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An agency staff review of an existing Federal regulation performed in response to Executive Order 12291.

16. Abstract
Federal Motor Vehicle Safety Standard 201, Occupant Protection in Interior Impact, regulates the performance of certain vehicle interior surfaces in crashes. During the 1960's and early 1970's, the manufacturers generally modified instrument panels of cars and light trucks, installing padding, reducing the rigidity of panel structures and extending the panel downward and toward the passenger. This evaluation analyzes the effectiveness and benefits of instrument panel improvements in frontal crashes of cars and light trucks. It also estimates the cumulative fatality reduction - for unrestrained front seat occupants in frontal crashes - for all safety standards and vehicle improvements of the 1964-84 era. The study is based on statistical analyses of FARS, NCSS and NASS accident data and MVMA2D computer simulations of occupants impacting the instrument panel in frontal crashes. It was found that:

- The instrument panel improvements of the 1965-75 era reduced fatality risk and serious injury risk by nearly 25 percent for unrestrained right front passengers of cars in frontal crashes, saving up to 700 lives per year.
- A preliminary analysis of light trucks indicates close to 25 percent reduction of fatality risk between model years 1968 and 1976, for unrestrained right front passengers in frontal crashes.
- All the passenger car standards and improvements of the 1964-84 period, other than safety belts, save about 2200 driver and front seat passenger fatalities per year in frontal crashes.

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instrument panel; dashboard; MVMA2D; frontal impact; light truck; padding; crashworthiness; evaluation; simulation; accident analysis; biomechanics; FARS; statistical analysis; NASS; NCSS;

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LIST OF ABBREVIATIONS

A/C	air conditioning
ACIR	Automotive Crash Injury Research
AIS	Abbreviated Injury Scale
BMDP	Biomedical programs (P series)
CDC	Collision Deformation Classification
CRASH	Computer Reconstruction of Accident Speeds on the Highway
Delta V	velocity change during impact
df	degrees of freedom
DV	Delta V
FARS	Fatal Accident Reporting System
g	unit of acceleration approximately equal to 32.2 ft/sec^2
GM	General Motors Corp.
GMR	General Motors Research
HIC	Head Injury Criterion
HSRI	Highway Safety Research Institute, now called UMTRI
IP	Instrument Panel
LIP	Lower Instrument Panel
MIP	Mid Instrument Panel
mph	miles per hour
MPV	Multipurpose Passenger Vehicle
MVMA	Motor Vehicle Manufacturers Association
MVMA2D	MVMA 2 Dimensional crash simulation computer program
MY	Model Year
NASS	National Accident Sampling System

NCSS	National Crash Severity Study
NHTSA	National Highway Traffic Safety Administration
PADS2	Passenger And Driver Simulation program, version 2
PDOF	Principal Direction Of Force
R	correlation coefficient
RF	Right Front
SAE	Society of Automotive Engineers
SAS	Statistical Analysis System
sqrt	square root
SWRI	Southwest Research Institute
TIP	Top Instrument Panel
TSC	Transportation Systems Center
UCLA	University of California at Los Angeles
VIN	Vehicle Identification Number
VINA	Vehicle Identification Number Analysis program

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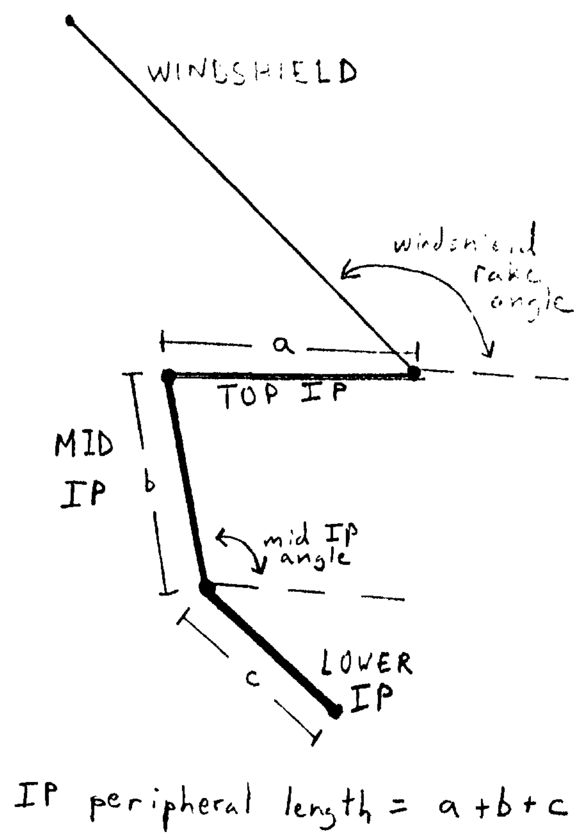
SUMMARY

"Occupant Protection in Interior Impact" is the title of Federal Motor Vehicle Safety Standard 201. More generally, it is the synthesis of occupant compartment geometry, energy absorbing materials on the interior surfaces of the compartment and the integrity and controlled crush of the entire vehicle structure. It is all the parts of a vehicle - other than the restraint system - which, if well designed, combine to make the occupant compartment a potentially safe environment even in a severe crash.

The instrument panel is the single most important component for protecting the unrestrained right front passenger in a frontal crash. It is the large interior surface immediately in front of the passenger, whose knees are almost certain to contact the lower instrument panel. The chest is likely to impact the mid panel and the head may rebound from the windshield and contact the top surface of the panel. Appropriate design and energy absorbing materials can lessen the injuries from these contacts. But the influence of the



panel is not limited to these direct contacts by the passenger. A panel with appropriate geometry and force deflection characteristics can help keep the unrestrained passenger in an upright position during the crash and reduce the severity of the interactions with the windshield, the roof header and other components.

During the 1960's and 1970's, the manufacturers gradually modified the instrument panels of cars and light trucks in ways believed to reduce the injury risk for unrestrained right front passengers in frontal crashes. Instrument panel tops were padded in most cars by the mid 1960's. Subsequently, Standard 201 required the padding in all cars as of January 1, 1968 and in light trucks after September 1, 1981. The manufacturers gradually reduced the rigidity of mid and lower instrument panels (although Standard 201, as promulgated, does not set requirements in those areas). The panels were extended back further toward the passenger and the knee impact area enlarged. Softer, larger panels were believed to be helpful in reducing direct contact injuries and to decelerate the passenger more evenly over a longer time period ("ride down"), also keeping him in an upright position.

Executive Order 12291 (February 1981) requires agencies to evaluate their existing regulations. The objectives of an evaluation are to determine the actual benefits - lives saved, injuries prevented, damage avoided - and costs of safety equipment installed in production vehicles in connection with a standard. Standard 201 is the regulation on performance of the instrument panel during interior impacts. As explained above, though, many of the actual modifications of instrument panels were made well in advance of Standard 201 or were in areas of the panel not specifically covered by the standard. One objective of this report is to evaluate the cumulative reduction of fatalities and injuries of unrestrained right front passengers in frontal crashes as a result of all the instrument panel modifications that have been gradually made in cars and light trucks since the early 1960's. The study also takes a preliminary look at the correlation between injury severity, for various body regions, and certain parameters describing the geometry and force deflection characteristics of instrument panels.

By now, NHTSA has published evaluations of nearly all major safety devices regulated by its safety standards, especially those which protect unrestrained drivers and/or right front passengers of passenger cars in frontal impacts - e.g. energy absorbing steering assemblies and High Penetration Resistant windshields. Each of the previous evaluations gave an estimate of the number of lives saved by a particular safety device. That makes it appropriate to add a second objective to this "evaluation of occupant protection in interior impacts for front seat occupants in frontal crashes." The goal is to estimate the cumulative reduction in frontal fatality risk for unrestrained drivers and right front passengers of cars of the 1980's, relative to cars of the 1960's - i.e., estimate the total of lives saved by <u>all</u> of the preceding safety devices combined <u>plus</u> the effects on crashworthiness of any other vehicle modifications that have not been evaluated or are not associated with a specific safety standard. For example, the change from rear wheel drive to front wheel drive in the 1980's is not connected to any particular safety standard but might nonetheless have safety implications if it affects vehicle crush characteristics. The analysis concludes the NHTSA evaluation of occupant protection in frontal crashes, addressing questions such as:

- o What is the net contribution of the vehicle modifications made during the 1960-84 period? When did the reductions take place?
- o Do the individual fatality reductions estimated for various safety standards in previous NHTSA evaluations add up to this evaluation's estimate of the overall reduction in fatalities from model year 1966 to 1969 (when most of those standards were implemented)?
- o Did cars get any safer after 1970, thanks to improvements not necessarily related to NHTSA's standards?

The evaluation for passenger car occupants consists of three analyses. First, National Crash Severity Study (NCSS) data were statistically analyzed to determine the risk of serious injuries specifically due to contact with the instrument panel, by model year (1960-78), for unrestrained right front passengers in frontal crashes. The analysis controlled for confounding factors such as differences in the crash severities of older and newer cars.

But panel modifications, as stated above, can even affect some of the injuries not directly due to panel contact. The second analysis gauges the effect of panel design on the right front passenger's overall injury risk, based on simulation of 5th, 50th and 95th percentile passenger interactions with the vehicle interior in 25-30 mph frontal barrier crashes, using the MVMA2D computer model. Crashes are simulated with instrument panels having the geometry and force deflection characteristics of cars of a wide range of model years (1965-83) and body styles - but with all other vehicle factors, such as the crash pulse, the materials of the windshield, etc. held constant. The trend, by model year, of the injury criteria predicted by these simulations, is thus in a sense attributable to changes in the instrument panel, since everything else is held constant. The simulations also permit a preliminary correlational analysis of various types of injury with instrument panel characteristics. Of course, the computer simulations of this report, which for the most part were not validated by actual crash tests, need to be interpreted cautiously and in particular should not be used for predicting the injury risk in specific makes and models of cars - but a large sample of simulations gives a good idea of the historical trend of injury risk.

The third analysis looks at the 16,000 fatal head on collisions of cars of two different model years on the Fatal Accident Reporting System (FARS) to see in each collision which driver is more likely to be killed - the one in the older car or in the newer car - taking into account such other factors such as the difference in vehicle weights, the drivers' ages, etc. The individual comparisons are combined into a model which predicts the unrestrained driver's fatality risk index as a function of model year, controlling for vehicle weight - and the decrease of this index from model year 1964 to 1984 estimates the cumulative reduction in frontal fatality risk, as a result of vehicle modifications (other than weight changes) during those years. The model is then extended to right front passengers. This approach using head on collisions eliminates most of the sources of bias that have often been present in earlier analyses to estimate fatality risk by model year: reporting biases, effects of factors other than vehicle modifications. When cars of two different model years collide head on, but with the same car weight, driver age, etc. and the fatalities occur consistently more often in the older car than in the newer one, the only conclusion is that the newer car is safer.

The study's most important results for unrestrained right front passengers of passenger cars are conveyed in Figures 1, 2 and 3. Figure 1 shows the relative risk of serious injury due to instrument panel contact, by model year (1960-78), based on the NCSS analysis. The average risk for 1971-78 cars is assigned a value of 100. Figure 2 shows the relative overall injury performance of instrument panels of different model years (1965-83) in the MVMA2D simulations. The measure of performance in Figure 2 cannot be translated into actual injury rates, but positive values mean higher injury risk and negative values, lower risk. Figure 3 shows the overall fatality risk index for unrestrained right front passengers in frontal crashes, by model year (1964-84). The average risk for 1973-84 cars is assigned the index value of 100. The three curves are derived from completely unrelated data sources and measure different types of risk, yet they all show nearly the same pattern: a large reduction (about 20 percent) of risk in cars of the later 1960's, followed by an additional smaller reduction (another 10 percent) in the early 1970's and a leveling off after that. These reductions coincide with the instrument panel modifications made by the manufacturers. It can be concluded that these modifications were effective in reducing injuries and fatalities -

FIGURE 1

SERIOUS INJURY DUE TO INSTRUMENT PANEL CONTACT, BY MODEL YEAR, NCSS, (1971-78 average = 100)

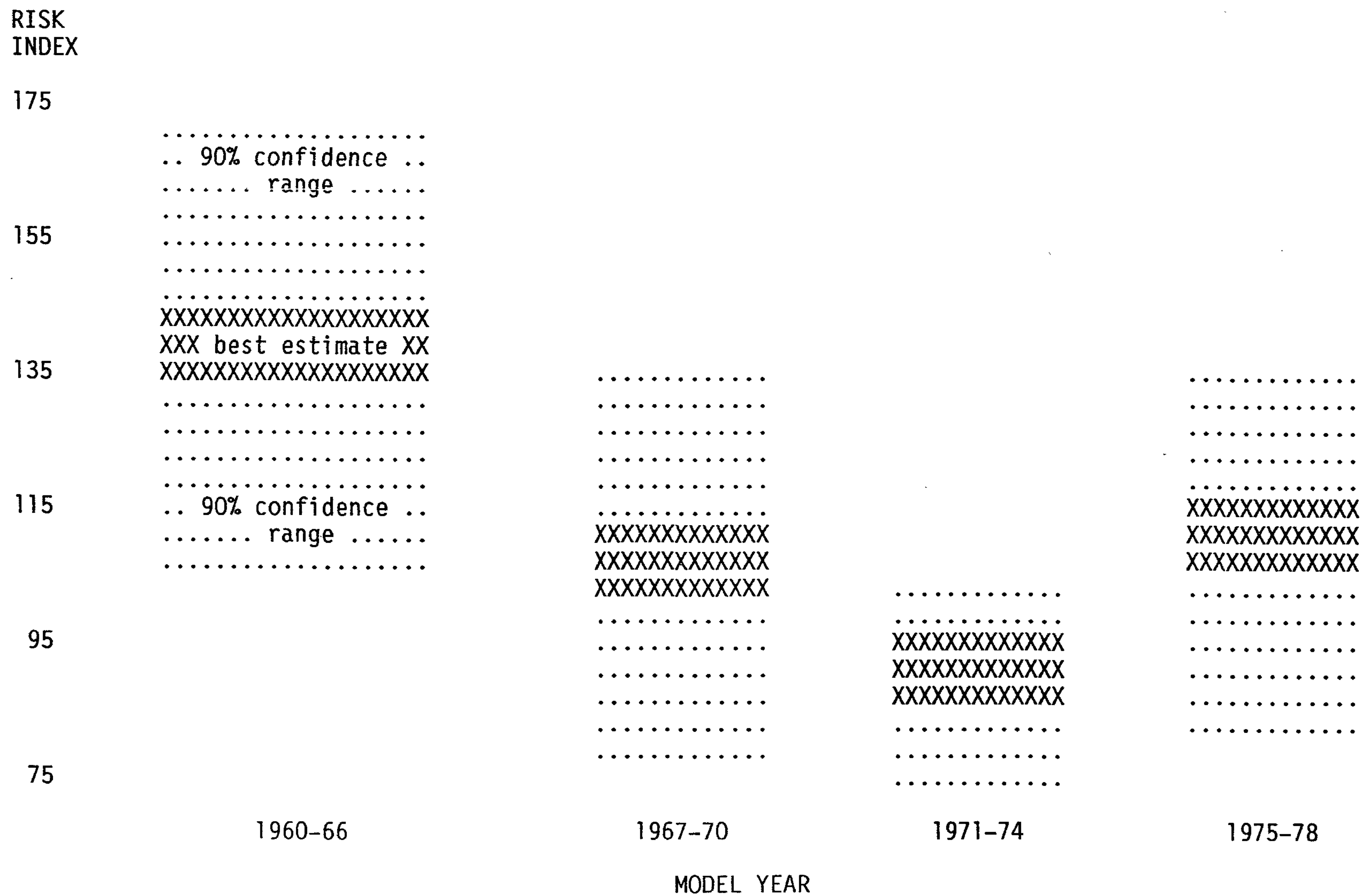


FIGURE 2: EFFECT OF INSTRUMENT PANEL DESIGNS ON OVERALL INJURY SCORE IN COMPUTER SIMULATIONS OF FRONTAL CRASHES

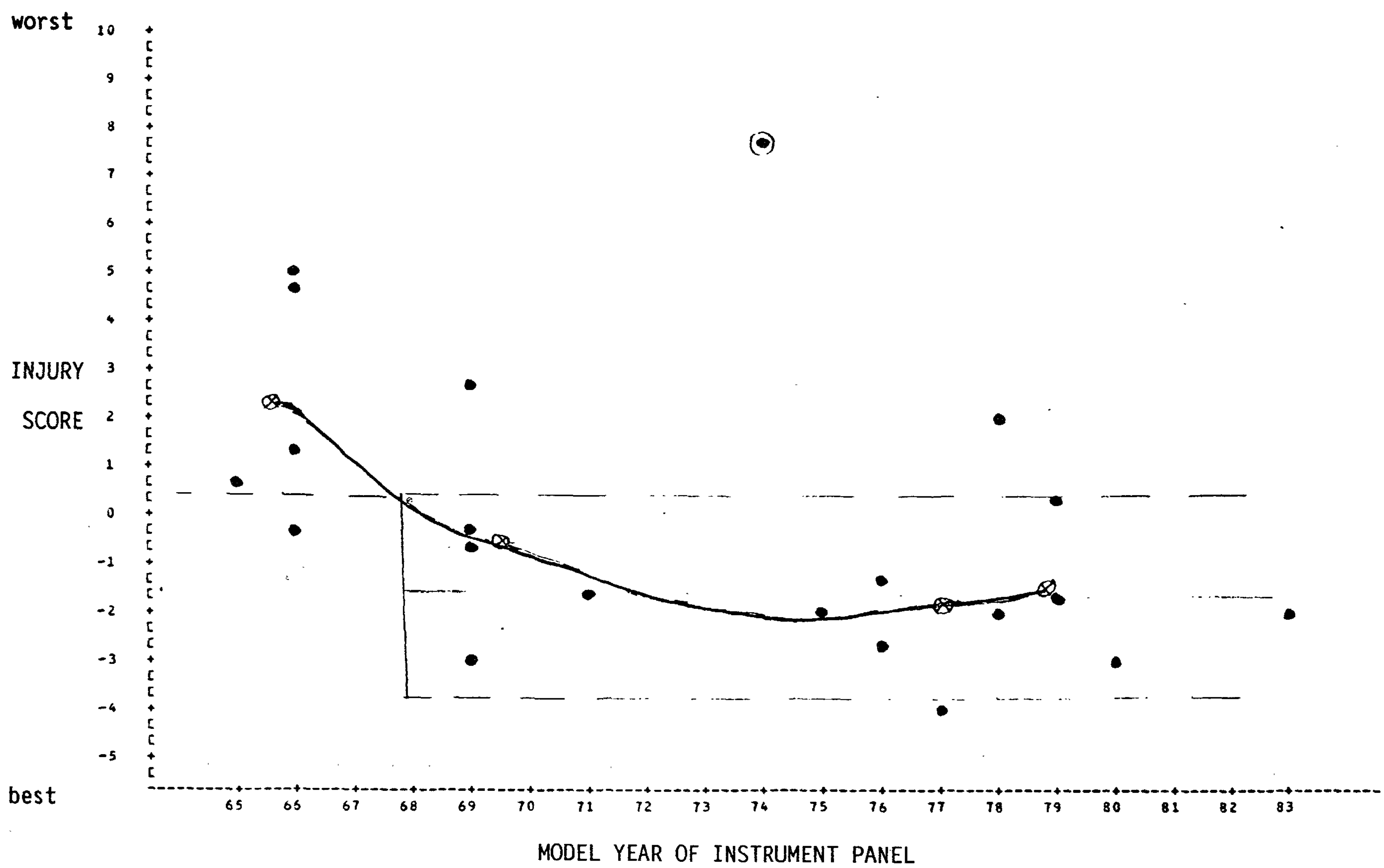
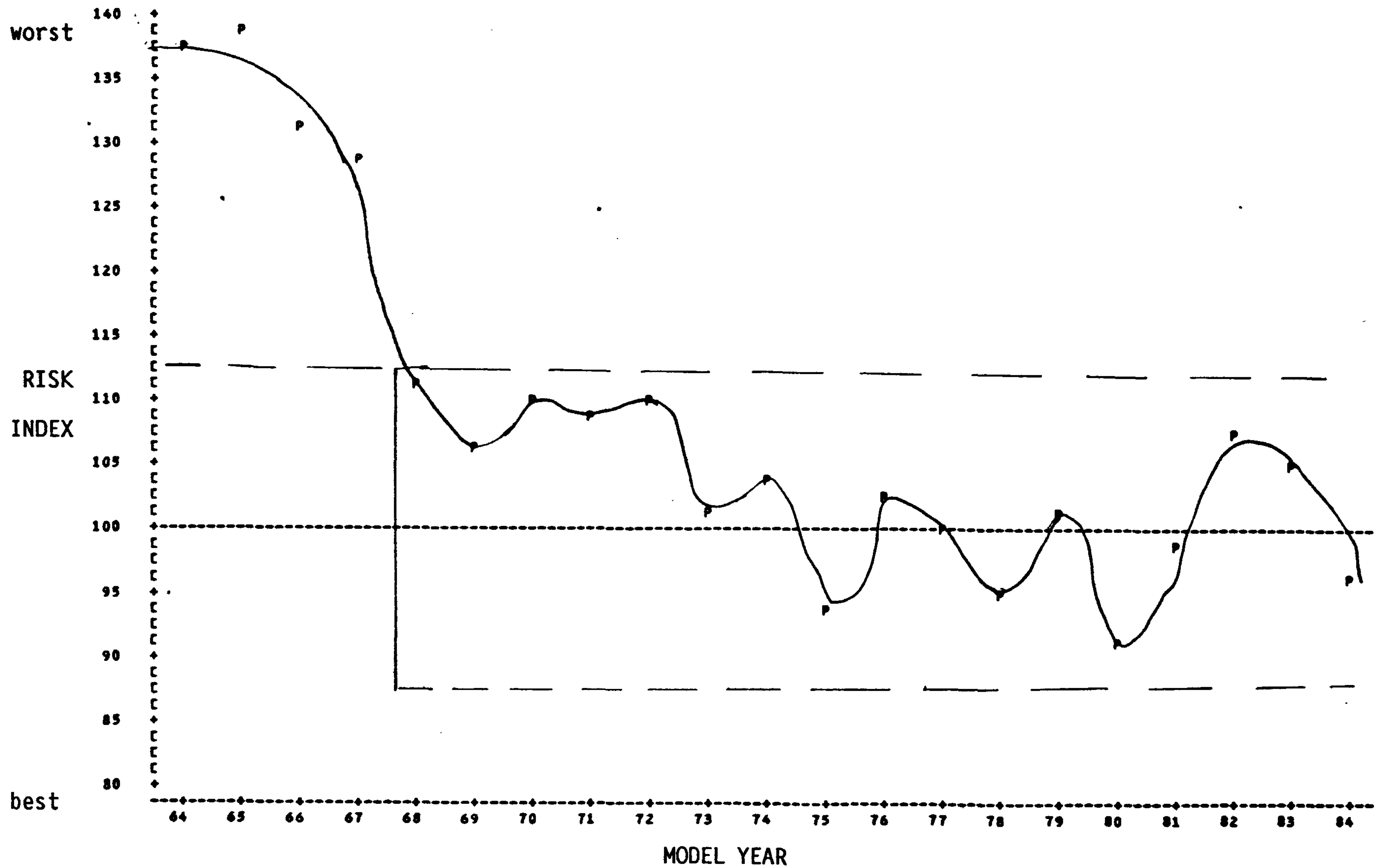


FIGURE 3: OVERALL FATALITY RISK INDEX FOR UNRESTRAINED RIGHT FRONT PASSENGERS IN FRONTAL CRASHES
(Adjusted for Car Weight Changes; 1973-84 Average = 100)



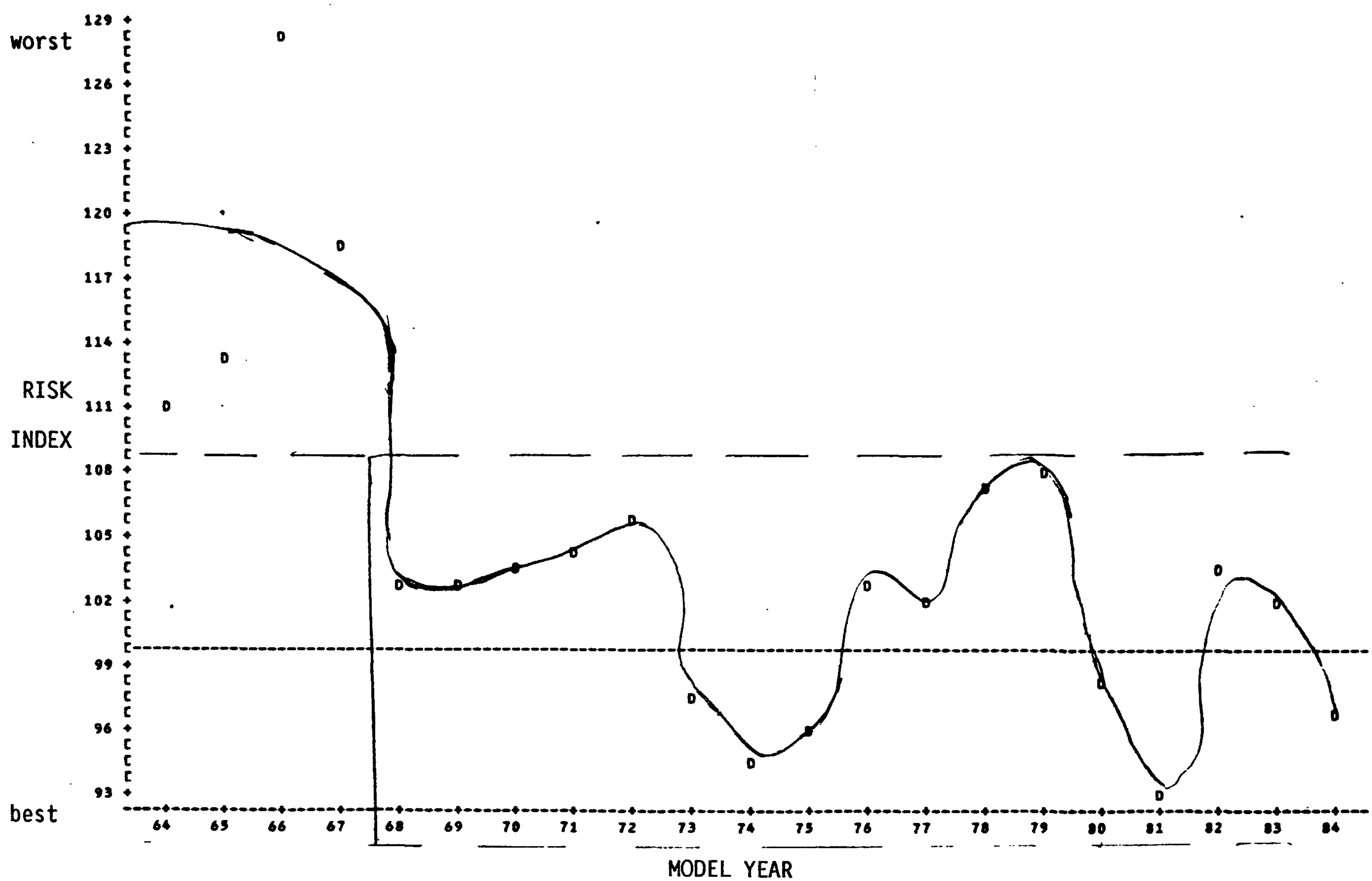
including, but not limited to the casualties specifically due to direct contact with the panel - and that a large proportion, if not most of the net reduction of overall fatality risk for right front passengers in frontal crashes is due to the panel modifications.

Figure 4 shows the overall fatality risk index for unrestrained drivers in frontal crashes, by model year (1964-84). The average risk for 1973-84 cars is again assigned the index value of 100. Figure 4 shows a large reduction (about 12 percent) in model years 1967-68, when energy absorbing steering assemblies were installed in passenger cars, with little net change from then on. The net difference between the 1964 and 1984 cars amounts to about 1300 driver fatalities per year - nearly the same as the reduction attributed by NHTSA's 1981 evaluation to the energy absorbing steering assembly. It seems that the energy absorbing steering assembly has been the vehicle modification of the 1964-84 period with the largest effect on unrestrained drivers' fatality risk in frontal crashes.

The study of light trucks included statistical analyses of injury rates in National Accident Sampling System (NASS) and NCSS data and a calibration of fatality risk indices similar to those for passenger cars. Because sample sizes were smaller, the results were not nearly as conclusive as for passenger cars.

The least firm section of this report is its use of computer simulations, generally not verified by crash or sled tests, to compare the injury risk with instrument panels of different model years. While the

FIGURE 4: OVERALL FATALITY RISK INDEX FOR UNRESTRAINED <u>DRIVERS</u> IN FRONTAL CRASHES
(Adjusted for Car Weight Changes; 1973-84 Average = 100)



simulations showed strong, intuitively reasonable correlations between certain types of panel design and high injury risk, it cannot be guaranteed that similar correlations would be found in real crashes. The FARS analysis for light trucks did not have precise curb weight data for the trucks. All of the NCSS, FARS and NASS analyses have relatively large sampling errors.

Although the evaluation concludes that instrument panel design has improved significantly since 1960, the panel still accounts for a large percentage of the serious injuries in frontal crashes. The major advances in biomechanics and simulation procedures during the past 10 years have encouraged NHTSA to undertake a research program on frontal protection for the right front passenger. An initial objective of that research is quantification of the injury consequences of changing various instrument panel design parameters - based in part on computer simulations which have been validated by crash or sled test data, a more accurate approach than the one used in this evaluation. The eventual goal is optimization of panel design.

Although the evaluation primarily investigates the safety of unrestrained occupants of cars of the 1960-84 era, it must not be forgotten that safety belts are the most important safety equipment introduced during that time. The effect of safety belts is not included in the fatality indices shown in Figures 3 and 4, but, regardless of the model year, belt users would have had a fatality risk far lower than unrestrained front seat occupants.

The principal findings and conclusions of the study are the following:

Principal Findings

Instrument panel as an injury source in 1970-78 passenger cars

- 56 percent of unrestrained right front passengers in frontal crashes who have nonminor (AIS 2 or greater) injuries receive at least one of these injuries from contact with the instrument panel; 44 percent receive all of their nonminor injuries from panel contact.

- 45 percent of nonminor instrument panel contact injuries are torso injuries; 18 percent involve the head or neck; 37 percent, the legs or arms.

- 47 percent of unrestrained right front passenger fatalities in frontal crashes receive at least one life threatening (AIS 4 or greater) injury from contact with the instrument panel; 27 percent receive all of their life threatening injuries from panel contact.

Instrument panel design changes - based on measurements in actual cars

- The rigidity of mid and lower instrument panels decreased steadily from model year 1965 to 1977.

- The vertical-longitudinal periphery of the instrument panel - i.e., the distance from the bottom of the windshield to the back of the dashboard to the lowest point on the panel (a + b + c on the diagram at the beginning of the Summary) - increased steadily from model year 1965 to 1977.

- In 1965-66 cars, the mid instrument panel slopes down and away from the passenger. By 1979, mid instrument panels were more nearly vertical or even sloped down and toward the passenger.

- The windshield is slightly more horizontal in cars of the late 1970's than in cars of the 1960's.

Instrument panel contact injury risk, by model year

- Let 100 be the average risk of nonminor (AIS 2+) injury due to instrument panel contact for unrestrained right front passengers in frontal crashes of 1971-78 model cars. The estimated risk index, by model year group is:

Model Years	Relative Risk Factor	90% Confidence Bounds
1960-66	140	109 to 171
1967-70	107	81 to 134
1971-74	90	76 to 104
1975-78	110	85 to 136

- Injury risk is 23 percent lower in 1967-70 cars than in 1960-66 cars.

- Injury risk is 29 percent lower in 1971-78 cars than in 1960-66 cars.

- The reduction from 1960-66 to 1967-78 cars is statistically significant. The differences among the three later model year groups are nonsignificant.

<u>Instrument panel design vs. injury risk, by model year (simulation results)</u>

- o Overall injury risk for unrestrained right front passengers in computer simulations of 25-30 mph frontal barrier crashes is significantly lower with 1969-71 and 1975-83 instrument panels than with 1965-66 panels. The 1975-83 panels may perform even slightly better than the 1969-71 panels.

- o Head and neck injury risk, femur injury risk and chest g's are significantly lower with 1975-83 panels than with 1965-66 panels.

- o Chest deflection, however, may be as severe or more severe with the 1975-83 panels than with the earlier panels.

<u>Correlation of injury with instrument panel parameters (simulation results)</u>

- o A preliminary analysis of the computer simulations (which for the most part were not validated by actual crash tests) shows lower overall injury risk in the cars whose panels protruded toward the passenger and downwards (large vertical-longitudinal periphery) and whose lower instrument panels could be crushed for many inches before they became rigid.

- o The least severe chest deflection was predicted in cars with soft mid instrument panels and hard lower instrument panels.

- o The lowest chest g's were predicted in cars with soft lower instrument panels.

- This study uses a head injury score based to a large extent on HIC. More favorable head injury scores were found in simulations of cars with more nearly horizontal windshields and soft lower instrument panels (which help keep the passenger in an upright position during the crash).

- Femur loads were lowest in cars with soft lower instrument panels. The panels also had a large vertical-longitudinal periphery and the mid instrument panel did not slope downward towards the passenger's knees.

- Since the more recent cars had softer, longer panels than cars of the mid 1960's, it is appropriate that they had lower predictions for every type of injury except for inconclusive results on chest deflection.

<u>Drivers' overall fatality risk index in frontal crashes, by model year</u>

- Let 100 be the average fatality risk for unrestrained drivers in frontal crashes of 1973-84 model cars. The estimated risk index, by model year group is:

Model Years	Relative Risk Index
1964-66	117
1968-70	103
1971-74	100
1975-78	102
1979-81	100
1982-84	101

The appropriate interpretation of the risk index is that if the fleet of 1964-66 cars had been replaced by a fleet of 1968-70 type cars with the same weights, driver ages, etc., there would have been only 103/117 as many driver fatalities in frontal crashes - i.e., a reduction of 12 percent.

- The fatality risk for unrestrained drivers is 12 percent lower in 1968-70 cars than in 1964-66 cars. It has remained almost constant since model year 1968.

- The 12 percent reduction in drivers' fatality risk in frontal crashes coincides with the installation of energy absorbing steering columns in 1967-68 cars - which an earlier NHTSA evaluation has credited with a 12 percent reduction of fatality risk in frontal crashes.

<u>Passengers' overall fatality risk index in frontal crashes, by model year</u>

- Let 100 be the average fatality risk for unrestrained right front passengers in frontal crashes of 1973-84 model cars. The estimated risk index, by model year group is:

Model Years	Relative Risk Index
1964-66	136
1968-70	109
1971-74	106
1975-78	98
1979-81	97
1982-84	103

- The fatality risk for unrestrained right front passengers is 20 percent lower in 1968-70 cars than in 1964-66 cars.

- The fatality risk for unrestrained right front passengers is 26 percent lower in 1973-84 cars than in 1964-66 cars.

- The big reduction of right front passengers' fatality risk in cars of the late 1960's, followed by a further, more gradual reduction in the early to mid 1970's, coincides with the manufacturers' modifications of instrument panels.

- In cars of model years 1960-65, right front passengers' fatality risk in frontal crashes was 25 percent higher than for the drivers of the same cars. Since model year 1971, driver and right front passenger fatality risk have been about equal.

<u>Lives saved per year by all frontal crashworthiness improvements in cars</u>

- The fatality risk index for unrestrained <u>drivers</u> in frontal crashes dropped from 117 in 1964-66 cars to 100 in 1973-84 cars. That is equivalent to <u>saving 1300 lives per year</u>.

- The overall benefit for drivers can be apportioned as follows:

	Lives Saved
Energy absorbing steering assemblies	1100 - 1300
All other vehicle modifications	0 - 200
	1300

- The fatality risk index for unrestrained <u>right front passengers</u> in frontal crashes dropped from 136 in 1964-66 cars to 100 in 1973-84 cars. That is equivalent to <u>saving 900 lives per year</u>.

o The overall benefit for right front passengers can be apportioned as follows:

	Lives Saved
Instrument panel modifications	400 - 700
Windshield glazing and mounting	100 - 300
All other vehicle modifications	0 - 400
	900

o All the passenger car modifications of the 1964-84 period, other than restraint systems, save a total of 2200 front seat occupant fatalities per year in frontal crashes.

Light trucks: injury risk by model year

o The NASS and NCSS files do not contain enough cases for finding meaningful trends in the nonminor injury rate in frontal crashes of light trucks, vans and multipurpose passenger vehicles. The observed injury rates are:

Model Years	Right Front Passengers	Drivers
	NASS AIS 2+ Injury Rate (%)	
1966-70	12.9	9.7
1971-74	7.4	7.5
1975-78	9.1	8.2
1979-81	12.3	10.7
1982-85	10.9	12.3
	NCSS Hospitalization Rate (%)	
1961-70	11.4	6.0
1971-74	7.6	10.8
1975-78	14.1	10.1

Light trucks: drivers' fatality risk index in frontals, by model year

o Let 100 be the average fatality risk for unrestrained drivers in frontal crashes of 1973-84 model light trucks, vans and multipurpose passenger vehicles. The estimated risk index, by model year group is:

Model Years	Relative Risk Index
1964-68	127
1969-72	116
1973-76	106
1977-81	98
1982-84	96

o The fatality risk for unrestrained drivers is 16 percent lower in 1977-81 trucks than in 1969-72 trucks. It has remained almost constant since model year 1977.

o The 16 percent reduction in drivers' fatality risk in frontal crashes coincides with the installation of energy absorbing steering columns in pickup trucks and the phasing out of forward control vehicles.

Light trucks: passengers' fatality risk index in frontals, by model year

o Let 100 be the average fatality risk for unrestrained right front passengers in frontal crashes of 1973-84 model light trucks, vans and multipurpose passenger vehicles. The estimated risk index, by model year group is:

Model Years	Relative Risk Index
1964-68	135
1969-72	114
1973-76	106
1977-81	97
1982-84	97

- The fatality risk for unrestrained right front passengers is 15 percent lower in 1977-81 trucks than in 1969-72 trucks and 28 percent lower than in 1964-68 trucks. It has remained almost constant since model year 1977.

- Throughout model years 1960-84, right front passengers' fatality risk in frontal crashes was consistently close to 10 percent lower than for the drivers of the same trucks.

Conclusions

- Instrument panel modifications, implemented by manufacturers on a voluntary basis during the later 1960's and early to mid 1970's, have significantly reduced the fatalities and serious injuries of right front passengers in frontal crashes.

- The safety literature of 1968-70 claims that instrument panels were becoming softer and extending further toward the passenger and the floor. Tests and measurements of instrument panels in production vehicles of the 1965-80 era show the claims are correct.

- The safety literature of 1968-70 claims that softer and more extensive instrument panels reduce injury risk by cushioning direct impacts, providing better ride down and keeping the passenger in an upright position during the crash. The computer simulations of crashes with production instrument panels support all of these claims.

- Cars of the 1970's are significantly safer than cars of the same weight from the mid 1960's for unrestrained front seat occupants in frontal crashes. But cars of the mid 1980's are about as safe in frontal crashes as cars of the same weight from the mid 1970's.

- Energy absorbing steering assemblies meeting Standards 203 and 204 are responsible for most of the improvement in frontal crashworthiness for unrestrained drivers in cars of the 1964-84 era.

- The manufacturers' voluntary improvements to instrument panels are responsible for most of the improvement in frontal crashworthiness for unrestrained right front passengers in cars of the 1964-84 era. Windshield modifications meeting Standards 205 and 212 account for a smaller share of the fatality reduction.

- No firm conclusions can be drawn on the frontal crashworthiness of light trucks. The preliminary analysis of fatal accident data showed promising reductions of risk during the early to mid 1970's, a time of major safety improvements to light trucks. But the small samples of nonfatal accident data do not show similar trends in the injury rates.

CHAPTER 1

INTRODUCTION AND BACKGROUND

1.1 Evaluation of NHTSA regulations and programs

Executive Order 12291, dated February 17, 1981, requires Federal agencies to perform evaluations of their existing regulations [18]. The evaluations should determine the actual costs and actual benefits of existing rules. More recently, Executive Order 12498, dated January 4, 1985, requires agencies to develop a regulatory planning process including publication of plans to review existing regulations pursuant to Executive Order 12291 [19].

The National Highway Traffic Safety Administration began to evaluate its existing Federal Motor Vehicle Safety Standards in 1975 [38]. Its goals have been to monitor the actual benefits and costs of safety equipment installed in production vehicles in response to standards. More generally, evaluations compare a standard's actual on the road performance and effectiveness with goals that may have been specified when the rule was initially promulgated - e.g., in its preamble, regulatory impact analysis, or other supporting documents - including analyses of possible benefits or impacts that had not been originally anticipated. The agency has published 16 comprehensive evaluations of safety standards or other vehicle programs to date. NHTSA intends to evaluate every one of its safety standards that can be associated with a tangible, clearly defined modification in production vehicles and whose costs and benefits can be measured by analyzing data on production vehicles.

1.2 Evaluation of Standard 201

Federal Motor Vehicle Safety Standard 201 "specifies requirements to afford impact protection for occupants" in interior impacts [5]. It took effect for passenger cars on January 1, 1968 and was extended to light trucks, vans and multipurpose passenger vehicles on September 1, 1981.

Standard 201 is commonly thought of as the safety standard responsible for "padded instrument panels" and other modifications to instrument panels. In particular, the standard is commonly associated with reducing the risk of injury for the right front passenger in frontal crashes. These perceptions engender some misconceptions about the standard. First, manufacturers' efforts to improve the safety of the interior compartment did not come about solely because of Standard 201. Instrument panels that were padded in some form or another were optional or standard on most makes and models of passenger cars by 1963 [4]. Second, Standard 201 is not limited to instrument panels, but sets energy absorption requirements for seatbacks, sun visors and armrests, too. As for instrument panels, the standard's requirements are limited to certain designated "head impact areas," which are typically just the top of the instrument panel. Finally, because of Standard 201's force limit (a 3 millisecond peak of 80 g's for a 15 pound headform in a 15 mph impact), mere padding is not sufficient to meet the standard; rather, the padding and the structure under it must meet a dynamic impact test.

The effect of Standard 201 on manufacturers' modifications of the interior compartment may reach beyond what is actually required by the standard. The original December 1966 Notice of Proposed Rulemaking contemplated force limits for the "knee" and "child" impact areas (i.e., the lower and mid instrument panel) [15], but they did not become part of the standard [57]. Again, in 1970, NHTSA proposed to add a knee impact test, forbid certain types of protrusions from the panel and extend Standard 201 to light trucks [16]. Only the extension to light trucks was eventually adopted and it did not take effect until September 1981 [17]. Even though Standard 201 did not finally adopt the requirements for mid and lower instrument panels, the proposals for such requirements more or less coincided with voluntary efforts by the manufacturers to improve those parts of the panel. Similarly, light trucks tended to meet Standard 201 many years before it was a requirement, in part, perhaps, because the extension to light trucks was proposed many years before it was promulgated [20]. Thus, in a wider sense, Standard 201 can be somehow associated with instrument panel improvements beyond those specifically mentioned in the standard.

1.3 Evaluation objectives

Standard 201 may be the last of the early (pre 1975) safety standards to be evaluated by NHTSA. As stated above, NHTSA intends to evaluate every standard that can be associated with tangible modifications to production vehicles and whose benefits are measurable by analyzing data on production vehicles. Most of the other early standards associated with safety devices having readily measurable, potentially significant benefits have been evaluated:

105 - dual master cylinders and front disc brakes [40]
108 - side marker lamps [34]
202 - head restraints [33]
203 - energy absorbing steering assemblies [32]
204 - steering column displacement [32]
205 - High Penetration Resistant windshields [36]
207 - seat back locks [39]
208 - manual safety belts [21], [37]
212 - adhesive bonding of the windshield [36]
213 - child safety seats [31]
214 - side door beams [35]
301 - fuel system integrity [47]

Standard 201 is harder to evaluate than the preceding standards because it is not associated with a single safety device but rather a series of evolutionary improvements to instrument panels. The dates of the improvements are not well known, varying from model to model and even within models. Many of the improvements were in areas not specifically regulated by the standard. Injury reductions cannot readily be isolated to specific panel modifications: the various components of the panel, plus other components of the car, work together as a unit to provide a safe, or unsafe, interior environment for the occupant. A series of simple "before - after" analyses of effectiveness, one for each specific panel modification, is impossible. Instead, the best that can be done is to track the relative safety of instrument panels in frontal crashes over a long range of model years: from the early 1960's to the early 1980's. This study is really a historical evaluation of occupant protection in frontal interior impact.

The evaluation for passenger car occupants consists of three analyses, ranging from the most specific to the most general. The first analysis (Chapter 2), based on National Crash Severity study data, specifically examines the proportion of right front passengers, involved in frontal towaway crashes, who have serious injuries due to contact with the instrument panel. How has the injury risk changed from model year 1960 through 1978?

Changes in instrument panel geometry or materials, however, can affect more than just the risk of injury due to contact with the instrument panel. For example, a panel that is small and far away from the passenger may not result in many direct contact injuries but may indirectly increase overall injury risk by leaving the passenger more exposed to contact with other components. The second analysis (Chapter 3) gauges the effect of instrument panel design on the right front passenger's overall injury risk. Statistical analysis of accident data would not be suitable here. Many vehicle factors besides the panel may affect the trend of overall injury risk from one model year to the next. The statistical analysis would not tell whether the panel changes or other vehicle modifications were responsible for the trend. Instead, computer simulations of occupant interactions with the vehicle interior, specifically the MVMA2D program [3], are used to isolate the effect of the panel. Crashes are simulated with instrument panels having the geometry and force deflection characteristics of cars of a wide range of model years (1965-83) and body styles - but with other conditions, such as the crash pulse, the seat position, and the materials of the windshield, etc. held constant. The variation of the injury criteria, from simulation to simulation, are thus in a sense attributable to changes in the instrument panel. The results of the analysis are expressed in <u>nonparametric</u> terms - i.e., they test if instrument panels of the 1970's are significantly safer than those of the 1960's, but do not tell how much safer or how many injuries are avoided. The current (1987) state of the art in computer simulations makes it unwise to carry through the injury criteria predicted by the simulations to actual injury rates when the simulations have not been "validated" by crash or sled tests with the vehicle being simulated. In other words, rather than estimating the occupant's actual injury risk as a function of model year, the analysis will compare the relative ranking of cars of different model years on a variety of injury criteria calculated by the simulations. The analysis can also examine the correlation between injury severity, for various body regions, and certain parameters describing the geometry and force deflection characteristics of instrument panels.

The third analysis (Chapter 4) goes beyond evaluating instrument panels and tracks the relative fatality risk of right front passengers <u>and</u> drivers in frontal crashes, by model year, for cars of model years 1964-84. Moreover, the fatality risk is controlled for vehicle weight differences, occupant age, belt usage, etc. In other words, for two cars of different model years, but having the same weight, occupants of the same age, involved in frontal crashes of the same severity, etc., the analysis predicts which of the cars has higher fatality risk. The analysis is performed because this is the last NHTSA evaluation of the major early frontal crashworthiness standards. Each of the previous evaluations gave an estimate of the number of lives saved by a particular safety device. This analysis estimates the total of lives saved by <u>all</u> of the preceding safety devices combined <u>plus</u> the effects on crashworthiness of any other vehicle modifications that have not been evaluated or are not associated with a specific safety standard. Two examples are the change from genuine to pillared hardtops in the 1970's and from rear wheel drive to front wheel drive in the 1980's. The change to pillared hardtops was not related to any particular standard, but may to a significant extent have been motivated by evidence that it would enhance safety. The change to front wheel drive was principally motivated by factors other than safety but could nonetheless have safety implications if it affects vehicle crush characteristics. The purpose of the analysis is twofold:

- o Is the sum of the fatality reductions ascribed by the NHTSA evaluations to the individual safety standards consistent with the actual reduction in overall fatality risk during the model years that the standards were mostly implemented (1966-69)?
- o Did cars get any safer after that, thanks to improvements not necessarily related to NHTSA's standards?

This evaluation is certainly not the first attempt to evaluate the net effectiveness of vehicle improvements during the past 20-30 years, based on aggregate analysis of fatality or injury rates by model year rather than summing up estimates of casualties saved by individual safety devices. The General Accounting Office [11], Graham [22], and Malliaris [41], among others, performed multivariate analyses on casualty rates per 100 crash exposed occupants, or 10,000 vehicle registration years, or 100,000,000 vehicle miles, as a function of model year and other variables. The studies, though, are believed to be biased because of two secular trends that are difficult to control for:

- o The "age" effect, whereby older cars tend to have higher reported casualty rates than new ones, because many of the low severity crashes of the older cars go unreported. Thus, there is a spurious reduction of injury risk for the cars of later model years.

- The "calendar year" effect. In order to circumvent the "age" effect, the comparison is limited, say, to cars of the same age, e.g., model year 1968 in calendar year 1970 vs. model year 1978 in calendar year 1980. But casualty rates, especially per 100,000,000 vehicle miles, have been dropping steadily for reasons primarily unrelated to the vehicle. Thus, the 1978 cars have a much lower casualty rate in 1980 than the 1968 cars did in 1970, because all cars had lower casualty rates in the later calendar years.

Since both of these secular biases tend to make the cars of later model years look safer, most of the earlier analyses exaggerated the benefits of safety improvements.

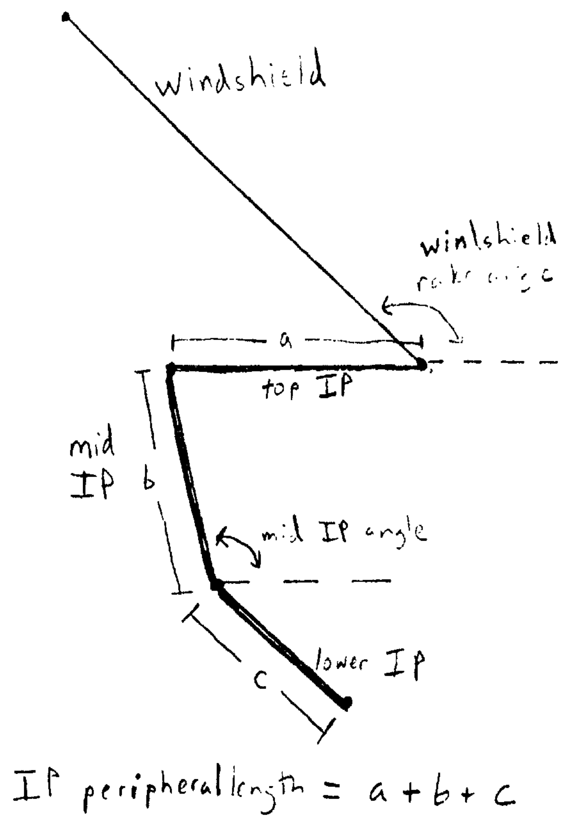
What makes a less biased analysis now possible is the accumulation of 12 years of Fatal Accident Reporting System (FARS) data, containing over 16,000 fatal head-on collisions of two passenger cars. When two cars meet head-on, both drivers have, as it were, been exposed to the same frontal crash and the likelihood of one driver vs. the other being killed can be predicted as a function of the <u>model years</u> of the two cars, the vehicle weights, the drivers' ages and belt usage, etc. The "age" and "calendar year" biases do not apply because the two cars are involved in the same crash.

Essentially, each head-on collision is used as one of the pairs in a "double pair comparison analysis [12]." Logistic regression with maximum likelihood estimation [29] is used to combine the results of all the individual double pair comparison analyses into a coherent model which estimates the relative fatality risk as a function of the vehicle's model year and other vehicle and occupant characteristics, as will be explained in Chapter 4.

The study of light trucks (Chapter 5) includes statistical analyses of injury rates in National Accident Sampling System and National Crash Severity Study data and a calibration of fatality risk indices similar to those for passenger cars. The accident samples, however, are much smaller than those for cars.

1.4 Instrument panel modifications, 1960-80

In a 30 mph frontal barrier impact of a typical vehicle, the average sized unrestrained right front passenger contacts the instrument panel with three body regions. About 60-70 milliseconds after impact, his knees contact the lower instrument panel and drive into it, forwards, at first, and later upwards because the rigid toeboard holds his feet and forces his knees to flex. If the lower panel is stiff and relatively close to the occupant, it can slow down the forward movement of his torso, substantially. At 80-90 milliseconds his head hits the windshield and rebounds downwards.



Close to 100 milliseconds after impact, the chest contacts the mid instrument panel. At about 110 milliseconds, the car has been fully decelerated and disengages from the barrier. Finally, around 130 milliseconds, his head, which had bounced off the windshield, strikes the top surface of the instrument panel. This sequence of impacts provides the framework for reducing injury risk by modifying the instrument panel.

Padding on instrument panels, installed for the purpose of reducing injury risk, first became available as optional equipment in 1956 [4]. By 1963, most cars could be purchased with some padding on the instrument panel, usually as an option but sometimes as standard equipment. By the time that Standard 201 took effect (January 1, 1968), most cars already had padded instrument panel tops. Biomechanics research of the 1960's made it clear that the thin, relatively soft padding typically used on instrument panels was of little value in protecting the chest or legs from blunt impact trauma. It might be useful for reducing head injuries in low severity impacts, but at higher crash severities padding alone is insufficient for head injury protection; there would have to be a carefully designed energy absorbing structure underneath the padding [25].

During the early 1960's it was envisioned that the lap belts then being installed in passenger cars would be widely used. The lap belt would keep the occupant's torso and legs away from the panel. The lap belted occupant would hit only the top of the panel with his head. The primary emphasis of research, as well as Standard 201, was on the energy absorption characteristics of the top of the panel.

Soon it became evident that most passengers, especially those who tended to get into severe crashes, were unrestrained. The instrument panel, rather than the lap belt, was now seen as the primary locus of the right front passenger's interaction with the vehicle interior in a frontal crash. The panel ought to be designed to dissipate the kinetic energy of the unrestrained passenger's torso and legs at a safe force level <u>and</u> hold the passenger in a posture that would minimize the probability of serious injury from other vehicle interior components. This approach to instrument panel design was articulated by Wilson at GM and Daniel at Ford in 1969 and 1970 papers [9], [58].

One of the most important safety improvements consistent with this approach was the gradual reduction of the rigidity of the mid and lower instrument panels during the 1960's and, to a lesser extent, the 1970's, as well [6], [58]. Panels were designed to deform at a controlled rate. Daniel explicitly set targets of 1200 pounds maximum force deflection for the chest in a 20 mph impact and 1400 pounds optimum for the knees in a 12 mph impact [9]. The latter would be low enough to prevent serious femur or pelvic injury but high enough to slow down the occupant's torso and reduce the speed of the chest to mid instrument panel impact to 20 mph or less. The 1200 pound load on the chest was considered tolerable and would give the panel the potential of protecting the unrestrained occupant in a 30 mph barrier crash. Happily, the understanding that less rigid panels were safer coincided with the increased availability and use of plastics as a partial substitute for more rigid steel. The ever increasing weight consciousness in car design was impetus for thinning steel panel structures.

Certain especially rigid and unsafe instrument panel designs were discontinued, such as the all die cast panel, the rigid "eyebrow" extension of the top of the instrument panel towards the occupant [8], and the panel which is a continuation of the firewall material.

Wilson and Daniel especially stress the concept of "ride down" [9], [58]. The closer the panel to the unrestrained occupant, the sooner the occupant will contact the panel in a crash. Early contact is advantageous because the car and its panel are still moving forward and the velocity difference between the passenger and the panel is not yet as great as it will be later. Since the passenger contacts the panel while the car is still moving forward, he and the panel together "ride down" the last part of the car's impact. Essentially, some of the occupant's kinetic energy is dissipated by the exterior vehicle structure rather than the panel or the occupant himself. Designers of the late 1960's sought ways to bring the instrument panel closer to the occupants and enhance ride down. It had to be done with subtlety, because vehicle seats are adjustable. If occupants find the panel so close that they cannot sit comfortably, they will adjust the seat backwards and lose the ride down advantage. Designers found ways to move panels closer to occupants without causing discomfort. The rear surface of the panel was made more nearly vertical, whereas previously the panel often protruded toward the occupant at the top and then swung away from the occupant at the chest and knee level. Interestingly, it is primarily the unrestrained passenger who benefits from being close to the instrument panel; the lap and shoulder belted passenger gets most of his ride down from the belt system and may be able to avoid head to panel contact if the panel is far enough away.

Instrument panels were lowered as cars were built with lower beltlines and the lower instrument panel was extended downwards. The advantages are twofold. Short occupants are less likely to contact the rigid mid instrument panel with their heads on their way forwards. A well defined lower instrument panel, extending fairly low, is well engaged by the knees and a large portion of the occupant's kinetic energy is dissipated through this contact. By the time the occupant's chest contacts the mid instrument panel, it has already been slowed down to some extent. By contrast, a narrow lower instrument panel, sloping away from the occupant, might be pushed out of the way rather than fully engaged by the knees and provide little energy absorption.

Researchers became aware of the role of the instrument panel in reducing the severity of contacts with other vehicle components. Daniel felt this was best achieved by keeping the occupant's "torso <u>in an upright position</u> while providing ample space for both head and chest deceleration at safe load levels [9]." Maintaining the torso in an upright position is a delicate task of fine tuning the relative positions and force deflection characteristics of the mid and lower instrument panels and the windshield. For example, if the lower panel is too prominent and rigid, the occupant will pitch forward, with greater head injury risk. But if the lower panel is too recessed and soft, the chest to mid panel impact will be severe.

Over the years, manufacturers have made an effort to remove knobs or other hard protrusions from parts of the instrument panel that are likely to be contacted by adults or children. The Insurance Institute for Highway Safety has been vigorous in alerting the safety community about hazardous protrusions from the panel [50].

It is noteworthy that panels were improved gradually, with different makes and models changing in different years and that most of these improvements were not necessitated by Standard 201. As Wilson reported in 1969, "Many other areas of the vehicle have been improved gradually over the years. The knee impact region of the instrument panel is one such area. Lower instrument panel improvements, while not as well publicized as those made in windshields and [steering] columns, have nonetheless reduced lower extremity and hip injuries significantly [58]."

Force deflection tests and measurements were performed on 21 actual instrument panels of cars ranging from model year 1965 to 1983 (Chapter 3). That makes it possible to check if instrument panels were indeed modified in the ways described above.

Although instrument panel design has improved significantly since 1960, the panel still accounts for a large percentage of the serious injuries in frontal crashes, as discussed in the next section. The major advances in biomechanics and simulation procedures during the past 10 years have encouraged NHTSA to undertake a research program on frontal protection for the right front passenger. Primary objectives of that research will be a quantitative evaluation of the injury consequences of changing various instrument panel design parameters, followed by optimization of panel design [6].

1.5 Injury risk due to instrument panel contact

Huelke conducted in-depth investigations of crashes involving model year 1961-65 cars and found the instrument panel responsible for 13 of the 45 right front passenger fatalities [27]. That is 29 percent of all fatalities and the overwhelming majority of the deaths in frontal crashes.

Malliaris, Hitchcock and Hedlund analyzed NCSS data (principally cars of the 1970's and late 1960's) and found that the instrument panel accounts for 11.2 percent of the "harm" occurring to all passenger car occupants in all crashes [42]. The panel ranks third as a source of harm; only the steering assembly and occupant ejection rank higher. The panel is the most important cause of harm to legs and arms, accounting for 30 percent of the harm.

Tables 1-1 and 1-2 take a more detailed look at the injuries for cars of model years 1970-78 on NCSS. The first column of Table 1-1 examines the occupants most likely to contact the instrument panel: right front passengers in frontal crashes. Among passengers who had at least one nonminor (AIS 2 or greater [1]) injury, 41 percent sustained nonminor injuries only from contacting the instrument panel. An additional 7 percent had nonminor injuries from the panel and from another source, but

TABLE 1-1

ROLE OF INSTRUMENT PANEL AS SOURCE OF AIS 2+ INJURIES

NCSS, Cars of MY 1970-78	Right Front Passengers		Drivers	
Percent of Persons with AIS 2+ Injuries (Known Contact Points)	Frontal Crashes	All Crashes	Frontal Crashes	All Crashes
AIS 2+ inj. from panel only	41	30	9	7
Most severe AIS 2+ from panel Less severe AIS 2+ elsewhere	7	5	4	3
Most severe AIS 2+ not from panel Secondary AIS 2+ from panel	8	7	17	12
AIS 2+ from other sources only	44	58	70	78
	100	100	100	100
N of injured persons in sample	300	525	755	1312

TABLE 1-2

ROLE OF INSTRUMENT PANEL AS SOURCE OF FATAL INJURIES

NCSS, Cars of MY 1970-78	Right Front Passengers		Drivers	
Percent of Persons with Fatal Injuries (Known Contact Points)	Frontal Crashes	All Crashes	Frontal Crashes	All Crashes
Fatal inj. from panel only	27	17	4	3
Life threatening injuries from panel and other sources	20	11	10	6
Fatal inj. from other sources only	53	72	86	91
	100	100	100	100
N of fatalities in sample	15	54	82	156

the panel contact resulted in a higher AIS than the other sources. Thus, 48 percent received their most severe injury from the panel and would have a lower maximum AIS if the panel injury could be ameliorated. Yet another 8 percent had nonminor injuries from the panel and from other sources, but the AIS from the panel did not exceed the AIS from other sources. In other words, a majority of 56 percent of right front passengers in frontal crashes with AIS 2+ injuries included the instrument panel among their AIS 2+ injury sources.

When nonfrontal crash modes are included (second column of Table 1-1), the proportion of right front passenger injuries due to the panel is of course lower. Drivers have a much lower risk than right front passengers of sustaining their primary injury from the panel (13 percent of drivers vs. 48 percent of passengers sustained their most severe AIS from the panel in frontal crashes). But 17 percent of drivers had a secondary nonminor injury from the panel, so a total of 30 percent of the drivers with AIS 2+ injuries in frontal crashes had an AIS 2+ injury from the panel.

Table 1-2 shows that the instrument panel is slightly less common as a source of fatal injury than for nonfatal AIS 2-5 injuries. The first column shows that 27 percent of the right front passengers killed in frontal crashes sustained their highest AIS from the panel and did not sustain a life threatening injury (AIS 4-6) from any other source. These fatalities are the most likely to be saved by panel improvements. An additional 20 percent of the fatalities had life threatening injuries from the panel and from other sources. Thus, a total of 47 percent of the right front passenger fatalities in frontal crashes had life threatening injuries from contacting the panel. For drivers, this total is 14 percent, with only 4 percent sustaining life threatening injuries from the panel and no other sources.

The NCSS file contained 245 individual AIS 2+ injuries due to instrument panel contact for right front passengers in cars of model years 1971-78 in frontal crashes. The distribution of these injuries by body region is:

Head or neck	18 percent
Chest, abdomen or pelvis	45 percent
Legs or arms	37 percent

1.6 Review of previous effectiveness studies

Campbell performed "A Study of Injuries Related to Padding on Instrument Panels" in 1963 [4]. At that time, padding was available as an option on most cars. He found records of 792 front seat passengers of cars with padding among the frontal crashes on the Automotive Crash Injury Research file. For each of these persons he found a matching case: a passenger in a car without padding of the same make and model year, with similar crash severity and occupant characteristics. This is an excellent technique for analyzing a large but biased file like ACIR. The passengers with the padded instrument panels had a statistically significant reduction of head injuries relative to their counterparts in the unpadded cars, while both groups had about the same risk of neck, thorax, abdomen, arm and leg injuries. They had 24 percent fewer head injuries of AIS severity level 2 or greater.

Nahum et al had been conducting in depth investigations of selected accidents since 1962 at UCLA. In 1968, they examined the risk of leg injury due to instrument panel contact, as a function of model year [45]. Among 251 front seat occupants of cars of model years 1957-64, 40 had leg injuries of AIS severity level 2 or greater, due to instrument panel contact. Only 10 of 213 occupants of cars of model years 1965-67 had such injuries. That is a 71 percent reduction of leg injury risk. The effectiveness estimate is undoubtedly exaggerated, however, due to uncorrected biases in the data. In the later years, UCLA was investigating accidents that were, on the average, less severe than their earlier samples. Thus, there are substantial spurious or exaggerated reductions of almost all types of injuries, in their data, for newer cars [44].

NHTSA performed a preliminary evaluation of the effect of Standard 201 in passenger cars as part of its 1979 Regulatory Evaluation for extending the standard to light trucks [20], p. 27. Simple tabulation of National Crash Severity Study (NCSS) data showed that occupants of pre Standard 201 cars (model year 1967 and earlier) had a 1.27 percent likelihood of injuries of AIS 3 or greater involving contact with one of the components subsequently regulated by Standard 201 (instrument panels, seatbacks, armrests or sunvisors). Occupants of post Standard 201 cars had a 0.81 percent injury risk. That is a 36 percent reduction in the risk of serious injuries due to contact with components regulated by Standard 201. Next, the Regulatory Evaluation assumes "that the equipment used to meet the requirements of FMVSS 201...were the only forces acting to reduce the occupant injury level of the post 1968 models for occupants who hit the FMVSS 201...components [20], p.32." In fact, the discussion of Section 1.4 shows that some of the most important instrument panel improvements of the late 1960's were in the geometry and force deflection characteristics of the chest and knee impact areas and were not directly mandated by Standard 201, even though they were implemented in passenger cars at about the same time as the standard. If the extension of Standard 201 to light trucks were to be accompanied by corresponding voluntary improvements to the chest and knee impact areas of light trucks then it might be reasonable to predict, as the Regulatory Evaluation does, that the extension of Standard 201 to light trucks would be accompanied by a serious injury reduction from Standard 201 components on the order of 36 percent (except in the 44 percent of light trucks believed to "already comply" with Standard 201). But if the knee and chest improvements had already been implemented years before Standard 201 took effect for light trucks, the primary injury reduction could be expected in the model years when the improvements were made rather than at the time that Standard 201 officially took effect.

CHAPTER 2

ANALYSES OF NCSS DATA

National Crash Severity Study (NCSS) data on unrestrained right front passengers of cars involved in frontal crashes were divided into four groups according to the age of the cars: model years 1960-66, 1967-70, 1971-74 and 1975-78. The rate of instrument panel contact injury - specifically, the number of AIS 2 or greater injuries per 100 crash involved occupants - was computed for each group. The injury rates were adjusted with control variables in order to correct for potential biases in the NCSS data. The adjusted injury rates in the three later groups were significantly lower than in the 1960-66 cars, with reductions in the 20 to 35 percent range.

2.1 Description of the NCSS data

Since 1977, NCSS has been a primary source of detailed information on vehicle and injury performance in highway accidents involving passenger cars. NCSS is a probability sample of 12,050 towaway accidents which occurred during 1977-79 and were investigated by 7 multidisciplinary teams. A detailed description of NCSS may be found in [49].

In this report, NCSS is used to study unrestrained right front passengers' risk of nonminor injury, due to instrument panel contact, in frontal crashes. Did the risk change for more recent model year cars, as the panels were gradually modified, for the group of occupants most likely to be affected by the modifications? As explained in Chapter 1, many small changes were made to instrument panels, in different model years in different cars. It is not meaningful to designate a single "transition" model year - e.g., the year in which Standard 201 took effect (1968) and compare injury risk in the years immediately before and after the transition, as was done, for example, in NHTSA's evaluations of windshield improvements [36] or seat back locks [39]. It is more appropriate to calculate the injury risk for cars of each model year and to track the trend in the injury rate over the 1960-78 model year range represented in NCSS. In particular, since NCSS does not contain enough cases for statistically meaningful injury rates for a single model year, it is best to group several adjacent years. Thus injury risk is computed for cars of model years 1960-66, 1967-70, 1971-74 and 1975-78. The year 1966 is the earliest cutoff that can be used for the oldest group and still make it large enough to have enough cases for statistically meaningful injury rates; the last three groups are of roughly equal size on NCSS.

NCSS codes the injury location, type, severity (AIS [1]) and contact source for up to 6 injuries per occupant. The contact source codes in NCSS are detailed and divide the instrument panel into subregions. Since the objective is to study overall nonminor (AIS 2 or greater) injury risk due to contact with the panel or any structures on or underneath it, the following NCSS codes for contacts with subregions of the panel are all included among "instrument panel contact injuries":

1 Instrument panel
4 Glove compartment area
5 Hardware items (ashtray, instruments, knobs, keys)
6 Heater or A/C ducts
7 A/C or ventilating ducts
10 Radio

NCSS is not a simple random sample but a stratified sample with 4 strata and unequal sampling proportions: 100, 25, 10 and 5 percent. Cases from the 4 strata are counted 1, 4, 10 or 20 times, respectively, in tabulations of NCSS data. As a result, the cell entries in some NCSS tables are much larger than would appear at first glance. Over 95 percent of the observed AIS 2 or greater injuries in NCSS come from the 100 percent sampling stratum. Yet the remaining 5 percent, because of their higher weight factors, contribute disproportionately to sampling variances of NCSS statistics. For that reason, injuries of passengers who were not killed or hospitalized (or were not in the 100 percent sampling stratum) are considered "minor" even if they were AIS 2. This somewhat artificial threshold of "nonminor injury" is indispensable for statistically meaningful results (see [32], pp. 146-149).

The measure of injury risk used with NCSS is the number of individual AIS 2 or greater <u>injuries</u> due to panel contact per 1000 unrestrained right front <u>passengers</u> involved in frontal towaway crashes. For example, if there are 10 passengers and 9 are uninjured while the tenth is hospitalized and has an AIS 2 head injury and an AIS 3 chest injury from contacting the panel, the injury risk is 200 per 1000 passengers.

2.2 Unadjusted injury rates by model year group

Table 2-1, which is based on simple computation of the injury rates in (weighted) raw NCSS data, shows lower injury risk in the newer cars. There were 953 (weighted) unrestrained right front passengers in frontal crashes of cars of model years 1960-66. Within that group, the

TABLE 2-1

NONMINOR INSTRUMENT PANEL CONTACT INJURIES*, BY MODEL YEAR
UNRESTRAINED RIGHT FRONT PASSENGERS OF PASSENGER CARS,
IN FRONTAL CRASHES, NCSS

Model Years	n of Injuries*	Weighted N of Passengers	Injuries per 1000 Passengers	Reduction Rel. to MY 60-66 (%)
1960-66	58	953	60.86	
1967-70	107	2323	46.06	24
1971-74	125	3001	41.65	32
1975-78	120	2174	55.20	9

*Individual injuries rated AIS 2 or greater, due to contact with the instrument panel, glove compartment area, instrument panel hardware, radio or ducts behind the panel, among persons who were hospitalized. A passenger may have up to 6 such injuries.

hospitalized passengers had among them 58 nonminor injuries involving contact with the instrument panel. That is an injury rate of 60.86 per 1000 passengers. For model years 1967-70, there were 107 injuries among 2323 passengers, an injury rate of 46.06 per 1000. The injury rate for the 1967-70 cars is 24 percent lower than in the 1960-66 cars. Similarly, the observed injury rate in the 1971-74 cars is 32 percent lower than in the 1960-66 autos and in the 1975-78 cars it is 9 percent lower than in the oldest model year group.

Injury rates computed directly from NCSS data, however, tend to give biased effectiveness estimates, especially when old cars are compared to new ones. One kind of bias, present on many accident files, stems from the fact that older cars tend to have more "severe" crashes than newer ones; that inflates the injury rates in the older cars and exaggerates effectiveness estimates [38]. There is an even stronger bias in the opposite direction, unique to NCSS injury rates involving contacts with specific components [32], pp. 142-145. The NCSS teams with the highest rates of missing data on injury contact source also happened to be located in areas where a large percentage of the cars on the road are 10 or more years old. Thus, the older cars have an artificially low reported <u>instrument panel contact</u> injury rate because so many of the panel contact injuries are reported as being of unknown source. In the newer cars, the reported injury rates are closer to the true rates; the reduction of risk from older to newer cars is understated.

For unbiased estimates of the effect of instrument panel changes on injury risk, it is necessary to adjust the injury rates in Table 2-1 to account for differences in the crash severities of the newer and older cars as well as the team to team differences in contact point reporting rates.

2.3 Adjustment of the NCSS injury rates

The modeling procedure used to adjust the NCSS injury rates is iterative selection of control variables. The procedure, which resembles stepwise regression, was developed in NHTSA's evaluation of energy absorbing steering assemblies [32], pp. 164-183 and refined in the evaluation of side door beams [35], pp. 225-252. It can be used here with minor changes.

2.3.1 Adjustment procedure

The starting point is the set of four unadjusted injury rates shown in Table 2-1. A list of potential control variables, defined below, is drawn from the NCSS data elements. For each potential control, the (weighted) occupant count N_{ij} is tabulated for each of the 4 values i of model year group and each value or class interval j of the control group. The injury count n_{ij} is likewise tabulated. Table 2-2 works out the procedure, as an example, for the control variable, "passenger age." The actual N_{ij} and n_{ij} are shown in the two left columns of the top section of the table. An artificial 3 way contingency table of model year by control variable by injury is formed by defining

$$C_{ij1} = n_{ij}$$

to be the count of injuries and

TABLE 2-2

EXAMPLE: PASSENGER AGE AS A CONTROL VARIABLE

Model Years	Weighted N of Passengers	n of Injuries	N of Passengers Minus n of Injuries
ACTUAL DATA			
		AGE LESS THAN 35	
1960-66	752	38	714
1967-70	1801	59	1742
1971-74	2443	77	2366
1975-78	1626	51	1575
	6622		
		AGE 35 OR MORE	
1960-66	201	20	181
1967-70	522	48	474
1971-74	558	48	510
1975-78	548	69	479
	1829		
SMOOTHED DATA			
		AGE LESS THAN 35	
1960-66	752	32.7	719.3
1967-70	1801	57.5	1743.5
1971-74	2443	74.4	2368.6
1975-78	1626	60.3	1565.7
	6622		
		AGE 35 OR MORE	
1960-66	201	25.3	175.7
1967-70	522	49.5	472.5
1971-74	558	50.6	507.4
1975-78	548	59.7	488.3
	1829		

ADJUSTED EFFECTIVENESS		Adjusted "Expected" Injuries	Adjusted Reduction (%)
1960-66	6622(32.7/752) + 1829(25.3/201) =	518.17	
1967-70	6622(57.5/1801) + 1829(49.5/522) =	384.86	25.7
1971-74	6622(74.4/2443) + 1829(50.6/558) =	367.52	29.1
1975-78	6622(60.3/1626) + 1829(59.7/548) =	444.83	14.9

$$C_{ij2} = (N_{ij} - n_{ij})$$

to be the count of passengers minus the count of injuries. In Table 2-2, the contingency table is formed by the two right columns in the top section labeled "actual data." The cell entries of the 3 way table C_{ijk} are smoothed by the BMDP4F multidimensional contingency table analysis program [10]. In Table 2-2, the smoothed data are shown in the two right columns in the middle section of the page labeled "smoothed data." The marginals of the <u>four</u> model year groups are adjusted (using the smoothed cell entries) to have the same distribution of the control variable. The injury reduction for the three later model year groups, relative to the 1960-66 cars, are recalculated using the "expected" cell entries, resulting in effectiveness estimates R_2, R_3 and R_4 superseding the estimates of 24.3 percent, 31.6 percent and 9.3 percent obtained from the unadjusted data (Table 2-1). The calculation of the "expected" n of injuries and the adjusted effectiveness estimates is carried out in the last section of Table 2-2. Let

$$D_2 = R_2 - 24.3, \quad D_3 = R_3 - 31.6, \quad D_4 = R_4 - 9.3$$

be the deviations of the new estimates from the earlier ones and let D be the sum of the <u>absolute values</u> of these deviations. In Table 2-2,

$$D = 1.4 + 2.5 + 4.9 = 8.8$$

D is a measure of how much the control variable influences the effectiveness estimates. The control variable which results in the greatest value of D is chosen as the <u>first</u> control variable. This is the "first step" of the "stepwise regression." The remaining control variables are scanned. Those for which D has a value of less than 5 percent are not used in later steps, for they have little influence on the effectiveness estimate.

Next, for each of the control variables still in the running, form the artificial 4 way table of model year group, by the first control variable, by that variable, by count of injuries/count of passengers minus count of injuries. The cell entries are again smoothed, the marginals adjusted and the injury reductions recalculated. Let D* be the sum of the absolute values of the deviations of the recalculated injury reductions from those obtained in the previous step. The control variable which results in the greatest value of D is chosen as the <u>second</u> control variable. This is the "second step." The process continues until none of the remaining control variables produces D as large as 5 percent or until all tables have too many cells for the amount of data available (viz., fewer than 5 injury cases per cell). The injury reductions calculated in the last step are the <u>adjusted</u> estimates of effectiveness based on NCSS.

2.3.2 Control variables

Eight potential control variables were analyzed. The variables and their categories or class intervals as used in the analysis were the following:

- NCSS team (Calspan, HSRI, Indiana - Miami, Kentucky, SWRI, Dynamic Science)
- Delta V (less than 20 mph, 20 mph or more)
- Principal Direction of Force (12:00, other)
- Vehicle or object struck (collision with car or light truck, collision with heavy truck or single vehicle crash)
- Damage - horizontal location (centered damage - 2nd letter or Collision Deformation Classification [7] is D or C, other)
- Vehicle weight (less than 3650 pounds, 3650 pounds or more)

- o Passenger age (5 to 34 or unknown, 35 or more)
- o Sex (male, female)

Where continuous variables were divided into two class intervals (Delta V, vehicle weight, age), the boundary was placed at the median value for the injuries in the 1960-66 cars. When categorical variables were collapsed to two categories (PDOF, vehicle/object struck, damage - horizontal location), the approach was to group the "more severe" and the "less severe" categories and to split the 1960-66 injury cases as evenly as possible between the two groups.

The Indiana and Miami teams are grouped into a single category because they had nearly identical vehicle age distributions <u>and</u> missing data rates on contact points [32], p. 144.

Delta V is estimated on NCSS by the CRASH program [43] and is missing in about 41 percent of frontal impacts. When Delta V is estimated on NCSS, that estimate is used here. When Delta V is missing, a rougher approximation is obtained, for use in this analysis, from the Collision Deformation Classification (CDC) of the damaged vehicle. As in NHTSA's evaluation of child safety seats, the approximation consists of two steps [31], pp. 221-222. First, the CRASH program is executed, using the CDC of the case vehicle and assuming the damage is the result of impacting a rigid immobile fixed object [43], pp. 5, 20-22. The result DV^H of this first step, however, usually overestimates Delta V in comparison with a reconstruction based on the full CRASH program [31], p. 222, perhaps because CRASH overestimates the extent of damage that occurs in the "average" car with a given CDC. The second step is to obtain a best estimate DV, by the formula

$$DV = 4.645 + .7082\ DV^{H}$$

which is a regression equation derived by comparing DV^{H} to the Delta V actually reported on NCSS, for those cases where it was estimated by the full CRASH program. Since all NCSS cases which were known to be frontal also had a full CDC, there were no missing data on the Delta V variable used in this analysis.

Cases were not used in the analysis if they had missing data on the weight of the vehicle or the passenger's sex or if they were vehicle to vehicle collisions and the type of the other vehicle was unknown. Child passengers less than 5 years old as well as all restrained passengers were excluded since their injury mechanisms are quite different from unrestrained adults.

2.3.3 Results

NCSS Team was by far the most influential control variable in the first step of the adjustment procedure. Table 2-3 shows that the effectiveness estimate for each of the three later model year groups, relative to the 1960-66 cars, increased substantially after adjusting for NCSS team. The injury reduction for 1967-70 cars relative to 1960-66 cars was 24.3 percent in the unadjusted data (first line of Table 2-3) and 33.7 percent after adjusting for team to team differences (2nd line of Table 2-3). For the newer cars, the bias was even greater: effectiveness in the 1971-74 cars rose from 31.6 to 42.3 percent (+10.7) and in the 1975-78

TABLE 2-3

ADJUSTMENT OF INSTRUMENT PANEL INJURY RATES BY CONTROL VARIABLES
(AIS 2 or greater injuries per 100 occupants,
right front passengers of passenger cars, NCSS)

Control Variable		Injury Reduction Relative to 1960-66 Cars							
		1967-70 Cars		1971-74 Cars		1975-78 Cars			
First	Second	Obs. Red.	Change in Red.	Obs. Red.	Change in Red.	Obs. Red.	Change in Red.	Sum of Changes	Disposition of Control Variable
NO CONTROL VARIABLES		24.3		31.6		9.3			
NCSS team		33.7	+9.4	42.3	+10.7	29.7	+20.4	40.5	✓
Delta V		17.4	-6.9	29.6	-2.0	13.8	+4.7	13.6	
Sex		25.2	+0.9	34.6	+3.0	14.3	+5.0	8.9	
Passenger age		25.7	+1.4	29.1	-2.5	14.2	+4.9	8.8	
PDOF		21.6	-2.7	29.5	-2.1	5.3	-4.0	8.8	
Vehicle weight		27.1	+2.8	32.7	+1.1	10.4	+1.1	5.0	
Veh./obj. struck		25.2	+0.9	31.3	-0.3	6.4	-2.9	4.1	x
Damage - horizontal		22.3	-2.0	30.6	-1.0	8.9	-0.4	3.4	x
NCSS team		33.7		42.3		29.7			
NCSS team	Delta V	23.3	-10.4	36.0	-6.3	21.0	-8.7	25.4	✓
NCSS team	PDOF	30.1	-3.6	39.9	-2.4	20.1	-9.6	15.6	xx
NCSS team	passenger age	31.2	-2.5	38.6	-3.7	26.7	-3.0	9.2	xx
NCSS team	vehicle weight	35.5	+1.8	42.9	+0.6	24.7	-5.0	7.4	xx
NCSS team	sex	32.5	-1.2	42.9	+0.6	25.9	-3.8	5.6	xx

✓ selected
x deleted: sum of incremental changes less than 5%
xx deleted: would have too many cells at next step

cars from 9.3 to 29.7 percent (+20.4). As explained in Section 2.1, the older cars are overrepresented in the teams with high missing data rates on contact points and, as a result, have spuriously low instrument panel contact injury rates. The sum of the absolute values of the changes in effectiveness is

$$9.4 + 10.7 + 20.4 = 40.5$$

Delta V was the second most influential control variable, with the absolute values of the changes adding up to 13.6. Effectiveness in the 1967-70 and 1971-74 cars dropped after adjustment for Delta V, since they had lower speed crashes than the 1960-66 cars, but effectiveness increased in the 1975-78 cars, which were overrepresented at some of the Northern NCSS teams where crashes happened to be more severe than average. Sex, passenger age, PDOF and vehicle weight had moderate influence, with the sum of the changes ranging from 8.9 to 5.0. Adjustment for sex, age and vehicle weight generally increased effectiveness, while adjustment for PDOF reduced it. The type of vehicle or object struck and the horizontal damage location had little influence because they were basically uncorrelated with vehicle model year; the sum of the changes was less than 5 percent.

The result of the first step of the iterative procedure is to select NCSS team as the first control variable and to drop vehicle/object struck and horizontal damage location from further consideration as controls.

The starting point for the second step of the iterative procedure is shown beneath the solid line in Table 2-3. The effectiveness estimates, adjusted for NCSS team, are 33.7, 42.3 and 29.7 percent. Effectiveness is recalculated, adjusted for NCSS team and each of the remaining control variables, one at a time. Delta V is the most influential control variable at the second step, since the results adjusted for NCSS team and Delta V differ the most from those adjusted for NCSS team alone. Effectiveness fell from 33.7 to 23.3 percent in the 1967-70 cars, relative to the 1960-66 cars, a drop of 10.4 percent. Effectiveness fell from 42.3 to 36.0 percent in the 1971-74 cars (-6.3) and from 29.7 to 21.0 in the 1975-78 cars (-8.7). It is noteworthy that Delta V had a positive influence on effectiveness in the 1975-78 cars at the first step and a negative one on this step; that is due to the intercorrelation between the control variables NCSS team and Delta V, as described above. The sum of the drops is 25.4 percent. PDOF, age, vehicle weight and sex had less influence; the sum of the changes ranged from 15.6 down to 5.6 percent.

The result of the second step is that Delta V, in addition to NCSS team, is selected as a control variable. At this point, further steps are inadvisable. The 58 injury cases in the 1960-66 cars are already subdivided among 12 cells (6 team groups x 2 intervals of Delta V). Further splitting of the data would take the average cases per cell well below the permissible minimum of 5.

The best estimates of effectiveness, based on the iterative procedure, are the following:

Model Years	Reduction Rel. to 1960-66 (%)
1967-70	23.3
1971-74	36
1975-78	21

If the average for model years 1971-78 (i.e., the arithmetic average of the risks for 1971-74 and 1975-78) is arbitrarily assigned a risk factor of 100, the relative risk factors for each of the model year groups are:

Model Years	Relative Risk Factor
1960-66	140
1967-70	107
1971-74	90
1975-78	110

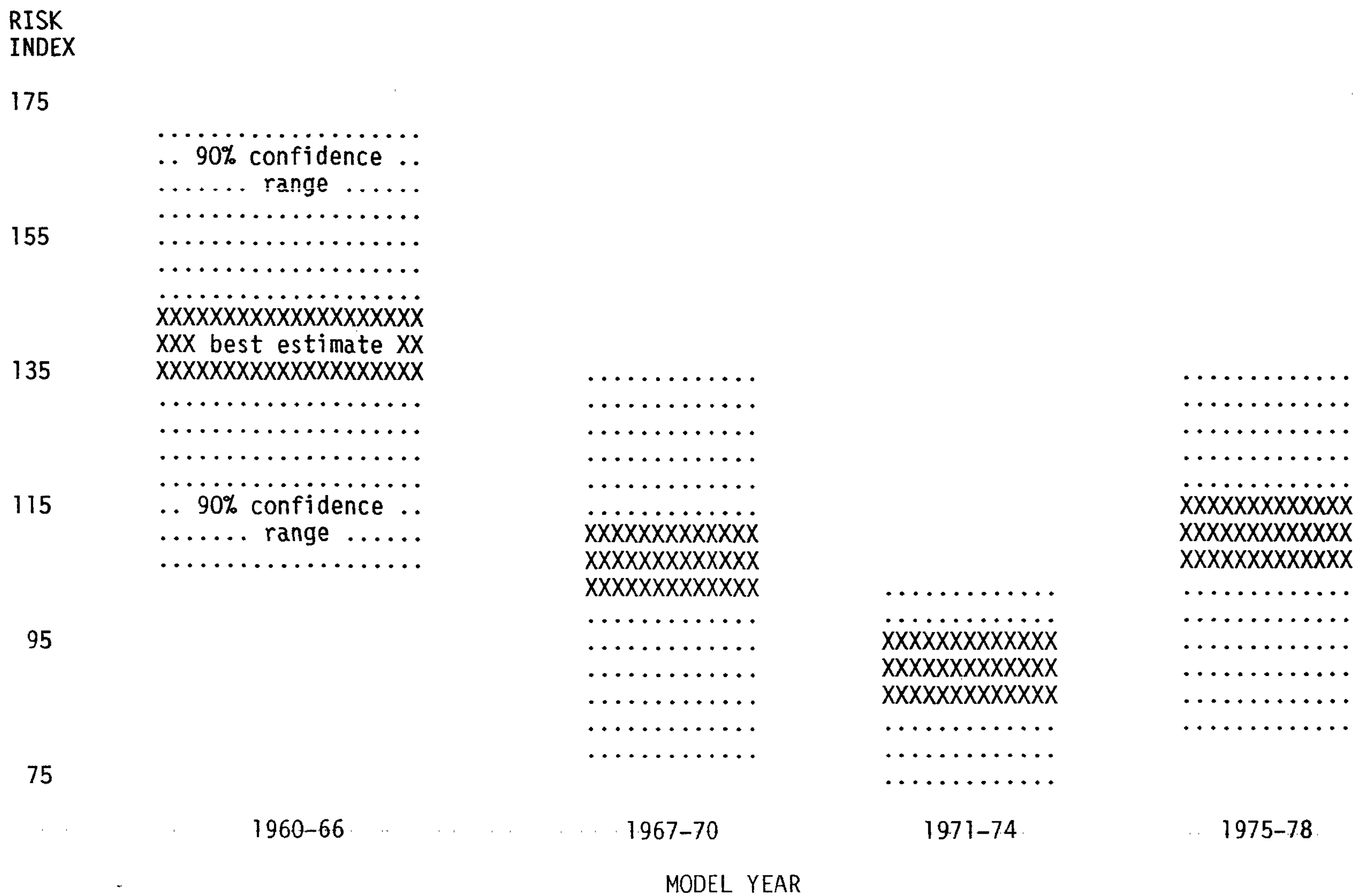
The relative risk factors are tabulated in Figure 2-1. They will subsequently be compared to the results of Chapters 3 and 4, where impact protection for the passenger in frontal crashes is analyzed by quite different methods.

2.3.4 Sampling error of the effectiveness estimates

Sampling errors for the injury risk in each model year group are derived by a jackknife procedure identical to the one used in NHTSA's evaluation of steering assemblies [32], pp. 187-193. The NCSS sample of unrestrained right front passengers in frontal crashes is divided into 10 systematic random subsamples of equal size. One subsample is removed and the injury rates for each model year group is recomputed for the remaining 9/10 of the sample, adjusting for NCSS team and Delta V and using the same data smoothing technique as was applied to the full sample. The subsample is returned, another removed, and the injury rates recalculated, etc. The variation found in the 10 calculation is the basis for establishing

FIGURE 2-1

RELATIVE RISK OF AIS 2+ INJURY DUE TO INSTRUMENT PANEL CONTACT, BY MODEL YEAR, NCSS, UNRESTRAINED RIGHT FRONT PASSENGERS IN FRONTAL CRASHES (1971-78 average = 100)



sampling errors. The advantage of the jackknife technique is that it gives an empirical assessment of the effects on variance of the NCSS sampling plan and the particular control variables chosen. These effects can vary considerably from one analysis to another.

The absolute and relative sampling errors were the following:

Model Years	Injury Risk	Standard Deviation	Coefficient of Variation	Confidence Bounds
	X	S	S/X	X ± 1.833S
1960-66	140	17.02	.1216	109 to 171
1967-70	107	14.50	.1355	81 to 134
1971-74	90	7.68	.0853	76 to 104
1975-78	110	14.07	.1279	85 to 136

The injury risk is the relative measure defined in the preceding section, i.e., injury rates were multiplied by a constant so that the 1971-78 average comes out to 100. The confidence bounds are 90 percent bounds: 1.833 is the critical value (alpha = .05) of a t distribution with 9 df, the appropriate value to use since the jackknife procedure was based on 10 subsamples.

Is the observed reduction of injury risk statistically significant? Perhaps the most appropriate comparison would be the average for 1971-78 vs. 1960-66. The average injury risk for 1971-78 is 100 and its standard deviation is

$$(7.68^2 + 14.07^2)^{.5} / 2 = 8.01$$

The t value for the difference between the 1960-66 and the 1971-78 injury risk is

$$(140 - 100) / (17.02^2 + 8.01^2)^{.5} = 2.13$$

Since this value is within the critical region of a t distribution with 9 df (alpha = .05), the reduction is significant. Rough confidence bounds for the reduction are given by

$$(1 - 100/140) \pm 1.833(100/140)[(17.02/140)^2 + (8.01/100)^2]^{.5}$$

$$= 29 \pm 19 \text{ percent}$$

$$= 10 \text{ to } 48 \text{ percent}$$

2.4 Benefits of instrument panel improvements

In 1982, when the large majority of passenger cars on the road in the United States had been built in model year 1971 or later and the overwhelming majority had been built in 1967 or later, there were 66,700 right front passengers of passenger cars who sustained nonfatal injuries at AIS levels 2 to 5 [21], p. VI-7. The estimate is based on the National Accident Sampling System. The NCSS data analyzed in Table 1-1 suggest that 30 percent of right front passengers who had AIS 2 or greater injuries received them from instrument panel contacts and no other sources. In other words, 20,000 right front passengers had AIS 2 or greater injuries from the instrument panel alone - at a time when most cars were built in 1971 or later and had a "relative risk factor" of 100 for instrument panel contact injury. If all the cars on the road in 1982 had 1960-66 type instrument panels, where the relative risk factor was 140, the number of injured persons would have increased to

$$(140/100) \times 20{,}000 = 28{,}000$$

In other words, the instrument panel improvements of the mid to late 1960's and early 1970's saved 8,000 right front passengers per year from sustaining more than a minor injury.

Also in 1982, there were 5200 right front passenger fatalities [21], p. VI-4. Table 1-2 indicates that about 17 percent, or 880 of the fatalities were caused primarily by contact with the instrument panel, with no other life threatening injury sources. A case by case analysis of NCSS suggested that about half of frontal fatalities involve catastrophic collapse of the passenger compartment or Delta V above 35 mph [30], Table 4. A conservative assumption is that they would not be saved by instrument panel improvements. That leaves 440 passengers killed by instrument panel contact alone in otherwise survivable crashes. If all the cars on the road in 1982 had 1960-66 type instrument panels, where the relative risk factor was 140 rather than 100, the number of fatalities would have increased to

$$(140/100) \times 440 = 616$$

In other words, a fairly conservative estimate is that instrument panel improvements saved about 176 lives per year. The estimate is based on the distribution of fatalities in cars of the mid 1970's. If a larger proportion of fatalities in cars of the early 1960's were due to instrument panel contact (29 percent in Huelke's 1961-65 data [27]) and occurred under otherwise survivable conditions, the estimate of lives saved by the panel improvements could be twice as high. If, in addition, panel improvements helped reduce risk of injury from components other than the panel (see Section 1.4), the benefits could be even greater.

2.5 Possible effect on injuries from other components

An important hypothesis in Section 1.3 is that changes in instrument panel geometry or materials can affect more than just the risk of injury due to contact with the panel. A well designed panel, by providing ride down and keeping the occupant in an upright position, can limit the severity of impacts into the windshield, header, pillars, etc. If so, the overall injury rate for unrestrained right front passengers in frontal crashes ought to decrease in parallel with the panel contact injury rate. Indeed, Table 2-4 shows that 11.8 percent of passengers of model year 1960-66 cars were hospitalized in frontal crashes on NCSS, but only 7.7 percent of 1967-70 car passengers: a 35 percent reduction. The casualty rate in 1971-74 cars is 36 percent lower than in 1960-66, while in 1975-78 cars it is 26 percent lower. The reductions in overall injury risk closely parallel the previous findings on panel contact injuries.

One shortcoming of Table 2-4 is that it cannot distinguish injury reductions due to panel modifications of the 1960-78 era from the effects of other frontal crashworthiness improvements. The only really well known improvement is the High Penetration Resistant windshield, which was introduced in 1966. Perhaps the 1960-65 cars should not be included in the analysis, since they had the old windshield. Table 2-4 shows, however, that the casualty rate for 1966 cars alone (12.7%) is about the same as for 1960-66 cars (11.8%). The large reductions of hospitalization in the 1967-78 cars, at least according to NCSS, would still be there even if the 1960-65 cars were excluded from the analysis. These reductions in overall injury risk can probably be attributed in large measure to the improvement of the instrument panel. The effect of the panel on overall injury risk is analyzed in far greater detail in Chapter 3.

TABLE 2-4

NONMINOR (HOSPITALIZATION OR FATALITY) INJURY RATE, BY MODEL YEAR, UNRESTRAINED RIGHT FRONT PASSENGERS OF PASSENGER CARS, IN FRONTAL CRASHES, NCSS

Model Years	n of Hospitalized Passengers	N of Passengers	Casualty Rate (%)	Reduction Rel. to MY 60-66 (%)
1960-66	112	953	11.8	
1966 only	44	346	12.7	
1967-70	178	2323	7.7	35
1971-74	227	3001	7.6	36
1975-78	189	2174	8.7	26

CHAPTER 3

MVMA2D COMPUTER SIMULATIONS OF FRONTAL CRASHES

Computer simulations of the trajectories of unrestrained right front passengers in frontal barrier crashes were performed for 21 passenger cars ranging from model year 1965 to 83 - at two speeds (25 and 30 mph) for each of three occupant sizes. The simulations were based on the MVMA2D model [3]. Since the objective was to evaluate instrument panels, only the parameters relating to panel geometry and force deflection characteristics, as observed in tests of actual panels, were varied from car to car. Other parameters such as the windshield composition or the vehicle crash pulse were kept identical across all simulations. A nonparametric analysis of the injury criteria predicted by the simulations showed significantly lower injury risk for cars of the late 1960's than cars of the mid 1960's and a possible additional reduction for cars of the mid to late 1970's. A statistical analysis of the parameters relating to panel geometry and force deflection characteristics confirms that panels were gradually modified during the 1965-80 period in the ways described in Section 1.4. A correlation analysis between the injury scores obtained in the simulations and the geometry and force deflection measurements shows that the panel modifications described as "improvements" in Section 1.4 for the most part are indeed associated with reductions of torso, head and femur injury risk. In other words, the MVMA2D simulations suggest that panels became safer - and that they became safer for the reasons stated in the literature.

3.1 Analytic objectives

The detailed procedures used in the simulations are more understandable if the findings of Chapter 2 are briefly reviewed: unrestrained right front passengers in 1967-78 cars had significantly lower risk of instrument panel contact injuries in actual crashes than 1960-66 cars. Chapter 2 is primarily limited to injuries caused directly by panel contact, but changes in panel geometry or materials can affect even those injuries not directly due to contact with the panel (see Section 1.3). The analysis of accident data could not easily discern the indirect effects of the panel improvements (which were implemented gradually over many years) from the possible effects of other vehicle modifications unrelated to the panel. In addition, there were just enough NCSS cases for significant results on overall panel contact injury risk; it would have been futile to study head, thorax and femur injuries separately or to attempt to relate the injury reductions to specific panel modifications.

The MVMA2D simulation model, unlike accident data, makes it possible to study the effects on panel modifications in isolation. The model is run for a series of hypothetical cars that have the panel characteristics of a variety of actual vehicles (model years 1965 through 1983) but are alike in all respects other than the panel. It becomes possible to discern the extent to which changes in the panel caused the later cars to have lower overall injury risk for various body regions than the old cars.

The approach, then, is to measure the instrument panel geometry and force deflection characteristics, in a consistent manner, for vehicles of different model years. The approach uses a "generic" vehicle whose crash pulse, materials and geometry, other than in the panel region, are close to the average values for the vehicle fleet. The input data to the simulation, in each case, are the instrument panel values for a specific make, model and model year and the generic values for parts of the car other than the panel. (As described in Appendix A, the crash pulse of a 1979 Ford Granada and the seat and floor geometry and materials of a 1983 Chevrolet Celebrity are the generic values used in all the simulations.)

For a fair comparison between older and newer cars, the same makes and models ought to be represented for the different model year groups. In each model year group, there should be the same variety of car manufacturers and sizes. In other words, there should be a matrix of cars of various manufacturers and market categories in each of several model year groups. Simulations need to be performed for a range of impact speeds and occupant types.

3.2 Some preliminary words of caution regarding simulation results

The state of the art for the MVMA2D simulation model, as of 1987, is that injury predictions for a given vehicle in a particular crash mode cannot be guaranteed for accuracy unless "validated" by an actual crash test, with dummies, duplicating the simulation. None of the simulations of older cars were validated by actual crash tests; neither were the simulations with 5th and 95th percentile dummies in the newer cars or the 25 mph barrier crashes. In particular, the 5th and 95th percentile dummy parameters in these simulations are derived from a preliminary scaling of the 50th percentile Hybrid III dummy to other sizes. No such dummies have actually been constructed as of Summer 1987. The scaling factors may need to be revised after construction and testing of actual dummies.

Thus, the injury scores for <u>individual</u> makes and models of cars, as reported in this chapter, ought not be regarded as predictions of what would actually happen in highway accidents. Moreover, as stated above, the simulations were not intended to model the actual cars but a hypothetical vehicle having the panel geometry and force deflection of one car and the crash pulse, windshield materials, etc. of another. For example, a car whose instrument panel performed poorly in combination with the "generic" Granada crash pulse and Celebrity seat might have performed better with its own crash pulse and seat. A related problem is that MVMA2D is sensitive to small changes of input parameters such as panel geometry or force deflection; these parameters, in turn, were measured on sample cars using techniques that are to some extent judgmental and nonrepeatable. The objective, to be sure, is not to rate individual cars but to compare averages across groups of cars: specifically, older vs. more recent cars.

As stated above, there were excellent correlations between the panel characteristics on the various cars and the injury scores. It should be noted, though, that these are injury scores predicted by MVMA2D rather than those that might occur in real crashes. The correlations might only be reflecting assumptions built into the simulation model and do not necessarily prove a cause and effect relationship between panel improvements and injury reduction in actual crashes. In particular, the parameters used to simulate the occupant seemed to have a fairly strong linkage between body regions. As a result, abrupt decelerations of the femurs were propagated as high noncontact g's to the chest and head, perhaps more so than would occur in real crashes. That may explain the high correlation, in the simulations, between stiff lower instrument panels and high chest g's and HIC - but the correlation might not be so high in the real world.

In the statistical analyses, all the simulation results (HIC, chest g's, etc.) as well as the vehicle descriptors (force-deflection, etc.) were transformed to normal scores based on rank orders. As a result, the analyses are all nonparametric in the sense that they can show if injury scores were significantly reduced, but they <u>cannot</u> indicate by what percentage the injury risk was reduced. It is not valid to attempt to translate the trends in the graphs to quantitative statements about injury reduction: e.g., if one of the graphs shows a 2 inch drop in the "injury score" from 1965 to 1970 and a 1 inch drop from 1970 to 1975, it cannot be inferred that the first set of panel improvements gave twice the injury reduction as the latter. The nonparametric approach was purposely chosen as a precaution against making quantitative inferences about injury reduction from the simulation results; it also makes the data much easier to handle statistically. In the analyses, composite injury scores are defined for various body regions and for the entire body, based on weighted averages of the normalized rank order scores. It must be emphasized that the weighting schemes are not intended to represent the exact contribution of each injury criterion to overall injury risk. It is definitely not appropriate to use the composite injury scores for making quantitative trade-offs between one type of injury and another - e.g., "a particular vehicle modification reduces injury criterion 1 by 10 percent and increases criterion 2 by 10 percent, but this has a net benefit because criterion 1 is twice as important as criterion 2."

NHTSA is currently undertaking a research program based on validated MVMA2D simulations and other data [6]. It will include a systematic and comprehensive analysis of the effect on injury risk as a result of modifying instrument panel and other vehicle parameters. Primary objectives of that research will be a quantitative evaluation of the injury consequences of changing various design parameters, followed by optimization of panel design. The work in this chapter, on the other hand, is primarily concerned with evaluating existing panels; it compares historical trends in panel design and injury risk, suggesting possible associations between some design parameters and injury risk, but not at a level of detail or precision suitable for optimizing panel design.

3.3 Planning and running the simulations

A total of 126 MVMA2D simulations were run: 21 cars at each of two frontal barrier impact speeds (25 and 30 mph) and 3 dummy sizes (50th percentile male, 5th percentile female and 95th percentile male). The test matrix of cars was meant to cover 6 broad manufacturer/market classes which, together, represent a large portion of the market:

1. Full sized Ford
2. Full sized GM
3. Compact GM
4. Compact Chrysler and similar cars
5. Volkswagen (subcompact) and similar cars
6. Nissan or Honda (subcompact)

It includes four model year groups:

1. Pre-standard (1965-66)
2. Early post-standard (1969-71)
3. Pre-downsized big cars and rear wheel drive small cars (1974-76)
4. Downsized big cars and front wheel drive small cars (1977-83)

Appendix A, Section 1, describes the difficulties of obtaining MVMA2D input data on cars corresponding to each of the above groups. The final test matrix included 21 cars for which simulations were feasible:

Car Group	MY Group	
1	1	66 Ford Galaxie 500
	2	69 Ford LTD
	3	76 Ford LTD
	4	79 Ford LTD
2	1	65 Chevrolet BelAir
	2	69 Chevrolet BelAir
	3	76 Chevrolet Caprice Classic
	4	78 Buick LeSabre
3	1	66 Chevrolet Chevy II
	2	69 Chevrolet Nova
	4	83 Chevrolet Celebrity
4	1	66 Plymouth Valiant
	2	69 Dodge Dart
	3	77 Plymouth Volare
	3	79 Ford Mustang
5	1	66 VW Beetle
	outlier	74 VW Beetle
	4	80 Dodge Omni
6	2	71 Datsun 1200
	4	75 Honda Civic
	4	78 Honda Accord

Appendix A describes the steps undertaken to assemble a full MVMA2D input data set for each of the cars, including the vehicle interior geometry, the force deflection characteristics, definitions of the dummies and crash pulses plus the necessary control parameters. The principal difficulty is that the source data for some of the cars is incomplete or was measured differently than on others. Appendix A lists the techniques and assumptions used to assure that the simulation models were run in a consistent manner. It also shows how the the input data for the various cars differed only in the force deflection and geometry of the instrument panels, but were the same for other vehicle factors, as specified in the analytic objectives.

3.4 Simulation results: injury risk by model year group

3.4.1 Raw injury scores

Ten injury scores were computed from each of the simulations:

Femur	Peak axial load at knee (pounds - sum of 2 knees)
Neck	Peak shear force, upper neck joint (pounds) Peak compressive force, upper neck joint (pounds) Peak neck moment (inch-pounds)
Head	Head Injury Criterion (HIC) Peak head g's
Chest	Chest g's (3 millisecond peak) GMR modified Severity Index (resultant) Peak deflection of the front part of the chest ellipse - as output by MVMA2D (inches) S Delta S - i.e., peak (deflection x rate of deflection), front part of chest ellipse (inches-inches/second)

The peak shear and compressive neck forces are the maximum differences between the force on the neck and the force on the head. The peak neck moment is the maximum difference between the moments on the upper neck and the lower neck. Chest deflection and (deflection x rate of deflection), as defined above, are obtained from the printout on the chest to mid IP interaction. Chest deflection is the maximum deflection of the front part of the chest ellipse, as defined in MVMA2D, not the deflection between sternum and spine, as commonly defined in injury criteria. Peak (deflection x rate of deflection) is henceforth abbreviated as S Delta S. The deflections and S Delta S values obtained in the simulations should not be equated to levels found in laboratory tests.

Four chest severity scores were selected to represent various hypotheses about parameters related to chest injury. Peak g's and the Chest Severity Index are both based on acceleration and are correlated with one another. Direct contacts and noncontact phenomena can make contributions to both of them. Chest deflection and S Delta S measure the severity of direct contacts to the chest. They are correlated with one another but not necessarily with the first two measures. Likewise, three neck and two head severity scores are selected to represent the variety of parameters associated with injury and to provide some redundancy.

After the analyses of the preceding variables were completed, it was suggested that peak angular acceleration may be an important factor in head injury, worthy of study. Section 3.7 presents some analyses of angular acceleration, finding it to be closely correlated with other head and neck injury measures.

Table 3-1 shows the results of the 30 mph barrier crash

TABLE 3-1

MVMA2D RESULTS: 30 MPH CRASHES

		Femur	Neck			Head		Chest			
Vehicle	Dummy	Axial	Shear	Comp.	Moment	HIC	Peak g's	Peak g's	Index	Defl	SDeltaS
79 Ford	50%	2627	424	377	3556	1091	103	68.6	511	2.15	268
	5%	1955	234	121	935	975	152	80.0	511	2.14	228
	95%	2736	408	808	5233	588	93	90.3	658	1.88	162
76 Ford	50%	1636	303	710	3226	675	86	62.8	297	4.24	899
	5%	1258	206	407	1190	952	149	63.9	378	3.76	592
	95%	2100	305	1049	4796	681	76	58.9	176	4.26	754
69 Ford	50%	2272	361	306	3344	994	91	121.9	1117	2.15	274
	5%	2084	119	240	1308	928	153	101.3	768	2.11	254
	95%	2737	346	984	5839	626	85	64.3	241	1.64	132
66 Ford	50%	2746	698	515	4727	3118	142	99.4	895	2.25	253
	5%	2247	570	370	2407	2688	163	106.2	1114	1.21	108
	95%	2323	386	755	5142	675	90	100.9	693	2.77	305
78 Buick	50%	1702	289	1010	4489	1100	93	67.7	307	1.73	262
	5%	1543	366	748	2031	1258	127	65.0	335	1.54	263
	95%	1608	316	1149	6273	816	102	71.6	328	1.69	262
76 Chevy	50%	1691	461	609	2261	740	101	62.1	287	3.90	776
	5%	1348	166	300	1325	2481	188	83.8	768	3.25	502
	95%	1841	442	1045	4786	512	85	72.1	352	3.30	485
69 Chevy	50%	2165	208	735	3806	992	96	69.8	460	3.95	922
	5%	1350	296	613	1833	1272	141	92.7	762	3.42	569
	95%	1954	319	957	4628	712	77	76.0	446	4.01	788
65 Chevy	50%	1903	232	555	3254	761	99	79.9	721	3.74	624
	5%	1731	384	734	3722	1848	198	126.4	1265	1.83	235
	95%	2144	317	801	4375	476	86	97.8	762	2.69	377

TABLE 3-1 (Continued)

MVMA2D RESULTS: 30 MPH CRASHES

		Femur	Neck			Head		Chest			
Vehicle	Dummy	Axial	Shear	Comp.	Moment	HIC	Peak g's	Peak g's	Index	Defl	SDeltaS
83 Celebrity	50%	2350	399	871	3003	866	87	71.9	405	1.46	231
	5%	1619	172	400	1338	771	127	59.8	222	1.45	290
	95%	3106	493	987	8088	840	94	118.7	1021	1.43	165
69 Nova	50%	3406	507	557	4645	3214	167	127.0	1537	1.49	147
	5%	2866	384	373	2183	1987	148	121.5	1240	1.50	151
	95%	3300	537	669	5028	1353	86	118.1	1114	.88	63
66 Nova	50%	3024	644	305	3704	2165	114	107.4	1223	4.00	786
	5%	2446	485	489	3512	1893	192	123.8	1255	2.85	460
	95%	3091	557	472	4598	1020	97	107.6	872	3.59	683
79 Mustang	50%	2301	244	562	2790	707	84	79.4	665	3.93	1051
	5%	2185	215	110	1154	907	148	60.8	288	3.92	996
	95%	2815	219	699	3361	483	76	79.6	514	4.03	980
77 Volare	50%	2022	571	777	3495	631	92	46.2	64	4.10	815
	5%	1029	102	88	1272	1058	146	54.8	180	4.11	858
	95%	1390	203	1095	5432	642	84	59.2	168	4.10	756
69 Dart	50%	2291	243	475	2940	662	95	79.6	533	4.27	814
	5%	1815	330	484	2428	2118	178	79.4	674	3.18	470
	95%	2705	310	796	4041	538	77	85.3	609	3.60	585
66 Valiant	50%	2059	266	641	3038	748	83	89.4	811	4.15	770
	5%	1694	327	147	1527	1043	145	81.8	633	3.89	685
	95%	2479	351	836	5023	442	81	101.5	759	3.29	564

TABLE 3-1 (Concluded)

MVMA2D RESULTS: 30 MPH CRASHES

		Femur	Neck			Head		Chest			
Vehicle	Dummy	Axial	Shear	Comp.	Moment	HIC	Peak g's	Peak g's	Index	Defl	SDeltaS
80 Omni	50%	3774	381	406	3238	1015	94	76.7	460	4.36	764
	5%	1209	572	580	1943	1121	143	52.9	226	4.03	594
	95%	1569	391	682	5045	777	92	44.1	117	3.70	408
74 Beetle	50%	3199	566	498	3224	1944	105	121.9	1181	4.47	1068
	5%	4596	517	712	3205	3085	189	160.5	1531	3.90	881
	95%	4526	961	820	8906	866	89	86.8	661	4.18	831
66 Beetle	50%	3232	800	524	5309	767	119	111.2	1077	1.90	210
	5%	4836	864	1079	4101	6895	243	176.2	1744	1.36	149
	95%	4290	835	684	6999	717	107	95.4	624	1.53	135
78 Accord	50%	2627	293	208	2379	797	89	81.8	666	4.26	1207
	5%	2242	159	70	782	1158	141	74.8	517	4.18	916
	95%	3116	1005	642	5235	1865	127	75.5	445	4.18	835
75 Civic	50%	1543	442	1044	4429	1496	101	68.1	349	3.28	444
	5%	1519	417	800	2120	962	119	90.1	768	2.46	297
	95%	2239	401	1015	4930	555	78	83.7	505	3.08	435
71 Datsun	50%	3018	395	887	4132	1030	109	61.7	254	4.24	687
	5%	937	525	727	2461	1562	139	70.8	516	2.89	362
	95%	2273	297	1038	5580	692	87	67.1	297	3.96	642

simulations, with 50th, 5th and 95th percentile dummies, for all cars, while Table 3-2 shows the results of the 25 mph simulations. The tables display considerable variations from car to car; however, as explained in Section 3.2, it is not the purpose of the study to estimate injury risk for particular makes and models of cars and the results for a particular car are not necessarily representative of what would have happened in a real crash or even in a staged collision. The median values of HIC and chest g's in the tables are:

Speed	Median HIC	Median Chest g's
25	705	67.5
30	952	79.9

These values are of the same magnitude as actual barrier crash tests with unrestrained dummies in the right front seat. For example, NHTSA's sled tests with unrestrained dummies in a 1981 Chevrolet Citation sled buck [39], p. 40, had a median HIC of 402 at 26.5 mph and 1794 at 30 mph (HIC varied greatly from test to test with the unrestrained dummies). The median chest g's were 69 at 26.5 mph and 82 at 30 mph - close indeed to the simulation results.

Although the medians for the simulations are consistent with laboratory test results, Tables 3-1 and 3-2 nevertheless show individual cases of extremely high HIC or chest g's. These readings are apparently attributable to the rigidity of the joints of the simulated occupants. When their knees penetrate to the stiffest part of the lower IP or when their feet drive against the toeboard or firewall, the high acceleration spikes are soon propagated to their chests and heads (noncontact forces) where they are added to the direct contact forces occurring at that

TABLE 3-2

MVMA2D RESULTS: 25 MPH CRASHES

		Femur		Neck		Head		Chest			
Vehicle	Dummy	Axial	Shear	Comp.	Moment	HIC	Peak g's	Peak g's	Index	Defl	SDeltaS
79 Ford	50%	1764	210	289	2185	881	87	58.6	203	1.40	86
	5%	1166	208	139	906	922	156	64.4	277	1.41	89
	95%	1973	201	570	3275	449	79	64.6	217	.55	22
76 Ford	50%	1031	366	622	2883	416	90	51.6	134	2.54	264
	5%	1182	223	417	1236	624	151	66.7	319	1.85	190
	95%	1133	174	826	3704	421	69	53.9	125	1.90	172
69 Ford	50%	1590	235	234	2147	931	87	80.8	482	.70	42
	5%	1475	173	166	1065	699	130	74.9	381	1.03	71
	95%	1720	228	625	3424	358	66	54.0	95	.05	0
66 Ford	50%	2129	638	507	2351	2029	120	81.3	506	.94	62
	5%	1833	412	271	1866	1882	128	92.8	682	.35	13
	95%	1610	456	439	4110	563	79	65.8	187	1.12	70
78 Buick	50%	1654	397	884	4042	778	80	47.0	78	1.04	52
	5%	1209	424	715	2187	916	130	57.7	188	1.16	76
	95%	1543	496	966	4076	565	79	58.8	142	.74	38
76 Chevy	50%	1197	301	583	2107	388	108	63.0	253	1.83	144
	5%	1235	188	392	1790	2798	197	80.2	657	1.54	133
	95%	1561	457	637	4005	572	75	59.8	145	.98	50
69 Chevy	50%	1447	329	761	3431	623	90	65.2	296	2.21	223
	5%	1180	317	542	1594	661	152	76.6	462	1.79	190
	95%	1583	116	895	4206	358	71	71.1	315	1.45	134
65 Chevy	50%	1662	186	429	2589	1175	97	77.0	509	1.28	111
	5%	1731	278	850	3980	1452	183	100.1	679	.49	30
	95%	2113	426	555	4517	562	80	70.8	251	.43	17

TABLE 3-2 (Continued)

MVMA2D RESULTS: 25 MPH CRASHES

		Femur	Neck			Head		Chest			
Vehicle	Dummy	Axial	Shear	Comp.	Moment	HIC	Peak g's	Peak g's	Index	Defl	SDeltaS
83 Celebrity	50%	1524	449	767	2798	512	75	49.7	97	.96	58
	5%	1277	225	406	1141	569	114	62.1	241	1.44	221
	95%	2208	383	930	4702	594	85	80.7	421	none	none
69 Nova	50%	2686	316	568	2952	1086	106	81.9	563	.59	216
	5%	1975	218	270	1605	1257	161	91.6	567	.79	48
	95%	3101	602	662	4112	862	73	73.1	366	.02	0
66 Nova	50%	2208	489	301	3280	1219	100	86.6	701	1.98	230
	5%	1643	353	437	2720	1591	172	101.8	828	1.48	163
	95%	2520	510	467	4140	869	80	70.4	319	1.41	135
79 Mustang	50%	2096	236	580	2506	621	75	85.3	659	2.54	311
	5%	1741	210	160	1173	716	144	58.9	227	3.12	371
	95%	2283	197	466	2283	344	70	77.2	421	2.68	318
77 Volare	50%	855	364	803	3325	479	80	39.2	54	2.37	172
	5%	751	133	108	1457	762	138	51.9	133	2.99	312
	95%	1150	366	872	3518	418	76	52.3	94	2.09	168
69 Dart	50%	1411	228	615	2581	410	93	53.7	165	2.12	203
	5%	1332	171	418	2030	1532	168	73.7	395	1.74	161
	95%	1920	196	804	3934	358	71	67.7	255	1.33	115
66 Valiant	50%	1584	212	594	2733	722	75	67.5	444	1.83	202
	5%	1422	280	124	1576	904	120	82.4	500	2.18	261
	95%	1800	223	667	3984	359	74	82.4	453	1.02	85

TABLE 3-2 (Concluded)

MVMA2D RESULTS: 25 MPH CRASHES

		Femur	Neck			Head		Chest			
Vehicle	Dummy	Axial	Shear	Comp.	Moment	HIC	Peak g's	Peak g's	Index	Defl	SDeltaS
80 Omni	50%	1532	147	223	1732	595	86	35.6	45	2.70	181
	5%	1178	425	373	1327	712	122	48.0	68	2.24	167
	95%	1369	280	513	3045	433	83	40.3	37	1.84	119
74 Beetle	50%	2669	354	455	3182	1039	108	83.9	635	2.33	284
	5%	3669	279	521	2649	1442	149	129.0	1097	2.51	384
	95%	3887	452	941	6348	899	83	73.9	382	1.90	200
66 Beetle	50%	2827	458	703	4112	1474	112	79.1	530	.24	4
	5%	4278	492	764	3828	2639	161	114.2	1004	.54	31
	95%	3490	493	816	6307	605	97	78.4	417	.04	0
78 Accord	50%	2140	266	128	1711	571	88	59.3	234	3.26	435
	5%	1890	180	37	826	781	126	54.6	171	2.90	296
	95%	2620	798	517	2978	1098	111	61.6	201	1.89	170
75 Civic	50%	1213	494	958	3356	987	96	46.2	79	.53	25
	5%	1208	305	590	1683	705	109	78.6	494	1.08	81
	95%	1891	317	978	4401	424	70	69.4	273	.33	14
71 Datsun	50%	967	552	766	3004	610	85	42.7	69	1.72	134
	5%	809	504	719	2117	1280	116	57.5	209	1.21	95
	95%	1609	378	808	4535	429	80	59.8	149	1.19	88

instant, resulting in even larger net acceleration spikes for the head and chest. Moreover, an aggressive lower IP (or a largely absent lower IP, causing the lower body momentum to be stopped by the even more aggressive foot to firewall contact) would cause any occupant to pitch forward head first, further increasing HIC, but especially more rigid occupants like the ones in the simulations. Since acceleration is raised to the 2.5 power in the calculation of HIC, twice the acceleration results in 5.65 times the HIC. Some of the high HICs for 5th percentile occupants were due to direct head contact with the mid IP in the large older cars but, interestingly, none of the high HICs were due to contacting the header - which was the cause of some very high HICs in the Citation sled tests [39], p. 40. Conversely, the unusually low values or complete absence of chest deflection in some of the simulations are likewise attributable to the rigidity of the simulated occupant and the 2 dimensional nature of the simulation. The simulated occupant maintains a seated posture; if the lower IP is aggressive, the chest is kept away from the mid IP or at least slowed down a lot before contacting it. When the feet become enmeshed in the toeboard or firewall, the knees have nowhere to go but up, further preserving the occupant's seated posture. Although similar upward motion of the knees is seen in laboratory tests with unrestrained dummies [51], it may have been exaggerated in these simulations.

3.4.2 Normalized rank order scores

Tables 3-1 and 3-2 provide 60 scores for each vehicle: 10 different injury measures for each of 3 dummy sizes at 2 speeds. The first step of the statistical analysis is to rank the 21 vehicles on each of the 60 scores. For example, the 78 Accord has the lowest neck compressive force <u>for 5th percentile dummies in 30 mph crashes</u>, so it receives a rank score of 1 on that attribute; the 77 Volare is second lowest, so it gets a 2; the 76 Ford LTD is the median, receiving a score of 11; the 66 Beetle is highest, so it gets a 21. The rank scores are nonparametric in the sense that a difference of 1 in rank scores does not correspond to any particular difference in the underlying raw injury score.

Next, the rank scores R_i are converted into a normally distributed variable Y_i by Blom's formula

$$Y_i = \text{PSI}\ ((R_i - .375)/21.25)$$

where PSI is the inverse cumulative normal (probit) function [26], p. 362. For example, the Accord would receive a score of -1.89; the Volare, -1.43; the 76 Ford would receive a score of 0; and the 66 Beetle, +1.89. The higher the score, the <u>higher</u> the predicted injury risk.

Now there are 60 scores, each of which has the unit normal distribution. The great advantage of these normal scores is that linear combinations of them will still be normally distributed and easy to analyze. The next step is to develop weighted sums of the scores representing overall predictions of injury performance.

FEMRANK is the variable denoting the overall femur severity score for a particular vehicle.

$$\text{FEMRANK} = \text{sqrt}(1/6)\ [\text{FEMUR}(50,25)+\text{FEMUR}(5,25)+\text{FEMUR}(95,25) \\ +\text{FEMUR}(50,30)+\text{FEMUR}(5,30)+\text{FEMUR}(95,30)]$$

where FEMUR(i,j) is the normalized rank score for femur load for the ith percentile dummy in a j mph crash. The purpose of dividing by the square root of 6 is that if the 6 FEMUR(i,j) were <u>independent</u> unit normal variables then FEMRANK would also be a <u>unit</u> normal variable. It puts FEMRANK on the same scale as its component parts. (Of course, in reality, the 6 simulations for the same car are not independent and FEMRANK has standard deviation greater than 1. For statistical significance tests, it is necessary to compute the actual standard deviation of FEMRANK.)

HNRANK is the overall head and neck injury severity score for a particular vehicle.

```
HNRANK  =  sqrt(1/66) [2xHIC(50,25)+2xHIC(5,25)+2xHIC(95,25)
                      +2xHIC(50,30)+2xHIC(5,30)+2xHIC(95,30)
                      +2xHEADG(50,25)+2xHEADG(5,25)+2xHEADG(95,25)
                      +2xHEADG(50,30)+2xHEADG(5,30)+2xHEADG(95,30)
                      +SHEAR(50,25)+SHEAR(5,25)+SHEAR(95,25)
                      +SHEAR(50,30)+SHEAR(5,30)+SHEAR(95,30)
                      +COMPRESS(50,25)+COMPRESS(5,25)+COMPRESS(95,25)
                      +COMPRESS(50,30)+COMPRESS(5,30)+COMPRESS(95,30)
                      +MOMENT(50,25)+MOMENT(5,25)+MOMENT(95,25)
                      +MOMENT(50,30)+MOMENT(5,30)+MOMENT(95,30)]
```

Again, the purpose of dividing by the square root of 66 is that if the component parts were independent unit normal variables then HNRANK would also be a <u>unit</u> normal variable. The head injury scores are multiplied by 2 in the preceding formula but the neck injury scores are not. Thereby each head score contributes 4 times as much to the variance of HNRANK as each neck score. Since there are 12 head scores and 18 neck scores, the ratio of the contributions of head and neck injury in the variance of HNRANK is 48:18, which is appropriate, since head injuries are more frequent than neck injuries.

Three measures of chest injury risk will be used in the analyses. GRANK is a chest severity score based on acceleration measurements (peak g's and the Severity Index).

```
GRANK  =  sqrt(1/12) [CHESTG(50,25)+CHESTG(5,25)+CHESTG(95,25)
                     +CHESTG(50,30)+CHESTG(5,30)+CHESTG(95,30)
                     +CSI(50,25)+CSI(5,25)+CSI(95,25)
                     +CSI(50,30)+CSI(5,30)+CSI(95,30)]
```

DFLRANK is a score based on chest deflection and S Delta S (deformations due to direct contact).

```
DFLRANK  =  sqrt(1/12) [SDeltaS(50,25)+SDeltaS(5,25)+SDeltaS(95,25)
                       +SDeltaS(50,30)+SDeltaS(5,30)+SDeltaS(95,30)
                       +DEFL(50,25)+DEFL(5,25)+DEFL(95,25)
                       +DEFL(50,30)+DEFL(5,30)+DEFL(95,30)]
```

Finally, CRNK is the average of the GRANK and DFLRANK and it is the most comprehensive measure of overall chest injury risk.

```
CRNK  =  sqrt(1/2) [DFLRANK + GRANK]
```

Three measures of overall injury risk (average for all body regions) will be analyzed. TRNK25 is the overall injury risk in 25 mph crashes.

```
TRNK25  =  sqrt(1/108) [2xHIC(50,25)+2xHIC(5,25)+2xHIC(95,25)
                       +2xHEADG(50,25)+2xHEADG(5,25)+2xHEADG(95,25)
                       +SHEAR(50,25)+SHEAR(5,25)+SHEAR(95,25)
                       +COMPRESS(50,25)+COMPRESS(5,25)+COMPRESS(95,25)
                       +MOMENT(50,25)+MOMENT(5,25)+MOMENT(95,25)
                       +2xCHESTG(50,25)+2xCHESTG(5,25)+2xCHESTG(95,25)
                       +2xCSI(50,25)+2xCSI(5,25)+2xCSI(95,25)
                       +2xSDeltaS(50,25)+2xSDeltaS(5,25)+2xSDeltaS(95,25)
                       +2xDEFL(50,25)+2xDEFL(5,25)+2xDEFL(95,25)
                       +3xFEMUR(50,25)+3xFEMUR(5,25)+3xFEMUR(95,25)]
```

The components are given integer weights which yield a total contribution to variance of 24 for the head scores, 9 for the neck scores, 48 for the chest scores and 27 for the femur scores - a reasonable distribution for a study focusing on the effects of instrument panels on overall injury risk. TRNK30 is the overall injury risk in 30 mph crashes, defined the same way. Finally,

$$TRNK = sqrt(1/2)\ [TRNK25 + TRNK30]$$

is the most comprehensive measure of passengers' overall injury risk and the most important dependent variable in the analysis.

It must be reemphasized that the weighted composite scores are not intended to represent the exact contribution of each injury criterion to overall injury risk. It is definitely not appropriate to use them for making quantitative trade-offs between one type of injury and another. Rather, the scores are weighted to represent the relative importance of the various body regions in overall injury severity and to give fair representation to a variety of factors that have been suggested as influential in causing injury to individual body regions. Since the newer cars turn out to have generally better scores on almost all the injury criteria, the details of the weighting scheme are not so important for evaluating the direction of the overall injury trend - but these scores might not be suitable for precision tasks (beyond the scope of this report) such as optimizing panel design.

3.4.3 Analysis: injury risk by model year group

As defined in Section 3.4.2, the dependent variables for the injury analysis are the following normalized rank order scores:

TRNK	Overall injury score
CRNK	Chest injury score
GRANK	Chest injury score (acceleration measurements only)
DFLRANK	Chest injury score (deflection & S Delta S)
FEMRANK	Femur injury score
HNRANK	Head and neck injury score
TRNK25	Overall injury score (25 mph crashes only)
TRNK30	Overall injury score (30 mph crashes only)

Table 3-3 lists the scores for each vehicle, ordered by car group (as defined in the test matrix of Section 3.3.1). The table shows many variations from car to car, but a general trend to lower injuries for the later cars on all the variables except DFLRANK. The trend is more easily seen if the data are graphed by model year. Figure 3-1 shows the observations of TRNK, the overall injury score, by model year. Each data point on the graph is one car; the number denotes the car group to which the car of that model year belongs. There is a sizable drop in the injury scores from the cluster of cars around MY 1966 to the cluster around MY 1969 and a smaller drop from the 1969 cluster to the later cars. One evident outlier is the 1974 Beetle, which had much higher injury scores on the simulations than the other cars of the mid 1970's. It will be seen (in Section 3.5 and Table 3-5) that the 74 Beetle, although meeting the requirements of Standard 201, generally had panel geometry and materials more characteristic of pre 1966 cars. Therefore, it ought not to be included in the model year group containing the cars of the late 60's and early 1970's, the way it was originally listed in Section 3.3.1. Instead, it is not included in any of the four model year groups, although the data are used in all the analyses that do not specifically pertain to model year groups.

The main objective, however, is not to compare individual cars but rather the average results for the four model year groups. Table 3-4 lists the results by model year groupings and, in the lower section, the average result for each model year group. For example, the average overall injury score TRNK is 2.26 in model year group 1 (65-66 cars); it

FIGURE 3-1: TRNK (Overall Injury Score) BY MODEL YEAR

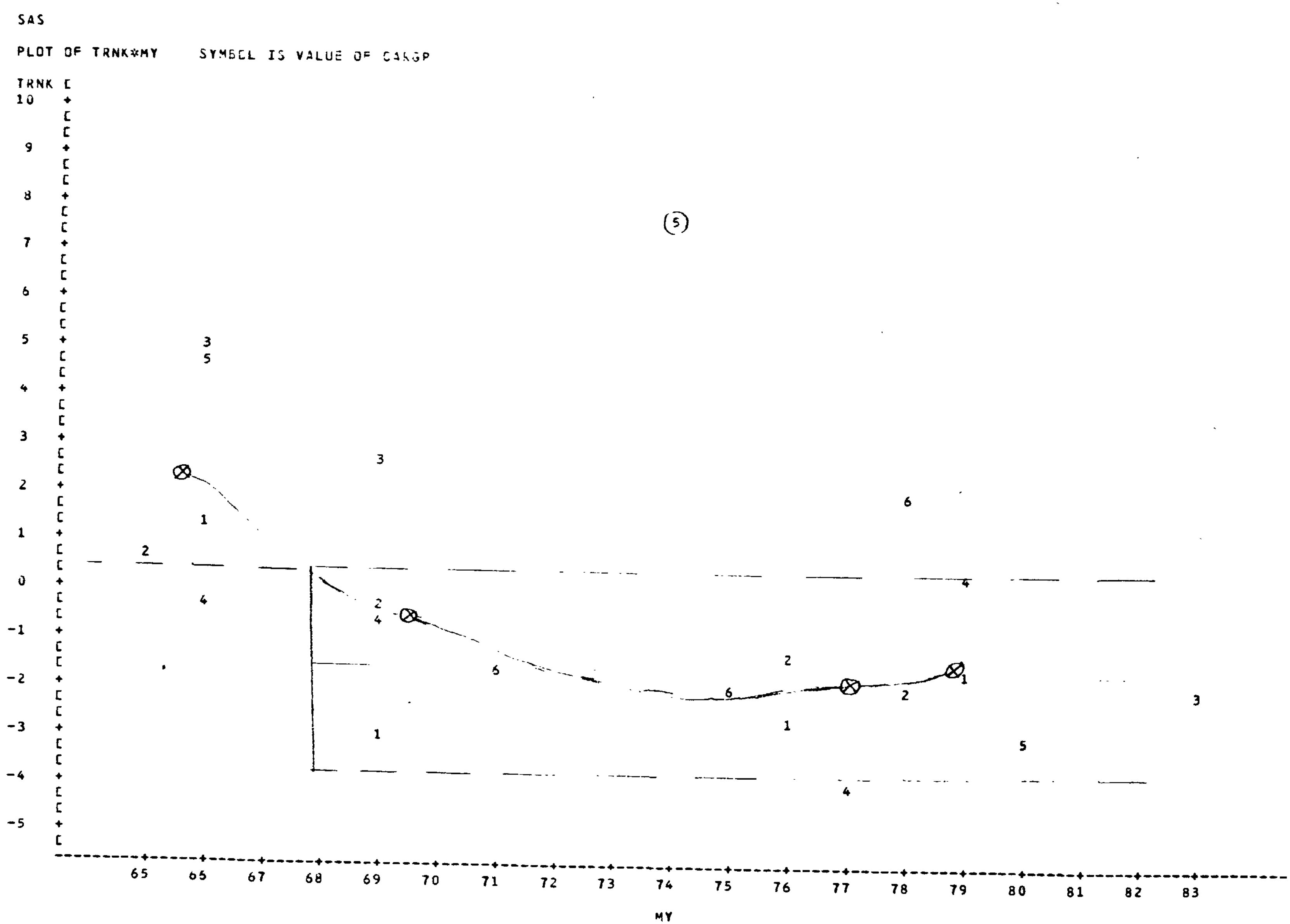


TABLE 3-3

MVMA2D RESULTS: NORMALIZED RANK ORDER SCORES, BY CAR GROUP

Car Group	MY Group	Vehicle	TRNK	CRNK	GRANK	DFLRANK	FEMRANK	HNRANK	TRNK25	TRNK30
1	1	66 Ford Galaxie 500	1.34	-1.01	1.86	-3.29	.90	2.82	.73	1.16
	2	69 Ford LTD	-2.92	-2.19	- .01	-3.08	.20	-2.82	-2.91	-1.22
	3	76 Ford LTD	-2.74	.13	-2.73	2.92	-2.73	-2.64	-1.70	-2.17
	4	79 Ford LTD	-1.67	-1.75	- .59	-1.89	.09	- .99	-1.56	- .81
2	1	65 Chevrolet BelAir	.58	.00	2.19	-2.19	- .07	1.12	.95	- .13
	2	69 Chevrolet BelAir	- .33	1.41	.19	1.81	-1.50	- .94	- .06	- .41
	3	76 Chevrolet Caprice	-1.24	- .60	- .87	.02	-1.98	.29	- .27	-1.48
	4	78 Buick LeSabre	-2.12	-3.50	-2.67	-2.28	-1.50	1.74	-1.24	-1.75
3	1	66 Chevrolet Chevy II	4.94	3.36	3.83	.93	1.82	3.25	3.71	3.28
	2	69 Chevrolet Nova	2.65	- .33	3.74	-4.20	3.06	2.42	1.50	2.24
	4	83 Chevrolet Celebrity	-1.87	-2.13	.14	-3.15	.27	-1.07	-1.17	-1.48
4	1	66 Plymouth Valiant	- .28	2.31	2.22	1.04	- .30	-3.02	.26	- .65
	2	69 Dodge Dart	- .61	.65	- .18	1.10	- .16	-1.75	- .56	- .31
	3	77 Plymouth Volare	-4.08	-1.55	-5.27	3.08	-3.74	-2.14	-2.82	-2.95
	3	79 Ford Mustang	.32	3.71	.56	4.69	1.11	-4.91	1.38	- .93
5	1	66 VW Beetle	4.73	- .75	3.60	-4.67	3.95	5.90	3.40	3.30
	none	74 VW Beetle	7.71	5.82	3.95	4.28	3.57	3.69	5.51	5.40
	4	80 Dodge Omni	-2.88	-2.38	-5.36	1.99	-1.24	-1.20	-3.14	- .92
6	2	71 Datsun 1200	-1.62	-1.99	-2.99	.17	-1.98	1.26	-1.67	- .63
	4	75 Honda Civic	-1.96	-1.79	- .48	-2.05	-1.64	.09	-1.50	-1.27
	4	78 Honda Accord	2.04	2.57	-1.12	4.76	1.86	-1.10	1.17	1.72

TRNK=Overall injury score
GRANK=Chest injury score (acceleration measurements only)
FEMRANK=Femur injury score
TRNK25=Overall injury score (25 mph crashes only)

CRNK=Chest injury score
DFLRANK=Chest injury score (deflection & S Delta S)
HNRANK=Head and neck injury score
TRNK30=Overall injury score (30 mph crashes only)

TABLE 3-4

MVMA2D RESULTS: NORMALIZED RANK ORDER SCORES, BY MODEL YEAR GROUP

MY Group	Car Group	Vehicle	TRNK	CRNK	GRANK	DFLRANK	FEMRANK	HNRANK	TRNK25	TRNK30
1	1	66 Ford Galaxie 500	1.34	-1.01	1.86	-3.29	.90	2.82	.73	1.16
	2	65 Chevrolet BelAir	.58	.00	2.19	-2.19	-.07	1.12	.95	-.13
	3	66 Chevrolet Chevy II	4.94	3.36	3.83	.93	1.82	3.25	3.71	3.28
	4	66 Plymouth Valiant	-.28	2.31	2.22	1.04	-.30	-3.02	.26	-.65
	5	66 VW Beetle	4.73	-.75	3.60	-4.67	3.95	5.90	3.40	3.30
2	1	69 Ford LTD	-2.92	-2.19	-.01	-3.08	.20	-2.82	-2.91	-1.22
	2	69 Chevrolet BelAir	-.33	1.41	.19	1.81	-1.50	-.94	-.06	-.41
	3	69 Chevrolet Nova	2.65	-.33	3.74	-4.20	3.06	2.42	1.50	2.24
	4	69 Dodge Dart	-.61	.65	-.18	1.10	-.16	-1.75	-.56	-.31
	6	71 Datsun 1200	-1.62	-1.99	-2.99	.17	-1.98	1.26	-1.67	-.63
3	1	76 Ford LTD	-2.74	.13	-2.73	2.92	-2.73	-2.64	-1.70	-2.17
	2	76 Chevrolet Caprice	-1.24	-.60	-.87	.02	-1.98	.29	-.27	-1.48
	4	77 Plymouth Volare	-4.08	-1.55	-5.27	3.08	-3.74	-2.14	-2.82	-2.95
	4	79 Ford Mustang	.32	3.71	.56	4.69	1.11	-4.91	1.38	-.93
4	1	79 Ford LTD	-1.67	-1.75	-.59	-1.89	.09	-.99	-1.56	-.81
	2	78 Buick LeSabre	-2.12	-3.50	-2.67	-2.28	-1.50	1.74	-1.24	-1.75
	3	83 Chevrolet Celebrity	-1.87	-2.13	.14	-3.15	.27	-1.07	-1.17	-1.48
	5	80 Dodge Omni	-2.88	-2.38	-5.36	1.99	-1.24	-1.20	-3.14	-.92
	6	75 Honda Civic	-1.96	-1.79	-.48	-2.05	-1.64	.09	-1.50	-1.27
	6	78 Honda Accord	2.04	2.57	-1.12	4.76	1.86	-1.10	1.17	1.72
AVERAGE FOR MODEL YEAR GROUP 1			**2.26**	**.78**	**2.74**	**-1.63**	**1.26**	**2.01**	**1.81**	**1.39**
AVERAGE FOR MODEL YEAR GROUP 2			**-.57**	**-.49**	**.15**	**-.84**	**-.08**	**-.37**	**-.74**	**-.06**
AVERAGE FOR MODEL YEAR GROUP 3			**-1.93**	**.42**	**-2.08**	**2.68**	**-1.83**	**-2.35**	**-.85**	**-1.88**
AVERAGE FOR MODEL YEAR GROUP 4			**-1.41**	**-1.50**	**-1.68**	**-.44**	**-.36**	**-.42**	**-1.24**	**-.75**
COMBINED AVERAGE FOR MY GROUPS 3 AND 4			**-1.62**	**-.73**	**-1.84**	**.81**	**-.95**	**-1.19**	**-1.09**	**-1.20**

TRNK=Overall injury score
GRANK=Chest injury score (acceleration measurements only)
FEMRANK=Femur injury score
TRNK25=Overall injury score (25 mph crashes only)
CRNK=Chest injury score
DFLRANK=Chest injury score (deflection & S Delta S)
HNRANK=Head and neck injury score
TRNK30=Overall injury score (30 mph crashes only)

drops to -0.57 in model year group 2 (69-71 cars); TRNK averages -1.93 in MY group 3 (pre-downsized big cars and rear wheel drive smaller cars) and -1.41 in MY group 4 (downsized big cars and front wheel drive small cars). The combined average for the 10 cars of model year groups 3 and 4 (cars of the mid 1970's to early 1980's) is -1.62.

Is the reduction of the overall injury scores statistically significant? Perhaps the most appropriate comparison would be the average for groups 3 and 4 (1975-83) vs. group 1 (1965-66). An ordinary t test of the difference between two sample means is performed, comparing the sample of 5 values of TRNK from MY group 1 vs. the 10 values of TRNK in MY groups 3 and 4. The t statistic is 3.61, so the reduction clearly is statistically significant (df=13, one sided p=.0016). In other words, the simulations predict that the panel geometry and materials of 1975-83 cars provide greater safety to unrestrained right front passengers than do the panels of 1965-66 cars - although they do not predict how much safer.

The overall injury scores in cars of MY group 2 (1969-71) are also significantly lower than in group 1 (1965-66): t = 1.99, df = 8, one sided p = .041. But the reduction from group 2 (average score -0.57) to groups 3 and 4 (average score -1.62) does not achieve statistical significance: t = 1.05, df = 13, one-sided p = .16. Thus, the simulations indicate a significant injury reduction for cars of the late 1960's relative to cars of the mid 1960's and a possible additional reduction for cars of the 1970's relative to cars of the late 1960's.

The average values of TRNK for the four MY groups are marked as circled X's on Figure 3-1 (and the outlying 1974 Beetle likewise circled). A bold horizontal line is drawn through TRNK = -1.62, the average value for groups 3 and 4 combined. Dotted lines are drawn through TRNK = -1.62 ± 2. They do not imply confidence bounds in a rigorous sense but they give a rough idea of the "noise" range. Note that 4 out of the 5 1965-66 cars are <u>above</u> the upper dotted line, while 4 out of the 5 1969-71 cars and 9 out of the 10 1975-83 cars are <u>below</u> it. Above all, note the similarity of the patterns in Figures 3-1 and 2-1 (the NCSS analysis): a big reduction in cars of the mid to late 1960's, followed by a smaller reduction and a leveling off in the 1970's.

Figure 3-2 presents the results for the combined chest injury score CRNK. Although the trend is toward lower injury risk (according to Table 3-4, CRNK averages 0.78 in MY group 1, -0.49 in MY group 2 and -0.73 in combined groups 3 and 4), it is clear from Figure 3-2 that the variations within MY groups are almost as large as those between groups. Indeed, the difference between group 1 and combined groups 3 and 4 is not statistically significant: t = 1.27, df = 13, one-sided p = .12. Figures 3-3 and 3-4 decompose CRNK into its components GRANK (acceleration based chest scores) and DFLRANK (direct contact deformation based scores). Now it becomes clear why CRNK has only a slight trend: GRANK has a strong favorable trend toward lower chest g's in the later cars while DFLRANK may be going in the opposite direction. The reduction in GRANK from group 1 (average value 2.74) to groups 3 and 4 (average value -1.84) is obviously significant: t = 4.57, df = 13, one-sided p = .0003. The increase in

FIGURE 3-2: CRNK (Chest Injury Score) BY MODEL YEAR

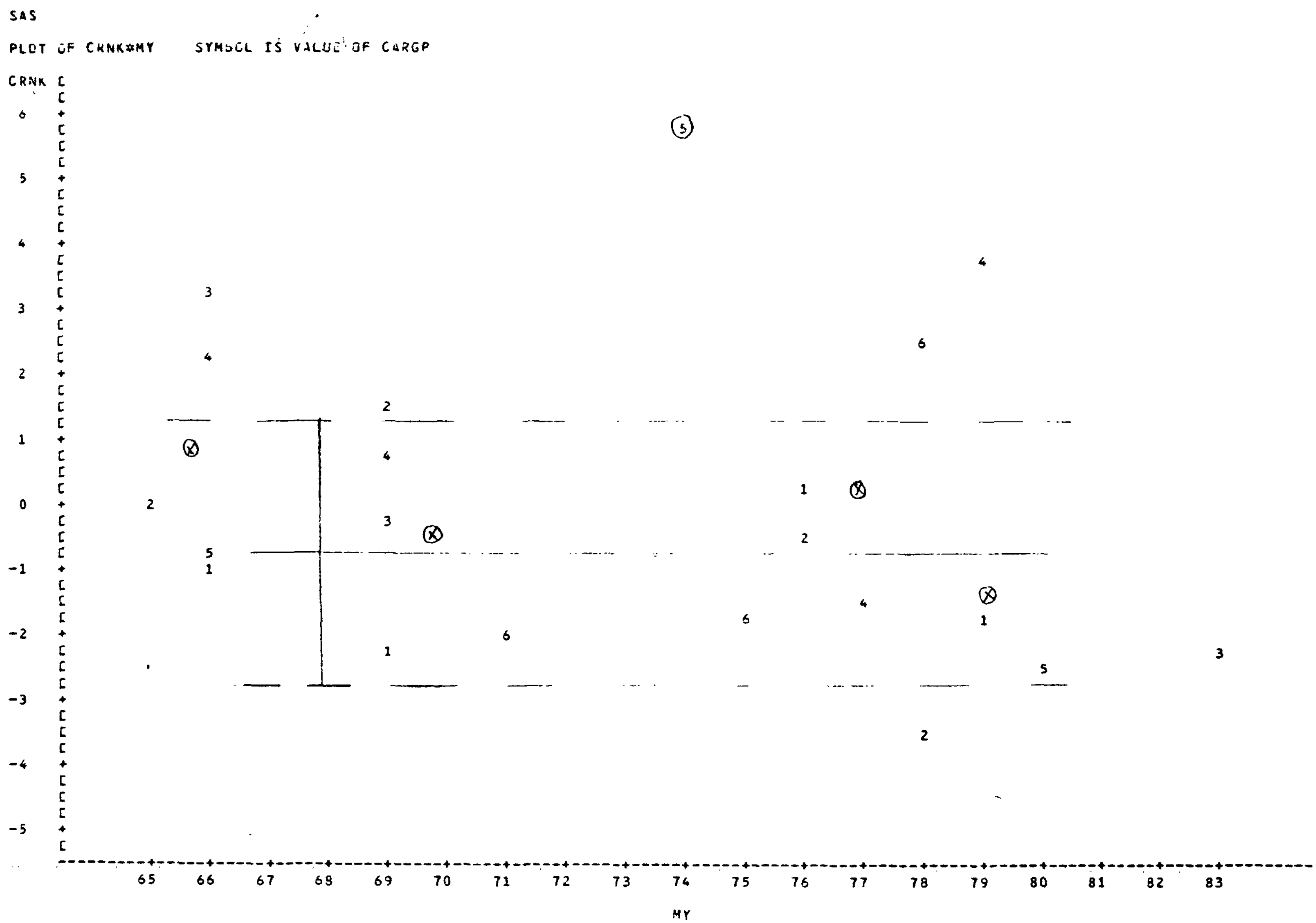


FIGURE 3-3: GRANK (Chest Acceleration Score) BY MODEL YEAR

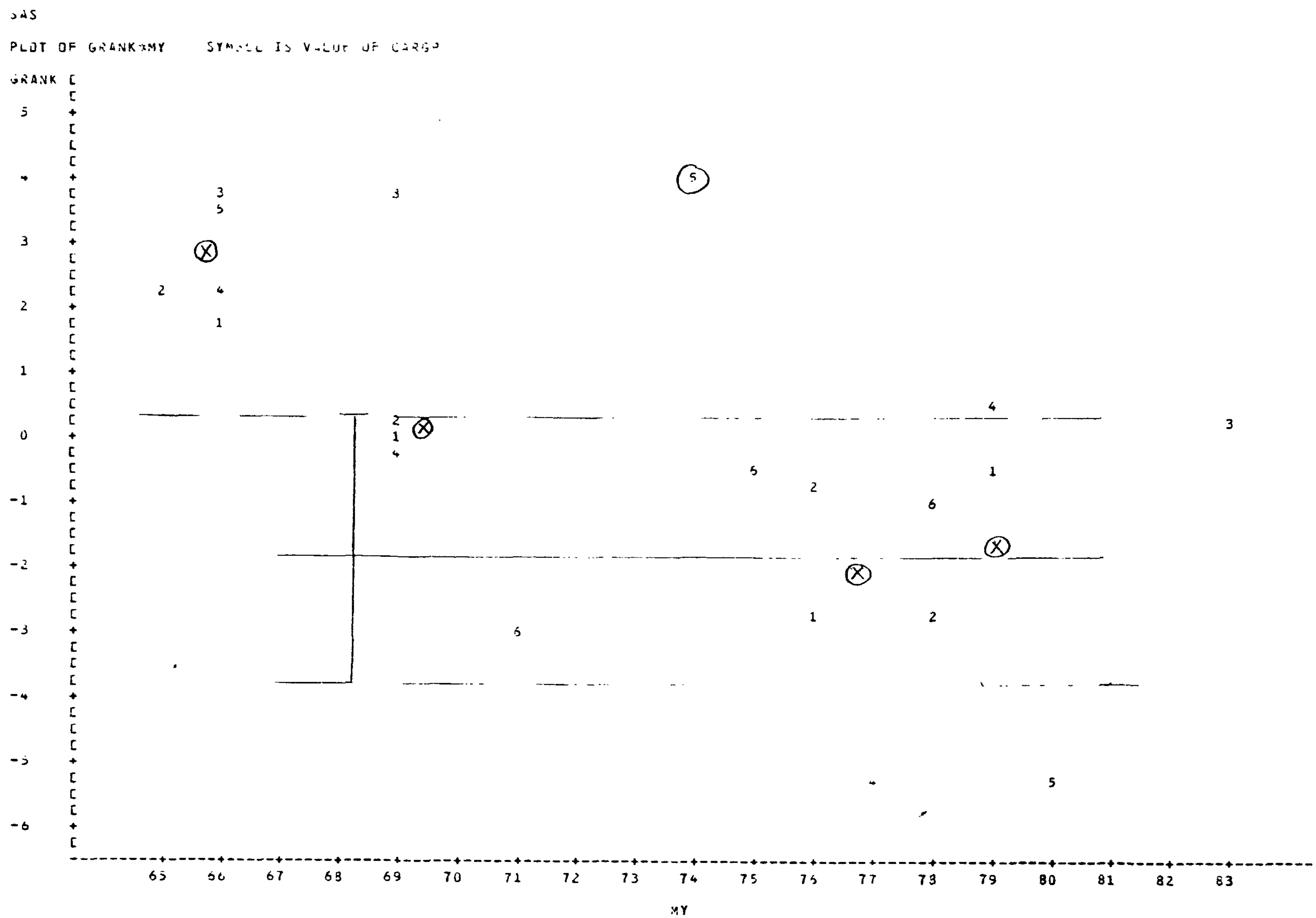
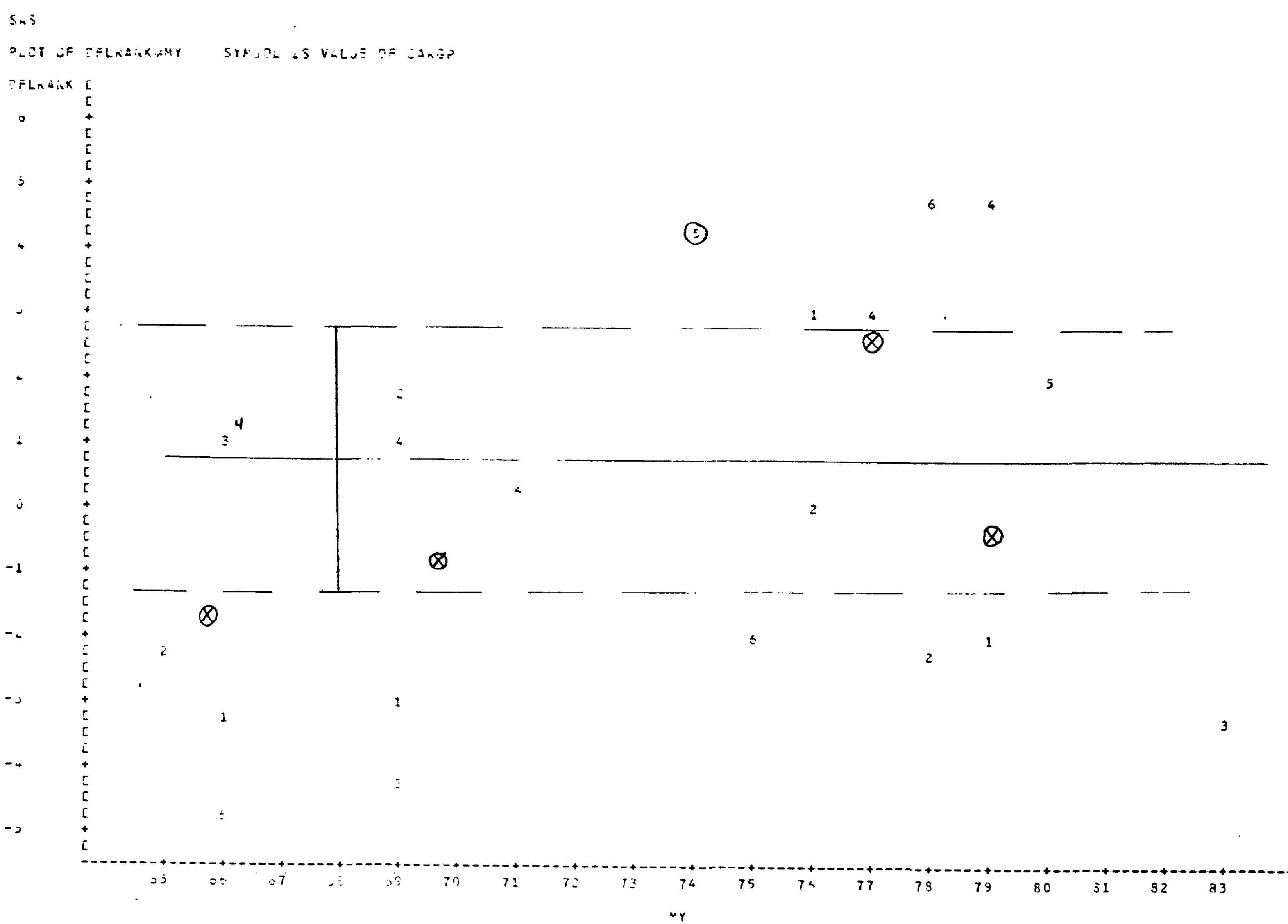


FIGURE 3-4: DFLRANK (Chest Deflection Score) BY MODEL YEAR



DFLRANK from group 1 (average value -1.63) to groups 3 and 4 (average value 0.81) is, however, nonsignificant: $t = -1.54$, $df = 13$, one-sided $p = .08$. It can be seen in Figure 3-3 that the values of GRANK for the 1965-66 cars are all well above the "noise" range for the later cars, whereas in Figure 3-4, the DFLRANK values are far more dispersed.

Figure 3-5 indicates that FEMRANK, the femur injury score, has a moderate trend toward lower injury in the later model years, although there is some overlap between the earlier and later cars. The reduction in FEMRANK from group 1 (average value 1.26) to groups 3 and 4 (average value -0.95) is statistically significant: $t = 2.31$, $df = 13$, one-sided $p = .02$.

Head and neck injury, as predicted by HNRANK, also decreased in the later cars. Figure 3-6 shows that 4 of the 5 cars in MY group 1 had HNRANK predictions above the error range for the later cars. The reduction in HNRANK from group 1 (average value 2.01) to groups 3 and 4 (average value -1.19) is significant: $t = 2.47$, $df = 13$, one-sided $p = .014$.

There are hardly any differences in average performance on the 25 mph and 30 mph crashes. Figure 3-7 shows almost the same trend on TRNK25, the overall injury score based on the 25 mph simulations, as Figure 3-8 does on TRNK30: a big reduction in cars of the later 1960's followed by a possible additional reduction and a levelling off in the 1970's. It is the same trend as in Figure 3-1 (TRNK, the combination of

FIGURE 3-5: FEMRANK (Femur Injury Score) BY MODEL YEAR

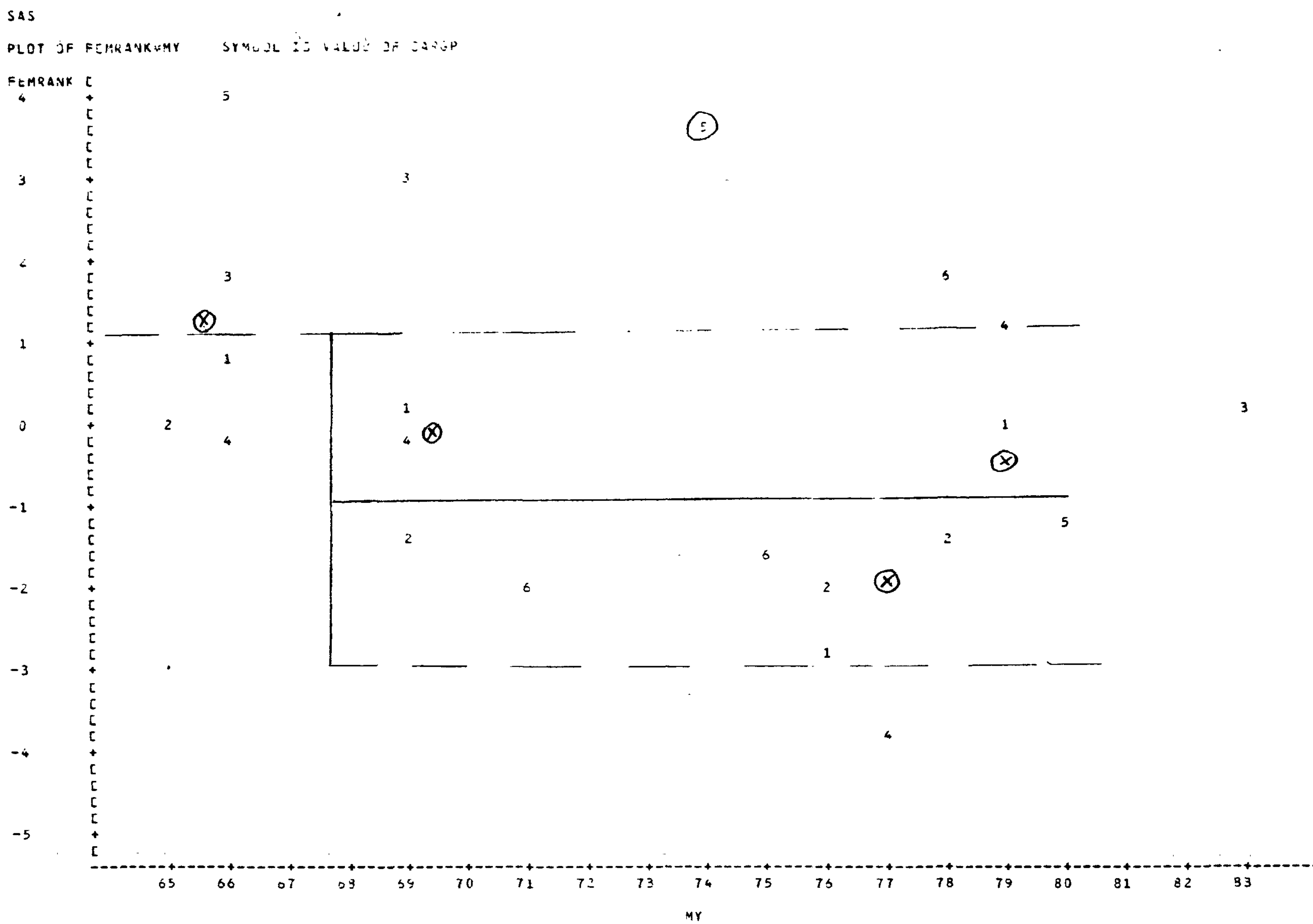


FIGURE 3-6: HNRANK (Head and Neck Injury Score) BY MODEL YEAR

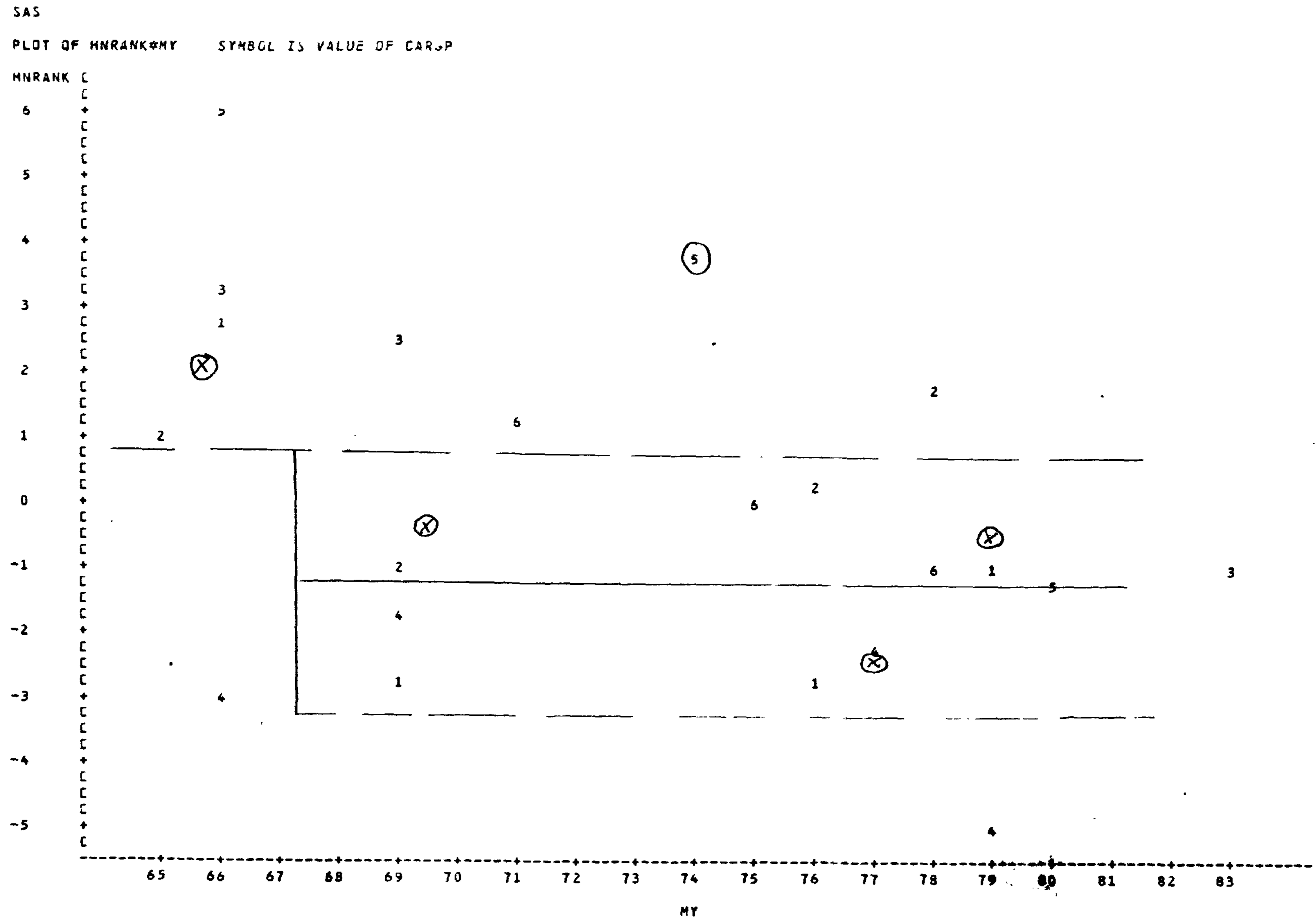


FIGURE 3-7: TRNK25 (Overall Injury Score - 25 mph crashes) BY MODEL YEAR

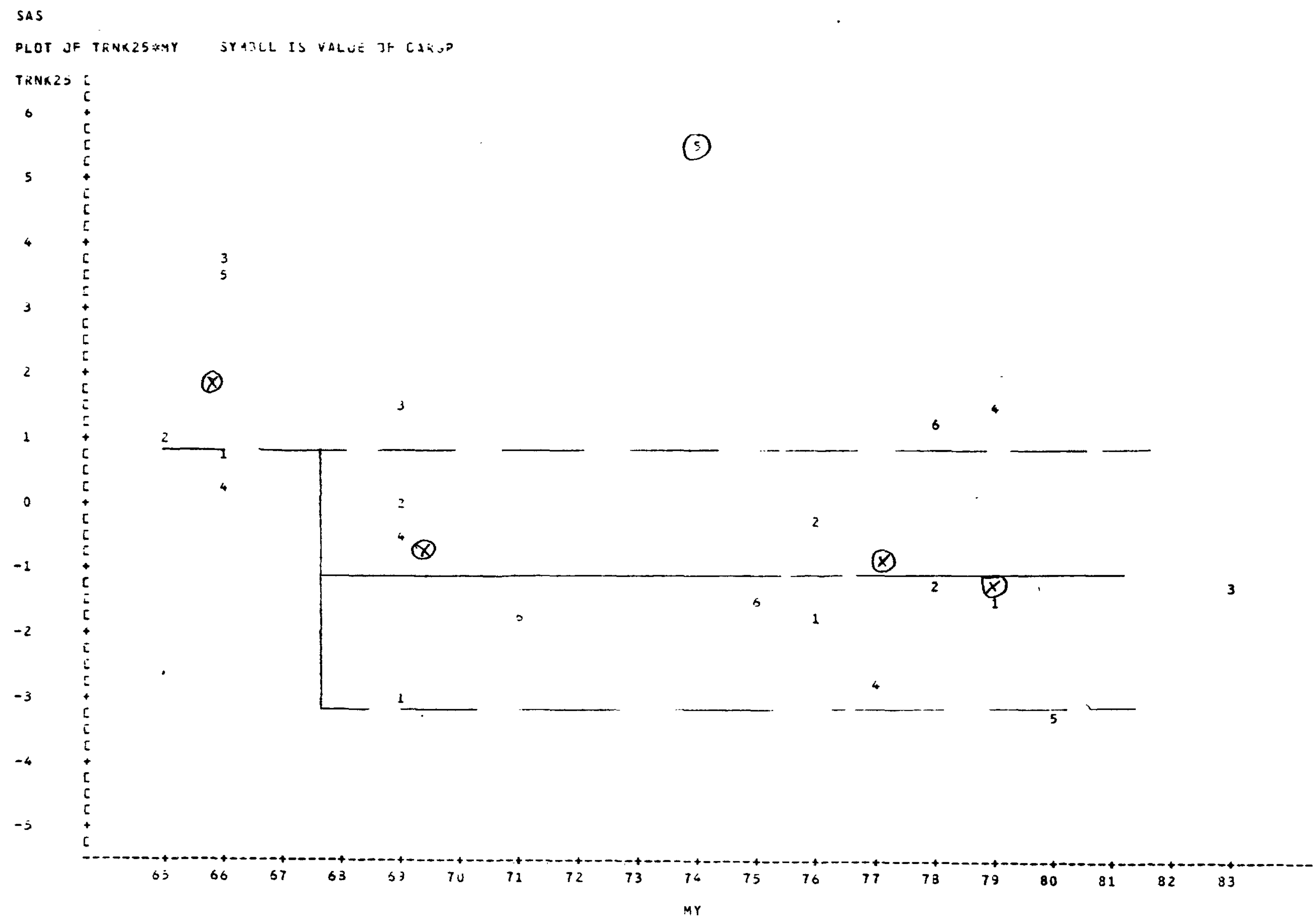
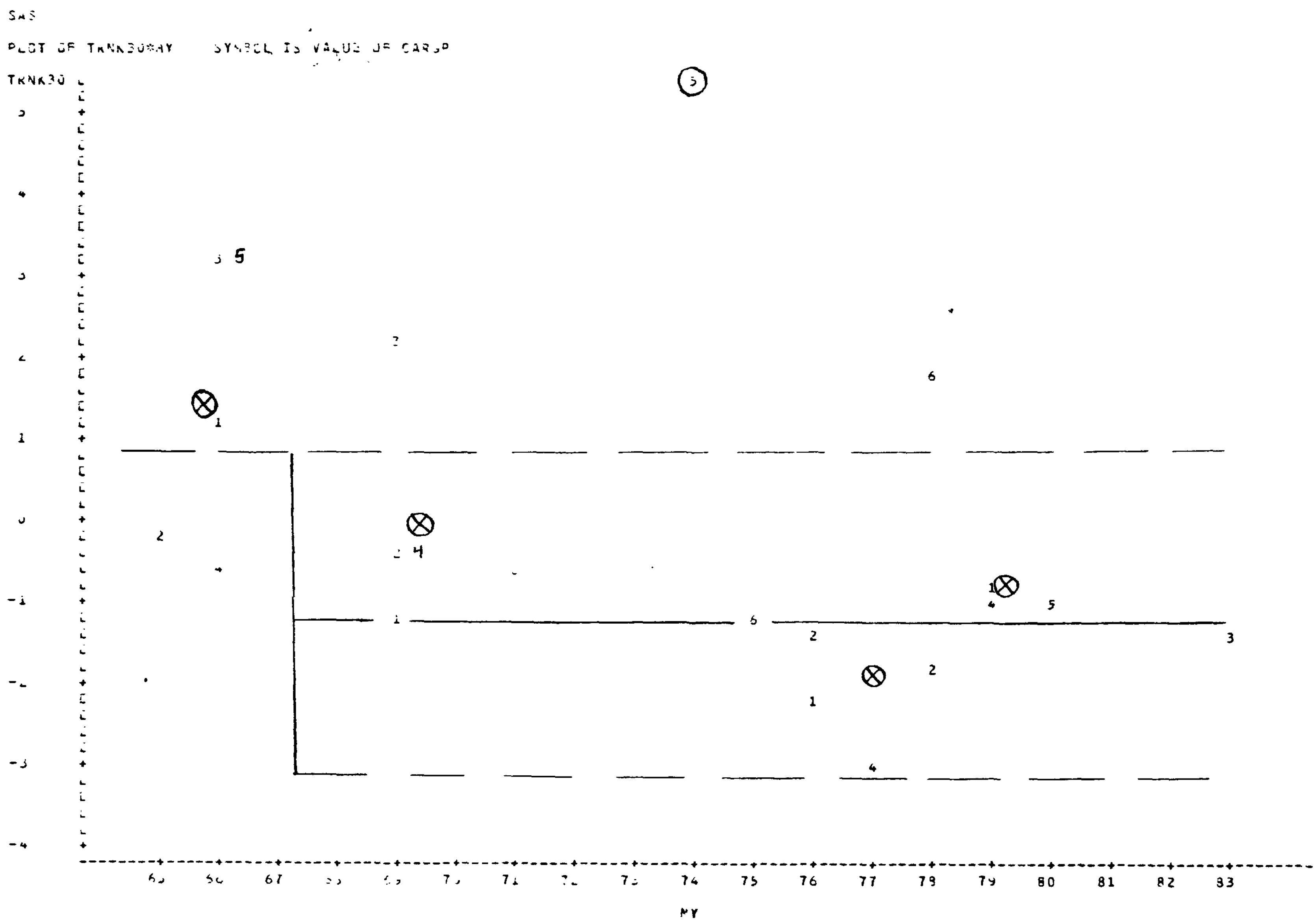


FIGURE 3-8: TRNK30 (Overall Injury Score - 30 mph crashes) BY MODEL YEAR



TRNK25 and TRNK30). The reduction in TRNK25 from group 1 (average value 1.81) to groups 3 and 4 (average value -1.09) is significant: $t = 3.46$, $df = 13$, one-sided $p = .002$. TRNK30 likewise drops significantly from group 1 (average value 1.39) to groups 3 and 4 (average value -1.20): $t = 3.28$, $df = 13$, one-sided $p = .003$.

3.5 Instrument panel geometry and force deflection - by model year

The preceding analyses of injury scores by model year group showed some clear trends - always in the right direction except for DFLRANK (chest deflection and S Delta S). The input data to the simulations - instrument panel geometry and force deflection characteristics - can also be statistically analyzed to see if panel design changed significantly over the years and to relate the changes in injury scores (as predicted by the simulation models - see Section 3.2) to specific changes in panel design. In particular, did panel design really change in the ways described in the literature (see Section 1.4)? Did these panel modifications ameliorate injury risk as predicted by researchers?

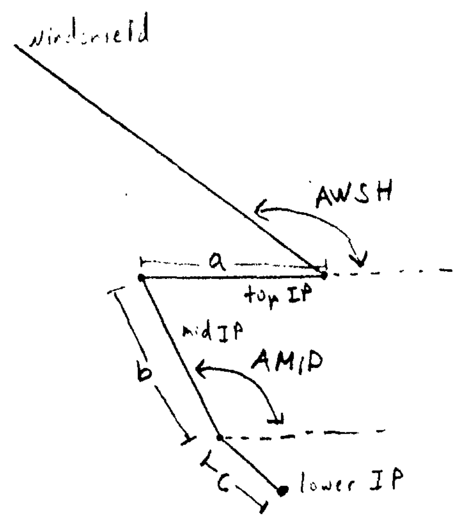
The first step of the analysis is to look only at the changes of panel design over the model years 1965-83. Cohen performed similar analyses, but with different vehicles and characterizations of the panel parameters [6]. The analysis here is based on the 21 cars of the test matrix and uses 6 parameters to describe the vehicle interior - 3 for geometry and 3 for force deflection:

IPL	Instrument panel length
AMIP	Angle of the mid IP
AWSH	Rake angle of the windshield

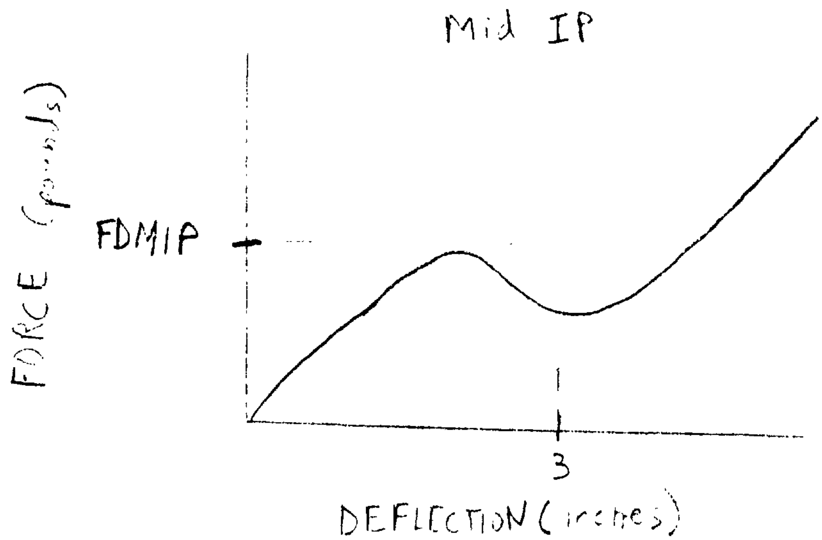
FDMIP Max. force deflection of mid IP in first 3 inches
FDLIP6 Max. force deflection of lower IP at 6 inches
LIP2000 Inches till lower IP reaches 2000 pounds force defl.

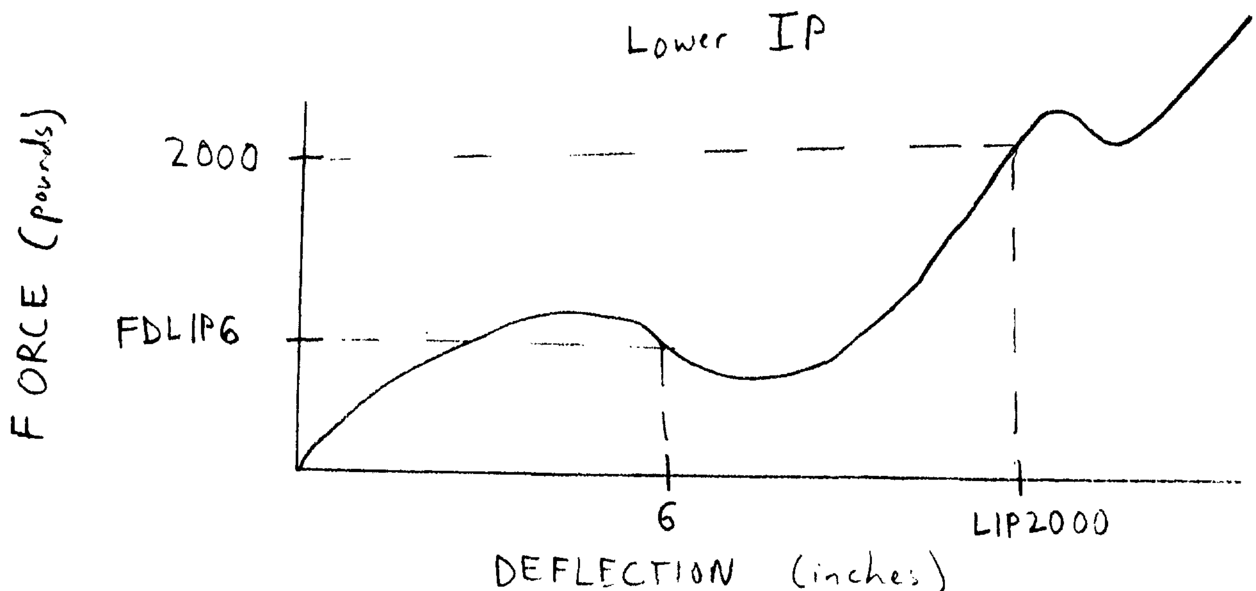
IPL is the perimeter length from the front of the top IP to the bottom of the lower IP in a longitudinal cross section of the car down the middle to the right front passenger's seat position. IPL was obtained by adding the lengths of the top, mid and lower IP measurements by the contractor (for the older cars) or TSC (for the newer cars). The panel measurements derived from crash test data (Accord, Celebrity, Mustang and Omni) were not used here, since some length has been "added" as an aid to running MVMA2D (see Section 3.3.3). AMIP is the angle between the mid IP surface and a vector pointing toward the front of the car. When AMIP is less than 90, the mid IP slopes downward toward the passenger; when AMIP is greater than 90, the mid IP falls away from the passenger. AWSH is measured the same way as AMIP, but usually has values well over 90. The more "raked" the windshield, the greater AWSH. IPL, AMIP and AWSH are illustrated in the accompanying diagram.

$$IPL = a + b + c$$



FDMIP, FDLIP6 and LIP2000, illustrated on the force deflection curves in the accompanying diagram, are based on the actual input data used in the MVMA2D simulations, which sometimes differ from the numbers supplied by the contractor, as explained in Section 3.4.3. FDMIP is the maximum force deflection of the mid instrument panel anywhere in the first 3 inches of penetration. The 3 inch cutoff is selected because the passengers' chests typically penetrate that far or less in the simulations. FDLIP6 is the force deflection of the lower IP at exactly 6 inches





penetration depth. In most of the 30 mph simulations, the knees penetrate well beyond 6 inches. Thus FDLIP6 describes the aggressiveness of the lower IP in the earlier stages of the passenger's interaction with the panel. LIP2000 is the amount of penetration needed to reach 2000 pounds force deflection in the lower IP, a force level that will stop the passenger's forward motion in a few inches. It describes the aggressiveness of the lower IP in the later stages of the passenger's contact. On 4 cars where the force never reached 2000 pounds in the MVMA2D input data, LIP2000 was arbitrarily set at 18 inches - i.e., a number higher than for any of the other cars. In general, the stiffer the panel, the <u>higher</u> FDMIP and FDLIP6 and the <u>lower</u> LIP2000.

Next, the measurements were converted to normalized rank order scores, somewhat resembling the process for the injury scores (see Section 3.4.2). The 21 cars were given ranks from 1 (lowest measurement) to 21 (highest measurement) on each of the six variables and the ranks were transformed to unit normal variates by the formula in Section 3.4.2. The normalized rank order scores can readily be analyzed by conventional methods for correlation with model year and with the injury scores.

Table 3-5 shows the values of the 6 parameters for each of the 21 cars, organized by manufacturer/market class. Although there are exceptions, the general trend in each class is that IPL, AWSH and LIP2000 increased while AMIP, FDMIP and FDLIP6 decreased. In Table 3-6, the cars are listed by model year group. The lower part of the table shows the average values for each model year group. For example, the normalized

TABLE 3-5

INSTRUMENT PANEL GEOMETRY AND FORCE DEFLECTION: NORMALIZED RANK ORDER SCORES, BY CAR GROUP

Car Group	MY Group	Vehicle	IPL	AMIP	AWSH	FDMIP	FDLIP6	LIP2000
1	1	66 Ford Galaxie 500	-1.16	1.89	.30	.78	1.16	-1.43
	2	69 Ford LTD	- .23	.00	.63	- .49	.36	- .78
	3	76 Ford LTD	1.16	.63	.95	.30	- .63	1.36
	4	79 Ford LTD	- .36	- .56	.12	-1.89	.00	- .49
2	1	65 Chevrolet BelAir	.00	.49	- .12	.30	.49	- .24
	2	69 Chevrolet BelAir	.36	.12	- .95	.00	- .30	.12
	3	76 Chevrolet Caprice	.95	- .56	- .30	- .24	- .30	.36
	4	78 Buick LeSabre	- .95	.24	.63	- .95	- .12	1.36
3	1	66 Chevrolet Chevy II	- .63	.78	- .63	1.89	.78	- .95
	2	69 Chevrolet Nova	- .49	1.43	- .30	- .12	1.89	-1.16
	4	83 Chevrolet Celebrity	1.89	-1.89	1.16	-1.43	.24	- .12
4	1	66 Plymouth Valiant	- .78	1.16	.63	1.16	.63	- .63
	2	69 Dodge Dart	- .12	.95	.30	.49	- .49	- .36
	3	77 Plymouth Volare	.78	.36	- .78	.12	- .78	.78
	3	79 Ford Mustang	.63	- .78	1.43	-1.16	-1.16	.49
5	1	66 VW Beetle	-1.89	- .36	-1.89	- .63	.95	1.36
	none	74 VW Beetle	-1.43	- .24	-1.43	1.43	1.43	-1.89
	4	80 Dodge Omni	1.43	- .95	.00	- .36	-1.89	1.35
6	2	71 Datsun 1200	.12	- .12	-1.16	.63	-1.43	.63
	4	75 Honda Civic	.24	-1.43	- .49	.95	.12	.24
	4	78 Honda Accord	.49	-1.16	1.89	- .78	- .95	.00

IPL=Instrument panel length
AWSH=Windshield rake angle
FDLIP6=Force deflection of lower IP at 6 inches

AMIP=Angle of the mid IP
FDMIP=Max. force/deflection of mid IP in 1st 3 inches
LIP2000=Penetration at which lower IP reaches 2000 lbs

TABLE 3-6

INSTRUMENT PANEL GEOMETRY AND FORCE DEFLECTION: NORMALIZED RANK ORDER SCORES, BY MODEL YEAR GROUP

MY Group	Car Group	Vehicle	IPL	AMIP	AWSH	FDMIP	FDLIP6	LIP2000
1	1	66 Ford Galaxie 500	-1.16	1.89	.30	.78	1.16	-1.43
	2	65 Chevrolet BelAir	.00	.49	- .12	.30	.49	- .24
	3	66 Chevrolet Chevy II	- .63	.78	- .63	1.89	.78	- .95
	4	66 Plymouth Valiant	- .78	1.16	.63	1.16	.63	- .63
	5	66 VW Beetle	-1.89	- .36	-1.89	- .63	.95	1.36
2	1	69 Ford LTD	- .23	.00	.63	- .49	.36	- .78
	2	69 Chevrolet BelAir	.36	.12	- .95	.00	- .30	.12
	3	69 Chevrolet Nova	- .49	1.43	- .30	- .12	1.89	-1.16
	4	69 Dodge Dart	- .12	.95	.30	.49	- .49	- .36
	6	71 Datsun 1200	.12	- .12	-1.16	.63	-1.43	.63
3	1	76 Ford LTD	1.16	.63	.95	.30	- .63	1.36
	2	76 Chevrolet Caprice	.95	- .56	- .30	- .24	- .30	.36
	4	77 Plymouth Volare	.78	.36	- .78	.12	- .78	.78
	4	79 Ford Mustang	.63	- .78	1.43	-1.16	-1.16	.49
4	1	79 Ford LTD	- .36	- .56	.12	-1.89	.00	- .49
	2	78 Buick LeSabre	- .95	.24	.63	- .95	- .12	1.36
	3	83 Chevrolet Celebrity	1.89	-1.89	1.16	-1.43	.24	- .12
	5	80 Dodge Omni	1.43	- .95	.00	- .36	-1.89	1.35
	6	75 Honda Civic	.24	-1.43	- .49	.95	.12	.24
	6	78 Honda Accord	.49	-1.16	1.89	- .78	- .95	.00
AVERAGE FOR MODEL YEAR GROUP 1			**- .89**	**.79**	**- .34**	**.70**	**.80**	**- .38**
AVERAGE FOR MODEL YEAR GROUP 2			**- .07**	**.48**	**- .30**	**.10**	**.00**	**- .31**
AVERAGE FOR MODEL YEAR GROUP 3			**.88**	**- .09**	**.33**	**- .24**	**- .72**	**.75**
AVERAGE FOR MODEL YEAR GROUP 4			**.46**	**- .96**	**.55**	**- .74**	**- .43**	**.39**
COMBINED AVERAGE FOR MY GROUPS 3 AND 4			**.63**	**- .61**	**.46**	**- .54**	**- .55**	**.53**

IPL=Instrument panel length
AWSH=Windshield rake angle
FDLIP6=Force deflection of lower IP at 6 inches

AMIP=Angle of the mid IP
FDMIP=Max. force/deflection of mid IP in 1st 3 inches
LIP2000=Penetration at which lower IP reaches 2000 lbs

rank order score for IPL averaged -0.89 in the 65-66 cars, -0.07 in the 1969-71 cars and 0.63 in the 1975-83 cars (combination of groups 3 and 4).

Figure 3-9 graphs the values of IPL for the 21 cars by model year. The numbers of the data points represent the manufacturer/market class. The circled X's are the averages for the four model year groups and the outlier 1974 Beetle is also circled (its panel length is far below the general trend). Figure 3-9 shows a strong positive correlation between model year and instrument panel length. Indeed the linear correlation between IPL and model year is .64 and it is statistically significant (df = 19, p = .0018). The increase in IPL from MY group 1 (average value -0.89) to MY groups 3 and 4 (average value 0.63) is likewise significant (t = 3.48, df = 13, p = .004). The trend is consistent with statements in the literature (see Section 1.4) that panels became more protrusive and extended lower, so as to enhance ride down and provide better engagement by the passenger's knees.

Figure 3-10 graphs the values of AMIP by model year as well as the averages for the four model year groups. Figure 3-10 shows a clear negative correlation between model year and the angle of the mid IP. Indeed the linear correlation between AMIP and model year is -.71 and it is statistically significant (p = .0003). The decrease in AMIP from MY group 1 (average value 0.79) to MY groups 3 and 4 (average value -0.61) is likewise significant (t = 3.12, df = 13, p = .008). The trend is consistent with statements in Section 1.4 that panels dropped away from passengers in the older cars but have become more nearly vertical or taper down

FIGURE 3-9: IPL (Instrument Panel Length) BY MODEL YEAR

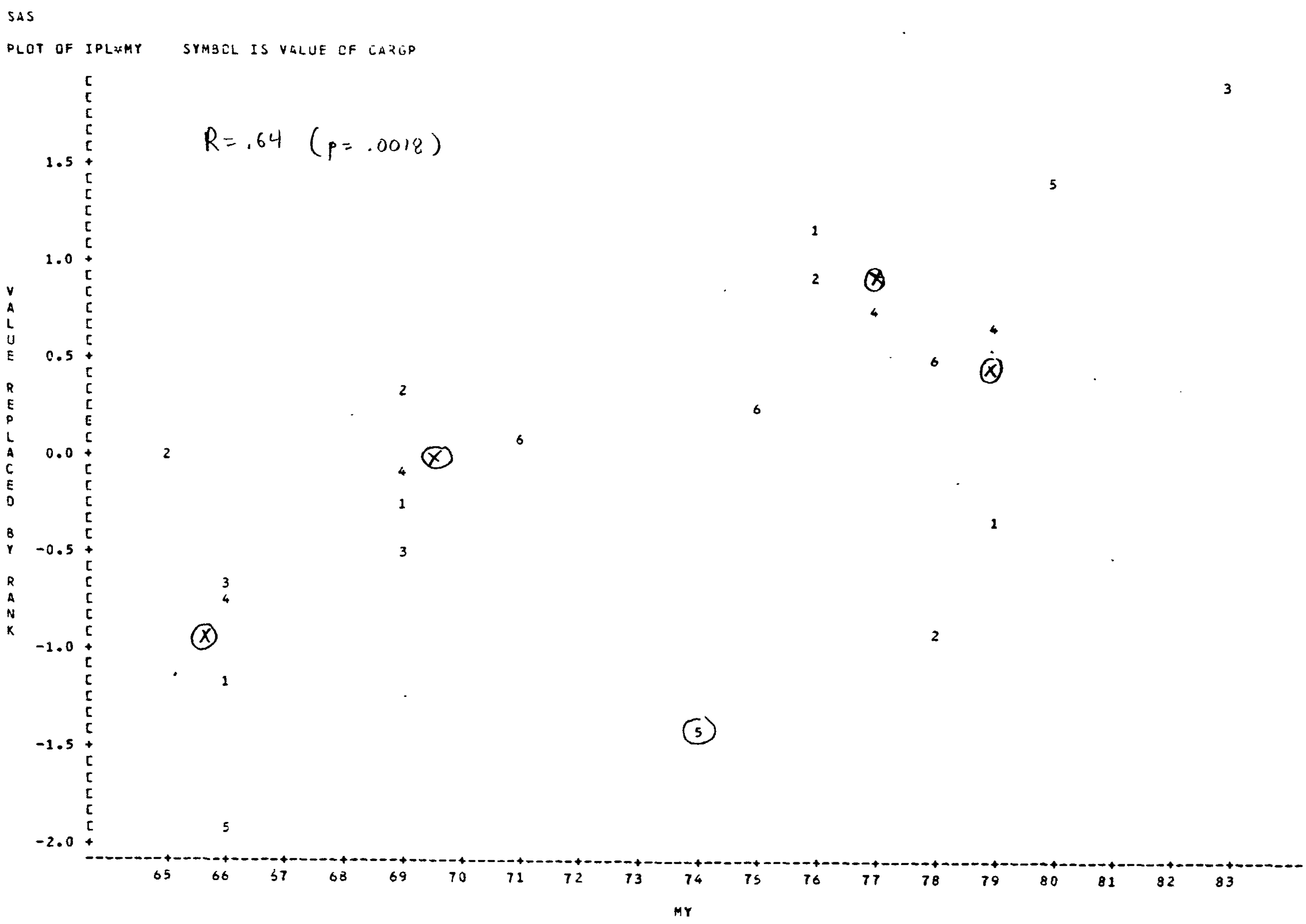
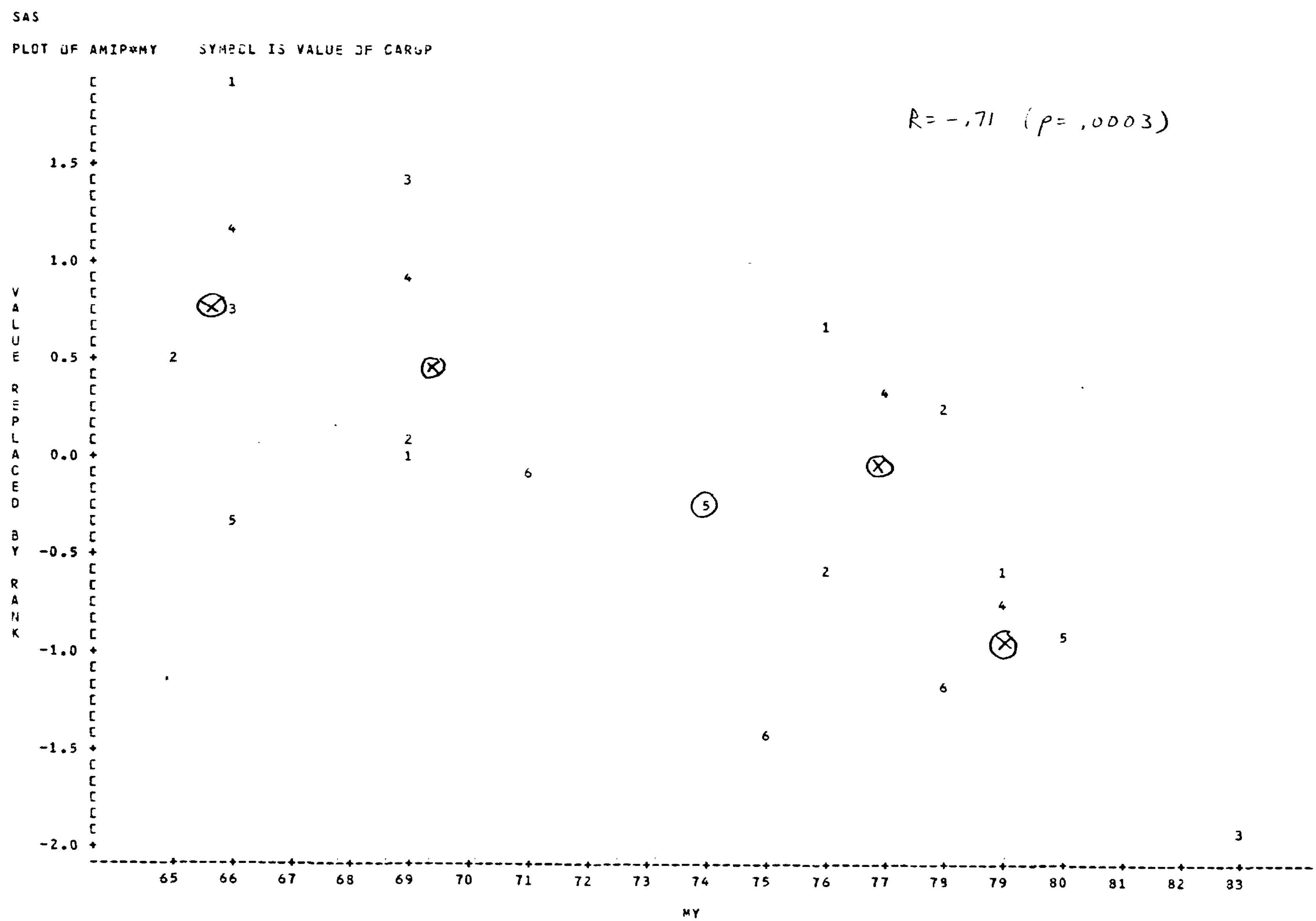


FIGURE 3-10: AMIP (Angle of the Mid IP) BY MODEL YEAR



toward the passenger in more recent cars.

The historical record of windshield rake angles is shown in Figure 3-11. The normalized rank order scores vary widely from car to car. (The wide variations in fact represent slight differences in the actual rake angles.) Nevertheless, there appears to be a modest trend to more raked windshields in the more recent cars. The linear correlation between model year and AWSH is .42, which is on the borderline of statistical significance (p. = .054). The increase in AWSH from MY group 1 (average value -0.34) to MY groups 3 and 4 (average value 0.46) does not achieve significance (t = 1.59, df = 13, p = .14). Nevertheless, the data are consistent with earlier statements that windshields have become more raked (more nearly horizontal).

Figure 3-12 shows a definite trend toward softer mid instrument panels. The linear correlation between model year and FDMIP is -0.60, which is statistically significant (p = .004). The reduction in FDMIP from MY group 1 (average value 0.69) to MY groups 3 and 4 (average value -0.54) is also significant (t = 2.55, df = 13, p = .02). The results are certainly consistent with statements in the literature that instrument panels have become softer.

Lower instrument panels have also become softer, as evidenced by Figures 3-13 and 3-14. Figure 3-13 shows a strong negative trend for FDLIP6, the lower IP force deflection at 6 inches depth - although, perhaps, some of the latest cars have flattened out or even reversed the

FIGURE 3-11: AWSH (Rake Angle of the Windshield) BY MODEL YEAR

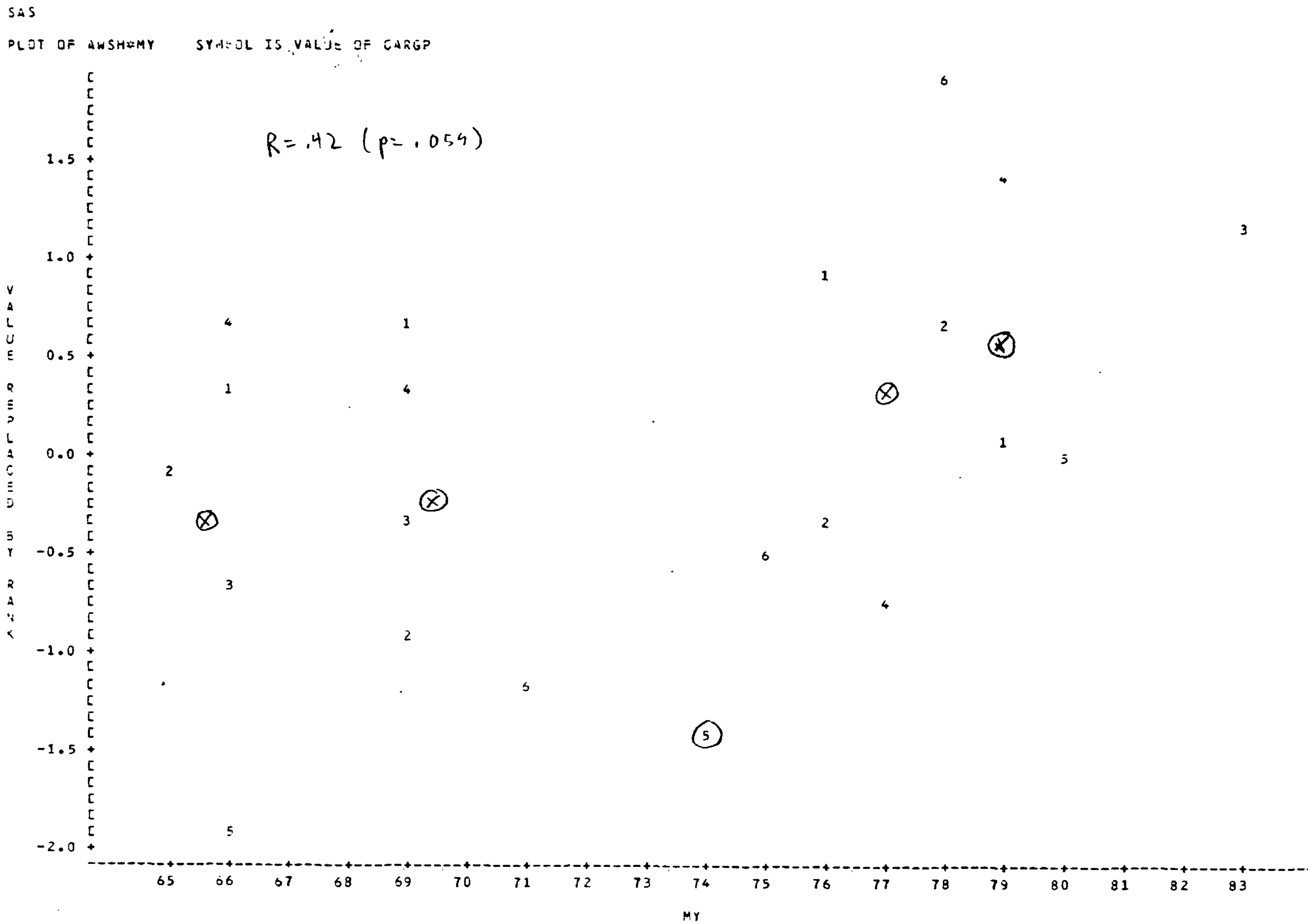


FIGURE 3-12: FDMIP (Max. Force Deflection of Mid IP in First 3 Inches) BY MODEL YEAR

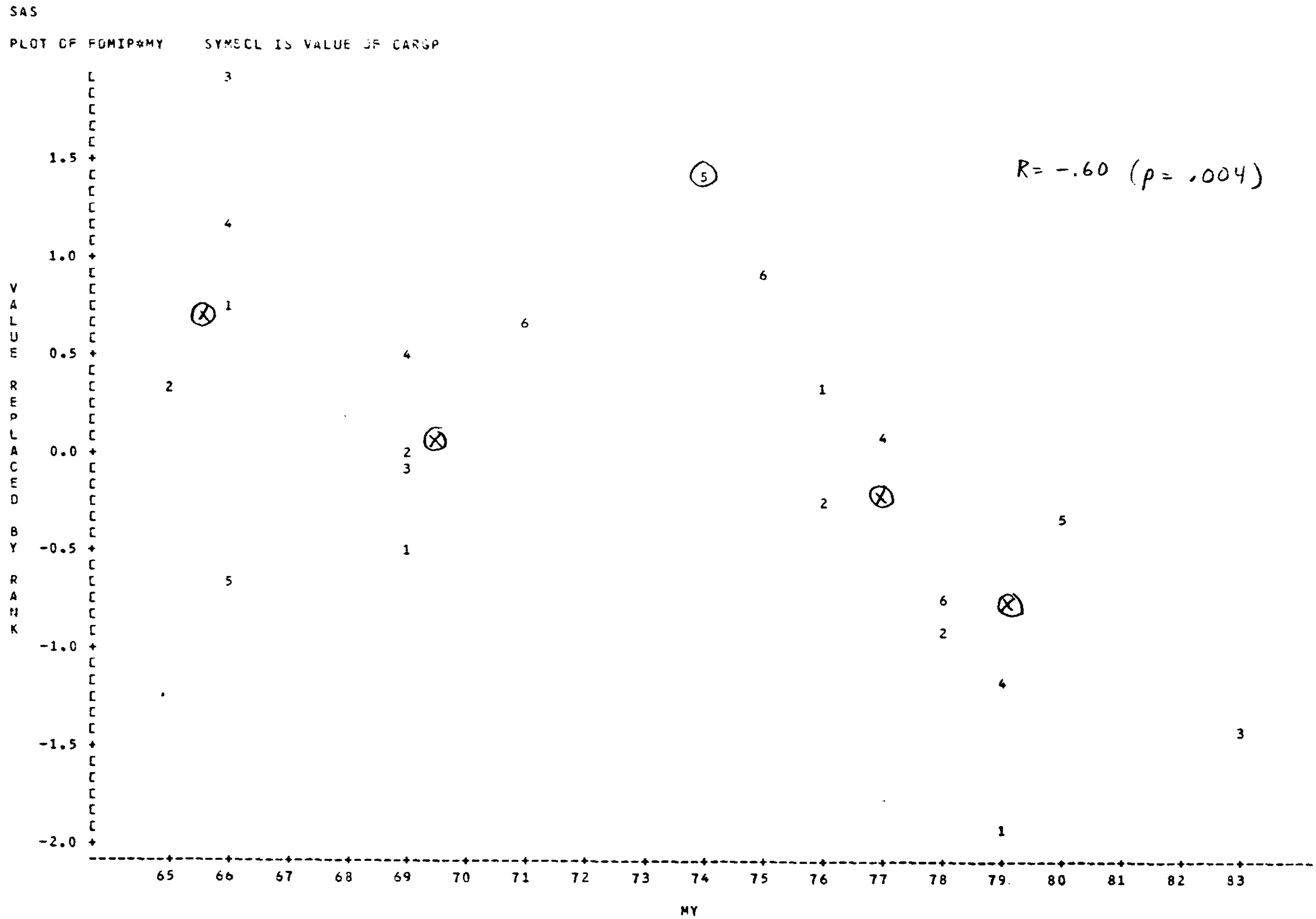


FIGURE 3-13: FDLIP6 (Max. Force Deflection of Lower IP at 6 Inches) BY MODEL YEAR

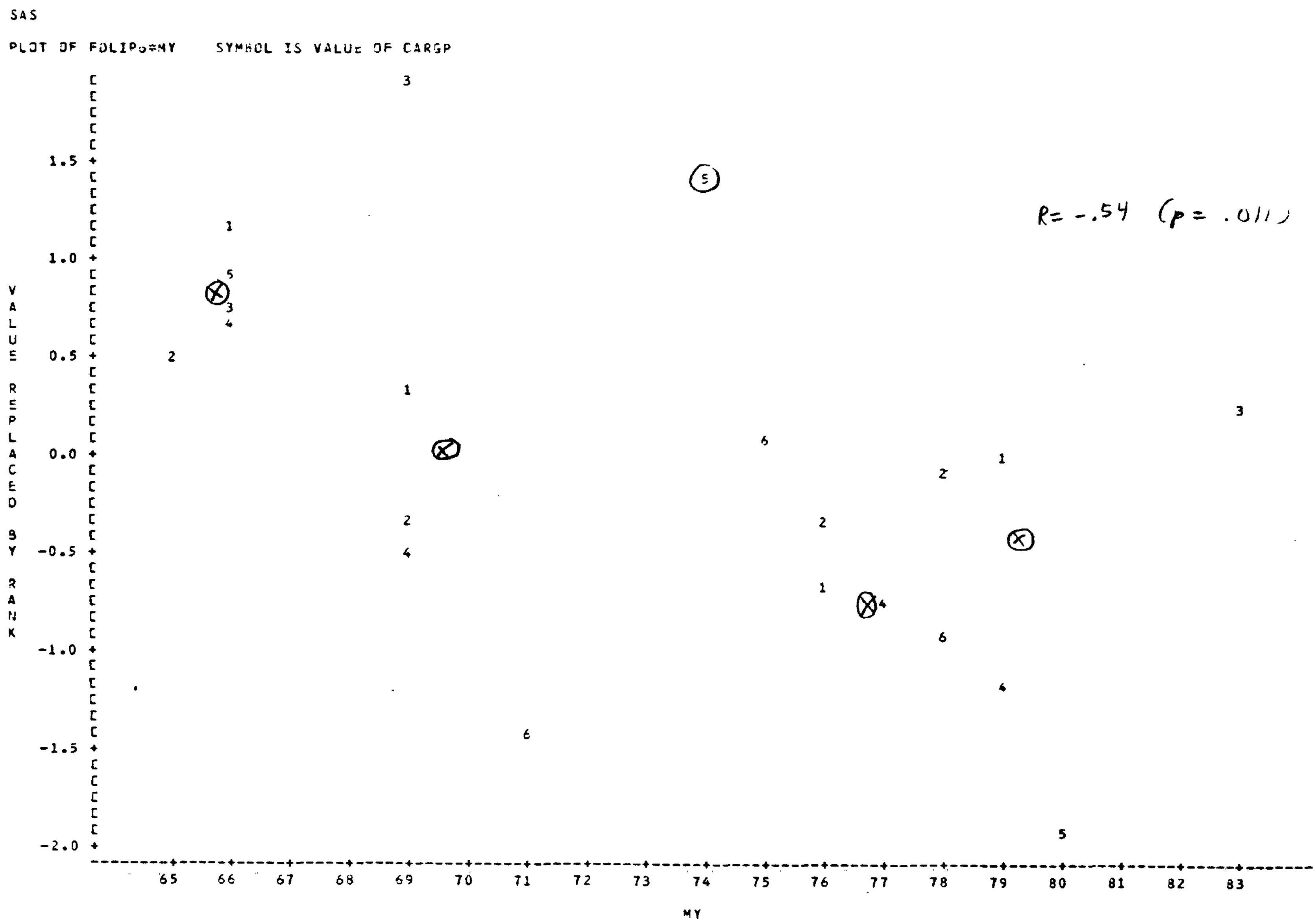
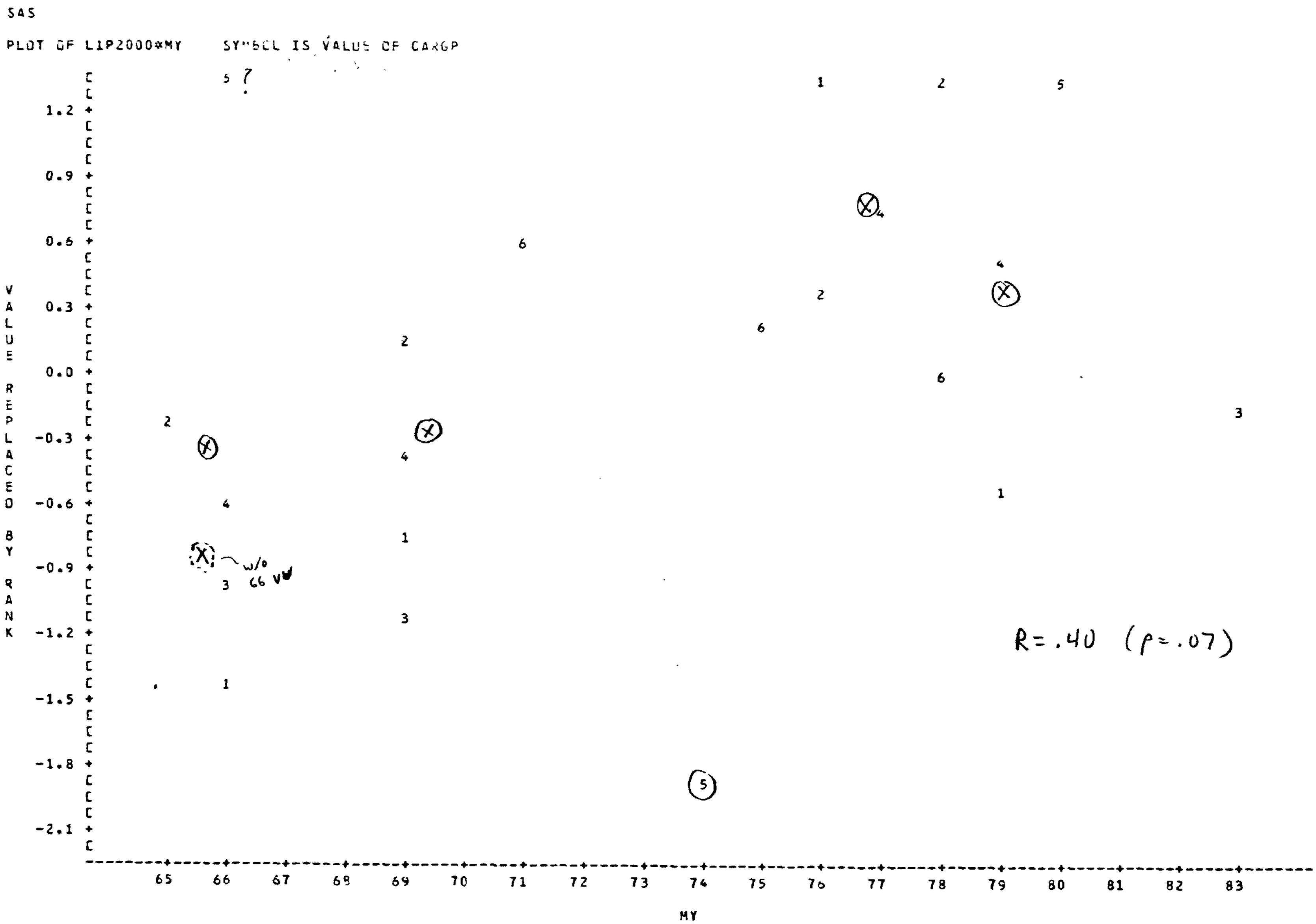


FIGURE 3-14: LIP2000 (Inches Till Lower IP Reaches 2000 lbs Force Deflection) BY MODEL YEAR



trend by having a sort of knee bolster. The correlation between FDLIP6 and model year is -.54, which is significant (p = .011). The reduction in FDLIP6 from MY group 1 (average value 0.80) to MY groups 3 and 4 (average value -0.55) is also significant (t = 4.29, df = 13, p = .0009). Figure 3-14 shows a corresponding positive trend for LIP2000, the depth at which the lower IP reaches 2000 pounds force deflection. The correlation between LIP2000 and model year is .40, which approaches significance (p = .011). The increase in LIP2000 from MY group 1 (average value -0.37) to MY groups 3 and 4 (average value 0.53) is also borderline significant (t = 2.06, df = 13, p = .06). These statistics understate the real trend; the 66 Beetle reached a fairly high rigidity in a relatively short distance, but never reached 2000 pounds, so its very high value of LIP2000 is deceptive. Without the 66 Beetle, the average for MY group 1 is -0.82 rather than -0.37. This average is shown on Figure 3-14 as an X inside a dotted circle.

The statistical analysis of the instrument panel measurements confirms each of the statements made in Section 1.4 about what happened to the panels during the 1960-80 period.

3.6 Relation of injury risk to panel geometry and force deflection

Since the injury scores and the instrument panel parameters are all expressed as normalized rank orders, it is straightforward to perform correlational analyses relating the injury scores

TRNK	Overall injury score
CRNK	Chest injury score
GRANK	Chest injury score (acceleration measurements only)

DFLRANK	Chest injury score (chest deflection and S Delta S)
FEMRANK	Femur injury score
HNRANK	Head and neck injury score
TRNK25	Overall injury score (25 mph crashes only)
TRNK30	Overall injury score (30 mph crashes only)

to the instrument panel parameters

IPL	Instrument panel length
AMIP	Angle of the mid IP
AWSH	Rake angle of the windshield
FDMIP	Max. force deflection of mid IP in first 3 inches
FDLIP6	Max. force deflection of lower IP at 6 inches
LIP2000	Inches till lower IP reaches 2000 pounds force defl.

The scope of the analysis, as stated in Section 3.2, is to offer some preliminary explanations of why instrument panels of cars of the 1970's have more satisfactory injury performance than cars of the mid 1960's - not to obtain estimates of injury severity as a function of panel design or to find the design which results in the lowest possible injury. The analysis is carried out in two stages: simple correlation and multiple correlation (stepwise regression). The 21 data points for the correlation and regression analyses are the 21 cars of the sled test matrix: values of the injury scores and IP parameters have been computed for each of the cars and are shown in Tables 3-3 and 3-5. The simple correlation approach is useful as a preliminary scan, indicating what parameters have the strongest association with various types of injury and whether these parameters have changed historically. Its shortcoming is that the panel geometry and force deflection parameters themselves are often intercorrelated (e.g., cars with soft mid IP's often tend to have soft lower IP's). The effects of two parameters working together or against one another can be masked in the simple correlation analysis. Multiple regression analysis is more helpful for explaining why certain panel features are especially associated with high or low injury risk.

Table 3-7 shows the linear correlations of each of the IP parameters with each of the injury scores, as well as with model year. For example, the correlation between TRNK, the overall injury score and IPL, the instrument panel length is -.64. This is a statistically significant correlation (df = 19, p = .002). Indeed, Figure 3-15, a scatterplot of TRNK by IPL for the 21 cars, clearly shows an association between longer instrument panels and lower injury risk. The numbers on the graph indicate the manufacturer/market classes of the cars. Appendix D contains 48 scatterplots similar to Figure 3-15, one for each injury score - panel parameter combination.

Table 3-7 indicates which panel parameters have significant correlations (single asterisk, R = .44 or more, df = 19, p less than .05) or borderline correlations (double asterisk, R from .36 to .43, p from .05 to .11) with injury scores. The most important question is whether the correlation of a panel parameter with injury and its correlation with model year have the same or opposite signs. For example, IPL has <u>positive</u> correlation with MY and <u>negative</u> correlation with TRNK. In other words, more recent cars have longer instrument panels and longer panels are associated with lower injury risk. The increase in IPL helps explain why injuries <u>decreased</u> in the more recent cars. But FDLIP6 has <u>negative</u> correlation with MY and <u>negative</u> correlation with DFLRANK. In other words, more recent cars have softer lower IP's which are less helpful in slowing the chest to mid IP contact. The decrease in FDLIP6 helps explain

TABLE 3-7

MVMA2D INJURY PREDICTIONS VS. INSTRUMENT PANEL GEOMETRY AND FORCE DEFLECTION:
CORRELATIONS OF NORMALIZED RANK ORDER SCORES

Correlation Coefficient		IPL	AMIP	AWSH	FDMIP	FDLIP6	LIP2000
MY	model year	.64*	-.71*	.42**	-.60*	-.54*	.39**
TRNK	overall injury	-.64*	.18	-.36**	.38**	.62*	-.52*
CRNK	chest injury	-.23	.13	-.01	.43**	.22	-.46*
GRANK	chest injury (accel. measurements)	-.63*	.31	-.22	.31	.84*	-.67*
DFLRANK	chest inj. (deflection & S Delta S)	.33	-.14	.20	.19	-.54*	.10
FEMRANK	femur injury	-.59*	.06	-.11	.02	.63*	-.52*
HNRANK	head and neck injury	-.65*	.19	-.66*	.30	.59*	-.20
TRNK25	overall injury (25 mph crashes)	-.60*	.18	-.31	.37**	.60*	-.47*
TRNK30	overall injury (30 mph crashes)	-.65*	.17	-.40**	.38**	.60*	-.54*

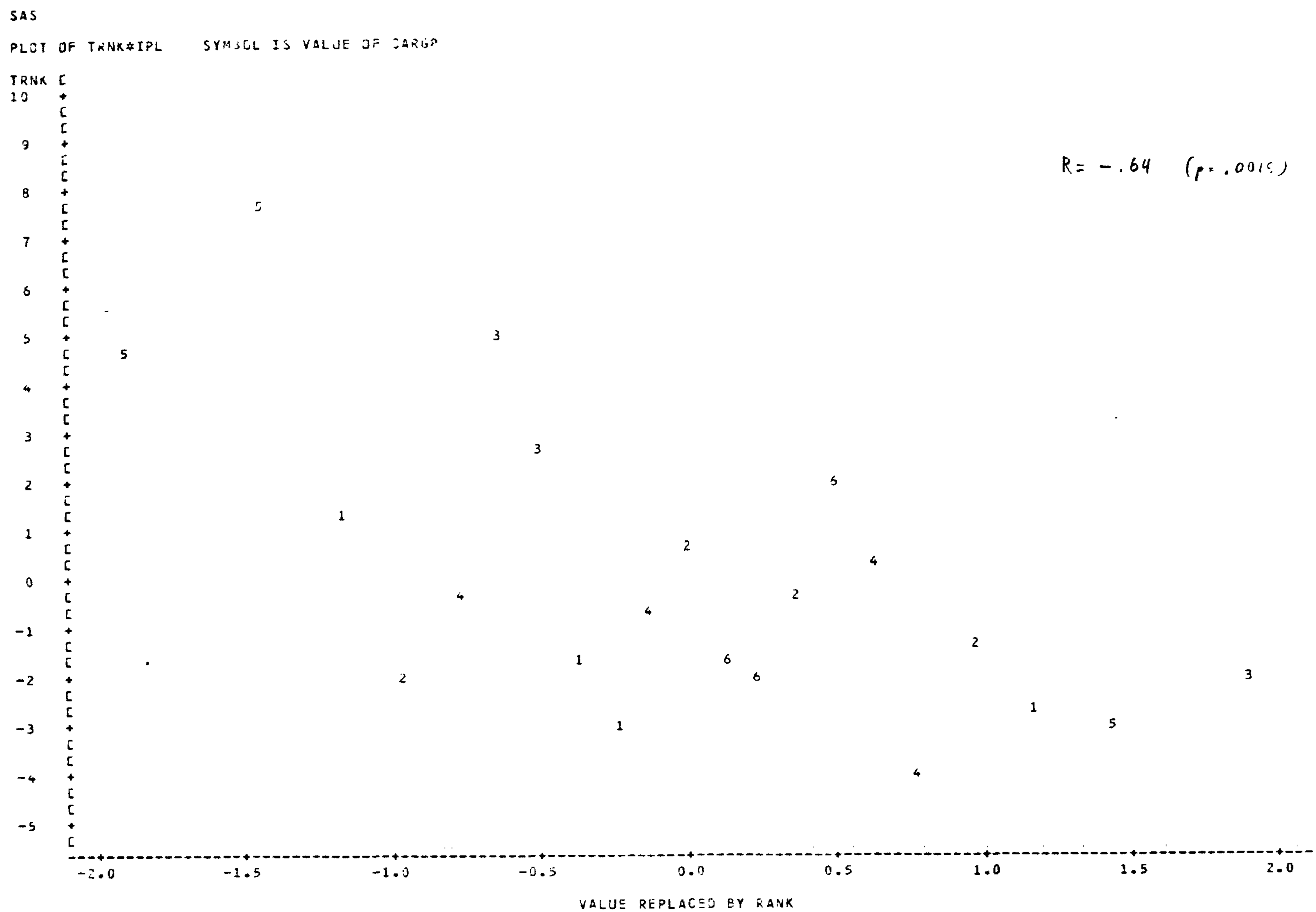
IPL=Instrument panel length
AWSH=Windshield rake angle
FDLIP6=Force deflection of lower IP at 6 inches
AMIP=Angle of the mid IP
FDMIP=Max. force/deflection of mid IP in 1st 3 inches
LIP2000=Penetration at which lower IP reaches 2000 lbs

*Significant correlation (R = .44 or more, df = 19, p less than .05)
**Borderline correlation (R from .36 to .43, p from .05 to .11)

Bold underline - consistent with injury reduction in later cars

Dotted underline - consistent with injuries increasing in later cars

FIGURE 3-15: TRNK (Overall Injury Score) BY IPL (Instrument Panel Length)



why chest compression <u>increased</u> in the more recent cars, at least according to MVMA2D.

Table 3-8 shows the combination of panel parameters, selected by stepwise multiple regression, that gives the best prediction of the injury scores. For example, IPL is the first independent variable selected for a model to predict TRNK and LIP2000 is the second; adding further parameters to the model does not significantly improve the predictions. The multiple correlation coefficient for the model is .70 (which exceeds the correlations of TRNK with any of the individual parameters - see Table 3-7). The coefficients for IPL and LIP2000 in the regression model are both negative; since IPL and LIP2000 increased in more recent cars, the model would tend to predict lower injury risk in the newer cars. Figure 3-16 is a scatterplot of the 21 actual values of TRNK, based on the MVMA2D simulations, vs. the expected values based on the regression model using IPL and LIP2000. The numbers on the graph indicate the model year groups of the cars. Appendix E contains 8 scatterplots similar to Figure 3-16, one regression model for each injury score.

The results in Table 3-7 and 3-8 are easiest to understand by starting with the injuries to individual body regions (FEMRANK, HNRANK, GRANK, DFLRANK) and working back to the more comprehensive measures (CRNK, TRNK, TRNK25, TRNK30). FEMRANK, the femur injury score, understandably has a strong positive correlation with FDLIP6 (R=.63) and a strong negative correlation with LIP2000 (-.52). In other words, the more rigid the lower IP, the higher the femur injury risk. It also has a strong

TABLE 3-8

MVMA2D INJURY PREDICTIONS VS. INSTRUMENT PANEL GEOMETRY AND FORCE DEFLECTION:
MODELS SELECTED BY STEPWISE REGRESSION

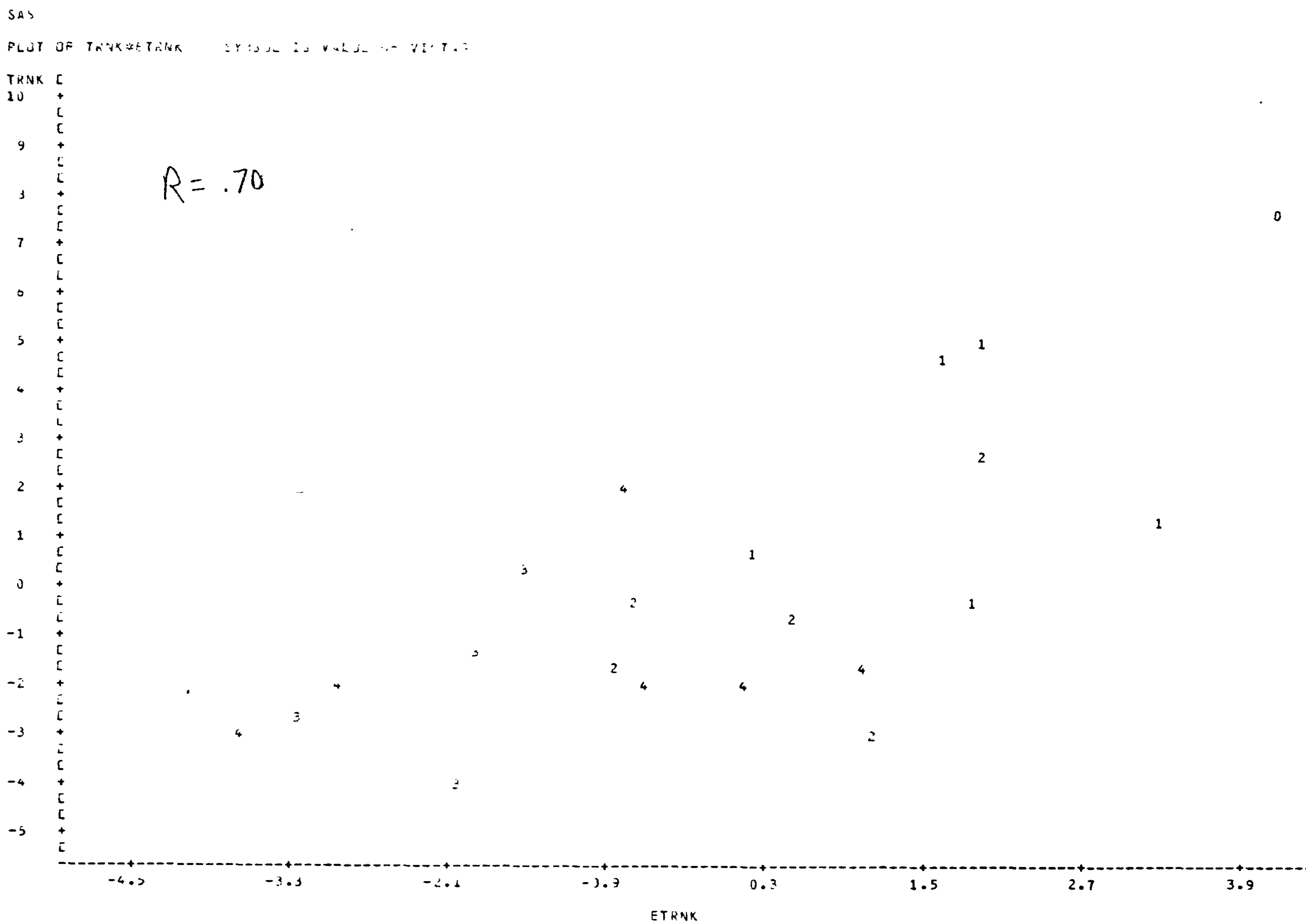
		Multiple R	Panel Parameters Selected (Sign of Regression Coefficient)		
			First	Second	Third
TRNK	overall injury	.70	IPL (-)	LIP2000 (-)	
CRNK	chest injury	.53	LIP2000 (-)	FDMIP (+)	
GRANK	chest injury (accel. measurements)	.84	FDLIP6 (+)		
DFLRANK	chest inj. (deflection & S Delta S)	.65	FDLIP6 (-)	FDMIP (+)	
FEMRANK	femur injury	.74	FDLIP6 (+)	AMIP (-)	IPL (-)
HNRANK	head and neck injury	.78	AWSH (-)	FDLIP6 (+)	
TRNK25	overall injury (25 mph crashes)	.66	FDLIP6 (+)	IPL (-)	
TRNK30	overall injury (30 mph crashes)	.72	IPL (-)	LIP2000 (-)	

IPL=Instrument panel length
AWSH=Windshield rake angle
FDLIP6=Force deflection of lower IP at 6 in.
AMIP=Angle of the mid IP
FDMIP=Max. force/deflection of mid IP in 1st 3 inches
LIP2000=Penetration at which lower IP reaches 2000 lbs

No underline - consistent with injury reduction in later cars

Dotted underline - consistent with injuries increasing in later cars

FIGURE 3-16: TRNK (Overall Injury Score) BY (-1.6 IPL - LIP2000)



negative correlation with IPL (-.59) - i.e., longer and more obtrusive panels, with their improved ride down qualities and better knee contact areas, are associated with lower femur injury risk. Another possible explanation is that IPL has strong negative intercorrelation with FDLIP6 (R=-.66); since FDLIP6 is highly correlated with FEMRANK, IPL would have at least some negative association with FEMRANK, even if there were no cause and effect relationship.

A clearer picture emerges in the multiple regression analysis. As might be expected, FDLIP6, the force on the lower IP at 6 inches deflection, is the first variable selected, with a positive coefficient; LIP2000, the deflection of the lower IP at which force reaches 2000 pounds, is not selected since it is largely redundant with FDLIP6. AMIP, the angle of the mid instrument panel, which only has +.06 correlation with FEMRANK in Table 3-7, is the second variable selected in the regression. Its relationship with FEMRANK had been masked by its intercorrelation with FDLIP6 and IPL (the newer cars tend to have higher IPL, lower FDLIP6 <u>and</u> lower AMIP). Surprisingly, the coefficient is negative - i.e., if the mid IP slopes toward the occupant, femur injury risk is higher. It might have been expected that such a slope would produce earlier knee to lower IP contact and better ride down; what actually happened is that the cars with mid IP's vertical or sloping toward the occupant tended to have lower IP's that were fairly high up and sloped sharply away from the passenger. This was perhaps a compensatory measure to provide seating comfort. The result was that passengers' knees slid forward in the simulation until the feet engaged the firewall and a harder part of the lower IP was reached - resulting in a large combined femur load.

IPL, the perimeter length of the panel, is the third and last variable selected by the regression, with a negative coefficient, suggesting that longer and more obtrusive panels may indeed be associated with lower femur injury risk. The multiple R is .74. Since FDLIP6 and IPL have strong correlations with model year in the opposite direction of their regression coefficients, they tend to make femur injury decrease in the more recent cars but AMIP, whose correlation with model year is in the same direction as its regression coefficient, partially counteracts that effect (as indicated by the dotted underlining of AMIP in Table 3-8). The net effect is that femur injury risk declined in cars of the late 1960's and early 1970's, as panels became softer and longer, but the decline leveled off in later years as AMIP began to decrease (see Figure 3-5).

HNRANK, the head and neck injury score, has a strong negative correlation with the windshield rake angle AWSH (-.66) and IPL (-.65) and a strong positive correlation with FDLIP6 (.59). In the stepwise regression, however, only AWSH and FDLIP6 are selected. The correlation of IPL with HNRANK seems mainly due to its intercorrelation with the other two parameters. The regression, with a multiple R of .78, gives a negative coefficient to AWSH and a positve one to FDLIP6. The more raked the windshield, the lower the head and neck injury risk; specifically, a raked windshield results in earlier head contact and better ride down for the unrestrained occupant - a desirable effect only slightly offset by a penalty of greater head and neck rotation. The strong relationship of

HNRANK with FDLIP6 shows that a stiff lower IP stops the passenger's lower body and makes him plunge head first, with greater force, into the windshield. As stated in Section 1.4, a relatively soft lower IP is needed to maintain the upright position of the unrestrained passenger during the collision, preventing excessive head injuries. Since AWSH and FDLIP6 have correlations with model year in the opposite direction of their correlations with HNRANK, it is appropriate that head and neck injury decreased in the more recent cars (see Figure 3-6).

GRANK, the chest acceleration score, has exceptional correlation with FDLIP6 (.84). It is the only independent variable which makes a significant contribution in the regression analysis. A lower IP with high force deflection at about 6 inches depth sends strong noncontact g's to the chest at about the same time that the chest contacts the mid IP, resulting in a high spike, at least in these MVMA2D simulations in which the occupant seemed to have a fairly strong linkage between body regions. As a result, abrupt decelerations of the femurs were propagated as high noncontact g's to the chest and head, perhaps more so than would occur in real crashes. LIP2000 and IPL also have significant linear correlations with GRANK, but this would appear to be due to their intercorrelation with FDLIP6. It is interesting to note that FDMIP, mid instrument panel stiffness, only has limited correlation with GRANK (.31). Since FDLIP6 is much lower in newer cars than in older cars, so is GRANK (see Figure 3-3).

DFLRANK, the chest injury score based on chest deflection and S Delta S, is also strongly correlated with FDLIP6 (-.54), but in the opposite direction. FDLIP6 is the first variable selected by the stepwise regression. FDMIP, the maximum force of the mid instrument panel during its first 3 inches of deflection, is the second; the effect of FDMIP, which is masked in Table 3-7 due to its positive intercorrelation with FDLIP6, becomes clear in the regression. The multiple R is .65. Logically, FDLIP6 has a negative coefficient and FDMIP, a positive one. In other words, the stiffer the lower IP, the better a job it does slowing the occupant's torso, by applying force through the knees, before the chest contacts the mid IP. But the stiffer the mid IP, the more severe the chest injuries due to direct contact with it. Thus, a lower IP like a knee bolster - quickly developing high forces and perhaps protruding toward the occupant - is desirable for reducing DFLRANK but might be detrimental for other types of injuries to unrestrained passengers because they pitch head forward rather than staying in an upright position. Since FDLIP6 is lower for newer cars, DFLRANK would tend to increase for newer cars, but the effect is partially counteracted by FDMIP, which is also lower for newer cars and has the opposite sign in the regression (see Figure 3-4).

That completes the analysis of four specific injury types. As might have been expected, windshield rake angle was an important factor in head injuries and irrelevant to the other injuries; mid IP stiffness was important in predicting direct contact chest injury and irrelevant to the other types. Lower IP stiffness, however, was important not only in femur injury but also was selected as a key variable in each of the other types. A stiff lower IP transmitted noncontact accelerations to the head and chest and caused the unrestrained passenger to lose his upright posture but it had the desirable effect of slowing the chest to mid IP interaction. Longer and more obtrusive instrument panels were associated with reductions of nearly all types of injuries, perhaps because they have better ride down qualities, but perhaps merely because they tend to be softer, too (intercorrelation with the other parameters). IP length was selected as an important variable, though, in only one of the regressions.

The analysis of composite injury measures begins with CRNK, the combination of acceleration and deflection based chest injury scores. As stated above, chest g's increased in the MVMA2D simulations when FDLIP6 increased, while chest deflection was reduced. The effects cancel one another and, as a result, CRNK has little correlation with FDLIP6 (.22). Table 3-7 shows that CRNK has a significant negative correlation with LIP2000 (-.46), the penetration depth at which the force deflection for the lower IP reaches 2000 pounds. LIP2000 is a variable generally describing the stiffness of the lower IP after deformations well beyond 6 inches: the stiffer the panel, the <u>lower</u> LIP2000. LIP2000 has significant correlation with GRANK (-.67) but <u>not</u> with DFLRANK (.10); only the first 6 inches or so of the lower IP have the possibility of significantly slowing the occupant <u>before</u> the chest contacts the mid IP, whereas at greater depths the lower IP transmits forces to the torso through the femurs when the chest is already in contact with the mid IP. FDMIP, as might be expected, has positive correlation with CRANK, although of borderline significance (.43). Table 3-8 shows that the stepwise regression in fact selects LIP2000 and FDMIP as the key variables, although the multiple R of

.53 is inferior to the regressions for the other injury scores. The best compromise for chest injury is obtained with a soft mid IP and with a lower IP that is neither too hard nor too soft, but dissipates energy gradually over a long stroke. Since newer cars tend to have lower FDMIP and higher LIP2000 than older cars, CRNK tends to be slightly lower, on the average, for the newer cars (see Figure 3-2).

TRNK, the overall injury score, has significant or borderline significant correlation with nearly all of the panel parameters. TRNK, after all, is the composite of FEMRANK, HNRANK, GRANK and DFLRANK and each of the panel parameters has significant association with at least one of those injury types. Specifically, IPL (-.64), LIP2000 (-.52) and AWSH (-.36) have negative correlation with TRNK, while FDLIP6 (.62) and FDMIP (.38) have positive correlation. The regression selects IPL and LIP2000 as the two most important parameters, both with negative coefficients and a multiple R of .70. Longer, lower, more obtrusive instrument panels with an extensive depth of deformable material (taking a long time to reach 2000 pounds force) were associated with reductions of almost all the individual injury types for unrestrained occupants: they have good ride down qualities, help keep the occupant in an upright position and assure a good knee to lower panel contact. Since more recent cars tend to have significantly higher values of IPL and LIP2000, it is not surprising that unrestrained right front passengers are predicted to have lower overall injury risk in frontal crashes (see Figure 3-1).

TRNK30 and TRNK25, the overall injury scores in 30 and 25 mph crashes, have virtually the same correlation patterns as one another and as TRNK. The regression for TRNK30 results in selection of the same variables as for TRNK - IPL and LIP2000 - with the same signs for the regression coefficients and a multiple R of .72. The regression for TRNK25, appropriately, results in the selection of FDLIP6 rather than LIP2000, to accompany IPL. (The positive coefficient for FDLIP6 is, however, equivalent to a negative coefficient for LIP2000). In the more severe 30 mph crashes, the performance of the lower IP after extensive deformation, as expressed by LIP2000, seems to be more important. In the 25 mph crashes, the lower IP performance in the earlier stages of crush, as expressed by FDLIP6, is the critical factor. Since the lower instrument panels of newer cars tend to be softer throughout the first 12 inches or so of crush - i.e., lower FDLIP6 and higher LIP2000 - and also have higher IPL, both TRNK25 and TRNK30 tend to be lower in the more recent cars (see Figures 3-7 and 3-8).

3.7 A comment on angular acceleration of the head

MVMA2D prints out the angular acceleration of the center of mass of the head, in radians/second^2, throughout the simulation. The peak absolute values during the first 160 milliseconds are:

	30 mph crashes			25 mph crashes		
	50th %ile	5th %ile	95th %ile	50th %ile	5th %ile	95th %ile
79 Ford	12593	13666	10417	7166	13212	4794
76 Ford	8440	8923	10057	8661	10276	7676
69 Ford	12037	13048	10344	11281	13732	6849
66 Ford	14077	24401	9212	14378	14716	11658

	30 mph crashes			25 mph crashes		
	50th %ile	5th %ile	95th %ile	50th %ile	5th %ile	95th %ile
78 Buick	11438	10122	14762	11366	13708	10361
76 Chevy	6032	12260	6836	5243	12085	9880
69 Chevy	10417	11692	9863	10722	7755	7872
65 Chevy	9601	21790	7985	7997	25525	12287
83 Celebrity	10519	5962	14358	6470	7333	10271
69 Nova	17725	23010	13326	6261	15147	7337
66 Nova	15150	17797	11385	11187	18078	11465
79 Mustang	9411	5628	8001	9693	7211	6046
77 Volare	9943	14683	11525	9945	8623	7962
69 Dart	6447	23753	10258	7839	21594	8358
66 Valiant	8763	13046	9713	7798	9368	5516
80 Omni	16219	10643	14259	10516	8882	7605
74 Beetle	11694	17548	10111	12611	14657	10413
66 Beetle	10536	21895	8694	9365	15859	10460
78 Accord	11209	7963	13669	7488	6029	6396
75 Civic	10334	14444	12087	9379	11219	7566
71 Datsun	11316	14058	10805	7807	12067	8676

Some of the exceptionally severe accelerations for the 5th percentile dummies occurred in cars where they strike the mid instrument panel with their heads.

The results are converted into normalized rank order scores as in Section 3.4.2 and then combined into a single variable.

HAARANK = sqrt(1/6) [HAA(50,25)+HAA(5,25)+HAA(95,25)
+HAA(50,30)+HAA(5,30)+HAA(95,30)]

where HAA(i,j) is the normalized rank score for femur load for the ith percentile dummy in a j mph crash. The composite HAARANK scores for each vehicle are:

79 Ford	- .74	79 Mustang	-2.52
76 Ford	-1.30	77 Volare	- .02
69 Ford	.43	69 Dart	.44
66 Ford	2.45	66 Valiant	-1.78
78 Buick	1.43	80 Omni	.60
76 Chevy	-2.31	74 Beetle	1.41
69 Chevy	- .68	66 Beetle	.78
65 Chevy	.92		
83 Celebrity	- .79	78 Accord	-1.51
69 Nova	1.04	75 Civic	- .04
66 Nova	2.14	71 Datsun	.09

HAARANK has excellent correlation with HNRANK (the composite measure of HIC, head g's and 3 neck injury scores defined in Section 3.4.2): $R = .70$, $df = 19$, $p = .0004$. That is one of the highest correlations between two injury measures in this study. Not surprisingly, HAARANK displays many of the same characteristics as HNRANK. For example, head angular acceleration tends to be lower in the newer cars. The average value of HAARANK is 0.90 in MY group 1, 0.26 in MY group 2, -1.54 in group 3 and -0.18 in group 4. The average value for groups 3 and 4 (MY 1975-83 cars), -0.72, is significantly lower than the average for MY group 1 (1965-66 cars): $t = 2.13$, $df = 13$, one-sided $p = .03$.

HAARANK and HNRANK also have similar correlation patterns with the 6 parameters describing panel geometry and force deflection:

	correlation with					
	IPL	AMIP	AWSH	FDMIP	FDLIP6	LIP2000
HAARANK	-.56	.44	-.44	.40	.49	-.33
HNRANK	-.65	.19	-.66	.30	.59	-.20

The most noticeable difference is that HAARANK is significantly correlated with AMIP, but not HNRANK. In other words, when the mid panel slopes downward toward the passenger, angular acceleration of the head is less severe than when the top of the instrument panel protrudes toward the passenger, catches the chest, and allows the head to spin. In the stepwise regression analysis, IPL is the only independent variable which makes a significant contribution. Large (and soft) panels do the best job keeping the passenger in an upright position and minimizing angular acceleration of the head.

CHAPTER 4

FRONTAL FATALITY RISK BY MODEL YEAR: ANALYSES OF FARS DATA

Fatal Accident Reporting System (FARS) head on collisions of two passenger cars, one of model year X and the other of model year Y, were tabulated to see how often the driver of the car of model year X was killed vs. how often the driver of the car of model year Y. A statistical analysis was performed to measure the intrinsic frontal fatality risk of cars of each model year, after controlling for differences of the vehicle weights, belt usage, etc., of cars of different model years. Driver fatality risk in frontal crashes declined by about 12 percent from model years 1964-66 to 1968-69 and remained almost constant between model years 1969 and 1984 - for cars of the same weight. The 12 percent reduction is almost entirely attributable to the introduction of energy absorbing steering assemblies in 1967-68 [32], p. xix.

The analysis was extended to right front passengers; their fatality risk in frontal crashes declined by about 20 percent from model years 1964-66 to 1968-70, possibly declined by another 9 percent or so in the early to mid 1970's and remained fairly constant from then till model year 1984 - for cars of the same weight. The reductions virtually duplicate the pattern seen in the analyses of instrument panel improvements (Chapters 2 and 3). Better instrument panels and, to a lesser extent, windshields and doors seem to account for most of the reduction of unrestrained right front passengers' fatality risk in frontal crashes during the 1964-84 period.

In head on collisions, the effect of vehicle weight is of paramount importance, overwhelming the effect of safety improvements and other vehicle design changes. A head on collision between a 3100 pound car of the 1964-66 era and a 3000 pound car of the 1975-84 era is about equally risky for the occupants of both cars - a 100 pound weight advantage would make up for all the safety equipment lacking in the older car.

4.1 Analysis objectives, approach and key variables

The objective of the analysis, as stated in Section 1.3, is to compare the intrinsic fatality risk in frontal crashes for drivers and right front passengers of cars of different model years: to track the fatality risk trend from model year 1964 to 1984. It will provide a measure of how much safer cars have become over the past 20 years and an estimate of how many lives are saved. This "macro" estimate of lives saved includes the effects of all the occupant protection devices previously evaluated by NHTSA plus the effects on crashworthiness of any other vehicle modifications that have not been evaluated or are not associated with a specific safety standard. Two examples are the change from genuine to pillared hardtops in the 1970's and from rear wheel drive to front wheel drive in the 1980's. The purpose of the analysis is twofold:

- o Is the sum of the fatality reductions ascribed by the NHTSA evaluations to the individual safety standards consistent with the actual reduction in overall fatality risk during the model years that the standards were mostly implemented (1966-69)?
- o Did cars get any safer after that, thanks to improvements not necessarily related to NHTSA's standards?

Previous attempts to compare the intrinsic fatality risks of cars of two different model years have typically been confounded by reporting biases or by secular trends unrelated to vehicle safety improvements. For example, the number of injured occupants per 100 crash involved occupants typically increases, especially in State accident data, as cars get older - because noninjury crashes of older cars are often unreported. The spurious inflation of the injury rates for the older cars is misinterpreted to mean that they are less safe. As another example, the fatality rate per 100,000,000 car miles (or per million registered vehicle years) has greatly declined since 1966, for reasons only partly related to the vehicle. Regression models based on historical trend in the fatality rates inevitably tend to attribute too much of the decline to vehicle factors, because many of the factors that are really responsible for the decline are almost impossible to quantify.

Analyses of head on collisions between two passenger cars, fatal to at least one or perhaps both drivers, do not suffer from the preceding shortcomings. Virtually all fatal head on collisions, since 1975, have been reported to FARS, so there is no problem with reporting bias. When two cars collide head on, both drivers have, so to speak, the same frontal crash experience. If car A and car B have the same weight, consider the head on collisions between car A and car B in which the drivers have the same age, sex, etc.: if, in these collisions, the driver of car A is killed significantly less often than the driver of car B, it can only mean that car A is safer for drivers than car B. Thus, fatal head on collisions are suitable for comparing the intrinsic fatality risk of two different cars, given their involvement in a crash (the analysis does not take into account the relative crash avoidance capabilities of the cars).

Likewise, frontal crash involvements of passenger cars having a driver and a right front passenger - one or both of whom was killed - have been reported to FARS since 1975. If the damage is neither concentrated on the right front nor on the left front, the driver and right front passenger had about the same frontal crash experience. Consider those crashes of car A in which the driver and right front passenger have the same age, sex, etc.: if the right front passenger is killed significantly less often than the driver, it can only mean that car A is safer for right front passengers than for drivers.

Finally, the results of the two analyses can be composed to obtain a comparison of the intrinsic risk for right front passengers. For example, if

car A is safer for right front passengers than for drivers
car A is safer for drivers than car B
car B is safer for drivers than for right front passengers

then car A is safer for right front passengers than car B.

Unfortunately, even in 12 years of FARS data (1975-86), there are relatively few crashes in which both cars have the same weight and their drivers have the same age, sex, etc. The analysis should include all the head on collisions, including those where the vehicle weights or driver characteristics differ. It should quantify the relative effects of each of those factors and characterize the relative fatality risk of the two drivers by a statement like

> In this particular head on collision configuration, the driver of car A is, on the average, 9 percent less likely to be killed than the driver of car B: since car A is x pounds heavier than car B, this accounts for a 4 percent reduction; since driver A is y years younger than driver B, this accounts for a 3 percent reduction; and, finally, <u>car A is intrinsically 2 percent safer than car B</u> (i.e., that would be the risk reduction if there were no differences on the other factors).

The critical variables that need to be controlled for in the analysis of drivers in head on collisions are

- o vehicle weight - specifically the ratio of the weights of the two cars
- o exact damage location - although both drivers in a head on collision experience frontal crash forces, in these very severe crashes the driver may be more endangered by intrusion related phenomena if the damage is along the left front; less along the right front. It is necessary to consider both cars' exact damage location.
- o driver age - specifically, some transformation that expresses how much "younger" one driver is than the other
- o driver sex - since some believe that females are more vulnerable to fatal injury than males in identical crash situations [13]
- o belt usage
- o drivers' alcohol consumption - since some believe that intoxication reduces a person's ability to survive impact trauma

After controlling for these factors, what will remain may be considered the "intrinsic" difference in the safety of the two vehicles. Note that a car's level of belt usage is not considered as part of its "intrinsic" safety but rather as one of the differences to be controlled for. That is because belt usage depends largely on the types of people who purchase a certain car and tends to decline as the car ages. The analysis seeks to find which of two cars has a "friendlier" interior and vehicle structure after controlling for belt usage.

Finally, the objective is not to compare the safety of individual makes and models of cars, but the averages for each model year. Thus, the only descriptors that will be entered for each car are its model year and the preceding list of control variables. The final product of the model will be a safety index for each model year from 1964 to 1984. If, for example, the index for 1966 is A and for 1976 is B, then the drivers of 1976 cars are intrinsically [1 - (B/A)] safer than they would have been in 1966 cars of the same weight, when all types of head on collisions are taken into account.

The model for right front passengers, as stated above, is performed in two stages. The first stage is an evaluation of the relative intrinsic fatality risk of right front passengers and drivers of the same car, by model year. The data for this model are not limited to cars involved in head on crashes, but include all cars that were in frontal impacts and had a driver and a right front passenger, at least one of whom was killed. For example, the ratio of passenger to driver fatalities, after controlling for differences in age, sex, etc. and making an adjustment for vehicle damage location, if off-center, might be R_B in model year 1976 and R_A in 1966. In the second stage, these relative ratios are combined with the driver safety indices of the preceding model to get passenger safety indices - viz., $R_B \times B$ in model year 1976 and $R_A \times A$ in 1966. Thus, right front passengers of 1976 cars are intrinsically $[1 - (R_B x B/R_A x A)]$ safer than they would have been in

1966 cars of the same weight, when all types of head on collisions are taken into account. The two stage approach is needed because the FARS files do not have an adequate sample of head on crashes between two cars, each of which had a right front passenger, at least one of whom was killed (such cases are much rarer than head on crashes in which at least one driver was killed, since nearly all cars have a driver, but far fewer have passengers). If the FARS sample had been adequate, it would have been possible to do a single model for the right front passengers, just like the driver model.

4.2 Analysis for drivers in head on collisions

4.2.1 FARS data reduction

Over 16,000 head on collisions involving two passenger cars and fatal to at least one of the drivers were extracted from the 1975-86 FARS files. A "head on" collision had to be a crash involving exactly two vehicles (VE_FORMS = 2); both vehicles had to be passenger cars (BODY_TYP 1-13) of model years 1964-84; both had to have frontal damage (IMPACT2 = 11, 12 or 1); the "most harmful event" for each vehicle had to be a collision with another motor vehicle, in transport or in "other roadway" (prior to 1979, this variable was not defined on FARS, so it was not used as a filter). A 2 vehicle file was designed, with one record for each collision, containing information on vehicle no. 1 and its driver and on vehicle no. 2 and its driver. The file contained the FARS variables on each vehicle's make, model, model year, body style, and principal impact point plus each driver's age, sex, manual and automatic restraint usage, and whether or not alcohol had been consumed (DRINKING).

The most important control variable for the analysis is the vehicle's weight. The FARS weight variable VIN_WGT, deciphered from the VIN by the computer program VINA [55], is not usable for several reasons. It does not provide estimates for cars of model years 1964 and 65. It purports to give estimates of "shipping weight" (unoccupied car without fuel or other fluids) and does so until model year 1982 or 83. But starting in those years, VINA seems to estimate the "curb weight" (unoccupied car with fuel and other fluids) for some makes and models, resulting in a spurious increase of 100 pounds or so over the previous model year. Since fatality risk in head on collisions is highly sensitive to vehicle weight, a trial run of the regression analysis with VINA weights compensated for the spurious weight increase by making the 1982-84 cars far more "intrinsically dangerous" than the 1968-81 cars.

The remedy was to obtain a source of vehicle weight information that is consistent from model year to model year and provides a complete record from 1964 to 1984: the curb weights published in Automotive News Almanacs [2] based on reports from the manufacturers. Typically, the Almanacs list one weight for each make/model code and model year in FARS. If so, every car, except station wagons, of that make/model code and model year was assigned the Almanac weight. Often, though, there are two or more weights in the Almanacs corresponding to a single code in FARS. Most typically, for popular American cars, the Almanacs list weights for 6 and 8 cylinder models (or 4 and 6). In those cases, Ward's Automotive Yearbooks [56] were consulted to find the sales mix and a sales weighted average of the vehicle weights was used. For some imports, disaggregated sales data were unavailable; if the two or more weights listed in the Almanac - corresponding to a single FARS code - were close together, their simple average was used. If they were far apart (e.g., Mercedes, where many different models are collapsed to one or two FARS codes), the make/model was dropped from the analysis. Appendix F lists the curb weights used in the analyses of this chapter by make/model code and model year.

Station wagons are a special case since they weigh more than a coupe or sedan of the same make, model and engine type, but the Almanacs do not give separate estimates for station wagons. An analysis of the VINA weights in FARS, however, showed the following average weight increases for station wagons relative to other cars of the same make, model and model year:

Imports	5.2 percent weight increase
Domestic up to 3500 lbs	8.5 percent weight increase
Domestic over 3500 lbs	13.4 percent weight increase

These increases have been fairly consistent over the past 25 years. Therefore, if a car was a station wagon (BODY_TYP = 6), the Almanac weight was increased by the amount shown above.

The same approach cannot be used for light trucks because a single make/model code in FARS (e.g., Chevrolet van) may correspond to a number of different vehicles with a wide variety of curb weights (viz., different wheelbases and gross weight ratings). A detailed analysis of the VIN might shed light on the curb weight; trucks, however, can vary widely in their cargo weight - and neither FARS nor the VIN tell how much cargo a truck was carrying at the time of the accident or the extent to which the cargo should be counted toward the effective vehicle mass during the collision.

The FARS information on manual and automatic restraints was transformed into three binomial variables suitable for logistic regression analysis: LAP1, LAPSH1, and UNKRES1 for the driver of vehicle no. 1 and 3 similar variables for the driver of vehicle no. 2.

> LAP1 = 1 if FARS explicitly states that "lap belt only" was used or if the car was MY 1973 and earlier and FARS states "restraint used, type not specified." Else LAP1 = 0.
>
> LAPSH1 = 1 if FARS explicitly states that "lap and shoulder belts" were used, or if the car was MY 1974 and later and FARS states "restraint used, type not specified," or if automatic belts were in use or an air bag deployed. Else LAPSH1 = 0.
>
> UNKRES1 = 1 if FARS states that restraint use was unknown. Else UNKRES1 = 0.

4.2.2 A simple model: no control for vehicle weight or other factors

As a "rehearsal" for the logistic regression of fatality risk by model year, vehicle weight and other factors, it is instructive to build a simpler model which measures the relative fatality risk when two cars of different model years collide head on, without adjustment for differences in weight, etc. The simple model illustrates the procedures used to translate tabulations of fatalities into risk indices; its results will show the overwhelming influence of vehicle weight on fatality risk in head on collisions.

The starting point for the simple model is a tabulation of the head on crashes in FARS (more specifically the file created from FARS in Section 4.2.1) by model year of the "case" vehicle, model year of the "other" vehicle and where the fatalities occurred. Crashes where both cars are of the same model year are <u>not</u> used in this analysis. For example, there were N = 108 head on collisions between 1975 and 1979 cars that killed at least one of the drivers.

In 18 collisions, the 75 driver died, the 79 survived
In 71 collisions, the 79 driver died, the 75 survived
In 19 collisions, both drivers died

Of course, the large disparity in the fatalities is due to the greater mass of the 1975 cars. The above statistics supply <u>two</u> data points for the logistic regression. First, considering 1975 as the "case" vehicle model year and 1979 as the "other" vehicle: a case vehicle driver died in 37 of the 108 collisions. The <u>ratio of collisions with a case vehicle fatality to total collisions</u> is R = 37/108 = .343. Second, with 1979 as the "case" vehicle and 1975 as the "other," R = 90/108 = .833. A partial list of tabulation results is:

Case MY	Other MY	R	N
75	66	.375	48
75	70	.491	106
75	74	.582	165
75	77	.542	155
75	79	.343	108
75	81	.255	47
79	66	.633	30
79	70	.699	73
79	75	.833	108
79	82	.474	78

Each of the preceding tabulation results, plus all other results for case vehicle model year and other vehicle model year ranging from 63 to 85 (but not equal to one another) furnish one data point for the regression. The dependent variable in the regression is

$$\text{LOGODDS} = \log[R/(1-R)]$$

(where R is set to .01 if it is zero and .99 if it is one, so as to avoid infinite values for LOGODDS). The independent variables are M63, M64, ..., M84, where Mi = 1 if the case vehicle model year is i, Mi = -1 if the other vehicle model year is i and Mi = 0, otherwise. A weighted <u>logistic regression on aggregate data</u> is performed, the weight factor being N.

The regression coefficients are

INTERCEPT	.309	M70	-1.02	M78	- .55
M63	.45	M71	- .88	M79	- .42
M64	- .58	M72	- .99	M80	- .09
M65	- .58	M73	-1.25	M81	- .10
M66	- .62	M74	-1.19	M82	.05
M67	- .75	M75	-1.31	M83	- .03
M68	-1.05	M76	-1.09	M84	- .02
M69	-1.19	M77	-1.02	"M85"	.00

There is no actual M85 variable, but all the other model year coefficients are measured relative to the risk for 1985 cars. The more negative the coefficient, the lower the fatality risk. The results for model years 1963 and 1985 are unreliable due to the small sample size, which is why these model years were subsequently not used in the analyses. R^2 is .71.

The regression results are used to generate fatality risk indices by an abstract form of double pair comparison analysis [12]. The easiest way to explain the method is first to review an example of conventional double pair comparison analysis: let p_1 be the number of lap belted rear seat passenger fatalities and d_1 be the number of unrestrained driver fatalities in the actual FARS crashes where there was a lap belted back seat passenger <u>and</u> an unrestrained driver and at least one of them died. Let p_2 be the number of unrestrained rear seat passenger fatalities and d_2 be the number of unrestrained driver fatalities in the actual FARS crashes where there was a unrestrained back seat passenger <u>and</u> an unrestrained driver and at least one of them died. Then

$$(p_1/d_1) \ / \ (p_2/d_2)$$

estimates the fatality risk of lap belted back seat passengers relative to unrestrained back seat passengers (since the unrestrained drivers act as a control group).

The more abstract form of the analysis that will be used here is largely parallel. Construct a file of all head on collisions on FARS which were fatal to at least one driver (actually this file has each collision twice: once with vehicle no. 1 as the case vehicle and once with vehicle no. 2 as the case vehicle; it has over 32,000 crash situations). Consider the hypothetical situation where each case vehicle is replaced by a 1975 car, while the other vehicle stays what it actually is. Use the regression coefficients to estimate P75, the proportion of the 32,000 case vehicle drivers who are killed and C75, the proportion of the 32,000 control group (other vehicle) drivers who are killed. Now consider another hypothetical situation where each case vehicle is replaced by a 1979 car, while the other vehicle stays what it actually is. Use the regression coefficients to estimate P79, the proportion of the 32,000 case vehicle drivers who are killed and C79, the proportion of the 32,000 control group (other vehicle) drivers who are killed. Then

$$(P75/C75) \ / \ (P79/C79)$$

estimates the fatality risk for drivers of model year 1975 cars in head on collisions relative to the risk for drivers of model year 1979 cars (since the drivers of the "other" cars act as a control group).

P75 and C75 are estimated as follows. Recall that .309 is the regression intercept; let Ai be the estimated regression coefficient for model year i and N(i,j) be the actual number of head on crashes on FARS involving model years i and j. Let R(i,j) be the regression's <u>estimate</u> of the ratio of driver fatalities in the cars of model year i to N(i,j). In other words

$$R(i,j) = 1/[1+\exp(Aj-Ai-.309)]$$

whereas

$$R(j,i) = 1/[1+\exp(Ai-Aj-.309)]$$

If the case vehicle is always replaced by a model year 1975 car,

$$\begin{aligned} P75 &= \sum N(i,j)R(75,j) \ / \ \sum N(i,j) \\ &= \sum N(i,j)/[1+\exp(Aj-A75-.309)] \ / \ \sum N(i,j) \end{aligned}$$

whereas

$$\begin{aligned} C75 &= \sum N(j,i)R(j,75) \ / \ \sum N(j,i) \\ &= \sum N(j,i)/[1+\exp(A75-Aj-.309)] \ / \ \sum N(j,i) \end{aligned}$$

The quantities Pi/Ci for the various model years become more tangible through indexing. The <u>unadjusted frontal fatality risk index for drivers</u> shall be set to 100 for the average of model years 1973 through 1984 - i.e., let

$$U = 100 \ / \ (P73/C73+...+P84/C84)$$

and define

$$Ui = U(Pi/Ci)$$

to be the risk index for model year i. The unadjusted risk indices, by model year, are:

1964	92	1971	71	1978	94
1965	92	1972	66	1979	105
1966	89	1973	53	1980	137
1967	80	1974	55	1981	137
1968	62	1975	50	1982	155
1969	55	1976	60	1983	145
1970	64	1977	64	1984	145

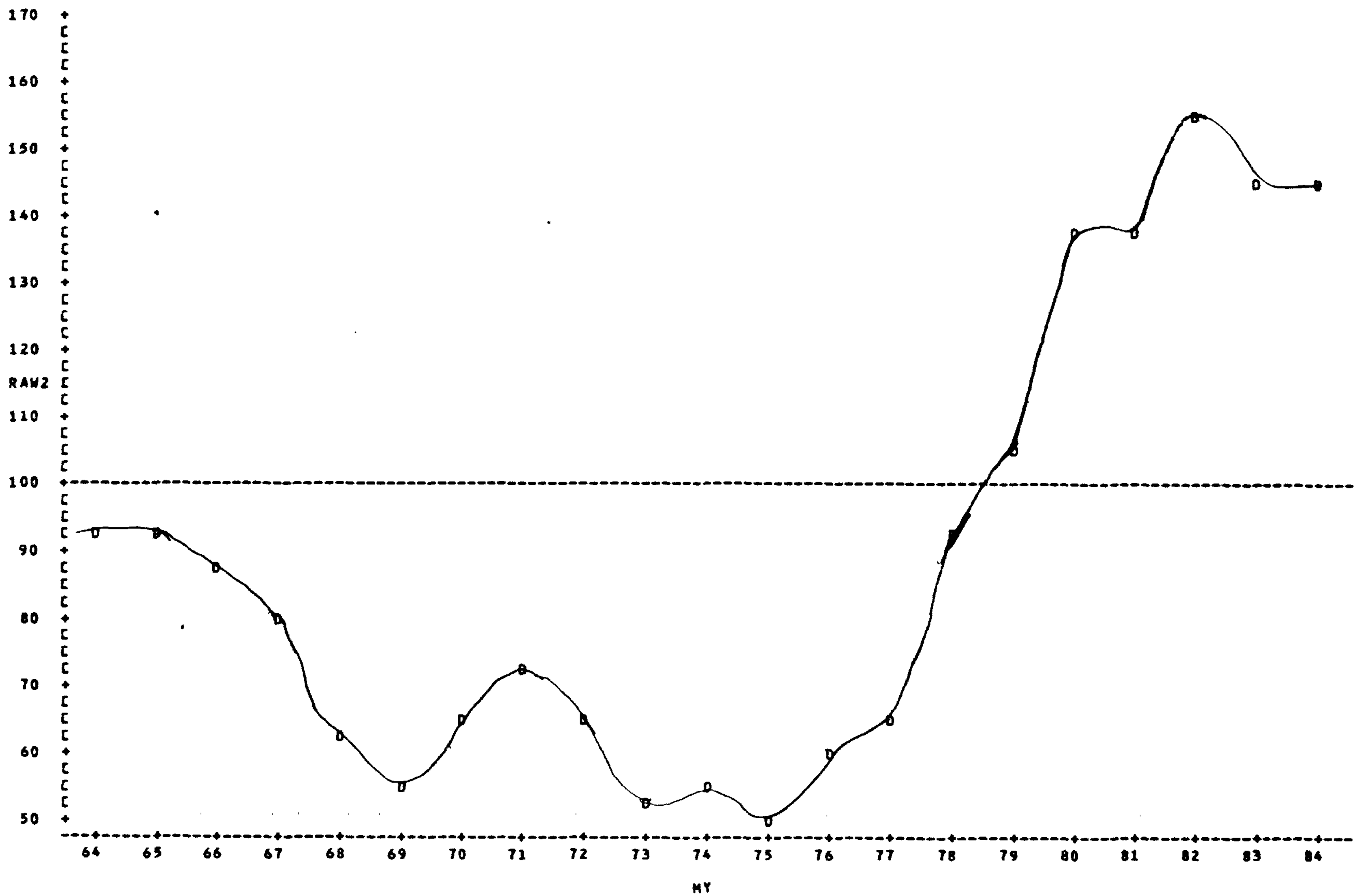
The appropriate interpretation of the risk index is that, in head on collisions between cars of model year 1975 and 1979, there would typically be 50 fatalities in the MY 75 cars for every 105 fatalities in the MY 1979 cars. The unadjusted risk index does not control for any differences in driver age, etc., that may have occurred in the actual FARS crashes. Since it does not control for vehicle weight, it is only appropriate for head on crashes, where the relative weights of the two vehicles is critically important. It would not apply at all to frontal single vehicle crashes, where the vehicle weight factor has a much smaller effect.

Figure 4-1 is a graph of the unadjusted risk index by model year. It shows even more clearly the trends that can be found in the above table. Unadjusted risk declined steadily from 1964 to 1969, a period during which cars got bigger <u>and</u> received some well known safety improvements. There was a moderate rise from 1970 to 1971-72: even though big cars got bigger, this was more than offset by the increased market share for imported subcompacts and the introduction of domestic subcompacts. The index fell sharply during 1972-75 as cars reached their all

FIGURE 4-1: UNADJUSTED FATALITY RISK INDEX FOR DRIVERS, BY MODEL YEAR

RISK FACTOR BY MODEL YEAR (1973-84 AVERAGE = 100)
UNADJUSTED DRIVER DATA

PLOT OF RAW2*MY   SYMBOL USED IS O



time heaviest weights, although there was a slight increase in 1974 when the first fuel shortage depressed big car sales. The index rose steeply after 1976 and had reached unprecedented heights by 1982; it was a period of downsizing and increasing market share for imported small cars. It finally leveled off in 1983-84, when a fuel glut led to a halt in downsizing.

"Downsizing" is well known to occur when manufacturers completely restyle their cars, using a smaller platform, etc. What is perhaps not so well known is that manufacturers can easily increase or decrease the weights of their cars by a considerable amount every year, even between major restylings, as they adapt to changing market demand for various engines or options or to federal regulations concerning bumpers, emissions, etc. It is interesting to see how the basic full-sized Chevrolet changed its average weight every year - not just in the well known downsizing year of 1977:

1964	3555	1971	4011	1978	3788
1965	3644	1972	4171	1979	3720
1966	3649	1973	4303	1980	3496
1967	3696	1974	4354	1981	3586
1968	3695	1975	4318	1982	3609
1969	3794	1976	4361	1983	3593
1970	3883	1977	3769	1984	3592

Note how weight crept up steadily from 1964 to 1974 and that the major downsizing of 1977 only brought the weight back to the 1969 levels. Also note that the small weight changes from year to year for this high volume car tend to be consistent with the trend in the safety index - upwards in the years that the index declined, and vice versa.

4.2.3 A model which controls for vehicle weight and other factors

The simple model defined in the preceding section was a logistic regression on aggregated data. For each combination of the two categorical independent variables (MY of the case vehicle and MY of the other vehicle), the dependent variable was the fatality rate in the FARS cases which had those values of the independent variables. There were usually enough FARS cases to produce meaningful fatality rates for each combination and allow a linear regression of the log odds of the fatality rate by the independent variables.

At first glance, it would appear that the same technique could be used for a model that adjusts for vehicle weight, driver age, etc. Subdivide the control variables into ranges and calculate the fatality rate for each combination of the independent variables - e.g., when MY of car no. 1 is 1975 and weight of car no. 1 is 4000-4499 pounds; MY of car no. 2 is 1979 and weight of car no. 2 is 3000-3499 pounds; driver no. 1 is 20-39 years old and driver no. 2 is 40-59 years old; etc. This approach cannot be used because the 32,000 available cases are insufficient to produce meaningful injury rates in each cell (21 values of MY for car no. 1 x 21 values of MY for car no. 2 x 5 weight ranges for car no. 1 x 5 weight ranges for car no. 2 x 3 age ranges for driver no. 1 x 3 age ranges for driver no. 2 x etc.). Furthermore, since the dependent variable is believed to be extremely sensitive to vehicle weight, it would be far too coarse to subdivide vehicle weight into class intervals as broad as 500 pounds. Vehicle weight ought to be treated as a continuous variable.

A more satisfactory analysis approach is to perform logistic regression on disaggregate data, using maximum likelihood principles [29]. Here, each of the 32,000 available FARS cases is a data point in the regression (i.e., the 16,000 actual FARS head on collisions, treating car no. 1 as the case vehicle and car no. 2 as the other vehicle and then again these same 16,000 collisions, but now treating car no. 2 as the case vehicle and car no. 1 as the other vehicle). Unlike the simple model, crashes where both cars are of the same model year are included in the analysis. The dependent variable is the outcome for the driver of the case vehicle, equaling 1 if the driver died and 0 if he survived. The independent variables are the actual model years, weights, etc. of the vehicles and the ages, gender, belt usage, etc. of the drivers. The regression procedure takes this large number of individual observations of success (driver survival) or failure (driver fatality) under different actual circumstances to predict the driver fatality rate under any hypothetical combination of circumstances. Specifically the model generates an equation which expresses the log odds of the fatality rate as a linear combination of the independent variables - just like the equation produced by a conventional logistic regression on aggregate data.

The independent variables are defined as follows:

- M64, M65, ..., M83 are the same as in the simple model - i.e., Mi = 1 if the case vehicle model year is i, Mi = -1 if the other vehicle model year is i and Mi = 0, otherwise.
- LWGT is the log of the ratio of the weight of the case vehicle to the weight of the other vehicle (i.e., the model assumes a logistic relationship between the fatality risk and the weight ratio)

- PDOF compares the exact impact location for the two vehicles. Let IMPACT2c be the point of impact for the case vehicle; IMPACT2o, for the other other vehicle. Define

PDOF	= 0	if IMPACT2c = IMPACT2o
	= .5	if IMPACT2c = 1 and IMPACT2o = 12 or if IMPACT2c = 12 and IMPACT2o = 11
	= 1	if IMPACT2c = 1 and IMPACT2o = 11
	= -.5	if IMPACT2c = 11 and IMPACT2o = 12 or if IMPACT2c = 12 and IMPACT2o = 1
	= -1	if IMPACT2c = 11 and IMPACT2o = 1

  The more positive PDOF, the less dangerous the situation for the driver of the case vehicle relative to the other vehicle.

- LAGE is based on a comparison of the ages of the two drivers. Let AGEc be the age of the driver of the case vehicle and AGEo be the age of the driver of the other vehicle. Define

$$\text{LAGE} = \log(120 - \text{AGEo}) - \log(120 - \text{AGEc})$$

  The rationale for the transformation of the age variable is that adults' fatality risk in crashes at first increases slowly as age increases but ever more rapidly with increasing age [13]; so does the transformed variable log(120 - age). Cases where either driver's age is unknown are excluded from the analysis.

- SEX

SEX	= 0	if both drivers were males or both were females
	= 1	if the driver of the case vehicle was male and the other, female
	= -1	if the driver of the case vehicle was female and the other, male

  Cases where either driver's gender is unknown are excluded from the analysis.

- LAP = LAPc - LAPo, where LAPc and LAPo are as defined in Section 4.2.1.

- LAPSH = LAPSHc - LAPSHo, where LAPSHc and LAPSHo are as defined in Section 4.2.1.

- UNKRES = UNKRESc - UNKRESo, where UNKRESc and UNKRESo are as defined in Section 4.2.1.

o DRINK = 1 if drinking was reported for the driver of the case vehicle (DRINKING = 1) but was not reported or was unknown for the driver of the other vehicle

DRINK = -1 if drinking was reported for the driver of the other vehicle but was not reported or was unknown for the driver of the case vehicle

DRINK = 0 otherwise

The regression coefficients are

INTERCEPT	.538	LWGT	-5.421	PDOF	- .092
LAGE	2.841	SEX	.261	LAP	- .604
LAPSH	- .746	UNKRES	- .216	DRINK	.198
M64	.30	M71	.17	M78	.22
M65	.34	M72	.19	M79	.24
M66	.62	M73	.01	M80	.02
M67	.44	M74	- .06	M81	- .09
M68	.13	M75	- .02	M82	.15
M69	.12	M76	.13	M83	.11
M70	.15	M77	.12	"M84"	.00

There is no actual M84 variable, but all the other model year coefficients are measured relative to the risk for 1984 cars. The more negative the coefficient, the lower the fatality risk. All of the control variables have coefficients with the appropriate sign - i.e., the case vehicle driver's fatality risk is higher when the case vehicle weight is lower, the damage location is toward the case vehicle's driver and away from the other vehicle's driver, the case vehicle driver is older, a female, unrestrained and having consumed alcohol. The regression coefficient is statistically significant (two sided alpha less than .05) for LWGT (chi square = 7144.76), LAGE (chi square = 2588.78), SEX (chi square = 99.91), LAP (chi square = 43.62), LAPSH (chi square = 107.52), UNKRES (chi square = 10.36) and DRINK (chi square = 48.88). It is borderline significant (one sided alpha less than .10) for PDOF (chi square = 1.96). Appropriately, the effect for LAPSH is larger than that for LAP, which is in turn greater than the one for UNKRES (restraint use maybe but unknown for sure).

In 89.6 percent of the cases, the model correctly predicted the actual outcome - i.e., predicted a fatality risk greater than .5 in cases where the case vehicle occupant died or predicted a fatality risk less than .5 in cases where the case vehicle occupant survived.

An abstract form of double pair comparison analysis, nearly identical to what was used in the simple model (see Section 4.2.2), generates fatality risk indices from the regression results. Construct a file of all head on collisions on FARS which were fatal to at least one driver (actually this file has each collision twice: once with vehicle no. 1 as the case vehicle and once with vehicle no. 2 as the case vehicle; it has over 32,000 crash situations). Recall that .538 is the regression intercept and that -5.421, -.092, 2.841, .261, -.604, -.746, -.216 and .198 are the regression coefficients for LWGT, PDOF, LAGE, SEX, LAP, LAPSH, UNKRES and DRINK, respectively. Let Ai be the regression coefficient for model year i. Select any particular one of the 32,000 actual crash situations on the file; suppose the case vehicle was of model year i and the other vehicle was of model year j. The regression model predicts that the likelihood of a case vehicle driver fatality in that crash situation is

$$p = 1 / [1 + \exp(Aj - Ai - .538 + 5.421LWGT + .092PDOF - 2.841LAGE - .261SEX + .604LAP + .746LAPSH + .216UNKRES - .198DRINK)]$$

whereas

$$c = 1 / [1 + \exp(Ai - Aj - .538 - 5.421LWGT - .092PDOF + 2.841LAGE + .261SEX - .604LAP - .746LAPSH - .216UNKRES + .198DRINK)]$$

is the regression model's estimate of the likelihood that the driver of the other vehicle died in the crash (where LWGT, PDOF, etc. are the actual values of those independent variables for that particular crash).

Now consider the hypothetical situation where the case vehicle is replaced by a 1975 car of the same weight, while the other vehicle stays what it actually is. The damage locations stay the same as in the actual case. So do the characteristics of both drivers: their age, sex, belt usage and alcohol status. In short, the only thing that changes is the "model year" of the case vehicle - i.e., the level of safety equipment and structure of the actual case vehicle is replaced by the level of safety equipment and structure that was characteristic of 1975 cars. The values of LWGT, PDOF, LAGE, SEX, LAP, LAPSH, UNKRES and DRINK remain the same. In this hypothetical situation, the regression model would predict that the likelihood of a case vehicle driver fatality is no longer p but rather

$$p75 = 1 / [1 + \exp(Aj-A75-.538+5.421LWGT+.092PDOF-2.841LAGE-.261SEX \\ +.604LAP+.746LAPSH+.216UNKRES-.198DRINK)]$$

whereas c is replaced by

$$c75 = 1 / [1 + \exp(A75-Aj-.538-5.421LWGT-.092PDOF+2.841LAGE+.261SEX \\ -.604LAP-.746LAPSH-.216UNKRES+.198DRINK)]$$

as the regression model's estimate of the likelihood that the driver of the other vehicle died in the crash

Just let P75 be the sum of the values of p75 for the 32,000 crash situations on the file and C75 be the sum of the c75's. Similarly calculate Pi and Ci for all the other model years from 1964 to 84. Then, for example,

$$(P75/C75) \; / \; (P79/C79)$$

estimates the intrinsic fatality risk of model year 1975 cars in frontal collisions relative to the intrinsic risk of model year 1979 cars of the same weight - averaged over the gamut of driver ages, etc. and crash situations that occur in the United States.

The quantities Pi/Ci for the various model years become more tangible through indexing. The <u>adjusted frontal fatality risk index for drivers</u> shall be set to 100 for the average of model years 1973 through 1984 - i.e., let

$$ADJ = 100 \; / \; (P73/C73+\ldots+P84/C84)$$

and define

$$ADJi = ADJ \times (Pi/Ci)$$

to be the risk index for model year i. The adjusted risk indices, by model year, are:

1964	111	1971	105	1978	107
1965	113	1972	106	1979	108
1966	128	1973	97	1980	98
1967	118	1974	94	1981	93
1968	103	1975	96	1982	104
1969	102	1976	103	1983	102
1970	104	1977	102	1984	97

The appropriate interpretation of the risk index is that if the fleet of 1966 cars had been replaced by a fleet of 1968 type cars of the same weights, there would have been only 103/128 of the head on crash fatalities. Since the adjusted risk index controls for vehicle weight, it might be appropriate not only for head on crashes but also for other types of frontal impacts.

Figure 4-2 is a graph of the adjusted risk index by model year. It shows even more clearly the trends that can be found in the above table. Driver fatality risk in frontal crashes declined sharply in model year 1967-68, the years in which the important safety modifications, especially the introduction of energy absorbing steering columns, took place. There was a 12 percent reduction from the 1964-66 average index of 117.3 to the 1968-70 average of 103. After model year 1968, there is little net change in fatality risk. The 1973-84 average of 100 is 3 percent below the 1968-70 average of 103, although that difference could easily be in the "noise" range. The standard deviation of the regression coefficients for the individual model years is about .105. A change of 2 standard deviations in the regression coefficient would increase or decrease the index by about 9. Thus, dotted lines are drawn on Figure 4-2 at index values 109 and 91, representing the 95 percent noise band around the 1973-84 average value of 100. Every index value before 1968 is above the noise band. Every index value from 1968 onwards is within the noise band; the oscillations of the index within the noise band does not appear to have any obvious pattern.

Figure 4-3 shows the enormous effect of controlling for vehicle weight and other factors. It is a graph of the adjusted (plain line) and unadjusted (hashed line) risk indices, on the same scale. (The unadjusted index, however is not exactly the same as in Figure 4-1; here it has been made fully comparable to the adjusted index - instead of dividing the unadjusted Pi/Ci by the 1973-84 average of the unadjusted Pi/Ci, they are divided by the 1973-84 average of the adjusted Pi/Ci.) The fluctuations

FIGURE 4-2: ADJUSTED FATALITY RISK INDEX FOR DRIVERS, BY MODEL YEAR

RISK FACTOR BY MODEL YEAR (1973-84 AVERAGE = 100)
ADJUSTED DRIVER DATA

PLOT OF ADJ*MY   SYMBOL USED IS D

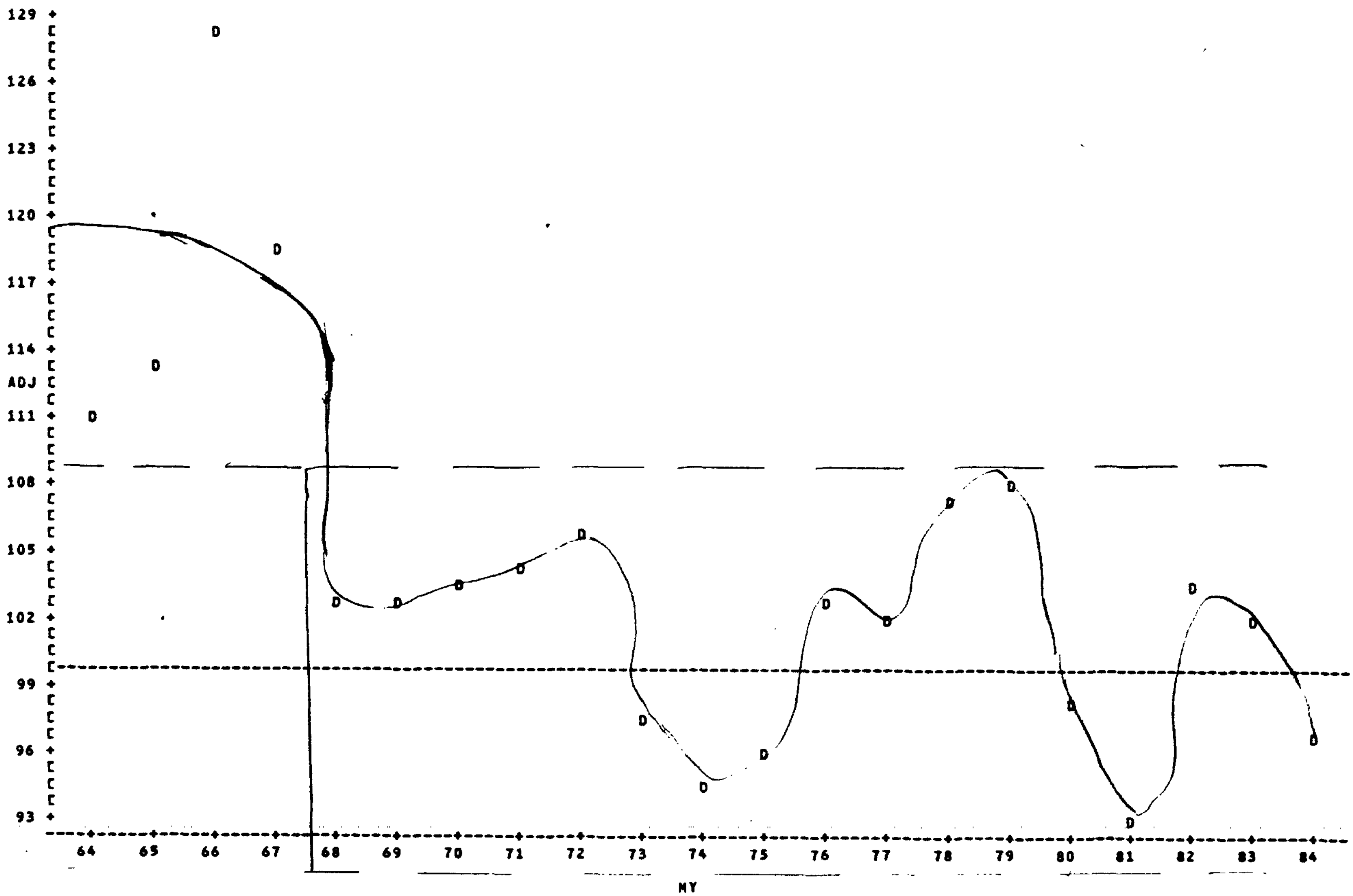
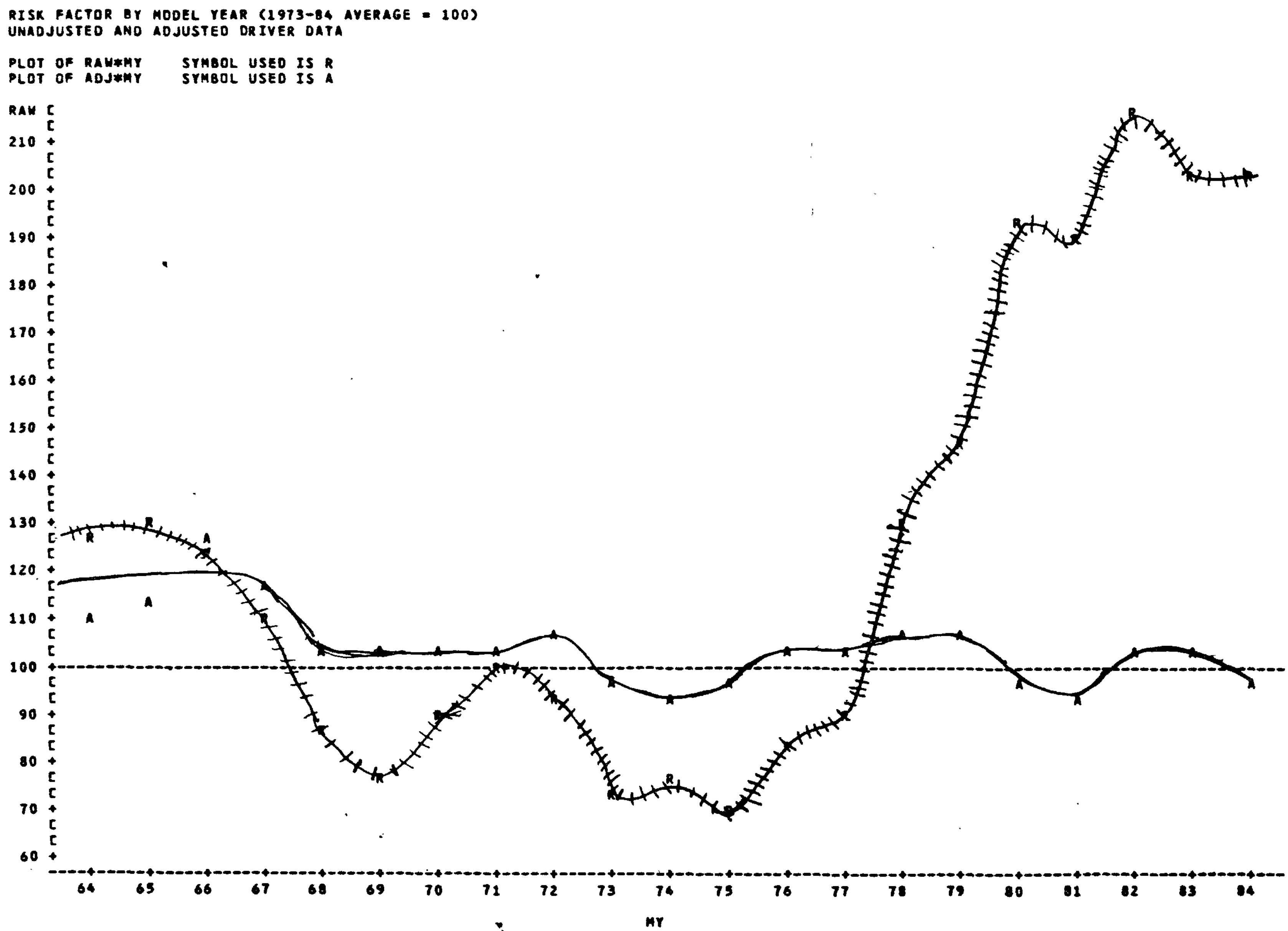


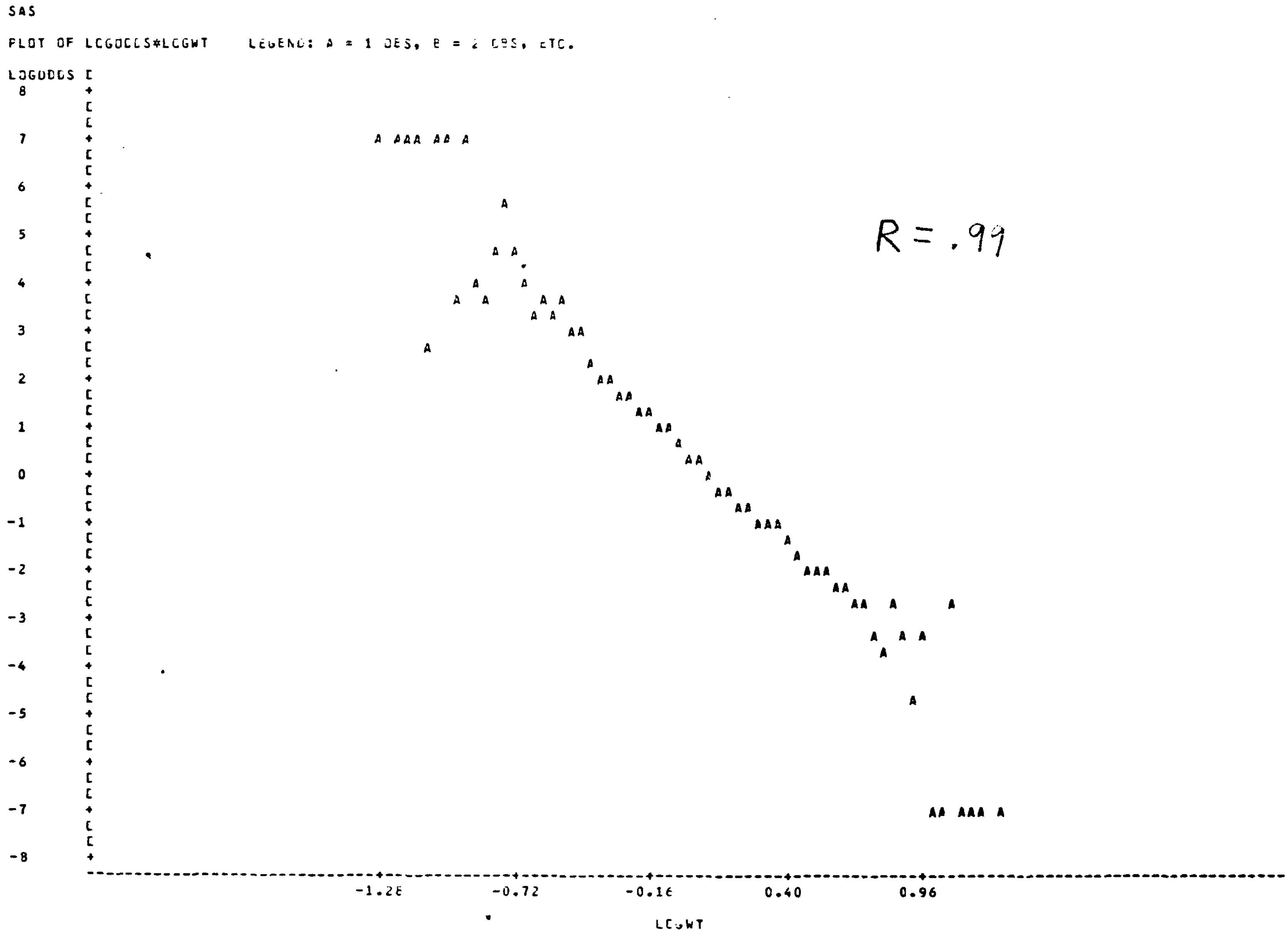
FIGURE 4-3: ADJUSTED (Plain Line) AND UNADJUSTED (Hatched Line) FATALITY RISK INDICES FOR DRIVERS



of the adjusted index after 1968 are almost trivial in comparison to the large changes in the unadjusted index. Even the larger dip of the adjusted index in 1968, as a result of the major safety improvements of the late 1960's, is small compared to the effects of vehicle weight changes on fatality risk in head on collisions. From 1966 to 1977, when cars were heavier than usual, the unadjusted index is always lower than the adjusted; in 1964-65 and from 1978 onward it is higher, sometimes much higher.

Since the effect of vehicle weight is so crucial, it is appropriate to ask if the regression model used the appropriate mathematical formulation for the effect of weight on fatality risk. Specifically, is it reasonable to assume a linear relationship between the log odds of a fatality occurring in the case vehicle (LOGODDS) and the log of the ratio of the case vehicle weight to the other vehicle's weight (LWGT)? The question was addressed by running a logistic regression model on aggregate data, i.e., a weighted linear regression in which the independent variable is LWGT, ranging from -1.12 to +1.28, subdivided into 75 class intervals each of width .04. The 32,000 FARS cases are tabulated by LWGT class intervals and LOGODDS, the dependent variable, is the proportion of cases in each class interval where the case vehicle driver died. The weight factor for the regression is the number of FARS cases in each class interval of the independent variable. Figure 4-4 shows that the 75 data points have a fantastic linear fit, except at the edges, where fatality rates are based on handfuls of FARS cases. R squared is .975. Clearly, logistic regression is a good procedure for dealing with the effect of

FIGURE 4-4: LOGODDS of Driver Fatality in Case Vehicle BY LOG(WEIGHT RATIO)



vehicle weight. There does not appear to be any danger that weight effects will be spuriously attributed to other factors because of a nonlinear LWGT - LOGODDS relationship.

4.3 Extension of the analysis to right front passengers

The analysis for right front passengers, as explained in Section 4.1, is performed in two stages, so as to maximize the sample size of the data. The first stage is a model which assesses the relative fatality risk of right front passengers and drivers of the same car, by model year, controlling for differences in the age and sex, etc. of the occupants (Sections 4.3.1 - 4.3.3). The data are not limited to head on crashes but include other frontal impacts, as well. In the second stage, these ratios of passenger to driver fatality risk are combined with the driver fatality indices of Section 4.2.3 to obtain passenger safety indices (Section 4.3.4).

4.3.1 FARS data reduction

The 1975-86 FARS files contain records of nearly 34,000 frontal impacts of passenger cars of model years 1964-84 in which there were a driver and a right front passenger and at least one of them died. A frontal impact is one whose principal impact location was 11, 12 or 1 o'clock. Passenger cars were vehicles with BODY_TYP 1-13. If a car had two RF passengers, only the first was included in the analysis (the second RF passenger is typically a child sitting on somebody's lap). Right front passengers age 4 or less were excluded, partly because the other chapters of this report are limited to analyses for older children and adults, partly because the models use occupant age as a control variable and need fatality risk to increase steadily as age increases - which is only true from about age 5 onwards.

Only those cars in which the driver and the RF passenger were unrestrained are used in the analysis, in contrast to the preceding model for head on collisions. The preceding model looked at drivers of two different cars: the belt usage of one is relatively uncorrelated with the other's belt usage. To exclude all cases in which one driver or the other was not known to be unrestrained would have reduced the sample size intolerably. Instead, belt usage became a control variable. Here, on the other hand, driver and front passenger belt usage in the same car are highly correlated. The analysis can be limited to cases where both are unrestrained (which is what is really wanted, for consistency with Chapters 2 and 3) without losing too much of the sample.

A 2 occupant file was created, with one record for each frontally impacted car, containing information on the driver and the RF passenger. The file contained the FARS variables on the vehicle's make, model, model year, body style and principal impact point, plus the driver and RF passenger's age, sex and alcohol status. Cases where either occupant's age or gender were unknown was not used.

Vehicle weight is not a control variable in this model. Since the driver and RF passenger are occupants of the same car, they are both, so to speak, in cars of the same weight. On the other hand, impact location is more important as a control variable, since a frontal impact with a fixed object that is more toward one side of the car is generally more threatening to the occupant on that side of the car.

4.3.2 A simple model: no control variables

As a "rehearsal" for the logistic regression of passenger vs. driver fatality risk by model year, occupant age, etc. it is useful to build a simpler model which presents the ratio of RF passenger to driver fatalities as a function of model year, without control for other factors.

The starting point for the simple model is a tabulation of the frontal impacts by model year (ranging from 1960 to 1985 in this case) and fatality status of the driver and RF passenger. For example, there were 1173 frontal impacts on FARS of cars of model year 1965 and 2382 of model year 1975. The fatality status was:

Model Year	Driver Died Passenger Survived	Passenger Died Driver Survived	Both Died
1965	441	565	167
1975	972	905	505

The next step is to compute the ratio of RF passenger to driver fatalities. (The formulation of the dependent variable is different from the models of Section 4.2, where it was the number of fatalities in the case vehicle divided by the total number of crashes; the reason is that the fatality ratio, as defined here, would not have been suitable for the type of regressions used in Section 4.2.) For example, in model year 1965, 565 + 167 = 732 RF passengers died and 441 + 167 = 608 drivers died. This is a ratio of 120 RF passenger fatalities per 100 driver fatalities. The ratios of RF passenger fatalities per 100 drivers killed, by model year, are:

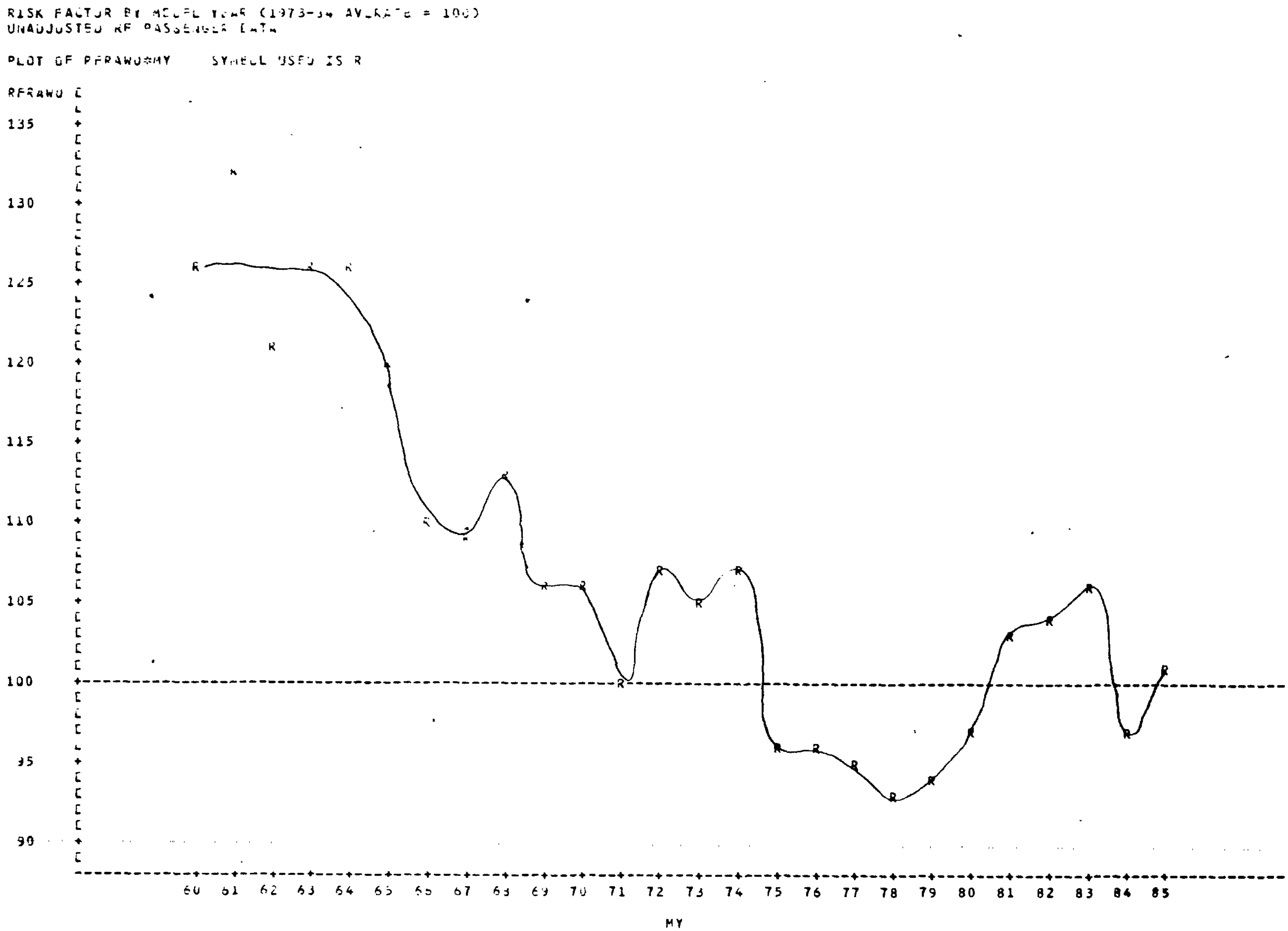
1960	126	1969	106	1978	93
1961	132	1970	106	1979	94
1962	121	1971	100	1980	97
1963	126	1972	107	1981	103
1964	126	1973	105	1982	104
1965	120	1974	107	1983	106
1966	110	1975	95	1984	97
1967	109	1976	96	1985	101
1968	112	1977	95		

Figure 4-5 is a graph of the unadjusted fatality ratios by model year. It clearly shows a higher fatality rate for RF passengers than for drivers in cars of the early to mid 1960's. The gap between the two seating positions narrowed in the late 1960's and early 1970's. In cars of the later 1970's, the fatality rate for RF passengers was slightly lower than for drivers, but by the 1980's, the rates were again close to equal.

4.3.3 A model which controls for occupant and impact characteristics

The simple model defined in the preceding section did not require any regression analysis at all. There was one data point (RF to driver fatality ratio) for each model year. When control variables are introduced, there are several data points for each model year - e.g., the fatality ratio when both occupants are young males and the impact is in the 11:00 area, etc. A more complex analysis, including regression, is needed to compute the average fatality ratio in each model year after

FIGURE 4-5: UNADJUSTED RATIO OF RF PASSENGER TO DRIVER FATALITIES, BY MODEL YEAR



controlling for differences in the occupant and impact location variables. Nevertheless, it is possible to keep the model simple enough to use logistic regression on aggregate data. In the driver model (Section 4.2.3), there were far too many cells for logistic regression on aggregate data: partly because each collision involved 2 cars, resulting in 21 x 21 = 441 model year combinations for 1964-84 cars; partly because the ultrasensitive vehicle weight variable (for both cars) would have had to be subdivided into many class intervals, etc. Here, only one car is analyzed in each case, so there are only 21 model year cells. Vehicle weight is not a control variable at all; nor is belt usage, since the analysis is limited to unrestrained occupants, as explained in Section 4.3.1. Alcohol status is also inadvisable as a control variable, since it is too often unreported for RF passengers. That leaves age, gender and impact location: the first can be subdivided into a manageable number of class intervals; the other two are already categorical variables with few categories.

Specifically, the independent variables in the regression are defined as follows:

- M64, M65, ..., M83 are model year indicators - i.e., Mi = 1 if the car's model year is i and Mi = 0, otherwise (and all the Mi's are zero if the model year is 84).

- PDOF = 0 if IMPACT2 = 12
  = 1 if IMPACT2 = 11
  = -1 if IMPACT2 = 1

  The more positive PDOF, the less dangerous the situation for the RF passenger relative to the driver.

- o LAGE is based on a comparison of the ages of the driver and the RF passenger. Let AGEp be the age of the RF passenger and AGEd be the age of the driver. Define

$$LAGE = \log(120 - AGEd) - \log(120 - AGEp)$$

LAGE is subdivided into 10 class intervals. Here are the ranges of the class intervals and the point value of LAGE that is substituted for all the values in the class interval:

If LAGE ranges from	to	Set LAGE to
less than	-1.0	-1.05
-1.0	- .6	- .75
- .6	- .4	- .5
- .4	- .2	- .3
- .2	0	- .1
0	.2	.1
.2	.4	.3
.4	.6	.5
.6	1.0	.75
1.0 and greater		1.05

- o SEX = 0 if both occupants were males or both were females
  = 1 if the RF passenger was male and the driver, female
  = -1 if the RF passenger was female and the driver, male

There are 21 x 3 x 10 x 3 = 1890 possible combinations of the independent variables. The nearly 34,000 FARS cases meeting the criteria of Section 4.3.1 are tabulated by the independent variables. In 1243 of the 1890 potential combinations of the independent variables, there is at least one FARS case. Each of these 1243 cells is one data point in the regression. The ratio R of RF passenger to driver fatalities among the FARS cases in that cell is calculated just like in the simple model (Section 4.3.2). (Logistic regression cannot be performed if this ratio is zero or infinite. In order to avoid such values of the ratio, cells in which there were zero RF fatalities or zero driver fatalities were modified to have .1 RF or driver fatalities.) The dependent variable in the regression is

$$LOGODDS = \log(R)$$

The weight factor for the weighted logistic regression is the number of FARS cases in each cell.

The regression coefficients are

INTERCEPT	.008	PDOF	- .768	LAGE	2.204
SEX	- .207				
M64	.23	M71	.05	M78	- .12
M65	.22	M72	.05	M79	- .06
M66	.03	M73	.04	M80	- .08
M67	.09	M74	.11	M81	.07
M68	.08	M75	- .02	M82	.04
M69	.05	M76	.00	M83	.03
M70	.06	M77	- .02	"M84"	.00

There is no actual M84 variable, but all the other model year coefficients are measured relative to the risk for 1984 cars. The more negative the coefficient, the lower the fatality risk for the RF passenger relative to the driver. All of the control variables have coefficients with the appropriate sign - i.e., the RF passenger's fatality risk is higher, relative to the driver, when the damage location is toward the right front of the vehicle, the RF passenger is older than the driver, and the RF passenger is a female while the driver is male. The regression coefficients for all the control variables are statistically significant (two sided alpha less than .05; in fact it is less than .0001): for PDOF, t = 33.31 (df = 1219); for LAGE, t = 37.30; for SEX, t = -10.83. R squared for the model is .684.

An abstract form of double pair comparison analysis, nearly identical to what was used in the simple model for drivers (see Section

4.2.2), generates adjusted fatality ratios from the regression results. Use the file of 1243 cells describing the variety of frontal impacts of 1964-84 cars on FARS in which there was an unrestrained driver and an unrestrained RF passenger and at least one died. Recall that .008 is the regression intercept and that -.768, 2.204 and -.207 are the regression coefficients for PDOF, LAGE and SEX, respectively. Let Ai be the regression coefficient for model year i. Select any particular one of the 1243 cells on the file; suppose the vehicle was of model year i and that the cell contained a total of N actual RF passenger plus driver fatalities. The regression model predicts that the <u>number</u> of RF passenger fatalities in that cell is

$$p = N / [1 + \exp(-Ai-.008+.768PDOF-2.204LAGE+.207SEX)]$$

whereas

$$c = N - p$$

is the regression model's estimate of the number of driver fatalities in that cell (where PDOF, LAGE, etc. are the actual values of those independent variables for that particular crash).

Now consider the hypothetical situation where the cars in that cell are replaced by 1975 cars, while the damage location and occupant characteristics remain unchanged. In short, the only thing that changes is the "model year" of the vehicle - i.e., the level of safety equipment and structure of the actual case vehicle is replaced by the level of safety equipment and structure that was characteristic of 1975 cars. In this hypothetical situation, the regression model would predict that the the number of RF passenger fatalities in that cell is no longer p but

$$p75 = N / [1 + \exp(-A75 - .008 + .768PDOF - 2.204LAGE + .207SEX)]$$

whereas the number of driver fatalities changes from c to

$$c75 = N - p75$$

Just let P75 be the sum of the values of p75 for the 1243 cells on the file and C75 be the sum of the c75's. Similarly calculate Pi and Ci for all the other model years from 1964 to 84. Then, for example,

$$P75/C75$$

estimates the intrinsic fatality risk of unrestrained RF passengers relative to unrestrained drivers of the same age and sex in model year 1975 cars involved in centered frontal collisions. The ratios of RF passenger fatalities per 100 drivers killed, by model year, are:

1964	124	1971	104	1978	89
1965	123	1972	104	1979	94
1966	102	1973	104	1980	93
1967	108	1974	110	1981	106
1968	108	1975	98	1982	104
1969	104	1976	100	1983	103
1970	106	1977	98	1984	100

Figure 4-6 is a graph of the adjusted fatality ratio by model year, whereas Figure 4-7 graphs the adjusted (plain line) and unadjusted (hashed line) fatality ratios on the same scale. Unlike the head on collision model (Section 4.2.3), there is little difference between the adjusted and the unadjusted data. The control variables are of little importance, despite their strong correlation with the dependent variable, because they had only modest intercorrelation with the model year of the car. In general, the unadjusted fatality ratio is slightly higher than the adjusted, possibly reflecting the fact that females are more likely to

FIGURE 4-6: ADJUSTED RATIO OF RF PASSENGER TO DRIVER FATALITIES, BY MODEL YEAR

RISK FACTOR BY MODEL YEAR (1973-84 AVERAGE = 100)
ADJUSTED RF PASSENGER DATA

PLOT OF RFADJ*MY   SYMBOL USED IS A

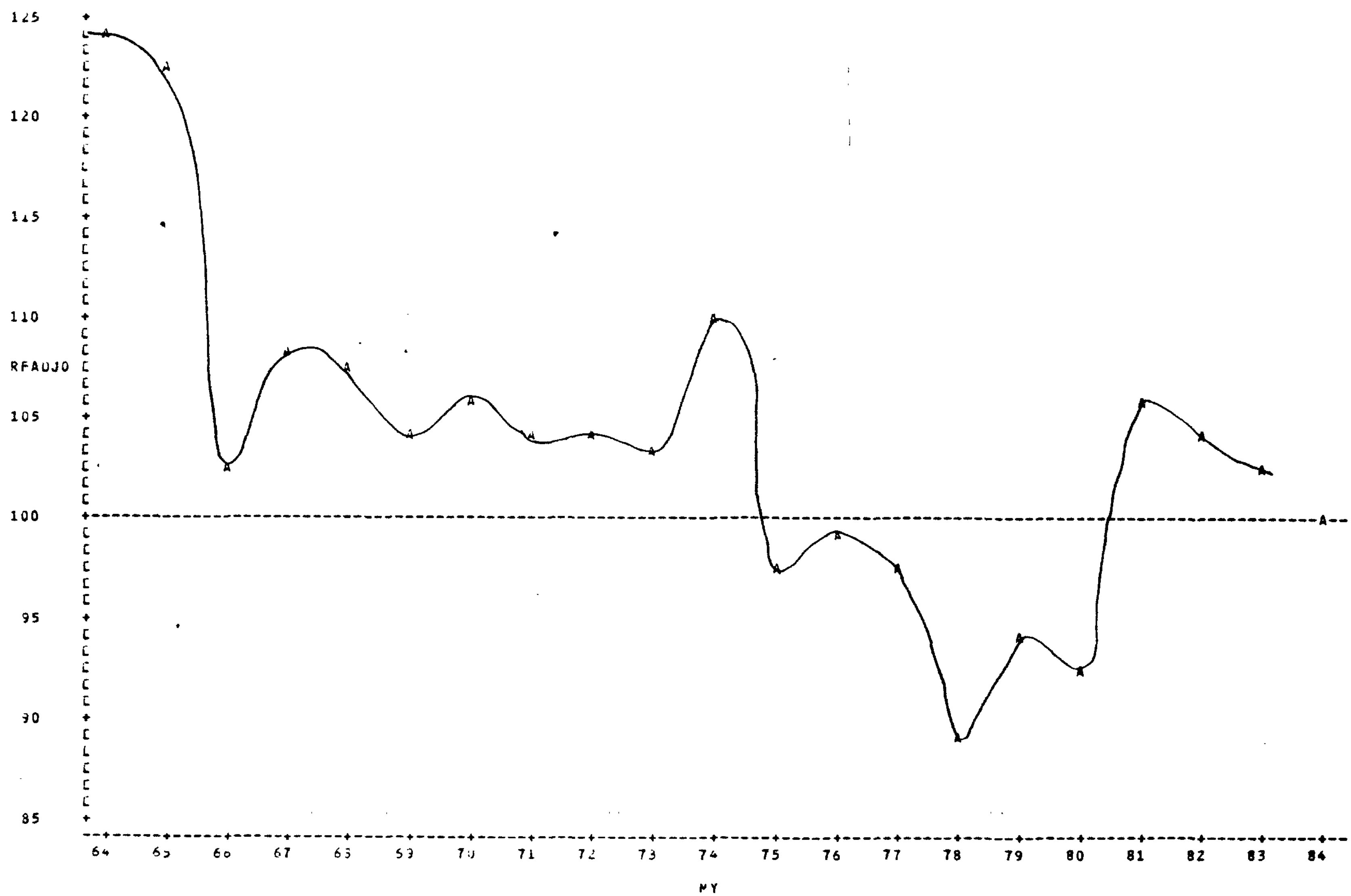
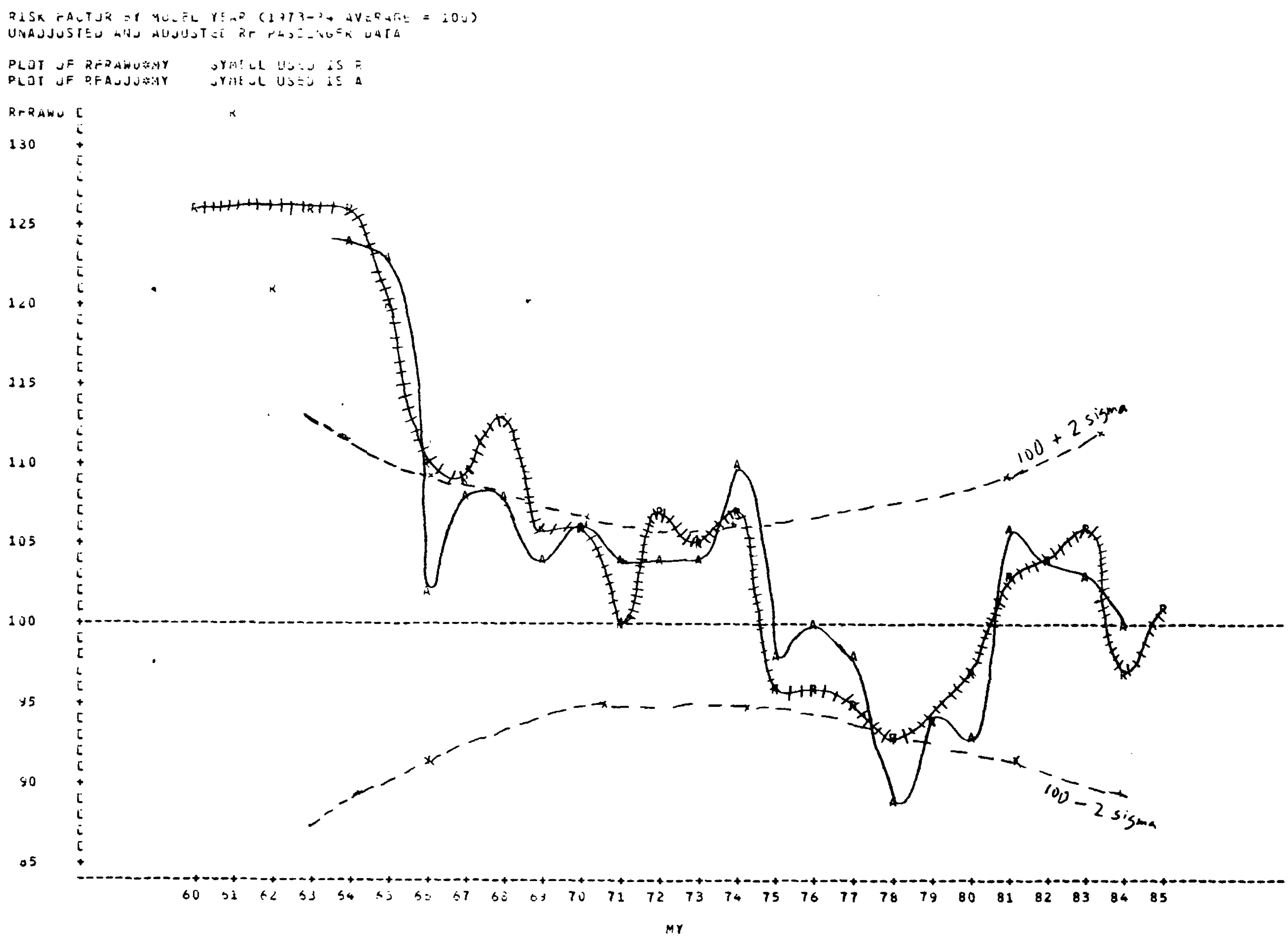


FIGURE 4-7: ADJUSTED (Plain Line) AND UNADJUSTED (Hatched Line) RATIOS OF RF PASSENGER TO DRIVER FATALITIES



be RF passengers and males, the drivers. The unadjusted fatality ratio tends to exceed the adjusted ratio especially in the earlier model years, perhaps because there used to be relatively more fixed object impacts involving the right front of the car. But all the adjustment effects are trivial, especially in comparison to the effect of vehicle weight on what happened in the head on collisions (Figure 4-3).

Here, the adjusted and unadjusted fatality ratios show basically the same thing: that unrestrained RF passengers were 20-25 percent more vulnerable than unrestrained drivers in frontal crashes in cars of model years 1960-65. It is no wonder that the RF position was called the "suicide seat" in those days. Something important was done to improve safety for the RF position in the mid to late 1960's, because the fatality ratio dropped from the 120-125 to the 105-110 range <u>despite</u> the introduction of energy absorbing steering assemblies in front of the driver position during that period. In other words, the improvements for the RF seating position were even more effective than the energy absorbing steering assembly was for drivers. The fatality ratio remains at close to 105 in cars of the early 1970's and drops below 100 in the later 1970's, recovering to about 100 in the early 1980's. The 95 percent noise bands on either side of the hypothesis that drivers and passengers have equal risk are represented by the dotted, approximately parabolic curves on Figure 4-7. They are based on the data in the simple model: if n is the actual number of driver plus RF passenger fatalities in a particular model year,

$$100 [.5 + 1.96 \text{ sqrt}(.5 \times .5 / n)] / [.5 - 1.96 \text{ sqrt}(.5 \times .5 / n)]$$

and

100 [.5 - 1.96 sqrt(.5 x .5 / n)] / [.5 + 1.96 sqrt(.5 x .5 / n)]

are the upper and lower critical values (two sided alpha = .05) for the hypothesis that the fatality ratio is 100. Figure 4-7 shows that the high values of the fatality ratio in 1960-65 cars are well above the noise bands, whereas almost all the values from 1969 onwards are within the noise bands. Nevertheless, there seems to be a pattern of movement from the upper noise band to the lower one during the 1970's suggesting that the reduction of the fatality ratio during that time may be more than just random variation.

4.3.4 Fatality index for right front passengers

An absolute fatality index for unrestrained RF passengers in frontal crashes is obtained by multiplying each model year's adjusted driver index (Section 4.2.3) by the adjusted ratio of RF passenger to driver fatality risk. The RF passenger risk indices, by model year, are:

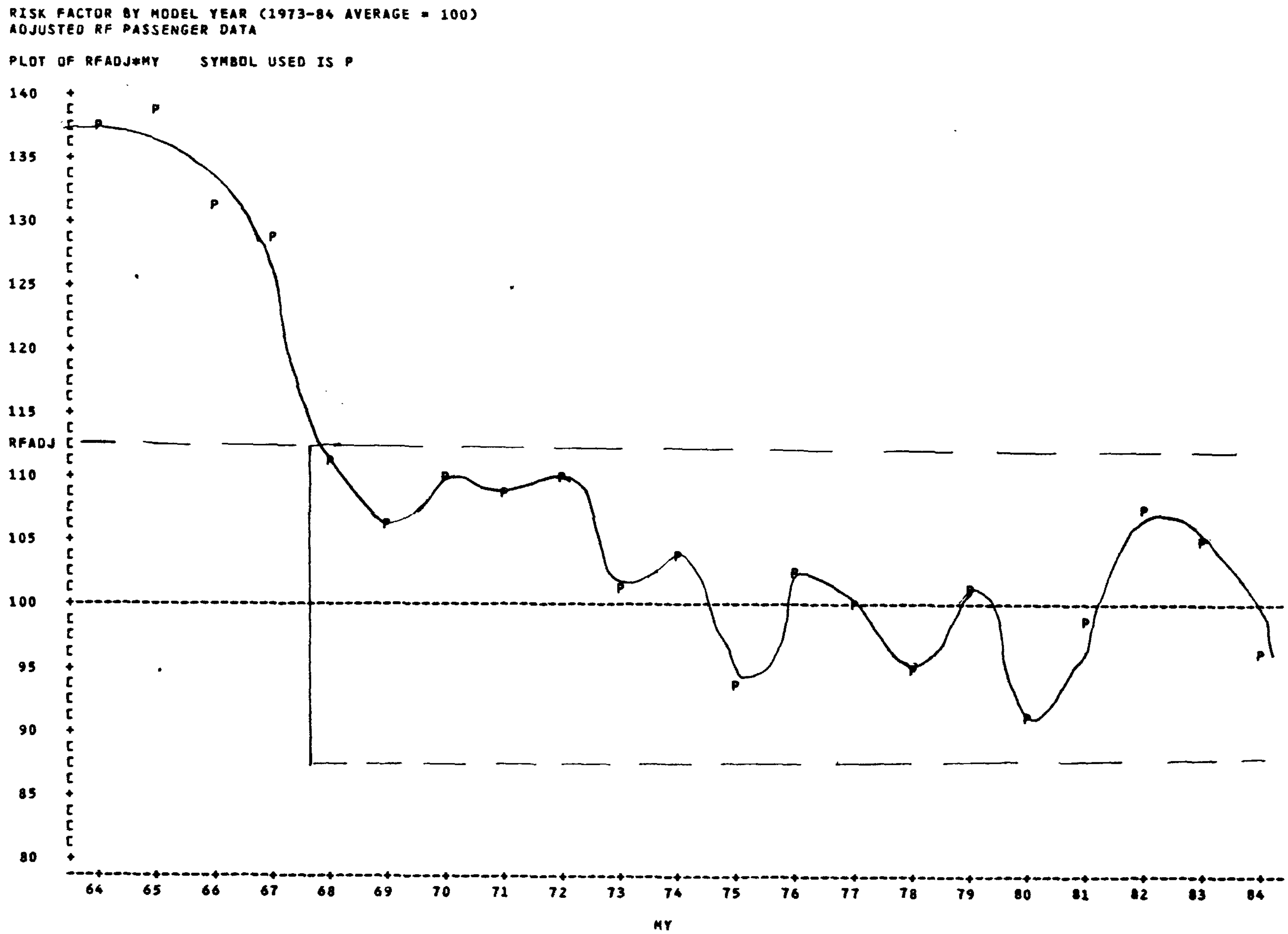
1964	137	1971	109	1978	96
1965	139	1972	110	1979	101
1966	131	1973	101	1980	91
1967	128	1974	104	1981	99
1968	111	1975	94	1982	108
1969	107	1976	102	1983	105
1970	110	1977	100	1984	97

The appropriate interpretation of the risk index is that if the fleet of 1966 cars had been replaced by a fleet of 1968 type cars of the same weights, there would have been only 111/131 of the RF passenger fatalities in head on crashes. Since the adjusted risk index controls for vehicle weight, it might be appropriate not only for head on crashes but also for other types of frontal impacts.

Figure 4-8 is a graph of the adjusted risk index for unrestrained RF passengers, by model year. Fatality risk declined steadily in cars of the mid to late 1960's, especially in model year 1968, dropping from an average index of 135.7 in model years 1964-66 to 109.1 in model years 1968-70 - a 20 percent fatality reduction. After model year 1969, there may have been an additional, smaller drop in fatality risk. The 1973-84 average of 99.7 is 9 percent below the 1968-70 average of 109.1, although it is possible that the difference is in the "noise" range. The risk indices in Figure 4-8 are calculated by multiplying two more or less independently derived statistics (the driver risk index and the RF to driver fatality ratio), each of which has a coefficient of variation close to 4.5 percent; the product should have coefficient of variation close to 6.4 percent. The dotted lines drawn on Figure 4-8 at index values 112.2 and 87.2 represent the 95 percent noise band around the 1973-84 average value of 99.7. <u>Every</u> index value before 1968 is well above the noise band. Every value from 1968 onwards is within the noise band; nevertheless, the proximity to the upper dotted line of each of the first 5 values after 1968 does suggest that there was a subsequent reduction of risk in the early to mid 1970's, which leveled out in the later 1970's.

What is most remarkable about Figure 4-8 is its similarity to Figures 2-1 (the NCSS analysis) and 3-1 (the MVMA2D simulations). In each case, the casualty risk for the unrestrained RF passenger declined by a substantial amount from cars of the mid 1960's to the late 1960's, followed by a smaller reduction in the early 1970's and leveling out in the mid 1970's and early 1980's. The three results are based on

FIGURE 4-8: ADJUSTED FATALITY RISK INDEX FOR RF PASSENGERS, BY MODEL YEAR



independent data sources and measure different phenomena: Figure 2-1 measures the injury risk due to direct contact with the instrument panel. Figure 3-1 measures the effect of instrument panel changes not only on direct contact injuries but also on other injuries, as a result of modification of occupant trajectories. Figure 4-8 describes the effect not only of instrument panel changes but also the effects of any other changes in vehicle equipment and structures. Not only the timing but even the magnitude of the reductions are similar:

Overall Fatality Risk Index

Model Yrs.	Index
1964-66	135.7
1968-70	109.1
1973-84	99.7

IP Contact Injury Index (Section 2.3.3)

Model Yrs.	Index
1960-66	140
1968-70	107
1971-78	100

What inferences can be made from the consistency of the three analyses? The NCSS analyses (Chapter 2) show that instrument panel improvements reduced injuries due to instrument panel contact; they show when the reductions took place and how large they were. The NCSS analyses do not reveal if the panel improvements led to modifications of occupant trajectories, affecting injuries due to contacts other than the instrument panel. The MVMA2D simulations (Chapter 3) confirm that panel improvements reduced direct contact injuries and furthermore reveal that the panel improvements ameliorated the trajectories of unrestrained RF passengers in frontal crashes, resulting in reductions of injuries other than those due to direct contact with the panel (e.g., the head injury reductions shown in Figure 3-6). These reductions had the same timing and statistical significance as the direct contact injury reductions - but the nonparametric approach of the MVMA2D analyses makes it impossible to gauge the exact magnitude of the reductions. Now, the FARS analysis shows an overall reduction of fatality risk whose timing coincides with the other two analyses and whose magnitude coincides with the direct contact injury reductions in NCSS. The most reasonable inference - since there have been no other known frontal crashworthiness improvements with comparable overall benefits at the RF seating position - is that the overall fatality reductions shown in Figure 4-8 are mostly due to improved instrument panels and that the effect of the panel improvements on overall casualty risk of unrestrained RF passengers in frontal crashes is about the same as their effect on direct contact injuries: close to a 20 percent reduction in the mid to late 1960's, followed by nearly 10 percent additional reduction in the early 1970's, leveling off after that.

4.4 Combined index for drivers and right front passengers

An assessment of the overall crashworthiness of cars for unrestrained front seat occupants in frontal crashes can be obtained by taking the weighted average of the driver and RF passenger adjusted fatality indices. The appropriate weighting is 3 to 1, since driver fatalities outnumber RF passengers killed by that margin [21], p. VI-4. The combined risk indices, by model year, are:

1964	117	1971	106	1978	104
1965	120	1972	107	1979	106
1966	129	1973	98	1980	96
1967	121	1974	97	1981	94
1968	105	1975	95	1982	105
1969	104	1976	103	1983	103
1970	105	1977	102	1984	97

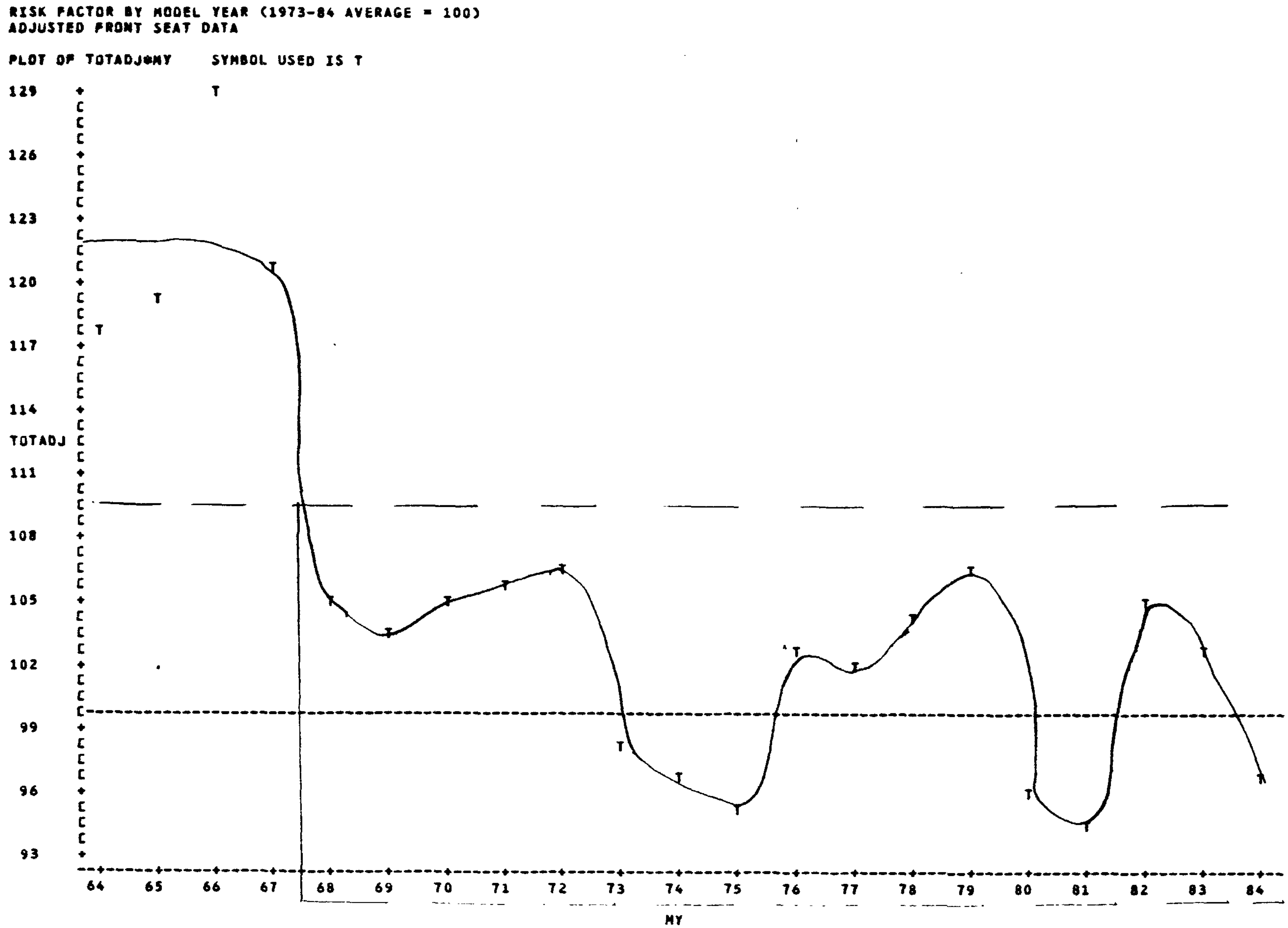
These risk indices have already been adjusted for vehicle weight and other factors; they compare the relative safety of two cars of different model years but having the same weight, age of occupants, etc.

Figure 4-9 is a graph of the combined risk index by model year. It looks a lot like the driver's risk index (Figure 4-2), which is not surprising since the combined index is 3 parts driver and 1 part passenger. Averaging in the RF passenger index does seem to have made the curve in Figure 4-9 smoother than the one in Figure 4-2, though. The 95 percent noise bands are shown by the two dotted lines at index values 110 and 91 (almost the same as for the driver model). Overall fatality risk of unrestrained front seat occupants in frontal crashes dropped by 14 percent between model years 1964-66 (average index 121.9) and 1968-70 (average index 104.6). Every index value before 1968 is above the noise bands. After model year 1968, there is little net change in fatality risk. The 1973-84 average of 100 is 4 percent below the 1968-70 average of 104.6, although that difference could easily be in the "noise" range. Every index value from 1968 onwards is within the noise band; the oscillations of the index within the noise band does not appear to have any obvious pattern.

4.5 Lives saved by frontal crashworthiness improvements

The safety indices for the driver (Section 4.2.3 and Figure 4-2) and the right front passenger (Section 4.3.4 and Figure 4-8) can be used to obtain estimates of the number of lives saved per year, in frontal crashes, as a result of all vehicle modifications <u>other than belts</u> during

FIGURE 4-9: COMBINED ADJUSTED FATALITY RISK INDEX FOR DRIVERS AND RF PASSENGERS, BY MODEL YEAR



the 1964-84 period.

During the mid 1980's, there have been about 20,000 driver and right front passenger fatalities per year in cars: 15,000 drivers and 5,000 right front passengers [21], p. VI-4, [14], p. 7-2. Half of the fatalities have been in frontal crashes (principal impact point 11, 12 or 1:00 in FARS): 7,500 drivers and 2,500 RF passengers [14], p. 6-12. The automobile mix that was on the road during the mid 1980's consists largely of 1973-84 cars, which have a fatality index of 100 for drivers and 99.7 for RF passengers. If these had been replaced by older type cars of the same weights (and the same levels of belt usage), the fatality index would have been higher than 100 and the number of fatalities would have increased proportionately.

The estimated numbers of <u>driver</u> fatalities that would have occurred in the mid 1980's with older type cars are:

Type of Cars	Safety Index	Estimated Driver Fatalities	Lives Saved
1973-84	100	7500 (actual)	
1968-70	103	7725	225
1964-66	117.3	8800	1075
			1300

The safety indices suggest that a total of 1300 drivers per year are being saved in frontal crashes as a result of vehicle modifications (other than belts and crash avoidance measures) implemented during 1964-84. About 1075 were saved by improvements during the late 1960's and 225 by all subsequent modifications.

This aggregate measure of safety benefits corresponds well with NHTSA's estimate of lives saved by a single safety device, the energy absorbing steering assembly, which benefits unrestrained drivers in frontal crashes. NHTSA's evaluation estimated that energy absorbing steering assemblies, which were implemented in 1967-68 and subsequently were improved or refined slightly, save 1347 lives per year [32], p. xix. That estimate, however, used 1978 aggregate fatalities as the "baseline" and would be reduced to 1125 if it were calculated by the same technique today, since the baseline number of potentially fatal crashes has dropped by 17 percent since 1978 (due to factors unrelated to vehicle crashworthiness, viz., fewer young drivers, shift from cars to light trucks, etc.). The estimate of 1125 lives saved by energy absorbing steering assemblies alone is almost identical to the 1075 lives saved in the late 1960's and accounts for just about all of the 1300 fatality reduction in the full 1964-84 period. The other NHTSA evaluations do not claim that any other specific safety devices saved unrestrained drivers in frontal crashes. The fatality index corroborates this assessment.

The estimated numbers of <u>right front passenger</u> fatalities that would have occurred in the mid 1980's with older type cars are:

Type of Cars	Safety Index	Estimated RF Passgr. Fatalities	Lives Saved
1973-84	99.7	2500 (actual)	
			235
1968-70	109.1	2735	
			665
1964-66	135.7	3400	
			900

The safety indices suggest that a total of 900 RF passengers per year are being saved in frontal crashes as a result of vehicle modifications (other than belts and crash avoidance measures) implemented during 1964-84. About 665 were saved by improvements during the late 1960's and 235 by all subsequent modifications.

Many if not most of these 900 lives saved can be attributed to instrument panel improvements. Earlier NHTSA evaluations claim about 112 lives saved per year by adhesive bonding of the windshield [36], p. xxx; a large part of that saving would accrue to RF passengers in frontal crashes. The windshield evaluation also suggests that a few RF passengers may be saved by the High Penetration Resistant windshield - by avoiding laceration of major vessels or ejection through the windshield - but the number is in all likelihood below 100 per year. That leaves 700 of the 900 lifesavings unaccounted for. It is unlikely that vehicle structural modifications or vehicle design changes not specifically recognized as safety related had any major effect on the RF passenger, since no such effect was seen for drivers. That leaves the instrument panel.

Section 2.4 presented a conservative estimate that instrument panel improvements have saved 176 lives per year - based only on their reduction of injuries directly involving panel contact and taking into account that only about 30 percent of frontal RF passenger fatalities (see Table 1-1) involve panel contact and no other source and that 50 percent of frontal fatal crashes involved collapse of the passenger compartment or Delta V above 35 mph. But the MVMA2D simulations of Chapter 3 clearly demonstrated that the panel improvements of the late 1960's and early

1970's ameliorated occupant trajectories in frontal crashes and reduced the risk of many types of injury to the same extent as those directly involving panel contact. That would allow for an estimate of lives saved which is 2 to 3 times higher than the one in Section 2.4. Finally, as described in Section 4.3.4, the reductions in the RF passenger fatality index coincide with the instrument panel improvements described in the literature and the injury reductions seen in NCSS and the MVMA2D simulations.

The most reasonable estimate for lives saved per year in passenger cars by instrument panel improvements would be in the 400 to 700 range - most if not all the reduction in the fatality index that is not accounted for by previously evaluated safety devices.

A total of 2200 drivers and right front passengers of passenger cars are saved per year in frontal crashes as a result of vehicle modifications which affect crashworthiness, other than belts, and which have been implemented during 1964-84.

CHAPTER 5

ANALYSES OF LIGHT TRUCKS

NHTSA's crash data files on light trucks and vans are considerably smaller than those on passenger cars, making it difficult to analyze the trend in injury risk over the years. The National Accident Sampling System (NASS) for 1982-85 contains a relatively large sample of truck accidents. The injury rate (at AIS 2 or greater) of unrestrained right front passengers of light trucks in frontal crashes does not show a clear trend from model year 1966 through model year 1985. Likewise, the National Crash Severity Study (NCSS) injury rates do not change significantly between model years 1960 and 1978.

In frontal impacts of light trucks on the Fatal Accident Reporting System (FARS), the fatality risk of right front passengers, <u>relative</u> to drivers, has remained almost constant through model years 1964-84. There are some preliminary indications that the <u>absolute</u> fatality risk for drivers and passengers in head on crashes decreased substantially in trucks of the mid 1970's and perhaps also in the late 1960's, after controlling for the weight of the truck. The findings must be considered tentative, though, until more accurate data on the weights of the trucks become available.

5.1 <u>Analyses of NASS data</u>

NASS is a probability sample of motor vehicle accidents in the United States [46]. NASS began to operate in 1979. During 1982-85, 50

NASS teams were collecting data on a consistent set of accident, vehicle and occupant variables - the NASS data sets for 1982-85 are combined and analyzed as a homogeneous file. In this report, NASS is used to study the <u>overall</u> nonminor injury risk (AIS 2 [1] or greater) of unrestrained right front passengers of light trucks, vans and multipurpose passenger vehicles (MPV). The analysis is not limited, as in Chapter 2, to injuries due to instrument panel contact - partly because the sample size of light truck occupants would be far to small for such an analysis and partly because it was shown in Chapters 3 and 4 that panel improvements can significantly reduce many types of injuries in frontal crashes - not just those due to direct contact with the panel. Another advantage of using the overall injury rate is that there is no worry about the team to team differences in missing data on contact points - a major cause of bias in Chapter 2. Such bias would be unacceptable here, because the samples are not large enough to permit the bias control techniques used in Chapter 2.

In light trucks, just as in passenger cars, there is no single "transition" model year where all instrument panel modifications were made. The analysis for light trucks, like the one for passenger cars (Chapter 2), is not a simple "before - after" comparison but rather tracks the injury rate over a series of model year groups: 1966-70, 1971-74, 1975-78, 1979-81 and 1982-85. The year 1966 is chosen to start the series because all light trucks have High Penetration Resistant windshields from then on; thus, the overall injury rates are not affected by glazing modifications [36]. The last model year group starts with 1982 because that is the model year in which Standard 201 was extended to light trucks (see Section 1.2).

NASS is not a simple random sample, but a stratified cluster sample with numerous strata and a variety of unequal sampling proportions. The most appropriate weights for NASS data in effectiveness analyses (as opposed to using them for national estimates) are the "Ockham weights" developed by Partyka [48]. They give the same weight to all the cases in a given stratum and time period; the cases in the stratum containing most of the fatalities are given a weight of 1; the other strata are given weights equal to the ratio of the sampling interval for that stratum to the interval for the first stratum. The 1983 Ockham weights listed in [48] are appropriate for NASS up to mid 1984; yet another set of weight was needed for the later 1984 and the 1985 files. Use of the Ockham weights and limitation of the data to towaway crashes make the various years of NASS quite similar to NCSS.

The injury rate used with NASS is the (weighted) number of right front passengers in frontal towaway crashes with AIS 2 or greater injuries per 100 (weighted) RF passengers in frontal towaway crashes. Table 5-1 shows that the injury rate had no consistent trend among the various model year groups. In trucks of model years 1966-70, there were 18.239 (weighted) injured passengers among a total of 141.637 passengers: an injury rate of 12.9 percent. The injury rate dropped to 7.4 percent in the 1971-74 trucks, returned to 9.1 percent in the 1975-78 trucks and 12.3 percent in the 1979-81 trucks, and leveled off at 10.9 percent in the 1982-85 trucks. The lower part of Table 5-1 shows the actual, unweighted number of cases on which the injury rates are based. There are only about one fifth as many injury cases as were available for the passenger car

TABLE 5-1

NONMINOR (AIS 2 OR GREATER) INJURY RATE, BY MODEL YEAR
UNRESTRAINED RIGHT FRONT PASSENGERS OF LIGHT TRUCKS,
VANS AND MPV'S, IN FRONTAL TOWAWAY CRASHES, NASS 1982-85

Model Years	n of Casualties	N of Passengers	AIS 2+ Casualty Rate (%)
	OCKHAM WEIGHTED DATA		
1966-70	18.239	141.637	12.9
1971-74	26.143	354.396	7.4
1975-78	51.924	569.416	9.1
1979-81	45.686	372.914	12.3
1982-85	48.353	444.011	10.9
	UNWEIGHTED DATA		
1966-70	11	58	19.0
1971-74	19	124	15.3
1975-78	26	184	14.1
1979-81	20	135	14.8
1982-85	23	113	20.4

analyses of Chapter 2 (compare the lower part of Table 5-1 with Table 2-1). With only 11, 19, 26, 20 and 23 actual injury cases in the five model year groups, the fluctuations of the injury rates in Table 5-1 could easily be due to sampling error alone. Unless the true reduction of injury risk in light trucks has been dramatic, it would have been unreasonable to expect these data to reveal a significant trend.

For comparison purposes, Table 5-2 shows the injury rates of drivers of light trucks in frontal crashes, by model year group. Since drivers outnumber RF passengers by 3 to 1, the sample sizes are 3 times as large. Yet Table 5-2 does not show any clear trend for the drivers' injury rates: they varied from 9.7 percent in the 1966-70 trucks to 7.5 percent in the 1971-74 trucks, then back up to 8.2 percent in model years 1975-78, 10.7 percent in 1979-81 and 12.3 percent in 1982-85. It is not clear whether this U shaped pattern of the injury rates is purely coincidental, reflects a real reduction of injury rates subsequently masked by a bias in NASS data against the newer trucks (such as the shift in the light truck market toward smaller vehicles and the inreasing recreational use of light trucks), or (least likely) indicates a real improvement followed by a real worsening of injury risk.

5.2 Analyses of NCSS data

The NCSS sample, operational during 1977-79 for passenger cars (see Section 2.1), was extended part of the time to include light trucks. For model years up to 1978, it provides a sample not quite as large as NASS. The most statistically meaningful injury rate for use with NCSS

TABLE 5-2

NONMINOR (AIS 2 OR GREATER) INJURY RATE, BY MODEL YEAR
UNRESTRAINED DRIVERS OF LIGHT TRUCKS, VANS AND MPV'S,
IN FRONTAL TOWAWAY CRASHES, NASS 1982-85

Model Years	n of Casualties	N of Drivers	AIS 2+ Casualty Rate (%)
	OCKHAM WEIGHTED DATA		
1966-70	50.961	526.492	9.7
1971-74	90.198	1200.857	7.5
1975-78	146.950	1789.512	8.2
1979-81	146.855	1367.648	10.7
1982-85	169.531	1373.766	12.3
	UNWEIGHTED DATA		
1966-70	32	174	18.4
1971-74	45	342	13.2
1975-78	84	547	15.3
1979-81	74	436	17.0
1982-85	87	369	23.6

data is the proportion of right front passengers who were killed or hospitalized - since all fatalities and hospitalizations are in the 100 percent sampling stratum of NCSS, but not all AIS 2 injuries.

Table 5-3 shows that the NCSS injury rate had no consistent trend among the various model year groups. In trucks of model years 1961-70, the injury rate was 11.4 percent. The rate dropped to 7.6 percent in the 1971-74 trucks, but returned to 14.1 percent in the 1975-78 trucks. The average for 1971-78, 10.6 percent, is almost the same as the average for 1961-70. Of course, the sample sizes, as shown in the lower part of Table 5-3 are small and only drastic real trends are likely to have been revealed by the data.

For comparison purposes, Table 5-4 shows the NCSS injury rates of drivers. It is a surprisingly low 6.0 percent for model years 1961-70 and rises to 10.8 percent in 1971-74 and 10.1 percent in 1975-78. The trend is at variance to what happened to right front passengers in NCSS and drivers in NASS (Table 5-2), reflecting the small sample sizes which make all injury rates subject to a lot of sampling error.

The NASS and NCSS data, in combination, suggest that no overwhelming changes (e.g., 40 percent or more) have occurred in the <u>nonfatal</u> injury risk of right front passengers of light trucks in frontal crashes during model years 1966-85. The samples were inadequate for the detection of smaller changes on the order of 10 or 20 percent, especially if they took place gradually during that period.

TABLE 5-3

NONMINOR (HOSPITALIZATION OR FATALITY) INJURY RATE, BY MODEL YEAR, UNRESTRAINED RIGHT FRONT PASSENGERS OF LIGHT TRUCKS, VANS AND MPV'S, IN FRONTAL CRASHES, NCSS

Model Years	n of Hospitalized Passengers	N of Passengers	Casualty Rate (%)
	WEIGHTED DATA		
1961-70	14	123	11.4
1971-74	15	197	7.6
1975-78	24	170	14.1
	UNWEIGHTED DATA		
1961-70	14	37	37.8
1971-74	15	56	26.8
1975-78	24	74	32.4

TABLE 5-4

NONMINOR (HOSPITALIZATION OR FATALITY) INJURY RATE, BY MODEL YEAR, UNRESTRAINED DRIVERS OF LIGHT TRUCKS, VANS AND MPV'S, IN FRONTAL CRASHES, NCSS

Model Years	n of Hospitalized Drivers	N of Drivers	Casualty Rate (%)
	WEIGHTED DATA		
1961-70	26	431	6.0
1971-74	69	636	10.8
1975-78	76	750	10.1
	UNWEIGHTED DATA		
1961-70	26	101	25.7
1971-74	69	169	40.8
1975-78	76	229	33.2

5.3 Analyses of fatality trends in FARS data

Chapter 4 presented a two part strategy for estimating the fatality risk index by model year of drivers and right front passengers of passenger cars in frontal crashes: in head on crashes of cars of two different model years, analyze which driver is more likely to be killed, controlling for differences in the weights, etc., of the two cars (Section 4.2); in frontal impacts where there is a driver and a right front passenger, analyze which of the two is more likely to be killed, as a function of the car's model year (Section 4.3). The second part of the strategy can be carried out as easily for light trucks as for cars. The head on collision model, though, requires exact data on the weights of the vehicles. Such data on light trucks were not available at the time of this study. A preliminary head on collision model for light trucks, using average truck weights by model year derived from NASS and NCSS data, is presented in Section 5.3.3.

5.3.1 Fatality ratio of right front passengers to drivers

Although the estimation of the fatality ratio was the second part of the modeling process in Chapter 4, it is discussed first here because it does not rely on vehicle weight data and the results can be accepted with confidence. The 1975-86 FARS files contain records of nearly 10,000 frontal impacts of light trucks, vans or MPV's in which there were a driver and a right front passenger and at least one of them died. Light trucks, vans and MPV's included FARS BODY_TYP codes 39-41, 43-44 or 50-52 until 1981 and 40-69 during 1982-86. (Short utility vehicles - code 12 - could also have been included in the analysis but weren't.) All other definitions and procedures are the same as in Sections 4.3.

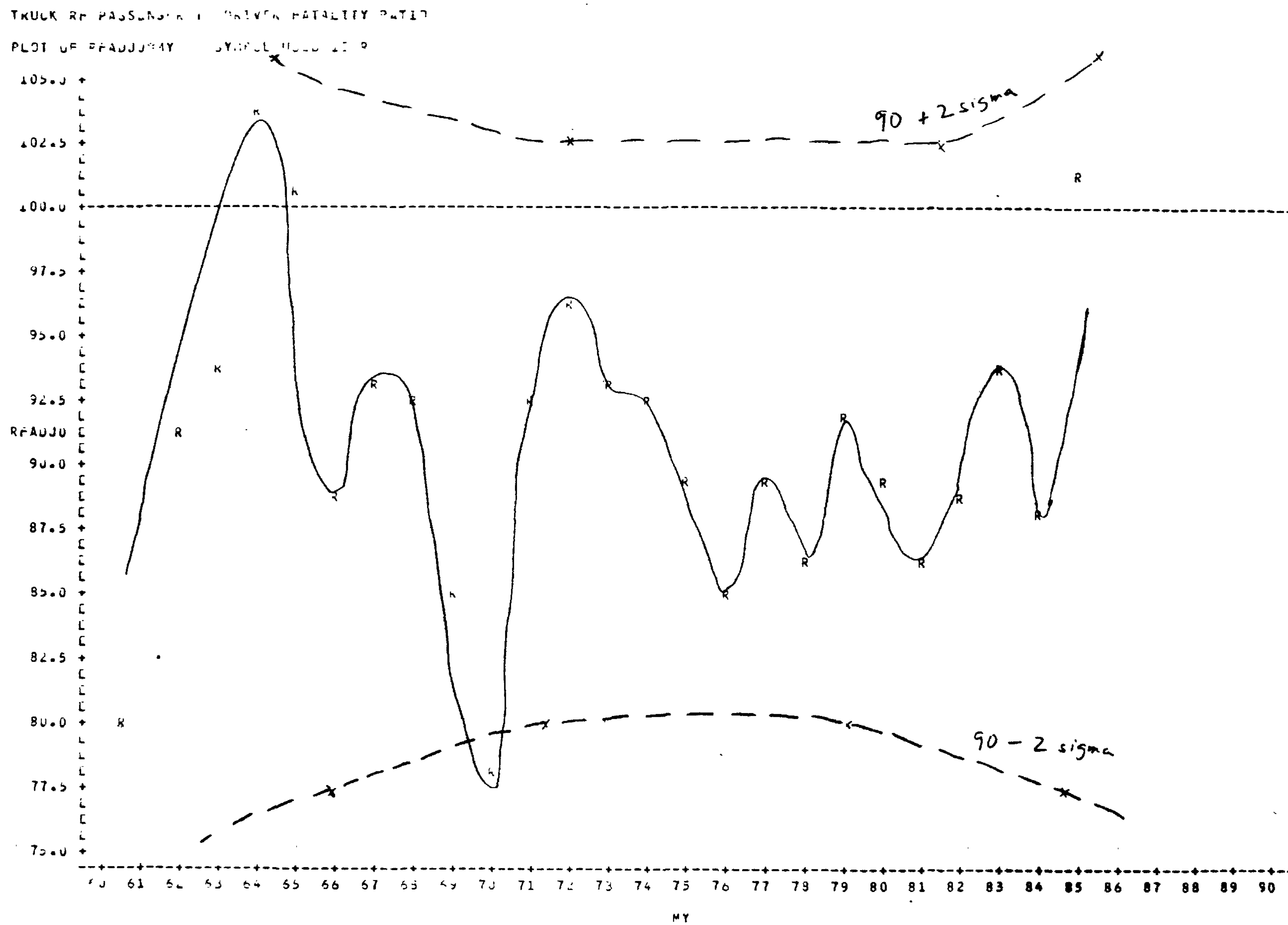
A simple model is built, presenting the ratio of RF passenger to driver fatalities as a function of model year, without control for other factors, based directly of tabulation of the cases by model year and fatality status of the driver and the RF passenger. The ratios of RF passenger fatalities per 100 drivers killed, by model year, are:

1960	105	1969	85	1978	86
1961	68	1970	78	1979	92
1962	91	1971	93	1980	89
1963	94	1972	96	1981	86
1964	104	1973	93	1982	89
1965	101	1974	92	1983	94
1966	89	1975	90	1984	88
1967	93	1976	85	1985	100
1968	92	1977	89		

Figure 5-1 is a graph of the unadjusted fatality ratios by model year. Unlike the situation for passenger cars, the fatality risk of RF passengers of light trucks has been consistently about 90 percent as high as for drivers throughout the 1960-85 model year range. The 95 percent noise bands on either side of the hypothesis that RF passenger fatality risk is 90 percent as high as drivers' are represented by the dotted, approximately parabolic curves on Figure 5-1. All of the observed fatality ratios during the 1964-84 period are within the noise bands and most of the fluctuations are small compared to the width of the bands.

In Section 4.3.3, the simple fatality ratios for passenger cars were adjusted for differences in the age and sex of the drivers and

FIGURE 5-1: UNADJUSTED RATIO OF RF PASSENGER TO DRIVER FATALITIES, LIGHT TRUCKS, BY MODEL YEAR



passengers, etc. All of the adjustments made little or no difference, as shown in Figure 4-7. A similar regression analysis for light trucks also showed that the adjustment procedure would hardly change the results.

In summary, the fatality risk for RF passengers of light trucks has remained constant <u>relative</u> to drivers' fatality risk. If drivers' fatality risk was reduced between 1964 and 1984, the passengers' risk would have been reduced by about the same amount.

5.3.2 <u>A simple model for driver risk: no control for vehicle weight</u>

The 1975-86 FARS files contain over 30,000 head on collisions fatal to at least one of the drivers and involving two passenger cars <u>or</u> a passenger car and a light truck <u>or</u> two light trucks; while 16,000 of these collisions involved only passenger cars, 14,000 involved at least one light truck. The accident records were collected in a file, using the procedures of Section 4.2.1.

The starting point for the simple model is a tabulation of the head on crashes by model year <u>and</u> body style (i.e., car or light truck) of the case vehicle, model year and body style of the "other" vehicle, and where the fatalities occurred. For example, suppose there were N = 100 head on collisions between 1975 trucks and 1979 cars that killed at least one of the drivers. Suppose that

In 10 collisions, the 75 truck driver died, the 79 car driver survived
In 80 collisions, the 79 car driver died, the 75 truck driver survived
In 10 collisions, both drivers died

(This was not an actual data point but just an example. Of course, the large disparity in the fatalities would primarily be due to the greater mass of the 1975 trucks.) The above statistics supply two data points for the logistic regression. First, considering 1975 truck as the "case" vehicle model year and 1979 car as the "other" vehicle: a case vehicle driver died in 20 of the 100 collisions. The ratio of collisions with a case vehicle fatality to total collisions is R = 20/100 = .2. Second, with the 1979 car as the "case" vehicle and the 1975 truck as the "other," R = 90/100 = .9. Each combination of case vehicle model year and body style and other vehicle model year and body style (with model year ranging from 64 to 84) furnishes one data point for the regression. The dependent variable in the regression is

$$\text{LOGODDS} = \log[R/(1-R)]$$

(where R is set to .01 if it is zero and .99 if it is one, so as to avoid infinite values for LOGODDS). The independent variables are M64, ..., M83 and T64, ..., T84, where Mi = 1 if the case vehicle is a car and its model year is i, Mi = -1 if the other vehicle is a car and its model year is i and Mi = 0, otherwise. Ti = 1 if the case vehicle is a truck and its model year is i, Ti = -1 if the other vehicle is a truck and its model year is i and Ti = 0, otherwise. A weighted logistic regression on aggregate data is performed, the weight factor being N.

The regression coefficients are

INTERCEPT	.32	M71	- .83	M78	- .61
M64	- .66	M72	- .97	M79	- .42
M65	- .71	M73	-1.19	M80	- .02
M66	- .59	M74	-1.13	M81	- .05
M67	- .74	M75	-1.28	M82	.09
M68	-1.02	M76	-1.05	M83	.06
M69	-1.13	M77	-1.00	"M84"	.00
M70	-1.01				

T64	-1.33	T71	-1.96	T78	-2.27
T65	-1.40	T72	-1.85	T79	-2.34
T66	-1.42	T73	-2.09	T80	-1.97
T67	-1.66	T74	-2.06	T81	-1.86
T68	-1.73	T75	-2.16	T82	-1.78
T69	-1.92	T76	-2.23	T83	-1.92
T70	-1.77	T77	-2.28	T84	-1.72

R^2 is .73. There is no actual M84 variable, but all the other model year coefficients are measured relative to the risk for 1984 cars. The more negative the coefficient, the lower the fatality risk. The regression coefficients for the trucks are always lower than those for cars, reflecting, among other things, the greater weight of the trucks and the tendency for their drivers to be younger and male. The regression coefficients for the passenger cars differ only trivially from those obtained in the simple model for car to car collisions only (Section 4.2.2) This is reassuring evidence that the models developed in Chapter 4, which were based on car to car collisions only, are also valid, as a minimum, for car to truck collisions.

The regression results are used to generate fatality risk indices by an abstract form of double pair comparison analysis [12], as in Section 4.2.2. Construct a file of all head on collisions involving cars or light trucks which were fatal to at least one driver (actually this file has each collision twice: once with vehicle no. 1 as the case vehicle and once with vehicle no. 2 as the case vehicle; it has over 60,000 crash situations). Consider the hypothetical situation where each case vehicle is replaced by a 1975 truck, while the other vehicle stays what it actually is. Use the regression coefficients to estimate TP75, the proportion of the 60,000 case vehicle drivers who are killed and TC75, the proportion of the 60,000 control group (other vehicle) drivers who are killed. Now consider another hypothetical situation where each case vehicle is replaced by a 1979 truck, while the other vehicle stays what it actually is. Use the regression coefficients to estimate TP79, the proportion of the 60,000 case vehicle drivers who are killed and TC79, the proportion of the 60,000 control group (other vehicle) drivers who are killed. Then

$$(TP75/TC75) \ / \ (TP79/TC79)$$

estimates the fatality risk for drivers of model year 1975 trucks in head on collisions relative to the risk for drivers of model year 1979 trucks (since the drivers of the "other" vehicles act as a control group).

TP75 and TC75 are estimated as follows. Recall that .320 is the regression intercept; let Aik be the estimated regression coefficient for model year i and body type k (k=0 for cars and k=1 for trucks). Let N(i,k,j,m) be the actual number of head on crashes on FARS involving a vehicle of model year i and body type k and a vehicle of model year j and body type m. Let R(i,k,j,m) be the regression's <u>estimate</u> of the ratio of driver fatalities in the vehicles of model year i and body type k to N(i,k,j,m). In other words

$$R(i,k,j,m) = 1/[1+\exp(Ajm-Aik-.320)]$$

whereas

$$R(j,m,i,k) = 1/[1+\exp(Aik-Ajm-.320)]$$

If the case vehicle is always replaced by a model year 1975 truck,

$$\begin{aligned} TP75 &= \sum N(i,k,j,m)R(75,1,j,m) \ / \sum N(i,k,j,m) \\ &= \sum N(i,k,j,m)/[1+\exp(Aj-A_{75,1}-.320)] \ / \sum N(i,k,j,m) \end{aligned}$$

whereas

$$TC75 = \sum N(j,m,i,k)R(j,m,75,1) \;/\; \sum N(j,m,i,k)$$
$$= \sum N(j,m,i,k)/[1+\exp(A_{75,1}-Aj-.320)] \;/\; \sum N(j,m,i,k)$$

The quantities TPi/TCi for the various model years become more tangible through indexing. The <u>unadjusted frontal fatality risk index for drivers of light trucks</u> shall be set to 100 for the average of model years 1973 through 1984 - i.e., let

$$U = 100 \;/\; (TP73/TC73+\ldots+TP84/TC84)$$

and define

$$Ui = U(TPi/TCi)$$

to be the risk index for light trucks of model year i. The unadjusted risk indices, by model year, are:

1964	176	1971	107	1978	83
1965	167	1972	117	1979	79
1966	165	1973	96	1980	106
1967	136	1974	99	1981	116
1968	129	1975	91	1982	124
1969	111	1976	86	1983	110
1970	125	1977	83	1984	129

The appropriate interpretation of the risk index is that, in head on collisions between trucks of model year 1970 and 1979, there would typically be 125 fatalities in the MY 75 trucks for every 79 fatalities in the MY 1979 trucks. The unadjusted risk index does not control for any differences in driver age, etc., that may have occurred in the actual FARS crashes. Since it does not control for vehicle weight, it is only appropriate for head on crashes, where the relative weights of the two vehicles is critically important. It would not apply at all to frontal single vehicle crashes, where the vehicle weight factor has a much smaller effect.

Figure 5-2 is a graph of the unadjusted risk index by model year. It shows even more clearly the trends that can be found in the above table. Unadjusted risk declined steadily from 1964 to 1979. In the first half of that period, trucks got bigger. During the second half, trucks did not grow much heavier, if at all, but there were some well known safety related improvements such as the installation of energy absorbing steering columns in pickup trucks [28] and the gradual elimination of forward control vehicles. The index rose steeply beginning in 1980; it was a period of downsizing and increasing market share for imported small trucks. Nevertheless, the unadjusted risk index is not nearly as high in trucks of the mid 1980's (110-130) as it was in trucks of the mid 1960's (135-175) <u>despite</u> the fact that trucks of the mid 1980's may be as light as trucks of the mid 1960's. This is already evidence that the intrinsic fatality risk for drivers of light trucks has been reduced during the past 25 years.

An unadjusted fatality index for RF passengers of light trucks in frontal crashes is obtained by multiplying each model year's driver index by the ratio of RF passenger to driver fatality risk and then multiplying by a constant (close to 1.1) so that the average of the 1973-84 indices is 100. The RF passenger indices, by model year, are:

1964	203	1971	111	1978	80
1965	189	1972	126	1979	81
1966	163	1973	100	1980	105
1967	141	1974	102	1981	112
1968	133	1975	91	1982	123
1969	105	1976	81	1983	116
1970	109	1977	82	1984	127

Figure 5-3 graphs the RF passenger fatality index. It shows the same

FIGURE 5-2: UNADJUSTED FATALITY RISK INDEX FOR DRIVERS OF LIGHT TRUCKS, BY MODEL YEAR

UNADJUSTED RISK FACTOR BY MODEL YEAR (1973-84 AVERAGE = 100)
TRUCK DRIVER RISK INDEX

PLOT OF ADJ*MY   SYMBOL USED IS A

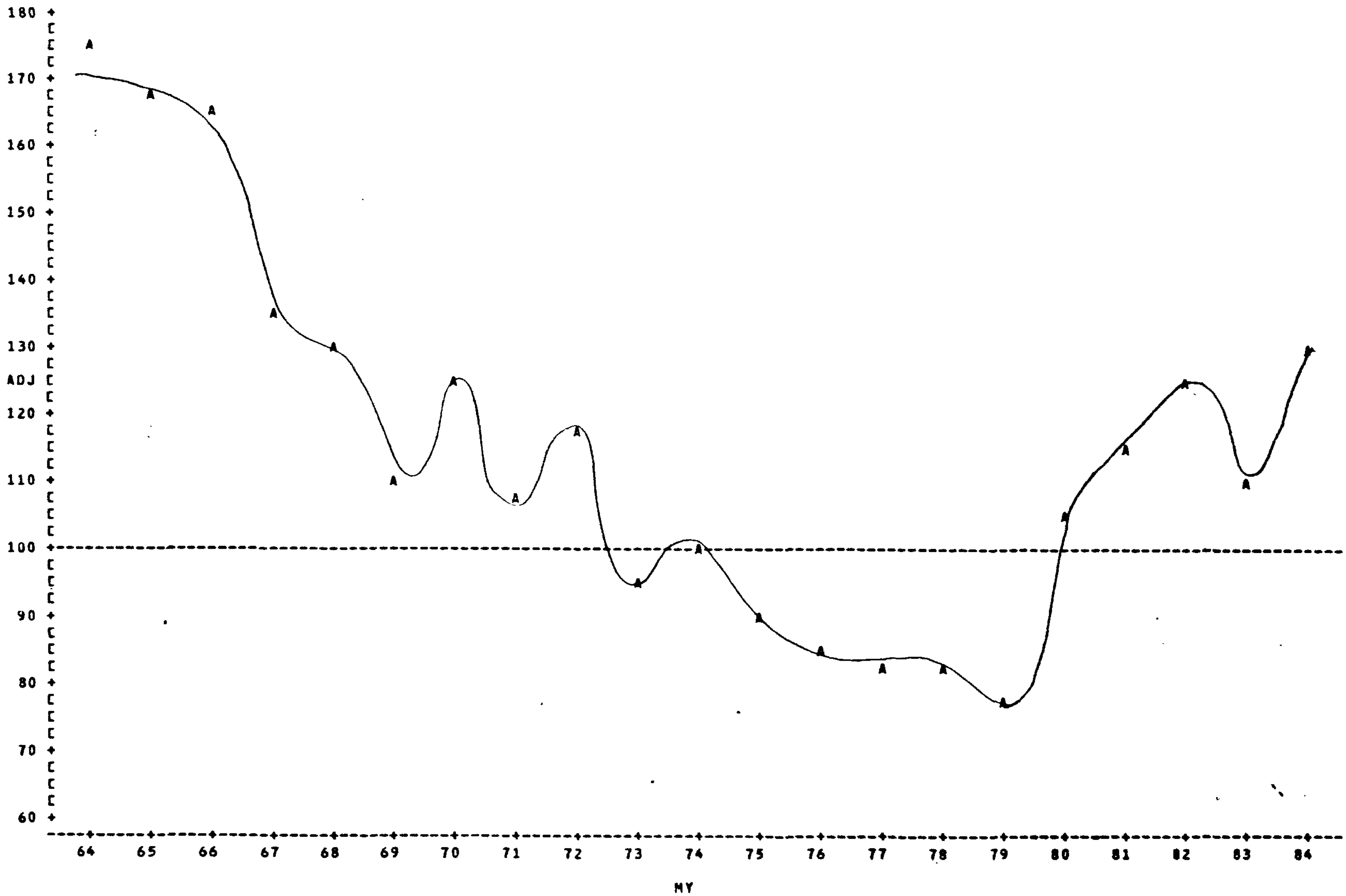
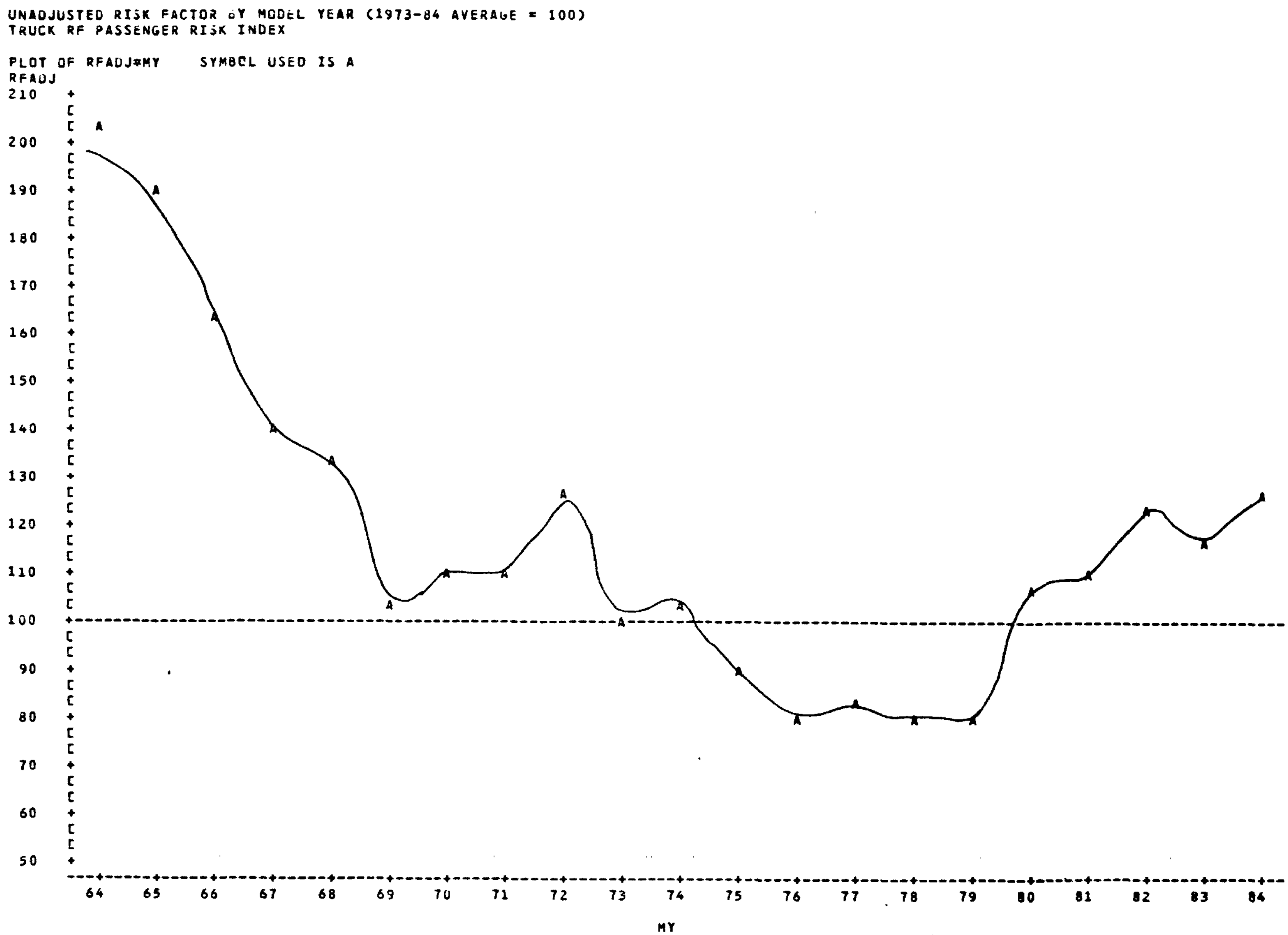


FIGURE 5-3: UNADJUSTED FATALITY RISK INDEX FOR RF PASSENGERS OF LIGHT TRUCKS, BY MODEL YEAR



trends as the driver index, since the ratio of RF passenger to driver fatalities was close to .9 throughout 1964-84.

5.3.3 A preliminary model controlling for vehicle weight

In the model for head on collisions of passenger cars (Section 4.2.3), it was possible to obtain a good estimate of the weight of each car from Automotive News Almanac listings of weights by make, model and model year [2] and merge this information with the FARS make/model codes. The same cannot be done for light trucks because each "model" of truck, as defined on FARS (e.g., 1969 Ford Van) may comprise trucks of many different series and greatly different weights. Publications such as the annual Truck Index [53] provide weights for each series of trucks, but a complex decoding of VINs would be needed to merge the data with FARS. That effort was beyond the scope of this study.

Instead, the weight data in the Truck Index are used indirectly and on an aggregate basis. The NCSS and NASS files list the curb weight of each light truck, based on decoding of the VIN and looking it up in the Truck Index tables. These data are used to estimate the average curb weight of all the light trucks of a specific model year on FARS. These weights do not include any cargo weights, nor do they take into account how much of the cargo weight, if any, should be added to the effective mass of a truck. Similarly, the Automotive News car weights are used to find the average weight of all the cars of a specific model year on FARS. The adjusted model uses the same logistic regression on aggregate data as the simple model of the preceding section, except that information is added to indicate the average weight of the case vehicles of a given model year and body type - and likewise for the other vehicle in the collision.

Specifically, the light trucks in 1982-85 NASS data are tabulated by model year (1964-84) and type of light truck (BODYTYPE codes 40-49 are vans, 50-54 are pickups and 55-59 are defined to be MPV's in this analysis). In each cell, note the actual unweighted number of NASS cases and the average curb weight of the trucks. The same is done with the NCSS (here VBDYSTY codes 5-6 are vans, 7 is MPV and 8 is pickup), which continues as far as model year 1978. All the light trucks on the FARS file of head on collisions (see Section 5.3.2) are tabulated by model year and type of truck (up to calendar year 1981, BODY_TYP codes 39-44 and 52 are MPV's, 50 is pickup and 51 is van; starting in calendar year 1982, BODY_TYP codes 40-49 are vans, 50-54 are pickups and 55-59 are MPV's, as in NASS). Consider, for example, the data for model year 1977:

	Pickups		Vans		MPV's	
	N	Avg. Weight	N	Avg. Weight	N	Avg. Weight
NASS	133	3690	47	3936	25	4188
NCSS	137	3803	49	3945	31	3952
NASS + NCSS	270	3747	96	3941	56	4057
FARS	882		239		112	

Since there are 133 MY 77 pickups in NASS, weighing an average of 3690 pounds and 137 pickups in NCSS weighing an average of 3803 pounds, the overall average for the 270 pickups in NASS plus NCSS is 3747 pounds. Similarly, the overall average for vans is 3941 pounds and for MPV's, 4057 pounds. Since there are 882 pickups, 239 vans and 112 MPV's on FARS, the average weight of model year 1977 trucks on FARS, based on NASS and NCSS data is

$$(3747 \times 882 + 3941 \times 239 + 4057 \times 112) / (882 + 239 + 112) = 3813 \text{ pounds}$$

The average weight of model year 1977 trucks on FARS, based only on NASS data is

$$(3690 \times 882 + 3936 \times 239 + 4188 \times 112) / (882 + 239 + 112) = 3783 \text{ pounds}$$

In model year 1977, the weight based on NASS and NCSS data is 30 pounds higher than the one based on NASS alone, presumably reflecting a slightly heavier mix of trucks at the NCSS sites than at the NASS locations. In fact, during the 1964-78 model years where both NASS and NCSS data are available, the NASS + NCSS estimate averages 35 pounds higher per model year than the NASS estimate. Thus, the NASS + NCSS estimate is used for model years 1964-78 and the NASS estimate + 35 pounds is used for model years 1979-84. Finally, even by this procedure, the extimates for 1964 and 1972 were unreasonably high. The 1964 estimate was lowered to 3400 pounds, for consistency with the next two years. The 1972 estimate was high because the 1972 pickups on NASS were inexplicably several hundred pounds heavier than pickups of neighboring model years. Therefore the 1972 average was estimated again, using only the NCSS pickups. By this procedure, the average weights of light trucks, by model year, are:

1964	3400	1971	3683	1978	3874
1965	3406	1972	3788	1979	3875
1966	3439	1973	3826	1980	3684
1967	3599	1974	3824	1981	3509
1968	3630	1975	3808	1982	3436
1969	3665	1976	3858	1983	3554
1970	3677	1977	3813	1984	3378

The average weights of the passenger cars on FARS by model year, based on the weights of individual makes and models as listed in Automotive News Almanacs (see Section 4.2.1), are:

1964	3165	1971	3352	1978	3219
1965	3203	1972	3486	1979	3050
1966	3393	1973	3601	1980	2757
1967	3351	1974	3541	1981	2727
1968	3449	1975	3709	1982	2680
1969	3529	1976	3602	1983	2784
1970	3453	1977	3536	1984	2743

Figure 5-4 graphs the average weight of passenger cars and light trucks by model year. Both types of vehicles gained about 500 pounds during the 1960's and early 1970's and lost it later on. But there are two major differences between cars and trucks. The average weight of cars began to decline in 1976 and the weight reduction was essentially completed by 1980; during that period, cars became 1000 pounds lighter due to downsizing and replacement of large cars by imports and subcompacts. Light trucks, on the other hand, had relatively constant weight throughout 1973-79 and only began downsizing in 1980; by 1984 they had shed about 500 pounds - only half as much as cars. Light trucks of the mid 1980's weighed about the same as those of the mid 1960's, while cars became a net 500 pounds lighter in the 20 year period.

At this point it becomes possible to rerun the logistic regression on aggregate data that was used in the simple model (Section 5.3.2), but with the added information on the average weight of cars or light trucks of a given model year. Initially, it was attempted to run exactly the same regression as in the simple model, but with the additional independent variable LWGT, which is the logarithm of the ratio of the

FIGURE 5-4: AVERAGE WEIGHT OF CARS AND LIGHT TRUCKS, BY MODEL YEAR

average weight of the case vehicles (of that body type and model year) to the other vehicles - e.g., if the case vehicles are 1975 trucks and the other vehicles are 1979 cars, LWGT = log(3808/3050). The regression was unsuccessful, assigning an unreasonably high coefficient of -8.30 to LWGT, because LWGT is confounded with the other independent variables and the regression cannot tell their effects apart. (Here, each model year and body type has exactly one weight - the average weight - whereas in the disaggregate logistic regression for passenger cars in Section 4.2.3 there was a great variety of individual car weights among the various cars of the same model year.)

A better approach is to run the regression in two steps. First, the dependent variable LOGODDS (same as in the simple model) is regressed against just two independent variables: LWGT and TRUCK (which is 1 if the case vehicle is a truck and the other vehicle a car, -1 if vice versa, and 0 if both are trucks or both are cars). With R squared of .72, the best fit is

$$\text{LOGODDS} = .320 - 4.298\ \text{LWGT} - .735\ \text{TRUCK}$$

That is a plausible coefficient for LWGT; since aggregate rather than disaggregate data are used, it is reasonable to expect a coefficient slightly lower than the 5.421 derived in the disaggregate regression for passenger cars in Section 4.2.3.

The second step is to transform the dependent variable LOGODDS into

$$\text{LOGODDS}' = \text{LOGODDS} + 4.298\ \text{LWGT}$$

which is, so to speak, the log of the fatality odds ratio that would have been observed if the case vehicles and the other vehicles had the same average weight. Next, a regression is performed with the same variables as in the simple model, but with LOGODDS' rather than LOGODDS as the dependent variable. The regression coefficients are

INTERCEPT	.32	M71	.03	M78	.08
M64	- .04	M72	.06	M79	.04
M65	- .05	M73	- .02	M80	.00
M66	.32	M74	- .03	M81	- .08
M67	.12	M75	.02	M82	- .01
M68	- .03	M76	.12	M83	.13
M69	- .05	M77	.09	"M84"	.00
M70	- .02				
T64	- .41	T71	- .70	T78	- .79
T65	- .47	T72	- .46	T79	- .85
T66	- .44	T73	- .66	T80	- .70
T67	- .49	T74	- .63	T81	- .80
T68	- .52	T75	- .75	T82	- .81
T69	- .67	T76	- .77	T83	- .81
T70	- .51	T77	- .86	T84	- .83

R^2 is .42, which is excellent considering that the vehicle weight effect has been eliminated from the regression by its incorporation in the dependent variable.

The regression coefficients are used to estimate risk factors such as TP75/TC75 <u>exactly</u> as in the unadjusted model of Section 5.3.2, except that the formulas

$$R(i,k,j,m) = 1/[1+\exp(Ajm-Aik-.320)]$$

and

$$R(j,m,i,k) = 1/[1+\exp(Aik-Ajm-.320)]$$

are replaced by

$$R(i,k,j,m) = 1/[1+\exp(Ajm-Aik-.320+4.298LWGT)]$$

and

$$R(j,m,i,k) = 1/[1+\exp(Aik-Ajm-.320-4.298LWGT)]$$

The <u>adjusted frontal fatality risk index for drivers of light trucks</u> shall be set to 100 for the average of model years 1973 through 1984 - i.e., let

$$U = 100 / (TP73/TC73+...+TP84/TC84)$$

and define

$$Ui = U(TPi/TCi)$$

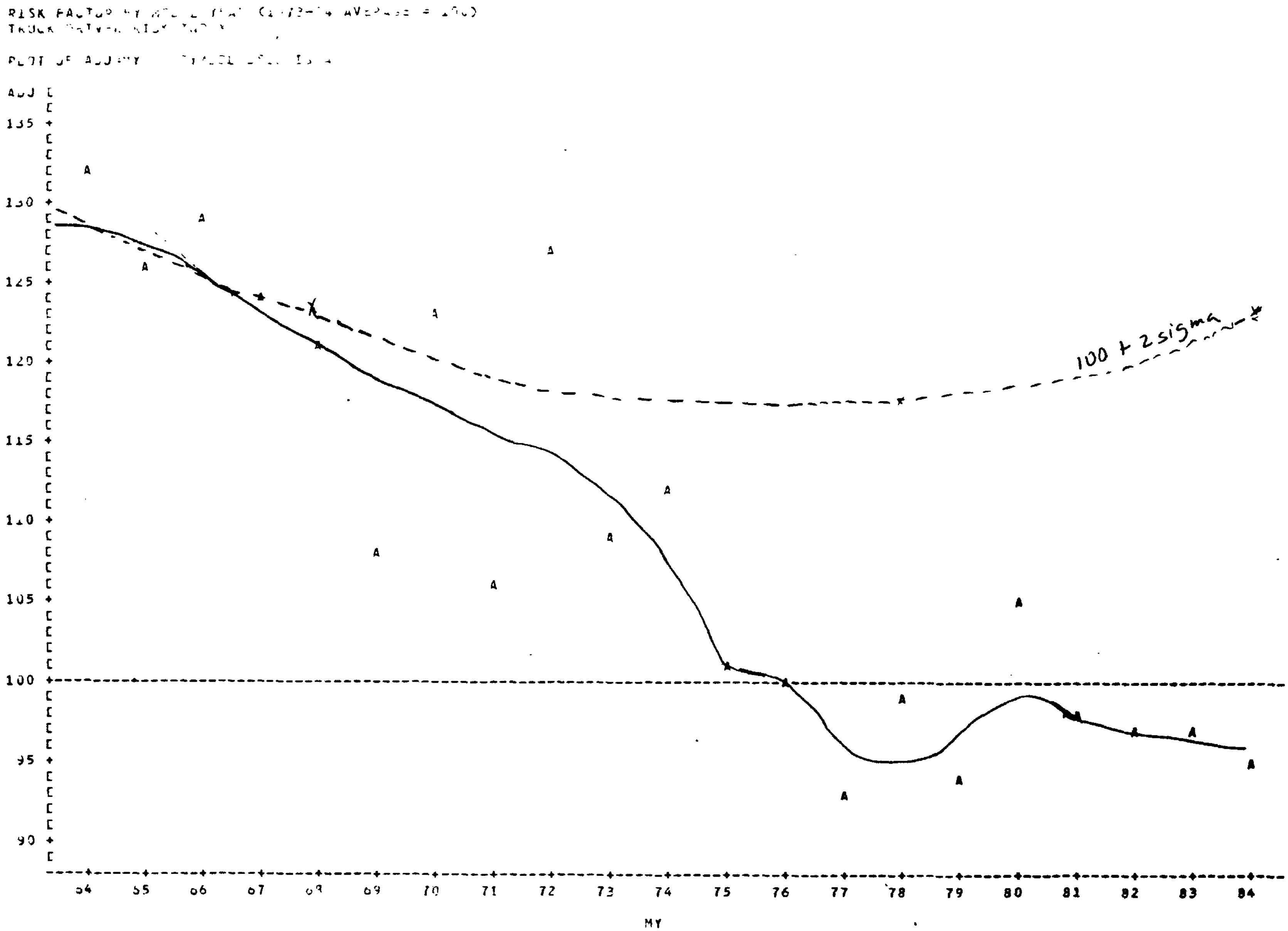
to be the risk index for light trucks of model year i. The adjusted risk indices, by model year, are:

1964	132	1971	106	1978	99
1965	127	1972	127	1979	94
1966	129	1973	109	1980	105
1967	124	1974	112	1981	98
1968	121	1975	101	1982	97
1969	108	1976	100	1983	97
1970	123	1977	93	1984	95

The appropriate interpretation of the risk index is that if the fleet of 1968 light trucks had been replaced by a fleet of 1978 type light trucks of the same weights, there would have been only 99/121 of the head on crash fatalities. Since the adjusted risk index controls for vehicle weight, it might be appropriate not only for head on crashes but also for other types of frontal impacts.

Figure 5-5 is a graph of the adjusted risk index for drivers by model year. It is not so clear where the trend line should go in the early 1970's because of the fluctuation of the indices - due to possible inaccuracies in the truck weight data plus generally small sample sizes (as indicated by the wide 95 percent noise bands around the 1973-84

FIGURE 5-5: ADJUSTED FATALITY RISK INDEX FOR DRIVERS OF LIGHT TRUCKS, BY MODEL YEAR



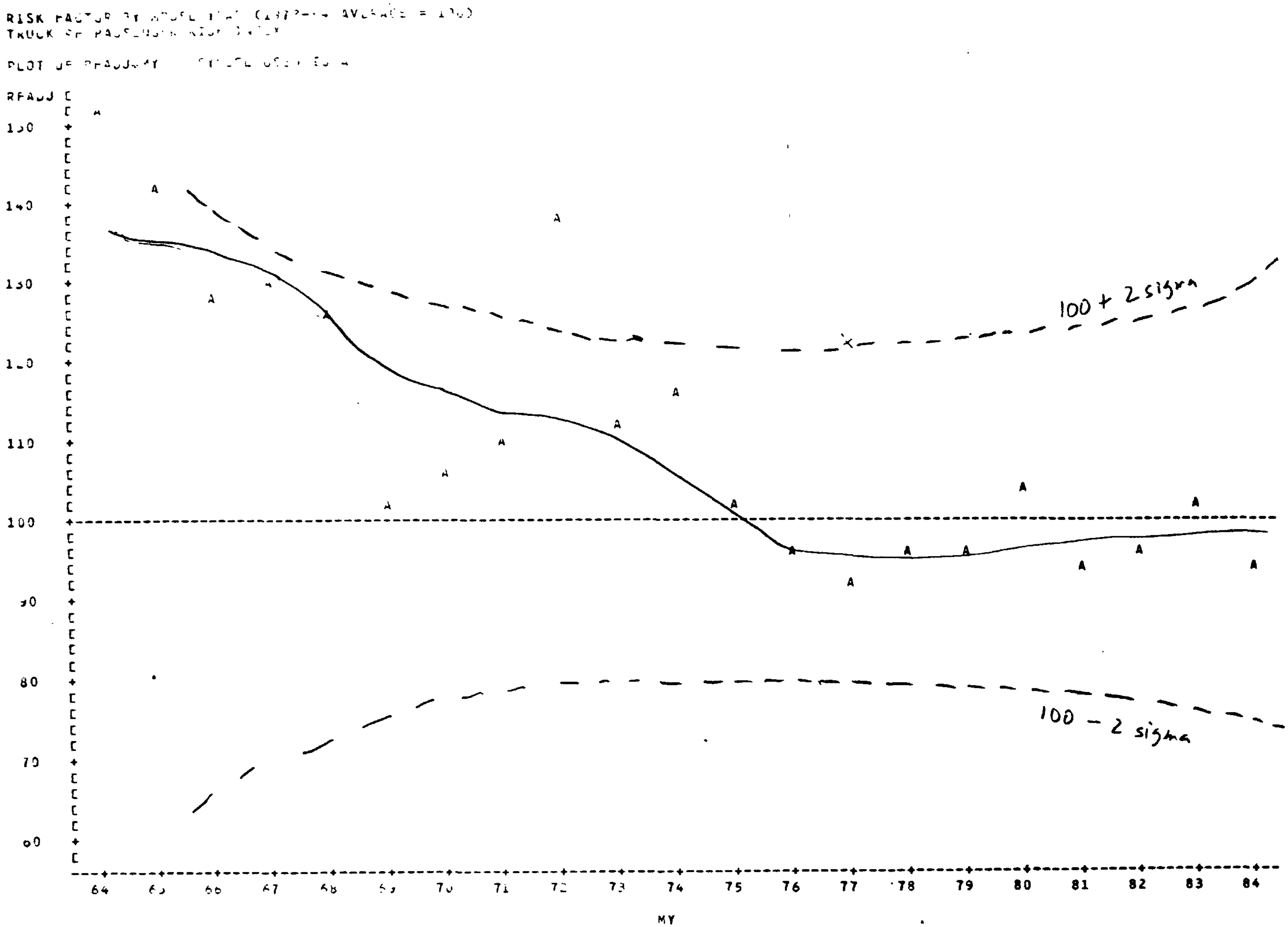
average of 100; the upper noise band is the parabolic dotted curve and the lower band doesn't even fit on the graph; sampling error is estimated by the same procedure as in Section 4.2.3). Nevertheless, the important trends are quite clear. Fatality risk dropped by a moderate amount in the late 1960's and early 1970's and then declined steeply in the mid 1970's: the time when energy absorbing steering assemblies were voluntarily installed in pickup trucks while production of forward control vehicles was generally curtailed. Those are the two most obvious vehicle modifications that could be expected to benefit drivers in frontal crashes - and it appears they did. Fatality risk dropped by a total of about 20 percent from the mid 1960's to trucks of the mid 1970's. Fatality risk has been nearly constant since about 1977.

An adjusted fatality index for RF passengers of light trucks in frontal crashes is obtained by multiplying each model year's driver index by the ratio of RF passenger to driver fatality risk and then multiplying by a constant (close to 1.1) so that the average of the 1973-84 indices is 100. The RF passenger indices, by model year, are:

1964	153	1971	110	1978	95
1965	143	1972	137	1979	97
1966	127	1973	113	1980	105
1967	129	1974	115	1981	94
1968	125	1975	102	1982	96
1969	102	1976	95	1983	102
1970	107	1977	93	1984	94

Figure 5-6 graphs the RF passenger fatality index. Although sampling error is fairly large, as indicated by the 95 percent noise bands, it seems likely that fatality risk dropped by about 20-25 percent from trucks of the 1966-68 period (average index 127) to 1975-80 trucks (average index

FIGURE 5-6: ADJUSTED FATALITY RISK INDEX FOR RF PASSENGERS OF LIGHT TRUCKS, BY MODEL YEAR



98). The fluctuations in the individual points make it difficult to determine exactly where the greatest drop occurred, but it was somewhere in the 1969-75 period. Fatality risk was virtually constant during model years 1975-84. The data suggest that the instrument panel improvements typically made on cars during the late 1960's and early 1970's (see Section 1.4) may have been extended to light trucks, with corresponding benefits, a few years later - but undoubtedly no later than the mid 1970's and well in advance of the September 1, 1981 effective date of the extension of Standard 201 to light trucks. Structural improvements of trucks such as the gradual phasing out of forward control vehicles may also have been responsible for some of the reduction.

In summary, these preliminary fatality indices show a reduction of fatality risk in frontal crashes of about 20 percent for drivers and right front passengers of light trucks. Most of the reduction was achieved in trucks of the early to mid 1970's, with little change after that. The statistical analyses of NASS and NCSS data (Sections 5.1 and 5.2) did not show a corresponding reduction of nonfatal injury risk but, as noted there, the sample sizes were too small to reliably detect any reductions unless they were up in the 40 percent range. Thus, the FARS results are not inconsistent with NASS and NCSS. It is possible that some improvements to light trucks in fact did reduce fatalities but had less effect on nonfatal injuries (the phasing out of forward control vehicles is a good candidate, since this would be primarily beneficial in the more severe crashes). It is also possible that there was a reduction of nonfatal injury risk parallel to the fatality reduction, but the small

NASS and NCSS samples did not show it. Finally, if more detailed truck weight data become available, a more refined analysis of the fatality risk indices might change some of the results.

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APPENDIX A

PLANNING AND RUNNING THE MVMA2D SIMULATIONS

1. Test matrix
2. Geometry and force deflection measurements
3. Derivation of MVMA2D geometry
4. Derivation of MVMA2D force deflection characteristics
5. Running MVMA2D
6. Anomalies and exceptions in the simulations

1. Test matrix Originally, instrument panel and windshield geometry and force deflection characteristics were measured for 19 passenger cars of model years 1975-83 [52]. The work was completed by a NHTSA contractor in 1983. The measurements were the input data for the PADS2 simulation of occupant trajectories [24], which at that time was believed appropriate for modeling the trajectory of the unrestrained right front passenger. For this study, six manufacturer/market classes were selected from among the 19 cars and the same contractor was assigned to find older cars in these classes and perform identical measurements on them. The original design called for tests in the following manufacturer/market classes, which, together, represent a large portion of the market:

1. Full sized Ford
2. Full sized GM
3. Compact GM
4. Compact Chrysler
5. Volkswagen (subcompact)
6. Nissan or Honda (subcompact)

Four model year groups were to be represented:

1. Pre-standard (1965-66)
2. Early post-standard (1969-71)
3. Pre-downsized big cars and rear wheel drive small cars (1974-76)
4. Downsized big cars and front wheel drive small cars (1977-83)

Where possible, there should be a car of each market class in each model year group. (Some combinations, such as 1965-66 Nissan, were dropped because such cars were uncommon or nonexistent in the United States.)

Thirteen specific older cars were selected which, in combination with some of the 19 that had already been tested, would fill out the matrix to the maximum possible extent. These 13 older cars were the 1966, 69 and 76 full-sized Fords, the 1965, 69 and 76 full-sized Chevrolets, the

1966 and 69 Nova, the 1966 and 69 Dart or Valiant, the 1966 and 74 VW Beetles and the 1971 Datsun 1200. The cars were tested by the contractor (see next section) and the PADS2 input data supplied to NHTSA in 1984. In 1985 it became evident that PADS2 was not suitable for modeling the unrestrained right front passenger and that the MVMA2D simulation model would have to be used instead. At that point neither the 13 older vehicles nor the original 19 cars were available for retesting to obtain a full MVMA2D input data set. Those cars whose instrument panels had been dynamically tested - all 13 old cars and 10 of the 19 newer ones - could at least be converted to partial MVMA2D input sets. But newer cars whose panels had not been dynamically tested or for which certain geometry measurements were unavailable had to be replaced in the matrix. In some cases the substitutes only resembled rather than met the characteristics that were originally demanded. The final result was a matrix of 21 cars for which MVMA2D simulations were feasible:

Car Group	MY Group	
1	1	66 Ford Galaxie 500
	2	69 Ford LTD
	3	76 Ford LTD
	4	79 Ford LTD
2	1	65 Chevrolet BelAir
	2	69 Chevrolet BelAir
	3	76 Chevrolet Caprice Classic
	4	78 Buick LeSabre
3	1	66 Chevrolet Chevy II
	2	69 Chevrolet Nova
	4	83 Chevrolet Celebrity
4	1	66 Plymouth Valiant
	2	69 Dodge Dart
	3	77 Plymouth Volare
	3	79 Ford Mustang

5	1	66 VW Beetle
	2	74 VW Beetle
	4	80 Dodge Omni
6	2	71 Datsun 1200
	4	75 Honda Civic
	4	78 Honda Accord

There were no problems obtaining data on full sized Ford and GM cars from each of the 4 model year groups. No 1974-76 Nova was available for MVMA2D input and the Celebrity was the closest thing to the Citation in the original matrix. The 1979 Mustang only fits in with the Chrysler compacts in that it is about the same size. It is not a substitute for the Aries or Reliant because it has rear wheel drive. It is a sort of replicate for the Volare. The Dodge Omni came closest to the VW Rabbit among available vehicles. The Honda Civic and Accord both have front wheel drive, so there is no post-1975 Japanese car with rear wheel drive in the matrix. The resulting matrix falls short of a "complete block" design but it was the best available under the circumstances.

<u>2. Geometry and force deflection measurements</u> On the 13 older cars, the contractor obtained the information to describe the seven contact planes of the PADS2 model [23], pp. 6-11. PADS2 and MVMA2D are both two dimensional models and it is only necessary to describe the longitudinal and vertical components of locations, velocities, etc. The seven planes are the "lower," "mid," and "upper" instrument panels, the windshield, the header, the seat cushion and the seatback. The endpoints of these planes are measured relative to the point where the toeboard intersects the floorboard, which is the origin in the two dimensional coordinate system of PADS2. The length and angle of the planes is also measured. Since

most instrument panels do not have straight, clearly defined lower, mid and upper regions, the contractor had to use judgment to express the panel contours as 3 straight lines. Seat location was measured when the seat was in the middle of its track.

The situation was more complicated for the newer cars. The contractor measured the panel, windshield and header, but could not measure the seats since only the front section of the car was purchased. The Transportation Systems Center (TSC) performed its own set of PADS2 measurements, including the seats [54]. The panel measurements differed from the contractor's and seats were measured in their furthest back position. Finally, measurements were obtained from NHTSA crash test data on those of the newer cars which had been crash tested [6]. This last set of measurements is believed to be the most accurate and, moreover includes all the geometry data needed for running MVMA2D. These measurements based on crash tests were used wherever they were available (on the Accord, Celebrity, Mustang and Omni); otherwise, the TSC measurements, with correction for the seat location, were used (on the 79 Ford LTD, the LeSabre, the Volare and the Civic).

The contractor performed dynamic tests of mid and lower instrument panel force deflection characteristics by firing a body form at the instrument panel at a specified speed [23], pp. 17-27. First, two dummy knees were fired into the lower instrument panel at 15 mph and at the angle normally seen in barrier crashes. Then, a dummy chest block was fired into the mid instrument panel at 20 mph. That is the order in which impacts occur in actual crashes (see Section 1.4). The data reduction system provided measurements of force deflection as a function of crush depth, both on the way in and on the rebound. The 15 and 20 mph impact speeds were selected as being representative of a 30 mph barrier collision. Due to "ride down," as explained in Section 1.4, the passenger contacts the panel at less than 30 mph. However, in most of the older cars, there is less ride down and these impact speeds are more characteristic of a 25 than a 30 mph barrier crash. Dynamic force deflection is velocity sensitive, so the results are definitely not appropriate for crashes less than 25 or more than 30 mph. It was decided to use the contractor's dynamic force deflection measurements, as is, for both 25 and 30 mph simulations, but not to perform simulations for speeds other than 25 and 30 mph. It should also be noted that the force deflection measurements are sensitive to changes in the location and direction of the impact and may differ a fair amount for two different cars of the same make, model and model year. The same contractor performed the tests on the newer and the older cars, using the same methods. Unlike the panel geometry situation, there are no comparability problems here.

Dynamic tests were not conducted on top instrument panels. Instead, the contractor measured static force deflection by forcing a dummy headform into the top panel at a rate of 2 inches per second, after the panel had already been statically compressed by the knee and chest forms [23], pp. 12-17 and 21.

3. Derivation of MVMA2D geometry MVMA2D allows much latitude for defining

the frame of reference, describing the interior surfaces, etc. TSC, however, has developed a paradigm for modeling the interior surfaces facing the unrestrained right front passenger. The same approach is used for all 21 cars of the matrix. All cars will be modeled as having 8 "regions": the top IP, the mid IP, the lower IP, the windshield, the roof (consisting of 2 "line segments": roof top and header), the floor (consisting of 3 line segments: floorboard, toeboard and firewall), the seat (consisting of 2 line segments: seat back and seat cushion) and the seat frame (consisting of the seat beam).

The contractor's and TSC's PADS2 measurements provide no information about the floor (floorboard, toeboard and firewall) other than that the toeboard-floorboard junction is the point (0,0) in the PADS2 coordinate system. Therefore, a generic floor was developed and used for all cars except those 4 in the matrix for which floor measurements (the Accord, Celebrity, Mustang and Omni) had been obtained from crash test data. The generic floor's coordinates was the average of 11 cars for which measurements had been obtained from crash test data (the 4 above plus 7 not included in the matrix - but excluding the 81 Concord whose measurements were quite different from the others). In MVMA2D coordinates, the average floorboard extended from (8,-6) to (58.37,-6), the toeboard from (58.37,-6) to (63.71,-10.61) and the firewall from (63.71,-10.61) to (63.71,-30). In particular, for all cars in the matrix except the 4 mentioned above, (0,0) in PADS2 corresponds to (58.37,-6) in MVMA2D coordinates.

Finally, the seat beam at its front end has coordinates (X,Z+5), where (X,Z) is the front end of the seat cushion (recall that Z is a negative number). The back end of the seat beam is (X-5.83,Z+6.55). These are the locations of the seat beam, relative to the seat cushion, in the generic Celebrity seat.

<u>4. Derivation of MVMA2D force deflection characteristics</u> On the Accord, Celebrity, Mustang and Omni, TSC's force deflection data for instrument panels, already in MVMA2D format, were used. On the other 17 cars, visual inspection of the contractor's graphs, using the dynamic data for the mid and lower IP's and the static data for the top IP, provided a series of deflection-force pairs and ratios for permanent to total deformation (G) and stored to total energy (R). These become a piecewise linear "static" force deflection curve and G and R coefficients in MVMA2D [3], pp. 261-273.

One problem with the contractor's dynamic tests is that they often did not go deep enough into the lower IP (e.g., 8 inches or less). Additional data points were needed to run MVMA2D, where penetrations of 12 inches or more often occur in 30 mph barrier crashes. Several techniques were used to extend the data. (1) Sometimes the contractor's static test results could be used from the point where the dynamic test results left off. (2) If the contractor's dynamic data show an upward trend at the end, it is possible to extrapolate that trend. (3) If the contractor's dynamic data show no upward trend at the end and the static data are not helpful, continue at a constant force until deformation approaches the firewall and then finish with a force/deflection curve similar to the firewall's.

The locations of the lower, mid and upper IP were translated from PADS2 to MVMA2D coordinates (except for the Accord, Celebrity, Mustang and Omni, which were already in MVMA2D coordinates), with (0,0) in PADS2 corresponding to (58.37,-6) in MVMA2D. The windshield and header endpoints, however, were not directly translated, because it was believed that the contractor/TSC data start the windshield too low in some cases. Instead, the windshield was assumed to start at the endpoint of the top IP and the header from the endpoint of the windshield. The rooftop was assumed horizontal, starting at the endpoint of the header. It is important to note that the actual windshield and header rake angles were entered for each car, rather than "generic" values. The windshield rake angle is an important component of a car's frontal interior geometry, affecting the location and severity of instrument panel contact, especially the head to panel contact. Thus, although the windshield rake angle is not a characteristic of the panel per se, it was felt that it should be considered in any analysis of the effects of panel geometry on injury risk.

One problem with MVMA2D is the way it handles "edge effects" (the diminution of the force deflection if contact between a body region and a vehicle surface is close to their edges) [3], pp. 102-108. When the panel is treated as 3 separate regions, the "edge effect" can result in inappropriate reductions of force deflection characteristics. The remedy was to continue the lower IP an additional 8 inches in both directions and the mid IP downward for 8 inches - while telling MVMA2D to ignore the knee and hip to mid IP and the chest to lower IP interactions. The remedy was not needed on the Accord, Celebrity, Mustang and Omni since TSC had already lengthened the panels in a similar way.

TSC developed stable initial seating postures for the 5th, 50th and 95th percentile dummies in the Celebrity. It was decided to use the Celebrity seat and these postures as "generic" for all cars - but the vertical alignment of the seat relative to the panel could vary from car to car. In other words, use the vertical coordinates, dummy angles, etc., of the Celebrity but raise or lower the IP, windshield, header and roof. For example, if the contractor reported that the seat cushion in one of the older cars is one inch higher than in the Celebrity, <u>lower</u> the IP, windshield, etc. in that old car by an inch.

The procedure described so far is the one that would be used for 50th percentile dummies in older cars. That is because the contractor measured the seated height in the mid position. But seat tracks are not level: seats rise as they are pushed forward. The amount of vertical motion varies from car to car and is unknown for the older cars. Therefore, a generic value was used for all the cars: the average value for 27 relatively new cars measured by TSC (and stored in their data base PCFG3). The averages are .404 inches upward in the fore position and .348 inches downward in the aft position. But the Celebrity seat (see above) only moved up .188 inches in the fore position and down .187 inches in the aft position. Thus, to get generic vertical movements, it will be necessary to move the roof, windshield and IP down an additional (.404 - .188) inches in the forward position runs and up an additional (.348 - .187) inches in the aft position runs.

The preceding discussion applies to the older cars. For the 4 newer cars whose seat height data comes from TSC, the height was measured in the aft position. To translate that height to mid position, .348 inches has to be subtracted first. Then proceed as above.

Horizontal alignment of the seat also varies from car to car and was measured by the contractor (in the mid position) or TSC (in the furthest back position). Some of the seats, however, appear to be unreasonably close or far from the instrument panel. Since distance from the seat to the panel can significantly affect injury risk, errors in this measurement should be avoided. It was decided to take a generic value of 24 inches <u>from the back of the mid IP to the seatback/seat cushion junction</u> for the 50th percentile dummy in the mid position. This, to the nearest inch, is the average distance in the vehicle setups based on crash test data and it is also within an inch of the average for MGA's older cars. A further motivation for using a generic value is that occupants will tend to move the seat backwards or forwards until they are sitting at a "comfortable" distance from the panel. For the 5th percentile dummy in the forward position, move the seat 2.774 inches forward (average value in 27 cars measured by TSC). For the 95th percentile in the aft position, move it 2.815 inches backward. The X coordinate of the dummy's chest c.g. has to be moved, as needed, to keep the dummy in a stable position on the seat. These generic values for the X coordinates of the seat and the dummy, relative to the mid IP, were even used for the Accord, Celebrity, Mustang and Omni - the only case where input data based on crash tests were superseded.

If the contractor could not perform a static head to top IP test, the top IP data from a similar vehicle was used (e.g., 75 Honda Civic for 71 Datsun 1200).

Generic force deflection characteristics were used for all components other than the instrument panel: the windshield, floor, toeboard, firewall, roof, header, and seat beam. The values that TSC derived for the Celebrity [6] were used for all the other cars.

5. Running MVMA2D The remaining items needed for running the simulation are occupant parameters, a list of occupant body region to vehicle contact surface interactions, the crash pulse and control statements. In the 50th percentile runs, the simulated occupant has the body dimensions, mass distribution, joint characteristics, etc. of a Hybrid III dummy. The 5th percentile occupant is intended to represent a Hybrid III dummy scaled down to the size of a 5th percentile female; the 95th percentile occupant is a Hybrid III dummy scaled upwards. The force deflection characteristics of the simulated occupants' chests (which are not exactly the same as for a Hybrid III dummy) are:

Inches	Pounds
0.079	450
2.283	1239
3.937	1349
5.906	4000

The permissible occupant body region to vehicle surface interactions were:

Head	to	windshield, top ip, roof, seat
Thorax	to	mid ip, seat, seat frame, floor
Knee	to	lower ip, floor
Toe, heel	to	floor
Hand	to	mid ip, floor

Hip	to	seat, seat frame, floor
Upper leg	to	seat, seat frame, floor
Elbow	to	mid ip

In addition, if the mid instrument panel reaches a height of -33.2 inches or more (in MVMA2D coordinates), a head to mid IP interaction has to be added for the 5th percentile dummy, whose head will clip the mid IP on the way forwards. This interaction appeared on some of the larger old cars.

The same generic crash pulses were to be used for all cars, as explained in Section 3.2: one for 30 mph barrier impacts and one for 25 mph. TSC has a data base of crash pulses in 30 mph barrier impacts for 27 cars of model years 1979-82 - based on actual 30 mph crash tests or on a scaling from crash tests at 35 mph. The median values for the tests were 22.1 peak g's at 67 milliseconds after impact; 20 of the 27 cars had only a single peak. The 1979 Ford Granada reached 21.7 peak g's at 68 milliseconds and had only a single peak; it was by far the closest to the median values. Therefore, the 30 and 25 mph crash pulses for the 1979 Ford Granada were used for <u>all</u> cars.

The 30 mph barrier crash simulation was allowed to run for 160 milliseconds and the 25 mph simulation for 192 milliseconds. At that time, occupants have completed their forward motion and are rebounding. The simulations were cut off at that point to suppress calculation of noncontact HIC during rebound, which can sometimes be unrealistically large in MVMA2D. Data lines were printed out every 2 milliseconds in the 30 mph simulations and every 3 milliseconds in the 25 mph runs. Diagrams were produced every 20 msec in the 30 mph crashes and every 24 msec in the

25 mph crashes. The printed data included:

Head and chest motion
Leg forces
Neck reaction forces
g's at the head and chest accelerometers
Severity indices for head and chest
Each of the body region - vehicle surface interactions

A total of 126 simulations were successfully completed: 21 cars, with 5th, 50th and 95th percentile dummies (in the fore, mid and aft positions along the seat track, respectively), at 25 and 30 mph.

Appendix B presents the MVMA2D input data decks for the Celebrity with a 50th percentile dummy and for a 1976 Ford LTD with 50th, 5th and 95th percentile dummies. The Celebrity deck, largely developed by TSC, provided many of the generic values for the other cars. Appendix C shows the results for the 1976 Ford LTD in a 25 mph impact.

6. Anomalies and exceptions in the simulations Several cars required adjustments in the input data decks in order to achieve plausible simulations, as evidenced by reasonable occupant trajectories in the schematic diagrams and an absence of fatal error messages.

When the roof is less than 35.7 inches above the seat cushion, the 95th percentile dummy's head is in the roof. The contractor and TSC measurements of interior geometry resulted in roof clearances of less than 35.7 inches on 5 cars (Valiant, Dart, both Beetles, Datsun, Civic). The roof, header, windshield and instrument panels on these cars were raised, in the 95th percentile runs, until the clearance reached 35.7 inches. On the 74 Beetle, a similar procedure was required even for the 50th percentile dummy.

On the 66 Ford Galaxie and 69 Ford LTD it was not possible to use the "generic" spacing of 24 inches from the mid IP to the back of the seat cushion. Since the firewall is close behind the mid IP, this put the occupants' feet through the toeboard. Instead, the same firewall to seat cushion spacing was used as in the 76 Ford LTD. This spacing is also supported by the contractor's seat location measurements and photographs.

On the 66 Plymouth Valiant and 69 Dodge Dart it was thought inappropriate to use the "generic" spacing of 24 inches from mid IP to back of seat cushion. The generic spacing is too long, since the top of the mid IP has an "eyebrow" protruding about 2 inches toward the passenger. The 24 inches should be measured from the front of the "eyebrow," not the back. The contractor's seat location measurements support this. The remedy was to use the same seat cushion to firewall measurements as in 76 Ford LTD.

On the 66 and 74 Volkswagen the generic firewall would be unreasonably far forward, resulting in occupants sliding completely under the panel. A more appropriate firewall location is obtained by having it come straight up from the floorboard/toeboard junction (at X=58.37 inches). Since these cars have virtually no top IP, the head to top IP interaction was suppressed.

Minor adjustments were needed to prevent error terminations of MVMA2D, such as eliminating the "breakdown" levels of deflection for the chest and the windshield and smoothing out one sharp dip in TSC's force deflection curve for the Accord mid IP.

APPENDIX B

EXAMPLES OF MVMA2D INPUT DATA DECKS

1983 Chevrolet Celebrity with 50th percentile male, 25 mph

1976 Ford LTD with 50th percentile male, 25 mph

1976 Ford LTD with 5th percentile female, 25 mph

1976 Ford LTD with 95th percentile male, 25 mph

CHUCK

CELE835025

.OUT;1

File _DBA2:[SCRATCH.CJK]CELE835025.OUT;1 (5223,47,0), last revised on 16-JUL-1987 10:33, is a 90 block sequential file owned by UIC [CHUCKK]. *The records are variable length with FORTRAN (FTN) carriage control. The longest record is 120 bytes.*

Job CELE835025 (218) queued to TXG3 on 16-JUL-1987 10:38 by user CHUCKK, UIC [CHUCKK], under account NPP-01 at priority 4, started on printer _TXG3: on 16-JUL-1987 12:12 from queue TXG3.


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VVVVVVVVV   8888888888888888888888888888888888888888888888888888888888888888888888888888888888888888   VVVVVVVVV
VVVVVVVVV   888888888888888888888888  Digital Equipment Corporation - VAX/VMS Version V4.3  888888888888888888888888   VVVVVVVVV
VVVVVVVVV   8888888888888888888888888888888888888888888888888888888888888888888888888888888888888888   VVVVVVVVV
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100 •        •         •     MVM•A 2D CRA•SH VICTI•M SIMULA•TION    •         •         •
101 •1.      •1.       •32.174  •0.      •0.       •192.0   •1.0     •3.       •24.      •
102 •0.      •0.       •0       •0.      •0.       •0.      •10.     •.000001  •15.      •
103 •0.80    •.02      •100000. •15000.  •20.      •.05     •10.     •1.       •1.       •
104 •0.      •00000000•70.1     •00000000•200.     •00000000•201.    •00000000•0.        •
106 •TOE     •         •FLOOR   •        •         •        •        •         •         •
106 •HAND    •         •MID IP  •        •         •        •        •         •         •
106 •HAND    •         •FLOOR   •        •         •        •        •         •         •
106 •HEAD    •         •ROOF    •        •         •        •        •         •         •
106 •HEAD    •         •WINDSHIE•LD      •         •        •        •         •         •
106 •HEAD    •         •SEAT    •        •         •        •        •         •         •
106 •HEAD    •         •TOP IP  •        •         •        •        •         •         •
106 •HEEL    •         •FLOOR   •        •         •        •        •         •         •
106 •KNEE    •         •LOWER IP•        •         •        •        •         •         •
106 •KNEE    •         •FLOOR   •        •         •        •        •         •         •
106 •HIP     •         •FLOOR   •        •         •        •        •         •         •
106 •HIP     •         •SEAT    •        •         •        •        •         •         •
106 •HIP     •         •SEAT FRA•ME      •         •        •        •         •         •
106 •THORAX  •         •MID IP  •        •         •        •        •         •         •
106 •THORAX  •         •SEAT    •        •         •        •        •         •         •
106 •THORAX  •         •SEAT FRA•ME      •         •        •        •         •         •
106 •THORAX  •         •FLOOR   •        •         •        •        •         •         •
106 •ELBOW   •         •MID IP  •        •         •        •        •         •         •
106 •UPPER LE•G        •SEAT FRA•ME      •         •        •        •         •         •
106 •UPPER LE•G        •FLOOR   •        •         •        •        •         •         •
106 •UPPER LE•G        •SEAT    •        •         •        •        •         •         •
200 •Hybili 5•0th Male•         •        •         •        •        •         •         •
201 •   0.512•  12.402•   5.748•   3.740•  15.827•   0.0   •  10.630•   1.575•  -1.260•
202 •   2.992•   5.630•   2.874•   1.890•   6.102•   9.134•   5.197•   5.669•6.5      •
203 •   0.026•   0.099•   0.018•   0.113•   0.070•   0.052•   0.023•   0.026•   0.009•
204 •   0.221•   1.593•   0.142•   1.115•   1.584•   1.637•   0.212•   0.372•         •
205 •  28.411•   0.575•   0.0   •   0.398•   17.4  •10.     •         •-25.     •.35      •
206 •  28.411•   0.575•   0.0   •   0.398•   17.4  •10.     •         •-22.     •.35      •
207 •  96.031•   5.700•   0.0   •   0.0   •   0.0  •500.    •-14.9    •-56.9    •.35      •
208 •  96.031•   5.700•   0.0   •   0.0   •   0.0  •500.    •-4.2     •-84.2    •.35      •
209 •  22.304•  92.933•   0.0   •   0.0   •1380.716•500.    •0.       •-75.3    •.01      •
210 •   0.0  •  29.827•   0.0   •   0.0   • 203.567•100.    •135.     •0.       •.5       •
211 •   0.0  •  10.001•   0.0   •   0.0   • 221.269•150.    •28.      •-197.    •.5       •
212 •   0.0  •  10.001•   0.0   •   0.0   •  63.725•40.     •0.       •-165.    •.5       •
213 • 750.884•   0.0  • 755.211•   1.981•          •        •   0.0   •         •         •
214 •  19.986• 230.610•   0.0   •   0.0   •         •        •   1.969•         •.5       •
215 •   4.062•  13.276•   0.0   •   0.111•  19.711• 8.      •25.      •         •.80      •
216 •   4.062•  17.524•   0.0   •   0.053•  74.902• 30.     •7.04     •         •.80      •
218 •2.992   • 7.087   •        •         •         •        •         •         •         •
219 •UPPER LE•G        •        •         •5.       •1.      •         •         •         •
219 •TOE     •         •        •         •6.       •2.      •         •         •         •
219 •HIP     •         •        •         •4.       •1.      •         •         •         •
219 •HEEL    •         •        •         •6.       •2.      •         •         •         •
219 •HAND    •         •        •         •8.       •3.      •         •         •         •
219 •THORAX  •         •CHESTMAT•         •2.       •1.      •         •         •         •
219 •HEAD    •         •        •         •1.       •3.      •         •         •         •
219 •KNEE    •         •        •         •5.       •1.      •         •         •         •
219 •ELBOW   •         •        •         •8.       •1.      •         •         •         •
220 •HEAD    •         •   0.472•   0.0   •   4.488•   3.740•         •         •         •
220 •KNEE    •         •   9.449•   0.0   •   2.677•   2.677•         •         •         •
220 •ELBOW   •         •  -4.543•   0.0   •   2.362•   1.772•         •         •         •
220 •THORAX  •         •   1.535•  -1.102•   5.984•   4.803•         •         •         •
220 •HEEL    •         •   8.937•   0.0   •   2.520•   2.520•         •         •         •
220 •HAND    •         •   7.047•   0.0   •   2.717•   1.535•         •         •         •
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```
220 •HIP      •        •   1.024•  -0.472•   4.921•   4.921•           •         •         •
220 •TOE      •        •   3.64 •  -6.19 •   1.181•   1.181•           •         •         •
220 •UPPER LE•G        •   3.937•  -0.315•   5.0  •   3.071•           •         •         •
242 •3003.537•   0.0  •3020.846•   7.926•          •         •          •         •         •
221 •CHESTMAT•         •    0.0 •   0.0  •    0.0  • 1000.  • 1000.1 •   0.0   •   0.0   •
222 •CHESTMAT•         •   30.00•          •         •        •CHSTAT  •CHZERO  •GRCHST  •
223 •GRCHST  • 0.079  • 0.10   •          •         •        •         •         •         •
223 •GRCHST  • 0.0    • 0.0    •          •         •        •         •         •         •
223 •GRCHST  • 5.906  • 0.99   •          •         •        •         •         •         •
223 •GRCHST  • 3.937  • 0.50   •          •         •        •         •         •         •
223 •GRCHST  • 2.283  • 0.10   •          •         •        •         •         •         •
224 •GRCHST  • 0.0    • 1.0    •          •         •        •         •         •         •
224 •GRCHST  • 0.079  • 0.5    •          •         •        •         •         •         •
224 •GRCHST  • 5.906  • 0.005  •          •         •        •         •         •         •
224 •GRCHST  • 3.937  • 0.1    •          •         •        •         •         •         •
224 •GRCHST  • 2.283  • 0.2    •          •         •        •         •         •         •
225 •CHSTAT  • 0.0    •   0.0  •          •         •        •         •         •         •
225 •CHSTAT  • 0.079  • 449.62 •          •         •        •         •         •         •
225 •CHSTAT  • 2.283  •1239.454•          •         •        •         •         •         •
225 •CHSTAT  • 3.937  •1348.855•          •         •        •         •         •         •
225 •CHSTAT  • 5.906  •4000.   •          •         •        •         •         •         •
226 •CHZERO  •-1.     •   0.0  •          •         •        •         •         •         •
300 •83Celeb/•50hyb/mi•d       •          •         •        •         •         •         •
301 •80.64    •92.49   •129.97  •143.55  •16.46    •-36.93  •-80.    •-10.    •92.84    •
302 •0.       •0.      •0.      •0.      •0.       •0.      •0.      •0.      •0.       •
303 •22.53    •0.      •-28.28  •0.      •3.54     •0.      •        •        •         •
304 •0.       •0.      •0.      •0.      •         •        •        •        •         •
217 •-12.20   •0.35    •-37.48  •-13.58  •-52.91   •53.39   •0.      •0.      •         •
411 •SEAT BAC•K        •-1.     •17.40   •-35.46   •25.64   •-12.82  •        •         •
411 •SEAT CUS•HION     •-1.     •25.64   •-12.82   •42.25   •-17.27  •        •         •
411 •SEAT BEA•M        •-1.     •36.42   •-10.72   •42.25   •-12.27  •        •         •
400 •83ChevCe•lebrity •         •         •         •        •        •        •         •
401 •SEAT     •        •SEAT MAT•ERIAL    •0.       •1.      •1.      •1.      •         •
402 •SEAT     •        •3.      •1.       •1.       •     0.•     0.•        •         •
409 •SEAT BAC•K        •SEAT    •         •5.0      •0.      •        •    -1.•     1.•  •
410 •SEAT BAC•K        •     1.•          •         •        •        •        •         •
409 •SEAT CUS•HION     •SEAT    •         •5.0      •0.      •        •    -1.•     2.•  •
410 •SEAT CUS•HION     •     1.•          •         •        •        •        •         •
409 •SEAT CUS•HION2    •SEAT    •         •5.0      •0.      •        •    -1.•     3.•  •
410 •SEAT CUS•HION2    •     1.•          •         •        •        •        •         •
401 •SEAT FRA•ME       •STEEL   •         •0.       •1.      •1.      •1.      •         •
402 •SEAT FRA•ME       •1.      •1.       •1.       •0.      •0.      •        •         •
409 •SEAT BEA•M        •SEAT FRA•ME       •.528     •.1      •-1.     •1.      •         •
410 •SEAT BEA•M        •     1.•          •         •        •        •        •         •
401 •FLOOR    •        •FLOOR MA•TERIAL   •0.       •1.      •1.      •1.      •         •
402 •FLOOR    •        •     3.•2.        •1.       •     0.•     0.•        •         •
409 •FLOORBOA•RD       •FLOOR   •         •.528     •0.      •        •    -1.•     1.•  •
410 •FLOORBOA•RD       •     1.•          •         •        •        •        •         •
411 •FLOORBOA•RD       •    -1.•    8.00•   -6.00•   62.10•   -6.00•          •         •
409 •TOEBOARD•         •FLOOR   •         •.528     •     .37•     1.•     2.•         •
410 •TOEBOARD•         •     1.•          •         •        •        •        •         •
411 •TOEBOARD•         •    -1.•   62.10•   -6.00•   69.50•   -9.89•          •         •
409 •FIREWALL•         •FLOOR   •         •.528     •0.      •        •     1.•     3.•  •
410 •FIREWALL•         •     1.•          •         •        •        •        •         •
411 •FIREWALL•         •    -1.•   69.50•   -9.89•   69.50•  -29.89•          •         •
401 •ROOF     •        •ROOF MAT•ERIAL    •0.       •1.      •1.      •1.      •         •
402 •ROOF     •        •     2.•6.        •1.       •     0.•     0.•        •         •
409 •ROOF TOP•         •ROOF    •         •.528     •0.      •        •     1.•     1.•  •
410 •ROOF TOP•         •     1.•          •         •        •        •        •         •
411 •ROOF TOP•         •    -1.•    8.00•  -48.45•   20.35•  -48.45•          •         •

409 •HEADER   •        •ROOF    •         •.528     •0.      •        •     1.•     4.•  •
410 •HEADER   •        •     1.•          •         •        •        •        •         •
411 •HEADER   •        •    -1.•   20.35•  -48.45•   36.58•  -47.38•          •         •
401 •WINDSHIE•LD       •GLASS MA•TERIAL   •         •1.      •1.      •1.      •         •
402 •WINDSHIE•LD       •1.      •5.       •1.       •     0.•     0.•        •         •
409 •WINDSHIE•LD       •WINDSHIE•LD       •.528     •0.      •        •     1.•     1.•  •
410 •WINDSHIE•LD       •     1.•          •         •        •        •        •         •
411 •WINDSHIE•LD       •    -1.•   35.08•  -47.38•   59.73•  -33.72•          •         •
401 •TOP IP   •        •TOP IP M•ATERIAL •0.       •1.      •1.      •1.      •         •
402 •TOP IP   •        •1.      •4.       •1.       •     0.•     0.•        •         •
401 •MID IP   •        •MID IP M•ATERIAL •0.       •1.      •1.      •1.      •         •
402 •MID IP   •        •1.      •4.       •1.       •     0.•     0.•        •         •
401 •LOWER IP•         •LOW IP M•ATERIAL •0.       •1.      •1.      •1.      •         •
402 •LOWER IP•         •1.      •4.       •1.       •     0.•     0.•        •         •
409 •IP PANEL•-1ST     •TOP IP  •         •.528     •.1      •        •    -1.•     1.•  •
410 •IP PANEL•-1ST     •     1.•          •         •        •        •        •         •
411 •IP PANEL•-1ST     •    -1.•   59.78•  -32.89•   53.75•  -32.14•          •         •
409 •IP PANEL•-2ND     •MID IP  •         •.528     •.50     •        •     1.•     1.•  •
410 •IP PANEL•-2ND     •     1.•          •         •        •        •        •         •
411 •IP PANEL•-2ND     •    -1.•   53.75•  -32.14•   49.64•  -21.76•          •         •
409 •IP PANEL•-3RD     •LOWER IP•         •.528     •.20     •        •     1.•     1.•  •
410 •IP PANEL•-3RD     •     1.•          •         •        •        •        •         •
411 •IP PANEL•-3RD     •    -1.•   47.78•  -23.24•   67.50•  -15.46•          •         •
403 •TOP IP M•ATERIAL •0.0      •0.0     •0.0      •1000.0  •1000.1  •0.0     •0.0      •
404 •TOP IP M•ATERIAL •5.620    •        •         •        •TIPSTAT •TIPI    •GRTIP    •
405 •GRTIP   •-1.     •0.385    •        •         •        •        •        •         •
406 •GRTIP   •-1.     •0.190    •        •         •        •        •        •         •
407 •TIPSTAT •0.00    •   0.00  •        •         •        •        •        •         •
407 •TIPSTAT •4.60    • 700.0   •        •         •        •        •        •         •
408 •TIPI    • -1.0   •   0.0   •        •         •        •        •        •         •
403 •MID IP M•ATERIAL •0.0      •0.0     •0.0      •1000.0  •1000.1  •0.0     •0.0      •
404 •MID IP M•ATERIAL •5.620    •        •         •        •MIPSTAT •MIPI    •MIPGR    •
405 •MIPGR   •-1.     •0.819    •        •         •        •        •        •         •
406 •MIPGR   •-1.     •0.057    •        •         •        •        •        •         •
407 •MIPSTAT •0.0     •0.0      •        •         •        •        •        •         •
407 •MIPSTAT •1.00    • 950.    •        •         •        •        •        •         •
407 •MIPSTAT •7.50    • 700.    •        •         •        •        •        •         •
407 •MIPSTAT •9.50    •1750.    •        •         •        •        •        •         •
408 •MIPI    •-1.0    •0.0      •        •         •        •        •        •         •
403 •LOW IP M•ATERIAL •0.0      •0.0     •0.0      •1000.0  •1000.1  •0.0     •0.0      •
404 •LOW IP M•ATERIAL •5.620    •        •         •        •LIPSTAT •LIPI    •LIPGR    •
405 •LIPGR   •-1.     •0.971    •        •         •        •        •        •         •
406 •LIPGR   •-1.     •0.008    •        •         •        •        •        •         •
407 •LIPSTAT •0.00    •   0.0   •        •         •        •        •        •         •
407 •LIPSTAT •1.30    • 650.    •        •         •        •        •        •         •
407 •LIPSTAT •3.20    • 150.    •        •         •        •        •        •         •
407 •LIPSTAT •5.50    •1200.    •        •         •        •        •        •         •
407 •LIPSTAT •8.00    • 650.    •        •         •        •        •        •         •
407 •LIPSTAT •12.0    •3450.    •        •         •        •        •        •         •
408 •LIPI    •-1.0    •   0.0   •        •         •        •        •        •         •
403 •FLOOR MA•TERIAL  •   0.000•   0.000•    0.394•    7.874•    9.843•    0.000•    0.000•
404 •FLOOR MA•TERIAL  •   5.620•          •         •        •CPSTAT  •ICARP   •GRCARP   •
405 •GRCARP  •-0.394  •0.1      •        •         •        •        •        •         •
406 •GRCARP  •-0.394  •0.5      •        •         •        •        •        •         •
407 •CPSTAT  •0.000   •   0.000•   0.000•    0.000•    0.000•    0.000•    0.000•        •
407 •CPSTAT  •0.197   • 196.850•   0.000•    0.000•    0.000•    0.000•    0.000•        •
407 •CPSTAT  •0.394   • 787.402•   0.000•    0.000•    0.000•    0.000•    0.000•        •
407 •CPSTAT  •7.874   •7874.016•   0.000•    0.000•    0.000•    0.000•    0.000•        •
407 •CPSTAT  •9.843   •   0.000•   0.000•    0.000•    0.000•    0.000•    0.000•        •
408 •ICARP   •-.394   •         •        •         •        •        •        •         •
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180  412 *1.        *4.       *.3       *0.0      *0.0      *         *         *         *         *
181  412 *1.        *1.       *.75      *0.0      *0.0      *         *         *         *         *
182  412 *2.        *2.       *.8       *0.0      *0.0      *         *         *         *         *
183  412 *3.        *1.       *.75      *0.0      *0.0      *         *         *         *         *
184  412 *3.        *2.       *.9       *0.0      *0.0      *         *         *         *         *
185  412 *3.        *5.       *.55      *0.0      *0.0228   *         *         *         *         *
186  412 *3.        *4.       *.5       *0.0      *0.0      *         *         *         *         *
187  403 *ROOF MAT*ERIAL      *0.       *0.       *0.       *100.     *101.     *0.       *-1.0     *
188  404 *ROOF MAT*ERIAL      *5.       *0.       *0.       *0.       *RSTAT    *IROOF    *DGR      *
189  407 *RSTAT     *-1.      *1200.    *-65.36   *67.38    *-29.36   *4.78     *         *         *
190  408 *IROOF     *-1.      *0.       *         *         *         *         *         *         *
191  405 *DGR       *0.       *0.       *         *         *         *         *         *         *
192  405 *DGR       *.001     *.01      *         *         *         *         *         *         *
193  405 *DGR       *10.      *.01      *         *         *         *         *         *         *
194  406 *DGR       *0.       *1.       *         *         *         *         *         *         *
195  406 *DGR       *.001     *.91      *         *         *         *         *         *         *
196  406 *DGR       *.75      *.8       *         *         *         *         *         *         *
197  406 *DGR       *1.5      *.5       *         *         *         *         *         *         *
198  406 *DGR       *10.      *.3       *         *         *         *         *         *         *
199  403 *SEAT MAT*ERIAL      *    0.0  *    0.0  *    3.937*    6.693*    7.480*    0.0  *    0.0  *
200  404 *SEAT MAT*ERIAL      *5.62     *         *         *         *SSEAT    *ISEAT2   *GRSEAT   *
201  405 *GRSEAT  *   -0.984*.1         *         *         *         *         *         *         *
202  406 *GRSEAT  *   -0.984*.5         *         *         *         *         *         *         *
203  407 *SSEAT   *    0.0  *    0.0  *    0.0  *    0.0  *    0.0  *    0.0  *    0.0  *         *
204  407 *SSEAT   *    1.850*   37.768*    0.0  *    0.0  *    0.0  *    0.0  *    0.0  *         *
205  407 *SSEAT   *    4.213*  202.328*    0.0  *    0.0  *    0.0  *    0.0  *    0.0  *         *
206  407 *SSEAT   *    4.961*  330.469*    0.0  *    0.0  *    0.0  *    0.0  *    0.0  *         *
207  407 *SSEAT   *    7.008*1252.86  *    0.0  *    0.0  *    0.0  *    0.0  *    0.0  *         *
208  407 *SSEAT   *    7.480*    0.0  *    0.0  *    0.0  *    0.0  *    0.0  *    0.0  *         *
209  408 *ISEAT2  *-1.0     *         *         *         *         *         *         *         *
210  403 *STEEL   *         *    0.000*    0.000*    0.394*    4.724*    5.906*    0.000*    0.000*
211  404 *STEEL   *         *    5.620*         *         *         *SSTEEL   *ISTEEL1  *GRSTEEL  *
212  405 *GRSTEEL *    0.000*0.       *         *         *         *         *         *         *
213  405 *GRSTEEL *    0.394*.1       *         *         *         *         *         *         *
214  405 *GRSTEEL *    4.724*.9       *         *         *         *         *         *         *
215  405 *GRSTEEL *    5.906*.99      *         *         *         *         *         *         *
216  406 *GRSTEEL *    0.000*1.       *         *         *         *         *         *         *
217  406 *GRSTEEL *.394     *.8       *         *         *         *         *         *         *
218  406 *GRSTEEL *    4.724*.05      *         *         *         *         *         *         *
219  406 *GRSTEEL *    5.906*.005     *         *         *         *         *         *         *
220  407 *SSTEEL  *    0.000*    0.000*    0.000*    0.000*    0.000*    0.000*    0.000*         *
221  407 *SSTEEL  *    0.394*1574.803*    0.000*    0.000*    0.000*    0.000*    0.000*         *
222  407 *SSTEEL  *    4.724*1574.803*    0.000*    0.000*    0.000*    0.000*    0.000*         *
223  407 *SSTEEL  *    5.906*    0.000*    0.000*    0.000*    0.000*    0.000*    0.000*         *
224  408 *ISTEEL1 *-.394    *         *         *         *         *         *         *         *
225  403 *GLASS MA*TERIAL   *0.90     *1.50     *0.85     *1000.    *1000.1   *0.0      *0.0      *
226  404 *GLASS MA*TERIAL   *5.620    *         *         *         *GLASTAT  *GLASP    *GRGLAS   *
227  405 *GRGLAS  *-1.      *0.977    *         *         *         *         *         *         *
228  406 *GRGLAS  *-1.      *0.004    *         *         *         *         *         *         *
229  407 *GLASTAT *0.00     *  0.00   *         *         *         *         *         *         *
230  407 *GLASTAT *1.25     *550.0    *         *         *         *         *         *         *
231  407 *GLASTAT *1.75     *490.0    *         *         *         *         *         *         *
232  407 *GLASTAT *3.60     *840.0    *         *         *         *         *         *         *
233  407 *GLASTAT *4.00     *800.0    *         *         *         *         *         *         *
234  407 *GLASTAT *6.00     *830.0    *         *         *         *         *         *         *
235  407 *GLASTAT *6.50     *820.0    *         *         *         *         *         *         *
236  407 *GLASTAT *9.00     *500.0    *         *         *         *         *         *         *
237  407 *GLASTAT *9.25     *  0.0    *         *         *         *         *         *         *
238  408 *GLASP   *0.0      *  0.0    *         *         *         *         *         *         *
239  408 *GLASP   *0.9      *675.0    *         *         *         *         *         *         *
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240  408 *GLASP   *1.50     *  0.0 .  *         *         *         *         *         *         *
241  600 *granoda2*5mph     *         *         *         *         *         *         *         *
242  601 *    0.00*   36.67*    0.00*    0.00*    0.00*    0.00*    0.00*    0.00*    0.00*
243  602 *    440.*      1.*      1.*        *        *        *        *        *        *
244      *    0.00*   -3.80*    0.50*   -4.02*    1.00*   -4.24*    1.50*   -4.46*    0.00*
245      *    2.00*   -4.69*    2.50*   -4.91*    3.00*   -5.13*    3.50*   -5.34*    0.00*
246      *    4.00*   -5.54*    4.50*   -5.75*    5.00*   -5.96*    5.50*   -6.17*    0.00*
247      *    6.00*   -6.37*    6.50*   -6.56*    7.00*   -6.75*    7.50*   -6.94*    0.00*
248      *    8.00*   -7.13*    8.50*   -7.31*    9.00*   -7.49*    9.50*   -7.66*    0.00*
249      *   10.00*   -7.83*   10.50*   -7.99*   11.00*   -8.15*   11.50*   -8.30*    0.00*
250      *   12.00*   -8.45*   12.50*   -8.60*   13.00*   -8.74*   13.50*   -8.87*    0.00*
251      *   14.00*   -9.00*   14.50*   -9.14*   15.00*   -9.26*   15.50*   -9.39*    0.00*
252      *   16.00*   -9.51*   16.50*   -9.63*   17.00*   -9.75*   17.50*   -9.88*    0.00*
253      *   18.00*  -10.00*   18.50*  -10.13*   19.00*  -10.26*   19.50*  -10.38*    0.00*
254      *   20.00*  -10.51*   20.50*  -10.63*   21.00*  -10.76*   21.50*  -10.89*    0.00*
255      *   22.00*  -11.01*   22.50*  -11.13*   23.00*  -11.25*   23.50*  -11.37*    0.00*
256      *   24.00*  -11.48*   24.50*  -11.59*   25.00*  -11.69*   25.50*  -11.79*    0.00*
257      *   26.00*  -11.88*   26.50*  -11.97*   27.00*  -12.05*   27.50*  -12.13*    0.00*
258      *   28.00*  -12.21*   28.50*  -12.28*   29.00*  -12.34*   29.50*  -12.40*    0.00*
259      *   30.00*  -12.46*   30.50*  -12.51*   31.00*  -12.56*   31.50*  -12.60*    0.00*
260      *   32.00*  -12.65*   32.50*  -12.68*   33.00*  -12.71*   33.50*  -12.74*    0.00*
261      *   34.00*  -12.77*   34.50*  -12.79*   35.00*  -12.81*   35.50*  -12.82*    0.00*
262      *   36.00*  -12.83*   36.50*  -12.84*   37.00*  -12.85*   37.50*  -12.85*    0.00*
263      *   38.00*  -12.85*   38.50*  -12.85*   39.00*  -12.84*   39.50*  -12.84*    0.00*
264      *   40.00*  -12.83*   40.50*  -12.82*   41.00*  -12.81*   41.50*  -12.80*    0.00*
265      *   42.00*  -12.79*   42.50*  -12.78*   43.00*  -12.76*   43.50*  -12.75*    0.00*
266      *   44.00*  -12.74*   44.50*  -12.73*   45.00*  -12.72*   45.50*  -12.72*    0.00*
267      *   46.00*  -12.71*   46.50*  -12.70*   47.00*  -12.70*   47.50*  -12.70*    0.00*
268      *   48.00*  -12.69*   48.50*  -12.69*   49.00*  -12.69*   49.50*  -12.70*    0.00*
269      *   50.00*  -12.71*   50.50*  -12.72*   51.00*  -12.73*   51.50*  -12.74*    0.00*
270      *   52.00*  -12.76*   52.50*  -12.78*   53.00*  -12.80*   53.50*  -12.83*    0.00*
271      *   54.00*  -12.85*   54.50*  -12.88*   55.00*  -12.91*   55.50*  -12.94*    0.00*
272      *   56.00*  -12.98*   56.50*  -13.02*   57.00*  -13.06*   57.50*  -13.11*    0.00*
273      *   58.00*  -13.16*   58.50*  -13.21*   59.00*  -13.26*   59.50*  -13.32*    0.00*
274      *   60.00*  -13.38*   60.50*  -13.44*   61.00*  -13.51*   61.50*  -13.58*    0.00*
275      *   62.00*  -13.64*   62.50*  -13.72*   63.00*  -13.79*   63.50*  -13.87*    0.00*
276      *   64.00*  -13.95*   64.50*  -14.02*   65.00*  -14.10*   65.50*  -14.18*    0.00*
277      *   66.00*  -14.27*   66.50*  -14.35*   67.00*  -14.44*   67.50*  -14.52*    0.00*
278      *   68.00*  -14.61*   68.50*  -14.69*   69.00*  -14.78*   69.50*  -14.87*    0.00*
279      *   70.00*  -14.95*   70.50*  -15.04*   71.00*  -15.12*   71.50*  -15.20*    0.00*
280      *   72.00*  -15.29*   72.50*  -15.37*   73.00*  -15.45*   73.50*  -15.53*    0.00*
281      *   74.00*  -15.60*   74.50*  -15.68*   75.00*  -15.75*   75.50*  -15.82*    0.00*
282      *   76.00*  -15.89*   76.50*  -15.96*   77.00*  -16.02*   77.50*  -16.08*    0.00*
283      *   78.00*  -16.14*   78.50*  -16.19*   79.00*  -16.25*   79.50*  -16.30*    0.00*
284      *   80.00*  -16.34*   80.50*  -16.39*   81.00*  -16.43*   81.50*  -16.47*    0.00*
285      *   82.00*  -16.50*   82.50*  -16.54*   83.00*  -16.56*   83.50*  -16.59*    0.00*
286      *   84.00*  -16.61*   84.50*  -16.63*   85.00*  -16.64*   85.50*  -16.66*    0.00*
287      *   86.00*  -16.67*   86.50*  -16.67*   87.00*  -16.67*   87.50*  -16.67*    0.00*
288      *   88.00*  -16.67*   88.50*  -16.66*   89.00*  -16.65*   89.50*  -16.63*    0.00*
289      *   90.00*  -16.62*   90.50*  -16.60*   91.00*  -16.57*   91.50*  -16.27*    0.00*
290      *   92.00*  -15.58*   92.50*  -14.92*   93.00*  -14.27*   93.50*  -13.64*    0.00*
291      *   94.00*  -13.03*   94.50*  -12.43*   95.00*  -11.86*   95.50*  -11.29*    0.00*
292      *   96.00*  -10.75*   96.50*  -10.22*   97.00*   -9.70*   97.50*   -9.20*    0.00*
293      *   98.00*   -8.72*   98.50*   -8.25*   99.00*   -7.79*   99.50*   -7.35*    0.00*
294      *  100.00*   -6.92*  100.50*   -6.50*  101.00*   -6.10*  101.50*   -5.71*    0.00*
295      *  102.00*   -5.33*  102.50*   -4.97*  103.00*   -4.61*  103.50*   -4.27*    0.00*
296      *  104.00*   -3.94*  104.50*   -3.62*  105.00*   -3.31*  105.50*   -3.01*    0.00*
297      *  106.00*   -2.72*  106.50*   -2.45*  107.00*   -2.18*  107.50*   -1.92*    0.00*
298      *  108.00*   -1.67*  108.50*   -1.43*  109.00*   -1.20*  109.50*   -0.98*    0.00*
299      *  110.00*   -0.76*  110.50*   -0.56*  111.00*   -0.36*  111.50*   -0.17*    0.00*
```

300		•	112.00•	0.01•	112.50•	0.19•	113.00•	0.36•	113.50•	0.52•	0.00•
301		•	114.00•	0.67•	114.50•	0.82•	115.00•	0.96•	115.50•	1.09•	0.00•
302		•	116.00•	1.22•	116.50•	1.34•	117.00•	1.46•	117.50•	1.57•	0.00•
303		•	118.00•	1.68•	118.50•	1.78•	119.00•	1.87•	119.50•	1.96•	0.00•
304		•	120.00•	2.05•	120.50•	2.13•	121.00•	2.20•	121.50•	2.28•	0.00•
305		•	122.00•	2.34•	122.50•	2.41•	123.00•	2.46•	123.50•	2.52•	0.00•
306		•	124.00•	2.57•	124.50•	2.62•	125.00•	2.66•	125.50•	2.70•	0.00•
307		•	126.00•	2.74•	126.50•	2.78•	127.00•	2.81•	127.50•	2.84•	0.00•
308		•	128.00•	2.86•	128.50•	2.88•	129.00•	2.90•	129.50•	2.92•	0.00•
309		•	130.00•	2.94•	130.50•	2.95•	131.00•	2.96•	131.50•	2.97•	0.00•
310		•	132.00•	2.97•	132.50•	2.98•	133.00•	2.98•	133.50•	2.98•	0.00•
311		•	134.00•	2.98•	134.50•	2.97•	135.00•	2.97•	135.50•	2.96•	0.00•
312		•	136.00•	2.95•	136.50•	2.94•	137.00•	2.93•	137.50•	2.92•	0.00•
313		•	138.00•	2.91•	138.50•	2.89•	139.00•	2.88•	139.50•	2.86•	0.00•
314		•	140.00•	2.84•	140.50•	2.82•	141.00•	2.80•	141.50•	2.78•	0.00•
315		•	142.00•	2.76•	142.50•	2.74•	143.00•	2.71•	143.50•	2.69•	0.00•
316		•	144.00•	2.67•	144.50•	2.64•	145.00•	2.62•	145.50•	2.59•	0.00•
317		•	146.00•	2.56•	146.50•	2.54•	147.00•	2.51•	147.50•	2.48•	0.00•
318		•	148.00•	2.45•	148.50•	2.42•	149.00•	2.39•	149.50•	2.36•	0.00•
319		•	150.00•	2.33•	150.50•	2.30•	151.00•	2.27•	151.50•	2.24•	0.00•
320		•	152.00•	2.21•	152.50•	2.18•	153.00•	2.15•	153.50•	2.12•	0.00•
321		•	154.00•	2.09•	154.50•	2.06•	155.00•	2.03•	155.50•	2.00•	0.00•
322		•	156.00•	1.97•	156.50•	1.94•	157.00•	1.91•	157.50•	1.88•	0.00•
323		•	158.00•	1.85•	158.50•	1.82•	159.00•	1.79•	159.50•	1.76•	0.00•
324		•	160.00•	1.73•	160.50•	1.70•	161.00•	1.67•	161.50•	1.64•	0.00•
325		•	162.00•	1.61•	162.50•	1.58•	163.00•	1.56•	163.50•	1.53•	0.00•
326		•	164.00•	1.50•	164.50•	1.47•	165.00•	1.44•	165.50•	1.42•	0.00•
327		•	166.00•	1.39•	166.50•	1.36•	167.00•	1.34•	167.50•	1.31•	0.00•
328		•	168.00•	1.28•	168.50•	1.26•	169.00•	1.23•	169.50•	1.21•	0.00•
329		•	170.00•	1.18•	170.50•	1.16•	171.00•	1.13•	171.50•	1.11•	0.00•
330		•	172.00•	1.09•	172.50•	1.06•	173.00•	1.04•	173.50•	1.02•	0.00•
331		•	174.00•	0.99•	174.50•	0.97•	175.00•	0.95•	175.50•	0.93•	0.00•
332		•	176.00•	0.91•	176.50•	0.89•	177.00•	0.87•	177.50•	0.85•	0.00•
333		•	178.00•	0.83•	178.50•	0.81•	179.00•	0.79•	179.50•	0.77•	0.00•
334		•	180.00•	0.75•	180.50•	0.73•	181.00•	0.71•	181.50•	0.70•	0.00•
335		•	182.00•	0.68•	182.50•	0.66•	183.00•	0.64•	183.50•	0.63•	0.00•
336		•	184.00•	0.61•	184.50•	0.60•	185.00•	0.58•	185.50•	0.56•	0.00•
337		•	186.00•	0.55•	186.50•	0.53•	187.00•	0.52•	187.50•	0.51•	0.00•
338		•	188.00•	0.49•	188.50•	0.48•	189.00•	0.46•	189.50•	0.45•	0.00•
339		•	190.00•	0.44•	190.50•	0.43•	191.00•	0.41•	191.50•	0.40•	0.00•
340		•	192.00•	0.39•	192.50•	0.38•	193.00•	0.37•	193.50•	0.35•	0.00•
341		•	194.00•	0.34•	194.50•	0.33•	195.00•	0.32•	195.50•	0.31•	0.00•
342		•	196.00•	0.30•	196.50•	0.29•	197.00•	0.28•	197.50•	0.27•	0.00•
343		•	198.00•	0.26•	198.50•	0.26•	199.00•	0.25•	199.50•	0.24•	0.00•
344		•	200.00•	0.23•	200.50•	0.22•	201.00•	0.21•	201.50•	0.21•	0.00•
345		•	202.00•	0.20•	202.50•	0.19•	203.00•	0.18•	203.50•	0.18•	0.00•
346		•	204.00•	0.17•	204.50•	0.16•	205.00•	0.16•	205.50•	0.15•	0.00•
347		•	206.00•	0.15•	206.50•	0.14•	207.00•	0.13•	207.50•	0.13•	0.00•
348		•	208.00•	0.12•	208.50•	0.12•	209.00•	0.11•	209.50•	0.11•	0.00•
349		•	210.00•	0.10•	210.50•	0.10•	211.00•	0.09•	211.50•	0.09•	0.00•
350		•	212.00•	0.08•	212.50•	0.08•	213.00•	0.08•	213.50•	0.07•	0.00•
351		•	214.00•	0.07•	214.50•	0.06•	215.00•	0.06•	215.50•	0.06•	0.00•
352		•	216.00•	0.05•	216.50•	0.05•	217.00•	0.05•	217.50•	0.04•	0.00•
353		•	218.00•	0.04•	218.50•	0.04•	219.00•	0.03•	219.50•	0.03•	0.00•
354	603	•	2.•	1.•	1.•	•	•	•	•	•	•
355		•	0.00•	0.00•	300.00•	0.00•	0.00•	0.00•	0.00•	0.00•	0.00•
356	604	•	2.•	0.•	•	•	•	•	•	•	•
357		•	0.00•	0.00•	300.00•	0.00•	0.00•	0.00•	0.00•	0.00•	0.00•
358	700	•	Unrestrained	•	•	•	•	•	•	•	•

```
MMMMMMMMMM   7777777777777777777777777777777777777777777777777777777777777777777777777777777777777777777777777   MMMMMMMMMM
MMMMMMMMMM   777777777777777777777777  Digital Equipment Corporation - VAX/VMS Version V4.3  777777777777777777777777   MMMMMMMMMM
MMMMMMMMMM   7777777777777777777777777777777777777777777777777777777777777777777777777777777777777777777777777   MMMMMMMMMM
```

```
 CCCC  H   H  U   U   CCCC  K   K  K   K
C      H   H  U   U  C      K  K   K  K
C      H   H  U   U  C      K K    K K
C      HHHHH  U   U  C      KKK    KKK
C      H   H  U   U  C      K K    K K
C      H   H  U   U  C      K  K   K  K
 CCCC  H   H  UUUUU   CCCC  K   K  K   K
```

```
FFFFFFFFFF   000000    RRRRRRRR   DDDDDDDD   77777777     666666   5555555555   000000    222222   5555555555
FFFFFFFFFF   000000    RRRRRRRR   DDDDDDDD   77777777     666666   5555555555   000000    222222   5555555555
FF         00      00  RR      RR DD      DD       77   66         55         00      00 22      22 55
FF         00      00  RR      RR DD      DD       77   66         55         00      00 22      22 55
FF         00      00  RR      RR DD      DD       77   66         555555     00    0000         22 555555
FF         00      00  RR      RR DD      DD       77   66         555555     00    0000         22 555555
FFFFFFFF   00      00  RRRRRRRR   DD      DD     77     66666666         55   00  00  00       22         55
FFFFFFFF   00      00  RRRRRRRR   DD      DD     77     66666666         55   00  00  00       22         55
FF         00      00  RR  RR     DD      DD   77       66      66         55 0000    00     22             55
FF         00      00  RR  RR     DD      DD   77       66      66         55 0000    00     22             55
FF         00      00  RR    RR   DD      DD 77         66      66 55      55 00      00   22       55      55
FF         00      00  RR    RR   DD      DD 77         66      66 55      55 00      00   22       55      55
FF           000000    RR      RR DDDDDDDD   77           666666     555555     000000    2222222222   555555
FF           000000    RR      RR DDDDDDDD   77           666666     555555     000000    2222222222   555555
```

```
        000000    UU      UU  TTTTTTTTTT   ;;;;      11
        000000    UU      UU  TTTTTTTTTT   ;;;;      11
      00      00  UU      UU      TT       ;;;;    1111
      00      00  UU      UU      TT       ;;;;    1111
      00      00  UU      UU      TT                 11
      00      00  UU      UU      TT                 11
      00      00  UU      UU      TT       ;;;;      11
      00      00  UU      UU      TT       ;;;;      11
      00      00  UU      UU      TT       ;;;;      11
      00      00  UU      UU      TT       ;;;;      11
  ..  00      00  UU      UU      TT         ;;      11
 ...  00      00  UU      UU      TT         ;;      11
....    000000    UUUUUUUUUU      TT       ;;      111111
  ..    000000    UUUUUUUUUU      TT       ;;      111111
```

File _DBA2:[SCRATCH.CJK]FORD765025.OUT;1 (5222,66,0), last revised on 16-JUL-1987 08:59, is a 89 block sequential file owned by UIC [CHUCKK]. The records are variable length with FORTRAN (FTN) carriage control. The longest record is 120 bytes.

Job FORD765025 (153) queued to TXG3 on 16-JUL-1987 09:05 by user CHUCKK, UIC [CHUCKK], under account NPP-01 at priority 4, started on printer _TXG3. on 16-JUL-1987 09 05 from queue TXG3


```
MMMMMMMMMM   7777777777777777777777777777777777777777777777777777777777777777777777777777777777777777777777777   MMMMMMMMMM
MMMMMMMMMM   777777777777777777777777  Digital Equipment Corporation - VAX/VMS Version V4.3  777777777777777777777777   MMMMMMMMMM
MMMMMMMMMM   7777777777777777777777777777777777777777777777777777777777777777777777777777777777777777777777777   MMMMMMMMMM
```


```
100 •         •         •     MVM•A 2D CRA•SH VICTI•M SIMULA•TION    •         •         •
101 •1.       •1.       •32 174  •0.      •0.       •192.0   •1.0     •3.       •24.      •
102 •0.       •0.       •0.      •0.      •0.       •0.      •10.     •.000001  •15.      •
103 •0.80     •.02      •100000  •15000   •20.      •.05     •10.     •1.       •1.       •
104 •0.       •00000000•70 1     •00000000•200.     •00000000•201.    •00000000•0.        •
106 •TOE      •         •FLOOR   •        •         •        •        •         •         •
106 •HAND     •         •MID IP  •        •         •        •        •         •         •
106 •HAND     •         •FLOOR   •        •         •        •        •         •         •
106 •HEAD     •         •ROOF    •        •         •        •        •         •         •
106 •HEAD     •         •WINDSHIE•LD      •         •        •        •         •         •
106 •HEAD     •         •SEAT    •        •         •        •        •         •         •
106 •HEAD     •         •TOP IP  •        •         •        •        •         •         •
106 •HEEL     •         •FLOOR   •        •         •        •        •         •         •
106 •KNEE     •         •LOWER IP•        •         •        •        •         •         •
106 •KNEE     •         •FLOOR   •        •         •        •        •         •         •
106 •HIP      •         •FLOOR   •        •         •        •        •         •         •
106 •HIP      •         •SEAT    •        •         •        •        •         •         •
106 •HIP      •         •SEAT FRA•ME      •         •        •        •         •         •
106 •THORAX   •         •MID IP  •        •         •        •        •         •         •
106 •THORAX   •         •SEAT    •        •         •        •        •         •         •
106 •THORAX   •         •SEAT FRA•ME      •         •        •        •         •         •
106 •THORAX   •         •FLOOR   •        •         •        •        •         •         •
106 •ELBOW    •         •MID IP  •        •         •        •        •         •         •
106 •UPPER LE•G         •SEAT FRA•ME      •         •        •        •         •         •
106 •UPPER LE•G         •FLOOR   •        •         •        •        •         •         •
106 •UPPER LE•G         •SEAT    •        •         •        •        •         •         •
200 •Hybiii 5•0th Male•          •        •         •        •        •         •         •
201 •    0.512•  12.402•   5 748•   3.740•  15.827•   0.0  •  10.630•   1.575•  -1.200•
202 •    2.992•   5.630•   2.874•   1.890•   6.102•   9.134•   5.197•   5.069•0.5        •
203 •    0.026•   0.099•   0.018•   0.113•   0.070•   0.052•   0.023•   0.026•   0.009•
204 •    0.221•   1.593•   0 142•   1.115•   1.584•   1.637•   0.212•   0.372•           •
205 •   28.411•   0 575•   0 0  •   0.398•   17.4 •10        •        •-25.     •.35      •
206 •   28.411•   0.575•   0.0  •   0.398•   17.4 •10.       •        •-22.     •.35      •
207 •   96.031•   5.700•   0 0  •   0.0  •   0.0  •500.      •-14.9   •-56.9    •.35      •
208 •   96.031•   5.700•   0.0  •   0.0  •   0.0  •500.      •-4.2    •-64.2    •.35      •
209 •   22.304•  92.933•   0.0  •   0.0  •1380.716•500.      •0.      •-75.3    •.01      •
210 •    0 0  •  29.827•   0.0  •   0.0  • 203.567•100       •135.    •0.       •.5       •
211 •    0 0  •  10.001•   0.0  •   0.0  • 221.269•150.      •28.     •-197.    •.5       •
212 •    0.0  •  10.001•   0.0  •   0.0  •  63.725•40.       •0.      •-165.    •.5       •
213 • 750.884•    0.0  • 755 211•   1.981•          •        •   0.0  •         •         •
214 •  19 986• 230.610•   0 0  •   0.0  •          •        •   1.969•         •.5       •
215 •    4.062•  13.276•   0 0  •   0.111•  19.711• 8.      •25.     •         •.60      •
216 •    4.062•  17.524•   0.0  •   0.053•  74.902• 30.     •7.04    •         •.80      •
218 •2.992    • 7.087   •         •        •         •        •        •         •         •
219 •UPPER LE•G         •         •        •5.       •1.      •        •         •         •
219 •TOE      •         •         •        •6.       •2.      •        •         •         •
219 •HIP      •         •         •        •4.       •1.      •        •         •         •
219 •HEEL     •         •         •        •6.       •2       •        •         •         •
219 •HAND     •         •         •        •8.       •3.      •        •         •         •
219 •THORAX   •         •CHESTMAT•         •2.       •1.      •        •         •         •
219 •HEAD     •         •         •        •1.       •3.      •        •         •         •
219 •KNEE     •         •         •        •5.       •1.      •        •         •         •
219 •ELBOW    •         •         •        •8.       •1.      •        •         •         •
220 •HEAD     •         •   0 472•   0.0  •   4.488•   3.740•          •         •         •
220 •KNEE     •         •   9 449•   0.0  •   2.677•   2.677•          •         •         •
220 •ELBOW    •         •  -4 543•   0.0  •   2.362•   1.772•          •         •         •
220 •THORAX   •         •   1 535•  -1.102•   5.984•   4.803•          •         •         •
220 •HEEL     •         •   8 937•   0.0  •   2.520•   2.520•          •         •         •
220 •HAND     •         •   7 047•   0.0  •   2.717•   1.535•          •         •         •
```

```
60  220 •HIP      •        •   1 024•  -0.472•   4.921•   4.921•          •         •         •
61  220 •TOE      •        •   3 64 •  -6.19 •   1.181•   1.181•          •         •         •
62  220 •UPPER LE•G        •   3 937•  -0.315•   5 0  •   3.071•          •         •         •
63  242 •3003.537•   0.0  •3020 846•   7.926•           •        •          •         •         •
64  221 •CHESTMAT•         •   0 0  •   0.0  •   0.0  • 1000.  • 1000.  •    0.0  •    0.0  •
65  222 •CHESTMAT•         •   30 00•          •          •        •CHSTAT   •CHZERO   •GRCHST   •
66  223 •GRCHST   • 0.079  • 0 10   •          •          •        •          •         •         •
67  223 •GRCHST   • 0.0    • 0 0    •          •          •        •          •         •         •
68  223 •GRCHST   • 5 906  • 0 99   •          •          •        •          •         •         •
69  223 •GRCHST   • 3 937  • 0 50   •          •          •        •          •         •         •
70  223 •GRCHST   • 2 283  • 0.10   •          •          •        •          •         •         •
71  224 •GRCHST   • 0.0    • 1.0    •          •          •        •          •         •         •
72  224 •GRCHST   • 0 079  • 0 5    •          •          •        •          •         •         •
73  224 •GRCHST   • 5.906  • 0 005  •          •          •        •          •         •         •
74  224 •GRCHST   • 3 937  • 0 1    •          •          •        •          •         •         •
75  224 •GRCHST   • 2.283  • 0.2    •          •          •        •          •         •         •
76  225 •CHSTAT   • 0.0    •    0 0 •          •          •        •          •         •         •
77  225 •CHSTAT   • 0 079  • 449 62 •          •          •        •          •         •         •
78  225 •CHSTAT   • 2.283  •1239 454•          •          •        •          •         •         •
79  225 •CHSTAT   • 3.937  •1348 855•          •          •        •          •         •         •
80  225 •CHSTAT   • 5 906  •4000    •          •          •        •          •         •         •
81  226 •CHZERO   •-1.     •    0 0 •          •          •        •          •         •         •
82  300 •76Ford/5•0hyb/mid•          •          •          •        •          •         •         •
83  301 •80.64    •92 49   •129.97  •143.55  •16 46   •-36.93  •-80.    •-10.     •92.84    •
84  302 •0.       •0       •0.      •0.      •0.      •0.      •0.      •0.       •0.       •
85  303 •18.146   •0       •-28.28  •0.      •3.54    •0.      •        •         •         •
86  304 •0.       •0.      •0.      •0.      •        •        •        •         •         •
87  217 •-12.20   •0 35    •-37.48  •-13.58  •-52.91  •53.39   •0.      •0.       •         •
88  411 •SEAT BAC•K        •-1.     •13 016  •-35.46  •21.256  •-12.82  •         •         •
89  411 •SEAT CUS•HION     •-1.     •21.256  •-12.82  •37.866  •-17.27  •         •         •
90  411 •SEAT BEA•M        •-1.     •32.036  •-10.72  •37.866  •-12.27  •         •         •
91  400 •76FordLT•D        •        •        •        •        •        •         •         •
92  401 •SEAT     •        •SEAT MAT•ERIAL   •0.      •1.      •1.      •1.       •         •
93  402 •SEAT     •        •2       •1.      •1.      •     0.•      0.•         •         •
94  409 •SEAT BAC•K        •SEAT    •        •5.0     •0.      •     -1.•      1.•          •
95  410 •SEAT BAC•K        •      1.•        •        •        •        •         •         •
96  409 •SEAT CUS•HION     •SEAT    •        •5.0     •0.      •     -1.•      2.•          •
97  410 •SEAT CUS•HION     •      1.•        •        •        •        •         •         •
98  401 •SEAT FRA•ME       •STEEL   •        •0.      •1.      •1.      •1.       •         •
99  402 •SEAT FRA•ME       •1       •1.      •1.      •0.      •0.      •         •         •
100 409 •SEAT BEA•M        •SEAT FRA•ME      •.528    •.1      •-1.     •1.       •         •
101 410 •SEAT BEA•M        •      1 •        •        •        •        •         •         •
102 401 •FLOOR    •        •FLOOR MA•TERIAL  •0.      •1.      •1.      •1.       •         •
103 402 •FLOOR    •        •      3.•2.      •1.      •     0.•      0.•         •         •
104 409 •FLOORBOA•RD       •FLOOR   •        •.528    •0.      •     -1.•      1.•          •
105 410 •FLOORBOA•RD       •      1.•        •        •        •        •         •         •
106 411 •FLOORBOA•RD       •     -1.•   8 00•   -6.00•   58.37•   -6.00•         •         •
107 409 •TOEBOARD•         •FLOOR   •        •.528    •     .37•      1.•      2.•          •
108 410 •TOEBOARD•         •      1.•        •        •        •        •         •         •
109 411 •TOEBOARD•         •     -1.•  58.37•   -6.00•   63.71•  -10.61•         •         •
110 409 •FIREWALL•         •FLOOR   •        •.528    •0.      •        •      1.•      3.•  •
111 410 •FIREWALL•         •      1.•        •        •        •        •         •         •
112 411 •FIREWALL•         •     -1 •  63.71•  -10.61•   63.71•  -30.00•         •         •
113 401 •ROOF     •        •ROOF MAT•ERIAL   •0.      •1.      •1.      •1.       •         •
114 402 •ROOF     •        •      2.•6.      •1.      •     0.•      0.•         •         •
115 409 •ROOF TOP•         •ROOF    •        •.528    •0.      •        •      1.•      1.•  •
116 410 •ROOF TOP•         •      1.•        •        •        •        •         •         •
117 411 •ROOF TOP•         •     -1.•   8.37• -51.440•  27.216• -51.440•         •         •
118 409 •HEADER   •        •ROOF    •        •.528    •0.      •        •      1.•      2.•  •
119 410 •HEADER   •        •      1.•        •        •        •        •         •         •

120 411 •HEADER   •        •     -1 • 27.216• -51.440•  32.788• -48.092•         •         •
121 401 •WINDSHIE•LD       •GLASS MA•TERIAL  •        •1.      •1       •1.       •         •
122 402 •WINDSHIE•LD       •1       •5.      •1.      •     0.•      0.•         •         •
123 409 •WINDSHIE•LD       •WINDSHIE•LD      •.528    •0.      •      1.•      1.•          •
124 410 •WINDSHIE•LD       •      1.•        •        •        •        •         •         •
125 411 •WINDSHIE•LD       •     -1.• 32.788• -48.092•  57.804• -31.534•         •         •
126 401 •TOP IP   •        •TOP IP M•ATERIAL •0.      •1.      •1.      •1.       •         •
127 402 •TOP IP   •        •1.      •4       •1.      •     0.•      0.•         •         •
128 401 •MID IP   •        •MID IP M•ATERIAL •0.      •1.      •1.      •1.       •         •
129 402 •MID IP   •        •1.      •4.      •1.      •     0.•      0.•         •         •
130 401 •LOWER IP•         •LOW IP M•ATERIAL •0.      •1.      •1       •1.       •         •
131 402 •LOWER IP•         •1.      •4.      •1.      •     0.•      0.•         •         •
132 409 •IP PANEL•-1ST     •TOP IP  •        •.528    •.1      •     -1.•      1.•          •
133 410 •IP PANEL•-1ST     •      1.•        •        •        •        •         •         •
134 411 •IP PANEL•-1ST     •     -1.• 57.804• -31.534•  44.870• -32.620•         •         •
135 409 •IP PANEL•-2ND     •MID IP  •        •.528    •.25     •      1.•      1.•          •
136 410 •IP PANEL•-2ND     •      1.•        •        •        •        •         •         •
137 411 •IP PANEL•-2ND     •     -1.• 45.256• -32.645•  51.154• -16.084•         •         •
138 409 •IP PANEL•-3RD     •LOWER IP•        •.528    •.20     •      1.•      1.•          •
139 410 •IP PANEL•-3RD     •      1.•        •        •        •        •         •         •
140 411 •IP PANEL•-3RD     •     -1.• 45.144• -31.338•  54 919•  -7.624•         •         •
141 403 •TOP IP M•ATERIAL •0.0     •0.0     •0.0     •1000.0  •1000.1  •0.0     •0.0      •
142 404 •TOP IP M•ATERIAL •5 620   •        •        •        •TIPSTAT •TIPI    •GRTIP    •
143 405 •GRTIP    •-1.     •0.662   •        •        •        •        •         •         •
144 406 •GRTIP    •-1.     •0 164   •        •        •        •        •         •         •
145 407 •TIPSTAT •0.00    •   0 00 •        •        •        •        •         •         •
146 407 •TIPSTAT •5.65    • 578 0  •        •        •        •        •         •         •
147 408 •TIPI     • -1.0   •   0 0  •        •        •        •        •         •         •
148 403 •MID IP M•ATERIAL •0.0     •0.0     •0 0     •1000.0  •1000.1  •0.0     •0.0      •
149 404 •MID IP M•ATERIAL •5.620   •        •        •        •MIPSTAT •MIPI    •MIPGR    •
150 405 •MIPGR    •-1.     •0 517   •        •        •        •        •         •         •
151 406 •MIPGR    •-1.     •0.102   •        •        •        •        •         •         •
152 407 •MIPSTAT •0.0     •0.0     •        •        •        •        •         •         •
153 407 •MIPSTAT •1.30    •1800    •        •        •        •        •         •         •
154 407 •MIPSTAT •3.70    • 700    •        •        •        •        •         •         •
155 407 •MIPSTAT •7 00    •1500    •        •        •        •        •         •         •
156 408 •MIPI     •-1.0    •0.0     •        •        •        •        •         •         •
157 403 •LOW IP M•ATERIAL •0.0     •0.0     •0.0     •1000.0  •1000.1  •0.0     •0.0      •
158 404 •LOW IP M•ATERIAL •5.620   •        •        •        •LIPSTAT •LIPI    •LIPGR    •
159 405 •LIPGR    •-1.     •0 999   •        •        •        •        •         •         •
160 406 •LIPGR    •-1.     •0.001   •        •        •        •        •         •         •
161 407 •LIPSTAT •0.00    •    0 0 •        •        •        •        •         •         •
162 407 •LIPSTAT •1.00    • 500    •        •        •        •        •         •         •
163 407 •LIPSTAT •3.70    • 600    •        •        •        •        •         •         •
164 407 •LIPSTAT •4 80    •1130    •        •        •        •        •         •         •
165 407 •LIPSTAT •5.80    • 650    •        •        •        •        •         •         •
166 407 •LIPSTAT •10.0    • 650    •        •        •        •        •         •         •
167 407 •LIPSTAT •16.0    •1850    •        •        •        •        •         •         •
168 408 •LIPI     •-1.0    •   0.0  •        •        •        •        •         •         •
169 403 •FLOOR MA•TERIAL  •  0 000•   0.000•   0.394•   7.874•   9.843•   0.000•   0.000•
170 404 •FLOOR MA•TERIAL  •  5 620•         •        •        •CPSTAT  •ICARP   •GRCARP   •
171 405 •GRCARP   •-0.394  •0.1     •        •        •        •        •         •         •
172 406 •GRCARP   •-0.394  •0 5     •        •        •        •        •         •         •
173 407 •CPSTAT   •0.000   •   0 000•   0.000•   0.000•   0.000•   0.000•   0.000•          •
174 407 •CPSTAT   •0.197   • 196.850•   0.000•   0.000•   0.000•   0.000•   0.000•          •
175 407 •CPSTAT   •0.394   • 787.402•   0.000•   0.000•   0.000•   0.000•   0.000•          •
176 407 •CPSTAT   •7.874   •7874 016•   0.000•   0.000•   0.000•   0.000•   0.000•          •
177 407 •CPSTAT   •9.843   •   0 000•   0.000•   0.000•   0.000•   0.000•   0.000•          •
178 408 •ICARP    •- 394   •        •        •        •        •        •         •         •
179 412 •1.       •4.      •.3      •0.0     •0.0     •        •        •         •         •
```

```
412 •1.      •1.      •.75     •0 0     •0.0     •        •        •        •        •
412 •2.      •2       •.8      •0 0     •0.0     •        •        •        •        •
412 •3       •1.      • 75     •0.0     •0 0     •        •        •        •        •
412 •3.      •2       •.9      •0 0     •0 0     •        •        •        •        •
412 •3.      •5.      • 55     •0 0     •0.0228  •        •        •        •        •
412 •3       •4       • 5      •0 0     •0.0     •        •        •        •        •
403 •ROOF MAT•ERIAL   •0       •0       •0       •100.    •101     •0.      •-1 0    •
404 •ROOF MAT•ERIAL   •5       •0.      •0.      •0.      •RSTAT   •IROOF   •DGR     •
407 •RSTAT   •-1.     •1200    •-65.36  •67.38   •-29.36  •4.78    •        •        •
408 •IROOF   •-1.     •0.      •        •        •        •        •        •        •
405 •DGR     •0.      •0.      •        •        •        •        •        •        •
405 •DGR     •.001    •.01     •        •        •        •        •        •        •
405 •DGR     •10      • 01     •        •        •        •        •        •        •
406 •DGR     •0.      •1       •        •        •        •        •        •        •
406 •DGR     •.001    •.91     •        •        •        •        •        •        •
406 •DGR     • 75     •.8      •        •        •        •        •        •        •
406 •DGR     •1.5     •.5      •        •        •        •        •        •        •
406 •DGR     •10.     •.3      •        •        •        •        •        •        •
403 •SEAT MAT•ERIAL   •     0 0 •    0.0 •   3.937•   6.693•   7.480•    0.0 •    0.0 •
404 •SEAT MAT•ERIAL   •5.62     •        •        •        •SSEAT   •ISEAT2  •GRSEAT  •
405 •GRSEAT  •  -0.984•.1       •        •        •        •        •        •        •
406 •GRSEAT  •  -0.984•.5       •        •        •        •        •        •        •
407 •SSEAT   •    0.0 •     0 0 •    0.0 •    0.0 •    0.0 •    0.0 •    0.0 •        •
407 •SSEAT   •  1.850•  37 768•    0.0 •    0.0 •    0 0 •    0 0 •    0.0 •        •
407 •SSEAT   •  4.213• 202 328•    0.0 •    0.0 •    0.0 •    0.0 •    0.0 •        •
407 •SSEAT   •  4.961• 330 469•    0.0 •    0 0 •    0.0 •    0.0 •    0.0 •        •
407 •SSEAT   •  7.008•1252 86 •    0.0 •    0 0 •    0 0 •    0.0 •    0.0 •        •
407 •SSEAT   •  7.480•     0 0 •    0.0 •    0.0 •    0.0 •    0.0 •    0.0 •        •
408 •ISEAT2  •-1.0    •        •        •        •        •        •        •        •
403 •STEEL   •        •   0 000•   0.000•   0.394•   4.724•   5.906•   0.000•   0 000•
404 •STEEL   •        •   5 620•        •        •        •SSTEEL  •ISTEEL1 •GRSTEEL •
405 •GRSTEEL •  0.000•0         •        •        •        •        •        •        •
405 •GRSTEEL •  0.394• 1        •        •        •        •        •        •        •
405 •GRSTEEL •  4.724•.9        •        •        •        •        •        •        •
405 •GRSTEEL •  5.906•.99       •        •        •        •        •        •        •
406 •GRSTEEL •  0.000•1.        •        •        •        •        •        •        •
406 •GRSTEEL •.394    •.8       •        •        •        •        •        •        •
406 •GRSTEEL •  4.724• 05       •        •        •        •        •        •        •
406 •GRSTEEL •  5.906• 005      •        •        •        •        •        •        •
407 •SSTEEL  •  0.000•   0 000•   0 000•   0.000•   0.000•   0.000•   0.000•        •
407 •SSTEEL  •  0 394•1574 803•   0.000•   0 000•   0 000•   0.000•   0.000•        •
407 •SSTEEL  •  4.724•1574.803•   0.000•   0 000•   0.000•   0.000•   0.000•        •
407 •SSTEEL  •  5.906•   0 000•   0.000•   0.000•   0.000•   0.000•   0.000•        •
408 •ISTEEL1 •-.394   •        •        •        •        •        •        •        •
403 •GLASS MA•TERIAL  •0 90    •1.50    •0.85    •1000.   •1000 1  •0 0     •0.0     •
404 •GLASS MA•TERIAL  •5.620   •        •        •        •GLASTAT •GLASP   •GRGLAS  •
405 •GRGLAS  •-1.     •0 977   •        •        •        •        •        •        •
406 •GRGLAS  •-1      •0 004   •        •        •        •        •        •        •
407 •GLASTAT •0.00    •  0.00  •        •        •        •        •        •        •
407 •GLASTAT •1.25    •550 0   •        •        •        •        •        •        •
407 •GLASTAT •1.75    •490 0   •        •        •        •        •        •        •
407 •GLASTAT •3 60    •840.0   •        •        •        •        •        •        •
407 •GLASTAT •4.00    •800 0   •        •        •        •        •        •        •
407 •GLASTAT •6 00    •830 0   •        •        •        •        •        •        •
407 •GLASTAT •6.50    •820 0   •        •        •        •        •        •        •
407 •GLASTAT •9.00    •500 0   •        •        •        •        •        •        •
407 •GLASTAT •9.25    •  0 0   •        •        •        •        •        •        •
408 •GLASP   •0.0     •  0 0   •        •        •        •        •        •        •
408 •GLASP   •0.9     •675.0   •        •        •        •        •        •        •
408 •GLASP   •1.50    •  0 0   •        •        •        •        •        •        •
```

```
600 •granado2•5mph   •        •        •        •        •        •        •        •
601 •   0.00•  36.67•   0 00•   0 00•   0.00•   0.00•   0 00•   0.00•   0.00•
602 •   440.•     1 •     1 •        •        •        •        •        •        •
    •   0.00•  -3.80•   0 50•  -4 02•   1.00•  -4.24•   1.50•  -4.46•   0.00•
    •   2 00•  -4 69•   2 50•  -4 91•   3 00•  -5.13•   3.50•  -5.34•   0.00•
    •   4.00•  -5.54•   4 50•  -5.75•   5.00•  -5.96•   5.50•  -f.17•   0.00•
    •   6.00•  -6.37•   6 50•  -6 56•   7.00•  -6.75•   7.50•     94•   0.00•
    •   8.00•  -7.13•   8 50•  -7.31•   9.00•  -7.49•   9.50•  -7.66•   0.00•
    •  10.00•  -7.83•  10 50•  -7 99•  11.00•  -8 15•  11 50•  -8.30•   0.00•
    •  12.00•  -8.45•  12 50•  -8.60•  13.00•  -8 74•  13.50•  -8.87•   0.00•
    •  14.00•  -9.00•  14 50•  -9 14•  15.00•  -9.26•  15.50•  -9.39•   0.00•
    •  16.00•  -9.51•  16.50•  -9.63•  17.00•  -9.75•  17.50•  -9.88•   0.00•
    •  18.00• -10.00•  18 50• -10 13•  19.00• -10.26•  19.50• -10.38•   0.00•
    •  20.00• -10.51•  20 50• -10.63•  21.00• -10 76•  21 50• -10.89•   0 00•
    •  22.00• -11.01•  22 50• -11.13•  23.00• -11.25•  23.50• -11.37•   0.00•
    •  24 00• -11.48•  24.50• -11 59•  25.00• -11.69•  25 50• -11.79•   0.00•
    •  26.00• -11.88•  26 50• -11.97•  27.00• -12.05•  27 50• -12.13•   0.00•
    •  28 00• -12.21•  28 50• -12.28•  29 00• -12.34•  29 50• -12.40•   0.00•
    •  30.00• -12.46•  30 50• -12.51•  31.00• -12.56•  31 50• -12.60•   0.00•
    •  32.00• -12 65•  32 50• -12.68•  33 00• -12.71•  33 50• -12.74•   0.00•
    •  34.00• -12 77•  34.50• -12.79•  35.00• -12.81•  35 50• -12.82•   0.00•
    •  36 00• -12.83•  36 50• -12 84•  37.00• -12.85•  37.50• -12.85•   0.00•
    •  38.00• -12.85•  38 50• -12.85•  39.00• -12.84•  39.50• -12.84•   0.00•
    •  40 00• -12.83•  40 50• -12 82•  41.00• -12.81•  41.50• -12.80•   0.00•
    •  42.00• -12.79•  42 50• -12.78•  43.00• -12.76•  43.50• -12.75•   0.00•
    •  44 00• -12.74•  44 50• -12.73•  45.00• -12.72•  45.50• -12.72•   0.00•
    •  46.00• -12.71•  46.50• -12.70•  47.00• -12.70•  47.50• -12.70•   0.00•
    •  48.00• -12.69•  48.50• -12.69•  49.00• -12.69•  49.50• -12.70•   0.00•
    •  50.00• -12.71•  50.50• -12.72•  51.00• -12.73•  51.50• -12.74•   0.00•
    •  52.00• -12.76•  52 50• -12.78•  53.00• -12.80•  53 50• -12.83•   0.00•
    •  54 00• -12 85•  54 50• -12.88•  55.00• -12.91•  55.50• -12.94•   0.00•
    •  56.00• -12.98•  56.50• -13.02•  57.00• -13.06•  57.50• -13.11•   0.00•
    •  58.00• -13.16•  58.50• -13.21•  59.00• -13.26•  59.50• -13.32•   0.00•
    •  60 00• -13.38•  60 50• -13 44•  61.00• -13.51•  61.50• -13.58•   0.00•
    •  62.00• -13.64•  62 50• -13.72•  63.00• -13.79•  63.50• -13.87•   0.00•
    •  64 00• -13.95•  64 50• -14.02•  65.00• -14.10•  65.50• -14.18•   0 00•
    •  66.00• -14.27•  66.50• -14.35•  67.00• -14.44•  67.50• -14.52•   0.00•
    •  68.00• -14.61•  68 50• -14.69•  69.00• -14.78•  69.50• -14.87•   0.00•
    •  70.00• -14.95•  70.50• -15.04•  71.00• -15.12•  71.50• -15.20•   0.00•
    •  72.00• -15.29•  72.50• -15.37•  73.00• -15.45•  73.50• -15.53•   0.00•
    •  74.00• -15.60•  74 50• -15.68•  75.00• -15.75•  75.50• -15.82•   0.00•
    •  76.00• -15.89•  76 50• -15.96•  77.00• -16.02•  77.50• -16.08•   0.00•
    •  78.00• -16.14•  78 50• -16.19•  79.00• -16.25•  79.50• -16.30•   0.00•
    •  80.00• -16.34•  80 50• -16.39•  81.00• -16.43•  81.50• -16.47•   0.00•
    •  82.00• -16.50•  82 50• -16 54•  83.00• -16.56•  83.50• -16.59•   0.00•
    •  84.00• -16.61•  84 50• -16.63•  85.00• -16.64•  85 50• -16.66•   0.00•
    •  86.00• -16.67•  86.50• -16 67•  87.00• -16.67•  87.50• -16.67•   0.00•
    •  88.00• -16.67•  88.50• -16.66•  89.00• -16.65•  89.50• -16.63•   0.00•
    •  90.00• -16.62•  90.50• -16.60•  91.00• -16.57•  91.50• -16.27•   0.00•
    •  92.00• -15.58•  92.50• -14.92•  93.00• -14.27•  93.50• -13.64•   0.00•
    •  94.00• -13.03•  94 50• -12.43•  95.00• -11.86•  95 50• -11.29•   0.00•
    •  96.00• -10 75•  96 50• -10.22•  97.00•  -9.70•  97.50•  -9.20•   0.00•
    •  98.00•  -8.72•  98 50•  -8.25•  99.00•  -7.79•  99.50•  -7.35•   0.00•
    • 100.00•  -6.92• 100 50•  -6.50• 101.00•  -6.10• 101.50•  -5.71•   0.00•
    • 102.00•  -5.33• 102.50•  -4.97• 103.00•  -4.61• 103 50•  -4.27•   0.00•
    • 104.00•  -3.94• 104.50•  -3.62• 105.00•  -3.31• 105.50•  -3.01•   0.00•
    • 106.00•  -2.72• 106.50•  -2.45• 107.00•  -2.18• 107.50•  -1.92•   0.00•
    • 108.00•  -1.67• 108.50•  -1.43• 109.00•  -1.20• 109.50•  -0.98•   0.00•
    • 110 00•  -0.76• 110 50•  -0.56• 111.00•  -0 36• 111.50•  -0.17•   0.00•
    • 112 00•   0.01• 112 50•   0.19• 113.00•   0.36• 113.50•   0.52•   0.00•
```

300		•	114.00•	0.67•	114.50•	0.82•	115.00•	0.96•	115.50•	1.09•	0.00•
301		•	116.00•	1.22•	116.50•	1.34•	117.00•	1.46•	117.50•	1.57•	0.00•
302		•	118,00•	1.68•	118.50•	1.78•	119.00•	1.87•	119.50•	1.96•	0.00•
303		•	120.00•	2.05•	120.50•	2.13•	121.00•	2.20•	121.50•	2.28•	0.00•
304		•	122.00•	2.34•	122.50•	2.41•	123.00•	2.46•	123.50•	2.52•	0.00•
305		•	124.00•	2.57•	124 50•	2.62•	125.00•	2.66•	125.50•	2.70•	0.00•
306		•	126.00•	2.74•	126 50•	2.78•	127.00•	2.81•	127.50•	2.84•	0.00•
307		•	128.00•	2.86•	128.50•	2.88•	129.00•	2.90•	129.50•	2.92•	0.00•
308		•	130.00•	2.94•	130 50•	2.95•	131.00•	2 96•	131.50•	2.97•	0.00•
309		•	132.00•	2.97•	132 50•	2.98•	133.00•	2.98•	133.50•	2.98•	0.00•
310		•	134.00•	2.98•	134.50•	2.97•	135.00•	2.97•	135.50•	2.96•	0.00•
311		•	136.00•	2.95•	136 50•	2.94•	137.00•	2.93•	137.50•	2.92•	0.00•
312		•	138.00•	2.91•	138.50•	2.89•	139.00•	2.88•	139.50•	2.86•	0.00•
313		•	140.00•	2.84•	140.50•	2.82•	141.00•	2.80•	141.50•	2.78•	0.00•
314		•	142.00•	2.76•	142.50•	2.74•	143.00•	2.71•	143.50•	2.69•	0.00•
315		•	144.00•	2.67•	144.50•	2.64•	145.00•	2.62•	145.50•	2.59•	0.00•
316		•	146.00•	2.56•	146 50•	2.54•	147.00•	2.51•	147.50•	2.48•	0.00•
317		•	148.00•	2.45•	148.50•	2.42•	149.00•	2.39•	149.50•	2.36•	0.00•
318		•	150.00•	2.33•	150 50•	2.30•	151.00•	2.27•	151.50•	2.24•	0.00•
319		•	152.00•	2.21•	152 50•	2.18•	153.00•	2.15•	153.50•	2.12•	0.00•
320		•	154.00•	2.09•	154 50•	2.06•	155 00•	2.03•	155.50•	2.00•	0.00•
321		•	156.00•	1.97•	156.50•	1.94•	157.00•	1.91•	157.50•	1.88•	0.00•
322		•	158.00•	1 85•	158 50•	1.82•	159.00•	1.79•	159.50•	1.76•	0.00•
323		•	160.00•	1.73•	160 50•	1.70•	161.00•	1.67•	161.50•	1.64•	0.00•
324		•	162.00•	1.61•	162.50•	1.58•	163.00•	1.56•	163.50•	1.53•	0.00•
325		•	164.00•	1.50•	164 50•	1.47•	165.00•	1 44•	165.50•	1.42•	0.00•
326		•	166.00•	1.39•	166.50•	1.36•	167.00•	1.34•	167.50•	1.31•	0.00•
327		•	168.00•	1.28•	168.50•	1.26•	169.00•	1.23•	169.50•	1.21•	0.00•
328		•	170.00•	1.18•	170 50•	1.16•	171.00•	1.13•	171.50•	1.11•	0.00•
329		•	172.00•	1.09•	172 50•	1.06•	173.00•	1.04•	173.50•	1.02•	0.00•
330		•	174.00•	0.99•	174 50•	0.97•	175.00•	0.95•	175.50•	0.93•	0.00•
331		•	176.00•	0.91•	176 50•	0.89•	177.00•	0.87•	177.50•	0.85•	0.00•
332		•	178.00•	0.83•	178.50•	0.81•	179.00•	0.79•	179.50•	0.77•	0.00•
333		•	180.00•	0.75•	180 50•	0.73•	181.00•	0 71•	181.50•	0.70•	0.00•
334		•	182.00•	0.68•	182 50•	0.66•	183.00•	0.64•	183.50•	0.63•	0.00•
335		•	184.00•	0.61•	184 50•	0 60•	185.00•	0.58•	185.50•	0.56•	0.00•
336		•	186.00•	0.55•	186 50•	0.53•	187.00•	0.52•	187.50•	0.51•	0.00•
337		•	188.00•	0.49•	188 50•	0.48•	189.00•	0.46•	189.50•	0.45•	0.00•
338		•	190.00•	0.44•	190 50•	0.43•	191.00•	0.41•	191.50•	0.40•	0.00•
339		•	192.00•	0.39•	192 50•	0.38•	193.00•	0.37•	193.50•	0.35•	0.00•
340		•	194.00•	0.34•	194 50•	0.33•	195.00•	0.32•	195.50•	0.31•	0.00•
341		•	196.00•	0.30•	196 50•	0.29•	197.00•	0.28•	197.50•	0.27•	0.00•
342		•	198.00•	0.26•	198.50•	0.26•	199.00•	0.25•	199.50•	0.24•	0.00•
343		•	200.00•	0.23•	200 50•	0.22•	201.00•	0.21•	201.50•	0.21•	0.00•
344		•	202.00•	0.20•	202.50•	0.19•	203.00•	0.18•	203.50•	0.18•	0.00•
345		•	204.00•	0.17•	204.50•	0.16•	205.00•	0.16•	205.50•	0.15•	0.00•
346		•	206.00•	0.15•	206.50•	0.14•	207.00•	0.13•	207.50•	0.13•	0.00•
347		•	208.00•	0.12•	208.50•	0.12•	209.00•	0.11•	209.50•	0.11•	0.00•
348		•	210.00•	0.10•	210.50•	0.10•	211.00•	0.09•	211.50•	0.09•	0.00•
349		•	212.00•	0.08•	212 50•	0.08•	213.00•	0.08•	213.50•	0.07•	0.00•
350		•	214.00•	0.07•	214 50•	0.06•	215.00•	0.06•	215.50•	0.06•	0.00•
351		•	216.00•	0.05•	216 50•	0.05•	217.00•	0.05•	217.50•	0.04•	0.00•
352		•	218.00•	0.04•	218 50•	0.04•	219.00•	0.03•	219.50•	0.03•	0.00•
353	603	•	2.•	1.•	1.•	•	•	•	•	•	•
354		•	0.00•	0.00•	300 00•	0.00•	0.00•	0.00•	0.00•	0.00•	0.00•
355	604	•	2.•	0.•	•	•	•	•	•	•	•
356		•	0.00•	0.00•	300 00•	0 00•	0.00•	0 00•	0.00•	0.00•	0.00•
357	700	•	Unrestreined	•	•	•	•	•	•	•	•

```
EEEEEEEEEE   2222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222   EEEEEEEEEE
EEEEEEEEEE   22222222222222222222222222  Digital Equipment Corporation - VAX/VMS Version V4.3  22222222222222222222222222   EEEEEEEEEE
EEEEEEEEEE   2222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222   EEEEEEEEEE
```

CHUCKK

FORD760525

OUT;1

File _DBA2:[SCRATCH.CJK]FORD760525.OUT;1 (5249,64,0), last revised on 16-JUL-1987 09:46, is a 89 block sequential file owned by UIC [CHUCKK]. The records are variable length with FORTRAN (FTN) carriage control. The longest record is 120 bytes.

Job FORD760525 (180) queued to TXG3 on 16-JUL-1987 09:54 by user CHUCKK, UIC [CHUCKK], under account NPP-01 at priority 4, started on printer _TXG3. on 16-JUL-1987 09.55 from queue TXG3.


```
EEEEEEEEEE   2222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222   EEEEEEEEEE
EEEEEEEEEE   22222222222222222222222222  Digital Equipment Corporation - VAX/VMS Version V4.3  22222222222222222222222222   EEEEEEEEEE
EEEEEEEEEE   2222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222222   EEEEEEEEEE
```


```
100 •          •          •      MVM•A 2D CRA•SH VICTI•M SIMULA•TION    •          •          •
101 •1.        •1.        •32 174  •0.       •0.       •102.0   •1.0     •3.        •24.       •
102 •0.        •0.        •0.      •0.       •0.       •0.      •10.     •.000001 •15.        •
103 •0.80      •.02       •100000. •15000.   •20.      •.05     •10.     •1.        •1.        •
104 •0.        •00000000•70.1      •00000000•200.      •00000000•201.    •00000000•0.          •
106 •TOE       •          •FLOOR   •         •         •        •        •          •          •
106 •HAND      •          •MID IP  •         •         •        •        •          •          •
106 •HAND      •          •FLOOR   •         •         •        •        •          •          •
106 •HEAD      •          •ROOF    •         •         •        •        •          •          •
106 •HEAD      •          •WINDSHIE•LD      ,•         •        •        •          •          •
106 •HEAD      •          •SEAT    •         •         •        •        •          •          •
106 •HEAD      •          •TOP IP  •         •         •        •        •          •          •
106 •HEEL      •          •FLOOR   •         •         •        •        •          •          •
106 •KNEE      •          •LOWER IP•         •         •        •        •          •          •
106 •KNEE      •          •FLOOR   •         •         •        •        •          •          •
106 •HIP       •          •FLOOR   •         •         •        •        •          •          •
106 •HIP       •          •SEAT    •         •         •        •        •          •          •
106 •HIP       •          •SEAT FRA•ME       •         •        •        •          •          •
106 •THORAX    •          •MID IP  •         •         •        •        •          •          •
106 •THORAX    •          •SEAT    •         •         •        •        •          •          •
106 •THORAX    •          •SEAT FRA•ME       •         •        •        •          •          •
106 •THORAX    •          •FLOOR   •         •         •        •        •          •          •
106 •ELBOW     •          •MID IP  •         •         •        •        •          •          •
106 •UPPER LE•G           •SEAT FRA•ME       •         •        •        •          •          •
106 •UPPER LE•G           •FLOOR   •         •         •        •        •          •          •
106 •UPPER LE•G           •SEAT    •         •         •        •        •          •          •
200 •Hybiii 5•th Femal•e           •         •         •        •        •          •          •
201 •    0.437•   10.573•    4.900•    3.189•   13.493•    0.0  •    9.063•    1.343• -1.074 •
202 •    2.551•    4.800•    2 450•    1.611•    5.202•    7.787•    4.431•    4.833• 0.5    •
203 •    0.016•    0.062•    0 011•    0.070•    0.043•    0.032•    0.014•    0.016•    0.005•
204 •    0.101•    0.725•    0.066•    0.507•    0.721•    0.745•    0.097•    0.100•         •
205 •  17.71 •    0.358•    0 0  •    0.0  •    0.0  •10.      •         •-25.     •.35      •
206 •  17.71 •    0.358•    0.0  •    0.0  •    0.0  •10.      •         •-22.     •.35      •
207 •  59.86 •    3.550•    0 0  •    0.0  •    0.0  •500.     •-16.9    •-56.9    •.35      •
208 •  59 86 •    3.55 •    0 0  •    0.0  •    0.0  •500      •-4.2     •-44.2    •.35      •
209 •  13.90 •   57.93 •    0 0  •    0.0  • 860 73  •500.     •0.       •-75.3    •.01      •
210 •    0.0 •   18.60 •    0.0  •    0.0  • 126.90  •100.     •135.     •0.       •.5       •
211 •    0.0 •    6.23 •    0.0  •    0.0  • 137.94  •150.     •28.      •-197.    •.5       •
212 •    0.0 •    6.23 •    0 0  •    0.0  •  39.73  •40.      •0.       •-165.    •.5       •
213 • 641.44 •    0.0  •  884 05 •    1.44 •         •         •         •         •         •
214 •  17.08 •  230.610•    0 0  •    0.0  •         •         •    1.68 •         •.5       •
215 •  2.531 •    8.184•    0 0  •    0.111•    6.012•  8.     •25.      •         •.00      •
216 •  2.531 •   10.802•    0.0  •    0.053•   46.368• 30.     • 7.04    •         •.00      •
218 •  2.55  •    6.06 •    0.0  •    0.0  •    0.0  •    0.0  •    0.0  •    0.0  •    0.0  •
219 •UPPER LE•G        •         •         •5.       •1.       •         •         •         •
219 •TOE     •         •         •         •6.       •2        •         •         •         •
219 •HIP     •         •         •         •4.       •1.       •         •         •         •
219 •HEEL    •         •         •         •6.       •2.       •         •         •         •
219 •HAND    •         •         •         •8.       •3.       •         •         •         •
219 •THORAX  •         •CHESTMAT•          •2.       •1.       •         •         •         •
219 •HEAD    •         •         •         •1.       •3.       •         •         •         •
219 •KNEE    •         •         •         •5.       •1.       •         •         •         •
219 •ELBOW   •         •         •         •8.       •1.       •         •         •         •
220 •HEAD    •         •    0.40 •    0.0  •    3.84 •    3.19 •         •         •         •
220 •KNEE    •         •    8 07 •    0.0  •    2.29 •    2.29 •         •         •         •
220 •ELBOW   •         •   -3.84 •    0.0  •    2.02 •    1.51 •         •         •         •
220 •THORAX  •         •    1.32 •   -.94  •    5.11 •    4.10 •         •         •         •
220 •HEEL    •         •    7 64 •    0.0  •    2.15 •    2.15 •         •         •         •
220 •HAND    •         •    6 02 •    0.0  •    2.32 •    1.32 •         •         •         •
```

```
60  220 •HIP      •        •   0 87 •  -0.38 •   4.20 •   4.20 •          •         •         •
61  220 •TOE      •        •   4 27 •  -6.83 •   1 01 •   1.01 •          •         •         •
62  220 •UPPER LE•G        •   3 37 •  -0 26 •   4.27 •   2.62 •          •         •         •
63  242 •2565 78 •  0 0  3•536 25   •   5.79 •        •        •          •         •         •
64  221 •CHESTMAT•         •    0 0 •    0.0 •    0.0 • 1000.  • 1000.1 •     0.0 •     0.0 •
65  222 •CHESTMAT•         •   30 00•        •        •        •CHSTAT   •CHZERO   •GRCHST   •
66  223 •GRCHST   • 0 079  • 0 10   •        •        •        •          •         •         •
67  223 •GRCHST   • 0.0    • 0 0    •        •        •        •          •         •         •
68  223 •GRCHST   • 5.906  • 0.99   •        •        •        •          •         •         •
69  223 •GRCHST   • 3 937  • 0 50   •        •        •        •          •         •         •
70  223 •GRCHST   • 2 283  • 0 10   •        •        •        •          •         •         •
71  224 •GRCHST   • 0.0    • 1 0    •        •        •        •          •         •         •
72  224 •GRCHST   • 0.079  • 0 5    •        •        •        •          •         •         •
73  224 •GRCHST   • 5 906  • 0 005  •        •        •        •          •         •         •
74  224 •GRCHST   • 3 937  • 0 1    •        •        •        •          •         •         •
75  224 •GRCHST   • 2.283  • 0 2    •        •        •        •          •         •         •
76  225 •CHSTAT   • 0 0    •    0 0 •        •        •        •          •         •         •
77  225 •CHSTAT   • 0.079  • 449 62 •        •        •        •          •         •         •
78  225 •CHSTAT   • 2 283  •1239 454•        •        •        •          •         •         •
79  225 •CHSTAT   • 3.937  •1348 855•        •        •        •          •         •         •
80  225 •CHSTAT   • 5.906  •4000    •        •        •        •          •         •         •
81  226 •CHZERO   •-1.     •    0 0 •        •        •        •          •         •         •
82  300 •76Ford/0•5hyb/fwd•         •        •        •        •          •         •         •
83  301 •80 64    •91 55   •129 01  •142.67  •16.76   •-44.40  •-80.      •-10.     •92.84    •
84  302 •0.       •0.      •0.      •0.      •0.      •0.      •0.        •0.       •0.       •
85  303 •21.670   •0       •-26.56  •0.      •3.02    •0.      •          •         •         •
86  304 •0        •0.      •0       •0.      •        •        •          •         •         •
87  217 •-12.20   •1.29    •-37 46  •-13.66  •-54.09  •61.16   •0.        •0.       •         •
88  411 •SEAT BAC•K        •-1      •15.790  •-35.648 •24.030  •-13.008 • •         •         •
89  411 •SEAT CUS•HION     •-1.     •24 030  •-13.008 •40 640  •-17.458 • •         •         •
90  411 •SEAT BEA•M        •-1.     •34.810  •-10.908 •40.640  •-12.458 • •         •         •
91  400 •76FordLT•D5thPcti•leDummy •        •        •        •          •         •         •
92  401 •SEAT     •        •SEAT MAT•ERIAL   •0.      •1.      •1.        •1.       •         •
93  402 •SEAT     •        •2       •1.      •1.      •      0.•       0.•          •         •
94  409 •SEAT BAC•K        •SEAT    •        •5.0     •0.      •      -1.•       1.•          •
95  410 •SEAT BAC•K        •      1.•        •        •        •          •         •         •
96  409 •SEAT CUS•HION     •SEAT    •        •5.0     •0       •      -1.•       2.•          •
97  410 •SEAT CUS•HION     •      1 •        •        •        •          •         •         •
98  401 •SEAT FRA•ME       •STEEL   •        •0.      •1.      •1.        •1.       •         •
99  402 •SEAT FRA•ME       •1       •1       •1.      •0       •0.        •         •         •
100 409 •SEAT BEA•M        •SEAT FRA•ME      •.528    •.1      •-1.       •1.       •         •
101 410 •SEAT BEA•M        •      1.•        •        •        •          •         •         •
102 401 •FLOOR    •        •FLOOR MA•TERIAL  •0.      •1.      •1         •1.       •         •
103 402 •FLOOR    •        •    3 •2         •1.      •      0.•       0.•          •         •
104 409 •FLOORBOA•RD       •FLOOR   •        •.528    •0.      •      -1.•       1.•          •
105 410 •FLOORBOA•RD       •      1 •        •        •        •          •         •         •
106 411 •FLOORBOA•RD       •     -1 •   0 00•   -6.00•   58.37•     -6 00•         •         •
107 409 •TOEBOARD•         •FLOOR   •        • 528    •     .37•       1.•       2 •          •
108 410 •TOEBOARD•         •      1.•        •        •        •          •         •         •
109 411 •TOEBOARD•         •     -1.•  58.37•   -6.00•   63.71•    -10.61•         •         •
110 409 •FIREWALL•         •FLOOR   •        •.528    •0       •       1.•       3.•          •
111 410 •FIREWALL•         •      1.•        •        •        •          •         •         •
112 411 •FIREWALL•         •     -1.•  63.71•  -10.61•   63.71•    -30.00•         •         •
113 401 •ROOF     •        •ROOF MAT•ERIAL   •0.      •1.      •1         •1.       •         •
114 402 •ROOF     •        •    2.•6.        •1.      •       0 •       0.•          •         •
115 409 •ROOF TOP•         •ROOF    •        •.528    •0.      •       1.•       1.•          •
116 410 •ROOF TOP•         •      1.•        •        •        •          •         •         •
117 411 •ROOF TOP•         •     -1.•   8.37• -51.224•  27.216•   -51.224•         •         •
118 409 •HEADER   •        •ROOF    •        •.528    •0.      •       1.•       2.•          •
119 410 •HEADER   •        •      1.•        •        •        •          •         •         •
```

```
120 411 •HEADER   •        •     -1 • 27.216• -51.224•  32.788• -47.876•          •         •
121 401 •WINDSHIE•LD       •GLASS MA•TERIAL  •        •1.      •1.      •1.       •         •
122 402 •WINDSHIE•LD       •1.      •5.      •1.      •       0 •      0.•          •         •
123 409 •WINDSHIE•LD       •WINDSHIE•LD      •.528    •0.      •       1.•      1.•          •
124 410 •WINDSHIE•LD       •      1.•        •        •        •          •         •         •
125 411 •WINDSHIE•LD       •     -1.• 32.788• -47 876•  57.804• -31.318•          •         •
126 401 •TOP IP   •        •TOP IP M•ATERIAL •0.      •1.      •1.      •1        •         •
127 402 •TOP IP   •        •1       •4.      •1       •      0.•       0.•          •         •
128 401 •MID IP   •        •MID IP M•ATERIAL •0.      •1.      •1       •1.       •         •
129 402 •MID IP   •        •1.      •4.      •1.      •      0.•       0.•          •         •
130 401 •LOWER IP•         •LOW IP M•ATERIAL •0.      •1.      •1.      •1.       •         •
131 402 •LOWER IP•         •1.      •4.      •1.      •      0.•       0.•          •         •
132 409 •IP PANEL•-1ST     •TOP IP  •        •.528    •.1      •      -1.•       1.•          •
133 410 •IP PANEL•-1ST     •      1 •        •        •        •          •         •         •
134 411 •IP PANEL•-1ST     •     -1.• 57.804• -31.318•  44.870• -32.404•          •         •
135 409 •IP PANEL•-2ND     •MID IP  •        •.528    •.25     •       1.•       1.•          •
136 410 •IP PANEL•-2ND     •      1.•        •        •        •          •         •         •
137 411 •IP PANEL•-2ND     •     -1.• 45.256• -32.429•  51.154• -15.868•          •         •
138 409 •IP PANEL•-3RD     •LOWER IP•        •.528    •.20     •       1.•       1.•          •
139 410 •IP PANEL•-3RD     •      1.•        •        •        •          •         •         •
140 411 •IP PANEL•-3RD     •     -1.• 45.144• -31.122•  54.919•  -7.408•          •         •
141 403 •TOP IP M•ATERIAL •0 0     •0.0     •0.0     •1000.0  •1000.1   •0.0      •0.0      •
142 404 •TOP IP M•ATERIAL •5.620   •        •        •        •TIPSTAT  •TIPI     •GRTIP    •
143 405 •GRTIP    •-1.     •0 662   •        •        •        •          •         •         •
144 406 •GRTIP    •-1.     •0.164   •        •        •        •          •         •         •
145 407 •TIPSTAT  •0.00    •   0.00 •        •        •        •          •         •         •
146 407 •TIPSTAT  •5.65    • 578.0  •        •        •        •          •         •         •
147 408 •TIPI     • -1.0   •    0 0 •        •        •        •          •         •         •
148 403 •MID IP M•ATERIAL •0 0     •0.0     •0.0     •1000.0  •1000.1   •0.0      •0.0      •
149 404 •MID IP M•ATERIAL •5.620   •        •        •        •MIPSTAT  •MIPI     •MIPGR    •
150 405 •MIPGR    •-1.     •0.517   •        •        •        •          •         •         •
151 406 •MIPGR    •-1.     •0 102   •        •        •        •          •         •         •
152 407 •MIPSTAT  •0.0     •0 0     •        •        •        •          •         •         •
153 407 •MIPSTAT  •1.30    •1800    •        •        •        •          •         •         •
154 407 •MIPSTAT  •3.70    • 700    •        •        •        •          •         •         •
155 407 •MIPSTAT  •7.00    •1500    •        •        •        •          •         •         •
156 408 •MIPI     •-1.0    •0.0     •        •        •        •          •         •         •
157 403 •LOW IP M•ATERIAL •0 0     •0.0     •0.0     •1000.0  •1000.1   •0.0      •0.0      •
158 404 •LOW IP M•ATERIAL •5 620   •        •        •        •LIPSTAT  •LIPI     •LIPGR    •
159 405 •LIPGR    •-1.     •0 999   •        •        •        •          •         •         •
160 406 •LIPGR    •-1.     •0 001   •        •        •        •          •         •         •
161 407 •LIPSTAT  •0 00    •    0 0 •        •        •        •          •         •         •
162 407 •LIPSTAT  •1.00    • 500    •        •        •        •          •         •         •
163 407 •LIPSTAT  •3.70    • 600    •        •        •        •          •         •         •
164 407 •LIPSTAT  •4.80    •1130    •        •        •        •          •         •         •
165 407 •LIPSTAT  •5.80    • 650    •        •        •        •          •         •         •
166 407 •LIPSTAT  •10.0    • 650    •        •        •        •          •         •         •
167 407 •LIPSTAT  •16 0    •1850    •        •        •        •          •         •         •
168 408 •LIPI     •-1.0    •    0 0 •        •        •        •          •         •         •
169 403 •FLOOR MA•TERIAL   •  0 000•   0 000•   0.394•   7.874•    9.843•    0.000•    0 000•
170 404 •FLOOR MA•TERIAL   •  5.620•        •        •        •CPSTAT   •ICARP    •GRCARP   •
171 405 •GRCARP   •-0.394  •0 1     •        •        •        •          •         •         •
172 406 •GRCARP   •-0.394  •0 5     •        •        •        •          •         •         •
173 407 •CPSTAT   •0.000   •  0 000•   0.000•   0.000•   0.000•    0.000•    0.000•          •
174 407 •CPSTAT   •0.197   • 196.850•   0.000•   0 000•   0.000•    0.000•    0.000•          •
175 407 •CPSTAT   •0.394   • 787.402•   0.000•   0.000•   0.000•    0.000•    0.000•          •
176 407 •CPSTAT   •7.874   •7874.016•   0 000•   0.000•   0.000•    0.000•    0.000•          •
177 407 •CPSTAT   •9.843   •  0 000•   0.000•   0.000•   0.000•    0.000•    0.000•          •
178 408 •ICARP    •-.394   •        •        •        •        •          •         •         •
179 412 •1.       •4.      • 3      •0.0     •0.0     •        •          •         •         •
```

```
180  412 •1.        •1.        •.75       •0 0       •0.0       •          •          •          •          •
181  412 •2.        •2.        •.8        •0 0       •0 0       •          •          •          •          •
182  412 •3.        •1.        • 75       •0 0       •0.0       •          •          •          •          •
183  412 •3.        •2.        • 9        •0.0       •0 0       •          •          •          •          •
184  412 •3.        •5.        •.55       •0.0       •0 0228    •          •          •          •          •
185  412 •3.        •4         • 5        •0 0       •0 0       •          •          •          •          •
186  403 •ROOF MAT•ERIAL       •0         •0.        •0         •100.      •101.      •0         •-1.0      •
187  404 •ROOF MAT•ERIAL       •5.        •0         •0         •0         •RSTAT     •IROOF     •DGR       •
188  407 •RSTAT     •-1.       •1200      •-65 36    •67.38     •-29.36    •4.78      •          •          •
189  408 •IROOF     •-1.       •0         •          •          •          •          •          •          •
190  405 •DGR       •0.        •0.        •          •          •          •          •          •          •
191  405 •DGR       •.001      •.01       •          •          •          •          •          •          •
192  405 •DGR       •10.       •.01       •          •          •          •          •          •          •
193  406 •DGR       •0.        •1.        •          •          •          •          •          •          •
194  406 •DGR       •.001      • 91       •          •          •          •          •          •          •
195  406 •DGR       •.75       •.8        •          •          •          •          •          •          •
196  406 •DGR       •1.5       •.5        •          •          •          •          •          •          •
197  406 •DGR       •10.       •.3        •          •          •          •          •          •          •
198  403 •SEAT MAT•ERIAL       •      0 0 •      0.0 •    3.937•     6.693•     7.480•      0.0 •      0.0 •
199  404 •SEAT MAT•ERIAL       •5.62      •          •          •          •SSEAT     •ISEAT2    •GRSEAT    •
200  405 •GRSEAT    •   -0.984• 1         •          •          •          •          •          •          •
201  406 •GRSEAT    •   -0.984• 5         •          •          •          •          •          •          •
202  407 •SSEAT     •      0 0 •      0 0 •      0 0 •      0.0 •      0.0 •      0.0 •      0.0 •          •
203  407 •SSEAT     •    1.850•   37 768•      0.0 •      0.0 •      0 0 •      0.0 •      0.0 •          •
204  407 •SSEAT     •    4.213•  202 328•      0.0 •      0 0 •      0.0 •      0.0 •      0.0 •          •
205  407 •SSEAT     •    4.961•  330 469•      0.0 •      0.0 •      0.0 •      0.0 •      0.0 •          •
206  407 •SSEAT     •    7.008•1252 86  •      0 0 •      0.0 •      0 0 •      0.0 •      0.0 •          •
207  407 •SSEAT     •    7.480•      0.0 •      0.0 •      0.0 •      0.0 •      0.0 •      0.0 •          •
208  408 •ISEAT2    •-1.0      •          •          •          •          •          •          •          •
209  403 •STEEL     •          •    0 000•    0 000•    0.394•    4.724•    5.906•    0 000•    0.000•
210  404 •STEEL     •          •    5 620•          •          •          •SSTEEL    •ISTEEL1   •GRSTEEL   •
211  405 •GRSTEEL   •    0.000•0           •          •          •          •          •          •          •
212  405 •GRSTEEL   •    0.394• 1          •          •          •          •          •          •          •
213  405 •GRSTEEL   •    4.724• 9          •          •          •          •          •          •          •
214  405 •GRSTEEL   •    5 906• 99         •          •          •          •          •          •          •
215  406 •GRSTEEL   •    0.000•1.          •          •          •          •          •          •          •
216  406 •GRSTEEL   •.394      • 8        •          •          •          •          •          •          •
217  406 •GRSTEEL   •    4.724• 05         •          •          •          •          •          •          •
218  406 •GRSTEEL   •    5.906• 005        •          •          •          •          •          •          •
219  407 •SSTEEL    •    0.000•    0 000•    0.000•    0 000•    0 000•    0.000•    0.000•          •
220  407 •SSTEEL    •    0.394•1574 803•    0.000•    0 000•    0.000•    0.000•    0.000•          •
221  407 •SSTEEL    •    4.724•1574 803•    0.000•    0.000•    0.000•    0.000•    0.000•          •
222  407 •SSTEEL    •    5.906•    0 000•    0.000•    0.000•    0 000•    0.000•    0.000•          •
223  408 •ISTEEL1   •-.394     •          •          •          •          •          •          •          •
224  403 •GLASS MA•TERIAL      •0 90      •1.50      •0 85      •1000.     •1000.1    •0.0       •0.0       •
225  404 •GLASS MA•TERIAL      •5.620     •          •          •          •GLASTAT   •GLASP     •GRGLAS    •
226  405 •GRGLAS    •-1.       •0.977     •          •          •          •          •          •          •
227  406 •GRGLAS    •-1.       •0 004     •          •          •          •          •          •          •
228  407 •GLASTAT   •0.00      •  0.00    •          •          •          •          •          •          •
229  407 •GLASTAT   •1.25      •550 0     •          •          •          •          •          •          •
230  407 •GLASTAT   •1 75      •490 0     •          •          •          •          •          •          •
231  407 •GLASTAT   •3.60      •840 0     •          •          •          •          •          •          •
232  407 •GLASTAT   •4.00      •800 0     •          •          •          •          •          •          •
233  407 •GLASTAT   •6.00      •830 0     •          •          •          •          •          •          •
234  407 •GLASTAT   •6.50      •820 0     •          •          •          •          •          •          •
235  407 •GLASTAT   •9.00      •500 0     •          •          •          •          •          •          •
236  407 •GLASTAT   •9.25      •  0 0     •          •          •          •          •          •          •
237  408 •GLASP     •0 0       •  0 0     •          •          •          •          •          •          •
238  408 •GLASP     •0 9       •675 0     •          •          •          •          •          •          •
239  408 •GLASP     •1.50      •  0 0     •          •          •          •          •          •          •


240  600 •granada2•5mph        •          •          •          •          •          •          •          •
241  601 •    0 00•    36.67•     0 00•     0 00•     0.00•     0.00•     0.00•     0.00•     0.00•
242  602 •     440 •        1.•       1 •          •          •          •          •          •          •
243      •    0.00•    -3.80•     0 50•    -4.02•     1 00•    -4.24•     1.50•    -4.46•     0.00•
244      •    2.00•    -4.69•     2 50•    -4.91•     3.00•    -5 13•     3.50•    -5.34•     0.00•
245      •    4.00•    -5.54•     4 50•    -5 75•     5.00•    -5.96•     5 50•    -6.17•     0.00•
246      •    6 00•    -6.37•     6 50•    -6.56•     7.00•    -6 75•     7.50•    -6.94•     0.00•
247      •    8.00•    -7.13•     8 50•    -7.31•     9.00•    -7.49•     9 50•    -7.66•     0.00•
248      •   10.00•    -7.83•    10 50•    -7.99•    11.00•    -8 15•    11.50•    -8.30•     0.00•
249      •   12.00•    -8.45•    12 50•    -8.60•    13.00•    -8 74•    13.50•    -8.87•     0.00•
250      •   .14.00•   -9.00•    14 50•    -9 14•    15.00•    -9.26•    15.50•    -9.39•     0.00•
251      •   16.00•    -9.51•    16 50•    -9 63•    17.00•    -9.75•    17.50•    -9.88•     0.00•
252      •   18 00•   -10.00•    18 50•   -10.13•    19.00•   -10 26•    19.50•   -10.38•     0.00•
253      •   20.00•   -10.51•    20 50•   -10.63•    21 00•   -10 76•    21.50•   -10.89•     0.00•
254      •   22.00•   -11.01•    22 50•   -11.13•    23.00•   -11.25•    23.50•   -11.37•     0.00•
255      •   24.00•   -11.48•    24.50•   -11.59•    25.00•   -11.69•    25.50•   -11.79•     0.00•
256      •   26.00•   -11.88•    26 50•   -11.97•    27.00•   -12.05•    27.50•   -12.13•     0.00•
257      •   28.00•   -12.21•    28.50•   -12.28•    29.00•   -12.34•    29 50•   -12.40•     0.00•
258      •   30.00•   -12.46•    30.50•   -12.51•    31.00•   -12.56•    31 50•   -12.60•     0.00•
259      •   32 00•   -12.65•    32 50•   -12.68•    33.00•   -12 71•    33 50•   -12 74•     0.00•
260      •   34.00•   -12 77•    34 50•   -12.79•    35.00•   -12.81•    35.50•   -12.82•     0.00•
261      •   36.00•   -12.83•    36 50•   -12.84•    37.00•   -12.85•    37.50•   -12.85•     0.00•
262      •   38.00•   -12.85•    38.50•   -12.85•    39.00•   -12.84•    39.50•   -12.84•     0.00•
263      •   40.00•   -12.83•    40.50•   -12.82•    41.00•   -12.81•    41.50•   -12.80•     0.00•
264      •   42.00•   -12.79•    42.50•   -12.78•    43.00•   -12.76•    43.50•   -12.75•     0.00•
265      •   44.00•   -12.74•    44 50•   -12.73•    45.00•   -12 72•    45.50•   -12.72•     0.00•
266      •   46.00•   -12 71•    46.50•   -12.70•    47.00•   -12.70•    47.50•   -12.70•     0.00•
267      •   48.00•   -12.69•    48.50•   -12.69•    49.00•   -12.69•    49.50•   -12.70•     0.00•
268      •   50.00•   -12.71•    50.50•   -12.72•    51.00•   -12.73•    51 50•   -12.74•     0.00•
269      •   52.00•   -12.78•    52.50•   -12.78•    53.00•   -12.80•    53.50•   -12.83•     0.00•
270      •   54.00•   -12.85•    54.50•   -12.88•    55.00•   -12.91•    55.50•   -12.94•     0.00•
271      •   56.00•   -12.98•    56.50•   -13.02•    57.00•   -13.06•    57.50•   -13.11•     0.00•
272      •   58.00•   -13.16•    58.50•   -13.21•    59.00•   -13.26•    59.50•   -13.32•     0.00•
273      •   60.00•   -13 38•    60 50•   -13.44•    61.00•   -13.51•    61 50•   -13.58•     0.00•
274      •   62.00•   -13.64•    62.50•   -13.72•    63.00•   -13.79•    63 50•   -13.87•     0.00•
275      •   64.00•   -13.95•    64 50•   -14.02•    65.00•   -14.10•    65.50•   -14.18•     0.00•
276      •   66.00•   -14 27•    66 50•   -14.35•    67.00•   -14.44•    67.50•   -14.52•     0.00•
277      •   68 00•   -14 61•    68 50•   -14 69•    69.00•   -14.78•    69.50•   -14.87•     0.00•
278      •   70 00•   -14.95•    70 50•   -15.04•    71.00•   -15 12•    71.50•   -15.20•     0.00•
279      •   72.00•   -15 29•    72 50•   -15.37•    73.00•   -15.45•    73.50•   -15.53•     0.00•
280      •   74.00•   -15.60•    74 50•   -15.68•    75.00•   -15.75•    75.50•   -15.82•     0.00•
281      •   76.00•   -15.89•    76 50•   -15.96•    77.00•   -16.02•    77.50•   -16 08•     0.00•
282      •   78.00•   -16 14•    78.50•   -16.19•    79.00•   -16.25•    79 50•   -16.30•     0.00•
283      •   80.00•   -16.34•    80 50•   -16 39•    81.00•   -16.43•    81.50•   -16.47•     0.00•
284      •   82 00•   -16.50•    82.50•   -16.54•    83.00•   -16.56•    83 50•   -16.59•     0.00•
285      •   84.00•   -16.61•    84 50•   -16.63•    85.00•   -16.64•    85 50•   -16 66•     0.00•
286      •   86.00•   -16.67•    86 50•   -16.67•    87.00•   -16.67•    87.50•   -16.67•     0.00•
287      •   88.00•   -16.67•    88 50•   -16.66•    89.00•   -16 65•    89 50•   -16.63•     0.00•
288      •   90.00•   -16.62•    90 50•   -16 60•    91.00•   -16.57•    91 50•   -16.27•     0.00•
289      •   92.00•   -15.58•    92 50•   -14.92•    93.00•   -14.27•    93.50•   -13.64•     0.00•
290      •   94.00•   -13.03•    94 50•   -12.43•    95.00•   -11.86•    95 50•   -11.29•     0.00•
291      •   96.00•   -10.75•    96 50•   -10.22•    97.00•    -9 70•    97.50•    -9.20•     0.00•
292      •   98.00•    -8 72•    98 50•    -8.25•    99.00•    -7.79•    99.50•    -7.35•     0.00•
293      •  100.00•    -6.92•   100 50•    -6.50•   101.00•    -6 10•   101 50•    -5.71•     0.00•
294      •  102 00•    -5.33•   102.50•    -4.97•   103.00•    -4 61•   103.50•    -4.27•     0.00•
295      •  104.00•    -3.94•   104.50•    -3.62•   105 00•    -3.31•   105 50•    -3.01•     0.00•
296      •  106.00•    -2.72•   106.50•    -2.45•   107.00•    -2.18•   107 50•    -1.92•     0.00•
297      •  108.00•    -1.67•   108.50•    -1.43•   109.00•    -1.20•   109.50•    -0.98•     0.00•
298      •  110.00•    -0.76•   110.50•    -0.56•   111.00•    -0 36•   111.50•    -0.17•     0.00•
299      •  112.00•     0.01•   112 50•     0.19•   113.00•     0.36•   113.50•     0.52•     0.00•
```

300		114.00	0.67	114.50	0.82	115.00	0.96	115.50	1.09	0.00
301		116.00	1.22	116.50	1.34	117.00	1.46	117.50	1.57	0.00
302		118.00	1.68	118.50	1.78	119.00	1.87	119.50	1.96	0.00
303		120.00	2.05	120.50	2.13	121.00	2.20	121.50	2.28	0.00
304		122.00	2.34	122.50	2.41	123.00	2.46	123.50	2.52	0.00
305		124.00	2.57	124.50	2.62	125.00	2.66	125.50	2.70	0.00
306		126.00	2.74	126.50	2.78	127.00	2.81	127.50	2.84	0.00
307		128.00	2.86	128.50	2.88	129.00	2.90	129.50	2.92	0.00
308		130.00	2.94	130.50	2.95	131.00	2.96	131.50	2.97	0.00
309		132.00	2.97	132.50	2.98	133.00	2.98	133.50	2.98	0.00
310		134.00	2.98	134.50	2.97	135.00	2.97	135.50	2.96	0.00
311		136.00	2.95	136.50	2.94	137.00	2.93	137.50	2.92	0.00
312		138.00	2.91	138.50	2.89	139.00	2.88	139.50	2.86	0.00
313		140.00	2.84	140.50	2.82	141.00	2.80	141.50	2.78	0.00
314		142.00	2.76	142.50	2.74	143.00	2.71	143.50	2.69	0.00
315		144.00	2.67	144.50	2.64	145.00	2.62	145.50	2.59	0.00
316		146.00	2.56	146.50	2.54	147.00	2.51	147.50	2.48	0.00
317		148.00	2.45	148.50	2.42	149.00	2.39	149.50	2.36	0.00
318		150.00	2.33	150.50	2.30	151.00	2.27	151.50	2.24	0.00
319		152.00	2.21	152.50	2.18	153.00	2.15	153.50	2.12	0.00
320		154.00	2.09	154.50	2.06	155.00	2.03	155.50	2.00	0.00
321		156.00	1.97	156.50	1.94	157.00	1.91	157.50	1.88	0.00
322		158.00	1.85	158.50	1.82	159.00	1.79	159.50	1.76	0.00
323		160.00	1.73	160.50	1.70	161.00	1.67	161.50	1.64	0.00
324		162.00	1.61	162.50	1.58	163.00	1.56	163.50	1.53	0.00
325		164.00	1.50	164.50	1.47	165.00	1.44	165.50	1.42	0.00
326		166.00	1.39	166.50	1.36	167.00	1.34	167.50	1.31	0.00
327		168.00	1.28	168.50	1.26	169.00	1.23	169.50	1.21	0.00
328		170.00	1.18	170.50	1.16	171.00	1.13	171.50	1.11	0.00
329		172.00	1.09	172.50	1.06	173.00	1.04	173.50	1.02	0.00
330		174.00	0.99	174.50	0.97	175.00	0.95	175.50	0.93	0.00
331		176.00	0.91	176.50	0.89	177.00	0.87	177.50	0.85	0.00
332		178.00	0.83	178.50	0.81	179.00	0.79	179.50	0.77	0.00
333		180.00	0.75	180.50	0.73	181.00	0.71	181.50	0.70	0.00
334		182.00	0.68	182.50	0.66	183.00	0.64	183.50	0.63	0.00
335		184.00	0.61	184.50	0.60	185.00	0.58	185.50	0.56	0.00
336		186.00	0.55	186.50	0.53	187.00	0.52	187.50	0.51	0.00
337		188.00	0.49	188.50	0.48	189.00	0.46	189.50	0.45	0.00
338		190.00	0.44	190.50	0.43	191.00	0.41	191.50	0.40	0.00
339		192.00	0.39	192.50	0.38	193.00	0.37	193.50	0.35	0.00
340		194.00	0.34	194.50	0.33	195.00	0.32	195.50	0.31	0.00
341		196.00	0.30	196.50	0.29	197.00	0.28	197.50	0.27	0.00
342		198.00	0.26	198.50	0.26	199.00	0.25	199.50	0.24	0.00
343		200.00	0.23	200.50	0.22	201.00	0.21	201.50	0.21	0.00
344		202.00	0.20	202.50	0.19	203.00	0.18	203.50	0.18	0.00
345		204.00	0.17	204.50	0.16	205.00	0.16	205.50	0.15	0.00
346		206.00	0.15	206.50	0.14	207.00	0.13	207.50	0.13	0.00
347		208.00	0.12	208.50	0.12	209.00	0.11	209.50	0.11	0.00
348		210.00	0.10	210.50	0.10	211.00	0.09	211.50	0.09	0.00
349		212.00	0.08	212.50	0.08	213.00	0.08	213.50	0.07	0.00
350		214.00	0.07	214.50	0.06	215.00	0.06	215.50	0.06	0.00
351		216.00	0.05	216.50	0.05	217.00	0.05	217.50	0.04	0.00
352		218.00	0.04	218.50	0.04	219.00	0.03	219.50	0.03	0.00
353	603	2.	1.	1.						
354		0.00	0.00	300.00	0.00	0.00	0.00	0.00	0.00	0.00
355	604	2.	0.							
356		0.00	0.00	300.00	0.00	0.00	0.00	0.00	0.00	0.00
357	700	Unrestrained								

```
GGGGGGGGGG   444444444444444444444444444444444444444444444444444444444444444444444444444444444444444444444   GGGGGGGGGG
GGGGGGGGGG   4444444444444444444444  Digital Equipment Corporation - VAX/VMS Version V4.3  4444444444444444444444   GGGGGGGGGG
GGGGGGGGGG   444444444444444444444444444444444444444444444444444444444444444444444444444444444444444444444   GGGGGGGGGG

                              CCCC  H   H  U   U   CCCC  K   K  K   K
                             C      H   H  U   U  C      K  K   K  K
                             C      H   H  U   U  C      K K    K K
                             C      HHHHH  U   U  C      KKK    KKK
                             C      H   H  U   U  C      K K    K K
                             C      H   H  U   U  C      K  K   K  K
                              CCCC  H   H  UUUUU   CCCC  K   K  K   K

     FFFFFFFFFF    OOOOOO    RRRRRRRR    DDDDDDDD    77777777      666666     999999    5555555555    222222    5555555555
     FFFFFFFFFF    OOOOOO    RRRRRRRR    DDDDDDDD    77777777      666666     999999    5555555555    222222    5555555555
     FF          OO      OO  RR      RR  DD      DD        77    66         99      99  55          22      22  55
     FF          OO      OO  RR      RR  DD      DD        77    66         99      99  55          22      22  55
     FF          OO      OO  RR      RR  DD      DD        77    66         99      99  555555              22  555555
     FF          OO      OO  RR      RR  DD      DD        77    66         99      99  555555              22  555555
     FFFFFFFF    OO      OO  RRRRRRRR    DD      DD      77      66666666    99999999         55          22          55
     FFFFFFFF    OO      OO  RRRRRRRR    DD      DD      77      66666666    99999999         55          22          55
     FF          OO      OO  RR  RR      DD      DD    77        66      66        99           55      22              55
     FF          OO      OO  RR  RR      DD      DD    77        66      66        99           55      22              55
     FF          OO      OO  RR    RR    DD      DD  77          66      66        99   55      55    22          55      55
     FF          OO      OO  RR    RR    DD      DD  77          66      66        99   55      55    22          55      55
     FF            OOOOOO    RR      RR  DDDDDDDD    77            666666     999999      555555    2222222222    555555
     FF            OOOOOO    RR      RR  DDDDDDDD    77            666666     999999      555555    2222222222    555555

                               OOOOOO    UU      UU  TTTTTTTTTT      ::::       11
                               OOOOOO    UU      UU  TTTTTTTTTT      ::::       11
                             OO      OO  UU      UU      TT          ::::     1111
                             OO      OO  UU      UU      TT          ::::     1111
                             OO      OO  UU      UU      TT                     11
                             OO      OO  UU      UU      TT                     11
                             OO      OO  UU      UU      TT          ::::       11
                             OO      OO  UU      UU      TT          ::::       11
                             OO      OO  UU      UU      TT          ::::       11
                             OO      OO  UU      UU      TT          ::::       11
                             OO      OO  UU      UU      TT            ::       11
                             OO      OO  UU      UU      TT            ::       11
                               OOOOOO    UUUUUUUUUU      TT          ::       111111
                               OOOOOO    UUUUUUUUUU      TT          ::       111111
```

File _DBA2:[SCRATCH.CJK]FORD769525 OUT;1 (5250,59,0), last revised on 16-JUL-1987 09.46, is a 90 block sequential file owned by UIC [CHUCKK]. The records are variable length with FORTRAN (FTN) carriage control. The longest record is 120 bytes.

Job FORD769525 (183) queued to TXG3 on 16-JUL-1987 09.55 by user CHUCKK, UIC [CHUCKK], under account NPP-01 at priority 4, started on printer _TXG3. on 16-JUL-1987 09 55 from queue TXG3.


```
GGGGGGGGGG   444444444444444444444444444444444444444444444444444444444444444444444444444444444444444444444   GGGGGGGGGG
GGGGGGGGGG   4444444444444444444444  Digital Equipment Corporation - VAX/VMS Version V4.3  4444444444444444444444   GGGGGGGGGG
GGGGGGGGGG   444444444444444444444444444444444444444444444444444444444444444444444444444444444444444444444   GGGGGGGGGG
```


```
100 •         •         •     MVM•A 2D CRA•SH VICTI•M SIMULA•TION    •         •         •
101 •1.       •1        •32.174  •0        •0.       •192.0    •1.0      •3.       •24.      •
102 •0.       •0.       •0       •0        •0.       •0.       •10.      • 000001  •15.      •
103 •0.00     • 02      •100000  •15000.   •20       •.05      •10       •1.       •1.       •
104 •0.       •00000000•70 1     •00000000•200       •00000000•201       •00000000•0.        •
106 •TOE      •         •FLOOR   •         •         •         •         •         •         •
106 •HAND     •         •MID IP  •         •         •         •         •         •         •
106 •HAND     •         •FLOOR   •         •         •         •         •         •         •
106 •HEAD     •         •ROOF    •         •         •         •         •         •         •
106 •HEAD     •         •WINDSHIE•LD       •         •         •         •         •         •
106 •HEAD     •         •SEAT    •         •         •         •         •         •         •
106 •HEAD     •         •TOP IP  •         •         •         •         •         •         •
106 •HEEL     •         •FLOOR   •         •         •         •         •         •         •
106 •KNEE     •         •LOWER IP•         •         •         •         •         •         •
106 •KNEE     •         •FLOOR   •         •         •         •         •         •         •
106 •HIP      •         •FLOOR   •         •         •         •         •         •         •
106 •HIP      •         •SEAT    •         •         •         •         •         •         •
106 •HIP      •         •SEAT FRA•ME       •         •         •         •         •         •
106 •THORAX   •         •MID IP  •         •         •         •         •         •         •
106 •THORAX   •         •SEAT    •         •         •         •         •         •         •
106 •THORAX   •         •SEAT FRA•ME       •         •         •         •         •         •
106 •THORAX   •         •FLOOR   •         •         •         •         •         •         •
106 •ELBOW    •         •MID IP  •         •         •         •         •         •         •
106 •UPPER LE•G         •SEAT FRA•ME       •         •         •         •         •         •
106 •UPPER LE•G         •FLOOR   •         •         •         •         •         •         •
106 •UPPER LE•G         •SEAT    •         •         •         •         •         •         •
200 •Hybiii 9•5th Male•          •         •         •         •         •         •         •
201 •    0.558•   13.511•    6 262•    4.074•   17.242•    0.0  •   11.581•    1.716•   -1.373•
202 •    3.260•    6.133•    3 131•    2.059•    6.648•    9.951•    5.662•    6.176•0.5       •
203 •    0.034•    0.128•    0.023•    0.146•    0.090•    0.067•    0.030•    0 033•    0.011•
204 •    0.343•    2.469•    0.220•    1.729•    2.456•    2.538•    0.329•    0.576•          •
205 •   36.95 •    0.748•    0 0  •    0.0  •    0.0  •10.      •         •-25.     •.35      •
206 •   36.95 •    0.748•    0 0  •    0.0  •    0.0  •10.      •         •-22.     •.35      •
207 •  124.91•     7.410•    0 0  •    0.0  •    0.0  •500.     •-16.9    •-56.9    •.35      •
208 •  124.91•     7.410•    0 0  •    0.0  •    0.0  •500.     •-4.2     •-44.2    •.35      •
209 •   29.010•  120.88•     0.0  •    0.0  •1795.94  •500.     •0.       •-75.3    •.01      •
210 •    0.0  •   38.800•    0 0  •    0.0  • 264.79  •100.     •135.     •0.       •.5       •
211 •    0.0  •   13.010•    0 0  •    0.0  • 287.81  •150.     •28.      •-197.    •.5       •
212 •    0.0  •   13.010•    0 0  •    0.0  •  82.90  •40.      •0.       •-165.    •.5       •
213 •  819.66 •    0.0  •  137 18 •    2.36 •         •         •    0.0  •         •         •
214 •   21.82 •  230.610•    0 0  •    0.0  •         •         •    2.15 •         •.5       •
215 •    5.285 •   17.402•   0 0  • 0 111   •  25.460 • 8.      •25       •         •.80      •
216 •    5.285 •   22.505•   0 0  • 0.053   •  96.748 •30.      • 7.04    •         •.80      •
218 •    3.260•    7.740•    0 0  •    0.0  •    0.0  •    0.0  •    0.0  •    0.0  •    0.0  •
219 •UPPER LE•G         •         •         •5.       •1.       •         •         •         •
219 •TOE      •         •         •         •6.       •2        •         •         •         •
219 •HIP      •         •         •         •4.       •1.       •         •         •         •
219 •HEEL     •         •         •         •6.       •2.       •         •         •         •
219 •HAND     •         •         •         •8.       •3.       •         •         •         •
219 •THORAX   •         •CHESTMAT•          •2.       •1.       •         •         •         •
219 •HEAD     •         •         •         •1.       •3        •         •         •         •
219 •KNEE     •         •         •         •5        •1.       •         •         •         •
219 •SHIN     •         •         •         •6.       •1.       •         •         •         •
219 •ELBOW    •         •         •         •8.       •1.       •         •         •         •
220 •HEAD     •         •    0 51 •    0.0  •    5.45 •    4.08 •         •         •         •
220 •KNEE     •         •   10 32 •    0.0  •    2.93 •    2.93 •         •         •         •
220 •SHIN     •         •   -6 00 •    0.0  •    4.00 •    2.00 •         •         •         •
220 •ELBOW    •         •   -4 90 •    0.0  •    2.58 •    1.93 •         •         •         •
220 •THORAX   •         •    1 68 •   -1.20 •    6.53 •    5.24 •         •         •         •
```

```
 60  220 •HEEL     •          •   9 76 •   0.0  •   2.75 •   2.75 •          •          •          •
 61  220 •HAND     •          •   7 70 •   0.0  •   2.97 •   1.68 •          •          •          •
 62  220 •HIP      •          •   1 11 •  -0.48 •   5.37 •   5.37 •          •          •          •
 63  220 •TOE      •          •   5.46 •  -8.72 •   1.29 •   1.29 •          •          •          •
 64  220 •UPPER LE•G          •   4 30 •  -0.34 •   5.46 •   3.35 •          •          •          •
 65  242 •3278 65 •    0.0   •2767 37 •   9 45 •          •          •          •          •          •
 66  221 •CHESTMAT•           •   0.0  •   0.0  •   0.0   • 1000.    • 1000.1 • 0.0      •     0.0  •
 67  222 •CHESTMAT•           •   30 00•          •          •   •CHSTAT   •CHZERO   •GRCHST   •
 68  223 •GRCHST   • 0.079   • 0.10     •          •          •          •          •          •
 69  223 •GRCHST   • 0 0     • 0 0      •          •          •          •          •          •
 70  223 •GRCHST   • 5.906   • 0.99     •          •          •          •          •          •
 71  223 •GRCHST   • 3.937   • 0.50     •          •          •          •          •          •
 72  223 •GRCHST   • 2.283   • 0.10     •          •          •          •          •          •
 73  224 •GRCHST   • 0.0     • 1.0      •          •          •          •          •          •
 74  224 •GRCHST   • 0.079   • 0.5      •          •          •          •          •          •
 75  224 •GRCHST   • 5.906   • 0.005    •          •          •          •          •          •
 76  224 •GRCHST   • 3.937   • 0.1      •          •          •          •          •          •
 77  224 •GRCHST   • 2.283   • 0.2      •          •          •          •          •          •
 78  225 •CHSTAT   • 0.0     •    0 0   •          •          •          •          •          •
 79  225 •CHSTAT   • 0.079   • 449 62   •          •          •          •          •          •
 80  225 •CHSTAT   • 2.283   •1239 454•          •          •          •          •          •
 81  225 •CHSTAT   • 3.937   •1348 855•          •          •          •          •          •
 82  225 •CHSTAT   • 5.906   •4000      •          •          •          •          •          •
 83  226 •CHZERO   •-1       •    0 0   •          •          •          •          •          •
 84  300 •76Ford/9•5hyb/oft•            •          •          •          •          •          •
 85  301 •80.64    •95 651  •125 651 •147.651 •18.691  •-35.547 •-80.     •-10.     •92.84    •
 86  302 •0.       •0.      •0.       •0.      •0.      •0.      •0.      •0.      •0.       •
 87  303 •15.104   •0.      •-29 261  •0       •3.54    •0.      •          •          •          •
 88  304 •0.       •0.      •0.       •0.      •          •          •          •          •          •
 89  217 •-12.20   •-2.811  •-30 00   •-22.00  •-51.040 •54.239  •-4.349  •-70.00  •          •
 90  411 •SEAT BAC•K         •-1.      •10.201  •-35.273 •18.441  •-12.633 •          •          •
 91  411 •SEAT CUS•HION      •-1.      •18.441  •-12.633 •35.051  •-17.083 •          •          •
 92  411 •SEAT BEA•M         •-1       •29.221  •-10.533 •35.051  •-12.083 •          •          •
 93  400 •76FordLT•D95thePc•tileDumm•y          •          •          •          •          •
 94  401 •SEAT     •          •SEAT MAT•ERIAL   •0.      •1.      •1.      •1.      •          •
 95  402 •SEAT     •          •2.       •1.      •1.      •      0.•      0.•          •          •
 96  409 •SEAT BAC•K         •SEAT     •        •5.0     •0.      •       -1.•      1.•          •
 97  410 •SEAT BAC•K         •       1 •        •          •          •          •          •          •
 98  409 •SEAT CUS•HION      •SEAT     •        •5.0     •0.      •       -1.•      2.•          •
 99  410 •SEAT CUS•HION      •       1 •        •          •          •          •          •          •
100  401 •SEAT FRA•ME        •STEEL    •        •0       •1.      •1.      •1.      •          •
101  402 •SEAT FRA•ME        •1.       •1.      •1.      •0.      •0.      •          •          •
102  409 •SEAT BEA•M         •SEAT FRA•ME        •.528    •.1      •-1.     •1.      •          •
103  410 •SEAT BEA•M         •      1.•          •          •          •          •          •          •
104  401 •FLOOR    •          •FLOOR MA•TERIAL  •0.      •1.      •1.      •1.      •          •
105  402 •FLOOR    •          •       3 •2.      •1.      •      0.•      0.•          •          •
106  409 •FLOORBOA•RD        •FLOOR    •        •.528    •0.      •       -1.•      1.•          •
107  410 •FLOORBOA•RD        •      1.•          •          •          •          •          •          •
108  411 •FLOORBOA•RD        •     -1.•    8.00•   -6.00•   58.37•   -6.00•          •          •
109  409 •TOEBOARD•          •FLOOR    •        •.528    •       .37•       1.•      2.•          •
110  410 •TOEBOARD•          •      1.•          •          •          •          •          •          •
111  411 •TOEBOARD•          •     -1.•   58.37•   -6.00•   63.71•  -10.61•          •          •
112  409 •FIREWALL•          •FLOOR    •        •.528    •0.      •       1.•      3.•          •
113  410 •FIREWALL•          •       1 •          •          •          •          •          •          •
114  411 •FIREWALL•          •     -1.•   63.71•  -10.61•   63.71•  -30.00•          •          •
115  401 •ROOF     •          •ROOF MAT•ERIAL   •0.      •1.      •1.      •1.      •          •
116  402 •ROOF     •          •     2.•6  •1.      •      0.•       0 •          •          •
117  409 •ROOF TOP•          •ROOF     •        •.528    •0.      •       1.•      1.•          •
118  410 •ROOF TOP•          •       1 •          •          •          •          •          •          •
119  411 •ROOF TOP•          •      -1 •    8.37• -51.601•  27.216• -51.601•          •          •

120  409 •HEADER   •          •ROOF     •        •.528    •0.      •       1.•      2.•          •
121  410 •HEADER   •          •      1.•          •          •          •          •          •          •
122  411 •HEADER   •          •     -1.•  27 216• -51.601•  32.788• -48.253•          •          •
123  401 •WINDSHIE•LD        •GLASS MA•TERIAL  •        •1.      •1.      •1.      •          •
124  402 •WINDSHIE•LD        •1        •5.      •1       •      0.•      0.•          •          •
125  409 •WINDSHIE•LD        •WINDSHIE•LD       •.528    •0.      •       1.•      1.•          •
126  410 •WINDSHIE•LD        •      1.•          •          •          •          •          •          •
127  411 •WINDSHIE•LD        •     -1.•  32.788• -48.253•  57.804• -31.695•          •          •
128  401 •TOP IP   •          •TOP IP M•ATERIAL •0.      •1.      •1.      •1.      •          •
129  402 •TOP IP   •          •1.       •4.      •1.      •      0.•      0.•          •          •
130  401 •MID IP   •          •MID IP M•ATERIAL •0.      •1.      •1.      •1.      •          •
131  402 •MID IP   •          •1.       •4.      •1.      •      0.•      0.•          •          •
132  401 •LOWER IP•          •LOW IP M•ATERIAL •0.      •1.      •1.      •1.      •          •
133  402 •LOWER IP•          •1.       •4.      •1.      •      0.•      0.•          •          •
134  409 •IP PANEL•-1ST      •TOP IP   •        •.528    •.1      •       -1.•      1.•          •
135  410 •IP PANEL•-1ST      •      1.•          •          •          •          •          •          •
136  411 •IP PANEL•-1ST      •     -1.•  57.804• -31.695•  44.870• -32.781•          •          •
137  409 •IP PANEL•-2ND      •MID IP   •        •.528    •.25     •       1.•      1.•          •
138  410 •IP PANEL•-2ND      •      1.•          •          •          •          •          •          •
139  411 •IP PANEL•-2ND      •     -1.•  45.256• -32.806•  51.154• -16.245•          •          •
140  409 •IP PANEL•-3RD      •LOWER IP•          •.528    •.20     •       1.•      1.•          •
141  410 •IP PANEL•-3RD      •      1.•          •          •          •          •          •          •
142  411 •IP PANEL•-3RD      •     -1.•  45.144• -31.499•  54.919•  -7.785•          •          •
143  403 •TOP IP M•ATERIAL •0.0      •0.0     •0.0     •1000.0  •1000.1  •0.0     •0.0      •
144  404 •TOP IP M•ATERIAL •5.620    •          •          •          •TIPSTAT •TIPI     •GRTIP    •
145  405 •GRTIP    •-1.     •0.662    •          •          •          •          •          •          •
146  406 •GRTIP    •-1.     •0.164    •          •          •          •          •          •          •
147  407 •TIPSTAT •0.00    •   0 00  •          •          •          •          •          •          •
148  407 •TIPSTAT •5.65    • 578 0    •          •          •          •          •          •          •
149  408 •TIPI     • -1.0   •   0 0   •          •          •          •          •          •          •
150  403 •MID IP M•ATERIAL •0.0      •0.0     •0.0     •1000.0  •1000.1  •0.0     •0.0      •
151  404 •MID IP M•ATERIAL •5.620    •          •          •          •MIPSTAT •MIPI     •MIPGR    •
152  405 •MIPGR    •-1.     •0.517    •          •          •          •          •          •          •
153  406 •MIPGR    •-1.     •0 102    •          •          •          •          •          •          •
154  407 •MIPSTAT •0.0     •0.0      •          •          •          •          •          •          •
155  407 •MIPSTAT •1.30    •1800     •          •          •          •          •          •          •
156  407 •MIPSTAT •3.70    • 700     •          •          •          •          •          •          •
157  407 •MIPSTAT •7.00    •1500     •          •          •          •          •          •          •
158  408 •MIPI     •-1.0    •0.0      •          •          •          •          •          •          •
159  403 •LOW IP M•ATERIAL •0.0      •0.0     •0.0     •1000.0  •1000.1  •0.0     •0.0      •
160  404 •LOW IP M•ATERIAL •5.620    •          •          •          •LIPSTAT •LIPI     •LIPGR    •
161  405 •LIPGR    •-1.     •0 999    •          •          •          •          •          •          •
162  406 •LIPGR    •-1.     •0.001    •          •          •          •          •          •          •
163  407 •LIPSTAT •0.00    •   0 0   •          •          •          •          •          •          •
164  407 •LIPSTAT •1.00    • 500     •          •          •          •          •          •          •
165  407 •LIPSTAT •3.70    • 600     •          •          •          •          •          •          •
166  407 •LIPSTAT •4.80    •1130     •          •          •          •          •          •          •
167  407 •LIPSTAT •5.80    • 650     •          •          •          •          •          •          •
168  407 •LIPSTAT •10.0    • 650     •          •          •          •          •          •          •
169  407 •LIPSTAT •16.0    •1850     •          •          •          •          •          •          •
170  408 •LIPI     •-1.0    •   0.0   •          •          •          •          •          •          •
171  403 •FLOOR MA•TERIAL  •   0 000•   0.000•   0.394•   7.874•   9.843•   0.000•   0.000•
172  404 •FLOOR MA•TERIAL  •   5.620•          •          •          •CPSTAT  •ICARP    •GRCARP   •
173  405 •GRCARP   •-0.394  •0 1      •          •          •          •          •          •          •
174  406 •GRCARP   •-0.394  •0 5      •          •          •          •          •          •          •
175  407 •CPSTAT   •0.000   •   0.000•   0.000•   0.000•   0.000•   0.000•   0.000•          •
176  407 •CPSTAT   •0.197   • 196 850•   0 000•   0.000•   0.000•   0.000•   0.000•          •
177  407 •CPSTAT   •0.394   • 787 402•   0.000•   0.000•   0.000•   0.000•   0.000•          •
178  407 •CPSTAT   •7.874   •7874 016•   0.000•   0.000•   0.000•   0.000•   0.000•          •
179  407 •CPSTAT   •9.843   •   0 000•   0.000•   0.000•   0.000•   0.000•   0.000•          •
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180  408 •ICARP    •-.394    •          •          •          •          •          •          •
181  412 •1.       •4.       • 3        •0.0       •0 0       •          •          •          •          •
182  412 •1.       •1        • 75       •0.0       •0.0       •          •          •          •          •
183  412 •2.       •2.       • 8        •0.0       •0.0       •          •          •          •          •
184  412 •3.       •1        • 75       •0.0       •0.0       •          •          •          •          •
185  412 •3.       •2        • 9        •0 0       •0 0       •          •          •          •          •
186  412 •3.       •5.       • 55       •0 0       •0 0228    •          •          •          •          •
187  412 •3.       •4.       • 5        •0 0       •0.0       •          •          •          •          •
188  403 •ROOF MAT•ERIAL     •0.        •0.        •0.        •100.      •101.      •0.        •-1.0      •
189  404 •ROOF MAT•ERIAL     •5.        •0.        •0.        •0.        •RSTAT     •IROOF     •DGR       •
190  407 •RSTAT    •-1.      •1200      •-65.36    •67.38     •-29.36    •4.78      •          •          •
191  408 •IROOF    •-1.      •0         •          •          •          •          •          •          •
192  405 •DGR      •0        •0         •          •          •          •          •          •          •
193  405 •DGR      •.001     • 01       •          •          •          •          •          •          •
194  405 •DGR      •10       • 01       •          •          •          •          •          •          •
195  406 •DGR      •0.       •1.        •          •          •          •          •          •          •
196  406 •DGR      •.001     • 91       •          •          •          •          •          •          •
197  406 •DGR      •.75      • 8        •          •          •          •          •          •          •
198  406 •DGR      •1.5      •.5        •          •          •          •          •          •          •
199  406 •DGR      •10.      •.3        •          •          •          •          •          •          •
200  403 •SEAT MAT•ERIAL     •     0 0  •    0.0   •    3.937•     6.693•     7.480•     0.0   •     0.0  •
201  404 •SEAT MAT•ERIAL     •5.62      •          •          •          •SSEAT     •ISEAT2    •GRSEAT    •
202  405 •GRSEAT   •  -0.984•.1         •          •          •          •          •          •          •
203  406 •GRSEAT   •  -0.984•.5         •          •          •          •          •          •          •
204  407 •SSEAT    •    0.0  •    0.0   •    0.0   •    0.0   •    0 0   •    0.0   •    0.0   •          •
205  407 •SSEAT    •    1.850•  37 768•      0 0   •    0.0   •    0 0   •    0.0   •    0.0   •          •
206  407 •SSEAT    •    4.213• 202 328•      0.0   •    0 0   •    0.0   •    0.0   •    0.0   •          •
207  407 •SSEAT    •    4.961• 330 469•      0.0   •    0.0   •    0.0   •    0.0   •    0.0   •          •
208  407 •SSEAT    •    7.008•1252 86 •      0.0   •    0.0   •    0.0   •    0 0   •    0.0   •          •
209  407 •SSEAT    •    7 480•    0 0 •      0.0   •    0 0   •    0.0   •    0.0   •    0.0   •          •
210  408 •ISEAT2   •-1.0     •          •          •          •          •          •          •          •
211  403 •STEEL    •         •   0 000•     0.000•     0.394•     4.724•     5.906•     0.000•     0.000•
212  404 •STEEL    •         •   5 620•                       •          •SSTEEL    •ISTEEL1   •GRSTEEL   •
213  405 •GRSTEEL  •  0.000•0           •          •          •          •          •          •          •
214  405 •GRSTEEL  •  0.394• 1          •          •          •          •          •          •          •
215  405 •GRSTEEL  •  4.724• 9          •          •          •          •          •          •          •
216  405 •GRSTEEL  •  5.906•.99         •          •          •          •          •          •          •
217  406 •GRSTEEL  •  0.000•1.          •          •          •          •          •          •          •
218  406 •GRSTEEL  •.394     • 8        •          •          •          •          •          •          •
219  406 •GRSTEEL  •  4.724• 05         •          •          •          •          •          •          •
220  406 •GRSTEEL  •  5.906• 005        •          •          •          •          •          •          •
221  407 •SSTEEL   •  0.000•    0 000•     0.000•     0.000•     0.000•     0.000•     0.000•          •
222  407 •SSTEEL   •  0.394•1574 803•     0.000•     0.000•     0.000•     0 000•     0.000•          •
223  407 •SSTEEL   •  4 724•1574 803•     0.000•     0.000•     0.000•     0.000•     0.000•          •
224  407 •SSTEEL   •  5.906•    0 000•     0.000•     0.000•     0.000•     0.000•     0.000•          •
225  408 •ISTEEL1  •-.394    •          •          •          •          •          •          •          •
226  403 •GLASS MA•TERIAL    •0 90      •1.50      •0.85      •1000.     •1000 1    •0.0       •0.0       •
227  404 •GLASS MA•TERIAL    •5 620     •          •          •          •GLASTAT   •GLASP     •GRGLAS    •
228  405 •GRGLAS   •-1.      •0 977     •          •          •          •          •          •          •
229  406 •GRGLAS   •-1.      •0 004     •          •          •          •          •          •          •
230  407 •GLASTAT  •0.00     •  0 00    •          •          •          •          •          •          •
231  407 •GLASTAT  •1.25     •550 0     •          •          •          •          •          •          •
232  407 •GLASTAT  •1.75     •490 0     •          •          •          •          •          •          •
233  407 •GLASTAT  •3 60     •840 0     •          •          •          •          •          •          •
234  407 •GLASTAT  •4.00     •800.0     •          •          •          •          •          •          •
235  407 •GLASTAT  •6.00     •830 0     •          •          •          •          •          •          •
236  407 •GLASTAT  •6.50     •820 0     •          •          •          •          •          •          •
237  407 •GLASTAT  •9.00     •500 0     •          •          •          •          •          •          •
238  407 •GLASTAT  •9.25     •   0 0    •          •          •          •          •          •          •
239  408 •GLASP    •0.0      •   0 0    •          •          •          •          •          •          •
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240  408 •GLASP    •0.9      •675 0     •          •          •          •          •          •          •
241  408 •GLASP    •1.50     •   0 0    •          •          •          •          •          •          •
242  600 •granada2•5mph      •          •          •          •          •          •          •          •
243  601 •     0.00•    36 67•      0 00•      0 00•      0.00•      0 00•      0 00•      0.00•      0.00•
244  602 •      440 •        1 •        1 •          •          •          •          •          •          •
245      •     0.00•    -3.80•      0 50•     -4.02•      1.00•     -4.24•      1.50•     -4.46•      0.00•
246      •     2.00•    -4.69•      2 50•     -4.91•      3.00•     -5 13•      3.50•     -5.34•      0.00•
247      •     4.00•    -5 54•      4 50•     -5.75•      5 00•     -5.96•      5.50•     -6 17•      0.00•
248      •     6.00•    -6.37•      6 50•     -6.56•      7.00•     -6.75•      7.50•     -6.94•      0.00•
249      •     8.00•    -7 13•      8 50•     -7 31•      9.00•     -7.49•      9.50•     -7.66•      0.00•
250      •    10.00•    -7.83•     10 50•     -7.99•     11 00•     -8.15•     11 50•     -8.30•      0.00•
251      •    12.00•    -8 45•     12 50•     -8.60•     13 00•     -8 74•     13.50•     -8.87•      0.00•
252      •    14.00•    -9.00•     14.50•     -9.14•     15.00•     -9 26•     15 50•     -9.39•      0.00•
253      •    16.00•    -9.51•     16 50•     -9.63•     17.00•     -9 75•     17.50•     -9.88•      0.00•
254      •    18.00•   -10.00•     18 50•    -10 13•     19.00•    -10 26•     19 50•    -10.38•      0.00•
255      •    20.00•   -10.51•     20 50•    -10.63•     21.00•    -10.76•     21.50•    -10.89•      0.00•
256      •    22.00•   -11.01•     22.50•    -11.13•     23.00•    -11.25•     23.50•    -11.37•      0.00•
257      •    24.00•   -11.48•     24 50•    -11.59•     25.00•    -11.69•     25.50•    -11.79•      0.00•
258      •    26.00•   -11.88•     26.50•    -11.97•     27.00•    -12.05•     27 50•    -12.13•      0.00•
259      •    28.00•   -12.21•     28 50•    -12.28•     29.00•    -12.34•     29.50•    -12.40•      0.00•
260      •    30 00•   -12.46•     30 50•    -12 51•     31.00•    -12.56•     31.50•    -12.60•      0.00•
261      •    32.00•   -12.65•     32.50•    -12.68•     33.00•    -12.71•     33.50•    -12.74•      0.00•
262      •    34 00•   -12.77•     34 50•    -12.79•     35.00•    -12.81•     35.50•    -12.82•      0.00•
263      •    36.00•   -12.83•     36 50•    -12.84•     37.00•    -12.85•     37.50•    -12.85•      0.00•
264      •    38.00•   -12.85•     38 50•    -12.85•     39.00•    -12.84•     39.50•    -12.84•      0.00•
265      •    40.00•   -12.83•     40 50•    -12.82•     41.00•    -12.81•     41.50•    -12.80•      0.00•
266      •    42.00•   -12.79•     42 50•    -12.78•     43.00•    -12.76•     43.50•    -12.75•      0.00•
267      •    44.00•   -12.74•     44.50•    -12.73•     45.00•    -12.72•     45.50•    -12.72•      0.00•
268      •    46.00•   -12.71•     46.50•    -12.70•     47.00•    -12.70•     47.50•    -12.70•      0.00•
269      •    48.00•   -12.69•     48 50•    -12.69•     49.00•    -12.69•     49.50•    -12.70•      0.00•
270      •    50.00•   -12.71•     50.50•    -12.72•     51.00•    -12.73•     51 50•    -12.74•      0.00•
271      •    52.00•   -12.76•     52 50•    -12.78•     53.00•    -12 80•     53 50•    -12.83•      0.00•
272      •    54.00•   -12.85•     54.50•    -12.88•     55.00•    -12.91•     55.50•    -12.94•      0.00•
273      •    56.00•   -12.98•     56.50•    -13.02•     57.00•    -13.06•     57.50•    -13.11•      0.00•
274      •    58 00•   -13.16•     58 50•    -13.21•     59.00•    -13.26•     59.50•    -13.32•      0.00•
275      •    60.00•   -13.38•     60 50•    -13.44•     61.00•    -13.51•     61.50•    -13.58•      0.00•
276      •    62 00•   -13.64•     62 50•    -13 72•     63.00•    -13.79•     63.50•    -13.87•      0.00•
277      •    64.00•   -13.95•     64 50•    -14.02•     65.00•    -14.10•     65.50•    -14.18•      0.00•
278      •    66.00•   -14.27•     66 50•    -14.35•     67.00•    -14.44•     67.50•    -14.52•      0.00•
279      •    68.00•   -14.61•     68 50•    -14.69•     69.00•    -14.78•     69.50•    -14.87•      0.00•
280      •    70.00•   -14.95•     70.50•    -15.04•     71.00•    -15.12•     71.50•    -15.20•      0.00•
281      •    72.00•   -15.29•     72.50•    -15.37•     73.00•    -15.45•     73.50•    -15.53•      0.00•
282      •    74.00•   -15.60•     74.50•    -15.68•     75.00•    -15.75•     75.50•    -15.82•      0.00•
283      •    76.00•   -15.89•     76.50•    -15.96•     77.00•    -16.02•     77.50•    -16.08•      0.00•
284      •    78.00•   -16.14•     78 50•    -16.19•     79.00•    -16.25•     79.50•    -16.30•      0.00•
285      •    80.00•   -16 34•     80 50•    -16.39•     81.00•    -16.43•     81.50•    -16.47•      0.00•
286      •    82.00•   -16.50•     82 50•    -16.54•     83.00•    -16.56•     83.50•    -16.59•      0.00•
287      •    84.00•   -16.61•     84.50•    -16.63•     85.00•    -16.64•     85 50•    -16.66•      0.00•
288      •    86.00•   -16.67•     86 50•    -16 67•     87.00•    -16 67•     87.50•    -16.67•      0.00•
289      •    88.00•   -16.67•     88 50•    -16.66•     89.00•    -16.65•     89 50•    -16.63•      0.00•
290      •    90.00•   -16.62•     90 50•    -16.60•     91.00•    -16.57•     91.50•    -16.27•      0.00•
291      •    92.00•   -15.58•     92 50•    -14.92•     93.00•    -14.27•     93 50•    -13.64•      0.00•
292      •    94.00•   -13.03•     94 50•    -12.43•     95.00•    -11.86•     95.50•    -11.29•      0.00•
293      •    96.00•   -10.75•     96 50•    -10.22•     97 00•     -9 70•     97 50•     -9.20•      0.00•
294      •    98.00•    -8.72•     98 50•     -8.25•     99.00•     -7 79•     99 50•     -7.35•      0.00•
295      •   100.00•    -6.92•    100 50•     -6.50•    101 00•     -6.10•    101.50•     -5.71•      0.00•
296      •   102.00•    -5.33•    102 50•     -4.97•    103.00•     -4.61•    103.50•     -4.27•      0.00•
297      •   104.00•    -3.94•    104 50•     -3.62•    105 00•     -3 31•    105.50•     -3.01•      0.00•
298      •   106.00•    -2.72•    106 50•     -2.45•    107 00•     -2 18•    107.50•     -1.92•      0.00•
299      •   108.00•    -1.67•    108 50•     -1.43•    109 00•     -1 20•    109 50•     -0.98•      0.00•
```

300		110.00	-0.76	110.50	-0.56	111.00	-0.36	111.50	-0.17	0.00
301		112.00	0.01	112.50	0.19	113.00	0.36	113.50	0.52	0.00
302		114.00	0.67	114.50	0.82	115.00	0.96	115.50	1.09	0.00
303		116.00	1.22	116.50	1.34	117.00	1.46	117.50	1.57	0.00
304		118.00	1.68	118.50	1.78	119.00	1.87	119.50	1.96	0.00
305		120.00	2.05	120.50	2.13	121.00	2.20	121.50	2.28	0.00
306		122.00	2.34	122.50	2.41	123.00	2.46	123.50	2.52	0.00
307		124.00	2.57	124.50	2.62	125.00	2.66	125.50	2.70	0.00
308		126.00	2.74	126.50	2.78	127.00	2.81	127.50	2.84	0.00
309		128.00	2.86	128.50	2.88	129.00	2.90	129.50	2.92	0.00
310		130.00	2.94	130.50	2.95	131.00	2.96	131.50	2.97	0.00
311		132.00	2.97	132.50	2.98	133.00	2.98	133.50	2.98	0.00
312		134.00	2.98	134.50	2.97	135.00	2.97	135.50	2.96	0.00
313		136.00	2.95	136.50	2.94	137.00	2.93	137.50	2.92	0.00
314		138.00	2.91	138.50	2.89	139.00	2.88	139.50	2.86	0.00
315		140.00	2.84	140.50	2.82	141.00	2.80	141.50	2.78	0.00
316		142.00	2.76	142.50	2.74	143.00	2.71	143.50	2.69	0.00
317		144.00	2.67	144.50	2.64	145.00	2.62	145.50	2.59	0.00
318		146.00	2.56	146.50	2.54	147.00	2.51	147.50	2.48	0.00
319		148.00	2.45	148.50	2.42	149.00	2.39	149.50	2.36	0.00
320		150.00	2.33	150.50	2.30	151.00	2.27	151.50	2.24	0.00
321		152.00	2.21	152.50	2.18	153.00	2.15	153.50	2.12	0.00
322		154.00	2.09	154.50	2.06	155.00	2.03	155.50	2.00	0.00
323		156.00	1.97	156.50	1.94	157.00	1.91	157.50	1.88	0.00
324		158.00	1.85	158.50	1.82	159.00	1.79	159.50	1.76	0.00
325		160.00	1.73	160.50	1.70	161.00	1.67	161.50	1.64	0.00
326		162.00	1.61	162.50	1.58	163.00	1.56	163.50	1.53	0.00
327		164.00	1.50	164.50	1.47	165.00	1.44	165.50	1.42	0.00
328		166.00	1.39	166.50	1.36	167.00	1.34	167.50	1.31	0.00
329		168.00	1.28	168.50	1.26	169.00	1.23	169.50	1.21	0.00
330		170.00	1.18	170.50	1.16	171.00	1.13	171.50	1.11	0.00
331		172.00	1.09	172.50	1.06	173.00	1.04	173.50	1.02	0.00
332		174.00	0.99	174.50	0.97	175.00	0.95	175.50	0.93	0.00
333		176.00	0.91	176.50	0.89	177.00	0.87	177.50	0.85	0.00
334		178.00	0.83	178.50	0.81	179.00	0.79	179.50	0.77	0.00
335		180.00	0.75	180.50	0.73	181.00	0.71	181.50	0.70	0.00
336		182.00	0.68	182.50	0.66	183.00	0.64	183.50	0.63	0.00
337		184.00	0.61	184.50	0.60	185.00	0.58	185.50	0.56	0.00
338		186.00	0.55	186.50	0.53	187.00	0.52	187.50	0.51	0.00
339		188.00	0.49	188.50	0.48	189.00	0.46	189.50	0.45	0.00
340		190.00	0.44	190.50	0.43	191.00	0.41	191.50	0.40	0.00
341		192.00	0.39	192.50	0.38	193.00	0.37	193.50	0.35	0.00
342		194.00	0.34	194.50	0.33	195.00	0.32	195.50	0.31	0.00
343		196.00	0.30	196.50	0.29	197.00	0.28	197.50	0.27	0.00
344		198.00	0.26	198.50	0.26	199.00	0.25	199.50	0.24	0.00
345		200.00	0.23	200.50	0.22	201.00	0.21	201.50	0.21	0.00
346		202.00	0.20	202.50	0.19	203.00	0.18	203.50	0.18	0.00
347		204.00	0.17	204.50	0.16	205.00	0.16	205.50	0.15	0.00
348		206.00	0.15	206.50	0.14	207.00	0.13	207.50	0.13	0.00
349		208.00	0.12	208.50	0.12	209.00	0.11	209.50	0.11	0.00
350		210.00	0.10	210.50	0.10	211.00	0.09	211.50	0.09	0.00
351		212.00	0.08	212.50	0.08	213.00	0.08	213.50	0.07	0.00
352		214.00	0.07	214.50	0.06	215.00	0.06	215.50	0.06	0.00
353		216.00	0.05	216.50	0.05	217.00	0.05	217.50	0.04	0.00
354		218.00	0.04	218.50	0.04	219.00	0.03	219.50	0.03	0.00
355	603	2.	1.	1.						
356		0.00	0.00	300.00	0.00	0.00	0.00	0.00	0.00	0.00
357	604	2.	0.							
358		0.00	0.00	300.00	0.00	0.00	0.00	0.00	0.00	0.00
359	700	Unrestrained								

APPENDIX C

EXAMPLE OF MVMA2D SIMULATION RESULTS

1976 Ford LTD with 50th percentile male, 25 mph

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NNNNNNNNNN   000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000   NNNNNNNNNN
NNNNNNNNNN   000000000000000000000000  Digital Equipment Corporation - VAX/VMS Version V4.3  000000000000000000000000   NNNNNNNNNN
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                          CCCC  H   H  U   U   CCCC  K   K  K   K
                         C      H   H  U   U  C      K  K   K  K
                         C      H   H  U   U  C      K K    K K
                         C      HHHHH  U   U  C      KKK    KKK
                         C      H   H  U   U  C      K K    K K
                         C      H   H  U   U  C      K  K   K  K
                          CCCC  H   H  UUUUU   CCCC  K   K  K   K

FFFFFFFFFF    000000    RRRRRRRR   DDDDDDDD   77777777    666666   5555555555    000000     222222    5555555555
FFFFFFFFFF    000000    RRRRRRRR   DDDDDDDD   77777777    666666   5555555555    000000     222222    5555555555
FF          00      00  RR      RR DD      DD         77 66        55          00      00 22      22 55
FF          00      00  RR      RR DD      DD         77 66        55          00      00 22      22 55
FF          00      00  RR      RR DD      DD         77 66        555555      00    0000         22 555555
FF          00      00  RR      RR DD      DD         77 66        555555      00    0000         22 555555
FFFFFFFF    00      00  RRRRRRRR   DD      DD       77   66666666        55    00  00  00       22         55
FFFFFFFF    00      00  RRRRRRRR   DD      DD       77   66666666        55    00  00  00       22         55
FF          00      00  RR  RR     DD      DD     77     66      66        55  0000    00     22             55
FF          00      00  RR  RR     DD      DD     77     66      66        55  0000    00     22             55
FF          00      00  RR    RR   DD      DD   77       66      66  55    55  00      00   22         55    55
FF          00      00  RR    RR   DD      DD   77       66      66  55    55  00      00   22         55    55
FF            000000    RR      RR DDDDDDDD   77          666666      555555     000000   2222222222   555555
FF            000000    RR      RR DDDDDDDD   77          666666      555555     000000   2222222222   555555

                          000000    UU      UU TTTTTTTTTT     ;;;;    5555555555
                          000000    UU      UU TTTTTTTTTT     ;;;;    5555555555
                        00      00  UU      UU     TT         ;;;;    55
                        00      00  UU      UU     TT         ;;;;    55
                        00      00  UU      UU     TT                 555555
                        00      00  UU      UU     TT                 555555
                        00      00  UU      UU     TT         ;;;;          55
                        00      00  UU      UU     TT         ;;;;          55
                        00      00  UU      UU     TT         ;;;;            55
                        00      00  UU      UU     TT         ;;;;            55
                  ....  00      00  UU      UU     TT           ;;    55      55
                  ....  00      00  UU      UU     TT           ;;    55      55
                  ....    000000    UUUUUUUUUU     TT         ;;        555555
                  ....    000000    UUUUUUUUUU     TT         ;;        555555
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File _DBA2:[SCRATCH.CJK]FORD765025.OUT;5 (5253,60,0), last revised on 16-JUL-1987 10:15, is a 610 block sequential file owned by UIC [CHUCKK]. The records are variable length with FORTRAN (FTN) carriage control. The longest record is 133 bytes.

Job FORD765025 (202) queued to TXG3 on 16-JUL-1987 10:22 by user CHUCKK, UIC [CHUCKK], under account NPP-01 at priority 4, started on printer _TXG3: on 16-JUL-1987 11:50 from queue TXG3.


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NNNNNNNNNN   000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000   NNNNNNNNNN
NNNNNNNNNN   000000000000000000000000  Digital Equipment Corporation - VAX/VMS Version V4.3  000000000000000000000000   NNNNNNNNNN
NNNNNNNNNN   000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000000   NNNNNNNNNN
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1 1001 *46,47,40*,6,5,17,*8,45,4  *         *         *         *         *         *         *
2 1002 *         *         *         *         *         *         *         *         *         *
3 1003 *0.       *0.       *0.       *11.55    *.025     *         *         *         *         *
4 1004 *40.      *499.99   *560.     *0.       *.85      *201.     *5.       *5.       *         *
5 1500 *0.       *1.       *-1.5     *76.5     *1.       *-52.     *10.      *0.       *         *
6 1501 *24.      *0.       *0.       *1.       *1.       *0.       *1.       *0.       *0.       *
7 1600 *         *         *         *         *         *         *         *         *         *
```

HEAD CENTER OF MASS MOTION

(POSITIONS AND VELOCITIES RELATIVE TO VEHICLE FRAME)
(ACCELERATIONS RELATIVE TO INERTIAL FRAME)

TIME (MSEC)	X (IN)	X-VEL. (IN/SEC)	X-ACCEL. (G'S)	Z (IN)	Z-VEL. (IN/SEC)	Z-ACCEL. (G'S)	HEAD ANGLE (DEG)	ANG. VEL. (DEG/SEC)	ANG. ACC. (RAD/SEC**2)
0.00	18.72	0.00	0.000	-40.31	0.00	1.000	80.64	0.00	0.00
3.00	18.73	5.52	0.177	-40.31	0.55	0.000	80.65	4.61	-52.86
6.00	18.75	12.73	0.262	-40.31	0.14	-0.575	80.65	3.62	-77.88
9.00	18.80	21.37	0.211	-40.31	-0.64	-0.642	80.66	0.19	-105.21
12.00	18.88	31.20	0.156	-40.31	-1.32	-0.463	80.65	-4.44	-109.92
15.00	18.99	42.02	0.103	-40.32	-1.80	-0.301	80.62	-8.90	-118.74
18.00	19.13	53.72	0.056	-40.32	-2.12	-0.173	80.58	-12.65	-139.19
21.00	19.31	66.32	0.121	-40.33	-2.32	-0.090	80.53	-16.49	-128.17
24.00	19.53	79.81	0.253	-40.34	-2.42	-0.012	80.47	-21.66	-107.96
27.00	19.79	94.08	0.377	-40.34	-2.42	0.066	80.39	-28.09	-88.50
30.00	20.10	108.95	0.463	-40.35	-2.31	0.139	80.30	-35.41	-74.47
33.00	20.45	124.21	0.505	-40.36	-2.12	0.204	80.18	-43.54	-66.45
36.00	20.84	139.67	0.508	-40.36	-1.86	0.258	80.03	-52.34	-64.21
39.00	21.29	155.17	0.475	-40.37	-1.54	0.312	79.86	-61.66	-68.79
42.00	21.77	170.58	0.368	-40.37	-1.19	0.276	79.66	-71.62	-83.02
45.00	22.31	185.83	0.131	-40.37	-0.95	0.157	79.43	-81.62	-120.36
48.00	22.89	200.82	-0.301	-40.38	-0.79	0.227	79.16	-91.95	-169.97
51.00	23.51	215.55	0.037	-40.38	-0.49	0.181	78.87	-101.22	-45.95
54.00	24.18	230.41	0.853	-40.38	-0.38	-0.029	78.56	-108.38	134.07
57.00	24.90	245.69	0.909	-40.38	-0.23	0.230	78.24	-111.96	117.43
60.00	25.66	261.48	0.722	-40.38	0.41	0.855	77.91	-111.63	4.37
63.00	26.47	278.06	1.073	-40.38	1.83	1.135	77.57	-109.85	38.15
66.00	27.33	295.65	1.202	-40.37	3.32	1.458	77.26	-101.59	54.42
69.00	28.24	313.86	1.241	-40.36	5.20	1.687	76.96	-91.79	63.43
72.00	29.21	332.88	1.590	-40.34	6.87	1.034	76.71	-78.98	86.72
75.00	30.24	353.39	3.040	-40.32	5.94	-3.693	76.50	-56.91	104.61
78.00	31.33	375.72	3.480	-40.31	0.71	-4.698	76.38	-24.98	169.28
81.00	32.49	398.49	3.305	-40.31	-3.68	-2.504	76.34	-2.36	118.33
84.00	33.73	423.30	7.322	-40.33	-5.07	-0.226	76.40	58.20	640.64
87.00	35.04	454.62	12.926	-40.34	-5.17	-0.119	76.79	209.05	997.32
90.00	36.46	487.27	7.958	-40.36	-4.63	1.833	77.62	316.03	47.75
93.00	37.95	500.74	-37.559	-40.36	3.35	20.333	78.51	268.74	12.35
96.00	39.37	435.48	-70.492	-40.31	29.95	7.793	79.51	462.78	1879.66
99.00	40.61	401.49	-17.444	-40.23	14.91	-21.980	81.40	810.27	2307.21
102.00	41.79	384.44	-28.202	-40.22	-2.85	-8.239	84.52	1294.65	3140.56
105.00	42.89	342.69	-50.862	-40.24	-7.47	-0.588	89.15	1773.54	2657.18
108.00	43.82	277.24	-83.707	-40.26	-6.39	2.710	95.16	2252.90	3308.09
111.00	44.54	197.22	-74.598	-40.28	-5.33	-3.659	102.62	2606.87	-447.03
114.00	45.00	115.51	-56.964	-40.30	-14.32	-7.482	109.95	2239.16	-1877.83
117.00	45.28	76.17	-13.638	-40.35	-15.31	2.570	116.60	2282.53	936.80
120.00	45.47	50.37	-36.408	-40.40	-23.38	-21.220	123.00	1689.20	-8660.92

HEAD CENTER OF MASS MOTION

(POSITIONS AND VELOCITIES RELATIVE TO VEHICLE FRAME)
(ACCELERATIONS RELATIVE TO INERTIAL FRAME)

TIME (MSEC)	X (IN)	X-VEL. (IN/SEC)	X-ACCEL. (G'S)	Z (IN)	Z-VEL. (IN/SEC)	Z-ACCEL. (G'S)	HEAD ANGLE (DEG)	ANG. VEL. (DEG/SEC)	ANG. ACC. (RAD/SEC**2)
120.00	45.47	50.37	-36.408	-40.40	-23.38	-21.220	123.00	1689.20	-8660.92
123.00	45.57	28.44	2.527	-40.51	-43.15	-12.815	125.86	349.93	-5168.41
126.00	45.66	35.29	-8.523	-40.65	-45.31	-0.361	125.81	-356.62	-4194.52
129.00	45.76	26.15	-24.293	-40.77	-23.85	19.189	123.96	-714.95	1044.95
132.00	45.79	-0.09	-20.886	-40.78	15.75	25.387	122.02	-556.21	1259.19
135.00	45.80	6.98	11.255	-40.71	30.24	19.832	120.44	-581.50	-1450.49
138.00	45.84	18.88	12.989	-40.60	45.58	12.069	118.31	-850.51	-2094.32
141.00	45.90	25.42	4.342	-40.44	63.02	17.599	115.11	-1306.61	-3003.75
144.00	45.98	23.45	-1.754	-40.21	85.32	20.497	110.42	-1808.79	-2609.42
147.00	46.04	16.13	-5.484	-39.92	109.58	20.993	104.43	-2141.48	-1152.89
150.00	46.07	7.31	-5.593	-39.56	133.48	19.757	97.83	-2251.43	-474.35
153.00	46.08	-4.79	-14.017	-39.12	154.13	14.873	90.95	-2363.44	-1237.22
156.00	46.04	-22.79	-13.038	-38.64	170.16	12.829	83.60	-2515.17	-562.21
159.00	45.95	-39.81	-12.803	-38.11	183.93	11.006	75.96	-2568.76	-106.94
162.00	45.80	-56.88	-13.367	-37.54	195.80	9.556	68.25	-2561.27	173.20
165.00	45.60	-74.30	-13.576	-36.93	205.50	7.110	60.63	-2515.33	355.92
168.00	45.36	-85.95	-9.909	-36.30	212.56	3.474	53.66	-2047.30	2716.11
171.00	45.08	-101.20	-13.215	-35.66	213.75	-1.074	48.10	-1686.16	1697.91
174.00	44.75	-118.23	-13.760	-35.03	210.67	-4.371	43.45	-1425.51	1363.04
177.00	44.37	-134.71	-12.796	-34.40	203.20	-8.356	39.50	-1211.30	1156.42
180.00	43.95	-146.26	-9.813	-33.82	186.07	-13.779	36.06	-1074.45	1023.94
183.00	43.49	-159.92	-12.185	-33.28	172.08	-10.732	33.14	-858.63	1441.40
186.00	42.99	-175.10	-12.418	-32.79	160.03	-10.525	30.96	-595.62	1581.00
189.00	42.44	-189.24	-10.792	-32.32	147.09	-11.896	29.58	-321.94	1599.31
192.00	41.86	-201.02	-8.777	-31.90	132.61	-12.923	29.03	-44.59	1636.62

CHEST CENTER OF MASS MOTION

(POSITIONS AND VELOCITIES RELATIVE TO VEHICLE FRAME)
(ACCELERATIONS RELATIVE TO INERTIAL FRAME)

TIME (MSEC)	X (IN)	X-VEL. (IN/SEC)	X-ACCEL. (G'S)	Z (IN)	Z-VEL. (IN/SEC)	Z-ACCEL. (G'S)
0.00	18.15	0.00	0.405	-28.28	0.00	-0.202
3.00	18.15	5.40	0.182	-28.28	-0.25	-0.196
6.00	18.18	12.01	-0.025	-28.28	-0.54	-0.257
9.00	18.23	19.81	-0.123	-28.28	-0.88	-0.279
12.00	18.30	28.68	-0.221	-28.29	-1.26	-0.333
15.00	18.40	38.48	-0.272	-28.29	-1.70	-0.317
18.00	18.53	49.08	-0.315	-28.30	-2.06	-0.227
21.00	18.70	60.46	-0.416	-28.30	-2.32	-0.141
24.00	18.90	72.62	-0.552	-28.31	-2.47	-0.070
27.00	19.13	85.42	-0.691	-28.32	-2.55	-0.016
30.00	19.41	98.68	-0.816	-28.33	-2.56	0.031
33.00	19.72	112.22	-0.925	-28.33	-2.51	0.070
36.00	20.08	125.87	-1.025	-28.34	-2.41	0.098
39.00	20.48	139.48	-1.110	-28.35	-2.28	0.113
42.00	20.92	153.03	-1.067	-28.35	-2.25	-0.051
45.00	21.40	166.56	-0.892	-28.36	-2.37	-0.084
48.00	21.92	180.35	-0.466	-28.37	-2.34	0.129
51.00	22.48	194.25	-0.535	-28.38	-2.40	0.274
54.00	23.08	207.92	-0.891	-28.38	-2.58	0.602
57.00	23.73	221.62	-1.007	-28.39	-2.31	1.102
60.00	24.41	235.33	-1.216	-28.40	-1.47	1.591
63.00	25.14	248.90	-2.003	-28.40	-0.07	1.890
66.00	25.91	262.09	-3.040	-28.40	1.84	1.760
69.00	26.71	274.31	-5.400	-28.39	2.92	-0.701
72.00	27.55	283.83	-8.095	-28.38	0.19	-3.832
75.00	28.41	291.13	-10.320	-28.39	-5.22	-5.097
78.00	29.29	297.16	-10.893	-28.41	-11.58	-5.807
81.00	30.20	303.78	-10.150	-28.46	-18.53	-6.160
84.00	31.12	311.08	-10.617	-28.53	-25.99	-6.767
87.00	32.06	317.61	-10.848	-28.62	-33.80	-6.213
90.00	33.03	326.48	-6.235	-28.73	-40.10	-4.604
93.00	34.03	340.92	-0.816	-28.85	-44.54	-2.592
96.00	35.07	353.95	-3.549	-28.99	-42.50	6.574
99.00	36.14	357.25	-8.479	-29.10	-33.34	7.158
102.00	37.21	353.50	-10.785	-29.19	-28.14	1.670
105.00	38.26	347.64	-8.258	-29.28	-28.72	1.126
108.00	39.29	341.24	-9.025	-29.35	-24.84	1.239
111.00	40.30	332.99	-6.423	-29.42	-22.30	3.740
114.00	41.29	323.38	-16.754	-29.48	-17.94	1.890
117.00	42.21	285.51	-41.900	-29.54	-20.89	-5.347
120.00	42.99	235.73	-37.396	-29.61	-20.43	8.978

CHEST CENTER OF MASS MOTION

(POSITIONS AND VELOCITIES RELATIVE TO VEHICLE FRAME)
(ACCELERATIONS RELATIVE TO INERTIAL FRAME)

TIME (MSEC)	X (IN)	X-VEL. (IN/SEC)	X-ACCEL. (G'S)	Z (IN)	Z-VEL. (IN/SEC)	Z-ACCEL. (G'S)
120.00	42.99	235.73	-37.396	-29.61	-20.43	8.978
123.00	43.63	185.14	-46.004	-29.65	-5.55	16.473
126.00	44.10	130.73	-39.234	-29.63	18.02	24.116
129.00	44.42	86.70	-34.168	-29.53	45.60	21.440
132.00	44.62	43.25	-41.061	-29.36	67.73	16.127
135.00	44.66	-14.15	-44.096	-29.14	83.02	12.391
138.00	44.55	-59.54	-26.149	-28.86	99.79	14.444
141.00	44.33	-81.50	-10.866	-28.54	113.59	9.659
144.00	44.07	-94.29	-5.951	-28.19	122.34	5.556
147.00	43.77	-102.31	-2.946	-27.81	127.00	2.811
150.00	43.45	-108.09	-2.102	-27.43	128.87	0.494
153.00	43.12	-111.63	2.159	-27.04	129.04	1.058
156.00	42.79	-111.67	1.828	-26.65	129.52	-0.350
159.00	42.45	-111.71	1.762	-26.26	128.83	-1.000
162.00	42.12	-111.15	2.896	-25.88	127.59	-0.943
165.00	41.79	-109.77	3.016	-25.50	125.60	-2.004
168.00	41.46	-110.73	1.008	-25.13	121.80	-2.992
171.00	41.13	-110.24	1.827	-24.77	119.08	-1.744
174.00	40.80	-110.40	-0.305	-24.41	117.44	-1.120
177.00	40.46	-113.09	-2.393	-24.06	116.72	-0.120
180.00	40.11	-119.09	-4.437	-23.71	118.50	1.400
183.00	39.75	-124.24	-2.930	-23.35	119.84	1.008
186.00	39.37	-127.30	-1.189	-22.99	121.14	1.370
189.00	38.99	-128.39	0.202	-22.62	123.18	2.149
192.00	38.60	-128.08	1.338	-22.25	126.12	2.988

16-JUL-87 08:58:18 MVMA 2D CRASH VICTIM SIMULATION granada25mph Unrestrained
Hybiii 50th Male 76Ford/50hyb/mid 76FordLTD

FEMUR AND TIBIA LOADS (LB)

WITH FEMUR SENSOR LOCATED 14.25(IN) FROM HIP LEG MASS FROM SENSOR TO KNEE 15.0991 (LBS SEC**2/IN)

	FEMUR			TIBIA	
TIME	AXIAL AT SENSOR	AXIAL AT KNEE	SHEAR AT KNEE	AXIAL AT KNEE	AXIAL AT FOOT
0.00	10.1	3.8	-23.7	-2.9	3.6
3.00	8.3	8.7	-20.1	-10.2	6.3
6.00	6.5	13.9	-18.0	-16.0	10.8
9.00	6.0	14.0	-18.0	-16.2	12.9
12.00	5.5	14.0	-18.4	-16.3	14.1
15.00	4.8	13.7	-18.8	-16.7	14.3
18.00	4.0	13.2	-19.2	-17.5	13.3
21.00	2.7	12.2	-19.5	-18.8	11.5
24.00	1.2	11.0	-19.8	-20.5	9.0
27.00	0.3	10.1	-20.1	-22.2	6.4
30.00	-0.7	9.3	-20.4	-24.2	4.2
33.00	-0.9	9.4	-21.7	-27.2	2.8
36.00	0.2	11.3	-24.6	-31.5	2.2
39.00	1.7	13.7	-27.9	-36.0	2.4
42.00	3.6	16.6	-31.4	-40.8	2.8
45.00	42.4	63.3	-121.6	49.3	303.3
48.00	97.3	126.2	-263.3	286.6	908.7
51.00	68.6	91.2	-326.9	320.5	1076.4
54.00	32.9	52.4	-381.5	350.8	1234.0
57.00	-27.1	-10.6	-411.5	354.6	1306.3
60.00	-99.2	-84.1	-404.4	329.8	1254.6
63.00	-143.6	-125.5	-316.1	250.4	928.8
66.00	-69.1	-31.8	-161.5	146.1	403.2
69.00	149.0	243.4	-115.1	158.2	266.4
72.00	285.6	422.0	-92.0	157.9	143.9
75.00	315.7	464.2	-72.7	132.6	41.0
78.00	348.1	502.1	-60.1	112.7	0.0
81.00	373.4	526.8	-50.9	97.8	0.0
84.00	432.2	586.0	-36.7	82.3	0.0
87.00	706.0	887.6	-14.3	75.2	0.0
90.00	793.5	969.6	-23.1	84.3	0.0
93.00	528.5	648.9	-95.3	-9.2	27.8
96.00	345.7	420.8	-115.0	0.8	96.0
99.00	624.7	754.2	-359.5	355.0	1196.4
102.00	589.8	729.3	-233.9	218.5	642.4
105.00	614.9	776.4	-250.5	193.0	612.7
108.00	521.2	679.0	-200.4	146.6	364.9
111.00	452.2	603.4	-154.8	109.2	131.5
114.00	448.9	568.0	-198.2	139.5	25.2
117.00	531.5	553.2	-371.1	263.0	0.0
120.00	602.8	568.4	-440.2	276.6	0.0

16-JUL-87 08:58:18 MVMA 2D CRASH VICTIM SIMULATION granada25mph Unrestrained
Hybiii 50th Male 76Ford/50hyb/mid 76FordLTD

FEMUR AND TIBIA LOADS (LB)

WITH FEMUR SENSOR LOCATED 14.25(IN) FROM HIP LEG MASS FROM SENSOR TO KNEE 15.0991 (LBS SEC**2/IN)

	FEMUR			TIBIA	
TIME	AXIAL AT SENSOR	AXIAL AT KNEE	SHEAR AT KNEE	AXIAL AT KNEE	AXIAL AT FOOT
120.00	602.8	568.4	-440.2	276.6	0.0
123.00	570.4	588.3	-339.4	163.2	0.0
126.00	579.7	633.9	-320.8	94.9	0.0
129.00	620.5	711.4	-407.2	56.9	0.0
132.00	716.1	802.4	-647.8	45.8	0.0
135.00	839.3	896.4	-933.3	57.7	0.0
138.00	933.2	987.4	-1188.9	56.8	0.0
141.00	984.4	1016.2	-1331.1	39.6	0.0
144.00	983.7	1030.8	-1270.3	3.1	0.0
147.00	906.1	972.5	-958.3	-57.0	0.0
150.00	388.9	400.3	-355.8	-51.5	0.0
153.00	287.5	322.7	-246.9	-154.4	-127.5
156.00	388.2	481.4	-78.8	-409.3	-666.6
159.00	124.2	177.1	-171.3	-80.8	-126.0
162.00	-173.1	-182.3	-695.8	537.3	1388.6
165.00	-89.0	-93.8	-631.7	418.8	896.6
168.00	45.6	62.1	-502.0	206.1	205.0
171.00	117.7	152.4	-517.5	125.1	-5.4
174.00	139.4	187.1	-562.1	109.4	-3.2
177.00	136.2	189.4	-520.9	87.1	0.0
180.00	134.3	187.3	-451.2	61.1	0.0
183.00	119.9	164.7	-324.1	26.3	-33.0
186.00	77.4	107.8	-157.0	-5.5	-115.2
189.00	23.7	39.9	-47.8	-5.9	-158.8
192.00	-17.7	-10.8	-158.6	100.8	155.1

UNFILTERED ACCELERATIONS AT ACCELEROMETERS (G'S)

	HEAD			CHEST			HIP		
TIME	A-P	S-I	RESULTANT	A-P	S-I	RESULTANT	X	Z	RESULTANT
0.00	-0.163	0.987	1.000	-0.287	-0.184	0.341	0.166	-0.746	0.764
3.00	-0.175	-0.099	0.201	-0.064	-0.188	0.199	-0.428	-0.312	0.529
6.00	-0.165	-0.713	0.732	0.157	-0.258	0.302	-1.084	0.028	1.085
9.00	-0.104	-0.808	0.814	0.258	-0.285	0.384	-1.148	0.017	1.149
12.00	-0.079	-0.628	0.633	0.361	-0.343	0.497	-1.224	-0.039	1.225
15.00	-0.053	-0.471	0.474	0.436	-0.328	0.546	-1.277	-0.076	1.279
18.00	-0.027	-0.364	0.365	0.516	-0.240	0.569	-1.315	-0.090	1.318
21.00	-0.105	-0.278	0.297	0.634	-0.158	0.653	-1.349	-0.100	1.353
24.00	-0.248	-0.197	0.317	0.767	-0.091	0.772	-1.385	-0.098	1.388
27.00	-0.384	-0.115	0.400	0.901	-0.042	0.902	-1.396	-0.146	1.403
30.00	-0.480	-0.040	0.482	1.020	0.003	1.020	-1.418	-0.183	1.430
33.00	-0.534	0.026	0.534	1.125	0.039	1.125	-1.467	-0.208	1.481
36.00	-0.546	0.081	0.552	1.221	0.067	1.223	-1.548	-0.222	1.564
39.00	-0.524	0.135	0.541	1.304	0.083	1.307	-1.649	-0.228	1.665
42.00	-0.414	0.095	0.425	1.234	-0.076	1.237	-1.761	-0.219	1.775
45.00	-0.161	-0.029	0.163	1.023	-0.104	1.028	-2.377	0.580	2.447
48.00	0.250	0.054	0.256	0.521	0.116	0.534	-2.874	1.444	3.216
51.00	-0.075	0.109	0.133	0.482	0.262	0.549	-2.002	0.346	2.032
54.00	-0.835	-0.020	0.835	0.704	0.594	0.921	-1.146	-0.485	1.244
57.00	-0.942	0.195	0.962	0.887	1.098	1.411	-0.095	-1.973	1.976
60.00	-0.890	0.690	1.126	1.309	1.593	2.062	0.868	-3.994	4.087
63.00	-1.297	0.928	1.595	2.401	1.914	3.070	1.114	-5.992	6.095
66.00	-1.498	1.229	1.937	3.940	1.825	4.342	-0.875	-6.412	6.472
69.00	-1.593	1.448	2.153	7.613	-0.522	7.630	-9.265	-8.128	12.326
72.00	-1.788	0.755	1.941	11.921	-3.482	12.419	-18.555	-11.942	22.066
75.00	-2.095	-4.042	4.553	15.111	-4.537	15.778	-24.262	-14.327	28.176
78.00	-2.276	-5.161	5.641	15.942	-5.103	16.739	-27.266	-13.998	30.650
81.00	-2.620	-3.057	4.026	14.704	-5.418	15.670	-27.050	-11.237	29.291
84.00	-7.065	-1.092	7.149	13.580	-5.597	14.688	-24.039	-5.604	24.684
87.00	-12.574	-1.748	12.695	11.276	-4.355	12.088	-19.195	6.449	20.250
90.00	-8.207	0.148	8.208	5.865	-3.524	6.842	-14.345	12.169	18.811
93.00	32.726	27.425	42.698	0.879	-3.208	3.326	-9.970	8.378	13.022
96.00	67.807	22.992	71.599	-0.722	6.433	6.473	-3.064	9.579	10.057
99.00	20.268	-16.067	25.864	1.562	9.450	9.578	-4.885	15.594	16.341
102.00	28.183	-1.346	28.215	4.622	6.338	7.844	-5.115	14.232	15.123
105.00	49.594	3.694	49.731	3.015	5.037	5.871	-6.100	13.808	15.095
108.00	61.642	1.356	61.657	3.495	5.876	6.837	-5.022	11.753	12.781
111.00	69.251	-20.461	72.211	0.880	6.658	6.715	-4.529	9.955	10.937
114.00	48.965	-28.963	56.890	7.790	11.275	13.704	-2.637	6.551	7.062
117.00	11.241	-2.566	11.530	25.236	19.987	32.192	1.220	-2.719	2.980
120.00	17.824	-49.111	52.245	17.469	27.750	32.790	-0.946	-9.581	9.628

UNFILTERED ACCELERATIONS AT ACCELEROMETERS (G'S)

	HEAD			CHEST			HIP		
TIME	A-P	S-I	RESULTANT	A-P	S-I	RESULTANT	X	Z	RESULTANT
120.00	17.824	-49.111	52.245	17.469	27.750	32.790	-0.946	-9.581	9.628
123.00	-9.604	-15.760	18.456	24.943	36.636	44.322	-1.276	-1.279	1.806
126.00	6.648	-10.842	12.718	26.486	38.054	46.364	-1.304	4.022	4.228
129.00	30.662	3.732	30.889	31.562	32.941	45.621	-0.310	9.220	9.225
132.00	31.044	12.122	33.326	38.806	30.618	49.430	-2.217	7.056	7.396
135.00	0.207	20.877	20.878	37.952	27.905	47.107	-8.370	-0.078	8.371
138.00	-6.004	14.008	15.241	18.541	22.900	29.464	-14.736	-5.492	15.726
141.00	2.847	13.794	14.085	4.896	12.774	13.680	-18.916	-6.763	20.089
144.00	7.475	15.136	16.881	1.633	7.074	7.260	-19.643	-4.305	20.109
147.00	8.691	17.435	19.481	-0.109	3.349	3.351	-16.206	0.178	16.207
150.00	6.183	18.183	19.205	-0.295	0.713	0.771	-7.589	-1.837	7.808
153.00	12.005	12.998	17.694	-2.765	0.004	2.765	-6.457	1.851	6.717
156.00	8.972	13.456	16.173	-1.993	-1.240	2.347	-5.951	8.761	10.591
159.00	7.084	13.642	15.372	-2.015	-1.837	2.727	-2.538	5.592	6.141
162.00	6.224	14.059	15.375	-3.806	-1.955	4.279	1.988	-0.184	1.996
165.00	5.788	13.326	14.529	-3.591	-2.981	4.667	-2.054	-2.143	2.969
168.00	4.231	12.272	12.981	-1.290	-3.780	3.994	-6.738	-1.663	6.940
171.00	9.405	10.277	13.931	-1.200	-2.522	2.793	-8.813	0.233	8.816
174.00	11.816	8.791	14.727	1.049	-1.774	2.061	-9.146	2.170	9.400
177.00	13.995	6.091	15.263	3.117	-0.812	3.221	-8.468	3.374	9.116
180.00	16.449	1.179	16.491	4.990	0.490	5.014	-7.414	3.964	8.407
183.00	15.351	6.246	16.573	3.690	0.148	3.693	-6.553	3.614	7.484
186.00	15.270	7.332	16.939	2.181	0.709	2.293	-5.132	2.736	5.816
189.00	15.631	5.634	16.616	1.011	1.733	2.006	-3.583	1.835	4.026
192.00	15.557	3.574	15.963	0.012	2.834	2.834	-1.908	1.307	2.313

NECK REACTION FORCES
IN HEAD, NECK, AND UPPER TORSO SYSTEMS

	UPPER NECK JOINT FORCES (LB)				LOWER NECK JOINT FORCES (LB)				MOMENTS (IN-LBS)	
TIME (MSEC)	SHEAR ON NECK	COMPRESSIVE ON NECK	SHEAR ON HEAD	COMPRESSIVE ON HEAD	SHEAR ON NECK	COMPRESSIVE ON NECK	SHEAR ON TORSO	COMPRESSIVE ON TORSO	UPPER NECK	LOWER NECK
0.00	0.00	0.00	0.00	0.00	-1.66	2.05	-1.64	2.06	0.00	0.00
3.00	-2.27	9.94	-0.12	10.20	-3.26	13.98	-3.17	14.00	6.83	13.90
6.00	-3.41	15.66	-0.02	16.02	-4.03	20.94	-3.89	20.97	9.08	19.73
9.00	-2.93	16.36	0.59	16.61	-2.99	21.95	-2.82	21.97	12.98	20.43
12.00	-2.29	14.59	0.84	14.75	-2.06	20.00	-1.90	20.02	14.22	16.81
15.00	-1.68	13.00	1.11	13.06	-1.29	18.14	-1.14	18.15	16.25	17.88
18.00	-1.13	11.73	1.38	11.71	-0.53	16.61	-0.38	16.61	20.65	19.09
21.00	-1.73	10.87	0.60	10.99	-1.27	15.39	-1.13	15.40	20.90	22.34
24.00	-3.01	10.03	-0.82	10.44	-2.75	14.19	-2.60	14.22	20.98	28.61
27.00	-4.20	9.20	-2.17	9.87	-4.10	13.02	-3.96	13.07	21.00	34.45
30.00	-5.01	8.44	-3.12	9.31	-4.95	11.99	-4.81	12.04	21.03	38.47
33.00	-5.39	7.79	-3.64	8.74	-5.26	11.10	-5.12	11.17	21.09	40.47
36.00	-5.37	7.26	-3.74	8.22	-5.08	10.42	-4.94	10.49	21.16	40.58
39.00	-4.99	6.74	-3.48	7.63	-4.43	9.79	-4.29	9.85	21.25	38.99
42.00	-3.91	7.16	-2.33	7.82	-2.87	10.64	-2.71	10.68	21.33	33.85
45.00	-1.53	8.42	0.26	8.56	0.34	12.35	0.54	12.34	21.45	22.44
48.00	2.87	7.82	4.43	7.05	5.92	11.51	6.10	11.41	20.71	1.23
51.00	-0.49	8.22	1.22	8.14	1.26	11.11	1.43	11.09	2.32	2.36
54.00	-8.66	10.24	-6.35	11.82	-9.11	12.02	-8.92	12.16	-16.70	25.32
57.00	-9.15	7.70	-7.36	9.43	-9.78	8.21	-9.65	8.37	-8.77	34.55
60.00	-7.24	1.48	-6.78	2.94	-7.29	0.57	-7.28	0.69	17.81	48.13
63.00	-10.78	-1.26	-10.81	1.00	-12.70	-3.44	-12.76	-3.22	23.40	69.97
66.00	-12.14	-4.39	-12.78	-1.82	-16.16	-7.21	-16.29	-6.90	27.14	80.11
69.00	-12.62	-6.59	-13.69	-3.91	-20.84	-6.14	-20.97	-5.67	28.95	84.41
72.00	-15.97	0.17	-15.62	3.34	-29.61	5.76	-29.41	6.72	25.84	96.23
75.00	-28.81	48.17	-18.67	52.93	-47.18	61.35	-43.81	63.80	-14.23	113.97
78.00	-32.76	58.47	-20.48	63.82	-50.30	71.59	-43.85	75.71	-8.80	134.19
81.00	-31.80	36.43	-23.93	42.02	-44.06	43.49	-37.91	48.94	23.92	160.62
84.00	-72.92	15.36	-68.54	29.24	-84.38	16.43	-79.96	31.58	48.53	379.26
87.00	-126.61	19.29	-123.75	40.59	-136.56	21.56	-128.48	51.04	48.53	379.26
90.00	-80.32	0.89	-79.82	8.95	-71.03	3.72	-68.41	19.49	129.08	708.53
93.00	-48.68	41.62	-48.20	42.18	16.70	-3.72	17.55	-7.45	223.70	559.35
96.00	-157.71	466.98	-183.59	457.42	-54.81	408.36	29.72	410.95	248.40	216.93
99.00	-222.98	549.06	-278.35	523.18	-185.84	565.08	-46.57	593.03	187.87	422.21
102.00	-267.75	459.60	-345.73	404.22	-215.61	465.62	-89.30	505.28	211.05	942.45
105.00	-208.04	400.09	-316.34	321.37	-121.54	391.89	-18.91	409.87	324.63	1200.34
108.00	-230.27	391.44	-373.02	259.04	-128.74	382.23	-29.89	402.22	413.85	948.57
111.00	-172.37	421.34	-371.78	262.72	-7.62	403.64	97.76	391.70	461.27	1024.25
114.00	-360.55	472.12	-570.69	164.96	-171.71	465.53	-9.92	496.08	1198.87	1305.11
117.00	-870.62	415.65	-942.22	-207.31	-702.16	462.54	-449.83	710.36	2025.00	2804.03
120.00	-644.65	572.17	-861.93	-5.34	-354.42	543.85	-89.78	642.91	2553.55	5436.92

NECK REACTION FORCES
IN HEAD, NECK, AND UPPER TORSO SYSTEMS

	UPPER NECK JOINT FORCES (LB)				LOWER NECK JOINT FORCES (LB)				MOMENTS (IN-LBS)	
TIME (MSEC)	SHEAR ON NECK	COMPRESSIVE ON NECK	SHEAR ON HEAD	COMPRESSIVE ON HEAD	SHEAR ON NECK	COMPRESSIVE ON NECK	SHEAR ON TORSO	COMPRESSIVE ON TORSO	UPPER NECK	LOWER NECK
120.00	-644.65	572.17	-861.93	-5.34	-354.42	543.85	-89.78	642.91	4162.30	5753.03
123.00	-641.45	721.42	-959.30	107.93	-467.58	681.77	-132.34	816.04	3847.39	5801.19
126.00	-346.11	691.64	-712.58	300.64	-231.69	600.41	22.41	643.17	2945.88	3883.29
129.00	-261.10	454.36	-484.85	198.83	-233.44	361.32	-89.48	420.76	1160.03	1941.12
132.00	-320.54	193.82	-374.02	-20.59	-275.88	110.95	-219.31	200.81	839.32	1870.88
135.00	-223.51	-164.06	-102.00	-257.82	-159.61	-228.82	-228.94	-159.44	729.45	1521.86
138.00	-136.67	-103.29	-62.10	-159.86	-84.86	-154.19	-128.21	-120.57	730.38	1210.37
141.00	-61.28	-160.96	31.25	-169.37	-1.57	-211.72	-54.12	-204.69	657.05	772.77
144.00	-12.97	-196.08	84.80	-177.27	46.03	-237.01	1.32	-241.43	413.73	326.86
147.00	14.77	-207.58	103.34	-180.64	55.78	-233.56	26.55	-238.66	38.09	-105.83
150.00	10.55	-196.20	81.26	-178.89	41.39	-212.44	29.14	-214.46	-46.70	-134.32
153.00	97.14	-172.50	142.99	-136.91	132.65	-183.59	135.58	-181.44	-84.32	-590.79
156.00	88.89	-152.73	116.83	-132.58	112.01	-153.26	123.73	-143.96	-157.44	-580.96
159.00	89.92	-136.09	100.31	-128.63	105.38	-131.76	121.56	-117.00	-210.63	-600.34
162.00	98.71	-125.05	92.80	-129.50	110.55	-120.75	129.93	-99.59	-249.64	-649.00
165.00	111.87	-120.91	89.31	-138.41	118.50	-114.29	140.52	-85.79	-280.17	-713.36
168.00	89.80	-82.97	63.17	-104.68	66.32	-91.91	88.62	-70.65	-748.09	-981.93
171.00	133.88	-48.52	109.25	-91.33	124.21	-52.56	134.66	-7.55	-666.89	-1143.17
174.00	148.16	-6.08	134.14	-63.20	149.17	-8.87	140.07	52.06	-670.21	-1223.10
177.00	156.19	30.39	154.18	-39.37	165.19	30.29	132.55	103.13	-696.71	-1288.05
180.00	154.03	69.38	177.92	7.70	168.70	94.47	96.69	167.44	-762.56	-1348.27
183.00	162.51	49.23	165.49	-38.03	172.37	44.81	118.82	132.67	-794.22	-1404.37
186.00	163.93	45.25	163.33	-47.39	170.44	39.02	115.14	131.59	-813.83	-1430.87
189.00	155.63	65.37	166.06	-30.31	158.94	61.69	88.19	145.92	-834.78	-1420.50
192.00	141.31	85.59	164.95	-9.22	140.91	83.78	57.67	153.46	-850.52	-1377.10

KINETIC ENERGY (FT-LBS)

TIME	TOTAL BODY	HEAD	TORSO	LEGS	ARMS
0.00	3517.71	246.08	1891.98	984.31	395.34
3.00	3516.81	246.51	1891.09	983.86	395.34
6.00	3508.94	247.11	1886.29	980.18	395.35
9.00	3497.22	247.76	1879.31	974.78	395.37
12.00	3484.50	248.38	1871.69	969.05	395.38
15.00	3470.97	248.96	1863.55	963.06	395.40
18.00	3456.92	249.55	1855.03	956.93	395.41
21.00	3442.31	250.16	1846.04	950.69	395.41
24.00	3427.03	250.79	1836.49	944.34	395.39
27.00	3411.08	251.45	1826.34	937.93	395.35
30.00	3394.45	252.14	1815.58	931.47	395.26
33.00	3376.93	252.82	1804.14	924.83	395.14
36.00	3357.98	253.49	1791.85	917.69	394.95
39.00	3337.27	254.12	1778.55	909.91	394.70
42.00	3314.98	254.68	1764.53	901.40	394.36
45.00	3280.97	255.15	1749.57	882.31	393.94
48.00	3191.64	255.38	1732.17	810.68	393.41
51.00	3090.20	255.33	1708.35	733.75	392.77
54.00	3006.95	255.34	1676.60	683.00	392.01
57.00	2927.40	255.64	1645.21	635.42	391.13
60.00	2857.04	256.20	1615.50	595.21	390.13
63.00	2799.66	257.19	1589.32	564.16	388.99
66.00	2753.65	258.80	1566.18	540.96	387.70
69.00	2688.26	260.49	1526.69	514.81	386.27
72.00	2550.62	262.47	1434.20	469.28	384.67
75.00	2376.85	265.55	1310.60	417.88	382.83
78.00	2199.27	270.27	1179.19	369.11	380.70
81.00	2037.66	275.06	1060.71	323.63	378.25
84.00	1902.31	282.34	961.13	283.39	375.44
87.00	1785.96	298.41	870.23	245.21	372.11
90.00	1688.53	316.26	796.21	209.54	366.53
93.00	1605.42	309.50	755.53	184.27	356.12
96.00	1445.52	220.85	733.69	155.10	335.88
99.00	1269.23	179.30	692.94	112.88	284.11
102.00	1147.90	163.04	638.77	97.18	248.91
105.00	1055.16	131.83	591.01	97.20	235.12
108.00	983.66	92.77	553.96	106.95	229.98
111.00	913.66	57.41	521.92	108.11	226.22
114.00	843.69	25.23	492.03	103.78	222.65
117.00	731.50	19.91	397.12	95.32	219.16
120.00	600.29	10.61	308.23	88.86	192.59

KINETIC ENERGY (FT-LBS)

TIME	TOTAL BODY	HEAD	TORSO	LEGS	ARMS
120.00	600.29	10.61	308.23	88.86	192.59
123.00	438.39	3.15	254.14	85.48	95.62
126.00	331.41	2.99	209.69	82.29	36.44
129.00	254.22	2.64	169.77	75.13	6.69
132.00	240.42	3.35	151.59	62.19	23.29
135.00	247.58	3.46	159.15	44.33	40.64
138.00	263.04	5.56	178.22	27.34	51.93
141.00	275.04	11.16	183.31	21.73	58.83
144.00	299.12	20.67	182.48	34.80	61.17
147.00	337.68	31.04	183.67	60.40	62.56
150.00	369.70	39.82	189.13	77.27	63.48
153.00	386.06	48.96	190.55	82.37	64.18
156.00	350.22	58.59	185.29	41.73	64.62
159.00	319.84	66.48	179.88	8.75	64.73
162.00	323.23	73.31	174.83	10.68	64.61
165.00	337.38	79.37	169.34	24.40	64.28
168.00	339.31	77.86	166.24	31.43	63.77
171.00	329.13	77.65	161.77	26.68	63.03
174.00	316.36	78.12	158.49	19.22	60.53
177.00	308.56	77.73	158.46	17.93	54.44
180.00	308.55	72.44	165.55	23.38	47.19
183.00	315.64	70.20	171.96	31.64	41.84
186.00	319.60	70.52	176.59	32.74	39.74
189.00	317.77	71.35	179.87	26.52	40.03
192.00	319.97	71.79	182.76	24.47	40.95

16-JUL-87 08:58:18 MVMA 2D CRASH VICTIM SIMULATION PAGE 7-08- 1
Hybiii 50th Male 76Ford/50hyb/mid 76FordLTD granoda25mph Unrestrained MVMA 2D. VER.3.

SEVERITY INDICES FOR UNFILTERED ACCELERATIONS (AT ACCELEROMETERS)

HEAD: HIC= 415.85, BEG. TIME= 90.00, END TIME= 135.00
3 MSEC AVER= 77.199 AT TIME= 95.00
PEAK= 89.504 AT TIME= 95.00

CHEST: 3 MSEC AVER= 51.550 AT TIME= 133.00
PEAK= 53.498 AT TIME= 133.00

	HEAD SEVERITY INDEX			HEAD GMR MODIFIED S.I.			CHEST SEVERITY INDEX			CHEST GMR MODIFIED S.I.		
TIME	A-P	S-I	RESULTANT	A-P	S-I	RESULTANT	A-P	S-I	RESULTANT	A-P	S-I	RESULTANT
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.01
6.00	0.00	0.00	0.00	0.02	0.01	0.01	0.00	0.00	0.00	0.04	0.02	0.02
9.00	0.00	0.00	0.00	0.03	0.02	0.01	0.00	0.00	0.00	0.05	0.03	0.02
12.00	0.00	0.00	0.00	0.05	0.02	0.02	0.00	0.00	0.00	0.05	0.03	0.03
15.00	0.00	0.00	0.01	0.07	0.02	0.02	0.00	0.00	0.00	0.06	0.04	0.03
18.00	0.00	0.01	0.01	0.10	0.03	0.03	0.00	0.00	0.00	0.06	0.05	0.04
21.00	0.00	0.01	0.01	0.12	0.04	0.03	0.00	0.00	0.00	0.07	0.06	0.04
24.00	0.00	0.01	0.01	0.13	0.05	0.04	0.00	0.00	0.00	0.07	0.07	0.05
27.00	0.00	0.01	0.01	0.14	0.06	0.05	0.00	0.00	0.01	0.07	0.09	0.05
30.00	0.00	0.01	0.01	0.14	0.08	0.05	0.01	0.00	0.01	0.08	0.15	0.05
33.00	0.00	0.01	0.01	0.15	0.13	0.06	0.01	0.00	0.01	0.08	0.21	0.05
36.00	0.00	0.01	0.01	0.15	0.16	0.06	0.02	0.00	0.02	0.08	0.23	0.06
39.00	0.00	0.01	0.01	0.16	0.17	0.07	0.02	0.00	0.02	0.09	0.25	0.06
42.00	0.00	0.01	0.01	0.16	0.18	0.07	0.03	0.00	0.03	0.09	0.27	0.06
45.00	0.00	0.01	0.01	0.17	0.22	0.08	0.03	0.00	0.03	0.09	0.29	0.07
48.00	0.00	0.01	0.01	0.19	0.27	0.09	0.03	0.00	0.03	0.09	0.31	0.07
51.00	0.00	0.01	0.01	0.19	0.28	0.10	0.03	0.00	0.03	0.10	0.32	0.07
54.00	0.00	0.01	0.01	0.20	0.33	0.11	0.03	0.00	0.04	0.10	0.32	0.08
57.00	0.01	0.01	0.01	0.20	0.37	0.11	0.04	0.00	0.04	0.11	0.33	0.08
60.00	0.01	0.01	0.02	0.21	0.37	0.11	0.04	0.01	0.05	0.11	0.33	0.08
63.00	0.01	0.01	0.02	0.21	0.38	0.11	0.05	0.02	0.08	0.11	0.33	0.08
66.00	0.02	0.01	0.04	0.21	0.38	0.12	0.11	0.04	0.16	0.11	0.33	0.09
69.00	0.03	0.02	0.06	0.21	0.38	0.12	0.33	0.04	0.40	0.12	0.34	0.09
72.00	0.04	0.02	0.07	0.22	0.38	0.12	1.27	0.07	1.41	0.13	0.34	0.10
75.00	0.05	0.05	0.12	0.22	0.39	0.12	3.33	0.17	3.71	0.18	0.34	0.17
78.00	0.08	0.21	0.32	0.22	0.39	0.12	6.27	0.33	7.00	0.29	0.34	0.31
81.00	0.10	0.33	0.49	0.22	0.39	0.12	9.08	0.52	10.23	0.38	0.34	0.43
84.00	0.25	0.35	0.67	0.22	0.39	0.12	11.31	0.74	12.90	0.43	0.34	0.51
87.00	1.26	0.35	1.70	0.24	0.39	0.14	13.07	0.92	15.02	0.46	0.34	0.55
90.00	2.50	0.36	2.97	0.25	0.40	0.15	13.78	1.01	15.90	0.46	0.35	0.56
93.00	4.73	1.93	7.50	0.83	0.70	2.18	13.86	1.07	16.08	0.46	0.35	0.56
96.00	104.36	26.25	148.93	102.06	9.00	151.86	13.86	1.14	16.15	0.46	0.35	0.56
99.00	143.10	28.42	192.90	119.21	9.06	171.70	13.87	1.86	16.87	0.47	0.35	0.57
102.00	150.77	29.42	202.39	120.28	9.06	173.06	13.92	2.41	17.53	0.47	0.35	0.57
105.00	181.81	29.45	233.57	136.03	9.06	188.96	14.01	2.62	17.88	0.47	0.36	0.57
108.00	256.85	29.48	308.80	198.18	9.07	251.31	14.05	2.82	18.15	0.47	0.36	0.57
111.00	365.65	30.61	420.94	309.17	9.18	360.39	14.08	3.12	18.52	0.48	0.36	0.57
114.00	459.85	45.05	541.94	389.23	12.47	491.04	14.15	3.67	19.19	0.48	0.36	0.58
117.00	476.48	48.40	564.53	392.53	12.57	496.99	19.02	7.00	28.91	1.06	0.57	2.63
120.00	478.24	60.21	579.57	392.60	18.90	505.63	26.21	15.32	47.28	1.71	1.77	7.35

16-JUL-87 08:58:18 MVMA 2D CRASH VICTIM SIMULATION PAGE 7-08- 2
Hybiii 50th Male 76Ford/50hyb/mid 76FordLTD granada25mph Unrestrained MVMA 2D. VER.3.

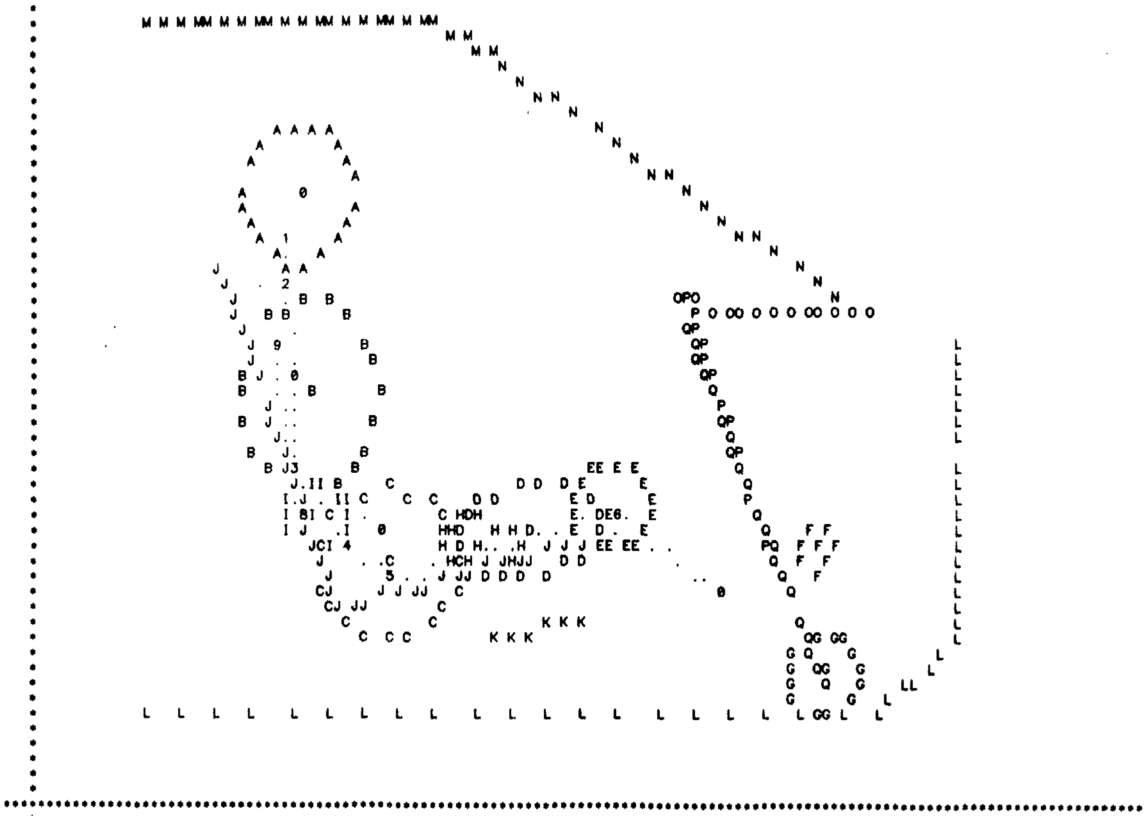
SEVERITY INDICES FOR UNFILTERED ACCELERATIONS (AT ACCELEROMETERS)

HEAD: HIC= 415.85, BEG. TIME= 90.00, END TIME= 135.00
3 MSEC AVER= 77.199 AT TIME= 95.00
PEAK= 89.504 AT TIME= 95.00

CHEST: 3 MSEC AVER= 51.550 AT TIME= 133.00
PEAK= 53.498 AT TIME= 133.00

	HEAD SEVERITY INDEX			HEAD GMR MODIFIED S.I.			CHEST SEVERITY INDEX			CHEST GMR MODIFIED S.I.		
TIME	A-P	S-I	RESULTANT	A-P	S-I	RESULTANT	A-P	S-I	RESULTANT	A-P	S-I	RESULTANT
120.00	478.24	60.21	579.57	392.60	18.90	505.63	26.21	15.32	47.28	1.71	1.77	7.35
123.00	479.72	92.03	614.89	392.62	34.77	524.30	32.22	33.23	74.96	2.36	6.90	18.96
126.00	480.07	94.59	618.14	392.62	34.84	524.42	43.06	60.13	119.01	4.07	16.62	42.58
129.00	485.72	94.82	624.28	393.67	34.84	525.51	55.99	83.09	161.31	6.70	23.39	64.14
132.00	512.78	95.52	653.15	403.56	34.85	536.77	75.97	99.22	204.18	12.88	26.92	87.09
135.00	515.63	98.53	659.84	403.58	35.04	537.14	109.62	113.68	260.47	27.24	29.76	122.38
138.00	515.94	100.95	662.90	403.58	35.08	537.22	123.98	125.22	291.19	29.75	31.54	133.45
141.00	515.99	103.10	665.18	403.58	35.13	537.27	125.16	128.99	296.89	29.76	31.68	133.76
144.00	516.22	105.43	667.98	403.58	35.19	537.38	125.22	129.95	297.99	29.76	31.68	133.77
147.00	516.81	108.66	672.27	403.59	35.34	537.64	125.23	130.13	298.18	29.77	31.68	133.77
150.00	517.23	112.94	677.41	403.59	35.58	537.99	125.23	130.16	298.20	29.77	31.69	133.77
153.00	517.61	116.50	681.74	403.59	35.72	538.23	125.23	130.16	298.21	29.78	31.69	133.78
156.00	518.68	118.42	685.26	403.60	35.76	538.37	125.26	130.16	298.24	29.78	31.70	133.78
159.00	519.21	120.45	688.19	403.60	35.80	538.47	125.27	130.17	298.27	29.78	31.70	133.78
162.00	519.55	122.58	690.95	403.60	35.85	538.56	125.33	130.18	298.35	29.78	31.71	133.78
165.00	519.81	124.67	693.54	403.60	35.90	538.63	125.42	130.21	298.48	29.79	31.71	133.78
168.00	519.88	126.72	695.79	403.61	35.94	538.68	125.43	130.31	298.60	29.79	31.71	133.78
171.00	520.33	127.99	697.77	403.61	35.95	538.73	125.43	130.37	298.67	29.79	31.71	133.78
174.00	521.45	128.85	700.12	403.62	35.96	538.79	125.43	130.39	298.70	29.80	31.71	133.79
177.00	523.27	129.30	702.71	403.66	35.96	538.87	125.46	130.39	298.73	29.80	31.71	133.79
180.00	526.55	129.35	706.12	403.81	35.96	539.02	125.61	130.39	298.88	29.80	31.72	133.79
183.00	529.55	129.46	709.39	403.91	35.96	539.15	125.73	130.39	299.01	29.80	31.73	133.79
186.00	532.27	129.86	712.87	403.99	35.97	539.30	125.78	130.39	299.05	29.80	31.73	133.79
189.00	535.09	130.20	716.34	404.09	35.97	539.45	125.79	130.40	299.07	29.80	31.74	133.79
192.00	537.99	130.34	719.57	404.19	35.97	539.57	125.79	130.42	299.10	29.81	31.74	133.79

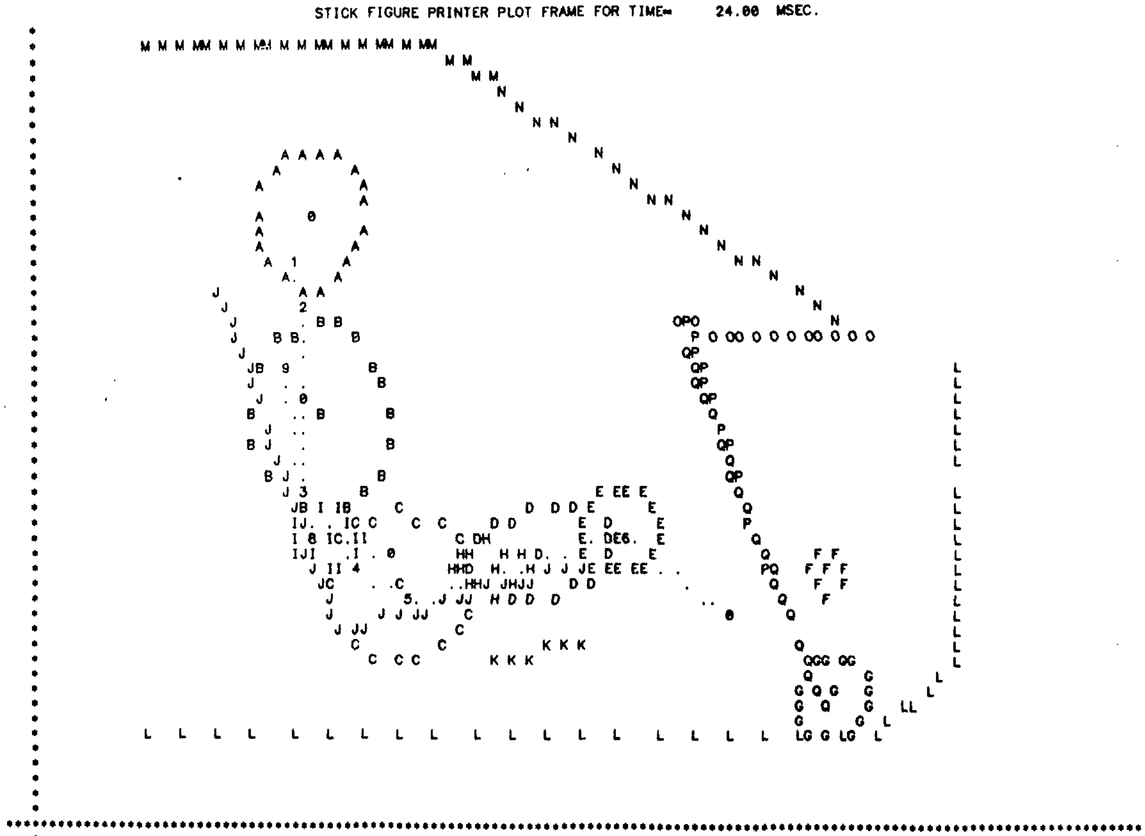
STICK FIGURE PRINTER PLOT FRAME FOR TIME= 0.00 MSEC.



COORDINATE RANGES FOR PLOT ARE X= -1.50 (AT LEFT) TO 76.50 (AT RIGHT) AND Z= 1.00 (AT BOTTOM) TO -52.00 (AT TOP)
SCALE FACTOR IS (IN) = 6.000 (IN) , X AND Z POINT RESOLUTION ERRORS EQUAL RESPECTIVELY 0.300 AND 0.500 (IN) IN SCALE.

16-JUL-87 08:58:18 MVMA 2D CRASH VICTIM SIMULATION PAGE 8-45- 2
Hybiii 50th Male 76Ford/50hyb/mid 76FordLTD granada25mph Unrestrained MVMA 2D, VER.3,

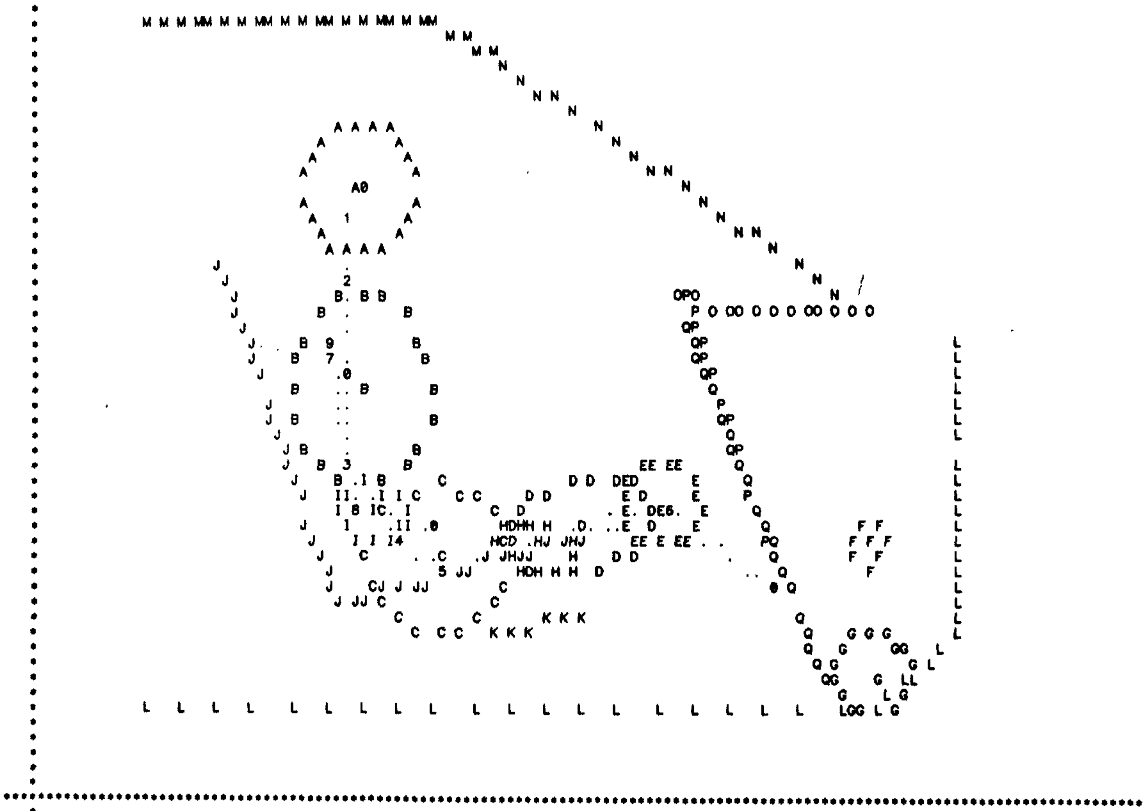
STICK FIGURE PRINTER PLOT FRAME FOR TIME= 24.00 MSEC.



COORDINATE RANGES FOR PLOT ARE X= -1.50 (AT LEFT) TO 76.50 (AT RIGHT) AND Z= 1.00 (AT BOTTOM) TO -52.00 (AT TOP)
SCALE FACTOR IS (IN) = 6.000 (IN) , X AND Z POINT RESOLUTION ERRORS EQUAL RESPECTIVELY 0.300 AND 0.500 (IN) IN SCALE.

16-JUL-87 08:58:18 MVMA 2D CRASH VICTIM SIMULATION PAGE 8-45- 3
Hybiii 50th Male 76Ford/50hyb/mid 76FordLTD granada25mph Unrestrained MVMA 2D, VER.3,

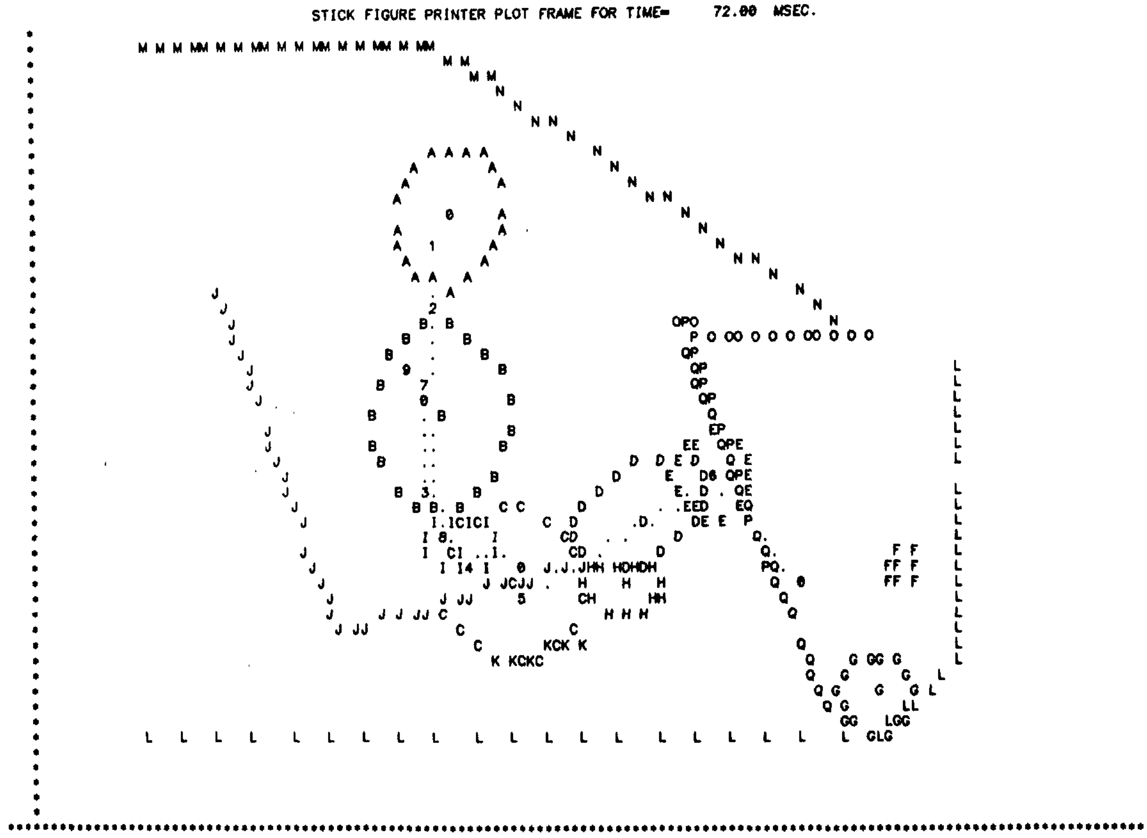
STICK FIGURE PRINTER PLOT FRAME FOR TIME= 48.00 MSEC.



COORDINATE RANGES FOR PLOT ARE X= -1.50 (AT LEFT) TO 76.50 (AT RIGHT) AND Z= 1.00 (AT BOTTOM) TO -52.00 (AT TOP)
SCALE FACTOR IS (IN) = 6.000 (IN) , X AND Z POINT RESOLUTION ERRORS EQUAL RESPECTIVELY 0.300 AND 0.500 (IN) IN SCALE.

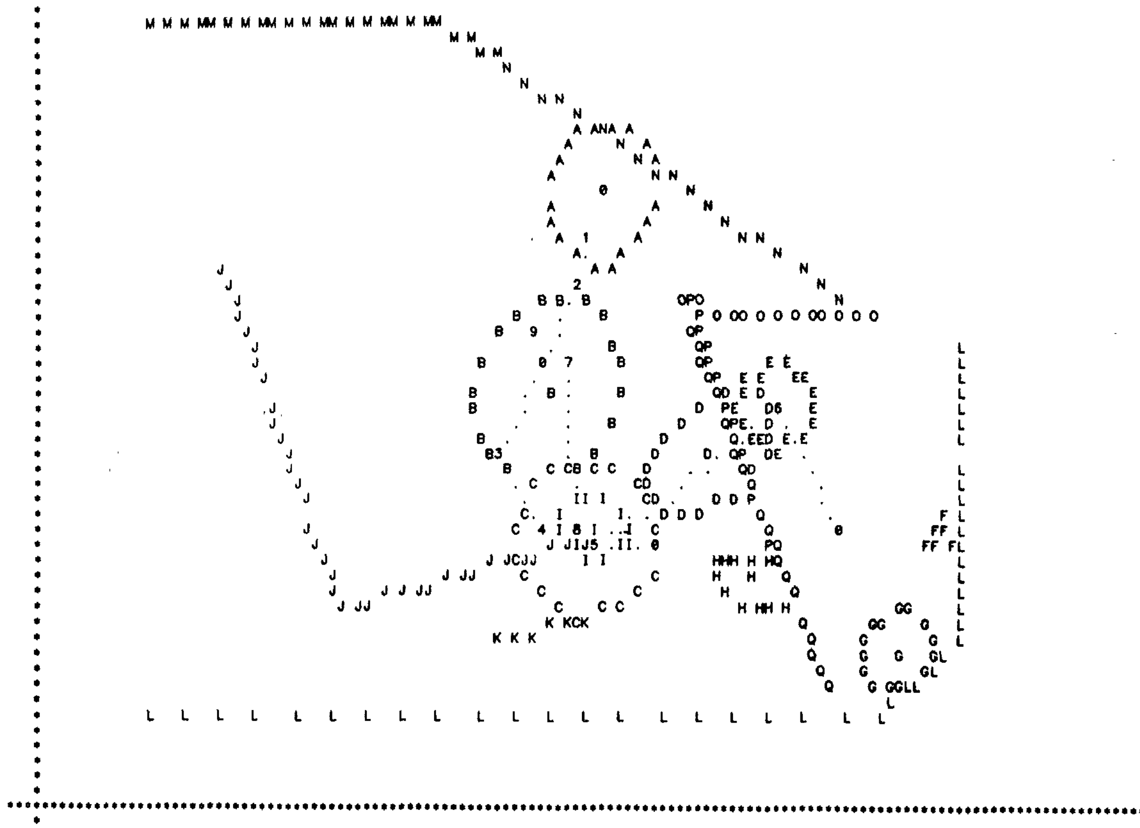
16-JUL-87 08:58:18 MVMA 2D CRASH VICTIM SIMULATION PAGE 8-45- 4
Hybiii 50th Male 76Ford/50hyb/mid 76FordLTD granada25mph Unrestrained MVMA 2D, VER.3,

STICK FIGURE PRINTER PLOT FRAME FOR TIME= 72.00 MSEC.



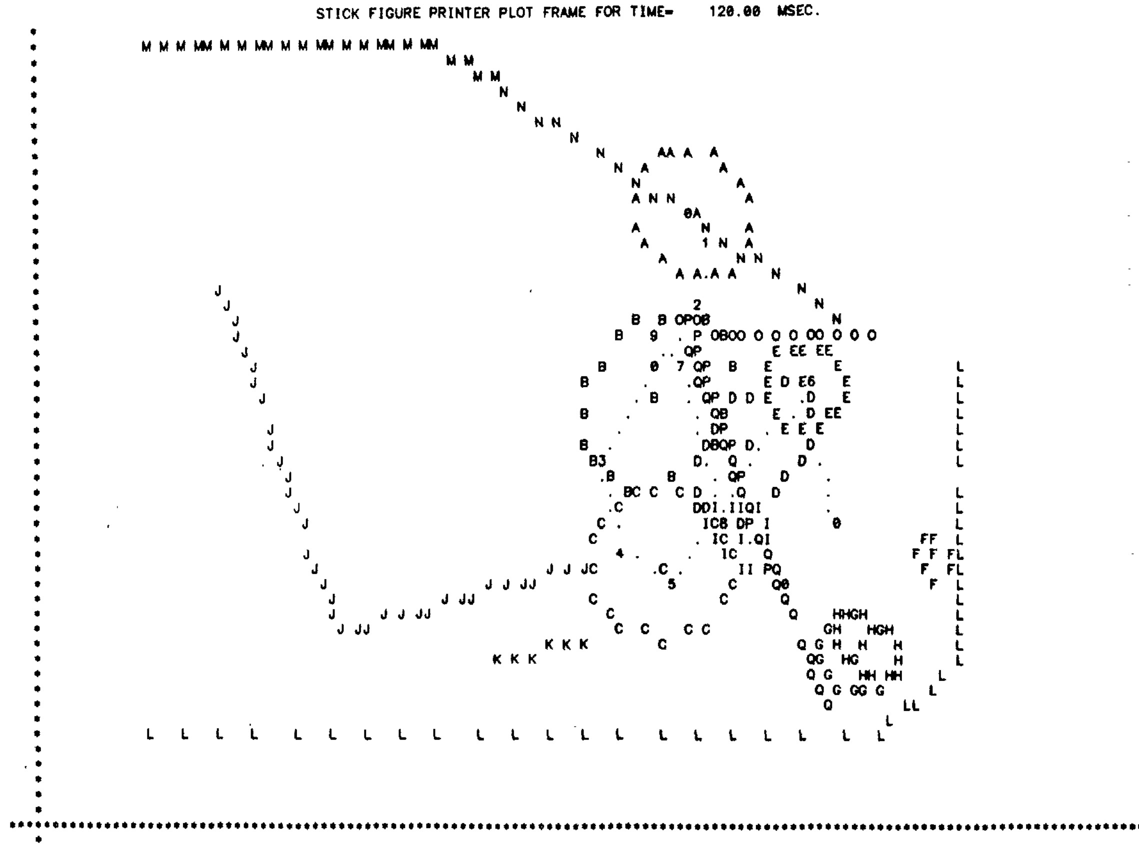
COORDINATE RANGES FOR PLOT ARE X= -1.50 (AT LEFT) TO 76.50 (AT RIGHT) AND Z= 1.00 (AT BOTTOM) TO -52.00 (AT TOP)
SCALE FACTOR IS (IN) = 6.000 (IN) , X AND Z POINT RESOLUTION ERRORS EQUAL RESPECTIVELY 0.300 AND 0.500 (IN) IN SCALE.

STICK FIGURE PRINTER PLOT FRAME FOR TIME= 96.00 MSEC.



COORDINATE RANGES FOR PLOT ARE X= -1.50 (AT LEFT) TO 76.50 (AT RIGHT) AND Z= 1.00 (AT BOTTOM) TO -52.00 (AT TOP)
SCALE FACTOR IS (IN) = 6.000 (IN) , X AND Z POINT RESOLUTION ERRORS EQUAL RESPECTIVELY 0.300 AND 0.500 (IN) IN SCALE.

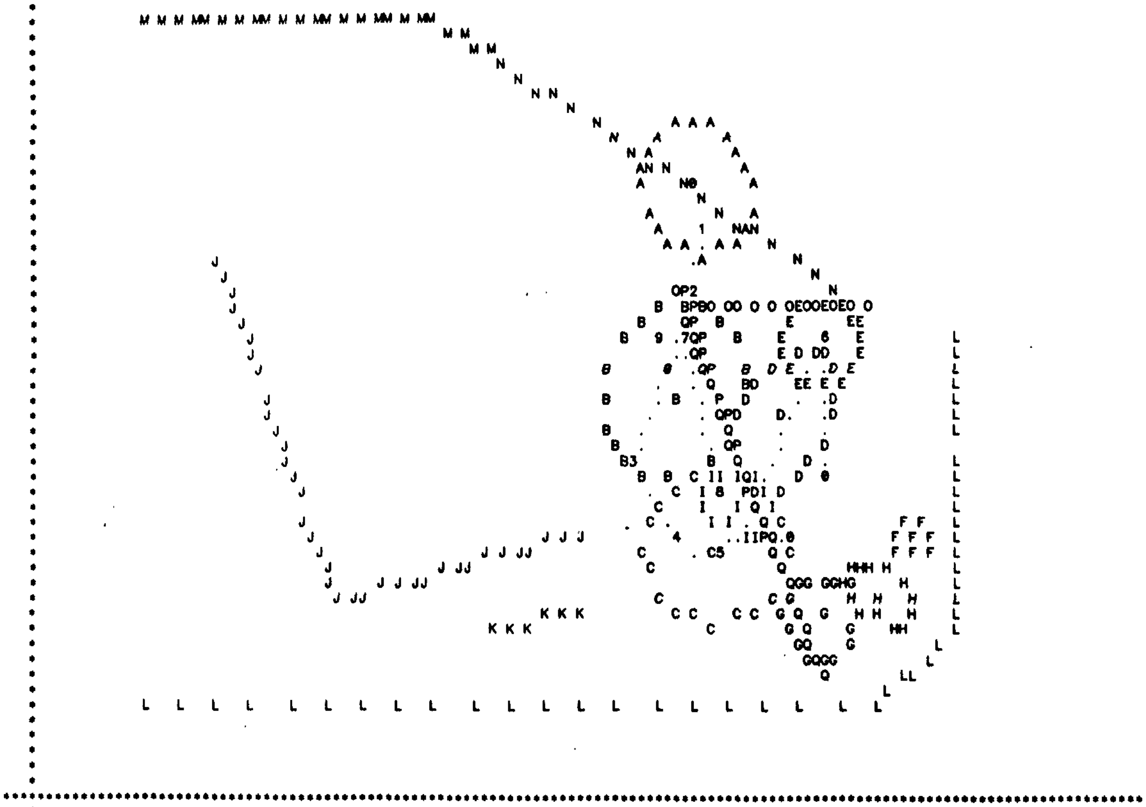
STICK FIGURE PRINTER PLOT FRAME FOR TIME= 120.00 MSEC.



COORDINATE RANGES FOR PLOT ARE X= -1.50 (AT LEFT) TO 76.50 (AT RIGHT) AND Z= 1.00 (AT BOTTOM) TO -52.00 (AT TOP)
SCALE FACTOR IS (IN) = 6.000 (IN) , X AND Z POINT RESOLUTION ERRORS EQUAL RESPECTIVELY 0.300 AND 0.500 (IN) IN SCALE.

16-JUL-87 08:58:18 MVMA 2D CRASH VICTIM SIMULATION PAGE 8-45- 7
Hybiii 50th Male 76Ford/50hyb/mid 76FordLTD granada25mph Unrestrained MVMA 2D, VER.3,

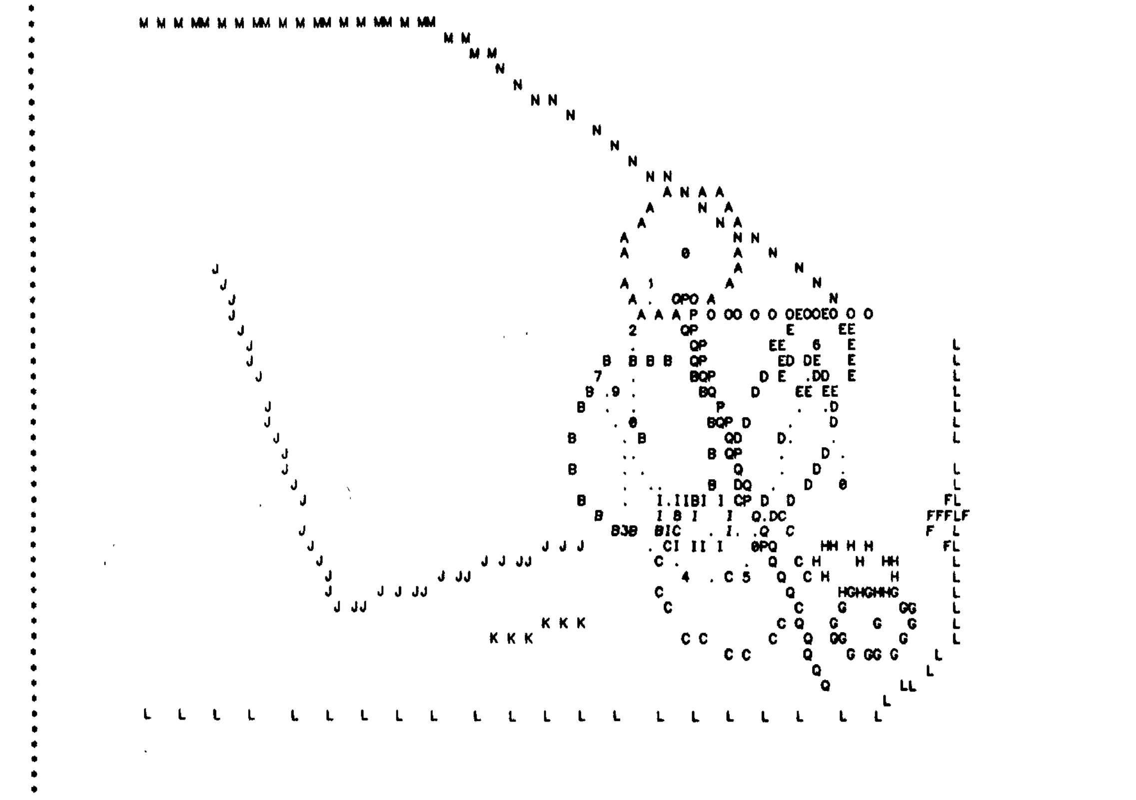
STICK FIGURE PRINTER PLOT FRAME FOR TIME= 144.00 MSEC.



COORDINATE RANGES FOR PLOT ARE X= -1.50 (AT LEFT) TO 76.50 (AT RIGHT) AND Z= 1.00 (AT BOTTOM) TO -52.00 (AT TOP)
SCALE FACTOR IS (IN) = 6.000 (IN) , X AND Z POINT RESOLUTION ERRORS EQUAL RESPECTIVELY 0.300 AND 0.500 (IN) IN SCALE.

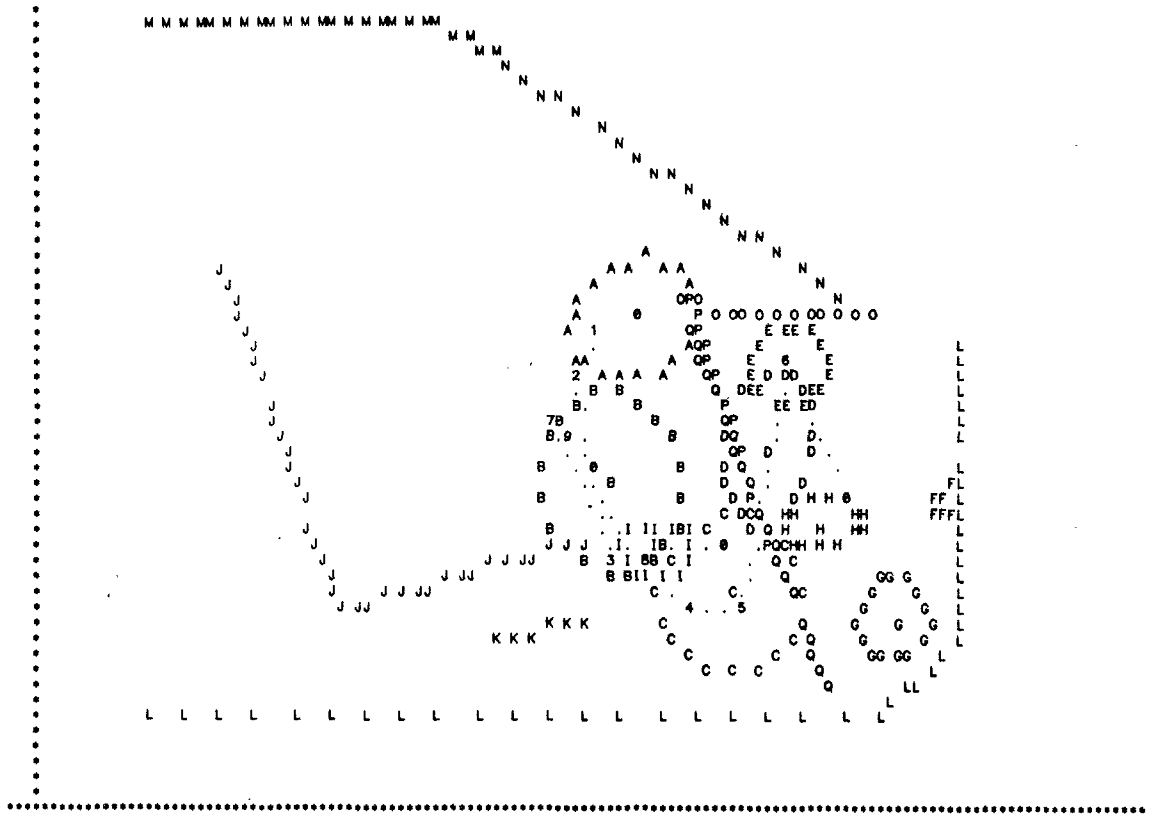
16-JUL-87 08:58:18 MVMA 2D CRASH VICTIM SIMULATION PAGE 8-45- 8
Hybiii 50th Male 76Ford/50hyb/mid 76FordLTD granada25mph Unrestrained MVMA 2D, VER.3,

STICK FIGURE PRINTER PLOT FRAME FOR TIME= 168.00 MSEC.



COORDINATE RANGES FOR PLOT ARE X= -1.50 (AT LEFT) TO 76.50 (AT RIGHT) AND Z= 1.00 (AT BOTTOM) TO -52.00 (AT TOP)
SCALE FACTOR IS (IN) = 6.000 (IN) , X AND Z POINT RESOLUTION ERRORS EQUAL RESPECTIVELY 0.300 AND 0.500 (IN) IN SCALE.

STICK FIGURE PRINTER PLOT FRAME FOR TIME= 192.00 MSEC.



COORDINATE RANGES FOR PLOT ARE X= -1.50 (AT LEFT) TO 76.50 (AT RIGHT) AND Z= 1.00 (AT BOTTOM) TO -52.00 (AT TOP)
SCALE FACTOR IS (IN) = 6.000 (IN) , X AND Z POINT RESOLUTION ERRORS EQUAL RESPECTIVELY 0.300 AND 0.500 (IN) IN SCALE.

STICK FIGURE SYMBOL LEGEND

SYMBOL DESIGNATION	SYMBOL
HEAD C.G.	0
UPPER NECK JOINT	1
LOWER NECK JOINT	2
UPPER TORSO C.G.	0
UPPER SPINE JNT.	3
LOWER SPINE JNT.	4
HIP JOINT	5
KNEE	6
LOWER LEG C.G.	0
SHOULDR AT TORSO	9
SHOULDER AT ARM	7
ELBOW	8
LOWER ARM C.G.	0
BODY FILLER PTS	.
ZERO COORD LINES	*
HEAD	A
THORAX	B
HIP	C
UPPER LEG	D
KNEE	E
TOE	F
HEEL	G
HAND	H
ELBOW	I
SEAT	J
SEAT FRAME ,	K
FLOOR	L
ROOF	M
WINDSHIELD	N
TOP IP	O
MID IP	P
LOWER IP	Q

CONTACT INTERACTION BETWEEN

ELLIPSE THORAX MADE OF CHESTMAT

AND

LINE SEAT BACK WHICH IS AN ELEMENT OF REGION SEAT MADE OF SEAT MATERIAL

INITIAL LINE LENGTH = 24.09(IN) EDGE CONSTANT = 0.000

TIME (MSEC)	DEFLECTION LINE (IN)	DEFLECTION ELLIPSE (IN)	DEFL. RATE LINE (IN/SEC)	DEFL. RATE ELLIPSE (IN/SEC)	FORCE NORMAL (LB)	FORCE TANGNTL. (LB)	CONTACT LOCATION ON LINE POSITION (NONDIM.)	CONTACT LOCATION ON LINE RATE (IN/SEC)	CONTACT LOCATION IN SPACE X (IN)	CONTACT LOCATION IN SPACE Z (IN)	CONTACT LOCATION ON BODY SEG. X (IN)	CONTACT LOCATION ON BODY SEG. Z (IN)
0.00	1.96	0.01	0.	0.	49.0	0.0	0.458	0.	14.94	-24.41	3.72	3.37
3.00	1.95	0.01	-5.	0.	48.5	6.1	0.458	2.	16.26	-24.41	3.72	3.37
6.00	1.93	0.01	-11.	0.	46.9	13.2	0.459	4.	17.58	-24.41	3.73	3.37
9.00	1.88	0.01	-18.	0.	43.9	20.3	0.459	6.	18.90	-24.41	3.73	3.37
12.00	1.82	0.01	-27.	0.	40.5	27.0	0.460	9.	20.22	-24.41	3.74	3.36
15.00	1.72	0.01	-36.	0.	38.6	28.9	0.462	12.	21.54	-24.42	3.74	3.36
18.00	1.60	0.01	-45.	0.	36.1	27.1	0.463	15.	22.85	-24.42	3.75	3.36
21.00	1.45	0.01	-56.	0.	33.0	24.7	0.466	19.	24.17	-24.42	3.76	3.36
24.00	1.27	0.01	-67.	0.	29.2	21.9	0.468	23.	25.47	-24.42	3.78	3.35
27.00	1.05	0.00	-79.	0.	24.8	18.6	0.472	28.	26.78	-24.42	3.79	3.35
30.00	0.80	0.00	-91.	0.	19.6	14.7	0.476	32.	28.08	-24.42	3.81	3.34
33.00	0.51	0.00	-103.	0.	13.8	10.3	0.480	37.	29.38	-24.41	3.83	3.33
36.00	0.18	0.00	-115.	0.	7.1	5.3	0.485	42.	30.68	-24.41	3.86	3.32
39.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
42.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
45.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
48.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
51.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
54.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
57.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
60.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
63.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
66.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
69.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
72.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
75.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
78.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
81.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
84.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
87.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
90.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
93.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
96.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
99.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
102.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
105.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
108.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
111.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
114.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
117.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
120.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00

CONTACT INTERACTION BETWEEN

ELLIPSE THORAX MADE OF CHESTMAT

AND

LINE SEAT BACK WHICH IS AN ELEMENT OF REGION SEAT MADE OF SEAT MATERIAL

INITIAL LINE LENGTH = 24.09(IN) EDGE CONSTANT = 0.000

TIME (MSEC)	DEFLECTION LINE (IN)	DEFLECTION ELLIPSE (IN)	DEFL. RATE LINE (IN/SEC)	DEFL. RATE ELLIPSE (IN/SEC)	FORCE NORMAL (LB)	FORCE TANGNTL. (LB)	CONTACT LOCATION ON LINE POSITION (NONDIM.)	CONTACT LOCATION ON LINE RATE (IN/SEC)	CONTACT LOCATION IN SPACE X (IN)	CONTACT LOCATION IN SPACE Z (IN)	CONTACT LOCATION ON BODY SEG. X (IN)	CONTACT LOCATION ON BODY SEG. Z (IN)
120.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
123.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
126.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
129.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
132.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
135.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
138.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
141.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
144.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
147.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
150.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
153.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
156.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
159.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
162.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
165.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
168.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
171.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
174.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
177.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
180.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
183.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
186.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
189.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
192.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00

CONTACT INTERACTION BETWEEN

ELLIPSE HIP ASSUMED TO BE RIGID

AND

LINE SEAT BACK WHICH IS AN ELEMENT OF REGION SEAT MADE OF SEAT MATERIAL

INITIAL LINE LENGTH = 24.09(IN) EDGE CONSTANT = 0.000

TIME (MSEC)	DEFLECTION LINE (IN)	DEFLECTION ELLIPSE (IN)	DEFL. RATE LINE (IN/SEC)	DEFL. RATE ELLIPSE (IN/SEC)	FORCE NORMAL (LB)	FORCE TANGNTL. (LB)	CONTACT LOCATION ON LINE POSITION (NONDIM.)	CONTACT LOCATION ON LINE RATE (IN/SEC)	CONTACT LOCATION IN SPACE X (IN)	CONTACT LOCATION IN SPACE Z (IN)	CONTACT LOCATION ON BODY SEG. X (IN)	CONTACT LOCATION ON BODY SEG. Z (IN)
0.00	0.63	0.00	0.	0.	12.8	0.0	0.935	0.	20.13	-14.07	-1.70	3.63
3.00	0.62	0.00	-5.	0.	12.6	1.1	0.935	1.	21.45	-14.08	-1.70	3.63
6.00	0.60	0.00	-10.	0.	12.2	2.8	0.935	3.	22.77	-14.08	-1.70	3.63
9.00	0.56	0.00	-16.	0.	11.4	4.6	0.936	5.	24.08	-14.08	-1.71	3.62
12.00	0.50	0.00	-24.	0.	10.2	6.2	0.937	8.	25.39	-14.08	-1.71	3:62
15.00	0.41	0.00	-32.	0.	8.5	6.3	0.938	11.	26.70	-14.08	-1.71	3.62
18.00	0.30	0.00	-41.	0.	6.2	4.7	0.940	14.	28.00	-14.08	-1.72	3.61
21.00	0.17	0.00	-51.	0.	3.4	2.5	0.942	18.	29.30	-14.09	-1.72	3.61
24.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
27.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
30.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
33.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
36.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
39.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
42.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
45.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
48.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
51.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
54.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
57.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
60.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
63.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
66.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
69.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
72.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
75.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
78.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
81.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
84.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
87.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
90.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
93.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
96.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
99.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
102.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
105.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
108.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
111.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
114.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
117.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
120.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00

CONTACT INTERACTION BETWEEN

ELLIPSE HIP ASSUMED TO BE RIGID

AND

LINE SEAT BACK WHICH IS AN ELEMENT OF REGION SEAT MADE OF SEAT MATERIAL

INITIAL LINE LENGTH = 24.09(IN) EDGE CONSTANT = 0.000

TIME (MSEC)	DEFLECTION LINE (IN)	DEFLECTION ELLIPSE (IN)	DEFL. RATE LINE (IN/SEC)	DEFL. RATE ELLIPSE (IN/SEC)	FORCE NORMAL (LB)	FORCE TANGNTL. (LB)	CONTACT LOCATION ON LINE POSITION (NONDIM.)	CONTACT LOCATION ON LINE RATE (IN/SEC)	CONTACT LOCATION IN SPACE X (IN)	CONTACT LOCATION IN SPACE Z (IN)	CONTACT LOCATION ON BODY SEG. X (IN)	CONTACT LOCATION ON BODY SEG. Z (IN)
120.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
123.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
126.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
129.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
132.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
135.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
138.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
141.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
144.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
147.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
150.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
153.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
156.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
159.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
162.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
165.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
168.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
171.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
174.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
177.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
180.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
183.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
186.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
189.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
192.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00

CONTACT INTERACTION BETWEEN

ELLIPSE HIP ASSUMED TO BE RIGID

AND

LINE SEAT CUSHION WHICH IS AN ELEMENT OF REGION SEAT MADE OF SEAT MATERIAL

INITIAL LINE LENGTH = 17.20(IN) EDGE CONSTANT = 0.000

TIME	DEFLECTION		DEFL. RATE		FORCE		CONTACT LOCATION ON LINE		CONTACT LOCATION IN SPACE		CONTACT LOCATION ON BODY SEG.	
	LINE	ELLIPSE	LINE	ELLIPSE	NORMAL	TANGNTL.	POSITION	RATE	X	Z	X	Z
(MSEC)	(IN)	(IN)	(IN/SEC)	(IN/SEC)	(LB)	(LB)	(NONDIM.)	(IN/SEC)	(IN)	(IN)	(IN)	(IN)
0.00	2.99	0.00	0.	0.	117.1	0.0	0.241	0.	26.03	-11.00	4.87	2.59
3.00	2.99	0.00	1.	0.	117.2	42.3	0.241	5.	27.35	-11.01	4.87	2.60
6.00	2.99	0.00	2.	0.	117.5	88.1	0.243	10.	28.67	-11.01	4.87	2.60
9.00	3.00	0.00	4.	0.	118.1	88.6	0.245	17.	29.98	-11.01	4.87	2.60
12.00	3.02	0.00	6.	0.	119.2	89.4	0.249	24.	31.29	-11.01	4.86	2.61
15.00	3.04	0.00	8.	0.	120.6	90.5	0.254	33.	32.60	-11.01	4.86	2.61
18.00	3.07	0.00	11.	0.	122.6	92.0	0.260	42.	33.90	-11.01	4.86	2.62
21.00	3.10	0.00	13.	0.	125.1	93.8	0.268	53.	35.20	-11.02	4.85	2.62
24.00	3.15	0.00	16.	0.	128.2	96.2	0.279	64.	36.49	-11.02	4.85	2.62
27.00	3.20	0.00	19.	0.	131.9	98.9	0.291	76.	37.78	-11.02	4.85	2.62
30.00	3.26	0.00	22.	0.	136.2	102.2	0.305	88.	39.06	-11.02	4.85	2.62
33.00	3.33	0.00	25.	0.	141.2	105.9	0.321	100.	40.34	-11.03	4.85	2.62
36.00	3.42	0.00	28.	0.	146.8	110.1	0.340	113.	41.62	-11.03	4.86	2.62
39.00	3.51	0.00	32.	0.	153.1	114.8	0.361	126.	42.89	-11.04	4.86	2.61
42.00	3.61	0.00	35.	0.	160.0	120.0	0.384	138.	44.15	-11.05	4.86	2.61
45.00	3.71	0.00	38.	0.	167.6	125.7	0.409	150.	45.41	-11.05	4.86	2.61
48.00	3.83	0.00	42.	0.	176.0	132.0	0.436	161.	46.66	-11.06	4.86	2.61
51.00	3.97	0.00	47.	0.	185.3	139.0	0.465	170.	47.89	-11.06	4.85	2.62
54.00	4.11	0.00	50.	0.	195.5	146.6	0.495	178.	49.11	-11.05	4.84	2.63
57.00	4.27	0.00	53.	0.	212.1	159.1	0.527	186.	50.32	-11.04	4.82	2.66
60.00	4.43	0.00	55.	0.	240.0	180.0	0.561	196.	51.50	-11.03	4.78	2.70
63.00	4.60	0.00	55.	0.	268.4	201.3	0.596	208.	52.67	-11.03	4.73	2.76
66.00	4.76	0.00	53.	0.	296.4	222.3	0.633	222.	53.83	-11.04	4.66	2.84
69.00	4.92	0.00	50.	0.	323.0	242.3	0.673	235.	54.98	-11.07	4.58	2.93
72.00	5.05	0.00	39.	0.	371.5	278.6	0.715	238.	56.09	-11.12	4.48	3.03
75.00	5.15	0.00	23.	0.	413.6	310.2	0.756	235.	57.14	-11.21	4.38	3.13
78.00	5.19	0.00	4.	0.	431.5	323.6	0.797	228.	58.11	-11.36	4.27	3.22
81.00	5.17	0.00	-14.	0.	422.9	317.2	0.836	221.	58.98	-11.55	4.17	3.31
84.00	5.11	0.00	-27.	0.	389.6	292.2	0.874	215.	59.77	-11.78	4.08	3.38
87.00	5.02	0.00	-30.	0.	342.9	257.2	0.911	211.	60.48	-12.03	4.02	3.43
90.00	4.94	0.00	-20.	0.	303.1	227.3	0.948	211.	61.12	-12.26	4.00	3.45
93.00	4.90	0.00	-7.	0.	282.3	211.7	0.985	215.	61.73	-12.47	4.02	3.43
96.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
99.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
102.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
105.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
108.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
111.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
114.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
117.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
120.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00

CONTACT INTERACTION BETWEEN

ELLIPSE HIP ASSUMED TO BE RIGID

AND

LINE SEAT CUSHION WHICH IS AN ELEMENT OF REGION SEAT MADE OF SEAT MATERIAL

INITIAL LINE LENGTH = 17.20(IN) EDGE CONSTANT = 0.000

TIME	DEFLECTION		DEFL. RATE		FORCE		CONTACT LOCATION ON LINE		CONTACT LOCATION IN SPACE		CONTACT LOCATION ON BODY SEG.	
	LINE	ELLIPSE	LINE	ELLIPSE	NORMAL	TANGNTL.	POSITION	RATE	X	Z	X	Z
(MSEC)	(IN)	(IN)	(IN/SEC)	(IN/SEC)	(LB)	(LB)	(NONDIM.)	(IN/SEC)	(IN)	(IN)	(IN)	(IN)
120.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
123.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
126.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
129.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
132.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
135.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
138.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
141.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
144.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
147.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
150.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
153.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
156.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
159.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
162.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
165.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
168.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
171.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
174.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
177.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
180.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
183.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
186.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
189.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
192.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00

CONTACT INTERACTION BETWEEN

ELLIPSE UPPER LEG ASSUMED TO BE RIGID

AND

LINE SEAT CUSHION WHICH IS AN ELEMENT OF REGION SEAT MADE OF SEAT MATERIAL

INITIAL LINE LENGTH = 17.20(IN) EDGE CONSTANT = 0.000

TIME	DEFLECTION		DEFL. RATE		FORCE		CONTACT LOCATION ON LINE		CONTACT LOCATION IN SPACE		CONTACT LOCATION ON BODY SEG.	
(MSEC)	LINE (IN)	ELLIPSE (IN)	LINE (IN/SEC)	ELLIPSE (IN/SEC)	NORMAL (LB)	TANGNTL. (LB)	POSITION (NONDIM.)	RATE (IN/SEC)	X (IN)	Z (IN)	X (IN)	Z (IN)
0.00	1.51	0.00	0.	0.	30.8	0.0	0.825	0.	35.35	-15.03	3.73	2.75
3.00	1.51	0.00	1.	0.	30.9	11.7	0.825	5.	36.67	-15.03	3.73	2.75
6.00	1.52	0.00	3.	0.	31.0	23.2	0.827	11.	37.99	-15.03	3.73	2.75
9.00	1.53	0.00	5.	0.	31.2	23.4	0.829	17.	39.31	-15.03	3.73	2.75
12.00	1.54	0.00	7.	0.	31.5	23.6	0.833	25.	40.62	-15.03	3.73	2.75
15.00	1.57	0.00	9.	0.	32.0	24.0	0.838	33.	41.93	-15.04	3.74	2.75
18.00	1.60	0.00	11.	0.	32.6	24.5	0.845	43.	43.23	-15.04	3.74	2.75
21.00	1.64	0.00	14.	0.	33.4	25.1	0.853	53.	44.53	-15.04	3.74	2.75
24.00	1.68	0.00	17.	0.	34.4	25.8	0.864	64.	45.83	-15.04	3.74	2.75
27.00	1.74	0.00	21.	0.	35.5	26.7	0.876	76.	47.12	-15.04	3.75	2.75
30.00	1.81	0.00	24.	0.	36.9	27.7	0.890	88.	48.41	-15.03	3.75	2.75
33.00	1.89	0.00	28.	0.	40.2	30.2	0.907	101.	49.69	-15.03	3.75	2.75
36.00	1.97	0.00	31.	0.	46.3	34.8	0.926	113.	50.97	-15.03	3.76	2.75
39.00	2.07	0.00	34.	0.	53.2	39.9	0.947	126.	52.25	-15.03	3.77	2.75
42.00	2.18	0.00	37.	0.	60.7	45.5	0.970	138.	53.52	-15.03	3.77	2.75
45.00	2.29	0.00	38.	0.	68.7	51.5	0.995	150.	54.78	-15.03	3.78	2.75
48.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
51.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
54.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
57.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
60.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
63.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
66.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
69.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
72.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
75.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
78.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
81.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
84.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
87.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
90.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
93.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
96.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
99.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
102.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
105.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
108.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
111.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
114.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
117.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
120.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00

CONTACT INTERACTION BETWEEN

ELLIPSE UPPER LEG ASSUMED TO BE RIGID

AND

LINE SEAT CUSHION WHICH IS AN ELEMENT OF REGION SEAT MADE OF SEAT MATERIAL

INITIAL LINE LENGTH = 17.20(IN) EDGE CONSTANT = 0.000

TIME	DEFLECTION		DEFL. RATE		FORCE		CONTACT LOCATION ON LINE		CONTACT LOCATION IN SPACE		CONTACT LOCATION ON BODY SEG.	
(MSEC)	LINE (IN)	ELLIPSE (IN)	LINE (IN/SEC)	ELLIPSE (IN/SEC)	NORMAL (LB)	TANGNTL. (LB)	POSITION (NONDIM.)	RATE (IN/SEC)	X (IN)	Z (IN)	X (IN)	Z (IN)
120.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
123.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
126.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
129.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
132.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
135.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
138.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
141.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
144.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
147.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
150.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
153.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
156.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
159.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
162.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
165.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
168.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
171.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
174.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
177.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
180.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
183.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
186.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
189.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
192.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00

CONTACT INTERACTION BETWEEN

ELLIPSE HEEL ASSUMED TO BE RIGID

AND

LINE FLOORBOARD WHICH IS AN ELEMENT OF REGION FLOOR MADE OF FLOOR MATERIAL

INITIAL LINE LENGTH = 50.37(IN) EDGE CONSTANT = 0.000

	DEFLECTION		DEFL. RATE		FORCE		CONTACT LOCATION ON LINE		CONTACT LOCATION IN SPACE		CONTACT LOCATION ON BODY SEG.	
TIME (MSEC)	LINE (IN)	ELLIPSE (IN)	LINE (IN/SEC)	ELLIPSE (IN/SEC)	NORMAL (LB)	TANGNTL. (LB)	POSITION (NONDIM.)	RATE (IN/SEC)	X (IN)	Z (IN)	X (IN)	Z (IN)
0.00	0.01	0.00	0.	0.	6.0	0.0	0.928	0.	54.76	-5.99	10.45	2.01
3.00	0.01	0.00	1.	0.	6.9	2.7	0.929	5.	56.08	-5.99	10.45	2.01
6.00	0.01	0.00	1.	0.	8.7	7.0	0.929	11.	57.40	-5.99	10.45	2.01
9.00	0.01	0.00	0.	0.	10.4	8.3	0.930	18.	58.72	-5.99	10.45	2.01
12.00	0.01	0.00	0.	0.	11.4	9.1	0.931	26.	60.03	-5.99	10.45	2.01
15.00	0.01	0.00	0.	0.	11.5	9.2	0.933	35.	61.34	-5.99	10.45	2.01
18.00	0.01	0.00	0.	0.	10.8	8.6	0.935	45.	62.64	-5.99	10.45	2.01
21.00	0.01	0.00	-1.	0.	9.3	7.4	0.938	56.	63.95	-5.99	10.45	2.01
24.00	0.01	0.00	-1.	0.	7.3	5.8	0.942	68.	65.24	-5.99	10.45	2.02
27.00	0.01	0.00	-1.	0.	5.2	4.1	0.946	80.	66.54	-5.99	10.45	2.02
30.00	0.00	0.00	-1.	0.	3.4	2.7	0.952	93.	67.83	-6.00	10.45	2.02
33.00	0.00	0.00	0.	0.	2.2	1.8	0.957	106.	69.12	-6.00	10.45	2.02
36.00	0.00	0.00	0.	0.	1.8	1.4	0.964	119.	70.40	-6.00	10.45	2.02
39.00	0.00	0.00	0.	0.	1.9	1.5	0.972	132.	71.67	-6.00	10.45	2.02
42.00	0.00	0.00	0.	0.	2.2	1.8	0.980	145.	72.95	-6.00	10.45	2.02
45.00	0.01	0.00	4.	0.	5.5	4.4	0.989	150.	74.20	-5.99	10.45	2.02
48.00	0.06	0.00	34.	0.	56.0	44.8	0.997	109.	75.37	-5.94	10.46	2.01
51.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
54.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
57.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
60.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
63.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
66.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
69.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
72.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
75.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
78.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
81.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
84.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
87.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
90.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
93.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
96.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
99.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
102.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
105.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
108.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
111.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
114.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
117.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
120.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00

CONTACT INTERACTION BETWEEN

ELLIPSE HEEL ASSUMED TO BE RIGID

AND

LINE FLOORBOARD WHICH IS AN ELEMENT OF REGION FLOOR MADE OF FLOOR MATERIAL

INITIAL LINE LENGTH = 50.37(IN) EDGE CONSTANT = 0.000

	DEFLECTION		DEFL. RATE		FORCE		CONTACT LOCATION ON LINE		CONTACT LOCATION IN SPACE		CONTACT LOCATION ON BODY SEG.	
TIME (MSEC)	LINE (IN)	ELLIPSE (IN)	LINE (IN/SEC)	ELLIPSE (IN/SEC)	NORMAL (LB)	TANGNTL. (LB)	POSITION (NONDIM.)	RATE (IN/SEC)	X (IN)	Z (IN)	X (IN)	Z (IN)
120.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
123.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
126.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
129.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
132.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
135.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
138.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
141.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
144.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
147.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
150.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
153.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
156.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
159.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
162.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
165.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
168.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
171.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
174.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
177.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
180.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
183.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
186.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
189.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
192.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00

CONTACT INTERACTION BETWEEN

ELLIPSE HEEL ASSUMED TO BE RIGID

AND

LINE TOEBOARD WHICH IS AN ELEMENT OF REGION FLOOR MADE OF FLOOR MATERIAL

INITIAL LINE LENGTH = 7.05(IN) EDGE CONSTANT = 0.370

TIME (MSEC)	DEFLECTION LINE (IN)	DEFLECTION ELLIPSE (IN)	DEFL. RATE LINE (IN/SEC)	DEFL. RATE ELLIPSE (IN/SEC)	FORCE NORMAL (LB)	FORCE TANGNTL. (LB)	CONTACT LOCATION ON LINE POSITION (NONDIM.)	CONTACT LOCATION ON LINE RATE (IN/SEC)	CONTACT LOCATION IN SPACE X (IN)	CONTACT LOCATION IN SPACE Z (IN)	CONTACT LOCATION ON BODY SEG. X (IN)	CONTACT LOCATION ON BODY SEG. Z (IN)
0.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
3.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
6.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
9.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
12.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
15.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
18.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
21.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
24.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
27.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
30.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
33.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
36.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
39.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
42.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
45.00	0.25	0.00	101.	0.	258.1	206.5	0.173	111.	75.85	-6.61	11.40	0.54
48.00	0.55	0.00	97.	0.	732.9	586.3	0.211	61.	77.02	-6.56	11.40	0.53
51.00	0.82	0.00	79.	0.	950.5	760.4	0.222	12.	77.97	-6.40	11.41	0.47
54.00	1.02	0.00	51.	0.	1106.5	885.2	0.224	16.	78.80	-6.26	11.42	0.40
57.00	1.12	0.00	17.	0.	1192.7	954.2	0.228	17.	79.52	-6.20	11.44	0.33
60.00	1.12	0.00	-20.	0.	1170.2	936.2	0.231	17.	80.12	-6.22	11.45	0.24
63.00	1.01	0.00	-53.	0.	888.3	710.6	0.234	13.	80.61	-6.32	11.45	0.15
66.00	0.82	0.00	-70.	0.	399.9	169.2	0.236	5.	80.99	-6.47	11.46	0.05
69.00	0.60	0.00	-74.	0.	268.6	104.4	0.238	5.	81.30	-6.64	11.46	-0.05
72.00	0.38	0.00	-69.	0.	150.2	101.9	0.241	8.	81.56	-6.82	11.45	-0.15
75.00	0.19	0.00	-57.	0.	44.7	35.7	0.246	18.	81.81	-6.99	11.45	-0.24
78.00	0.05	0.00	-40.	0.	0.0	0.0	0.258	0.	82.06	-7.16	11.44	-0.33
81.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
84.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
87.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
90.00	0.00	0.00	35.	0.	0.0	0.0	0.405	0.	83.39	-7.86	11.40	-0.54
93.00	0.14	0.00	52.	0.	34.9	28.0	0.466	155.	83.80	-8.05	11.39	-0.57
96.00	0.30	0.00	49.	0.	267.3	213.9	0.532	135.	84.20	-8.23	11.39	-0.58
99.00	0.38	0.00	1.	0.	393.0	314.4	0.563	36.	84.34	-8.31	11.38	-0.63
102.00	0.29	0.00	-61.	0.	253.7	203.0	0.567	-10.	84.18	-8.39	11.36	-0.71
105.00	0.03	0.00	-110.	0.	0.0	0.0	0.551	0.	83.79	-8.52	11.33	-0.80
108.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
111.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
114.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
117.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
120.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00

CONTACT INTERACTION BETWEEN

ELLIPSE HEEL ASSUMED TO BE RIGID

AND

LINE TOEBOARD WHICH IS AN ELEMENT OF REGION FLOOR MADE OF FLOOR MATERIAL

INITIAL LINE LENGTH = 7.05(IN) EDGE CONSTANT = 0.370

TIME (MSEC)	DEFLECTION LINE (IN)	DEFLECTION ELLIPSE (IN)	DEFL. RATE LINE (IN/SEC)	DEFL. RATE ELLIPSE (IN/SEC)	FORCE NORMAL (LB)	FORCE TANGNTL. (LB)	CONTACT LOCATION ON LINE POSITION (NONDIM.)	CONTACT LOCATION ON LINE RATE (IN/SEC)	CONTACT LOCATION IN SPACE X (IN)	CONTACT LOCATION IN SPACE Z (IN)	CONTACT LOCATION ON BODY SEG. X (IN)	CONTACT LOCATION ON BODY SEG. Z (IN)
120.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
123.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
126.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
129.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
132.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
135.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
138.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
141.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
144.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
147.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
150.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
153.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
156.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
159.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
162.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
165.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
168.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
171.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
174.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
177.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
180.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
183.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
186.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
189.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
192.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00

CONTACT INTERACTION BETWEEN

ELLIPSE HIP ASSUMED TO BE RIGID

AND

LINE SEAT BEAM WHICH IS AN ELEMENT OF REGION SEAT FRAME MADE OF STEEL

INITIAL LINE LENGTH = 6.03(IN) EDGE CONSTANT = 0.100

TIME	DEFLECTION LINE	DEFLECTION ELLIPSE	DEFL. RATE LINE	DEFL. RATE ELLIPSE	FORCE NORMAL	FORCE TANGNTL.	CONTACT LOCATION ON LINE POSITION	CONTACT LOCATION ON LINE RATE	CONTACT LOCATION IN SPACE X	CONTACT LOCATION IN SPACE Z	CONTACT LOCATION ON BODY SEG. X	CONTACT LOCATION ON BODY SEG. Z
(MSEC)	(IN)	(IN)	(IN/SEC)	(IN/SEC)	(LB)	(LB)	(NONDIM.)	(IN/SEC)	(IN)	(IN)	(IN)	(IN)
0.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
3.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
6.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
9.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
12.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
15.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
18.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
21.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
24.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
27.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
30.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
33.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
36.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
39.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
42.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
45.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
48.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
51.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
54.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
57.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
60.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
63.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
66.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
69.00	0.10	0.00	49.	0.	384.1	288.1	0.282	235.	54.97	-11.06	4.57	2.94
72.00	0.23	0.00	39.	0.	916.6	687.5	0.400	238.	56.08	-11.12	4.48	3.04
75.00	0.32	0.00	22.	0.	1284.8	963.6	0.518	235.	57.13	-11.21	4.37	3.13
78.00	0.36	0.00	3.	0.	1437.6	1078.2	0.633	228.	58.10	-11.35	4.27	3.23
81.00	0.34	0.00	-15.	0.	1367.1	1025.3	0.745	221.	58.98	-11.54	4.16	3.32
84.00	0.28	0.00	-28.	0.	1108.3	831.2	0.853	215.	59.76	-11.77	4.07	3.39
87.00	0.19	0.00	-30.	0.	528.1	396.1	0.959	211.	60.47	-12.03	4.01	3.44
90.00	0.11	0.00	-20.	0.	80.0	60.0	1.064	211.	61.12	-12.26	3.99	3.45
93.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
96.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
99.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
102.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
105.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
108.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
111.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
114.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
117.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
120.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00

CONTACT INTERACTION BETWEEN

ELLIPSE HIP ASSUMED TO BE RIGID

AND

LINE SEAT BEAM WHICH IS AN ELEMENT OF REGION SEAT FRAME MADE OF STEEL

INITIAL LINE LENGTH = 6.03(IN) EDGE CONSTANT = 0.100

TIME	DEFLECTION LINE	DEFLECTION ELLIPSE	DEFL. RATE LINE	DEFL. RATE ELLIPSE	FORCE NORMAL	FORCE TANGNTL.	CONTACT LOCATION ON LINE POSITION	CONTACT LOCATION ON LINE RATE	CONTACT LOCATION IN SPACE X	CONTACT LOCATION IN SPACE Z	CONTACT LOCATION ON BODY SEG. X	CONTACT LOCATION ON BODY SEG. Z
(MSEC)	(IN)	(IN)	(IN/SEC)	(IN/SEC)	(LB)	(LB)	(NONDIM.)	(IN/SEC)	(IN)	(IN)	(IN)	(IN)
120.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
123.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
126.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
129.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
132.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
135.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
138.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
141.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
144.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
147.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
150.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
153.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
156.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
159.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
162.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
165.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
168.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
171.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
174.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
177.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
180.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
183.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
186.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
189.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
192.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00

CONTACT INTERACTION BETWEEN

ELLIPSE KNEE ASSUMED TO BE RIGID

AND

LINE IP PANEL-3RD WHICH IS AN ELEMENT OF REGION LOWER IP MADE OF LOW IP MATERIAL

INITIAL LINE LENGTH = 25.65(IN) EDGE CONSTANT = 0.200

TIME (MSEC)	DEFLECTION LINE (IN)	DEFLECTION ELLIPSE (IN)	DEFL. RATE LINE (IN/SEC)	DEFL. RATE ELLIPSE (IN/SEC)	FORCE NORMAL (LB)	FORCE TANGNTL. (LB)	CONTACT LOCATION ON LINE POSITION (NONDIM.)	CONTACT LOCATION ON LINE RATE (IN/SEC)	CONTACT LOCATION IN SPACE X (IN)	CONTACT LOCATION IN SPACE Z (IN)	CONTACT LOCATION ON BODY SEG. X (IN)	CONTACT LOCATION ON BODY SEG. Z (IN)
0.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
3.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
6.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
9.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
12.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
15.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
18.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
21.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
24.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
27.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
30.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
33.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
36.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
39.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
42.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
45.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
48.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
51.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
54.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
57.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
60.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
63.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
66.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
69.00	0.60	0.00	213.	0.	300.0	90.0	0.346	-139.	70.35	-23.35	12.11	0.27
72.00	1.24	0.00	212.	0.	508.8	152.7	0.331	-125.	71.18	-23.96	12.10	0.38
75.00	1.87	0.00	212.	0.	532.4	159.7	0.317	-106.	71.97	-24.53	12.08	0.47
78.00	2.51	0.00	211.	0.	555.9	166.8	0.306	-85.	72.74	-25.03	12.07	0.54
81.00	3.14	0.00	211.	0.	579.3	173.8	0.297	-65.	73.47	-25.48	12.06	0.59
84.00	3.78	0.00	212.	0.	636.3	190.9	0.291	-48.	74.16	-25.88	12.05	0.62
87.00	4.41	0.00	210.	0.	941.2	282.4	0.286	-32.	74.81	-26.23	12.05	0.64
90.00	5.03	0.00	206.	0.	1018.8	305.6	0.283	-16.	75.42	-26.53	12.05	0.65
93.00	5.65	0.00	205.	0.	723.1	65.8	0.282	-3.	75.98	-26.79	12.04	0.66
96.00	6.26	0.00	205.	0.	650.0	14.8	0.282	-1.	76.49	-27.03	12.04	0.68
99.00	6.87	0.00	195.	0.	650.0	195.0	0.282	-20.	76.96	-27.28	12.03	0.70
102.00	7.42	0.00	171.	0.	650.0	195.0	0.277	-60.	77.31	-27.60	12.02	0.75
105.00	7.90	0.00	146.	0.	650.0	195.0	0.269	-84.	77.54	-27.98	11.99	0.83
108.00	8.30	0.00	118.	0.	650.0	195.0	0.258	-100.	77.65	-28.39	11.96	0.92
111.00	8.62	0.00	96.	0.	650.0	195.0	0.246	-100.	77.68	-28.79	11.92	1.03
114.00	8.88	0.00	77.	0.	650.0	195.0	0.235	-94.	77.65	-29.16	11.87	1.13
117.00	9.09	0.00	70.	0.	650.0	195.0	0.224	-79.	77.60	-29.48	11.82	1.24
120.00	9.31	0.00	81.	0.	650.0	195.0	0.217	-54.	77.59	-29.75	11.77	1.33

CONTACT INTERACTION BETWEEN

ELLIPSE KNEE ASSUMED TO BE RIGID

AND

LINE IP PANEL-3RD WHICH IS AN ELEMENT OF REGION LOWER IP MADE OF LOW IP MATERIAL

INITIAL LINE LENGTH = 25.65(IN) EDGE CONSTANT = 0.200

TIME (MSEC)	DEFLECTION LINE (IN)	DEFLECTION ELLIPSE (IN)	DEFL. RATE LINE (IN/SEC)	DEFL. RATE ELLIPSE (IN/SEC)	FORCE NORMAL (LB)	FORCE TANGNTL. (LB)	CONTACT LOCATION ON LINE POSITION (NONDIM.)	CONTACT LOCATION ON LINE RATE (IN/SEC)	CONTACT LOCATION IN SPACE X (IN)	CONTACT LOCATION IN SPACE Z (IN)	CONTACT LOCATION ON BODY SEG. X (IN)	CONTACT LOCATION ON BODY SEG. Z (IN)
120.00	9.31	0.00	81.	0.	650.0	195.0	0.217	-54.	77.59	-29.75	11.77	1.33
123.00	9.57	0.00	90.	0.	650.0	195.0	0.212	-33.	77.64	-29.97	11.73	1.40
126.00	9.85	0.00	90.	0.	650.0	195.0	0.209	-18.	77.73	-30.14	11.69	1.47
129.00	10.11	0.00	81.	0.	671.6	182.1	0.207	-9.	77.84	-30.28	11.65	1.53
132.00	10.33	0.00	65.	0.	715.7	127.0	0.206	-6.	77.92	-30.38	11.61	1.59
135.00	10.50	0.00	50.	0.	750.2	106.1	0.206	-5.	77.98	-30.46	11.56	1.65
138.00	10.64	0.00	40.	0.	777.1	86.3	0.205	-4.	78.01	-30.52	11.51	1.70
141.00	10.74	0.00	31.	0.	798.2	79.8	0.205	-3.	78.02	-30.57	11.47	1.75
144.00	10.82	0.00	20.	0.	813.6	92.0	0.204	-4.	78.02	-30.61	11.43	1.80
147.00	10.86	0.00	6.	0.	821.6	109.9	0.204	-4.	77.99	-30.64	11.40	1.83
150.00	10.86	0.00	-5.	0.	342.4	30.0	0.203	-3.	77.93	-30.65	11.37	1.86
153.00	10.85	0.00	3.	0.	293.0	78.9	0.204	9.	77.89	-30.64	11.35	1.89
156.00	10.86	0.00	-1.	0.	516.8	155.0	0.205	21.	77.87	-30.60	11.33	1.91
159.00	10.85	0.00	-14.	0.	252.3	75.7	0.209	26.	77.87	-30.52	11.32	1.92
162.00	10.77	0.00	-44.	0.	0.0	0.0	0.211	0.	77.78	-30.45	11.29	1.94
165.00	10.58	0.00	-75.	0.	0.0	0.0	0.209	0.	77.57	-30.41	11.25	1.98
168.00	10.32	0.00	-91.	0.	0.0	0.0	0.205	0.	77.29	-30.40	11.20	2.02
171.00	10.05	0.00	-93.	0.	0.0	0.0	0.202	0.	76.99	-30.38	11.15	2.06
174.00	9.77	0.00	-94.	0.	0.0	0.0	0.199	0.	76.70	-30.34	11.11	2.10
177.00	9.48	0.00	-98.	0.	0.0	0.0	0.197	0.	76.41	-30.28	11.07	2.13
180.00	9.18	0.00	-102.	0.	0.0	0.0	0.196	0.	76.13	-30.19	11.03	2.16
183.00	8.87	0.00	-104.	0.	0.0	0.0	0.196	0.	75.84	-30.08	11.00	2.18
186.00	8.56	0.00	-98.	0.	0.0	0.0	0.197	0.	75.57	-29.94	10.97	2.20
189.00	8.28	0.00	-87.	0.	0.0	0.0	0.199	0.	75.35	-29.78	10.96	2.21
192.00	8.04	0.00	-79.	0.	0.0	0.0	0.203	0.	75.17	-29.60	10.95	2.22

CONTACT INTERACTION BETWEEN

ELLIPSE HEAD ASSUMED TO BE RIGID

AND

LINE WINDSHIELD WHICH IS AN ELEMENT OF REGION WINDSHIELD MADE OF GLASS MATERIAL

INITIAL LINE LENGTH = 30.00(IN) EDGE CONSTANT = 0.000

TIME (MSEC)	DEFLECTION LINE (IN)	DEFLECTION ELLIPSE (IN)	DEFL. RATE LINE (IN/SEC)	DEFL. RATE ELLIPSE (IN/SEC)	FORCE NORMAL (LB)	FORCE TANGNTL. (LB)	CONTACT LOCATION ON LINE POSITION (NONDIM.)	CONTACT LOCATION ON LINE RATE (IN/SEC)	CONTACT LOCATION IN SPACE X (IN)	CONTACT LOCATION IN SPACE Z (IN)	CONTACT LOCATION ON BODY SEG. X (IN)	CONTACT LOCATION ON BODY SEG. Z (IN)
0.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
3.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
6.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
9.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
12.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
15.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
18.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
21.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
24.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
27.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
30.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
33.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
36.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
39.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
42.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
45.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
48.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
51.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
54.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
57.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
60.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
63.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
66.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
69.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
72.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
75.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
78.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
81.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
84.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
87.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
90.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
93.00	0.36	0.00	272.	0.	427.1	236.2	0.275	419.	62.72	-43.83	-3.78	-1.19
96.00	1.09	0.00	213.	0.	940.2	542.6	0.315	380.	64.08	-43.78	-3.76	-1.25
99.00	1.70	0.00	204.	0.	496.0	305.5	0.351	344.	65.21	-43.70	-3.71	-1.35
102.00	2.32	0.00	206.	0.	598.2	402.5	0.383	321.	66.24	-43.69	-3.63	-1.52
105.00	2.91	0.00	183.	0.	709.8	527.6	0.412	285.	67.16	-43.70	-3.49	-1.76
108.00	3.40	0.00	142.	0.	802.6	653.2	0.437	235.	67.91	-43.70	-3.26	-2.07
111.00	3.76	0.00	95.	0.	824.4	718.6	0.457	175.	68.45	-43.66	-2.92	-2.45
114.00	3.99	0.00	62.	0.	801.3	731.1	0.471	104.	68.78	-43.62	-2.51	-2.79
117.00	4.14	0.00	44.	0.	802.1	754.9	0.481	75.	68.96	-43.59	-2.08	-3.08
120.00	4.27	0.00	43.	0.	804.0	776.4	0.489	46.	69.09	-43.55	-1.60	-3.32

CONTACT INTERACTION BETWEEN

ELLIPSE HEAD ASSUMED TO BE RIGID

AND

LINE WINDSHIELD WHICH IS AN ELEMENT OF REGION WINDSHIELD MADE OF GLASS MATERIAL

INITIAL LINE LENGTH = 30.00(IN) EDGE CONSTANT = 0.000

TIME (MSEC)	DEFLECTION LINE (IN)	DEFLECTION ELLIPSE (IN)	DEFL. RATE LINE (IN/SEC)	DEFL. RATE ELLIPSE (IN/SEC)	FORCE NORMAL (LB)	FORCE TANGNTL. (LB)	CONTACT LOCATION ON LINE POSITION (NONDIM.)	CONTACT LOCATION ON LINE RATE (IN/SEC)	CONTACT LOCATION IN SPACE X (IN)	CONTACT LOCATION IN SPACE Z (IN)	CONTACT LOCATION ON BODY SEG. X (IN)	CONTACT LOCATION ON BODY SEG. Z (IN)
120.00	4.27	0.00	43.	0.	804.0	776.4	0.489	46.	69.09	-43.55	-1.60	-3.32
123.00	4.41	0.00	51.	0.	806.1	292.6	0.492	4.	69.10	-43.63	-1.38	-3.41
126.00	4.58	0.00	58.	0.	808.7	49.3	0.492	1.	69.06	-43.77	-1.38	-3.41
129.00	4.73	0.00	36.	0.	810.9	104.8	0.491	1.	69.00	-43.90	-1.53	-3.35
132.00	4.77	0.00	-12.	0.	651.7	213.4	0.490	3.	68.90	-43.95	-1.68	-3.28
135.00	4.72	0.00	-19.	0.	73.6	77.9	0.491	17.	68.78	-43.90	-1.80	-3.23
138.00	4.65	0.00	-24.	0.	0.0	0.0	0.493	0.	68.70	-43.81	-1.96	-3.15
141.00	4.57	0.00	-32.	0.	0.0	0.0	0.496	0.	68.65	-43.69	-2.18	-3.02
144.00	4.45	0.00	-47.	0.	0.0	0.0	0.500	0.	68.62	-43.52	-2.48	-2.82
147.00	4.28	0.00	-68.	0.	0.0	0.0	0.505	0.	68.60	-43.29	-2.83	-2.54
150.00	4.04	0.00	-91.	0.	0.0	0.0	0.512	0.	68.60	-42.98	-3.15	-2.21
153.00	3.73	0.00	-114.	0.	0.0	0.0	0.521	0.	68.60	-42.58	-3.42	-1.86
156.00	3.35	0.00	-139.	0.	0.0	0.0	0.530	0.	68.58	-42.11	-3.66	-1.47
159.00	2.90	0.00	-163.	0.	0.0	0.0	0.540	0.	68.55	-41.57	-3.83	-1.06
162.00	2.38	0.00	-187.	0.	0.0	0.0	0.550	0.	68.48	-40.97	-3.95	-0.64
165.00	1.78	0.00	-210.	0.	0.0	0.0	0.559	0.	68.37	-40.32	-4.01	-0.22
168.00	1.13	0.00	-226.	0.	0.0	0.0	0.568	0.	68.21	-39.63	-4.01	0.15
171.00	0.43	0.00	-238.	0.	0.0	0.0	0.575	0.	67.99	-38.93	-3.98	0.46
174.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
177.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
180.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
183.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
186.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
189.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
192.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00

CONTACT INTERACTION BETWEEN

ELLIPSE TOE ASSUMED TO BE RIGID

AND

LINE FIREWALL WHICH IS AN ELEMENT OF REGION FLOOR MADE OF FLOOR MATERIAL

INITIAL LINE LENGTH = 19.39(IN) EDGE CONSTANT = 0.000

TIME (MSEC)	DEFLECTION LINE (IN)	DEFLECTION ELLIPSE (IN)	DEFL. RATE LINE (IN/SEC)	DEFL. RATE ELLIPSE (IN/SEC)	FORCE NORMAL (LB)	FORCE TANGNTL. (LB)	CONTACT LOCATION ON LINE POSITION (NONDIM.)	CONTACT LOCATION ON LINE RATE (IN/SEC)	CONTACT LOCATION IN SPACE X (IN)	CONTACT LOCATION IN SPACE Z (IN)	CONTACT LOCATION ON BODY SEG. X (IN)	CONTACT LOCATION ON BODY SEG. Z (IN)
0.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
3.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
6.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
9.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
12.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
15.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
18.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
21.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
24.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
27.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
30.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
33.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
36.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
39.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
42.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
45.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
48.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
51.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
54.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
57.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
60.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
63.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
66.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
69.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
72.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
75.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
78.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
81.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
84.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
87.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
90.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
93.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
96.00	0.28	0.00	160.	0.	457.9	366.3	0.365	41.	86.79	-17.68	4.18	-7.24
99.00	0.66	0.00	94.	0.	1043.4	483.7	0.366	-6.	87.08	-17.70	4.16	-7.25
102.00	0.85	0.00	34.	0.	1218.3	178.6	0.365	2.	87.15	-17.69	4.13	-7.27
105.00	0.87	0.00	-21.	0.	1215.7	162.4	0.364	-2.	87.04	-17.68	4.09	-7.28
108.00	0.72	0.00	-70.	0.	715.2	127.9	0.364	-2.	86.75	-17.67	4.04	-7.30
111.00	0.47	0.00	-94.	0.	274.0	51.0	0.364	-2.	86.35	-17.66	4.00	-7.32
114.00	0.17	0.00	-106.	0.	58.9	10.0	0.363	-2.	85.89	-17.65	3.95	-7.33
117.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
120.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00

CONTACT INTERACTION BETWEEN

ELLIPSE TOE ASSUMED TO BE RIGID

AND

LINE FIREWALL WHICH IS AN ELEMENT OF REGION FLOOR MADE OF FLOOR MATERIAL

INITIAL LINE LENGTH = 19.39(IN) EDGE CONSTANT = 0.000

TIME (MSEC)	DEFLECTION LINE (IN)	DEFLECTION ELLIPSE (IN)	DEFL. RATE LINE (IN/SEC)	DEFL. RATE ELLIPSE (IN/SEC)	FORCE NORMAL (LB)	FORCE TANGNTL. (LB)	CONTACT LOCATION ON LINE POSITION (NONDIM.)	CONTACT LOCATION ON LINE RATE (IN/SEC)	CONTACT LOCATION IN SPACE X (IN)	CONTACT LOCATION IN SPACE Z (IN)	CONTACT LOCATION ON BODY SEG. X (IN)	CONTACT LOCATION ON BODY SEG. Z (IN)
120.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
123.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
126.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
129.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
132.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
135.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
138.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
141.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
144.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
147.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
150.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
153.00	0.21	0.00	223.	0.	196.0	158.8	0.387	140.	84.84	-18.11	3.81	-7.36
156.00	0.80	0.00	152.	0.	1120.0	896.0	0.406	89.	85.18	-18.47	3.86	-7.35
159.00	1.07	0.00	38.	0.	1428.0	437.6	0.411	4.	85.43	-18.58	3.89	-7.34
162.00	1.07	0.00	-36.	0.	1391.3	1113.0	0.410	-13.	85.40	-18.56	3.90	-7.34
165.00	0.89	0.00	-84.	0.	978.2	699.9	0.409	-9.	85.20	-18.54	3.90	-7.34
168.00	0.61	0.00	-98.	0.	480.4	102.7	0.408	-3.	84.91	-18.53	3.90	-7.34
171.00	0.33	0.00	-84.	0.	146.5	38.5	0.408	3.	84.62	-18.53	3.90	-7.34
174.00	0.12	0.00	-50.	0.	5.8	4.6	0.410	20.	84.41	-18.56	3.91	-7.34
177.00	0.03	0.00	-11.	0.	0.0	0.0	0.415	0.	84.32	-18.66	3.93	-7.33
180.00	0.05	0.00	23.	0.	0.0	0.0	0.425	0.	84.34	-18.84	3.96	-7.33
183.00	0.16	0.00	47.	0.	73.2	58.6	0.438	96.	84.46	-19.10	4.01	-7.31
186.00	0.30	0.00	46.	0.	288.4	230.8	0.453	89.	84.61	-19.39	4.05	-7.30
189.00	0.41	0.00	23.	0.	446.7	357.4	0.464	49.	84.72	-19.60	4.09	-7.28
192.00	0.44	0.00	-6.	0.	480.3	42.8	0.467	1.	84.76	-19.67	4.12	-7.27

CONTACT INTERACTION BETWEEN

ELLIPSE HAND ASSUMED TO BE RIGID

AND

LINE IP PANEL-2ND WHICH IS AN ELEMENT OF REGION MID IP MADE OF MID IP MATERIAL

INITIAL LINE LENGTH = 17.58(IN) EDGE CONSTANT = 0.250

TIME	DEFLECTION		DEFL. RATE		FORCE		CONTACT LOCATION ON LINE		CONTACT LOCATION IN SPACE		CONTACT LOCATION ON BODY SEG.	
(MSEC)	LINE (IN)	ELLIPSE (IN)	LINE (IN/SEC)	ELLIPSE (IN/SEC)	NORMAL (LB)	TANGNTL. (LB)	POSITION (NONDIM.)	RATE (IN/SEC)	X (IN)	Z (IN)	X (IN)	Z (IN)
0.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
3.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
6.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
9.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
12.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
15.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
18.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
21.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
24.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
27.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
30.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
33.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
36.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
39.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
42.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
45.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
48.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
51.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
54.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
57.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
60.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
63.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
66.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
69.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
72.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
75.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
78.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
81.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
84.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
87.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
90.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
93.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
96.00	0.50	0.00	372.	0.	204.7	102.3	1.103	202.	75.03	-14.55	9.55	-0.60
99.00	1.55	0.00	319.	0.	371.7	185.8	1.140	225.	76.15	-14.29	9.53	-0.62
102.00	2.43	0.00	271.	0.	177.2	88.6	1.181	242.	77.10	-13.90	9.49	-0.67
105.00	3.20	0.00	248.	0.	49.0	24.5	1.224	244.	77.95	-13.45	9.44	-0.73
108.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
111.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
114.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
117.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
120.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00

CONTACT INTERACTION BETWEEN

ELLIPSE HAND ASSUMED TO BE RIGID

AND

LINE IP PANEL-2ND WHICH IS AN ELEMENT OF REGION MID IP MADE OF MID IP MATERIAL

INITIAL LINE LENGTH = 17.58(IN) EDGE CONSTANT = 0.250

TIME	DEFLECTION		DEFL. RATE		FORCE		CONTACT LOCATION ON LINE		CONTACT LOCATION IN SPACE		CONTACT LOCATION ON BODY SEG.	
(MSEC)	LINE (IN)	ELLIPSE (IN)	LINE (IN/SEC)	ELLIPSE (IN/SEC)	NORMAL (LB)	TANGNTL. (LB)	POSITION (NONDIM.)	RATE (IN/SEC)	X (IN)	Z (IN)	X (IN)	Z (IN)
120.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
123.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
126.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
129.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
132.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
135.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
138.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
141.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
144.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
147.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
150.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
153.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
156.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
159.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
162.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
165.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
168.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
171.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
174.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
177.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
180.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
183.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
186.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
189.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
192.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00

CONTACT INTERACTION BETWEEN

ELLIPSE THORAX MADE OF CHESTMAT

AND

LINE IP PANEL-2ND WHICH IS AN ELEMENT OF REGION MID IP MADE OF MID IP MATERIAL

INITIAL LINE LENGTH = 17.58(IN) EDGE CONSTANT = 0.250

TIME (MSEC)	DEFLECTION LINE (IN)	DEFLECTION ELLIPSE (IN)	DEFL. RATE LINE (IN/SEC)	DEFL. RATE ELLIPSE (IN/SEC)	FORCE NORMAL (LB)	FORCE TANGNTL. (LB)	CONTACT LOCATION ON LINE POSITION (NONDIM.)	CONTACT LOCATION ON LINE RATE (IN/SEC)	CONTACT LOCATION IN SPACE X (IN)	CONTACT LOCATION IN SPACE Z (IN)	CONTACT LOCATION ON BODY SEG. X (IN)	CONTACT LOCATION ON BODY SEG. Z (IN)
0.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
3.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
6.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
9.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
12.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
15.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
18.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
21.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
24.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
27.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
30.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
33.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
36.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
39.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
42.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
45.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
48.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
51.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
54.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
57.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
60.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
63.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
66.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
69.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
72.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
75.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
78.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
81.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
84.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
87.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
90.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
93.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
96.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
99.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
102.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
105.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
108.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
111.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
114.00	0.16	0.04	248.	60.	169.8	50.9	0.135	90.	68.25	-30.48	-3.69	-3.44
117.00	0.46	0.62	57.	222.	513.9	154.2	0.149	78.	69.02	-30.54	-3.69	-3.44
120.00	0.62	1.24	49.	189.	709.1	212.7	0.160	65.	69.67	-30.62	-3.62	-3.54

CONTACT INTERACTION BETWEEN

ELLIPSE THORAX MADE OF CHESTMAT

AND

LINE IP PANEL-2ND WHICH IS AN ELEMENT OF REGION MID IP MADE OF MID IP MATERIAL

INITIAL LINE LENGTH = 17.58(IN) EDGE CONSTANT = 0.250

TIME (MSEC)	DEFLECTION LINE (IN)	DEFLECTION ELLIPSE (IN)	DEFL. RATE LINE (IN/SEC)	DEFL. RATE ELLIPSE (IN/SEC)	FORCE NORMAL (LB)	FORCE TANGNTL. (LB)	CONTACT LOCATION ON LINE POSITION (NONDIM.)	CONTACT LOCATION ON LINE RATE (IN/SEC)	CONTACT LOCATION IN SPACE X (IN)	CONTACT LOCATION IN SPACE Z (IN)	CONTACT LOCATION ON BODY SEG. X (IN)	CONTACT LOCATION ON BODY SEG. Z (IN)
120.00	0.62	1.24	49.	189.	709.1	212.7	0.160	65.	69.67	-30.62	-3.62	-3.54
123.00	0.76	1.75	39.	151.	879.0	263.7	0.169	64.	70.19	-30.68	-3.48	-3.73
126.00	0.86	2.13	27.	104.	1016.2	304.9	0.179	67.	70.57	-30.69	-3.28	-3.95
129.00	0.90	2.40	3.	73.	1097.7	329.3	0.190	76.	70.81	-30.60	-3.09	-4.15
132.00	0.91	2.54	1.	22.	1139.2	341.8	0.203	80.	70.92	-30.44	-2.96	-4.27
135.00	0.90	2.52	-5.	-34.	1074.3	322.3	0.216	74.	70.87	-30.21	-2.90	-4.33
138.00	0.88	2.35	-10.	-77.	565.7	169.7	0.229	75.	70.68	-29.94	-2.85	-4.37
141.00	0.86	2.07	0.	-111.	170.3	51.1	0.242	81.	70.39	-29.61	-2.80	-4.41
144.00	0.86	1.71	-1.	-125.	135.6	40.7	0.257	85.	70.07	-29.26	-2.73	-4.47
147.00	0.78	1.41	-32.	-102.	103.7	31.1	0.272	86.	69.73	-28.88	-2.64	-4.55
150.00	0.68	1.10	-33.	-105.	71.0	21.3	0.287	86.	69.38	-28.49	-2.51	-4.64
153.00	0.58	0.78	-33.	-107.	37.5	11.2	0.302	85.	69.03	-28.10	-2.37	-4.74
156.00	0.48	0.46	-33.	-107.	3.7	1.1	0.318	85.	68.69	-27.70	-2.20	-4.85
159.00	0.31	0.21	-70.	-70.	0.0	0.0	0.334	0.	68.36	-27.30	-2.02	-4.96
162.00	0.10	0.00	-69.	-69.	0.0	0.0	0.350	0.	68.04	-26.89	-1.83	-5.07
165.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
168.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
171.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
174.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
177.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
180.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
183.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
186.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
189.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
192.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00

CONTACT INTERACTION BETWEEN

ELLIPSE ELBOW ASSUMED TO BE RIGID

AND

LINE IP PANEL-2ND WHICH IS AN ELEMENT OF REGION MID IP MADE OF MID IP MATERIAL

INITIAL LINE LENGTH = 17.58(IN) EDGE CONSTANT = 0.250

TIME (MSEC)	DEFLECTION LINE (IN)	DEFLECTION ELLIPSE (IN)	DEFL. RATE LINE (IN/SEC)	DEFL. RATE ELLIPSE (IN/SEC)	FORCE NORMAL (LB)	FORCE TANGNTL. (LB)	CONTACT LOCATION ON LINE POSITION (NONDIM.)	CONTACT LOCATION ON LINE RATE (IN/SEC)	CONTACT LOCATION IN SPACE X (IN)	CONTACT LOCATION IN SPACE Z (IN)	CONTACT LOCATION ON BODY SEG. X (IN)	CONTACT LOCATION ON BODY SEG. Z (IN)
0.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
3.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
6.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
9.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
12.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
15.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
18.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
21.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
24.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
27.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
30.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
33.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
36.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
39.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
42.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
45.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
48.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
51.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
54.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
57.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
60.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
63.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
66.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
69.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
72.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
75.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
78.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
81.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
84.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
87.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
90.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
93.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
96.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
99.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
102.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
105.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
108.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
111.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
114.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
117.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
120.00	0.69	0.00	375.	0.	841.7	252.5	0.809	68.	72.39	-19.49	-3.09	-1.39

CONTACT INTERACTION BETWEEN

ELLIPSE ELBOW ASSUMED TO BE RIGID

AND

LINE IP PANEL-2ND WHICH IS AN ELEMENT OF REGION MID IP MADE OF MID IP MATERIAL

INITIAL LINE LENGTH = 17.58(IN) EDGE CONSTANT = 0.250

TIME (MSEC)	DEFLECTION LINE (IN)	DEFLECTION ELLIPSE (IN)	DEFL. RATE LINE (IN/SEC)	DEFL. RATE ELLIPSE (IN/SEC)	FORCE NORMAL (LB)	FORCE TANGNTL. (LB)	CONTACT LOCATION ON LINE POSITION (NONDIM.)	CONTACT LOCATION ON LINE RATE (IN/SEC)	CONTACT LOCATION IN SPACE X (IN)	CONTACT LOCATION IN SPACE Z (IN)	CONTACT LOCATION ON BODY SEG. X (IN)	CONTACT LOCATION ON BODY SEG. Z (IN)
120.00	0.69	0.00	375.	0.	841.7	252.5	0.809	68.	72.39	-19.49	-3.09	-1.39
123.00	1.60	0.00	223.	0.	1431.9	429.6	0.819	52.	73.17	-19.62	-3.16	-1.44
126.00	2.05	0.00	86.	0.	1234.0	370.2	0.826	24.	73.51	-19.66	-3.16	-1.43
129.00	2.16	0.00	-10.	0.	1190.3	94.7	0.827	-3.	73.49	-19.67	-3.11	-1.41
132.00	2.03	0.00	-65.	0.	511.8	98.4	0.826	-6.	73.25	-19.64	-3.05	-1.37
135.00	1.82	0.00	-77.	0.	172.5	42.6	0.825	-8.	72.95	-19.59	-2.99	-1.34
138.00	1.56	0.00	-92.	0.	116.6	30.1	0.823	-9.	72.61	-19.53	-2.93	-1.30
141.00	1.27	0.00	-103.	0.	38.5	11.6	0.822	-10.	72.24	-19.46	-2.87	-1.25
144.00	0.95	0.00	-109.	0.	0.0	0.0	0.820	0.	71.86	-19.39	-2.81	-1.21
147.00	0.62	0.00	-113.	0.	0.0	0.0	0.818	0.	71.47	-19.31	-2.76	-1.16
150.00	0.27	0.00	-118.	0.	0.0	0.0	0.815	0.	71.08	-19.24	-2.70	-1.11
153.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
156.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
159.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
162.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
165.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
168.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
171.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
174.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
177.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
180.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
183.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
186.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
189.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
192.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00

CONTACT INTERACTION BETWEEN

ELLIPSE HEAD ASSUMED TO BE RIGID

AND

LINE IP PANEL-1ST WHICH IS AN ELEMENT OF REGION TOP IP MADE OF TOP IP MATERIAL

INITIAL LINE LENGTH = 12.98(IN) EDGE CONSTANT = 0.100

TIME (MSEC)	DEFLECTION LINE (IN)	DEFLECTION ELLIPSE (IN)	DEFL. RATE LINE (IN/SEC)	DEFL. RATE ELLIPSE (IN/SEC)	FORCE NORMAL (LB)	FORCE TANGNTL. (LB)	CONTACT LOCATION ON LINE POSITION (NONDIM.)	CONTACT LOCATION ON LINE RATE (IN/SEC)	CONTACT LOCATION IN SPACE X (IN)	CONTACT LOCATION IN SPACE Z (IN)	CONTACT LOCATION ON BODY SEG. X (IN)	CONTACT LOCATION ON BODY SEG. Z (IN)
0.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
3.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
6.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
9.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
12.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
15.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
18.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
21.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
24.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
27.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
30.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
33.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
36.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
39.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
42.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
45.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
48.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
51.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
54.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
57.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
60.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
63.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
66.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
69.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
72.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
75.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
78.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
81.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
84.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
87.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
90.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
93.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
96.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
99.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
102.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
105.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
108.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
111.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
114.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
117.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
120.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00

CONTACT INTERACTION BETWEEN

ELLIPSE HEAD ASSUMED TO BE RIGID

AND

LINE IP PANEL-1ST WHICH IS AN ELEMENT OF REGION TOP IP MADE OF TOP IP MATERIAL

INITIAL LINE LENGTH = 12.98(IN) EDGE CONSTANT = 0.100

TIME (MSEC)	DEFLECTION LINE (IN)	DEFLECTION ELLIPSE (IN)	DEFL. RATE LINE (IN/SEC)	DEFL. RATE ELLIPSE (IN/SEC)	FORCE NORMAL (LB)	FORCE TANGNTL. (LB)	CONTACT LOCATION ON LINE POSITION (NONDIM.)	CONTACT LOCATION ON LINE RATE (IN/SEC)	CONTACT LOCATION IN SPACE X (IN)	CONTACT LOCATION IN SPACE Z (IN)	CONTACT LOCATION ON BODY SEG. X (IN)	CONTACT LOCATION ON BODY SEG. Z (IN)
120.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
123.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
126.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
129.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
132.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
135.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
138.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
141.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
144.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
147.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
150.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
153.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
156.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
159.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
162.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
165.00	0.44	0.00	179.	0.	16.2	8.1	1.028	93.	65.00	-32.21	4.67	-1.33
168.00	0.99	0.00	187.	0.	23.1	11.6	1.054	93.	64.68	-31.70	4.47	-1.70
171.00	1.56	0.00	192.	0.	16.6	8.3	1.079	100.	64.30	-31.15	4.27	-1.99
174.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
177.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
180.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
183.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
186.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
189.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00
192.00	0.00	0.00	0.	0.	0.0	0.0	0.000	0.	0.00	0.00	0.00	0.00

CATEGORY AND CONTACT INTERACTION INDEX

APPENDIX D

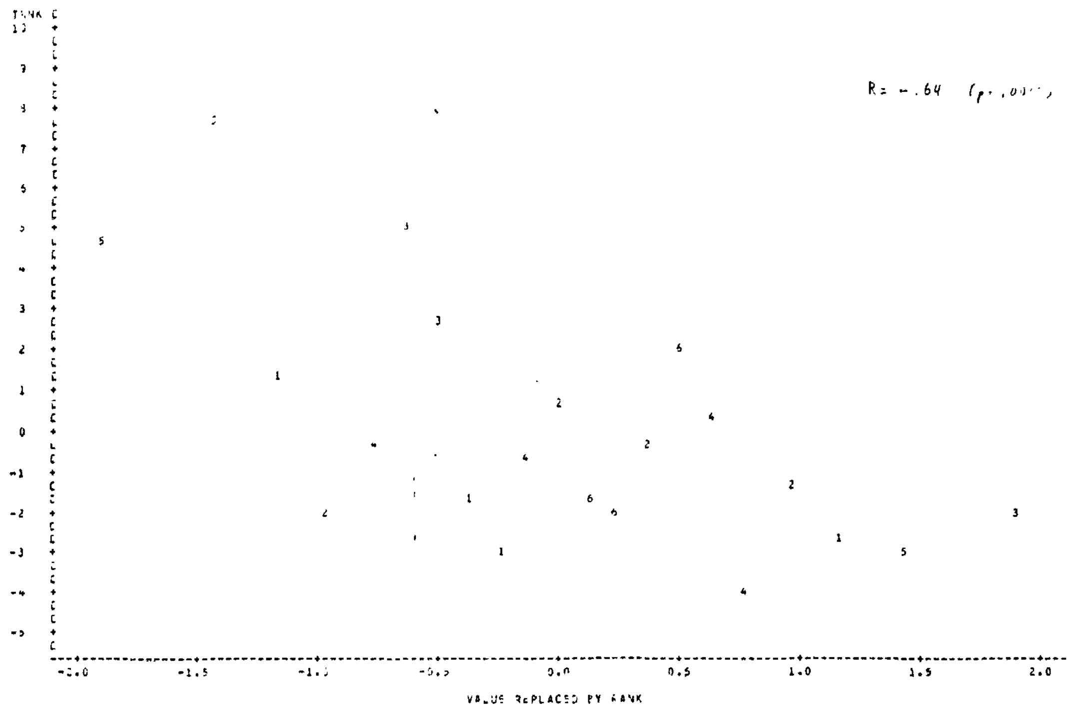
SCATTERPLOTS OF INJURY SCORES VS. PANEL PARAMETERS

SAS

PLOT OF TRNK*IPL

TRNK by IPL

9:04 FRIDAY, JUNE 12, 1987 15

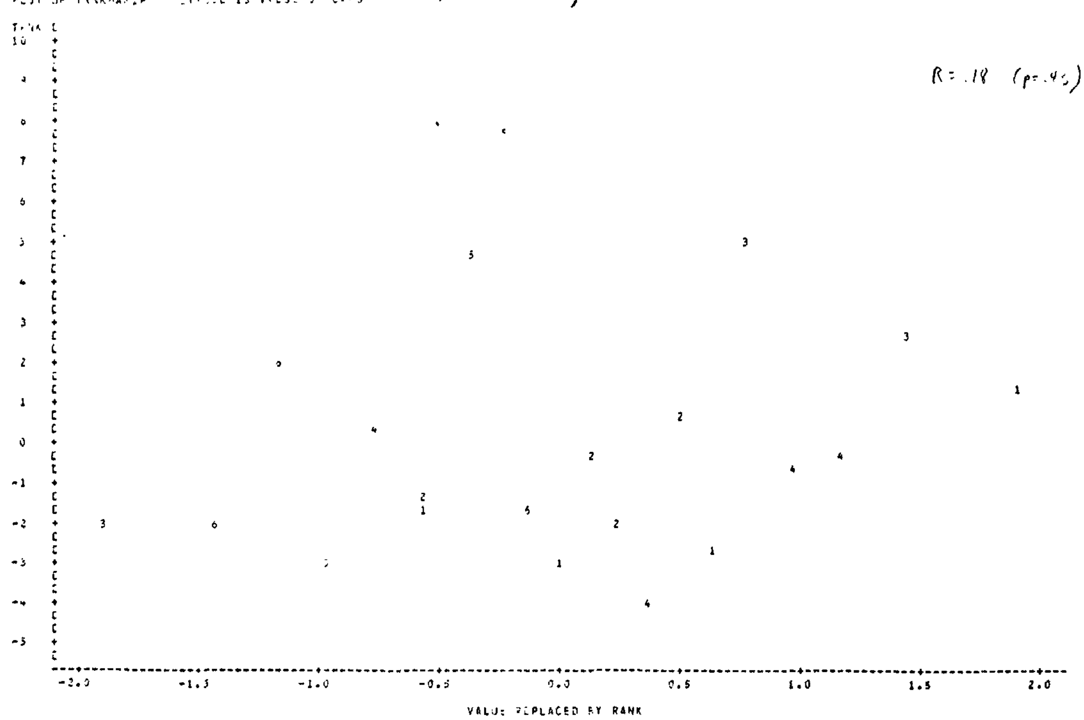


SAS

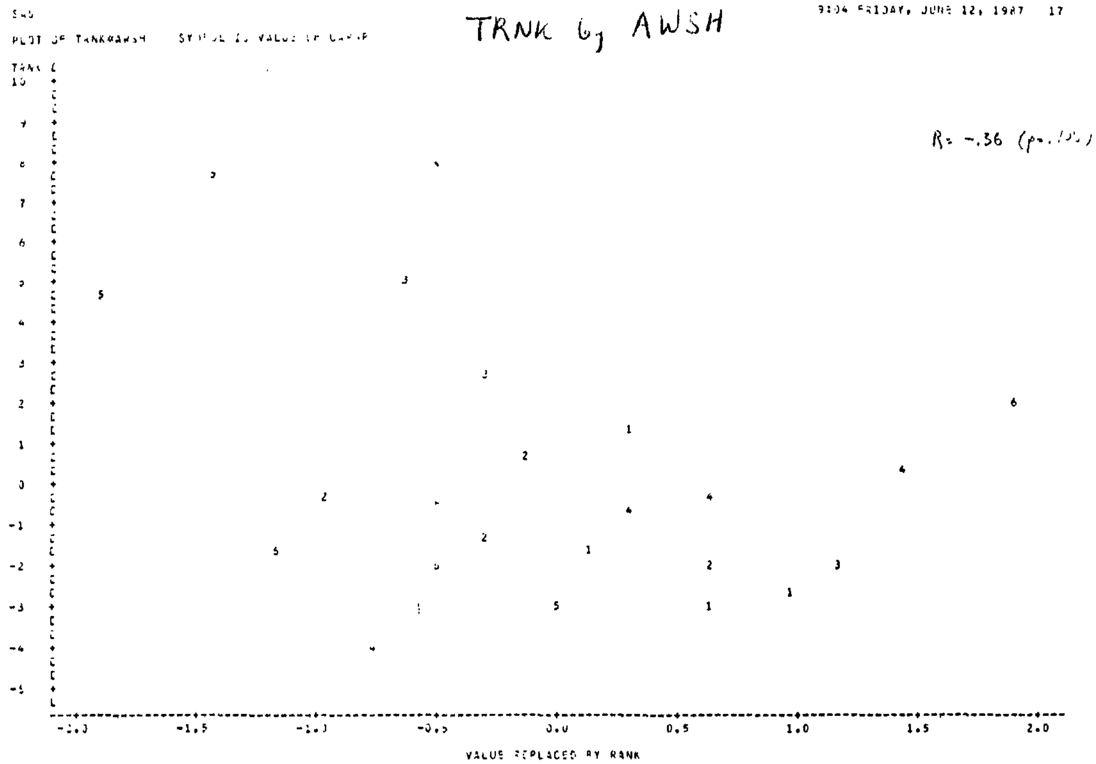
PLOT OF TRNK*AMIP

TRNK by AMIP

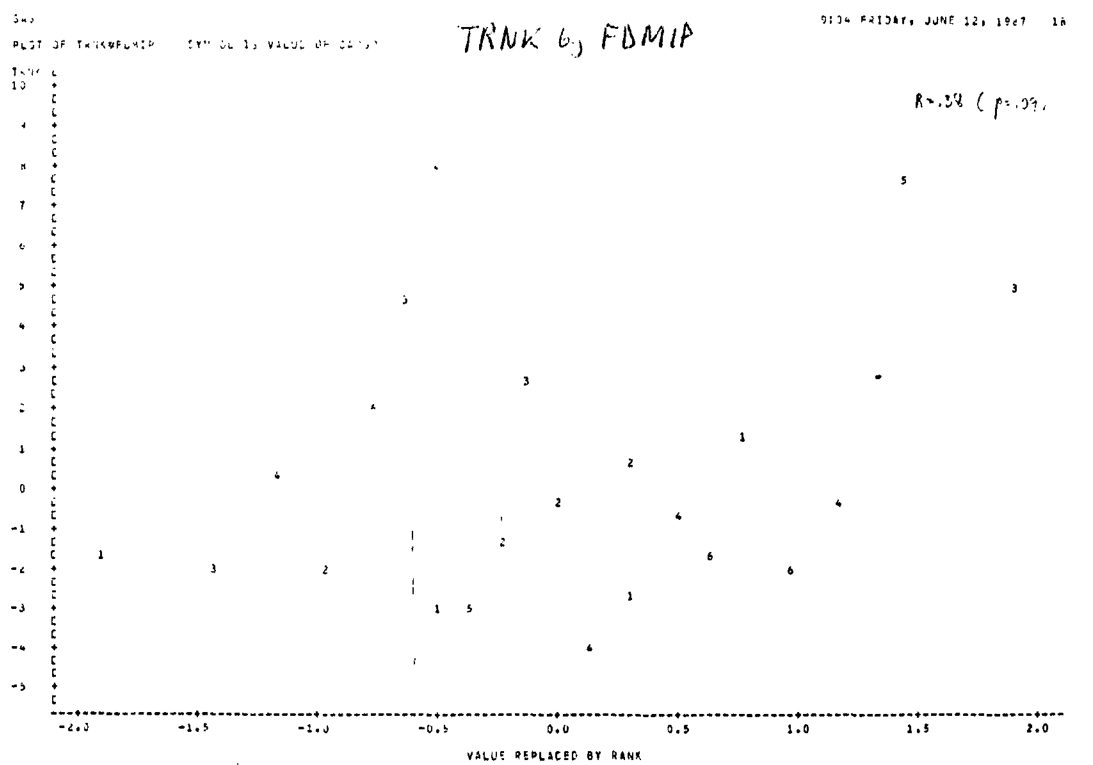
9:04 FRIDAY, JUNE 12, 1987 14



TRNK by AWSH



TRNK by FDMIP



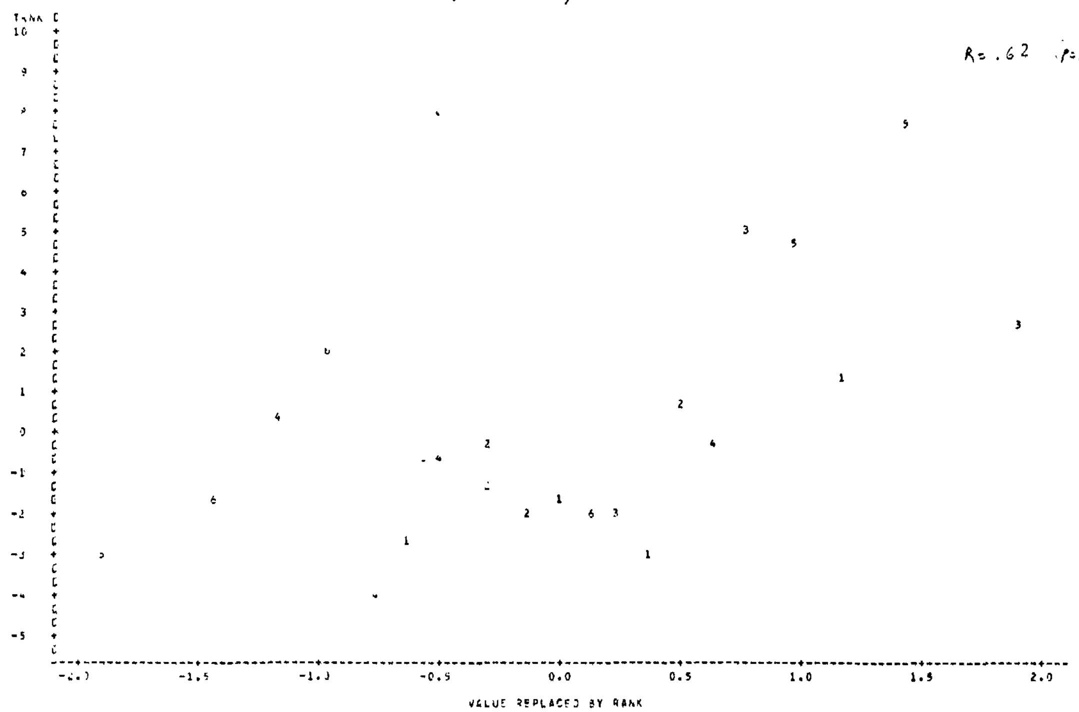
SAS

PLOT OF TRNK*FDLIP6 SYMBOL IS VALUE OF GROUP

TRNK by FDLIP6

9:04 FRIDAY, JUNE 12, 1987 19

R= .62 (p=.00[illegible])



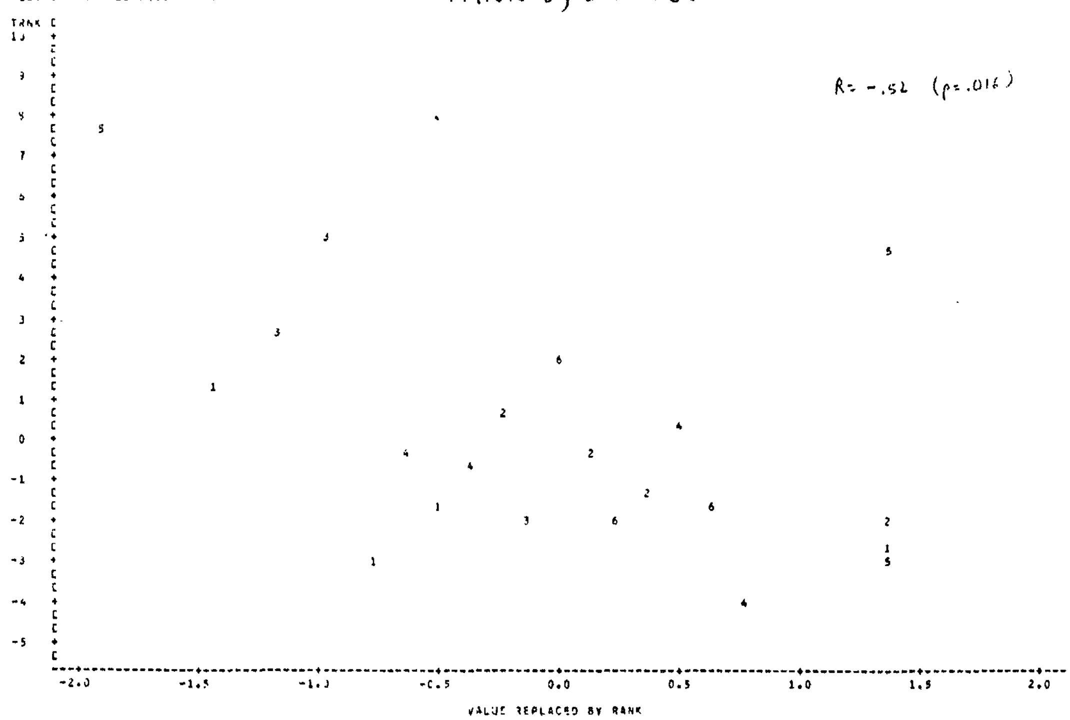
SAS

PLOT OF TRNK*LIP2000 SYMBOL IS VALUE OF GROUP

TRNK by LIP2000

9:04 FRIDAY, JUNE 12, 1987 20

R= -.52 (p=.016)



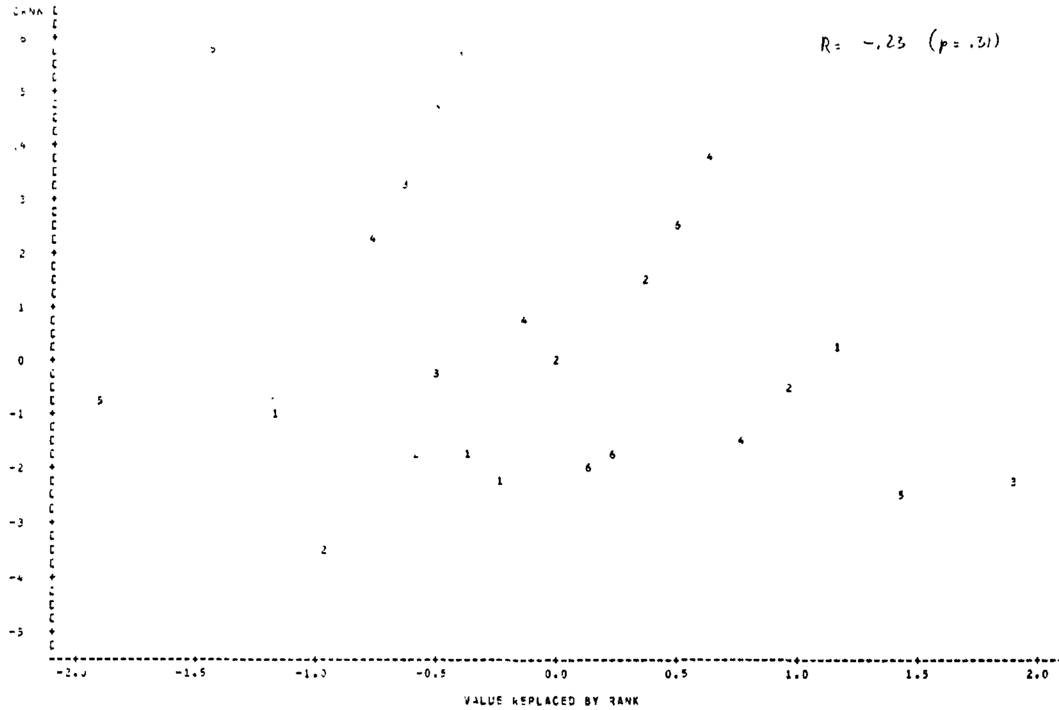
SAS

PLOT OF CRNK*IPL SYMBOL IS VALUE OF GROUP

9:04 FRIDAY, JUNE 12, 1987 9

CRNK by IPL

R= -.23 (p= .31)



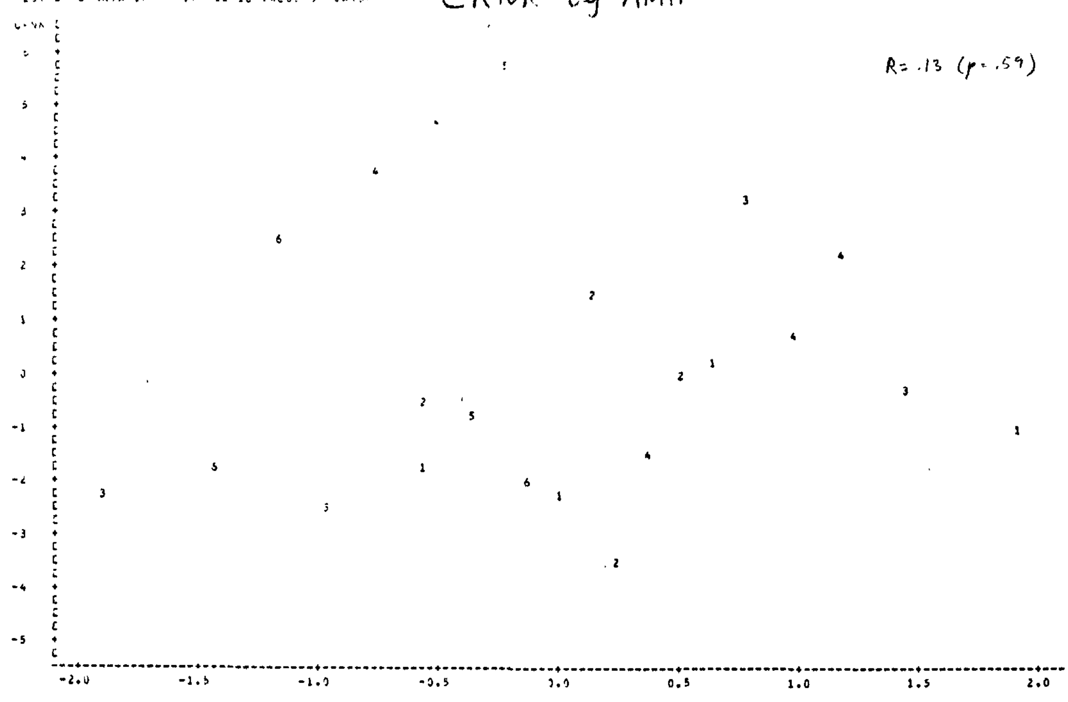
SAS

PLOT OF CRNK*AMIP SYMBOL IS VALUE OF GROUP

9:04 FRIDAY, JUNE 12, 1987 10

CRNK by AMIP

R= .13 (p= .59)



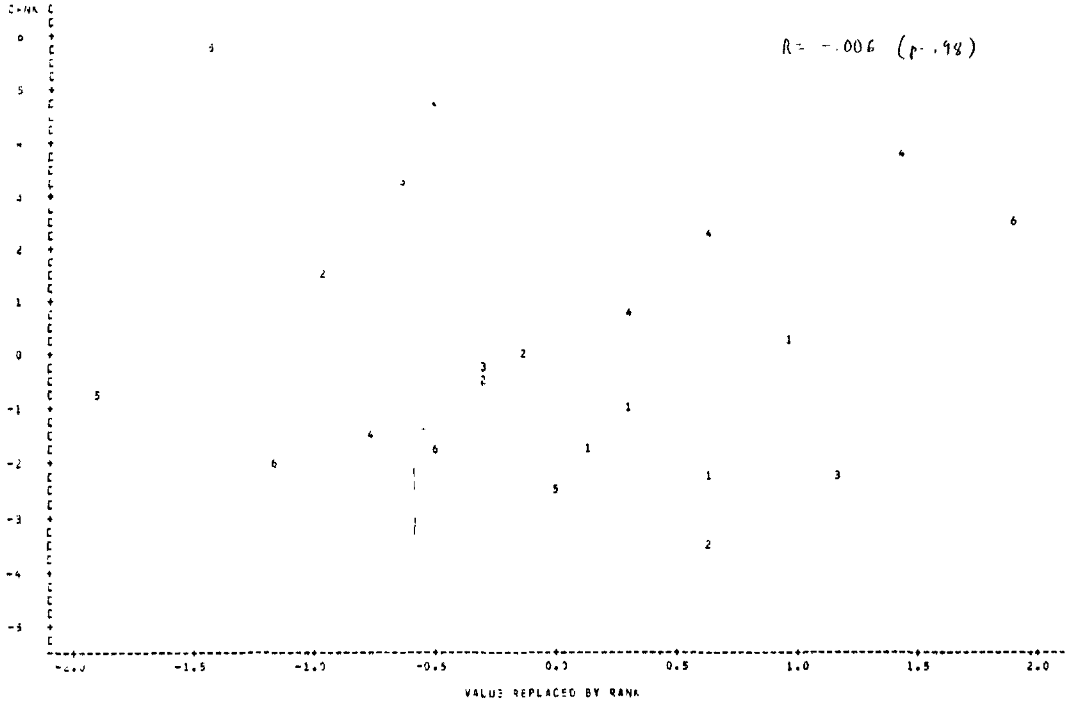
SAS

PLOT OF CRNK*AWSH SYMBOL IS VALUE OF GROUP

9104 FRIDAY, JUNE 12, 1997 11

CRNK by AWSH

R= -.006 (p=.98)



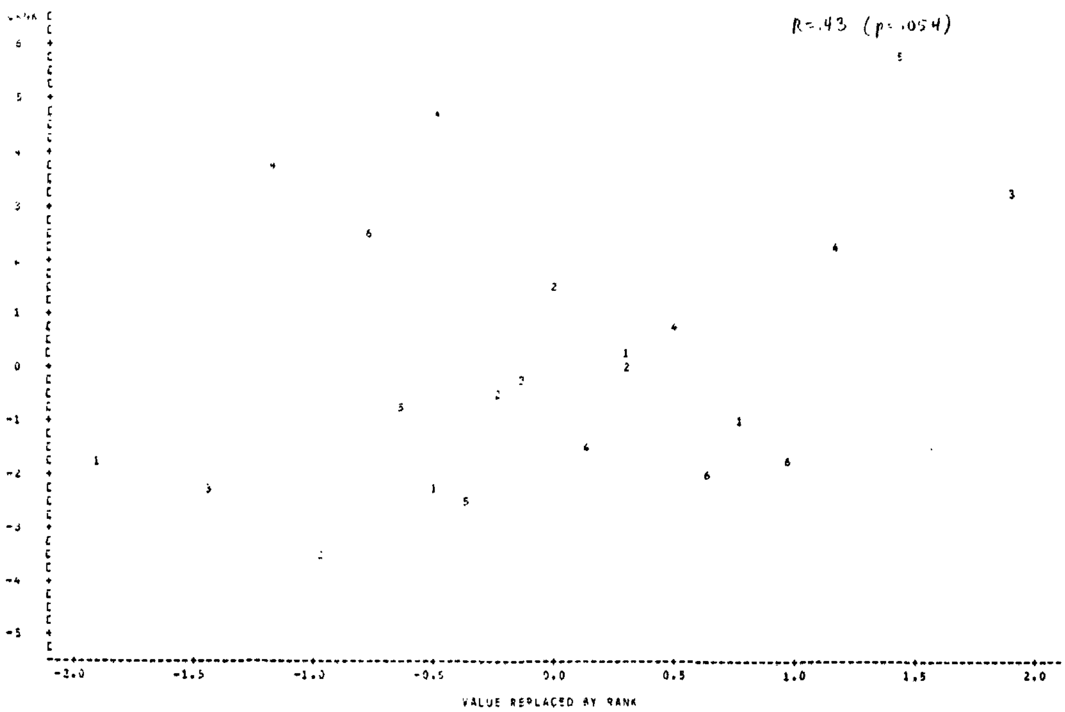
SAS

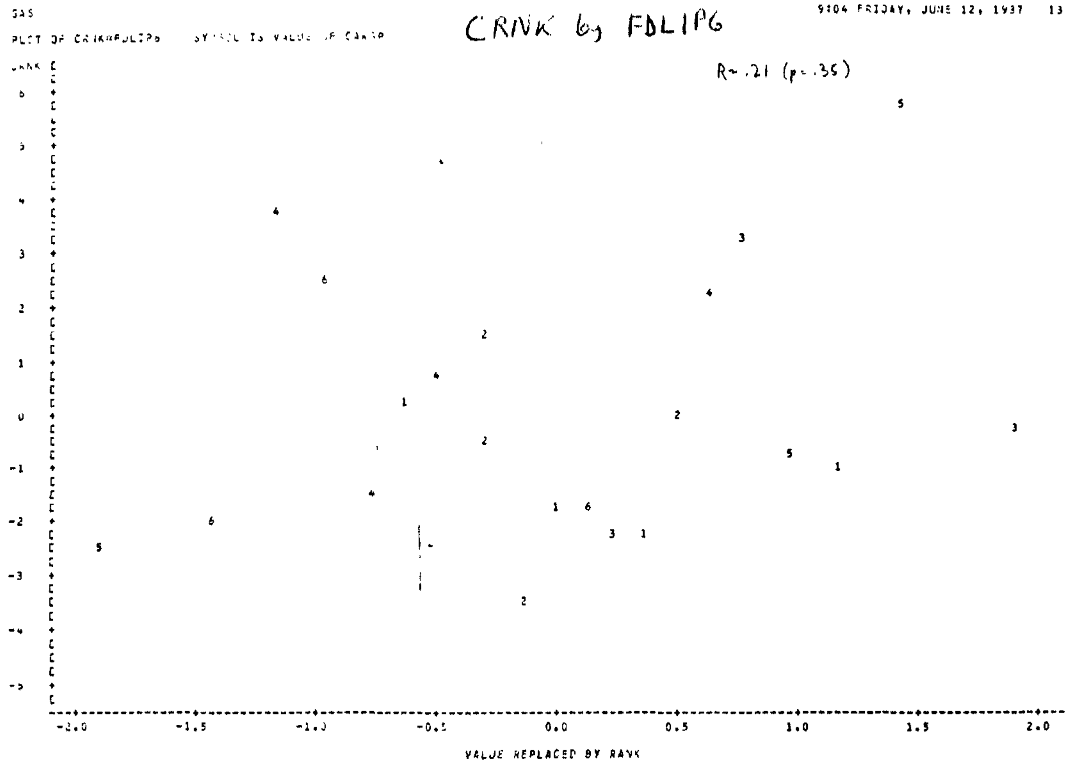
PLOT OF CRNK*FDMIP SYMBOL IS VALUE OF GROUP

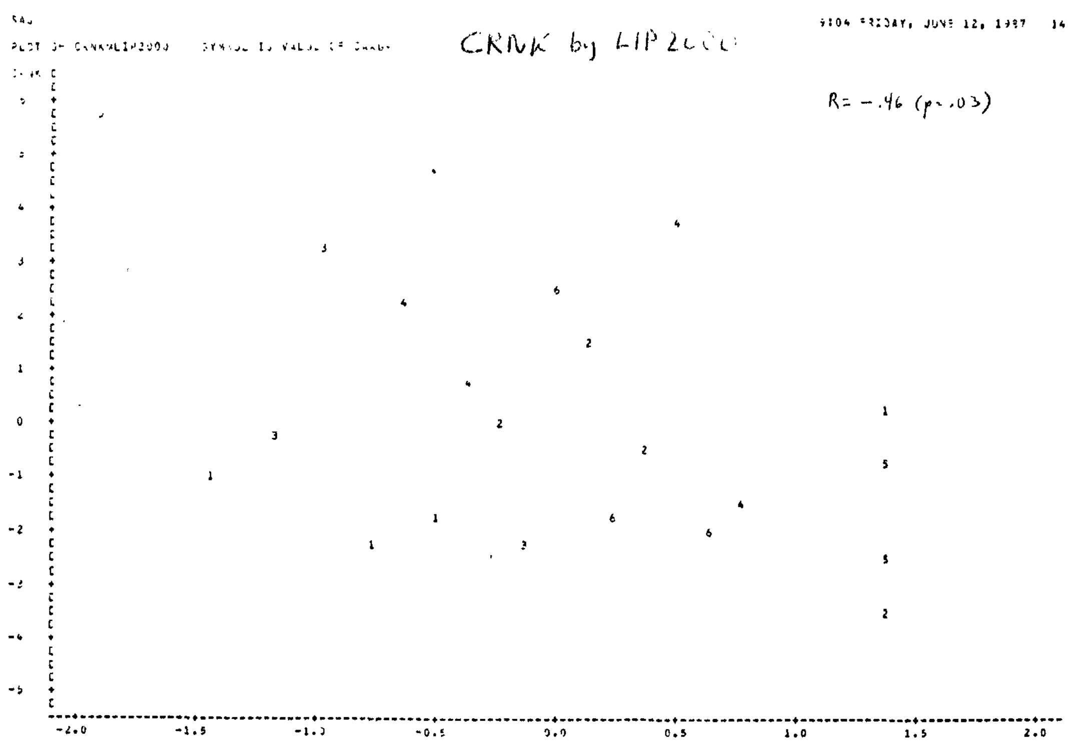
9104 FRIDAY, JUNE 12, 1997 12

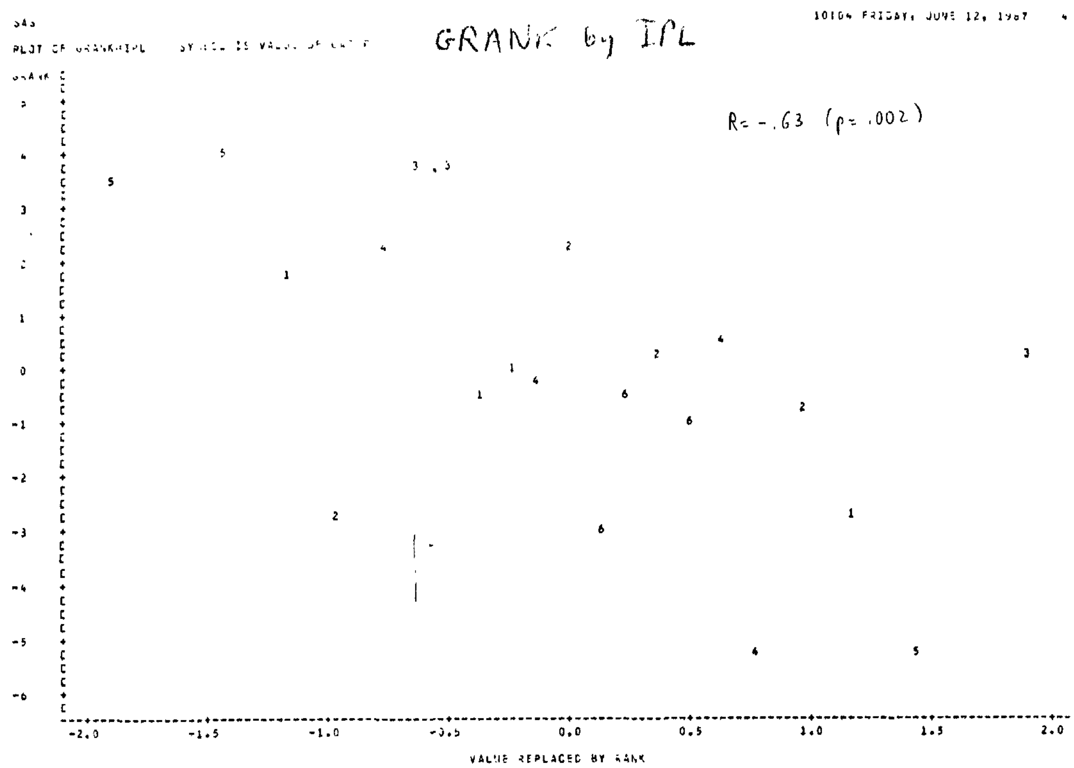
CRNK by FDMIP

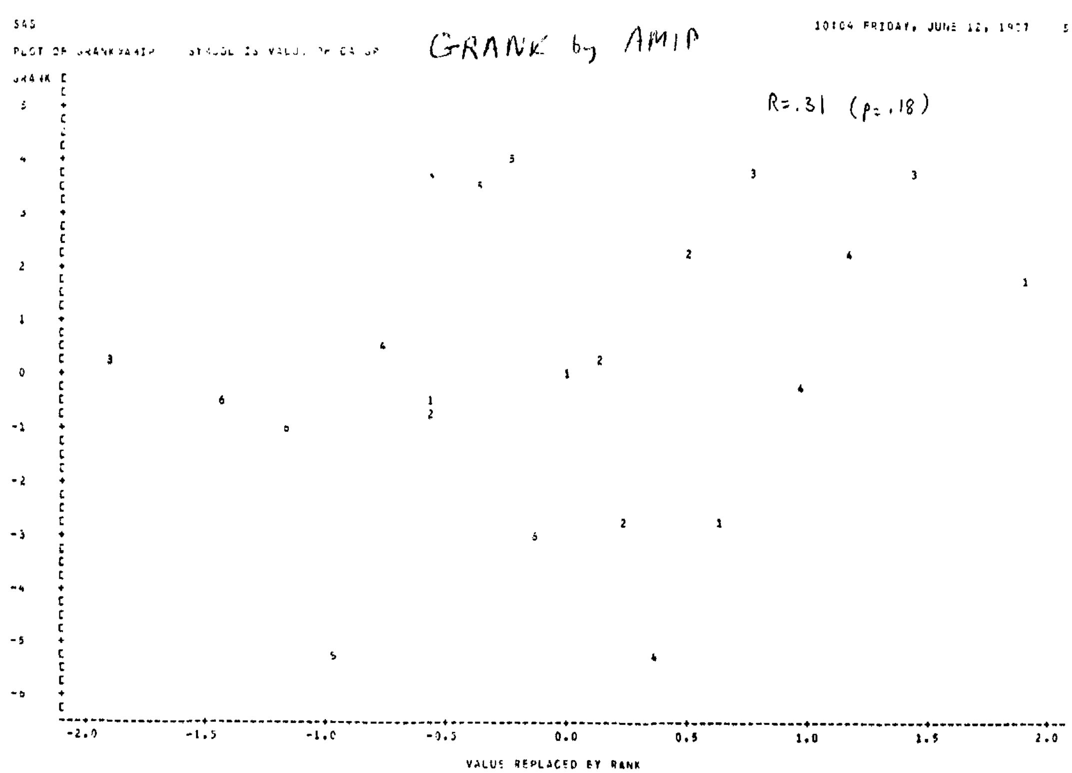
R=.43 (p=.054)




SAS
9:04 FRIDAY, JUNE 12, 1987 13
CRNK by FDLIP6
R=.21 (p=.35)
VALUE REPLACED BY RANK


SAS
9:04 FRIDAY, JUNE 12, 1987 14
CRNK by LIP2000
R= -.46 (p=.03)
VALUE REPLACED BY RANK


SAS
10:04 FRIDAY, JUNE 12, 1987
GRANK by IPL
R= -.63 (p= .002)
VALUE REPLACED BY RANK


SAS
10:04 FRIDAY, JUNE 12, 1987
GRANK by AMIP
R=.31 (p=.18)
VALUE REPLACED BY RANK

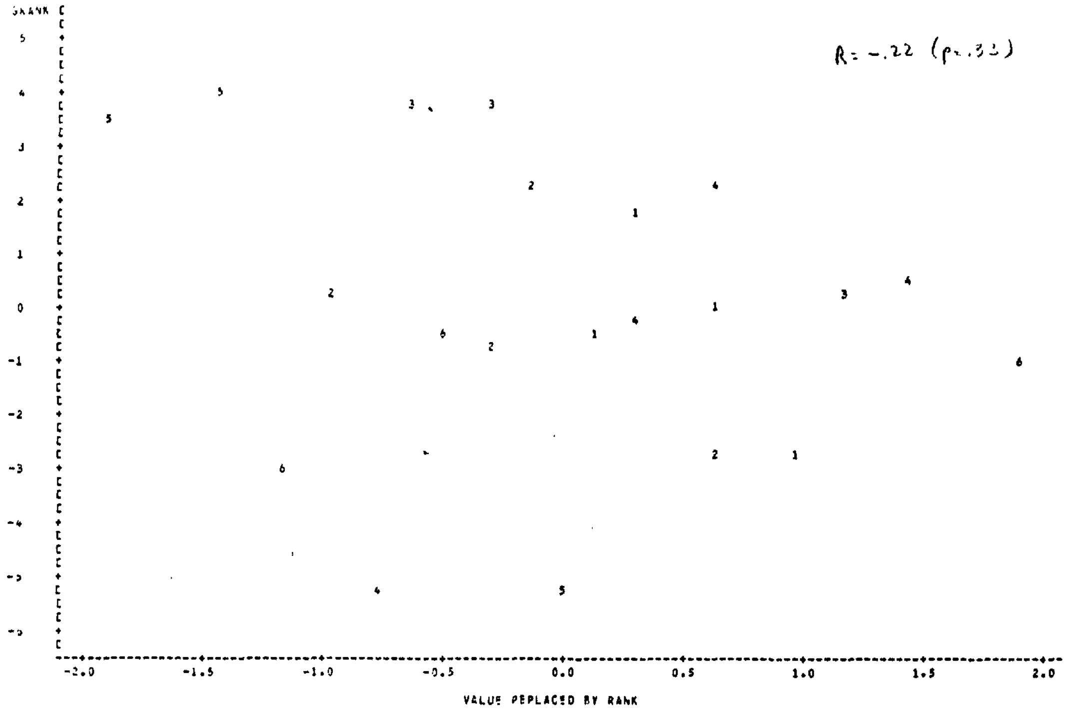
SAS

10:04 FRIDAY, JUNE 12, 1987 6

PLOT OF GRANK*AWSH SYMBOL IS VALUE OF GROUP

GRANK by AWSH

R= -.22 (p=.33)



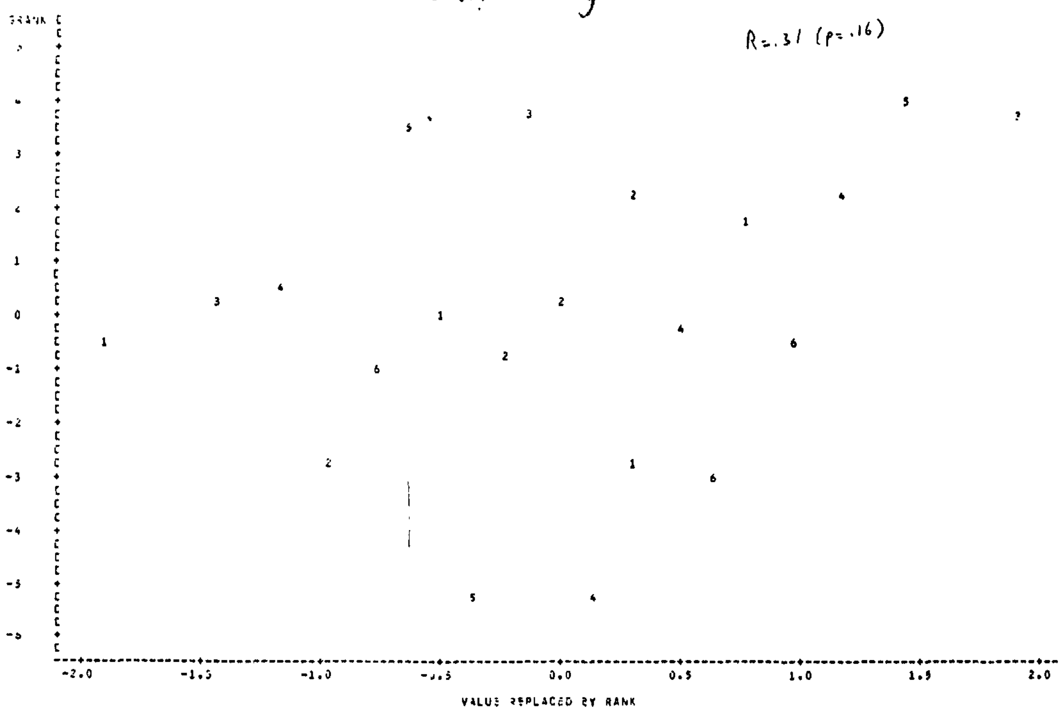
SAS

10:04 FRIDAY, JUNE 12, 1987 7

PLOT OF GRANK*FDMIP SYMBOL IS VALUE OF GROUP

GRANK by FDMIP

R=.31 (p=.16)

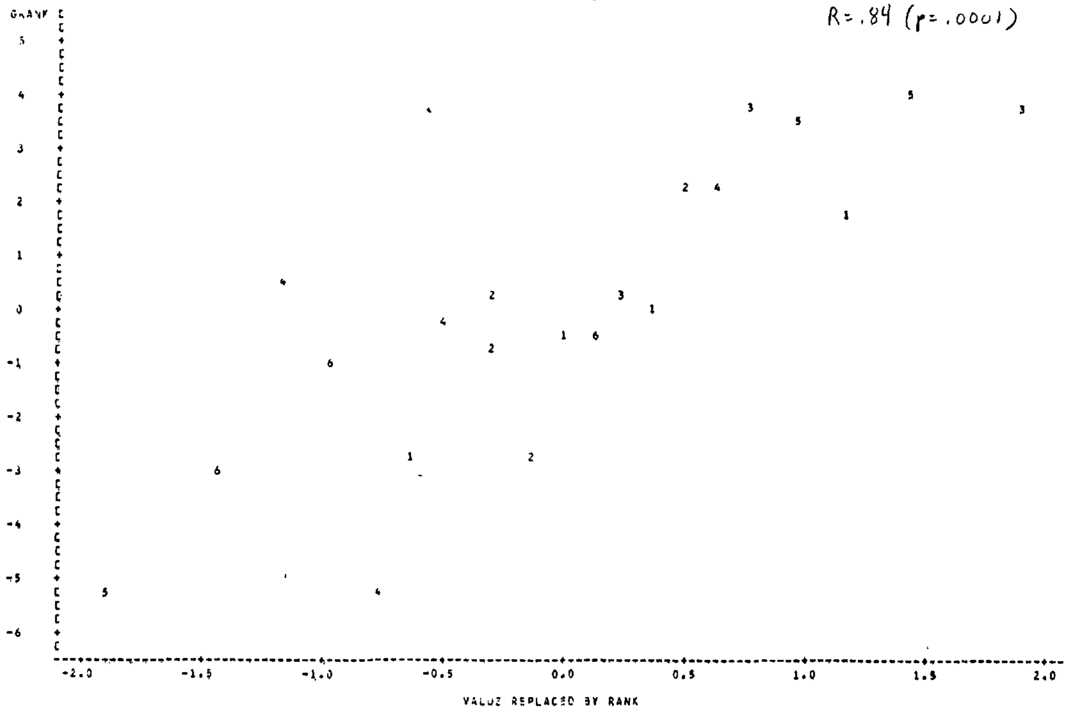


SAS 10:04 FRIDAY, JUNE 12, 1987 5

PLOT OF GRANK*FDLIPG SYMBOL IS VALUE OF GROUP

GRANK by FDLIPG

R=.84 (p=.0001)

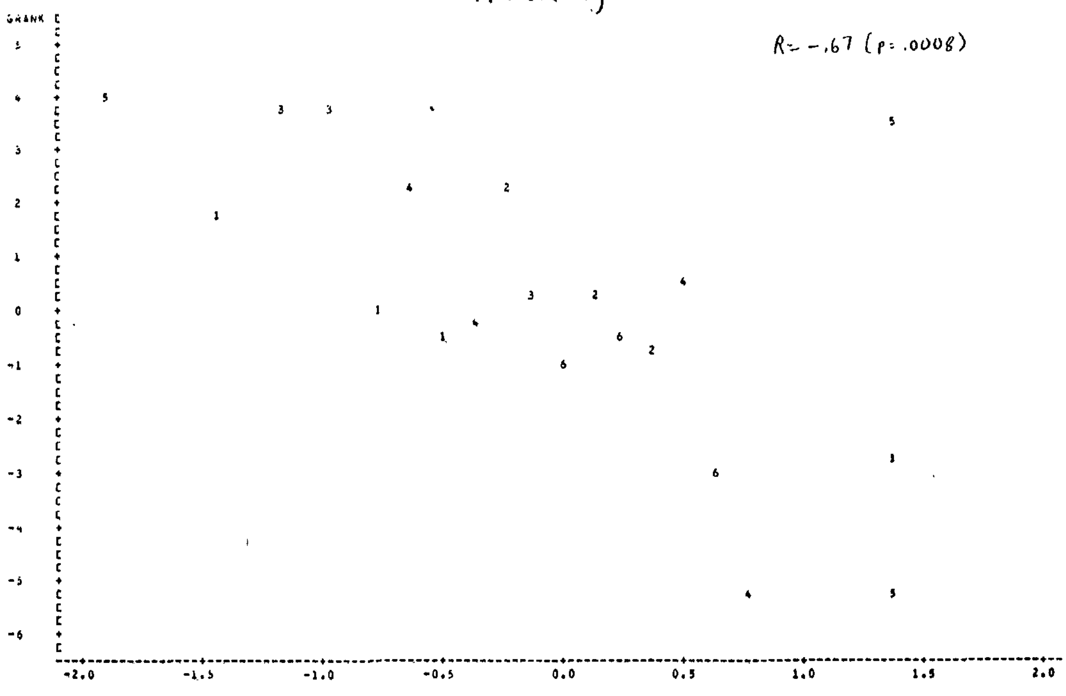


SAS 10:04 FRIDAY, JUNE 12, 1987 9

PLOT OF GRANK*LIP2000 SYMBOL IS VALUE OF GROUP

GRANK by LIP2000

R=-.67 (p=.0008)



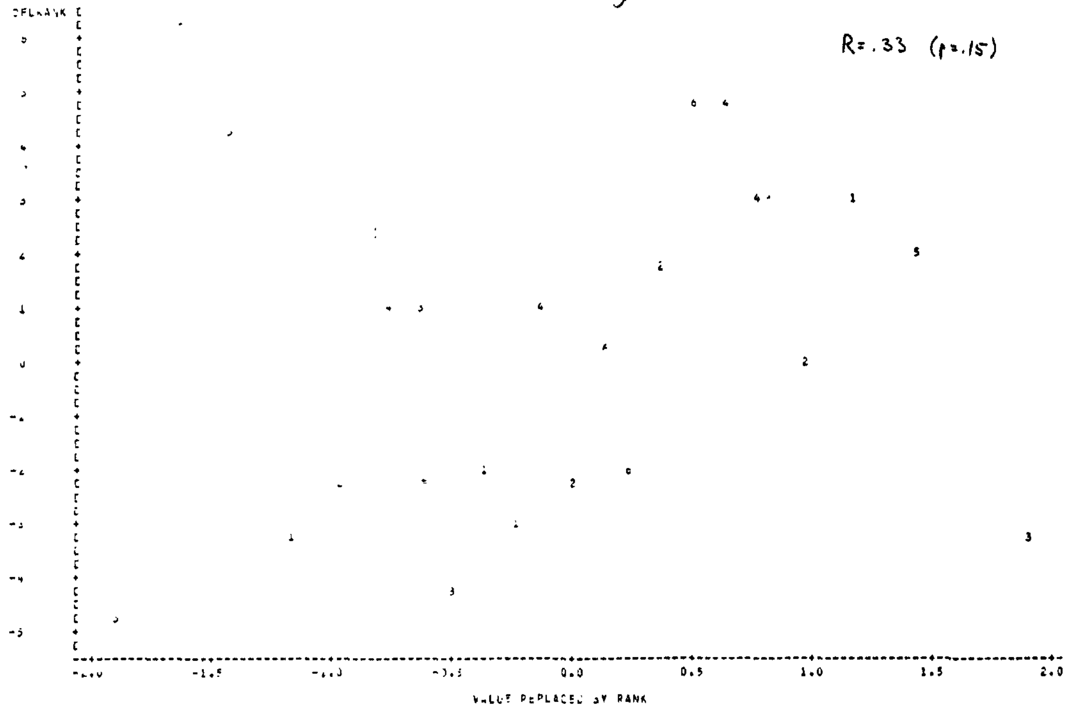
NOTE: 1 OBS HIDDEN

SAS 9:29 TUESDAY, SEPTEMBER 29, 1987 2

PLOT OF DFLRANK*IPL SYMBOL IS VALUE OF [illegible]

DFLRANK by IPL

R=.33 (p=.15)

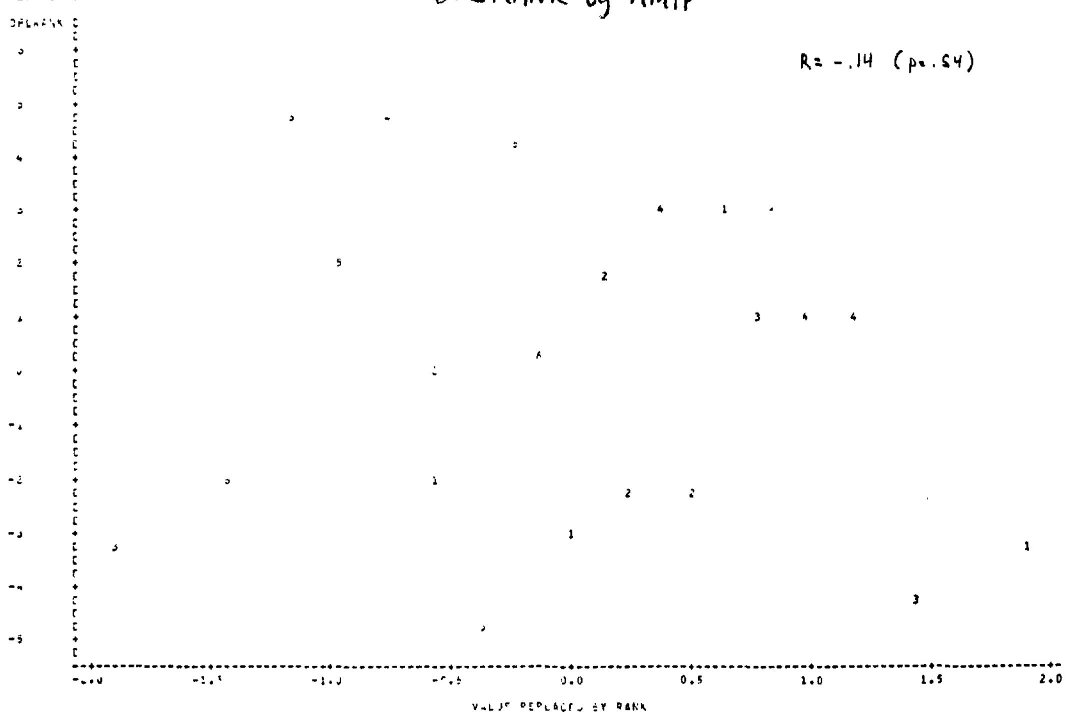


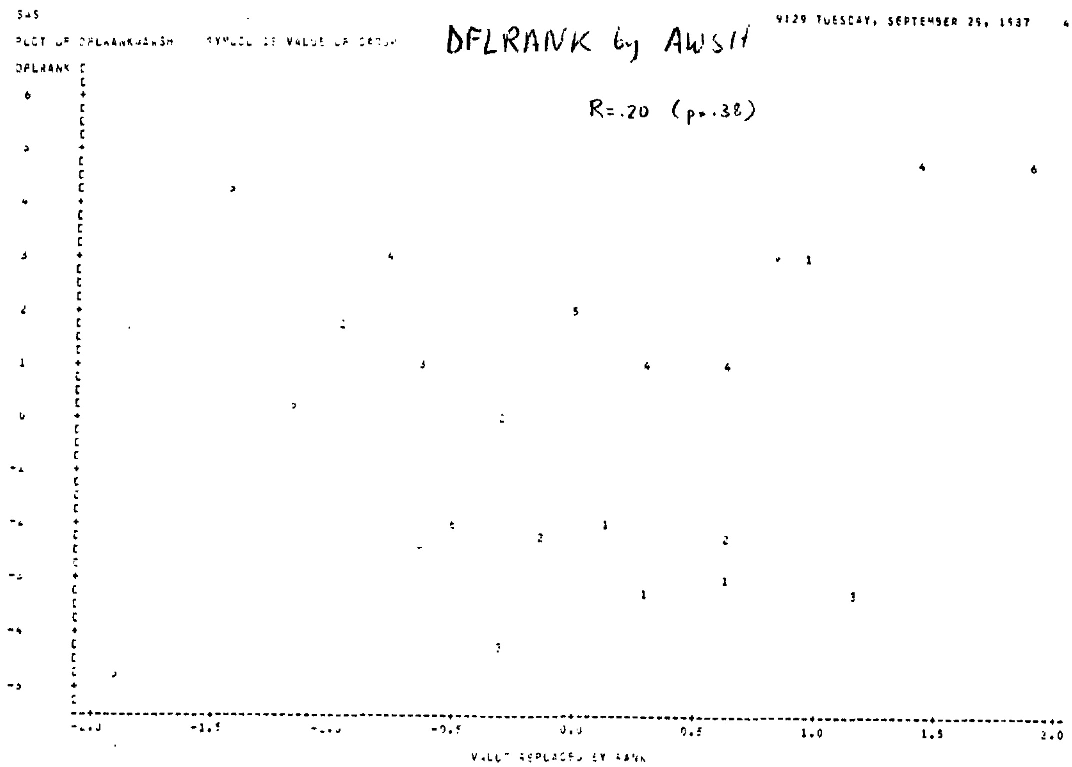
SAS 9:29 TUESDAY, SEPTEMBER 29, 1987 3

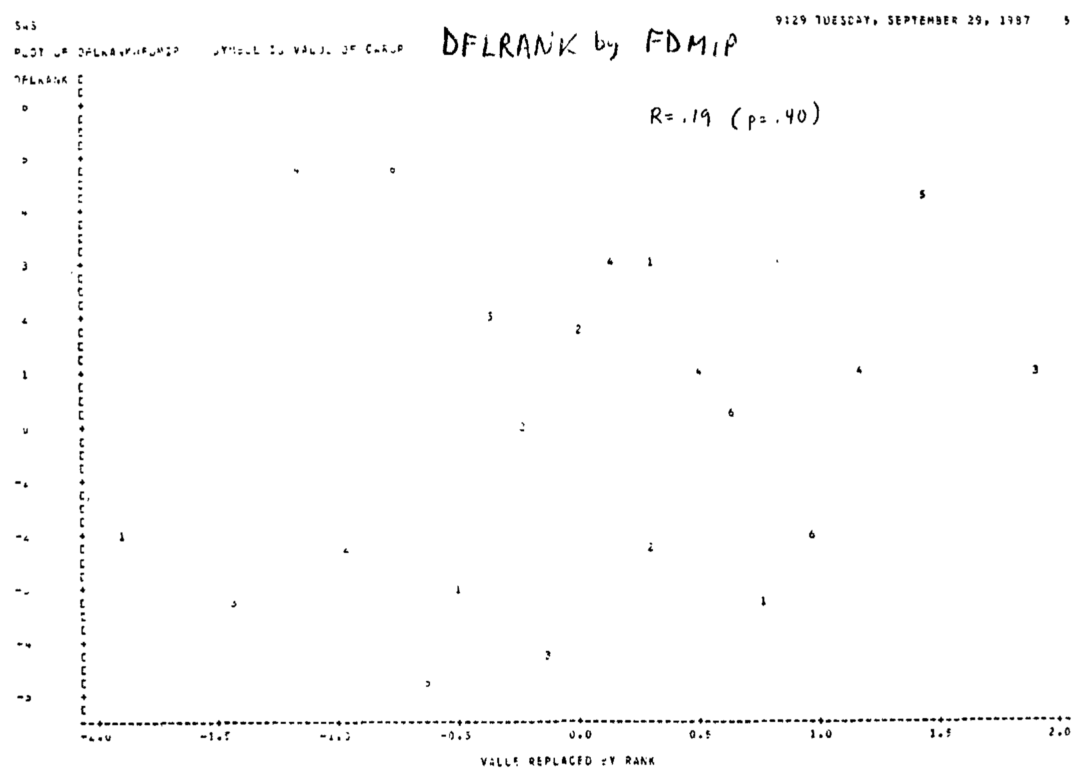
PLOT OF DFLRANK*AMIP SYMBOL IS VALUE OF [illegible]

DFLRANK by AMIP

R= -.14 (p=.54)




SAS
9:29 TUESDAY, SEPTEMBER 29, 1987
DFLRANK by AWSH
R=.20 (p=.38)
DFLRANK
VALUE REPLACED BY RANK

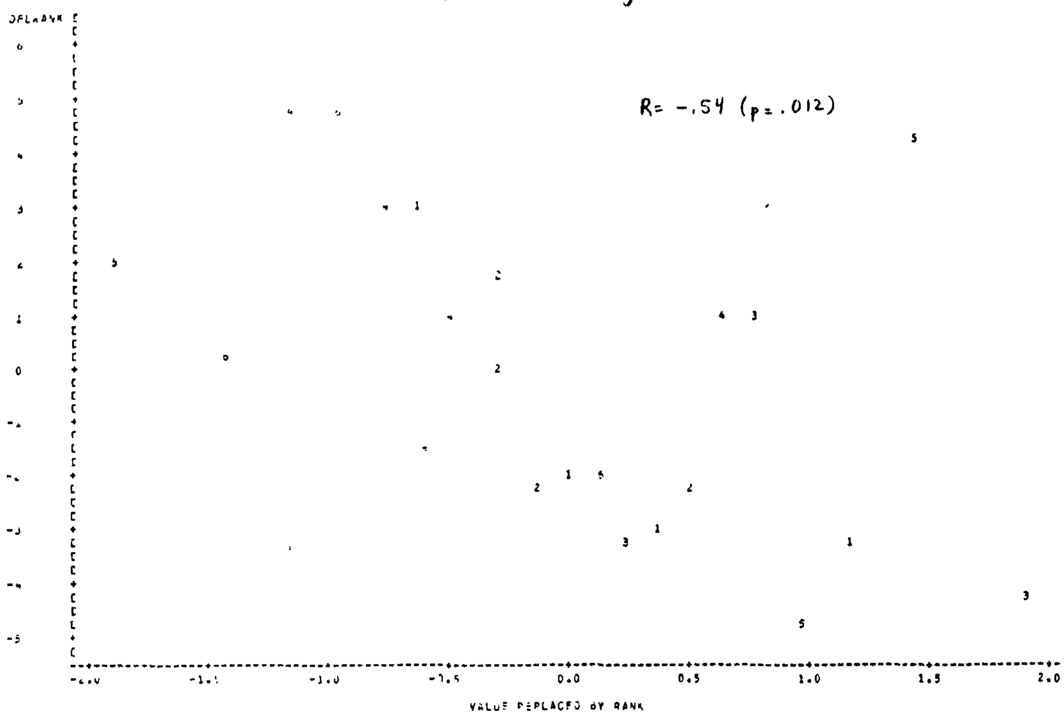

SAS
9:29 TUESDAY, SEPTEMBER 29, 1987
DFLRANK by FDMIP
R=.19 (p=.40)
DFLRANK
VALUE REPLACED BY RANK

SAS 3329 TUESDAY, SEPTEMBER 29, 1987 6

PLOT OF DFLRANK*FDLIP6 SYMBOL IS VALUE OF GROUP

DFLRANK by FDLIP6

R= -.54 (p= .012)

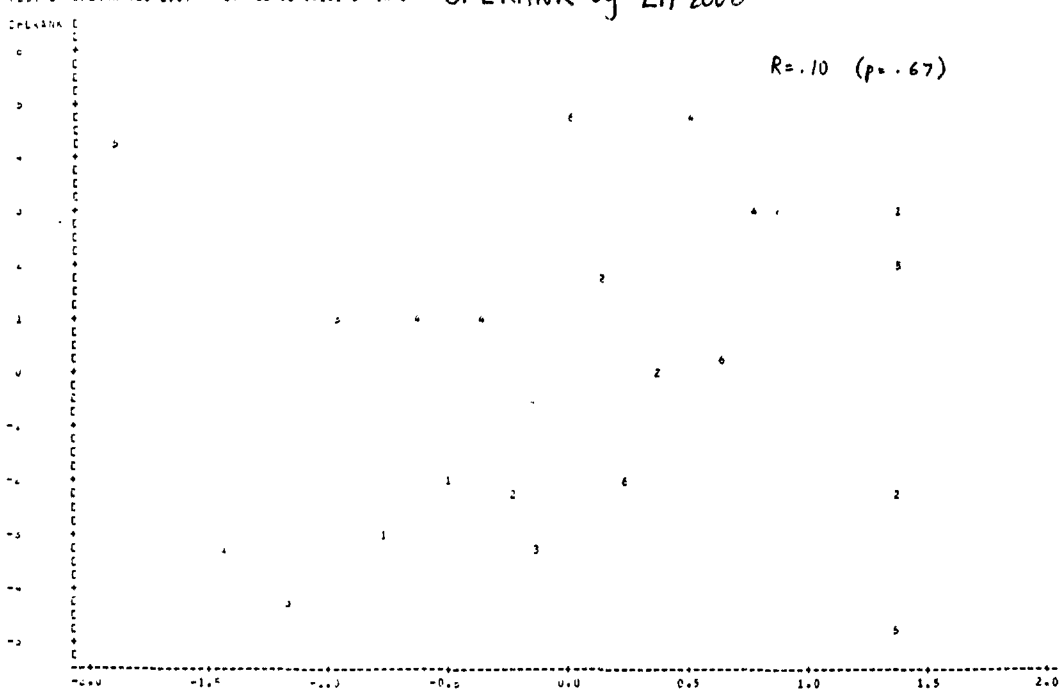


SAS 3329 TUESDAY, SEPTEMBER 29, 1987 7

PLOT OF DFLRANK*LIP2000 SYMBOL IS VALUE OF GROUP

DFLRANK by LIP2000

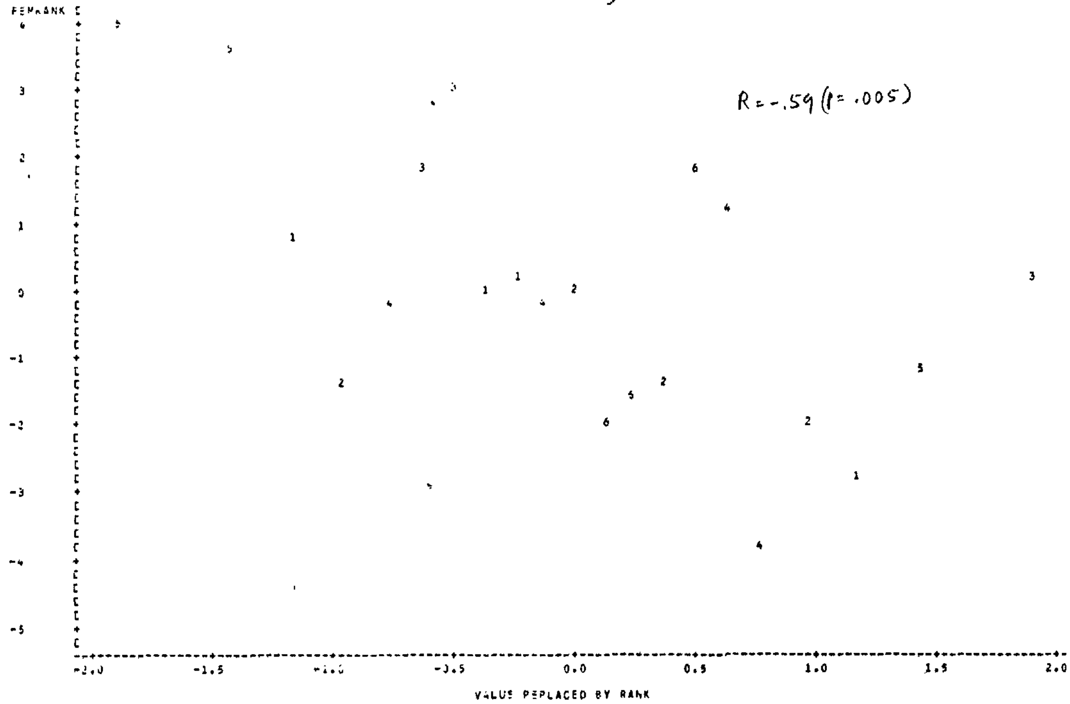
R=.10 (p= .67)



SAS 10:04 FRIDAY, JUNE 12, 1997 11

PLOT OF FEMRANK*IPL SYMBOL IS VALUE OF GROUP

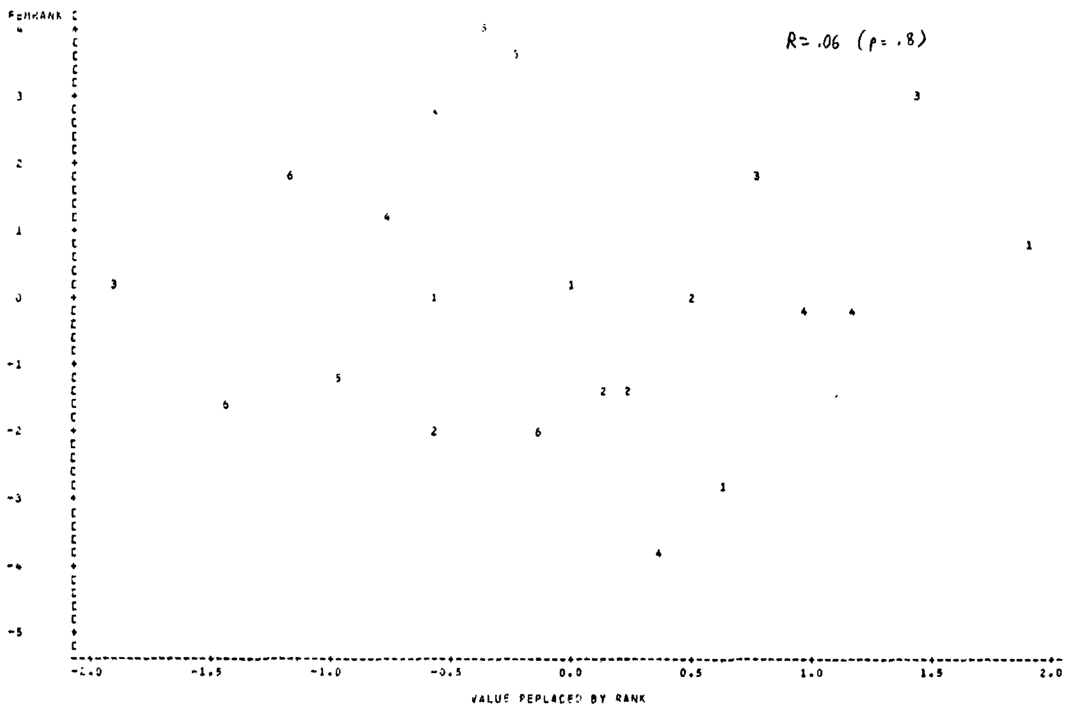
FEMRANK by IPL



SAS 10:04 FRIDAY, JUNE 12, 1997 12

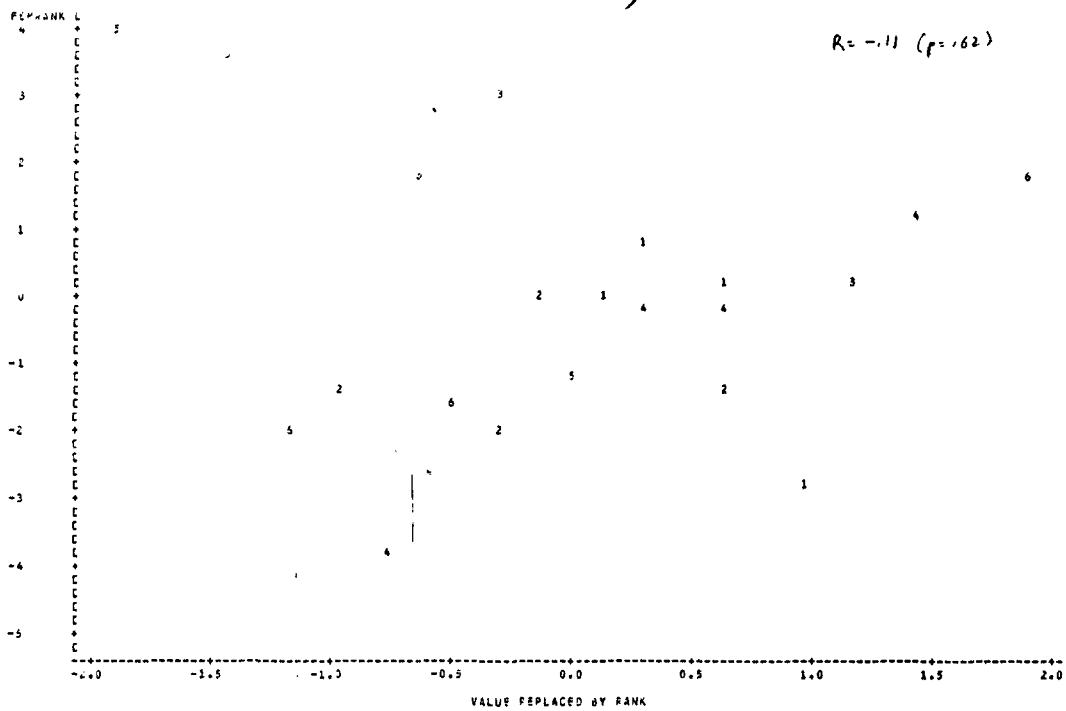
PLOT OF FEMRANK*AMIP SYMBOL IS VALUE OF GROUP

FEMRANK by AMIP



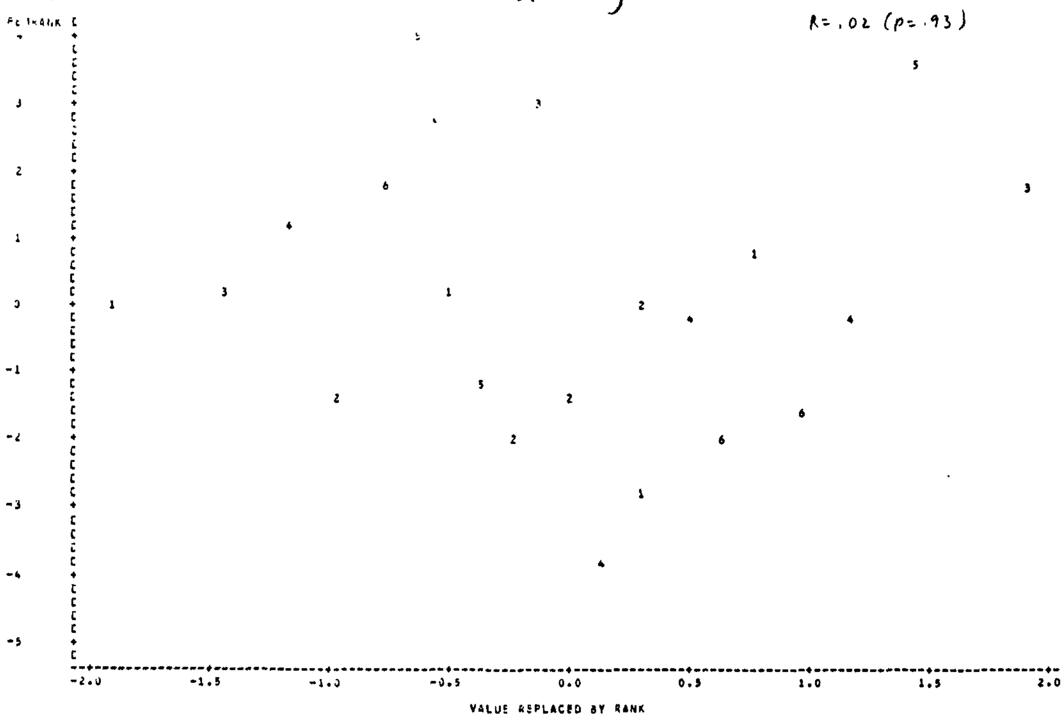
SAS
PLOT OF FEMRANK*AWSH   SYMBOL IS VALUE OF GROUP   FEMRANK by AWSH   10:04 FRIDAY, JUNE 12, 1987   13

R= -.11 (p=.62)



SAS
PLOT OF FEMRANK*FDMIP   SYMBOL IS VALUE OF GROUP   FEMRANK by FDMIP   10:04 FRIDAY, JUNE 12, 1987   14

R= .02 (p=.93)



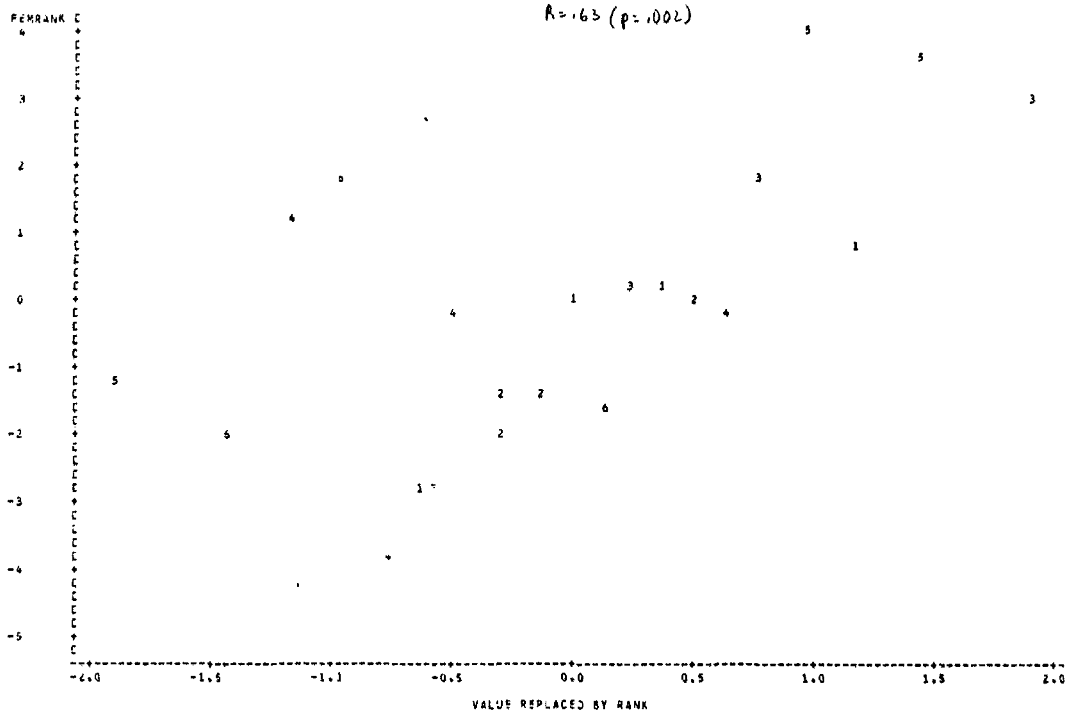
SAS

PLOT OF FEMRANK*FDLIP6   SYMBOL IS VALUE OF GROUP

FEMRANK by FDLIP6

R=.63 (p=.002)

10:04 FRIDAY, JUNE 12, 1987 15

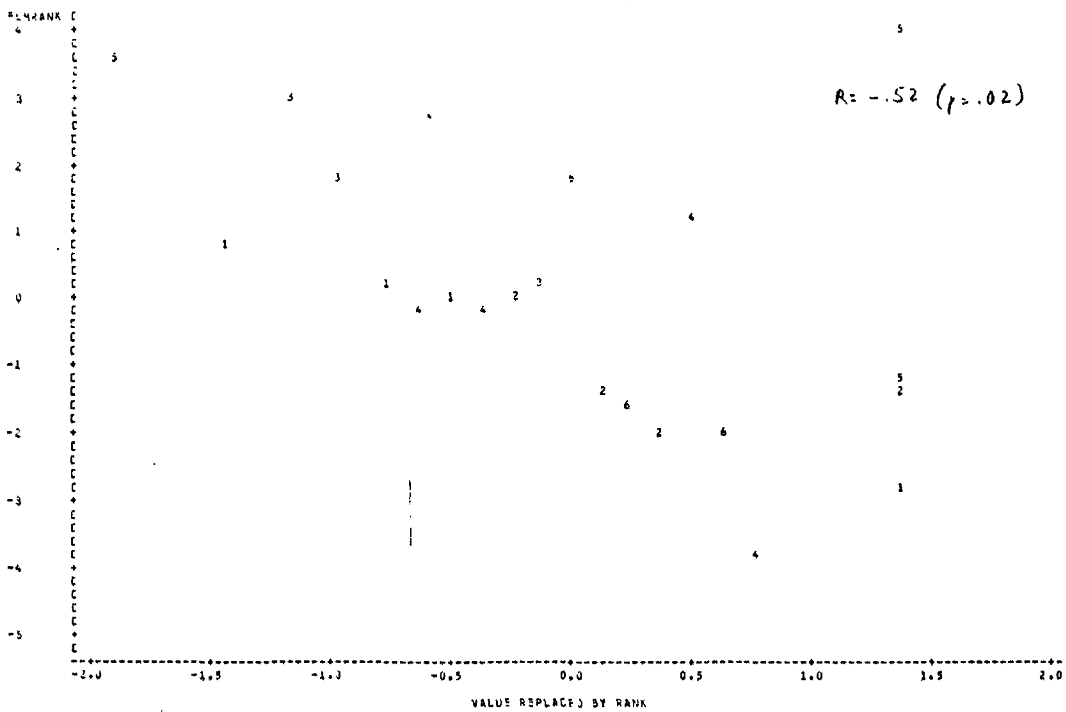


SAS

PLOT OF FEMRANK*LIP2000   SYMBOL IS VALUE OF GROUP

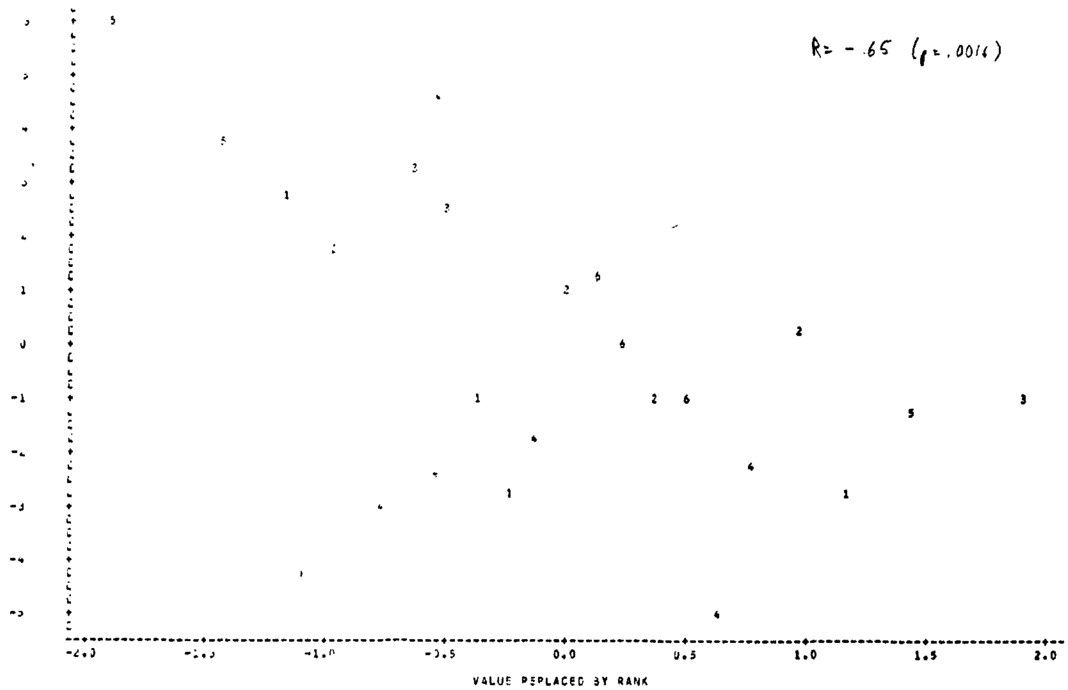
FEMRANK by LIP2000

10:04 FRIDAY, JUNE 12, 1987 16



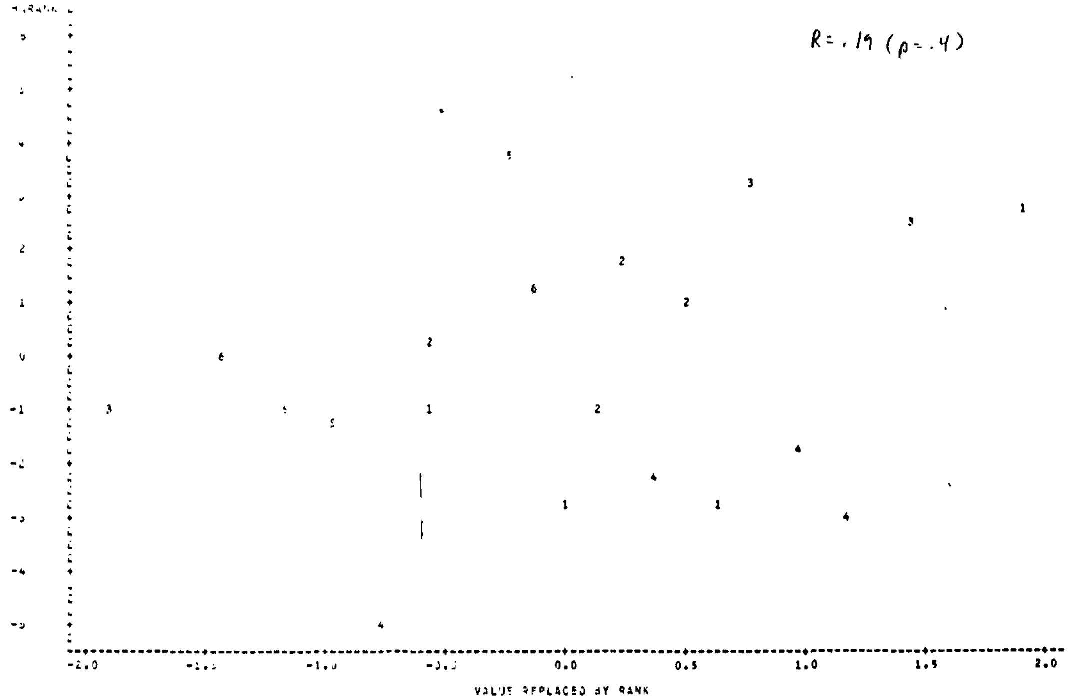
HNRANK by IPL

14:30 THURSDAY, JUNE 18, 1987 4

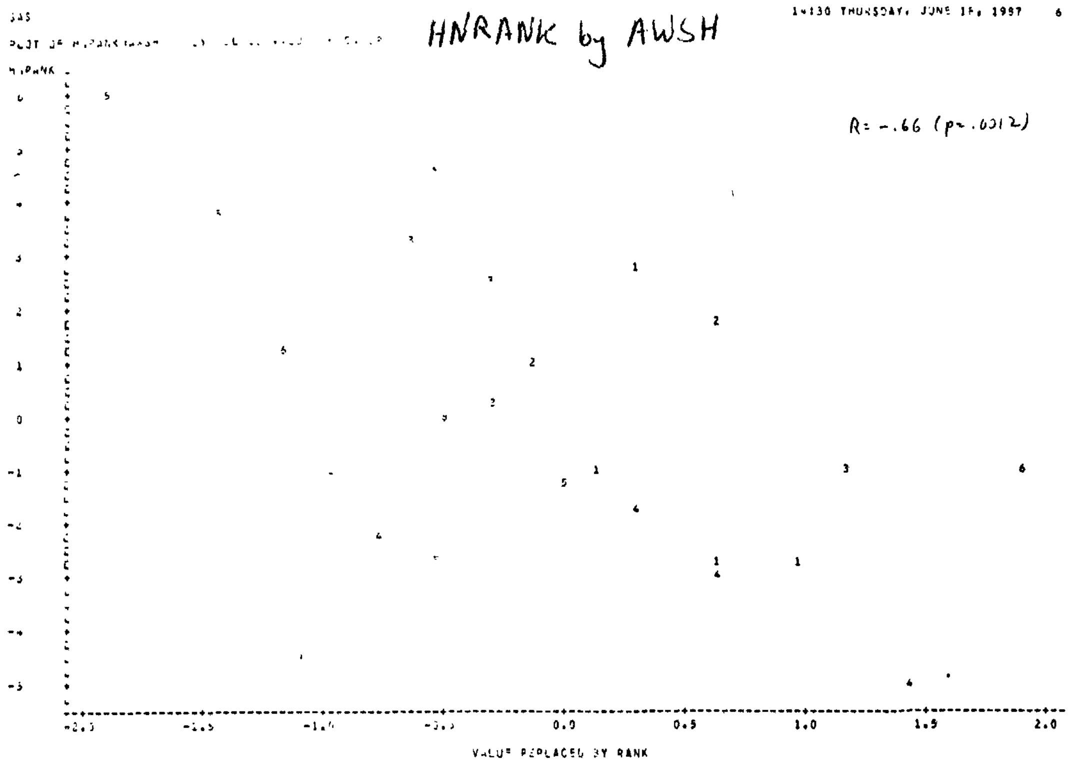


HNRANK by AMIP

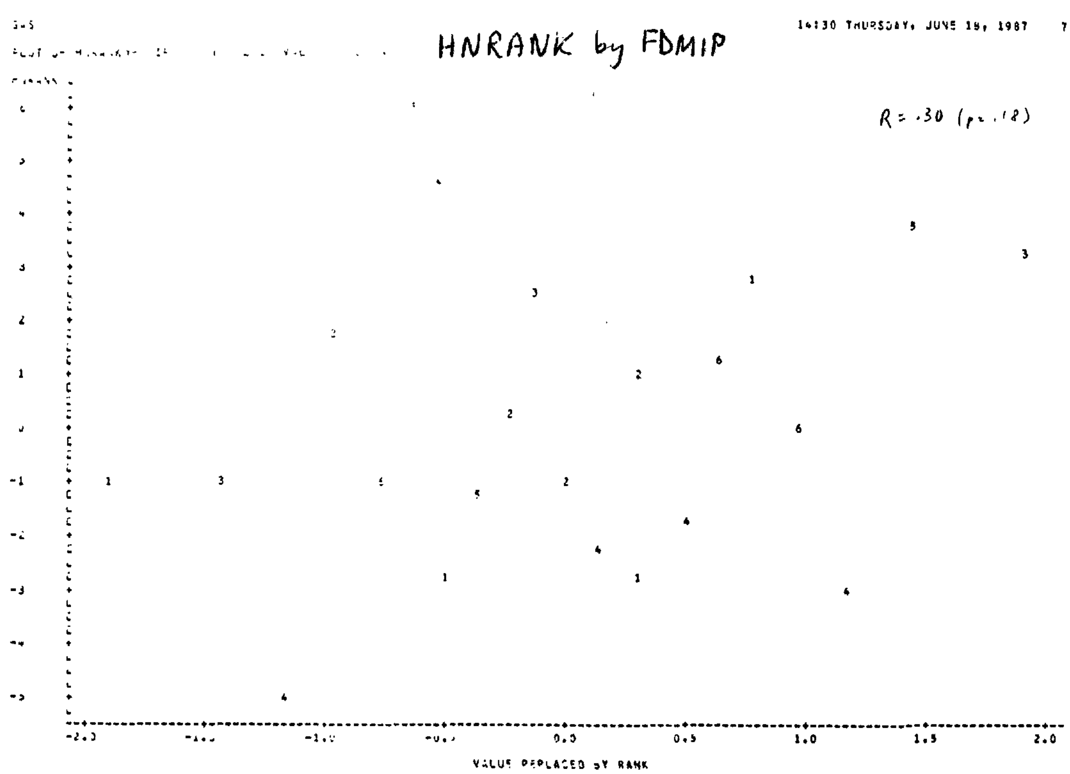
14:30 THURSDAY, JUNE 18, 1987 5



HNRANK by AWSH

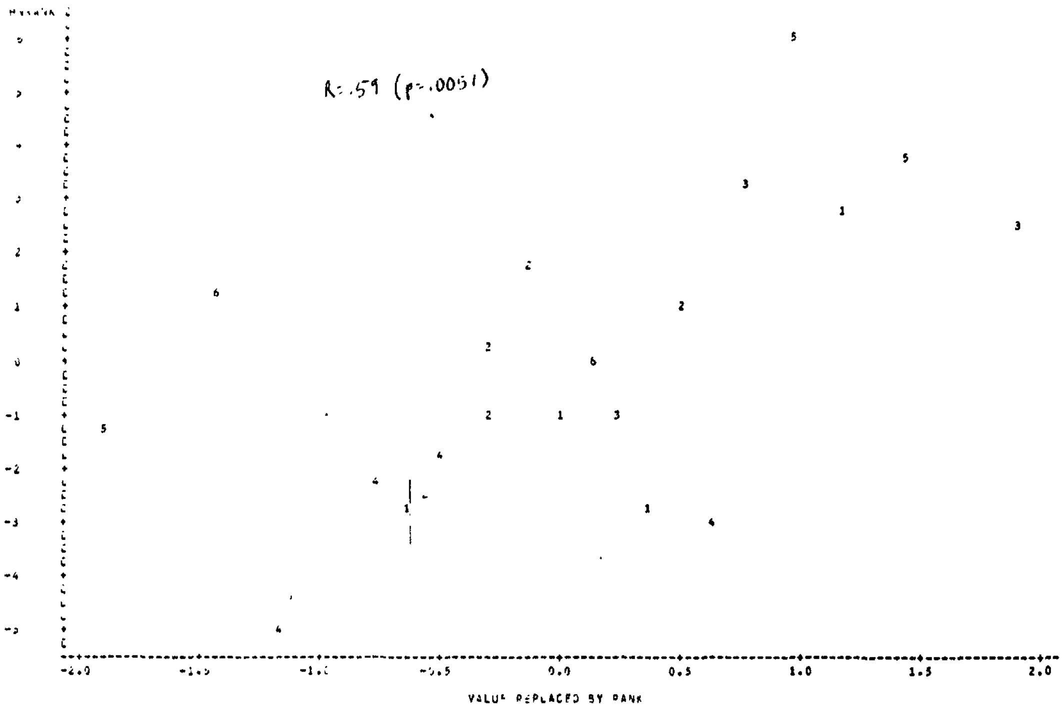


HNRANK by FDMIP



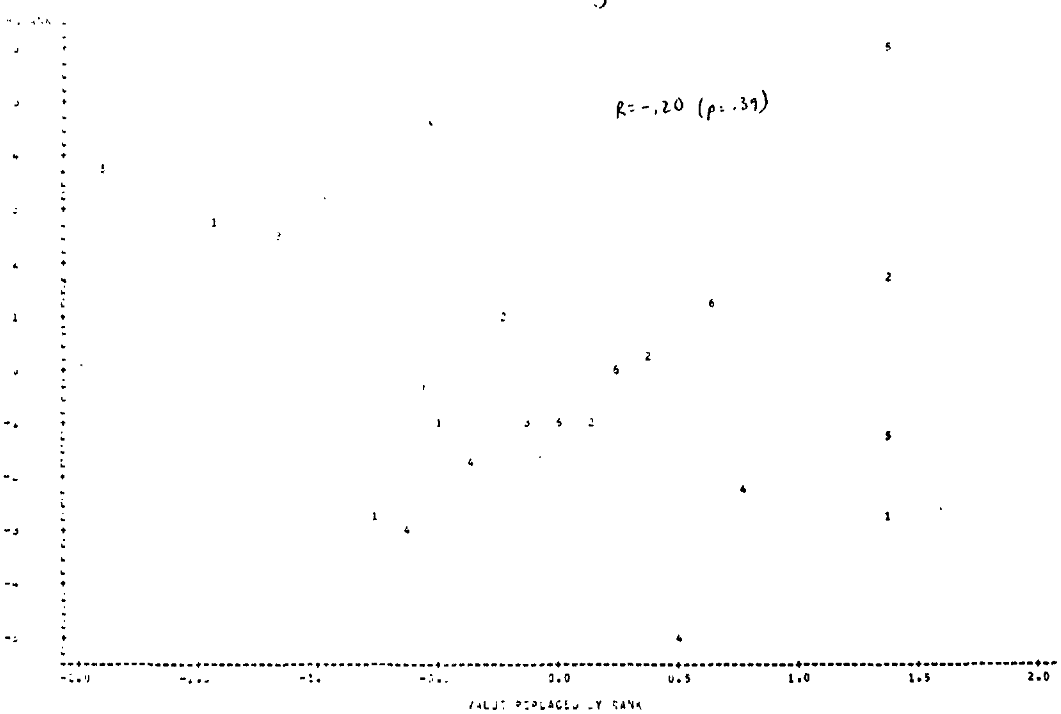
HNRANK by FDLIP6

14:30 THURSDAY, JUNE 18, 1997 8



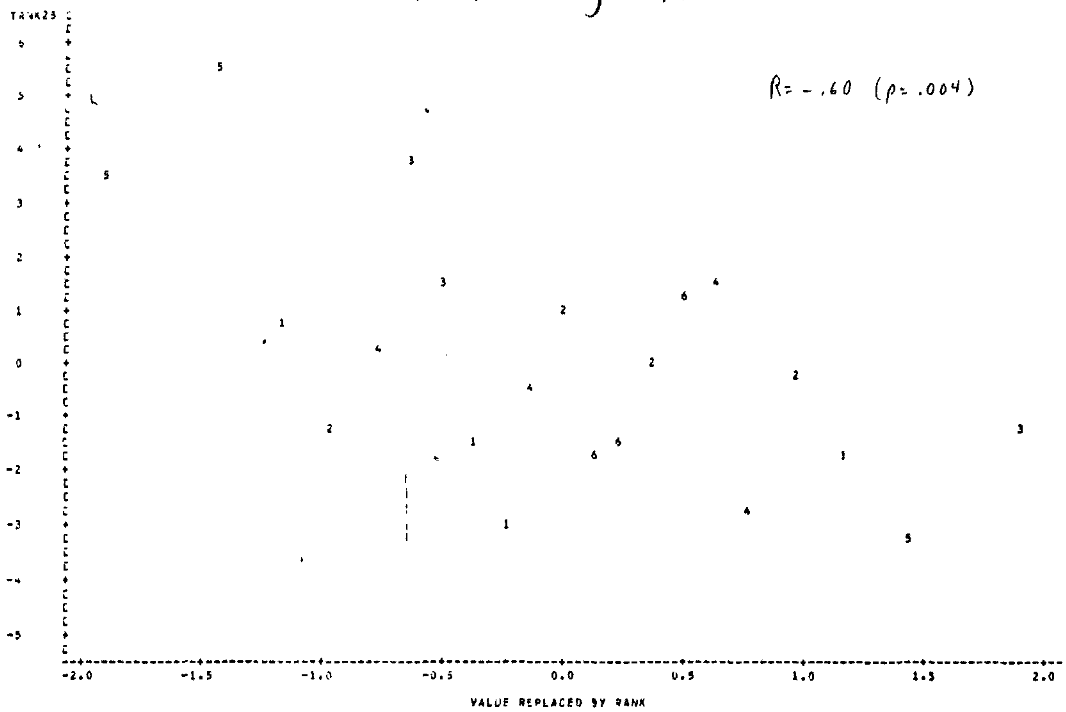
HNRANK by LIP2000

14:30 THURSDAY, JUNE 18, 1997 9



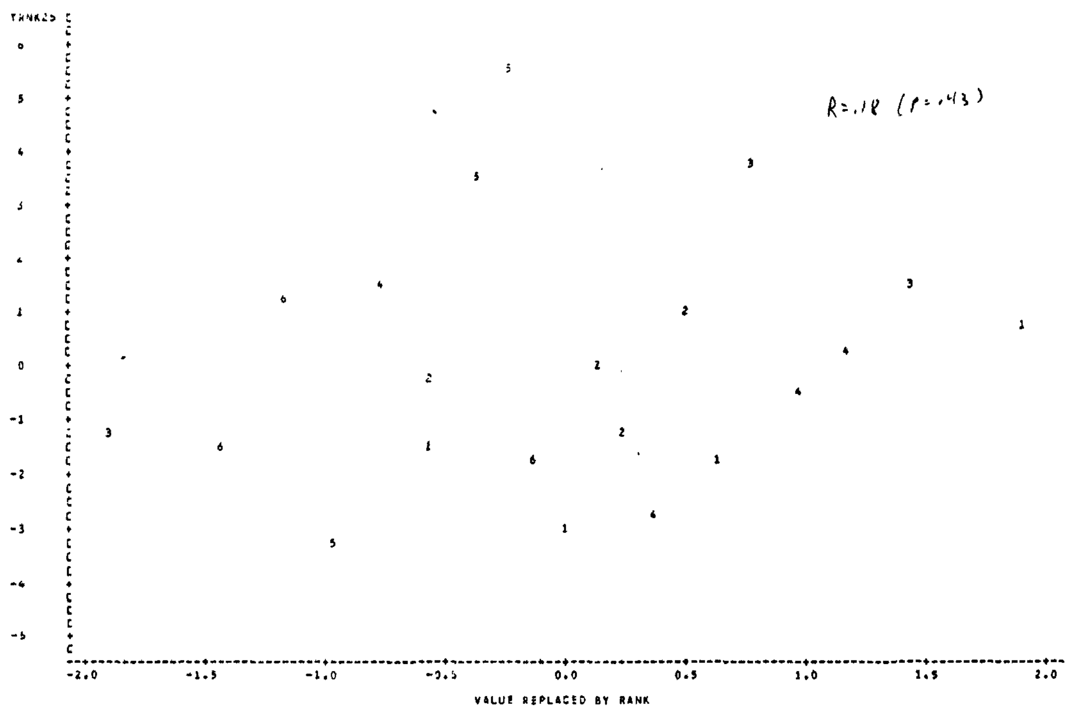
SAS
PLOT OF TRNK25*IPL   SYMBOL IS VALUE OF GROUP   10:04 FRIDAY, JUNE 12, 1987   32

TRNK25 by IPL



SAS
PLOT OF TRNK25*AMIP   SYMBOL IS VALUE OF GROUP   10:04 FRIDAY, JUNE 12, 1987   33

TRNK25 by AMIP

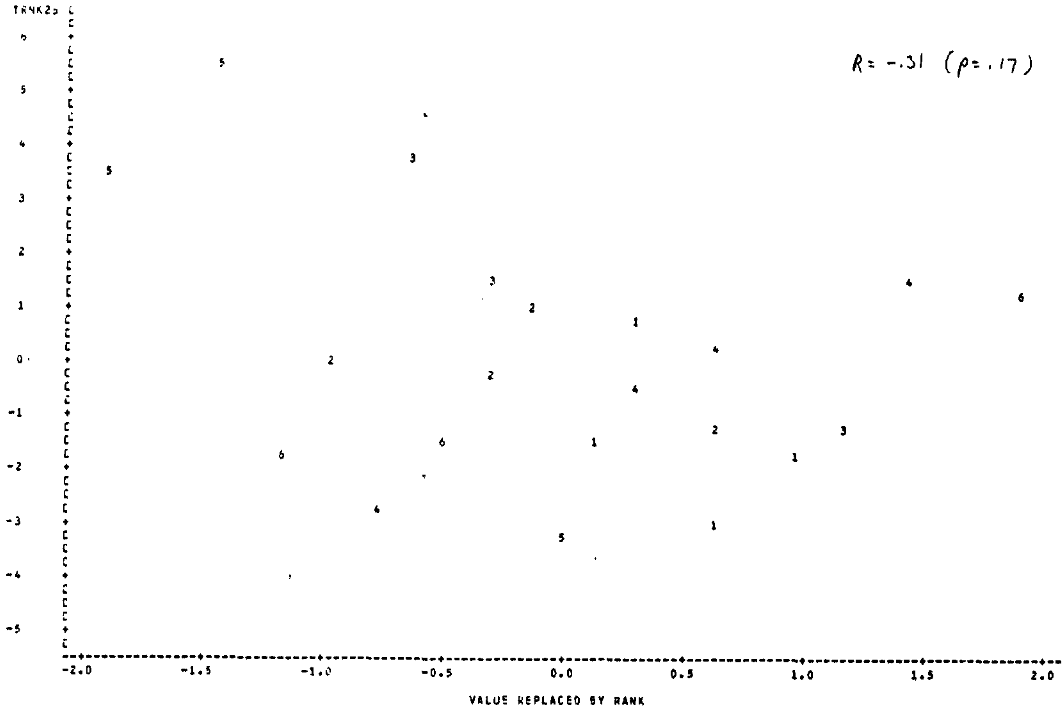


SAS

PLOT OF TRNK25*AWSH SYMBOL IS VALUE OF GROUP

TRNK25 by AWSH

10:04 FRIDAY, JUNE 12, 1987 34

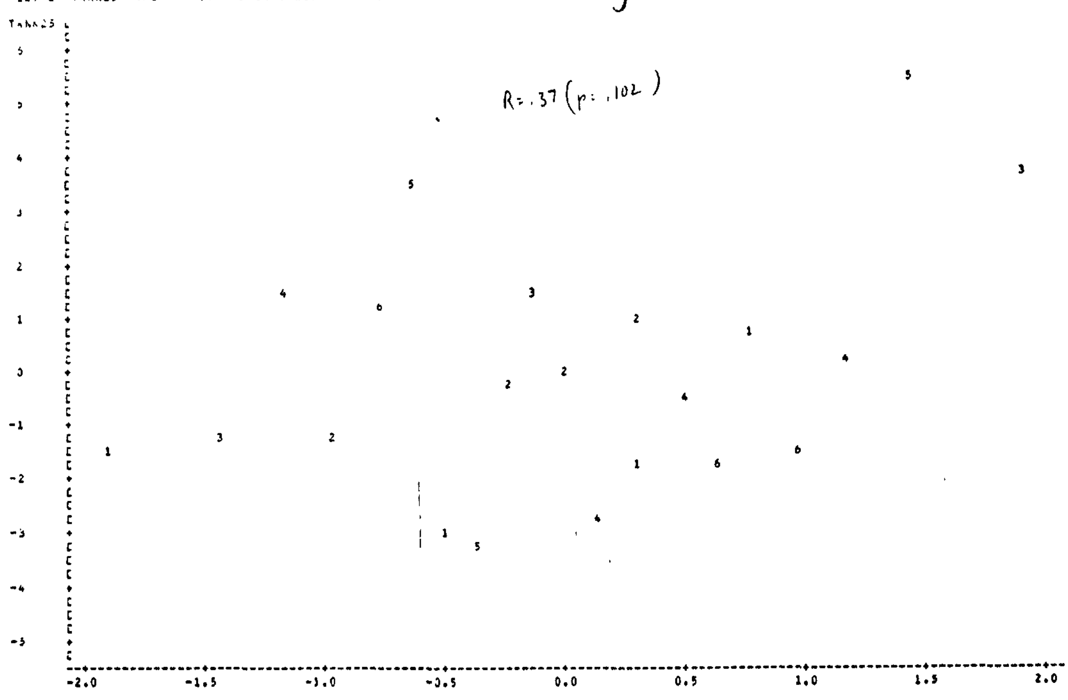


SAS

PLOT OF TRNK25*FDMIP SYMBOL IS VALUE OF GROUP

TRNK25 by FDMIP

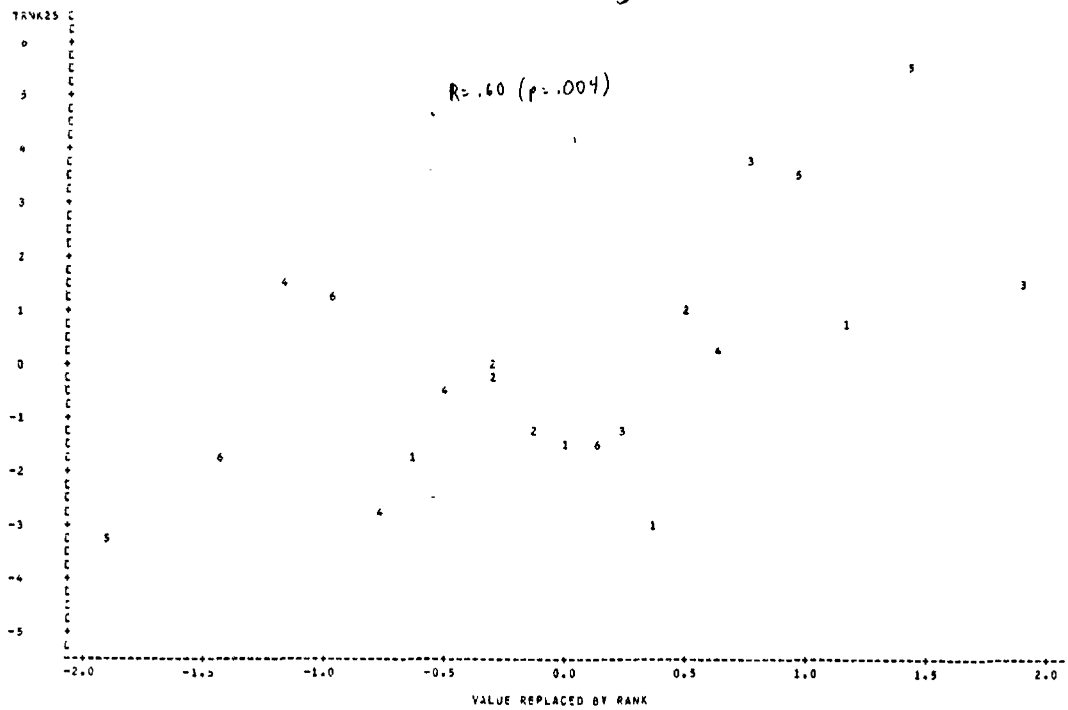
10:04 FRIDAY, JUNE 12, 1987 35



SAS 10:04 FRIDAY, JUNE 12, 1987 36

PLOT OF TRNK25*FDLIP6 SYMBOL IS VALUE OF GROUP

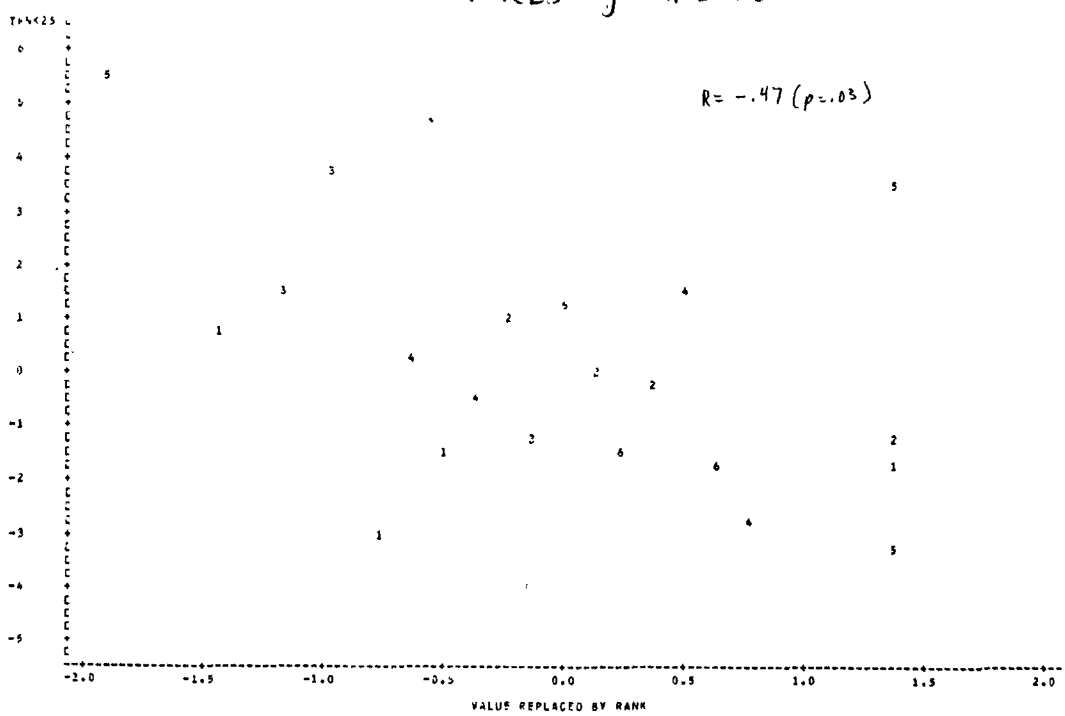
TRNK25 by FDLIP6



SAS 10:04 FRIDAY, JUNE 12, 1987 37

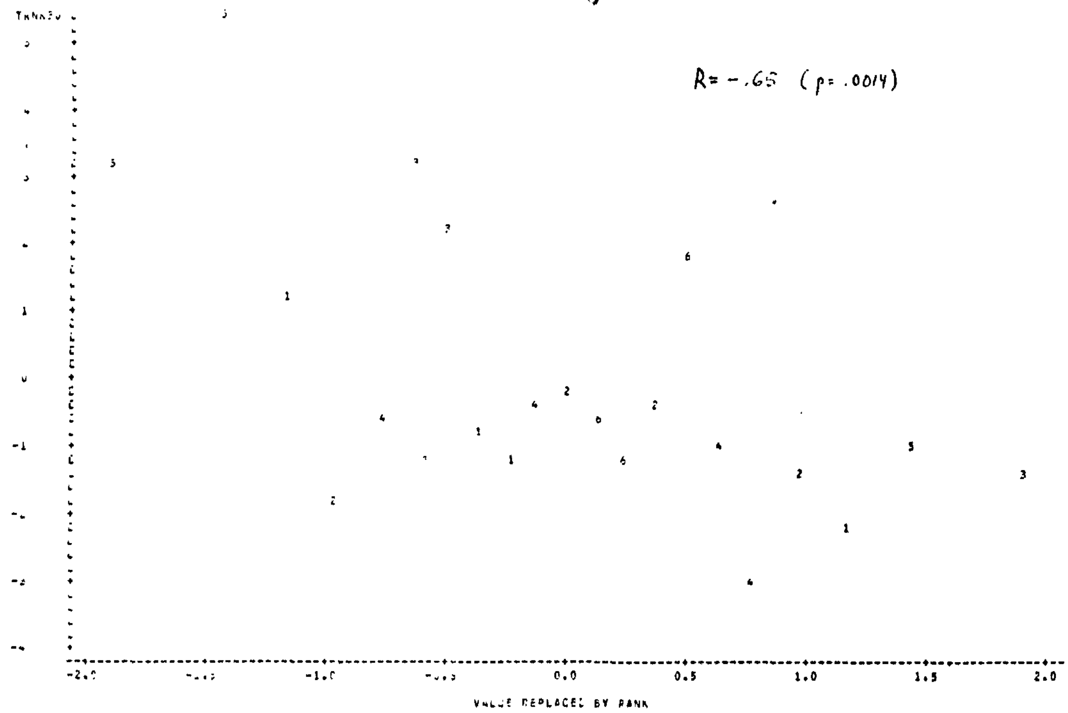
PLOT OF TRNK25*LIP2000 SYMBOL IS VALUE OF GROUP

TRNK25 by LIP2000



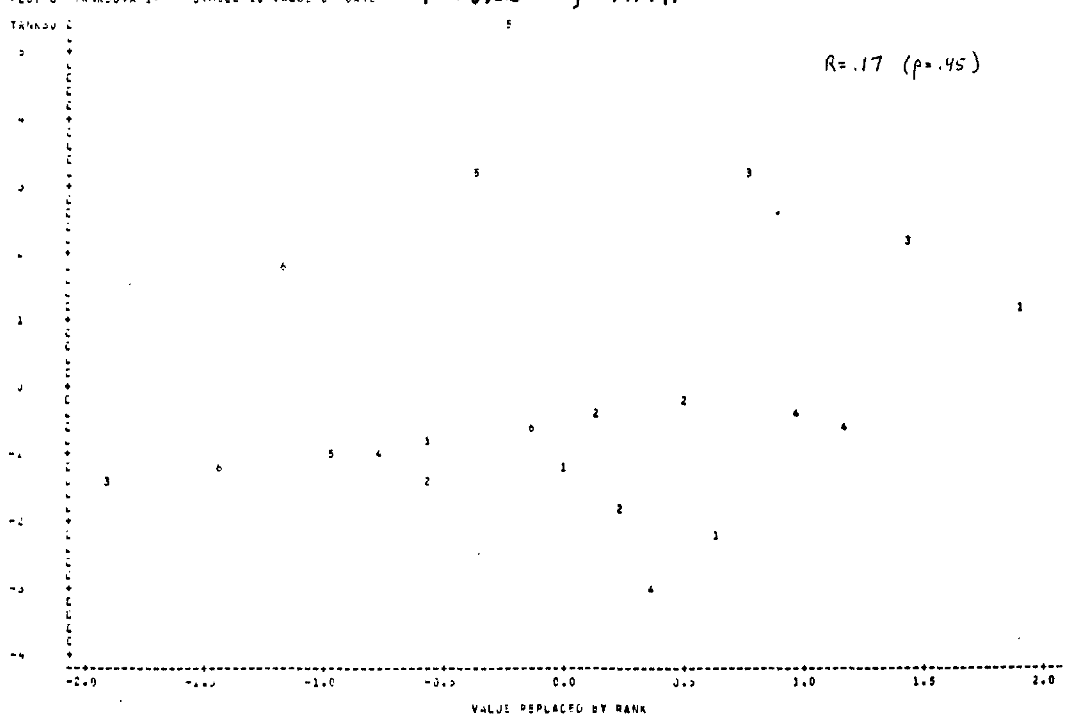
SAS

PLOT OF TRNK30*IPL SYMBOL IS VALUE OF GROUP TRNK30 by IPL 9:29 TUESDAY, SEPTEMBER 29, 1987 9



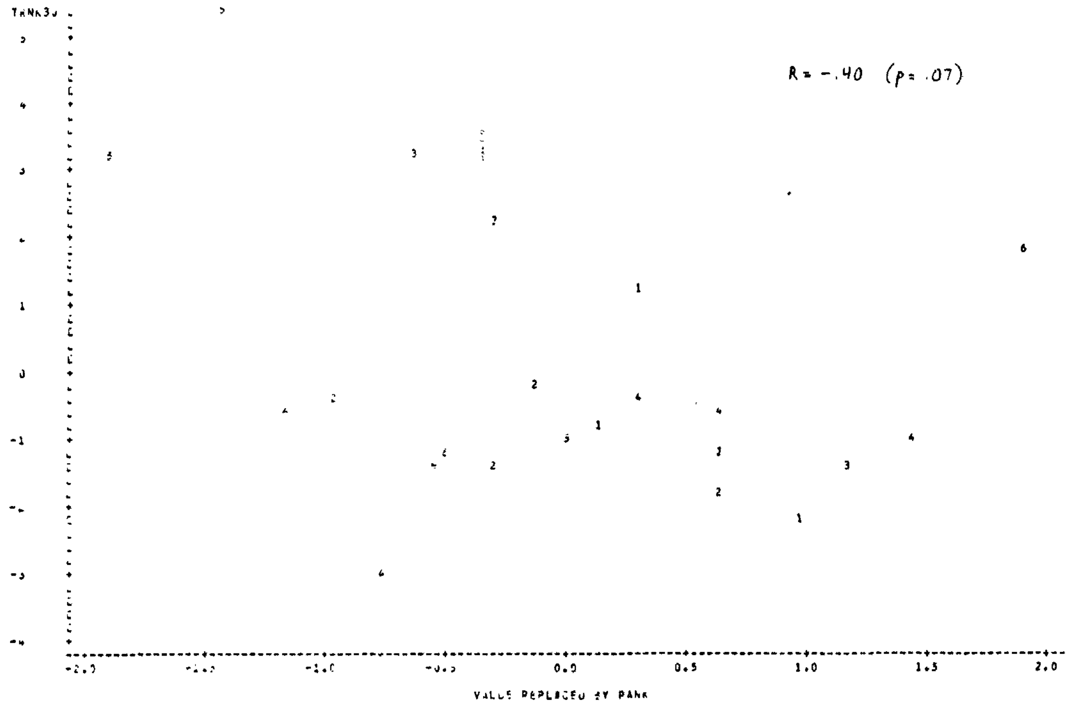
SAS

PLOT OF TRNK30*AMIP SYMBOL IS VALUE OF GROUP TRNK30 by AMIP 9:29 TUESDAY, SEPTEMBER 29, 1987 10



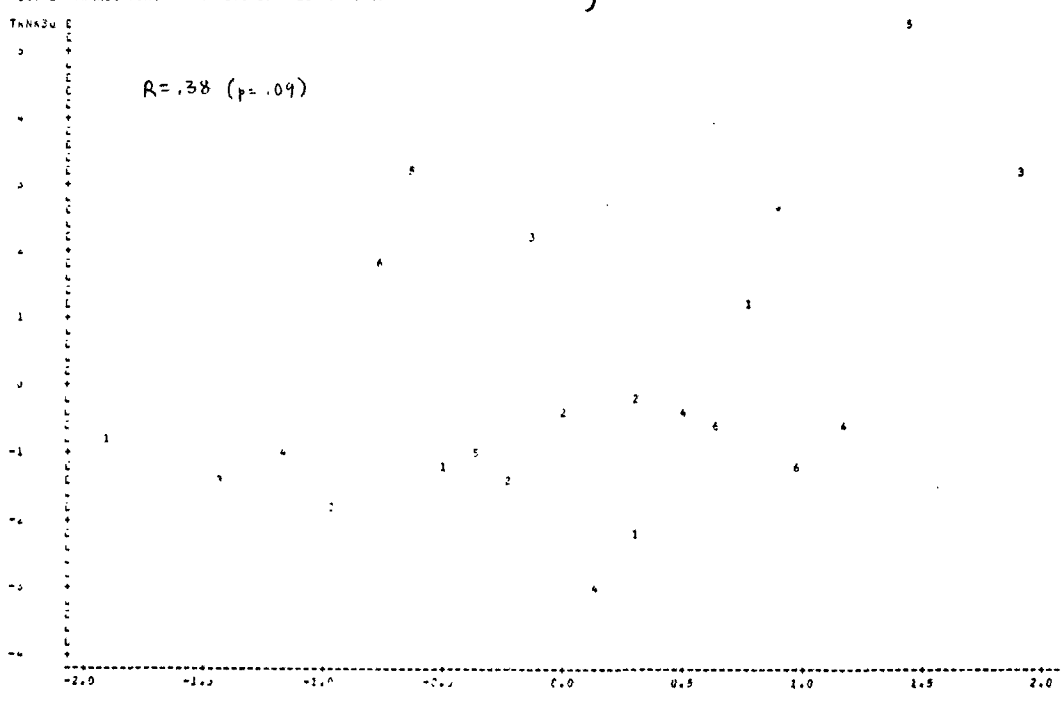
SAS 9:29 TUESDAY, SEPTEMBER 29, 1987 11

TRNK30 by AWSH



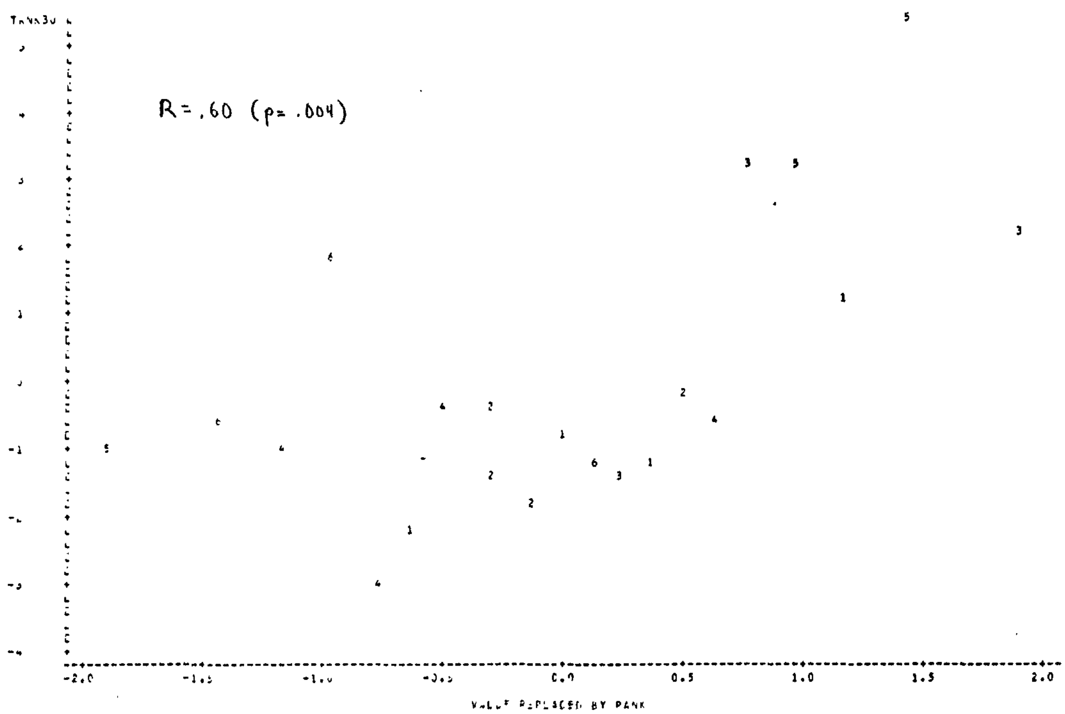
SAS 9:29 TUESDAY, SEPTEMBER 29, 1987 12

TRNK30 by FDMIP



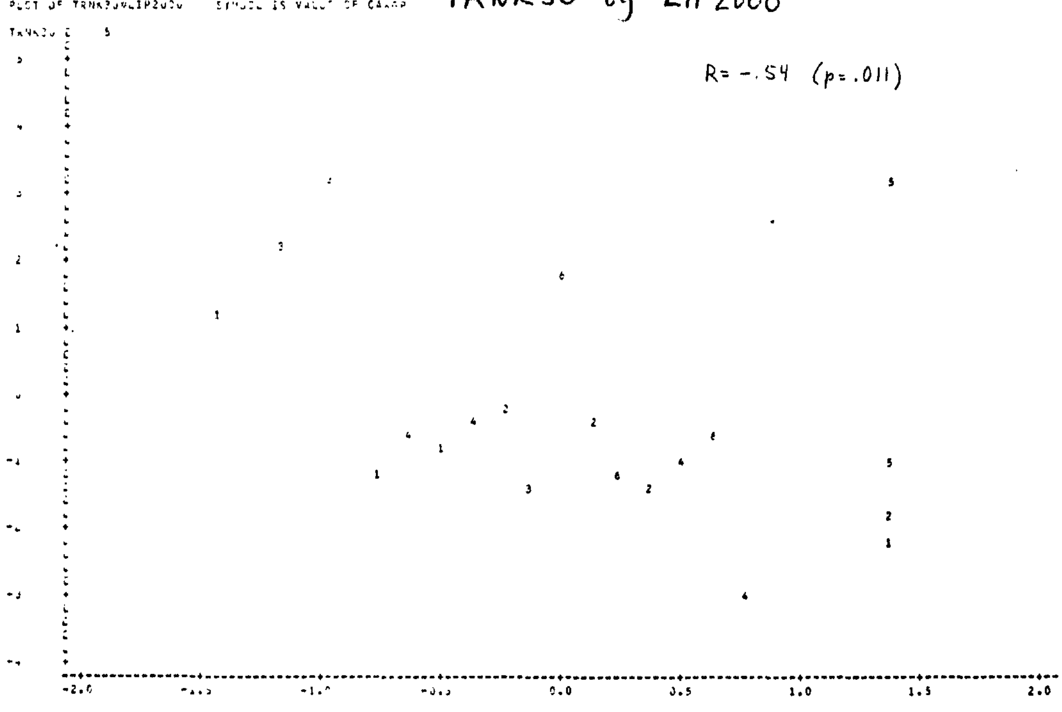
SAS

TRNK30 by FDLIP6 9:29 TUESDAY, SEPTEMBER 29, 1987 13



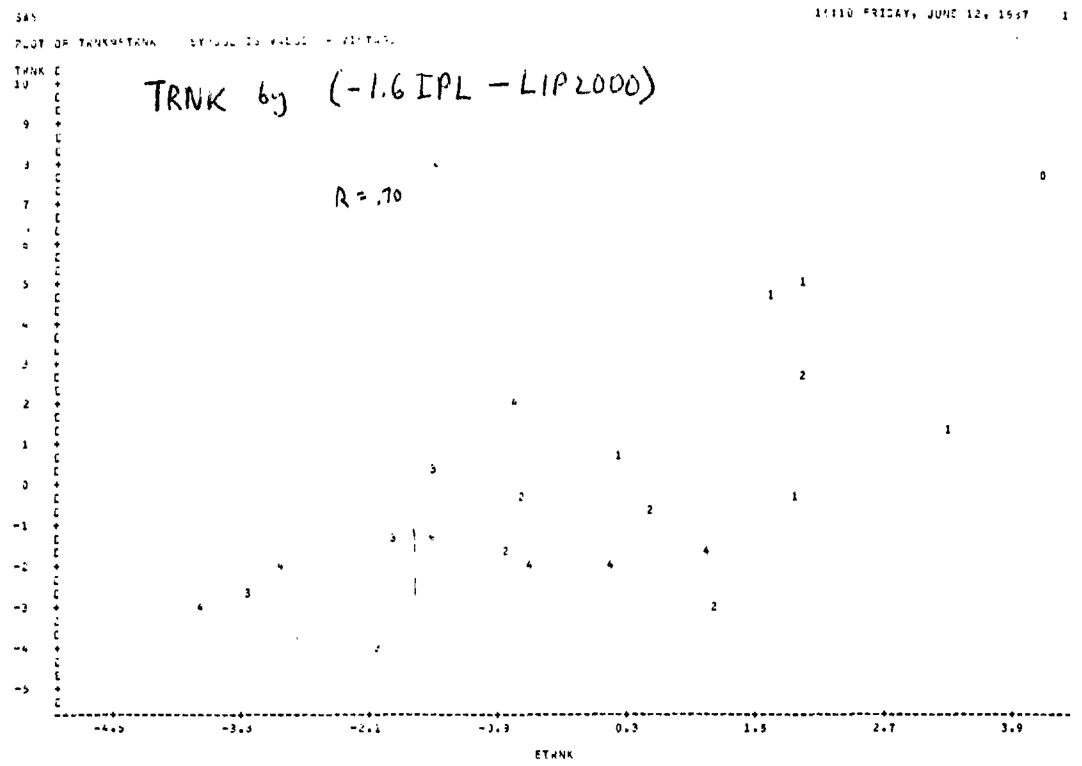
SAS

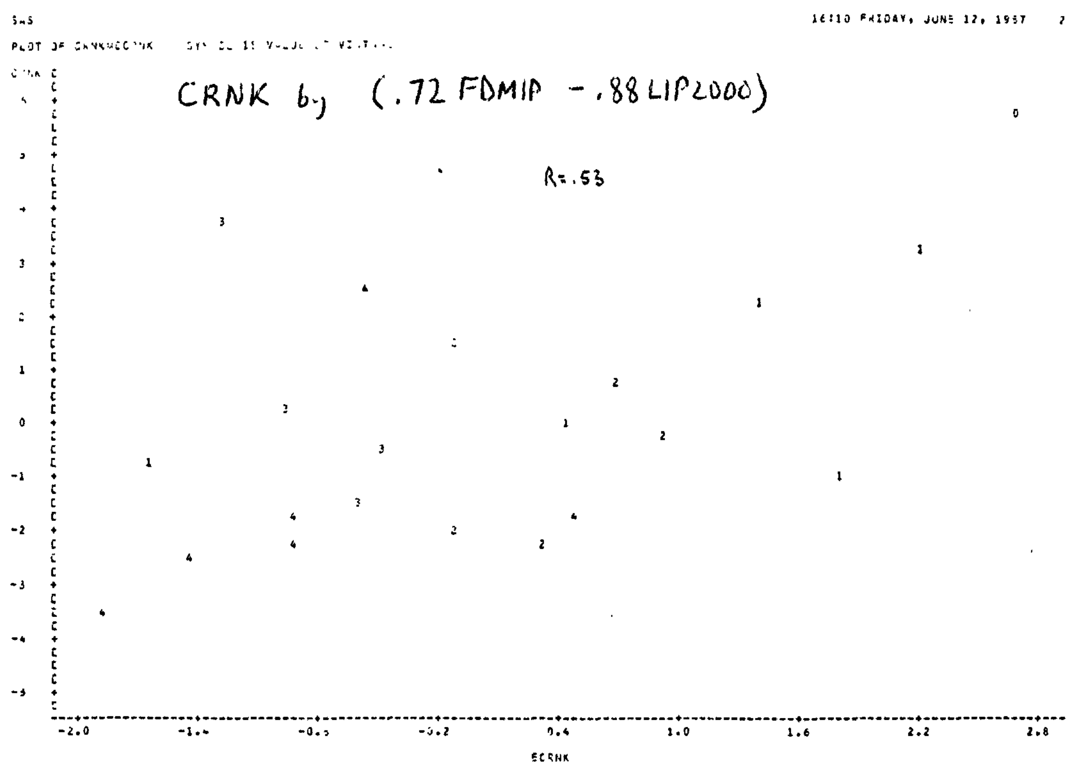
TRNK30 by LIP2000 9:29 TUESDAY, SEPTEMBER 29, 1987 14



APPENDIX E

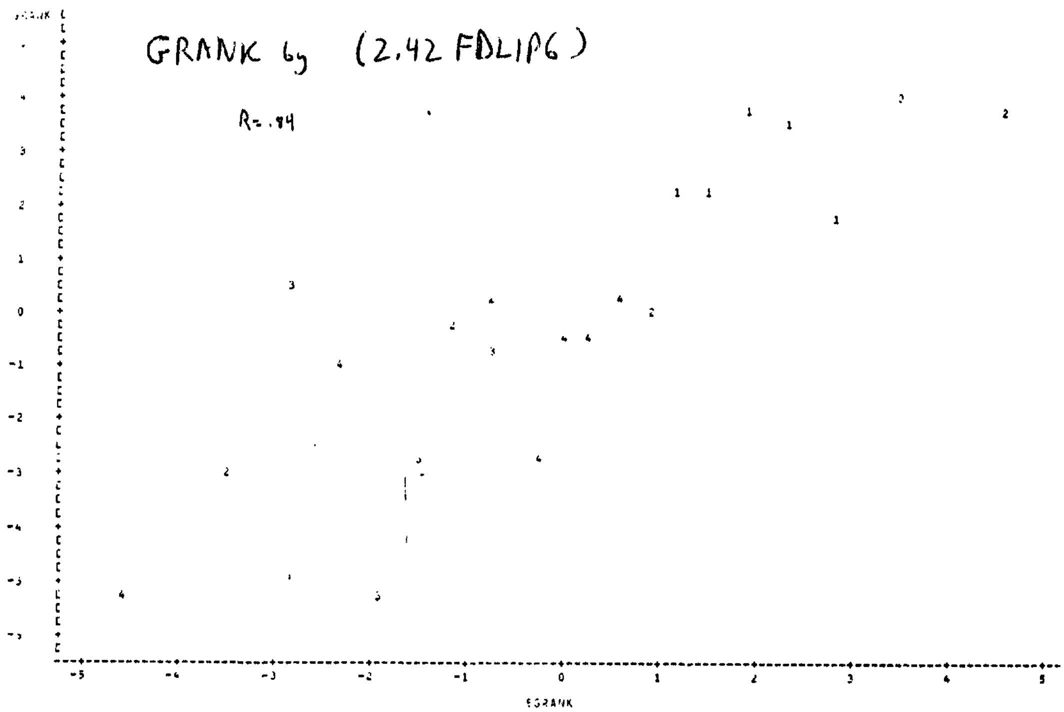
SCATTERPLOTS OF OBSERVED VS. PREDICTED: MULTIPLE REGRESSIONS OF INJURY SCORES VS. PANEL PARAMETERS


TRNK by (-1.6 IPL - LIP2000)
R = .70
ETRNK


CRNK by (.72 FDMIP - .88 LIP2000)
R=.53
ECRNK

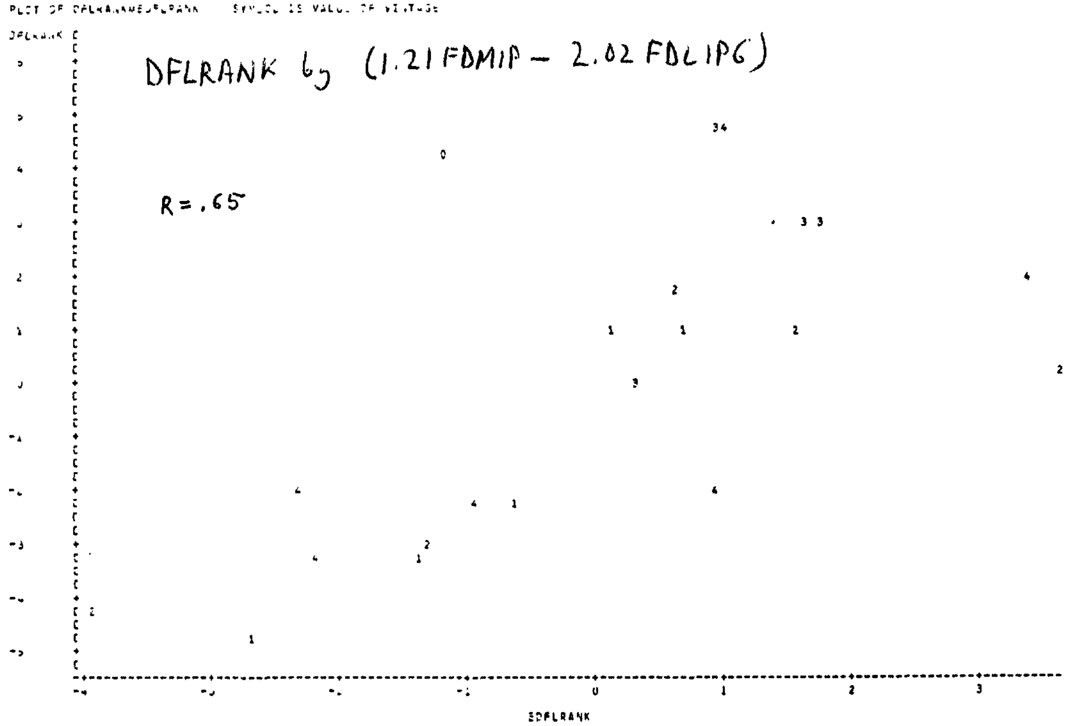
SAS 15:10 FRIDAY, JUNE 12, 1987 4

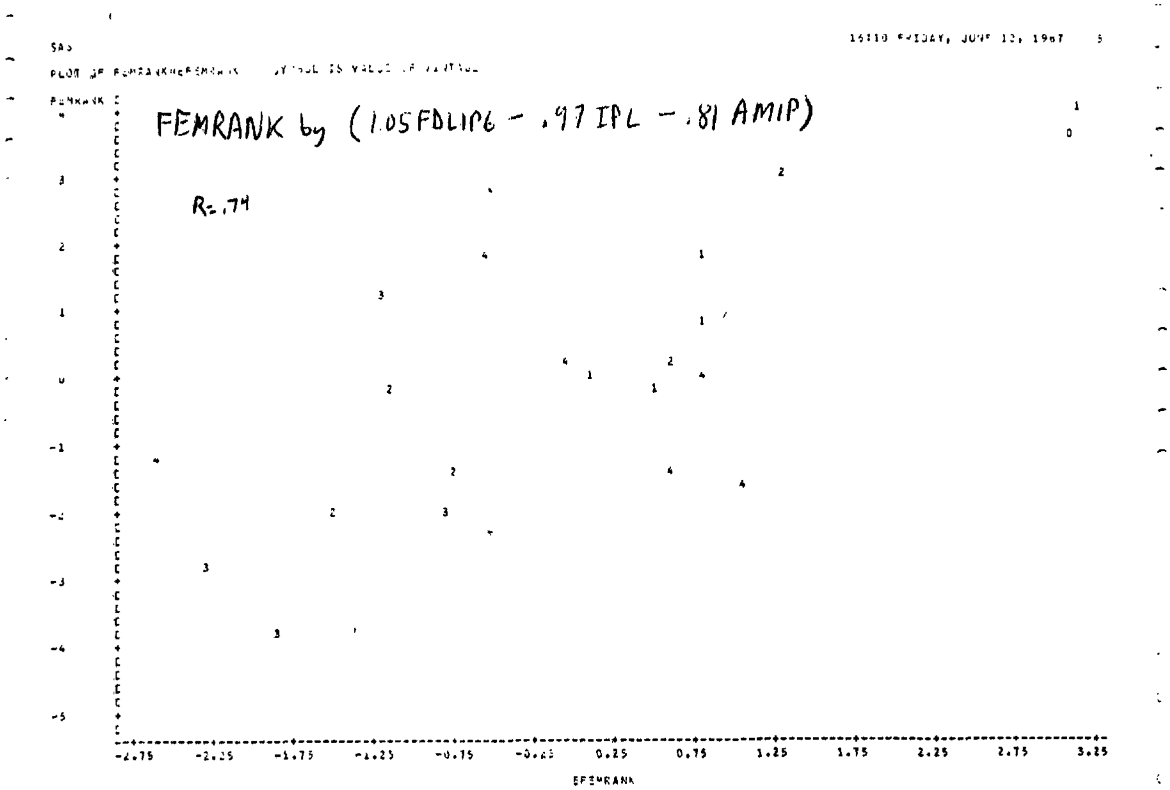
PLOT OF GRANK*EGRANK SYMBOL IS VALUE OF VINTAGE

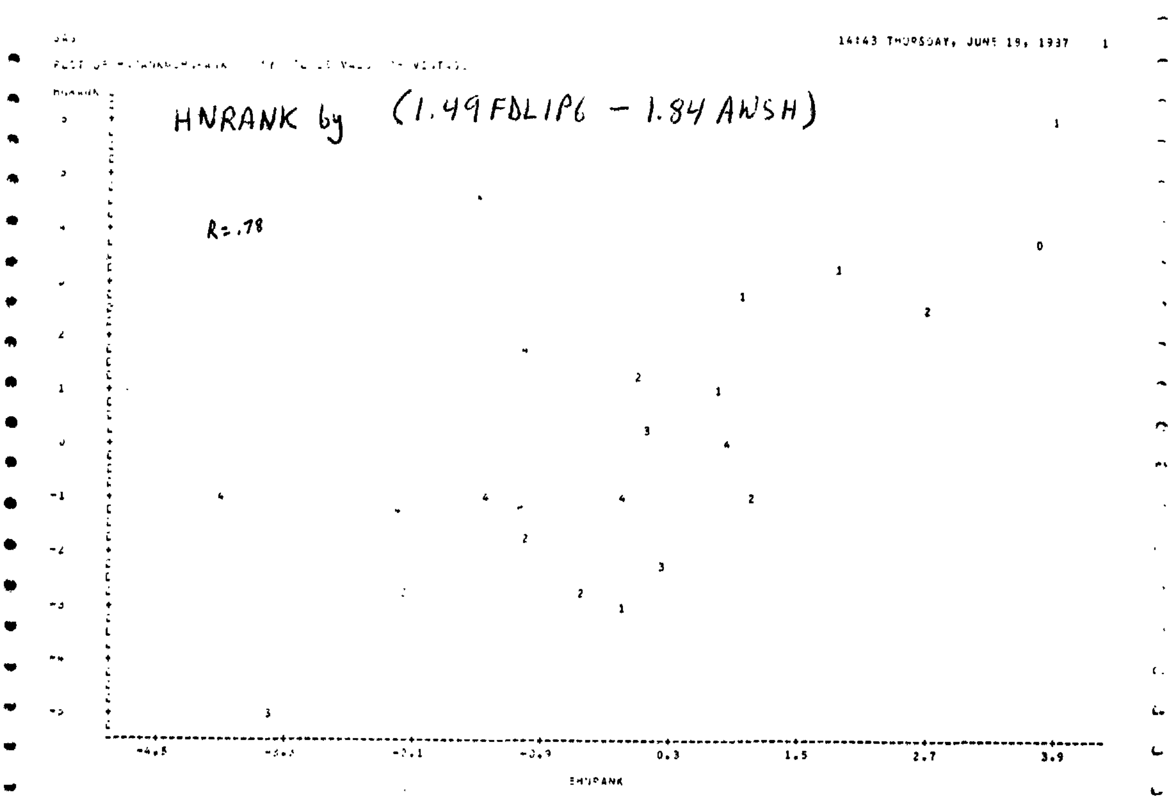


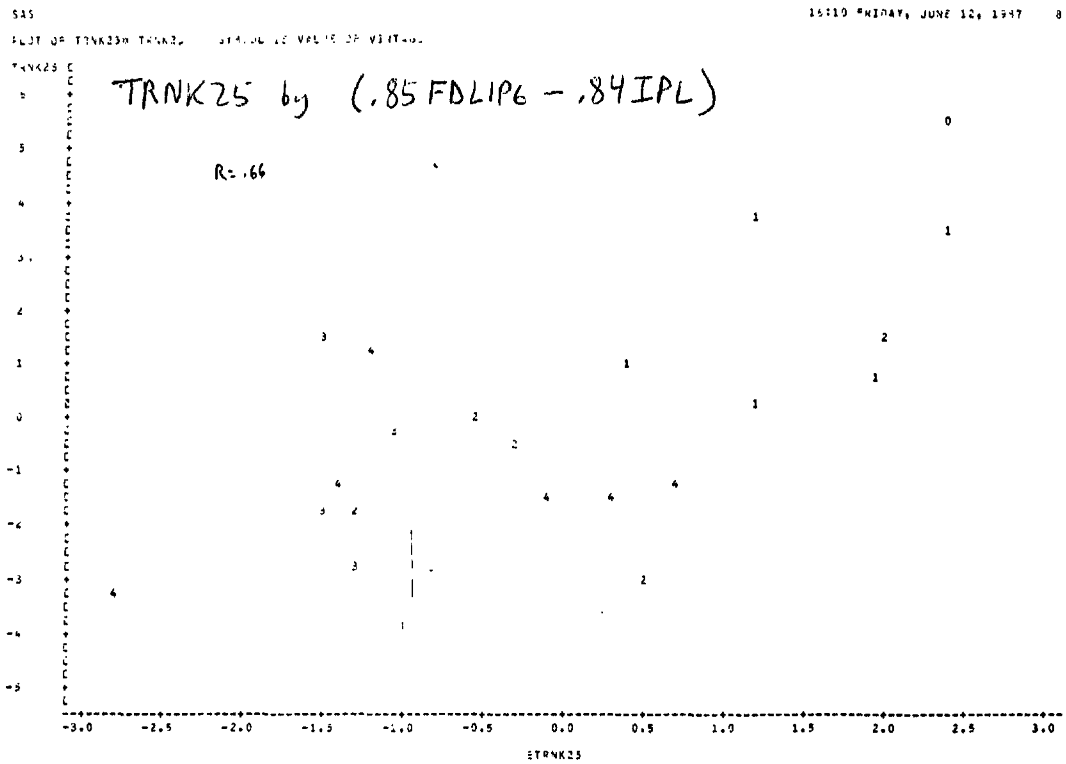
SAS 9:36 TUESDAY, SEPTEMBER 29, 1987 1

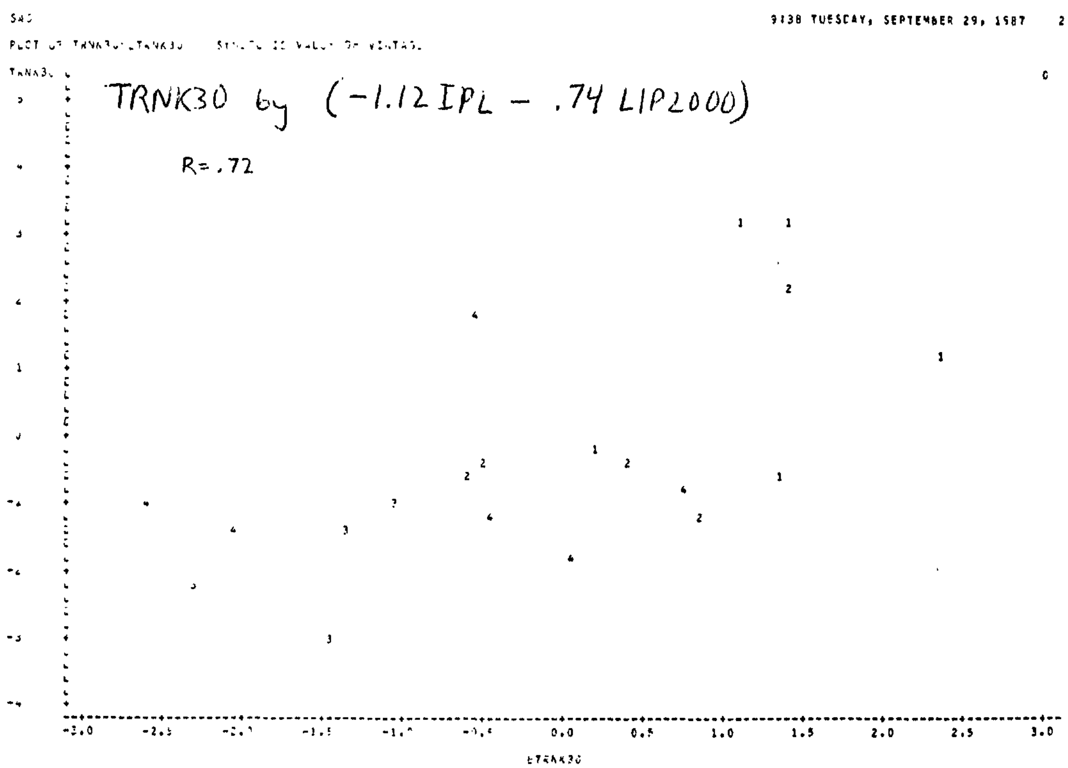
PLOT OF DFLRANK*EDFLRANK SYMBOL IS VALUE OF VINTAGE




FEMRANK by (1.05FDLIP6 - .97 IPL - .81 AMIP)
R=.74
-2.75 -2.25 -1.75 -1.25 -0.75 -0.25 0.25 0.75 1.25 1.75 2.25 2.75 3.25


HNRANK by (1.49FDLIP6 - 1.84 AWSH)
R=.78
14:43 THURSDAY, JUNE 19, 1937
0.3 1.5 2.7 3.9


SAS
TRNK25 by (.85 FDLIP6 - .84IPL)
R=.66
ETRNK25


SAS
9:38 TUESDAY, SEPTEMBER 29, 1987 2
TRNK30 by (-1.12 IPL - .74 LIP2000)
R=.72
ETRNK30

APPENDIX F

PASSENGER CAR CURB WEIGHTS BASED ON AUTOMOTIVE NEWS, BY MAKE, MODEL AND MODEL YEAR

CURB WEIGHTS FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME / MY / FREQUENCY	C63	C64	C65	C66	C67	C68	C69	C70
ALFA-GTV-6	0	0	0	0	0	0	0	0
ALFA-SPIDER	0	0	0	0	0	0	0	0
AMER-AMBASSADOR	0	3206	3120	3229	3326	3381	3452	3588
AMER-AMX	0	0	0	0	0	0	0	0
AMER-EAGLE	0	0	0	0	0	0	0	0
AMER-HORNET/CONC	0	0	0	0	0	0	0	2852
AMER-JAVELIN	0	0	0	0	0	3026	3010	3133
AMER-PACER	0	0	0	0	0	0	0	0
AMER-RAMBLER	2622	2550	2549	2658	2816	2820	2836	0
AMER-REBEL/MATOR	0	2935	2556	3125	3259	3251	3245	3291
AMER-SPIRIT/GRML	0	0	0	0	0	0	0	2435
ASTON MARTIN	0	0	0	0	0	0	0	0
AUDI-FOX	0	0	0	0	0	0	0	0
AUDI-QUATTRO	0	0	0	0	0	0	0	0
AUDI-SUPER 90	0	0	0	0	0	0	0	0
AUDI-UNK AUTO	0	0	0	0	0	0	0	0
AUDI-100	0	0	0	0	0	0	0	2353
AUDI-4000	0	0	0	0	0	0	0	0
AUDI-5000	0	0	0	0	0	0	0	0
BMW-OTH AUTO	0	0	0	2445	0	0	0	0
BMW-UNK AUTO	0	0	0	0	0	2073	2073	0
BMW-1600/2002	0	0	0	2445	0	0	2073	2073
BMW-318I/320I	0	0	0	0	0	0	0	0
BMW-524/8/30/33I	0	0	0	0	0	0	0	0
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(CONTINUED)

CURB WEIGHTS FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME / MY / FREQUENCY	C63	C64	C65	C66	C67	C68	C69	C70
BMW-630/633	0	0	0	0	0	0	0	0
BMW-733I	0	0	0	0	0	0	0	0
BUIC-APOLLO	0	0	0	0	0	0	0	0
BUIC-CENTURY	0	0	0	0	0	0	0	0
BUIC-ELECTRA	4366	4352	4346	4430	4361	4317	4395	4517
BUIC-LESABRE	4235	4045	3947	4027	4001	4098	4186	4243
BUIC-REGAL	2807	3113	3161	3336	3469	3481	3510	3666
BUIC-REGAL(G,T	0	0	0	0	0	0	0	0
BUIC-RIVIERA	4136	0	0	4316	4342	4360	4327	4342
BUIC-SKYHAWK	0	0	0	0	0	0	0	0
BUIC-SKYHAWK-J	0	0	0	0	0	0	0	0
BUIC-SKYLARK	0	0	0	0	0	0	0	0
BUIC-SOMERSET	0	0	0	0	0	0	0	0
CADI-CIMARRON	0	0	0	0	0	0	0	0
CADI-DEVILLE/BRO	4785	4794	4756	4756	4728	4866	4780	4784
CADI-ELDORADO	0	0	0	0	4688	4777	4728	4728
CADI-LIMOUSINE	0	0	0	0	0	0	5744	0
CADI-OTH AUTO	0	4794	0	0	0	0	0	4784
CADI-SEVILLE	0	0	0	0	0	0	0	0
CADI-UNK AUTO	0	4794	4756	4756	4728	4866	4780	4784
CHEV-CAMARO	0	0	0	0	3027	3071	3116	3267
CHEV-CAPRICE/IMP	3530	3555	3644	3649	3698	3695	3794	3883
CHEV-CAVALIER	0	0	0	0	0	0	0	0
CHEV-CELEBRITY	0	0	0	0	0	0	0	0
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(CONTINUED)

CURB WEIGHTS FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME / MY / FREQUENCY	71	72	73	74	75	76	77	78
ALFA-GTV-6	0	0	0	0	0	0	0	0
ALFA-SPIDER	0	0	0	0	0	0	0	0
AMER-AMBASSADOR	3587	3606	3814	4079	0	0	0	0
AMER-AMX	0	3166	3136	0	0	0	0	0
AMER-EAGLE	0	0	0	0	0	0	0	0
AMER-HORNET/CONC	2717	2698	2516	2857	2993	3093	3065	3081
AMER-JAVELIN	3154	3142	3117	3141	0	0	0	0
AMER-PACER	0	0	0	0	2995	3180	3162	3236
AMER-RAMBLER	0	0	0	0	0	0	0	0
AMER-REBEL/MATOR	3344	3380	3508	3794	3803	3808	3917	3921
AMER-SPIRIT/GRML	2630	2572	2720	2762	2757	2764	2806	2748
ASTON MARTIN	0	0	0	0	0	0	0	0
AUDI-FOX	0	0	0	2102	2037	2108	2070	2070
AUDI-QUATTRO	0	0	0	0	0	0	0	0
AUDI-SUPER 90	0	2238	0	0	0	0	0	0
AUDI-UNK AUTO	2353	0	0	0	0	0	0	0
AUDI-100	2353	2366	2367	2569	2571	0	2568	0
AUDI-4000	0	0	0	0	0	0	0	0
AUDI-5000	0	0	0	0	0	0	0	2695
BMW-OTH AUTO	0	0	0	0	0	0	0	0
BMW-UNK AUTO	0	0	0	0	0	0	0	0
BMW-1600/2002	2073	0	0	0	0	2460	0	0
BMW-318I/320I	0	0	0	0	0	0	2650	2630
BMW-524/8/30/33I	0	0	0	0	4340	3300	0	0
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(CONTINUED)

CURB WEIGHTS FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME / MY / FREQUENCY	71	72	73	74	75	76	77	78
BMW-630/633	0	0	0	0	0	0	3360	0
BMW-733I	0	0	0	0	0	0	0	0
BUIC-APOLLO	0	0	3342	3420	3511	0	0	0
BUIC-CENTURY	0	0	0	0	0	0	0	0
BUIC-ELECTRA	4581	4669	4724	4842	4849	4797	3945	3882
BUIC-LESABRE	4252	4457	4424	4451	4512	4461	3729	3604
BUIC-REGAL	3706	3631	3907	4124	3962	3881	3808	3208
BUIC-REGAL(G,T	0	0	0	0	0	0	0	0
BUIC-RIVIERA	4502	4697	4647	4732	4680	4676	3917	3891
BUIC-SKYHAWK	0	0	0	0	3013	2992	2894	2886
BUIC-SKYHAWK-J	0	0	0	0	0	0	0	0
BUIC-SKYLARK	0	0	0	0	3417	3420	3423	3368
BUIC-SOMERSET	0	0	0	0	0	0	0	0
CADI-CIMARRON	0	0	0	0	0	0	0	0
CADI-DEVILLE/BRO	4843	4845	4596	5174	5149	5273	4472	4286
CADI-ELDORADO	4811	4825	4777	5105	5254	5231	5101	5052
CADI-LIMOUSINE	0	5662	0	6032	5866	5892	4870	0
CADI-OTH AUTC	0	0	0	0	0	0	0	0
CADI-SEVILLE	0	0	0	0	0	4341	4300	4289
CADI-UNK AUTO	4843	4845	4996	5174	5149	0	0	0
CHEV-CAMARO	3298	3331	3426	3533	3630	3602	3571	3518
CHEV-CAPRICE/IMP	4011	4171	4303	4354	4318	4361	3769	3788
CHEV-CAVALIER	0	0	0	0	0	0	0	0
CHEV-CELEBRITY	0	0	0	0	0	0	0	0
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(CONTINUEC)

CURB WEIGHTS FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME / FREQUENCY	MY 79	80	81	82	83	84	85
ALFA-GTV-6	0	0	0	0	0	2823	0
ALFA-SPIDER	2455	0	0	0	0	0	0
AMER-AMBASSADOR	0	0	0	0	0	0	0
AMER-AMX	0	0	0	0	0	0	0
AMER-EAGLE	0	3361	3352	3350	3344	3360	0
AMER-HORNET/CONC	2837	2837	2892	2897	2906	0	0
AMER-JAVELIN	0	0	0	0	0	0	0
AMER-PACER	3232	0	0	0	0	0	0
AMER-RAMBLER	0	0	0	0	0	0	0
AMER-REBEL/MATOR	0	0	0	0	0	0	0
AMER-SPIRIT/GRML	2603	2663	2767	2693	0	0	0
ASTON MARTIN	0	0	0	0	4100	0	0
AUDI-FOX	2070	0	0	0	0	0	0
AUDI-QUATTRO	0	0	0	0	0	2838	0
AUDI-SUPER 90	0	0	0	0	0	0	0
AUDI-UNK AUTO	0	0	0	0	0	0	0
AUDI-100	0	0	0	0	0	0	0
AUDI-4000	0	2206	2342	2201	2191	0	0
AUDI-5000	2701	2701	2703	0	2703	2927	2965
BMW-OTH AUTO	0	0	0	0	0	0	0
BMW-UNK AUTO	0	0	0	0	0	0	0
BMW-1600/2002	0	0	0	0	0	0	0
BMW-318I/320I	2530	2500	2500	2500	2360	2360	0
BMW-524/8/30/33I	0	0	3210	0	3035	0	0
~~TOTAL~~	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(CONTINUED)

CURB WEIGHTS FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME / FREQUENCY	MY 79	80	81	82	83	84	85
BMW-630/633	0	0	0	0	3350	0	0
BMW-733I	3770	0	0	0	0	0	0
BUIC-APOLLO	0	0	0	0	0	0	0
BUIC-CENTURY	0	0	0	2777	0	0	0
BUIC-ELECTRA	3977	3897	3863	3854	3858	3861	3243
BUIC-LESABRE	3695	3526	3640	3670	3682	3689	3496
BUIC-REGAL	3193	3206	3267	3259	3256	3216	3172
BUIC-REGAL*G,T	0	0	0	0	0	0	2499
BUIC-RIVIERA	3862	3849	3753	3800	3809	3799	3799
BUIC-SKYHAWK	2661	2868	0	2424	2424	2418	2418
BUIC-SKYHAWK-J	0	0	0	2424	2624	2418	2418
BUIC-SKYLARK	3366	2515	2515	2554	2557	2560	2615
BUIC-SOMERSET	0	0	0	0	0	0	2499
CADI-CIMARRON	0	0	0	2587	2639	2583	2583
CADI-DEVILLE/BRO	4382	4219	4151	3923	3935	3935	0
CADI-ELDORADO	3897	3914	3930	3733	3748	3734	3734
CADI-LIMOUSINE	0	0	0	0	0	0	0
CADI-OTH AUTO	0	0	0	0	0	0	0
CADI-SEVILLE	4290	4185	4167	3814	3844	3804	3804
CADI-UNK AUTO	0	0	0	0	0	0	0
CHEV-CAMARO	3512	3457	3430	2980	3025	3024	3023
CHEV-CAPRICE/IMP	3720	3496	3586	3609	3593	3592	3588
CHEV-CAVALIER	0	0	0	2398	2422	2379	2392
CHEV-CELEBRITY	0	0	0	2726	2761	2749	2742
~~TOTAL~~	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(CONTINUED)

CURB WEIGHTS FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME MY FREQUENCY	63	64	65	66	67	68	69	70
CHEV-CHEVETTE	0	0	0	0	0	0	0	0
CHEV-CITATION	0	0	0	0	0	0	0	0
CHEV-CORVAIR	2540	2555	2495	2530	0	2555	2585	0
CHEV-CORVETTE	3037	3110	3135	3140	3155	3210	3245	3285
CHEV-EL CAMINO	0	3081	3138	3195	3210	3288	3281	3427
CHEV-MALIBU/CHVL	0	3081	3138	3195	3210	3288	3251	3427
CHEV-MONTE CARLO	0	0	0	0	0	0	0	3563
CHEV-MONZA	2540	2555	0	2530	2555	0	2585	0
CHEV-NOVA	2674	2725	2766	2791	2809	3039	3069	3093
CHEV-SPECTRUM	0	0	0	0	0	0	0	0
CHEV-SPRINT	0	0	0	0	0	0	0	0
CHEV-VEGA	0	0	0	0	0	0	0	0
CHRY-CORDOBA	0	0	0	0	0	0	0	0
CHRY-E-CLASS	0	0	0	0	0	0	0	0
CHRY-LASER	0	0	0	0	0	0	0	0
CHRY-LEBARON	0	0	0	0	0	0	0	0
CHRY-NEWPRT/NYER	4045	4045	4292	4300	4292	4202	4297	4392
CHRY-OTH AUTO	0	0	0	0	0	0	4297	0
CHRY-UNK AUTO	4045	4045	4292	4300	4292	4202	4297	4392
CHRYS-LEBARON GT	0	0	0	0	0	0	0	0
DODG-ARIES(K)	0	0	0	0	0	0	0	0
DODG-ASPEN	0	0	0	0	0	0	0	0
DODG-CHALLENGER	0	0	0	0	0	0	0	3177
DODG-CHALNGR-IMP	0	0	0	0	0	0	0	0
~~TOTAL~~	~~94444~~	~~142436~~	~~144378~~	~~185761~~	~~213988~~	~~220848~~	~~267000~~	~~260636~~

(CONTINUED)

CURB WEIGHTS FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME MY FREQUENCY	63	64	65	66	67	68	69	70
DODG-COLT	0	0	0	0	0	0	0	0
DODG-CONQUEST	0	0	0	0	0	0	0	0
DODG-COR/CHG/MAG	0	3430	3376	3353	3339	3357	3327	3360
DODG-DART	2658	2757	2772	2860	2889	2929	2938	3039
DODG-DAYTONA	0	0	0	0	0	0	0	0
DODG-DIPLOMAT	0	0	0	0	0	0	0	0
DODG-DODGE 400	0	0	0	0	0	0	0	0
DODG-DODGE 600	0	0	0	0	0	0	0	0
DODG-MIRADA	0	0	0	0	0	0	0	0
DODG-OMNI	0	0	0	0	0	0	0	0
DODG-POLARA/MONA	0	3800	4077	4118	4113	3995	3985	4065
DODG-ROYL MONACO	0	0	0	0	0	0	0	0
DODG-ST REGIS	0	0	0	0	0	0	0	0
FERRARI	0	0	0	0	0	0	0	0
FIAT-BRAVA/131	0	0	0	0	0	0	0	0
FIAT-STRADA	0	0	0	0	0	0	0	0
FIAT-X-1/9	0	0	0	0	0	0	0	0
FIAT-124 CPE/SED	0	0	0	0	0	1923	2035	2061
FIAT-124 SPIDER	0	0	0	0	0	2010	2085	0
FIAT-128	0	0	0	0	0	0	0	0
FIAT-850/SPYDER	0	0	0	0	0	1540	1623	0
FORD-ESCORT	0	0	0	0	0	0	0	0
FORD-EXP	0	0	0	0	0	0	0	0
FORD-FAIRLANE	3077	3110	3109	3074	3087	3423	3216	3260
~~TOTAL~~	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(CONTINUED)

CURB WEIGHTS FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME / MY FREQUENCY	71	72	73	74	75	76	77	78
CHEV-CHEVETTE	0	0	0	0	0	1931	2019	2046
CHEV-CITATION	0	0	0	0	0	0	0	0
CHEV-CORVAIR	0	0	0	0	0	0	0	0
CHEV-CORVETTE	3292	3305	3407	3390	3529	3541	3534	3572
CHEV-EL CAMINO	3427	3423	3687	3845	3928	3981	3825	3196
CHEV-MALIBU/CHVL	3427	3423	3687	3845	3928	3981	3825	3196
CHEV-MONTE CARLO	3586	3603	3823	4036	4043	4023	3948	3435
CHEV-MONZA	0	0	0	0	2863	2826	2798	2731
CHEV-NOVA	3127	3145	3289	3331	3471	3364	3334	3342
CHEV-SPECTRUM	0	0	0	0	0	0	0	0
CHEV-SPRINT	0	0	0	0	0	0	0	0
CHEV-VEGA	2202	2213	2268	2446	2495	2523	2533	0
CHRY-CORDOBA	0	0	0	0	4110	4090	4139	4188
CHRY-E-CLASS	0	0	0	0	0	0	0	0
CHRY-LASER	0	0	0	0	0	0	0	0
CHRY-LEBARON	0	0	0	0	0	0	3636	3648
CHRY-NEWPRT/NYER	4323	4340	4293	4645	4633	4555	4513	4603
CHRY-OTH AUTO	0	0	0	0	0	0	0	0
CHRY-UNK AUTO	4323	4340	4293	4645	0	0	0	0
CHRYS-LEBARON GT	0	0	0	0	0	0	0	0
DODG-ARIES(K)	0	0	0	0	0	0	0	0
DODG-ASPEN	0	0	0	0	0	3356	3319	3270
DODG-CHALLENGER	3196	3220	3245	3245	0	0	0	0
DODG-CHALAGR-IMP	0	0	0	0	0	0	0	2594
TOTAL	[illegible]							

(CONTINUED)

CURB WEIGHTS FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME / MY FREQUENCY	71	72	73	74	75	76	77	78
DODG-COLT	[illegible]	2059	2053	2183	2250	2325	2152	2152
DODG-CONQUEST	0	0	0	0	0	0	0	0
DODG-COR/CHG/MAG	3399	3422	3588	3680	3835	3995	3958	4032
DODG-DART	3004	2973	3040	3168	3159	3072	0	0
DODG-DAYTONA	0	0	0	0	0	0	0	0
DODG-DIPLOMAT	0	0	0	0	0	0	3434	3603
DODG-DODGE 400	0	0	0	0	0	0	0	0
DODG-DODGE 600	0	0	0	0	0	0	0	0
DODG-MIRADA	0	0	0	0	0	0	0	0
DODG-OMNI	0	0	0	0	0	0	0	2137
DODG-POLARA/MONA	4038	4038	4060	4300	4508	4250	3570	3586
DODG-ROYL MONACO	0	0	0	0	4508	4250	3970	0
DODG-ST REGIS	0	0	0	0	0	0	0	0
FERRARI	0	0	0	0	0	0	0	0
FIAT-BRAVA/131	0	0	0	0	2460	2455	2495	2455
FIAT-STRADA	0	0	0	0	0	0	0	0
FIAT-X-1/9	0	0	0	0	0	0	2035	0
FIAT-124 CPE/SED	2087	2075	2113	2298	2370	0	0	0
FIAT-124 SPIDER	2044	2047	0	2128	2320	2250	2250	2250
FIAT-128	0	1735	1778	1905	1980	1990	1950	1973
FIAT-850/SPYDER	1590	1580	1590	0	0	0	0	0
FORD-ESCORT	0	0	0	0	0	0	0	0
FORD-EXP	0	0	0	0	0	0	0	0
FORD-FAIRLANE	3360	0	0	0	0	0	0	0
TOTAL	[illegible]							

(CONTINUED)

CURB WEIGHTS FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME / FREQUENCY	MY 79	80	81	82	83	84	85
CHEV-CHEVETTE	2069	2088	2026	2076	2094	2134	2114
CHEV-CITATION	0	2508	2513	2517	2507	2502	2494
CHEV-CORVAIR	0	0	0	0	0	0	0
CHEV-CORVETTE	3503	3334	3307	3342	0	3192	3192
CHEV-EL CAMINO	3172	3130	3149	3221	3224	0	0
CHEV-MALIBU/CHVL	3172	3130	3149	3221	3226	0	0
CHEV-MONTE CARLO	3220	3243	3236	3250	3224	3249	3231
CHEV-MONZA	2830	2782	0	0	0	0	0
CHEV-NOVA	3325	0	0	0	0	0	0
CHEV-SPECTRUM	0	0	0	0	0	0	1808
CHEV-SPRINT	0	0	0	0	0	0	1488
CHEV-VEGA	0	0	0	0	0	0	0
CHRY-CORDOBA	3804	3433	3458	3550	3568	0	0
CHRY-E-CLASS	0	0	0	0	2583	2595	2595
CHRY-LASER	0	0	0	0	0	2550	2550
CHRY-LEBARON	3463	3366	3381	2529	2601	2560	2560
CHRY-NEWPRT/NYER	3835	3896	3891	3719	3749	0	0
CHRY-OTH AUTO	0	0	0	0	0	0	0
CHRY-UNK AUTO	0	0	0	0	0	0	0
CHRYS-LEBARON GT	0	0	0	0	0	0	2539
DODG-ARIES(K)	0	0	2338	2327	2327	2382	2382
DODG-ASPEN	3168	3225	0	0	0	0	0
DODG-CHALLENGER	0	0	0	0	0	0	0
DODG-CHALNGR-IMP	2594	2679	2833	2756	2723	0	0
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(CONTINUED)

CURB WEIGHTS FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME / FREQUENCY	MY 79	80	81	82	83	84	85
DODG-COLT	1931	1838	1927	1922	1908	1913	1938
DODG-CONQUEST	0	0	0	0	0	0	2898
DODG-COR/CHG/MAG	3799	0	0	0	2277	2248	2248
DODG-DART-	0	0	0	0	0	0	0
DODG-DAYTONA	0	0	0	0	0	2567	2567
DODG-DIPLOMAT	3462	3357	3388	3444	3490	3556	3556
DODG-DODGE 400	0	0	0	2683	0	0	0
DODG-DODGE 600	0	0	0	0	2564	2530	2530
DODG-MIRADA	0	3439	3432	0	0	0	0
DODG-OMNI	2192	2176	2184	2219	2190	2211	2220
DODG-PCLARA/MONA	0	0	0	0	0	0	0
DODG-ROYL MONACO	0	0	0	0	0	0	0
DODG-ST REGIS	3708	3783	0	0	0	0	0
FERRARI	0	0	0	0	0	0	3406
FIAT-BRAVA/131	2490	0	2550	0	0	0	0
FIAT-STRADA	2281	[illegible]	2105	0	0	0	0
FIAT-X-1/9	0	2130	2130	0	0	0	0
FIAT-124 CPE/SED	0	0	0	0	0	0	0
FIAT-124 SPIDER	2310	2360	0	0	0	0	0
FIAT-128	1950	0	0	0	0	0	0
FIAT-850/SPYDER	0	0	0	0	0	0	0
FORD-ESCORT	0	0	2050	2050	2047	2113	2113
FORD-EXP	0	0	2092	2135	2156	2212	2212
FORD-FAIRLANE	0	0	0	0	0	0	0
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(CONTINUED)

CURB WEIGHTS FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME / MY / FREQUENCY	63	64	65	66	67	68	69	70
FORD-FAIRMONT	0	0	0	0	0	0	0	0
FORD-FALCON	2455	2578	2574	2726	2750	2880	2923	3249
FORD-FIESTA	0	0	0	0	0	0	0	0
FORD-GRANADA	0	0	0	0	0	0	0	0
FORD-LTD II	0	0	0	0	0	0	0	0
FORD-LTD/GAL/CUS	3800	3849	3541	3703	3701	3703	3900	3791
FORD-MAVERICK	0	0	0	0	0	0	2487	2487
FORD-MUSTANG	0	0	2602	2749	2835	2904	3040	3069
FORD-PINTO	0	0	0	0	0	0	0	0
FORD-RANCHERO	0	3110	0	3079	3087	3423	3216	3260
FORD-TEMPO	0	0	0	0	0	0	0	0
FORD-THUNDERBIRD	4355	4653	4650	4566	4435	4565	4549	4621
FORD-TORINO/GRAN	0	3110	3109	3079	0	3423	3216	3303
HOND-ACCORD	0	0	0	0	0	0	0	0
HOND-CIVIC	0	0	0	0	0	0	0	0
HOND-OTH AUTO	0	0	0	0	0	0	0	0
HOND-PRELUDE	0	0	0	0	0	0	0	0
HOND-UNK AUTO	0	0	0	0	0	0	0	0
HOND-600	0	0	0	0	0	0	0	1355
IMPERIAL-LEBARON	0	0	0	0	5060	4970	4925	4940
ISUZU-I-MARK	0	0	0	0	0	0	0	0
ISUZU-IMPULSE	0	0	0	0	0	0	0	0
ISUZU-UNK AUTO	0	0	0	0	0	0	0	0
JAGU-XJ-S COUPE	0	0	0	0	0	0	0	0
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	257600	[illegible]

(CONTINUED)

CURB WEIGHTS FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME / MY / FREQUENCY	63	64	65	66	67	68	69	70
JAGU-XJ6/XJ12	0	0	0	0	0	0	0	0
JAGU-XK-E	0	0	0	0	0	2464	0	0
LINC-MARK	0	0	0	0	0	0	4762	4866
LINC-TOWNCAR/CON	0	5257	5275	5285	5255	5180	5208	4910
LINC-UNK AUTO	0	5257	0	0	0	0	5208	4910
LINC-VERSAILLES	0	0	0	0	0	0	0	0
LNCI-BETA SD/HPE	0	0	0	0	0	0	0	0
MAZD-COSMO	0	0	0	0	0	0	0	0
MAZD-GLC	0	0	0	0	0	0	0	0
MAZD-MIZER	0	0	0	0	0	0	0	0
MAZD-RX2	0	0	0	0	0	0	0	0
MAZD-RX3	0	0	0	0	0	0	0	0
MAZD-RX4	0	0	0	0	0	0	0	0
MAZD-RX7	0	0	0	0	0	0	0	0
MAZD-618/616	0	0	0	0	0	0	0	0
MAZD-626	0	0	0	0	0	0	0	0
MAZD-808	0	0	0	0	0	0	0	0
MERC-BOBCAT	0	0	0	0	0	0	0	0
MERC-CAPRI-DOM	0	0	0	0	0	0	0	0
MERC-CAPRI-IMP	0	0	0	0	0	0	0	0
MERC-COMET	2615	2989	2507	3073	3113	3307	0	0
MERC-COUGAR	0	0	0	0	3119	3235	3534	3440
MERC-COUGAR XR7	0	0	0	0	3119	3235	3534	3440
MERC-CYCLONE	0	0	0	3073	0	3307	3427	3600
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(CONTINUED)

CURB WEIGHTS FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME / MY FREQUENCY	71	72	73	74	75	76	77	78
FORD-FAIRMONT	0	0	0	0	0	0	0	2803
FORD-FALCON	0	0	0	0	0	0	0	0
FORD-FIESTA	0	0	0	0	0	0	0	1762
FORD-GRANADA	0	0	0	0	3366	3449	3393	3291
FORD-LTD II	0	0	0	0	0	0	4061	4068
FORD-LTD/GAL/CUS	3992	4175	4292	4302	4502	4451	4414	4266
FORD-MAVERICK	2672	2701	2766	2883	2911	3000	3024	0
FORD-MUSTANG	3188	3209	3227	2839	2815	2914	2862	2843
FORD-PINTO	2015	2050	2216	2443	2581	2562	2443	2425
FORD-RANCHERO	3380	3734	3837	4037	4265	4179	4061	4068
FORD-TEMPO	0	0	0	0	0	0	0	0
FORD-THUNDERBIRD	4615	4562	4742	5047	5101	5006	4137	4040
FORD-TORINO/GRAN	3380	3734	3837	4037	4265	4243	0	0
HOND-ACCORD	0	0	0	0	0	0	2018	2078
HOND-CIVIC	0	0	1536	1605	1718	1721	1714	1713
HOND-OTH AUTO	0	1344	0	0	0	0	0	0
HOND-PRELUDE	0	0	0	0	0	0	0	0
HOND-UNK AUTO	1355	1344	0	1605	1718	1721	0	0
HOND-600	1355	1344	0	0	0	0	0	0
IMPERIAL-LEBARON	4960	5085	5020	4955	5205	0	0	0
ISUZU-I-MARK	0	0	0	0	0	0	0	0
ISUZU-IMPULSE	0	0	0	0	0	0	0	0
ISUZU-UNK AUTO	0	0	0	0	0	0	0	0
JAGU-XJ-S COUPE	0	0	0	0	0	3925	0	0
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(CONTINUED)

CURB WEIGHTS FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME / MY FREQUENCY	71	72	73	74	75	76	77	78
JAGU-XJ6/XJ12	0	0	0	0	0	0	0	0
JAGU-XK-E	2464	0	0	0	0	0	0	0
LINC-MARK	5003	4956	5084	5246	5352	5227	4871	4787
LINC-TOWNCAR/CON	5062	5116	5210	5195	5277	5225	5052	4836
LINC-UNK AUTO	5062	0	0	0	0	5226	0	0
LINC-VERSAILLES	0	0	0	0	0	0	3916	3913
LNCI-BETA SD/HPE	0	0	0	0	0	0	0	0
MAZD-COSMO	0	0	0	0	0	2845	0	0
MAZD-GLC	0	0	0	0	0	0	1965	1965
MAZD-MIZER	0	0	0	0	0	2078	0	0
MAZD-RX2	2065	2310	2340	2525	0	0	0	0
MAZD-RX3	0	2085	2165	2335	2365	2410	2360	2360
MAZD-RX4	0	0	0	2645	2765	2780	2765	0
MAZD-RX7	0	0	0	0	0	0	0	0
MAZD-618/616	2140	0	0	0	0	0	0	0
MAZD-626	0	0	0	0	0	0	0	0
MAZD-808	0	0	2013	2100	0	2175	0	0
MERC-BOBCAT	0	0	0	0	2641	2623	2472	2495
MERC-CAPRI-DOM	0	0	0	0	0	0	0	0
MERC-CAPRI-IMP	2115	2208	2388	2433	0	2655	2655	0
MERC-COMET	2766	2761	2877	2893	2943	3006	3058	0
MERC-COUGAR	3425	3476	3516	0	4346	4376	4012	4032
MERC-COUGAR XR7	3425	3476	3516	4262	0	0	4253	4231
MERC-CYCLONE	3646	0	0	0	0	0	0	0
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(CONTINUED)

CURB WEIGHTS FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME MY

FREQUENCY	79	80	81	82	83	84	85
FORD-FAIRMONT	2700	2717	2762	2801	2850	0	0
FORD-FALCON	0	0	0	0	0	0	0
FORD-FIESTA	1762	1783	0	0	0	0	0
FORD-GRANADA	3262	3269	2933	2938	0	0	0
FORD-LTD II	3942	0	0	0	0	0	0
FORD-LTD/GAL/CUS	3611	3584	3602	3602	3055	3152	3081
FORD-MAVERICK	0	0	0	0	0	0	0
FORD-MUSTANG	2634	2607	2608	2746	2732	2819	2790
FORD-PINTO	2445	2488	0	0	0	0	0
FORD-RANCHERO	3942	0	0	0	0	0	0
FORD-TEMPO	0	0	0	0	0	2408	2408
FORD-THUNDERBIRD	4022	3262	3268	3242	3106	3101	3099
FORD-TORINO/GRAN	0	0	0	0	0	0	0
HOND-ACCORD	2170	2199	2201	2128	2141	2229	2228
HOND-CIVIC	1727	1751	1842	1864	1873	1841	1841
HOND-OTH AUTO	0	0	0	0	0	0	0
HOND-PRELUDE	2106	2180	2148	2138	2200	2264	0
HOND-UNK AUTO	0	0	0	0	0	0	0
HOND-600	0	0	0	0	0	0	0
IMPERIAL-LEBARON	0	0	0	0	0	0	0
ISUZU-I-MARK	0	0	0	2189	0	2189	0
ISUZU-IMPULSE	0	0	0	0	2714	2734	0
ISUZU-UNK AUTO	0	0	2267	2189	0	0	0
JAGU-XJ-S COUPE	0	0	0	0	0	0	0
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(CONTINUED)

FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME MY

FREQUENCY	79	80	81	82	83	84	85
JAGU-XJ6/XJ12	[illegible]	0	4080	4044	0	4066	0
JAGU-XK-E	0	0	0	0	0	0	0
LINC-MARK	4783	4144	4097	4046	4035	3629	0
LINC-TOWNCAR/CON	4843	4090	4104	0	0	0	0
LINC-UNK AUTO	0	0	0	0	0	0	0
LINC-VERSAILLES	3913	3814	0	0	0	0	0
LNCI-BETA SD/HPE	0	0	2700	0	0	0	0
MAZD-COSMO	0	0	0	0	0	0	0
MAZD-GLC	1955	1965	1893	1913	1913	1913	1913
MAZD-MIZER	0	0	0	0	0	0	0
MAZD-RX2	0	0	0	0	0	0	0
MAZD-RX3	0	0	0	0	0	0	0
MAZD-RX4	0	0	0	0	0	0	0
MAZD-RX7	2350	2395	2345	2345	2360	0	2430
MAZD-618/616	0	0	0	0	0	0	0
MAZD-626	2565	2595	2530	2585	2398	2358	2398
MAZD-808	0	0	0	0	0	0	0
MERC-BOBCAT	2515	2535	0	0	0	0	0
MERC-CAPRI-DOM	2663	2640	2631	2790	2802	2851	2830
MERC-CAPRI-IMP	0	0	0	0	0	0	0
MERC-COMET	0	0	0	0	0	0	0
MERC-COUGAR	4016	3228	2929	2968	0	3095	3095
MERC-COUGAR XR7	4154	3228	3233	3219	3140	0	0
MERC-CYCLONE	0	0	0	0	0	0	0
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(CONTINUED)

CURB WEIGHTS FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME MY FREQUENCY	63	64	65	66	67	68	69	70
MERC-GR MARQUIS	0	0	0	0	0	0	0	0
MERC-LN7	0	0	0	0	0	0	0	0
MERC-LYNX	0	0	0	0	0	0	0	0
MERC-MARQ/MNTREY	0	4145	4010	4090	3985	3965	4238	4222
MERC-MONARCH	0	0	0	0	0	0	0	0
MERC-MONTEGO	0	0	0	3073	3113	3307	3289	3387
MERC-TOPAZ	0	0	0	0	0	0	0	0
MERC-ZEPHYR	0	0	0	0	0	0	0	0
MERZ-190	0	0	0	0	0	0	0	0
MERZ-230/280SL	0	0	0	0	2975	0	0	0
MERZ-300/280SEL	0	0	0	0	0	0	0	3305
MERZ-35/38/45SL	0	0	0	0	0	0	0	0
MERZ-35/38/45SLC	0	0	0	0	0	0	0	0
MERZ-380/450 SE	0	0	0	0	0	0	0	0
MERZ-45/38/50SEL	0	0	0	0	0	0	0	0
MG-MGB	0	1883	0	1920	1920	1920	0	1920
MG-MGB GT	0	1863	0	0	2190	2190	0	0
MG-MIDGET	0	0	0	1566	0	1512	0	1512
MITS-CORDIA	0	0	0	0	0	0	0	0
MITS-MIRAGE	0	0	0	0	0	0	0	0
MITS-STARION	0	0	0	0	0	0	0	0
MITS-TREDIA	0	0	0	0	0	0	0	0
NISS-B210/1200	0	0	0	0	1968	0	0	0
NISS-F-10	0	0	0	0	0	0	0	0
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(CONTINUED)

CURB WEIGHTS FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME MY FREQUENCY	63	64	65	66	67	68	69	70
NISS-OTH AUTO	0	0	0	0	1968	0	2072	0
NISS-PL411/RL411	0	0	0	1951	1968	0	0	0
NISS-PULSAR	0	0	0	0	0	0	0	0
NISS-SENTRA	0	0	0	0	0	0	0	0
NISS-STANZA	0	0	0	0	0	0	0	0
NISS-UNK AUTO	0	1980	0	0	1968	2017	2072	0
NISS-200 SX	0	0	0	0	0	0	0	0
NISS-240...300Z	0	0	0	0	0	0	0	3300
NISS-310	0	0	0	0	0	0	0	0
NISS-510	0	0	0	0	0	2017	2072	2072
NISS-610	0	0	0	0	0	0	0	0
NISS-710	0	0	0	0	0	0	0	0
NISS-810/MAXIMA	0	0	0	0	0	0	0	0
CLDS-CALAIS	0	0	0	0	0	0	0	0
CLDS-CIERO	0	0	0	0	0	0	0	0
CLDS-CUTLASS	0	3229	3339	3347	3353	3453	3485	3568
CLDS-DELTA 88	4239	4084	4051	4045	4097	4113	4210	4136
CLDS-FIRENZA	0	0	0	0	0	0	0	0
OLDS-OMEGA	0	0	0	0	0	0	0	0
CLDS-STARFIRE	0	4345	0	4205	0	0	0	0
CLDS-TORONADO	0	0	0	4495	4494	4465	4481	4498
OLDS-98	4413	4403	4382	4368	4413	4385	4426	4397
CPEL-GT	0	0	0	0	0	0	1881	1881
CPEL-ISUZU	0	0	0	0	0	0	0	0
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(CONTINUED)

CURB WEIGHTS FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME / MY FREQUENCY	71	72	73	74	75	76	77	78
MERC-GR MARQUIS	0	0	0	0	0	0	0	0
MERC-LN7	0	0	0	0	0	0	0	0
MERC-LYNX	0	0	0	0	0	0	0	0
MERC-MARQ/MNTREY	4334	6421	4602	4646	4767	6613	4552	4518
MERC-MONARCH	0	0	0	0	3352	3458	3416	3306
MERC-MONTEGO	3371	3791	3854	4020	4307	4224	0	0
MERC-TOPAZ	0	0	0	0	0	0	0	0
MERC-ZEPHYR	0	0	0	0	0	0	0	2779
MERZ-190	0	0	0	0	0	0	0	0
MERZ-230/280SL	0	0	0	0	0	0	0	0
MERZ-300/280SEL	0	0	3395	0	0	0	0	0
MERZ-35/38/45SL	0	0	0	3710	3780	3795	3815	3815
MERZ-35/38/45SLC	0	0	3765	0	3820	3905	0	0
MERZ-380/450 SE	0	0	3995	3995	0	0	0	0
MERZ-45/38/50SEL	0	0	0	0	4140	4135	0	4080
MG-MGB	1920	1920	1920	2394	2287	2290	2338	2338
MG-MGB GT	2190	2190	2190	2426	0	0	0	0
MG-MIDGET	1512	1512	0	1746	1854	1827	1849	1826
MITS-CORDIA	0	0	0	0	0	0	0	0
MITS-MIRAGE	0	0	0	0	0	0	0	0
MITS-STARION	0	0	0	0	0	0	0	0
MITS-TREDIA	0	0	0	0	0	0	0	0
NISS-B210/1200	1596	1598	1640	1945	2055	2095	1958	2020
NISS-F-10	0	0	0	0	0	0	1570	1995
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(CONTINUED)

CURB WEIGHTS FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME / MY FREQUENCY	71	72	73	74	75	76	77	78
NISS-OTH AUTO	0	0	0	0	0	0	0	0
NISS-PL411/RL411	0	0	0	0	0	0	0	0
NISS-PULSAR	0	0	0	0	0	0	0	0
NISS-SENTRA	0	0	0	0	0	0	0	0
NISS-STANZA	0	0	0	0	0	0	0	0
NISS-UNK AUTO	0	0	0	0	0	0	0	0
NISS-200 SX	0	0	0	0	0	0	2365	2445
NISS-240...300Z	2306	2350	2500	2499	2735	2772	2768	2840
NISS-310	0	0	0	0	0	0	0	0
NISS-510	2046	2040	2140	0	0	0	0	2263
NISS-610	0	0	2280	2413	2556	2477	0	0
NISS-710	0	0	0	2304	2477	2398	2387	0
NISS-810/MAXIMA	0	0	0	0	0	0	2659	2738
OLDS-CALAIS	0	0	0	0	0	0	0	0
OLDS-CIERO	0	0	0	0	0	0	0	0
OLDS-CUTLASS	3540	3523	3871	4012	3844	3998	3881	3270
OLDS-DELTA 88	4286	4363	4368	4515	4544	4481	3725	3705
OLDS-FIRENZA	0	0	0	0	0	0	0	0
OLDS-OMEGA	0	0	3426	3428	3629	3500	3366	3291
OLDS-STARFIRE	0	0	0	0	3007	2983	2864	2877
OLDS-TORONADO	4670	4672	4794	4838	4787	4761	4747	4767
OLDS-98	4620	4576	4662	4776	4883	4786	3985	4124
OPEL-GT	1836	2121	2120	0	0	0	0	0
OPEL-ISUZU	0	0	0	0	0	2136	2175	2177
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(CONTINUED)

CURB WEIGHTS FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME / FREQUENCY	MY 79	80	81	82	83	84	85
MERC-GR MARQUIS	0	0	0	0	3790	0	0
MERC-LN7	0	0	0	2146	0	0	0
MERC-LYNX	0	0	2072	2056	2063	2118	2118
MERC-MARQ/MNTREY	3707	3636	3699	3710	3065	3008	3008
MERC-MONARCH	3255	3267	0	0	0	0	0
MERC-MONTEGO	0	0	0	0	0	0	0
MERC-TOPAZ	0	0	0	0	0	2413	2413
MERC-ZEPHYR	2732	2722	2768	2800	2812	0	0
MERZ-190	0	0	0	0	0	2680	0
MERZ-230/280SL	0	0	0	0	0	0	0
MERZ-300/280SEL	0	0	0	0	0	0	0
MERZ-35/38/45SL	3815	0	3605	0	0	3640	3640
MERZ-35/38/45SLC	3860	0	0	0	0	0	0
MERZ-380/450 SE	0	0	0	0	0	0	0
MERZ-45/38/50SEL	4080	0	0	0	0	0	3770
MG-MGB	2338	2338	0	0	0	0	0
MG-MGB GT	0	0	0	0	0	0	0
MG-MIDGET	1826	0	0	0	0	0	0
MITS-CORDIA	0	0	0	0	2182	2182	2362
MITS-MIRAGE	0	0	0	0	0	0	2032
MITS-STARION	0	0	0	0	2820	2820	2914
MITS-TREDIA	0	0	0	0	2205	2205	0
NISS-B210/1200	1983	1960	1960	1960	0	0	0
NISS-F-10	0	0	0	0	0	0	0
TOTAL	332471	285026	282413	281061	[illegible]	[illegible]	[illegible]

(CONTINUED)

CURB WEIGHTS FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME / FREQUENCY	MY 79	80	81	82	83	84	85
NISS-OTH AUTO	0	0	0	0	0	0	0
NISS-PL411/RL411	0	0	0	0	0	0	0
NISS-PULSAR	0	0	0	0	1907	1907	0
NISS-SENTRA	0	0	0	1920	1885	1880	1880
NISS-STANZA	0	0	0	2186	2208	2303	2243
NISS-UNK AUTO	0	0	0	0	0	0	0
NISS-200 SX	2365	2624	2624	2590	2598	2525	0
NISS-240...300Z	2817	2815	2924	2838	2930	2931	0
NISS-310	2000	2004	2000	1954	0	0	0
NISS-510	2263	2204	2138	0	0	0	0
NISS-610	0	0	0	0	0	0	0
NISS-710	0	0	0	0	0	0	0
NISS-810/MAXIMA	2752	0	2800	2794	0	2880	0
OLDS-CALAIS	0	0	0	0	0	0	2512
OLDS-CIERA	0	0	0	2711	2750	2775	2765
OLDS-CUTLASS	3270	3300	3262	3247	3300	3248	3276
OLDS-DELTA 88	3744	3612	3676	3673	3695	3648	3649
OLDS-FIRENZA	0	0	0	2412	2415	2415	2415
OLDS-OMEGA	2291	2508	2500	2517	2540	2559	0
OLDS-STARFIRE	2822	2810	0	0	0	0	0
OLDS-TORONADO	3851	3720	3806	3700	3905	3807	3807
OLDS-98	3965	3955	3923	3961	4005	4005	3167
OPEL-GT	0	0	0	0	0	0	0
OPEL-ISUZU	2195	0	0	0	0	0	0
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(CONTINUED)

CURB WEIGHTS FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME / FREQUENCY	MY 63	64	65	66	67	68	69	70
OPEL-KADETTE	0	0	1677	0	1570	1722	1711	1691
OPEL-MANTA/1900	0	0	0	0	0	0	0	0
PEUG-UNK AUTO	0	0	0	0	0	0	2295	0
PEUG-505/504	0	0	0	0	0	0	0	0
PEUG-604	0	0	0	0	0	0	0	0
PLYM-ARROW	0	0	0	0	0	0	0	0
PLYM-BARRACUDA	0	0	3014	2909	2968	3103	3060	3173
PLYM-CARAVELLE	0	0	0	0	0	0	0	0
PLYM-CHAMP/COLT	0	0	0	0	0	0	0	0
PLYM-CRICKET	0	0	0	0	0	0	0	0
PLYM-FURY	0	3369	3671	3829	3794	3777	3803	3844
PLYM-GRAN FURY	0	0	3671	0	0	3777	3803	3844
PLYM-HORIZON	0	0	0	0	0	0	0	0
PLYM-RELIANT(K)	0	0	0	0	0	0	0	0
PLYM-SAPPORO-IMP	0	0	0	0	0	0	0	0
PLYM-SATLIT/BELV	3275	[illegible]	3336	3335	3311	3332	3294	3331
PLYM-VAL/DST/SCP	2675	2703	2761	2752	2811	2825	2867	2959
PLYM-VOLARE	0	0	0	0	0	0	0	0
PONT-ASTRE	0	0	0	0	0	0	0	0
PONT-BONNE/CATAL	4076	4076	4075	4128	4163	4162	4256	4264
PONT-FBIRD/TR AM	0	0	0	0	3226	3232	3375	3516
PONT-FIERO	0	0	0	0	0	0	0	0
PONT-GRAND AM	0	0	0	0	0	0	0	0
PONT-GRAND PRIX	0	4123	4110	4218	4204	4204	3865	3936
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(CONTINUED)

CURB WEIGHTS FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME / FREQUENCY	MY 63	64	65	66	67	68	69	70
PONT-J-2000	0	0	0	0	0	0	0	0
PONT-LEMANS/TEMP	2985	3126	3297	3380	3437	3450	3545	3606
PONT-PHOENIX	0	0	0	0	0	0	0	0
PONT-SUNBIRD	0	0	0	0	0	0	0	0
PONT-T1000	0	0	0	0	0	0	0	0
PONT-VENTURA	0	0	0	0	0	0	0	0
PONT-6000	0	0	0	0	0	0	0	0
PORS-OTH AUTO	1983	0	0	0	0	0	0	0
PORS-UNK AUTO	1983	0	0	0	0	0	0	0
PORS-911	0	0	0	0	0	0	0	2249
PORS-912/912E	0	0	0	0	2134	0	2095	0
PORS-914	0	0	0	0	0	0	0	1984
PORS-924	0	0	0	0	0	0	0	0
PORS-928	0	0	0	0	0	0	0	0
PORS-930/TURBO	0	0	0	0	0	0	0	0
PORS-944	0	0	0	0	0	0	0	0
RENA-ALLIANCE	0	0	0	0	0	0	0	0
RENA-ENCORE	0	0	0	0	0	0	0	0
RENA-FUEGO	0	0	0	0	0	0	0	0
RENA-LECAR	0	0	0	0	0	0	0	0
RENA-R18I	0	0	0	0	0	0	0	0
RENA-10/DAUPHINE	0	0	0	0	0	0	1825	0
RENA-12	0	0	0	0	0	0	0	0
SAAB-UNK AUTO	0	0	0	0	1875	0	0	0
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(CONTINUED)

CURB WEIGHTS FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME / FREQUENCY	MY 71	72	73	74	75	76	77	78
OPEL-KADETTE	1717	1961	0	0	0	0	0	0
OPEL-MANTA/1900	2146	2153	2183	2141	2208	0	0	0
PEUG-UNK AUTO	0	0	0	0	0	3030	0	3075
PEUG-503/504	0	0	0	0	0	3030	0	3075
PEUG-604	0	0	0	0	0	0	0	0
PLYM-ARROW	0	0	0	0	0	2226	2227	2212
PLYM-BARRACUDA	3145	3142	3195	3195	0	0	0	0
PLYM-CARAVELLE	0	0	0	0	0	0	0	0
PLYM-CHAMP/CCLT	0	0	0	0	0	0	0	0
PLYM-CRICKET	1966	1961	0	0	0	0	0	0
PLYM-FURY	3899	3960	3980	4315	3826	4009	3970	3983
PLYM-GRAN FURY	0	3960	3980	4315	4460	4215	4213	0
PLYM-HORIZON	0	0	0	0	0	0	0	2137
PLYM-RELIANT(K)	0	0	0	0	0	0	0	0
PLYM-SAPPORO-IMP	0	0	0	0	0	0	0	2609
PLYM-SATLIT/BELV	3429	3486	3619	3682	3826	4009	0	0
PLYM-VAL/DST/SCP	1943	2919	2985	3100	3082	3069	0	0
PLYM-VOLARE	0	0	0	0	0	3367	3311	3266
PONT-ASTRE	0	0	0	0	2572	2519	2560	0
PONT-BONNE/CATAL	4296	4349	4416	4502	4565	4416	3700	3692
PONT-FBIRD/TR AM	3491	3480	3462	3589	3496	3657	3451	3483
PONT-FIERO	0	0	0	0	0	0	0	0
PONT-GRAND AM	0	0	0	0	0	0	0	0
PONT-GRAND PRIX	3975	3962	4117	4231	4167	4183	3939	3293
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(CONTINUED)

CURB WEIGHTS FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME / FREQUENCY	MY 71	72	73	74	75	76	77	78
PONT-J-2000	0	0	0	0	0	0	0	0
PONT-LEMANS/TEMP	3531	3571	3925	3942	3838	4019	3817	3222
PONT-PHOENIX	0	0	0	0	0	0	3307	3317
PONT-SUNBIRD	0	0	0	0	0	2812	2738	2751
PONT-T1000	0	0	0	0	0	0	0	0
PONT-VENTURA	3095	3131	3373	3405	3445	3484	3307	0
PONT-6000	0	0	0	0	0	0	0	0
PORS-OTH AUTO	0	0	0	0	0	0	0	0
PORS-UNK AUTO	0	0	0	0	0	0	0	0
PORS-911	2250	2250	2250	2425	0	2538	0	2425
PORS-912/912E	0	0	0	0	0	0	0	0
PORS-914	1982	1900	1900	2139	2205	0	0	0
PORS-924	0	0	0	0	0	0	2447	2623
PORS-928	0	0	0	0	0	0	0	0
PORS-930/TURBO	0	0	0	0	0	0	0	0
PORS-944	0	0	0	0	0	0	0	0
RENA-ALLIANCE	0	0	0	0	0	0	0	0
RENA-ENCORE	0	0	0	0	0	0	0	0
RENA-FUEGO	0	0	0	0	0	0	0	0
RENA-LECAR	0	0	0	0	0	0	0	1819
RENA-R18I	0	0	0	0	0	0	0	0
RENA-10/DAUPHINE	1907	0	0	0	0	0	0	0
RENA-12	0	2050	0	0	0	0	0	0
SAAB-UNK AUTC	0	0	0	0	0	2560	0	0
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(CONTINUED)

CURB WEIGHTS FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME / MY FREQUENCY	79	80	81	82	83	84	85	
OPEL-KADETTE	0	0	0	0	0	0	0
OPEL-MANTA/1900	0	0	0	0	0	0	0
PEUG-UNK AUTO	3075	0	0	0	0	0	0
PEUG-505/504	0	0	3190	0	0	0	0
PEUG-604	0	0	0	3500	0	0	0
PLYM-ARROW	2272	2272	0	0	0	0	0
PLYM-BARRACUDA	0	0	0	0	0	0	0
PLYM-CARAVELLE	0	0	0	0	0	0	2527
PLYM-CHAMP/COLT	1838	1838	1927	1888	0	1913	0
PLYM-CRICKET	0	0	0	0	0	0	0
PLYM-FURY	0	0	0	0	0	0	0
PLYM-GRAN FURY	0	3740	3708	3446	3497	3558	3558
PLYM-HORIZON	2192	2176	2184	2219	2190	2174	2174
PLYM-RELIANT(K)	0	0	2338	2327	2323	2361	2361
PLYM-SAPPORO-IMP	2605	2786	2833	2756	2723	0	0
PLYM-SATLIT/BELV	0	0	0	0	0	0	0
PLYM-VAL/DST/SCP	0	0	0	0	0	0	0
PLYM-VOLARE	3166	3221	0	0	0	0	0
PONT-ASTRE	0	0	0	0	0	0	0
PONT-BONNE/CATAL	3737	3616	3676	3270	3306	3197	3197
PONT-FBIRD/TR AM	3460	3432	3435	2995	2996	2957	2958
PONT-FIERO	0	0	0	0	0	2459	2459
PONT-GRAND AM	0	0	0	0	0	0	2518
PONT-GRAND PRIX	3230	3270	3290	3343	3384	3260	3267
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(CONTINUED)

CURB WEIGHTS FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME / MY FREQUENCY	79	80	81	82	83	84	85	
PONT-J-2000	0	0	2399	2399	2383	2400	0
PONT-LEMANS/TEMP	3193	3142	3124	0	0	0	0
PONT-PHOENIX	3317	2567	2547	2544	2504	2533	0
PONT-SUNBIRD	2770	2769	0	0	0	0	2389
PONT-T1000	0	0	2003	2128	2128	2138	0
PONT-VENTURA	0	0	0	0	0	0	0
PONT-6000	0	0	0	2729	2644	2746	2746
PORS-OTH AUTO	0	0	0	0	0	0	0
PORS-UNK AUTO	0	0	0	0	0	0	0
PORS-911	0	0	2756	0	0	0	0
PORS-912/912E	0	0	0	0	0	0	0
PORS-914	0	0	0	0	0	0	0
PORS-924	2623	0	0	0	0	0	0
PORS-928	3197	0	3351	0	3351	0	0
PORS-930/TURBO	2854	0	0	0	0	0	0
PORS-944	0	0	0	0	0	0	2797
RENA-ALLIANCE	0	0	0	0	2000	2000	1957
RENA-ENCORE	0	0	0	0	0	2006	2006
RENA-FUEGO	0	0	0	2379	2379	0	0
RENA-LECAR	1815	1820	1820	1820	1820	0	0
RENA-R18I	0	0	2261	0	0	0	0
RENA-10/DAUPHINE	0	0	0	0	0	0	0
RENA-12	0	0	0	0	0	0	0
SAAB-UNK AUTO	0	0	0	0	0	0	0
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(CONTINUED)

CURB WEIGHTS FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME / MY FREQUENCY	63	64	65	66	67	68	69	70
SAAB-99/99E/900	0	0	0	0	0	0	0	0
SUBA-BRAT	0	0	0	0	0	0	0	0
SUBA-FE/GF/DL/G	0	0	0	0	0	0	0	0
SUBA-STAR	0	0	0	0	0	0	0	0
SUBA-UNK AUTO	0	0	0	0	0	0	0	1630
TOYT-CAMRY	0	0	0	0	0	0	0	0
TOYT-CARINA	0	0	0	0	0	0	0	0
TOYT-CELICA	0	0	0	0	0	0	0	0
TOYT-CELICA SUPR	0	0	0	0	0	0	0	0
TOYT-COROLLA	0	0	0	0	0	0	1637	1566
TOYT-CORONA	0	0	0	2139	2139	2260	2260	2235
TOYT-CRESSIDA	0	0	0	0	0	0	0	0
TOYT-CROWN	0	0	0	0	0	0	2890	0
TOYT-MR2	0	0	0	0	0	0	0	0
TOYT-OTH AUTO	0	0	0	2139	2139	2260	0	0
TOYT-STARLET	0	0	0	0	0	0	0	0
TOYT-TERCEL	0	0	0	0	0	0	0	0
TOYT-UNK AUTO	0	0	0	2139	2139	2260	0	0
TRIU-SPITFIRE	0	0	0	0	0	0	0	1652
TRIU-TR6	0	0	0	0	0	0	0	0
TRIU-TR7/TR8	0	0	0	0	0	0	0	0
VOLV-OTH AUTC	0	2320	0	0	2195	0	0	0
VCLV-UNK AUTC	0	0	0	2228	2195	0	0	0
VOLV-122	0	0	0	0	2195	2360	0	0
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(CONTINUED)

CURB WEIGHTS FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME / MY FREQUENCY	63	64	65	66	67	68	69	70
VOLV-142/144/145	0	0	0	0	0	2663	2584	2607
VOLV-164	0	0	0	0	0	0	2928	2937
VOLV-1800	0	0	0	2320	0	0	0	0
VOLV-242/244/245	0	0	0	0	0	0	0	0
VOLV-262/264/265	0	0	0	0	0	0	0	0
VOLV-740 GLE	0	0	0	0	0	0	0	0
VOLV-760 GLE	0	0	0	0	0	0	0	0
VW-BEETLE	1631	1631	1631	1719	1764	1808	1808	1808
VW-DASHER	0	0	0	0	0	0	0	0
VW-JETTA	0	0	0	0	0	0	0	0
VW-KARMAN GHIA	1808	1808	1808	1830	1852	1918	1918	1918
VW-OTH AUTO	1631	1631	1631	0	1764	1808	1808	1808
VW-RABBIT	0	0	0	0	0	0	0	0
VW-SCIROCCO	0	0	0	0	0	0	0	0
VW-SC/FASTBACK	0	0	0	2062	2062	2116	2116	2235
VW-SUPER BEETL	0	0	0	0	0	0	0	0
VW-UNK AUTO	1631	1631	1631	1719	1764	1808	1808	1808
VW-411/412	0	0	0	0	0	0	0	0
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(CONTINUED)

CURB WEIGHTS FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME / FREQUENCY	MY 71	72	73	74	75	76	77	78
SAAB-99/99E/900	0	2360	2490	2800	2560	2560	2575	2575
SUBA-BRAT	0	0	0	0	0	0	0	2145
SUBA-PE/GF/DL/G	0	1640	1850	2003	0	2045	1990	2015
SUBA-STAR	1630	0	0	1980	0	0	0	0
SUBA-UNK AUTO	1630	1640	0	0	0	0	1990	0
TOYT-CAMRY	0	0	0	0	0	0	0	0
TOYT-CARINA	0	1914	2202	0	0	0	0	0
TOYT-CELICA	0	2266	2300	2447	2498	2583	2570	2590
TOYT-CELICA SUPR	0	0	0	0	0	0	0	0
TOYT-COROLLA	1820	1820	1820	1938	0	2275	2158	2165
TOYT-CORONA	2170	2170	2170	2420	2610	2576	2665	2555
TOYT-CRESSIDA	0	0	0	0	0	0	0	2693
TOYT-CROWN	0	0	0	0	0	0	0	0
TOYT-MR2	0	0	0	0	0	0	0	0
TOYT-OTH AUTO	0	0	0	0	0	0	0	0
TOYT-STARLET	0	0	0	0	0	0	0	0
TOYT-TERCEL	0	0	0	0	0	0	0	0
TOYT-UNK AUTO	0	0	0	0	0	0	0	0
TRIU-SPITFIRE	1652	1708	0	1710	1931	1828	1850	1850
TRIU-TR6	2156	0	2156	2390	2390	2422	0	0
TRIU-TR7/TR8	0	0	0	0	2241	2272	2478	2454
VOLV-OTH AUTO	0	0	0	0	0	0	0	0
VOLV-UNK AUTO	0	0	0	0	0	0	0	0
VOLV-122	0	0	0	0	0	0	0	0
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(CONTINUED)

CURB WEIGHTS FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME / FREQUENCY	MY 71	72	73	74	75	76	77	78
VOLV-142/144/145	2660	2568	2666	2710	0	0	0	0
VOLV-164	2937	2908	2999	3106	3190	0	0	0
VOLV-1800	2541	2477	2589	0	0	0	0	0
VOLV-242/244/245	0	0	0	0	2880	2920	2933	2877
VOLV-262/264/265	0	0	0	0	0	3114	0	0
VOLV-740 GLE	0	0	0	0	0	0	0	0
VOLV-760 GLE	0	0	0	0	0	0	0	0
VW-BEETLE	1807	1807	1826	1896	1896	1970	1970	2110
VW-DASHER	0	0	0	1984	0	2262	2207	2162
VW-JETTA	0	0	0	0	0	0	0	0
VW-KARMAN GHIA	1918	1918	0	1984	0	0	0	0
VW-OTH AUTO	1807	0	0	0	0	0	0	0
VW-RABBIT	0	0	0	0	1830	1900	1900	1940
VW-SCIROCCO	0	0	0	0	1940	2015	2015	1948
VW-SC/FASTBACK	2282	2282	2282	0	0	0	0	0
VW-SUPER BEETL	0	0	1584	2028	0	0	0	0
VW-UNK AUTO	1807	0	0	0	0	0	0	0
VW-411/412	2447	2447	2447	2402	0	0	0	0
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(CONTINUED)

CURB WEIGHTS FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME / MY FREQUENCY	79	80	81	82	83	84	85
SAAB-99/99E/900	2660	2640	2676	2631	2626	2626	2773
SUBA-BRAT	2180	2200	2200	2220	0	0	0
SUBA-FE/GF/DL/G	2024	2086	2082	2138	2138	2199	2269
SUBA-STAR	0	0	0	0	0	0	0
SUBA-UNK AUTO	0	2086	2082	2138	2138	0	0
TOYT-CAMRY	0	0	0	0	2392	2392	2392
TOYT-CARINA	0	0	0	0	0	0	0
TOYT-CELICA	2515	2505	2619	2523	2531	2531	2531
TOYT-CELICA SUPR	0	2855	2866	2932	2970	2970	2970
TOYT-COROLLA	2154	2170	2230	2313	2149	2161	2161
TOYT-CORONA	2546	2537	2587	0	0	0	0
TOYT-CRESSIDA	2816	2838	2921	2861	0	3020	3020
TOYT-CROWN	0	0	0	0	0	0	0
TOYT-MR2	0	0	0	0	0	0	2459
TOYT-OTH AUTO	0	0	0	0	0	0	0
TOYT-STARLET	0	0	1724	1724	0	0	0
TOYT-TERCEL	0	1893	1906	1920	1985	1985	1985
TOYT-UNK AUTO	0	0	0	0	0	0	0
TRIU-SPITFIRE	1654	1867	0	0	0	0	0
TRIU-TR6	0	0	0	0	0	0	0
TRIU-TR7/TR8	0	2575	0	0	0	0	0
VOLV-OTH AUTO	0	0	0	0	0	0	0
VOLV-UNK AUTO	0	0	0	0	0	0	0
VOLV-122	0	0	0	0	0	0	0
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

(CONTINUED)

CURB WEIGHTS FROM AUTOMOTIVE NEWS ALMANACS

TABLE OF MMNAME BY MY

MMNAME / MY FREQUENCY	79	80	81	82	83	84	85
VOLV-142/144/145	0	0	0	0	0	0	0
VOLV-164	0	0	0	0	0	0	0
VOLV-1800	0	0	0	0	0	0	0
VOLV-242/244/245	2844	2891	2891	2879	0	2919	0
VOLV-262/264/265	3183	0	0	0	0	0	0
VOLV-740 GLE	0	0	0	0	0	0	2952
VOLV-760 GLE	0	0	0	0	3068	3079	0
VW-BEETLE	0	0	0	0	0	0	0
VW-DASHER	2162	2162	2162	0	0	0	0
VW-JETTA	0	0	1892	2026	0	2026	2275
VW-KARMAN GHIA	0	0	0	0	0	0	0
VW-OTH AUTO	0	0	0	0	0	0	0
VW-RABBIT	1940	1900	1900	1900	1900	1950	0
VW-SCIROCCO	1948	1948	1948	2159	2079	2181	0
VW-SC/FASTBACK	0	0	0	0	0	0	0
VW-SUPER BEETL	0	0	0	0	0	0	0
VW-UNK AUTO	0	0	0	0	0	0	0
VW-411/412	0	0	0	0	0	0	0
TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]