BY THE COMPTROLLER GENERAL 109980

Report To The Congress

OF THE UNITED STATES

10857

Passive Restraints For Automobile Occupants-- A Closer Look

Passive restraints for front-seat occupants will be required in all cars after September 1, 1983. Either an air bag or an automatic seat belt, the two prominent systems being considered, will serve this function. A solid chemical, sodium azide, will be used to generate the gas to inflate the air bag.

These systems offer life-saving and injury-prevention potential; however, the Department of Transportation's quantification of the benefits lends a degree of certainty not fully supported by the test data. Industry's testing indicates that a deploying air bag may be a danger to out-of-position occupants. The Department should perform additional testing to determine if modifications are needed to the Federal standard to address this problem.

In addition, the Environmental Protection Agency and the Department of Labor should give high priority to assure research is performed to measure the health and safety risks in the production and disposal of sodium azide.

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COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

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To the President of the Senate and the
Speaker of the House of Representatives

This is our report on the Department of Transportation's rule which mandates passive restraint systems for front seat occupants in automobiles. We made this review to provide the Congress with information on the Department's effectiveness and cost estimates for the mandated systems as well as the potential health and safety hazards associated with the use of sodium azide in air bag systems.

We made our review pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), and the Accounting and Auditing Act of 1950 (31 U.S.C. 67).

We are sending copies of this report to the Director, Office of Management and Budget; the Secretaries of Transportation and Labor; the Administrator of the Environmental Protection Agency; and other interested parties.

Comptroller General
of the United States

AGC 00029
AGC 00024
AGC 00009
AGC 00425
AGC 00494
DLG 00398
DLG 02282

Testing
motor vehicle safety
motor vehicle standards
Transportation: safety
traffic accidents
safety standards
health hazards
research & development

COMPTROLLER GENERAL'S
REPORT TO THE CONGRESS

PASSIVE RESTRAINTS FOR AUTOMOBILE OCCUPANTS--A CLOSER LOOK

D I G E S T

All new cars manufactured after September 1, 1983, will be required to have passive restraint systems requiring no action by occupants. The two systems being considered are air bags and automatic seat belts.

The Secretary of Transportation mandated passive front seat restraint systems to overcome the public's reluctance to buckle up their seat belts. He based his 1977 decision, in part, on the following premises:

--Passive restraints, when fully integrated into the U.S. automotive fleet, will prevent about 9,000 traffic deaths and 65,000 serious injuries annually.

--Use of sodium azide as the generator of gas for air bags would present no insurmountable health, safety, or environmental problems.

--Passive restraints can be installed at a reasonable cost to the customer, and the cost of the systems will be more than offset by insurance savings.

Passive restraints offer life-saving and injury-prevention potential. However, Transportation's specific quantification of the benefits lends a degree of certainty not fully supported by the test data.

Moreover, testing conducted after the mandate indicates a potential danger from a deploying air bag may exist for out-of-position occupants.

Many questions are unanswered concerning the health and safety risks of using the chemical sodium azide to inflate air bags. In addition, the estimates of air bag cost and insurance savings are optimistic.

Because of the potential danger for out-of-position occupants, GAO recommends that the

Secretary require additional testing by the National Highway Traffic Safety Administration on this problem. Depending on the outcome of this testing, the Secretary should consider appropriate modifications to the passive restraint standard including, if warranted, additional performance requirements covering the out-of-position occupant problem.

Because of the importance of the mandate, both in terms of cost and safety to the American public, the actual experience with passive restraints must be evaluated. To develop a program that will avoid conflicting interpretations of real world data, GAO recommends that the Secretary

--appoint a task force comprised of representatives from the Safety Administration, the insurance industry, the automobile industry, and independent highway safety researchers to develop an evaluation plan;

--require the Safety Administration to collect and analyze the data needed to implement the evaluation plan; and

--make modifications to the standard where warranted.

The evaluation program should be designed to ensure the complete reporting, collection, and analysis of relevant data from actual accidents to measure the reliability and effectiveness of air bag and passive belt restraint systems.

Because of the projected widespread use of sodium azide in air bag systems beginning in 1981, the Administrator of the Environmental Protection Agency and the Secretary of Labor, through the Occupational Safety and Health Administration, should require that high priority be given to additional research on sodium azide to measure its health and safety risks.

PASSIVE RESTRAINT EFFECTIVENESS

The Safety Administration's estimate of passive restraint effectiveness is based primarily on laboratory test data and engineering judgments.

The Safety Administration relied on laboratory test data to develop its estimates because sufficient field experience depicting the performance of passive restraints in actual accident situations was not available.

The Safety Administration's estimate that passive restraints, when installed in all cars, will prevent about 9,000 deaths and 65,000 serious injuries annually may not prove to be accurate in actual experience. Although passive restraints have been tested extensively, most testing was on air bags rather than automatic seat belts. Results of these tests support the conclusion that air bags offer potential to save lives and prevent injuries in frontal collisions. However, the conclusion as to the extent of these benefits and the benefits in other types of crashes was based largely on subjective judgment. This introduces a great deal of uncertainty into the estimates because:

--Laboratory crash conditions provide a simplified and limited simulation of real crash conditions.

--Emphasis on testing air bag systems in small cars is lacking and extrapolating test data from large cars to small cars is difficult.

--Biomechanical knowledge about human responses in crashes and human tolerances to injuries is limited.

The uncertainties involved in trying to estimate passive restraint effectiveness is compounded by the lack of field data depicting system performance in the real world. Current real world data for air bags is still too limited to support a reliable estimate of effectiveness in reducing serious and fatal injuries. Although more real world data exists on automatic seat belts, the data must be reviewed with caution because experience is limited.

SODIUM AZIDE

Automobile manufacturers have chosen to use sodium azide for air bags because it is a solid chemical with a good combination of

efficient gas production and very low toxic effluents. The Safety Administration believes that because the sodium azide container is hermetically sealed and buried deep within the steering hub and instrument panel, the chances of causing harm to the occupants is extremely remote.

Since air bag systems containing sodium azide could be installed in millions of cars beginning in 1981, additional research needs to be conducted on this chemical to measure its health and safety risks. Sodium azide has been shown to be a mutagen in plant life, bacteria, and animal cells, and there is speculation it may also be a cancer-causing agent. Further testing is needed to determine the degree of risk to production workers exposed to this chemical during its manufacture. A timely assessment of the potential problems in scrapping cars equipped with sodium azide air bag systems is also needed.

COST OF AIR BAGS

At the time of the mandate, the Safety Administration's estimated cost was $112 for air bags and $25 for passive belts. While there was general agreement on the cost of passive belts, industry's cost estimates were considerably higher for the air bag; General Motors' was $193 and Ford's was $235.

The Safety Administration's cost estimate of $112 was unrealistic because certain cost items industry deemed essential were excluded. Furthermore, the estimate was based on the assumption that most cars would be equipped with air bags; however, current industry plans call for heavy use of passive belts--at least in the initial years of the mandate.

Industry estimates that the cost of an air bag increases substantially at lower production volumes. General Motors' current cost estimate (in 1979 dollars) is $581 for 1982 cars (400,000 units) and $509 for 1983 cars (750,000 units). Ford's current estimate (in 1982 dollars) is $828 (200,000 units per year). The Safety Administration is evaluating these latest estimates.

INSURANCE SAVINGS

The Safety Administration indicated that passive restraints will result in insurance premium discounts, but the ultimate impact is still unknown. Several major insurance companies either offer or plan to offer discounts for passive restraints.

According to the major insurance companies, the ultimate savings will depend on

--actual claims experience reflecting the effectiveness of air bags and passive belts in reducing injuries and deaths and

--certain economic variables such as inflation, car designs, cost of restraints, and competition.

AGENCY COMMENTS

The Department concurs with the GAO recommendations concerning the evaluation program and, in fact, has already taken some initial steps to implement such a program. However, the Department disagrees that the Safety Administration should perform additional testing on the out-of-position occupant problem. It believes the appropriate way to handle this problem is to monitor the industry's development and testing programs and to test the production systems when they become available.

The Safety Administration has had independent testing done in establishing performance criteria for the normally seated front seat occupants. GAO does not understand its reluctance to carry out further testing to determine whether similar performance criteria is needed for the out-of-position occupant.

The Department must also do its own independent testing to assess the seriousness of the problem and develop, if necessary, requirements for out-of-position occupants in the passive restraint standard.

The agencies do not agree with the GAO recommendation to give high priority to research on sodium azide. GAO continues to believe high priority is warranted to determine whether sodium azide is a carcinogen and/or mutagen and how the air bag systems can be safely disposed of in the scrapping process.

The National Transportation Board also commented on GAO's draft report and found no points of contradiction or conflict between the data presented in the report and the Board's material on the passive restraint mandate.

Contents

ABBREVIATIONS

EPA	Environmental Protection Agency
GAO	General Accounting Office
OSHA	Occupational Safety and Health Administration

CHAPTER 1

INTRODUCTION

Automobile occupant restraint systems offer great potential for reducing deaths and serious injuries on the Nation's highways. Seat belt systems are presently required in cars and, when used, are effective in reducing deaths and injuries. However, studies show that less than 20 percent of front seat occupants are buckling up. On June 30, 1977, the Secretary of Transportation mandated passive front seat restraint systems to overcome the public's reluctance to buckle up. All cars manufactured on or after September 1, 1983, will be required to have passive restraint systems requiring no action by occupants. The two systems being considered are air bags and automatic seat belts.

The Secretary's mandate was issued amid considerable controversy over the effectiveness and cost of passive restraint systems as well as potential health, safety, and environmental hazards associated with the use of sodium azide in air bag systems. This report addresses these issues.

ESTABLISHMENT OF VEHICLE SAFETY STANDARDS

Congressional concern over the increasing number of motor vehicle deaths led to enactment of the National Traffic and Motor Vehicle Safety Act of 1966 (15 U.S.C. 1381), which was designed to reduce motor vehicle accidents and the deaths and injuries resulting from such accidents. The act specifies that the Secretary of Transportation shall establish appropriate Federal motor vehicle safety standards. According to the act, each standard shall be practical, shall meet the need for motor vehicle safety, and shall be stated in objective terms. In prescribing standards, the Secretary shall consider, among other items, (1) relevant motor vehicle safety data, (2) whether the proposed standard is reasonable, practical, and appropriate for the particular type of motor vehicle or item of motor vehicle equipment for which it is prescribed, and (3) the extent to which such standards will contribute to carrying out the purposes of the act.

The Secretary has delegated responsibility for designing the Federal motor vehicle safety standards to the National Highway Traffic Safety Administration (hereafter referred to as the Safety Administration). The Safety Administration is responsible for (1) handling rulemaking actions (that is, establishing and publishing the safety standards in the Federal Register), (2) assuring that vehicles meet applicable standards, and (3) investigating vehicle safety defects.

The Safety Administration spent about $12 million on these activities in fiscal year 1977.

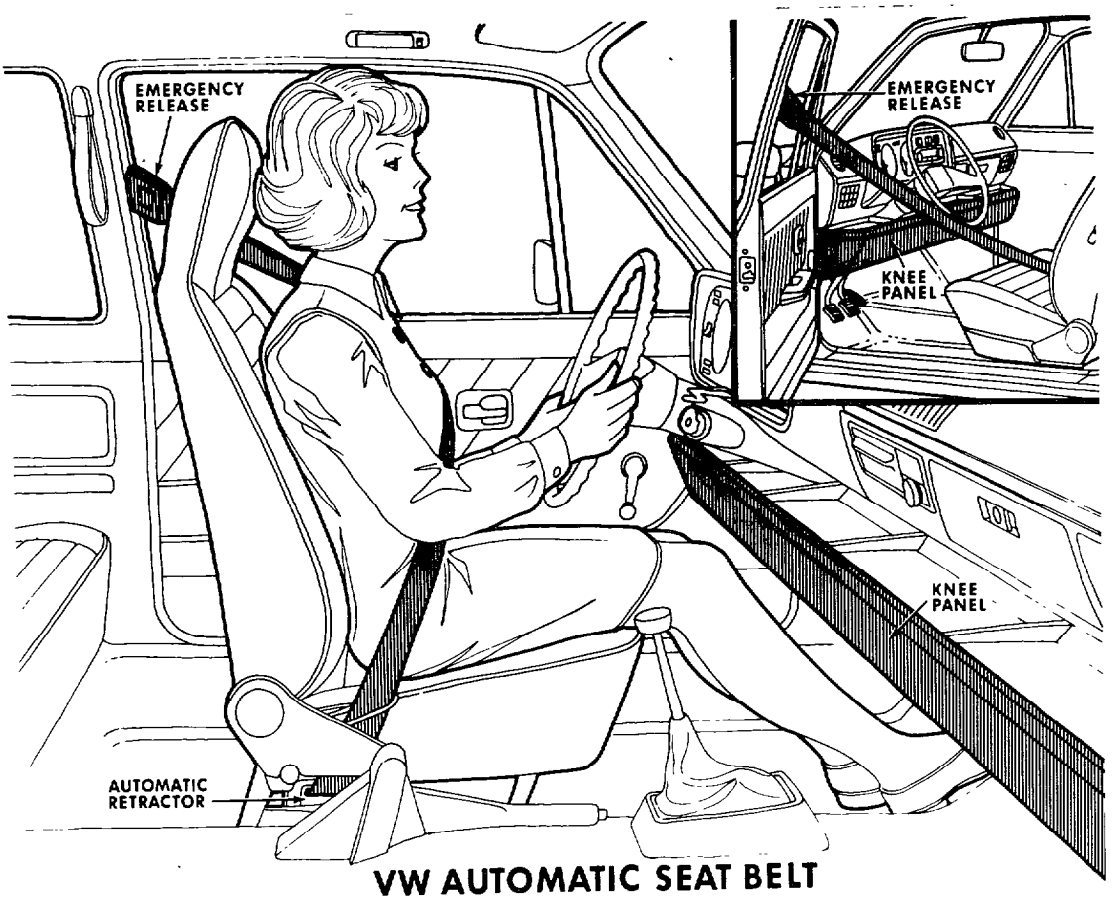
In carrying out its responsibilities, the Safety Administration has issued more than 50 individual motor vehicle safety standards. These standards set a level of performance which the vehicle or the vehicle component is required to meet under specific test conditions. Some standards are aimed at preventing accidents and protecting the occupants if a crash occurs. Federal Motor Vehicle Safety Standard No. 208--Occupant Crash Protection is one of the latter standards which encompasses occupant restraint systems.

OCCUPANT RESTRAINT SYSTEMS

The most common restraint systems for automobile occupants are the lap belt and lap/shoulder belt. These systems are considered "active" restraint systems since the occupant is required to buckle up if the system is to provide the designed protection. If the occupant does not buckle up, the system provides no protection. The primary function of the active belt system when buckled is to restrain the occupant, allowing the occupant to move with the car and limiting the occupant's contact with the vehicle interior. Active lap/shoulder belt systems do this by constraining the the occupant's body at the pelvis and chest.

In contrast with active belt restraint systems, the passive belt and air bag systems are designed to protect occupants without their participation. Passive belt systems are automatically deployed as the occupant enters the vehicle and closes the door. The passive belt system evaluated by the Safety Administration in its passive restraint mandate consists of a shoulder belt which deploys automatically and a knee bolster to prevent the occupant from sliding under the belt in frontal crashes. (See Fig. 1.) Car manufacturers have indicated they also may offer a passive belt system employing both a lap and shoulder belt.

FIGURE 1

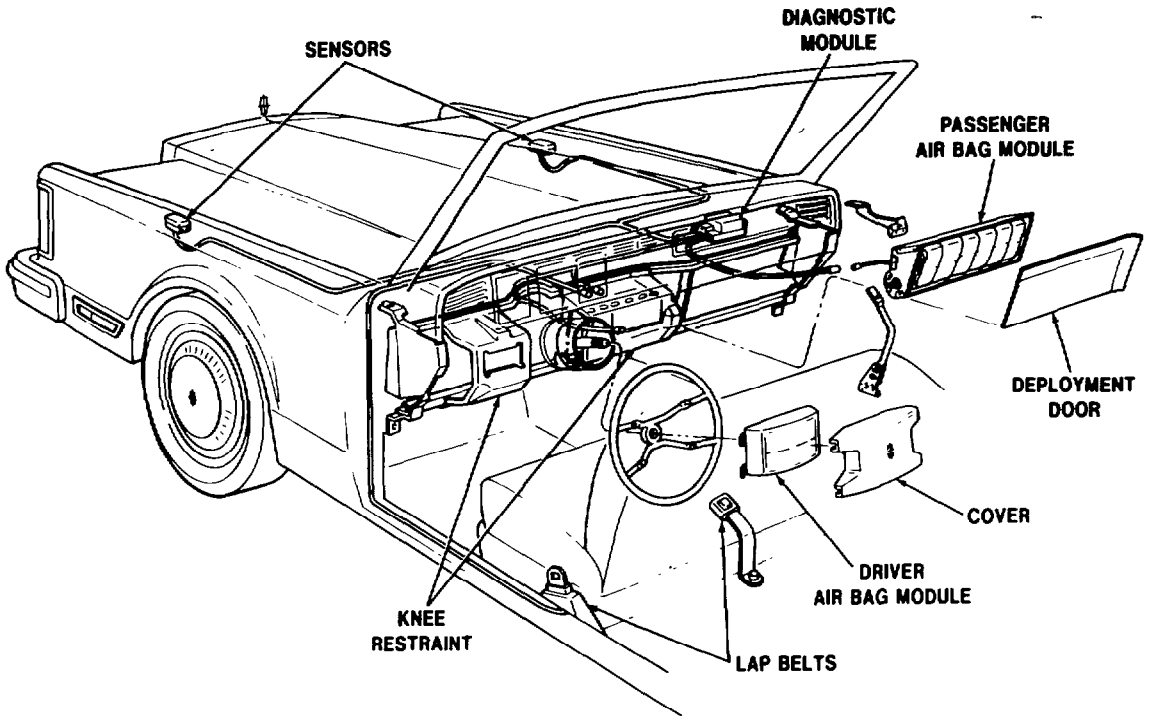


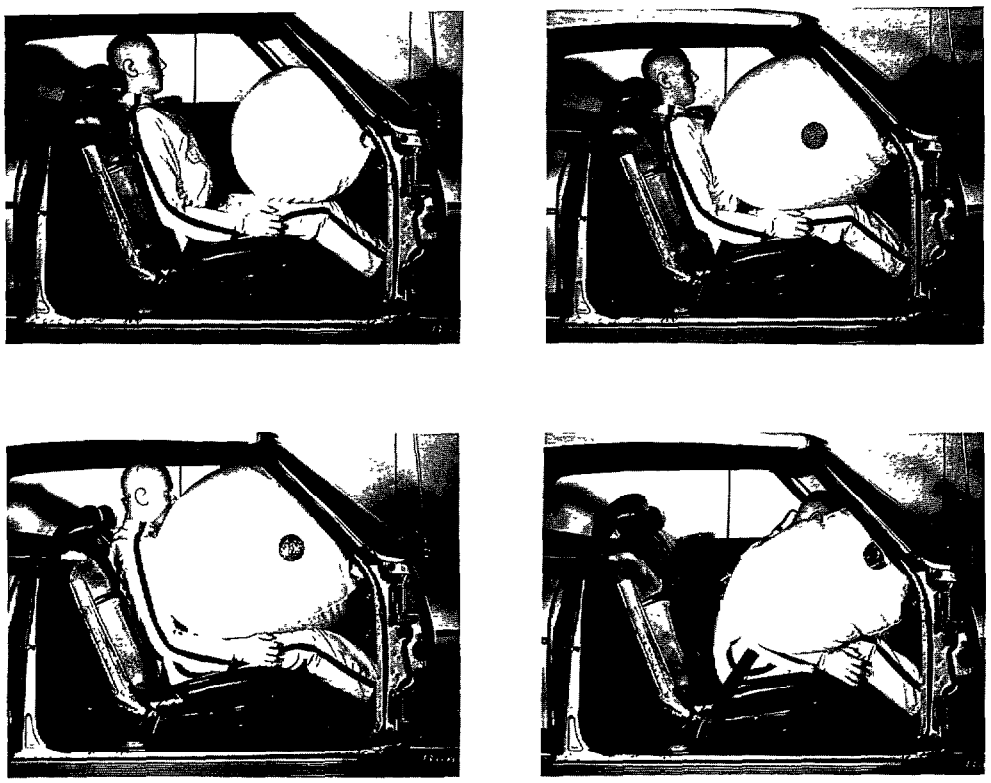
VW AUTOMATIC SEAT BELT

A PASSIVE BELT SYSTEM

An air bag system (See Fig. 2) is designed to deploy within a few hundredths of a second after the start of a serious crash and distributes forces widely across the occupant's head and chest as opposed to the concentrated forces at the pelvis and chest. Air bag systems protect front seat occupants in a frontal crash in which the major impact occurs while the air bag is inflated. While the air bag provides protection in frontal crashes without action by the occupant, a lap belt should be used with the air bag for adequate protection in lateral and rollover crashes.

FIGURE 2





A DEMONSTRATION OF AN AIR BAG SYSTEM IN OPERATION.

EXISTING SEAT BELT USE

Active belt systems have not been as effective as they could be due to the public's reluctance to use them. Usage is about 14 percent based on observations made in 1977 and 1978. The effectiveness of promotional campaigns and mass media appeals has not clearly been established. Some say such appeals can increase seat belt use significantly while others believe such techniques have only limited impact. Safety Administration officials and some other experts believe the most effective media campaign would not increase belt use beyond 30 percent. The only method capable of attaining higher usage rates, they say, is passage and enforcement of a mandatory law.

Twenty-one foreign jurisdictions have implemented mandatory safety belt use laws as of June 1978.

FOREIGN JURISDICTIONS WITH SAFETY BELT USE LAWS

Country	Effective date	Country	Effective date
Australia	Jan. 1971	The Netherlands	Sept. 1975
Japan	Dec. 1971	Norway	Sept. 1975
New Zealand	Jun. 1972	Denmark	Jan. 1976
France	Jul. 1973	Switzerland	Jan. 1976
Czechoslovakia	Jan. 1974	Soviet Union	Jan. 1976
Puerto Rico	Jan. 1974	West Germany	Jan. 1976
Sweden	Jan. 1975	Province of Ontario, Canada	Jan. 1976
Belgium	Apr. 1975	Province of Quebec, Canada,	Sept. 1976
Luxembourg	Jun. 1975	Yugoslavia	Jan. 1977
Finland	Jul. 1975		
Israel	Jul. 1975		
Austria	Jul. 1975		

After the law was passed in Ontario, Canada, usage increased to above 70 percent and then declined to 50 percent when enforcement was relaxed. In Sweden, usage increased from less than 50 percent to more than 80 percent in the first year after legislation was passed. Likewise, since 1972 surveys have shown that Australian drivers' usage rates have ranged from a low of 65 percent to a high of 94 percent. In contrast, Japan has less than 1 percent belt usage. However, according to Safety Administration staff, the law in Japan applies only to freeways and is not enforced.

Enforcement of the law through sanctions appears to be necessary to maintain high belt use. Penalties in foreign jurisdictions for not using belts can range up to $300. Some jurisdictions also assign points against a driver's license or send the violator to jail.

In the United States, no serious attempt has been made to pass a Federal mandatory belt-use law similar to the 55 miles per hour speed limit. Several States have attempted to pass legislation requiring belt use, but none have succeeded. The State of Oregon has come close to passing a law, and Tennessee has passed a child restraint law.

The Congress, in the recently enacted Surface Transportation Assistance Act of 1978 (Public Law 95-599, 92 Stat. 2727), has shown interest in promoting seat belt use. Title II of the act stipulates that each State must spend at least 2 percent of the highway safety grant funds apportioned to it in each fiscal year, 1979 through 1982, on programs to encourage motor vehicle drivers and passengers to wear seat belts. The act authorizes $750 million to be appropriated for State highway safety grants during this 4-year period.

The act also directs the Secretary of Transportation to arrange for the National Academy of Sciences to investigate and study methods of encouraging use of automotive safety belts. The National Academy of Sciences is required to report on the results of its study and make recommendations to the Secretary and the Congress no later than November 6, 1979.

EVENTS LEADING TO THE PASSIVE RESTRAINT MANDATE

Recognizing that seat belts, when worn, are highly effective in preventing occupants from contacting parts of the vehicle interior and from being thrown from the vehicle, the Safety Administration in 1968 issued Federal Motor Vehicle Safety Standard No. 208--Occupant Crash Protection. Standard 208 required the installation of lap and shoulder belt assemblies at front "outboard" 1/ seating positions (except for convertibles), and lap belt assemblies at all other designated seating positions. However, because of limited belt use and the belief that mandatory seat belt usage laws are highly unlikely, the Safety Administration has long anticipated that passive restraints might be necessary to provide effective crash protection to vehicle

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1/Excludes center seating position.

occupants. Since the late 1960s, it has spent about $9 million on passive restraint testing.

In 1971 the Safety Administration amended the occupant crash protection standard to require passive restraints in all cars beginning August 15, 1973. In a law suit by Chrysler Corporation in 1972, a Federal court upheld the Safety Administration's authority to issue a passive restraint standard but held that the standard should be withdrawn and could not be reinstated until the agency had developed a test dummy adequate to measure the performance of passive restraint systems.

In March 1974 Safety Administration officials determined that an adequate test dummy had been developed and again proposed mandatory passive restraints. In consideration of comments received in response to the proposal, the passive restraint mandate was once again proposed in a modified form in June 1976. In the interim, General Motors Corporation sold about 10,000 air bag-equipped full size Buicks, Oldsmobiles, and Cadillacs. Volkswagen sold about 75,000 passive belt-equipped Rabbit model passenger cars through November 1977. Volvo Corporation also introduced a relatively small number of air bag-equipped vehicles into service. Ford Motor Company had earlier manufactured 831 air bag-equipped Mercurys. These vehicles were manufactured under an option placed in the standard in 1971 to permit optional production of vehicles with passive restraint systems in place of seat belt assemblies.

In 1972 the standard was amended to require an "ignition interlock" system on front seat belts to force their use before the vehicle could be started. However, as a result of widespread adverse public reaction to the ignition interlock system, the Congress voided that requirement in 1974. The Congress also provided in its 1974 legislation 1/ for a 60-day period in which it could disapprove, by means of a concurrent resolution, any standard which required an occupant restraint system other than seat belts.

On December 6, 1976, former Secretary of Transportation William T. Coleman, Jr. called for a passive restraint demonstration program rather than a mandate. In his decision, Secretary Coleman noted that the prospect of the Federal Government mandating passive restraints in all automobiles had become increasingly controversial. Questions about effectiveness, reliability, cost, governmental interference

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1/Public Law 93-492, §109, 88 Stat. 1470.

in the lives of individuals, and public acceptability had been raised by opponents of the air bag, the most publicized form of passive restraint. On the other hand, advocates of the air bag had pointed to the great safety benefits and reduced insurance costs that could result from mandating passive restraints.

Secretary Coleman called upon the automobile manufacturers to join the Federal Government in conducting a demonstration program to exhibit the effectiveness of passive restraints. The Secretary stated that he was convinced that passive restraints were technologically feasible, would provide the public with substantially increased protection in traffic accidents, and could be produced economically. He cited the following three major reasons for proposing a demonstration program rather than mandating passive restraints in all cars:

> "First, the goal of motor vehicle safety would not be served by a mandate of passive restraints which is ultimately rejected by the public. I believe that if the public does not have an opportunity to become familar with the benefits of passive restraints prior to their installation in all cars, a strong negative reaction is likely. While such a conclusion is clearly a matter of judgment, the public record and our experience with the ignition interlock system and motorcycle helmet use requirements indicate that the public would react adversely to a Federal mandate of unfamiliar devices directed toward self-protection which also add substantially to the price of an automobile. Rejection by the public would lead to administrative or congressional reversal of a passive restraint requirement that could result in hundreds of millions of dollars of wasted resources, severe damage to the nation's economy, and, equally important, a poisoning of popular sentiment toward efforts to improve occupant restraint systems in the future.
>
> "Second, because such a mandate would mean replacing the lap and shoulder seat belt system that is effective when used, with passive restraint systems, which have operating characteristics unlike those of any other safety equipment now in automobiles and which (in the case of air bags) are among the most costly automobile safety devices that have been federally required to date, I believe the Federal government owes the public more exposure to the operation of passive systems

than we usually require before issuing a Federal safety standard.

"Third, two important outcomes could result from such a demonstration program which would be foreclosed by a mandate at the present time. First, a demonstration program could create sufficient consumer demand for passive restraints that manufacturers would voluntarily offer them as an option at a reasonable price or as standard equipment. Second, it is possible that the Department's efforts to increase levels of seat belt use would lead to a conclusion that much higher voluntary belt use than we now predict could be achieved. On the basis of present information, I am not prepared to surrender the prospect of substantially increasing seat belt use."

In January 1977 the demonstration program was formalized by contract with the major automobile manufacturers, who agreed to make 500,000 air bag and passive belt-equipped cars available to the general public over a 2-year period beginning in September 1979. Under the program, the Safety Administration was supposed to monitor the passive systems closely for reliability and effectiveness in reducing deaths and injuries.

Early in 1977 Secretary of Transportation Brock Adams reconsidered the December 1976 decision and reopened the question on the future of passive restraints. By the Secretary's subsequent actions--initiating rulemaking and mandating passive restraints--the demonstration contracts with General Motors and Ford Motor Co. were terminated under the contract terms. Several reasons were cited for this shift, including:

--Public acceptance or rejection of passive restraints is not one of the statutory criteria which the Department is charged by law to apply in establishing standards.

--Passive restraints, when fully integrated into the U.S. automotive fleet, will prevent 12,000 traffic deaths annually, or about 9,000 more than the current active seat belt systems.

--Passive restraints can be installed at a reasonable cost to the customer ($112 for air bags and $25 for passive seat belts), and the cost

of the systems will be more than offset through insurance savings.

--Use of sodium azide as the gas generator for air bags would present no insurmountable health, safety, or environmental problems.

On June 30, 1977, Secretary of Transportation Adams mandated passive restraint systems for

--passenger cars with a wheel base of more than 114 inches manufactured after September 1, 1981;

--passenger cars with a wheel base of more than 100 inches manufactured after September 1, 1982; and

--all passenger cars manufactured on or after September 1, 1983.

The Secretary's passive restraint mandate was not disapproved by the Congress during its 60-day review period.

JUDICIAL REVIEW OF THE PASSIVE RESTRAINT STANDARD

After its Congressional review, the standard was challenged in the courts by two public interest groups: the Pacific Legal Foundation, and Ralph Nader and Public Citizen. The Ford Motor Company was an intervenor in the case arguing on behalf of the Government. The court, however, rejected these challenges and upheld the standard. (See Pacific Legal Foundation et al. v. Department of Transportation, Civ. No. 78-1034 (D.C. Cir., decided Feb. 1, 1979.)

Pacific Legal Foundation challenged the standard on grounds that (1) experimental and real-world data do not support the Secretary's findings on air bag effectiveness, (2) the Secretary exceeded his authority by failing to consider public reaction to the standard, and (3) the Secretary ignored various hazards to public safety that are posed by air bags.

The court observed that it was not authorized to substitute its judgment for that of the Secretary of Transportation. After reviewing the record of the laboratory tests and limited field experience, the court ruled that under the applicable standard of judicial review, the Secretary's conclusions on air bag effectiveness were not lacking a rational basis. The court explained that heavy reliance on carefully

conducted simulations and tests (as opposed to complete reliance on actual experience data) could and did provide a rational basis for Standard 208. The court did point out that the higher than projected fatality rate experienced in current air bag-equipped cars does not change its position because the number of such cars is relatively small and several of the fatalities occurred under extraordinary conditions. However, the court stated that as a necessary corollary to this position, the Department of Transportation should monitor closely the actual road experience and make needed modifications to the standard.

The court also rejected the second challenge and noted that the Secretary had explicity discussed the relationship between the standard and public attitudes. As for the third major challenge, the court indicated that (1) new methods of inflating air bags and other technological innovations offer prospects for reducing the likelihood of inadvertent deployments and deployment-related injuries and (2) even without such improvements, hazards associated with air bags were not statistically substantial or serious when balanced against the injuries the air bag may prevent.

Ralph Nader and Public Citizen challenged the delayed and phased-in implementation of the standard. The court rejected this argument by explaining that the need for orderly implementation of the standard and the time necessary to gear up for production provided good cause for the Secretary's implementation timetable.

SCOPE OF REVIEW

We reviewed the records maintained by the Safety Administration, including the dockets which record positions taken by domestic and foreign vehicle manufacturers, consumer groups, vehicle users, and other interested parties. In addition, we reviewed certain passive restraint test reports provided by the Safety Administration in support of its effectiveness calculations. We also reviewed effectiveness studies based on the limited real accident data on passive restraints conducted by the Safety Administration, General Motors Corporation, and the Insurance Institute for Highway Safety.

The following consultants with expertise in statistical analysis and biomechanics assisted us in reviewing laboratory test data and the actual experience analyses:

Dr. Lindsay I. Griffin III
Research Psychologist
Texas Transportation Institute
Texas A & M University

Dr. John W. Melvin
Research Scientist
Highway Safety Research Institute
University of Michigan

We also discussed passive restraint effectiveness and the sodium azide issue with officials from the Safety Administration, Ford Motor Company, General Motors Corporation, air bag component suppliers, insurance companies, independent automotive safety research firms, medical experts, and toxicologists. In addition, we evaluated supporting data for Ford Motor Company, General Motors Corporation, and Safety Administration air bag cost estimates.

HANDLING AGENCY COMMENTS

We obtained formal comments on a draft of this report from the Department of Transportation, the Environmental Protection Agency, and the Department of Labor. Their comments are attached as appendixes to the report.

In its response, the Department of Transportation believed that the report contained speculative and inaccurate statements. We addressed each item and provided our comments immediately following the allegation in the body of the Department's response. (See app. II.)

We provided a copy of our draft report to the National Transportation Board. The Board found no points of contradiction or conflict between the data presented in the draft report and the material it has collected in connection with its review of Standard 208.

CHAPTER 2

PASSIVE RESTRAINT EFFECTIVENESS

The Safety Administration estimated that passive restraints, when installed in all cars, will prevent about 9,000 traffic deaths and 65,000 serious injuries annually. In making these estimates, the Safety Administration relied primarily on laboratory test data and its engineering judgment to derive effectiveness rates for each system. The Safety Administration relied on the laboratory test data to develop these estimates because sufficient field experience depicting how these systems performed in real accidents was not available.

Engineering judgment and laboratory testing were necessary to project what would happen with passive restraints in the real world. However, the Safety Administration's specific quantification of the benefits lends a degree of certainty not warranted by the available data. The estimated benefits are uncertain due to limitations in the test data and a lack of knowledge about human responses in crashes and human tolerances to injuries. Because of the uncertainty about these estimates, a timely and comprehensive field evaluation must be performed.

PASSIVE RESTRAINT EFFECTIVENESS ESTIMATES

The Safety Administration calculated the life-saving and injury-prevention benefits based on its estimate of overall effectiveness rates for each type of restraint system. The effectiveness rate represents the restraint system's expected capability of reducing fatal and serious injuries compared to what would happen if no restraints were used. The Safety Administration applied these rates to its estimate of the number of fatalities that would have occurred if no restraints were used (27,200) to obtain the estimated 9,000 lives saved annually.

In arriving at the overall effectiveness rates for each system, the Safety Administration first developed effectiveness rates for various types of accidents--frontal, side, rollover, and rear--and then weighted these by the estimated occurrence of serious to fatal injuries in these types of accidents. The specific rates that were developed are contained in table I.

The data in table I shows that air bags without lap belts, when compared to no restraints at all, are 40 percent effective in reducing serious injuries and fatalities. Further analysis of the data shows that air bags with lap

belts have the highest overall effectiveness rate--66 percent--and are most effective in frontal crashes--77 percent.

TABLE I - SAFETY ADMINISTRATION'S ESTIMATE OF EFFECTIVENESS RATES

	Accident Mode:	Frontal 1/	Side	Rollover	Rear	Overall 2/
II.	Frequency of serious to fatal injury by accident mode:	.53	.31	.14	.02	1.00
III.	Effectiveness in each accident mode 3/:					
	1. Active lap/ shoulder belt 4/:	.58	.58	.73	.30	.60
	2. Air bag with lap belt:	.77	.50	.65	.15	.66
	3. Air bag without lap belt:	.65	.16	.05	.10	.40
	4. Automatic shoulder belt/knee bolster:	.58	.40	.40	.30	.50
	5. Knee bolster only:	.21	.09	.03	.08	.15

1/Frontal crashes include collisions with other cars or with fixed objects in which the primary crash forces are head-on, plus or minus 30 degrees.

2/To obtain the overall effectiveness of a restraint system, the relative probability of an injury (II above) is multiplied by the effectiveness in that crash mode, (III 1, 2, 3, 4, 5, above) and the products are summed for the four crash modes.

3/Effectiveness rates shown represent the expected reduction in fatalities and serious injuries using the restraint system compared to what would happen if no restraints were used.

4/Derived from field data obtained in the Restraint System Evaluation Program Highway Safety Research Center, University of North Carolina.

In its explanation for rulemaking, the Safety Administration stated that the effectiveness rates for each crash mode were based on an analysis of the results of hundreds of passive restraint crash tests and sled (i.e., a mockup) simulations performed in various crash modes. It said the results of these tests were compared with results of similar tests using active lap/shoulder belts. Then the differences were quantified and applied against active lap/shoulder belt effectiveness estimates based on real crash data obtained from the statistical analysis of seat belt effectiveness in 1973-75 model cars involved in towaway crashes.

The process described above was not followed. Instead, the effectiveness estimates were based extensively on engineering judgment plus knowledge gained from years of testing. Safety Administration officials told us that any passive restraint effectiveness estimate contains uncertainties, but the rulemaking process required a specific estimate of lives saved. They said because a specific number was necessary, the 9,000 lives saved estimate was, in their opinion, the best estimate available.

Before the mandate, the Safety Administration did establish a special task force to determine passive restraint effectiveness based on available laboratory test data. Our review showed that the task force was reluctant to cite a specific estimate of passive restraint effectiveness. The task force assigned to review laboratory and crash test data concluded that an analysis of the data based on engineering judgment:

> " * * * leads to a qualitative conclusion that passive restraints offer the potential for substantial benefits in frontal collisions (including the possibility of oblique frontal impact up to 25 degrees) for nearly all size vehicles (2,000 lbs. and greater)."

It concluded, however, that "it does not seem possible to make quantitative estimates from this data." One of the problems cited was the simplified and limited simulations of the crash environment. On this point, the task force paper noted that:

> "An important point which has not been addressed is the fact that all these laboratory results are for the frontal crash environment only. While frontal crashes account for the majority of the fatalities (about 50-60 percent), less than 20 percent of these accrue from aligned crashes.
>
> The other basic crash modes of side, rear, and rollover must also be included in an overall assessment of effectiveness. In these modes, "engineering judgment" must replace laboratory results in order to obtain a system's effectiveness value."

Despite these uncertainties, the task force reached an agreement with Safety Administration management on an effectiveness range for air bags. These estimates, when applied to the Safety Administration's estimate of 27,200 front seat occupant fatalities annually, result in a range of about

6,300 to 9,200 fatalities prevented annually if air bags are used. The lower estimate is based on the assumption that air bags without an accompanying lap belt are ineffective in side collisions. The higher estimate assumes that air bags in all side collisions are as effective as active lap/shoulder belts in side collisions that occur on the same side as the occupant.

The task force member responsible for reviewing laboratory test data told us that while he agreed with this effectiveness range, he would have preferred fuller disclosure of the uncertainties involved. In the mandate, however, the Safety Administration did not use the Task Force's recommended estimates of lives saved but relied on its earlier estimates derived from the data shown in table I.

ANALYSIS OF TEST DATA

We reviewed the test data with our consultant on biomechanical science to determine if it fully supports the effectiveness estimates.

Automatic shoulder belt/knee bolsters testing

The Safety Administration sponsored eight crash tests to determine if Volkswagen's passive belt system met the performance requirements of the standard. Although some early tests showed problems with the driver side, later testing in 1976-77 showed the system to be in compliance with the Safety Administration's performance requirements for full frontal crashes.

Some other data was available from testing performed by Volkswagen, the University of Heidelberg, and General Motors. Volkswagen and the University of Heidelberg concluded that, on the basis of their testing, the automatic shoulder belt/knee bolster system performed as well as or better than active lap/shoulder belt systems and air bag systems. However, General Motors, in testing its version of the automatic shoulder belt/knee bolster system, concluded that an active lap belt would have to be worn with this system to provide occupant protection equal to that provided by active lap/shoulder belts in all accident situations.

Air bag testing

The Safety Administration has sponsored extensive testing of air bag restraint systems. Research to evaluate the performance of production-oriented air bag systems started with sled testing in 1969 and car crash testing in 1970. As air bags improved, further testing was done using various

car sizes in both sled and car crash testing. From information provided by the Safety Administration, we compiled a list of 49 research studies containing about 1,800 air bag sled or car crash tests. Of these, 685 were evaluative tests measuring the performance of production type air bag systems against the injury measurement criteria provided in the Safety Administration's occupant restraint standard. The other tests were to develop (1) production type air bag systems for subsequent evaluative tests or (2) advanced air bag systems not representative of the type likely to be installed in cars under the Safety Administration's current performance requirements.

The 685 evaluative tests included tests of 790 driver and passenger air bag systems. (See table II.)

TABLE II - EVALUATIVE TESTING OF PRODUCTION-TYPE AIR BAGS

	TEST TYPE			NUMBER OF SYSTEMS TESTED						
				DRIVER SYSTEM WITH			PASSENGER SYSTEM WITH			
TEST CONFIGURATION	STATIC	IMPACT SLED	CAR CRASH	DUMMY	HUMAN	CADAVER	DUMMY	HUMAN	CADAVER	TOTAL
FRONTAL:										
full frontal	29	420	70	155	40	1	300	91	1	588
off-set	-	-	13	11	-	1	11	-	2	25
oblique	-	53	22	30	-	-	63	-	-	93
out-of-position	43	18	3	3	-	-	42	21	-	66
Total frontal	72	491	108	199	40	2	416	112	3	772
SIDE:	-	-	11	1	-	-	10	-	1	12
REAR:	-	-	2	2	-	-	2	-	-	4
ROLLOVER:	-	-	1	1	-	-	1	-	-	2
Total	72	491	122	203	40	2	429	112	4	
TOTAL TESTS		685								
TOTAL SYSTEMS					245			545		790

The results of these tests support the conclusion that air bags offer potential safety benefits in frontal collisions. However, the conclusion as to the extent of these benefits and the benefits in the other crash modes was based

largely on subjective judgment. This introduces a great deal of uncertainty into the estimates because:

--Laboratory crash conditions provide a simplified and limited simulation of real crash conditions.

--Emphasis on testing air bag systems in small cars is lacking and extrapolating test data derived from large cars to small cars is difficult.

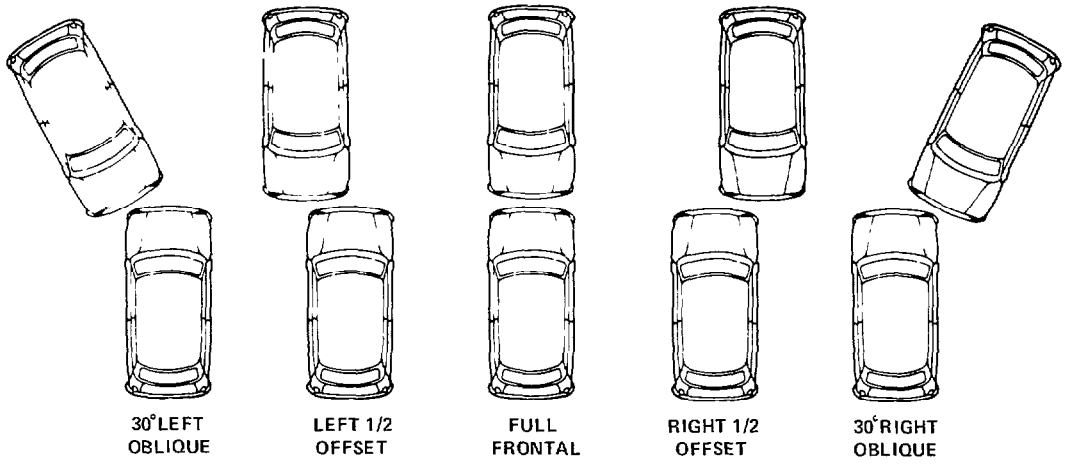
--Biomechanical knowledge about human responses in crashes and human tolerances to injuries is limited.

Simplified simulation of real world crash environment

Most of the Safety Administration testing (see table II) was conducted in the frontal crash mode--which is intended to simulate collisions with other cars or with fixed objects in which the primary crash forces are head on or 30 degrees either side of head on. Testing in the other three crash modes was very limited--11 side crash tests, 2 rear crash tests, and 1 rollover crash test. These 3 crash modes account for about 12 percent, or 1,100, of the Safety Administration's estimated 9,000 lives saved if all cars were equipped with air bags. An engineer, who the Safety Administration told us was responsible for the effectiveness estimate, said that effectiveness in the side, rear, and rollover crashes was estimated primarily on the basis of engineering judgment rather than test data. He said that most of the estimated 9,000 lives saved with air bags pertained to the frontal crash mode and that is why most of the testing was performed in that mode.

Although the Safety Administration sponsored extensive frontal crash testing with air bags, 76.2 percent (588 out of 772 tests) of the evaluative testing of production-type systems was conducted in the full frontal crash configuration as opposed to frontal oblique or offset crashes.

FRONTAL CRASH CONFIGURATIONS



Safety Administration engineers said they relied primarily on this one crash configuration since they believed it was the most severe test for a restraint system. The crash deceleration forces on car occupants in a full frontal crash need to be absorbed over a shorter stopping distance than in other types of frontal crashes. Thus, they believed it was appropriate to rely on full frontal crash test data in estimating air bag effectiveness over the full spectrum of frontal crashes.

Results of the full frontal crash tests generally show air bags to be an excellent restraint system under laboratory conditions. This was expected since that is the type of crash for which the air bag is best suited--crashes in which the major impact occurs while the air bag is inflated and vehicle occupants are facing forward and centered on the seat. However, a 1974-75 analysis 1/ of towaway accidents sponsored by the Safety Administration indicated that the proportion of people injured in full frontal crashes may make up only 20 percent of all occupants injured in frontal crashes.

1/"Restraint System Evaluation Program," Highway Safety Research Center, University of North Carolina.

The limited role of the full frontal barrier crash test in simulating the full spectrum of real frontal crashes was recognized in a technical paper commenting on the Safety Administration's National Crash Injury Severity Study. 1/ This paper pointed out a number of other crash variables in real crash simulations including:

--Variation of "g-forces" (forces exerted on the human body) for a fixed change in velocity. In particular, offset frontal collisions, common on the highway, have lower g-forces than fixed barrier crashes of the same change in velocity. This may result in less serious injury, especially for restrained occupants.

--Vertical forces in nonrollover collisions. Vertical forces are insignificant in fixed barrier tests but quite common on the highway. In vehicle-to-vehicle collisions they can result from different bumper heights, especially when braking begins before impact. In single vehicle collisions they can result from offroad excursions on uneven surfaces. Vertical forces are especially important in the case of the energy-absorbing steering column and the air bag because they may cause the vehicle occupant to strike the device from an angle other than the one for which it was designed.

--Side-to-side movement in nonrollover impact. The vehicle interior spins while the occupant moves straight ahead, resulting in different contact points from a collision without rotation, but with the same direction of force. Rotation is likely to occur in offset collisions, which are common on the highway.

--Occupant preimpact actions, such as braking or change of posture, may affect contact points and tolerance to impact.

1/Charles J. Kahane and Russell A. Smith, National Highway Traffic Safety Administration, and K. J. Tharp, Ph.D., University of Houston, Texas, "The National Crash Severity Study."

The limitations of the full frontal barrier crash test were also recognized in a Safety Administration-sponsored research report. 1/

> "We would like to point out that full frontal, fixed object collisions account for only a small percentage of the total societal cost of accidents Therefore, this full frontal barrier test mode is probably used in testing to a much greater degree than it should be. Over the years the full frontal barrier test has become sort of a standard by which the performance of various restraint systems can be evaluated in a relative fashion. The danger, we feel, lies in the fact that undue emphasis may be placed upon this accident mode to the point that the designer may design a restraint system that functions optimally in a test mode that is not representative of real world accidents. If this happens, the vehicle occupants in more prevalent accident modes may receive injuries that are higher than they would have been had the restraint been designed to function optimally in the more prevalent mode."

We discussed the lack of test data on other than the full frontal crash mode and the effect of occupant mislocation on air bag performance with the Safety Administration engineer primarily responsible for preparing its air bag effectiveness estimate. He told us there was less data than desirable outside of the 90-degree, full frontal crash mode. He said "the numbers were muddy because we are not sure of all the test data." However, based on his engineering judgment, "the level of risk in going ahead with air bags was less than the level of risk in waiting for more test data."

Our review of the test results generally showed air bags to be an effective restraint system in those cases where the occupant and air bag mechanics followed a pattern for which the restraint system was designed--centered contact of head with bag without missing or sliding off the bag. However, the results of the tests performed outside of the full frontal crash mode were mixed.

1/Fitzpatrick Engineering, "Vehicle Integration and Evaluation of Advanced Restraint Systems - Restraint System Analysis Report", Dec. 1977.

Some of the test data indicated satisfactory performance outside the full frontal crash mode (oblique, offset, and out-of-position occupant testing). For example, General Motors conducted a series of frontal and oblique car crash tests which showed that the air bag system performed effectively. 1/

On the other hand, test results in some instances indicated reduced performance under conditions where occupants may not move straight forward, and so may not strike the center of the air bag. Conditions where the occupant is out-of-position may occur frequently in real crashes where occupants are not wearing an accompanying lap belt. These conditions result from:

--preimpact conditions such as panic braking or crash avoidance maneuvering,

--abnormal occupant seating posture, or

--offaxis impact directions.

For example, an early Safety Administration-sponsored series of tests conducted by the Highway Safety Research Institute, University of Michigan, 2/ showed air bag effectiveness was somewhat reduced for 22.5-degree, right frontal oblique impacts. The Institute attributed the problem to the occupant sliding around the end of the air bag and recommended that changes in air bag design be studied. Another series of tests conducted for the Safety Administration by Calspan 3/ showed the 30-mile per hour, full frontal impact effectiveness of the air bag was good. However, the study concluded:

> "The same conventional air bag proved to be less effective in restraining an occupant during a 30 degree oblique angle frontal impact at 30 m.p.h. It was observed that the occupant rolled on the surface of the air bag allowing the back of the

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1/General Motors Corporation, "Crash Testing The General Motors Air Cushion," June 1974.

2/Highway Safety Research Institute, The University of Michigan, "Studies of Inflating Restraint Systems," Mar. 1971.

3/Calspan Corporation, "Research and Development of An Advanced Inflatable Occupant Restraint System," Sept. 1971.

head to contact the A-post of the vehicle. However, this contact was not considered to have serious injury implications for the case of a padded A-post. The rotational motion of the head rolling on the surface of the air bag may produce angular head accelerations injurious to the head and neck. Further investigation is warranted."

A more recent Safety Administration-sponsored study by Calspan 1/ compared the relative effectiveness of air bags and active lap/shoulder belts in various frontal crash configurations. In this study, the contractor was to run a series of 38 car-to-car crashes in various crash configuraations. The first six tests were full frontal crashes. Calspan concluded that for the full frontal tests at 30 miles per hour both air bags and active lap/shoulder belts gave satisfactory levels of protection.

A second series of tests was conducted in the frontal offset crash mode in which Calspan concluded that:

"In driver-to-driver impacts, both the cadaver and the dummy results did not satisfy chest resultant injury criteria with ACRS [Air Cushion Restraint System]* * *."

Although the test dummy results point out possibly diminished air bag effectiveness in the frontal offset crash configuration, the cadaver results were inconclusive. Despite the chest injury data exceeding the chest injury criteria established by the Safety Administration, the cadaver injuries based on a postcrash autopsy did not indicate a life-threatening exposure.

Human volunteers were tested for out-of-position effects in a May 1972 study performed for the Safety Administration. 2/ The volunteers were seated in the right front and center passenger positions and air bags were deployed to study their effect on the subjects. The following body orientations were studied: right front seat passenger in normal seated posture; center front seat passenger in normal

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1/Calspan Corporation, "Evaluation Tests of GM Air Cushion Restraints," 1975-77.

2/Aerospace Medical Research Laboratory, Wright-Patterson Air Force Base, "Experimental Evaluation of the Development of an Air Bag Restraint Using Human Subjects," May 1972.

posture; right and center front seat passengers seated side by side in a normal seated posture; right front seat passenger with legs crossed; front seat passenger seated sideways; right front seat passenger with arms forward; and right front seat passenger leaning forward.

The test subjects experienced little or no ill effects with the exception of the leaning forward passenger. The measure of leaning forward was the angle which the chest made relative to a horizontal line. The testing was designed to decrease torso angle gradually from 90 degrees in 7-degree increments. The angles actually tested were 90, 75, 68, and 61 degrees. The volunteers tolerated the tests well at 90 and 75 degrees. At 68 degrees, however, one volunteer complained of "seeing stars," mild headache, disorientation, and confusion. A second volunteer at 68 degrees also saw stars and developed a frontal headache that persisted for 3 days. At 61 degrees a volunteer experienced severe headaches, disorientation, intermittent nausea, and some minor burning. The medical investigator and the medical monitor terminated the testing because "further testing would have imposed an undue injury hazard to the subjects."

These test results were obtained with earlier inflation components of the air bag system. The Safety Administration has stated that newer inflation components have eliminated these potential deployment dangers by controlling the propellant burn rate to start relatively slowly and speed up as inflation proceeds. As a result, an out-of-position occupant should be "pushed away" from the inflation source before the maximum inflation rates and forces develop. However, the Safety Administration has not sponsored tests of the more current systems' effect on human volunteers under similar out-of-position conditions.

Safety Administration researchers, recognizing the need to determine specific interrelationships of occupants, vehicle interiors, and restraint systems for out-of-position as well as normally seated occupants, recommended in 1973 that laboratory simulations of actual crashes be performed. One such study, performed by Dynamic Science, investigated a fatal accident involving an air bag in a 1975 Oldsmobile. 1/ Safety Administration-sponsored investigators conjectured that the victim's chest may have been against the steering wheel at the time of impact and that the inflating air bag

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1/Dynamic Science, Inc., "An Investigation of Some Responses of An Out-of-Position Driver in an ACRS-Equipped Oldsmobile During Crash Induced Bag Deployment," May 1977.

may have deployed in such a manner as to crush the victim's larynx.

To check out this possibility, Dynamic Science designed a test to crash an air bag-equipped 1975 Oldsmobile moving at 25 miles per hour into a wooden telephone pole. Prior to the crash, a test dummy was positioned in the automobile in a manner similar to the fatal accident, with its chest as close to the steering wheel as possible and its head rotated backward to allow the chin to touch the top of the steering wheel rim.

In the fatal accident, the telephone pole remained intact and the automobile came to a stop. Although the test was supposed to duplicate the accident, the pole sheared off after the vehicle hit it. Therefore, the impact forces acting on the dummy were primarily from the air bag deploying rather than a combination of impact and deployment forces that might have occurred if the pole had remained intact and the car had come to a complete stop at impact.

In its report on the test results, the Safety Administration discussed the possibility that an air bag could deploy in a manner which could crush an occupant's larynx. The report concluded:

> "There is the undemonstrated possibility, regardless of how remote, that the bag or its cover could have fatally assaulted the driver's larynx. Equally undemonstrated is the possibility that for the accident, the combination of bag deployment forces and vehicle deceleration forces imposed fatal injuries to the thorax of the accident driver. However, the results from the crash test, although not conclusive, render this possibility more remote among the many possible explanations for the death.
>
> "A fundamental limitation of speculating on the cause of the accident driver's death, and then attempting to relate that to the test results, goes back to the lack of autopsy results. All the speculation about the trauma-induced fatality would be moot if indeed the driver died or was in the process of dying before impact because of a naturally occurring disease or physiological problem (e.g., heart disease or choking)."

Contrary to the conclusion reached by the Safety Administration, we believe, based on our review of the test data, that the threat of injury to the larynx or to the brain or

spinal cord from air bag deployment could not be ruled out. No additional testing for this particular out-of-position condition was conducted by the Safety Administration.

Although the Safety Administration believed the newer systems would eliminate air bag deployment dangers to occupants, recent testing by General Motors has indicated that potential problems still exist. General Motors informed the Safety Administration in January 1979 that results of tests using test dummies and pigs as surrogates for children indicated a potential danger to out-of-position children from its experimental passenger side air bag system.

General Motors told us that child test dummies are inadequate for measuring the degree of potential deployment injuries because they provide only a crude torso resemblence and do not provide a means for measuring many potential injuries (i.e., neck injuries). Pigs are used as human surrogates to get a better injury measurement, but the correlation between the results with these animals and those with young children is unknown. Nonetheless, General Motors informed us that the implications of the test results are too significant for it to continue to plan production of its experimental passenger side system.

General Motors officials said they believe the air bag deployment problem was not insurmountable, but they stressed the difficulty of developing a system that minimized deployment risks and still deployed fast enough to be effective in severe crashes. General Motors had intended to introduce these air bags in its 1981 model year production (1 year before the mandate becomes effective). However, General Motors officials said that based on the recent test results, the experimental passenger side system is not satisfactory for production. Further development is in progress and the time schedule for introduction has been delayed.

We discussed the General Motors test results with the Safety Administration officials. They told us that Volvo had experienced similar adverse results in testing for out-of-position children. Safety Administration officials said they were concerned about these recent developments and planned to monitor the manufacturers' efforts to resolve the problem. However, as of February 1979, they were not planning to perform any out-of-position occupant testing to define the magnitude of the problem.

Lack of small car testing

Another limitation in the test data is the lack of air bag testing in small cars. Future cars will be both lighter

and smaller and present a more difficult task in managing crash forces. Unfortunately, most of the Safety Administration's air bag testing was restricted to large cars. Thus, relating this large car data to the small car which is likely to be seen in the 1990s presents still another element of uncertainty in estimating the effectiveness of these restraint systems.

Because subcompact vehicles are believed to present the most difficult case for restraint systems, the Safety Administration sponsored testing of air bags in small cars. During the period 1971 to 1973, it sponsored about 18 car crash tests with small cars--Pinto, Gremlin, Volkswagen, etc.--equipped with production-type air bags. Generally, the results showed reduced performance in small cars.

More current testing performed by Minicars, Inc. and Dynamic Science for the Safety Administration has demonstrated better results for air bags in small cars. Minicars, Inc., conducted 48 sled tests and 2 car crash tests in an effort to develop production-type driver restraint systems for three small vehicles--Vega, Valiant, and Chevette. 1/ Only the Vega was actually crash tested. Two car-to-barrier tests were conducted. The research contractor concluded that air bags could meet Safety Administration performance requirements in the Vega, Valiant, and Chevette if the following modifications were made:

--Improved steering column design.

--Crushable lower dash capable of allowing 4-5 inches of knee penetration.

--Increased air bag volume and pyrotechnic charge (approximately 20-percent increase).

Dynamic Science also has conducted a recent series of crash tests comparing Volvo air bag systems and conventional lap/shoulder belt restraints in frontal car-to-car collisions at speeds of 32 to 46 miles per hour. 2/ The air bags and the belts performed about the same in meeting the Safety Administration criteria.

1/Minicars, Inc., "Small Car Driver Inflatable Restraint System Evaluation," Apr. 1977.

2/Dynamic Science, Inc., "Evaluation of Occupant Protection Devices and Restraint Systems," Dec. 1977.

A parallel series of tests using Volvos were conducted at Dynamic Science to test advanced restraint systems. 1/ The Volvos with advanced air bag systems met the Safety Administration's injury performance criteria with test dummies at speeds up to 50 miles per hour. The Volvos tested, however, were heavier than the Vegas used in the Minicar, Inc. testing discussed above--3,300 pounds as opposed to 2,500 pounds. An engineer assisting the Safety Administration's evaluation of the laboratory test data questioned whether the Volvo tests were representative of air bag performance in a small cars.

General Motors also conducted a series of car crash tests with air bag-equipped Chevettes. On the basis of its evaluative crash tests with Vegas equipped with air bags, General Motors concluded in a March 1977 memorandum to the Safety Administration that:

> "The available Chevette ACRS [Air Cushion Restraint System] data are not sufficient to predict the performance of an Air Cushion Restraint System based on the experimental components used over the full range of field accident conditions."

One concern expressed by General Motors was that:

> "The existing test technology is not sufficient to evaluate the possibility that air cushion restraints might actually produce negative side effects (e.g., the combination of the deploying ACRS and the crash forces could result in hand or arm injuries)."

Limits in biomechanical knowledge

Our consultant on biomechanical science noted several problems related to the biomechanical use of the present type of test dummies specified for use by the Safety Administration (the so-called Part 572 dummy). Such test dummies are intended to simulate the shape and mass distribution of the average male human body. These dummies represent the body only crudely and do not simulate the mechanical response of such critical structures as the head, neck, and chest. Most features of the Part 572 dummy were developed to improve the repeatability and reproducibility of the dummy to ensure that each dummy responds to impact the

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1/Dynamic Science, Inc., "Vehicle Integration and Evaluation of Advanced Restraint Systems," 1977.

same way each time--the first priority of any test device. As a result, the Part 572 dummy gives exaggerated values of accelerations and forces generated under some of the impact situations typical of restraint systems testing. Another testing problem is that the injury criteria specified by the Safety Administration was based on biomechanical impact data obtained with human cadavers. As a result the limited injury criteria put forth by the Safety Administration (i.e. head, chest, and thigh bone injury criteria) were obtained with the best available surrogate of the human body but are interpreted with a surrogate (the Part 572 dummy) which does not necessarily respond in the same manner as the human body.

The human body is a very complicated biomechanical structure, and a complete understanding of the critical body structures and their injury limits is not presently available. Current research work is aimed at improving this situation. However, in cases such as brain injury, it may be many years before an adequate understanding of all the possible kinds of injury and their causes is achieved. The same is true to a lesser extent of the chest. The simplified injury criteria specified by the Safety Administration presented the best information available at the time they were formulated, but they neglect other possible forms of injury--such as neck, spine, and abdominal injuries--because little quantitative data is available on these subjects. Such incomplete specifications of potential types of injury in a restraint system's performance standard require that restraint system development be approached on a very conservative basis in order to ensure that a system aimed at preventing one type of injury does not produce another, possibly more serious, type of injury.

FIELD EXPERIENCE

Actual field experience with air bags is limited to about 12,000 cars. A little more than 200 of these cars have been involved in crashes in which the bags deployed. Field experience with passive belts is more extensive--over 75,000 Volkswagen Rabbits with the system have been sold. The accuracy of effectiveness estimates using field data is questionable because of both the relatively small number of accident cases and uncertainties in the input data.

Air bag experience

Field experience with air bags is limited to 12,187 air bag-equipped cars. These cars consist of the following:

Manufacturers' test fleets:

1972 Mercurys	831
1973 Chevrolets	1,000
1975 Volvos	75

Privately owned vehicles:

1974-76 Buicks, Cadillacs, Oldsmobiles	10,281
Total	12,187

As of October 1978, these cars had been involved in 334 reported accidents. Air bags deployed in 205 crashes, 1/ and the severity of injuries to front seat occupants is shown below.

Injury severity:	Number of occupants
None-minor	250
Moderate-severe	35
Serious-critical	2
Fatal	5
Total	292

Although the number of serious injuries and fatalities in the air bag deployment accidents is small, several groups, including the Insurance Institute for Highway Safety, General Motors, and the Safety Administration, have performed analyses of air bag effectiveness using the data. The results of these studies have been somewhat contradictory.

The Insurance Institute for Highway Safety made a study comparing the injuries sustained by three groups of front seat occupants in real crashes: those restrained by an air bag; those wearing lap/shoulder belts; and those using no restraints. 2/ Only full-size and luxury cars involved in frontal crashes were included. Occupants 2 years of age and

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1/In addition to the air bag deployment crashes, the Safety Administration reported three inadvertent deployments on the road.

2/Insurance Institute for Highway Safety, "Air Bags and Lap/Shoulder Belts - An Updated Comparison of Their Effectiveness in Real World, Frontal and Frontal Corner Crashes," May 25, 1977.

younger were eliminated from the data set. In addition, vehicles were eliminated from the study if they had front end damage extending to the windshield and beyond and had passenger compartment intrusion. For frontal crashes only, the Insurance Institute concluded that air bags and lap/shoulder belts reduced injury severity by 66 percent and 59 percent, respectively, compared to nonuse of restraints. In the study a similar comparison was made for frontal corner crashes, but the results were not as reliable as the results for frontal crashes because of the small sample size.

The General Motors study compared injuries sustained by 180 crash-involved occupants protected by an air bag to injuries of a matched control group of 2,024 occupants involved in similar accidents in cars without an air bag. 1/ The accidents involving the two groups of occupants were matched on the following variables:

--Direction of impact.

--Area of vehicle damage.

--Type of damage.

--Amount of vehicle crush.

--Estimated barrier speed.

--Object contacted.

--Use of lap belt.

The results of the study showed that the air bag reduced moderate or greater injuries by 5.6 percent and severe or greater injuries by 17.8 percent.

The Safety Administration has questioned the results of both studies. Aside from the general lack of data, it concluded:

--The usefulness of the Insurance Institute for Highway Safety study was limited because of the selection criteria limits were narrow.

1/General Motors Corporation, "Matching Case Methodology for Measuring Restraint Effectiveness," SAE Paper 780415, Feb. 27-Mar. 3, 1978.

--The methods used in the General Motors study were of doubtful value in objectively assessing the experience of air bag-equipped vehicles.

We reviewed both studies with our consultant on statistical analysis. On the Insurance Institute for Highway Safety study, we concluded:

--The number of crash-involved occupants is small (104 in air bag-equipped cars; 575 in cars without air bags).

--The estimates of air bag effectiveness should not be applied to all frontal accidents but to a smaller subset of these accidents involving full size or luxury cars and front seat occupants over the age of 2.

Regarding the General Motors study, we believe the matching case methodology was basically sound. However, as with the Insurance Institute for Highway Safety study, the injury data, especially the number of fatalities, was still too limited to provide statistically significant results.

The Safety Administration also analyzed air bag effectiveness using the available field data. 1/ The analysis compared the number of serious injuries and fatalities experienced in the air bag-equipped cars to injuries sustained in cars not so equipped. The data was adjusted to account for the fact that the air bag-equipped vehicles were all large cars while the non-air bag-equipped vehicles to which they were compared were made up of all cars--subcompact, compact, intermediate, and large. For frontal deployments only, the Safety Administration determined that air bags were 52 percent effective in reducing moderate or greater injuries. The Safety Administration pointed out, however, that the number of injuries of greater severity were much too small to be statistically significant.

Automatic shoulder belt/ knee bolster experience

The automatic shoulder belt/knee bolster passive restraint system was introduced by Volkswagen in its 1975 model. Eight front seat occupant fatalities had occurred in the approximately 75,000 Volkswagen Rabbits equipped with these systems through November 1977. The Safety Administration attempted to assess the fatality reduction effectiveness

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1/Federal Register, Vol. 42, No. 128, July 5, 1977.

of the Volkswagen automatic shoulder belt/knee bolster system by comparing these fatalities to fatalities during the same period occurring in Volkswagen Rabbits equipped with active lap/shoulder belts. 1/ The Safety Administration concluded in this study that the death rate per 100 million miles driven for the automatic shoulder belt/knee bolster restraint-equipped Volkswagen Rabbits was only one-third that of the active lap/shoulder belt-equipped Volkswagen Rabbits.

The Safety Administration found the study results encouraging even though the experience is still limited. However, Safety Administration statisticians told us the Volkswagen experience with automatic shoulder belt/knee bolster systems must be examined with caution since their effectiveness depends on whether or not they are used, and these systems can be disengaged very easily by occupants. They observed that people who bought Volkswagen Rabbits equipped with the automatic system may be more inclined to use it than people who bought Volkswagen Rabbits without these passive systems or the general car-buying public.

A recent public opinion survey conducted for the Safety Administration by Peter D. Hart Research Associates, Inc. indicates that those who do not use belt restraints may try to defeat the system. According to a Safety Administration summary of the opinion survey's major findings: 2/

> "Infrequent users of seat belts also rate the comfort of passive belts very low, apparently transferring their view of active belts to this newer system. The severity of their disappointment with any sort of belt system is reflected in the responses that infrequent belt users give when asked, 'If you have to buy a car with automatic seat belts, what would you say the likelihood is that you or someone in your household would try to find a way to disconnect the belt system so that you could avoid wearing the belts?' Fully 52% of those who never or infrequently use

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1/U.S. Department of Transportation, National Highway Traffic Safety Administration, "Assessing Field Performance of VW Rabbit Passive Belt Knee Bolster System," Mar. 10, 1978.

2/U.S. Department of Transportation, National Highway Traffic Safety Administration, "Public Attitudes Toward Passive Restraint Systems Summary Report," Aug. 1978.

seat belts say it is 'very likely' that they would try to disconnect the automatic system.* * *"

Field evaluation plans

Accident data is necessary to measure the effectiveness of air bags and automatic seat belt systems in actual experience. Under the demonstration program negotiated between the Safety Administration and the automobile industry in January 1977, the Safety Administration was committed to monitoring closely the reliability of the passive systems and their effectiveness in reducing deaths and injuries. The June 1977 passive restraint mandate did not commit the Safety Administration to a monitoring program. However, in September 1978 the Safety Administration awarded a $62,000 contract to the Center for the Environment and Man, Inc. to develop a methodology for evaluating the effectiveness of air bags and passive belts introduced by the automobile manufacturers on an optional basis before the mandate's September 1981 effective date. With the large-scale introduction of passive restraints after September 1981, the Safety Administration plans to evaluate these systems through its National Accident Sampling System.

In March 1979 the National Transportation Safety Board issued a report on its evaluation of the Safety Administration's plan for monitoring passive restraints. The Board concluded that an evaluation of the real world effectiveness of passive restraints was essential and a formal evaluation program plan was required to coordinate these activities effectively. The Board found that the Safety Administration was committed to evaluating the standard but its current efforts were unorganized; the current contract to develop an evaluation methodology for use up to the effective date of the standard, September 1, 1981, was limited to assessing fatality reduction and belt usage rates; and no evaluation plan was documented or under development to cover the period after September 1, 1981. The Board was concerned that the Safety Administration's evaluation program would not address questions such as:

--What level of reliability will air bags and belt systems have?

--Will knee bolsters in passive belt-equipped cars perform effectively?

--Are the restraints causing any injuries?

--What is the disconnect rate for belts?

--How many bags are not reinstalled after deployment?

--How many inadvertent deployments of air bags will occur?

Consequently, the Board recommended that the Safety Administration develop and publish for public comment a formal evaluation program plan to manage effectively its evaluation activities concerning the passive restraint standard.

CONCLUSIONS

The Secretary of Transportation based his decision to mandate passive restraints in all passenger cars on the Safety Administration's estimate of the life-saving and injury-prevention potential for such systems. The Safety Administration based its estimate of system effectiveness on laboratory test results. From its engineering experience and analyses of these test results, the Safety Administration concluded that passive restraints would save about 9,000 lives and 65,000 serious injuries each year.

We agree that carefully conducted tests, laboratory data, and experimental simulations can provide the bases for the issuance of a motor vehicle safety standard by the Secretary. However, we believe that the Safety Administration's specific quantification of the benefits in this case lends a degree of certainty not fully supported by the test data. Furthermore, we believe that not all of the uncertainties underlying the Safety Administration's estimate were fully disclosed or discussed in the justification for the mandate.

The Safety Administration did not perform the comprehensive comparative testing between active lap/shoulder belts and each passive restraint system needed to support its estimate of lives saved. Although passive restraints have been tested extensively, most testing was on air bags rather than the automatic shoulder belt/knee bolster system. Moreover, the testing appeared to be directed more at furthering air bag technology than, as the Safety Administration maintained, comparing active belt restraints with passive restraints to provide a basis for comparing the effectiveness of both.

The results of these tests support the conclusion that passive restraints offer potential safety benefits in frontal collisions--the primary crash mode of the tests. The extent of these benefits and the benefits in the other crash modes was based largely on subjective judgment. This introduces a great deal of uncertainty into the estimates because:

--Laboratory crash conditions provide a simplified and limited simulation of real crash conditions.

--Emphasis of testing air bag systems in small cars is lacking and extrapolating test data from large cars to small cars is difficult. A higher proportion of small cars is likely in the 1990s.

--Biomechanical knowledge about human responses in crashes and human tolerances to injuries is limited.

While engineering judgments reinforced by laboratory testing are worthwhile, they are only the first steps in a systematic research and development effort. Such efforts need to be followed up with an evaluation of passive restraint effectiveness in the real world. However, field data depicting passive restraint performance in actual accidents is still too limited either to support or refute the Safety Administration's estimates. Several groups attempted to derive effectiveness estimates from this limited data; however, this has only intensified the controversy because each came up with different estimates. Consequently, we believe a timely and comprehensive field evaluation must be performed as a cooperative effort among all affected parties.

In addition to the question of the effectiveness estimates, we believe the Safety Administration failed to consider adequately and investigate the out-of-position occupant problem. Some of the early testing with human volunteers indicated the possibility of problems in this area. Also, the Safety Administration's investigation of a fatal accident in an air bag-equipped car was inconclusive as to whether the occupant's position was a factor in causing the death. Despite these indications, the Safety Administration, at the time of the mandate, believed that the out-of-position occupant problem would be solved with the newer systems. However, the results of recent air bag testing for out-of-position children by General Motors and Volvo show that a potential problem still exists. We believe the problem should be thoroughly examined before air bags appear in large numbers of cars on the Nation's highways.

RECOMMENDATIONS

Because of the recent adverse testing results for out-of-position children, we recommend that the Secretary of Transportation require the Safety Administration to test further to evaluate this problem. Depending on the outcome of this testing, the Secretary should consider appropriate modifications to the passive restraint standard, including

additional performance requirements covering the out-of-position occupant problem, if warranted.

Moreover, because of the mandate's importance in terms of cost and safety to the American public, passive restraint performance in real crashes must be evaluated.

To develop an evaluation program and avoid the present conflicting interpretations of real world data, we recommend that the Secretary

--appoint a task force comprised of representatives from the Safety Administration, the insurance industry, the automobile industry, and independent highway safety researchers to develop an evaluation plan;

--require the Safety Administration to collect and analyze the data needed to implement the evaluation plan; and

--modify the standard, where warranted.

The evaluation program should be designed to ensure the complete reporting, collection, and analysis of relevant data from actual accidents to measure the reliability and effectiveness of air bag and passive belt restraint systems.

AGENCY COMMENTS

The Department of Transportation in its comments on our draft report disagreed with our recommendation that it perform additional air bag testing directed toward determining whether performance criteria for out-of-position occupants should be included in the passive restraint standard. The agency believes that its earlier out-of-position testing and its investigations of all crashes of cars equipped with air bags has established that out-of-position occupants can be protected from serious injury from air bag inflation.

The Department states that the automobile industry has the responsibility "to design its system so that they will meet both the performance requirements of Federal standards and their more basic legal responsibilities to provide a safe product." The Department expressed its confidence that the industry can better design safety within the broad performance requirements of the present standard than within more narrow confines of a design standard, or a standard that attempts to define every conceivable performance need. The Department also stated it is reluctant to add further performance criteria to the passive restraint standard unless a substantial problem is identified that can only be addressed in this way.

Consequently, the Department believes the appropriate way to ensure that systems that are produced for use by the public are as safe as possible is to monitor the development and testing programs of the industry and to test production cars with air bags as they become available. The Department states that these cars will be tested not only for compliance with requirements of the passive restraint standard but also to determine other aspects of performance.

We do not suggest that the Department has the responsibility for designing an air bag system for use in automobiles. Our concern rests on the possibility that the performance criteria established by the agency for testing air bag systems may not be extensive enough to safeguard the out-of-position occupant, especially small children.

The Department does not share our concern about the potential injuries to out-of-position occupants. Some of the earlier testing with volunteers (pp. 23 and 24 of the report) showed indications of possible problems, and one of the five fatalities in crashes of air bag equipped cars suggested the potential danger of a deploying air bag to an out-of-position occupant (pp. 24 and 25 of the report). These instances of potential injuries, along with the current problems being experienced by automobile manufacturers with out-of-position children testing, support our recommendation to the Department for action.

Although the Department has mandated the passive restraint standard, it attempts to transfer responsibility for the systems being developed and the safety of affected members of the public to the automobile industry. We share the Department's belief that the industry will not introduce air bag systems that could cause harm to automobile occupants. But the Department, as it pointed out in its comments to us, does have the responsibility to develop accurate, reproducible, and relevant test methods for assuring that performance standards are met. Independent testing has been sponsored by the Department in the past and we do not understand its reluctance to sponsor further testing to determine whether a uniform performance criterion for out-of-position occupants is warranted. Performance criteria have been established by the Department for the driver and front-seat occupant in their normal seated positions.

We therefore continue to believe the Department should sponsor independent testing to assess the seriousness of the out-of-position problems and develop, if needed, performance criteria for out-of-position adults and children.

In commenting on our second recommendation to appoint a task force to develop a plan to evaluate the performance of passive restraints in the real world, the Department states that our recommendation is already essentially programmed to be carried out. The Department said it plans to publish its proposed plan for comment in the fall of 1979. Further, the Department advised that it is presently constituting an advisory committee for the National Accident Sampling System which will be composed of a broad spectrum of experts representing a wide variety of interests and expertise. The Department stated that since it intends to use the National Accident Sampling System in its evaluation program, it would be appropriate that the Advisory Committee be used to assess the passive restraint evaluation plan.

We are pleased that action has been started to develop a plan for evaluating passive restraint performance. We are hopeful that the Department and the Advisory Committee can agree on the types of information needed, the systems for capturing the information, and the methodology for using the data to determine the reliability and effectiveness of passive restraint systems. The need for agreement on these matters is important if the results are to be accepted by the interested parties. During our review, we found that the widely different results from basically the same data created conflict, not acceptance.

CHAPTER 3

SODIUM AZIDE

Air bag technology currently is centered on systems that burn solid chemicals to generate gases which rapidly fill air bags. Automobile manufacturers have chosen to use sodium azide as the gas "generant" for air bags when the passive restraint mandate begins.

The use of sodium azide as a gas generant in air bag systems in millions of cars poses potential health and safety risks. Sodium azide has been shown to be a mutagen 1/ in plant life, bacteria, and animal cells; however, insufficient testing has been done to show if it is a mutagen in whole animals or humans. Since sodium azide may be a mutagen to humans, another concern is that it may be a carcinogen (cancer-causing) agent because most mutagens are also carcinogens. In addition, sodium azide has the potential to form highly explosive reaction products during the scrapping process if it comes into contact with heavy metals such as copper or lead. More research is needed on this chemical to investigate these potential health and safety risks.

In announcing the passive restraint mandate in June 1977, the Department of Transportation said it was satisfied that sodium azide could be used safely in both an industrial setting and in automobiles. While the Safety Administration did not mandate sodium azide systems, it has defended the use of the chemical as safe and reliable for air bag systems. The most significant problem foreseen by the Safety Administration was disposing of cars with undeployed air bags. However, the Safety Administration assumed this problem could be solved by simple technical devices or by a well-enforced regulation.

The Environmental Protection Agency (EPA) and the Occupational Safety and Health Administration (OSHA), Department of Labor, have indicated they do not plan any immediate action concerning the use of sodium azide in air bag systems. EPA acknowledged that certain problems could occur in disposing of cars with undeployed air bag systems, but did not view them as insurmountable. It believed, despite the potential risks, that industry has time to develop methods for ensuring safe disposal. Similarly, OSHA had no immediate plans

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1/Substance that tends to cause hereditary changes in an organism.

for developing an occupational exposure standard for sodium azide.

THE AIR BAG RESTRAINT SYSTEM

Air bags are fabric cushions that fill rapidly with gas to protect the occupant against hitting the vehicle interior in a crash. The earliest systems had stored gas that was released into the bags at the instant of a serious crash. These early stored gas systems were bulky and costly. Moreover, concern existed over the hardness of the air bag resulting from the high gas flow rate when the bag began to inflate. This posed a particular problem to occupants not seated properly in a vehicle crash. Another concern was whether the stored gas system could maintain sufficient pressure over the normal 10-year life of an automobile. As a result of these concerns, manufacturers turned to systems that burn solid chemicals to generate gases. Following considerable research, automobile manufacturers have chosen to use sodium azide as the chemical because it is a solid propellant with a good combination of efficient gas production with very low toxicity in the inflation products.

PROBLEMS POSED BY SODIUM AZIDE AIR BAG SYSTEMS

The Safety Administration concluded in a March 1978 report 1/ that no significant risk to either production workers or car occupants would result from using sodium azide in air bag systems. While the Safety Administration foresaw some problems disposing of automobiles equipped with sodium azide restraint systems it concluded that prefiring the chemical before or during scrappage would eliminate the problems.

Production and handling

Although recognizing the toxic, mutagenic, and possibly carcinogenic characteristics of sodium azide, the Safety Administration took the position that the chemical could be manufactured and handled with no serious problems:

> "Adequate safegards exist or can be put into place to ensure occupational safety and health, as well as evironmental safety in the production, packaging, transportation, and installation of sodium azide in air bag inflators. The number of

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1/National Highway Traffic Safety Administration, U.S. Department of Transportation, "Sodium Azide in Automotive Air Bags," Mar. 30, 1978.

sodium azide and inflator manufacturers is small, and they are experienced in handling chemicals whose danger is at least as great as is the danger of sodium azide. These companies should be relatively easy to monitor, and will have an interest in exercising due care because of their legal liability should an occupational or environmental mishap occur."

In arriving at its conclusion, the Safety Administration relied extensively on the experience of Canadian Industries Limited, citing its 40 years of sodium azide production with virtually no known health, safety, or environmental problems.

The Canadian firm has produced the chemical since 1937, but it has manufactured it only during portions of these 40 years--normally from 2 weeks to 2 months a year. The company said that during this period about 50 workers who had been exposed to sodium azide had reported to its plant hospital. The symptoms ranged from mild headaches to one case of fainting. No chronic or long-term health problems related to sodium azide exposure at the Canadian plant had been reported.

In April 1978, Canadian Industries Limited asked McGill University to determine the feasibility of investigating possible health effects of sodium azide on its workers. McGill University pointed out that a study of the short-term effects could be made but that the feasibility of a study of the long-term or chronic health effects would be questionable. The university concluded, however, that if the number of people working with sodium azide increased, it might be advisable to undertake studies to determine the health status of those formerly as well as currently employed in sodium azide work. McGill University noted that two problems would be involved with a study of long-term health effects: the number of workers exposed to sodium azide is small; and, since the azide plant was not in continual operation, no single worker has had continous exposure to only sodium azide without being exposured to other toxic materials in different parts of the plant.

In June 1979, a Canadian Industries Limited official advised us the company was actively considering a detailed study of the short- and long-term effects of sodium azide exposure.

Car occupant exposure

In its March 1978 report, the Safety Administration noted that because the sodium azide container is hermetically sealed and buried deep within the steering hub and instrument panel, the chances of exposure while the automobile is in use is exceptionally remote. The Safety Administration concluded it is extremely unlikely that a mechanic or passenger would ever be exposed to an acute dose of sodium azide from deploying air bags. The report also concluded that it is unlikely that chronic mutagenic effects would ever be experienced, since little or no unburned sodium azide is left in the car when the air bags are deployed. The Safety Administration reported that the products resulting from air bag deployment were almost pure nitrogen and that no detectable amounts of sodium azide appeared to enter air bags.

The Safety Administration's determination that these products pose no risk to car occupants may ultimately be proven. Testing performed in June 1978 with more refined measuring techniques indicated that small amounts of sodium azide enter the deploying air bag. Safety Administration officials acknowledged that this testing does show some unburned sodium azide could be entering the air bag. However, they told us the amounts were so minute that they posed no risk to car occupants. Enough evidence exists to justify the need for additional research to support that position.

In a scientific paper by the College of Agriculture Research Center, Washington State University, 1/ researchers concluded that sodium azide is a powerful mutagen in rodent cells. We discussed this with Dr. Andris Kleinhofs, one of the authors of the paper. He said there is no evidence showing that sodium azide is a mutagen to humans. Dr. Kleinhofs said that even if it was, the risk of exposure to humans may be more than offset by the air bag's life-saving potential. However, he said that before the degree of risk can be determined, it will be necessary to determine (1) the amount of unburned sodium azide that a car occupant is exposed to when an air bag deploys and (2) whether or not the chemical is a mutagen and/or carcinogen to humans.

Sodium azide is suspected to be a carcinogen based on some researchers' observations that a high correlation

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1/College of Agricultural Research Center, Washington State University, Pullman, Washington, "Azide Mutagencity in Mammalian Cell Culture," Scientific Paper No. 4976.

exists between mutagenicity and carcinogenicity. 1/2/ Dr. Bruce Ames, a researcher at the University of California at Berkeley, told us that his studies show that nearly 90 percent of mutagens are carcinogens. He also said the reverse is true: 90 percent of carcinogens turn out to be mutagens. Dr. Kleinhofs also said that mutagenic/ carcinogenic relationships work both ways. Because of this potential risk, these researchers said sodium azide should be carefully tested.

In a cancer study on sodium azide 3/ sponsored by the National Cancer Institute, laboratory rats were fed various doses of sodium azide over a 2-year period beginning in December 1968. Opinions on the Institute study's results have been mixed. Dr. Ames told us the Institute cancer study was not thorough enough to enable him to draw a definite conclusion from the results of the test. Dr. Kleinhofs said he concluded the results of the Institute study were negative but added that the study should be repeated because of the small number of experiments. The head of the Institute's cancer-testing program told us that, depending on how the test statistics are viewed, either a positive or a negative conclusion could be made on the carcinogenicity of sodium azide. As of October 1978, the Institute was reexamining its study data.

Further research on the carcinogenicity of sodium azide is being sponsored by PPG Industries, Inc. The firm is producing the chemical under experimental use permits as a soil sterilizing agent to destroy undesirable organisms. PPG Industries, Inc., is having an independent laboratory conduct the carcinogenicity tests in order to meet EPA certification requirements for pesticides. This study involves feeding sodium azide to laboratory rats and will not be completed until 1980. In December 1978, a PPG Industries, Inc., researcher told us that the study was about half completed

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1/Joyce McCann, Edmund Choi, Edith Yamasaki, and Bruce N. Ames, "Detection of Carcinogens as Mutagens in the Salmonella/Microsome Test: Assay of 300 Chemicals." Volume 72, No. 12, pp. 5135-5139, Dec. 1975 Medical Sciences.

2/P.N. Magee, et al, University of Tokyo Press, "Overlapping of Carcinogens and Mutagens." Tokyo/University Park Press, Baltimore, pp. 191-215, 1976.

3/National Cancer Institute, Carcinogenesis Bioassay Experimental Design Status Report, Apr. 4, 1978.

and no adverse findings had been found. However, he said this was typical of most cancer studies and that adverse findings, if any, usually appear at the end. In his opinion, the most critical part of the testing is still ahead.

Results of the above cancer studies may not apply to the use of sodium azide in air bags, since the most apparent type of exposure with these devices is inhalation while the studies were based on ingestion. According to some researchers, the manner in which a toxic agent enters the body may have a profound influence on how it affects the body. For example, a National Cancer Institute research official said the results of a carcinogenicity study can vary significantly due to the method of testing (ingestion, inhalation, injection, skin absorption, etc.). This official said some chemicals have tested position as carcinogens by ingestion but negative by inhalation and vice versa. The PPG Industries, Inc., spokesman also agreed that the results of a cancer study could vary due to the chemical pathway and said that the results of its study apply only to ingestion. He said his firm had made no plans or commitments to conduct an inhalation test on sodium azide.

Disposal of air bag equipped cars

The Safety Administration's March 1978 report recognizes that disposing of cars equipped with sodium azide air bag systems could be hazardous to workers in the automobile scrap industry and the surrounding environment. The report pointed out that as a result of the scrapping process, sodium azide could end up in a variety of places, such as

--in and around the machinery used to shred the hulks and to handle and process the scrap;

--in the environment surrounding the disposal plant, primarily from piles of scrap stored in the open yard;

--in water used to wash or process the scrap;

--in the air filters from blowers used to separate light, nonmetallic components of the scrap; and

--in landfill where it would be buried with some of the nonmetallic residue.

Consequently, the workers may come into direct contact with the chemical, causing adverse health effects similiar to those noted in some production workers (i.e. mild headaches to prostration). In addition, when sodium axide comes into

contact with heavy metals such as copper or lead, it can form highly explosive reaction products. 1/ These metals are commonly found in automobiles around scrap yards.

To overcome these potential hazards, the Safety Administration concluded the air bags should be prefired before cars are scrapped or the sodium azide could be burned in the scrapping process. A number of possible alternatives were suggested:

--Inflators could be deployed by exposing them to a signal that they could be designed to respond to but that is unique and would not be found in any other setting where cars are found.

--A mechanism could be built into the system that would generate an electrical signal to the inflator as the vehicle is being shredded to inflate the air bags.

--The vehicle scrap coming from the shredder could be heated to a temperature that would ignite sodium azide so that it would be burned before further processing.

Although the Safety Administration acknowledged the need for assuring prefiring of air bag inflators prior to scrappage, it indicated immediate action was unnecessary since the number of cars with unfired air bags entering the scrapping process would not become significant until the mid to late 1990s. Instead, the Safety Administration suggested that the amounts of sodium azide (or byproducts of sodium azide degradation) could be monitored to determine if dangerous levels are occurring at any point in the scrappage process. If hazardous levels began to occur, appropriate action could be taken to increase the number of prefirings before shredding or to ensure that the sodium azide is burned during or immediately after vehicle shredding.

In the Department's comments on our draft report, the Safety Administration cited the work that had been done and the results achieved from two studies sponsored by the

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1/National Institute for Occupational Safety and Health, Current Intelligence Bulletin: "Explosive Azide Hazard," Aug. 16, 1976.

Motor Vehicle Manufacturers Association. 1/ Noting that these studies were identification studies only, the Safety Administration stated that it has contracted with Arthur D. Little, Inc., to study methods of safe air bag disposal.

Ford Motor Company and General Motors engineers generally agree the technology exists or could be designed to allow prefiring of air bags. However, the engineers said that it should not be assumed that prefiring will automatically be done by scrap yard personnel and this could be a serious problem. They said items such as batteries and radiators are removed because of their economic value but the same incentive may not exist for recycled air bag hardware. The engineers said checking for unfired air bags would be difficult since the hardware is buried in the steering wheel and instrument panel.

ROLE OF FEDERAL AGENCIES

The primary objective of the Safety Administration's March 1978 report was to provide EPA and OSHA with information on sodium azide as it is used in automobile air bag systems so that these agencies could assess the potential hazards from the perspective of their responsibilities and legal authority. The Safety Administration said that based on discussions resulting from the March 1978 report and other information which becomes available, it would attempt to develop a coordinated and responsible Federal policy on the use of sodium azide in automotive air bags.

Environmental Protection Agency

EPA is responsible under the Toxic Substances Control Act of 1976 (15 U.S.C. 2601) for regulating chemical substances and mixtures which present an unreasonable risk of injury to health or the environment and for taking action if chemical substances and mixtures present imminent hazards. Sodium azide was identified in an EPA-sponsored study of potential industrial carcinogens and mutagens, 2/ but EPA has not given it a high research priority because of the

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1/Arthur D. Little Inc., Boston, "An Investigation of the Potential Human and Environmental Impact Associated with Motor Vehicle Air Bag Restraint Systems," Dec. 1978, and Battelle Columbus Laboratories, Columbus "Gas Generant Research," Dec. 1978.

2/Dr. Lawrence Fishbein, "Potential Industrial Carcinogens and Mutagens," May 1977.

relatively small amounts currently in use and the limited number of persons exposed to it. In response to our request for its assessment of the potential hazards of sodium azide use, EPA advised us:

> "Sodium azide is inherently a very toxic chemical. It is clear that sodium azide poses a hazard to humans as an acute poison, principally by virtue of its potent hypotensive effect. Data are also available which give rise to some concern for its effects on neurological systems and on certain metabolic processes, and as a mutagenic, and perhaps carcinogenic substance.
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> "An additional safety hazard of concern is that sodium azide can form highly explosive azides with other metals, notably copper and lead.
>
> "Very little information is available to evaluate sodium azide as a potential environmental contaminant. Some limited data suggest that sodium azide might be moderately persistent in soil and water under alkaline conditions. There are no data available concerning the potential of sodium azide to bioaccumulate or biomagnify.
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> "Based on our understanding of the design, production, installation, and operational features of the sodium azide air bag systems, the focal point of concern for all three of these factors - the potential for significant direct human exposure to sodium azide, for its coming in contact with other metals with which it can form explosive compounds, and for its release to the general environment - is when automobiles having undetonated air bag systems are disposed. The most apparent control practice would be to ensure that the air bag system is detonated at an appropriate point before or during the scrapping and shredding of the automobile. We are aware of certain practical problems involved in this, but we do not see these as unsurmountable. We think there is adequate time before any significant number of automobiles with undetonated sodium azide air bag systems reach the scrappers and shredders to allow the scrappers and shredders to examine methods of effectively enforcing the detonation of these systems. Shredders now effectively enforce the removal of gas tanks,

including spare cans carried in the trunk, to protect their equipment.

"EPA does not intend at this time to approve or disapprove the use of sodium azide in automobile air bag systems. It is our thinking that despite the potential risks adequate time exists for concerned industry parties to develop methods to ensure the safe disposal of these systems and that it is premature for EPA to begin developing disposal methods to prescribe to industry. Inherent in this position is our intention to maintain an active interest in all developments with respect to sodium azide and the air bag systems to allow us to move quickly, if it should at some future time prove to be urgent that we do so, to protect against any unreasonable risk posed by these systems."

Occupational Safety and Health Administration

OSHA is responsible under the Occupational Safety and Health Act of 1970 (29 U.S.C. 651) to assure every worker, as far as possible, of safe and healthful working conditions. The Secretary of Labor is authorized to, among other things, set mandatory safety and health standards where needed. OSHA informed us that it has advised the Safety Administration that it does not have any projects underway to develop an occupational exposure standard for sodium azide. OSHA stated, however, that since sodium azide is included in a National Institute for Occupational Safety and Health list of suspected carcinogens the chemical will come under review for possible regulation.

Rulemaking on a procedure for identifying, classifying and regulating carcinogens is expected in 1979. Moreover, several months will be needed after such a procedure is issued before OSHA can determine whether sodium azide would be regulated and, if so, what priority it might be given. OHSA did volunteer to work jointly with the Safety Administration to develop guidelines for measures to protect workers. However, according to OSHA, the guidelines would serve only as an informational device. If a specific standard for occupational exposure is not developed, the agency will fall back on its "general duty" clause. This clause requires an employer to furnish a place of employment free from recognized hazards likely to cause serious harm or death.

CONCLUSIONS

Since air bag systems containing sodium azide could be installed in millions of cars beginning in 1981, additional research should be done this chemical to measure its health and safety risks. Long-term health risks stem from the fact that sodium azide has been shown to be a mutagen in plant life, bacteria, and animal cells. Because of this, there is speculation the chemical may also be a carcinogen. Until further studies have been performed to determine whether sodium azide may be a mutagen or carcinogen to humans, the degree of risk facing production workers from exposure to this chemical during its manufacture is unknown. Also needed is a more timely assessment of the problems which may result from scrapping cars equipped with sodium azide air bag systems.

RECOMMENDATIONS

Because of the projected widespread use of this chemical in air bag systems beginning in 1981, we recommend that the Administrator of the Environmental Protection Agency and the Secretary of Labor, through the Occupational Safety and Health Administration, require that high priority be given to having additional research done on sodium azide to measure its health and safety risks.

AGENCY COMMENTS

In its response to our draft report (see app. II), the Department of Transportation disagreed with us, as is noted in the following excerpts.

> "The NHTSA [National Highway Traffic Safety Administration] does not want to minimize any real and significant potential hazards that may arise with the use of sodium azide in air bags. It does believe, however, that discussion of the subject in the GAO report lacks proper perspective on the relative hazards posed. Such an imbalanced presentation can immeasurably damage public confidence in this major public health program. The NHTSA believes that along with its sister agencies, the EPA and OSHA, and the automobile manufacturers, it is acting responsibly to ensure that the use of sodium azide in air bags will not introduce any substantial new hazards to public health and safety, or to the environment.

"The NHTSA disagrees with the recommendation of the GAO that the EPA and OSHA give a high priority to having additional research on sodium azide health and safety risks. Appropriate priority is already being given the subject at the present time. Compared with other risks in the environment and workplace, research beyond that already being carried out on sodium azide does not seem warranted as the GAO report suggests.

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"Therefore, the Agency does not believe that priorities should be set in a vacuum without consideration given to the relative priority of such research, given the current work by various parties such as PPG Industries. The diversion of additional resources would be unlikely to have payoff consistent with the expenditures. Of course, NHTSA will continue its work with the EPA and OSHA. The public can be assured that the subject is continuing to be given its appropriate priority relative to other chemical exposure issues."

In its comments (see app. III), EPA indicated it will follow all developments concerning the use of sodium azide in air bags to enable it to move quickly to protect the public against any health risks posed by these systems. The agency stated that the concerned industry parties have the primary responsibility for developing safe disposal methods and believes that adequate time exists for them to do so.

In its comments (see app. IV), the Department of Labor stated it does not have its own research capabilities but would convey our recommendations to OSHA's sister agency--the National Institute for Occupational Safety and Health, Department of Health, Education, and Welfare.

From the above reactions to our recommendation, it is obvious the agencies do not share our concern that immediate research is needed. We continue to believe high priority is warranted.

We have recognized the attention given to sodium azide by the agency and others but answers have not been obtained for two important questions:

--How should sodium azide air bag equipped cars be handled during the scrapping process?

--Is sodium azide likely to be a mutagen and/or a carcinogen to humans?

Air bag-equipped cars are scheduled to be introduced in the fall of 1981, although some may be sold earlier. Usually, 2 or more years are required to obtain results from carcinogenic research. Consequently, we believe high priority should be given to research to determine whether sodium azide is a mutagen and/or carcinogen to humans so adequate safeguards can be implemented if necessary.

CHAPTER 4

COST OF AIR BAGS

The Secretary of Transportation, in the mandate, concluded that passive restraints could be installed at a reasonable cost to the customer and the cost of the systems will be more than offset by insurance savings. The Safety Administration had estimated that air bags would cost $112 and passive belts would cost $25. While there was general agreement on the cost of passive belts, the industry's cost estimates were considerably higher for the air bag.

Air bag cost estimates at the time of the passive restraint mandate were based on the assumption that air bags would be installed in almost all cars. Instead, it now appears that passive belts, rather than air bags, will be installed in a significant number of cars. Revised industry cost estimates indicate that air bag costs could increase substantially at lower production volumes. In addition, the Safety Administration's estimate excluded certain design features that Ford Motor Company and General Motors Corporation indicated would be included in air bag systems offered to the public. Also, the Safety Administration's estimate excluded some manufacturing cost elements included in the Ford and General Motors cost estimates.

TENUOUS NATURE OF EARLY COST ESTIMATES

The cost estimates of Ford Motor Company, the General Motors Corporation, and the Safety Administration at the time of the passive restraint mandate are shown below:

Initial Estimated Cost of

Full Front Air Bags

Cost item	Ford	General Motors	Safety Administration
Equipment	$121	$102	$ 89
Manufacturing	68	66	28
Profit-Manufacturers	9	0	3
Profit-Dealers	47	45	10
Minus removed active belt	-10	-20	-18
	$235	$193	$112

Note: A general estimate of the cost of replacing an air bag system after an air bag deploying accident is about 2-1/2 times the original cost.

Too many uncertainties surround the introduction of air bag systems by 1981 to allow a high degree of confidence in these estimates. The estimates, based on hypothetical production designs, depend largely on engineering judgments and design assumptions that may change. Consequently, the cost estimates could increase or decrease before production and after on-the-road experience. More significantly, the estimates assume most cars would include air bags as standard equipment. This assumption is not realistic. The standard provides that manufacturers will provide frontal crash protection by means that require no action by vehicle occupants. This allows automotive manufacturers the option of providing either air bags or passive belts to meet the performance requirements.

General Motors and Ford informed us their current plans call for heavy reliance on passive belts--at least in the initial years of the mandate. General Motors' current estimates for air bags (expressed in 1979 dollars) are $581 for its 1982 model year cars based on a projected volume of 400,000 units, and $509 for its 1983 model year cars based on a projected volume of 750,000 units. In July 1979, Ford informed us that at a projected volume of 200,000 units, its estimate for the air bag is $828 per car (expressed in 1982 dollars). In addition, Ford's estimate for a projected volume of 787,000 units is $575 per car (expressed in 1982 dollars).

We did not audit these latest estimates, however the Safety Administration has contracted with a private firm to develop independent cost estimates using the manufacturers' designs.

SAFETY ADMINISTRATION EXCLUDED FEATURES THAT MANUFACTURERS INTEND TO INSTALL IN CARS

The Safety Administration's equipment cost estimate of $89 is based on a potential air bag supplier's quotation for an air bag system. The quotation reflects the system Ford indicated would be installed in its automobiles and that it used in preparing its equipment cost estimate. The Safety Administration, however, adjusted the supplier's quotation to reflect its own design assumptions. The Safety Administration modified the supplier's design, substituting a simple warning light ($1) and a single sensor ($4) for the supplier's more extensive dual sensor/diagnostic system ($31). Although the car manufacturers agreed that continued research and development efforts may reduce the need for complicated sensor and diagnostic systems, they contend the present stage of air bag system development requires these devices.

The Safety Administration believed the manufacturers' extensive diagnostic systems were unnecessary and that a simple warning light to indicate operational readiness was all that was needed to meet the requirements of the occupant restraint standard. The Safety Administration's estimated cost of $1 was based on an early General Motors estimate which General Motors later increased to include a more extensive diagnostic system. General Motors officials said their more extensive diagnostic system design was based on the need for maximum reliability assurances. Similarly, Ford officials told us that a design which merely meets the letter of the law is insufficient; the design must meet the intent of the law. Ford's warning and diagnostic system includes

--a "safing" sensor to prevent inadvertent deployments,

--a capacitor for maintaining power if an accident cuts off the power, and

--a mechanism that suppresses transient voltage to prevent accidental deployment.

Ford officials, however, said that once air bag systems are thoroughly proven by real experience, the need for extensive diagnostics may eventually diminish.

The Safety Administration, in preparing its estimate, substituted a single crash sensor for the manufacturers' dual sensing system. It believed a single sensor was sufficient to meet the performance requirements of the occupant restraint standard. General Motors officials included two dual sensor assemblies in their cost estimate. They told us a single sensor could meet the crash requirements of the standard but, because of slower bag inflation rates under certain crash conditions, "the single sensor is unlikely to meet the needs of the public." Ford's design also uses dual sensors, and its officials said that two sensors were needed to cover the wide variances in impact directions. However, in July 1978, Ford officials noted that their testing program had not been completed and the dual sensor assumption would be reexamined as testing proceeded.

SAFETY ADMINISTRATION EXCLUDED CERTAIN INDUSTRY MANUFACTURING COST ESTIMATES

The Safety Administration relied primarily on the Ford and General Motors estimates in projecting $28 for manufacturing costs. But frequently the Safety Administration adjusted the Ford and General Motors estimates for manufacturing costs ($68 and $66 respectively) which resulted in reducing costs or, in some instances, deleting costs

entirely. For example:

--The Safety Administration estimated $1 for steering column redesign, using Ford's estimate. General Motors' higher estimate was disregarded on the basis that it represented a completely new steering wheel/steering column which the Safety Administration believed exceeded the performance requirements of the occupant restraint standard. General Motors officials disagreed. They said the energy-absorbing steering column had to be modified to work effectively with an air bag. The Safety Administration agreed such a modification would yield additional safety benefits, but it concluded the design changes appeared to exceed the performance requirements of the passive restraint standard.

--The Safety Administration estimated $1 for engineering research and development based on an early General Motors estimate using a 1-year amortization period. The Safety Administration recomputed the General Motors estimate using a 5-year amortization period which they believed to be more appropriate. General Motors revised its estimate upward using a 3-year amortization period. The Safety Administration, however, stayed with the earlier General Motors estimate. The Safety Administration also disregarded Ford's estimate for engineering costs because it included crash testing a large number of cars, which was expensive and did not seem to correspond to the views of General Motors and other car manufacturers.

--The Safety Administration excluded entirely the overhead included in the Ford cost estimate on the basis that Ford had not reported "special" overhead provisions in previous cost estimates for Federal safety regulations. We found that Ford had reported overhead in previous cost estimates for Federal safety and emission standards. We reviewed the basis for Ford's current estimate as well as the results of our prior review of Ford safety standard cost submission. 1/ In our opinion, Ford's overhead cost

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1/"Effectiveness, Benefits, and Cost of Federal Safety Standards For Protection of Passenger Car Occupants," GAO Report to the Committee on Commerce, United States Senate, CED-76-121, July 1976.

estimate is a reasonable approximation of incremental overhead costs (i.e., indirect labor, taxes, insurance, general engineering support, purchasing, inventory control, etc.) that would be associated with equipping its cars with air bags.

--The Safety Administration also excluded from its estimate General Motors' provision for commercial expenses because General Motors failed to provide adequate explanation of these costs. In addition, the Safety Administration said that General Motors had not reported this cost category in the past. General Motors' commercial expenses include such costs as distribution, warehousing, product liability, service training, normal engineering, etc. General Motors included this cost category in previous safety standard cost submissions to the Safety Administration. In our review 1/ of the effectiveness, benefits, and costs of passenger car safety standards, we concluded that General Motors had adequate and reasonable backup data supporting its cost submissions to the Safety Administration.

Safety Administration officials told us they rejected certain industry design assumptions and manufacturing costs because they believed the automobile industry normally overdesigned new equipment, taking out unnecessary items later.

INDUSTRY ESTIMATES

Both the Ford estimate ($235) and General Motors estimate ($193) were preliminary estimates. Future costs will be affected by revisions in program assumptions, engineering test data, and specific product design requirements. However, except for dealer markup or profit, both preliminary estimates represented reasonable approximations of cost based on their respective cost accounting procedures, which were consistent with past estimating procedures for Federal safety and emission standards. The estimates were reasonably supported by documentation (design layouts, cost sheets, vendor quotations, and historical cost relationships). The exception involved the manufacturers' estimate of dealer markup. Dealer markup percentages used by the Safety Administration, General Motors, and Ford were:

1/See footnote, p. 56.

	Dealer profit	
	Percent	Amount
Safety Administration	8.0	$10
General Motors Corporation	21.8	45
Ford Motor Company	23.5	47

Ford and General Motors computations of dealer markups were generally consistent with their past cost submissions for Federal safety and emission regulations. However, dealers seldom obtain the full suggested list price for a car. In 1977, for example, dealers received an average of 10 percent for their mark-up. Consequently, the Safety Administration's figure of 8 percent appears more realistic.

CONCLUSIONS

The Safety Administration's $112 air bag cost estimate does not reflect increased costs that will come with lower production volumes. Moreover, its estimate excluded certain design and manufacturing costs which appear to us to be reasonably supported by the automobile manufacturers. Although the manufacturers' early estimates appear more realistic, it should be recognized they were based on preliminary hypothetical design and volume assumptions.

The manufacturers' current estimates for air bag systems are substantially higher based on the lower volume projections for the number of cars to be equipped with an air bag. The Safety Administration is reviewing and evaluating the latest manufacturer cost estimates.

CHAPTER 5

INSURANCE PREMIUM DISCOUNTS

Although the Safety Administration has indicated that passive restraints will result in significant insurance premium discounts, the ultimate impact of these devices on insurance rates remains to be seen. Several major automobile insurance companies have indicated that they will provide premium discounts for passive restraint-equipped cars. However, other major insurance companies we queried have not committed themselves to offering premium discounts. Still others said they do not plan to offer discounts to owners of cars equipped with passive restraints. Regardless of their present position on discounts, the concensus among the insurance firms we contacted was that the impact of passive restraints on insurance rates would ultimately depend on

--the actual effectiveness of these devices in reducing injuries and deaths and

--economic variables such as inflation, car design, and competition from other insurance companies.

Other factors making it difficult to assess the impact of passive restraints on insurance rates include the dissimilarities in insurance liability coverages between States having no-fault insurance laws and those with regular fault or tort insurance laws. Premium discounts can vary considerably depending on the type of coverage in each State. In addition, opinions differ among insurance companies on the effectiveness of automatic seat belts.

ULTIMATE IMPACT ON INSURANCE RATES WILL DEPEND ON ACTUAL CLAIMS EXPERIENCE

Some major insurance companies have indicated they plan to offer initial discounts to owners of 1982 cars equipped with air bags (manufactured on or after September 1, 1981.) However, the long-term insurance impact will depend on how effective these devices are in reducing the severity and frequency of medical claims. In March 1978, we sent a questionnaire to 20 of the largest automobile insurance companies. (See app. I for a copy of the questionnaire.) Responses to the questionnaire disclosed that:

--Eleven companies plan to offer discounts in 1981 to owners of cars equipped with air bags; 3 of these companies indicated they did not plan to offer discounts for automatic belts.

--Four companies were undecided on air bag and automatic seat belt discounts.

--Five companies did not plan to offer discounts for either air bags or automatic seat belts.

Although 11 of the insurers indicated they would offer some type of passive restraint discount in 1981, only 6 provided data on the extent of their discounts. Air bag discounts in a no-fault State ranged from about 3 to 7 percent of the total premium, while in a fault or tort State the discount ranged from 1 to 3-1/2 percent. The other five companies offering passive restraint discounts did not quantify them because they preferred to wait for actual claims experience and/or they were concerned about economic variables such as inflation, car designs, or competition from other insurance companies.

The consensus among the 20 companies was that actual claims experience would ultimately determine the economic impact of passive restraints on insurance rates. Some of the companies' comments follow:

--"It is very difficult to predict what will happen to automobile insurance rates in model year (1982). The guesses (on premiums and discounts) should not be used as a basis for Federal policy." U.S. Fidelity and Guaranty Company.

--"It will take ten years or more for the full impact of passive restraint systems to be reflected in the liability experience. The normal ratemaking process, rather than special discounts, is best suited for recognizing and taking into account this kind of gradual change in the experience." State Farm Mutual.

--"As with discounts for safety bumpers, the insured cars will change from 100% unequipped to 100% equipped at which time rating differentials become academic. In the transition phase the cost impact will be shared by all insured via shared general rate level." Detroit Automobile Inter-Insurance Exchange.

--"Until actual claims experience develops, we cannot predict the financial impact of the introduction of air bags." Commercial Union Assurance Companies.

--"Claims experience will dictate the amount of discount for vehicles equipped with passive restraints." Travelers.

--"By (model year) 1982 the data will still be too limited and immature to allow us to calculate any discounts. Therefore we will most likely continue the judgementally selected 30% discount" United Services Automobile Association.

Two companies--Allstate and Nationwide--have been strong advocates of air bag restraint systems and were the first insurers to offer discounts for these devices. Both companies told us their discounts were judgmental, since little data was available on air bag claims experience. The insurers used Safety Administration effectiveness data for air bags plus their own actuarial data in developing the discounts. Their discounts amount to a 30-percent reduction in the premiums for personal injury protection coverage in no-fault States or a 30-percent reduction in the premiums for medical coverage in fault or tort States. Both companies believed actual claims experience will show these discounts were warranted. The companies believe their current discounts are conservative and the greatest insurance cost savings will accrue in the future when a substantial portion of the Nation's automobile fleet is equipped with air bags. However, the insurers agreed that in the long run, insurance rates will be based on actual claims experience.

OTHER FACTORS AFFECTING PASSIVE RESTRAINT DISCOUNTS

Several of those companies unwilling to furnish estimates on 1981 discounts as a result of passive restraints were concerned about other variables, such as inflation, car designs, legal factors, competition, cost of passive restraints, etc. Some of their comments follow:

--"Too many variables to consider - how much inflation in price of medical care/auto repairs? What will the legal climate be in (model year) 1982? Value of the dollar vs. currency of countries exporting large number of autos to U.S.?" Safeco Insurance Companies.

--"We have no way of knowing, or realistically estimating, what our average premium will likely be by (model year) 1982. It will depend on a great many factors over which we have no control: the prevailing rate of inflation, changes in the tort system * * * " State Farm Mutual.

--"It is not possible to estimate cost at this time because of variables such as inflation, car designs energy crisis and other significant influences on loss payments." Insurance Company of North America.

--"A final determination can be made only after we have researched the possibilities including the competitive climate." Aetna Casualty and Surety Company.

--"We cannot at this time give a dollar of percentage estimate to the credits or charges to be applied to air bag equipped vehicles. The credits or charges would be based on actuarial studies, engineering studies, and competitive pricing criteria * * *. We do anticipate that inflation will continue to rise * * * " Commerial Union Assurance Companies.

In addition to the economic factors, premium discounts in 1981 will vary significantly due to the type of insurance available in each State as well as the type of passive restraint used. The major beneficiaries of insurance premium discounts will be the owners of passive restraint-equipped cars in the 26 States having some form of no-fault insurance law. The main reason for this is that insurance payouts for injuries are greater in no-fault States due to high recovery limits--three States have unlimited medical recovery. In fault or tort States, recovery limits for injuries are subject to much lower limits, often ranging from $1,000 to $5,000. Since the payouts for injuries can be greater in no-fault States, the premiums are higher and thus the amount of discount would also be larger. Below is a table showing the differences in air bag discounts on insurance premiums for no-fault and fault or tort States.

Premium Discounts for Air Bags as of March 1978

Company	Michigan (no-fault)	Illinois (fault)
Hartford	$17.08	$6.83
Nationwide	10.74	2.17
Liberty	12.00	3.20
Allstate	14.61	3.83
Travelers	16.48	1.60
GEICO	9.78	5.18

Another factor which may influence insurance rates is the type of passive restraint. Four of the six companies now offering discounts for air bags do not offer discounts for automatic seat belts. Also, 8 of the 20 companies indicated they do not plan to offer discounts for these devices in 1981. Four other companies were undecided. Two of the insurance companies--Allstate and Nationwide--who have been strong advocates of air bags, told us they were not planning to offer discounts for automatic belts because these can be defeated since they must have an emergency release mechanism to allow easy exit from a vehicle in emergency situations. In addition, Allstate told us that automatic belts may not offer crash protection to small children or larger adults and may not meet the injury criteria of Standard 208.

In July 1978, a senior Nationwide Insurance Company official told us, however, that the modifications to Standard 208 being considered by the Safety Administration may alleviate the problem of front seat occupants defeating use of the system. These modifications were incorporated into the standard in November 1978. In its explanation of the rulemaking action, the Safety Administration stated that all new passive belt designs would be monitored to see if the system is being defeated in the field.

CONCLUSIONS

Several major insurance companies have indicated they plan to offer passive restraint discounts. However, some are undecided, while others do not plan to offer passive restraint discounts at all. The type of insurance coverage in a State--fault or no-fault--will have a marked influence on insurance rates. Discounts in the 26 no-fault States are considerably greater than those in the other States. Also, the type of restraint system--air bag or automatic belts--could determine the amount of discount. Several major insurers do not offer disounts for these devices because of questions relating to their usage and effectiveness.

Although the Safety Administration has indicated that passive restraints will result in significant insurance premium discounts, the ultimate impact of passive restraints on insurance rates is uncertain. The impact of passive restraints will in the long run depend on claims experience and/or restraint system effectiveness as well as certain economic variables such as inflation, car designs, cost of restraints, and competition.

APPENDIX I

AUTOMOBILE PASSIVE RESTRAINTS

SURVEY OF INSURANCE COMPANIES

APPENDIX I

U.S. GENERAL ACCOUNTING OFFICE

AUTOMOBILE PASSIVE RESTRAINT SURVEY
OF INSURANCE COMPANIES

INTRODUCTION

This questionnaire is directed toward major insurance companies which provide insurance coverage for private passenger vehicles. It is part of a U. S. General Accounting Office attempt to obtain an overview of the impact of passive restraints on the entire private passenger vehicle insurance industry.

We have selected standard no-fault (Michigan) and non-no-fault (Illinois) states to provide for insurance premium variation. If your company does not insure vehicles in Michigan and/or Illinois, please provide the requested information for a no-fault or non-no-fault state typical of those in which your company does provide private passenger vehicle coverage.

Your organization may include subsidiary companies which also insure private passenger vehicles. If so, please combine main office and subsidiary data in your response to this questionnaire.

For questions where data is not readily available (e.g. future premiums), please give your best estimate rather than conduct a lengthy analysis.

It is not our intent to identify companies; we will report only summary data. Please give your name and telephone number so that we may call you for clarifying information, if necessary.

Please return the completed questionnaire in the enclosed envelope within 10 days. If you have any questions, please call Michael Ross at (313) 226-6044.

NAME_____

COMPANY_____

TELEPHONE NUMBER (___) _____
Area code Number

GENERAL INFORMATION

1. Please indicate for each of the listed categories your organization's average annual premiums (on a nation-wide basis) for private passenger vehicles.

. bodily injury liability	$_____
. medical payments	_____
. personal injury protection	_____
. uninsured motorist	_____
. death and disability	_____
. property damage liability	_____
. collision	_____
. comprehensive	_____
. other (specify)_____	_____
_____	
_____	

APPENDIX I

PLEASE QUOTE ALL PREMIUMS ON AN ANNUAL BASIS.

2. For each of the listed categories, what is your average annual premium for private passenger cars in the state of Michigan? (If insurance is not provided in Michigan, indicate a typical no-fault state in your area _____).

. bodily injury liability	$_____
. medical payments	_____
. personal injury protection	_____
. uninsured motorist	_____
. death and disability	_____
. property damage liability	_____
. collision	_____
. comprehensive	_____
. other (specify) _____	_____

3. For each of the listed categories, what is your average annual premium for private passenger cars in the state of Illinois? (If insurance is not provided in Illinois, indicate a typical non-no-fault state in your area _____).

. bodily injury liability	$_____
. medical payments	_____
. personal injury protection	_____
. uninsured motorist	_____
. death and disability	_____
. property damage liability	_____
. collision	_____
. comprehensive	_____
. other (specify)_____	_____

4. Does your company currently provide a rate discount to policy holders who own cars equipped with air bags or passive seat belts?

	Yes	No
air bag equipped cars	☐	☐
passive belt equipped cars	☐	☐

(IF YOUR ANSWER TO BOTH PARTS OF THIS QUESTION IS NO, SKIP TO QUESTION 7.)

APPENDIX I

CURRENT POLICY DISCOUNTS FOR AUTOMOBILES EQUIPPED WITH PASSIVE RESTRAINTS

5. For both no-fault and non-no-fault states, indicate the discount on your average policy for automobiles equipped with passive restraints.

	No-Fault State	Non-No-Fault State
air bags	$_____	$_____
passive belts	$_____	$_____

6. a) Please indicate the current increases or decreases in coverages (in Michigan or your no-fault state) for policies on air bag and/or passive belt equipped cars.

Premium portion	Dollar Increase	Dollar Decrease
. bodily injury liability	$_____	$_____
. medical payments	_____	_____
. personal injury protection	_____	_____
. uninsured motorist	_____	_____
. death and disability	_____	_____
. property damage liability	_____	_____
. collision	_____	_____
. comprehensive	_____	_____
. other (specify) _____	_____	_____

_____

☐ No increases or decreases

b) Please indicate the current increases or decreases in coverages (in Illinois or your non-no-fault state) for policies on air bag and/or passive belt equipped cars.

Premium Portion	Dollar Increase	Dollar Decrease
. bodily injury liability	$_____	$_____
. medical payments	_____	_____
. personal injury protection	_____	_____
. uninsured motorist	_____	_____
. death and disability	_____	_____
. property damage liability	_____	_____
. collision	_____	_____
. comprehensive	_____	_____
. other (specify)_____	_____	_____

_____

☐ No increases or decreases

APPENDIX I

POLICY DISCOUNTS FOR 1982 MODEL YEAR AUTOMOBILES EQUIPPED WITH PASSIVE RESTRAINTS

Beginning in the 1982 model year, new cars with wheel bases greater than 114 inches will be required to have either air bags or passive seat belts.

7. Does your company expect to offer automatic rate discounts in 1982 to policy holders who own cars equipped with these passive restraints?

	Yes	No
. air bag equipped cars	☐	☐
. passive belt equipped cars	☐	☐

(IF YOUR ANSWER TO BOTH PARTS OF THIS QUESTION IS NO, SKIP TO QUESTION 9)

8. What are your company's discount estimates for model year 1982 cars equipped with passive restraints? (Specify dollars or percentages)

	No-fault state		Non-no-fault state	
	Dollars	Percent of average policy premium	Dollars	Percent of average policy premium
air bag equipped cars	_____	_____	_____	_____
passive belt equipped cars	_____	_____	_____	_____

(IF YOU ANSWERED QUESTION 8, SKIP TO QUESTION 10)

9. If your company does not expect to offer automatic rate discounts for cars equipped with air bags or passive belts, please indicate the reason. (Check all that apply)

☐ Would prefer to wait for actual claims experience

☐ Do not think air bags will reduce claims

☐ Do not think passive belts will reduce claims

☐ Costs of passive restraints are uncertain

☐ Other (specify) _____

_____

10. How much do you think your average policy will cost (on a nationwide basis) when 1982 cars are introduced?

$_____

11. Please indicate the increases or decreases in premium portions that are expected for 1982 air bag equipped cars. (not passive belt equipped)

Premium portion	Dollar Increase	Dollar Decrease
. bodily injury liability	$_____	$_____
. medical payments	_____	_____
. personal injury protection	_____	_____
. uninsured motorist	_____	_____
. death and disability	_____	_____
. property damage liability	_____	_____
. collision	_____	_____
. comprehensive	_____	_____
. other (specify) _____	_____	_____

_____

☐ No increases or decreases.

APPENDIX I

12. Please indicate the increases or decreases in premium portions that are expected for 1982 passive belt equipped cars.

Premium portion	Dollar Increase	Dollar Decrease
. bodily injury liability	$_____	$_____
. medical payments	_____	_____
. personal injury protection	_____	_____
. uninsured motorist	_____	_____
. death and disability	_____	_____
. property damage liability	_____	_____
. collision	_____	_____
. comprehensive	_____	_____
. Other (specify) _____	_____	_____

☐ No increases or decreases.

RATE DISCOUNTS WHEN ALL CARS ARE EQUIPPED WITH PASSIVE RESTRAINTS

13. Beyond 1982, has your company prepared, or had access to, any actuarial studies estimating the impact on insurance rates of changes in the severity and frequency of injuries as a result of passive restraints?

☐ Yes

☐ No (SKIP TO QUESTION 15)

14. If yes, please briefly describe the conclusions reached.

APPENDIX I

15. If all cars on the road have air bags or passive belts (1990's) what impact do you believe these devices will have on insurance rates? (Check one column for each premium portion)

Premium portion	Probable Increase	Probable Decrease
. bodily injury liability	☐	☐
. medical payments	☐	☐
. personal injury protection	☐	☐
. uninsured motorist	☐	☐
. death and disability	☐	☐
. property damage liability	☐	☐
. collision	☐	☐
. comprehensive	☐	☐
. other (specify) _____	☐	☐
_____		
No impact is anticipated.	☐	

PRODUCT LIABILITY

6. Does your company currently offer product liability insurance?

☐ Yes
☐ No (SKIP TO QUESTION 19)

7. Does your company currently offer product liability insurance for organizations involved in producing or selling air bags?

☐ Yes
☐ No (SKIP TO QUESTION 19)

8. If yes, please indicate the types of businesses for which your firm furnishes product liability coverage on air bags? (Check all that apply)

☐ air bag componet suppliers
☐ air bag manufacturers
☐ automobile manufacturers
☐ automobile dealerships
☐ other (specify)_____

_____

19. If you wish to elaborate on a particular question or provide additional comments, please use the space provided below.

APPENDIX II

DEPARTMENT OF TRANSPORTATION COMMENTS

This appendix contains the Department of Transportation's comments to our draft report. The Department noted that our report

> "* * * contains a number of speculative and inaccurate statements which, if not corrected, will be likely to mislead the public."

We have addressed those comments by providing our position in brackets immediately under the paragraph or set of paragraphs in which a point is raised. In those instances where the Department's contentions were germaine, appropriate changes were made in the report. However, the Department frequently raised points which are not at issue in our report but which it believed were necessary to fully inform the public. We restricted our responses to those questions or issues relating directly to the report.

OFFICE OF THE SECRETARY OF TRANSPORTATION

WASHINGTON, D.C. 20590

ASSISTANT SECRETARY
FOR ADMINISTRATION

JUN

Mr. Henry Eschwege
Director
Community and Economic
Development Division
U. S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Eschwege:

We have enclosed two copies of the Department of Transportation's reply to the General Accounting Office (GAO) draft report, "Passive Restraints for Automobile Occupants--A Closer Look." The Department has reviewed the draft report and our comments on the findings and recommendations are fully discussed in the enclosed statement.

If we can further assist you, please let us know.

Sincerely,

for Edward W. Scott, Jr.

Enclosures

APPENDIX II

DEPARTMENT OF TRANSPORTATION

REPLY TO THE

GAO DRAFT REPORT OF MAY 1979

PASSIVE RESTRAINTS FOR AUTOMOBILE OCCUPANTS -- A CLOSER LOOK

The General Accounting Office (GAO) report, "Passive Restraints for Automobile Occupants -- a Closer Look," was begun about September 1977. It followed promulgation of an amendment to the occupant crash protection standard, Federal Motor Vehicle Safety Standard (FMVSS) 208, to require that frontal crash protection be provided in new cars automatically, without any action being required such as the buckling of safety belts.

Congressional consideration of the standard, in accordance with section 125 of the National Traffic and Motor Vehicle Safety Act (15 U.S.C. 1401(b)), which did not result in a resolution of disapproval from either the House or the Senate, was nearly completed as the GAO study was initiated. As the GAO study was begun, the Congress issued two major comprehensive reports on the automatic (passive) restraint standards as well as records of the two extensive hearings that were held on the subject in 1977.

FMVSS 208 specifies that an automobile must provide a minimum level of crash protection for front seat occupants in prescribed frontal crash tests that simulate highway crashes. The level of protection is measured using a human surrogate -- an anthropomorphic dummy -- that has instruments located in the head, chest, and legs to measure the potential for serious injury to a human in a similar crash.

The standard does not prescribe any particular technology that is to be used to provide that protection, and two quite different technologies, air bags and automatic safety belts, have been developed and commercialized that will meet the performance criteria specified. Automobile manufacturers must select, design, and engineer occupant protection systems that will meet the requirements of the standard and that will otherwise not degrade the safety of vehicle occupants.

APPENDIX II

Summary of GAO Findings and Recommendations

The purpose of the GAO report is indicated in the introduction:

> The Secretary's mandate was issued amid considerable controversy over the effectiveness and cost of passive restraint systems as well as potential health, safety and environmental hazards associated with the use of sodium azide in air bag systems. This report addresses these issues.

The GAO report does not challenge the need for improved safety through automatic crash protection of automobile occupants. Indeed, the GAO generally supports the Secretary's finding that air bags and automatic safety belts will provide such protection.

The GAO's recommendations suggest additional actions that it believes would be prudent for the National Highway Traffic Safety Administration (NHTSA) and other agencies to take to ensure the standard will provide the greatest possible protection to the public health and safety. Specifically, the GAO endorses the earlier recommendations of the National Transportation Safety Board (NTSB) that the NHTSA evaluate the real world experience with automatic crash protection systems in the early 1980's and recommends that a task force be appointed from among representatives of the NHTSA, the insurance industry, the automobile industry, and independent highway safety researchers to develop an evaluation plan.

The GAO also recommends that the NHTSA carry out additional testing of automatic restraint systems with out-of-position occupants and consider, if warranted, additional performance requirements covering this situation. Finally, the GAO recommends that the Environmental Protection Agency (EPA) and the Occupational Safety and Health Administration (OSHA) give a high priority to additional research on the potential health and safety risks associated with the use of sodium azide. The GAO made no recommendations on the other two subjects of its study, the cost of air bags and insurance savings that will come from their use. Other than the possible inclusion of additional performance requirements in the standard, the GAO also did not recommend any change in the occupant crash protection requirements issued by Secretary Brock Adams two years ago.

A more complete summary of the GAO report is contained in the appendix to the Department of Transportation reply.

SUMMARY OF DEPARTMENT OF TRANSPORTATION POSITION

The report of the General Accounting Office (GAO) entitled, "Passive Restraints for Automobile Occupants -- a Closer Look," contains some constructive criticism and recommendations for ensuring the successful implementation of the automatic occupant crash protection standard.

The GAO concludes "that passive restraints do offer life-saving and injury-prevention potential." Its findings and recommendations do not question the foundation of the standard. In addition, the report suggest ways in which the implementation of the standard could be improved.

[GAO COMMENT: We cannot agree that our report does not question the foundation of the standard. Our report points out certain weaknesses in the quantification of benefits to be derived and in the cost estimates for air bag restraint systems--items which the Department had used in support of its decision to mandate passive restraint systems.]

Unfortunately, the report does not put the issues discussed into the context of the larger issues of motor vehicle safety, and it contains a number of speculative and inaccurate statements which, if not corrected, will be likely to mislead the public.

[GAO COMMENT: Our concern for motor vehicle safety is evidenced by our suggestions directed toward improving implementation of the passive restraint standard. With regard to the Department's contention that our report contains speculative and inaccurate statements, we provide responses immediately following each such allegation in the body of the Department's statement.]

The critical issue is what should be done about the fatalities and injuries to automobile occupants who are involved in crashes given:

1. the number of fatalities in motor vehicle accidents is increasing and is now estimated to be greater than 50,000 per year, with more than half being front seat occupants of passenger cars who could have frontal crash protection from automatic restraints.

2. the potential worsening of this situation associated with the use of an increasing proportion of smaller passenger cars in the future as a result of energy conservation efforts,

3. the low rate of safety belt usage even where major programs have been tried to increase usage (fewer than one person in ten who is involved in a serious crash is using a safety belt of any kind),

4. the availability of at least two practical types of systems that will provide automatic crash protection to vehicle occupants, both of which have been successfully produced for sale to the public, and

5. the substantial amount of on-the-road experience with automatic restraints that demonstrates that they can reduce occupant fatalities by up to one-half.

The GAO has, in the past, strongly urged the agency to improve motor vehicle safety through its rulemaking and other powers. It has also acknowledged, as a result of its own analyses, the great value that has come from the agency's motor vehicle safety standards in lifesaving and injury mitigation.

In 1976, the GAO issued a report estimating that the motor vehicle safety standards taking effect in the later 1960's were saving approximately 5,000 lives per year by 1974. The report was critical of the fact that little further improvement was made in the safety of 1970-1973 model cars.

In 1978, the GAO released a study, "Unwarranted Delays by the Department of Transportation to Improve Light Truck Safety," that concluded, "The occupants of any motor vehicle should be assured of a high degree of built-in safety against ... the

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risk of death or injury when an accident does occur." In that report, the GAO recommended that the NHTSA "take actions to improve the safety of light trucks. In cases where the need for safety features is known and applying the safety features to light trucks appears feasible, expeditious rulemaking should be initiated."

The NHTSA believes that the promulgation of the automatic crash protection standard was consistent with the need for action to reduce automobile occupant fatalities and injuries and the feasibility of such action.

The National Traffic and Motor Vehicle Safety Act under which motor vehicle safety standards are promulgated requires that these standards be minimum standards for motor vehicle performance. As a minimum performance standard, FMVSS No. 208 does not and cannot specify all aspects of occupant safety under all possible conditions. The law requires that standards be written in performance terms to provide the latitude needed by the manufacturers to use their best engineering judgment in designing features and systems into their vehicles that are feasible, effective, reliable and low in cost.

At a time when regulatory reform is regarded as an important goal for government programs, the NHTSA believes that it would be ill-considered for it to attempt to specify in great detail all design, engineering, and performance requirements for automatic restraints. The automobile companies and their suppliers are far better equipped to ensure that their particular products are properly designed both to meet the general performance requirements of the standard and the other criteria needed for successful commercialization, including those suggested by GAO.

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Furthermore, the NHTSA has been carefully following the programs of the major automobile manufacturers to produce automobiles with automatic restraints, both air bags and automatic belts. Agency officials have reviewed extensive program development and test data from these manufacturers showing that they are acting to ensure that the automatic restraints they produce for sale to the public will provide a high level of protection to vehicle occupants of various ages and sizes, seated both in and out of position, in a wide spectrum of collisions.

For example, the companies and their suppliers have carried out extensive testing on sensors, sensor locations, and sensor functions to be sure that they can discriminate among collisions with different objects (other vehicles, poles, barriers) in head-on, corner, sideswipe, and other conditions so that the air bags can be inflated when necessary, while not inflating when they are not needed. The production system will be very reliable, and air bag systems will have sophisticated electronic diagnostic systems that will provide a warning to the driver of virtually any potential malfunction.

The automobile manufacturers have also undertaken major projects to assess all aspects of personal, occupational, and environmental safety involved in the use of sodium azide as a component of the air bag propellant. The NHTSA is following up the work of the manufacturers with review and with its own research.

Our confidence that automobile manufacturers can better design safety systems within the broad performance requirements of this standard than within more narrow confines of a design standard, or a standard that attempts to define every conceivable performance need, is being well rewarded. And the public will reap the ultimate benefit of their work.

[GAO COMMENT: We agree that the Department should not attempt to specify all design, engineering, and performance requirements for automotive restraints. However, because of the potential threat to out-of-position occupants, we are concerned that performance criteria established by the Department may not be comprehensive enough. Since the standard presently contains performance criteria for the normally positioned occupant, we do not understand the Department's reluctance to consider a similar requirement for out-of-position occupants.]

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CHAPTER 1, INTRODUCTION

The introduction to the GAO report contains several inaccuracies and misleading statements, some of which are carried over into the Digest of the report. These include the following:

Safety Belt Usage

The GAO quotes a figure of 20 percent for safety belt usage in the U.S. This figure is no longer accurate. At the time Secretary Adams issued the automatic restraint requirement, belt usage was around 20 percent according to observations made in 1976. Nearly half of these were wearing only a lap belt which provides substantially less protection than the lap and shoulder belts together. Later observations made in 1977 and 1978 show that usage is deteriorating, and driver usage now stands at around 14 percent.

> [GAO COMMENT: The percentage figure was changed on p. 5 of the report to reflect these later observations.]

Furthermore, the recently completed National Crash Severity Study (NCSS), carried out by the NHTSA, indicates that of those who are involved in crashes, serious enough to disable at least one automobile, only 8.4 percent of the occupants were wearing belts. These figures reinforce the conclusion that a substantial number of motorists will not have adequate crash protection unless it is provided automatically.

In its discussion of belt use laws, the GAO failed to mention that the U.S. Congress initially passed an incentive grant program for State passage of safety belt use laws in 1973. However, no appropriation was ever provided by the Appropriations Committees. Indeed, in floor debate, the House instructed the agency not to expend funds for this program.

The Coleman and Adams Decisions

In discussing the decision by former Secretary of Transportation, William Coleman, to negotiate contracts with various automobile companies for the production of cars equipped with automatic restraints (the "Coleman Plan"), the GAO states that Secretary Adams "concluded that the proposed demonstration program was unnecessary and cancelled the contracts."

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This statement is not correct. Secretary Adams in fact considered the existence of the voluntary contracts to be important to the implementation schedule. In the preamble to the standard, the Secretary discussed this point along with the question of ensuring public acceptance of automatic restraints:

> "... the 4-year lead time represents a continuation of of its logical conclusion of the early voluntary production of passive restraints represented by the December 1976 decision. The continued opportunity for early, gradual and voluntary introduction of passive restraints to the public in relatively small numbers offers a great deal of benefit in assuring the orderly implementation of a mandatory passive restraint requirement. Experience with the limited quantities of early passive-restraint-equipped vehicles can confirm in the public's mind the value of these systems prior to mandatory production. Because of the value of such a voluntary phase -- in approach to both the manufacturer and the public, the Department anticipates that the manufacturers which were parties to the earlier demonstration program agreements will continue their current preparations for voluntary production of passive restraints. The Department also expects that other manufacturers will undertake to produce limited quantities prior to the effectivity of the mandate. The Department intends to vigorously support the efforts of manufacturers to foster sales on a voluntary basis, both through major public information programs and through efforts to encourage their purchase by Federal, other government agencies, and private-fleet users."

[GAO COMMENT: Our statement has been revised to reflect the circumstances of the contract termination. The Secretary's actions did, in fact, cancel the two major contracts (Ford and General Motors) under the termination clause of those contracts.]

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GAO states that the reasons for Secretary Adams' decision were: 1) public acceptance of passive restraints is not one of the staturory criteria. 2) Passive restraints would prevent 9,000 fatalities per year, 3) passive restraints can be installed at a reasonable cost, and 4) sodium azide as a gas generant presents no insurmountable safety, health or environmental problems. These are not accurate statements of Secretary Adams' reasons.

> [GAO COMMENT: Our statement, as made, is correct. The reasons we have cited, along with several other reasons, are discussed at length in the Departments' final rule published in the Federal Register (Vol. 42, No. 128 - July 5, 1977, pp. 34289-34299) and in the Department's supporting document entitled "Explanation of Rule Making Action."]

Secretary Adams generally agreed with Mr. Coleman that public acceptance of automatic restraints would be important to their successful introduction. However, he did not believe that the Coleman demonstration plan was consistent with the seriousness of the problem of providing crash protection for automobile occupants.

Secretary Adams found in addition that it was unlikely that an informed public would reject automatic restraints, particularly because they would be offered a choice of restraint systems meeting a performance requirement. For example, since the air bag requires no action on the part of an occupant to be effective and as it is completely unobtrusive, it should be particularly popular. The NHTSA has engaged in a major program of public education on automatic restraints that includes the showing of a number of cars equipped with demonstration air bag systems and automatic belts around the country, the publication and dissemination of pamphlets and other information on automatic restraints, regular public presentations on the subject by NHTSA officials, and the publication of two major progress reports on the occupant crash protection programs of the agency.

A public opinion survey carried out for the NHTSA in 1978 by Peter D. Hart Research Associates indicates that most adults have heard about both the automatic restraint standard and about the technologies that will be used to meet it.

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The basic reasons the automatic restraint standard was promulgated by Secretary Adams in 1977 are:

- o A large number of automobile occupant fatalities and serious injuries, particularly in frontal crashes, could be prevented with better occupant restraint.
- o Belt usage in the U.S. is very low.
- o Practicable alternative technologies for providing automatic crash protection for automobile occupants are available.
- o There will be an increasing proportion of smaller cars in the U.S. fleet as a result of the energy situation and the automotive fuel economy program, that hold the prospect of increasing the fatality and injury rates unless new measures are taken to improve automobile safety.

The cost of automatic restraints, the specific estimates of the effectiveness of automatic restraints in saving lives and reducing injuries, and the safety of sodium azide when used as a gas generant in air bags are aspects of the question of whether air bag technologies are practicable.

The conclusion that insurance savings would more than offset the cost of automatic restraint systems is only one aspect of the consideration of costs and benefits -- both monetary and otherwise--on which the automatic restraint standard was based. The savings on insurance premiums was an estimate from one of the largest automobile insurers, Nationwide Insurance Company, and was based on their actual claims experience in 1975. These companies agreed that the insurance savings that would have accrued if all cars had been equipped with automatic restraint systems would have been $32 per car. But the insurance savings are only a part of the total individual and societal savings that come from reducing fatalities and injuries from motor vehicle crashes. The other savings include reduced losses not covered by insurance, reduced social welfare costs for accident victims and their families, and so on.

Furthermore, the National Traffic and Motor Vehicle Safety Act does not require that motor vehicle safety standards have quantifiable economic benefits that outweigh the cost of implementing them even if all safety benefits could be put into economic terms. Rather it requires that they be minimum

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standards that meet the need for motor vehicle safety, that they be practicable and objective, and that they be stated in performance terms. The NHTSA believes that the automatic occupant crash protection standard meets these criteria, and where it has been tested in the courts, the courts have agreed.

Judicial Review of the Automatic Restraint Standard

Although the GAO discusses the recent lawsuits against the Department on the automatic restraint standard, it ignores the earlier landmark decision in Chrysler versus DOT which established, in 1972, the clear authority of the DOT to mandate automatic restraints. Even back in 1972, the court recognized that the DOT could act to counter the disastrous consequences of low seat belt usage. Further, the court recognized that, because of the automobile industry's history of inadequate allocation of resources to improve safety, Congress empowered the DOT to issue safety standards which could only be met by improved technology. As the U.S. Court of Appeals for the District of Columbia noted in Pacific Legal Foundation v. DOT in 1979, the 1972 Chrysler case implied that a major safety standard could be based solely on experimental data.

Finally, in Chrysler, the court squarely held that DOT's "decision to require passive restraints is supported by substantial evidence."

[The Chrysler decision required delaying implementation of the automatic restraint rule until specifications of the anthropomorphic dummy used to test compliance were corrected. The decision in Pacific Legal Foundation Vs. DOT found that the specification of the dummy to be used in the present standard was adequate to meet the criterion of objectivity.]

[GAO COMMENT: Nowhere in our report have we questioned the Department's authority to mandate passive restraints. On the contrary, our recognition of the Department's authority serves as the basis for our recommendations to the Secretary of Transportation to improve its occupant protection standard. Further, we did not ignore the Chrysler versus the Department of Transportation decision. We discuss it on p. 7 of the report. Our discussion under this caption, however, relates to the court challenges that were made after the mandate was issued in July 1977.]

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CHAPTER 2, AUTOMATIC RESTRAINT EFFECTIVENESS

The GAO's discussion of restraint system effectiveness and its recommendations to the Secretary of Transportation indicate confusion about the respective roles of the government and the industry in a regulatory program using performance standards with manufacturer self-certification of compliance. Such a program places major responsibilities on the manufacturers for design, engineering and testing of products to meet Federal requirements. Because of the latitude provided the manufacturer under this type of regulatory program, estimates of effectiveness of the different systems manufacturers may choose to make are very difficult. And they are just what their name implies -- estimates based on the best available information, analysis, and professional judgment.

[GAO COMMENT: We are aware of the respective roles of these parties in the regulatory program. We have presented the Federal Government's responsibilities in chapter 1 of the report. (See pp. 1 and 2.)]

A careful reading of the preamble to the standard promulgated in 1977 will show that the decision to issue it was predicated on the major life and injury saving that automatic crash protection could give, not on the specific estimate that they could save 7,000 lives, 9,000 lives, or 11,000 lives. It was determined that the general performance requirements of the standard would insure that it would provide a substantial benefit regardless of the technologies used to meet it. The specific effectiveness estimates were to be made using assumptions about the design and engineering choices to be made by the manufacturers. The estimates were made as a part of the NHTSA's overall analysis of the probable environmental and economic impacts of the standard.

[GAO COMMENT: The Agency has consistently cited 9,000 lives would be saved by the use of passive restraints. This figure was cited in the Department's preamble to the final rule and in its testimony before the congressional committees during deliberations on that rule. In addition, the Agency continues to cite this specific figure in the numerous publications it has issued on passive restraints.]

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It is the automobile manufacturer that has the responsibility to design its products so that they will meet both the performance requirements of Federal standards and their more basic legal responsibilities to provide a safe product. The occupant crash protection standard does not mandate a particular system or design. Rather, it allows the automaker to choose whatever system it believes will best suit its products and the people who will buy and use them. These systems must then be designed and engineered so that they will meet or exceed the crash performance requirements set forth: that the injury criteria measured by test dummies in the vehicle when it is crash tested into a solid barrier at 30 miles per hour will not be exceeded. These criteria are established so that if a human being is involved in a similar crash, they are not likely to be seriously injured.

By contrast, the role of the Government, and the purpose of its research program, is distinctly different. First, the NHTSA's research supports the development of accurate, reproducible and relevant test methods. The agency's biomechanics research supporting the specification of an anthropometric test dummy must be adequate to ensure that it is: (1) a reasonable surrogate for a human being, and (2) an objective test instrument. It was on the latter factor that the original automatic restraint standard faltered in Chrysler v. DOT. Second, the NHTSA's research should identify "the need for motor vehicle safety," both through accident investigation and through vehicle testing. Third, it should investigate the performance of technologies that can be used to improve motor vehicle safety. The research into the potential of new technologies involves both determining the capabilities of the technology, and studying any possible side effects that may arise from the commercialization of the technology.

The NHTSA is not expected, on the other hand, to design and build specific features into automobiles of various types and to test them in a full spectrum of tests to ensure that the standards set by the agency can be met by all manufacturers in all of their products.

The principles underlying the distinctions between the role of the Government and the role of the manufacturer were clearly established in the 1972 decision of the Court of Appeals for the Sixth Circuit in the case of Chrysler v. DOT. This decision established the principle that the Department could establish standards that required the development of new technologies. The standard in that case, of course, was the automatic occupant crash protection standard as issued in 1971 that specified broad performance requirements and test procedures that could be met with a variety of restraint designs.

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Neither that Court of Appeals, nor the Court of Appeals for the District of Columbia in its 1979 decision upholding Secretary Adams' decision in every respect in Pacific Legal Foundation v. DOT, suggested that the NHTSA has specific responsibility for the additional testing that the GAO recommends the NHTSA undertake. Furthermore, the details of restraint performance depend strongly on the particular restraint system design and installation selected by a manufacturer. Thus, the most that testing by the agency could hope to show is that it is possible to design systems that do not harm occupants, including out-of-position occupants, or that perform well in small cars.

Indeed, the agency has done a substantial amount of this kind of testing. The development and test programs conducted by the NHTSA have, in fact, demonstrated that air bags and passive belts can be designed to perform well with out-of-position occupants and in small cars. Recently the NHTSA installed and tested an air bag system in a Chevette which, in a 32 mph barrier crash test, met the performance requirements of Standard 208 in every regard.

> [GAO COMMENT: It is with a clear understanding and full appreciation of the respective roles of Government and the industry in a regulatory program using performance standards that we recommend testing be performed to ascertain whether present performance standards need to be amended or modified. In the development of air bag systems to meet performance standards promulgated by the Government, certain potentially hazardous side effects have arisen which could seriously impact upon the commercialization of air bag systems. Notwithstanding NHTSA's development and test programs which, according to NHTSA, have demonstrated that air bags can be designed to perform well with out-of-position occupants, more recent developmental testing by General Motors and Volvo indicate that a problem exists for out-of-position children. Within this context, we believe the Department should sponsor testing directed toward assessing the seriousness of the problems and developing, if warranted, performance criteria for out-of-position adults and children.

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This type of testing falls squarely within the Government's responsibility as stated by the Department on p. 86: " * * * The research into the capabilities of the technology, and studying any possible side effects that arise from the commercialization of the technology."]

In addition, the car makers have and are continuing to run thousands of tests on cars of all sizes with automatic restraints. For example, in the early 1970's Ford carried out a major test series with air bags in subcompact Pintos.

The GAO's major theses in its discussion of automatic restraint effectiveness, and the NHTSA's responses are summarized as follows:

GAO	NHTSA
1. The NHTSA"s quantification of the benefits of automatic restraints "lends a degree of certainty not fully supported by the test data."	The estimates of automatic restraint effectiveness made by the NHTSA were conservative estimates based on expert comparison and interpretation of a substantial amount of engineering test and highway crash data. It is the most comprehensive estimate that has been carried out on the subject and is a far more solid estimate than generally accompanies major public health measures. Furthermore, the decision to require automatic restraints was not predicated on a specific estimate that they would save 9,000 or any other number of lives. Rather, the estimate was an attempt to quantify one of the most important consequencences of the standard.

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2. The frontal barrier crash, used by the NHTSA for many of its restraint system tests, may not be fully representative of the variety of crashes that automobiles have.	The frontal barrier crash is one of the most severe tests of restraint system performance. It is repeatable, allowing ready comparison of test results with different cars and at different proving grounds. It is accepted by virtually all researchers as a good, standard test of restraint system performance. Both the NHTSA and the automobile manufacturers, in their development of production systems, use many other tests of restraint system performance.
3. The NHTSA has not carried out sufficient testing of the performance of automatic restraints with out-of-position occupants.	The NHTSA has devoted a substantial amount of its research effort to understand all aspects of the performance potential of air bags and to investigating their performance with occupants of all shapes and sizes in a wide variety of likely and unlikely positions. The only way, however, that one can be assured that systems that are sold to the public will perform well is for the manufacturers to test them in a variety of circumstances including with out-of-position occupants. The various companies currently developing air bag systems for production have conducted extensive out-of-position occupant tests, and the NHTSA is monitoring their activities. The agency will also test production systems as soon as they become available.

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4. The NHTSA has not carried out sufficient testing of small cars with automatic restraints.	The NHTSA has developed air bag systems for a variety of production and experimental cars including its two small research safety vehicles, the Ford Pinto, Chevrolet Chevette, Chevrolet Vega, Ford Fiesta, and Volvo 244. In addition, agency officials have seen installations and test results from a number of manufacturers in small cars. The Volkswagen Rabbit has been sold to the public for that have proven to be highly effective and acceptable to the public. Nevertheless, recognizing the greater challenge in installing air bags in small cars, the Secretary provided six years of lead time for small cars to meet the standard - more lead time than has been provided for any standard ever issued.
5. The limitations of biomechanical knowledge also make estimates of automatic restraint effectiveness uncertain.	There are uncertainties in biomechanical knowledge, but our knowledge in this area is very substantial. The NHTSA has been conservative in setting injury criteria for occupant crash protection, and has changed these criteria as more has been learned about human injury tolerance. Experience with cars meeting the injury criteria on the road has shown the wisdom of the NHTSA's policy on the establishment of injury criteria. Despite the limitations of using dummies as surrogates in dynamic crash testing, and using injury criteria to determine whether a system meets the requirements of FMVSS 208, this test protocol is far superior to component tests or design requirements. Given the major loss of life among automobile occupants in accidents, it would be irresponsible to wait for perfect knowledge to issue a standard and test procedure.

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A detailed discussion of these five topics follows:

1. Effectiveness Estimates

The data that served as a basis for the automatic restraint system effectiveness estimate is better, by a wide margin, than is generally available for most public health programs. The performance of manual belts has been studied exhaustively in the field and in experimental crashes. Because of the large number of variables among automobiles, belt designs, occupants, the highway environment, and accident types, it is not possible to precisely determine restraint system effectiveness. Nevertheless, the field and experimental data shows conclusively that manual belt systems, when used by the occupant, automatic belts, and air bags are very effective in substantially improving the protection of automobile occupants in serious crashes. The specific estimates made by the Department for these systems are the best available, and are soundly based on performance of these systems on the road, on extensive testing and analysis, on information supplied by auto makers and their suppliers, and on the engineering judgment of experts within the agency and among its contractors.

[GAO COMMENT: We agree that passive restraints offer potential for saving lives and preventing injuries. However, we believe the Department's specific quantification of the benefits lends a degree of certainty not fully supported by the data. For the reasons presented in chapter 2, we believe the estimates based on laboratory tests contain a great deal of uncertainty.

These uncertainties are compounded by the fact that real world data for air bags is still too limited to support reliable estimates of effectiveness in reducing serious and fatal injuries.]

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The GAO draft report suggests that the correct way to make a quantitative comparison between automatic and manual restraints is to test each system in an identical test protocol. The NHTSA does not agree. Effectiveness estimates are subject to many more variables than could be accounted for in such a comparison. This is the reason why expert engineering judgment in this area, supported by a substantial body of test data and experience, may be the most reliable means of making a comparison.

> [GAO COMMENT: Testing each system in an identical test protocol was cited in the Department's Explanation of Rule Making Action as a suitable methodology for determining effectiveness. As stated on p. 36 of our report, we have no objection to the use of subjective engineering judgment and test data to estimate effectiveness. However, as we have shown in our report, little evidence exists to link the test data with the Department's estimates of passive restraint effectiveness.]

Given the available data, the U.S. Court of Appeals for the District of Columbia ruled in Pacific Legal Foundation v. DOT that, despite the agency's publicly announced position that there is a lack of precision in its estimates of automatic restraint effectiveness based primarily on crash test data, the agency's carefully conducted tests provided a basis for the automatic restraint mandate of 1977. The courts (and most automotive safety engineers) recognize that expert scientific and engineering judgment is an entirely valid component of agency decisionmaking. (See, for example, Neff vs. Federal Trade Commission, 111 F2d 889; W.S. Butterfield Theaters, Inc., vs. Federal Communications Commission, 237 F2d 552; and Ethyl Corporation vs. EPA, 541 F.2d 1128.

> [GAO COMMENT: We have not questioned the Department's authority to issue a mandate based primarily on test data. Our concern is with the uncertainty of the effectiveness estimates and the need for objective and timely field monitoring. The U.S. Court of Appeals also recognized that safety standards based heavily on experimental simulations need to be closely monitored in actual road experience.]

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The results of actual field experience with over 12,000 air bag vehicles and about 100,000 cars with automatic belts have fully supported (and, in fact, generally, exceeded) the agency's conservative estimates based upon engineering analysis of crash tests.

> [GAO COMMENT: We disagree that the actual field experience fully supports the Department's estimates. Actual field experience with air bags, especially for fatalities, is still too limited to lead to meaningful statistical conclusions. The Department itself has stated that insufficient real world data exists, in that the number of severe injuries is much too small to be statistically significant. Field experience with the VW passive belt is more extensive and as the Department states, the results are encouraging. However, Safety Administration officials have told us this experience should be examined with caution since passive belt effectiveness depends on whether they are used and these systems can be easily disengaged by occupants. (See p. 33 of the report.)]

While the data is better than in most public health programs, it does contain uncertainties and is subject to interpretation. In addition, the performance of specific designs that meet the requirements of the standard may have different levels of overall effectiveness in the field. It is obvious, for example, that an automatic belt in a Volkswagen Rabbit will not perform identically with an air bag in a General Motors luxury car in all crash modes. Yet both systems are designed to meet the same standard and are tested against it.

The estimate that automatic restraints would save 9,000 lives and 65,000 serious injuries each year is conservative for the following reasons:

- The estimate was of the number of lives that would be saved and injuries prevented in 1975 if all cars were equipped with automatic restraints. Fatalities and injuries in that year were substantially lower than they would be expected to be in the late 1980's without an automatic restraint requirement because of increased travel and other factors. Automobile occupant fatalities in 1978 for example, were about ten percent higher than in 1975.

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- Safety belt usage was assumed to be 20 percent, and later data has shown that belt usage among people involved in crashes is less than half this figure.

- The estimate was based on the performance of the first generation of automatic restraints. Substantial improvements in the performance of automatic restraints are being achieved with the second generation systems being designed for the cars of the 1980's, and these improvements should be translated into greater system effectiveness in the real world.

[GAO COMMENT: Undoubtedly, factors such as those cited by the Department may affect the Department's estimate of the number of lives that would be saved or injuries that would be prevented. However, the estimated 9,000 lives saved is based on passive restraint effectiveness estimates which in our opinion are questionable because of the uncertainties discussed in chapter 2. Consequently, any new projections of lives saved and injuries prevented using the Department's effectiveness estimates would contain the same uncertainties.]

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2. Barrier Crash Testing

The NHTSA selected the frontal and angular barrier crash as the primary compliance test requirement of FMVSS No. 208, and as one of the main tests used in its research, for several reasons:

- The barrier crash test is one of the most severe from the standpoint of vehicle deceleration in that the vehicle absorbs all of the energy of the crash and cannot over- or underride the barrier. This test, therefore, is one that puts the greatest demands on the restraints to cushion the occupant during the crash.

- The barrier crash test is repeatable so that comparable results can be obtained from the test even when it is carried out at different laboratories on different vehicles.

- The barrier crash test is accepted by virtually all researchers as a good standard test of restraint system performance.

The NHTSA is well aware of the potential for injury from factors other than those for which the frontal and angular barrier crash tests are designed. Many of the other motor vehicle safety standards are designed to address these other hazards. However, among the most frequent and severe injuries are those produced by an occupant's collision with the front part of the occupant compartment (steering wheel, instrument panel, windshield, and so on). Standard 208 is designed primarily to ameliorate the casualties in frontal crashes, where more than half of the deaths occur.

[GAO COMMENT: The Department's response does not address our finding that the full frontal barrier crash test--the primary test mode used in its evaluative testing of production-type air bag systems--is an overly simplified simulation of the real world crash environment. The full frontal barrier crash test provides a suitable test to compare the relative performance of different restraint systems in this particular test mode. However, we believe that test results for this particular test mode should not be extrapolated to the full range of real world accidents (side, rear, and rollover) or even to the range of all frontal accidents such as obliques and offsets. As we discussed on page 19 of our report, a 1974-75 Department-sponsored analysis of towaway accidents indicated that the proportion of people injured in crashes represented by the full frontal barrier crash test may make up only 20 percent of all occupants injured in frontal crashes.]

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3. Out-Of-Position Occupants

The NHTSA has devoted a substantial part of its research and development effort to understanding the performance potential of air bags and investigating their interaction with occupants of all shapes and sizes in a wide variety of likely and unlikely positions. In this work, the key parameters of air bag systems that affect performance have been varied: inflation characteristics and timing, bag construction and venting, bag folding and deployment trajectory, and other aspects of the design and performance of the system. Through this work it was found that out-of-position occupants can be protected from serious injury from air bag inflation. See, for example, Minicars-DOT-HS-803-670 "Development of Solid Propellant Inflation Techniques for the Subcompact Car Passenger Restraint System," Phase I, October 1978; Calpsan-DOT-HS-803-612 "Front Passenger Aspirator Air Bag Systems for Small Cars," Phase II Evaluation, March 1978.

Because there are a large number of choices that must be made in the design of an air bag system, a manufacturer must carry out a full spectrum of developmental testing to ensure that the bags will deploy in a variety of frontal crash situations where they are needed, that they will provide the occupant protection that is needed for a variety of people of different sizes and shapes, and that they will not cause disproportionate injury even in unusual situations such as with out-of-position occupants.

The NHTSA has been reviewing the developmental work being done by General Motors, Ford, Chrysler, and Volvo to minimize air bag deployment hazards to small children who may be in close proximity to the air bag when it deploys. Because of the fact that such potential hazards are strongly a function of the design and performance features of various vehicle systems, the Agency believes that such review of manufacturers' activities is the most efficient and effective way to ensure that the systems that are actually produced will be optimally safe.

The NHTSA has investigated all crashes of cars equipped with air bags that it has been able to identify. This includes more than 200 crashes in which the air bags deployed. The agency has particularly studied the injuries to out-of-position occupants in these crashes. In its analysis, the NHTSA has found no evidence of significant injuries being caused by the deployment of air bags, nor of crash injuries that were more serious because of the air bag. The crashes that were investigated included a number in which children were occupants of the car at the time of the crash.

In addition, the NHTSA has undertaken a study of the characteristics of people riding in cars: their age, sex, seating position, posture, and use of manual restraints. This work is being carried out as part of the Agency's ongoing comprehensive observations of safety belt usage around

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the country. This information, which will begin to be available late in the summer, can place the out-of-position occupant problem in perspective by indicating the likelihood that a person will be seated in a way not intended by the vehicle designer at the time of a crash. This information should be useful to manufacturers in making decisions on the design parameters for vehicle interiors and for any type of restraint system.

The NHTSA has considered at various times adding further performance criteria to the requirements of FMVSS No. 208. However, the Agency is very reluctant to do so unless a substantial problem is identified that can only be addressed in this way. Such additional criteria tend to restrict innovations in designs and test procedures used by the manufacturers. They can also decrease the incentive to a manufacturer to try to achieve the safest possible systems because they freeze performance requirements, and inhibit innovation.

The government will continue to monitor the design and test programs of the manufacturers and, as production cars with air bags become available, will test them not only for compliance with the requirements of FMVSS No. 208, but also to determine other aspects of performance as it has done with air bag production equipped cars in the past. The Agency will keep an open mind concerning the addition of further performance criteria to the standard.

[GAO COMMENT: The Department disagrees with us on the need for additional testing on the out-of-position occupant problem. It believes the appropriate way to handle this problem is to monitor the industry's development and testing programs and to test the production systems when they become available. The Department points out that it has the responsibility to develop accurate, reproducible, and relevant test methods in establishing performance requirements for Federal standards (p. 86). It is within the context of this responsibility that we believe the Department should perform additional testing specifically on the out-of-position occupant problem which has surfaced since Standard 208 was promulgated. The Department has established performance criteria for the driver and front seat occupant seated in normal positions. Recent industry tests indicate a substantial problem for the out-of-position occupants may warrant a modification to the existing performance criteria.]

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4. Automatic Restraints in Small Cars

The fact that smaller cars were likely to be produced in the 1980's because of fuel economy requirements, and the greater likelihood of serious injury or death in a crash of a smaller car, was one of the factors that led Secretary Adams to issue the standard requiring automatic crash protection in passenger cars. Thus, the successful installation of automatic restraints in small cars has been a major goal of the NHTSA.

Providing occupant crash protection in a small car is generally more difficult than in a larger car. There is a limited amount of exterior structure available to absorb the crash energy, making the deceleration of the vehicle during the crash more severe than in a larger car if the integrity of the occupant compartment is to be kept intact. Triggering and inflation times for smaller car air bags also must generally be shorter than for a large car system.

Despite the additional challenge of designing restraints for small cars, the NHTSA has demonstrated that air bags can be readily designed to meet the occupant protection requirements of FMVSS No. 208 in current production cars. Furthermore, the NHTSA and the vehicle manufacturers have designed experimental small cars that very substantially exceed the performance requirements of FMVSS No. 208 using air bags. Volkswagen's experience in marketing cars with automatic belts for more than four years shows that these systems can also be used successfully in small cars.

The NHTSA has devoted a substantial part of its research budget to the development and testing of automatic restraints in small cars. Air bag and automatic belt designs have been developed and tested by the NHTSA for its two Research Safety Vehicles built by Minicars and Calspan as well as for the Ford Pinto, Chevrolet Vega, Chevrolet Chevette, Ford Fiesta, and Volvo 244. In addition, NHTSA officials have seen small car air bag installations and have assessed test results from several manufacturers including Ford, Nissan (Datsun), Toyota, Honda, and Volkswagen. The Agency is currently installing and testing an air bag system in a Dodge Omni.

Nevertheless, the Secretary recognized the additional difficulties presented by small cars in the standard by giving an unprecedented six years of lead time for these cars. The rulemaking notice for the standard discussed the small car question in some detail.

The NHTSA's work with Research Safety Vehicles shows that with modification of the structure of a small car, and air bags specially designed for such vehicles, their safety performance can be improved substantially. Even without these modifications, automatic restraints will greatly improve protection of occupants of small cars compared with their being unrestrained, and will provide a level of safety equivalent to that provided by manual belts when used.

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[GAO COMMENT: We agree that fuel economy requirements will likely mean a larger number of small cars in the 1980s and that serious injuries or death may be more likely in a crash of a smaller car. A careful reading of our report (pp. 27 and 28) will show we have recognized the research and testing mentioned by the Agency. Nevertheless, most of the air bag test data available to the Department in making its estimate of air bag effectiveness was performed with large cars. Consequently, using effectiveness data obtained on large cars to estimate effectiveness of small cars in the future presents another element of uncertainty in trying to estimate the effectiveness of restraint systems.]

5. State of Biomechanics Knowledge

During the past ten years, since the requirement for automatic crash protection was first contemplated, the NHTSA and other researchers have advanced the state of biomechanics knowledge very substantially. However, because human response to trauma is a very complex phenomenon, there is always more to be learned about it.

As a result, the NHTSA has been conservative in establishing injury criteria for FMVSS 208. However, as data and knowledge have increased in the field, the injury criteria have been modified to reflect our increased understanding of injury mechanisms and human tolerance to trauma.

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The use of crash testing with instrumented anthropomorphic test dummies is a major step forward from previous crash safety standards. In the past, such standards have specified performance levels for components (such as for strength, energy absorption capability, or durability) that were assumed to be related to the protection of human occupants. The automatic crash protection standard, on the other hand, requires a test of the full restraint system in a highly realistic situation. Whatever the limitations of biomechanics knowledge, the performance tests specified in FMVSS 208 should result in a very substantial improvement in the performance of restraint systems.

Experience with production cars that were equipped with air bags shows that people who have been in crashes where the air bags deployed have had fewer and less severe injuries overall than have occupants of similar cars without such restraints who were in crashes of the same type.

A study of air bag effectiveness by the Insurance Institute for Highway Safety compared injuries of occupants of cars equipped with air bags to injuries of occupants without air bags who were in otherwise similar cars. Even where injuries were classed as being of the same level of severity on the Abbreviated Injury Scale (AIS), the occupants of cars with air bags generally had fewer injuries, and the most serious were generally injuries to the extremities. For people without restraints, there were far more head, neck, and torso injuries.

Thus, the agency believes that despite the limitations of biomechanics knowledge and of the Part 572 dummy as a measuring instrument, the dummy and test procedures provide a good measure of the critical aspects of occupant injury potential. It is important to measure injury potential in a crash with devices that simulate human responses even if the simulation is not exact. Neither component performance nor design standards fully address the ultimate purpose of a crashworthiness standard which is to assure a reduction in occupant crash injuries.

> [GAO COMMENT: We do not disagree with the use of the Part 572 test dummy as a measuring instrument for compliance testing. However, the human body is a very complicated biochemical structure and sufficient information is not available to have a complete understanding of the critical structures in the body and their injury limits. Thus, relying on the instrument to simulate human responses and injury potential in a laboratory setting lacks an exactness which creates still another element of uncertainty in attempting to estimate passive restraint effectiveness under the full spectrum of crash conditions.]

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Recommendations of the GAO

The NHTSA disagrees with the GAO's recommendations for additional testing of hypothetical restraint systems beyond that contemplated in the NHTSA's current research agenda. The Agency believes that the appropriate way to ensure that systems that are produced for use by the public are as safe as possible is to monitor the development and testing programs of the industry and to test production systems as soon as they become available.

The Agency has a plan for the evaluation of the effectiveness of automatic crash protection systems under development that it intends to publish this fall for public comment. The Agency places a high priority on this activity and expects that its plan will meet the primary recommendations in the National Transportation Safety Board's recent report. Thus, the NHTSA concurs in the GAO's endorsement of the Board's recommendations.

The GAO recommended that "the Secretary appoint a task force comprised of representatives from the Safety Administration, the insurance industry, the automobile industry, and independent highway safety researchers to develop an evaluation plan." The NHTSA is presently constituting an advisory committee for the National Accident Sampling System (NASS). It is to be composed of a broad spectrum of experts representing a wide variety of interests and expertise. Since the Agency intends to use the NASS in its evaluation program, it is appropriate that the NASS Advisory Committee be used to assess the automatic restraint evaluation plan. Thus, this recommendation by the GAO is already essentially programmed to be carried out.

[GAO COMMENT: The Department's response to our recommendations is discussed at the end of chapter 2.]

Additional Points

The GAO report discusses one particular crash of a car equipped with an air bag, and the NHTSA's tests that were carried out to try to understand what happened in that crash (see pages 37-39 of the GAO draft report). In its conclusion to this discussion, the report incorrectly states that the NHTSA "ruled out" the idea that there may have been an assault to the larynx of the occupant in the crash. That is not the case. The agency concluded only that the likelihood was undemonstrated. As a result of its investigation of this crash, however, the agency did advise General Motors that they believed that it was unwise to use the thick plastic covering over the driver air bag which might unnecessarily injure an out-of-position driver when the air bag deploys.

[GAO COMMENT: In our view, the Department had ruled out the possibility that the air bag deployment contributed to the injuries because:

--it concluded the possiblity was undemonstrated and more remote than other possible explanations for the death (p. 25 of the report), and

--it failed to perform additional testing for this particular out-of-position condition.]

On page 43, the report discusses General Motors' concern that the combination of the deploying air bag and the crash forces could result in hand and arm injuries to occupants of sub-compact cars in crashes. While this may be true, such injuries are usually the least serious occurring in a crash and do not approach life-threatening severity. It is very unlikely that these injuries would be as severe as the injuries to the head, neck, and torso of unrestrained occupants.

[GAO COMMENT: The Department discounts General Motors' concern on the basis that any injuries incurred as a result of the deploying airbag would be minor compared to the more serious injuries that could be prevented by the air bag. General Motors in its comment, however, is pointing out the possibility that occupants who otherwise might not have been injured in low-speed accidents may suffer injuries as a direct result of the deploying air bag.]

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The report discusses the General Motors' air bag effectiveness study, "Matching Case Methodology for Measuring Restraint Effectiveness," and states (page 50) that "GAO believes the matching case methodology was basically sound."

The NHTSA does not agree that the matching case methodology used by General Motors was sound. The Agency examined (Examination of the General Motors Matching Case Methodology for Evaluating Restraint System," NHTSA, November 1977) the study and found two sources of serious bias, both leading to systematic underestimates of the air bag effectiveness. One bias is introduced by the broad limits used in matching impact severity (measured crush). A second bias results from a disparity in the age of injured occupants. When corrections are made to mitigate these biases, the air bag effectiveness was found to be in the range of 30 percent to 60 percent.

The NHTSA agrees that the methodology developed by GM is a potentially useful one, but it needs refinement to eliminate its systematic bias and to increase its ability to discriminate between injuries of greater and lesser severity.

In its critique of the GM "Matching Case Methodology," the Insurance Institute for Highway Safety stated,

> "We have already documented a number of serious discrepancies and inconsistencies in the GM data sent to us compared with information submitted by GM to DOT. Several of these discrepancies are sufficient to raise very basic questions concerning the care with which the matching was performed by GM. For example, contrary to the description of its matching in the attached letter, there are cases in which lap belted occupants were matched with air bag restrained occupants who were not wearing their belts; at least eleven instances of this error have been identified. There is also at least one example of the reverse -- an air bag restrained occupant who was wearing a lap belt matched with an unrestrained occupant. In another instance, a fatally injured lap/shoulder belted occupant was matched with a non-lap belted air bag occupant. (GM itself became aware of this latter error and informed us that it should be removed from the matching cases.)

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Other discrepancies noted included differences in the number of matched occupants for particular air bag crashes submitted to us compared with the number reported for the same crashes in prior GM documents. In some of these instances, we received more matched cases than GM had previously reported, and in other instances we received fewer matched cases."

[GAO COMMENT: The Department has not questioned the GM methodology but has criticized the way certain accident cases were matched (i.e. direction of impact, area of vehicle damage, estimated speed etc.) Although we agree with the Department that other variables can be used in determining effectiveness, (for example, occupant age) the basic problem still remains--a lack of sufficient data, especially at higher severity injury levels, to determine the level of air bag effectiveness with any reasonable degree of precision. It is in recognition of this problem that we have called for the Safety Administration, the automobile industry, and independent researchers to agree upon an acceptable evaluation plan prior to the introduction of passive restraint systems.]

CHAPTER 3, SODIUM AZIDE

The GAO draft report presents no new information in its discussion of sodium azide. Rather it restates a number of real and imagined potential hazards associated with the use of sodium azide as a gas generant for air bag systems. The GAO makes no attempt to evaluate either the likelihood that the hazard will materialize, or the seriousness of its potential consequences. Thus, the report raises no issues that are not already being addressed by the manufacturers or by the government. Furthermore, as in the chapter on automatic restraint effectiveness, the GAO again confuses the responsibilities of the industry and the government in relation to this issue.

> [GAO COMMENT: We are fully aware of the respective responsibilities of the interested parties, as evidenced by our discussion of the Federal agencies' role on pages 47-49 of our report.]

Just as the choice of a restraint system design and engineering is the responsibility of the manufacturer, the choice of materials and inflation methods for air bags is similarly the manufacturer's responsibility. In making their choices, the manufacturers have responsibilities under various occupational and environmental laws to ensure that they are not introducing new health, safety, or environmental hazards.

Various technologies have been used to inflate air bags. The air bag systems that were orignally designed by the Eaton Corporation for Ford Motor Company used stored gas to inflate the bags. The system was used for the passenger restraints on a fleet of 831 1972 Mercurys. The General Motors' Air Cushion Restraint System used a hybrid passenger air bag inflator that had a combination of stored gas and a small pyrotechnic charge to inflate the bag. The driver system inflator used sodium azide.

Sodium azide, was an obvious choice as an air bag inflation material. Sodium azide produces virtually pure nitrogen gas on burning with an appropriate oxidizing agent, it is inexpensive and readily available, it burns rapidly but will not explode on ignition, and it is highly stable when sealed within a container, such as an air bag inflator. Purely pyrotechnic systems have the additional advantage that they will not lose their potential to inflate the bags effectively with increased age.

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Thus, as manufacturers and suppliers developed air bag systems, they generally turned to inflators using sodium azide to produce the gas required for inflation. One notable exception was the Allied Chemical Corporation which continued its development program of both driver and passenger air bag inflators of the hybrid type. Although Allied successfully tested its sytsems, it stopped its inflator development work in 1978 as automobile manufacturers all made commitments to suppliers of pyrotechnic systems using sodium azide for their 1981 model cars.

The NHTSA, in its Environmental Impact Statements, (EIS) published in 1976 and 1977, cited the fact that sodium azide production would probably expand substantially if automatic restraints were required in automobiles sold in the U.S. The EIS noted the many desirable characteristics of this material but also discussed that the primary potential problem with its use would be in the disposal of automobiles equipped with air bags.

The 1977 rulemaking notice stated:

> "The Agency is satisfied that the material can be used safely both in an industrial setting and in motor vehicles during its lifetime, due to inaccessibility and strength of the sealed canisters in which it is packed. The problem is to assure a proper means of disposal. Junked vehicles that are shredded have batteries and gas tanks removed routinely, and the air bag could be easily deployed by an electric charge at the same time. A hazard remains, however, for those vehicles that are simply abandoned. However, the Agency judges that the chemical's relative inaccessibility will discourage attempts to tamper with it. The proportion of abandoned cars is less than 15 percent of those manufactured. The Department will work with the Environmental Protection Agency to develop appropriate controls for the disposal of air bag systems employing sodium azide."

During the Congressional consideration of the standard, certain parties opposed to the standard cited again and again potential hazards with the use of sodium azide in automotive air bags as justification for disapproving the standard.

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The GAO implies that neither the NHTSA nor other parties has given the matter of sodium azide sufficient attention when in fact a great amount of time and resources have been focused on it. The NHTSA and other Federal agencies (particulary the Environmental Protection Agency and the Occupational Safety and Health Administration), the automobile manufacturers, their suppliers, and the chemical companies that produce or intend to produce the chemical have taken a number of actions to ensure that any potential hazards are well understood and that appropriate measures can be taken to ensure that the public and the environment are not exposed to significant risks as a result of the use of sodium azide in air bags.

- On January 31, 1978, several NHTSA staff members visited Huron Valley Steel Company, an advanced automobile recycling company, and the Ford Motor Company, to discuss disposal methods and the effect of undeployed air bags on vehicle scrappage and the recovery of materials from that process.

- On March 30, 1978, the NHTSA released a draft report, "Sodium Azide in Automotive Air Bags," that discussed the subject in detail.

- On April 7, 1978, the NHTSA sponsored a meeting on the subject that included officials from the EPA, OSHA, GAO, the automobile companies, air bag suppliers, chemical companies, and other interested parties.

- In May 1978, the Thiokol Chemical Corporation released a study prepared for the Ford Motor Company, "Sodium Azide Investigation Programs," that discussed the nature of sodium azide and its use in air bag inflators.

- In the spring of 1978, the Motor Vehicle Manufacturers Association initiated two studies of sodium azide with Arthur D. Little, Incorporated, and with Battelle Columbus Laboratories. These resulted in the reports:

  -- "An Investigation of the Potential Human and Environmental Impact Associated with Motor Vehicle Air Bag Restraint Systems," Arthur D. Little, Inc., Boston, December 1978.

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-- "Gas Generants Research," Battelle Columbus Laboratories, Columbus, December 1978.

The A.D. Little report identified no events in the life cycle of air bags that could be classified as "imminently dangerous" to humans or to the environment. They found no significant potential environmental impacts associated with normal deployment of the systems or in the abandonment of vehicles with non-deployed systems. The report recommended deactivation, such as by inflation, of air bag systems early in the salvage cycle for scrapped vehicles to reduce the likelihood of workers being injured or chronically exposed to sodium azide or its decomposition products.

The Battelle report, citing experiments that were carried out with air bag inflators and with cars equipped with air bag sytems, found that normal baling and shredding operations in scrap yards would not be hindered by the presence of inflatable restraint systems. While the Battelle researchers did not identify any serious safety or environmental problems in the manufacture or use of cars equipped with inflatable restraints, they suggested that further research and experimentation would be useful.

- Because the Little and Battelle studies were problem identification studies only, the NHTSA contracted with A.D. Little to study methods of safe air bag disposal.

- PPG Industries has for a number of years been carrying out research into the use of sodium azide as a soil sterilizing agent. The company currently has a temporary EPA permit for its use and is carrying out toxicological and environmental chemistry studies to satisfy EPA guidelines for a permanent permit. PPG recommends application of sodium azide directly onto the soil at a rate of up to 120 pounds per acre for agricultrual purposes.

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- The potential carcinogenicity of sodium azide is being investigated. It has been shown that sodium azide is mutagenic, and while most mutagens are also carcinogens, there is no evidence that sodium azide is carcinogenic. Several studies have shown negative or nonconclusive results. Dr. Elizabeth K. Weisburger, Chief of the Laboratory of Carcinogen Metabolism, National Institutes of Health, has informed the NHTSA that one can easily conclude that sodium azide is not a powerful carcinogen, and it is her belief that it is doubtful that sodium azide is carcinogenic at all.

- NHTSA personnel have met with, and discussed cooperative programs with the two primary automobile salvage associations in the U.S. (to determine the best means of handling cars with air bags when they are scrapped): the Automotive Dismantlers and Recyclers of America, and the Institute for Scrap Iron and Steel.

The studies by A.D. Little and Battelle tend to dispel most of the concerns raised regarding the use of sodium azide in automotive air bags. In particular, they support the NHTSA's original conclusion that sodium azide can be used safely both in an industrial setting and in motor vehicles during their lifetime due to the inaccessibility and strength of the sealed canisters in which it is packed.

The only area that has been identified as presenting a potential problem if proper actions are not taken, is in the scrappage of automobiles equipped with air bags. This potential hazard can be eliminated merely by inflating the air bag early in the salvage cycle.

The NHTSA does not want to minimize any real and significant potential hazards that may arise with the use of sodium azide in air bags. It does believe, however that discussion of the subject in the GAO report lacks proper perspective on the relative hazards posed. Such an imbalanced presentation can immeasurably damage public confidence in this major public health program. The NHTSA believes that along with its sister agencies, the EPA and OSHA, and the automobile manufacturers, it is acting responsibly to ensure that the use of sodium azide in air bags will not introduce any substantial new hazards to public health and safety, or to the environment.

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The NHTSA disagrees with the recommendation of the GAO that the EPA and OSHA give a high priority to having additional research on sodium azide health and safety risks. Appropriate priority is already being given the subject at the present time. Compared with other risks in the environment and workplace, research beyond that already being carried out on sodium azide does not seem warranted as the GAO report suggests.

For example, there are other potentially harmful chemicals used in automobiles. Asbestos and polyvinyl chloride are used in production of vehicles in large quantities. The asbestos dust and vinyl chloride monomers are well known carcinogens. Other toxic chemicals used in production vehicles include sulfuric acid, freon, and methanol. The issue of flammability may be put into perspective by considering the huge quantities of potentially flammable materials which are shipped commercially. These materials range from gasoline to metallic sodium.

If one considers sodium azide in comparison with such major environmental hazards as the newly discovered chemical dumps, the environmental dispersion of PBB's, and kepone, giving extraordinary priority to sodium azide research would seem ill considered.

Therefore, the Agency does not believe that priorities should be set in a vacuum without consideration given to the relative priority of such research, given the current work by various parties such as PPG Industries. The diversion of additional resources would be unlikely to have payoff consistent with the expenditures. Of course, NHTSA will continue its work with the EPA and OSHA. The public can be assured that the subject is continuing to be given its appropriate priority relative to other chemical exposure issues.

[GAO COMMENTS: The Department states it has contracted with A.D. Little to study methods of airbag disposal. We recognize this on page 47 of our report.

The Department disagrees with our recommendation for priority action on determining whether sodium azide is a potential mutagen and/or carcinogen in humans. This is discussed at the end of chapter 3.]

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CHAPTER 4, COST OF AIR BAGS

The NHTSA does not disagree with most of the facts presented in the chapter on air bag cost. However, the Agency believes that the GAO discussion is likely to be highly misleading.

The cost of meeting a motor vehicle safety standard that is stated in performance terms is not controlled by the NHTSA. A manufacturer has a considerable amount of latitude in designing vehicles to comply with Federal standards, and the choice made by a manufacturer may strongly affect both the cost of making the vehicle and the prices charged dealers and the public. The best example is, of course, the manufacturers choice of whether to use automatic belts (which are relatively inexpensive) or whether to use air bags (which are somewhat higher in cost) to meet the automatic restraint standard.

> [GAO COMMENT: We generally agree that the cost of meeting performance standards is not controlled by the Department because the manufacturer can select the specific system to be used. However, in the case of passive restraints, the manufacturers do not have a choice between air bags or the less costly passive belts in all instances. Passive belt systems are not yet feasible for cars with three seating positions in the front. Consequently, the manufacturers have no choice except to install air bags in cars with three front seat postions.]

A number of other factors also affect the prices that the consumer will be charged for air bags:

- Production volumes are probably the most important factor affecting the cost of manufacturing air bags. Estimates given the NHTSA by various manufacturers and their suppliers indicate that doubling production volume, which makes the use of automated machines more feasible, will result in a reduction in production cost of as much as 50 percent.

- Whether air bags are standard equipment on a car line or are offered as optional equipment will also affect their cost. If only one system is offered, production volume will be maximized, and in addition, engineering and testing costs will be substantially reduced. There could also be reduced production costs since the same equipment is installed on each car that is on the production line.

- The decision of a manufacturer whether to make or buy components for an air bag system can also significantly affect the cost of manufacture for several reasons. First, unit costs of components made by an auto company tend to be much lower than the cost of parts obtained from suppliers. The cost of parts from a supplier is also strongly dependent on the contractual arrangements made with suppliers including the guaranteed annual purchase volumes, the length of the contractual arrangement, the arrangements made for facilities, tooling, and the way in which liability risks are shared.

The DOT's 1976 estimate of $112 was an estimate of the cost of a representative air bag system that would meet the minimum performance requirements of FMVSS No. 208. The Agency analyzed the differences between its estimate and those of GM and Ford, and came up with essentially the same reasons for the differences as did the GAO. The NHTSA believes that it is entirely appropriate that the manufacturers design and build into their systems features that will improve performance beyond the minimum requirements of the standard, and does not dispute the fact that these additional features may add some small cost to a restraint system.

Economic inflation is a major factor accounting for key differences between estimates of air bag cost. For example, the GAO quotes several figures provided by GM and Ford for air bags that will be produced under the automatic restraint standard at the beginning of the chapter and in its Digest. The GAO failed, however, to note that these figures are quoted in 1982 and 1983 dollars. At a rate of inflation of only 8 percent, costs expressed in 1982 dollars would be nearly 60 percent higher than the same costs expressed in 1976 dollars.

[GAO COMMENT: We clarified our report to show that the GM estimate is based on 1979 dollars. In addition, we incorporated Ford's updated estimate based on 1982 dollars. (See p. 54.)]

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It is also important to note a recent estimate from General Motor's President Elliot M. Estes, of the cost of complying with all Federal safety standards from 1980 through 1984, including the full implementation of automatic restraints. The average cost of safety standards per vehicle produced by GM is estimated by the company to be as follows (in 1978 dollars):

Model Year	Incremental Cost	Cumulative Cost
1980	$ 5	$ 5
1981	30	35
1982	20	55
1983	55	110
1984	5	115

In 1982, approximately one quarter of GM's production will have to be equipped with automatic restraints. In 1983, approximately three-quarters of its production will have to have them, and in 1984, all will have to be so equipped. Part of the cost of equipping the 1982 models with optional air bags will be borne in 1981 with the voluntary offering of air bags on 1981 full-size models.

These estimates from General Motors are probably a much more accurate estimate of the cost of complying with the automatic restraint standard than the exaggerated figures presented at the beginning of the GAO's chapter on cost.

[GAO COMMENT: The figures referred to by the Department as "exaggerated" are cost estimates from General Motors and Ford. The $115 figure cited by the Department represents General Motors' rough estimate of the average cost of safety standards as opposed to the cost of air bags which is the subject of this chapter--Cost of Air Bags. The $115 estimate is based on a mix of air bags and passive belts and was computed as follows:

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	Market volume	Estimated cost	Average weighted cost
	(percent)		(dollars)
Air bags	10	$500	$ 50
Passive belts	90	70	60
Total			$110
Bumper standard			5
Total			$115

For an air bag-equipped car, the consumer will not pay the average passive restraint cost but, rather, the higher air bag cost.]

The NHTSA has a contract now underway to carry out analyses of the production costs of restraint systems by examination of the actual hardware that has been or will soon be in production. These will provide an independent cost estimate that can be used as a basis for understanding the more recent estimates of the industry.

[GAO COMMENT: This effort was discussed in our report. (See p. 54.)]

The NHTSA would like to note that to make progress in any field often requires that certain costs be borne early in the program. Many millions of dollars have already been spent by manufacturers and their suppliers in preparation for the production of automatic restraints in the 1980's. If the standard were to apply for a few years, and if these costs had to be recouped during this period, automatic restraints would be very expensive indeed. But the standard will be in effect for many years afterward. As consumer preferences for one or another system manifest themselves and as the systems are further developed to reduce cost and improve performance,

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the cost of meeting the standard will invariably go down. At the same time, the benefits of the standard, in both human and economic terms, will begin to accrue in substantial measure in this period after the initial implementation of the standard.

Finally, one should compare the cost of automatic restraints with the cost of other options that have been embraced by most car buyers. Air conditioning adds more than $500 to the price of a car, and an automatic transmission adds about $300. The average new car has nearly $1,000 in optional comfort, convenience, and appearance options.

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CHAPTER 5, INSURANCE PREMIUM DISCOUNTS

In the Digest to the report, the GAO states, ". . . estimates of air bag cost and insurance savings are optimistic." This conclusion, at least with respect to insurance savings, is not supported by the findings of Chapter 5 on insurance premium discounts.

The Secretary stated in the preamble to the rulemaking notice that "...the evidence indicates that premiums are fundamentally based on claims experience." However, the notice quoted from an estimate made by Nationwide Mutual Insurance Companies that the savings in insurance premiums should average $32.50 per insured car year if all cars were equipped with air bags. Their estimate was based on 1975 claims data and the NHTSA's estimate of air bag effectiveness in reducing fatalities and injuries in that year.

[GAO COMMENT: We believe that the Department's handling of the cost of passive restraints in its preamble to the rulemaking notice was optimistic. In the preamble, it stated that:

"If, as projected, passive restraints are effective in saving lives and reducing injuries, as compared to existing belt systems at present use rate, the insurance savings that will result will offset a major portion, and possibly all, of the cost to the consumer of the systems. There may be some doubt on this point that arises from skepticism concerning the behavior of insurers.

* * * * *

"The $32.50 annual insurance savings estimated by Nationwide would be sufficient to pay for the added operating cost (around $4 per year) of an air-bag-equipped car with enough left over to more than pay for the initial cost of the system. Discounting at the average interest rate on new car loans measured in real terms (6 percent), the air bag would almost recover the initial cost in 4 years, with a savings over operating cost of $107."

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We believe that to imply that the cost of passive restraints will be offset in 4 years is both optimistic and misleading. As disclosed in chapter 4, the Department's air bag cost estimate was based on unrealistic production volumes and did not include certain design and manufacturing costs. Regarding the Department's discussion of insurance premium discounts to be offset against cost, we concluded that the ultimate impact of passive restraints on insurance rates is uncertain. Obviously, the ultimate impact will depend on claims experience as a result of passive restraint effectiveness as well as inflation, car design, cost of restraints, and competition.]

The NHTSA fully agrees with the analysis made by the GAO of the factors that influence insurance premiums, but believes that most of the material presented in this chapter is irrelevant to the question of what insurance savings could be attributed to the savings in lives and injuries that will come from the implementation of the automatic restraint standard. Furthermore, the Agency believes that the responses of the insurance companies to the GAO's questionnaire cannot be adequately assessed without seeing the questions that were asked, and requests that the questionnaire and the major verbatim responses be reproduced in the report. This would seem particularly important since the GAO report seems to imply that the insurance industry, which has and continues to strongly advocate the standard, has now expressed some very negative views on certain aspects of automatic restraints. This industry has not changed its strong support for the automatic crash protection standard.

[GAO COMMENT: We disagree with the Department that most of the material in this chapter is irrelevant. This chapter discloses the uncertainty of insurance savings by discussing those factors that will impact on future insurance savings, i.e., actual claims experience, restraint system effectiveness, and fault or no-fault insurance coverage. Regarding the Department's request that the questionnaire and major verbatim responses be reproduced in the report, we have included the questionnaire as appendix I. However, it is not practicable to include the verbatim responses.]

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The fact is that, all other things being equal, if fewer people die or are injured on the highways, the insurance company payouts to policyholders (claims) will be lower. This must eventually be reflected in reduced insurance premiums. The Nationwide estimate is simply an attempt to relate the reduced injuries and fatalities predicted for automatic restraints to insurance rates.

The current premium discounts for cars equipped with air bags that are presented by the GAO are irrelevant to the question of what insurance savings will ultimately accrue for owners of cars with automatic restraints. These are a reflection of the policies of the companies in setting rates when they are uncertain about claims and bear little or no relation to potential future savings.

[GAO COMMENT: A careful reading of the paragraph preceeding the discount table on p. 62 clearly shows that the presentation was not intended to illustrate potential future insurance savings but was to demonstrate the extent of differences for air bag discounts between fault and no-fault States.]

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It should be noted that there is a serious error in the list of reasons supposedly given by Allstate and Nationwide for not offering discounts for cars equipped with automatic belts. A belt system that failed to meet the injury criteria of FMVSS No. 208 would be subject to recall by the manufacturer. The GAO should check its records to correct any mistake on this matter.

[GAO COMMENT: This comment was made to us by Allstate Insurance Company. The full text of the comment was:

"Finally, we have in the past maintained certain reservations about the ability of passive restraint equipped cars to meet the crash test criteria of standard 208. As you probably know, the Volkswagon Rabbit operates under an exemption from certain of the crash test criteria and it thus remains to be seen whether or not a passive belt system can be produced which meets all of the test requirements. Since it is possible that many of our concerns could be resolved by future design developments and testing, we are not foreclosing altogether the possibility of such a discount. However, we must await this further information and data."]

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APPENDIX: Summary of the GAO Report, "Passive Restrainits for Automobile Occupants - A Closer Look"

GAO Introduction

The General Accounting Office introduced its study of automatic restraints with discussions of: the background and criteria for the promulgation of Federal Motor Vehicle Safety Standards, the technology of occupant restraint systems, safety belt usage in the U.S. and abroad, the events leading to the decision by Secretary of Transportation Brock Adams to require automatic restraints, and the recent judicial review of the standard. The introduction also describes the scope of the GAO review. They discuss automatic restraint effectiveness, the use of sodium azide as a gas generant, the cost of air bags, and insurance premium discounts.

Effectiveness

The GAO report reviews the National Highway Traffic Safety Administration's (NHTSA's) estimates of the effectiveness of passive restraints that were used in the Secretary's decision to require automatic crash protection in new cars. It discusses the testing that had been performed on manual belts, automatic belts, and air bags to develop the system and derive estimates of their effectiveness. The report also reviews the field experience with manual and automatic restraints, and the analysis of that experience by NHTSA and others.

Although the GAO does not challenge the NHTSA estimate that automatic restraints would save about 9,000 lives and 65,000 serious injuries each year, it concluded that the estimate was quantified to a degree of certainty that was not fully supported by the test data. The GAO's opinion is that the NHTSA did not carry out sufficiently comprehensive comparative testing of the various manual and automatic restraints to support the detailed estimates made by the agency of automatic restraints effectiveness. Nevertheless, the GAO did conclude that automatic restraints "do offer lifesaving and injury-prevention potential."

The GAO cited four factors that it believes are responsible fot the uncertainty in the estimated effectiveness of automatic restraints: 1) crash testing performed to date by the NHTSA is primarily in simplified crash modes that

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simulate the crashes that occur on public roads in only a limited way, 2) the NHTSA has conducted insufficient testing of the performance of air bags with occupants who are not in their normal seating position at the time of the crash, 3) the NHTSA has conducted insufficient development and testing of automatic restraints in small cars, and 4) biomechanical knowledge is limited, so that tests using anthropomorphic test dummies may not accurately or completely measure human injury potential in crashes.

Thus, the GAO recommends that the NHTSA carry out additional testing of air bag systems with out-of-position occupants and set additional performance criteria for automatic restraints if it is warranted.

The report concludes that the available field data is insufficient to either support or refute the NHTSA's effectiveness estimates. As a result, the GAO concurs in the recommendations of the National Transportation Safety Board (NTSB) that a timely and comprehensive field evaluation be performed as soon as new cars appear on public roads with air bag systems in reasonable numbers, an activity the NHTSA is already planning.

As a part of the planning for the evaluation of automatic restraint performance, the GAO recommends that the Secretary of Transportation appoint a task force that includes members from the insurance industry, the automobile industry, and independent researchers to develop an evaluation methodology and plan for automatic restraint performance in use on public roads by the general public.

Sodium Azide

The GAO report next discusses the use of sodium azide as a gas generant for air bags. The report implies that the use of sodium azide in large numbers of production automobiles may pose potential health and safety risks. It discusses both known and speculative potential hazards, but does not draw any conclusions as to the relative likelihood that any of them would, in fact, be a threat to health and safety.

Thus, the GAO recommends that the Administrator of the Environmental Protection Agency (EPA) and the Secretary of Labor, through the Occupational Safety and Health Administration (OSHA), require that a high priority be given to additional research on sodium azide to determine its health and safety risks.

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Air Bag Cost

The GAO assesses cost estimates made by the NHTSA, General Motors, and Ford before the decision to require automatic restraints in new cars. It concludes that the NHTSA estimate did not include certain design and manufacturing costs that appear to be reasonable and consistent with other cost estimates made by manufacturers. On the other hand, it found that the NHTSA's estimate of dealer profit was more realistic than the figures used by the manufacturers.

The GAO quotes some recent cost estimates for air bags by manufacturers that are based on low volume production and include estimated inflationary cost increases over the next several years. The GAO notes that the NHTSA is reviewing and evaluating the latest cost estimates of the manufacturers, and makes no specific recommendations relating to air bag cost estimates.

Insurance Premium Discounts

The GAO sent questionnaires to various insurance companies on the establishment of rates for cars equipped with automatic restraints, and the report summarizes at least some of the information obtained from these questionnaires. The report states that several major insurers plan to offer discounts for cars equipped with automatic restraints, and quotes some discounts presently being given for cars with air bags. It indicates that some insurers are undecided or have no plans for such discounts.

The report finds that several factors could influence the rates for cars with automatic restraints including: whether the state in which the car is insured is a fault or a no-fault state, whether the car is equipped with air bags or automatic belts, and what the actual experience is with the restraints. The GAO concludes that the ultimate impact of automatic restraints on insurance rates depends on claims experience and that insurance rates generally depend on factors such as inflation, car design, business costs, and competition. The report makes no recommendations relating to insurance premium discounts.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JUN 28 1979

OFFICE OF
PLANNING AND MANAGEMENT

Honorable Henry Eschwege
Director, Community & Economic
Development Division
United States General Accounting Office
Washington, D.C. 20548

Dear Mr. Eschwege:

The Environmental Protection Agency (EPA) has reviewed the General Accounting Office (GAO) draft report entitled "Passive Restraints For Automobile Occupants--A Closer Look," and have limited our response to Chapter 3: Sodium Azide.

In general, the chapter presents an accurate summary of the sodium azide issue. However, there are two items which we wish to call to GAO's attention.

On pages sixty-seven and seventy-three, the report states that sodium azide is included on EPA's list of potential industrial carcinogens and mutagens. GAO does not provide a citation or reference to this EPA "list." Perhaps, GAO is referring to the report entitled "Potential Industrial Carcinogens and Mutagens" (EPA 560/5-77-005; May 1977), prepared by Dr. Lawrence Fishbein of the National Center for Toxiological Research. In this report, often referred to as the "Fishbein report," Dr. Fishbein provides some general information on several categories of chemicals that he has identified or suspects as having mutagenic and/or carcinogenic properties, including sodium azide. While this report is an excellent first cut at identifying and classifying potential mutagens and carcinogens, it is far from being a definitive list of such chemicals. More importantly, it is not an "EPA list."

[GAO COMMENT: The report has been revised to attribute the "list" to Dr. Fishbein. (See p. 47.)]

A second item involves the mutagenicity of sodium azide. In the Digest on page VI and the text on page 76, sodium azide is noted as being "a mutagen in some forms of animal and plant life." It is believed that the reference to animal life is somewhat of an overstatement. Prior to seeing this report, we were unaware of any evidence showing sodium azide to be mutagenic in any but bacterial and whole plant assays. On page 66 of the GAO report, reference is made to an apparently unpublished study from Washington State University reporting a mutagenic effect of sodium azide in rodent cells. Our Office of Toxic Substances was unable to acquire this report in time for this review, but nevertheless, it is believed that one study showing mutagenicity in rodent cells does not fully support the statement that sodium azide is a mutagen "in some forms of animal ... life." A more accurate statement is made on page 60: "sodium azide has been shown to be a mutagen in plant life, bacteria, and animal cell."

In closing, we wish to reiterate our position on sodium azide that was expressed in a July 18, 1978, letter to Mr. Oliver W. Krueger of GAO and quoted in the report. We stated that, despite the potential health risks from sodium azide in air bags, adequate time exists for concerned industry parties rather than EPA to develop methods to ensure the safe disposal of these air bag systems. However, we intend to maintain an active interest in all developments with respect to sodium azide and air bag systems to allow us, if necessary, to move quickly to protect the public against any unreasonable health risk posed by these systems. To date, we have not seen any information that would lead the Agency to change this position.

We appreciate the opportunity to comment on the report prior to its issuance to Congress.

Sincerely yours,

William Drayton, Jr.
Assistant Administrator for
Planning and Management

[GAO COMMENT: The wording in the report has been revised to eliminate the inconsistencies cited in the first paragraph. (See pp. vi, 40, and 50.)]

U. S. Department of Labor

Inspector General
Washington, D C 20210

JUN 13 1979

Mr. Gregory J. Ahart
Director
Human Resources Division
United States General Accounting Office
Washington, D.C. 20548

Dear Mr. Ahart:

This is in response to your request for comments on the draft General Accounting Office (GAO) report "Passive Restraints for Automobile Occupants -- A Closer Look." The report discusses (1) the Secretary of Transportation's June 30, 1977 mandate that all new cars manufactured on or after September 1, 1983 will be required to have passive restraint systems requiring no action by occupants and (2) the two passive restraint systems being considered -- air bags and automatic seat belts. The GAO report recommends that the Secretary of Labor, through the Occupational Safety and Health Administration, require that high priority be given to additional research on sodium azide, a solid chemical used in air bags, to measure its health and safety risks.

The Occupational Safety and Health Administration does not have the capabilities to conduct the research suggested by GAO. As a primarily standards setting, enforcement and training organization, we would normally defer to our sister research agency, the National Institute for Occupational Safety and Health (Department of Health, Education and Welfare), or the National Cancer Institute, for cancer or other toxic effects research. We would willingly convey GAO's recommendations for further evaluation of sodium azide's potential risk to NIOSH for consideration as a candidate for their research programs. The GAO report indicates that they have already been in contact with the National Cancer Institute with respect to their research on sodium azide.

It is our intent to work with the National Highway Traffic Safety Administration should sodium azide be chosen as the air bag inflation agent, in taking appropriate steps to inform employees and employers of any potential hazards and to direct enforcement activities to assure that necessary precautions are taken by the employer to minimize employee exposure.

Sincerely,

Marjorie Fine Knowles

MARJORIE FINE KNOWLES
Inspector General

(347420)

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