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[redacted] 1994

TRANSPORTATION SCIENCES CENTER
ACCIDENT RESEARCH GROUP

Division of Calspan Corporation
[redacted] NY [redacted]

CALSPAN POWER WINDOW INVESTIGATION

CALSPAN CASE NO. 94-11

VEHICLE: 1991 TOYOTA CAMRY DX

LOCATION: [redacted] PA

INCIDENT DATE: [redacted] 1994

Contract No. DTNH22-94-A-07047

Prepared for:

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

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15. Supplementary Notes
On-site investigation of a power window incident that resulted in a fatality to a 3 year old child occupant.

16. Abstract

This on-site investigation focused on a 3 year old child occupant who was a right rear passenger in a 1991 Toyota Camry, 4 dr. sedan. While his father was driving the vehicle on an urban expressway, the child occupant and his twin brother were seated in booster seats in the rear outboard positions. They apparently unbuckled the manual 3-point lap and shoulder belt systems and exited the booster seats. One of the children probably opened the right rear power window which allowed the right rear occupant to extend his head and right arm out the window opening. The power window was subsequently closed against the child's neck. The other child alerted the driver of the situation. The driver powered-down the window and pulled the child from the window area.

The driver maneuvered the vehicle onto the right shoulder and placed the child on the trunk deck as he attempted to wave-down passing motorists for assistance. An EMT stopped and initiated resuscitation efforts as the driver continued to attract assistance. The child was subsequently transported to a local hospital then transferred to a major medical facility for children where he expired. The cause of death was listed as asphyxia with no AIS codable injuries noted to the body.

17. Key Words Power window lock-out switch 60 lbs. of force	*18. Distribution Statement* General Public		
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CALSPAN POWER WINDOW INVESTIGATION
CALSPAN CASE NO. 94-11
VEHICLE: 1991 TOYOTA CAMRY DX
LOCATION: [redacted] PA

SUMMARY

Calspan's Special Crash Investigation Team initiated an on-site investigation at the request of the NHTSA COTR of a child fatality that resulted from a power-operated rear door window. The incident occurred on an urban interstate in [redacted] PA, on [redacted] 1994, during evening hours. The driver of the vehicle stated that the weather conditions were clear and warm, and the area was dark with no artificial lighting. He was driving a 1991 Toyota Camry DX, 4 dr. sedan. The vehicle was equipped with power windows at all four doors, power door locks, 2-point motorized shoulder belts in the front outboard seat positions, and 3-point lap and shoulder belts in the rear outboard positions. The front seat positions and the center rear were equipped with manual lap belts. The vehicle was manufactured on [redacted] 1991, and was identified by the following vehicle identification number (VIN): 4T1SV21E2MU[redacted]. Calspan inspected the vehicle on [redacted] 1994. At the time of our inspection, the Toyota had an odometer reading of 52,430 km (32,525 miles).

The driver was traveling in a northerly direction on the inboard lane of the interstate, en route to his residence. He was transporting his twin three year old sons and had been driving approximately 10-15 minutes. The driver stated that it was nearing the children's bedtime and that they were slightly rambunctious riding in the rear seat of the Toyota Camry. At the start of the trip, the driver buckled both children into Evenflo Sightseer booster seats in the outboard rear positions. The booster seats were forward facing and were not equipped with an integral belt system or tether restraint. The booster seats had an abdominal shield that pivoted at the right side of the seat. The vehicle's manual 3-point lap and shoulder belt secured the child and the booster seat to the respective position. Both manual belt systems extended from the C-pillar and buckled at the inboard aspect of the seated position.

The driver stated that due to the warm weather, he had partially opened all four power door windows during the drive. He estimated that each window was opened approximately 7.6 cm (3.0"). The power windows were controlled by a master switch panel that was integrated into the left front door armrest, forward of the pull handle. The switch panel contained four rocker type switches that were positioned in two rows for the four door windows. The driver's window had an automatic down mode that powered the window to the full down-position when the switch was depressed and momentarily held in that position. The right front and rear door windows required constant switch pressure to fully open the windows. To return all the windows to their up-positions, the driver must lift the forward edge of each switch and hold the switch in the up-position until the window is fully closed or at the desired height. Located forward of the cluster of window switches was a detent type

lock-out switch for the right front and rear door power windows. The lock-out mode was activated by depressing the square switch and released by depressing the switch again, which returned the switch to the up and off-position. The lock-out mode could lock-out the power window operation of the right front and rear doors with the windows in any position, from the full up to the full down position.

The right front and rear doors were equipped with separate switches to operate the power window for the specific door only. These switches were mounted flush with the door panel and were located 15 cm (6") below the beltline and 9.50 cm (3.75") rearward of the leading edge of the door panel. The toggle-type switches were vertically operated which required constant pressure in the up and down positions to power the window. When pressure was released from the switch, the switch automatically returned to the center (neutral) off-position. The rear door windows were polygonal in shape with horizontal measurements of 66 cm (26") at the base and 48.5 cm (19.1") at the roof side rail, and vertical measurements of 40 cm (15.75") at the B-pillar and 36.6 cm (14.4") at the C-pillar. The rear windows did not retract fully into the door panel. In the full down position, the center of the glass extended 10.80 cm (4.25") above the beltline. As the rear windows were lowered, the rear edge of the glazing disengaged from the window track along the C-pillar while the forward edge remained engaged with the B-pillar track.

The driver stated that while driving with the windows partially open, he had the radio on to a volume level that was slightly above the wind noise level from the windows. He denied other distractions from his driving task such as smoking, eating, etc. The driver stated that the twin male children were relatively well behaved passengers when riding in the Toyota Camry. On several occasions in the past, he reported that they had "played" with the rear seat power windows. He further stated that the children recently developed a habit of unbuckling the manual belt systems and exiting the booster seats. During this trip, the driver stated that the children got out of their booster seats on several occasions. He instructed them to get back into the seats. The left rear positioned child allegedly accused his brother of throwing his candy Easter eggs out of the right rear window. The driver directed his attention toward the right rear of the vehicle and observed both children facing the right rear window. He stated that the right front passenger seat back and head restraint partially obstructed his view of the children's activities. The seat was adjusted to a rearward track position with the seat back slightly reclined and the head restraint adjusted to an up-position. Both children had similar hair color and style and were wearing identical jackets, therefore it was difficult for the driver to initially determine which child was closest to the door window. He was able to determine that the children were positioned front-to-back and not side-to-side against the door.

The child who was originally seated in the left rear position stated that his brother was caught in the window. The driver immediately looked toward the children and observed the right rear child positioned against the door with his head and right arm extending out the window opening with the window closed against him. He noted that the child was positioned toward the forward portion of the window near the B-pillar area. While driving, he immediately lowered the right rear window with the driver console switch and reached with his right arm to retrieve the child from the window. As he pulled the child back into the vehicle, he stated that he fell limp onto the right rear seat

cushion then onto the floor. The driver immediately suspected a severe problem with the child and began to initiate lane change maneuvers toward the right (outboard) shoulder. Due to moderate to heavy traffic flow, he had to allow several vehicles to pass him on the right before steering onto the east (right) shoulder.

As the driver brought his vehicle to a controlled stop on the east shoulder, he immediately exited the vehicle and retrieved the child from the rear seat area of the vehicle and placed him on top of the trunk deck. The driver, who stated that he was not trained in CPR techniques, attempted mouth-to-mouth resuscitation by holding the child's nose and breathing into his mouth. There was no response from the child and the driver stated that he began to panic. He attempted to wave-down passing motorists, however, no one would stop. He then took off his jacket and began waving it at vehicles with his son lying on the trunk deck. The driver could not identify a time-frame from the incident until he was able to flag-down a passing motorist. An adult male stopped and identified himself as an emergency medical technician (EMT). The EMT advised the driver to continue to wave-down vehicles as he attempted to revive the child.

The driver stated that a [redacted] State Trooper was traveling in the southbound direction on the divided interstate and noted the vehicles parked on the east shoulder. The Trooper directed his A-pillar mounted spotlight on the vehicles and observed the EMT attending to the child. The EMT advised the Trooper to radio for an ambulance. An ambulance arrived on-scene within minutes of the call. The paramedics evaluated the condition of the child and continued to attend to him on the trunk deck of the Toyota Camry. The paramedics apparently shocked the heart and obtained a heart beat and placed the child in the ambulance where they transported him to a local hospital (not a trauma unit). The investigating State Trooper transported the driver and the other child passenger to the hospital. The Trooper authorized towing of the vehicle to a crime lab for an inspection of the vehicle.

At the hospital, the father (driver) stated the child's condition was stabilized and closely monitored. The medical staff subsequently arranged for transport of the patient to a [redacted] in [redacted] He was transported by ambulance approximately 6-8 hours later to the center. The driver estimated that the ambulance transport to the other hospital required approximately 30-45 minutes. Following arrival, the medical staff monitored the child's condition and told the parents that the child's outcome was difficult to predict, however, the next 72 hours would be critical. The child remained on a ventilator in an unconscious state and expired at 0945 hours, approximately thirteen hours after the incident. The autopsy report listed asphyxia as the cause of death due to compression of the neck from the power window. The child also sustained a 10 x 0.3 cm (4 x 1/8") horizontally orientated furrow (depression) on the right side of the neck. In addition, there was cyanosis of the head and neck above the furrow. There were no AIS codable injuries to the body.

The power window system was thoroughly inspected and tested during Calspan's inspection of the vehicle on [redacted] 1994. The power windows would not operate unless the ignition key was turned to the on-position, or the engine was running. The master console of switches located on the driver's

armrest were in proper operating condition. Each window switch operated its respective window in both the up and down modes. All windows would stop at any position when the operating force was released from either the driver's switch console or the individual door switch. The switches returned to the neutral (off) position. The detent lock-out switch functioned properly in both the on and off-positions. With the switch depressed in the lock-out mode, the driver's window remained operational in both the up and down positions. The right front and rear door windows would not operate in any position. This mode was tested with the windows in the up, down, and partially opened positions. As the lock-out switch was depressed again, it returned to the off-position and the three door windows were fully operational from all switch locations.

The power windows were not equipped with force limiters or a load sensing type reversal mechanism. When the switches were held in the up modes, the windows continued to close until a resisting force was encountered that would stall the door mounted electric motor. A hand-held force gauge was used to measure the closing force of the right rear window. The gauge was Calspan property and was purchased and calibrated by our Equipment Standards Laboratory (ESL). The stick force indicator gauge was manufactured by [redacted] and [redacted] The gauge was identified by [redacted] and was calibrated on [redacted]/93. The gauge is due for recalibration on [redacted]94. The face gauge was a dial indicator gauge that was calibrated to read in pounds and was capable of measuring from 0-100 pounds of force. A wooden block was fabricated to fit in the base of the gauge with a slot cut in the base of the block to accommodate the glazing.

The gauge and block were placed at various points along the right rear window as the window was powered-up, compressing the gauge between the top edge of the glazing and the window frame. This procedure was performed with the ignition in the on-position and with the engine running. The window was also raised against the force gauge from various levels, from the full down position which allowed the glazing and internal mechanism to travel approximately 19.70 cm (7.75") to less than 2.5 cm (1.0") of travel before stalling against the force gauge. These procedures were repeated several times to ensure consistent results. The results are as follows:

	Ignition Switch In On-Position (Engine Off)	Engine Running
Gauge Location		
Forward Edge of Glazing	43-45 lbs. of Force	60 lbs. of Force
Mid Glazing	43-45 lbs. of Force	60 lbs. of Force
Rear Edge	40-43 lbs. of Force	50 lbs. of Force

The force levels were lower at the rear edge of the glazing due to the design of the door and window

frame which allowed the glazing to disengage from the rear vertical window frame as the window was lowered. As the glazing was raised against the gauge, the glazing was subsequently deflected outward, thus rotating the force gauge between the glazing and the upper window frame.

The force exerted by the Toyota Camry's power window system was substantial to not only asphyxiate an occupant, but to also cause severe injury due to crushing. There was insufficient evidence to determine direct fault in this incident. The fatally injured child could have inadvertently closed the window on himself, or the father could have attempted to close the window without realizing the child was extended outside the passenger compartment. The most likely scenario involves the other child who probably attempted to prevent his brother from throwing his candy Easter eggs out the vehicle's window. It was obvious that the power windows were not in the lock-out mode and that the father allowed the children to play with the windows and not remain in their child restraints.

SELECTED PRINTS

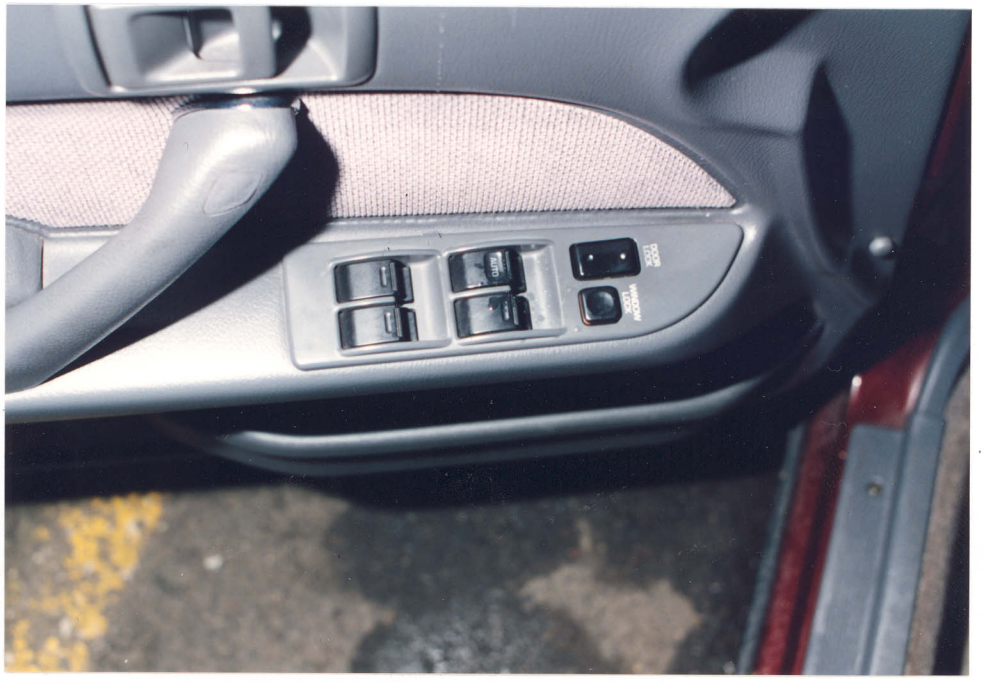
1. Left front three-quarter view of the Toyota Camry.

2. Left rear three-quarter view of the Toyota Camry.

3. Approximate opened positions of all four door windows.

4. Exterior view of the right rear window in the full down-position.

5. Interior view of the fully opened right rear window.



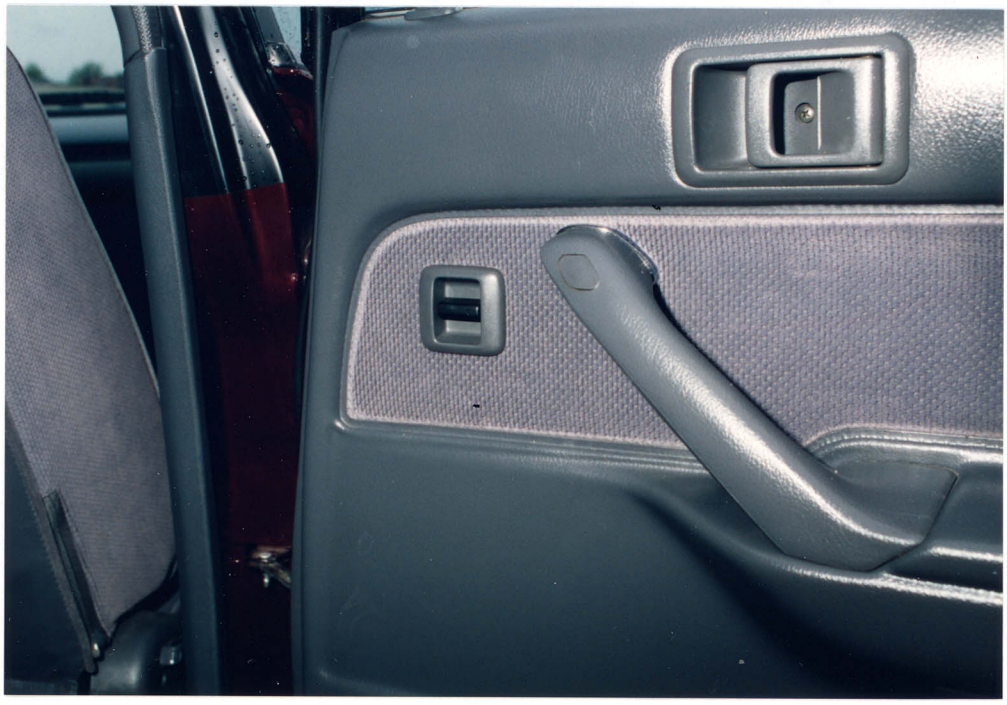
6. Power window switch console on the driver's side door armrest.

7. Close-up view of the power window switch console.

8. View across the rear seat area toward the right rear door.

9. Evenflo Sightseer booster seat (reversed position on seat).

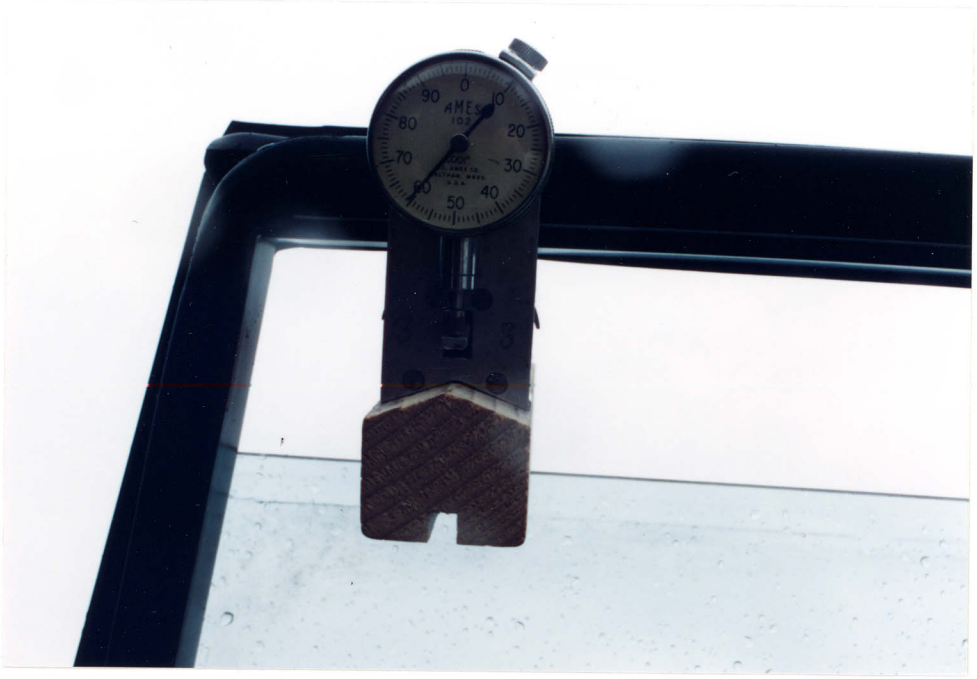
10. Overall view of the right rear interior door panel.



11. Close-up view of the right rear door power window switch.

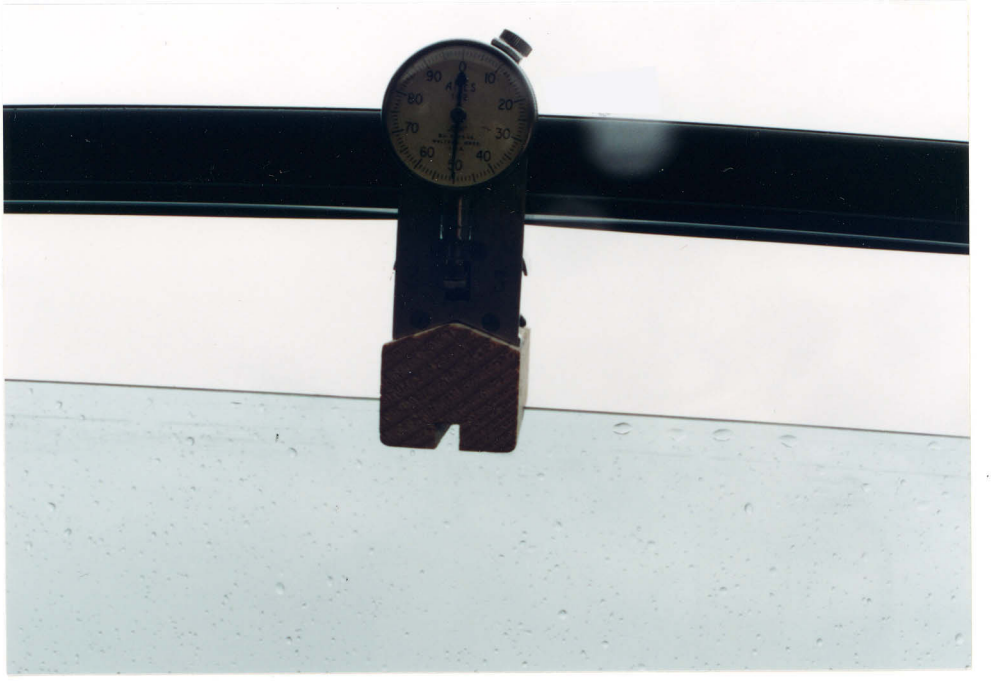
12. Right front seat back and head restraint obstruction of driver's view toward the right rear area.

13. Force gauge positioned between the right rear window and the window frame adjacent to the B-pillar.



14. Gauge reading of 60 lbs. of force.

15. Gauge positioned at the mid portion of the right rear window.



16. Gauge reading of 50 lbs. of force at mid window.