had EDR capability to store deployment and non-deployment events. The vehicle was not supported by the Bosch Crash Data Retrieval (CDR) system and the air bag module was not imaged on site. The RCM was later imaged by a manufacturer's representative and provided to VRTC as a proprietary document. Two events were recovered. Both events occurred at approximately the same time as the vehicle struck the curb and pole. A summary of the data is provided below.

The first record was a non-deployment event that occurred during the left plane to curb impact. The RCM recorded this as a frontal event. The maximum estimated longitudinal delta-V was -4.1 km/h (-2.6 mph) at the RCM and -7.4 km/h (-4.6 mph) at the front sensors.

The pre-crash data was as follows:

Time Before Event	Vehicle Speed (km/h)	Vehicle Speed (mph)	Stability Control in Progress (Yes/No)	ABS in Progress (Yes/No)	Traction Control Brake in Progress (Yes/No)	Brake Depressed (Yes/No)
5	96.56	60.0	No	No	No	No
4	86.10	53.50	No	Yes	No	Yes
3	72.24	44.89	No	Yes	No	Yes
2	72.82	45.25	No	No	No	No
1	58.40	36.29	No	No	No	Yes

The second record was a deployment event that occurred during the left plane to impact to the utility pole. The maximum estimated lateral delta-V was 22.0 km/h (13.7 mph) at the side sensor. The left IC and left seat back mounted side air bags deployed at 8 ms.

The pre-crash data for this event was as follows:

Time Before Event	Vehicle Speed (km/h)	Vehicle Speed (mph)	Stability Control in Progress (Yes/No)	ABS in Progress (Yes/No)	Traction Control Brake in Progress (Yes/No)	Brake Depressed (Yes/No)
5	86.10	53.50	No	Yes	No	Yes
4	72.24	44.89	No	Yes	No	Yes
3	72.82	45.25	No	No	No	No
2	58.40	36.29	No	No	No	Yes
1	21.03	13.07	No	Yes	No	Yes

The PCM was imaged by a manufacturer's representative and provided to VRTC as a proprietary document. The data set included 125 data items that had been sampled at 5 times per second that provided 25 seconds of data in the rolling buffer. Working backwards from the deployment event, the data was interpreted as follows. Approximately 14 seconds prior to the deployment event, the vehicle began accelerating from a near stop to 96 km/h (60 mph) at 4 seconds prior to the event. The ABS flags were turning on and off, which indicated that the ABS fuses were installed and the system was in an alert state sensing increasing wheel speed differences. The vehicle braked twice before impact.

NHTSA Recalls and Investigations

Based on the VIN, there were two related recalls associated with this vehicle. The first was NHTSA recall number 19V904 and was related to this crash. The summary indicates that a valve in the hydraulic control unit of the antilock braking system may stick open. The safety risk indicated that this issue may result in extended brake pedal travel required to stop the vehicle, increasing the risk of a crash. The second was NHTSA recall number 19V001 and regarded the potential for a passenger frontal air bag inflator rupture. The database was queried in September 2020.

Figure 7. Interior damage, the 2008 Mercury Milan.

Interior Damage

The Mercury sustained severe interior damage from intrusions, occupant contacts, and air bag deployments (**Figure 7**). The driver loaded the left door with his left hip and shoulder. He was displaced to the right and loaded the center console. There was lateral intrusion of the left door, left B pillar, floor, driver seat cushion, and left roof side rail. There was longitudinal intrusion of the driver's seat back into the second row.

Manual Restraint Systems

The front row was equipped with driver and front right passenger lap and shoulder seat belts. The driver's belt was equipped with continuous loop belt webbing, a sliding latch plate, an emergency locking retractor (ELR), and an adjustable upper anchor that was adjusted to the full up position. The front right passenger's seat belt was equipped the same as the driver's, but had a switchable ELR/automatic locking retractor (ALR). Both seat belts were equipped with retractor pretensioners. The driver's belt pretensioner actuated and the belt was locked in the spooled-out position. The passenger's belt pretensioner did not actuate. There were no indications of crash-related scuffing or stretching and there was no occupant in the seat at the time of crash.

Supplemental Restraint Systems

The Mercury was equipped with a Certified Advanced-208 Compliant frontal air bag system that consisted of dual-stage drivers and passenger's frontal air bags, seat track positioning sensors, a front right occupant weight sensor, and retractor pretensioners. The manufacturer of the Mercury has certified that this vehicle was compliant with the advanced air bag portion of the Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The vehicle was also equipped with front row seat-mounted side air bags and IC air bags for both rows. The driver's seat-mounted side air bag and the left IC air bag deployed during the crash.

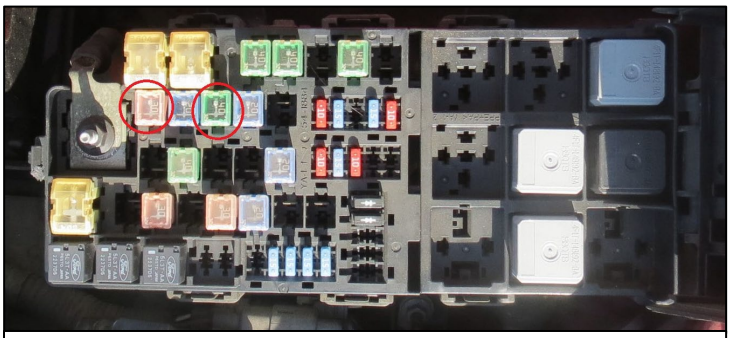


Figure 8. Fuse locations/amperage at the time of inspection, the 2008 Mercury Milan.

The left IC air bag measured 135 cm (53.1 in) long and 39 cm (15.3 in) high in its deflated state. The left side air bag measured 21 cm (8.2 in) long and 14 cm (5.5 in) high.

ABS Discussion/Issues

During the vehicle inspection, the air bag control module, ABS module, and powertrain control module were removed and secured by the VRTC representative for later imaging and/or valve observation. The brake fluid reservoir was examined; it was determined that the level was correct, and that the fluid was of the proper color. The brake pedal was manipulated by hand, and it had 5 cm (1.9 in) of travel, from 15 cm (5.9 in) to 10 cm (3.9 in) to the floorboard. As discussed earlier, the driver had indicated that he had pulled the ABS pump and ABS valves fuses at some point. During the inspection of the power distribution box, it was determined that, while the fuses were intact, they had been switched and

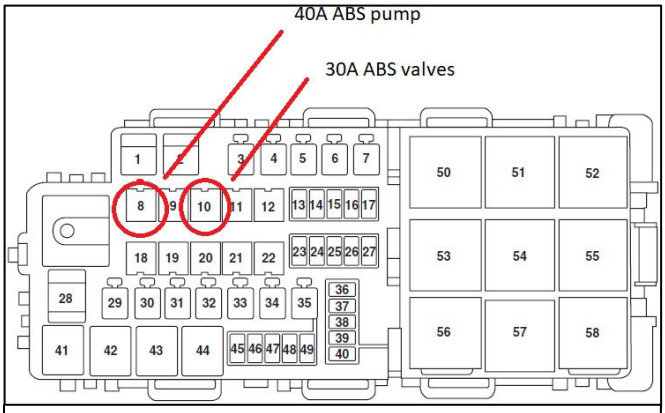


Figure 9. Power distribution box, fuse locations/amperage, the 2008 Mercury Milan.

were in the incorrect positions with a 30A fuse in the ABS pump slot and a 40A fuse in the ABS valves slot (**Figures 8** and **9**). In the driver interview, he indicated that the fuses were in place at the time of the crash. The investigation revealed that the ABS was active at the time of the crash. It appears that one tire did lock up and that the vehicle's loss of control was related to the lock up.

2008 MERCURY MILAN OCCUPANT

Driver Demographics

Age/sex:	26 years/male
Height:	193 cm (75 in)
Weight:	71 kg (156 lbs)
Eyewear:	Unknown
Seat type:	Bucket
Seat track position:	Middle track position
Manual restraint usage:	Lap and shoulder belt used
Usage source:	Vehicle inspection
Air bags:	Steering wheel mounted front air bag did not deploy; seat-mounted side air and IC air deployed
Alcohol/drug data:	None
Egress from vehicle:	Extricated by rescue personnel
Transport from scene:	Ambulance
Type of medical treatment:	Hospitalized for one day

Driver Injuries

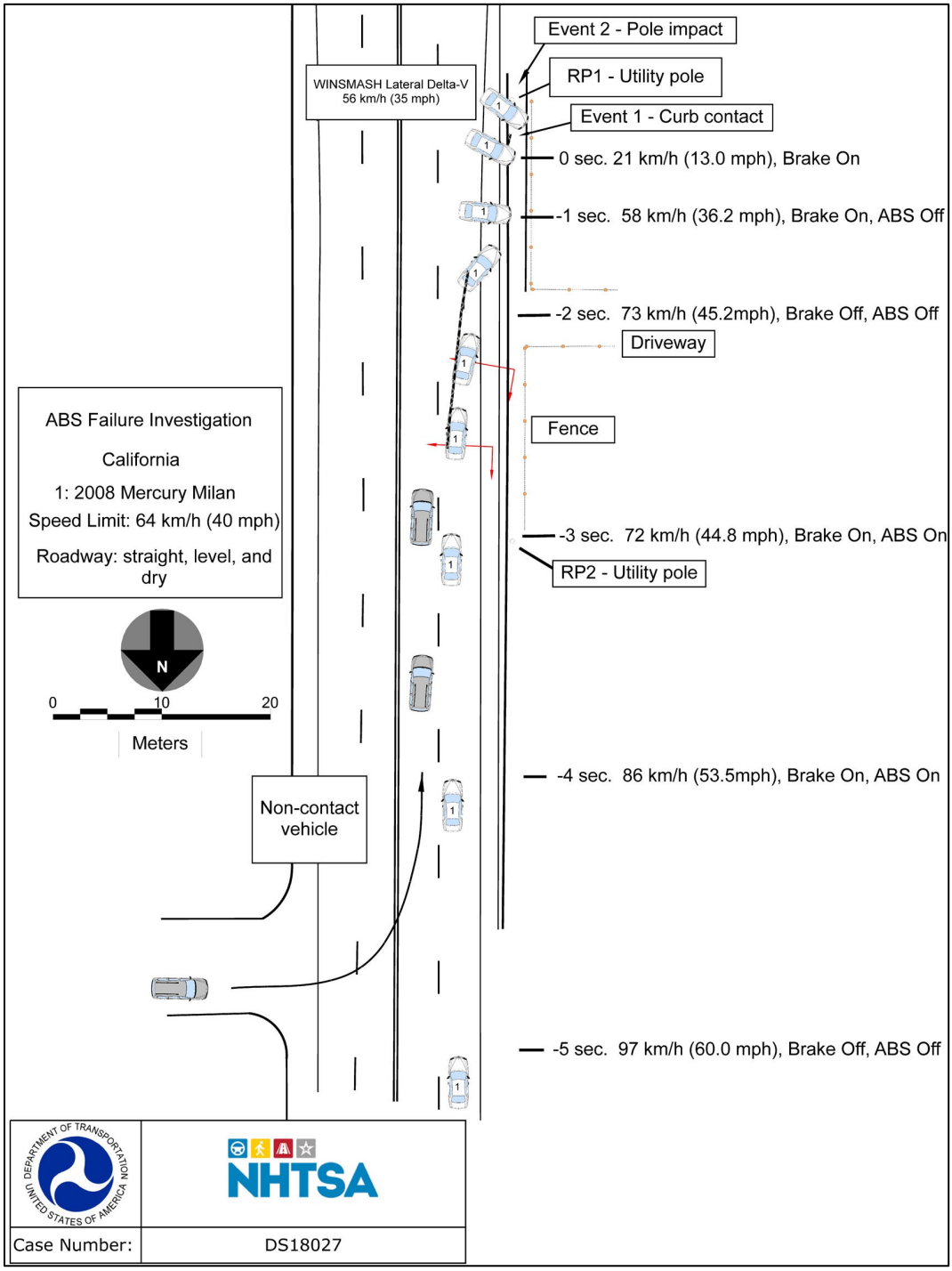
Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Multiple acute superior and inferior left sacral fracture, some of which extend into foramen. Acute left superior pubic rami fracture. Left obturator ring fracture	856161.3	Door	Probable
2	Grade 3 splenic laceration (2.5 cm). Hemoperitoneum	544224.3	Tandem IPC Driver side air bag, Door	Probable
3	Oblique fracture through left distal clavicle, minimally displaced	750731.2	Door	Certain
4	Abrasions, right hip	810202.1	Center console	Certain
5	Abrasions, right hand	710202.1	Unknown	Unknown
6	Abrasions, left anterior shoulder	710202.1	Door	Probable

Source: discharge summary, radiology reports, and ER report.

Driver Kinematics

The 26-year-old male driver was seated in an unknown posture with the seat adjusted to the middle track position. He was wearing the available lap and shoulder seat belt. The driver was actively steering and braking prior to impact. The vehicle began a clockwise rotation, and the driver was displaced to the left. The left plane impact to the Mercury deployed the left IC air bag and driver's seat-mounted side impact air bag. The pretensioner actuated at this time. The driver was displaced to the left and slightly rearward in response to the 260-degree direction of force. His left hip contacted the intruding door, causing the multiple pelvic fractures. His left shoulder contacted the door, causing the clavicle fracture. His left torso contacted the left side air bag while it was in contact with the door, causing the splenic laceration. He was displaced to the right by the intrusion, and his right hip struck the center console. He was trapped in the vehicle. Emergency responders opened the left rear door and removed the driver from the vehicle. He sustained "A" (incapacitating) injuries. He was transported by ambulance to a local trauma center, where he was hospitalized for one day.

CRASH DIAGRAM



DOT HS 813 045
January 2021

U.S. Department
of Transportation

**National Highway
Traffic Safety
Administration**

15024-120420-v1a