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Evaluation of FMVSS-301--Fuel System Integrity

Task I Report

Interim Report

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16. Abstract

One approach to the evaluation of the effectiveness of FMVSS 301 is to determine the incidence of fire in motor vehicles of various production years by studying fire department statistics, and to determine the incidence of crashes of all types for the same vehicles by studying police accident statistics. This report of the work done in Task I of this contract presents the results of a survey of available data sets for implementing this method.

Fire and/or Police department data will be obtained from the State of New York, Illinois, Michigan, Maryland, Iowa, and Missouri. Arrangements are currently being made to acquire at least two calendar years of data from each of these states. Other data sources which will be surveyed include the Fatal Accident Reporting System (FARS) and the National Crash Severity Study (NCSS). In Michigan and New York comparisons will be made of fire records in the Police and Fire Department files.

Tentative plans for analysis of the data are discussed. Finally, there is a review of data sources which were reviewed but excluded from the study for various reasons. Some were rejected because they were not large enough; some because of inadequate detail for critical variables such as car model year.

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EVALUATION OF FMVSS 301--FUEL SYSTEM INTEGRITY

TASK I REPORT

1. INTRODUCTION

The FMVSS 301 was originally promulgated to be effective on January 1, 1968. Its purpose was to set standards for the construction of the fuel system in passenger cars so that the fuel system would be less likely to rupture and spill the flammable fuel in a crash. The rationale for this was that if fuel spillage could be reduced, the potential for post crash fires would also be reduced. If the number of crash fires were reduced, the number of fatalities, the number and seriousness of injuries, and the amount of property damage should also all be reduced.

The standard was strengthened effective with the 1976 model year passenger cars, and again for the 1977 model year passenger cars. It is a timely question, then, to evaluate the performance of the standard to determine whether it has in fact reduced the occurrence of crash fires, and if so, whether different amounts of reduction have been achieved by the different versions of the standard.

The occurrence of a crash fire is a rare event. Estimates range from an occurrance rate of 0.1% to 0.5% of police reported crashes. The rate is higher in fatal crashes. Fires may be involved in about 2% of the fatal crashes. Injuries and fatalities are even rarer than fires, although the occurrence of a crash fire is associated with a higher likelihood of injury or death.

Fuel spillage is presumably more frequent a crash event than is fire, since it would logically precede a fire, and since even if fuel is spilled, it does not always ignite. However, while fuel spills are more frequent than fires, they are not as well reported in any extant data. As a result, evaluation of the effectiveness of FMVSS 301 will concentrate on reductions of crash fires.

The event of a crash fire is not well reported in many accident data sets. One source of data which might be exploited to improve the reporting of fire in crashes is data from fire departments. It is possible that such data may not include as high a proportion of small post-crash fires as of large post-crash fires. In addition, the fire department data must be coupled with accident data in order to determine the rate of occurrence of fire among crashes of cars of a given model year. Thus, one approach to the evaluation is to use fire department data to determine the number of crash fires for each model year of car and to use police department data to estimate the number of crashes of each model year. The ratio of the two would then be analyzed to estimate the effectiveness of FMVSS 301. Here, the model year of the car is used to determine the compliance with the various forms of the standard.

Another approach to the analysis is to use a single set of data which contains both the record of crashes and the records of fires in those crashes--if such sets exist. This approach has many attractive advantages in terms of consistency of data, ability to relate the fire crashes to other variables, such as crash severity, among others. However, its use is naturally limited by data availability.

One additional conceptual difficulty is that the age of the car is confounded with the compliance to the standard. That is, new cars meet the more stringent standards, while old cars met only the less stringent standards. It is possible that the fuel system integrity degrades with the age of the car. If that is the case, then it will be difficult to distinguish the effect of age from the difference between the more recent and the older standards. This could be alleviated by analyzing the data from the years when the cars meeting the earliest version of the standard were new, but that seems infeasible because of lack of appropriate data. The approach which will be taken will be to estimate an age effect among cars subject to a particular standard. If such an effect is found, then this will be used to adjust the rates for ages of the cars.

2. DATA SETS TO BE USED

After a review of the existing data, HSRI plans to obtain and analyze the data sets discussed below. It is possible that some might not be available, but this is thought unlikely in most cases. The other data sources reviewed and evaluated (and excluded) are detailed in Section 4.

The dats sets planned for utilization are as follows.

2.1 Accident Data from Illinois

These data include all police reported accidents involving passenger cars for the state of Illinois. The data elements include post-crash fires, as well as model year of the car, and some information about the crash (type, section of car damaged, etc.). There are approximately 1200-1500 crash fires among about 380,000 passenger car crashes per year. Under the null hypothesis that the crash fire rate is about the same for all model years, this would result in about 80-100 car fires for each model year. HSRI has worked with the Illinois data in the past, and anticipates no difficulties with these data. Arrangements to obtain the additional data for the years 1976 and 1977 have been made, and tapes have been sent to Illinois.

2.2 Data from the State of Michigan

These data will be the state fire department data for the years 1975-1977 and the state police accident records for the same years. Since the accident records do not record the occurrence of a fire in a crash, the fire department data will be used to estimate the number of passenger car fires for each model year, and the accident data will be used to estimate the number of crashes for each model year. These ratios will then be analyzed. It should be noted that this approach is less precise than one

using a single set of data. First of all, there are likely to be bias errors involved in the use of two different data sets. Secondly, the use of a ratio estimate results in a higher variability than of a rate estimate from a single data set.

Beginning January 1, 1978, the state police accident form in Michigan will include variables noting the presence of fuel spillate in crashes in Michigan and the occurrence of fires in the crashes. All police jurisdictions are to use this new form beginning January 1. HSRI will obtain the 1978 accident data on a quarterly basis as well as the 1978 fire department data to use these current data in the evaulation.

2.3 Data from the State of New York.

Again two data sources will be utilized: state fire department records and state accident records. The New York accident data includes a variable for fire as the second adverse event in a crash. In addition, the injury data include special categories for burns. The injury data can be used to validate the completeness of the fire variable in the crash data. Thus, the New York accident data can be used as a single source in the evaluation.

New York also has computerized fire department data. These will be used to obtain estimates of the number of crash fires involving passenger cars by model year. These estimates will be used to form ratios of car fires to the car accidents. This will provide two types of data for evaluation of FMVSS 301 and for cross checking the validity of each. One set will be the data contained in the accident files. The other will also use the fire department data. Data from the 1976 and 1977 will be sought.

2.4 Additional States Data

Three additional states have data which appear also to be useful. These are the states of Iowa, Maryland, and Missouri. All three have both police accident data and fire department data which can be used together to estimate the ratios of crash fires to number of crashes for each model year of car. The accident data do not include crash fires, so only the ratio

estimates can be used, HSRI will arrange to access these data for use in the evaulation. Arrangements with Iowa are in progress. The other states have had only a preliminary contact.

2.5 Other Data Sources

A six month study of crash fires was conducted in California from June 8, 1976 to Dec. 8, 1976. During this period in the study area 575 car crash fires were identified and data collected on them. HSRI is trying to obtain those data as well as the number of crashes of all cars in the same period and area, for use in the evaulation. This effort is likely to be successful. Although these data are somewhat limited, they may provide additional evidence in the evaluation.

The Fatal Accident Reporting System (FARS) includes fire as a crash variable. These data can be used to identify fires in crashes which involve at least one fatality. Their use directly for evaluating FMVSS 301 is somewhat limited, because the occurrence of a fire is associated with a higher fatality rate than is non-occurrence. Thus, even if the occurrence of fires were reduced substantially by the standard, this might not be evident in fatal data. The selection of crashes by fatality self-selects a set with a higher proportion of fires.

Crash data from the National Severity Study (NCSS) will be used primarily to investigate which crash configurations appear to be associated with the occurrence of fires. This will give insight into which crash variables might influence fire or fuel spillage. These variables will then be checked to estimate differences in the populations of crashes in the different model years. If differences are found which are large enough to affect the conclusions of the study, then adjustments for type of crash will be attempted. While the NCSS data are expected to supply useful detail about a few crash fires and/or fuel spills, the number of such occurrences is expected to be too small for general use in the evaluation of FMVSS 301. Review of the fire department records in at least two of the areas covered by the NCSS teams is planned to determine whether fire department records indicate additional cases of crash fires which were not included in the NCSS

sample. This review will also be useful to determine actual coding practices of cases known to involve crash fires. This has begun in the local NCSS area.

Samples of the fire department data in Michigan will be reviewed to determine which code values most closely correspond with crash fires. Similar sampling is planned with the New York fire department data, if feasible. It may be joined to the review of the fire department data in the NCSS area in New York.

3. PLANNED ANALYSIS METHODS

Many of the data sets will require that the numbers of crash fires be estimated from fire department data for each model year (version of FMVSS 301) and that the number of crashes be estimated separately from accident data. The resulting ratio consists of two random quantities; the number of crash fires and the number of crashes. The variances of this ratio will be estimated and used in weighting the data to adjust for the expected unequal variances among the different versions of the standard.

The occurrence of a crash fire or fuel spillage is related to the severity of the crash and the portion of the car which is damaged. If for some reason the crashes involving one group of cars differ in severity, proportion of rear impacts, or some other crash variable from the accidents involving another group of cars, this difference could affect the fire rates. Because of the limited amount of data available in fire department records about the crash, it is not likely that fire department records can be used to relate fires to crash variables. However, the different groups of cars will be compared in the accident files to determine whether significant differences in crash configurations exist. If they do, a difficult interpretation problem will exist. Two approaches are suggested. The simplest, which will be done, is to describe the differences observed in the crash populations and qualitatively describe the likely influences on the fire rates and on the conclusions. The second, which is more difficult and may not be feasible, is to relate the fire rates to crash configurations in data sets where both fire and crash information is available (e.g., Illinois and New York data), and use the resulting relationships to adjust for differences in the observed crash populations in other data sets.

For those data sets where the crash information and the fire information are in the same file, a linear models approach to categorical data will be

to try to separate the effects of car age from 301 standard version. In addition, to the extent that the data allow, the post-crash fire rates will be related to crash variables, such as type of crash, area of impact, etc. For large files it may be more efficient to determine the complete set of fire cases, but to use a 5% to 20% of the file in estimating the denominator data. If this is the case, th denominator will have an additional source of variation--due to the sampling--which the numberator does not have. This can be calculated and will be incorporated into the variances if sampling of files is used.

Finally, the New York data and the early 1978 data from Michigan will be used to compare the fires identified in the accident records with those identified in the fire department records. From this comparison some information as to the presumed reliability of the other sources which use fire department and police department data concurrently will be obtained. One conceivable outcome of this might be the conclusion that only a specified fraction of the crash fires appear in the fire department data. If this were the case, then better estimates of the size of the fire problems would be formed. The estimates of the effectiveness would not be affected.

4. DATA SOURCES REVIEWED AND EXCLUDED

A number of data sets appeared initially promising, but were found not to contain critical data elements upon closer examination. Several accident data sets were noted as containing the occurrence of "fire", but this turned out to be cases where no crash was involved. The fires were cases where a car had a fire of some sort, requiring an emergency call by the police, which resulted in an "incident" report. No crash was involved.

Some other data sets turned out to lack any method of identifying the cars with a particular standard. That is, no model year or age information was available. As a result, these data could not be used to estimate fire rates separately for the cars meeting the different versions of the standard. Additional reasons for exclusion were only partial coverage of a state by the fire data and/or police data, unavailability of data, or lack of a usable computerized data management system to access the data.

Data collected by the National Association of Independent Insurers were investigated. They were found to lack any data elements which would identify claims as having been related to a fire. They were also only available for claims which were through 1973. Contacts with a few individual insurance companies are in progress, but insurance data do not appear to be of sufficient detail for car crash fires to be useful.

The following table gives other state data files investigated but rejected together with the reason for rejection.

Table 4-1

Data Sources Evaluated and Rejected

Data Set	Reason for Rejection
California	Fire department data do not include the model year of the car.
Oregon	Computerized accident data file does not include car model year. Sampling of the file followed by hard copy review to record model year was judged too expensive for the small number of fires which were anticipated.
North Dakota	Computerized crash data do not include model year. Sampling and hard copy review were judged too expensive since the smallness of the data set would result in very low chance of detecting any difference.
Mississippi	(same as North Dakota)
New Hampshire	Only the first harmful event is computerized. Thus only non-crash fires would be included. No computerized fire department data.
Florida	Only non-crash fires are included in accident data. No computerized fire department data.
Arizona	Accident data only includes non-crash fires. Fire department data includes only 80 reporting jurisdictions out of 180 in the state.
West Virginia	Fire data are not actually computerized yet.
Ohio	Accident data only available since 7/77. (Earlier data are in a non-computerizable data management system, so they could not provide them to us.)
Connecticut	Accident data do not include model year.
Delaware	Fire data not available yet. Accident data "fire" means first aid by fireman, not crash fires.
Minnesota	Accident data do not include model year.
Montana	No fire department data; fire data not available in accident records.

Table 4-1 continued

Data set	Reason for Rejection
Oklahoma	No fire department data; fire not included in accident data (except for a specialty short-term study in 1972).
Rhode Island	Accident data not computerized
South Dakota	Accident data do not include model year
Washington	Fire department data available only for some counties; accident data does not include fire
West Virginia	Fire department data not computerized yet
Utah	No fire data; fires in accident data were only included in a 5 county project which was discontinued
Kansas	No fire data; fire not recorded in accident data