

ROLLOVER ACCIDENTS

...a subject bibliography
from HIGHWAY SAFETY
LITERATURE

DOT HS-802 8754

PB 277 643

SB 24
December 1977

AVAILABILITY OF DOCUMENTS

Documents listed in this bibliography are **not** available from the National Highway Traffic Safety Administration unless so specified. They must be ordered from the sources indicated in the citations, usually at cost. Ordering information for the most common sources is given below.

NTIS: National Technical Information Service, Springfield, Va. 22151. **Order by title and accession number: PB, AD, or HS.**

GPO: Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. **Give corporate author, title, personal author, and catalog or stock number.**

Corporate author: Inquiries should be addressed to the organization listed in the individual citation.

Reference copy only: Documents may be examined at the NHTSA Technical Reference Division or borrowed on inter-library loan through your local library.

See publication: Articles in journals, papers in proceedings, or chapters in books are found in the publication cited. These publications may be in libraries or purchased from publishers or dealers.

SAE: Society of Automotive Engineers, Dept. HSL, 400 Commonwealth Drive, Warrendale, Pa. 15096. Order by title and SAE report number.

TRB: Transportation Research Board, National Academy of Sciences, 2101 Constitution Ave., N.W. Washington, D.C. 20418.

This bibliography has been prepared because of the interest in the subject by the staff in the program areas of NHTSA. The citations and abstracts have appeared in the publication *Highway Safety Literature* and are in the HSL information retrieval system.

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SB-20	Pedestrians	HS-802 504
SB-21	Technical Reports of the National Highway Traffic Safety Administration; a Bibliography, 1976	HS-802 518
SB-22	Accident Risk Forecasting	HS-802 567
SB-23	Vehicle Lighting	HS-802 873
SB-24	Rollover Accidents	HS-802 875

1. Report No. DOT-HS-802 875		2. Government Accession No.		3. Recipient's Catalog No. PB277643	
4. Title and Subtitle Rollover Accidents; a Bibliography				5. Report Date	
				6. Performing Organization Code	
7. Author(s) Flynn, Lois, comp.				8. Performing Organization Report No.	
9. Performing Organization Name and Address U. S. Department of Transportation National Highway Traffic Safety Administration Technical Reference Division Washington, D.C. 20590				10. Work Unit No. (TRIS)	
				11. Contract or Grant No.	
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 HSL 67-01 - 77-05	
				14. Sponsoring Agency Code	
15. Supplementary Notes					
16. Abstract <p>This bibliography represents literature acquired since the establishment of the National Highway Traffic Safety Administration (NHTSA) concerning motor vehicles involved in rollover accidents. It is comprised of NHTSA contract reports, reports of other organizations concerned with highway safety, and articles from periodicals in related fields.</p> <p>Citations follow the format used in the monthly abstract journal <u>Highway Safety Literature</u> and are indexed by a key-word-out-of-context (KWOC) listing, author, corporate author, contract number, and report number.</p> <p>Documents listed herein may be examined in the Technical Reference Branch, NHTSA, 400 Seventh St. S.W., Washington, D.C. Availability is given in the individual citations.</p>					
17. Key Words Rollovers; Accidents; Motor vehicles			18. Distribution Statement Document is available to the public through the National Technical Information Service, Springfield, Va. 22161		
19. Security Classif. (of this report) Unlimited		20. Security Classif. (of this page) Unlimited		21. Price MF PC A06/A01	

FOREWORD

This bibliography is one in a series of subject bibliographies to be published irregularly reflecting expressed interests of readers of Highway Safety Literature. Documents cited in these bibliographies may be examined in the Technical Reference Branch, National Highway Traffic Safety Administration. Few of the documents are available for distribution by NHTSA. Please note availability as given in individual entries.

Suggestions of subjects for future bibliographies should be forwarded to

Mrs. W. Desmond, Chief
Technical Reference Branch
National Highway Traffic Safety Administration
400 Seventh St., S.W.
Washington, D. C. 20590

HS-000 581

ENCOUNTER OF VEHICLES AT INTERSECTIONS

Discusses sideways skid or overturning along the vehicles curved path, and collision at points of intersection of two or more vehicle paths.

by M Peleg
Israel Inst. of Tech.
Publ: The Bulletin of the Research Council of Israel

HS-000 657

SEAT BELTS IN CONVERTIBLE CAR ACCIDENTS

Discusses safety value of wearing seat belts in roll-over accidents. Evidence concludes that seat belts are as valuable in convertibles as in cars of other body styles.

by B. J. Campbell
Publ: ACIR Bulletin n3 pl-4 (Oct 1962)
1962
Reprint
Availability: See serial citation

HS-000 675

DEATH AND INJURY ON COUNTRY ROADS: A STUDY OF 816 PERSONS INVOLVED IN RURAL TRAFFIC ACCIDENTS

Accident reports show single vehicle and rollover accidents predominate, and impact speeds and injury severity to be higher, in rural accidents.

by A. I. Adams
Sydney Univ., Australia
Publ: Medical Journal of Australia
1967 ; 9p

HS-001 311

THE SINGLE CAR ACCIDENT PROBLEM

Discusses improvements in motor vehicle design and the importance of removing roadside obstacles to eliminate single-car accidents.

by KA Stonex
General Motors Corp.
1964 ; 25p

HS-001 414

SAFETY CAR PROGRAM-FEASIBILITY STUDY

The feasibility study discusses concepts of systems engineering, safety car design, crash injury prevention, and safety ratings.

Fairchild Hiller Corp.
1966 ; 49p

HS-001 715

THE DESIGN AND DEVELOPMENT OF A MORE EFFECTIVE CHILD RESTRAINT CONCEPT

Impact tests indicate that the restraint system will retain a child-like dummy in rollovers, side impacts, and frontal impacts at moderate speeds.

by SA Heap; EP Grenier
Ford Motor Co.

14p

HS-002 101

MINIMUM PERFORMANCE CRITERIA FOR ROLL-OVER PROTECTIVE SYSTEM FOR RUBBER-TIRED, SELF-PROPELLED SCRAPERS

Describes criteria for static laboratory test to provide testing agency with means of testing for adequacy of a roll-over protective system (ROPS) design.

Society of Automotive Engineers, Inc.
1967 ; 2p
Availability: SAE

HS-002 265

THE OVERTURNING OF CARS AS A RESULT OF SEVERE BRAKING

Determines under what conditions a car might overturn following braking which locks its rear wheels.

by RN Kemp; ID Neilson
England Road Res. Lab.
1967 ; 27p

Preceding page blank

HS-002 647

HS-002 351

TRACTOR ROLL-OVER PROTECTION FRAMES

Development of a frame for protection of operators of both farm and industrial tractors and for the reductions of fatalities in the event of accidental trailer upsets.

by EC Carlson
International Harvester Co.
Publ: National Safety News

HS-002 647

913 COMPACT CAR ACCIDENTS

Analyzes accidents involving four makes of compact cars and summarizes results with respect to rollover accidents, seatbelt use, severity of injuries, and injury causes.

Indiana State Police
1963 ; 14p

HS-003 100

MINIMUM PERFORMANCE CRITERIA FOR ROLL-OVER PROTECTIVE SYSTEM FOR RUBBER-TIRED, SELF-PROPELLED SCRAPERS

SAE recommended practice presents facilities, apparatus, procedures, and performance requirements.

Society of Automotive Engineers, Inc.
1967 ; 2p

HS-003 357

HOW SAFE ARE SMALL CARS

Accident rate comparison between small and large cars. Rates of accidents are not higher for small cars but rates of serious injury or death for occupants are sharply higher. Discusses types of accidents, higher rollover rate of small cars.

by HG Miller
National Safety Council
Publ: Traffic Safety

HS-004 164

AUTO SAFETY: A LONG WAY TO GO

Suggests that the 20 federal motor vehicle safety standards now in effect and the changes made in cars to comply with them are just a first step in safety. Outlines what the standards cover and criticizes their dilution to allow auto industry to comply with them. Singles out shoulder and lap belts and head restraints for poor design in new car models. Suggests that crash protection is inadequate. Recommends that minimum

HSL sb-24

levels of handling and steering performance be established, structural design be improved to give protection to occupants in rollovers, standards for carbon monoxide penetration of passenger compartment be established, and National Highway Safety Bureaus budget and staff be increased.

Publ: Consumer Reports p179-183 (Apr 1968)
1968
Availability: see publication

HS-004 288

AGRICULTURAL TRACTOR ACCIDENTS. A DESCRIPTION OF 14 TRACTOR ACCIDENTS AND A COMPARISON WITH ROAD TRAFFIC ACCIDENTS

Every year approximately 50 people are killed and 1,000 injured in England and Wales through accidents to tractors. Tractor accidents have a much higher mortality and serious-injury rate than road-traffic accidents producing injuries of the crush type; the trunk is more likely to be injured than the head or extremities. Recommends safety frames that are strong enough to protect the drivers.

by WD Rees
Publ: British Medical Journal

HS-004 802

A STUDY OF VOLKSWAGEN ACCIDENTS IN THE UNITED STATES

Data are based on rural, injury-producing accidents involving 879 Volkswagen cars and 26,673 other cars. Dangerous and fatal injuries are more frequent among the occupants of VW and other small cars than among occupants of larger cars because of ejection rather than size of car. Ejection is more likely in rollover accidents, and these accidents are more likely in small cars. The distribution of accident severity in VWs is essentially the same as for most other cars, and the frequency of fire much less. Major causes of injury in VW were windshield, interior structures, ejection, and instrument panel, in that order. More young people and more women drive smaller cars than large cars.

by John W. Garret; Arthur Stern
Cornell Aeronautical Lab., Inc. Buffalo, N.Y. Automotive Crash Injury Research
Rept. No. CAL-VJ-1823-R32 ; 1968 ; 123p 8 refs
Study supported by Volkswagen of America, Inc.
Availability: Corporate author

HS-005 132

THIRTY-THREE FATAL CRASHES WITH SEAT BELTS

Examines the reasons seat belts failed to protect lives. Five drivers were killed by steering shaft, which was displaced into the drivers' seating space 11/2 to 21/2 feet. Eight of the accidents were rollovers, in four of which car doors opened. Shoulder harness is needed to keep head and torso inside the car in such cases. Seat belts cannot prevent death from crushing of the car interior; better design is needed. Motorists need

December 1, 1977

HS-006 601

to wear seat belts and upper torso restraints, and autos need to provide more side impact protection and safer steering assembly.

by Horace E. Campbell
Publ: Rocky Mountain Medical Journal v61 n8 p27-9 (Aug 1964)
1964
Availability: see publication

HS-005 784

ROLL-OVER RISKS

A series of tests was conducted on two identical high-loaded trailers, driven to the roll-over point, to establish the relative stability of two different suspension layouts, the conventional and the independent. The first exercise driven at various low speeds was a road evaluation, the second involved the same techniques around a large circle, and the third was performed on S-turns. Results proved that the independent suspension was more stable, could resist extreme efforts to turn over, and afforded a considerably easier ride.

by R.D. Cater
Publ: Commercial Motor v129 n3318 p56-9 818 Apr 1969
1969
Availability: see publication

HS-005 917

ROOF AND WINDSHIELD HEADER CONSTRUCTION

Describes dynamic testing procedures relative to auto roof structure and a new static laboratory testing technique. Outlines windshield header design, testing procedures, and the evolution of a design which provides a skidding action. The new design reduces potential head injury hazard from impact. Rearward head rotation is minimized.

by Gerald W Ropers; Edwin H Jr Klove
General Motors Corp., Detroit, Mich.
1968 ; 9p 2 refs
Availability: Paper 14 in General Motors Proving Ground, Proc. of Automotive Safety Seminar, 11-12 Jul 1968 (HS-005 901)

HS-006 008

MOTOR CARRIER ACCIDENT INVESTIGATION. GROSS & SONS TRANSPORT COMPANY-ACCIDENT OF JANUARY 24, 1969-JEROME, IDAHO

One fatality and \$30,000 property damage resulted from accident in which tractor-semitrailer ran off road and overturned. Truck driver had been on duty an excessive time and evidently went to sleep. He had also been drinking heavily during the trip.

Bureau of Motor Carrier Safety
1969 ; 9p

HS-006 039

INTEGRATED SEAT AND OCCUPANT RESTRAINT PERFORMANCE. FINAL REPORT

The potential value of the integrated seat concept as a means for promoting the use of restraint systems by passengers is covered. Seat belts and upper torso restraints, both attractively designed and convenient, should reduce injury in head-on impacts and rollover accidents. Lateral restraint and protection against compartment penetration are required before injury reduction in side impacts can be achieved. Occupant restraint for rear impacts may be achieved with yielding seat-backs and appropriate head rests. A program is recommended that is directed toward short term determination of performance requirements for an integrated restraint system and toward long range research and development to provide improved integrated occupant restraint.

Cornell Aeronautical Lab., Inc.
1967 ; 145p

HS-006 059

MEDICAL-ENGINEERING PANEL: THE STORY OF AN ACCIDENT

Some engineering concepts and problems in accident investigation are introduced to the medical profession. Reconstruction of the injury producing mechanisms in an automobile collision is a major problem. Standards for the description of injuries are urgently needed.

by J.R. Ruby; H.A. Fenner; D.F. Hvelke; Arnold W., Siegel
Publ: Ford Motor Co., Dearborn, Mich.
1968 ; 21 refs
Availability: In American Assoc. for Automotive Medicine, PRE-CRASH FACTORS IN TRAFFIC SAFETY, 17-18 Oct 1968 p223-44 (HS-006 046)

HS-006 601

EXPERIENCES WITH ANTI-ROLL BAR EQUIPPED TRACTORS

The Illinois Division of Highways uses nearly 1,000 tractor mowers to cut and clear vegetation from the right-of-way three times a year or more. After five fatalities and 45 personal injury cases involving roll-over accidents, anti-roll bars were tested on several tractors. It is recommended that anti-roll bars and seat belts be used together. Illinois has now installed them on more than half its tractor mowers.

by G. F. Kuhns
Illinois Dept. of Public Works and Buildings, Division of Highways, Springfield
1966 ; 21p
Presented at Farm and Industrial Equipment Institute, National Institute for Farm Safety

HS-006 706

ENGINEERING BASICS OF ROLL OVER PROTECTIVE STRUCTURES

One of the demands on construction vehicle engineering groups is that operators be given reasonable protection against crushing should the vehicle roll over. In this paper the history of such structures is reviewed, basic design considerations are emphasized, and possible evaluation methods are presented.

by G.L. Klose
Caterpillar Tractor Co.
1969 ; 15p
Presented at the National Farm, Construction and Industrial Machinery Meeting, Milwaukee, Wis., 8-11 Sept 1969.

HS-006 822

REDESIGN CUTS DEATH TOLL OF ARMY JEEP, BUT OLD MODELS STAY

The 1970 jeeps will have a completely new rear suspension designed to correct the dangerous handling problems of these vehicles. The army plans to retain the 90,000 jeeps already in service, but is giving drivers special training to use them because they go out of control and turn over too easily.

by Joseph J. Kelleher; Michael Kolbenschlag
Publ: Product Engineering v40 n8 p20-1 (21 Apr 1969)
1969
Availability: see publication

HS-006 837

STUDY OF SMALL CAR ACCIDENTS JANUARY 1, 1961 TO JULY 31, 1962

Portions of the New Jersey Garden State Parkway were surveyed to determine the proportion of small cars and the number of such cars involved in traffic accidents. Small cars are not involved in a disproportionate number of accidents as compared to standard cars.

by J.A. ARTALE
New Jersey Hwy. Authority
1962 ; 10p

HS-006 942

PRELIMINARY INVESTIGATIONS OF A HYDRAULIC BUMPER AND ROLL-OVER STRUCTURE

An experimental program on the design and test of two specific items can be adapted to protect occupants of military vehicles. These items are a hydraulic bumper capable of attenuating crash forces transmitted to vehicle occupants so that they will be within human tolerance limits and roll-over structure capable of protecting vehicle occupants in rollover ac-

cidents. Both items are demountable and can be fitted to existing vehicles.

by John P. Stapp; Sidney T. Lewis; James J. Ryan
Minnesota Univ.
7-831
1968 ; 30p

HS-007 058

A STUDY OF VOLKSWAGEN ACCIDENTS IN THE UNITED STATES

The performance of 879 Volkswagen two-door sedan beetles models was compared with that of 26,673 American and imported cars involved in rural injury-producing accidents in 30 states. Rollover occurred more frequently for small foreign sedans than for American cars. Among late-model American cars, Corvair overturned most frequently. The greater frequency of ejection, and not car size alone, is the primary reason for sharply increased hazards of injury and death among occupants of pre-1966 Volkswagens. The frequency of fire among Volkswagens, after the accident took place, was among the lowest of all cars studied. Leading causes of injury are discussed, and some differences between Volkswagens and U.S. cars are noted.

by Arthur stern; John W Garrett
Publ: Journal of Safety Research v1 n3 p115-26 (Sep 1969)
1969
Availability: see publication

HS-007 124

VEHICLE ROLLOVER DYNAMICS PREDICTION BY MATHEMATICAL MODEL

Improving occupant survivability during a rollover accident requires a detailed analysis of the dynamics and statistical significance of a particular rollover situation as well as the structural performance of the vehicle involved. A two-dimensional model describing vehicle rollover has been developed which, in conjunction with a proposed index of performance, allows such an evaluation. Dynamic equations of motion for ground contact and airborne travel are used in the model which is programmed for solution on a digital computer. Validation of the model establishes the feasibility of this approach for predicting the rollover characteristics of a vehicle and determining relative safety performance between vehicles.

by J. E. Ford; J. E. Thompson
Chrysler Corp.
Publ: Stapp Car Crash Conference (13th) Proceedings
1969 ; 10p
Presented at the 13th Stapp Car Crash Conference, Boston, Mass., 2-4 Dec 1969.

HS-007 133

COMPARISONS OF CAR CRASHES IN THREE COUNTRIES

A comparative analysis of detailed road crash data from four different environments is presented. Three of the studies were on-scene investigations of crashes from Adelaide, Australia;

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Birmingham, and Worcestershire, England. The fourth set of data was taken from ACIR reports by Cornell Aeronautical Lab., Inc. of predominantly rural crashes in the United States. The results show that there are considerable similarities between rural crashes in England and the United States, and urban crashes in Adelaide and Birmingham. Further, urban crashes have quite distinct characteristics from rural crashes. In urban collisions, speeds are low (22 mph), side impacts are frequent and lead to many injuries from the door structures. There are fewer injuries per person. In rural crashes impact speeds are higher, there are more frontal impacts and rollovers, and more injuries per person.

by G. Anthony Ryan; G. Murray Mackay
Monash Univ. (Australia) Birmingham Univ. (England)
Publ: Stapp Car Crash Conference (13th) Proceedings
1969 ; 17p
Presented at the 13th Stapp Car Crash Conference, Boston,
Mass., 2-4 Dec 1969.

HS-007 250

COMPACT CAR ACCIDENT STUDY. GARDEN STATE PARKWAY: JANUARY 1968-JUNE 1969

Garden State Parkway Statistics for January 1968-June 1969 show that 35% of all cars using the Parkway were compacts which were involved in 24% of all accidents. However, 36.8% of all injuries, 41.2% of driver fatalities, and 33.3% of passenger fatalities occurred in compacts. Single vehicle accidents occurred with 27.3% of the standard-size cars, and 38.2% of the compacts. Only 2.4% of the standard cars overturned, while 9.4% of the compacts did. Volkswagen had more overturns (27.6%) than any other single make. Slippery roads accounted for about a quarter of the accidents. Data from 1969 showed 39.2% of standard-size car drivers and 61.7% of compact car drivers are under 30 years old. Only about one-third of all accident-involved drivers are wearing seat belts. Tabulated statistics also include: type of accident; injuries by location of person in the car; vehicles leaving the roadway; road surface conditions; Volkswagen involvement; traffic and accident exposure; and car and accident survey by 6 vehicle classes subdivided by make of car.

New Jersey Hwy. Authority
1969 ; 22p

HS-007 471

ANALYSIS OF FARM TRACTOR ACCIDENTS TO DETERMINE CORRECTIVE MEASURES

A set of rules for safe tractor operation is presented. The objectives of the study were to demonstrate that a process of systematic accident analysis can yield safe tractor operating practices; to develop information on equipment changes needed; to classify driver and/or victim deficiencies; and to identify accident causes. Recommendations include: tractor safety promotion; engineering changes such as overturn protection and rearview mirrors; better tractor accident information retrieval; and the application of the techniques used in this study to other accident areas.

by T. David M. Farland
National Safety Council
1969 ; 31p

HS-007 785

CHARTING A COMMUNITY TOPP PROGRAM

A community tractor safety program is outlined. Information on the extent of the tractor upset problem, what the Tractor Overturn Prevention and Protection (TOPP) program is, and the benefits and means of promoting it is given in question and answer form. How to build the program, what message to use, what barriers may be encountered, and ways of interesting and using various mass media are detailed.

National Safety Council
1970 ; 8p
Included in FFA Tractor Safety Program Kit 1969-70 and
Tractor Overturn Prevention and Protection Program.

HS-007 791

PREVENTING TRACTOR OVERTURNS

Present figures indicate at least 1000 annual fatalities from farm tractor accidents. A National Safety Council study indicates 6 in 10 of these involve tractor overturn. Safety devices such as crush-resistant cabs and safety belts are now available, but prevention of upset is the basic need. Factors contributing to upsets are: performance and stability characteristics of the tractor; human limitations of the operator; and adverse ground and weather conditions. Specific hazards are given with the safety defense for each.

National Safety Council
1970 ; 20p
Included in FFA Tractor Safety Program Kit 1969-70 and in
Tractor Overturn Prevention and Protection Program.

HS-007 808

DOT CRASH SURVIVABILITY PROGRAM

The feasibility of designing a vehicle that will protect most occupants in most crashes is discussed. Distance is required to control crash forces; most injuries and fatalities result from frontal crashes where the most distance is available to cushion occupants. Impact tests with dummies, baboons, and human subjects testing air bag restraints are described. Impact tests with unmodified cars and with cars modified to be more crashworthy are also described, including head-on, rear end, side, and rollover crashes.

by Robert L. Carter
National Hwy. Safety Bureau, Washington, D.C.
Publ: International Conference on Passive Restraints,
Washington, 1970, p9-190
1970 ; 10p
Availability: In HS-007 822

HS-007 876

TRUCK CRASH TESTING

Static and dynamic tests were made to study the collision of trucks against different kinds of obstacles such as barriers, cars, and guardrails; wedging of cars under trucks; rollovers; forward sliding of the load; and impact of driver against the steering wheel. It is concluded that there are marked dif-

ferences in the behavior of cars and trucks, such as diverse structural behavior in some types of collision possibility of post-collision fires, and different kind of steering wheel impact on the driver. Information derived from the tests may be helpful in introducing changes in design which could make trucks safer.

by E. Franchini
Fiat Auto-Avio Res. Labs., Turin (Italy)
Publ: 1970 International Safety Conference Compendium, (P-30), New York, 1970, p901-120
Rept. No. SAE-700411 ; 1970 ; 17 refs
Includes summaries in French and German. Presented at 1970 International Safety Conference Compendium: Detroit, Mich., 13-15 May 1970, Brussels, Belgium, 8-11 Jun 1970.
Availability: SAE; In HS-007 859

HS-007 927

FIELD STUDIES OF ROLLOVER PERFORMANCE

The characteristics of rollover accidents are described, based on a representative sample of British cars and light vans. Rollovers are either initiated by impact with another vehicle or are simple rolls, the incidence of other types of roll being low. Door opening rates are high. The character of roof collapse is described. The sources of injury to occupants are discussed. Injury to the head or face occurred in 96% of injured occupants. Seat belts, when worn, prevent ejection but cannot offer complete immunity from injury. Improvements in crash-worthiness are suggested.

by I. D. Tampen; G. M. Mackay
Ford Motor Co. Ltd. (England) Birmingham Univ. (England)
Publ: 1970 International Auto Safety Conf. Compendium (-30), New York, 1970, p969-77
1970
Includes summaries in French and German. Presented at 1970 International Automobile Safety Conference: Detroit, Mich., 13-15 May 1970, Brussels, Belgium, 8-11 Jun 1970.
Availability: SAE; In HS-007 859

HS-008 587

DECLINE IN AUTOMOTIVE COLLISION INJURIES: A TEN YEAR COMPARISON OF CLINICAL CASES

This paper is an overview to indicate the reduction in injuries that has resulted from application of the Safety Standards as well as from efforts of the automotive industry. With the exception of hood penetration, side impact, and rollover collisions, higher impact speed and greater vehicle deformation must be present in collisions involving current domestic vehicles to produce injuries similar to those observed in earlier model vehicles. The shift of position of injury producing components in the vehicle interior demonstrates the overall effect of industry and government efforts. The data also suggest that two areas, side impact and rollover protection, are principal collision areas that must be improved.

by Dale E. Runge; Arnold W. Siegel; Alan M. Nahum
California Univ., Los Angeles
Publ: Proceedings of the 13th Annual Conf. of the AAAM, 1969, p185-95
1969
Presented at the 13th annual conference of the American Assoc. for Automotive Medicine, Minneapolis, Minn., 16-17 Oct 1969.
Availability: In HS-008 596

HS-008 696

DYNAMIC PROBLEMS WITH AN AIR BAG RESTRAINT SYSTEM

Crash testing has revealed dynamic problems with present designs for air bag passive restraints which must be resolved. Out-of-position occupants can restrict deployment of the air bag or affect its restraint action. In rollover and side impact accidents, today's air bag offers only minimal restraint. Accordingly, it appears essential to use the lap belt, in combination with air bags, to achieve an improved restraint system over current systems when usage rates and effectiveness are considered. The noise level created by air bag actuation may exceed tolerance levels in some humans. Inadvertent deployment of air bags could compromise the driver's control of the vehicle. These and other technical problems must be resolved before such systems are furnished in automobiles to be sold to the public.

by J. A. Pflug
Ford Motor Co.
1971 ; 6p
Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

HS-008 847

EXPERIMENTAL SAFETY VEHICLE EMPHASIZE CRASH-WORTHINESS

Three experimental safety vehicles being built for the National Highway Safety Bureau offer improved energy absorption, occupant restraint systems and intrusion limits. Specifications call for a five-passenger, four-door sedan with the weight limit of 4,200 pounds. Features briefly described are the front structure protection; sideswipe, rollover, and fuel spillage protection; interior features; steering; handling; directional stability; braking; visibility.

Publ: Automobile Engineering v79 n1 p54-7 (Jan 1971)
1971
Availability: see publication

HS-008 859

A STUDY OF THE FREQUENCY AND TYPE OF TRACTOR OVERTURNS ON NEBRASKA HIGHWAYS AND FARMS

The purpose of this study was to determine tractor overturn accident characteristics, the nature and extent of injury, the causes of the overturns and what measures can be taken to prevent overturns or reduce their seriousness. Data from 100 accidents were studied; 42 resulted in death to the operator 56 in injury, and 2 in no injury. It was found that 34% of the overturns involved operators under 20 years of age; that 48% of the operators had less than a high school education; that 78% were experienced in operating a tractor; that only nine of the tractors had some kind of protective device; that 42% of the accidents took place on a road; that the leading cause of accidents was improper operation of the tractor. The types of tractors involved in different types of overturn are discussed.

by Rollin Schnieder; Robert J. Florell
Nebraska Univ. Cooperative Extension Service
1969 ; 29p

HS-008 921

**CARS WILL BE SAFER-IF THIS IDEA WORKS.
HERS'S THE LOWDOWN ON THE FIGHT OVER
"AIR BAGS"**

The advantages and disadvantages of air bags for occupant protection are discussed. The Department of Transportation may require air bags in cars built after January 1, 1973, and the automotive industry insists that more time is needed to work out the engineering and safety problems. Air bag protection in frontal, side impact, and rollover accidents is discussed.

by Anonymous
Publ: Changing Times p31-3 (Nov 1970)
1970
Availability: see publication

HS-008 936

**COMPACT CAR ACCIDENT STUDY. GARDEN
STATE PARKWAY**

The general picture of a compact car is that it does not get into more than its share of accidents, but does inflict proportionately more injuries on its riders; it is involved in more single-vehicle accidents, it runs off the road more, it has a greater tendency to overturn, and it is operated by relatively young drivers. The results of the present study do not substantially alter the above, but suggest that the differences between standard and compact cars may be gradually lessening. Whether this is a situation that is peculiar to the Parkway or indicative of a general trend is uncertain. It may be that the recent emphasis on safety is having some effect on accident and injury trends. Whatever the case, it is likely that additional safety requirements of the Federal government will produce changes in automobiles in the early 1970's. Recognition by the American Auto industry of a sizable market for small, economical cars through its introduction of several new cars in this category should also become noticeable toward the end of 1970.

New Jersey Hwy. Authority
1969 ; 30p

HS-009 103

ROLL STIFFNESS COULD SPELL DANGER

The rollover tendencies of semitrailers are discussed. Roll stiffness, roll resistance, load transfer are discussed, and ways of improving the stability of vehicles, especially semitrailers, are briefly described.

by P. A. C. Brockington
Publ: Commercial Motor v130 n3338 p57 (5 Sep 1969)
1969
Availability: see publication

HS-009 105

**PROTECTION OF DRIVERS OF LORRIES AND
AGRICULTURAL TRACTORS IN CASE OF
OVERTURNING OR IMPACT**

On the basis of impact and loading tests, regulations for minimum standards have been established in Sweden for farm tractor and lorry cabs.

by G. Ekberg
Sweden National Road Safety Board, Stockholm
Publ: Conference on Road Safety (Brussels), 1968, Vol.2,
pA13-1 to A13-15
1968
Abstracts in English, French, Dutch, and German.
Availability: see publication

HS-009 299

**SOME COLLISION ASPECTS OF BRITISH ROAD
ACCIDENTS**

Aspects of collision performance of interest to design engineers are outlined based on at-scene studies of accidents. The relative frequency with which different areas of the car are struck is discussed, and the importance of impacts other than the direct frontal type is emphasized. Rollover accidents are discussed in relation to roof collapse and consequent injury. Various categories of objects struck are described; three-fourths are other vehicles. Door opening during the collision phase is reviewed in terms of the mechanism whereby doors open and the rates with which they open, according to make of vehicle and the presence of longitudinal restraint designed into the latch mechanism. These results may help in establishing priorities for improved crash performance design of vehicles. Seven statistical tables are included for the accident types discussed.

by G. M. MacKay
Publ: Automobile Engineer v59 n13 p500-3 (Dec 1969)
1969
Availability: see publication

HS-009 543

THE GREAT SACK RACE

An air bag restraint system for passenger cars is the prime candidate being considered by Detroit to meet the January 1973 deadline proposed by the Department of Transportation for mandatory installation of an effective passive restraint system. Considering the lead time the industry needs in order to design such a system into the 1973 cars, it is not likely to meet the deadline. The standards cover protection from rollover, frontal, and side impact collisions. Difficulty is anticipated in meeting the proposed standards for protection from rollovers because no standard rollover test exists and because there is little information in the literature on the subject.

Publ: Motor Trend v22 n7 p8-9, 90 (Jul 1970)
1970
Availability: see publication

HS-009 564

DESIGN AND TESTING OF ROLLOVER PROTECTIVE STRUCTURES IN ACCORDANCE WITH SAE J395

Plastic analysis type of analytical calculations are included in this paper as a guide for designers to size rollover protective structures to meet SAE J395. Basic design considerations are given including material selection, brittle failures, local buckling, and allowable deflections. The design is applied to crawler tractor canopy prototypes.

by William P. Macarus
International Harvester Co.
Rept. No. SAE-710509 ; 1971 ; 8p7 refs
Presented at Earthmoving Industry Conference, Central Illinois Section, Peoria, 5-7 Apr 1971.
Availability: SAE

HS-009 651

ROLL-OVER PROTECTIVE STRUCTURES FOR FARM AND CONSTRUCTION TRACTORS. A 50-YEAR REVIEW

Over the past 50 years, an estimated 30,000 tractor operators have been accidentally crushed under their overturned vehicles. During that timestability, preventive devices, and education have been tried to reduce the number of such accidents. Within the past 15 years, worldwide activity has been concentrated on developing adequate roll-over protective structures (ROPS) for operator protection. In order to measure the adequacy of the structures, various worldwide performance standards have been created. The latest include those of the SAE, which recognizes the need for a ROPS to absorb energy in order to minimize injury to the operator.

by James F. Arndt

1971 ; 9p25 refs
Presented at Earthmoving Industry Conference, Central Ill. Section, Peoria-5-7 Apr 1971.

HS-009 657

AIR BAGS BY '73?

A number of passive restraints are being considered by the automotive industry to meet the federal government deadline of January 1, 1973 for mandatory installation in automobiles. Air bags are the most often discussed system, but others being considered include deployable nets and crash blankets. The standard requires effective protection in head-on collisions at 30 mph, lateral collisions at 15 mph, and rollovers at speeds up to 60 mph. Despite significant research advances, the industry maintains it cannot meet the imposed deadline.

Publ: Fleet Owner

HS-009 759

THE NATURE OF THE COLLISION. A STUDY OF BRITISH ROAD ACCIDENTS

Some data from a representative sample of British cars involved in urban and rural collisions are given. The information was obtained from statistically representative sample studies of accidents visited at the scene within some 30 minutes of their occurrence. The relative frequency of various crash configurations is given and some of the consequences in terms of rollover experience, door opening rates, and penetration of the passenger compartment are discussed. The reduction in door opening rates with the use of anti-burst latch designs is illustrated. Variations in collision speeds with environmental changes are outlined. These results provide some insight into the priorities of crash protective design, in terms of establishing the relative importance of various crash configurations.

by G. M. Mackay
Publ: Technical Aspects of Road Safety n42-43 p2.1-2.13 (Mar 1970)
1970 ; 5 refs
Availability: see publication

HS-009 832

SNOWMOBILE CRASH ANALYSIS

This article presents some initial results of a continuing study of Michigan snowmobile crashes. The study is somewhat biased due to failure to report minor snowmobile crashes. Young male drivers had the highest crash rate. The most frequent accident cause was striking rough terrain or a ditch. Striking fixed objects and wires was more frequent at night.

by Marion Compton; William Carlson
Publ: HIT Lab Reports p6-8 (Mar 1971)
1971 ; 1 ref
Availability: see publication

HS-010 225

CODE H33 FARM TRACTOR, CODE H34 FRONT END LOADERS AND H24 TRACTORS -- INSTALLATION OF ROLL BARS, SAFETY BELTS AND CABS

Evaluation was made of the practicability and usefulness of roll bars and safety belts on tractors, particularly when fitted with cabs or canopies. Cabs, roll bars, and safety belts were mounted on a code H24 crawler tractor, a code H33 agricultural tractor, and a code H34 front end loader. It was determined that the roll bars are adequate and safe, providing the seat belts are fastened. It was concluded, however, that the roll bars were uneconomical for universal installation on all RCAF tractors because the tractors are normally operated on smooth terrain. Canvas overhead protection, at a small cost, without roll bars, was recommended for the Code H24 and Code H33 tractors. A permanent cab was recommended for the Code H34, without roll bars. This vehicle is very stable in operation and is required during all types of inclement weather. It is recommended that tractors used on hilly and rough terrain should have roll bars.

by comp. Givens, G. A.
Canada Central Experimental and Proving Estab.
1964 ; 53p

HS-010 242

HIGHWAY ACCIDENT REPORT. INTERSTATE BUS-AUTOMOBILE COLLISION AND ROLLOVER ON INDIANA ROUTE 57, SOUTH OF PETERSBURG, INDIANA, NOVEMBER 24, 1969

A bus was traveling southbound on a two lane highway in dense fog and darkness at 40 to 45 mph. While rounding a right hand curve on a downgrade and approaching an intersection the bus driver saw the headlights of an automobile which he thought was entering the highway from the right and coming at him. He steered to the right, applied the brakes; the bus swerved clockwise, skidded, struck the automobile, which in fact was stopped at the intersection, slid sideways and rolled over in a ditch. The automobile was struck broadside by the bus and slid southward, away from the bus. The bus driver and all occupants were injured during the rollover and an infant was killed. The automobile driver was slightly injured. The probable cause of the accident was that the bus driver misjudged the location of the automobile because of an illusion caused by the fog. Contributing factor was the excessive speed of the bus for road conditions.

National Transp. Safety
1971 ; 37p

HS-010 438

SUMMARY OF TRAFFIC ACCIDENTS INVOLVING TEEN-AGE DRIVERS-1969

Statistical summaries of Washington State accidents involving drivers under 20 are presented.

Washington State Patrol
1970 ; 12p

HS-010 634

SIMULATION OF SIDEWAYS OVERTURNING OF WHEEL TRACTORS ON SIDE SLOPES

A mathematical model which predicts when a wheel tractor will overturn sideways is discussed. In addition to the usual tire and tractor parameters, this model also considers the slope, turning radius, bump height, and side forces on the tires. The mathematical model predicted some overturns which actually did not occur during experimental tests.

by J. B. Liljedahl; Dennis Larson
Nebraska Univ. Purdue Univ.
Grant
1971 ; 9p20 refs
Presented at the National Farm, Construction, and Industrial Machinery Meeting, Milwaukee, 13-16 Sep 1971.

HS-010 810

AUTOMOBILE COLLISION AND THE EFFECT OF THE NEW U. S. A. STANDARDS

The evolution of collision injury safety in modern American automobiles is traced. The effectiveness of several standards

is described and collision examples are given where current performance standards are under study. Conclusions of detailed accident studies by medical-engineering teams at UCLA are presented. Reduced injury levels due to improved steering wheel/column systems, windshields, and other protective features are illustrated. The need for improved side impact protection and adequate child restraints is discussed. Cases are presented illustrating other problem areas, such as underride protection, seat anchorage failure, fuel tank rupture, hood latch failure, and windshield pillar failure. The need for further intensive medical-engineering collision research to be used as a basis for future performance standards is stressed.

by A. M. Nahum; A. W. Siegel
California Univ., Los Angeles
Publ: HS-010 808, Conference on Road Safety, Vol. 2
Biomechanics of Accidents, Pt.2, Brussels, 1968 p15-(1-80)
1968
Summaries in French, Dutch and German.
Availability: In HS-010 808

HS-010 877

FCIM INDUSTRY IS MAKING CONCERN FOR THE OPERATOR A HIGH-PRIORITY OBJECTIVE

Manufacturers of farm, construction, and industrial machinery are giving increasing consideration to operator safety and comfort. Rollover protective structures on heavy construction and industrial equipment are discussed. A mathematical model has been developed to simulate sideways overturning of farm tractors. Other aspects briefly discussed are: tower crane monitoring systems, an electronic overload warning system for mobile cranes, safety signs for attachment to the machinery, a lower noise for modular cabs, and cab air conditioning.

HS-010 945

DEVELOPMENT OF ROPS CRITERIA FOR CONSTRUCTION AND INDUSTRIAL VEHICLES

Performance standards for roll-over protective structures (ROPS) have been developed for four classes of equipment: tracked tractors, loaders, motor graders, and wheel scraper prime movers. The criteria were developed, after study of European, Federal, and California codes, by studying the behavior of roll-proven structures in a laboratory and converting these observations into numerical relationships. The criteria establish five major requirements: resist horizontal force (related to machine weight); absorb energy (must deflect without catastrophic failure); withstand vertical load after deflection equal to machine weight; meet above requirements without entering critical zone; must perform at 0eF or material must exhibit Charpy "v" notch impact strength of 8 ft-lb at 20eF.

by Staab J.E.
Caterpillar Tractor Co.
1971 ; 14p 14 re
Presented at the National Farm, Construction and Industrial Machinery meeting, Milwaukee, 13-16 Sep 1971.
Availability: SAE

HS-010 946

CALIFORNIA'S DEVELOPMENT OF SAFETY STANDARDS FOR HEAVY EARTHMOVING EQUIPMENT

California established the Division of Industrial Safety to develop and enforce safety standards for the workmen in places of employment. Many safety standards have been developed which included roll-over protective structures for heavy earthmoving equipment. When it is determined that a need exists for a new safety order such as Construction Safety Order 1596, which requires roll-over protective structures for heavy earthmoving equipment, the division thoroughly analyzes the engineering, education, and enforcement procedures and techniques as they develop the state safety standard. At the present time, the division is investigating the need for safety standards pertaining to environmental control for the operators of equipment used in construction.

by Farmer C.W.
California Dept. of Industrial Relations
1971 ; 4p

Presented at the National Farm, Construction and Industrial Machinery Meeting, Milwaukee, 13-16 Sep 1971.
Availability: SAE

HS-010 968

TRACTOR ACCIDENTS IN AUSTRALIA

It is estimated that tractor accidents account for about 100 deaths and 8,000 non-fatal serious injuries each year in Australia. From a collection of newspapers, the primary reporting source of tractor accidents, it was determined that about 4 deaths occur annually per 10,000 tractors, but in hilly farming regions, death rates may reach 25 per 10,000 tractors. Drivers under 25 and over 45 are most involved, with overturns representing 63% of all accidents. Suggestions for improved tractor safety are included.

by I. W., Grevis-James; W. F., Baillie
Melbourne Univ. (Australia)
Rept. No. Ag-Eng-1/66 ; 1966 ; 13p
Availability: Corporate author

HS-010 986

MAN VS. CAR: WHERE SAFETY RESEARCH STOPS

There is a need for a set of technically complete, well organized and compatible tests of vehicle safety. Proposed tests will involve destructive testing of crashworthiness under dynamic conditions; nondestructive tests of vehicle dynamic performance under normal and abnormal conditions; driver testing and training under various conditions; quantitative evaluation and design of highway surfaces, design, and traffic control devices. Tests are illustrated for roll-over limit, lateral acceleration vs. steering, transient dynamic performance, defensive driving, steering forces, braking, and visibility. xri

by Nat. Wood
Publ: Machine Design

HS-011 015

ROPS SAFETY COMPLIANCE TESTING

This paper describes the static test of construction equipment roll-over protective structures (ROPS) as performed in accordance with the applicable SAE Recommended Practices. Details of the test facility are presented including test fixturing concepts and pertinent design calculations. The heavy equipment tie-down methods and restraint systems are shown. Data acquisition accuracy and methods are described. Data from several tests are compared with data from SAE committee files.

by Robert W., Weed; Hartwell C., Davis
Lockheed Propulsion Co.
1971 ; 10p

Presented at the National Farm, Construction and Industrial Machinery Meeting, Milwaukee, 13-16 Sep 1971.
Availability: SAE

HS-011 087

HIGHWAY ACCIDENT REPORT. INTERSTATE BUS-AUTOMOBILE COLLISION, INTERSTATE ROUTE 15, BAKER, CALIFORNIA, MARCH 7, 1968

A man driving under the influence of alcohol and carbon monoxide was traveling the wrong way when he collided with an interstate bus. Both vehicles were being driven at normal freeway cruising speed. The bus driver braked severely and steered toward the median in an unsuccessful attempt to avoid a collision. The auto driver also attempted evasive action. The bus overturned and was gutted by fire, killing 19 of the 30 passengers and injuring the 11 survivors, some severely. The auto driver was killed instantly and ejected. The auto also caught fire and was gutted. Rapid propagation of the fire and inaccessibility of escape facilities gave the passengers in the middle of the bus little chance to survive. The fire was caused by power steering oil being discharged under high pressure from a broken fitting, ignited by exposed electrical circuits.

National Transportation Safety Board
Rept. No. SS-H-3 ; 1968 ; 78p
Availability: Corporate author

HS-011 288

COMPARTMENT COLLAPSE AND AUTO CRASH INJURY

The case records of 153 motor vehicle accidents studied since March 1968 were reviewed. In 43 cases, compartment collapse was noted. The accidents were categorized according to the principal part of the car affected: front, side, and roof. Crash characteristics and injury production were compared to determine the role of compartment collapse in injury causation. The