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COST EVALUATION FOR NINE FEDERAL MOTOR VEHICLE STANDARDS VOLUME VI FMVSS 220, 221, & 222

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FINAL REPORT

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16. Abstract
The consumer cost was established for the implementation cost of each of the nine Federal Motor Vehicle Safety Standards. The standards study are:

FMVSS 105 Hydraulic Brake Systems on Passenger Cars
FMVSS 108 Side Marker Lamps
FMVSS 122 Motorcycle Brake Systems
FMVSS 202 Head Restraints
FMVSS 207 Seating Systems
FMVSS 213 Child Seating Systems
FMVSS 220 School Bus, Rollover Protection
FMVSS 221 School Bus, Joint Strength
FMVSS 222 School Bus, Seating and Crash Protection

For each standard a representative sample of makes and models of vehicles or components was established. The components required to meet the standard were purchased and their costs estimated. The first year of the imposition of the standard and the year immediately preceding it were emphasized. By analysis, the consumer costs attributed to the standard for each make and model or components were determined. A weighted average was developed from the samples and applied to the total industry volumes to determine the consumer cost for the implementation of each standard. The weighted average of weight variance due to the implementation of the standard was also determined. The before and after cost variance was not applied to FMVSS 213 Child Seating Systems and the FMVSS 122 Motorcycle Brake Systems.

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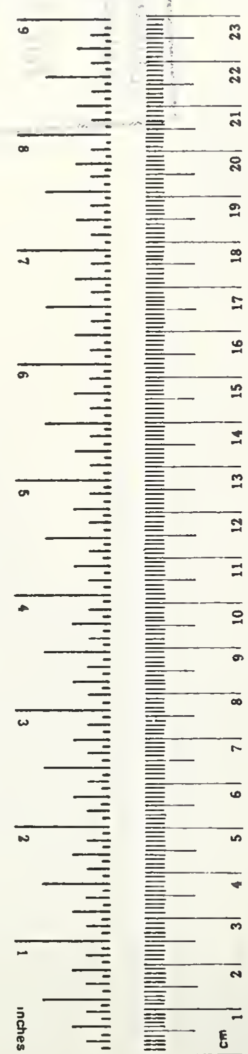
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

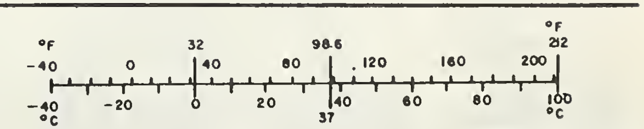
Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



ABSTRACT

Total consumer out-of-pocket costs have been estimated for three school bus Federal Motor Vehicle Safety Standards. They are:

1. FMVSS 220 Rollover Protection
2. FMVSS 221 Body Joint Strength
3. FMVSS 222 Seating and Crash Protection

From a list of eight major school bus body builders, three were selected for plant visits by De Lorean personnel. The manufacturers representatives were questioned as to the extent of design, material, production, and personnel changes required to meet each standard. A plant inspection tour was made and the types of buses produced and the rates of production were established.

The general findings as to the changes in design and production required to meet the new standards were:

1. FMVSS 220 - No change
2. FMVSS 221 - Adhesive added to body joints
3. FMVSS 222 - Seats strengthened, padding added, front barriers added, seat belts added to under 10,000 pound vehicles

The typical variable profit of the manufactur's was established as was an average dealer's discount. The average costs of complying with the standards were established as:

1. FMVSS 220 - No cost
2. FMVSS 221 - $242.37
3. FMVSS 222 - $784.72 (over 10,000 pounds GVWR)
   - $249.92 (under 10,000 pounds GVWR)

PREFACE

The Contractor, the De Lorean Motor Company in the presentation of the Final Report on the Cost Evaluation for Nine Federal Motor Vehicle Standards has divided this report into six major categories. Each volume contains the complete study related to the designated standard or standards. The Contractor acknowledges the contribution of its staff, the automotive manufacturing community and the automotive dealers. Special acknowledgement is made to the Contract Technical Manager, Mr. Robert Lemmer of the National Highway Traffic Safety Administration, Department of Transportation, for his contributions and timely reviews throughout the program. Acknowledgement for assistance in providing the data on the FMVSS 220, 221, and 222 is made of Mr. R Kurre of the Wayne Corporation, Messrs. R. Verhul and F. Barrington of the Carpenter Body Works, Inc., and Messrs. T. Harrell and W. Nowicki of Superior-Lima Division of Sheller Globe Corporation.

The Cost estimating techniques employed in the study are based on automotive industry practice and have been previously used on other programs by the Contractor. The following listing includes recent and current programs using essentially the same estimating procedures and techniques as those employed in this study.

- Contract NHTSA-DOT-HS-7-01770
  Development of a Motor Vehicle Materials Historical, High-Volume Industrial Processing Rates Cost Data Bank - Ford F-100 Truck

FMVSS 201 Study of passenger car requirements as applied to light trucks and vans.

FMVSS 203 and 204 Study of passenger car requirements as applied to light trucks and vans.

- <u>Contract NHTSA-DOT-HS-8-01767</u>
  Cost Evaluation of Four Federal Motor Vehicle Safety Standards.

  Cost Review of Pedestrian Safety Modifications.

- <u>Contract NHTSA-DOT-HS-9-02258</u>
  Cost Evaluation of Three Federal Motor Vehicle Safety Standards.

- <u>Renault USA, Inc.</u>
  Consumer Cost Estimate of Subcompact Vehicles.

- <u>De Lorean Motor Company</u>
  Manufacturing Cost Studies of Components of lightweight vehicles.

- <u>Contract NHTSA-DOT-HS-9-02112</u>
  Preliminary incremental cost estimate for the implementation of the extension of FMVSS 105 to light trucks, vans and MVT's.

  Study the cost and weight change for passenger car pedestrian initial impact protection implementation.

Product feasibility, consumer cost and implementation schedule analysis for implementation brake inspectability requirements.

Cost data developed on this program for automotive standards are based on 1979 Model Year Economics and 1978 macro-analysis of autombile and component manufacturers. For standards related to other than automotive manufacturers, the data is based on 1979 year economics and macro-analysis factors applicable to the manufacturer. Dealer discount on related automotive products was established at 16.97% for the industry. A dealer discount of 25% was applied to the motorcycle related products. The child seat dealer discounts varied from 40% to 50%. Distributor cost where applicable is reflected in the dealer wholesale cost.

In reviewing this report, the reader is cautioned that the application of an average cost per pound factor that can be developed from the data presented could result in serious cost errors. Cost data can only effectively be developed by using manufacturing processing personnel applying automotive cost estimating technology. For any cost factor to be effective the designs, size, construction, and manufacturing techniques must be nearly the same. In this report a considerable variation can be noted in the cost and weight of what appears to be similar components. Only a detailed review of these components would explain the variation.

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VOLUME VI FMVSS 220 - SCHOOL BUS, ROLLOVER PROTECTION

FMVSS 221 - SCHOOL BUS, JOINT STRENGTH

FMVSS 222 - SCHOOL BUS, SEATING AND CRASH PROTECTION

INTRODUCTION

Under Contract DOT-HS-8-02015, the Contractor conducted a program to derive the consumer cost and weight variance in the implementation of FMVSS - 220,221 and 222.

An Integrated Cost Sampling Plan was developed, approved by the Contract Technical Manager, and followed to obtain, if any, changes in cost and weight due to implementation of the standards.

Automotive industry type teardown and manufacturing cost estimating techniques were applied to develop cost and weight data for the implementation analysis.

Appendix A of this report represents a summary of cost elements and weight of components involved in the study. In Figure 1 elements of component cost are shown. The boxes with the solid lines contain data derived from the cost and weight processing of components of the systems studied. Those with dotted boxes were cost elements considered in the estimating processing and the summarized results are contained in the cost in Appendix A.

In this study, the consumer cost is the summation of the variable cost, corporation other cost and profit and dealer markup. The variable cost is considered as those costs that vary with the volume of production and consist of the cost of direct material, direct labor and variable burden. The Other Cost and Profit consist of those items identified in Figure 1 and 1A and are:

Indirect Material
Indirect Burden
Fixed Burden
Tooling Cost
Engineering and Warranty Cost
Selling and Administration Cost
Other Corporate Cost
Corporation Profits
Distributor Cost

The Dealer-Markup consists of the dealer expense and profit.

The costs included in Appendix A are variable cost, dealer wholesale, dealer mark-up, and consumer cost.

The variable costs of production of components are those incremental costs associated with that component. The major categorical contributors to variable costs are direct labor, direct materials, and variable burden. Other minor contributors to variable cost such as setup costs, where applicable, are included in the variable burden rate.

Direct labor costs are determined as an average rate depending on the worker classification required to perform the tasks identified in the process study (e.g., punch press operator, drill press operator, machinist). Average labor rates are determined from

ELEMENTS OF CONSUMER COST

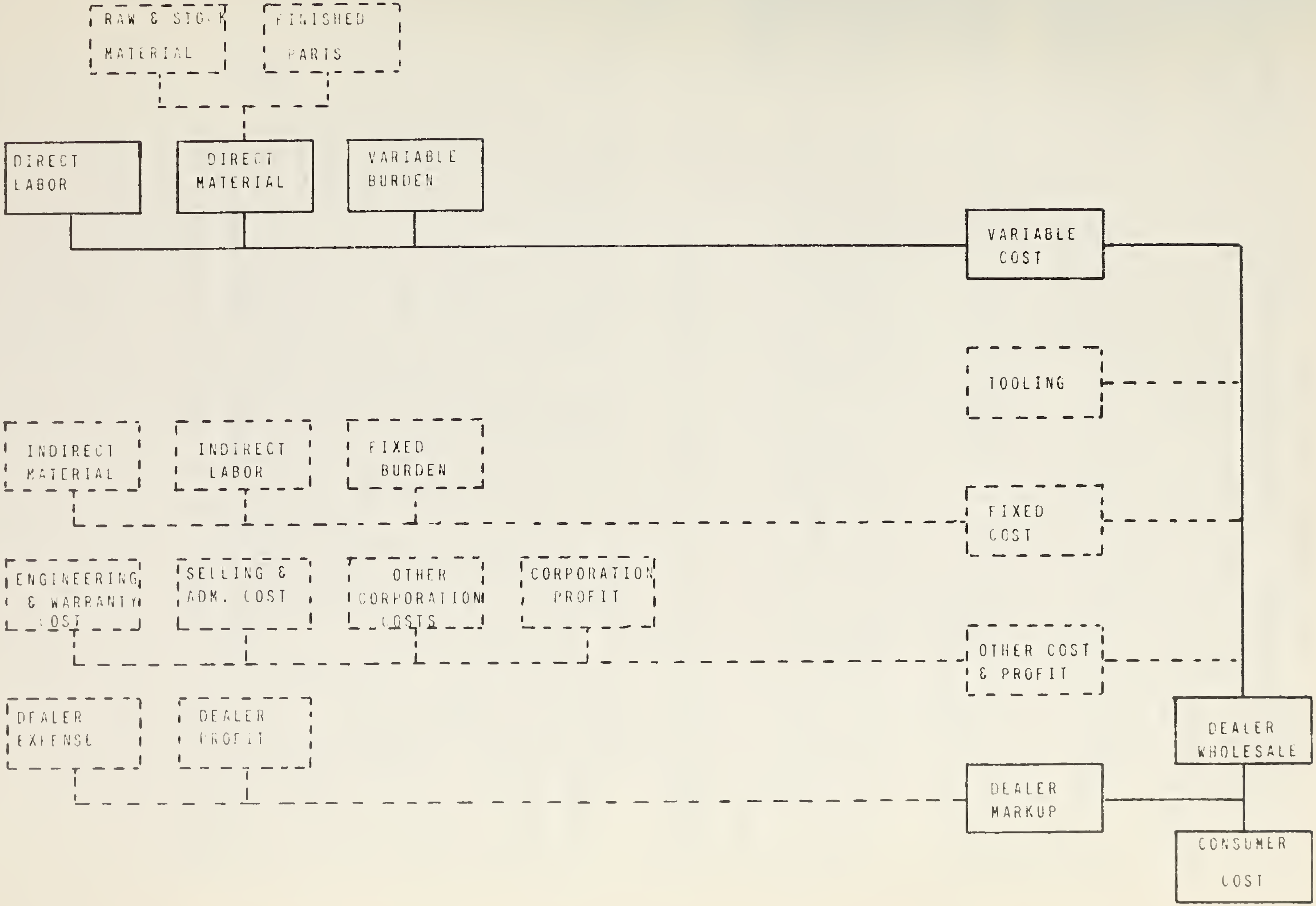

FIGURE 1

Union records, Department of Labor statistics, or a combination thereof. Labor fringe benefits and standard allowance for less than 100 percent labor efficiency are included in the average labor rate.

For each component, the process analysis identified the operation, type of equipment, pieces per hour, number of men, and number of machines. This data when extended by information from the data bank and all component operations summarized will produce the total direct labor cost per component.

Direct material costs are those costs associated with the purchase of all material required in the production process. Accordingly, direct material costs include the cost of not only the material in the finished component, but also that of the material scrapped minus salvage price, due to material removal or incorrectly worked components that cannot be salvaged.

Variable burden costs are estimated charges that attempt to account for all other expenses due to the production process and that vary directly with the production volume and that contribute to the cost of sales. Examples of sources of such expenses include, but are not limited to, perishable tools (e.g., drill bits, spot welding tips), fuel and power requirements and direct supervision and clerical. The total of all expenses that vary with the production quantity is estimated, based on a production planning volume. The sum of these expenses is then apportioned to each component on some logical scheme. The amount of apportionment is known as a variable burden rate.

Several methods of applying variable burden have been popularly accepted in the past as well as during current times. Total costs that are apportioned on the number of pieces produced, or material usage, misrepresent true costs whenever parts of different sizes or complexities are produced. Costs apportioned on direct labor misrepresent true costs in a highly automated production process.

This study utilizes a burden rate applied on occupancy time in a given machine, or station, performing a task during the production process. Burden rates are calculated on basis of a combination of machine or station complexity, cycle time, area occupied, and other considerations that more realistically reflect the true rate of apportionment of total variable expenses.

The cost development process and teardown procedures requires that each component be weighed, tagged with identification data, and analyzed for general type of material and manufacturing method utilized. Experienced personnel qualified by many years of production processing were employed to develop the basic data. The processing method, specific manufacturing operation, type of equipment, pieces per hour, number of men, number of machines, general type of material, rough weight of material and tooling costs were all elements of data furnished by the process engineer. A finite estimating and processing technique utilizes this basic data plus model year economics and volumes contained in a data bank to extend the data into consumer cost.

The data bank contains approximately six hundred operation rates and over sixty materials utilized in the automotive type industry and covers twelve model year economics. In this study, the terms "Model Year Economics" and "Model Year Production Volumes" are utilized. The term model year directly related to a designated year of a vehicle design. Normally in the United States, the model year starts in retail sales approximately in September. The volume is related to the number of vehicles produced of a specific design year vehicle. The term economics relates to the average cost elements involved in the production of a specific car year. The model production years normally are not related to the calendar year or a corporation fiscal year. For this study, the Contract Technical Manager designated the Model Year Economics to be 1979.

The Dealer Wholesale Cost for this study was developed by use of the Macro-analysis Method. A factor expressing the relationship of the variable cost to the Dealer Wholesale Cost was obtained from studying financial data related to the specific industry or manufacturer of the product. The macro-analysis study utilized data obtained from public files, annual financial reports, the 10K Report filed annually by the United States manufacturers and previous cost studies of similar products. The variable cost multiplied by the factor will produce the dealer wholesale cost.

Although other methods can be used to derive a dealer wholesale cost, it is believed by the Contractor that the variable cost macro-analysis factor method produces an acceptable average dealer wholesale cost. The macro-analysis factor includes:

A. Indirect labor - these costs are determined by apportioning the total estimated wages for indirect labor over the planned production volume. Indirect labor is comprised of, but not limited to, supervision and management, clerical, janitorial, plant security, etc. The total labor cost is not affected by variations in the production rate.

B. Indirect material - these costs are determined by apportioning the total estimated costs for all material necessary for the proper functioning of the manufacturing plant and not related to the finished product over the planned production volume. Indirect materials are comprised of, but not limited to, stationery and office supplies, janitorial supplies, maintenance supplies, first aid and medical supplies, etc.

C. Fixed burden - is determined by apportioning the remaining estimated expenses related to the operation of a manufacturing plant over the planned production volume. All such expenses are conveniently accumulated categorically as burden. Such expenses are comprised of, but not limited to, property taxes, insurance costs, depreciation charges on buildings and capital equipment, etc.

D. Tooling cost - is determined by apportioning the total expense by expense of special tooling to manufacture a component over the entire life production volume of that component. This cost factor could vary as the component or sub-component could have several years application beyond the study period of a program.

Further, the component or sub-component could be extended over several product lines. Thus the years of amortization and production volumes could have a definite bearing on the tooling cost of the component. With this knowledge, the process engineer would be required to use judgment in the application of the amortization and volume factor.

E. Other Cost and Profit - include items of engineering cost, warranty costs, selling and administrative costs, corporate burden and taxes (excluding factory burden and taxes), corporate depreciation and maintenance (excluding factory depreciation and maintenance), and other corporate costs and profit.

The dealer wholesale cost could be derived by the method of applying individual detailed cost factors stated above to the variable cost. This would produce a very accurate dealer wholesale cost. However, the data to accomplish this would not be available publicly or could it be expected that such confidential data would be made available for study groups.

Dealer Markup is the summation of all costs incurred in the operation of a dealership (salaries, taxes, depreciation, advertising, maintenance, etc.) and the dealer's profit. The Contractor was cognizant of a potential problem in attempting to arrive at an equitable dealer markup to apply in the cost calculations. The United States dealer is an independent business man over whom the manufacturer can exercise only limited controls. Although manufacturers have suggested retail prices, the dealer is actually free to bargain with each customer to establish the selling price for a vehicle. For this study it is assumed that the dealer's markup is based upon the full suggest price and is reflected in the consumer cost of the system or components studied.

Appendix B contains photographs for each system studied. These photographs provide a quick overview of the various systems.

COST EVALUATION - FMVSS 220/221/222 SCHOOL BUS ROLLOVER PROTECTION/BODY JOINT STRENGTH/SEATING AND CRASH PROTECTION

The Delorean Motor Company has studied the history of the three Safety Standards to be considered. They were first published in the Federal Register in 1975. The original date for them to become effective was October 26, 1976, but this was changed by Congress to April 1, 1977. FMVSS 220, School Bus Rollover Protection, was directed to improving the structural resistance of the passenger compartment to crushing in the event that the bus overturns. FMVSS 221, Body Joint Strength, specifies a minimum performance level for school bus body panel joint strength. It is intended to improve the structural integrity of the body during crash impact and to prevent laceration of the bus occupants and their ejection from the bus. FMVSS 222, School Bus Seating and Crash Protection specifies seating, restraining barrier and impact zone requirements for school buses. It includes a concept of "compartmentalization' of seated occupants during crash impacts and was developed in the light of findings as to the impractability of providing belt type restraints in standard school buses.

In order to gather data on the costs of the three standards De Lorean requested three major school bus manufacturers to allow our representatives to visit their production plants and meet with key personnel. The three manufacturers were selected from the list of eight shown in Table 1. Each manufacturer selected for a visit was a leading producer of school buses; those selected were Carpenter Body Works, Superior-Lima Division of Sheller-Globe Corporation, and Wayne Corporation.

TABLE 1 - SCHOOL
BUS MANUFACTURERS

1. Blue Bird Body Company
   Fort Valley, GA 31030

2. Carpenter Body Works, Inc.
   West Main Street
   Mitchell, IN 47446

3. Coach and Equipment Sales Corporation
   P.O. Box 36
   Penn Yan, NY 14527

4. Collins Industries
   P.O. Box 58
   Hutchinson, KS 67501

5. Superior-Lima Division
   Sheller Glove Corporation
   1200 East Kibby Street
   Lima, OH 45802

6. Thomas Built Buses, Inc.
   P.O. Box 1849
   High Point, N.C. 27261

7. Ward School Bus Manufacturing, Inc.
   Highway 65 South
   Conway, AR 72032

8. Wayne Corporation
   P.O. Box 1447
   Richmond, IN 47374

Messrs. R. Mc Lean and M. Harvey of De Lorean met with Mr. R. Kurre of Wayne Corporation at the Richmond, Indiana plant on July 18, 1979. We met with Mr. R. Verhul, Chief Engineer and Mr. F. Barrington, Safety Engineer at the Mitchell, Indiana plant of the Carpenter Body Works, Inc. on July 19, 1979. Finally, we met with Mr. T. Harrell, Engineering Manager and Mr. W. Nowicki, Safety Projects Engineer of Superior-Lima Division in Lima, Ohio on October 9, 1979. All of the gentlemen listed above were very cooperative and answered our questions fully. The commercial brochures for the school buses were obtained from each manufacturer.

Some data directed specifically to the costs of the Federal Motor Vehicle Safety Standards was obtained.

FMVSS 220 SCHOOL BUS ROLLOVER PROTECTION

The requirements for demonstrating compliance with FMVSS 220 are stated in the Standard to be:

> "S4 Requirements. When a force equal to 1½ times the unloaded vehicle weight is applied to the roof of the vehicle's body structure through a force application plate as specified in S5., Test procedures-
>
> (a) The downward vertical movement at any point on the application plate shall not exceed 5½ inches; and
>
> (b) Each emergency exit of the vehicle provided in accordance with Standard 217 (571.217) shall be capable of opening as specified in that standard during the full application of the force and after release of the force, except that an emergency exit located in the roof of the vehicle is not required to be capable of being opened during the application of the force. A particular vehicle (i.e., test specimen) need not meet the emergency opening requirement after release of force if it is subjected to the emergency exit opening requirements during the full application of the force (41 F.R. 36027-August 26, 1976)"

Compliance with FMVSS 220 has posed only minor problems for school bus manufacturers. Of the three bus manufacturers contacted, two, Wayne and Superior, stated that they made no changes for compliance with the rollover standard. Carpenter made a minor change in the roof rail design to improve the retention of the roof rafters. They added a channel to the roof rail as is shown in Figure 2. The added cost of the channels has been estimated by De Lorean to be $114.72 per bus. Carpenter also added roof bows to certain models of the forward control type. However, the volume of production of forward control buses is so small that Carpenter considers the overall effect on costs of the change to be negligible. The added weight to the Carpenter buses resulting from the added channels was a total of 145.2 pounds.

In answer to an inquiry from the US General Accounting Office of November 4, 1976 concerning the costs of compliance with the proposed school bus safety standards, Mr. R. Kurre of Wayne Corporation stated that the impact of FMVSS 220 on the bus design had caused "no change".[1] He further reports "All states specify more stringent requirements for rollover protection than FMVSS 220."

FMVSS 221 SCHOOL BUS BODY JOINT STRENGTH

The requirements for demonstrating compliance with FMVSS 221 are stated in the Standard to be:

> "S5. Requirement. When tested in accordance with the procedure of S6, each body panel joint shall be capable of holding the body panel to the member

[1] Letter from Mr. R. Kurre, Wayne Corporation to Mr. H.R. Fine, US General Accounting Office, January 5, 1977. Copy in possession of De Lorean.

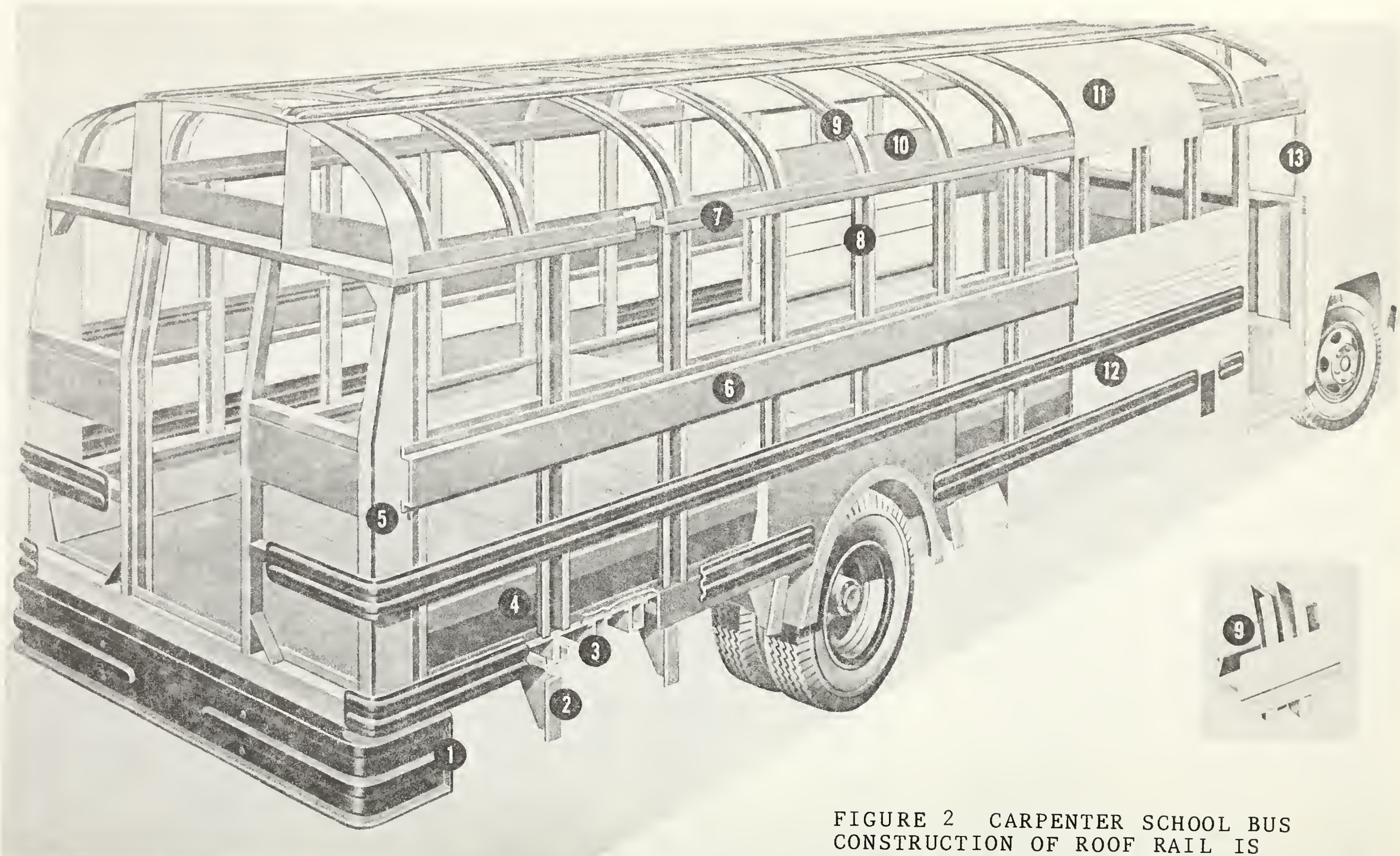

FIGURE 2 CARPENTER SCHOOL BUS CONSTRUCTION OF ROOF RAIL IS SHOWN AT 7 AND IN INSET 9

to which it is joined when subjected to a force of 60% of the tensile strength of the weakest joined body panel determined pursuant to S6.2."

The Standard applies only to school buses with a gross vehicle weight rating of more than 10,000 pounds.

The universal practice in constructing pre-standard school buses was to rivet the external panels to the body structure. Without exception, the response of the bus body manufacturers to the imposition of FMVSS 221 was to add an adhesive to the panels and structure at the time they were joined. The quantities of epoxy adhesive that each manufacturer uses in assembling a bus body are shown below:

Superior	- 5.0 liters	- 1.32	gallons	(T. Harrell)
Carpenter	-	- 1.3	gallons	(R. Verhul)
Wayne	-	- .6	gallon	(R. Kurre)
	AVERAGE	1.07	gallons	

The average amount of adhesive used per bus is seen to be 1.07 gallons and this was used in our cost estimates. It is considered reasonable to use the arithmetic average in this case since each manufacturer produces about 5000 buses per year to Federal Motor Vehicle Safety Standards. The equality of vehicles produced by the three manufacturers made a weighted average unnecessary.

We obtained an estimate of the number of plant personnel who were added to apply the adhesive from

Messrs. T. Harrell and W. Nowicki of Superior-Lima Division as follows:

CATEGORY	NUMBER ADDED	HOURS/DAY
Production Assemblers	12	96
Inspectors	3	24
Resin Handlers-Mixers	3	24
Wipers-Paint Preparation	2	16
Formen	2	16
Physical Tester	1	8
Fixture Cleaners	28	56
TOTAL	51	240

All added personnel work 8 hours per day relative to the adhesive application with the exception of the fixture cleaners who spend about 2 hours per day on epoxy cleanup. If Superior is assumed to produce 5000 buses per year which must comply with FMVSS 221, working 250 days per year, this would result in a rate of 5000/250 or 20 buses per day covered by FMVSS 221. When we visited them, Superior was producing 24 buses per day of all types (excluding van conversions). Therefore, it seems reasonable to assume the 20 units per day rate. This would be 240/20 or 12 manhours per bus spent on the adhesive applications.

In estimating the cost to the manufacturer of production processes we frequently employ a variable profit quantity, usually expressed as a percentage of net sales. Figures on the variable profits of bus manufacturers are quite difficult to obtain. Usually, they are divisions of larger corporations so that individual financial performance is not reported but is consolidated in the overall corporate report (Superior is a division of Sheller-Globe Corporation, Wayne a division of Wayne Corporation). Or the company may be privately held and not subject to making its financial performance public (Carpenter is privately held). Therefore, our best estimate of the financial performance of a bus division must be drawn from the overall performance of a Corporation which has as a major component a bus producing division.

Sheller-Globe is such a corporation. In the 1978 Annual Report of Sheller-Globe they state that of $600,308,000 total sales, $78,532,000 was of vehicles, the majority of which were school buses. The Annual Report for 1978 further states:

NET SALES	COSTS OF SALES	VARIABLE PROFIT
$602,999,000	$520,342,000	$82,657,000

Therefore, the variable profit for 1978 for the total corporation is 13.71% of net sales. This compares with a 15.76% variable profit average over five years of Sheller-Globe's performance. De Lorean assumed that the overall corporate average variable profit margin for 1978 was representative of that achieved by the bus division.

The school bus manufacturers all stated that their plant personnel were members of a union of the United Automobile Workers (UAW) of America and that their hourly wages were, on the average, about 10% less than those of the workers in the major automobile plants. Since

De Lorean has the year-by-year average hourly wages of assembly plant workers, we discounted these by 10% in estimating the bus manufacturers costs.

De Lorean therefore estimated the total cost of implementing FMVSS 221 on the basis of:

Epoxy adhesive - 1.07 gallons	- $ 13.85
Plant labor - 12.0 hours	- $168.00
Variable profit -13.71	- $ 28.91
Total Manufacturing Cost	- $210.76

To obtain the cost to the consumer we must also consider the dealers or distributors margin, usually expressed as a percentage of the selling price. School buses are generally purchased by School districts from dealers or distributors who represent the manufacturer. The actual purchase usually involves two manufacturers; the chassis manufacturer, and the bus body builder. A chassis is purchased separately from the body and is usually sent to the body manufacturer for completion. The school bus business is extremely competitive. Although the dealer markup is nominally 15% of the manufacturer's price, they almost never are able to realize such a profit. The purchases are usually made by the process of firm fixed-price bidding and the bids from one dealer to another may vary only by a few hundred dollars on a large quantity of buses. Indeed, it is reported that some dealers frequently sell the new buses at their costs, counting on the resale of traded-in buses and service to make their profit. However, for purposes of cost estimating we have assumed that the dealers discount averages 13.09% of the selling price. Therefore, the total cost per bus of complying with FMVSS 221 is

$242.37. The added weight is that of the adhesive and was fully offset by the elimination of mechanical fasteners.

In his submission to the US General Accounting Office of January 5, 1977, Mr. R. Kurre of Wayne Corporation stated that the cost of complying with FMVSS 221 resulted in a price increase of approximately $180.00 per bus.

FMVSS 222 SCHOOL BUS SEATING AND CRASH PROTECTION

The requirements for demonstrating compliance with FMVSS 222 are:

> "S5. Requirements. (a) Each vehicle with a gross vehicle weight rating of more than 10,000 pounds shall be capable of meeting any of the requirements set forth under this heading when tested under the passenger seat (i.e., test specimen) in that weight class need not meet further requirements after having met S5.1.2 and S5.1.5, or having been subjected to either S5.1.3, 5.1.4, or S5.3.
>
> (b) Each vehicle with a gross vehicle weight rating of 10,000 pounds or less shall be capable of meeting the following requirements of all seating positions other than the driver's seat: (1) The requirements of 571.208, 571.209, and 571.210 (Standard Nos. 208,209, and 210) as they apply to multipurpose passenger vehicles; and (2) the requirements of S5.1.2, S5.1.3, S5.1.4, S5.1.5 and S5.3 of this Standard. However, the requirements of Standard Nos. 208 and 210 shall be met at W seating positions in a bench seat using a body block as specified

> in Figure 2 of this standard, and a particular school bus passenger seat (i.e., a test specimen) in that weight class need not meet further requirements after having met S5.1.2 and S5.1.5 or having been subjected to either S5.1.3, S5.1.4, S5.3, or 571.210 (Standard No. 210)."

The manufacturers of school buses stated that the major costs of complying with FMVSS 222 were comprised of seat modifications. The metal tube frames of the seats had to be strengthened and additional padding had to be installed on each seat. In addition, the standard required:

> "S5.2 Restraining barrier requirements. Each vehicle shall be equipped with a restraining barrier forward of any designated seating position that does not have the rear surface of another school bus passenger seat within 20 inches of its seating reference point, measured along a horizontal longitudinal line through the seating reference point in the forward direction."

This requirement has resulted in the provision of two impact barriers per bus ahead of the front seats of each bus of over 10,000 pounds gross vehicle weight rating. The smaller buses are not required to have impact barriers installed.

In order to make an estimate of the costs incurred in complying with FMVSS 222, De Lorean acquired one each of a typical pre-standard school bus passenger seat and of a post-standard seat. These seats were obtained from:

Wolverine School Bus & Equipment Supply
16291 West 14 Mile Road
Birmingham, Michigan

The seats were manufactured by Carpenter Body Works, Inc. and were:

Pre-DOT Standard: Model 72-E-39 Left Hand ($120.30)
Post-DOT Standard: Model 77-E-39 Left Hand ($138.40)

The seats were inspected at the time they were received, weighed, and then completely disassembled into their component parts. The seats photographed before and after disassembly; the photographs appear in Appendix B. Using our standard cost estimating procedures we determined the cost for each seat component based on production volumes of 100,000 per year. This production volume for a single model was considered realistic since all three of the bus manufacturers interviewed stated that they produced more than 150,000 total bus seats per year. A component cost summary of the bus seats appears in Appendix A.

We determined that the total cost to consumers of the pre-standard seat was $41.21 and that it weighed 44.71 pounds. We also determined that the consumer cost of the post-standard seat was $73.46 and that its weight was 58.41 pounds. The costs were broken down as follows:

	Variable Mfg. $	Fixed $	Dealer $	Consumer $
Pre-standard	31.14	4.67	5.39	41.20
Post-standard	55.51	8.33	9.62	73.46

Therefore, a typical school bus equipped with eleven rows of seats (22 seats) would cost on a pre-standard basis 22x$41.20 or $906.40. The same bus equipped with post-standard seats would cost 22x$73.46

or $1616.12. Although we did not perform a detailed estimate of the cost of the impact barrier, from considerations of its size and weight we assume that each impact barrier costs about $37.50 or a total of $75.00 per bus. This increases the cost of the seat installation in the post-standard bus to $1691.12. The difference, which can be attributed to the cost of complying with FMVSS 222 is $784.72. In a letter to De Lorean dated July 27, 1979, Mr. R. Kurre, Director of Engineering, Wayne Corporation stated that the distributor cost for eleven rows of seats for a pre-standard bus was $907.83 and that the post-standard seats and barriers cost $1565.73. This would be a difference of distributor costs of $657.90 or a consumer cost of $756.58 per bus. Further in his statement to the U.S. General Accounting Office of January 5, 1977, Mr. Kurre reported that the imposition of FMVSS 222 originally cost $700.00. Assuming that school bus costs have inflated a conservative 10% between the time of Mr. Kurre's response to the GAO and the present a total of $770.00 would be the amount calculated. This figure is seen to agree quite closely with our 1979 estimate of $784.72. The added weight for a typical 66 passenger bus was 361.4 pounds with the frontal barriers estimated at a total of 60 pounds.

The case of the school bus which weights less than 10,000 pounds requires the costs of lap belt installations at each seated position to be added to the differential costs of the pre-standard and post-standard seats. The typical school bus in the under 10,000 pound class is a van conversion which seats 16 passengers. The seats are 30 inches wide rather than 39 inches as is found in the standard school bus. Assuming that the cost of the seats is roughly proportional to their width, the total cost differential for the 16 passenger bus seats is:

$$\text{COST INCREASE-SEATS} = 8 \left(\frac{30}{39} \right) \times \$32.26 - \$198.56$$

Based on 1979 economics, the lap belts would cost $3.21 each installed. The total cost of the lap belts would be 16 x $3.21 or $51.36. This brings the total cost of equipping a van conversion school bus to comply with FMVSS 222 to $249.92. As has been indicated, no frontal barriers are required in this class of vehicle.

APPENDIX A

SUMMARY OF COMPONENT COST AND WEIGHT DATA

FMVSS - 221 SCHOOL BUS SEATS SUMMARY OF COMPONENT COST AND WEIGHT DATA

Item	Req'd Per Vehicle	Material	Weight	Total Tooling ($000)	COST PER VEHICLE $						
					VARIABLE COST				Whole-sale Cost	Dealer Markup	Consumer Cost
					Material	Labor	Burden	Total			
1972 SCHOOL BUS SEAT	-	VAR	44.7103	560.	23.4710	3.0561	4.6149	31.1420	35.8133	5.3940	41.2073
1977 SCHOOL BUS SEAT	-	VAR	58.4060	705.	32.8578	15.3963	7.2585	55.5126	63.8395	9.6152	73.4547

APPENDIX B

PHOTOGRAPHS

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INTERNATIONAL HARVESTER CHASSIS

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1979 CARPENTER MODEL 74SB2909 66 PASSENGER SCHOOL BUS
ENTRANCE DOOR

1979 CARPENTER MODEL 74SB2909 66 PASSENGER SCHOOL BUS
BODY PANELS

1979 CARPENTER MODEL 74SB2909 66 PASSENGER SCHOOL BUS
LEFT SIDE

1979 CARPENTER MODEL 74SB2909 66 PASSENGER SCHOOL BUS
FMVSS 222 TYPE SEATS

1979 CARPENTER MODEL 74SB2909 66 PASSENGER SCHOOL BUS
FMVSS 222 FRONT BARRIERS

1979 CARPENTER MODEL 74SB2909 66 PASSENGER SCHOOL BUS
FMVSS 222 FRONT BARRIERS

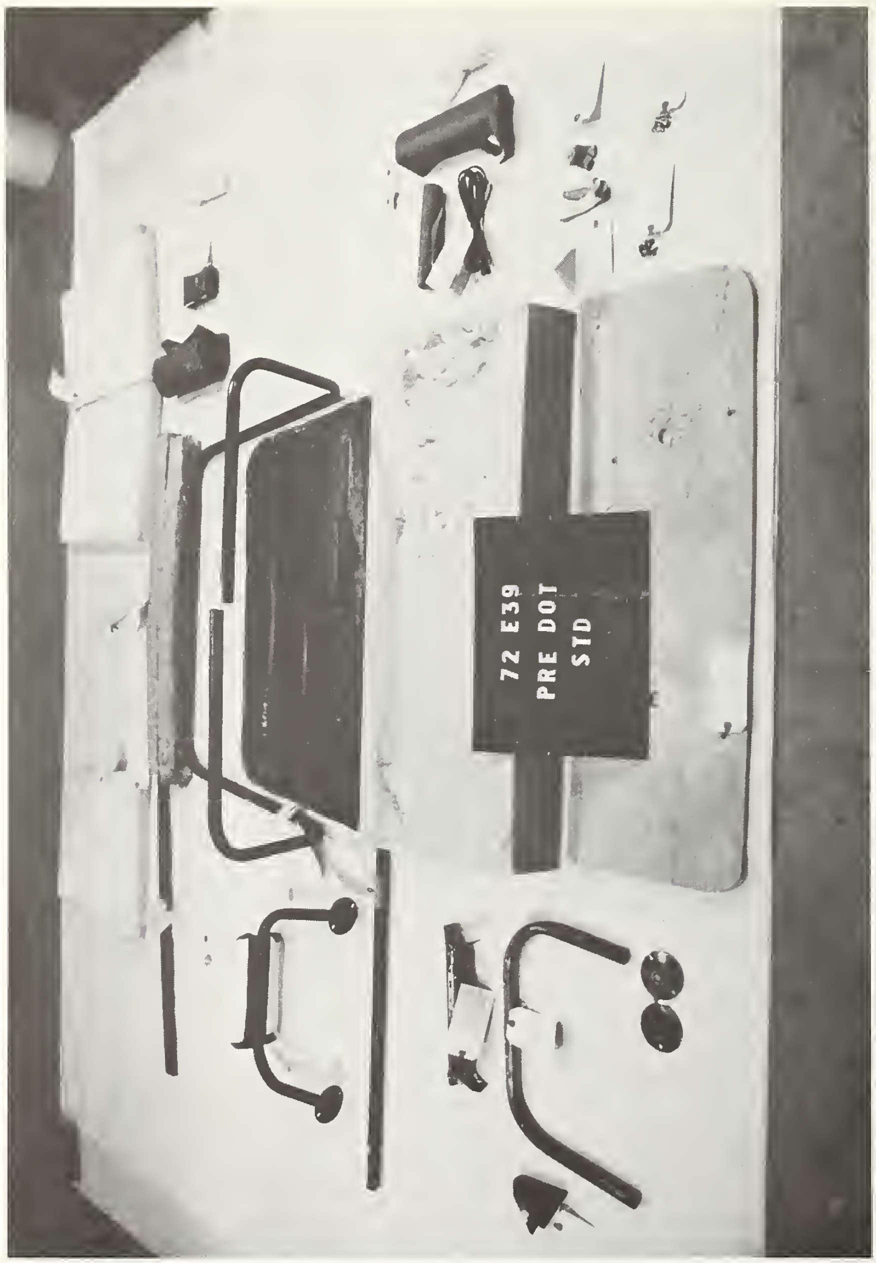
1979 CARPENTER MODEL 74SB2909 66 PASSENGER SCHOOL BUS
INTERIOR ROOF CONSTRUCTION

1976 CARPENTER MODEL 66 PASSENGER SCHOOL BUS
PRE-FMVSS 222 SEATS

1972 PRE DOT STD
BUS SEAT

1972 PRE DOT STD
BUS SEAT

1972 PRE DOT STD
BUS SEAT



1972 PRE DOT STD
BUS SEAT

1972 PRE DOT STD
BUS SEAT

1977 AFTER DOT STD
BUS SEAT

1977 AFTER DOT STD
BUS SEAT

1977 AFTER DOT STD
BUS SEAT

1977 AFTER DOT STD
BUS SEAT

1977 AFTER DOT STD
BUS SEAT

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