Burgett

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National Highway Traffic Safety Administration

Collision Avoidance System Cost-Benefit Analysis

Volume II—Appendices A-E

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Contract No. DTNH 22-80-C-07530
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16. Abstract

Collision-avoidance systems under development in the U.S.A., Japan and Germany were evaluated. The performance evaluation showed that the signal processing and the control law of a system were the key parameters that decided the system's capability, in terms of target discrimination, and the ability to avoid false alarms and missed the targets. The benefits evaluation of selected radar systems was conducted using the Kinetic Research Accident Environment Simulation and Projection (KRAESP) Model and an accident data base which was adjusted to be nationally representative. The results indicated that radar braking systems were most effective in the rear impact mode as well as substantial benefits in frontal, vehicle-to-vehicle, and fixed-object impacts. The effectiveness of the radar systems in the side impact mode was very limited. Non-motorist impacts may be avoided by radar braking systems; however, the ability of the radar to detect pedestrians, bicyclists, and motorcyclists needs further study.

17. Key Words	18. Distribution Statement
Automotive Radar, Collision Avoidance Systems, Brakes, Anti-skid Brakes, Cost-Benefit Analysis, Accident Data, KRAESP, North Carolina 1979 Accident Data	Document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161

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Unclassified	Unclassified	259	

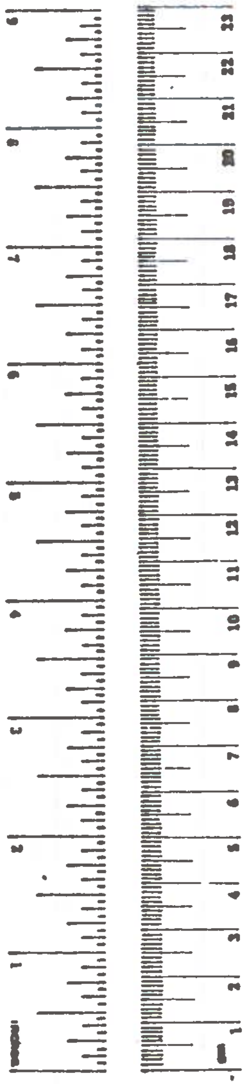
Form DOT F 1700.7 (8-72)

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

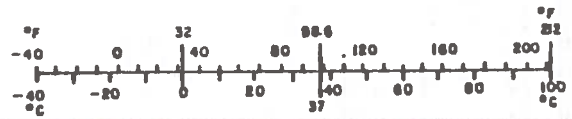
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



ACKNOWLEDGEMENT

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The significant conributions by Drs. L. Carpenter and D. Grimes are also appreciated.

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APPENDIX A

BIBLIOGRAPHY

SAE

-1-
AN - 780858
TI - The Near-Term Prospect For Automotive Electronics: Minicars' Research Safety Vehicle
AU - Friedman, Donald; Belohoubek, Erwin (Minicars, Inc., RCA Laboratories)
SO - Society of Automotive Engineers Proceedings No. P-76
IT - MICROPROCESSOR; ANTISKID DEVICES; ELECTRONIC DISPLAYS; RADAR; VEHICLE SAFETY
AB -

As President of Minicars, Inc., Mr. Friedman provides overall direction and integration of efforts in the conduct of all programs and projects. Such direction has specifically involved the socio-political and economic cost/benefit analysis of accidents and transportation missions; the development of electronic, propulsion, suspension, energy management, passive restraint and crashworthy structural subsystems for the Research Safety Vehicle and other diverse NHTSA programs; as well as the development of electric and hybrid-electric vehicles.

As the head of Microwave Integrated Circuits at RCA Laboratories, Dr. Belohoubek is responsible for the development of active and passive Microwave Integrated circuits, including transistor amplifiers, multipliers, active microwave filters, various solid state radars and other microwave subsystems.

-2-
AN - 770662
TI - Tandem Anti-Lock Systems for Air Braked Vehicles
AU - O'Keefe, P. J.; Hutchins, M. L. (Bendix Heavy Vehicle Systems Group)
SO - Society of Automotive Engineers Technical Paper No. 770662
IT - AIR BRAKES; ANTISKID DEVICES; BRAKES; TRUCK TRAILERS
AB -

Tandem anti-lock systems have recently begun to appear on air-braked vehicles. These designs provide a cost effective system while still meeting the performance requirements of FMVSS-121. However, they cannot be universally applied to all vehicles without reservation. This paper discusses possible tandem anti-lock system configurations and factors influencing their application to different vehicle and suspension types. These discussions will be based on computer suspension model studies and vehicle tests. Tandem anti-lock vehicle test data will be shown along with comparisons to axle by axle anti-lock control performance.

-3-
AN - 760348
TI - Development and Evaluation of Anti-Lock Brake Systems
AU - Cardon, Maurice H.; Hickner, George B.; Rothfusz, Ralph W. (Bendix Corp.)
SO - Society of Automotive Engineers Technical Paper No. 760348
IT - BRAKES; PASSENGER CAR PERFORMANCE; SKID RESISTANCE
AB -

Anti-lock systems which effectively prevent wheel lock have been developed for passenger cars, trucks, articulated vehicles and buses. Six anti-lock system configurations involving individual wheel and axle control are discussed. Also discussed are techniques for evaluating the performance anti-systems; included are straight line braking, the use of a split coefficient surface and braking in a turn. The results of computer simulation studies and vehicle tests conducted to evaluate the performance of the various anti-lock system configurations are presented. It is concluded that the best anti-lock system configuration for a particular vehicle requires a trade off among vehicle design characteristics, desired level of braking, and vehicle handling

-3-
AN - 740018
TI - Electronics and Automotive Engineering
AU - Ziomek, Joseph F. (Ford Motor.Co.)
SO - Society of Automotive Engineers Publication No. SP-388
IT - ELECTRIC CONTROL-ELECTRONIC; AUTOMOBILE INDUSTRY; FUEL CONTROL; COST ANALYSIS
AB -

A discussion of the automotive industry's reluctance to implement new electronics applications, this paper examines the basis on which design engineers accept or reject automotive electronics designs. Unless these new designs demonstrate economic or other advantages over designs emanating from traditional technology, they will be rejected. However, there are now several areas of uncontested electronic application: fuel metering, emissions/diagnostics, antiskid, radio, headlamp dimmer, and seat interlock. A careful cost effective study of future implementation of electronic systems is recommended.

COMPENDEX (ENGINEERING INDEX)

3/5/1
922510 ID NO.- EI790422510
ELECTRONIC BRAKING SYSTEM.
Hayes, Edward J.; Megginson, George W.
Kelsey-Hayes Co, Romulus, Mich
Int Conf on Automot Electron, Proc, Dearborn, Mich, Sep 25-27 1978
Publ by SAE (P-78/76), Warrendale, Pa, 1978. Also Available from IEEE (Cat n 78CH1343-3VT), New York, NY p 111-113

Electronic braking systems for air-brake vehicles have been required by the Federal Motor Vehicle Safety Standard 121 since 1975. Prior to the implementation of the standard, heavy trucks required 330 to 450 feet to stop from 60 M. P. H. on a dry surface. A passenger car can make the same stop within 200 feet. To reduce this difference and avoid lateral instability, Standard 121 requires air-brake vehicles to stop within 293 feet and remain within a 12-foot lane without sustained wheel lock. Most vehicles require an electronic braking system known as antilock or antiskid to meet the no-wheel lock requirement. Criticism of antilock systems apparently stems from (1) maintenance cost, (2) misunderstanding of operation, (3) the cost/benefit, (4) system failures, and (5) resistance to government regulations. These 5 objections are discussed. 4 refs.

DESCRIPTORS: (*BRAKES, AIR, *Control Equipment), (MOTOR TRUCKS, Legislation), (CONTROL EQUIPMENT, ELECTRIC, Costs),
IDENTIFIERS: ANTILOCK BRAKE CONTROL
CARD ALERT: 602, 632, 663, 902, 715, 732

3/5/2
679146 ID NO.- EI761279146
ANTI-LOCK BRAKE SYSTEM CONFIGURATIONS.
Anon
Automot Eng v 84 n 2 Feb 1976 p 43-45 CODEN: AUEGBB

Possible configuration of an anti-lock braking system range from fully independent single-wheel control to a common control for all wheels on the vehicle. However, practical considerations generally limit the selection to either individual wheel control or common control of the wheels on a single axle. Since the vehicle is usually reasonably stable even without anti-lock braking and the load variation on any given wheel is relatively small, the performance demands placed on passenger-car anti-lock hardware are less severe than most other applications. The highway tractor imposes a different set of constraints on the anti-lock system designer. Stability and stopping performance are established by government regulation. There is greater concern about inputs to the steering system caused by unbalanced brake forces across the front axle. Rear axle loads can vary by a factor of ten. Most anti-lock systems which meet the requirements of FMVSS 121 are of the axle-control configuration, representing a compromise on the cost-benefit scale which is biased toward greater benefit at higher cost.

DESCRIPTORS: (*AUTOMOBILES, *Brakes), CONTROL SYSTEMS, ADAPTIVE,
CARD ALERT: 602, 662, 731

8/5/3
460304 ID NO.- EI741060304
ELECTRONICS AND AUTOMOTIVE ENGINEERING.
Ziomek, Joseph F.
Ford Mot Co, Dearborn, Mich
SAE Spec Publ n 388. SAE/IEEE Conf, Tutorial Sess on Autom

Electron, Detroit, Mich, Feb 27-28 1974, Pap 740018, p 225-227
CODEN: SAESA2

A discussion of the automotive industry's reluctance to implement new electronics applications, this paper examines the basis on which design engineers accept or reject automotive electronics designs. Unless these new designs demonstrate economic or other advantages over designs emanating from traditional technology, they will be rejected. However, there are now several areas of uncontested electronic application: fuel metering, emissions/diagnostics, antiskid, radio, headlamp dimmer, and seat interlock. A careful cost effectiveness study of future implementation of electronic systems is recommended. 1 ref.

DESCRIPTORS: (*AUTOMOBILES, *Electronic Equipment),
CARD ALERT: 662, 663, 715

20/7/1
908360 DA
COST-BENEFIT CONSIDERATIONS FOR DETERMINING PRIORITIES IN SAFETY STANDARDS
Langner, Werner; Lincke , Wolfgang
Volkswagenwerk AG, West Germany
HS-801 745, Proceedings, International Congress on 1975 Monograph Automotive Safety (4 th), Washi ngton, D. C., 1975 ; HS-017 156
SUBFILE: HSL
Volkswagen's revised benefit-cost techniques are discussed. It is shown that benefit-cost considerations are useful tools in establishing a qualitative and quantitative scheme for comparing different possible safety standards. After the safety program objectives and parameters have been defined, the benefit and cost elements to be included are determined, along with their quantitative values and constraints. Cost is defined in terms of cost of purchase, operating cost, and maintenance and repair cost. Safety measure benefit is defined as the reduction of accident-caused damage. Four safety measures (a mandatory three-point belt system, a passive restraint system, a specially reinforced automobile front structure combined with mandatory active belt system, and the improved front structure combined with a passive restraint system) are graphically represented in a system of coordinates where benefit is plotted against cost. It is concluded that a passive restraint system is advantageous in combination with a reinforced front structure if an amount of $81 or more is to be incurred. The following methods were used in the revised cost-benefit approach: nonlinear optimization

computations to compute consistent safety measure combinations, and thus determine consistent test conditions; and a sensitivity analysis to investigate the effect and variances of societal cost figures, frequencies of the various types of accidents, and effectiveness rating assessments. In order to show whether the incorporation of the new safety measure is useful and at what total cost, the following two optimization calculations are performed: an optimized benefit-cost function for roof padding and improved door locks; and the effects of these measures on other safety measures such as alcohol interlock systems, antilock systems, safety distance warning devices, and constant beam width control. The societal cost figures for fatalities and injuries derived by Volkswagen and the National Highway Traffic Safety Administration are compared. It is shown that the curve of optimized total benefit is changed considerably by the variation of societal cost figures. The frequency of a certain type of accident significantly affects the benefit produced by a safety measure designed to reduce damage caused by the specific type of accident. The optimization procedure is applied to several sets of varying effectiveness ratings resulting from shifts of cumulative frequency curves of fatalities by accident impact velocity. A comprehensive picture of the results of sensitivity analysis are given. For structural improvement measures, consistent test conditions were computed as a function of total cost. The curves of the test velocity for frontal, lateral, and rear impact tests are then plotted versus one another for assumed variations in input data. The graph shows a clearly defined band of consistent test velocities for the vehicle rear and side as Presented at the Fourth International Congress on Automotive Safety, San Francisco, 14-16 Jul 1975.

20/7/2
906296 DA
AUTOMOTIVE ELECTRONICS: CHALLENGE TO DESIGNERS
Automotive Engineering v84 n8 1976 Monograph p52-7 HS-019 297
SUBFILE: HSL

The field of automotive electronics is discussed in aspects of principles, technology, design philosophy, centralization, design problems, current activity, and future trends. Electronic principles discussed concern integrated circuit (solid-state) semiconductors. The principal element of solid-state circuitry is silicon, in which covalent bonds may be established with the lack of free electrons. The semiconductor material may be improved by arsenic or phosphorus additions, controllable for charge preponderance and mobility characteristics. Technology of solid-state circuitry has proceeded from invention of the point contact transistor in 1947. By the mid-1950's a photolithographic process aided production, and a new industry was expanding and finding new applications. Implementation and production of metal-oxide-semiconductor devices was justified by the late 1960's, and wide-scale introduction of electronics in the automotive field began. Solid-state devices also found application in computer, entertainment, and aerospace fields as solid-state devices were combined to form integrated circuits of more than 100 components and large-scale integrated circuits with over 16,000 components. Automotive electronics became increasingly sophisticated in such applications as the integrated circuit chip for an analog/digital fuel sensor. Design philosophy has revolved around miniaturization, low voltage requirement, and minimal power loss characteristics. Low cost is becoming another attractive factor, with cost-effectiveness as the final criterion for automotive applications. Automotive design applications have enforced more stringent operating conditions than other fields of use, introducing dynamic systems and adverse environmental conditions into the function/effect relationship, including electrical, thermal, mechanical, and climatic stresses. Arguments on the issue of centralization of the automotive design package are given, favoring the subsystem approach with at least three areas of concentration: adjacent to the engine to provide electronic control of the power unit; near the driver to provide instrumentation and switchgear cluster control; and in the luggage compartment for auxiliary systems. The subsystem approach is preferred as offering design flexibility. Hybrid control systems and unique control designs are also considered for utilizing electronics in the automotive design. Current activity in solid-state technology in the United States, Japan, and Europe is focused on improvement of existing systems, implementation of new engine control devices, development of new auxiliary systems, and large-scale integration of systems. Electronic fuel injection is used to illustrate progress in automotive solid-state electronics. Other applications being developed include antiskid control, automatic headway monitoring, digital display, impaired driver control, transistorized ignition, monitoring, digital Based on papers presented at the Inst. of Electrical Engineers Conference on Automotive Electronics, London, 5-8 Jul 1976 (see HS-019 325).

20/7/3
906266 DA
THE STATUS OF AUTOMOTIVE ELECTRONICS IN THE U.S.A.
Jones , Trevor O.
General Motors Proving Grounds, United States of
HS-019 325, Automobile Electronics. International 1976 Monograph Conference , London?, 1976 p5-8 HS-019 327
SUBFILE: HSL

A general review is provided of four broad, related areas of automotive electronics activities in the U.S.: improving existing electronic and converting electromechanical systems; application of electronics to engine control; application of electronics to new systems; and integrated central computer systems. It is suggested that low-cost transducers and actuators continue to present major barriers to development, but progress is continuing. Long-range developments of systems to assist drivers, such as impaired-driver detector and automatic radar brakes are described. Multiplex wiring systems and digital displays are suggested as shorter-range developments. There is a growing appreciation on the part of automotive engineers for the capability of microprocessors and the flexibility of digital electronics, but the automotive engineer needs to provide more detailed characterization data to support computer modeling and programming in order to fully utilize this capability. Two challenges for the electronics engineer are stated: near-term achievement of cost-effective integrated electronic systems and longer-range development of cost-effective systems to help reduce driver-caused accidents, with particular attention to the drinking driver. Earlier predictions of 10% of the cost of an automobile being represented by electronic systems in the 1980's is considered conservative in view of the applications which are possible and projected. Conference held in London, 6-9 Jul 1976.

20/7/4
905397 DA
SENSIBLE SAFETY: IS IT IN YOUR FUTURE?
Driver v10 n8 1977 Monograph p16-9 HS-020 411
SUBFILE: HSL

A research safety vehicle (RSV) developed by Minicars, Inc. of Goleta, Calif. working under contract with NHTSA is the result of months of analyzing data on automobile accidents, and is on a cost/benefit methodology to determine which safety features would be included. If the benefit did not exceed four times the cost, it was not included. The cost/benefit methodology assumes that safety features do not sell. The car is built on a 104-inch wheelbase with unitized construction and weighs 2,000 lbs. The body is a thin-wall steel structure filled with polyurethane foam which acts as a shock absorber and braces the thin sheetmetal structure. The 200 lbs of foam cost $1,200 but could cost $1 per lb by 1980. The engine is a 1500cc Honda Civic stratified charge mounted amidships with a five-speed transmission. Gas mileage is estimated to be 26 mpg city, 37 mpg open road and 30 mpg combined. The body is a plastic "glove" that provides a soft skin rather than the standard sheet metal. Electronics will include a microprocessor-controlled information center which, in addition to standard dashboard information will read out safety malfunctions. The system also includes a microwave radar which shows location, speed, direction of other cars and obstacles. If a crash is unavoidable the system automatically activates a special braking system. A possible add-on to the microprocessor is a memory unit that detects driver impairment through preprogramming of "driver signatures". Mass-produced cost of the minicar would be about $3,500.

20/7/5
901972 DA
COLLISION AVOIDANCE RADAR BRAKING SYSTEMS INVESTIGATION--PHASE 1 STUDY. FINAL REPORT
Wong, R. E.; Payne, D. V.; Grierson, W. O.; Troll , W. C.
Bendix Res. Labs., Southfield
1974 120p HS-801 253
AVAILABLE FROM: National Technical Information Service
CONTRACT NO.: DOT-HS-4-00913; Contract
SUBFILE: HSL

The feasibility of an automotive radar braking system suitable for installation on all U. S. automobiles as standard equipment was investigated on the basis of utilizing state-of-the-art technology and demonstrating cost effective performance in terms of preventing accidents otherwise caused by inattentive or tardy driver response. A technology survey identified several radar brake system concepts existing in demonstrable hardware and capable of automatically responding to and avoiding impact with obstacles on a collision course. To assess the cost effectiveness of radar brakes, four generalized baseline systems were defined: automatic noncooperative; automatic cooperative; semi-automatic noncooperative; and semi-automatic cooperative. These four system types were then considered in regard to their effectiveness in preventing accidents of certain categories judged responsive to their respective performance capabilities. Accident types, descriptions and frequencies were surveyed and categorized from a selected sample of 21,000 reported events in Texas. This sample was used to estimate the total annual nationwide accident population by category and societal cost as determined from a formula involving fatality, injury and property losses. Results of this study indicated that the Automatic Noncooperative Radar Brake system was cost effective at an initial consumer cost of $211. However, the assumptions required to validate this conclusion were: Rept. for Jun-Sep 1974.

20/7/6
264199 DA
ELECTRONICS AND AUTOMOTIVE ENGINEERING
Ziomek, JF
Society of Automotive Engineers; .2 Pennsylvania Plaza; New York; 10001
Ford Motor Company
Feb 1974 pp 225-227 1974
REPORT NO.: SAE Paper No. 740018;
SUBFILE: HRIS

A discussion of the automotive industry's reluctance to implement new electronics applications, this paper examines the basis on which design engineers accept or reject automotive electronics designs. Unless these new designs demonstrate economic or other advantages over designs emanating from traditional technology, they will be rejected. However, there are now several areas of uncontested electronic application: fuel metering, emissions/diagnostics, antiskid, radio, headlamp dimmer, and seat interlock. A careful cost effectiveness study of future implementation of electronic systems is recommended. From: Automotive Electronics, SAE SP-388, 225-227, February 1974; SAE Paper No. 740013.

20/7/7
165666 DA
NEW ANTILOCKING DEVICE FOR COMMERCIAL VEHICLES OPTIMIZED IN RESPECT OF ACTIVE SAFETY AND COSTS
Reinecke, E; Weise, L
International Federation of Auto Techniques Engs 3 Avenue du President Wilson F 75116 Paris France
Analytic 1 p German
SUBFILE: TRRL; IRRD; HRIS
To increase the active safety of motor vehicles, electronic anti-skid regulating systems have been developed. The main requirements made with regard to the function of the regulating system are as follows: short braking distance, stability of course and steerability in all driving situations. A regulating system will fulfil these requirements in case of most of the commercial vehicles in an optimal way if all wheels of the vehicle are regulated individually. However, in spite of a full integration of the electronics, such an individual regulation required a comparatively high expenditure often not being made for reasons of economy. In order to obtain a more favourable cost-benefit relation, messrs Wabco-Westinghouse have developed a so-called diagonal regulating system as an alternative to the individual regulating system. Due to a novel type of arranging the regulating circuits, a considerable reduction in cost is obtained, the efficiency being nearly the same as in the case of the individual regulating system. Apart from an analysis of cost it will be reported on brake tests by means of the new regulating system in comparison with the individual regulating system and well-known simple systems. The tests will not only be made on straight roads with a homogeneous coefficient of friction but also on roads with a different coefficient of friction between the left and the right of the vehicle and in bends. /Author/TRRL/ This report was presented at the 16th International Automobile Technical Congress.

20/7/8
143993 DA
COLLISION AVOIDANCE RADAR BRAKING SYSTEMS INVESTIGATION. PHASE II STUDY. VOLUME II. TECHNICAL REPORT
Wong, RE; Faris, WR; Grierson, WO; Troll, WC; Powell, YM
Bendix Research Laboratories; .20800 Ten and One-Half Mile Road; Southfield; Washington; Michigan; D.C.; 48076; 20590
Sep 1976 Final Rpt. 187 pp 1976
AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22161
REPORT NO.: RLD-8035-Vol-2; DOT-HS-802-020; PB-258175/9ST
CONTRACT NO.: DOT-HS-4-00913; Contract
SUBFILE: NTIS; HRIS
A computer simulation program was employed to evaluate the system cost-effectiveness of 36 automatic/ radar brake system configurations. The effects of changing system design parameters and operational differences within each system were examined. 1973 traffic accident data sources representing six states and six counties were selected to provide the largest practical data base and to reduce biases due to geographic, economic and reporting agency influences. System

evaluation was made in a comparative form to show the estimated values to society over the lifetime of the vehicle and benefits were estimated in reduction of fatalities, injuries, and property damage. The study results indicate that an automatic/noncooperative radar brake system can be designed which could effectively suppress the false alarms due to non-hazardous targets and still be cost-effective in reducing motor traffic accidents. See also PB-258 174.

20/7/9
143997 DA
COLLISION AVOIDANCE RADAR BRAKING SYSTEMS INVESTIGATION. PHASE II STUDY. VOLUME I. SUMMARY REPORT
Wong, RE; Faris, WR; Grierson, WO; Troll, WC; Powell, YM
Bendix Research Laboratories; .20800 Ten and One-Half Mile Road; Southfield; Washington; Michigan; D.C.; 48076; 20590
Sep 1976 Final Rpt. 53 pp 1976
AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22161
REPORT NO.: RLD-8035-Vol-1; DOT-HS-802-019; PB-258174/2ST
CONTRACT NO.: DOT-HS-4-00913; Contract
SUBFILE: NTIS; HRIS
An instrumented test automobile equipped with an automatic/noncooperative radar brake system was used to gather and classify experimental data on radar false alarms as a function of various radar system parameters such as: detection range cut off (RCO), antenna beamwidth, range delay and vehicle velocity. The test vehicle was driven over three roadways under actual traffic conditions within the metropolitan area of Detroit, Michigan. The roadways typify much of the high density, high speed, urban and suburban driving in the United States. Results of the test program showed that both the detection range cut off and antenna beamwidth have a pronounced effect upon the false alarm problem; the range delay and vehicle velocity are of secondary importance. Analytical analyses were also performed to determine the effects of radar design parameters such as beamwidth and frequency on rain clutter and radar detection probability for three target classifications ranging from pedestrians to full size passenger cars. A computer simulation program was employed to evaluate the system cost-effectiveness of 36 system configurations. See also PB-237 546.

20/7/10
080954 DA
COLLISION AVOIDANCE RADAR BRAKING SYSTEMS INVESTIGATION: PHASE I STUDY
Wong, RE; Payne, DV; Grierson, WO; Troll, WC
Bendix Research Laboratories; .20800 Ten and One-Half Mile Road; Southfield; Washington; Michigan; D.C.; 48076; 20590
Oct 1974 Final Rpt. 120 pp 1974
AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22151
REPORT NO.: RLD-7299; PB-237546/7SL
CONTRACT NO.: DOT-HS-4-00913; Contract
SUBFILE: NTIS; HRIS
The feasibility of an automotive radar braking system suitable for installation on all U.S. automobiles as standard equipment was investigated on the basis of utilizing state-of-the-art technology and demonstrating cost-effective performance in terms of preventing accidents otherwise caused by inattentive or tardy driver response. A technology survey identified several radar brake system concepts existing in demonstrable hardware and capable of automatically responding to and avoiding impact with obstacles on a collision course. To assess the cost-effectiveness of radar brakes, four generalized baseline systems were defined: Automatic/noncooperative;

automatic/cooperative; semi-automatic/noncooperative; semi-automatic/-cooperative. These four system types were then considered in regard to their effectiveness in preventing accidents of certain categories judged responsive to their respective performance capabilities.

22/7/2
908357 DA
AUTOMOBILE TRANSPORTATION COST TRADEOFFS
Husted, Robert A.
Department of Transportation, Energy and
HS-801 745, Proceedings, International Congress on 1975 Monograph Automotive Safety (4 th), Washington, D. C., 1975 p HS-017 159
SUBFILE: HSL

The results of cost-benefit studies related to the air quality and accident cost of automobile transportation are presented. Current estimates of the major annual societal costs per automobile in the United States are summarized. Cost categories are: amortized first cost, fuel and highway costs, auto accident losses, maintenance and garage, parking and tolls, and air quality losses. Average costs and benefits are given for the 1974 to 1975 change in Federal Emission Control Standards (ECS) for new cars. New car incremental first costs, fuel consumption incremental costs, and air quality benefits are presented for the present baseline oxidation catalyst ECS and the following alternative ECS's: the California 75 freeze (improved oxidation catalyst system with a lean burn engine and prechambered stratified charge giving hydrocarbon (HC), carbon monoxide (CO) and nitrogen oxide (NOx) levels of .9, 9, and 2 grams per mile, respectively); the Statute 77 freeze (advanced oxidation catalyst system with lean burn and oxidation catalyst giving HC, CO, and NOx levels of .4, 3.4, and 2 grams per mile); and the Statue 78 freeze (advanced dual catalyst system giving HC, CO, and NOx levels of .4, 3.4, and .4 grams per mile, respectively). The resulting benefit-cost ratio tradeoffs are given. Benefit-cost data for current lap-shoulder belt and air bag/lap belt restraint systems are given. Data from nearly 1.5 million accident-involved cars in the states of New York, North Carolina, Texas, and Washington are analyzed to determine the impact of car size on the risk of fatality or serious injury. The results permit the future effects of small car usage to be projected. The correlation of fatality and serious injury risk to the weight of the vehicle driven and the weight of the vehicle hit are shown. A methodology is developed with an empirical basis to quantify the influence of factors for projecting relative fatality and injury risks for each of the following accident categories: multi-car, single car.

and car-truck. The relative fatality and serious injury risk projections (with or without restraints) of all injury categories is shown. In all cases, the risk level in 1985 is lower than in 1974, if mandatory passive restraints are included. If not, a 20% risk increase in 1985 results with the small car shift. Economically, projected fuel consumption benefits are shown to exceed incremental accident losses. The impact of the 55mph speed limit on accident severity is projected. If the speed limit is strictly enforced, the accident fatality risk is estimated to be reduced by 15%, and the benefit for reduced automobile accident losses to be $30 per annum per person. In addition, a 2.5% average fuel saving is estimated. Presented at the Fourth International Congress on Automotive Safety, San Francisco, 14-16 Jul 1975.

22/7/3
904350 DA
EVALUATION OF THE COMPROMISES AMONG SAFETY, WEIGHT, COST AND SERVICE
Ventre , Philippe
Regie Nationale des Usines Renault (France)
1977 21p 8refs HS-021 552
SUBFILE: HSL

Renault's Basic Research Vehicle (BRV) and Renault's production 20 TL are compared in terms of general specifications, collision performance, estimated statistical performance, and cost. The vehicles are similar in mechanical layout and equipment, although the BRV is considerably heavier and has less interior space. The Renault 20 TL affords protection for the belted occupants at impact speeds of up to 50 to 60 km/hr. The BRV, for a price increase of 25% to 30%, a weight increase of 11%, and a loss of interior occupant space of about 10%, gives protection to belted occupants at speeds of between 60 and 70 km/hr in frontal collisions, and 50 to 60 km/hr in side collisions. The cost benefit ratio is a 12% decrease in fatalities. The greatly increased side protection of the BRV is responsible for the increase in costs. As side collisions concern only 30% of all fatalities in vehicles, the considerable gains in those saved do not represent a significant decrease in the overall number of people killed in vehicles. A balance in severity of frontal collisions could be found in a vehicle between the Renault 20 TL and the BRV by improving performance of the restraint systems in a structure identical to that of the Renault 20 TL. The economic advantage of the BRV's increased side protection has not been proved. Presented at 5th International Congress on Automotive Safety, Cambridge, Mass., 11-14 Jul 1977.

22/7/4
904250 DA
VEHICLE SAFETY RESEARCH IN CANADA
Welbourne , Eric R.
Department of Transport
HS-802 501, "International Technical Conference on 1976 Monograph Experiment al Safety Vehicles (6th) Repor t," Washin HS-021 652
SUBFILE: HSL

Canadian research in automotive design and safety has centered on evaluation, in a Canadian context, of vehicular modifications originated elsewhere, in particular for collision avoidance and crashworthiness of the passenger automobile. Projects have included the following: relationship of headlamps to nighttime vision, including mathematical modeling of objects on the roadway; cost-effectiveness studies of improvements to defogging and defrosting systems; selection of standards for motor vehicle inspections; cost-effectiveness studies of various occupant protection systems; and a study of injuries of restrained occupants in order to deduce what improvements should be made in the overall occupant protection system. Future research will include the adaptive behavior of the driver to particular accident countermeasures. Presented at the Conference held in Washington, 12-15 Oct 1976.

22/7/5
904247 DA
THE CONTRIBUTION OF VOLKSWAGEN TO THE RESEARCH SAFETY VEHICLE PROGRAM
Lincke, Wolfgang
Volkswagenwerk AG, Res. and Devel., Germany
HS-802 501, "International Technical Conference on Experimental Safety Vehicles (6th) Report," Washin 1976 Monograph HS-021 855
SUBFILE: HSL
Cost/benefit analyses were derived from analytical studies of automobile use and accidents and from technical considerations concerning accident avoidance and crashworthiness. The absolute benefit of safety measures was not taken into consideration. Rather, a search was made for combinations of safety measures that would yield maximum benefit at a given cost. Sensitivity analyses were used to demonstrate that combinations of this nature are hardly affected even by a grave lack of precision in the input data. Consistent measures were derived for the improvement of crashworthiness; these are tabulated. The effect of frontal, lateral, and rear impacts at various test speeds on weights and cost, and the compatibility problems raised by vehicles of differing type and mass were considered. Technical considerations can go far towards creating a rational basis for decisions on which a set of test specifications is to be used. Similar considerations may be applied to accident avoidance measures. The methodology can be used in the Research Safety Vehicle Proj. Presented at the Conference held in Washington, 12-15 Oct 1976.

082721 DA

INTERNATIONAL CONFERENCE ON OCCUPANT PROTECTION. (3RD)

Society of Automotive Engineers; .2 Pennsylvania Plaza; New York; 10001

Jul 1974 Proceeding 419 pp 1974

SUBFILE: HRIS

This special publication contains the following 26 papers presented at the 3rd International Conference on Occupant Protection held in Troy, Michigan, July 10-12, 1974: Energy Basis for Collision Severity, K.L. Campbell; Automotive Recorder Research--A Summary of Accident Data and Test Results, S.S. Teel, S.J. Peirce, and N.W. Lutkerfedder; An Inexpensive Automobile Crash Recorder, C.Y. Warner, J.C. Free, B. Wilcox, and D. Friedman; First Results of Exact Accident Data Acquisition on Scene, U.N. Wanderer and H.M. Weber; In-Depth Accident Data and Occupant Protection--A Statistical Point of View, J. O'Day; Development of Energy Absorbing Automotive Structures Using Scale Model Test Techniques, M.J. Pavlick; Front End Structures Crash Response Characterization, L.M. Shaw, G.F. Brammeier, and R.L. Anderson; Crash Energy Management in Subcompact Automobiles, P.M. Miller, M.O. Ryder, Jr., and N.E. Shoemaker; Theoretical and EXperimental Investigations on the Crashworthiness of Small Cars, H.J. Schimkat; BARBI, A new Radar Concept for Precollision Sensing, G.F. Ross; Fluid Crash Sensor, S. Ikeda, K. Nonaka, and M. Fukushima; The Development of an Air Bag on Collapsible Dashpanel Restraint System for Right Front Seat Occupants, N.E. Shoemaker and D.J. Biss; Study on Air Bag Systems for Nissan Small-Sized Cars, F. Abe and S. Satoh; Human Volunteer and Anthropomorphic Dummy Tests of General Motors Driver Air Cushion System, G.R. Smith, E.C. Gulash, and R.G. Baker; Anthropomorphic Dummy and Human Volunteer Tests of Advanced and/or Passive Belt Restraint Systems, T.H. Glenn; The Efforts of the National Highway Traffic Safety Administration in the Development of Advanced Passive Protection Systems and Child Restraint Systems, C.E. Strother and R.M. Morgan; Development of Energy-Absorbing Safety Belt Webbing, J. Takada; A Force Limiting System on a Three-Point-Belt System Depending on Crash Velocity, D. Adomeit; Performance Matrices of Four Restraint Systems, U. Seiffert and W. Schwanz; Improved Restraint for U.S. Army Aircrewman, R.W. Carr and W.J. Nolan; An Introduction to Scale Model Testing to Determine Air Cushion Crash Sensor Location, T.O. Jones and W.A. Elliott; Scale Modeling of Vehicle Crashes--Techniques, Applicability, and Accuracy - Cost Effectiveness, B.S. Holmes and G. Sliter; Test Sled Simulation of Crash Induced Yaw and Pitch, A. Jordan; The Highway Safety Research Institute Dummy Compared with General Motors Biofidelity Recommendations and the Hybrid II Dummy, R.F. Neathery, H.J. Mertz, R.P. Hubbard, and M.R. Henderson, with Discussion by R.L. Hess and J.W. Melvin; Human Chest Impact Protection Criteria, R.L. Stalnaker and D. Mohan; and GM-ATD 502 Anthropomorphic Dummy--Development and Evaluation, J.A. Tennanth, R.H. Jensen, and R.A. Potter. Conference held at Troy, Michigan, July 10-12, 1974.

RADAR BRAKING AND COLLISION AVOIDANCE SYSTEMS

II. HARDWARE

A BIBLIOGRAPHY

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  3  3947 BRAK?
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  5 48994 SYSTEM? ?
  6   375  ANTILOCK OR ANTISKID OR ANTI(W)
  7   424  ANTILOCK? OR ANTISKID? OR ANTI(
  8   302 (3+5)*6
  9    18 ELECTRONIC? ?(2W)BRAK?
 10 13435  AUTOMOBILE? ? OR AUTOMOTIVE
 11   108 (7+9)*10
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909820 DA
BARBI, A NEW RADAR CONCEPT FOR PRECOLLISION SENSING
Ross , G. F.
Sperry Rand Corp., Philadelphia, Pa.
HS-015 670 (SAE-P-53), International Conference on 1974
Monograph Occupant P rotection (3rd) Proc eedings, N ew York,
1 HS-015 680
REPORT NO.: SAE-740574;
SUBFILE: HSL

A novel and low-cost scheme for automotive precollision sensing called BARBI (BAseband Radar Bag Initiator) is described. An extension of this technique is also suggested for braking applications. The proposed technique involves the transmission and reception of a subnanosecond baseband or video impulse-like signal (i.e., no RF carrier) and requires virtually no microwave components. The very fast signal risetime permits leading edge resolution on approaching vehicles of much less than a foot; closing velocity is obtained by using range-rate techniques. By incorporating sequential range gating techniques, the false alarm rate can be reduced to less than one in ten years for all the cars in the U. S. today. Conference held in Troy, Mich., 10-12 Jul 1974.

909063 DA
THE CHALLENGE OF AUTOMOTIVE ELECTRONICS IN THE U.S.A.
Jones , T. O.
General Motors Corp.
HS-016 434, Convergence 74, International Colloqui 1975
Monograph um on Auto motive Ele ctronic Te chnology C
onference HS-016 440
SUBFILE: HSL

The growth of electronics from the vacuum tube to the transistor and finally large scale integrated circuits, and the impact of this growth on automotive electronics is discussed. Brief descriptions of current automotive electronic subsystems are presented. Several experimental automotive integrated electronic systems, including diagnostic systems and display systems, which have been developed and tested are covered. A simple digital system containing inputs from transducers and driver commands, outputs to displays and actuators, and a central processor is used to describe the problems associated with installing an integrated electronic control system on an automobile. The problems associated with automatic radar braking are enumerated. Conference held in Troy, Mich., 28-30 Oct 1974.

908381 DA
SOCIETAL COSTS, AND THEIR REDUCTION BY SAFETY SYSTEMS
Struble , Donald E.
Minicars, Inc.
HS-801 745, Proceedings, International Congress on 1975
Monograph Automotive Safety (4 th), Washi ngton, 197 5
p695-782 HS-017 134
SUBFILE: HSL

A methodology is presented that permits a detailed calculation of the benefits to be gained by a particular safety system. It is based on a subdivision of the injury population, utilizing various accident files. Primary subdivision occurs according to vehicle class, accident mode (principal damage area), and barrier equivalent velocity (which is based on vehicle velocities, masses, and eccentricity of impact). Societal costs are assigned according to injury severity, and are based on recently reviewed health care and hospital cost information. Having thus established a baseline societal cost calculation for the current vehicle and traffic environment, the methodology then proceeds to calculate how various safety systems would reduce societal costs, by way of computing the reductions in accident frequency, injury severity, or both. Safety systems considered are: impaired performance detectors (IPD) (drunkometers, which reduce frequency); improved brakes with or without radar (which reduce both frequency and severity); and structure and/or restraint improvements (which reduce severity). The methodology calculates net benefits (societal benefit minus expenditure) for various combinations of these systems, forcing them to compete for the available benefit. The safety system combinations are rank-ordered accordingly, thus providing a rational way to determine implementation priorities. The top safety package was found to have 0.9 g driver-activated brakes, front-seat airbags, lap belts in the rear, and a 50% effective IPD. The package would have a yearly benefit/cost ratio of 3.6. The benefits are not total of the benefits produced by each system alone, but the true, total benefit of the package as a whole. Presented at the Fourth International Congress on Automotive Safety, San Francisco, 14-16 Jul 1975.

906614 DA
MICROPROCESSORS IN AUTOMOBILES
Herzog , G. B.
RCA Labs., Princeton, N.J.
HS-018 960, "Automotive Energy Efficiency Program, 1976
Monograph " Cambridg e, 1976 p3 43-62 HS-018 975
SUBFILE: HSL

The development and applications for microprocessors in automobiles are reviewed. The RCA Laboratories' work in microprocessing as applied to automotive electronics has been concerned with engine control, braking control, transmission control, solid state sensors, driver displays, power actuators, and radar braking. Viewgraphs representing the systems discussed are presented. Oral presentation made at the Automobile Engine Control Symposium, Cambridge, 8-9 Jul 1975.

906268 DA
AUTOMOBILE ELECTRONICS.
Institution of Electrical Engineers, Electronics Div., Savoy Pl., London WC2, En
1976 ence-Pub-1 171p 101refs HS-019 325
AVAILABLE FROM: Society of Automotive Engineers
REPORT NO.: SAE-P-64; IEE-Confer;
SUBFILE: HSL
Papers are presented with illustrative tables, figures, graphic materials, and photographs, and deal with the following topics: automatic headway systems; specifications for electromagnetic compatibility; design and development of futuristic and advanced electronic systems for automobile applications; semiconductors in automotive electronics; automobile testing and diagnosis; radar instrumentation; motorcycle braking; vehicle location; weighing facilities; automatic guidance for road vehicles; handicapped driver vehicles; and status of automobile electronics in the U.S.A., Europe, and Japan. Electronic systems and components of special interest for near-term use in private and commercial vehicles include timing regulation, air cushion control, intrusion alarm, alternator rectifier, voltage regulator, tachometer, climate control, windshield wiper control, wheel lock sensing and control, traction control, clock and amenities regulation, fuel metering, exhaust emissions control, engine performance monitoring and control, automatic transmission control, ignition systems, vehicle instrumentation, driver information systems, cruise and speed control, and anti-glare and headlamp beam control. Overall prognosis for automobile electronics is good provided cost, performance, reliability, and market acceptance limitations are overcome. Includes HS-019 326--HS-019 361. Conference organized in association with the Institution of Electronic and Radio Engineers, Institution of Mechanical Engineers, and Society of Automotive Engineers.

906015 DA
THE STATUS OF THE JAPANESE ESV (EXPERIMENTAL SAFETY VEHICLE) PROGRAM
Koyanagi , Takeaki
Ministry of International Trade and Industry Japan
1976 5p HS-019 583
SUBFILE: HSL
In the autumn of 1973, the first ESV's were delivered to the Japanese Governmental Agency for evaluative testing by Nissan and Toyota. The tests were conducted by the Japan Automobile Research Institute, Inc. (JARI) in the spring of 1974. Presently, Japanese ESV projects are seeking to make technological advances in order to realize further improvement, particularly in the safety field. One of the new technology themes for fiscal 1976 is an anti-crash auto brake system employing a radar system. Traffic accidents in Japan have been decreasing (reduction of accident rate by 3.6% from 1974 to 1975). General plans for national traffic safety measures proposed at the National Traffic Safety Countermeasures Committee meeting in 1976 include overall traffic safety programs, road maintenance and the traffic environment as a whole. Attention will also be focused on the education of both motorists and the general public. Presented at the Sixth International Technical Conference on Experimental Safety Vehicles, Washington, D.C., 12-16 Oct 1976. Proceedings to be published Apr 1977.

905227 DA
SOME RECENT AND FUTURE AUTOMOTIVE ELECTRONIC DEVELOPMENTS
Jones , Trevor O.
Science v195 1977 Monograph p1156-60 HS-020 582
SUBFILE: HSL
The automotive industry continues to examine new electronic technologies for their applicability to the automobile. Today, 16 electronic systems (headlight control, alternator rectifier, voltage regulator, tachometer, cruise control, electronic ignition, climate control, windshield wiper control, wheel-lock control, clock, intrusion alarm, air-cushion control, electronic fuel injection, lamp timing control, spark timing control, and electronic digital displays) can be found on the automobile, and future engine and emission control systems will soon be added. Four electronic systems associated with engine control have been introduced: the microprocessed sensing and automatic regulation (MISAR), which precisely controls spark timing for all conditions of load and speed consistent with driveability and emission control requirements; electronic fuel injection (EFI) systems, which provide improved starting and driveability in relation to carburetor systems; the electronically controlled dual displacement engine (DDE), which deactivates half the cylinders at various speeds, computing its commands based upon engine temperature, transmission gear, engine vacuum, speed, and throttle opening; and the closed-loop knock limiting system, which controls ignition timing only under knocking conditions to improve fuel economy while satisfying exhaust emission control requirements. Catalysis, simultaneous control of hydrocarbons, carbon monoxide, and nitrogen oxide emission with a single catalyst, is the only known method of achieving the 1978 statutory emission standards, however, its technology has not matured sufficiently. Electronic truck systems include wheel-lock control, vehicle weighing systems, and tire pressure warning devices. Digital electronic displays and multiplex wiring systems, using a single fiber-optic cable, are expected to be near-term developments. On a longer range basis, automatic radar brakes and intoxicated driver interlocks will receive considerable attention.

905203 DA
ON BOARD ELECTRONICS
Mohan , John G.
Automotive Industries v156 n4 1977 Monograph p18-25 HS-020 606
SUBFILE: HSL

Although the necessary technology exists, development of electronics on automobiles is slow. Automotive electronics can be divided into three categories: control devices, displays and diagnosis, and interconnection systems. There are two types of control devices, the microprocessor and the analog device. The microprocessor is a general purpose digital computer with one or more large scale integrated circuits, comprised of four functional components: a central processing unit, a memory area holding controlling data, a memory holding operational data, and some form of input-output circuitry to hook it to the engine. The analog device is a computer which creates an electrical analogy of the mathematical problem to be solved. The variables, from sensor input, are represented by electric voltage or current which the computer manipulates in accordance with the mathematical formulas analoged on its memory. The basic difference between the two systems is that the analog system plots a continuous graph and must move the entire curve to step around undesirable points, while the digital system, having more flexibility, is capable of plotting points on the graph individually. Currently, the microprocessor control for engines seems the most practical for the future, but reliability and cost are two major obstacles to implementation. Two systems of microprocessing on the drawing board are the single function controller and the multipurpose controller. In the single purpose processor, all computing functions are not integrated into a single box, but rather, a series of processors tied to a central memory. The centralized memory contains the parameter values which are implemented by the periphery processors. It is the processors which convert sensor signals from the analog to the digital and transmit them to the central memory. After receiving instructions, they implement the power amplification necessary to perform the function. The other system uses one control unit for all systems. The central memory contains the computer program as well as the parameter values. The driver adds his input to the computer along with the monitored functions and the central processor sends out control signals to the transducers controlling car functions. The advantages of the central processor system are in its flexibility and capability to handle complex functions. Although microprocessors and electric gadgetry increase their role in the automobile, they do not remove control from the driver, but rather enhance it, as in anti-skid braking and radar braking. Electronic displays must be visible at all time, have a long life span, and be unaffected by temperature changes. Presently the cost of digital displays is critical and will require specialized repair procedures. There are two diagnosing systems under development: the microprocessor which which a mechanic can check whether a system falls within a certain

903738 DA
TRANSPORTATION: ELECTRONICS GALORE. MICROPROCESSORS BROADEN IMPACT ON LAND, SEA, AND AIR TRANSPORT
Kaplan , Gadi
Spectrum v15 n1 1978 Monograph p59-62 HS-022 354
SUBFILE: HSL

The use of electronics is leading to many improvements in ground, air, and marine transportation. In both hardware and software areas, important steps are being taken to upgrade service, increase safety, cut costs, conserve energy, and reduce pollution. With microprocessors, as many as 60 different automobile engine functions can be accurately assessed in less than four minutes. Among these functions are primary and secondary ignition, starting, battery charging, fuel-air mixture compression, and timing. Motor vehicle communications systems are improved, with higher capacity, more reliable signaling, greater frequency stabilization, and improved audio quality. Sensors installed in buses help to warn against failures. Air pressure of brakes, oil pressure, and engine temperature are monitored and malfunction automatically signals a dispatch center. Microprocessors and advanced algorithms upgrade traffic control signals to reduce congestion, travel time, and fuel consumption. Automatic vehicle monitoring (AVM) is being field tested. The AVM system includes a communications subsystem for monitoring vehicle status and returning control commands to vehicles, and a computer subsystem for managing information flow, processing incoming data, generating displays for a dispatcher, and preparing records. An ultrasonic technique for detecting flaws in railroad tracks is being tested and electric railroad performance is being improved. Air transportation may soon benefit from a vortex advisory system being tested at O'Hare airport, which may help to regai? landing capacity and to reduce delays at airports. An airborne radar-beacon collision-avoidance system (BCAS) has been tested for warning of the presence of other aircraft within 37 km. To use the system, the aircraft must be equipped with an Air Traffic Control Radar Beacon System (ATCRBS) transponder. Another system provides a light signal at the beginning of runway to confirm voice communication with a traffic controller. Yet another system provides pilots with direct access to weather information. Marine navigation is being upgraded with the expansion of the "Loran C" system and additions to ship displays. A microprocessor-based satellite navigation system for ships is demonstrating good reliability, and systems exist for monitoring ships' structural safety and engine performance. Other applications show progress in controlling pollution in the major bodies of water.

902194 DA
ANALYSIS OF PROBLEMS ON THE APPLICATION OF RADAR SENSORS TO AUTOMOTIVE COLLISION PREVENTION. FINAL REPORT
Chandler, R. A.; Wood, L. E.; Warner , B. D.
Office of Telecommunications, Washington, D.C.
1973 368P HS-801 011
AVAILABLE FROM: National Technical Information Service
CONTRACT NO.: DOT-HS-314-3-601; Contract
SUBFILE: HSL

The results of an investigation of the practicality and technical feasibility of applying radar as a sensor for automatic automotive braking systems are described. Radar signatures of a variety of targets are given which were obtained with a 10 GHz multiple-frequency CW radar. These targets include automobiles, trucks, corner reflectors, pedestrians, and cyclists. Effects of rainfall on radar performance are considered with respect to frequency, rainfall rate, and whether the radar is a CW or pulsed system. An analysis of system performance as affected by road geometry is provided, as is a study of some of the considerations involved in the dynamics of vehicle stopping. The relative desirability of cooperative and non-cooperative systems are compared on the bases of technical complexity, costs, maintenance, and overall effectiveness. A study is made of possibly hazardous radiation levels resulting from the general use of vehicular microwave radars. Results are given with respect to different radiation standards. Rept. for Mar-Nov 1973. For summary rept., see HS-801 010.

901924 DA
COLLISION AVOIDANCE RADAR BRAKING SYSTEM INVESTIGATION (PHASE 1). FINAL REPORT
Demos, G.; Kazel, S.; Carlson, R.; Viergutz, O.; Morita, D.; Lanera , D.
IIT Research Inst., Chicago, Ill.
1974 307p HS-801 309
AVAILABLE FROM: National Technical Information Service
CONTRACT NO.: DOT-HS-4-00935; Contract
SUBFILE: HSL

The results are described of an investigation of automotive collision avoidance radar braking system concepts and technology. The purpose of this three-month study program, which constitutes Phase 1 of a multi-phase NHTSA effort, has been to assess the state-of-the-art of current radar braking technology and to arrive at a comprehensive definition of the radar braking concept. The concept definition includes a characterization of the many factors which enter into the concept, the techniques which are applicable to the concept, and a determination of the problem areas which require additional research. Among the subject areas receiving special attention were: identification and analysis of the manner in which driver, driving environment, and vehicle characteristics in conjunction with radar braking objectives the subsystems of the radar braking concepts as to the function, tradeoffs, alternative implementation, and technology limitations; appraisal of the current state-of-the-art in radar braking techniques and systems; generation of candidate braking systems and radar techniques; and analysis of accident statistics to determine the relative benefits of the candidate system configurations. Report for Jun 1974 - Sep 1974.

901250 DA
ANALYSIS OF PROBLEMS IN THE APPLICATION OF RADAR SENSORS TO AUTOMOTIVE COLLISION PREVENTION, PHASE 3, VOL. 1. FINAL REPORT
Chandler, R. A.; Jacobson, L. A.
Department of Commerce, Inst. for Telecommunication Sciences, Boulder, Colo. 80
1976 32p 3refs HS-802 014
AVAILABLE FROM: National Technical Information Service
CONTRACT NO.: DOT-HS-5-01096; Contract
SUBFILE: HSL

The results of the third phase of an investigation of the practicality and technical feasibility of applying radar as a sensor for automatic braking systems are described. Hardware evaluation of a baseband system as a brake sensor is discussed, and target signatures generated by the system are presented. Analyses of the performance of different types of systems in the presence of rain are given; performance of a realistic system in minimimum-radius horizontal curves is analyzed; estimates of the probability of intersystem blinding generated by multiple vehicles are given. Results of the baseband radar hardware evaluation show that the target detection performance for automotive targets is acceptable. The system is also simple, low cost, and has minimal radiation hazards. The major problem is broad antenna coverage, unacceptably wide for automotive braking sensors. If coverage can be narrowed to five degrees or less, the system should be considered. The simplest solution for acceptable performance in rainfall will be the use of pulsed radar systems. The blinding study for multiple vehicles demonstrates that the probability of blinding is increased somewhat for a multiple vehicle encounter, but it is not significant. Antenna pattern effects would reduce even this level so it is concluded that multiple-vehicle blinding is improbable. Study of range limiting techniques for reducing false alarms on curves showed that reduced range in curves is a promising technique. The study recommends that a prototype pulsed system designed for automotive applications should be built, since the pulsed systems have a number of advantages over other types of radar. Two figures show the comparative radar signatures of a bicyclist, motorcyclist and a station wagon, and the maximum range v. rainfall rate. Two tables show signals from various targets in decibels, and the minimum required signal-to-noise ratios for different radar systems--pulsed, diplex Doppler, and FM-CW. Rept. for Mar-Dec 1975. Vol. 2 is HS-802 015.

901249 DA
ANALYSIS OF PROBLEMS IN THE APPLICATION OF RADAR SENSORS TO AUTOMOTIVE COLLISION PREVENTION, PHASE 3, VOL. 2. FINAL REPORT
Chandler, R. A.; Jacobson, L. A.
Department of Commerce, Inst. for Telecommunication Sciences, Boulder, Colo.

AVAILABLE FROM: National Technical Information Service
CONTRACT NO.: DOT-HS-5-01096; Contract
SUBFILE: HSL

The results of the third phase of an investigation of the practicality and technical feasibility of applying radar as a sensor for automatic braking systems are described. Hardware evaluation of a baseband system as a brake sensor is discussed, and target signatures generated by the system are presented. Analyses of the performance of different types of systems in the presence of rain are given; performance of a realistic system in minimum-radius horizontal curves is analyzed; estimates of the probability of intersystem blinding generated by multiple vehicles are given. Results of the baseband radar hardware evaluation show that the target detection performance for automotive targets is acceptable. The system is also simple, low cost and has minimal radiation hazards. The major problem is broad antenna coverage, unacceptably wide for automotive braking sensors. If coverage can be narrowed to five degrees or less, the system should be considered. The simplest solution for acceptable performance in rainfall will be the use of pulsed radar systems. The blinding study for multiple vehicles demonstrates that the probability of blinding is increased somewhat for a multiple vehicle encounter, but it is not significant. Antenna pattern effects would reduce even this level so it is concluded that multiple-vehicle blinding is improbable. Study of range limiting techniques for reducing false alarms on curves showed that reduced range in curves is a promising technique. The study recommends that a prototype pulsed system designed for automotive applications should be built, since the pulsed systems have a number of advantages over other types of radar. The report contains 18 figures, nine of them showing radar signatures of various automobiles and one showing comparative signatures of a bicyclist, motorcyclist and a station wagon, elliptical regions observed by gated binaural system, effects of rainfall upon radar performance (four figures) and four figures illustrating signal level v. off-boresight angle at different curves and with both uniform and cosine aperture illumination. The two tables show the signals from various targets in decibels, and the minimum required signal-to-noise ratios for different radar systems--pulsed, diplex Doppler and FM-CW. Rept. for Mar 1975 - Dec 1975. Vol. 1 is HS-802 014.

900754 DA
RSV RESEARCH SAFETY VEHICLE- , PHASE III, BIMONTHLY PROGRESS REPORT FOR JUNE/JULY 1977
Minicars, Inc., 35 La Patera Lane, Goleta, Calif. 93017
1977 166p 20refs HS-802 600
CONTRACT NO.: DOT-HS-7-01552; Contract
SUBFILE: HSL

Report is made on the progress of the Research Safety Vehicle (RSV) Phase III program during the third bimonthly reporting period. The report is organized into 22 task sections; in each section task progress is summarized to the subtask level. Tasks include product improvement of inflatable restraints; front seat passive belt restraints; structural and systems refinement; and plastic material improvement. Also detailed are plastic material improvement; electronic systems; ride-and-handling and braking; and compatibility analysis. Other tasks are: diesel engine; high technology engine/transmission; structural and systems fabrication; and accident/benefit analysis. Progress is reported on tasks concerning the advanced engine; glazing; production planning; and tooling. Five appendices present data and progress reports from subcontractors, concerning data on the Honda engine, electronics, automotive radar developments in the Federal Republic of Germany, automation of manual transmission, evaluation of effects of restraint system implementation schedules, and a proposal for an advanced, gasoline-fueled piston engine.

900125 DA
INTERNATIONAL TECHNICAL CONFERENCE ON EXPERIMENTAL SAFETY VEHICLES (2ND) SINDELFINGEN, GERMANY, OCTOBER 26-29, 1971. REPORT
National Hwy. Traf. Safety Administration
1971 HS-820 181
SUBFILE: HSL

The nature and status of experimental safety vehicle programs in their countries were described by governmental representatives from the United States, Germany, Japan, Great Britain, Italy, France, the Netherlandsxes Sweden, and Belgium. Technical presentations were made by representatives of the automotive industries of six countries dealing with experimental safety vehicles, crashworthiness, vehicle safety, and safety devices. A crashworthiness seminar considered problems of structure in safety carsrestraints, occupant simulation, subsystems, and testing. An accident avoidance seminar considered problems of visibility, vehicle steering and handling, accident contributing factors, application of radar to auto control and sensing, and braking.

308678 DA
A BASEBAND RADAR SYSTEM FOR AUTO BRAKING APPLICATION
Ross, GF
Society of Automotive Engineers 400 Commonwealth Drive Warrendale Pennsylvania 15096
Sensor Systems
Mar 1978 6 p.
REPORT NO.: SAE 780262;
SUBFILE: HRIS

This paper describes a Baseband Radar (BAR) sensor for radar braking applications. We show how the normally wide effective beamwidth of the BAR is narrowed by using interferometry in conjuction with a novel delay line digital processor scheme. The beamwidth of the breadboard system spans a traffic lane width at 45 meters. The paper describes the details of the BAR sensor frontend and preliminary test results sponsored by the U.S. Department of Transportation and the Institute for Telecommunication Sciences.

301519 DA
IMPROVED RADAR ANTICOLLISION DEVICE
Flannery, JB; Sims, JC, Jr; Brainard, SR; Ruderman, L
Society of Automotive Engineers
Collision Avoidance Systems
Society of Automotive Engineers Preprints 1979 8 p. 16 Ref.
AVAILABLE FROM: Engineering Societies Library 345 East 47th Street New York New York 10017
REPORT NO.: SAE 790456;
SUBFILE: EIT; HRIS

The authors describe an automotive anticollision device which uses pulsed radar and is controlled by a microprocessor. The radar and its control significantly reduce false target response, loss of braking due to multi-path signal cancellation and blinding from other radar equipped vehicles. Increased range with reduced false target response allows warning of an impending collision and effective automatic braking. Prepared for SAE Meeting, 26 February-2 March, 1979.

300263 DA
ACCELERATION AND DECELERATION OF MODERN VEHICLES
Samuels, SE; Jarvis, JR
Australian Road Research Board 500 Burwood Road Vermont South Victoria 3133 Australia 0 86910 424 1
Dec 1978 Res Rpt. 22 p. 56 Fig. 8 Tab. 8 Ref.
REPORT NO.: ARR No. 86;
SUBFILE: TRRL; IRRD; HRIS

The acceleration and deceleration performance capabilities of a group of modern passenger cars have been measured in a controlled test situation. Data, taken only in dry conditions, have been compared where possible with those upon which some current design standards are related. This comparison has shown a dramatic improvement in both acceleration and deceleration capabilities of modern passenger cars. This improvement in braking capability raises the question of whether drivers are making judgements, concerning their wet weather braking capacity, which could be at variance with those cited in present design standards. Vehicles were divided into low, medium and high acceleration performance categories, and these categories were extrapolated into the newly-registered Australian vehicle population of 1975. It was found that a similar number of vehicles had been registered in each category and this was felt to be particular feature of the local market. /Author/TRRL/

264226 DA
AUTOMOTIVE RADAR BRAKE
Troll, WC
Society of Automotive Engineers; .2 Pennsylvania Plaza; New York; 10001
Bendix Corporation
Feb 1974 7 pp 1974
REPORT NO.: SAE Paper No. 740095;
SUBFILE: HRIS

An automatic braking system for automotive vehicles is described. The system employs an onboard radar sensor to measure distance and relative closing velocity to obstacles in the vehicle path. This range and range-rate information is processed to generate a control signal which is a measure of the critical braking level existing in the dynamic environment. In response to selected control signal thresholds, the system provides the driver with advance warning of potential collision situations and can subsequently automatically apply vehicle braking if the driver response to the warning is judged inadequate. Problem areas associated with practical implementation of the automatic braking system on the production automobile are discussed.

262370 DA
DIPLEX DOPPLER RADAR FOR AUTOMOTIVE OBSTACLE DETECTION
General Motors Research Laboratories
IEEE Transactions on Vehicular Technology VOL. VT23NO. 2 .May 1974 pp 34-44 15 Fig. 12 Ref. 1974
SUBFILE: HRIS

The usefulness of radar as an automotive obstacle detection system is currently being investigated. Possible applications of such a system presently are automatic braking and air bag actuation and eventually the totally automatic highway. One type of radar having possible potential for these short range applications is diplex Doppler radar. The microwave and electronic circuits basic to a diplex Doppler radar obstacle detection system are described in this paper. The system provides analog outputs proportional to range, velocity, and time to impact relative to an obstacle, as well as indicating whether the velocity is opening or closing. /Author/ Presented at the 23rd IEEE Vehicular Technology Conference, Dallas, Texas, 6-8 December 1972.

223875 DA
CASE FOR ELECTRONIC FUEL INJECTION
Pond, JB; Esherlman, RH
Automotive Industries VOL. 146 NO. 12 .Jun 1972 pp 47-51
SUBFILE: HRIS

this article surveys the pros and cons of fuel injection and carburetion systems. When the emissions and safety objectives of the government's programs are coordinated, they will indirectly force the automotive industry to adopt electronic fuel injection (efi), no matter how good carburetors or mechanical fuel injection gets. Efi systems are more compatible with the electronic systems being considered for adaptive speed control, automatic vehicle speed control, engine speed limiters, radar braking, automatic vehicle braking by remote devices, and adaptive emission monitoring and control devices. Carburetors are becoming more expensive due to increased complexity and precision, while efi systems are becoming simpler and cheaper due to savings gained through mass production. /author/

181910 DA
AUTOMOTIVE RADAR RESEARCH
Chandler, RA
Institute for Telecommunication Sciences; .Office of Telecommunications; Boulder; Washington; Colorado; D.C.; 80302 ; 20590
Jul 1977 Final Rpt. 58 p. 1977
AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22161
REPORT NO.: DOT-HS-803-399; PB-283751/6ST
CONTRACT NO.: DOT-HS-6-01375; Contract
SUBFILE: NTIS; HRIS
The report describes the investigation of the interference effect of radar brake sensors operating in the 60GHz vicinity with satellite communication systems and radio astronomy activity. Also, the results of the study on an experimental baseband radar system, which was built and tested under this contract, are discussed. (Portions of this document are not fully legible)

180111 DA
RECENT TRENDS IN AUTOMOTIVE RADAR
Codd, RD
Lucas (Joseph) Limited, England
Radio and Electronic Engineer VOL. 47 NO. 10 .Oct 1977 pp 472-476 31 Ref. 1977
AVAILABLE FROM: Engineering Societies Library 345 East 47th Street New York New York 10017
SUBFILE: EIT; HRIS
The possible advantages to be gained from the development of vehicle radar systems are outlined and the factors influencing the design of a suitable system are discussed. The various types of system which are commonly considered are introduced and their relative merits and associated problems are explained. The systems considered are automatic headway control, headway warning, automatic braking and pre-collision sensing. It is concluded that significant problems remain to be solved before practical automative radar can become a reality for the general motoring public.

176759 DA
MM RADAR FOR HIGHWAY COLLISION AVOIDANCE
Wu, Y; Tresselt, CP
Department of Transportation
Microwave Journal VOL. 20 NO. 11 .Nov 1977 pp 39-59 1977
AVAILABLE FROM: Engineering Societies Library 345 East 47th Street New York New York 10017
SUBFILE: EIT; HRIS
An automatic/noncooperative radar braking system can both prevent and reduce the severity of accidents caused by inattentive or slow responding drivers. Tests indicate that narrow antenna beam and limiting the range at which brakes are applied. This paper describes a 36 GHz radar possessing these desird paraeters which is size compatible with compact cars.

173964 DA
MICROCOMPUTER CONTROL FOR THE CAR OF THE FUTURE
Belohoubek, EF; Cusack, J; Risko, J; Rosen, J
RCA Engineer VOL. 23 NO. 1 .Jun 1977 pp 26-31 8 Ref. 1977
AVAILABLE FROM: Engineering Societies Library 345 East 47th Street New York New York 10017
SUBFILE: EIT; HRIS
The introduction of microprocessors to the automobile opens many new exciting possibilities for improved performance, safety, and convenience in future cars. This paper investigates the use of microprocessors to monitor and display a variety of performance- and safety- related sensors in the automobile and to adapt a noncooperative cw/fm radar to automotive needs. A description of the radar is provided including its performance specifications and functions. The radar has successfully demonstrated headway control with respect to other vehicles on the road; collision-mitigation braking when a collision is clearly imminent; and warning the driver of obstacles and cars ahead.

173211 DA
MICROCOMPUTER CONTROLLED RADAR AND DISPLAY SYSTEM FOR CARS
Belohoubek, E; Cusack, J; Risko, J; Rosen, J
Society of Automotive Engineers; .400 Commonwealth Drive; Warrendale; Pennsylvania; 15096
Sarnoff (David) Research Center, RCA
Jul 1977 10 pp 1977
REPORT NO.: SAE 770267;
SUBFILE: HRIS
An experimental, non-cooperative automotive radar has been developed for collision mitigation and automatic headway control. The FM/CW radar is interfaced with a microcomputer to aid in the elimination of false alarms and handle the braking, warning, and headway control algorithms. A single-line, self-scan plasma display together with a series of sensors is also interfaced with the on-board computer to provide normal driving related information and warning messages in case of malfunctions in the car. /SASI/

159867 DA
SYSTEM CONSIDERATIONS FOR THE DESIGN OF RADAR BRAKING SENSORS
Chandler, RA; Wood, LE
IEEE Transactions on Vehicular Technology VOL. VT-2NO. 2 .May 1977 pp 151-160 16 Ref. 1977
AVAILABLE FROM: Engineering Societies Library 345 East 47th Street New York New York 10017
SUBFILE: EIT; HRIS
This paper is concerned with the review and discussion of topics fundamental to the design of operational radar sensors for automatically activated braking systems for automobiles. Expected benefits in terms of reduced accidents and societal costs are briefly discussed, and a short discussion on modes of operation is presented. Target detectability characteristics are reviewed, and selected vehicles and pedestrian range-amplitude signatures at 10, 35, and 60 GHz are presented, as are discussions of atmospheric effects on propagation between 10 and 100 GHz. A short analysis of highway geometry effects on system performance is given, and false detection and intersystem problems are discussed in terms of this analysis.

157375 DA
INTERNATIONAL CONFERENCE ON AUTOMOBILE ELECTRONICS - CONFERENCE PAPERS (CONTINUED)
Institution of Electrical Engineers
Institution of Electrical Engineers, Proceedings 1976 Analytic pp 96-159 Figs. Tabs. Refs.
REPORT NO.: Conf. Pub. No. 141;
SUBFILE: TRRL; IRRD; HRIS
The following papers were amongst those presented at the conference on automobile electronics:- Automatic speed control system for automobiles, Moody,RL; Time compressed aural communication links to moving vehicles, Hodgson,DG; Radiating cable performance for use with a driver information system, Harms,PL and Johannessen,R; Identity transponder system for vehicle location, McEwen,CD; A system for automatic vehicle location, Deslandes, PA; A drive-by-wire vehicle control system for severely disabled drivers, Penoyre,S; Feaver,JL and Stoneman,BG; An automatic headway control system based on the use of a microwave telemetry link, Dobson,JS; Allard,R; Ford,RL; Pinson,JT and Roberts,JD; Harmonic and two-frequency radars for vehicle headway applications, Davies,DEN, Makridis,H and McEwen,CD; Evaluation of a g-band automative primary radar, Codd,RD; Headway radar using pulse techniques, Hahlganss,G; The advanced electronic fuel and engine control and diagnostic system, Broad,MJ; AFF - an automatic guidance system for road vehicles, Domann,H; Motorcycle braking, Watson,PMF, Lander,FTW and Miles,J; A digital electronic system for automobile testing and diagnosis, Cross, TA. /TRRL/

152953 DA
RESULTS FROM A COLLISIONS AVOIDANCE RADAR BRAKING SYSTEM INVESTIGATION
Troll, WC; Wong, RE; Wu, YK
Bendix Corporation; .20800 Ten and One-Half Mile Road; Southfield; Michigan; 48076
Bendix Corporation
11 pp Figs. Tabs. Phots. 6 Ref. 1977
REPORT NO.: SAE 770265;
CONTRACT NO.: DOT-HS-4-00913; Contract
SUBFILE: HSRI; HRIS
Results of previous studies have indicated that an automatic/noncooperative radar braking system may provide a significant benefit in preventing accidents that may otherwise be caused by driver inattention or tardy driver response. However, one of the major technical problem areas in implementing the automatic/noncooperative radar brake system is in achieving sufficient target discrimination. This is necessary to allow rejection of non-hazardous objects and to maintain a sufficiently low false alarm rate while retaining recognition capability on all potential hazards. This paper presents the results of an experimental and computer simulation study conducted to resolve the effects of the various system parameters which may be significant to the target recognition problem. The target discrimination experimental study was conducted using an instrumented test vehicle equipped with an automatic/noncooperative radar braking system to gather parametric data under typical traffic conditions. The test courses selected for the experiments typify much of the high density, high speed, urban and suburban driving in the United States. The sensitivities of the various radar brake system parameters are also discussed. /HSRI/ This paper was presented at the International Automotive Engineering Congress and Exposition held by the Society of Automotive Engineers in Detroit, February 28-March 4, 1977. Research sponsored by the Department of Transportation.

144000 DA
ANALYSIS OF PROBLEMS IN THE APPLICATION OF RADAR SENSORS TO AUTOMOTIVE COLLISION PREVENTION. PHASE III. VOLUME II
Chandler, RA; Jacobson, LA
Institute for Telecommunication Sciences; .Office of Telecommunications; Boulder; Washington; Colorado; D.C.; 80302 ; 20590
Sep 1976 Final Rpt. 64 pp 1976
AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22161
REPORT NO.: DOT-HS-802-015; PB-258190/8ST
CONTRACT NO.: DOT-HS-5-01096; Contract
SUBFILE: NTIS; HRIS
The report describes the results of the third phase of an investigation of the practicality and technical feasibility of applying radar as a sensor for automatic braking systems. Hardware evaluation of a baseband system as a brake sensor is discussed, and target signatures generated by the system are presented. Analyses of the performance of different types of systems in the presence of rain are given; performance of a realistic system in minimum-radius horizontal curves is analyzed; estimates of the probability of intersystem blinding generated by multiple vehicles are given. See also PB-240 733, PB-240 950, and PB-258 004.

143988 DA
ANALYSIS OF PROBLEMS IN THE APPLICATION OF RADAR SENSORS TO AUTOMOTIVE COLLISION PREVENTION. PHASE III, VOLUME I
Chandler, RA; Jacobson, LA
Institute for Telecommunication Sciences; .Office of Telecommunications; Boulder; Washington; Colorado; D.C.; 80302 ; 20590
Sep 1976 Final Rpt. 33 pp 1976
AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22161
REPORT NO.: DOT-HS-802-014; PB-258004/1ST
CONTRACT NO.: DOT-HS-5-01096; Contract
SUBFILE: NTIS; HRIS
The report describes the results of the third phase of an investigation of the practicality and technical feasibility of applying radar as a sensor for automatic braking systems. Hardware evaluation of a baseband system as a brake sensor is discussed, and target signatures generated by the system are presented. Analyses of the performance of different types of systems in the presence of rain are given; performance of a realistic system in minimum-radius horizontal curves is analyzed; estimates of the probability of intersystem blinding generated by multiple vehicles are given. See also PB-240 950.

128690 DA
RADAR GUNN: APPLICATIONS TO HIGHWAYS
Brun, P
Societe de Ingenieurs de l'Automobile
Societe de Ingen de l'Automobile, Journal de la N6/7 Jun 1973 pp 425-431 4 Fig. French
SUBFILE: TRRL; IRRD; HRIS
The author reviews the applications of the new semi-conductor hyperfrequency devices, called gunn diodes, to cars. Their small dimensions and competitive price enable detection systems to be devised for car application such as sensors (traffic flow, traffic count with recording of direction, speed measurement, recording of obstacles, control of weights, etc.) and at a later stage, for detecting obstacles in the fog (assistance in braking, vehicle spacing for preventing collisions, speed measurements, vehicle identification, etc.). /TRRL/

127963 DA
AUTOMOTIVE STATION KEEPING AND BRAKING RADARS. A REVIEW
Jones, TO; Grimes, DM
General Motors Proving Ground; Michigan University, Ann Arbor
Microwave Journal VOL. 18 NO. 10 .Oct 1975 pp 49-53 8 Fig. 22 Ref. 1975
SUBFILE: HRIS
The current automotive radar system state-of-the-art is reviewed, and it is concluded that although considerable development work remains before radar becomes a practical automotive system, significant progress has been made in the field. The use of cooperative radar breaking systems must be preceded by a detailed analysis of anticipated vehicle collision directions and obstacles. The biological effects must be evaluated before installation of such systems as standard equipment. Details are discussed of station keeping or cruise-control radar systems to aid drivers. System considerations are also set forth. A prototype braking radar which consists of 5 major parts is reported.

090634 DA
ANALYSIS OF PROBLEMS IN THE APPLICATION OF RADAR SENSORS TO AUTOMOTIVE COLLISION PREVENTION
Chandler, RA; Wood, LE; Jacobson, LA
Institute for Telecommunication Sciences; .Office of Telecommunications; Boulder; Washington; Colorado; D.C.; 80302 ; 20590
Mar 1975 Rinal Rpt. 306 pp 1975
AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22161
PB-240950/6ST
CONTRACT NO.: DOT-HS-4-00813; Contract
SUBFILE: NTIS; HRIS

The report describes the results of the second phase of an investigation of the practicality and technical feasibility of using radar sensors for automatic automotive braking systems. Radar signatures of typical vehicular targets at 35 GHz and 60 GHz are shown. Results are compared with 10 GHz signatures obtained in Phase I. Tracking radar systems and their feasibility in the automotive application are discussed with respect to the problem of potentially high false alarm rates caused by highway curves. The problem of intersystem blinding is considered in depth, and estimations are made of the effectiveness of polarization isolation and frequency-hopping in reducing blinding effects. The performance of diplex radar systems in blinding configurations is discussed. Preliminary specifications are recommended as guidelines for judging the acceptability of prototype systems for marketing. Performance tests for verifying a system's compliance with the suggested specifications are outlined and discussed.

090568 DA
ANALYSIS OF PROBLEMS IN THE APPLICATION OF RADAR SENSORS TO AUTOMOTIVE COLLISION PREVENTION. EXECUTIVE SUMMARY
Chandler, RA; Wood, LE; Jacobson, LA
Institute for Telecommunication Sciences; .Office of Telecommunications; Boulder; Washington; Colorado; D.C.; 80302 ; 20590
Mar 1975 Final Rpt. 27 pp 1975
AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22161
PB-240733/6ST
CONTRACT NO.: DOT-HS-4-00813; Contract
SUBFILE: NTIS; HRIS

The report describes the results of the second phase of an investigation of the practicality and technical feasibility of using radar sensors for automatic automotive braking systems. Radar signatures of typical vehicular targets at 35 GHz and 60 GHz are shown. Results are compared with 10 GHz signatures obtained in Phase I. Tracking radar systems and their feasibility in the automotive application are discussed with respect to the problem of potentially high false alarm rates caused by highway curves. The problem of intersystem blinding effectiveness of polarization isolation and frequency-hopping in reducing blinding efforts. The performance of diplex radar systems in blinding configurations is discussed. Preliminary specifications are recommended as guidelines for judging the acceptability of prototype systems for marketing. Performance tests for verifying a system's compliance with the suggested specifications are outlined and discussed.

090117 DA
COLLISION AVOIDANCE RADAR BRAKING SYSTEM INVESTIGATION (PHASE I)
Demos, G; Kazel, S; Carlson, R; Viergutz, O; Morita, D
IIT Research Institute; .10 West 35th Street; Chicago; Washington; Illinois; D.C.; 60616; 20590
Dec 1974 Final Rpt. 307 pp 1974
AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22161
REPORT NO.: IITRI-E6306; PB-238486/5ST
CONTRACT NO.: DOT-HS-4-00935; Contract
SUBFILE: NTIS; HRIS

The subject areas receiving special attention in the study, were: (1) identification and analysis of the manner in which driver, driving environment, and vehicle characteristics in conjunction with radar braking objectives, affect the requirements of the system, (2) characterization of the subsystems of the radar braking concepts as to the function, tradeoffs, alternative implementation, and technology limitations, (3) appraisal of the current state-of-the-art in radar braking techniques and systems, (4) generation of candidate braking systems and radar techniques, and (5) analysis of accident statistics to determine the relative benefits of the candidate system configurations. Portions of this document are not fully legible.

080720 DA
BARBI, A NEW CONCEPT FOR PRECOLLISION SENSING
Ross, GF
Society of Automotive Engineers; .2 Pennsylvania Plaza; New York; 10001
Sperry Rand Corporation
pp 141-154 1974
REPORT NO.: SAE Paper No 740574;
SUBFILE: HRIS
This paper describes a novel and low-cost scheme for automotive precollision sensing called BARBI, an acronym for Baseband Radar Bag Initiator. An extension of this technique is also suggested for braking applications. The proposed technique involves the transmission and reception of a subnanosecond baseband or video impulse-like signal (i.e., no RF carrier) and requires virtually no microwave components. The very fast signal risetime permits leading edge resolution on approaching vehicles of much less than a foot; closing velocity is obtained by using range-rate techniques. By incorporating sequential range gating techniques, the false alarm rate can be reduced to less than one in ten years for all the cars in the U. S. today. Presented at the Third International Conference on Occupant Protection, 1974.

051686 DA
ANALYSIS OF PROBLEMS ON THE APPLICATION OF RADAR SENSORS TO AUTOMOTIVE COLLISION PREVENTION
Wood, LE; Chandler, RA; Warner, BD
Institute for Telecommunication Sciences ./Office of Telecommunications, Dept of Commerce; Boulder; Colorado
Dec 1973 Final Rpt 368 pp 1973
AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22151
PB-226065/1
CONTRACT NO.: DOT-HS-314-3-601; Contract
SUBFILE: NTIS
The report describes the results of an investigation of the practicality and technical feasibility of applying radar as a sensor for automatic automotive braking systems. Radar signatures of a variety of targets are given which were obtained with a 10 GHz multiple-frequency CW radar. These targets include automobiles, trucks, corner reflectors, pedestrians, and cyclists. Effects of rainfall on radar performance are considered. An analysis of system performance as affected by road geometry is provided, as is a study of some of the considerations involved in the dynamics of vehicle stopping. A study is made of possibly hazardous radiation levels resulting from the general use of vehicular microwave radars.

924321 DA
HAVE WE FINALLY FOUND THE RIGHT DESIGN FOR TIRE STUDS?
Reitz, B
Fagersta Brunks A.B.
1969 5p HS-004 799
SUBFILE: HSL
Studs are the best and most used antiskid device for tires. The history of anti-skid devices is reviewed, stating the basic principles for the construction and function of studs as well as their fitting into tires. Special problems with regard to heat buildup and wear are treated, including their influence on choice of material and design for the stud jacket. The ability of the stud point to penetrate into ice of various hardnesses is considered. Presented at International Automotive Engineering Congress, Detroit, Michigan.

924232 DA
A CAR FITTED WITH AN AUTOMATIC BRAKE PUMPING DEVICE
Chinn, B.P.; Wilkins, H.A.
Road Res. Lab., Crowthorne, Berks. (England)
1968 18p HS-004 890
REPORT NO.: RRL-LR-164;
SUBFILE: HSL
Skidding and loss of control might be avoided by "pumping" the brakes. An experimental automatic brake pumping device operating on the hydraulic circuit to all four wheels can prevent wheel locking. This experimental design needs further development before achieving economic practicality.

924137 DA
FOUR WHEEL DRIVE FORD MUSTANG
Ferguson (Harry) Res. Ltd. (England)
Engineering Monograph HS-004 987
SUBFILE: HSL
A four-wheel-drive Mustang was demonstrated by Harry Ferguson Research Ltd. Performance and controllability were superior to the standard model driven on ice and snow. Goal is to obtain public and industry acceptance of the principle as an optional extra.

923650 DA
PROPORTIONING VALVE TO SKID CONTROL-A LOGICAL PROGRESSION
Lueck, Frederick E.; Gartland, William A.; Denholm, Michael J.
Borg-Warner Corp.
1967 10p HS-005 503
SUBFILE: HSL
This paper discusses the development of a family of brake control devices capable of handling all vehicles from passenger cars through air-braked heavy trucks. These devices include: hydraulic and pneumatic load-sensitive proportioning valves, and skid control systems. Except for passenger car skid control, these devices can be retro-fitted on existing vehicles. Presented at SAE Mid-Year Meeting, Chicago, Ill.

923453 DA
AN ASSESSMENT OF THE AUTOMOTIVE PRODUCTS ''ANTILOK'' ANTI-LOCKING BRAKING SYSTEM FITTED TO AN ARTICULATED VEHICLE
Wilkins, H.A.; Chinn, B.P.
England Road Res. Lab.
1968 17p HS-005 712
SUBFILE: HSL
Jack-knifing of articulated vehicles is usually caused by locking of the tractor rear wheels when brakes are applied. A method of preventing jack-knifing is to use an anti-locking braking system to prevent these wheels from locking. Tests on such a system are described, in which jack-knifing was eliminated. Braking distance differed little from that of an unmodified vehicle, being slightly shorter on a slippery surface and slightly longer on other surfaces.

922808 DA
UNCOVER ANTISKID CONTROL SYSTEM FAILURES FAST
Schultz, M
Motor Monograph HS-006 372
SUBFILE: HSL
This explanation for mechanics outlines the steps in finding out what is wrong with antiskid systems and servicing them. The parts of the system and how to test and service them are discussed.

922412 DA
WHAT WE KNOW ABOUT WINTER DRIVING
Anonymous
Journal of American Insurance Monograph HS-006 780
SUBFILE: HSL
National Safety Council researchers test equipment and techniques to improve driving on ice and snow. Traction tests investigate use of chains, studded tires; teaching skid control are discussed; methods to end truck jackknifing are studied. Several winter driving tips are offered.

922103 DA
ADAPTIVE ANTI-LOCK BRAKING: A REALITY FOR AIR BRAKED VEHICLES
Latvala, Bruce E.; Morse , Robert J.
Bendix-Westinghouse Automotive Air Brake Co., Elyria, Ohio
1970 8p HS-007 092
AVAILABLE FROM: Society of Automotive Engineers
REPORT NO.: SAE-700112;
SUBFILE: HSL

An adaptive braking control system was developed for vehicles using air brakes. Basic components include: a speed sensor mounted within the wheel, an electronic controller, and a modulator to adjust wheel brake chamber pressure. Specifications and operations of the system are discussed showing performance under several typial conditions. Wheel lock is prevented under any braking condition, vehicle stability is improved, and stopping distances are reduced. Benefits to be gained from adaptive braking are more impressive at high speeds than at low. Presented at Automotive Engineering Congress, Detroit, Mich., 12-16 Jan 1970.

921858 DA
CONTROLLED ROTATION OF BRAKED WHEELS
Airheart, Franklin B.; Yarber , Gordon W.
Hurst/Airheart Products, Inc., Van Nuys Calif.
1970 8p HS-007 353
AVAILABLE FROM: Society of Automotive Engineers
REPORT NO.: SAE-700113;
SUBFILE: HSL

Automatic skid control provides the rotation control needed to stop a wheeled vehicle safely through a control system which senses wheel speed, has control logic, and controls braking torque. This paper describes how these essential control functions are used on the vehicle: to control skid and rotation or to prevent complete loss of vehicle control. Performance as related to vehicle stability, directional control, stopping distance, tire damage, and relative cost must be evaluated to determine the final configuration. Presented at Automotive Engineering Congress, Detroit, Mich., January 12-16, 1970.

921320 DA
BRAKE SYSTEM COMPONENT DYNAMIC PERFORMANCE MEASUREMENT AND ANALYSIS
Fisher , D. K.
Michigan Univ. Hwy. Safety Res. Inst.
1970 International Auto. Safety Conf. Compendium Monograph HS-007 904
SUBFILE: HSL

Results of a comprehensive investigation into the dynamic performance of braking system components are presented. Typical transient and sinusoidal dynamic response data are illustrated for drum and disc brakes and for rigid and flexible brake lines. Laboratory transient response data for complete brake systems are also presented. A generalized brake system mathematical model, based on a component by component analysis, is formulated. The utility of this model in the design of anti-wheel lock devices and in human factors braking control investigations is discussed. Includes summaries in French and German. Presented at 1970 International Automobile Safety Conference: Detroit, Mich., 13-15 May 1970, Brussels, Beligum, 8-11 Jun 1970.

920774 DA
SPINNING CAR WHEELS ENERGIZE ANTI-SKID BRAKE
Product Engineering Monograph HS-008 455
SUBFILE: HSL

New research to perfect a low cost, compact, fast response, antilock skid control for automobiles has been revealed by Mullard Research Laboratories, Redhill, England. A separate antilock control is used at each wheel. Mullard says its system, like others already demonstrated and on the road, consists of both electronic and mechanical components to control brake pressure. Mullard uses a new brake pressure modulating mechanism that obtains energy from the car's spinning wheels.

920588 DA
THE CHRYSLER ''SURE-BRAKE'': THE FIRST PRODUCTION FOUR-WHEEL ANTI-SKID SYSTEM
Schafer, T. C.; Douglas , J. W.
Bendix Corp. Chrysler Corp.
1971 11p HS-008 642
SUBFILE: HSL

The paper outlines testing, development and operation of the first production four-wheel slip control system for passenger cars in the United States. The Chrysler Corporation calls the system ''SURE-BRAKE'', but it is more generally known as ''anti-skid.'' Considerations that led Chrysler into the ''SURE-BRAKE'' system, the philosophy behind the system and a detailed explanation of its operation are given, as well as the development and testing leading to the release as an option on the 1971 Imperial. The testing program introduced a new dimension to brake engineering. Before the advent of wheel slip control systems, brake tests were always terminated at the point of skid, and were conducted mainly on black top or concrete roads. For the first time, thousands of stops were made at maximum deceleration on every available surface. The paper lists the results obtained and attempts to pass on some of the lessons learned in handling skidding vehicles. Presented at Automotive Engineering Congress, Detroit, Mich., 11-15 Jan 1971.

920459 DA
HYBRID COMPUTER SIMULATION OF THE DYNAMIC RESPONSE OF A VEHICLE WITH FOUR-WHEEL ADAPTIVE BRAKES
Hickner, G. B.; Elliott, J. G.; Cornell , G. A.
Bendix Corp.
1971 11p HS-008 772
SUBFILE: HSL
An improved version of a seventeen-degree-of-freedom hybrid computer simulation is being modified to include a four-wheel adaptive braking system (ABS). The derivation and verification of the ABS model the form of the integrated vehicle/ABS model, and future plans for validation and utilization of the integrated hybrid simulation are presented. Presented at Automotive Congress and Exposition, Detroit, Mich., 11-15 Jan 1971.

919720 DA
HOW THE 1971 CARS REALLY WILL BE BETTER
Lund , Robert
Popular Mechanics Monograph HS-009 526
SUBFILE: HSL
The improvements of 1971 automobile models are described. The one change that will be common to most new cars will be reworking of the engines to enable them to run on unleaded gasoline. Brakes, antiskid systems, and safety devices are also discussed.

919119 DA
ANTI-SPIN DEVICE FOR '71
Automotive Industries Monograph HS-010 130
SUBFILE: HSL
New features of the 1971 model Buick automobile are described: antiskid device, improved steering and suspension, and new chassis. The engines are all designed to operate on unleaded gasoline and come equipped with an evaporative emission control system. Improved serviceability is also a feature.

918950 DA
THE SAFETY CARS ARE COMING
Shuman , A. B.
Motor Trend Monograph HS-010 299
SUBFILE: HSL
Experimental safety car prototypes are nearing completion with in-built safety design far in advance of any production automobiles. Similar in size and weight to standard large American sedans, they are designed to be superior in avoiding accidents, withstanding crashes and protecting occupants, minimizing injuries to pedestrians, providing for escape and for various emergencies. ... brakes, air bag restraints, periscopic rear mirrors, fire protection and prevention. After the cars are crash tested in spring of 1972, 12 more of improved design will be built for further research and testing, ultimately to lead to safer production automobiles.

917751 DA
COMPUTERIZED ENERGY DISTRIBUTION AND AUTOMATED CONTROL
Sognefest, P. W.; Anderson, R. L.; Estes, 3rd, B. E.; Nedbal , R. G.
Essex International, Inc.
1972 8p HS-011 509
AVAILABLE FROM: Society of Automotive Engineers
SUBFILE: HSL
The control system is comprised of a central computer with a digital multiplexing system. The subsystems of the car that were tested include fuel injection, ignition, power assist, comfort, and lighting. In its final form this system will make decisions for all the subsystems on the automobilesuch as antiskid braking, gear selection, automatic speed control, and driver displays. The system will evolve onto the car in pieces such as engine controllighting, and automatic temperature control. As economic factors dictate, the components will evolve into a single computerized system. The automatic temperature control system is economical today. The central computer will be economical for certain functions in two-three years. Presented at Automotive Engineering Congress, Detroit, 10-14 Jan 1972.

917321 DA
SPECIALIZED ROAD SURFACES FOR TRACTION TEST PURPOSES
Smithson, F. D.; Allen , C. V.
General Motors Proving Ground
1972 11p 6refs HS-012 042
AVAILABLE FROM: Society of Automotive Engineers
REPORT NO.: SAE-720469;
SUBFILE: HSL

There is a growing need for specialized road surfaces in order to conduct a variety of tire and/or vehicle tests. Surfaces which would fulfill this need should meet the following objectives: be entirely prescribable utilizing easily obtainable components and simple construction techniques; provide the desired frictional characteristics; and exhibit reasonable durability. This paper discusses the basic characteristics of road surfaces which influence their frictional performance and must be controlled to obtain the desired results. These frictional phenomena are then related to specific tests to explain how they can influence results. This discussion provides the basis for an outline of the development of a specialized road surface which was designed to meet the previously outlined objectives. Presented at the National Automobile Engineering Meeting, Detroit, 22-26 May 1972.

917197 DA
END OF THE AIR BAG? VOLKSWAGEN'S ESV SHOWS NEW THINKING ON PASSANGER RESTRAINT
Bladon , S.
Autocar v136 n3968 1972 Monograph p48-50 (4 May 1972) HS-012 166
SUBFILE: HSL

Safety belts which move into position by engine manifold suction and are tensioned by gas cell action are described. Volkswagen's anti-lock braking system and experimental safety car are described.

917067 DA
TOWARDS SAFER ROAD VEHICLES< CONFERENCE HELD AT TRANSPORT AND ROAD RESEARCH LABORATORY< CROWTHORNE, ENGLAND, JANUARY 28, 1972. PROCEEDINGS 31
Transport and Road Res. Lab., Crowthorne, Berks., England
1972 160p HS-012 296
REPORT NO.: TRRL-LR-481;
SUBFILE: HSL

The proceedings present a comprehensive and up-to-date account of British work aimed at improving vehicle safety. Topics include the British approach to safer vehicles; vehicle features which might reduce the likelihood of accidents especially vehicle handling and anti-lock brake systems; and methods for the protection of vehicle occupants and of pedestrians. A brief description of the static displays and vehicle demonstrations presented at the conference is also included. Co-sponsored by Society of Motor Manufacturers and Traders.

917060 DA
APPLICATION OF THE PARAMETER PLANE METHOD TO THE HANDLING OF A VEHICLE UNDER EMERGENCY CONDITIONS
Guntur , R. R.
Technische Hogeschool, Delft (Netherlands),
1972 10p HS-012 303
AVAILABLE FROM: Society of Automotive Engineers
SUBFILE: HSL

The parameter plane method gives clearer insight into the behavior of a vehicle under emergency braking conditions. The advantage of the method lies in the use of two independent parameters instead of one. Information about the stability of a vehicle is obtained in a convenient form and may be used in designing an adaptive braking system. The effect of wheel locking on the handling characteristics of the vehicle is studied; the degree of instability is redefined as a nondimensional number, and its utility is indicated. If a specified degree of stability is to be achieved the roots of the character equation of the system must lie within specified boundaries of the complex s-plane. These boundaries may be mapped on the parameter plane. An adaptive brake control system may be designed to confine the movement of the operating point to the region thus specified. Presented at National Automobile Engineering Meeting, Detroit, 22-26 May 1972.

916644 DA
SOME FACTORS LIMITING DRIVER-VEHICLE PERFORMANCE
Mortimer, R. G.; Olson, P. L.
Michigan Univ. Hwy. Safety Res. Inst.
1973 10p HS-012 722
AVAILABLE FROM: Society of Automotive Engineers
SUBFILE: HSL
Measurement of drivers' performance at the limit of capability is difficult due to methodological problems, moment to moment variability of drivers, differences between drivers, and their interactions with the characteristics of the vehicle, road, and environment. Longitudinal and lateral vehicle control are discussed by reference to results of braking and steering tests, with emphasis on variations between performance of drivers. Driver effectiveness in vehicle braking is a function of the brake system deceleration/pedal force gain. Overall braking performance could be improved by increasing the abilities of drivers who are poor in this task by training in brake modulation on dry and wet pavements. The best drivers are as effective as an antilocking brake system, except on the equivalent of ice covered pavement. In steering control drivers increase their response frequency bandwidth as task difficulty increases. Comparisons are shown between an inexperienced and an experienced driver in curve negotiation. Presented at International Automotive Engineering Congress, Detroit, 8-12 Jan 1973.

916527 DA
DEVELOPMENT OF THE BRAKE SYSTEM FOR THE GENERAL MOTORS EXPERIMENTAL SAFETY VEHICLE
Roller, A. E.; Oakley, W. J.; Cattin, W. J.
General Motors Corp.
1973 11p HS-012 840
AVAILABLE FROM: Society of Automotive Engineers
REPORT NO.: SAE-730081;
SUBFILE: HSL
Design of a four wheel, antilock disc brake system using a hydraulic power brake system with an electro-hydraulic back-up system, and the brake system components, including wheel lock control, a load sensing proportioner, and warning lights, is described. The design of the dual piston caliper for the disc brakes provides a redundant system thereby minimizing the effect of a single line or hose failure. Tests conducted during the development period indicate that the parking brake system is capable of holding on a 30% grade within the actuation limit of 90 lb maximum for a hand brake system and that braking efficiency and brake fade performance are very good. Presented at International Automotive Engineering Congress, Detroit, 8-12 Jan 1973.

916147 DA
HYDRAULIC BRAKE ACTUATION SYSTEMS UNDER CONSIDERATION OF ANTILOCK SYSTEMS AND DISC BRAKES
Strien, H; Depenheuer, O.
Teves (Alfred) G.m.b.H. (West Germany)
1973 12P HS-013 225
AVAILABLE FROM: Society of Automotive Engineers
REPORT NO.: SAE-730535;
SUBFILE: HSL
Three variations of hydraulic boosters for power-assisted brake systems and a dual-circuit control valve for hydraulic full-power brake systems are described. The units all make use of the accumulator, for this offers the driver more security than the continuous-flow system. It has been suggested that brake systems be classified by means of an efficiency factor (total brake force/driver's pedal effort) and that an effectiveness coefficient be introduced as a comparision value to correlate the efficiency factor of a brake system having failed boosting with that of an intact system. Applying these values to brake systems using the desribed boosters helps judge the advantages and disadvantages and emphasizes the importance of a new ZHS 2.2 booster, especially for heavier vehicles with disc brakes. A hydraulic actuation system is especially attrative when a vehicle is also to be equipped with antilocking devices. Presented at Automobile Engineering Meeting, Detroit, 14-18 May 1973.

915992 DA
AN EVALUATION OF MEASURES TO REDUCE ACCIDENT OCCURRENCE
Hoffmann, E. R.
Melbourne Univ. (Australia)
HS-013 337, Papers presented at the National Road 1972 Monograph Safety Sym posium, Ca nberra, 19 72 p443-56 6 HS-013 382
SUBFILE: HSL
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 antiskid 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.

915856 DA
INTERNATIONAL TECHNICAL CONFERENCE ON EXPERIMENTAL SAFETY VEHICLES (3RD), UNITED KINGDOM PRESENTATION. CONFERENCE PAPERS, WASHINGTON, D. C., MAY 30-JUNE 2, 1972
Department of the Environment, London, England
1972 161p refs HS-013 518
SUBFILE: HSL
In the United Kingdom, it is felt that accidents can be avoided if cars have better handling qualities and equipment, which gives drivers more information about their surroundings and what they and others are doing; occupants should be protected against accidents as far as possible; and vehicles should be designed to minimize injuries inflicted on those whom they strike. The British Car Safety Program emphasizes the development of practical engineering safety systems capable of being incorporated into a wide variety of cars. Papers dealing with driver aid and information systems, vehicle handling, occupant protection, impact testing, and improved body design are presented. Includes HS-013 519--HS-013 529.

915694 DA
THE DYNAMICS AND HANDLING PERFORMANCE OF AUTOMOBILE-TRAVEL TRAILER COMBINATION
Chiang, S. L.; Wong, R. E.; Elliott , J. S.
Bendix Res. Labs., Southfield
In HS-013 673, International Congress on Automotiv 1973 Monograph e Safety (2nd) Proce edings. V ol. 2, Rec reaticnal HS-013 680
REPORT NO.: Paper-73024;
SUBFILE: HSL
A computerized mathematical model has been developed for analyzing the dynamic behavior of an intermediate size passenger car towing a travel trailer. The computer program has been used: to evaluate the system responses of a combination vehicle (CV) during straight line braking and combined braking and steering maneuvers; to aid the design of a trailer brake actuator; to illustrate the behavior of weight equalizer bars; and to show the interactions between a weight equalizer and the trailer brake actuator. The computerized simulation was also utilized to examine the causes of trailer sway and jackknifing and vehicle responses to avoidance steering maneuvers and to study the effects on CV stability, control, and path deviation caused by aerodynamically induced forces and moments generated during encounter with intercity buses or large trucks. The simulation results for all of the above cases are summarized. Presented at the Congress held in San Francisco, 16-18 Jul 1973.

915436 DA
TECHNICAL PRESENTATION. PT. 1. THE JAPANESE TECHNICAL PRESENTATIONS
Hasegawa, T.; Yamoto, K.; Baba, T.; Wada, A.; Kawano, J.; Fujita, S.; Marumo, N.; Serisawa, Y.; Kawashima, K.; Hayano, H.; Irimajiri , A.
HS-013 939, International Technical Conference on 1973 Monograph Experiment al Safety Vehicles (4th), Wash ington, 19 HS-013 942
SUBFILE: HSL
Technical presentations are made by the Japanese; Toyota, Nissan, and the Honda Motor Company are represented. The Toyota Motor Company outlines their ESV program with special attention to braking, handling and steering, and their energy management system. The Nissan Motor Company outlines the development, evaluation, and future safety considerations of their ESV program. The Honda Motor Company outlines the present development status of their ESV with special attention to the structure, accident avoidance, and the tires and brakes.

915429 DA
ACCIDENT AVOIDANCE SEMINAR. PT. 1. INTRODUCTION. PT. 2. STEERING, HANDLING AND BRAKING
Anonymous
HS-013 939, International Technical Conference on 1973 Monograph Experiment al Safety Vehicles (4th), Wash ington, 19 HS-013 949
SUBFILE: HSL
Papers are presented by: Saab-Scania of Sweden speaking on accident avoidance requirements; Toyota Motor Company of Japan remarking on vehicle handling; Daimler-Benz of Germany commenting on American ESV accidents; Girling Ltd. of Great Britain discussing American ESV brake specifications; Citroen Automobiles of France remarking on vehicle antilock systems; General Motors Corporation of the United States, Alfa Romeo of Italy, Girling Ltd. of Great Britain, and Daimler-Benz of Germany speaking on safety aspects of vehicle handling.

915227 DA
THE EFFECTIVENESS OF ANTISKID MATERIALS AS MEASURED ON A CIRCULAR TRACK APPARATUS
Hegmon, R. R.; Meyer, W. E.
Pennsylvania State Univ., University Park. Dept.
1966 40p HS-014 151
SUBFILE: HSL
The friction of a standard tire under slip on an ice track on which antiskid materials, treated with calcium chloride, were spread was measured. Under otherwise equal conditions, friction was found to be highest for all antiskid materials tested with the size fractions passing sieve no. 8 and retained on sieve no. 30. Of five composite materials tested, well-graded river sand, coke, and boilerhouse cinders gave comparable performance on an equal weight basis, whereas the friction obtained with poorly-graded river sand and limestone was lower. The outstanding effect of increased rate of application was to reduce the deterioration of friction with the number of wheel passes. These results, though reliable, must be considered preliminary because several operational variables remain to be investigated. Prepared for the Automotive Safety Research Program, Pennsylvania State University.

911100 DA
EUROPEAN TECHNOLOGY TRENDS
Mullins, P. J.
Automotive Industries v150 n5 1974 Monograph p25-9 HS-014 395
SUBFILE: HSL
Trends in the European automobile industry are discussed. It is noted that design innovations have traditionally been regarded as the answer to specific problems of European driving, but that changes due to desire for more luxury are also being made. Consideration is given to the success of radial-ply tires, steel-belted radials, glass fiber tires, windshield defogging, disc brakes, anti-lock braking systems, the Fabrostrip method wiring, radar warning systems, automatic transmissions, suspension systems, the Wankel rotary engine, body construction, and the Stirling engine.

910959 DA
FEDERAL SAFETY STANDARDS: THEIR OBJECTIVE AND HOW THEY AFFECT HEAVY-DUTY VEHICLES
Tompkins, S. J.
Rockwell International Corp. Troy, Mich.
HS-014 519, Conference of the American Association 1973 Monograph for Automo tive Medic ine (17th), Proceedi ngs, Oklah HS-014 537
SUBFILE: HSL
The role of the trucking industry in accident prevention is discussed ... is on Federal Motor Vehicle Safety Standard 121, the braking standard, which seeks to make trucks more compatible with automobiles in their braking performance, stopping without veering out of a 12-foot lane in a shorter distance. Axles and springs must be strengthened, and an anti-wheel-lock device is needed. It is suggested that a total systems approach is necessary to meet the standard; 800 brake and axle combinations must be studied, modified, and tested to assure compatibility. Conference held in Oklahoma City, 14-17 Nov 1973.

910932 DA
FATAL ACCIDENTS DURING A TWELVE-MONTH PERIOD (1972), INVOLVING VOLVO MODELS 140 AND 164 VEHICLES
Samuelsson, L.
Report on the Fourth International Technical Confe 1973 Monograph rence on E xperimenta l Safety V HS-014 564
SUBFILE: HSL
Fatal accidents involving Volvo models 140 and 164 vehicles in Sweden in 1972 are analyzed to indicate the situations and the ways occupants are fatally injured, and to what degree safety-improvement items could have led to a reduction in the number of fatalities. The items evaluated include: improved interior with energy-absorbing units; safety belts and the VESC-body, with regard to impact/energy absorption in frontal, lateral, rear and roof deformation; and anti-skid brakes. Appraisal was primarily based on degree of vehicle deformation and the reduction in size of the passenger compartment. On the basis of the Volvo 140-series cars, it would have been possible to achieve a fatal injury reduction of 40-55% through interior improvements alone, or, optionally, through 100% use of safety belts. Appendix 3. See HS-013 939.

910635 DA
HYBRID SIMULATION IN THE AUTOMOTIVE INDUSTRIES
Soliman, J. I.
Journal of Automotive Engineering 1973 Monograph HS-014 861
SUBFILE: HSL
The role of digital and analog computers in automotive engineering is examined. The mechanisms of each are described along with their advantages and drawbacks, and the effectiveness of the hybrid computer in many cases is noted. Applications of hybrid computation include engine/vehicle simulation, antiskid braking control systems, vehicle ride simulation, directional stability, cumulative damage data reduction, and control systems design and optimization. It is concluded that the hybrid computer can solve problems that formerly were unsolvable or solvable only by clumsy, time-consuming methods.

910527 DA
TIRES AND BRAKES. THE JAPANESE TECHNICAL PRESENTATION, SECT. 2, PT. 1
Irimajiri , A.
Honda R and D Co. Ltd., Tokyo (Japan)
HS-013 939, INTERNATIONAL TECHNICAL CONFERENCE ON 1973
Monograph HS-014 969
SUBFILE: HSL
The performance and characteristics of tires and brakes on Japanese experimental safety vehicles are discussed. Some emphasis is placed on acceleration and cornering tests of run-flat tires, which are seen as a safety system for the vehicle itself. The tire must be improved so that deflated its characteristics approach those of tires inflated to the specified pressure. The anti-skid Orake system to be installed on the Honda ESV is also described in terms of friction coefficients and stopping distances on dry and wet asphalt, rough ice using snow tires, and smooth ice using spike and snow tires. The system is shown to have a marked effect on handling and directional stability.

910523 DA
THE VOLKSWAGEN EXPERIMENTAL SAFETY VEHICLE. THE FEDERAL REPUBLIC OF GERMANY TECHNICAL PRESENTATION. SECT. 2, PT. 2
Willumeit , H.-P.
Volkswagenwerk A. G., Wolfsburg (West Germany)
HS-013 939, REPORT ON THE 4TH INTERNATIONAL TECHNI
Monograph .071973 HS-014 973
AVAILABLE FROM: Bound in HS-013 939
SUBFILE: HSL
The Volkswagen Experimental Safety Vehicle (ESVW) 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.

910522 DA
NEW INVESTIGATIONS OF HUK ACCIDENT RESEARCH: "INTERIOR SAFETY OF AUTOMOBILES". THE FEDERAL REPUBLIC OF GERMANY TECHNICAL PRESENTATION. SECT.2, PT.2
Danner , M.
HUK-Verband (West Germany)
HS-013 939, REPORT ON THE 4TH INTERNATIONAL TECHNI
Monograph .071973 HS-014 974
AVAILABLE FROM: Bound in HS-013 939
SUBFILE: HSL
Interior safety of automobiles is the object of research by German automobile insurers. 27,500 accident cases contained such detailed data on accident circumstances, damage to passenger vehicles and occupant injuries that it was possible to subject them to a thorough, scientific analysis. The benefit of anti-locking systems is examined as to no benefit, benefit possible, benefit probable, or benefit certain. Division of these benefit categories according to accident situations indicates that importance must be attached to maintaining steerability and curtailing the braking distance on a wet roadway when evolving anti-locking systems. Driver reaction and collision speed are considered in determining an Equivalent Test Speed (ETS) range for test of vehicle safety in an effort to alleviate the number of vehicle accidents and occupant injuries.

910510 DA
CONCLUSIONS AND PROJECTIONS ON ESV DEVELOPMENT. THE UNITED STATES TECHNICAL PRESENTATION, SECT. 2, PT. 5
Lundstrom , L. C.
General Motors Corp., Detroit
HS-013 939, INTERNATIONAL TECHNICAL CONFERENCE ON 1973
Monograph HS-014 986
SUBFILE: HSL
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.

910505 DA
STEERABILITY DURING EMERGENCY BRAKING. THE SWEDISH TECHNICAL PRESENTATION, SECT. 2, PT. 6
Rundkvist, S.
Volvo A.B., Goteborg (Sweden)
HS-013 939, INTERNATIONAL TECHNICAL CONFERENCE ON 1973 Monograph HS-014 991
SUBFILE: HSL

The Swedish experimental safety vehicle program, an investigation of steerability during emergency braking, is divided into four task groups: accident investigation; simulation testing by mathematical model; and performance and statistical field testing. Objectives of the accident investigation task were: to find the percentage of locked wheel accidents; to find typical situations for locked-wheel accidents; and to estimate possible benefits if steerability during braking had been possible. Simulation testing objectives were to complement field tests and to perform a systematic investigation of the influence of typical anti-skid parameters. The field performance tests investigated the relationship between braking and steering capability under various vehicle characteristics and equipment, and road, speed, and load conditions in various maneuvers. The statistical tests sought to determine how an average driver behaves during an emergency situation and whether or not having steerability works to his advantage.

910494 DA
STEERING, HANDLING AND BRAKING. SAFER BRAKING SYSTEMS. ACCIDENT AVOIDANCE SEMINAR. SECT. 3, PT. 2
Oppenheimer, P.; Ingram, B.
Girling Ltd., Birmingham, Warwick (England)
HS-013 939, Report on the International Technical 1973 Monograph Conference on Experimental Safety Vehicles (4th), HS-015 002
SUBFILE: HSL

Increasing legislative requirements are reviewed against the practical experience of the motor industry and the theoretical investigations of scientists, so that the practicing automotive engineer may appreciate the current state-of-the-art of braking systems and the progress toward improved road safety. Braking regulations in the U. S., Sweden, and the European Economic Community are outlined. Methods of reducing the incidence and effects of brake failures are discussed, including periodic inspections, accident investigations, divided circuits, and warning indicators. Stopping performance improvements are considered, as are vehicle braking dynamics, in terms of proportioning valves, adhesion utilization, locked wheels, and rear or four-wheel control. Further consideration is given to anti-locking brake systems. Conference held in Kyoto, Japan, 13-16 Mar 1973.

910066 DA
WHAT'S NEW IN MOTORCYCLE ENGINEERING
Covington, J.
Automotive Engineering 1974 Monograph HS-015 433
SUBFILE: HSL

Motorcycle technology is described in terms of increasing engine output, upgrading safety, improving road handling, and decreasing emitted sound and pollutants. To improve the torque/speed characteristics of engines, computers are emerging as a tool in the analysis of gas dynamics, and they serve familiar roles in exhaust emission analysis. In the areas of handling and braking, equipment developed in other automotive areas is significantly contributing to improvements for motorcycles. Antiskid brakes work almost as effectively on two-wheel, single track bikes as they do on truck and cars. Automotive suspension diagnostic principles also works well on motorcyice components, and muffler design principles evolved for larger vehicles are as applicable on a smaller scale. Based on SAE papers 740626, "Design Considerations for Motorcycle Exhaust Systems"; 740627, "Motorcycle Emissions, Their Impact and Possible Control Techniques"; 740630, "Anti-Lock Brake System Application to a Motorcycle Front Wheel"; 740628, "A Study of Motorcycle Suspension"; and 740745, "Development of a 500cc Single-Cylinder Two-cycle Engine for Motorcycle Racing and Motocross Application".

909342 DA
PRESENT AND FUTURE AUTOMOBILE ANTILOCK BRAKING SYSTEMS
AUTOMOTIVE ENGINEERING 1974 Monograph HS-016 159
SUBFILE: HSL

Design features of an antilock braking systems for automobiles are summarized, including induction sensors, electronic control, and brake pressure modulation. It is hoped that the systems under study will lead to one which will cost as much as a good car radio. Future systems include the single-circuit antilock in conjunction with power steering, the three-circuit antilock, and single- and two-circuit antilock for vehicles without power steering. Details are given on the energy sources, system fluids, actuation of rear brake circuits, possible changes needed in power steering design, and the use of a hydraulic pump, the cost of which would not be accepted by the public until the necessity for antilock is recognized or when it is required by government regulations. Based on SAE-741084, "Introduction of Antilock Braking Systems for Cars," by H.-C. Klein and W. Fink.

909055 DA
THE STATUS OF AUTOMOTIVE ELECTRONICS IN EUROPE
Villa , G. F.
Fiat S. p. A.
HS-016 434, Convergence 74. International Colloqu 1975 Monograph ium on Aut omotive El ectronic T echnology Conference HS-016 448
SUBFILE: HSL

A historical background of European automotive electronics is offered, followed by an analysis of the value of the electronic equipment which may be installed on automobile vehicles in the near future. Factors influencing future development are discussed, including market requirements, cost, experience, and the peculiarity of automotive application requirements. Technological criteria are also considered, such as standard discrete components, thick and thin film technique, standard integrated circuits, large and medium scale integration, micro-computers and programmable logics, transducers and actuators, voltage stabilization for electronic ignition, and adaptive systems for antiskid. Conference held in Troy, Mich., 28-30 Oct 1974.

908240 DA
1973 WINTER TEST REPORT. COMMITTEE ON WINTER DRIVING HAZARDS TRAFFIC CONFERENCE, NATIONAL SAFETY COUNCIL, STEVENS POINT, WISCONSIN (JANUARY 29 TO FEBRUARY 9, 1973)
National Safety Council, Com. on Winter Driving Hazards
1973 83p HS-017 281
SUBFILE: HSL

Tests conducted on snow and ice covered surfaces (graded area, flooded and frozen, and an iarport runway) in 1973 to evaluate various equipment, design features, accessories for motor vehicles, and various driving techniques are reported. The following test objectives were selected: stopping and stability performance of a tractor semi-trailer equipped with anti-wheel-lock device; braking distance tests of a 3-axle straight truck to establish a correlation with air and ice temperature and other variables; pulling ability of radial tires in conventional tread patterns as compared with snow tires in snow; performance of tire chains equipped with swivel hooks versus conventional chains; stopping performance of elastomeric chains compared to conventional chains; effect of salt application on coefficient of friction of ice covered surfaces; control and control recovery comparison of snow tires and studded snow tires; controlled stops on ice comparing neutral versus in-gear braking; and driver education workshops. The following vehicles and equipment were used: a Chevrolet sedan; a Ford LTD sedan; a friction trailer; two 3-axle straight trucks; a 3-axle Peterbilt tractor and tandem axle Fruehauf flatbed semi-trailer with anti-lock brakes; two tire-traction vehicles; and a variety of 4-door sedans for use in the driver education program. The basic ice courses were a straight ice pad 1,000 feet long and 250 feet wide, and an ice circle with a 200 foot radius. For specific purposes, more restrictive courses were laid out on these surfaces. It is concluded that: a good relationship is established between locked wheel stopping distance and ice surface temperature for 3-axle vehicles with gross loaded weights of 38,720 pounds, and a fair relationship for those partially loaded to 28,360 pounds; in terms of reduction of ice stopping distance, swivel hook chains provide much improvement over the use of regular tires, but not as great as V-bar reinforced chains; elastomeric chains provice some traction assistance on ice, but even with the X-device attached, it is only half the traction advantage of V-bar reinforced chains; if ice thickness is one-eighth inch, salt application at a rate of about 700 pounds per two lane mile at 21 degrees F air temperature will cause melting and elimination of ice within three hours; the use of studded snow tires on the rear wheels of a passenger vehicle provides significant benefit in rear-end skid recovery capability during a transient lateral maneuver; in panic situations, ice stopping is not affected by the car's gear position (in or out), but, in braking at low speeds, an automatic drive automobile with a fast idle may prove incapable of making the maneuver if the vehicle is left in gear; and the 1973 driver education workshops attended by 60 people, appears to have been highly successful.

907356 DA
AN INVESTIGATION OF INTEGRATED RETARDER/FOUNDATION BRAKE SYSTEMS FOR COMMERCIAL VEHICLES
Limpert , Rudolph
University of Utah
1975 10p 36refs HS-018 170
AVAILABLE FROM: Society of Automotive Engineers
REPORT NO.: SAE-750126;
SUBFILE: HSL

The potential usefulness of commercial vehicle brake systems which integrate a hydrodynamic retarder into the foundation brake system was investigated. A hydrodynamic retarder is a device that utilizes viscous damping as mechanism for retarding the vehicle. The damping fluid is cooled by means of the engine radiator or a separate cooler in the case of a retarder equipped trailer. It is suggested that the hydrodynamic retarder, when properly integrated into the foundation brake system, will absorb as much as 90% of all braking energy in typical-effectiveness stops for frame vehicles, and as much as 30% in the case of a retarder equipped tractor-semitrailer combination. Analysis of the temperature response of foundation brakes currently used on commercial vehicles indicates that lower temperatures and less fade can only be achieved through lower values of braking energy, and thus, less vehicle weight and speed, or through increased levels of cooling capacity. Present foundation brake designs do not allow economical increases in convective cooling coefficient or cooling area. However, depending on the downhill operating conditions, the proposed retarder may absorb all or a portion of the vehicle braking energy. For economic reasons, the retarding capacity must be a function of intended vehicle use, traffic conditions, and other related factors. If the retarder/foundation brake system is designed such that for any braking requirement the hydrodynamic retarder is applied and then the foundation brake, a truck brake system may be developed which will provide essentially fade free brakes and significantly extended brake lining life. Foundation brakes weighing about 40% less than present systems may be installed, since temperatures will not increase during downhill braking, due to the absorption of nearly all continued braking energy by the retarder. This weight savings will more than compensate for the additional weight of the retarder. It is suggested that additional optional procedures in federal braking standards are needed to encourage the early development of safer commercial vehicles. A future combination of integrated retarder/foundation brakes with wheel-antilock control appears to be the ultimate in commercial vehicle transportation safety. Presented at the Automotive Engineering Congress and Exposition, Detroit, Mich., 24-28 Feb 1975.

907017 DA
INTERNATIONAL CONFERENCE ON VEHICLE SYSTEM DYNAMICS (3RD)
Sachs, H. K. , ed.
Virginia Polytechnic Inst. and State Univ. at Blacksburg, Va.; American Society of Mechanical Engineers; Wayne State Univ.
1975 332p refs HS-018 546
AVAILABLE FROM: Swets and Zeitlinger, Amsterdam
SUBFILE: HSL

Discussions by over 100 researchers from academic institutions and industrial research organizations of the following vehicle dynamic problems are presented: the stability of taxiing aircraft; dynamic analysis of a pendulous suspension system; a track model for computer studies of railway vehicle dynamics; oscillatory instability of a tractor-semitrailer vehicle; the stability parameters of an articulated vehicle in five degrees of freedom; direct and indirect methods for stability studies of articulated vehicles; scheduling delays in synchronous transportation networks; the application of an electroviscous damper to a vehicle suspension system; simulation of vehicle braking with anti-lock devices; a comparison of tire influence on vehicle handling; driving simulator design for realistic handling; look ahead steering strategy; optimal aero-mechanical design for specialized man-in-the-loop driver-vehicle systems; and techniques for obtaining improvements in the handling qualities and performance of a submerged vehicle. Also discussed are: a finite element analysis of automotive sheet metal under impact loading; a technical and analytical approach to ride quality improvement on a surface effect ship using active feedback control; levered vehicle design by simulation; responses of segmented plate structures to traveling normal loads; practical operation and testing of an urban electric vehicle; and limiting performance characteristics of vehicle impact safety devices. Abstracts of 26 vehicle dynamic research efforts not discussed in any detail are also provided. Includes HS-018 547--HS-018 560.

906267 DA

CURRENT STATUS OF AUTOMOBILE ELECTRONICS IN EUROPE

Maund, J. E.; Hill , W. F.
Lucas Electrical Ltd., United Kingdom

HS-019 325, Automobile Electronics. International 1976 Monograph Conference , London?, 1976 p1-4 HS-019 326
SUBFILE: HSL

Principal electronic applications are alternators, electronic flasher control, fuel injection, electronic ignition, controlled-slip braking, automatic transmission, vehicle condition monitoring, and circuit realization. The alternator regulator is currently the only application of electronics likely to be found on European cars of the basic family-sedan category. Higher line models may include electronic tachometers, electronic flashers, and possibly electronic fuel injection and electronic ignition. A few cars also use electronics to operate warning lights, for delayed switching, air-conditioning control, cruise control, and some accessories. Adoption of the electronic alternator on a wide scale resulted from emergence of efficient power diodes capable of withstanding high temperatures and from a demand for increased generator capacity. Higher reliability was realized in volume production and the complete changeover to electronic alternators is seen as assured in the near future. Electronic flasher controls give longer service life than is obtainable from oscillating thermal relay types and can be used for hazard warning and direction indication. Their use is expected to spread progressively, despite a cost disadvantage. Electronic fuel injection systems offer improved engine power, flexibility, and economy. Good running characteristics can be obtained by modulating fuel schedule in response to engine temperatures, and effort will continue to be applied to refining fuel injection technology. Electronic ignition reduces maintenance required and improves stability of timing, with fitment presently confined to cars exported to the U.S. and a few luxury or high-performance cars in Europe. Emission control measures are promoting the adoption of electronic ignition further, utilizing either analog pulse-circuit or digital timing control. Electronic controlled-slip braking, which features self-checking of actuators and sensors, is being considered for adoption in some luxury and high-performance vehicles. Electronic control of conventional automatic transmissions is scheduled for future use in gear-shift timing and shift quality, offering the possibility of additional drive range options, adjustable shift point scheduling, and reduction in gearbox unit size. Vehicle condition monitoring of coolant level, brake fluid and engine oil levels, lamp failure detection, and alternator performance is presently feasible, and is in an early stage of development encouraged by use in commercial vehicles, availability of cheap integrated circuits, legislation, and warranty conditions. Circuit realization by electronics is foreseen, as the need for large quantities or performance requirements dictate future market and manufacturing decisions, based on considerations of siting, compactness, performance, cost, environmental exposure, and reliability. Overall the use of electronics in automobiles is seen as a measure for reducing fuel and Conference held in London, 6-9 Jul 1976.

906262 DA

AUTOMOBILE ELECTRONICS - CENTRALISED OR DECENTRALISED?

Ehlers , K.
Department of Electrical Engineering of

HS-019 325, Automobile Electronics. International 1976 Monograph Conference , London?, 1976 p21- 2 HS-019 331
SUBFILE: HSL

The feasibility of centralizing automobile electronic components into a main unit to offer a more comprehensive vehicle wiring system, improved reliability, ideal servicing conditions, and a reduction in costs was investigated. Three types of components are identified by function: conversion of driver's instructions to signals; control/regulation of engine or individual assembly operations; and aiding/boosting items of electronic accessory equipment (such as the antiskid system). These electronic components are used variously in three categories of automobiles: specially equipped, conventionally equipped per specifications and legislation, and combination equipped with special and regulated components. Special components may include hazard warning flashers, intermittent wiper controls, speed holding devices, auxiliary heater control units, electronic ignition systems, electronic fuel injection, headlight cleaning system control units, and radios with traffic-report decoder. Regulated components may include lighting equipment, hazard systems, or functionally specified equipment. The consequences of centralizing all electronic components, units, and systems in all categories of equipment and automobiles would result in: 100% electronic capacity equipment whether needed or wanted or not; non-optimum location of centralized electronics; redesign of all sensors and switches; high investments for design and manufacturing changes; high costs for the consumer; and automobile manufacturers' obligation or tendency to develop proprietary equipment. In view of these likely results, centralization of automobile electronics is not recommended. Ideal future locations for automobile electronic components are suggested alternatively on the basis of main assemblies which are grouped functionally; one near the driver, one near the power unit (engine), and one or more near special equipment such as an antiskid system (perhaps in the trunk section). Cross-links between electronic assemblies would integrate the overall system for purposes of maintenance and cost control. The desirability for standardization of basic component groups which could be used in all of a vehicle's electronic clusters is suggested. Conference held in London, 6-9 Jul 1976.

906142 DA
AUTOMOTIVE DESIGN ANALYSIS PANEL OF THE TASK FORCE ON MOTOR VEHICLE GOALS BEYOND 1980. REPORT
Automotive Design Analysis Panel, Task Force on Motor Vehicle Goals Beyond 1980
1976 351p 36refs HS-019 453
SUBFILE: HSL

An analysis of automotive design relative to motor vehicle goals beyond 1980 relates user-established requirements of auto size/roominess and performance/acceleration to federally established emission and safety requirements. The analysis also relates representative technological options available to manufacturers concerning automobile weight and materials, to fuel economy potentially achievable in the 1980's time period. The analysis was conducted at two primary levels of interest: vehicle component level and integrated vehicle level, with some illustrative results for the new car fleet. Of nine auto attributes studied in the analysis (size, performance in acceleration and gradeability, structural technology, engine technology, drivetrain technology, emission standards, safety standards, fuel economy, and cost), two (fuel economy and cost), are treated as dependent variables. Auto sizes considered were the functional equivalents of six-passenger, five-passenger, and four-passenger cars; performance (acceleration) levels evaluated were 11.12 seconds, 14-15 seconds, and 20-21 seconds for acceleration to 60 mph, corresponding to horsepower to vehicle test weight ratios of .04, .03, and .02 horsepower per pound, respectively. Three emission control levels were considered: current (1975-1976) Federal standards for exhaust emissions of hydrocarbons, carbon monoxide, and oxides of nitrogen (1.5/15/3.1 gm/miles) and the progressively stricter standards of .41/3.4/2.0 and .41/3. 4/.4, respectively. Two safety levels were designated (as realized in current auto design and as potentially realizable in 40 mph crashworthiness capability and anti-lock brakes). Vehicle configuration (auto structure and components) was studied in three levels of curb weight: current; weight-conscious; and innovative (substituting aluminum for steel/iron in relatively low risk components). Alternative engines were selected for analysis within the analytical constraints: the current Otto-cycle engine; the top performing 1975 engine; a lightweight diesel engine; and the Stirling engine. Selections for drivetrains studied were described as current and upgraded (more gears and a lock-up clutch in the torque converter on automatic transmissions). Effects of emission standards upon fuel economy were indicated by the use of analytical ranges. Results of the analysis show that within an uncertainty band of a few miles per gallon, due to the impact of still unsettled emission and safety requirements, the new car fleet average fuel economy can be increased by up to 100% from current levels (about 15.6 mpg) without changes in current fleet mix and without changes in passenger or baggage volume, given sufficient time and efforts to accomplish the necessary development. It appears actions: reduction of nonfunctional weight and auto redesign

905443 DA
WHEEL BEARING MOUNTINGS FOR HIGHWAY VEHICLES
Waski, Henry J.
Timken Co.
1976 14p 2refs HS-020 365
AVAILABLE FROM: Society of Automotive Engineers
REPORT NO.: SAE-760373;
SUBFILE: HSL

The basic considerations for wheel bearing performance are reviewed; and new approaches for design, calculation, and standardization are introduced. The most common method of bearing selection is based on the static wheel load at the ground, but additional loads are imposed by cornering conditions. Further radial loads are imposed by disc brakes, belted and radial tires, and the tractive effort created by driving wheels. Special bearing problems are incurred by boat trailer wheels, which require replacement of bearings because of water deterioration rather than fatigue. A successful wheel bearing mounting requires a tight cup fit in the rotating hub; cleaning and painting the hub to prevent porosity and eliminate loose sand or scale; adequate lubrication with good oil seals; and preloading or setting the bearing only at optimum conditions. Accelerated testing is recommended, because it indicates a relative performance against an established base line. Standardization is being brought about through a grouping or line of standardized wheel bearing combinations using existing bearing parts, thereby reducing the number of hubs, bearing sets, wheels, and rims and promoting maximum interchangeability of suspension members, brakes, and anti-skid brake control packages. Future wheel bearing mountings call for a new, sealed, two-row, preset, sealed, and greased bearing for independently sprung wheels in a compact package, and for a live spindle design for an independently sprung driving wheel with cones mounted directly on the shaft. Presented at Automotive Engineering Congress and Exposition, Detroit, 23-27 Feb 1976.

905258 DA
SECOND GENERATION BUILDING BLOCK CIRCUITS - A UNIQUE NEW FREQUENCY TO VOLTAGE CONVERTER
Miller , Robert W.
National Semiconductor
HS-020 537 (SAE-SP-417), "Recent Advances in Autom 1977 Monograph otive Elec tronics," Warrendale , Pa., 197 7 p107-17 HS-020 550
REPORT NO.: SAE-770161;
SUBFILE: HSL
A unique frequency-to-voltage converter (FVC) designed for the specific interface problems found in automotive systems is free of the typical compromises associated with adapting conventional FVC's to automotive requirements because it interfaces directly with magnetic pickup, and its output is directly proportional to frequency even as the frequency goes to zero. Two specific application areas are explored. The need for an electronic speedometer/tachometer for better reliability and easier instrument panel design calls for a ripple-free, low frequency FVC or F-I converter. At the front of the most adaptive braking systems is a wheel speed to voltage conversion. This device can go one step further and provide some of the logic required in multiple input anti-skid systems. Presented at International Automotive Engineering Congress and Exposition, Detroit, 28 Feb-4 Mar 1977.

904367 DA
MINICARS RSV BRAKE SYSTEM
Rudolf .Limpert
University of Utah 1977 Monograph 31p 10refs HS-021 535
SUBFILE: HSL
The service brake and collision mitigation systems of the Minicars Research Safety Vehicle (RSV), Phase 2, were designed and costed. Performance objectives were the following: no degradation of performance with the antiskid operational for dry, wet, or slippery road surfaces; vehicle stability during braking in a turn; meet or exceed requirements of Federal Motor Vehicle Safety Standard (FMVSS) 105-75; and minimizing weight of brake system hardware. The system chosen was the full hydraulic, four wheel disc, four wheel antiskid braking system. Possibilities considered but rejected for the collision mitigation system included solid propellant rocket thrusters, negative hovair, aerodynamic devices such as spoilers or negative lift wings, high friction pads, and underside air bags. The collision mitigation system, intended to substantially reduce impact speeds in collisions which are not avoidable by driver action, was designed and tested in a prototypal vehicle. A stopping distance of 131 ft can be achieved from 60 mph. The collision mitigation system uses automatic rapid service brake application and causes peak braking forces to be developed within approximately 8 ft after receipt of a signal, when the vehicle is traveling at 50 mph. For a stationary target, rear impact speeds may be reduced to approximately 14 mph from an initial speed of 50 mph by using the collision mitigation system. The cost of the brake system hardware is estimated at $286 when an annual mass production of 300,000 units is considered. Presented at 5th International Congress on Automotive Safety, Cambridge, Mass., 11-14 Jul 1977. Based on work subcontracted from MINICARS, Inc.

904362 DA
FLEET VEHICLES TODAY AND TOMORROW. THE RESULTS OF A SURVEY CONDUCTED BY THE NATIONAL ASSOCIATION OF FLEET ADMINISTRATORS, INC.
Berke., Robert J. , comp.
National Assoc. of Fleet Administrators, Inc.
1977 8p HS-021 540
SUBFILE: HSL
A survey of members showed a desire for a 112 inch wheelbase, four-door sedan weighing 3000 lb and having a six-cylinder engine, front wheel drive, high roof, a four passenger seating capacity, a large square trunk, many improved safety features, and better gasoline mileage. The following rates of dissatisfaction were noted: 80% with present fuel economy levels, 50% with shock absorbers, and 64% with rust protection on rocker panels, doors and fender skirts. The most wanted options were 40,000 mile tires, extended life brake pads and linings, high energy ignition systems, lifetime shock absorbers, heavy duty suspension systems, antiskid braking devices, five year rustproofing, and speed control. The most desired safety improvements were improved braking capability and improved headlight illumination. Other safety features desired included the following, in order of interest: glass protection, improved belt restraint system, high-visibility taillights, location of the headlight dimmer switch, fixed headrests, energy-absorbing bumpers, combination taillights, automatic headlight dimmers, and air bags or other passive restraint systems. Sketches of a suggested vehicle are presented. Presented at 5th International Congress on Automotive Safety, Cambridge, Mass., 11-14 Jul 1977.

903198 DA
THEY TAME WINTER TERROR
Anonymous
Journal of American Insurance 1964 Monograph HS-700 469
SUBFILE: HSL
Test plans of the National Safety Council's Committee on Winter Driving Hazards are presented. In addition to studded tire research, tests will be conducted on brake systems of automobiles, school buses, and trucks and an antiskid device.

902254 DA

EXPERIMENTAL SAFETY VEHICLE TRADEOFF AND INTEGRATION SYSTEMS STUDIES. VOL. 2. SECT. 6 THROUGH 12. FINAL REPORT

Anonymous

American Machine and Foundry Co., Santa Barbara

1973 911p HS-800 923

AVAILABLE FROM: National Technical Information Service

CONTRACT NO.: DOT-HS-257-2-514; Contract

SUBFILE: HSL

This volume is comprised of seven sections: vehicle dynamics math simulation, describing the effect of front/rear weight distribution on dynamic performance; creshworthiness-weight tradeoff, describing crashworthy weight variations as a function of collision mode; rear visibility tradeoffs, reporting studies of see-through headrests and the implications of C post removal; occupant restraint tradeoffs, rating competing concepts for occupant protection; engine effects on safety performance, considering V-8, gas turbine, and rotary engines; braking performance analysis, rating two groups of antiskid and non-antiskid braking systems, including brake proportioning auxiliaries; and producibility, describing present and future producibility criteria, and the weight and probable cost increment of a producible, crashworthy ESV autobody. The final design in its producible version weighs about 4400 lb. and provides crashworthiness and front and rear occupant protection in barrier crashes up to 45 mph, plus redundant 4-wheel antiskid braking systems for a standard five-passenger family sedan. Rept. for Aug 1972-Jul 1973. Portions of this study were subcontracted to Bendix Res. Labs. and Budd Co. Vol. 1 is HS-800 922.

901597 DA

MOTOR VEHICLE SAFETY DEFECT RECALL CAMPAIGNS REPORTED TO THE NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION BY DOMESTIC AND FOREIGN VEHICLE MANUFACTURERS, APRIL 1, 1975 TO JUNE 30, 1975

National Hwy. Traffic Safety Administration,

1975 43p HS-801 650

AVAILABLE FROM: Government Printing Office

SUBFILE: HSL

This tabulation of safety defect recall campaigns includes the make and model, model year, description of the defect requiring manufacturer's corrective action, number ofvehicles recalled, date of notification, and identification number. Automobiles, trailers, motor homes, boat trailers, trucks, semi-trailers, buses, motorcycles, anti-lock systems, wheels, tires, disc brake assembly, shock absorbers, locks, fairings, and road lamps are included. The status of domestic and foreign campaigns completed as of June 30, 1975 are also given.

MAINTENANCE MANUAL. FINAL REPORT

Ultrasystems, Inc., Dynamic Science Div., 1850 West Pinnacle Peak Rd., Phoenix,

1976 87p HS-802 009

AVAILABLE FROM: National Technical Information Service

REPORT NO.: UI-8256-76-14;

CONTRACT NO.: DOT-HS-4-00853; Contract

SUBFILE: HSL

A new compact automatic vehicle controller (CAVC) was designed, built, and checked out based upon a weight reduction study of the conventional NHTSA automatic vehicle controller in response to meeting needs in the national trend toward smaller vehicles. The new controller also features electronic components that are more temperature stable than those used in the previous controller. This manual provides installation, operation, maintenance, and technical information for the CAVC, written at a level allowing immediate application of the system by moderately experienced personnel. The CAVC automatically controls an automobile incorporating five basic functions: braking, steering, throttle, clutch, and fifth wheel; and is controlled by preselected inputs from an electronic controller. Desired vehicle maneuvers can be initiated locally by an on-board driver or remotely through radio controlled commands from another vehicle. Major components of the CAVC include: electronic controller, brake actuator, throttle actuator, steering actuator, clutch actuator, pressure-compensated variable-displacement hydraulic pump, hydraulic fluid reservoir, hydraulic accumulator package, fifth-wheel and lift assembly, hoses and cables, and remote control radio transmitter. Functional description, typical installation, and operation procedures for these components, and as a system, are described as well as essential preventive maintenance routines. Troubleshooting of the system is instructed on the theory of CAVC operation, calibration, test procedures, and diagnostic aids. The manual also provides drawings, wiring diagrams, and a detailed description of all components. Rept. for Jan 1976-Mar 1976.

901164 DA

ELECTROMAGNETIC INTERFERENCE EFFECTS ON MOTOR VEHICLE ELECTRONIC CONTROL AND SAFETY DEVICES. FINAL REPORT. VOL. 1 - SUMMARY

Espeland, R. H.; Layton, D. H.; Warner, B. D.; Teters, L. R.; Morri, E. L., Jr.

Department of Commerce, Inst. for Telecommunication Sciences, Boulder, Colo. 80

1976 24p 11refs HS-802 107

AVAILABLE FROM: National Technical Information Service

CONTRACT NO.: DOT-HS-5-01097; Contract

SUBFILE: HSL

As a part of the Dept. of Transportation's Road Vehicle Electromagnetic Compatibility/Electromagnetic Interference (EMC/EMI) program, a computerized coupling analysis program was used to determine the effects of body shielding, aperture size, and cable lengths on signal coupling in the 100 to 200 MHz band between a simulated mobile radio emission and a moduled air-cushion restraint system cable as it might be used in a motor vehicle. The degree of coupling is more dependent upon the largest aperture dimension than upon the aperture area; a greater than 40 dB attenuation of signal was predicted due to cable shielding. A series of susceptibility tests performed on an electronic speed control system and an antiskid control module determined functional upset levels of injected signals at critical circuit ports on these devices. Upset criteria are based on performance departures from normal, resulting from the injection of interfering signals. Injected signals are designed to represent levels and durations characteristic of those generated within the vehicle or coupled from external sources. Tabular displays are made of summaries of source and coupled signal waveforms and of field strengths and frequency ranges of electromagnetic fields encountered by automobiles under normal operating conditions. Guidelines for promoting EMC in the use of electronic control and safety devices in automobiles emphasize the need for coordination and integration of all aspects; they constitute Phase 2 of the project. Phase 3 should test functional units to support EMC management for design, system engineering, and normal maintenance phases. Testing and evaluation of special subsystems should also be considered. Research should deal with the feasibility of a central processor or control system for integrated electronics applications. Rept. for 1 Mar 1975-1 Jul 1976.

901163 DA

ELECTROMAGNETIC INTERFERENCE EFFECTS ON MOTOR VEHICLE ELECTRONIC CONTROL AND SAFETY DEVICES. VOL. 2 - MEASUREMENTS, ANALYSIS AND TESTING. FINAL REPORT

Espeland, R. H.; Layton, D. H.; Warner, B. D.; Teters, L. R.

Department of Commerce, Inst. for Telecommunication Sciences, Boulder, Colo. 80

1976 141p 11refs HS-802 108

AVAILABLE FROM: National Technical Information Service

CONTRACT NO.: DOT-HS-5-01097; Contract

SUBFILE: HSL

The electrical environment of a motor vehicle during normal operating conditions is evaluated, and a summary is given of power supply variations and electrical signal transient characteristics. Both source and coupled signals were measured. Data and pictures are presented on waveforms associated with the light switch, air conditioner clutch, the starter, the ignition system, flashers, fan and windshield wiper motors, the alternator, and the horn. With each switching (energizing or de-energizing) of equipment from the power bus, there is nominally a 12V dc level change. Transients are sometimes associated with these switching actions which range from 1 V to greater than 100 V in amplitude. The larger transients are generally associated with the de-energizing of inductive loads. Sinusoidal or repetitive waveforms are associated with the motors and vibrators. Their fundamental frequencies are generally below 1 kHz, and their amplitude varied from 0.1 V to more than 3 V. The coupled signals generally appear as exponentially decaying "spikes" and/or as decaying sinusoids. The amplitude and duration of these waveforms are highly dependent on circuit loading and resonance. Typical recorded values range from less than 50 mV to greater than 1 V. Results are given of the use of a computerized coupling analysis program to determine the effects of body shielding, aperture size, and cable lengths on signal coupling in the 100 to 200 MHz band between a simulated mobile radio emission and a modeled air-cushion restraint system cable as it might be used in a motor vehicle. The body shielding depends primarily on the relative positions of the transmitting source and the aperture. The amount of body metal in the direct path between these locations will yield some signal attenuation due to shielding. The cable shielding varies to a small degree as a function of frequency. As much as 30 dB variation in received signal level was observed for the 100 to 200 MHz band, resulting from a fixed aperture size. Also, there was an approximately 10 dB increase in received signal when the length of aperture was increased from four to 40 inches. Finally, results of a series of susceptibility tests were performed on an electronic speed control system and an antiskid control module to determine functional upset levels of injected signals at critical circuit ports on these devices. The upset criteria were based on performance departures from normal, resulting from the injection of interfering signals. The injected signals were designed to represent levels and durations characteristic of those generated within the vehicle or coupled from external sources. Signal characteristics are shown to depend on circuit susceptibility, namely frequency, duty cycle, and polarity. Examples are as follows: the low-frequency susceptibility and high-frequency immunity of the speed control sensor compared to an opposite situation Rept. for 1 Mar 1975-1 Jul 1976. Vol. 3 (Automotive EMC Guidelines) is HS-802 109.

900102 DA
INTERNATIONAL TECHNICAL CONFERENCE ON EXPERIMENTAL SAFETY VEHICLES (3RD), WASHINGTON D. C., MAY 30-JUNE 2, 1972. REPORT
National Hwy. Traf. Safety Administration
1972 398p HS-820 217
AVAILABLE FROM: Government Printing Office
SUBFILE: HSL
The proceedings include status reports by governmental representatives and technical reports by automotive industry representatives from the U. S., Federal Republic of Germany, Japan, Great Britain, Italy, France, Sweden, and Belgum. A discussion on rulemaking and experimental vehicles is included.

304765 DA
COLLISION AVOIDANCE RADAR BRAKING SYSTEMS INVESTIGATION - PHASE III STUDY
Faris, WR
Bendix Research Labs., Southfield, MI.; National Highway Traffic Safety Administration, Washington, DC.
May 1979 26p
AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22161
REPORT NO.: RLD-8940; DOT-HS-805-050; PB80-105349
CONTRACT NO.: DOT-HS-6-01450; Contract
SUBFILE: NTIS
The document is the final report of the Phase III program to study the potential application of an anticipatory radar braking system in preventing motor vehicle accidents. The program was undertaken by Bendix Research Laboratories for the National Highway Traffic Safety Administration. The report describes the design of the experimental radar braking system and the installation of the system on two test vehicles. A summary of the functional tests which demonstrate the performance of the experimental system is included as well. The system description is divided into three sections. Section 2 outlines the design of the radar sensor, including the signal processing electronics, control panel display, and installation of the entire subsystem on the test vehicles. Sections 3 and 4 describe the design of the brake actuation subsystem and the anti-lock subsystem, respectively, and include information about installation of these two subsystems on test vehicles. Section 5 outlines functional tests conducted with the two test vehicles equipped with the radar braking system. The preliminary tests outlined in Section 5 demonstrate the performance of the radar braking system. In addition to general observations about closed-loop braking performance of the two radar-brake-equipped test vehicles. Section 6 outlines the major differences in performance between the two test vehicles. More extensive tests of the radar braking system installed in the test vehicles are recommended. .See also report dated Sep 76, PB-258 174.

304109 DA
TIRE HYDROPLANING (A BIBLIOGRAPHY WITH ABSTRACTS)
Habercom, GEJ
National Technical Information Service, Springfield, VA.
Aug 1979 135p
AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22161
NTIS/PS-79/0800/7ST
SUBFILE: NTIS
Studies are cited on the interaction of an automotive or aircraft tire with a wet pavement, resulting in reduced traction, skidding, or complete loss of contact under certain conditions. The discussions cover the composition and surface characteristics of highway and runway pavements, the acquisition or retention of water films on roads during rainfall, skid resistance and antiskid measures, tread engineering, testing and measuring equipment and methodology, critical speeds, wheel spindown, water depth factors, rolling contact loads, and associated topics. (This updated bibliography contains 126 abstracts, 7 of which are new entries to the previous edition.)

301696 DA

ELECTRONIC CONTROL UNIT FOR PASSENGER CAR ANTISKID

Leiber, H; Czinozel, A

Institute of Electrical and Electronics Engineers 345 East 47th Street New York New York 10017

Bosch, (R), Stuttgart, Germany

1979 Conf Paper pp 65-69

AVAILABLE FROM: Engineering Societies Library 345 East 47th Street New York New York 10017

REPORT NO.: 79CH1379-9VT;

SUBFILE: EIT; HRIS

In a new antiskid system for passenger cars two wheel speed sensors measure the angular velocity of the front wheels. In order to minimize brake force differences of the rear axle on roadways with split coefficients, a common control for the rear wheels has been chosen. The hydraulic unit consists of three (for front-rear brake systems) or four (for diagonal brake systems) novel solenoid valves and a return pump driven by an electric motor. Brake pressure can be raised in a steady or stepwise way, held at a constant level or decreased. The electronic unit is mainly of digital design and consists of a few integrated circuits. The antiskid system provides many sophisticated functions. As a result the circuitry is highly complex. A digital design was chosen because it allows for greater integration than an analog design. To ensure optimal system safety the main components of the system are checked for proper functioning prior to driving the vehicle. En route the main system components are continuously monitored. The overall antiskid system is switched off once a critical defect has been detected. In that case the normal brake system is available and a warning lamp indicates to the driver that the antiskid system is not functioning. Prepared for IEEE Vehicular Technology Conference, 29th, Conf Rec of Pap Arlington Heights Illinois, March 27-30, 1979. Also available from IEEE Service Center, Piscataway, New Jersey.

301522 DA

INFLUENCE OF ANTISKID SYSTEMS ON VEHICLE DIRECTIONAL DYNAMICS

Bisimis, E

Society of Automotive Engineers

Teves, (A), West Germany

Society of Automotive Engineers Preprints 1979 12 p. 6 Ref.

AVAILABLE FROM: Engineering Societies Library 345 East 47th Street New York New York 10017

REPORT NO.: SAE 790455;

SUBFILE: EIT; HRIS

The results presented demonstrate the influence of longitudinal tire slip and load transfer during braking on steering behavior of cars in terms of parameters which have been found to be important for the function of the driver/vehicle control loop. This is followed by a description of an antiskid system and a comparison of directional properties during braking with conventional brake system and with antiskid. The importance of appropriate selection of slip levels during adaptation of antiskid systems to a given vehicle is pointed out. Prepared for SAE Meeting, 26 February-2 March, 1979.

301500 DA

ELECTRONIC CONTROL SYSTEMS FOR GROUND VEHICLES

Hayes, EJ; Megginson, GW

Society of Automotive Engineers

Kelsey-Hayes Company

Society of Automotive Engineers Preprints 1979 8 p. 4 Ref.

AVAILABLE FROM: Engineering Societies Library 345 East 47th Street New York New York 10017

REPORT NO.: SAE 790457;

SUBFILE: EIT; HRIS

The wide spread installation of anti-wheel lock systems in the United States has been interrupted. To assist the continuity of development after this interruption, we believe it worthwhile to review some of the designs that have evolved to date. Potential for antilock to improve vehicle stability during heavy braking has been demonstrated. However, with the current situation in the United States, Europe and Japan will probably lead the way in the popular use of electronic antilock systems.

301474 DA
ANTISKID SYSTEM FOR PASSENGER CARS WITH A DIGITAL ELECTRONIC CONTROL UNIT
Leiber, H; Czinczel, A
Society of Automotive Engineers
Society of Automotive Engineers Preprints 1979 Conf Paper 12 p.
AVAILABLE FROM: Engineering Societies Library 345 East 47th Street New York New York 10017
REPORT NO.: SAE 790458;
SUBFILE: EIT; HRIS

By introducing modern digital electronics, Bosch succeeded in developing a high-performance antiskid system for passenger cars. A digital design approach was chosen since it allows for a greater degree of integration than an analog design. This results in increased reliability. The hydraulic unit comprises three of four solenoid valves and a return pump driven by an electric motor. The system prevents vehicle swerving and maintains steerability while attaining remarkable gains in stopping distance at the same time. Therefore, the objective of the antiskid system (ABS) is to reduce the brake pressure in the individual wheel should excessive braking occur so that the wheels generate maximum brake force without locking. Thus vehicle steerability is maintained and vehicle swerving prevented. Simplified mechanical components and introduction of new technologies for the electronic control unit characterize the Bosch high-performance ABS system for passenger cars. From the February 26-March 2, 1979 Meeting.

301020 DA
THE SECOND INTERNATIONAL CONFERENCE ON THE PREVENTION OF SKIDDING ACCIDENTS - REPORT OF PROCEEDINGS
Zoeppritz, HP
Franckh'sche Verlagshandlung
ATZ - Automobil Technische Zeitschrift VOL. 80 NO. 3 Mar 1978 pp 129-131 German
SUBFILE: TRRL; IRRD; HRIS

The causes of motor-vehicle skidding accidents on wet highways were discussed at the second international conference on the prevention of skidding accidents. A number of contributions on the general theme of "tyres, the vehicle and vehicle components" are summarized. Contributors to the conference reported on skidding resistance of tyres and its effect on vehicle control; vehicular anti-skidding qualities; suspension design to prevent sideways skidding or forward skidding under braking conditions; the measurement of shear stresses between tyre and road surface; the frictional resistance of vehicle tyres under wet conditions; and Japanese and European methods for measuring the friction between tyre and road surface. Further contributions dealt with braking control systems; models for simulating anti-locking brake systems; the effect of tyre construction, tread pattern and influence of tread rubber compounds on the skidding resistance of tyres. /TRRL/

263437 DA
FEDERAL SAFETY STANDARD: THEIR OBJECTIVE AND HOW THEY AFFECT HEAVY DUTY VEHICLES
Tompkins, SJ
Rockwell International Corporation
American Association for AutomMedicine Conf Proc N17 16 pp Figs. Tabs. Phots. 1973
REPORT NO.: MVSS 121;
SUBFILE: HSRI; HRIS

The transportation industry is faced with more than 300 vehicle safety standards proposed since 1966, when the Department of Transportation was directed to issue federal motor vehicle safety standards. The objective is to make highways safer for all users. Some 100 of the standards affect trucks; however, Federal Motor Vehicle Safety Standard.(FMVSS) 121 has a greater impact on the trucking industry than any federal regulation ever. Becoming effective Sept. 1, 1974, this "braking standard" seeks to make trucks more compatible with automobiles in their braking performance: Stopping in much shorter distances than ever before and doing so without veering out of a 12-foot lane. Larger, more powerful brakes are necessary to meet the stopping distances, and new front brakes will be required because, under the standard, about 50 percent of the braking will be done by front brakes, whereas today's heavy-duty vehicles have about 30 percent braking ability on the front. The higher deceleration levels result in a dynamic weight shift to the front axle assembly, so axles and springs must be strengthened. The requirement to stay within a 12-foot lane necessitates an anti wheel-lock device. The interaction of axles, brakes, springs and anti wheel-lock devices must be considered in meeting the requirements of the standard; thus, a total systems approach appears necessary. Herein lies the challenge, considering that there are some 800 brake and axle combinations to study, modify and test to assure compatibility. Conference Proceedings of the 17th Conference of the American Association of Automotive Medicine, 1973.

263371 DA
PASSENGER CAR DIRECTIONAL CONTROL TEST PROGRAM
Boyer, RC; Enserink, E
Ultrasystems, Incorporated; .Dynamic Science Division; Phoenix; Washington; Arizona; D.C.; 20590
Dec 1973 Final Rpt. 251 pp 1973
AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22151
REPORT NO.: 2310-73-161; PB-234313/5
CONTRACT NO.: CN-DOT-HS-046-3-667; Contract
SUBFILE: NTIS; HRIS

The effects of various antilock system configurations on the directional control of passenger cars are documented. Tests were conducted on straight and curved paths with high, medium, and low friction coefficient surfaces. To isolate the effects of the antilock systems, one test vehicle was tested with the following antilock systems: no antilock; drive shaft controlled rear; select-low rear; select-low front and rear; independent front, select-low rear; four-wheel independent. Two additional vehicles of similar weight were tested with and without a drive shaft controlled rear antilock system to assess the effects of vehicle dynamics. Results suggest that the four-wheel independent configuration performs best from a safety standpoint and that vehicle dynamics affect performance of the antilock system. /NTIS/

263218 DA
SAFETY RELATED ELECTRONICS IN THE AUTOMOTIVE ENVIRONMENT
Slavin, M; Elliott, DR
Bendix Corporation
Autcmotive Electrical Equipment pp 85-95 Figs. Phots. 1973
SUBFILE: HSRI; HRIS

Automotive control systems, using complex electronics, have been introduced in areas such as anti-sid braking and fuel injection. In such applications there are strong safety implications. Consequently, electronics reliability at aerospace levels is required at automotive cost. A Bendix-developed anti-skid system, which is described, is an example of how this objective was achieved within the hostile automotive environment. The automotive environment and the methods adopted in designing, manufacturing and testing to achieve the required reliability are reviewed. The paper discusses first-, second-and third-generation systems based on the increased use of complex intergrated circuits.

262184 DA
COMING CLOSER: RADAR BRAKING FOR AUTOMOBILES
Automotive Engineering VOL. 82 NO. 2 .Feb 1974 pp 61-66 14 Fig. 1974
SUBFILE: HRIS

Radar braking is seen as an emergency back-up system to conventional driver control. The goal is to avoid or reduce impact, but it is not to be a substitute for good driving. The difficulty in distinguishing a threatening object from a non-threatening one has led to the formation of two separate systems. One uses conventional radar "bounce" to identify objects, and seeks through technical refinements to reduce false alarms, system crosstalk and weather-related errors. The second system proposes to tag potential threats with frequency-doubling reflectors. The first system which is being developed by Bendix Corporation, is integrated with the Bendix antiskid braking system. It employs a homodyne solid-state doppler radar. A signal processor computes deceleration requirements against closing vehicles and generates braking commands when a critical deceleration threshold is exceeded. Automatic braking in the Bendix system is preceded by an audible warning signal. The second system, in which targets are tagged, is designed by RCA. The tags are mounted on the back of vehicles, as RCA believes that nearly one third of all collisions are rear end collisions. The reflector in this system returns the second harmonic of the frequency received, thus making it immune to clutter and other interference present. The RCA system excludes false alarms from such objects as signs, guardrails and trees. It also requires cooperation of highway users, in that they must fit reflectors. While the Bendix system uses a wheel speed sensor to determine vehicle speed, the RCA unit uses an independent microwave doppler speed sensor. The RCA passive reflector could be produced for $5-$10 in large quantities, a cost far less than the damage which would be prevented.

241846 DA
FRONTIERS OF TECHNOLOGY STUDY, ADDITIONAL DATA FOR PRELIMINARY IMPLEMENTATION REPORT - SECTION XI: ADVANCED BRAKING SYSTEMS FOR HIGHWAY VEHICLES
North American Rockwell Corporation; .ND
PROJ NO NSS-10
SUBFILE: HRIS
this report provides a review of the state-of-the-art in automatic (anti-skid) control of wheel brakes and technical information background and information sources relative to the development of automatic brake control devices. In addition, it relates the areas of application of this technology to urban transportation systems. To obtain efficient braking and retain directional stability and control, effective control of wheel slippage is required. Automatic control devices, commonly referred to as anti-skid (or anti-lock) brake controls, have been developed which can provide control functions ranging from operator assistance in avoiding skids to fully automatic and precise control of the vehicular braking process. The basic technology for an anti-lock brake control has been developed in the aircraft and automotive field. With sufficient emphasis and support of study, research and development efforts, this technology can be expanded for application to present and future forms of land transportation systems. It was recommended that: (1) a program of on-vehicle testing be accomplished for the purpose of developing design criteria, safety standards, testing standards, and operator skills and techniques; (2) A comprehensive program to obtain useful quantitative tire characteristics be created; and (3) simulation methods and techniques, establishing acceptable standards of degree of simulation, and providing guidelines for optimalization and performance criteria be developed. /UMTA/

225779 DA
THE EFFECT OF TIRE CONSTRUCTION ON BRAKING FORCE COEFFICIENTS
Meades, JK
Rrl Reports, Road Research Lab /UK/ 1969
REPORT NO.: Rept Lr 224;
SUBFILE: HRIS
THE PEAK AND SLIDING BRAKING FORCE COEFFICIENTS FOR RADIAL- AND BIAS-PLY TIRES WERE COMPARED AT CAR SPEEDS BETWEEN 30 AND 80 MPH ON A RANGE OF WET SURFACES. BOTH WINTER AND NORMAL, SIPED (ALL-PURPOSE) TREADS WERE USED. THE DIFFERENCES PRODUCED BY THE TYPE OF TIRE CONSTRUCTION WERE NOT GREATLY INFLUENCED BY THE TYPE OF TREAD. THE RADIAL-PLY TIRES GAVE HIGHER PEAK BRAKING FORCE COEFFICIENT ON ALL SURFACES THAN DID THE BIAS-PLY TIRES. GENERALLY, THE DIFFERENCES WERE INDEPENDENT OF SPEED AND WERE LEAST ON COARSE-TEXTURED SURFACES AND GREATEST ON FINE-TEXTURED SURFACES. (THE DIFFERENCES RANGED FROM ALMOST 0 TO 0.1.) THE SLIDING BRAKING-FORCE COEFFICIENTS WERE HIGHER FOR THE RADIAL-PLY TIRES THAN FOR THE
SURFACES BUT LOWER (WORSE) ON THE COARSE-TEXTURED SURFACES. THE MAXIMUM DIFFERENCE WAS ABOUT 0.05. THE PEAK VALUES OF BRAKING FORCE WERE OBTAINED BEFORE SLIDING BEGAN, THE DIFFERENCE BETWEEN THE PEAK AND SLIDING VALUES BEING PARTICULARLY MARKED AT THE HIGH SPEEDS. THIS EMPHASIZES THE POTENTIAL VALUE OF ANTI-LOCKING BRAKES. /BPR/

224041 DA
A PROCEDURE FOR EVALUATING VEHICLE BRAKING PERFORMANCE
Highway Safety Research Institute; .Murphy, RW
Oct 1971 Final Rept 24 pp 1971
SUBFILE: NTIS; HRIS
the report describes a method for determining vehicle braking efficiency whereby actual stopping distances achieved by the vehicle are compared to ideal stopping distances theoretically achievable if the vehicle brake system were able to modulate the brakes such that the tires produced peak braking forces throughout the stop. Test procedures are described for both vehicle and tire tests, along with the method employed for calculating ideal stopping distance. Results from tests and calculations are presented for two vehicles equipped with four-wheel antilock systems, which demonstrate that the method is viable and realistic. A means of comparing tire peak capability on a given surface to that produced by a standard tire is also discussed. /author/

218400 DA
THE EFFECTIVENESS OF ANTISKID MATERIALS
Hegmon, RR; Meyer, WE
Highway Research Record, Hwy Res Board 1968 No 227, pp 50-56, 7 FIG, 5 TAB, 4 REF
SUBFILE: HRIS
the effectiveness of four commonly used antiskid materials was tested on a circular track apparatus on ice and packed snow. The tests were conducted with a full-sized automotive wheel which was made to slip until the maximum coefficient of friction was obtained. Initial friction values were quite high and deceptive. To sustain relatively high coefficients of friction after some traffic has passed, increased rates of application are required. The difference in the performance of the four materials was found to be small. The particle size has a pronounced effect on the performance of antiskid materials and especially the contribution of the very fine particles (passing a no. 50 seive) is minor and their elimination is recommended. The physical properties of the materials that affect their usefulness as antiskid materials were determined and are reported. /author/

192207 DA

DISTRICT OF COLUMBIA TRUCK AND BUS SAFETY DEMONSTRATION PROJECT

Rucker, E; Wood, R

Potomac Research, Incorporated; .7655 Old Springhouse Road; McLean; Washington; Virginia; D.C.; 22101; 20590

Sep 1978 Final Rpt. 166 p. 1978

AVAILABLE FROM: National Technical.Information Service 5285 Port Royal Road Springfield Virginia 22161

REPORT NO.: DOT-HS-803-866; PB-293626/8ST

CONTRACT NO.: DOT-HS-7-01725; Contract

SUBFILE: NTIS; HRIS

The purpose of the project was to demonstrate the validity and effectiveness of the Federal Motor Vehicle Safety Standards and Regulations, Vehicle in Use Inspection Standards, Part 570, Subpart B, in discovering safety-critical outages during periodic inspection of vehicles with Gross Vehicle Weight Rating (GVWR) of more than 10,000 pounds. The project also intended to provide an opportunity for evaluating some commercially available heavy duty automotive inspection equipment, particularly FMVSS 121 System anti-skid brake test equipment. The project obtained data and developed procedures for testing 121 Systems in an inspection lane environment. Portions of this document are not fully legible.

189975 DA

ACCIDENTS INVOLVING LOSS OF CONTROL WHEN BRAKING - A STUDY OF THE ON-THE-SPOT SURVEY DATA

Neilson, ID

Mechanical Engineering Publications Limited P.O. Box 24, Northgate Avenue Bury St Edmunds England 0 85298 356 5

1977 pp 203-11 11 Tab. 2 Ref.

REPORT NO.: No. 1976-5;

SUBFILE: TRRL; IRRD; HRIS

The paper discusses accident studies carried out "on-the-spot: by the Transport and Road Research Laboratory to assess the contributions of road, vehicle and road user to highway accidents. The paper examines in particular the 8% of accidents in which control of a car was lost when braking. Drivers were usually travelling too fast for either the road layout or for unexpected traffic hazards. Braking loss of control ultimately resulted in spinning and drifting. The study showed that while there is no serious fault in the braking balance of cars generally, more attention to the condition of brakes and tyres would make a contribution to greater safety. The most effective introduction would be the fitting of front and rear anti-locking braking systems. /TRRL/ This paper was presented at the Conference on Braking of Road Vehicles, held at Loughborough University of Technology, March 23-25, 1976.

188254 DA

DOPPLER RADAR SKID CONTROL DEVICE ENHANCES AUTO SAFETY

Kaneko, Y; Fukumori, Y

Dempa Publications, Incorporated

Japan Electronic Engineering Jan 1978 pp 54-57 4 Fig. 1 Tab. 3 Phot.

SUBFILE: TRRL; IRRD; HRIS

Details are given of a Doppler radar skid control system, consisting of a Doppler radar vehicle speed sensor, a wheel speed sensor, a controller and an actuator. The device gives safe and effective braking of vehicles by preventing the rear wheels from locking. This is achieved by comparing ground speed measured by radar during braking, with the wheel speed, obtaining the wheel slip ratio and controlling it according to a set value. If the hydraulic pressure of the brakes is too high during emergency braking and the slip ratio exceeds the set value, an actuator operates to release brake pressure once, and to increase pressure when the speed of the wheels increases. This procedure is repeated until the set value of slip ratio is obtained, and the vehicle is stopped. A brief account is given of the effectiveness of the Doppler radar device when mounted on a passenger car. /TRRL/

181964 DA

IMPROVED PASSENGER CAR BRAKING PERFORMANCE. APPENDICES

Ervin, RD; Campbell, JD; Sayers, M; Bunch, HM

Highway Safety Research Institute; .Huron Parkway and Baxter Road; Ann Arbor; Washington; Michigan; D.C.; 48105; 20590

Mar 1978 199 p. 1978

AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22161

REPORT NO.: DOT-HS-803-459; UM-HSRI-78-12-3; PB-284396/9ST

CONTRACT NO.: DOT-HS-6-01368; Contract

SUBFILE: NTIS; HRIS

This report contains: Data from twelve-car survey test program-vehicle descriptions and data summaries; Calculated results of a quasi-static analysis; Data from in-depth test program on five cars; Simulation results using dynamic braking model; A look at the accuracy of simplified methods for computing reference vehicle ideal stopping distance for the braking efficiency test technique; Antilock braking model; Test sequence and prodedure.

181614 DA
TIRE HYDROPLANING (A BIBLIOGRAPHY WITH ABSTRACTS)
Habercom, GE, Jr
National Technical Information Service; .5285 Port Royal Road; Springfield; Virginia; 22161
Aug 1978 Bibliog. 127 p. 1978
AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22161
NTIS/PS-78/0776/1ST
SUBFILE: NTIS; HRIS
Studies are cited on the interaction of an automotive or aircraft tire with a wet pavement, resulting in reduced traction, skidding, or complete loss of contact under certain conditions. The discussions cover the composition and surface characteristics of highway and runway pavements, the acquisition or retention of water films on roads during rainfall, skid resistance and antiskid measures, tread engineering, testing and measuring equipment and methodology, critical speeds, wheel spindown, water depth factors, rolling contact loads, and associated topics. (This updated bibliography contains 120 abstracts, 17 of which are new entries to the previous edition.)

178343 DA
AUTOMOTIVE VEHICLES OF THE FUTURE
Friedman, D
Minicars, Incorporated
Transportation Research News N76 May 1978 pp 8-10 3 Fig. 1978
AVAILABLE FROM: Transportation Research Board Publications Office 2101 Constitution Avenue, NW Washington D.C. 20418
SUBFILE: HRIS
This article relates advanced motor vehicle design concepts to government rule-making requirements in the specific areas of fuel economy, emissions, and safety, noted that weight reduction offers that most hope for improving fuel economy. It also offers the hope for achieving acceptable levels of vehicle performance and overall energy efficiency with the low powered advanced propoulsion systems. A more difficult, riskier, longer term, capital-intensive, but practical and more effective approach to weight reduction is to alter the structural architecture. With respect to propulsion systems, there is expected to be an emphasis on smaller engines mounted transversely to gain crush space and turbocharged, especially diesels or stratified-charged internal compustion engines. The Minicars RSV, which carries a microprocessor, offers a computer-controlled automatic shift mechanism and a "smart" cruise control, which responds by slowing or speeding to radar impressions of the traffic environment ahead. With electronics, automobilies are expected to have reasonably sophisticated on-board diagnostic capbility, read-out displays, and electronically controlled antiskid breaking systems. Fuel economy can also be ... discussed with respect to the new material and technology already identified. The four-and-six-passenger vehicles will meet all of the government regulations for 1985.

173241 DA
ANTI-LOCK BRAKE SYSTEM FOR PASSENGER CARS-DEVELOPMENT OF A BRAKE SYSTEM GIVING YAW STABILITY AND STEERABILITY DURING EMERGENCY BRAKING
Kullberg, G; Nordstrom, O; Palmkvist, G
National Swedish Road & Traffic Research Institute; .Fack; S-581 01 Linkoeping; Sweden
48 pp 24 Fig. 1977
REPORT NO.: VTI Rpt. No. 100A;
SUBFILE: HRIS
The report describes the development of a so-called anti-lock braking system and the results from field tests with an experimental vehicle. The purpose of the project has been to demonstrate in practice the possiblities to maintain steerability and yaw stability during emergency braking in a curve. Furthermore, to create conditions for making necessary investigations to support regulations concerning anti-lock systems, to build up technical know-how independent of industrial interests and to offer the results for the disposal of the industry. The results from tests made on ice and on dry asphalt concrete show that the anti-lock system gives the experimental vehicle good steerability and yaw stability during emergency braking in a curve. At the same time good braking efficiency is maintained. /Author/

173112 DA
INTRODUCTORY REMARKS TO THE SECOND INTERNATIONAL SKID PREVENTION CONFERENCE
Goodwin, WA
Tennessee Department of Transportation
Transportation Research Circular N192 Feb 1978 pp 3-4 1978
AVAILABLE FROM: Transportation Research Board Publications Office 2101 Constitution Avenue, NW Washington D.C. 20418
SUBFILE: HRIS
The objectives of this conference are noted and brief comments are made on research efforts to improve the tractive resistance of the roadway. This conference which emphasized the implementation of research findings, presented an overview of current knowledge, demonstrated how this knowledge can be applied to improve safety, and attempted to determine what further steps must be taken to learn how existing knowledge can be applied, or what further research is needed. Research effort has been most concerted in the measurement of skid resistance. Driver education, and automobile and tire manufacture are other areas of research. It is noted that there must be a systematic effort to optimize the relation of the driver and the machine to the driving environment. Brief comments are made on the First International Skid Prevention Conference. This article appeared in the Transportation Research Circular Number 192, Summary: Second International Skid Prevention Conference.

167617 DA
TOWARD SAFER MOTOR VEHICLES
Braun, RL
Sri International
IEEE Spectrum VOL. 14 NO. 11 .Nov 1977 pp 81-86 3 Fig. 2 Tab. 1977
SUBFILE: HRIS
The overall automobile safety problem is discussed as a 3-part system consisting of the motor vehicles, users and highways. The safety problems that affect current vehicles primarily involve maintenance. Two basic ways to improve travel safety of vehicles are to improve crash avoidance and crashworthiness. The National Highway Traffic Safety Administration's Experimental Safety vehicle and the Research Safety Vehicle are described. Antiskid braking systems, air-bag protection, energy-absorbing bumpers, crash-energy management techniques and other safety features as well as fuel economy measures were incorporated in these vehicles. An electronic driver display integrated with a microcomputer, and advanced automobile electronics' capabilities are also discussed. It is recommended that occupant protection by passive restraint systems be improved, active restraints be retained, stringent countermeasures for alcohol and drug-involved drivers be implemented, the 55 m/h maximum speed limit be enforced, the strength and reliability of brake, suspension, fuel, ignition and bumper systems be enhanced, highways (remove booby-traps, deploy energy-absorbing barriers, correct inadequate signs) be improved, emergency response be improved, and driver attitude and knowledge of laws be improved.

167186 DA
TIRE HYDROPLANING (A BIBLIOGRAPHY WITH ABSTRACTS)
Adams, GH
National Technical Information Service; .5285 Port Royal Road; Springfield; Virginia; 22161
Sep 1977 108 pp 1977
AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22161
NTIS/PS-77/0732/6ST
SUBFILE: NTIS; ATRIS
Studies are cited on the interaction of an automotive or aircraft tire with a wet pavement, resulting in reduced traction, skidding, or complete loss of contact under certain conditions. The discussions cover the composition and surface characteristics of highway and runway pavements, the acquisition or retention of water films on roads during rainfall, skid resistance and antiskid measures, tread engineering, testing and measuring equipment and methodology, critical speeds, wheel spindown, water depth factors, rolling contact loads, and associated topics. (This updated bibliography contains 103 abstracts, 20 of which are new entries to the previous edition.) Supersedes NTIS/PS-76/0684.

165671 DA
SKID CONTROL SYSTEM WITH DOPPLER RADAR SPEED SENSOR
Kiyoto, M; Takeuchi, Y; Lizuka, H; Fukumori; Katsumata, M
International Federation of Auto Techniques Engs 3 Avenue du President Wilson F 75116 Paris France
Nissan Motor Company Limited, Japan
Analytic 1 p
SUBFILE: TRRL; IRRD; HRIS

A two-wheel anti-skid system using a microwave Doppler radar has been developed. The radar measures true ground speed even during a panic stop and is not affected by problems associated with conventional vehicular speed sensing units such as wheel lock and wheel slip. The true ground speed signal from the radar enabled a closed loop skid control and therefore, the system has become adoptable without any readjustment to many kinds of vehicles, light or heavy, small or big, with automatic or manual transmission. The electronic control circuits of the system use digital IC's; two counters, a set-reset flip-flop and other gates. The 24 GHZ Doppler radar is integrated on an alumina substrate (MIC). Whole electronic circuits including the MIC and the control circuit are housed in a waterproof case, part of which forms a radar horn antenna. A hybrid computer contributed a comparison of the system performance for a wide variety of system parameters. These parameters were optimized through hybrid computer simulation. Road tests indicate advantages of this system over some existing anti-skid system. /Author/TRRL/ This report was presented at the 16th International Automobile Technical Congress.

163933 DA
DEVELOPMENT AND EVALUATION OF ANTI-LOCK BRAKE SYSTEMS
Cardon, MH; Hickner, GB; Rothfusz, RW
Bendix Research Laboratories; Bendix Automotive Control Systems Group; Bendix Heavy Vehicle Systems Group
Transportation Research Record N624 Proceeding pp 1-14 7 Fig. 6 Tab. 7 Ref. 1976
AVAILABLE FROM: Transportation Research Board Publications Office 2101 Constitution Avenue, NW Washington D.C. 20418
SUBFILE: HRIS

Anti-lock systems which control wheel lock have been developed for passenger cars, trucks, articulated vehicles and buses. Six anti-lock system configurations involving individual wheel and axle control are discussed. Also discussed are techniques for evaluating the performance of antilock systems; included are straight line braking, the use of a split coefficient surface and braking in a turn. The results of computer simulation studies and vehicle tests conducted to evaluate performance of the various anti-lock system schemes are presented. It is concluded that the best anti-lock system configuration for a vehicle class requires a trade-off among vehicle design factors, desired level of braking, and vehicle handling performance and cost. /Author/ 624. Skidding Accidents--which contains ancillary papers to the proceedings of a conference conducted by the Transportation Research Board, May 2-6, 1977.

163904 DA
EFFECTIVENESS OF ANTILOCK BRAKES IN PÁSSENGER CARS
Pulling, NH
Liberty Mutual Insurance Company
Transportation Research Record N623 pp 76-79 20 Ref. 1976
AVAILABLE FROM: Transportation Research Board Publications Office 2101 Constitution Avenue, NW Washington D.C. 20418
SUBFILE: HRIS

At the First International Skid Conference eighteen years ago, Lister and Kemp described experiements with antilock braking for passenger cars. Subsequently a number of systems were developed and several were placed in limited production. Although both 2-wheel and 4-wheel antilock braking systems perform superbly well under treacherous driving conditions, they have not proved to be commercially successful. Several published studies are reviewed which have shown that antilock braking in automobiles has worthwhile potential for skid control and accident avoidance. An economic study of 100 skidding accidents from a randomly-selected sample of 613 insurance cases is described in detail. The benefit/cost ratios for passenger cars was estimated from the data to be 1.4 for 2-wheel antilock braking and 1.3 for 4-wheel systems, and payback periods were determined to be about 7 and 8 years respectively. The outlook for antilock brakes in passenger cars is discussed. /Author/ This article appeared in Transportation Research Record No. 623, Skidding Accidents: Wet-Weather Accident Experience, Human Factors, and Legal Aspects.

159850 DA
ANTI-LOCK BRAKING SYSTEM FOR CARS
Kullberg, K; Nordstroem, O; Palmkvist, G
Swedish Board for Technical Development Fack S-100 72 Stockholm43 Sweden
Monograph 52 pp 13 Fig. 2 Tab. 11 Phot. Swedish
REPORT NO.: Report No. 73-33383u;
SUBFILE: TRRL; IRRD; HRIS

The report describes the development of an anti-lock braking system and the results of field tests with an experimental vehicle. The purpose of the project has been to demonstrate in practice the possibilities of maintaining steerability and yaw stability during emergency braking in a curve. Furthermore, to create conditions for making necessary investigations to support regulations concerning anti-lock systems, to build up technical knowledge independent of industrial interests and to offer the results to industry. The results from tests made on ice and on dry asphalt concrete show that the anti-lock system gives the experimental vehicle good steerability and yaw stability during emergency braking in a curve. At the same time good braking efficiency is maintained.

156560 PR
IMPROVED PASSENGER CAR BRAKING PERFORMANCE
INVESTIGATORS: Fancher, P
PERFORMING ORG: Highway Safety Research Institute; Michigan University Huron Parkway and Baxter Road, Ann Arbor, Michigan , 48109
SPONSORING ORG: National Highway Traffic Safety Administration; Department of Transportation
CONTRACT NO.: DOT-HS-6-01368; Contract
SUBFILE: HSRI; HRIS
PROJECT START DATE: 7606
PROJECT TERMINATION DATE: 7802

The current Federal Motor Vehicle Safety Standard 105-75 is intended to ensure safe braking performance under normal and emergency conditions. However, its presently defined test conditions measure brake effectiveness only in straight-line stops on surfaces having a high coefficient of friction. Thus the purpose of this research is to provide information to expand the scope of the federal standard to include other braking conditions. The work includes experimental establishment of the performance range of current passenger car brake systems in straight-line and turn maneuvers on surfaces having low and split coefficients of friction; development of test procedures; testing of five representative passenger cars, including one equipped with an antilock braking system; and evaluation of test results. The study recommendations will be used in developing an expanded FMVSS 105 relating to the braking performance of passenger cars.

153223 DA
FAST ACTUATOR FOR AN ANTI-LOCK BRAKING SYSTEM
Skoyles, DR
Philips' Telecommunication Review VOL. 36 NO. 3 .pp 74-84 1976
AVAILABLE FROM: Engineering Societies Library 345 East 47th Street New York New York 10017
SUBFILE: EIT; HRIS

A description is given of an electro-hydraulic brake-pressure control, developed for testing electronic circuits for anti-lock braking systems for road vehicles. After an introduction to the problem and a short description of the contact between the tire and the road surface on braking, a survey is given of the basic principles of anti-lock systems. Such a system consists of three main parts: a sensor for the angular velocity of the wheel, a processing unit, and an actuator that, if required, can reduce the brake pressure and increase it again (this has since been modified and improved). The actuator includes an electronically controlled solenoid valve, which reduces the brake pressure if wheel lock is imminent by causing brake fluid to flow out of the brake system, a pump that returns the fluid to the master cylinder, and a variable restrictor, which ensures that the rate at which the brake pressure increases again depends on the type of road surface. Various fail-safe arrangements are included to give trouble-free operation: if a leak occurs in the solenoid valve, or even if the valve stays open, normal braking is retained.

152930 DA
AN ASSESSMENT OF THE ACCIDENT AVOIDANCE AND SEVERITY REDUCTION POTENTIAL OF RADAR WARNING, RADAR ACTUATED, AND ANTI-LOCK BRAKING SYSTEMS
Tumbas, NS; Treat, JR; McDonald, ST
Society of Automotive Engineers; .400 Commonwealth Drive; Warrendale; Pennsylvania; 15096
Indiana University, Bloomington
12 pp Figs. Tabs. 7 Ref. 1977
REPORT NO.: SAE 770266;
SUBFILE: HSRI; HRIS
A group of 215 in-depth accident reports prepared as part of a tri-level accident causation study by a multi-disciplinary team was examined to assess the benefit derived from the hypothetical application of various combinations of radar warning, radar actuated, and anti-lock braking systems. The approach was to have an accident analyst evaluate post hoc the benefit which would have been derived if one or more of the vehicles involved in each accident had been equipped with various types and combinations of these hypothetical systems; twin system types or combinations were defined. On one extreme, it was found that two-wheel anti-lock systems, by themselves, had relatively little accident prevention potential; only one of the 215 accidents (0.5%) would definitely have been prevented by such a system, although with less assurance there was some possibility of prevention of up to eight accidents (3.7%). On the other extreme, the most complex of the systems defined, comprised of a non-cooperative radar system with both actuation and warning potential, coupled with a four-wheel anti-lock system, would definitely have prevented 39 of these accidents (18.0%), with some possibility of prevention of up to (0 accidents (41.9% of those examined). /HSRI/ Proceedings of the International Automotive Engineering Congress and Exposition, 28 Feb-4 March 1977 Detroit, Michigan.

151133 DA
ELECTROMAGNETIC INTERFERENCE EFFECTS ON MOTOR VEHICLE ELECTRONIC CONTROL AND SAFETY DEVICES. VOLUME I. SUMMARY
Espeland, RH; Layton, DH; Warner, BD; Teters, LR; Morrison, ELJ
Institute for Telecommunication Sciences; .Office of Telecommunications, 325 Broadway; Boulder; Washington; Colorado; D.C.; 80302; 20590
Nov 1976 Final Rpt. 24 pp 1976
AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22161
REPORT NO.: DOT-HS-802-107-Vol-1; PB-261765/2ST
CONTRACT NO.: DOT-HS-5-01097; Contract
SUBFILE: NTIS; HRIS
This report summarizes the analysis and measurement tasks accomplished for this phase of the DOT Road Vehicle EMC/EMI program and the contents of EMC Guidelines proposed for the design and maintenance phases of electronic safety and control systems. A computerized coupling analysis program was used to determine the effects of body shielding, aperture size, and cable lengths on signal coupling in the 100 to 200 MHz band between a simulated mobile radio emission and a modeled air-cushion restraint system cable as it might be used in a motor vehicle. A series of susceptibility tests were performed on an electronic speed control system and an anti-skid control module to determine functional upset levels of injected signals at critical circuit ports on these devices. The upset criteria were based on performance departures from normal, resulting from the injection of interfering signals. The injected signals were designed to represent levels and durations characteristic of those generated within the vehicle or coupled from external sources. A set of basic guidelines to promote EMC in the use of electronic control and safety devices in automobiles are presented. The applications and technological developments concerned with current automotive electronics are discussed. The research conducted by the automotive industry to explore the feasibility of a central processor or control system and potential problem areas are reviewed.

148984 DA
MODIFICATIONS OF STEERING AXLE CAM BRAKES FOR FMVSS 121
Marting, PG
Society of Automotive Engineers; .400 Commonwealth Drive; Warrendale; Pennsylvania; 15096
Wagner Electric Company
11 pp Figs. Tabs. Phots. 3 Ref. 1976
REPORT NO.: SAE 760845/MVSS 121;
SUBFILE: HSRI; HRIS
The increased torque levels required on front axles of air brake vehicles to comply with the 60 miles per hour, 245 foot stopping distance of FMVSS 121 created brake packaging problems not only due to the brake assemblies being larger for a given axle weight, but due to the inclusion of antilock hardware and the larger front axles. To produce the additional torque, increased brake input power was needed, necessitating material and design changes of the basic foundation brake. Many of these design considerations are discussed in this paper. /HSRI/ This paper was presented at the Truck Meeting of the Society of Automotive Engineers, November 1-4, 1976, Indianapolis, Indiana.

145124 DA
SURE-SEAL ENVIRONMENTAL CONNECTORS FOR AUTOMOTIVE ELECTRONICS
Goodman, DS; Burns, E
Society of Automotive Engineers; .400 Commonwealth Drive; Warrendale; Pennsylvania; 15096
Itt Cannon Electric
Feb 1975 6 pp 1975
REPORT NO.: SAE # 750138;
SUBFILE: HRIS
A new series of environmentally-sealed connectors has been developed for automotive use. They are presently being used on truck anti- skid brake control systems. These connectors prevent the entry of moisture and dirt, and are, at the same time, resistant to hydrocarbon fluids used in and around motor vehicles--such as gasoline, motor oil, transmission fluid, etc. /GMRL/

134741 DA
ANTI-LOCK BRAKE SYSTEM CONFIGURATIONS
Automotive Engineering VOL. 87 .Feb 1976 pp 43-45 1976
REPORT NO.: SAE #760348;
SUBFILE: HRIS
A given anti-lock brake system configuration may be "best" in one case and "worst" in another, depending on vehicle type, load distribution and variation, and a host of other factors. Here's a discussion of advantages and disadvantages of six possible configuration. /GMRL/

134013 DA
NATIONAL AUTO PLANNING
Callahan, JM
Automotive Industries VOL. 54 NO. 4 .Feb 1976 pp 19-22 5 Fig. 1976
SUBFILE: HRIS
The final drafts are being completed of a series of studies on motor vehicle goals beyond 1980 by an interagency task force. The study was designed primarily to find ways to improve fuel efficiency of highway vehicles and to coordinate the efforts of all government regulatory agencies. To accomplish these goals, the task force proposed a wide range of vehicle changes. Objectives were blended with other automotive goals of improved safety, reduced emissions, greater quietness, and improved damageability. Most of NHTSA's goals (air bags, anti-lock brakes, soft-nose, 7 mph bumpers etc.) are recommended. It is expected that the future cars will be smaller, lighter and cheaper. The task force will feed data and various equations into a computer which is then expected to produce answers for the government on a wide range of questions such as those related to energy demand, retail costs, level of unemployment expected, sales volume listing the characteristics of 26 families of future cars which could be ordered and sold to the public. Each car family has one of five types of engines, one of 3 transmissions, one of three body structures, one of 3 catalysts, one of 4 levels of safety, plus 3 sizes of cars. Differences between the scientists on the task force and the auto manufacturers, as well as problems common to both parties are discussed.

095944 DA
INVESTIGATION OF SOME EXPERIMENTAL MOTORCYCLE PARAMETERS
Hirsch, NR; Meinnert, RJ
National Motor Vehicle Safety Advisory Council; .400 7th Street, SW; Washington; D.C.; 20590
Amf Harley-Davidson Motor Company, Incorporated
Jul 1973 Proceeding 20 pp 10 Fig. 1973
REPORT NO.: Paper #73043;
SUBFILE: NSC; HRIS
AMF/Harley-Davidson and AMF/Advanced Systems Laboratory investigated specific items which would be feasible for use on a near-term experimental safety motorcycle. This investigation was carried out on a cost sharing basis with the National Highway Traffic Safety Administration (NHTSA). Items which were investigated included anti-lock braking system, conspicuity, improved headlight system, improved traction tires, and dynamic tire failure. Each item was carried through a hardware availability investigation, prototyping and limited testing. The conclusions drawn are that an anti-lock brake system is feasible on a motorcycle and even in early development stages, greatly reduced stopping distance over a skidding vehicle. Vehicle conspicuity can be greatly improved at nighttime with the use of reflective tire sidewalls, rider clothing, and vehicle paint and reflective tapes. A substantial improvement in the headlight system was realized by use of a two-lamp system. A tungsten-halogen lamp was used in conjunction with a conventional tungsten two-beam headlamp, with only the two-beam lamp used for low beam operation. Improved traction tires did not produce conclusive results due to the short time interval available. Dynamic tire failure can be made less hazardous by use of a method which retains the tire bead in the rim bead seat. /Author/ Proceedings of the 2nd International Congress on Automotive Safety, July 16-18, 1973.

095599 DA
INTRODUCTION OF ANTILOCK BRAKING SYSTEMS FOR CARS
Klein, HC; Fink, W
Society of Automotive Engineers; .2 Pennsylvania Plaza; New York; 10001
Oct 1974 6 pp 1974
REPORT NO.: SAE #741084;
SUBFILE: HRIS

The overall question of brake actuation, antilock control and other vehicle functions requiring servo assistance will be discussed. Too much effort has been devoted in treating each of these units on an individual basis. This paper describes ways in which this complex subject can be dealt with in a unified manner, to provide a more compact and reliable solution. /SAE/

095598 DA
DESIGN CONSIDERATIONS OF ADAPTIVE BRAKE CONTROL SYSTEMS
Guntur, RR
Society of Automotive Engineers; .2 Pennsylvania Plaza; New York; 10001
Delft University of Technology, Netherlands
Oct 1974 20 pp 1974
REPORT NO.: SAE #741082;
SUBFILE: HRIS

In this paper, some of the design aspects of adaptive brake control systems are studied, especially the interaction of the software with the hardware of the system. Two modes of operation of the brake pressure modulator have been considered; the software changes are effected to modify further the mode of operation of the system. The effect of the rate of rise of wheel cylinder pressure and the effect of rate of decay of pressure on the effectiveness and the maximum wheel slip in the first cycle have been studied. The hardware and the software are so modified as to give satisfactory performance of the wheel and the vehicle for four different forward speeds and for three different road conditions. /SAE/

051679 DA
REQUIREMENTS ANALYSIS AND FEASIBILITY STUDIES FOR AN EXPERIMENTAL SAFETY MOTORCYCLE
Bartol, J; Livers, GD; Hirsch, NR
AMF Incorporated .Advanced Systems Laboratory; Santa Barbara ; California
Nov 1973 Final Rpt 111 pp 1973
AVAILABLE FROM: National Technical Information Service 5285 Port Royal Road Springfield Virginia 22151
PB-225866/3
CONTRACT NO.: DOT-HS-257-3-585; Contract
SUBFILE: NTIS

The desirability and costs of near term safety improvements in motorcycles was determined and preliminary specifications and a recommended development plan for a near term experimental safety motorcycle was prepared. The program covered the following areas of safety: anti-lock brake, improved traction tires, improved headlamp system, conspicuity, windshield, rear vision, security system, fuel system and flexible fenders.

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-1-

AN - 791046
TI - Evaluation of the Braking Performance of a Tractor-Semitrailer Equipped with Two Different Types of Anti-Lock Systems
AU - Lam, C. P.; Guntur, R. R.; Wong, J. Y. (Transport Technology Research Lab, Dept. of Mechan)
SO - Society of Automotive Engineers Technical Paper No. 791046
CC - CONSTRUCTION & INDUSTRIAL MACHINERY,
IT - AIR BRAKES; ANTISKID DEVICES; COMPUTER SIMULATION; TRUCK TRACTORS; TRUCK TRAILERS
AB -

In this paper, a digital computer model for studying the braking performance of an articulated vehicle equipped with anti-lock devices is presented. Using this computer model, the braking characteristics of a tractor-semitrailer fitted with a commercially available system (System A) is compared with that of the same vehicle equipped with a proposed system (system B). The deficiencies of system A are identified. The merits and disadvantages of system B are also examined. Based on the results of the simulation study, guiding principles for the development of the control logic of anti-lock brake systems are suggested.

-2-

AN - 790599
TI - Advanced Braking Controls for Business Aircraft
AU - Longyear, D. M.; Hirzel, E. A. (Hydro-Aire Div., Crane Co.)
SO - Society of Automotive Engineers Technical Paper No. 790599
CC - SAFETY
IT - AIRCRAFT OPERATION-AIRCRAFT PERFORMANCE; ANTISKID DEVICES; AUTOMATIC CONTROL; BRAKES; BUSINESS AIRCRAFT
AB -

This paper discusses the phenomenon involved in stopping an aircraft and the capabilities required to meet Microwave Landing System operations.

Today's major terminals are becoming saturated, primarily because of the increased commercial traffic, and to relieve the pressure, business aircraft are being relegated to outlying fields. In some airports, they are severely restricted or outlawed.

The Microwave Landing System opens new vistas for the entire aviation industry because it greatly expands the access to the terminal and thereby offers additional landing windows for the business aircraft operators.

However, to operate in the Microwave Landing System, the nonscheduled operator will be required to have avionics equipment similar to the larger commercial aircraft. Also, if he is to take full advantage of the landing facilities, he will require full automatic braking capability.

-3-
AN - 790458
TI - Antiskid System for Passenger Cars with a Digital Electronic Control Unit
AU - Leiber, Heinz; Czinczel, Armin (Robert Bosch GmbH (Stuttgart/Germany))
SO - Society of Automotive Engineers Technical Paper No. 790458
CC - SAFETY
IT - ANTISKID DEVICES; AUTOMATIC CONTROL; BRAKES; CONTROL SYSTEMS
AB -

By introducing modern digital electronics, BOSCH succeeded in developing a high-performance antiskid system for passenger cars. A digital design approach was chosen since it allows for a greater degree of integration than an analog design.

This results in increased reliability. The hydraulic unit comprises three of four solenoid valves and a return pump driven by an electric motor. The system prevents vehicle swerving and maintains steerability while attaining remarkable gains in stopping distance at the same time.

As passenger cars developed, brake systems also improved steadily. Today almost optimal brake force generation has been achieved which assures stable braking on uniform roadways without any yaw movements as long as there is no excessive braking.

Excessive braking will result in wheel lock-up. In this case the vehicle is no longer steerable, may even swerve and in general the stopping distance will be longer than with optimal brake action.

Therefore, the objective of the antiskid system (ABS) is to reduce the brake pressure in the individual wheel should excessive braking occur so that the wheels generate maximum brake force without locking. Thus vehicle steerability is maintained and vehicle swerving prevented.

Although the first patents concerning antiskid systems date back to 1905, actual development did not begin until 1957. By 1966 the control problems experienced had been essentially solved. However, the introduction of high-performance antiskid systems, which also maintain steerability, failed in the following period due to their complexity and reliability problems with the electronic control unit which comprised numerous discrete electronic components. Simplified mechanical components and introduction of new technologies for the electronic control unit characterize the BOSCH high-performance ABS system for passenger cars.

-4-
AN - 790457
TI - Electronic Control Systems for Ground Vehicles
AU - Hayes, Edward J.; Megginson, George W. (Kelsey-Hayes Co., Romulus, MI)
SO - Society of Automotive Engineers Technical Paper No. 790457
CC - SAFETY
IT - ANTISKID DEVICES; BRAKES; ELECTRIC CONTROL-ELECTRONIC
AB -

The wide spread installation of anti-wheel lock systems in the development after this interruption, we believe it worthwhile to review some of the designs that have evolved to date. Potential for antilock to improve vehicle stability during heavy braking has been demonstrated. However, with the current situation in the United States, Europe and Japan will probably lead the way in the popular use of electronic antilock systems.

-5-
AN - 790455
TI - Influence of Antiskid Systems on Vehicle Directional Dynamics
AU - Bisimis, E. (Alfred Teves GmbH (Frankfurt/Germany))
SO - Society of Automotive Engineers Technical Paper No. 790455
CC - SAFETY
IT - ANTISKID DEVICES; BRAKES; VEHICLE DIRECTIONAL CONTROL; VEHICLE DYNAMICS; COMPUTER APPLICATIONS
AB -

The results presented demonstrate the influence of longitudinal tire slip and load transfer during braking on steering behavior of cars in terms of parameters which have been found to be important for the function of the driver/vehicle control loop. This is followed by a description of an antiskid system and a comparison of directional properties during braking with conventional brake system and with antiskid. The importance of appropriate selection of slip levels during adaptation of antiskid systems to a given vehicle is pointed out.

-6-
AN - 780856
TI - Electronic Braking System
AU - Hayes, Edward J. (Research and Development, Kelsey-Hayes Company, Ro); Megginson, George W. (Brake Control Systems, Kelsey-Hayes Company, Romul)
SO - Society of Automotive Engineers Proceedings No. P-76
IT - ANTISKID DEVICES; ELECTRIC CONTROL-ELECTRONIC; SAFETY DEVICES
AB -

Electronic braking systems for air-brake vehicles have been required by the Federal Motor Vehicle Safety Standard 121 since 1975. The need for the standard and the difficulty in documenting its benefits are discussed. Public criticism, court and legislative action threaten to cause it to follow the seat belt inter-lock. Major opposition derives from misunderstanding and opposition to government regulation.

-7-
AN - 780262
TI - A Baseband Radar System for Auto Braking Application
AU - Ross, Gerald F. (Sensor Systems, Sperry Research Center)
SO - Society of Automotive Engineers Technical Paper No. 780262
IT - BRAKES; DIGITAL ELECTRONICS; ELECTRIC CIRCUITS; RADAR; RESEARCH
AB -

This paper describes a BAseband Radar (BAR) sensor for radar braking application; an early version of the BAR concept was reported previously as a precollision sensor for air bag activation. In this paper we show how the normally wide effective beamwidth of the BAR is narrowed by using interferometry in conjunction with a novel delay line digital processor scheme. The beamwidth of the breadboard system spans a traffic lane width at 45 meters. The paper describes the details of the BAR sensor front-end and preliminary test results sponsored by the U.S. Department of Transportation and the Institute for Telecommunication Sciences.

-8-
AN - 770266
TI - An Assessment of the Accident Avoidance and Severity Reduction Potential of Radar Warning, Radar Actuated, and Anti-Lock Braking Systems
AU - Tumbas, Nicholas S.; Treat, John R.; McDonald, Stephen T. (Institute for Research in Public Safety, Indiana U)
SO - Society of Automotive Engineers Technical Paper No. 770266
IT - ANTISKID DEVICES; BRAKES; CRASH RESEARCH; RADAR
AB -

A group of 215 in-depth accident reports prepared as part of a tri-level accident causation study by a multidisciplinary team was examined to assess the benefit derived from the hypothetical application of various combinations of radar warning, radar actuated, and anti-lock braking systems. The approach was to have an accident analyst evaluate post hoc the benefit which would have been derived if one or more of the vehicles involved in each accident had been equipped with various types and combinations of these hypothetical systems; ten system types or combinations were defined. On one extreme, it was found that two-wheel anti-lock systems, by themselves, had relatively little accident prevention potential; only one of the 215 accidents (0.5%) would definitely have been prevented by such a system, although with less assurance there was some possibility or prevention of up to eight accidents (3.7%). On the other extreme, the most complex of the systems defined, comprised of a non-cooperative radar system with both actuation and warning potential, coupled with a four-wheel anti-lock system, would definitely have prevented 39 of these accidents (18.0%), with some possibility of prevention of up to 90 accidents (41.9% of those examined).

-9-

AN - 770265
TI - Results from a Collisions Avoidance Radar Braking System Investigation
AU - Troll, William C.; Wong, Richard E. (Research Labs, The Bendix Corp.); Wu, Yung Kuang (U.S. Dept. of Transportation)
SO - Society of Automotive Engineers Technical Paper No. 770265
IT - ANTISKID DEVICES; BRAKES; CRASH RESEARCH
AB -

Results of previous studies have indicated that an automatic/noncooperative radar braking system may provide a significant benefit in preventing accidents that may otherwise be caused by driver inattention or tardy driver response. However, one of the major technical problem areas in implementing the automatic/noncooperative radar brake system is in achieving sufficient target discrimination. This is necessary to allow rejection of non-hazardous objects and to maintain a sufficiently low false alarm rate while retaining recognition capability on all potential hazards.

This paper presents the results of an experimental and computer simulation study conducted to resolve the effects of the various system parameters which may be significant to the target recognition problem. The target discrimination experimental study was conducted using an instrumented test vehicle equipped with an automatic/noncooperative radar braking system to gather parametric data under typical traffic conditions. The test courses selected for the experiments typify much of the high density, high speed, urban and suburban driving in the United States. The sensitivities of the various radar brake system parameters are also discussed. This work was sponsored by National Highway Traffic Safety Administration of the U. S. Department of Transportation.

-10-

AN - 770161
TI - Second Generation Building Block Circuits-A Unique New Frequency to Voltage Converter
AU - Miller, Robert W. (National Semiconductor)
SO - Society of Automotive Engineers Technical Paper No. 770161
IT - ANTISKID DEVICES; ELECTRIC CIRCUITS; ELECTRIC EQUIPMENT-ELECTRONIC; INSTRUMENT PANELS
AB -

A new level of electronic building blocks for automotive system design is evolving. These circuits will perform specific functions with high accuracy, low cost, and a minimum of external components. This paper describes a unique frequency to voltage converter designed for the specific interface problems found in automotive systems.

The concept of a building block device requires that a function be performed in the same way as it can be mathematically defined. This device is free of the typical compromises associated with adapting conventional F-V converters to automotive requirements. It interfaces directly with magnetic pickups and its output is directly proportional to frequency even as the frequency goes to zero.

Two specific application areas are explored. The need for an electronic speedometer/tachometer for better reliability and easier instrument panel design calls for a ripple-free low frequency F-V or F-I converter.

At the front of most adaptive braking systems is a wheel speed to voltage conversion. This device can go one step further and provide some of the logic required in multiple input anti-skid systems.

-11-

AN - 770098
TI - Evaluation of Vehicle Installed Wheel Lock Control Hardware with a Hybrid Computer Simulation
AU - Grimm, R. A.; Bremer, R. J.; Jain, F. J.; Levijoki, W. A. (AC Spark Plug Div., General Motors Corp.)
SO - Society of Automotive Engineers Technical Paper No. 770098
IT - COMPUTER SIMULATION; ANTISKID DEVICES; SIMULATION
AB -

A real-time hybrid computer simulation which is interfaced with an air brake truck is described. The simulation interconnects with the wheel lock electronic controller-modulator hardware and air brake system of a multiple axle truck to provide a laboratory tool for simulating vehicle braking performance. This technique provides controllable vehicle and road characteristics for evaluating the actual wheel lock and vehicle pneumatic system hardware. A set of comparative data is given and the merits of the simulation technique are discussed.

-12-

AN - 760845
TI - Modifications of Steering Axle Cam Brakes for FMVSS 121
AU - Marting, Paul G. (Wagner Electric Corp.)
SO - Society of Automotive Engineers Technical Paper No. 760845
IT - AIR BRAKES; ANTISKID DEVICES; BRAKES; VEHICLE DYNAMICS
AB -

The increased torque levels required on front axles of air brake vehicles to comply with the 60 miles per hour, 245 foot stopping distance of FMVSS 121 created brake packaging problems not only due to the brake assemblies being larger for a given axle weight, but due to the inclusion of antilock hardware and the larger front axles. To produce the additional torque, increased brake input power was needed, necessitating material and design changes of the basic foundation brake.

Many of these design considerations are discussed in this paper.

-13-
AN - 760025
TI - Front Brake Interactions with Heavy Vehicle Steering and Handling During Braking
AU - Gillespie, T. D. (Ford Motor Co.)
SO - Society of Automotive Engineers Technical Paper No. 760025. Also published in SAE TRANSACTIONS (1976)
IT - STEERING; AIR BRAKES; BRAKES; COMPUTER SIMULATION; VEHICLE DIRECTIONAL CONTROL; VEHICLE DYNAMICS
AB -

The increased braking performance required on air-brake equipped commercial vehicles by the Federal Motor Vehicle Safety Standard 121 results in vehicles with higher front brake torque capacity and greater deceleration capability. Using a simple analytical model, certain mechanisms by which handling during braking is influenced by tire characteristics, load transfer during braking, steering system characteristics, brake imbalance, and other factors are demonstrated. In addition, analysis of the steering system shows how steer angle deviations arise from braking and lateral forces acting against compliance of the steering linkage, and the influence of caster geometry on these deviations.

To investigate certain quantifiable characteristics of handling performance, the HSRI Directional Response Computer Program for predicting the longitudinal and directional response behavior of trucks was modified to include the effects of a compliant steering system subject to the force and moment inputs of the front tires. Measurement of bias ply truck tire force and moment characteristics for use in the computer simulation revealed that tire aligning torque characteristics reverse in direction at high braking levels and may dominate the effect of geometric caster built into the steering system.

Studies utilizing the modified program indicate that (a) no vehicle will stop perfectly straight without driver steering corrections because of steer angle deviations and (b) the steering reactions fed back to the steering wheel during braking may reverse direction with antilock brake cycling, largely because of the reversal of tire aligning torques. A relationship between these steering reactions and front brake torque level is shown.

-14-
AN - 750383
TI - Brake Fluid Functionability in Conventional and Anti-Skid Systems in Arctic Conditions
AU - Brown, David; Harrington, Colin (Res. Lab., Burmah Castrol Co. (United Kingdom))
SO - Society of Automotive Engineers Technical Paper No. 750383
IT - BRAKES; FLUID FLOW; VEHICLE PERFORMANCE TESTS
AB -

The effect and description of vehicle braketests performed under conditions of low ambient temperature and the evaluation of the effect of brake fluid viscosity, under these conditions, on brake system performance. Vehicle braking tests were performed within the arctic circle.

-15-
AN - 750086
TI - A Review of Philosophical Considerations in the Development of Radar Brake Systems
AU - Chandler, R. A.; Wood, L. E. (U.S. Dept. of Commerce); Lemeshewsky, W. A. (U.S. Dept. of Transportation)
SO - Society of Automotive Engineers Technical Paper No. 750086. Also published in SAE TRANSACTIONS Vol 84 (1975)
IT - BRAKES
AB -

The National Highway Traffic Safety Administration (NHTSA) has been involved in an investigation into the economic and technical feasibility of applying radar devices as sensors for automatic braking systems. Several different system application philosophies have been defined and discussed with consideration being given to the expected economic and safety benefits afforded by each.

The technical feasibility study, performed for NHTSA by the Institute for Telecommunication Sciences of the U.S. Department of Commerce, included such topics as radiation hazards, intersystem blinding effects, performance restrictions imposed by common highway geometries, effects of precipitation on signal propagation, and analysis of vehicular radar cross sections.

-16-
AN - 741086
TI - An Investigation of Brake Balance for Straight and Curved Braking
AU - Limpert, Rudolf; Gamero, Franco E. (University of Utah); Boyer, Ron (Dynamic Science Div., Ultrasystems)
SO - Society of Automotive Engineers Technical Paper No. 741086. Also published in SAE TRANSACTIONS Vol 83 (1974)
IT - BRAKES; FRICTION MATERIALS; VEHICLE DIRECTIONAL CONTROL; VEHICLE DYNAMICS
AB -

Most motor vehicles operating on our highways today are designed to exhibit high levels of straight-line braking performance without providing sufficient stability during combined braking and steering maneuvers. A basic engineering analysis is presented that allows optimum values of brake balance to be determined for both straight and curved braking. The effects of brake fade on brake balance are discussed. Different wheel antiskid systems are analyzed, and test results are presented for three domestic vehicles. A methodology for determining expected safety benefits of advanced brake systems is reviewed.

-17-
AN - 741084
TI - Introduction of Antilock Braking Systems for Cars
AU - Klein, Hans Christof; Fink, Werner (ITT-Teves Germany)
SO - Society of Automotive Engineers Technical Paper No. 741084
IT - BRAKES; SERVOMECHANISMS; VEHICLE PERFORMANCE
AB -

The overall question of brake actuation, antilock control and other vehicle functions requiring servo assistance will be discussed. Too much effort has been devoted in treating each of these units on an individual basis. This paper describes ways in which this complex subject can be dealt with in a unified manner, to provide a more compact and reliable solution.

-18-
AN - 740630
TI - Antilock Brake System Application to a Motorcycle Front Wheel
AU - Miennert, Raymond J. (Harley-Davidson Motor Co., Inc.)
SO - Society of Automotive Engineers Technical Paper No. 740630
IT - ANTISKID DEVICES; DISC BRAKES; MOTORCYCLES; BRAKES
AB -

Antilock brake systems suitable for use on a motorcycle were investigated under an experimental safety motorcycle program.

Due to program constraints, the only systems investigated were those already perfected by brake system manufacturers. This enabled utilization of the latest state-of-the-art principles to accomplish the desired result in the shortest time.

Various types of systems and power sources were investigated. The system chosen for the motorcycle application was a fluid powered system in conjunction with a production hydraulic disc brake. Laboratory and field tests have been conducted with results exceeding expectations.

-19-
AN - 740551
TI - Automatic Stabilization of Tractor Jackknifing in Tractor-Semitrailer Trucks
AU - Susemihl, Enrique Alfonso (Universidad Nacional del Sur (Argentina)); Krauter, Allan I. (Cornell University)
SO - Society of Automotive Engineers Technical Paper No. 740551. Also published in SAE TRANSACTIONS Vol 83 (1974)
IT - SAFETY; TRAILERS; TRUCK TRAILERS; TRUCK DESIGN
AB -

This paper describes an automatic stabilizing technique to prevent tractor jackknifing in tractor-semitrailer trucks. This stabilizing technique consists of the detection of the onset of a jackknife and the subsequent application of corrective action. The onset of a jackknife is detected through the behavior of the drive wheels, and the corrective action consists of a form of corrective braking; that is, the simultaneous operation of the antiskid systems at all axles of the truck. The results obtained in this study indicate that the stabilizing technique may effectively prevent the development of a tractor jackknife during braking. Furthermore, the implementation of this technique in a real truck would be relatively simple and require a minimum of additional hardware.

-20-

AN - 740313
TI - Braking Regulations in Europe
AU - Oppenheimer, Paul (Girling Ltd. (England))
SO - Society of Automotive Engineers Technical Paper No. 740313. Also published in SAE TRANSACTIONS Vol 83 (1974)
IT - BRAKES; REGULATIONS; VEHICLE SAFETY; LEGISLATION
AB -

Important new braking regulations for motor vehicles and trailers have recently been introduced by Sweden, the Economic Commission for Europe (Geneva), and the European Economic Community (Brussels).

This paper describes the relevant rulemaking procedures and the international organizations which provide for industry participation. The technical content of these regulations is summarized and specific examples of difficult, interesting, or unusual demands are highlighted. Some comparisons with the appropriate United States federal standards have been included and the European method of type approval is explained against the background of self-certification in the United States.

Several new European proposals for tractor/trailer compatibility, brake apportioning, and antiskid systems are reviewed to illustrate the current status of legislative progress in Europe.

-21-

AN - 740137
TI - The Utilization of a Computer Simulation as an Aid to Predict Compliance with MVSS 121
AU - Gurney, John W. (Ford Motor Co.); Bernard, James E. (University of Michigan)
SO - Society of Automotive Engineers Technical Paper No. 740137. Also published in SAE TRANSACTIONS Vol 83 (1974)
IT - SIMULATION
AB -

Certain sections of Motor Vehicle Safety Standard 121 require that air braked commercial vehicles have the capacity to produce an average deceleration of more than 17 ft/s\u2 from 60 mph to stop without prolonged wheel lockup on a surface characterized by an ASTM skid number of 75. Since commercial vehicles commonly include a wide variety of geometric and load configurations, careful steps must be taken by the manufacturer to assure conformance of each vehicle produced.

Ford has found it useful to approach this problem with a program combining vehicle testing and computer simulation. A simple computer model is employed to select critical vehicles for subsequent testing. These vehicles serve a twofold purpose: to demonstrate empirically conformance to the stopping distance requirements of MVSS 121, and to permit correlation of a more sophisticated simulation. This more comprehensive model is then utilized to calculate the longitudinal braking performance of other vehicles. In this paper, some details of the Ford program are given, with particular attention to the testing and simulation of vehicles equipped with antilock braking systems.

-22-
AN - 740129
TI - Engineering Design Benefits of Silicone Brake Fluids
AU - Chapman, D. R. (Stauffer Chemical Co.)
SO - Society of Automotive Engineers Technical Paper No. 740129
IT - BRAKES; HYDRAULIC FLUIDS; HYDRAULIC SYSTEMS; SILICON
AB -

For several years a search has been conducted for improved motor vehicle brake fluids not regulated by present SAE or federal specifications. Safety performance needs are exceeding the present capability of conventional brake fluids, and federal improvement of performance specifications is currently under way to remedy this situation. Silicone-based brake fluids have been the only viable product developed to date.

The primary goal of this search has been based on the need to identify a fluid that can be used in any vehicle on the road with no detrimental effects on any component of the braking system. This paper discusses silicone hydraulic brake fluid formulations that are capable of performing this first and most important task. Physical properties of silicone fluids that provide improved safety and performance are presented. Such fluids provide cost savings in reduced structural damage and the means for potential cost savings in new safety design capability for warning light systems, brake power boosters, smaller and lighter components, and antiskid, automatic, and wheellock control devices. Silicone brake fluids offer an infinitely superior all-weather, all-climate brake fluid for reduced maintenance and replacement costs.

-23-
AN - 740094
TI - Automatic Braking by Radar
AU - Flannery, John B. (AutoStop Corp.)
SO - Society of Automotive Engineers Technical Paper No. 740094. Also published in SAE TRANSACTIONS Vol 83 (1974)
IT - BRAKES; RADAR; TESTS; RELIABILITY
AB -

Braking system, developed by AutoStop Corp., uses Doppler-generated signals to reduce stopping distance of vehicle in danger of collision. Safety device acts on conventional controls of vehicle, provides backup where driver's reaction time is not adequate, and rapid deceleration is required to avoid collision. Actuation of controls to achieve deceleration is accomplished by two vacuum bellows, one mechanically linked to the brake pedal, another linked to throttle and accelerator. Braking action is initiated by driver. System discriminates between objects which present danger of collision, and false targets such as traffic in adjacent lanes and signposts.

-24-
AN - 740049
TI - A Fleet Operator's Comments on FMVSS 121 Braking System Compatibility
AU - Lewis, James M. (United Parcel Service, Inc.)
SO - Society of Automotive Engineers Technical Paper No. 740049
IT - AIR BRAKES; ANTISKID DEVICES; SAFETY; TRUCK OPERATION-TRUCK PERFORMANCE
AB -

Federal Motor Vehicle Safety Standard (FMVSS) 121 has introduced many new and varied problems for vehicle manufacturers, component manufacturers, and vehicle operators. An area of great concern to vehicle operators, particularly fleets, is the question of compatibility associated with antilock system intermix, old and new vehicle intermix, and control standardization.

This paper discusses the compatibility related problems observed during limited fleet tests and evaluation of FMVSS 121 braking systems. Test data, observations, and possible solutions are presented with emphasis on the need for more extensive investigation in this area to ensure that the goal of FMVSS 121-increased truck safety- is achieved.

-25-
AN - 730699
TI - Intermixing of Tractors and Trailers Equipped with Existing and FMVSS 121 Braking Systems
AU - Stearns, G. W. (Wagner Electric Corp.)
SO - Society of Automotive Engineers Technical Paper No. 730699
IT - AIR BRAKES; ANTISKID DEVICES; REGULATIONS
AB -

There are a number of factors affecting the braking stability on tractor-semitrailer combination vehicles when intermixing new and existing braking systems. The changes in the stability of combination vehicles caused by the differences in brake performance levels, brake torque utilization, and brake system response of new and existing systems will be evaluated. The new and the existing systems will be pictorially compared and discussed to clarify the features and performance parameters required on the new equipment which must work in conjunction with pre-FMVSS 121 brake systems.

-26-
AN - 730698
TI - Comparative Analysis of Air Brake Antiskid Systems - A Truck Builder's View
AU - Turvill, Paul A. (PACCAR, Inc.)
SO - Society of Automotive Engineers Technical Paper No. 730698. Also published in SAE TRANSACTIONS Vol 82 (1973)

AB -

Numerous air brake antiskid systems, each representing a unique approach to achieving a common goal, are being promoted to fill the market created by the performance criteria contained in Federal Motor Vehicle Safety Standard (MVSS) 121. Nine of these systems were examined in order to determine the range of available features and performance, and to discover what new factors will have to be taken into account by vehicle manufacturers to accommodate antiskid systems as standard equipment.

The early effective date of MVSS 121 has forced introduction of antiskid systems with only minimal field exposure. The next generation of systems designs is already being considered, and is expected to incorporate refinements based on current experiences of skid control suppliers, vehicle manufacturers, and users.

-27-

AN - 730697
TI - Operation Redesign: Axles and Brakes for MVSS 121
AU - Thornton, Clarke F. (Rockwell International)
SO - Society of Automotive Engineers Technical Paper No. 730697
IT - AIR BRAKES; ANTISKID DEVICES; AXLES; REGULATIONS
AB -

The purpose of this paper is to discuss the detail known to affect the design of axles, brakes, wheels, and related equipment that will be used on air-braked vehicles under Federal Motor Vehicle Safety Standard (FMVSS) 121. In specific, this paper shows the change that is expected to occur on redesigned axle and braking equipment compatible with the higher levels of vehicle deceleration and controllability to satisfy the Standard.

Variables affecting vehicle brake performance and design and application problems related to MVSS 121 qualification are presented.

-28-

AN - 730653
TI - Tractor-Semitrailer Handling: A Dynamic Tractor Suspension Model
AU - Vincent, Ronald J.; Krauter, Allan I. (Cornell University)
SO - Society of Automotive Engineers Technical Paper No. 730653
IT - AXLES; COMPUTER SIMULATION; SUSPENSION SYSTEMS; TRUCK TRACTORS; VEHICLE DYNAMICS
AB -

This paper describes the addition of tandem-drive axles and tractor suspension dynamics to a digital computer model of a tractor-semitrailer truck. The extended model provides 22 degrees of freedom for the vehicle. Two degrees of freedom are included for the motion of each tractor axle; vertical tire flexibility, tandem-axle suspension jacking, and tandem-axle roll steer are also included in the extended model.

The features of the previous vehicle model (based on the work of Mikulcik) are retained in the extended model. These features include nonlinear equations for translation, yaw, pitch, and roll of both the

the fifth wheel), wheel rotation dynamics, and antiskid brake control. The model also includes a simulated ''driver'' which specifies the steering angle and the air pressure applied to the brakes.

The extended model is compared with the prior model by performing comparison tests involving simultaneous cornering and braking. The model is then used to investigate the effects of nonhorizontal torque rods at the tandem axles on the behavior of the vehicle.

-29-
AN - 730535
TI - Hydraulic Brake Actuation Systems under Consideration of Antilock Systems and Disc Brakes
AU - Depenheuer, Otto; Strien, Hans (Alfred Teves GmbH (Germany))
SO - Society of Automotive Engineers Technical Paper No. 730535. Also published in SAE TRANSACTIONS Vol 82 (1973)
IT - ACTUATORS; ANTISKID DEVICES; DISC BRAKES; HYDRAULIC CONTROL; HYDRAULIC SYSTEMS
AB -

Hydraulic power braking systems for use in passenger cars and light trucks are attracting considerable automotive design attention. This is due to their compactness, smaller space requirements, and better operating ''feel,'' as well as their more direct control over the braking function, which has extremely short application and release times. Moreover, they are readily adaptable to the energy source and controls of an antilock system, and they contribute to (or even form the basis of) a central power-supply system that would provide servo assistance to other vehicle systems. This paper describes and explains ways of creating these brake systems and gives design calculations of brake layouts based on standard values and comparative judgment criteria.

-30-
AN - 730184
TI - Effects of Tire Slip on the Handling Performance of Tractor-Semitrailers in Braking Maneuvers
AU - Olsson, George R. (The University of Michigan)
SO - Society of Automotive Engineers Technical Paper No. 730184
IT - AIR BRAKES; ANTISKID DEVICES; TIRES; TRUCK TRAILERS
AB -

Automatic braking control systems for trucks and tractor-semitrailers have become the subject of a sizeable research and development effort. These devices can provide improved vehicle stability and control characteristics in braking maneuvers. An analysis utilizing a mathematical model of a tractor-semitrailer vehicle yielded the following results: favorable stability and control characteristics in braking maneuvers are maintained when front wheels do not lock, tractor rear-wheel slip remains less than front-wheel longitudinal slip, and semitrailer rear wheels do not lock. Effects of kingpin (fifth wheel) location and introduction of coulomb friction at the kingpin are also discussed.

-31-
AN - 730181
TI - A Digital Computer Method for the Prediction of Braking Performance of Trucks and Tractor-Trailers
AU - Bernard, James E. (Highway Safety Research Inst., University of Michi)
SO - Society of Automotive Engineers Technical Paper No. 730181. Also published in SAE TRANSACTIONS Vol 82 (1973)
IT - ANTISKID DEVICES; AXLES; BRAKES; COMPUTER SIMULATION; SUSPENSION SYSTEMS; TIRES
AB -

The simulation of the longitudinal performance of trucks and articulated vehicles requires careful attention to tandem axle dynamics, the brake system model, and the tire model. The approach which was taken to these problems in a recently developed digital simulation is given. Results for the braking performance of an articulated vehicle and a straight truck are compared to empirical data. In addition, simulation results are given for the articulated vehicle equipped with a simple antiskid system.

-32-
AN - 730081
TI - Development of the Brake System for the General Motors Experimental Safety Vehicle
AU - Oakley, W. J. (Delco Moraine Div., General Motors Corp.); Roller, A. E. (Pontiac Motor Div., General Motors Corp.); Cattin, W. J. (Engineering Staff, General Motors Corp.)
SO - Society of Automotive Engineers Technical Paper No. 730081
IT - BRAKES; HYDRAULIC SYSTEMS; VEHICLE SAFETY
AB -

The Experimental Safety Vehicle program in General Motors was a study in meeting the Department of Transportation performance requirements, with the sole objective being to meet or exceed all of the contract specifications. This vehicle was not intended for production; it was a safety idea car with many unique features including a four-wheel, anti-lock disc brake system using a hydraulic power brake system with an electro-hydraulic back-up system. In addition, the design of the dual piston caliper for the disc brakes provides a redundant system thereby minimizing the effect of a single line or hose failure. This feature coupled with the redundant back-up power brake system provided performance under various failed conditions approximately equal to the original effectiveness with only a slight increase in pedal effort.

This brake system, developed for the ESV, satisfied the General Motors performance objectives, and equaled or surpassed the contract requirements of the ESV program.

-33-
AN - 720872
TI - Optimization of Commercial Transport Airplane Stopping Systems
AU - Meredith, D. B.; Hainline, B. C. (The Boeing Co.)
SO - Society of Automotive Engineers Technical Paper No. 720872
IT - ANTISKID DEVICES; BRAKES; LANDING GEAR
AB -

The role of the aircraft manufacturer in the design, integration, and optimization of commercial transport airplane stopping systems is discussed. Specific emphasis is placed on: system design considerations, configurations, and features; laboratory and flight testing; typical problems encountered; and future basic data requirements. Advancements in stopping system simulation techniques and antiskid control systems in recent years have allowed large improvements in stopping system efficiency. Future improvements are dependent on obtaining basic data on tire and brake dynamic characteristics for use in simulation studies to control and improve the combined brake and tire frequency response phase lag. It is anticipated that new rational landing rules being developed by the FAA must account for and include the effect of the engine thrust reversing system on stopping distances. The design, development, certification, and operation of airplanes with integrated air brake, wheel brake, and thrust reversing systems will further emphasize optimization of the total airplane stopping system.

-34-
AN - 720868
TI - Antiskid and Modern Aircraft
AU - Hirzel, E. A. (Hydro-Aire Div., Crane Co.)
SO - Society of Automotive Engineers Technical Paper No. 720868
IT - ANTISKID DEVICES; AUTOMATIC CONTROL; BRAKES
AB -

The essence of braking control is to adjust the brake pressure properly at all times to maintain brake torque at the correct level to balance the tire-runway friction force at its peak value, and thus give the aircraft maximum available deceleration.

Hydro-Aire has been involved in the development of skid control systems from the days of the old ''tire savers'' to today's fully automatic braking controls. This paper presents the technical history and evolution of the modern brake control or ''antiskid'' system.

-35-
AN - 720283
TI - Computerized Energy Distribution and Automated Control
AU - Sognefest, P. W.; Anderson, R. L.; Estes III, B. E.; Nedbal, R. G. (Essex International, Inc.)
SO - Society of Automotive Engineers Technical Paper No. 720283
IT - AUTOMATIC CONTROL; ELECTRIC CONTROL-ELECTRONIC
AB -

A digital computerized energy distribution and automated control system is being developed at Essex Internationa- l's Vehicular Research and MOS Manufacturing Facilities in Pittsburgh. The control system is comprised of a central computer in conjunction with a digital multiplexing system. Prototypes of the system have been tested; the subsystems of the car that were tested include fuel injection, ignition, power assist, comfort, and lighting.

In its final form this system will make decisions for all the subsystems on the automobile. For example, antiskid braking, gear selection, automatic speed control, and driver displays will be incorporated. The system will evolve onto the car in pieces such as engine control, lighting, and automatic temperature control. Then, as economic factors dictate, the components will evolve into a single computerized system. The automatic temperature control system is economical today. The central computer will be economical for certain functions in 2-3 years.

-36-
AN - 720031
TI - Design and Development of an Hydraulic Powered Wheel Slide Protection System
AU - Cochrane, Robin A. (Girling Ltd.)
SO - Society of Automotive Engineers Technical Paper No. 720031
IT - ANTISKID DEVICES
AB -

A Wheel Slide Protection system is considered in which a hydraulic power source is used to modulate braking effort at each wheel of a vehicle. The reasons for selecting this type of power source are discussed, together with other parameters employed in the design of the system.

System operation is described with particular emphasis on the functioning of the hydraulic actuators and their response to electrical control signals.

Evaluation has been carried out on different vehicles over a wide range of surfaces. Certain observations are made as a result of these tests.

-37-
AN - 710248
TI - The Chrysler ''Sure-Brake'' - The First Production Four-Wheel Anti-Skid System
AU - Douglas, J. W. (Chrysler Corp.); Schafer, Thomas C. (Bendix Corp.)
SO - Society of Automotive Engineers Technical Paper No. 710248. Also published in SAE TRANSACTIONS Vol 80 (1971)
IT - ANTISKID DEVICES; BRAKES
AB -

The paper outlines testing, development, and operation of the first production four-wheel slip control system for passenger cars in the United States. The Chrysler Corporation calls the system ''Sure-Brake,'' but it is more generally known as ''anti-skid.''

The first portion of the paper deals with considerations that led Chrysler into the ''Sure-Brake'' system, the philosophy behind the

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system and a detailed explanation of its operation. The second portion deals with the development and testing leading to the release as an option on the 1971 Imperial.

The testing program introduced a new dimension to brake engineering. Before the advent of wheel slip control systems, many thousands of brake tests were conducted but were always terminated at the point of skid. These tests were also conducted mainly on black top or concrete roads. For the first time, thousands of stops were made at maximum deceleration on every available surface. The paper lists the results obtained and attempts to pass on some of the lessons learned in handling skidding vehicles.

-38-
AN - 700112
TI - Adaptive Anti-Lock Braking - A Reality for Air Braked Vehicles
AU - Latvala, Bruce E.; Morse, R. J. (Bendix-Westinghouse Automotive Air Brake Co.)
SO - Society of Automotive Engineers Technical Paper No. 700112. Also published in SAE TRANSACTIONS Vol 79 (1970)
IT - AIR BRAKES
AB -

A braking control system for air braked vehicles has been developed which prevents wheel lock under any braking condition and thereby improves vehicle stability and reduces stopping distance.

The theory of operation and the specifications of the system are discussed and performance under several typical conditions is shown.

-39-
AN - 690214
TI - Measurement of Tire Brake Force Characteristics as Related to Wheel Slip (Antilock) Control System Design
AU - Harned, John L.; Johnston, L. E.; Scharpf, Glen (General Motors Engineering Staff)
SO - Society of Automotive Engineers Technical Paper No. 690214. Also published in SAE TRANSACTIONS Vol 78 (1969)
IT - ANTISKID DEVICES; BRAKES; TIRES
AB -

Tire brake force characteristic data are presented that should be helpful in the design of wheel slip control systems. Correlation of these data has been established with antilock system performance. Experimentally measured mu-slip curves are given for a large number of tire/road pairings. These measurements cover a wide range of commercial tire types on dry and wet road surfaces and glare ice. It is shown how wet road characteristics are affected by road construction, water cover depth, and tread wear. The measuring system used to obtain these data is described and variability of the experimental measurements is discussed

-40-
AN - 690213
TI - Evolution of Sure-Track Brake System
AU - Madison, R. H. (Ford Motor Company); Riordan, Hugh E. (Kelsey-Hayes Co.)
SO - Society of Automotive Engineers Technical Paper No. 690213. Also published in SAE TRANSACTIONS Vol 78 (1969)
IT - BRAKES
AB -

The history, system philosophy, design evolution and performance of the sure-track anti-lock automotive braking system are presented and discussed. Considerations of performance, driver skill, reliability and commercial acceptance resulted in the choice of a vacuum-electronic rear wheel antilock system that incorporates individual wheel speed sensing and control of braking as a pair.

The system provides superior directional stability under ''panic'' braking conditions while maintaining stopping distance equal to or shorter than those for locked wheels under most road conditions.

-41-
AN - 680458
TI - Design and Performance Considerations for a Passenger-Car Adaptive Braking System
AU - Schafer, Thomas C.; Howard, D. W. (Bendix Corp., Brake and Steering Div.); Carp, Ralph W. (Bendix Corp., Automotive Electronics Div.)
SO - Society of Automotive Engineers Technical Paper No. 680458. Also published in SAE TRANSACTIONS Vol 77 (1968)
IT - ANTISKID DEVICES; BRAKES
AB -

The basic philosophy for a logical approach to the design and implementation of an adaptive vehicular braking system is defined. Tentative system specifications, goals and objectives are outlined. The many technical factors, both external to the vehicle and within the vehicle, necessary to establish a general mathematical model of an adaptive braking control system are emphasized. Techniques utilized to obtain experimental data to support systems analysis and computer studies are discussed. Various control configurations are presented.

Vehicle performance is summarized for two configurations of an electronically controlled vacuum actuated adaptive braking system.

-42-
AN - 670505
TI - Trends in Braking Techniques of the European Vehicles
AU - Furia, Andre; Schachter, Sully; Gancel, Pierre (DBA, France)
SO - Society of Automotive Engineers Technical Paper No. 670505
IT - BRAKES; DISC BRAKES; VALVES-VALVE MECHANISMS
AB -

Disc brakes and modulating valves work together to improve the stability of a car during braking. This fact, as well as the increased

possibility of braking control, comprise the main reasons for the tendency of European manufacturers to employ four disc brakes and modulating valves in their cars. Floating and fixed calipers are both used, but the first category has advantages which seem conclusive for the future. The next step could be the use of antiskid devices, the object of considerable research efforts, none of which has given any conclusive results to date.

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- 780834
- Electronic Applications to the Automobile by Robert Bosch GmbH
- Scholl, Hermann (Board of Management, Robert Bosch GmbH, 7000 Stutt)
- Society of Automotive Engineers Proceedings No. P-76
- AIR CARGO HANDLING; IGNITION SYSTEMS; ANTISKID DEVICES; ELECTRONIC FUEL INJECTION; MICROPROCESSOR
-

Robert Bosch GmbH has been developing and manufacturing electrical uipment for automobiles for approximately 80 years and electronic uipment for over 20 years.

The first section of this paper describes the beginnings of tomotive electronics and their early products. The second section als with the most important current products which include, in rticular, electronic fuel injection, breakerless ignition, and the tiskid.

The last part describes the development of future products which nsistently use digital technology and in many cases a microcomputer. e most significant project in this series is the digital engine ntrol to manage gasoline injection, ignition and automatic ansmission.

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- 750432
- Application of Microprocessors to the Automobile
- Jones, T. O. (General Motors Technical Center); Schlax, T. R.; Colling, R. L. (General Motors Corp.)
- Society of Automotive Engineers Publication No. SP-393
- ELECTRIC EQUIPMENT-ELECTRONIC; DESIGN; SAFETY DEVICES; COMPUTER APPLICATIONS
-

This paper describes microprocessor technology as it may be plied to the automobiles of the future.

The microprocessor requirements described in this paper were nerated as a result of the evaluation of the Alpha IV vehicle system ich utilizes a solid-state, digital 4-bit, microprocessor to perform veral vehicle control and display functions. The development of the pha IV system encompassed not only the interface circuit design and croprocessor programming, but also, the derivation of the digital gorithms and control laws for the functions which have traditionally en performed in an analog fashion.

The control functions performed include: Cruise Control, ur-Wheel-Lock Control, Traction Control, Speed Warning, Speed miting, Ignition Spark Advance and Dwell, Automatic Door Locks, and ti-Theft System. The display functions include: Speedometer (both alog and digital), Odometer, Trip Odometer, Tachometer, Clock, and apsed Time.

I - 790456
- An Improved Radar Anticollision Device
I - Flannery, John B.; Sims Jr., John C.; Brainard, Snelling R.; Ruderman, Leon (Collision Avoidance Systems)
I - Society of Automotive Engineers Technical Paper No. 790456
- SAFETY
- AUTOMATIC CONTROL; RADAR; SAFETY
-

The authors describe an automotive anticollision device which uses lsed radar and is controlled by a microprocessor. The radar and its ntrol significantly reduce false target response, loss of braking due multi-path signal cancellation and blinding from other radar uipped vehicles. Increased range with reduced false target response lows warning of an impending collision and effective automatic aking.

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I - 770267
- Microcomputer Controlled Radar and Display System for Cars
- Belohoubek, E.; Cusack, J.; Risko, J.; Rosen, J. (RCA Labs, David Sarnoff Research Center)
I - Society of Automotive Engineers Technical Paper No. 770267
- COMPUTER APPLICATIONS; ELECTRIC CONTROL-ELECTRONIC; ELECTRIC EQUIPMENT-ELECTRONIC; INSTRUMENT PANELS; RADAR
-

An experimental, non-cooperative automotive radar has been veloped for collision mitigation and automatic headway control. The I/CW radar is interfaced with a microcomputer to aid in the imination of false alarms and handle the braking, warning, and adway control algorithms. A single-line, self-scan plasma display gether with a series of sensors is also interfaced with the on-board mputer to provide normal driving related information and warning ssages in case of malfunctions in the car.

3 9 /C?
SER:
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3-
I - 740574
I - BARBI, A New Radar Concept for Precollision Sensing
I - Ross, Gerald F. (Sperry Rand Corp.)
I - Society of Automotive Engineers Proceedings No. P-53
- SAFETY; RADAR; ELECTRIC CIRCUITS
3 -

This paper describes a novel and low-cost scheme for automotive recollision sensing called BARBI, an acronym for BAseband Radar Bas

iator. An extension of this technique is also suggested for
ing applications. The proposed technique involves the transmission
reception of a subnanosecond baseband or video impulse-like signal
., no RF carrier) and requires virtually no microwave components.
very fast signal risetime permits leading edge resolution on
oaching vehicles of much less than a foot; closing velocity is
ined by using range-rate techniques. By incorporating sequential
e gating techniques, the false alarm rate can be reduced to less
one in ten years for all the cars in the U. S. today.

- 740095
- Automotive Radar Brake
- Troll, William C. (Bendix Corp.)
- Society of Automotive Engineers Technical Paper No. 740095. Also published in SAE TRANSACTIONS Vol 83 (1974)
- BRAKES; RADAR; SAFETY; SAFETY DEVICES
-

An automatic braking system for automotive vehicles is described.
system employs an onboard radar sensor to measure distance and
tive closing velocity to obstacles in the vehicle path. This range
range-rate information is processed to generate a control signal
h is a measure of the critical braking level existing in the
mic environment. In response to selected control signal
sholds, the system provides the driver with advance warning of
ntial collision situations and can subsequently automatically apply
cle braking if the driver response to the warning is judged
lequate. The critical threshold at which automatic braking is
vated is selected to be well beyond that of a normal alert driver,
eby allowing him time to exercise his own options.
Problem areas associated with practical implementation of the
matic braking system on the production automobile are discussed.
Approaches to the problem of similarly equipped vehicles mutually
rfering with each other consider controlled radiation, modulation,
signal processing techniques. All-weather performance is discussed
terms of radar operating frequency and road surface conditions. The
lem of false alarming on off-path nonhazardous objects typified by
s, bridges, and other lane traffic is treated with respect to
ressing false alarms while maintaining adequate detectability and
formance response on true obstacles. System-driver interface
siderations and related human factors are discussed in terms of
ct on system design and operational philosophy.

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  1  5670 COST(W)BENEFIT OR COST(W)EFFECTI
  2    17  (RADAR AND BRAK?) OR ELECTRONIC
  3    63  ANTILOCK? OR ANTISKID? OR ANTI(
  4   462  (COLLISION OR ACCIDENT? ?) AND
  5  6773  AUTOMOBILE? ? OR AUTOMOTIVE OR
  6    19 (2+3)*5
  7    24 4*5
  8     2 1*6
  9     0 1*7
 10    17  #6 NOT THEFT
 11    15 7-6
 12    14  #11 NOT RAIL

Print 10/5/1-17
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N T I S DATABASE

1. RADAR BRAKING & ANTISKID
2. COLLISION AVOIDANCE

Collision Avoidance Radar Braking Systems Investigation - Phase III Study

Bendix Research Labs., Southfield, MI.*National Highway Traffic Safety Administration, Washington, DC. (025254000)

Final rept. Sep 76-May 79
AUTHOR: Faris, William R.
GO125E1 Fld: 13F, 13L, 17I, 85H, 85D, 63H GRAI8002
May 79 26p
Rept No: RLD-8940
Contract: DOT-HS-6-01450
Monitor: DOT-HS-805-050
See also report dated Sep 76, PB-258 174.

Abstract: The document is the final report of the Phase III program to study the potential application of an anticipatory radar braking system in preventing motor vehicle accidents. The program was undertaken by Bendix Research Laboratories for the National Highway Traffic Safety Administration. The report describes the design of the experimental radar braking system and the installation of the system on two test vehicles. A summary of the functional tests which demonstrate the performance of the experimental system is included as well. The system description is divided into three sections. Section 2 outlines the design of the radar sensor, including the signal processing electronics, control panel display, and installation of the entire subsystem on the test vehicles. Sections 3 and 4 describe the design of the brake actuation subsystem and the anti-lock subsystem, respectively, and include information about installation of these two subsystems on test vehicles. Section 5 outlines functional tests conducted with the two test vehicles equipped with the radar braking system. The preliminary tests outlined in Section 5 demonstrate the performance of the radar braking system. In addition to general observations about closed-loop braking performance of the two radar-brake-equipped test vehicles. Section 6 outlines the major differences in performance between the two test vehicles. More extensive tests of the radar braking system installed in the test vehicles are recommended.

Descriptors: *Automobiles, *Radar equipment, *Dynamic braking, *Collision avoidance, Brakes(Motion arresters), Accident prevention, Design, Evaluation, Performance, Tests, Data acquisition, Automatic control

Identifiers: Antilock brake systems, NTISDOTHTS

PB80-105349 NTIS Prices: PC A03/MF A01

Improved Passenger Car Braking Performance

Michigan Univ., Ann Arbor. Highway Safety Research Inst.*National Highway Traffic Safety Administration, Washington, D.C. (407 825)

Final technical rept. Jun 76-Feb 78
AUTHOR: Ervin, R. D.; Campbell, J. D.; Sayers, M.; Bunch, H.
E2602C3 Fld: 13F, 13L, 85H, 85D GRAI7824
Mar 78 125p
Rept No: UM-HSRI-78-12
Contract: DOT-HS-6-01368
Monitor: DOT-HS-803-458

Abstract: Test conditions were studied as candidates for extending the scope of the stopping distance requirements of FMVSS 105-75, 'Hydraulic Brake Systems.' Conditions of interest included low and split friction surfaces as well as straight-line braking and braking-in-a-turn maneuvers. Two large test programs were conducted and various analytical efforts were applied to the examination of the candidate test conditions and methods. Throughout all of the study activities, only stopping distance performance was taken as the measure for evaluating the utility of the candidate conditions and methods. It was concluded that only the low friction, straight-line braking condition constitutes a viable extension of the stopping requirements of 105-75. It was also found that stopping distances in a turn do not differ significantly from stopping distances measured in straight-line braing. Further, stopping distances on split friction surfaces do not appear generally useful as characterizations of vehicle safety quality.

Descriptors: *Passenger vehicles, *Dynamic braking, Hydraulic brakes, Stopping, Test facilities, Disc brakes, Drum brakes, Economic analysis, Safety engineering

Identifiers: *Stopping distance, *Braking distance, Antilocking devices, NTISDOTHTS

PB-284 648/3ST NTIS Prices: PC A06/MF A01

Improved Passenger Car Braking Performance. Appendices

Michigan Univ., Ann Arbor. Highway Safety Research Inst.*National Highway Traffic Safety Administration, Washington, D.C. (407 825)

Final rept. Jun 76-Feb 78
AUTHOR: Ervin, R. D.; Campbell, J. D.; Sayers, M.; Bunch, H.
E2592L3 Fld: 13F, 85H GRAI7824
Mar 78 199p
Rept No: UM-HSRI-78-12-3
Contract: DOT-HS-6-01368
Monitor: DOT-HS-803-459

Abstract: ;Contents: Data from twelve-car survey test program-vehicle descriptions and data summaries; Calculated results of a quasi-static analysis; Data from in-depth test program on five cars; Simulation results using dynamic braking model; A look at the accuracy of simplified methods for computing reference vehicle ideal stopping distance for the braking efficiency test technique; Antilock braking model; Test sequence and procedure.

Descriptors: *Passenger vehicles, *Braking, Hydraulic brakes, Distance, Tests, Efficiency, Evaluation, Standards, Safety engineering, Friction

Identifiers: Federal motor vehicle safety standard, Antilock brake systems, NTISDOTHTS

PB-284 396/9ST NTIS Prices: PC A09/MF A01

Improved Passenger Car Braking Performance

Michigan Univ., Ann Arbor. Highway Safety Research Inst.*National Highway Traffic Safety Administration, Washington, D.C. (407 825)

Final summary rept. Jun 76-Feb 78
AUTHOR: Ervin, R. D.; Campbell, J. D.; Sayers, M.; Bunch, H.
E2585E2 Fld: 13F, 85H GRAI7824
Mar 78 30p
Rept No: UM-HSRI-78-12-1
Contract: DOT-HS-6-01368
Monitor: DOT-HS-803-457

Abstract: Test conditions were studied as candidates for extending the scope of the stopping distance requirements of FMVSS 105-75, 'Hydraulic Brake Systems.' Conditions of interest included low and split friction surfaces as well as straight-line braking and braking-in-a-turn maneuvers. Two large test programs were conducted and various analytical efforts were applied to the examination of the candidate test activities, only stopping distance performance was taken as the measure for evaluating the utility of the candidate conditions and methods. It was concluded that only the low friction, straight-line braking condition constitutes a viable extension of the stopping requirements of 105-75. It was also found that stopping distances in a turn do not differ significantly from stopping distances measured in straight-line braking. Further, stopping distances on split friction surfaces do not appear generally useful as characterizations of vehicle safety quality.

Descriptors: *Passenger vehicles, *Braking, Hydraulic brakes, Distance, Tests, Evaluation, Standards, Safety engineering, Friction

Identifiers: Federal motor vehicle safety standards, Antilock brake systems, NTISDOTHTS

PB-284 243/3ST NTIS Prices: PC A03/MF A01

Automotive Radar Research

Institute for Telecommunication Sciences, Boulder, Colo.*National Highway Traffic Safety Administration, Washington, D.C.

Final rept. 1 Jun 76-15 Aug 77
AUTHOR: Chandler, Richard A.
E2464C2 Fld: 13F, 17I, 85D, 85H, 63H GRAI7823
Jul 77 58p
Contract: DOT-HS-6-01375
Monitor: DOT-HS-803-399

Abstract: The report describes the investigation of the interference effect of radar brake sensors operating in the 60GHz vicinity with satellite communication systems and radio astronomy activity. Also, the results of the study on an experimental baseband radar system, which was built and tested under this contract, are discussed. (Portions of this document are not fully legible)

Descriptors: *Radar, *Frequency allocation, Brakes(Motion arresters), Automobiles, Radar equipment, Electromagnetic compatibility, Extremely high frequencies, Radiofrequency interference, Radio astronomy

Identifiers: NTISDOTHTS

PB-283 751/6ST NTIS Prices: PC A04/MF A01

Skidding Accidents: Tires, Vehicles, and Vehicle Components

Transportation Research Board, Washington, D.C.
AUTHOR: Segel, Leonard
D3803E4 Fld: 13F, 13L, 85D*, 85H GRAI7726
1976 179p
Rept No: TRB/TRR-621; ISBN-0-309-02574-5
Monitor: 18
Proceedings of a Conference conducted by the Transportation Research Board, on May 2-6, 1977.

Abstract: The 17 papers deal with the following areas: Tire-vehicle system elements bearing on the probabilities of loss o: control; skid resistance properties of tires and their influence on vehicle control; vehicle design and skid resistance; design of suspension to prevent pulling to one side and skidding during breaking-particularly on a surface with differing coefficient of friction; ASTM skid trailers instrumentation systems thru computerization; measurement of shear forces developed between tire and pavement; measuring skid resistance of passenger car tires on an indoor facility; a consideration of tire-road traction measuring method in Japan; an overview of European measuring methods and techniques; wheel lock control state-of-the-art; brake modeling anti-lock simulation; effect of tire construction variables on passenger tire wet traction; effects of tread composition on wet skid resistance of passenger tires; tire wet traction performance--the influence of tread pattern; the effect of operating conditions on the skid performance of tires; influence of tread depth on wet skid resistance of tires and the wet roadhold of tires--a European viewpoint.

Descriptors: *Motor vehicle accidents, *Skid resistance, *Automobile tires, *Meetings, Suspension systems(Vehicles), Stability, Maneuverability, Control, Braking, Brakes(Motion arresters), Tires, Pavement, Traction, Treads

Identifiers: Cornering maneuvers, Wet pavements, Tire traction, Tire tread patterns, Antilock brake systems, Vehicle road interface, NTISNASTRB, NTISNASNRC

PB-272 809/5ST NTIS Prices: PC A09/MF A01

Analysis of Problems in the Application of Radar Sensors to Automotive Collision Prevention. Phase III. Volume II

Office of Telecommunications, Boulder, Colo. Inst. for Telecommunication Sciences.*National Highway Traffic Safety Administration, Washington, D.C. (406 445)

Final rept. Mar-Dec 75
AUTHOR: Chandler, R. A.; Jacobson, L. A.
D0065D1 Fld: 13F, 17I, 85B, 85D, 63H GRAI7626
Sep 76 64p
Contract: DOT-HS-5-01096
Monitor: DOT-HS-802-015
See also PB-240 733, PB-240 950, and PB-258 004.

Abstract: The report describes the results of the third phase of an investigation of the practicality and technical feasibility of applying radar as a sensor for automatic braking systems. Hardware evaluation of a baseband system as a brake sensor is discussed, and target signatures generated by the system are presented. Analyses of the performance of different types of systems in the presence of rain are given; performance of a realistic system in minimum-radius horizontal curves is analyzed; estimates of the probability of intersystem blinding generated by multiple vehicles are given.

Descriptors: *Automobiles, *Brakes(Motion arresters), *Radar, Automatic control, Detectors, Signatures, Rain, Visibility, Reflectivity, Atmospheric attenuation, Traffic safety

Identifiers: Baseband radar, NTISDOTHTS

PB-258 190/8ST NTIS Prices: PC A04/MF A01

Collision Avoidance Radar Braking Systems Investigation. Phase II Study. Volume II. Technical Report

Bendix Research Labs., Southfield, Mich.*National Highway Traffic Safety Administration, Washington, D.C. (304 180)

Final rept. May 75-Jan 76
AUTHOR: Wong, R. E.; Faris, W. R.; Grierson, W. O.; Troll, W. C.; Powell, Y. M.
DOO65A2 Fld: 13F, 13L, 17I, 85B, 85D, 63H GRAI7626
Sep 76 187p
Rept No: RLD-8035-Vol-2
Contract: DOT-HS-4-00913
Monitor: DOT-HS-802-020
See also PB-258 174.

Abstract: A computer simulation program was employed to evaluate the system cost-effectiveness of 36 automatic/ radar brake system configurations. The effects of changing system design parameters and operational differences within each system were examined. 1973 traffic accident data sources representing six states and six counties were selected to provide the largest practical data base and to reduce biases due to geographic, economic and reporting agency influences. System evaluation was made in a comparative form to show the estimated values to society over the lifetime of the vehicle and benefits were estimated in reduction of fatalities, injuries, and property damage. The study results indicate that an automatic/noncooperative radar brake system can be designed which could effectively suppress the false alarms due to non-hazardous targets and still be cost-effective in reducing motor traffic accidents.

Descriptors: *Automobiles, *Radar equipment, *Dynamic braking, *Collision avoidance, Accident prevention, Automatic control, Systems engineering, Computerized simulation, Feasibility, Data acquisition

Identifiers: *Radar braking systems, False alarms, Nonhazardous targets, NTISDOTHTS

PB-258 175/9ST NTIS Prices: PC A09/MF A01

Collision Avoidance Radar Braking Systems Investigation. Phase II Study. Volume I. Summary Report

Bendix Research Labs., Southfield, Mich.*National Highway Traffic Safety Administration, Washington, D.C. (304 180)

Final rept. May 75-Jan 76
AUTHOR: Wong, R. E.; Faris, W. R.; Grierson, W. O.; Troll, W. C.; Powell, Y. M.
DOO65A1 Fld: 13F, 13L, 17I, 85B, 85D, 63H GRAI7626
Sep 76 52p
Rept No: RLD-8035-Vol-1
Contract: DOT-HS-4-00913
Monitor: DOT-HS-802-019
See also PB-237 546.

Abstract: An instrumented test automobile equipped with an automatic/noncooperative radar brake system was used to gather and classify experimental data on radar false alarms as a function of various radar system parameters such as: detection range cut off (RCO), antenna beamwidth, range delay and vehicle velocity. The test vehicle was driven over three roadways under actual traffic conditions within the metropolitan area of Detroit, Michigan. The roadways typify much of the high density, high speed, urban and suburban driving in the United States. Results of the test program showed that both the detection range cut off and antenna beamwidth have a pronounced effect upon the false alarm problem; the range delay and vehicle velocity are of secondary importance. Analytical analyses were also performed to determine the effects of radar design parameters such as beamwidth and frequency on rain clutter and radar detection probability for three target classifications ranging from pedestrians to full size passenger cars. A computer simulation program was employed to evaluate the system cost-effectiveness of 36 system configurations.

Descriptors: *Automobiles, *Radar equipment, *Dynamic braking, *Collision avoidance, Field tests, Radar target designators, Data acquisition, Automatic control, Factor analysis, Warning systems, Beam width, Velocity, Range(Extremes), Experimental data, Performance evaluation, Revisions, Accident prevention, Safety engineering, Computerized simulation

Identifiers: *Radar braking systems, False alarms, Test vehicles, Nonhazardous targets, NTISDOTHTS

PB-258 174/2ST NTIS Prices: PC A04/MF A01

Analysis of Problems in the Application of Radar Sensors to Automotive Collision Prevention. Phase III, Volume I

Institute for Telecommunication Sciences, Boulder, Colo.*National Highway Traffic Safety Administration, Washington, D.C. (403 394)

Final rept. Mar-Dec 75
AUTHOR: Chandler, R. A.; Jacobson, L. A.
D0063E1 Fld: 13F, 17I, 85B, 85D, 63H, 86X GRAI7626
Sep 76 33p
Contract: DOT-HS-5-01096
Monitor: DOT-HS-802-014
See also PB-240 950.

Abstract: The report describes the results of the third phase of an investigation of the practicality and technical feasibility of applying radar as a sensor for automatic braking systems. Hardware evaluation of a baseband system as a brake sensor is discussed, and target signatures generated by the system are presented. Analyses of the performance of different types of systems in the presence of rain are given; performance of a realistic system in minimum-radius horizontal curves is analyzed; estimates of the probability of intersystem blinding generated by multiple vehicles are given.

Descriptors: *Motor vehicles, *Brakes(Motion arresters), *Radar, Automatic control, Detectors, Collision avoidance, Signatures, Rain, Reflectivity, Visibility, Atmospheric attenuation

Identifiers: Baseband radar, NTISDOTHTS

PB-258 004/1ST NTIS Prices: PC A03/MF A01

Analysis of Problems in the Application of Radar Sensors to Automotive Collision Prevention

Institute for Telecommunication Sciences, Boulder, Colo.*National Highway Traffic Safety Administration, Washington, D.C. (403 394)

Final rept. Jan 74-Jan 75
AUTHOR: Chandler, R. A.; Wood, L. E.; Jacobson, L. A.
C4661C1 Fld: 13F, 85B, 85D, 91B GRAI7513
Mar 75 306p
Contract: DOT-HS-4-00813
Monitor: DOT-HS-801-452

Abstract: The report describes the results of the second phase of an investigation of the practicality and technical feasibility of using radar sensors for automatic automotive braking systems. Radar signatures of typical vehicular targets at 35 GHz and 60 GHz are shown. Results are compared with 10 GHz signatures obtained in Phase I. Tracking radar systems and their feasibility in the automotive application are discussed with respect to the problem of potentially high false alarm rates caused by highway curves. The problem of intersystem blinding is considered in depth, and estimations are made of the effectiveness of polarization isolation and frequency-hopping in reducing blinding effects. The performance of diplex radar systems in blinding configurations is discussed. Preliminary specifications are recommended as guidelines for judging the acceptability of prototype systems for marketing. Performance tests for verifying a system's compliance with the suggested specifications are outlined and discussed.

Descriptors: *Brakes(Motion arresters), *Collision avoidance, *Radar, Automobiles, Automatic control, Signatures, Detectors, Electromagnetic interference, Microwave equipment

Identifiers: DOT/4IZ/IE, DOT/5A, NTISDOTHTS

PB-240 950/6ST NTIS Prices: PC A14/MF A01

Analysis of Problems in the Application of Radar Sensors to Automotive Collision Prevention. Executive Summary

Institute for Telecommunication Sciences, Boulder, Colo.*National Highway Traffic Safety Administration, Washington, D.C. (403 394)

Final rept. Jan 74-Jan 75
AUTHOR: Chandler, R. A.; Wood, L. E.; Jacobson, L. A.
C4604G1 Fld: 13F, 13L, 17I, 85D, 85B, 63H GRAI7512
Mar 75 27p
Contract: DOT-HS-4-00813
Monitor: DOT-HS-801-453

Abstract: The report describes the results of the second phase of an investigation of the practicality and technical feasibility of using radar sensors for automatic automotive braking systems. Radar signatures of typical vehicular targets at 35 GHz and 60 GHz are shown. Results are compared with 10 GHz signatures obtained in Phase I. Tracking radar systems and their feasibility in the automotive application are discussed with respect to the problem of potentially high false alarm rates caused by highway curves. The problem of intersystem blinding is considered in depth, and estimations are made of the effectiveness of polarization isolation and frequency-hopping in reducing blinding efforts. The performance of diplex radar systems in blinding configurations is discussed. Preliminary specifications are recommended as guidelines for judging the acceptability of prototype systems for marketing. Performance tests for verifying a system's compliance with the suggested specifications are outlined and discussed.

Descriptors: *Collision avoidance, *Radar, Automobiles, Radar detection, Braking, Ground vehicles

Identifiers: Radar signatures, DOT/4IZ/IE, DOT/4DZ/DB, NTISDOTHTS

PB-240 733/6ST NTIS Prices: PC A03/MF A01

Collision Avoidance Radar Braking System Investigation (Phase I)

IIT Research Inst., Chicago, Ill.*National Highway Traffic Safety Administration, Washington, D.C. (175 350)

Final rept. 11 Jun-11 Sep 74
AUTHOR: Demos, G.; Kazel, S.; Carlson, R.; Viergutz, O.; Morita, D.
C4165H1 Fld: 13F, 17I, 13L, 85D*, 85B, 63H GRAI7506
Dec 74 307p*
Rept No: IITRI-E6306-1
Contract: DOT-HS-4-00935
Monitor: DOT-HS-801-309

Abstract: The subject areas receiving special attention in the study, were: (1) identification and analysis of the manner in which driver, driving environment, and vehicle characteristics in conjunction with radar braking objectives, affect the requirements of the system, (2) characterization of the subsystems of the radar braking concepts as to the function, tradeoffs, alternative implementation, and technology limitations, (3) appraisal of the current state-of-the-art in radar braking techniques and systems, (4) generation of candidate braking systems and radar techniques, and (5) analysis of accident statistics to determine the relative benefits of the candidate system configurations. Portions of this document are not fully legible.

Descriptors: *Automobiles, *Collision avoidance, *Brakes(Motion arresters), *Radar, Performance tests, Automotive engineering, Systems engineering, Radiation hazards, Accident prevention

Identifiers: Trade off analysis, *Radar braking systems, DOT/5A, DOT/4DZ/DB, NTISDOTHSA, NTISDOT

PB-238 486/5ST NTIS Prices: PC A14/MF A01

Passenger Car Directional Control Test Program

Ultrasystems, Inc., Phoenix, Ariz. Dynamic Science Div.*National Highway Traffic Safety Administration, Washington, D.C. (408 442)

Final rept. May-Dec 73
AUTHOR: Boyer, R. C.; Enserink, E.
C3492G3 Fld: 13F, 85B GRAI7422
Dec 73 251p
Rept No: Dynamic Science-2310-73-161
Contract: DOT-HS-046-3-667
Monitor: DOT-HS-801-061

Abstract: The effects of various antilock system configurations on the directional control of passenger cars are documented. Tests were conducted on straight and curved paths with high, medium, and low friction coefficient surfaces. To isolate the effects of the antilock systems, one test vehicle was tested with the following antilock systems: no antilock; drive shaft controlled rear; select-low rear; select-low front and rear; independent front, select-low rear; four-wheel independent. Two additional vehicles of similar weight were tested with and without a drive shaft controlled rear antilock system to assess the effects of vehicle dynamics. Results suggest that the four-wheel independent configuration performs best from a safety standpoint and that vehicle dynamics affect performance of the antilock system.

Descriptors: *Passenger vehicles, *Braking, Control, Stability, Stopping, Road tests, Acceleration, Steering

Identifiers: *Antilock brake systems, NTISDOTHSA

PB-234 313/5 NTIS Prices: PC A12/MF A01

Analysis of Problems on the Application of Radar Sensors to Automotive Collision Prevention

Office of Telecommunications, Boulder, Colo. Inst. for Telecommunications Sciences. (406 445)

Final rept. Mar-Nov 73
AUTHOR: Wood, L. E.; Chandler, R. A.; Warner, B. D.
C2164D1 Fld: 13L, 17I, 13F, 85D GRAI7404
Dec 73 31p
Contract: DOT-HS-314-3-601
Monitor: DOT-HS-801 010

Abstract: The report describes the results of an investigation of the practicality and technical feasibility of applying radar as a sensor for automatic automotive braking systems. Radar signatures of a variety of targets are given which were obtained with a 10 GHz multiple-frequency CW radar. These targets include automobiles, trucks, corner reflectors, pedestrians, and cyclists. Effects of rainfall on radar performance are considered with respect to frequency, rainfall rate, and whether the radar is a CW or pulsed system. An analysis of system performance as affected by road geometry is provided, as well as a study of some of the considerations involved in the dynamics of vehicle stopping. A study is made of possibly hazardous radiation levels resulting from the general use of vehicular microwave radars.

Descriptors: *Brakes(Motion arresters), *Motor vehicle accidents, *Collision avoidance, *Continuous wave radar, Automatic control, Feasibility, Detectors, Radiation effects, Hazards

Identifiers: NHTSA

PB-226 084/2 NTIS Prices: PC A03/MF A01

Analysis of Problems on the Application of Radar Sensors to Automotive Collision Prevention

Office of Telecommunications, Boulder, Colo. Inst. for Telecommunication Sciences. (406 445)

Final rept. Mar-Nov 73
AUTHOR: Wood, L. E.; Chandler, R. A.; Warner, B. D.
C2163K4 Fld: 13L, 13F, 17I, 85D, 63H GRAI7404
Dec 73 368p
Contract: DOT-HS-314-3-601
Monitor: DOT-HS-801 011

Abstract: The report describes the results of an investigation of the practicality and technical feasibility of applying radar as a sensor for automatic automotive braking systems. Radar signatures of a variety of targets are given which were obtained with a 10 GHz multiple-frequency CW radar. These targets include automobiles, trucks, corner reflectors, pedestrians, and cyclists. Effects of rainfall on radar performance are considered. An analysis of system performance as affected by road geometry is provided, as is a study of some of the considerations involved in the dynamics of vehicle stopping. A study is made of possibly hazardous radiation levels resulting from the general use of vehicular microwave radars.

Descriptors: *Brakes(Motion arresters), *Continuous wave radar, *Automobiles, Radar detection, Automatic traction, Feasibility, Collision avoidance, Radiation effects

Identifiers: NHTSA

PB-226 065/1 NTIS Prices: PC A16/MF A01

AN ASSESSMENT OF THE AUTOMOTIVE PRODUCTS 'ANTILOK' ANTI-LOCKING BRAKING SYSTEM FITTED TO AN ARTICULATED VEHICLE

Road Research Lab., Crowthorne (England).
AUTHOR: Wilkins, H. A.; Chinn, B. P.
6202C3 Fld: 13F, 946 USGRDR6914
1968 17p*
Rept No: RRL-LR191

Abstract: Jack-knifing of articulated vehicles is usually caused by the locking of the tractor rear wheels, when brakes are applied. A method of preventing jack-knifing is to use an anti-locking braking system to ensure that these wheels do not lock. This report describes the results obtained during braking tests with an articulated lorry, which had the Automotive Products Group 'Antilok' anti-locking braking system fitted to the rear brakes of the tractor unit. The anti-locking system completely prevented the tractor rear wheels from locking, and jack-knifing, which occurred with the standard braking system, was eliminated. The braking distances obtained did not differ much from those given by the unmodified vehicle, being slightly shorter on a slippery surface and slightly longer on other surfaces. (Author)

Descriptors: (*Vehicle brakes, *Cargo vehicles), Braking, Trailers, Load distribution, Servomechanisms, Roads, Surface properties, Road tests, Instrumentation, Weight, Great Britain

Identifiers: *Antilocking braking system, Truck tractors, Skid resistance

PB-184 042 CFSTI Prices: HC A02/MF A01

Research Safety Vehicle - Phase II. Volume IIIb. Subcontractor Final Reports: RCA Laboratories, Stanford Research Institute, Systems Technology, Inc., University of Utah

Minicars, Inc., Goleta, Calif.*National Highway Traffic Safety Administration, Washington, D.C.

Rept. for Jul 75-Dec 76.
E1625B3 Fld: 13F, 13L, 85D, 85H GRAI7816
Nov 77 378p
Contract: DOT-HS-5-01215
Monitor: DOT-HS-803-252
See also Volume 3a, PB-280 154.

Abstract: The report covers the electronics portion of a larger program aimed at the development of a Research Safety Vehicle (RSV) for the mid-1980's. The specific objectives for this phase of the program were to develop and test (a) a noncooperative radar system for the purpose of obstacle warning and collision mitigation; and (b) an electronic central display system that provides the driver with normal driving-related information together with emergency warning messages if a malfunction occurs in certain safety-related parts of the car. To perform these sometimes complex functions efficiently, reliably, and in a very short time, microcomputers are used that are interfaced with a number of sensors as well as with the radar.

Descriptors: *Automobiles, *Safety engineering, *Electric equipment, Radar, Modulation, Radio frequencies, Antennas, Signal processing, Collision avoidance, Detectors, Display systems, Automotive engineering, Warning systems, Microcomputers

Identifiers: *Research safety vehicles, *Electronic equipment, Compact automobiles, NTISDOTHTS

PB-280 155/3ST NTIS Prices: PC A17/MF A01

Research Safety Vehicle - Phase II. Volume I. Executive Summary

Minicars, Inc., Goleta, Calif.*National Highway Traffic Safety Administration, Washington, D.C.

Final rept. Jul 75-Dec 76
AUTHOR: Struble, Donald
E1204B3 Fld: 13F, 85H GRAI7813
Dec 76 25p
Contract: DOT-HS-5-01215
Monitor: DOT-HS-803-249
See also PB-265 248.

Abstract: Volume I summarizes the results of the Minicars Research Safety Vehicle Phase II program, as detailed in Volumes II and III. Phase I identified trends leading to the desired national social goals of the mid-1980's in vehicle crashworthiness, crash avoidance, damageability, pedestrian safety, fuel economy, emissions and cost, and characterized an RSV to satisfy them. In Phase II an RSV prototype was designed, developed and tested to demonstrate the feasibility of meeting these goals simultaneously. Although further refinement is necessary to assure operational validity, in all categories the results meet or exceed the most advanced performance specified by The Presidential Task Force on Motor Vehicle Goals beyond 1980.

Descriptors: *Automobiles, *Safety engineering, Collision avoidance, Model tests, Safety devices, Fuel consumption, Exhaust emissions, Cost estimates, Feasibility

Identifiers: Crashworthiness, *Research safety vehicles, *Minicars, NTISDOTHTS

PB-278 385/OST NTIS Prices: PC A02/MF A01

Road Safety. Experimental Safety Vehicle. (Report on the Fourth International Technical Conference) (Securite Routiere Vehicule Experimental de Securite. Quatrieme Conference Technique Internationale)

NATO Committee on the Challenges of Modern Society, Brussels (Belgium).*National Highway Traffic Safety Administration, Washington, D.C. (406 609)
C6283G2 Fld: 13F, 13L, 85D, 96D GRAI7610
Mar 73 615p
Rept No: NATO/CCMS-34
Monitor: 18
NATO furnished.

Abstract: The report includes the conference opening remarks, status reports by governmental representatives and the formal technical presentations by the automotive industries participating. The Conference ended with the technical papers presented and the discussions held during the parallel seminars on 'Crashworthiness' and 'Accident Avoidance,' a discussion period on rulemaking and experimental safety vehicles, and summations and concluding remarks by the United States and Japan.

Descriptors: *Automobiles, *Safety engineering, *Meetings, Collision avoidance, Traffic safety, Automobile bodies, Braking, Steering, Accident prevention, Japan, United States government

Identifiers: *Crashworthiness, *Experimental safety vehicles, NATO, NTISEPAL

PB-250 156/7ST NTIS Prices: PC E09/MF A01

Accident Avoidance Test Report-Nissan and Toyota Experimental Safety Vehicles

Ultrasystems, Inc., Phoenix, Ariz. Dynamic Science Div.*National Highway Traffic Safety Administration, Washington, D.C. (408 442)

Final rept. Apr 74-Jul 75
AUTHOR: Boulay, P.; Macaulay, T.
C5552C3 Fld: 13F, 13L, 85D, 95D, 96D GRAI7526
Sep 75 153p
Rept No: Dynamic Science-2310-75-116
Contract: DOT-HS-4-00860
Monitor: DOT-HS-801-713

Abstract: Two Experimental Safety Vehicles (ESVs) manufactured by Nissan and Toyota of Japan were tested to evaluate the accident avoidance performance of each vehicle. The report contains a brief description of each vehicle and of each test [illegible] performed included: Braking performance -stopping distance, pedal force, emergency braking, brake efficiency, and parking brake tests; steering performance -transient and steady state yaw response; handling -lateral acceleration, sinusoidal steer, and trapezoidal steer tests; overturning immunity -drastic steer and brake tests. Each of the above results are presented and compared to the Japanese ESV design requirements.

Descriptors: *Automobiles, *Accident prevention, *Safety engineering, Dynamic tests, Safe handling, Braking, Steering, Design standards

Identifiers: Experimental safety vehicles, Toyota Motor Company, Nissan Motor Company, Toyota automobiles, Nissan automobiles, DOT/5A, DOT/4DZ/DB, NTISDOTHTS

PB-245 596/2ST NTIS Prices: PC A08/MF A01

International Congress on Automotive Safety (3rd) Proceedings, Held at San Francisco, on July 15-17, 1974. Volume 2, Supplement

National Motor Vehicle Safety Advisory Council, Washington, D.C.*National Highway Traffic Safety Administration, Washington, D.C.

Conference proceedings.
C4794A1 Fld: 13L, 13F, 85D GRAI7515
Mar 75 874p*
Monitor: DOT-HS-801-481
See also PB-227 839, and Volume 1, PB-241 766.

Abstract: This is the second volume of the proceedings on pedestrian safety, bicyclist safety, vehicle mix, small car-big car mix, vehicle factors affecting pedestrian and bicyclist safety.

Descriptors: *Traffic safety, *Motor vehicle accidents, *Meetings, Accident prevention, Bicycles, Safety engineering, Collision avoidance, Pedestrian movement, Automobiles, Motorcycles, Structural design

Identifiers: DOT/5A, DOT/4DZ, NTISDOTHTS

PB-241 767/3ST NTIS Prices: PC E10/MF A01

International Congress on Automotive Safety (3rd) Proceedings, Held at San Francisco on July 15-17 1974. Volume 1, Supplement

National Motor Vehicle Safety Advisory Council, Washington, D.C.*National Highway Traffic Safety Administration, Washington, D.C.

Conference proceedings.
C4793L4 Fld: 13L, 13F, 85D* GRAI7515
Mar 75 668p*
Monitor: DOT-HS-801-480
See also Volume 2, PB-241 767.

Abstract: Because the United States experienced an unprecedented and dramatic drop in highway fatalities coupled with a strong consumer demand for smaller, more economical automobiles, some experts believe the smaller car to be much less safe than the normal size American car to which many are accustomed. While experiencing an overall drop in highway fatalities, bicyclist deaths from crashes with motor vehicles acutely increased during the most critical months of the energy crisis. This is not surprising when we hear that last year more bicycles were sold than automobiles. The bicycle must be regarded as a highway vehicle, and the Council hopes to find ways by which the increasing death and injury toll of unprotected bicyclists can effectively be reduced through improved designs of motor vehicles. Pedestrian deaths which account for approximately 20 percent of our highway fatalities, might also be significantly reduced through improved vehicle designs.

Descriptors: *Traffic safety, *Motor vehicle accidents, *Meetings, Accident prevention, Bicycles, Safety engineering, Collision avoidance, Pedestrian movement, Automobiles, Motorcycles, Structural design

Identifiers: DOT/5A, DOT/4DZ, NTISDOTHTS

PB-241 766/5ST NTIS Prices: PC E09/MF A01

An Evaluation of the U.S. Family Sedan ESV Project

Battelle Columbus Labs., Ohio.*National Highway Traffic Safety Administration, Washington, D.C. (407 080)

Final rept. Feb 73-Oct 74
AUTHOR: Alexander, G. H.; Vergara, R. D.; Herridge, J. T.; Millicovsky, W.; Neale, M. R.
C4461F3 Fld: 13F, 13L, 85D*, 96D* GRAI7510
Oct 74 368p*
Contract: DOT-HS-322-3-621
Monitor: DOT-HS-801-255

Abstract: An evaluation has been made of the results obtained from the U.S. Family Sedan Experimental Safety Vehicle (ESV) Project. The topical framework for the evaluation includes: (1) General vehicle design; (2) technology for accident avoidance; (3) technology for crash energy management; (4) technology for post-crash safety; and (5) nonoperating safety. It is concluded that, in general, the Family Sedan ESV Project approached or met its demanding basic objectives.

Descriptors: *Passenger vehicles, *Safety engineering, Design criteria, Collision avoidance, Collision research, Safety devices, Brakes(Motion arresters), Steering, Suspension systems(Vehicles)

Identifiers: DOT/5A, DOT/4DZ, *ESV(Experimental Safety Vehicles), *Experimental safety vehicles, *Family sedans, *Safety cars, NTISDOTHTS

PB-239 823/8ST NTIS Prices: PC A16/MF A01

Development and Evaluation of Anticipatory Crash Sensors for Automobiles

Transportation Systems Center, Cambridge, Mass. (407 082)

Final rept. Jun 70-Jun 73
AUTHOR: Hopkins, J.; Holmstrom, F. R.; Hazel, M.; Abbott, R.
C2723G2 Fld: 13F, 13L, 85D, 96D GRAI7411
Feb 74 335p
Rept No: DOT-TSC-NHTSA-73-6
Monitor: DOT-HS-801 036

Abstract: The report discusses the means, effectiveness, and estimated costs of carrying out anticipatory sensing of automobile collisions. Actuation of passive restraint systems requires only a small advance warning to extend the protection of such devices to impact speeds of 30 to 60 MPH -- a range encompassing a large number of fatal and severe-injury accidents. Radar is the most promising crash sensing technique. Design, construction, and extensive test of prototype systems, accompanied by studies of component cost and reliability, show that an OEM price of $20 per unit should be attainable for systems exhibiting high electronic reliability.

Descriptors: *Automobiles, *Crash locator beacons, *Radar equipment, Collision avoidance, Accident prevention, Safety devices, Actuators, Collision research

Identifiers: *Air bag restraint systems, *Automobile crash sensors, NHTSA

PB-230 964/9 NTIS Prices: PC A15/MF A01

Improvement in Cable Barrier Design

National Aeronautical Establishment, Ottawa (Ontario). Structures Section.
AUTHOR: Mccaffrey, G. F. W.
C2175D1 Fld: 13B, 50A STAR1201
Oct 72 29p
Rept No: LTR-ST-621
Monitor: 18
Conf-Presented at Ann. Conv. Of the Roads and Transportation Assoc. Of Can., Winnipeg, Manitoba, 2-5 Oct. 1973.

Abstract: A review of current practices in highway barrier design is presented with particular emphasis on cable barriers. The development of a mathematical model for vehicle barrier dynamics and the design of experiments to validate the model are also reported. The importance of a number of design details on barrier performance is discussed and related to other barriers in current use. (Author)

Descriptors: *Barriers, *Cables (Ropes), *Highways, *Structural design criteria, Automobiles, Collision avoidance, Safety devices, Traffic control, Urban transportation

Identifiers: NASA

N74-10477/9 NTIS Prices: PC A03/MF A01

Accident Avoidance Evaluation of Ford Experimental Safety Vehicles

Dynamic Science, Phoenix, Ariz. (407 293)

Final rept. Jan-Jul 73.
C2162J3 Fld: 13F, 85D*, 96D GRAI7404
Nov 73 152p*
Rept No: 2310-73-104
Contract: DOT-HS-046-2-468
Monitor: DOT-HS-800 976

Abstract: An experimental safety vehicle manufactured by Ford Motor Company was tested to verify compliance with basic design requirements and to evaluate the accident avoidance performance of the vehicle. The report contains results of tests and evaluations performed on this vehicle.

Descriptors: *Passenger vehicles, *Safety engineering, Accident prevention, Design standards, Evaluation, Tests, Safe handling, Maneuverability, Braking, Steering, Internal combustion engines, Visibility

Identifiers: *Safety cars, NHTSA

PB-225 928/1 NTIS Prices: PC A08/MF A01

Accident Avoidance Evaluation of General Motors Experimental Safety Vehicle

Dynamic Science, Phoenix, Ariz. (407 293)

Final rept. Jul-Dec 72
C1204A4 Fld: 13F, 13L, 85D*, 96D GRAI7315
May 73 159p*
Rept No: 2310-73-1
Contract: DOT-HS-046-2-468
Monitor: DOT-HS-800 854

Abstract: Two Experimental Safety Vehicles manufactured by General Motors Corporation were tested by Dynamic Science to verify compliance with basic design requirements and to evaluate the accident avoidance performance of the vehicles. The report contains results of tests and evaluations performed on these vehicles. Results from two tasks are presented and compared to the design requirements: Task I - Evaluation of Design Requirements - includes the vehicles' weights, dimensions, passenger capacity, and overall body style definitions. Task II - Accident Avoidance Evaluations - includes data on the vehicles' braking, handling, steering, overturn immunity, engine, and visibility capabilities.

Descriptors: (*Automobiles, Design standards), (*Accident prevention, Automobiles), (*Safety engineering, Automobiles), Evaluation, Automobile bodies, Braking, Steering, Automobile engines, Tests

Identifiers: *Safety cars, NHSB

PB-221 182/9 NTIS Prices: PC A08/MF A01

Experimental Safety Vehicle (Family Sedan): Design, Development and Fabrication

AMF, Inc., Santa Barbara, Calif. Advanced Systems Lab.

Final rept.
C077414 Fld: 13L, 13F, 85D, 95D GRAI7311
Mar 72 751p
Contract: DOT-HS-00090
Monitor: DOT-HS-800 689

Abstract: The report reviews and summarizes the activities and significant events in the design, development, and fabrication of an Experimental Safety Vehicle (Family Sedan). It consists mainly of a technical description of how the final design of the major vehicle subsystems was attained. Only data and analyses developed subsequent to that submitted in the Preliminary Design Report of March 1971 is contained in the report. (Author)

Descriptors: (*Automobiles, Design), (*Safety, Automobiles), Collision avoidance, Braking, Suspension systems(Vehicles), Automobile tires, Vehicle wheels, Steering gear, Control, Mirrors, Bumpers, Safety belts, Electric wiring

Identifiers: Structural crashworthiness, NHSB

PB-218 466/1 NTIS Prices: PC E03/MF A01

Parametric Study of Vehicle Dynamic Response. Volume II - Appendices

Digitek Corp., Marina del Rey, Calif. (405 760)

Final rept. May-Oct 70
AUTHOR: Gray, Cory
A2512C3 Fld: 13F, 13L, 85E, 85D GRAI7116
Nov 70 334p*
Rept No: 20301201-2
Contract: FH-11-7315
Monitor: DOT-HS 800 476
See also Volume 1, PB-200 431.

Abstract: An automobile in the class of the Experimental Safety Vehicle Family Sedan was subjected to a series of accident avoidance tests to evaluate the effects of vehicle parameter changes on performance. This volume contains four appendices which describe the test vehicle, the test facilities, and the test plans; and presents all of the reduced data in the form of tables. (Author)

Descriptors: (*Passenger vehicles, *Safety), Collision avoidance, Tables(Data), Performance, Test equipment

Identifiers: *Safety cars

PB-200 432 NTIS Prices: PC A15/MF A01

Parametric Study of Vehicle Dynamic Response. Volume I - Program Summary

Digitek Corp., Marina del Rey, Calif. (405 760)

Final rept. May-Oct 70
AUTHOR: Gray, Cory
A2512C2 Fld: 13F, 13L, 85E, 85D GRAI7116
Nov 70 90p*
Rept No: 20301201-2
Contract: FH-11-7315
Monitor: DOT-HS-800 475
See also Volume 2, PB-200 432.

Abstract: An automobile in the class of the Experimental Safety Vehicle Family Sedan was subjected to a series of accident avoidance tests to evaluate the effects of vehicle parameter changes on performance. Weight and suspension parameter variations were studies with respect to braking, handling, overturning immunity, and engine output capabilities. This volume presents a review of the methodology and a summary of the results. (Author)

Descriptors: (*Passenger vehicles, *Safety), Collision avoidance, Broking, Steering, Performance

Identifiers: *Safety cars

PB-200 431 NTIS Prices: PC A05/MF A01

User 8497   Date:30oct80   Time:20:56:49   File: 13

Set	Items	Description
1	1170	COST(W)BENEFIT OR COST(W)EFFECTI
2	24	(RADAR AND BRAK?) OR ELECTRONIC
3	25	ANTILOCK? OR ANTISKID? OR ANTI(
4	46	(COLLISION OR ACCIDENT? ?) AND
5	1768	AUTOMOBILE? ? OR AUTOMOTIVE OR
6	31	(2+3)*5
7	7	4*5
8	0	1*6
9	0	1*7
10	34	6+7
11	34	#10 NOT THEFT

Print 11/5/1-34

Search Time: 0.062   Prints: 34   Descs.: 22

INSPEC (INSTITUTE OF ELECTRICAL ENGINEERS

1978-80 CITATIONS

RADAR BRAKING

OR COLLISION AVOIDANCE

447591 B80047489
SYSTEM FUNCTIONS IN FUTURE MOTORCARS
KOUMANS, W.A.
HOOGLERAAR VERVOERSTECH., TECH. HOGESCHOOL EINDHOVEN, EINDHOVEN, NETHERLANDS
TIJDSCHR. NED. ELEKTRON.- AND RADIOGENOOT. (NETHERLANDS) VOL.45, NO.2 27-30 1980 Coden: NERTA9
Treatment: APPLIC~GENERAL,REVIEW~
JOURNAL PAPER~
Languages: DUTCH
DISCUSSES APPLICATIONS OF (MICRO-)ELECTRONICS IN MOTORCARS, POINTING OUT THAT THEY WILL REMAIN DEPENDENT ON A MULTIPLICITY OF SENSORS AND ACTUATORS. DIFFERENT CLASSES OF FUNCTIONS ARE DESCRIBED' SIGNALLING DRIVING CONDITIONS LIKE EXCESSIVE SPEED, BRAKING DISTANCE, OBSTACLES ENTERING THE REQUIRED FREE SPACE IN FRONT OF THE CAR, DANGER OF BLACK ICE OR AQUAPLANING, OR EVEN ROAD BLOCKAGES ON THE INTENDED ROUTE; SIGNALLING MALFUNCTIONING OF THE VEHICLE BEFORE DANGER ARISES; CONTROLLING CRITICAL FUNCTIONS LIKE ANTI-SKID BRAKING SYSTEMS, IGNITION AND FUEL METERING CONTROL; AND EXTERNAL CONTROL FUNCTIONS LIKE INFLUENCING TRAFFIC SIGNALS OR GIVING ACCESS TO A BUSLANE. THE DIFFICULT CONDITIONS TO WHICH MOTORCAR-ELECTRONICS ARE SUBJECTED ARE INDICATED.
Descriptors: AUTOMOBILES; SIGNALLING; SAFETY SYSTEMS; INSTRUMENTATION; TRAFFIC CONTROL
Identifiers: SIGNALLING; FUEL METERING; IGNITION CONTROL; SAFETY SYSTEMS; INSTRUMENTATION; AUTOMOBILE ELECTRONICS; ROAD TRAFFIC CONTROL
Section Class Codes: B8520B, B0160

446140 B80045571
AN X-BAND COLLISION AVOIDANCE RADAR FOR EMERGENCY VEHICLES
SKOTNICKI, J.R.; STEWART, C.V.
IEEE
1980 IEEE REGION V CONFERENCE DIGEST. ENGINEERING AND SOCIETY INTERFACES 81-5 1980
21-23 APRIL 1980 SAN ANTONIO, TX, USA
Publ: IEEE NEW YORK, USA
VI+120
Treatment: APPLIC~PRACTICAL APPLIC~
REPORT SECTION~
THE DESIGN OF AN X-BAND AUTOMOTIVE COLLISION AVOIDANCE RADAR WHICH COULD BE USED ON POLICE, FIRE, AND EMERGENCY MEDICAL VEHICLES IS PRESENTED. THE RADAR DETECTS AND TRACKS MOVING OBJECTS IN FRONT OF AND WITHIN A QUARTER OF A MILE OF THE VEHICLE ON WHICH IT IS MOUNTED. A MICROPROCESSOR IS USED TO MAINTAIN TRACK FILES ON POTENTIAL HAZARDS AND TO ISSUE APPROPRIATE WARNINGS TO THE VEHICLE OPERATOR. THE SYSTEM COULD ALSO BE USED FOR AUTOMATIC BRAKING AND AIR-BAG ACTIVATION. IN POLICE APPLICATION, IT COULD BE USED TO MEASURE THE VELOCITY OF OTHER VEHICLES. FURTHERMORE, BY KEEPING TRACK OF THE GROUND CLUTTER DOPPLER SHIFT, A HIGHLY ACCURATE SPEEDOMETER CAN BE IMPLEMENTED. THE RADAR, CONSTRUCTED ENTIRELY FROM OFF-THE-SHELF COMPONENTS, IS A BISTATIC, HETERODYNE, FREQUENCY-MODULATED SYSTEM. THE FRONT ENDS OF BOTH THE TRANSMITTER AND RECEIVER CONSIST OF 10 GHZ MICROWAVE ASSOCIATES GUNNPLEXER SYSTEMS. IN THE RECEIVER, THE RF FRONT END IS FOLLOWED BY A CONVENTIONAL FM RECEIVER, THE OUTPUT OF WHICH IS SAMPLED AND FED TO THE MICROPROCESSOR. THE PROCESSOR, IN TURN, DRIVES A DISPLAY THAT ALERTS THE DRIVER TO POTENTIAL HAZARDS (5 Refs)
Descriptors: RADAR SYSTEMS; TRACKING SYSTEMS; AUTOMOBILES
Identifiers: EMERGENCY VEHICLES; X-BAND AUTOMOTIVE COLLISION AVOIDANCE RADAR; TRACKING SYSTEMS
Section Class Codes: B6320

387784 B80027477
SMOOTH ACCELERATION WITH LESS ENERGY. TRAM 2000' POWER ELECTRONICS IN A DRIVE CAR
WERDER, J.
RTE (SWITZERLAND) NO.1 46-8 1980 Coden: RTEEDH
Treatment: APPLIC~PRACTICAL APPLIC~
JOURNAL PAPER~
Languages: GERMAN
A BRIEF BUT INFORMATIVE DESCRIPTION OF THE NEW, EFFICIENT CONTROL CIRCUITS IN THE BROWN-BOVERI TRACTION UNITS FOR ZURICH TRAMWAYS IS GIVEN, ILLUSTRATED BY BLOCK DIAGRAMS OF THE DRIVE AND BRAKE MODES AND OF THE ELABORATE CONTROL CIRCUITS. THE DRIVE COMPLEX (2 PER CAR) POSSESSES AN ANTI-SKID PROTECTION, (BRAKE-BLOCKING IS AVOIDED), A MECHANICAL ENERGY STORAGE (REGENERATIVE BRAKING) AND A LOW-LOSS SPEED/POWER SWITCHING SYSTEM BY MEANS OF A DC-CONVERTER/CHOPPER CIRCUIT WORKING AT 440 HZ. THERE IS AN AUTOMATIC PRE-SELECTION OF OPTIMAL ACCELERATION AND DECELERATION RATES FOR THE 9 WORKING SPEEDS (6-60 KM/HR) AND 8 DESCENDING/STOPPING SPEEDS
Descriptors: ROAD VEHICLES; POWER SUPPLY CIRCUITS
Identifiers: TRAM 2000; POWER ELECTRONICS; CONTROL CIRCUIT; TRACTION UNITS; ZURICH TRAMWAYS; MECHANICAL ENERGY STORAGE; REGENERATIVE BRAKING; POWER SWITCHING SYSTEM; CHOPPER CIRCUIT; DC CONVERTOR
Section Class Codes: B8520B

364360 C80013879
COMPUTER-AIDED DESIGN OF AUTOMOBILE ANTI-SKID BRAKING SYSTEM
MATLA, R.
INST. MASZYN ELEKTRYCZNYCH, POLITECH. WARSZAWSKIEJ, WARSAW, POLAND
ARCH. ELEKTROTECH. (POLAND) VOL.28, NO.2 421-8 1979
Coden: ARELA4
Treatment: PRACTICAL APPLIC~
JOURNAL PAPER~
Languages: POLISH
A DIGITAL SIMULATION METHOD OF AUTOMOBILE BRAKING IS PRESENTED. BASIC NONLINEARITIES OF THE BRAKING PROCESS WERE ANALYSED AND A NEW METHOD OF CRITICAL SKID DETERMINATION WAS PROPOSED. AN ELECTRONIC BRAKING REGULATOR WAS INTRODUCED AND ITS PARAMETERS OPTIMIZED (4 Refs)
Descriptors: CAD; BRAKING; AUTOMOBILES
Identifiers: AUTOMOBILE; CRITICAL SKID DETERMINATION; ELECTRONIC BRAKING REGULATOR; CAD; ANTISKID BRAKING SYSTEM
Section Class Codes: C7440

332083 B80008219, C80004558
SPEED MEASUREMENT BY RADAR FOR ANTI-LOCK BRAKING (ROAD VEHICLE)
JOHNSTON, R.H.
PHILIPS RES. LABS., REDHILL, ENGLAND
IEE
SECOND INTERNATIONAL CONFERENCE ON AUTOMOTIVE ELECTRONICS 185-8 1979
29 OCT. - 2 NOV. 1979 LONDON, ENGLAND
Publ: IEE LONDON, ENGLAND
XI+297
Treatment: APPLIC~PRACTICAL APPLIC~
REPORT SECTION~
AN IDEAL ANTI-LOCK BRAKING SYSTEM REQUIRES AN ACCURATE MEASUREMENT OF THE VEHICLE ROAD SPEED AS A REFERENCE FOR THE CONTROL OF WHEEL SLIP. THE AUTHOR DESCRIBES A DOPPLER RADAR SPEED MEASURING SYSTEM, THE OUTPUT OF WHICH MAY BE COMPARED WITH WHEEL SPEED SENSORS FOR THE SUBSEQUENT CONTROL OF THE VEHICLE BRAKES. MODERN LOW POWER MICROWAVE COMPONENTS ENABLE SUCH RADAR APPLICATIONS TO BE A PRACTICAL POSSIBILITY FOR AUTOMOTIVE USE. AN OUTLINE IS GIVEN OF THE MAIN FACTORS INVOLVED IN THE DESIGN AND USE OF A PROTOTYPE SYSTEM AND SOME RESULTS OBTAINED, WHICH ARE SEEN TO MEET MOST OF THE REQUIREMENTS OF A SPEED REFERENCE. ALSO DISCUSSES THE DESIGN REQUIREMENTS OF THE DOPPLER RADAR AND PRESENTS SOME OF THE RESULTS OBTAINED FROM AN X-BAND (10000 MHZ) SYSTEM MOUNTED IN A VEHICLE
Descriptors: AUTOMOBILES; BRAKES; RADAR APPLICATIONS; VELOCITY MEASUREMENT
Identifiers: ANTILOCK BRAKING SYSTEM; VELOCITY MEASUREMENT; DOPPLER RADAR SPEED MEASURING SYSTEM
Section Class Codes: B8520B, B6320E, B7320E, C3360B, C3120E

332081 B80008217, C80004556
SOME AUTOMOTIVE RADAR SYSTEM CONSIDERATIONS
JONES, T.O.; GRIMES, D.M.
PENNSYLVANIA STATE UNIV., UNIVERSITY PARK, PA, USA
IEE
SECOND INTERNATIONAL CONFERENCE ON AUTOMOTIVE ELECTRONICS 175-9 1979
29 OCT. - 2 NOV. 1979 LONDON, ENGLAND
Publ: IEE LONDON, ENGLAND
XI+297
Treatment: APPLIC-PRACTICAL APPLIC-THEORETICAL~
REPORT SECTION~
CONSIDERS THE POSSIBILITY OF INSTALLING A COMPUTERISED RADAR SYSTEM IN AUTOMOBILES IN ORDER TO REDUCE ACCIDENTS. VARIOUS CONSTRUCTIONAL, OPERATIONAL AND ECONOMIC DIFFICULTIES PREVENTING THE REALISATION OF SUCH A SYSTEM AT PRESENT ARE POINTED OUT (19 Refs)
Descriptors: AUTOMOBILES; RADAR APPLICATIONS; SAFETY; RADAR SYSTEMS; ACCIDENTS; TRAFFIC COMPUTER CONTROL; ACCELERATION CONTROL; BRAKES
Identifiers: AUTOMOTIVE RADAR SYSTEM; AUTOMOBILES; SAFETY; ACCIDENT PREVENTION; COMPUTERISED CONTROL; ACCELERATION CONTROL; BRAKE CONTROL
Section Class Codes: B8520B, B0160, B7320E, B6320, C3360B, C3120E, C7420

331754 B80008191, C80004205
MICROPROCESSOR IMPLEMENTATION OF A HEAVY TRUCK ANTILOCK BRAKING SYSTEM
SMEDLEY, D.G.
IEE
SECOND INTERNATIONAL CONFERENCE ON AUTOMOTIVE ELECTRONICS 33-7 1979
29 OCT. - 2 NOV. 1979 LONDON, ENGLAND
Publ: IEE LONDON, ENGLAND
XI+297
Treatment: APPLIC-THEORETICAL-
REPORT SECTION-
DISCUSSES RECENT RESEARCH DONE INTO THE USE OF A MICROPROCESSOR TO PERFORM THE ANTILOCK FUNCTION OF AN ELECTRONIC BRAKING SYSTEM. AFTER A STATEMENT OF OBJECTIVES AND REQUIREMENTS FOR AN ANTILOCK BRAKING SYSTEM IN THE USA AND A BRIEF DESCRIPTION OF THE COMPONENTS AND OPERATION OF AN AXLE-BY-AXLE SYSTEM, THE AUTHOR TRACES THROUGH THE DEVELOPMENT OF A PROTOTYPE MICROPROCESSOR BASED SYSTEM. DESIGN OF THE SOFTWARE, HARDWARE AND INTEGRATION OF THE TWO ARE DISCUSSED. PROBLEMS ENCOUNTERED IN DEVELOPMENT AND TESTING AND THE SOLUTIONS FOUND ARE HIGHLIGHTED
Descriptors: AUTOMOBILES; MICROCOMPUTERS; BRAKES; CONTROLLERS
Identifiers: ANTILOCK BRAKING SYSTEM; ELECTRONIC BRAKING SYSTEM; PROTOTYPE MICROPROCESSOR BASED SYSTEM
Section Class Codes: B8520B, C3220, C5250, C3260Z

322772 B80008185
SECOND INTERNATIONAL CONFERENCE ON AUTOMOTIVE ELECTRONICS
IEE
SECOND INTERNATIONAL CONFERENCE ON AUTOMOTIVE ELECTRONICS 1979
29 OCT. - 2 NOV. 1979 LONDON, ENGLAND
Publ: IEE LONDON, ENGLAND
Treatment: APPLIC-PRACTICAL APPLIC-
DISSERTATION-
THE FOLLOWING TOPICS WERE DEALT WITH: AUTOMOTIVE INSTRUMENTATION; MICROCOMPUTER APPLICATIONS; FUEL INJECTION SYSTEMS; ELECTRONIC IGNITION SYSTEMS; ELECTRONIC ENGINE CONTROLS; AUTOMATED ENGINE TEST FACILITY; DIGITAL ELECTRONIC SPARK ADVANCE SYSTEM; ANTILOCK BRAKING SYSTEM; INTEGRATED TIMER CONTROLLER. 57 PAPERS WERE PRESENTED, OF WHICH 56 ARE PUBLISHED IN FULL IN THE PRESENT PROCEEDINGS, AND 1 AS ABSTRACT ONLY
Descriptors: AUTOMOBILES; ELECTRIC IGNITION; DIGITAL INSTRUMENTATION
Identifiers: AUTOMOTIVE INSTRUMENTATION; MICROCOMPUTER APPLICATIONS; FUEL INJECTION SYSTEMS; ELECTRONIC IGNITION SYSTEMS; ELECTRONIC ENGINE CONTROLS; AUTOMATED ENGINE TEST FACILITY; ELECTRONIC SPARK ADVANCE SYSTEM; ANTILOCK BRAKING SYSTEM; INTEGRATED TIMER CONTROLLER; AUTOMOBILES; DIGITAL INSTRUMENTATION
Section Class Codes: B8520B

313532 B80001906, C80001129
ACR 500 RAIL-BRAKE RADAR
ARNOLD, W.
SIEMENS-ALBIS BER. (SWITZERLAND) VOL.31, NO.2 70-3 JULY 1979 Coden: SABRBJ
Treatment: APPLIC-PRACTICAL APPLIC-
JOURNAL PAPER-
Languages: GERMAN
IN AUTOMATED MARSHALLING YARDS, THE SPEED OF FREIGHT CARS ROLLING DOWNHILL MUST BE MEASURED. CONTINUOUS WAVE DOPPLER RADAR UNITS ARE SUITABLE FOR THIS PURPOSE. THE FOLLOWING CONTRIBUTION DESCRIBES THE DESIGN AND THE OPERATING PRINCIPLES OF THIS RADAR UNIT FOR CIVILIAN APPLICATION
Descriptors: RADAR APPLICATIONS; RADAR MEASUREMENT; RAIL TRAFFIC; TRAFFIC CONTROL
Identifiers: AUTOMATED MARSHALLING; RAIL BRAKE RADAR; CONTINUOUS WAVE DOPPLER RADAR; SPEED MEASUREMENT; RAIL TRAFFIC ; TRAFFIC CONTROL
Section Class Codes: B6320, B7320E, C3360D

300523 B79050978, C79032772
DESIGN CRITERIA FOR ELECTRONIC BRAKING CONTROLLERS
MATLA, R.
POLITECH. WARSAW, WARSAW, POLAND
ARCH. ELEKTROTECH. (POLAND) VOL.27, NO.4 927-39 1978 Coden: ARELA4
Treatment: GENERAL,REVIEW-THEORETICAL-
JOURNAL PAPER-
Languages: POLISH
BASIC ELECTRONIC BRAKING CONTROLLER SYSTEMS ARE REVIEWED. TO ANALYSE PHENOMENA DURING BRAKING OF A MOTOR-CAR A NONLINEAR DIFFERENTIAL EQUATIONS SYSTEM WAS ARRANGED. NUMERICAL SOLUTION OF THIS SYSTEM HELPED IN STUDIES OF ROAD SURFACE INFLUENCE OF BRAKING ACTION SPEED (8 Refs)
Descriptors: BRAKING; AUTOMOBILES; CONTROLLERS; NONLINEAR DIFFERENTIAL EQUATIONS
Identifiers: ELECTRONIC BRAKING CONTROLLER SYSTEMS; NONLINEAR DIFFERENTIAL EQUATIONS SYSTEM; ROAD SURFACE INFLUENCE OF BRAKING ACTION SPEED; DESIGN CRITERIA; MOTOR CAR BRAKING
Section Class Codes: B8520B, C3360B, C3220

273645 B79041427, C79026335
AUTOMOBILE ELECTRONICS
WESTBROOK, M.H.
FORD MOTOR CO. LTD., BASILDON, ENGLAND
PHYS. TECHNOL. (GB) VOL.10, NO.2 54-61 MARCH 1979
Coden: PHYTBK
Treatment: PRACTICAL APPLIC~
JOURNAL PAPER~
SYSTEMS TO MAKE CARS SAFER, MORE EFFICIENT AND EASIER TO DRIVE ARE DESCRIBED' THESE INCLUDE ENGINE MANAGEMENT SYSTEMS, ELECTRONIC INSTRUMENTATION, TRAFFIC AND ROAD INFORMATION SYSTEMS, MULTIPLEX RING-MAIN DISTRIBUTION, TRANSMISSION CONTROL, ANTI-SKID BRAKES AND MINOR SYSTEMS (9 Refs)
Descriptors: AUTOMOBILES; CONTROL SYSTEMS; ELECTRIC IGNITION
Identifiers: TRAFFIC AND ROAD INFORMATION SYSTEMS; AUTOMOBILE ELECTRONICS; CAR ENGINE MANAGEMENT SYSTEM; AUTOMOBILE TRANSMISSION CONTROL; ELECTRONIC CONTROL SYSTEM
Section Class Codes: B8520B, C3360B, C3380B

248032 C79020794
ELECTRONIC CONTROL UNIT FOR PASSENGER CAR ANTISKID
LEIBER, H.; CZINCZEL, A.
BOSCH GMBH, STUTTGART, GERMANY
IEEE
PROCEEDINGS OF THE 29TH IEEE VEHICULAR TECHNOLOGY CONFERENCE
65-9 1979
27-30 MARCH 1979 ARLINGTON HEIGHTS, IL, USA
Publ: IEEE NEW YORK, USA
XII+407
Treatment: PRACTICAL APPLIC~
REPORT SECTION~
A HIGH-QUALITY ANTISKID SYSTEM FOR PASSENGER CARS IS INTRODUCED BY TWO WELL-KNOWN GERMAN AUTOMAKERS. TWO WHEEL SPEED SENSORS MEASURE THE ANGULAR VELOCITY OF THE FRONT WHEELS. IN ORDER TO MINIMIZE BRAKE FORCE DIFFERENCES OF THE REAR AXLE ON ROADWAYS WITH SPLIT COEFFICIENTS, A COMMON CONTROL FOR THE REAR WHEELS HAS BEEN CHOSEN. THE HYDRAULIC UNIT COMPRISES THREE (FOR FRONT-REAR BRAKE SYSTEM) OR FOUR (FOR DIAGONAL BRAKE SYSTEM) NOVEL SOLENOID VALVES AND A RETURN PUMP DRIVEN BY AN ELECTRIC MOTOR. BRAKE PRESSURE CAN BE RAISED IN A STEADY OR STEPWISE WAY, HELD AT A CONSTANT LEVEL OR DECREASED THE ELECTRONIC UNIT IS MAINLY OF DIGITAL DESIGN AND CONSISTS OF A FEW INTEGRATED CIRCUITS. THE ANTISKID SYSTEM COMPRISES MANY SOPHISTICATED FUNCTIONS WHICH RESULT IN A HIGH COMPLEXITY OF THE CIRCUIT. THE DIGITAL DESIGN WAS CHOSEN BECAUSE IT ALLOWS FOR A GREATER INTEGRATION THAN THE ANALOG DESIGN
Descriptors: ROAD VEHICLES
Identifiers: ANTISKID SYSTEM; WHEEL SPEED SENSORS; COMMON CONTROL; ELECTRONIC CONTROL UNIT
Section Class Codes: C3360B

232836 B79027951
NON-COOPERATIVE COLLISION WARNING SYSTEM FOR AUTOMOBILES
PETERS, H.J.; WOCHER, B.
ROBERT-BOSCH GMBH, STUTTGART, GERMANY
NACHR. ELEKTRON. (GERMANY) VOL.33, NO.3 81-4 MARCH 1979 Coden: NAELDV
Treatment: GENERAL,REVIEW~
JOURNAL PAPER~
Languages: GERMAN
IN DEPENDENCE OF THE OWN SPEED, COLLISION AVOIDANCE SYSTEMS MUST GIVE RELIABLE WARNINGS ABOUT DANGEROUS APPROACHES, BUT MUST SUPPRESS FALSE ALARMING CAUSED BY MARKER POSTS, GUARD RAILS AND OTHER TYPICAL OBSTACLES. REQUIRED PERFORMANCE, SELECTION OF APPROPRIATE RADAR PRINCIPLE AND FREQUENCY, CONSTRUCTION AND TESTS RESULTS OF AN EQUIPMENT DEVELOPED JOINTLY BY AEG-TELEFUNKEN AND BOSCH ARE DESCRIBED. A FREQUENCY OF 35 GHZ IS USED. THE EVALUATION OF THE RADAR ECHO SIGNALS IS DONE BY A PROGRAMMABLE PROCESSOR (12 Refs)
Descriptors: RADAR APPLICATIONS; ROAD VEHICLES; ALARM SYSTEMS
Identifiers: COLLISION WARNING SYSTEM; AUTOMOBILES; COLLISION AVOIDANCE SYSTEMS; RADAR; AEG-TELEFUNKEN; BOSCH; RADAR ECHO SIGNALS; PROGRAMMABLE PROCESSOR
Section Class Codes: B6320, B8520B, B0160

221881 C79015224
A HEADWAY SAFETY POLICY FOR AUTOMATED HIGHWAY OPERATIONS
FENTON, R.E.
DEPT. OF ELECTRICAL ENGNG., COLUMBUS, OH, USA
IEEE TRANS. VEH. TECHNOL. (USA) VOL.VT.28, NO.1 22-8 FEB. 1979 Coden: ITVTAB
Treatment: APPLIC~THEORETICAL~
JOURNAL PAPER~
THE MAXIMUM CAPACITY, COST, AND SAFETY OF AN AUTOMATED HIGHWAY SYSTEM ARE LARGELY DEPENDENT ON THE SELECTED HEADWAY POLICY, I.E., THE SPECIFICATION OF A MINIMUM ACCEPTABLE HEADWAY (AS A FUNCTION OF SPEED) FOR MAINLINE OPERATIONS. A POLICY, DESIGNED TO AVERT COLLISIONS DUE TO @REASONABLE@ LEAD-CAR DECELERATIONS, IS PRESENTED AND EVALUATED IN THE CONTEXT OF ACHIEVING HIGH CAPACITY (>3600 VEHICLE/LANE/HR) OVER A RANGE OF TYPICAL HIGHWAY SPEEDS-13.5 TO 30 M/S (30.2 TO 67.2 MI/H). THIS INVOLVED A DETAILED ANALYSIS TO DETERMINE BOTH THE RELATIONSHIPS BETWEEN, AND THE REQUIREMENTS ON, THE SEVEN PARAMETERS WHICH ARE EMBEDDED IN THIS POLICY. THESE PERTAIN TO SYSTEMS-LEVEL OPERATIONS, THE CAPABILITIES OF A VEHICLE@S AUTOMATIC CONTROL SYSTEM, AND THE VEHICLE/ROADWAY INTERFACE. THE TRADE-OFFS ASSOCIATED WITH SAFETY, CAPACITY, AND COST (IN THE FORM OF REQUIRED FUTURE DEVELOPMENT EFFORTS) ARE IDENTIFIED, AND THREE GENERAL APPROACHES TO SELECTING PARAMETERS FOR AN OPERATIONAL SYSTEM ARE SPECIFIED (10 Refs)
Descriptors: TRAFFIC CONTROL SYSTEMS; ROAD TRAFFIC; SAFETY; RAPID TRANSIT SYSTEMS
Identifiers: AUTOMATED HIGHWAY SYSTEM; HEADWAY POLICY; AUTOMATIC CONTROL SYSTEM; SAFETY; CAPACITY; COST; TRAFFIC CONTROL SYSTEM; COLLISION AVOIDANCE; RAPID TRANSIT SYSTEM
Section Class Codes: C3360B

191549 B79016167, C79006548
THE NEAR-TERM PROSPECT FOR AUTOMOTIVE ELECTRONICS' MINICARS' RESEARCH SAFETY VEHICLE
FRIEDMAN, D.; BELOHOUBEK, E.
SOC. AUTOMOTIVE ENGRS., IEEE
CONVERGENCE 78 INTERNATIONAL CONFERENCE ON AUTOMOTIVE ELECTRONICS 120-30 1978
25-27 SEPT. 1978 DEARBORN, MI, USA
Publ: SOC. AUTOMOTIVE ENGRS. WARRENDALE, PA, USA
169
Treatment: GENERAL,REVIEW~
REPORT SECTION~
THE ELECTRONICS UNDER DEVELOPMENT BY RCA LABORATORIES FOR THE RSV DURING THE CURRENT PHASE III EFFORT INCLUDE A BI-STATIC K/SUB U/-BAND FM/CW RADAR, COSMAC 1802 MICROCOMPUTER, ALPHA NUMERIC DISPLAY, AND NUMEROUS ELECTROMECHANICAL INTERFACES. THIS TECHNOLOGY CONTROLS THE FOLLOWING FUNCTIONS' WARNING OF PATHWAY OBSTACLES AND POTENTIAL ACCIDENTS, AUTOMATIC COLLISION MITIGATION, AUTOMATIC CRUISE/HEADWAY CONTROL, AUTOMATIC FUEL ECONOMICAL SHIFTING OF THE MANUAL TRANSMISSION, ANTI-SKID BRAKING, AIRBAG IMPACT SENSING, VEHICLE SYSTEMS STATUS AND DIAGNOSTICS, OPERATIONAL INFORMATION DISPLAYS, ENTERTAINMENT AND COMMUNICATIONS (4 Refs)
Descriptors: ROAD VEHICLES; PROJECT ENGINEERING
Identifiers: AUTOMOTIVE ELECTRONICS; CRUISE/HEADWAY CONTROL; FUEL ECONOMICAL SHIFTING; AIRBAG IMPACT SENSING; BISTATIC K/SUB U/ BAND RADAR; ANTISKID BREAKING
Section Class Codes: B8520, C3360B

190075 B79014166, C79006283
DOPPLER RADAR SPEED SENSOR FOR ANTI-SKID CONTROL SYSTEM
BABA, K.; FUKUMORI, Y.; KANEKO, Y.; SEKINE, K.; ENDO, A.
NISSAN MOTOR CO. LTD., TOKYO, JAPAN;
SOC. AUTOMOTIVE ENGRS., IEEE
CONVERGENCE 78 INTERNATIONAL CONFERENCE ON AUTOMOTIVE ELECTRONICS 114-19 1978
25-27 SEPT. 1978 DEARBORN, MI, USA
Publ: SOC. AUTOMOTIVE ENGRS. WARRENDALE, PA, USA
169
Treatment: APPLIC~PRACTICAL APPLIC~
REPORT SECTION~
A 24 GHZ DOPPLER SPEED SENSOR FOR SKID CONTROLS HAS BEEN DEVELOPED. THE MICROWAVE SENSOR IS DESIGNED USING BOTH WAVEGUIDE AND THIN-FILM TECHNOLOGIES AND ASSEMBLED INTO A SMALL INTEGRATED UNIT MEASURING 27*10*9 MM. THE RADAR UNIT AND THE CONTROL CIRCUITRY ARE HOUSED IN A WATERPROOF MODULE OF 94*140*78 MM. PART OF THE CASING FORMS A HORN ANTENNA, WHICH RADIATES A VERTICALLY POLARIZED BEAM INCIDENT AT 45 DEGREES ON THE ROAD SURFACE, WHEN MOUNTED ON THE VEHICLE. THE ERROR IN SPEED MEASURING IS USUALLY LESS THAN 10 PERCENT (3 Refs)
Descriptors: VELOCITY CONTROL; TRANSDUCERS; RADAR APPLICATIONS
Identifiers: DOPPLER SPEED SENSOR; MICROWAVE SENSOR; HORN ANTENNA; ANTI SKID CONTROL SYSTEM
Section Class Codes: B6320, C3240, C3120E

180672 C79007943
ELECTRONIC APPLICATIONS TO THE AUTOMOBILE BY ROBERT BOSCH GMBH
SCHOLL, H.
ROBERT BOSCH GMBH, STUTTGART, GERMANY
SOC. AUTOMOTIVE ENGRS., IEEE
CONVERGENCE 78 INTERNATIONAL CONFERENCE ON AUTOMOTIVE ELECTRONICS 23-39 1978
25-27 SEPT. 1978 DEARBORN, MI, USA
Publ: SOC. AUTOMOTIVE ENGRS. WARRENDALE, PA, USA
169
Treatment: GENERAL,REVIEW~
REPORT SECTION~
ROBERT BOSCH GMBH HAS BEEN DEVELOPING AND MANUFACTURING ELECTRICAL EQUIPMENT FOR AUTOMOBILES FOR APPROXIMATELY, 80 YEARS AND ELECTRONIC EQUIPMENT FOR OVER 20 YEARS. THE FIRST SECTION OF THIS PAPER DESCRIBES THE BEGINNINGS OF AUTOMOTIVE ELECTRONICS AND THEIR EARLY PRODUCTS. THE SECOND SECTION DEALS WITH THE MOST IMPORTANT CURRENT PRODUCTS WHICH INCLUDE, IN PARTICULAR, ELECTRONIC FUEL INJECTION, BREAKERLESS IGNITION, AND THE ANTISKID. THE LAST PART DESCRIBES THE DEVELOPMENT OF FUTURE PRODUCTS WHICH CONSISTENTLY USE DIGITAL TECHNOLOGY AND IN MANY CASES A MICROCOMPUTER. THE MOST SIGNIFICANT PROJECT IN THIS SERIES IS THE DIGITAL ENGINE CONTROL TO MANAGE GASOLINE INJECTION, IGNITION AND AUTOMATIC TRANSMISSION (7 Refs)
Descriptors: AUTOMOBILES; COMPUTERISED CONTROL
Identifiers: AUTOMOTIVE ELECTRONICS; ELECTRONIC FUEL INJECTION; BREAKERLESS IGNITION; ANTISKID; DIGITAL ENGINE CONTROL; AUTOMOBILE ELECTRONICS
Section Class Codes: C7420, C3360B

180670 C79007941
CONVERGENCE 78 INTERNATIONAL CONFERENCE ON AUTOMOTIVE ELECTRONICS
SOC. AUTOMOTIVE ENGRS., IEEE
CONVERGENCE 78 INTERNATIONAL CONFERENCE ON AUTOMOTIVE ELECTRONICS 1978
25-27 SEPT. 1978 DEARBORN, MI, USA
Publ: SOC. AUTOMOTIVE ENGRS. WARRENDALE, PA, USA
Treatment: APPLIC~GENERAL,REVIEW~
DISSERTATION~
THE FOLLOWING TOPICS WERE DEALT WITH' POWER TRAIN CONTROL; AUTOMOTIVE ENGINE CONTROL; DIGITAL SPARK TIMING SYSTEM; ELECTRONIC BRAKING SYSTEM; FOLLOWED BY APPLIED AUTOMOTIVE ELECTRONICS
Descriptors: VEHICLES; COMPUTERISED CONTROL
Identifiers: AUTOMOTIVE ENGINE CONTROL; DIGITAL SPARK TIMING SYSTEM; ELECTRONIC BRAKING SYSTEM; POWER TRAIN CONTROL
Section Class Codes: C7420

179410 C79006554
ANTISKID SYSTEM FOR PASSENGER CARS WITH A DIGITAL ELECTRONIC CONTROL UNIT
LEIBER, H.
ROBERT BOSCH GMBH, STUTTGART, GERMANY
COLLOQUIUM ON ANTILOCK BRAKING ON THE ROADS 7/1 1978
17 NOV. 1978 LONDON, ENGLAND
Publ: IEE LONDON, ENGLAND
36
Treatment: GENERAL,REVIEW~
REPORT SECTION~
SUMMARY FORM ONLY GIVEN, SUBSTANTIALLY AS FOLLOWS' THIS ARTICLE DISCUSSES TWO VERSIONS OF THE BOSCH SYSTEM CONSISTING OF SPEED SENSORS, AN ELECTRONIC CONTROL UNIT AND HYDRAULIC CONTROL ELEMENTS. THE OPERATION OF THESE AND THE SAFETY MONITORING CIRCUIT IS DESCRIBED. THE ANTISKID SYSTEM PERFORMANCE IS SHOWN IN A TABLE
Descriptors: DIGITAL CONTROL; BRAKING; AUTOMOBILES
Identifiers: PASSENGER CARS; DIGITAL ELECTRONIC CONTROL UNIT ; BOSCH SYSTEM; SPEED SENSORS; ELECTRONIC CONTROL UNIT; HYDRAULIC CONTROL ELEMENTS; SAFETY; MONITORING CIRCUIT; ANTISKID SYSTEM; BRAKING; AUTOMOBILES
Section Class Codes: C3360B

179407 C79006551
COLLOQUIUM ON ANTILOCK BRAKING ON THE ROADS
COLLOQUIUM ON ANTILOCK BRAKING ON THE ROADS 1978
17 NOV. 1978 LONDON, ENGLAND
Publ: IEE LONDON, ENGLAND
Treatment: GENERAL,REVIEW~
DISSERTATION~
THE FOLLOWING TOPICS WERE DEALT WITH' ANTILOCK BRAKING AND UK LEGISLATION; THE US ANTILOCK STANDARDS; ELECTRONIC DESIGN CONSIDERATIONS; ANTILOCK PERFORMANCE IN FLEET OPERATION; THE ANTISKID SYSTEM FOR PASSENGER CARS AND COMMERCIAL VEHICLE ANTILOCK BRAKING
Descriptors: BRAKING
Identifiers: UK LEGISLATION; US ANTILOCK STANDARDS; ELECTRONIC DESIGN CONSIDERATIONS; ANTILOCK PERFORMANCE; FLEET OPERATION; ANTISKID SYSTEM; PASSENGER CARS; COMMERCIAL VEHICLE ANTILOCK BRAKING
Section Class Codes: C3360B

179404 C79006547
ELECTRONIC BRAKING SYSTEM
HAYES, E.J.; MEGGINSON, G.W.
KELSEY-HAYES CO., ROMULUS, MI, USA
SOC. AUTOMOTIVE ENGRS., IEEE
CONVERGENCE 78 INTERNATIONAL CONFERENCE ON AUTOMOTIVE ELECTRONICS 111-13 1978
25-27 SEPT. 1978 DEARBORN, MI, USA
Publ: SOC. AUTOMOTIVE ENGRS. WARRENDALE, PA, USA
169
Treatment: APPLIC-GENERAL,REVIEW-
REPORT SECTION-
ELECTRONIC BRAKING SYSTEMS FOR AIR-BRAKE VEHICLES HAVE BEEN REQUIRED BY THE FEDERAL MOTOR VEHICLE SAFETY STANDARD 121 SINCE 1975. THE NEED FOR THE STANDARD AND THE DIFFICULTY IN DOCUMENTING ITS BENEFITS ARE DISCUSSED. PUBLIC CRITICISM, COURT AND LEGISLATIVE ACTION THREATEN TO CAUSE IT TO FOLLOW THE SEAT BELT INTER-LOCK. MAJOR OPPOSITION DERIVES FROM MISUNDERSTANDING AND OPPOSITION TO GOVERNMENT REGULATION (4 Refs)
Descriptors: BRAKING
Identifiers: ELECTRONIC BREAKING SYSTEM
Section Class Codes: C3360B

110385 B78039783, C78022632
DOPPLER RADAR SKID CONTROL DEVICE ENHANCES AUTO SAFETY
KANEKO, Y.; FUKUMORI, Y.
HITACHI LTD., TOKYO, JAPAN
JEE (JAPAN) NO.133 54-7 JAN. 1978 Coden: JELEBR
Treatment: APPLIC-EXPERIMENTAL-
JOURNAL PAPER-
DISCUSSES THE DEVELOPMENT OF A SAFE AND EFFECTIVE BRAKING SYSTEM BASED ON THE DOPPLER RADAR WHICH CAN BE MOUNTED ON ANY AUTOMOBILE. IT IS CONSIDERED TO BE AN IMPORTANT BREAKTHROUGH FOR INCREASED AUTOMOBILE SAFETY AND IS EXPECTED TO BE USED EXTENSIVELY IN THE FUTURE. THE DOPPLER RADAR SKID CONTROL SYSTEM CONSISTS OF A DOPPLER RADAR VEHICLE SPEED SENSOR, A WHEEL-SPEED SENSOR, A CONTROLLER AND AN ACTUATOR. THE SYSTEM IS DESIGNED SO THAT IF A CAR IS BRAKED SUDDENLY ON A SLIPPERY ROAD, IT CAN BE PREVENTED FROM TURNING AND SKIDDING INTO VEHICLES IN ADJACENT LANES OF INTO VEHICLES MOVING IN THE OPPOSITE DIRECTION
Descriptors: AUTOMOBILES; SAFETY SYSTEMS; BRAKING; RADAR APPLICATIONS
Identifiers: RADAR SKID CONTROL SYSTEM; WHEEL SPEED SENSOR; SAFETY SYSTEM; ROAD VEHICLE; ELECTRIC SENSING DEVICE; MICROWAVE SPEED SENSOR; DOPPLER RADAR
Section Class Codes: B6320, B0160, B8520, C3360B, C3240D

108118 B78039787, C78019945
NARROWING THE EFFECTIVE ANTENNA BEAMWIDTH OF A BASEBAND RADAR FOR AUTO BRAKING APPLICATION
ROSS, G.F.
SPERRY RES. CENTER, SUDBURY, MA, USA
IEEE
1978 INTERNATIONAL SYMPOSIUM DIGEST. ANTENNAS AND PROPAGATION 296-301 1978
15-19 MAY 1978 WASHINGTON, DC, USA
Publ: IEEE NEW YORK, USA
XVI+457
Treatment: APPLIC-
REPORT SECTION-
DESCRIBES A BASEBAND RADAR (BAR) SENSOR BEAM-NARROWING SCHEME FOR RADAR BRAKING APPLICATION; SHOWS HOW THE NORMALLY WIDE EFFECTIVE BEAMWIDTH OF THE BAR IS NARROWED BY USING INTERFEROMETRY IN CONJUNCTION WITH A NOVEL DELAY LINE DIGITAL PROCESSOR SCHEME. THE DETAILS OF THE BAR SENSOR FRONT-END AND PRELIMINARY TEST RESULTS ARE PRESENTED (7 Refs)
Descriptors: RADAR APPLICATIONS; RADAR ANTENNAS; BRAKING; ROAD VEHICLES; ANTENNA RADIATION PATTERNS
Identifiers: INTERFEROMETRY; DELAY LINE DIGITAL PROCESSOR; AUTOMOTIVE BASEBAND RADAR BRAKING; ANTENNA BEAMWIDTH NARROWING
Section Class Codes: B6320, B5270, C3370H, C3360B

108117 B78039786, C78019791
ELECTROMAGNETIC SENSING FOR VEHICLE CONTROL APPLICATION
YUNG-KUANG WU
DEPT. OF TRANSPORTATION, NAT. HIGHWAY TRAFFIC SAFETY ADMINISTRATION, WASHINGTON, DC, USA
IEEE
1978 INTERNATIONAL SYMPOSIUM DIGEST. ANTENNAS AND PROPAGATION 292-5 1978
15-19 MAY 1978 WASHINGTON, DC, USA
Publ: IEEE NEW YORK, USA
XVI+457
Treatment: EXPERIMENTAL-
REPORT SECTION-
RADAR SIGNATURES OF AUTOMOBILES, TRUCKS, PEDESTRIANS, AND CYCLISTS HAVE BEEN OBTAINED AT 10, 35, AND 60 GHZ. MOST OF THE CROSS-SECTION STUDIES WERE PERFORMED USING LINEAR HORIZONTAL POLARISATION. A ROAD-TEST STUDY WAS CONDUCTED OVER THREE ROADWAYS TYPIFYING MUCH OF THE HIGH-DENSITY, HIGH-SPEED, URBAN AND SUBURBAN DRIVING IN THE UNITED STATES. AN INSTRUMENTED TEST VEHICLE EQUIPPED WITH AN AUTOMATIC RADAR BRAKING SYSTEM WAS USED. RESULTS OF THE TEST PROGRAM ARE GIVEN (5 Refs)
Descriptors: RADAR APPLICATIONS; ROAD VEHICLES; BRAKING
Identifiers: LINEAR HORIZONTAL POLARISATION; AUTOMATIC RADAR BRAKING SYSTEM; ROAD VEHICLE CONTROL; EM SENSING; RADAR SIGNATURE; RADAR DETECTION CUTOFF RANGE; ANTENNA BEAM
Section Class Codes: B6320, C3360B

097754 C78019785
ANTISKID CONTROL FOR AUTOMOBILE
HIKIDA, R.; HAYASHI, Y.; ARAKAWA, H.; MORI, T.; YAMAMOTO, Y.
TOYOTA CENTRAL RANDD LAB., NAGOYA, JAPAN
TRANS. SOC. INSTRUM. AND CONTROL ENG. (JAPAN) VOL.14, NO.1 97-102 FEB. 1978 Coden: TSICA9
Treatment: APPLIC~
JOURNAL PAPER~
Languages: JAPANESE
THIS STUDY IS CONCERNED WITH A METHOD TO CONTROL BRAKING PRESSURE OF REAR WHEELS FOR PREVENTING THE SKID. DETECTED SIGNALS ARE THE LONGITUDINAL ACCELERATION OF A VEHICLE AND THE MEAN VELOCITY OF BOTH REAR WHEELS. THE ACCELERATION SIGNAL IS PUT INTO AN INTEGRATOR WHICH GIVES THE COMPUTED VEHICLE VELOCITY AS AN OUTPUT. THE DIFFERENCE BETWEEN THE COMPUTED AND THE MEASURED WHEEL VELOCITY IS AMPLIFIED. WHILE THE AMPLIFIED SIGNAL IS SMALL, IT IS NEGATIVELY FED BACK TO THE INTEGRATOR THROUGH A LOW-PASS FILTER. ONCE A SKID OCCURS, THE OUTPUT FROM THE DIFFERENTIAL AMPLIFIER INCREASES, BECAUSE THE CONTROLLER IS DESIGNED NOT TO FOLLOW SUCH A RAPID CHANGE IN THE WHEEL VELOCITY. IMMEDIATELY AFTER THE OUTPUT SIGNAL EXCEEDS A PREDETERMINED LEVEL, THE FEEDBACK LOOP IS SHUT OFF AND AN ACTUATOR RELEASES THE BRAKE PRESSURE. WHEN THE SIGNAL FROM THE AMPLIFIER FALLS BELOW THE PREDETERMINED LEVEL, THE BRAKE PRESSURE IS INCREASED AGAIN. THE PERFORMANCE OF THE SYSTEM HAS BEEN INVESTIGATED EXPERIMENTALLY ON ROADS WITH VARIOUS FRICTIONAL COEFFICIENTS AND IN ENGINE BRAKING OPERATION (11 Refs)
Descriptors: AUTOMOBILES; BRAKING; DIFFERENTIAL AMPLIFIERS; FEEDBACK; SAFETY SYSTEMS
Identifiers: REAR WHEELS; LONGITUDINAL ACCELERATION; INTEGRATOR; WHEEL VELOCITY; DIFFERENTIAL AMPLIFIER; FEEDBACK LOOP; ACTUATOR; BRAKE PRESSURE; PERFORMANCE; FRICTIONAL COEFFICIENTS; ENGINE BRAKING; CAR ANTISKID CONTROL
Section Class Codes: C3360B, C3120E, C3370L

097753 B78036862, C78019784
ELECTRONICS IN MOTOR VEHICLES
BERGMANN, H.
RADIO FERNSEHEN ELEKTRON. (GERMANY) VOL.26, NO.21-22 725-28 1977 Coden: RFELB6
Treatment: APPLIC-GENERAL,REVIEW~
JOURNAL PAPER~
Languages: GERMAN
A GENERAL SURVEY OF INTERNATIONAL APPLICATIONS IS PRESENTED WITH 11 BLOCK OR CIRCUIT DIAGRAMS COVERING IGNITION SYSTEMS (INCLUDING ONE WITH A MICROPROCESSOR), SPEED REGULATOR, ANTI-LOCKING BRAKE CONTROLLER, FLASHER, WINDSCREEN-WASHER PAUSE CONTROLLER, REV. COUNTER, ICE-ALARM, AND A RING-CORE LAMP MONITOR (13 Refs)
Descriptors: AUTOMOBILES; ELECTRIC IGNITION; ALARM SYSTEMS; VELOCITY CONTROL; CONTROLLERS; BRAKING
Identifiers: MOTOR VEHICLES; IGNITION SYSTEMS; SPEED REGULATOR; BRAKE CONTROLLER; FLASHER; LAMP MONITOR; WINDSCREEN WASHER CONTROLLER; REVOLUTIONS COUNTER; ICE ALARM
Section Class Codes: B8520, C3360B, C3370L, C3220, C3120E

095179 B78035063
APPLICATIONS OF RADAR TECHNOLOGY FOR THE GENERAL PUBLIC
KITAHARA, T.; KOTO, K.; BAN, K.; MORINAKA, A.; NODA, H.
MITSUBISHI DENKI GIHO (JAPAN) VOL.51, NO.10 657-61 OCT. 1977 Coden: MTDNAF
Treatment: GENERAL,REVIEW~
JOURNAL PAPER~
Languages: JAPANESE
ADVANCES IN THE TECHNOLOGY OF MICROWAVE SOLID-STATE DEVICES AND MICROWAVE ICS HAVE GREATLY FACILITATED THE GENERATION OF MICROWAVES, WITH THE RESULT THAT APPLICATIONS ARE BEING FOUND FOR RADAR IN FIELDS IN WHICH IT HAS BEEN LITTLE USED IN THE PAST. EQUIPMENT FOR MEASURING AUTOMOBILE SPEEDS, AND COLLISION-AVOIDANCE SENSORS FOR TRAVELING CRANES ARE ALREADY IN ACTUAL PRODUCTION, WHILE MICROWAVE SENSORS FOR AUTOMOBILES AND RADAR BEACONS FOR MARINE SEARCH AND RESCUE ARE NOW UNDER DEVELOPMENT. THE ARTICLE DESCRIBES THE PRESENT STATUS OF THESE DEVELOPMENTS (4 Refs)
Descriptors: RADAR APPLICATIONS; REVIEWS
Identifiers: MICROWAVE SENSORS; AUTOMOBILES; RADAR BEACONS; MARINE SEARCH; COLLISION AVOIDANCE; TRAVELLING CRANES; RADAR TECHNOLOGY APPLICATIONS
Section Class Codes: B6300

085081 C78017066
HIGH QUANTITY, LOW COST, HIGH ENVIRONMENT AUTOMOTIVE TRANSDUCERS, A NEW BREED
DRILL, B.F.
PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON AUTOMOTIVE TECHNOLOGY AND AUTOMATION 9/1-8 1977
I 27 SEPT. - 10 OCT. 1976 ROME, ITALY
Publ: AUTOMOTIVE AUTOMATION LTD. CROYDON, ENGLAND
574
Treatment: GENERAL,REVIEW~
REPORT SECTION~
DEALS WITH THE DEVELOPMENT OF AUTOMATIVE TRANSDUCERS IN THE FIELDS OF ANTI-POLLUTION EMISSION CONTROL SYSTEMS; ANTI-SKID, ANTI-WHEEL LOCK AND ANTI-BLOCK DEVICES; AND VEHICLE DIAGNOSTICS
Descriptors: AUTOMOBILES; AUTOMOBILE INDUSTRY; TRANSDUCERS
Identifiers: AUTOMOTIVE TRANSDUCERS; EMISSION CONTROL SYSTEMS; VEHICLE DIAGNOSTICS; ANTI SKID DEVICES
Section Class Codes: C3360B, C3240

085072 B78030287, C78017056
MM RADAR FOR HIGHWAY COLLISION AVOIDANCE
YUNG-KUANG WU; TRESSELT, C.P.
DEPT. OF TRANSPORTATION, WASHINGTON, DC, USA
MICROWAVE J. (USA) VOL.20, NO.11 39-42, 59 NOV. 1977
Coden: MCWJAD
Treatment: PRACTICAL APPLIC~
JOURNAL PAPER~
AN AUTOMATIC/NONCOOPERATIVE RADAR BRAKING SYSTEM CAN BOTH PREVENT AND REDUCE THE SEVERITY OF ACCIDENTS CAUSED BY INATTENTIVE OR SLOW RESPONDING DRIVERS. TESTS INDICATE THAT DISCRIMINATION AGAINST FALSE TARGETS IS ACHIEVABLE BY USING A NARROW ANTENNA BEAM AND LIMITING THE RANGE AT WHICH BRAKES ARE APPLIED. A 36 GHZ RADAR POSSESSING THESE DESIRED PARAMETERS IS DESCRIBED WHICH IS SIZE COMPATIBLE WITH COMPACT CARS (8 Refs)
Descriptors: RADAR SYSTEMS; SAFETY SYSTEMS; ACCIDENTS; BRAKING; AUTOMOBILES; TRAFFIC CONTROL
Identifiers: RADAR BRAKING SYSTEM; NARROW ANTENNA BEAM; 36 GHZ; COLLISION AVOIDANCE; ACCIDENTS PREVENTION; SAFETY SYSTEMS ; AUTOMOBILES; MILLIMETRE RADAR
Section Class Codes: B6320, C3360B

081799 B78029491
SUBSYSTEM SUSCEPTIBILITY TESTING
ESPELAND, R.H.; YUNG-KUANG WU
INST. FOR TELECOMMUNICATION SCI., US DEPT. OF COMMERCE, BOULDER, CO, USA
IEEE
1977 IEEE INTERNATIONAL SYMPOSIUM ON ELECTROMAGNETIC COMPATIBILITY 344-6 1977
2-4 AUG. 1977 SEATTLE, WA., USA
Publ: IEEE NEW YORK, USA
XI+487
Treatment: EXPERIMENTAL~
REPORT SECTION~
SUSCEPTIBILITY TESTS WERE PERFORMED ON TWO AUTOMOTIVE ELECTRONIC CONTROL SUBSYSTEMS TO DETERMINE THE LEVELS OF INJECTED SIGNALS AT CRITICAL CIRCUIT PORTS REQUIRED TO CAUSE MALFUNCTION OF THESE DEVICES. THE INJECTED SIGNALS WERE DESIGNED TO REPRESENT LEVELS AND DURATIONS CHARACTERISTIC OF THOSE GENERATED WITHIN THE VEHICLE OR COUPLED FROM EXTERNAL SOURCES. THE TEST OBJECTS WERE AN ELECTRONIC SPEED CONTROL SYSTEM AND AN ANTISKID CONTROL MODULE. THIS PAPER DISCUSSES THE METHODOLOGY, INSTRUMENTATION, AND RESULTS OBTAINED FROM THIS TEST PROGRAM. THE RESULTS SHOW CIRCUIT SUSCEPTIBILITY DEPENDENCE ON INTERFERENCE SIGNAL FREQUENCY, AMPLITUDE, DUTY CYCLE, AND POLARITY
Descriptors: AUTOMOBILES; ELECTRIC CONTROL EQUIPMENT; RADIOFREQUENCY INTERFERENCE; ELECTRONIC EQUIPMENT TESTING
Identifiers: AUTOMOTIVE ELECTRONIC CONTROL SUBSYSTEMS; CRITICAL CIRCUIT PORTS; INJECTED SIGNALS; SPEED CONTROL; ANTISKID CONTROL; METHODOLOGY; INSTRUMENTATION; CIRCUIT SUSCEPTIBILITY; FREQUENCY; AMPLITUDE; DUTY CYCLE; POLARITY

Section Class Codes: B5230, B7310Z

042748 B78016213
HIGHWAY COLLISION AVOIDANCE-A POTENTIAL LARGE-SCALE APPLICATION OF MM RADAR
TRESSELT, C.P.; YUNG-KUANG WU
BENDIX COMMUNICATIONS DIV., BALTIMORE, MD, USA
IEEE
EASCON-77 16-7A/7PP. 1977
26-28 SEPT. 1977 ARLINGTON, VA, USA
Publ: IEEE NEW YORK, USA
XXIV+784+40 (SUPPL.)
Treatment: APPLIC~
REPORT SECTION~
AN AUTOMATIC/NONCOOPERATIVE RADAR BRAKING SYSTEM CAN PROVIDE A SIGNIFICANT BENEFIT IN PREVENTING AND MITIGATING ACCIDENTS CAUSED BY DRIVER INATTENTION OR TARDY RESPONSE. ASSUMING THAT SUFFICIENT TARGET DISCRIMINATION CAN BE ACHIEVED TO REJECT NON-HAZARDOUS SITUATIONS. ROAD TESTS INDICATE THAT DISCRIMINATION AGAINST FALSE TARGETS IS ACHIEVABLE BY USING A NARROW ANTENNA BEAM AND LIMITING THE RANGE AT WHICH BRAKES ARE APPLIED. MILLIMETER WAVELENGTHS PERMIT THE DESIRED BEAMWIDTH FROM AN ANTENNA SIZE COMPATIBLE WITH COMPACT CARS. THE RESULTS OF THIS STUDY ARE REVIEWED AND A DETAILED DESCRIPTION IS GIVEN OF A LOW POWER SOLID STATE 36 GHZ RADAR WHICH USES DIPLEXED-CW TO OBTAIN RANGE INFORMATION, AND ON-OFF MODULATION TO PROVIDE POSITIVE RANGE CUTOFF (9 Refs)
Descriptors: RADAR APPLICATIONS; ROAD VEHICLES; BRAKING; SAFETY SYSTEMS
Identifiers: RADAR BRAKING SYSTEM; TARGET DISCRIMINATION; BEAMWIDTH; 36 GHZ RADAR; HIGHWAY COLLISION AVOIDANCE
Section Class Codes: B6320

042679 B78016131
A STUDENT-DESIGNED AUTOMOTIVE COLLISION AVOIDANCE SYSTEM
HADEN, C.R.
SCHOOL OF ELECTRICAL ENGNG. AND COMPUTER SCI., UNIV. OF OKLAHOMA, NORMAN, OK, USA
IEEE TRANS. VEH. TECHNOL. (USA) VOL.VT-27, NO.1 31-4 FEB. 1978 Coden: ITVTAB
Treatment: PRACTICAL APPLIC~
JOURNAL PAPER~
A RECEIVER-TRANSMITTER SYSTEM AT 99 MHZ IS ENERGIZED BY A SHOCK ACTIVATED SWITCH TO PROVIDE WARNINGS OF COLLISION, EMERGENCY VEHICLES, OR OTHER ROAD HAZARDS. THE SYSTEM WAS INTENDED TO BE SIMPLE AND RELIABLE, AND, WHEN TRANSLATED INTO MODERN INTEGRATED CIRCUIT TECHNOLOGY, IT CAN BE INSTALLED AT A LOW COST PER VEHICLE. IT PROVIDES ADVANTAGES OVER RADAR BRAKING IN THAT IT IS PRACTICALLY FEASIBLE AND MUCH LESS EXPENSIVE. IT HAS ADVANTAGES OVER OTHER APPROACHES IN THAT IT CAN BE USED IN THE DAYTIME OR AT NIGHT AND IN ANY WEATHER (10 Refs)
Descriptors: RADIO LINKS; AUTOMOBILES; SAFETY
Identifiers: AUTOMOTIVE COLLISION AVOIDANCE SYSTEM; SHOCK ACTIVATED SWITCH; RECEIVER TRANSMITTER SYSTEM
Section Class Codes: B6250Z

033573 B78012958, C78006542
CERTAIN TRENDS IN THE DEVELOPMENT OF AUTOMOTIVE ELECTRONIC COMPONENTS AND SYSTEMS
MATLA, R.
INST. MASZYN ELEKTRYCZNYCH, POLITECH. WARSZAWSKA, WARSAW, POLAND
PRZEGL. ELEKTROTECH. (POLAND) VOL.53, NO.10 444-6 OCT. 1977 Coden: PZELAL
Treatment: APPLIC~GENERAL,REVIEW~
JOURNAL PAPER~
Languages: POLISH
BASIC DEVELOPMENT TRENDS IN THE AUTOMOTIVE ELECTRONICS ARE DISCUSSED. IN THE CASE OF CARS SPECIAL ATTENTION IS GIVEN TO ANTI-SKID BRAKES, AUTOMATIC GEARBOXES AND IGNITION SYSTEMS. COMPUTER-CONTROLLED DIAGNOSTIC SYSTEMS AND MONOLITHIC MICROPROCESSORS FOR AUTOMOTIVE APPLICATIONS ARE DESCRIBED (10 Refs)
Descriptors: AUTOMOBILES; COMPUTERISED CONTROL
Identifiers: AUTOMOTIVE ELECTRONIC COMPONENTS; AUTOMATIC GEARBOXES; IGNITION SYSTEMS; MONOLITHIC MICROPROCESSORS; ANTISKID BRAKES; COMPUTER CONTROLLED DIAGNOSIS SYSTEM
Section Class Codes: B8520, C7410D, C3360B

032439 B78012943, C78005227
TRAM-CARS WITH PHASE-ANGLE CONTROL IN AUSTRIA-THE DEVICE FOR ELECTRIC TRACTION
WITTMANN, H.
ELEKTR. BAHNEN (GERMANY) VOL.48, NO.11 278-84 NOV. 1977 Coden: ELBAAQ
Treatment: GENERAL,REVIEW~
JOURNAL PAPER~
Languages: GERMAN
THE MUNICIPAL TRANSPORT AUTHORITIES OF LINZ AND GRAZ WILL TAKE THE DELIVERY OF 22 NEW CHOPPER-CONTROLLED ARTICULATED VEHICLES UNITS WITH EIGHT AXLES EACH AND COMBINED REGENERATIVE AND RESISTANCE BRAKE. THE ARTICLE BRIEFLY GIVES INFORMATION ON THE ELECTRIC TRACTION EQUIPMENT. A DESCRIPTION IS GIVEN OF THE MAIN CURRENT CIRCUIT AND THE ELECTRONIC DRIVING AND BRAKING CONTROL. SEMICONDUCTOR POWER DEVICES WITH HIGH REVERSE VOLTAGE RATING ARE USED FOR THE CHOPPERS. THE ELECTRONIC DRIVING AND BRAKING CONTROL, SYSTEM SIMATIC WITH TTL-TECHNIQUE AND INTEGRATED AMPLIFIERS IS EMPLOYED ON MORE THAN 100 THYRISTOR CHOPPER-CONTROLLED VEHICLES (8 Refs)
Descriptors: ELECTRIC VEHICLES; REGENERATIVE BRAKING; ELECTRIC DRIVES; TRANSISTOR-TRANSISTOR LOGIC; TRACTION; ROAD VEHICLES
Identifiers: ELECTRIC TRACTION; ELECTRIC TRACTION EQUIPMENT; MAIN CURRENT CIRCUIT; ELECTRONIC DRIVING; BRAKING CONTROL; INTEGRATED AMPLIFIERS; THYRISTOR; TRAMCAR PHASE ANGLE CONTROL; CHOPPER CONTROLLED ARTICULATED VEHICLE UNITS; COMBINED REGENERATIVE/RESISTANCE BRAKE; SEMICONDUCTING POWER DEVICES
Section Class Codes: B8520, C3360B

ISMEC (Mechanical Engineering)

Radar Braking or Collision Avoidance

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User 8497   Date:30oct80   Time:20:58:25   File: 14

Set Items Description
  1    81 COST(W)BENEFIT OR COST(W)EFFECTI
  2     4  (RADAR AND BRAK?) OR ELECTRONIC
  3    37  ANTILOCK? OR ANTISKID? OR ANTI(
  4     7  (COLLISION OR ACCIDENT? ?) AND
  5  2886  AUTOMOBILE? ? OR AUTOMOTIVE OR
  6    15 (2+3)*5
  7     3 4*5
  8     0 1*6
  9     0 1*7
 10    17 6+7

Print 10/5/1-17

Search Time:  0.028   Prints:  17   Descs.:  21
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094054 D79011047
Fluid power-its place in car design
Anonymous
Design Engineering 59-65 Mid-May 1979 Coden: DEMCBS
England
Treatment: G.N.P
02
Descriptors: Hydraulic equipment; Automobiles; Pumps; Motor vehicle steering; Motor vehicle brakes; Technology; Inventions ; Servomechanisms; Motor vehicle components; Fluidic devices; Fluidic systems; Hydraulic power transmission systems; Motor vehicles
Identifiers: hydraulic pumps; power steering; brake actuation; full power systems; power boost systems; anti-skid systems; active ride control; automobile industry
Section Class Codes: D6200, D2600

094045 D79011038
Experience with the conception and development of .the Mercedes-Benz/Bosch anti-lock system (braking system)
Burckhardt, M.
Automobitechnische Zeitschrift Vol. 81, No. 5 201-208 May 1979 Coden: AUTZA6
FRG
02
Languages: German
(4 Refs)
Descriptors: Motor vehicle brakes; Tires; Control systems; Sensing devices; Safety; Reliability; Monitoring; Design; Operations; Performance; Automobiles; Motor vehicle engineering
Identifiers: anti-lock braking system; digital data processing; circuitry; schematics; Mercedes-Benz; Bosch
Section Class Codes: D6200

087805 D79004798
Anti-lock braking (commercial and experimental systems)
Automotive Engineer Vol. 4, No. 1 43-52 Coden: EUENDA
England
Treatment: G.N.P
02
(4 Refs)
Descriptors: Brakes; Standards; Electronic equipment; Valves ; Adhesion; Hydraulic systems; Control equipment; Control systems; State of the art; Technology; Automobiles
Identifiers: anti-lock brakes; FMVSS 121; schematics; electronic components; Bendix Westinghouse; modulators; controllers
Section Class Codes: D5590

086624 D79003617
Safety measures from research to production (automotive applications)
Neilson, I. D.
Automotive Engineer Vol. 3, No. 6 35-38 Dec. 1978 Coden: EUENDA
England
02
Descriptors: Automobiles; Motor vehicles; Safety; Safety systems
Identifiers: TRRL; anti-lock motorcycle brakes; side impact protection
Section Class Codes: D6200

071692 D78003685
Baseband radar system for atuomobile braking application
Ross, G. F.
Sperry Research Center, USA
Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096, USA
SAE Congress and Exhibition 1978 Feb. 27-Mar. 3, 1978 Detroit, Michigan, USA
06
Descriptors: Radar equipment; Motor vehicle brakes; Automobiles; Motor vehicles
Section Class Codes: D8300

065398 D7705025
ELECTRO-HYDRAULICS-ITS SIGNIFICANCE TODAY FOR CONTROL AND REGULATION TECHNIQUES
BACKE, W.
IND. - ANZ. (GERMANY) VOL.99, NO.52 981-3 29 JUNE 1977
Coden: IANZAQ
Treatment: A
02
Languages: GERMAN
Descriptors: HYDRAULIC CONTROL EQUIPMENT
Identifiers: REGULATION; PROCESS CONTROL; INJECTION MOULDING MACHINES; DUAL CYLINDER RESONANCE TEST MACHINES; HYDRAULIC POWER; AIRCRAFT; RAILWAY SEAT; MOTOR CAR BRAKE ANTILOCKING SYSTEM; ELECTROHYDRAULICS
Section Class Codes: D2450

062677 D7702304
STATE OF THE ART OF THE US EXPERIMENTAL SAFETY VEHICLES (ESV)
ROMPE, K.
AUTOMOBILTECH. Z. (GERMANY) VOL.79, NO.6 227-31 JUNE 1977 Coden: AUTZA6
Treatment: X
02
Languages: GERMAN
(12 Refs)
Descriptors: AUTOMOBILES; SAFETY
Identifiers: US; EXPERIMENTAL SAFETY VEHICLES; AUTOMOBILE; VEHICLE STRUCTURAL PROPERTIES; OCCUPANT PROTECTION; ACCIDENT ANALYSIS; ACCIDENT AVOIDANCE; BIOMECHANICS; CALSPAN/CHRYSLER; MINICARS
Section Class Codes: D6210, D1190

050150 D7604887
AUTOMOTIVE ELECTRONICS' CHALLENGE TO DESIGNERS
AUTOMOT. ENGINEERING (USA) VOL.84, NO.8 52-7 AUG. 1976
Coden: AVEGBI
Treatment: X
02
Descriptors: MOTOR VEHICLES; ELECTRONIC EQUIPMENT
Identifiers: DESIGN; FUEL INJECTION; ANTISKID CONTROL; IGNITION SYSTEM; INSTRUMENTATION; AUTOMOTIVE ELECTRONICS
Section Class Codes: D6200, D8300

046375 D7601112
ELECTRONIC BRAKING CORRECTOR
HARTLEY, J.
AUTOMOT. ENGINEER (GB) VOL.1, NO.4 58-9 APRIL-MAY 1976
Coden: EUENDA
Treatment: X
02
Descriptors: MOTOR VEHICLE BRAKES
Identifiers: AUTOMATIC WARNING; ANTISKID; ELECTRONIC BRAKING CORRECTOR; CONTROL UNIT; BENDIX WESTINGHOUSE SYSTEM; CARS; AIR PRESSURE; VALVES; TRACTORS
Section Class Codes: D6200

033839 D7503664
A REVIEW OF ANTI-SKID BRAKING
MADISON, R.H.; RIORDAN, H.E.; DOUGLAS, J.W.; SCHAEFER, T.C.; GRIMM, R.A.
FORD MOTOR CO., DEARBORN, MI, USA;
AUTOMOT. ENG. (USA) VOL.83, NO.7 34-8, 57 JULY 1975
Coden: AVEGBI
Treatment: A
02
Descriptors: MOTOR VEHICLE BRAKES
Identifiers: ANTISKID BRAKING; MOTOR VEHICLES; PERFORMANCE TESTING; AUTOMOTIVE BRAKING STABILITY; SYSTEM DESIGN
Section Class Codes: D6200

030063 D7507428
THE SAFETY OF THE VW-GOLF (AUTOMOBILE)
SEIFFERT, U.
AUTOMOBILTECH. Z. (GERMANY) VOL.77, NO.4 110-14 APRIL 1975 Coden: AUTZA6
Treatment: A
02
Languages: GERMAN
(3 Refs)
Descriptors: AUTOMOBILES; SAFETY
Identifiers: VW GOLF; SAFETY; ACCIDENT AVOIDANCE; REAR AXLE; BRAKE SYSTEM; VISIBILITY; ERGONOMIC DESIGN OF SEATS; INSTRUMENT GROUPING; AERODYNAMIC SHAPE; COLLISIONS; RESTRAINT SYSTEMS
Section Class Codes: D6210, D1190

025606 D7502971
PRESENT AND FUTURE AUTOMOBILE ANTILOCK BRAKING SYSTEMS
KLEIN, H.-C.; FINK, W.
AUTOMOT. ENG. (USA) VOL.82, NO.10 46-9 OCT. 1974
Coden: AVEGBI
Treatment: A
02
Descriptors: MOTOR VEHICLE BRAKES
Identifiers: AUTOMOBILE ANTILOCK BRAKING SYSTEMS; DESIGN; INDUCTION SENSORS; ELECTRONIC CONTROL; BRAKE PRESSURE MODULATION
Section Class Codes: D6210

023110 D7500475
WHAT'S NEW IN MOTORCYCLE ENGINEERING
COVINGTON, J.
AUTOMOT. ENG. (USA) VOL.82, NO.9 37-43 SEPT. 1974
Coden: AVEGBI
Treatment: NP
02
Descriptors: DESIGN; SAFETY; POLLUTION; INTERNAL COMBUSTION ENGINES; MOTOR VEHICLE BRAKES; MOTOR VEHICLE SUSPENSION
Identifiers: WOBBLE; ANTI LOCK BRAKES; MOTORCYCLE TECHNOLOGY ; ENGINE EFFICIENCY; OUTPUT; BRAKING; SAFETY FACTORS; SUSPENSION SYSTEMS; NOISE; EMISSIONS CONTROL; DESIGN; AUTOMOTIVE APPLICATIONS; COMPUTER; PREDICT; SPEED/TORQUE CHARACTERISTICS; AUTOMATED DESIGN
Section Class Codes: D6290, D5410, D1340

019350 D7404344
ANTI-LOCK BRAKING (FOR CARS AND TRUCKS)
HARTLEY, J.
AUTOMOT. DES. ENG. (GB) VOL.13 15, 17, 19 JUNE 1974
Coden: ADEGBS
Treatment: AP
02
Descriptors: MOTOR VEHICLE BRAKES
Identifiers: ELECTRONICS; LEGISLATION; CAR; TRUCK SYSTEMS; POWER SOURCE; POWER SOURCE; ANTI JACK KNIFING; ANTI LOCK BRAKING
Section Class Codes: D6200

018667 D7403661
FLUIDIC-PNEUMATIC ANTI-SKID SYSTEM FOR CARS
ROMITI, A.; BELFORTE, G.
POLITECHNICO TORINO, ITALY
FLUID. Q. (USA) VOL.6, NO.1 45-57 JAN. 1974 Coden: FLQUA2
Treatment: P
02
Descriptors: FLUIDIC DEVICES; PNEUMATIC EQUIPMENT; MOTOR VEHICLE BRAKES; ACTUATORS
Identifiers: CARS; AUTOMATICALLY DECREASE; REMOVE; BRAKING ACTION; AXLE; WHEELS; SKID; SLIDING SPEED; THRESHOLD; DEVICE; FLUIDIC AMPLIFIER; ANTI SKID SYSTEM; PNEUMATIC SIGNAL
Section Class Codes: D6210, D2600

013620 D7406126
COMING CLOSER' RADAR BRAKING FOR AUTOMOBILES
TROLL, W.C.; SHEFER, J.; KLENSCH, R.J.; JOHNSON, H.C.; KAPLAN, G.S.
BENDIX CORP., CINCINNATI, OHIO, USA;
AUTOMOT. ENG. (USA) VOL.82, NO.2 61-6 FEB. 1974
Coden: AVEGBI
Treatment: P
02
Descriptors: MOTOR VEHICLE BRAKES; RADAR APPLICATIONS; AUTOMATIC CONTROL
Identifiers: RADAR BRAKING; AUTOMOBILES; COLLISION AVOIDANCE ; IMPACT REDUCTION; PASSIVE REFLECTOR; AUTOMATIC BRAKING
Section Class Codes: D6210

000479 D7300479
SAFETY RELATED ELECTRONICS (FOR ANTI-SKID BRAKING) IN THE AUTOMOTIVE ENVIRONMENT
SLAVIN, M.; ELLIOTT, D.R.
BENDIX CORP., NEWPORT NEWS, VA., USA
INSTN. MECH. ENGRS
CONFERENCE ON AUTOMOTIVE ELECTRICAL EQUIPMENT 85-95 1973
13-14 SEPT. 1972 BRIGHTON, SUSSEX, ENGLAND
Publ: INSTN. MECH. ENGRS. LONDON, ENGLAND
VI+168PP. ISBN 0 85298 060 4
Treatment: AN
06
Descriptors: MOTOR VEHICLE BRAKES; SAFETY SYSTEMS; CONTROL SYSTEMS; RELIABILITY
Identifiers: SAFETY; AUTOMOTIVE ENVIRONMENT; AUTOMOTIVE CONTROL SYSTEMS; RELIABILITY; ANTI SKID BRAKING; DESIGN; ELECTRONIC CONTROL UNIT
Section Class Codes: D6200

Table 3

Summary of Effectiveness of Braking System Models (Total N - 215)

Models	Certain		Certain or Probable		Certain, Probable or Possible	
	Accidents Prevented %	Prevented or Reduced in Severity* %	Accidents Prevented %	Prevented or Reduced in Severity* %	Accidents Prevented %	Prevented or Reduced in Severity* %
1. Radar Warning - Cooperative	0.5	5.1	6.0	12.1	14.9	14.9
2. Radar Warning - Non-Cooperative	0.5	6.5	9.3	16.7	21.9	21.9
3. Rear Wheel Anti-Lock	0.5	0.5	1.9	1.9	3.7	3.7
4. Four Wheel Anti-Lock	2.8	3.7	7.9	7.9	13.0	13.0
5. Coop. Warning & Rear Wheel Anti-Lock	0.9	5.6	7.9	14.0	18.1	18.1
6. Non-Coop. Warning & Rear Wheel Anti-Lock	0.9	7.0	11.2	18.6	25.1	25.1
7. Coop. Warning & 4-Wheel Anti-Lock	4.2	9.3	13.5	16.7	23.7	23.7
8. Non-Coop. Warning and 4-Wheel Anti-Lock	4.7	11.2	16.7	21.9	30.2	30.2
9. Coop. Warning & Actuation & Rear Wheel Anti-Lock	13.0	15.8	20.0	21.4	25.6	26.0
10. Non-Coop. Warning & Actuation & 4-Wheel Anti-Lock	18.1	25.1	31.6	38.1	41.9	45.1

*Severity Reduction was defined as occurring when impact speed of any one vehicle was reduced 10 mph or 25%, whichever was greater.

APPENDIX B

SAMPLES OF RECORD LAYOUTS AND CODING FORMS

NORTH CAROLINA RECORD LAYOUT

ACCIDENT REPORT RECORD LAYOUT
(type 1 Record-March, 1973)

Relative Position Within Type 1	No. Bytes	Field Encoded In	Description
1	1	B	Type Record (must be 1)
2	1	B	Action Required by Update Program 1 = Delete entire record 2 = Build new record 3 = Delete specified fields from record 4 = Supplement specified fields in record 5 = Replace specified fields in record 9 = Print out of accident case ~~8 = Voided number~~ 7=FLAG RECORD SENT TO HWY
3	1	B	Sequence Number - Two digits separated by comma.
4	1	B	Total Number of Type 1 Records (2 digits)
5	1	B	Investigated by 1 = Mun. Police, 2 = Sheriff, 3 = Rural or County Police, 4 = Highway Patrol, 5 = Other Traffic Inv. Agency.
6-8	3	B	Report Number - Must be 6 digits numeric.
9-10	2	B	Accident Date - 6 digits month, day, year
11	1	B	Day of Week - Monday = 1, Tuesday = 2, Wednesday = 3, Thursday = 4, Friday = 5, Saturday = 6, Sunday = 7
12-13	2	B	Time - Hour and Minute (4 digits) Hex 'F's for not stated. 4th bit from left 0 = AM 1 = PM. NOON IS 12 P.M., MIDNIGHT IS 12 A.M. BUT SAME DATE AS IF IT WERE 11:59 P.M..
14	1	B	County - '00' = Alam. (Hex 'FF' if not stated)
15	1	B	Area - (Highway Patrol)
16-27	12	ZD ?	City - Up to 12 digits alphabetic or blank if rural. (See Exhibit A for city abbreviations)
28-30	3	B	City Population

zoned decimal ?

Relative Position Within Type 1	No. Bytes	Field Encoded In	Description
31-50	20	ZD	On Road - Highway class (I = Interstate, US = United States, NC = North Carolina Route, RP = Rural Paved, RU = Rural Unpaved). The route or road number, alternate route direction (A = alternate, B = business, N = north, E = east, S = south, W = west, C = Connector), a comma and 'R' if ramp or 'SR' if service road. OR PP = private property, military reservation, college campus, or non-traffic. OR City street - street name as shown on accident report (See Exhibit B for street abbreviations)
51-53	3	B	Miles or Feet - miles shown to hundredths of a mile. '0' if intersection.
54	1	ZD	M = miles, F = feet
55-56	2	ZD	Direction - N, E, S, W, NE, NW, SE, SW.
57-76	20	ZD	From (or) Intersection - 5 position county. OR 2 position state (GA, SC, TN, VA). OR 20 position street name. OR Highway class, number, alternate, ramp or service road (same as ON ROAD
77-88	12	ZD	Toward - Highway number (same as ON Road), -OR- City name (12 positions), -OR- 5 position county, -OR- 2 position state, -OR- 'Dead End Road', -OR- 'NS' if not stated.
89	1	B	Accident Type - Vehicle 1 - Codes may be 1-22
90	1	B	Accident Type - Vehicle 2 - will be same as vehicle 1 unless otherwise stated.
91-93	3	B	Additional Property Damage- rounded to dollars HEX 'FF' = NOT STATED. (This is only 2 bytes wide)

*ADDED JUNE 11, 1973

Relative Position Within Type 1	No. Bytes	Field Enclded In	Description
	31	PA	Vehicle #1 Driver Name - (not shown in accident master file) 1 = complete first, middle and last names. An apostrophe (') will appear between middle and last names. - OR - 2 = 'Hit and Run' if hit and run and no driver's name is shown. -OR - 3 = the owner's name if parked vehicle and no driver. May be individual name or co. name.
			Vehicle #1 Driver Address - (not shown in accident master file) only present if 1 = no North Carolina driver's license is shown - OR - 2 = address is different than shown on N.C. drivers license. Address is in same format as driver license master file. Filler when address is not given in hex '0'.
			Instate Addresses
	20	PA ?	Street Address
	2	B	City Code
	3	P	ZIP Code (zero if not given)
			Out of State Addresses
	12	PA	Street Address
	9	PA	City
	1	B	State (do not use if '00' or 'FF')
	3	P	ZIP Code (zero if not given)
	1	B	Flag Byte X'80' = out of state address
	4	B	Not Used

Relative Position Within Type 1	No. Bytes	Field Encoded In	Description
94-95	2	ZD	Vehicle #1 Driver Race/Sex - WM, WF, NM, NF, IM, IF, OM, OF, W, I, N, O, M, F. (left justify) - OR - 'NS' if both are not stated. - OR - 'OW' if owner's name and address is typed.
96-98	3	B	Vehicle #1 Driver License Number
99	1	B	Vehicle #1 Learner's or Pedestrian - 1 = Learner's Permit 2 = Licensed out of state 3 = Pedestrian or bicyclist
100	1	B	Vehicle # 1 License or permit issued by: (low four bits) 1 = North Carolina 2 = Other than N.C. (U.S. military, other country, other state) 3 = Not stated Residency of Driver or Owner: (high four bits) 1 = non- resident
101-102	2	B	Vehicle #1 Date of Birth - 6 digit date (month-day-year)

Relative Position Within Type 1	No. Bytes	Field Encoded In	Description
103	1	B	Vehicle #1 Age at Date of Accident
104	1	B	Vehicle #1 Armed Forces 1 = yes, 2 = no.
105	1	B	Vehicle #1 Vehicle Type Description — Code Two or four door sedan (pass. veh) — 1 Two or four door sedan & house trailer — 2 Passenger car and trailer — 3 Station Wagon (passenger) — 4 Station Wagon (truck) — 5 Commercial Bus — 6 School Bus — 7 Activity Bus — 8 Truck with two axles — 9 Truck with two axles and trailer — 10 Truck with three axles — 11 Truck with three axles and trailer — 12 Truck tractor and semi-trailer — 13 Taxicab — 14 Farm Equipment — 15 Farm Tractor — 16 Motorcycle — 17 Motor Scooter or Motor Bike — 18 Ambulance — 19 Bicyclist — 20 Recreational vehicle, self-contained — 21 "Camper" mounted on 2 axle truck — 22 Camper mounted on 2 axle trk-trailer — 23 Other Motor Vehicle — 24 Pedestrian — 25 Not Stated — 26
106	1	ZD	Vehicle #1 Additional Vehicle Code 'M' if military 'E' if emergency vehicle on emergency run 'S' if state owned 'P' if other publicly owned
107-109	3	B	Vehicle #1 Amount of Damage - rounded to dollars HEX 'FF' = NOT STATED.

Relative Position Within Type 1	No. Bytes	Field Encoded In	Description
110-112	3	ZD	Vehicle #1 Injuries - Front Seat - Injury class (K = kille A = incapaciting, C = no visible significant injury, 0 = no injury). If seat position is not occupied - 'N'.
113-115	3	ZD	Vehicle #1 Injuries - Rear Seat - 'N' if not occupied.
116	1	B	Total K - Vehicle 1
117	1	B	Total A - Vehicle 1
118	1	B	Total B - Vehicle 1
119	1	B	Total C - Vehicle 1
120	1	B	Total 0 - Vehicle 1
121	1	B	Total Occupants - Vehicle 1 - Number shown - OR - 'FF' for not stated.
122	1	B	Vehicle # 1 Charges Made - 1 = Yes, 2 = No.
	31	PA	Vehicle #2 Driver Name - (not shown in accident master file) 1 = complete first, middle and last names. An apostrophe (') will appear between middle and last names. - OR - 2 = 'Hit and Run' if hit and run and no driver's name is shown. - OR - 3 = the owner's name if parked vehicle and no driver. May be individual name or co. name.

Relative Position Within Type 1	No. Bytes	Field Encoded In	Description
			Vehicle #2 Driver Address - (not shown in accident master file) only present if 1 = no North Carolina driver's license is shown - OR - 2 = address is different than shown on N.C. driver's license. Address is in same form as driver license master file. Filler when address is not given in hex '0'.
			Instate Addresses
	20	PA	Street Address
	2	B	City Code
	3	P	ZIP Code (zero if not given)
			Out of State Addresses
	12	PA	Street Address
	9	PA	City
	1	B	State (do not use if '00' or 'FF')
	3	P	ZIP Code (zero if not given)
	1	B	Flag Byte X'80' = out of state address
	4	B	Not Used

Relative Position Within Type 1	No. Bytes	Field Encoded In	Description
123-124	2	ZD	Vehicle #2 Driver Race/Sex - WM, WF, NM, NF, IM, IF, OM, OF, W, I, N, O, M, F. -OR- 'NS' if both are not stated. -OR- 'OW' if owner's name and address is typed.
125-127	3	B	Vehicle #2 Driver License Number
128	1	B	Vehicle #2 Learner's or Pedestrian 1 = Learner's permit. -OR- 2 = Licensed out of state. -OR- 3 = Pedestrian or bicyclist.
129	1	B	Vehicle #2 License or permit issued by: (low four bits) 1 = North Carolina 2 = other than N.C. (US, military, other country other state) 3 = not stated Residency of driver or owner: (high four bits) 1 = non-resident
130-131	2	B	Vehicle #2 Date of Birth - 6 digit date(month-day-year).
132	1	B	Vehicle #2 Age at Date of Accident
133	1	B	Vehicle #2 Armed Forces - 1 = yes, 2 = No.
134	1	B	Vehicle #2 Vehicle Type- (Use same code table as listed for Vehicle #1 Vehicle type as shown on Page 4.
135	1	ZD	Vehicle #2 Additional Vehicle Code - 'M' if military. 'E' if emergency vehicle on emergency run. 'S' if state owned. 'P' if other publicly owned.
136-138	3	B	Veh.#2 Amount of Damage - Rounded to dollars HEX 'FF' = NOT STATED.

Relative Position Within Type 1	No. Bytes	Field Encoded In	Description
139-141	3	ZD	Veh. #2 Injuries - Front Seat - Injury class (K = killed, A = incapacitating injury, B = non-incapacitating, C = no visible significant injury, O = no injury). If seat position is not occupied - 'N'.
142-144	3	ZD	Veh. #2 Injuries - Rear Seat - 'N' if not occupie
145	1	B	Vehicle #2 - Total K
146	1	B	Vehicle #2 - Total A
147	1	B	Vehicle #2 - Total B
148	1	B	Vehicle #2 - Total C
149	1	B	Vehicle #2 - Total O
150	1	B	Vehicle #2 - Total Occupants - Number shown. -OR- 'FF' for not stated.
151	1	B	Vehicle #2 Charges Made - 1 = Yes, 2 = No
152-154	3	B	Vehicle 1 Initial Point of Contact - Up to 3 points. Codes 1 through 26, Code 30 - no contact
155-157	3	B	Vehicle 2 Initial Point of Contact - Up to 3 poin
158	1	B	1-Locality - Code as shown (1 through 4). 1 = Business, 2 = Residential 3 = School & Playground, 4 = Open Country
159	1	B	2-Speed Limit - 2 digit numeric code or 'FF' for not stated.
160	1	B	3-Road Feature - 1 digit numeric code (1 through 7) or 'FF' for not stated. 1 = Bridge or Underpass, 2 = Driveway, 3 = Alley Intersection, 4 = Intersection of two roadways, 5 = Non-intersection median crossover, 6 = End or [illegible]nning of divided highway, 7 = Other

Relative Position Within Type 1	No. Bytes	Field Encoded In	Description
161	1	B	4-Road Surface - 1 digit numeric code (1 through 6) or 'FF' for not stated. 1 = Concrete, 2 = Smooth Asphalt, 3 = Coarse Asphalt, 4 = Gravel, 5 = Dirt or Sand, 6 = Other
162	1	B	5-Road Defects - 1 digit numeric code (1 through 7) or 'FF' for not stated. 1 = Loose material on surface, 2 = holes, deep ruts, 3 = Low shoulders, 4 = Soft shoulders, 5 = Other defects, 6 = Road under construction, 7 = No defects
163	1	B	6-Road Condition - 1 digit numeric code (1 through 6) or 'FF' for not stated. 1 = Dry, 2 = Wet, 3 = Oily, 4 = Muddy, 5 = Snowy, 6 = Icy
164	1	B	7-Light Condition - 1 digit numeric code (1 through 5) or 'FF' for not stated. 1 = daylight, 2 = Dusk, 3 = Dawn, 4 = Darkness (street lighted), 5 = Darkness (street not lighted)
165	1	B	8-Weather - 1 digit numeric code (1 through 6) or 'FF' for not stated. 1 = Clear, 2 = Cloudy, 3 = Raining, 4 = Snowing, 5 = Fog, 6 = Sleet or hail
166	1	B	9-Traffic Control - 1 or 2 digit code (1 through 10) or 'FF' for not stated. 1 = Stop sign, 2 = Yield sign, 3 = Stop and Go signal, 4 = Flashing signal with stop sign, 5 = Flashing signal without stop sign, 6 = R.R. gate and flasher, 7 = R.R. flasher 8 = Officer, 9 = Other device, 10 = No control present
167	1	B	Traffic Control Condition - 1 bit = not operating, 2 bit on = not visible.

No. Bytes	Field Encoded In	Description
1	B	18-Vehicle 1 Tire Impressions (Ft.) - 1 to 3 digit numeric.
1	B	18-Vehicle 2 Tire Impressions (Ft.) - 1 to 3 digit numeric.
2	B	19-Vehicle 1 Distance Traveled After Impact - Rounded to whole feet.
2	B	19-Vehicle 2 Distance Traveled After Impact - Rounded to whole feet.
1	ZD	20-Vehicle 1 Direction Travel - Type N, E, S, W, or blank if not stated.
1	B	Road On - 1 = Vehicle 1 on 1st road in location 2 = Vehicle 1 on 2nd road in location 3 = Vehicle 1 on neither road.
1	ZD	21-Vehicle 2 Direction Travel - Type N, E, S, W, or blank if not stated.
1	B	Road On - 1 = Vehicle 2 on 1st road in location 2 = Vehicle 2 on 2nd road in location 3 = Vehicle 2 on neither road.
5	B	22-Vehicle 1 Violation Indicated - 1 violation for each byte. Hex '0's if not used. 1 = Speeding below 65 mph, 2 = Speeding 65 to 75 mph, 3 = Speeding over 75 mph, 4 = Failed to yield right-of-way, 5 = Driving wrong side road, 6 = Improper overtaking, 7 = Disregarded stop sign or signal, 8 = Disregarded traffic signal, 9 = Following to closely, 10 = Improper turn, 11 = Improper or no signal, 12 = Improper parking location, 13 = Under influence of alcohol, 14 = Reckless driving, 15 = Racing, 16 = Failed to see movement safe, 17 = Passing on curve, 18 = Passing on hill, 19 = Passed stopped school bus, 20 = Improper lights, 21 = Improper brakes, 22 = Other improper drivin 25 = No violation indicated, 26 = Not stated

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Relative Position Within Type 1	No. Bytes	Field Encoded In	Description
197-201	5	B ✓	23-Vehicle 2 Violation Indicated - Up to 5 violations. 1 Violation in each byte. (Typing Code same as for Vehicle 1 Violation Indicated as listed on Page 11.)
202	1	B	24-Vehicle 1 Misc. Action 1 = Avoiding pedestrian 2 = Avoiding other wheeled vehicle 3 = Avoiding fixed object 4 = Avoiding animal 5 = Fire or mechanical failure 6 = Fell from vehicle 7 = Driverless moving vehicle 8 = Skidded out of control 9 = Pushing or towing vehicle (do not include trailer) Code 13 = Driver information to be added to statistical reports, but entry not to be shown on commercial record checks. 10 = Vehicle parked on private property, 11 = Vehicle legally parked, 12 = Vehicle and driver information omitted. (Do not use for stat. reports)
203	1	B	25-Vehicle 2 Misc. Action - (Same as above)
	INFORMATION FROM DRIVERS LICENSE MASTER FILE		
204	1	B	Vehicle 1 License Number Action - 1 = N.C. drivers license number on systems. 2 = N.C. control number on system. 3 = New N.C. control number. 4 = Improper N.C. drivers license number.
205-207	3	B	Vehicle 1 N.C. Drivers License Number or N.C. Control No.
208	1	B	Vehicle 1 License Status (High order 4 bits) 1 = N.C. oper., 2 = N.C. chauffeur, 3 = Both. Restrictions low order 4 bits.
209-214	6	ZD	1 Position 1st Name 5 positions last

Relative Position Within Type 1	No. Bytes	Field Encoded In	Description
215	1	B	Vehicle 2 License Number Action 1 = N.C. drivers license number on system. 2 = N.C. control number on system. 3 = New N.C. control number. 4 = Improper N.C. drivers license number.
216-218	3	B	Vehicle 2 N.C. Drivers License Number or N.C. Control No.
219	1	B	Vehicle 2 License Status 1 = Operator, 2 = Chauffeur, 3 = Both. Restrictions (low order 4 bits)
220-225	6	ZD	1 Position 1st name, 5 positions last name

Relative Position Within Type 1	No. Bytes	Field Encoded In	Description
226-230	5	ZD	Blanks - Not Used
231-232	2	ZD	Vehicle 1 - Year of Manufacture - 2 Digit numeric. Blank if not stated.
233-242	10	ZD	Vehicle 1 - Make of Vehicle - 1-10 digits alphabetic, left justified. Blank if not stated.
243-249	7	ZD	Vehicle 1 - License Plate Number - 1-7 digits right justified. Blank if not stated. Does not include temporary plates or permits.
250-251	2	ZD	Vehicle 1 - License State - 2 Digit alphabetic abbreviation of state issuing license plate - (see Exhibit C for abbreviations). Blank if not stated.
252-253	2	ZD	Vehicle 1 - License Year - 2 Digit numeric year of plate issue. Should be year of accident or previous year. Blank if not stated.
254-269	16	ZD	Vehicle 1 - VIN Vehicle identification number, 1-16 digits alphabetic and numeric. Blank if not stated.
270-272	3	P	Vehicle 1 - Odometer - Mileage on vehicle at time of accident in whole miles. Zero if not stated.
273-287	15	PA	Vehicle 1 - TAD 1 TAD for every 3 bytes. Each part of the vehicle which is damaged is described in the first 3 characters (unpacked) and the severity of damage denoted in the last character. Legitimate TAD ratings are FC,FD,FL,FR,BC,BD,BL, BR,LP,RP,LFQ,RFQ,LBQ,RBQ,LD,RD,L&T,R&T,TOP. The severity is 0-7.

Relative Position Within Type 1	No. Bytes	Field Encoded In	Description
288-290	3	B	Vehicle 1 - Reasons SR-1 was not mailed. First Byte X'80' - Case Reconstruction X'40' - Exempt by Class X'20' - Self Insured X'10' - Surety Bond X'08' X'04' X'02' X'01' Second Byte X'80' - Vehicle parked or stopped in travel lane and no violation indicated. X'40' - Driver killed X'20' - Nonreportable accident X'10' - Driver under the age of 15 X'08' - Military vehicle X'04' - Private property or parked vehicle X'02' - Vehicle type - Other motor vehicle X'01' - Vehicle Type - Farm Tractor or Farm equipment Third Byte X'80' - Owner of parked vehicle X'40' - State, local or federal government owned vehicle. X'20' - Vehicle type is a pedestrian or bicyclis X'10' - Hit and Run vehicle X'08' - No or incomplete mailing address X'04' - One vehicle accident - no injury other than driver X'02' - No insurance record X'01' - Valid insurance certification in insurance file.
291	1	B	Vehicle 1 - reasons SR-1 mailed X'80' - No Registration record such as invalid plate number. X'40' - Insurance stop on Registration Record X'20' - Active FS-4 in Insurance File X'10' - Out of State Plate number X'08' -Plate Inquiry X'04' - Invalid Certification X'02' X'01'
292-296	5	ZD	Blanks - Not used.

Relative Position Within Type 1	No. Bytes	Field Encoded In	Description
297-298	2	B	Vehicle 1 Latest Certification Date. 2 Position date in YY-MM-DD DDATE format.
299-300	2	B	Vehicle 1 - Latest Insurance Company Code. 1 Digit alphabetic followed by binary number for code assigned to Insurance Company.
301-305	5	ZD	Blanks - Not Used.
306-307	2	ZD	Vehicle 2 - Year of Manufacture. Same as for Vehicle 1 - year of manufacture on Page 14.
308-317	10	ZD	Vehicle 2 - Make of Vehicle. Same as for Vehicle 1 - make of vehicle on Page 14.
318-324	7	ZD	Vehicle 2 - License Plate Number. Same as Vehicle 1 - License Plate Number on Page 14.
325-326	2	ZD	Vehicle 2 - License State. Same as Vehicle 1 - License State on Page 14.
327-328	2	ZD	Vehicle 2 - License Year. Same as Vehicle 1 - License Year on Page 14.
329-344	16	ZD	Vehicle 2 - VIN. Same as Vehicle 1 - VIN on Page 14.
345-347	3	P	Vehicle 2 - Odometer. Same as Vehicle 1 - Odometer on Page 14.
348-362	15	PA	Vehicle 2 - TAD. Same as Vehicle 1 TAD on Page 14.
363-365	3	B	Vehicle 2 - Reasons SR-1 Not Mailed. Same as Vehicle 1 SR-1 not mailed on Page 15.

Relative Position Within Type 1	No. Bytes	Field Encoded In	Description
366	1	B	Vehicle 2 - Reasons SR-1 Mailed. Same as Vehicle 1 Reasons SR-1 mailed on Page 15 .
367-371	5	ZD	Blanks - Not Used.
372-373	2	B	Vehicle 2 - Latest Insurance Certification Date Same as Vehicle 1 Latest Certification Date on Page 15 .
374-375	2	B	Vehicle 2 - Latest Insurance Code. Same as Vehicle 1 latest Insurance code on Page 15 .
376-400	25	ZD	Blank - Not Used.

PENNSYLVANIA RECORD LAYOUT

CARD/T[illegible] LAYOUT

System	File Name	File Ident.	Page
Accident Records	Location — Accident Date & Location	AI 101	1 of 5
Subsystem	**Analyst** / **Length**	**Date**	**Revision Date**
	Boedeker / 80	Jan. 1970	6-1-75

Data Name	Columns	Picture
Accident Report Number	1–6	N
Vehicle Number	7–8	N
CD. No. 1	9	N
Date of Collision (Mo. / Day / Yr.)	10–15	N
Dy. of Week	16	N
Time Of Accident (2400)	17–20	N
County	21–22	N
City	23–26	N
Urban/Rural	27	A
Functional Class of Road	28	N
Adm. Class	29	N
Prefix (Card Ident.)	30	A
PRIMARY TRAFFICWAY: Route No., Co. Road No. or Name, Street No. or Name, Street Code No.	31–45	A/N
Section	46	N
Prefix (Detail Loc.)	47	N
Equation	48	A
Seg No.	49–50	N

Data Name	Columns	Picture
Mile Post	51–55	N
Ramp Code	56–59	N A N
Diagram Analysis Data (1st Vehicle / 2nd Vehicle / Impact Position)	60–69	A/N
Intersection, Ref. or Between	70	N
Cross Road Class	71	N
[illegible]	72	N
STATUS	73	N
DATE OF ENTRY	74–78	N
4K	79	A
DELETE CODE	80	X

DELETE CODE = X'FA'

Data Name	Columns	Picture
	1–50	

Data Name	Columns	Picture
	51–100	

CARD LAYOUT

System: ACCIDENT RECORDS	File Name: LOCATION — ACCIDENT LOCATION, CONDITIONS & TIMES	File Ident.: AT 102	Page: 2 of 5
Subsystem:	Analyst: BOEDEKER	Length: 90	Date: Jan. 1970

Revision Date:

Data Name	Card Columns	Picture
Accident Report Number	1–6	N
Vehicle Number	7–8	N
CD NO. (2)	9	N
SECONDARY TRAFFICWAY — Intersecting, Reference, or Between (Ahead) Route No., County Road No. or Name, Street No., Name, or Code No., Railroad Intersection No.	10–24	A/N
NON-INTERSECTION OR BETWEEN (BACK) TRAFFICWAY	25–39	A/N
Distance From Reference Miles or Feet	40–43	N
Miles or [illegible]	44	A
Direction From Reference	45–46	A
Severity	47	N
Estimated Property Damage Amount	48–49	N

Data Name	Card Columns	Picture
(Dollars)	51–52	
Junction or Interchange	53	N
Char. of Road or Junction — Straight or Curve; Alley, Reader etc.	54–55	11
On, off, or other Roadway	56	N
Directional Analysis — Collision Type; Object Struck	57–60	N
Road Surface	61	N
Weather	62	N
Light Conditions	63	N
Investigation by	64	N
TIMES — Police Dispatched (2400); Police Arrived (2400); Ambulance Arrived (2400)	65–76	N
Traffic Impeded — Hrs. / Mins.	77–80	N

CARD/TAPE LAYOUT

System	ACCIDENT RECORDS
Subsystem	
File Name	DRIVER AND VEHICLE — DRIVER & VEHICLE INFORMATION
Analyst	Boedeker
Length	80
File Ident.	AI 1Ø3
Date	Jan. 1970
Page	3 of 5
Revision Date	

Data Name	Columns	Picture
Accident Report Number	1–6	N
Vehicle Number	7–8	N
C.D. NO. 3	9	N
Driver Information		
Residence Proximity	10	N
Driver Occupation	11–12	N
Sex	13	N
Age	14–15	N
Injury Class	16	N
Seat Belt	17	N
Ejection	18	N
Vehicle Information		
Year	19–20	N
Make	21–24	A
Model	25–27	A
Style	28–29	A
License Plate Number	30–37	A/N
Veh. Reg. State	38–39	A/N
Trailer Information	40	N
Vehicle Type	41–42	N
Additional Vehicle Information	43–44	N
Officer Action	45	N
VIN	46–50	
Vehicle Identification Number	51–60	A/N
Odometer (Mileage)	61–66	N
Special Coding For Use By Cities	67–80	A/N

CARD/( ) LAYOUT

System	File Name	File Ident.	Page
ACCIDENT RECORDS	ACCIDENT CONDITIONS	AT 104	4 of 5

Subsystem	File Name (cont.)	Analyst	Length	Date	Revision Date
	VEHICLE DAMAGE & ACCIDENT CONDITIONS	BOEDEKER	80	JAN 1970	5-17-72

Data Name	Card Columns	Picture
Accident Report Number	1–6	N
Vehicle Number	7–8	N
CO. NO. 4	9	N
Severity of Veh. Damage	10	N
Estimated Vehicle Damage Amount (Dollars)	11–15	N
Driver/Veh. Actions	16–17	N
Misc. Actions 1 2 3	18–23	N
Vehicle Direction	24–25	A
Speeds: Posted, Safe	26–29	N
Contributing Circumstances 1 2 3 4 5	30–39	N
Traffic Control	40	N
Road Type	41	N
Road Separation	42	N
Vehicle Condition (Defects) 1 2 3 4	43–50	N

Data Name	Card Columns	Picture
Defects 5	51–52	
Sobriety	53	N
Chemical Test Results	54–55	N
DRIVER'S LICENSE NUMBER: D.L. NUMBER – LAST NAME	56–59	A OR N
D.L. NUMBER	60–67	N
BLANK – [illegible]	68	N
BLANK – [illegible]	69	N
BLANK	70–72	
INIT'S: 1st, [illegible]	73–74	A A
BIRTH DATE – MO.	75–76	N
BIRTH DATE – DAY	77–78	N
BIRTH DATE – YR.	79–80	N
STATE *		

CARD/TAPE LAYOUT

System: ACCIDENT RECORDS	File Name: INJURY — Occupants and non-occupants Injured or Killed	File Ident.: AI 105	Page: 5 of 5
Subsystem:	Analyst: BOEDEKER — Length: 80	Date: Jan. 1970	Revision Date:

Card columns 1–50

Accident Report Number	Vehicle Number	CD NO 5	Occupant 1: Sex	AGE	Seat Position	Injury Class	Seat Belt	Ejection	2	3	4	5	6
									Same	Same	Same	Same	Same
N	N	N	ALL NUMERIC										

Card columns 51–80

7	Pedestrian, Bicyclist, or other non-occupant: Resident Proximity	Occupation	Sex	Age	Status	Injury Class	Exact Location	ACTIONS	VIOLATIONS 1	2	3	Sobriety	Chemical Test Results	[illegible]	[illegible]	[illegible]
Same																
	ALL NUMERIC													N	N	N

NASS CODING FORMS

ACCIDENT FORM

Primary Sampling Unit Number ___ ___ (1 2)

Case Number ___ ___ ___ ___ (3 4 5 6)

Record Number 1 (7)

Transaction Code ___ (8)

Version Number 2 (9)

IDENTIFICATION

Year of Accident

___ Code the year in which the
cident occurred.

(10)

Month of Accident

01) January ___(07) July
02) February ___(08) August
03) March ___(09) September
04) April ___(10) October
05) May ___(11) November
06) June ___(12) December

(11 12)

Day of Week

1) Sunday ___(5) Thursday
2) Monday ___(6) Friday
3) Tuesday ___(7) Saturday
4) Wednesday ___(9) Unknown

(13)

Investigating Police Agency

___ Code assigned numerical value
ntained in the NASS Coding Manual.
99) Unknown

(14 15)

Stratification
ck the box which indicates why this
cident was selected. Code the box's
tter in the space provided.

CCIDENT TYPE		Most Severe Police Reported Injury		
		K	A	B,C,O,U
& Nonmotorist		A	B	C
orcycle		D	E	F
ck	tow away	G	H	I
	nontow away	G	H	J
her tor icle	tow away	K	L	M
	nontow away	K	L	N

(16)

11. Sampling Interval
(NOTE: Code the result from the computer sampling program.)

___ ___ ___ . ___ ___ (17 18 19 20 21)

12. First Harmful Event

Collision with *Motor Vehicle In Transport*
___(01) Head-on
___(02) Rear-end
___(03) Angle
___(04) Sideswipe, endswipe, and very narrow impact frontal
___(08) Other collision type: ______________
___(09) Unknown collision type

Collision with *Pedestrian or Nonmotorist*
___(11) Pedestrian
___(12) Pedacyclist
___(13) Other nonmotorist: ______________

Collision with *Stationary Object*
___(31) Motor vehicle not in transport
___(32) Tree (up to 50 cm circumference)
___(33) Tree (over 50 cm circumference)
___(34) Pole - fixed
___(35) Pole - breakaway--did break away
___(36) Pole - breakaway--did not break away
___(37) Movable objects (post, fence, mail box, delineator, etc.)
___(38) Culvert, railroad tracks, curb
___(39) Abutment, retaining wall, bridge support
___(40) Embankment
___(41) Building, rigid
___(42) Building, framed
___(43) Bridge rail
___(44) Guard rail
___(45) Impact attenuator
___(46) Ground
___(47) Median barrier
___(48) Train
___(49) Other stationary objects: ______________

Collision with *Nonstationary Object*
___(51) Animal
___(52) Trailer, disconnected in transport
___(53) Train
___(59) Other nonstationary objects: ______________

Non-Collision
___(61) Overturned
___(62) Fire or Explosion
___(63) Jackknifed
___(64) Immersion
___(69) Other non-collision: ______________

___ ___ (22 23)

13. Relation to Roadway (location of first harmful event)

___(1) On roadway
___(2) On shoulder
___(3) In median
___(4) On roadside
___(5) Outside right-of-way
___(6) Off roadway - location unknown
___(7) In parking lane
___(9) Unknown

24

14. Number of Vehicle Forms Submitted

_______ Code only the number of motor vehicles in transport for which a VEHICLE FORM was submitted.

25 26

15. Number of Pedestrian & Nonmotorist Forms Submitted

_______ Code only the number of pedestrians and/or nonmotorists for which a PEDESTRIAN & NONMOTORIST FORM was submitted.

27 28

16. Police Reported Accident Severity

___(1) K - Killed
___(2) A - Incapacitating injury
___(3) B - Nonincapacitating injury
___(4) C - Possible injury
___(5) O - No injury
___(9) Unknown

29

17. Involvement of Hit & Run in Accident

___(1) No
___(2) Yes
___(9) Unknown

30

ADMINISTRATIVE ITEMS

18. Hour of Day

___:___ Code reported military time of accident.
(NOTE: midnight = 2400)
___(9999) Unknown

31 32 33 34

19. Light Conditions

___(1) Daylight
___(2) Dark
___(3) Dark, but lighted
___(4) Dawn
___(5) Dusk
___(9) Unknown

35

20. Atmospheric Conditions

___(1) Normal (no adverse atmospheric related driving conditions)
___(2) Raining
___(3) Sleeting
___(4) Snow falling
___(5) Fog
___(6) Other (e.g., smog, smoke, blowing sand or dust, etc.): ______________________
___(9) Unknown

21. Area Type
(NOTE: Use FHWA required individual state definitions for the roadway segment on which the accident occurred.)
___(1) Rural
___(2) Urban
___(9) Unknown

22. Road TA-1 Classification

___(01) Interstate
___(02) Other federal aid primary
___(03) Federal aid secondary
___(04) Federal aid urban arterial
___(05) Federal aid urban collector
___(06) Nonfederal aid arterial
___(07) Nonfederal aid collector
___(08) Nonfederal aid local
___(99) Unknown

38 3

23. Class Trafficway

___(01) Interstate
___(02) Other limited access
___(03) Other U.S. route
___(04) Other state route
___(05) Other major artery
___(06) County road
___(07) Local road
___(08) Other road: ______________________
___(99) Unknown

40 4

24. Roadway Section Type

___(01) Non-junction
___(02) Three leg intersection
___(03) Four leg intersection
___(04) More than four leg intersection
___(05) Intersection related
___(06) Interchange area
___(07) Driveway, alley access, etc.
___(08) Railroad grade crossing
___(99) Unknown

42 4

ENVIRONMENTAL DATA

Number of Travel Lanes

) One ___(5) Five
) Two ___(6) Six
) Three ___(7) Seven or more
) Four ___(9) Unknown

44

Trafficway Division and Median Type

) Undivided
ed (median width > to four feet)
) Paved flush--painted or unpainted (i.e., not curbed)
) Curbed
) Unpaved, uncurbed median (e.g., grass, gravel, etc.)
) Median barrier
) Other median type: ______
) Unknown

45

Access Control

) Full
) Partial
) Uncontrolled
) Unknown

46

Direction of Travel Flow

) One way
) Two way
) Unknown

47

Shoulder Presence

) No shoulder
) One shoulder
) Two shoulders
) Unknown

48

Roadway Alignment

) Straight
) Curve
) Unknown

49

Roadway Profile

) Level
) Grade
) Hillcrest
) Sag
) Unknown

50

Surface Type

) Concrete
) Bituminous
) Brick, block
) Slag, gravel, or stone
) Dirt
) Other: ______
) Unknown

51

33. Surface Condition

___(1) Dry
___(2) Wet
___(3) Snowy, slushy
___(4) Icy
___(5) Other (e.g., sand, dirt, oil): ______
___(9) Unknown

52

34. Junction Traffic Controls

___(1) No controls
___(2) Control not functioning
Control Functioned
___(3) Traffic signal
___(4) Stop sign or yield sign
___(5) Railroad crossing control
___(6) Other traffic control: ______
___(8) Not applicable
___(9) Unknown

53

35. Accident Occurrence in School Zone

___(1) No
___(2) Yes
___(9) Unknown

54

36. Speed Limit

______ m.p.h. -- Code actual posted or statuatory speed limit.
___(99) Unknown

55 56

37. Restriction of Right-of-Way at Scene
(NOTE: The restriction must have existed prior to this accident.)
___(1) No restrictions
___(2) Narrow bridge (as defined)
___(3) Previous accident
___(4) Maintenance, repair, or construction activity on roadway
___(5) Roadway immersion (e.g., standing water)
___(6) Other roadway restriction: ______
___(9) Unknown

57

(NOTE: If more than one restriction exists they should be coded in the order in which they are numbered.)

38. Additional Restriction of Right-of-Way at Scene
(NOTE: See question 37 note above.)
___(3) Previous accident
___(4) Maintenance, repair, or construction activity on roadway
___(5) Roadway immersion (e.g., standing water)
___(6) Other roadway restriction: ______
___(7) More than two restrictions
___(8) Not applicable
___(9) Unknown

58

SPECIAL STUDIES-INDICATORS

Information Collected From This Accident As A Part of the Special Studies Subsystem

◯ NO -- Code 2 for each of questions 39 through 43.

If YES -- Check (✓) each of the studies from the list to the right that were indicated; code 1 for the checked studies and 2 for the studies not checked.

39. ___ Side Intrusion

40. ___ Steering Column

41. ___ Roof Intrusion

42. ___ Motorcycle

43. ___ Truck Underride

COMMENTS:

Collision Pedestrian

...pe:	___	Accident	Diagram	Nonmotorist	...	...	...	...	...	...
...quired:		1	___	___	___	___	___	___	___	
...cluded:		___	___	___	___	___	___	___	___	___

COMPLETED BY TEAM

...icate columns 1 through 3 from the first ... of this form.

...Number 1 (9) Stratification ___ (10)

	Month	Day	Year
... of Accident	___ ___ (11 12)	___ ___ (13 14)	7 9 (15 16)
... Sampled (Listed)	___ ___ (17 18)	___ ___ (19 20)	7 9 (21 22)
... Assigned to ...estigator(s)	___ ___ (23 24)	___ ___ (25 26)	7 9 (27 28)
... Scene Field Work ...pleted	___ ___ (29 30)	___ ___ (31 32)	7 9 (33 34)
...pleting Person (Initials)	___ ___ ___ (35 36 37)		
... Case Reviewed and Ap-...ved for Submission to ZC	___ ___ (38 39)	___ ___ (40 41)	7 9 (42 43)
...pleting Person (Initials)	___ ___ ___ (44 45 46)		
... Data Entered (RDE)	___ ___ (47 48)	___ ___ (49 50)	7 9 (51 52)
...pleting Person (Initials)	___ ___ ___ (53 54 55)		

(1) Case Complete - No Updates Required

(2) Case to be Updated

(3) Case Dropped - Reason:

______________________ ___ (56)

COMPLETED BY ZONE CENTER ...

Type of Review

___(1) All variables ___(2) Key variables ___ (10)

Case Status

___(1) Complete ___(2) Not complete ___ (11)

	Month	Day	Year	Initials
Date Received at Zone Center	___ ___ (12 13)	___ ___ (14 15)	7 9 (16 17)	___ ___ ___
Date Review Number One Completed GO TO 2 (9)	___ ___ (69 70)	___ ___ (71 72)	7 9	___ ___ ___ (74 75 76)
Date Review Number Two Completed	___ ___ (10 11)	___ ___ (12 13)	7 9 (14 15)	___ ___ ___ (16 17 18)
Date Review Number Three Completed	___ ___ (19 20)	___ ___ (21 22)	7 9 (23 24)	___ ___ ___ (25 26 27)
Date Review Number Four Completed	___ ___ (28 29)	___ ___ (30 31)	7 9 (32 33)	___ ___ ___ (34 35 36)
Date Review Number Five Completed	___ ___ (37 38)	___ ___ (39 40)	7 9 (41 42)	___ ___ ___ (43 44 45)
Date Medical Record Updates Received	___ ___ (46 47)	___ ___ (48 49)	7 9 (50 51)	___ ___ ___ (52 53 54)
Date Official Record Updates Received	___ ___ (55 56)	___ ___ (57 58)	7 9 (59 60)	___ ___ ___ (61 62 63)
Date Case Corrections Entered into Data Base GO TO 3 (9)	___ ___ (64 65)	___ ___ (66 67)	7 9 (68 69)	___ ___ ___ (70 71 72)
Date Update Corrections Entered into Data Base	___ ___ (10 11)	___ ___ (12 13)	7 9 (14 15)	___ ___ ___ (16 17 18)

COMPLETED BY ZONE CENTER

...in error, ...to be up-...ed, and not ...sing ...be updated ...or (not ...table) ...table) ...stionable ...ated and ...rected ...uencing er-... in CDC's ...injury data ...or incor-...tly noted ...a entry in ...or ...own coded ...field form

NOTE: DUPLICATE COLUMNS 1 THROUGH 8 AND GO TO CARD: 4 (9).

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Response	___	___	___	___	___	___	___	___	___	___	___	___	___	___	___	___	___	___	___	___	___	___	___	___	___

Variable	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
Response	___ (35)	___ (36)	___ (37)	___ (38)	___ (39)	___ (40)	___ (41)	___ (42)	___ (43)	___ (44)	___ (45)	___ (46)	___ (47)	___ (48)	___ (49)	___ (50)	___ (51)	___ (52)

DAMAGE DESCRIPTION

Wheels Locked by Damage

RF __

LF __

RR __

LR __

(1) Yes, (2) No, (8) NA, (9) Unk.

TYPE of TRANSMISSION

__ Manual __ Automatic

Average Track: ________

Maximum Width: ________

WHEEL STEER ANGLES

for locked front wheels displaced rear axles onl

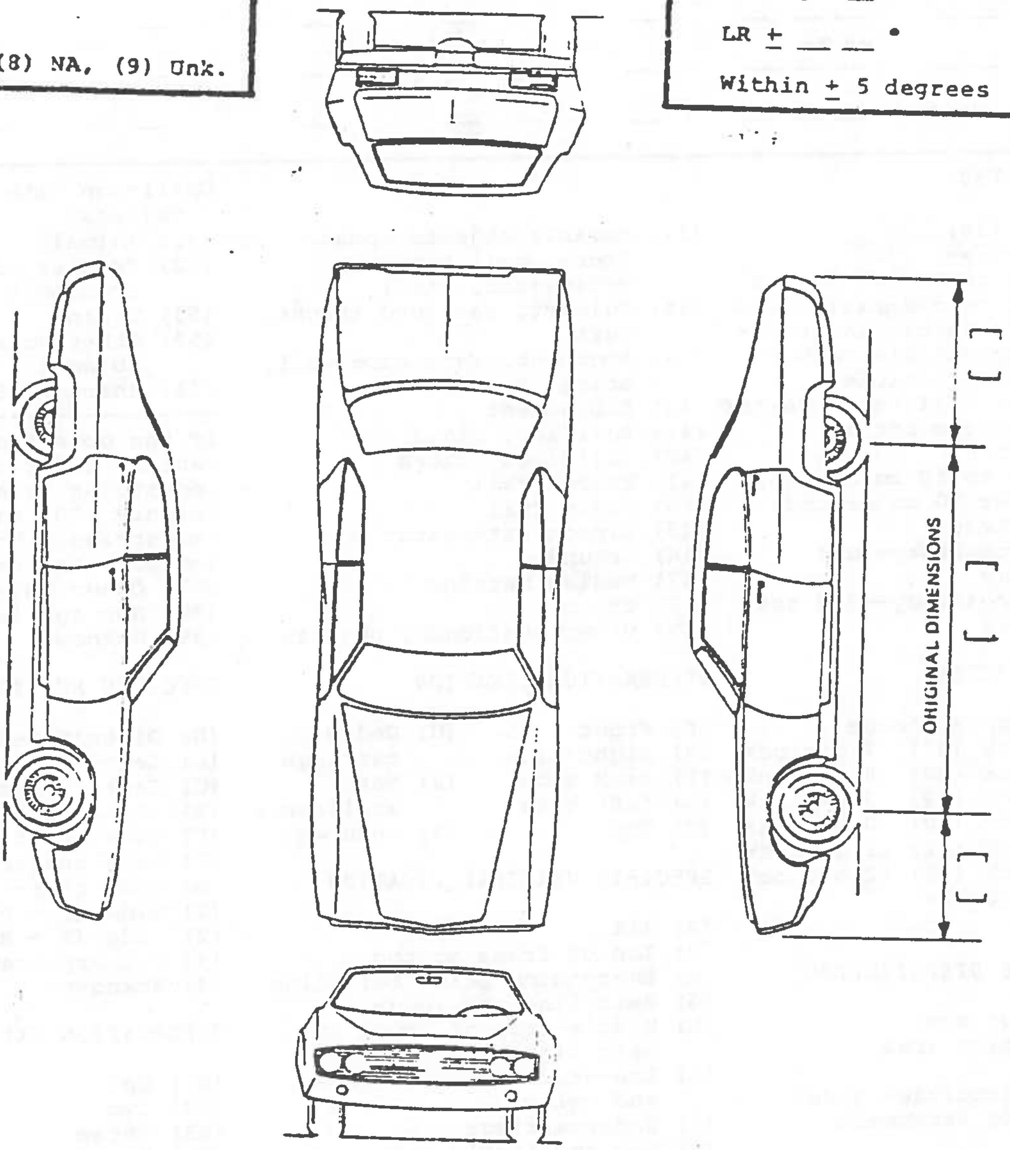
RF ± __ __ °

LF ± __ __ °

RR ± __ __ °

LR ± __ __ °

Within ± 5 degrees



NOTE: Measure C_1 to C_6 from *driver* to *passenger* side in *front* or *rear* impacts--*rear* to *front* in *side* impacts.

Direct L	Direct D±	Impact Number	L	C_1	C_2	C_3	C_4	C_5	C_6	D±
		1								
		2								
		3								
		4								

NOTE: If pulling trailer sketch of trailer and age received on verse side.

NOTE: Sketch new rimeter and shac damage. Annotat observations whi might be useful reconstructing t accident (e.g., grass in tire be direction of str ations, scuff on sidewall, etc.).

COLLISION DEFORMATION CLASSIFICATION by IMPACT SEQUENCE

...fic ...ct ...er	Object Contacted	Direction of Force (degrees)	Deformation Location	Specific Horizontal Location	Specific Vertical Location	Type of Damage Distribution	Deformation Extent Guide	Common Impact Number
.	__ __	__ __ __	__	__	__	__	__ __	__
	__ __	__ __ __	__	__	__	__	__ __	__
.	__ __	__ __ __	__	__	__	__	__ __	__
	__ __	__ __ __	__	__	__	__	__ __	__

Reduction Section

...CONTACTED

...hrough (30)

...object contacted by the ...e under consideration was ...r motor vehicle in trans... ...code the Vehicle Number ...ed to that vehicle.

...ion with *Stationary Object* ...otor vehicle not in ...ransport

...ree (up to 50 cm around)
...ree (over 50 cm around)
...ole - fixed
...ole - breakaway--did ...reak away
...ole - breakaway--did not ...reak away

(37) Movable objects (post, fence, mail box, delineator, etc.)
(38) Culvert, railroad tracks, curb
(39) Abutment, retaining wall, bridge support
(40) Embankment
(41) Building, rigid
(42) Building, framed
(43) Bridge rail
(44) Guard rail
(45) Impact attenuator
(46) Ground
(47) Median barrier
(48) Train
(49) Other stationary objects

Collision with *Nonstationary Objects*
(51) Animal
(52) Trailer, disconnected in transport
(53) Train
(59) Other nonstationary objects
(71) through (96)

If the object contacted by the vehicle under consideration was pedestrian or nonmotorist, add seventy (70) to the assigned Pedestrian & Nonmotorist Number, and code the resultant sum.
(97) Other object
(98) Not applicable
(99) Unknown

...ION OF FORCE

...nhorizontal force
... o'clock (07) 7 o'clock
... o'clock (08) 8 o'clock
... o'clock (09) 9 o'clock
... o'clock (10) 10 o'clock
... o'clock (11) 11 o'clock
... o'clock (12) 12 o'clock
...t applicable
...known

DEFORMATION LOCATION

(F) Front
(R) Right side
(B) Back side
(L) Left side
(T) Top
(U) Undercarriage
(8) Not applicable
(9) Unknown

SPECIFIC HORIZONTAL LOCATION

(D) Distributed--side or end
(L) Left--front or rear
(C) Center--front or rear
(R) Right--front or rear
(F) Side front--left or right
(P) Side center section--L or R
(B) Side rear--left or right
(Y) Side (F + P) or end (L + C)
(Z) Side (P + B) or end (C + R)
(8) Not applicable
(9) Unknown

...DAMAGE DISTRIBUTION

...e impact area
...row impact area
...eswipe
...lover (includes side)
...rhanging structure
...ner
... applicable
...nown

SPECIFIC VERTICAL LOCATION

(A) All
(H) Top of frame to top
(E) Everything below belt line
(G) Belt line and above
(M) Middle--top of frame to belt line or hood
(L) Low--top of frame, frame, and below
(X) Undercarriage
(8) Not applicable
(9) Unknown

*DEFORMATION EXTENT GUIDE**

(01) One
(02) Two
(03) Three
(04) Four
(05) Five
(06) Six
(07) Seven
(08) Eight
(09) Nine
(98) Not applicable
(99) Unknown

...tilizing the CRASH program only one of these two digits can be used; drop the leading zero.

...der the above CDC's on the basis of the CRASH program results, if used. If CRASH is exer... ...n none, or no more than one CDC (where two or more exist), subjectively order the two most ...impacts (in terms of assumed change in velocity, delta "V").

Indicate the two most severe impacts from those listed above.

...A	Object Contacted	Direction of Force	Deformation Location	Specific Horizontal Location	Specific Vertical Location	Type of Damage Distribution	Deformation Extent Guide
...ST	15. __ __ (26 27)	16. __ __ (28 29)	17. __ (30)	18. __ (31)	19. __ (32)	20. __ (33)	21. __ __ (34 35)
...ary	22. __ __ (36 37)	23. __ __ (38 39)	24. __ (40)	25. __ (41)	26. __ (42)	27. __ (43)	28. __ __ (44 45)

Coding Section

29. Documentation of More Than Two CDCs

___(1) Yes
___(2) No
___(8) Not applicable
___(9) Unknown

46

INTERIOR ITEMS

30. Number of VIN Characters

________ characters -- Code the actual number of alphanumeric characters which comprise the vehicle's VIN number.
___(99) Unknown

47 48

31. Vehicle Identification Number

Code the seven left most alphanumeric characters.
___(9999999) Unknown
Left justify!
Slash zeros "Ø"

49 50 51 52 53 54 55

32. Registration of Vehicle

___(1) Not registered
___(2) In-state (at least)
___(3) Out-of-state (only)
___(4) Other registration (e.g., federal, foreign, military):

____
___(9) Unknown

56

33. Vehicle Special Use (this trip)

___(1) None
___(2) School related
___(3) Emergency related
___(9) Unknown

57

34. Odometer Reading

________ miles -- Code mileage to the nearest 1,000 miles.
___(001) Less than 1,500 miles
___(998) Not applicable
___(999) Unknown

58 59 60

35. Passenger Compartment Integrity

___(01) No integrity loss
Yes, integrity was lost through:
___(02) Windshield
___(03) Door
___(04) Roof
___(05) Windshield & door
___(06) Windshield & roof
___(07) Door & roof
___(08) Windshield, door & roof
___(98) Not applicable
___(99) Unknown

36. Passenger Compartment Intrusion (NOTE: Code the area in terms of the most severe intrusion.)

___(01) None
___(02) Front (i.e., steering column, dash)
___(03) Right side (i.e., door[s] with or without sill override)
___(04) Left side (i.e., door[s] with or without sill override)
___(05) Rear (i.e., trunk, rear seat intruded upon)
___(06) Bottom (i.e., floor)
___(07) Top (i.e., windshield, "A", "B", "C", or "D" pillar[s], roof)
___(08) Two or more areas
___(98) Not applicable
___(99) Unknown

37. Magnitude of Intrusion

___(1) Less than five centimeters
___(2) Between five and fifteen centimeters
___(3) Greater than fifteen centimeter
___(8) Not applicable
___(9) Unknown

38. Fire Occurrence

___(1) No fire
Yes, fire occurred
___(2) Started in vehicle, minor
___(3) Started in vehicle, major
___(4) Started external to vehicle, minor
___(5) Started external to vehicle, major
___(6) Origin unknown
___(9) Unknown occurrence

...TRAINT SYSTEM		Front Seat: Left	Front Seat: Middle	Front Seat: Right	Second Seat: Left	Second Seat: Middle	Second Seat: Right	Third Seat: Left	Third Seat: Middle	Third Seat: Right	Other Position or Unit'
...IVE	Availability	___	___	___	___	___	___	___	___	___	___
	Indication of Usage	___	___	___	___	___	___	___	___	___	___
...IVE	System	___	___	___	___	___	___	___	___	___	___
	Defeated	___	___	___	___	___	___	___	___	___	___

...ive Restraint System ...vailability

None
Lap belt and shoulder harness
Lap belt
Shoulder harness
Helmet
Child safety seat
Other restraint: ___
Unknown

Active Restraint System - Indication of Usage

(1) None (includes unavailability)
(2) Lap belt and shoulder harness
(3) Lap belt
(4) Shoulder harness
(5) Helmet
(6) Child safety seat - in proper use
(7) Other restraint used
(9) Unknown

Passive Restraint System

(1) None Available
(2) Air bag - deployed
(3) Air bag - did not deploy
(4) Passive belt
(5) Other restraint: ___
(9) Unknown

Passive Restraint Defeated

(1) No (includes unavailability
Yes
(2) Passive belt not worn
(3) Air bag disconnected
(4) Air bag not reinstalled
(5) Other restraint
(9) Unknown

...pecify the Other ...osition or Unit ...eferenced: ___

...ICATIONS of EJECTION

Not ejected
Not applicable

If ejection is suspected or reported, indicate the avenue; for multiple avenues number them and utilize the same numbers consistently throughout.

Medium Status
___ Open
___ Separation
___ Closed, closed when damaged
___ Status unknown

...ction Area
Windshield
Left front
Right front
Left rear
Right rear
Rear
___ Roof (convertible or sun roof)
___ Other area (e.g., sidecar, back of pickup, etc.)
___ Unknown

Ejection Medium
___ Door
___ Open roof structure
___ Fixed windows
___ Other medium type
___ Unknown

Operable windows
___ Roll down type
___ Hinged type
___ Sliding type
___ Other type window

CHECK ALL AREAS of SUSPECTED OCCUPANT CONTACT

...NT
Windshield
Mirror
Steering assembly, including transmission selector lever when column mounted
Add-on equipment (e.g., CB, tape deck, air conditioner)
Instrument panel and below, excluding foot controls and parking brake
Other front object

...DE
Side interior surface, excluding hardware or armrests
Side hardware or armrests
Roof pillar supports
Window glass or frame
Other side object

INTERIOR
___ Seat, back support
___ Belt restraint system
___ Head restraint
___ Air cushion
___ Other occupants
___ Interior loose objects
___ Other interior object

ROOF
___ Front header
___ Rear header
___ Roof side rails
___ Roof or convertible top

FLOOR
___ Floor
___ Floor or console mounted transmission lever, including console
___ Parking brake handle
___ Foot controls including parking brake

REAR
___ Backlight (rear window)
___ Backlight storage rack, door, etc.
Other rear objects

EXTERIOR of OCCUPANT'S VEHICLE
___ Hood
___ Outside hardware (e.g., outside mirror, antenna)
___ Other exterior surface or tires
___ Unknown exterior objects

NON-CONTACT INJURY
___ Non-contact injury source (impact force)

___ Injured, unknown source
___ Not applicable - NO INJURY
___ Unknown if injured

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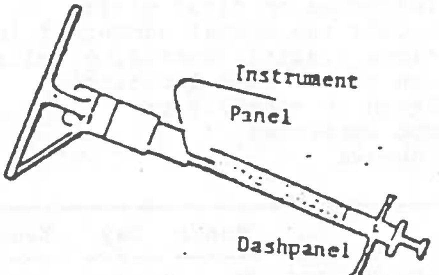
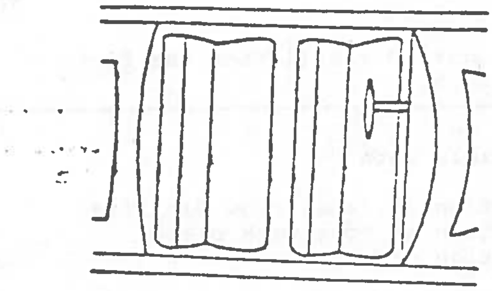
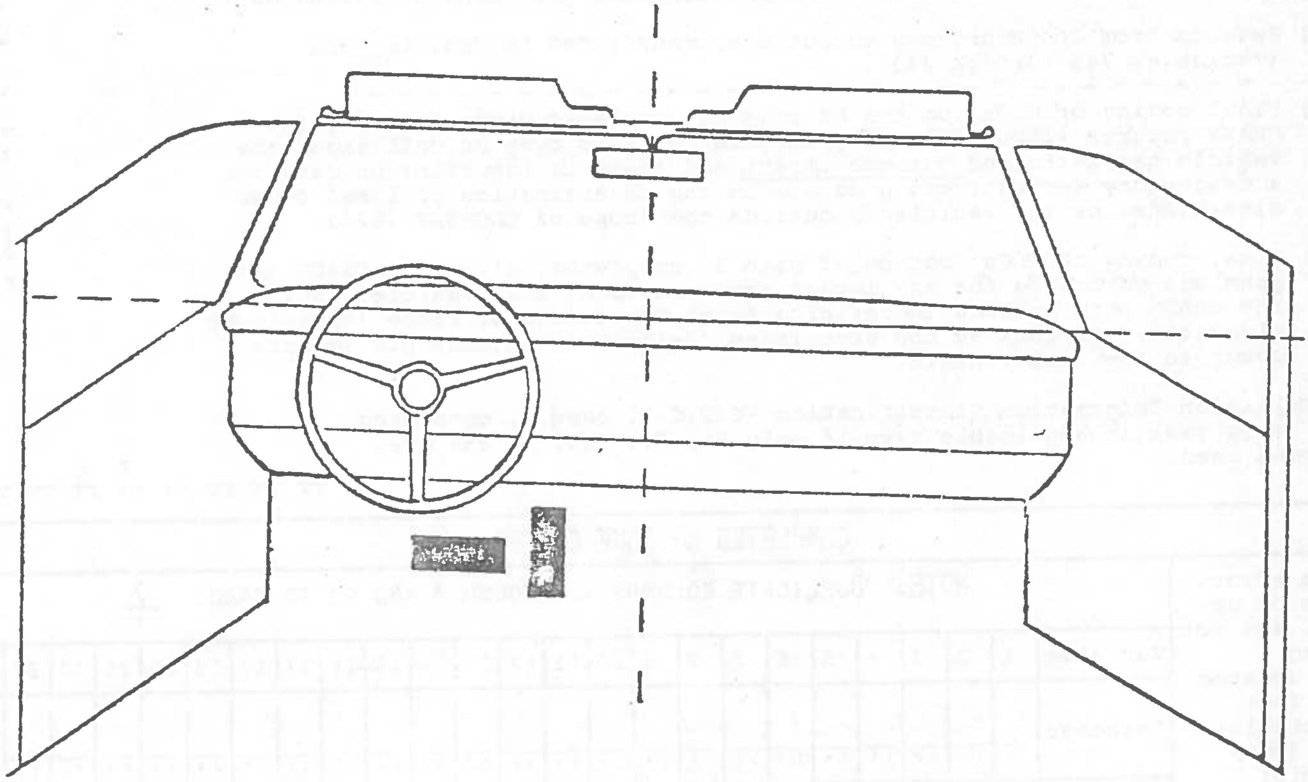
VEHICLE INTERIOR

POINTS OF OCCUPANT CONTACT





INTERIOR SKETCH



Sketch controls in appropriate positions, if contacted. Sketch all occupant contact points an
code on *preceeding* page. Dash lines indicate center of instrument panel-windshield area and t
of panel for measurement purposes.

1/79

VEHICLE LOG

COMPLETED BY TEAM

icate columns 1 through 8 from the first of this form.

Number 1 (col. 9)

icate columns 10 and 11 from the first of this form.

Vehicle Inspection

___(1) Inspected on first visit
___(2-6) Code the actual number of locations visited (including follow-ups to the same location)
___(7) Seven or more visits
___(8) Not inspected
___(9) Unknown

13

ce of Vehicle Data

1) Inspection at repair/tow facility
2) Inspection at home/work place
3) Inspection other: ____________
4) Not inspected (photos or repair data obtained)
5) Not inspected (no data)
9) Unknown

12

	Month	Day	Year	Initials
Date decision was made not to further attempt to inspect vehicle. Reason: ____________	14 15	16 17	7 9 (18 19)	20 21 22

vehicle inspected and field data elements obtained. 23 24 25 26 7 9 (27 28) 29 30 31

1) CRASH program inapplicable for this vehicle, or there is insufficient data for trajectory or damage reconstruction of the most severe (highest) impact associated with this vehicle (variables V46 through V49=Unknown).

2) Results from CRASH program output are transferred to Vehicle Form (variables V46 through V49).

32

1) Final coding of CDCs, bottom of page 3, completed without exercising CRASH program since it is inapplicable for this type of collision, the vehicle has sustained but one impact and there is insufficient data for a trajectory reconstruction to aid in the determination of final force directions, or the vehicle is outside the scope of CDC-SAE J224a.

2) Final coding of CDCs, bottom of page 3, completed, given the CRASH program was exercised for any impact experienced by this vehicle. NOTE: the CRASH program aids in refining final Directions of Force (trajectory algorithm) and ranking the severities (delta-V) when multiple impacts occur to the same vehicle.

33

Collision Deformation Classification (C.D.C.), page 3, completed. This task is applicable even if only 8s, 9s, 98s, or 99s are codes used.

34 35 36 37 7 9 (38 39) 40 41 42

COMPLETED BY ZONE CENTER

n error, o be up-, and not ng
updated (not ctable) (cor- ble) ionable ed and cted ncing er- n CDC's jury data incor- y noted entry in

wn coded eld form

NOTE: DUPLICATE COLUMNS 1 THROUGH 8 AND GO TO CARD: 2 (col. 9)

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Response	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Variable	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Response	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59
Variable	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
Response	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80				

SUPPLEMENTAL ITEMS

39. Type of Most Severe Impact

___(01) Head-on: with vehicle
___(02) Rear-end: struck other vehicle
___(03) Rear-end: struck by vehicle
___(04) Angle: striking other vehicle
___(05) Angle: struck - left side
___(06) Angle: struck - right side
___(07) Sideswipe, endswipe, and very narrow impact frontal
___(08) Front impact with object
___(09) Side impact with object
___(10) Rear impact with object
___(11) Impact with pedestrian or nonmotorist
___(12) Other impact: ___________
___(98) Not applicable (Non-Collision)
___(99) Unknown

67 68

40. Rollover Involvement

___(1) Yes
___(2) No
___(9) Unknown

69

41. Jackknife Involvement

___(1) Yes
___(2) No
___(9) Unknown

70

42. Submission of Potential Safety Problem Bulletin

___(1) Yes
___(2) No
___(9) Unknown

71

VEHICLE WEIGHT ITEMS

43. Vehicle Curb Weight

________ pounds -- Code weight to the nearest 100 pounds.
___(001) Less than 150 pounds
___(997) 99,650 lbs or more
___(999) Unknown

72 73 74

44. Vehicle Cargo Weight

________ pounds -- Code weight to the nearest 100 pounds.
___(000) Less than 50 pounds
___(997) 99,650 lbs or more
___(999) Unknown

75 76 77

45. Investigator Reported Source of Cargo Weight

___(1) No cargo
___(2) Measured
___(3) Estimated
___(4) Rated capacity
___(5) Unknown: source of weight

C R A S H PROGRAM

HIGHEST | Secondary | HI...

46. Total Delta V

________ nearest k.p.h. ________
(NOTE: 000 means less than 0.5 k.p.h.)
___(999) Unknown

47. Longitudinal Component of Delta V

________ nearest k.p.h. ________
(NOTE: 000 means greater than -0.5 and less than 0.5 k.p.h.)
___ (999) Unknown

±

48. Lateral Component of Delta V

________ nearest k.p.h. ________
(NOTE: 000 means greater than -0.5 and less than 0.5 k.p.h.)
___ (999) Unknown

±

49. Energy Absorption

________ nearest 100 newton-meters [joules] ________
(NOTE: 0000 means less than 50 newton-meters.)
___(9999) Unknown

POLICE REPORT

50. Estimated Travel Speed

________ nearest m.p.h.
(NOTE: 00 means stopped.)
___(97) 97 m.p.h. or higher
___(99) Unknown

AGE DESCRIPTION

Wheels Locked by Damage

RF __

LF __

RR __

LR __

Yes, (2) No, (8) NA, (9) Unk.

TYPE of TRANSMISSION

__ Manual __ Automatic

Average Track: ______.

Maximum Width: ______.

WHEEL STEER ANGLES
(For locked front wheels or displaced rear axles only)

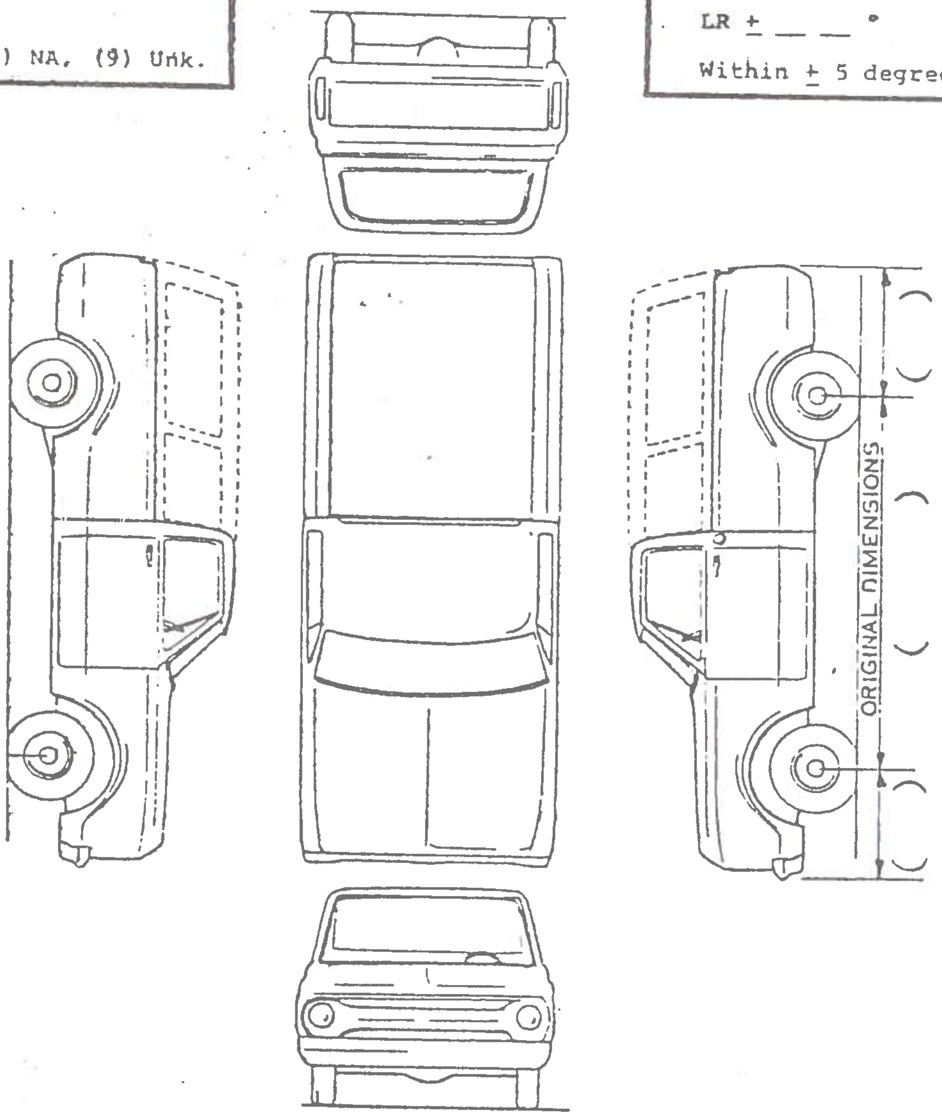
RF ± __ __ °

LF ± __ __ °

RR ± __ __ °

LR ± __ __ °

Within ± 5 degrees



List any tires which are deflated due to damage on the back of this page.

NOTE: Measure C_1 to C_6 from *driver* to *passenger* side in *front* or *rear* impacts--*rear* to *front* in *side* impacts.

t	Direct D±	Impact Number	L	C_1	C_2	C_3	C_4	C_5	C_6	D±
		1								
		2								
		3								
		4								

NOTE: If pulling trailer sketch type of trailer and damage received on reverse side.

NOTE: Sketch new perimeter and shade damage. Annotate observations which might be useful in reconstructing the accident (e.g., grass in tire bead, direction of striations, scuff on sidewall, etc.).

DAMAGE DESCRIPTION

Wheels Locked by Damage

RF __

LF __

RR __

LR __

(1) Yes, (2) No, (8) NA, (9) Unk.

TYPE of TRANSMISSION

__ Manual __ Automatic

Average Track: ______

Maximum Width: ______

WHEEL STEER ANGLES
(For locked front wheels displaced rear axles onl

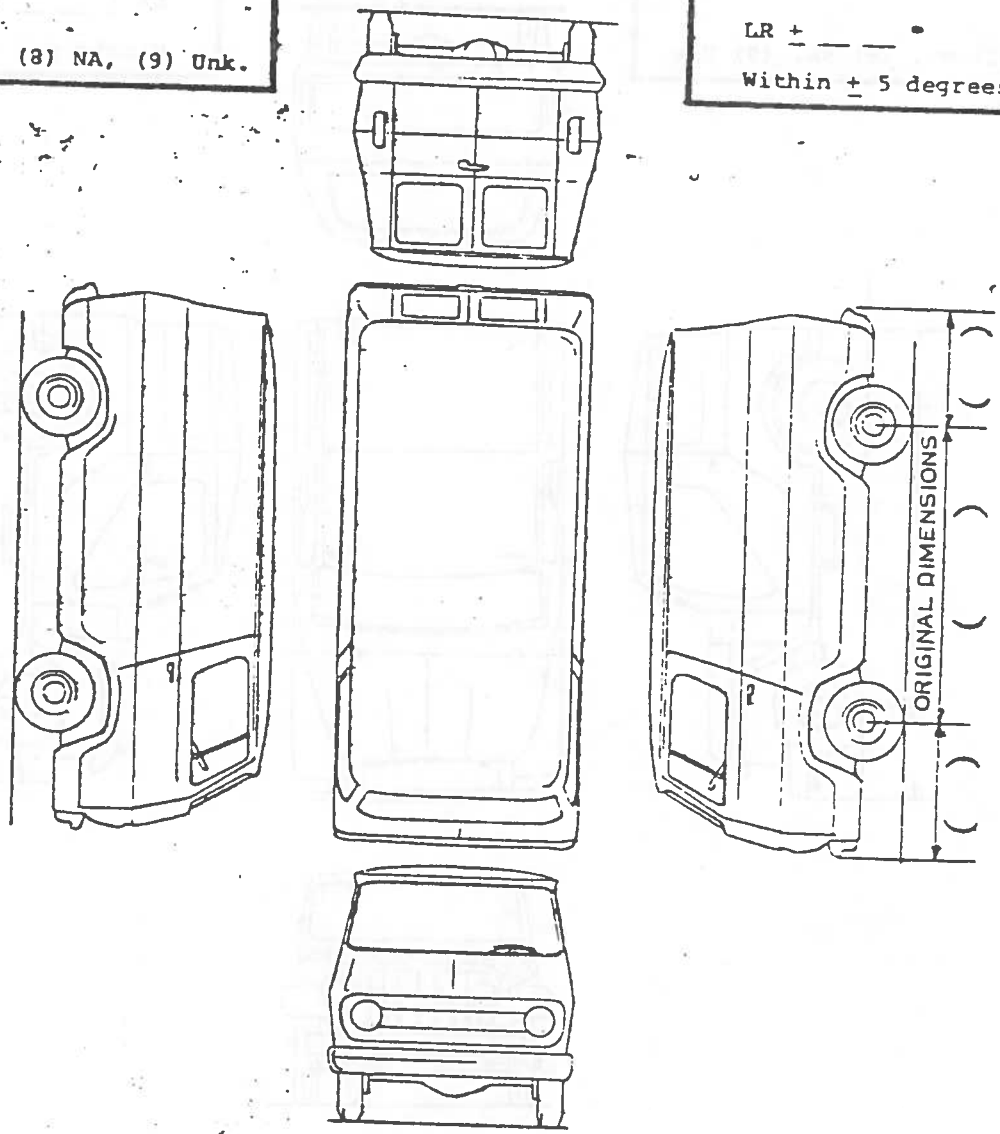
RF ± ___ °

LF ± ___ °

RR ± ___ °

LR ± ___ °

Within ± 5 degrees



NOTE: Measure C_1 to C_6 from *driver* to *passenger* side in *front* or *rear* impacts--*rear* to *front* in *side* impacts.

Direct L	Direct D±	Impact Number	L	C_1	C_2	C_3	C_4	C_5	C_6	D±
		1								
		2								
		3								
		4								

NOTE: If pulling trailer sketch of trailer and age received on verse side.

NOTE: Sketch new rimeter and sha damage. Annota observations wh might be useful reconstructing accident (e.g., grass in tire b direction of st ations, scuff o sidewall, etc.)

'AGE DESCRIPTION

Wheels Locked by Damage

RF __

LF __

RR __

LR __

) Yes, (2) No, (8) NA, (9) Unk.

TYPE of TRANSMISSION

__ Manual __ Automatic

Average Track: ______.___

Maximum Width: ______.___

WHEEL STEER ANGLES
(For locked front wheels or displaced rear axles only)

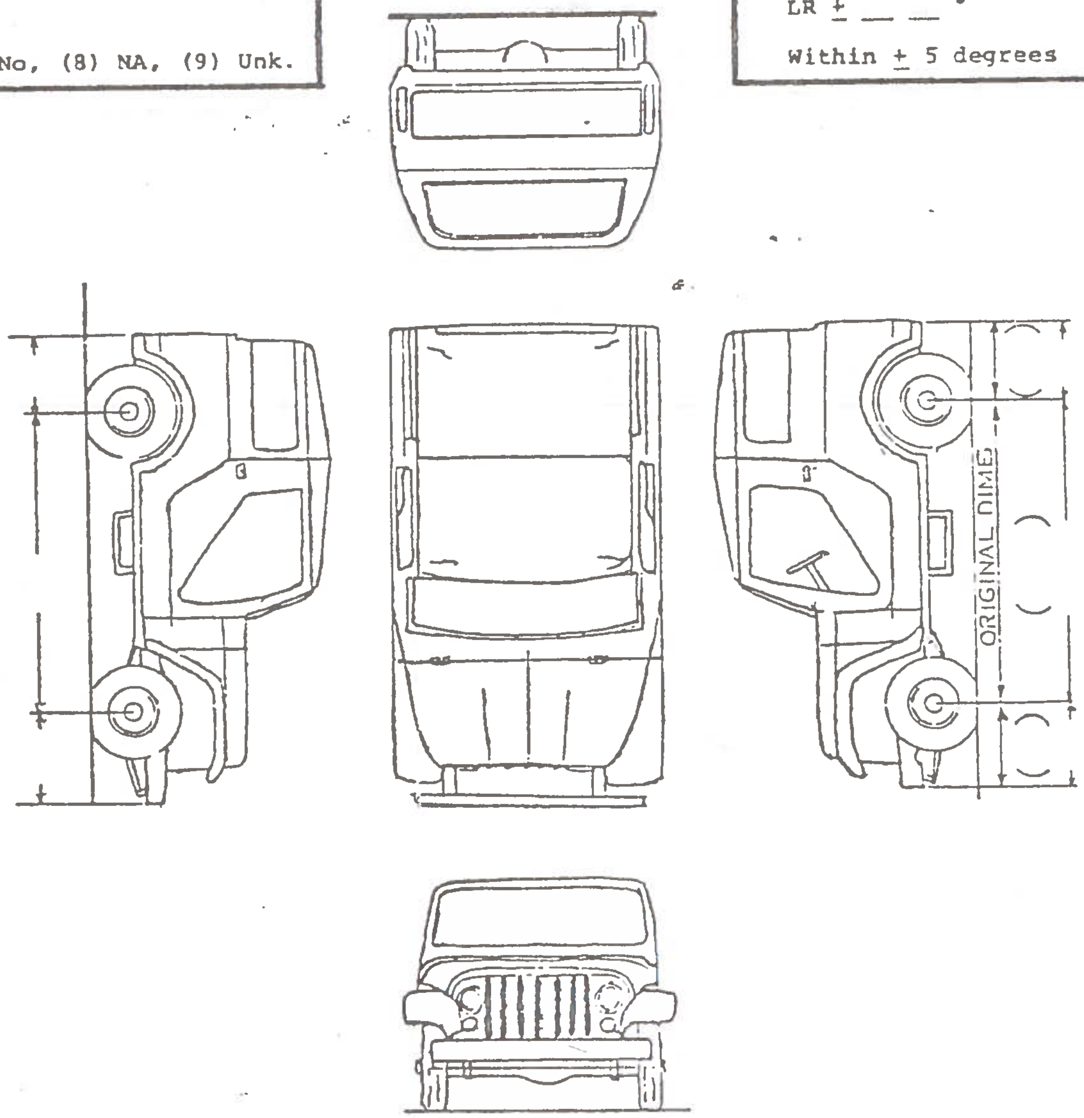
RF ± __ __ °

LF ± __ __ °

RR ± __ __ °

LR ± __ __ °

Within ± 5 degrees



List any tires which are deflated due to damage on the back of this page.

NOTE: Measure C_1 to C_6 from *driver* to *passenger* side in *front* or *rear* impacts—*rear* to *front* in *side* impacts.

rect L	Direct D±	Impact Number	L	C_1	C_2	C_3	C_4	C_5	C_6	D±
		1								
		2								
		3								
		4								

NOTE: If pulling trailer sketch type of trailer and damage received on reverse side.

NOTE: Sketch new perimeter and shade damage. Annotate observations which might be useful in reconstructing the accident (e.g., grass in tire bead, direction of striations, scuff on sidewall, etc.).

DAMAGE DESCRIPTION

Wheels Locked by damage

RF __ For rear wheels circle axle(s)

LF __

RR __ 2 3 4

LR __ 5 6

(1) Yes, (2) No, (8) NA, (9) Unk.

TYPE of TRANSMISSION

__ Manual __ Automatic

Front Track: ___.___

Cab Width: ___.___

WHEEL STEER ANGLES
(For locked front wheels or displaced rear axles only)

RF ± __ __ ° For rear wheels circle axle(s)

LF ± __ __ °

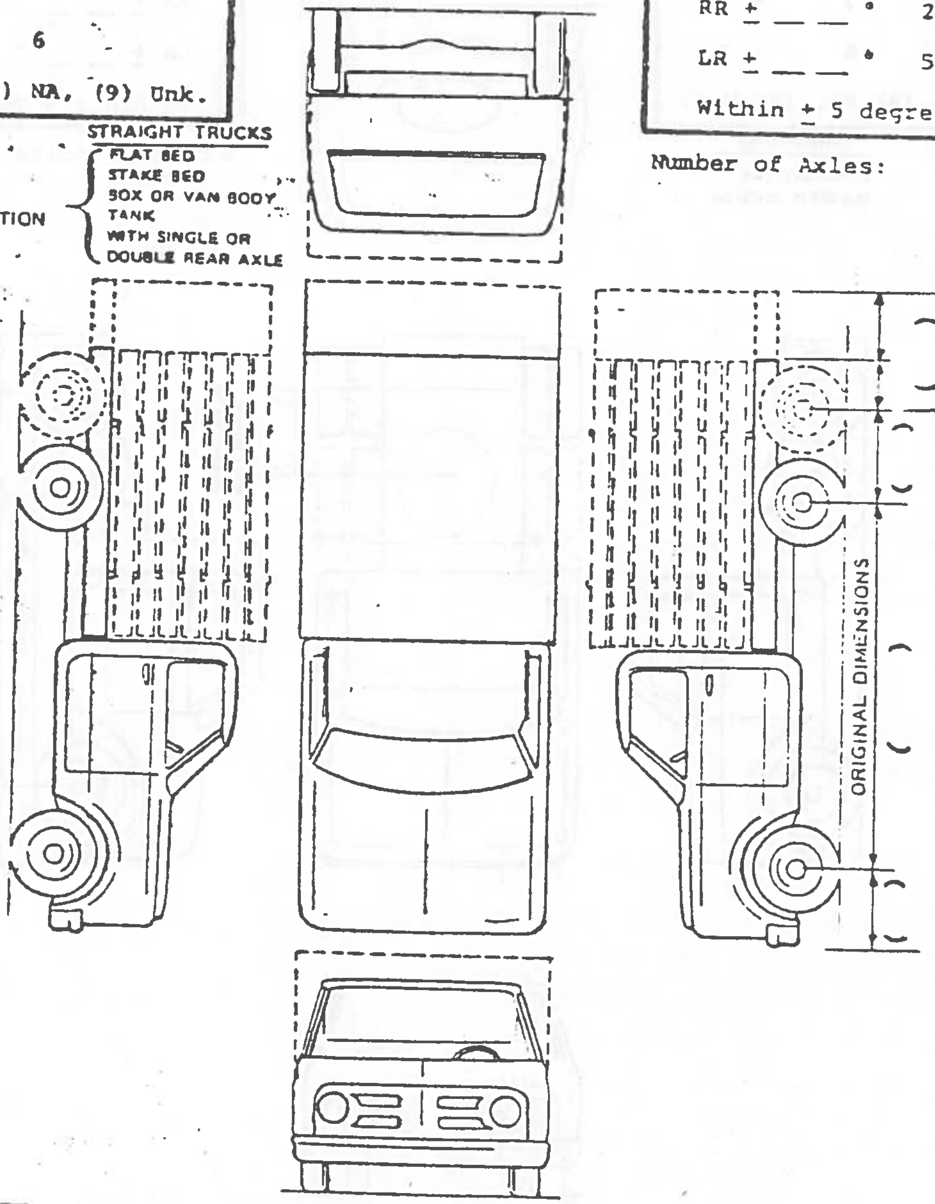
RR ± __ __ ° 2 3 4

LR ± __ __ ° 5 6

Within ± 5 degrees

Number of Axles: Total ___ Truck ___ Semi ___ Full ___

NOTE: Apply CDC scheme to damage sustained by this unit, but locate applicable CDCs only at top of page three. Do not enter the classification at the bottom of page three (coding section), Ignore any trailing units in formulating the CDCs.



NOTE: Measure C_1 to C_6 from *driver* to *passenger* side in *front* or *rear* impacts--*rear* to *front* in *side* impacts.

NOTE: If pulling trailer sketch type of trailer and damage received on reverse side.

Impact Number	L	C_1	C_2	C_3	C_4	C_5	C_6	D±
1								
2								
3								
4								

NOTE: Sketch ne[ar] perimeter and shade damage. Annotate observ[a]tions which mig[ht] be useful in re[-]constructing th[e] accident (e.g., grass in tire bead, direction of striations, scuff on side-wall, etc.)

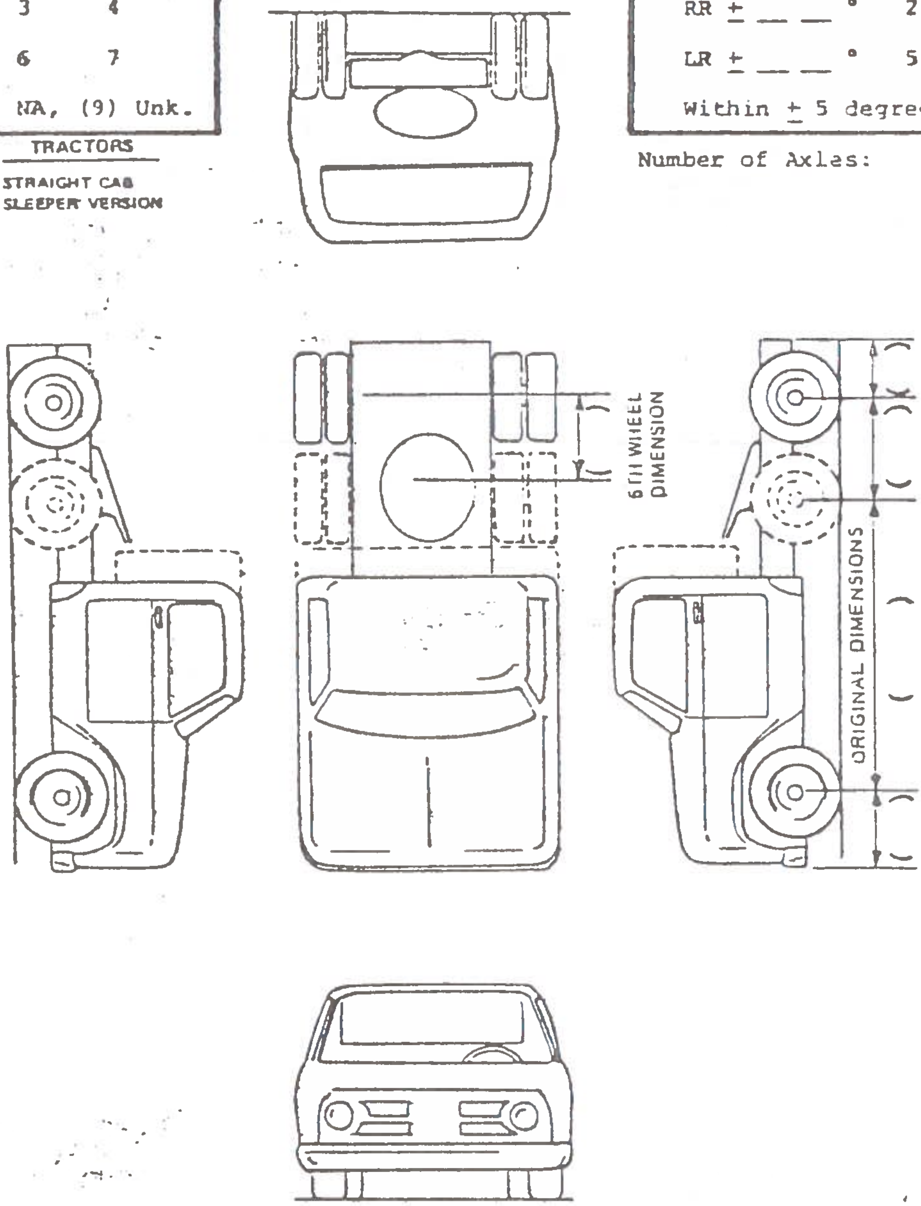
AGE DESCRIPTION	TYPE of TRANSMISSION	WHEEL STEER ANGLES (For locked front wheels or displaced rear axles only)
Wheels Locked by Damage	__ Manual __ Automatic	
RF __ For rear wheels circle axle(s)	Front Track: ______ .	RF ± __ __ ° For rear wheels circle axle(s)
LF __	Cab Width: ______ .	LF ± __ __ °
RR __ 2 3 4		RR ± __ __ ° 2 3 4
LR __ 5 6 7		LR ± __ __ ° 5 6 7
Yes, (2) No, (8) NA, (9) Unk.		Within ± 5 degrees

Number of Axles: Total ___

Tractor ___

Semi ___

Full ___



applicable ... only at top of page three ... (coding section), Ignore any
ication at the bottom of page three (coding section)
trailing units in formulating the CDCs.

List any tires which are deflated due to damage on the back of this page.

NOTE: Measure C_1 to C_6 from *driver* to *passenger* side in *front* or *rear* impacts--*rear* to *front* in *side* impacts.

E: If pulling
ailer sketch
pe of trailer
d damage
ceived on
verse side.

Impact Number	L	C_1	C_2	C_3	C_4	C_5	C_6	D±
1								
2								
3								
4								

NOTE: Sketch new perimeter and shade damage. Annotate observations which might be useful in reconstructing the accident (e.g., grass in tire bead, direction of striations, scuff on sidewall, etc.)

DAMAGE DESCRIPTION

Wheels Locked by Damage

RF ___ For rear wheels circle axle(s)

LF ___

RR ___ 2 3 4

LR ___ 5 6 7

(1) Yes, (2) No, (8) NA, (9) Unk.

TYPE of TRANSMISSION

___ Manual ___ Automatic

Front Track: ______

Cab Width: ______

WHEEL STEER ANGLES (For locked front wheels displaced rear axles on

RF ± ___ ___ ° For rear w circle axl

LF ± ___ ___ °

RR ± ___ ___ ° 2 3

LR ± ___ ___ ° 5 6

Within ± 5 degrees

Number of Axles: Total

Tractor

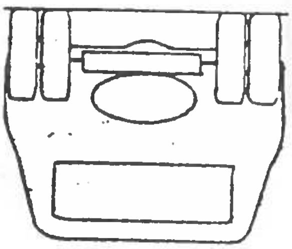
Semi

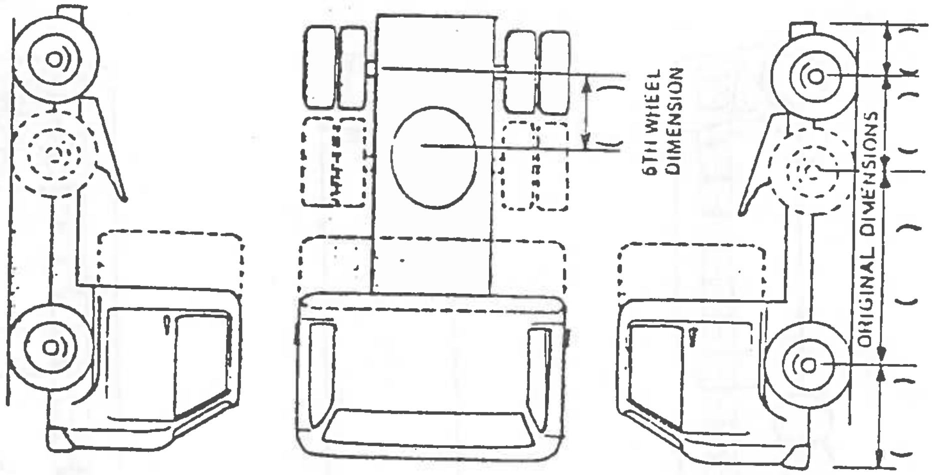
Full

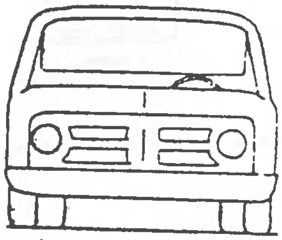
NOTE: Apply CDC scheme to damage sustained by this unit, but locate applicable CDCs only at top of page three. Do not enter the classification at the bottom of page three (coding section). Ignore any trailing units in formulating the CDCs.

TRACTORS

CAB-OVER SLEEPER VERSION







NOTE: Measure C_1 to C_6 from *driver* to *passenger* side in *front* or *rear* impacts--*rear* to *front* in *side* impacts.

NOTE: If pulling trailer sketch type of trailer and damage received on reverse side.

Impact Number	L	C_1	C_2	C_3	C_4	C_5	C_6	D±
1								
2								
3								
4								

NOTE: Sketc perimeter a shade damag Annotate ob tions which be useful i constructir accident (e grass in ti bead, direc of striatic scuff on si wall, etc.)

MAGE DESCRIPTION

Wheels Locked by Damage

RF __ For rear wheels circle axle(s)

LF __

RR __ 2 3

LR __

Yes, (2) No, (8) NA, (9) Unk.

TYPE of TRANSMISSION

__ Manual __ Automatic

Front Track: ______.

Cab Width: ______.

WHEEL STEER ANGLES
(For locked front wheels or displaced rear axles only)

RF ± __ __ ° For rear wheels circle axle(s)

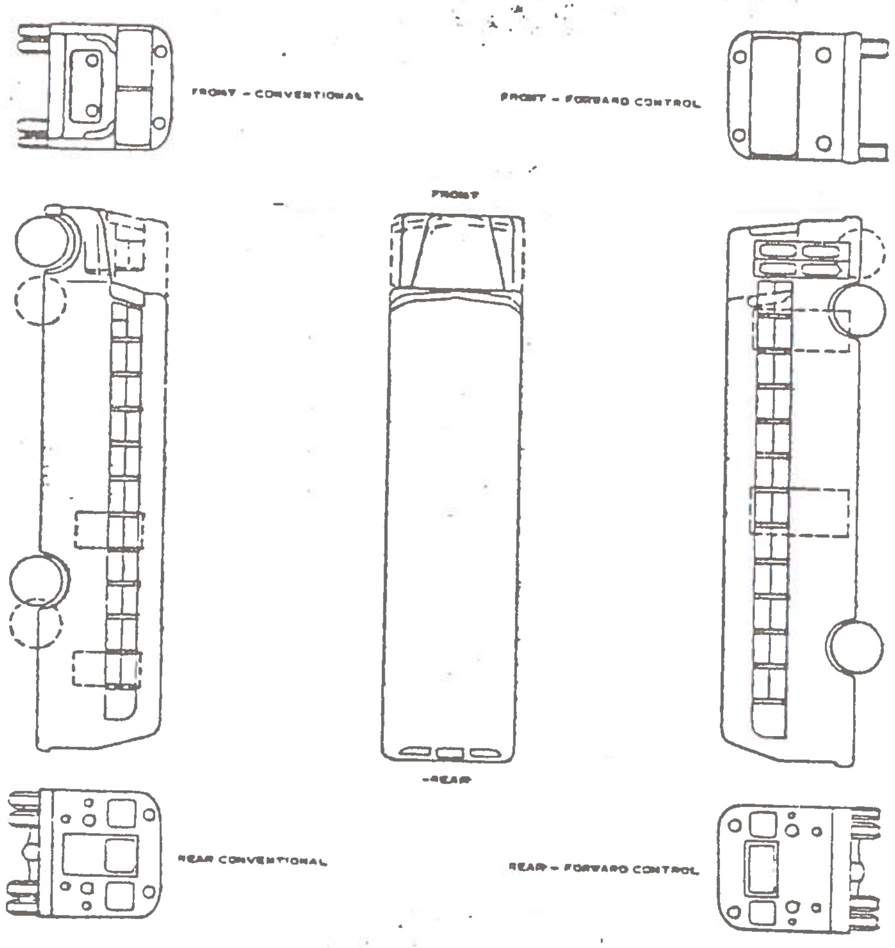
LF ± __ __ °

RR ± __ __ ° 2 3

LR ± __ __ °

Within ± 5 degrees

...ication at the bottom of page three (coding section). Ignore any trailing units in formulating the CDCs.



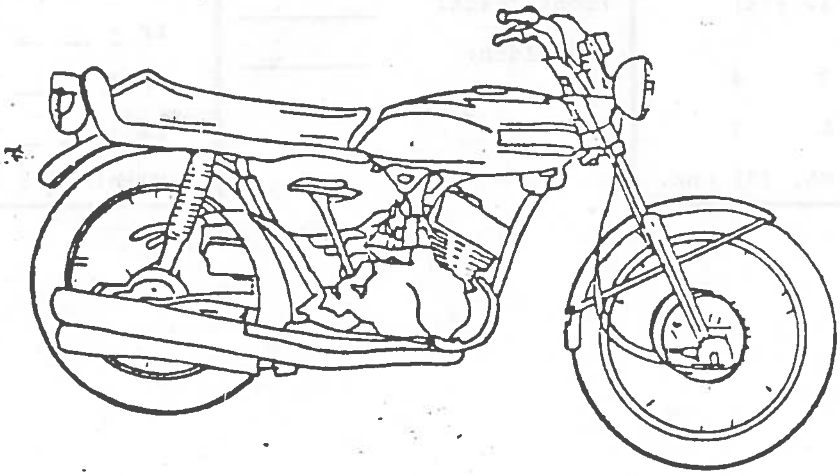
List any tires which are deflated due to damage on the back of this page.

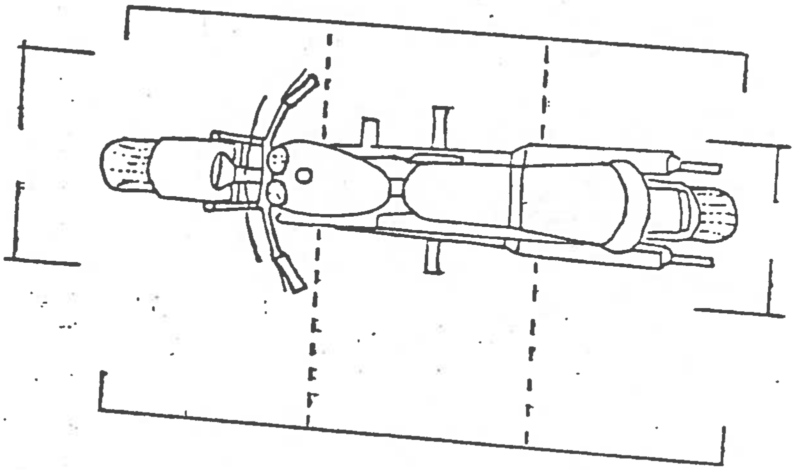
NOTE: Measure C_1 to C_6 from *driver* to *passenger* side in *front* or *rear* impacts--*rear* to *front* in *side* impacts.

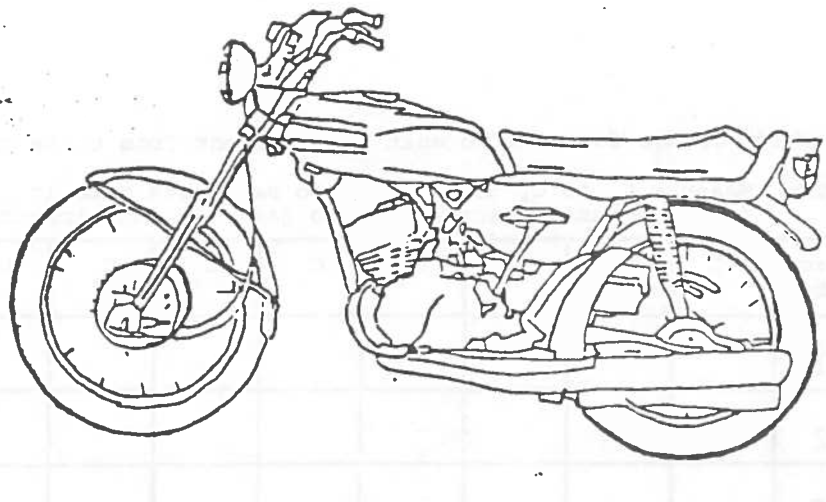
: If pulling ...iler sketch ...e of trailer damage ...eived on ...erse side.

Impact Number	L	C_1	C_2	C_3	C_4	C_5	C_6	D±
1								
2								
3								
4								

NOTE: Sketch new perimeter and shade damage. Annotate observations which might be useful in reconstructing the accident (e.g., grass in tire bead, direction of striations, scuff on sidewall, etc.)







…GE DESCRIPTION

Wheels Locked by Damage

…F __ For rear wheels circle axle(s)

…F __

…R __ 2 3 4

…R __ 5 6 7

…Yes, (2) No, (8) NA, (9) Unk.

TYPE of TRANSMISSION

__ Manual __ Automatic

Front Track: ________

Cab Width: ________

WHEEL STEER ANGLES
(For locked front wheels or displaced rear axles only)

RF ± __ __ ° For rear wheels circle axle(s)

LF ± __ __ °

RR ± __ __ ° 2 3 4

LR ± __ __ ° 5 6 7

Within ± 5 degrees

…ication at the bottom of page three (coding section). Ignore any
trailing units in formulating the CDCs.

List any tires which are deflated due to damage on the back of this page.

Sketch and shade damage for traffic unit if different from those previously depicted.

NOTE: Measure C_1 to C_6 from *driver* to *passenger* side in *front* or *rear* impacts—*rear* to *front* in *side* impacts.

If pulling …ler sketch … of trailer damage …ived on …rse side.

Impact Number	L	C_1	C_2	C_3	C_4	C_5	C_6	D±
1								
2								
3								
4								

NOTE: Sketch new perimeter and shade damage. Annotate observations which might be useful in reconstructing the accident (e.g., grass in tire bead, direction of striations, scuff on sidewall, etc.)

DEPARTMENT OF TRANSPORTATION
National Highway Traffic
Safety Administration

DRIVER FORM

Form Approved:
O.M.B. No. 004-R-

1. Primary Sampling Unit Number ___ ___ 1 2

2. Case Number ___ ___ ___ ___ 3 4 5 6

3. Record Number 4 (7)

4. Transaction Code ___ 8

5. Version Number 2 (9)

IDENTIFICATION

6. Vehicle Number ___ ___ 10 11

7. Number of Occupants This Motor Vehicle

________ occupant(s) -- Code the actual number of persons (including the driver if present) that were an occupant of this vehicle. The number of OCCUPANT FORMs does not have to equal this value.
___(99) Unknown

___ ___ 12 13

8. Driver Presence In Vehicle

___(1) Yes
___(2) No

___ 14

(NOTE: If *no* driver was present *in* this vehicle, indicate and subsequently code *Not applicable* for the remaining nonenvironmental questions on this form. No OCCUPANT FORM for the driver is required. Remember, if the person who had been driving this motor vehicle prior to the accident was injured outside of this vehicle, that person is handled on the PEDESTRIAN & NONMOTORIST FORM.

DRIVER INTERVIEW

9. Months Driving Experience This Class of Vehicle (e.g., passenger car, light truck, motorcycle, etc.)

________ months -- Code actual months of previous driving experience up to 60.
(NOTE: 45 days or less equals 1 month; a month and a half equals 2 months.)
___(61) Greater than five years
___(98) Not applicable
___(99) Unknown

___ ___ 15 16

10. Estimated Mileage This Vehicle (Estimated total mileage that driver has driven in this specific accident involved vehicle.)

________ miles to the nearest 100
___(001) Less than 150 miles
___(997) 99,650 miles or more
___(998) Not applicable
___(999) Unknown

___ ___ 17 18

11. Purpose of Trip

___(01) To place of work
___(02) Work-related business
___(03) Convention
___(04) Civic/education/religious
___(05) Eat meal
___(06) Medical or dental
___(07) Shopping
___(08) Family or personal business
___(09) Visit friends or relatives
___(10) Pleasure driving
___(11) Sightseeing
___(12) Entertainment
___(13) Recreation (participant)
___(14) Vacation
___(15) Change of vehicle without change of mode
___(16) Change means of transportation
___(17) Pick up or leave off passengers
___(18) Return home
___(19) Lodging (overnight)
___(20) Other social: ________________

___(21) Other purpose: ________________

___(98) Not applicable
___(99) Unknown

___ 20

12. Frequency Driving Road

___(1) Daily
___(2) Weekly
___(3) Monthly
___(4) Less than once a month
___(5) First time on road
___(8) Not applicable
___(9) Unknown

13. Driver Education

___(1) No formal driver training
___(2) In training at time of accident
___(3) High school driver training
___(4) Commercial driver training
___(5) Other formal driver training (e.g., college, military, etc.): ________________

___(6) Two or more types of formal driver training
___(8) Not applicable
___(9) Unknown

ter- ewee | Official Sources

. License Status This Class of Vehicle

___ (1) Valid license
___ (2) No license, license required ___
___ (3) Suspended/revoked ___ *
___ (4) Expired license ___ *
___ (5) Learner's permit ___ *
___ (8) Not applicable (no license required) ___ *
___ (9) Unknown ___

24

(NOTE: If information was obtained from official sources, code it; otherwise, code the interviewee's response.)

Interviewee | Official Sources

15. License Restriction

___ (1) No restrictions ___
___ (2) Glasses and/or contact lenses ___
___ (3) Daylight driving only ___
___ (4) Handicap related restriction ___ *
___ (5) Activity restriction ___ *
___ (6) Other restriction: ___ *

___ (8) Not applicable ___
___ (9) Unknown ___

25

(NOTE: If more than one restriction exists choose the one with the lowest numerical value.)

16. Additional License Restriction

___ (3) Daylight driving only ___
___ (4) Handicap related restriction ___
___ (5) Activity restriction ___ *
___ (6) Other restriction: ___ *

___ (7) More than two restrictions ___
___ (8) Not applicable ___
___ (9) Unknown ___

26

ACCIDENT DESCRIPTION INSTRUCTIONS

not interrupt person during general descrip-
on (narrative), unless he/she requests your
sistance. Attempt to summarize the narra-
re while minimizing any disruptions of the
son's internal logic. Specific questions
be asked later. Write these questions
m in the space below or on the other side
the paper, prior to the interview.

ECIFIC QUESTION: ________________

driver operated a truck, was
truck regulated in interstate
merce by the Bureau of Motor
rier Safety (BMCS)?

___ Yes
___ No
___ Unknown

GENERAL DESCRIPTION OF ACCIDENT SEQUENCE

(This represents a synopsis of an uninterrupted narrative by the driver.)

PRE-CRASH

ection of Travel
TE: If interviewee does not know, insert
om other sources when determinable.)

. North
. East
. South
. West
. Northeast
___ Southeast
___ Northwest
___ Southwest
___ Not applicable
___ Unknown

Travel Lane
(NOTE: Lane one is the curb or shoulder lane; lane two is the next lane, etc. to the median or centerline. Opposing lanes are numbered similarly and distinguished by direction of travel.)

___ 1st lane
___ 2nd lane
___ 3rd lane
___ 4th lane
___ 5th or additional lane
___ On shoulder
___ On trafficway
___ Off road
___ Outside trafficway
___ Not applicable
___ Unknown

Estimated Travel Speed
(NOTE: Record as obtained from interviewee in increments of 5 m.p.h.; note information source e.g., speedometer, estimate, etc.)

___ Stopped ___ Less than 5 m.p.h.

_______ Actual speed (in increments)
___ Not applicable ___ Unknown

INFORMATION SOURCE:

Driver Actions Prior to Accident
(NOTE: This reports the driver's actions prior to any indication that did or should have alerted the driver to the fact that the driver was about to be involved in a traffic accident.)

___ Normal - i.e., straight at constant speed
___ Decelerating ___ Accelerating
___ Overtaking ___ Turning
___ Stopping ___ Stopped
___ Other actions ___ Unknown

Attempted Avoidance Actions
(NOTE: Carefully query this elicited information.)

___ None
___ Braking
___ Steering left
___ Steering right
___ Braking and steering left
___ Braking and steering right
___ Accelerating
___ Accelerating and steering left
___ Accelerating and steering right
___ Releasing brake
___ Other actions
___ Not applicable
___ Unknown

AT-CRASH

Estimated Impact Speed
(NOTE: Record as obtained from interviewe increments of 5 m.p.h.; note information source e.g., speedometer, estimate, etc.)

___ Stopped ___ Less than 5 m.p

_______ Actual speed (in increments)
___ Not applicable ___ Unknown

INFORMATION SOURCE:

[1] Object Contacted

(✓) Motor vehicle
(0) Guardrail
(1) Ditch
(2) Ground
(3) Tree
(4) Pole
(5) Sign
(6) Pedacyclist
(7) Pedestrian
(8) Other: ____________
(9) Unknown

[2] Vehicle Impact Location

(1) Front
(2) Right side
(3) Rear
(4) Left side
(5) Top
(6) Undercarriage
(7) Other: ____________
(8) Not applicable
(9) Unknown

[3] Vehicle Orientation

(1) Tracking, no skidding
(2) Tracking, skidding
(3) Rotated clockwise to pat of travel
(4) Rotated counterclockwise path of travel
(5) Rolling over
(6) Jackknifed
(7) Other: ____________
(8) Not applicable
(9) Unknown

DRIVER VIEW of TOTAL ACCIDENT CONTACT SEQUENCE

Did More Than Six Impacts Occur? ___ Unknown, ___ No, ___ Yes: code the six severest impac

Accident Sequence Number	Common Impact Number	Object Contacted[1]	One Vehicle: Vehicle Number	One Vehicle: Impact Location[2]	One Vehicle: Vehicle Orientation[3]	Other Vehicle--if applicab: Vehicle Number	Other Vehicle: Impact Location[2]	Other Vehicle: Vehicl Orientat
1	__	__	__	__	__	__	__	__
2	__	__	__	__	__	__	__	__
3	__	__	__	__	__	__	__	__
4	__	__	__	__	__	__	__	__
5	__	__	__	__	__	__	__	__
6	__	__	__	__	__	__	__	__

POST-CRASH

Rest Position

n roadway
n shoulder
n parking lane
n median
ff roadway (beyond shoulder area)
ther:

____

ot applicable
nknown

Driver Inputs Between Last Point-of-Impact and Final Rest Position

___ None
___ Braking
___ Steering left
___ Steering right
___ Braking and steering left
___ Braking and steering right
___ Acceleration followed by braking
___ Acceleration followed by braking and steering
___ Releasing brake
___ Other:

____

___ Not applicable
___ Unknown

ltiple impacts occurred, describe driver inputs between initial and last point-of-impact.

____

____

ACCIDENT DIAGRAM

a rough sketch of the accident sequence as described by the driver. Note impact and final positions carefully. If possible, relate these to some identifiable object in the area, and d vehicle and pedestrian or nonmotorist headings relative to an object, as well.

Indicate North

uggage or other cargo in vehicle when accident occurred? Estimated Weight: __________ lbs

ibe: ____

nt location of vehicle (if not yet inspected)? _______________________________________

ny of the Following Restrictions of the -of-Way Exist Prior to the Accident

one
arrow bridge (as defined)
revious accident
aintenance, repair, or construction ctivity on roadway
oadway immersion (standing water)
ther roadway obstruction or condition:

____

nknown

Road Surface Condition

___ Dry
___ Wet
___ Snowy, slushy
___ Icy
___ Other:

____

___ Unknown

* THIS COMPLETES THE DRIVER (FORM) ORIENTED QUESTIONS OF THIS INTERVIEW; CONTINUE THIS INTERVIEW WITH THE OCCUPANT (FORM) ORIENTED QUESTIONS *

POLICE REPORT	POLICE, HOSPITAL/MEDICAL, OR OTHER OFFICI

POLICE REPORT

Traffic Violation Charged Against This Driver

NO -- Code 2 for each of questions 17 through 22.

If YES -- Check (✓) each of the violations below that were indicated; code 1 for the checked violations and 2 for the violations not checked.

___ Not applicable -- Code 8 for each of questions 17 through 22.
___ Unknown -- Code 9 for each of questions 17 through 22.

17. ___ Speeding — 27

18. ___ Driving While Intoxicated — 28

19. ___ Reckless Driving — 29

20. ___ Driving With Suspended or Revoked License — 30

21. ___ Other Violation Charged — 31

22. ___ Unknown Violation Charged — 32

23. Alcohol Involvement
(NOTE: A psychomotor test is not considered a test for the purposes of this question.)
___(1) No, test not given
___(2) No, test given
___(3) Yes, test not given
___(4) Yes, test given
___(8) Not applicable
___(9) Unknown
33

POLICE, HOSPITAL/MEDICAL, OR OTHER OFFICI

24. Measured Blood Alcohol Level

.___ % -- Code actual reported number representing fraction of alcohol present.
___(97) Not tested
___(98) Not applicable
___(99) Unknown
3

OFFICIAL RECORDS

Code in the space provided the actual number of recorded convictions/suspensions/accidents that occurred within the last three (3) years (as measured from the date of the accident).

___ Not applicable -- Code 8 for each of questions 25 through 29.
___ Unknown -- Code 9 for each of questions 25 through 29.

25. ___ Previous Speeding Convictions

26. ___ Previous Other Moving Violations Convictions

27. ___ Previous Driving While Intoxicated Convictions

28. ___ Previous Recorded Suspensions and Revocations

29. ___ Previous Accidents

(NOTE: The coded value: 7, indicates that the actual recorded value was seven or more; be sure that the actual value is recorded in the space provided near the question number.)

COMMENTS:

E N V I R O N M E N T A L   D A T A

Number of Travel Lanes

(1) One
(2) Two
(3) Three
(4) Four
___(5) Five
___(6) Six
___(7) Seven or more
___(9) Unknown

41

Trafficway Division and Median Type

(1) Undivided
ꞮDed (median width > to four feet)
(2) Paved flush--painted or un-painted (i.e., not curbed)
(3) Curbed
(4) Unpaved, uncurbed median (e.g., grass, gravel, etc.)
(5) Median barrier
(6) Other median type: ____________________
(9) Unknown

42

Access Control

(1) Full
(2) Partial
(3) Uncontrolled
(9) Unknown

43

Direction of Travel Flow

(1) One way
(2) Two way
(9) Unknown

44

Shoulder Presence

(1) No shoulder
(2) Left shoulder
(3) Right shoulder
(4) Left and right shoulders
(9) Unknown

45

Roadway Alignment

(1) Straight
(2) Curve right
(3) Curve left
(9) Unknown

46

36. Roadway Profile

___(1) Level
___(2) Positive grade
___(3) Negative grade
___(4) Hillcrest
___(5) Sag
___(9) Unknown

47

37. Surface Type

___(1) Concrete
___(2) Bituminous
___(3) Brick, block
___(4) Slag, gravel, or stone
___(5) Dirt
___(6) Other: ____________________
___(9) Unknown

48

38. Surface Condition

___(1) Dry
___(2) Wet
___(3) Snowy, slushy
___(4) Icy
___(5) Other (e.g., sand, dirt, oil): ____________________
___(9) Unknown

49

39. Junction Traffic Controls

___(1) No controls
___(2) Control not functioning

Control Functioned

___(3) Traffic signal
___(4) Stop sign or yield sign
___(5) Railroad crossing control
___(6) Other traffic control: ____________________
___(8) Not applicable
___(9) Unknown

50

40. Accident Occurrence in School Zone

___(1) No
___(2) Yes
___(9) Unknown

51

41. Speed Limit

________ m.p.h. -- Code actual posted or statuatory speed limit.
___(99) Unknown

52 53

ꞮMMENTS:

DRIVER LOG

COMPLETED BY TEAM

Duplicate columns 1 through 8 from the first page of this form.

Card Number 1 (9)

Duplicate columns 10 and 11 from the first page of this form.

Date environmental data (variables D30 through D41) applicable to this driver (traffic unit) were collected from the field.

Month	Day	Year	Initial
__ __ (12, 13)	__ __ (14, 15)	7 9 (16, 17)	__ __ (18, 19)

☐ (1) Driver was not present; therefore, interview was not applicable for this form. STOP LOG COMPLETE!

☐ (2) Driver was present. CONTINUE!

Date official driver records requested. __ __ (22, 23) __ __ (24, 25) 7 9 (26, 27) __ __ (28, 29)

☐ (1) Official driver records received before first submission.

☐ (2) Official driver records applicable but not obtainable. Reason: ____________

☐ (3) Official driver records requested but not received at time of case submission.

Date official driver record data entered on Driver Form (variables D14 through D16 and D25 through D29). NOTE: This task is applicable even if only 9s are coded. __ __ (32, 33) __ __ (34, 35) 7 9 (36, 37) __ __ (38, 39)

COMPLETED BY ZONE CENTER

_-Not in error, not to be updated, and not missing
1-To be updated
2-Error (not correctable)
3-Error (correctable)
4-Questionable
5-Updated and corrected
6-Sequencing error in CDC's or injury data
7-Error incorrectly noted
8-Data entry in error
9-Unknown coded on field form

NOTE: DUPLICATE COLUMNS 1 THROUGH 8 AND GO TO CARD: 2 (9)

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Response	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
Variable	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
Response	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58
Variable	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74
Response	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80			

DRIVER FORM UPDATE RECORD

THIS SECTION MUST BE COMPLETED PRIOR TO INITIAL CASE SUBMISSION

Primary Sampling Unit Number	__ __ (1 2)	DRIVER'S NAME: ____________ (sanitize later)
Case Number	__ __ __ __ (3 4 5 6)	INVESTIGATOR: ____________
Record Number	4 (7)	
Transaction Code	2 (8)	
Version Number	2 (9)	
Vehicle Number	__ __ (10 11)	

CIRCLE THE NUMBER OF EACH VARIABLE TO BE UPDATED AND COMPLETE UPON RECEIPT OF THIS DATA

License Status This Class of Vehicle	__ (24)
License Restriction	__ (25)
Additional License Restriction	__ (26)
Measured Blood Alcohol Level	__ __ (34 35)
Previous Speeding Convictions	__ (36)
Previous Other Moving Violations Convictions	__ (37)
Previous Driving While Intoxicated Convictions	__ (38)
Previous Recorded Suspensions and Revocations	__ (39)
Previous Accidents	__ (40)

ATTACH TO THIS FORM ANY SUPPORTING OFFICIAL RECORDS FOR THIS DRIVER

1/79

CRASH PROGRAM SUMMARY

This form presents the CRASH Program summary information for traffic units numbered:

First Vehicle [Veh #1] ____

Second Vehicle [Veh #2] ____

Primary Sampling Unit Number __

Case Number __ __ __

Common Impact Number __

2. VEHICLE SIZE?

Veh #1 ____

Veh #2 ____

COLLISION DEFORMATION CLASSIFICATION?

3. Veh #1 __ __-__ __ __ __-__

4. Veh #2 __ __-__ __ __ __-__

5. KNOWLEDGE of Vehicle WEIGHTS?

___ No - skip to 8.
___ Yes:

6. Veh #1 __ __ __ __

7. Veh #2 __ __ __ __

8. KNOWLEDGE of REST and IMPACT POSITIONS?

___ No - go to 37. -- Damage Dimensions
___ Yes:

9. REST Veh #1 X __ __ __.__

Y __ __ __.__

ψ __ __ __.__

Veh #2 X __ __ __.__

Y __ __ __.__

ψ __ __ __.__

10. IMPACT Veh #1 X __ __ __.__

Y __ __ __.__

ψ __ __ __.__

Veh #2 X __ __ __.__

Y __ __ __.__

ψ __ __ __.__

11. Did Vehicle One SLIDE SIDEWAYS?

___ No - skip to 14.
___ Yes:

12. Did rotation cease prior to final rest?

___ No - skip to 14.
___ Yes:

13. Location X __ __ __.__

Y __ __ __.__

ψ __ __ __.__

14. Was Vehicle One's PATH CURVED?

___ No - skip to 16.
___ Yes: X __ __ __.

15. Point on Path Y __ __ __.

16. Did Vehicle One ROTATE?

___ None - skip to 18.
___ Clockwise:
___ Counterclockwise:

17. More than 360 degrees?

___ No
___ Yes

18. Did Vehicle Two SLIDE SIDEWAYS?

___ No - skip to 21.
___ Yes:

19. Did rotation cease prior to final rest?

___ No - skip to 21.
___ Yes: X __ __ __.

20. Location Y __ __ __.

ψ __ __ __.

21. Was Vehicle Two's PATH CURVED?

___ No - skip to 23.
___ Yes: X __ __ __.

22. Point on Path Y __ __ __.

23. Did Vehicle Two ROTATE?

___ None - skip to 25.
___ Clockwise:
___ Counterclockwise:

24. More than 360 degrees

___ No
___ Yes

25. COEFFICIENT of FRICTION? __.__

26. ROLLING RESISTANCE? [Option (1) or (2)]

(1) Proportion of Braking Each Wheel

27. Veh #1 RF __.__

LF __.__

RR __.__

LR __.__

Veh #2 RF ___.__ __

LF ___.__ __

RR ___.__ __

LR ___.__ __

OR

(2) Longitudinal Deceleration

Veh #1 ___.__ __

Veh #2 ___.__ __

TRAJECTORY SIMULATION?

___ No - skip to 37.
___ Yes: Steer Angles?

Veh #1 RF __ __
LF __ __
RR __ __
LR __ __

Veh #2 RF __ __
LF __ __
RR __ __
LR __ __

TERRAIN BOUNDARY?

___ No - skip to 37.
___ Yes: Boundary Points?

XBP1 __ __ __.__
YBP1 __ __ __.__
XBP2 __ __ __.__
YBP2 __ __ __.__

SECONDARY FRICTION COEFFICIENT? __.__ __

37. Are DAMAGE DIMENSIONS Known?

___ No - skip to 52.
___ Yes: Dimensions in Inches

38. Side damage
41. End damage Veh #1 L __ __ __.__

39. Side damage
42. End damage C_1 __ __ __.__

C_2 __ __ __.__

C_3 __ __ __.__

C_4 __ __ __.__

C_5 __ __ __.__

C_6 + __ __ __.__

40. Side damage
43. End damage D - __ __ __.__

44. Side damage
47. End damage Veh #2 L __ __ __.__

45. Side damage
48. End damage C_1 __ __ __.__

C_2 __ __ __.__

C_3 __ __ __.__

C_4 __ __ __.__

C_5 __ __ __.__

C_6 + __ __ __.__

46. Side damage
49. End damage D - __ __ __.__

52. IMPROVED FORCE DIRECTIONS?

___ No - PROGRAM COMPLETED!
___ Yes: Angles from Straight

53. Veh #1 + - __ __ __ __

54. Veh #2 + - __ __ __ __

this Common Impact was with a Motor Vehicle *Not In Transport*, fill in the information below.

Model Year: ____________ Make: ____________________

Curb Weight: ____________ lbs Model: ____________________

The CDC, crush profile (C_1 through C_6), and trajectory measurements for this vehicle should be recorded above.

COMPLETE and ATTACH the appropriate schematic (Vehicle Form - page 2) to this Form.

1/79

NATIONAL ACCIDENT SAMPLING SYSTEM

CONTINUOUS SAMPLING SUBSYS

DEPARTMENT OF TRANSPORTATION
National Highway Traffic Safety Administration

OCCUPANT FORM

Form Approved: O.M.B. No. 004-R-

1. Primary Sampling Unit Number ___ ___ (1 2)

2. Case Number ___ ___ ___ ___ (3 4 5 6)

3. Record Number 5 (7)

4. Transaction Code ___ (8)

5. Version Number 2 (9)

IDENTIFICATION

6. Vehicle Number ___ ___ (10 11)

7. Occupant Number ___ ___ (12 13)

OCCUPANT INTERVIEW

8. Occupant's Age

_______ year(s) -- Code actual age at time of accident.
___(00) Less than one year old
___(97) 97 years and older
___(99) Unknown

___ ___ (14 15)

9. Occupant's Sex

___(1) Male
___(2) Female
___(9) Unknown

___ (16)

10. Occupant's Height

_______ inches -- Code actual height to the nearest inch.
___(99) Unknown

___ ___ (17 18)

11. Occupant's Weight

_______ pounds -- Code actual weight to the nearest pound.
___(999) Unknown

___ ___ ___ (19 20 21)

12. Occupant's Role

___(1) Driver
___(2) Passenger
___(9) Unknown

___ (22)

13. Occupant's Seat Position

___(01) Front seat-left side
___(02) Front seat-middle
___(03) Front seat-right side
___(04) Second seat-left side
___(05) Second seat-middle
___(06) Second seat-right side
___(07) Third seat-left side
___(08) Third seat-middle
___(09) Third seat-right side
___(10) Front seat-additional passenger
___(11) Second seat or beyond-additional passenger
___(12) Truck-tractor sleeping section
___(13) Other enclosed area: ______________
___(14) In or on unenclosed area area type: ______________
___(15) In or on trailing unit unit type: ______________
___(99) Unknown

___ ___ (23 ...)

(NOTE: INVESTIGATOR as used below refers to the product of individual observation, police reports, and any other sources used that culminated in the assessment which represents the final opinion of the investigator.)

14. Entrapment
(NOTE: Entrapped means that part of the occupant was in the vehicle and mechanically restrained; jammed doors and immobilizing injuries by themselves are not sufficient to constitute entrapment.)

Interviewee		Investigator	
___	(1) Not entrapped	___	C
___	(2) Entrapped	___	O
___	(8) Not applicable	___	D
___	(9) Unknown	___	E

___ (2...)

(NOTE: Motorcyclists cannot be either entrapped or ejected.)

15. Ejection

___	(1) None	___	
___	(2) Partial ejection	___	C
___	(3) Complete ejection	___	O
___	(4) Ejection, unknown degree	___	D
___	(8) Not applicable	___	E
___	(9) Unknown	___	

___ (2...)

e	Inves-tigator

Ejection Area

	Investigator	
(01) Windshield	___	
(02) Left front	___	
(03) Right front	___	
(04) Left rear	___	
(05) Right rear	___	C
(06) Rear	___	
(07) Roof (convertible or sun roof)	___	O
(08) Other area (e.g., sidecar, back of pickup, etc.): ________	___	D E
(98) Not applicable	___	
(99) Unknown	___	

27 28

Ejection Medium

	Investigator	
(01) Door	___	
(02) Open roof structure	___	
(03) Fixed windows	___	
rable windows		
(04) Roll down type	___	C
(05) Hinged type	___	
(06) Sliding type	___	O
(07) Other type: ________	___	D E
(08) Other medium: ________	___	
(98) Not applicable	___	
(99) Unknown	___	

29 30

18. Medium Status

Interviewee		Investigator	
___	(1) Open	___	C
___	(2) Separation	___	O
___	(3) Closed, closed when damaged	___	D
___	(8) Not applicable	___	E
___	(9) Unknown	___	

V5

31

19. Treatment - Mortality

Interviewee		Official Sources	
___	(1) Fatal	___	
Nonfatal			
___	(2) Hospitalization	___	C
___	(3) Transported and released	___	O
___	(4) Treatment-other: ________	___	D E
___	(5) No treatment	___	
___	(9) Unknown	___	

32

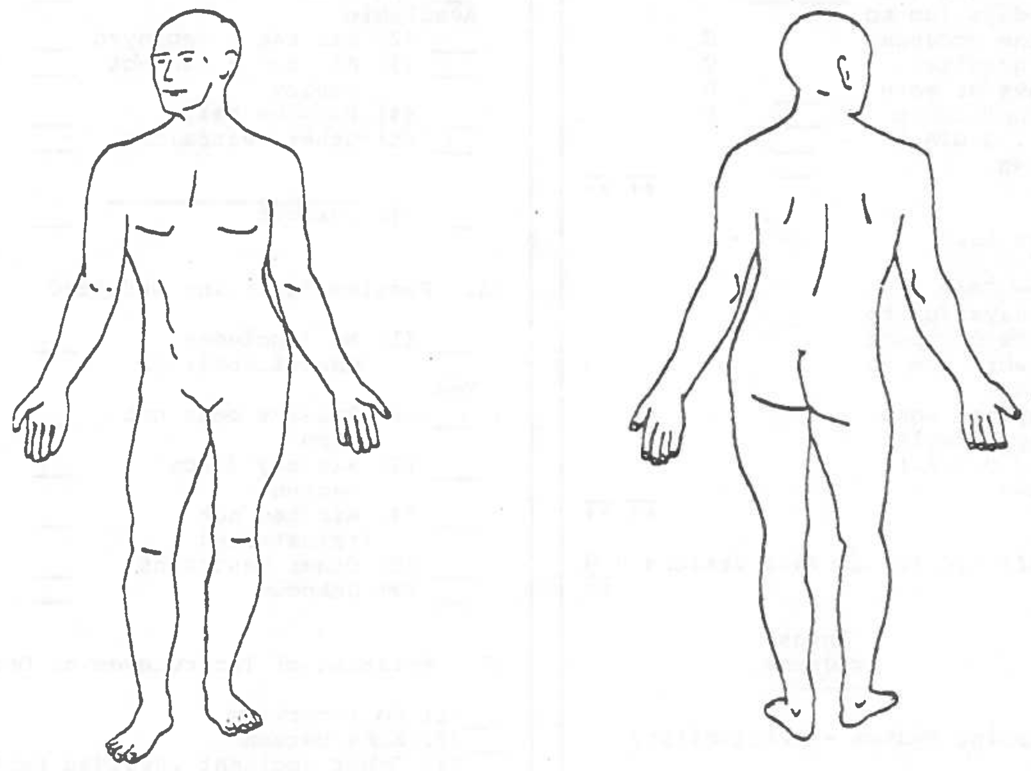
MENTS:

1/79

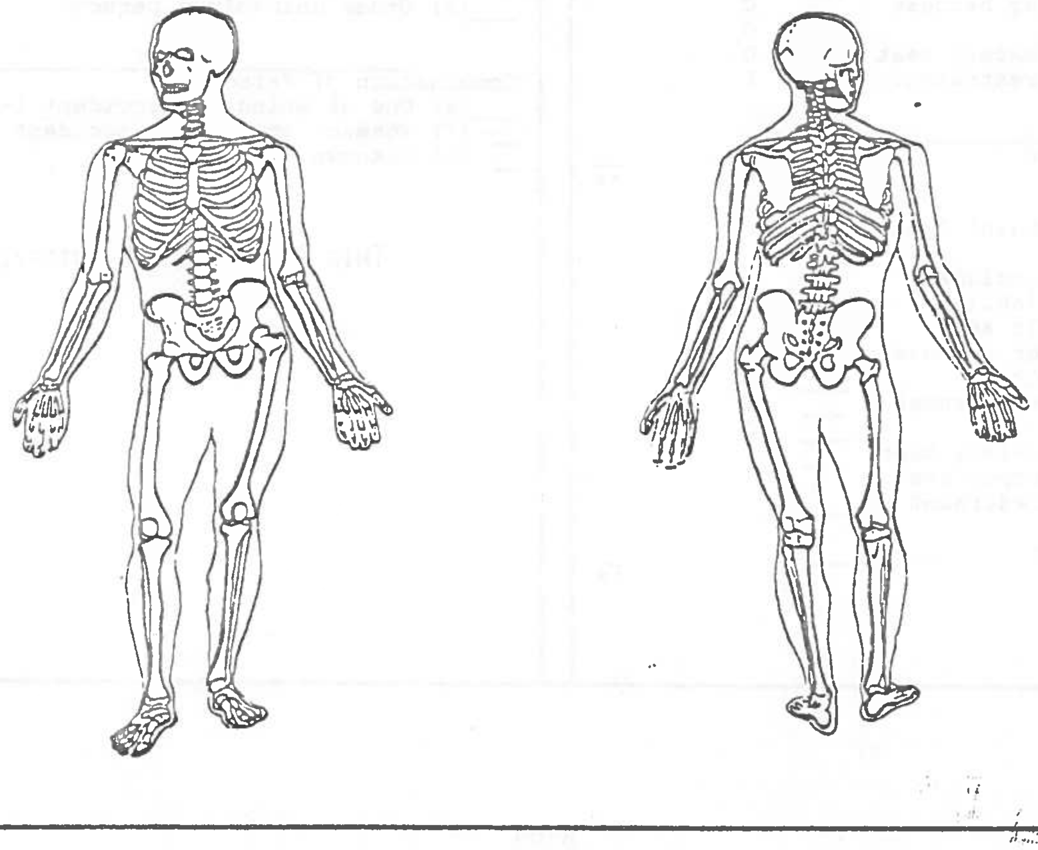
INTERVIEWEE INJURY DATA

Indicate the *Nature*, *Location*, and injury *Source* of all injuries

Soft Tissue Injuries



Skeletal Injuries



-ee	Official Sources

Hospital Stay

___ day(s) -- Code the number of days (up to 30) that the occupant stayed in hospital. ________
(31) 31 days or more
(98) Not applicable (e.g., D.O.A.) ___
(99) Unknown ___

CODE ___ ___ 33 34

Working Days Lost

___ day(s) -- Code the number of days (up to 30) that the occupant lost from work due to the accident.
(31) 31 days or more
(98) Not applicable (e.g., D.O.A.)
(99) Unknown

___ ___ 35 36

This variable deleted in this version 9 37

-ee	Investigator

Active Restraint System - Availability

(1) None ___
(2) Lap belt and shoulder harness ___
(3) Lap belt ___
(4) Shoulder harness ___
(5) Helmet ___
(6) Child safety seat ___
(7) Other restraint: ___ ________
(9) Unknown ___

CODE ___ 38

Active Restraint System - Use

(1) None (includes unavailability) ___
(2) Lap belt and shoulder harness ___
(3) Lap belt ___
(4) Shoulder harness ___
(5) Helmet ___
(6) Child safety seat - in proper use ___
(7) Other restraint used ___
(9) Unknown ___

CODE ___ 39

Interviewee	Investigator

25. Passive Restraint System

___ (1) None ___
Available
___ (2) Air bag - deployed ___
___ (3) Air bag - did not deploy ___
___ (4) Passive belt ___
___ (5) Other restraint: ___ ________
___ (9) Unknown ___

CODE ___ 40 V5

26. Passive Restraint Defeated

___ (1) No (includes unavailability) ___
Yes
___ (2) Passive belt not worn ___
___ (3) Air bag disconnected ___
___ (4) Air bag not reinstalled ___
___ (5) Other restraint ___
___ (9) Unknown ___

CODE ___ 41 V5

27. Relation of Interviewee to Occupant

___(1) No interview
___(2) Same person
___(3) Other accident involved person: ________

Uninvolved Person
___(4) Relative or friend
___(5) Other uninvolved person: ________

Combination of Persons
___(6) One of which was accident involved
___(7) None of which were accident involved
___(9) Unknown

___ 42

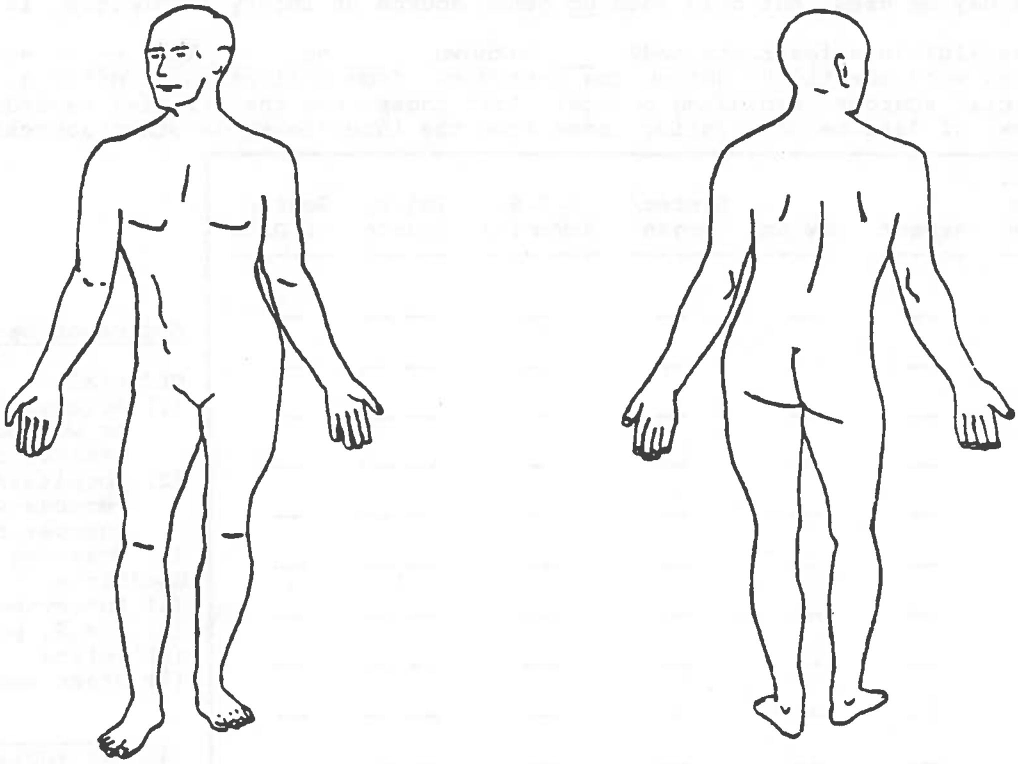
THIS COMPLETES THE INTERVIEW

1/79

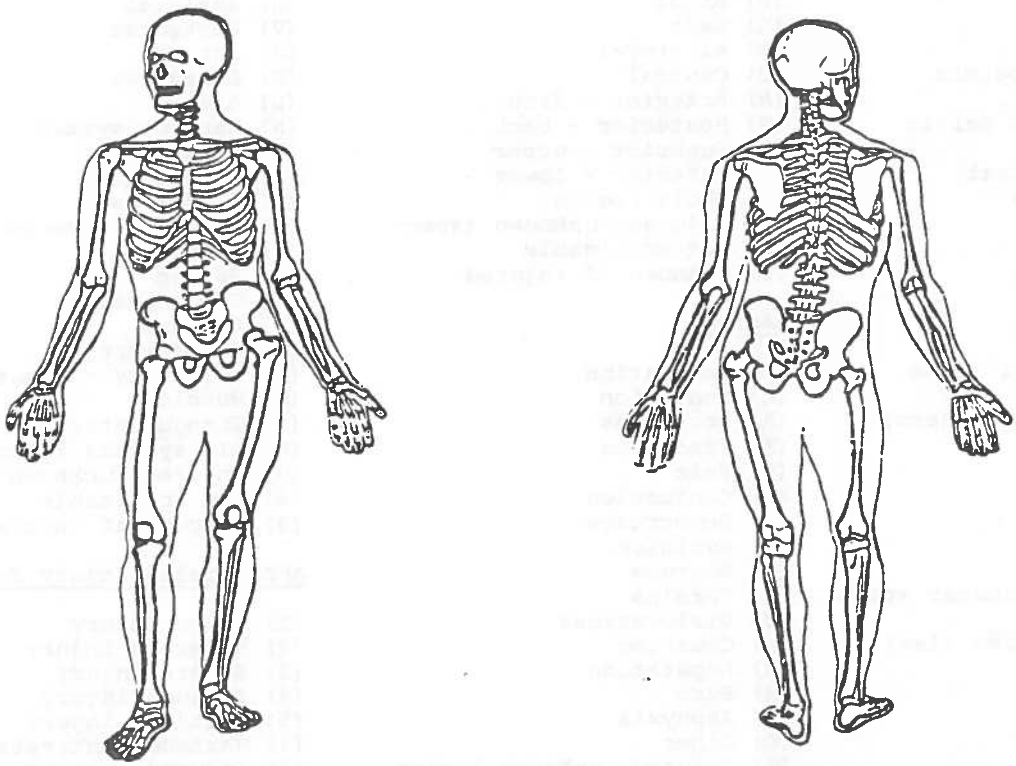
OFFICIAL INJURY DATA

Indicate the *Nature* and *Location* of *All* injuries.

Soft Tissue Injuries



Skeletal Injuries



O C C U P A N T   I N J U R Y   C L A S S I F I C A T I O N

ider all injuries which are reported from both unofficial and official sources. The informa- from official sources takes precedence over similar injuries reported by any other source. ther words, do not list the same injury twice; supercede the interview data with official data he case of similar injuries. List all injuries by official medical sources first. Police rted injuries may be used, but only when no other source of injury information is available.

more than ten (10) injuries sustained? ___ Unknown, ___ No, ___ Yes -- If more than ten imilar injuries were identified during the interview, from collection of official data, and other unofficial sources (excluding police), list those from the official records first, ex- ting that level of data before listing those from the interviewee or other sources.

I.S.S. Body Region	O.I.C. Body Region	Aspect	Lesion	System/ Organ	A.I.S. Severity	Injury Source	Source of Data
___	___	___	___	___	___	___ ___	___
___	___	___	___	___	___	___ ___	___
___	___	___	___	___	___	___ ___	___
___	___	___	___	___	___	___ ___	___
___	___	___	___	___	___	___ ___	___
___	___	___	___	___	___	___ ___	___
___	___	___	___	___	___	___ ___	___
___	___	___	___	___	___	___ ___	___
___	___	___	___	___	___	___ ___	___
___	___	___	___	___	___	___ ___	___

Source of Data

Official
(1) Autopsy records with or without hospital/ medical records
(2) Hospital/medical records without autopsy records
(3) Treating physician
Unofficial
(4) Interviewee
(5) E.M.S. personnel
(6) Police
(7) Other source: ____________
(8) Not applicable
(9) Unknown

S. Body Region

Head or neck
Face
Chest
Abdominal or pelvic contents
Extremities or pelvic girdle
General (external)
Not applicable
Unknown

C. Body Region

Head - skull
Face
Neck - cervical spine
Shoulder
Upper extremities (arm)
Arm (upper)
Elbow
Forearm
Wrist - hand
Chest
Abdomen
Back - thoracolumbar spine
Pelvic - hip
Lower extremities (leg)
Thigh
Knee
Leg (lower)
Ankle - foot
Whole body
Injured, unknown region
Not applicable
Jnknown if injured

Aspect of Injury

(R) Right
(L) Left
(B) Bilateral
(C) Central
(A) Anterior - front
(P) Posterior - back
(S) Superior - upper
(I) Inferior - lower
(W) Whole region
(U) Injured, unknown aspect
(8) Not applicable
(9) Unknown if injured

Lesion

(L) Laceration
(C) Contusion
(A) Abrasions
(F) Fractures
(P) Pain
(K) Concussion
(H) Hemorrhage
(V) Avulsion
(R) Rupture
(S) Sprains
(D) Dislocations
(N) Crushing
(M) Amputation
(B) Burn
(X) Asphyxia
(O) Other
(U) Injured, unknown lesion
(8) Not applicable
(9) Unknown if injured

System/Organ

(S) Skeletal
(V) Vertebrae
(J) Joints
(D) Digestive
(L) Liver
(N) Nervous system
(B) Brain
(C) Spinal cord
(E) Eyes - ears
(A) Arteries - veins
(H) Heart
(Q) Spleen
(G) Urogenital
(K) Kidneys
(R) Respiratory
(P) Pulmonary - lungs
(M) Muscles
(I) Integumentary
(W) All systems in region
(U) Injured, unknown system
(8) Not applicable
(9) Unknown if injured

Abbreviated Injury Scale

(1) Minor injury
(2) Moderate injury
(3) Severe injury
(4) Serious injury
(5) Critical injury
(6) Maximum (untreatable)
(7) Injured, unknown severity
(8) Not applicable
(9) Unknown if injured

Reduction Section

Injury Source

FRONT
(01) Windshield
(02) Mirror
(03) Steering assembly, including transmission selector level when column mounted
(04) Add-on equipment (e.g., CB, tape deck, air conditioner)
(05) Instrument panel and below, excluding foot controls and parking brake
(09) Other front object

SIDE
(11) Side interior surface, excluding hardware or armrests
(12) Side hardware or armrests
(13) Roof pillar supports
(14) Window glass or frame
(19) Other side object

INTERIOR
(21) Seat, back support
(22) Belt restraint system
(23) Head restraint
(24) Air cushion
(25) Other occupants
(26) Interior loose objects
(29) Other interior object

ROOF
(31) Front header
(32) Rear header
(33) Roof side rails
(34) Roof or convertible top

FLOOR
(41) Floor
(42) Floor or console mounted transmission lever, including console
(43) Parking brake handle
(44) Foot controls including parking brake

REAR
(51) Backlight (rear window)
(52) Backlight storage rack, door, etc.
(59) Other rear objects

EXTERIOR of OCCUPANT'S VEHICLE
(61) Hood
(62) Outside hardware (e.g., outside mirror, antenna)
(63) Other exterior surface or tires
(69) Unknown exterior objects

EXTERIOR of OTHER MOTOR VEHICLE
(71) Bumper
(72) Hood edge
(73) Other front of vehicle
(74) Hood
(75) Hood ornament
(76) Windshield, roof rail, A-pillar
(77) Side surface
(78) Side mirrors
(79) Other side protrusions
(80) Rear surface
(81) Undercarriage

OTHER VEHICLE or OBJECT in the ENVIRONMENT
(86) Ground
(87) Other vehicle or object
(89) Unknown vehicle or object

NONCONTACT INJURY
(90) Noncontact injury source (impact force)

(97) Injured, unknown source
(98) Not applicable
(99) Unknown if injured

OCCUPANT INJURY CLASSIFICATION

If there are six or less injuries listed in the O.I.C. reduction section, code all of the injuries ordered by Source of Data (1st-autopsy, 2nd-hospital/medical, 3rd-treating physician, or 4th-interviewee and other sources) and by A.I.S. severity within source.

If there are more than six injuries order the injuries by source and by A.I.S. severity within source. Code this ordering, injury by injury. If a group of ordered injuries has the same source, the same A.I.S., and the group includes at least the sixth and seventh injuries in the ordering, then a choice must be made as to which injury or injuries to code.

Choose the injury or injuries that will enable the maximum number of different I.S.S. body regions to be represented in the coded data. If no new I.S.S. body region can be added, then simply code in accordance with the original ordering.

If the occupant has less than six injuries, then the number of rows required to be completed is equal to the number of injuries plus one (e.g., no injuries requires one row i.e., columns 43 to 50). In the additional row "not applicable" will be coded for all variables including A.I.S. severity. In essence, "not applicable" means "no injury".

Update Candidate: ◯ *Yes* ◯ *No*

	I.S.S. Body Region	O.I.C. Body Region	Aspect	Lesion	System/ Organ	A.I.S. Severity	Injury Source	Source of Data
1ST	__	28. __ (43)	29. __ (44)	30. __ (45)	31. __ (46)	32. __ (47)	33. __ __ (48 49)	34. __ (50)
2ND	__	35. __ (51)	36. __ (52)	37. __ (53)	38. __ (54)	39. __ (55)	40. __ __ (56 57)	41. __ (58)
3RD	__	42. __ (59)	43. __ (60)	44. __ (61)	45. __ (62)	46. __ (63)	47. __ __ (64 65)	48. __ (66)
4TH	__	49. __ (67)	50. __ (68)	51. __ (69)	52. __ (70)	53. __ (71)	54. __ __ (72 73)	55. __ (74)
5TH	__	56. __ (75)	57. __ (76)	58. __ (77)	59. __ (78)	60. __ (79)	61. __ __ (80 81)	62. __ (82)
6TH	__	63. __ (83)	64. __ (84)	65. __ (85)	66. __ (86)	67. __ (87)	68. __ __ (88 89)	69. __ (90)

RESPONSES

MANNER

(1) Telephone
(2) Personal visit to home, work, etc.
(3) Letter (questionnaire)
(4) Other [specify]

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

RESULT

(01) No answer (to phone call, <u>no</u> one home, etc.)
(02) Other person at home, work, etc.--interviewee to contact investigator
(03) Other person at home, work, etc.--investigator to repeat call, visit, leave questionnaire, or try elsewhere
(04) Must obtain permission of attorney or insurance company
(05) Attorney or insurance company refused permission
(06) Refused interview for other than on advice of attorney or insurance company [specify or write "unknown reason"]

____

(07) Attorney or insurance company provided permission
(08) No return of letter (questionnaire)
(09) Partial or complete interview
(10) Other [specify]

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

g. ______________________________

h. ______________________________

70. Injury Severity (Police Rating)

___(1) K - Killed
___(2) A - Incapacitating injury
___(3) B - Nonincapacitating injury
___(4) C - Possible injury
___(5) O - No injury
___(9) Unknown

___ 91

If any of the coded Injury Sources have "other" codes, i.e. 09, 19, 29, 59, 63, or 87; describe the injury source below in the space provided. Clearly indicate each description by numerical value.

COMMENTS:

ATTACH TO THIS FORM ANY SUPPORTING MEDICAL DOCUMENTATION FOR THIS OCCUPANT

1/79

OCCUPANT LOG

COMPLETED BY TEAM

Duplicate columns 1 through 8 from the first page of this form.

Card Number 1 (9)

Duplicate columns 10 through 13 from the first page of this form.

INTERVIEW CONTACT RECORD

Contact Sequence	Month	Day	Year	Time of Contact	Contacting Investigator	Manner	Result
1ST	14 15	16 17	7 9 (18 19)	20 21 22 23	24 25 26	27	28 29
2ND	30 31	32 33	7 9 (34 35)	36 37 38 39	40 41 42	43	44 45
3RD	46 47	48 49	7 9 (50 51)	52 53 54 55	56 57 58	59	60 61
4TH	62 63	64 65	7 9 (66 67)	68 69 70 71	72 73 74	75	76 77
GO TO 2 (9) 5TH	10 11	12 13	7 9 (14 15)	16 17 18 19	20 21 22	23	24 25
6TH	26 27	28 29	7 9 (30 31)	32 33 34 35	36 37 38	39	40 41
7TH	42 43	44 45	7 9 (46 47)	48 49 50 51	52 53 54	55	56 57
8TH	58 59	60 61	7 9 (62 63)	64 65 66 67	68 69 70	71	72 73
GO TO 3 (9) 9TH	10 11	12 13	7 9 (14 15)	16 17 18 19	20 21 22	23	24 25

COMMENTS:

____

____

____

____

____

For responses to Manner and Result see back of page 7.

Date decision was made not to further attempt to obtain a direct or surrogate interview regarding the general data elements (variables 008 through 027). __ __ __ __ 7 9 (26 27 28 29 30 31)

Deciding Person (Initials) __ __ __ (32 33 34)

Mark Appropriate Box

- ☐ (1) Official medical injury data received before first submission.
- ☐ (2) Official medical injury data inapplicable (no medically diagnosed treatment).
- ☐ (3) Official medical injury data applicable but not obtainable.
  Reason: ______________
- ☐ (4) Official medical injury data requested but not received at time of case submission.

__ (35)

Date Occupant Injury Classification (O.I.C.), page 7, completed. __ __ __ __ 7 9 (36 37 38 39 40 41)

Completing Person (Initials). NOTE: This task is applicable even if only 8s, 9s, 98s, or 99s are the codes used. __ __ __ (42 43 44)

COMPLETED BY ZONE CENTER

NOTE: DUPLICATE COLUMNS 1 THROUGH 8 AND GO TO CARD: 4 (9).

- _ -Not in error, not to be updated, and not missing
- 1-To be updated
- 2-Error (not correctable)
- 3-Error (correctable)
- 4-Questionable
- 5-Updated and corrected
- 6-Sequencing error in CDC's or injury data
- 7-Error incorrectly noted
- 8-Data entry in error
- 9-Unknown coded on field form

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Response	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Variable	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Response	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59
Variable	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
Response	60	61	62	63	64	65	66	67			71	72	73	74	75	76	77	78	79						

OCCUPANT FORM UPDATE RECORD

THIS SECTION MUST BE COMPLETED PRIOR TO INITIAL CASE SUBMISSION

1. Primary Sampling Unit Number __ __ (1, 2)
2. Case Number __ __ __ __ (3, 4, 5, 6)
3. Record Number 5 (7)
4. Transaction Code 2 (8)
5. Version Number 2 (9)
6. Vehicle Number __ __ (10, 11)
7. Occupant Number __ __ (12, 13)

OCCUPANT'S NAME: ______________ Age: __ __

(sanitize later)

DATA ON INITIAL SUBMISSION: Sex: __

Treatment - Mortality: __

Hospital Stay: __ __

INVESTIGATOR: ______________

ENTER RESPONSE FOR EACH VARIABLE WHERE DATA ON INITIAL SUBMISSION WAS UNKNOWN OR IS FELT TO BE IN ERROR, GIVEN RECEIPT OF OFFICIAL MEDICAL RECORD(S)

8. Occupant's Age __ __ (14, 15)
9. Occupant's Sex __ (16)
19. Treatment - Mortality __ (32)
20. Hospital Stay __ __ (33, 34)

COMPLETE PRIOR TO INITIAL CASE SUBMISSION

INJURY DATA CODED ON INITIAL SUBMISSION

28. __ 29. __ 30. __ 31. __ 32. __ 33. __ __ 34. __

35. __ 36. __ 37. __ 38. __ 39. __ 40. __ __ 41. __

42. __ 43. __ 44. __ 45. __ 46. __ 47. __ __ 48. __

49. __ 50. __ 51. __ 52. __ 53. __ 54. __ __ 55. __

56. __ 57. __ 58. __ 59. __ 60. __ 61. __ __ 62. __

63. __ 64. __ 65. __ 66. __ 67. __ 68. __ __ 69. __

UPDATED INJURY DATA BASED ON SUBSEQUENTLY ACQUIRED OFFICIAL MEDICAL DATA

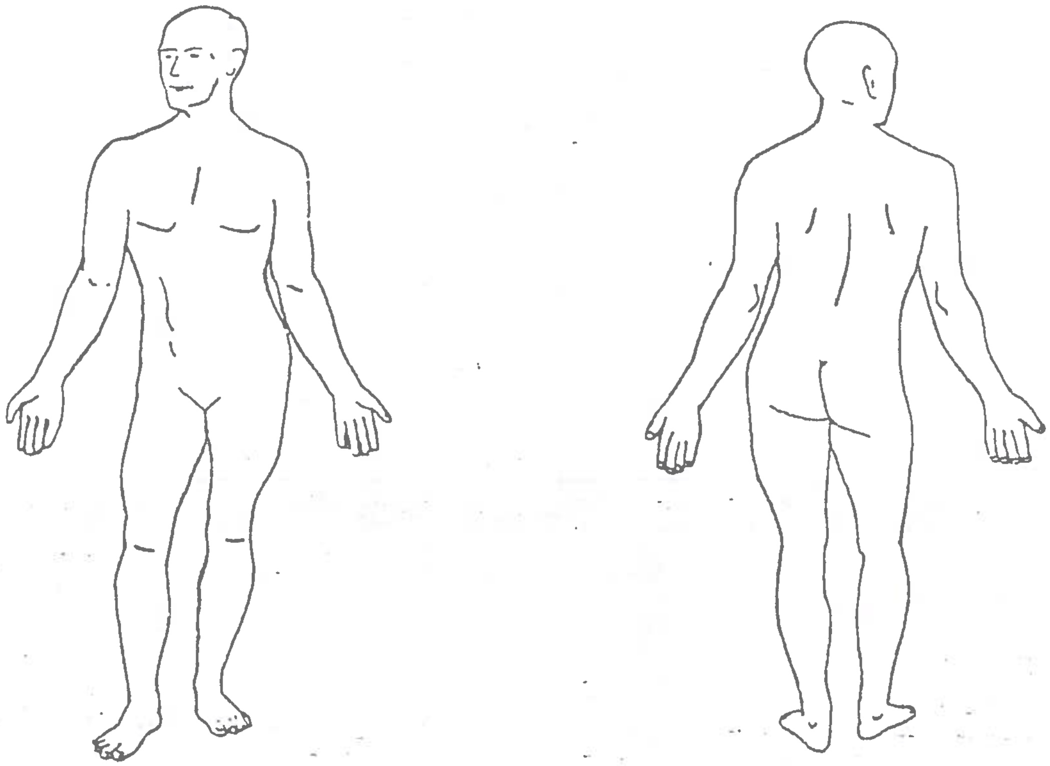
28. __ (43)	29. __ (44)	30. __ (45)	31. __ (46)	32. __ (47)	33. __ __ (48, 49)	34. __ (50)
35. __ (51)	36. __ (52)	37. __ (53)	38. __ (54)	39. __ (55)	40. __ __ (56, 57)	41. __ (58)
42. __ (59)	43. __ (60)	44. __ (61)	45. __ (62)	46. __ (63)	47. __ __ (64, 65)	48. __ (66)
49. __ (67)	50. __ (68)	51. __ (69)	52. __ (70)	53. __ (71)	54. __ __ (72, 73)	55. __ (74)
56. __ (75)	57. __ (76)	58. __ (77)	59. __ (78)	60. __ (79)	61. __ __ (80, 81)	62. __ (82)
63. __ (83)	64. __ (84)	65. __ (85)	66. __ (86)	67. __ (87)	68. __ __ (88, 89)	69. __ (90)

INDICATE THE NATURE AND LOCATION OF ALL INJURIES FROM THE OFFICIAL MEDICAL REPORT(S) ON THE REVERSE SIDE AND ATTACH THE REPORT(S) TO THIS UPDATE

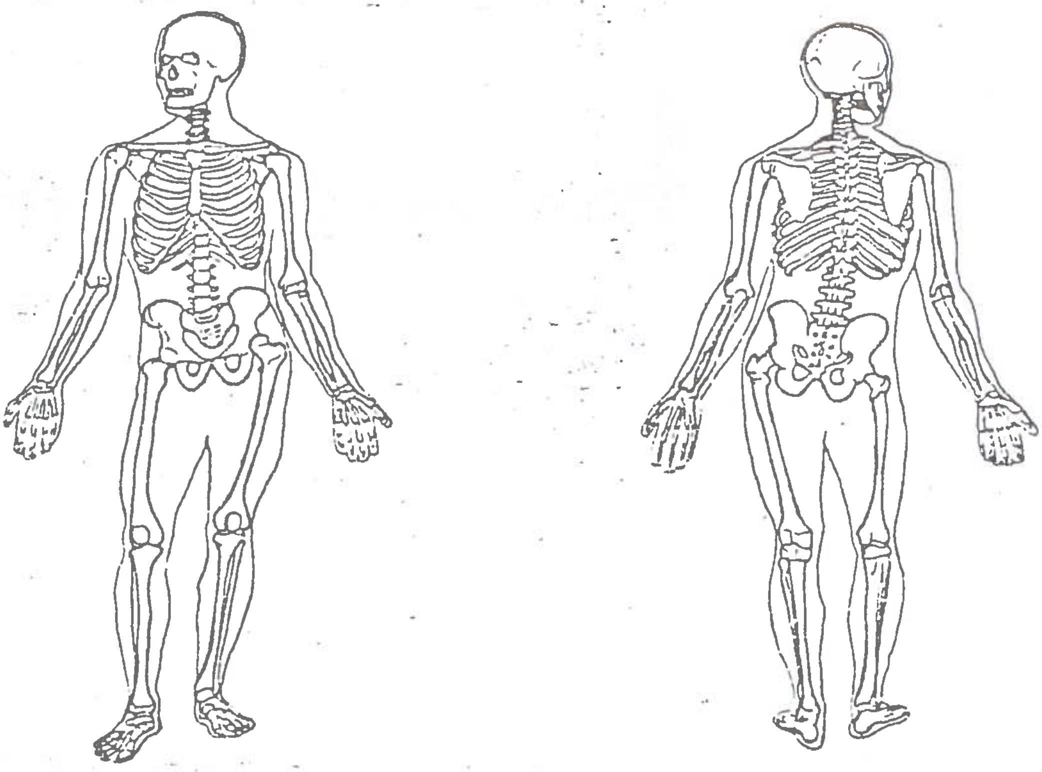
OFFICIAL INJURY DATA

ate the *Nature* and *Location* of *All* injuries.

Soft Tissue Injuries



Skeletal Injuries



NATI... L ACCIDENT SAMPLING SYSTEM CONTINUOUS SAMPLING SUBSYSTEM

DEPARTMENT OF TRANSPORTATION
National Highway Traffic
Safety Administration

PEDESTRIAN & NONMOTORIST FORM

Form Approved:
O.M.B. No. 004-R-572

1. Primary Sampling Unit Number ___ ___ (1 2)

2. Case Number ___ ___ ___ ___ (3 4 5 6)

3. Record Number 2 (7)

4. Transaction Code ___ (8)

5. Version Number 2 (9)

IDENTIFICATION

6. Pedestrian or Nonmotorist's Number ___ ___ (10 11)

7. Pedestrian or Nonmotorist's Type

___(1) Pedestrian
___(2) Bicyclist
___(3) Other cyclist: ____________________
___(4) Animal related
___(5) Other nonmotorist: ____________________
___(9) Unknown

___ (12)

PEDESTRIAN OR NONMOTORIST INTERVIEW

8. Pedestrian or Nonmotorist's Age

_______ year(s) -- Code actual age at time of accident.
___(00) Less than one year old
___(97) 97 years and older
___(99) Unknown

___ ___ (13 14)

9. Pedestrian or Nonmotorist's Sex

___(1) Male
___(2) Female
___(9) Unknown

___ (15)

10. Pedestrian or Nonmotorist's Height

_______ inches -- Code actual reported height to the nearest inch.
___(99) Unknown

___ ___ (16 17)

11. Pedestrian or Nonmotorist's Weight

_______ pounds -- Code actual reported weight to the nearest pound.
___(999)

___ ___ ___ (18 19 20)

12. Purpose of Trip

___(01) To place of work
___(02) Work-related business
___(03) Convention
___(04) Civic/education/religious
___(05) Eat meal
___(06) Medical or dental
___(07) Shopping
___(08) Family or personal business
___(09) Visit friends or relatives
___(10) Pleasure driving
___(11) Sightseeing
___(12) Entertainment
___(13) Recreation (participant)
___(14) Vacation
___(15) Change of vehicle without change of mode
___(16) Change means of transportation
___(17) Pick up or leave off passengers
___(18) Return home
___(19) Lodging (overnight)
___(20) Other social: ____________
___(21) Other purpose: ____________
___(98) Not applicable
___(99) Unknown

___ ___ (21 22)

13. Months Cycling Experience

_______ months -- Code actual months of previous cycling experience up to 60.
(NOTE: 45 days or less equals 1 month; a month and a half equals 2 months.)
___(61) Greater than five years
___(98) Not applicable
___(99) Unknown

___ ___ (23 24)

ACCIDENT DESCRIPTION INSTRUCTIONS

Do not interrupt person during general description (narrative), unless he/she requests your assistance. Attempt to summarize the narrative while minimizing any disruptions of the person's internal logic. Specific questions may be asked later. Write these questions down in the space below or on the other side of the page, prior to the interview.

SPECIFIC QUESTION: ____________________

____

____

GENERAL DESCRIPTION OF ACCIDENT SEQUENCE

(This represents a synopsis of an uninterrupted narrative by the pedestrian or nonmotorist.)

____

____

____

____

____

____

____

____

ACCIDENT DIAGRAM

rough sketch of the accident sequence as described by the pedestrian or nonmotorist. Note and final rest positions carefully. If possible, relate these to some identifiable object area, and record vehicle and pedestrian or nonmotorist headings relative to an object, as

Indicate North

edestrian or Nonmotorist's Location

) In motor vehicle not in transport on trafficway
) In motor vehicle not in transport off trafficway
) In motor vehicle not in transport location unknown
) In intersection in crosswalk
) In intersection on sidewalk, median, or island
) In intersection on roadway
) In intersection location unknown
) Nonintersection in crosswalk
) Nonintersection on sidewalk, median, island, or shoulder
) Nonintersection on bike path
) Nonintersection on roadway
) Nonintersection off road
) Unknown

___ ___
25 26

edestrian's Action

) Pedestrian struck vehicle
) Dart-out, midblock
) Intersection dash
) Vehicle turning, pedestrian not running
) Intersection related, vehicle not turning, pedestrian not running
) Stopped vehicle, midblock - going to or from (e.g., bus stop, vendor, etc.)
) Vehicle backing up
) Disabled vehicle related
) Struck by rebounding or out-of-control vehicle
) Other circumstances:

____

) Not applicable
) Unknown

___ ___
27 28

16. Treatment - Mortality

Interviewee		Official Sources
___	(1) Fatal	___
	Nonfatal	
___	(2) Hospitalization	___
___	(3) Transported and released	___
___	(4) Treatment-other: ________________	___
___	(5) No treatment	___
___	(9) Unknown	___

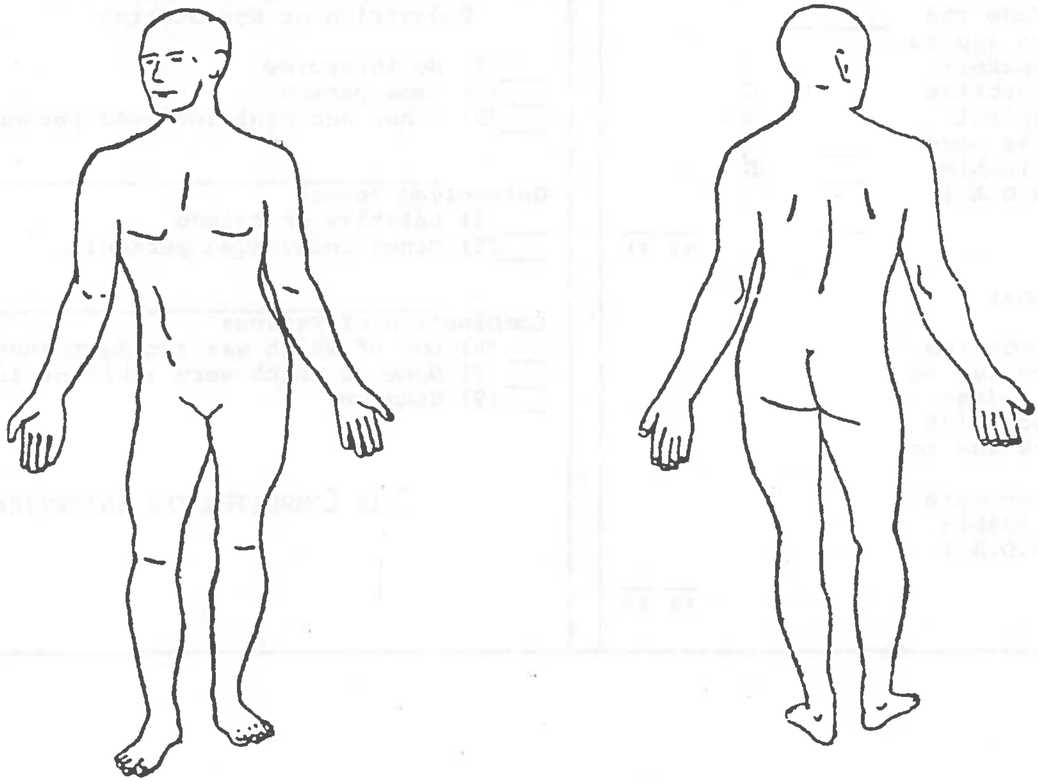
CODE

___
29

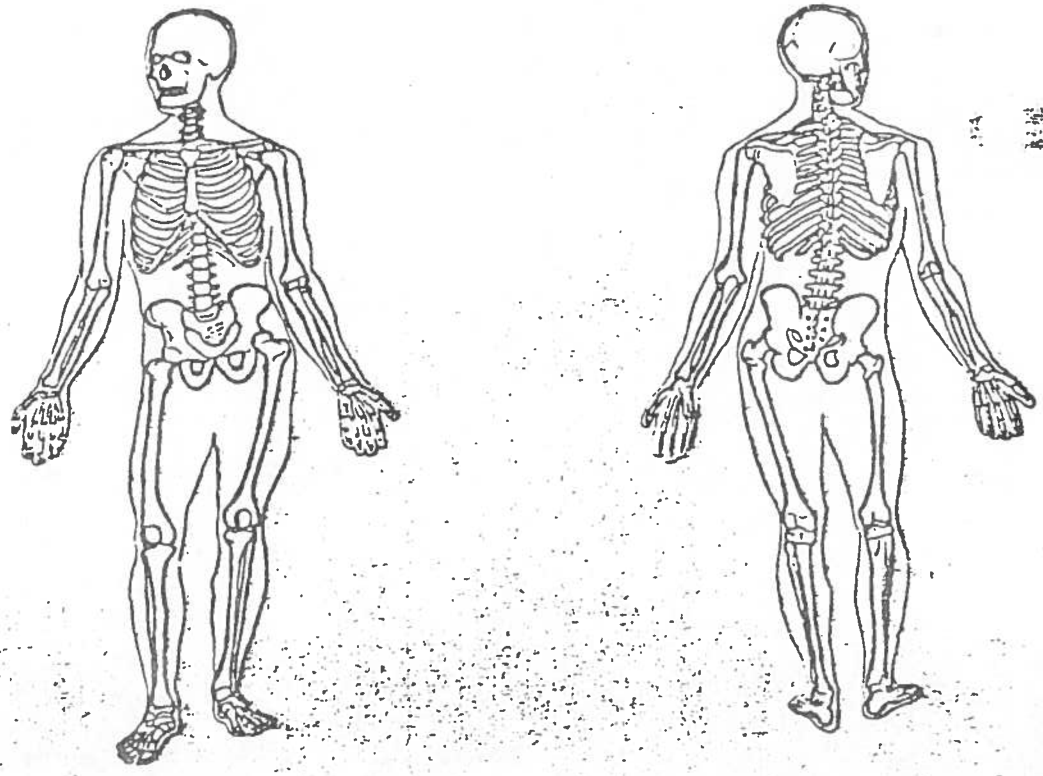
INTERVIEWEE INJURY DATA

Indicate the *Nature*, *Location*, and injury *Source* of all injuries.

Soft Tissue Injuries



Skeletal Injuries



Official Sources

----

ospital Stay

_ day(s) -- Code the number of days (up to 30) that the pedestrian or nonmotorist stayed in hospital. ________

(31) 31 days or more ___
(98) Not applicable (e.g., D.O.A.) ___
(99) Unknown ___

C O D E

__ __ 30 31

orking Days Lost

_ day(s) -- Code the number of days (up to 30) that the pedestrian or nonmotorist lost from work due to the accident.

(31) 31 days or more
(98) Not applicable (e.g., D.O.A.)
(99) Unknown

__ __ 32 33

19. *This variable deleted in this version* 9 (34)

20. Relation of Interviewee to Pedestrian or Nonmotorist

___(1) No interview
___(2) Same person
___(3) Other accident involved person:

____

Uninvolved Person
___(4) Relative or friend
___(5) Other uninvolved person:

____

Combination of Persons
___(6) One of which was accident involved
___(7) None of which were accident involved
___(9) Unknown

__ 35

THIS COMPLETES THE INTERVIEW

MENTS:

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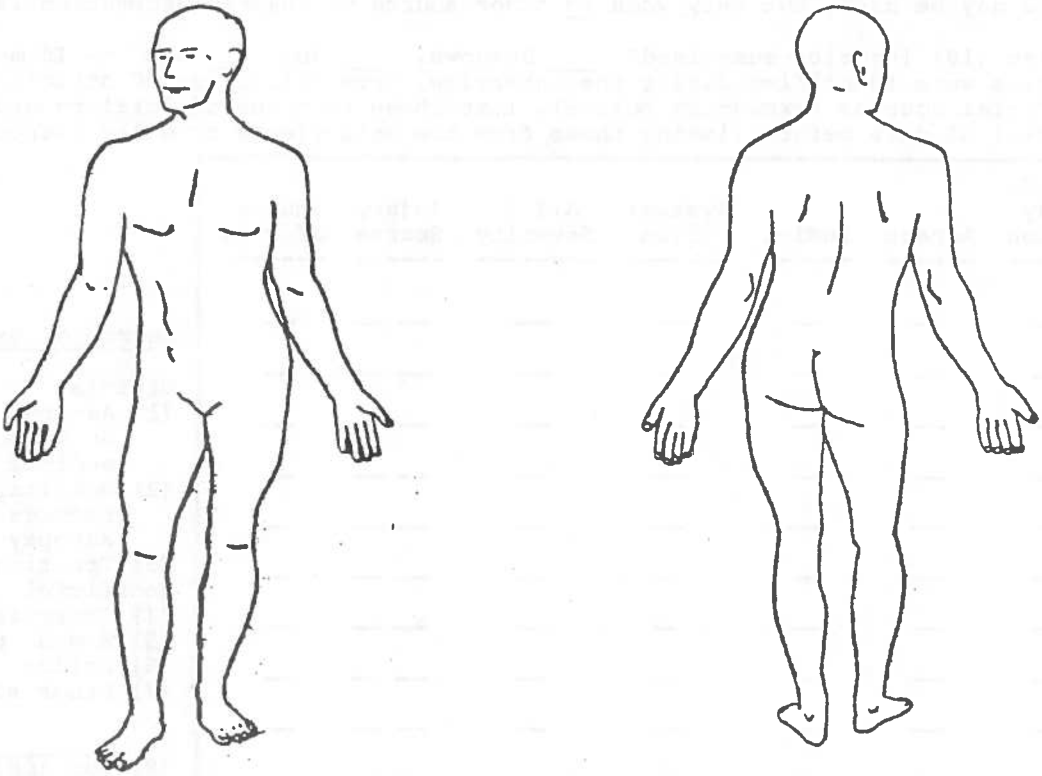
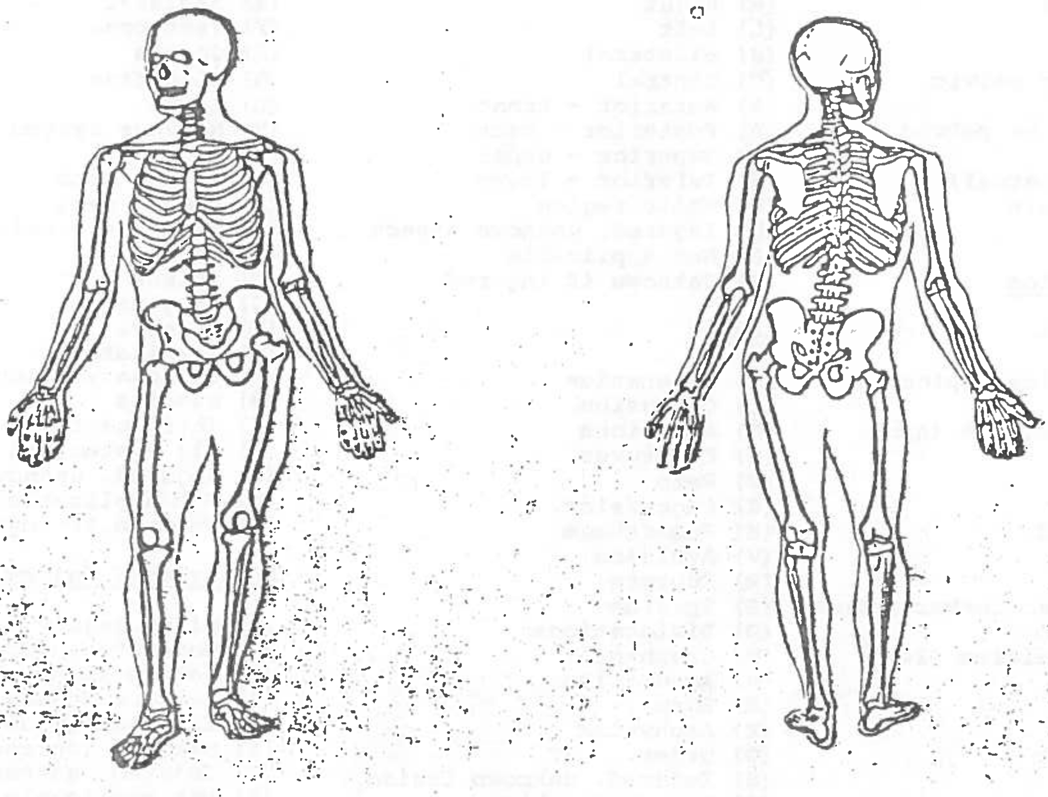
OFFICIAL INJURY DATA

Indicate the *Nature* and *Location* of *All* injuries.

Soft Tissue Injuries



Skeletal Injuries



O C C U P A N T   I N J U R Y   C L A S S I F I C A T I O N

der all injuries which are reported from both unofficial and official sources. The informa- from official sources takes precedence over similar injuries reported by any other source. her words, do not list the same injury twice; supercede the interview data with official data e case of similar injuries. List all injuries by official medical sources first. Police ted injuries may be used, but only when no other source of injury information is available.

nore than ten (10) injuries sustained? ___ Unknown, ___ No, ___ Yes -- If more than ten nilar injuries were identified during the interview, from collection of official data, and other unofficial sources (excluding police), list those from the official records first, ex- ing that level of data before listing those from the interviewee or other sources.

.S.S. Body egion	O.I.C. Body Region	Aspect	Lesion	System/ Organ	A.I.S. Severity	Injury Source	Source of Data
__	__	__	__	__	__	__ __	__
__	__	__	__	__	__	__ __	__
__	__	__	__	__	__	__ __	__
__	__	__	__	__	__	__ __	__
__	__	__	__	__	__	__ __	__
__	__	__	__	__	__	__ __	__
__	__	__	__	__	__	__ __	__
__	__	__	__	__	__	__ __	__
__	__	__	__	__	__	__ __	__
__	__	__	__	__	__	__ __	__

Source of Data

Official
(1) Autopsy records with or without hospital/ medical records
(2) Hospital/medical records without autopsy records
(3) Treating physician

Unofficial
(4) Interviewee
(5) E.M.S. personnel
(6) Police
(7) Other source: ______________
(8) Not applicable
(9) Unknown

Reduction Section

. Body Region

ead or neck
ace
hest
bdominal or pelvic ontents
xtremities or pelvic irdle
eneral (external)
ot applicable
nknown

. Body Region

ead - skull
ace
eck - cervical spine
houlder
pper extremities (arm)
rm (upper)
lbow
orearm
rist - hand
hest
bdomen
ack - thoracolumbar spine
elvic - hip
ower extremities (leg)
high
nee
eg (lower)
nkle - foot
hole body
Injured, unknown region
Not applicable
Unknown if injured

Aspect of Injury

(R) Right
(L) Left
(B) Bilateral
(C) Central
(A) Anterior - front
(P) Posterior - back
(S) Superior - upper
(I) Inferior - lower
(W) Whole region
(U) Injured, unknown aspect
(8) Not applicable
(9) Unknown if injured

Lesion

(L) Laceration
(C) Contusion
(A) Abrasions
(F) Fractures
(P) Pain
(K) Concussion
(H) Hemorrhage
(V) Avulsion
(R) Rupture
(S) Sprains
(D) Dislocations
(N) Crushing
(M) Amputation
(B) Burn
(X) Asphyxia
(O) Other
(U) Injured, unknown lesion
(8) Not applicable
(9) Unknown if injured

System/Organ

(S) Skeletal
(V) Vertebrae
(J) Joints
(D) Digestive
(L) Liver
(N) Nervous system
(B) Brain
(C) Spinal cord
(E) Eyes - ears
(A) Arteries - veins
(H) Heart
(Q) Spleen
(G) Urogenital
(K) Kidneys
(R) Respiratory
(P) Pulmonary - lungs
(M) Muscles
(I) Integumentary
(W) All systems in region
(U) Injured, unknown system
(8) Not applicable
(9) Unknown if injured

Abbreviated Injury Scale

(1) Minor injury
(2) Moderate injury
(3) Severe injury
(4) Serious injury
(5) Critical injury
(6) Maximum (untreatable)
(7) Injured, unknown severity
(8) Not applicable
(9) Unknown if injured

Injury Source

FRONT
(01) Windshield
(02) Mirror
(03) Steering assembly, including transmission selector lever when column mounted
(04) Add-on equipment (e.g., CB, tape deck, air conditioner)
(05) Instrument panel and below, excluding foot controls and parking brake
(09) Other front object

SIDE
(11) Side interior surface, excluding hardware or armrests
(12) Side hardware or armrests
(13) Roof pillar supports
(14) Window glass or frame
(19) Other side object

INTERIOR
(21) Seat, back support
(22) Belt restraint system
(23) Head restraint
(24) Air cushion
(25) Other occupants
(26) Interior loose objects
(29) Other interior object

ROOF
(31) Front header
(32) Rear header
(33) Roof side rails
(34) Roof or convertible top

FLOOR
(41) Floor
(42) Floor or console mounted transmission lever, including console
(43) Parking brake handle
(44) Foot controls including parking brake

REAR
(51) Backlight (rear window)
(52) Backlight storage rack, door, etc.
(59) Other rear objects

EXTERIOR of NONMOTORIST'S VEHICLE
(61) Hood
(62) Outside hardware (e.g., outside mirror, antenna)
(63) Other exterior surface or tires
(69) Unknown exterior objects

EXTERIOR of OTHER MOTOR VEHI
(71) Bumper
(72) Hood edge
(73) Other front of vehicle
(74) Hood
(75) Hood ornament
(76) Windshield, roof rail, pillar
(77) Side surface
(78) Side mirrors
(79) Other side protrusions
(80) Rear surface
(81) Undercarriage

OTHER VEHICLE or OBJECT in t ENVIRONMENT
(86) Ground
(87) Other vehicle or object
(89) Unknown vehicle or obje

NONCONTACT INJURY
(90) Noncontact injury sourc (impact force)

(97) Injured, unknown source
(98) Not applicable
(99) Unknown if injured

OCCUPANT INJURY CLASSIFICATION

If there are six or less injuries listed in the O.I.C. reduction section, code all of the injuries ordered by Source of Data (1st-autopsy, 2nd-hospital/medical, 3rd-treating physician, o 4th-interviewee and other sources) and by A.I.S. severity within source.

If there are more than six injuries order the injuries by source and by A.I.S. severity within source. Code this ordering, injury by injury. If a group of ordered injuries has the same source, the same A.I.S., and the group includes at least the sixth and seventh injuries in the ordering, then a choice must be made as to which injury or injuries to code.

Choose the injury or injuries that will enable the maximum number of different I.S.S. body regions to be represented in the coded data. If no new I.S.S. body region can be added, then simply code in accordance with the original ordering.

If the pedestrian or nonmotorist has less than six injuries, then the number of rows required be completed is equal to the number of injuries plus one (e.g., no injuries requires one row i columns 36 to 43). In the additional row "not applicable" will be coded for all variables including A.I.S. severity. In essence, "not applicable" means "no injury".

Update Candidate: ◯ *Yes* ◯

	I.S.S. Body Region	O.I.C. Body Region	Aspect	Lesion	System/ Organ	A.I.S. Severity	Injury Source	Sour of D
1ST	__	21. __ (36)	22. __ (37)	23. __ (38)	24. __ (39)	25. __ (40)	26. __ __ (41 42)	27. __
2ND	__	28. __ (44)	29. __ (45)	30. __ (46)	31. __ (47)	32. __ (48)	33. __ __ (49 50)	34. __
3RD	__	35. __ (52)	36. __ (53)	37. __ (54)	38. __ (55)	39. __ (56)	40. __ __ (57 58)	41. __
4TH	__	42. __ (60)	43. __ (61)	44. __ (62)	45. __ (63)	46. __ (64)	47. __ __ (65 66)	48. __
5TH	__	49. __ (68)	50. __ (69)	51. __ (70)	52. __ (71)	53. __ (72)	54. __ __ (73 74)	55. __
6TH	__	56. __ (76)	57. __ (77)	58. __ (78)	59. __ (79)	60. __ (80)	61. __ __ (81 82)	62. __

· of the coded Injury Sources have "other"
 i.e. 09, 19, 29, 59, 63, or 87; describe
ijury source below in the space provided.
.y indicate each description by numerical

POLICE REPORT

Injury Severity (Police Rating)

) K - Killed
) A - Incapacitating injury
) B - Nonincapacitating injury
) C - Possible injury
) O - No injury
) Unknown

64. Traffic Violation Charged Against This Pedestrian or Nonmotorist

___(1) Yes: ____________
___(2) No
___(9) Unknown

65. Alcohol Involvement
(NOTE: A psychomotor test is not considered a test for the purposes of this question.)
___(1) No, test not given
___(2) No, test given
___(3) Yes, test not given
___(4) Yes, test given
___(9) Unknown

POLICE, HOSPITAL/MEDICAL, OR OTHER OFFICIAL

66. Measured Blood Alcohol Level

.____ % -- Code actual reported number representing fraction of alcohol present.
___(97) Not tested
___(99) Unknown

FMENTS:

ATTACH TO THIS FORM ANY SUPPORTING MEDICAL DOCUMENTATION FOR THIS PEDESTRIAN OR NONMOTORIST.

1/79

COMPLETED BY TEAM

Duplicate columns 1 through 8 from the first page of this form.

Card Number 1 (9)

Duplicate columns 10 and 11 from the first page of this form.

COMMENTS:

____

____

____

____

____

For responses to Manner and Result see back of page 7.

INTERVIEW CONTACT RECORD

Contact Sequence	Month	Day	Year	Time of Contact	Contacting Investigator	Manner	Result
1ST	12 13	14 15	7 9 (16 17)	18 19 20 21	22 23 24	25	26 27
2ND	28 29	30 31	7 9 (32 33)	34 35 36 37	38 39 40	41	42 43
3RD	44 45	46 47	7 9 (48 49)	50 51 52 53	54 55 56	57	58 59
4TH	60 61	62 63	7 9 (64 65)	66 67 68 69	70 71 72	73	74 75
GO TO 2 (9) 5TH	10 11	12 13	7 9 (14 15)	16 17 18 19	20 21 22	23	24 25
6TH	26 27	28 29	7 9 (30 31)	32 33 34 35	36 37 38	39	40 41
7TH	42 43	44 45	7 9 (46 47)	48 49 50 51	52 53 54	55	56 57
8TH	58 59	60 61	7 9 (62 63)	64 65 66 67	68 69 70	71	72 73
GO TO 3 (9) 9TH	10 11	12 13	7 9 (14 15)	16 17 18 19	23 21 22	23	24 25

Date decision was made not to further attempt to obtain a direct or surrogate interview regarding the general data elements (variables P08 through P20). ___ ___ ___ ___ 7 ___ (26 27 28 29 30 31)

Mark Appropriate Box

Deciding Person (Initials). ___ ___ ___ (32 33 34)

☐ (1) Official medical injury data received before first submission.

☐ (2) Official medical injury data inapplicable (no medically diagnosed treatment).

☐ (3) Official medical injury data applicable but not obtainable.

Reason: _______________

☐ (4) Official medical injury data requested but not received at time of case submission.

___ (35)

Date Occupant Injury Classification (O.I.C.), page 7, completed. ___ ___ ___ ___ 7 ___ (36 37 38 39 40 41)

Completing Person (Initials). NOTE: This task is applicable even if only 8s, 9s, 98s, or 99s are the codes used. ___ ___ ___ (42 43 44)

COMPLETED BY ZONE CENTER

NOTE: DUPLICATE COLUMNS 1 THROUGH 8 AND GO TO CARD: 4 (9)

- Not in error, not to be updated, and not missing
- 1-To be updated
- 2-Error (not correctable)
- 3-Error (correctable)
- 4-Questionable
- 5-Updated and corrected
- 6-Sequencing error in CDC's or injury data
- 7-Error incorrectly noted
- 8-Data entry in error
- 9-Unknown coded on field form

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	[illegible]	20	21	22	23	24
Response	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	[illegible]	29	30	31	32	33
Variable	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
Response	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58
Variable	51	52	53	54	55	56	57	58	59	50	61	62	63	64	65	66								
Response	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75								

APPENDIX C
RATE OF UNKNOWN VALUES FOR DELTA-V IN THE 1979 NASS ANALYSIS FILE

Concern over the apparently high rate of unknown values in the variable Total Delta-V in the 1979 NASS Analysis File has prompted further analysis of the problem. Table C-1 presents the frequency distribution of values of Delta-V for the 3902 passenger cars in the 1979 NASS file. The "known Delta-V" rate for unweighted vehicle counts is 76.4 percent corresponding to 2,983 vehicles. The weighted counts, which correspond to multiplication of each unweighted case by the National Inflation Factor, show 89.4 percent unknown. This is the statistic that was reported in our February Progress Report. For analysis purposes, the weighted count is the statistic of interest in that the projection to nationally representative data is accomplished by use of the weighting factor. Table C-1 implies a higher rate of missing or unknown Delta-V for those cases which constitute smaller samples of the stratum which they represent. This is confirmed by Table C-2 which shows a decreasing percent of known Delta-V as the magnitude of the National Inflation Factor is increased.

For quality control purposes, one will usually want to examine characteristics of the cases on an unweighted basis. Table C-3 presents rates of unknown Delta-V by levels of Police Accident Report Severity using unweighted counts. A high incidence of unknown Delta-V is associated with accidents of low severity, of which there is a large number. Secondarilly, there is a tendency to a somewhat lower rate of known Delta-V in fatal, presumably very severe, accidents.

One may restrict the examination of the data to only passenger vehicles or one may consider the situation for all vehicles in the file. Table C-4 tabulates the percent known Delta-V by vehicle body type for all 5,515 vehicles in the NASS file. The fraction of known Delta-V is in the range of 23 percent for passenger car types (NASS codes one through nine). This is consistent with Table C-1. As expected, Dalta-V is not cojputed for most other vehicle types. A puzzling feature is that Pickups, Vans, Truck Based Station Wagons show known Delta-V rates comparable to those for passenger cars. This is not expected since the CRASH2 computer algorithm, unless it has been recently modified, does not admit light trucks and vans as applicable vehicles.

Tables C-5, C-6 and C-7 show that unknown Delta-V is associated in part with unknown data regarding vehicle damage. Then the CDC code is known, Delta-V is complete at a rate of about 40 percent. Unfortunately, the CDC codes are unknown for 2,864 or 52 percent of the cases. It may be noted that vehicle damage is not defined for certain vehicle types such as medium and large trucks. It is also the case that CRASH2 cannot compute Delta-V for either vehicle in a two car impact if vehicle damage is known for only one of the two cars. Therefore, it may be helpful for some purposes to tabulate rates of unknown Delta-V by accidents rather than by vehicles. This may result in certain differences in the results quoted. Such tabulations are not provided here.

Other notable findings in Tables C-5, C-6, and C-7 are that Delta-V is evidently harder to determine for Damage Extent One and Damage Extent greater than five. These correspond to minor impacts and to very severe impacts. There may be some problems in examining vehicles receiving minor damage since the car will have left the scene. Severely damaged vehicles may be so distorted by the impact that it is difficult to ascertain meaningful damage profiles. Numerically, the Damage Extent One vehicles account for a larger fraction of cases than do severely damaged vehicles, but severely damaged vehicles may be the ones mostly associated wilth fatalities. Side impacts were evidently more difficult to evaluate than front and rear impacts. This is characteristic of the CRASH2 methodology. Crashes involving top damage (usually rollover) are, of course, not amenable to calculation of Delta-V. These are a significant but not dominant fraction of the cases, amounting to 147 of the 2,651 vehicles for which CDC Horizontal Location is known.

Table C-8 indicates the interesting fact that PSU Number 9 has a very low rate of completion of Delta-V at 3 percent known. The other PSU's range from 15.6 percent to 29.2 percent known Delta-V.

TABLE C-1. FREQUENCY DISTRIBUTION OF TOTAL DELTA-V FOR PASSENGER CARS IN THE 19791 NASS FILE

Delta-V (mph)	Unweighted Cases	Weighted Cases
0 to 10	184	290,317
10 to 20	348	425,560
20 to 30	222	221,380
30 to 40	81	72,168
40 to 50	44	28,665
50 to 60	16	10,957
60 to 70	10	4,106
70 to 80	7	4,130
80 to 90	3	2,905
90 to 100	1	235
100 to 110	2	1,120
110 to 120	0	0
120 to 130	0	0
130 to 140	1	196
Unknown	2,983	8,932,810
Total	3,902	9,994,547
Percent Known	23.6%	10.6%

TABLE C-2. PERCENT KNOWN VALUE OF DELTA-VIN THE 1979 NASS FILE PASSENGER CAR VEHICLE RECORDS BY CATEGORIES OF NATIONAL INFLATION FACTOR

NIF	Total Cases	Percent Known Delta-V
0 to 100	28	7.1
100 to 200	91	36.3
200 to 300	293	34.1
300 to 400	220	34.1
400 to 500	250	36.0
500 to 600	217	31.3
600 to 700	172	23.8
700 to 800	178	24.2
800 to 900	135	33.3
900 to 1,000	141	26.2
1,000 to 1,200	232	28.4
1,200 to 1,400	178	27.0
1,400 to 1,600	170	23.5
1,600 to 1,800	136	32.4
1,800 to 2,000	126	25.4
2,000 to 3,000	437	24.5
3,000 to 4,000	217	12.9
4,000 to 5,000	140	7.9
5,000 to 6,000	106	4.7
6,000 to 7,000	74	2.7
7,000 to 8,000	75	2.7
8,000 to 9,000	50	0.0
9,000 to 10,000	62	0.0
10,000 to 00	174	0.0
Total/Mean	3,902	23.6

TABLE C-3. PERCENT KNOWN VALUE OF DELTA-V IN THE 1979 NASS FILE PASSENGER CAR VEHICLE RECORDS BY CATEGORIES OF POLICE ACCIDENT REPORT SEVERITY

PAR Severity	Total Cases	Percent Known Delta-V
Killed	97	30.9
A	928	36.3
B	573	32.6
C	545	26.8
O	1,722	12.7
Unknown	37	0.0
Total/Mean	3,902	23.6

TABLE C-4. PERCENT KNOWN VALUE OF DELTA-V IN THE 1979 NASS FILE VEHICLE RECORDS BY CATEGORIES OF VEHICLE BODY TYPE

Vehicle Body Type	Total Cases	Percent Known Delta-V
2-Door	2,211	23.6
4-Door	1,112	25.6
Station Wagon	318	23.6
Convertible	55	20.0
Off-Road Vehicle	71	22.5
Pickup Body Automobile	35	31.4
Unknown Type Automobile	100	0.0
Pickup Truck	659	24.4
Van	208	15.4
Truck-based Station Wagon	14	21.4
Single Unit Truck 1	49	0.0
Single Unit Truck 2	34	0.0
Single Unit Truck 3	38	0.0
Single Unit Truck Unknown GVW	7	0.0
Two Unit Truck	182	0.0
Multi Unit Truck	2	0.0
Truck Tractor	10	0.0
Unknown Type Truck	23	0.0
School Bus	8	12.5
Intercity Bus	2	0.0
Urban Bus	11	0.0
Other Bus	2	0.0
Unknown Type Bus	1	0.0
Motorcycle	226	0.0
Moped	17	0.0
Other Motorbike	3	0.0
Unknown Type Motorcycle	17	0.0
Snowmobile	51	0.0
Farm Vehicle	2	0.0
Construction Equipment	2	0.0
Ambulance	8	25.0
Camper	4	0.0
Fire Truck	2	0.0
Unknown	81	0.0
Total/Mean	5,515	23.6

TABLE C-5. PERCENT KNOWN VALUE OF DELTA1-V IN THE 1979 NASS FILE VEHICLE RECORDS BY CATEGORIES OF CDC DAMAGE EXTENT

Damage Extent	Total Cases	Percent Known Delta-V
1	1,006	37.0
2	773	49.4
3	539	46.2
4	131	38.2
5	74	46.0
6	54	29.1
7	26	30.8
8	13	30.8
9	35	8.6
98	1,905	0.1
99	959	0.1
Total/Mean	5,515	23.6

TABLE C-6. PERCENT KNOWN VALUE OF DELTA-V IN THE 1979 NASS FILE VEHICLE RECORDS BY CATEGORIES OF CDC HORIZONTAL LOCATION

Horizontal Location	Total Cases	Percent Known Delta-V
Front	1,469	49.4
Right	346	35.8
Left	389	36.3
Back	266	46.6
Top	147	0.7
Undercarriage	34	0.0
8	1,905	0.1
9	959	0.1
Total/Mean	5,515	23.6

TABLE C-7. PERCENT KNOWN VALUE OF DELTA-V IN THE 1979 NASS FILE VEHICLE RECORDS BY CATEGORIES OF CDC DIRECTIONS OF IMPACT FORCE

Direction of Impact Force	Total Cases	Percent Known Delta-V
0	210	0.5
1	254	48.4
2	190	48.4
3	55	30.9
4	18	38.9
5	31	45.2
6	251	41.4
7	34	41.2
8	39	33.3
9	54	48.2
10	177	49.2
11	286	48.6
12	1,052	45.4
98	1,905	0.1
99	959	0.1
Total/Mean	5,515	23.6

TABLE 8. PERCENT KNOWN VALUE OF DELTA-V IN THE 1979 NASS FILE VEHICLE RECORDS BY CATEGORIES OF PSU NUMBER

PSU Number	Total Cases	Percent Known Delta-V
1	610	15.6
2	570	24.4
3	566	23.5
4	593	20.7
5	544	28.7
6	576	20.0
7	545	19.1
8	473	20.7
9	565	3.0
10	473	29.2
Total/Mean	5,515	23.6

APPENDIX D
ADJUSTMENTS MADE TO THE 1979 NORTH CAROLINA DATA TO MAKE IT NATIONALLY REPRESENTATIVE

A significant priority in the evaluation of radar activated brake systems is the use of accident data which is representative of national experience. A previous report has documented significant differences between the State of North Carolina Accident data and national data provided by the 1979 NASS file.* Major differences exist between the state and national data regarding speed limits, rural-urban balance, and fatality rate per vehicle mile travelled. North Carolina shows higher speeds, more rural accidents, and a higher fatality rate per vehicle mile travelled than the national data show.

This paper documents a simple adjustment to a subset of the 1979 North Carolina data which brings the distribution of speed limits into line with national data. The subset used contains the first 10,000 vehicles from the overall 1979 North Carolina data file. Table D-1 is a comparison of the speed limit frequency distribution for this data and for passenger cars in the 1979 NASS file. Cases where speed limit is unknown have been ignored. These data are shown graphically in Figure D-1.

The adjustment was performed by statistically weighting each of the 10,000 vehicle involvements in the sample file. The weight factor for a particular speed limit range is:

$$WT = \frac{\text{NASS Percent}}{\text{NC Percent}}$$

*"Implementation and Preliminary Analysis of 1979 State of North Carolina Accident Data...," Kinetic Research, Goleta, California, Report Number KR-TR-103, March 1981.

TABLE D-1. SPEED LIMITS IN NORTH CAROLINA AND NASS PERCENT DISTRIBUTION*

Speed Limit	Percent Frequency North Carolina	Percent Frequency NASS
10 to 15	2.12	0.7
20 to 25	7.20	16.4
30 to 35	40.13	50.5
40 to 45	18.03	12.8
50 to 55	32.50	19.6

*These data are shown graphically in Figure D-1.

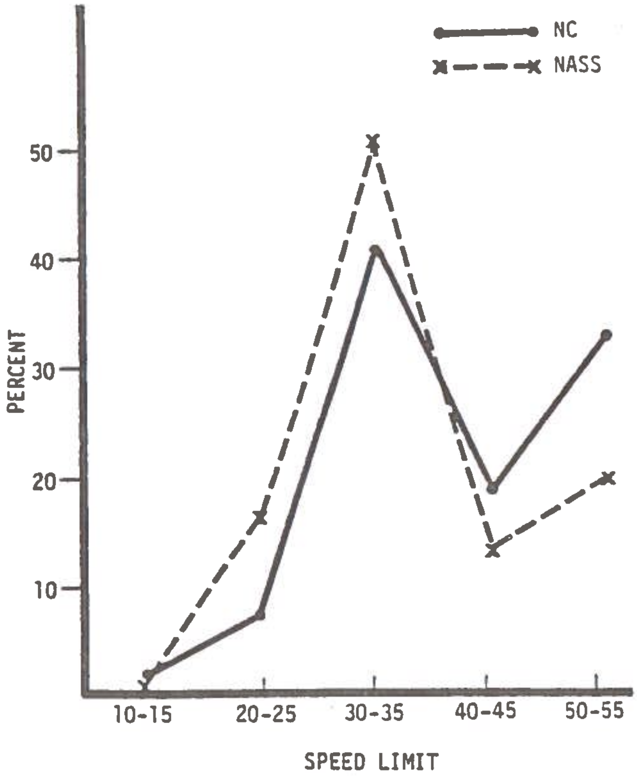


FIGURE D-1. DISTRIBUTION OF INVOLVED VEHICLE SPEED LIMITS IN NORTH CAROLINA AND NASS 1979 ACCIDENTS

If Speed Limit was unknown, the weight factor became zero. This resulted in the elimination of 1,338 cases. Consequently the weight factor was multiplied by the factor:

$$F = 10{,}000/8{,}662$$

to result in a total weighted count of 10,000 cases. This was for arithmetic convenience.

In order to examine the effect of the case weighting, the statistic fatalities per accident involved vehicle were examined in the original North Carolina data, in the modified file, and in the NASS file for one and two vehicle accidents. The results are given in Table D-2.

It can be seen that the adjustment for speed limit brings the fatality involvement rate very nearly into line with national experience, at least for the subset of cases considered.

Other variables may be similarly compared. Table D-3 shows the urban-rural balance for NASS and the adjusted and unadjusted North Carolina files. These data are tabulated by vehicle involvements in one- and two-car accidents.

If the "Mixed" category is proportionately distributed among rural and urban, the adjusted North Carolina results become:

Urban	75.11
Rural	24.40

This is quite close to the NASS result. In any case, the adjustment produces considerable improvement in the rural-urban balance.

Table D-4 compares data for road surface condition. In this case, the file adjustment does not produce significant change in the distribution of the values of road surface condition. The elimination of cases with unknown speed limit also results in elimination of cases with unknown surface condition.

TABLE D-2. FATALITIES PER ACCIDENT INVOLVED VEHICLE (ONE- AND TWO-CAR ACCIDENTS)

File	Fatalities per Accident Involved Vehicle (One- and Two-Car Accidents)
NASS	0.00323
North Carolina	
Original	0.00510
Original less cases with unknown speed limit	0.00485
Adjusted	0.00347

TABLE D-3. LOCALITY IN NASS AND NORTH CAROLINA VEHICLE INVOLVEMENT

Locality	North Carolina (Original)	North Carolina (Original Less unknown speed limit)	North Carolina (Adjusted)	NASS
Urban	46.09	49.68	60.12	72.71
Rural	25.65	28.86	19.53	27.29
Mixed	19.21	25.02	19.86	-
Unknown	9.05	0.44	0.52	0.00

TABLE D-4. ROAD SURFACE CONDITION IN NASS AND NORTH CAROLINA VEHICLE INVOLVEMENTS

Locality	North Carolina (original)	North Carolina (original less unknown speed limit)	North Carolina (Adjusted)	NASS
Dry	49.77	54.55	56.49	67.88
Wet	28.54	31.18	30.78	19.92
Snow	1.25	1.28	1.06	2.58
Ice	9.07	9.97	8.73	8.67
Other	2.56	2.94	2.89	-
Unknown	8.81	0.07	0.07	0.75

These results are gratifying with regard to the degree that the fatality experience in North Carolina is reconciled with national experience by a simple adjustment. The suggestion is that speed limits, and associated travel speeds and accident severities, are the major determinants of fatality experience, or at least of differences in fatality experience between North Carolina and NASS. Urban - rural balance is closely correlated with the speed data. Road surface condition is evidently not correlated with speed limit, nor would one expect that it would be.

It will be helpful to pursue adjustment with regard to other variables, such as surface condition, to verify that fatality experience remains in good agreement. It may also be useful to make comparisons for all injury levels. This will require a correlation of AIS scales (as used in NASS) with Police Injury Scales (KABCO as used in North Carolina). Data is available which provides a distribution over AIS for each police code and vice-versa. However, it is recommended that the police coding of injuries be included in the NASS files to aid in such analyses. Naturally, the best thing is to verify that an adjusted North Carolina file would provide a nationally representative Vrel distribution. This cannot be tested, however, since NASS is highly incomplete in accident closing speed data (specifically Delta-V). Given similar numbers of each vehicle type in both files, it must be assumed that similar travelling speeds (or speed limits as a surrogate) will produce similar accident severities. This conclusion is supported by the coincidence of fatality data achieved by adjustment of the North Carolina file.

APPENDIX E

TRIP REPORTS

Dr. Grimes' Report
on His Trip to Japan

THE PENNSYLVANIA STATE UNIVERSITY
121 ELECTRICAL ENGINEERING EAST BUILDING
UNIVERSITY PARK, PENNSYLVANIA 16802

June 11, 1981

Department of Electrical Engineering
Dale M. Grimes, Head

Area Code 814
865-7667

Dr. Anil V. Khadilikar
Minicars, Inc.
55 Depot Road
Goleta, CA 93017

Dear Anil:

The following is a report on my recent trip to Japan and Goleta.

I arrived in Tokyo about dinner time on Monday, April 27, 1981, Japanese time. After clearing customs, I took a limousine to a Tokyo railroad station and, from there, a taxi to Hotel Okura where I stayed two nights.

Upon arrival, I had a message to call Mr. Yoichi Kaneko of Hatachi, whom I had met a few years ago at an SAE Conference in Detroit. He is first author on "Doppler Radaŕ Skid Control Device Enhances Auto Safety," JEE, January 1978, pp. 54-57. That development was a joint one of Hitachi and Nissan (Mr. Fukumori). I didn't learn a lot I didn't already know except they are still pursuing the speedometer, and thinking of higher frequencies. They are looking at potential tractor and airplane markets as well as electric braking. Hitachi is also working at a low level with the Nissan-Mitsubishi combination on their microprocessor logic and programming. We had dinner together at the Okura, Tel. 0423-23-1111.

Earlier in the day, I telephoned Mr. Makino of Toyota to inquire about the radar that Nissan had reported that Toyota will report on in London (0565-28-2121). Since Makino's English is poor and my Japanese non-existent, we talked through a Mr. Onoda who works for Makino in the patent department. They would not permit me to visit nor would they answer any technical questions. Nonetheless they did at least confirm some activity. The paper is to be given. They promised to mail me a pre-edition of the paper as soon as it cleared the corporation, without waiting for the conference. Upon my return to Pennsylvania, the copy had already arrived. Attached is a photostatic copy of the introduction. Unfortunately, though understandably, they ask... "please keep the contents of this paper confidential until October 20, this year." I believe their request to be very reasonable in that they wish to announce their own new product. Nonetheless if you, Dr. Wu and I could work out some way to keep any analysis confidential until October 20, it would appear to me that we could still use their information. Incidentally, neither of the Toyota authors has his name on any of the Toyota patents in our files here at The Pennsylvania State University.

Wednesday, April 29, 1981, being a national holiday, I traveled by train and cab to Yokohama, where I checked into the Yokohama Hotel. It is a new and delightful hotel, only a strip park separates it from the bay. I recommend it highly to anyone traveling that way. I spent Thursday, April 30, 1981, at the Nissan Central Research Laboratories. The Nissan people could hardly have been more open or more gracious. A copy of the agenda accompanies. I was picked up at 0900 by Mr. Mizote, who was with Hirota in London during the Fall 1979 IEE Meeting. We drove to the Nissan Central Research Labs. The laboratories are under the direction of Mr. Watanabe whom I met in Hamburg during June 1979. He was to join us, but was called to the downtown Tokyo headquarters. The meeting was attended by the persons listed on the accompanying sheet and also by Mssrs. Fujiki and Matsumura. I was later to learn that the latter two were the only electrical engineers present, all others being mechanical ones.

Although the entire group knew some English, only Saito was fluent, Kiyoto and Fujichi were better at it than the others. Conversation was strongly influenced by the language barrier. I previously sent you a descriptive folder.

The laboratories employ about 400 engineers, 70% of which are mechanical engineers. Mr. Baba supervises the affected groups, totalling about 30 engineers. In addition to radar, they have constructed a 60 GHz communication system. The auto portion has a Gunn inside a tuned cavity with a flared horn pointing straight up. The communicant hangs overhead, suspended from poles. The EMI studies are based on SAE standards and are measured with a log periodic array of linear elements, over a frequency range of 70-1000 MHz. Pictures of these are on p. 12 of the descriptive folder.

Figures quoted for the chamber are:

22 x 16 x 8 meters

outside isolation,	-80 db 500 kHz - 1 GHz
reflection loss	15 db at 70 MHz
	20 db at 100 MHz
	30 db at 300 MHz
	40 db at 1000 MHz

It must have cost them a mint!

Since Nissan's system is basically pulsed Doppler, while SEL and Toyota have FM-CW, they were very interested in my version of how the two systems would compare.

The antenna is a horn-fed parabolic reflector located directly in front of the radiator; attached are two photographs of it (1), (2). You will observe it is oriented at approximately 45° from the vertical and striated, rather than solid, to permit airflow through into the automotive cooling system. The entire RF system is located just below the base at the lower left. Processing electronics on this trial unit is located in the trunk (3) and are in the two flat boxes at the bottom of the photograph.

During all tests an A scope was connected which gave me access to all target data, though the microprocessor itself was range gated. From it I observed that signal fade from ground bounce was not a problem, as theory says it shouldn't be under these circumstances. Although the lead edge of the transmitted pulse was sharp enough, the return was not. This could be a problem as more accurate range and range rate data is demanded. You have already received their antenna patterns.

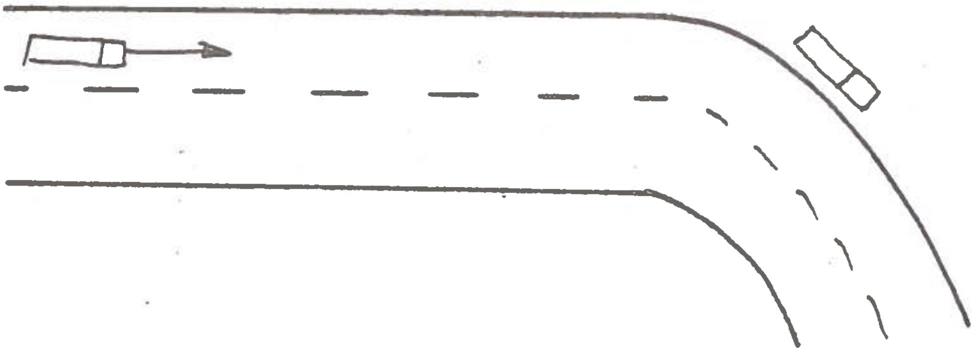
In common with our experience on the Bendix cars here in State College, the VDO car in London, and the SEL car in Stuttgart, most false alarms came when our driver deliberately closed on the car ahead. The usual algorithms are more restrictive than many drivers in leaving space between vehicles. Perhaps a term including acceleration should be added, for example, in the Nissan case, their algorithm is

$$R = S[V_n(2V_a - V_n)/2\alpha].$$

which might be modified to an expression such as

$$R = S[V_n(2V_a - V_n - k\dot{V}_n)/2\alpha]$$

We traveled over some 6 km of city streets where the roadway clutter was about as bad as it gets. Photos (4) and (5) show some of the obstruction encountered. Photos (6) through (10) show scenes we encountered driving the expressway portion of the trip, some 15 km. Note that we encountered metallic walls, a tunnel, curves and simply a lot of traffic. We encountered one false alarm on the trip that was not of the nature described above — the details are shown on the sketch. I see no way false alarms of this sort can be avoided.



Following the roadway tests, we put up the cylindrical, aluminum - coated targets shown in photos (11) and (12). In each photo it lines up with the edge of the car and is in front of the steel fence. The positions are just where the targets dissappear from the A scope. We had to use this area since the proving ground was occupied by new model vehicles.

Later during discussions, Baba mentioned that the Japanese government (MITI) promised $1.5M to assist the development of radar brakes. That started Nissan and Mitsubishi, with some aid from Hitachi, and he presumes this was instrumental with Toyota and Fujitsu. Later it developed more like $0.15M was actually made available. They have only the one unit and are at a point of decision. They are unsure what, or on what basis any go - no go, decision will be made. However, if they do proceed they will move up in frequency, consolidate the electronics, and move it inside the passenger compartment. Yet when they asked me what I thought should be done, they said that their analysis agreed with mine. We know they are using 60 GHz for communication, though I saw no evidence of MIC work. They seemed very anxious to learn about other work in various places around the world.

Yours very truly,

DMGrimes

DMG:kgp

Enclosures

cc: Y. K. Wu

AUTOMOTIVE RADAR USING MM WAVE

T. Takehana*, Y. Isogai*, T. Sakamoto*, T. Ochiai** and T. Nogami**

* Fujitsu Ten Limited, Japan

** Toyota Motor Co., Ltd., Japan

1. Introduction

A few years ago, a big accident of cars occurred in the tunnel (near Mt. Fuji) of the expressway connecting the megalopolises on the Pacific coast in Japan, causing a fire and heavy casualties, and furthermore more than one hundred cars were burnt down.
Then expressway was completely blocked over six months.

In order to avoid such a collision, a kind of ACAS (Automatic Collision Avoidance System) is thought to be effective.

As a result of various investigations and research[1)3)4)], it is reported that the consumer's price, if less than $1,000, could achieve satisfactory cost to benefit.

Nearly ten years have passed now since the start of research and developments of these systems, however, the practical one has not come out yet.

We presume main reasons for it are to be due to the difficulties to realize the secure operations of ACAS in complicated road geometrics and traffic flows, cost, frequency allocations and radiation hazard.

We have been developing 50GHz radar system for about seven years in view of the feasibility of sharp beams effective in reducing malfunctions, the size that the system can be easily installed in a compact car, reasonable cost and manufacturing technology.

Among ACAS radars being reported, the highest frequency is 35 GHz[2)] used by VDO Adolf Schindling AG. We, however, consider the optimum frequency to be 50 to 60 GHz to make the system more compact.

Our radar model here is so designed as to construct the transmitter and receiver antennas in the shape of the letter V, RF circuit and amplifier are installed at the base of them, then, featuring a simple construction and easy to mass-product.

By this model, performance degradation due to the weather conditions, such as rain, snow, etc., detection probability and false alarms at expressway driving under overcongested conditions in Japan are tested, and their findings are thought to be the level of practical use.

Dr. Carpenters' Report
on His Trip to West Germany

TRIP REPORT

Lynn Carpenter

On May 20, 1981 I drove to Schwalbach (TS) to visit VDO Adolf Schindling AG. There I met Heinz Allerdist, and his supervisor Günter Halgauss and also Helmut Angermüller who helped with English translations. We talked for several hours and viewed the video tapes three times. The video tape demonstrates three cases: 1) constant distance and speed, 2) changing distance and speed, and 3) changing lanes on the autobahn. The safety distance is computed by the equation

$$S_s = v \cdot t_R + \frac{v^2}{2b_1} + \frac{(v - v_D)^2}{2b_2} \quad (1)$$

where v = vehicle velocity

t_R = driver reaction time - from 0.8 to 12. sec., approx. 1.0 sec.

v_D = relative velocity of target

b_1 = breaking deceleration of driver vehicle $-7\ m/sec^2$ for dry condition

b_2 = breaking deceleration of target vehicle -9 m/sec for dry condition

The parameters for the video tape were $t_R = 1$ sec., $b_1 = 7\ m/sec^2$ and $b_2 = 9\ m/sec^2$. The audio alarm sounds when the radar determined distance is less than the safety distance. The parameters can be varied but the best values according to Mr. Allerdist is $t_R = 1$ sec., $b_1 = 7\ m/sec^2$ and $b_2 = 7\ m/sec^2$. We planned to take a ride in the VDO vehicle but it was not operating at the time we planned to drive it and so it was agreed to come back on Wednesday, May 21, for the test drive.

On Wednesday, May 21, Mr. Allerdist and Mr. Angermüller, along with a test driver went with me for about 2½ hours to drive a Mercedes equipped with the VDO radar. We drove through downtown Frankfurt, on the autobahn around Frankfurt and through the countryside around Schwalbach.

An analog display showed the target distance and relative velocity. In addition, the VDO Radar Display showed the difference between the target distance and the safety distance calculated by the μP and a visual degree of warning display for the driver evaluation. The radar picked up targets quite satisfactory and did a reasonable job avoiding false alarms. However, we did have several false alarms from guardrails and signs. It also generated an alarm when changing lanes close behind another vehicle when no danger was apparent. Mr. Allerdist indicated that the sensitivity was higher than usual due to the repair of the logarithmic amplifier from the previous day.

I was satisfied that VDO has a viable system of warning drivers of obsticles ahead. They have the philosophy that the radar should aid the driver as a warning device and do not believe it should be used to activate the brakes. Their strategy is to look ahead 120 m to complement the driver's skill. I think they have succeeded in this objective. However, the cost of about $1000 or approximately 2,000 Deutsche Marks appears too high for the apparent benefit of the warning radar. VDO has stopped development of the automotive radar for this reason. They have spent more than one million Deutsche Marks of the company money but do not believe the system could be marketed successfully within the next five years.

The antenna is parabolic with a tapered horn feed that comes from the side, out to the center and then projects back onto the parabolic surface. The waveguide appears to be b = 1.5 a and the tape extends out about a factor of two. In addition, a metalic shield extends from the edge of the parabolic tapered into the feed in order to direct the beam toward the center at close (about 30 m) distances. The signal threshhold is set at a constant level up to 30 m and then

diminishes as R^2 until 90 m after vehicle is maintained at a constant level out to 120 m. An accelerometer determines if car is moving laterally and reduces the range on turns.

On Friday, May 22, 1981, I visited the Institute fur Verkehrswesen at the University of Karlsruhe. Dr. Wilhelm Leutzbach was out of town, but I was able to spend about six hours with his assistant, Dr. Claus D. Jahnke. Dr. Jahnke is just finishing his thesis work on analysis of the radar warning system and was quite familiar with the details of the study. In addition, he showed me a study from December, 1975 for the German Ministry of Research and Technology that might be loosely translated, "Traffic Considerations and Suppositions for Developing a Warning Radar." This report was done by Professor Dr. -Ing W. Leutzbech and Professor Dr. -Ing G. Steierwald with assistance from Dr. Ing. U. Köhler and Dr. Ing. H. Zackor. This study is in German but I will spend considerable spare time here describing my understanding.

One aspect of this report is a cost-benefit analysis that attempts to assess what would be a reasonable price for the radar warning systems. It estimates the cost of traffic accidents in West Germany for 1975 (converted to U.S. money by dividing Deutsche Marks by 2):

$\$150 \times 10^6$	Cost of People Killed
57×10^6	Major Injury to People
3×10^6	Minor Injury to People
$\$210 \times 10^6$	Cost of Personal Injury

Some percentage reduction in accidents would produce a dollar reduction of personal injury. For example, if the number collisions were reduced by 10%, a cost saving of 21 million dollars would result. The authors of the report were not able to say what percentage cost is due to rear-end collisions, those thought to be most likely reduced with the implementation of automotive warning radar. A reduction of 5 to 10% of all accidents is thought to be the range of the effect of a warning radar system. It should be pointed out that these costs are for 1975 which could be doubled to bring the figure to today's cost considering devaluation of inflation.

In Figure 1 are shown three cases of potential savings due to reduction of percentage of accidents. The three cases are a) Autobahn only, b) Country roads including autobahn, and c) all driving roads. The largest cost savings for the same percentage reduction occurs for c) all driving roads because this encompasses the largest number of accidents. Similarly, the largest cost savings occurs with a lifetime of ten years rather than three or five years because the radar warning devices last for a longer period of time.

The investment cost was then considered for installing the radar systems on a driving population of 20 million vehicles in Germany over a system lifetime of n years where 3, 5 and 10 years were considered. This calculation allowed an equivalent investment cost savings to be determined as a function of percentage reduction of accidents. A translated dollar equivalent investment cost savings is shown by dividing Deutsche Marks by 2.

It is thought that the autobahn driving conditions provide the most likely area where reduction is probable, and this has the lowest investment cost savings. The total driving condition offers the greatest savings but because of system design, it is not thought that the radar warning system would be as effective in reducing collisions in overall driving conditions. However, an initial investment cost of $35 for each warning unit would represent the average savings in accidents avoided over its lifetime. This cost savings of $35 is much less than a minimum price for the radar units that is thought to be $500. This study provides a rather pessimistic attitude toward the cost effectiveness of the automotive warning radar systems.

On Friday afternoon, I met also Professor Wiedermann who is mainly interested in simulations and traffic flow. However, he had driven the radar safety automobiles and expressed the position that I heard throughout Germany, i.e., the radar systems could never be used with automotive braking. German drivers and highways are

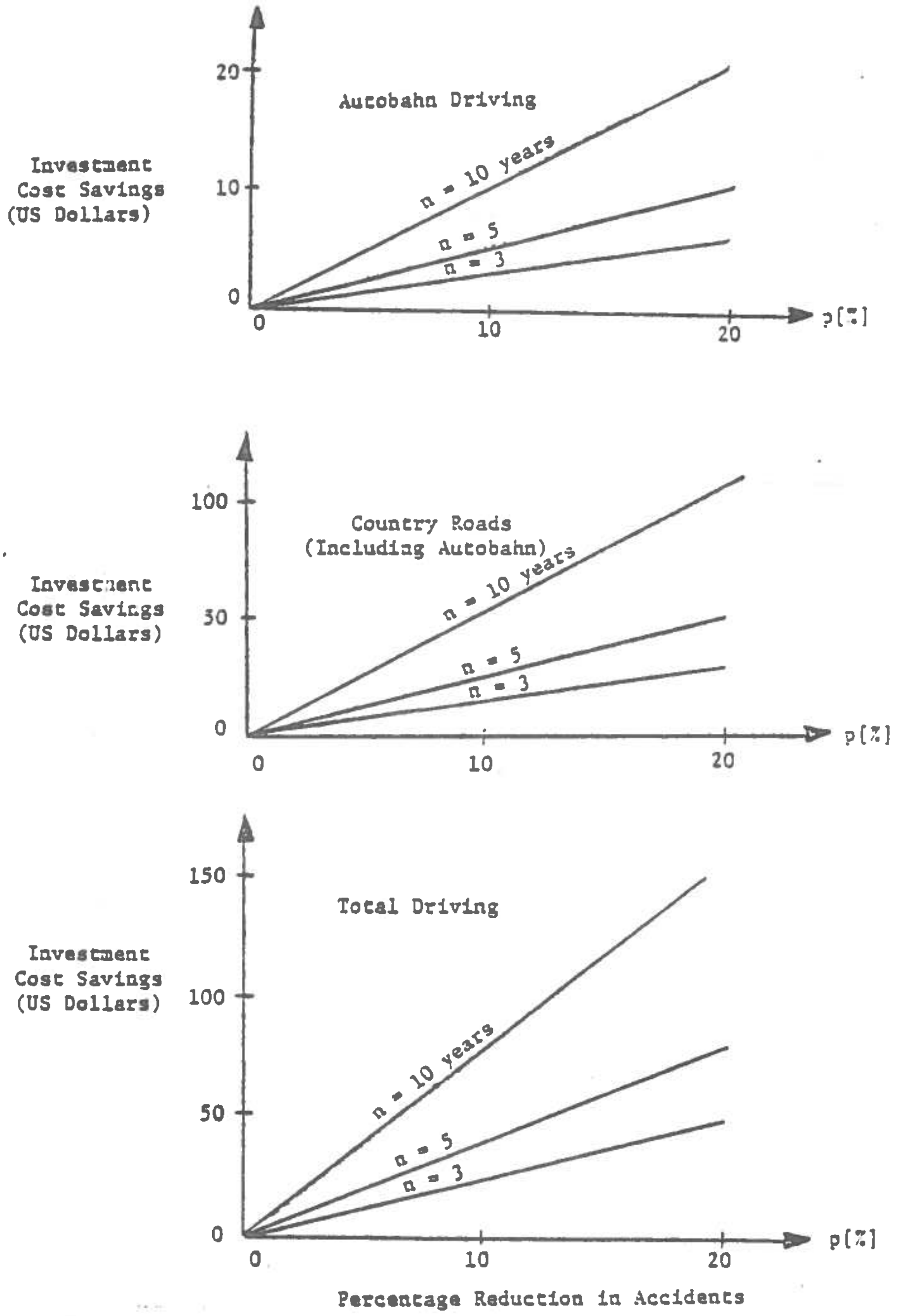


FIGURE 1. Investment Cost Saving vs. Percentage Reduction in Accidents for three driving conditions (a) Autobahn only (b) Contry Roads including Autobahn and (c) all Driving Roads.

somewhat different than U.S. ones. There is a fierce independence maintained about individual driving. There are no speed limits on the autobahn and considerable variation in speed exists. The right lane traffic moves at 50-60 mph and the passing lane moves at 80-90 mph. Thus, the relative speed of different vehicles on the autobahn is 10-40 mph and the purpose of the radar safety systems is to aid the driver judging safe distance and relative speed.

Dr. Jahnke explained the radar collision avoidance evaluation studies as consisting of three areas:

(1) Investigation of effect of safety radar on car following strategies,

(2) Evaluation of alarm occurance by observer in with driver,

(3) Analysis of questionaires on opinions of company drivers.

These will be discussed in detail from my visit with Dr. C. Jahnke, Dr. H. Zackor, Dr. G. Steierwald, Dr. Wiedermann and Dr. J. Schönharting. Although this data has been analyzed and prepared for publication, the results and conclusions have not been completed so they were not willing to provide copies of the data used in this report. However, they were willing to discuss it with me and they will provide a copy of the report as soon as it is published.

1. Investigation of Effect of Safety Radar on Car Following Strategy

Strings or sequences of vehicles (7 to 10) are driven together with the lead vehicle carrying out a predetermined variation in speed between 30 and 90 km/hr. The cars following in the platoon are then examined in terms of speed and distance from the car ahead. Four strategies are considered to examine how the following autos are described by model calculations. The usual following model is described in a paper by Gazis, D.C., Herman, R. and R. B. Potts, entitled, "Car-Following Theory of Steady-State Traffic Flow" in Operation Research 7(4), 1959. Dr. Jahnke is trying to determine what affect the collision avoidance radar has on the following behavior. In particular, he is examining the "stability" which measures whether subsequent autos in the chain of the platoon are tending to remain separate or not. The deceleration b(t) can be expressed as a function of time by

$$b(t) = \frac{\lambda\, v^{M}(t)}{[\Delta x(t - \tau)]^{L}} \quad \Delta v(t - \tau)$$

where τ = the time from the change in lead car position.

λ = proportionality factor.

Δv = change in speed of the following car.

Δx = change in distance of separation of the following car.

M and L are parameters to fit the response.

The values of b range from 0.5 to 0.8 m/sec^2 and the following behavior is stable when b < 0.5 m/sec^2. The best stability occurs when the parameters in the safety distance equation are τ = 1.2 sec. reaction time and b_2 = 5, the deceleration of the radar equipped vehicle.

2. Evaluation of Alarm Occurance by Observer in Auto with Driver

On five types of roadways (i.e. 2 autobahn, 2 country roads and also city streets) observers were present in the automobile to record the occurance of radar alarms. About 3,000 incidents were recorded and documented. The normal occurance of alarms were found at a rate between 1 and 1.8 alarm warning per km as shown in Figure 2. One autobahn (A-5) was chosen for its straightness and the other (A-8) for the curves. Similarly on the country road, one was relatively straight (B-35) and the other (B-463) had many curves. The graph shown in Figure 2 show the relative number of warning alarms in different situations.

It is seen in Figure 2 that the Appropriate Warnings were broken down into three categories:

(1) Standard straight ahead driving up too close to the target detected by the radar.

(2) Changing lanes by the radar vehicle during driving and detecting a target vehicle too close.

(3) Another car changing lanes into the path of the radar vehicle.

The False Warnings have two categories:

(1) Detecting another target in neighboring lanes because the beam width was too wide.

(2) Surrounding targets along the roadway that are detected by the radar.

The last category represents warnings that could not be identified with any particular targets.

The most frequent type of alarm is during straight-ahead driving where the driver of the radar equipped automobile comes up too fast on a vehicle ahead of it.

Except for winding country roads (B-463), the false warnings due to changing lanes is nearly comparable to that of surrounding targets. The both account for a significant number of false warning alarms of about 0.5 warnings/hr. Thus, the sum of false warnings has a frequency of about one false warning per km. This is viewed by the authors of that report as an unacceptability high false warning frequency; particularly compared to an appropriate warning frequency of about two warnings/km.

3. Analysis of Questionaires on Opinions of Company Drivers

This aspect of the study used about 3000 sample questionaires of company drivers for SEL, Bosch and VDO. Since each company has developed a somewhat different radar warning system, a direct comparison between companies cannot be made. However, several indications were brought out in this data. VDO systems had more alarms occur during the course of the driving studies. The SEL system, which has a builtin 0.1 to 0.3 sec integration time in which the target signal must be present for an alarm to occur, had the least number of alarms. My experience in driving these vehicles was that the FM/CW system developed by SEL had sophisticated signal processing and was able to reduce greatly the number of false warnings because of this condition. The Bosch-Telefunken System had a similar delay time of 0.2 to 0.4 sec. The signal processing insisted that the target be present for such a period of time and this greatly reduced the number of false warnings.

The questionaires were provided by the three companies who had their own employees drive the vehicles and rate the performance. Dr. Zackor felt that the company drivers were biased in favor of the system because they had a vested interest in the system performance being rated high. The company employees pointed out that these were technical people who were interested and critical evaluations. These evaluations have helped the company determine the appropriate signal processing to make the interface between the driver and the system work properly.

4. Conclusion

This report concluded at the end of the 1980 offers important current information about the evaluation of collision avoidance radar in Germany. There is a diversity of opinion on what conclusions can be drawn from the report. Dr. Zackor was the most skeptical that automotive radar has any future in Germany. Dr. Neininger and Dr. Oehlen were the most optimistic that a viable system can be marketed. Dr. Jahnke was informed in the most detail about the results and appeared neutral about the likelihood of these systems performing satisfactory. Dr. Ackermann thought the cost was prohibitatively expensive. In total, my opinion from talking to everyone that I was able to talk with, the evaluation is basically negative. Both cost and false alarms are not easily reduced at this stage and thus it was not likely that customers would want to pay the cost of an operational system. It is not known what reaction the public drivers will have to the automotive radars. They are rather complex devices and the display is a little difficult to learn how to use and to see in the field of view when driving. On the other hand, they provide the driver with additional important information and significantly improve his capabilities for avoiding an accident. Evaluating the price of this improved driving ability is difficult and will only be accomplished with more development and evaluation.

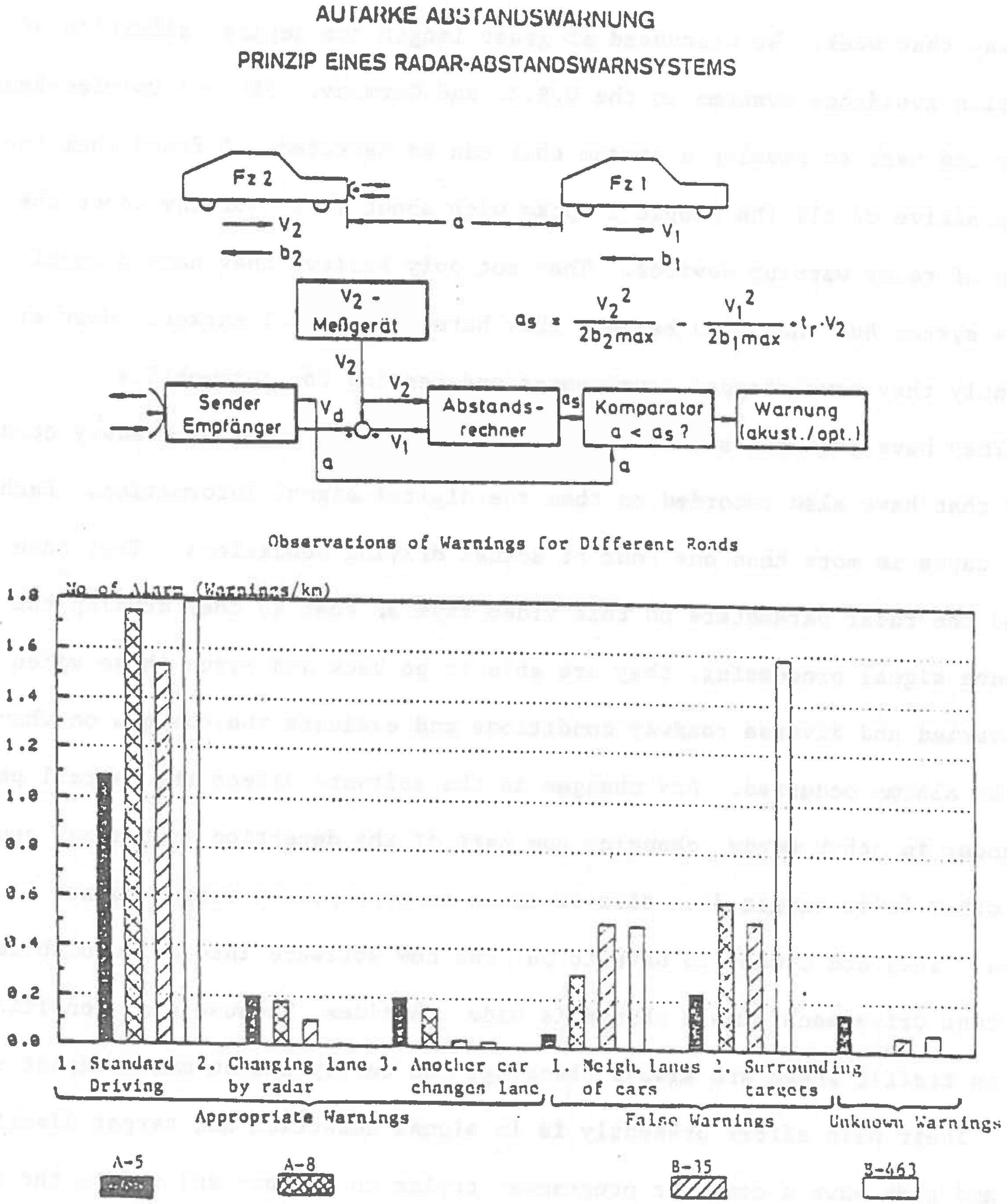


FIGURE 2. Warnings of various types for Four Roads.

On Wednesday, May 27, 1981 I visited Standard Electrik Lorenz AG at Stuttgart. I talked primarily with Dr. Neininger. Dr. Oehlen joined us for a couple of hours and Mr. Laue was there from Daimler-Benz because Dr. Reiniger was away that week. We discussed at great length the general situation of collision avoidance systems in the U.S.A. and Germany. SEL and Daimler-Benz are trying hard to develop a system that can be marketed. I found them the most positive of all the people I spoke with about it in Germany about the future of radar warning devices. They not only believe they have a nearly viable system but they also believe they have a potential market. However, presently they have stopped development and testing for automobiles.

They have produced several (four, I think) video tapes of roadway conditions that have also recorded on them the digital signal information. Each of these tapes is more than one hour of actual driving conditions. They have recorded the radar parameters on this video tape so that as they develop the software signal processing, they are able to go back and rerun these video tapes over varied and diverse roadway conditions and evaluate the changes on when and how the alarms occurred. Any changes in the software affect the overall performance; in other words, changing one part of the detection system may cause some other false target detection or cause an appropriate target to not be detected. They don't want to have to put the new software into an automobile and do a test drive each time a change is made. Besides, because road conditions such as traffic ahead are always changing, one rarely has an exact repeat situation. Their main effort presently is in signal detection and target discrimination and they have a computer programmer trying to improve and refine the current system.

They believe the FM/CW system is the best. They developed it primarily because the relative speed is critically important in determination of the safety distance and that relative speed can best be determined from the FM/CW system. They have done some calculations of the change in safety distance for different values of relative speed as a function of the speed of the automobile and they find at high speed and high relative speed the degree of accuracy required is high and can only be provided by FM/CW. They also believe the more narrow bandwidth possible for FM/CW is more likely to be licensed for use at 35 GHz.

They were reluctant to discuss the cost of such a system but evidently believe they will be able to market a system. It was my feeling from discussing cost with them that a cost to the company in the vicinity of $1000 was about what they expected. Of course, it depends on the number of radar units that would be manufactured and the type of display and signal processing system they would finally decide to use.

We all took a test drive at lunch time with Mr. Laue driving and Mr. Laue and I drove the automobile equipped with the radar unit for about one hour in the afternoon with Mr. Laue. The display on this system was the best one that I saw; however, it was still a little complicated and difficult to learn how to use.

The display is shown in Figures 3, 4, and 5 for three different conditions. There are seven green LED's left of center that each represent 5 m excess distance from the target and the safety distance as calculated from the equation

$$s = \frac{v_2^2}{2b_2} - \frac{v_1^2}{2b_1} + v_2 \cdot \tau \qquad (2)$$

where v_1 = speed of target

b_1 = deceleration of the target

v_2 = speed of radar-equipped vehicle

b_2 = deceleration of radar-equipped vehicle

τ = driver reaction time (approximately 1 sec)

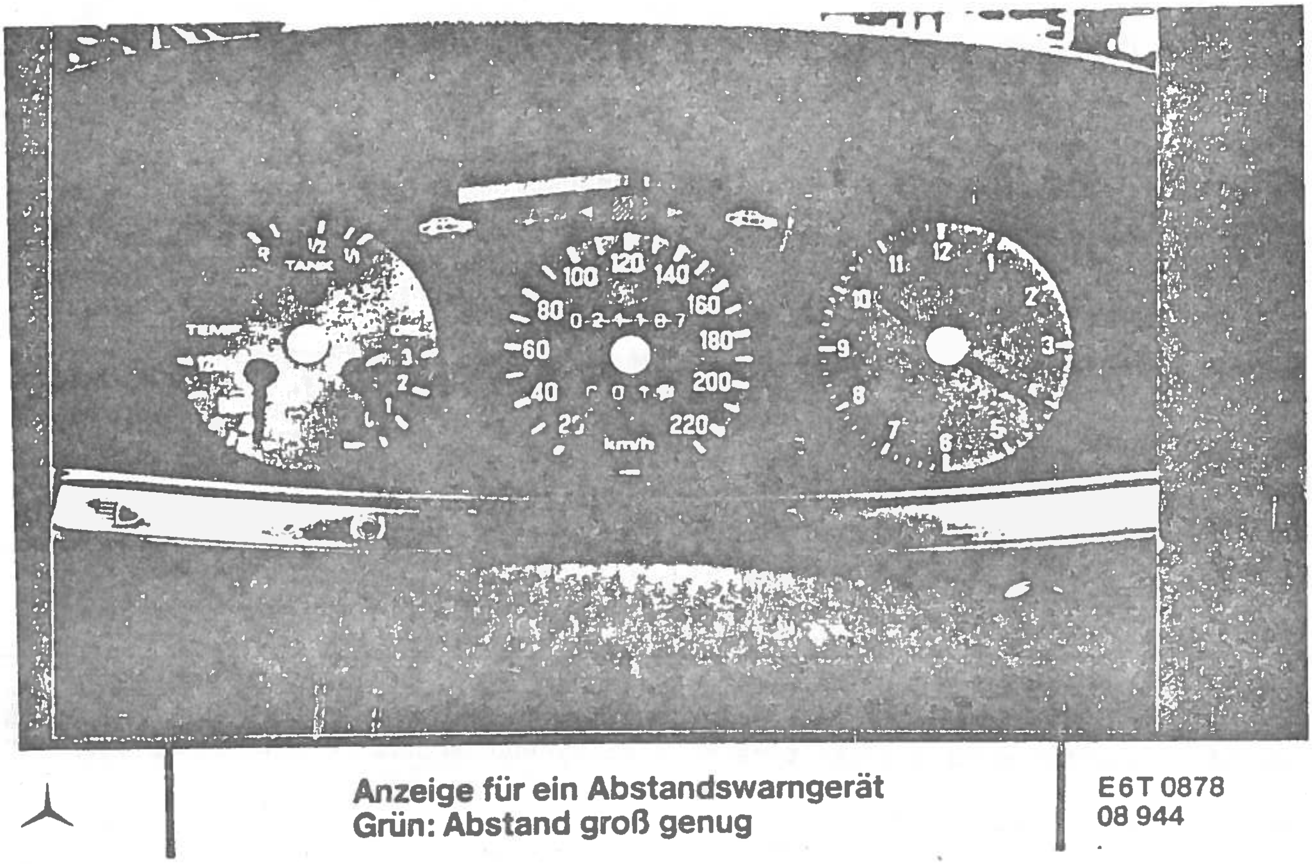


Figure 3. Radar System Warning Display Green Lights On.

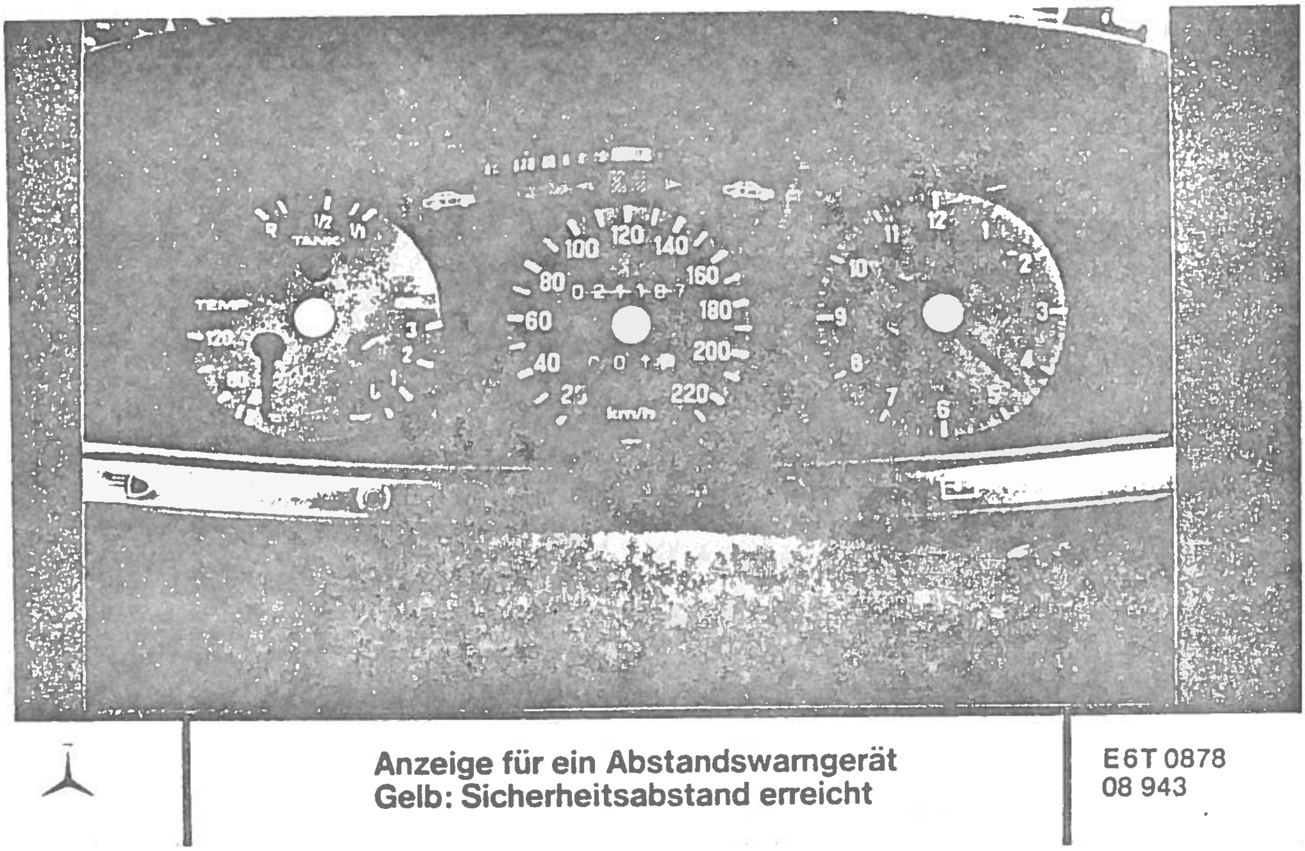


Figure 4. Radar System Warning Display Yellow Lights On.

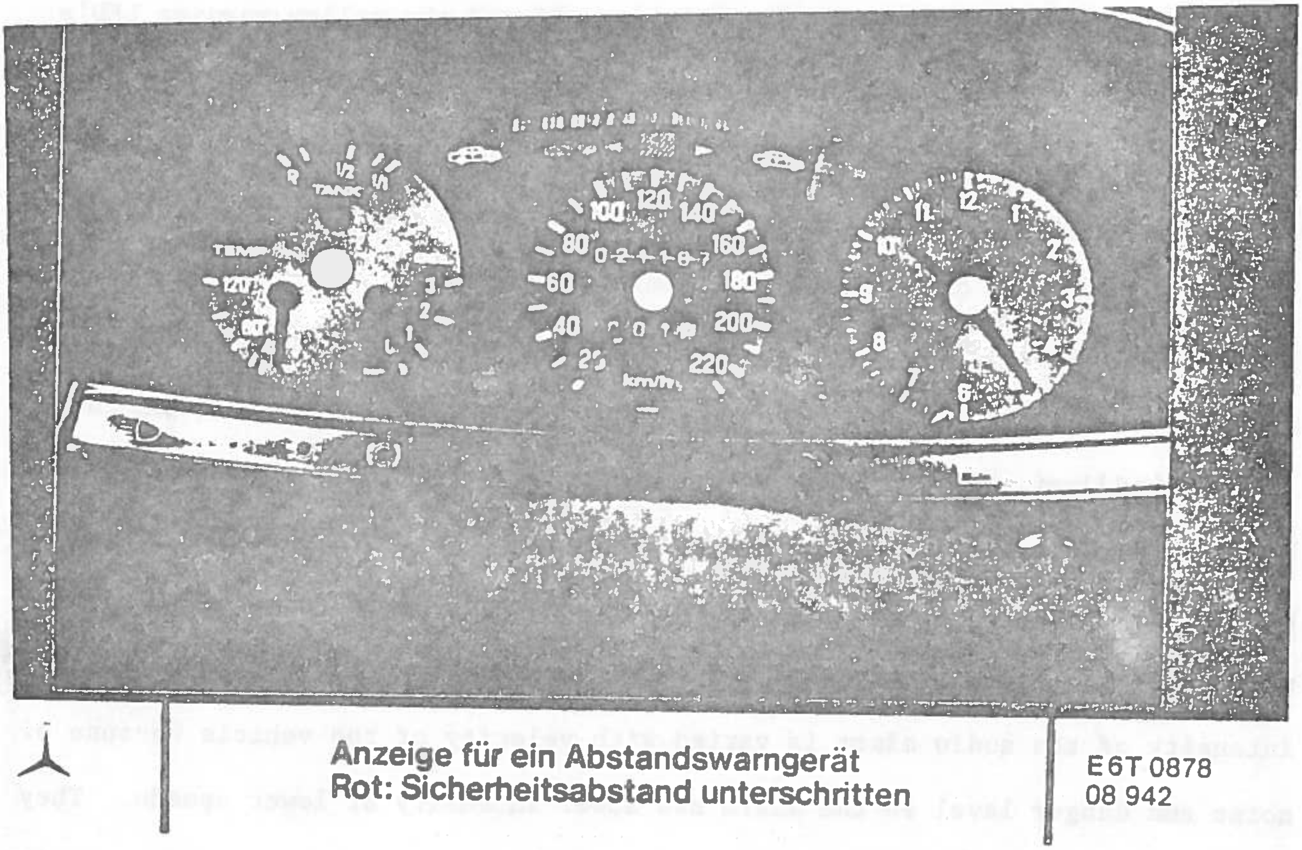


Figure 5. Radar System Warning Display Red Lights On.

If no target is detected by the radar, all of the green LED's are off. If a target is detected at a distance greater than 35 m more than the safety distance, all of the green LED's are illuminated . Then as the radar equipped auto approaches the target at a closer distance, one green LED is removed for each reduction of 5 m. So that when the radar vehicle is just at the safety distance, all of the green LED's are off and the yellow warning LED's in the center are eliminated as shown in Figure 4. No alarm is sounded when the yellow LED's are eliminated. The interval for the yellow warning light is ± 2.5 m about the safety distance. However, as the separation distance continues to decrease, one red LED is illuminated for each 2.5 m closer to the target than the safety distance. There are seven red LED's so it is possible to display a separation interval 20 m less than the safety distance. When the red LED is illuminated, an audio alarm is sounded. The audio alarm presently has two frequencies 1000 Hz and 1600 Hz. The 1000 Hz represents the less dangerous situation and the 1600 Hz alarm indicates a more dangerous situation where the separation distance is less than 10 km of the safety distance. The intensity of the audio alarm is varied with velocity of the vehicle because of noise and danger level so the alarm has lower intensity at lower speeds. They intend to vary the pulse alarm repetition rate as well in order to provide more audio warning information to the driver.

I was very much impressed with the amount of information that was provided by this display. However, it is rather complicated and may, in fact, provide too much input to the driver. Driving the development of these radar systems, a two month study was commissioned by the German Government to the Fraunhofer Institute für Informations und Datenverarbeitung at the University of Karlsruhe. This was a socialogical study of the various displays of the three systems. The title of this report was "Felderprobung Autarker Abstrands Warn Systeme/ Ergonomische Beurterlung." No tests were performed and only inspection of the different instrument panels was done. All were criticized and an overhead display was recommended. The three displays were thought to be too complex and recommendations for better displays were prepared that provided more distance perspective information. The recommendation preferred by companies were a sequence of six lights: two green in the center; one yellow on each side; and one red outside each yellow with the relative size increasing from green to red as shown in Figure 6.

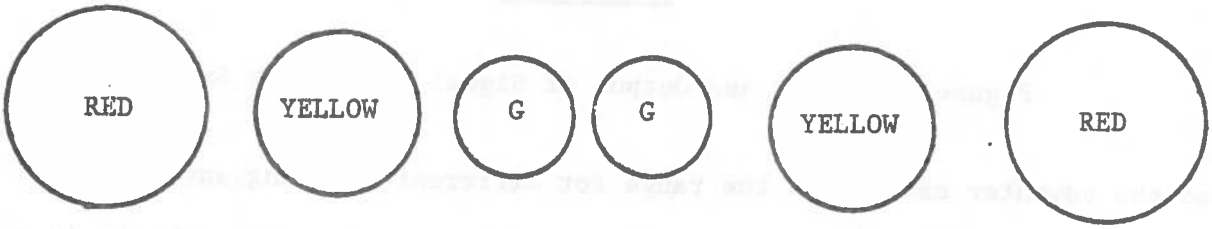


Figure 6. Display suggested for future instrument panel.

They also criticized the accoustical signals because they were intermittant and the breaks were too long. They recommended the frequency should be changed corresponding to the dangerousness of the distance and that the loudness be variable and under the control of the driver because windows might be opened or closed, the radio on or off and other variable noise conditions. There appears to be no difficulty implementing such suggestions.

The signal processing can be represented schematically as in Figure 7. A picture of the processing system is shown in Figure 8. The transmitter and receiver system is shown in Figure 9. The transmitter is connected to the bistatic antenna system shown in Figure 10 along with the Road Condition Indicator which allows the driver to set parameters b_1 and b_2 in accordance with the road surface variation. The system is shown installed on a vehicle in Figure 11. The turning measure provides an indication whether or not the vehicle is turning

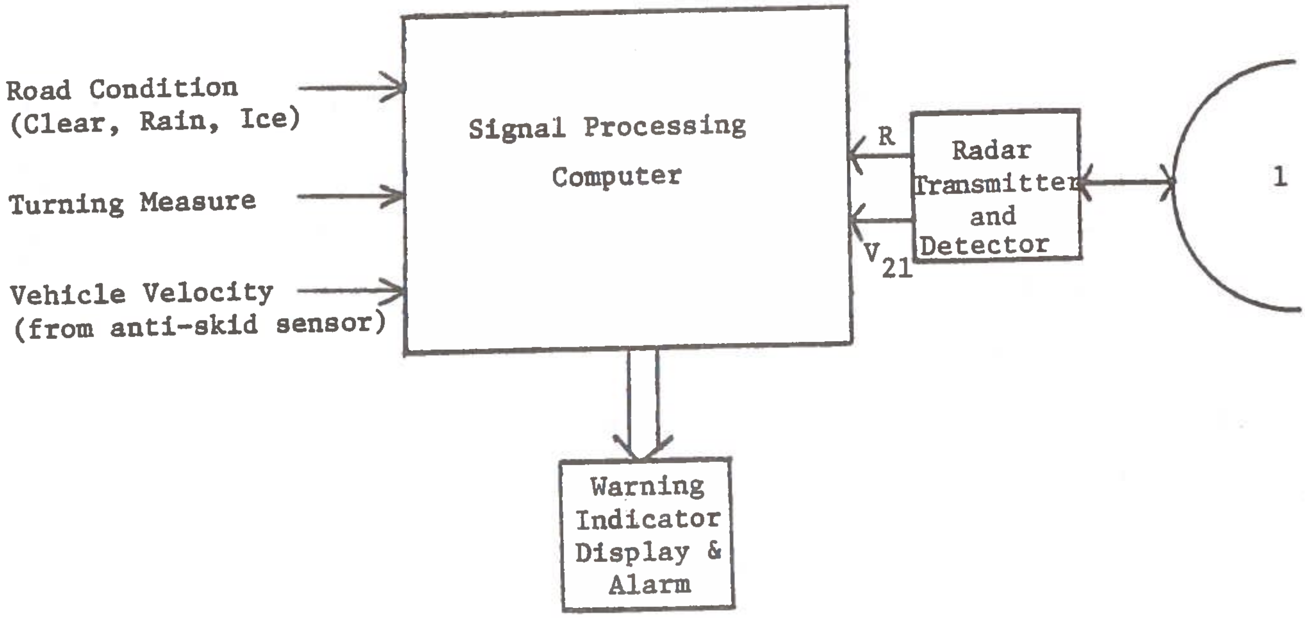


Figure 7. Input and Output of Signal Processing System.

so the computer can reduce the range for different steering angles. This is done in order to reduce false alarms during curves where the vehicle is turning.

The antenna has a beam width $\pm$ 2.5° at 3 dB; however, since the system has a two-way dynamic range of about 20 dB that is more applicable for beamwidth. The one clear false alarm when I drove this vehicle was a situation where I was passing a truck in an adjoining lane traveling straight along an open lane. As I approached the truck about 30 m on the right, the red light indicator and audio alarm were activated indicating the large return from the truck in the side lobes was adequate to appear as a target straight ahead.

The signal processing unit utilizes a Intel 8080 with 4 K storage capacity. The input range R and relative velocity v_{21} each go into a shift register memory with four locations that operate on the First In First Out (FIFO) principle. These inputs along with the vehicle velocity are processed for 40-50 m sec in order to determine if an appropriate target return is present. This process is called bridging and the algorithm used to determine target validity varies with driving speed and relative speed. The detection of a valid target depends on

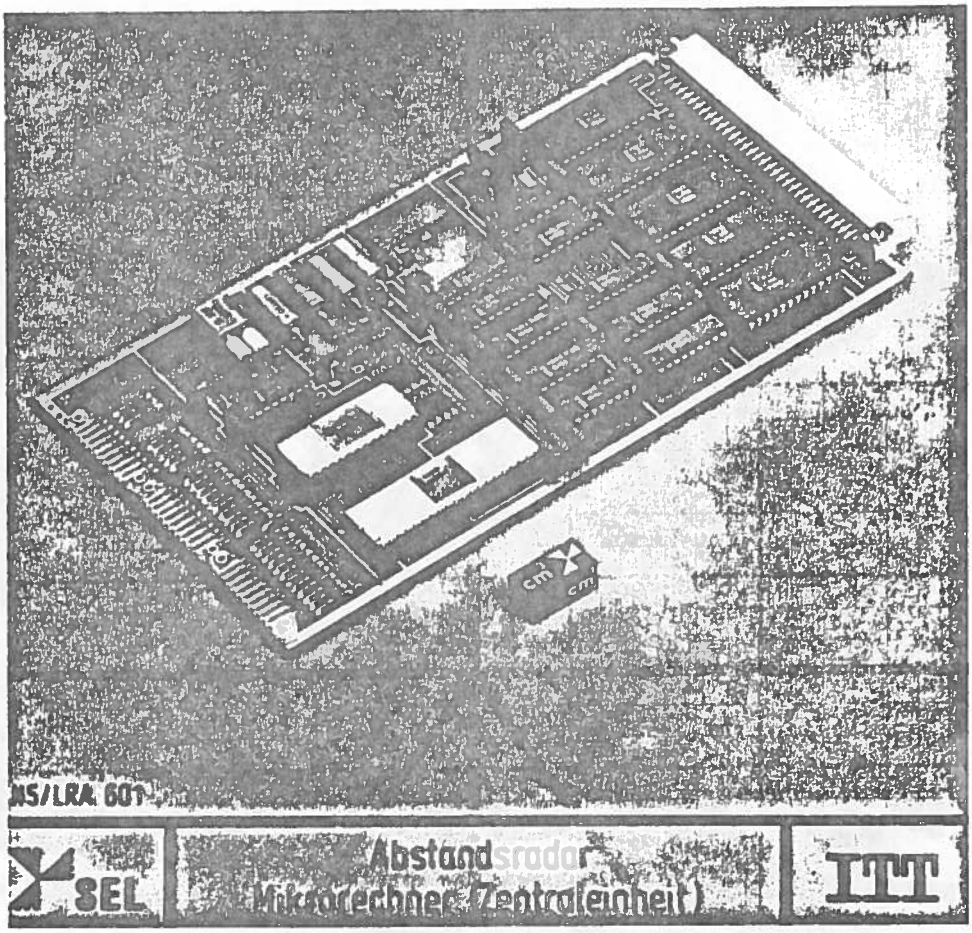


FIGURE 8. SEL System Central Processing Unit.

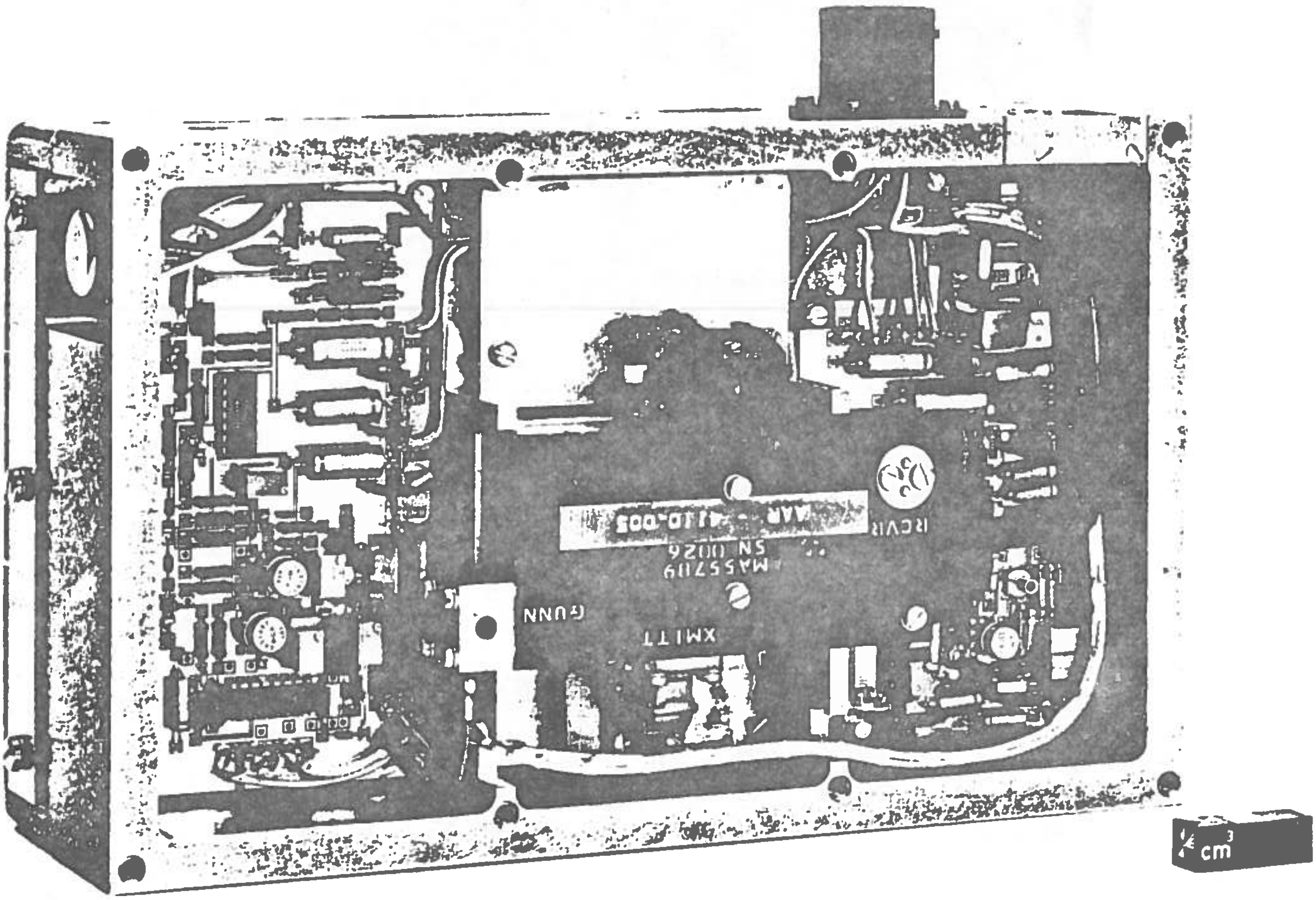


FIGURE 9. SEL System Transmitter and Receiver.

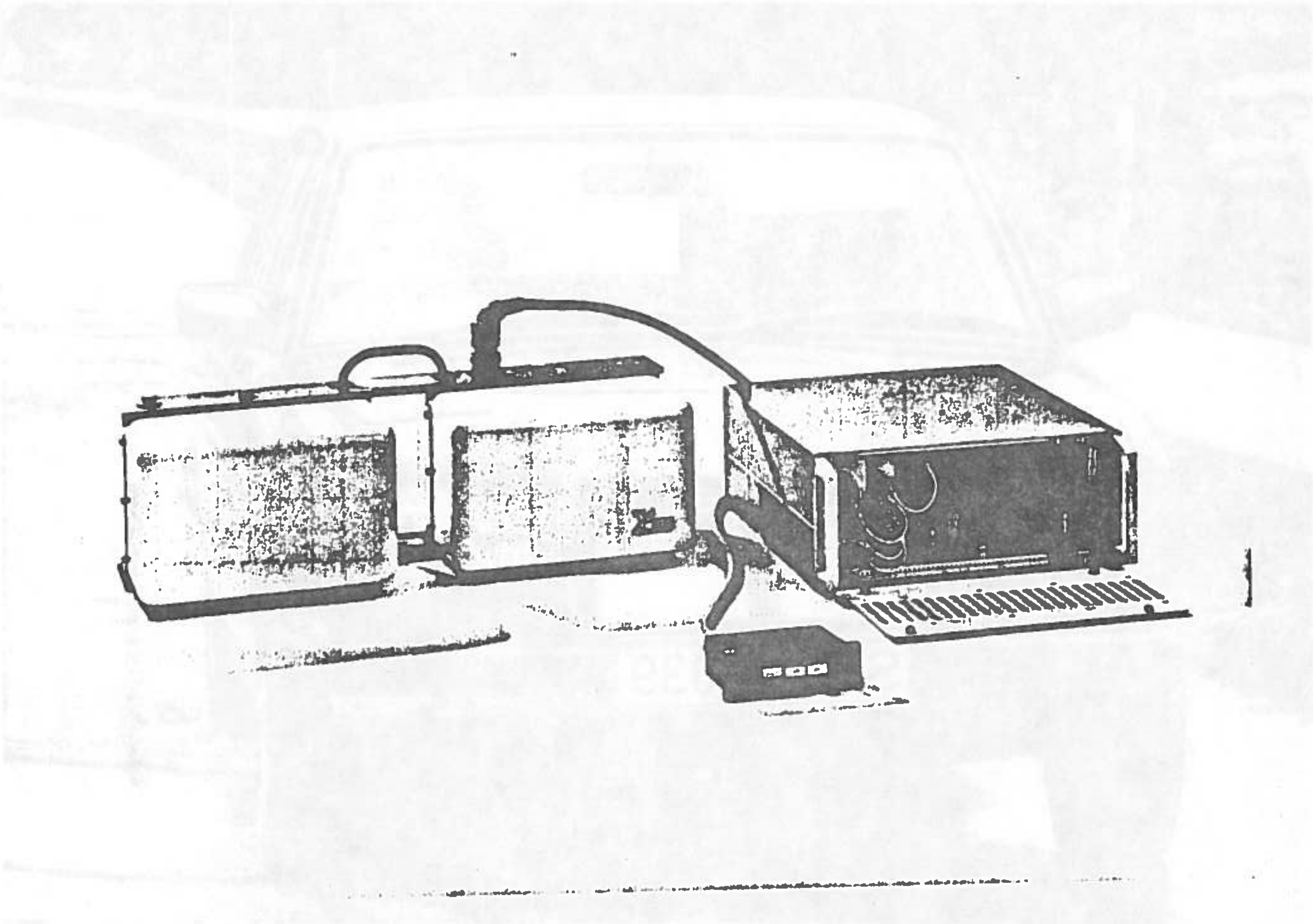


FIGURE 10. SEL Transmitter Connected to the Bistatic Antenna and the Road Condition Indicator.

FIGURE 11. SEL System Installed in a Vehicle.

the sensitivity setting of the radar detector.

After a valid target is detected and the distance to the target determined, the safety distance is computed by Equation 2 and the range of the target with respect to the safety distance is determined. This information is stored in memory for reference and the process is repeated. A valid target must be present for 0.2 sec before the alarm is activated. This selects only those targets present for a particular period and allows some false alarms to be eliminated. This is a sort of time integration of the return signal to determine appropriate target selection.

Another way false targets such as guard rails are eliminated is to consider relative speed as a function of time. Guard rails have a nearly constant relative speed equivalent to that of the automobile and the range determination remains relative constant whereas a valid target would have a range that was decreasing with respect to the radar vehicle. Thus, signal processing is able to eliminate guard rails because of the radar return signature.

On June 1, 1981, I visited Fr. Fritz Ackermann at Robert Bosch GMBH. Hans J. Peters had sent a letter indicating that he would be there representing AEG-Telefunken. However, he was not able to make it at the last minute because some problem that he had to take care of in Ulm. Dr. Wocher is quite knoledgable about the signal processing and had developed the time expansion technique, had also expected to be there but was not able to make it. Mr. Pfeudler was there from the microwave development area and Mr. Pischke, who developed the computer programming, was there during the afternoon and took me for the test drive with their system operating.

Dr. Ackermann said that the technical problem had been solved to develop a radar which performed to the specifications. The restrictive factor is the cost. With three Gunn oscillators required that cost over one hundred dollars each, the system was too expensive to be marketed in the manner they believe could be feasible. They had stopped work on the brake activating systems and I believe the driver warning system has the best chance of success, at least in Germany.

They are very pleased with their pulse system. They have a maximum peak power of 300 mW and a range of 150 m. The pulse repetition frequency has been reduced from 250 kHz to 30 kHz because they found that large and distant targets were producing false alarms because it appeared to the radar to be very close instead of more than one pulse separation distance.

They have also developed a monostatic radar system to replace the bistatic system. This reduces the cost of the additional antenna system and also helps synchronization of the receiver. They had some problems with the precise delay from transmitter to receiver that relate to the signal processing.

The 20 n sec pulse system measures range and rate of change of range to get the relative speed v_{21} between the target and the radar-equipped auto whose speed is also used as an input from the speedometer. The speed of the target vehicle can then be calculated. A new target can be detected after 250 m sec.

The input from the road condition indicator changes the acceleration b_2 of the radar equipped car but keeps the same acceleration b_1 for the target. The distance to a valid target is reduced drastically from 120 m if the steering wheel is turned so the automobile is more than ½° from the straight ahead direction.

The flow chart for the signal processing is shown in Figure 12. At the start, the program determines the autos own speed from the velocity sensor and the angle of the automobile from an angle sensor. Then an inquiry is made whether a target is present in the radar return. If not, the program turns off the display and starts over. If a target is present, the distance to the target and the relative speed of the target with respect to the radar vehicle is determined. If the target is approaching the radar vehicle at a speed greater than the vehicle speed, it is assumed the return is due to oncoming traffic and the target is rejected, the display is turned off and the program starts again.

If the computer program still has a valid target at this point, it watches it for 125 m sec or some multiple of 125 m sec up to 500 m sec and requires that the target be present for this entire time. At this point an appropriate target has been identified and the safety distances is calculated as was done in equations (1) and (2). However, one more qualification exists. If the automobile is turning as indicated by the steering angle input, the range is reduced and if the reduced range is less than the target range, the valid target is rejected, the display is turned off and the program restarted. If the target distance is less than the allowed range, it is compared with the safety distance d_1. If the target distance is not less than the safety distance, the given LED's are eliminated indicating a valid target is present. The green LED's represent 5 m increments between the target distance and the safety distance and there are seven of them so

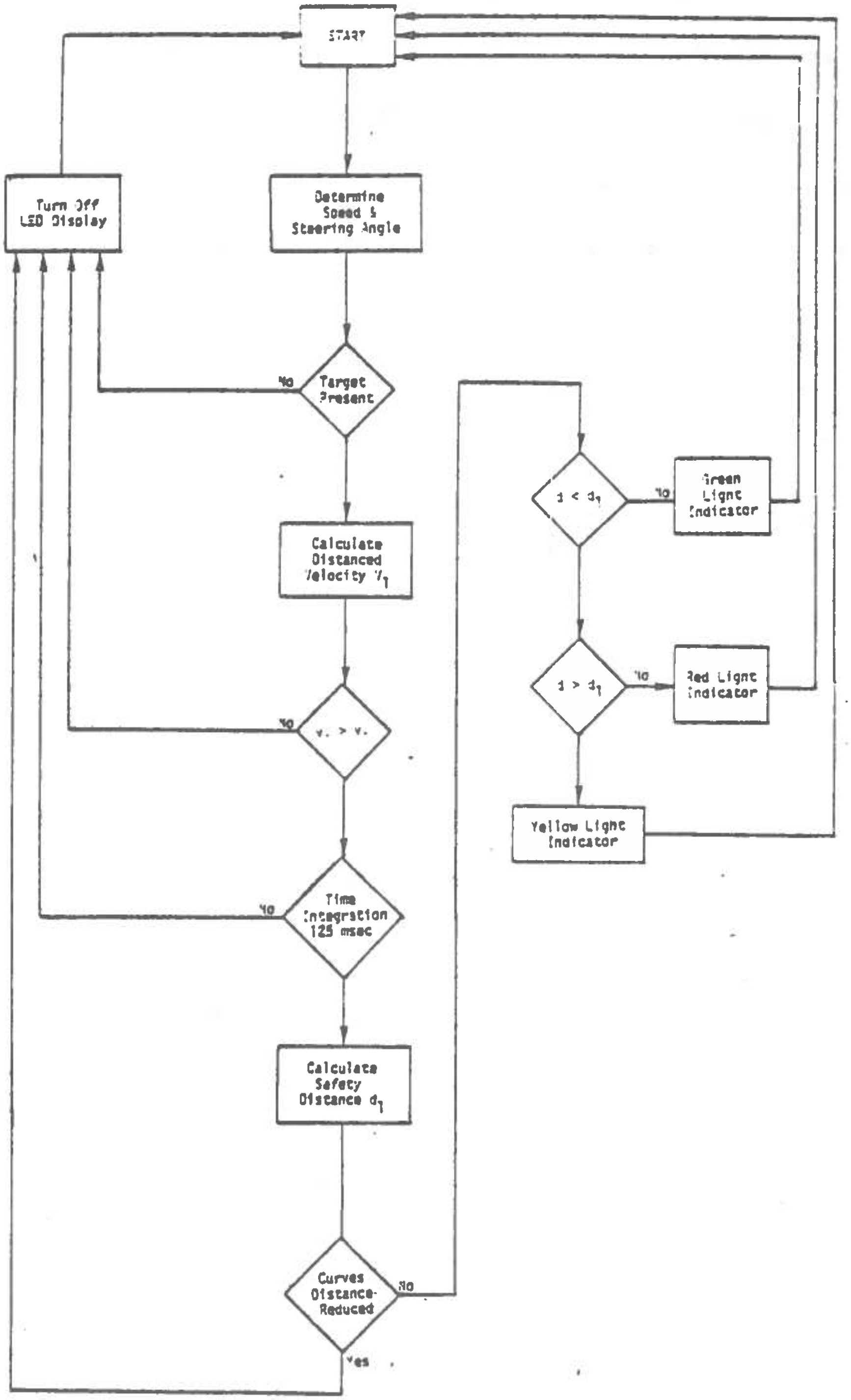


FIGURE 12. Flow Chart for Bosch Microprocessor Decision and Control of Collision Avoidance System.

35 m excess over the safety distance can be indicated by this display similar to SEL's. The Bosch display is shown in Figure 13. The vertical LED's have seven green, two yellow, and three red that provide distance information about the difference between the target distance and the safety distance. Each of these LED's reprints increments of 5 m.

The horizontal LED's are used for warning and not to indicate information. The number of red lights eliminated indicates the degree of changes. Figure 14 illustrates how the display is intended to be used by the driver mounted on the dashboard. The on-off switch is on the immediate right and the road condition selector in the middle allows the driver to set b_2 for dry, rain, or snow conditions. In Figure 15, the bistatic antenna system is shown along with a display unit, and Figure 16 shows the monostatic system along with the display and speed-transducer used to monitor the vehicles own speed. The bistatic unit is shown mounted on the vehicle in Figure 17. The internal operational components of the microprocessor and display is shown in Figure 18. This display utilizes the Intel 8048 microprocessor which has 1 K storage capacity on the μP. This microprocessor was chosen for compactness and reduction in cost and the 1 K memory limits the signal processing capacitor of the unit.

On the test drive on country, city, and expressway roads, the system performed quite satisfactory. There was some problem with the closeness of the leading vehicle required to produce a warning and Mr. Pischke thought there may be some difficulty with the calculations of safety distance in the programming. The system did good in recognizing appropriate targets and not producing false alarms.

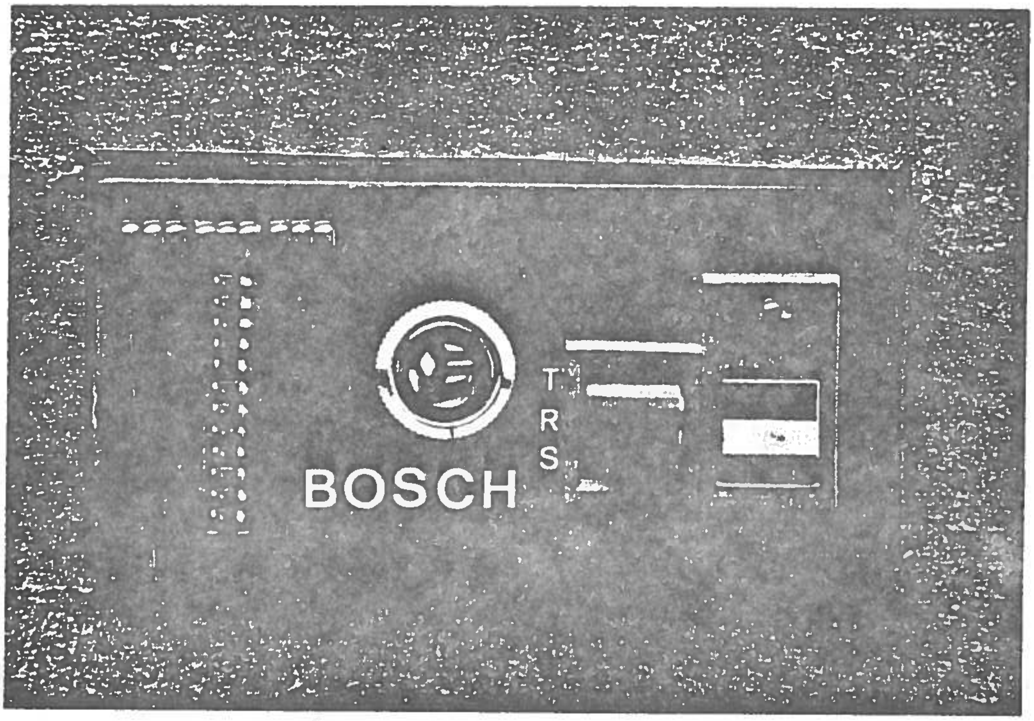


FIGURE 13. Bosch System Warning Display.

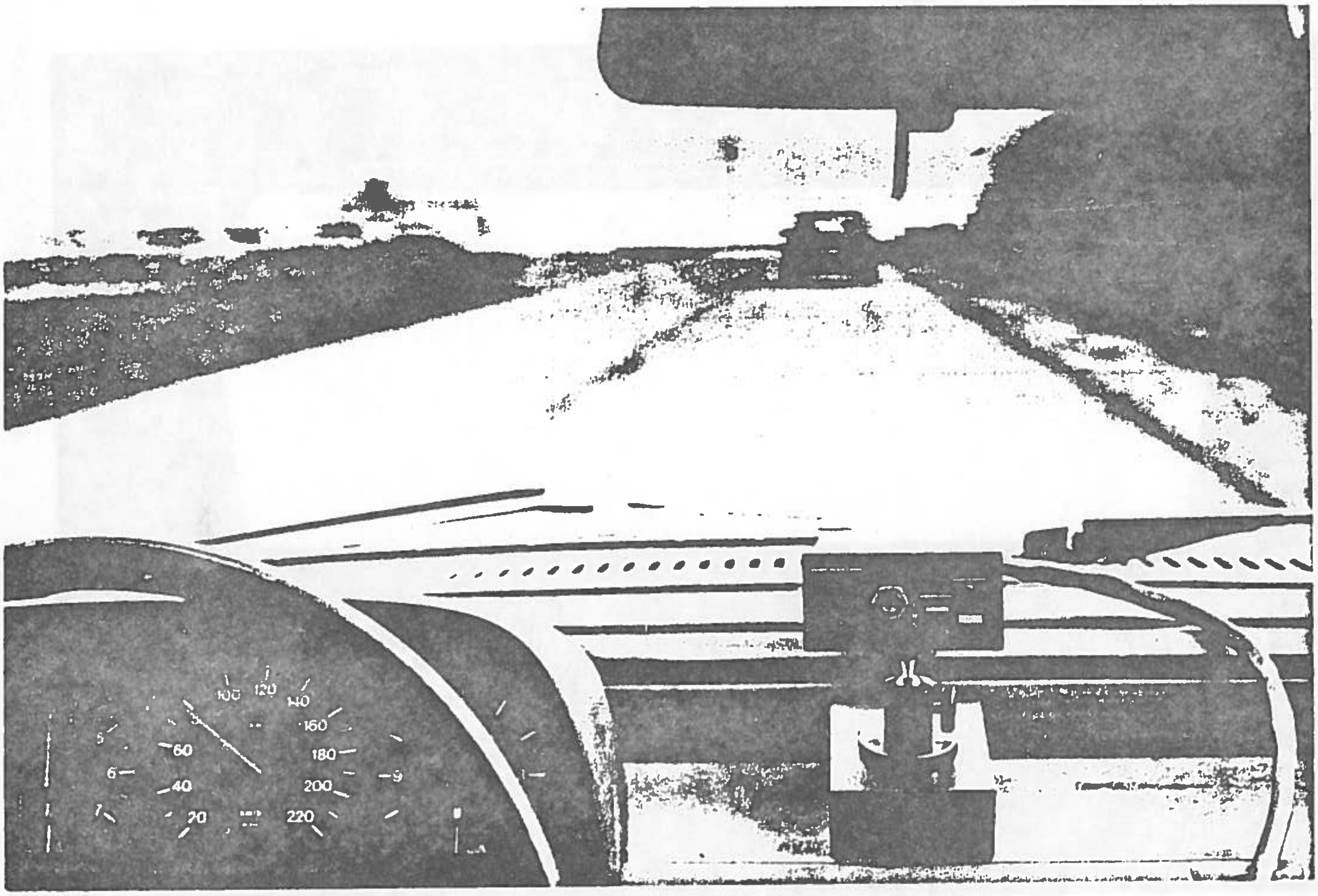


FIGURE 14. Bosch System Warning Display Mounted on the Dashboard.

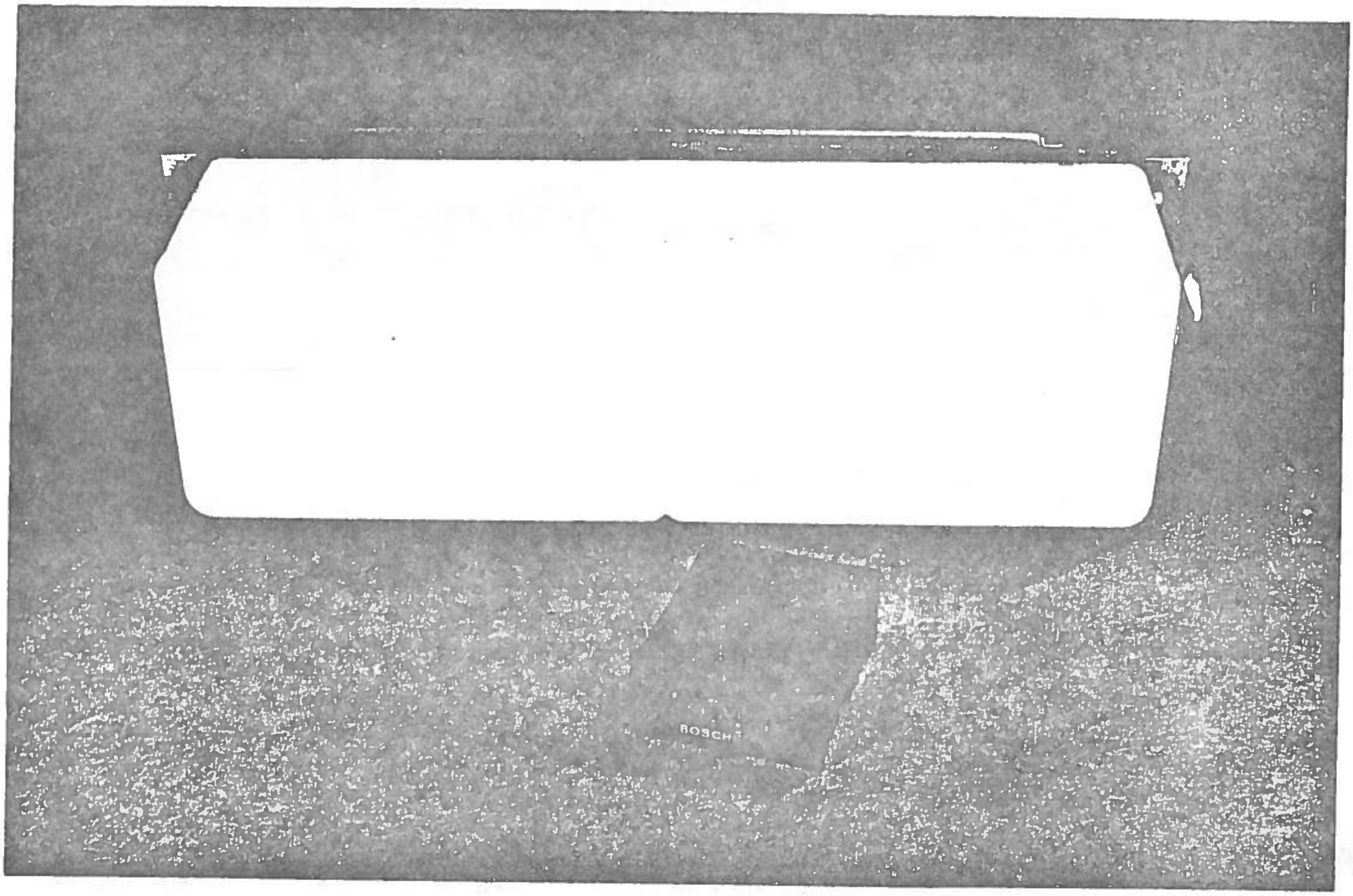


FIGURE 15. Bosch System Bistatic Antenna and Warning Display.

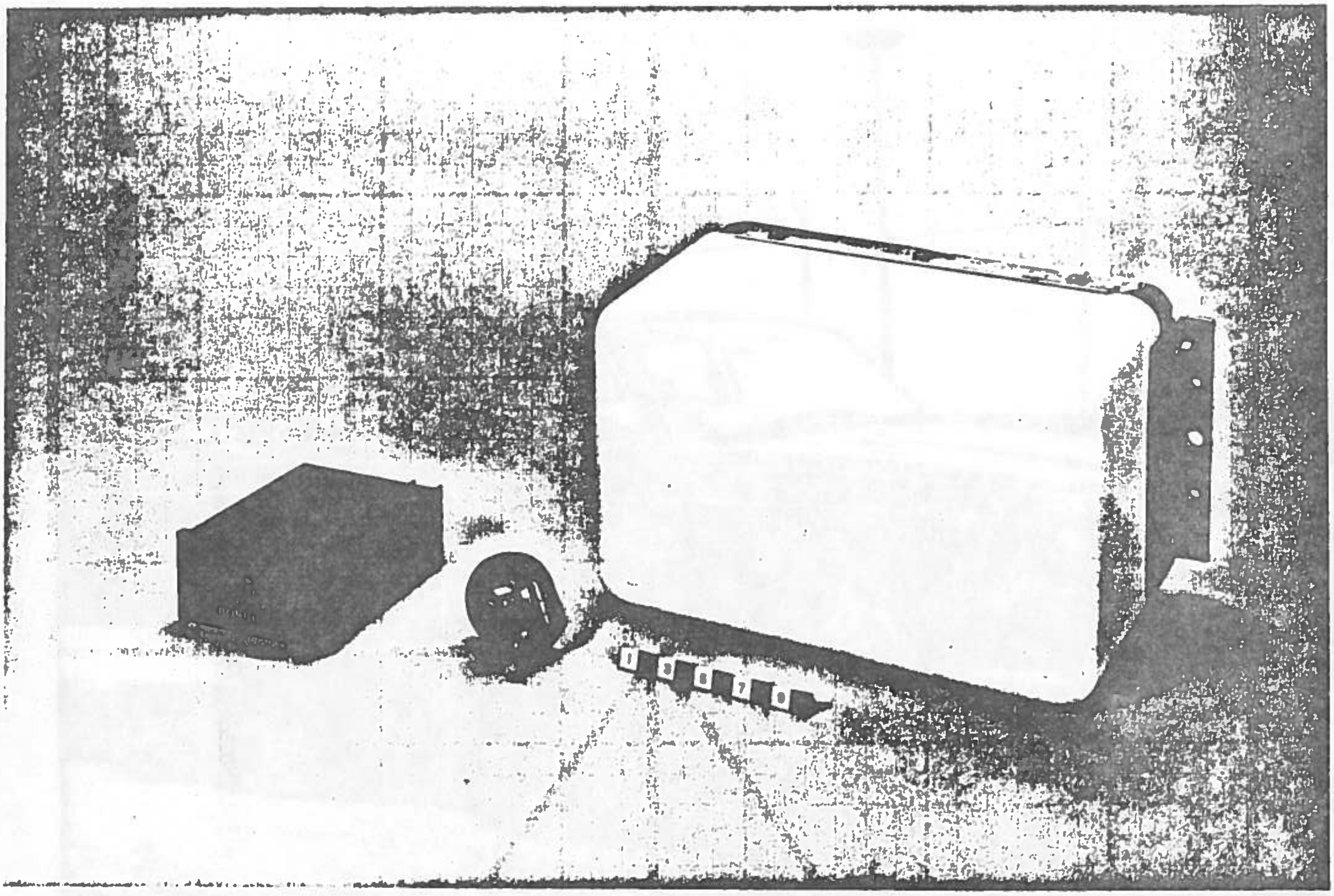


FIGURE 16. Bosch Monostatic System with Display.

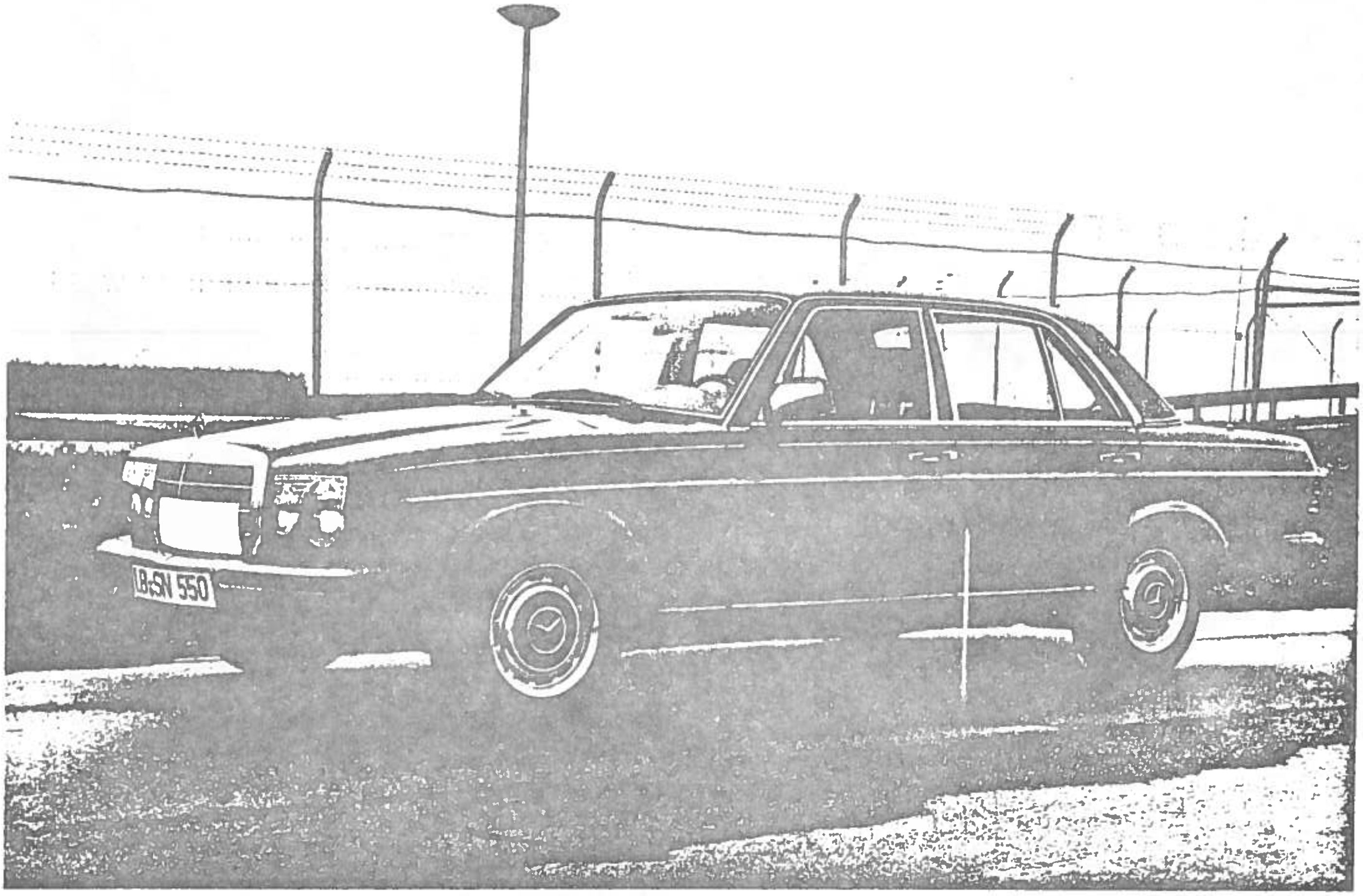


FIGURE 17. Bosch System on a Test Vehicle

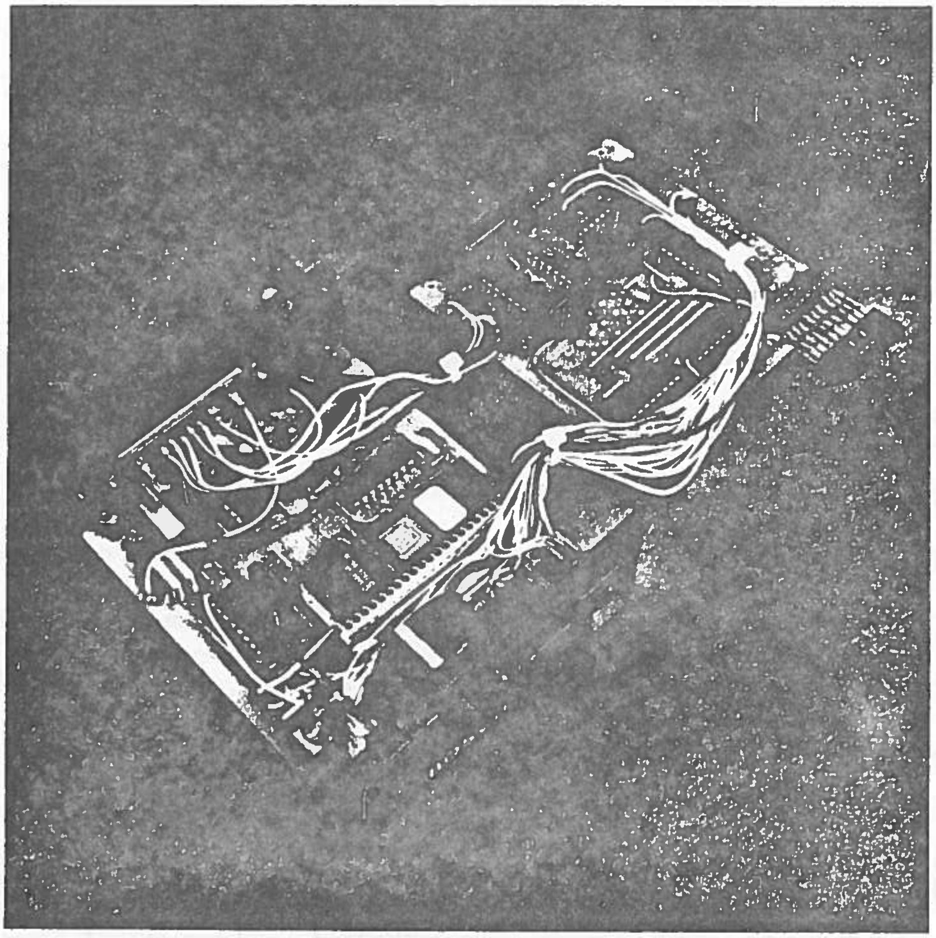


FIGURE 18. Bosch System Central Processing Unit and Display.

CONCLUSION

I was very much impressed with the technical development of the collision avoidance radar by the three German groups working on them. In particular, the signal processing is quite developed and sophisticated. They have had units operational now for several years and have significant road experience which has allowed them to make significant evaluations of type and reduction of false alarms. I received varying estimates of false alarm rates. Dr. Zackor believes that about 20% of those alarms presented to a driver is the lower limit of false alarms of these systems because of variations in the roadway, drivers changing lanes and close proximity of automobiles on roads and streets. On the other hand, the manufacturers believe a few percent of those alarms presented to the driver will be interpreted by him as false alarms. However, everyone recognized the predominant significance of the false alarm problem. It seemed universally accepted that the two primary difficulties in the feasibility or success of collision avoidance radar were (1) reduced cost and (2) low false alarms. The overall experience as I interpret it is that it is possible to reduce the false alarms to a few percent, but it is unlikely that cost can be brought into an acceptable range below $500.

The people with which I discussed automotive collisional avoidance radars all expressed great concern that automatic breaking would not work because they did not believe the false alarms can be completely removed and that inappropriate application of the brakes could cause an accident and incur liability. They believe the best possibility for success exists with a warning system to extend the capability of the driver while leaving the final decision making capacity with the driver. Driving an automobile is seen as a complicated task and considerable intelligence is necessary to judge direction, speed and trajectory. Some computer programming has been done to help the decision-making for appropriate and false targets, but a false alarm rate of a few percent remains.