Figure 28. TYPICAL EXTERIOR DIMENSIONS FOR A 12 PASSENDER 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)

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

*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**

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

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.</strong> Type of Service</td>
<td><strong>3.</strong> Demand Characteristics</td>
<td></td>
</tr>
<tr>
<td>· Demand Responsive</td>
<td>· Maximum Number of Passengers to be Carried at One Time</td>
<td></td>
</tr>
<tr>
<td>· Fixed Route</td>
<td>· Mix of Wheelchair and Seated Passengers to be Carried</td>
<td></td>
</tr>
<tr>
<td>· Special Service</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| **2.** Service Characteristics | **4.** Service Area Characteristics |
| · Number of Trips per Day | · Terrain and Condition of Roads |
| · Length of Round Trip | · Size of Service Area |
| · Time of Day | · 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**

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

<table>
<thead>
<tr>
<th>FLEET SIZE</th>
<th>NUMBER OF BACK-UP VEHICLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>up to 7</td>
<td>1</td>
</tr>
<tr>
<td>8 to 20</td>
<td>2 or 3</td>
</tr>
<tr>
<td>20 or more</td>
<td>1 per 10 vehicles in fleet</td>
</tr>
</tbody>
</table>

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.

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**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
Figure 32. Side Mounted Platform Lifts.
Figure 33. Rear Mounted Platform Lifts.
TABLE 22

WHEELCHAIR LIFT MANUFACTURERS' SPECIFICATIONS

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Braun Corp. L-200 Buslift</td>
<td>750</td>
<td>X</td>
<td>X X X OP</td>
<td>X</td>
<td>X</td>
<td>X X X</td>
<td>44' 30</td>
<td>X</td>
<td>OP</td>
<td>X</td>
<td>1 yr P &amp; W</td>
<td></td>
</tr>
<tr>
<td>Coach &amp; Equipment Series IV</td>
<td>750</td>
<td>X</td>
<td>X X X OP</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>44' 34</td>
<td>OP</td>
<td>OP</td>
<td>X</td>
<td>1 yr P &amp; W</td>
<td></td>
</tr>
<tr>
<td>Collins Industries M-29</td>
<td>1100</td>
<td>X</td>
<td>X X X OP</td>
<td>X</td>
<td>X</td>
<td>X X X</td>
<td>44' 32</td>
<td>OP</td>
<td>OP</td>
<td>OP</td>
<td>1 yr P &amp; W</td>
<td></td>
</tr>
<tr>
<td>Drive-Master</td>
<td>400</td>
<td>X</td>
<td>X X X OP</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>48 33</td>
<td>X</td>
<td>X X</td>
<td>X</td>
<td>1 yr P &amp; W</td>
<td></td>
</tr>
<tr>
<td>Mobility Dynamics Inc. Mark I</td>
<td>750</td>
<td>X</td>
<td>X X X OP</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>40 30'</td>
<td>X</td>
<td>X X</td>
<td>X</td>
<td>1 yr P &amp; W</td>
<td></td>
</tr>
<tr>
<td>Para Industries, Ltd.</td>
<td>600</td>
<td>X</td>
<td>X X X OP</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>39 36</td>
<td>X</td>
<td>X X</td>
<td>X</td>
<td>1 yr P &amp; W</td>
<td></td>
</tr>
<tr>
<td>Reb Manufacturing Inc. 2-in-1</td>
<td>1000</td>
<td>X</td>
<td>X X X X</td>
<td>X</td>
<td>X</td>
<td>X X X</td>
<td>37' 30</td>
<td>X</td>
<td>X</td>
<td>OP</td>
<td>1 yr P &amp; W</td>
<td></td>
</tr>
<tr>
<td>Recon Corp. R-30A</td>
<td>600</td>
<td>X</td>
<td>X X X X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>44' 30</td>
<td>X</td>
<td>X X</td>
<td>X</td>
<td>1 yr P &amp; W</td>
<td></td>
</tr>
<tr>
<td>Skillcraft Industries, Inc.</td>
<td>900</td>
<td>X</td>
<td>X X X OP</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>42 32</td>
<td>X</td>
<td>X X</td>
<td>X</td>
<td>1 yr P &amp; W</td>
<td></td>
</tr>
<tr>
<td>Total Mobility, Inc.</td>
<td>750</td>
<td>X</td>
<td>X X X OP</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>36 36</td>
<td>X</td>
<td>X X</td>
<td>X</td>
<td>1 yr P &amp; W</td>
<td></td>
</tr>
<tr>
<td>Timesavers Products, Inc.</td>
<td>500</td>
<td>X</td>
<td>X X X X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>40 34</td>
<td>X</td>
<td>X X</td>
<td>X</td>
<td>6 months P &amp; W</td>
<td></td>
</tr>
</tbody>
</table>

E = Electric, H = Hydraulic, E/H = Electric-Hydraulic, OP = Optional, I = Inboard, S = Side, O = Outboard, R = Rear, SP = Special Door, P = Passenger, P&W = Parts & Warranty, E = Either Workmanship
Rear Door Steps in Standard Position

Step Lift in Front Door of Large Transit Vehicle

Rear Door Steps in Lift Position

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

<table>
<thead>
<tr>
<th>Lift Capacity (lbs)</th>
<th>DCHP</th>
<th>595</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MDOT</td>
<td>750</td>
</tr>
<tr>
<td></td>
<td>NCTCOG</td>
<td>1,000</td>
</tr>
</tbody>
</table>

Usable Platform Dimensions

<table>
<thead>
<tr>
<th>(Minimum ins. of Length times Width)</th>
<th>MDOT</th>
<th>42.5 x 32.5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NCTCOG</td>
<td>42 x 32</td>
</tr>
</tbody>
</table>

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
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 commercial 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 com-
munication, 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

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

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

<table>
<thead>
<tr>
<th>Category</th>
<th>Average</th>
<th>Range</th>
<th>Standard Deviation</th>
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<tr>
<td>Operating Cost ($)</td>
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<td>Vehicle Miles</td>
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<td>Passengers</td>
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<td>12,125 - 134,518</td>
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<tr>
<td>Number of Buses</td>
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<td>1 - 17</td>
<td>3.32</td>
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<td>Operating Cost per:</td>
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<tr>
<td>Vehicle Mile ($)</td>
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<tr>
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<td>Passengers per Vehicle Mile</td>
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<td>0.13 - 1.03</td>
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**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

Every other oil-change add: Air Filter = $5.00
Every 6 months add: Change Rear End Gear Lube = 10.00

Total = $19.10

### 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

Total = $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

Total = $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
    Total: $720.00

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

   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.

Combined 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 drive-shaft 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,