RESEARCH INPUT FOR COMPUTER SIMULATION OF AUTOMOBILE COLLISIONS
VOLUME I
DEVELOPMENT OF DATA BANK

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RESEARCH INPUT FOR COMPUTER SIMULATION OF AUTOMOBILE COLLISIONS
Volume I: Development of Data Bank

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16. Abstract

This report summarizes the results of a detailed review of existing experimental data from staged automobile collisions and it presents long range plans to meet future data needs in relation to computer aids for reconstruction of highway accidents.

A total of 141 staged collisions involving 170 individual vehicles with usable damage information were reviewed. The experimental damage data were coded and entered in a computerized data bank which was developed within the research program. Only seven staged collisions were found to include usable documentation of data from the spinout trajectories of the vehicles.

Detailed plans are presented for application of the developed data bank. A sample application to refine the empirical structural crush tables of the CRASH program is included in the report. All data collected within the research program are presented in the Appendix.

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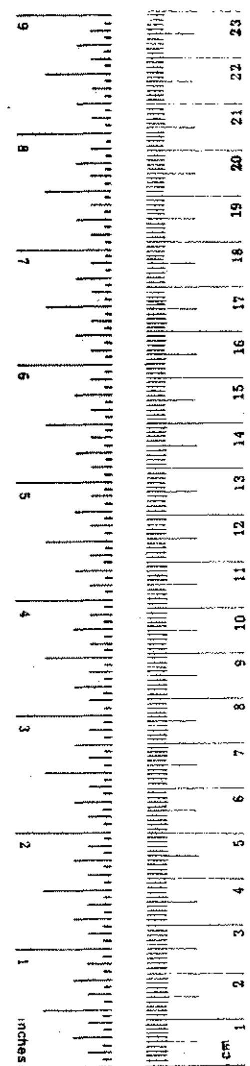
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

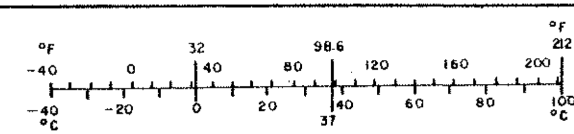
Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	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



FOREWORD

This document summarizes the research achieved under Contract No. DOT-HS-7-01511, "Research Input for Computer Simulation of Automobile Collisions", with National Highway Traffic Safety Administration, U. S. Department of Transportation. Volume I summarizes previous existing experimental data from staged collisions and presents plans for future data needs. The experimental data generated in twelve staged collisions are reported in Volumes II and III of this document. Volume II contains the experimental test data for Test No. 1 through No. 5. Volume III contains the test data for Test No. 6 through No. 12. The reconstruction of these collisions, using the CRASH and SMAC simulation programs, is reported in Volume IV of this document.

The Contract Technical Manager for Phase II was Mr. Thomas Noga of the National Highway Traffic Safety Administration.

This report has been reviewed and approved by:

K. Hendershot

K. C. Hendershot, Head
Transportation Research Department

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

1.1 Objectives

The overall objective of Phase 1 of this research program, which is reported herein, has been to locate, review, decipher and place in usable form available experimental data on structural crush properties of automobiles and on the spinout trajectories produced by measured collision conditions. The primary purpose of this assembly of data from staged collisions has been to provide a state-of-the-art basis for verification or adjustment of the empirical force-deflection relationships for vehicle structures that are used in the Simulation Model of Automobile Collisions (SMAC) and the Calspan Reconstruction of Accident Speeds on the Highway (CRASH) computer programs. Where available, the trajectory data have been gathered to provide a basis for (1) evaluating the corresponding accuracies of SMAC and CRASH and (2) refining the empirical coefficients for spinout motions that are used in CRASH. However, beyond these planned initial applications of the assembled data, the in-depth review of published information has served to identify data gaps and, thereby, to provide guidance for presently needed experiments and for long term planning to meet future data needs in relation to computer aids for reconstruction of automobile collisions.

1.2 Background

1.2.1 Computer Aided Reconstruction

The SMAC and CRASH computer programs have both been developed for the purpose of achieving improved uniformity and accuracy in interpretations of the physical evidence in automobile collisions. The two programs constitute substantially different approaches to the analysis of evidence. SMAC, which was developed first (Reference 1), is a "simulation" type of program that generates a time-history form of response prediction and a corresponding body of "evidence" (i.e., rest positions, damage and tire marks and tracks) in the same manner as an exploratory physical experiment. The more recent CRASH (References 2, 5) is a simpler, "closed-form" type of calculation procedure which makes direct use of the physical evidence in a given case to produce an approximation of the corresponding impact conditions.

Comparisons of SMAC and CRASH results with experimental data show considerable promise (References 1 through 6). However, rigorous evaluations of the validity, accuracy and parameter sensitivities of the two programs have been hampered by a limited availability of suitable measured data from staged collisions (References 2 and 6). Also, the analytical representations and corresponding input data for the structural crush aspects of both computer programs reflect the use of "first approximation" approaches based on limited test data that include a range of vehicle sizes and model years.

The presently reported research task has been directed toward the collection and review of available data from staged collisions for use in further evaluation of the validity and accuracy of each of the cited computer programs and also, for guiding the planning of a series of staged collisions to fill major data gaps.

1.2.2 Related Literature

A sizable body of literature exists on the more traditional techniques of investigation and reconstruction of highway accidents (e.g., References 7 through 20). However, a careful review of that literature reveals a nearly total absence of experimental data that are adequately documented to provide a basis for testing the validity and accuracy of reconstruction techniques.

Investigation manuals (e.g., References 7 through 13) provide instructions on the measurement and documentation of physical evidence. They also generally present very simple relationships or tables for interpretation of skidmarks and discussions of the principle of conservation of momentum. However, they do not include demonstrations of the validity of presented analytical relationships or any usable data from staged collisions.

The more academic papers on the accident reconstruction topic (e.g., References 14 through 18) develop equations for application of conservation of momentum and work-energy relationships. But they generally do not include data suitable for rigorous evaluations of validity and accuracy.

Some relatively rare publications (e.g., References 19, 20) do present experimental data that can be applied to certain aspects of reconstruction calculations (i.e., energy absorption through structural crush).

As a result of the described situation with regard to investigation and reconstruction literature, it has been necessary in the present research program to seek usable results of crash tests that have been performed for other purposes. In many instances, the documentation of such tests has been found to not be adequate for the purpose of rigorous validation of reconstruction techniques. Also, many staged collisions have involved structural modifications and/or artificial constraints on spinout motions (e.g., "snubbing" cables).

While the above facts were fully recognized prior to the start of the present study, a need was seen to thoroughly review the available data and to code it in a standard format. A data coding format that is independent of any specific application procedure was selected so that the resulting staged-collision data bank can serve for use with revised and extended future analytical procedures.

1.3 Methodology

1.3.1 Data Acquisition and Coding

In accordance with the objectives of Phase 1 of the research program as stated above, a literature search was conducted for the purposes of:

1) Assembling additional crash test data for use in verification or refinement of the structural crush aspects of both the SMAC and CRASH computer programs, and

2) Seeking additional staged collision data with documented spinout trajectories for use in further validation of the SMAC and CRASH programs.

The Calspan Technical Library performed a search of five data files to obtain titles, abstracts and other pertinent information on the available literature having to do with automobile collisions. The computer-based data files searched were:

HSL (Highway Safety Literature)
ISMEC (Mechanical Engineering)
NTIS (National Technical Information Service)
TRIS (Transportation Research Information Service)
EI (Engineering Index).

The keyword combinations employed in the search were:

automobile collision tests
automobile barrier tests
automobile impact tests
automobile crash tests.

Approximately 1200 abstracts were obtained from the search of these data files. A review of the abstracts initially indicated that approximately 150 citations might contain structural crush information useful to the program in terms of refining the damage analysis aspects of the SMAC and CRASH computer programs.

In addition to the automated data file search conducted, efforts were made to trace applicable literature through reference lists and other means. Much of the readily obtainable foreign literature was in the form of technical papers presented at symposia or in technical journals and it did not contain the degree of reporting detail necessary for use within the current research program. It is believed that the data base might be extended significantly if the source documents were available.

Further, it should be noted that the cited data files do not contain all of the literature that is applicable to the current research program. In fact, since automotive crash testing is an ongoing activity, delays between reporting and report availability through NTIS (for example) can reduce data availability. Therefore, Calspan also conducted a search of its own files for applicable reports and discovered a number of proprietary tests and Canadian Department of Transportation Compliance Crash Tests for use in this task. A number of other sources of information including draft reports and published reports not yet available through NTIS were made available.

Once the potentially useful reports were on hand, they were scanned to determine whether or not sufficient information was reported on the documentation of crash test conditions and post-crash vehicle damage to make the test results useful for evaluating accident reconstruction techniques.

Wide variations in reporting formats and data content were found. In many cases, such fundamental information as test vehicle model, year of manufacture, or test weight were not reported. In other cases, vehicle deformation was not reported and photographic evidence of damage was inappropriate for use in estimating damage dimensions.

A great deal of automobile crash testing has been conducted for the purpose of extending the crashworthiness of automobiles. These types of programs have utilized modifications to automotive structures as a means of evaluation and, thus, many available collision experiments (i.e., those employing vehicle modifications) were not suitable to the current program.

The great majority of the reported cases found to be useful in this task involved staged collisions in which post-impact trajectory information could not be used. Most cases involved either fixed barriers or moving barrier impacts in which vehicle rebound and rest positions were not reported. Of the remaining car-to-car staged collisions, trajectory information was found to be generally inapplicable unless the test conditions were designed to obtain such information because the vehicles were physically prevented from running out to a natural rest position by means of post-impact arresting devices.

The data extracted from each applicable crash test consisted of vehicle information, damage dimensions and trajectory/rest position data (when available). The data forms and instructions used for this purpose are shown in Appendix 1. Each case that was subject to interpretation (that is, that required scaling or photographic evaluation of damage) was coded independently by at least two individuals in an attempt to control the quality of the data obtained. Differences in the independently coded data were then resolved by a third party.

Information contained on the data forms was then transcribed on the RICSAC Program Staged Collision Data Bank Coding Form (also shown in Appendix 1) for keypunching and subsequent storage in the computer data bank.

1.3.2 Selected Data Formats

In view of the greater availability of damage data (i.e., as opposed to comprehensive information, including trajectories) from staged collisions, two separate data forms were prepared (Appendix 1) for use in the data collection portion of this research program. The damage data form was applied to all usable staged collisions. When appropriate data were available, the trajectory data form was also applied.

The objective of the selected data formats has been to concisely summarize measured impact speeds and speed changes and those items of physical evidence that are needed for reconstruction calculations, without imposing constraints or limitations to the current analytical forms of the CRASH and SMAC reconstruction programs. For example, provision has been made in the forms for recording damage profiles at as many as three different elevations, where available, even though only one elevation is currently utilized. The trajectory data form has been aimed at the provision of a concise but comprehensive summary of evidence related to the spinout trajectories and the rest positions.

1.3.3 Staged Collision Data Bank

The compilation of existing staged collision data and of the data to be collected from the staged collisions of Phase II of this contract will be assembled into a computerized data base called the RICSAC Staged Collision Data Bank. The reasons for selecting this approach are fairly obvious. Foremost is the fact that the manifest objective of RICSAC is to provide staged collision data to verify and upgrade the capabilities of computer programs for accident reconstruction. Hence, to compile the staged collision information as computer data simplifies the process of utilizing this data with other computer programs.

Having decided to "computerize" this staged collision data, the issues of convenience, efficiency, and portability must be addressed. For the RICSAC staged collision data bank to be convenient, it should be supported by an array of file manipulation software which enables the user to edit the data, sort and list the data, add new data, and transfer data to other applications programs. The file manipulation software should be operable in either interactive or batch mode and its man/machine interface should be user-oriented and idiot-proof. For reasons of efficiency, the staged collision data bank should be of an indexed file format which enables quick access to a particular collision without the usual intervening processing required to get to it as is often required in sequential file formats.

Portability implies more than just providing software in ANSI FORTRAN. Proper selection of a file format must be made which facilities storing of the staged collision data bank on several types of computer storage media such as disc, tape, or cards. Admittedly, the disc version is the one that allows convenient manipulation of the data, but tape and card formats should be available for backup storage. The entire system should be devised so that the data and assorted software may be installed on government computers or those machines being used by future contractors who may need access to this data. In conclusion, it is a good idea to expend the effort towards proper planning in the beginning to ensure that the results of this research will be usable by other investigators.

Each staged collision in the RICSAC staged collision data bank is encoded into twenty formatted computer card images (eighty characters). Packing of the data has been avoided and the formats have liberal field widths to ensure readability. Each staged collision has an index entry included in the file index located near the beginning of the file. The RICSAC file has two status records at the very beginning of the file that identify several general items such as number of collisions, etc. The index is designed to provide efficient retrieval of collision data as well as quick sorting of classes of collisions. All of these design features reflect a modern, flexible, and straightforward data base concept.

The file manipulation software that has been assembled for RICSAC provides a full range of information retrieval services. Users will be able to add, insert, or replace collisions in the data bank from card input or interactive terminal operations. A special listing facility will permit display of data bank status, the index, and any user-selected collision. Also, by using keyed data in the index, certain classes of collisions, such as all subcompact rear impacts, may be retrieved by a single command. A special interface facility will provide other users with a way of transferring RICSAC data to their application programs.

The initial staged collision data bank will be configured for 300 cases, but it could as well be 10,000 cases. All software file manipulation routines are idiot-proofed, which means that no accidental user input may erase data or result in an abnormal termination of the computer program.

As a demonstration of the usage of the staged collision data bank, the CRUSH program developed under Contract No. DOT-HS-6-01372 (Reference 23) has been modified to read RICSAC compatible data cards and input its results to a Curve-Fitting Routine to improve the CRUSH tables in the CRASH2 program. This effort is discussed in Section 3.

In conclusion, to avoid having to repeat the RICSAC exercise in the future and to avoid having to redevelop software, effort has been expended in integrating the staged collision data into a coherent data base concept. This data base, together with its information retrieval software, may be installed on any future contractor's computer or on NHTSA's PDP 11-40 minicomputer in Washington. Details of the design concepts may be found in Section 3.

2. CONCLUSIONS AND RECOMMENDATIONS

2.1 Conclusions

2.1.1 An immediate and urgent need exists for the performance of staged collisions in the more common accident configurations to provide basic response data required for rigorous evaluations of the validity and accuracy of reconstruction techniques.

2.1.2 Most of the available results of staged collisions have only a limited usefulness for the purpose of evaluating reconstruction procedures. This fact is the result of (1) fragmentary reporting formats, (2) the use of inappropriate test procedures, and (3) vehicle structure modifications.

2.1.3 In the world literature related to highway accidents and to staged collisions, a surprisingly small amount of attention is given to the need for rigorous tests of the validity of interpretations of physical evidence by accident investigators.

2.2 Recommendations

2.2.1 Plans should be made for supporting a continuing program of staged collision test series performed specifically for the purpose of permitting rigorous evaluations of the validity and accuracy of reconstruction techniques. Note that such evaluations should emcompass the total range of collision speed changes, ΔV, that will be included in applications.

2.2.2 Arrangements should be made to monitor all NHTSA-sponsored staged collisions so that appropriate tests can be selected for use in relation to accident reconstruction studies.

2.2.3 A minimum instrumentation package compatible with data needs for accident reconstruction purposes should be required in all tests selected in 2.2.2.

2.2.4 Modified test procedures should be adopted, where possible, to permit realistic spinout motions of vehicles in staged collisions.

2.2.5 Results of staged collisions selected in 2.2.2 should be investigated and reported by an experienced investigation team. A standard accident reporting format should be used.

2.2.6 Subsequent to the investigation and documentation of a staged collision (2.2.5), the CRASH2 computer program should be applied to the evidence prior to disturbance of the collision scene. This procedure will insure comprehensive reporting, compatibility of the individual items of evidence, and it will provide a concise summary of the evidence which can be used in evaluations of other reconstruction techniques (e.g., SMAC).

2.2.7 Arrangements should be made with government agencies in foreign countries to obtain response data from staged collisions. Monitoring of test activities by a knowledgeable individual within each country can insure that usable data will not be overlooked.

2.2.8 Efforts should be continued to obtain data from staged collisions performed by members of the Motor Vehicle Manufacturers Association (MVMA).

2.2.9 The RICSAC staged collision data bank and supporting software should be finalized and installed on a government computer system, such as the PDP 11-40 at NHTSA headquarters in Washington. This would provide online information retrieval for NHTSA and its contractors.

3. DISCUSSION OF RESULTS

3.1 Existing Staged Collision Data

The literature survey conducted for this program screened more than 1200 publications in an attempt to uncover as much information applicable to the objectives as was possible within the rather limited time available. A review of abstracts of these 1200 publications indicated that approximately 150 were likely to contain the degree of detail in reporting of staged collision results and testing procedures that was necessary for refining the structural representation employed in the SMAC and CRASH computer programs. Each of these publications was reviewed in detail to extract the information required to simmarize the collision as indicated on the data forms in Appendix 1.

In many cases, critical information was found to be unreported or unavailable from drawings or photographs, or one or more of the vehicles involved was modified. A bibliography of reports and publications found to contain useful information is provided in Section 5 of this report. These reports yielded 141 staged collisions with a total of 170 separate vehicles for inclusion into the data bank developed under this program.

The staged collisions thus far summarized in the data bank are broken down by vehicle size category and impact location in Table 3-1. Frontal impacts naturally represent the largest category in the sample, and with the exception of the large size category, are fairly well distributed over the vehicle size range. Side and rear impacts are much less prevalent and are not as evenly distributed among the size categories.

Table 3-2 introduces a further breakdown of the collected data by impact speed for each vehicle size and impact location. The large majority of the collisions occurred in the 20 to 30 MPH impact speed range as is to be expected due to a heavy concentration of FMVSS compliance tests in the sample.

Table 3-1 STAGED COLLISION DISTRIBUTION BY VEHICLE SIZE AND IMPACT LOCATION

	IMPACT LOCATION			
	FRONT	SIDE	REAR	TOTAL
MINICAR	37	0	0	37
SUBCOMPACT	29	2	0	31
COMPACT	15	6	0	21
INTERMEDIATE	32	11	3	46
FULL SIZE	23	4	4	31
LARGE	3	1	0	4
	139	24	7	170

Table 3-2 STAGED COLLISION DISTRIBUTION BY IMPACT TYPE AND SPEED

		SPEED (MPH)							
		0-10	11-20	21-30	31-40	41-50	>51	TOTALS	
MINICAR	FRONT	0	2	22	10	3	0	37	37
	SIDE	0	0	0	0	0	0	0	
	REAR	0	0	0	0	0	0	0	
SUBCOMPACT	FRONT	1	0	25	2	1	0	29	31
	SIDE	0	1	1	0	0	0	2	
	REAR	0	0	0	0	0	0	0	
COMPACT	FRONT	0	0	10	4	1	0	15	21
	SIDE	0	5	1	0	0	0	6	
	REAR	0	0	0	0	0	0	0	
INTERMED-IATE	FRONT	0	2	19	4	7	0	32	46
	SIDE	0	1	6	2	2	0	11	
	REAR	0	0	0	1	1	1	3	
FULL SIZE	FRONT	2	1	11	5	3	1	23	31
	SIDE	0	4	0	0	0	0	4	
	REAR	0	1	3	0	0	0	4	
LARGE	FRONT	0	0	3	0	0	0	3	4
	SIDE	0	1	0	0	0	0	1	
	REAR	0	0	0	0	0	0	0	
TOTAL		3	18	101	28	18	2		170

From the viewpoint of the desired rigorous evaluations of the validity and accuracy of all aspects of the SMAC and CRASH computer programs, no fully documented staged collisions, including realistic spinout trajectories, were found within Phase 1 of this research program (i.e., with measured values for ΔVs, tire-terrain friction coefficient, rolling resistances and steering system responses). In almost all cases involving two vehicles, the testing procedures precluded a natural "end" to the collision; that is, the vehicles were artificially snubbed to prevent a realistic roll-out or spin-out resulting in unrealistic rest positions. There were, however, seven cases uncovered that provided at least partial information on spinout trajectories as required for corresponding validation purposes. These cases have been included in the data bank and are listed together with those providing damage information only in Appendix 2.

3.2 Long Term Plans

The validity and accuracy of present and future analytical techniques for reconstruction of highway accidents must be rigorously evaluated under two distinctly different conditions of application. First, the basic validity and accuracy of a reconstruction procedure must be established by means of detailed correlation with measured responses in experiments in which all items of input data have been directly measured. Second, the accuracy of the reconstruction technique must also be evaluated under field conditions, in which some aspects of the collision are necessarily estimated by the investigator (e.g., rolling resistances of individual wheels, steering system responses induced either by damage, tire aligning torques or the driver, etc.).

Both conditions of technique evaluation can be achieved with results of staged collisions in which comprehensive measurements have been made of all data items needed for the reconstruction calculations. With such test results, field conditions can readily be simulated by withholding part of the measured data. However, staged collisions in which incomplete measurements of the input requirements for reconstruction calculations have been made can obviously serve only for technique evaluations under field conditions. In such evaluations, the roles of investigator estimates and of technique shortcomings in the production of errors cannot be distinguished.

3.2.1 Staged Collisions

An immediate and urgent need is seen for the performance of special staged collisions for the purposes of (1) rigorously establishing accuracy ranges of analytical reconstructions for the more common collision configurations and vehicle sizes and (2) resolving recognized or suspected reconstruction difficulties in certain frequently occurring accident types (e.g., "pocketing" sideswipes, configurations in which the duration of contact is unusually prolonged, cases involving significant side slip angles prior to collision, etc.). However, subsequent to completion of the cited fundamental development tasks, it appears that a long term program of extensions and refinements can be achieved in a cost-effective manner on the basis of "piggyback" testing, in which tests performed for other purposes can serve to provide the required response data. Thus, the priorities for performance of staged collision experiments should be as follows:

Special Test Series

(1) Basic accident configurations (i.e., the more common types) for the existing vehicle size population.

(2) Frequently occurring accident types that involve recognized or suspected reconstruction difficulties.

"Piggyback" Tests

(3) Tests which will permit refinement of empirical crush properties (a) to distinguish specific contact locations along sides and (b) to include effects of over/underride of interacting structures.

(4) Tests which will permit refinement of vehicle categories to include special vehicle types, such as station wagons, rear-engine vehicles, etc.

(5) Tests which will provide data for periodic updates of vehicle size and type categories and of the corresponding crush tables to reflect changes in the vehicle population.

In view of the preceding considerations regarding a need for staged collisions including comprehensive measurements of the data required for reconstruction calculations, a recommended minimum instrumentation package is defined in Reference 24 which has been prepared within Phase 1 of this research program for use in future collision experiments.

3.2.2 Vehicle Instrumentation

The following items are included in the recommended minimum instrumentation package, in addition to the basic measures of linear and angular velocities and accelerations:

(1) steering system displacement time-history

(2) individual wheel rotational time-history

(3) pitch and roll displacement time-histories.

The recommended minimum instrumentation package will provide the data required for evaluation of basic validity (i.e., with all reconstruction inputs directly measured). Also, item (1) can serve to guide the future development of a steering-system degree of freedom in the SMAC program and/or the trajectory option of CRASH2 (it should be noted that the Calspan-developed Highway-Vehicle-Object Simulation Model (HVOSM) computer program (Reference 21) includes such a steer degree of freedom). It can also provide guidance for corresponding modification of the SPIN2 calculations of CRASH2. Item (2) will provide direct measures of the extents of individual wheel lockup during the spinout. Item (3) can provide a basis for development of an approximation of the effects of longitudinal and lateral weight transfer within the present analytical constraints of plane motion and it can also serve for validation purposes in any future development of a three-dimensional reconstruction technique.

3.2.3 Test Procedures

In addition to the minimum instrumentation package, certain procedural changes are recommended both for special staged collisions and for selected collision experiments that are being performed for other purposes but which can serve in evaluations of reconstruction techniques. The following items are included:

(1) Elimination of "snubbing" constraints and/or late brake applications of the involved vehicles. Whenever possible, the vehicles should be towed to the collision point in gear and should be permitted to come to rest without any unnatural constraints on spinout motions.

(2) Each staged collision should be investigated and reported in the manner of a real accident.

In many of the car-to-car collisions that have been performed by Calspan and others, in relation to research in restraint systems and/or structural crashworthiness, the striking vehicle has been "snubbed" by a trailing cable subsequent to the collision. Also, the struck vehicle has generally been motionless at impact, making the collision conditions not representative of typical highway accidents. The early UCLA-ITTE series of staged collisions (e.g., Reference 22) included late applications of full braking at unspecified times and positions. Also, in most staged collisions the vehicles have been towed with the transmissions in neutral. As a result of the cited test procedures, the resulting spinout trajectories generally cannot be applied in meaningful evaluations of the accuracies of reconstruction techniques.

In addition to the above problems with test procedures, the results of staged collisions have generally not been reported with sufficient detail to permit their use for rigorous validations of reconstruction techniques. Since staged collisions tend to be very expensive experiments, the additional costs of using modified test procedures and of producing detailed investigation reports are considered to be well justified by the corresponding benefits in relation to the development of accident reconstruction procedures.

3.2.4 Investigation Procedures

The investigative and analytical aspects of accident reconstruction are intimately related. Therefore, future refinements of reconstruction techniques must necessarily involve corresponding refinements in investigation procedures,

For example, the need for an investigator's estimate of the direction of principal force (DOPF) is considered by some to be the Achille's heel of the CRASH2 reconstruction procedure. For this reason, development of the following related aspects of accident investigation and reporting are recommended as a part of long-range plans.

(1) An interpretation technique for damage profile matches in terms of the indicated DOPF. A graphical procedure is believed to be best suited to the task, using the existing CRASH2 format for definition of damage profiles. Or an automatic check of the compatibility of individual damage profiles with the specified DOPF could possibly be incorporated in CRASH2.

(2) Procedures for measurement, coding and interpretation of tangential deflections of vehicle structures.

(3) A procedure for correlation of occupant contact points with the DOPF.

(4) Inclusion of a detailed analysis of tire marks at the point of impact, where available, for use in damage-only applications of CRASH2 (i.e., evidence of positions and headings at impact, directions of motion subsequent to impact).

3.2.5 Evaluations of Reconstruction Accuracy

To achieve a realistic evaluation of the accuracy of a reconstruction technique any iterative adjustments of the impact speeds and the collision configurations (e.g., SMAC) must be either (a) automated or (b) performed without prior knowledge of the conditions of collision. Otherwise, misleading results may be produced by manual iterations performed with a prior knowledge of the correct speeds and speed-changes.

3.2.6 Staged Collision Data Bank

The computerized bank of staged collision data that is reported herein should be maintained and kept up to date as additional collision experiments are performed. The basic data bank should be kept independent of specific reconstruction techniques so that it can serve for testing the validity and accuracy of any extended and refined techniques that may be developed in the future.

Special computer routines will be required to extract items from the basic data bank for application in analysis procedures such as that in the CRUSH program (Reference 23). Note that the analytical procedure of CRUSH referred to here consists only of the portion of the program that extracts damage parameters such as absorbed energy, damage area, first moment of damage area, etc., as opposed to generating empirical fits. By this means, a second data bank of processed damage information in a format determined by the specific reconstruction technique will be created.

Finally, a computer routine for automatically fitting several forms of analytical relationships (e.g., linear, bilinear, polynomial) to multiple data points will be required to permit periodic updates of empirical fits to the processed data contained in the second bank described above. As the number of data points in that bank becomes more extensive, consideration can be given to "zoning" of the vehicle crush properties (e.g., side contacts at wheels vs. those on doors) and to adoption of force deformation relationships more realistic than the present linear one.

Application of the staged-collision data bank for the purpose of refinement and periodic updating of an accident reconstruction technique is depicted schematically in Figure 3-1. Specific details of the staged collision data bank are presented in Appendix 3.

3.2.7 Staged Collision Data Bank Planning

The purpose of the Staged Collision Data Bank is to provide a data storage and retrieval system which will contain measured data from staged collisions. This data will be used to update current accident analysis techniques as well as provide for future reconstruction program design, verification, and training. Consequently, this data bank must be of a coherent structure which includes all the measured or estimated quantities required now or presumed useful in the future. The design should provide easy maintenance of the data as well as efficient data retrieval capabilities.

Design Considerations

There are about 120 individual data items describing a staged collision planned for inclusion in the data bank. Assuming a record size of 80 characters (a computer data card, for instance), then 20 cards would be required to describe one staged collision. Assuming an upper limit of 10,000 cases, which could be achieved over a several year period with the provision of staged collision data by members of the Motor Vehicle Manufacturers Association (MVMA), this data file would take 100 boxes of cards. Clearly, hand manipulation of one hundred boxes of computer cards is out of the question. This is an overall file size of 16 million bytes, which is large but well within the capabilities of disc storage (an IBM 3330-1 disc drive can hold 200 million bytes) and/or tape storage (a 2400' reel of tape can hold 22 million bytes). One would assume that when the file is not in use, it

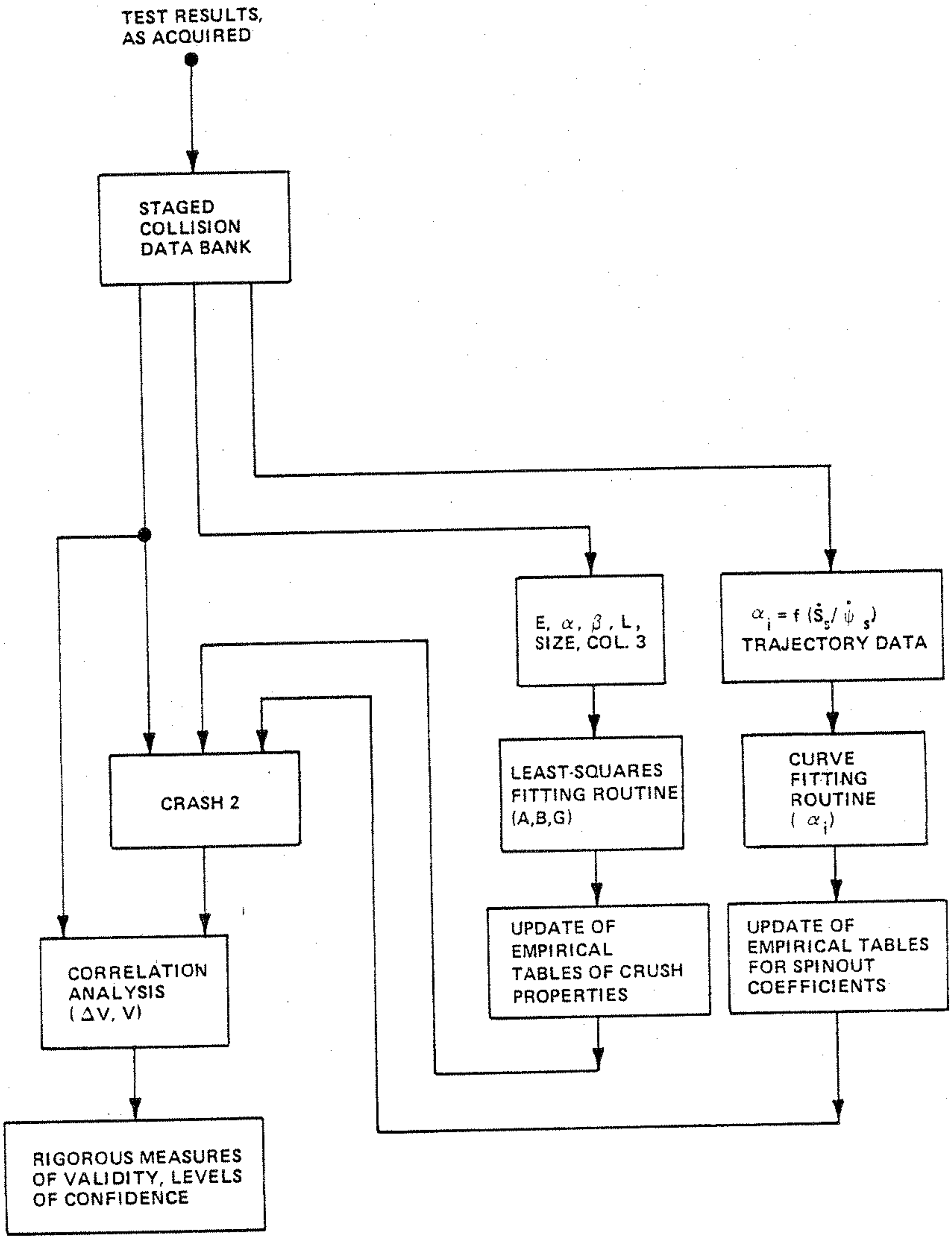


Figure 3-1 SCHEMATIC FLOW CHART FOR APPLICATIONS OF STAGED COLLISION DATA BANK

would be "spooled" to tape. During heavy periods of usage, the file would be restored to disc and would cost, at today's prices, about $60 per week of disc rental at the upper limit of 10,000 cases. We plan to start out with an initial file size of 1000 cases costing about $6.00 per week of disc space rental. An option would always be available to "rebuild" the file to a larger size.

The software input/output access technique to be used is the FORTRAN direct access input/output method. With this technique, the programmer asks for a particular record number and the system software fetches it in a random access fashion that is very direct and efficient. With the normal FORTRAN "sequential" input/output method, the programmer always gets the next record, rather than a particular one. To clarify this concept, consider the programmer who wants to retrieve the 800th record in a file. With normal "sequential" input/output, the program has to read and ignore the first 799 records before getting the desired one. With FORTRAN direct access input/output, the program goes directly to the 800th record with no intervening steps. Obviously, the file has to be on disc for this to work. This is an excellent choice since Calspan's IBM computer has this capability, as does McAuto which provides data processing services for NHTSA, as does the DEC PDP 11-40 minicomputer that NHTSA owns in Washington.

File Layout

The Staged Collision Data File consists of 80 character records - a lot of them. The first two records, called the "file status records" are used to identify the file, its creation date, the number of staged collisions in it, the space remaining, and so forth. The next 1000 records, called the "index", describe each collision in a concise way, such as title, agency, impact speeds, collision configuration, and the like. Each index record contains a pointer (record number) to the exact location of that collision's twenty data records further down in the file. This allows the program to go directly to that place in the file without having to process intervening records. Another advantage of the index technique is that a fairly efficient "sort" of the data can be accomplished by utilizing the index card summary parameters as "keys". For example, if one wished to retrieve those cases involving 1973 compact cars, a scan of the index will provide pointers for easy retrieval of just that class of cases. The last 20,000 records contain the data. For each case there are twenty 80 character records with all the data outlined in the suggested coding forms in Appendix 1. Since the records are all eighty characters long, the notion of card image is retained. To add a staged collision to the file, twenty cards are input to the file maintenance program. It, in turn, copies an image of those cards on the disc file, adds an index entry, and updates the file status.

The data records are not packed, rather they are laid out in wide fields to enhance readability in the coding forms and any "dumps" of the file. With memory technology improving in a cost-per-bit sense, it is economical to maximize readability at the expense of minimizing data storage capacity. The index is packed data since it will be used for high speed sorting operations. The details of the format of the entire RICSAC staged collision data bank are given in Appendix 3.

File Maintenance Program

The file maintenance program builds the staged collision file, modifies it, and prints or punches its contents. The program will be principally interactive, but can also be run in batch mode much in the same way as the CRASH2 program. Basically, the user will be prompted for a command. Upon receipt of the command, the function is executed and another prompt provided. There are ten commands planned, they are as follows:

1. BUILD password (CR)

The BUILD function erases the old file and builds a new one, possibly of a larger size. For obvious reasons, the password will be kept fairly secret. Build resets most of the parameters in the "file status records" and clears the index and data records to blanks.

2. LIST STATUS (CR)

This option provides a display of the file status records, formatted into readable English.

3. LIST INDEX (CR)

The entire index is displayed in formatted, readable style by this option.

4. LIST DATA (qualifiers) (CR)

A single collision, or a class of collisions can be displayed by this option in readable form. The qualifier "ALL" implies the entire file to be listed. A single collision may be specified by one of the two absolute qualifiers:

Absolute Qualifiers: NUMBER = ____________________
TITLE = ____________________

A class of collisions may be specified by one or more of the sort qualifiers.

Sort Qualifiers: AGENCY = ____________________
SIZE1 = ____________________
SIZE2 = ____________________
YEAR1 = ____________________
YEAR2 = ____________________
CONFIG1 = ____________________
CONFIG2 = ____________________
SPEED1 = ____________________
SPEED2 = ____________________
DELTAV1 = ____________________
DELTAV2 = ____________________

The qualifiers will probably be separated by commas, with continuation lines provided for the intricate sorts.

5. EDIT DATA (entry sequence number, new) (CR)

The edit command is for interactive use only since it will trigger a series of user interrogatories to modify items in the 20 record set for the specified case. If "new" is selected, a new staged collision may be keyed in.

6. READ DATA (entry sequence number, new) (CR)

This command is similar to the "edit" command, except that twenty cards are read rather than a question-answer sequence. Thus, this option is suitable for batch runs only.

7. PUNCH DATA (qualifiers) (CR)

Using the qualifiers, PUNCH will transfer a 20 card copy of a collision or a set of collisions to an output data set specified by the user in his Job Control Language setup.

8. TAPE COPY (CR)

Tape copy will generate a backup tape copy of the staged collision data file for security purposes.

9. HELP (COMMAND) (CR)

Help will provide syntax information on the command specified in the operand field.

10. END (CR)

END terminates operations with the file maintenance program.

Work Accomplished to Date

The RICSAC file format has been defined and a survey of the world literature has resulted in a moderate number of cases being coded onto punched cards. A listing of those punched cards is given in Appendix 2.

The overall system design of the RICSAC file maintenance software has been completed. The main program and the "BUILD" function have been coded and checked out. The BUILD function erases the old definition of the RICSAC and defines a new structure. Figure 3-2 shows a typical interactive run for this option choice. The other file maintenance functions have been coded, but at the time of the printing of this report are still being debugged.

As an applications example, data from the RICSAC staged collision data bank were input to an upgraded version of the CRUSH routine for the purpose of improving the CRASH program's A, B, and G crush constants. Using a least squares curve fit, the new CRUSH routine reads RICSAC data for a class of collisions and determines a fit to the data to give the crush constants. In the included example, data from the RICSAC data bank for all intermediate side impacts has been used to exercise the CRUSH routine. Figure 3-3 shows the printout results from that run.

Intermediate Side (new data)	A = 327.83
	B = 61.36
	G = -869.07
Intermediate Side (old data*)	A = 143.0
	B = 50.4
	G = 202.7

*"Yielding Barrier Test Data Base - Refinement of Damage Data Tables in the CRASH Program" R. R. McHenry, Interim Report, December 1976 (Reference 23).

```
ENTER COMMAND (LIST,EDIT,READ,PUNCH,TAPECOPY,HELP,BUILD, OR END)
?


                    RICSAC FILE MAINTENANCE PROGRAM

DESCRIPTION OF OPTIONS

BUILD:                       ERASE AND REDEFINE DATA BANK FILE

LIST STATUS:                 LIST DATA BANK FILE STATUS

LIST INDEX:                  LIST DATA BANK INDEX

LIST DATA:                   LIST STAGED COLLISION DATA

EDIT DATA:                   ADD OR MODIFY COLLISION DATA

READ DATA:                   ADD OR MODIFY COLLISION DATA FROM CARDS

PUNCH DATA:                  TRANSFER DATA TO OTHER PROGRAMS

TAPECOPY:                    MAKE A TAPE BACKUP COPY OF DATA BANK

HELP (COMMAND NAME):         USER ASSISTANCE SERVICE

END:                         TERMINATE PROGRAM OPERATIONS

NOTE: ABBREVIATIONS ARE O.K.

ENTER COMMAND (LIST,EDIT,READ,PUNCH,TAPECOPY,HELP,BUILD, OR END)
BUILD  GODZILLA


++++ BUILD OPTION ++++


ENTER NEW DATASET NAME?
(NOTE: USE THE DATASET NAME FROM JCL CARD - 8 CHAR. MAX.)
JYRICSAC

ENTER NEW DATA DEFINITION NAME?
(NOTE: USE THE DDNAME FROM JCL CARD - 8 CHAR. MAXIMUM)
FT10F001
```

Figure 3-2 INTERACTIVE RUN OF RICSAC FILE MAINTENANCE PROGRAM (BUILD OPTION)

```
   ENTER A FILE TITLE? (40 CHARACTERS MAX.)
   RICSAC STAGED COLLISION DATA BANK


   ENTER TODAY'S DATE?  (NOTE: 12 CHARACTERS MAX)
   25 MAY 1977


   ENTER THE MAXIMUM NUMBER OF COLLISIONS?
      100


++++ RICSAC STATUS RECORD # 2 INITIALIZED ++++
++++ RICSAC INDEX INITIALIZED ++++
++++ RICSAC DATA RECORDS INITIALIZED ++++


ENTER COMMAND (LIST,EDIT,READ,PUNCH,TAPECOPY,HELP,BUILD, OR END)
END



                  ++++ RICSAC FILE MAINTENANCE PROGRAM COMPLETED ++++
```

Figure 3-2 (Continued)

```
==== INPUT DATA AND CRUSH ROUTINE RESULTS ====

PERP. SIDE IMPACT TEST 6       SEPT. 76
VEHICLE TYPES :       4    4
VEHICLE WEIGHTS:     4440.00   4430.00
VEHICLE DAMAGE INDICES: 03RPEW2    12FDEW1
COLLISION SPEEDS:          0.0     519.20
A(2),B(2),G(2):        233.70      49.90      547.30
DIRECTION OF PRINCIPAL FORCE:       90.00        0.0
V1 DAMAGE DATA:     80.00           7.20       7.20       7.20       7.20       4.80       2.40       8.
V2 DAMAGE DATA:     80.00           1.80       1.80       3.20       6.00       0.00       0.00       9.
GAM(1:2):        0.98        0.98
ENERGY(2):  120184.37
DELV1:   253.64
SUMENG:   757199.50
ENERGY(1):  637015.12
ALPHA1,BETA1:          499.20       1643.51



==== INPUT DATA AND CRUSH ROUTINE RESULTS ====

PERP. SIDE IMPACT TEST 44      FEB. 1973
VEHICLE TYPES :       4    4
VEHICLE WEIGHTS:     4100.00   3860.00
VEHICLE DAMAGE INDICES: 03RYEW3    12FDEW2
COLLISION SPEEDS:          0.0     536.80
A(2),B(2),G(2):        233.70      49.90      547.30
DIRECTION OF PRINCIPAL FORCE:       90.00        0.0
V1 DAMAGE DATA:     76.00          14.30       8.10       8.70       4.40       3.10       5.00      -3.
V2 DAMAGE DATA:     76.00           4.00      15.00       0.00       0.00       0.00       0.00       7.
GAM(1:2):        1.00        0.99
ENERGY(2):  400577.56
DELV1:   257.98
SUMENG:   734707.25
ENERGY(1):  334129.69
ALPHA1,BETA1:          516.04       2086.83



==== INPUT DATA AND CRUSH ROUTINE RESULTS ====

OBLIQUE SIDE IMPACT TEST 5     FEB. 1973
VEHICLE TYPES :       4    4
VEHICLE WEIGHTS:     3805.00   3550.00
VEHICLE DAMAGE INDICES: 02RPEW4    12FZEW3
COLLISION SPEEDS:          0.0     804.32
A(2),B(2),G(2):        233.70      49.90      547.30
DIRECTION OF PRINCIPAL FORCE:       45.00        0.0
V1 DAMAGE DATA:     67.60           3.80      11.30      16.30      15.00      13.80       5.00     -20.
V2 DAMAGE DATA:     48.80           0.00      28.00       0.00       0.00       0.00       0.00      22.
GAM(1:2):        0.74        0.88
ENERGY(2):  504561.94


DELV1:   312.65
SUMENG:  1238147.00
ENERGY(1):  733585.06
ALPHA1,BETA1:          822.01       5418.60
```

Figure 3-3 SAMPLE RUN OF UPDATED CRUSH ROUTINE USING RICSAC DATA FOR INTERMEDIATE SIDE COLLISIONS

```
==== INPUT DATA AND CRUSH ROUTINE RESULTS ====

90 DEG. SIDE IMPACT TEST 2       FEB. 73
VEHICLE TYPES :      4    4
VEHICLE WEIGHTS:     3860.00   3600.00
VEHICLE DAMAGE INDICES: 03RYEW4     12FDEW2
COLLISION SPEEDS:          0.0      320.16
A(2),B(2),G(2):       233.70      49.90     547.30
DIRECTION OF PRINCIPAL FORCE:       90.00       0.0
V1 DAMAGE DATA:     76.00          24.00      16.50     18.30     16.60     10.00     12.90      1.07
V2 DAMAGE DATA:     76.00           8.30      20.00      0.00      0.00      0.00      0.00      5.11
GAM(1:2):        1.00       0.93
ENERGY(2):  700635.94
DELV1:   334.30
SUMENG:  1615285.00
ENERGY(1):  914649.06
ALPHA1,BETA1:        1215.24      10172.30


==== INPUT DATA AND CRUSH ROUTINE RESULTS ====

90 DEG. SIDE IMPACT TEST 30     FEB. 73
VEHICLE TYPES :      4    4
VEHICLE WEIGHTS:     4150.00   3740.00
VEHICLE DAMAGE INDICES: 03RYEW2     12FDEW1
COLLISION SPEEDS:          0.0      254.00
A(2),B(2),G(2):       233.70      49.90     547.30
DIRECTION OF PRINCIPAL FORCE:       90.00       0.0
V1 DAMAGE DATA:     76.00           7.90       5.80      6.60      5.00      0.0       5.00      -9.76
V2 DAMAGE DATA:     76.00           0.00       1.50      0.00      0.00      0.00      0.00      12.67
GAM(1:2):       0.90       0.96
ENERGY(2):   56338.30
DELV1:   120.05
SUMENG:   171475.56
ENERGY(1):  115137.73
ALPHA1,BETA1:         362.52       1035.90


==== INPUT DATA AND CRUSH ROUTINE RESULTS ====

90 DEG. SIDE IMPACT TEST 31     FEB. 73
VEHICLE TYPES :      4    4
VEHICLE WEIGHTS:     4100.00   3800.00
VEHICLE DAMAGE INDICES: 03RYEW2     12FDEW1
COLLISION SPEEDS:          0.0      538.56
A(2),B(2),G(2):       233.70      49.90     547.30
DIRECTION OF PRINCIPAL FORCE:       90.00       0.0
V1 DAMAGE DATA:     76.00          14.40       8.40      8.40      6.00      2.90      5.60       2.02
V2 DAMAGE DATA:     76.00          11.00      14.00      0.00      0.00      0.00      0.00       1.52


GAM(1:2):        1.00       1.00
ENERGY(2):  561312.50
DELV1:   238.84
SUMENG:   739560.50
ENERGY(1):  178248.00
ALPHA1,BETA1:         542.64       2242.85


                 ==== RESULTS OF LEAST SQUARES FIT ====

                 A =    327.83
                 B =     61.36
                 G =   -869.07
```

Figure 3-3 (Continued)

The difference in the results may be attributed to a larger sample size, a wider range of speed change, and to the inclusion of different makes of vehicles. Using the RICSAC final data and the file manipulation software, all the CRASH program crush constants may be updated in this fashion.

Conclusions

The file layout and software system design can provide NHTSA with a powerful and convenient tool for directing future research efforts in staged collisions. Since the file format and file maintenance software are user-oriented, any NHTSA contractor who runs a staged collision test may dial up a NHTSA computer with an interactive terminal and add that staged collision to the data bank. This feature alone will be popular since it eliminates middlemen and paperwork. Also, the contractor may modify any collision in which errors or discrepancies are uncovered. The contractors will, of course, have access to data of any staged collision in the data bank.

The RICSAC staged collision data bank and associated software should assist NHTSA in planning future series of staged collisions since the data bank provides an instant information retrieval system which can easily synopsize what types of collisions have already been done. Maintenance of the system is enhanced by the tape and card backup procedures provided in the RICSAC software. The type of FORTRAN capabilities being used are common enough to make the system very portable, from minicomputers to large mainframes.

Finally, to assist those contractors who wish to interface their computer programs to the RICSAC data, the "PUNCH DATA" option is a general data transfer routine to which the contractor may wish to make special modifications in order to generate a secondary file for use with special programs to process the data. Calspan will provide detailed documentation to assist in this type of effort.

Calspan feels that the concepts described should be implemented fully in the near future. An information retrieval system for staged collision data that is designed with computer aided reconstruction requirements in mind is a powerful concept that will pay for itself in terms of future organization, manipulation, and storage of staged collision data.

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APPENDIX 1

DATA FORMS AND INSTRUCTIONS

Figure 1 STAGED COLLISION DAMAGE DATA

IMPACT CONFIGURATION ______________________

TESTING AGENCY ______________________

SOURCE OF DATA ______________________

	VEHICLE #1				VEHICLE #2			
YEAR	______				______			
MAKE	______				______			
MODEL	______				______			
SIZE CATEGORY	______				______			
TEST WGT.	______			LBS	______			LBS
IMPACT SPEED	______			MPH	______			MPH
SPEED CHANGE	______			MPH	______			MPH
VDI	______				______			
DIRECTION OF PRINCIPAL FORCE	______			DEG	______			DEG
INITIAL CONTACT	______				______			
DAMAGE ELEVATION	____	____	____		____	____	____	
L	____	____	____		____	____	____	
D	____	____	____		____	____	____	
INCHES C_1	____	____	____		____	____	____	
INCHES C_2	____	____	____		____	____	____	
INCHES C_3	____	____	____		____	____	____	
INCHES C_4	____	____	____		____	____	____	
C_5	____	____	____		____	____	____	
C_6	____	____	____		____	____	____	

REMARKS ______________________

Figure 2 STAGED COLLISION TRAJECTORY DATA

IMPACT CONFIGURATION ______________________________

TESTING AGENCY ______________________________

SOURCE OF DATA ______________________________

		VEHICLE #1		VEHICLE #2	
YEAR		________		________	
MAKE		________		________	
MODEL		________		________	
SIZE CATEGORY		________		________	
TEST WGT		________	LBS	________	LBS
IMPACT SPEED		________	MPH	________	MPH
SPEED CHANGE		________	MPH	________	MPH
VDI		________		________	
POINT OF IMPACT	X	________	FT	________	FT
	Y	________	FT	________	FT
	ψ	________	DEG	________	DEG
POINT OF REST	X	________	FT	________	FT
	Y	________	FT	________	FT
	ψ	________	DEG	________	DEG
END OF ROTATION	X	________	FT	________	FT
	Y	________	FT	________	FT
	ψ	________	DEG	________	DEG
CURVED PATH	X	________	FT	________	FT
	Y	________	FT	________	FT
ROTATION		________		________	
360°<ROT?		________		________	
ROLLING RESISTANCE	RF	________		________	
	LF	________		________	
	RR	________		________	
	LR	________		________	

TIRE-TERRAIN FRICTION ________

REMARKS ______________________________

____

____

STAGED COLLISION DAMAGE DATA INSTRUCTIONS

IMPACT CONFIGURATION - A brief description of the general type of impact, for example:

Frontal SAE Barrier Impact
Perpendicular Side Impact
Oblique Side Impact
Head-on Frontal Impact
Offset Frontal Impact.

TESTING AGENCY - The name of the organization performing/reporting the test.

SOURCE OF DATA - Corporate report number, date, and test number (if available). Also, NTIS-PB number if available.

YEAR
MAKE
MODEL - Self-explanatory. Note, however, that if a barrier impact, either SAE Barrier or SAE Moving Barrier should be indicated under the VEHICLE #2 heading.

		1	2	3	4	5	6
		MINICAR	SUBCOMPACT	COMPACT	INTERMEDIATE	FULL SIZE	LARGE
WHEEL BASE INCHES	NOMINAL	93.2	96.4	106.8	113.9	121.1	125.2
	FROM	<93.2	94.9	101.7	110.4	117.6	123.3
	TO	94.8	101.6	110.3	117.5	123.2	>125.2
CURB WGT. POUNDS	NOMINAL	1902	2753	3247	3947	4565	5009
	FROM	<1902	2328	3001	3598	4257	4788
	TO	2327	3000	3597	4256	4787	>5009
OVERALL LENGTH INCHES	NOMINAL	159.8	174.9	196.2	212.8	223.7	229.4
	FROM	<159.8	167.4	185.6	204.6	218.3	226.6
	TO	167.3	185.5	204.5	218.2	226.5	>229.4

SIZE CATEGORY - The size category of the vehicles tested can be determined from the above table. It should be noted that the above nominal values are based on the averages of a number of vehicles and it is likely that inconsistent determination of the size category based on the different measurements may occur for any given vehicle. Also, the above table lists curb weight which is not necessarily the same as test weight. Some interpretation and judgement may be required in the specification of this descriptor.

TEST WEIGHT - Weight of the vehicles as tested. Note that this weight is, in general, not the same as curb weight but should be reported. If unavailable, curb weight (as available from MVMA specifications or Automotive News model year summaries) can be used but should be enclosed in parentheses to indicate an estimated value.

IMPACT SPEED - Self-explanatory.

SPEED CHANGE - Difference between impact speed and speed at time of separation of two vehicles (or vehicle and barrier). This item is generally not reported and if not, should be left blank.

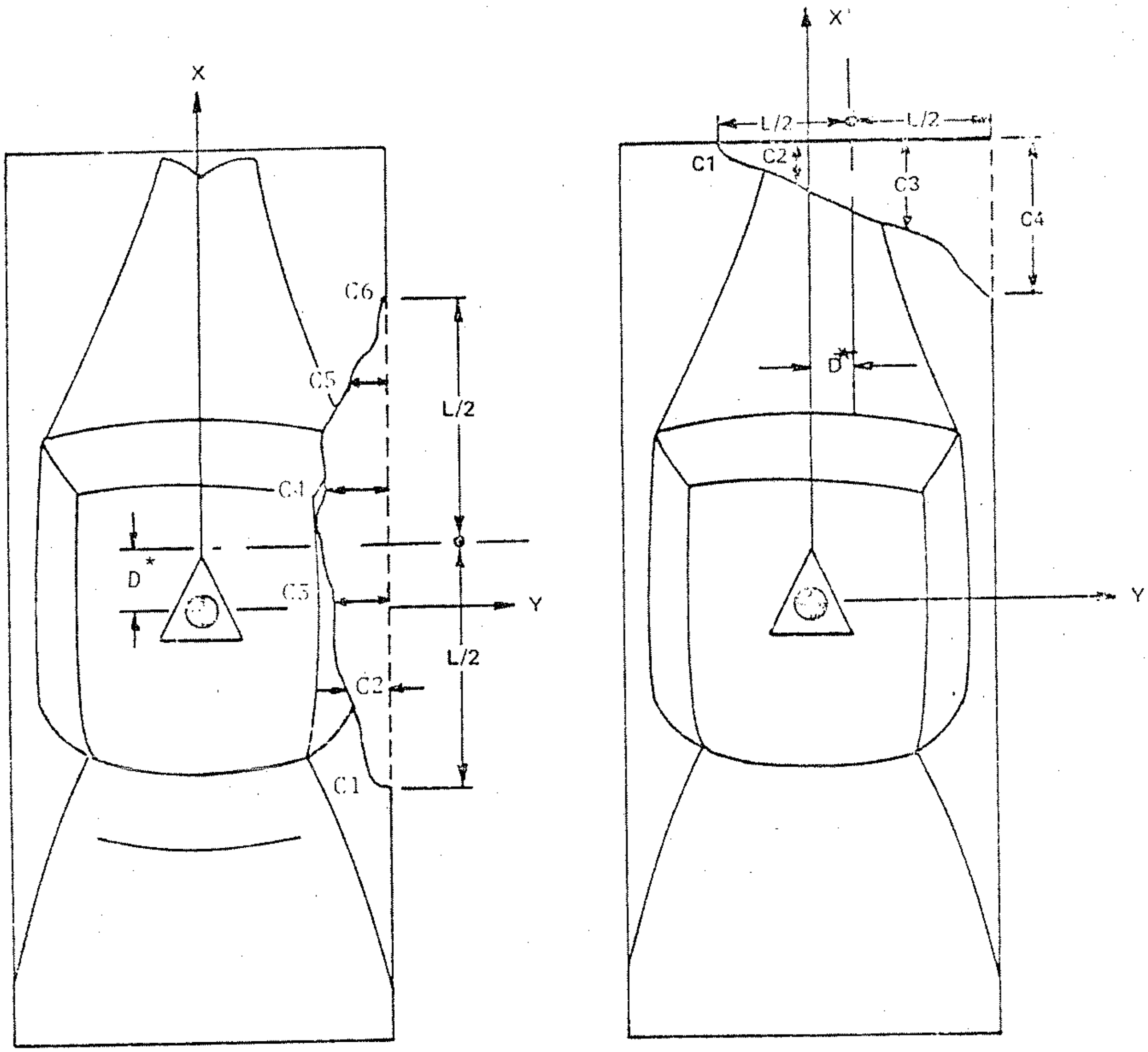
VDI - Vehicle Damage Index. If not reported, this item should be obtained from drawings or photographs of the vehicles in conjunction with damage measurements. Undamaged vehicle dimensional information that may be required is generally available from MVMA specifications. If this item cannot be determined with confidence it should be estimated and enclosed in parentheses.

DIRECTION OF PRINCIPAL FORCE - This item is required if it is known with a higher degree of accuracy than the clock direction of the VDI and follows the clock direction convention. For example, a frontal impact has a clock direction of 12 and a DOPF of 0 deg.; a perpendicular right side impact is 3 o'clock and 90 deg.; a rear impact is 6 o'clock and 180 deg.; and a perpendicular left side impact is 9 o'clock and -90 deg.

INITIAL CONTACT - If a wide contact area, supply the general location of the contact, for example: front, right side, etc. If the initial contact is localized, reference the point of initial contact to known location, for example: Door Opening Reference (DOR).

DAMAGE ELEVATION - The option is provided for supplying damage information at as many as three different elevations if this information is known. If only one damage profile is available, supply the elevation (above the ground) at which the damage is known. If unknown, supply an estimate (for example, 20 inches), and enclose in parentheses.

The following damage information is supplied consistent with the sketch supplied. If any values are estimated, enclose them in parentheses. Very often these items will have to be scaled from sketches or photographs.



*D shown positive

DAMAGE DIMENSIONS

L - Length of the direct damage area. Note that this length should not include induced damage. For example, in a perpendicular side impact, L should be entered as the width of the impacting car. Similarly, in a head-on frontal impact between a large and small car, L should be the width of the small car.

D - Offset between the center of the contact area (center of L) and the vehicle center of gravity. For side impacts, D is positive if the center of L is forward of the vehicle c.g. and negative, if it is behind the c.g. For front and rear impacts, D is positive if the center of L is to the right of the vehicle centerline and negative if it is to the left. If the location of the vehicle c.g. is not reported, it is necessary in the case of side impacts to determine it from whatever information is available. For example, MVMA specifications provide front and rear overhangs and wheelbase so that the axle locations can be determined and if the axle load distribution is reported, the c.g. position can then be calculated. If not reported, the curb weight distribution is available in the MVMA specifications.

C_1 THROUGH C_6 - Depth of deformation at 2, 4, or 6 equally spaced stations along the damage length L.

REMARKS - Any additional qualifiers that may be appropriate.

RICSAC PROGRAM
STAGED COLLISION DATA BANK CODING FORM

PROGRAM		PUNCHING INSTRUCTIONS	GRAPHIC	PAGE OF
PROGRAMMER	DATE		PUNCH	

Card	Fields (columns 1–80)								
1	TITLE					[illegible]	[illegible]	[illegible]	[illegible]
2	MAKE V1	MODEL V1				YEAR V1	[illegible]	[illegible]	[illegible]
3	V1 TYPE	VGI V1	WEIGHT V1	IMPACT X V1		[illegible] V1	[illegible] V1	[illegible]	
4	[illegible] X V1	[illegible] Y V1	[illegible] V1	[illegible] V1	[illegible] V1	[illegible] V1	[illegible] V1	[illegible] V1	[illegible]
5	ROTATION V1	> 360° V1	ROLL R. RF V1	ROLL R. LF V1	ROLL R. [illegible] V1	ROLL R. LR V1	LR DEPTH OF DAMAGE [illegible]		
6	DAMAGE ELEVATION V1	WIDTH V1	DEPTH 1 V1	DEPTH 2 V1	DEPTH 3 V1	DEPTH 4 V1	DEPTH 5 V1	DEPTH 6 V1	[illegible]
7	DAMAGE ELEVATION V1	WIDTH V1	DEPTH 1 V1	DEPTH 2 V1	DEPTH 3 V1	DEPTH 4 V1	DEPTH 5 V1	DEPTH 6 V1	[illegible]
8	DAMAGE ELEVATION V1	WIDTH V1	DEPTH 1 V1	DEPTH 2 V1	DEPTH 3 V1	DEPTH 4 V1	DEPTH 5 V1	DEPTH 6 V1	[illegible]
9	MAKE V2	MODEL V2				YEAR V2	[illegible] V2	[illegible]	
10	V2 TYPE	VGI V2	WEIGHT V2	IMPACT X V2		IMPACT Y V2	IMPACT [illegible] V2	[illegible] V2	

RICSAC PROGRAM
STAGED COLLISION DATA BANK CODING FORM

PROGRAM
PROGRAMMER
DATE
PUNCHING INSTRUCTIONS
GRAPHIC
PUNCH
PAGE OF

RESET X V2	RESET Y V2	RESET Ψ V2	E.O.R X V2	E.O.R Y V2	E.O.R Ψ V2	CURVE X V2	CURVE Y V2		11
ROTATION C V2	±360° V2	ROLL R. RF V2	ROLL R. LF V2	ROLL R. RR V2	ROLL R. LR V2	RATIO OF DAMAGE EXTENTS V2			12
DAMAGE ELEVATION V2	WIDTH V2	DEPTH 1 V2	DEPTH 2 V2	DEPTH 3 V2	DEPTH 4 V2	DEPTH 5 V2	DEPTH 6 V2	DAMAGE OFFSET V2	13
DAMAGE ELEVATION V2	WIDTH V2	DEPTH 1 V2	DEPTH 2 V2	DEPTH 3 V2	DEPTH 4 V2	DEPTH 5 V2	DEPTH 6 V2	DAMAGE OFFSET V2	14
DAMAGE ELEVATION V2	WIDTH V2	DEPTH 1 V2	DEPTH 2 V2	DEPTH 3 V2	DEPTH 4 V2	DEPTH 5 V2	DEPTH 6 V2	DAMAGE OFFSET V2	15
TIRE-GND. FRICTION COEFFICIENT									16
COMMENTS									17
COMMENTS									18
COMMENTS									19
COMMENTS									20

APPENDIX 2

STAGED COLLISION DATA

```
COMPACT           03RYEW3 3020.                                   90.

(20)     76.0     16.6     10.2     9.6      6.9      1.9      3.3      -5.0

FORD                  CUSTOM 4 DR. SEDAN  1968 FRONT                30.3
INTERMEDIATE      12FDEW2 3900                                    0.0

(20)     79.3     1.0      16.0                                            0.0

HEAD ON FRONTAL IMPACT  MAY 1973        HD.-ON CENT.CALSPAN      YB-2987-V-8
FORD                  4 DR. SEDAN       1969 FRONT                40.6
FULL SIZE         12FDEW3 4310                                    0.0

(20)     73.      27.      27.                                             0.0

CHEVROLET             NOVA 2-DR. SEDAN    1968 FRONT              39.9
COMPACT           12FDEW3 3190                                    0.0

(20)     73       30       30                                              0.0

NOVA - COMPACT WGT BUT INTERMEDIATE WB

HEAD ON FRONTAL IMPACT  MAY 1973        HEAD-ON     CALSPAN      YB-2987-V-8
FORD                  4 DR. SEDAN       1969 FRONT                41.5
FULL-SIZE         12FDEW3 4120.                                   0.0

(20)     76.      33.      33.

BUICK                 ELECTRA 4-DR.       1968 FRONT              41.5
FULL SIZE                                                         0.0

(20)     75.      34.4     34.4

FORD - FULL SIZE WB BUT INTERMEDIATE WGT.

HEAD ON FRONTAL IMPACT  MAY 1973        HD.-ON CENT.CALSPAN      YB-2987-V-8
FORD                  4 DR. SEDAN       1969 FRONT                41.3
FULL SIZE         12FDEW3 4240                                    0.0
```

```
(20.)    66.       25.5      25.5                                                  0.0

CHEVROLET              VEGA 2 DR.          1971 FRONT               41.3
SUBCOMPACT         12FDEW3 2495                               0.0

(20)     66.0      30.7      30.7                                                  0.0




HEAD ON FRONTAL IMPACT    MAY 1973         HEAD-ON      CALSPAN      YB-2987-V-8
FORD                   4 DR. SEDAN         1968FULL FRONT           43.7
INTERMEDIATE       12FDEW3 3050                               0.0

(20)     76.0      34.       34.                                                   0.0

FORD                   4 DR. SEDAN         1968FULL FRONT           43.7
INTERMEDIATE       12FDEW3 3910                               0.0

(20)     76.0      30.       30.                                                   0.0

BOTH VEHICLES INTERMEDIATE BY WGT. BUT FULL SIZE BY WB

HEAD-ON FRONTAL                              FRONTAL    CALSPAN      AJ-2844-V-3
FORD                   4 DR. SEDAN         1968 FRONT               43.8
INTERMEDIATE       12FDEW3 3960.                              0.0

(20)     (50.8)    23.0      23.0                                                  0.0

OPEL                   2 DR. SEDAN         1968 FRONT               43.8
MINICAR            12FDEW4 1750.                              0.0

(20)     (50.8)    41.0      41.0                                                  0.0




PERP. SIDE IMPACT FEB. 72    TEST 44      PERP. SIDE   CALSPAN      YB 2987-V-9
FORD                   4 DR. SEDAN         1968FULL FRONTAL         30.5
INTERMEDIATE       12FDEW2 3060                               0.0
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(20.)   76.0    4.0     15.0                                    0.0

PLYMOUTH            FURY 4 DR. SEDAN     1969RIGHT SIDE      0.0
INTERMEDIATE    03RYEW3 4100.

(20.)   76.0    14.3    8.1     8.7     4.4     3.1     5.0     5.3




OBLIQUE SIDE  FEB. 78  TEST 5           OBL. SIDE   CALSPAN     YB-2987-V-9
FORD                4 DR. SEDAN         1968 RT. FRONT      45.7
INTERMEDIATE    12FZEW3 3550                             0.0

(20.0) (43.8)  0.0      23.0                                    14.0

FORD                4 DR. SEDAN         1968 RT. SIDE        0.0
INTERMEDIATE    02RPEW4 3805                             45

(20)    37.6    3.8     11.3    16.3    15.0    13.8    5.0     -21.0




SAE BARRIER IMPACT    JAN 77            FRONTAL      CALSPAN     ZP-6014-V-7
TOYOTA              CORONA              1976 FRONT           29.7
SUBCOMPACT      12FDEW2 2680                             0.0

(20)    63.8    10.5    15.5                                    0.0

SAE BARRIER




SAE BARRIER IMPACT   JAN 77             FRONTAL      CALSPAN     ZP-6014-V-11
PLYMOUTH            ARROW               1976 FRONT           29.7
MINICAR         12FDEW2 2070                             0.0
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```
(20)     63.4     19.9     19.9                                    0.0

SAE BARRIER

SAE BARRIER IMPACT                      FRONTAL     CALSPAN     ZP-6014-V-13
HONDA              CIVIC 4 DR.          1976 FRONT             29.6
MINICAR          12FDEW2 2530                            0.0

(20)     50.3     15.5     15.3                                    0.0

SAE BARRIER

SAE BARRIER    JAN 77                   FRONTAL     CALSPAN     ZP-6014-V-15
DATSUN             CHERRY F-10 2DR. SDN1976 FRONT             29.7
SUBCOMPACT       12FDEW2 2380                            0.0

(20)     (62)     17.      17.                                     0.0

SAE BARRIER

SAE BARRIER IMPACT    JAN 77            FRONTAL     CALSPAN     ZP-6014-V-6
CHEVROLET          IMPALA 4 DR. SDN     1976 FRONT             29.5
FULL SIZE        12FDEW2 5210                            0.0

(20)     79.5     24.75    24.75                                   0.0
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SAE BARRIER

SAE BARRIER IMPACT   JAN 77                FRONTAL      CALSPAN      ZP-6014-V-5
PONTIAC                 VENTURA 4 DR. SDN.  1976 FRONT                29.8
COMPACT            12FDEW2 4000                              0.0

(20)     72.4      21.5      20.3                                         0.0

SAE BARRIER

SAE BARRIER IMPACT         JAN 77          FRONTAL      CALSPAN      ZP-6014-V-8
FIAT                    131-4 DR. SEDAN     1976 FULL FRONT       29.7
SUBCOMPACT         12FDEW3 3030.                             0.0

(20.)    63.6      20.1      20.9                                         0.0

SAE BARRIER

SAE BARRIER IMPACT                         FRONTAL      CALSPAN      ZP-6014-V-4
FORD                    GRANADA 4 DR. SDN.  1976 FULL FRONT       29.3
COMPACT            12FDEW2 4140.                             0.0

(20.)    74.0      21.5      22.0                                         0.0
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SAE BARRIER




SAE BARRIER IMPACT                         FRONTAL     CALSPAN      ZP-6014-V-12
FORD                 PINTO 2 DR. WAGON     1976 FULL FRONT      29.53
SUBCOMPACT        12FDEW3 3450                            0.0

(20.)   69.7     22.0     21.5                                      0.0

SAE BARRIER




SAE BARRIER IMPACT    JAN 77               FRONTAL     CALSPAN      ZP-6014-V-16
RENAULT              5GTL-2DR. HATCHBACK 1976 FULL FRONT      29.5
MINICAR           12FDEW2 1890                            0.0

(20.0)  60.0     10.75    8.5                                       0.0

SAE BARRIER




SAE BARRIER IMPACT       JAN 77            FRONTAL     CALSPAN      ZP-6014-V-3
DODGE                MONACO  4 DR. SDN.  1976 FULL FRONT      29.5
FULL SIZE         12FDEW3 4970                            0.0

(20.0)  79.8     26.0     26.0                                      0.0
```

SAE BARRIER

RIGID BARRIER IMPACT TEST D14 1970 FRONTAL RRL LR-155 PB-196-409
BMC MINI (70) FULL FRONT 20.0
MINICAR 12FDEV2 1520 0.0

(20.0) 55.5 0.4 0.4 0.0

RIGID BARRIER

RIGID BARRIER IMPACT TEST D-6 1970 FRONTAL RRL LR-155 PB-196-409
BMC MINI (70) FULL FRONTAL 30.7
MINICAR 12FDEV3 1507 0.0

(20.0) 55.5 15.6 15.6 0.0

RIGID BARRIER

RIGID BARRIER IMPACT TEST 66-4 1970 FRONTAL RRL LR-155 PB-196-409
BMC MINI (70) FULL FRONT 32.0
MINICAR 12FDEW4 1657 0.0

(20.0) 55.5 19.2 19.2 0.0

RIGID BARRIER

```
RIGID BARRIER IMPACT  TEST 66-3   1970   FRONTAL     RRL  LR-155 PB-196-409
BMC                 MINI                (70) FULL FRONT      32.0
MINICAR            12FDEW4  1713                          0.0


(20.0)  55.5     19.2     19.2                                      0.0


RIGID BARRIER
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RIGID BARRIER IMPACT  TEST D-11  1970    FRONTAL     RRL  LR-155 PB-196-409
BMC                 MINI                (70) FULL FRONT      37.5
MINICAR            12FDEW4  1508                          0.0


(20.0)  55.5     20.4     20.4                                      0.0


RIGID BARRIER
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RIGID BARRIER IMPACT  TEST D-15   1970  FRONTAL      RRL  LR-156 PB-196-409
BMC                 1100  4DR SEDAN     (70) FULL FRONT      23.9
MINICAR            12FDEW2  2166                          0.0


(20.0)  50.0     15.0     15.0                                      0.0


RIGID BARRIER
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RIGID BARRIER IMPACT TEST D-12 1970 FRONTAL RRL LR-155 PB-196-409
BMC 1100 4DR SEDAN (70) FULL FRONT 28.6
MINICAR 12FDEV2 2117 0.0

(20.0) 60.0 13.2 13.2 0.0

RIGID BARRIER

RIGID BARRIER IMPACT TEST D-5 1970 FRONTAL RRL LR-155 PB-196-409
BMC 1100 4DR SEDAN (70) FULL FRONT 30.7
MINICAR 12FDEV2 1902 0.0

(20.0) 50.0 15.6 15.0

RIGID BARRIER

RIGID BARRIER IMPACT TEST 66-1 1970 FRONTAL RRL LR-155 PB-196-409
BMC 1100 4DR SEDAN (70) FULL FRONT 37.5
MINICAR 12FDEV4 2168 0.0

(20.0) 60.0 27.0 27.0 0.0

RIGID BARRIER

RIGID BARRIER IMPACT TEST D-16 1970 FRONTAL RRL LR-155 PB-196-409
BMC 1800 4DR SEDAN (70) FULL FRONT 27.3
SUBCOMPACT 12FDEW2 2802 0.0

(20.0) 66.3 13.2 13.2 0.0

RIGID BARRIER

RIGID BARRIER IMPACT TEST 7 1970 FRONTAL RRL LR-155 PB-196-409
BMC 1800 4DR SEDAN (70) FULL FRONT 28.6
SUBCOMPACT 12FDEW3 2633 0.0

(20.0) 66.3 16.8 16.8 0.0

RIGID BARRIER

RIGID BARRIER IMPACT TEST D-13 1970 FRONTAL RRL LR-153 PB-196-409
BMC 1800 4DR SEDAN (70) FULL FRONT 36.1
SUBCOMPACT 12FDEW3 2803 0.0

(20.0) 66.3 20.4 20.4 0.0

RIGID BARRIER

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RIGID BARRIER IMPACT  TEST D-9   1970    FRONTAL     RRL  LR-155 PB-196-409
HILLMAN              IMP 2DR SEDAN      (70) FULL FRONT      28.6
MINICAR          12FDEV3  1613                              0.0

(20.0)  60.3     18.0     18.0                                          0.0

RIGID BARRIER
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RIGID BARRIER IMPACT  TEST D-8   1970    FRONTAL     RRL  LR-155 PB-196-409
RENAULT               1100  4DR SEDAN    (70)  FULL FRONT      30.0
MINICAR          12FDEV3 1755                               0.0

(20.0)  60.0     21.6     21.6                                          0.0

RIGID BARRIER
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RIGID BARRIER IMPACT  TEST D-10   1970   FRONTAL     RRL  LR-155 PB-196-409
VOLKSWAGEN            BEETLE             (70) FULL FRONT      38.2
MINICAR          12FDEV3  1675                              0.0

(20.0)  61.0     22.8     22.8                                          0.0

RIGID BARRIER
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RIGID BARRIER IMPACT TEST 66-2   1970    FRONTAL     RRL LR-155  PB-196-409
VOLKSWAGEN           BEETLE              (70) FULL FRONT      34.8
MINICAR             12FDEW3 1878                           0.0

(20.0)   61.0   24.0    24.0                                          0.0

RIGID BARRIER




OFFSET FRONTAL IMPACT TEST OCT 76 TEST 7OFFSET-FRONTCALSPAN      ZP-5950-V-1
PLYMOUTH             FURY 4 DR. SEDAN    1975 LEFT FRONT      29.9
INTERMEDIATE        12FYEW2 4430.                          0.0

(20.)   35.     24.     21.     16.     15.     11.     8.      21.

HONDA                CVCC 2 DR. SEDAN    1975 LEFT FRONT      29.9
MINICAR             12FYEW4 2170                           0.0

(20.)   35.     31.5    29.5    26.5    22.5    21.5    11.5    10.0



SIDE IMPACT-RIGID POLE FEB 73 TEST 46   PERP. SIDE  CALSPAN      YB-2987-V-9
FORD                 CUSTOM 4 DR. SEDAN  1968RT.FRONT DOOR    21.3    (22.1)
INTERMEDIATE        03RPAN4 4085.                          90.

(20.)   12.8    28.     30.     32.     31.     29.     27.     2.5

RIGID POLE           12.8 IN DIAM.
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PERP CAR-TO-CAR SIDE IMPACT TEST 6 SEP76PERP. SIDE CALSPAN ZP-5950-V-1
FORD TORINO 4 DR. SEDAN 1975 FULL FRONT 29.5
INTERMEDIATE 12FDEW1 4430. 0.0

(20.) 80. 1.0 1.8 3.2 6.0 0.0

PLYMOUTH FURY 4 DR. SEDAN 1975 RIGHT SIDE 0.0
INTERMEDIATE 02RPEW2 4440 90.0

(20.) 30. 7.2 7.2 7.2 7.2 4.8 2.4 13.

TASK4 TEST 3 CAR-TO-CAR JUL 76 FRONT-OFFSET CALSPAN ZP-5950-V-1
FORD TORINO 4 DR. SEDAN 1975 LEFT FRONT 23.45
INTERMEDIATE 12FYEW3 4610. 0.0

(20.) 43.0 36.0 (26.) (23.) (17.) (10.) (4.) 18.0

HONDA CVCC 2 DR. SEDAN 1975 LEFT FRONT 23.45
MINICAR 12FDEW3 2190. 0.0

(20.) 43.0 22.5 (21.) (19.) (17.) (15.) (4.) 8.0

SAE BARRIER IMPACT JAN 77 FRONTAL CALSPAN ZP-6014-V-14
MAZDA 808 MIZER 4 DR.WAGON1976 FULL FRONT 29.3
MINICAR 12FDEW2 2790. 0.0

(20.) 63.0 18.3 20.0 0.0

SAE BARRIER

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SAE BARRIER IMPACT    JAN 77               FRONTAL      CALSPAN       ZP-6014-V-10
RENAULT                5 GTL 2 DR.HATCHBACK1976 FULL FRONT       29.4
MINICAR           12FDEW2 2360.                               0.0

(20.)   60.      10.5     10.5                                       0.0

SAE BARRIER
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SAE BARRIER IMPACT    JAN 77               FRONTAL      CALSPAN       ZP-6014-V-9
AUSTIN                 MINI 1000 2 DR.SEDAN1976 FULL FRONT       29.3
MINICAR           12FDEW3 1930                                0.0

(20.)   51.5     17.1     17.3                                       0.0

SAE BARRIER
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SAE BARRIER IMPACT    JAN 77               FRONTAL      CALSPAN       ZP-6014-V-2
DODGE                  ASPEN 4 DR. SEDAN   1976 FULL FRONT       29.7
INTERMEDIATE      12FDEW2 4140                                0.0

(20.)   72.8     19.8     20.5                                       0.0

SAE BARRIER
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SAE BARRIER IMPACT JAN 77 FRONTAL CALSPAN ZP-6014-V-1
FORD MAVERICK 4 DR.SEDAN 1976 FULL FRONT 29.3
COMPACT 12FDEW2 3700. 0.0

(20.) 70.5 20.4 17.5 0.0

SAE BARRIER

RIGID BARRIER IMPACT 1968 TEST A FRONTAL RRL LR-132
ANGLIA VAN (67) FULL FRONT 18.1
MINICAR 12FDEW1 2170. 0.0

(20.) 59.0 6.5 6.5 0.0

RIGID BARRIER

RIGID BARRIER IMPACT 1968 TEST B FRONTAL RRL LR-132
ANGLIA 2 DR. SEDAN (67) FULL FRONT 36.1
MINICAR 12FDEW3 2188. 0.0

(20.) 57. 19.0 20.0 0.0

RIGID BARRIER

RIGID BARRIER IMPACT 1968 TEST C FRONTAL RRL LR-132
ANGLIA 2 DR. SEDAN (67) FULL FRONT 48.1
MINICAR 12FDEW4 2208 0.0

(20.) 57.0 33.5 33.5 0.0

RIGID BARRIER

RIGID BARRIER IMPACT 1968 TEST D FRONTAL RRL LR-132
ANGLIA 2 DR. SEDAN (67) FULL FRONT 25.6
MINICAR 12FDEW2 2191 0.0

(20.) 57.0 14.0 12.5 0.0

RIGID BARRIER

PROPRIETARY CAR-TO-CAR IMPACT TEST 4/77FRONT-REAR CALSPAN ZM-6103-V-1
OLDSMOBILE DYNAMIC 88 4DR H.T. 1959 FRONT RIGHT 59.96 (-27.0)
FULL SIZE 12FDEW3 4600. 0.0

(20.) 53.0 18. 20. 21. 22. 24. 25. 15.

CHEVROLET CHEVELLE MALIBU 2DR 1972 LEFT REAR 0.0 (33.0)
INTERMEDIATE 06BDEW6 3760. 180.

(20.) 53.0 55. 54. 53. 52. 50. 49. 9.0

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SAE BARRIER COMPLIANCE TEST  1/31/73    FRONTAL     CALSPAN
VOLKSWAGEN          411 2 DR SEDAN      1972 FULL FRONT      30.1
SUBCOMPACT        12FDEW2 2600.                         0.0


(20.)   66.       20.6     20.6                                 0.0


SAE BARRIER
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SAE BARRIER COMPLIANCE TEST   1/25/73   FRONTAL     CALSPAN
FORD                   CORTINA          1972 FULL FRONT      29.4
SUBCOMPACT        12FDEW2 2420                          0.0


(20.)   67.0      13.5     13.5                                 0.0


SAE BARRIER
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SAE BARRIER COMPLIANCE TEST  9/20/72    FRONTAL     CALSPAN      ZP-5166-K
PLYMOUTH               BARRACUDA 2DR. HT.  1972 FULL FRONTAL   29.5
COMPACT           12FDEW2 3360                          0.0


(20.)   75.0      19.6     19.6                                 0.0


SAE BARRIER
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SAE BARRIER COMPLIANCE TEST 9/21/72 FRONTAL CALSPAN ZP-5166-K
VOLKSWAGEN 411 (2DR SDN) 1972 FULL FRONT 29.9
SUBCOMPACT 12FDEW3 3210. 0.0

(20.) 55.0 27.6 27.6 0.0

SAE BARRIER

SAE BARRIER COMPLIANCE TEST 10/4/72 FRONTAL CALSPAN ZP-5166-K
PLYMOUTH CRICKET 2DR SDN 1972 FULL FRONT 30.4
SUBCOMPACT 12FDEW2 2580. 0.0

(20.) 63. 18.7 18.7 0.0

SAE BARRIER

SAE BARRIER COMPLIANCE TEST 10/5/72 FRONTAL CALSPAN ZP-5166-K
CADILLAC CALAIS 1972 FULL FRONT 29.9
LARGE 12FDEW2 5730. 0.0

(20.) 80. 24.5 24.5 0.0

SAE BARRIER

SAE BARRIER COMPLIANCE TEST 12/13/72 FRONTAL CALSPAN ZP-5161-K
PLYMOUTH SATELLITE 2DR SDN 1972 FULL FRONT 29.8
INTERMEDIATE 12FDEW2 3730. 0.0

(20.) 80. 18.1 18.1 0.0

SAE BARRIER

SAE BARRIER COMPLIANCE TEST 1/15/73 FRONTAL CALSPAN ZP-5161-K
PONTIAC GRAND PRIX 2DR HT 1973 FULL FRONT 29.6
FULL SIZE 12FDEW2 4360. 0.0

(20.) 77.0 25.5 25.5 0.0

SAE BARRIER COMPLIANCE TEST 1/11/73 FRONTAL CALSPAN ZP-5161-K
PORSCHE 914 1973 FULL FRONT 29.4
MINICAR 12FDEW3 2290. 0.0

(20.) 65. 20.3 20.3 0.0

SAE BARRIER

SAE BARRIER COMPLIANCE TEST 3/15/73 FRONTAL CALSPAN

TOYOTA COROLLA 1973 FULL FRONT 29.3
MINICAR 12FDEW2 2020. 0.0

(20.) 60. 15.6 15.6 0.0

SAE BARRIER

SAE BARRIER COMPLIANCE TEST 1/14/75 FRONTAL CALSPAN ZP-5613-V
DATSUN B-210 2DR SDN 1974 FULL FRONT 29.3
MINICAR 12FDEW2 2400. 0.0

(20.) 61.0 18.5 18.5 0.0

SAE BARRIER

SAE BARRIER COMPLIANCE TEST 1/28/75 FRONTAL CALSPAN ZP-5613-V
DATSUN 710 2DR SEDAN 1974 FULL FRONT 29.45
SUBCOMPACT 12FDEW2 2580. 0.0

(20.) 63. 14.5 14.5 0.0

SAE BARRIER

SAE BARRIER COMPLIANCE TEST 1/28/75 FRONTAL CALSPAN ZP-5613-V
VOLKSWAGEN DASHER 2DR SEDAN 1974 FULL FRONT 29.27

SUBCOMPACT 12FDEW2 2250. 0.0

(20.) 63. 14. 14. 0.0

SAE BARRIER

SAE BARRIER COMPLIANCE TEST 3/7/73 FRONTAL CALSPAN
CHEVROLET NOVA 1973 FULL FRONT 29.4
INTERMEDIATE 12FDEW2 3310. 0.0

(20.) 73. 16.6 16.6 0.0

SAE BARRIER

SAE BARRIER COMPLIANCE TEST 3/22/73 FRONTAL CALSPAN
CHEVROLET VEGA 1973 FULL FRONT 29.4
SUBCOMPACT 12FDEW2 2540. 0.0

(20.) 56. 20.6 20.6 0.0

SAE BARRIER

SAE BARRIER COMPLIANCE TEST 2/20/73 FRONTAL CALSPAN
FORD CAPRI 1973 FULL FRONT 29.1
SUBCOMPACT 12FDEW2 2380. 0.0

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(20.)   65.     19.8    19.8                                          0.0

SAE BARRIER
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SAE BARRIER COMPLIANCE TEST  3/29/73    FRONTAL     CALSPAN      ZP-5161-K
CHEVROLET           CORVETTE            1973 FULL FRONT     29.4
SUBCOMPACT      12FDEW2 3690                            0.0

(20.)   69.     20.2    20.2                                          0.0

SAE BARRIER
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SAE BARRIER COMPLIANCE TEST  6/26/73    FRONTAL     CALSPAN
DODGE               POLARA              1973 FULL FRONT     29.3
FULL SIZE       12FDEW2 4170                            0.0

(20.)   80.     22.8    22.8                                          0.0

SAE BARRIER
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SAE BARRIER COMPLIANCE TEST  8/10/73    FRONTAL     CALSPAN
PLYMOUTII           CRICKET             1973 FULL FRONT     29.55
MINICAR         12FDEW2 2030                            0.0
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(20.) 63. 15.3 15.3 0.0

SAE BARRIER

SAE BARRIER COMPLIANCE TEST 12/19/73 FRONTAL CALSPAN ZP-5405-V

FORD CAPRI 1973 FULL FRONT 29.63

SUBCOMPACT 12FDEW2 2060 0.0

(20.) 63. 22.5 22.5 0.0

SAE BARRIER

SAE BARRIER COMPLIANCE TEST 1/29/74 FRONTAL CALSPAN ZP-5405-V

FORD PINTO 1974 FULL FRONT 29.36

SUBCOMPACT 12FDEW2 2900 0.0

(20.) 69.4 21.0 21.0 0.0

SAE BARRIER

SAE BARRIER COMPLIANCE TEST 1/29/74 FRONTAL CALSPAN ZP-5405-V

OLDSMOBILE CUTLASS 2DR SDN 1974 FULL FRONT 29.44

INTERMEDIATE 12FDEW2 4060. 0.0

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(20.)   76.5    26.1    26.1                                         0.0

SAE BARRIER





SAE BARRIER COMPLIANCE TEST  5/14/74    FRONTAL     CALSPAN      ZP-5161-K
CHEVROLET            CHEVELLE MALIBU WGN 1974 FULL FRONTAL    29.75
INTERMEDIATE     12FDEW2 4440.                            0.0

(20.)   76.6    24.0    24.0                                         0.0

SAE BARRIER





SAE BARRIER COMPLIANCE TEST  5/14/74    FRONTAL     CALSPAN      ZP-5161-K
PONTIAC              GRAND AM 4DR SDN    1974 FULL FRONT      29.58
INTERMEDIATE     12FDEW2 4430.                            0.0

(20.)   77.3    23.75   23.75                                        0.0

SAE BARRIER





SAE BARRIER COMPLIANCE TEST  5/16/74    FRONTAL     CALSPAN      ZP-5161-K
PLYMOUTH             DUSTER              1974 FULL FRONT      29.67
COMPACT          12FDEW2 3180.                            0.0

(20.)   71.8    17.9    17.9                                         0.0
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SAE BARRIER




SAE BARRIER COMPLIANCE TEST  5/16/74    FRONTAL      CALSPAN      ZP-5161-K
BUICK                  CENTURY 2DR SDN    1974 FULL FRONT       29.55
INTERMEDIATE     12FDEW2 4020.                           0.0

(20.)   79.0     24.9     24.9                                     0.0

SAE BARRIER




SAE BARRIER COMPLIANCE TEST  5/15/74    FRONTAL      CALSPAN      ZP-5161-K
BUICK                  ELECTRA 4DR HT     1974 FULL FRONT       29.37
LARGE            12FDEW2 5030                            0.0

(20.)   79.9     22.3     22.3                                     0.0

SAE BARRIER




SAE BARRIER COMPLIANCE TEST  1/15/75    FRONTAL      CALSPAN      ZP-5513-V
FORD                   CUSTOM 500 4DR SDN  1975 FULL FRONTAL    29.22
FULL SIZE        12FDEW2 5150                            0.0

(20.)   79.5     24.0     24.0                                     0.0
```

SAE BARRIER

SAE BARRIER COMPLIANCE TEST 1/15/75 FRONTAL CALSPAN ZP-5613-V
CHEVROLET MONTE CARLO 2DR CPE 1975 FULL FRONTAL 28.99
INTERMEDIATE 12FDEW2 0.0

(20.) 77.6 26.3 26.3 0.0

SAE BARRIER

SAE BARRIER COMPLIANCE TEST 1/15/75 FRONTAL CALSPAN ZP-5613-V
AMC GREMLIN 2DR SDN 1975 FULL FRONT 29.22
SUBCOMPACT 12FDEW2 3370 0.0

(20.) 70.6 14.4 14.4 0.0

SAE BARRIER

SAE BARRIER COMPLIANCE TEST 1/29/75 FRONTAL CALSPAN ZP-5613-V
DODGE MONACO 4DR WGN 1975 FULL FRONT 29.54
LARGE 12FDEW2 5010 0.0

(20.) 80.0 24.2 24.2 0.0

SAE BARRIER

SAE BARRIER COMPLIANCE TEST 2/11/75 FRONTAL CALSPAN ZP-5613-V
FORD GRAN TORINO 4DR HT 1975 FULL FRONT 29.5
FULL SIZE 12FDEW2 3580 0.0

(20.) 80. 22.75 22.75 0.0

SAE BARRIER

SAE BARRIER COMPLIANCE TEST 2/11/75 FRONTAL CALSPAN ZP-5613-V
FORD GRANADA 2DR HT 1975 FULL FRONTAL 29.45
COMPACT 12FDEW3 4450 0.0

(20.) 74. 25.34 25.34 0.0

SAE BARRIER

SAE BARRIER COMPLIANCE TEST 2/11/75 FRONTAL CALSPAN ZP-5613-V
CHEVROLET NOVA 2DR. SDN. 1975 FULL FRONTAL 29.65
COMPACT 12FDEW2 3280 0.0

(20.) 73. 19.87 19.87 0.0

SAE BARRIER

SAE BARRIER COMPLIANCE TEST 1/29/75 FRONTAL CALSPAN ZP-5613-V
HONDA CIVIC 2DR SDN 1974 FULL FRONT 29.55
MINICAR 12FDEW2 1760 0.0

(20.) 59.25 17.1 17.1 0.0

SAE BARRIER

SAE BARRIER COMPLIANCE TEST 1/12/75 FRONT CALSPAN ZP-5613-V
CHEVROLET MONZA 2DR SDN 1975 FULL FRONTAL 29.65
SUBCOMPACT 12FDEW2 3280 0.0

(20.) 66. 19.87 19.87 0.0

SAE BARRIER

SAE BARRIER COMPLIANCE TEST 2/12/75 FRONTAL CALSPAN ZP-5613-V
PLYMOUTH VALIANT 1975 FULL FRONTAL 29.44
COMPACT 12FDEW2 3240 0.0

(20.) 71. 13.0 13.0 0.0

SAE BARRIER

SAE BARRIER COMPLIANCE TEST 1/28/75 FRONTAL CALSPAN ZP-5613-V
DODGE COLT 2DR SDN 1974 FULL FRONT 29.58
SUBCOMPACT 12FDEW3 2400. 0.0

(20.) 64. 18.1 18.1 0.0

SAE BARRIER

SAE BARRIER COMPLIANCE TEST 2/22/73 FRONTAL CALSPAN
TRIUMPH TR-6 1973 FULL FRONTAL 29.2
MINICAR 12FDEW2 2450. 0.0

(20.) 58. 18.4 18.4 0.0

SAE BARRIER

SAE BARRIER COMPLIANCE TEST 6/18/73 FRONTAL CALSPAN ZP-5161-K
AUSTIN MARINA 2DR SDN 1973 FULL FRONTAL 29.4
SUBCOMPACT 12FDEW2 2210. 0.0

(20.) 65. 16.6 16.6 0.0

SAE BARRIER

SAE BARRIER COMPLIANCE TEST 3/28/73 FRONTAL CALSPAN ZP-5161-K
BMW BAVARIA 1973 FULL FRONTAL 29.3
COMPACT 12FDEW2 3110 0.0

(20.) 69. 20.2 20.2 0.0

SAE BARRIER

SAE BARRIER COMPLIANCE TEST 9/21/73 FRONTAL CALSPAN ZP-5161-K
FORD CORTINA 1972 FULL FRONT 29.56
SUBCOMPACT 12FDEW2 2480 0.0

(20.) 67. 15.4 15.4 0.0

SAE BARRIER

SAE BARRIER COMPLIANCE TEST 12/19/73 FRONTAL CALSPAN ZP-5405-V
FIAT 124 4DR SDN 1973 FULL FRONTAL 29.37
MINICAR 12FDEW2 2660. 0.0

(20.) 64. 17.5 17.5 0.0

SAE BARRIER

SAE BARRIER COMPLIANCE TEST 1/14/75 FRONTAL CALSPAN ZP-5613-V
TOYOTA CORONA 2DR SDN 1974 FULL FRONTAL 29.3
SUBCOMPACT 12FDEW2 2840 0.0

(20.) 55. 14.75 14.75 0.0

SAE BARRIER

SAE BARRIER COMPLIANCE TEST 2/28/73 FRONTAL CALSPAN
DATSUN B210 1973 FULL FRONTAL 29.3
MINICAR 12FDEW2 2270. 0.0

(20.) 61. 14.2 14.2 0.0

SAE BARRIER

FRONTAL SAE BARRIER IMPACT TEST 1 FRONTAL CALSPAN YB-2990-K-2
CHEVROLET IMPALA 2DR HT 1970 FULL FRONT 31.0
FULL SIZE 12FDEW2 4076. 0.0

(20.) 79.8 25.6 25.6 0.0

SAE BARRIER

FRONTAL SAE BARRIER IMPACT TEST 2   FRONTAL   CALSPAN   YB-2990-K-2
PLYMOUTH   FURY 2DR HT   1970 FULL FRONT   31.1
FULL SIZE   12FDEW2 4420.   0.0

(20.)   79.6   23.4   0.0

SAE BARRIER

ANGLED BARRIER IMPACT TEST 3   30DEG. FRONTCALSPAN   YB-2990-K-2
CHEVROLET   BISCAYNE 4DR SDN   1970 LEFT FRONT   30.0
FULL SIZE   12FDEW4 4360.   0.0

(20.)   79.8   44.0   34.3   24.9   16.3   8.0   2.0   0.0

RIGID BARRIER

FRONTAL SAE BARRIER IMPACT TEST 4   FRONTAL   CALSPAN   YB-2990-K-2
CHEVROLET   CHEVELLE 2D HT   1970 FULL FRONT   19.5
INTERMEDIATE   12FDEW2 4000.   0.0

(20.)   75.4   18.0   18.0   0.0

SAE BARRIER

```
HEAD ON RIGID POLE IMPACT TEST 5         FRONTAL     CALSPAN      YB-2990-K-2
CHEVROLET            IMPALA 2DR HT       1970 CENTER FRONT   38.9
FULL SIZE       12FCEN3 4460.                           0.0

(20.)   12.     28.     33.5    33.5    28.                         0.0

RIGID POLE
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HEAD ON RIGID POLE IMPACT TEST 6         FRONTAL     CALSPAN      YB-2990-K-2
FORD                 MAVERICK 2DR SDN    1970 CENTER FRONT   30.4
COMPACT         12FCEN3 3123.                           0.0

(20.)   12.     (18.)   (23.5)  (23.5)  (18.)                       0.0
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FRONTAL SAE BARRIER IMPACT TEST 7A       FRONTAL     CALSPAN      YB-2990-K-2
PLYMOUTH             FURY I 4DR SDN      1970 FULL FRONT      6.0
FULL SIZE       12FDEW1 4450.                           0.0

(20.)   79.5    (2.0)   (2.0)                                       0.0

SAE BARRIER
```

FRONTAL SAE BARRIER IMPACT TEST 7B   FRONTAL   CALSPAN   YB-2990-K-2
PLYMOUTH   FURY I 4DR SDN   1970 FULL FRONT   31.0
FULL SIZE   12FDEW2 4510.   0.0

(20.)   79.5   24.2   24.2   0.0

SAE BARRIER

ANGLED BARRIER IMPACT TEST 8   FRONTAL   CALSPAN   YB-2990-K-2
FORD   GALAXIE 2D HT   1970 LEFT FRONT   30.5
FULL SIZE   12FDEW3 4570.   0.0

(20.)   79.3   33.0   26.   19.1   13.   8.4   1.5   0.0

RIGID BARRIER

FRONTAL SAE BARRIER IMPACT TEST 9   FRONTAL   CALSPAN   YB-2990-K-2
AMC   GREMLIN 2DR SDN   1970 FULL FRONT   29.6
SUBCOMPACT   12FDEW2 3300.   0.0

(20.)   70.6   12.0   14.5   0.0

SAE BARRIER

FRONTAL SAE BARRIER IMPACT TEST 12 FRONTAL CALSPAN YB-2990-K-2
VOLKSWAGEN BEETLE 1970 FULL FRONT 30.7
MINICAR 12FDTW2 2440. 0.0

(20.) 61. 19.7 19.7 0.0

SAE BARRIER

OFFSET FRONTAL IMPACT TASK 4 TEST 1 OFFSET FRONTCALSPAN ZP-3950-V-1
PLYMOUTH FURY 4DR SDN 1975 LEFT FRONT 29.72
INTERMEDIATE 12FYEW2 4450. 0.0

(20.) 10. 23.0 (15.5) (12.3) (9.5) (6.7) (2.0) (-18.2)

RENAULT R-5 2DR SDN 1976 LEFT FRONT 29.72
MINICAR 12FDLW3 2210. 0.0

(20.) 43. 25. (21.3) (18.5) (16.5) (12.5) (9.5) (-7.3)

RIGID BARRIER FRONTAL IMPACT TEST 2 FRONTAL AGBABIAN PB-230-907
FORD PINTO 1972 FULL FRONT 34.2
SUBCOMPACT 12FDLW3 2756. 0.0

(20.) 70. 29. 28. 0.0

RIGID BARRIER

RIGID BARRIER REAR IMPACT TEST 261-1 REAR DYN.SCIENCE PB-220-842
PLYMOUTH FURY 1968 FULL REAR 39.0
INTERMEDIATE 06BDEW4 3425. 180.

(20.) 70. 36.5 36.5 0.0

RIGID BARRIER

RIGID BARRIER FRONTAL IMPACT TEST 1 FRONTAL AGBABIAN PB-230-902
FORD PINTO 1972 FULL FRONT 30.2
SUBCOMPACT 12FDEW3 2760. 0.0

(20.) 70. 24.0 24.0 0.0

RIGID BARRIER

HEAD ON FRONTAL IMPACT BASELINE TEST 4 FRONTAL AMF PB-231 561
AMC HORNET 2DR SDN 1973 FULL FRONT 37.5
COMPACT 12FDEW3 (2777.) 0.0

(20.) 71. 25. 25. 0.0

AMC HORNET 2DR SDN 1973 FULL FRONT 37.5
COMPACT 12FDEW3 (2777.) 0.0

(20.) 71. 27. 27. 0.0

RIGID BARRIER IMPACT TEST 1 FRONTAL AMF PB-231 561
AMC HORNET 2DR SDN 1973 FULL FRONT 49.7
COMPACT 12FDEW3 (2777.) 0.0

(20.) 71. 33. 33. 0.0

RIGID BARRIER

SAE MOVING BARRIER SIDE IMPACT 60 DEG SIDE FAA TEST 679
VOLVO 2DR SEDAN 1972 LEFT DOR 0.0
COMPACT 10LPEW3 3105. -60.

(20.) (44.) 0.0 (5.) (8.5) (9.) (7.3) 0.0 (-4.0)

SAE MOVING BARRIER LEFT FRONT 20.
12FYEW1 4000. 0.0

(20.) (37.) 0.0 0.0 0.0

BARRIER LOWERED - NO SILL OVERRIDE

SAE MOVING BARRIER SIDE IMPACT 60 DEG SIDE FAA TEST 681
VOLVO 2DR SEDAN 1971 LEFT DOR 0.0
COMPACT 10LPEW3 3120. -60.

(20.) (50.) 0.0 (9.5) (14.) (13.) (9.5) 0.0 (-4.0)

SAE MOVING BARRIER LEFT FRONT 20.
12FYEW1 4000. 0.0

(20.) (44.) 0.0 0.0 0.0

OVERRIDE OF SILL

SAE MOVING BARRIER SIDE IMPACT 60 DEG SIDE FAA TEST 686
BUICK RIVIERA 2DR SDN 1974 RIGHT DOR 0.0
FULL SIZE 02RPEW3 5490. 60.

(20.) (66.) 0.0 (9.0) (15.5) (17.5) (13.) 0.0 (-16.7)

SAE MOVING BARRIER RIGHT FRONT 20.
12FDEW1 4000. 0.0

(20.) (53.) 0.0 0.0 0.0

OVERRIDE OF SILL

SAE MOVING BARRIER SIDE IMPACT 60 DEG SIDE FAA TEST 684
CADILLAC 2DR SEDAN 1974 LEFT DOR 0.0
LARGE 10LPEW3 5810. -60.

(20.) (78.5) 0.0 (11.) (15.5) (15.8) (13.3) 0.0 (-16.)

SAE MOVING BARRIER LEFT FRONT 20.
12FYEW1 4000. 0.0

(20.) (70.) 0.0 0.0 0.0

OVERRIDE OF SILL

SAE MOVING BARRIER SIDE IMPACT 60 DEG SIDE FAA TEST 644
AMC HORNET 4DR SDN 1971 LEFT DOR 0.0
COMPACT 10LPEW3 3440. -60.

(20.) (52.5) 0.0 (7.8) (12.) (14.) (10.) 0.0 (-2.0)

SAE MOVING BARRIER LEFT FRONT 20.0
12FYEW1 4000. 0.0

(20.) (45.) 0.0 0.0 0.0

OVERRIDE OF SILL

```
SAE MOVING BARRIER SIDE IMPACT          60 DEG SIDE FAA         TEST 690
PLYMOUTH            SCAMP 2DR HT        1973 LEFT DOR        0.0
COMPACT         10LPEW3 3780.                              -60.


(20.)   (69.)   0.0     (7.5)   (13.8)  (16.)   (12.5)  0.0     (14.5)


SAE MOVING BARRIER                                LEFT FRONT     20.
                12FYEW1 4000.                              0.0


(20.)   (63.)   0.0     0.0                                     0.0



OVERRIDE OF SILL



SAE MOVING BARRIER SIDE IMPACT          60 DEG SIDE FAA         TEST 635/637
VOLKSWAGEN          STATION WAGON 2DR   1973 DOR             0.0
SUBCOMPACT      10LPEW3 3060.                              -60.


(20.)   (64.)   0.0     (7.0)   (12.0)  (13.5)  (12.)   0.0     (-2.)


SAE MOVING BARRIER                                LEFT FRONT     20.
                12FYEW1 4000.                              0.0


(20.)   (58.)   0.0     0.0                                     0.0



AVERAGE OF LEFT & RIGHT SIDE TESTS
OVERRIDE OF SILL


SAE MOVING BARRIER SIDE IMPACT          60 DEG SIDE FAA         TEST 626/633
CHEVROLET           IMPALA 2DR HT       1973 DOR             0.0
FULL SIZE       10LPEW3 4925.                              -60.


(20.)   (62.7)  0.0     (8.4)   (13.6)  (15.8)  (12.)   0.0     (-4.3)


SAE MOVING BARRIER                                LEFT FRONT     20.
                12FYEW1 4000.                              0.0


(20.)   (54.)   0.0     0.0                                     0.0



AVERAGE OF LEFT & RIGHT SIDE TESTS
OVERRIDE OF SILL


SAE MOVING BARRIER SIDE IMPACT          60 DEG SIDE FAA         TEST 576/577
```

CHEVROLET IMPALA 2DR HT 1971 DOR 0.0
FULL SIZE 10LPEW3 4630. -60.

(20.) (67.5) 0.0 (7.6) (12.7) (15.1) (11.0) 0.0 (-3.0)

SAE MOVING BARRIER LEFT FRONT 20.0
12FYEW1 4000. 0.0

(20.) (58.5) 0.0 0.0 0.0

AVERAGE OF LEFT & RIGHT SIDE TESTS
OVERRIDE OF SILL

SAE MOVING BARRIER SIDE IMPACT 60 DEG SIDE FAA TEST 622/625
CHEVROLET IMPALA 4DR HT 1973 DOR 0.0
FULL SIZE 10LPEW3 4930. -60.

(20.) (53.) 0.0 (4.5) (9.0) (12.5) (12.0) 0.0 (1.0)

SAE MOVING BARRIER LEFT FRONT 20.
12FYEW1 4000. 0.0

(20.) (43.0) 0.0 0.0 0.0

AVERAGE OF LEFT & RIGHT SIDE TESTS
OVERRIDE OF SILL

SAE MOVING BARRIER SIDE IMPACT 60 DEG SIDE FAA TEST 589/604
CHEVROLET NOVA 4DR SDN 1972 DOR 0.0
COMPACT 10LPEW3 3745. -60.

(20.) (50.) 0.0 (6.) (12.) (14.) (11.) 0.0 (-1.2)

SAE MOVING BARRIER LEFT FRONT 20.0
12LYEW1 4000. 0.0

(20.) (43.) 0.0 0.0 0.0

AVERAGE OF LEFT & RIGHT SIDE TESTS
OVERRIDE OF SILL

HEAD-ON-FRONTAL TEST 14 HEAD-ON FRNT CALSPAN ZM-5096-V-1
OPEL 2 DR SDN 1968 FULL FRONT 43.8 63.8

```
MINICAR             12FDEW6 1750.    -6.0      0.0       0.0       0.0
-51.9    0.0        -1.2
CCW      NO         1.0      1.0      0.0      0.0
(20.)    62.2       41.0     41.0                                          0.0


FORD                    4 DR SDN               1968 FRONT           43.8      26.3
INTERMEDIATE        12FDEW2 3960.    5.9       0.0       180.0     0.0
-12.6    0.0        180.6
CCW      NO         1.0      1.0      0.0      0.0
(20.)    62.2       23.0     23.0                                          0.0

(0.8)



PERPENDICULAR SIDE IMPACT                      PERP. SIDE  UCLA-ITTE   SP-202
PLYMOUTH                4 DR SDN               1960 FULL FRONT      40.0      (11.0)
INTERMEDIATE        01FDEW3 (3500.) -13.3      0.0       0.0       (30.)
50.0     -21.0      -147.    39.0     -20.0    -173.
CCW      NO.        1.0      0.0      0 0      0.0
(20.)    (73.8)     (24.)    (21.)    (18.)    (16.)     (14.)     (12.)   0.0


PLYMOUTH                4 DR SDN               1960 LEFT SIDE       40.0      (10.6)
INTERMEDIATE        10LZEW3 (3500.) 0.0        -5.25     -90.      (-60.)
19.6     -60.9      (-336.)
CCW      NO.        0.0      0.0      1.0      1.0
(20.)    (35.)      (7.)     (14.)    (14.)    (13.)     (10.)     (3.)    (-72.5)


(0.8)
NOTE THAT FULL BRAKING WAS APPLIED LATE IN THE SPINOUT TRAJECTORIES AT
UNSPECIFIED TIMES AND POSITIONS.   28.8 IN. TOTAL COMBINED CRUSH
 PER SP-202

FRONT-TO-REAR IMPACT   TEST 225-2&3            FRONT-REAR  DYN. SCIENCED8-213 218
FORD                    4 DR. SEDAN            1968 FULL REAR       0.0
INTERMEDIATE        06BDEW4 3483.                                130.


(20.)    76.        33.8     33.8                                          0.0


FORD                    4 DR. SEDAN            1968 FULL FRONT      41.0
INTERMEDIATE        12FDEW1 3304.                                0.0


(20.)    76.        4.8      4.8                                           0.0





REAR BARRIER IMPACT   TEST 225-1               REAR          DYN. SCIENCED8-213 218
FORD                    4 DR. SEDAN            1968 FULL REAR       38.0
INTERMEDIATE        06BDEW6 3515.                                180.
```

```
(20.)   76.     46.8    46.8                                    0.0

RIGID BARRIER








OBLIQUE SIDE IMPACT   MRA-3             OBLIQUE SIDE CALSPAN    ZQ-5708-V-1
CHEVROLET           CHEVELLE 4 DR WGN   1964 RF CORNER     33.0    (16.3)
COMPACT         01RFEW2 3095.   -0.5    -2.0     0.0     (50.)
33.0    -17.0   -51.0
CCW     NO      1.0     1.0     1.0     1.0
(20.)   (24.)   (4.)    (7.)    (7.)    (8.)    (10.)   (12.)   (73.)


PLYMOUTH            2 DR. SDN           1964 LF FENDER     32.5    (12.5)
INTERMEDIATE    08LFEW3 3340.   6.5     7.5     -48.0   (-70.)
43.0    -8.0    -39.0
CW      NO      1.0     1.0     1.0     1.0
(20.)   (43.)   (10.)   (14.)   (17.)   (17.)   (13.)   (3.)    (63.)


0.77
COLLISION INVOLVED 2 IMPACTS FOR EACH VEH. DELTAV VECTOR SUM OF BOTH.
2ND IMPACT DATA-VI:VDI=02RZEW3,DOPF=(80),IC=RRSIDE.L=(80),C1=(3),C2=(7.5
C3=(2),C4=(1.5),C5=(2.5),C6=(.5),D=(-50);V2:VDI=08LZEW2,DOPF=(-90),
IC=LRSIDE.L=(80),C1=(7.5),C2=(5.5),C3=(3),C4=(1),C5=(1),C6=(3.5),D=(-78)
OFFSET FRONTAL IMPACT   MRA-1           OFFSET FRONT CALSPAN    ZQ-5708-V-1
CHEVROLET           2 DR SDN            1963 LEFT FRONT    30.5    (34.2)
INTERMEDIATE    12FYEW4 3080.   -8.4    1.0     0.0     0.0
-7.3    4.2     -25.0
CCW     NO      0.0     1.0     0.0     0.0
(20.)   34.0    46.5    (39.)   (36.)   (30.)   (22.5)  14.5    -22.5


CHEVROLET           4 DR SDN            1964 LEFT FRONT    31.5    (26.7)
INTERMEDIATE    12FYEW5 3950.   8.4     -1.0    180.0   0.0
0.7     -2.5    162.5
CCW     NO      0.0     1.0     0.0     0.0
(20.)   35.0    57.0    (51.5)  (48.0)  (45.5)  (42.5)  35.5    -22.0


(0.5)



FRONT TO REAR IMPACT  X-96              FRONT-REAR  UCLA-ITTE   11TH STAPP
FORD                CUSTOM 4DR SDN      1967 FULL FRONT    30.0
FULL SIZE       12FUEW1 4630.                            0.0
```

```
(20.)    79.      (10.)    (10.)                                              0.0

FORD                    CUSTOM 4DR SDN      1967 FULL REAR        0.0
FULL SIZE          06BDEW4  4820.                              180.

(20.)    79.      34.8     34.8                                               0.0





FRONT TO REAR IMPACT X-95                   FRONT-REAR  UCLA-ITTE   11TH STAPP
FORD                    CUSTOM 4DR SDN      1967 FULL FRONT       30.0
FULL SIZE          12FDEW1 4680.                               0.0

(20.)    79.      (10.)    (10.)                                              0.0

FORD                    CUSTOM 4DR SDN      1967 FULL REAR        0.0
FULL SIZE          06BDEW4  4770.                              180.0

(20.)    79.      38.      38.                                                0.0





FRONT TO REAR IMPACT  X-94                  FRONT-REAR  UCLA-ITTE   11TH STAPP
FORD                    CUSTOM 4DR SDN      1967 FULL FRONT       20.
FULL SIZE          12FDEW1  4630.                              0.0

(20.)    79.      3.0      3.0                                                0.0

FORD                    CUSTOM 4DR SDN      1967 FULL REAR        0.0
FULL SIZE          06BDEW2  4760.                              180.

(20.)    79.      13.      13.                                                0.0





FRONT TO REAR IMPACT  X-93                  FRONT-REAR  UCLA-ITTE   11TH STAPP
FORD                    CUSTOM 4DR SDN      1967 FULL FRONT       30.0
FULL SIZE          12FDEW1  4610.                              0.0
```

```
(20.)   79.      (10.)    (10.)                                              0.0


FORD                    CUSTOM 4DR SDN       1967 FULL REAR      0.0
FULL SIZE          06BDEW4  4635.                            180.0


(20.)   79.      36.      35.                                                0.0






OFFSET RIGID POLE IMPACT TEST 1 1/22/76 OFFSET FRONT TTI         RF-3258-1
CHEVROLET               CHEVELLE MALIBU 2DR 1970 FRONT          25.5
INTERMEDIATE       12FYEW3 3600.    7.1      -1.3     -180.    0.0
5.6      -3.15     -197.
CCW      NO        (.01)    (.01)    (.01)    (.01)
(20.)    (22.8)    10.3     24.6     27.4     29.7     27.4     19.4     (-15.8)


RIGID POLE 16IN DIA






0.74




OBLIQUE SIDE IMPACT   TEST 3  4/21/76   OBLIQUE SIDE TTI         RF-3258-1
CHEVROLET               CHEVELLE MALIBU 2DR 1973 LEFT FR FENDER 25.5    (20.9)
INTERMEDIATE       11LDEW3 3830.    20.0     11.0     0.0      (-36.0)
45.0     25.0      114.0
CCW      NO        0.01     0.01     0.01     0.01
(20.)    (122.)    (3.8)    (12.8)   (15.3)   (12.8)   (5.1)    (2.6)    (-34.0)

CHEVROLET               CHEVELLE MALIBU 2DR 1973 LEFT FRONT      38.5    (21.0)
INTERMEDIATE       01FDEW2 3810.    26.2     -1.05    120.0    (24.)
22.5     26.0      -41.0
CCW      NO        0.01     0.01     0.01     0.01
(20.)    72.       (26.)    (20.)    (13.)    (3.)     (6.)     (5.)     0.0


0.75




PERPENDICULAR SIDE IMPACT TEST 2 3/11/76PERP. SIDE  TTI          RF-3258-1
CHEVROLET               CHEVELLE LAGUNA 2DR 1973 LF FENDER       25.5    (15.0)
INTERMEDIATE       10LYEW3 3970.    0.0      12.0     0.0      (-56.5)
44.0     16.0      -143.0                             (16.0)   (19.0)
CCW      NO        (.01)    (.01)    (.01)    (.01)
(20.)    (95.4)    0.0      3.6      10.8     5.0      3.8      0.0      (18.0)
```

```
CHEVROLET            CHEVELLE LAGUNA 2DR 1973 FULL FRONT      25.6     (15.9)
INTERMEDIATE     01FDIW2 3960.    2.0       2.0       90.0     (33.5)
34.4     29.8    17.0    (16.0)  (16.0)  (17.0)
CCW      NO      (.01)   (.01)   (.01)   (.01)
(20.7    71.0    15.3    13.6    19.0    12.2      12.6     14.4     0.0

0.75
```

APPENDIX 3

RICSAC FILE FORMAT

The following is a rigorous description of the selected file layout for the staged collision data bank. The reader should note that there is ample room for expansion to add data items without increasing overall file size, since there are some unused areas on some records.

A. File Status Records

Record 1	Column	Format	Description
	1-20	20A1	Data set name (from IBM Data Definition)
	21-28	8A1	DDNAME (from IBM Data Definition)
	29-68	40A1	Title of file.
	69-80	12A1	Creation Date

Record 2	Column	Format	Description
	1-8	8A1	Date of last update
	9-16	I8	Current # of collisions in file
	17-24	I8	Maximum # of collisions allowed
	25-32	I8	Next available index number
	33-40	I8	Next available data record
	41-80		Not used

NOTE: The file Status Records are very important. The various titles, data set names, etc., provide the option of maintaining more than one staged collision data file. We have no current plans for such a capability, but it should be designated in at the beginning. The "current and maximum # of collisions" help the software prevent overflowing the file with too many collisions. The "next available index and data records" direct the program to the proper slots for adding new collisions.

B. Index Records

Record 3-1003	Column	Format	Description
	1-40	40A1	Title of staged collision
	41-44	4A1	Agency conducting test
	45-48		Not used
	49-50	I2	Model year - V1
	51-52	I2	Impact speed - V1
	53-54	I2	Speed change - V1
	55	A1	Vehicle size - V1
	56	A1	R, L, F, B Code - V1
	57-58	I2	Model year - V2
	59-60	I2	Impact speed - V2
	61-62	I2	Speed change - V2
	63	A1	Vehicle size - V2
	64	A1	R, L, F, B Code - V2
	65-72	I8	Location of first data record
	73-80	I8	Index entry sequence number

NOTE: There is one index record (or card) for each staged collision, up to a maximum of 1000. Collisions can be retrieved absolutely with the title or the index entry sequence number. Collisions can be sorted by agency, model year, impact speed, speed change, vehicle size and location of deformation.

C. Data Records

Data Card 1	Column	Format	Description
	1-40	40A1	Title of staged collision
	41-52	12A1	Collision impact configuration
	53-64	12A1	Testing agency
	65-76	12A1	Source of information
	77-78		Not used
	79-80	I2	Card #1 set equal to "1"

Data Card 2	Column	Format	Description
	1-20	20A1	Manufacturer - V1
	21-40	20A1	Model - V1
	41-44	4A1	Model year - V1
	45-60	16A1	Initial impact configuration - V1
	61-68	F8.2	Impact speed - V1
	69-76	F8.2	Delta-V speed change - V1
	77-78		Not used
	79-80	I2	Card # set equal to "2"

Data Card 3	Column	Format	Description
	1-16	16A1	Vehicle size - V1
	17-24	8A1	Vehicle damage index - V1
	25-32	F8.2	Vehicle weight - V1
	33-40	F8.2	Impact X-position - V1
	41-48	F8.2	Impact Y-position - V1
	49-56	F8.2	Impact heading - V1
	57-64	F8.2	Direction of principal force - V1
	65-78		Not used
	79-80	I2	Card # set equal to "3"

Data Card 4	Column	Format	Description
	1-8	F8.2	Rest X-position - V1
	9-16	F8.2	Rest Y-position - V1
	17-24	F8.2	Rest Heading - V1
	25-32	F8.2	End-of-rotation X-position - V1
	33-40	F8.2	End-of-rotation Y-position - V1
	41-48	F8.2	End-of-rotation heading - V1
	49-56	F8.2	Point-on-curve X-position - V1
	57-64	F8.2	Point-on-curve Y-position - V1
	65-78		Not used
	79-80	I2	Card # set to "4"

Data Card 5	Column	Format	Description
	1-8	8A1	Rotation direction - V1
	9-16	8A1	>360° rotation flag - V1
	17-24	F8.2	Rolling resistance RF - V1
	25-32	F8.2	Rolling resistance LF - V1
	33-40	F8.2	Rolling resistance RR - V1
	41-48	F8.2	Rolling resistance LR - V1
	49-56	F8.2	Ratio of damage extents - V1
	57-78		Not used
	79-80	I2	Card # set equal to "5"

Data Cards 6,7,8	Column	Format	Description
	1-8	F8.2	Damage elevation - V1
	9-16	F8.2	Width of damage - V1
	17-24	F8.2	Depth #1 - V1
	25-32	F8.2	Depth #2 - V1
	33-40	F8.2	Depth #3 - V1
	41-48	F8.2	Depth #4 - V1
	49-56	F8.2	Depth #5 - V1
	57-64	F8.2	Depth #6 - V1
	65-72	F8.2	Midpoint offset - V1
	73-78		Not used
	79-80	I2	Card # set to "6", "7", or "8"

NOTE: Since 3 damage profiles at different elevations is permitted, 3 data cards are required.

Cards 9-15 These cards are exactly like cards 2-8, excepting that the data is for vehicle 2.

Card 16	Column	Format	Description
	1-8	F8.2	Tire-ground friction coefficient
	9-78		Not used
	79-80	I2	Card # set to "16"

Cards 17-20	Column	Format	Description
	1-72	72A1	Comments
	73-78		Not used
	79-80	I2	Card # set to "17", "18", "19", or "20"

Please note that although twenty cards define a staged collision, the associated record numbers of these cards depend on the collision's placement within the file. For example, the first collision in the staged collision file is at records 1003 to 1023. The second collision is at records 1024-1044. Figure 3-1 shows a schematic layout of this staged collision data bank.

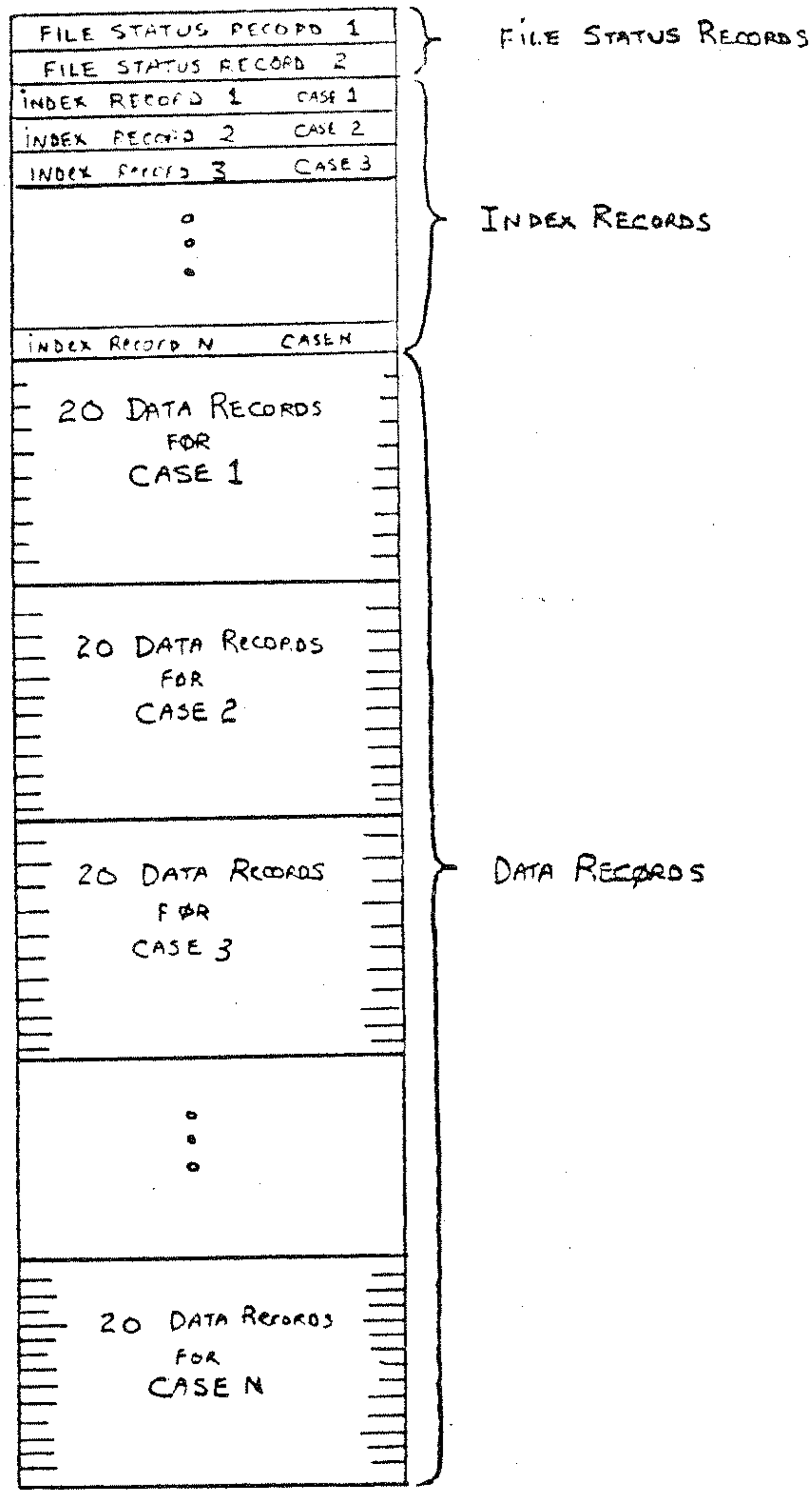

Figure 3-1 SCHEMATIC LAYOUT OF RICSAC DATA BANK FILE