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EQUIPMENT AND MAINTENANCE REQUIREMENTS FOR LIGHT-WEIGHT ACCESSIBLE BUS OPERATIONS

Department of Civil and Sanitary Engineering
Michigan State University
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16. Abstract

Guidelines have been developed to assist small private non-profit agencies with little experience in providing transport service to select vehicles and related equipment appropriate to their service needs. Emphasis is on light-weight accessible vehicles, that is, vans, modified vans, and small buses. The report synthesizes operating and maintenance experience for these types of service with such vehicles, and presents practical suggestions relative to operations. The material contained in the report is to assist existing or potential operators understand the applications and limitations of the current state-of-the-art in vehicles and equipment. The objective of the manual is to assist state coordinators of light-weight accessible transit services in implementing better and more efficient transportation.

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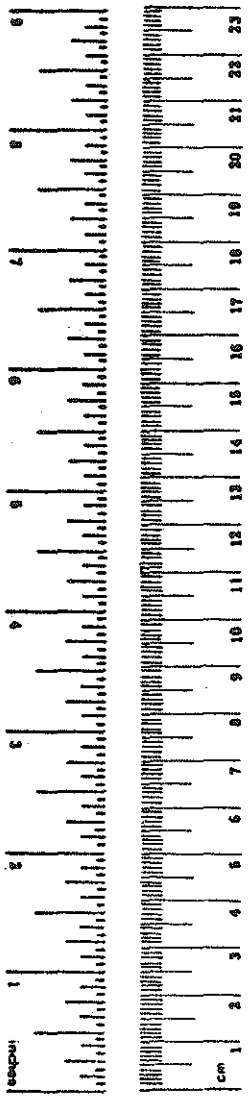
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

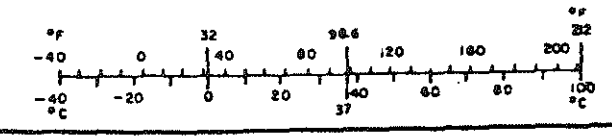
Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	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



Preface

The material contained in this manual has been collected and synthesized from many sources including vehicle and equipment manufacturers, operators, maintenance personnel, and state and federal research reports. The emphasis has been placed on vans, modified vans, and body-on-chassis small buses most appropriate to light-weight accessible transportation services. However, much of the material may be useful to larger vehicles. The manual has been prepared to direct and assist transportation managers of agencies providing light-weight vehicle transit services in acquiring, operating, and maintaining vehicles and related equipment.

Every effort was made to gain current data relative to the provision of such services and it is felt that the manual represents the present state-of-the-art. Not all manufacturers are necessarily represented in the manual but this does not imply endorsement or lack thereof of the products of those represented or not represented. Prices quoted are based upon reported 1979 and 1980 prices.

The manual draws heavily from the Michigan experience, particularly the Small Bus Program of the Michigan Department of Transportation.

Potential providers of such transit services should refer to federal, state, and local ordinances relating to the use of such vehicles for transporting school children, and to special licensing provisions for drivers. The sample specifications provided should be used as a guide for the solicitation of bids for vehicles that will meet the particular needs of specific operators.

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INTRODUCTION

Recent experience in the procurement, operation, and maintenance of vehicles used in the provision of transit service for elderly and handicapped persons has identified several significant problems. These problems have been generally catagorized as start-up difficulties related to a lack of operator experience in the selection, procurement, inspection, operation and maintenance of the vehicles available for such service. It has been suggested that many of these difficulties could be resolved if the experiences and expectations of the existing vehicle operators were synthesized and the information disseminated to potential operators through Federal and State government agencies.

The purpose of this project is to provide a mechanism to improve the understanding of interested agencies relative to the selection of such transit vehicles and equipment and their subsequent maintenance requirements. Materials have been developed to identify the range of vehicles and the options available from various manufacturers so that reasonable decisions might be made in the selection of vehicles appropriate to the service envisioned. These data, together with the approximate cost ranges of the basic vehicles and standard equipment as well as available options, should enable agencies to compare and procure equipment meeting both their service needs and budget constraints. Typical procurement specifications are included to assist agencies in developing specifications for the receipt of competitive bids.

Information is also included to assist agencies in making inspections of vehicles upon delivery and to assist in designing maintenance schedules and procedures to minimize vehicle down-time. The experience of other agencies in the use of these vehicles is used to generate the inspection and maintenance recommendations.

The relative operating characteristics and maintenance requirements of the three types of vehicles considered in

this program (vans, modified vans, and body-on-chassis small buses) are identified so that a better understanding of the service provisions of these types of vehicles will be possible prior to procurement.

The information developed in this project is presented in manual format for use by agencies interested in supplying transportation through the use of light-weight transit vehicles. Although the original target groups were those agencies interested in supplying transportation to elderly and handicapped persons, the information has much broader application. A coordinated audio/visual presentation is also available for use by state personnel for highlighting the findings of this project.

Section-I Light-Weight Vehicles for Transit Use

The types of light-weight vehicles most generally utilized in transit operations are standard vans, modified vans and small buses. These types of vehicles normally offer the seating capacity, maneuverability, and wheelchair lift options desirable for a wide range of applications.

Standard Vans

The standard American van vehicle manufactured by Dodge, Ford, Chevrolet and GMC has found some application for public transit. The seating capacity of these vehicles ranges from five passengers on the smaller 110 inch wheelbase models up to 14 or 15 passengers on the extended length models with a 127 or 138 inch wheelbase. Figures 1 and 2 and the accompanying information in Tables 1 and 2 show the dimensions of standard production vans. Seating capacity is based on the seating arrangements shown in Figure 3.

Several considerations should be taken into account before selecting a standard van as a transportation vehicle. One particular problem with the standard production van is that the interior headroom (about 53 inches from floor to roof) does not allow passengers to stand erect while boarding or leaving the vehicle. This can be especially troublesome for elderly passengers with limited mobility, or for someone attempting to load or unload a wheelchair passenger. When equipped with a wheelchair lift, these vans are generally considered too small to comfortably accommodate more than six to eight ambulatory passengers. The headroom available at the rear and side entrances (about 48 inches) is also considered too low for wheelchair passengers to enter using a wheelchair lift. Figures 4 and 5 and Table 3 show the dimensions of a typical wheelchair and passenger based on the 95th percentile measurements for males and females. Comparing these figures to the dimensions in Figure 2 it can also be seen that wheelchairs are severely limited as to their positions inside the

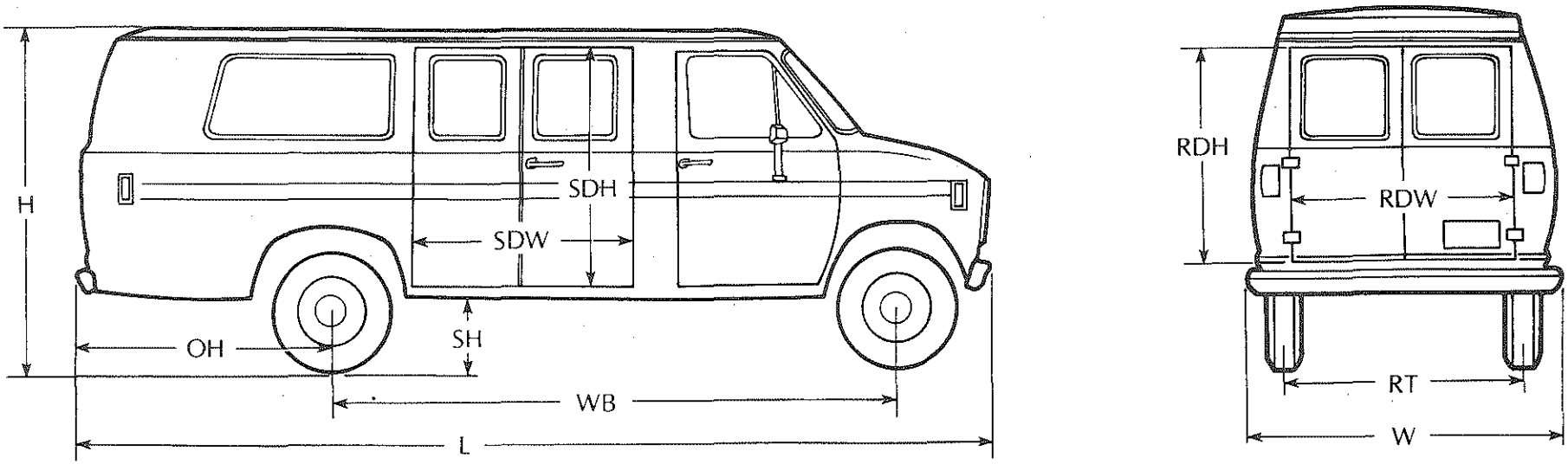


Figure 1. EXTERIOR DIMENSIONS FOR STANDARD PRODUCTION VANS

TAB 1

EXTERIOR DIMENSIONS FOR STANDARD VANS

Model	CHEVROLET & GMC G20	G20	G30	DODGE B200	B300	B300 Maxivan	FORD E150	E250	E350 Supervan
GROSS VEHICLE WEIGHT GVW (lbs)	6,600	6,600	8,600	6,050	7,200	8,550	NA	NA	NA
WHEELBASE WB (ins)	110	125	125	109.6	127.6	127.6	124	138	138
OVERALL LENGTH L (ins)	178.2	202.2	202.2	178.9	196.9	222.9	186.8	206.8	226.8
OVERALL WIDTH W (ins)	79.5	79.5	79.5	79.8	79.8	79.8	79.8	79.8	79.8
OVERALL HEIGHT H (ins)	80.2	80.2	81.2	79.6	80.9	80.6	80.5	82.0	83.7
REAR OVERHANG OH (ins)	48.0	48.0	48.0	40.0	40.0	61.0	37.8	43.8	63.8
REAR TRACK RT (ins)	68.0	68.0	68.0	65.2	65.2	65.2	67.0	66.0	66.0
STEP HEIGHT SH (ins)	20	20	20	20	20	20	20	20	20
SIDE DOOR (HINGED)									
WIDTH SDW (ins)	NA	NA	NA	49.3	49.3	49.3	NA	NA	NA
HEIGHT SDH (ins)	NA	NA	NA	47.2	47.2	47.2	NA	NA	NA
SIDE DOOR (SLIDING)									
WIDTH SDW	44.2	44.2	44.2	39.8	39.8	39.8	48.0	48.0	48.0
HEIGHT SDH (ins)	49.2	49.2	49.2	47.2	47.2	47.2	48.0	48.0	48.0
REAR DOOR									
WIDTH RDW (ins)	54.4	54.4	54.4	49.3	49.3	49.3	54.0	54.0	54.0
HEIGHT RDH (ins)	48.8	48.8	48.8	47.2	47.2	47.2	47.9	47.9	47.9
TURNING DIAMETER AT FRONT BUMPER (ft.)	43.57	48.48	46.62	NA	NA	NA	44.3	49.7	55.3

NA = Not Available

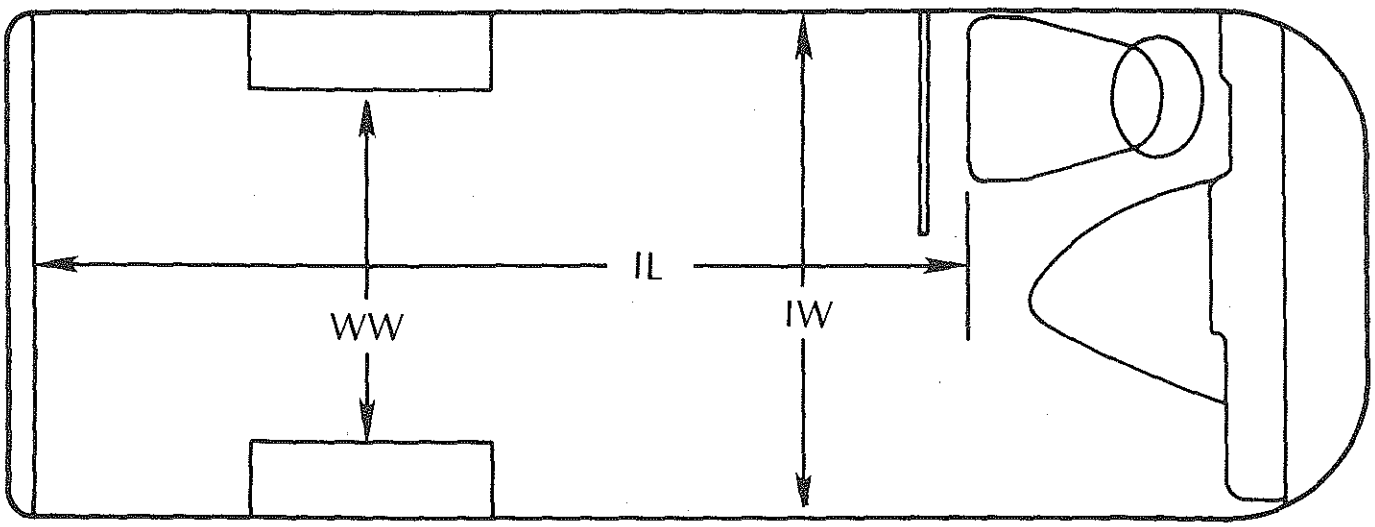


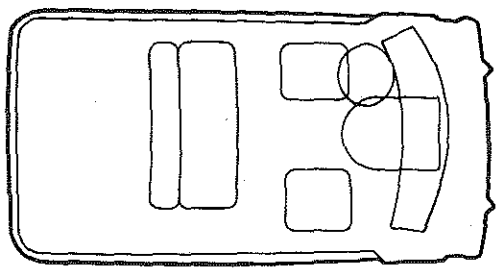
Figure 2. INTERIOR DIMENSIONS FOR STANDARD VANS.

TABLE 2

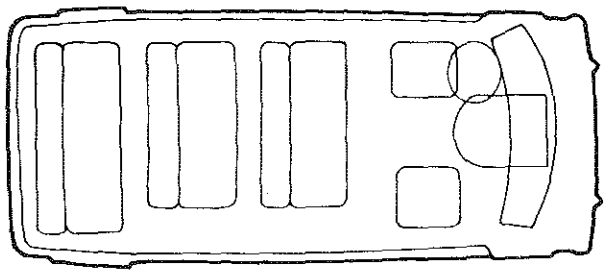
INTERIOR DIMENSIONS FOR STANDARD VANS

	CHEVROLET & GMC			DODGE			FORD		
Model	G20	G20	G30	B200	B300	B300	E150	E250	E350
WHEELBASE WB	110	125	125	109.6	127.6	127.6	124	138	138
LENGTH - BACK OF FRONT SEAT TO REAR DOOR AT SHOULDER HEIGHT IL (ins)	94.2	118.2	118.2	92.9	110.9	136.9	91.2	111.2	131.2
WIDTH AT SHOULDER HEIGHT IW (ins)	70.8	70.8	70.8	69.0	69.0	69.0	70.6	70.6	70.6
WIDTH BETWEEN WHEEL-HOUSINGS WW (ins)	53.5	53.5	53.5	50.0	50.0	50.0	48.0	48.0	48.0
MAXIMUM INTERIOR HEIGHT FLOOR TO ROOF - (ins)	53.7	53.8	53.8	53.2	53.2	53.2	51.6	51.6	51.6

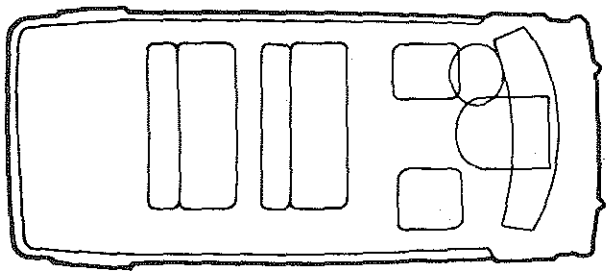
Figure 3. SEATING ARRANGEMENTS FOR STANDARD VANS.



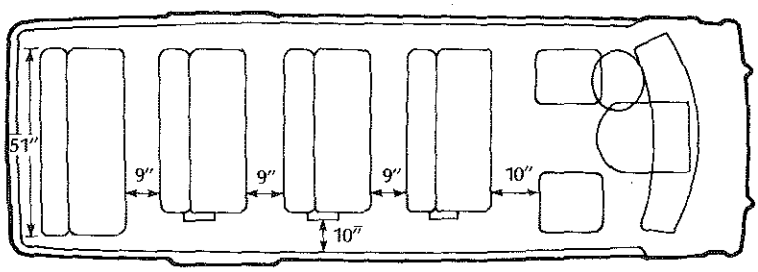
FIVE PASSENGER 110 INCH WHEELBASE



TWELVE PASSENGER 127.6 INCH WHEELBASE



EIGHT PASSENGER 127.6 INCH WHEELBASE



FIFTEEN PASSENGER 127.6 INCH OR 138 INCH WHEELBASE

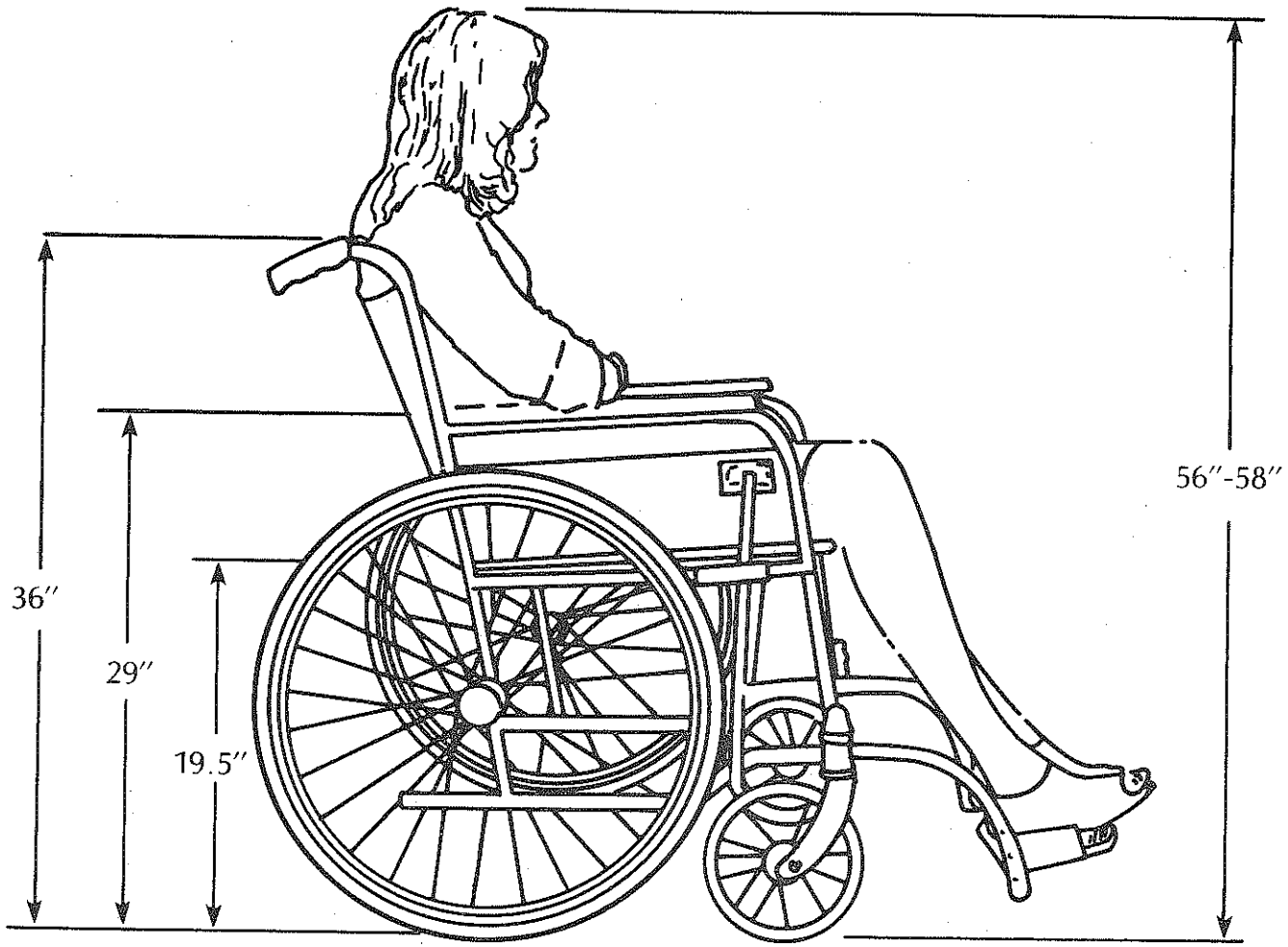


Figure 4. WHEELCHAIR AND USER DIMENSIONS SIDE VIEW.

Source: Ryden (1977).

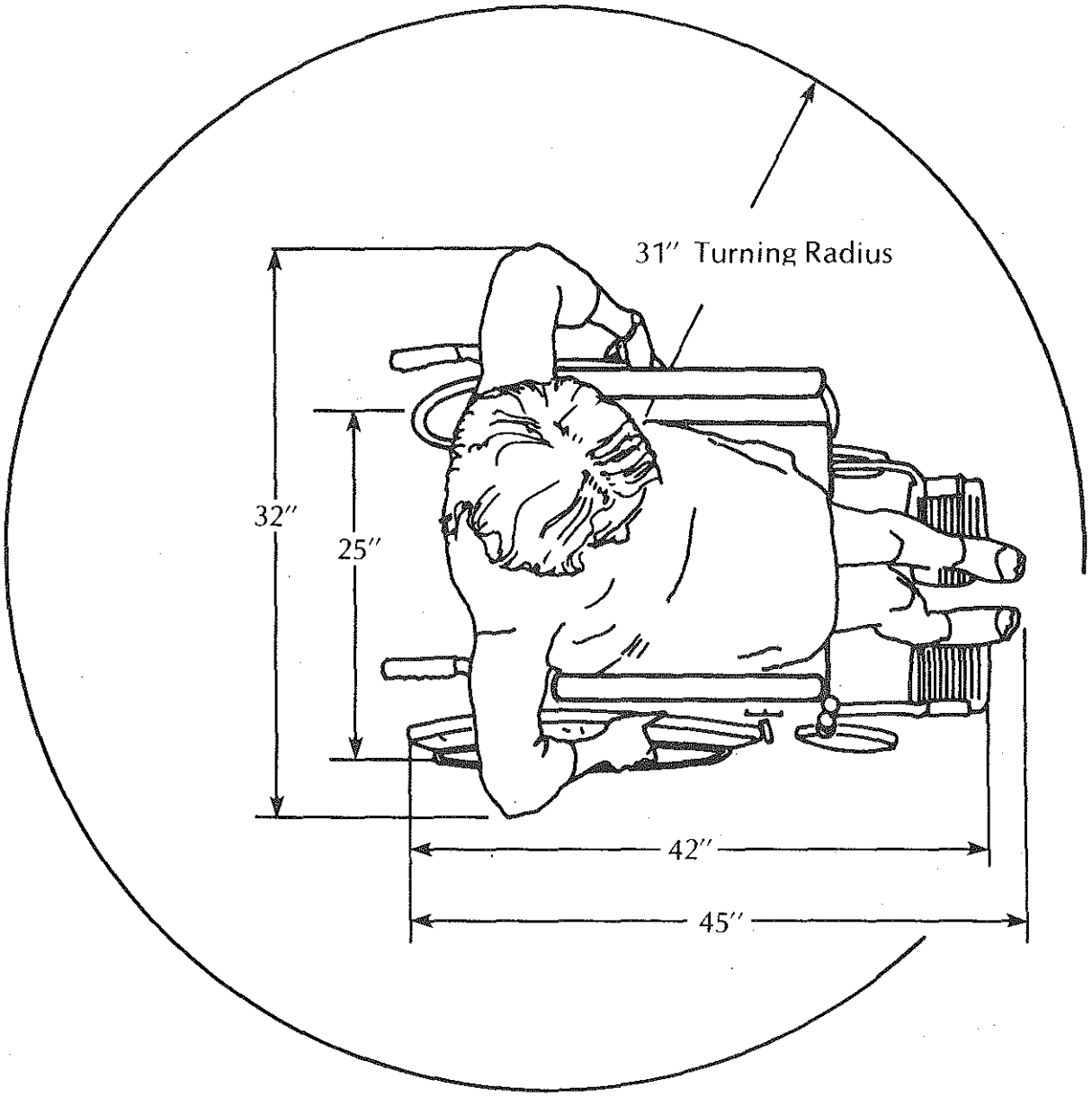


Figure 5. WHEELCHAIR AND USER DIMENSIONS TOP VIEW.

Source: Ryden (1977).

TABLE 3

ADDITIONAL WHEELCHAIR INFORMATION

Wheel radius	12"
Folded width	11"
Wheelchair storage space	11"(W)x42"(L)x36"(H)
Standard chair weight	50 lbs.
Motorized chair weight	110 lbs.
Minimum length for two chairs, one in front of the other, both occupied	100"
Minimum length for two chairs, side-by-side, both occupied	60"

Source: Ryden (1977).

vehicle. Wheelchairs cannot face one another from opposite sides of the vehicle. Neither can two wheelchairs be accommodated between the wheelhousings of the vehicle.

Other considerations relating to standard vans include the 20 inch step height from the ground at the side entrance. This height can be extremely difficult for the elderly or for passengers using crutches or walkers to negotiate. There is also a problem with the narrow width of the aisleway along the side of the vehicle and between the seats (about 10 inches) which makes the seats difficult to access for passengers with mobility impairments. Passengers with mobility limitations may find it nearly impossible to access the standard bench seat at the rear of the vehicle due to the barrier created by the narrow aisle width and the protrusion of the wheelhousing into the aisleway.

Standard and optional equipment available on production vans not only varies between manufacturers but also depends on the size and model of vehicle ordered from a particular manufacturer. Several of the typical standard and optional features available on production vans are listed in Table 4. It should be noted that optional equipment designed to make a standard production van accessible to wheelchair passengers, such as wheelchair lifts, and other items designed to improve the utility of the vehicle for transit use, such as transit type (double passenger) seats, are not available from the original manufacturer.

Standard production vans have been used successfully to provide transportation for various agencies. In instances where the considerations of limited interior space do not pose a problem, the standard van can be a useful alternative as a transit vehicle.

Modified Vans

In an attempt to improve the utility of the standard production van for transit use, modified vans have been introduced. As the name implies, these are standard production

TABLE 4

TYPICAL STANDARD AND OPTIONAL EQUIPMENT
FOR STANDARD PRODUCTION VANS

Standard Equipment	Optional Equipment
225-350 Cubic Inch Displacement Gasoline Engine	360-400 Cubic Inch Displacement Engine
Manual Steering	Power Steering
3 or 4 Speed Manual Transmission	3 Speed Automatic Transmission
Power Front Disc Brakes with Rear Drum Brakes	33-36 Gallon Fuel Tank
21-22 Gallon Fuel Tank	Fifteen Passenger Seating (bench seats)
Five Passenger Seating	63 or 117 amp Alternators
Windshield Defrosting and Defogging System	59-85 amp-hour Batteries
Interior and Exterior Rear View Mirrors	Auxiliary Heaters
	Air Conditioning
	Citizens' Band Radios
	Tinted Windows
	Rustproofing
	AM/FM Radios

vans that have been altered to increase headroom, widen the body, or make the vehicle accessible to wheelchair passengers. The modifications are made by companies other than the original manufacturer such as those shown in Table 5.

The most common modification made to a van is the addition of a raised roof to increase interior headroom. This is done by removing the standard roof at or below the roof line and replacing it with a steel, aluminum, or fiberglass raised roof. This modification allows for headroom up to 74 inches. As a safety feature, the State of Michigan specifies that the roof be capable of supporting the weight of a fully loaded vehicle if overturned (MDOT). Some manufacturers use a raised roof that is structurally reinforced with a steel frame. However, this is not a standard practice. Other common modifications include the addition of wheelchair lifts and securement devices, transit-type double passenger seats, rubber covered plywood floors, sliding passenger windows and lower rise steps (12 inches or less preferred) at the main passenger entrance.

Other modifications are also preferred for passenger safety and comfort. These include handholds for support at all points of negotiation, such as entrances, seat backs, stanchions, etc., protective padding of hard surfaces, roof ventilation for warm weather climates, insulation in the walls and roof and weatherproofing of doors and windows, and well lighted interiors. The requirements of at least two government agencies for the design specifications of this type of vehicle are available (MDOT; Ryden, 1977), and sample specifications appear in Appendix A. Other states may already use similar specifications for the procurement of light-weight transit vehicles. Many of the requirements detailed in these specifications are a result of the experience gained from the actual use of these vehicles for transit purposes.

One vehicle being offered by the Wide One Corporation has been increased in overall width by 14 inches by widening the frame and extending the axles on a standard Dodge B-300 Maxivan.

TABLE 5

REPRESENTATIVE MANUFACTURERS OF TYPICAL MODIFIED VANS FOR TRANSIT USE

Coach and Equipment Sales Corporation
Post Office Box 36
Penn Yan, New York 14527
(315) 536-2321

Collins Industries
Post Office Box 48
Hutchinson, Kansas 67501
(316) 633-4441

National Coach Corporation
17129 South Kingsview Avenue
Carson, California 90746
(213) 538-3122

Wide-One Corporation
3051 East La Palma Avenue
Anaheim, California 92806
(714) 630-7933

This vehicle can also be equipped with a raised roof. The wider body affords the options of either a wider aisleway or increased seating capacity.

Any modification to a standard van may alter the structural integrity of the vehicle. However, with special attention to high quality materials and workmanship in producing these modifications, vehicle safety can be maintained. Written procurement specifications used by several state agencies for the purchase of transit vehicles are designed to help insure that a high level of vehicle safety is maintained, and that quality workmanship and materials go into the production of these vehicles.

Interior and exterior views of several typical modified vans are shown in Figures 6 through 10, and the manufacturers' specifications for the 1980 versions of these vehicles are shown in Tables 6 through 9. The manufacturers' specifications indicate the manner in which these vehicles are normally designed and equipped. Some manufacturers are willing to make limited modifications to their standard designs based on procurement specifications supplied by the purchaser. If particular aspects of a vehicle do not suit the purchaser's service needs it may be possible to have them changed by the vehicle manufacturer. Alterations in design, however, may result in a higher purchase price. Schematic diagrams showing the typical exterior and interior dimensions of this type of vehicle are shown in Figures 11 and 12.

Typical standard equipment on a modified van is given in Table 10. Standard equipment does vary between manufacturers, and may be limited by either the original manufacturer or the van modification company.

The 1980 prices for these vans range from approximately $16,000 to over $29,000 depending on the vehicle type and optional equipment desired. Typical optional items for modified vans are also listed in Table 10. The addition of optional equipment can substantially increase the price of the van. For example, the installed cost of a wheelchair lift

TABLE 6 COACH AND EQUIPMENT SALES CORPORATION SPECIFICATIONS FOR THE FORTIVAN

Manufacturer	Coach and Equipment Sales Corp.
Vehicle (Name)	Fortivan
Bus Size (Passenger Range)	9 - 13
Type of Vehicle	Modified Van
Approximate Cost (1980 Model)	$19,000 - $25,000
Vehicle Dimensions	
GVW (lbs)	9,000
Length (ins)	223.1 / 202.2
Width (ins)	79.8 / 79.5
Height (ins)	115 / 112.5 with Air
Wheelbase (ins)	127.6 / 125
Rear Track (ins)	
Passenger Entrance	
Height (ins)	74
Width (ins)	33 / 32
Step Heights (ins)	
Ground to 1st	12
1st to 2nd	8
2nd to Aisle	9
Inside Width (ins)	71.5
Aisle Width (ins)	
Head Room Over Aisle	73.25
Chassis Specifications	DodgeB-300 Maxi-Van/Chevrolet Van
Engine Make	Dodge/Chevrolet
Engine Model	Gasoline
Number of Cylinders	V-8
Brake Horse Power	
Torque (ft-lbs)	
Bore/Stroke	
Displacement (ins)	360/350
Transmission	
Make	Chrysler/GM
Model	3 sp. automatic
Suspension	
Front	2,000 lb. springs, H.D. shocks
Rear	3,100 lb. springs, H.D. shocks
Permit Weight (lbs)	
Front	4,000
Rear	6,200
Tires	
Front	8.75 x 16.5F
Rear	8.75 x 16.5F
Brakes	
Front	12.82" x 1.19" Disc power
Rear	12.00" x 2.25" Drum
Steering	Power
Fuel Capacity (gals)	36
Electrical System	
Alternator (amps)	117
Battery (amps-Hrs)	85
Interior Lights	6
Instrument & Controls	
Body Specifications	
Exterior Walls (Gauge & Material)	20 steel
Interior Walls (Gauge & Material)	16 steel
Insulation (Thickness & Material)	0.5" plywood-Rubber cover
Floor (Gauge & Material)	Tinted-Transit Horizontal
Windows	Slide open
Lift Specifications	
Manufacturer & Model	Coach & Equipment
Door Size (Height/Width)	79" x 49"
Lift Dimensions (Length/Width)	44" x 34"
Automatic	Electric Hydraulic
Manual override	Optional
Weight Capacity (lbs)	750
Location of Controls	
Platform Storage (Fold up/down)	Manual - Power optional
Wheelchair Securement Equipment	
Manufacturer	
Orientation of Chair when Secure	
Part of Chair Secured	
Minimum Chair Width	
Maximum Chair Width	
Type of Operation	
Heater (Btu's)	25,000
Air Conditioning (Btu's)	18,000 or 30,000
Seating Capacity	
With Lift	6 + 2 wheelchairs
Without Lift	9 - 13

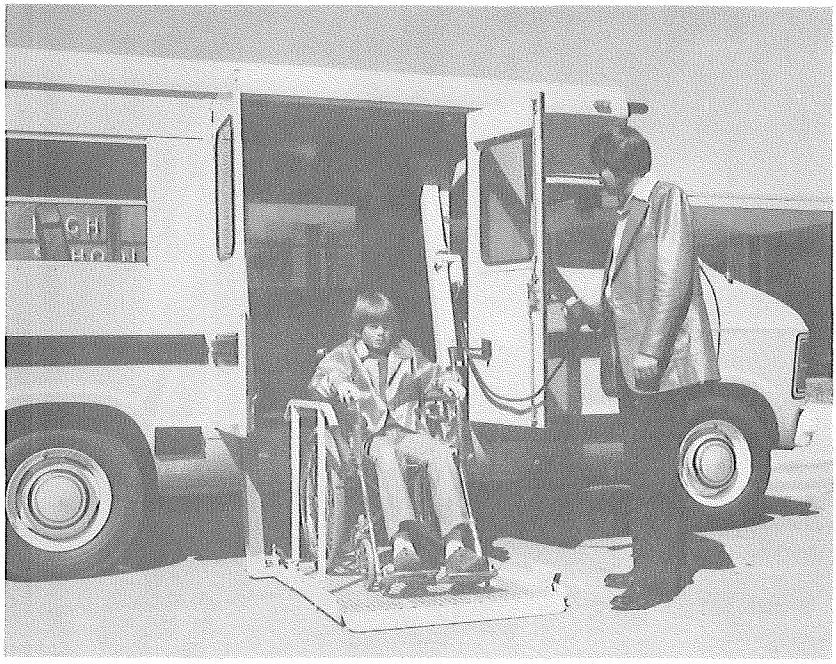
Fortivan

Fortivan Interior

Figure 6. Coach and Equipment Sales Corporation Fortivan -- Modified Van.

TABLE 7 COLLIN'S INDUSTRIES
SPECIFICATIONS FOR THE OMNI-BUS

Manufacturer	Collin's Industries
Vehicle (Name)	Omni-Bus
Bus Size (Passenger Range)	up to 14
Type of Vehicle	Modified Van
Approximate Cost (1980 Model)	$16,000 - $22,000
Vehicle Dimensions	
GVW (lbs)	9,000
Length (ins)	223/226
Width (ins)	80
Height (ins)	102 Plus Vent
Wheelbase (ins)	127.6/138
Rear Track (ins)	
Passenger Entrance	
Height (ins)	82
Width (ins)	26 minimum
Step Heights (ins)	
Ground to 1st	11
1st to 2nd	7.5
2nd to Aisle	7.5
Inside Width (ins)	75
Aisle Width (ins)	16 minimum
Head Room Over Aisle	74
Chassis Specifications	Dodge B-300/Ford E-350
Engine Make	Maxi-Van / Super-Van
Engine Model	Chrysler / Ford
Number of Cylinders	Chrysler
Brake Horse Power	V-8
Torque (ft-lbs)	
Bore/Stroke	
Displacement (ins)	360/351
Transmission	
Make	Chrysler / Ford
Model	3 sp. automatic
Suspension	
Front	
Rear	
Permit Weight (lbs)	
Front	
Rear	
Tires	
Front	8.75 x 16.5F
Rear	8.75 x 16.5F
Brakes	
Front	Power Disc
Rear	12" x 2.5" Drum
Steering	Power
Fuel Capacity (gals)	
Electrical System	
Alternator (amps)	63 (90 available)
Battery (amps-Hrs)	70 (85 available)
Interior Lights	driver, passenger, step area
Instrument & Controls	
Body Specifications	
Exterior Walls (Gauge & Material)	22-steel
Interior Walls (Gauge & Material)	25-steel
Insulation (Thickness & Material)	2.5" Fiberglass
Floor (Gauge & Material)	0.5" plywood
Windows	sliding or Sash (Tinted)
Lift Specifications	
Manufacturer & Model	Collin's
Door Size (Height/Width)	68" x 48"
Lift Dimensions (Length/Width)	44" x 32"
Automatic	Electric-Hydraulic
Manual override	Included
Weight Capacity (lbs)	1100
Location of Controls	On 6 ft. cable
Platform Storage (Fold up/down)	Manual-Power Optional
Wheelchair Securement Equipment	
Manufacturer	Collin's
Orientation of Chair when Secure	Front or side facing
Part of Chair Secured	Wheels
Minimum Chair Width	18"
Maximum Chair Width	24"
Type of Operation	Manual or Automatic
Heater (Btu's)	35,000
Air Conditioning (Btu's)	22,000 minimum
Seating Capacity	
With Lift	7 + 2 wheelchairs
Without Lift	up to 14



Lift Equipped

Standard Entrance

Standard Interior

Figure 7. Collins Industries Omni-Bus -- Modified Van.

Table 8 NATIONAL COACH CORPORATION SPECIFICATIONS FOR THE PARATRANSIT

Manufacturer	National Coach Corp.
Vehicle (Name)	Paratransit
Bus Size (Passenger Range)	9 - 12
Type of Vehicle	Modified Van
Approximate Cost (1980 Model)	
Vehicle Dimensions	
GVW (lbs)	9,000
Length (ins)	225/220
Width (ins)	79.8
Height (ins)	101.0
Wheelbase (ins)	127.6/138
Rear Track (ins)	
Passenger Entrance	
Height (ins)	73.25
Width (ins)	26.5
Step Heights (ins)	
Ground to 1st	11
1st to 2nd	7.5
2nd to Aisle	7.5
Inside Width (ins)	76
Aisle Width (ins)	
Head Room Over Aisle	83.25
Chassis Specifications	Dodge B-300/Ford E350 Maxi-Van Super-Van
Engine Make	Dodge/Ford
Engine Model	Gasoline
Number of Cylinders	V-8
Brake Horse Power	
Torque (ft-lbs)	
Bore/Stroke	
Displacement (ins)	360/351
Transmission	
Make	Chrysler/Ford
Model	3 sp. automatic
Suspension	
Front	2,000 lb springs H.D. shocks
Rear	3,100 lb springs H.D. shocks
Permit Weight (lbs)	
Front	4,000
Rear	6,200
Tires	
Front	8.75 x 16.5F/9.50 x 16.5E
Rear	8.75 x 16.5 F/9.50 x 16.5E
Brakes	
Front	Power Disc
Rear	Power Drum
Steering	Power
Fuel Capacity (gals)	36
Electrical System	
Alternator (amps)	63/60 (117 optional)
Battery (amps-Hrs)	70 (85 optional)
Interior Lights	
Instrument & Controls	
Body Specifications	
Exterior Walls (Gauge & Material)	
Interior Walls (Gauge & Material)	
Insulation (Thickness & Material)	
Floor (Gauge & Material)	
Windows	Tinted
Lift Specifications	
Manufacturer & Model	Collins
Door Size (Height/Width)	not less 62" x 25"
Lift Dimensions (Length/Width)	42.5" x 32.5"
Automatic	Electric Hydraulic
Manual override	Included
Weight Capacity (lbs)	1100
Location of Controls	on a 6ft. cable
Platform Storage (Fold up/down)	Power
Wheelchair Securement Equipment	
Manufacturer	
Orientation of Chair when Secure	Forward or side facing
Part of Chair Secured	
Minimum Chair Width	
Maximum Chair Width	
Type of Operation	Front chassis supplied
Heater (Btu's)	Rear 39,500
Air Conditioning (Btu's)	
Seating Capacity	
With Lift	6 + 3 or 10 + 2 wheelchairs
Without Lift	9 - 12

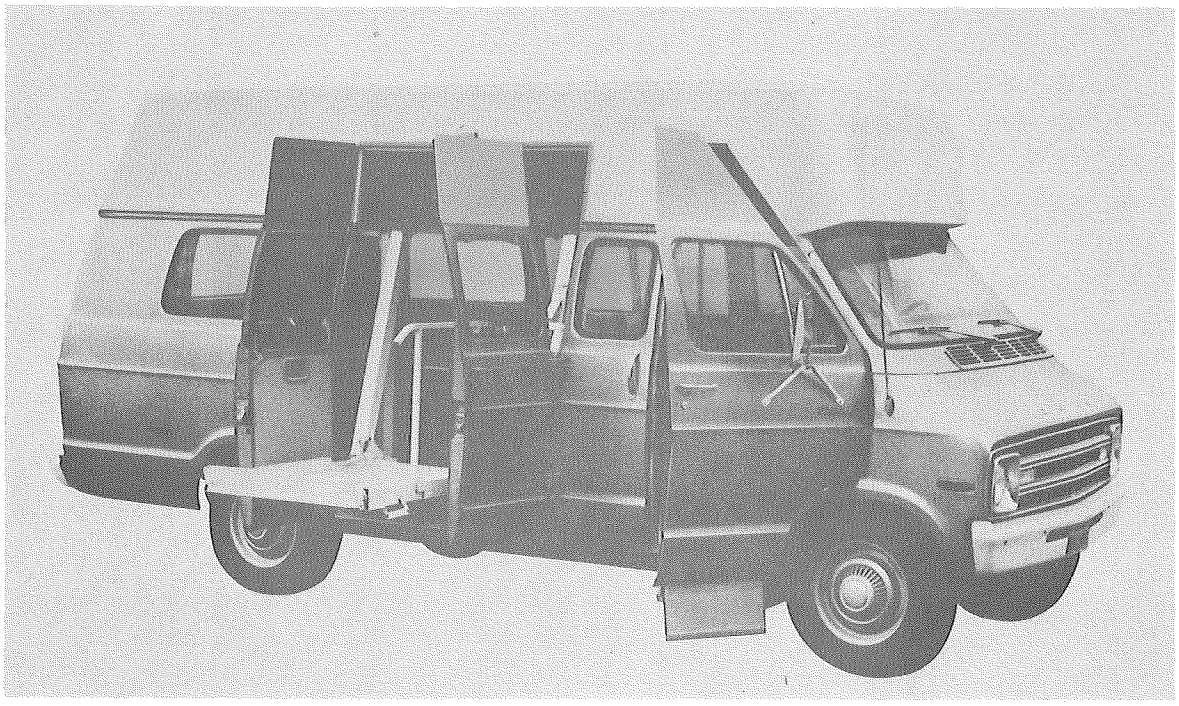


Figure 8. National Coach Corporation Paratransit -- Modified Van.

TABLE 9 WIDE-ONE COPORATION
SPECIFICATIONS FOR MODEL WO-1

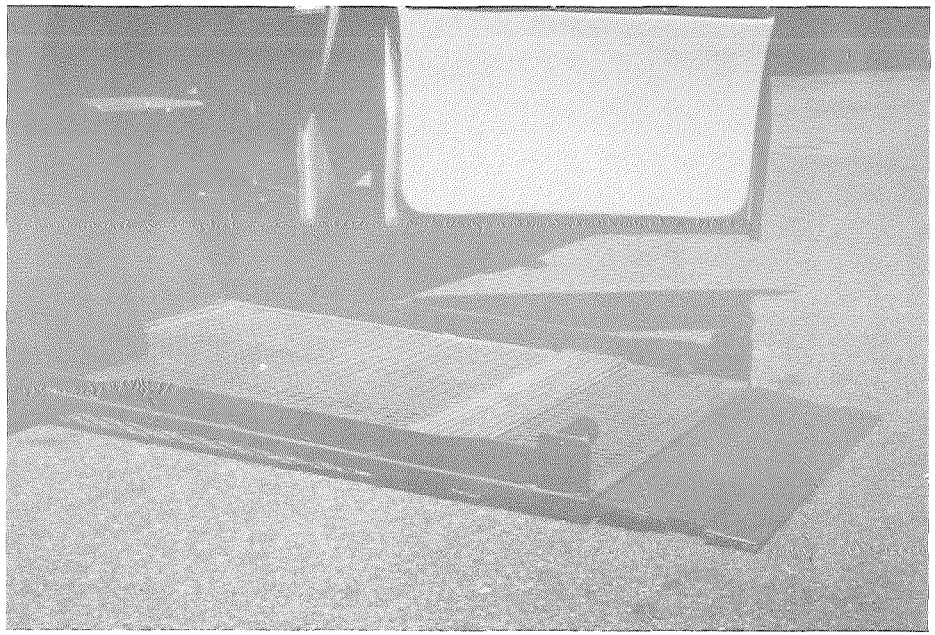
Manufacturer	Wide One Corporation
Vehicle (Name)	Wide One Model WO-1
Bus Size (Passenger Range)	14 - 19 passengers, 1 - 8 wheelchairs
Type of Vehicle	Modified Van
Approximate Cost (1980 Model)	$18,000 - $29,000
Vehicle Dimensions	
GVW (lbs)	9,000
Length (ins)	223.6
Width (ins)	94.5
Height (ins)	105
Wheelbase (ins)	127.6
Rear Track (ins)	80
Passenger Entrance	
Height (ins)	72
Width (ins)	31
Step Heights (ins)	
Ground to 1st	11
1st to 2nd	8
2nd to Aisle	8
Inside Width (ins)	82
Aisle Width (ins)	14 at knee, 17 at hip
Head Room Over Aisle	74
Chassis Specifications	Dodge B-300 Maxi Van
Engine Make	Chrysler
Engine Model	Gasoline
Number of Cylinders	V-8
Brake Horse Power	
Torque (ft-lbs)	
Bore/Stroke	
Displacement (ins)	360
Transmission	
Make	Chrysler
Model	3 sp.-automatic with aux. cooler
Suspension	
Front	H.D. springs, 1-3/16" shocks
Rear	Leaf springs, 1-3/16" shocks
Permit Weight (lbs)	
Front	4,000
Rear	6,200
Tires	
Front	8.75 x 16.5F, 12 ply steel radial
Rear	8.75 x 16.5F, 12 ply steel radial
Brakes	
Front	Power Disc 12.8" x 1.2"
Rear	Drum 3"
Steering	Power
Fuel Capacity (gals)	36
Electrical System	
Alternator (amps)	117
Battery (amps-Hrs)	85 main plus 85 lift auxiliary
Interior Lights	75" florescent each side, 2 dome
Instrument & Controls	full set, gauge type
Body Specifications	
Exterior Walls (Gauge & Material)	20 - steel
Interior Walls (Gauge & Material)	1/8" fiberglass
Insulation (Thickness & Material)	fiberglass
Floor (Gauge & Material)	1/2" plywood-carpet or rubber cover
Windows	Tinted, privacy passenger windows
Lift Specifications	
Manufacturer & Model	Wide One Lectralift
Door Size (Height/Width)	Fits into passenger entrance
Lift Dimensions (Length/Width)	42" x 30"
Automatic	All electric with tandem drive
Manual override	Emergency hand crank
Weight Capacity (lbs)	Rated 750, maximum 1200
Location of Controls	At lift
Platform Storage (Fold up/down)	Slides in to become bottom step (manual)
Wheelchair Securement Equipment	Buyer's option or:
Manufacturer	Aeroquip
Orientation of Chair when Secure	Forward or Side Facing
Part of Chair Secured	3 points-two wheels and opposite frame
Minimum Chair Width	none
Maximum Chair Width	30 in.
Type of Operation	manual
Heater (Btu's)	front and rear
Air Conditioning (Btu's)	front and rear, 30,000
Seating Capacity	
With Lift	16 plus driver
Without Lift	19 plus driver

Model WO-1

Model WO-1 Interior

Figure 9. Wide One Corporation Model WO-1 -- Modified Van.

Main Passenger Entrance



Main Passenger Entrance with Platform Wheelchair Lift. When stored (by sliding the lift under the vehicle) this lift acts as the lowest step in the entrance well.

Figure 10. Wide One Corporation Model WO-1 -- Modified Van.

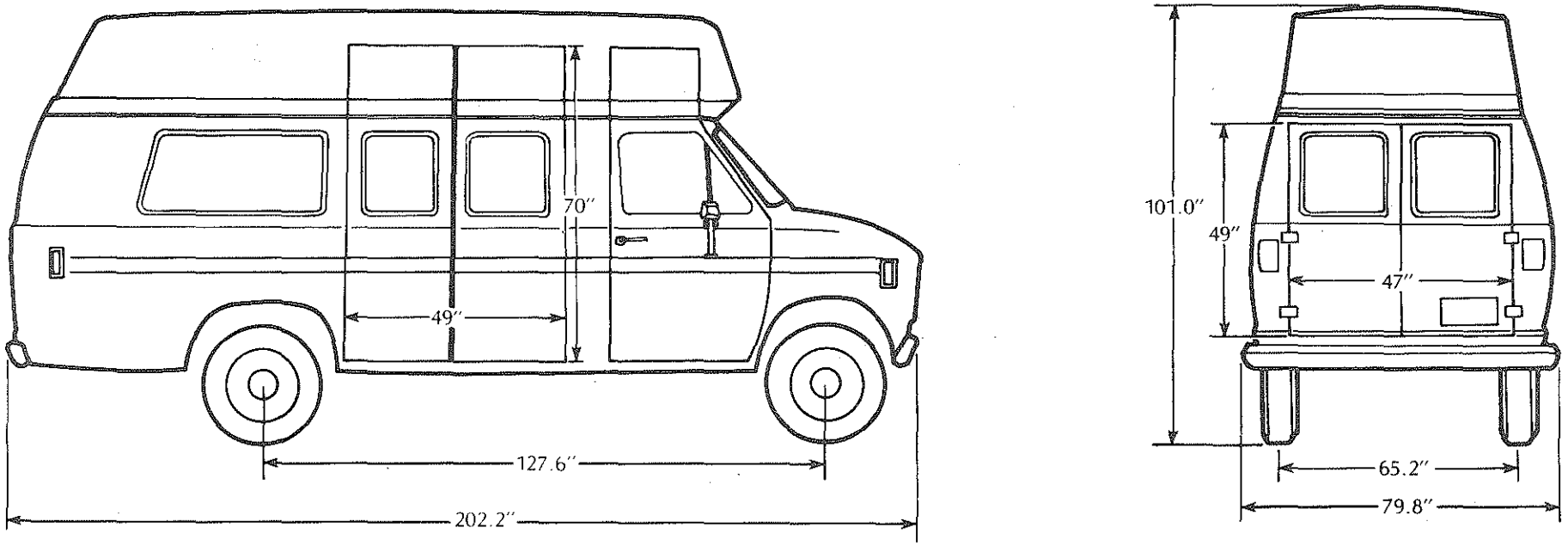


Figure 11. TYPICAL EXTERIOR DIMENSIONS FOR A MODIFIED VAN.

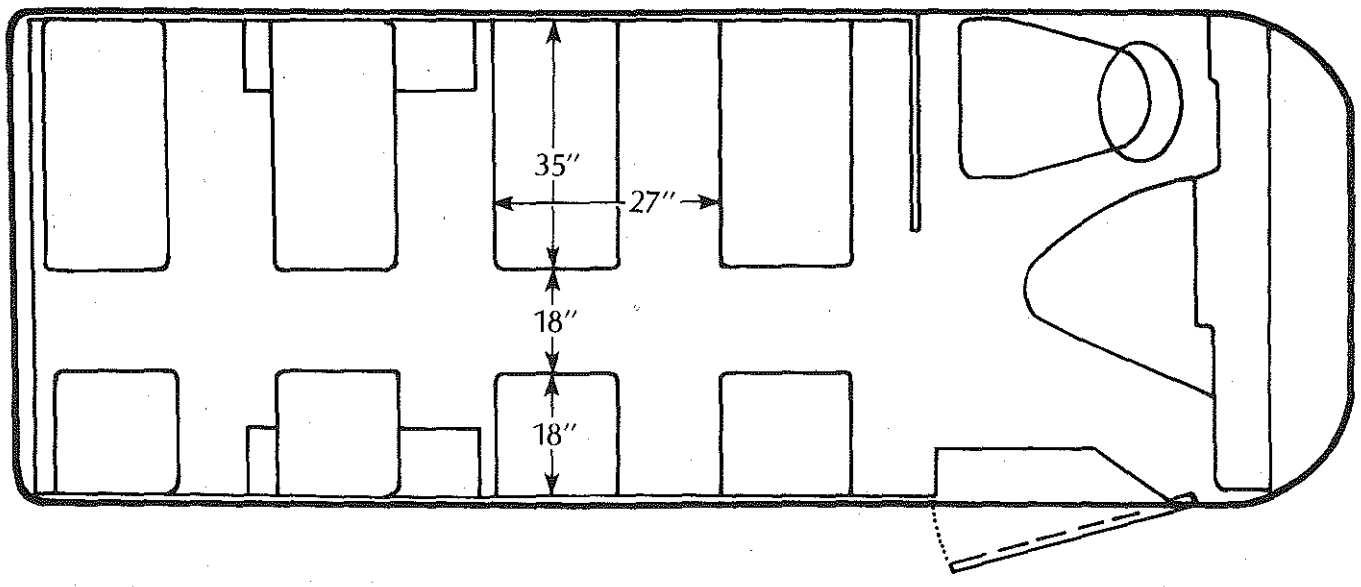


Figure 12. TYPICAL TRANSIT-TYPE SEATING ARRANGEMENT FOR 12 PASSENGER MODIFIED VAN WITHOUT LIFT.

TABLE 10

TYPICAL STANDARD AND OPTIONAL EQUIPMENT
AVAILABLE ON MODIFIED VANS

Standard Equipment	Optional Equipment
Power Steering	Air Conditioning -- Front and Rear
Power Front Disc Brakes	Wheelchair Lift or Ramp
350 or 360 V-8 Gasoline Engine	Wheelchair Securement Devices
3 Speed Automatic Transmission	Folding Passenger Seats (Flip-Type)
9000 lb Gross Vehicle Weight	Removable Seats ("Quick Release")
Heavy Duty Shock Absorbers	Roof Vents
21 to 36 Gallon Fuel Tank	Increased Capacity Cooling System
Heavy Duty Battery and Alternator	Increased Output Passenger Heaters
Sliding Transit-Type Tinted Windows	Increased Output Batteries and Alternators (recommended with wheelchair lifts)
Transit-Type Neoprene Seats	Larger C.I.D. Engine
Rubber-Covered Plywood Floor	Rustproofing
Front and Rear Heaters	AM/FM Radio
Insulation in Walls and Roof	Citizens' Band Radios
Windshield Defrosting and Defogging System	Destination Signs
Exterior Lighting Meeting Federal Motor Vehicle Safety Standards	Fire Extinguishers
Passenger Entrance and Emergency Exit	First Aid Kit
Interior and Exterior Rear View Mirrors	Emergency Road-Aid Kit
Driver Controlled Passenger Lighting	

in a van in 1980 was between $2,000 and $4,000 and air conditioners range in price from $1,000 to $2,000. Expensive optional equipment may increase operating costs by increasing gasoline consumption through increased vehicle weight or increased load on the engine. These options will also increase maintenance costs because parts will wear out and break down. The practical need for optional equipment should be given careful consideration.

Under day to day use in transit programs, modified vans have been found to last for about five or six years. This, of course, depends on many factors, including type of operation (city vs. rural), type of roads encountered, climate conditions, preventive maintenance program, driver training and experience. Most important to the extended life of a vehicle is the use of a preventive maintenance program.

Seating Arrangements

Modified vans can usually seat nine to twelve passengers depending on the seating arrangement used. An extended width body on a modified van will allow for seating up to sixteen passengers. Typical seating arrangements available for modified vans are shown in Figures 12 through 18. There are advantages and disadvantages for both the perimeter seating (aisle-facing) arrangement and the forward facing arrangement. Aisle-facing seats are easier to access for passengers with walkers or crutches and allow for wider aisle ways. However, acceleration, deceleration, and turning maneuvers tend to be uncomfortable for passengers in aisle-facing seats, especially for elderly and handicapped passengers. Adding accommodations for each wheelchair will generally eliminate two passenger seats unless the flip-type seats are used with wheelchair restraints. The side-mounted wheelchair lift also eliminates two passenger seats, hence adding a lift and accommodations for two wheelchairs reduces ambulatory seating to six or eight.

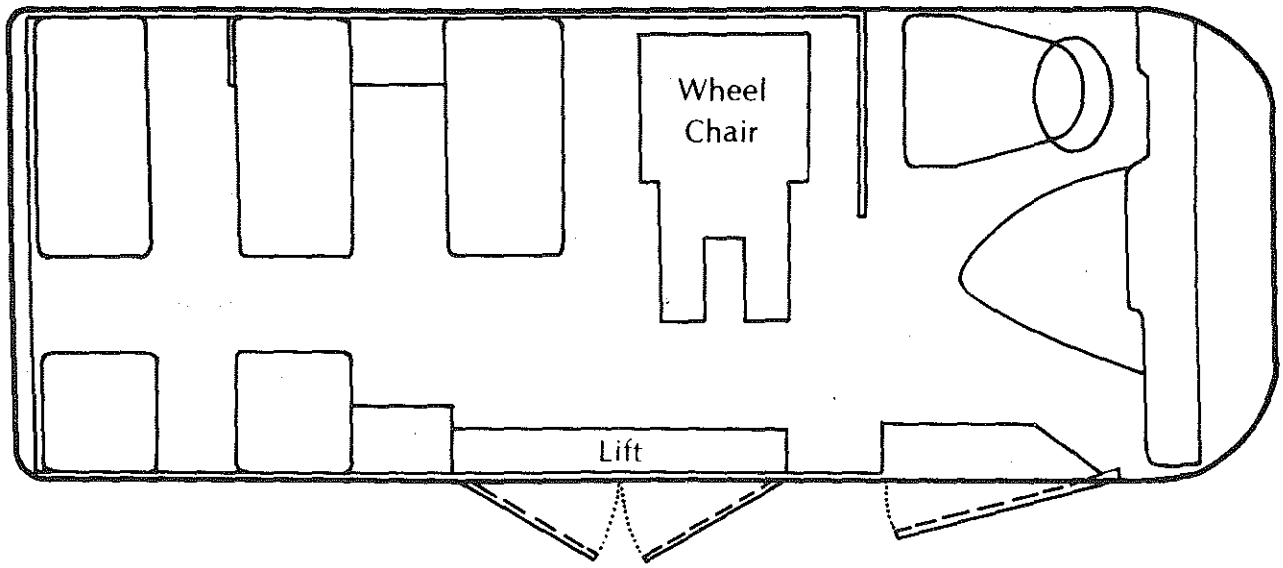


Figure 13. TYPICAL SEATING ARRANGEMENT FOR MODIFIED VAN: EIGHT STANDARD SEATS PLUS ONE WHEELCHAIR POSITION.

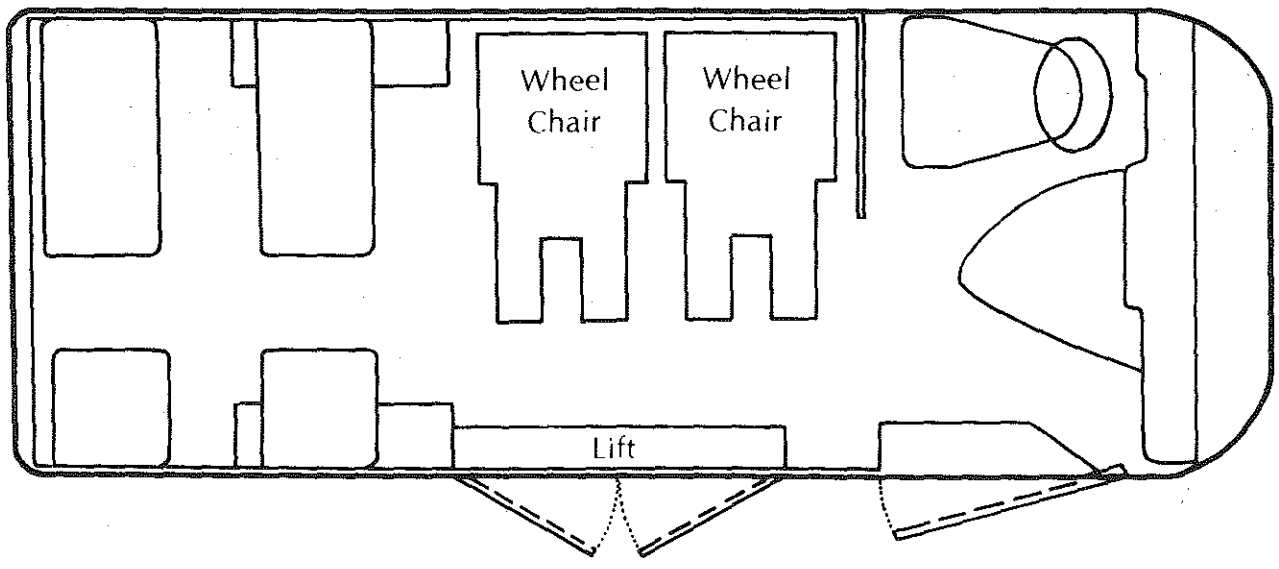


Figure 14. TYPICAL SEATING ARRANGEMENT FOR MODIFIED VAN: SIX STANDARD SEATS PLUS TWO WHEELCHAIR POSITIONS.

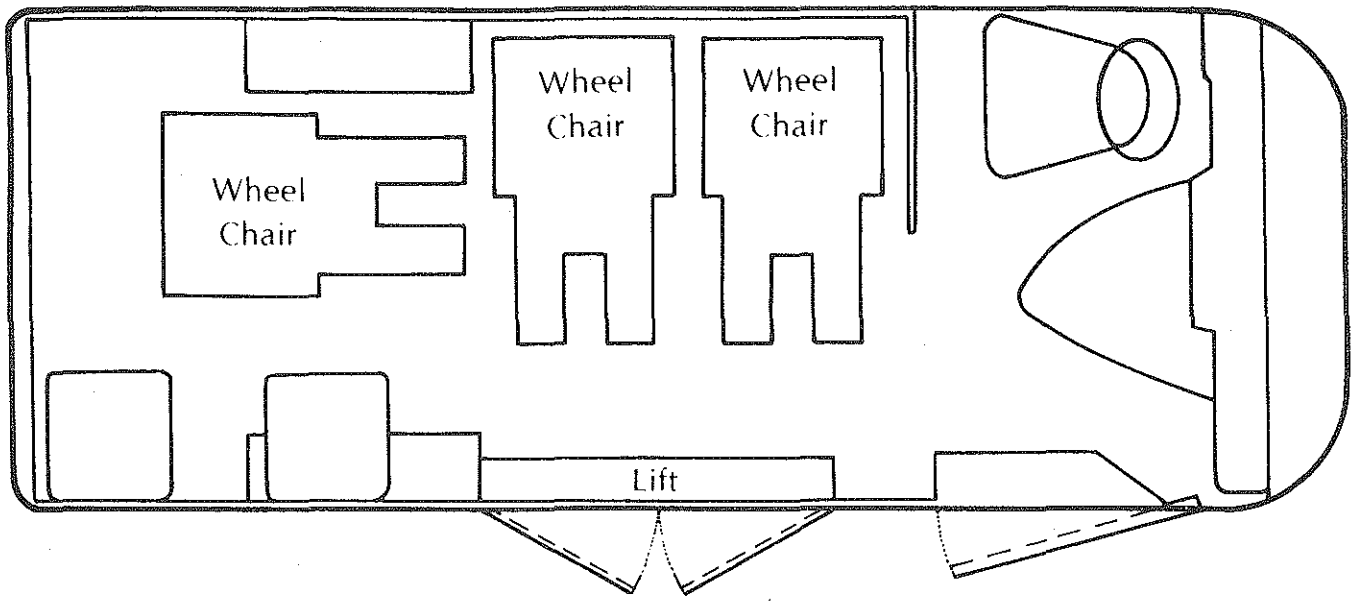


Figure 15. TYPICAL SEATING ARRANGEMENT FOR MODIFIED VAN: TWO STANDARD SEATS PLUS THREE WHEELCHAIRS.

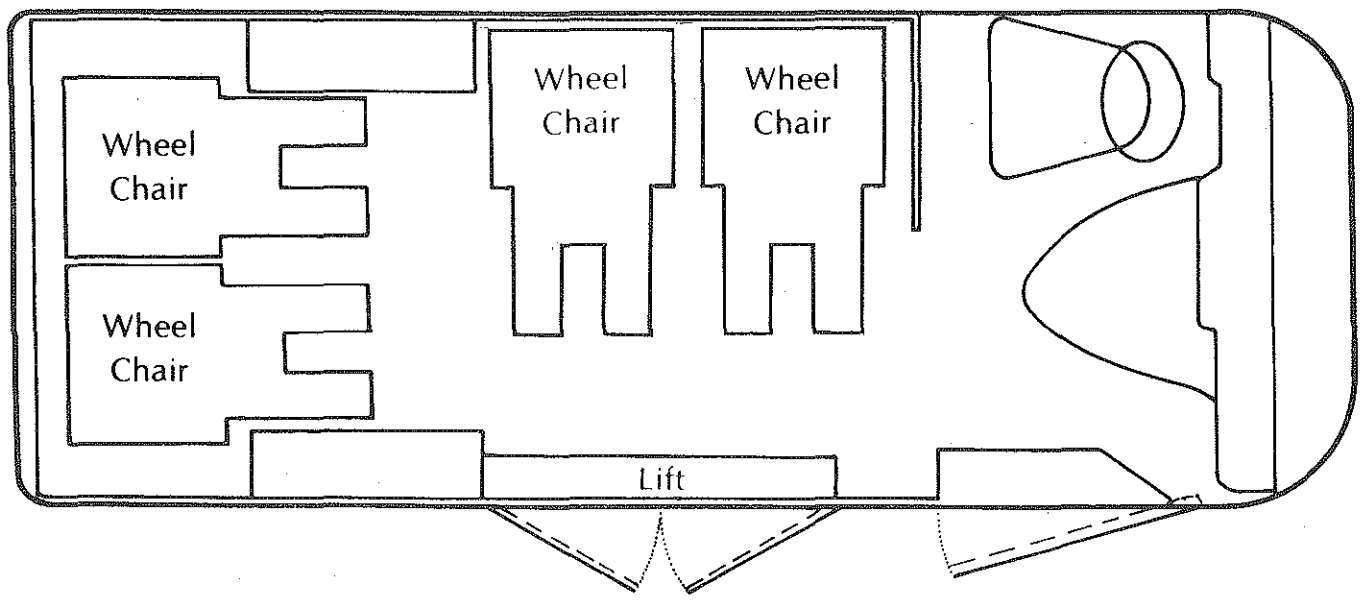
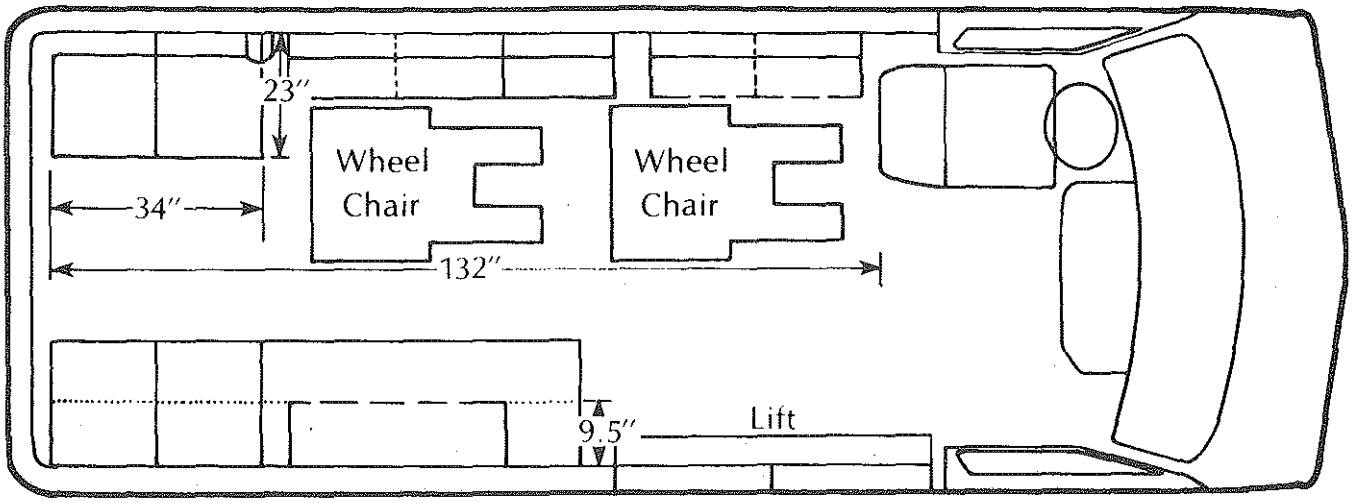
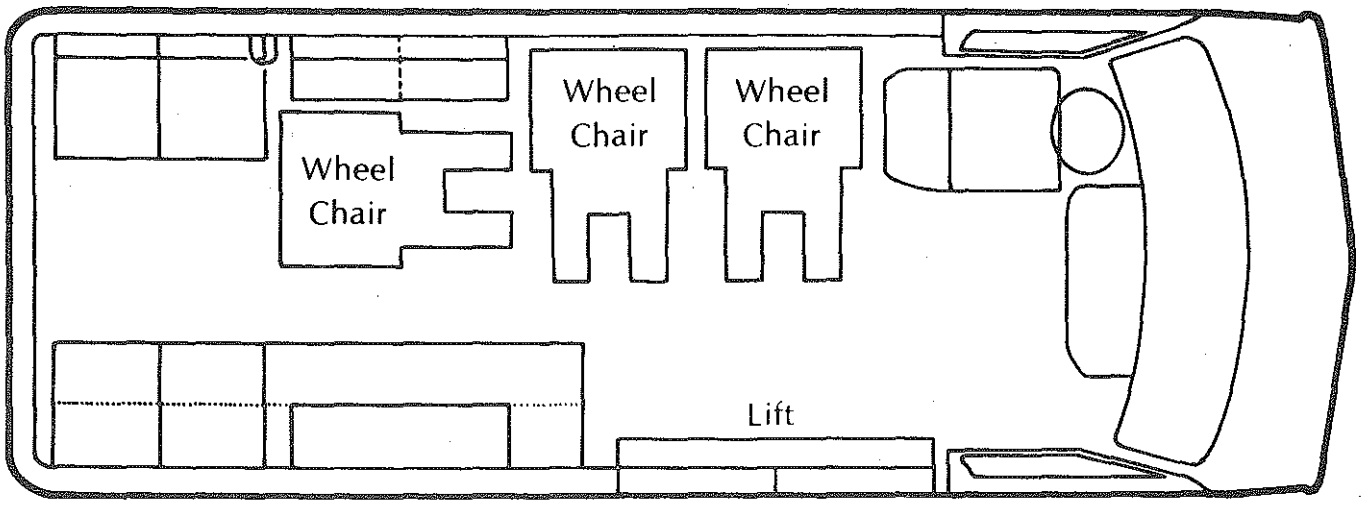


Figure 16. TYPICAL MODIFIED VAN WITH FOUR WHEELCHAIR POSITIONS.

Figure 17. TYPICAL MODIFIED VAN WITH PERIMETER "FLIP-TYPE" SEATING.



TWO WHEELCHAIR POSITIONS



THREE WHEELCHAIR POSITIONS

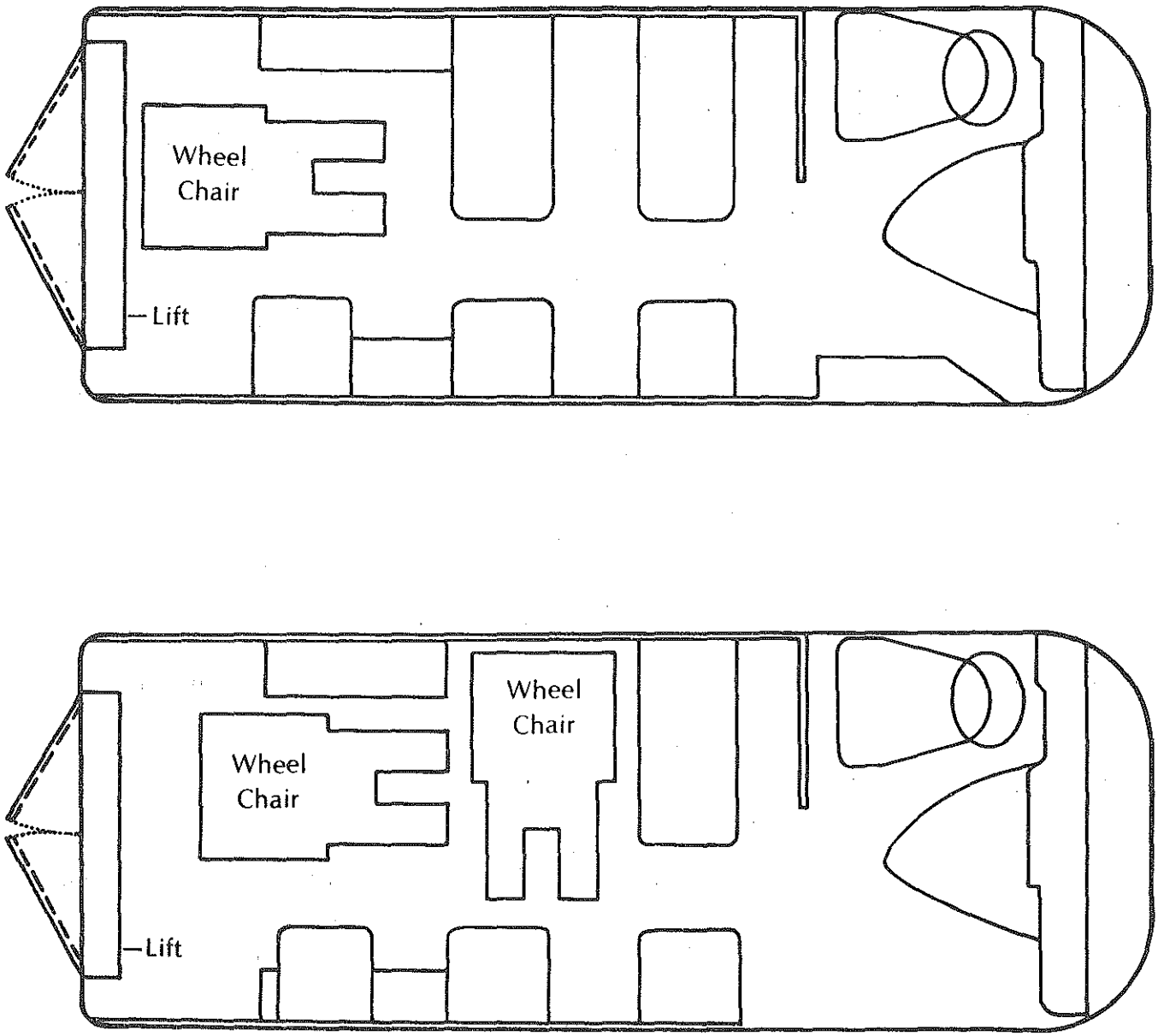


Figure 18. SEATING ARRANGEMENTS FOR MODIFIED VAN WITH LIFT AT REAR OF VEHICLE.

Rear mounted wheelchair lifts are available that are stored either inside or outside the vehicle. The rear-mounted lifts require the loss of three standard seats for the first wheelchair plus two additional seats for each additional wheelchair position.

It should be noted that for the seating arrangement shown with four wheelchair positions (Figure 16), the two positions at the rear of the vehicle are difficult to access when both positions are used simultaneously, and may be functionally realistic only on the wider-body modified van. When more than two wheelchairs are to be carried at the same time the rule is first on last off.

The flexibility of a light-weight accessible bus to carry both ambulatory and wheelchair passengers can be greatly enhanced through the use of folding (flip-type) or removable ("quick-release") seats. Either the removable or folding seat can be coordinated with wheelchair restraints. Folding seats are available for both single or double occupancy, and can be either forward or aisle-facing. Removable seats are usually double occupancy, and are fastened with brackets to the floor of the vehicle. Removable seats can also be either forward or aisle-facing.

Small Buses

What have become known in the transit industry as small buses are vehicles built on chassis designed for light trucks. Hence, these vehicles are often referred to as "body-on-chassis" vehicles. The chassis usually used are produced by Chevrolet, Dodge, Ford and GMC. Photographs of several typical small buses suitable for transporting elderly and handicapped persons are shown in Figures 19 through 26. The manufacturers' specifications for these small buses, shown in Tables 11 through 15, also indicate the manner in which these vehicles are normally designed and equipped. Some manufacturers are willing to make limited modifications to their standard designs based on procurement specifications supplied by the purchaser.

TABLE 11 CARPENTER BODY WORKS
SPECIFICATIONS FOR THE CADET CV

Manufacturer	Carpenter Body Works
Vehicle (Name)	Cadet CV
Bus Size (Passenger Range)	10 - 18 / 10 - 22
Type of Vehicle	Small Bus
Approximate Cost (1980 Model)	$18,000 - $24,000/$22,000 - $28,000
Vehicle Dimensions	
GVW (lbs)	11,500/14,500
Length (ins)	224/252
Width (ins)	82
Height (ins)	112/114
Wheelbase (ins)	125
Rear Track (ins)	82.5/85
Passenger Entrance	
Height (ins)	78
Width (ins)	29
Step Heights (ins)	
Ground to 1st	14
1st to 2nd	7 / 8
2nd to Aisle	7 / 8
Inside Width (ins)	79
Aisle Width (ins)	19" with 30" seats
Head Room Over Aisle	78
Chassis Specifications	Chevrolet
Engine Make	Chevrolet
Engine Model	Gasoline
Number of Cylinders	V-8
Brake Horse Power	165
Torque (ft-lbs)	255
Bore/Stroke	4.00/3.48
Displacement (ins)	350
Transmission	
Make	Chevrolet
Model	3-sp. Automatic
Suspension	
Front	4,500 lb. coil springs
Rear	5,000 lb. leaf springs
Permit Weight (lbs)	
Front	4,000/4,500
Rear	7,800/11,000
Tires	
Front	7.50 x 16.0 D/8.00 x 19.5 E
Rear	Dual 7.50 x 16.0 D/8.00 x 19.5 E
Brakes	
Front	Power Disc
Rear	Power Disc
Steering	Power
Fuel Capacity (gals)	30
Electrical System	
Alternator (amps)	63/80 (105 available)
Battery (amps-Hrs)	80
Interior Lights	Included
Instrument & Controls	Included
Body Specifications	
Exterior Walls (Gauge & Material)	20-steel
Interior Walls (Gauge & Material)	22-steel
Insulation (Thickness & Material)	1.5" Fiberglass
Floor (Gauge & Material)	14-steel
Windows	Aluminum

Lift Specifications		
Manufacturer & Model	Reb	Reb/Collins
Door Size (Height/Width)	63" x 33"	63 x 39.25"
Lift Dimensions (Length/Width)	42" x 27"	41.5"x30"/42.5"x26.5"
Automatic	Electric-Hydraulic	
Manual override	Included	Included/Optional
Weight Capacity (lbs)	1,000	
Location of Controls	6 ft. cable at lift	
Platform Storage (Fold up/down)	power	

Wheelchair Securement Equipment	
Manufacturer	Collins
Orientation of Chair when Secure	Side
Part of Chair Secured	Wheels
Minimum Chair Width	
Maximum Chair Width	
Type of Operation	Automatic or Manual
Heater (Btu's)	75,000/150,000 available
Air Conditioning (Btu's)	Available
Seating Capacity	
With Lift	10+2 or 6+3/14+2 or 8+4 wheelchairs
Without Lift	up to 18/up to 22

Cadet "CV" Standard Model

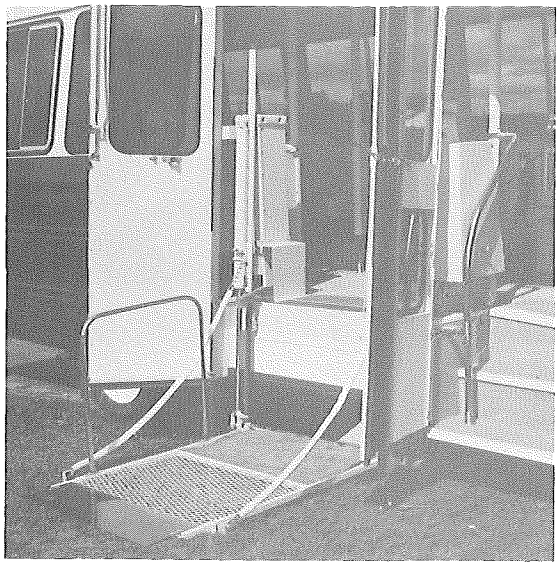
Lift Equipped

Figure 19. Carpenter Cadet "CV" -- Small Bus.

TABLE 12 COACH AND EQUIPMENT SALES CORPORATION SPECIFICATIONS FOR THE FORTIBUS

Manufacturer	Coach and Equipment Sales Corp.
Vehicle (Name)	Fortibus
Bus Size (Passenger Range)	12 - 21
Type of Vehicle	Small Bus
Approximate Cost (1980 Model)	$21,500 - $34,000
Vehicle Dimensions	
GVW (lbs)	
Length (ins)	233/233/253/249/262
Width (ins)	80/90/90/90/90
Height (ins)	105/107/107/107/107 add 10" with air conditioning
Wheelbase (ins)	138/138/158/146/163
Rear Track (ins)	
Passenger Entrance	
Height (ins)	79
Width (ins)	28/36/36/36/36
Step Heights (ins)	
Ground to 1st	10.5/10.75/10.75/10.75/10.75
1st to 2nd	7.75
2nd to Aisle	7.75
Inside Width (ins)	75.5/85.5/85.5/85.5/85.5
Aisle Width (ins)	
Head Room Over Aisle	74/76/76/76/76
Chassis Specifications	Ford/Ford/Ford/GMC or/Dodge/Chevy
Engine Make	
Engine Model	Gasoline
Number of Cylinders	V-8
Brake Horse Power	
Torque (ft-lbs)	
Bore/Stroke	
Displacement (ins)	351/351/351/350/360
Transmission	
Make	Ford/Ford/Ford/Chevy/Dodge
Model	3 sp. Automatic
Suspension	
Front	
Rear	
Permit Weight (lbs)	
Front	4,500/ /4,200/4,200/3,900/4,000
Rear	11,000/ /7,400/8,000/7,500/8,000
Tires	
Front	8.00 x 16.5 E or 8.75 x 16.5 E
Rear	Duals 8.00 x 16.5 or 8.75 x 16.5 E
Brakes	
Front	Power Disc
Rear	Drum
Steering	Power
Fuel Capacity (gals)	42.5/42.5/33/50
Electrical System	/ /100/100/105/117
Alternator (amps)	/ /80/80/80/85
Battery (amps-Hrs)	
Interior Lights	
Instrument & Controls	
Body Specifications	
Exterior Walls (Gauge & Material)	20 - steel
Interior Walls (Gauge & Material)	
Insulation (Thickness & Material)	
Floor (Gauge & Material)	0.5" plywood-Rubber Cover
Windows	
Lift Specifications	
Manufacturer & Model	Coach & Equipment
Door Size (Height/Width)	79 x 49
Lift Dimensions (Length/Width)	44 x 34
Automatic	Electric-Hydraulic
Manual override	Available
Weight Capacity (lbs)	750
Location of Controls	
Platform Storage (Fold up/down)	Manual - Power Optional
Wheelchair Securement Equipment	
Manufacturer	
Orientation of Chair when Secure	Side Facing
Part of Chair Secured	Wheels
Minimum Chair Width	
Maximum Chair Width	
Type of Operation	
Heater (Btu's)	
Air Conditioning (Btu's)	18,000; 36,000 available
Seating Capacity	
With Lift	8+2/9+2/16+2/16+2/16+2 wheelchairs
Without Lift	12/17/20/20/21

Fortibus Exterior



With Wheelchair Lift

Fortibus Interior

Figure 20. Coach and Equipment Sales Corporation Fortibus -- Small Bus.

TABLE 13 SUPERIOR DIVISION OF THE SHELLER GLOBE CORPORATION SPECIFICATIONS FOR THE TRANSLINER

Manufacturer	Superior Division Sheller Globe Corp. Transliner
Vehicle (Name)	700/800
Bus Size (Passenger Range)	up to 16 / up to 20
Type of Vehicle	Small Bus
Approximate Cost (1980 Model)	$30,000 - $35,000
Vehicle Dimensions	
GVW (lbs)	14,500/17,280 or 18,000
Length (ins)	252 or 280/252 or 280
Width (ins)	84 / 96
Height (ins)	
Wheelbase (ins)	133 or 157/137 or 167*
Rear Track (ins)	
Passenger Entrance	
Height (ins)	
Width (ins)	
Step Heights (ins)	
Ground to 1st	
1st to 2nd	
2nd to Aisle	
Inside Width (ins)	79 / 90
Aisle Width (ins)	
Head Room Over Aisle	78 / 78
Chassis Specifications	Chevy / GMC
Engine Make	or GMC
Engine Model	Gasoline/Gasoline or Diesel
Number of Cylinders	V-8 / V-8
Brake Horse Power	
Torque (ft-lbs)	
Bore/Stroke	
Displacement (ins)	350/350 or 4-53T Diesel
Transmission	
Make	Chevrolet/Allison
Model	3sp automatic/automatic or manual
Suspension	
Front	
Rear	
Permit Weight (lbs)	
Front	4,500/7,000
Rear	11,000/15,000 or 18,500
Tires	
Front	
Rear	Duals
Brakes	
Front	Power
Rear	
Steering	Power
Fuel Capacity (gals)	30 to 50 gals
Electrical System	
Alternator (amps)	130
Battery (amps-Hrs)	180
Interior Lights	
Instrument & Controls	
Body Specifications	
Exterior Walls (Gauge & Material)	20 - steel
Interior Walls (Gauge & Material)	20 - steel
Insulation (Thickness & Material)	1.5" Fiberglass
Floor (Gauge & Material)	0.625" plywood
Windows	
Lift Specifications	
Manufacturer & Model	Collins or Reb
Door Size (Height/Width)	
Lift Dimensions (Length/Width)	Varies with model
Automatic	Electric/Hydraulic
Manual override	Included
Weight Capacity (lbs)	700 to 1,000
Location of Controls	at lift with Master shut-off in dash
Platform Storage (Fold up/down)	
Wheelchair Securement Equipment	
Manufacturer	Telloc/Collins/Framelock
Orientation of Chair when Secure	Side/Side/Side or Front
Part of Chair Secured	Wheels/Wheels/Frame
Minimum Chair Width	22 / 22 / Unlimited
Maximum Chair Width	28 / 28
Type of Operation	manual/semi auto/manual
Heater (Btu's)	Front 60,500 Rear 81,200
Air Conditioning (Btu's)	up to 60,000 available
Seating Capacity	
With Lift	9 + 2 or 12 + 2/12 + 2 or 16 + 2
Without Lift	up to 16 / up to 20

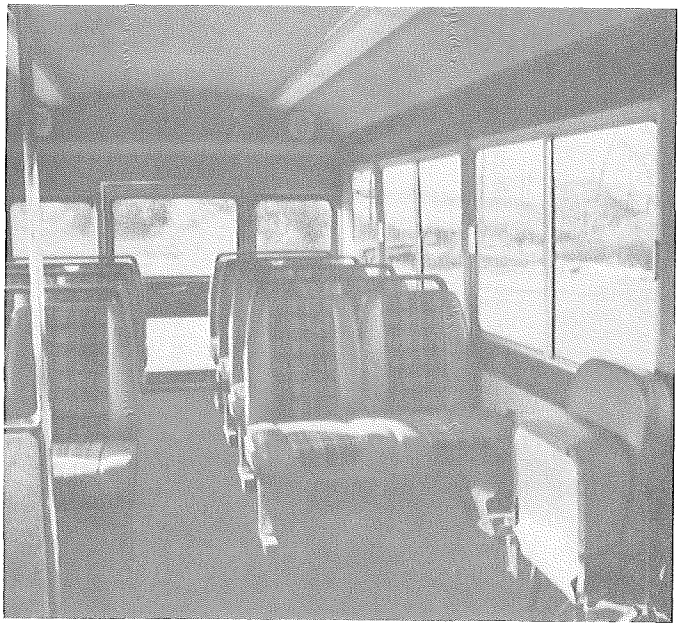
*125" also available

Transliner 700

Transliner 700 Interior

Figure 21. Superior Division of the Sheller-Globe Corporation Transliner 700 -- Small Bus.

Transliner 800



Transliner 800 Interior

Figure 22. Superior Division of the Sheller-Globe Corporation Transliner 800 -- Small Bus.

TABLE 14 WAYNE CORPORATION
SPECIFICATIONS FOR THE BUSETTE AND TRANSETTE

Manufacturer	Wayne Corporation
Vehicle (Name)	Busette / Transette
Bus Size (Passenger Range)	up to 20
Type of Vehicle	Small Bus
Approximate Cost (1980 Model)	$14,000 - $16,000/$21,000 - $26,000
Vehicle Dimensions	
GVW (lbs)	10,000 or 8,900/10,000
Length (ins)	210.5
Width (ins)	94.25
Height (ins)	93.5
Wheelbase (ins)	125
Rear Track (ins)	92.7
Passenger Entrance	
Height (ins)	54
Width (ins)	35
Step Heights (ins)	
Ground to 1st	14.5
1st to 2nd	7.5
2nd to Aisle	4.4
Inside Width (ins)	89 at seat cushion level
Aisle Width (ins)	14 or 17 Depends on seating
Head Room Over Aisle	63 / 75
Chassis Specifications	Chevrolet & GMC
Engine Make	Chevrolet
Engine Model	Gasoline
Number of Cylinders	V-8
Brake Horse Power	165 or 180
Torque (ft-lbs)	255 or 310
Bore/Stroke	4.00/3.48 or 4.125/3.75
Displacement (ins)	350 or 400
Transmission	
Make	Chevrolet
Model	3 sp. Automatic
Suspension	
Front	Independent Coil Spring
Rear	Full Floating Design
Permit Weight (lbs)	
Front	3,900 or 3,400 / 3,900
Rear	7,200 or 6,200 / 7,200
Tires	
Front	8.00 x 16.5 D
Rear	Dual 8.00 x 16.5 D
Brakes	
Front	12.5" x 1.53" Disc
Rear	13.00" x 3.5" Drum
Steering	Power
Fuel Capacity (gals)	33
Electrical System	
Alternator (amps)	63 or 130 (Depends on Accessories)
Battery (amps-Hrs)	80
Interior Lights	Stepwell & Dome
Instrument & Controls	
Body Specifications	
Exterior Walls (Gauge & Material)	18 - steel
Interior Walls (Gauge & Material)	16 and 24 steel
Insulation (Thickness & Material)	1.5" fiberglass
Floor (Gauge & Material)	0.625" Plywood-Rubber Cover
Windows	Sliding-Tinted
Lift Specifications	
Manufacturer & Model	Collins
Door Size (Height/Width)	52" x 50"
Lift Dimensions (Length/Width)	41.0" x 29.5"
Automatic	Electric-Hydraulic
Manual override	Included
Weight Capacity (lbs)	1100
Location of Controls	6 Ft. Cable
Platform Storage (Fold up/down)	Power
Wheelchair Securement Equipment	
Manufacturer	Wayne
Orientation of Chair when Secure	Side, Front, Rear
Part of Chair Secured	Wheels
Minimum Chair Width	19"
Maximum Chair Width	24" - outside of wheels*
Type of Operation	Manual
Heater (Btu's)	Front - Chassis Supplied Rear - 35,100
Air Conditioning (Btu's)	
Seating Capacity	
With Lift	11 - 15
Without Lift	up to 20

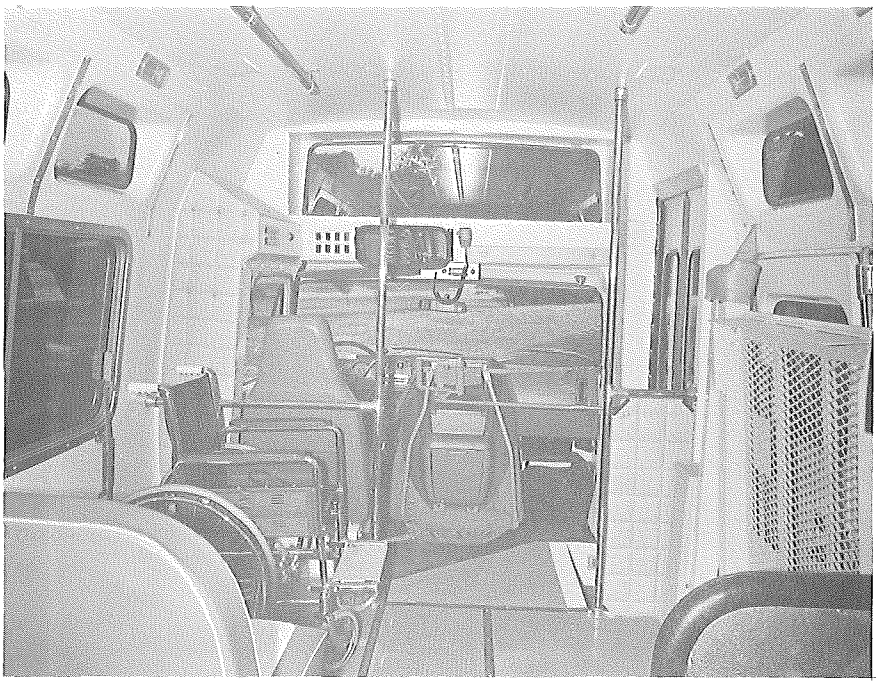
* Optional manufacturers equipment is available to accommodate all chair widths.

Busette With Wheelchair Lift

Busette Interior With Wheelchair

Figure 23. Wayne Corporation Busette -- Small Bus.

Transette With Wheelchair Lift



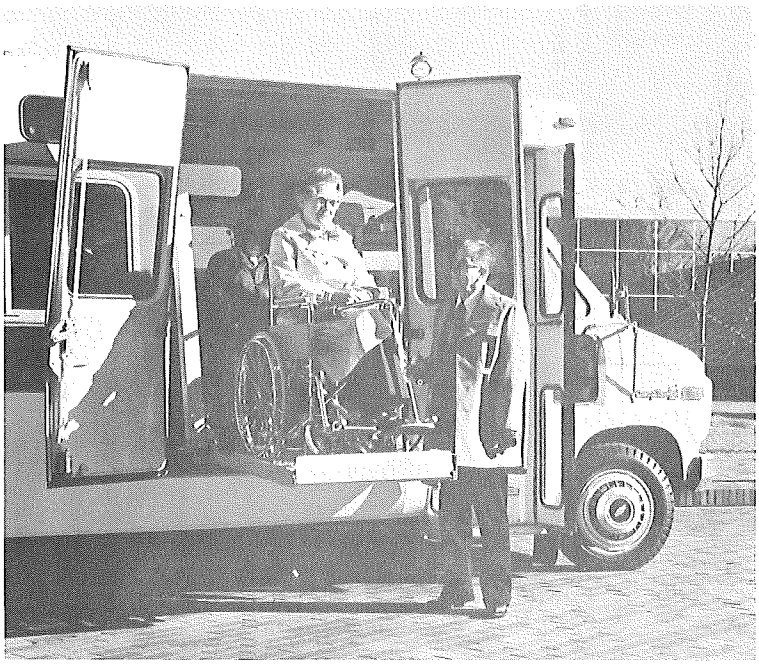
Transette Interior With Wheelchair Lift

Figure 24. Wayne Corporation Transette -- Small Bus.

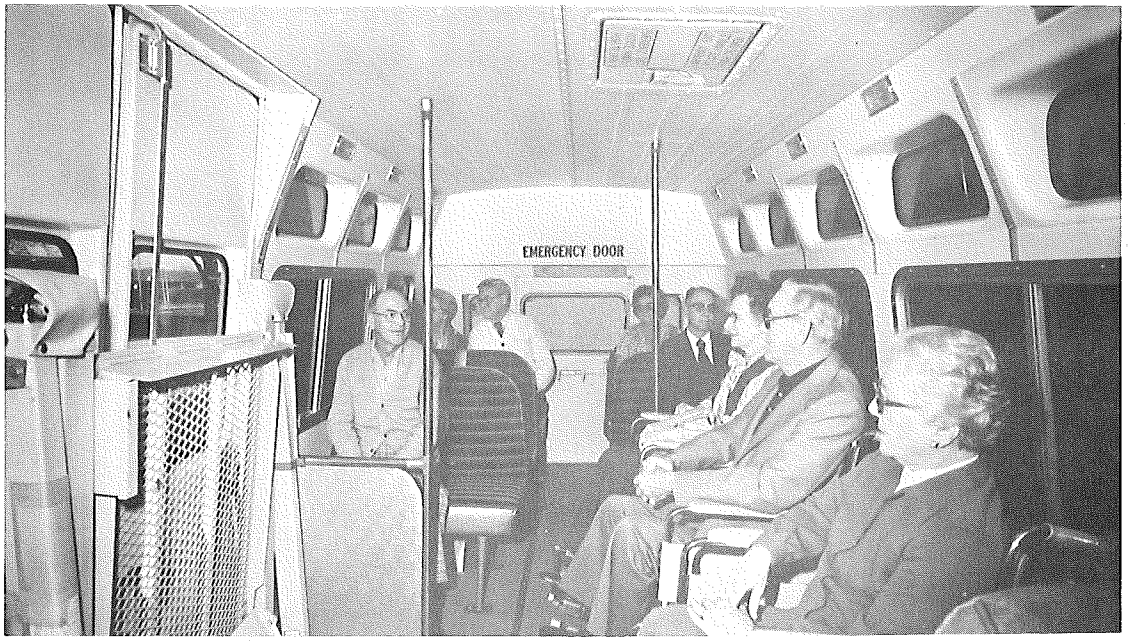
TABLE 15 WAYNE CORPORATION
SPECIFICATIONS FOR THE TRANSETTE XT

Manufacturer	Wayne Corporation
Vehicle (Name)	Transette XT
Bus Size (Passenger Range)	up to 20
Type of Vehicle	Small Bus
Approximate Cost (1980 Model)	$28,000 - $34,000
Vehicle Dimensions	
GVW (lbs)	11,000
Length (ins)	245
Width (ins)	93.44
Height (ins)	107.70
Wheelbase (ins)	157
Rear Track (ins)	82.7
Passenger Entrance	
Height (ins)	79
Width (ins)	31.42
Step Heights (ins)	
Ground to 1st	11
1st to 2nd	8
2nd to Aisle	8
Inside Width (ins)	89 at seat cushion level
Aisle Width (ins)	17
Head Room Over Aisle	75.30
Chassis Specifications	Chevrolet
Engine Make	Chevrolet
Engine Model	Gasoline
Number of Cylinders	V-8
Brake Horse Power	165
Torque (ft-lbs)	255
Bore/Stroke	4.00/3.48
Displacement (ins)	350
Transmission	
Make	Chevrolet
Model	3-sp. automatic
Suspension	
Front	Independent Coil Spring
Rear	Full Floating Design
Permit Weight (lbs)	
Front	4,000
Rear	7,500
Tires	
Front	8.75 x 16.5 D
Rear	Dual 8.75 x 16.5 D
Brakes	
Front	12.5" x 1.53" Disc
Rear	13.00" x 2.5" Drum
Steering	Power
Fuel Capacity (gals)	40
Electrical System	
Alternator (amps)	63 or 130 (Depends on Accessories)
Battery (amps-Hrs)	50 amp @ 20 amps./hr. rate
Interior Lights	Stepwell and Dome
Instrument & Controls	
Body Specifications	
Exterior Walls (Gauge & Material)	18 - Steel
Interior Walls (Gauge & Material)	16 and 24 Steel
Insulation (Thickness & Material)	1.5" Fiberglass
Floor (Gauge & Material)	0.375" Plywood-Rubber Cover
Windows	Sliding Tinted
Lift Specifications	
Manufacturer & Model	Collins
Door Size (Height/Width)	52" x 50" or 70" x 50"
Lift Dimensions (Length/Width)	41.0" x 29.5"
Automatic	Electric-Hydraulic
Manual override	Included
Weight Capacity (lbs)	1100
Location of Controls	6 Ft. Cable
Platform Storage (Fold up/down)	Power
Wheelchair Securement Equipment	
Manufacturer	Wayne
Orientation of Chair when Secure	Side, Front, Rear
Part of Chair Secured	Wheels
Minimum Chair Width	19"
Maximum Chair Width	20" - outside of wheels*
Type of Operation	Manual
Heater (Btu's)	Front - Chassis supplied Rear - 35,100
Air Conditioning (Btu's)	
Seating Capacity	
With Lift	11 to 17
Without Lift	up to 20

* Optional manufacturers equipment is available to accommodate all chair widths.

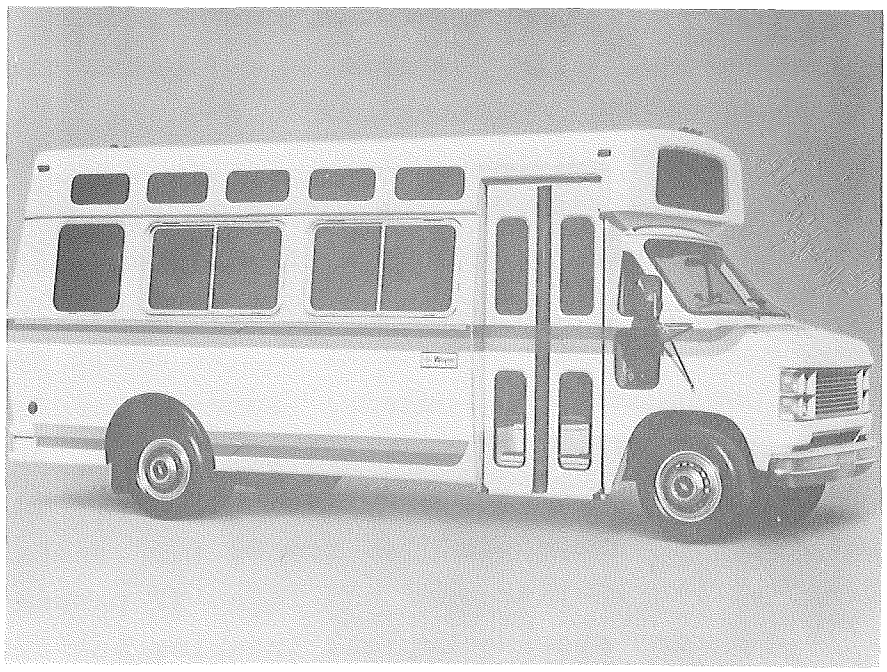


Transette XT With Wheelchair Lift



Transette XT Interior With Wheelchair Lift

Figure 25. Wayne Corporation Transette XT -- Small Bus.



Transette XT Standard Entrance

Transette XT Standard Interior

Figure 26. Wayne Corporation Transette XT -- Small Bus.

If particular aspects of a vehicle do not suit an operator's service needs, it may be possible to have them changed by the vehicle manufacturer. Alterations in design, however, may result in a higher purchase price.

As shown in Figure 27, the add-on body of these vehicles is typically constructed around a steel frame added to the chassis. Often these vehicles are very similar in construction to school buses, and in most cases can be built according to school bus construction standards. Several manufacturers of typical small buses are listed in Table 16.

Small buses are larger than modified vans and can carry more passengers. These vehicles are of two general size categories--12 to 16 passenger and 16 to 22 passenger. Schematic diagrams showing typical interior and exterior dimensions of a 12 and 20 passenger small bus are shown in Figures 28 through 31. Because of the increased size of these vehicles, they can more easily accommodate wheelchair passengers, or a mix of wheelchair and ambulatory passengers. Table 17 gives a comparison of the relative size of standard production vans, modified vans, and small buses.

The increased size of the small buses does limit road maneuverability somewhat compared to the van or the modified van. However, these vehicles are still small enough that this does not usually represent a problem.

Typical standard and optional equipment is virtually the same as for the modified vans, as shown in Table 18. However, standard equipment does vary between manufacturers, and careful consideration should be given to the practical need for optional equipment. Manufacturers offer a selection of chassis type and wheelbase, with the gross vehicle weight ranging from about 10,000 pounds up to 18,000 pounds for vehicles with a seating capacity of 22 or less. Although gasoline engines are more common, at least one manufacturer offers a small bus with a diesel engine.

Small buses also usually offer a wide variety of interior options and seating arrangements. Typical seating arrangements

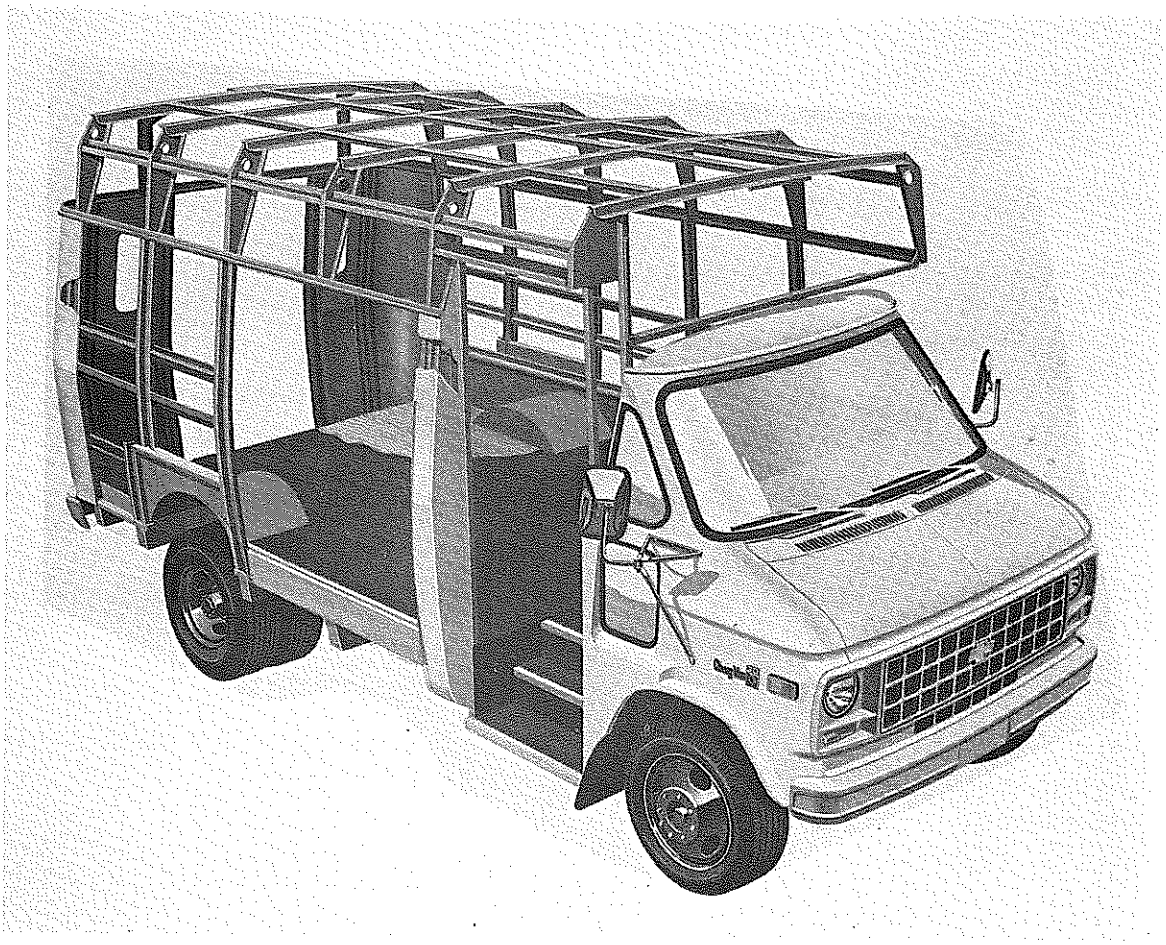


Figure 27. Small Bus Bodies are Generally Constructed Around a Steel Framework.

TABLE 16

REPRESENTATIVE MANUFACTURERS OF TYPICAL SMALL BUSES FOR TRANSIT USE

Carpenter Body Works, Inc.
Mitchell, Indiana 47446
(812) 849-3131

Coach and Equipment Sales Corporation
Post Office Box 36
Penn Yan, New York 14527
(315) 536-2321

Superior Division
Sheller Globe Corporation
1200 East Kibby Street
Lima, Ohio 45802
(419) 227-7777

Wayne Corporation
Wayne Transportation Division
Richmond, Indiana 47374
(317) 962-7511

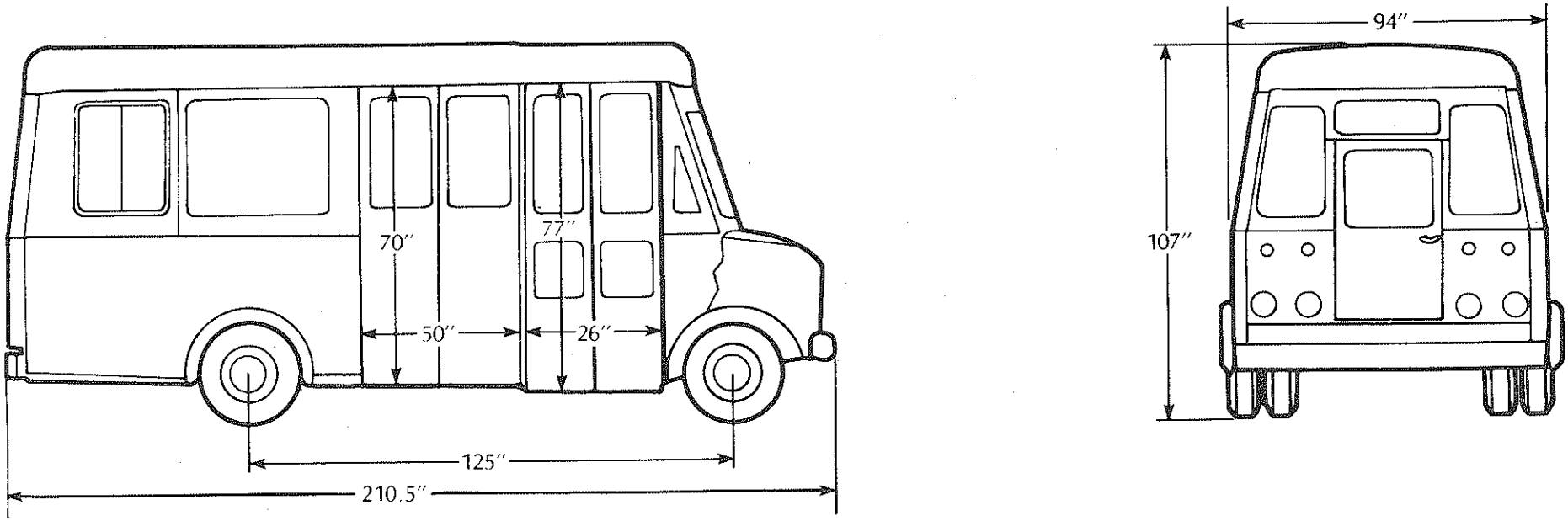
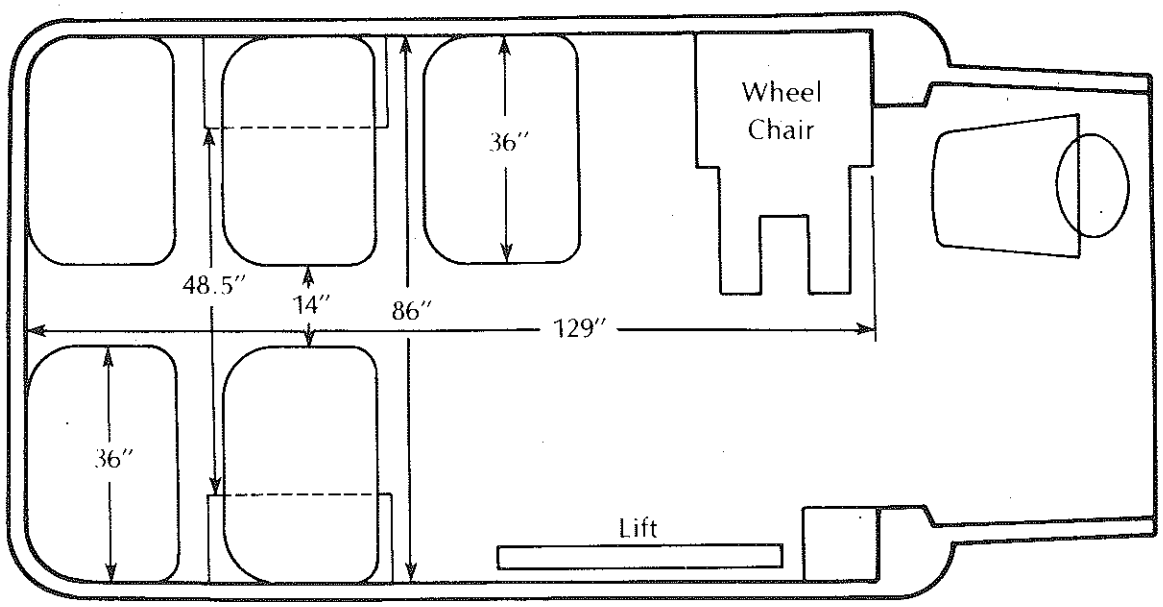


Figure 28. TYPICAL EXTERIOR DIMENSIONS FOR A 12 PASSENGER SMALL BUS.



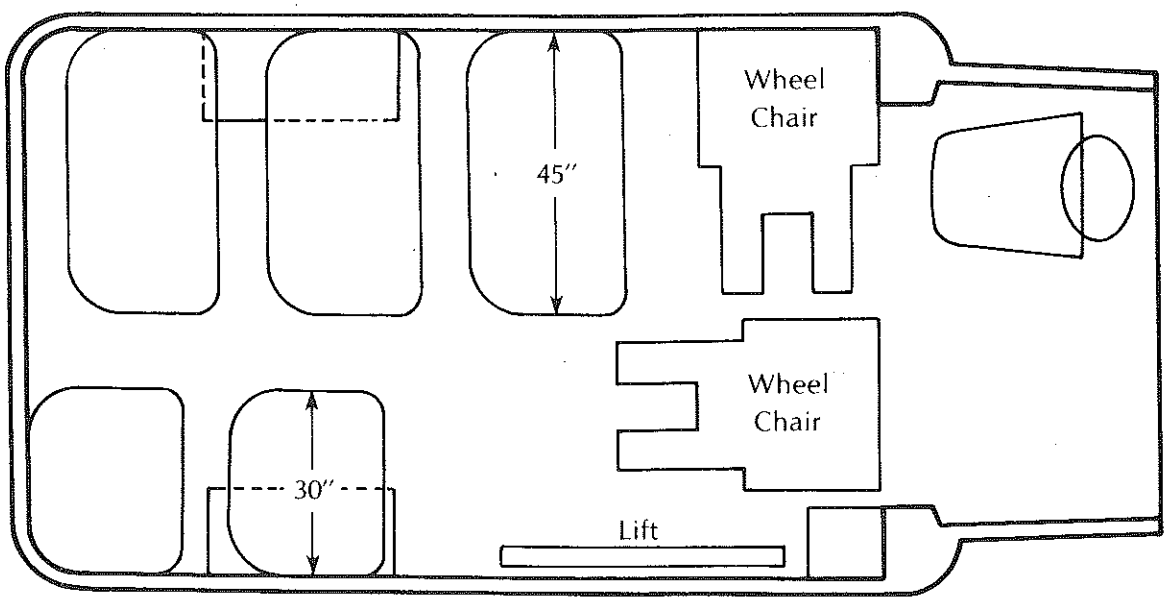


Figure 29. TYPICAL INTERIOR DIMENSIONS AND SEATING ARRANGEMENTS FOR A 12 PASSENGER SMALL BUS.

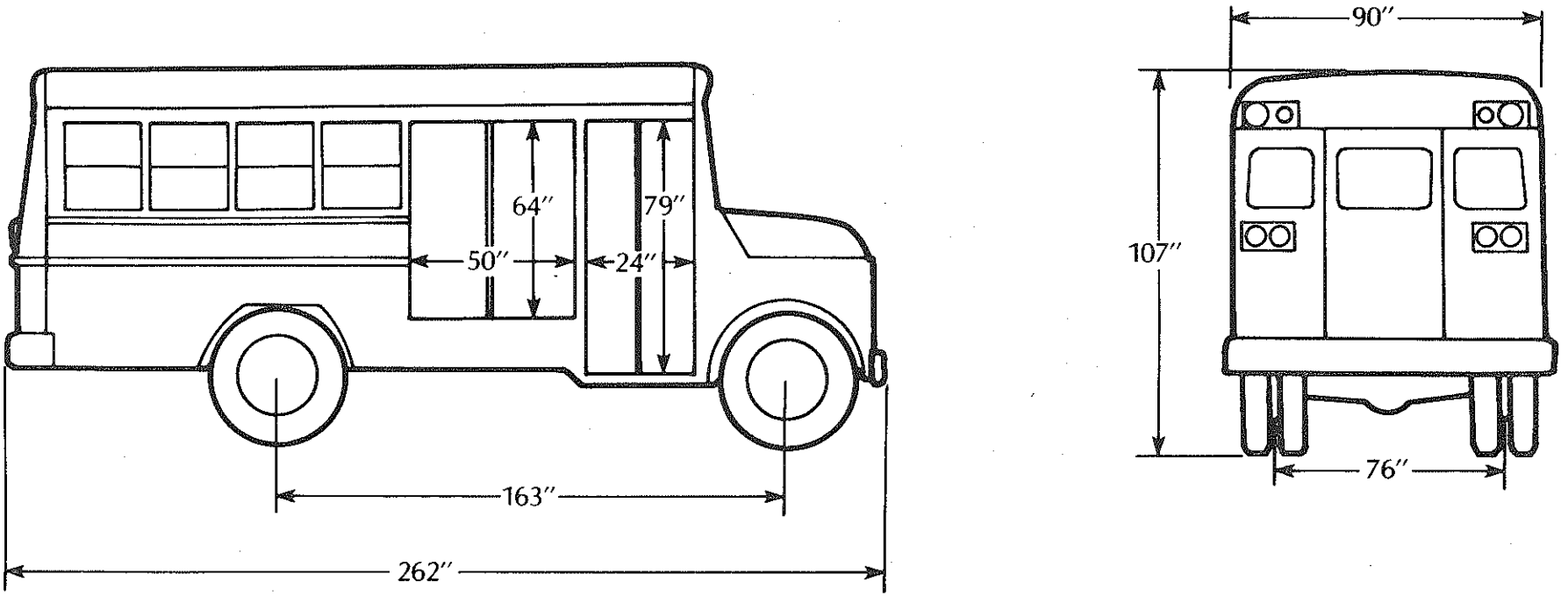
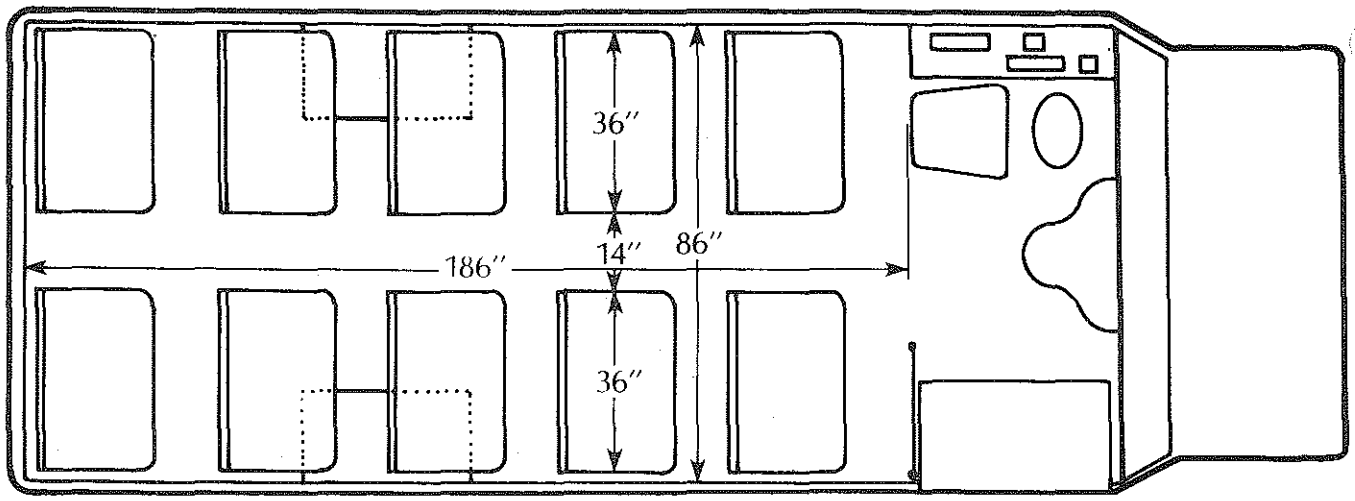


Figure 30. TYPICAL EXTERIOR DIMENSIONS FOR A 20 PASSENGER SMALL BUS.



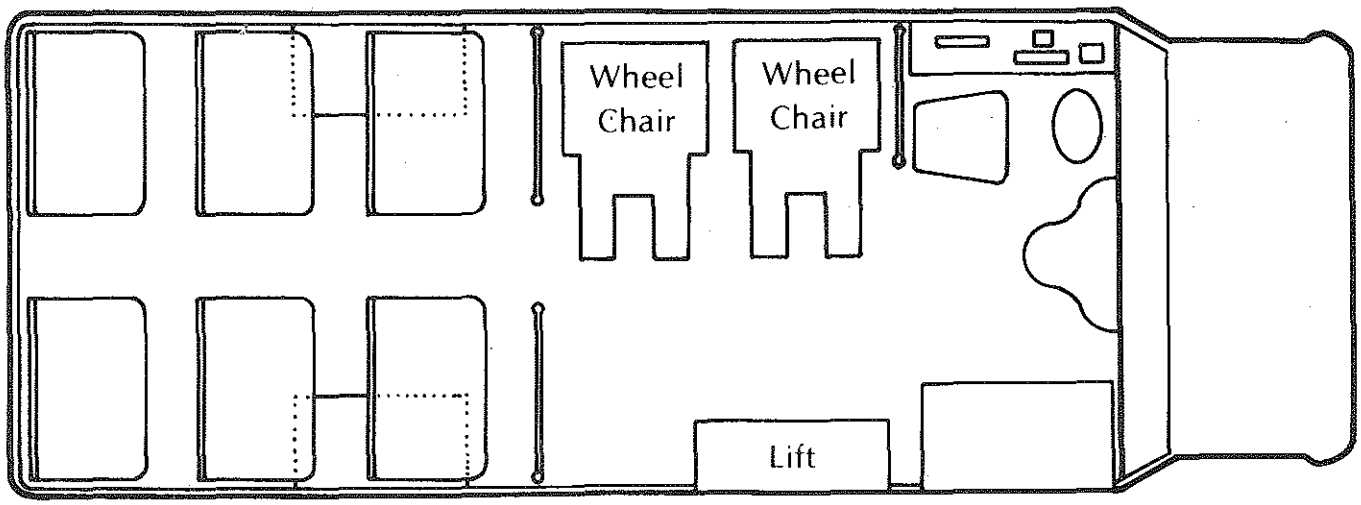


Figure 31. TYPICAL INTERIOR DIMENSIONS AND SEATING ARRANGEMENTS FOR A 20 PASSENGER SMALL BUS.

TABLE 17

DIMENSIONS FOR VANS, MODIFIED VANS AND SMALL BUSES
(1980 VEHICLES)

Overall	Vans	Modified Vans	Small Buses
Length (ins)	178 - 227	220 - 227	233 - 280
Width (ins)	- 80	80 - 94.5	80 - 96
Height (ins)	80 - 84	101 - 115*	93.5 - 117
Interior			
Length (ins)**	91 - 137	131 - 137	130 - 220
Width (ins)	69 - 71	69 - 82	79 - 90
Headroom (ins)	52 - 54	64 - 74	63 - 78
GVW (lbs)	6,050 - 8,550	9,000	10,250 - 18,000
Wheelbase (ins)	110 - 138	127 - 138	125 - 167
Seating Capacity	5 - 15	9 - 16	12 - 22

*Higher value generally indicates the addition of air conditioning mounted on the roof.

**Measured from the back of the drivers seat to the rear of the vehicle.

TABLE 18

TYPICAL STANDARD AND OPTIONAL EQUIPMENT FOR SMALL BUSES

Standard Equipment	Optional Equipment
Dual Rear Wheels	Air Conditioning -- Front and Rear
Power Steering	Wheelchair Lift or Ramp
350 or 360 V-8 Gasoline Engine	Wheelchair Securement Devices
3 Speed Automatic Transmission	Folding Passenger Seats (Flip-Type)
10,000-18,000 lb Gross Vehicle Weight	Removable Seats
Heavy Duty Shock Absorbers	Brake Retarders
30 to 36 Gallon Fuel Tank	Roof Vents
Heavy Duty Battery and Alternator	Increased Capacity Cooling Systems
Sliding Transit-Type Tinted Windows	Increased Output Passenger Heaters
Transit Type Neoprene Seats	Increased Output Batteries and Alternators (recommended with wheelchair lift)
Rubber-Covered Plywood Floor	Larger C.I.D. Gasoline Engine
Front and Rear Heaters	Diesel Engine
Insulation in Walls and Roof	Rustproofing
Windshield Defrosting and Defogging System	Citizens' Band Radio
Exterior Lighting Meeting Federal Motor Vehicle Safety Standards	Destination Signs
Passenger Entrance and Emergency Exit	Fire Extinguisher
Interior and Exterior Rear View Mirrors	First Aid Kit
Driver Controlled Passenger Lighting	Emergency Road Kit
	Larger Fuel Tank

for small buses are shown in Figures 29 and 31. Adding accommodations for a wheelchair will generally eliminate room for two standard passenger seats unless removable or folding seats are used.

The initial cost of a small bus can range from approximately $14,000 to over $35,000 (1980 model year) depending on the vehicle size and optional equipment ordered. Air conditioning units for small buses are expensive, ranging from $2,500 to $3,800. Generally, the same types of lifts that are used on modified vans can be used on small buses (1980 cost between $2,000 and $4,000 per unit installed); however, larger lifts, with a higher rated lifting capacity are available. The State of Michigan specifies a minimum lifting capacity of 750 pounds for lifts used on both modified vans and small buses (MDOT).

The Vehicle Equipment Selection Process

Selecting the right vehicle for a particular type lightweight bus transportation service can be a difficult task. However, matching the proper vehicle with the type of service can strongly improve the efficiency of the operation. In at least one state, experience indicates that the efficiency of service provided by Section 147 program (rural public transportation) operators was sometimes lacking because the wrong size vehicle was purchased (Hayes, 1979). Larger vehicles (16-20 passenger) appear more efficiently utilized for longer trips, while smaller vehicles (6-8 passenger) seem better suited for dial-a-ride type door-to-door service for short trips. The vans and modified vans can become uncomfortable for passengers when carried over long distances due to the limited interior space, and are usually impractical for passenger loads of more than twelve. A twenty-passenger small bus may be difficult to maneuver in city traffic or in narrow city streets. A twenty-passenger bus is also too large for efficient use with small passenger loads. Using one size of

vehicle for all types of service can be a costly mistake. Therefore, it is important to carefully plan service needs prior to the purchase of a vehicle.

The planning of service needs requires, at a minimum, the determination and evaluation of the elements shown in Table 19. Each of these elements may influence the size, type, and number of vehicles required.

As a general guide, the vehicle should be large enough to accommodate approximately 1-1/2 times the estimated maximum demand. The estimated mix of wheelchair and seated passengers must also be considered. It is clear from the material describing the size of light-weight accessible buses that if it is anticipated that three or four wheelchair passengers will be carried along with four or more seated passengers, a 20 passenger small bus will be required.

The characteristics of the service area influence both the size of the vehicle selected and the type of optional equipment desired. The width of the streets in the service area, and the need to maneuver the vehicle in driveways or cul-de-sacs, may require a vehicle with a short wheelbase and small turning radius. Generally, the shorter the wheelbase, the shorter the overall vehicle length, and the more maneuverability offered. For areas with a hilly terrain it may be required to have a vehicle with a low gear ratio in final drive. However, the need to travel long distances on level ground at high speeds would indicate that a high gear ratio is required. Extremes in climate, either hot or cold, would indicate the need for an auxiliary air conditioner or heater. The size of the service area and the fueling opportunities available may dictate the need for a larger-than-standard fuel tank. The availability of service opportunities may also dictate the selection of a particular vehicle since local dealership service, especially for work done under the vehicle warranty, can save a great deal of time when problems occur. Finding local service for certain vehicles may be difficult, however, especially for vehicle body repairs and wheelchair

TABLE 19

ELEMENTS FOR PLANNING SERVICE NEEDS

1. Type of Service
   - Demand Responsive
   - Fixed Route
   - Special Service

2. Service Characteristics
   - Number of Trips per Day
   - Length of Round Trip
   - Time of Day

3. Demand Characteristics
   - Maximum Number of Passengers to be Carried at One Time
   - Mix of Wheelchair and Seated Passengers to be Carried

4. Service Area Characteristics
   - Terrain and Condition of Roads
   - Size of Service Area
   - Type of Street System
   - Climate

lift maintenance.

To maximize vehicle utilization, it is usually preferable to select the smallest vehicle (while remembering that some reserve seat capacity is desirable) that can safely and comfortably accommodate the anticipated demand. This may require the selection of two or more vehicles of different sizes, which will also increase the flexibility of your service.

Some possible guidelines for matching vehicle size and type of service developed by the Michigan Department of Transportation for rural public transportation operators are shown in Table 20. These guidelines may be helpful when determining which type of vehicle to select for many types of transit use.

The number of vehicles required by a particular system is dependent on the service type, demand, size of vehicle selected and the characteristics of the service. A careful evaluation of the anticipated number of trips per day, length of time required to make each trip, and the time of day each trip will be made should indicate the number of vehicles of each size needed.

It is desirable to provide a transit operation with back-up vehicles, that is, vehicles that are kept in reserve for use when other vehicles break down, or for use in limited special service. Small systems, those with only one or two vehicles, may not be able to provide for a back-up vehicle and will need to rely heavily on preventive maintenance to keep the system operative. Larger systems may be able to reduce their need for back-up vehicles by establishing a good preventive maintenance program coordinated with a policy of off-hour maintenance and repairs. As a "rule of thumb" for estimating the number of extra vehicles required for systems of varying fleet size, the information in Table 21 should be helpful. Keeping vehicles in reserve may be difficult, since operators are often under pressure to use all available vehicles to a maximum.

TABLE 20

GUIDELINES FOR MATCHING VEHICLE SIZE AND SERVICE TYPE

Service Type	Variation of Service Type	Vehicle Size
I. Demand Response Operating Patterns	A. "Pure Demand" - same day door-to-door service within a small area.	8-12 passenger
	B. "Advance Reservation" - planned trip service. Usually scheduled 24-hours in advance of trip	8-12 passenger or larger depending on trip length, demand and terrain
II. Fixed Route Service Patterns	A. "Fixed Schedule" - vehicle follows a prescribed path with defined pickup points	16-19 passenger or larger depending on trip length
	B. "Route Deviation" - vehicle leaves Fixed route to pick up or drop off passengers	12-16 passenger, 16-19 passenger depending on terrain
III. Special Service Transportation	A. "Group Service" - single point to point service	Size determined by number of passengers
	B. "Agency Client" - frequent human service trips to and from agency locations	12-16 passenger, 16-19 passenger depending on terrain
	C. "Subscription Service" - normally work trip service. Also includes standing orders	8-12 passenger, 12-16 passenger depending on trip length

Source: Hayes (1979), pp. 9-10.

TABLE 21

BACK-UP VEHICLE REQUIREMENTS

FLEET SIZE Number of Vehicles	NUMBER OF BACK-UP VEHICLES
up to 7	1
8 to 20	2 or 3
20 or more	1 per 10 vehicles in fleet

SOURCE: The Institute of Public Administration (1975), page IV-6.

Optional Equipment

The optional items selected for a light-weight accessible bus will often improve the quality of service offered. However, these items may also contribute to maintenance or other problems. Examples from Michigan experience with optional equipment include:

- Air Conditioning: Original equipment units are generally the most reliable in terms of maintenance. However, they are usually only effective for cooling the area near the driver. Other add-on type units are available which are capable of cooling the entire inside of the vehicle, however, maintenance appears to be a continuing problem with these units. A major reason for this is improper installation. Experience has found that, in some cases, air conditioning hoses were mounted directly to the underside of the vehicle with no consideration given to protecting the hoses from rubbing against the frame and wearing through. After a few road miles the hoses would become frayed and burst or leak. Electrical wiring can also be troublesome. Such things as combining 8 gauge and 16 gauge wire leading to terminals will cause the system to "blow out". Service for these types of units may be difficult to find (Hayes, 1979).

- Auxiliary Rear Heaters: "These units are effective in the larger vehicles for heating the passenger compartment. Experience has shown that maintenance problems relate primarily to the installation of the unit." (1)

- Cruise Control: "These are ineffective for short, stop and go trips, but may save energy on long highway trips. These units create additional maintenance problems." (2)

- Tinted Glass: "A must with air conditioning. This reduces the rays of the sun coming through the windows of the vehicle." (3)

- Heavy Duty Electrical System: "Proved effective when additional electrical equipment was added to the vehicle and helped prevent overloading." (4)

- Heavy Duty Suspension System: "Provided more durability to the vehicle and added extra life. This system helped prevent major breakdowns of suspension springs and shock absorbers." (5)

- Luxury Seats (thick cushions): Ease hardness of heavy suspension.

- Engine Block Heater: "Helped provide good engine starting in the colder climates. Most beneficial to projects that had no inside storage for their vehicles." (6)

- Luggage Rack: "A useful accessory to store and hold packages, however, in most cases it reduces seating capacity or obstructs passenger movement. Can create time delays in schedules if driver has to assist passengers." (7)

- Power Steering and Brakes: "A great aid to the driver of a transit vehicle which allows better maneuverability. Provides a better turning radius and allows for smoother stopping." (8)

- Two-Way FM Radio: "Excellent method of communications for dispatching and scheduling. Provides emergency usage in case of a breakdown, accident or passenger problem. Mobile units and base station total a large expense." (9)

- CB Radio: "Proved worthwhile in areas of low CB usage. Range is limited and reception is not as good as a 2-way FM radio." (10) Some areas have experienced FCC licensing problems. Channel 9 is good for emergency calls, since it is monitored by police.

New Vehicle Checklist

Taking delivery of a new vehicle can be a disappointing experience, especially if a new vehicle is accepted prior to a careful and thorough inspection. New vehicles may often be delivered with parts missing, faulty workmanship, or in a condition which does not meet specifications. If possible, the vehicle should be inspected at the dealership prior to taking delivery.

A new vehicle acceptance checklist that is used by the State of Michigan for all new bus purchases is shown in Appendix B. A checklist of this type should be filled out for each vehicle purchased. The person performing the inspection must be familiar with any vehicle specifications supplied to the manufacturer at the time the vehicle was ordered. If the vehicle does not pass the inspection, for whatever reason, it should remain at the dealership until the problems can be

rectified. This may delay putting a vehicle into operation, but in the long run it will save much time and money by reducing repeated trips back to the dealer for repairs.

Do not hesitate to:

1. Road test the vehicle and check:
   a. the steering;
   b. the transmission;
   c. the brakes.

2. Operate the wheelchair lift and check for:
   a. hydraulic leaks;
   b. rough or hesitant operation;
   c. proper operation of the manual override;
   d. proper operation of the automatic stop (if so equipped).

Most importantly, be familiar with what the equipment is supposed to do, and make sure it operates properly. Manufacturers will usually supply operating instructions for each vehicle including descriptions of individual components. State agencies may be able to aid in the familiarization process by identifying seminars, workshops, showcases or equipment displays available in your area. Other operators may also be willing to help by showing you their equipment.

New Vehicle Warranty

Briefly, a warranty is an agreement by a vehicle manufacturer that for a specified period of time and/or for a specified mileage, the manufacturer will pay for any repairs necessary to correct defects in the assembly or the components of a vehicle. A new vehicle warranty can be an extremely valuable item. However, the light-weight transit vehicles described in this text are generally not constructed entirely by a single manufacturer. Hence, problems may arise as to the areas of warranty responsibility for each manufacturer involved in the construction of the finished product. It is vital that the purchaser be aware of the requirements and limitations of the warranties on each vehicle, and be informed as to the warranty responsibility of each manufacturer involved

in the production of the vehicle or any optional equipment which may include a warranty.

In general, warranty work is performed by the dealer who sells the vehicle. In the case of a composite vehicle such as a small bus, the engine and chassis are under warranty by the company which manufactured these parts, and the body and wheelchair lift are under warranty by the body manufacturer. Thus, a vehicle with a Transette body built onto a Chevrolet chassis will be under warranty by both the Wayne Richmond Corporation and the Chevrolet Division of General Motors. If repairs are needed on the engine, the drive train, the front end, or any other part of the chassis assembly, the local Chevrolet dealer will perform the repairs. Warranty work on the coach body will be performed by the local Wayne Corporation distributor.

In places where there are no dealerships for chassis or body within easy reach, arrangements can be made for local mechanics to perform repair work and be reimbursed by the manufacturer under the terms of the warranty. It is important that these arrangements be made in advance; clearance must be obtained from the manufacturer's state or district representative. Manufacturers may refuse to reimburse unauthorized repair work, and in some cases, unauthorized repairs or modifications may void the warranty. So where vehicles are operated in isolated areas, it is especially important that arrangements for warranty work be made as part of the basic planning of the operation.

Both chassis and body components are usually under warranty for one year or 12,000 miles of service, whichever comes first. Every manufacturer's warranty contains exceptions, however. For example, adjustments in body part fit or carburetor settings must be made within 90 days on GM, Ford and Dodge vehicles. On Ford vehicles, friction parts such as brake linings and windshield wiper blades are under warranty for 6,500 miles. Some body manufacturers will only warranty electrical parts for 90 days. Because warranty provisions do vary among

manufacturers, it is important that purchasing agencies understand the exact terms of each vehicle's warranty before the time of purchase.

Warranty provisions are always conditional upon a certain specified standard of maintenance by the vehicle operator. Recommended maintenance for a vehicle in heavy passenger service may exceed minimum warranty provisions. Operators should be familiar with the terms of the warranty on each of their vehicles, since failure to perform the minimum maintenance specified by the manufacturer may void the warranty.

As with any legal contract, there may be an element of negotiation in any warranty matter. If a vehicle shows a clear defect in parts or workmanship, manufacturers will usually honor their warranty. If a vehicle has clearly been abused by the operator, then the manufacturer may refuse to reimburse repairs resulting from that abuse. Where there is some question about responsibility for a malfunction, most manufacturers will be willing to negotiate a partial settlement. No hard and fast rules can be given for these situations, but operators can put themselves in the best possible bargaining position by:

1. Dealing with authorized dealers and mechanics.
2. Keeping up a high standard of maintenance and good records.

Section-II Wheelchair Lifts and Restraint Equipment

To make a transit system accessible to passengers with wheelchairs, probably the most important pieces of optional equipment are the wheelchair lift and wheelchair securement devices. It is important that an operator be informed as to the types and limitations of available equipment, and be knowledgeable in the care and handling of the equipment purchased.

The technology needed to accommodate wheelchair users on public transit vehicles is still in an early stage of development. At present, light-weight accessible buses are not designed specifically to accommodate passengers using wheelchairs so, to some extent, all of the wheelchair lift and securement equipment currently on the market represent an attempt to make existing vehicles accessible to wheelchair-users. A great deal of further research and development is needed before a completely satisfactory solution is achieved.

Several manufacturers produce ramps that can be used on vans or small buses to load wheelchair passengers. Ramps have several major disadvantages, which include:

1. The incline is usually too steep to allow a wheelchair passenger to independently enter a vehicle.
2. A heavy passenger and wheelchair will require a rather strong individual to help them enter and exit the vehicle.
3. In adverse weather conditions (snow, ice, etc.) ramps can be extremely dangerous.

Transit managers should seriously consider whether these problems can be resolved prior to ordering ramp equipment.

Wheelchair Lifts

Basically, there are two types of wheelchair lift machinery presently available. The first type is a small electric or electro-hydraulic elevator, consisting of a platform which unfolds or swings from the side or rear of the vehicle through

doors separate from the main passenger door. Manual operation or an electric motor will move the platform from vertical (stored position) to horizontal (positioned for use), and hydraulic pistons or an electric motor will lower and raise the platform from the height of the vehicle floor to the ground and back. Examples of platform lifts are shown in Figures 32 and 33. Platform lifts are the type usually used on vans and small buses, and models are available that are stored inside or outside the vehicle.

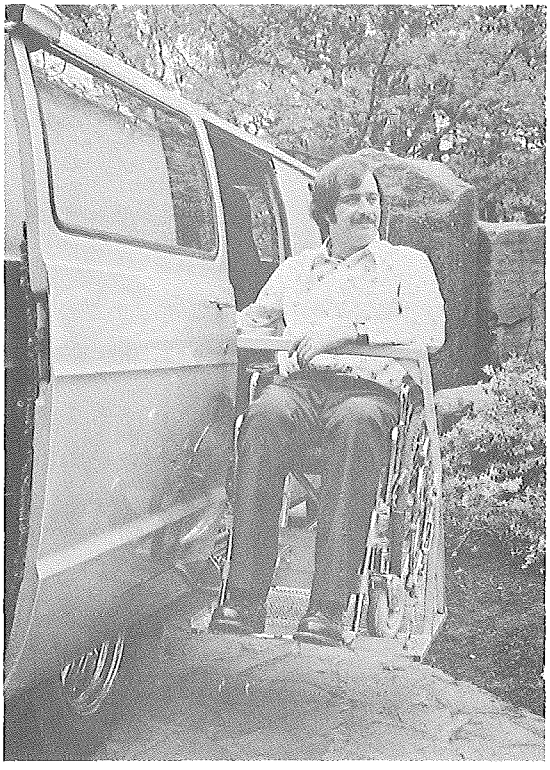
Platform lifts are also available that swing out from the vehicle side door rather than folding down. These rotary platforms are typically smaller and lighter weight than the folding type, and are designed primarily for use on privately owned vehicles. This type of platform lift usually requires that the vehicle be equipped with a sliding side door rather than the double folding doors. Folding platform lifts can be used on a vehicle with a sliding or folding doorway. A list of several manufacturers of platform-type wheelchair lifts is shown in Table 22 along with the characteristics of the lifts produced.

With the second type of lift, the steps of the main entrance-way rearrange themselves into a flat platform, which then raises and lowers hydraulically. No separate door is needed with this in-step lift, since the basic stairwell serves as the lift area. This type of lift is pictured in Figure 34. At this time the in-step lifts are designed primarily for use on the larger 30 to 50 passenger transit buses, and have only recently (1980 model) been made available on the Superior Transliner type vehicle discussed in this report. Therefore, only a passing mention of in-step lifts will be given here.

The in-step lift may be operated from the driver's seat; the platform lift requires that the operator either ride the lift platform along with the passenger, or stand alongside the vehicle to work the controls.

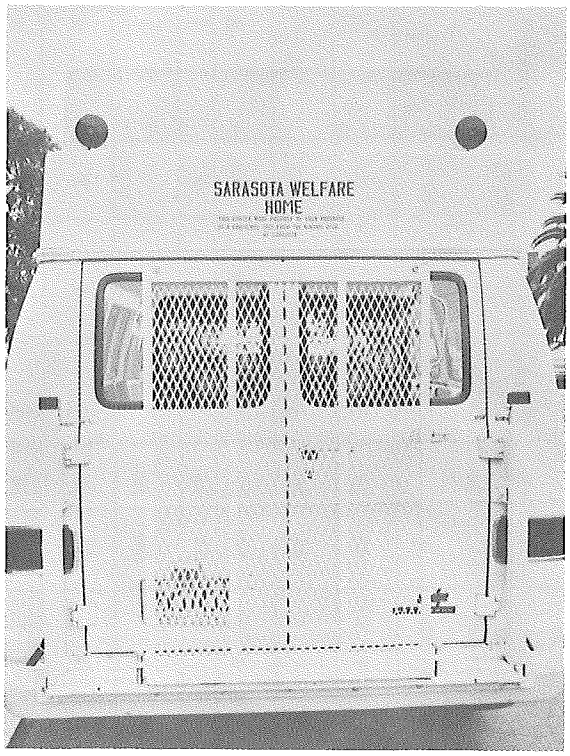
Three distinct degrees of power operation are available with platform-type lifts. The most fundamental is the power

Folding Lift

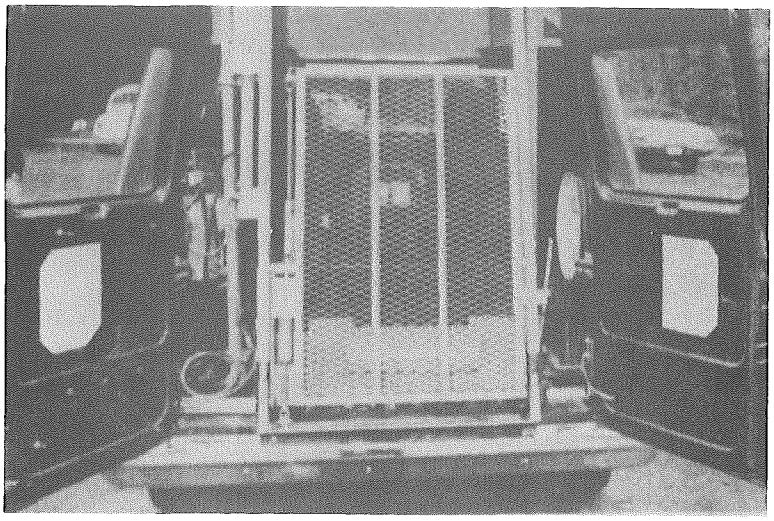


Rotary Lift

Figure 32. Side Mounted Platform Lifts.



Outside Storage



Inside Storage

Figure 33. Rear Mounted Platform Lifts.

TABLE 22

WHEELCHAIR LIFT MANUFACTURERS' SPECIFICATIONS

Manufacturer	Load Capacity (Lbs.)	Power Mode			Powered Operations				Stow Operations		Stow Location		Lift Door Location			Platform Dimensions (Inches)		Manual Over-ride	Safety Shut-Off	Hand Rail	Control By			Warranty
		E	H	E/H	Up	Down	Stow	Door	Fold	Rotary	I	O	S	R	SP	L	W				P	A	E	
Braun Corp. L-200 Buslift	750		X		X		X	OP	X		X		X	X	X	44	30	X		OP			X	1 yr P & W
Coach & Equipment Series IV	750		X		X	X	OP		X		X				X	44	34	OP	OP			X		1 yr P & W
Collins Industries W-29	1100		X		X	X	OP		X		X		X	X	X	44½	32½	OP	OP	OP			X	1 yr P & W
Drive-Master	400	X			X	X	X	OP		X	X		X			48	33	X	X	X			X	1 yr P & W
Mobility Dynamics Inc. Mark I	750	X			X	X	X	OP	X		X		X	X		40	30½						X	1 yr P & W
Para Industries, Ltd.	600		X		X	X	X	OP	X		X		X	X		39	36		X	X			X	1 yr except: Hydraulics, 90 days P & W
Reb Manufacturing Inc. 2-in-1	1000		X		X	X	X		X		X		X	X	X	37½	30	X	X	OP			X	1 yr or 12000 miles P & W
Ricon Corp. R-30A	600	X			X	X	X	OP	X		X		X	X		44	30½	X	X	OP			X	1 yr P & W
Skillcraft Industries, Inc.	900		X		X	X	OP	OP	X			X	X	X		42	32	X	X				X	1 yr P & W
Total Mobility, Inc.	750		X		X		X	OP		X	X		X			36	36	X	X	X			X	1 yr P & W
Timesavers Products, Inc.	500		X		X	X	X		X		X		X	X		40	34						X	6 months P & W

E = Electric
H = Hydraulic
E/H = Electric-Hydraulic
OP = Optional

I = Inboard
O = Outboard
S = Side
R = Rear
SP = Special Door
OP = Optional

P=Passenger
A=Attendant
E=Either
P&W = Parts & Workmanship

Rear Door Steps in Standard Position

Rear Door Steps
in Lift Position

Step Lift in Front Door
of Large Transit Vehicle

Figure 34. Passive Step Lifts
on Large Transit Vehicles.

movement of the lift up and down. All platform lifts are equipped in this manner, with a manual override available on some models in case of power failure. The stowage operation, that is, the folding of the platform from horizontal to vertical for storage or vice versa for use, is a power operation on some models. Manual stowage or deployment of a platform is not difficult so that the power fold operation is not considered a necessity. Lifts equipped with the power fold operation are sometimes referred to as being "semi-automatic" or "fully-automatic" depending on the manufacturer. The term "fully-automatic" may also refer to a lift equipped with a power operation for opening and closing the lift doors as well as stowing or deploying the platform. It is recommended that complete clarification be obtained with respect to the manufacturers' definition of "fully" and "semi" automatic lifts. While the "semi" and "fully" automatic modes of operation do add a certain level of convenience to the lift operation, they also invariably add to maintenance problems.

It is important that once a lift is purchased that spare parts and manufacturer's service be available. A good lift can outlive a bus or van, and can be reinstalled in another vehicle provided spare lift parts can be obtained. Check the track record of a manufacturer prior to purchase. Be as sure as possible that a company will still be in business a few years from now.

Lift Features

It is extremely important that a wheelchair lift exhibit several minimum characteristics for safety considerations as well as the prolonged operational abilities of the lift unit. Detailed procurement specifications describing minimum required lift characteristics have been adopted by several Government agencies including the Department of California Highway Patrol (DCHP, 1979), the Michigan Department of Transportation (MDOT), and the North Central Texas Council of Governments (NCTCOG; Ryden, 1977). Several of the minimum recommended lift

characteristics are summarized in Table 23. It is recommended that the sample procurement specifications for lifts (see Appendix A) be reviewed prior to purchase, and that a minimum specification be supplied to the manufacturer. This is to insure that the lift will meet service needs.

In addition to these minimum requirements, there are several characteristics related to lifts that are considered desirable. Some lifts may be equipped with an automatic shut-off mechanism which is activated when the lift contacts the ground or some obstruction such as a curb, rock or tree branch. This is a useful option and can help prevent damage to your equipment, or injury to the operator.

Some lifts also come equipped with a hand railing for the wheelchair passenger. This is mounted on the platform, and usually folds down across the platform when not in use. This type of railing can help prevent the wheelchair from rolling off the platform when held by the wheelchair occupant. This also lends a sense of security to the wheelchair passenger.

It is desirable that the moving mechanisms of the lift, including chains, belts, and gears not be exposed. Exposed parts can become clogged with dirt, snow or ice, and even if they are set away from the passenger accidents can happen.

It is also important that the lift controls be located such that either the bus driver or the user can operate the equipment. When the lift is in operation the bus driver or other attendant should be either on the lift platform or next to it outside of the vehicle. In either case the driver will be in a position to have a clear view of the lift and wheelchair, and be able to aid the user in case of an emergency. Figure 35 shows the correct positions of the attendant when operating a wheelchair lift, and assisting a passenger.

Lift Location

There are advantages and disadvantages of having a platform lift mounted at the vehicle side door or rear door. Rear mounted lifts may be better suited for rural operations where

TABLE 23

SUMMARY OF MINIMUM LIFT CHARACTERISTICS

Lift Capacity (lbs)	DCHP - 595 MDOT - 750 NCTCOG - 1,000
Usable Platform Dimensions (Minimum ins. of Length times Width)	MDOT - 42.5 x 32.5 NCTCOG - 42 x 32

Platform must have a non-skid surface.

Platform must have front and side anti-roll-off barriers.

Lift must be capable of manual operation in case of power failure.

Operating the Lift

Assisting the Passenger

Figure 35. Proper Position for Attendant When Operating Lift and Assisting the Passenger On and Off the Platform.

Note: For safety, the wheelchair passenger should face away from the vehicle when using the lift.

access to the curb side of the vehicle may be impractical due to road side ditches, tall grass, heavy snow or narrow driveways. Rear mounted lifts may also be more accessible in areas where one-way streets restrict boarding from the side of the vehicle. Rear mounted wheelchair lifts that are stored outside the vehicle are not practical in cold climates where snow or freezing rain is common during the winter months. Constant snow removal is time consuming and a nuisance, and freezing conditions will render an outside lift inoperative. However, rear mounted lifts stored outside the vehicle may be completely suitable in warm climates, and they do afford greater interior passenger space.

Side mounted lifts may be better suited to most urban applications where curb side passenger pickup is common. Also, side mounted lifts may eliminate some of the potential hazard of severe passenger injury in the event of a rear end collision while the lift is in operation. A rear end collision can render a rear mounted lift inoperative, leaving passengers stranded on board. The decision of where to mount the lift should be made only after careful consideration of how and where the vehicle and lift are to be used.

Regardless of where the lift is mounted it should be remembered that maneuverability of a wheelchair inside a vehicle is extremely restricted. This is especially true for the modified vans. As a rule the first wheelchair on the vehicle will be the last one off. This should be taken into account when planning the passenger pickup and delivery schedule. If not carefully planned the driver will waste time loading and unloading passengers several times.

Lift Maintenance

The basic problem with lift equipment is that light machinery must be made to do very heavy duty work while exposed to extremely destructive elements, especially temperature extremes, water, dirt, mud, gravel, and salt-induced corrosion.

A piece of equipment that worked well under laboratory conditions may be unable to stand up to continuous use in rural areas and in the climate of the northern states, particularly where salt is used heavily for ice-removal.

Lift maintenance is of prime importance from both a safety and operational viewpoint. Proper maintenance will prolong the operational life of a lift and decrease safety hazards. A minimum lift maintenance program should include:

1. A daily pre-operative safety check.
   a. Run the lift through one complete cycle to be sure that it is operable before attempting to pick up a passenger and also to check for seal leakage and the binding of hardware.
   b. Check for frayed or damaged lift cables, hydraulic hoses, or chains.
   c. Check for physical damage and jerkey operation. Look for hazardous protrusions, exposed edges, etc. Make sure that all such protrusions are adequately padded and protected.
   d. Check all fasteners. All bolts should be snug.
   e. Make sure lift is properly secured to the vehicle when stored.
   f. Make all necessary repairs immediately. Do not use a lift in an unsafe condition.
   g. Clean the lift completely of dirt, mud, gravel and corrosive elements such as salt.
2. Weekly maintenance.
   a. Lubricate all rubbing and bearing surfaces.
   b. Lubricate sliding extension channel.
   c. Check and lubricate manual controls. (only lubricate the lift with the manufacturers' specified lubrication material)

Lift equipment is also vulnerable to damage by improper operation, since the amount of force needed to lift a heavy wheelchair (up to 300 pounds or more) will quickly inflict serious damage if the operator makes a mistake. Platform-type lifts having long hydraulic pistons can be damaged by allowing

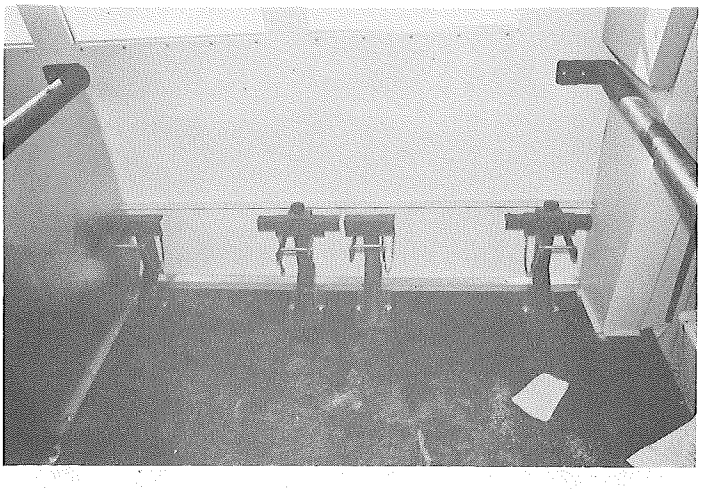
the platform to drive against the ground. An automatic shut-off mechanism is especially useful for preventing this type of damage. Likewise, if any moving part is allowed to jam or bind, serious damages can result; a corroded or frozen hinge on an in-step lift can be broken by the force of the other machinery. On some equipment, care must be taken not to press two control buttons at once, or a short circuit could blow fuses.

Most of the lift machinery currently available can be made to give acceptable service if operators and maintenance staff take into account the limitations of the machinery and the magnitude of the wear and tear it receives. None of the equipment is especially complicated, although a few components on some lifts may not be heavy enough to consistently do the job for which the lift was designed. To keep lift machinery running reliably, three things must be done.

1. Be sure that the lift equipment is correctly installed. Unfortunately, the only method of doing this may be to return the vehicle to the vendor to investigate chronic problems.
2. Train all drivers thoroughly in the proper operation of the lift, and make sure that they all understand what will damage the equipment.
3. Far exceed the manufacturer's specifications on cleaning and lubrication, and keep all parts properly tightened and adjusted.

Wheelchair and Passenger Restraints

Wheelchair restraint or securement equipment is also in an early stage of development. Photographs showing several types of equipment are shown in Figures 36 and 37. The problem of securing a wheelchair-using passenger is really the problem of securing a passenger who must remain seated in a lightly-constructed, semi-collapsible chair throughout the ride. Several restraints now in use secure the rear wheels of the chair, and will hold a wheelchair in place in the course of a normal, safely-driven passenger trip. But even a well-secured wheelchair provides very little protection for the



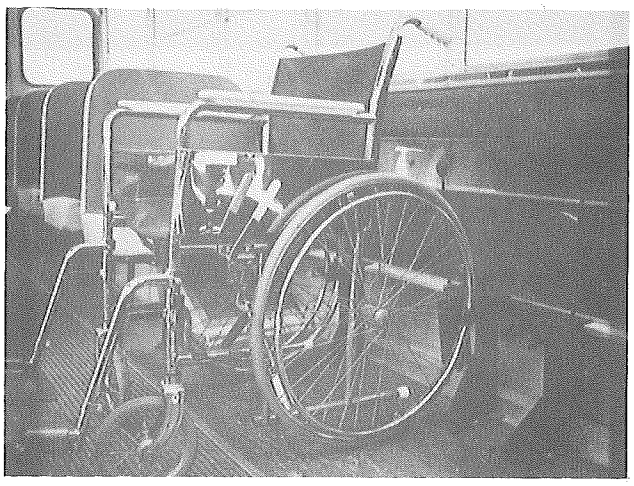
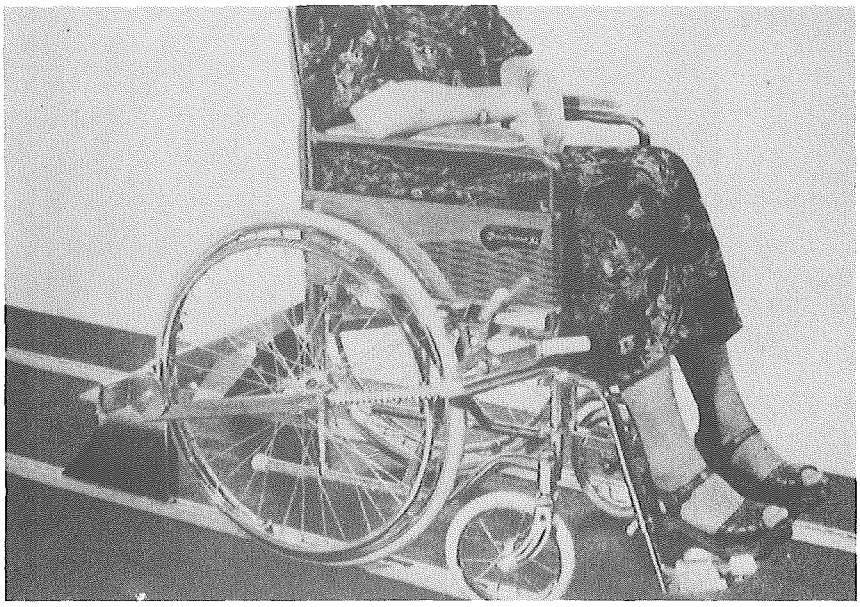
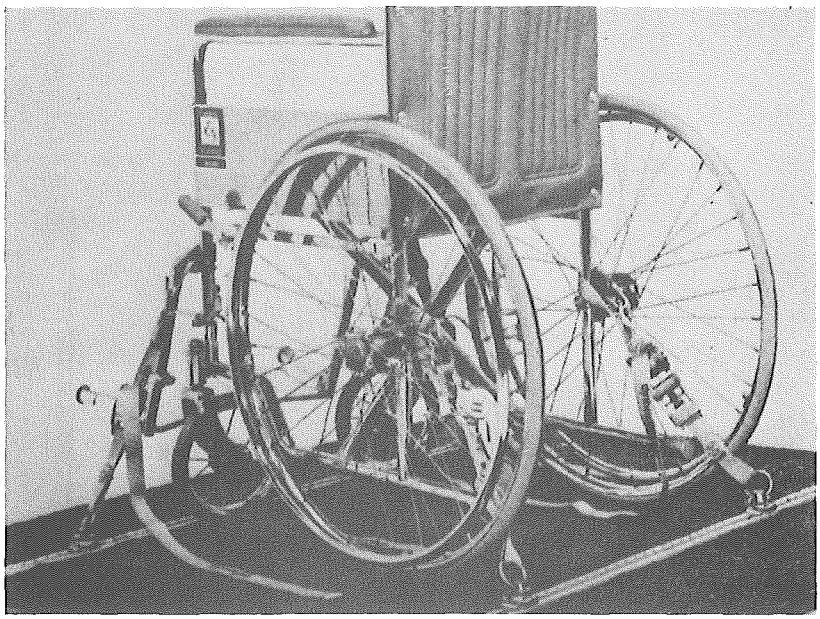


Figure 36. Wheel-locking Wheelchair Securement Devices.



Adjustable Metal Clamps Secure Both Sides of the Chair to a Bracket on the Floor



Cargo-type Belts Secure the Chair to Brackets on the Floor

Figure 37. Frame-locking Wheelchair Securement Devices.

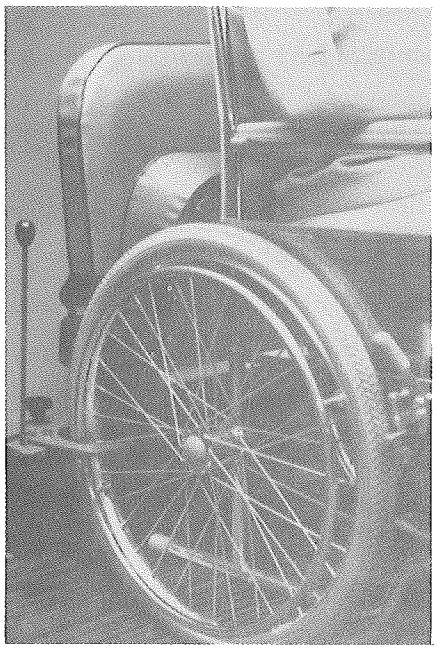
passenger in the event of an accident.

Tests have shown that when secured in an aisle-facing position on the vehicle, a standard wheelchair gives very poor lateral support and will collapse in the event of a front end collision (Schneider and Melvin, 1978). When front-facing, the wheelchair and the passenger will both pitch forward in an emergency stop or if a front end collision occurs. If the passenger is properly secured in the wheelchair, the front facing position is relatively safe provided there is nothing located in front of the wheelchair which the passenger might strike. A wheelchair facing the rear of the vehicle must be supported from behind by a bulkhead, railing or other structure which will completely prevent the chair from rotating backwards on its own rear axle. This is extremely important because left free, a standard wheelchair will rotate over the rear axle and cause serious injury to the passenger.

Some manufacturers of the wheel-type securement devices have coordinated these with a passenger seat that folds up out of the way when a wheelchair passenger is to be secured in its place. This is commonly referred to as a "flip-seat", and is used when there is a need to maintain as much standard seating space as possible (see Figure 38).

At least two manufacturers produce wheelchair restraint devices that secure the frame of the wheelchair as opposed to the rear wheels. One such device, shown in Figure 37, is a metal structure that is fastened to the floor of the vehicle. This arrangement may reduce the pitch of a forward-facing wheelchair during an emergency stop. However, these units will not increase the structural integrity of the wheelchair in a side-facing position. These units are also available with a removable two passenger seat. Another device for securing the frame of the chair, also shown in Figure 37, uses cargo belts that clip onto the chair frame and fasten to the floor of the vehicle.

The variation in chair and wheel size among wheelchairs now in use may make it necessary to readjust the securement



Restraint with Single Folding Seat

Restraint with Double Folding Seat

Figure 38. Wheelchair Restraints Combined with Folding Passenger Seats.

setting for each separate passenger, which can be a clumsy and time-consuming procedure. However, restraints must be capable of securing wheelchairs of various sizes. Wheel-type restraints cannot be used with wheelchairs having low profile wheels and tires on the front and rear of the chair. However, in simulated crash tests, straps or belts which wrap around the frame of a wheelchair have been found to be an ineffective procedure for securing a wheelchair inside the vehicle because the chair itself has no lateral strength (Schneider and Melvin, 1978).

It is strongly recommended that wheelchair passengers be secured in addition to securing their chair. Standard bus- or "truck-length" safety belts are commonly used for this purpose, although these have limitations. For example, when the passenger faces sideways, lap restraints will not completely prevent the passenger from lateral movement in the event of an accident. As noted earlier this can cause damage to the wheelchair, and injury to the passenger. When facing forward a lap restraint alone will not prevent the upper torso of a wheelchair passenger from rotating forward during a sudden stop. This can result in serious injury due to contact with vehicle interior structures.

Abdominal passenger restraints, such as that pictured in Figure 39, have been found to successfully redistribute the belt force applied to the abdominal region during a crash (Schneider and Melvin, 1978). However, measured forces directly beneath the restraint belt were still great enough to cause possible damage to internal organs. It is recommended that wheelchair passenger safety belts be of the type that fit around the passenger's pelvic bone and that these be coordinated with an upper torso restraint. Both the lap restraint and the upper torso restraint should be anchored to the vehicle to minimize passenger movement in the event of an accident.

Wheelchair and passenger restraint equipment should also be inspected daily:

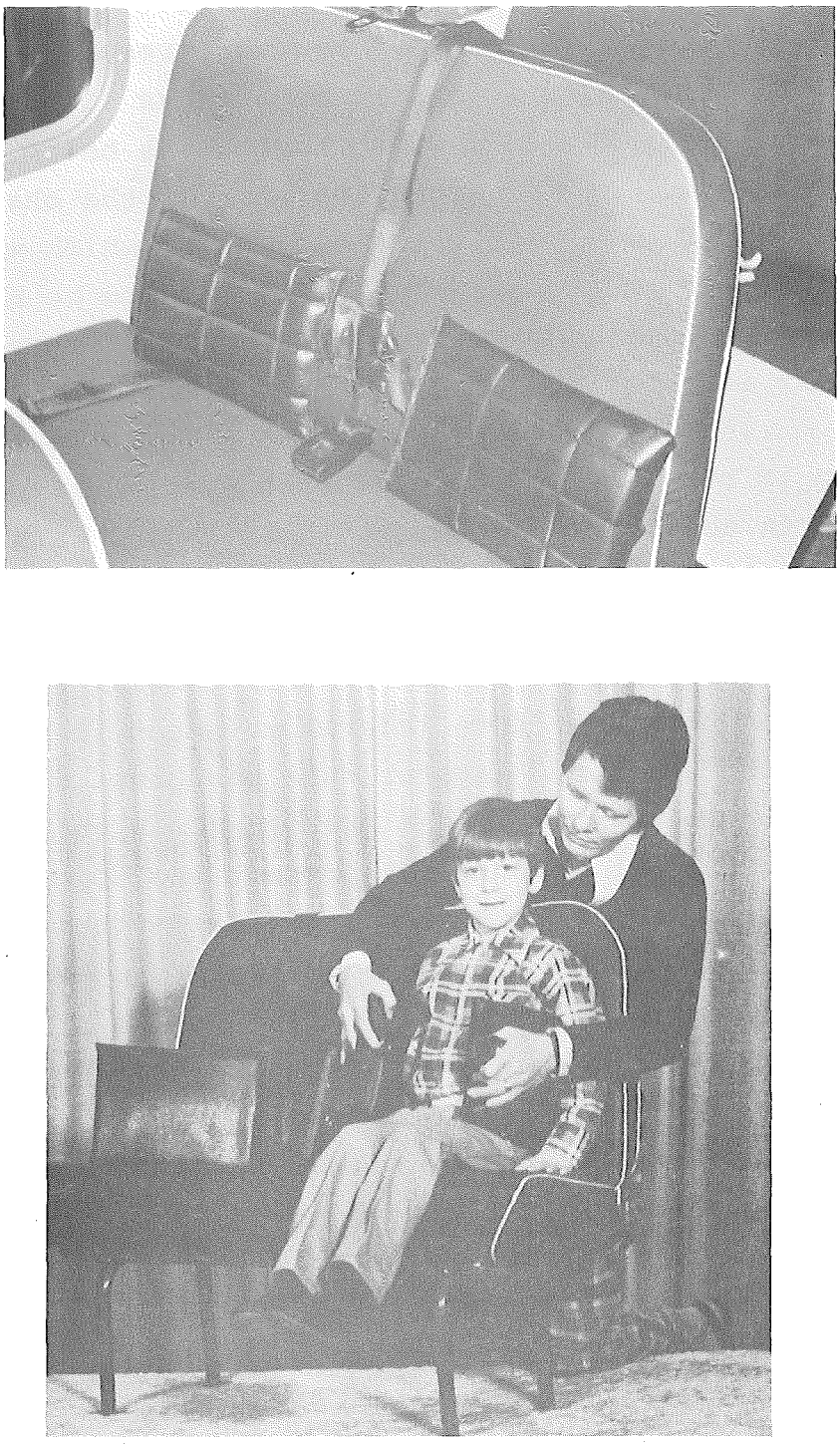


Figure 39. Abdominal Passenger Restraint.

1. Check to see that the wheelchair securement device is intact and in good working condition.
2. A sufficient number of restraining belts should be available to insure that all wheelchair passengers can be secured while being loaded, unloaded and transported.

As with the lift equipment, most commerical restraint equipment can be made to work if correctly used and properly cared for. Constant cleaning and lubrication will make adjustments easier; pins held in place by spring-loaded ball-and-socket arrangements must be kept well lubricated.

Section-III Communications Equipment

Reliable two-way communications are critical to any transportation service. Good communications save fuel, time and aggravation, and constitute an important aid to safety. Several types of communication systems are available. These include:

1. Two-way radio in various bandwidths.
2. Mobile telephones.
3. Telephone paging systems.
4. Ordinary telephones.

Two-Way FM Radio

A good two-way radio system is the ideal communication system for a transit operation. Two-way radio enables a central dispatcher to know the location of every vehicle. It also enables a driver to call for emergency help without having to leave the vehicle.

There is a specific series of steps necessary when setting up a two-way radio system:

1. Designing the system. It takes expert knowledge of a highly technical nature to design a two-way radio system. Factors to be considered include:
   a. Preferred frequency.
   b. Service area to be covered.
   c. Exact latitude, longitude, and altitude of all fixed equipment.
   d. Number of mobiles, or vehicle radios.
   e. Electrical power of the mobile units.
   f. Electrical power of the base station, or central dispatch radio.

Terrain, weather, man-made structures, and the presence of other broadcasters' signals must all be considered in the design of a two-way radio system. Any radio system must be closely-tailored to the individual needs of the service in which it is being used; what will work in one place may be

much less effective somewhere else.

For this reason, a transit operator who is not personally familiar with the technical side of radio communications should seek expert advice in designing a system. It may be necessary to pay a consultant to design the system, although local sheriff's departments, rescue squads, or colleges and universities may do this for you free of charge. It is important to work with someone who is both knowledgeable about radio communications and familiar with local conditions. Major manufacturers have sales staff who will provide assistance in designing a radio system and obtaining a license.

2. Frequency coordination. In order to minimize interference among the hundreds of broadcasters, each individual broadcaster is assigned a specific frequency. Certain groups of frequencies are officially reserved for certain types of transit operations. In general, frequencies available to transit services are found in the 43 Megahertz (MHZ), 150 MHZ, and 450 MHZ areas of the radio frequency spectrum.

Certain frequencies are desirable for certain service conditions. A "low-band" setting around 43 MHZ, for instance, has a relatively long range. On the other hand, low-band frequencies are subject to certain kinds of interference, and may experience "dead-spots" in built-up areas. An ultra-high frequency (UHF) setting around 450 MHZ will give better coverage in built-up areas, and has less problem with interference. However, a UHF frequency has a shorter range than a low-band frequency, requires a higher antenna, and in some localities has the disadvantage of being a great deal more "crowded" with users. The question of the most effective frequency for an individual operation is a very technical decision which depends entirely upon local conditions.

When an operator decides on his preferred area of the frequency spectrum, he must then apply for frequency coordination. For a frequency in the 43 MHZ or 150 MHZ bandwidth, application must be made to the National Association of Motor Bus Operators in Washington, D.C. For a frequency in the 450 MHZ

area, application must be made to the American Trucking Association, also in Washington, D.C. In both cases, the applications must describe exactly the entire design of the system. The coordinating agency will then notify the operator of the exact frequency on which he may broadcast.

3. Licensing. All broadcasters must be licensed by the Federal Communications Commission (FCC), which regulates all broadcasting in the United States. Upon receipt of a recommended frequency, the operator must submit a detailed application for a license to the FCC describing the exact design of the system and listing the recommended frequency. When the license arrives, it is legal to begin broadcasting.

Remember that this procedure may take six months or more, so allow enough lead time before you must begin two-way radio operation.

Buying Radio Equipment

After you have designed your basic system, and while the licensing procedures are in process, you should initiate your agency's procedures for buying your radio equipment.

Major radio equipment manufacturers have a wide variety of equipment available. Base station units, including dispatcher's console and microphone, generally sell for $800 to $1,000. Antenna equipment may run up to $2,000 more, depending upon the equipment required in a particular location. Each mobile unit, or vehicle radio, will run at least $800 to $1,000. There are several types of mobile units. Some can be permanently installed in the vehicle. Some are removable, much the same as an automobile cassette tape recorder. Others can be worn by the driver like a "walkie-talkie" -- these portable units tend to be more expensive than dash-mounted mobiles.

In choosing radio equipment, buy the sturdiest equipment available, since transit radio equipment gets very hard wear. Pay particular attention to the availability of service, and buy only equipment which can be serviced locally.

Citizens' Band Radio

Citizens' band radio has an extremely limited effectiveness for regular transport communications. Because of the number of CB users, the band has become overcrowded and the likelihood of serious interference makes CB frequencies unreliable for dispatch communications in most places. The short broadcast range of CB radio also restricts its use as a communications method for dispatching. However, in areas of low CB usage, and where a base station is not a requirement, the CB radio can provide an effective method of making emergency communications, and is considerably less expensive than two-way FM radios.

Mobile Telephones

In some areas, it is possible to install radio-telephone service, so that passengers can actually talk to the driver over the telephone. Theoretically, mobile telephone communication could preclude the need for a dispatcher. In practice, however, few transit operators use mobile telephone communication. It is the most expensive of all systems, with mobile units costing around $2,000 if purchased and $70 to $80 a month if leased. Also, mobile telephone service is not available in all areas of the country.

Telephone Pagers

While not ideal, pagers of the kind worn by doctors may be used under some circumstances by light-weight bus transportation systems. Each pager is a small one-way receiver; it has no broadcast capacity. The dispatcher dials a number on the telephone, the message travels along phone lines to a radio tower and is then broadcast to the receiver.

Pager units cost about $200 each. They may be purchased or rented; very often an operator will subscribe to a paging service and pay a monthly rate for both the pager and the service.

While one-way communication is better than no radio communication, the driver's inability to answer over the paging unit can be frustrating. In order to communicate with the dispatcher or with another vehicle, the driver must park the vehicle and find a telephone, losing valuable time from the schedule.

With patience and ingenuity, a one-way dispatch system can be made to work in some instances; drivers should be given call-in points from which they are scheduled to telephone the dispatcher. Local business people may allow your drivers to use their phones on a regular basis. Where the schedule is tight or the routes stretch over a large area, however, pagers are generally not adequate for radio communications.

Ordinary Telephones

It is possible to operate a light-weight bus transportation system with no radio equipment at all if passengers are required to reserve rides in advance and each driver is given a list of the day's scheduled boardings. As with the pagers, drivers are given "phone-in" points where they must call the office.

This system will serve under conditions of very light passenger loads, or extremely regular routes and schedules. A great deal of cooperation by passengers and drivers alike is required to make it function. However, there are times when there is no substitute for an instantaneous conversation between a driver and the dispatcher.

Some points to remember:

1. Buy sturdy equipment, even if it costs more.
2. Obtain a maintenance contract on any equipment you buy.
3. Obtain reliable advice and assistance prior to any purchase.

Section-IV Preventive Maintenance

Preventive maintenance means performing certain regular maintenance procedures on a vehicle to prevent malfunctions, rather than waiting until something goes wrong and then fixing it. It also means performing necessary repairs promptly, so as to keep damage minimal. Before you take delivery on your first vehicle, you should have firm arrangements for maintaining it. A good preventive maintenance program is as important to a successful transportation system as the purchase of the vehicles themselves.

Maintenance Arrangements

It may be advantageous to handle maintenance in one of several ways:

1. Contract maintenance out to commercial mechanics.
2. Arrange with other agencies, such as city or county garages, or school bus operators, to maintain vehicles.
3. Set up an "in-house" maintenance facility.
4. Keep some maintenance work "in-house" and contract out other work, depending on the job.

Many operators handle their maintenance by the fourth method, since certain jobs require special expertise and machinery. However, most one or two vehicle operations cannot afford the staff or facilities required to perform maintenance "in-house" on a regular basis. The major advantages of performing maintenance "in-house" are:

1. Vehicles will have priority for attention.
2. Mechanics will be familiar with your vehicles.
3. Most important, the mechanic will be your employee, and not someone else's.

To maintain your own vehicles, you will need certain minimal facilities. In most places, it is necessary to have a garage, or at least a building where vehicles can be brought under cover to be serviced. Your garage should have proper

drainage to permit the washing of vehicles, and preparations should be made for the disposal of waste motor oil.

There should be equipment for lifting and jacking vehicles. If a full hydraulic hoist is out of the question, at least have a good hydraulic jack and a set of jack stands.

Your mechanics should have as complete a set of tools as possible. At the very least, your transportation manager or chief driver should have a basic set of small tools so that necessary minor repairs can be performed on the spot -- something extremely important to good preventive maintenance.

Regardless of how the maintenance arrangements are made, the important thing is that you make them an integral part of the initial planning of your participation in any transportation program. Once the system is operating, there will not be time to stop and make these arrangements.

Maintenance Schedule

Once you have arranged for your maintenance facilities and personnel, work with your drivers and mechanics to develop a basic maintenance schedule. The drivers, or other attendants, can perform an important function in vehicle maintenance through a systematic daily inspection of each vehicle. The daily inspection should be made prior to each day's use of the vehicle and should include a thorough examination of the vehicle exterior, interior, and engine compartment. The items in Table 24 represent the most important elements of the daily check. Daily records should be kept for each vehicle indicating any damage sustained, repairs or adjustments necessary, and the amount of any fluid added to the vehicle. Problems should be reported immediately.

Mechanics should be made aware of the minimum maintenance requirements for each vehicle. Manufacturers' recommendations vary for each type of vehicle, but with every vehicle, certain maintenance must be performed either at a specific mileage or within a specific period of time, or the vehicle's reliability will suffer, its worklife may be shortened, and the warranty

TABLE 24

ELEMENTS OF THE PRE-TRIP DAILY VEHICLE INSPECTION

Exterior Inspection	Interior Inspection	Engine Compartment
•Headlights	•Wheelchair Lift	•Fluid Levels
•Turnsignals	•Wheelchair Restraints	•Motor Oil
•Back-up Lights	•Passenger Restraints	•Transmission
•Tires, for inflation and tread wear	•Brakes	•Brake
•Windshield Wipers	•Steering	•Steering
•Windows	•Transmission Selector	•Radiator
•Mirrors	•Gauges and Indicators	•Battery
•Cleanliness	•Cleanliness	•Windshield Washer
•Body Damage		•Belts and Hoses

provisions may be violated.

The State of Michigan recommends the following minimum maintenance schedule for vans and small buses in passenger service (MDOT):

Every month:

1. Change motor oil.
2. Replace oil, air, and fuel filters.
3. Lubricate chassis.

Every 8,000 miles:

1. Check brakes, replace parts if necessary.
2. Check wheel bearings, repack or replace if necessary.

Every 10,000 miles:

1. Rotate tires, replace if necessary.

Every 12,000 miles:

1. Tune engine.
2. Replace spark plugs.

Every 15,000 miles:

1. Service transmission.
2. Change oil in rear axle differential.

As needed:

1. Spark plug and coil wires.
2. Belts and hoses.

In addition, other items of maintenance are bound to arise:

1. Rustproofing, if not included in purchase specifications.
2. Alternator replacement.
3. Starter motor replacement.
4. Windshield wiper motor replacement.
5. Exhaust components, including mufflers, manifolds, pipes, hangers, and clamps.
6. Headlamps, and bulbs for turn signals, brake lights, and marker lights.

7. Vehicle interior fittings and seat materials.
8. Windshield wiper blades.
9. Wheelchair lift components.
10. Wheelchair restraint components.

Replacement frequency for these unscheduled items varies widely with operating conditions. Unscheduled repairs will occur in any transportation system, and preparations should be made to take care of them quickly.

It should be remembered that a manufacturer may recommend a more frequent schedule for specific maintenance items, in which case the manufacturer's recommended maintenance schedule should be followed.

Remember also that regular washing and cleaning are important to good maintenance, especially where salt is used for clearance of roads and widewalks. Accumulated salt will greatly accelerate rusting. Where chloride compounds are used to control dust on unpaved roads, they may even cause a corrosion problem in summer. It is thus important to plan for regular and frequent washing as part of basic maintenance.

Whatever arrangement you make for maintenance, the important thing is that someone must take the responsibility for seeing to it that the maintenance actually gets done. Transportation staff should understand that they are individually and jointly responsible for the condition of the vehicles. Drivers should be encouraged to report any malfunctions, and the transportation manager should see to it that repairs are performed promptly. In general, the faster repairs are made, the less they cost, and the better the preventive maintenance, the fewer repairs are necessary.

Maintenance Records

A maintenance chart should be prepared for each vehicle and kept readily accessible. It is important to be able to check quickly to see when each vehicle is due for preventive maintenance, and to note what maintenance still needs to be

performed. It is equally important to keep complete records of what maintenance and repairs have already been performed, since recurring malfunctions of the same part may indicate that corrections are needed in the operation or maintenance of the equipment, or that changes in the design of the vehicle or of individual components may be necessary.

Maintenance forms should be easy to find and easy to work with. Included in Appendix B are sample forms already in use by the State of Michigan for both the daily inspection and monthly maintenance schedule. You may wish to design your own record system. The exact layout of the forms may vary, but the use of the records is crucial. Complex forms are useless if no one has the time to fill them out.

It is essential to keep a complete file of repair bills on each vehicle. These bills will tell you a great deal about your vehicles and the care they are receiving.

Operating Costs

It is important to have a secure source of operating funds established prior to start-up of a light-weight bus transportation system. Seldom, if ever, do passenger fares cover operating costs, and an outside source of subsidy is usually necessary. For example, for the last six months of fiscal year 1978-1979, operating revenues (fares) only accounted for an average of 22 percent of operating costs for 30 non-urban light-weight bus programs operating in Michigan. The remainder of operating expenses were met through state and local subsidy.

The magnitude of operating costs for light-weight bus systems depends on a combination of many factors including the number of vehicles operated, the number of passengers carried, the vehicle miles of service offered, the terrain and climate of the service area, employee wages, and the level of maintenance performed. Evaluation of several of these factors for 30 non-urban light-weight bus systems operating in Michigan during fiscal year 1978-1979 revealed no simple relationship

between total operating cost and any single factor. However, as shown in Figure 40, there is a distinct relationship between annual vehicle miles of service and annual cost. The diagonal lines in Figure 40 represent the boundaries for the range of values for 90 percent of the non-urban light-weight bus programs.

The evaluation indicated that the average values of the operating characteristics for these 30 systems would yield a reasonable estimate of annual operating costs. Table 25 contains these summary statistics. The average operating cost per passenger for these systems was $1.89, and the average cost per vehicle mile was $.85.

Maintenance is an integral part of a system's operating cost, and it is important to set aside in advance enough money for maintenance and repairs. Otherwise, there may not be time to find the money for unscheduled repairs without a serious disruption in service.

Your maintenance budget will depend on the type of vehicle you buy, the cost of local mechanical labor and parts, and the severity of weather and road conditions in your area. Operators of passenger vans and small buses in Michigan advise that a safe maintenance budget should run between $1,500 and $2,500 per vehicle per year. They note that maintenance costs increase as a vehicle ages, and they also note that vehicle parts and labor costs are among the fastest rising costs in the economy.

To help get some idea of how much to budget for maintenance, talk to other vehicle operators in your area, either passenger or freight. Also contact local mechanics and parts suppliers regarding freight and repair costs in your locality. Don't underestimate the expense of running a passenger van or a small bus; this can be an expensive operation.

Current (1979) cost estimates for many of the standard maintenance items are shown in Table 26. The labor costs cited are approximately those for an in-house mechanic. Commercial mechanics are currently (1979) charging about $24.00

per hour, and the labor cost estimates shown in Table 26 should be adjusted accordingly if any repairs have to be contracted out.

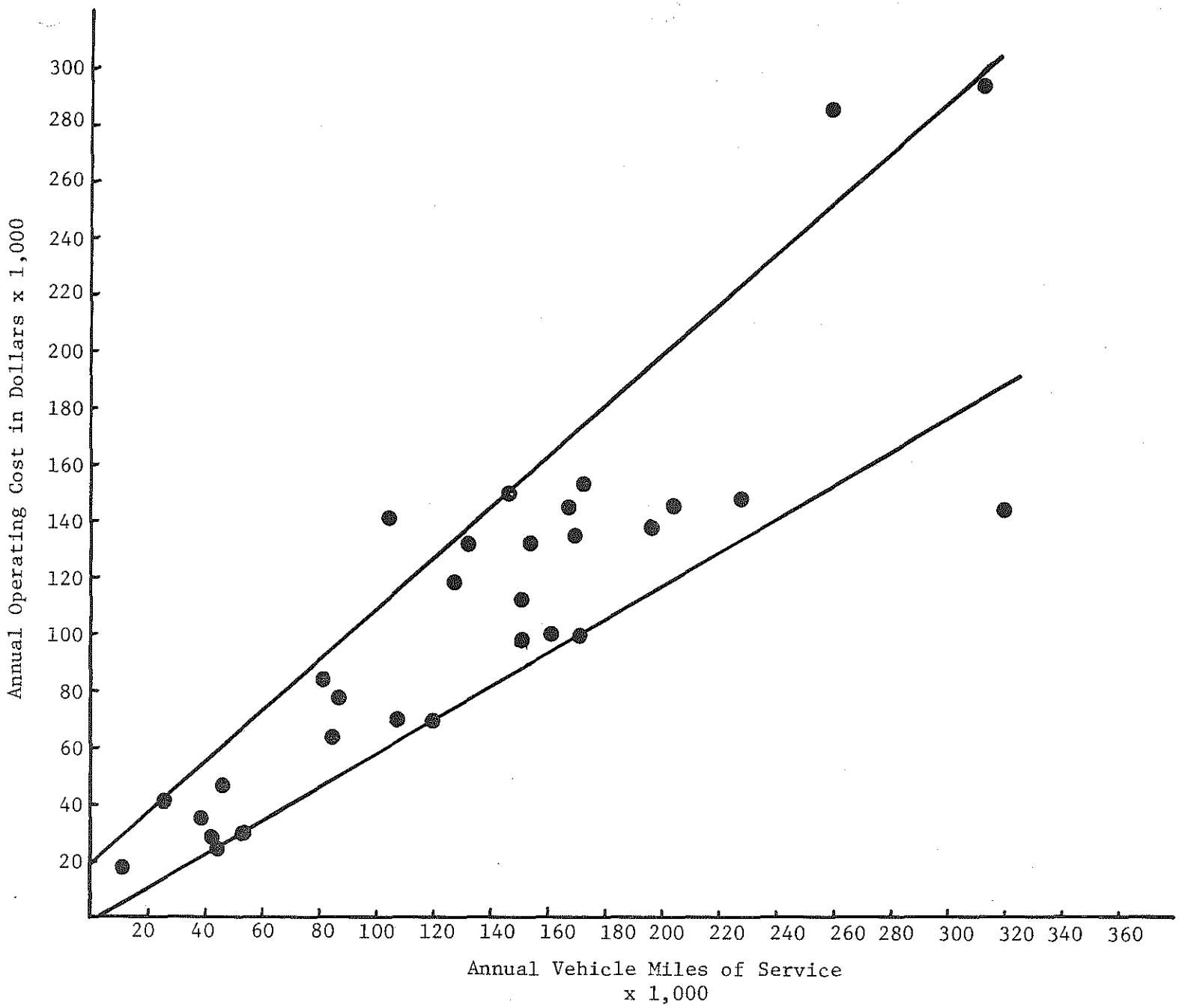


Figure 40. Annual Operating Cost as Related to Annual Vehicle Miles of Service for 30 Non-Urban Light-Weight Bus Programs in Michigan (FY 78-79).

TABLE 25

AVERGE ANNUAL OPERATING STATISTICS FOR 30 NON-URBAN LIGHT-WEIGHT BUS SYSTEMS IN MICHIGAN (FY 78-79)

	Average	Range	Standard Deviation
Operating Cost ($)	120,506	19,297 - 356,798	78,760
Vehicle Miles	146,253	11,817 - 342,652	85,092
Passengers	64,030	12,125 - 134,518	32,141
Number of Buses	5.10	1 - 17	3.32
Population of Service Area	15,790	2,071 - 44,594	11,399
Operating Cost per: Vehicle Mile ($)	0.85	0.45 - 1.63	0.25
Passenger ($)	1.89	0.83 - 3.91	0.79
Passengers per Vehicle Mile	0.53	0.13 - 1.03	0.21

SOURCE: Michigan Department of Transportation Records.

TABLE 26

MAINTENANCE COST ESTIMATES BY MAINTENANCE ITEM
(in 1979 Dollars)

I.	Basic Lubrication and Filter Change		
	A. Motor Oil:	6 quarts X $.60/quart	= $ 3.60
	B. Oil Filter:		= 2.00
	C. Fuel Filter:		= 1.50
	D. Chassis Grease:		= 2.00
	E. Labor:	1 hour X $10/hour	= 10.00
			$ 19.10
	Every other oil-change add: Air Filter		= $ 5.00
	Every 6 months add: Change Rear End Gear Lube		= 10.00
II.	Brakes		
	A. Front Disc Brakes:		
	1. Turn rotors:	$10 each X 2	= $ 20.00
	2. Replace pads:	$18 set X 2	= 36.00
	3. Rebuild Calipers:	$3/kit X 2	= 6.00
	4. Labor:	1 hour X $10/hour	= 10.00
			$ 72.00
	B. Rear Drum Brakes:		
	1. Reline shoes:	$20/set X 2	= $ 40.00
	2. Turn drums:	$10/each X 2	= 20.00
	3. Labor:	2 hours X $10/hour	= 20.00
			$ 80.00

If needed: Wheel Cylinder Kits	$5/kit X 2	=	$ 10.00
If needed: Entire Wheel Cylinder	$10 each X 2	=	20.00
III. Engine Tune-Up			
A. Spark Plugs:	$1.00 each X 8	=	8.00
B. Spark Plug Wires:	$20/set	=	20.00
C. Distributor Rotor:		=	1.00
D. Distributor Cap:		=	4.00
E. Labor:			
1. Check air gap:			
2. Adjust carburetor:			
3. Adjust vacuum advance:	1 hour X $10/hour	=	10.00
4. Check timing:			$ 33.00
IV. Transmission Service			
A. Transmission Fluid:	$2.06/gallon X 2	=	$ 4.12
B. Filter:		=	2.00
C. Labor:	1 hour X $10/hour	=	10.00
			$ 16.12
V. Major Components Needing Replacement			
A. Alternator:			
1. Part:		=	$ 40.00
2. Labor:	1 hour X $10/hour	=	10.00
			$ 50.00

B.	Starter Motor:		
	1. Part:		= $ 40.00
	2. Labor:	1 hour X $10/hour	= 10.00
			$ 50.00
C.	Universal Joints:		
	1. Part:	$5.00 each X 2	= $ 10.00
	2. Labor:	$10/hour X 2 hours	= 20.00
			$ 30.00
D.	Shock Absorbers:		
	1. Part:	$25.00 each X 4	= $ 100.00
	2. Labor:	$10/hour X 1 hour	= 10.00
			$ 110.00
E.	Radiator:		
	1. Part:		= $ 100.00
	2. Labor:	$10/hour X 1 hour	= 10.00
			$ 110.00
F.	Motor Mounts:		
	1. Part:	$6.00 each X 3	= $ 18.00
	2. Labor:	$10/hour X 1 hour	= 10.00
			$ 28.00
G.	Engine: (Including Manifold, Starter, Alternator)		
	1. Engine (New):		= $1100.00
	2. Labor:	$10/hour X 16 hours	= 160.00
			$1260.00

H.	Transmission:		
	1. Transmission (New):		= $ 600.00
	2. Labor:	$10/hour X 12 hours	= 120.00
			$ 720.00
I.	Differential and Rear Axle Assembly:		
	1. Assembly (New):		= $ 600.00
	2. Labor:	$10/hour X 12 hours	= 120.00
			$ 720.00

Source: Ann Arbor Transportation Authority, Ann Arbor, Michigan, 1979.

Section-V Operating Experience with Light-Weight Accessible Buses and Component Maintenance

The State of Michigan has now accumulated several years of experience with modified vans and small buses in regular passenger service. While conditions in Michigan do not replicate operating conditions in every other part of the country, experiences there may give a good indication of what can be expected of a passenger vehicle under extremely adverse conditions.

Vehicles in Use

The vehicles currently used in light-weight bus programs in Michigan are either:

1. Raised-roof van conversions, usually built onto Dodge B-300 or Ford E-350 chassis by:
   a. RICO
   b. National Coach
   c. Collins
   d. Coach and Equipment

2. Small buses, chiefly:
   a. Carpenter Cadets;
   b. Wayne Transettes;
   c. Coach and Equipment Fortibuses.

   These buses are built onto either Dodge, Chevrolet, or Ford one-ton truck chassis.

Most of the vehicles have V-8 gasoline engines, automatic transmissions, and power steering and brakes. Many are equipped with lifts and restraint mechanisms for wheelchairs. Some are fitted with two-way radios.

Vehicle Component Experience

Consensus among operators in Michigan seems to be that while the vehicles presently available are not ideal, the Dodge and Ford van conversions, and the Cadet, Transette, and Fortibus small buses are basically serviceable, and that with proper handling and good mechanical attention, these

vehicles can be kept running at a reasonable level of reliability.

In order to provide prospective light-weight bus operators with an idea of what to expect from one of these vehicles, what follows is a summary of experience with the component parts of small passenger vehicles in general, gathered from several long-time operators of these vehicles in the State of Michigan. The maintenance noted here should be considered minimal rather than definitive.

Engines

Both van conversions and small buses usually use gasoline-powered V-8 truck motors. These engines are made for heavy-duty service, and under most conditions can provide adequate power for passenger service.

Different operators have different preferences among Dodge, Chevrolet, and Ford engines; each has its own individual operating characteristics. Most operators agree that if properly cared for, any of these engines will give reasonable, reliable service. A well-maintained engine may go over 100,000 miles before requiring a major overhaul.

Operators stress that engine life depends very heavily upon the care the engine is given, both by drivers and by mechanics. Regular oil and oil filter changes are of prime importance, followed closely by careful treatment by drivers. Operators also emphasize that a gasoline engine driven at low speeds for long periods of time requires special maintenance measures to keep carburetor and combustion chambers cleaned out.

Electrical components take an especially heavy load on vehicles equipped with wheelchair lifts. Operators suggest that a light-weight vehicle in transit service should be equipped with an alternator with at least an 80 ampere output for a vehicle without a wheelchair lift, and a 100 ampere output for any vehicle with a wheelchair lift and/or two-way FM radio communications equipment. A powerful quick-recharge

type battery is also mandatory.

In localities where the roads are especially rough, vibration will tend to break down radiators, necessitating frequent repair or replacement.

For an engine in regular passenger service, operators stress that manufacturer's recommended maintenance schedules should be considered minimum, and will usually have to be exceeded considerably to get the maximum life out of an engine. For good engine maintenance:

1. Keep the oil clean and at the correct level. In general, change the oil and the oil filter on schedule, but watch the dipstick. When a vehicle needs its oil changed, the oil on the dipstick will look dirty and constantly run a quart low no matter how much oil is added. When the oil reaches this stage, it has lost much of its lubricating capacity. Change the oil and filter rather than adding any more oil.
   The oil level is important. Both running low on oil or overfilling the crankcase can damage the engine. The dipstick should be checked with the vehicle sitting level. After shutting off the engine, wait several minutes to allow the oil to drain back into the pan before checking the dipstick.

2. Between full tune-ups, ignition and carburetor can be kept adjusted. Spark plugs can be kept clean and correctly gapped. Pay attention to the running of the engine -- if it starts to run rough, stall, hesitate, or smoke, the engine should be promptly adjusted back into smooth operation. The engine will last longer, as well as run better.

3. Change air and fuel filters on schedule, or as needed. Under dusty conditions, frequent changes of air filters may be needed. Likewise, persistently dirty gasoline may require that gas line filters be changed ahead of schedule.

4. Keep belts and hoses in good condition, and properly adjusted. A loose fanbelt will result in insufficient alternator output and eventually a dead battery. A broken fanbelt will cause the engine to overheat rapidly. A loose or broken gas line can cause a fire. Rubber deteriorates under heat and friction, so belts and hoses need constant attention. An overly

tight belt can also cause premature failure of alternators or power steering units.

5. Make sure that antifreeze protection is sufficient. Don't take chances -- frozen coolant can crack an engine block, as well as breaking the radiator and hoses. In cold weather, windshield washer antifreeze should be substituted for water in the windshield washer reservoir.

None of this mechanical attention requires either sophisticated equipment or extensive facilities. It does require that someone pay attention to the engine from day to day and from week to week. Since the driver is the staff member with the closest contact with the vehicle, drivers should be made responsible for paying attention to the engine and reporting any malfunctions or necessary maintenance promptly.

Drivers must also understand that proper handling is essential to prolonging engine life. Slow-speed, stop-and-go driving is hard on a gasoline engine, and drivers must learn to compensate for the fact that the engine is being driven under adverse conditions. Operators caution drivers on the following points regarding treatment of the engine:

1. CHECK THE MOTOR OIL DAILY BEFORE STARTING ANY ENGINE. Coolant, battery water, and transmission fluid should be checked at least once a day, or if trouble is indicated by dashboard gauges, but the motor oil level should be watched religiously.

2. DON'T RUN A COLD ENGINE HARD. Parts aren't properly lubricated until the motor has run for a few minutes. Don't "rev" the motor any harder than necessary to start it. Either idle the motor for a few minutes or drive it gently for a mile or two before taking it up to highway speed, especially in cold weather.

3. WATCH THE GAUGES ON THE DASHBOARD. Don't ignore either overcharging or discharging on the ammeter. If the oil pressure gauge reads low or the temperature gauge reads high, shut the motor off immediately, unless otherwise instructed by the owner's manual supplied by the vehicle manufacturer.

4. PAY ATTENTION TO ENGINE SMELLS AND NOISE. If it smells wrong or sounds wrong, something probably is wrong.

5. KEEP THE MOTOR "BLOWN OUT". At low speeds, a gasoline engine does not clean itself out properly, and carbon and other deposits accumulate in the carburetor and the combustion chambers. If your operation does not include some highway driving every day, have the last driver of the day take the vehicle to a stretch of open road and run the motor up through all the ranges of the transmission. It isn't necessary to "floor" the accelerator -- 3/4 of the way down will do the job.

Coupled with the standard maintenance schedule, these precautions will keep an engine operating to the best of its capacity for as long as possible.

Transmissions

The automatic transmissions in use on most light-weight buses will usually run between 60,000 and 80,000 miles before requiring replacement. Transmissions are extremely intolerant of abuse, however, and operators report that bad driving habits may completely ruin the entire unit in a very short time. Operators emphasize that drivers should avoid trying to "rock" a stuck vehicle free by spinning the wheels, since this is a major cause of transmission damage.

Overheating has been a problem with some automatic transmissions in light-weight transit service. In areas where the terrain is steep, it may be advisable to install a transmission cooler in addition to the standard radiator connection for the transmission lines.

The transmission also requires constant care and attention, since small vehicles in regular passenger service subject transmissions to heavy loads under start-and-stop conditions. Operators suggest:

1. UNDER CONDITIONS OF HEAVY USE OR STEEP TERRAIN, SPECIFY OR INSTALL A TRANSMISSION OIL COOLER. This is a small radiator for the transmission fluid alone. Heat is the great enemy of transmission parts, and under heavy wear, the main

radiator may not be able to cool the transmission fluid sufficiently. Once overheated, transmission fluid is degraded.

2. SERVICE THE TRANSMISSION ON SCHEDULE, AND PAY ATTENTION TO THE COLOR AND LEVEL OF THE FLUID ON THE DIPSTICK. Change the transmission fluid and change or clean the filter screen according to your maintenance schedule, and adjust the transmission bands as well. Between scheduled service, notice the level and the color of the fluid on the dipstick. The fluid should be clear and rosy. Dark fluid and a burned smell are often signs of trouble. Such fluid should be replaced after the transmission is serviced and any damage repaired.

3. WATCH FOR LEAKAGE. A puddle of transmission fluid under a standing vehicle may indicate that a seal or connection is leaking.

Drivers should be shown how to care for the transmission:

1. DRIVE GENTLY. Accelerate smoothly -- avoid jackrabbit starts.

2. IF YOU GET STUCK, CALL A TOW TRUCK. Operators cite a major source of transmission damage in drivers trying to dislodge a stuck vehicle by "rocking" or "spinning" the vehicle loose. What you save in towing fees may be lost several times over in transmission repairs.

3. PAY ATTENTION TO THE PERFORMANCE OF THE TRANSMISSION. Drivers should know at what speed the transmission is supposed to shift. If it doesn't shift on schedule, it may need fluid or an adjustment.

Drive Line and Rear End

Operators report that with careful driving and regular lubrication, drive shaft, universal joints, and differential-rear axle parts are not a major source of trouble. Universal joints have a limited lifespan, depending upon driving conditions and vehicle handling.

Vehicles can be ordered with the differential gear ratio best suited to the type of service the vehicle will be performing. This will improve gas mileage and prolong the life

of the engine.

In light-weight bus service, a rear-axle-differential assembly can give about 90,000 miles of service before requiring replacement.

As with other components, driving which is most comfortable for passengers is also easiest on drive train components. Passenger operations subject drive shafts and universal joints to extremely hard wear. Differential and rear axle parts also take a beating. To preserve these parts as long as possible:

1. LUBRICATE U-JOINTS AND CHANGE DIFFERENTIAL OIL ON OR AHEAD OF SCHEDULE.

2. WATCH SEALS IN DIFFERENTIAL HOUSING AND REAR AXLE FOR SIGNS OF LEAKAGE. Pulling or dampness in the rear brakes may indicate that a seal is leaking. Also watch for a puddle of fluid under the differential housing.

3. REPLACE WORN U-JOINTS PROMPTLY. A worn universal joint gives off a buzzing vibration when the vehicle is moving, especially when either accelerating or decelerating. Worn U-joints will also give an audible "clank" when the vehicle is put into forward or reverse range from "neutral" or "park", or from forward to reverse or vice versa. Worn universal joints should be replaced before damage to the driveshaft occurs; a broken universal joint will completely disable the vehicle.

Drivers should:

1. BE ALERT FOR NOISES OR OTHER INDICATIONS OF DRIVE LINE TROUBLE.

2. AVOID HARD ACCELERATION.

Brakes

Most light-weight buses are equipped with disc brakes on the front wheels, and drum brakes on the rear wheels. The reason for this is the added brake life and stopping performance obtained with front disc brakes; since the front brakes absorb most of the stopping load, rear disc brakes are not considered a necessity.

Operators report that under heavy passenger service, front and rear brakes wear rapidly. This is especially true where start-and-stop driving is coupled with steep terrain. In such places, brakes may need new brake pads and shoes as often as every 7,000 miles.

Operators say that while driving habits and maintenance are important to prolonging brake life, a vehicle in bus service can be expected to go through many sets of brake linings and pads during the lifetime of the vehicle.

Brakes will require constant attention on any vehicle in regular passenger service. Every operating budget should allow generous expenditures for brake parts, and reliable sources of brake parts and service should be found before operations begin. To get the maximum wear out of brakes:

1. FRONT DISC BRAKES:
   - A. CHECK PADS FOR WEAR, REPLACE BEFORE THEY WEAR ALL THE WAY DOWN.
   - B. KEEP CALIPERS FREELY-OPERATING AND PROPERLY-ADJUSTED.
   - C. DO THESE JOBS IMMEDIATELY WHEN NEEDED. If a brake pad wears through completely or a caliper binds or malfunctions, the rotor can be damaged in less than a day's driving.
2. REAR DRUM BRAKES:
   - A. CHECK SHOES FOR WEAR, REPLACE BEFORE THEY WEAR ALL THE WAY DOWN.
   - B. KEEP SHOES PROPERLY-ADJUSTED.
   - C. WATCH WHEEL CYLINDERS AND AXLE SEALS FOR SIGNS OF LEAKAGE.
   - D. PERFORM REPAIRS AND ADJUSTMENTS PROMPTLY.
     - (1) If shoes wear through, drums will be damaged.
     - (2) Leaking brake fluid or rear-end lubricant will interfere with braking and damage shoes.

Drivers should:

1. DRIVE SO AS TO AVOID THE NEED FOR HARD, SUDDEN BRAKING.

2. BE ALERT FOR TROUBLE.

   A. Pay attention to the feel of the brake pedal. A low or spongy pedal indicates a leak in the system or air in the lines.

   B. Notice if the brakes pull to either side.

   C. Learn to recognize the sharp, sweet smell of leaking brake fluid.

3. BE SURE THE EMERGENCY BRAKE IS RELEASED BEFORE PUTTING THE VEHICLE IN GEAR. Drivers should develop a reflex action of working the emergency brake release lever before moving the transmission selection lever.

Have any brake trouble fixed immediately -- any brake malfunction is a safety hazard.

Steering and Front End

Virtually all light-weight buses are equipped with power steering. A power steering unit will usually last the worklife of the engine, although fluid level, seals, and hose connections must be checked regularly for signs of fluid leakage.

Operators say that it takes extreme care on the driver's part to keep from throwing the front end out of alignment. Hitting curbs or chuckholes, or driving too fast across railroad tracks can spoil front end alignment quickly. Drivers should be taught how to approach a stop at a curb so as to avoid striking the curb with the front wheels.

Operators also say that it is critical to keep the front end lubricated, especially where road and weather conditions are severe. It may be necessary to exceed considerably manufacturer's specifications on frequency of lubrication. Good maintenance includes:

1. CHECK THE LEVEL OF THE POWER STEERING FLUID DAILY, AND WATCH HOSES, SEALS, AND CONNECTIONS FOR SIGNS OF LEAKAGE.

2. UNDER SEVERE OPERATING CONDITIONS, LUBRICATE THE FRONT END WELL AHEAD OF SCHEDULE. Some operators install grease fittings on all joints in the front end, rather than relying on factory-sealed joints.

3. WATCH FRONT TIRES FOR UNEVEN WEAR. Uneven tread wear may indicate that the front end needs alignment.

4. KEEP STEERING BELTS PROPERLY ADJUSTED.

Drivers should:

1. AVOID HITTING CURBS OR DRIVING FASTER THAN NECESSARY ON ROUGH PAVEMENT OR ACROSS RAILROAD TRACKS.

2. AVOID HOLDING THE STEERING WHEEL HARD TO LEFT OR RIGHT TO THE POINT WHERE THE POWER STEERING UNIT WHINES. The force of the power assist can damage front-end parts.

3. REPORT SLIPPING BELTS OR OTHER STEERING MALFUNCTIONS.

4. BE ALERT FOR PULLING TO RIGHT OR LEFT WHILE DRIVING.

Chassis and Body

The chassis assemblies on light-weight buses have not been a major source of trouble in themselves. Problems have arisen, however, from the addition of a raised roof, or the fitting of a bus body onto the chassis. The most immediate difficulty is that the same vehicle is under warranty by two different companies. Jurisdictional disputes may arise over warranty work close to the dividing line between the two sections of the vehicle.

Experience indicates that the vehicle industry has needed some practice to get a good "fit" between body and chassis, and between body and raised roof. A raised-roof on a van is basically a fiberglass bubble attached to the body of the van,

either with or without steel reinforcement. On some installations, leaks will occur. Bus body "fit" problems have also included gaps in insulation which allow either cold air or fumes or both to blow into the vehicle.

A recurring difficulty in small buses and vans has been the installation of wiring and hoses. Short circuits have been caused by screws being turned through wires running between interior and exterior panels. Wires and hoses have been installed so that they contact body parts and wear through.

In general, the body problems of light-weight bus equipment are those of a composite vehicle:

1. No one manufacturer is clearly responsible for the entire vehicle.
2. The vehicle is not really designed as a unit.

Experience in small bus construction has been limited, and manufacturers may still be in a stage of trial and error. For whatever reason, operators cite these composite-vehicle difficulties as among the most frequent causes of trouble with light-weight bus equipment.

Corrosion and vibration are constantly at work upon the chassis and body of a passenger vehicle. Care should be taken to counteract these forces.

1. RUSTPROOF EVERY VEHICLE BEFORE IT IS PUT INTO SERVICE.

2. WAX EACH VEHICLE AT LEAST ONCE A YEAR.

3. IF POSSIBLE, HAND-WASH EACH VEHICLE AT LEAST ONCE A WEEK. Pay attention to wheel wells and the rest of the underside of the vehicle, where salt may accumulate.

4. MAKE A THOROUGH TIGHTENING AN IMPORTANT PART OF REGULAR MAINTENANCE. At least once a week, go over each vehicle and make sure all screws, nuts, and bolts are properly adjusted to the manufacturer's torque specifications. A common cause of damage is that vehicles literally shake apart. Shock absorbers and steering parts have been known to separate completely, and body parts sometimes fall off and get lost. Loose parts should be tightened before nut, bolt, and screw threads become stripped.

5. CHECK THE CONDITION OF WIRING AND HOSES. Watch the ammeter; a small, constant discharge may indicate a short circuit. Antifreeze on the floor of the vehicle means a leak in the heater-defroster. Such leaks also cause windows to steam up, and heater output to be reduced.

Drivers can:

1. TAKE IT EASY ON ROUGH PAVEMENT. Where the road is bad, slow down. In most places, the law requires a complete stop at railroad crossings -- obey it to the letter.

2. PAY ATTENTION TO NOISES AND VIBRATIONS THAT INDICATE LOOSE PARTS. Report these promptly.

3. WATCH THE AMMETER AND TEMPERATURE GAUGES. Report readings that indicate trouble.

Tires

Tires are a major consideration for every motor vehicle operator. They are important:

1. As a vehicle component whose regular replacement must be budgeted.

2. As a maintenance item requiring constant attention, both for reasons of economy and reasons of safety.

A well-cared-for tire will give between 8,000 and 20,000 miles of service. Tire life depends upon a variety of factors:

1. Local climate conditions. Heat is a tire's great enemy.

2. Local road conditions, including pavement material. Chuckholes and sharp objects in the pavement will shorten tire life. Certain paving materials also wear tires more rapidly than do other materials.

3. Proper inflation. This is probably the most critical. A tire in regular passenger service gets very hard wear, and needs constant care to prolong its worklife.

4. Load. Overloading a tire will cause it to wear rapidly. Make sure that all of the tires on a vehicle are designed to carry the weight load they will be subjected to.

The most important thing in the care of a tire is to keep it inflated to the correct pressure. The correct pressure will vary with the load carried, but every tire is designed to be inflated to a certain pressure under a certain weight of loading. Know these specifications for all of your tires, and see to it that drivers check tire pressure at least once daily. Tires should always be checked when they are cool. Underinflation and overinflation are equally damaging.

The second key to tire preservation is correct driving. Drivers should:

1. Pay attention to the pavement, and avoid broken pavement, broken glass, or other sharp objects on the road.

2. Avoid "burning rubber". Accelerate and stop smoothly, and take corners gently.

3. Check tires visually each time they board the vehicle. If a tire looks low, or has a bulge in it, the driver should attend to it before it goes flat or blows out.

Front end alignment is also important. A misaligned front end will ruin front tires. Again, drivers should avoid hitting chuckholes, curbs, railroad tracks, or parking dividers. Uneven wear on the front tires indicates that the front end is out of line. If the trouble is caught quickly enough, the damage to the tires can be minimized.

Tires are designed to be "rotated" -- that is, shifted from one wheel to another according to a specified pattern, to even out the wear each tire receives. Rotation patterns vary; radial tires must be rotated differently than bias-ply tires. Know the correct rotation schedule and pattern for your tires, and follow the proper procedure.

Tires should be protected as much as possible from destructive substances. Allowing a vehicle to stand in puddles of petroleum substances can deteriorate tires. Summer sunlight can also deteriorate tires on vehicles left unused through the summer.

Figure 41 shows several patterns of tire wear and indicates the cause of each and the appropriate corrective measure. Inspect the tires periodically and note the wear patterns and tread depth.

It is recommended (MVMA, 1979) that a tire be replaced if (see Figures 42 and 43):

1. The tread is worn so that less than 2/32 inch (1.6 mm) remain when measured in any two adjacent major grooves at three locations spaced approximately equally around the outside of the tire. For vehicles over 10,000 lbs GVWR the steering axle wheels should be replaced under this criteria if the tread depth is below 4/32 inch (3.2 mm).

2. The tire is worn to the level of the tread wear indicators in any two or more adjacent tread grooves or when cord or fabric is exposed.

3. The tire is worn or regrooved so that cord is exposed through the tread.

4. The sidewall has damaged body cords.

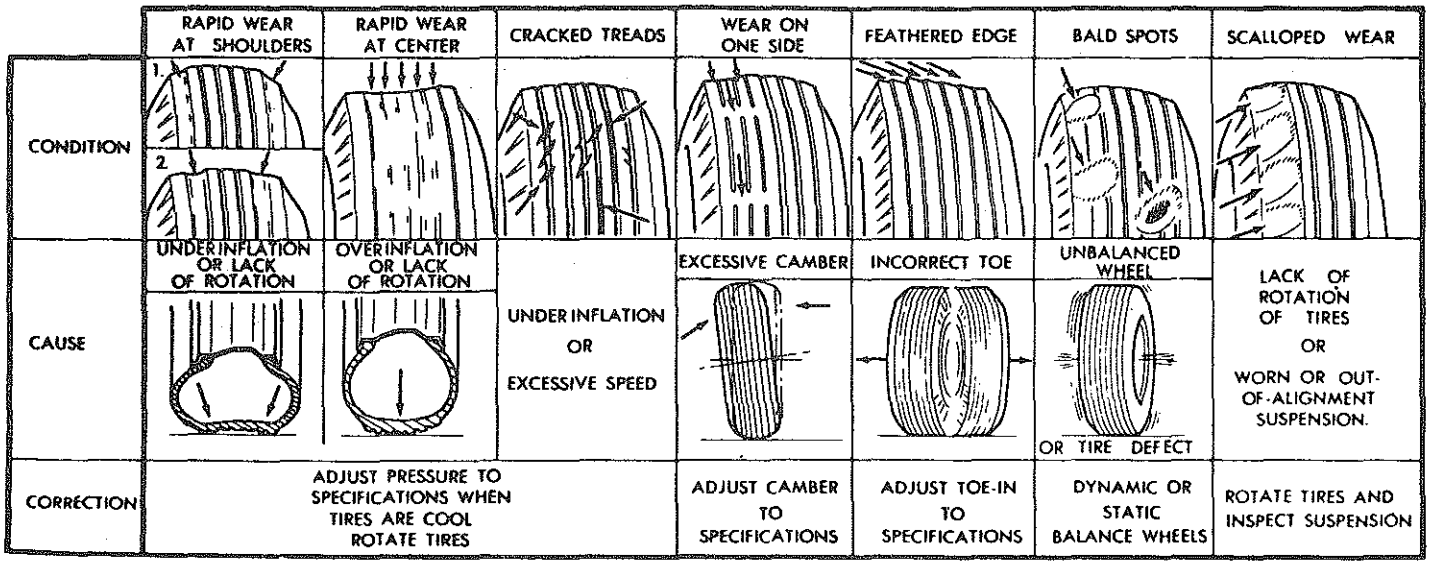
5. The tire has an unrepaired fabric break or has been repaired with a blowout patch or has a knot that is visible.

6. For vehicles over 10,000 lbs GVWR, a steering axle tire requires a reinforcement repair to the cord body.

7. The tire has tread cuts, snags or sidewall cracks in excess of one inch (25 mm) in any direction and deep enough to expose cords, or if the tire has visible bumps, bulges or knots indicating partial failure or separation of tire structure.

Tire manufacturers put out several informative manuals on tire makes and specifications. These can be obtained from any dealer. As with other components, the key rule in purchasing tires is to deal with reputable dealers and to buy the best quality products possible.

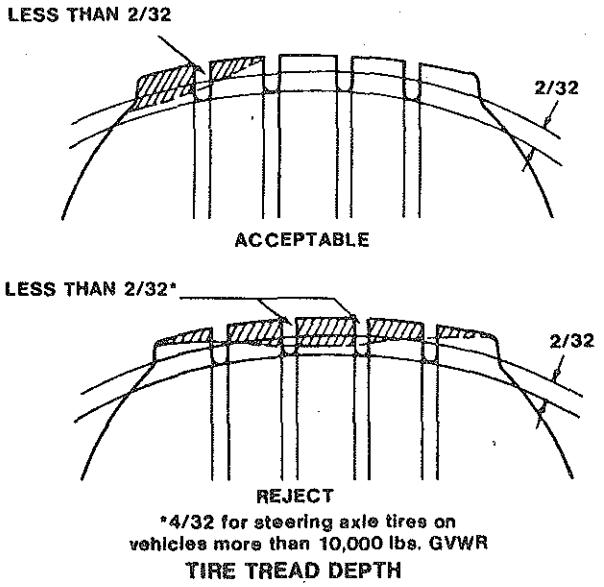
In general, you can now buy tires in two types of construction -- bias-ply and radial. These terms refer to the



TIRE WEAR PATTERNS

Figure 41.

Source: MVMA (1979)



TIRE TREAD DEPTH

Figure 42. Tire Tread Depth Requiring Tire Replacement.

Source: MVMA (1979)

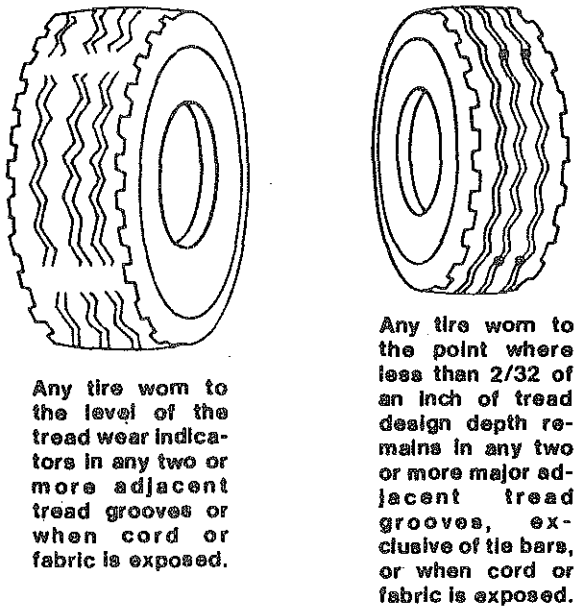


Figure 43. Tire Wear Requiring Tire Replacement

Source: MVMA (1979)

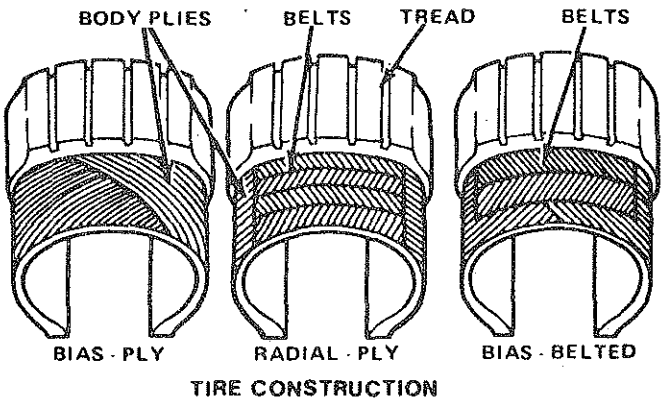


Figure 44.

Source: MVMA (1979)

angle of the cords of material which comprise the body of the tire. In a bias-ply tire, the cords run diagonally, at an angle to the centerline of the tread. In a radial tire, the cords are perpendicular to the centerline. Bias-ply tires may have a belt of non-extensible material running circumferentially around the tire directly under the tread. Radial tires are always "belted" in this way (see Figure 44).

Operators report varying experiences with radial versus bias-ply tires. Radial tires are more expensive than bias-ply. Under the right conditions, they may also last longer, and give a smoother ride and better fuel mileage. Radial tires take especially careful attention -- correct inflation on a radial seems to allow less margin for error than on a bias-ply tire. Radial tires are not interchangeable with non-radial tires -- it may be possible to run radial tires on a rear axle and bias-ply on the front, but never the other way around. A radial and a bias-ply tire should never be run on the same axle. No matter what type of tire is selected it is most important that all of the tires on the same axle be of the same size and construction.

In areas where heavy snow and deep mud are part of normal operating conditions, it may be advisable to mount snow tires on the drive axle. This may be especially good practice in the case of passenger vans with single rear wheels, as opposed to small buses with "duals" on the rear. Operators should consider the operating conditions in their own localities; if ice and freezing rain are more common than deep snow, then snow tires may not be advisable.

In especially steep and remote areas, operators may assign a set of tire chains to each vehicle. Chains are not for everyday operation, however, their use is very hard on a vehicle. With many operators, the rule seems to be: "If you need chains, better cancel service."

If possible, keep one spare tire per vehicle, mounted to a wheel and readily accessible. At the very least, keep one spare tire for every type of vehicle in the fleet. In many

localities, commercial road service is available for routine tire repair. Other operators must fix their own flat tires.

The important thing is to have the tire repair procedure worked out in advance. Drivers should know what to do or where to call in case of a "flat". Before allowing drivers to change any tire, be sure that they are physically capable of doing the job, that they know how to do it and that they have the right equipment. Vans and buses are heavier than automobiles, and an amateur tire change can result in serious injury.

Interior Passenger Comfort

In considering passenger comfort, manufacturers and operators have had to strike a balance between the requirements of passenger comfort and the need for compact dimensions. Operators usually give conservative estimates of actual as opposed to rated passenger capacity. True capacity will vary with the physical size of passengers. As a general rule, each wheelchair space will eliminate two ambulatory passenger spaces unless removable or folding seats are used.

Some light-weight buses are built and furnished very much like school buses. Since the suspension must be heavy-duty, these vehicles often give a hard ride. Some manufacturers offer optional seats with thicker cushions than standard; these may be essential in services carrying senior citizens or passengers in delicate physical condition.

Operators point out that careful thought should be given to the physical requirements of passengers; passengers who have trouble stretching, bending, or twisting should not be forced to negotiate cramped seats or narrow aisles.

There is some discussion among operators of the advantages of aisle-facing as opposed to forward-facing seats; aisle-facing seats are easier to get into and out of. On the other hand, passengers tend to dislike riding sideways, since acceleration, deceleration, and turns all cause discomfort to a side-facing passenger.

On van conversions and school bus type vehicles, the height of the first boarding step above ground level has presented difficulty for less agile passengers. The State of Michigan requires in its own vehicle purchase specifications that the first step on a vehicle be no more than 12 inches in height, and that each additional step be no more than nine inches in height (MDOT).

On vehicles purchased in the past, various means were tried to compensate for a high boarding step. Some operators have issued their drivers with portable footstools. Other operators have attached auxiliary steps of their own design and construction to their vehicles. With these arrangements, operators caution that whatever portable step is used must be sturdy, stay firmly in place when stepped on, and be easily cleared of snow and ice. A step welded or bolted to the vehicle may cause serious body damage if the driver strikes such a step against a curb or other obstruction.

On some early light-weight buses, automatically-extending electric steps were tried. These were not notably successful, since mud, ice, and corrosion often incapacitated the machinery.

Heating and ventilation are both sources of complaints on light-weight buses. In cold weather, light insulation combined with an enlarged body may render standard van heating units inadequate. In summer, poorly-designed ventilation and the protrusion of the engine into the passenger compartment make some vehicles uncomfortably warm. Roof vents can be helpful in ventilating a vehicle. Air conditioning units in light-weight buses have been prone to maintenance problems.

The interior of a passenger vehicle gets a great deal of wear. In general, the faster small damage can be mended, the longer the interior furnishings will stand up to the wear:

1. VERTICAL HANDHOLDS OFTEN WORK LOOSE. Since these are usually attached with metal screws, it is important to keep these tightened before the attachment holes and the screw threads become stripped.

2. DASHBOARD CONTROL KNOBS AND OTHER SMALL FURNISHINGS COME LOOSE, FALL OFF, AND GET LOST. Try to keep these parts tightened. If the part keeps coming off, it may be possible to improvise a fitting of your own that will work, rather than repeatedly buying new parts.

3. MEND TORN UPHOLSTERY QUICKLY. A rip only gets larger with time.

4. KEEP THE INTERIOR CLEAN. In the absence of heated storage facilities, this is easier said than done in winter. If a vehicle is mopped out and left outdoors overnight, there may be a dangerous amount of ice on the floor the next morning.

   There are no easy solutions to this problem. Operators must often simply do the best they can, keeping vehicles swept out and free of trash, and taking advantage of any brief warm weather.

   One partial solution is to bring the vehicle to a high standard of cleanliness before the cold weather arrives, and to try to keep it there. In this way, each individual cleaning job will be relatively small. Rubber or linoleum floor covering is recommended for ease of cleaning and maneuverability of wheelchairs. However, carpeting may be used where these considerations do not represent a problem.

Drivers can:

1. REPORT LOOSE PARTS IMMEDIATELY, BEFORE THE PARTS ARE LOST OR FURTHER DAMAGE IS DONE.

2. REPORT DAMAGE TO UPHOLSTERY.

3. KEEP THE VEHICLE SWEPT OUT AND DUSTED AT ALL TIMES.

Wheelchair Lifts and Restraints

Wheelchair lifts can be a major source of difficulty for several reasons:

1. The technology is in an early stage of development.
2. Manufacturers tend to enter and leave the field quickly.

3. Parts and service are not always locally available.
4. Lift machinery is vulnerable to wear, dirt, and rust.

There seem to be no easy solutions to the problem of lift reliability, except to buy the most durable machinery available, and to consider the local availability of parts and service when deciding which brand to install.

Operators also point out that regular cleaning and lubrication are absolutely essential for keeping lift equipment in operating condition. Drivers must also be carefully instructed on the correct operation of the lift, since one mistake can cause a great deal of damage. Three frequent causes of damage are:

1. Allowing the pistons to push the platform against the ground.
2. Moving a vehicle while the lift is lowered.
3. Careless handling of the control cord on some units:
   a. Dropping the control box.
   b. Catching the control cord in the machinery.

A supply of microswitches and other parts should be kept on hand, especially in locations where service is not readily available. It is also wise to have local mechanics learn to repair the lifts; manufacturers will often cooperate in this kind of training.

The main source of difficulty with wheelchair restraining equipment is that the technology of carrying wheelchair users as transit passengers is still in an early stage of development. In an accident, the wheelchair passenger will receive little protection unless lap and torso restraints are used in addition to the wheelchair restraint. Side-facing passengers are especially vulnerable even when secured with safety belts.

A further complication is that there are types of wheelchairs which cannot be secured with currently-available commercial restraint equipment. Some operators have built their

own locking devices for these. Some users of these chairs have enough strength to shift to regular bus seats. Others simply hold on to a handhold. Neither arrangement really affords satisfactory protection.

The chief operating difficulty with present restraining equipment is the time it takes to operate the restraints. It may take several minutes to secure a single passenger. Paraplegic passengers can often secure their own chairs into the restraints, but quadruplegic passengers require considerable assistance in getting their chairs positioned and locked down.

Operators say that the best they can do is to keep the restraint equipment tightened, adjusted, and lubricated. They also emphasize that drivers must be sure that the equipment is used properly. It is important that all locks and clamps be secured completely for the equipment to afford even minimal safety.

Maintenance - The Key Words

A light-weight bus service is often an attempt by dedicated people to make light-duty equipment do heavy-duty work under adverse conditions on a minimal budget. New operators often go into the program without fully understanding the difficulties involved in the simplest passenger vehicle operation.

In general, people who run the programs agree that these systems can be made to work under almost any conditions, given some ingenuity, some cooperation, and a lot of patience.

Everyone connected with these programs seems to feel that they are well worth the effort.

The key words to good maintenance are constant attention. With individual components and entire vehicles alike, the better the equipment is "looked after", the smaller the repair jobs will be when they do occur, the longer the vehicle will last, and the more reliable the service will be. Many operators feel that as a whole, the light-weight buses available for

transit use often receive heavier use than that for which they were designed. These vehicles may not always work reliably without attention -- but given constant care, they can be kept working reliably enough to maintain a reasonable level of service.

Some hints:

1. IF POSSIBLE, USE AS MANY VEHICLES OF THE SAME TYPE AS POSSIBLE FOR YOUR ENTIRE FLEET. It will be easier to find parts and will cut repair time.

2. IN CHOOSING YOUR VEHICLES, PAY ATTENTION TO THE AVAILABILITY OF PARTS. Some operators report delays of several weeks on replacement parts in some localities. Try to select a model for which parts can be found with the least possible delay.

3. IF POSSIBLE, STOCKPILE FREQUENTLY-REPLACED PARTS. Brake parts are first in this category, followed by exhaust components, filters and lubricants.

4. BUY THE BEST QUALITY PARTS AVAILABLE. Parts must at least equal original equipment specifications.

5. MAKE SURE THAT WHATEVER EQUIPMENT YOU BUY IS AS TOUGH AND SIMPLE AS POSSIBLE, WHILE STILL AFFORDING PASSENGERS AND DRIVERS A MINIMUM STANDARD OF COMFORT. Before you invest in furnishings for appearance's sake, such as special upholstery or carpeting, remember the amount of wear your vehicle is going to get, and be sure that all equipment on your vehicle can stand up to considerable punishment.

6. MAKE SURE THAT AS FEW DIFFERENT PEOPLE AS POSSIBLE OPERATE EACH VEHICLE. If possible, make one or two drivers responsible for each vehicle, and let them know that the vehicle is "theirs" to take care of.

Section-VI Preservation Driving

When all is said and done, the chief factor in the work-life of your vehicles will be the type of driving to which they are subjected. The basic fact of life in light-weight vehicle transit service is that most vehicles will receive harder wear than they were ever designed to endure. Given this fact, an operator's best hope of controlling maintenance costs is to see to it that vehicles get the best handling possible. Drivers should be taught to drive vehicles with a conscious effort to prolong the worklife of the vehicles. This kind of driving can be termed preservation driving.

A professional driver training program may be a very good investment. State agencies, police or sheriff's departments, or local school districts may offer driver training courses -- you may be able to contract with one of these agencies to train your drivers. The fact that your drivers undergo formal training may help to lower your insurance rates. It will certainly cut your maintenance, repair, and replacement costs. The training of your drivers should be another important part of your initial planning for participation in any transportation program.

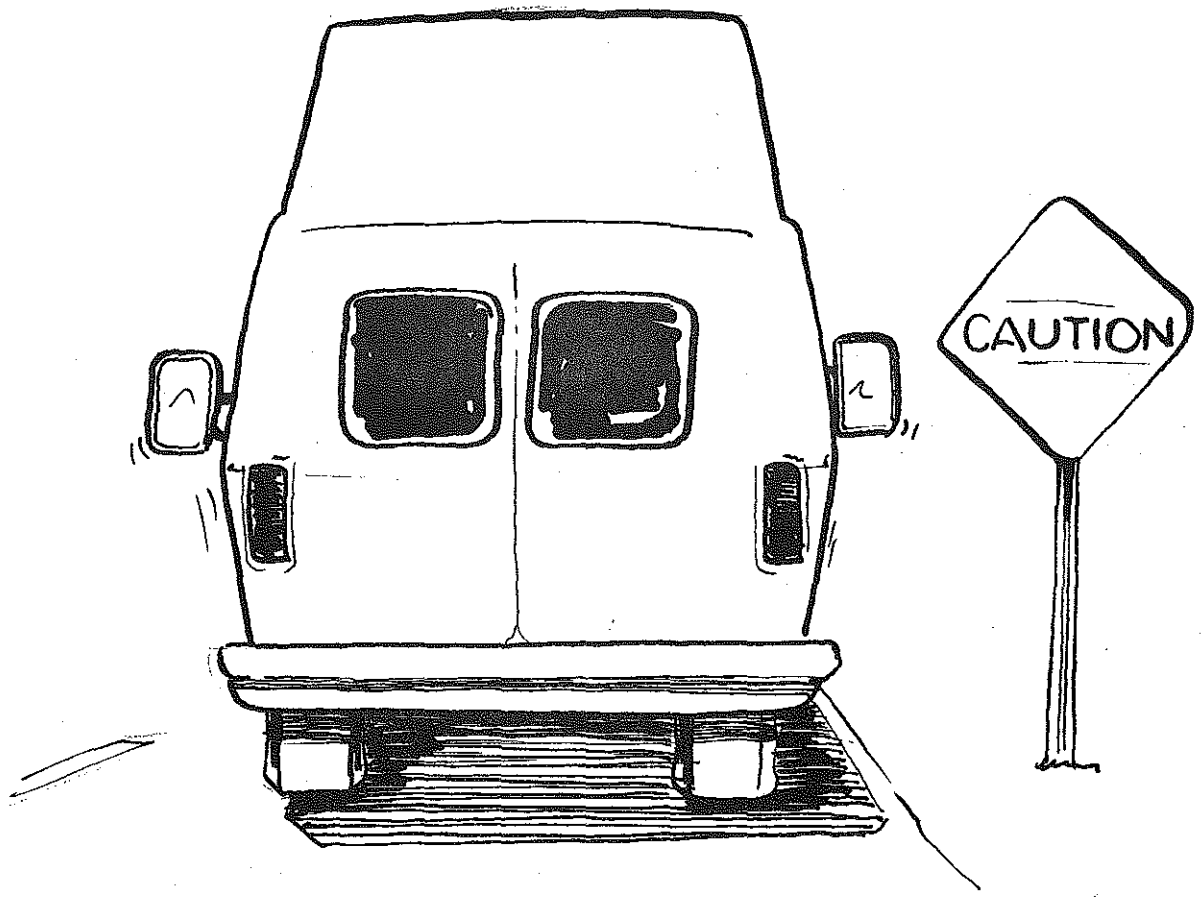
General Vehicle Handling

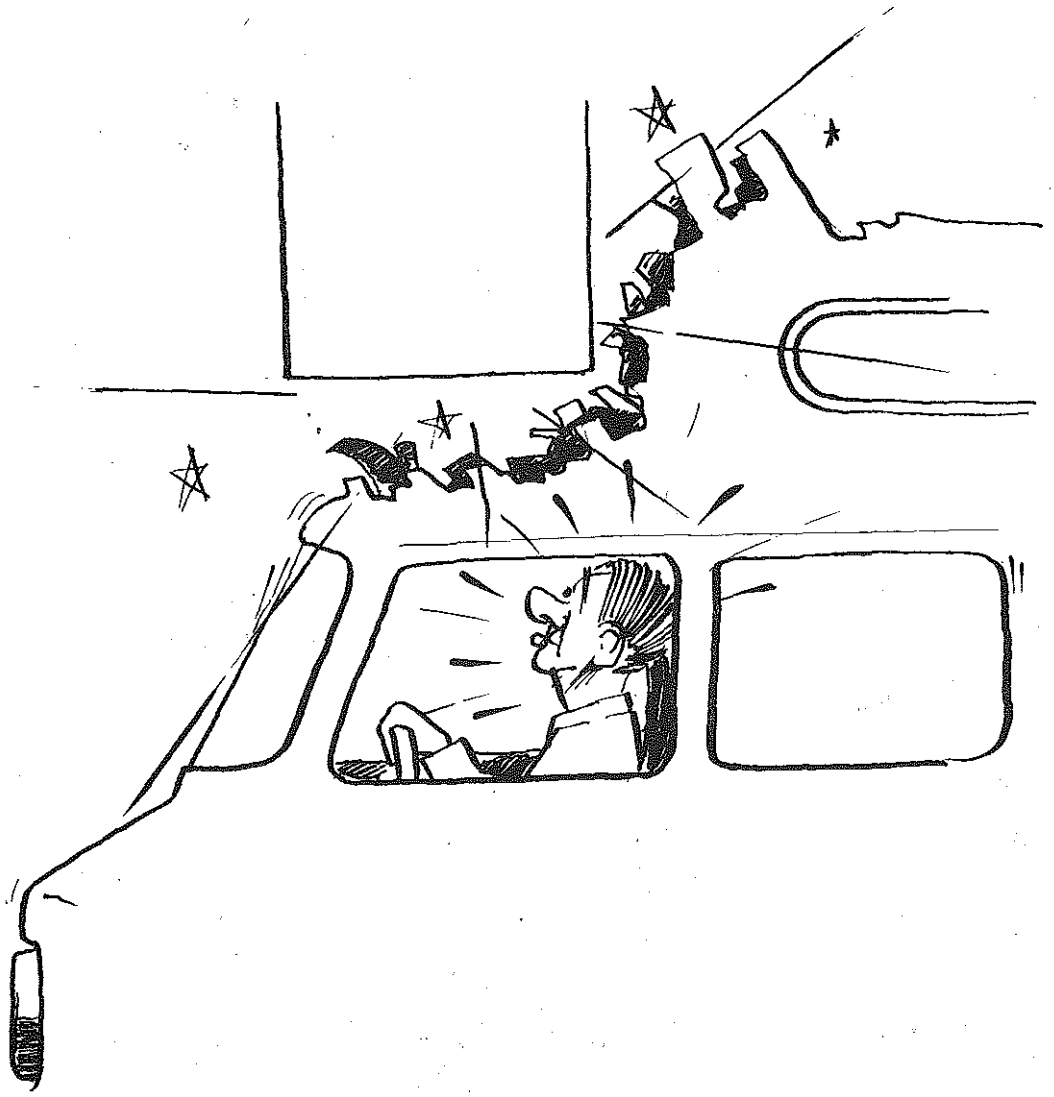
The handling of a van or small bus should be a matter of practice, caution, and common sense. Unfortunately, experience indicates that the required caution and sense are not common enough to be taken for granted, and that the operation of a vehicle larger than an automobile requires some special instruction. Before any driver is given charge of a vehicle, the agency should make sure that he or she understands the basic handling of this type of vehicle.

Clearance

A very common and very expensive cause of damage to light-weight accessible vehicles arises from the size of these vehicles

DRIVE WITH CAUTION





BE AWARE OF AREAS WITH LOW OVERHEAD CLEARANCE...

in relation to their ease of handling. It is easy to forget how high and how wide the vehicle really is. Drivers whose only experience has been with smaller and lower vehicles must be carefully trained to watch side, rear, and overhead clearances. Severe damage can result on the agency's own premises, when entering or leaving a garage or maneuvering in a parking lot.

Pay special attention to instruction on overhead clearance. The fiberglass and steel construction of many light-weight transit vehicles makes major overhead damage extremely difficult and very expensive to repair. In many localities, it may not be possible to find facilities to repair a severely-damaged roof.

Drivers should be taught to judge overhead clearances accurately, and should know everything in the area under which their vehicles cannot safely fit. Roofed entrances to buildings and parking areas are notoriously destructive to light-weight buses. Drivers should also know the clearances of all viaducts in their driving area. Overhanging tree limbs can break clearance lights, and may damage a vehicle roof.

Some light-weight bus operators place warning stickers on the dashboards of their vehicles reminding drivers to watch overhead clearance. However you call the problem to your drivers' attention, be sure that all your drivers understand the importance of watching overhead clearance before they make their first run.

Drivers should be shown how to read their side-mirrors and especially the "bubble" mirrors mounted on the larger side-mounted rear view mirrors. It takes some practice for a new driver to learn to position a bus or van in its lane. Before any driver is allowed to carry passengers, several days of familiarization are in order, to be sure that the driver is comfortable with the size of the vehicle.

A Fresnel lens can also be placed on the rear window of the vehicle. This lens allows the driver to view directly behind the vehicle without leaving the drivers seat.

Starting, Stopping and Turning

In general, driving habits that are most comfortable for passengers are also easiest on the vehicle. Good driving need not be slow, but it should, above all else, be smooth.

1. Accelerate easily. With some vehicles, the driver can achieve a smooth acceleration by easing off on the accelerator pedal just before the transmission shifts into the next range. Jackrabbit starts and hard shifts increase wear on the engine, the entire drive train and the tires -- as well as being uncomfortable and possibly dangerous to passengers, especially the elderly and the handicapped.

2. Brake and stop smoothly. A driver should learn to watch the road as far ahead as possible, so that sudden braking is kept to a minimum. A driver should also start slowing down well in advance of each stop. The brakes on many vans and small buses are very positive, and a new driver may need several hours of practice to learn to stop smoothly. As with hard accelerations, sudden stops may injure passengers. They may also cause rear-end collisions.

3. Turn gently. A driver must be especially careful not to hit or run over curbs when cornering:

    a. Seated passengers may be thrown from seats.

    b. Wheelchair-using passengers may be thrown from their chairs, or their chairs may come loose from restraints. Serious injury may occur in either case.

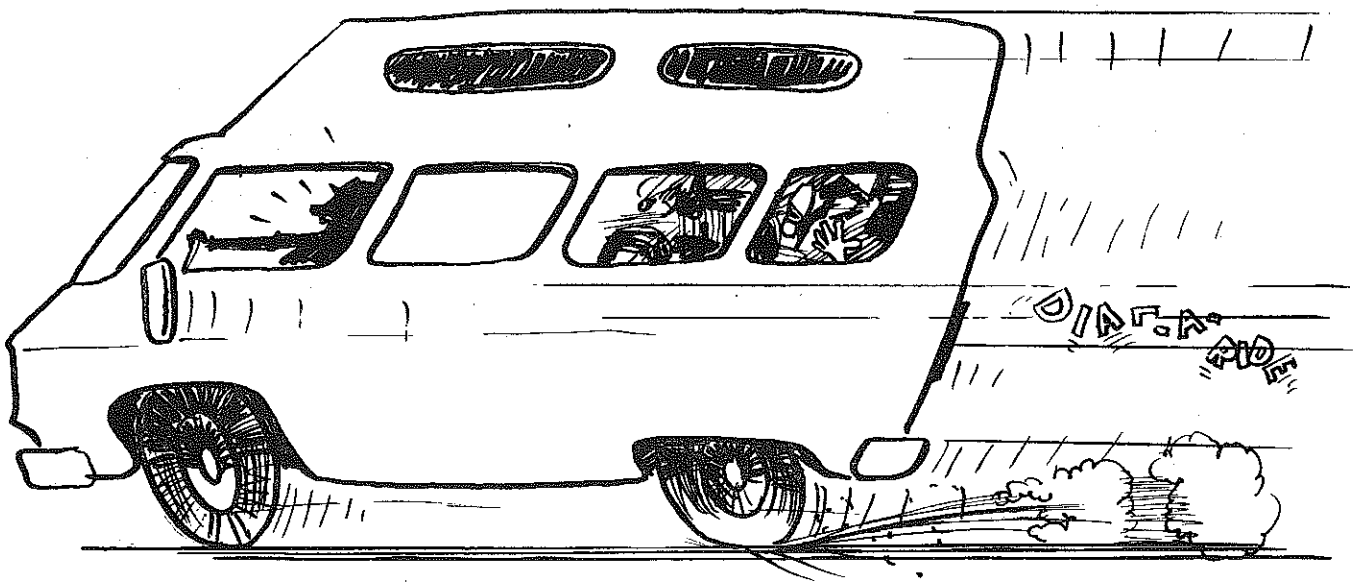
    c. Damage may result to the vehicle body and chassis.

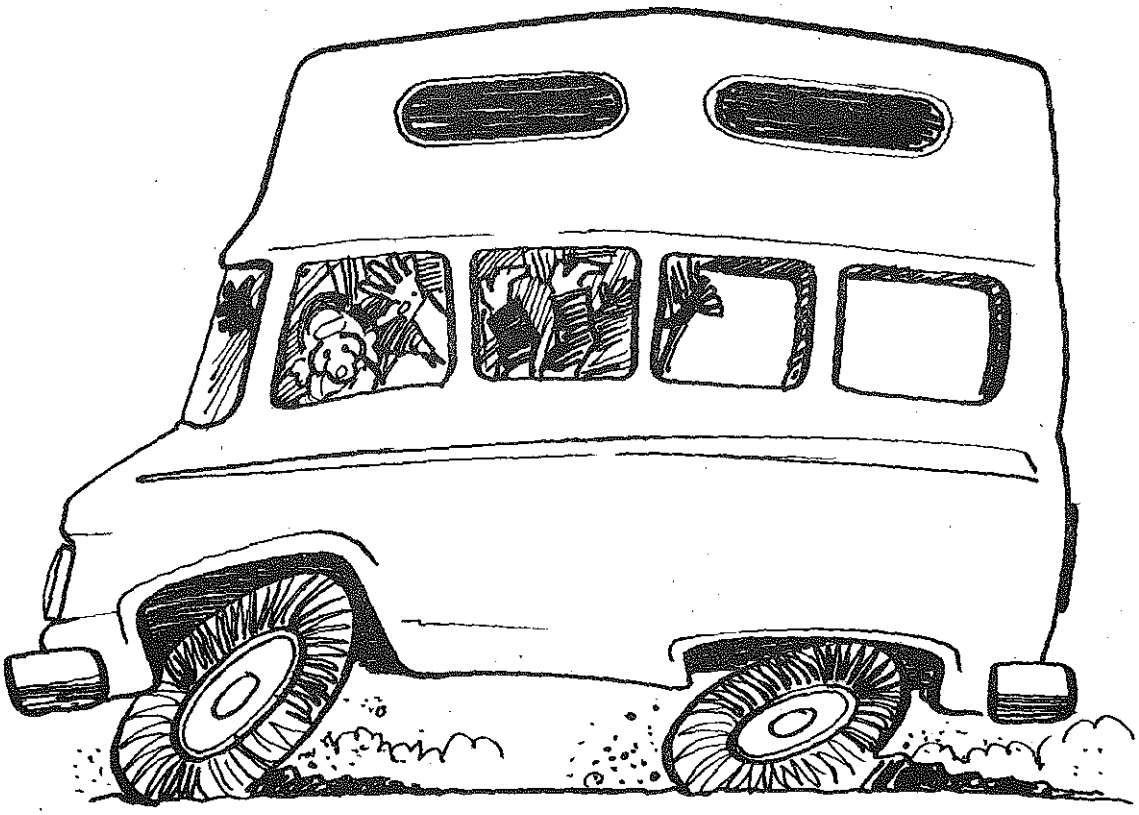
    d. Front-end alignment may be spoiled.

    e. Damage may result to municipal furnishings, such as lamp posts and stop signs.

Someone accustomed to driving a smaller vehicle should be shown how to corner "wide", and how to watch the mirrors for clearance.

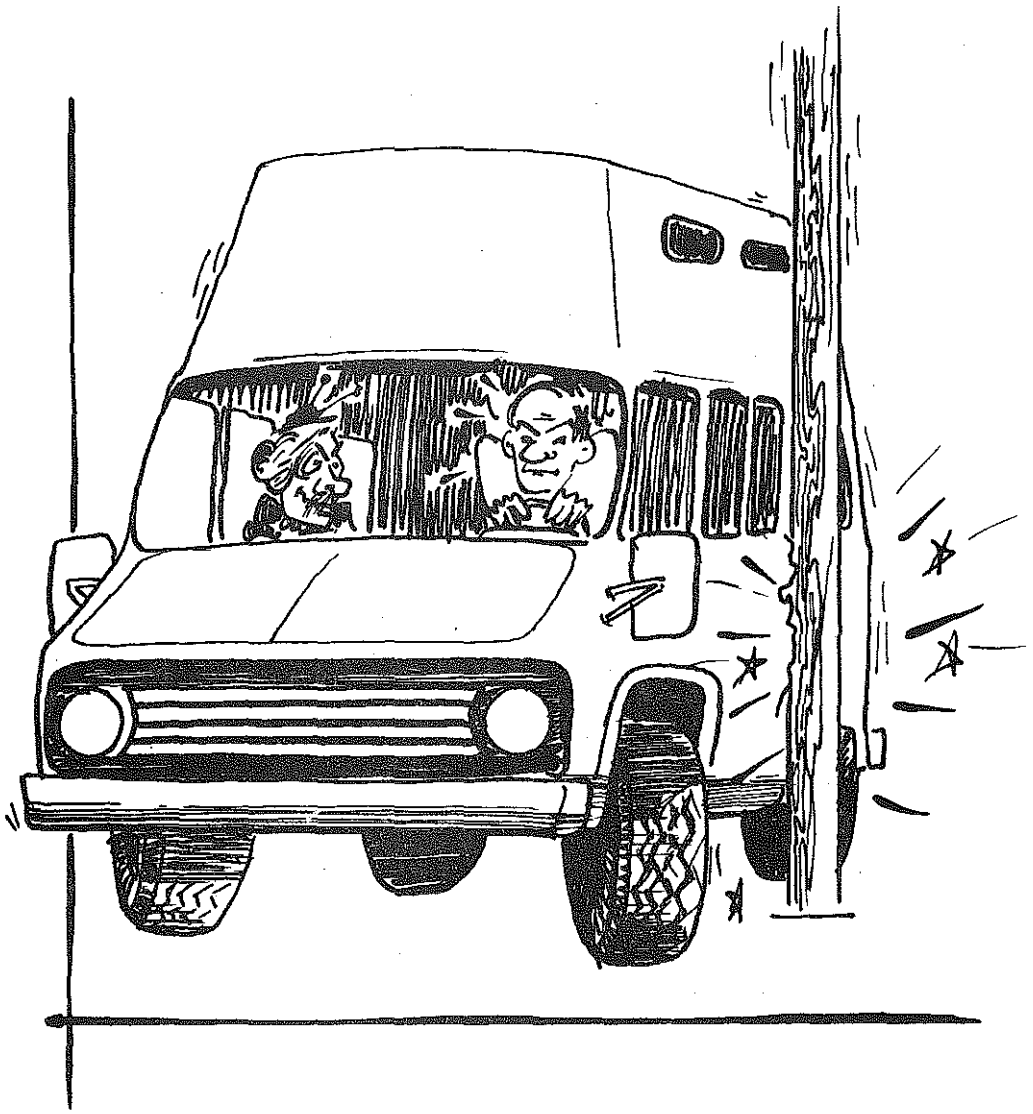
AVOID
JACKRABBIT STARTS





AVOID ABRUPT STOPS

TURNING MANEUVERS MAY BE *MORE DIFFICULT...*



Road Conditions

Good preservation driving requires that drivers pay attention to road conditions. In some areas, the condition of the pavement, or the lack of it, may create serious maintenance problems even with the most careful driving. In general, a driver can minimize the wear and tear by taking it easy.

Chuckholes can be steered around, large rocks in the road can be avoided. State laws usually require passenger vehicles to stop at railroad crossings. Front end alignment lasts longer if drivers obey the law to the letter, and then cross tracks very gently.

Where there is other traffic on the road, drivers should be taught to use emergency flashers generously as they slow down for obstacles. If necessary, a driver can pull over to let faster traffic pass. In general, a bad stretch of road should be taken slowly, and schedules arranged accordingly.

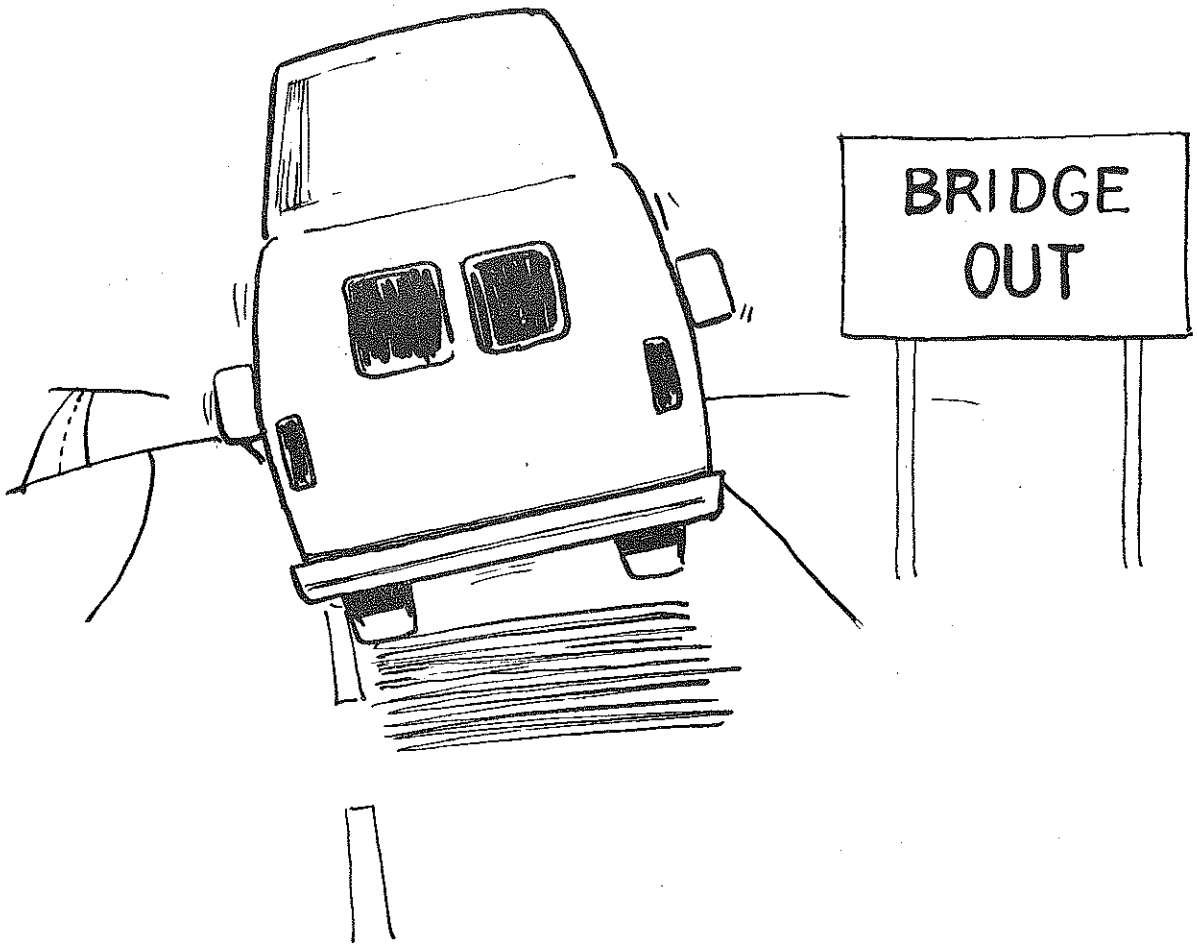
Getting stuck and having to be towed out can seriously accelerate the depreciation of a vehicle. Getting stuck and trying to free the vehicle under its own power can destroy a transmission. In rural areas, a driver may be tempted to take the vehicle into a place it can't be driven out of, often in an attempt to get a passenger as close as possible to the door of their home. This is often a tricky judgement to make, since many elderly or handicapped passengers do require assistance to get from the vehicle into their homes, or from their homes to the vehicle.

The agency may require that passengers who need assistance bring along a friend or relative to help them across the yard in places where it is likely the vehicle will get stuck. Volunteers may be enlisted to serve as attendants on each vehicle.

Drivers should be given shovels for clearing either snow or mud or both, whichever they are likely to encounter. If at all possible, drivers should make every effort to avoid getting stuck.

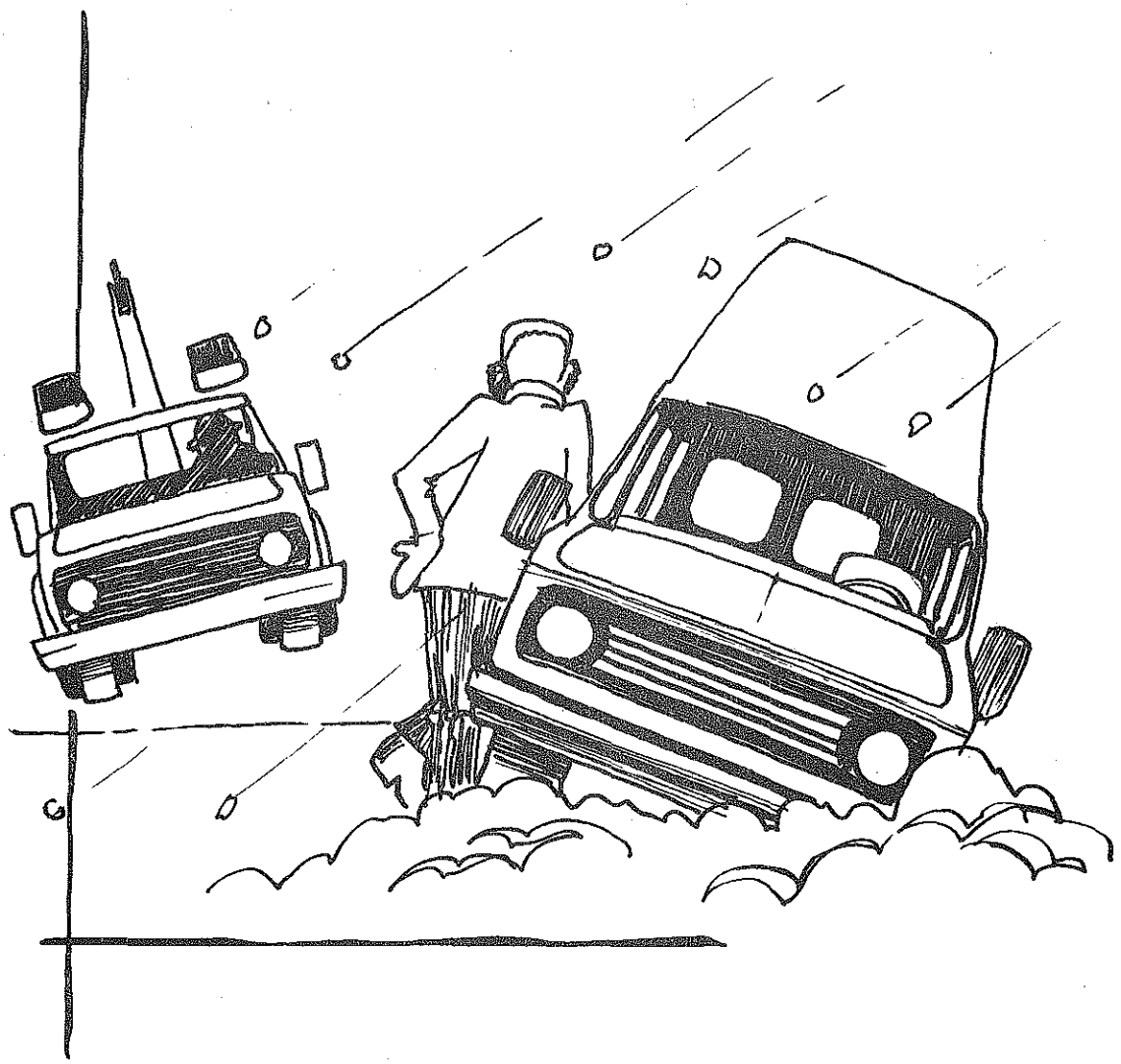
Once the vehicle is stuck, it must be towed free carefully. The tow-chain or winch-cable should be attached to a solid part

BE AWARE
OF LOCAL ROAD CONDITIONS...



SAVE THE VEHICLE

WAIT FOR A TOW



of the chassis according to the manufacturer's recommendations -- drivers should know where to attach a tow-hook. A vehicle should always be pulled free, since pushing will almost always result in some body damage.

Local Difficulties

A light-weight bus operation is a very local type of service, and strongly subject to the particular conditions of its operating area. Drivers may have to be alert to livestock on the road, logging trucks or switchbacks, farm machinery, and weather conditions from dust storms to flooding to blizzards. They may also face problems of vandalism and theft. Drivers should be familiar with the local situation, but don't take a driver's familiarity for granted. If there are special operating difficulties in your area, make sure that all your drivers know about them and what to do about them.

Selecting the Right Driver

The driver's own frame of mind is critically important to good preservation driving. A driver in an unsettled or irritated mood can raise maintenance costs considerably, either through mistakes in judgement that lead to accidents, or through using hard driving to vent emotions.

In this type of service, a great deal of trouble can be saved by being careful to hire the right driver in the first place. It is almost impossible to train the wrong person into the right kind of driving, since passenger service involves stresses and strains over and above the handling of the vehicle.

Transit staff often get the "backlash" of passengers' own problems. This is especially true in light-weight bus operations, where passengers and drivers are in very close contact. In addition, an occasional passenger seems to take an unholy delight in tormenting drivers with constant complaints and criticisms. In such instances, drivers must be able to let a

INTERVIEW ALL PROSPECTIVE DRIVERS...

great deal of abuse "roll off" without allowing it to affect their driving.

Be careful to match your drivers to the type of passengers they will be serving, as well as to the type of driving they will be doing. Someone whose chief experience has been in truck driving may find it difficult to get used to the difference between passengers and freight. Someone who has been a school bus driver may have to learn different disciplinary techniques for dealing with senior citizens. A driver who has been trained in fixed-route service may feel uneasy in demand-responsive service, and vice-versa.

Conversely, a great many maintenance expenses can result because a driver feels out of place. In general, a driver who is comfortable with the passengers being served and the type of driving involved will also be easy on the vehicle.

Hiring

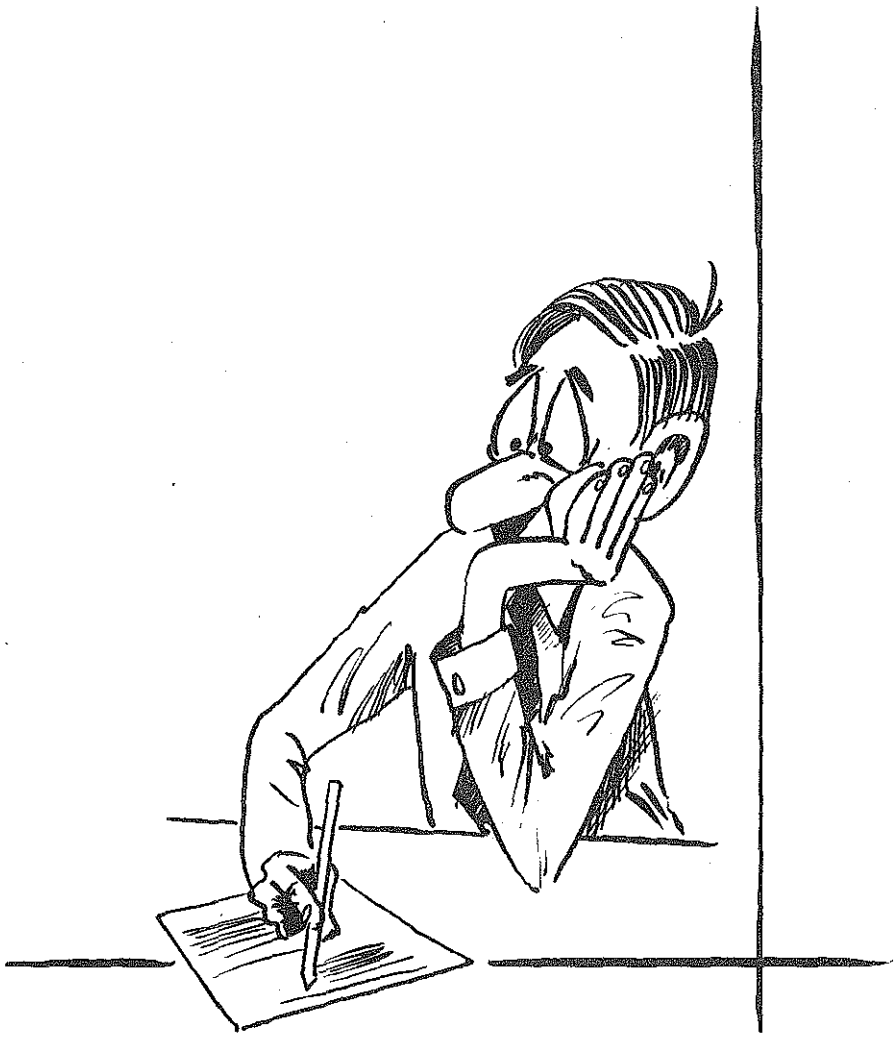
Be as choosy as you can, given the limitation of your budget and the caliber of local talent. This is not an ordinary driving job, and the people you hire should be somewhat special. Expect to interview as many as a dozen people for each applicant you hire.

Anti-discrimination laws and basic fairness may indicate that an objective written test be given to all applicants, with a fixed score for passing. Phrase your questions to examine the applicant's basic knowledge of the motor vehicle codes; you may also include questions on what to do in given situations, remembering that there may be more than one correct answer.

Every applicant should also be given a driving test administered by the transportation manager of the agency. If you don't feel comfortable with someone's driving, the chances are that your passenger will feel less comfortable with it. Pay special attention to driving habits and matters of judgment.

Be sure to check the driving record of every applicant. Send the applicant's name, birthdate, and driver's license

GIVE EACH PROSPECTIVE DRIVER A *WRITTEN EXAM...*



HAVE EACH PROSPECTIVE DRIVER TAKE A *ROAD TEST*...

number to your state's motor vehicle authorities. Within a week or two they should furnish you with a transcript of the individual's driving record. Look for patterns in an applicant's record. A series of accidents may indicate a chronic problem with the person's driving even if these accidents were not technically the person's fault.

Above all, take the time to interview every applicant. A few minutes conversation may tell you a great deal about an applicant's suitability as a driver. You need someone who is intelligent, calm, cheerful, and capable of both cooperation and independent judgment. The time you spend in selecting the best personnel available will be repaid in:

1. Improved passenger relations.
2. Increased operating efficiency in general.
3. Lower maintenance and repair costs in particular.

In Conclusion

The field of transportation with light-weight accessible buses is a relatively new one, and the entire state-of-the-art is in an early stage of development. This means that while further research and development is needed in the design of vehicles and components, operators must gear their services to the equipment currently available. At the present time, the skill, ingenuity, and good judgment of the people operating and maintaining the vehicles may count for as much as the exact specifications of the vehicles themselves in determining the success or failure of a light-weight bus transportation project. Optimum performance of the equipment depends upon optimum performance by drivers, mechanics, dispatchers, and supervisors, whatever the type of vehicle in service.

FOOTNOTES

(1) Hayes, Jack, Rural Public Transportation Vehicles, Bureau of Urban and Public Transportation, Michigan Department of Transportation, Prepared for the U.S. Department of Transportation, FHWA, UMTA, Final Report, August, 1979, p. 4.

(2) Ibid, pg. 5.

(3) Ibid, pg. 5.

(4) Ibid, pg. 5.

(5) Ibid, pg. 5.

(6) Ibid, pg. 5.

(7) Ibid, pg. 5.

(8) Ibid, pg. 5.

(9) Ibid, pg. 6.

(10) Ibid, pg. 6.

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Hayes, J., Rural Public Transportation Vehicles, Bureau of Urban and Public Transportation, Michigan Department of Transportation, prepared for the U.S. Department of Transportation, FHWA & UMTA, Final Report, August, 1979.

Department of California Highway Patrol, Information Bulletin: "Adopted Wheelchair Lift Regulations for Buses", July 9, 1979.

Institute of Public Administration, Planning Handbook -- Transportation Services for the Elderly, prepared for the Administration on Aging, Washington, D.C., November, 1975.

Michigan Department of Transportation, Small Bus Specifications, Bureau of Urban and Public Transportation.

Motor Vehicle Manufacturers Association of the United States, Inc. (MVMA), Vehicle Inspection Handbook -- Truck/Bus/School Bus, prepared by the Engineering Division of the MVMA, July, 1979.

Ryder, T. K., Functional Specifications for Small Transit Vehicles for Use in Handicapped and Elderly Transportation Services, North Central Texas Council of Governments, September, 1977.

Schneider, L. W. and Melvin, J. W., Impact Testing of Restraint Devices Used with Handicapped Children in Bus Seats and Wheelchairs, the University of Michigan Highway Safety Research Institute, prepared for the Bureau of Crippled Children, Department of Public Instruction, Madison, Wisconsin, Final Report, November, 1978.

APPENDIX A

Sample
PURCHASE SPECIFICATIONS
for
FRONT SECTION VANS
and
BODY ON FORWARD CONTROL CHASSIS
COMPACT BUSES

May 1980

FOREWORD

These specifications have been provided by the U.S. Department of Transportation, Transportation Systems Center, Cambridge, Massachusetts. They are intended to provide a sample of specifications for use in the procurement of light-weight buses.

These specifications have been revised to reflect currently available equipment; most of the detail items described are available directly from the manufacturer and his dealers as standard equipment or options. The remaining features, not so available, can be obtained through body modification work, or otherwise arranged for through the contractor who bids on the vehicles to be purchased.

The vehicle features described have had the benefit of many suggestions and experiences of users, from discussions with manufacturers and from a safety review by the University of Michigan.

The specifications, therefore, are offered for use, as seems appropriate to purchasers, with confidence that the features are appropriate to the 16(b)(2) application. Purchasers may have other preferences in some of the detailed features. Where there is confidence in other designs or options, substitution may be made.

Note that in some sections there are discussions or additional information about a vehicle use or element; such statements are preceded by a black dot.

1.0 INTENDED VEHICLE APPLICATION

Vehicles will be required to operate on all types of roadways at a variety of speeds and shall be capable of prolonged idling. They will be frequently started and stopped, with great demands thus placed on the driveline and braking system. Reversing in service will be common. Overall size, maneuverability, and general appearance must be in keeping with residential neighborhood scale. It is the Purchaser's intention to procure a vehicle which is reliable in operation, comfortable and safe for 10 to 15 passengers and low in maintenance costs for over 100,000 miles.

The vehicle required is a "top-line" automotive manufacture multi-purpose van, with a high-quality conversion. The base van is to be the most durable available with those options which will make the van better suited to stop/start duty cycles.

The conversion itself should strengthen the base structure of the vehicle. The conversion supplier should also provide those modifications to the van which are required to meet these specifications, and should be prepared to provide warranty and after-sales service on completed vehicles.

Bids will be accepted for new 1981 models only.

Vehicles other than front section vans or body on forward control chassis of up to a maximum of 11,500 lbs. GVW are the only vehicle types acceptable for this procurement.

2.0 COMPONENTS, MATERIALS, WORKMANSHIP AND COMPLETENESS

These specifications reflect the bidder's preference as to dimensions, materials, and major components. However, the bidder shall not omit any part or detail which goes to make the vehicle complete and ready for service, even though such part or detail is not mentioned in these specifications.

All units or parts and workmanship shall be manufacturer's best quality. All parts shall be new, and in no case will used, reconditioned, or obsolete parts be accepted. Any one part used shall be an exact duplicate in manufacture and

design and construction in each of the vehicles furnished in this contract. Standard equipment throughout each vehicle shall be so installed that it will be interchangeable among the vehicles.

The price to be quoted in any Proposal submitted shall include all items of labor, material, tools, equipment, and other costs necessary to fully complete the manufacture and delivery of the buses pursuant to these specifications. It is the intent of these specifications to provide and require a complete vehicle of the type prescribed, ready for operation. The bidder shall assume sole responsibility for the entire vehicle as to warranty and after-sales parts and service. It is not acceptable to have divided responsibility for body and chassis or for body and power train components.

3.0 GENERAL DIMENSIONS

Interior headroom	72" at center minimum
Seating capacity	see attached seating chart supplied by purchaser
Gross vehicle weight	shall not exceed the designed capacity of axles or other suspension elements at maximum rated load

The net weight of the converted vehicle shall be distributed on the axles in proportion to their minimum capacities.

Note also requirements of 19.4 in this specification.

4.0 ENGINE

4.1

The engine shall be of an established design, produced by a reputable and recognized engine manufacturer with readily available sources of replacement parts in major (state name) cities.

4.2

Gasoline engine shall be fitted; heavy duty truck-type with quality bearings, pistons, and crankshaft designed for sustained full load operation, capable of delivering at least 165 net flywheel HP to the power train, with all accessories including air conditioning compressor operating. For hilly terrain the engine shall be capable of delivering at least 175 net flywheel HP to the power train with all accessories, including air conditioning compressor operating. Torque curves shall be supplied to show that the engine has torque characteristics at least equal to those of a V-8 of approximately 165-175 HP.

4.3

Optional Equipment: In areas with severe winter cold (several occasions of -30°F.) an engine heater, tank or engine block type shall be provided for.

4.4

Engine shall be furnished with a large capacity full flow oil filter easily reached and replaced without removal of any major component. A replaceable air cleaner is required.

5.0 ENGINE COMPARTMENT

Engine compartment shall be insulated to minimize transmission of noise, exhaust, odor, smoke or heat to the interior of the van. A fresh air plenum chamber shall be sealed and insulated from the engine compartment. No interior body surface accessible to a passenger or in the immediate vicinity of the driver shall attain a temperature greater than 100 degrees Fahrenheit generated by the engine. There shall be engine access outside the coach for frequently checked engine functions. If access to the engine is provided from inside the coach, it shall be properly sealed and soundly constructed to retain its shape and securing method, and shall not require removal of any secured fixtures (grabrails, stanchions, heater assemblies, etc.) inside the coach. Wires and hoses shall not

be routed on or near manifolds or exhausts in a manner which will allow them to overheat and/or ignite.

6.0 COOLING SYSTEM

6.1

The largest available radiator and fan for this vehicle shall be supplied. The fan shall be thermostatically controlled so as to be effectively power driven only above the maximum efficient engine temperature, and shall maintain engine temperature not to exceed 235°F with an ambient temperature of 100°F and all accessories operating.

6.2

Radiator surge or overflow tank shall be provided (coolant kit) such that coolant expelled is saved and restored to the cooling system.

6.3

Coolant provided shall be permanent antifreeze (ethylene glycol) with rust inhibitor, mixed with water so as to protect from freezing down to -30°F.

7.0 FUEL SYSTEM

7.1

Fuel tank shall be a minimum 33 U.S. gallon capacity, internally baffled to prevent surging and rigidly supported by at least four (4) independent supports, arranged for easy removal. A plastic fuel tank is acceptable only if installed in a manner such that it is adequately protected by structural members of the vehicle. The gas line from carburetor to pump shall be one piece steel. Filler pipe or inspection plate shall be removable for easy inspection.

7.2

An underbody fuel filter is required with replaceable type elements.

8.0 EXHAUST SYSTEM

The exhaust system shall meet U.S. Government noise level and exhaust emission requirements. A certificate stating compliance shall be provided to the buyer with each vehicle. See AIR POLLUTION of these specifications (Sec. 33) as to specific requirements.

9.0 TRANSMISSION

9.1

Transmission shall be fully automatic. The transmission shall be installed such that removal as a unit, without disturbing the engine or final drive, is possible.

9.2

Transmission shall be the heaviest duty available, equipped with a hydraulic transmission governor, adequate torque capacity clutch packs, oil pump with a minimum capacity to supply all transmission lube and shift requirements at idle speed; oil filter, and water-oil or air-oil heat exchanger to maintain safe operating temperature at full rated loads.

The bidder is required to certify that the automatic transmission provided is suited to the engine choice for the vehicle and is of adequate strength and capacity to perform under the frequent start-stop duty cycle anticipated.

9.3

Transmission shift level shall be interlocked with starting motor to prevent engagement of starter in any gear position other than Neutral or Park.

10.0 FRONT SUSPENSION

Axle Capacity	4,000 lbs. minimum
Spring Capacity	1,900 lbs. minimum at ground

Solid tubular or beam axle, or independent front suspension, is allowable. In the case of the latter, all friction points shall be equipped with fittings for periodic lubrication. All

friction points on either type of suspension shall be equipped with replaceable bushing or inserts. The manufacturer's heaviest, highest quality spindles and largest front wheel bearings that are suitable shall be fitted. The heaviest duty available shock absorbers shall be provided.

11.0 REAR AXLE & FINAL DRIVE

Conventional construction, truck-type rear axle, utilizing heavy tubes pressed into cast center section, or one piece casting, is preferred. Ring gear should be bolted, not riveted, to differential carrier.

Low speed performance is more important than high top speed in this application. (A positive traction, limited slip type differential is mandatory when mud or snow are expected as seasonal driving conditions.)

Axle Capacity	7,000 lbs. minimum
Spring Capacity	3,500 lbs. minimum at ground

12.0 PROPELLER SHAFT

The propeller shaft shall be the heaviest duty component available, utilizing one or more Spicer needle bearing universal joints or equivalent. A guard shall be fitted to the vehicle so as to prevent the propeller shaft from striking any hoses, wires, tanks or the pavement should the front universal joint break.

13.0 STEERING

13.1

The required pull at the rim shall not exceed 20 pounds to turn the front wheel five degrees right or left. These requirements are for a wet vehicle empty on a dry concrete floor, clean and free from loose or foreign material with tires inflated to rated maximum pressure. The pull at the rim for a wet vehicle with a full load (150 lbs. per passenger x maximum passenger capacity) shall not exceed 30 pounds under

the same conditions as outlined above. If power steering is required to meet this specification bidder shall so state.

13.2

Steering mechanism shall be constructed so as to make the wheel essentially free from road shock and vibration. Steering from full left to full right turn shall be accomplished in no more than five complete turns of the steering wheel. Steering mechanism shall be self-centering, requiring little, or no effort for the operator to bring the vehicle back to a straight-ahead position after turning. Steering wheel shall not be less than 16 inches in diameter and wheel ring shall be provided with synthetic resin construction molded over metal. Further, it shall be provided will puller holes in the hub so that a standard or universal puller may be used.

13.3

Provision shall be made for easy external adjustment of steering gear backlash.

13.4

All steering linkage wear points, including tie rod ends, shall be fitted with lubrication fittings and replaceable bushings or inserts.

14.0 BRAKES

14.1

A dual hydraulic brake system shall be provided.

14.2

Service brakes shall be four wheel internal expanding or disc type, power assisted, capable of decelerating the vehicle with a full seated load to a stop within 88' from a speed of 30 m.p.h. Combination brakes of disc front and drum rear are also acceptable.

14.3

Notwithstanding the requirement of 14.2 above, the brakes supplied shall be the largest available from the vehicle

manufacturer, consistent with the weight of the vehicle, and suited to both the safety and comfort of the passengers.

14.4

Parking brake shall be mechanical type, either hand or foot operated, at left of driver, activating rear wheel brakes. The parking brake shall be capable of holding the vehicle stationary for 5 minutes, in both the forward and reverse directions, on a 20 percent grade on dry pavement with a full seated load.

Many users plan on probable 5000 mile replacement of front disc brake linings. This appears to be reasonable for heavily used vehicles.

15.0 WHEELS

Vehicles shall be equipped with the heaviest duty available ventilated pressed steel wheels, 16.5" diameter and 6.00" width (unless otherwise specified), single front and dual rear. All wheels are to be interchangeable. Extra heavy duty wheel bearings are required. (See 10.0.)

Other wheel sizes may be desireable to match those already in other vehicles of the fleet.

Body on forward control chassis shall be dual rear wheel vehicles.

16.0 TIRES

Vehicles are to be equipped with six tires (load range E, 10 ply rating) of size 8.00x16.5 (unless otherwise specified). Tires are to be supplied with the vehicle from the factory.

Spare wheel and tire shall also be supplied with each vehicle. The spare shall be securely mounted in a location other than the passenger compartment. Mounting on the rear door is permissible if it does not interfere with the door operation. Spare shall not be located in front of the radiator.

Jack and handle shall be provided and shall be screw type.

17.0 ELECTRICAL SYSTEM

The vehicle is to be supplied with a 12 volt electrical system. All components are to be selected and integrated to function in an environment characterized by low engine (alternator) speeds and high amperage draws due to lights, flashers, air conditioning or heater, and other accessories in constant operation.

For gasoline-powered vehicles, an alternator is required of at least:

(1) 60 amperes output at governed engine speed.

(2) 90 amperes output at governed engine speed.

(Purchasers operating in areas where winter temperatures are frequently below 20°F or when the vehicle is air conditioned or lift-equipped should select #2.)

The buyer desires that the vehicle be fitted with a single battery of 250 ampere hour rating. Batteries shall be mounted on pull-out type tray with access door if under body, or shall be easily accessible from the front opening outside the vehicle. Inside of battery compartment shall be covered with a durable insulating material to prevent electrical shorts. Battery compartment and tray shall be coated with acid resistant paint.

Wiring - All general purpose wiring shall be vinyl or both vinyl and fabric insulated, color coded for ease of identification. Engine compartment wiring insulation shall be polyethylene or equal. A full schematic of all OEM and conversion wiring must be included.

18.0 INSTRUMENTS AND CONTROLS

18.1

The following instruments shall be provided:

-Ammeter consistent with alternator size, or voltmeter
-Low-charge warning light (alternator)
-Oil pressure gauge or indicator
-Fuel tank level gauge
-Engine temperature gauge or indicator
-Audible headlight on indication and headlight high beam indicator
-And, speedometer, signal lights, and any other equipment required by Federal or State law.

All instruments are to be grouped on a single panel in full view of the driver, with no instruments obstructed by controls, trim panels, or other appurtenances, and arranged in a consistent and uniform manner.

18.2

The following controls, in addition to the normal steering, braking, and transmission functions, shall be provided:

-Column mounted turn signal lever (self-cancelling)
-Emergency flasher control facing driver and clearly visible
-Door control (manual) capable of being locked open at driver's right hand and within arm's reach for a short person (5'2" height)
-Master exterior light switch, and auxiliary switches for any clearance or marker lights. Switches must all be of uniform type.
-Switches and temperature controls for passenger compartment heaters and air conditioners
-Separate switch and temperature controls for driver heaters, defrosters and air conditioners
-Electric starter switch
-Two-speed wiper control
-Windshield washer
-Passenger compartment lights.

All controls shall be within driver's arm reach with seat belt fastened. All non OEM switches shall be of uniform type, either push-pull or rocker type, mounted in convenient groupings in a panel near the driver's left hand and shall be labeled and illuminated. Illumination of the auxiliary panel shall be adjustable.

19.0 BODY STRUCTURE

19.1

The body structure shall be adequately reinforced at all joints and corners where stress concentration may occur and shall adequately carry required loads and stand road shock without deformation, cracking or other structural failure.

19.2

The side and end framing shall be so designed and constructed that they will carry their proportion of the stresses

around these openings. All posts in body side and roof sections shall be of durable channel or box construction, securely fastened to the underframe structure so that the entire frame shall act as one unit without any movement at the joinings. The end posts shall be designed to resist shear at the welds.

19.3

All exterior panels shall be riveted, welded, or bonded to the body frame. The body shall be thoroughly water tested and made tight to prevent leakage.

19.4

Raised roof caps shall have at least one fixed, tinted safety glass window. Roof conversions may be of steel, aluminum or fiberglass, but shall include a collapse resistant steel rollover cage which must comply with 19.2 Roll bars, if suited, must comply with head room requirements and be protectively padded as in 26.6.

*Raised roofs can be a problem with garage door heights and repair lifts.

19.5

Before assembling all metal body parts shall be given a thorough multiple stage anti-corrosion treatment. Zinc chromate or zinc phosphate prime paint shall be applied to both aluminum and steel. Interior surfaces of body panels and posts which are covered by trim materials shall be given protection against corrosion (Sec. 26.3).

19.6

All nuts, bolts, clips, washers, clamps, and like fasteners shall be zinc or cadium plated or phosphate coated to prevent corrosion. All exterior panels shall be riveted or huck bolted in place and no sheet metal screws shall be permitted.

19.7

Stepwells are to be on one-piece construction, either molded fiberglass, stamped aluminum, stainless or corrosion-

resistant steel, with coved corners and adequate reinforcement to prevent deflection. Stepwell is to be at least 12" deep and all treads are to be 9" deep with at least a 1-1/2" white front edge of flooring material on both the top vertical and leading horizontal surfaces of each step. Individual risers shall not exceed 8" in height, and in the case of more than one riser all shall be the same height. The stepwell shall be illuminated by at least one lamp providing a white light actuated automatically by the opening of the door.

19.8

The wheelhouses shall be of sturdy construction of galvanized steel or of steel treated for corrosion resistance and providing ample clearance for front and rear tires, under load and under all positions of the front wheels while steering. In the event that tires extend beyond the side of the vehicle, splash aprons or fenders shall be provided.

19.9

Access doors shall be provided, where necessary to service transmission, engine, radiator, batteries, and air conditioning components.

19.10

The entire body-frame under structure, frame cavities and body cavities of the vehicle is to be fully rustproofed with nonflammable wax-type material, applied at time of manufacture. Automotive tar or pitch quality undercoating applied at a local dealer is <u>not satisfactory</u>.

19.11

Chromium-plated trim pieces are not acceptable. Any bright metal exterior trim shall be stainless steel or polished aluminum.

20.0 DOORS

20.1

The vehicle shall be equipped with (purchaser indicate which option is preferred):

(1) Single section front entrance door located opposite the driver; the door shall be of the front hinged "sedan type" and shall be driver operated by a simple, manually operated control with over-center linkage of self locking type, or

(2) A bi-fold hinged door with a weather tight seal.

The door operating hardware must be sturdy enough to be used as a hand hold for boarding passengers. The door hinge system itself must be sturdy enough to withstand this form of use for the life of the vehicle without distortion or losing seal. The door shall have a clear center opening width of at least 32" and full height of at least 72" with roof conversion and 47" without roof conversion.

*Some sedan type front doors have a panel added to the top of the original van front door; this provides for a higher door opening into a raised roof. These do not stand up well as compared to a rebuilt, unitized all steel door.

20.2

A side entrance door shall be provided only when a lift is required. The door shall be a two section, hinged type with meeting edges that are gasketed to form a weather tight seal.

Vehicles to be equipped with lifts and roof conversions shall have the double side entrance doors extended at the top to give a minimum 71" clearance between the floor and top of the door opening. There shall be a minimum entry way at least 32" wide after provision has been made for lift hardware. There shall be provisions for tie back straps to hold the doors open.

20.3

The vehicle shall be equipped with a rear opening emergency door/doors with appropriate operating instructions clearly written, in large letters and in an obvious location. The door shall be clearly marked "EMERGENCY EXIT" in letters at least two inches high at the top of or directly above the exit on the inside. The emergency exit shall have a horizontal

opening of at least 24" and a vertical opening of at least 48" measured from floor level. Seats shall not prevent easy access to the emergency exit. Door/doors shall be able to be opened from the inside or outside.

21.0 WINDOWS

21.1

Windshield shall be fixed type, glazed with laminated safety glass, tinted above eye level (gradutint).

21.2

Main side sash shall be anodized aluminum horizontal or vertical slide type equipped with latches which prevent closing on brake application. Sash shall be hinged at the top kick-out type, or manual opening large enough to allow unobstructed passage, for emergency escape in compliance with FMVSS 217.

21.3

Laminated safety plate glass or tempered glass is to be provided in side windows, rear windows, entrance door or standee windows. All glazing (except as 21.1 above) shall be tinted to $\leq$ 33% transmittance.

22.0 HEATING, VENTILATING AND AIR CONDITIONING

22.1

The heating system shall have at least two unit type heaters, one located in the driver's area and one in the passenger area. Output of the passenger heater shall be at least 30,000 BTU. The passenger compartment heater shall be located at least three seat rows in back of the driver's seat. No heater lines shall be exposed.

22.2

Heater fans are to be individually controlled by three-position switches; low, high and off. They must be individually controlled for temperature setting from the instrument panel.

22.3

Provision shall be made for defrosting of the windshield and driver's left hand side window. Such provision shall be adjustable and within easy reach of the driver.

22.4

Ventilation for the driver shall be provided by means of driver-controlled (internal) vents in the front or side of the body. They shall direct air to the pedal area and shall be weatherproof.

22.5

Air conditioning system (OPTION) must be adequate (minimum 1-1/2 ton capacity rated at a minimum 30,000 BTU per hour) to cool both the driver and the passenger area. It is mandatory that separate individually controlled air conditioning outlets for the driver's compartment, including driver's feet be provided. System may be self contained heavy duty type.

The bidder shall provide test data substantiating the air conditioner ability to cool the vehicle interior to a temperature 15°F cooler than exterior conditions of temperature and humidity up to 90°F and 100% relative humidity, and to maintain that temperature during operation with varying engine speed.

The bidder shall also provide complete details on the compressor, condenser, and evaporator or heat exchanger units used, and shall state exactly the power required to operate the condenser fans, whether electrical or mechanical.

23.0 BUMPERS

Bumpers shall be heavy duty wide channel wrap-around type and of sufficient strength and height from the ground so as to permit the pushing of one vehicle by a follower, without damage to either vehicle. The bumpers at the front and rear of the vehicle shall be tapered in toward the body. Bumper guards shall be installed on the front bumper. Bumpers are to be painted, not chromium plated or bright metal. Bumper

guards shall be dealer provided faced with rubber pads for added shock resistance and prevention of override.

24.0 INTERIOR LIGHTING

Interior shall be illuminated and rheostat controlled so as to provide a minimum of 12 foot candles of illumination over the entire normal reading position of each two passengers cross seat. Lighting should be adjustable from the driver's position. Lights shall operate with or without engine running. Front door hooded stepwell light shall be mounted and wired to light when the door is open so stairwell and immediate outside area, in front of and to the side of the stepwell, is illuminated.

*Lighting level is not so much intended for reading as it is for good visibility for persons whose visual activity may be poor.

25.0 EXTERIOR LIGHTING

All exterior lights must meet the requirements of the state of the purchaser and all applicable Federal Regulations (Federal Motor Vehicle Safety Standards).

The flasher unit for directional signals and emergency flashers shall be replaceable from inside the vehicle and shall be a simple plug-in unit.

Wheelchair lift lights which illuminate the lift device (when lift is ordered) and the area outside the vehicle, in front and to the sides of the lift shall be provided.

*An option which may be desirable is a driver adjustable spot light mounted so as to illuminate doors and steps of residences. (Automatic vehicle washers could damage this light.)

26.0 INTERIOR

26.1

The subfloor shall be of minimum 1/2" thick, 5-ply waterproof plywood securely fastened to steel and covered from wall

to wall with a non-skid RCA transit floor, hard rubber, or approved equal. All edges shall be properly sealed to prevent entrance of moisture. Floor shall be at least 1/8" thick and smooth under seats and 3/16" ribbed non-skid surface in the aisle and at entrance ways of both door and floor areas surrounding the lift. Steps shall be covered with 3/16" ribbed step treads. The step edge shall be marked in white flooring material in conformance with Federal Motor Carrier regulations.

26.2

Any insulation material used between the inner and outer panels shall be fire-resistant and sealed to minimize entry of moisture and to prevent its retention in sufficient quantities to impair insulation properties. Insulation properties shall be unimpaired by vibration, compacting or settling during the life of the coach. The insulation material shall be non-hygroscopic and resistant to fungus and breeding of insects. Any insulation material used inside the engine compartment shall be fire-resistant and shall not retain oils or water. Body areas so insulated shall be thoroughly treated with Tuff-Cote, Ziebart, Polyoleum, or equivalent before application of insulation.

26.3

All interior panels shall be textured aluminum and/or rust resistant polyeurathane (IMRON equivalent) painted sheet steel, aluminum, or malamine with colars harmonizing with other vehicle colors. Fiber, wood or vinyl covered fiber or wood panels are not acceptable.

26.4

Vinyl covered neoprene foam padding may be used to cover interior areas above passenger eye level where there is possibility of striking the head. It must be securely fastened to the body structure.

26.5

Stanchions, 1-1/4" diameter of corrosion resistant steel tubing shall be in the entry area. All stanchions should be firmly and permanently attached to mounting cups (if any). All vertical stanchions shall be padded. Stanchions shall be provided at each wheelchair location if so equipped. Grab rails should be provided at both sides of the door and shall be within reach from the ground to assist passengers both in boarding and alighting. A handhold device shall be provided in the lift area to enable a person standing on the lift, perhaps using crutches or a walker, to steady himself through the entire lift operation.

27.0 SEATING (OPTIONS)

27.1

Handicapped units' seats shall be identical to those in the regular units except as otherwise herein provided. Each wheelchair position shall be fitted to enable quick and easy installation of regular type seats when wheelchair positions are not needed. Contractor shall provide the appropriate number of seats that would normally occupy wheelchair locations, of the same type, color and quality to match permanent coach seats. In all cases, the procuring office and the contractor will agree to seat layout with diagrams.

27.2

Passenger seats except at wheelchair locations shall be all forward facing, covered with commercial grade vinyl or heavy duty woven fabric, color coded with exterior vehicle colors. Seats shall be of heavy duty, fully padded (4 inch) construction. Seat backs and bottoms shall be contoured for maximum confort. Minimum seat cushion depth 15", width 18" per passenger. Seat backs shall be between 18" and 20" high. No arm-rests attached. Seats shall be 15" maximum from floor to front edge of seat cushion. At least 10" of knee room should be provided from edge of one seat to the back of the

seat in front. Seat covering shall be fire resistant and shall not support combustion. Seat padding shall be neoprene foam. Seats are to be anchored such that they are easily removable for installation of wheelchair hold downs. The seats shall be a different color from the floor so as to be of contrast. All seats shall be equipped with seat belts. Aisle shall be minimum of 16" measured between seat cushions and shall extend the length of the vehicle such that there is a clear path to the emergency back doors.

*The following comments from users may be useful here (above):

It was mentioned that vinyl cuts easily and that fabric can be just as satisfactory. The width of 18" seems high. Seventeen inches is normal, according to several converters. No users disputed the draft figures, although one thought that arm-rests would be helpful to the elderly when cornering; they can also cause difficulty when entering and leaving seats.

Some users thought the seat belts should be retractable. An aisle is usually measured between seat supports rather than edges according to a converter, so this should be clarified.

Sixteen inches was mentioned as the maximum possible aisle and one user thought an aisle bigger than 14" was needed. A converter said it was possible to give up one seat to have a 2-3 tier luggage area for shoppers just behind the entrance door.

27.3

The driver's seat shall be full foam (neoprene) construction. The back and cushion of the seat shall be perforated black vinyl or upholstered in heavy duty fabric and of bucket configuration. The seat shall be securely mounted so that that front of the seat cushion shall not be higher than fifteen inches from the floor with a driver of 160 pounds sitting in the seat. The seat shall have vertical and fore and aft slide adjustments. The full fore and aft range of seat adjustment shall be accommodated in the mounting; there shall be no

interference between any grab rail or stanchion with the seat in the full rearward position.

28.0 PAINTING AND LETTERING

28.1

The exterior paint of the vehicle will require ___ colors. The contractor will be provided with wording, numbers, locations, letter styling and colors that are to appear on both sides of the vehicle; these may be diagrams or color photographs.

28.2

All metal surfaces shall be treated with zinc chromate primer prior to painting. The contractor will be provided with color chips or with specific paint manufacturer's color numbers. Paint material will be polyeurathane equivalent to Dupont "Imron".

28.3

Interior paint will harmonize with seats and exterior colors. Top of dash shall be flat finish.

29.0 WHEELCHAIR LIFT (OPTION)

*Please read technical observations and user comments at the end of this section.

Vehicle shall be equipped with an electro/hydraulic or electro/mechanical powered wheelchair lift mounted on the curb side of the vehicle, accessible via access doors as specified in Subsection 20.2. The lift shall be mounted so as not to detract from the structural integrity of the vehicles. The lift gate shall be of heavy duty frame design. The wheelchair entrance doors shall be the swinging type and shall also have a tie back strap to hold doors back while lift is in operation. The lift shall be fully automatic in all its action including fold up and stowage.

The lift shall have a non-skid platform. The controls shall be placed outside the vehicle in such a position to

enable the attendant or the handicapped person, once the person is on the lift, to operate the lift. In the fully lowered position, the platform shall be of sufficient strength to support at least 600 - lb. load. The platform shall measure at least 42" long by at least 32" wide, or wider to the maximum extent permitted by the chassis of the vehicle. A safety device shall extend the full length of the curb side edge of the platform and shall be movable hinged surface to provide a barrier to prevent the wheelchair from rolling off the street end of the lift during operation. A barrier (minimum height - 1-1/2") shall also be provided on each side of the platform to prevent wheelchairs from rolling over the edge. It is also recommended that the doors to the lift opening be restricted in their travel to 90° to form a retaining enclosure.

Power unit shall be 12 volt operated. Power unit will be readily accessible for service. In the event of power failure, the lift platform shall be able to be lowered with passengers and shall be able to be raised without passengers.

Lift shall be capable of being used from curb level or ground. It shall be equipped with a leading edge cut-off switch to prevent damage when used on uneven ground. The lift shall be capable of safely lifting a minimum static-load of 600 lbs. The lift platform shall be capable of being raised or lowered with a load in no more than 15 seconds. All power units, operating joints, linkage, and mounting points to the body shall be certified by the manufacturer as being adequate for the loading. The operation of the unit shall provide a smooth, jerk-free ride in both up and down directions.

Power unit will be controlled with a master cut-off switch mounted in vehicle dash and a hand-held switch on a pigtail at the door. Switches shall be deadman type, weather proof, and labeled as to function.

System control valve shall be solenoid controlled and shall be accessible for ease of maintenance.

Gravity down shall also be controlled by a manual hand valve or crank in the event of electric power loss. All sliding

surfaces and load bearing pivot points must be free of exposed grease when in the transport position.

The side and top frame of lift intruding into the body shall be properly padded to protect the riders from bodily injury. Platform shall fold into door area for storing while not in use. Platform, in stored position, shall not intrude into vehicle body more than 14 inches. Lift shall be adequately restrained in stored position to prevent the lift from coming adrift while vehicle is in motion. The lift device in its stored position shall not rattle.

*Comments on Wheelchair Lifts:

One converter feels very strongly that lift doors should open no more than 90 degrees, giving the passenger a feeling of riding within an enclosure. Many individuals feel very uneasy going out onto the ramp if the doors are folded back a full 180 degrees, because of the rather exposed and vulnerable sensation provided. It was felt that if the doors opened only 90 degrees and are solidly secured in that position, it may be possible to dispense with the three inch side support provision. However, it is probably better to keep some side support provision to prevent the wheel from slipping off the platform and lodging in the space between the platform and the door.

One user group remarked that the 600 pound capacity for the lift is marginal for use with powered wheelchairs. However, this assumes that the driver is riding on the lift along with the passenger. The converters indicated that the lifts were not designed for such use. The lift operator is supposed to be standing on the ground. One user commented, however, that they had a problem when on at least one occasion a wheelchair fell from the lift while it was in operation. Hence, they require their drivers to ride the lift with their hands on the wheelchair.

A 36" wide platform was recommended by one user while another stated that his 34" platform caused no problems.

However, the suppliers are limited by the structural members in the van chassis in determining how wide the door can be. It is probably possible to extend somewhat wider than 30 inches, but 36 inches appears to be impossible with the current chasses available.

A platform length of 41" would allow some lifts to be used without having to count length of toe-board safety device. Another user thought a 42" minimum length was sufficient as was a 32" minimum width. A 3" side barrier is design restrictive and would not allow use of a very popular lift (which has a 1-1/2 inch barrier).

One agency indicated they have had problems with their lifts damaging when being lowered to uneven ground. The problem is that the lift will continue to operate until both sides have contacted the ground. The result is that the mechanism is lifting the bus, placing considerable strain on the electro/hydraulic components that drive it. Requiring a leading edge cut-off switch should prevent damage.

It may be disadvantageous to have the system valve "externally mounted" since untrained persons could misadjust it. This could lead to injuries. The phrase "accessible for ease of maintenance" might be a solution here. All sliding lift surfaces can be free of grease when in the transport positioning, but inner sliding channel construction, which is reported to be more rigid than bearing construction and caused fewer piston problems, cannot be free of grease when in a non-stowed position. Also, it would rule out at least one popular lift to require that it be sealed roller or sleeve bearing construction.

Requiring a "completely" weatherproof switch may be overkill.

30.0 RAMP (OPTION)

Ramp shall be all aluminum construction equipped with wide channels to provide guides for both sides of wheelchair wheels and non-skid steps between the channels. The fold out and fold in action of the ramp shall be spring loaded to assist

both operations. Ramp shall be equipped with a locking device to secure it in stored position and working position. The capacity of the ramp will be a minimum of 800 pounds but not weigh more than 80 pounds.

RAMP DIMENSIONS

Overall Width	27"
Channel Guide Width	5"
Stair Tread Width	15"
Minimum Track Width	26"
Maximum Track Width	26"
Extended Length	83 3/4"
Closed Height	45 1/2"
Method of Attachment to Van Floor Hinge	5 Bolts
To Van for Spring Bracket	4 Bolts

*Reservations were expressed concerning the ramp. It was felt that the ramp as specified would be too steep to permit even a fairly strong operator to push any and all passengers up it. Further, it was felt that the 600 pounds minimum strength is probably inadequate considering the combined weight of a husky driver, a husky passenger and a powered wheelchair. A converter thought that a 400 pound specification was about all that could be provided by a manufacturer of a ramp of less than 80 lbs. Possibly a ramp should be avoided if such heavy loads are expected.

31.0 WHEELCHAIR RESTRAINTS

All vans equipped with wheelchair lifts or ramps shall have wheelchair locking devices permanently affixed to the vehicle for the forward facing wheelchair positions for which the vehicle is designed. The automatic locking device shall incorporate means to ensure that the device cannot vibrate loose during normal transit operations. Care must be taken that the device will not damage any portion of the wheelchair in normal operation. The locking device shall be capable of securing the wheelchair wheels so that they are immobilized during transport, with longitudinal movement not to exceed two inches forward and backward, and without any lateral movement whatever.

Each wheelchair tie-down shall be equipped with safety belts (conforming with FMVSS Nos. 208, 209, and 210) and shall be equipped with shoulder-crossing safety belts which are anchored to the floor supporting structural members.

32.0 FIRE AND FIRST AID EQUIPMENT

First aid kit (16 passenger) and one five pound type 5 ABC or other dry powder or $C0_2$ fire extinguisher meeting all applicable Federal regulations shall be bracket mounted and easily accessible to the driver. An eighteen inch by 5/8" wrecking bar shall be clip mounted within reach of the driver. One six volt, bulb type, hand flash or lantern shall be provided and four 30-minute flares as well as three triangular reflectors for daytime use.

33.0 AIR POLLUTION

The Contractors bidding on these specifications are required to furnish a Warranty that the vehicles to be furnished will comply with the air pollution criteria established by the Secretary of the Department of Health, Education and Welfare of the United States Government as follows:

(1) Horsepower of the vehicle furnished is adequate for the speed and terrain in which it will operate. Such horsepower includes the demands of auxiliary power equipment.

(2) Gases and vapors emanating from the crankcase of spark ignition engines are controlled in such a manner as to minimize their escape to the atmosphere. (Such control may provide for the return of such gases to the induction system of the engine.)

(3) Visible emissions from the exhaust pipe will not exceed #1 on the Ringlemann Scale when measured at a point 6 inches from the tail pipe, with the vehicle in a steady state of operation.

(4) When the vehicle has idled for 3 minutes and then accelerates to 80% of rated speed under load, the opacity of the exhaust will not exceed #2 on the Ringlemann Scale thereafter.

The bidder shall provide a certificate containing this exact wording, signed by a duly sworn officer of the corporation.

34.0 DRIVERS ACCESSORIES

34.1

Mirrors: Right and lefthand fully adjustable outside rear view mirrors shall be provided. Mirrors shall be nominal 8"x10" in size and constructed of anodized aluminum or chrome plated, or other approved non-corrosive materials. "Low mount" brackets are required as opposed to "West Coast" mirrors which obstruct the driver's field of vision. Mirror arms shall be chrome plated and designed to permit mirrors to be moved out of the way to preclude damage by automatic bus washing equipment. A convex insert shall be provided on both outside rearview mirrors.

At least a 4"x12" rectangular rearview mirror shall be installed for the driver's viewing of the bus interior.

34.2

Windshield Wipers and Washers: Two heavy duty, electirc, two-speed wipers shall be controlled by a three position switch. The motor shall be mounted in an easily accessible location for inspection, maintenance or removal. A three quart electrically operated washer system shall be provided.

34.3

A driver's sunvisor shall be provided as well as the following miscellaneous items:

-Clip to store "Vehicle Condition Card" under or near sunvisor
-Pencil storage within convenient reach
-Clipboard and/or run board storage, within convenient reach and preferably visible, in pocket on engine cover
-Pocket for storage of passenger handouts
-Clip for holding transfers
-Coat hook, immediately behind seat
-Underseat box (or other location) for personal effects
-Litter receptacle, accessible to driver and passengers and easily removable for emptying
-Small map or reading light, easily reached from driver's seat and fully adjustable.

35.0 TWO-WAY RADIOS (OPTION)

The purchaser advises that vehicles furnished on this bid may be fitted with two-way radio equipment. The bidder shall insure that an adequate 12 volt power supply is available near the driver's compartment for mobile radio unit power. The bidder shall agree to work in close liaison with the buyer's communication equipment supplier in engineering a mounting for the radio mobile unit, including the antenna and driver's controls. Installation of the equipment should be provided for in the design. The vehicle supplier shall be responsible for fabricating all brackets, conduits and compartments to fit the electronic equipment.

*Some have purchased CB radio tranceivers in order to have an economical emergency (Channel 9) communication link. Buyers should seriously consider the safety possibilities of such equipment. A radio of this kind (CB) is <u>not</u> intended for general communications of dispatching - it is for emergency only.

APPENDIX B

NEW BUS ACCEPTANCE CHECKLIST

3032 (N 1/79)

Purchase Order No.	Vehicle Serial No.		License No.	Mileage
Year	Vehicle Make		Chassis Make	Vendor
Date Received	Pass.	Lift	Chassis Serial No.	Price
Key Numbers: Ignition	Door		Fare Box	Vaults

SPECIFICATIONS COMPLIANCE

CHASSIS	SPECS.	ACTUAL
1. Wheelbase		
2. Engine		
3. Steering		
4. Front Axle		
5. Rear Axle		
6. G.V.W.		
7. Axle Ratio		
8. Battery		
9. Alternator		
10. Power Brakes		
11. Frt. Brk. Size		
12. Rear Brk. Size		
13. Fuel Tank		
14. Stabilizer		
15. Wheels		
16. Tires		
17. Trans. Type		
18. Trans. Cooler		
19. Guarded Drvshft.		
20. Cooling System		
21. Clutch Type Fan		
EXTERIOR		
1. Entrance Door		
Height		
Width		
2. Entrance Steps		
1st Step Height		
2nd Step Height		
Tread Depth		
3. Rear Door		
4. Windows		
5. Bumpers		
6. Mirrors		
Sideview		
Convex		
7. Rustproofing		
SAFETY EQUIPMENT		
1. Fire Ext.		
2. First Aid Kit		
3. Triangle & Flares		
4. Emerg. Exit Markings		
5. Roof Hatch		
6. Rear Door Buzzer		
7. Backup Buzzer		

INTERIOR	SPECS.	ACTUAL
1. Driver's Seat		
2. Passenger Seats		
Spacing		
Single Width		
Double Width		
3. Aisle Width		
4. Headroom		
5. Flooring		
Steps		
Aisle		
Underseats		
6. A/C BTU's		
7. Heating BTU's		
8. Int. Mirror		
9. Angle View Lens		
10. Fare Box		
Vaults (2)		
Keys (4)		
11. Grabrails		
12. Stanchions		
13. Spare Tire/Rim		
14. Snow Tires		
15. Tire Changing Tools		
ACCESSIBILITY		
1. Wheelchair Lift		
Door Height		
Power Up		
Power Down		
Power Fold		
Manual Override		
Auto. Stop		
Wheel Stop		
Platform		
Width		
Length		
Adjst. Speed		
2. Securement Area		
Jump Seats		
Tie Downs		
Seat Belts		

INFORMATION FURNISHED WITH EACH VEHICLE

1. Wiring Diagrams _____
2. ...nuf. Statement of Origin _____
3. Repair & Parts Manuals _____
4. Maintenance Schedules _____
5. Structural Specifications _____
6. Operator's Instruction Manuals _____
7. Line Setting Tickets _____
8. Warranties _____

OPERATIONAL CHECKLIST

FLUID LEVELS

_____ engine oil level
_____ radiator
_____ battery water level
_____ brake fluid level
_____ windshield washer fluid
_____ transmission oil level (with engine running)

LIGHTS

_____ headlight – high beam
_____ headlight – low beam
_____ tail lights
_____ turn signals – front
_____ turn signals – rear
_____ brake lights
_____ back-up lights
_____ running lights
_____ 4-way flashers
_____ dash lights
_____ passenger lights
_____ fare box light
_____ entrance stepwell light
_____ lift entrance light

GAUGES

_____ amp or volt meter
_____ water temperature
_____ oil pressure
_____ speedometer
_____ fuel
_____ miscellaneous

EQUIPMENT CONTROLS

_____ front/rear heater
_____ defroster
_____ A/C condenser fans
_____ driver fan
_____ windshield wipers/washers
_____ horn
_____ door opener

GENERAL

_____ controls and gauge locations, labels
_____ interior and stanchion padding
_____ flooring installation
_____ seating installation
_____ doors and windows
_____ interior and exterior workmanship
_____ scratches, overspray, dents, rust
_____ missing, loose, stripped nuts, bolts, screws, rivets
_____ water leakage test
_____ road test

REMARKS

Small Bus Training Program

PRE-TRIP INSPECTION

DAILY VEHICLE CHECKLIST

DATE _____ VEHICLE _____

MILEAGE: Ending _____
Starting _____
Daily Total _____

INSPECT AND CHECK BELOW ITEMS IF O.K.

A. UNDER HOOD

1. Oil level _____
2. Radiator level _____
3. Battery level _____
4. Windshield washer level _____
5. Engine _____

B. EXTERIOR

1. Tires _____
2. Turn signals _____
3. Head lights _____
4. Tail lights _____
5. Mirrors _____
6. Windshield wipers _____
7. Fresh body damage _____
8. Cleanliness _____

C. INTERIOR

1. Brakes _____
2. Steering _____
3. Transmission _____

Safety Equipment:

4. Fire extinguisher _____
5. Flares _____
6. First aid kit _____
7. Dash gauges _____
8. Radio _____
9. Fresh damage _____
10. Cleanliness _____

D. FUEL ADDED _____ gal.
OIL ADDED _____ qts.
MILEAGE AT FUELING _____

VEHICLE DEFECT LIST

NOTE ANY DEFECTS BELOW

1. UNDER HOOD

2. EXTERIOR

3. INTERIOR

Maintenance Performed

_____
Driver Signature

_____
Mechanic Signature

824v

MDSHT 8008 (N7/79)

PREVENTIVE MAINTENANCE INSPECTION WORK SHEET

PERFORM MONTHLY
ALL DART VEHICLES

☑ OK
☒ ADJUSTMENT MADE
⊘ NEEDS ATTENTION

VEHICLE NO. _____
DATE _____
MILEAGE _____

SPECIAL INSTRUCTIONS
FOR REPAIRS NEEDED _____

PREPARE FOR INSPECTION		COMMENTS
☐ CHECK DRIVERS REPORT	☐ WASH VEHICLE	
☐ REVIEW MAINTENANCE HISTORY		

START UP AND DRIVE (CHECK OPERATION OF:)	
☐ STARTING	☐ TRANSMISSION
☐ PARKING BRAKE	☐ HORN
☐ SERVICE BRAKE	☐ SPEEDOMETER

REMAIN IN VEHICLE (CHECK OPERATION OF:)	
☐ FUEL GAUGE	☐ 4 WAY FLASHER, INDICATORS
☐ OIL GAUGE	☐ INTERIOR LIGHTS
☐ BATTERY CHARGING GAUGE	☐ INSTRUMENT PANEL LIGHTS
☐ WINDSHIELD WASHER & WIPERS	☐ HEATER & DEFROSTER
☐ STEERING WHEEL FREE PLAY	☐ AIR CONDITIONER
☐ REGISTRATION	☐ ALL WINDOW GLASS
☐ HEAD LIGHTS, HI INDICATOR	☐ DOORS
☐ HEAD LIGHTS, LOW	☐ SEATS
☐ TURN SIGNAL, INDICATORS	☐ SAFETY EQUIP.

OUTSIDE INSPECTION (CHECK OPERATION OF:)	
☐ HOOD	☐ OUTSIDE MIRRORS
☐ BUMPERS, BODY DAMAGE	☐ WHEELS & RIMS, TIGHTEN LUGS
☐ ALL LIGHTS	☐ TIRES, CHECK WEAR, CRACKS AND PRESSURE RECORD_____LBS. PER SQ. IN.
☐ FUEL CAP	
☐ FRONT END, KING PINS, WHEEL BEARINGS, TIE ROD ENDS	

UNDER HOOD (CHECK OPERATION OF:)	
☐ AIR COMPRESSOR, MOUNTING & BELT TENSION	☐ FUEL FILTER, CHANGE
☐ STEERING GEAR & SHAFT (LUBE)	☐ FUEL LEAKS, CORRECT
☐ POWER STEERING HOSES & OIL LEVEL	☐ RADIATOR, CHECK LEVEL
☐ THROTTLE LINKAGE	☐ RADIATOR, PRESSURE CHECK
☐ WATER PUMP & FAN BELT	☐ RADIATOR, CLEAN FRONT
☐ WATER PUMP & FAN HUB (LUBE)	☐ HOSES, CHECK & ADJUST
☐ C/CASE BREATHER, CLEAN/CHANGE	☐ ANTI FREEZE PROTECTED_____°
☐ AIR FILTER, CHANGE	☐ ALTERNATOR, BELT TENSION, TERMINALS, CHECK & LUBE
☐ EXHAUST SYSTEM, TIGHTEN	☐ BATTERY, CHECK WATER LEVEL
☐ ENGINE OIL, CHANGE	☐ BATTERY, CLEAN CABLES
☐ OIL FILTER, CHANGE	☐ MASTER CYLINDER, FILL
	☐ LUBRICATE ALL FITTINGS

UNDER CHASSIS	
☐ ENGINE & TRANS. MTG. BOLTS CHECK & ADJUST	☐ EXHAUST MUFFLER, TAIL PIPE HANGERS, TIGHTEN IF LOOSE
☐ BODY MTG. BOLTS CHECK & ADJUST	☐ DIFFERENTIAL, CHECK GEAR OIL LEVEL & CLEAN BREATHER
☐ TRANSMISSION, CHECK GEAR OIL LEVEL	☐ DIFFERENTIAL, CHECK FOR LEAKS
☐ TRANSMISSION, CHECK COVER, BELL & SEAL AREAS FOR LEAKS	☐ BRAKES, ADJUST IF NEEDED
	☐ SPRINGS, SHACKLES, U BOLTS, CHECK FOR CRACKS, RUST—TIGHTEN

DRIVE OFF & PARK	
☐ ENGINE OIL, CHECK LEVEL	☐ RECORD ALL PERTINENT INFO. IN VEHICLE RECORDS
☐ HOOD LATCH, CHECK	

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MECHANIC SIGNATURE