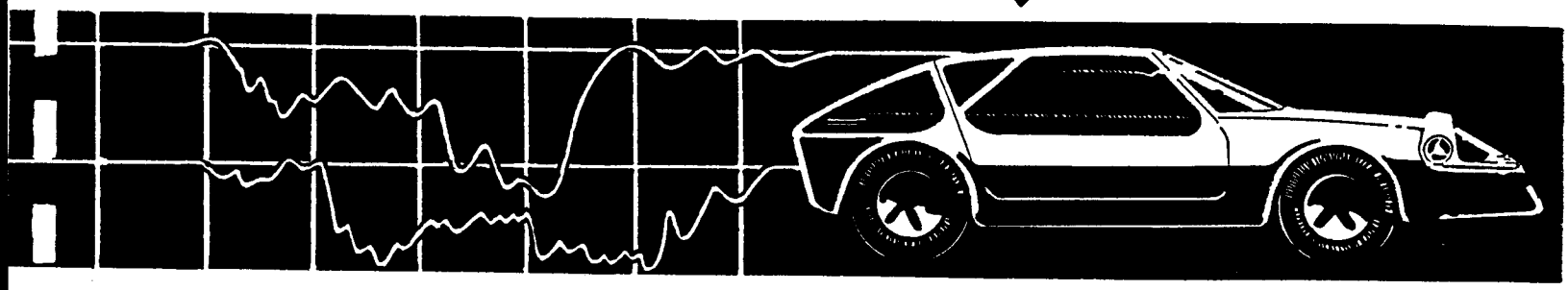
VOLUME II

ANALYSIS OF BENEFITS FOR THE IMPLEMENTATION OF PASSIVE RESTRAINT SYSTEMS IN AUTOMOBILES

Revised June 16, 1977

MINICARS, INC.



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VOLUME II

ANALYSIS OF BENEFITS FOR THE IMPLEMENTATION OF PASSIVE RESTRAINT SYSTEMS IN AUTOMOBILES

Submitted to:

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SECTION 1

SUMMARY

The objective of improved occupant protection is to save lives and mitigate injuries in automobile accidents. Rules mandating such improvement must be written so as to minimize their deleterious side effects (such as automobile price increases, public inconvenience, industry disruption, etc.). Such considerations were the focus of the effort reported in Volume I of this report. By themselves, they would tend to encourage the slowest possible implementation of any rule changes and corresponding changes in automotive design. Therefore, due consideration must also be given to the other side of the coin -- the benefits that rule changes produce in terms of lives saved and injuries mitigated. These benefits are the subject of Volume II.

The very brief time period of this study precluded making significant advances in the methodology for benefit calculation. Consequently, this work is based largely on previous efforts by Minicars and its subcontractor Kinetic Research to calculate benefits.[1-6] However, this study had several new features -- most notably the simultaneous time-phasing of a variety of restraint systems having different performance and usage characteristics, throughout a range of vehicle classes and seating positions. The "bookkeeping" in this study was, as a result, of unprecedented complexity.

This is not to say that this study is the definitive and last word on the subject. We do feel that the methodology is quite complete and is the best available at the present time. However, there are serious shortcomings in some of the data that have been used. The biases of the Multi-Disciplinary Accident Investigation (MDAI) file are well-known, and while the best available adjustments have been applied to it, the adjusted file is not as satisfactory a data base as will be available with the completion of the National Accident Severity Study. Another serious problem

exsits with the lack of biomechanical information -- data that permit dummy injury measures (as obtained in tests with dummy or in computer simulations) to be related to human injury severity resulting from actual collisions. Minicars and its subcontractor Kinetic Research have constructed relationships between dummy injury measures and human injury severity, based on available laboratory and accident data, but the results are hardly definitive.[7] [They do not consider, for example, the effects of crash victim age.]

One may say, then, that the results of this study have some use in comparing the effects of one restraint system implementation scheme to another. However, we would be lucky, indeed, if the absolute numbers of injuries and fatalities were within 20 to 30 percent of what would be seen in the real world. The data simply will not permit a more accurate evaluation. With time, the data situation will improve, but until such time it is still incumbent on policymakers to use the best available data with the best available methodology to arrive at the most rational decisions possible, recognizing the error bands that exist. It is also necessary to improve the data whenever possible, and to use the improved data to continuously update the trade-off studies that affect rulemaking decisions.

1.1 TRAFFIC ENVIRONMENT PROJECTIONS

Traffic environment projections used in this study were provided by the National Highway Traffic Safety Administration, based on its study of the feasibility of fuel economy standards,[8] or were derived as necessary from References 2 and 3 and other sources.[9-12] Between 1977 and 1990, total auto sales rise by 27 percent (a compounded rate of 1.86 percent per year). The number of autos on the road rises by 22.8 percent, and the exposure of these vehicles to accidents rises 23.5 percent. Market shares of sales show a slight shift toward small cars (minis, subcompacts, and compacts) and away from large cars (intermediate and full-size cars): the small/large sales mix changes from .497/.503 in 1977 to .514/.486 in 1990. However, the weights of vehicles in all classes show a remarkable decline by 1990, due primarily to fuel economy pressures. The percent changes in vehicle weights and accident exposures, by vehicle class, are shown in Table 1-1.

TABLE 1-1

RELATIVE CHANGES BETWEEN 1977 AND 1990 BY CAR CLASS
(PERCENT)

Auto Class	Weight of Vehicles Sold in One Model Year	Exposure-Weighted Mean Weight for Car Population	Accident Exposure Rate
Minicar	- 3.30	- 4.67	+350.00
Subcom.	-17.40	- 6.56	+ 24.36
Compact	-17.38	- 9.90	- 10.50
Interm.	-22.27	-17.44	+ 24.60
Full	-14.09	-16.60	- 48.41

For full-size cars, the change in weight of vehicles sold is less than the change in exposure-weighted mean weight because of the introduction of downsized GM models in 1977.

1.2 BENEFIT PROJECTIONS

Benefits are defined as the reductions of injuries and fatalities that would occur as the result of incorporating a set of safety systems in a specified manner, compared to a baseline of injuries and fatalities that would occur if no action were taken. As described in Volume I, the incorporation of restraint systems would occur as a result of a formulation of FMVSS 208 that would cause manufacturers to equip their cars in accordance with their capabilities and philosophies. Each alternate formulation of FMVSS 208, or alternate scenario, would lead to a unique implementation scheme to be adopted by the various manufacturers in the various car classes. The baseline for benefit calculations was an implementation scheme in which the current three-point harnesses were retained in all vehicle classes indefinitely. Clearly, the baseline does <u>not</u> correspond to current

injuries and fatalities, because these will continue to change as a function of total sales, market shares, vehicle weights, and vehicle usage.

For the purpose of benefit calculations, implementation scheme no. 14 was compared to the baseline. Scheme no. 14 is the likely industry response to a hypothetical rule formulated as follows:

a. Passive driver restraints installed in all full-size cars in 1981;

b. Passive full-front (driver and passenger) protection in all minis in 1981;

c. Passive driver restraints in all cars in 1982;

d. Passive full-front (driver and passenger) protection in all cars in 1983.

A second set of benefit calculations was based on implementation scheme no. 14A, which in the early years is similar to scheme no. 14, but which involves notifying industry well in advance of an intention to upgrade the passive restraint requirement to higher levels of performance. It has the advantage of increasing restraint system benefits without further aggravating industry's lead time problems. Driver and Passenger restraint implementation schedules, by manufacturer and vehicle class between 1977 and 1990, are shown in Tables 1-2 and 1-3 for schemes 14 and 14A, respectively.

Finally, a third set of benefit calculations was based on implementation scheme no. 0, in which all of the various passive restraint types used in scheme no. 14 are replaced by Type (1) -- the 1972 GM ACRS or equivalent. This was done to facilitate benefit comparisons with various estimates that have been made.

The results of these calculations are shown in Figures 1-1 through 1-3, in which the reductions of fatalities, severe injuries, and moderate injuries are shown as a function of time, for schemes 0, 14, and 14A. The shaded and cross-hatched bands represent uncertainties in relating dummy injury measures to human injury severity. [The uncertainties are due to differences in torso load distribution between unrestrained occupants, belted occupants, and air-bag protected occupants.]

Table 1-2. Driver and Passenger Restraint Implementation Scheme 14.

Driver

VEHICLE CLASS	MODEL YEAR 1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
GENL MOT														
MINI	0	0	0	0	4	4	4	4	2	2	2	2	2	2
SUBCOM	0	0	0	0	0	2	2	2	2	2	2	2	2	2
COMPACT	0	0	0	0	0	1	1	2	2	2	2	2	2	2
INTER	0	0	0	0	0	1	2	2	2	2	2	2	2	2
FULL	0	0	0	0	1	2	2	2	2	2	2	2	2	2
FORD														
MINI	0	0	0	0	4	4	4	2	2	2	2	2	2	2
SUBCOM	0	0	0	0	0	4	4	2	2	2	2	2	2	2
COMPACT	0	0	0	0	0	1	2	2	2	2	2	2	2	2
INTER	0	0	0	0	0	2	2	2	2	2	2	2	2	2
FULL	0	0	0	0	1	2	2	2	2	2	2	2	2	2
CHRYSLER														
MINI	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SUBCOM	0	0	0	0	0	4	4	4	4	4	4	4	4	4
COMPACT	0	0	0	0	0	4	4	4	4	4	4	4	4	4
INTER	0	0	0	0	0	1	1	1	1	2	2	2	2	2
FULL	0	0	0	0	1	1	1	1	1	2	2	2	2	2
AMER MOT														
MINI	0	0	0	0	4	4	4	4	4	4	4	4	4	4
SUBCOM	0	0	0	0	0	4	4	4	4	2	2	2	2	2
COMPACT	0	0	0	0	0	1	2	2	2	2	2	2	2	2
INTER	0	0	0	0	0	1	1	1	1	2	2	2	2	2
FULL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FOREIGN														
MINI	0	0	0	0	4	4	4	4	4	4	4	4	4	4
SUBCOM	0	0	0	0	0	4	4	4	4	4	4	4	4	4
COMPACT	0	0	0	0	0	2	2	2	2	2	2	2	2	2
INTER	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FULL	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Passenger

VEHICLE CLASS	MODEL YEAR 1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
GENL MOT														
MINI	0	0	0	0	4	4	4	4	2	2	2	2	2	2
SUBCOM	0	0	0	0	0	0	2	2	2	2	2	2	2	2
COMPACT	0	0	0	0	0	0	2	2	2	2	2	2	2	2
INTER	0	0	0	0	0	0	2	2	2	2	2	2	2	2
FULL	0	0	0	0	0	0	2	2	2	2	2	2	2	2
FORD														
MINI	0	0	0	0	4	4	4	4	4	2	2	2	2	2
SUBCOM	0	0	0	0	0	0	4	2	2	2	2	2	2	2
COMPACT	0	0	0	0	0	0	2	2	2	2	2	2	2	2
INTER	0	0	0	0	0	0	2	2	2	2	2	2	2	2
FULL	0	0	0	0	0	0	2	2	2	2	2	2	2	2
CHRYSLER														
MINI	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SUBCOM	0	0	0	0	0	0	4	4	4	4	4	4	4	4
COMPACT	0	0	0	0	0	0	4	4	2	2	2	2	2	2
INTER	0	0	0	0	0	0	1	1	1	2	2	2	2	2
FULL	0	0	0	0	0	0	1	1	1	2	2	2	2	2
AMER MOT														
MINI	0	0	0	0	4	4	4	4	4	4	4	4	4	4
SUBCOM	0	0	0	0	0	0	4	4	4	2	2	2	2	2
COMPACT	0	0	0	0	0	0	1	1	2	2	2	2	2	2
INTER	0	0	0	0	0	0	1	1	2	2	2	2	2	2
FULL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FOREIGN														
MINI	0	0	0	0	4	4	4	4	4	4	4	4	4	4
SUBCOM	0	0	0	0	0	0	4	4	4	4	4	4	4	4
COMPACT	0	0	0	0	0	2	2	2	2	2	2	2	2	2
INTER	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FULL	0	0	0	0	0	0	0	0	0	0	0	0	0	0

1 = 1972 GM ACRS
2 = Modified 1972 GM ACRS
3 = Advanced ACRS

0 = Active three-point harness
4 = Current passive belt system
5 = Advanced passive belt system

Table 1-3. Driver and Passenger Restraint Implementation Scheme 14A.

Driver

VEHICLE CLASS	MODEL YEAR 1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
GENL MOT														
MINI	0	0	0	0	4	4	4	4	3	3	3	3	3	3
SUBCOM	0	0	0	0	0	2	2	2	3	3	3	3	3	3
COMPACT	0	0	0	0	0	1	1	3	3	3	3	3	3	3
INTER	0	0	0	0	0	1	3	3	3	3	3	3	3	3
FULL	0	0	0	0	1	2	2	2	2	3	3	3	3	3
FORD														
MINI	0	0	0	0	4	4	4	4	4	3	3	3	3	3
SUBCOM	0	0	0	0	0	4	4	3	3	3	3	3	3	3
COMPACT	0	0	0	0	0	1	2	2	2	3	3	3	3	3
INTER	0	0	0	0	0	2	2	2	2	3	3	3	3	3
FULL	0	0	0	0	1	1	1	1	3	3	3	3	3	3
CHRYSLER														
MINI	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SUBCOM	0	0	0	0	0	4	4	4	4	5	5	5	5	5
COMPACT	0	0	0	0	0	4	4	4	3	3	3	3	3	3
INTER	0	0	0	0	0	1	1	1	1	3	3	3	3	3
FULL	0	0	0	0	1	1	1	1	1	3	3	3	3	3
AMER MOT														
MINI	0	0	0	0	4	4	4	4	4	5	5	5	5	5
SUBCOM	0	0	0	0	0	4	4	4	4	5	5	5	5	5
COMPACT	0	0	0	0	0	1	1	1	3	3	3	3	3	3
INTER	0	0	0	0	0	1	1	1	1	3	3	3	3	3
FULL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FOREIGN														
MINI	0	0	0	0	4	4	4	4	4	5	5	5	5	5
SUBCOM	0	0	0	0	0	4	4	4	4	5	5	5	5	5
COMPACT	0	0	0	0	0	3	3	3	3	3	3	3	3	3
INTER	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FULL	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Passenger

VEHICLE CLASS	MODEL YEAR 1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
GENL MOT														
MINI	0	0	0	0	4	4	4	4	3	3	3	3	3	3
SUBCOM	0	0	0	0	0	0	2	2	3	3	3	3	3	3
COMPACT	0	0	0	0	0	0	2	3	3	3	3	3	3	3
INTER	0	0	0	0	0	0	3	3	3	3	3	3	3	3
FULL	0	0	0	0	0	0	2	2	2	3	3	3	3	3
FORD														
MINI	0	0	0	0	4	4	4	4	4	3	3	3	3	3
SUBCOM	0	0	0	0	0	0	4	2	2	3	3	3	3	3
COMPACT	0	0	0	0	0	0	2	2	2	3	3	3	3	3
INTER	0	0	0	0	0	0	2	2	2	3	3	3	3	3
FULL	0	0	0	0	0	0	2	2	3	3	3	3	3	3
CHRYSLER														
MINI	0	0	0	0	0	0	0	0	0	0	0	0	0	0
SUBCOM	0	0	0	0	0	0	4	4	4	5	5	5	5	5
COMPACT	0	0	0	0	0	0	4	4	3	3	3	3	3	3
INTER	0	0	0	0	0	0	1	1	1	3	3	3	3	3
FULL	0	0	0	0	0	0	1	1	1	3	3	3	3	3
AMER MOT														
MINI	0	0	0	0	4	4	4	4	4	5	5	5	5	5
SUBCOM	0	0	0	0	0	0	4	4	4	5	5	5	5	5
COMPACT	0	0	0	0	0	0	1	1	3	3	3	3	3	3
INTER	0	0	0	0	0	0	1	1	1	3	3	3	3	3
FULL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FOREIGN														
MINI	0	0	0	0	4	4	4	4	4	5	5	5	5	5
SUBCOM	0	0	0	0	0	0	4	4	4	5	5	5	5	5
COMPACT	0	0	0	0	0	0	3	3	3	3	3	3	3	3
INTER	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FULL	0	0	0	0	0	0	0	0	0	0	0	0	0	0

1 = 1972 GM ACRS
2 = Modified 1972 GM ACRS
3 = Advanced ACRS

0 = Active three-point harness
4 = Current passive belt system
5 = Advanced passive belt system

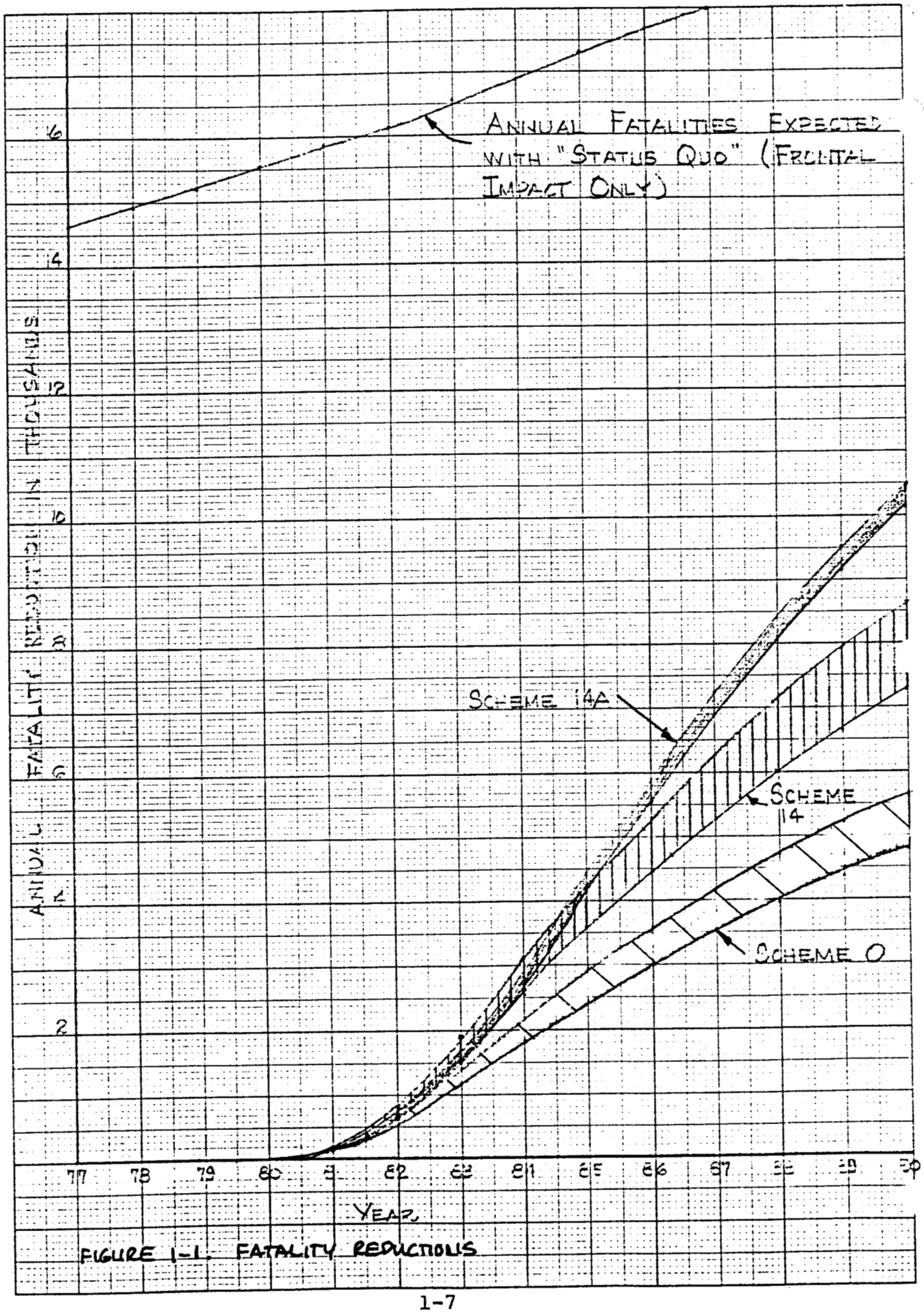

FIGURE 1-1. FATALITY REDUCTIONS

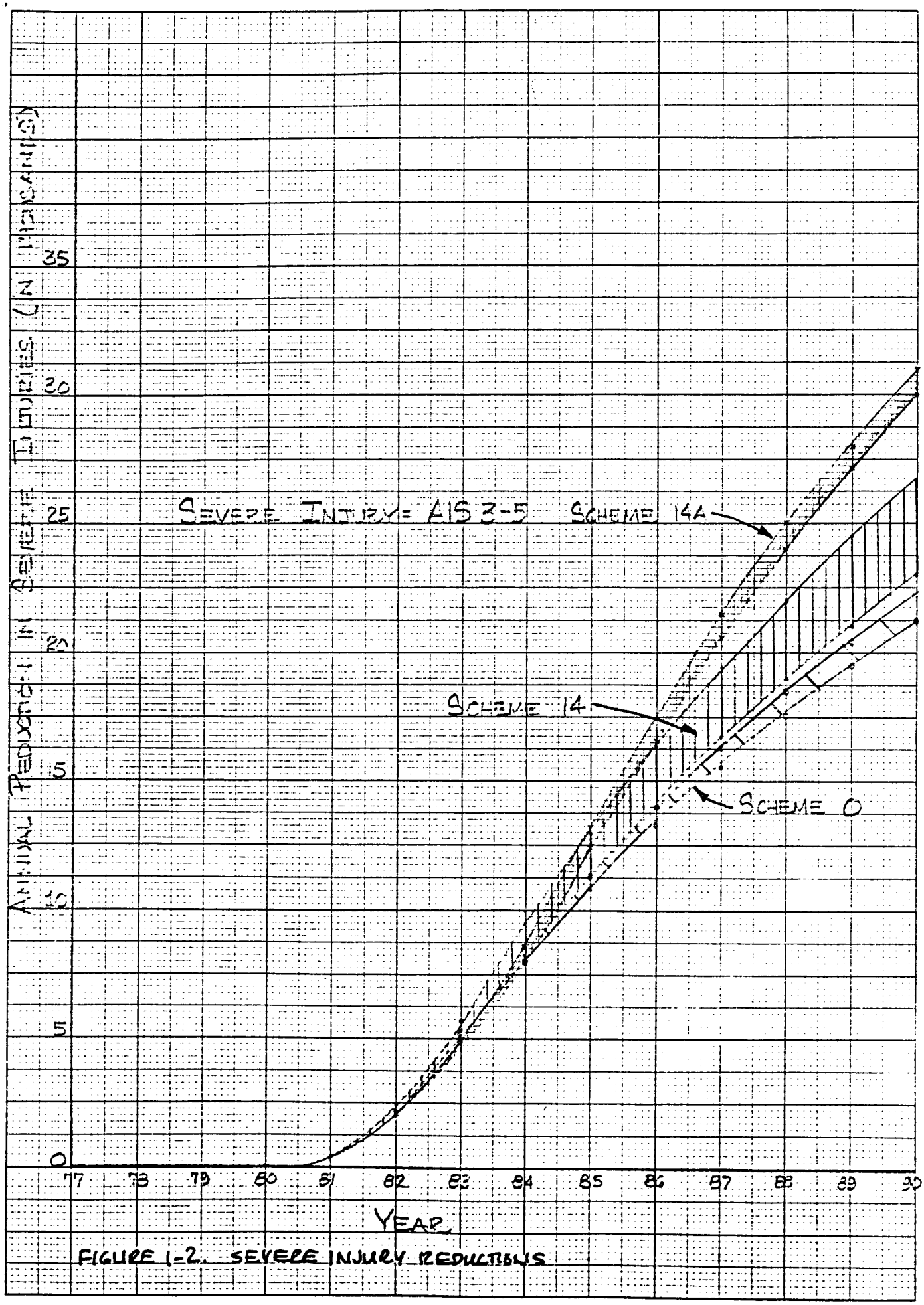

FIGURE 1-2. SEVERE INJURY REDUCTIONS

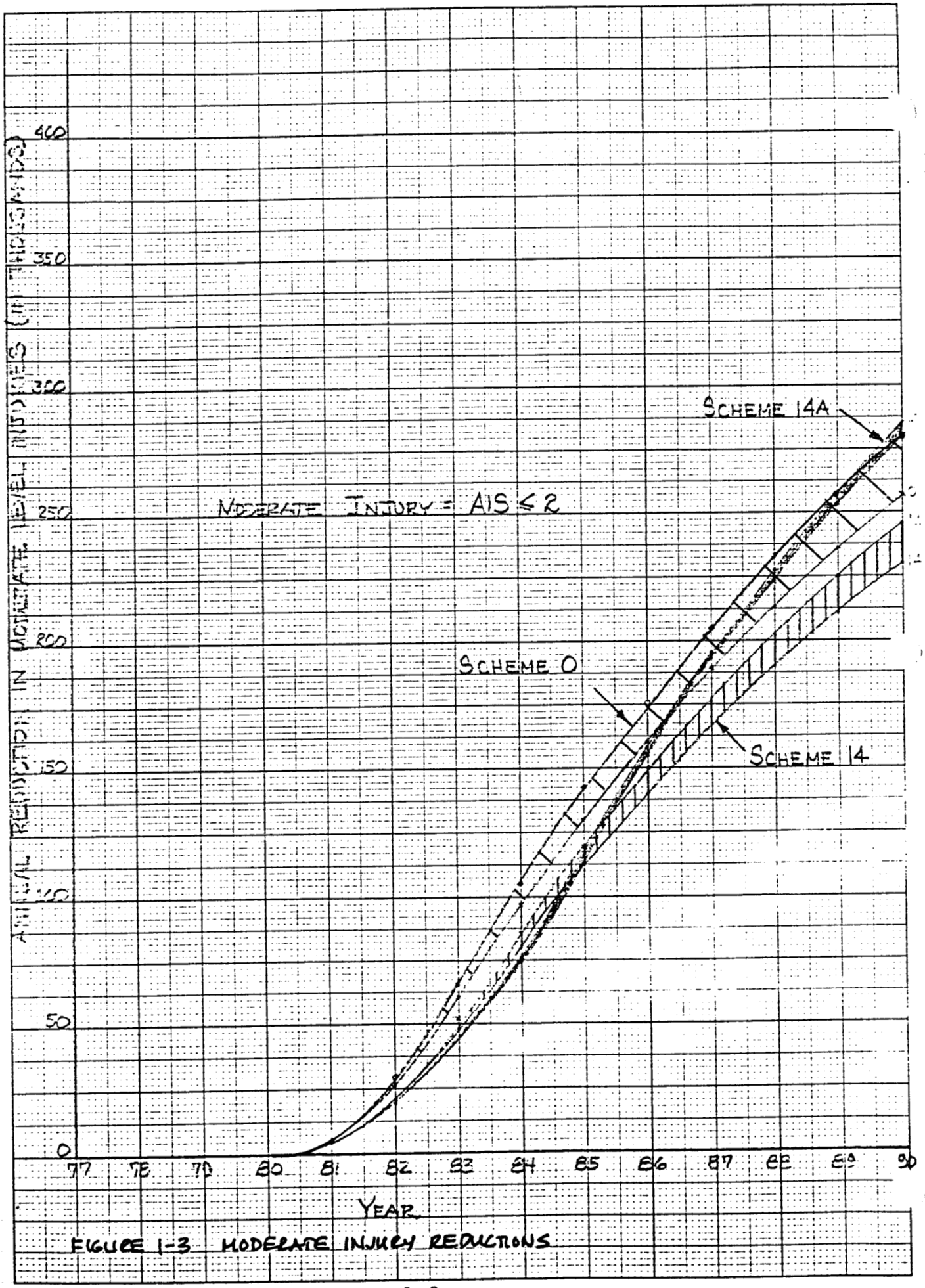

FIGURE 1-3 MODERATE INJURY REDUCTIONS

It is important to note that none of the benefits -- fatality, severe injury, or minor injury reductions -- has reached a steady-state condition. Even if vehicle sales, market shares, and weights were static after 1985, the benefits would not reach a steady-state condition until the year 2000 at least, because of the time required to scrap out old vehicles. [Scrappage of any given model year actually extends over a 25 year period.] Obviously, steady-state benefits (as estimated in other studies) would exceed the transient benefits calculated in this study.

It is also important to note that no benefits were calculated for side or rear impacts or rollovers.

Benefits are summarized in Tables 1-4 and 1-5. By 1990 yearly reductions in moderate injuries will reach 33 to 41 percent; yearly reductions in severe injuries will reach 36 to 52 percent; and yearly fatality reductions will reach 25 to 55 percent. Cumulative life savings by that time will range from 31,000 to 51,000.

TABLE 1-4

RANGE OF YEARLY PERCENTAGE SAVINGS IN 1990

Implementation Scheme	Moderate Injuries	Severe Injuries	Fatal Injuries
14	33 - 35	39 - 45	38 - 45
14A	40 - 41	51 - 52	53 - 55
0	37 - 41	36 - 38	25 - 30

TABLE 1-5

RANGE OF CUMULATIVE SAVINGS IN THOUSANDS BY 1990

Implementation Scheme	Moderate Injuries	Severe Injuries	Fatal Injuries
14	1210 - 1280	121 - 140	38 - 45
14A	1370 - 1390	146 - 153	49 - 51
0	1380 - 1510	114 - 120	29 - 31

SECTION 2

PROJECTED VEHICLE SALES AND POPULATIONS

Projections of vehicle sales and weights have been made by the National Highway Traffic Safety Administration for the purpose of examining the feasibility of fuel economy standards.[8] As shown in Table 2-1, total yearly sales were estimated to grow at the modest rate of 1.86 percent per year. Market shares by vehicle class and manufacturer were also estimated for 1976 and 1980, using the assumption that total market shares by manufacturer would remain constant, and that the distribution of sales by vehicle class would change only modestly. Accordingly, for each model year from 1977 through 1990, market shares were obtained for this study by linear interpolation and extrapolation. This procedure caused a slight redistribution in 1980 compact car sales to keep Chrysler's share of compact sales from becoming negative by 1990.

Also contained in Table 2-1 are the survival factors for automobiles as a function of their age. These data were obtained from the Allstate/Delorean study of restraint system benefits,[3] and compare well with data compiled by R. L. Polk[9] for the current automobile population. Table 2-1 also contains the relationship between vehicle usage (thousands of miles driven) and vehicle age.[2] In this study, vehicle usage was taken as the measure of accident exposure, and it was used with the survival factors in a computerized car population model to calculate the time-varying characteristics of the car and injury populations, such as the exposure-weighted mean vehicle weight in each car class, and injury exposure probabilities by restraint type, seating position, vehicle class, and fiscal year. [Statistical data are generally presented as of July 1 of each year, so in this study a fiscal year is the year ending July 1.]

Table 2-2 presents the automobile weights by class and model year. Data for the model years 1958 through 1973 were obtained from an Aerospace Corporation study,[10] while recent statistical data[11] were used for model years 1974, 1975, and 1976. Weights prior to 1958 were simply estimated. [The low survival rates of these old vehicles, coupled with their low usage, combine to produce very little effect on the present and future vehicle populations.] These data are plotted in Figure 2-1. Unfortunately, minicars

(text continued on Page 2-5)

Table 2-1. Inputs Regarding Sales, Scrappage, and Vehicle Usage (Accident Exposure)

TOTAL YEARLY SALES IN THOUSANDS — MODEL YEARS 1977-1990

9818	10001	10187	10376	10569	10765	10966
11169	11377	11588	11804	12029	12247	12475

FRACTION OF VEHICLES REMAINING IN A FISCAL YEAR, AS A FUNCTION OF MODEL YEAR (SCRAPPAGE)

0.671	1.000	0.992	0.974	0.959	0.928	0.886	0.831	0.747	0.633
0.484	0.337	0.232	0.160	0.107	0.091	0.074	0.050	0.039	0.032
0.028	0.021	0.017	0.014	0.009					

VEHICLE MILEAGE (EXPOSURE) AS A FUNCTION OF AGE

16.00	15.04	14.08	13.12	12.16	11.20	10.24	9.28	8.32	7.36
6.40	6.40	6.40	6.40	6.40	6.40	6.40	6.40	6.40	6.40
6.40	6.40	6.40	6.40	6.40					

MARKET SHARES BY VEHICLE CLASS AND MANUFACTURER — 1976

CLASS	GENL MOT	FORD	CHRYSLER	AMER MOT	FOREIGN
MINI	0.019	0.	0.	0.	0.060
SUBCOM	0.048	0.051	0.	0.005	0.053
COMPACT	0.091	0.073	0.059	0.020	0.017
INTER	0.193	0.044	0.035	0.004	0.
FULL	0.148	0.065	0.015	0.	0.

MARKET SHARES BY VEHICLE CLASS AND MANUFACTURER — 1980

CLASS	GENL MOT	FORD	CHRYSLER	AMER MOT	FOREIGN
MINI	0.019	0.013	0.	0.002	0.061
SUBCOM	0.048	0.038	0.028	0.004	0.054
COMPACT	0.087	0.069	0.043	0.019	0.016
INTER	0.206	0.055	0.027	0.004	0.
FULL	0.137	0.055	0.015	0.	0.

Table 2-2. Vehicle Weights by Weight Class and Model Year

YEAR	MINI	SUBCOM	COMPACT	INTER	FULL
1952	1915.	1968.	3000.	3500.	3800.
1953	1915.	1968.	3000.	3500.	3800.
1954	1915.	1968.	3000.	3500.	3800.
1955	1915.	1968.	3000.	3500.	3800.
1956	1915.	1968.	3000.	3500.	3800.
1957	1915.	1968.	3000.	3500.	3800.
1958	1915.	1968.	3041.	3191.	3815.
1959	1915.	1969.	2897.	3776.	3973.
1960	1915.	2044.	2679.	3756.	4067.
1961	1915.	2089.	2655.	2987.	3975.
1962	1915.	2088.	2723.	2934.	3978.
1963	1915.	2041.	2713.	3045.	3923.
1964	1915.	1787.	2721.	3180.	3941.
1965	1915.	1798.	2828.	3318.	4005.
1966	1915.	1909.	2823.	3363.	4061.
1967	1920.	1943.	2854.	3450.	4125.
1968	1926.	2002.	2941.	3503.	4152.
1969	1935.	2023.	2874.	3505.	4248.
1970	1942.	2093.	2874.	3655.	4288.
1971	1951.	2139.	2978.	3682.	4408.
1972	1960.	2214.	3027.	3787.	4481.
1973	1965.	2289.	3124.	4009.	4607.
1974	1979.	2521.	3199.	4209.	4839.
1975	1914.	2542.	3249.	4070.	4835.
1976	2008.	2580.	3359.	3964.	4679.
1977	1938.	2644.	3315.	4023.	4193.
1978	1938.	2644.	3234.	3531.	4159.
1979	1940.	2432.	3048.	3531.	4135.
1980	1890.	2318.	3020.	3522.	3913.
1981	1874.	2286.	3014.	3522.	3913.
1982	1874.	2286.	3014.	3382.	3687.
1983	1874.	2286.	2918.	3176.	3687.
1984	1874.	2252.	2871.	3173.	3687.
1985	1874.	2184.	2739.	3127.	3602.
1986	1874.	2184.	2739.	3127.	3602.
1987	1874.	2184.	2739.	3127.	3602.
1988	1874.	2184.	2739.	3127.	3602.
1989	1874.	2184.	2739.	3127.	3602.
1990	1874.	2184.	2739.	3127.	3602.

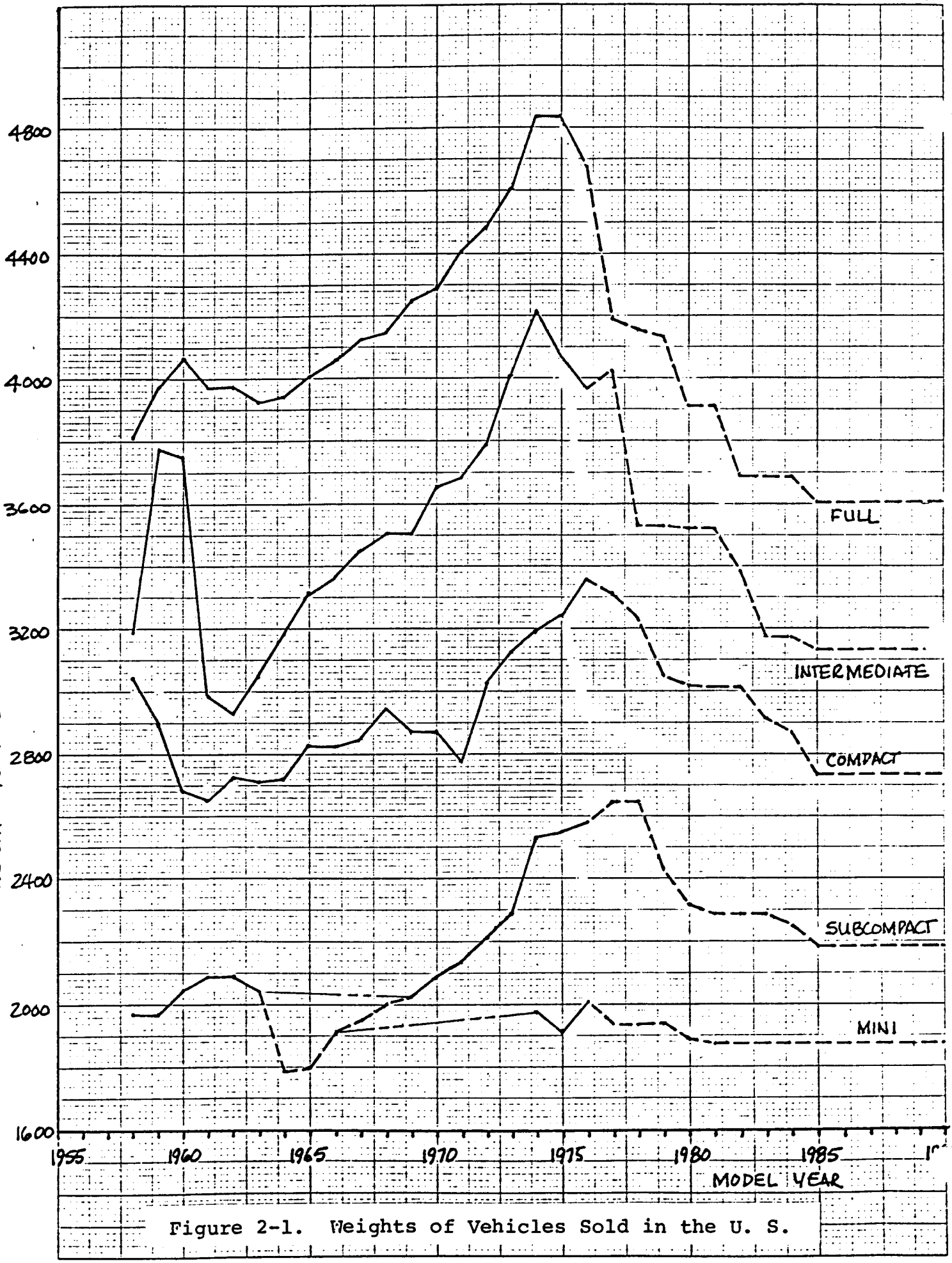

Figure 2-1. Weights of Vehicles Sold in the U. S.

were lumped with subcompacts, so some estimation was again required. This was facilitated by the fact that there were no domestic subcompacts between 1963 and 1970; the bulk of these (Volkswagen Beetles) would today be classified as minicars, and this undoubtedly accounts for the anomalous dip in the subcompact weights (shown in Figure 2-1 by a dotted line) during those years.

Weight projections for 1977 through 1990 were obtained from Document 2 of Reference 8, by way of assuming that the weight reductions shown therein would occur at, and only at, a major model change as indicated in Volume I. Sales-weighted mean weights were calculated for all the body styles within each vehicle class and manufacturer, and are shown in Table 2-3. While the results in Reference 8 indicate a lumping together of minis and subcompacts, the detail in Document 2 allows both weights and sales projections to be broken out separately. After suitable accounting for major model changes, weights were averaged (again sales-weighted) over the manufacturers in each vehicle class and model year. The results, also shown in Table 2-3, were used as the projected weights for 1977 through 1990.

Table 2-4 presents the original sales of vehicles currently on the road. Sales data back to 1963 were obtained from the Allstate/DeLorean study,[3] but unfortunately minicars were again lumped with subcompacts. However, sales of minis prior to 1963 was extremely limited, and sales figures were assumed accordingly. Sales data are also available from Wharton EFA, Inc.,[12] and go clear back to 1947, but it is clear that there are major discrepancies between references 3, 10, and 12 regarding the classification of vehicles. Therefore the sales of intermediate and full-size cars of Reference 12 were re-allocated among those two classes for this study; similar comments hold for subcompacts and compacts. Again, the accuracy of the data for older cars is not particularly critical for present and future vehicle mixes.

Table 2-5 presents the vehicle sales by manufacturer and vehicle class between 1977 and 1990. These data are derived directly from the total sales and market shares of Table 2-1. Table 2-6 presents a summation of the sales figures over the five manufacturers, and Table 2-7 presents the number of vehicles (in thousands) in the automobile population between now and 1990. Table 2-8 shows the growth in automobile (case vehicle) usage

(text continued on Page 2-11)

Table 2-3. Sales-Weighted Mean Weights.

		% Sales	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986-90
Mini	General Motors	20.0	2060	2060	2060	1900	1820	1820	1820	1820	1820	1820
	Ford	13.7				1810	1810	1810	1810	1810	1810	1810
	American Motors	2.1			2000	2000	2000	2000	2000	2000	2000	2000
	Foreign	64.2	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
	Sales-WTD Mean		1938	1938	1940	1890	1874	1874	1874	1874	1874	1874
Subcompact	General Motors	27.9	2801	2801	2801	2403	2403	2403	2403	2403	2253	2253
	Ford	22.1	2739	2739	2323	2323	2323	2323	2323	2173	2173	2173
	Chrysler	16.3			2200	2200	2200	2200	2200	2200	2050	2050
	American Motors	2.3	3140	3140								
	Foreign	31.4	2400	2400	2300	2300	2200	2200	2200	2200	2200	2200
	Sales-WTD Mean		2644	2644	2432	2318	2286	2286	2286	2252	2184	2184
Compact	General Motors	38.9	3384	3384	2900	2827	2827	2827	2827	2700	2627	2627
	Ford	24.5	3150	2859	2859	2859	2859	2859	2659	2659	2659	2659
	Chrysler	16.1	3556	3556	3556	3556	3556	3556	3556	3556	2956	2956
	American Motors	8.2	3298	3298	3298	3298	3298	3298	2936	2936	2450	2450
	Foreign	7.3	3100	3100	3000	3000	2900	2900	2800	2800	2700	2700
	Sales-WTD Mean		3315	3234	3048	3020	3014	3014	2918	2871	2739	2739
Intermediate	General Motors	70.4	3971	3274	3274	3274	3274	3274	3076	3076	3076	3076
	Ford	18.8	4249	4249	4249	4249	4249	3507	3507	3507	3261	3261
	Chrysler	9.2	3942	3942	3942	3942	3942	3942	3227	3227	3227	3227
	American Motors	1.5	4134	4134	4134	3445	3445	3445	3445	3245	3245	3245
	Sales-WTD Mean		4023	3531	3531	3522	3522	3382	3176	3173	3127	3127
Full	General Motors	66.4	3964	3964	3964	3964	3964	3622	3622	3622	3622	3622
	Ford	26.5	4632	4632	4632	3796	3796	3796	3796	3796	3544	3544
	Chrysler	7.1	4673	4200	3877	3877	3877	3877	3877	3877	3627	3627
	Sales-WTD Mean		4193	4159	4135	3913	3913	3687	3687	3687	3602	3602
TOTAL FLEET AVERAGE			3457	3288	3203	3123	3115	3027	2945	2927	2853	2853

Table 2-4. Original Sales (in Thousands) of Vehicles in the Current Vehicle Mix.

YEAR	MINI	SUBCOM	COMPACT	INTER	FULL	TOTAL
1952	20	180	228	500	3249	4177
1953	20	200	237	1000	4300	5757
1954	20	180	197	1000	4159	5556
1955	20	180	290	1500	5199	7189
1956	20	200	355	1100	4300	5975
1957	20	400	1002	1000	4270	6692
1958	20	200	691	500	3264	4675
1959	20	500	1134	800	3590	6044
1960	20	500	1832	800	3445	6597
1961	30	400	1825	600	3029	5884
1962	40	500	2006	800	3631	6977
1963	50	335	1499	1238	4239	7361
1964	60	399	1483	1572	4548	8062
1965	60	460	1611	1930	4697	8758
1966	65	553	1479	2196	4759	9052
1967	65	553	1468	2000	4378	8464
1968	65	682	1404	2313	4315	8779
1969	70	800	1544	2379	4518	9311
1970	70	941	1854	2217	3953	9035
1971	70	1663	1635	1871	3474	8713
1972	75	1749	1762	2280	3982	9848
1973	80	2144	2281	2763	4110	11378
1974	88	1670	2241	2303	2488	8790
1975	103	1772	2210	2313	2202	8600
1976	762	1514	2498	2670	2194	9638

Table 2-5. Vehicle Sales by Manufacturer, Vehicle Class, and Model Year

MFR	CLASS	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
GM	MINI	187	190	194	197	201	205	208	212	216	220	224	229	233	237
	SUB	471	480	489	498	507	517	526	536	546	556	567	577	588	599
	COM	884	890	897	903	909	915	921	927	933	939	944	950	955	961
	INT	1927	1995	2066	2138	2212	2288	2366	2446	2529	2613	2700	2791	2881	2975
	FULL	1426	1425	1424	1422	1419	1416	1412	1407	1402	1396	1390	1383	1375	1366
FORD	MINI	32	65	99	135	172	210	249	290	333	377	422	469	517	568
	SUB	469	445	420	394	367	339	310	279	247	214	180	144	107	69
	COM	707	710	713	716	719	721	724	726	728	730	732	734	735	736
	INT	459	495	532	571	610	651	694	737	782	829	876	926	977	1029
	FULL	614	600	586	571	555	538	521	503	484	464	443	421	398	374
CHRYSLER	MINI	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	SUB	69	140	214	291	370	452	537	625	717	811	909	1010	1115	1223
	COM	540	510	479	446	412	377	340	302	262	220	177	132	86	37
	INT	324	310	295	280	264	248	230	212	193	174	153	132	110	87
	FULL	147	150	153	156	159	161	164	168	171	174	177	180	184	187
AMC	MINI	5	10	15	21	26	32	38	45	51	58	65	72	80	87
	SUB	47	45	43	42	40	38	36	34	31	29	27	24	21	19
	COM	194	195	196	197	198	199	200	201	202	203	204	205	205	206
	INT	39	40	41	42	42	43	44	45	46	46	47	48	49	50
	FULL	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FOREIGN	MINI	592	605	619	633	647	662	677	693	708	724	741	758	775	792
	SUB	523	535	548	560	573	587	600	614	629	643	658	674	689	705
	COM	164	165	166	166	166	167	167	168	168	168	168	168	168	168
	INT	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	FULL	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 2-6. Vehicle Sales by Vehicle Class and Model Year.

VEHICLE CLASS	MODEL YEAR													
	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
MINI	816	870	927	986	1046	1109	1172	1240	1308	1379	1452	1528	1605	1684
SUBCOM	1579	1645	1714	1785	1857	1933	2009	2088	2170	2253	2341	2429	2520	2615
COMPACT	2489	2470	2451	2428	2404	2379	2352	2324	2293	2260	2225	2189	2149	2108
INTER	2749	2840	2934	3031	3128	3230	3334	3440	3550	3662	3776	3897	4017	4141
FULL	2187	2175	2163	2149	2133	2115	2097	2078	2057	2034	2010	1984	1957	1927

Table 2-7. Distribution of Vehicles by Vehicle Class and Fiscal Year.

FISCAL YEAR	VEHICLE CLASS					
	MINI	SUBCOM	COMPACT	INTER	FULL	TOTAL
1977	1950	13734	19898	23403	35733	94718
1978	2731	14550	20794	24189	33720	95984
1979	3554	15306	21614	24991	31810	97275
1980	4424	15988	22342	25836	30019	98609
1981	5324	16566	22955	26740	28397	99982
1982	6254	17062	23451	27677	26944	101388
1983	7197	17522	23812	28635	25666	102832
1984	8140	17992	24036	29626	24640	104434
1985	9057	18514	24149	30659	23862	106241
1986	9921	19117	24158	31702	23251	108149
1987	10726	19788	24074	32766	22774	110128
1988	11498	20522	23932	33854	22383	112189
1989	12251	21290	23736	34954	22007	114238
1990	12999	22098	23492	36065	21648	116302

Table 2-8. Total Accident Exposure Relative to 1977 and Average Vehicle Weights by Class.

FISCAL YEAR	CASE VEHICLE	OTHER VEHICLE	MINI	SUBCOM	COMPACT	INTER	FULL
1977	1.000	1.000	1969.	2378.	3140.	3876.	4441.
1978	1.012	1.015	1959.	2429.	3171.	3862.	4433.
1979	1.026	1.030	1953.	2451.	3171.	3820.	4415.
1980	1.040	1.046	1941.	2448.	3158.	3776.	4372.
1981	1.055	1.061	1926.	2433.	3142.	3734.	4315.
1982	1.071	1.075	1915.	2415.	3125.	3677.	4234.
1983	1.088	1.091	1906.	2396.	3099.	3595.	4143.
1984	1.107	1.109	1898.	2371.	3065.	3512.	4057.
1985	1.128	1.129	1892.	2339.	3018.	3434.	3972.
1986	1.148	1.147	1887.	2306.	2969.	3366.	3895.
1987	1.169	1.165	1883.	2277.	2926.	3310.	3832.
1988	1.191	1.185	1880.	2254.	2888.	3265.	3780.
1989	1.213	1.205	1878.	2236.	2856.	3229.	3737.
1990	1.235	1.225	1877.	2222.	2829.	3200.	3704.

1977 VEHICLE MILES FOR AUTOS IS 0.1052E+07 (Millions of Vehicle Miles)

and "other" vehicle (including trucks) usage between now and 1990, as well as the exposure-weighted mean vehicle weights. Finally, Tables 2-9 and 2-10 show the exposure probabilities for the "case" vehicle and "other" vehicle, subdivided by vehicle class. Table 2-9 may be interpreted as follows: given an accident in 1979, the probability that the "case" vehicle is a subcompact is 0.164. In any given year, these probabilities sum to unity. Similarly, Table 2-10 gives the probability that the "other" vehicle is in a specified class, given that a vehicle-to-vehicle accident has occurred. The growth in the number of accidents between now and 1990 is given by the "case" vehicle probabilities of Table 2-8.

Table 2-9. Accident Exposure for Automobiles (Case Vehicle) by Vehicle Class and Fiscal Year.

FISCAL YEAR	VEHICLE CLASS MINI	SUBCOM	COMPACT	INTER	FULL
1977	0.026	0.156	0.219	0.252	0.347
1978	0.036	0.161	0.225	0.257	0.321
1979	0.045	0.164	0.230	0.263	0.298
1980	0.055	0.166	0.233	0.268	0.277
1981	0.064	0.168	0.234	0.274	0.260
1982	0.072	0.170	0.234	0.279	0.244
1983	0.080	0.172	0.232	0.284	0.232
1984	0.087	0.174	0.229	0.289	0.221
1985	0.093	0.177	0.224	0.294	0.212
1986	0.098	0.180	0.219	0.298	0.205
1987	0.103	0.183	0.214	0.302	0.198
1988	0.108	0.186	0.208	0.306	0.191
1989	0.112	0.190	0.202	0.310	0.185
1990	0.117	0.194	0.196	0.314	0.179

Table 2-10. Other Vehicle Exposure by Vehicle Class and Fiscal Year.

FISCAL YEAR	VEHICLE CLASS MINI	SUBCOM	COMPACT	INTER	FULL	SM TRUCK	MED TRUCK	LG TRUCK
1977	0.021	0.126	0.176	0.202	0.279	0.109	0.055	0.033
1978	0.029	0.129	0.181	0.206	0.257	0.111	0.055	0.033
1979	0.036	0.131	0.184	0.210	0.238	0.111	0.056	0.033
1980	0.044	0.133	0.186	0.214	0.222	0.112	0.056	0.034
1981	0.051	0.134	0.187	0.219	0.207	0.111	0.056	0.034
1982	0.058	0.136	0.187	0.223	0.196	0.111	0.055	0.033
1983	0.064	0.138	0.186	0.228	0.186	0.110	0.055	0.034
1984	0.070	0.140	0.183	0.232	0.177	0.110	0.055	0.033
1985	0.075	0.142	0.180	0.236	0.170	0.110	0.055	0.033
1986	0.079	0.144	0.176	0.240	0.165	0.108	0.055	0.033
1987	0.083	0.147	0.172	0.244	0.159	0.108	0.054	0.032
1988	0.087	0.150	0.168	0.247	0.154	0.107	0.053	0.032
1989	0.091	0.154	0.163	0.251	0.150	0.106	0.053	0.032
1990	0.095	0.157	0.159	0.255	0.145	0.105	0.053	0.032

The following is a series of four tables (each of which covers three pages). Each of the four tables is a probability distribution by vehicle class, fiscal year, and restraint type, for schemes 14 and 14a as follows:

a. Scheme 14; driver (Table 2-11)
b. Scheme 14; passenger (Table 2-12)
c. Scheme 14a; driver (Table 2-13)
d. Scheme 14a; passenger (Table 2-14)

In a given fiscal year, a number in the tables is the probability of an accident involving a specified vehicle class and restraint type, given the involvement in an accident of a "case" vehicle. For example, given an accident, the probability that the accident involves an intermediate car with a modified GM 1972 ACRS in the driver position in 1983 is 0.037 with scheme 14 (see Table 2-11). In any given year, the probabilities sum to unity in a given seating position, since the restraint types and vehicle classes are all-inclusive. Once having these probabilities, occupancy by seat position is used to calculate injury probabilities (AIS 0-6). Restraint system usage rates are then used to redistribute the injury involvements among the six restraint types and a seventh classification--unrestrained.

Table 2-11. Driver Restraint Probabilities by Vehicle Class and Fiscal Year, Scheme 14.

BASE 3-PT HARNESS

FISCAL YEAR	VEHICLE CLASS MINI	SUBCOM	COMPACT	INTER	FULL
1977	0.026	0.156	0.219	0.252	0.347
1978	0.036	0.161	0.225	0.257	0.321
1979	0.045	0.164	0.230	0.263	0.298
1980	0.055	0.166	0.233	0.268	0.277
1981	0.054	0.168	0.234	0.274	0.239
1982	0.048	0.152	0.211	0.249	0.196
1983	0.042	0.128	0.179	0.211	0.158
1984	0.035	0.106	0.148	0.176	0.126
1985	0.029	0.086	0.121	0.144	0.099
1986	0.023	0.069	0.096	0.115	0.076
1987	0.018	0.053	0.074	0.090	0.057
1988	0.013	0.040	0.056	0.068	0.041
1989	0.009	0.029	0.040	0.049	0.029
1990	0.006	0.021	0.028	0.034	0.020

GM 1972 AIR BAG

FISCAL YEAR	VEHICLE CLASS MINI	SUBCOM	COMPACT	INTER	FULL
1977	0.	0.	0.	0.	0.
1978	0.	0.	0.	0.	0.
1979	0.	0.	0.	0.	0.
1980	0.	0.	0.	0.	0.
1981	0.	0.	0.	0.	0.021
1982	0.	0.	0.017	0.025	0.030
1983	0.	0.	0.033	0.036	0.030
1984	0.	0.	0.034	0.037	0.029
1985	0.	0.	0.031	0.036	0.028
1986	0.	0.	0.027	0.034	0.026
1987	0.	0.	0.024	0.030	0.022
1988	0.	0.	0.021	0.026	0.019
1989	0.	0.	0.018	0.022	0.015
1990	0.	0.	0.014	0.018	0.012

Table 2-11. Driver Restraint Probabilities by Vehicle Class and Fiscal Year, Scheme 14 (Continued)

MODIFIED GM 1972 ACRS

FISCAL YEAR	VEHICLE CLASS MINI	SUBCOM	COMPACT	INTER	FULL
1977	0.	0.	0.	0.	0.
1978	0.	0.	0.	0.	0.
1979	0.	0.	0.	0.	0.
1980	0.	0.	0.	0.	0.
1981	0.	0.	0.	0.	0.
1982	0.	0.005	0.002	0.006	0.019
1983	0.	0.012	0.012	0.037	0.044
1984	0.003	0.020	0.035	0.077	0.066
1985	0.009	0.029	0.059	0.113	0.085
1986	0.015	0.037	0.080	0.149	0.103
1987	0.022	0.043	0.099	0.183	0.118
1988	0.029	0.048	0.115	0.213	0.131
1989	0.035	0.052	0.128	0.239	0.140
1990	0.041	0.054	0.139	0.262	0.147

ADVANCED AIR BAG

FISCAL YEAR	VEHICLE CLASS MINI	SUBCOM	COMPACT	INTER	FULL
1977	0.	0.	0.	0.	0.
1978	0.	0.	0.	0.	0.
1979	0.	0.	0.	0.	0.
1980	0.	0.	0.	0.	0.
1981	0.	0.	0.	0.	0.
1982	0.	0.	0.	0.	0.
1983	0.	0.	0.	0.	0.
1984	0.	0.	0.	0.	0.
1985	0.	0.	0.	0.	0.
1986	0.	0.	0.	0.	0.
1987	0.	0.	0.	0.	0.
1988	0.	0.	0.	0.	0.
1989	0.	0.	0.	0.	0.
1990	0.	0.	0.	0.	0.

Table 2-11. Driver Restraint Probabilities by Vehicle Class and Fiscal Year, Scheme 14 (Continued).

CURRENT PASSIVE BELTS

FISCAL YEAR	VEHICLE CLASS MINI	SUBCOM	COMPACT	INTER	FULL
1977	0.	0.	0.	0.	0.
1978	0.	0.	0.	0.	0.
1979	0.	0.	0.	0.	0.
1980	0.	0.	0.	0.	0.
1981	0.010	0.	0.	0.	0.
1982	0.025	0.013	0.004	0.	0.
1983	0.038	0.032	0.008	0.	0.
1984	0.049	0.048	0.012	0.	0.
1985	0.055	0.061	0.014	0.	0.
1986	0.059	0.074	0.016	0.	0.
1987	0.063	0.086	0.017	0.	0.
1988	0.066	0.098	0.017	0.	0.
1989	0.068	0.109	0.016	0.	0.
1990	0.070	0.119	0.014	0.	0.

ADVANCED PASSIVE BELTS

FISCAL YEAR	VEHICLE CLASS MINI	SUBCOM	COMPACT	INTER	FULL
1977	0.	0.	0.	0.	0.
1978	0.	0.	0.	0.	0.
1979	0.	0.	0.	0.	0.
1980	0.	0.	0.	0.	0.
1981	0.	0.	0.	0.	0.
1982	0.	0.	0.	0.	0.
1983	0.	0.	0.	0.	0.
1984	0.	0.	0.	0.	0.
1985	0.	0.	0.	0.	0.
1986	0.	0.	0.	0.	0.
1987	0.	0.	0.	0.	0.
1988	0.	0.	0.	0.	0.
1989	0.	0.	0.	0.	0.
1990	0.	0.	0.	0.	0.

Table 2-12. Passenger Restraint Probabilities by Vehicle Class and Fiscal Year, Scheme 14.

BASE 3-PT HARNESS

FISCAL YEAR	VEHICLE CLASS MINI	SUBCOM	COMPACT	INTER	FULL
1977	0.026	0.156	0.219	0.252	0.347
1978	0.036	0.161	0.225	0.257	0.321
1979	0.045	0.164	0.230	0.263	0.298
1980	0.055	0.166	0.233	0.268	0.277
1981	0.054	0.168	0.234	0.274	0.260
1982	0.048	0.170	0.232	0.279	0.244
1983	0.042	0.153	0.208	0.253	0.212
1984	0.035	0.129	0.175	0.214	0.175
1985	0.029	0.107	0.145	0.179	0.143
1986	0.023	0.087	0.117	0.146	0.115
1987	0.018	0.070	0.093	0.117	0.091
1988	0.013	0.054	0.072	0.091	0.070
1989	0.009	0.041	0.054	0.069	0.052
1990	0.006	0.030	0.039	0.050	0.038

GM 1972 AIR BAG

FISCAL YEAR	VEHICLE CLASS MINI	SUBCOM	COMPACT	INTER	FULL
1977	0.	0.	0.	0.	0.
1978	0.	0.	0.	0.	0.
1979	0.	0.	0.	0.	0.
1980	0.	0.	0.	0.	0.
1981	0.	0.	0.	0.	0.
1982	0.	0.	0.	0.	0.
1983	0.	0.	0.002	0.003	0.002
1984	0.	0.	0.004	0.006	0.004
1985	0.	0.	0.005	0.009	0.006
1986	0.	0.	0.004	0.009	0.006
1987	0.	0.	0.004	0.008	0.005
1988	0.	0.	0.004	0.007	0.005
1989	0.	0.	0.003	0.006	0.004
1990	0.	0.	0.003	0.005	0.004

Table 2-12. Passenger Restraint Probabilities by Vehicle Class and Fiscal Year, Scheme 14 (Continued).

MODIFIED GM 1972 ACRS

FISCAL YEAR	VEHICLE CLASS MINI	SUBCOM	COMPACT	INTER	FULL
1977	0.	0.	0.	0.	0.
1978	0.	0.	0.	0.	0.
1979	0.	0.	0.	0.	0.
1980	0.	0.	0.	0.	0.
1981	0.	0.	0.	0.	0.
1982	0.	0.	0.002	0.	0.
1983	0.	0.005	0.019	0.029	0.018
1984	0.	0.014	0.042	0.069	0.043
1985	0.002	0.024	0.067	0.106	0.064
1986	0.008	0.032	0.090	0.143	0.084
1987	0.015	0.039	0.111	0.177	0.102
1988	0.023	0.045	0.127	0.208	0.117
1989	0.030	0.049	0.140	0.236	0.129
1990	0.036	0.052	0.151	0.259	0.138

ADVANCED AIR BAG

FISCAL YEAR	VEHICLE CLASS MINI	SUBCOM	COMPACT	INTER	FULL
1977	0.	0.	0.	0.	0.
1978	0.	0.	0.	0.	0.
1979	0.	0.	0.	0.	0.
1980	0.	0.	0.	0.	0.
1981	0.	0.	0.	0.	0.
1982	0.	0.	0.	0.	0.
1983	0.	0.	0.	0.	0.
1984	0.	0.	0.	0.	0.
1985	0.	0.	0.	0.	0.
1986	0.	0.	0.	0.	0.
1987	0.	0.	0.	0.	0.
1988	0.	0.	0.	0.	0.
1989	0.	0.	0.	0.	0.
1990	0.	0.	0.	0.	0.

Table 2-12. Passenger Restraint Probabilities by Vehicle Class and Fiscal Year, Scheme 14 (Continued).

CURRENT PASSIVE BELTS

FISCAL YEAR	VEHICLE CLASS MINI	SUBCOM	COMPACT	INTER	FULL
1977	0.	0.	0.	0.	0.
1978	0.	0.	0.	0.	0.
1979	0.	0.	0.	0.	0.
1980	0.	0.	0.	0.	0.
1981	0.010	0.	0.	0.	0.
1982	0.025	0.	0.	0.	0.
1983	0.038	0.014	0.003	0.	0.
1984	0.051	0.031	0.007	0.	0.
1985	0.062	0.046	0.008	0.	0.
1986	0.067	0.060	0.007	0.	0.
1987	0.070	0.074	0.006	0.	0.
1988	0.072	0.088	0.006	0.	0.
1989	0.074	0.100	0.005	0.	0.
1990	0.074	0.112	0.004	0.	0.

ADVANCED PASSIVE BELTS

FISCAL YEAR	VEHICLE CLASS MINI	SUBCOM	COMPACT	INTER	FULL
1977	0.	0.	0.	0.	0.
1978	0.	0.	0.	0.	0.
1979	0.	0.	0.	0.	0.
1980	0.	0.	0.	0.	0.
1981	0.	0.	0.	0.	0.
1982	0.	0.	0.	0.	0.
1983	0.	0.	0.	0.	0.
1984	0.	0.	0.	0.	0.
1985	0.	0.	0.	0.	0.
1986	0.	0.	0.	0.	0.
1987	0.	0.	0.	0.	0.
1988	0.	0.	0.	0.	0.
1989	0.	0.	0.	0.	0.
1990	0.	0.	0.	0.	0.

Table 2-13. Driver Restraint Probabilities by Vehicle Class and Fiscal Year, Scheme 14a.

BASE 3-PT HARNESS

FISCAL YEAR	VEHICLE CLASS MINI	SUBCOM	COMPACT	INTER	FULL
1977	0.026	0.156	0.219	0.252	0.347
1978	0.036	0.161	0.225	0.257	0.321
1979	0.045	0.164	0.230	0.263	0.298
1980	0.055	0.166	0.233	0.268	0.277
1981	0.054	0.168	0.234	0.274	0.239
1982	0.048	0.152	0.211	0.249	0.196
1983	0.042	0.128	0.179	0.211	0.158
1984	0.035	0.106	0.148	0.176	0.126
1985	0.029	0.086	0.121	0.144	0.099
1986	0.023	0.069	0.096	0.115	0.076
1987	0.018	0.053	0.074	0.090	0.057
1988	0.013	0.040	0.056	0.068	0.041
1989	0.009	0.029	0.040	0.049	0.029
1990	0.006	0.021	0.028	0.034	0.020

GM 1972 AIR BAG

FISCAL YEAR	VEHICLE CLASS MINI	SUBCOM	COMPACT	INTER	FULL
1977	0.	0.	0.	0.	0.
1978	0.	0.	0.	0.	0.
1979	0.	0.	0.	0.	0.
1980	0.	0.	0.	0.	0.
1981	0.	0.	0.	0.	0.021
1982	0.	0.	0.017	0.025	0.035
1983	0.	0.	0.035	0.036	0.042
1984	0.	0.	0.038	0.037	0.047
1985	0.	0.	0.035	0.036	0.047
1986	0.	0.	0.032	0.034	0.042
1987	0.	0.	0.028	0.030	0.037
1988	0.	0.	0.024	0.026	0.032
1989	0.	0.	0.021	0.022	0.026
1990	0.	0.	0.017	0.018	0.021

Table 2-13. Driver Restraint Probabilities by Vehicle Class and Fiscal Year, Scheme 14a (Continued).

MODIFIED GM 1972 ACRS

FISCAL YEAR	VEHICLE CLASS MINI	SUBCOM	COMPACT	INTER	FULL
1977	0.	0.	0.	0.	0.
1978	0.	0.	0.	0.	0.
1979	0.	0.	0.	0.	0.
1980	0.	0.	0.	0.	0.
1981	0.	0.	0.	0.	0.
1982	0.	0.005	0.	0.006	0.013
1983	0.	0.012	0.007	0.015	0.032
1984	0.	0.018	0.016	0.024	0.048
1985	0.	0.019	0.024	0.032	0.062
1986	0.	0.017	0.025	0.032	0.062
1987	0.	0.015	0.023	0.029	0.056
1988	0.	0.013	0.020	0.025	0.049
1989	0.	0.011	0.018	0.022	0.043
1990	0.	0.009	0.015	0.019	0.036

ADVANCED AIR BAG

FISCAL YEAR	VEHICLE CLASS MINI	SUBCOM	COMPACT	INTER	FULL
1977	0.	0.	0.	0.	0.
1978	0.	0.	0.	0.	0.
1979	0.	0.	0.	0.	0.
1980	0.	0.	0.	0.	0.
1981	0.	0.	0.	0.	0.
1982	0.	0.	0.002	0.	0.
1983	0.	0.	0.004	0.022	0.
1984	0.	0.003	0.014	0.053	0.
1985	0.002	0.011	0.032	0.082	0.004
1986	0.008	0.020	0.056	0.117	0.024
1987	0.015	0.028	0.079	0.154	0.048
1988	0.023	0.034	0.099	0.188	0.069
1989	0.030	0.040	0.116	0.217	0.087
1990	0.036	0.044	0.130	0.244	0.102

Table 2-13. Driver Restraint Probabilities by Vehicle Class and Fiscal Year, Scheme 14a (Continued).

CURRENT PASSIVE BELTS

FISCAL YEAR	VEHICLE CLASS MINI	SUBCOM	COMPACT	INTER	FULL
1977	0.	0.	0.	0.	0.
1978	0.	0.	0.	0.	0.
1979	0.	0.	0.	0.	0.
1980	0.	0.	0.	0.	0.
1981	0.010	0.	0.	0.	0.
1982	0.025	0.013	0.004	0.	0.
1983	0.038	0.032	0.008	0.	0.
1984	0.051	0.048	0.012	0.	0.
1985	0.062	0.061	0.012	0.	0.
1986	0.060	0.061	0.011	0.	0.
1987	0.053	0.055	0.010	0.	0.
1988	0.047	0.048	0.008	0.	0.
1989	0.040	0.042	0.007	0.	0.
1990	0.033	0.035	0.006	0.	0.

ADVANCED PASSIVE BELTS

FISCAL YEAR	VEHICLE CLASS MINI	SUBCOM	COMPACT	INTER	FULL
1977	0.	0.	0.	0.	0.
1978	0.	0.	0.	0.	0.
1979	0.	0.	0.	0.	0.
1980	0.	0.	0.	0.	0.
1981	0.	0.	0.	0.	0.
1982	0.	0.	0.	0.	0.
1983	0.	0.	0.	0.	0.
1984	0.	0.	0.	0.	0.
1985	0.	0.	0.	0.	0.
1986	0.007	0.013	0.	0.	0.
1987	0.017	0.032	0.	0.	0.
1988	0.025	0.050	0.	0.	0.
1989	0.034	0.068	0.	0.	0.
1990	0.041	0.085	0.	0.	0.

Table 2-14. Passenger Restraint Probabilities by Vehicle Class and Fiscal Year, Scheme 14a.

BASE 3-PT HARNESS

FISCAL YEAR	VEHICLE CLASS MINI	SUBCOM	COMPACT	INTER	FULL
1977	0.026	0.156	0.219	0.252	0.347
1978	0.036	0.161	0.225	0.257	0.321
1979	0.045	0.164	0.230	0.263	0.298
1980	0.055	0.166	0.233	0.268	0.277
1981	0.054	0.168	0.234	0.274	0.260
1982	0.048	0.170	0.234	0.279	0.244
1983	0.042	0.153	0.210	0.253	0.212
1984	0.035	0.129	0.177	0.214	0.175
1985	0.029	0.107	0.147	0.179	0.143
1986	0.023	0.087	0.119	0.146	0.115
1987	0.018	0.070	0.094	0.117	0.091
1988	0.013	0.054	0.073	0.091	0.070
1989	0.009	0.041	0.055	0.069	0.052
1990	0.006	0.030	0.040	0.050	0.038

GM 1972 AIR BAG

FISCAL YEAR	VEHICLE CLASS MINI	SUBCOM	COMPACT	INTER	FULL
1977	0.	0.	0.	0.	0.
1978	0.	0.	0.	0.	0.
1979	0.	0.	0.	0.	0.
1980	0.	0.	0.	0.	0.
1981	0.	0.	0.	0.	0.
1982	0.	0.	0.	0.	0.
1983	0.	0.	0.002	0.003	0.002
1984	0.	0.	0.004	0.006	0.004
1985	0.	0.	0.005	0.009	0.006
1986	0.	0.	0.004	0.009	0.006
1987	0.	0.	0.004	0.008	0.005
1988	0.	0.	0.004	0.007	0.005
1989	0.	0.	0.003	0.006	0.004
1990	0.	0.	0.003	0.005	0.004

MODIFIED GM 1972 ACRS

Table 2-14. Passenger Restraint Probabilities by Vehicle Class and Fiscal Year, Scheme 14a (Continued).

MODIFIED GM 1972 ACRS

FISCAL YEAR	VEHICLE CLASS MINI	SUBCOM	COMPACT	INTER	FULL
1977	0.	0.	0.	0.	0.
1978	0.	0.	0.	0.	0.
1979	0.	0.	0.	0.	0.
1980	0.	0.	0.	0.	0.
1981	0.	0.	0.	0.	0.
1982	0.	0.	0.	0.	0.
1983	0.	0.005	0.015	0.007	0.018
1984	0.	0.014	0.028	0.016	0.043
1985	0.	0.019	0.035	0.025	0.060
1986	0.	0.018	0.035	0.026	0.060
1987	0.	0.016	0.031	0.023	0.054
1988	0.	0.014	0.028	0.021	0.048
1989	0.	0.013	0.024	0.018	0.042
1990	0.	0.011	0.021	0.016	0.036

ADVANCED AIR BAG

FISCAL YEAR	VEHICLE CLASS MINI	SUBCOM	COMPACT	INTER	FULL
1977	0.	0.	0.	0.	0.
1978	0.	0.	0.	0.	0.
1979	0.	0.	0.	0.	0.
1980	0.	0.	0.	0.	0.
1981	0.	0.	0.	0.	0.
1982	0.	0.	0.	0.	0.
1983	0.	0.	0.002	0.022	0.
1984	0.	0.	0.012	0.053	0.
1985	0.002	0.005	0.030	0.082	0.004
1986	0.008	0.014	0.054	0.117	0.024
1987	0.015	0.022	0.078	0.154	0.048
1988	0.023	0.029	0.098	0.188	0.069
1989	0.030	0.035	0.115	0.217	0.087
1990	0.036	0.040	0.129	0.244	0.102

CURRENT PASSIVE BELTS

Table 2-14. Passenger Restraint Probabilities by Vehicle Class and Fiscal Year, Scheme 14a (Continued).

CURRENT PASSIVE BELTS

FISCAL YEAR	VEHICLE CLASS MINI	SUBCOM	COMPACT	INTER	FULL
1977	0.	0.	0.	0.	0.
1978	0.	0.	0.	0.	0.
1979	0.	0.	0.	0.	0.
1980	0.	0.	0.	0.	0.
1981	0.010	0.	0.	0.	0.
1982	0.025	0.	0.	0.	0.
1983	0.038	0.014	0.003	0.	0.
1984	0.051	0.031	0.007	0.	0.
1985	0.062	0.046	0.008	0.	0.
1986	0.060	0.048	0.007	0.	0.
1987	0.053	0.043	0.006	0.	0.
1988	0.047	0.038	0.006	0.	0.
1989	0.040	0.033	0.005	0.	0.
1990	0.033	0.029	0.004	0.	0.

ADVANCED PASSIVE BELTS

FISCAL YEAR	VEHICLE CLASS MINI	SUBCOM	COMPACT	INTER	FULL
1977	0.	0.	0.	0.	0.
1978	0.	0.	0.	0.	0.
1979	0.	0.	0.	0.	0.
1980	0.	0.	0.	0.	0.
1981	0.	0.	0.	0.	0.
1982	0.	0.	0.	0.	0.
1983	0.	0.	0.	0.	0.
1984	0.	0.	0.	0.	0.
1985	0.	0.	0.	0.	0.
1986	0.007	0.013	0.	0.	0.
1987	0.017	0.032	0.	0.	0.
1988	0.025	0.050	0.	0.	0.
1989	0.034	0.068	0.	0.	0.
1990	0.041	0.085	0.	0.	0.

SECTION 3
CHARACTERIZING AIR CUSHION PERFORMANCE IN FRONTAL IMPACTS

Estimates of the performance of three different driver air cushion systems were obtained for three different groupings of vehicle classes at barrier equivalent velocities (BEVs) between threshold-of-deployment levels (∿11 mph) and 50 mph.

The passenger vehicle classes were collapsed into three groupings as follows:

1. Minivehicle — This class is unchanged over that defined previously.

2. Compact/ Subcompact — As the designation would indicate, this class is made up of the compact and sub-compact vehicle classes as defined previously.

3. Full-Size — This class combines the full-size and intermediate classes that have been used previously.

The three restraint systems chosen were:

1. The 1974-1976 GM ACRS -- This system has been defined in Section 3.1 of Volume I.

2. A Modified GM ACRS -- This system has similarly been defined in Volume I. It is the above system, modified as necessary for small car application. It has been assumed that the improvements might be incorporated eventually in full-size vehicles and hence this system's performance in large cars was estimated.

3. A "Current Technology" air cushion system -- This system is described in the latter portion of Section 3.1, Volume I. Its performance was estimated in each of the three vehicle class groupings.

Performance is quantized as the expected peak resultant chest g level (-3ms) averaged over the different possible frontal accident modes and occupant sizes. In a subsequent section, these g levels will be associated with a distribution of expected injury levels (AIS levels).

Figure 3-1 is the result of this section, Figure 3-1a being for the "Prior Technology" air cushion systems (items 1 and 2 above) and Figure 3-1b being applicable to "Current Technology" systems.

The curves of Figure 3-1 were constructed using a combination of experimental (car crash) data, computer simulation, and engineering judgment. The later two were needed because crash data for existing systems did not cover the required velocity range and certain systems have yet to be applied to all necessary vehicle classes.

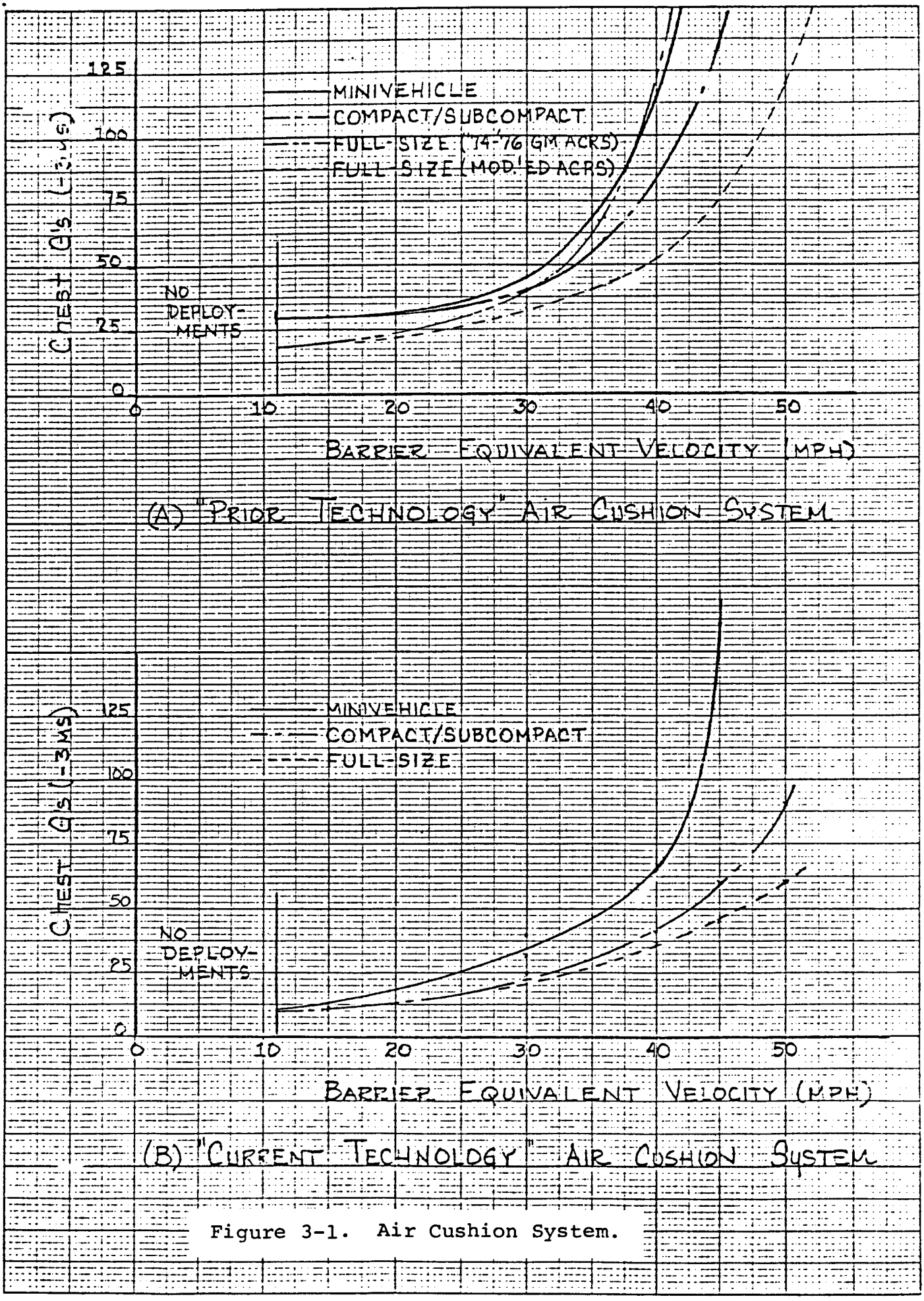

Figure 3-1. Air Cushion System.

"Prior Technology" Air Cushion Performance

The following laboratory data were available to us for estimating the performance of the 1974-1976 GM ACRS driver restraint.

1. A series of barrier impacts of 1975 GM ACRS-equipped Oldsmobile 98s-- Tests were conducted at nominally 35 mph and 40 mph with a 50th percentile dummy driver. These data were used to estimate performance of this system in full-size vehicles.

2. A head-on impact of a 1973 GM ACRS-equipped Chevrolet Impala with an identical vehicle at a closing velocity of 60 mph-- The data from this test was used to represent performance of the system in full-size vehicles at 30 mph.

3. Two SAE barrier impacts of 1974 Vegas-- The two vehicles, impacted at nominally 30 mph, were equipped with a modified GM ACRS driver restraint system. That is, the GM ACRS originally designed for use in large cars was modified by Minicars to perform satisfactorily in the Vega. These data were used to characterize the performance of the modified GM ACRS system at its design impact condition in the subcompact vehicle.

Performance under conditions other than those for which we had data was estimated using a simple one-dimensional driver airbag model, DBAG 2. First, the test data above was used to adjust the restraint descriptors in DBAG 2 to yield driver whole body decelerations matching those observed in the crashes. Secondly, crash motions simulating those impact velocities for which data was lacking were input to the program to predict driver deceleration levels under these conditions.

The results to this point where compiled in an internal Minicars' report entitled "Engineering Report, Estimate of ACRS Performance"* prepared by Lonney Pauls, a consultant to Minicars.

*This report is on file at Minicars, Inc.

The DBAG 2 simulations did not take into account vehicle intrusion and pitching which would certainly degrade air cushion performance at the higher impact severities. Only the minivehicle was "restraint limited" rather than "vehicle limited" (i.e., considering intrusion effects would not significantly change the results for this vehicle class grouping.) For the other two vehicle class groupings, the DBAG 2 simulation data above 30-35 mph was modified by engineering judgment. The exception to this was the full-size vehicle equipped with the 1974-1976 GM ACRS where test data existed to 40 mph. An extrapolation beyond this point, based on the experimental data trend, was done in this case.

"Current Technology" Air Cushion Performance

The following laboratory crash data were available to us for estimating the performance of the current-technology driver air cushion.

1. A series of barrier impacts of 1974 Ford LTDs equipped with a "current technology" driver ACRS -- These tests were used to represent the performance of this system in full-size vehicles at BEVs from 30 to 45 mph.

2. A series of barrier and car-to-car frontal impacts of 1975 Volvo 244s equipped with advanced air cushions -- These tests have been conducted under a variety of real-world frontal impact conditions at BEVs ranging from 30 mph to 50 mph. These data were used to represent the performance of "current technology" air cushions when installed in cars of the compact/subcompact vehicle grouping.

Again, DBAG 2 simulations were used to extrapolate the data to lower velocities and to model the "current technology" system in a minivehicle*. Full-size and compact/subcompact vehicle data above 45-50 mph were provided by exercising engineering judgment.

*Honda Civic crash performance was used to represent minivehicle crash characteristics.

SECTION 4

SUMMARY OF BENEFIT METHODOLOGY

This Section briefly describes the methodology used to generate the "A" and "B" tables contained in the Appendix. The following are descriptions of the important arrays, distributions, and transformations used in the methodology.

RESTRAINED F-ARRAY (F^{res}) gives the probability that a particular injury level (AIS) is incurred for a particular ΔV collision for a given restraint system, vehicle class, and seat position.

UNRESTRAINED F-ARRAY (F^{uns}) gives the probability that a particular injury level (AIS) is incurred for a particular ΔV collision. F^{uns} is derived from the adjusted MDAI file.

G vs ΔV CURVES are curves of accelerations, in g's, encountered as a function of ΔV for the various restraint systems considered and for the unrestrained case (corresponding to F^{uns}). Data for these curves were obtained as described in Section 3.

ΔV DISTRIBUTIONS [$N(\Delta V)$] are the numbers of occupant injuries/fatalities in the frontal mode per ΔV increment (5 mph) by year and seat position. These are derived from relative velocity distributions, obtained in turn from adjusted MDAI files and vehicle weight distributions and injury exposures relative to 1977.

RPROB DISTRIBUTIONS are driver/passenger restraint probabilities by vehicle class and year, obtained as indicated in Section 2, multiplied by the appropriate restraint usage rate.

The restrained F-array, F^{res}, for a given vehicle class (VEH), seat position (SP), and restraint type (RST), is determined from the G vs ΔV curves and the unrestrained F-array, F^{uns}, as follows: The velocity bounds of the kth-ΔV row in F^{res} are used in the G vs ΔV curves to determine the corresponding G-values from the restrained curve; these G-values are then used to obtain the associated lower and upper velocities

V_l^{unr} and V_u^{unr} from the unrestrained curve. [The "B" tables were produced by dividing the G-values for the airbags bags by 1.5 before determining V_l^{unr} and V_u^{unr}.] The probabilities for each injury level bounded by V_l^{unr} and V_u^{unr} in the unrestrained F-array are obtained by weighting and summing across ΔV within that velocity range determined by V_l^{unr} and V_u^{unr}, and the probabilities are then transferred to the corresponding injury levels in the F^{res} array.

The total number of injuries in the kth velocity range $N(\Delta V_k)$ is determined from the ΔV distribution. F^{res} times $N(\Delta V_k)$ times RPROB(VEH,SP,RST) is then the number of injuries in the ith injury level, kth velocity range, for the given vehicle class, seat position, and restraint type for a given year and implementation scheme. Summing this product over all ΔVs, vehicle classes, seat positions, and restraint types results in NINJ(AIS,YR,IMPLM), the total injuries in the frontal mode by AIS, year [YR], and implementation scheme [IMPLM]. Summing NINJ appropriately over injury levels results in the number of moderate [AIS 1 + AIS 2], severe [AIS 3 + AIS 4 + AIS 5], and fatal [AIS 6] injuries, reported in Tables A-1 through A-13 and B-1 through B-13 of the Appendix.

$$\sum_{VEH} \sum_{SP} \sum_{RST} RPROB(VEH, SP, RST) = 1$$

$$AIS, YR, IMPLM$$

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APPENDIX

TO: MINICARS, INC.

FROM: KINETIC RESEARCH, INC.
4513 VERNON BOULEVARD
MADISON, WISCONSIN 53705

SUBJECT: RESULTS OF RESTRAINT IMPLEMENTATION ANALYSIS

DATE: 21 JUNE 1977

COMMENTS:

TABLES A-(1-13) DIFFER FROM TABLES B-(1-13) ONLY IN THE G-FORCE FACTOR APPLIED TO THE 3 AIR-BAG RESTRAINT SYSTEMS (ADVANCED, GM 1972, AND MODIFIED GM 1972 ACRS). A-TABLES ASSUME AIR-BAG G'S = UNRESTRAINED G'S. B-TABLES ASSUME AIR-BAG G'S = 1.5 TIMES UNRESTRAINED G'S.

IMPLEMENTATION SCHEMES 14 AND 14A REFER TO THE PROBABILITY SCHEMES (DRIVER/PASSENGER RESTRAINT PROBABILITIES BY VEHICLE CLASS AND FISCAL YEAR) PROVIDED TO US BY MINICARS.

SCHEME 0 ASSUMES THE SAME PROBABILITIES FOR "BASE 3-PT HARNESS" AS SCHEMES 14 AND 14A (PROBABILITIES ARE IDENTICAL FOR THIS RESTRAINT TYPE), BUT THEN ASSUMES THAT ALL CARS NOT EQUIPPED WITH A "BASE 3-PT HARNESS" ARE EQUIPPED WITH "GM 1972 AIR BAGS".

SCHEME 4 IS SIMPLY THE PROJECTION OF THE CURRENT VEHICLE POPULATION LOSSES (TAKING INTO ACCOUNT ONLY THE PROJECTED INCREASES OF "INJURY EXPOSURE RELATIVE TO 1977" AND CHANGING "AVERAGE VEHICLE WEIGHT" DISTRIBUTION, AND ASSUMING NO NEW RESTRAINT TYPES ARE INTRODUCED). THIS SCHEME SERVES AS A BASELINE AGAINST WHICH SCHEMES 0, 14, AND 14A ARE COMPARED.

TABLE HEADING "MODERATE" COMBINES AIS LEVELS 1 AND 2; "SEVERE" AIS LEVELS 3, 4, AND 5; AND "FATALITY" AIS LEVEL 6.

TABLE A- 1

G-FACTOR = 1.0

NUMBER OF INJURY AND FATALITY LOSSES BY YEAR
ASSUMING IMPLEMENTATION SCHEME 14

YEAR	MODERATE	SEVERE	FATALITY
1977	563392.	47114.	14676.
1978	569989.	47762.	14927.
1979	576755.	48453.	15212.
1980	584670.	49276.	15572.
1981	589095.	49689.	15768.
1982	584754.	48934.	15472.
1983	571741.	47315.	14944.
1984	555411.	45368.	14275.
1985	542361.	43769.	13745.
1986	529927.	42282.	13267.
1987	520047.	40964.	12788.
1988	512828.	39942.	12435.
1989	508997.	39249.	12196.
1990	506470.	38717.	12006.

TABLE A- 2

G-FACTOR = 1.0

NUMBER OF INJURY AND FATALITY LOSSES BY YEAR
ASSUMING IMPLEMENTATION SCHEME 14A

YEAR	MODERATE	SEVERE	FATALITY
1977	563392.	47114.	14676.
1978	569989.	47762.	14927.
1979	576755.	48453.	15212.
1980	584670.	49276.	15572.
1981	588815.	49644.	15738.
1982	585475.	49104.	15554.
1983	572377.	47509.	15064.
1984	559254.	45680.	14489.
1985	531396.	42459.	13318.
1986	504704.	39389.	12276.
1987	478324.	36413.	11243.
1988	460684.	34157.	10438.
1989	444788.	32175.	9748.
1990	432296.	30585.	9201.

TABLE A- 3

G-FACTOR = 1.0

NUMBER OF INJURY AND FATALITY LOSSES BY YEAR
ASSUMING IMPLEMENTATION SCHEME 4

YEAR	MODERATE	SEVERE	FATALITY
1977	563392.	47114.	14676.
1978	569989.	47762.	14927.
1979	576755.	48453.	15212.
1980	584670.	49276.	15572.
1981	592577.	50048.	15877.
1982	600874.	50808.	16139.
1983	611717.	51876.	16562.
1984	621798.	52805.	16887.
1985	633896.	53946.	17312.
1986	644464.	54942.	17679.
1987	655706.	55928.	17998.
1988	666765.	56924.	18344.
1989	680069.	58106.	18751.
1990	693539.	59315.	19173.

TABLE A- 4

G-FACTOR = 1.0

NUMBER OF INJURY AND FATALITY LOSSES BY YEAR
ASSUMING IMPLEMENTATION SCHEME 0

YEAR	MODERATE	SEVERE	FATALITY
1977	563392.	47114.	14676.
1978	569989.	47762.	14927.
1979	576755.	48453.	15212.
1980	584670.	49276.	15572.
1981	587525.	49695.	15799.
1982	579622.	49337.	15833.
1983	562171.	48457.	15828.
1984	542872.	47406.	15721.
1985	527975.	46705.	15734.
1986	513634.	46069.	15774.
1987	501992.	45520.	15760.
1988	493061.	45212.	15842.
1989	487576.	45169.	16002.
1990	483940.	45189.	16144.

TABLE A- 5

G-FACTOR = 1.0

SUMMARY OF BENEFITS FROM IMPLEMENTATION SCHEME 14
(BASELINE PROJECTION LOSSES MINUS SCHEME-14 LOSSES)

YEAR	MODERATE	SEVERE	FATALITY
1977	0.	0.	0.
1978	0.	0.	0.
1979	0.	0.	0.
1980	0.	0.	0.
1981	3482.	359.	110.
1982	16120.	1874.	666.
1983	39976.	4561.	1618.
1984	66387.	7436.	2612.
1985	91535.	10178.	3566.
1986	114536.	12661.	4412.
1987	135659.	14963.	5210.
1988	153937.	16982.	5909.
1989	171072.	18857.	6554.
1990	187069.	20598.	7167.

TABLE A- 6

G-FACTOR = 1.0

SUMMARY OF BENEFITS FROM IMPLEMENTATION SCHEME 14A
(BASELINE PROJECTION LOSSES MINUS SCHEME-14A LOSSES)

YEAR	MODERATE	SEVERE	FATALITY
1977	0.	0.	0.
1978	0.	0.	0.
1979	0.	0.	0.
1980	0.	0.	0.
1981	3762.	404.	139.
1982	15399.	1704.	585.
1983	39340.	4367.	1498.
1984	62545.	7124.	2398.
1985	102500.	11487.	3994.
1986	139760.	15553.	5403.
1987	177382.	19514.	6755.
1988	206081.	22767.	7906.
1989	235281.	25931.	9003.
1990	261243.	28730.	9972.