

**TRANSPORTATION SCIENCES
CRASH DATA RESEARCH CENTER**

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**VERIDIAN ON-SITE ADVANCED OCCUPANT PROTECTION
SYSTEM (AOPS) INVESTIGATION**

NASS/SCI COMBO CASE NO. 2001-02-057E

VEHICLE - 2001 FORD TAURUS SE

LOCATION - STATE OF NEW YORK

CRASH DATE - JUNE, 2001

Contract No. DTNH22-94-D-07058

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points are coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems.

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16. <i>Abstract</i> This on-site investigation focused on the performance of the Advanced Occupant Protection System (AOPS) of a 2001 Ford Taurus SE 4-door sedan. The 2001 Ford Taurus was equipped with redesigned frontal air bags for the driver and front right passenger positions which failed to deploy as a result of an offset frontal collision with a 1996 Jeep Grand Cherokee Limited 4x4 sport utility vehicle. The 16 year old male driver of the 1996 Jeep Grand Cherokee Limited was operating the vehicle eastbound when he failed to observe the southbound 2001 Ford Taurus as he attempted to turn left (north) from a private driveway. As the Jeep crossed the southbound lane, the front left area was impacted by the front left area of the Ford resulting in moderate damage to both vehicles. The unrestrained 60 year old male driver of the 2001 Ford Taurus SE initiated a forward trajectory in response to the 1 o'clock impact force and loaded the knee bolster and steering wheel rim. Loading of the upper steering wheel rim resulted in a superficial laceration and contusion to the forehead. He also sustained a contusion to the right abdomen from contact to the lower steering wheel rim. The Ford Taurus driver was transported to a local hospital for treatment and released.			
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**VERIDIAN ON-SITE ADVANCED OCCUPANT PROTECTION
SYSTEM (AOPS) INVESTIGATION
NASS/SCI COMBO CASE NO. 01-02-057E
VEHICLE - 2001 FORD TAURUS SE
LOCATION - STATE OF NEW YORK
CRASH DATE - JUNE, 2001**

BACKGROUND

This on-site investigation focused on the performance of the Advanced Occupant Protection System (AOPS) of a 2001 Ford Taurus SE 4-door sedan. The 2001 Ford Taurus was equipped with redesigned frontal air bags for the driver and front right passenger positions which failed to deploy as a result of an offset frontal collision with a 1996 Jeep Grand Cherokee Limited 4x4 sport utility vehicle. The 16 year old male driver of the 1996 Jeep Grand Cherokee Limited was operating the vehicle eastbound when he failed to observe the southbound 2001 Ford Taurus as he attempted to turn left (north) from a private driveway. As the Jeep crossed the southbound lane, the front left area was impacted by the front left area of the Ford resulting in moderate damage to both vehicles. The unrestrained 60 year old male driver of the 2001 Ford Taurus SE initiated a forward trajectory in response to the 1 o'clock impact force and loaded the knee bolster and steering wheel rim. Loading of the upper steering wheel rim resulted in a superficial laceration and contusion to the forehead. He also sustained a contusion to the right abdomen from contact to the lower steering wheel rim. The Ford Taurus driver was transported to a local hospital for treatment and released.

The crash was identified by PSU 02 during normal sampling activities on June 11, 2001. The crash was selected as a CDS case and assigned NASS Case Number 01-02-057E. Due to the Ford Taurus driver's statement regarding belt usage and the researcher's documentation of buckle pretensioner displacement, the case was assigned as a NASS/SCI Combo case on June 21. The SCI investigator traveled to the PSU on June 25, 2001 to reinspect the Taurus and download the Restraints Control Module (RCM).

SUMMARY

Crash Site

This single vehicle crash occurred during the afternoon hours of June, 2001. At the time of the crash, it was daylight with no adverse conditions as the roads were dry. The crash occurred in the southbound lane of a (level) north/south two-lane rural roadway (see **Figure 9 - page 7**) which curved left for southbound traffic. The asphalt surfaced roadway was bordered by grass shoulders and tree clusters. No traffic control was present at the scene which had a posted speed limit of 89 km/h (55 mph).

Pre-Crash

The 16 year old male driver of the 1996 Jeep Grand Cherokee Limited 4x4 was initially stationary and facing east (**Figure 1**) when he proceeded to turn left (north) onto the main thoroughfare. The Jeep driver reported to police that tree branches from an adjacent tree cluster blocked his full view of the environment (*looked but did not see*), thus contributing to pre-crash circumstances. The police reported no tire marks at the scene indicative of driver avoidance maneuvers.

The 60 year old male driver of the 2001 Ford Taurus SE was operating the vehicle southbound (**Figure 2**) and negotiating a left curve at a (driver reported) speed of 89 km/h (55 mph) when he observed the 1996 Jeep Grand Cherokee cross his path of travel. Upon recognition of the impending harmful event, he steered left in avoidance and partially entered the northbound lane prior to the collision.



Figure 1. Eastbound approach view for the 1996 Jeep Cherokee.



Figure 2. Southbound approach view for the 2001 Ford Taurus SE.

Crash

As the Jeep crossed the southbound lane of the two-lane rural roadway, the front left area was impacted by the front left area of the Ford resulting in moderate damage to both vehicles. The missing vehicle algorithm of the WinSMASH reconstruction program computed velocity changes of 19.7 km/h (12.2 mph) for the subject vehicle and 18.6 km/h (11.6 mph) for the struck Jeep. Respective longitudinal components were -18.5 km/h (-11.5 mph) and -17.5 km/h (-10.9 mph). The impact induced deceleration was not sufficient to deploy the Ford's redesigned frontal air bag system. The Ford's Restraint Control Module (RCM) recorded a longitudinal element of -20.4 km/h (-12.7 mph) at the 78 millisecond interval *as a first stage deployment* (see **Figures 10-13, page 8**). The Ford Taurus came to rest in the southbound lane facing southeast as the Jeep Grand Cherokee came to rest in the northbound lane facing northeast.

Post-Crash

Following the crash, the Ford driver exited the vehicle with some assistance from rescue personnel. The exit status of the Jeep driver was unknown, however, he was reported by police as uninjured in the collision. The Ford driver was transported by ambulance to the emergency room of a local hospital for treatment and released within two hours. The 1996 Jeep Grand Cherokee Limited was driven from the scene as the 2001 Ford Taurus SE was towed due to disabling vehicle damage.

VEHICLE DATA

The 2001 Ford Taurus SE was manufactured in September, 2000 and identified by the vehicle identification number (VIN): 1FAFP53U51G (production number deleted). The driver's spouse leased the vehicle as new in December, 2000. The vehicle was a 4-door sedan equipped with power windows/door locks/driver seat, front-wheel drive, and a 3.0 liter, V-6 engine. At the time of the crash, the odometer had recorded 17,292 km (10,745 miles). The seating was configured with front bucket (with a "flip and fold" center console/seat) and a rear bench seat. No adjustable pedals were present in the vehicle. The driver reported no previous crashes or maintenance on the Ford's frontal air bag

system. A cellular phone was present (and on), however, it was unknown if it was in use or caused a distraction to the driver during pre-crash circumstances.

VEHICLE DAMAGE

Exterior

The 2001 Ford Taurus SE sustained moderate frontal damage as a result of the impact with the Jeep Grand Cherokee (**Figures 3 & 4**). The direct contact damage began at the front left bumper corner and extended 118.0 cm (46.5 in) inboard. The impact deformed the entire front end width resulting in a combined direct and induced damage length (Field L) of 124.0 cm (48.8 in). Six crush measurements were documented at the level of the reinforcement bar (*bumper fascia separation*): C1= 6.0 cm (2.4 in), C2= 25.0 cm (9.8 in), C3= 24.0 cm (9.4 in), C4= 17.0 cm (6.7 in), C5= 8.0 cm (3.1 in), C6= 0 cm. The Collision Deformation Classification (CDC) assigned for this impact to the Ford was 01-FDEW-2 with a principal direction of force of (+)20 degrees. An indentation was documented along the reinforcement bar and attributed to the front left bumper corner of the opposing Jeep. The hood was deformed slightly up and rearward from the impact force. The left fender was deformed rearward which produced a partial restriction of the left front door opening. The windshield was fractured at the left lower A-pillar from exterior impact forces (only). The left front tempered glazing was disintegrated post-crash by salvage personnel. Reduction in the left side wheelbase measured 3.0 cm (1.2 in).



Figure 3. Frontal damage to the 2001 Ford Taurus SE (hood and fenders removed).



Figure 4. Contour gauge overview.

Interior

Interior damage to the Ford Taurus was minimal and was attributed to occupant contact (**Figure 5**). Large indentations and scuff marks were documented on the left knee bolster. Deformation to the upper portion of the steering wheel rim measured 3.4 cm (1.3 in) along with 1.0 cm (0.4 in) to the lower portion. Steering column compression measured 3.0 cm (1.2 in) at the left shear capsule and 2.5 cm (1.0 in) at the right shear capsule (compressed forward completely off the shear plate). The column mounted transmission selector lever was displaced forward. A small scratch mark was identified on the left A-pillar. White colored dog hair was found throughout the vehicle interior. No component intrusions were found in the vehicle.



Figure 5. Interior damage to the 2001 Ford Taurus SE.

MANUAL RESTRAINT SYSTEMS

The interior of the Ford Taurus consisted of a six passenger seating configuration with front bucket (with a “flip and fold” center console that converted to a center seat position) and a rear bench seat. The driver 3-point manual lap and shoulder belt system consisted of a continuous loop belt webbing with a sliding latchplate and a dual mode retractor (inertial lock/belt sensitive). A stowage crease mark was noted on the shoulder webbing of the driver restraint (**Figure 6**) which followed the pattern of the inboard seat back taper. The specific location of these distinct line marks on the webbing indicated the driver probably sat on/against the belt in an *unrestrained fashion*. The driver stated during the SCI interview that he routinely buckled the belt in this manner to defeat the vehicle (restraint) audible chimes. Furthermore, loading marks on the lap and shoulder belt webbing (from the latchplate and D-ring) confirmed the latchplate was in the buckle at the time of collision induced pretensioner activation. The front center seat was equipped with a 2-point manual lap belt and a locking latchplate. The front right (and rear) seating position was equipped with a 3-point manual lap and shoulder belt system which consisted of a continuous loop belt webbing with a sliding latchplate and a retractor equipped with an inertial and switchable lock mechanism.



Figure 6. Crease marks to the front left restraint.

ADVANCED OCCUPANT PROTECTION SYSTEM (AOPS)

The 2001 Ford Taurus SE was equipped with dual stage redesigned frontal air bags (*vehicle not equipped with the seat mounted side impact air bag system option*) for the driver and front right passenger positions which did not deploy as a result of the crash (**Figure 7**). The driver air bag was housed in the center of the steering wheel with a horizontally oriented flap tear seam (H-configuration). The front right passenger air bag was housed in the right mid-instrument panel area with a single cover flap design hinged at the top aspect.



Figure 7. 2001 Ford Taurus SE non-deployed redesigned frontal air bag system.

The front restraint systems also included buckle pretensioners mounted longitudinally alongside the seat cushions. The activation of the driver side pretensioner resulted in 100.0 millimeters (3.9 in) of piston movement (**Figure 8**). The piston pulls a cable which lowers the height of the buckle assembly, reducing slack in both the lap and shoulder belt webbing. The front right seating position was not occupied, therefore, the buckle pretensioner did not activate.

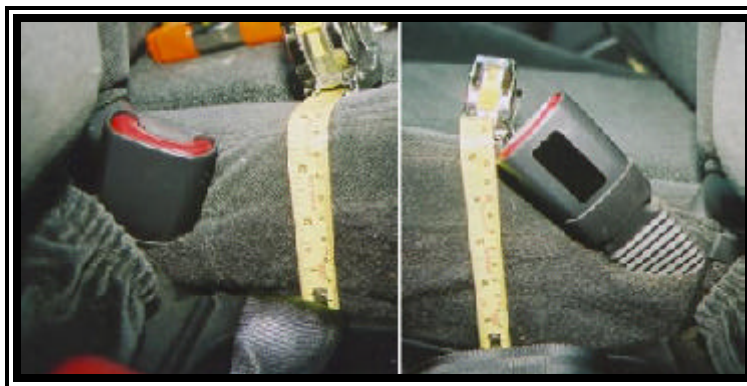


Figure 8. 2001 Ford Taurus SE driver (activated) and front right passenger (non-activated) buckle pretensioners.

Event Data Recorder (EDR)

The 2001 Ford Taurus SE Restraints Control Module (RCM) was located under the front right seat as the event data was retrieved via the J1962 connector found to the left of the steering column. The Event Data Recorder (EDR) records deployment and near-deployment events for the frontal air bag system. Although the redesigned frontal air bags did not deploy in this crash, the EDR recorded a (pretensioner) deployment event. The system status at deployment reflected the driver's belt switch circuit status as "buckled".

DRIVER DEMOGRAPHICS

Age/Sex: 60 year old male
Height: 170 cm (67 in)
Weight: 118 kg (260 lb)
Seat Track Position: Full rearward position
Manual Restraint Use: None
Usage Source: Vehicle inspection, medical report, driver interview
Eyeware: Prescription glasses
Type of Medical Treatment: Transported to a local hospital for treatment and released

Driver Injuries

<i>Injury</i>	<i>Severity (AIS 90)</i>	<i>Injury Mechanism</i>
*Laceration right forehead (superficial - 0.6 cm)	Minor (290602.1,7)	Steering wheel rim
^Contusion center forehead (silver dollar sized)	Minor (290402.1,7)	Steering wheel rim
*Contusion right abdomen	Minor (590402.1,1)	Steering wheel rim

Sources: ER record*/driver interview^

Driver Kinematics

The 60 year old male driver of the 2001 Ford Taurus SE was unrestrained (3-point manual lap and shoulder belt system available), and seated in an upright posture with a slight lean to the left (against the left front door). The seat track was adjusted to the full rearward position as his hands were placed at the 10 o'clock and 2 o'clock positions on the steering wheel rim. The *lack* of belt use was confirmed by contact points within the vehicle relative to the type and specific location of loading evidence documented on the front left restraint system. This loading evidence, when combined with the vehicle's EDR summary, was indicative of latched/buckled non-use by the driver.

At impact, the driver initiated a forward trajectory in response to the 1 o'clock impact force and loaded the knee bolster and steering wheel rim. Loading of the knee bolster was evidenced by the indentations and scuff marks documented on each side of the steering column, however, no injury was reported as a result. His head struck the *upper* portion of the steering wheel rim resulting in a superficial laceration and contusion to the forehead, evidenced by 3.4 cm (1.3 in) of deformation identified to this component. He also sustained a contusion to the right abdomen which was a result of loading to the *lower* portion of the steering wheel rim, evidenced by 1.0 cm (0.4 in) of deformation. Following the crash, the driver was removed from the vehicle through the left front door with some assistance from rescue personnel (driver refused the stabilizing backboard) and subsequently transported by ambulance to the emergency room of a local hospital for treatment and released within two hours. Deployment of the Ford's redesigned driver frontal air bag system would have mitigated the injuries sustained by the driver, thus preventing contact to the steering wheel hub and rim.

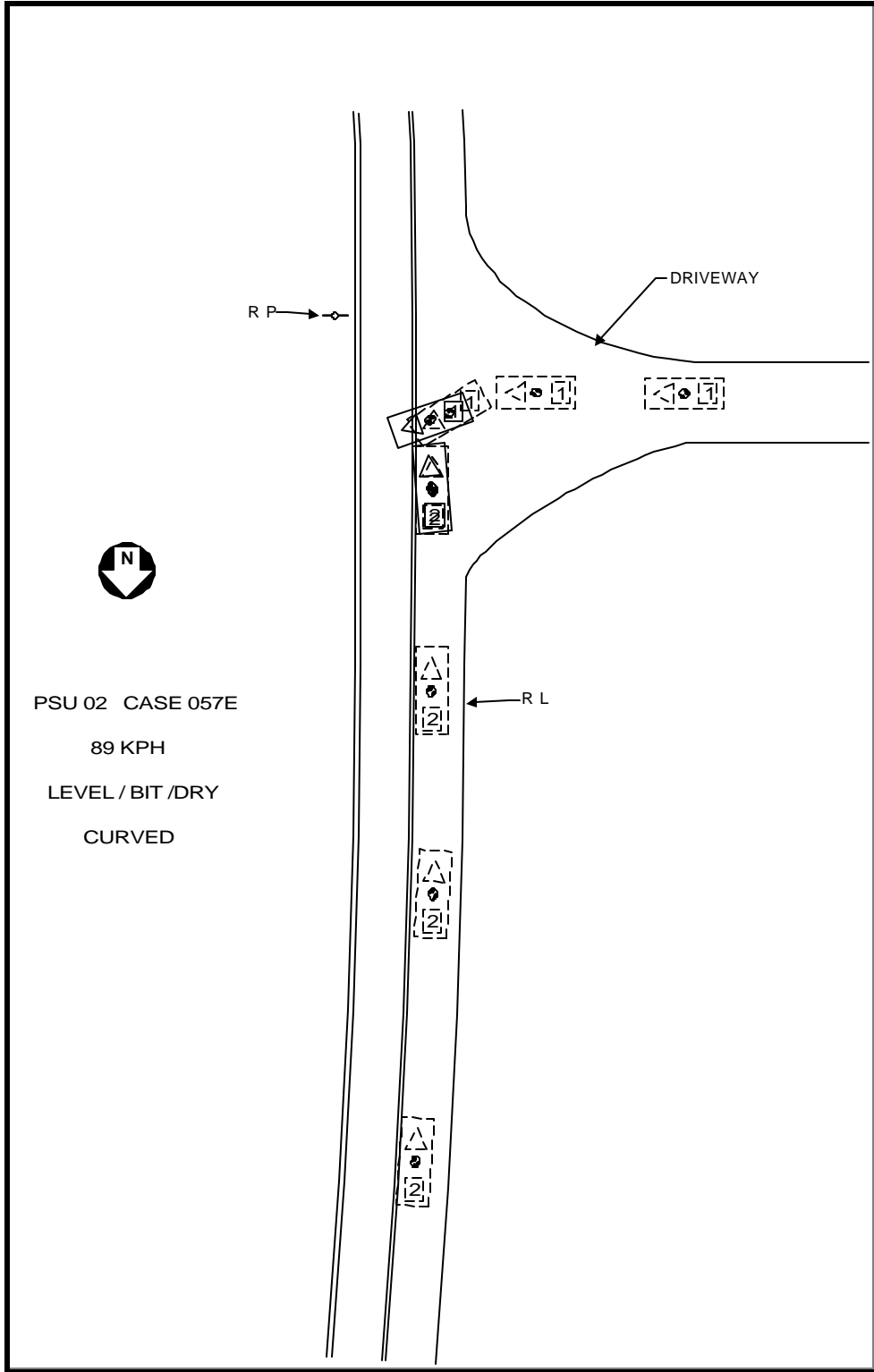


Figure 9. NASS Scene Diagram.



Vehicle Identification Number	11111111111100000
Investigator	
Case Number	
Investigation Date	
Crash Date	
Filename	2001-02-057E.CDR
Saved on	3/1/2002 11:17:25 AM
Data check information	738DA61E
Collected with CDR version	Crash Data Retrieval Tool 1.395
Collecting program verification number	E956A1D8
Reported with CDR version	Crash Data Retrieval Tool 1.395
Reporting program verification number	CA4043CE
Event(s) recovered	Deployment

System Status At Deployment

Data Validity Check	Valid
EDR Model Version	141
Time From Side Sailing Decision to Left (Driver) Side Bag Deployment (msec)	Not Deployed
Time From Side Sailing Decision to Right (Passenger) Side Bag Deployment (msec)	Not Deployed
Diagnostic Codes Active When Event Occurred	0
Time From Algorithm Wakeup to Pretensioner (msec)	37
Time From Algorithm Wakeup to First Stage - Unbelted (msec)	37
Time From Algorithm Wakeup to First Stage - Belted (msec)	0
Time From Algorithm Wakeup to Second Stage (msec)	0
Driver Seat Belt Buckle	Engaged
Passenger Seat Belt Buckle	Not Engaged
Driver Seat Tilt In Forward Position	No
Runtime (msec)	130
Number of Invalid Times in Recording	0

Parameter	Driver	Passenger
Time From Algorithm Wakeup to Pretensioner Deployment Attempt (msec)	37	Unbelted
Time From Algorithm Wakeup to First Stage Deployment Attempt (msec)	Not Deployed	Not Deployed
Time From Algorithm Wakeup to Second Stage Deployment Attempt (msec)	Not Deployed	Not Deployed

Figure 10. 2001 Ford Taurus SE EDR report.



Longitudinal Crash Pulse Data

Milliseconds	Acceleration (Gs)	Cumulative Delta V (MPH)
0	-2.6	-0.13
2	-3.36	-0.22
4	-5.06	-0.5
6	-6.51	-0.77
8	-7.26	-1.05
10	-6.85	-1.43
12	-5.4	-1.62
14	-4.86	-1.8
16	-5.62	-2.11
18	-5.75	-2.33
20	-4.86	-2.57
22	-4.34	-2.72
24	-5	-2.96
26	-6.19	-3.23
28	-6.92	-3.53
30	-6.75	-3.84
32	-6.48	-4.13
34	-7.78	-4.43
36	-10.23	-4.87
38	-9.83	-5.38
40	-5.89	-5.69
42	-4.95	-5.66
44	-9.47	-6.28
46	-12.83	-6.81
48	-10.75	-7.25
50	-6.04	-7.62
52	-3.99	-7.62
54	-6.96	-8.01
56	-10.37	-8.45
58	-9.96	-9.02
60	-9.47	-9.18
62	-11.06	-9.81
64	-9.86	-10.38
66	-6.86	-10.41
68	-7.57	-10.89
70	-9.37	-11.31
72	-8.46	-11.68
74	-7.36	-11.92
76	-7.41	-12.34
78	-7.24	-12.66

Figure 12. 2001 Ford Taurus SE EDR report.



Lateral Crash Pulse Data

Milliseconds	Acceleration (Gs)	Cumulative Delta V (MPH)
0	-0.21	0
2	-0.49	-0.04
4	-1.03	-0.07
6	-2.06	-0.15
8	-2.81	-0.29
10	-1.92	-0.4
12	-1.28	-0.37
14	-1.44	-0.5
16	-1.22	-0.55
18	-0.96	-0.57
20	-1.92	-0.64
22	-2.84	-0.81
24	-2.29	-0.9
26	-1.46	-0.92
28	-1.1	-1.01
30	-0.15	-1.03
32	0.89	-0.94
34	0.65	-0.94
36	-0.27	-0.94
38	-0.73	-1.01
40	-1.01	-0.99
42	-1.01	-1.1
44	-0.2	-1.1
46	0.06	-1.05
48	-1.03	-1.1
50	-1.38	-1.25
52	-0.08	-1.12
54	1.22	-1.21
56	1.25	-1.01
58	0.29	-1.1
60	-0.88	-1.12
62	-1.94	-1.12
64	-3.66	-1.41
66	-4.66	-1.49
68	-4.59	-1.8
70	-4.1	-1.89
72	-3.79	-2.13
74	-4.02	-2.24
76	-4.43	-2.48
78	-4.54	-2.68

Figure 13. 2001 Ford Taurus SE EDR report.