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SAFETY EFFECTIVENESS EVALUATION OF THE NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION'S PASSIVE RESTRAINT EVALUATION PROGRAM

UNITED STATES GOVERNMENT

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16.Abstract

The report includes an assessment of the activities of the National Highway Traffic Safety Administration (NHTSA) to evaluate the passive restraint standard (FMVSS 208 as amended July 5, 1977). The major findings of the report are:

1. It is essential that the NHTSA evaluate the real-world effectiveness of the passive restraint standard.
2. The NHTSA is committed to evaluating the passive restraint standard, but the current evaluation program is unorganized.
3. An evaluation program plan is required to effectively coordinate the evaluation activities and to address the complexities of this task.
4. The NHTSA has a contract study underway to develop an evaluation plan for the period up to the effective date of the standard, September 1, 1981. However, the study appears limited in scope to gross measures of effectiveness.
5. The NHTSA has no evaluation plan documented or under development to cover the period after September 1, 1981.
6. The effectiveness of the evaluation program will be improved by providing for public comment on the proposed evaluation plan.

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WASHINGTON, D.C. 20594

SAFETY EFFECTIVENESS EVALUATION

Adopted: March 16, 1979

THE NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION'S PASSIVE RESTRAINT EVALUATION PROGRAM

INTRODUCTION

The Independent Safety Board Act of 1974 mandates the Safety Board to "assess the effectiveness and publish findings of the Board with respect to the transportation safety consciousness and efficacy in preventing accidents of other government agencies." This mandate is primarily fulfilled by conducting "safety effectiveness evaluations" of selected programs being administered by the various agencies.

This safety effectiveness evaluation report was requested by the U.S. Senate Committee on Appropriations. The Safety Board was directed by the Committee "to review and assess the adequacy of the National Highway Traffic Safety Administration's plan for evaluating the effectiveness of passive restraints."1/ The Committee further directed that the Board's evaluation "should concentrate on assuring that NHTSA's plan will provide for the collection of relevant data to conduct an objective evaluation."

The Safety Board has reviewed both the passive restraint evaluation efforts currently underway within the NHTSA and its plans for the future. Numerous interviews were held with the NHTSA management and technical staff. Considerable effort was expended to solicit relevant data from the NHTSA and to have the NHTSA verify data gathered by the Safety Board. This report is based on data and information received as of January 31, 1979.

The Safety Board is also currently evaluating the rulemaking process within the NHTSA. That evaluation will fulfill a request from the House Committee on Public Works and Transportation to conduct "an evaluation of the truck braking standards (FMVSS 121) and passive restraint systems." The Safety Board will review the development of both standards including any evaluation programs. That evaluation report should be completed in 1979 and will update the findings in this report.

Background

One of the first actions the Department of Transportation (DOT) took to implement the National Traffic and Motor Vehicle Safety Act of 1966 occurred in

1/ 1979 Appropriation Bill for the Department of Transportation and Related Agencies, Senate Report No. 95-938.

1967 when it promulgated Federal Motor Vehicle Safety Standard (FMVSS) 208, Occupant Crash Protection. That standard required the installation of lap and shoulder belts in the front seats of all cars and lap belts in the rear seats. On June 30, 1977, the DOT amended FMVSS 208 to phase in a passive restraint provision beginning in 1981. The standard will become mandatory in passenger cars with wheelbases greater than 114 inches on September 1, 1981; in cars greater than 100 inches on September 1, 1982; and in all cars on September 1, 1983.

Two methods of complying with the passive restraint safety standard will be commercially available -- inflatable occupant restraints, commonly known as air bags, and passive belts. Air bags are fabric cushions which inflate in frontal collisions and keep the occupants from striking the vehicle's dashboard or windshield. Passive belts are similar to active belt systems now in use but are distinguished by automatic deployment around occupants when they enter the vehicle and close the doors.

The DOT estimates that when fully implemented, the passive restraint standard should save 9,000 lives and prevent or reduce many more moderate to serious injuries each year. It also estimates that the increased requirements will cost from $100 to $150 per car above the present cost of existing seatbelts. The passive restraint standard is thus one of the most significant safety rulemaking initiatives DOT has ever taken with regard to the economic impact and the projected reduction in injuries.

CURRENT NHTSA EVALUATION EFFORTS

The NHTSA, according to an Occupant Protection Program Progress Report dated August 30, 1978, is committed "to monitor the industry development of reliable passive restraint systems, and to educate the public on the new requirements and the technology that will be used to meet them." That report also states that the agency's present role is "to assist manufacturers in identifying and analyzing remedies for particularly challenging problems, assessing the effectiveness and consumer responses to particular systems, and making sure the public is knowledgeable about the systems offered in the marketplace." (emphasis added).

The current "passive restraint evaluation program" within the NHTSA includes the following activities:

- The NHTSA continues to sponsor contract teams to investigate accidents involving air bag-equipped cars. The scope of the investigations vary with the type of accident but usually involve clinical analyses of the accident.

- The National Crash Severity Study (NCSS) will continue until April 1980 collecting accident data. This is a national effort similar to the National Accident Sampling System (NASS) involving eight sites, but unlike NASS, the results will not be nationally representative. The Highway Safety Research Institute at Ann Arbor, Michigan, is under contract to analyze the NCSS data. This analysis should provide valuable statistics on the use and effectiveness of active seatbelts since over 12,000 accidents will have been investigated.

- o The Fatal Accident Reporting System (FARS) data is being routinely analyzed by the NHTSA. Special attention is being given to examining accidents involving Volkswagen Rabbits and Chevrolet Chevettes to compare those with passive seatbelts versus conventional systems.

- o The NASS currently has 10 sites in operation and has been collecting accident data since January 1, 1979. An earlier data collection effort which began in April 1978 was part of a pilot test of the system and was not retained for accident analysis.

FUTURE NHTSA EVALUATION PLANS

The NHTSA has described its future evaluation plans as a two-phase program. "Phase 1" will evaluate passive restraints voluntarily introduced by the automotive manufacturers prior to September 1981. "Phase 2" will evaluate passive restraints after FMVSS 208 goes into effect.

The NHTSA was unable to provide the Safety Board with a specific, documented plan for either Phase 1 or Phase 2. One study entitled "Final Design and Implementation Plan for Evaluating the Effectiveness of FMVSS 208: Occupant Crash Protection, May 1977," was identified by the Board. That study, however, was completed before the amendment to the FMVSS 208 which mandated the passive restraint requirement. Thus, the NHTSA technical staff have described this plan as obsolete.

The NHTSA did indicate that design work for phase 1 currently is being completed by the Center for Environment and Man (CEM) in Hartford, Connecticut. The work is part of a contract study entitled "Design Field Passive Restraint Evaluation," which was awarded on September 13, 1978.

The NHTSA statement of work for this contract contains the following elements:

- o The primary objective is to develop an evaluation program using alternative sampling designs to assess the fatality-reducing effectiveness of air bags and/or the usage rates and fatality-reducing effectiveness of passive belts. The program would be carried out beginning in calendar year 1979 before the mandatory installation of passive restraints.

- o The plans developed must --

  (a) rigorously define the effectiveness of passive restraint systems,

  (b) develop a methodology to measure effectiveness,

  (c) indicate the associated program costs, and

  (d) determine the number of accidents that can be investigated, specific statements on usage and effectiveness that can be addressed, the level of precision of those estimates, etc.

- Plans must consider the following sources of data --
  - (a) State accident reports,
  - (b) bi-level police agency data,
  - (c) NASS special studies, and
  - (d) special teams similar to the contract teams which investigate air bag accidents

- A valid control group of data must be developed.

- Detailed plans for the collection and analysis of data must be developed for evaluation programs costing $1, $2, and $3 million.

- The study is to be completed 6 months after the award date of the contract. At present the NHTSA estimates it will be completed by April 1979.

Subsequently, on January 11, 1979, the NHTSA indicated that "due to the small number of vehicles scheduled for introduction by the manufacturers prior to September 1981, it is doubtful this effort will be as extensive as originally conceived."2/ At that same time the NHTSA stated that "In Phase 2, after September 1981, we intend to evaluate passive restraint systems through the use of the accident investigation capability in the National Accident Sampling System."3/ No specific details were provided.

RELATED NHTSA PROJECTS

The NHTSA has certain research and development projects which are related to the evaluation of the passive restraint standard. Most of the work involves the testing and technical evaluation of the "next generation of air bags and passive belts," which the NHTSA defines as "simpler, lower in cost and capable of protecting occupants in higher speed crashes." In that regard the Safety Board is aware of the following NHTSA efforts:

- Evaluation of Passive Belts for Different Size Occupants -- This is a contract to evaluate how positioning the Volkswagen Rabbit passive belt affects system performance; and to design an improved belt anchorage system.

- Small Car Front-Seat Passenger Inflatable Restraint System -- This is a contract to demonstrate the performance of "current state-of-the-art air bags" in small passenger cars.

- Passive Restraint Development for Light Trucks and Vans -- This is a proposed contract to demonstrate the performance of "current state-of-the-art air bags" in light trucks and vans.

2/ Letter of January 11, 1979, from Administrator, NHTSA to Chairman, NTSB.
3/ Ibid

- o Upgrade of the 1975 Production Volvo Front-Seat Air Bag Systems-- This is a proposed contract to demonstrate the performance of air bags at crash speeds of 40 mph.

- o Comfort and Convenience of Passive Safety Belts -- This is a proposed contract to evaluate certain suggested changes to the FMVSS 208 with respect to comfort and convenience and to develop a new standard for these purposes.

ANALYSIS

Current Program

The Safety Board believes that the NHTSA's current passive restraint evaluation program is unorganized. There is no master plan which identifies the integral elements of the evaluation program or specifies a timetable for their completion. There apparently is no organizational unit within the NHTSA that is responsible for collectively assessing the results of individual activities or for determining whether the evaluation planning efforts are adequate. The NHTSA repeatedly provided general statements of the agency intent or tried to assure the Board that an adequate evaluation program did exist. Conflicting information was provided by different elements within the NHTSA. For example, when questioned about why the NHTSA was not pursuing a clinical investigation activity for passive belts similar to that for air bags, the Safety Board was told that the NHTSA knew all it needed to know about the effectiveness of belts. On the other hand, a recent NHTSA report stated that "little is known about the protective capability of passive belts in other than frontal collisions."4/

There is no apparent sense of urgency within the NHTSA to develop more detailed plans. The current CEM contract to develop the evaluation plans appears to have been initiated because of a Senate Appropriations Committee request to develop such a plan rather than because the agency felt such a plan was needed. The NHTSA has cited two reasons why it is difficult to specify a passive restraint evaluation program. First, there is a great deal of uncertainty about the total number of cars which the manufacturers will voluntarily introduce equipped with passive restraints. Second, there is even greater uncertainty as to the percentage of cars that will be equipped with passive belts versus air bags. The Safety Board recognizes these difficulties but believes that they only add additional rationale for developing plans without delay.

Phase 1 Plans (1979 - September 1981)

The CEM contract to design the Phase 1 evaluation plan is not to be completed until April 1979. Consequently, the Safety Board's analysis is limited to the NHTSA statement of work for the contract and the corresponding CEM proposal.

4/ Cooke, Conrad, "Past, Present and Future Safety Benefit Assessment Methods," NHTSA, March 1, 1978.

The statement of work requests the Center for Environment and Man to "rigorously define passive restraint effectiveness" and to develop a methodology "to measure effectiveness." The scope of the effort, however, is limited since the stated objective of the evaluation program is to assess fatality-reduction and belt-usage rates. It is not apparent whether the NHTSA evaluation program will go beyond these gross measures of effectiveness and 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?

These questions are typical of those raised during the development and public debate over the passive restraint standard. Failure to address these and others like them would reduce the value of any evaluations performed.

Similarly the statement of work places substantial emphasis on the statistical analysis of accident data. Although such analysis is very important, the evaluation program should not be limited to that. Many of the key issues associated with passive restraints can only be adequately studied through indepth investigations and clinical analyses.

In general, the Safety Board believes that the CEM contract is a step in the right direction. However, the Board is not convinced that the program plan requested will be sufficiently comprehensive to meet the challenge of the problem. Any evaluation of the passive restraint standard, especially one limited to the period before mandatory implementation, is an extremely complex endeavor. For example, the level of effort associated with the contract will probably force the contractor to use and adapt existing evaluation techniques. It will not allow for the development of new methods to handle any special problems associated with the evaluation.

In addition, the Phase 1 plan will have limited use once the standard becomes mandatory. Phase 1 entails a relatively small, hard-to-identify population of passive restraint-equipped cars which are voluntarily purchased, and an even smaller sample of accidents. Any evaluation program for this population would require substantive modification to handle any evaluations once the standard becomes mandatory.

The associated proposal submitted by the Center for Environment and Man and accepted by the NHTSA contains a rather thorough discussion of the problem. The Center for Environment and Man has previously completed several evaluation-type contracts for the NHTSA and thus appears to be aware of the complexities of a passive restraint evaluation program. Unfortunately, the proposal is almost entirely limited to a discussion of the problems and never specifies a definitive approach toward a solution.

Phase 2 Plans (After September 1981)

The Phase 2 evaluation program, as described by the NHTSA, is being built entirely around the capabilities of the NASS. By September 1981 the NHTSA projects that the NASS should be close to, if not at, full implementation and thus be capable of providing substantially improved accident data compared to that available today. For the first time, the NHTSA will have accident data being collected which is nationally representative. In addition, NASS special studies will provide the flexibility for a variety of data collection.

A basic premise of the NASS program is that trained technicians will collect substantial volumes of objective data. Therefore, it is not clear how the NASS could support an evaluation effort outside the scope of statistical analysis. Even if 50 NASS sites are in operation, the statistical analysis will be limited because of the relatively small number of accidents involving passive restraint-equipped cars. For example, in 1982 and 1983 combined there should be some 10,000 towaway accidents at the NASS sites involving passive restraints. Of these, only about 1,000 will involve moderate to serious injuries. If the 10,000 towaways were investigated, statistical estimates of the standard's overall impact should be possible. On the other hand, more detailed analyses, such as a comparison between passive belts and air bags, would likely require additional data. In addition, it is very unlikely that the NASS will investigate all of these 10,000 accidents, unless the NASS sampling plan is adjusted to essentially accomplish only the passive restraint evaluation.

Even if the NASS were redirected, the Phase 2 evaluation program would be limited in scope. As previously discussed in the analysis of the "Phase 1 Plans," an effective evaluation program must go beyond the statistical analysis of accident data and include a variety of activities.

Nevertheless, the Safety Board's primary concern is that the NHTSA does not have specific plans documented or even under development to cover the Phase 2 evaluation program. The passive restraint standard is an enormous endeavor. Both the NHTSA-projected benefits and costs are the largest ever associated with a motor vehicle safety standard. The passive restraint standard is complex and controversial. It is also a standard which was developed with heavy reliance on testing and laboratory simulations rather than on field experience. Therefore, it is essential that the NHTSA evaluate the real-world effectiveness of the standard in order to identify and make any modifications to the standard which might be necessary. The evaluation program should be operational when the the standard goes into effect since the first few years of the standard's implementation will be particularly critical. Consequently, in order to effectively manage a timely

evaluation program and to adequately address the complexities of this task, the NHTSA must start planning the evaluation program immediately. In that regard, current DOT policy, developed after the passive restraint standard was published, actually requires that a plan for evaluating a regulation be developed before the final rule is issued.

Suggested Approach to Develop an Evaluation Program

The first step in planning any program is to establish the objectives for the program. The NHTSA needs to reassess its concept of "an evaluation program." What should be the objectives of the program? What questions must be answered? And how soon must they be answered?

The Safety Board believes the evaluation program should be designed to address a variety of considerations in addition to an estimate of the standard's overall safety benefit. Questions such as those discussed in the analysis of the Phase I plan are certainly important. In fact, during the first few years these types of questions may be more significant than the standard's overall impact since the latter will initially be difficult to assess. Likewise, the evaluation program plan should provide for the evaluation of the major elements or requirements of the standard. For example, the NHTSA must be able to assess not only the overall benefits associated with the entire standard, but also the incremental benefits associated with the left-, right-, or center-seat occupant requirement as well. Finally, the evaluation must be comprehensive enough to analyze how other safety standards or vehicle design features affect the performance of passive restraints. In this manner the NHTSA could make future revisions to this or other standards to maximize the safety benefits.

In order to accomplish this, the Safety Board believes "the evaluation program plan" should coordinate a variety of the NHTSA's activities. Some of these activities are routinely performed by the NHTSA but are not normally considered evaluation activities. These would include compliance testing, defects monitoring, and research and development.

The compliance testing program must be an evaluation activity since estimates of effectiveness cannot be projected without corresponding estimates of industry compliance with the standard. In addition, the testing programs could be designed so that relative effectiveness between different models or design features could be evaluated. This would provide additional information to further interpret accident data or perhaps, to identify key elements to emphasize in the accident investigation activities.

The passive restraint standard will bring about the mass introduction of new technologies, thereby increasing the likelihood of safety-related defects. Many of the potential problems claimed by the air bag opponents will have to be discussed through the defects program, if the problems materialize. Consequently, an effective network of defects monitoring must be established and coordinated with the other evaluation efforts.

Research and development will be needed to provide indepth technical evaluations and to explore improvements to the standard. In this regard, the Board believes that the use of research efforts to reconstruct and simulate specific real-world accidents that have been investigated should be emphasized. This would provide invaluable information to better correlate research results with the results from accident data analysis and thus improve the NHTSA's evaluation capability.

Along with defining the objectives, the NHTSA should concern itself with how the data can be collected and analyzed. The plan should document the details of the evaluation program, describe when various tasks must be completed, and identify the organizational units responsible for them.

Naturally some segments of the plan may, by necessity, be rather tentative. Therefore, alternative situations of possible vehicle and accident population mixes, along with various data collection possibilities, similar to that being developed under the Phase 1 plan, should be considered. Data collection and analysis plans could then be developed with contingencies to cover the more probable combinations of circumstances. Decision points should be identified to activate the contingency plans if certain events occurred. These contingency plans are necessary, for instance, so that the NHTSA does not enter 1981 with NASS teams fully operational only to discover in 1983 that insufficient data had been collected for a particular problem area. The passive restraint evaluation plan, by necessity, will have to be dynamic; therefore, more planning and not less is needed between now and 1981.

Furthermore, some elements of the evaluation may be critical because of time constraints. For example, the evaluation of the standard's effectiveness will require a "control sample of data" to be collected which represents the situation before the standard is implemented. Obviously, since the standard is already being voluntarily introduced and will be mandated in 1981, the NHTSA cannot delay much longer.

In addition to the questions of data collection, careful attention must be given to analysis. In particular, the NHTSA should assess the impact of defining the "threshold criterion" for the accident data collected. Currently the most common threshold criterion used by the NHTSA is a "towaway accident," or simply stated, an accident from which the cars are towed away. Unfortunately, very little is actually known about the consequences of studying only towaways. This point was highlighted to the NHTSA in the "Report of the Invited Participants, 1978 Public Meeting to Review NASS." This report stated that "the likelihood of a vehicle being towed away will vary with the size of vehicles, driver injury, crash configuration, point of impact, and other variables of interest...." And further, that "towaway status, although it may presently be the best available criterion, is nevertheless a poor substitute for an objective measure for crash severity."

Similarly, the NHTSA must devise adequate procedures to handle missing data, particularly that introduced by accidents which the NHTSA is not aware of.

The NHTSA has indicated, for instance, that one third of all towaway accidents escaped detection by the notification system, which the NHTSA had established to identify and investigate accidents of air bag-equipped cars.

Finally, the NHTSA must clearly define any statistical techniques it will use to analyze the data. The need for this is best exemplified by considering the results of the Restraint System Evaluation Program, which was concluded in 1976, and upon which the NHTSA based much of the current passive restraint benefit estimates. In that program accident data were collected at five sites throughout the country, and subsequently analyzed by the University of North Carolina's (UNC) Highway Safety Research Center. At the same time a separate analysis of data from three of the teams was completed by the Highway Safety Research Institute (HSRI) at Ann Arbor, Michigan.

In both studies one measure of effectiveness of lap and shoulder belts was defined as the percent of reduction in moderate and serious injuries (AIS greater than or equal to 2) compared against injuries resulting from no restraint at all. Each study used a statistical technique to adjust the results so that the comparisons of the different restraint systems were based on equivalent accident severities. Overall the following adjusted results were obtained:

Effectiveness of Lap/Shoulder Belts (Percent)

UNC Study 56.5

HSRI Study 42.1

Some of the difference may be attributed to the fact that the HSRI study only considered data from three of the five teams. However, as can be seen in the following table, significantly different results were also obtained when the analysis was based on data from one team common to both studies:

Effectiveness of Lap/Shoulder Belts (Percent) 1/

	UNC Study	HSRI Study
Unadjusted	63.7	62.8
Adjusted	68.5	37.4

1/ Based only on data from the Southwest Research Institute Team

In this case the difference in the adjusted results is even larger. How much of this difference is a function of the different statistical techniques used in each study is not known. Nevertheless, the large variance in results emphasizes the complexity of this problem. Most importantly, it highlights the need to have the NHTSA identify its analysis plans before the evaluation program begins. By doing this the NHTSA would minimize the chance that the credibility of final evaluations results will be challenged.

In summary, the Safety Board believes that the NHTSA passive restraint evaluation program is a vital element of the rulemaking process. Therefore, the evaluation program should be developed with adequate input from industry, consumer, and highway safety organizations outside of the NHTSA. Development of the evaluation plans will be a complex endeavor requiring indepth study. In addition, it will undoubtedly require many management and policy decisions in some cases based on only engineering judgment. Organizations outside of the NHTSA have been studying passive restraints for several years and have expertise applicable to making these engineering judgments. Consequently, the public interest would be best served if the NHTSA would allow public participation in the development process. At a minimum, the NHTSA should publish a proposed evaluation plan and allow public comment on it. Since it will take time to evaluate the comments and develop the final plan, the proposed plan should be published no later than October 1979. The Safety Board recognizes that certain sections of the plan may not be completed by that time and thus the proposal may have to be limited to the major elements of the plan. Nevertheless, the deadline is critical so that the final plan can be developed and implemented by the time the standard goes into effect in September 1981. This procedure would ensure the effectiveness of any evaluation program developed.

CONCLUSIONS

1. It is essential that the NHTSA evaluate the real-world effectiveness of the passive restraint standard.

2. The NHTSA is committed to evaluating the passive restraint standard, but the current evaluation program is unorganized.

3. An evaluation program plan is required to effectively coordinate the evaluation activities and to address the complexities of this task.

4. The NHTSA has a contract study underway to develop an evaluation plan for the period up to the effective date of the standard, September 1, 1981. However, the study appears limited in scope to gross measures of effectiveness.

5. The NHTSA has no evaluation plan documented or under development to cover the period after September 1, 1981.

6. The effectiveness of the evaluation program will be improved by providing for public comment on the proposed evaluation plan.

RECOMMENDATIONS

Based on the results of this evaluation, the Safety Board recommended that the National Highway Traffic Safety Administration --

> "Develop and publish a formal evaluation program plan to effectively manage the NHTSA evaluation activities related to the passive restraint standard (FMVSS 208 as amended July 5, 1977). As part of its development, the proposed program plan should be published for public comment by October 1, 1979. (Class II, Priority Action) (H-79-12)"

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JAMES B. KING
Chairman

/s/ ELWOOD T. DRIVER
Vice Chairman

/s/ FRANCIS H. McADAMS
Member

/s/ PHILIP A. HOGUE
Member

March 16, 1979

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