

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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Highway Traffic Safety
Administration**

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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

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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>					
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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 Kolbenschlager
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

role of restraint systems in injury attenuation in each accident type was noted.

by John C. Balcerak; James S. Williams; John D. States; Martin W. Korn; David N. Kluge; Alexander T. Morris
Rochester Univ.
FH-11-7329; Contract FH-11-6796; FH-11-7422
Publ: HS-011 284, American Association for Automotive Medicine Proceedings of Fifteenth Conference, New York, 1972 p84-966
1972

Presented at the fifteenth conference of the American Assoc. for Automotive Medicine, Colorado Springs, 20-23 Oct 1971.
Availability: In HS-011 284

HS-011 401

TRACTOR OPERATION AND ROLL-OVER PROTECTIVE STRUCTURES

About half of fatal tractor accidents involve overturning. The hazards inherent in tractor operation are discussed. Misuse of tractors also contributes to overturning accidents. Protective devices for all types of tractors are described, including protective frames and safety belts. Operating safety precautions are also discussed.

National Safety Council
Publ: National Safety News

HS-011 468

SOME DESIGN ASPECTS FOR HIGH-SPEED SNOWMOBILE SAFETY

Constructional features of the 140 mph snowmobile Pegasus are related to the various specifications considered essential to operator safety. Development of this vehicle involved investigation of crucial parameters such as yaw and drag on directional stability while operating at high speeds. These effects and other aerodynamic influences are explained as they affect single-track and dual-track vehicles. The final design incorporated measures to counter adverse tendencies during high-speed operation, as well as backup devices such as a rollover bar, auxiliary braking system, fire protection, and an escape mechanism.

by Edgar Rose
Outboard Marine Corp.
Rept. No. SAE-720257; 1972; 9p 7refs
Presented at the Automotive Engineering Congress, Detroit, 10-14 Jan 1972.
Availability: SAE

HS-011 476

UTAH, WASATCH FRONT COUNTIES (WEBER, DAVIS, SALT LAKE AND UTAH) TRAFFIC ACCIDENTS BY TYPE AND ACCIDENT RATE, 1970

Statistics of motor vehicle accidents for Federal-aid and State designated highways are presented. The accident rates are ex-

pressed by frequency of accidents in relation to type, time, traffic volume, and location.

Utah State Dept. of Highways
1971; 202p
In cooperation with Federal Highway Administration.

HS-011 507

DESIGN FOR SURVIVAL

The thrust of the ESV (Experimental Safety Vehicle) program is in terms of crashworthiness, of the ability of the car's occupants to survive. The standards are impressive: survivability of passengers in 50 mph front and rear end collisions, with solid barriers, adequate protection for occupants to survive a 70 mph rollover, side protection to withstand 30 mph collisions, no damage to the body of the car in frontal or rear collisions up to 10 mph. The two major contractors in the program are Fairchild Industries Republic Division and AMF Inc.

Publ: Automotive Fleet

HS-011 512

SIMULATION OF ROLLOVER WITH A DYNAMIC ROOF CRUSH TEST

Tests to simulate rollovers are currently very often criticized because of the nonreproducibility of the tests and their results. A test procedure is used by Volkswagen in which a flat impact plate equal to the empty weight of the vehicle is dropped from a defined height onto the roof of the vehicle. The vehicle can be mounted on a bed at various angles relative to the impact plate. The results with this simple test method provide a comparative scale for roof rigidity rather than an absolute comparison with dynamic vehicle rollover roof rigidity. The problem of definition and evaluation of survival space is described. Based on the definitions that exist today, it is impossible to define a fixed survival space for assessing the behavior of vehicle roofs during rollover simulation tests.

by U. W. Seiffert
Volkswagenwerk A.G. (West Germany)
1972; 8p 3ref
Presented at Automotive Engineering Congress, Detroit, 10-14 Jan 1972.
Availability: SAE

HS-011 521

DETROIT'S SEARCH FOR THE SAFE AUTOMOBILE

New developments in the experimental safety vehicle (ESV) are described. Specifications are given for General Motors' and Ford's ESVs. General Motors is creating a completely new running car while Ford is adding minor changes to a standard Galaxie model. Similar safety items appear in the two ESVs: air bags; adjustable foot controls and fixed seats; and energy absorbing frames and bumpers. Both cars are over the weight requirement. Some other features of the General Motors car are: padding to protect occupants in 30 mph crashes; fixed side glass to reduce the chance of ejection in rollover;

and a double brake circuit. Ford's RSV has a modified frame designed to absorb 65% of the energy of a 50 mph barrier crash and a front end to absorb 35% of the crash energy. Ford is reportedly developing cushion-type seat belts as a possible alternative to air bags.

by Frank Beaumier
Publ: Motor Service p28-31 (Dec 1971)

HS-011 605

BUS COLLISION CAUSATION AND INJURY PATTERNS

A clinical interdisciplinary research methodology was applied to the problem of school bus and coach passenger protection. Pertinent findings of the study include collision causation factors resulting from driver, vehicle, and environmental influences. Injury causation and injury patterns are related to ejection, restraints, structure design, and seats. Occupant kinematics and the subsequent injury production are related to three classes of school bus and coach collisions. Post-collision factors influencing injury, such as egress, extrication, and fire are discussed.

by A. M. Nahum; A. W. Siegel; D. E. Runge
California Univ., San Diego; Automobile Club of Southern California.
Publ: HS-011 551, Stapp Car Crash Conference (15th) Proceedings, New York, 1972 p301-855
Rept. No. SAE-710860 ; 1972 ; refs
Presented at the fifteenth Stapp Car Crash Conference, Coronado, Calif., 17-19 Nov 1971.
Availability: In HS-011 551

HS-011 704

RALPH NADER VS. VOLKSWAGEN. AN EVALUATION OF THE VOLKSWAGEN: AN ASSESSMENT OF DISTINCTIVE HAZARDS

The allegations made by Ralph Nader are refuted. According to available crash statistics, to the results of controlled experiments, and to the most qualified engineering analysis, the following is true: The VW Beetle is not abnormally hazardous. It compares favorably with cars of equivalent age and size. Volkswagens do not crash more often or inflict greater injuries on occupants than other cars their size; nor do they appear to offer any unusual risk of fire. While the occupants of small cars suffer more injuries in collisions than occupants of large ones, there is no indication that small cars get into more accidents, and some indication they get into fewer serious accidents than large cars.

by J. Tomerlin
Publ: Road and Track
1972 ; refs

HS-012 066

ROLLOVER TESTING

This paper presents a summary of rollover testing history; provides an analysis of field accident data relating to rollovers; and summarizes GM's recent experience with a new method of rollover testing.

by R. A. Wilson; R. R. Gannon
General Motors Corp.
1972 ; 12p
Presented at National Automobile Engineering Meeting, Detroit, 22-26 May 1972.
Availability: SAE

HS-012 204

SMALL--ON SAFETY, THE DESIGNED-IN DANGERS OF THE VOLKSWAGEN

The book concludes that the Volkswagen Beetle is the most hazardous car currently in use in significant numbers in the U. S. This conclusion is based on the following factors: the danger of injury from the windshield, the weakness of the seat tracks and seat backs, the likelihood of the doors opening in a crash, the consequent likelihood of passenger ejection, the dangerous handling qualities which make the car quite unpredictable. These factors not only give the Beetle a higher propensity toward involvement in single vehicle crashes than most other cars, but also make the Beetle more likely to cause serious or fatal injury in any collision. The recommendations presented deal with the following aspects of the Volkswagen problem: size as a safety factor, responsibilities of Volkswagen, and responsibilities of NHTSA.

Center for Auto Safety
Publ: Published by Grossman Publishers, New York, \$6.950

HS-012 325

STAPP CAR CRASH CONFERENCE (16TH) PROCEEDINGS, NOVEMBER 8-10, 1972, DETROIT, MICHIGAN

Topics include occupant modeling, human body simulation, impact tolerances and injuries, impact tests, restraint system tests, and rollover and rear end accident studies. Special emphasis is given to head and neck simulation models.

Society of Automotive Engineers, Inc.
1972 ; 471p
Co-sponsored by Wayne State Univ., Univ. of Michigan, and Univ. of California, San Diego. Includes HS-012 378 through HS-012 398.
Availability: SAE

HS-012 388

INJURY MECHANISMS IN ROLLOVER COLLISIONS

Conclusions of a study of rollover collisions and the injuries resulting from them are presented. The injury severity, the type of injury, the body region injured, the frequency of injury, and the injury mechanism are all indicated. The study in-

cludes statistics on both restrained and unrestrained occupants, and shows that ejected occupants usually sustain more severe injury than contained occupants. Several conclusions are presented as to automobile structures in relation to injury.

by P. V. Hight; A. W. Siegel; A. M. Nahum
California Univ., San Diego
Publ: HS-012 325, Stapp Car Crash Conference (16th) Proc
1972

Supported by the Public Health Services, Automobile
Manufactures Assoc., Inc., and National Hwy. Traf. Safety
Administration.

HS-012 425

THE INJURY RISK OF ROLL-OVER ACCIDENTS IN RACING AND HIGHWAY DRIVING

The use of restraint systems to hold occupants inside vehicles and in place during rollover accidents is the single most effective means of protection. Prevention of roof collapse and preservation of the occupant space are essential for optimal function of restraint systems. Serious injury occurred only when there was collapse of the occupant space or when the occupants were ejected from their vehicles. Head injuries are common among unrestrained occupants. In spite of their lack of helmets, serious head injuries did not occur among restrained occupants. Upper extremity injuries were frequent in all groups and were caused by flailing of the upper extremities.

by J. D. States; R. Sweetland
Rochester Univ.
Contract FH-11-6796
Publ: HS-012 408, Triennial Congress on Medical and Relia
1971

HS-012 474

FATAL ACCIDENTS ON THE INTERSTATE SYSTEM, 1968-71

Police reports on 12,387 rural and urban fatal vehicle accidents were analyzed and 29 accident types were identified. Responsibility was assigned to one driver in each accident. Accident distribution by time of day, day of week, type of vehicle, driver age and sex, and the effect of weather and road conditions are discussed. Fewer than 9% of the drivers responsible for multiple vehicle fatal accidents were asleep or fatigued, as opposed to 20% for single vehicle fatal accidents. Drinking drivers were responsible for more multiple vehicle accidents in wrong way head on collisions. Of the fatal accidents, 51.8% were single vehicle ran off the road accidents in which 81% of the vehicles struck a fixed object and 56% overturned. Fifteen percent of the fatal accidents were rear end collisions, 12% were head on collisions, and 8.5% were pedestrian accidents. Countermeasures for avoiding future accidents are suggested.

by B. V. Chatfield; H. R. Hosea
Publ: Public Roads
1972

HS-012 502

STYLING AND SAFETY. CAN THEY LIVE TOGETHER?

In this interview General Motors design chief, Bill Mitchell discusses the development of a strong center-pillar which reduces reliance on screen pillars, thus leading to replacement of the hardtop. Windows of bonded layers of glass and plastic can now also be used as roof supports. Vision could be increased by use of roof-top periscopes and fixed glass windows which would eliminate the need for space for roll down windows and increase the glass area downwards. Sun-roofs are replacing convertibles because open cars may no longer meet rollover safety standards. Sports cars are becoming less popular due to high insurance rates and emissions regulations. Mitchell briefly discusses advantages of front-wheel-drive and mid-engine automobiles. Endura plastics are being used in automobile body construction to reduce minor damage. General Motors is moving toward standardization of piston-type 5 mph bumpers and fitting solid bumpers with hydraulic shock absorbers.

by R. Hutton
Publ: Autocar
1972

HS-012 564

HUMAN BODY INJURY AND VEHICLE CRASH DAMAGE

During the period 1 June 1970 to 31 May 1971, accidents involving injuries were investigated by Royal Canadian Mounted Police in British Columbia to determine the relationship between vehicle damage and injury severity. Injury severity and damage severity scales were developed. Results are tabulated and show that the number and severity of injuries tend to increase as vehicle damage increases and that 75% of fatal injuries occurred in most severely damaged vehicles. Data on cranial injuries indicate that almost 80% of cranial injuries were relatively minor and almost 75% of fatal cranial injuries occurred in association with severe vehicle damage. Data on injuries, fatalities, and vehicle damage in rollover accidents show similar pattern.

by E. O'F. Campbell
Traffic Injury Res. Foundation of Canada

14P
Availability: Corporate author

HS-012 657

A CRITIQUE OF THE NHTSA DEFECT INVESTIGATION OF THE 1960-1963 CORVAIR HANDLING AND STABILITY

The NHTSA investigation was evaluated by three outside engineers empanelled by NHTSA on September 15, 1971. NHTSA was aware that finding a defect in Corvaire handling and stability could require a similar finding for the Volkswagen Beetle, Renault Dauphine, and other vehicles which would have led to demands for recall of one to two million vehicles. NHTSA ignored conflicts of interest among individuals responsible for conduct and review of the investiga-

tion except when there might have been a protest from General Motors. A comparison between Highway Safety Research Institute and Texas Transportation Institute (TTI) tests of Corvair handling and stability and suppressed data from Corvair tests performed for NHTSA at TTI are included. A gap existed between the level of training and competency of NHTSA and TTI engineers and technicians, none of whom had specialized training or were recognized experts in the field.

by C. E. Nash
Public Interest Res. Group
1973 ; 78p
Availability: Corporate author \$5.00

HS-012 782

ACCIDENTS INVOLVING INJURY TO OCCUPANTS OF COMMERCIAL VEHICLES

Data on 634 commercial vehicle accidents in one English county between 1965-1968 are analyzed. Taken into account are the proportions of accidents in urban and rural areas and accidents by vehicle weight. Single vehicle accidents represented 52% and caused half of all injuries; vehicle vehicle accidents represented 42% overall and about 43% of all injuries. Front end collisions constituted about 53%, side impacts 15%, overturning 14%, and rear end 11%. For occupant injuries by impact type 54% occurred in front collisions, 20% in overturning, 11% in side impacts, 11% in other single vehicle accidents, and 4% in rear end impacts. Corresponding figures for fatal and serious injuries were 73% in frontal impacts, 10% in overturning, 13% in side impacts, 3% in other single vehicle accidents, and 1% in rear end impacts. Almost all overturning, about 95%, occurred in single vehicle accidents.

by I. S. Jones
Publ: HS-012 743, International Automobile Technical Con
1972
Availability: See serial citation

HS-012 836

SMALL VEHICLE STRUCTURAL DESIGN

General structural design criteria and the structural characteristics of a 1200 lb class standard car and a 1500 lb experimental safety vehicle (ESV) were studied. Crashworthiness of the 1200 lb car was evaluated by barrier collision tests conducted at increasing speeds and by rollover drop tests. Test results, which indicate that a weight increase of at least 30% is necessary to meet survival space requirements, led to the development and testing of the 1500 lb ESV. Considering the negative consequences that such a weight increase would have on the technical, economic, and commercial characteristics of small cars, it is doubtful that such a solution will be acceptable in practice. To solve present structural problems a compromise must be reached between safety requirements and those which condition the existence of the small car.

by G. Puleo
Fiat S.p.A. (Italy)
1973 ; 15p
Presented at International Automotive Engineering Congress,
Detroit, 8-12 Jan 1973.
Availability: SAE

HS-012 856

ANALYSIS OF ROLLOVER ACCIDENT FACTORS AND INJURY CAUSATION

One of the most violent automobile accidents in terms of occupant injury exposure is the rollover crash. In this environment the most consistently noted damaged area of the vehicle has been roof crush. It has been hypothesized that the prevention of significant roof crush will result in reduced injury severity. An analysis was made of 249 rollover accident investigation reports. The results disclosed that average occupant injuries in rollovers are at the lower end of the injury severity scale and are similar in severity to injuries in all other types of crashes. However, twice as many fatal injuries occur in rollovers than in all accidents and two-thirds of these fatalities are due to unrestrained occupant ejection. From these data it would appear that containment of occupants within the vehicle would provide a significant reduction of injury severity levels, and that reducing roof crush in rollover accidents will be of little significance in injury severity reduction.

by D. F. Huelke; J. C. Marsh, 4th.; H. W. Sherman
Michigan Univ. Michigan Univ. Hwy. Safety Res. Inst.
Publ: HS-012 850, American Association for Automotive Me
1973
Availability: In HS-012 850

HS-012 888

HIGHWAY ACCIDENT REPORT--BUS/STATION WAGON COLLISION, FOLLOWED BY BUS OVERTURN, U.S. ROUTE 66, NEAR MARSHFIELD, MISSOURI, OCTOBER 10, 1971

At 2:05 a.m. a westbound bus collided with a station wagon which was attempting to turn around in the westbound lane of U.S. 66. The station wagon was knocked about 90 feet westward by the impact; both its occupants were ejected and the passenger was killed. The bus skidded off the north of the Highway, encountered a drainage ditch, spun clockwise, and overturned. All 38 occupants were injured, four of them fatally, including one of five passengers ejected. The crash was caused by the maneuvering of the station wagon by an intoxicated driver and the bus driver's delayed evasive action. The bus rollover was caused by the lockup of the bus brakes which prevented steering control after the initial crash. Causes of injuries and fatalities to bus occupants were: localized window column failure; absence of passenger restraints; ejections through windows; and unyielding interior bus components. Failure to wear seatbelts contributed to the station wagon occupants' injuries.

National Transp. Safety Board
1972 ; 36p
Availability: Corporate author

HS-013 016

GENERAL MOTORS EXPERIMENTAL SAFETY VEHICLE--POWERTRAIN AND FUEL SYSTEM

An experimental safety vehicle powertrain and fuel system was developed which includes a low engine accessory package to meet the front visibility down angle of eight degrees, engine and transmission mounting for retention at high decelerations, a light aluminum engine, an over-the-rear-axle fuel tank, and a

December 1, 1977

unique evaporative emission fuel pipe routing to prevent leakage during vehicle rollover.

by F. A. Wyczalek; T. R. Leonard; D. W. Peterson
General Motors Corp.
1973 ; 10p
Presented at International Automotive Engineering Congress,
Detroit, 8-12 Jan 1973.
Availability: SAE

HS-013 035

**HIGHWAY ACCIDENT REPORT--RUNOFF AND
OVERTURN OF INTERCITY BUS ON INTERSTATE
95, RICHMOND, VIRGINIA, SEPTEMBER 3, 1972**

At about 2:20 a.m. a southbound intercity bus carrying 42 passengers climbed a raised median on a gradual curve to the right, struck and displaced 220 feet of median barrier rail, and returned to the southbound lanes. The bus then crossed the southbound lanes, glanced off the west-side guardrail, vaulted, and overturned on a steep embankment off the highway. Three passengers were killed, and all other passengers were injured. The probable cause of this crash was that the busdriver failed to stay awake and steer the bus, which permitted the bus to encounter the median, resulting in loss of vehicle control and in overturn of the bus on a guardrail inadequate to resist a shallow-angle impact. The absence of passenger restraints, which permitted the tumbling and ejection of passengers, contributed to fatalities and injuries. Undesired opening of side windows subjected to rollover-induced stresses contributed to ejections.

National Transp. Safety Board
1973 ; 21p
Availability: Corporate author

HS-013 084

**UTAH, WASATCH FRONT COUNTIES, TRAFFIC
ACCIDENTS BY TYPE AND ACCIDENT RATE, 1972**

Information on motor vehicle traffic accidents by type and rate for Federal-aid and State highways in the Wasatch Front counties (Weber, Davis, Salt Lake, and Utah) is presented. The accident rates are expressed by frequency of accidents in relation to type, time, traffic volume, and linear length. Utah State Law requires a driver involved in a motor vehicle accident resulting in the injury or death of any person, or property damage exceeding \$100, to submit a standard accident report to the State Department of Public Safety. The accident data presented were compiled from those reports.

Utah State Dept. of Highways
1973 ; 191p
In cooperation with Federal Hwy. Administration.
Availability: Corporate author

HS-013 267

**HANDLING AND STABILITY. VOLVO'S
EXPERIMENTAL SAFETY CAR**

Simulation of steering tasks of the Volvo's experimental safety car indicates that many parameters influence vehicle handling, but not all have the same importance to the road holding characteristics of the vehicle. The weight distribution on the

front and rear axles is one of the more important factors and can be influenced by the driver. For example, a fully loaded car may have a load of 40% on the front axle and 60% on the rear axle. This unbalanced distribution can cause problems for the driver in transient steering. It is important, therefore, that vehicles be designed so that even the worst weight distribution will not affect handling qualities to the extent that the driver has difficulty in controlling the steering. That is, handling performance should vary as little as possible regardless of disproportionate load distributions.

by F. Jaksch
Volvo A.B. (Sweden)
1973 ; 27p
Presented at Automobile Engineering Meeting, Detroit, 14-18
May 1973.
Availability: SAE

HS-013 318

THE MECHANICS OF VEHICLE COLLISIONS

The technical factors involved in the motion of vehicles and their collision are presented for the purpose of deriving accident reconstruction methods. The theory of axial collisions; the theoretical foundations of right angle and oblique collisions; and examples of parallel, head on, rectangular, and oblique collisions, and occupant kinematics are presented. The mechanics of braking on a straight road, on a grade, and in a curve; the causes of rollovers; and vehicle moments of inertia are outlined. The importance of driver reaction time in braking and night driving is emphasized.

by H. Reizes
Publ: by Charles C. Thomas, Springfield, Ill.
1973 ; 148p
Availability: Book dealer

HS-013 382

**AN EVALUATION OF MEASURES TO REDUCE
ACCIDENT OCCURRENCE**

Literature on vehicle design features which have a known relationship to accident occurrence is reviewed. No consideration was given to implied safety, that is, design features which if incorporated in the vehicle should improve safety, but for which there is at this time no known relation from accident statistics. The review indicates a number of areas in which improvements to vehicle design could be made in order to reduce the occurrence of accidents. These included the fitting of anti-skid devices to automobiles, motorcycles, and commercial vehicles; compulsory changing of tires when tread depth reaches 1/16 inch; improvements in vehicle visibility by means of daytime running lights, light paint colors, and reflectorized surfaces; fitting of efficient mud flaps on all wheels; and it appears necessary to have legislation limiting power available on motor vehicles operated by young drivers.

by E. R. Hoffmann
Melbourne Univ. (Australia)
Publ: HS-013 337, Papers presented at the National Road
Safety Symposium, Canberra, 1972 p443-566
1972 ; 58refs
Availability: In HS-013 337

HS-013 408

DETERMINATION OF INJURY MECHANISMS FROM FIELD ACCIDENT INVESTIGATIONS

Major causes of death and injury in automobile accidents are occupant ejection and steering assembly, windshield, or instrument panel impacts. Types of injuries produced by these secondary collisions are described. Automobile design improvements to reduce injury potential are mentioned. Injury patterns and injury severity associated with side impact, rear end, and rollover accidents are also briefly discussed.

by D. F. Huelke
Michigan Univ., Ann Arbor
1973 ; 17p

Presented at General Motors Automotive Safety Seminar,
Warren, Mich., 20-21 Jun 1973.
Availability: Corporate author

HS-013 425

A STUDY OF 1960-67 AND 1968-70 MODEL VOLKSWAGENS AND OTHER SEDANS IN RURAL U. S. ACCIDENTS

Rollover accident frequency has decreased from about 25% in 1960-67 Volkswagens to about 16% in 1968-70 models. Door opening has decreased from 37.2% for 1960-67 Volkswagens to 13.3% for 1968-70 models. Ejection through open doors represented about 75% of all ejections in 1960-67 cars and about 50% in 1968-70 cars. Windshield and window ejections increased. For Volkswagen, the windshield now is the second most frequent ejection site. Seat track damage in front impacts has decreased from 32.1 to 9.3% in the 1968-70 Volkswagens. Energy absorbing steering columns have virtually eliminated column penetration into the passenger compartment for all 1968-70 cars. Among 1967-70 Volkswagen occupant top structure, door ejection, and windshield caused injuries decreased. Flexion-torsion and instrument panel caused injuries increased. Study results indicate that 1968-70 Volkswagens resemble 1968-70 light U. S. cars and foreign sedans with respect to accident factors, types of vehicle damage, and occupant injury causes more closely than did 1960-67 Volkswagens.

by J. W. Garrett
Calspan Corp., Buffalo, N.Y.
1973 ; 97P

Sponsored by Volkswagen of America, Inc.
Availability: Corporate author

HS-013 432

HARDWARE DEVELOPMENT AND PRODUCTION FEASIBILITY AS RELATED TO VEHICLE STRUCTURES AND EXTERIORS RESEARCH

In developing crashworthy automobile structures emphasis should be placed on front, side, and rollover collisions where impact speeds exceed the limits of current structural adequacy. Structural crashworthiness research on full size, luxury, compact, and subcompact automobiles is reviewed. Research has progressed to the point with full size automobiles where the remaining problems are essentially related to manufacturing weight control, and operational performance. Equal protection for occupants of small and large cars can be obtained only if the small car is designed to provide protection throughout a

greater speed range than the larger car. However, it is unlikely that this will occur, and consequently, occupants of small cars must accept a greater risk than occupants of larger cars.

by P. M. Miller
Calspan Corp., Buffalo, N.Y.
1973 ; 38P

Presented at Vehicle Safety Res. Integration Symposium,
Washington, D.C., 30-31 May 1973.
Availability: GPO in the Symposium Proceedings

HS-013 527

SEAT BELT SYSTEMS FOR THE FUTURE

Seat belt systems being developed in the United Kingdom to meet 1973 and 1975 U. S. standards are discussed. An ignition seat belt interlock system and several passive seat belt systems are described. The utilization of energy absorbing tear webbing in seat belt assemblies is also discussed. The development work on passive belts indicates that systems can be devised which are reasonably acceptable to the car driver and passengers in terms of ease of entry and exit, method of actuation, and subsequent comfort in use. Further refinement of such systems is being pursued, together with the development of energy absorbing media to reduce maximum head deceleration and hence injury severity values to conform with the values required by the American authorities. As an alternative to the air bag the passive seat belt offers certain advantages. It restrains the occupants in many conditions of deceleration; its protection in conditions of rollover is possibly superior to that offered by the air bag; and in cases of secondary impact the occupant is still restrained.

by E. Nichol
Auto Restraint Systems Ltd. (England)
1972

Availability: In HS-013 518, International Technical Conference on Experimental Safety Vehicles (3rd), United Kingdom Presentation. Conference Papers, London, 1972 p96-121

HS-013 537

THE FIAT TECHNICAL PRESENTATION

Results of an analysis of Italian vehicle accidents and barrier collision, pole impact, and drop tests conducted with current Fiat production models were used by Fiat S. p. A. to develop a crashworthy experimental safety vehicle. It was found that severe head on pole impact tests and front and rear barrier collision tests at 15 and 45 provided 71 little significant data in determining the crashworthiness. The design of Fiat's 1500 lb experimental safety vehicle, which includes energy absorbing front and rear bumpers, is outlined, and impact test results are reported.

by O. Montabone
Fiat S.p.A., Turin (Italy)
1972

Availability: In HS-820 217, International Technical Conference on Experimental Safety Vehicles (3rd) Report, Washington, D. C., 1972 p2-157-2-184

December 1, 1977

HS-013 546

OCCUPANT PROTECTION OF 1,500 POUND ESV

Results of head on barrier collision pole impact and rear end impact tests indicate that the Honda R and D Co. Ltd.'s 1500 lb experimental safety vehicle (ESV) does not meet impact speed requirements established in the ESV specifications. In order to improve crash performance the most reasonable solution would be the extension of frontal body length. However, since Honda wishes to keep its ESV small, occupant protection can be improved by reinforcing the passenger compartment, making maximum use of crush distance, and including energy absorbing seat belts. The Honda ESV's injury reduction goals for front end, rear end, and side impact collisions, and rollover accidents are presented.

by H. Sugiura
Honda R and D Co. Ltd., Tokyo (Japan)
1972

Availability: In HS-820 217, International Technical Conference on Experimental Safety Vehicles (3rd) Report, Washington, D. C., 1972 p2-250-2-256

HS-013 547

**EXPERIMENTAL SAFETY VEHICLE--PHASE TWO--
DESIGNED AND DEVELOPED BY GENERAL
MOTORS**

Highlights of General Motors Corp.'s experimental safety vehicle (ESV) are discussed. Energy absorbing systems, restraint systems, and chassis design are briefly described. Results of impact tests, dolly rollover tests, drop tests, and accident avoidance and performance tests conducted with the ESV, are presented.

by J. W. Rosenkrands
General Motors Corp., Warren, Mich., Environmental
1972

Availability: In HS-820 217, International Technical Conference on Experimental Safety Vehicles (3rd) Report, Washington, D. C., 1972 p2-257-2-272

HS-013 604

**RESTRAINT SYSTEM EFFECTIVENESS-A STUDY OF
FATAL ACCIDENTS**

Accidents involving 706 fatally injured occupants in 1967 through 1972 cars were examined to assign the fatality reduction potential of a lap belt alone, a lap and shoulder belt, an air cushion alone, and an air cushion plus lap belt. If all the fatalities had been wearing a lap belt, 17% could have been saved. If all the fatalities had been wearing a lap and shoulder belt, 31% could have been saved. If all the cars had been equipped with air cushions, 18% of the fatalities could have been saved. If all the cars had been equipped with air cushions, and all the fatalities had been wearing a lap belt, 29% could have been saved. Projecting these results to the real world is influenced by current belt usage, belt usage incentive effects, air cushion introduction timetable effects, injury

reduction, the possibility of restraint system caused injuries, and restraint system cost effectiveness.

by R. A. Wilson; C. M. Savage
General Motors Corp., Warren Mich. Environmental
1973 ; 69p
Presented at General Motors Automotive Safety Seminar,
Warren, 20-21 Jun 1973.
Availability: Corporate author

HS-013 677

**DESIGN SAFETY PRINCIPLES FOR
RECREATIONAL VEHICLES BASED ON IN-DEPTH
ACCIDENT INVESTIGATION**

The most general principles of design that affect the safety of recreational vehicles are presented. Accident investigations included for illustration show the relation between in-depth accident investigation and design principles. The following safety design principles for recreational vehicles are recommended: the living support facilities should demonstrate the same basic safety as contemporary home construction; recreational vehicles should have the same basic features of crash survivability as other vehicles; systematic inspection and testing during the manufacture of recreational vehicles would improve safety performance; and recreational vehicle drivers should be required to demonstrate a minimum safe knowledge and skill in the operation of the vehicles.

by H. H. Hurt, Jr.
University of Southern California, Los Angeles
1973 ; 26p
Availability: In HS-013 673, International Congress on
Automotive Safety (2nd) Proceedings, Vol. 2, Recreational
Vehicle Safety, Washington, D. C., 1973

HS-013 679

**DETERMINING SAFETY CHARACTERISTICS OF
RECREATIONAL VEHICLES**

A basis for developing test methodology for recreational vehicle crashworthiness and handling tests is provided. Tests proposed to quantitatively evaluate the safe performance of recreational vehicles, so that future vehicles can be designed to be integrated into the overall transportation system in a safe manner, include brake performance tests, steering tests, handling tests, overturn immunity tests, barrier collision tests, pole impact tests, vehicle vehicle impact tests, and rollover simulation. A detailed description is presented for each of the proposed tests, including supporting justification for their recommended usage. The presentation highlights the critical parameters that should be monitored and used to obtain quantitative results.

by E. Enserink
Ultrasystems, Inc., Newport Beach
1973 ; 32p
Availability: In HS-013 673, International Congress on
Automotive Safety (2nd) Proceedings, Vol. 2, Recreational
Vehicle Safety, Washington, D. C., 1973

HS-013 739

SIMULATION OF VEHICLE IMPACT WITH THE TEXAS CONCRETE MEDIAN BARRIER. VOL. 1, TEST COMPARISONS AND PARAMETER STUDY

The performance of the Texas Concrete Median Barrier (CMB) was evaluated from the standpoint of severity of impact, vehicle exit angle, maximum roll angle, and maximum pitch angle for a wide range of vehicle encroachment conditions. A modified version of the Highway-Vehicle-Object Simulation Model (HVOSM) was used to simulate a 4780 lb. automobile impacting the CMB at speeds of 50, 70, and 80 mph at angles of 5, 10 and 15 degrees for each of those speeds. These parameter studies were preceded by a validation phase where full-scale tests on the CMB were successfully simulated with the HVOSM. For impact speeds of 70 mph and greater with impact angles of 15 degrees and greater, automobile rollover can be expected. The results of all simulated impacts with the CMB are presented graphically with regard to a severity index based on vehicle accelerations. Simulation models; Impact angle; Impact severity; Severity indexes; Acceleration;

by R. D. Young; E. R. Post; H. E. Ross, Jr.; R. M. Holcomb
Texas A and M Univ., College Station, Texas
1972 ; 86p
Sponsored by Texas Hwy. Dept. and Federal Hwy.
Administration.
Availability: NTIS

HS-013 822

AN EVALUATION OF THE SAFETY PERFORMANCE OF TRICYCLES AND MINIBIKES

Performance of tricycles for 2-6 year old children is marked by speeds of 4 to 7 mph, unrestricted steering, and seat height to rear track ratios of approximately one. Tricycle stability is satisfactory for pitchover for the single rider but is inadequate for rollover in normal play. It is recommended that the Bureau of Product Safety consider safety standards covering rollover stability, seat height adjustability, limited steering angle, and removal of the rear step bar to discourage double riding. Performance of six minibikes was characterized by maximum speeds of 25 mph, braking decelerations of .5g, and tractive accelerations in the range of .2g. Potential problems of inadvertent acceleration wheelies, pitch and bounce stability over uneven terrain, braking control nonlinearities, and cornering limitations because of structural elements contacting the ground were observed. Recommendations for consideration in Bureau of Product Safety standards cover braking, suspension, cornering, and acceleration characteristics.

by R. S. Rice
Calspan Corp., Buffalo
Contract FDA-72-91
1972 ; 109p
Report for 1 May-30 Sep 1972.
Availability: NTIS

HS-013 943

TECHNICAL PRESENTATIONS. PT. 2. THE FEDERAL REPUBLIC OF GERMANY TECHNICAL PRESENTATION

Daimler-Benz, Opel, Porsche and Volkswagenwerke are represented in the presentation made by West Germany. Daimler-Benz discusses their Mercedes-Benz ESV ESF-22; data on the car itself and impact test results are presented in summary form. Opel discusses their 2,000 pound ESV with their priorities being frontal impacts, rollovers, side impacts and rear impacts; work is being done on foam-filled structural elements. Porsche presents studies on the problem of an automatic adjustment of the wheel position to different driving conditions by introducing elasticity without affecting the wheel suspension in question. Volkswagen presents a detailed study of their ESV, including the vehicle description and test results, as well as a benefit cost analysis and future evaluations. The Accident and Motor Traffic Insurers present results of their research on interior safety of automobiles.

by H. Scherenberg; H. Wagner; B. Felzer; H. Willumeit; M. Danner
Publ: HS-013 939, International Technical Conference on Experimental Safety Vehicles (4th), Washington, 1973 p81-153.
1973 ; refs
Availability: In HS-013 939

HS-013 944

TECHNICAL PRESENTATIONS. PT. 3. THE FRENCH TECHNICAL PRESENTATION

The French Ministry of Transport presents traffic safety comparisons of various classes of common car makes and drivers; the Ministry of Equipment and Housing discusses the a priori effectiveness of antiskid brakes; Peugeot-Renault discusses their safety car with an eye to cost-efficiency, reviews the rating of accident severities of occupants and the necessary restraint devices, and proposes a test evaluation of compatibility between very different passenger cars; Citroen presents results of impact tests utilizing anthropometric dummies and suggests modifications.

by C. Berlioz; M. Frybourg; G. Boschetti; J. Hamon; C. Prost-Dame; P. Ventre; M. Clavel; S. Bohers
Publ: HS-013 939, International Technical Conference on Experimental Safety Vehicles (4th), Washington, 1973 p155-232.
1973 ; refs
Availability: In HS-013 939

HS-013 946

TECHNICAL PRESENTATIONS. PT. 5. THE UNITED STATES TECHNICAL PRESENTATION

The United States presentations are by the Office of the Secretary of Transportation, Dynamic Science, GM Technical Center, Ford Motor Co., American Machine and Foundry, Inc., and the National Highway Traffic Safety Administration (NHTSA). NHTSA and Dynamic Science report on ESV tests including results of vehicle and dummy performance. General Motors Corporation reports summarily on their ESV prototypes, drawing conclusions and making projections. Ford Motor Company compares their ESV, presently being tested,

with a production Ford. Also discussed is their crash test program (impact with stationary and moving objects). The American Machine and Foundry, Inc. (AMF), discusses the ESV tradeoff and integration studies program taking into account the interior, front end, body structure, systems, simulator, subsystems and producibility. AMF also presents a study on crashworthiness-weight tradeoff including their current ESV trade studies and a structural-design concept for the optimized vehicle. NHTSA reviews the preliminary specifications for a 3,000 lb ESV.

by N. Stahler; W. Steber; L. C. Lundstrom; J. D. Collins; A. L. Roth; W. Rup; W. Wingenbach; W. E. Scott
 Publ: HS-013 939, International Technical Conference on Experimental Safety Vehicles (4th), Washington, 1973 p277-331
 1973
 Availability: In HS-013 939

HS-013 953

FUTURE SAFETY STANDARDS AND THE ESV PROGRAM. PT. 2. THE PRESENTATIONS BY THE COMMITTEE OF COMMON MARKET CONSTRUCTORS (CCMC)

The University of Birmingham presents field studies of traffic accidents in Europe. Deaths and injuries in road accidents in 1970 are used for statistics. Data are analyzed by class of road user and fatalities, impact types, and injury severity by equivalent test type. How field accident studies can be used as an aid to defining appropriate specifications for crash performance is illustrated. The Peugeot-Renault Association discusses the efficiency of 3-point belts in real accidents, medical as well as technical data are presented, and conclusions are drawn as to the efficacy of seat belts. The Verbandes der Automobilindustrie concludes that further investigation is needed in the area of biomechanical research, evaluation of accident statistics, better testing methods, and creation of valid principles for multipurpose profit/cost analyses in vehicle and traffic safety.

by M. Quin; G. M. Mackay; C. Tarrriere; G. Brenken
 Publ: HS-013 939, International Technical Conference on Experimental Safety Vehicles (4th), Washington, 1973 p599-621
 1973 ; refs
 Availability: In HS-013 939

HS-013 985

MOTOR CARRIER ACCIDENT INVESTIGATION: COLUMBIA AGRICULTURAL CO-OP, INC. ACCIDENT, MAY 11, 1973, OAKRIDGE, OREGON. RUN-AWAY TRUCK

About 6:30 p.m. a cargo laden tractor semitrailer traveling at high speed on a 6% downgrade failed to negotiate a sharp curve, ran off the roadway, struck an embankment, overturned onto the highway, and after sliding 250 feet came to rest blocking both traffic lanes. The tractor cab, torn from the chassis and hurled 60 feet forward, landed upright with the driver pinned inside. He died before he could be extricated. Cause of the accident was determined as the driver's failure to downshift properly on a long steep grade. He was familiar with the area but ignored the posted warning signs. The driver had a long history of traffic violations and was under suspen-

sion on the day of the accident. Examination of the trailer after the accident showed that the brakes on the forward tandem axle wheels were inoperative. The truck was owned and operated by the driver. The cargo was bottled wine.

by Anonymous
 Bureau of Motor Carrier Safety, Washington
 1973 ; 13p
 Availability: Corporate author

HS-014 034

TESTING AND EVALUATION AS APPLIED TO VEHICLE STRUCTURES AND EXTERIORS

The techniques used for testing and evaluation of surface vehicles have been significantly improved in recent years as a result of the emphasis placed on vehicular safety by the National Highway Traffic Safety Administration. The automotive industry and independent test laboratories have incorporated the latest test techniques available in order to assure that meaningful data are evolving from the millions of dollars currently being expended on improving the safety of the surface vehicles. This paper presents a summary of testing and evaluation techniques currently being used in the area of vehicle structures and exteriors research. Support functions such as facility design, data acquisition and data processing are discussed. The paper reflects the latest in the state-of-the-art of test techniques as presented in public documents and reviews the merits and limitations of certain techniques.

by F. E. Arndt; R. L. Anderson; R. A. Rockow
 Dynamic Science, Phoenix
 Publ: HS-820 306, Vehicle Safety Research Integration Sy
 1973
 Availability: In HS-820 306

HS-014 044

LAMP EXAMINATION FOR ON OR OFF IN TRAFFIC ACCIDENTS

General aspects of lamp examination to determine whether they were on or off at the time of a traffic accident are reviewed. Several areas are considered: circumstances warranting lamp examination; the normal lamp, including appearance, principle of operation, and aging; the effect of collision on lamps; special considerations such as tampering, short circuits, rollover, direction of impact, or weather exposure; examining lamps and testing circuits; handling and storing lamps; lamps commonly used on motor vehicles; and experiments and collections.

by J. S. Baker; T. Lindquist
 Northwestern Univ., Evanston, Ill. Traf. Inst.
 1972 ; 33p
 Advanced Accident Investigation Series. Revision of unpublished report: Examination of Automobile Lamps for Traffic-Accident Investigation, Oct. 1964, Contract CPR-11-0879.
 Availability: Corporate author

HS-014 283

THE FARM TRACTOR: OVERTURN AND POWER TAKE-OFF ACCIDENT PROBLEM

The farm tractor overturn and power take-off accident problem in the United States is reviewed. Educational, design, research, legislative, and regulative material is presented. It is concluded that the fact that a farmer will use his tractor for a multitude of purposes under a wide variety of conditions and of necessity in an ever-changing environment, places high priority upon design and devices to minimize injury from overturn and power take-off accidents.

by L. W. Knapp, Jr.
Iowa Univ., Iowa City
1968 ; 56p

Prepared in cooperation with the U.S. Public Health Service, Injury Control Program.
Availability: Reference copy only

HS-014 362

DESIGN AND INSTALLATION OF ROPS FOR ARMY RETROFIT PROGRAM

The U. S. Army is faced with the requirement to provide Rollover Protective Structures (ROPS) on new and old construction equipment vehicles. Many of the commercial design practices can be followed but some military design features and operational conditions pose unusual problems. The large number of vehicles involved and the wide distribution made it necessary to study the problems and ramifications for each machine. New techniques of design and evaluation had to be developed to cover the major constraints of previously built machines. New design features have been incorporated into the ROPS to simplify shipment, visibility, and retrofit, including refinements on the two-post ROPS, mesh design for falling objects, and mounts.

by P. D. Hopler; W. O. Stewart
Army Mobility Equipment Res. and Devel. Center, Fort Belvoir, Va.
Rept. No. SAE-730752 ; 1973 ; 8p 4refs
Presented at the National Combined Farm, Construction and Industrial Machinery and Fuels and Lubricants Meetings, Milwaukee, 10-13 Sep 1973.
Availability: SAE

HS-014 364

DYNAMIC TESTING OF TRACTOR PROTECTION CABS--DEVELOPMENT OF METHOD, PRACTICAL EXPERIENCES

Studies on and tests for tractor protection frames or cabs are reported. Principles and energy values of dynamic tests are discussed as well as OEDC and ISO activities in establishing standards. Swedish practical experiences show a large decrease in fatalities as a result of these studies.

by H. A. Moberg
Statens Maskinprovningar, Uppsala (Sweden)
Rept. No. SAE-730761 ; 1973 ; 12 2refs
Presented at the National Combined Farm, Construction and Industrial Machinery and Fuels and Lubricants Meetings, Milwaukee, 10-13 Sep 1973.
Availability: SAE

HS-014 526

INJURY CAUSATION IN ROLLOVER ACCIDENTS

A study of 266 rollover crashes with 377 front seat occupants indicates that 62% of the vehicles meet the intent of Federal Motor Vehicle Safety Standard 216. Half of the occupants had minor or no reported injury; 30% of the non-restrained occupants were ejected during rollovers and 20% had critical or fatal injuries whereas belted occupants sustained critical or fatal injuries in 6% of cases. Of those ejected, about 50% were killed. Ejection is independent of roof crush. Contacts producing injury are distributed throughout the various contact areas with fractures appearing more often from exterior car objects. Head and extremities are most frequently injured. Minimal injury is found with roof crush up to 12 inches; for roof crush of 0-6 inches the percent of injuries from roof contacts is almost doubled for unrestrained occupants. Head injury severity from roof contact is not significantly related to roof crush.

by D. F. Huelke; J. C. Marsh., 4th; L. DiMento; H. W. Sherman; W. J. Balla., Jr.
Michigan Univ., Ann Arbor
Publ: HS-014 519, Proceedings of 17th Conference of the American Association for Autom
1973 ; 13refs
Availability: In HS-014 519

HS-014 527

A COMPARISON OF CONTACTS FOR UNRESTRAINED AND LAP BELTED OCCUPANTS IN AUTOMOBILE ACCIDENTS

The incidence and severity of contacts for lap belted and unrestrained occupants in different types of accident situations are compared. A contact is defined as a body part striking an area of the vehicle. The situations considered are defined by the clock direction of the force on the occupant, in seated location, restraint use, and whether a rollover occurred. The comparisons indicate that lap belts reduce windshield contacts when the body is thrown forward, they reduce certain types of side contacts for the driver when he is thrown to the side, and that they are associated with fewer front seat back injuries in rear collisions and fewer outside contacts in rollovers.

by F. Preston
Michigan Univ., Ann Arbor. Hwy. Safety Res. Inst.
Publ: HS-014 519, Proceedings of 17th Conference of the American Association for Autom
1973 ; 4refs
Availability: In HS-014 519

HS-014 847

MAINTENANCE/DESIGN PROBLEMS WITH EARTHMOVING MACHINES

Recurring maintenance and design problems associated with earthmoving machines are discussed. It is noted that contractors continue to buy the standard products although they are not entirely satisfied with them. Negligible cost saving and convenience are cited. Problem areas include fluid level check locations, fueling nozzles, radiator sight glass, hydraulic fluid filtering, rollover frames, horns, radiator hose failures, water pump seal failures, lubrication systems, rapid wear items, elec-

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tric wiring, tow hoods, rock damage, bumper needs, and recurring structural damage.

by C. E. Sanders
Publ: Automotive Engineering
1974

Based on SAE-740448, "Maintenance and Design Problems with Current Earthmoving Machines," presented at the 25th Anniversary Earthmoving Industry Conference, Peoria, Ill., 23-24 Apr 74, 1974.

Availability: See publication

HS-014 886

BEFORE THE CRASH: HOW BIOMECHANICS REDUCES FATALITIES AND INJURIES

Biomechanics, the study of forces against the body is discussed. Safety devices such as seat belts, shoulder harnesses, energy absorbing steering columns, padded dash boards, side door beams, high penetration resistant windshield and air bags emanated from biomechanical studies. Further research progress in this field, including human tolerance studies, is presented. The air bag is discussed. It proved safe in frontal collisions, but doubtful in angular crashes or rollovers. Production of Experimental Safety Vehicles was expensive and impractical.

by S. Raphael
Publ: WARD'S AUTO WORLD
1974

Availability: See publication

HS-014 965

EFFICIENCY OF THE 3-POINT BELT IN REAL ACCIDENTS. FUTURE SAFETY STANDARDS AND THE ESV PROGRAM, SECT. 5, PT. 2

Some 160 cases of occupants wearing three-point belts were compared to 782 cases of occupants not wearing safety belts in equivalently violent impacts. The distribution of collisions is shown according to how the impacted zone of the vehicle is distributed or localized, symmetrical or asymmetrical. Specific cases are described. Results show that: the three-point belts are efficient in frontal collisions, roll-overs, and some side collisions; there was no case in which the belt was harmful; the first fatal accident without belt occurs within the range of 16-25 km/h, but it is necessary to reach a range three times higher with a belt; the probability of being seriously injured or killed is six times lower with the belt in 96% of all frontal collisions; belt efficiency is at its lowest in side collisions.

by C. Tarrere
Renault-Peugeot Assoc., La Garenne-Colombes
Publ: HS-013 939, INTERNATIONAL TECHNICAL CONFERENCE ON
1973

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HS-014 973

THE VOLKSWAGEN EXPERIMENTAL SAFETY VEHICLE. THE FEDERAL REPUBLIC OF GERMANY TECHNICAL PRESENTATION. SECT. 2, PT. 2

The Volkswagen Experimental Safety Vehicle (ESV) is described. Characteristics, specifications, and test results are given for: the hydraulic brake system, anti-skid system, service, parking, and emergency brakes, tires and wheels, axles and steering, yaw response, handling (lateral acceleration, crosswind sensitivity, directional stability, etc.), windshield wipers and washers, headlight washing system, lighting and control system, crashworthiness, occupant protection, restraint system and sled tests, benefit cost considerations. A proposal for future ESV specifications is presented along with future evaluations.

by H.-P. Willumeit
Volkswagenwerk A. G., Wolfsburg (West Germany)
Publ: HS-013 939, REPORT ON THE 4TH INTERNATIONAL TECHNICAL
1973

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HS-014 981

UNITED KINGDOM REQUIREMENTS FOR A PRACTICAL SAFETY CAR. THE UNITED KINGDOM TECHNICAL PRESENTATION, SECT. 2, PT. 4

United Kingdom requirements for the practical safety car are reviewed in terms of accident prevention, occupant protection, and pedestrian safety. Consideration is given to a variety of areas: safety car design basis; impact tests to demonstrate the level of occupant protection; test conditions and methods for full frontal and partial frontal barrier impact, side impact, and overturning; pedestrian protection; braking; handling requirements; failures and instrument panel warning lights; life and serviceability of braking systems; test track surface frictional properties; lighting and visibility; design for durability and low operational costs; and front end design.

by D. Lister
Transport and Road Res. Lab., Crowthorne, Berks.
Publ: HS-013 939, INTERNATIONAL TECHNICAL CONFERENCE ON
1973

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HS-014 986

CONCLUSIONS AND PROJECTIONS ON ESV DEVELOPMENT. THE UNITED STATES TECHNICAL PRESENTATION, SECT. 2, PT. 5

The development and testing of General Motors experimental safety vehicle prototypes are reviewed, with comments included on recently published specifications and goals for a 3000-lb intermediate ESV. Areas for additional research in highway safety are suggested. Details are given on impact and rollover tests, noise prevention, occupant protection, passenger weight factors, mirror system, anti-lock brakes.

message center concept, bumper requirements, rear signaling system, and injury prediction.

by L. C. Lundstrom
General Motors Corp., Detroit
Publ: HS-013 939, INTERNATIONAL TECHNICAL
CONFERENCE ON
1973
Availability: In HS-013 939

HS-015 000

**PROGRESS REPORT OF THE ESV DEVELOPMENT
AT FIAT. THE ITALIAN TECHNICAL
PRESENTATION. SECT. 2, PT. 7**

Fiat reports on analysis of road accidents in which Fiat-built cars were involved. The most frequent type of accident is the front-end collision, followed in decreasing order of frequency, by side collision, rear-end collision and rollover. 80% of the accidents cause, on an average, moderate to severe damage to cars, and 80% of the accidents cause, on an average, light injuries to occupants. Present on-going research to define objectively what should be meant by a "safe vehicle" concerns vehicle handling and braking; experimental safety vehicles of 1500-lb., 2000-lb., and 2500-lb weight; restraint systems; and compatibility in impact. The development of the first experimental safety vehicle (ESV) prototypes in the three weight classes enabled Fiat to evaluate, as realistically as possible, the consequences of compliance with the requirements of the ESV specification. Such consequences are rather serious for smaller economic cars of the European type. However, tests have shown that the problems of the survival space and of low speed protection are technically solvable, but at the expense of still acceptable size increases and of cost increases which are not likely to be less than 40%.

by V. Montanari
Fiat S. P. A., Turin (Italy)
Publ: HS-013 939, REPORT ON THE 4TH
INTERNATIONAL TECHNICAL
1973
Availability: Bound in HS-013 939

HS-015 013

**THE FREQUENCY AND SEVERITY OF INJURIES TO
THE OCCUPANTS OF CARS SUBJECTED TO
DIFFERENT TYPES OF IMPACT IN ACCIDENTS: AN
INVESTIGATION OF BRITISH ROAD ACCIDENTS
FROM POLICE RECORDS**

Results of an investigation of the importance of different types of impact in 1596 British accidents are presented. Some findings of theoretical analysis are given first. Urban-rural comparisons are made, and the severity of various types of impacts is examined. The risk of serious injury and death is particularly high in all collisions with commercial vehicles, especially in rural areas; severities in frontal impacts of cars against other cars are in the order expected from the relative impact velocities. Other details are given on intersection collision injuries as well as those in rear-end, single car, and over-

turned vehicle accidents. Characteristics of the accidents are provided.

by G. Grime; I. S. Jones
University Coll., London (England). Res. Group in
Publ: INTERNATIONAL CONFERENCE ON THE
BIOKINETICS OF IMP
1973
Conference held in Amsterdam, 26-27 Jun 1973. Paper
supported by the Science Res. Council (England).
Availability: National Road Safety Organization Avenue du
General Mallert-Joinville 94 Arcueil, France

HS-015 082

**THE INFLUENCE OF STEERING AND SUSPENSION
SYSTEM DEGRADATION ON VEHICLE LIMIT
PERFORMANCE**

The influence of degraded steering and suspension components on open-loop vehicle performance at the limits of tire-road frictional coupling is examined. The major conclusion is that, with the exception of the shock absorber in certain maneuvers, the range of limit performance exhibited by new cars, as derived from design differences, is much larger than the in-use changes in limit performance of individual vehicles deriving from degradation of steering and suspension system components. Other conclusions include: the principal suspension component whose likely degradation influences limit performance is the shock absorber; indeterminacies of front wheel steer angle do not exhibit a first-order influence on vehicle limit performance; misalignment of front wheels contributes a significant alteration in limit lane change performance; vehicle limit braking performance is more severely degraded by brake imbalance than by steering and suspension component degradations; mass imbalance of road wheels has little influence on limit braking and steering performance; limit cornering capability of cars is insensitive to steering and suspension system degradation; and the rollover resistance of passenger cars can be reduced by shock absorber degradation, and may be influenced by front end misalignment.

by P. S. Fancher; R. D. Ervin; L. Segal
Michigan Univ., Ann Arbor. Hwy. Safety Res. Inst.
1974; 21p
Presented at the Automotive Engineering Congress, Detroit, 25
Feb-1 Mar 1974. Sponsored by the National Hwy. Traf. Safety
Admin.
Availability: SAE

HS-015 224

**THE ACCIDENT AVOIDANCE POTENTIAL OF THE
MOTOR VEHICLE: ACCIDENT DATA, VEHICLE
HANDLING AND SAFETY STANDARDS**

A critical speed methodology developed for categorizing traffic accidents relative to handling accident causation factors is applied to the investigation of highway collisions. Although only limited experience with the new methodology has been collected to date in accident studies conducted by the multidisciplinary accident investigation team of the University of Utah, significant improvements in separating handling accident causation factors are possible. Post-accident driver interviewing as well as driver's education efforts may benefit greatly from an accident analysis clearly identifying environmental, vehicular, or operator causation factors. It is noted that refinements to the procedures will be made as more detailed ac-