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**CRA ON-SITE AIR BAG DEPLOYMENT CRASH INVESTIGATION  
SCI CASE NO.: CR13006**

**OFFICE OF DEFECTS INVESTIGATION**

**VEHICLE: 2013 HYUNDAI ELANTRA**

**LOCATION: FLORIDA**

**CRASH DATE: JULY 2012**

Contract No. DTNH22-12-C-00269

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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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<i>16. Abstract</i> This on-site investigation focused on the deployment of the left Inflatable Curtain (IC) air bag and the partial separation of a sheet metal reinforcement to the headliner in a 2013 Hyundai Elantra. This component protruded into the driver compartment on the inner aspect of the deployed IC air bag. This 2013 Hyundai was identified in a search of potential vehicles displaying the separated reinforcement by the National Highway Traffic Safety Administration's (NHTSA) Office of Defects Investigation (ODI). The Hyundai was located at an insurance vehicle salvage facility. The Hyundai was involved in a multiple crash sequence that involved both front corners and a right side slap impact. All attempts to identify and locate the driver and owner of the vehicle have been unsuccessful; therefore this investigation was limited to the vehicle inspection.			
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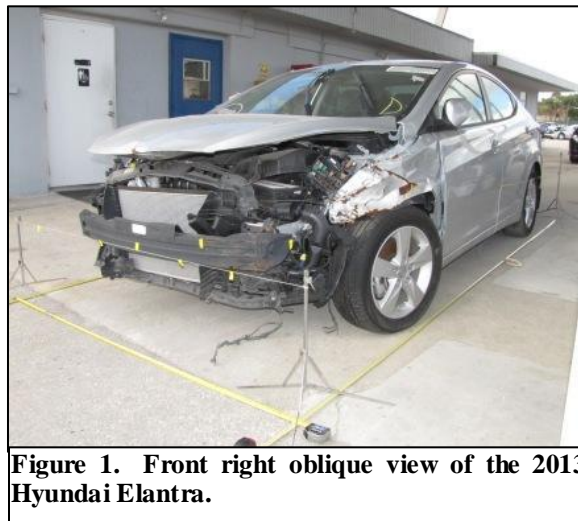
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***BACKGROUND***

This on-site investigation focused on the deployment of the left Inflatable Curtain (IC) air bag and the partial separation of a sheet metal reinforcement to the headliner in a 2013 Hyundai Elantra (**Figure 1**). This component protruded into the driver compartment on the inner aspect of the deployed IC air bag.



**Figure 1. Front right oblique view of the 2013 Hyundai Elantra.**

This 2013 Hyundai was identified in a search of potential vehicles displaying the separated reinforcement by the National Highway Traffic Safety Administration's (NHTSA) Office of Defects Investigation (ODI). The Hyundai was located at an insurance vehicle salvage facility. Details of the Hyundai's location were forwarded to the Crash Research & Analysis, Inc. (CRA) Special Crash Investigations (SCI) team on January 29, 2013. The SCI team immediately contacted the salvage facility to gain permission to inspect the vehicle. The request was referred to the insurance company and permission to inspect the Hyundai was gained from the insurance representative. The inspection of the Hyundai was completed on January 30, 2013. The insurance company refused to provide owner information or a copy of the Police Crash Report (PAR) citing privacy regulations for its customers.

A possible owner's name was obtained through a Vehicle Identification Number (VIN) search. Attempts to contact that person were unsuccessful. These attempts included a personal visit to the residence, calls to two land lines where service has been disconnected, and a letter correspondence requesting contact with the SCI investigator. Additional attempts to identify the owner and/or the PAR included a call to the original tow service and a personal visit to the county police department within the area of the tow facility and her listed address. The tow facility would not release information citing state law and the police department could not identify a PAR based on name, date of loss or vehicle type. Therefore, this on-site investigation was limited to the inspection of the Hyundai.

The Hyundai was equipped with a Certified Advanced-208 Compliant frontal air bag system, front retractor pretensioners, front seat-mounted air bags and the roof side rail-mounted IC air bags. Based on the inspection of the Hyundai, the vehicle was involved in a three-event crash with two other vehicles. The front left corner area sustained impact damage that included the bumper fascia and beam, the left front fender and suspension components. The front right area impacted a second vehicle resulting in minor severity damage located at the bumper corner and wrapping onto the right front fender. This impact produced a side-slap to the right rear door and quarterpanel of the Hyundai. The frontal, left seat-mounted and the left IC air bags deployed during the crash. Both front retractor pretensioners actuated. The Hyundai was occupied by a driver and a front right passenger. The front right passenger was detected by the weight sensor designed into the front right passenger seat. The Hyundai was equipped with an Event Data Recorder (EDR); however, the EDR was not supported by the Bosch Crash Data Retrieval (CDR) tool and software.

## ***CRASH SUMMARY***

### ***Crash Site***

The site of the crash is unknown.

### ***Pre-Crash***

The Hyundai's pre-crash travel and the events leading to the crash sequence are unknown.

### ***Crash***

The Hyundai was involved in three impact events. The specific order of the events is unknown. For reporting purposes, the events are discussed from left to right across the vehicle's frontal plane and onto the right side.

The front left corner area of the Hyundai impacted another vehicle. This event produced damage to the front bumper fascia and beam, left corner structure of the vehicle including the left front suspension, and the left fender. Although unconfirmed by a full reconstruction of the crash and EDR data, the impact deceleration produced by this damage was probably severe enough to require the deployment of the frontal air bags, the retractor pretensioners, and the left seat-mounted and IC air bags.

The front right corner of the Hyundai struck another vehicle that resulted in damage to the corner aspect of the bumper beam and the right fender. This event rotated the other vehicle in a clockwise (CW) direction resulting in a side-slap to the right side of the Hyundai.

The side-slap event resulted in a lateral 3 o'clock impact force to the right rear door and quarter panel. A black rubber tire transfer was present on the aft aspect of the door panel.

***Post-Crash***

The post-crash conditions and activities associated with this crash are unknown.

**2013 HYUNDAI ELANTRA*****Description***

The case vehicle was a 2013 Hyundai Elantra, four-door sedan. The Hyundai was manufactured on April 13, 2012 in Korea and was identified by Vehicle Identification Number (VIN): KMHDH4AE2DUxxxxxx. The reported crash date was July 13, 2012. The Hyundai was inspected on January 30, 2013 at an insurance vehicle salvage facility. At the time of the SCI inspection, the vehicle's 12-volt battery retained power. The odometer reading was 2,625 km (1,631 mi). The front-wheel drive Hyundai was powered by a 1.8-liter transverse-mounted I-4 gasoline engine linked to a 6-speed automatic transmission with a console-mounted transmission shifter. The unibody platform had a Gross Vehicle Weight Rating (GVWR) of 1,720 kg (3,792 lb) with Gross Axle Weight Ratings (GAWR) of 940 kg (2,072 lb) front and 800 kg (1,764 lb) rear. The service brakes were power-assisted, four-wheel disc with antilock. The steering was electric rack and pinion. The Hyundai was equipped with Hankook Optimo H426 all-season radial tires mounted on OEM five-spoke alloy wheels of the vehicle manufacturer recommended size of P205/55R16. The recommended cold tire pressures were 220 kPa (32 PSI) front and rear. The Hyundai was also equipped with a direct Tire Pressure Monitoring System (TPMS). The specific tire data at the time of the SCI inspection was as follows:

<b>Position</b>	<b>Measured Tire Pressure</b>	<b>Measured Tread Depth</b>	<b>Restricted</b>	<b>Damage</b>
LF	193 kPa (28 PSI)	7 mm (9/32 in)	Yes	None
LR	200 kPa (29 PSI)	7 mm (9/32 in)	No	None
RR	200 kPa (29 PSI)	7 mm (9/32 in)	No	None
RF	97 kPa (14 PSI)	7 mm (9/32 in)	No	None

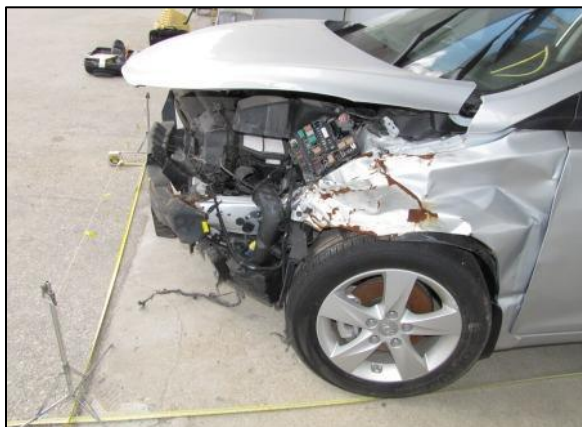
The interior of the Hyundai was configured for five-passenger seating with cloth-surfaced front bucket seats and a split, forward folding three-passenger second row seat. All five positions had adjustable head restraints. At the time of the SCI inspection, the front left head restraint was adjusted 6 cm (2.5 in) above the seat back while the front right was adjusted 4 cm (1.5 in) above the full-down position. All three rear head restraints were in the full-down positions. The safety systems consisted of manual 3-point lap and shoulder belts for the five seating positions. Supplemental restraint was provided by the CAC frontal air bags for the driver and front right positions, and side impact sensing front seat-mounted and roof side rail-mounted IC air bags.

***Exterior Damage***

The Hyundai was involved in three impact events in this crash. The damage below is described by severity and not chronological order. The bumper fascia, grill, and headlight assemblies were removed during post-crash assessment and discarded prior to the SCI inspection.

The front left corner area of the Hyundai impacted an unknown vehicle. The direct contact

damage began 34 cm (13.5 in) left of the vehicle's centerline and extended 29 cm (11.5 in) left to the bumper corner. Maximum crush was 11 cm (4.3 in) located at the corner of the bumper beam. The impact also displaced the left frame rail rearward 3 cm (1 in). The corner engagement involved the leading edge of the left front fender and the tire/wheel assembly (**Figure 2**). The fender and substructure were displaced downward and rearward. The tire/wheel engagement displaced the left wheelbase 12 cm (4.6 in) rearward, restricting the left front tire against the aft surface of the inner fender. The Collision Deformation Classification (CDC) for this event (Event 1) was 12FLEE5.



**Figure 2. Front left damage to the Hyundai.**



**Figure 3. Front right damage to the Hyundai.**

The right corner of the Hyundai impacted a second vehicle. The direct contact damage began 64 cm (25 in) right of the centerline and extended 5 cm (2 in) to the corner of the bumper beam (**Figure 3**). The end of the bumper beam was crushed 2 cm (0.8 in). The right front fender engaged the other vehicle as the vehicles rotated in opposite directions. The CDC for this event (Event 2) was 12FRES4.

The frontal impacts produced overlapping damage to the bumper beam. A combined damage profile was documented at the level of the beam and was 132 cm (52 in) in width (Field L). The profile was as follows: C1 = 11 cm (4.3 in), C2 = 3 cm (1.2 in), C3 = 2 cm (0.8 in), C4 = 1 cm (0.4 in), C5 = 1 cm (0.4 in), C6 = 2 cm (0.8 in).

The second vehicle side slapped the right side of the Hyundai (Event 3). The direct contact damage consisted of a black tire transfer to the right rear door and abrasions and dents to the door, C-pillar dogleg, and the right quarter panel (**Figure 4**). The direct damage began 29 cm (11.25 in) aft of the right rear axle and extended 123 cm (48.25



**Figure 4. Right side damage from the side slap event.**



in) forward to the mid aspect of the right rear door. The combined induced and direct contact damage began 41 cm (16 in) aft of the referenced axle and extended 135 cm (53 in) forward to the mid door. Maximum crush was 6 cm (2.25 in) and was located at the forward edge of the wheel opening, 39 cm (15.5 in) above the ground. The crush profile along the damage plane was as follows: C1 = 0 cm, C2 = 0 cm, C3 = 3 cm (1.1 in), C4 = 3 cm (1 in), C5 = 2 cm (0.6 in), C6 = 0 cm. The CDC for this event (Event 3) was 03RZEW1.

The left front, left rear, and right front doors remained closed during the crash and were operational post-crash. The right rear door was jammed in the closed position by the damage to the lower right C-pillar area. The vehicle's hood remained closed and displayed evidence that it was forced open post-crash. The trunk lid was closed and fully operational post-crash.

### ***Interior Damage***

The interior damage was isolated to the deployment of the multiple air bags, frictional abrasions on the latch plates of the front safety belt systems resultant to occupant loading, and the separation of the left headliner from the roof side rail during the deployment of the IC air bag. There was no reduction in size of the passenger compartment due to intrusion caused by exterior deformation.

### ***Manual Safety Belts***

The five safety belt systems consisted of continuous loop webbing and sliding latch plates. The driver's belt system retracted onto an Emergency Locking Retractor (ELR) that was equipped with a pretensioner. The front right belt system and the three rear seat belt systems utilized switchable ELR/Automatic Locking Retractors (ALR). The front right retractor was also equipped with a pretensioner. Both retractor pretensioners actuated during the crash. Both front positions utilized adjustable D-rings. The driver's D-ring was adjusted to the full-down position while the front right was adjusted 4 cm (1.5 in) above the full-down position.

The driver was restrained by the manual safety belt system. Belt usage was determined by the locked position of the retractor due to pretensioner actuation, the amount of webbing extended from the retractor, and loading evidence of the polymer surface of the latch plate. There was 142 cm (56 in) of webbing extending from the D-ring to the lower anchor at the sill. The full width of the polymer surface of the latch plate was abraded on both sides from frictional interaction with the belt webbing.

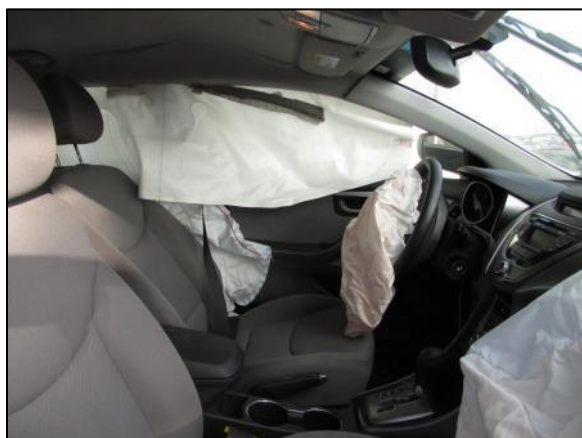
The front right passenger was restrained by the manual safety belt system. Similar to the driver's belt, the front right retractor was locked by pretensioner actuation with 173 cm (68 in) of webbing exposed from the D-ring to the lower anchor. Frictional abrasions from occupant loading were present on the latch plate surface.

The rear seat safety belts were stowed against the seat backs. There were no usage indicators on these belt systems.

### ***Supplemental Restraint Systems***

The Hyundai was equipped with six air bags that provided supplemental crash protection consisting of two frontal CAC air bags and side impact sensing front seat and roof side rail-mounted IC air bags. The Hyundai was not equipped with rollover sensors.

The frontal CAC air bag system consisted of dual stage air bags incorporated into the center hub of the steering wheel and the top of the right instrument panel, seat track positioning sensors, safety belt buckle switches, and a front right occupant classification sensor. Crash sensing and system diagnostics were contained within the Air bag Control Module (ACM) that was mounted to the center tunnel forward of the transmission shifter. A remote front impact satellite sensor was mounted to the upper center radiator support. Both frontal air bags deployed in the crash. The driver's air bag deployed from a tri-flap configuration and was 64 cm (25 in) in diameter in its deflated state. The air bag was vented by two 3 cm (1 in) diameter ports located 7 cm (2.75 in) forward of the peripheral seam at the 11 and 1 o'clock positions. The air bag was tethered by two internal straps at the 12 and 6 o'clock positions. The tether reinforcement was sewn to the face of the air bag with a 16 cm (6.25 in) diameter stitch pattern. There was no damage or occupant contact evidence to the driver's air bag. **Figure 5** is a view of the deployed air bags at the driver's position.



**Figure 5.** Deployed air bags in the driver's position of the Hyundai Elantra.



**Figure 6.** Deployed front right air bag of the Hyundai.

The front right air bag (**Figure 6**) deployed from a top-mount module in the right upper instrument panel. The cover flap was hinged at the forward edge and measured 24 cm (9.6 in) laterally and 12 cm (4.75 in) vertically. Measured dimensions of the deployed front right air bag were 36 cm (14.25 in) in width, 61 cm (24 in) in height, with a 56 cm (22 in) maximum excursion from the edge of the cover flap rearward. The air bag was vented by four ports, with

two on each side at the 3 and 9 o'clock positions. The front right air bag was not tethered. Similarly to the driver air bag, there was no occupant contact evidence or damage to this air bag.

The Hyundai was equipped with side impact sensing air bags that were designed to deploy during near-side impacts and during rollovers with impact occurring to the side surface of the vehicle. Side impact sensing was achieved by two satellite sensors located in the lower B-pillars. The vehicle was not equipped with rollover sensors. The left side impact air bags (seat back and IC) deployed as a result of the front left corner impact as there was no left side damage to the vehicle. The right frontal and right side slap impact did not deploy the right side impact air bags.

The left seat-mounted air bag deployed from the forward seam of the seat back. The seam was split over a vertical distance of 61 cm (24 in), the full height of the seat back. The air bag was D-shaped with a vertical dimension of 66 cm (26 in) and a maximum forward protrusion of 24 cm (9.5 in). The air bag was vented by a 95 mm (3.75 in) opening in the midpoint of the forward seam. There was no damage or occupant contact evidence to the seat-mounted air bag.

The left IC air bag deployed from the roof side rail. The headliner disengaged from the side rail allowing the IC to deploy downward. The IC was tethered to the left upper A-pillar by a 10 cm (4 in) long tether. The overall dimensions of the deployed IC air bag was 43 cm (17 in) vertically, extending below the level of the beltline, and was 163 cm (64 in) in length. The IC air bag provided near full coverage of the left front door window opening and full coverage of the left rear door window. A small triangular void was present in the area of the A-pillar, measuring 28 cm (11 in) along the top of the door panel and 23 cm (9 in) vertically to the upper aspect of the A-pillar. A barcoded label was present on the tether of the IC air bag and provided the following:

Key Safety Systems PA66  
Made in Mexico TB319LC0510340-6-5

The inflator for the left IC air bag was roof rail-mounted aft of the B-pillar. Several visible barcoded labels were present on the inflator and provided the following:

Patent Number: 7,401,808  
850103Y800 3X8505000  
MDCLNC447E0233

The air bag was encased in a soft fabric sleeve. This sleeve was perforated and tore away during the deployment of the IC air bag. The sleeve was found on the second row left floor of the Hyundai at the time of the SCI inspection. There was no damage or occupant contact evidence on the deployed left IC air bag.

### ***Headliner Reinforcement***

A thin gauge sheet metal reinforcement (stamped sheet metal) was applied to the top outer aspect of the matted-fabric headliner. This reinforcement was believed to add rigidity to the headliner during the manufacturing/installation process of the headliner to the vehicle. The reinforcement was 94 cm (37 in) in length and was approximately 3 cm (1.2 in) in height. It was applied to the top outer edge of the headliner with two-sided fabric tape. The two-sided tape was applied to the inner aspect of the reinforcement and to the matted headliner material. The matted surface of the headliner did not allow for proper adhesion of the reinforcement. A bead of liquid-type adhesive or hot glue was applied to the leading and trailing ends of the reinforcement, apparently to aid in the adhesion of the reinforcement to the headliner. **Figures 7 and 8** depict the reinforcement.



**Figure 7.** View from the exterior of the partially separated headliner reinforcement into the driver's compartment.



**Figure 8.** Exterior view of the back half of the reinforcement still attached to the headliner over the second row left position.

The leading edge of the reinforcement was positioned 52 cm (20.5 in) forward of the centerline of the left B-pillar with the trailing edge located 42 cm (16.5 in) aft of the referenced centerline.

During the deployment of the left IC air bag, the leading edge of the reinforcement separated from the headliner. The separation resulted from the tape and the glue disengaging from the inner surface of the headliner. The tape remained fused to the sheet metal reinforcement. The overall length of the separation of the reinforcement was 52 cm (20.5 in) with the leading edge extending 9 cm (3.5 in) below the roof side rail. This sheet metal reinforcement



**Figure 9.** Partially separated headliner reinforcement against inside surface of the left IC air bag.

protruded into the occupant compartment on the inside aspect of the deployed IC air bag (**Figure 9**). A barcoded label was applied to the reinforcement and headliner that provided the following:

T27  
2012-04-12 J20100428  
85310-3XAJ0 TX  
SKIN > NWF + PU <  
CAB

## ***OCCUPANT DATA***

### ***Driver***

The driver of the Hyundai is unknown. At the time of the SCI vehicle inspection, the driver's seat was adjusted to a full-rear track position and the seat back was reclined to a measured angle of 35 degrees. The head restraint was adjusted 3 cm (2.5 in) above the seat back. With this adjusted seat position, the horizontal distance between the mid-point of the driver's air bag module and the seat back was 77 cm (30.5 in).

The driver was restrained by the manual safety belt system as determined by the frictional abrasions on the latch plate and the actuated retractor pretensioner. There was no contact evidence within the vehicle to support his interaction with interior components. Additionally, there was no evidence to support his contact with or by the displaced headliner reinforcement.

### ***Front Right Passenger***

The front right passenger was seated in mid-track position with the seat track adjusted 10 cm (4 in) forward of the full-rear position. The seat back was reclined 25 degrees aft of vertical resulting in a horizontal distance of 88 cm (34.5 in) between the right instrument panel and the seat back.

The front right passenger was restrained by the manual safety belt system as evidenced by the locked position of the webbing extending from the actuated pretensioner. There were no occupant contact points within the front right passenger compartment to support interaction with interior components.