DOT HS-800 912

TRI-LEVEL ACCIDENT INVESTIGATION STUDY

Volume 1

Contract No. DOT-HS-031-1-135

August 1973

Final Report

PREPARED FOR:
U.S. DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION
WASHINGTON, D.C. 20590

TECHNICAL REPORT STANDARD TITLE PAGE

1 Report No.
DOT HS-800 912

2 Government Accession No

3. Recipient's Catalog No.

4 Title and Subtitle
Tri-Level Accident Investigation Study
Volume 1,

5. Report Date
August 1973

6. Performing Organization Code
01011-1

7 Author(s)
P. Cooley, J. O'Day, and S. Schultz

8 Performing Organization Report No
[redacted]
UM HSRI SA 72 2

9 Performing Organization Name and Address
Highway Safety Research Institute
University of Michigan
Ann Arbor, Michigan 48105

10 Work Unit No

11 Contract or Grant No
DOT-HS-031-1-155

12. Sponsoring Agency Name and Address
U.S. Department of Transportation
National Highway Traffic Safety Administration
Washington, D.C. 20590

13 Type of Report and Period Covered
Final Report
June 1, 1971 through
June 30, 1972

14. Sponsoring Agency Code

15 Supplementary Notes

16 Abstract

Volume I of a Final Report describing the first year of a tri-level accident study. Program design and methodology, Level III accident data characteristics, accident data analysis and topical areas relating to highway safety are discussed. Significant study findings are presented with some recommendations to improve motor vehicle safety.

17. Key Words
Tri-Level Accident Study, Final Report, Methodology, Data Analysis, Accident topics, Multi-disciplinary Investigations

18. Distribution Statement
Unlimited available through the
National Technical Information
Service, Springfield, Virginia
22151

19. Security Classif. (of this report)
Unclassified

20. Security Classif. (of this page)
Unclassified

21. No. of Pages
198

22. Price

Form DOT F 1700.7 (8-69)

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1.0 ACKNOWLEDGEMENTS

The Highway Safety Research Institute of The University of Michigan wishes to acknowledge the following individuals and organizations for their cooperation and assistance in conducting this Tri-Level Accident Study Program.

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Ann Arbor City Police Department
Washtenaw County Sheriff's Department
City of Ann Arbor Traffic Engineering Department
Superior Ambulance Company
Sakstrup's Motor Service
Northside Towing
Frain's Lake Service
Dick's Union 76
Ford Motor Company
General Motors Corporation
Chrysler Corporation
American Motors Corporation
Automobile Manufacturers Association
R & L Associates

2.0 Summary

This program of accident research was sponsored by the Accident Investigation Division of the Research Institute, National Highway Safety Transportation, Washington, D.C., and conducted by the Highway Safety Research Institute of the University of Michigan. This final report discusses and summarizes the results of this first year research effort, a Tri-Level Accident Investigation Study, under Contract No. DOT-HS-031-1-135, for the period of June 1, 1971 to June 30, 1972. Chief of the Accident Investigation Division was V. J. Esposito, and Contract Technical Manager, J. M. Keryeski.

Volume I contains the design of the program, methodology employed, a discussion of Level III accident data, an analysis and discussion of findings, as well as a detailed discussion of topical areas resulting from this first year of tri-level activity. Volume II contains the case summaries of 71 Level III multidisciplinary team case studies completed the first year of the program. Completed case studies were submitted to NHTSA throughout the course of the program, as well as periodic reports.

The program is based on the concept that various levels of accident data, and related driver-vehicle data, along with in-depth multidisciplinary accident investigation team findings within a fixed geographic base, can complement each other so as to:

- Determine causation of accidents and injuries, identify functional problems of the highway transportation system, and the need for countermeasures.
- Indicate appropriate countermeasure methods.
- Assess effectiveness of new safety features.
- Evaluate the performance of Vehicle and Highway Safety Standards.
- Establish trends through monitoring and evaluating the highway transportation system over time, caused by induced countermeasures and unintentional modifications to the system.

The Tri-Level Accident Investigation Study program was initiated at the Highway Safety Research Institute within an established organizational structure, with existing and continuing activities involving field accident investigations, accident data file building and data analyses. Of particular relevence to this program was a recently completed NHTSA sponsored study of driver exposure, accident data file building to include multidisciplinary accident investigations from teams around the country, also sponsored by the NHTSA, and a program of accident investigations going back ten years involving new car tow-away accident vehicles and supported by the AMA. These serve as a valuable adjunct in support of the tri-level concept.

Level III accident investigations through a multidisciplinary team were characterized with almost completely on-scene investigations. These were made possible by the cooperation of area police jurisdictions, and an effective field communications system employing two-way mobile radio in conjunction with the University of Michigan Department of Security. A well established rapport with police organizations existed through previous accident investigation efforts, which permitted the quick and effective implementation of the accident alerting system for this program. Accidents have been used for case studies throughout a rather broad and uniform geographic coverage of Washtenaw County, Michigan.

Analysis of all levels of accident data, as well as related driver and vehicle statistical information, is accomplished with the University of Michigan Computation Center. These data are available on-line, in a time sharing mode, for immediate access through various terminal facilities, which include portable teletype terminals available individually to HSRI staff. A variety of proven and demonstrated computer software in standardized format permits varied and extensive analytical evaluation of data.

While the extent of the multi-level data available this year was limited due to the relatively few Level III cases on file, and the discontinuity of time periods in coded material of various accident investigation efforts, analysis efforts did provide some significant findings. The tri-level concept in accident data of several levels of detail which complement and support one another, was found to be valuable and effective. Level III data provided for identification of problems, with extensive detail as to exactly "what happened". Level I data provided the frequency of occurrence, or statistical characteristics, in terms of "how often it happened". Level II information is comprised of a consistent and relatively exhaustive set of detailed data relating to new car accidents in Washtenaw County. In its present form, Level II Washtenaw County data provides an effective assessment of vehicle new safety features. As this file is expanded from year to year, it will also serve to measure the relative crashworthiness and performance of new safety improvements in each model year vehicle from previous model years. These data (Level II), however, do not have the necessary consistent overlapping time characteristics at this time, so as to provide for a detailed model year analysis.* Data file building for the forthcoming year will provide for the necessary time consistency in these data.

An examination of these data has re-emphasized that ejection remains the most significant mechanism for serious injury in accidents. Another finding is that windshield bond separation appears to be an effective gross indicator of accident and injury severity, perhaps analogous to that of an accelerometer.

An evaluation of the Abbreviated Injury Scale (AIS) as it relates to the current police code for classifying injury, was compared with a previous analysis. A wide variance still exists in the interpretation of the police code, particularly in lesser injury classifications. It is recommended that the attempt at correlating the two in the Collision Performance and Injury Report vehicle reporting form be abandoned, and that all references to a police injury code be eliminated.

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* An example of model year analysis might be the performance of different energy absorbing steering column designs relative to various vehicle types and years.

The State of Michigan's worst traffic accident* prompted an examination of the problem of the wrong-way driver on a divided highway. Such accidents occur (on the average) about once per hundred miles of interstate highway per year nationwide and are continuing to be a significant problem in highway safety. Generally, the accidents involve two vehicles, and fatal accidents average 1.4 deaths per accident, which makes them more severe than the the average fatal collision. A common feature of many of these accidents is the entrance onto a divided highway via an exit ramp, indicating that the motoring public may perform in a way not intended by designers. Alcohol is frequently involved in such wrong way entrances. It is recommended that highway designers and traffic engineers give full consideration to the impaired or otherwise non-alert driver (with his great potential for doing harm to others and his ubiquitous nature) in their choice of entrance ramp geometry and signing.

Of the 85 Level III in-depth accidents investigated, four involved destructive fires. Two of these cases brought out potential problems not related to the more common fuel system crash damage gasoline fires.

A motor home fire indicated some characteristics of that type of vehicle which suggest that the flammability standards should be reviewed for recreational vehicles. The separation of the engine and passenger compartments is marginal with respect to a fire barrier, and motor home interiors have an abundance of flammable material. Rapid egress from a burning vehicle can be complicated by the fact that the engine compartment is between the driver and the door. The current practice of detuning the engine ignition system to reduce undesirable emissions increases the likelihood for engines to backfire, creating additional potential for fire.

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* At Grand Blanc, Michigan on July 17, 1971; case study AA-100 (SPL).

An electrical fire which brought death to a driver prompted a series of tests to simulate the fire in an identical test vehicle. With the tendency toward more complex electrical systems in newer model vehicles, it is recommended that more attention be given to this mode of vehicle failure and its potential for injury. Fusing and circuit protection design must include consideration of conductors most susceptable to crash damage and subsequent fire.

Vehicular suicide was established as the most probable cause of two crashes investigated by the HSRI Level III team. While these by themselves, as well as the very limited mass statistical data in this area, do not serve to measure the full scope of the suicidal driver problem, it does prompt one to consider carefully causation of the vast segment of "single vehicle; run off roadway; strike fixed object" accidents resulting in death or serious injury. Involvement in such accidents by the Level III multidisciplinary accident team this year has added much insight so necessary in discerning when an accident is a potential vehicle suicide.

Thirteen Level III multidisciplinary investigations involved trucks, with relatively higher injury severities than for the average of non-truck accidents. Head-on collisions with trucks (3) accounted for fatal injuries to passenger car occupants, but minor or no injuries to the truck drivers. In the majority of these truck involvements, the accident might have been averted or reduced in severity had the handling of the truck been more responsive to the crash conditions as they developed for each particular accident setting. As commercial vehicles, trucks appear to have an endless array of varying designs, equipment features, components, subsystems and combination characteristics. While there have been various efforts to model passenger car dynamic response and handling, little has been accomplished to understand and "quantize" similar parameters in trucks.

It is recommended that truck accident investigations be conducted in parallel with research and testing to determine the dynamic response of trucks in the regime of limit performance with the aim of making trucks more compatible with the performance characteristics of the general vehicle population.

In one truck accident in which the vehicle struck a construction zone barrier, the driver told police that he was fatigued and had "gone to sleep". A witness (a second truck driver) told the investigators that the driver had not gone to sleep, but was motioning to him to stop for coffee when he struck the barrier. This suggested that "going to sleep" was an acceptable reason for such a crash, whereas not looking where he was going was not. Further analysis into this premise in Level I data revealed that truck drivers are involved in "going to sleep" accidents significantly more often than are passenger car drivers, but are cited for this violation significantly less often. This is disturbing considering the lethal potential of large trucks in accidents.

The tri-level concept of incorporating various levels of detail in accident data, with a broad program of field accident investigations within a fixed geographic area, was found to be an effective approach toward identifying problem areas in highway safety, including assessing the effectiveness of vehicle safety performance as well as evaluating standards and new safety features. While the program has been a year in duration, a year's data was not available for analysis. This did limit the potential for further analysis. The solution is inherent in the continuation of the program for the coming year. As data files become more consistent with identical time periods, valid comparative data will be available and the opportunity of discerning trends in accident data will be greater.

.0 Introduction

The writing and assembly of a final report requires one to review activities and events based on the experience of conducting various levels of accident investigations over the past year. In the extensive and broad study of traffic safety conducted by Arthur D. Little Inc. in 1966*, knowledge of traffic safety was categorized as existing in three groupings. These were summary statistics, isolated observations, and careful research. All of these areas were a part of this first year of Tri-Level Accident Investigation Study at the Highway Safety Research Institute (HSRI). Summary statistics are reflected in the continuous building of an accident file for Washtenaw County, Michigan, the geographic base area for the tri-level study. This was further augmented by the data file building of CPIR data cases, both from within HSRI, as well as from multi-disciplinary accident investigation teams throughout the county. Isolated observations were provided in most all Level III multi-disciplinary in-depth investigations in one form or another, some in glaring real-life detail. Careful research was involved in many in-depth accident case studies as well as within the data analysis efforts of the total study. Thus, it could be said that this first year of the study did provide an excellent vehicle for observing and participating in a variety of areas concerning highway safety.

In reflecting upon this first year, some comments are felt appropriate in terms of impressions and frustrations. First, is the intensity of violence evident in the immediate aftermath of an accident. This has had a marked effect on all program field personnel, particularly those whose involvement in field accident investigative efforts began with this program. The accompanying horror and sense of helplessness provided vivid first hand examples of failures in transportation. The acceptance of these isolated

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* Arthur D. Little Inc., The State of the Art of Traffic Safety.

but catastrophic events by society is perhaps the most disheartening part of the accident process. One almost always comes away with the feeling of general apathy on thepart of the motoring public.

When one considers the sophistication of current advanced technology, for example the monumental success of manned space exploration, the present "state of the art" in highway safety seems by comparison quite primitive. This discrepancy indicates the neglect of this national health problem and suggests the potential of technological innovation in analysing the problem and effecting solutions.

Objectives

Accident research activities are an integral part of the NHTSA mission, which is "to perform research and develop safety programs and standards in an effort to reduce the toll of deaths, injuries, and property damage from traffic crashes." Field accident studies, in varying degrees of scope and detail coupled with analyses of accident data over a fixed geographic base, constitute what is called the tri-level concept. It incorporates the collection of accident data at all reporting levels, ranging from police reported data to in-depth, detailed Multidisciplinary Accident Investigation team case studies, so as to achieve a unique and thorough accident data base for the geographic area. This area is Washtenaw County, Michigan. The establishing of such a data base makes possible valid statistical analyses between reporting levels, as well as within each reporting level. The objectives of these analyses include:

1. Identification of problems related to Human, Vehicle and Environment within Pre-crash, Crash, and Post-crash phases across the highway accident spectrum.
2. Indication of countermeasure methods and programs to eliminate, reduce or control identifiable problems.
3. Determining accident and injury causation as well as the effectiveness of new safety features.

4. Evaluation of federal Motor Vehicle and Traffic Safety Program Standards.

5. Early detection of design and functional problems of vehicle and highway.

6. Establishing a method for monitoring and evaluation changes in the highway transportation system over time, caused by induced countermeasures or by unintentional modification to the system.

The results of this first year's analyses are included in this final report.

Rationale

The tri-level accident study is structured on the premise that all levels of data, both independently and combined, provide a valuable resource which permits greater insight into the national health problem of highway injury and property loss. Level I data is basically police reported accident information, enhanced upon review with additional variables. These data are inclusive of all police reported accident information for the geographic area. Inherent in these data are accurate indications of area driving exposure, vehicle type mix, accident densities and accident type characteristics. Level II* accident data include all accidents within the geographic area involving current domestic model vehicles towed from the accident scene, regardless of injury. These are also termed clinical case investigations and are conducted by specialist professionals. They serve to establish norms for crashworthiness and injury production mechanisms of current model vehicles, assess the effectiveness of most recent vehicle standards and identify newly surfacing potential problems. Level III data results from in-depth, detailed accident case studies conducted by a multidisciplinary accident research team. While comparatively fewer in number, and with less statistical significance, Level III case studies provide greater insight into accident and injury causation, as well as

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* The terms Level I, II, and III are not precise. What we have termed Level II in this report is similar to the Cornell Aeronautical Laboratories Level III-A.

INTERSECTION ACCIDENT IN YPSILANTI, MICHIGAN.

a much finer assessment of vehicle and highway standards. Each may be considered as a small research study within itself, and serve to reveal potential problems within the broader matrix of factors for highway safety research.*

Together, these three different areas of accident data provide a valuable resource for analysis. Problems revealed in in-depth case studies (Level III) can be measured for statistical representativeness in basic accident data (Level I). Similarly, trends identified in Level I data may be explored in greater detail through specific accident cases in Level III investigations. Crash, injury, and new model vehicle performance data in Level II investigations both broaden the detailed data base so as to confirm or validate findings, as well as permit the identity of trends within Level II data alone. This tri-level approach thus makes possible valid statistical analyses between the various accident data levels. It also serves to continuously expose professionals in various disciplines related to highway safety to real-life traffic crashes, which are the problem in highway safety.

Design

Level I file building is based on systematic collection of police accident reports within Washtenaw County, Michigan. Its make up is a cross section of urban, rural, industrial and educational activities. One feature of significance is the disproportionate number of young drivers. This stems from the predominance of higher educational institutions in the county. These are The University of Michigan, Ann Arbor; Eastern Michigan University, Ypsilanti; Cleary College, Ypsilanti; Washtenaw County Community College, Washtenaw County; as well as the research and advanced learning institutions associated with a major university. Washtenaw County has an average of 60 to 75 fatal accidents per year, 3,000

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* DOT NHTSA publication, Program Matrix for Highway Safety Research, December 1970, J. C. Fell and S. N. Lee.

injury accidents per year, and 4,500 property accidents per year.

Level I accident data includes all police reported accident data generated within the county.* Upon collection, this data is analyzed and augmented by interpretation, providing additional variables not in original Police Accident Reports. Here, chronological coverage has been provided since 1968, with over 23,000 cases on file, with each accident case having a hard copy accident report back-up. Computer data files are updated quarterly, providing for continuous uninterrupted data collection. This portion of the tri-level program is supported by a gift to the University of Michigan from the Automobile Manufacturers Association.

In addition to the Washtenaw County Accident File, are various related data files which are useful adjuncts to basic Level I data. These include a sample of Driver Records, an expanded Fatality File, Alcohol Safety Action Program Files, Exposure Survey File, and an Emergency Medical Service Ambulance Record File. These data parallel the Washtenaw County Accident File and are used in analysis. Level II data is best classed as intermediate data, more detailed or more specialized than Level I, but less complete than the full MDAI reports. The Level II cases at HSRI include more data and detail than is provided in most other accident data which is classed as Level II. Accident case criteria here limits case studies to current domestic model vehicles towed from the accident scene, with minor or no injury, as well as those with moderate to severe injury. In each case, a completed Collision Performance Injury Report is provided along with vehicle and site photography. For the moderate to severe injury cases**, detailed injury and injury causation data is included, as well as an accident schematic. In general, these latter cases contain greater vehicle accident damage and occupant injury severity, and are viewed more as "failure" type accidents

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* These of course are "reported" accidents, i.e. those investigated by police under the rule requiring reporting of all injury accidents and those involving property damage greater than $200.

** Clinical Care Investigations, under Dr. Donald F. Huelke.

within the spectrum of Level II reports. Remaining Level II cases, or those where only minor, or no injuries occur, are considered more as the "success" category of the accident group.* Selected case studies, based upon various areas of particular interest (such as sub-components, full size vs. small size, vehicle head-on collisions, etc.) are orally presented at two month intervals. Each case study, of which there was a total of 430 cases for this past year, is coded, keypunched and periodically "built" into the HSRI CPIR-Long Form File. This file actually consists of 3 separate, but interrelated sub-files. They are:

1. Vehicle File - a single and complete record is built for each case vehicle in an accident case study.
2. Occupant File - similarly, a single and complete record is built for each case vehicle occupant in an accident case study.
3. Injury File - a single and complete record of each individual injured in an accident case study.

Level III case studies involve the in-depth, multidisciplinary approach to accident investigations. Here, all nine elements of the matrix for highway safety research** are addressed by specialist disciplines so as to thoroughly reconstruct accidents, bringing to bear all the relevant factors which influence both the cause and effects of the accident. This approach has been well established by NHTSA through the various multidisciplinary accident teams which currently exist across the country. Of particular interest is the almost completely on-scene approach (>90% of accident case studies) of the HSRI team. This permits a more thorough and accurate collection of vehicle, human, and roadside evidence so necessary in reconstructing the accident event. It has been made possible through a system of communication and alerting in cooperation with regional police jurisdictions. A total of 85 Level III case studies were completed during the past year.

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* Washtenaw County Level II Program under Mr. Ralph Darby.

** DOT NHTSA publication, Program Matrix for Highway Safety Research, December 1970, by J.C. Fell and S.N. Lee.

These include two special case studies where extensive investigative and testing efforts were required, in addition to the more conventional collection of accident case data. An average injury severity* of approximately AIS code 2.5 further characterizes Level III cases for the past year. While, this in itself is a form of "bias", it should be stressed that case acceptance criteria for Level III case studies by NHTSA also includes a bias. That is, the relatively fewer number of Level III case studies compared to Level II and I provides an accident population of limited value for statistical analysis. Because of this, a case selection guide was established which is perhaps best termed as a "one-of-a-kind" criteria. Wherever possible, new case studies are selected when the characteristics of the accident are sufficiently different from a previously completed accident case study and which present new and perhaps unique characteristics not found in previous cases. This approach permits as broad a coverage as possible in terms of accident type, while still conforming to case selection criteria as set forth by NHTSA.

In addition to the three data levels and county accident files described above, there are numerous other data files available to the tri-level study. In general, these files serve to augment a particular analysis task so as to confirm or support, as well as compare, findings generated from the Washtenaw County Accident and CPIR Long Form files. These data files include:

National Accident Summary File
Driver Record File
Bureau of Motor Carrier Safety Accident File
Exposure File
Alcohol Safety Action Program Files
Michigan Fatal File
Texas State File
Ohio, Pennsylvania and Indiana Turnpike Files
Others: Denver, Seattle, Miami, Vermont

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* This average is computed by summing the highest AIS Severity in each Level III case and dividing by the total number of cases.

Organization

The basic ingredients of the tri-level study are field investigations, data file building and data analyses. The latter two activities are a basic and vital continuing part of HSRI, whose established organization and expertise were brought into the tri-level study. Also, both Level I and Level II field investigations are an established* and continuing activity within HSRI, with their existing organization and expertise.

The enlargement of field accident investigation capabilities was a direct result of the tri-level accident study program. Here, a particular field accident team was assembled and equipped with provisions made for alerting to accidents for in-depth, on-scene investigations. Team field vehicles** were received for program use in mid-September 1971. These vehicles were equipped with two-way mobile communications equipment on a frequency used by the University of Michigan Department of Security. This office has 24-hour, continuous dispatching for University security and administrative activities, and provides a capable accident alerting system. Since the University of Michigan is the dominant institution in the City of Ann Arbor, as well as Washtenaw County, Michigan, the University's Security Office has direct, open telephone communication lines with both the Ann Arbor Police Department and the Washtenaw County Sheriff's Department. To further compliment this network, an additional single telephone channel for all incoming accident "alert" calls was also installed. This "red phone" terminates at two locations within HSRI (team "ready room" and individual team member offices) as well with an extension on the desk of the dispatcher, and base radio operator, within the University's security office. This telephone channel is used only for incoming calls from city and county police headquarters, as well as from area state police posts. During daylight hours, the phone is answered by Level III team personnel at HSRI. During night hours, calls are taken by the

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* Level I and II accident research activities are sponsored by the AMA.

** Two Dodge "Maxiwagon" vans specially equipped for field accident work.

University of Michigan security dispatcher with accident information passed onto Level III team personnel, whose names rotate on a "call list".

In addition to this police alerting communications network, a base monitor radio is situated within the HSRI "ready room". This is an 8-channel swept monitor receiver for continuous monitoring of area police transmissions. Switched outputs from this monitor radio are provided within the "ready room" and individual team personnel offices. Current policy within the city of Ann Arbor Police Department is to alert the HSRI Level III team to all injury accidents within the city. A degree of information screening (pedestrian, motorcycle, truck, late model passenger car, type of accident, gross severity of injury) is also provided in these communications. Police cooperation with the overall tri-level program has been excellent. This is not necessarily the result of current Level III activities only, but from conducting on-scene investigations in the area (Level II clinical case studies) for the past 10 years. This established trust and acceptance of field investigative personnel on-scene at accidents was merely transferred to include our Level III team and the new faces associated with the expanded field activity.

In addition to police accident alerting and field cooperation, has been the cooperation provided by many and varied local and state units of government, where information vital to the investigations has been obtained. Many of these are listed under the section titled <u>Acknowledgements</u>. In particular, has been the State of Michigan Secretary of State's Office in providing driver records promptly and oftentimes after considerable cross checking, and the Michigan Department of Public Health Laboratory in providing results of toxological tests.

Level III team personnel includes an automotive engineer, psychologist, environmental specialist and data analyst, in addition to the principal investigator, as full time staff. Their endeavors are augmented by others within HSRI and the University of Michigan on a part time, or consultative basis, as specialists with particular competence in problem areas which are examined in case studies.

In general, a minimum of two of the Level III team members respond to an accident alert and conduct on-scene investigations. Their objective, in addition to first assisting police and emergency medical personnel, is to collect as much information as possible relative to human, vehicle and environmental factors as quickly and efficiently as possible, before the accident scene is disturbed. As indicated previously, over 90% of cases completed this past year were on-scene, with the accident scene reasonably undisturbed. Accident follow-up depends mostly upon the level and detail of accident information obtained on-scene. An independent, and separate examination of the vehicle is accomplished in all case studies undertaken. In many instances, both human and environmental factors data are obtained completely on-scene by staying with the accident scene until all possible relevant data is obtained. The significance of on-scene investigations cannot be over-emphasized in relation to the quality and depth of information possible from a particular accident event. Every attempt will be made to continue this high percentage of actual on-scene investigations for the forthcoming year.

Perhaps the single most bothersome area inhibiting further Level III field research efficiencies is the one of privileged information, as it relates to accident data obtained for research purposes. In one instance* all members of the Level III field accident investigation team were subpoeaned, and compelled to spend a complete afternoon in a courtroom, never to be called to testify. In numerous other instances, information was denied or delayed for many weeks, due to possible legal implications and conflict with protecting one's rights. This is most prevalent in the area of human factors, primarily in accidents with severe or fatal injuries. This problem can

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* HSRI Case Study AA-151, a full size passenger car head-on collision with a sports car, fatally injuring the driver of the sports car. The driver of the full size vehicle was intoxicated and charged with manslaughter.

only increase as more area attorneys and insurance company officials become familiar with accident research activities within HSRI. It is recommended that the present draft authorization bill on behalf of the NHTSA to make accident data for research purposes privileged data, be supported with vigor and without compromise.

Each accident is sufficiently different from the last to require some variation in approach. However, the following general guidelines and policy followed by the HSRI Level III Accident Research team are offered here:

1. A minimum of two experienced and trained accident investigators respond as quickly as possible on-scene to candidate accidents.
2. Each investigator's approach toward obtaining information when on-scene should tend to complement the other's. For example, when one investigator is involved with on-scene vehicle data and photography, the other should be interviewing drivers, occupants, or witnesses for human data as well as reconstructing the accident in detail in conjunction with police and witnesses.
3. One investigator should accompany the injured to the hospital, and follow the injured through the Emergency Room process while obtaining injury information and human factors data when possible. When also possible, nearest of kin, relatives, friends who enter the hospital scene should also be queried for information relative to the injured. This is most effective if accomplished in the company of the police officer responsible for the case.
4. The second on-scene investigator remains at the accident site through clean-up and until after the scene has been abandoned by the various emergency personnel involved. A review of all events and evidence involved in the accident at this time, under a more relaxed and contemplative atmosphere, can provide greater understanding of the overall accident and the best approach from that point for additional detail.*
5. Independent follow-up investigations for more detailed (human, vehicle, and environmental) data are accomplished as soon after the accident event as possible.
6. A preliminary case debriefing is accomplished with all involved individuals at the earliest possible moment convenient.

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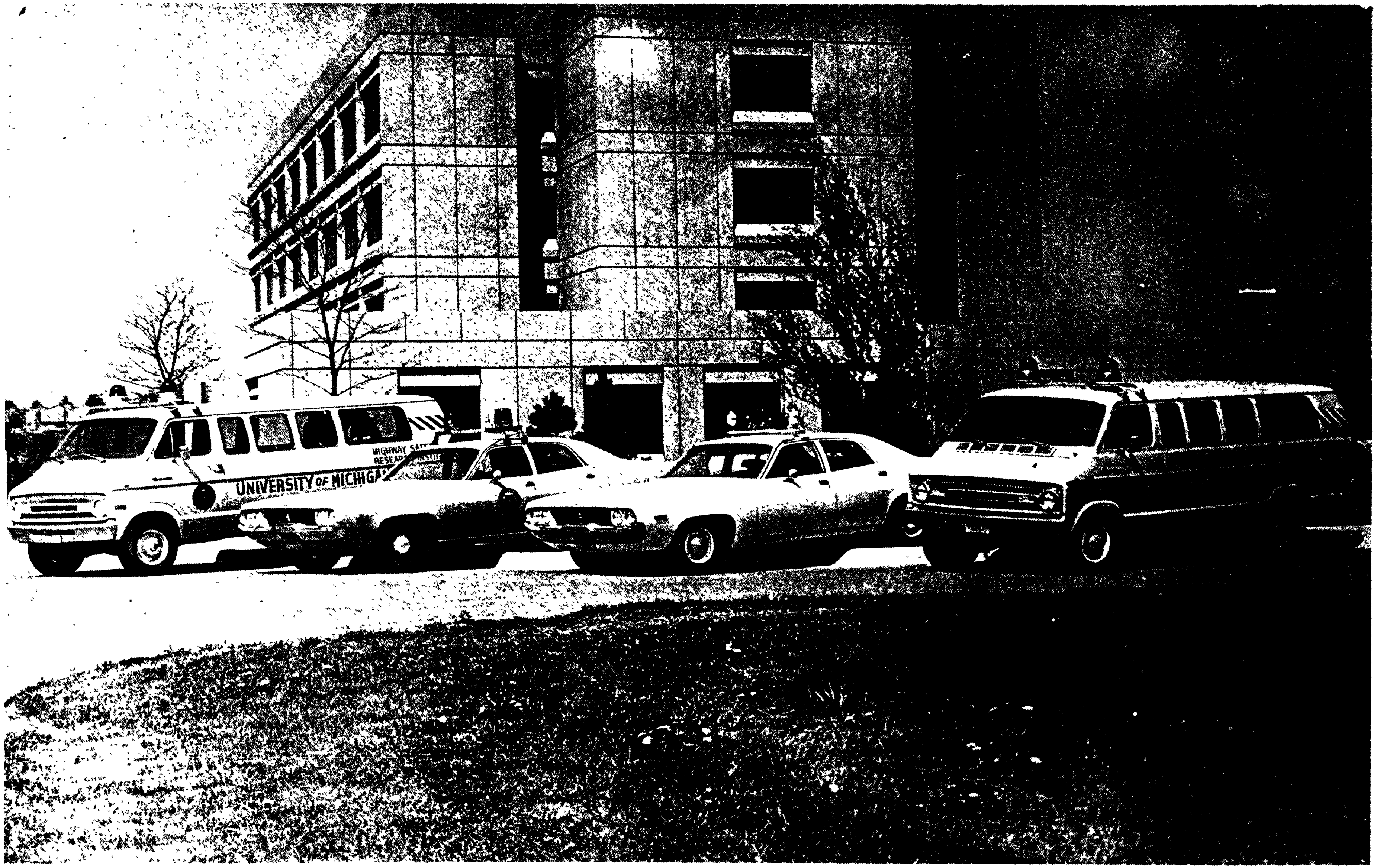
* HSRI accident vehicles are specially equipped for completing case paperwork in the field.



HIGHWAY SAFETY RESEARCH INSTITUTE FIELD ACCIDENT INVESTIGATION VEHICLES.

7. The more complete and detailed case disciplinary review are conducted only when all basic case data have been acquired.

While these may seem to accent the obvious, they nevertheless have provided the best approach for successfully completing an accident case study.

4 0 Analysis Methodology

The tri-level approach to data collection consists of the amalgamation of four sample sets of data into the three levels of analysis. Level I data has the greatest number of cases and the smallest number of variables, basically those recorded on police accident reports with the addition of information such as map coordinates for computer location on an automated map. Level II data consists of the census of all late model tow-away accidents in the county, investigated by two teams as off-scene vehicle and injury reports on the CPIR Revision III Form (with certain additional supplementary human, location and other data added). Finally, the MDAI team is an on-scene accident investigation activity collecting all of the data within the 9 cell NHTSA program matrix* and more supplementary data (see appendices for examples of some of these data forms).

There are several objectives within the accident investigation analysis programs in Washtenaw County. For Level II information, acquired mainly under AMA sponsorship, but augmented by many MDAI investigations, one objective is to draw inferences about injuries relative to vehicle make and model, or other vehicle characteristics. If the data set can be considered statistically representative (of some larger population), it is also possible to draw inferences about, say, seat belt usage (e.g., by sex of occupant), the distribution of injury types by height and weight of the occupants, etc. However, two key questions arise:

1. Is the data statistically representative of some larger population? If so, what population?
2. Is the data reliable, consistent, and accurate?

The latter question is perhaps easier to answer. Data provided by these programs is subjected to several tests of quality

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* DOT publication, <u>Program Matrix for Highway Safety Research</u>, December 1970, by J. C. Fell and S. N. Lee.

control, ranging from discussion of details between investigators and their supervisors to computer editing of an accident case report as it is entered into digital storage. In most all Level III case studies, the MDAI team has been on-scene before the vehicles were removed, with most of the injured followed to the hospital for immediate interviews and information as to condition. Although this past year's activities has involved the training of new people in accident investigation work, and a myriad of arrangements with hospitals, police departments, towing operators, licensing authorities, etc. to insure a smooth flow of data, we believe the general accuracy and completeness of the data can be defended.

For what has been classed as "Level II" cases, a set of information now covers 746 vehicles in machine readable form over a period of approximately two years. This information, or data file, has its own population characteristics, which should be understood before making further interpretations.

First, there are three university accident investigation activities operating within the county. In the present data set, the time periods covered by the digitally coded data resulting from investigations by these three teams are different but overlapping for approximately half of fiscal year 1972. In the next few months, however, it will be possible to look at a completely overlapping one-year period. This will further enhance the representativeness of the information.

The validity of the present Level II data file depends upon the type of inquiry to which it is subjected. Analyses relating injury to accident vehicle model year are inappropriate since the present data set contains few "non-injury" accidents for 1969 vehicles (the input of these accidents did not begin until late 1970), and few serious injury accidents for 1972 vehicles (because the injury accidents take a more circuitous route in investigation and compiling into the digital file). Analyses relating, for example, seat belt usage to sex are less likely to be biased, and the analyst should feel more confident in the results of such an analysis. A study of the type of accident involvement by manufacturer would seem to be approachable in this data, but one should suspect biases resulting from the fact that one manufacturer introduced a line of mini-cars a year earlier than another. The techniques of multivariate analysis helps to identify the extent of such biases and their effect when they do exist.

Secondly, if one intends to infer anything about the national population of accidents from this data, it should be approached with certain known reservations. Strictly speaking, this data set is representative only of accidents in a medium size, midwestern semi-rural county, containing two large Universities, several other colleges, and a somewhat larger than average new car and young driver population. That is, it represents Washtenaw County, Michigan. Conversely, one could argue that this particular geographic area does yield a broad distribution of different type accidents which occur on a variety of different types of roadways, involving people within a population dominated by the 18-25 age group. Communities within the area, however, also include drivers from ages 15-90 involved in accidents within a broad range of family income, and include older vehicles. Many studies with these data are concerned with injuries in recent model vehicles, with some numerical advantage of concentrating in a region with a high ratio of new to old cars.

Philosophically, this discussion may appear to stress reservations about these data to those who are mainly concerned with making inferences about the national population. However, it is believed that inferences can be made which are useful and significant relative to the national population, as long as these accident data characteristics are understood. For true statistical validity, perhaps it would be better to draw on a sample of the whole country (preferably stratified in some way) and investigate accidents on the basis of some random selection. With such an approach, however, it would be most difficult to maintain a team of professional investigators with the ability to get on scene to candidate accidents along with the necessary rapport with the various community authorities to obtain medical, psychological, and other information quickly and accurately needed for the types of analysis possible with this data set.

Level I data for Washtenaw County does serve a number of valuable purposes. It is possible to measure the representativeness of Level II data by comparing frequency counts in the two different data sets. This can identify accident cases that "got away", and yet still retain and describe their characteristics. It is also possible to conduct a search of Level I data files to determine the frequency of occurrence of particular types of accidents investigated as Level III case studies. For example, the detailed in-depth characteristics of house trailer accidents may be observed in an MDAI investigation; but the frequency of these accidents in the country population can be found more precisely in the mass data, or Level I data files. It is possible to compare reporting practices between various levels of data. (For example, the comparison of police injury coding practices with expert medical opinion, police speed reporting with an engineering analysis, etc.)

Finally, other Level I files for different regions of the United States permit the strengthening, or rejection of hypotheses about frequency of occurrence of accidents in the national population.

In this first year of the tri-level program, a methodology for analysis of data within the three levels has been established. The incomplete overlapping of Level II data from the several sources, however, precludes certain analyses at this time. As a full year of fully overlapping coverage becomes available, these shortcomings will be removed. We have nevertheless, included here the results of our analysis of these data, with qualification, and believe they are useful toward understanding more of the characteristics of injuries and accidents.

5.0 Level III Data

This section provides some descriptive statistical characteristics for the Level III multidisciplinary accident cases this past year which include 85 separate accidents with 107 vehicles, and 180 occupants. In addition, pertinent demographic characteristics of the county are presented here. Following these descriptive statistics, a summary of the many accident, human, vehicle, and environmental factors related to these accidents is also given in tabular form. These can also be used as a form of index to the case summaries in Volume II of this final report. Case numbers are given at the left page edge, so the reader can identify properties of the case by inspection of the columns to the right. Finally, a summary of the matrix cell factors reported in these cases is given, followed by a summary of the references to standards both by case number and summarized by cell.

It should be emphasized again that the Level III multidisciplinary team accident case selection is not random. Generally, more severe accidents were investigated, and a broad range of accident types was attempted. More generalized analyses utilizing the Washtenaw County CPIR data file, and from mass data files are presented in a later section. This section is primarily to display characteristics of the environment, and the Level III accident population.

Washtenaw County is semi-rural with a population of 234,103 people (1970) and land area of 711 square miles. Principal cities are Ann Arbor (pop.=99797) and Ypsilanti (pop.=29538), both of which are located near each other in the eastern portion of the county. Median age of the county population is 23.6 years (as compared with 26.3 years for the state of Michigan). The proportion of people using a motor vehicle as their primary means of transportation is 78%. Educational services are the major employer in the county, with manufacturing second.

Passenger car registration in the county is 100,519 (1971), with other vehicles (commercial, trailer, motorcycles, and municipal) totaling 31,775. Total roadway mileage in the county is 1522 of which 493 miles are primary roads, 938 are local roads and streets, and 120 are rural trunklines. There are 71 miles of expressway.

Figure 5-1 is a copy of an official county map, showing the major cities, townships, and road systems. A computer printed map is used in connection with the accident analysis activities. A plot of Level III accidents is shown on this map base as figure 5-2. (A description of the procedures for preparing digital maps of accident subsets within the Washtenaw County boundaries is given in Appendix F. Figure 5-3 has been prepared from the Washtenaw County Level I data file and is a 4% sample of 1968-1970 accidents. Inspection shows that the majority of the county's accidents occur near the two cities and along the corridor between them. The arithmetic mean position (i.e., the epicenter) of Level III accidents is located approximately at the University of Michigan Hospital, just northeast of the city center. Level III cases are similarly concentrated near the cities, but the distribution in the out-county region may be a little heavy since Level III accidents tend to be more serious and higher speed accidents. Figures 5-4, 5-5, and 5-6 describe some of the characteristics of Level III accident cases from investigations conducted by the HSRI multidisciplinary accident team. Figures 5-4, and 5-5 are histograms of number of injuries, and number of accidents by hour of the day. Fatalities are indicated on the injury histogram (Figure 5-4) as solid bars. Level III multidisciplinary team accidents are distributed in time similarly to those in Level I data. It is interesting to note that the fatal accidents investigated are nearly uniformly distributed with time.

Positive blood alcohol readings were obtained for 15 drivers of 24 drivers tested. Figure 5-6 shows the relationship between blood alcohol level and age of driver. This suggests a linear

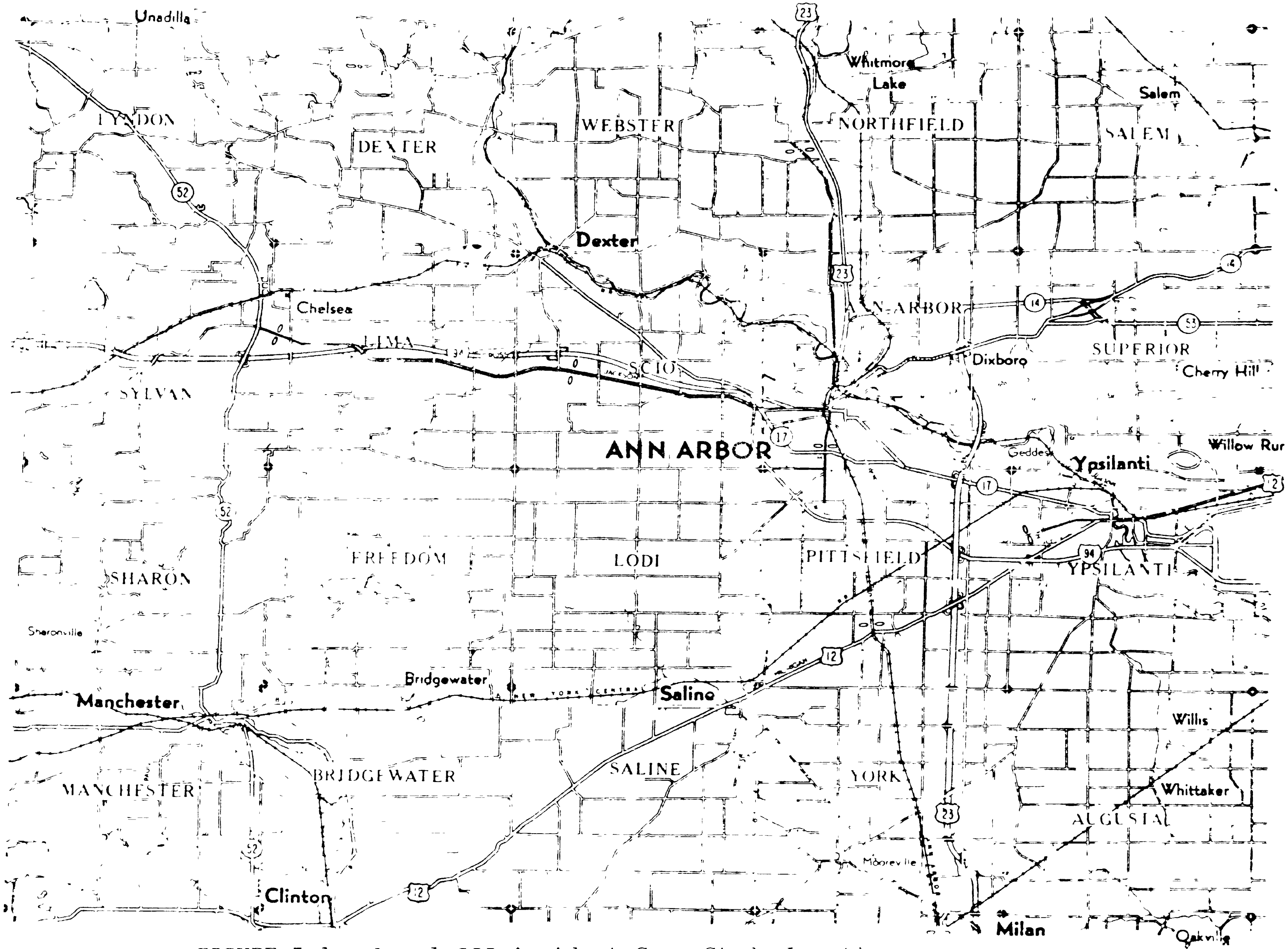
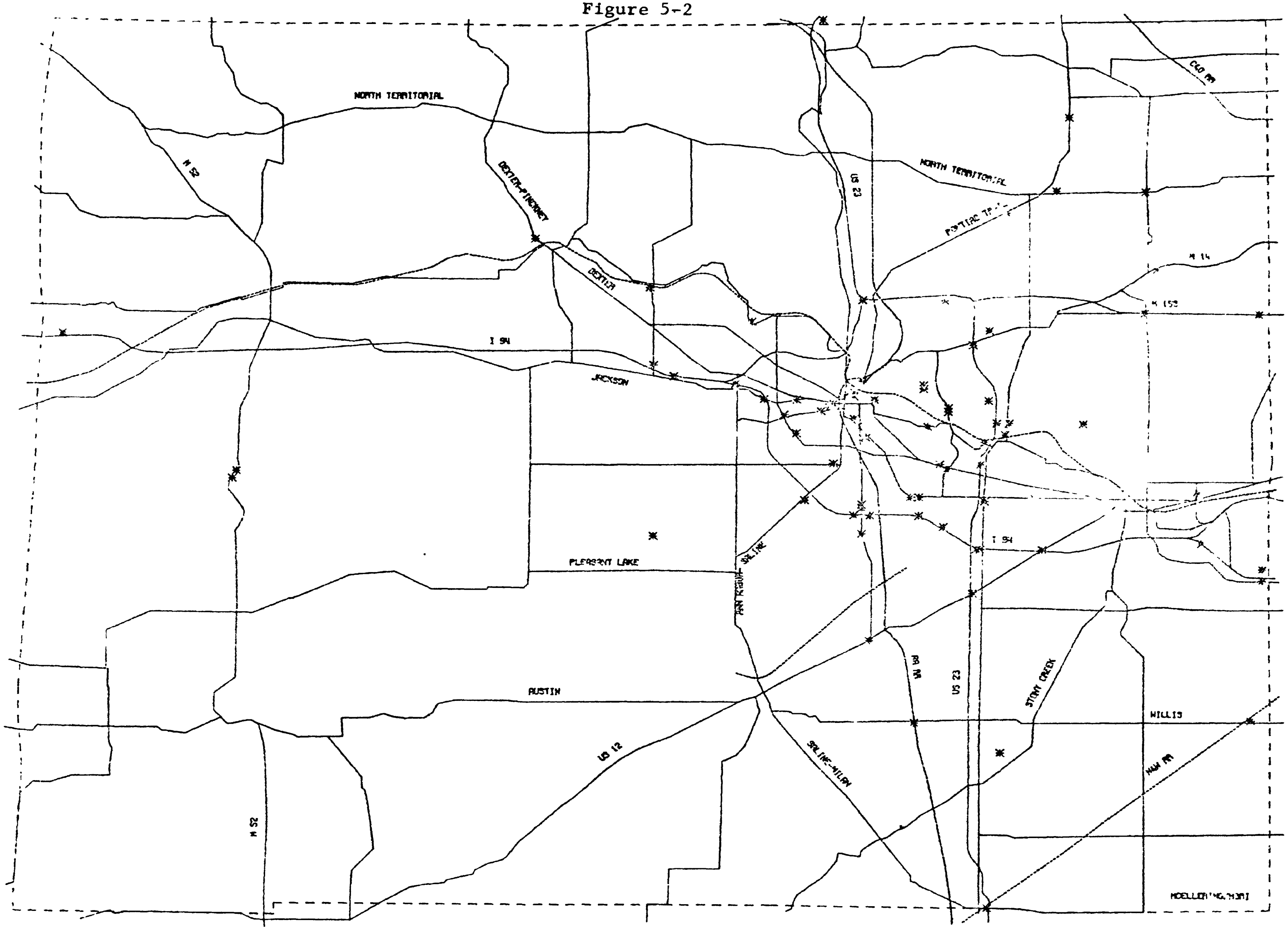


FIGURE 5-1. Level III Accident Case Study Locations.

WASHTENAW COUNTY MDAI ACCIDENTS: 1971-1972

Figure 5-2



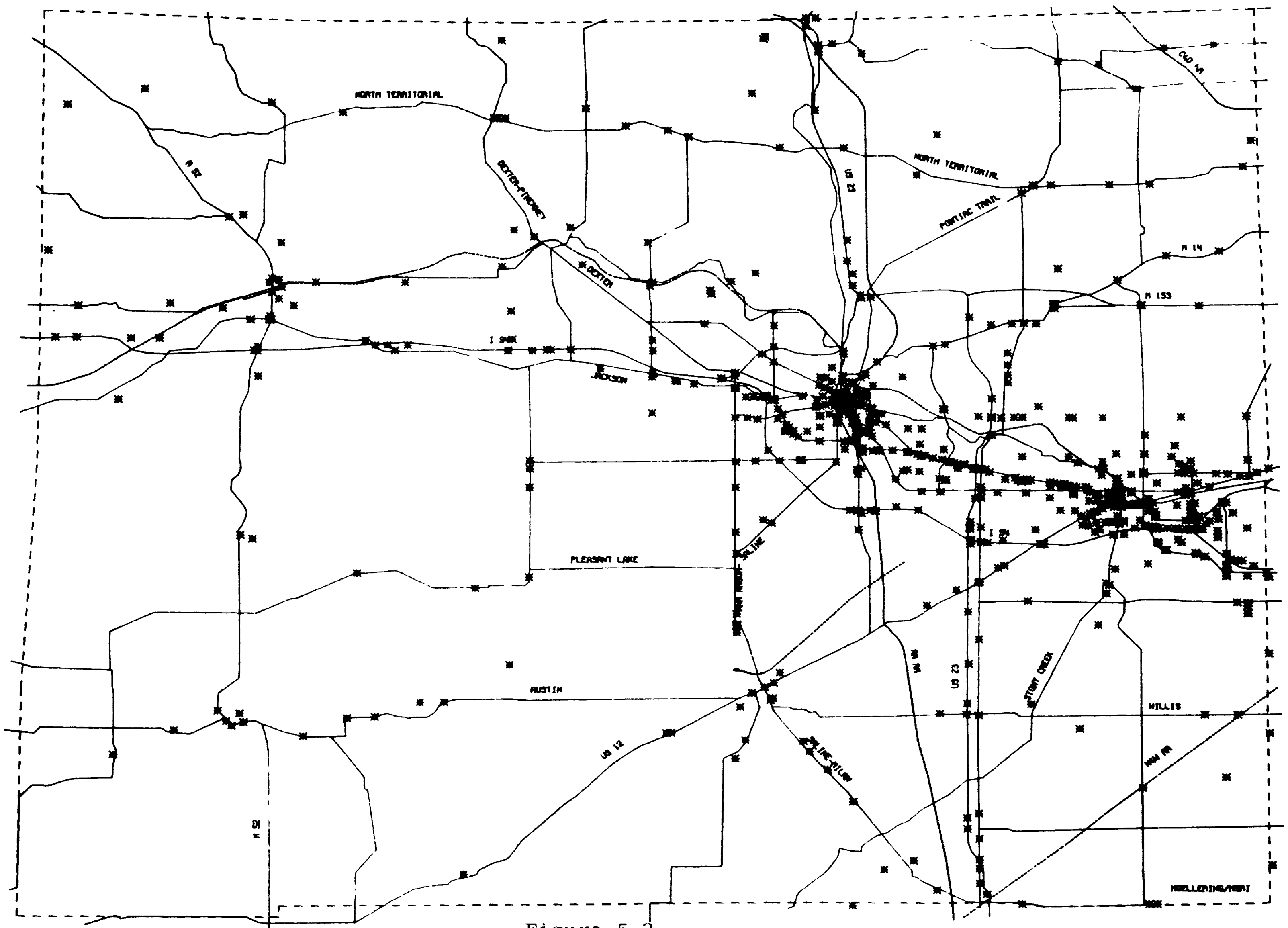
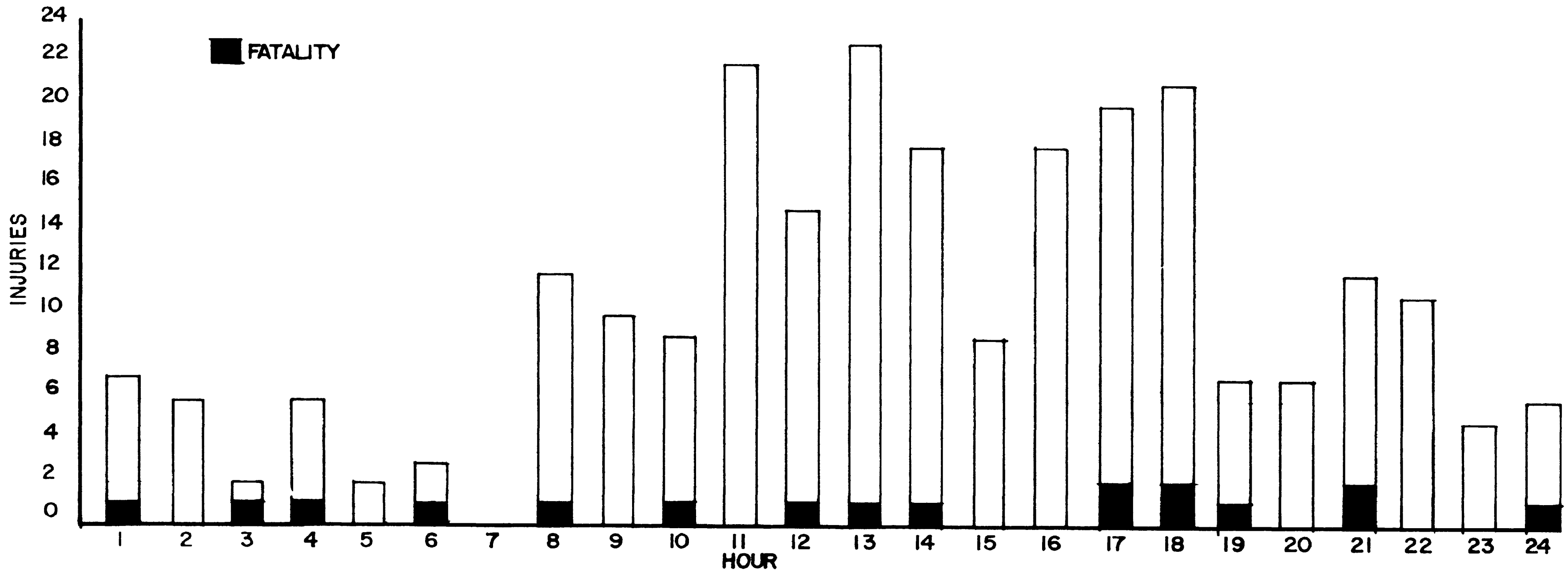
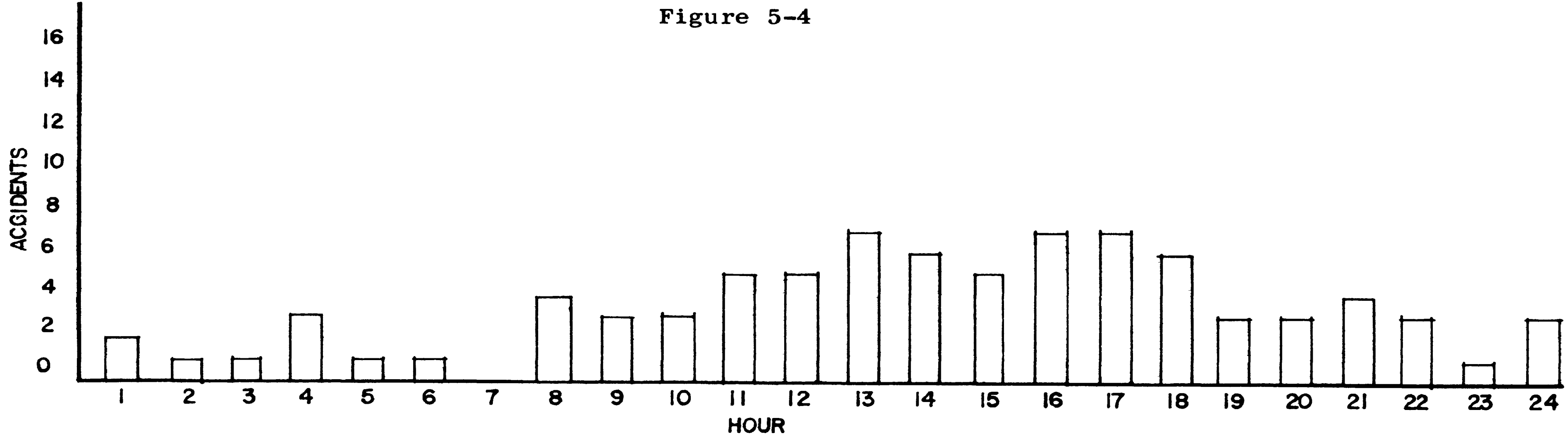


Figure 5-3

WASHTENAW 4 PERCENT TEST SAMPLE OF 1968-70 CRASHES



NUMBER OF INJURIES BY TIME
Figure 5-4



NUMBER OF ACCIDENTS BY TIME
Figure 5-5

trend. A positive relationship has been observed in other studies.* However, the data in this set is insufficient for any confirming significance at this time.

Figure 5-7 illustrates the distribution of vehicles involved in accidents investigated by the Level III MDAI team by major manufacturers. This indicates a predominance of General Motors products in this county. There are several data elements which vary significantly by manufacturers. Mean injury to occupant is significantly different, being the least in General Motors cars (0.58) and the greatest in foreign cars (3.67). The same difference does not occur in either the complete Washtenaw County CPIR data file, nor in the (police injury level) Level I data file. Such variation appears to result from a case selection procedure which has not yet been identified.

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* <u>Alcohol Abuse And Traffic Safety: A Study Of Fatalities DWI Offenders, Alcoholics, And Court-Related Treatment Approaches</u>, L. Filkins et al, Final Report Contract No. FH-11-6555 and FH-11-7129, HSRI University of Michigan, submitted June 26, 1970.

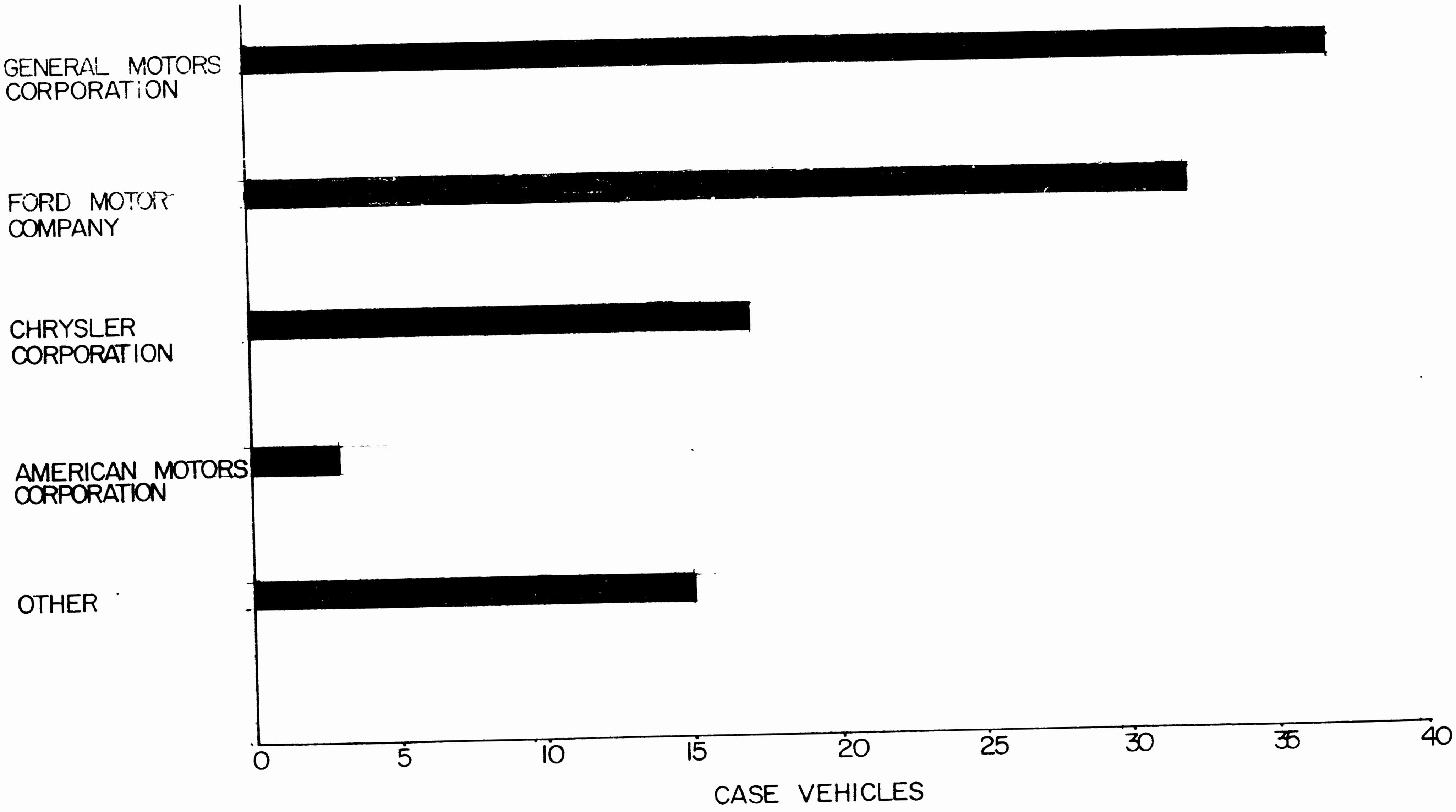


Figure 5-7

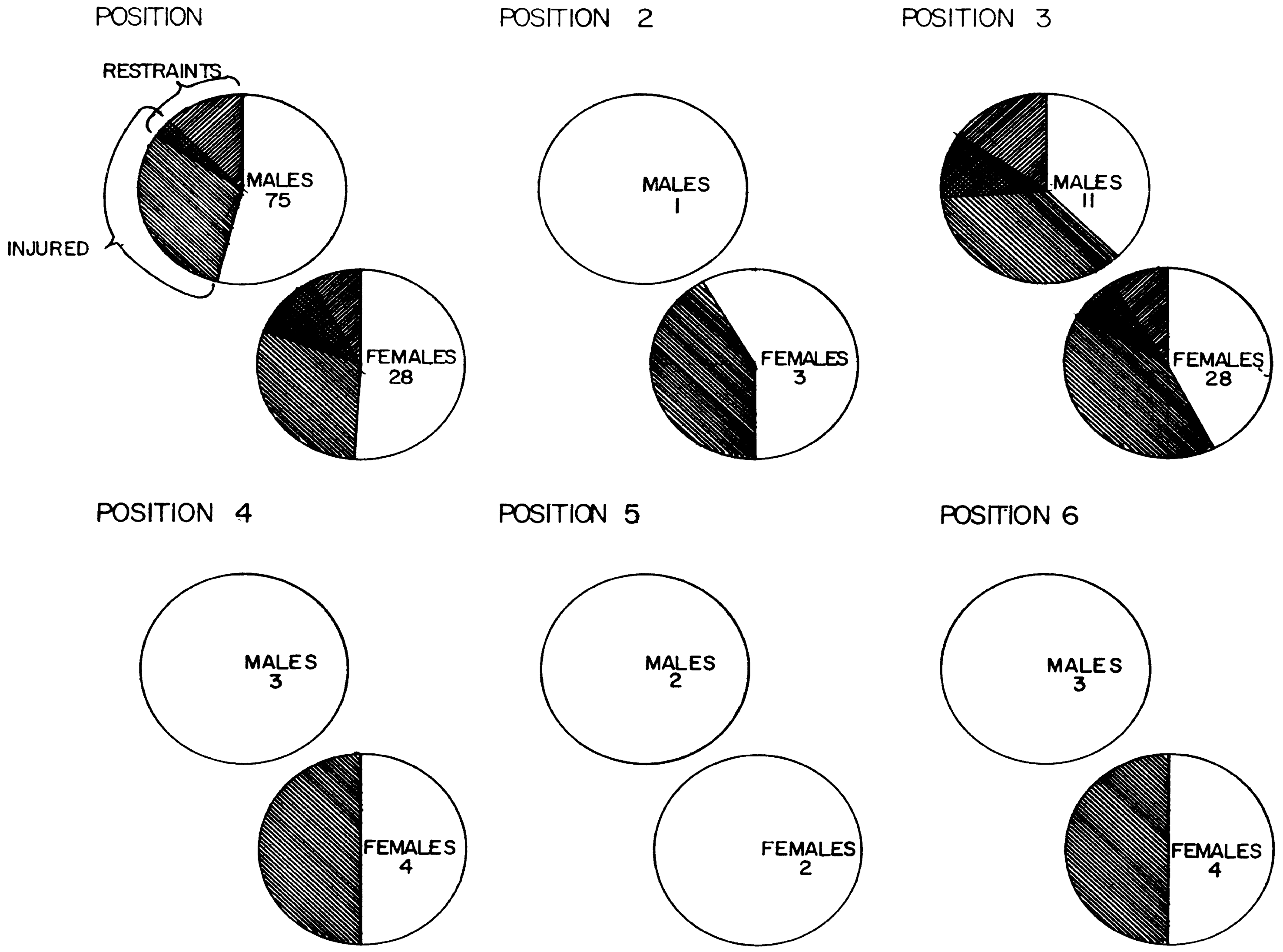
CASE VEHICLE INVOLVEMENT BY MANUFACTURER

Injury Distribution In Level III Accident Cases

The distribution of occupant position within an accident vehicle, restraint system usage, sex, and injury for the 163 vehicle occupants in accidents investigated as Level III case studies are given in graphical form in Figure 5-8. This presentation displays the interactions among these variables.

Several general observations may be made. For this set of relatively serious accidents (it should be clear that severity itself may bias these findings) drivers are most often males, and right seat passengers most often females. Of the 163 occupants who were seated in the right, or left front seat, only 3 were wearing upper torso restraint systems, and one of these was a relatively severe accident (impact speed of 35 miles per hour and VDI extent of 4). The two passengers in that car who wore upper torso restraints each had an injury of AIS rating 1.

Of the 17 rear seat occupants in this set of data, not one used a restraint. In the set of all new car Level II accident investigations in Washtenaw County, 17 of 141 rear seat occupants wore lap belts. These of course, include many non-injury accidents. A comparison of driver restraint usage in the larger (Level II) file is interesting. Of 685 drivers in the Washtenaw County Level II data set, 34 were wearing lap and upper torso restraints. This is approximately 5%, as compared with 2% in Level III data. It is not possible to observe any significant differences in lap or upper torso belt usage between the sexes in the Level III set. In the larger set of Washtenaw County Level II data, the two are almost precisely the same, 23.3% for females vs. 23.4% for males based on a sample of 472 females and 628 males. Upper torso restraint usage in the larger set of data is also more meaningful. Of approximately 1100 occupants in either right or left front seat, 4.4% wore upper torso restraints. This was 4.1% males and 4.8% females. This was not significantly different at the 10% level, but perhaps a hopeful indication of restraint acceptance among both sexes.



DISTRIBUTION OF INJURIES BY OCCUPANCY, SEX, AND RESTRAINT SYSTEM USAGE
Figure 5-8

Use of the upper torso restraints differs significantly with age. In the group of occupants where these restraints were available, and who were 12 to 21 years of age, only 1.6% made use of the restraints. In ages ranging from 22 and greater, 5.4% of tne occupants used them. Table 6-9 displays these findings in more detail. The relatively low use of the restraints among youthful front seat occupants may be some cause for concern among driver educators.

TABLE 5-9

Age of occupant (police groupings) vs. upper torso restraint usage--Washtenaw County new car CPIR data file Level II.

Age	No. of occupants	No. of users	% usage
0-12	29	3	10.3%
12-16	51	0	00.0%
17	50	1	2.0%
18-19	95	3	3.2%
20-21	102	1	1.0%
22-24	146	4	2.7%
25-29	125	11	8.8%
30-34	52	1	1.9%
35-44	98	6	6.1%
45-54	70	4	5.7%
55-63	45	5	11.1%
over 63	25	1	4.0%

In the 85 Level III cases (involving 180 occupants), the relationship between the Abbreviated Injury Scale (AIS) and the last digit of the Vehicle Damage Index (VDI) is shown on a scattergram in figure 5-9. VDI has been criticized as being a poor measure of true damage severity, since it can vary greatly with vehicle body style. The AIS is perhaps a more acceptable scale for injury severity description. Figure 5-9 shows a somewhat linear relationship between the two measures, but perhaps of more interest is the small variance of injury for low VDI's and relatively larger variance at high VDI levels.

The outliers on this plot deserve some explanation. The AIS=1 injury, with VDI of 7 involved a truck which skidded into a bridge rail, and whose cargo burst through the front of the cargo van crushing and girding off the upper half of the truck cab. The driver's most severe injury was a brush burn on his back occasioned by his sliding across rough upholstery. The fatal AIS=6 injury, with VDI of 2 involved an elderly driver in a vehicle without an energy absorbing steering column, who was crushed against the column by a heavy load being carried on the rear seat. His injuries included multiple rib fractures and massive hemo-thorax which included a ruptured inferior vena cava.

Also plotted in figure 5-9 is the mean injury level for each VDI with the ± 1 standard deviation range. Beyond VDI level 5, the data are too sparse for useful interpretation, but up to that point a linear trend is apparent.

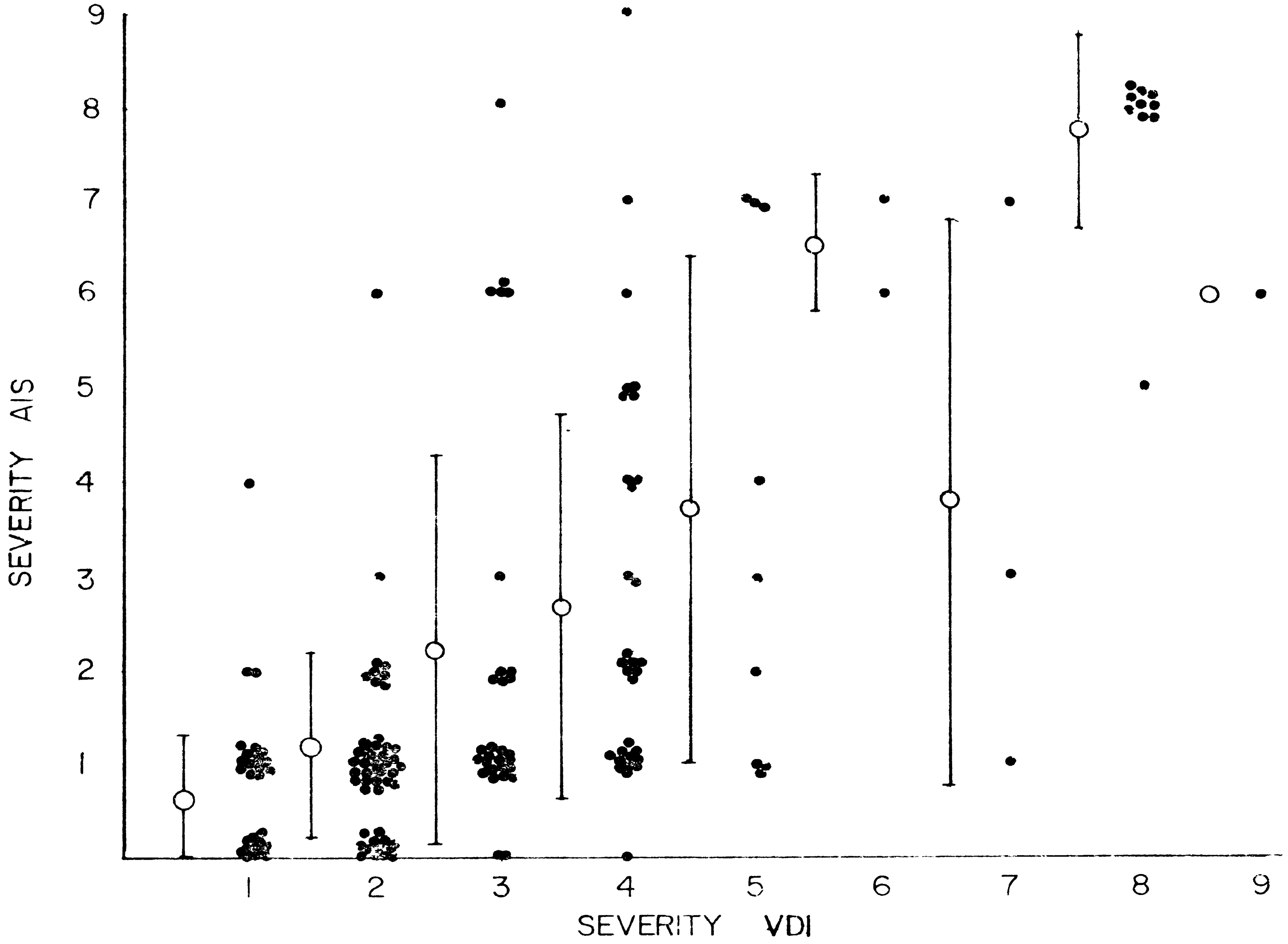


Figure 5-6. Abbreviated Injury Scale (AIS) vs. Vehicle Damage Index, MDAI cases.

Accident factors for the Level III MDAI cases are tabulated on the following pages. The left hand column contains the case number, with other columns self explanatory. The matrix cell tabulation indicates the number of citations of each of the 9 accident investigation matrix cells, without regard to sign. That is, cited without regard as to whether the cell factor was a positive or negative consideration.

A similar index follows for various human factors. Police and AIS injury codes may be compared, as can restraint usage and ejection. Case summaries are given in Volume II. The listing here can serve as an index to enter that volume.

Environmental data are summarized in pages that follow in a similar fashion. Vehicle data also follow the environmental data.

A summary of the number of references to Federal Motor Vehicle Safety Standards and Highway Safety Program Standards is also included. Last, are matrix cell counts which are summarized by case (with signs), and by cell.

This data summary section is intended primarily as a reference for more descriptive characteristics as they relate to a particular accident. For greater detail, as may be posed by the question, "are there any cases in which an occupant wearing a lap belt was ejected?", the computer file must be accessed. Variables selected for presentation here are common ones which avoid the need for machine data printout.

ACCIDENT FACTORS CASE INDEX

Case #	# Vehs	Coll Type	Date	Time	Precip	Matrix Cell 1-9 Cited								
AA100	2	HEAD-ON	17JUL 71	3PM	NONE	2	1	1	0	0	0	1	0	0
AA101	1	NO	7JUL 71	4AM	NONE	3	0	1	1	0	1	0	0	0
AA105	2	REAR-IMPT	12JUL 71	3PM	NONE	2	0	0	0	1	1	0	0	0
AA114	1	NO	22JUL 71	NOON	NONE	5	1	0	0	1	0	1	1	2
AA115	1	NO	29JUL 71	7PM	NONE	4	1	1	0	1	0	0	0	2
AA116	2	OTHER	3AUG 71	NOON	NONE	1	1	1	1	0	0	1	0	0
AA119	2	SIDE-SWIP	17AUG 71	9AM	NONE	3	1	0	0	1	0	1	0	0
AA120	1	NO	24AUG 71	4PM	NONE	3	0	0	0	1	1	3	0	1
AA121	2	SIDE-SWIP	25AUG 71	9PM	NONE	3	0	0	0	0	0	3	0	0
AA122	1	NO	31AUG 71	3AM	NONE	2	0	1	1	0	0	0	0	0
AA125	1	NO	8SEP 71	2PM	NONE	1	1	1	2	0	0	0	0	0
AA126	2	SIDE-SWIP	16SEP 71	NOON	NONE	1	1	0	2	0	0	1	0	1
AA129	1	NO	23SEP 71	10PM	NONE	3	2	4	1	1	0	0	2	0
AA130	1	NO	1OCT 71	5PM	NONE	2	2	2	0	1	0	0	1	0
AA132	2	T-INTER *	11OCT 71	5PM	NONE	2	0	1	0	1	0	2	0	1
AA133	3	L-INTER *	11OCT 71	7PM	NONE	3	1	0	1	1	1	3	0	0
AA134	1	NO	12OCT 71	5PM	NONE	1	0	0	0	0	0	1	0	1
AA136	1	NO	17OCT 71	4AM	OTHER	2	1	1	0	0	0	1	0	1
AA138	1	NO	8NOV 71	8AM	NONE	6	1	2	0	1	1	0	0	0
AA139	2	T-INTER *	9NOV 71	MDNT	NONE	1	1	0	1	3	0	3	1	1
AA140	2	HEAD-ON	11NOV 71	4PM	NONE	5	0	1	1	1	0	1	0	0
AA141	1	NO	12NOV 72	10AM	NONE	1	1	0	0	1	1	0	0	1
AA142	2	REAR-IMPT	17NOV 71	NOON	NONE	2	1	0	0	2	0	1	1	1
AA143	2	REAR-IMPT	21NOV 71	6AM	NONE	2	1	0	1	1	1	3	0	0
AA144	2	REAR-IMPT	2DEC 71	6PM	NONE	3	1	2	1	2	0	1	0	0
AA145	2	HEAD-ON	2DEC 71	6PM	NONE	4	2	2	1	4	0	1	1	1
AA146	2	L-INTER *	9DEC 71	10PM	RAIN	3	0	0	0	0	0	3	0	3
AA147	5	SIDE-SWIP	11DEC 71	4PM	NONE	2	0	2	0	0	0	1	0	1
AA148	1	NO	17DEC 71	1PM	NONE	3	1	0	0	0	0	0	0	1
AA149	3	HEAD-ON	19DEC 71	2AM	NONE	2	2	1	0	3	0	2	0	0
AA150	1	NO	21DEC 71	8PM	NONE	1	0	0	1	0	0	1	0	0
AA151	2	L-INTER *	21DEC 71	9PM	NONE	2	2	2	0	1	1	0	0	2
AA152	2	HEAD-ON	22DEC 71	11AM	NONE	2	1	0	3	2	0	2	0	1
AA153	2	HEAD-ON	22DEC 71	1PM	NONE	2	1	1	0	0	0	0	0	1
AA154	1	NO	23DEC 71	8AM	NONE	2	0	1	3	4	1	0	0	1
AA155	1	NO	30DEC 71	4AM	SNOW	3	1	0	2	0	2	2	0	1
AA156	1	NO	31DEC 71	2PM	SNOW	2	2	0	1	0	0	2	0	0
AA157	1	NO	4JAN 72	2PM	NONE	2	1	0	0	3	1	3	3	0
AA159	2	HEAD-ON	15JAN 72	7PM	NONE	1	1	0	0	4	0	0	0	1
AA160	2	L-INTER *	6JAN 72	5PM	NONE	1	1	0	0	1	1	0	0	0
AA161	2	REAR-IMPT	11JAN 72	11AM	NONE	2	0	0	0	1	0	2	0	0
[illegible]	1	NO	21JAN 72	5PM	NONE	1	1	0	0	2	0	1	0	0
[illegible]	1	NO	21JAN 72	4PM	NONE	2	0	1	0	0	0	1	0	0
[illegible]	2	T-INTER *	27JAN 72	9PM	SNOW	3	1	0	0	1	0	3	1	1
[illegible]	2	L-INTER *	6FEB 72	1PM	SNOW	1	2	0	0	1	0	2	0	1

* T & L intersections were coded together as type L intersections up to 2/72. From 2/72 on, they are coded separately.

ACCIDENT FACTORS CASE INDEX

Case #	# Vehs	Coll Type	Date	Time	Precip	Matrix Cell 1-9 Cited
AA166	2	T-INTER *	7FEB 72	8AM	NONE	1 0 0 0 3 0 1 0 0
AA167	1	NO	7FEB 72	3PM	NONE	2 0 0 1 1 1 0 0 0
AA168	1	NO	17FEB 72	8AM	NONE	2 1 0 1 0 0 1 0 0
AA169	3	REAR-IMPT	17FEB 72	8PM	NONE	3 1 0 0 1 0 1 0 2
AA170	1	NO	18FEB 72	10PM	NONE	2 0 0 0 1 0 0 0 0
AA171	1	NO	22FEB 72	MDNT	NONE	2 0 0 0 0 0 1 0 0
AA172	1	NO	23FEB 72	8PM	RAIN	2 0 0 0 3 0 1 1 1
AA173	1	NO	25FEB 72	2PM	NONE	4 2 0 1 1 0 1 1 1
AA174	2	HEAD-ON	28FEB 72	10AM	SNOW	1 1 0 3 1 0 0 1 0
AA175	1	NO	2MAR 72	1PM	NONE	3 1 1 2 1 0 1 1 0
AA176	1	NO	17MAR 72	NOON	NONE	3 1 0 0 0 0 2 0 0
AA177	2	L-INTER *	18MAR 72	1PM	NONE	2 2 0 0 2 0 1 0 1
AA178	1	NO	17MAR 72	11PM	NONE	0 1 0 1 1 0 2 0 0
AA179	1	NO	15MAR 72	2PM	NONE	0 0 0 0 0 0 0 0 0
AA180	2	HEAD-ON	24MAR 72	9PM	NONE	3 1 0 0 0 0 1 0 0
AA181	1	NO	27MAR 72	MDNT	SNOW	3 0 0 1 0 0 0 0 0
AA182	1	NO	24MAR 72	4PM	NONE	2 1 0 1 0 0 0 0 0
AA183	2	HEAD-ON	29MAR 72	3PM	NONE	3 0 0 1 4 0 2 0 1
AA184	1	NO	19FEB 72	4PM	NONE	1 0 0 1 0 1 0 0 1
AA185	1	NO	31MAR 72	5AM	NONE	1 0 0 0 0 0 1 0 0
AA186	1	NO	3APR 72	3PM	NONE	3 1 0 1 2 1 0 0 2
AA188	2	L-INTER *	2APR 72	11AM	NONE	4 3 1 0 0 0 0 0 0
AA189	1	NO	5APR 72	1AM	NONE	6 0 0 0 0 0 1 0 0
AA190	1	NO	6APR 72	9AM	NONE	4 1 1 0 1 1 0 0 1
AA191	2	HEAD-ON	9APR 72	6PM	NONE	2 1 0 0 0 0 1 0 1
AA192	2	L-INTER *	8APR 72	11AM	NONE	2 1 0 1 0 0 0 0 0
AA193	1	NO	10APR 72	10AM	NONE	2 1 1 0 0 0 1 0 0
AA194	2	L-INTER *	11APR 72	1AM	NONE	2 1 0 0 1 0 0 0 1
AA195	1	NO	14APR 72	5PM	NONE	2 0 0 0 1 0 1 0 0
AA196	2	HEAD-ON	16APR 72	11AM	RAIN	1 2 0 0 2 0 4 0 0
AA197	2	HEAD-ON	17APR 72	6PM	NONE	1 2 1 0 0 0 1 0 1
AA198	1	NO	20APR 72	1PM	NONE	1 0 0 0 0 0 1 0 1
AA199	2	HEAD-ON	22APR 72	6PM	NONE	9 0 0 0 0 0 2 0 0
AA200	2	HEAD-ON	24APR 72	1PM	NONE	1 1 0 0 0 0 0 0 1
AA201	1	YES-CONF?	24APR 72	4PM	NONE	1 0 0 0 0 0 1 0 0
AA202	2	L-INTER *	28APR 72	9AM	NONE	1 1 0 0 2 0 0 0 1
AA203	2	T-INTER *	30APR 72	5PM	NONE	2 0 0 0 1 0 1 0 1
AA204	1	NO	2MAY 72	6PM	NONE	2 0 0 0 1 0 1 0 0
AA205	1	NO	6MAY 72	MDNT	RAIN	3 0 1 0 1 0 0 0 0
AA206	2	L-INTER *	16MAY 72	2PM	NONE	3 2 1 0 1 0 1 0 0

HUMAN FACTORS CASE INDEX

Case #	Driver Bl Alch %mgx10	Age	Sex	AIS	Pol Inj	Seat locn/posn	Restraint Use	Ejection
AA100	13	24	MALE	8	K	FRONT LEFT	NO LAP NO TORSO	DOOR L SIDE
AA100	11	19	MALE	8	K	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA100	11	19	MALE	8	K	UNKWN UNKWN	NO LAP NO TORSO	NO EJECTION
AA100	11	21	MALE	8	K	UNKWN UNKWN	NO LAP NO TORSO	NO EJECTION
AA100	11	21	MALE	8	K	UNKWN UNKWN	NO LAP NO TORSO	NO EJECTION
AA100	11	18	MALE	8	K	UNKWN UNKWN	NO LAP NO TORSO	NO EJECTION
AA100	11	19	FEMALE	8	K	UNKWN UNKWN	NO LAP NO TORSO	NO EJECTION
AA100	11	20	MALE	8	K	UNKWN UNKWN	NO LAP NO TORSO	NO EJECTION
AA100	11	19	MALE	8	A	UNKWN UNKWN	NO LAP NO TORSO	NO EJECTION
AA101	0	27	FEMALE	0	0	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA105	0	27	FEMALE	1	0	FRONT LEFT	NORET LAP&TORSO	NO EJECTION
AA114	0	31	MALE	1	0	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA115	7	29	FEMALE	0	B	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA116	0	63	MALE	7	K	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA116	0	62	FEMALE	1	A	FRONTRIGHT	NO LAP NO TORSO	DOOR L SIDE
AA116	0	45	FEMALE	5	0	REAR LEFT	NO LAP NO TORSO	DOOR L SIDE
AA116	0	62	FEMALE	2	0	REAR CENTR	NO LAP NO TORSO	DOOR L SIDE
AA116	0	41	FEMALE	2	A	REAR RIGHT	NO LAP NO TORSO	NO EJECTION
AA119	0	44	MALE	0	0	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA119	0	23	FEMALE	1	A	OTHERCENTR	NO LAP NO TORSO	CYCLE EJECT
AA120	0	30	MALE	1	A	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA121	0	24	FEMALE	0	0	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA122	20	56	MALE	7	K	PEDESTRIAN	PEDESTRIAN	PEDESTRIAN
AA125	0	60	MALE	0	0	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA125	0	58	FEMALE	0	0	FRONTRIGHT	NO LAP NO TORSO	NO EJECTION
AA126	0	67	MALE	0	0	FRONT LEFT	NON-RETRACT LAP	NO EJECTION
AA126	0	64	FEMALE	0	0	FRONTRIGHT	NON-RETRACT LAP	NO EJECTION
AA129	0	24	MALE	1	0	FRONT LEFT	LAP ONLY ?TYPE	NO EJECTION
AA129	0	17	FEMALE	5	5	FRONTCENTR	NO LAP NO TORSO	WINDOW RSIDE
AA130	14	26	MALE	6	K	FRONT LEFT	NON-RETRACT LAP	NO EJECTION
AA130	14	27	MALE	2	A	FRONTRIGHT	NON-RETRACT LAP	NO EJECTION
AA132	0	24	MALE	4	A	FRONT LEFT	NO LAP NO TORSO	WINDSHIELD
AA133	4	63	MALE	6	K	FRONT LEFT	NO LAP NO TORSO	UNKNOWN
AA134	0	24	MALE	0	0	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA134	0	23	FEMALE	0	0	FRONTRIGHT	NO LAP NO TORSO	NO EJECTION
AA136	0	44	FEMALE	2	A	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA138	19	54	MALE	7	K	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA139	0	19	MALE	6	K	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA140	0	20	MALE	2	A	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA140	0	20	FEMALE	4	A	FRONTRIGHT	NO LAP NO TORSO	NO EJECTION
AA141	0	60	MALE	1	C	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA142	0	61	MALE	2	A	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA143	17	40	FEMALE	9	K	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA143	0	61	FEMALE	3	A	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA144	0	23	FEMALE	1	A	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA145	32	44	MALE	2	A	FRONT LEFT	NO LAP NO TORSO	DOOR L SIDE
AA145	32	71	MALE	2	A	FRONTRIGHT	NO LAP NO TORSO	NO EJECTION
AA145	0	18	MALE	1	A	FRONT LEFT	NONLOCK RET LAP	NO EJECTION
AA145	0	19	MALE	1	A	FRONTRIGHT	NONLOCK RET LAP	NO EJECTION

HUMAN FACTORS CASE INDEX

Case #	Driver Bl Alch %mgx10	Age	Sex	AIS	Pol Inj	Seat locn/posn	Restraint Use	Ejection
AA146	0	22	FEMALE	1	B	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA146	0	23	FEMALE	1	B	FRONTRIGHT	NO LAP NO TORSO	NO EJECTION
AA147	0	20	FEMALE	1	B	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA147	0	42	FEMALE	1	B	FRONTRIGHT	NO LAP NO TORSO	NO EJECTION
AA147	0	16	MALE	0	0	REAR RIGHT	NO LAP NO TORSO	WINDOW RSIDE
AA148	0	76	MALE	1	K	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA148	0	74	FEMALE	2	A	FRONTRIGHT	NO LAP NO TORSO	NO EJECTION
AA149	0	27	MALE	2	A	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA149	0	24	FEMALE	4	A	FRONTRIGHT	NON-RETRACT LAP	NO EJECTION
AA149	0	22	MALE	2	A	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA149	0	20	PREG FEM	5	A	FRONTRIGHT	NO LAP NO TORSO	NO EJECTION
AA149	0	21	MALE	1	B	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA150	9	24	MALE	0	0	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA151	0	21	MALE	8	K	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA152	0	22	MALE	1	B	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA152	0	18	FEMALE	1	A	FRONTCENTR	NO LAP NO TORSO	NO EJECTION
AA152	0	35	FEMALE	1	A	FRONTRIGHT	NO LAP NO TORSO	NO EJECTION
AA152	0	15	FEMALE	1	0	REAR LEFT	NO LAP NO TORSO	NO EJECTION
AA152	0	15	FEMALE	1	B	REAR RIGHT	NO LAP NO TORSO	NO EJECTION
AA153	0	19	FEMALE	1	A	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA154	0	31	MALE	1	B	FRONT LEFT	NO LAP NO TORSO	UNKNOWN
AA154	0	30	FEMALE	1	A	FRONTRIGHT	NO LAP NO TORSO	UNKNOWN
AA154	0	8	FEMALE	2	B	REAR CENTR	NO LAP NO TORSO	UNKNOWN
AA155	0	36	FEMALE	6	K	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA156	0	21	MALE	0	0	FRONT LEFT	NONLOCK RET LAP	NO EJECTION
AA157	0	21	MALE	1	A	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA159	0	51	FEMALE	3	A	FRONT LEFT	AUTOLOK RET LAP	NO EJECTION
AA159	0	29	MALE	1	0	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA160	0	48	MALE	1	B	FRONT LEFT	NONLOCK RET LAP	NO EJECTION
AA161	0	21	FEMALE	1	C	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA162	0	49	MALE	7	K	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA163	0	75	MALE	0	0	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA164	0	55	MALE	5	A	FRONT LEFT	NONLOCK RET LAP	NO EJECTION
AA164	0	9	FEMALE	6	K	FRONTRIGHT	NONLOCK RET LAP	NO EJECTION
AA165	0	22	MALE	1	A	FRONT LEFT	NORET LAP&TORSO	NO EJECTION
AA165	0	23	FEMALE	1	B	FRONTRIGHT	NORET LAP&TORSO	NO EJECTION
AA165	0	21	MALE	1	B	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA165	0	20	FEMALE	3	B	FRONTRIGHT	NO LAP NO TORSO	NO EJECTION
AA165	0	1	MALE	7	K	FRONTUNKWN	NO LAP NO TORSO	NO EJECTION
AA166	0	29	FEMALE	1	0	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA166	0	17	FEMALE	0	C	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA166	0	15	FEMALE	0	C	FRONTRIGHT	NO LAP NO TORSO	NO EJECTION
AA167	0	50	MALE	0	0	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA167	0	50	FEMALE	2	0	FRONTRIGHT	NO LAP NO TORSO	NO EJECTION
AA168	0	20	FEMALE	0	0	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA169	17	31	MALE	1	C	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA169	0	21	MALE	4	A	PEDESTRIAN	PEDESTRIAN	PEDESTRIAN
AA169	0	52	MALE	4	A	PEDESTRIAN	PEDESTRIAN	PEDESTRIAN

HUMAN FACTORS CASE INDEX

Case #	Driver Bl Alch %mgx10	Age	Sex	AIS	Pol Inj	Seat locn/posn	Restraint Use	Ejection
AA170	0	19	MALE	2	B	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA170	0	19	MALE	2	A	FRONTRIGHT	NO LAP NO TORSO	NO EJECTION
AA170	0	19	MALE	1	C	REAR LEFT	NO LAP NO TORSO	NO EJECTION
AA170	0	18	MALE	1	C	REAR RIGHT	NO LAP NO TORSO	NO EJECTION
AA171	0	29	MALE	0	A	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA172	0	21	MALE	1	A	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA172	0	23	FEMALE	3	A	FRONTRIGHT	NO LAP NO TORSO	NO EJECTION
AA173	0	28	MALE	6	K	FRONT LEFT	NO LAP NO TORSO	DOOR L SIDE
AA174	0	73	MALE	6	K	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA174	0	40	MALE	0	0	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA175	0	21	MALE	1	B	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA176	0	34	MALE	1	B	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA177	0	30	MALE	1	B	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA177	0	9	FEMALE	1	B	FRONTRIGHT	NO LAP NO TORSO	NO EJECTION
AA177	0	7	MALE	0	0	REAR CENTR	NO LAP NO TORSO	NO EJECTION
AA177	0	62	FEMALE	1	0	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA178	0	35	MALE	1	A	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA178	0	31	FEMALE	2	A	FRONTRIGHT	NO LAP NO TORSO	NO EJECTION
AA178	0	6	MALE	1	B	REAR LEFT	NO LAP NO TORSO	NO EJECTION
AA178	0	12	MALE	1	A	REAR RIGHT	NO LAP NO TORSO	NO EJECTION
AA179	0	19	FEMALE	0	0	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA179	0	20	MALE	0	0	FRONTCENTR	NO LAP NO TORSO	NO EJECTION
AA179	0	19	MALE	0	0	FRONTRIGHT	NO LAP NO TORSO	NO EJECTION
AA180	0	32	MALE	1	A	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA180	0	18	MALE	1	B	FRONT LEFT	LAP ONLY ?TYPE	NO EJECTION
AA180	0	17	FEMALE	3	A	FRONTRIGHT	NO LAP NO TORSO	NO EJECTION
AA180	0	15	MALE	1	A	REAR R CTR	NO LAP NO TORSO	NO EJECTION
AA181	0	50	MALE	1	B	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA182	0	28	MALE	1	A	OTHERCENTR	NO LAP NO TORSO	WINDOW LSIDE
AA183	0	51	MALE	2	B	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA184	0	35	MALE	0	0	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA184	0	16	MALE	0	0	FRONTRIGHT	NO LAP NO TORSO	NO EJECTION
AA185	0	39	MALE	1	C	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA186	0	53	MALE	0	C	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA188	0	38	FEMALE	1	0	FRONT LEFT	NONLOCK RET LAP	NO EJECTION
AA188	0	60	FEMALE	1	B	FRONTRIGHT	NO LAP NO TORSO	NO EJECTION
AA189	9	26	MALE	6	K	FRONT LEFT	NO LAP NO TORSO	ROOF OR CONV
AA190	0	22	MALE	0	0	FRONT LEFT	NONLOCK RET LAP	NO EJECTION
AA190	0	20	MALE	1	A	OTHERUNKWN	NO LAP NO TORSO	NO EJECTION
AA191	0	41	FEMALE	2	B	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA191	0	40	FEMALE	1	C	FRONTRIGHT	NO LAP NO TORSO	NO EJECTION
AA191	0	13	MALE	0	C	REAR LEFT	NO LAP NO TORSO	NO EJECTION
AA191	0	16	FEMALE	0	0	REAR RIGHT	NO LAP NO TORSO	NO EJECTION
AA192	0	71	MALE	1	0	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA192	0	63	FEMALE	1	B	FRONTRIGHT	NO LAP NO TORSO	NO EJECTION
AA192	0	51	MALE	1	B	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA192	0	83	FEMALE	3	A	FRONTRIGHT	NO LAP NO TORSO	NO EJECTION
AA192	0	38	FEMALE	1	B	REAR LEFT	NO LAP NO TORSO	NO EJECTION
AA192	0	58	FEMALE	3	C	REAR RIGHT	NO LAP NO TORSO	NO EJECTION
AA193	2	16	MALE	2	A	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA193	2	15	FEMALE	0	0	FRONTCENTR	NO LAP NO TORSO	NO EJECTION
AA193	2	17	MALE	1	B	FRONTRIGHT	NO LAP NO TORSO	NO EJECTION

HUMAN FACTORS CASE INDEX

Case #	Driver Bl Alch %mgx10	Age	Sex	AIS	Pol Inj	Seat locn/posn	Restraint Use	Ejection
AA194	0	29	FEMALE	0	0	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA194	0	19	MALE	1	A	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA194	0	18	FEMALE	0	0	FRONTRIGHT	NO LAP NO TORSO	NO EJECTION
AA194	0	1	MALE	0	0	FRONTRIGHT	NO LAP NO TORSO	NO EJECTION
AA195	0	77	FEMALE	0	0	FRONT LEFT	LAP ONLY ?TYPE	NO EJECTION
AA196	0	25	MALE	1	B	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA196	0	21	MALE	1	B	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA196	0	21	FEMALE	1	B	FRONTRIGHT	NO LAP NO TORSO	NO EJECTION
AA197	0	25	FEMALE	2	B	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA198	0	29	MALE	2	A	OTHERCENTR	NO LAP NO TORSO	DOOR R SIDE
AA199	0	36	MALE	1	A	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA199	0	37	FEMALE	7	K	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA199	0	33	MALE	7	K	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA199	0	33	MALE	1	A	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA200	0	32	MALE	1	B	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA200	0	63	FEMALE	1	B	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA201	0	56	MALE	0	0	FRONT LEFT	NON-RETRACT LAP	NO EJECTION
AA202	0	50	FEMALE	1	A	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA202	0	7	MALE	1	B	FRONTRIGHT	NO LAP NO TORSO	NO EJECTION
AA202	0	26	MALE	3	A	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA203	0	25	MALE	1	A	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA203	0	25	FEMALE	1	B	FRONTRIGHT	NO LAP NO TORSO	NO EJECTION
AA203	0	1	MALE	1	B	FRONTRIGHT	NO LAP NO TORSO	NO EJECTION
AA203	0	45	FEMALE	4	A	REAR LEFT	NO LAP NO TORSO	NO EJECTION
AA204	0	30	MALE	0	0	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA205	0	16	MALE	5	A	FRONT LEFT	NO LAP NO TORSO	TAILGATE
AA206	0	36	MALE	1	C	FRONT LEFT	NO LAP NO TORSO	NO EJECTION
AA206	0	31	MALE	1	C	FRONTRIGHT	NON-RETRACT LAP	NO EJECTION
AA206	0	26	MALE	0	0	OTHERCENTR	NO LAP NO TORSO	NO EJECTION
AA206	0	17	FEMALE	1	B	FRONT LEFT	NO LAP NO TORSO	NO EJECTION

ENVIRONMENTAL DATA SUMMARY

AA#	LOCATION	NO OF LANES	HORIZ CONFIG	VERT CONFIG	SIGNIFICANT HIGHWAY DATA	RELEVANT AMBIENT DATA
100	RURAL	5	STRAIGHT	LEVEL	FREEWAY	NO LIGHTING. DARK. INTERMITTANT SHOWERS
101	RESIDENTIAL	2/2	INTERSECTION	LEVEL	FIRE HYDRANT	DARK/DRY
105	COMMERCIAL	5	STRAIGHT	LEVEL	MAJOR ARTERIAL	CLEAR/DRY
114	RURAL	4	STRAIGHT	.9%		LIGHT/CLEAR/DRY
115	RURAL	2	STRAIGHT	.3%	UTILITY POLE	DUSK/DRY
116	RURAL	4	STRAIGHT	3%	FREEWAY	LIGHT/CLEAR/DRY
119	RURAL	2	STRAIGHT	2%		LIGHT/CLEAR/DRY
120	RURAL	4	CURVE	2%	INTERCHANGE	CLEAR/LIGHT/DRY
121	CAMPUS	2/2	INTERSECTION	2%	INTERSECTION	NIGHT/DRY
122	RESIDENTIAL	4/5	STRAIGHT	4%	FIELD	NIGHT/DRY
125	RURAL	4	STRAIGHT	LEVEL		LIGHT/CLEAR/DRY
126	RURAL	4	STRAIGHT	.5%	UNDER OVERPASS	LIGHT/CLEAR/DRY
129	RURAL	2	CURVE	LEVEL		NIGHT/DRY
130	RURAL	2	CURVE	LEVEL		LIGHT/CLEAR/DRY
132	RURAL	2	STRAIGHT	1.5%	R R CROSSING	LIGHT/CLEAR/DRY
133	RURAL	2	STRAIGHT	LEVEL	R R CROSSING	NIGHT/DRY
134	SCHOOL EDUCATIONAL	4	STRAIGHT	LEVEL		LIGHT/CLEAR/DRY
136	RURAL	2/2	INTERSECTION	LEVEL	TREE	NIGHT/FOG

AA#	LOCATION	NO OF LANES	HORIZ CONFIG	VERT CONFIG	SIGNIFICANT HIGHWAY DATA	RELEVANT AMBIENT DATA
138	RURAL	2	CURVE	LEVEL	TREE	LIGHT/CLEAR/DRY
139	RESIDENTIAL	4	CURVE	LEVEL	NO MEDIAN BARRIER	NIGHT/DRY
140	RURAL	2	CURVE	LEVEL		LIGHT/DRY
141	COMMERCIAL	4	STRAIGHT	LEVEL	FREEWAY	LIGHT/DRY
142	COMMERCIAL	4	STRAIGHT	LEVEL	FREEWAY	LIGHT/CLEAR/DRY
143	RESIDENTIAL	5	STRAIGHT	2°	POLES	DARK/CLOUDY ICE
144	COMMERCIAL	2	STRAIGHT	LEVEL		DUSK/DRY
145	COMMERCIAL	2	STRAIGHT	LEVEL		DUSK/DRY
146	SCHOOL/RESIDENTIAL	4/2	INTERSECTION	LEVEL	TRAFFIC LIGHTS	DARK/RAIN/WET
147	COMMERCIAL	3	STRAIGHT	2°	SHOPPING CENTER DRIVE	LIGHT/CLEAR/DRY
148	RESIDENTIAL	4	STRAIGHT	1.7%	THROUGH MAJOR URBAN INTERSECTION	OVERCAST/DRY
149	RURAL	2	STRAIGHT	2°		DARK/WET
150	RURAL	4	STRAIGHT	LEVEL		DARK/DRY
151	COMMERCIAL RESIDENTIAL	5	STRAIGHT	2%	NO MEDIAN BARRIER	DARK/DRY
152	RURAL	2	STRAIGHT	LEVEL	INTERSECTION	SUN GLARE LIGHT/CLEAR/DRY
153	RESIDENTIAL COMMERCIAL	2	STRAIGHT	1/2°	GAS STATION DRIVE	LIGHT/CLEAR/DRY
154	INDUSTRIAL RESIDENTIAL	4	STRAIGHT	3.5%	TREE OFF ROAD FREEWAY	LIGHT/OVERCAST/DRY
155	RURAL	2	STRAIGHT	1 1/2°	TREE	FREEZING RAIN DARK/ICE

ENVIRONMENTAL DATA SUMMARY

AA#	LOCATION	NO OF LANES	HORIZ CONFIG	VERT CONFIG	SIGNIFICANT HIGHWAY DATA	RELEVANT AMBIENT DATA
156	RURAL	4	CURVE	1°	FREEWAY INTERCHANGE	LIGHT/SNOW/ICE
157	COMMERCIAL	4	CURVE	1 1/2%	FREEWAY INTERCHANGE	LIGHT/ICE
159	RESIDENTIAL	5	STRAIGHT	LEVEL		DARK/WET
160	RURAL RESIDENTIAL	2/2	INTERSECTION	LEVEL	INTERSECTION	DUSK/CLEAR/DRY
161	RURAL	4	STRAIGHT	3 1/2%	FREEWAY OVERPASS	LIGHT/CLEAR/DRY
162	RURAL	4	STRAIGHT	LEVEL	TREE OFF ROAD FREEWAY	DUSK/CLOUDY/DRY
163	COMMERCIAL RESIDENTIAL	4	STRAIGHT	LEVEL	NO PEDESTRIAN CROSSWALK	LIGHT/CLEAR/DRY
164	RURAL	2	STRAIGHT	LEVEL	R R CROSSING	DARK/SNOW/ SLIPPERY
165	RURAL	2	STRAIGHT	LEVEL		LIGHT/OVERCAST/ WET
166	SCHOOL RESIDENTIAL	4/2	STRAIGHT INTERSECTION	LEVEL	HIGH SCHOOL DRIVE	LIGHT/CLEAR/ SNOW COVERED
168	SCHOOL	4/4	STRAIGHT INTERSECTION	LEVEL	INTERSECTION	LIGHT/DRY
172	RURAL	4	CURVE	LEVEL	FREEWAY INTERCHANGE	DARK/FOG/ SKIPPERY
173	RURAL	4	CURVE	LEVEL	FREEWAY	LIGHT/CLEAR/DRY
175	COMMERCIAL	4	STRAIGHT	1 1/2°	POWER POLE OFF ROAD	DARK/WET
176	RESIDENTIAL	4	CURVE	LEVEL	POWER POLE OFF ROAD	DARK/DRY
177	COMMERCIAL	2/2	CURVE/STRAIGHT	LEVEL	INTERSECTION	LIGHT/DRY

ENVIRONMENTAL DATA SUMMARY

AA#	LOCATION	NO OF LANES	HORIZ CONFIG	VERT CONFIG	SIGNIFICANT HIGHWAY DATA	RELEVANT AMBIENT DATA
178	RURAL	2/2	STRAIGHT	LEVEL	INTERSECTION	DARK/DRY
179	COMMERCIAL	2	CURVE	LEVEL		LIGHT/DRY
180	COMMERCIAL	4	STRAIGHT	1 1/2°	PREVIOUS CHANGE IN HORIZONTAL ALIGNMENT	DARK/DRY
181	INDUSTRIAL/ RURAL	2	CURVE	LEVEL	SUDDEN CHANGE IN HORIZONTAL ALIGNMENT	DARK/DRY
182	COMMERCIAL	X	PARKING LOT	→		LIGHT/DRY
183	RURAL/ RESIDENTIAL	4	CURVE	LEVEL	FREEWAY	LIGHT/OVERCAST WET
184	RURAL	2	STRAIGHT	1°		LIGHT/DRY
186	RURAL	1	CURVE	1°	FREEWAY EXIT RAMP	LIGHT/DRY
188	RESIDENTIAL	2/3	STRAIGHT/ STRAIGHT	LEVEL	INTERSECTION	LIGHT/DRY
189	RURAL	2	CURVE	LEVEL	SCENIC DRIVE	DARK/DRY
190	RURAL	1	CURVE	1°	FREEWAY EXIT RAMP	LIGHT/CLEAR/DRY
191	RURAL	2	CURVE	LEVEL	"Y" TYPE INTERSECTION	LIGHT/CLEAR/DRY
192	RESIDENTIAL	2/2	STRAIGHT/ STRAIGHT	LEVEL	INTERSECTION	LIGHT/DRY
193	RURAL	2	STRAIGHT	1°		LIGHT/CLEAR/DRY
194	RURAL	2/2	STRAIGHT/ STRAIGHT	LEVEL/ 1 1/2°	INTERSECTION	LIGHT/DRY
195	RESIDENTIAL	2	STRAIGHT	LEVEL	PEDESTRIAN PARKED CARS	LIGHT/CLEAR/DRY
196	COMMERCIAL	3	STRAIGHT	LEVEL	DRIVEWAY	OVERCAST/WET
197	RURAL	2	CURVE	LEVEL		SUN BLINDED DRIVER LIGHT/CLEAR/DRY

ENVIRONMENTAL DATA SUMMARY

AA#	LOCATION	NO OF LANES	HORIZ CONFIG	VERT CONFIG	SIGNIFICANT HIGHWAY DATA	RELEVANT AMBIENT DATA
198	RESIDENTIAL	2	"S" CURVE	1 1/2°	GRAVEL ON ROADWAY	LIGHT/CLEAR/DRY
199	RURAL	2	CURVE	LEVEL		LIGHT/CLEAR/DRY
200	COMMERCIAL	5/5	STRAIGHT/ STRAIGHT	LEVEL	INTERSECTION	CLEAR/DRY
201	RESIDENTIAL	2	STRAIGHT	3°	PEDESTRIAN, PARKED CARS	LIGHT/CLEAR/DRY
202	COMMERCIAL	5/4	STRAIGHT/ STRAIGHT	LEVEL	INTERSECTION	LIGHT/CLEAR/DRY
203	RESIDENTIAL	2/2	STRAIGHT/ STRAIGHT	LEVEL	INTERSECTION	LIGHT/DRY
204	RESIDENTIAL	2	STRAIGHT	LEVEL	RESIDENTIAL DRIVEWAY	LIGHT/DRY
205	RESIDENTIAL	2	"S" CURVE	1 1/2°	TREE OFF ROAD	DARK/DRY
206	RESIDENTIAL	2/3	STRAIGHT/ STRAIGHT	LEVEL/4°	INTERSECTION	LIGHT/CLEAR

ENVIRONMENTAL DATA SUMMARY

VEHICLE DATA SUMMARY

AA CASE NUMBER	MODEL YEAR	MAKE	MODEL	BODY TYPE	SPEED AT IMPACT	VDI	ACCIDENT CONFIGURATION
100	1960	PONTIAC	LEMANS	CONV.	80	11-FDAW-8	HEAD-ON
100	1969	PONTIAC	CATALINA	STA. WGN.	60	11-FDAW-8	HEAD-ON
101	1971	CHEVROLET	IMPALA	2-DOOR	--	01-FLEN-2	FIXED OBJECT, HEAD-ON
105	1970	VOLKSWAGEN	1500	2-DOOR	05	12-BDEA-2	REAR END
114	1969	WHITE	TRACTOR	--	--	12-FRAW-2	RUN-OFF ROAD
115	1969	CHEVROLET	NOVA	2-DOOR	25	12-FCEN-2	RUN-OFF ROAD
116	1971	PLYMOUTH	FURY	STA. WGN.	70	10-LYAW-4	HEAD-ON
119	1971	FORD	CUSTOM	4-DOOR	05	--	INTERSECTION
119	1971	SUZUKI	TS-90	MOTORCYCLE	30	--	INTERSECTION
120	1970	GMC	TRACTOR-TRAILER		40	00-TRGO-5	ROLL-OVER
121	1971	TRIUMPH	SPITFIRE	2-DOOR	20	11-FLEE-2	INTERSECTION
121	1966	VOLKSWAGEN	1300	2-DOOR	20	11-LZES-1	INTERSECTION
122	1971	CADILLAC	COUP-DE-VILLE	2-DOOR	--	05-BLEN-1	PEDESTRIAN
125	1969	FORD	CUSTOM	4-DOOR	20	00-RFEO-1	ROLL-OVER
126	1971	CHRYSLER	NEWPORT	4-DOOR	50	08-LFMS-1	ROLL-OVER
129	1969	PLYMOUTH	ROADRUNNER	2-DOOR	60	00-TYHO-4	RUN OFF ROAD
130	1971	CHEVROLET	CORVETTE	CONVERT. 2-DOOR	60	06-BDEW-4 12-FDEW-3	RUN OFF ROAD
132	1971	DODGE	COLT	2-DOOR	20	02-RDAW-4	CAR-TRAIN, INTERSECTION, ROLL-OVER
133	1971	PLYMOUTH	FURY	2-DOOR	05	04-BDAW-6 04-RFES-1	CAR-TRAIN INTERSECTION

VEHICLE DATA SUMMARY - PAGE 2

AA CASE NUMBER	MODEL YEAR	MAKE	MODEL	BODY TYPE	SPEED AT IMPACT	VDI	ACCIDENT CONFIGURATION
134	1970	PONTIAC	LEMANS	2-DOOR	05	12-FRMN-1	PEDESTRIAN
136	1972	PLYMOUTH	FURY	4-DOOR	35	11-FCEW-3	FIXED-OBJECT, HEAD-ON
138	1970	FORD	GALAXIE 500	2-DOOR	70	12-FYEW-6	FIXED OBJECT, HEAD ON
139	1971	CHEVROLET	NOVA	2-DOOR	25	07-LYAW-9	INTERSECTION
139	1970	GMC	ASTRO 95	TRACTOR	60	11-FZEW-2	INTERSECTION
140	1971	FIAT	850 SPIDER	CONV.	58	12-FREW-5	HEAD-ON
140	1970	OLDSMOBILE	TORONADO	2-DOOR	60	12-FRME-2	HEAD-ON
142	1972	INTERNATIONAL	TRACTOR -TRAILER		60	12-FZAW-4	REAR-END
142	1970	FORD	STAKE TRUCK		35	06-BDHW-4	REAR-END
143	1970	MERCURY	COUGAR	2-DOOR	25	05-BZEW-4 10-LBXW-1	HEAD-ON
143	1970	BUICK	SKYLARK	2-DOOR	25	12-FDEW-2	HEAD-ON
144	1970	MERCURY	COUGAR	2-DOOR	0	06-BDEW-1	REAR-END
144	1957	CHEVROLET	--	STA. WAG.	--	12-FDEW-1	REAR-END
145	1972	MERCURY	COMET	2-DOOR	25	12-FDEW-3	HEAD-ON
146	1970	CHEVROLET	IMPALA	2-DOOR	30	01-FZEW-2 03-RBEW-2 10-LBEN-2	INTERSECTION
146	1969	AMC	JAVELIN	2-DOOR	--	10-LFEW-3 09-LBMW-2	INTERSECTION
147	1971	FORD	CUSTOM	4-DOOR	15	11-LDHS-2	HEAD-ON
148	1969	PONTIAC	EXECUTIVE	4-DOOR	15	12-FDEW-2	FIXED OBJECT, HEAD-ON
149	1971	PONTIAC	FIREBIRD	2-DOOR	50	01-FZEW-4	HEAD-ON
149	1966	FORD	CUSTOM	4-DOOR	55	01-FZEW-4 12-LBMW-1	HEAD-ON
149	965	CHRYSLER	NEWPORT	4-DOOR	55	12-FDEW-2 12-LZMS-1	HEAD-ON

VEHICLE DATA SUMMARY - PAGE 3

AA CASE NUMBER	MODEL YEAR	MAKE	MODEL	BODY TYPE	SPEED AT IMPACT	VDI	ACCIDENT CONFIGURATION
150	1969	TRIUMPH	SPITFIRE	CONV.	15	00-TPGO-3 00-RDEO-1	ROLL-OVER
151	1969	CHEVROLET	BISCAYNE	2-DOOR	20	01-FDLW-2	HEAD-ON
151	1971	TRIUMPH	SPITFIRE	CONV.	44	10-LYAW-3 07-BLMW-1	HEAD-ON
152	1964	DODGE	--	4-DOOR	35	12-FDEW-2	HEAD-ON
152	1972	AMC	JAVELIN	2-DOOR	05	12-FDEW-2	HEAD-ON
153	1970	FORD	MAVERICK	2-DOOR	20	11-FREW-2	HEAD-ON
153	1967	CHEVROLET	IMPALA	2-DOOR	--	02-FREW-2	HEAD-ON
154	1971	OPEL	--	2-DOOR	15	12-FREN-2	FIXED OBJECT, HEAD-ON
155	1970	FORD	MAVERICK	2-DOOR	15	02-RFEN-3	FIXED OBJECT, HEAD-ON
156	1972	MERCURY	COUGAR	2-DOOR	45	10-LFLW-1 10-VFLW-1	OFF-ROADWAY
157	1968	CHEVROLET	STRAIGHT TRUCK		40	11-FZEW-7	FIXED OBJECT, HEAD-ON
159	1971	PLYMOUTH	DUSTER	2-DOOR	25	11-FLEE-7	HEAD-ON
159	1969	FORD	MUSTANG	2-DOOR	15	11-FLEE-4	HEAD-ON
160	1968	BUICK	ELECTRA	CONV.	45	02-FDEW-1	INTERSECTION
160	1970	FORD	LTD	4-DOOR	40	11-LZAS-3	INTERSECTION
161	1968	CHEVROLET	C-60 DUMP		47	12-FLMW-1	REAR-END
161	1972	CHEVROLET	VEGA	2-DOOR	0	06-BYEW-1	REAR-END
162	1970	CHEVROLET	EL CAMINO	PICK-UP	50	12-FLAN-7 03-RPEN-2	FIXED OBJECT, HEAD-ON
163	1971	FORD	CLUB WAGON	VAN	05	12-FLMN-0	PEDESTRIAN
164	1972	AMC	GREMLIN	2-DOOR	10	03-RYMN-4	INTERSECTION
165	1971	AMC	GREMLIN	2-DOOR	35	02-RFEW-4	HEAD-ON
165	1965	CHEVROLET	CORVAIR	4-DOOR	40	01-FYEW-5	HEAD-ON
166	1965	FORD	MUSTANG	CONV.	10	11-FDMW-1	INTERSECTION

VEHICLE DATA SUMMARY - PAGE 4

AA CASE NUMBER	MODEL YEAR	MAKE	MODEL	BODY TYPE	SPEED AT IMPACT	VDI	ACCIDENT CONFIGURATION
166	1971	PLYMOUTH	DUSTER	2-DOOR	05	02-RPEW 2	INTERSECTION
167	1971	CHEVROLET	SUBURBAN	STA. WGN.	40	00-RDHO-1	ROLL-OVER
168	1968	FORD	GALAXIE	4-DOOR	--	12-FRMN-1	PEDESTRIAN
169	1970	BUICK	ELECTRA	2-DOOR	35	12-FZEW-3	PEDESTRIAN
169	1969	DODGE	DART	2-DOOR	0	06-RDEW-5 12-FDEW-2	PEDESTRIAN
169	1970	GMC	CARRYALL SUBURB	STA. WGN.	0	12-FDLW-1	PEDESTRIAN
170	1969	FORD	FAIRLANE	2-DOOR	30	12-FZEW-4	FIXED OBJECT, HEAD-ON
172	1971	FORD	MAVERICK	2-DOOR	25	10-LPAN-3 10-LPEN 10-LFEW-2	FIXED OBJECT, HEAD-ON
173	1967	CHEVROLET	C-10 PICK-UP		45	00-TDAO-3 00-UBXO-1	ROLL-OVER
175	1970	FORD	MAVERICK	2-DOOR	33	01-FREN-4	FIXED OBJECT, HEAD-ON
176	1972	CHEVROLET	MALIBU	2-DOOR	35	12-FZEN-3	FIXED OBJECT, HEAD-ON
177	1969	FORD	LTD	4-DOOR	5	08-LFEE-2	INTERSECTION
177	1970	FORD	TORINO	CONV.	15	01-FZEW-1	INTERSECTION
178	1971	FORD	BRONCO	2-DOOR	40	00-XDAO-3	ROLL-OVER
179	1969	OLDSMOBILE	DELTA 88	4-DOOR	25	12-FRMN-8	PEDESTRIAN
180	1971	MERCURY	MARQUIS	4-DOOR	20	11-FDEW-3	HEAD-ON
180	1969	FORD	MUSTANG	2-DOOR	25	01-FDEW-3	HEAD-ON
181	1972	CADILLAC	EL DORADO	2-DOOR	--	12-FDEW-2	FIXED OBJECT, HEAD-ON
182	1972	HARLEY-DAVISON		MOTORCYCLE	--	--	FIXED OBJECT, HEAD-ON
183	1970	CHRYSLER	NEWPORT	4-DOOR	30	01-FDEW-3	HEAD-ON
183	1972	BUS		--	50	01-FLEW-2	HEAD-ON
184	1972	WINNEBAGO	MOTOR HOME			FIRE	--
185	1969	PONTIAC	BONNEVILLE	2-DOOR	80	12-FDEW-2	RUN OFF ROAD

VEHICLE DATA SUMMARY - PAGE 5

AA CASE NUMBER	MODEL YEAR	MAKE	MODEL	BODY TYPE	SPEED AT IMPACT	VDI	ACCIDENT CONFIGURATION
186	1970	FORD	STAKE-TRUCK		50	00-XDAO-4	ROLL-OVER
188	1970	HONDA	--	MOTORCYCLE	30	--	INTERSECTION
188	1970	FORD	MAVERICK	2-DOOR	15	03-RBMW-2	INTERSECTION
189	1970	PORCHE	914	2-DOOR			ROLL-OVER
190	1970	CHEVROLET	C-50	TRUCK	50	00-RFMO-1	ROLL-OVER
191	1970	HONDA	CB750	MOTORCYCLE	45	--	HEAD-ON
191	1971	AMC	MATADOR	4-DOOR	5	11-FDMW-2	HEAD-ON
192	1971	DODGE	DART	4-DOOR	5	01-FZEW-1	INTERSECTION
192	1962	BUICK	SPECIAL	2-DOOR	10	11-FLEE-2	INTERSECTION
193	1971	FORD	PINTO	2-DOOR	40	00-XDAO-3	ROLL-OVER
194	1969	CHEVROLET	CAMARO	2-DOOR	20	12-RBMW-2 12-FRES-1	INTERSECTION
194	1963	PLYMOUTH	SAVOY	4-DOOR	5	01-RBMS-2	INTERSECTION
195	1970	FORD	MAVERICK	2-DOOR	5	12-FREN-0	PEDESTRIAN
196	1972	CHEVROLET	NOVA	2-DOOR	5	01-FDEW-2	HEAD-ON
196	1971	TOYOTA	CORONA	4-DOOR	30	01-FZEW-2	HEAD-ON
197	1970	VOLKSWAGEN	1300	2-DOOR	10	01-FYEN-2	HEAD-ON
197	1971	HONDA	CL350	MOTORCYCLE	30	--	HEAD-ON
198	1972	HONDA	500	MOTORCYCLE	35	--	LOST CONTROL
199	1971	CHRYSLER	NEWPORT	4-DOOR	45	10-LFAW-5	HEAD-ON
199	1968	INTERNATION	TRACTOR-TRAILOR		45	12-FDEN-2 08-LRMW-2	HEAD-ON
200	1966	PLYMOUTH	BELVEDERE	2-DOOR	5	11-FLEE-2	INTERSECTION
200	1971	FORD	PINTO	2-DOOR	25	11-FLEW-2	INTERSECTION

VEHICLE DATA SUMMARY - PAGE 6

AA CASE NUMBER	MODEL YEAR	MAKE	MODEL	BODY STYLE	SPEED AT IMPACT	VDI	ACCIDENT CONFIGURATION
201	1970	OLDSMOBILE	DELTA	2-DOOR	18	12-FRMN-0	PEDESTRIAN
202	1965	AMC	CLASSIC	4-DOOR	25	01-FDEW-3	INTERSECTION
202	1972	CHEVROLET	IMPALA	2-DOOR	25	10-LPAW-4	INTERSECTION
203	1972	KAWASAKI	750	MOTORCYCLE	40	--	INTERSECTION
203	1971	FORD	COUNTRY SEDAN	STA. WGN.	15	08-LPAW-4	INTERSECTION
204	1965	CHEVROLET	IMPALA	2-DOOR	3	12-FRMN-0	PEDESTRIAN
205	1971	CHEVROLET	VEGA	2-DOOR	3	01-FRHW-8 00-XDAO-2	ROLL-OVER
206	1971	FORD	LTD	4-DOOR	30	10-FDEW-3 09-LBEW-2	INTERSECTION
206	1955	INTERNATIONAL	FIRETRUCK		20	01-RDEW-2	INTERSECTION

MOTOR VEHICLE SAFETY STANDARDS

STANDARD NUMBER	STANDARD TITLE	TIMES REFERRED
101	CONTROL LOCATION, IDENTIFICATION AND ILLUMINATION	1
103	WINDSHIELD DEFROSTING AND DEFOGGING SYSTEMS	1
105	HYDRAULIC SERVICE BRAKE, EMERGENCY BRAKE, PARKING BRAKE	1
111	REARVIEW MIRRORS	1
113	HOOD LATCH SYSTEM	8
121	AIR BRAKE SYSTEMS	1
201	OCCUPANT PROTECTION IN INTERIOR IMPACT	26
202	HEAD RESTRAINTS	3
203	IMPACT PROTECTION FOR THE DRIVER FROM STEERING CONTROLS	11
204	STEERING CONTROL REARWARD DISPLACEMENT	6
205	GLAZING MATERIALS	9
206	DOOR LOCKS AND DOOR RETENTION COMPONENTS	12
207	ANCHORAGE OF SEATS	9
208	SEAT BELT INSTALLATIONS	9
209	SEAT BELT ASSEMBLIES	5
210	SEAT BELT ASSEMBLY ANCHORAGES	1
211	WHEEL NUTS, WHEEL DISCS, AND HUB CAPS	3
212	WINDSHIELD MOUNTING	5
214	SIDE DOOR STRENGTH	7
216	ROOF CRUSH	3
301	FUEL TANKS, TANK FILLER PIPES, AND CONNECTIONS	8
302	FLAMMABILITY OF INTERIOR MATERIALS	1

HIGHWAY SAFETY PROGRAM STANDARDS

STANDARD NUMBER	STANDARD TITLE	TIMES REFERRED
1	PERIODIC MOTOR VEHICLE INSPECTION	5
3	MOTORCYCLE SAFETY	8
4	DRIVER EDUCATION	18
5	DRIVER LICENSING	19
7	TRAFFIC COURTS	3
8	ALCOHOL IN RELATION TO HIGHWAY SAFETY	24
9	IDENTIFICATION AND SURVEILLANCE OF ACCIDENT LOCATIONS	10
11	EMERGENCY MEDICAL SERVICES	8
12	HIGHWAY DESIGN, CONSTRUCTION, AND MAINTENANCE	23
13	TRAFFIC CONTROL DEVICES	12
14	PEDESTRIAN SAFETY	7
15	POLICE TRAFFIC SERVICES	2
16	DEBRIS HAZARD CONTROL AND CLEANUP	4

SUMMARY OF MATRIX CELLS BY CASE

	MATRIX CELL								
AA CASE NUMBER	1	2	3	4	5	6	7	8	9
100	(2)-	(1)-	(1)+				(1)-		
101	(3)-		(1)-	(1)-		(1)-			
105	(2)-				(1)+	(1)-			
114	(2)- (3)+				(1)-		(1)-	(1)-	(1)+ (1)-
115	(4)-	(1)+	(1)-		(1)+				(2)+
126	(1)-	(1)+	(1)- (1)+				(1)-		(1)+
129	(3)-	(1)- (1)+	(3)+ (1)-	(1)-	(1)-			(1)- (1)+	
130	(2)-	(1)+, (1)-	(2)-		(1)-			(1)-	
132	(2)-		(1)+		(1)-		(1)+ (1)-		(1)-
133	(3)-	(1)-		(1)-	(1)-	(1)-	(3)-		
134	(1)-						(1)-		(1)+
136	(2)-	(1)-	(1)-				(1)-		(1)+
138	(6)-	(1)-	(1)-		(1)-	(1)-			
139	(1)-	(1)-	(1)+	(1)-	(2)- (1)+		(3)-	(1)+	(1)+
140	(5)-		(1)+	(2)-	(1)-		(1)-		

SUMMARY OF MATRIX CELLS BY CASE,

	MATRIX CELL								
AA CASE NUMBER	1	2	3	4	5	6	7	8	9
141	(1)-	(1)-			(1)-	(1)-			(1)+
142	(2)-	(1)-			(2)-		(1)-	(1)+	(1)+
143	(2)-	(1)-		(1)-	(1)-	(1)-	(3)-		
144	(3)-	(1)-	(2)+	(1)-	(1)+ (1)-		(1)-		(2)-
145	(3)- (1)+	(1)- (1)+	(1)+ (1)-	(1)-	(1)+ (3)-		(1)-	(1)-	(1)+
146	(3)-						(3)-		(2)- (1)+
147	(2)-	(2)-					(1)-		(1)+
148	(3)-	(1)-							(1)+
149	(2)-	(2)-	(1)+		(2)+ (1)-		(2)-		
150	(1)-			(1)-			(1)-		
151	(2)-	(2)-	(1)- (1)+		(1)-	(1)-			(2)-
152	(2)-	(1)-		(3)-	(2)-		(2)-		(1)+
153	(2)-	(1)-	(1)-						(1)-
154	(2)-		(1)+	(3)-	(1)+ (3)-	(1)-			(1)-
155	(3)-	(1)-		(1)+ (1)-		(2)-	(3)-		(1)+
156	(2)-	(1)+ (1)-		(1)-			(1)+ (1)-		
157	(2)-	(1)-			(3)-	(1)-	(3)-	(2)+ (1)-	

SUMMARY OF MATRIX CELLS BY CASE,

	MATRIX CELL								
AA CASE NUMBER	1	2	3	4	5	6	7	8	9
159	(1)-	(1)+	(3)- (1)+						(1)+
160	(1)-	(1)-			(1)-	(1)+			
161	(2)-				(1)+		(1)- (1)+		
162	(1)-	(1)-			(1)+ (1)-		(1)-		
163	(1)+, (1)-		(1)+				(1)-		
164	(3)-	(1)-			(1)-		(3)-	(1)-	(1)+
165	(1)-	(1)+ (1)-			(1)-		(2)-		(1)+
166	(2)-				(3)-		(1)-		
167	(2)-			(1)-	(1)+	(1)+			
168	(2)-	(1)+		(1)-			(1)-		
169	(3)-	(1)-			(1)-		(1)-		(1)+, (1)-
170	(2)-				(1)-			(1)-	
171	(2)-	(1)-						(1)-	
172	(2)-				(2)- (1)+		(1)-	(1)-	(1)-
173	(4)-	(2)-		(1)-	(1)-		(1)-	(1)-	(1)+
174	(1)-	(1)-		(3)-	(1)-			(1)-	
175	(3)-	(1)-	(1)-	(2)-	(1)+		(1)-	(1)-	

SUMMARY OF MATRIX CELLS BY CASE,

	MATRIX CELL								
AA CASE NUMBER	1	2	3	4	5	6	7	8	9
176	(3)-	(1)-					(2)-		
177	(2)-	(2)+			(1)+ (1)-		(1)-		(1)-
178		(1)-		(1)-	(1)+		(2)-		
179	(2)-				(1)-		(1)-		
180	(4)-	(1)-	(1)-				(2)-		
181	(2)- (1)+			(1)-					
182	(1)- (1)+			(1)-					
183	(3)-			(1)-	(4)-		(2)-		(1)+
184	(1)-			(1)-		(1)+			(1)-
185	(1)-	(1)-			(1)-	(1)-	(1)-		
186	(2)+ (1)-	(1)-		(1)+	(1)- (1)+	(1)-			(1)+ (1)-
188	(2)- (2)+	(2)+ (1)-	(1)+						
189	(3)-	(2)-	(1)+	(1)+	(1)-			(1)+	
190	(4)-	(1)+	(1)+		(1)+	(1)+			(1)+
191	(2)-	(1)+					(1)-		(1)+ (1)-
192	(2)-	(1)-		(1)-					
193	(2)-	(1)-	(1)+				(1)-		

SUMMARY OF MATRIX CELLS BY CASE,

AA CASE NUMBER	MATRIX CELL								
	1	2	3	4	5	6	7	8	9
194	(1)+ (1)-	(1)-			(1)+		(1)-		
195	(1)+ (1)-				(1)+		(1)-		
196	(1)-	(2)-			(1)+ (1)-		(4)-		
197	(1)-	(1)- (1)+	(1)+				(1)-		(1)+
198	(1)-						(1)-	(1)-	(1)+
199	(8)- (1)+						(2)-		
200	(1)-	(1)-			(1)-		(1)-		(1)+
201	(1)-	(1)+					(1)-		(1)+
202	(1)-	(1)-			(1)-, (1)+				(1)+
203	(9)-	(1)+ (1)-	(1)+		(2)-		(1)-		
204	(3)-	(1)-							
205	(3)- (1)+		(1)+		(1)-				
206	(1)+	(1)+ (1)-	(1)+		(1)+	(1)-			

MATRIX CELL SUMMARY

1 -176 +18	2 -53 + 20	3 -16 + 24
4 -32 +3	5 -55 +21	6 -14 +5
7 -75 +3	8 -13 +6	9 -16 +29

6.0 Findings and Discussion

This section presents some results of initial analytical methods used in examining accident data. Data files utilized were those of the Washtenaw County, Michigan, Collision Performance and Injury Report (CPIR) file, and include Level III accident case studies completed this past year as part of the tri-level program in conjunction with previous years Level II cases.

Creating an Injury Severity Model using AID and MCA Programs.

One approach often employed in connection with accident data is to establish some hypothesis like: seat belts minimize injury, or driver education prevents accidents. Where there is a direct and obvious effect, perhaps as in the seat belt hypothesis, it is quite reasonable to look at a simple correlation and to observe that it is positive. Where the effect is less obvious -- for example in comparing several kinds of energy absorbing steering columns -- an observed correlation may in fact be spurious. Different steering columns may be installed in different size cars, and these different size cars may be driven by different age persons at different places, speeds, and times, and be involved in vastly different types of accidents. The techniques of multivariate analysis are useful here in determining interactions which affect such output measures as injury severity.

Of the more than 600 items of information about each occupant recorded in the CPIR file, many are obviously correlated with injury production. These include the vehicle damage index (VDI), inches of sheet metal crush, and impact speed. While none correlate directly with injury level, their association is expected, and can be easily established.

There are, on the other hand, many other information items for which the correlation is not quite so obvious. An empirical approach towards understanding these relationships is to define a dependent variable (such as severity of injury) and to select a number of candidate independent variables on the basis of experience, or previous analyses.

This approach was employed through an AID analysis of the Washtenaw County CPIR data file, and was structured to display the relationship between occupant injury level and many independent variables believed to have some association with injury.* The AID analysis provides two types of output. A set of one-way analysis of variance tables, with the results arranged in the order of increasing mean injury level; and a "tree" showing binary splits of data which best explain variation in injury as a function of the independent variables. A list of variables used in a first examination of the data is presented in Table 6-1. The resulting "tree" is shown in Figure 6-1. The first set of Analysis of Variance tables is included as Appendix H.**

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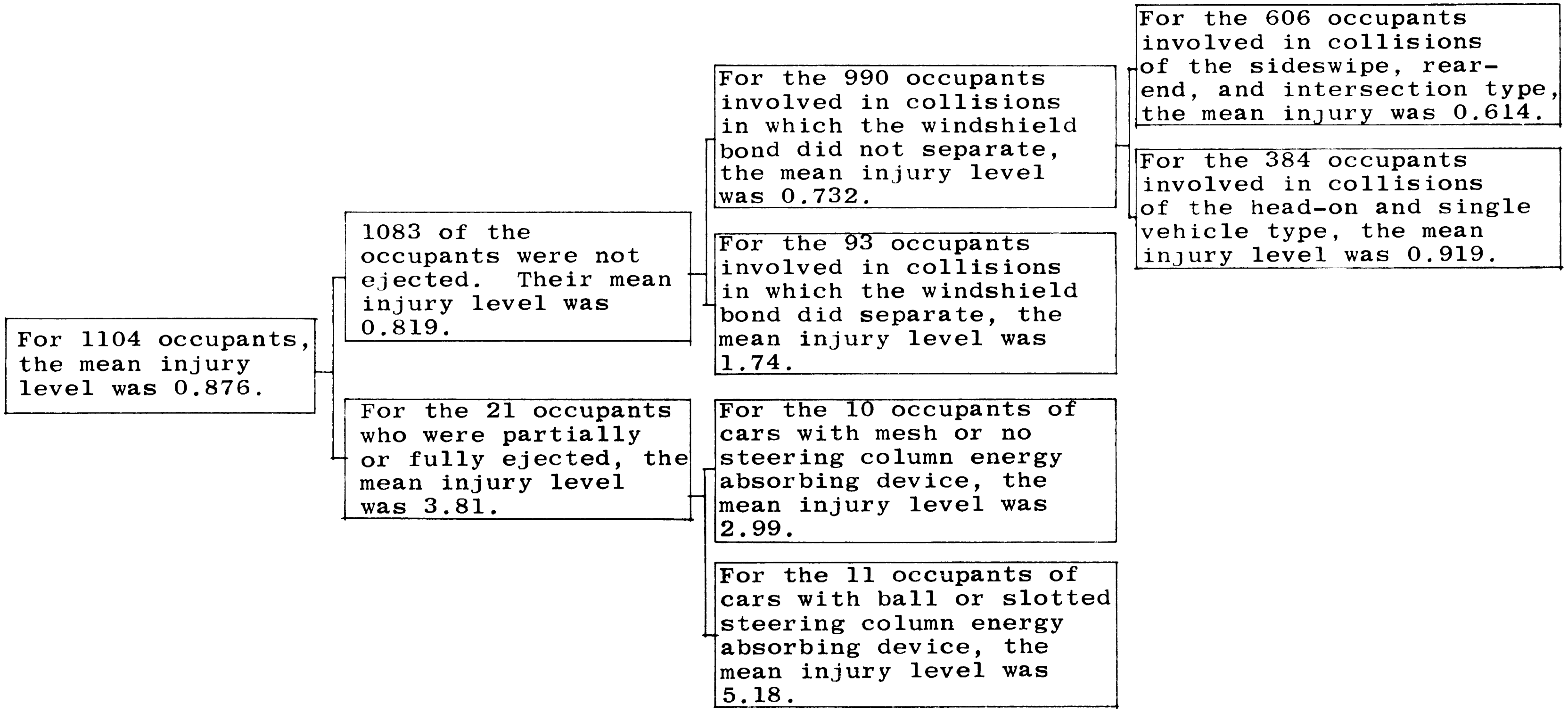
* Sondquist and Morgan, "The Detection of Interaction Effects", Monograph #35, Survey Research Center, Institute for Social Research, The University of Michigan. (1964)

** Andrews, Morgan, and Sondquist, "Multiple Classification Analysis". Survey Research Center, Institute for Social Research, The University of Michigan, 1969. A report on a computer program for Multiple Regression using categorical predictors.

TABLE 6-1

Independent Variables used in Washtenaw County New Car File AID Analysis.

1. Collision vehicle to object (yes, no, or unknown)
2. Collision vehicle to vehicle
   - Yes (configuration unknown)
   - No
   - Head on
   - Intersection (type L)
   - Sideswipe
   - Rear Impact
   - Other
   - Intersection (type T)
   - Unknown
3. Case vehicle Corporation
   - General Motors
   - Ford
   - Chrysler
   - American Motors
   - etc.
4. Model year of vehicle
5. Body style of vehicle
   - 2 door sedan
   - 4 door sedan
   - station wagon,
   - etc.
6. General area of principal damage to vehicle (from VDI)
   - front
   - right side
   - back
   - top
   - etc.
7. Collision type (from VDI)
   - Rollover
   - Fire
   - Wide impact
   - Narrow impact
   - Sideswipe
   - etc.
8. Steering column Energy Absorbing device (by type of device)
9. External object intrusion into passenger compartment (yes, no, un
10. Windshield bond separation (yes, no, unknown)
11. Occupant seat location
12. Occupant age
13. Lap belt worn (yes, no, unknown)
14. Upper torso restraint worn (yes, no, unknown)
15. Degree of ejection (none, partial, complete, unknown)



For 1104 occupants, the mean injury level was 0.876.

1083 of the occupants were not ejected. Their mean injury level was 0.819.

For the 21 occupants who were partially or fully ejected, the mean injury level was 3.81.

For the 990 occupants involved in collisions in which the windshield bond did not separate, the mean injury level was 0.732.

For the 93 occupants involved in collisions in which the windshield bond did separate, the mean injury level was 1.74.

For the 10 occupants of cars with mesh or no steering column energy absorbing device, the mean injury level was 2.99.

For the 11 occupants of cars with ball or slotted steering column energy absorbing device, the mean injury level was 5.18.

For the 606 occupants involved in collisions of the sideswipe, rear-end, and intersection type, the mean injury was 0.614.

For the 384 occupants involved in collisions of the head-on and single vehicle type, the mean injury level was 0.919.

Figure 6-1. AID Diagram for the Washtenaw County New Car Data Set.

With reference to Figure 6-1, the variable which best explains the variation in overall mean injury to occupants in this set of data is degree of ejection. Occupants experiencing partial or full ejection averaged 3.81 on the Abbreviated Injury Scale (AIS). Occupants not ejected averaged 0.819. Windshield bond separation is the second division of non-ejected occupants. This appears as a significant predictor of accident severity. Finally, on the upper branch, head-on and single vehicle accidents are separated from other accident configurations.

For the 21 ejected occupants, a subsequent division occurs for the type of energy absorbing steering column. The effect is to indicate that the steering column used in most Chrysler Corporation vehicles (a mesh column) is associated with lower injury for ejectees, than the GM and Ford steering columns. While the association is sufficiently strong for a data split, as shown in the diagram, it does not make good sense physically. This can be considered as a marker, or indicator variable, which points to a possible relationship which is, at the moment, hidden within the data. Steering column type is almost completely explained by differences among manufacturers, suggesting that the ejection phenomenon is best explained by that factor.

To follow up an examination of these injury producing factors, a Multiple Classification Analysis (MCA) was performed using those variables which (from the AID analysis) were judged most likely to significantly predict injury. As opposed to a multiple regression analysis, which ordinarily requires quantitative variables for predicting, MCA allows the use of qualitative, or categorical variables. For the most part information recorded in connection with an accident is categorical in form. In analyzing these data it is useful to be able to estimate the contribution of each of the code levels of a qualitative variable in terms of a dependent variable (in this case the severity of injury).

The complete MCA output is presented in Appendix I. It consists of all possible two-way tabulations of the predictor variables, (Table 1-15) followed by a tabulation of the relative contribution of each of the predictors, and their code values, to the severity of driver injury (the dependent variable).

Of the variables chosen for this analysis, windshield bond separation best predicts injury severity, independently accounting for 17% of the linear variance in severity. None of the other variables chosen contribute more than 2% of the variance in this model. The class mean of those cases with no separation is 0.62 on the AIS scale. The class mean of those with separation is 2.62. It should be clear that windshield bond separation may not necessarily cause injury, but may be simply a good indicator of accident severity. Percent separation is usually reported by the investigating teams, but has not generally been encoded into the digital files. This analysis suggests that, if all windshields have approximately the same retention capability, the percent separation measure may be a more precise measure of severity than other variables, and should be included into the digital file.

In the third tabulation, displaying severity as a function of type of EA column, there is no significant variance accounted for (0.3%). One could conclude that, at least in this data set, these three most common EA devices are not significantly different in terms of overall injury to the driver.

The overall multiple-R^2 (the square of the multiple correlation coefficient) is 17%, indicating that the one variable accounts for almost all of the variance in injury severity for these variables.

This program assumes no interactions among the variables, and the many two-way tables are printed out to allow an investigator to determine whether this is true. Windshield bond separation, as one can see from the bivariate tables, does not interact with the other variables. One exception to this is the low involvement rate of the mesh type EA column in rear damage to the vehicle. From a previous analysis it was noted that the mesh EA column is generally associated with Chrysler Corporation vehicles. There is nothing obvious in the present data to explain the underinvolvement in rear damage. This 4 x 2 table yields a chi-square of 8.2, significant at the .04 level. The value of -2 log (maximum likelihood ratio) is 9.1, and significant at the .03 level. The digital file containing Level III investigation cases studies included a tabulation of the location and severity of each injury to each occupant. The number of injuries, then is much larger than the number of occupants. This provides a data set of sufficient size to plot several types of injury distributions.

Figures 6-2 and 6-3 show the distribution of injuries by body anatomical location and severity (Abbreviated Injury Scale) for two subsets of the Washtenaw County 1969 to 1972 model year passenger cars. The major difference between the two populations in severity of head and neck injuries for ejected occupants. While this distribution of injury location is somewhat different, such as greater leg injuries for non-ejectees and more facial injuries, the increased severity in most categories for ejectees is strikingly clear.

In summary, we have shown that empirical multivariate analysis techniques are useful, as well as necessary to avoid the pitfalls of narrowly focused simple correlation. In the preceding section, the Automatic Interaction Detection algorithm was utilized for an initial examination of a set of accident data, and a Multiple Classification Analysis algorithm used to construct a linear model between several categorical variables and driver injury.

The association of windshield bond separation with increased driver injury suggests that this relationship may be a sensitive indicator of accident severity. It may, in fact, be thought of as a sort of accelerometer providing information relative to "g" forces in an accident. Factors restricting further substantiation of this

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JUL 24, 1972              * HSRI SYSTEMS - BAR GRAPH *
DISTRIBUTION OF INJURIES BY PART OF THE BODY AND BY SEVERITY
FOR ALL 1969-1972 MODEL AUTOMOBILE WASHTENAW COUNTY CPIR CASES
FOR EJECTED VICTIMS

   20+
     I
     I
     I
     I
   18+
     I
     I
     I
     I
   16+
     I
     I
     I
     I
   14+
     I
     I                  19
     I
     I                AIS3
   12+                AIS3
     I                AIS3
P    I                AIS3     16
E    I                AIS3
R    I                AIS2   AIS6
C  10+                AIS2   AIS6
E    I           13   AIS2   AIS6     13
N    I                AIS2   AIS6
T    I         AIS6   AIS1   AIS4   AIS6     12            12     12                                12
     I         AIS6   AIS1   AIS4   AIS6
    8+         AIS6   AIS1   AIS4   AIS6   AIS3          AIS3   AIS6                          11   AIS4
     I         AIS6   AIS1   AIS4   AIS6   AIS3          AIS3   AIS6                   10            AIS4
     I         AIS6   AIS1   AIS4   AIS6   AIS2          AIS3   AIS6                        AIS3   AIS3
     I         AIS6   AIS1   AIS3   AIS6   AIS2      9   AIS2   AIS6                 AIS4   AIS1   AIS3
     I         AIS6   AIS1   AIS3   AIS6   AIS2          AIS2   AIS6                 AIS4   AIS1   AIS3
    6+         AIS6   AIS1   AIS3   AIS5   AIS2   AIS4   AIS2   AIS5                 AIS4   AIS1   AIS1
     I         AIS6   AIS1   AIS3   AIS5   AIS2   AIS4   AIS2   AIS5                 AIS4   AIS1   AIS1
     I         AIS6   AIS1   AIS2   AIS2   AIS2   AIS4   AIS2   AIS5                 AIS4   AIS1   AIS1
     I         AIS5   AIS1   AIS2   AIS1   AIS2   AIS4   AIS1   AIS3                 AIS4   AIS1   AIS1
     I         AIS5   AIS1   AIS2   AIS1   AIS2   AIS4   AIS1   AIS3                 AIS4   AIS1   AIS1
    4+     5   AIS5   AIS1   AIS2   AIS1   AIS2   AIS1   AIS1   AIS3             5   AIS3   AIS1   AIS1
     I         AIS5   AIS1   AIS2   AIS1   AIS2   AIS1   AIS1   AIS3                 AIS3   AIS1   AIS1
     I  AIS6   AIS3   AIS1   AIS2   AIS1   AIS2   AIS1   AIS1   AIS3          AIS5   AIS2   AIS1   AIS1
     I  AIS6   AIS3   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS2          AIS5   AIS2   AIS1   AIS1
     I  AIS6   AIS3   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS2          AIS5   AIS2   AIS1   AIS1
    2+  AIS4   AIS2   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1      2   AIS5   AIS2   AIS1   AIS1
     I  AIS4   AIS2   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1          AIS5   AIS2   AIS1   AIS1
     I  AIS3   AIS2   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS2   AIS1   AIS1   AIS1
     I  AIS2   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1
     I  AIS2   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1
   .0+----++++---++++---++++---++++---++++---++++---++++---++++---++++---++++---++++---++++---++++---++++
        INTERN BRAIN  FACE   HEAD   NECK  SHOULD RT ARM LT ARM THORAX LUMBAR ABDMEN PELVIS RT LEG LT LEG
                      I N J U R E D   R E G I O N   O F   T H E   B O D Y
```

FIGURE 6-2. EJECTED VICTIM

INJURY DATA SET

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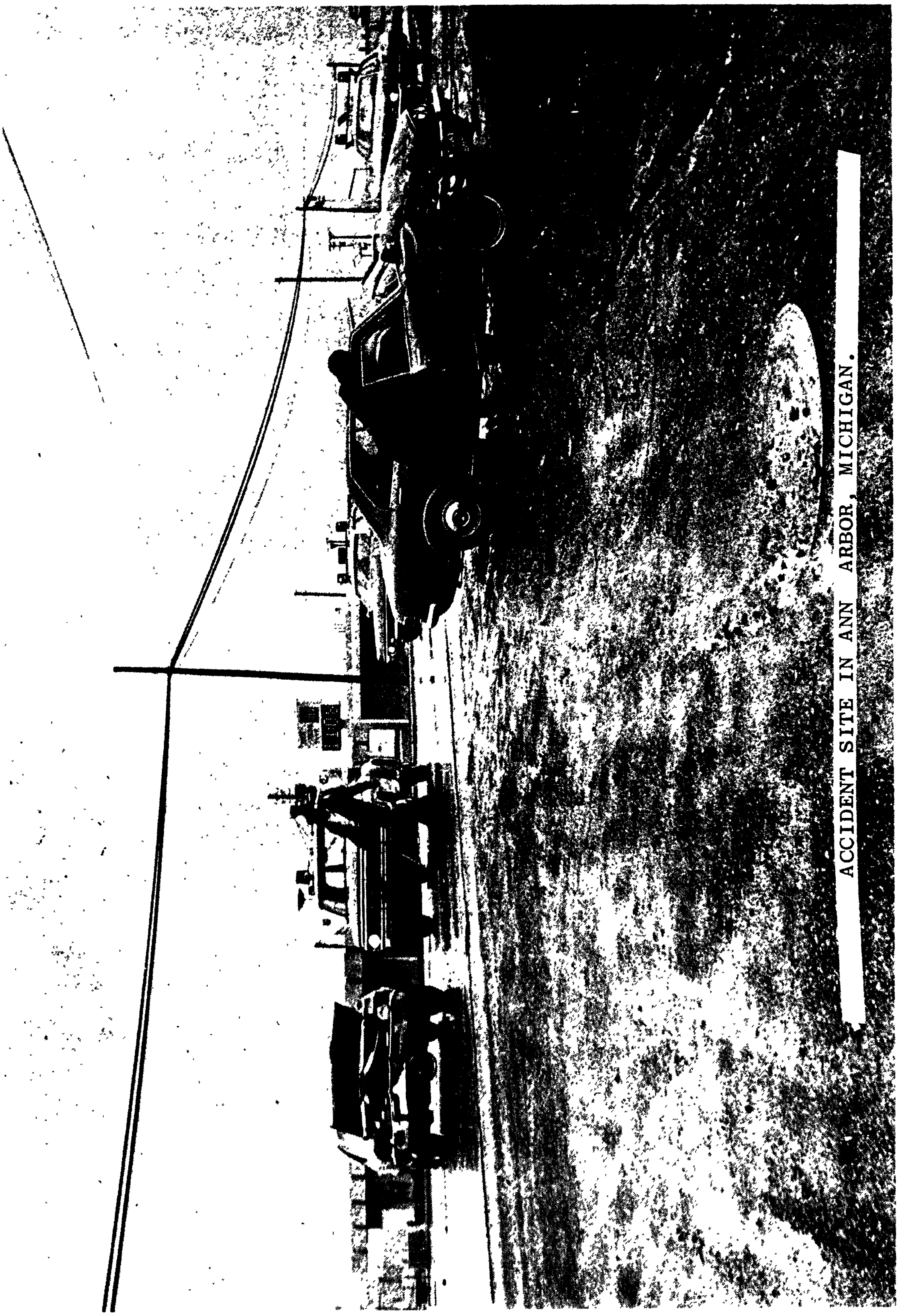
 JUL 24, 1972            * HSRI SYSTEMS - BAR GRAPH *
DISTRIBUTION OF INJURIES BY PART OF THE BODY AND BY SEVERITY
FOR ALL 1969-1972 MODEL AUTOMOBILE WASHTENAW COUNTY CPIR CASES
FOR NON-EJECTED VICTIMS

  20+
    I
    I
    I
    I
  18+
    I
    I
    I
    I
  16+                   302
    I                                                                                         298
    I                  AIS6
    I                  AIS3                                                                  AIS4
    I                  AIS2                                                                  AIS3
  14+                  AIS2                                                                  AIS2
    I                  AIS2                                                                  AIS2    259
    I                  AIS2                                                                  AIS2
    I                  AIS1    244                                                           AIS1   AIS3
    I                  AIS1                                                                  AIS1   AIS3
  12+                  AIS1   AIS3                                                           AIS1   AIS3
    I                  AIS1   AIS3                                                           AIS1   AIS2
P   I                  AIS1   AIS2                                                           AIS1   AIS2
E   I                  AIS1   AIS2                                                           AIS1   AIS2
R   I                  AIS1   AIS2                                                           AIS1   AIS1
C 10+                  AIS1   AIS1                                                           AIS1   AIS1
E   I                  AIS1   AIS1                                                           AIS1   AIS1
N   I                  AIS1   AIS1                                                           AIS1   AIS1
T   I                  AIS1   AIS1                                164                        AIS1   AIS1
    I                  AIS1   AIS1                                                           AIS1   AIS1
   8+                  AIS1   AIS1                         147   AIS4                        AIS1   AIS1
    I                  AIS1   AIS1    134                        AIS3                        AIS1   AIS1
    I                  AIS1   AIS1                        AIS2   AIS3                        AIS1   AIS1
    I                  AIS1   AIS1   AIS6           121   AIS2   AIS3                        AIS1   AIS1
    I                  AIS1   AIS1   AIS1                 AIS2   AIS2                        AIS1   AIS1
   6+                  AIS1   AIS1   AIS1          AIS3   AIS1   AIS2                        AIS1   AIS1
    I                  AIS1   AIS1   AIS1          AIS2   AIS1   AIS2                        AIS1   AIS1
    I                  AIS1   AIS1   AIS1          AIS1   AIS1   AIS1                        AIS1   AIS1
    I                  AIS1   AIS1   AIS1     78   AIS1   AIS1   AIS1                        AIS1   AIS1
    I                  AIS1   AIS1   AIS1          AIS1   AIS1   AIS1                        AIS1   AIS1
   4+             65   AIS1   AIS1   AIS1   AIS3   AIS1   AIS1   AIS1                   65   AIS1   AIS1
    I                  AIS1   AIS1   AIS1   AIS2   AIS1   AIS1   AIS1     58     53          AIS1   AIS1
    I           AIS6   AIS1   AIS1   AIS1   AIS2   AIS1   AIS1   AIS1                 AIS3   AIS1   AIS1
    I           AIS5   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS3   AIS5   AIS2   AIS1   AIS1
    I           AIS4   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS3   AIS1   AIS1   AIS1
   2+      24   AIS3   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1
    I           AIS2   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1
    I    AIS6   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1
    I    AIS6   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1
    I    AIS5   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1   AIS1
   0+----++++---++++---++++---++++---++++---++++---++++---++++---++++---++++---++++---++++---++++---++++
         INTERN BRAIN  FACE   HEAD   NECK   SHOULD RT ARM LT ARM THORAX LUMBAR ABDMEN PELVIS RT LEG LT LEG
                       I N J U R E D   R E G I O N   O F   T H E   B O D Y
```

FIGURE 6-3. NON-EJECTED VICTIM INJURY DATA SET relationship are the limited number of cases in the Washtenaw County data file, and lack of greater detail on percentage of windshield bond separation. This relationship will be further explored during the coming year with the larger set of accident cases to be stored in the data file.

The relationship between injury and windshield bond separation also indicates that one data element which should be collected routinely for vehicles investigated as Level III investigations or in which crash recorders are placed, is percentage of windshield bond separation.



ACCIDENT SITE IN ANN ARBOR, MICHIGAN.

6.1 Injury Level Classifications

Of particular interest during this past year of accident investigations, was the correlation between police injury codes and the AIS, Abbreviated Injury Code as used by multidisciplinary accident teams.

A previous study on exposure information conducted in 1970 included a comparison of the use of the police injury code and the Abbreviated Injury Scale (AIS).* Medical records for 540 victims of traffic accidents in Washtenaw County in 1968-69 were examined with an AIS code assigned each victim. These codes were then compared with police codes, which had been assigned in the police investigations.

Since this study was completed, however, definitions of police codes used in Michigan have changed. Data collected in this program permits a reexamination of the AIS and police scale.

Police codes used prior to 1971 in Michigan were:**

K=Fatal
A=Visible signs of injury, as bleeding wound or distorted member, or had to be carried from scene.
B=Other signs of injury, as bruises, abrasions, swelling.
C=No visible injury but complaint of pain or momentary unconsciousness.
O=No indication of injury.

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* Robert E. Scott and Phillip S. Carroll, Acquisition of Information on Exposure and on Non-Fatal Crashes, Volume II - Accident Data Inaccuracies, Report Number 03169-II, Highway Safety Research Institute; The University of Michigan; Ann Arbor, Michigan; May, 1971.

** Manual on Classification of Motor Vehicle Traffic Accidents, National Safety Council; Chicago, Illinois; 1962.

Starting in 1971, these codes are:*

K=Fatal
A=Incapacitating Injury is any injury other than fatal, which prevents the injured person from walking, driving, or normally continuing the activities which he is capable of performing prior to the motor vehicle traffic accident.
B=Nonincapacitating Evident Injury is any injury other than fatal and incapacitating, which is evident to any observer at the scene of the accident.
C=Possible Injury is any injury reported or claimed which is not fatal, incapacitating, or nonincapaciting evident injury.

Major differences in the two police scales exist in the "A" codes, i.e., visible injury versus incapacitating injury. Many injuries formerly coded as "A" were lacerations etc, with minor to moderate bleeding that was easily controlled and not incapacitating, and other evident but minor injury. Thus, we might expect that under the new definitions, the "A" category would include fewer minor injuries, and in turn a smaller proportion of all injured victims would be coded "A".

The distribution of AIS codes for each police injury code is given in Table 6-1 for non-fatal injuries from both data obtained in the exposure project and data from the current Tri-Level Accident Study program. The left column of each police code contains the distribution in percent for the data in 1968-69 accidents. The right column in each category contains the results of the current program.

Indeed, the incidence of injury of the higher AIS codes among the "A" victims is higher in the 1971-72 accidents investigated by the HSRI MDAI team. While the same is true of the "B" victims, the incidence of AIS=0 was higher for both the "C" and "O" police

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* Manual on Classification of Motor Vehicle Traffic Accidents, Second Edition, National Safety Council; Chicago, Illinois; May, 1970.

codes in the MDAI data although the numbers of cases in these categories is small. The differences in the distributions of "A" injury is significant at the 5% confidence level.

The mean AIS code for each police code is shown in Table 6.1-1, with fatals excluded. Here too, it should be noted that the severity of "A" injuries is slightly--but significantly--higher in the MDAI sample, but still will be a low average AIS. The means for "B" injuries show hardly any change, while the "C" and "O" groups have a lower mean AIS code. As was observed in the exposure project, the incidence of injuries (AIS $\geq$ 1) among the group with police codes of zero does not indicate that a proportion of "property damage" accidents are actually injury accidents, since these victims were all in accidents in which at least one occupant was recognized as injured by police.

TABLE 6.1-1

Mean AIS code by Police Code

Police Code	1968-1969 Exposure Project Data		1971-1971 MDAI Data	
	Mean AIS	Number	Mean AIS	Number
A	1.56	302	2.02	54
B	1.12	134	1.11	38
C	1.06	86	0.92	13
O	0.95	18	0.31	42

A very common interpretation of complications of injury using the police code is to assume that "A" injuries are "serious", "B's" are "moderate", and "C's" "minor". Both the data used in the exposure project and that collected in Level III accident investigations suggest that a large fraction "A" injuries are minor. The term "serious" was used loosely here, but we might ask "what fraction of the victims of a particular police code have injuries of at least a specific AIS code?" The proportion of non-fatal victims with at least an AIS code of 2 and 3 is shown in Table 6.1-2 for

Number AIS	Exposure	MDAI	Exposure	MDAI	Exposure	MDAI	Exposure	MDAI
	302	54	134	38	86	10	18	12
0 Injury	1.0	1.9	2.2	2.6	8.1	23.1	22.2	73.8
1 Minor	62.3	44.4	87.3	84.2	82.6	69.2	72.2	21.4
2 Moderate	21.2	25.9	7.5	13.2	4.7	0	5.6	4.8
3 Severe	11.9	13.0	2.2	0	4.7	7.7	0	0
4 Serious	2.3	7.4	0.7	0	0	0	0	0
5 Critical	1.3	7.4	0	0	0	0	0	0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	A		B		C		0	

Figure 6.1-1 Distribution of AIS Codes by Police Injury Codes in Percent.

both samples along with the 95% confidence interval resulting from the size of samples.*

The proportion of victims of the "A" group with AIS of 2, or greater, has increased from 36,8 to 53.7 percent in the latter sample, for a relative increase of 46%. The proportion with injuries of AIS to 3, or greater, has increased from 15.6 to 27.8 percent, for a relative increase of 78%. Nevertheless, over 46% of the "A" victims of the MDAI sample had only minor injuries, while over 63% had minor or moderate injuries. Only 36.8% were seriously (AIS=3-5) injured.

At least two potentially significant phenomena could result in differences between the distribution of the injury codes of the two samples. The change in definition of the police codes has been discussed, and should lead to a lower incidence of "A" cases among the injured. The current number of Level III accident cases also does not include a truly random, or representative, sample of all accidents, but on the average more severe crashes. This could be expected to lead to an over representation of the more severe "A" injuries in the MDAI sample. The sample drawn for the exposure project was a sample of occupants rather than an accident sample, but the occupants were limited to those transported to a hospital.

The possible biases mentioned above relate to the distribution of AIS codes within a police injury code. Both samples may also contain biases in the distribution of police codes. Such a bias in the MDAI sample could also result from the higher case load of severe crashes. In the case of the exposure project, the objective was to examine the severity of individual police codes, so a random sample was taken for each police code, but no attempt was made to select an unbiased sample of the various police codes.

The distribution of police codes, of both the exposure project and MDAI data, can be compared with police data from all accidents

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* The confidence interval is only given when the sample size is sufficient to justify an asymptotic normal curve.

in the county. Since only injury accidents were included in the two samples, non-injured occupants will be omitted as well as fatals. The distributions are given in Table 6.1-3 for both samples as well as for the entire county in 1970 and 1971.

The table also indicates that the relative incidence of "A's" in 1971 was lower than in 1970 with a ratio between the two of 0.61. This does not represent a change in the total number of injuries since only injured victims were included. In all likelihood, it represents the change in the use of the new definition of the police code introduced in 1971. While the relative incidence of "A" injuries in Washtenaw County was only six tenths of the incidence in 1970, the ratio for the entire state was seven tenths.

The change resulting from the new definitions might explain much of the difference in the distribution of AIS codes for "A" injuries in the exposure project and MDAI data sets. If the "A's" that were dropped (coded as B or C) in the police coding are assumed to be minor injuries of AIS=0,1, a comparison of the two data sets can be made by similarly adjusting the exposure project data. When 0.6 of the Exposure Project "A" cases are dropped from the lower two AIS categories, the fraction of the "A" injuries that are AIS $\geq$ 2 becomes 60.7% and 25.7% are then of AIS $\geq$ 3. The differences between these figures and the corresponding figures from the MDAI sample (53.7% and 27.8% respectively) are not statistically significant. While this does not prove that the differences in the proportion of "A" injuries of the two samples are the result of the change in definitions, it does indicate the differences are at least consistent with the change.

While we may conclude that the second edition of the "Manual on Classification of Motor Vehicle Traffic Accidents" improves the use of the police injury scale as an index of injury severity it is still not reliable. Only 28% of the "A" injuries of the MDAI sample were actually serious, and 45% were minor when classified by the AIS. Thus, only a samll fraction of the "A's" and hardly any of the "B's" and "C's" are injuries which might be described as serious.

Published versions of the Abbreviated Injury Scale as used above contain a table of equivalence between the AIS and earlier police codes.* The implied equivalence is:

AIS	POLICE CODE
0	0
1	C
2	B
3	B
4	B
5	A
6-9	K

This equivalence is clearly not consistent with the code definition of either the former, or present police scale. Many of the injuries of AIS=2,3, and 4 could be incapacitating at the scene and require transportation to a medical facility. Examples of such injuries are undisplaced long bone fractures (AIS=2), multiple amputation of digits (AIS=3), and amputation of limbs (AIS=4). These would be coded A by either edition of the police code. Conversely, AIS=4 (severe, life-threatening) includes ruptured spleen which could be undetected at the scene of an accident and be coded C or even 0.

The incidence in the MDAI sample of the AIS codes of published equivalence is given for each police code below:

Proportion of Each Police Injury Code of the MDAI Sample that Matches the Corresponding AIS Code

Police Code	Equivalent AIS Codes	Fraction of Police Codes in the Equivalent AIS Codes in Percent
A	5	7.4
B	2-4	13.2
C	1	69.2

---

* For example: Journal of American Medical Association, Volume 215, No. 2, January 11, 1971, page 279.

TABLE 6.1-2

Proportion of Victims with Significant Injury, by Police Code.

	A	B	C
1971-1972 Sample			
Percent with AIS $\geq$ 2	53.7	13.2	7.7
95% Confidence Interval	13	11	--
Percent with AIS $\geq$ 3	27.8	0	7.7
95% Confidence Interval	12	--	--
1968-1969 Sample			
Percent with AIS $\geq$ 2	36.8	10.5	9.3
95% Confidence Interval	5	5	--
Percent with AIS $\geq$ 3	15.6	3.0	4.7
95% Confidence Interval	4	--	--

TABLE 6.1-3

Distribution of Police Codes Among Injured Accident Victims

	Police Code in Percent			
	A	B	C	Total
MDAI Sample 1971-1972	50.9	36.8	12.3	100.0
Exposure Project Sample 1968-1969	57.8	25.7	16.5	100.0
Entire County 1970 (All occupants)	34.5	24.6	40.9	100.0
Entire County 1971 (All occupants)	20.9	32.0	47.1	100.0

The distribution of the exposure project is of no significance and merely reflects the arbitrary sample selected. However, both samples have distributions which are quite different from all accidents of the entire county for either year.

Few of the non-fatally injured of this sample of 174 were given AIS codes by the MDAI team and police codes assigned by the police department investigators which were consistent with the table published with the AIS. Furthermore, the inconsistencies were large with 44.4% of the "A" injuries actually with a severity of 1 (minor) on the AIS.

We are not aware of either the origin or intent of the equivalence published with the AIS, but it is obviously inconsistent with definitions of the scales. Any attempt to interpret police injury data using AIS equivalents would be grossly in error.

The published association of police codes with the AIS is misleading and it is recommended that its use and promulgation be discouraged.

The terms used for the AIS - which are moderate; severe (not life-threatening); serious (life-threatening, survival probable); critical (survival uncertain) are much more clearly related to the patient condition descriptors commonly used by hospitals for news releases and public announcements. Such terms and definitions of condition adopted by the Michigan Hospital Association are:

GOOD: Excellent or good prognosis; patient is conscious; vital signs are stable and within normal limits; patient is comfortable.

FAIR: Favorable prognosis; patient is conscious; vital signs are stable and within normal limits; minor complications and/or uncomfortable.

SERIOUS: Acutely ill with questionable prognosis; vital signs may be unstable and/or not within normal limits; a chance for improved prognosis.

CRITICAL: Questionable prognosis; vital signs are unstable and/or not within normal limits; major complications; probably on danger list; death may be imminent.

These can be interpreted in terms of appropriate AIS codes with much more reliability, than can the police codes.

Police codes apparently also suffer wide variation in usage from jurisdiction to jurisdiction. Evidence of this is given by the variation in the distribution of the codes for non-fatal injury from state to state. Figure 6.1-2, taken from the first footnote on Page 1 of the Injury Level Classifications, gives the relative distribution for 17 states. The change of the incidence of A injuries in Michigan after introduction of the current definitions - from 28% in 1970 to 19.6% in 1971 - is not nearly as great as the state-to-state differences shown in the figure.

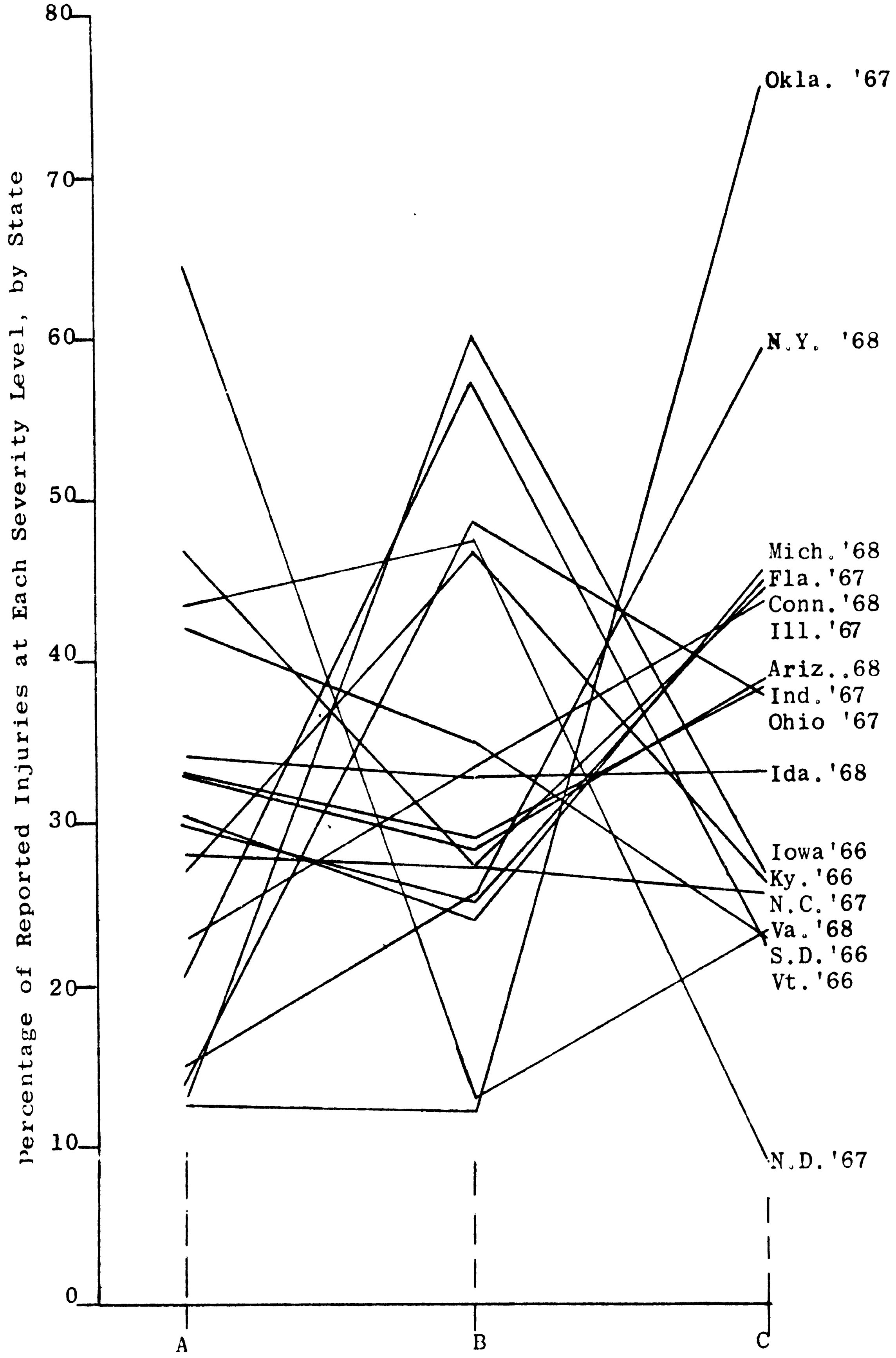
80
70
60
50
40
30
20
10
0
Percentage of Reported Injuries at Each Severity Level, by State
Okla. '67
N.Y. '68
Mich.'68
Fla.'67
Conn.'68
Ill.'67
Ariz.,68
Ind.'67
Ohio '67
Ida.'68
Iowa'66
Ky.'66
N.C.'67
Va.'68
S.D.'66
Vt.'66
N.D.'67
A
B
C
Injury Severity Levels

Figure 6.1-2

6.2 Grand Blanc Collision

Perhaps the most challenging and difficult accident case study attempted during the year was the Grand Blanc Collision.* It occurred early during the formation of the HSRI Level III accident research team, and was the first reported case study on the program. Our involvement was at the request of state authorities to assist the various police authorities involved in the initial investigation in understanding the physics of the accident. The Grand Blanc collision also had the dubious distinction of being the worst traffic accident in the history of the State of Michigan, with the attendent public outrage and full coverage by all news media. The event was a head-on collision which occurred on southbound Interstate 75 near Grand Blanc, Michigan on July 17, 1971 at 1:30 a.m., between a 1968 Pontiac Tempest convertible with one occupant, and a 1969 Pontiac Catalina stationwagon with nine occupants. Nine were killed, with the remaining survivor critically injured with survival uncertain. All victims were young, (under 25) with blood alcohol tests determining that both drivers were intoxicated. Considerable confusion prevailed, particularly in establishing which vehicle was going in the wrong direction. A careful examination of highway evidence (road surface characteristics, fluids residue, scrapes and gouges on the roadway) couples with examination of the vehicles and interviewing on-scene police personnel permitted a reconstruction of the dynamics of the accident. This was confirmed by momentum calculations which substantiated the "collision vector" of each vehicle at impact, as well as the trajectory of each vehicle after impact. Thus, it was established that the Pontiac Station wagon with nine youthful occupants was traveling south, in the southbound lanes of I-75 at a speed of approximately 60 mph, when it was struck near head-on** by the Pontiac convertible with one occupant, traveling north in the

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* Case Study AA-100 (SPL), "Head-On Collision/Interstate Highway/ Wrong-Way Vehicle", HSRI, October 1971.

** Collision heading was 15^{o} from center axis of each vehicle and approximately 5 inches left of center on each vehicle.

southbound lanes of I-75 at approximately 80 mph. After impact, the combined mass of both vehicles rotated slightly counterclockwise and skidded 30 feet southward as a single unit, whereas upon the convertible separated from the station wagon and rotated further counterclockwise about the station wagon so as to place both vehicles facing in a southerly direction.

Reconstructing the accident and establishing the actual dynamics of the vehicle did end much speculation, but did leave the companion problem of how the Pontiac convertible entered the southbound lanes of I-75 traveling north. The most probable entrance onto I-75 southbound of the wrong-way vehicle was at the Dixie Highway/I-75 interchange, 1.5 miles south of the accident site. Two other possible entry points were interchanges approximately 5.8 miles, and 8.8 miles south of the point of impact. These areas were examined closely in both daylight and darkness and it was noted that all three were marked according to the accepted standards, with "Wrong Way - Do Not Enter" signs at exit ramps to warn potential wrong-way entering drivers. It was conceivable, however, that a driver who was inattentive or whose driving abilities may have been impaired could enter these ramps the wrong way. Both interchanges had entrance and exit ramps quite close and parallel to each other with sight distance limitations and minimal night illumination.

At the suspect Dixie Highway interchange with I-75, the exit and entrance ramps had very similar geometric patterns and were but 1/8 mile apart.

There was no artificial illumination in the interchange vicinity at night. A double yellow line at the exit ramp was clearly visible in the daytime, but only with headlight illumination at night. There were two "Wrong Way - Do Not Enter" signs at the gore area but from that point on a driver who might enter the wrong way would encounter a series of red delineators only to indicate wrong way travel.

A count of traffic was made on southbound I-75 at 0100-0145 o'clock two weeks after the accident, but on the same day of the week and hour of the accident. From that count a computation was made of the expected number of southbound vehicles a wrong-way driver would have passed between his entrance and the actual accident site. Although traffic was not heavy at that time of the night, there was an average of one southbound vehicle each 38.7 seconds. Had a wrong-way vehicle entered the interchange 5.8 miles south of the accident site it would have passed an average of 15 vehicles. From the interchange 8.8 miles away, it would have passed 23 vehicles. This analysis was based on tabulation of traffic counts as shown in the accompanying Tables 6.2-1 and 6.2-2.

Table 6.2-1 presents the distance, assumed travel time for the wrong-way northbound convertible expected number of encounters of southbound vehicles by the northbound convertible and the probability of zero encounters for the northbound convertible.

Table 6.2-2 presents data used in analysis and Figure 6.2-1 is a plot of this data by time intervals and lane distributions.

From these data, the extreme and unlikely possibility was established that the wrong-way convertible could have entered at the two interchanges further south of the Dixie Highway/I-75 Interchange, and travelled to the vicinity of the accident area without generating a large number of encounters which may have led to either a crash or to some possible witness report of sighting a wrong way vehicle. Thus it was established that the wrong-way vehicle had entered I-75 at its interchange with Dixie Highway.

TABLE 6.2-1

Analysis of I-75 Traffic Data Number of Encounters of Southbound Vehicles by Northbound Convertible

Route Segment	Length	Travel Time[1] (in seconds)	Expected Encounters[1]	Probability of No Encounters[1]
Impact to Crest	.5 mi.	25.714	1.328	2.645×10^{-1}
Impact to Dixie Hgwy.	1.0 mi.	51.428	2.655	7.065×10^{-2}
Impact to Warrington Rd.	5.8 mi.	298.282	15.400	2.005×10^{-7}
Impact to Holly Road	8.8 mi.	452.566	23.366	9.669×10^{-11}
Crest to Dixie Hgwy.	.5 mi.	25.714	1.328	2.645×10^{-1}
Crest to Warrington Rd.	5.3 mi.	272.568	14.073	7.310×10^{-7}
Crest to Holly Road	8.3 mi.	426.852	22.038	2.686×10^{-10}
Dixie Hgwy. to Warrington Road	4.8 mi.	246.854	12.745	2.917×10^{-6}
Dixie Hgwy. to Holly Road	7.8 mi.	401.138	20.711	1.013×10^{-9}
Warrington Rd. to Holly Road	3.0 mi.	154.284	7.966	3.440×10^{-4}

[1] Calculated on basis of both Southbound and Northbound vehicles traveling at 70 mph. Southbound vehicles having an exponential inter-arrival time of 38.73 seconds.

TABLE 6.2-2

Arrival Times of Vehicles Southbound on I-75
At Baldwin Road Overpass, July 31, 1971, (Saturday)
1:10.00 am to 1:45.30 am. Times in seconds
past 1:10.00 am.

Veh. #	Time	Lane *
1	55	1
2	173	3
3	183	2
4	185	2
5	202	3
6	202	2
7	222	3
8	251	3
9	322	2
10	334	3
11	356	2
12	366	2
13	372	2
14	416	3
15	478	2
16	497	2
17	523	2
18	559	3
19	562	3
20	637	3
21	698	1
22	699	3
23	731	3
24	825	1
25	842	3
26	856	2
27	864	3
28	869	3
29	881	2
30	911	1
31	954	3
32	1161	3
33	1219	2
34	1288	3
35	1297	3
37	1328	2
38	1520	3
39	1558	2
40	1571	3
41	1577	2
42	1578	3
43	1578	1
44	1630	3
45	1712	2
46	1874	1
47	1882	3
48	1884	3
49	1885	2
50	1918	3
51	1961	2
52	2021	3
53	2057	3
54	2119	2
55	2130	3

* Lanes numbered left to right facing south.

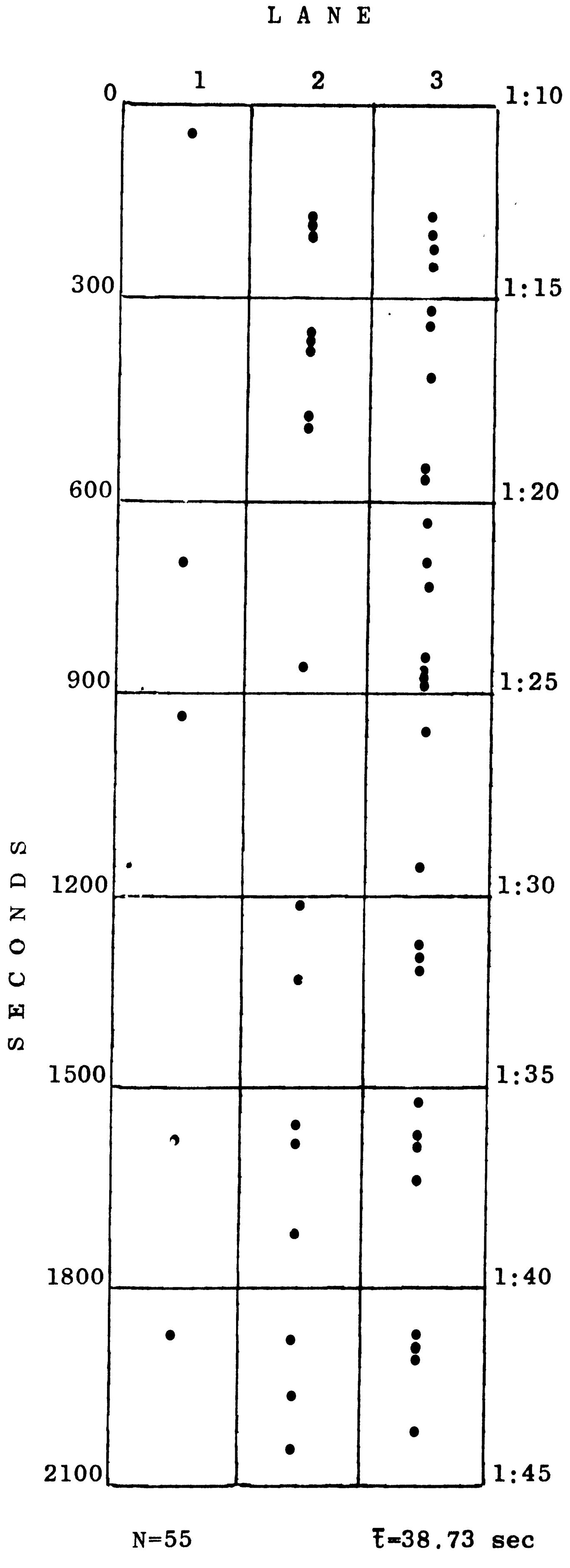

Figure 6.2-1

Distribution of traffic I-75 Southbound at Baldwin Road overpass Genessee County, MI 01:10-01:45:30 E.S.T. July 31, 1971. Each dot represents one vehicle passage. Lanes are numbered left to right facing South.

One suggestion provided to local news media and highway officials was that a quick appraisal of the occurrence of wrong-way entries at the suspect interchange be obtained simply by asking the public (through local newspapers as an example) to report such incidents to them, or to the highway department. Also, that a more precise understanding could be obtained by setting up traffic counters, cameras, or other surveillance devices to detect and count wrong-way entries. If these events do occur frequently at the intersection, such solutions as supplemental signs, geometric changes in the road, or lighting at the intersection should be considered.

One aspect of the suspect interchange which was found as a possible detriment, is its location astride the Genesee-Oakland County boundary and the consequent division of maintenance responsibility. This may have resulted in less than normal attention to potential highway safety problems at the location.

An important finding revealed by this accident case study was the "non-uniqueness" of head-on collisions on interstate highways. To the causal observer, head-on collisions resulting from wrong-way travel on interstate highways might seem comparatively rare. Yet, they happen (on the average) about once per hundred miles of interstate highway per year nationwise. There have been at least 50 such accidents in Michigan in the past five years; there were 28 in Texas in a single year (1969). Generally, they involve just two vehicles, but sometimes more. On the average, about 1.4 people die in each accident, which comparatively makes them relatively lethal. This particular accident was both spectacular and tragic because of the number of young persons who lost their lives. However, it is even more tragic that nationwide there will be about 400 wrong-way accidents on interstate highways during this year.

A California study* made during 1965-66 tabulated the frequency of wrong-way entrances on freeways by the type of interchange

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* "Wrong-Way Driving Reduced" by Thomas N. Tamburri, California Division of Highways (presented at the 48th Annual Meeting of Highway Research Board, January 1969).

involved. It was found that the most difficult interchange to control was the cone with left side ramps -- similar to the suspect interchange in this accident. The next most difficult was the half cloverleaf similar to interchanges farther south on I-75. Least susceptible to wrong-way entry is the full cloverleaf.

A recent Highway Safety Research Institute roadside survey in Washtenaw County, Michigan where breathalyzer readings were obtained to determine the blood alcohol content of randomly selected drivers brought out some interesting findings. Of those drivers on roads where traffic is light-to-medium between 1:00 a.m. and 3:00 a.m. (comparable to the Dixie Highway interchange in Grand Blanc Township), almost one-third had been drinking to some extent, and about 1 in 12 registered higher than 0.10 mg%. There is little question that a blood alcohol level of 0.10 mg% impairs the judgmental processes of all drivers. This suggests that an intersection configuration (and signing) which may be adequate for persons in full command of their faculties may need some extra treatment to handle those who are not as a result of alcohol.

In summary, the significant finding in this accident case study relative to highway design was the need for continuing surveillance of the operational results of each category of highway geometrics to determine whether, on occasion, the motoring public performs in a way not intended by designers. It was also recommended that highway designers and traffic engineers take the non-alert or impaired driver into consideration, and his potential for doing harm to others in designing highways, since the impaired driver apparently will not be completely eliminated from the highway system.

Upon completion of the investigation of the Grand Blanc collision, a meeting was held at the Highway Safety Research Institute on August 12, 1971. Interested parties to the Grand

Blanc accident were invited so as to discuss case findings prior to making them public. This meeting included:

James O'Day - University of Michigan - HSRI
Harry R. Keller - FHWA, Lansing, Michigan
George Gibson - FHWA, Lansing, Michigan
Donald N. Cortright - University of Michigan,
  Professor of Civil Engineering
Bruce Howard - University of Michigan - HSRI
Jimmie Wright - University of Michigan - HSRI
Ralph Darby - University of Michigan - HSRI
Max R. Hoffman - Michigan Dept. of State Highways
Harold Simmons - Michigan Dept. of State Highways
Peter Cooley - University of Michigan - HSRI
Captain John Amthor - Michigan State Police
Noel C. Bufe - Michigan State Police, Office of
  Highway Safety Planning
Daniel J. Minahan - University of Michigan - HSRI
Chief Chris Chapman - Grand Blanc Township Police Department

Case findings were presented by Mr. O'Day followed by discussion of recommendations for improvement to the I-75/Dixie Highway interchange. The conclusions appeared to be accepted by all attendees.* A date and place was set for a press conference to release these findings to the news media -- August 24, 1971 at the Grand Blanc Township Police Department headquarters in Grand Blanc, Michigan.

The press conference was held as scheduled with approximately 25-30 news media people in attendance. These included representatives from radio, newspapers and television. The conference was conducted by Chief Chapman of the Grand Blanc Township Police Department and included Dan Watt and George Gibson of the FHWA, Lansing and Max Hoffman, Michigan Department of State Highways and Peter Cooley of

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* An attachment is included in this case study report, AA-100 (SPL) which summarizes the I-75/Dixie Highway interchange findings and recommendations.

The University of Michigan Highway Safety Research Institute. The conference mechanism was to distribute copies of a letter of investigative findings with photographs from the Highway Safety Research Institute to Chief Chapman. This approach met the needs of the news media and left but few questions; those primarily centered about improvements, or changes, to the I-75/Dixie Highway interchange. Questions of that sort were answered by the FHWA regarding additional signs which would be installed at the suspect interchange.

The Dixie Highway interchange is not unique in design. It has many counterparts, both in Michigan and nationwide, and undoubtedly was designed and built with considerable thought both for the motorist and for the taxpayer. The fact that both of the drivers involved in this accident had their driving abilities impaired by high blood alcohol levels most certainly could have precipitated the wrong-way driving and caused subsequent failure of either driver to react to the impending collision. Establishing the presence of alcohol in both drivers also probably tended to deflate any pending public outcry.

The possibility of a similar accident occurring again at this interchange mathematically is very remote. If such a rarity were to reoccur, however, especially without alcohol involvement, public reaction probably would be traumatic.

6.3 Suicide by Vehicle Crash

One Level III accident study completed during the past year had suicide as its most probable cause.* Suicide was the significant causation factor based on an extensive study of the driver's background, and in particular, the acute emotional stresses to which he was subjected at the time of the fatal crash. Alcohol was also an important factor (BAC=.19%) and most likely contributed to the irrational logic, coupled with acute emotional stress, which led the driver to suicide as the best choice out of his dilemna. This case was particularly interesting inasmuch as the driver was also a clergyman of significant church rank.

Suicide was first suspected when tests conducted with a test vehicle, indicated it was most improbable for the victim's car to drift off the roadway and into the tree, which the victim's vehicle struck, without being deliberately guided into the tree. The investigation into the habits, problems, life style and personality traits of the driver during the human data collection phase of the case study, established overwhelmingly that the most probable cause was suicide.

This case was similar to another "single vehicle, run off the road and strike a fixed object" accident** which occurred shortly later. Here a rural youth who was having trouble with his fiancé, also nourished with alcohol, left the roadway striking a tree and sustaining fatal injuries. Again, a study of the vehicle path and tracks indicated the cause of the accident was again most probably suicide.

It is generally agreed, that in all matters of death, suicide

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* Case Study AA-138, "Single Vehicle/Fixed Object", December 21, 1971.

** Accident was not pursued as a Level III multidisciplinary in-depth investigation due to the age of the vehicle, but was investigated in conjunction with police because of its obscure cause at the time.

both medically and legally, is the most difficult to prove. Perhaps the most significant data in the area of vehicular suicide has been provided by John F. Edland, a forensic pathologist. Of 112 traffic deaths studied * 63 (or 56%) resulted from single vehicle accidents. Of the 112, eighteen were determined to be vehicular homicide (one a homicide with intent) leaving "93 cases for scrutiny as potential suicidal deaths". Dr. Edland's findings were based on police reports, autopsy results and psychiatric autopsies of the victims. Of this group, 3 were certified as unequivocal suicides, 3 probable and 2 equivocal suicides so that the deaths were ruled undetermined.

Alcohol was, as expected, a significant factor in this study. Mann** has emphasized that suicides of drunk or mentally ill individuals may be quite bizarre, which was also true of the suicide crashes investigated by HSRI.

While the two crashes investigated by HSRI by themselves do not serve to measure the full scope of the suicidal driver problem, the study by Dr. Edland does pose some disturbing statistics. Also our involvement in the vehicle suicides mentioned above, has provided our Level III team with the necessary additional insight so necessary in discerning when an accident is a potential vehicle suicide.

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* International Association for Accident and Traffic Medicine Proceedings, May 29-June 4, 1969, published by the University Of Michigan, Highway Safety Research Institute.

** Mann, G. and Karnitschuig, H.H., Differential Diagnosis of Accident, Homicide, and Suicide. Principles of Legal Medicine, 337-339, 1960, Richmond, Virginia.

6.4 Fires

Fires were involved in a significant portion of accident case studies during this past year. Four of the 86 accident studies completed during the past year resulted in fires which were substantial in terms of damage and injury. In two of the cases, death actually resulted from fire, while in a third, also a fatal accident, fire gutted the vehicle after the driver, and only occupant, was ejected and fatally injured. A fourth fire resulted in the complete destruction of a motor home, but without injury to its occupants.

Of particular interest was the one fatal fire, an electrical fire, resulting from loss of control of a 1970 Ford Maverick which struck a tree. Here, deformed sheet metal caused an electrical short circuit followed by fire. The dazed, or unconscious driver, was asphyxiated with death attributed to carbon monoxide poisoning. The driver was partially incinerated with carbonization over 30% of the body.

Our primary interest centered about the resulting fatality from what would normally have been a minor-to-moderate injury accident had a fire not occurred. A lengthy series of tests was conducted which resulted in inducing a similar fire in an identical vehicle, as well as simulating the fire characteristics in yet another test car.* This was the only accident involving an electrical fire accident covered by the Level III investigation team. A search of data files did not show any grouping, particular vehicle or accident type which could be considered suspect. In fact, the purely electrical fire seems to be a rare event in terms of reported accidents.

Since each newer model vehicle brought to the public by the manufacturer tends to require a more complex electrical system, with its potential for electrical shorts nominally increased, it is

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* Case Study AA-155, "Single Vehicle/Loss of Control/Tree Impact/Electrical Fire", March 1972.

recommended that more attention be given to this mode of vehicle failure, and its great potential for injury. Fusing and circuit protection should take into consideration crash mechanisms which damage electrical circuits, such as shorting conductors within a wiring harness to each other, which then fail to be protected by fuses or circuit breakers. Electrical circuit design and distribution should also take into consideration actual separation of conductors which when shorted can produce overheating and fire as well as physical protection of such circuits within the locations on vehicles most susceptible to crash damage. Motor Vehicle Safety Standard (MVPS) #302, Flammability of Interior Materials (effective September 1, 1972) is an attempt to limit the effects of a fire, once ignited. More effective fusing, and fail-safe circuit protection which might tend to overt the origins of a fire is certainly an area worthy of greater attention than is evident at present. Certainly limits on "burn rate", as defined in MVPS Standard #302, may have little effect on an electrical fire in the passenger compartment of a tightly enclosed vehicle (as is customarily the case in wintertime) which tends to be "oxygen starved" and conducive to generating fatal concentrations of carbon monoxide.

The case of the motorhome fire* was one in which the vehicle driver attempted to prime the engine carburetor with gasoline to facilitate starting. When the engine backfired through the carburetor, it ignited gasoline deposited about the carburetor. The resultant fire totally destroyed the motor home.

Since recreation vehicles are being added to our highway vehicle population at an expanding rate, this accident was of particular interest. The intent of MVPS Standard #302 (Flammability of Interior Materials) is to reduce occupant death and injury as a result of vehicle fires, particularly those fires not ignited by, or fed by gasoline. In conventional passenger vehicles, fuel

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* Case Study AA-184, "Winnebago Motor Home Fire", May 1972.

tank and fuel lines are kept outside the passenger compartment by metal barriers. In most motor homes, however, this separation is not as well defined. In the Winnebago design, separation of the passenger and engine compartments is by a fiberglass cover. In addition, there is a wooden floorboard and other wooden structure adjacent to the engine compartment. Again, a search of data files indicates that reported fires in this type of vehicle are relatively rare. Perhaps the more recent arrival of motor homes on the scene and their limited numbers is a consideration. Nevertheless, the fire barrier between passenger and engine compartments inherent in this type of vehicle design, appears minimal and ineffective. In regard to Standard #302, it is recommended that recreation vehicles of the motor home variety be reviewed independently to establish whether more stringent flammability or fire protection regulations are required.

A comment regarding clean air standards is also in order, regarding the mechanism of the fire in this motor home vehicle. Manufacturers have chosen one method for reducing exhaust emmission which involves detuning the ignition system.* One effect of this is to increase the likelihood for the engine to backfire through the carbuetor, creating the potential for fire. In the motor home fire**, it appears that there was some gasoline deposited on the air cleaner which ignited as a result of priming the gasoline by the driver. Perhaps this engine tuning method, with it's greater chance for backfire has created an additional fire hazard.

The remaining two accidents both involved fatal injuries and crash deformation to each vehicle which ruptured the fuel tank. Both accidents were spectacular in nature, and of the variety well documented in the literature. That is, the fire whose effects may have been even more devastating than the initial crash, but was nevertheless a result of the crash, and reported as a characteristic of the overall accident. Where a fire is not as a direct result of a crash, or a crash of insufficient severity to warrant a police traffic accident report, it is customary to consider the event as a non-accident.

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* Consumer's Report Magazine, April 1972.

** Case Study AA-184.

In the motor home fire mentioned, the official report was termed a "truck fire" and was filed on a conventional police complaint form. It is suspected that the apparent few accident fire cases in the mass data files does not truly represent the scope and significance of the vehicle fire hazard. Based on our analysis of data available, coupled with this past year's field accident experience, we believe that vehicle fires may be of a more significant magnitude in the vehicle population and a much greater safety hazard than is currently evident. The comments relative to more complex wiring systems in vehicles and the effects of the clean air standards on engine tuning above lead us to believe that vehicle fires may be increasing at a rate greater than is commonly accepted at present.

.5 Railroad-Car Accidents

A total of three railroad train-motor vehicle (or simpel R-V) collisions were investigated with Level III case studies completed this past year.

Fatalities occurred in two of these collisions,* with the passenger car driver seriously injured in the third case.** A high fatality rate is typical of this type of accident.

A second unifying experience in the three accidents is the disregard for traffic control divices displayed by the drivers. These control devices ranged from a positive drop gate device (AA-133) to a warning bell/flashing light system (AA-132) as well as a simple crossbuck sign (AA-164). An unusual feature in these accidents is that the drivers displayed a disregard for the traffic control devices in proportion to device sophistication - i.e., with the crossbuck signing the driver apparently did not adequately see or realize the significance of the signing; whereas with the most positive control, the driver departed from his traffic lane to actively ignore the warning!

These interesting factors, coupled with the fact that one accident site (AA-132) was the site of two other fatal accidents within a year of the case study, prompted a further examination of the basic features of railroad-vehicle (R-V) fatal accidents within Michigan. The source for the bulk of these data used and cited for this study was the Michigan Fatal Accident File, as maintained by the Highway Safety Research Institute in cooperation of the Michigan State Police.

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* Case Studies AA-133 and AA-164.

** Case Study AA-132.

Detailed Accident Characteristics

In the calendar period 1964-1970, there were 13,458 fatal automobile accidents in Michigan; of these, 366 were R-V accidents, accounting for 2.7% of the total fatal accidents in that period.* The highest number of fatal R-V accidents in a one-year period was 64 (in 1968); the low was 36 in 1964, the earliest year recorded in the HSRI data bank. This class of accidents is not a major one in the overall accident picture, but is not an insignificant contributor, either.

Table 6.5-1 compares the occurrence frequency for a number of factors in R-V fatal accidents to the corresponding figure for the total fatal accident population in Michigan. Aside from the expected predominance of single-car involvements in railroad accidents, several significant differential factors are displayed in this table.

While over one-half of the overall fatal accidents occurred during the nighttime period, slightly less than a third of the R-V accidents took place during nighttime. The occurrence of these accidents as a function of the time of day is shown in Figure 6.5-1. The peak accident period is the 4-6 p.m. period, when people are returning home. Thus, in general, R-V accidents appear to be more of a daytime phenomena. Fatal accidents during the nighttime are commonly associated with drinking. For example, among the 13,458 overall fatal accidents, 5504 occurred between the hours of 9 p.m. and 7 a.m., and over 40% of these were coded by the police as "had been drinking or using drugs." Since R-V accidents are predominantly a daytime phenomena, it would be expected that drinking would play a less important role than in all fatal accidents.

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* Of course, more than one death may result from one fatal collision; in 1970, among overall fatal collisions, there were 1.17 deaths per collision (e.g., 117 deaths in 100 fatal collisions). Among R-V fatal collisions, there were 1.22 deaths per collision (e.g., 122 deaths in 100 fatal R-V collisions). The source of these data is Michigan Traffic Accident Facts, 1970, Michigan Department of State Police, Lansing, Michigan.

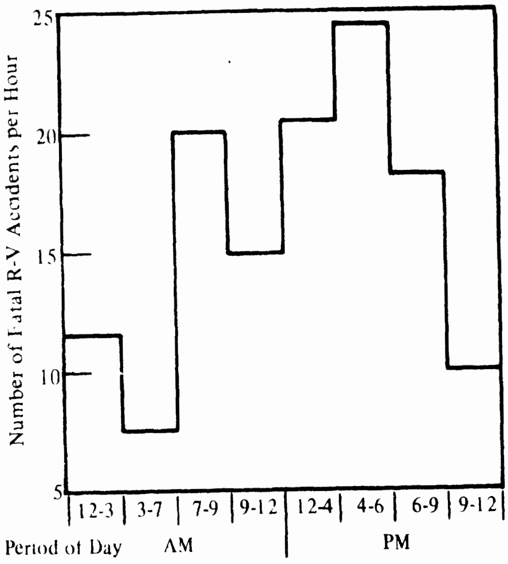

Figure 6.5-1. Fatal R-V accidents in Michigan by period of day (based on 366 accidents, January 1964-December 1970). Note that the time periods shown vary in duration from 2 to 4 hours, and that "number of accidents per hour" is the rate for each time period, not the total number of accidents that occurred in the period.

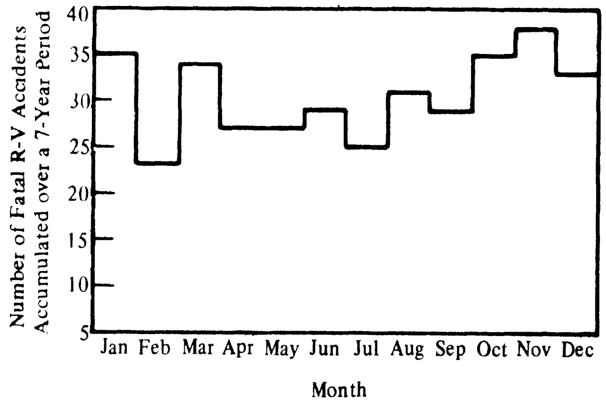

Figure 6.5-2. Fatal R-V accidents in Michigan by month of occurrence (based on 366 accidents, January 1964-December 1970).

The "Drinking or Drug Use" percentages presented in Table 6.5-1 confirm this is indeed the case; drinking is indicated in only 12.6% of the R-V accidents as compared to 26.6% for all fatals.

Other differences of lesser significance occur in driver sex and in road condition. Railroad accidents involve a somewhat higher percentage of females than found in the overall fatal accident picture. It is not known whether this actually represents some greater tendency for women to be involved in this type of accident, or simply reflects the fact that R-V accidents occur more often during the daytime, when women are more likely to drive. The HSRI Driver Record file does indicate that in Washtenaw County, Michigan, 46.1% of registered drivers are female and 53.9% male. On a registration basis alone, then, women are underinvolved in both types of accidents.

With respect to road condition, snow or ice conditions occur twice as often (12.0% vs. 6.8%) among R-V fatal accidents as they do among the overall fatal accidents. Correspondingly, as indicated in Figure 6.5-2, the five months which sustain the highest rate of railroad accidents are all late autumn, winter, or early spring months (i.e., October, November, December, January, and March), suggesting that traction may play a role in these accidents. Of course, 66% of the accidents still occur on dry roads, and February, a mid-winter month, has the lowest rate for the year. The February record is in fact much lower than would be indicated by the shortness of the month.

One of the most interesting facts that may be observed from Table 6.5-1 is the failure of the driver to observe traffic control signals (see "Violations"). In the overall population of all fatal accidents, "Failure to Observe a Traffic Control Device" was

TABLE 6.5-1

Characteristics of Fatal Accidents in Michigan, 1964-1970*

	Rail-Vehicle Fatals**	All Fatals**
Number of Cars Involved		
One	98.6%	56.9%
Two	1.4	38.0
Three or More	0.0	5.1
Time of Day		
Daytime	63.9%	44.0%
Dawn or Dusk	4.4	4.0
Nighttime	31.7	52.0
Road Condition		
Dry	66.1%	72.6%
Wet	21.3	20.6
Snow or Ice	12.0	6.8
Driver Residence		
In County	73.8%	69.5%
In State	21.3	24.8
Bordering State	3.0	3.5
Driver Sex		
Male	77.3%	83.3%
Female	22.7	16.7
Drinking or Drug Use		
Had	12.6%	26.6%
Had Not	39.3	50.1
Violations		
None	3.0%	20.3%
Speed too Fast	13.1	40.8
Failure to Yield	15.6	11.1
Left of Center	0.0	8.7
Improper Passing	0.0	3.2
Failed to Observe Traffic Control	52.5	8.2

---

* Police-reported values.

** Percentages are based on the total number of accidents in each category (i.e., 13,458 total fatal accidents, 366 fatal R-V accidents). "Other" categories (e.g., missing data, "unknown," etc.) account for the fact that percentages do not total 100%.

noted for only 8.2% of the cases. However, the violation was noted for 52.5% of the R-V fatal accident cases.

If these statistics could be accepted at face value, the conclusion would be clear: drivers ignore railroad warning signals. Unfortunately, however, it is felt that reporting biases may render this conclusion less forceful for the purpose of determining causative factors. For instance, the very fact that a driver has passed a set of warning devices and been struck by a train suggests that he disregarded the warnings. Consequently (and possibly after the fact), the violation may be coded simply as failure to observe a traffic control device when the original, or real violation might have been "speed too fast for conditions" (ice, limited sight distance, etc.), or some other more pertinent causative violation that subsequently prevented the driver from heeding or responding to the warnings.

In spite of such biases, however, the lack of respect that drivers have for railroad warning devices is probably a significant factor. In the case mentioned at the beginning of this discussion for instance, the driver ignored flashing lights and warning bells and failed to even stop before proceeding into the intersection. In another fatal railroad crossing accident that occurred on the same day in Ann Arbor, Michigan, a driver was killed after he deliberately drove off the pavement and onto the shoulder of the road in order to circumvent a drop-gate warning system that offered positive control of the intersection (nominally positive, at any rate). Everyone is familiar with the experience of encountering an operating warning device that is interrupting traffic for a stopped or nonexistent train. Such experiences erode the public's respect and confidence in the importance of the railroad crossing indicator as a valid warning of oncoming danger; instead, the indicator assumes a "Yield-Right-Of-Way" status. Education programs in conjunction with an improved technology for railroad crossing devices are needed to re-establish the authority of this device.

Occurrence Patterns

An investigation was made using spectral analysis techniques* to determine the occurrence of any characteristic temporal repetition patterns in R-V fatal accidents. Figure 6.5-3 plots the occurrence of these accidents by month for the seven-year period from 1964 to 1970. A study of these accidents both by the month and by the week showed little structure, and indicate that the process is essentially random.

Geographical Distribution

The geographical distribution of railroad-vehicle accidents in Michigan is best depicted by the HSRI computer plotting program output shown in Figure 6.5-4. Counties printed with "@" characters indicate those jurisdictions that have had between 20 and 40 fatal R-V accidents. All of these counties are located in the populous southeast portion of the State. Note that no county north of the Saginaw Bay-Thumb area has accumulated over four fatal accidents in the seven-year period.

The ranking of seven heavily populated counties by several factors pertinent to this study is presented in Table 6.1-2. In this table, the seven most heavily populated of Michigan's 83 counties (according to preliminary 1970 census data) are listed in order of their population rank (Rank A in Table 6.5-2). This ranking corresponds closely to the counties having the most registered vehicles in 1970 (Rank B in Table 6.5-2). Rank C, which orders the counties by number of R-V accidents, corresponds closely to the population ranking (with the exception of Genesee County, which is somewhat overrepresented).

Rankings D and E are based on the number of R-V accidents per 100,000 residents and per 100,000 registrations, respectively.

---

* J.A. Green, "The Spectral Analysis of Fatal Accident Timeseries," HIT-LAB Reports, September, 1971.

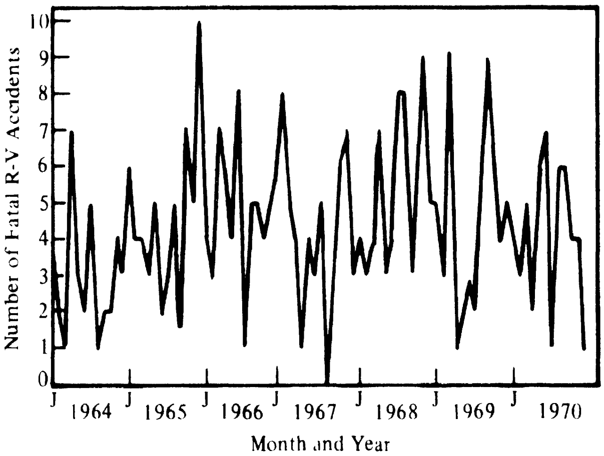

Figure 6.5-3. Fatal R-V accidents in Michigan each month, January 1964 through December 1970 (J=January).

```
SYMAP
TIME =     0.0
RAILROAD-VEHICLE FATAL ACCIDENTS IN MICHIGAN

FOR THE YEARS 1964-1970
```

Figure 6.5-4. Statewide Plot of R-V Accidents.

```
*

DATA VALUE EXTREMES ARE          0.0        40.00
ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
      ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)
  MINIMUM       0.0       0.00       2.45       4.96       9.96      19.97
  MAXIMUM       0.00      2.45       4.96       9.96      19.97      40.00
PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
                0.00      6.13       6.26      12.52      25.03      50.06
FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL         1          2          3          4          5          6
          ==============================================================
           --------- ::::::::: +++++++++ XXXXXXXXX ######### @@@@@@@@@
           --------- ::::::::: +++++++++ XXXXXXXXX ######### @@@@@@@@@
  SYMBOLS  ----1---- ::::2:::: ++++3++++ XXXX4XXXX ####5#### @@@@6@@@@
           --------- ::::::::: +++++++++ XXXXXXXXX ######### @@@@@@@@@
           --------- ::::::::: +++++++++ XXXXXXXXX ######### @@@@@@@@@
          ==============================================================
  FREQ.         21         25         15         10          8          4
          1   I--1--I    I::2::I    I++3++I    IXX4XXI    I##5##I    I@@6@@I
          2   I--1--I    I::2::I    I++3++I    IXX4XXI    I##5##I    I@@6@@I
          3   I--1--I    I::2::I    I++3++I    IXX4XXI    I##5##I    I@@6@@I
          4   I--1--I    I::2::I    I++3++I    IXX4XXI    I##5##I    I@@6@@I
          5   I--1--I    I::2::I    I++3++I    IXX4XXI    I##5##I
          6   I--1--I    I::2::I    I++3++I    IXX4XXI    I##5##I
          7   I--1--I    I::2::I    I++3++I    IXX4XXI    I##5##I
          8   I--1--I    I::2::I    I++3++I    IXX4XXI    I##5##I
          9   I--1--I    I::2::I    I++3++I    IXX4XXI
         10   I--1--I    I::2::I    I++3++I    IXX4XXI
         11   I--1--I    I::2::I    I++3++I
         12   I--1--I    I::2::I    I++3++I
         13   I--1--I    I::2::I    I++3++I
         14   I--1--I    I::2::I    I++3++I
         15   I--1--I    I::2::I    I++3++I
         16   I--1--I    I::2::I
         17   I--1--I    I::2::I
         18   I--1--I    I::2::I
         19   I--1--I    I::2::I
         20   I--1--I    I::2::I
         21   I--1--I    I::2::I
         22              I::2::I
         23              I::2::I
         24              I::2::I
         25              I::2::I
TIME =     0.0
```

Explanation of Figure 6.5-4 Plot.

These data indicate that the numbers of R-V accidents per capita or per vehicle for the heavily populated counties are actually low. When all Michigan counties are ranked according to R-V accidents per capita or per vehicle, those ranking the highest have actually had only a few R-V accidents in the past seven years. Such data have poor statistical reliability. If we limit our consideration to those 20 counties that have had at least seven R-V accidents in the past seven years (i.e., an average of at least one per year), the resultant ranking by R-V accidents per capita and per vehicle is that shown in Table 6.5-3. It is evident from Tables 6.5-2 and 6.5-3 that R-V accidents are not closely related to population or vehicle registrations. A better measure of the exposure factor would be obtained if the number of rail miles or number of grade crossings for each county were available.

TABLE 6.5-2

Statewide Ranking of Seven Most Heavily Populated Michigan Counties by Various Criteria.*

	Rank**				
County	A	B	C	D	E
Wayne	1	1	1	62	62
Oakland	2	2	3	59	59
Macomb	3	3	4	55	52
Genesee	4	4	2	44	42
Kent	5	5	5	50	49
Ingham	6	7	12	57	58
Washtenaw	7	6	10	51	47

* There are 83 counties in the State of Michigan.

** Ranking Code:

A-Rank by population.
B-Rank by registered vehicles.
C-Rank by total railroad-vehicle accidents.
D-Rank by R-V accidents per 100,000 population.
E-Rank by R-V accidents per 100,000 vehicle registrations.

TABLE 6.5-2

Statewide Ranking of Counties With One or More
R-V Accidents per Year by Various Criteria

	Rank*		
County	A	B	C
Alpena	44	42	1
Benzie	72	70	2
Antrim	63	64	3
Calhoun	13	12	4
Clare	58	55	5

* Ranking Code:

A-Rank by population.
B-Rank by registered vehicles.
C-Rank by R-V accidents per 100,000 population or per 100,000 vehicle registrations.

In view of these findings, it seems reasonable to improve the technical aspects of the traffic control devices and to better educate drivers in the importance of their function to reduce the number of fatalities arising from this type of accident. The material accrued in the study of Michigan Railroad-Vehicle Accidents, also served as the basis for an article in the HSRI publication HIT-LAB, issue of April 1972.

In conclusion, the investigators described here tend to verify the significant factors noted in the three Level III case studies previously identified. These are: (1) The critical impact of the collisions on human life; and (2) The low regard drivers have for traffic control devices.

6.6 Truck Accidents

A total of 13 Level III multidisciplinary investigations of accidents this past year involved trucks. Of these, 9 were tractor semi-trailer articulated vehicles, one a cab-over-engine stake truck, two conventional chassis van trucks and one a conventional chassis stake truck. In comparison with the total Level III case load for the year, truck accidents involved a relatively higher injury severity than for the average of non-truck accidents.

Most severe of all injuries were those involved in head-on collisions with trucks. However, only one of the three truck drivers involved in these accidents was injured, and the injuries sustained were minor. It may be belaboring the obvious to point out that since trucks are generally larger, heavier and structurally much stronger than passenger cars, passenger car occupants are at a disadvantage in a head-on collision with a truck. This fact is well supported by statistical studies. Table 6.6-1* is a tabulation of relative severities of injuries sustained in collisions of passenger cars with trucks compared with collisions with other passenger cars. This indicated the more common involvement of truck and passenger cars to be the rear-end or same-direction sideswipe collision (as were 2 of the 13 Level III case studies). It also substantiates the most severe accident type to be that of head-on collisions between truck and passenger cars. The indices**

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* HSRI Report 001580, "Statistical Analysis of Truck Accident Involvement," by R.E. Scott and J. O'Day, December, 1971.

** Two indices given in the last two columns show the over-representation (by severity) of trucks as compared to cars in the several kinds of accidents. These are defined as follows:

$$\text{Index \#1} \quad \frac{\text{no. of trucks involved in fatal accidents} \,/\, \text{no. of trucks involved in all accidents}}{\text{no. of cars involved in fatal accidents} \,/\, \text{no. of cars involved in all accidents}}$$

$$\text{Index \#2} \quad \frac{\text{no. of fatalities in truck fatal accidents} \,/\, \text{no. of trucks involved in all accidents}}{\text{no. of fatalities in car accidents} \,/\, \text{no. of cars involved in all accidents}}$$

Table 6.6-1

Involvement and Relative Severity of Truck and Car Accidents, by Type of Collision

	Passenger Cars			Trucks				
	# vehi. involved all acc.	# vehi. involved fat. acc.	# fatal-ities	# trucks involved all acc.	# trucks involved fat. acc.	# fatal-ities	Truck/car relative severity Index #1	Truck/car relative severity Index #2
Single vehicle collisions	74440 (15.4%)	926 (34.9%) ((1.24))	1068 (30.2%) ((1.43))	2820 (26.5%)	37 (19.2%) ((1.31))	39 (14.8%) ((1.38))	1.1	1.0
Right angle collisions	151120 (31.3%)	586 (22.1%) ((0.39))	740 (20.9%) ((0.49))	1960 (18.4%)	50 (25.9%) ((2.55))	76 (28.8%) ((3.88))	6.6	7.9
Same direction collisions (rear-end and sideswipe)	205980 (42.6%)	246 (9.3%) ((0.12))	315 (8.9%) ((0.15))	4700 (44.2%)	48 (24.9%) ((1.02))	63 (23.9%) ((1.34))	8.6	8.8
Opposite direction collisions (head-on and sideswipe)	51860 (10.7%)	894 (33.7%) ((1.72))	1405 (39.8%) ((2.71))	1140 (10.7%)	58 (30.0%) ((5.09))	86 (32.6%) ((7.54))	3.0	2.8
Total or Average	483400 (100%)	2652 (100%) ((0.54))	3528 (100%) ((0.73))	10620 (100%)	193 (100%) ((1.82))	264 (100%) ((2.49))	3.3	3.4

in Table 6.6-1 can also be interpreted as the relative probability of being killed in a car-truck collision as compared with a car-car collision of each indicated type.

While the relative severity of these accidents is interesting, it nevertheless is a measure of the effect of the crash. What perhaps would be of greater interest is something more in the area of determining crash causation. Causation factors, both primary and secondary are included in each case study. However, these tend to dissect the single, individual case study by itself, and do not consider the broader group of all the cases in the truck category.

What the 13 truck accidents do appear to have most in common, is that they point up problems with handling and control of trucks and tractor-trailors that are causal factors in the accidents. That is of course, with exception,* but in general, each accident may have been averted, or reduced in severity, had the handling of the truck been more responsive to the crash conditions as they developed for each particular accident. Certainly human error, caused for example as a result of fatigue, or a lack of understanding of the handling and control limits of the vehicle, also played a major role in the cause of the accidents. All five rollover accidents** did however, involve a situation in which the handling limits of the truck were exceeded. This, to a degree could also be attributed to the remaining case studies. While there have been various efforts in the past to model, or simulate passenger car dynamic response and handling, little has been accomplished to understand and "quantize" similar parameters in the world of trucks. The dynamic response of trucks in maneuvers in the regime of limit performance is less understood than for passenger cars. There are varied reasons for this, not the least perhaps is the fact that trucks to a large degree are much more custom built than passenger cars. Trucks are

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* Case Study AA-139 involved a passenger car which crossed a divided highway median out of control and collided with a truck without notice.

** Case Studies AA-120, AA-141, AA-157, AA-186, and AA-190.

TRUCK ROLLOVER FROM EXCESS SPEED IN EXITING INTERSTATE-94 IN CLOVERLEAF INTERCHANGE.

commercial vehicles, in which owners and operators must incorporate those features which tend to optimize operating economies. Many manufacturers have established themselves as specialists in producing a particular component, such as engines, transmissions, axles, steering gears and chassis units. Thus, the manufacturer in most instances is more of an assembler. Customizing may be extended further by the truck owner or operator, through modifications or component "add-ons" within his own facilities. An additional axle and wheels may often for example be added by the owner.* Many times these changes are necessary to correct a deficiency in operation or to improve performance, based on the operator's experience (and equipment preferences) over the years. The results of these variations in truck equipment is to create a broad variety of truck types and characteristics. This is further accentuated by the variety of different trailer types coupled to truck tractors, with further distinctly different handling characteristics depending on the variations of loading on each trailer. Directional instabilities of both integral and articulated trucks vary widely when subjected to severe braking maneuvers resulting in high decelerations. Studies** have brought out some of the complications peculiar to these relatively heavier vehicles in terms of handling. Some of these are:

1. Coulomb friction may be a sizable force in the vehicle rear suspension, which can lead to a "frozen" rear suspension and have a significant effect on ride and handling characteristics.

2. Time delays and lags in response of air brake systems can substantially degrade vehicle braking performance.

---

* In case study AA-174, the International Harvester Fleetstar 2110A tractor when manufactured had one rear axle, but at the time of the case accident had two rear axles. The post-manufacture modification was a "TAG" axle behind the drive axle to permit a higher load rating.

** Such as HSRI study, "The Bus, Truck and Tractor-Trailer Braking System Performance Study" under DOT contract, currently in progress.

3. Interaxle load transfer between axles of a tandem assembly may cause the wheels on one axle to lock prematurely causing difficulties in braking and handling maneuvers.* (Trucks equipped with tandem axles comprise a large segment of the truck population, with their unique characteristics.)

In the majority of Level III truck accident cases, again particularly those which were rollover accidents as mentioned above, turning capability and roll stability were a significant portion of case vehicle factors. This stems primarily from low values of the ratio; half-track width/c.g. height. Samples of these ratios for trucks (and buses) derived in a recent HSRI study** are presented in Figure 6.6-1. These static geometric measurements establish the potential of these vehicles to rollover on a reasonably high coefficient of friction surface, simply by execution of a step steer type maneuver. The truck type involved in the 13 Level III accident case studies covered this year, all fit within the characteristics of the truck types treated in the HSRI study.

A large number of factors influence roll-over potential. Some of these have recently been examined in a German paper by H. Isermann.*** For the case of torsionally rigid tractor and small articulation angles, findings in this work establish the range of expected roll-over limits for straight trucks.

In Iserman's work, four separate tanker truck rigs were subjected to static roll-over measurement on a tilt table with various loadings. All four vehicles were found to be capable of roll-over, when empty, at lateral accelerations between .62g and .82g, while the loaded vehicles could be rolled over with accelerations between

---

* The front tandem axle tends to be unloaded during braking in a "four leaf" suspension; the rear in a "walking beam" suspension.

** Under contract FH-11-7290, Federal Highway Administration.

*** H. Isermann, "Overtaking Limits of Articulated Vehicles with Solid and Liquid Loads", Deutsche Kraftfahrtforschung, No. 200, 1970. (MIRA Translation No. 58/70).

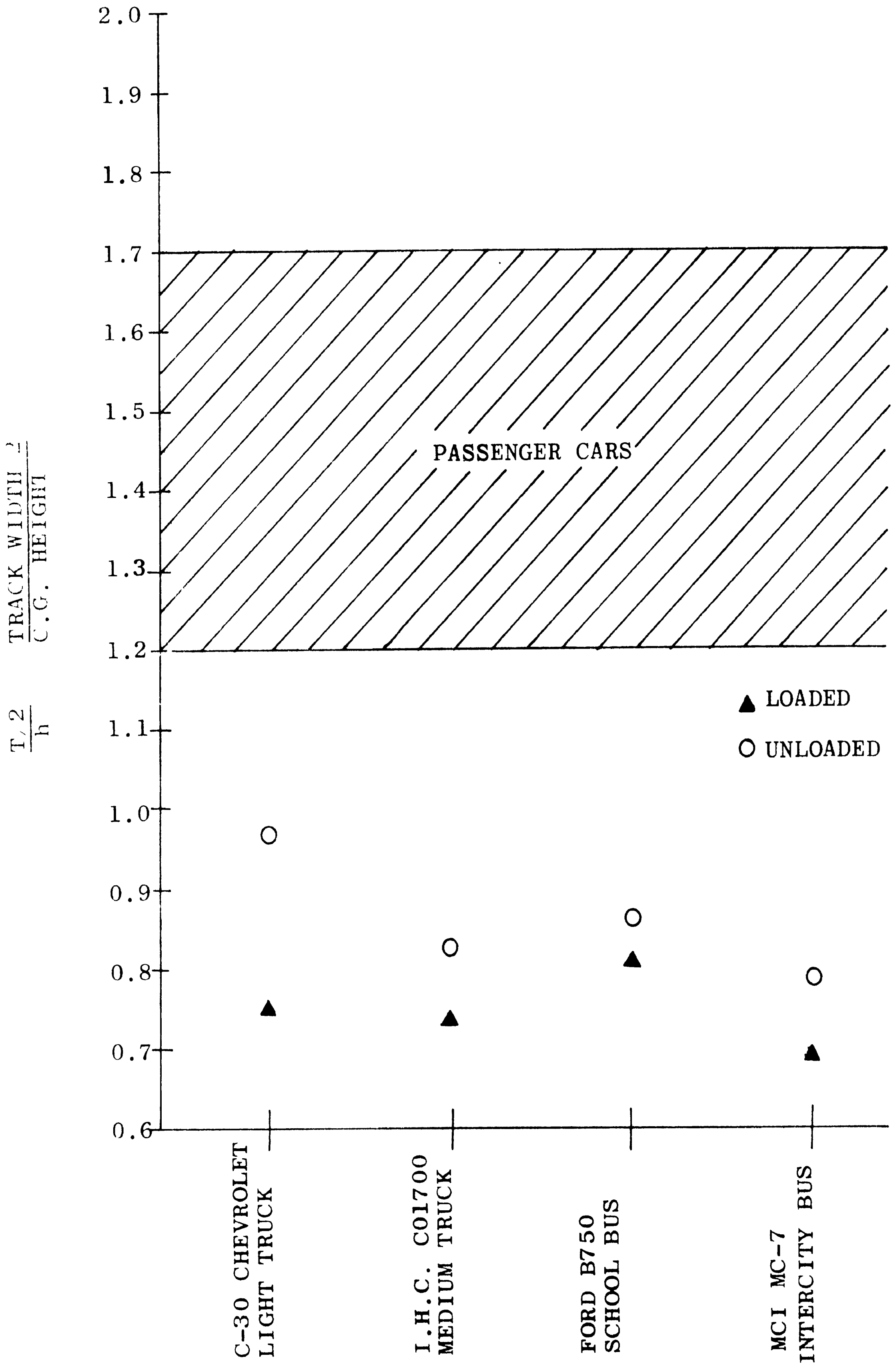
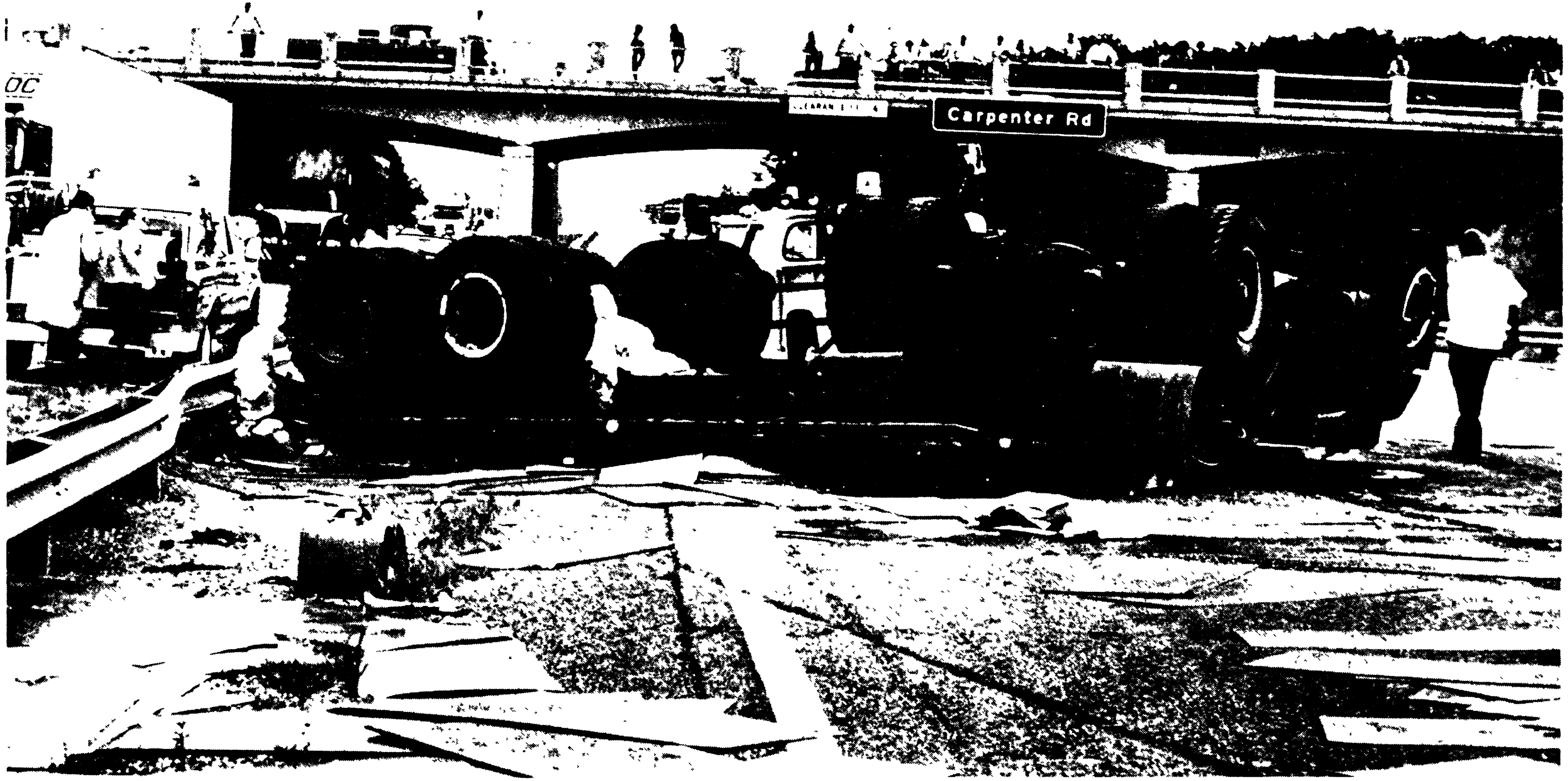


FIGURE 6.6-1 RATIOS OF HALF-TRACK WIDTH TO C.G. HEIGHTS



Steel hauler truck tractor semi-trailer roll-over on Interstate 94.

.33g and .36g. These surprisingly low accelerations were found even in the absence of dynamic factors such as liquid load sloshing and sprung mass roll transients.

The implications of these findings are of profound importance toward understanding limit performance measures for trucks. From this work, it appears that the predominant limit response constraining the range of realizable lateral maneuvers on a dry surface may be rollover. Likewise, the examination of braking or roadholding in a curved path may inadvertently be compromised by trespassing the roll stability boundary in the presence of a slightly excessive sideslipping response. Accident case studies acquired during the forthcoming year's program involving trucks will be examined with more of an effort toward better understanding the dynamics of the truck leading up to the crash, as well as attempting to better quantize those handling and stability characteristics which may have contributed to the crash.

One accident* of the 13 total Level III cases this past year involving a truck occurred when the driver crashed through a warning sign at a construction site. As a result of this accident, the incidence of construction site accidents in Washtenaw County, Michigan was investigated by examining some characteristics of those cases in the Washtenaw County Accident Data File (Level I) that occurred in the years 1968 to 1970.

A total of forty-three construction site accidents took place which averaged slightly over 14 accidents per year. During the same time span, a total of 21,261 Washtenaw County Accidents were recorded, so that the construction site accidents accounted for but 0.2% of the total.

In contrast to the case study which involved a truck, the subset of forty-three accidents examined involved passenger cars exclusively. Of the 66 vehicles involved in these accidents whose characteristics are known, 83% were full-sized passenger cars and 15% compact models. Similarly, the single vehicle configuration

---

* Case Study AA-114

is not the predominant accident configuration in the subset of cases on file. In 42% of the cases, a single vehicle was involved in the accident, while 49% involved two vehicles, with the remaining 9% involving three or more vehicles. It is noteworthy that two of the accidents involved 8 or more vehicles and, consequently, can represent rather large scale events.

The predominant features of the roadway in the single construction site truck accident, match those of the mass data. Thus, 63% of the accidents occurred during the daytime, and 49% when the roadway was dry. Wet roads did account for 40% of the events, but the ratio of daylight to nighttime accidents is nearly 2 to 1. (Unfortunately, little information on the type of roadway was available). Most of the accidents were coded as missing data for the "type of roadway" variable, but 14% were shown to have taken place on limited access highways. Considering the types of traffic control devices used, 47% of the cases showed no traffic control device present, while 16% showed some kind of control device. Only in one case was there found to be a control device present, but not functioning.

In regards to injury, the recorded accidents produced no fatalities but 44% were injury-producing; the remaining accidents involving only property damage.

Ninety-seven percent of the drivers in the subset also had not been drinking before the accident.

Because the case driver told the investigating officer he was sleeping or dozing when our single Level III truck accident took place, it would have been useful to interrogate the Washtenaw County data file to determine the involvement of truck drivers in accidents when the contributing circumstance was defined and coded as "sleepy or asleep", and when there was no resulting enforcement action. Unfortunately, the Washtenaw County data file does not contain such "driver impairment" information, so that recourse to another data bank was necessary. The Texas Accident Data Truck File (N=20, 641 cases) was accessed and a bivariate frequency was obtained using the variables "driver impairment" and "driver violation".

The combination "sleepy or asleep" and "no enforcement action" was selected to investigate the supposition that a driver falling asleep at the wheel is a more acceptable action (to his employer and to the police) than taking stimulating drugs in order to stay awake.

Of those 232 drivers (all types of vehicles) who were "fatigued or asleep", 157 were not charged with any violation. Seventy-five drivers who were "fatigued or asleep" were charged with violations.

The total number of trucks was 13,125. Of that number, 192 were coded "fatigued or asleep". Only 48 of those drivers were charged with a violation, leaving 144 which were not charged with a violation. Of the remaining 40 vehicles which were coded as vehicles other than trucks, 27 drivers were charged with violations, 13 were not charged.

Frequency Table

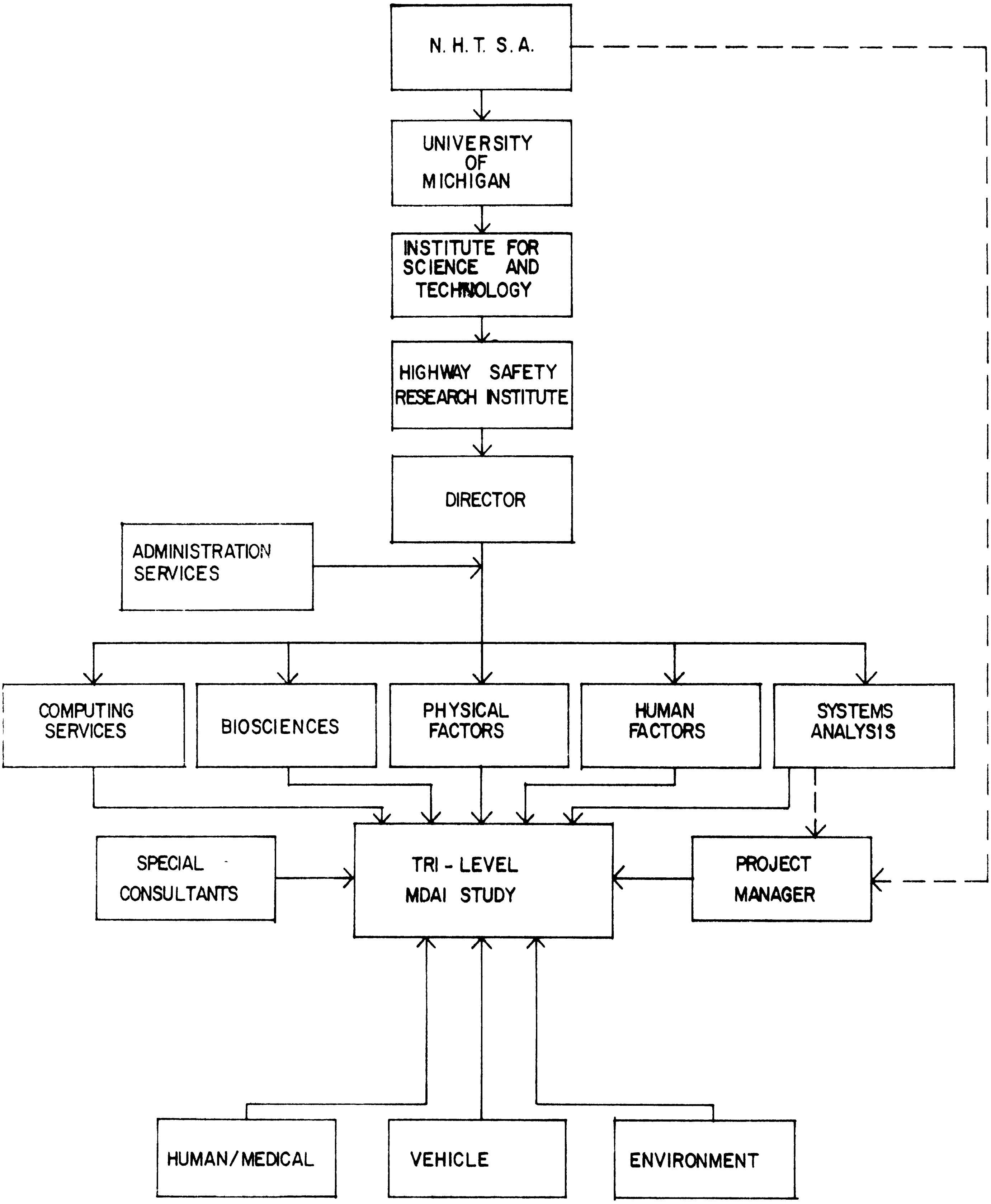
	Charged	Not Charged	Total
Trucks	48 (25%)	144 (75%)	192
Other	27 (67.5%)	13 (32.5%)	40
Total	75	157	232

The analysis indicates that the sleeping truck driver is involved in accidents more frequently than the sleeping "other vehicle" driver, but charged much less often. This suggests that perhaps fatigue may be an acceptable occupational characteristic among truck drivers, and less acceptable when found in non-truckers, as a bias among traffic officers.

7.0 APPENDICES

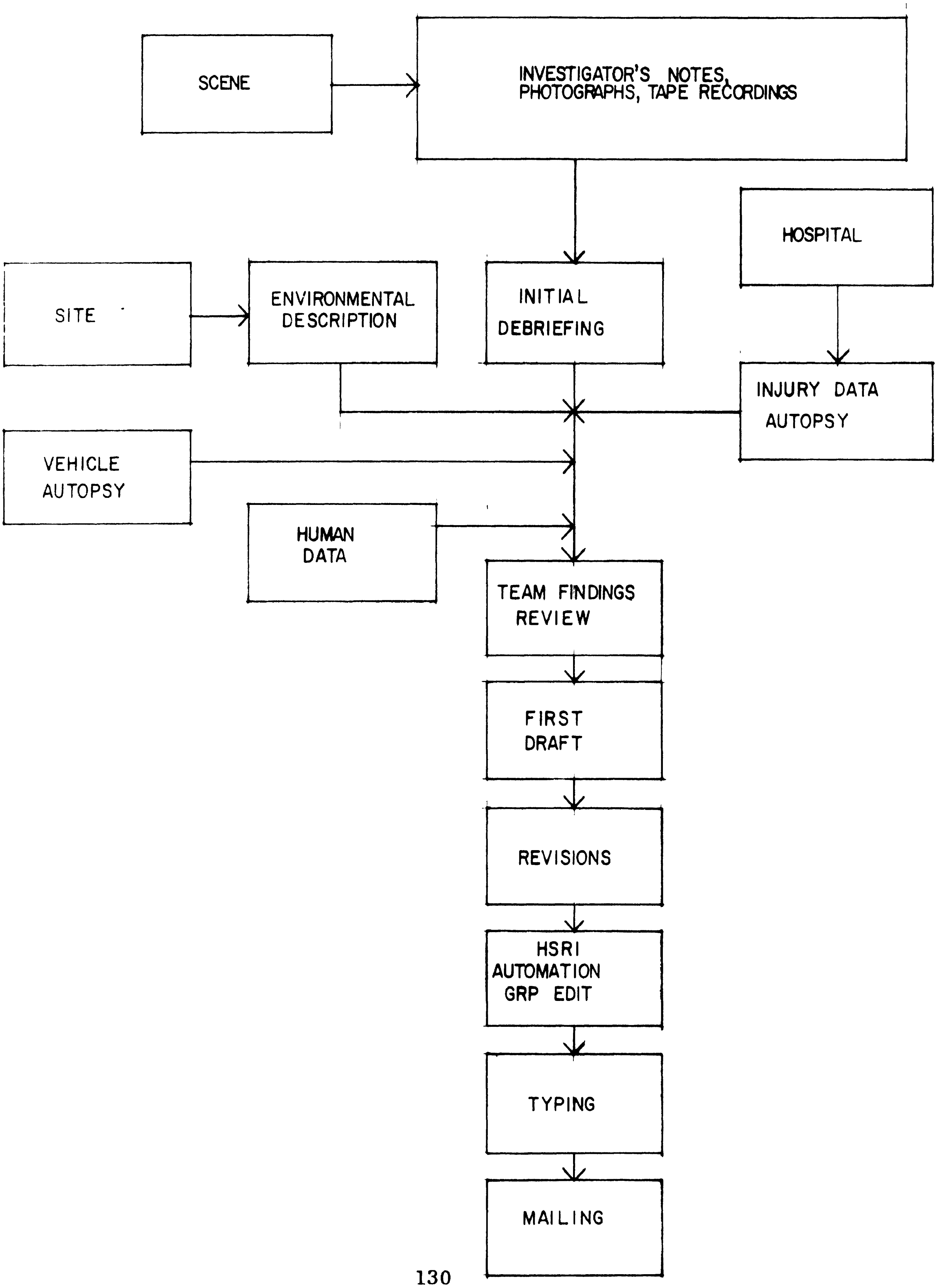
APPENDIX A

ORGANIZATION



APPENDIX B

REPORT CONSTRUCTION



APPENDIX C

LIST OF EQUIPMENT

1972 Dodge Maxiwagons (specially equipped for Field Accident Investigations.)

Hi/Lo Monitoradio Scanners

Motorola Two-Way Vehicle Radios

Panasonic Cartridge Recorder RS-80305

Sony Microphones F-95

Sony Nichel Cadnium Battery Packs BP-9

Sony Tape Recorders TC110

Honeywell Strobonar - Auto 770 Electronic Flashes

Honeywell Pentax Camera (with 35mm lens.)

Trumeter Measuring Wheels

Lufkin 100 foot cloth tapes

Lufkin 20 foot, 3/4 in. wide, measuring tapes

Unico No. 400 Gas Detecter Kits

Craftsman Automatic Protractor Model 9-3994

Craftsman Adjustible Mirrors

Dill Master Truck Tire Gauges

Bridgeport Model 400 Tire Gauges

Lumberman Crayons #496

Emergency 30 Minute Flares

Lufkin Surveyors Steel Arrows

David White Hand Level #5500

APPENDIX D

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LOCKS, DOOR	206
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<<<STANDARD 201>>>

ADJUSTABLE FORWARD SEATS
ARMRESTS
CONSOLE ASSEMBLIES
INSTRUMENT PANELS
INTERIOR COMPARTMENT DOORS
INTERIOR COMPARTMENT DOORS WITH LOCKING DEVICE
SEAT BACK FRAMES
SEAT BACKS
SEATS WITH HEAD RESTRAINTS
SEATS WITHOUT HEAD RESTRAINTS
SUN VISORS
WINDSHIELDS

<<<STANDARD 202>>>

BENCH-TYPE SEATS
HEAD RESTRAINTS
INDIVIDUAL SEATS
TYPE I SEAT BELT

<<<STANDARD 203>>>

FORWARD CONTROL CONFIGURATION
HORN ACTUATING MECHANISMS
PASSENGER CARS
STEERING CONTROL SYSTEMS
STEERING MECHANISMS
TYPE II SEAT BELT ASSEMBLY

<<<STANDARD 204>>>

FORWARD CONTROL CONFIGURATION
PASSENGER CARS
REARWARD DISPLACEMENT OF STEERING CONTL.
STEERING COLUMN
STEERING GEAR
STEERING SHAFT
STEERING WHEEL
TYPE II SEAT BELT ASSEMBLY

<<<STANDARD 205>>>

BUSES
GLAZING MATERIALS
INTERIOR PARTITIONS
MOTORCYCLES
MULTIPURPOSE PASSENGER VEHICLES
PASSENGER CARS
SCHOOL BUSES
TRUCKS
VEHICLE WINDOWS
WINDSHIELDS

<<<STANDARD 206>>>

CARGO-TYPE DOOR
COMPONENTS ON FOLDING DOORS
COMPONENTS ON ROLL-UP DOORS
DOOR HINGE SYSTEMS
DOOR HINGES
DOOR LATCHES
DOOR LOCKS
FRONT DOOR LOCKS
HINGED CARGO-TYPE DOORS
HINGED DOORS
MULTIPURPOSE PASSENGER VEHICLES
OUTSIDE LATCH RELEASE CONTROL
PASSENGER CARS
SIDE DOOR RETENTION COMPONENTS
SIDE DOORS
STRIKER ASSEMBLY
TRUCKS

<<<STANDARD 207>>>

ADJ SEAT BACK FOR COMFORT OF OCCUPANTS
BUSES
CONTROL FOR RELEASING RESTRAINING DEVICE
DRIVER SEAT
FOLDING SEAT
FOLDING SEAT BACK
HINGED OCCUPANT SEAT
MULTIPURPOSE PASSENGER VEHICLES
NON-LOCKING SUSP TYPE OCCUPANT SEATS
OCCUPANT SEAT
PASSENGER CARS
PASSENGER SEAT ON BUS
REARWARD FACING SEAT
RESTRAINING DEV FOR FORWARD-FACING SEAT
RESTRAINING DEV FOR REARWARD FACING SEAT
RESTRAINING DEVICE
SEAT ATTACHMENT ASSEMBLIES
SEAT BACKS
SEAT BELT ASSEMBLY
SEAT BENCH
SEATS
SELF-LOCKING DEVICE
SIDE FACING SEAT ON BUS
TRUCKS
UPPER CROSS-MEMBER OF SEAT BACK

<<<STANDARD 208>>>

ADJUSTABLE SEAT BACKS
ADJUSTABLE SEATS
ADJUSTABLE STEERING CONTROLS
BUSES
CONVERTIBLES
INTERSECT OF UPPER TORSO BELT W/LAP BELT
LAP BELT PROTECTION SYS W/BELT WARNING
LATCH MECHANISM
MOTOR HOMES
MOVABLE VEHICLE VENTS & WINDOWS
MULTIPURPOSE PASSENGER VEHICLES
OPEN-BODY TYPE VEHICLES
PASSENGER CARS
PASSIVE RESTRAINT SYSTEM
SEAT BELT ASSEMBLY
SEAT BELT INSTALLATIONS
SEAT BELT INTERLOCK
SEATBELT WARNING SYSTEM
TRUCKS
TYPE I SEAT BELT
TYPE II SEAT BELT ASSEMBLY
UPPER TORSO PORTION OF A SEAT BELT ASSY
VEHICLES CARRYING CHASSIS-MOUNT CAMPERS
WALK-IN VAN TYPE TRUCKS

<<<STANDARD 209>>>

ADJUSTING DEVICE
ADJUSTMENT FORCE
ADJUSTMENT HARDWARE
ATTACHMENT HARDWARE
AUTOMATIC LOCKING RETRACTOR
BREAKING STRENGTH
BUCKLE LATCH
BUCKLE RELEASE
BUCKLES
BUSES
COLORFASTNESS TO CRACKING
COLORFASTNESS TO STAINING
CORROSION RESISTANCE
ELONGATION
EMERGENCY-LOCKING RETRACTOR
INSTALLATION INSTRUCTIONS
MARKING
MULTIPURPOSE PASSENGER VEHICLES
NON-LOCKING RETRACTOR
PASSENGER CARS
PELVIC RESTRAINT
PERFORMANCE OF RETRACTOR
RELEASE MECHANISM
RESISTANCE TO ABRASION
RESISTANCE TO BUCKLE ABRASION
RESISTANCE TO LIGHT
RESISTANCE TO MICRO-ORGANISMS
RETRACTOR
SEAT BACK RETAINER
SEAT BACK RETAINER
SEAT BELT ASSEMBLY
STRAP
TEMPERATURE RESISTANCE
TILT-LOCK ADJUSTMENT
TRUCKS
TYPE I SEAT BELT
TYPE II SEAT BELT ASSEMBLY
TYPE 2A SHOULDER BELT
TYPE 3 SEAT BELT ASSEMBLY
UPPER TORSO RESTRAINT
WEBBING
WIDTH

<<<STANDARD 210>>>

BUSES
MULTIPURPOSE PASSENGER VEHICLES
PASSENGER CARS
SEAT BELT ANCHORAGE
SEAT FRAME
TRUCKS
TYPE I SEAT BELT
TYPE II SEAT BELT ANCHORAGE
TYPE II SEAT BELT ASSEMBLY

<<<STANDARD 211>>>

HUB CAPS
MULTIPURPOSE PASSENGER VEHICLES
PASSENGER CARS
WHEEL DISCS
WHEEL NUTS

<<<STANDARD 212>>>

WINDSHIELD MOUNTINGS

<<<STANDARD 213>>>

ADJUSTMENT
ATTACHMENT
BUCKLES
BUSES
CHILD SEATING SYSTEMS
CORROSION RESISTANCE
FORWARD-FACING SYSTEMS
HEAD RESTRAINTS
IMPACT PROTECTION
INSTALLATION INSTRUCTIONS
METALLIC PARTS
MULTIPURPOSE PASSENGER VEHICLES
PASSENGER CARS
REARWARD-FACING SYSTEMS
RELEASE MECHANISM
RETRACTORS
SEAT BACKS
TRUCKS
WEBBING

<<<STANDARD 214>>>

INITIAL CRUSH RESISTANCE
PASSENGER CARS
PEAK CRUSH RESISTANCE
SIDE DOOR STRENGTH

<<<STANDARD 215>>>

BRAKES
COOLING SYSTEMS
EXHAUST SYSTEM
EXTERIOR PROTECTION
FUEL SYSTEMS
LATCHING SYSTEMS
PASSENGER CARS
REFLECTIVE DEVICE OR HEADLAMP
TIRES

<<<STANDARD 301>>>

FUEL TANK CONNECTIONS
FUEL TANK FILLER PIPES
FUEL TANKS

APPENDIX E

DESCRIPTION OF ANALYSIS PROGRAMS AND DATA FILES

INTRODUCTION

The Highway Safety Research Institute at The University of Michigan maintains an extensive collection of accident records that document important features of traffic collisions in many areas of the country. Due to the sheer volume of our accident records to date, it is necessary to utilize computerized storage and analysis of the data. The Statistical Research System was developed to provide the necessary analysis capability and is a descendent of the OSIRIS System originated at The University of Michigan. Some familiarity with the language of modern digital computer systems and the data analysis packages that may be used in conjunction with these systems is, of course, necessary for successful operation. If the necessary familiarity is overly complex, then the people who are most likely to benefit from the data will never achieve the proficiency required. In order to make the data as accessible as possible to those who can benefit from it, HSRI has developed the SPAD (SPeedy Access to Data) System to provide a simplified method of using the accident files in conjunction with the Statistical Research System. It is hoped that this feature will foster an increased usage of the accident data files to answer questions that arise in the course of highway safety related activities and to explore new problems that had not previously been uncovered.

HSRI obtains accident data from a variety of sources: the two most prominent are the police agencies and the various Multidisciplinary Accident Investigation Teams. In this data, each accident is characterized by a number of factors that describe the driver, vehicle, and environmental conditions recorded by the investigator. The volume of recorded accidents and the large number of factors for each accident make manual data handling procedures impossible. The accident data is consequently transcribed onto magnetic tape in a form that is usable on a digital computer.

If the stored information is to be of any value, it is necessary to have some technique for accessing the magnetic tapes and deriving from them the information that is desired by the data analyst. This function is performed for the user by the Statistical Research System (SRS)--a group of computer programs prepared for and maintained by HSRI for data manipulation and analysis. By proper use of SRS, the experienced user can create new data files, modify or update existing ones, and perform a number of analysis operations on existing files that range in complexity from listing a subset of the data for detailed scrutiny to complex statistical operations such as multivariate analysis of variance. The SRS in conjunction with the accident files comprises a powerful system for the collection and analysis of data.

The final component in the analysis hierarchy shown in Figure 1 is the computer and its executive supervisor that controls the operation of all functions resident on the machine. All HSRI accident files as well as the SRS are maintained on The University of Michigan's IBM 360/67 Computer under supervision of the Michigan Terminal System (MTS). MTS was developed for operation in a time-sharing mode, so that access to the computer could be gained from a variety of remote terminals for conversational usage of the computer in a real-time environment. By issuing the proper commands to MTS it is possible to sign on the system as a registered user and to perform all the operations necessary to access the desired data file, carry out the analysis required, and arrange for printout or storage of the results obtained.

While computerized storage and analysis is the only practical method of handling large data bases, it does introduce several difficulties for the user,

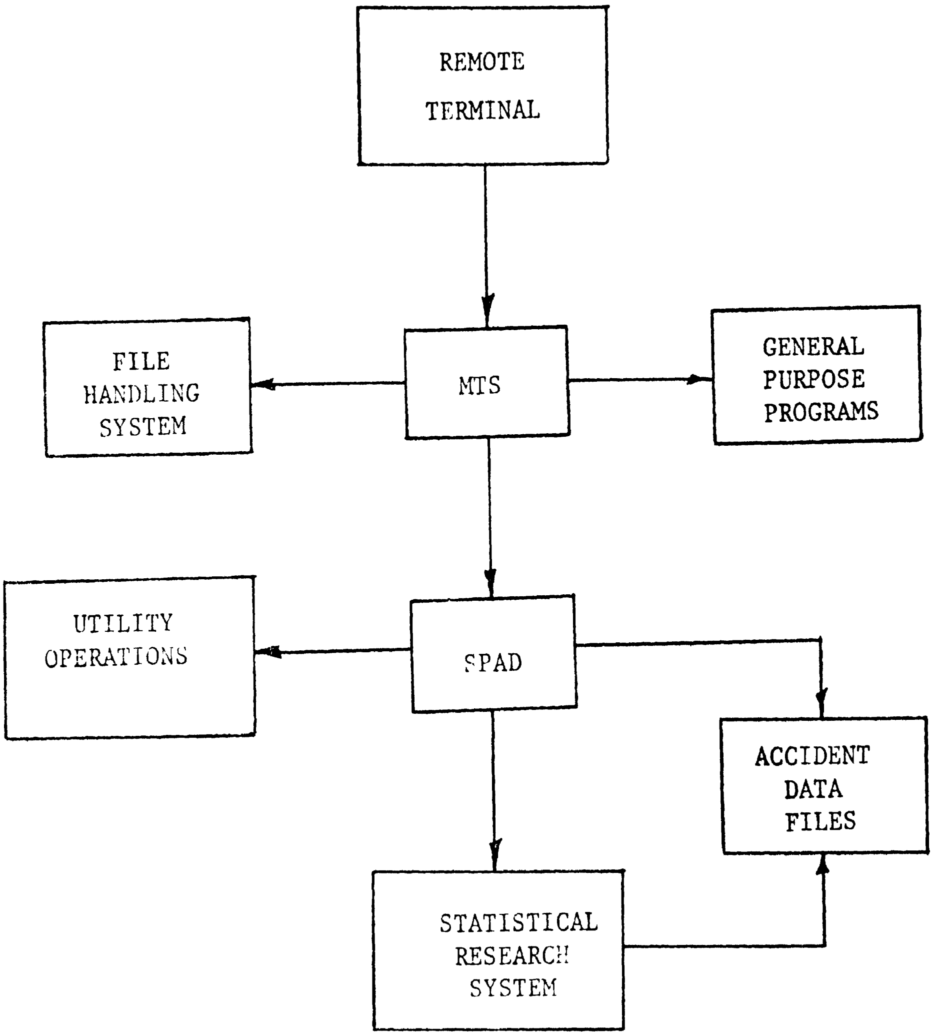


Figure 1 The Data Analysis Hierarchy

who, in most situations, is not experienced in computer operations. Thus, the minute attention to detail required to operate computers tends to repel many potential users who are unaccustomed to this detail in human relationships. Computers are designed for detailed tasks, however, and there is no reason that they should not be given the task of doing the operations that are difficult for the novice. The goal of the HSRI SPAD System is therefore clear: use of the computer itself to perform most of the detailed operations necessary to carry out an analysis task using the HSRI accident files. In implementing this goal, however, it is difficult to allow for all the possible manipulations that can be performed with MTS and SRS. Consequently, SPAD is designed to handle the routine operations normally encountered; the user is still encouraged to use the full capabilities of SRS to carry out more sophisticated analysis operations. In summary, SPAD is simply a technique to reduce the complexity of operations necessary to use SRS on MTS.

Before discussing the operational use of SPAD, a presentation of the background information on MTS, SRS, and the HSRI files necessary to successful use of the technique will be presented.

THE MICHIGAN TERMINAL SYSTEM (MTS)

The University of Michigan computer system can service a large number of remote users concurrently, offering each a wide variety of services. The task of keeping track of all the programs in the machine and of devoting some attention to each of them on a regular basis is handled by the MTS operating system. In order to request service from the computer, a potential user must first identify himself as a registered account holder and then communicate his requests via the MTS Command Language.

Two operational modes within MTS are possible: conversational or batch. In the conversational mode, a remote terminal is used to communicate directly with MTS through a typewriter-like keyboard in conjunction with a telephone. Each command is processed as it is received and the results are reported back to the user as they are generated. Since each command may be based on previously obtained results, the conversational mode of operation is highly interactive.

Batch mode, on the other hand, is non-interactive. All requests must be completely preplanned and submitted to a remote batch terminal at the same time. Some time later--minutes or hours, depending on program length and computer processing load--the results may be picked up at the batch terminal.

The command language and its usage is essentially the same for both batch and conversational modes. The primary difference is that MTS replies after most commands in the conversational mode confirming the action that it has just taken, notifying the user of certain errors in the command, or requesting additional information that was not supplied. This feature is very useful when errors are made in the instructions given to the system. For example, if certain words are misspelled and MTS is unable to interpret the command, an error message will be issued. In some cases the error can be identified and the user will then be prompted for new information. In addition, if MTS is asked to empty or destroy files (that may contain important information) a confirmation request is issued before the operation is carried out, thereby allowing the user to change his mind.

For use with SPAD, especially for the novice user, conversational mode offers the most useful set of alternatives. Consequently, the discussion and presentation of examples will be limited to conversational usage. Due to the interactive nature of the conversational mode, our examples will consist of data entered by the user and data outputted by the computer. In order to distinguish the two, user supplied input lines will be underlined while machine supplied output will not. In practice, this underlining should not be used.

THE STATISTICAL RESEARCH SYSTEM (SRS)

The Statistical Research System (SRS) is a package of data handling and processing programs to permit the analysis of large quantities of information in a timely fashion. SRS is resident on the University of Michigan IBM 360/67 computer and may be operated in either batch or conversational mode under MTS.

The system is a group of application programs and a subroutine library. Each program is accessed by a unique reference number. The SRS was designed to process magnetic tape or direct access files and consequently permits the analysis of large data sets. Control operations necessary to handle the magnetic tape (tape rewinding, positioning, etc.) are performed by the programs and are transparent to the user.

Three features of the SRS that are pertinent to the SPAD user are scussed in this section:

1) SRS program descriptions

2) File Structure

3) Filtering and Recoding Variables

SRS PROGRAM DESCRIPTIONS

A complete listing of the SRS analysis programs is given in Table III. For the purposes of this manual, we will only be concerned with those programs that are followed by an asterisk. Users are encouraged to utilize the full capabilities of the system when they feel that they have the experience to do so; more information can be obtained by calling HSRI.

CATALOG OF ANALYSIS PROGRAMS IN THE STATISTICAL RESEARCH SYSTEM

1) DATA SET LISTING*
2) HISTOGRAM*
3) MEANS AND MARGINALS*
4) ONE-WAY ANALYSIS OF VARIANCE*
5) BIVARIATE FREQUENCIES WITH TWO DIGIT CODES AND FOUR FILTERS*
6) PRINT COLUMNS
7) BIVARIATE FREQUENCIES
8) BIVARIATE FREQUENCIES WITH TWO DIGIT CODES
9) MISSING DATA CORRELATIONS
10) PARTIAL CORRELATIONS
11) LINEAR REGRESSION
12) MUTLIPLE ANALYSIS OF VARIANCE
13) AUTOMATIC INTERACTION DETECTOR
14) MULTIPLE CLASSIFICATION ANALYSIS
15) FACTOR ANALYSIS

Five programs have been chosen for SPAD to satisfy most user needs. The SPAD programs are:

1) Data Set Listing

   Selects and prints a subset of the data file.

2) Histograms

   Prints a bar graph showing the univariate frequency distribution of one variable.

3) Means and Marginals

   Means: Provides case counts, sum of weights, ranges, means, standard deviations, skewness, and kurtosis.

   Marginals: Provides one-way frequency distribution (univariates) of individual variables and percentages on the distributions.

4) One-Way Analysis of Variance

   Produces one-way analysis of variance tables.

5) Bivariate Frequencies

   Produces bivariate (two-way) frequency tables for pairs of variables.

SRS FILE STRUCTURE

HSRI accident files are stored on magnetic tape. The control operations necessary to handle the tape and read the information are performed by the SRS so that the user has no need to know the detailed structure of the files. There is a file structure concept that must be understood for successful use of the accident analysis system, however.

Each entry in the file is called a "CASE." In SRS data files, a CASE may refer to a variety of events, physical objects, or actions. In the most common situation, referred to as an ACCIDENT FILE , each accident is a case entry into the file. More often than not, of course, more than one vehicle is involved in an accident. It is possible to create a VEHICLE FILE by making each vehicle involved in an accident correspond to one case; descriptive information concerning the accident scene is repeated for each vehicle in a given accident. Again, each vehicle may contain several occupants and each occupant may be considered as a case (the OCCUPANT FILE). Finally, at the highest level of division usually found, each occupant (in each vehicle in each accident) may have several injuries. Using each separate injury as a case leads to the INJURY FILE concept.

Within each case, the descriptive information is coded into possible alphabetic or numeric values of certain VARIABLES that describe the case. This structure is illustrated in Figure 2 which shows a four-case file containing five descriptive variables. Here, the accident is characterized by the age and sex of the driver, the severity of the accident, the color of the striking vehicle, and the county where the accident took place. There is usually one variable for each question on an accident report. The number of variables (or pieces of information included) is on the order of one hundred for most accident files, but can go as high as 600-700 in the MDAI files where a large amount of detailed information is available.

HSRI ACCIDENT FILES

A total of twenty-three accident data files are currently (May 1972) available to users of the SPAD system. These files are based on eight mass accident data sources, and offer a variety of accident analysis opportunities.

The following descriptions define each accident data source and the available files in terms of representative years, data origin, case count, variable count, investigation level, and unique file biases and attributes.

WASHTENAW COUNTY, MICHIGAN ACCIDENT AND DRIVER RECORD FILES:

Data obtained from the Ann Arbor City Police Department, Washtenaw County Sheriff's Office, and the Michigan State Police has been built into a Level I accident file. The file is especially useful for file interrogations of a broad area representing urban, rural, academic, and industrial populations.

The Michigan Secretary of State authorities have furnished driver record data for Washtenaw County, which have been built into a driver file. The file is valid for each driver at least through 1969.

File Statistics:

File	Years	Number of Cases	Number of Variables
Washtenaw County	1968-1971	28,969	159
Washtenaw Driver File	through 1969	17,989	48

OAKLAND COUNTY, MICHIGAN ACCIDENT FILES:

Accident information furnished by the Michigan State Police and Traffic Improvement Association of Oakland County has been built into Level I accident files for the 1968, 1969, and 1970 calendar years. The 1969 and 1970 files contain additional variables which further document occupant statistics. Each data entry represents a single accident situation, and the file allows analysis of a combined urban and rural locality.

File Statistics:

File	Years	Number of Cases	Number of Variables
Oakland Co. 1968	1968 calendar year	25,387	120
1969	1969 calendar year	29,265	179
1970	1970 calendar year	29,650	156

CPIR REVISION 2 AND 3 VEHICLE, OCCUPANT, AND INJURY FILES:

Data based on the General Motors Collision Performance and Injury Report (Long Form) Revision 2 and 3 have been built into two sets of Level III files. Accident information obtained from Revision 3 report forms have been built into vehicle, injury, and occupant files, while the Revision 2 data have been built into a vehicle and an occupant file.

Revision 3 data originate from reports submitted by Multidisciplinary Accident Investigation teams sponsored by the National Highway Traffic Safety Administration and the Automobile Manufacturer's Association. A significant sampling bias accompanies the case study investigation opportunities that the file offers. Since the data are obtained from case studies, the file is definitely biased, and does not represent a sample of cases from each submitting area.

Accident investigation funded by the Automobile Manufacturer's Association and conducted by Donald Huelke at University of Michigan and Arnold Siegel of the Trauma Research Group at UCLA is the source of the Revision 2 data. Like the Revision 3 data, the Revision 2 data are also biased in that they reflect case studies , rather than a sample of cases in one locale.

File Statistics

File	Years	Number of cases	Number of Variables
CPIR 3 Vehicle	1969 to present	2780	576
Occupant		2970	636
Injury		11,500	647
CPIR 2 Vehicle	1967-1969 (overlap with CPIR 3)	716	320
Occupant		1162	507

CORNELL LEVEL I ACCIDENT AND LEVEL II ACCIDENT, VEHICLE, AND OCCUPANT FILES:

Accident information from police reports, driver records, and vehicle registration records has been build into a Level I accident file representing the eight western counties of New York State.

Level II data from police reports have been built into accident, vehicle, and occupant files. Both Level I and Level II data were collected by Cornell Aeronautical Laboratories, funded by the Automobile Manufacturer's Association. All four files are useful for analyses of a large multi-county area.

File Statistics:

File	Years	Number of cases	Number of Variables
Level I Accident	1970 calendar year	Approx. 45,000	159
Level II Accident	October 1970 - September 1971	7032	32
Vehicle		13,605	64
Occupant		20,319	77

BEXAR COUNTY, TEXAS ACCIDENT AND VEHICLE FILES:

Data for the San Antonio and entire Bexar County, Texas area have been built into Level I accident and vehicle files for the 1969 and 1970 calendar years. The data were obtained from the Texas Department of Public Safety. Since Bexar County parallels Oakland County, Michigan in size and composition, the file offers comparative analysis opportunities.

File Statistics:

File	Years	Number of Cases	Number of Variables
Bexar Co. 1969 Accident	1969 calendar year	26,673	56
Vehicle		45,859	139
1970 Accident	1970 calendar year	27,458	56
Vehicle		47,284	139

DADE COUNTY, FLORIDA ACCIDENT FILES:

The Metropolitan Dade County Public Safety Department has furnished accident data for the metropolitan Miami and entire Dade County, Florida area. The data have been built into Level I accident files for the 1969 and 1970 calendar years. While each accident case is not documented to the extent of the Washtenaw County or Oakland County, Michigan files, the Dade county file is useful for analyses of a metropolitan area. The user should take the file size into consideration of the analysis costs involved.

File Statistics:

File	Years	Number of Cases	Number of Variables
Dade County 1969	Jan. 1969-June 1969	31,056	83
1970	1970 calendar year	61,767	83

DENVER COUNTY, COLORADO ACCIDENT FILES:

Level I accident files for the 1969 and 1970 calendar years have been built from data obtained from the State of Colorado Department of Revenue. The data represent the Denver city and entire Denver County, Colorado area. The file offers analysis capabilities for a metropolitan area, and contains extensive variable documentation for each accident case entry.

File Statistics:

File	Years	Number of cases	Number of variables
Denver County 1969	1969 calendar year	25,581	234
1970	1970 calendar year	29,432	217

SEATTLE, WASHINGTON ACCIDENT FILE:

The state of Washington has furnished 1969 calendar year data that have been built into a Level I accident file. The file represents the greater Seattle area, and is especially useful for vehicle model size and type analysis, because of the extent of make/model category variables.

File Statistics:

File	Years	Number of cases	Number of Variables
Seattle 1969	1969 calendar year	26,000	194

APPENDIX F

WASHTENAW ACCIDENT LOCATION ANALYSIS: WALA

The following is a description of WALA, a program which allows MDAI investigators to locate and digitally plot either single or groups of accidents, vehicles, occupants or injuries by geographical location in the county on a calcomp plotted map. A team member can use the full facilities of the SR system in selecting a subset of cases and then route them to WALA for plotting. An example of a WALA test plot is included as an example.

A procedure has been developed to assist MDAI teams investigating the accident history relating to specific locations of interest in Washtenaw County. A SPAD-like system scans the latest Washtenaw tape with a data set list program to produce lists of accident locations as specified in a user supplied filter statement. The resulting list has a standard variable list and is put into file -T. -T may then be printed via *PRINT* or listed on the teletype as the user desires.

WALA Run Procedure:
1) $Source WALA(10)
2) $Source WALA(20)
3) enter user supplied SR filter statement
4) enter title of run
5) $Continue with WALA(30)

Run Procedure explanation:
1) this statement hangs the tape
2) this initiates DS List program
3) SR filter statement supplies the location specification. An intersection is specified by the intersection of two streets (and their reversals).

example: Include V14=4241 and V15-0813 and V16=000-904 and V11=70 or V14=0813 and V15=4241 and V16=000-904 and V11=70*.

The above statement specifies all accidents within 4/10 of a mile of the intersection of M52 and I-94. The variable names and numbers are the same as the latest Washtenaw dictionary. I have a list of street codes.

4) Appropriate title
5) This file contains the necessary run parameters and a standard variable list. It is intended to minimize the amount of information the user must supply

Upon completion of these 5 steps the specified DS List resides in -T. Since it is a temporary file, it disappears upon signoff. If the information is to be saved it should be transferred to a permanent file such as TBBL. The list may be:

1) listed on the teletype (ok for small lists)
2) sent to computer center via *PRINT*
3) printed out on the HSRI batch printer by specifying $SOURCE HSRI:PRINT. Users choosing option (3) should read Barbara Brown's memo of November 3, 1971 (please note that the file information <u>must</u> reside in TBBL) and notify Brad Jones of the fact that you have a job to be printed by this method. A yellow card must also be filled out.

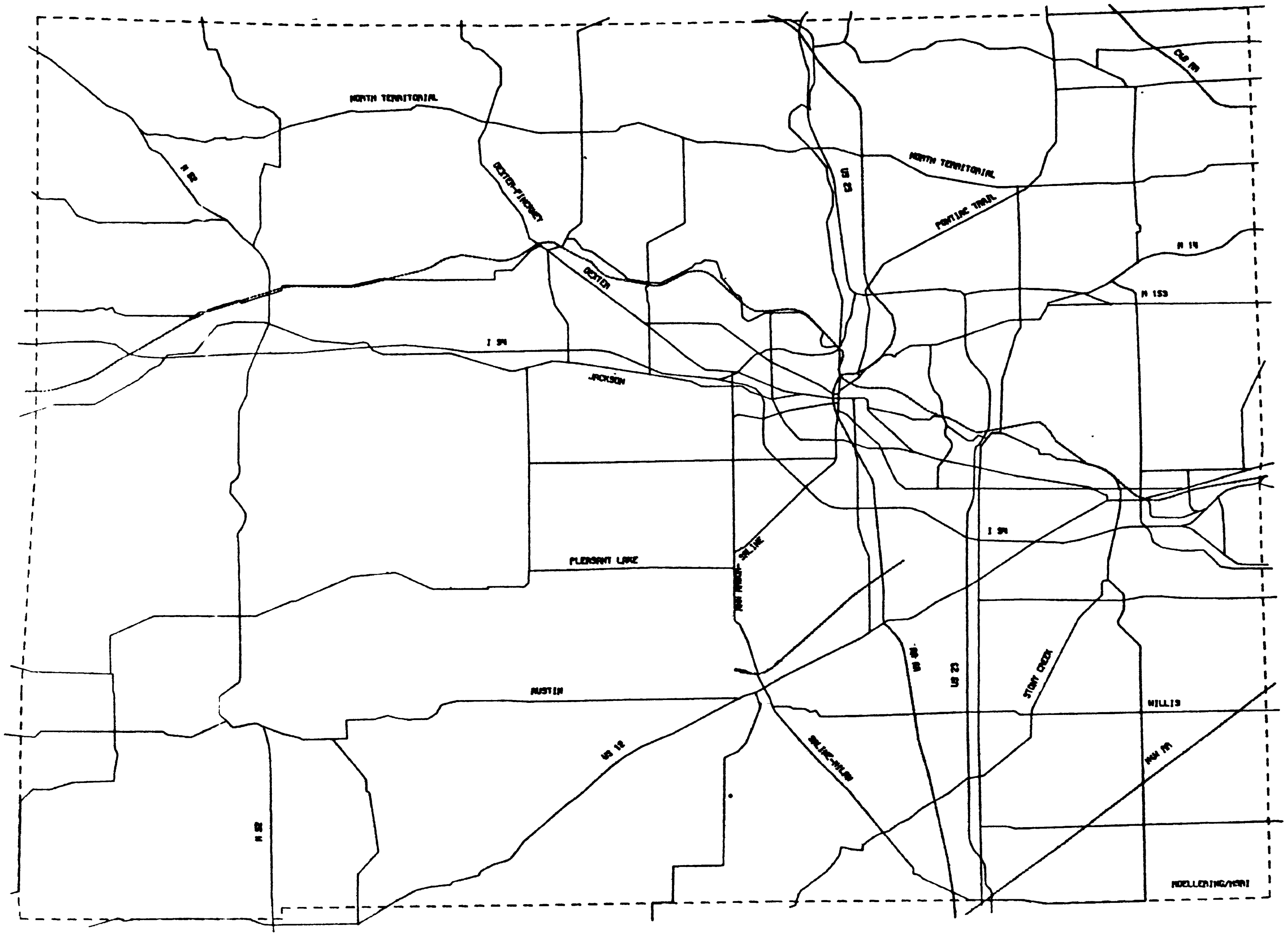
P.S. 1) Please note that variables after V147 have been displaced by a new variable.

2) The cost per run seems to be in the neighborhood of $12-15. Average time for each run is about 20 minutes.

STANDARD VARIABLE LIST

```
  LISTING OF DICTIONARY IN SAME ORDER AS RECORDS
VAR.#      VARIABLE NAME      LOC. WID DEC RESP CTYPVTYP MDCODE1 MDCODE2
   1 ACCIDENT CASE NUMBER         1  7  0    1    0    0
   3 LONGFORM CASE NUMBER         9  5  0    1    0    0  00999990099999
   9 MONTH OF ACCIDENT           32  2  0    1    0    0  00000990000013
  10 DAY OF MONTH OF ACCIDENT    34  2  0    1    0    0  00000990000032
  11 YEAR OF ACCIDENT            36  2  0    1    0    0  00000990000072
  13 HOUR OF DAY OF ACCIDENT     39  4  0    1    0    0  00099990002401
  14 STREET'OR HIGHWAY           43  4  0    1    0    0  0009999
  15 INTERSECT STREET            47  4  0    1    0    0  0009999
  16 DISTANCE FROM INTERSECTN    51  3  0    1    0    0  0000999
  17 DIRECTION FROM INTERSECT    54  1  0    1    0    0  0000009
  18 WEATHER                     55  1  0    1    0    0  00000090000006
  19 LIGHT CONDITION AT ACC.     56  1  0    1    0    0  00000090000007
  20 ROAD SURFACE CONDITION      57  1  0    1    0    0  00000090000005
  28 TOTAL NUMBER OF VEHICLES    67  1  0    1    0    0  0000009
  32 DIRECTION OF TRAVEL VEH1    71  1  0    1    0    0  0000009
  33 DIRECTION OF TRAVEL VEH2    72  1  0    1    0    0  0000009
  35 ACC. DIAGRAM INTERP.        74  2  0    1    0    0  0000099
  37 VEHICLE 1 MOVEMENT          77  2  0    1    0    0  00000990000010
  38 VEHICLE 2 MOVEMENT          79  2  0    1    0    0  00000990000010
  41 ACCIDENT SEVERITY           83  1  0    1    0    0  00000090000004
  43 DRIVER 1 DRINKING NOTED     86  1  0    1    0    0  00000090000004
  45 AGE OF DRIVER 1             88  2  0    1    0    0  0000099
  48 MODEL YEAR OF VEHICLE #1    92  2  0    1    0    0  0000099
  51 TYPE OF VEHICLE #1          98  2  0    1    0    0  00000990000010
  52 TRAILER VEHICLE #1         100  1  0    1    0    0  0000009
  55 VEH 1 REMOVAL FROM SCENE   105  1  0    1    0    0  00000090000003
  76 TOTAL PASS. VEH. #1        132  1  0    1    0    0  00000090000008
  77 PEDESTRIAN AGE POS. 1      133  2  0    1    0    0  0000099
  79 PEDESTRIAN INJURY POS. 1   136  1  0    1    0    0  00000090000006
  81 TOTAL INJ. VEH. #1         139  1  0    1    0    0  00000090000008
  82 TOTAL KILLED VEH.#1        140  1  0    1    0    0  00000090000008
  91 V.I.N. WT/HP RATIO VEH.1   156  4  0    1    0    0  0009999
  94 DRIVER 2 DRINKING NOTED    163  1  0    1    0    0  00000090000005
  96 AGE OF DRIVER 2            165  2  0    1    0    0  0000099
  99 MODEL YEAR OF VEH.#2       169  2  0    1    0    0  0000099
 102 TYPE VEH. #2               175  2  0    1    0    0  00000990000011
 103 TRAILER VEH. #2            177  1  0    1    0    0  0000009
 106 REMOVAL FROM SCENE VEH 2   182  1  0    1    0    0  00000090000004
 127 TOTAL PASS. VEH. #2        209  1  0    1    0    0  0000009
 128 PEDESTRIAN AGE POS. 2      210  2  0    1    0    0  0000099
 130 PEDESTRIAN INJURY POS.2    213  1  0    1    0    0  00000090000006
 132 TOTAL INJ. VEH.#2          216  1  0    1    0    0  0000009
 133 TOTAL KILLED VEH. #2       217  1  0    1    0    0  0000009
 142 VIN WT/HP RATIO VEH. 2     233  4  0    1    0    0  0009999
 144 SPEED VEH. 1               238  2  0    1    0    0  0000099
 145 SPEED VEH. 2               240  2  0    1    0    0  0000099
 153 WORST INJURY CAR 1         258  1  0    1    0    0  0000009
 154 WORST INJURY CAR 2         259  1  0    1    0    0  0000009

                THE LOGICAL RECORD SIZE IS  91      THE BLOCK SIZE IS     313
```



APPENDIX G COMPUTER MAP OF WASHTENAW COUNTY.

APPENDIX H. ANALYSIS OF VARIANCE TABLES FROM AID ANALYSIS.

```
** STEP NO.=  1        PARENT GROUP =  1 **      WASHTENAW INJURY AID
 TRY ON PREDICTOR 56   COLLISION-VEH. TO OBJ
   CODE      N      TOTAL WEIGHT          SUM OF Y        SUM Y-SQUARE           B S S             MEAN            STD. DEV.
     2     782   0.78200000E 03   0.60200000E 03   0.14260000E 04   0.30173492E 02   0.76982093E 00   0.11094608E 01
     1     322   0.32200000E 03   0.36500000E 03   0.12410000E 04   0.0              0.11335402E 01   0.16028481E 01
MAX. BSS=     0.30173492E 02      BSS/TSS =    0.01658   BETWEEN CODES   2
                                                 AND CODES   1
 TRY ON PREDICTOR 59   COLL.-VEH. TO VEH.
   CODE      N      TOTAL WEIGHT          SUM OF Y        SUM Y-SQUARE           B S S             MEAN            STD. DEV.
     7       2   0.20000000E 01   0.0              0.0              0.45371971E 01   0.0              0.0
     5      62   0.62000000E 02   0.32000000E 02   0.38000000E 02   0.96000595E 01   0.51612902E 00   0.58865440E 00
     6     186   0.18600000E 03   0.10200000E 03   0.21600000E 03   0.37339508E 02   0.54838705E 00   0.92766470E 00
     4     332   0.33200000E 03   0.31500000E 03   0.79300000E 03   0.40470749E 02   0.82460731E 00   0.11814976E 01
     3     101   0.10100000E 03   0.95000000E 02   0.15700000E 03   0.33020050E 02   0.94059402E 00   0.81837505E 00
     1       2   0.20000000E 01   0.20000000E 01   0.20000000E 01   0.38926697E 02   0.10000000E 01   0.0
     2     335   0.33500000E 03   0.38000000E 03   0.13100000E 04   0.38197050E 01   0.11343279E 01   0.16197987E 01
     8      34   0.34000000E 02   0.41000000E 02   0.15100000E 03   0.0              0.12058821E 01   0.17283010E 01
MAX. BSS=     0.40470749E 02      BSS/TSS =    0.02224   BETWEEN CODES   7  5  6  4
                                                 AND CODES   3  1  2  8
 TRY ON PREDICTOR114   CASE-CORPORATION
   CODE      N      TOTAL WEIGHT          SUM OF Y        SUM Y-SQUARE           B S S             MEAN            STD. DEV.
     9       2   0.20000000E 01   0.0              0.0              0.15371971E 01   0.0              0.0
     0       6   0.60000000E 01   0.10000000E 01   0.10000000E 01   0.45438013E 01   0.16666663E 00   0.37267792E 00
     4      34   0.34000000E 02   0.22000000E 02   0.36000000E 02   0.47054377E 01   0.64705878E 00   0.80008602E 00
     6       4   0.40000000E 01   0.30000000E 01   0.30000000E 01   0.46333189E 01   0.75000000E 00   0.43301266E 00
     2     433   0.43300000E 03   0.37200000E 03   0.98600000E 03   0.17139893E 01   0.85912240E 00   0.12405815E 01
     3     230   0.23000000E 03   0.20700000E 03   0.53500000E 03   0.10113792E 01   0.89999998E 00   0.12312937E 01
     1     391   0.39100000E 03   0.35200000E 03   0.10330000E 04   0.10589080E 02   0.90025574E 00   0.13580389E 01
     8       1   0.10000000E 01   0.20000000E 01   0.40000000E 01   0.96467218E 01   0.20000000E 01   0.0
     5       3   0.30000000E 01   0.80000000E 01   0.64000000E 02   0.0              0.26666660E 01   0.37712355E 01
MAX. BSS=     0.47054377E 01      BSS/TSS =    0.00259   BETWEEN CODES   9  0  4
                                                 AND CODES   6  2  3  1  8  5
 TRY ON PREDICTOR119   CASE-MODEL YEAR
   CODE      N      TOTAL WEIGHT          SUM OF Y        SUM Y-SQUARE           B S S             MEAN            STD. DEV.
     4      65   0.65000000E 02   0.30000000E 02   0.34000000E 02   0.11838730E 02   0.46153843E 00   0.55682957E 00
     2     578   0.57800000E 03   0.48100000E 03   0.13570000E 04   0.10151321E 02   0.83217990E 00   0.12865553E 01
     3     317   0.31700000E 03   0.27200000E 03   0.72800000E 03   0.20744568E 02   0.85804415E 00   0.12491150E 01
     1     144   0.14400000E 03   0.18400000E 03   0.54800000E 03   0.0              0.12777777E 01   0.14740553E 01
MAX. BSS=     0.20744568E 02      BSS/TSS =    0.01469   BETWEEN CODES   4  2  3
                                                 AND CODES   1
 TRY ON PREDICTOR124   CASE VEH.-BODY STYLE
   CODE      N      TOTAL WEIGHT          SUM OF Y        SUM Y-SQUARE           B S S             MEAN            STD. DEV.
     0     470   0.47000000E 03   0.39800000E 03   0.11600000E 04   0.69294167E 00   0.84680849E 00   0.13232527E 01
     1     333   0.33800000E 03   0.28800000E 03   0.61000000E 03   0.21800385E 01   0.85207099E 00   0.10386076E 01
     4      65   0.65000000E 02   0.60000000E 02   0.15400000E 03   0.13073820E 01   0.92307687E 00   0.12317295E 01
     2      70   0.70000000E 02   0.66000000E 02   0.16800000E 03   0.14209976E 01   0.94285709E 00   0.12292347E 01
     5      24   0.24000000E 02   0.23000000E 02   0.11900000E 03   0.12001810E 01   0.95833331E 00   0.20099573E 01
     3     137   0.13700000E 03   0.13200000E 03   0.45600000E 03   0.0              0.96350360E 00   0.15492334E 01
MAX. BSS=     0.21800385E 01      BSS/TSS =    0.00120   BETWEEN CODES   0  1
                                                 AND CODES   4  2  5  3
 TRY ON PREDICTOR144   C-(P)PRIN DAMAGE #
   CODE      N      TOTAL WEIGHT          SUM OF Y        SUM Y-SQUARE           B S S             MEAN            STD. DEV.
     0       5   0.50000000E 01   0.0              0.0              0.38535404E 01   0.0              0.0
     6      23   0.23000000E 02   0.90000000E 01   0.11000000E 02   0.68324900E 01   0.39130431E 00   0.57021201E 00
     3      76   0.76000000E 02   0.48000000E 02   0.15400000E 03   0.12339493E 02   0.63157892E 00   0.12757044E 01
     1     623   0.62300000E 03   0.51900000E 03   0.12790000E 04   0.14682080E 02   0.83306581E 00   0.11657476E 01
     4     150   0.15000000E 03   0.14000000E 03   0.41400000E 03   0.15092855E 02   0.93333328E 00   0.13743677E 01
     2     157   0.15700000E 03   0.15700000E 03   0.46100000E 03   0.16296265E 02   0.10000000E 01   0.13915110E 01
     5      18   0.18000000E 02   0.20000000E 02   0.72000000E 02   0.16338165E 02   0.11111107E 01   0.16629591E 01
     7      52   0.52000000E 02   0.74000000E 02   0.27600000E 03   0.0              0.14230766E 01   0.18117790E 01
```

```
MAX. BSS=     0.16333165E 02      BSS/TSS =    0.00898   BETWEEN CODES   0  6  3  1  4  2  5
                                                    AND CODES    7
 TRY ON PREDICTOR147   C-(B) COLL TYPE #
   CODE      N       TOTAL WEIGHT         SUM OF Y         SUM Y-SQUARE            B S S              MEAN             STD. DEV.
     9      61     0.61000000E 02    0.27000000E 02    0.39000000E 02    0.12121538E 02    0.44262290E 00    0.11945858E 01
     0       4     0.40000000E 01    0.20000000E 01    0.20000000E 01    0.12755685E 02    0.50000000E 00    0.50000000E 00
     3      48     0.48000000E 02    0.31000000E 02    0.41000000E 02    0.14977615E 02    0.64583331E 00    0.66110963E 00
     1     773     0.77300000E 03    0.65600000E 03    0.17200000E 04    0.20612946E 02    0.84864163E 00    0.12267447E 01
     8       3     0.30000000E 01    0.30000000E 01    0.30000000E 01    0.20572617E 02    0.10000000E 01    0.0
     2     142     0.14200000E 03    0.14300000E 03    0.44500000E 03    0.24728653E 02    0.10070419E 01    0.14559078E 01
     4      73     0.73000000E 02    0.10500000E 03    0.35700000E 03    0.0               0.14383554E 01    0.16797447E 01
MAX. BSS=     0.24728653E 02      BSS/TSS =    0.01359   BETWEEN CODES   9  0  3  1  8  2
                                                    AND CODES    4
 TRY ON PREDICTOR323   ST. COL. EA DEVICE
   CODE      N       TOTAL WEIGHT         SUM OF Y         SUM Y-SQUARE            B S S              MEAN             STD. DEV.
     0      16     0.16000000E 02    0.10000000E 02    0.12000000E 02    0.10221052E 01    0.62500000E 00    0.59947890E 00
     8      33     0.33000000E 02    0.21000000E 02    0.23000000E 02    0.30340948E 01    0.63636363E 00    0.54038048E 00
     7      37     0.37000000E 02    0.24000000E 02    0.32000000E 02    0.52108727E 01    0.64864862E 00    0.66642314E 00
     2     389     0.38900000E 03    0.31900000E 03    0.91500000E 03    0.65353088E 01    0.82005157E 00    0.12960320E 01
     5     380     0.38000000E 03    0.33900000E 03    0.94300000E 03    0.66829529E 01    0.89210522E 00    0.12983551E 01
     1     229     0.22900000E 03    0.22200000E 03    0.60400000E 03    0.10679703E 02    0.96943229E 00    0.13029785E 01
     4       7     0.70000000E 01    0.70000000E 01    0.11000000E 02    0.14425215E 02    0.10000000E 01    0.75592875E 00
     6       8     0.80000000E 01    0.12000000E 02    0.70000000E 02    0.14930117E 02    0.15000000E 01    0.25495090E 01
     3       4     0.40000000E 01    0.90000000E 01    0.41000000E 02    0.97688208E 01    0.22500000E 01    0.22776079E 01
     9       1     0.10000000E 01    0.40000000E 01    0.16000000E 02    0.0               0.40000000E 01    0.0
MAX. BSS=     0.14425215E 02      BSS/TSS =    0.00793   BETWEEN CODES   0  8  7  2  5  1  4
                                                    AND CODES    6  3  9
 TRY ON PREDICTOR333   EXTERNAL OBJ. INTRUSION
   CODE      N       TOTAL WEIGHT         SUM OF Y         SUM Y-SQUARE            B S S              MEAN             STD. DEV.
     2    1009     0.10090000E 04    0.83500000E 03    0.20630000E 04    0.27415512E 02    0.82755202E 00    0.11660852E 01
     0       1     0.10000000E 01    0.10000000E 01    0.10000000E 01    0.27539124E 02    0.10000000E 01    0.0
     1      94     0.94000000E 02    0.13100000E 03    0.60300000E 03    0.0               0.13936167E 01    0.21148815E 01
MAX. BSS=     0.27539124E 02      BSS/TSS =    0.01513   BETWEEN CODES   2  0
                                                    AND CODES    1
 TRY ON PREDICTOR342   WINDSHIELD BOND SEPAR.
   CODE      N       TOTAL WEIGHT         SUM OF Y         SUM Y-SQUARE            B S S              MEAN             STD. DEV.
     2     995     0.99500000E 03    0.74700000E 03    0.17010000E 04    0.15784865E 03    0.75075376E 00    0.10704737E 01
     0       4     0.40000000E 01    0.40000000E 01    0.40000000E 01    0.16190736E 03    0.10000000E 01    0.0
     1     105     0.10500000E 03    0.21600000E 03    0.96200000E 03    0.0               0.20571423E 01    0.22203760E 01
MAX. BSS=     0.16190736E 03      BSS/TSS =    0.08896   BETWEEN CODES   2  0
                                                    AND CODES    1
 TRY ON PREDICTOR580   SEAT LOCATION/POSITION
   CODE      N       TOTAL WEIGHT         SUM OF Y         SUM Y-SQUARE            B S S              MEAN             STD. DEV.
     0       6     0.60000000E 01    0.20000000E 01    0.40000000E 01    0.17759972E 01    0.33333331E 00    0.74535602E 00
     5      30     0.30000000E 02    0.19000000E 02    0.27000000E 02    0.31854362E 01    0.63333333E 00    0.70632070E 00
     2      31     0.31000000E 02    0.23000000E 02    0.49000000E 02    0.34269228E 01    0.74193543E 00    0.10149755E 01
     4      57     0.57000000E 02    0.43000000E 02    0.91000000E 02    0.42435168E 01    0.75438595E 00    0.10136032E 01
     1     685     0.68500000E 03    0.59700000E 03    0.16530000E 04    0.28012236E 01    0.87153280E 00    0.12859106E 01
     3     227     0.22700000E 03    0.21200000E 03    0.59000000E 03    0.20503263E 01    0.93392068E 00    0.13141193E 01
     6      63     0.63000000E 02    0.71000000E 02    0.25300000E 03    0.0               0.10441170E 01    0.16218529E 01
MAX. BSS=     0.42435168E 01      BSS/TSS =    0.00233   BETWEEN CODES   0  5  2  4
                                                    AND CODES    1  3  6
 TRY ON PREDICTOR582   OCC AGE (POLICE BRACKET)
   CODE      N       TOTAL WEIGHT         SUM OF Y         SUM Y-SQUARE            B S S              MEAN             STD. DEV.
     2      63     0.63000000E 02    0.41000000E 02    0.85000000E 02    0.33857965E 01    0.65079361E 00    0.96211934E 00
     0      84     0.84000000E 02    0.57000000E 02    0.10700000E 03    0.74243927E 01    0.67857140E 00    0.90185934E 00
     5     163     0.16300000E 03    0.12000000E 03    0.26300000E 03    0.12852722E 02    0.73619628E 00    0.10498505E 01
     1      96     0.96000000E 02    0.77000000E 02    0.16300000E 03    0.14314880E 02    0.80208331E 00    0.11237926E 01
    11      33     0.33000000E 02    0.27000000E 02    0.65000000E 02    0.14752667E 02    0.81818181E 00    0.11402950E 01
     8     106     0.10600000E 03    0.94000000E 02    0.33200000E 03    0.13647537E 02    0.88679242E 00    0.15315590E 01
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    3     118    0.11800000E 03    0.10500000E 03    0.24300000E 03    0.13465811E 02    0.88983047E 00    0.11258430E 01
    6     135    0.13500000E 03    0.12400000E 03    0.33800000E 03    0.13170137E 02    0.91851848E 00    0.12684197E 01
    4     119    0.11900000E 03    0.11300000E 03    0.34900000E 03    0.13156416E 02    0.94957978E 00    0.14251556E 01
    7      57    0.57000000E 02    0.56000000E 02    0.13800000E 03    0.15551635E 02    0.98245609E 00    0.12065783E 01
    9      76    0.76000000E 02    0.89000000E 02    0.36100000E 03    0.54309034E 01    0.11710520E 01    0.18381062E 01
   10      54    0.54000000E 02    0.64000000E 02    0.19800000E 03    0.0               0.11851845E 01    0.15039959E 01
MAX. BSS=     0.14732567E 02       BSS/TSS =    0.00812    BETWEEN CODES    2   0   5   1  11
                                               AND CODES    8   3   6   4   7   9  10
 TRY ON PREDICTOR592    LAP BELT WORN
   CODE     N       TOTAL WEIGHT           SUM OF Y          SUM Y-SQUARE          B S S              MEAN              STD. DEV.
    3      25    0.25000000E 02    0.90000000E 01    0.11000000E 02    0.68081617E 01    0.35999995E 00    0.55713558E 00
    0      26    0.26000000E 02    0.15000000E 02    0.87000000E 02    0.87642045E 01    0.57692307E 00    0.17358394E 01
    1     258    0.25800000E 03    0.19200000E 03    0.43600000E 03    0.13424606E 02    0.74418604E 00    0.10658836E 01
    2     795    0.79500000E 03    0.75100000E 03    0.21330000E 04    0.0               0.94465405E 00    0.13381500E 01
MAX. BSS=     0.13424606E 02       BSS/TSS =    0.00738    BETWEEN CODES    3   0   1
                                               AND CODES    2
 TRY ON PREDICTOR596    JP. TORSO WORN
   CODE     N       TOTAL WEIGHT           SUM OF Y          SUM Y-SQUARE          B S S              MEAN              STD. DEV.
    1      40    0.40000000E 02    0.24000000E 02    0.34000000E 02    0.31594343E 01    0.59999996E 00    0.69999999E 00
    3     209    0.20900000E 03    0.18300000E 03    0.56500000E 03    0.63898849E 00    0.87559807E 00    0.13916454E 01
    2     849    0.84900000E 03    0.74900000E 03    0.19850000E 04    0.55300436E 01    0.88221437E 00    0.12488956E 01
    0       6    0.60000000E 01    0.11000000E 02    0.33000000E 02    0.0               0.18333330E 01    0.32360811E 01
MAX. BSS=     0.31594343E 01       BSS/TSS =    0.00174    BETWEEN CODES    1
                                               AND CODES    3   2   0
 TRY ON PREDICTOR604    DEGREE OF EJECTION
   CODE     N       TOTAL WEIGHT           SUM OF Y          SUM Y-SQUARE          B S S              MEAN              STD. DEV.
    3       1    0.10000000E 01    0.0               0.0               0.76790596E 00    0.0               0:0
    2    1080    0.10800000E 04    0.88500000E 03    0.22430000E 04    0.15938435E 03    0.81944442E 00    0.11854792E 01
    0       2    0.20000000E 01    0.20000000E 01    0.40000000E 01    0.13423283E 03    0.10000000E 01    0.10000000E 01
    5      17    0.17000000E 02    0.58000000E 02    0.26600000E 03    0.35839931E 02    0.34117641E 01    0.20017300E 01
    4       4    0.40000000E 01    0.22000000E 02    0.15400000E 03    0.0               0.55000000E 01    0.28722811E 01
MAX. BSS=     0.13423283E 03       BSS/TSS =    0.10123    BETWEEN CODES    3   2   0
                                               AND CODES    5   4
SPLIT GROUP  1 ON PREDICTOR604    DEGREE OF EJECTION       INTO GROUP  2 WITH CODES   3   2   0
       AND GROUP  3 WITH CODES   5   4
          BSS IS      0.18423283E 03...BSS/TSS IS    0.10123...T-VALUE 11.14

  CANDIDATE GROUPS ARE  AS FOLLOWS.

  GROUP     N       TOTAL WEIGHT           SUM OF Y          SUM Y-SQUARE          T S S              MEAN              STD. DEV.
    2    1083    0.10830000E 04    0.88700000E 03    0.22470000E 04    0.15205283E 04    0.81902122E 00    0.11649031E 01
    3      21    0.21000000E 02    0.80000000E 02    0.42000000E 03    0.11523826E 03    0.38095236E 01    0.23425484E 01
```

APPENDIX I. MULTIPLE CLASSIFICATION ANALYSIS.

```
WASHTENAW MCA


   NUMBER OF PREDICTORS                       =       6
   SUBSCRIPT OF WEIGHT VARIABLE               =       0
   SUBSCRIPT OF DEPENDENT VARIABLE            =     600
   DEPENDENT VARIABLE:
      MAX CODE                                =       9.000000
      IF KEEP CASES WITH 1ST MD CODE          =      NO
      IF KEEP CASES WITH 2ND MD CODE          =      NO
   IF PRINT FREQUENCIES                       =     YES
   ITERATION MAXIMUM                          =      25
   CONVERGENCE TEST                           =       2
   FRACTION FOR CONVERGENCE                   =       0.005000
   IF PRINT COEFFICIENTS                      =      NO


                             PREDICTOR LIST

                        VARIABLE        MAXIMUM CODE
                           59                 8
                          144                 4
                          328                 5
                          342                 2
                          588                 7
                          599                 3

THE FOLLOWING NUMBER OF CASES WERE ELIMINATED FROM THIS ANALYSIS :
                  0 DUE TO THE ANALYSIS FILTER, IF REQUESTED
                  0 DUE TO DEPENDENT VARIABLE MAX OR MD CODES
                  0 DUE TO PREDICTOR MAX CODES


WEIGHTED FREQUENCY TABLE#     1

     ROW VAR     59:COLL.-VEH. TO VEH.
     COLUMN VAR   144:C-(P)PRIN DAMAGE #

  CODE     ( 0)   ( 1)   ( 2)   ( 3)   ( 4)   (
 ( 0)        0      0      0      0      0
 (  )        0      0      0      0      0
 ( 2)        0     74     27      5     11
 ( 3)        0     38      1      0      0
 ( 4)        0    107     39      1     40
 ( 5)        0     12      4      0     14
 ( 6)        0     70      2     26      2
 ( 7)        0      2      0      0      0
 ( 8)        0      8      3      0      5


WEIGHTED FREQUENCY TABLE#     2

     ROW VAR     59:COLL.-VEH. TO VEH.
     COLUMN VAR   328:ST. COL. EA DEVICE

  CODE     ( 0)   ( 1)   ( 2)   ( 3)   ( 4)   ( 5)   (
 ( 0)        0      0      0      0      0      0
 ( 1)        0      0      0      0      0      0
 ( 2)        0     24     50      0      0     43
 ( 3)        0      7     13      0      0     19
```

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 ( 4)       0     41     70      0      0     76
 ( 5)       0      7     11      0      0     12
 ( 6)       0     19     48      0      0     33
 ( 7)       0      0      1      0      0      1
 ( 8)       0      4      7      0      0      5


WEIGHTED FREQUENCY TABLE#     3

      ROW VAR     59:COLL.-VEH. TO VEH.
      COLUMN VAR   342:WINDSHIELD BOND SEPAR.

  CODE      ( 0)   ( 1)   ( 2)   (
 ( 0)       0      0      0
 ( 1)       0      0      0
 ( 2)       0     15    102
 ( 3)       0      1     38
 ( 4)       0      6    181
 ( 5)       0      2     28
 ( 6)       0      1     99
 ( 7)       0      0      2
 ( 8)       0      1     15


WEIGHTED FREQUENCY TABLE#     4

      ROW VAR     59:COLL.-VEH. TO VEH.
      COLUMN VAR   588:OCC HEIGHT (6 INCH BRAC)

  CODE      ( 0)   ( 1)   ( 2)   ( 3)   ( 4)   ( 5)   ( 6)   ( 7)   (
 ( 0)       0      0      0      0      0      0      0      0
 ( 1)       0      0      0      0      0      0      0      0
 ( 2)       0      0      0      0      0     26     64     27
 ( 3)       0      0      0      0      1     10     23      5
 ( 4)       0      0      0      0      3     51     87     46
 ( 5)       0      0      0      0      0      6     17      7
 ( 6)       0      0      0      0      0     28     53     19
 ( 7)       0      0      0      0      0      0      1      1
 ( 8)       0      0      0      0      1      4      8      3


WEIGHTED FREQUENCY TABLE#     5

      ROW VAR     59:COLL.-VEH. TO VEH.
      COLUMN VAR   599:RESTRAINT SYSTEM USEAGE

  CODE      ( 0)   ( 1)   ( 2)   ( 3)   (
 ( 0)       0      0      0      0
 ( 1)       0      0      0      0
 ( 2)       0     94     18      5
 ( 3)       0     27     10      2
 ( 4)       0    133     47      7
 ( 5)       0     22      8      0
 ( 6)       0     66     29      5
 ( 7)       0      0      1      1
 ( 8)       0     12      4      0


WEIGHTED FREQUENCY TABLE#     6
```

```
     ROW VAR   144:C-(P)PRIN DAMAGE #
     COLUMN VAR   328:ST. COL. EA DEVICE

 CODE      ( 0)   ( 1)   ( 2)   ( 3)   ( 4)   ( 5)   (
( 0)         0      0      0      0      0      0
( 1)         0     64    132      0      0    115
( 2)         0     17     26      0      0     33
( 3)         0      3     13      0      0     16
( 4)         0     18     29      0      0     25

WEIGHTED FREQUENCY TABLE#     7

     ROW VAR   144:C-(P)PRIN DAMAGE #
     COLUMN VAR   342:WINDSHIELD BOND SEPAR.

 CODE      ( 0)   ( 1)   ( 2)   (
( 0)         0      0      0
( 1)         0     12    299
( 2)         0      7     69
( 3)         0      0     32
( 4)         0      7     65

WEIGHTED FREQUENCY TABLE#     8

     ROW VAR   144:C-(P)PRIN DAMAGE #
     COLUMN VAR   588:OCC HEIGHT (6 INCH BRAC)

 CODE      ( 0)   ( 1)   ( 2)   ( 3)   ( 4)   ( 5)   ( 6)   ( 7)   (
( 0)         0      0      0      0      0      0      0      0
( 1)         0      0      0      0      1     89    151     70
( 2)                0      0      0      0     15     41     20
( 3)                0      0      0      0      8     17      7
( 4)                0      0      0      4     13     44     11

WEIGHTED FREQUENCY TABLE#     9

     ROW VAR   144:C-(P)PRIN DAMAGE #
     COLUMN VAR   599:RESTRAINT SYSTEM USEAGE

 CODE      ( 0)   ( 1)   ( 2)   ( 3)   (
( 0)         0      0      0      0
( 1)         0  [illegible]3  69     14
( 2)         0     59     13      4
( 3)         0     22      8      2
( 4)               45     27      0

WEIGHTED FREQUENCY TABLE#    10

     ROW VAR   328:ST. COL. EA DEVICE
     COLUMN VAR   342:WINDSHIELD BOND SEPAR.

 CODE      (  )   ( 1)   ( 2)   (
( 0)         0      0      0
( 1)         0      5     97
( 2)         0      7    193
( 3)         0      0      0
```

```
 ( 4)        0      0      0
 ( 5)        0     14    175

WEIGHTED FREQUENCY TABLE#    11

     ROW VAR   328:ST. COL. EA DEVICE
     COLUMN VAR   588:OCC HEIGHT (6 INCH BRAC)

  CODE     ( 0)   ( 1)   ( 2)   ( 3)   ( 4)   ( 5)   ( 6)   ( 7)   (
 ( 0)        0      0      0      0      0      0      0      0
 ( 1)        0      0      0      0      0     26     56     20
 ( 2)        0      0      0      0      3     50    100     47
 ( 3)        0      0      0      0      0      0      0      0
 ( 4)        0      0      0      0      0      0      0      0
 ( 5)        0      0      0      0      2     49     97     41

WEIGHTED FREQUENCY TABLE#    12

     ROW VAR   328:ST. COL. EA DEVICE
     COLUMN VAR   599:RESTRAINT SYSTEM USEAGE

  CODE     ( 0)   ( 1)   ( 2)   ( 3)   (
 ( 0)        0      0      0      0
 ( 1)        0     69     28      5
 ( 2)        0    145     48      7
 ( 3)        0      0      0      0
 ( 4)        0      0      0      0
 ( 5)        0    140     41      8

WEIGHTED FREQUENCY TABLE#    13

     ROW VAR   342:WINDSHIELD BOND SEPAR.
     COLUMN VAR   588:OCC HEIGHT (6 INCH BRAC)

  CODE     ( 0)   ( 1)   ( 2)   ( 3)   ( 4)   ( 5)   ( 6)   ( 7)   (
 ( 0)        0      0      0      0      0      0      0      0
 ( 1)        0      0      0      0      0      5     16      5
 ( 2)        0      0      0      0      5    120    237    103

WEIGHTED FREQUENCY TABLE#    14

     ROW VAR   342:WINDSHIELD BOND SEPAR.
     COLUMN VAR   599:RESTRAINT SYSTEM USEAGE

  CODE     ( 0)   ( 1)   ( 2)   ( 3)   (
 ( 0)        0      0      0      0
 ( 1)        0     22      3      1
 ( 2)        0    332    114     19

WEIGHTED FREQUENCY TABLE#    15

     ROW VAR   588:OCC HEIGHT (6 INCH BRAC)
     COLUMN VAR   599:RESTRAINT SYSTEM USEAGE

  CODE     ( 0)   ( 1)   ( 2)   ( 3)   (
```

```
( 0)        0      0      0      0
( 1)        0      0      0      0
( 2)        0      0      0      0
( 3)        0      0      0      0
( 4)        0      3      2      0
( 5)        0     96     25      4
( 6)        0    179     65      9
( 7)        0     76     25      7

NO.   OF   DATA   =    491
TOTAL WEIGHTS     = 0.49100000E 03
```

```
COEFFICIENTS CONVERGED TEST TYPE  2 ITERATION  4



DEPENDENT VARIABLE (Y)  =  600:  OVERALL OCC INJ SEVERITY


M E A N                    = 0.72097754E 00

SUM     OF      Y          = 0.35400000E 03
SUM OF Y SQUARE            = 0.83200000E 03
STANDARD  DEVIATION        = 0.10849571E 01
TOTAL  SUM  OF  SQUARES    = 0.57677393E 03
EXPLAINED SUM OF SQUARE    = 0.11619537E 03
RESIDUAL SUM OF SQUARES    = 0.46057857E 03



PREDICTOR      59:  COLL.-VEH. TO VEH.

       NO OF   SUM   OF    PER      C L A S S  DEVIATION FROM
CLASS  CASES  WEIGHTS  CENTS       M E A N     GRAND MEAN      COEFFICIENT

  2     117       117    23.8  0.80342E 00     0.82441E-01   -0.57336E-01
  3      39        39     7.9  0.92308E 00     0.20210E 00    0.27653E 00
  4     187       187    38.1  0.67914E 00    -0.41833E-01    0.71712E-02
  5      30        30     6.1  0.60000E 00    -0.12098E 00   -0.18848E 00
  6     100       100    20.4  0.57000E 00    -0.15098E 00   -0.90649E-01
  7       2         2     0.4  0.0            -0.72098E 00   -0.39995E 00
  8      16        16     3.3  0.13750E 01     0.65402E 00    0.63137E 00

ETA-SQUARE =  0.23089461E-01       BETA-SQUARE =  0.20739578E-01
       ETA =  0.15195215E 00              BETA =  0.14401239E 00

UNADJUSTED DEVIATION SS =  0.13317400E 02
ADJUSTED   DEVIATION SS =  0.11962049E 02



PREDICTOR    144:  C-(P)PRIN DAMAGE #

       NO OF   SUM   OF    PER      C L A S S  DEVIATION FROM
CLASS  CASES  WEIGHTS  CENTS       M E A N     GRAND MEAN      COEFFICIENT

  1     311       311    63.3  0.69132E 00    -0.29659E-01   -0.95199E-02
  2      76        76    15.5  0.69737E 00    -0.23609E-01   -0.10955E 00
  3      32        32     6.5  0.68750E 00    -0.33478E-01    0.17151E 00
  4      72        72    14.7  0.88889E 00     0.16791E 00    0.80532E-01

ETA-SQUARE =  0.41294917E-02       BETA-SQUARE =  0.40718541E-02
       ETA =  0.64261079E-01              BETA =  0.63811064E-01

UNADJUSTED DEVIATION SS =  0.23817844E 01
ADJUSTED   DEVIATION SS =  0.23485413E 01



PREDICTOR    328:  ST. COL. EA DEVICE
```

```
        NO OF   SUM  OF    PER     C L A S S  DEVIATION FROM
 LASS   CASES  WEIGHTS   CENTS      M E A N     GRAND MEAN    COEFFICIENT

   1     102        102   20.8  0.80392E 00    0.82944E-01   0.95635E-01
   2     200        200   40.7  0.62500E 00   -0.95978E-01  -0.57340E-01
   3     189        189   38.5  0.77778E 00    0.56800E-01   0.90654E-02

 ETA-SQUARE =  0.54660482E-02      BETA-SQUARE =  0.27844564E-02
        ETA =  0.73946238E-01             BETA =  0.52767947E-01

 UNADJUSTED DEVIATION SS =  0.31538286E 01
 ADJUSTED   DEVIATION SS =  0.16060019E 01


 PREDICTOR    342:  WINDSHIELD BOND SEPAR.

        NO OF   SUM  OF    PER     C L A S S  DEVIATION FROM
 LASS   CASES  WEIGHTS   CENTS      M E A N     GRAND MEAN    COEFFICIENT

   1      26         26    5.3  0.26154E 01    0.18944E 01   0.19038E 01
   2     465        465   94.7  0.61505E 00   -0.10592E 00  -0.10645E 00

  TA-SQUARE =  0.17082143E 00      BETA-SQUARE =  0.17252529E 00
        ETA =  0.41330546E 00             BETA =  0.41536158E 00

 UNADJUSTED DEVIATION SS =  0.98525360E 02
 ADJUSTED   DEVIATION SS =  0.99508102E 02


 PREDICTOR    588:  OCC HEIGHT (6 INCH BRAC)

        NO OF   SUM  OF    PER     C L A S S  DEVIATION FROM
CLASS   CASES  WEIGHTS   CENTS      M E A N     GRAND MEAN    COEFFICIENT

   4       5          5    1.0  0.60000E 00   -0.12098E 00  -0.23753E 00
   5     125        125   25.5  0.71200E 00   -0.89776E-02   0.76808E-02
   6     253        253   51.5  0.74308E 00    0.22105E-01  -0.32719E-02
   7     108        108   22.0  0.68519E 00   -0.35792E-01   0.97729E-02

 ETA-SQUARE =  0.59856987E-03      BETA-SQUARE =  0.52448874E-03
        ETA =  0.24465688E-01             BETA =  0.22901718E-01

 UNADJUSTED DEVIATION SS =  0.34523952E 00
 ADJUSTED   DEVIATION SS =  0.30251151E 00


 PREDICTOR    599:  RESTRAINT SYSTEM USEAGE

        NO OF   SUM  OF    PER     C L A S S  DEVIATION FROM
CLASS   CASES  WEIGHTS   CENTS      M E A N     GRAND MEAN    COEFFICIENT

   1     354        354   72.1  0.76554E 00    0.44559E-01   0.28970E-01
   2     117        117   23.8  0.64957E 00   -0.71405E-01  -0.29920E-01
   3      20         20    4.1  0.35000E 00   -0.37098E 00  -0.33774E 00

 ETA-SQUARE =  0.70251115E-02      BETA-SQUARE =  0.46520047E-02
        ETA =  0.83815932E-01             BETA =  0.68205595E-01
```

```
UNADJUSTED DEVIATION SS =  0.40519018E 01
ADJUSTED   DEVIATION SS =  0.26831560E 01


***MULTIPLE R  (ADJUSTED) = 0.41564   MULTIPLE R - SQUARE = 0.17276

    OUTPUT  COMPLETED.
```

APPENDIX J

MDAI ACCIDENT DATA COLLECTION FORMS

MOTORCYCLE COLLISION ANALYSIS FORM

Vehicle Identification

* Manufacturer ______________________________

* Model ______________________________

* Model year ______________________________

* Engine displacement (cc) ______________________________

* Manufacturer's Vehicle Identification Number ____________________

* Odometer Reading ___ ___ ___ ___ ___ . _

Vehicle Dimensions (inches)

* Wheelbase ____________________

* Overall length __________ _

* Handlebar width___ __________
(tip to tip)

Vertical dista . the seat to:

* Highe alebars ______________

* The tips ebars ______________

Followed by 7 pages of detail regarding motor cycle collisions.

Vehicle Equipment & Modifications

		Equipped (1, 2, 0)	Operational (1, 2, 3, 0)*
* Crash bars	Front	__________	
	Rear	__________	
* Windshield		__________	
* Extended front forks		__________	
* Luggage rack		__________	

---

*Where (1, 2, 3, 0) is indicated use:
1-yes, 2-no, 3-not applicable, 0-unknown

INVESTIGATION DATE	LOCATION	AA-

VEH'L VEH.NO.	TYPE (CAR, TRUCK, ETC.)

YEAR	MAKE	MODEL	BODY STYLE

COLOR

ODOMETER

MAINTENANCE	INSPECTION

INVESTIGATION

DEFECTS (DESCRIBE)

POWER ACCESSORIES/OPTIONS

PS ___ PB ___ A/C ___ PW ___ OTHER:

RESTRAINT SYSTEM

TYPE:

USE:

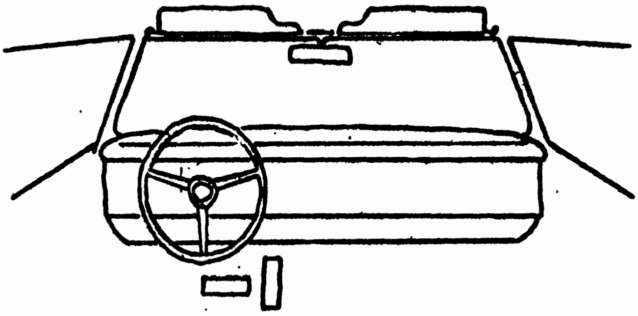
INJURY (CAUSATION/CONTACT)

DAMAGE DIRECTION OF FORCE	DAMAGE (DESCRIBE)

VEHICLE DYNAMICS

POST CRASH DAMAGE	<u>VDI</u> PRIMARY: SECONDARY: OTHER:

Interior Damage



NOTES

NAME | LIC.# | SEAT NO. | VEH'L NO. | CASE NO. AA-

Physical WGHT | HGT | DOB | MARRIED

PHYSICAL IMPAIRMENTS

INJURIES WHERE CONTACTED

INAL RESTING POSITION | CONSCIOUS,LOSS

XIT VEHICLE, OW? | FIRST AID, WHO, WHERE, TIME | LEFT SCENE, HOW

/ehicle HOW LONG OWNED MILES/YEAR YEARS DRIVING EXP'N

ESTRAINTS USED VEH'L CONDITION OVERALL BRAKES STEERING LAST SERVICE WHAT,WHERE

STIMATED SPEED | AT IMPACT | OTHER VEH'LS, OWNED, DRIVEN

Driving PREVIOUS ACCIDENTS TYPE WHEN

RIVER EDUCATION | EDUCATION- HIGH SCHOOL COLLEGE ADVANCED

PERIENCE ALL WEATHER % CITY % URBAN % HWY % DAY/NIGHT

MILIARITY CAR ROUTE AREA | LEFT/RIGHT FOOT BRAKING

STRAINT USE | SELF RATED DRIVING ABILITY

npact ACTION CONTROL OF VEH'L [illegible] | BRACING

UNAWARE

R(S) OPEN/JAM | EJECTION | STRUCK LOOSE OBJECTS | COVERING UP

SIMILAR SITUATIONS

Highway

TRAFFIC CONDITIONS

VIEW OBSTRUCTION | DISTRACTIONS | ASSUMPTIONS, OTHER VEH'L, TRAFFIC

HWY INVOLVEMENT   SPEED LIMIT   MAINTENANCE   CONTROLS

Trip Condition

DESCRIPTION | ORIGIN | PURPOSE

SLEEP   WORK/OCCUPATION   RECREATION. | TRAVEL LONG DISTANCES

PHYSICAL OVERALL   MAJOR SURGERY   ILLNESS   FAINTING   SEIZURES   EPILEPSY   DIABETES

MENTAL OVERALL   STRESS   PRESSURE   ATTITUDE TOWARD DRIVING

SMOKE   DRINK/RATE   EAT   MEDICINE   DRUGS

Finale

EDUCATION LEVEL | APPROX INCOME | WAS ACCIDENT PREVENTABLE

DRIVER   SUGGESTIONS   IMPROVEMENTS   CRITICISMS   COMMENTS

notes:

U.S. DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

VEHICLE CONDITION AND MAINTENANCE REPORT

TIRES	LF	LR	RR	RF
REMAINING TREAD DEPTH (1/32 in.)				
INFLATION PRESSURE (PSIG)				
DAMAGED IN COLLISION (1,2,3,0)*				

EVIDENCE OF IRREGULAR TREAD WEAR (1,2,3,0)* DESCRIBE	LF	
	LR	
	RR	
	RF	
EVIDENCE OF PREVIOUS TIRE REPAIR (1,2,3,0)* DESCRIBE	LF	
	LR	
	RR	
	RF	
EVIDENCE OF PRECRASH TIRE DEFECTS (1,2,3,0)* DESCRIBE	LF	
	LR	
	RR	
	RF	

STEERING AND SUSPENSION

STEERING WHEEL FREEPLAY IN DEGREES	

(1) 0-10 (4) 30-40 (0) UNKNOWN
(2) 10-20 (5) 40-50
(3) 20-30 (6) 50

SUSPENSION MODIFICATIONS (1,2,3,0)* DESCRIBE	FRONT	
	REAR	
SHOCK ABSORBER DEGRADATION (1,2,3,0)* DESCRIBE	LF	
	RF	
	RR	
	RF	

EXHAUST

EXHAUST SYSTEM DEFECTS (1,2,3,0)* DESCRIBE	

DRIVE TRAIN

ENGINE MODIFICATION (1,2,3,0)* DESCRIBE	
EVIDENCE OF DEFECTS ASSOCIATED WITH THE ENGINE OR ENGINE-DRIVEN ACCESSORIES (1,2,3,0)* DESCRIBE	

BRAKES

BRAKE FLUID LEVEL IN MASTER CYLINDER (Inches)	FRONT	
	REAR	

(1) DRY TO 1/2 (4) 2 OR MORE
(2) 1/2 TO 1 (0) UNKNOWN
(3) 1 TO 2

BRAKE FLUID CONTAMINATION (1,2,3,0)*	
FLUID LEAKAGE AROUND MASTER CYLINDER, HYDRAULIC TUBING, PROPORTIONING VALVE, OR BRAKE BACKING PLATES (1,2,3,0)* DESCRIBE	
AFTER APPLYING MODERATE FOOT PRESSURE TO BRAKE PEDAL FOR 1 MIN. DOES PEDAL MAINTAIN ITS POSITION? (1,2,3,0)*	

GENERAL INFORMATION

SWITCH OR CONTROL POSITION AT TIME OF COLLISION

WINDSHIELD WIPERS		DEFROSTER	
HEADLIGHTS		RADIO	
PARKING LIGHTS		TAPE DECK	
HEATER		AIR CONDITIONER	

(1) ON (3) NOT APPLICABLE
(2) OFF (4) UNKNOWN

CONDITION OF WINDSHIELD WIPER BLADE	LEFT	
	RIGHT	

(3) NOT EQUIPPED (6) SLIGHTLY DEGRADED
(4) BLADE MISSING (7) POOR
(5) GOOD (0) UNKNOWN

WINDSHIELD WIPER ARMS EQUIPPED WITH ANTI-WIND LIFT AIR FOILS (1,2,3,0)*	

GLASS

POSITION OF MOVEABLE GLASS PANES

	LEFT	RIGHT
FRONT VENT		
FRONT DOOR		
REAR DOOR		
REAR QUARTER		
TAILGATE (Station Wagon)		

(3) NOT APPLICABLE (7) 3/4 OPEN
(4) CLOSED (8) OPEN
(5) 1/4 OPEN (0) UNKNOWN
(6) 1/2 OPEN

CONDITION OF GLASS (PRECRASH)

	LEFT	RIGHT
FRONT VENT		
FRONT DOOR		
REAR		
REAR QUARTER		

TAILGATE OR BACKLIGHT	
CONDITION OF WINDSHIELD	

(3) NOT APPLICABLE (7) CHIPPED OR PITTED
(4) CLEAN (8) CRACKED
(5) LIGHTLY SOILED (9) OBSTRUCTED
(6) HEAVILY SOILED (0) UNKNOWN

MAINTENANCE AND INSPECTION

LUBRICATION STICKER

MILEAGE	
DATE	
SERVICE	
PERFORMED	

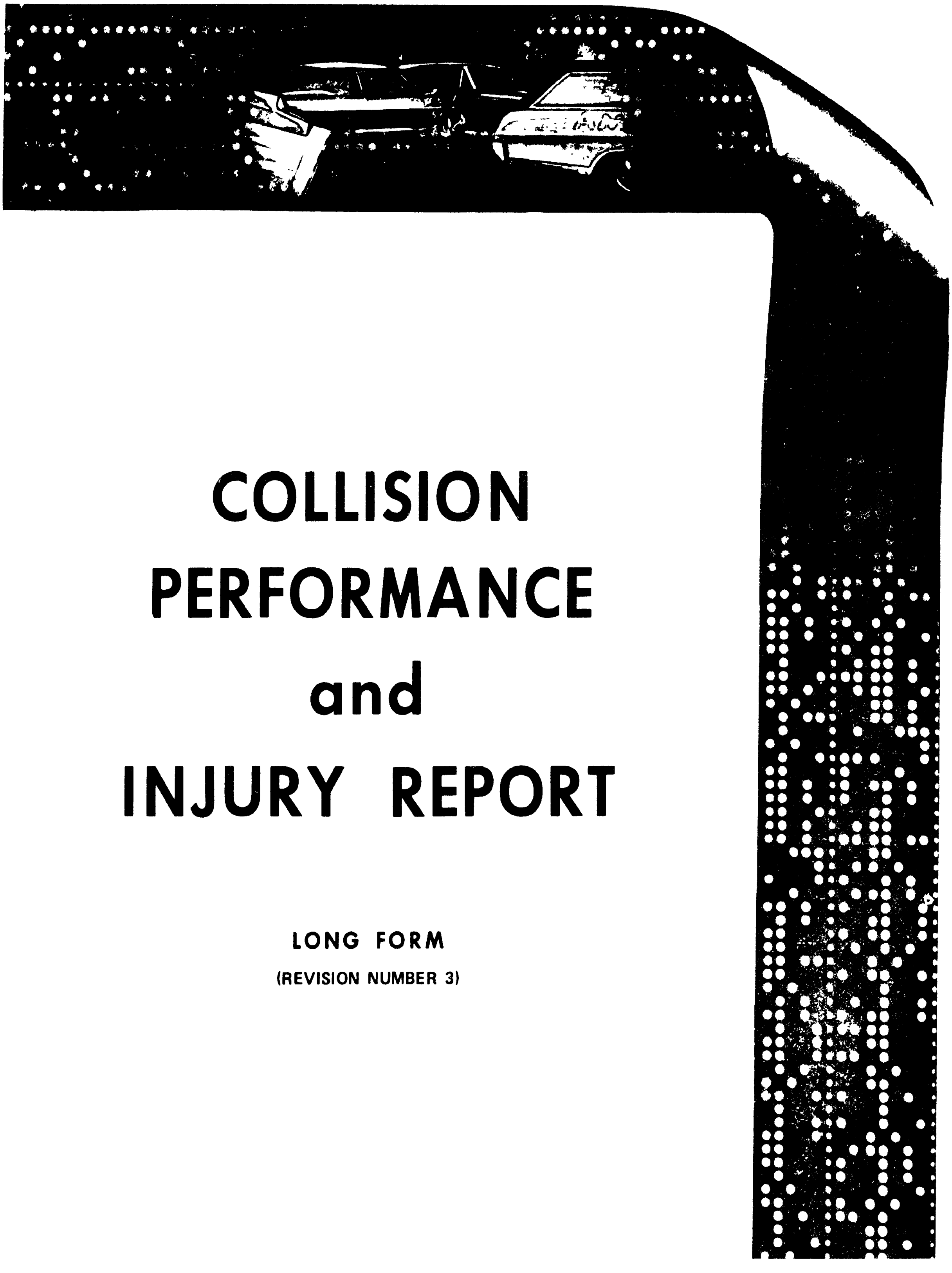
INSPECTION STICKER

ISSUING AGENCY	
DATE	
SERIAL NO.	
STATION NO.	

NOTES

HS Form 183
Dec. 1971

*(1) Yes, (2) No, (3) Not applicable, (0) Unknown



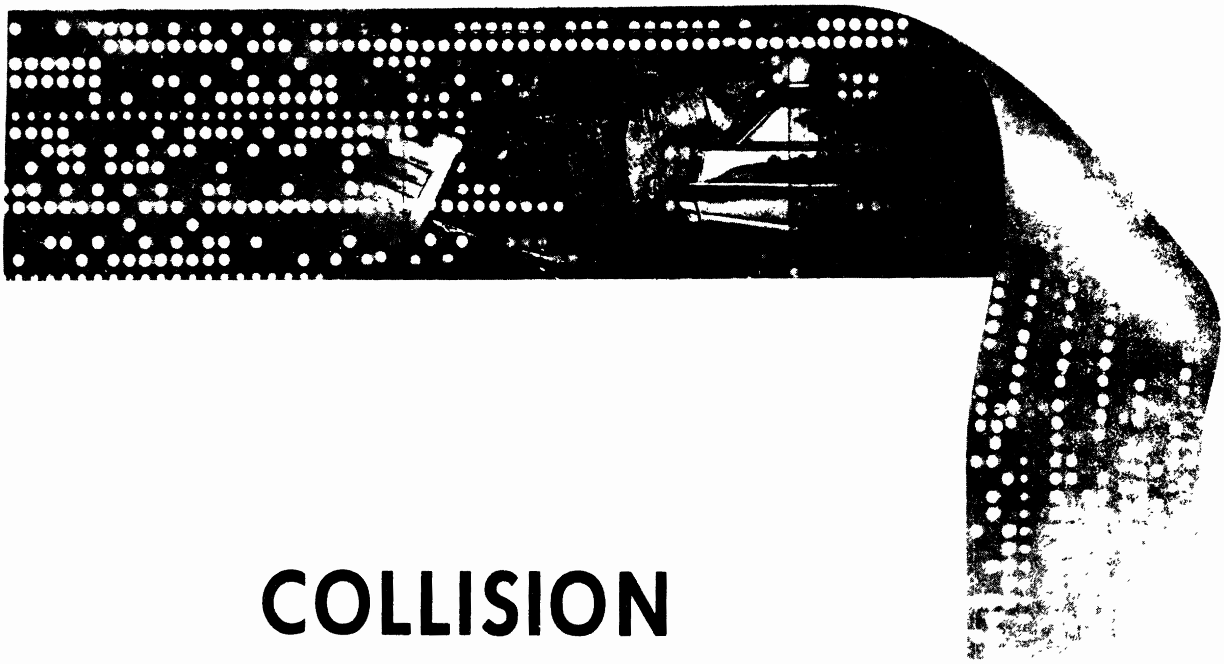
COLLISION PERFORMANCE and INJURY REPORT

LONG FORM

(REVISION NUMBER 3)

GM
PG2070

(THIS FORM REPLACED PG2002 IN SEPTEMBER 1969)



COLLISION PERFORMANCE and INJURY REPORT

TRUCK

(VERSION B)

COLLISION PERFORMANCE AND INJURY REPORT

This form was developed by General Motors and the Automobile Manufacturers Association to promote widespread interchange of standardized, comprehensive field data among professional research people engaged in accident investigation, and is designed to be used in conjunction with digital computers. Companion forms for recording car and bus collision data are also available. Professional accident researchers can obtain more information on this accident investigation system by writing to:

Automobile Manufacturers Association, Inc.
320 New Center Building
Detroit, Michigan 48202

Or

Safety Research & Development Laboratory
GM-ADAP
General Motors Proving Ground
Milford, Michigan 48042

GENERAL INSTRUCTIONS

THE FIELD INVESTIGATOR SHOULD:

Make a complete photographic description of the vehicle. (See Page 44 for instructions.)

See Page 31 for Occupant information Section instructions.

There are eight basic types of questions that you will be asked. Read the following examples, based on a fictitious accident, illustrating how these questions should be answered.

Accident: *A pickup truck with 3 occupants was involved in an accident on a dirt, country road in Arizona. The doors did not jam. The rear view mirror was not contacted by any occupant but it was broken.*

EXAMPLES:

A. Enter the name of the state (Arizona) in the blank. Enter nothing in the adjacent "Punch Code" column because all grey areas will be filled in by the Analysis Group.

B. The word "AREA" is an implied multiple choice "question". Since the answer "(2) rural" best describes the area, enter a "2" on the blank in the "Punch Code" column. A "2" will later be punched in Column 20 of a computer card in response to your answer.

C. The correct answer for the example shown is not in the list, so write the word "dirt" in the blank after "(4) other:__________". Also enter "4" in the "Punch Code" column because the column is not shaded grey this time.

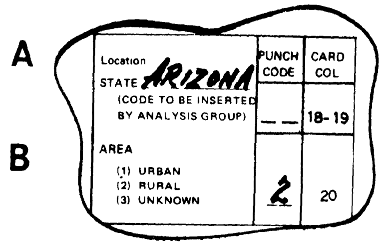
D. This type of question is written in a way that will save you time. (It could have been written, "Did the left front door jam?") The possible answers "(1,2,0)*" are given after the word "Front". The code key for (1,2,0) is given at the bottom of the page. Since "2" means "no", enter "2" in the answer blank because, according to our accident, the left front door did not jam.

E. Example E asks if the left rear door jammed. The code key for (1,2,3,0) is also given at the bottom of the page Since this was a two door pickup "3" is chosen, as the answer to indicate that the question is "not applicable".

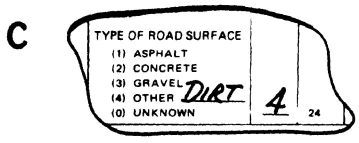
F. & G. These examples pertain to the rear view mirror. The questions and possible answers are grouped together at the heads of the two answer columns. Example F asks if the rear view mirror was damaged. Since the mirror was broken, mark the blank in the "Damaged" column with a "1".

Example G asks if the rear view mirror was contacted by an occupant. Since there was apparently no occupant contact, enter "2" in the Occupant Contact column. ("Contact" implies probable contact)

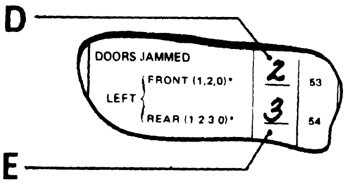
H. Example H offers no multiple choices. So enter the actual answer in the blank. Since there were 3 occupants, enter "03" in the blank. Notice that the answer is entered as far to the right as possible and the leading blanks are filled in with zeros.


A
B

	PUNCH CODE	CARD COL
Location STATE ARIZONA (CODE TO BE INSERTED BY ANALYSIS GROUP)	_ _	18-19
AREA (1) URBAN (2) RURAL (3) UNKNOWN	2	20

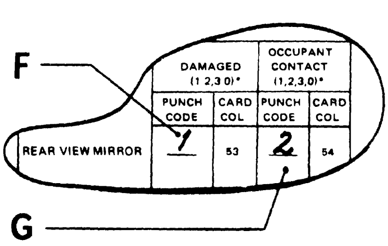

C

TYPE OF ROAD SURFACE (1) ASPHALT (2) CONCRETE (3) GRAVEL (4) OTHER DIRT (0) UNKNOWN	4	24

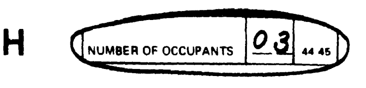

D
E

DOORS JAMMED

LEFT FRONT (1,2,0)*	2	53
LEFT REAR (1 2 3 0)*	3	54


F
G

	DAMAGED (1 2,3 0)*		OCCUPANT CONTACT (1,2,3,0)*	
	PUNCH CODE	CARD COL	PUNCH CODE	CARD COL
REAR VIEW MIRROR	1	53	2	54


H

NUMBER OF OCCUPANTS 03 44 45

THE ANALYSIS GROUP SHOULD:

Cross check all available information, photographs, etc.

Complete the report using all available information and the provided code keys.

*WHERE (1,2,0) OR (1,2,3,0) ARE INDICATED, USE 1 FOR YES 3 FOR NOT APPLICABLE
2 FOR NO 0 FOR UNKNOWN