APPENDIX A

NCSA ANALYSIS

Inadvertent Safety Belt Unlatching

November 17, 1992

Summary of Findings

This analysis, conducted by staff of the National Center for Statistics and Analysis, focused on specific make, model and model year vehicles equipped with either side-release or end-release manual lap-and-shoulder belts, as specified by the staff of the Office of Defect Investigation. Data from the Fatal Accident Reporting System (FARS) for 1985-1991 and selected state files from CARDfile for 1988-1990 (the three most recently available years) were used.

The analysis of state data focused on the fatal and incapacitating injury rate (K+A) per driver involved in these vehicles as a function of relevant crash, vehicle and driver characteristics. Only towed vehicles were included in the analysis. Files used for this analysis included Indiana, Maryland, Michigan and Pennsylvania (Washington and Texas do not include a towaway indicator on the file; Indiana's vehicle make/model codes did not permit identification of Caravan/Voyager). Since not all states identify the presence of right-front passengers unless they are injured, the analysis of state data used only drivers for consistency between states and with previous state data applications. Occupant ejection in the state files was sufficiently rare to prohibit any analysis from being conducted.

The analysis of FARS data focused on the rate of fatal injury per involved front outboard occupant, as well as the ejection rate per involved front outboard occupant (ejection is much more common in fatal crashes and therefore, could be analyzed).

The major portion of the analysis employed logistic regression models, using both FARS and state data, to estimate the effect of side- vs. end-release buckles, accounting for differences in the relevant crash, vehicle and driver attributes associated with occupant injury and ejection, as available and appropriate.

In addition to the effort to develop explanatory statistical models, several vehicles under study, (Ford Taurus/Mercury Sable, Lincoln Continental, and Dodge Caravan/Plymouth Voyager) changed from side-release to end-release buckles during the study period. These "crossover vehicles" were subjected to additional, separate study, comparing the before-and-after injury and ejection experience of vehicle occupants.

The findings are as follows.

Analysis of Crossover Vehicles

The first analysis uses the raw crash data to investigate vehicles that switched from the side- to end-release system. Using these vehicles in a before vs. after comparison forms a "natural peer group", such that the crash and driver characteristics should be quite similar. The asterisk in the column labeled "Stat Sign" indicates the difference between side- and end-release was statistically significant at the alpha=0.05 level, two-tailed test.

1. Analysis of Fatal Crashes

	Side Release		End Release		
Ejection	N	% Eject	N	% Eject	Stat Sign
Caravan/Voyager	592	8.3%	298	7.0%	
Continental	97	8.2%	14	7.1%	
Taurus/Sable	1090	6.0%	297	4.7%	

	Side Release		End Release		
Fatal Injury	N	% Fatal	N	% Fatal	Stat Sign
Caravan/Voyager	592	31.4%	300	21.3%	*
Continental	98	45.9%	14	50.0%	
Taurus/Sable	1089	43.0%	297	45.5%	

Of the six comparisons, only the difference for Caravan/Voyager fatal injury per involved occupant was statistically significant, with a higher rate for side-release buckles. It may be worthwhile to investigate this result further.

2. Analysis of State Data

Indiana	Side Release		End Release		
K+A Injury	N	% Inj	N	% Inj	Stat Sign
Taurus/Sable	455	1.0%	122	1.6%	

Maryland	Side Release		End Release		
K+A Injury	N	% Inj	N	% Inj	Stat Sign
Caravan/Voyager	418	15.3%	168	16.1%	
Taurus/Sable	1061	9.9%	273	11.7%	

Michigan	Side Release		End Release		
K+A Injury	N	% Inj	N	% Inj	Stat Sign
Caravan/Voyager	1931	6.5%	535	4.7%	
Taurus/Sable	3511	5.8%	791	5.6%	

Pennsylvania	Side Release		End Release		
K+A Injury	N	% Inj	N	% Inj	Stat Sign
Caravan/Voyager	1606	2.0%	511	2.2%	
Taurus/Sable	2227	2.1%	509	2.8%	

None of the comparisons of K+A injury rates were statistically significant within each state. A second-stage analysis was conducted, combining the resulting statistics for Caravan/Voyager across states (MD, MI, PA) and Taurus/Sable across states (IN, MD, MI, PA). Neither of the two test statistics yielded a significant difference in the K+A injury rate for side- vs. end-release.

In summary, only one statistically significant difference was found in all of the analyses of crossover vehicles.

Analysis of All Specified Vehicles

The vehicles specified by ODI staff were used in investigating the effect of side- vs. end-release systems on the likelihood of K+A injury using the state data files, the likelihood of occupant ejection in fatal crashes, and the fatal injury rate per occupant involved in a fatal crash. Logistic regression models were employed, using relevant variables for the crash, vehicle and occupant characteristics.

In preliminary analyses it was noted that the vehicles equipped with side-release systems tended to weigh more than those equipped with end-release systems. In addition, vehicle weight has been shown to be a significant factor in the likelihood of occupant injury. Therefore, it was important to incorporate vehicle weight into these analyses.

Due to the bias in reported safety belt use and the relationship of reported use to the event of interest, belt use was not employed in these models.

In general, the following explanatory variables were used in the modeling process (subject to availability on the state files):

- Posted speed limit,
- Vehicle weight (or ratio of weights for two-vehicle crashes),
- Impact location (farside/nearside/other),
- Rollover,
- Occupant (driver for state files) age,
- Occupant (driver for state files) sex,
- Seating position (for FARS data), and
- Side- vs. end-release system as equipped in vehicle.

3. Analysis of Fatal Crashes

The analysis of fatal crashes (both fatal injury and complete ejection) was conducted two ways - using two-vehicle crashes and all crashes, resulting in four separate analyses. The results of these analyses were consistent: in each analysis, the <u>side-release system</u> was associated with significantly <u>lower</u> ejection rates and rates of fatal injury per involved occupant compared with the end-release system. However, while the release type was statistically significant, it was generally marginally so

compared with the remaining variables and in light of the large sample sizes (ranging from 8,000 for two-vehicle crashes to 24,000 for all crashes). Its importance was relatively small compared to the other variables included in the models.

4. Analysis of State Data

The analysis of state data investigated the likelihood of K+A injury; there were enough cases to analyze ejection risk. In these analyses the release type was never statistically significant, in spite of the fact that several states provided over 30,000 cases for analysis. In addition, the state data models did not provide as good a statistical fit to the data compared with the models estimated for fatal crashes.

Summary

Having reviewed all of these analytical results, there is no pattern of evidence to suggest that side-release systems are less safe than end-release systems. On the contrary, the FARS analysis would suggest that end-release systems may be less safe. However, it must be remembered that the analysis employs surrogate measures (injury and ejection) representing the outcome of the event of interest (inadvertent unlatching), a phenomenon which cannot be measured directly in the crash data. In addition, due to the bias in reported safety belt use and the relationship of reported use to the event of interest, belt use was not employed in these models. Differential use rates between side- and end-release systems, due to factors other than the system itself (e.g., equipped vehicle, driver demographics, etc.) could easily confound the interpretation of this result.

It is likely that the most serious consequences of the occurrence of the alleged event would be represented in more serious crashes; for example, ejection is much more common in fatal crashes than in less serious crashes (ejection is a serious outcome in and of itself). Therefore, it is not surprising for the state data to show no difference.

In closing, there is no pattern of evidence in the crash data to support the allegation related to inadvertent unlatching for side-release systems.

APPENDIX B

Side Release Button	
Model Year	Model
1985-1987	Tempo
1985-1988	T-bird
1985-1989	Crown Victoria/Grand Marquis
1986-1988	Taurus/Sable
1985-1989	Mustang
1985-1988	Continental
1985-1989	Celebrity
1985-1988	Park Avenue, Old 98
1985-1989	Caprice
1985-1988	Monte Carlo
1985-1986	Bonneville, Olds 88, Buick LeSabre
1985-1989	Cadillac Seville
1985-1986	Pontiac Grand Am, Buick Skylark or Somerset, Olds Calais
1985-1987	Chrysler Lebaron (4dr & 2dr)
1987	Sundance and Shadow
1985-1987	Daytona
1985-1989	Aries, Reliant
1985-1988	Dodge 600, Plymouth Caravelle, Chrysler New Yorker
1985-1987	Dodge Diplomat, Plymouth Grand Fury, Chrysler Fifth Avenue
1985-1988	Caravan, Voyager

End Release	
Model Year	Model
1989	Taurus
1988-1990	Tracer
1989	Continental
1985-1989	Camaro, Firebird
1985-1989	Fiero
1989	Spirit, Acclaim
1989-1991	Caravan, Voyager (Front only in 1989 and 1990)
1985-1989	BMW 3 Series
1985-1986	Accord, Civic 2dr
1985-1989	Accord, Civic 4dr
1985-1986	Maxima
1985-1988	Sentra
1985-1989	Stanza
1985-1986	Volvo 7 Series
1985-1988	Volvo 2 Series
1985-1986	VW Golf, Jetta
1985-1986	Mercedes Benz

APPENDIX C

Safety Belt Buckle Test Openings
Based on 2306 Tests and 3969 Dummies

Test Type	Vehicle/Restraint Make	Comments	Restraint Type	Restrained Device	HIC Driver Pass		Buckle Type	Report #
30 mph frontal, NHF-FMVSS 301	1979 IH Scout II	"Possible deceleration of/during buckle spring tension"	3-Pt non	50th male	-	-	side	HS-6-01478
35 mph rear, NCAP-NHF-FMVSS 301	1980 Honda Prelude	"Seat belt buckle billet only in the event, permitting dummy to move rearward freely."	3-pt non.	50th male	n/a	n/a	side	HS-9-02274
35 mph frontal, NCAP-NHF	1980 Datsun 310 GX	RECALLED, Interal mechanical failure, passenger buckle failed at 44 mmtc.	3-pt. non.	50th male	1059	2039	end	HS-9-02274
35 mph frontal, NCAP-NHF	1980 Subaru	RECALLED, Interal Mechanical Failure, Driver buckle (see next entry)	3-pt. non.	50th male	1886	2836	end	DOT #133
35 mph frontal, NCAP-NHF	" (same car as above)	RECALLED, Interal mechanical failure, passenger buckle	"	"	1085	2836	end	"
35 mph frontal, NCAP-NHF	1984 Isuzu Impulse	"On rebound the driver . . . arm struck the buckle release button. . . "	3-pt non.	50th male	1769	2454	end	212-CAL-84-025
35 mph frontal, NCAP-NHF	1984 Plymouth Conquest	Post-impact, passenger belt released, drivers right elbow struck button	3-pt non.	50th male	1118	1085	end	212-CAL-84-086
34 mph 2 cars frontal, 90% overlap	two 1989 Hyundai's	Head hit the automatic belt release on rebound (in vehicle 2)	2-pt auto, non lap	50th male	1053	682	end	DOT #1373
Sled - CRABI 30 mph	Lincoln Belts	Test 16, Airbag pushed child seat and buckle into seat cushion	Child seat, Rear Face, Affing 3-pt	p 3/4 (9 Month)	n/a	486	side	CR/AB - 16
Sled - Child Seats	Old belt	Test 33, buckle used to restrain the child seat broke at the welding connection. Belt load 853 lbs.	child seat, forward	3-year old	n/a	n/a	side	DOTHS 807466 Test 33
35 mph frontal, NCAP	1992 Dodge Dakota Pickup	Driver safety belt unbuckled on rebound during impact. Film analysis show apparent elbow impact into red. release button.	3-pt non.	50th male	1086	987	end	NCAP No. MN9302