TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION

Veridian Engineering
Buffalo, New York 14225

REDESIGNED AIR BAG SPECIAL STUDY (RABSS)
SCI TECHNICAL SUMMARY REPORT

NASS CDS CASE NO. 1998-43-171E

RABSS VEHICLE - 1998 FORD MUSTANG CONVERTIBLE

LOCATION - STATE OF NORTH CAROLINA

CRASH DATE - JUNE, 1998

Contract No. DTNH22-94-D-07058

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
Washington, D.C. 20590

DISCLAIMER

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no responsibility for the contents or use thereof.

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the National Highway Traffic Safety Administration.

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

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

TECHNICAL REPORT STANDARD TITLE PAGE

1. *Report No.* 98-43-171E	2. *Government Accession No.*	3. *Recipient's Catalog No.*	
4. *Title and Subtitle* Redesigned Air Bag Special Study (RABSS) RABSS Vehicle - 1998 Ford Mustang Convertible Location - State of North Carolina		5. *Report Date*: August, 2000 6. *Performing Organization Code*	
7. *Author(s)* Crash Research Section		8. *Performing Organization Report No.*	
9. *Performing Organization Name and Address* Transportation Sciences Crash Research Section Veridian Engineering P.O. Box 400 Buffalo, New York 14225		10. *Work Unit No.* C01115.0298.(0000-0009) 11. *Contract or Grant No.* DTNH22-94-D-07058	
12. *Sponsoring Agency Name and Address* U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590		13. *Type of Report and Period Covered* Technical Summary Report Crash Date: June, 1998 14. *Sponsoring Agency Code*	
15. *Supplementary Notes* NASS investigation of head-on collision that involved a 1998 Ford Mustang convertible equipped with redesigned frontal air bags.			
16. *Abstract* This investigation focused on a two vehicle crash involving a 1998 Ford Mustang 2-door convertible (subject vehicle) and a 1991 Nissan King Cab pickup truck. The Ford Mustang was equipped with redesigned frontal air bags for the driver and right passenger positions which deployed as a result of a head-on collision with the Nissan pickup. The driver of the Ford was operating the vehicle southbound on a two lane rural roadway when she allowed the vehicle to cross the centerline into the path of the northbound Nissan. As the Ford entered the northbound lane, the frontal area impacted the frontal area of the Nissan resulting in moderate damage to both vehicles. The restrained 36 year old female driver of the Ford Mustang initiated a forward trajectory in response to the 12 o'clock impact force as the expanding air bag contacted the anterior aspect of the right forearm resulting in an abrasion and contusion. Loading of the manual restraint resulted in contusions to the left neck, chest and abdominal area while contact to the deployed redesigned driver air bag resulted in contusions to the right eyelid and cheek. She also sustained multiple fractures of the right femur from loading to the left knee bolster. The Ford driver was transported by ambulance to a local trauma center and admitted for nine days.			
17. *Key Words* Redesigned frontal air bag system Collision Deformation Classification (CDC): 12-FDEW-4 Proper use of the manual belt system Right eyelid/cheek contusion		18. *Distribution Statement* General Public	
19. *Security Classif. (of this report)* Unclassified	20. *Security Classif. (of this page)* Unclassified	21. *No. of Pages* 6	22. *Price*

TABLE OF CONTENTS

REDESIGNED AIR BAG SPECIAL STUDY (RABSS)
SCI TECHNICAL SUMMARY REPORT
NASS CDS CASE NO. 1998-43-171E
RABSS VEHICLE - 1998 FORD MUSTANG CONVERTIBLE
CRASH DATE - JUNE, 1998

BACKGROUND

This investigation focused on a two vehicle crash involving a 1998 Ford Mustang 2-door convertible (subject vehicle) and a 1991 Nissan King Cab pickup truck. The Ford Mustang was equipped with redesigned frontal air bags for the driver and right passenger positions which deployed as a result of a head-on collision with the Nissan pickup. The driver of the Ford was operating the vehicle southbound on a two lane rural roadway when she allowed the vehicle to cross the centerline into the path of the northbound Nissan. As the Ford entered the northbound lane, the frontal area impacted the frontal area of the Nissan resulting in moderate damage to both vehicles. The restrained 36 year old female driver of the Ford Mustang initiated a forward trajectory in response to the 12 o'clock impact force as the expanding air bag contacted the anterior aspect of the right forearm resulting in an abrasion and contusion. Loading of the manual restraint resulted in contusions to the left neck, chest and abdominal area while contact to the *deployed* redesigned driver air bag resulted in contusions to the right eyelid and cheek. She also sustained multiple fractures of the right femur from loading to the left knee bolster. The Ford driver was transported by ambulance to a local trauma center and admitted for nine days.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as CDS case number 98-43-171E and also included in the Redesigned Air Bag Special Study. The Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA) assigned the Special Crash Investigation (SCI) team at Veridian the task of case review and final report preparation.

SUMMARY

Crash Site

This two vehicle crash occurred during the early evening hours of June, 1998. At the time of the crash, it was daylight with intermittent rain as the roads were wet. The crash occurred in the northbound lane of an asphalt north/south two lane rural roadway **(see Figure 7 - page 6)** which curved left with a positive grade for northbound traffic. No traffic control was present at the scene which had a posted speed limit of 89 km/h (55 mph).

Pre-Crash

The 36 year old female driver of the 1998 Ford Mustang was operating the vehicle southbound **(Figure 1)** at a (police reported) speed of 97 km/h (60 mph) and negotiating a right curve when she allowed the vehicle to cross the centerline into the path of the northbound Nissan. The Ford driver reported no avoidance actions in anticipation of the impending crash. The 22 year old male driver of the 1991 Nissan pickup was operating the vehicle northbound **(Figure 2)** at a (police reported) speed of 80 km/h (50 mph) and negotiating a left curve when he observed the southbound Ford cross his path of travel. The front right seating position of the Nissan was occupied by a 22 year old female. The NASS researcher reported no skid marks at the scene indicative of driver avoidance maneuvers.

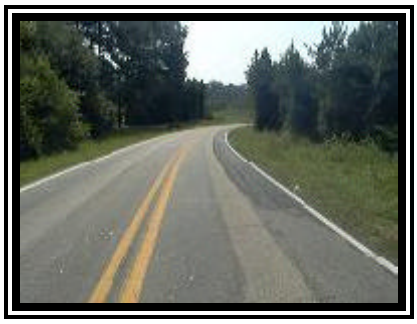

Figure 1. Southbound approach for the 1998 Ford Mustang.

Figure 2. Northbound approach for the 1991 Nissan pickup truck.

Crash

As the Ford Mustang entered the northbound lane, the frontal area impacted the frontal area of the Nissan pickup resulting in moderate damage to both vehicles. The *(SCI revised)* damage algorithm of the WinSMASH program computed velocity changes of 55.0 km/h (34.2 mph) for the subject vehicle and 56.5 km/h (35.1 mph) for the struck Nissan. Respective longitudinal components were -54.2 km/h (-33.7 mph) and -53.0 km/h (-32.9 mph). The impact induced deceleration was sufficient to deploy the Ford's redesigned frontal air bag system. At this point, each vehicle rotated clockwise as the Ford Mustang came to rest off the east shoulder faced northwest and the Nissan pickup in the southbound lane faced southeast.

Post-Crash

The driver of the Ford Mustang exited the vehicle under her own power. The exit status of the Nissan occupants were unknown. Treatment was rendered at the scene by fire department personnel and emergency medical technicians (EMTs). All occupants were transported by ambulance to a local trauma center as the Ford driver was admitted for nine days and the Nissan occupants were treated and released. Both vehicles were towed from the scene due to disabling damage.

RABSS VEHICLE

The 1998 Ford Mustang was identified by the Vehicle Identification Number (VIN): 1FAFP4444WF (production sequence deleted). The vehicle was a 2-door convertible equipped with rear wheel drive and a 3.8 liter, V-6 engine. The vehicle's odometer reading was 8,278 km (5,144 miles) at the time of the crash. The police report listed an unspecified relative as the owner of the vehicle. The seating was configured with front (folding) bucket and rear bench seats. The driver reported no previous crashes or maintenance on the air bag system (original equipment). No cell phone was present or in-use at the time of the collision.

VEHICLE DAMAGE

Exterior Damage

Figure 3. Frontal damage to the 1998 Ford Mustang convertible.

The 1998 Ford Mustang sustained moderate frontal damage as a result of the impact with the Nissan pickup **(Figure 3)**. The direct contact damage encompassed the entire frontal width resulting in a combined direct and induced damage length (Field L) of 115.0 cm (45.3 in). Six crush measurements were documented at the level of the reinforcement bar *(bumper fascia separation)*: C1= 0 cm, C2= 5.0 cm (2.0 in), C3= 50.0 cm (20.0 in), C4= 69.0 cm (27.2 in), C5= 60.0 cm (23.6 in), C6= 87.0 cm (34.3 in). The Collision Deformation Classification (CDC) for this impact to the Ford was 12-FDEW-4 with a principal direction of force of (+)10 degrees. The grille and headlight assemblies fractured and separated from the vehicle during the collision sequence. The right fender was displaced rearward which restricted/deflated the right front wheel/tire and jammed the right door (tempered window glazing disintegrated). The hood was deformed slightly up and rearward from the impact force. Reduction in the right side wheelbase measured 38.0 cm (15.0 in). The left side wheelbase was elongated 6.0 cm (2.4 in). The windshield was fractured by exterior impact forces (only).

Figure 4. Frontal damage to the 1991 Nissan pickup truck.

The 1991 Nissan King Cab pickup truck sustained moderate frontal damage as a result of the impact with the Ford Mustang **(Figure 4)**. The direct contact damage encompassed the entire frontal width resulting in a combined direct and induced damage length (Field L) of 122.0 cm (48.0 in). A maximum crush value of 75.0 cm (29.5 in) was documented at the C4 position. The *(SCI revised)* CDC for this impact to the Nissan was 11-FDEW-4 with a principal direction of force of (-)20 degrees. The bumper assembly (only) shifted slightly to the right. Bed to cab contact was noted to the right side. The right fender was displaced rearward as the hood was deformed up and rearward from the impact force. The windshield was fractured from exterior impact forces (only). Reduction in the right side wheelbase measured 19.0 cm (7.5 in).

Interior Damage

Damage to the interior surfaces of the Ford Mustang were moderate and attributed to intrusions and occupant contact. The front left restraint was stretched (loaded) with fabric transfers embedded into the webbing. The knee bolster was scratched and deformed (rigid plastic type). No deformation of the steering wheel rim was identified. Intrusions into the front right passenger space included 12.0 cm (3.9 in) of toepan intrusion and 11.0 cm (0.8 in) of instrument panel intrusion.

REDESIGNED AIR BAG SYSTEM

The 1998 Ford Mustang was equipped with redesigned frontal air bags for the driver and front right passenger positions. The air bags had deployed as a result of the crash. The driver air bag was housed in the center of the steering wheel with a horizontally oriented flap tear seam (H-configuration). The flaps were nearly symmetrical in shape as the upper flap measured 15.0 cm (5.9 in) in width and 7.0 cm (2.8 in) in height while the lower flap measured 15.0 cm (5.9 in) in width and 6.0 cm (2.4 in) in height. Although no contact evidence was identified on the exterior surface of the module cover flaps, a smudge mark was documented at the upper right quadrant of the air bag. The NASS researcher measured the diameter of the driver air bag at 48.0 cm (18.9 in) in its deflated state **(Figure 5)**. The bag was tethered by two internal straps and vented by two ports located at the 11 o'clock and 1 o'clock sectors on the rear aspect of the air bag.

The front right passenger air bag deployed from the right mid-instrument panel area with a horizontally oriented flap tear seam (H-configuration). The flaps were nearly symmetrical in shape as the upper flap measured 42.0 cm (16.5 in) in width and 8.0 cm (3.1 in) in height while the lower flap measured 42.0 cm (16.5 in) in width and 7.0 cm (2.8 in) in height. Although no contact evidence was identified on the exterior surface of the module cover flap, blood spattering was noted across the face of the air bag. The NASS researcher measured the passenger air bag at 62.0 cm (24.4 in) square in height in its deflated state **(Figure 6)**. No vent ports or internal tether straps were present. No cutoff switch was found for the front right air bag.

Figure 5. 1998 Ford Mustang redesigned driver air bag.

Figure 6. 1998 Ford Mustang redesigned passenger air bag.

DRIVER DEMOGRAPHICS

Age/Sex:	36 year old female
Height:	175 cm (69 in)
Weight:	98 kg (215 lb)
Seat Track Position:	Mid-to-rear position
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	NASS vehicle inspection, driver interview, police report
Eyeware:	Contact lenses
Type of Medical Treatment:	Transported to a local trauma center and admitted (9 days)

Driver Injuries

Injury	*Severity (AIS 90)*	*Injury Mechanism*
Right femur fracture (shaft)	Serious (851814.3,1)	Left knee bolster
Right femur fracture (neck)	Serious (851812.3,1)	Left knee bolster
Right calcaneus fracture	Moderate (851400.2,1)	Left toepan
Right eyelid contusion	Minor (297402.1,1)	Front left air bag
Right cheek contusion	Minor (290402.1,1)	Front left air bag
Left neck contusion	Minor (390402.1,2)	Shoulder belt webbing
Right lower chest/trunk contusion	Minor (490402.1,1)	Shoulder belt webbing
Right anterior forearm contusion	Minor (790402.1,1)	Expanding front left air bag
Right anterior forearm abrasion	Minor (790202.1,1)	Expanding front left air bag
Bilateral groin area contusion	Minor (590402.1,8)	Lap belt webbing
Right anterior thigh contusion	Minor (890402.1,1)	Left knee bolster

Driver Kinematics

The 36 year old female driver of the 1998 Ford Mustang was restrained by the available 3-point manual lap and shoulder belt system, seated in an upright posture with the seat track adjusted to the mid-to-rear position. Belt usage was confirmed by the stretched webbing and fabric transfers documented to the front left restraint. At impact, she initiated a forward trajectory in response to the 12 o'clock impact force as the expanding air bag contacted the anterior aspect of her right forearm resulting in an abrasion and contusion. This injury mechanism was evidenced by the size and location of the injury relative to the driver's stated pre-crash placement of the right hand on the steering wheel rim *(sourced to the center instrument panel in the NASS case file)*. Loading of the manual restraint resulted in contusions of the left neck, right lower chest (trunk) and lower abdominal region (groin). Contact to the *deployed* redesigned driver bag resulted in contusions of the right cheek and eyelid, evidenced by the smudge marks identified to the upper right quadrant of the air bag face *(sourced to the steering wheel rim in the NASS case file)*. Loading of the left knee bolster resulted in multiple fractures of the right femur (shaft/neck) as evidenced by the deformation documented to this component. The driver was transported by ambulance to a local trauma center for treatment and admitted for nine days. The combination of restraint options provided protection against further contact to the steering wheel hub/rim and potential serious injury.

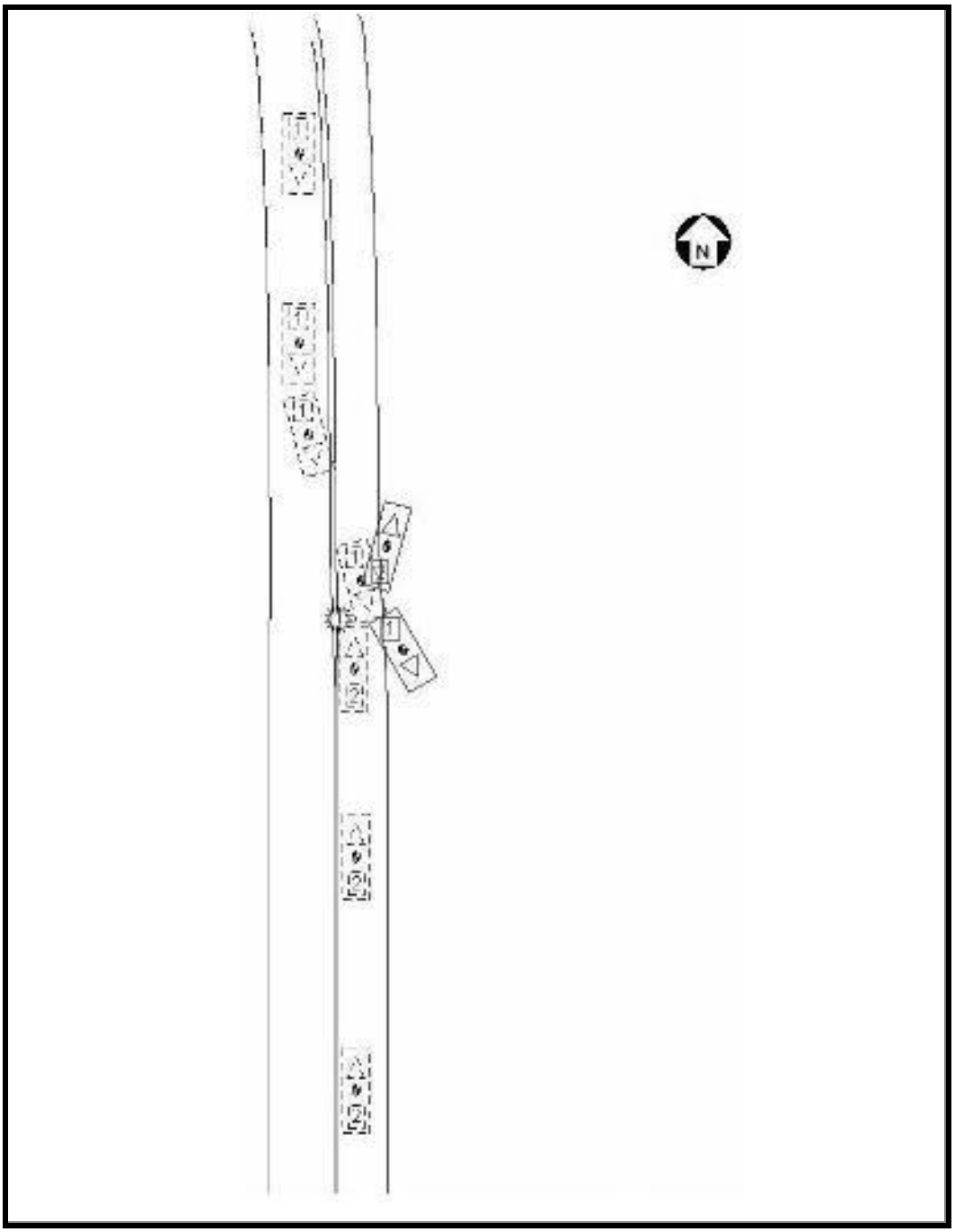

Figure 7. NASS Scene Diagram (physical plant and collision dynamics plotted incorrectly by the reseacher).