

SAFETY EVALUATION OF VEHICLES USED TO  
TRANSPORT THE HANDICAPPED AND ELDERLY

Prepared for

Contract No. DOT-TSC-1506  
DOT/Transportation Systems Center  
Kendall Square  
Cambridge, MA 02142

Paul L. Olson  
David V. Post  
Mark Huber

Prepared for the Department of Transportation,  
Transportation Systems Center, under Contract No.  
DOT-TSC-1506. The opinions, findings, and conclusions  
expressed in this publication are those of the authors  
and not necessarily those of the Transportation Systems  
Center.

June 26, 1978

Highway Safety Research Institute  
The University of Michigan  
Ann Arbor, Michigan 48109



Technical Report Documentation Page

1. Report No.		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle  Safety Evaluation of Vehicles Used to Transport the Handicapped and Elderly				5. Report Date June 26, 1978	
				6. Performing Organization Code 016228	
7. Author(s) Paul L. Olson, David V. Post and Mark Huber				8. Performing Organization Report No. UM-HSRI-78-25	
9. Performing Organization Name and Address Highway Safety Research Institute University of Michigan Ann Arbor, Michigan 48109				10. Work Unit No.	
				11. Contract or Grant No. DOT-TSC-1506	
12. Sponsoring Agency Name and Address DOT/Transportation Systems Center Kendall Square Cambridge, MA 02142				13. Type of Report and Period Covered Final - February 16, 1978 May 31, 1978	
				14. Sponsoring Agency Code	
15. Supplementary Notes					
16. Abstract  Draft specifications for the purchase and post-delivery inspection of converted van transit vehicles have been prepared by the government. This report describes a review of the specifications based upon:  <ol style="list-style-type: none"> <li>1. Analysis of crash data.</li> <li>2. Consultations with representatives of: <ol style="list-style-type: none"> <li>a. Transit organizations using such equipment.</li> <li>b. Manufacturing firms producing van conversion transit vehicles.</li> </ol> </li> </ol> <p>A significant number of recommendations for changes to the purchase specifications were received and are detailed in the report.</p>					
17. Key Words Transit Vehicle, Bus, Converted Van, Elderly, Handicapped			18. Distribution Statement		
19. Security Classif. (of this report)		20. Security Classif. (of this page)		21. No. of Pages 107+	22. Price



## CONTENTS

INTRODUCTION . . . . .	1
CRASH ANALYSIS . . . . .	5
PURCHASE SPECIFICATIONS . . . . .	11
1.0 INTENDED VEHICLE APPLICATION . . . . .	13
2.0 COMPONENTS, MATERIALS, WORKMANSHIP AND COMPLETENESS . . . . .	17
3.0 GENERAL DIMENSIONS . . . . .	19
4.0 ENGINE . . . . .	21
5.0 ENGINE COMPARTMENT . . . . .	23
6.0 COOLING SYSTEM . . . . .	25
7.0 FUEL SYSTEM . . . . .	27
8.0 EXHAUST SYSTEM . . . . .	29
9.0 TRANSMISSION . . . . .	31
10.0 FRONT SUSPENSION . . . . .	33
11.0 REAR AXLE & FINAL DRIVE . . . . .	35
12.0 PROPELLER SHAFT . . . . .	37
13.0 STEERING . . . . .	39
14.0 BRAKES . . . . .	41
15.0 WHEELS . . . . .	43
16.0 TIRES . . . . .	45
17.0 ELECTRICAL SYSTEM . . . . .	47
18.0 INSTRUMENTS & CONTROLS . . . . .	51
19.0 BODY STRUCTURE . . . . .	55
20.0 DOORS . . . . .	61
21.0 WINDOWS . . . . .	65
22.0 HEATING, VENTILATING AND AIR CONDITIONING . . . . .	67
23.0 BUMPERS . . . . .	71
24.0 INTERIOR LIGHTING . . . . .	73
25.0 EXTERIOR LIGHTING . . . . .	75
26.0 INTERIOR . . . . .	77
27.0 SEATING (OPTIONS) . . . . .	81
28.0 PAINTING AND LETTERING . . . . .	85
29.0 WHEELCHAIR LIFT (OPTION) . . . . .	87

30.0 RAMP (OPTION)	93
31.0 WHEELCHAIR RESTRAINTS	95
32.0 FIRE AND FIRST AID EQUIPMENT	97
33.0 AIR POLLUTION	99
34.0 DRIVERS ACCESSORIES	101
35.0 TWO WAY RADIOS (OPTION)	103
REPORT OF NEW TECHNOLOGY APPENDIX	105

## INTRODUCTION

One type of transit vehicle which has come into fairly common use in recent years is the converted van. The modifications effected during the conversion process can be many and varied, but normally include changes in the roof height, in the entry provisions, and in the windows and layout of seats.

The base vehicles are manufactured by Chrysler, Ford or General Motors and are purchased by a number of different firms which do the conversion work. They are then resold to transit organizations and placed in service.

These vehicles are used in a variety of transit operations. However, they are most frequently used for "personal" door-to-door service and are often the vehicle of choice for providing transit to the elderly and handicapped.

The latter applications are ones to which scant attention have been paid (until very recently), regardless of the type of transit vehicle being considered. Thus, guidelines to maximize the safety, comfort, and convenience of elderly and handicapped individuals are in a rather primitive state. This fact, coupled with the reduced degrees of freedom in terms of space, positioning of structural members, etc. characteristic of the converted van make the establishment of realistic purchase specifications a considerable challenge.

Draft specifications for both purchase and maintenance of modified van transit vehicles have been prepared by the government ("Specifications for Van Conversion Compact Bus" [9-77]). The work carried out by HSRI was designed to review these documents based on consultation with both users (i.e., transit authorities) and converters (i.e., firms which make the modifications). This report summarizes our findings and recommendations.

Method:

As a first step, CPIR (Collision Performance Injury Report) files were used to determine whether they might contain data relevant to the modification of vans for transit service.

The bulk of the useful information was gathered in face-to-face discussions held with representatives of two major converting firms and three operating agencies. These were as follows:

Converters

Coach and Equipment Corporation  
Penn Yan, New York

Collins Industries  
Hutchinson, Kansas

Operating Agencies

Ann Arbor Transit Authority (AATA)  
McComb County Essential Transportation Services (METS)  
Northeastern Oakland County Transportation Services (NEOTRANS)

In addition, telephone discussions were held with representatives of Bus-Con Corporation, National Coach Corporation, Recreational Industries Inc., Superior Division of Sheller-Globe Corporation, Wayne Corporation, and the Coachette Company. These companies are either not actively engaged in supplying vehicles under the UMTA 16(b)(2) program or are minor suppliers of vehicles at this time. These six companies and the two major suppliers are representative of the converter-manufacturer companies nationwide and account for a large portion of the conversion market. The Wayne Corporation and the Coachette Company provided written comments as well. Finally, a copy of the specification used by the Southeastern Michigan Transportation Authority (SEMTA), multi-county transportation consortium, was received and reviewed.

It should be noted that the attached document deals only with the purchase specifications. The only input received from any source



regarding the inspection specifications was that they looked more like a periodic inspection procedure, rather than a new vehicle acceptance inspection procedure. However this might be, no suggestions were received as to how it might be effectively changed.

#### Organization of the Report:

The material which follows is organized under two main headings. The first section describes the crash analysis work. The second section deals in detail with the specifications and changes which the investigators feel would improve them.

The material in the second section is organized under four headings:

Each section starts with the section number and title followed by the heading "Original" under which appears the relevant portion of the specification as originally provided. In most cases, this is followed by a "Comments" heading. These are distillations of inputs received from the individuals with whom the investigators talked. In many cases suggested changes resulted from these inputs and the Comments serve to explain the rationale for these changes. In other cases, changes are not recommended for one reason or another and the comments provide background or problems, etc. being experienced with these vehicles. Where appropriate, the next heading is "Suggested Changes." Here are listed the additions, and deletions which the investigators feel would improve the specification. Sometimes additional explanation is provided as to why certain choices were thought preferable.

Finally, if any changes are recommended, the specification is presented again in a "Suggested Revised Statement" incorporating the suggested changes.



## CRASH ANALYSIS



To evaluate the type of safety problems encountered with van-conversion vehicles a method involving analyzing computerized accidents to determine the frequency and types of accidents involving modified vans was used. A Collision Performance Injury Report (CPIR) file was accessed which contained 8,917 descriptive vehicle cases. These are in depth crash investigation reports of accidents which occurred in the United States between 1967 and 1977. Most of these accident investigations occurred in California, Michigan, or New York.

Out of the the 8,917 in depth investigation reports, 205 were found which represented van collisions not including school buses. A hard copy search of the actual accident reports revealed that only two of these accidents involved modified transit vans. Four other cases of accidents involving modified transit vans were found by persons who recollected such accidents via having been involved in the screening of all incoming accident investigation reports.

A number of areas relating to the safety evaluation of transport vehicles were addressed in the six cases retrieved in the CPIR file.

One case report (aa-424) addressed the need for vehicle maintenance and pre-trip inspections by the driver in a thorough enough manner to be able to report any defective or problem areas that would inhibit the safe operation of the vehicle. The report also suggested that educational programs relating to the maintenance of the vehicle be incorporated to strengthen pre-trip inspections.

Another topic area that was addressed by two case reports (aa-424, aa-454) was side glass retention and emergency release. One case vehicle was not equipped with windows for emergency exit. In a post collision situation where one or more exit doors are disabled, egress from the vehicle would be hampered. Retention during collision was the subject of the other report where occupants of the vehicle were ejected during rollover through window openings.

The subject of rear emergency door exits was discussed in two case reports (aa-424, aa-430). One problem that arose in a post collision situation was a result of the poor structural integrity of the vehicle. Both rear emergency doors were jammed closed due to deformation of the vehicle body during rollover. The report suggested dynamic testing of the vehicle as a possible area for investigation. The other report addressed rear emergency door exits in the open position. The report stated that an additional person was required to hold the door open in some situations. The possibility of a lock to hold the door open during exit was explored.

Most of the collision reports obtained from the CPIR files addressed a variety of aspects relating to interior vehicle improvements that might be considered to lessen the severity of injuries received by occupants during collision. Two cases (aa-430, aa-454) stated the need for transport vehicles to be equipped with restraining barriers for the front seated occupants or any designated seating position that does not have the rear surface of another passenger seat serving as a barrier. The purpose of these recommendations was to reduce the vulnerability to injury of the front seated occupants in the case of a frontal collision. Another subject that was addressed by three cases (aa-423, aa-424, aa-425) was seatbelt restraint of both driver and passenger. All three cases suggested that the driver of transport vehicles be encouraged or required to be restrained during vehicle operation. Increased injury prevention as well as vehicle control during collision would be the probable for a belted driver. One case study (aa-423) mentioned that passenger seat belts in transport vehicles be studied in relation to occupant kinematics during collision; passenger belts would have presumably reduced the level of injuries sustained.

Stanchions and stanchion mountings were the subject of three CPIR cases (aa-423, aa-424, aa-430). In all three cases stanchion strength and mounting were discussed as a result of collision damage

or occupant contact. The usual stanchion roof/floor attachment is by means of an attached retaining cup. As the stanchions were loaded and deformed, separation from the mounting cups and side wall attachment resulted in exposed sharp edges, potentially harmful to the occupants of the vehicle. One report stated that the ball and socket type of fastening appeared to be superior to the retaining cup type of attachment. It seemed to be the general opinion that all stanchion assemblies should be covered with energy absorbing material.

In four CPIR cases (aa-423, aa-424, aa-430, aa-454), the subject of the passenger seat in transport vehicles was addressed. The areas of concern were seat design, seat anchorage, seat cushion retention, and energy absorbing material covering. In the area of seat design, the question of how much deflection a given passenger seat should have during occupant loading in a collision was addressed. Also, the design of the seat frame in terms of the seatback horizontal crossbar was discussed as being potentially harmful to rearward seated occupants during collision. Some cases suggested energy absorbing material covering on seatbacks as a measure to reduce the probability of injury. Seat anchorage to the floor and sidewalls of the vehicle were also mentioned. In some collisions passenger seats were partially or completely separated from the vehicle body during collision creating another possible source for injury. It was suggested that passenger seats be anchored securely to the floor as well as the sidewall structure of the vehicle, thus enhancing the vehicle superstructure. Seat cushion retention during collision appeared to be an area addressed in four CPIR cases. Ideally, partial or complete separation during collision is not desirable. Egress as well as injury potential become the problem areas with loose seat cushions.

An attempt has been made to incorporate changes into the "Suggested Revised Statement" to reflect areas, like stanchion mounting, where we thought improvements could be made to reduce the potential for injury.





PURCHASE SPECIFICATIONS



## 1.0 INTENDED VEHICLE APPLICATION

Original. Vehicles will be required to operate on all types of neighborhood streets. 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.

The vehicle required is a "top-line" automotive manufacture compact van, with a high-quality conversion which provides higher roof placement for adult standing headroom, a driver operated passenger door with a very low step, and a high-quality interior trim and seating package. 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 19\_\_ models only.

Vehicles other than van conversions are not acceptable for this procurement.

Comments. There were several negative comments concerning the high-roof conversion which is implied by the phrase "adult standing head room." Some users felt that it was unnecessary and created stability problems. One user commented that the high roof was particularly undesirable in rural usage. One converter stated that many rural customers prefer the low-roof conversion.

The high-roof provision might be desirable if the vehicle is intended primarily for transporting the elderly, who might experience somewhat greater difficulty in moving to designated seating positions in a low-roof conversion.

The specifications state "vehicles will be required to operate in all types of neighborhood streets." However, many of these vehicles, particularly those intended for use by the elderly and handicapped, are operated on rural roads as well. In low population areas many vehicles are used nearly exclusively in rural service.

One or more converting organizations use low step configuration for vehicle entry which is apparently designed to drop into place when the entry door is opened. Individuals who have experienced this system in service say that invariably it fails within a matter of weeks due to build up of dirt, snow, ice, etc. and it has been necessary for them to discontinue its use.

Also, comments were received from users that a qualification of the phrase "low in maintenance cost" was desirable to indicate whether short-term or long-term costs were meant. It was stated that vehicles routinely saw over 100,000 miles of service, with some vehicles reaching 200,000 miles in their service life.

Suggested Changes. The first sentence might be altered to read "Vehicle will be required to operate on all types of roadways at a variety of speeds and shall be capable of prolonged idling."

Adding the phrase "for over 100,000 miles" to the first paragraph qualifies somewhat that low maintenance is desired for an extended period.

Substituting "multi-purpose" for "compact" in the second paragraph removes the potential for confusion that would occur when the manufacturers introduce real "compact vans" in 1980. Also, "multi-purpose vehicle" is the accepted description used by D.O.T.

Deletion of phrasing dealing with higher roof placement, passenger door and step, trim, and seating is recommended as these items are more properly part of other relevant paragraphs in the specification, rather than part of the intended vehicle application.

Suggested Revised Statement. 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 19 models only.

Vehicles other than van conversions are not acceptable for this procurement.



## 2.0 COMPONENTS, MATERIALS, WORKMANSHIP AND COMPLETENESS

Original. 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 not specified shall be manufacturer's best quality and shall conform in material, design or workmanship to the best practice known in the Automotive Industry. 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.

Comments. Several converters suggested that they should not be held accountable for OEM problems since the vehicle is warranted by the manufacturer. Thus, the manufacturer is responsible for chassis components, and the converter only for the modifications, additions, etc.

However, some users thought that divided responsibility made it possible for both manufacturers and converters to avoid warranty responsibility by blaming any failure on the other. Also, OEM dealers were reluctant to service vehicles after they had been modified in a

manner which made servicing more difficult.

Suggested Changes. None.



### 3.0 GENERAL DIMENSIONS

#### Original

Length overall	up to 240"
Width (exclusive of mirrors)	75" - 96"
Height overall	115" maximum
Turning radius	35' maximum
Interior headroom	72" at center minimum w/ roof conversion
Seating capacity	10-15 passengers
Gross vehicle weight	shall not exceed the designed capacity of axles or other suspension elements.
Wheelbase	123" minimum

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

Comments. It should be noted that many of these dimensions are determined by the manufacturer of the van chassis and not the converter. For example, the current maximum overall length and width available is 230 inches long and 80 inches wide. Wheel base is also determined by the vehicle selected for conversion. Turn radius as stated is insufficiently defined to be meaningful. It should be specified as curb-to-curb or wall-to-wall. However, again, this is determined by the vehicle manufacturer. Unless a particular turn radius is critical, the bidder runs the risk of unnecessarily excluding a chassis manufacturer.

The gross vehicle weight should be specified at fully rated load. Seating capacity obviously depends on the interior seating configuration elected and particularly it depends on the number of wheelchair tie-down positions required.

Suggested Changes. Delete reference to length, width, turning radius (or specify the type of turn radius required) and wheel base. Modify specification for interior headroom to allow a choice of

"60 inch minimum or 72 inch minimum at center." This will allow the purchaser to elect a low or high roof conversion by circling "60 inch minimum" or "72 inch minimum at center," as appropriate. In seating capacity, replace "10-15 passengers" with "see attached seating chart supplied by purchaser." This will ensure that seating and provision of wheelchair positions is as desired. Amplify gross vehicle weight specification by adding "at maximum rated load."

Suggested Revised Statement

Interior headroom	60" or 72" at center minimum w/ roof conversion
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.

## 4.0 ENGINE

### Subsection 4.1

Original. 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) cities.

Comments. No comments were received on this subsection. No suggestions for changes are made.

### Subsection 4.2

Original. Gasoline engine shall be fitted; heavy duty truck-type with quality bearings, pistons, crankshaft designed for sustained full load operation. Stellito valve seats, sodium cooled exhaust valves, and positive valve rotations are required. Displacement of at least 300 cu. in. is required for non-hilly terrain, capable of delivering at least 100 net flywheel HP to the power train, with all accessories including air conditioning compressor operating. (or, Engine displacement shall be at least 350 cu. in. for hilly terrain; capable of delivering at least 120 net flywheel HP to the power train with all accessories including air conditioning compressor operating.)

Suggested Changes. Delete valve characteristics, which are not relevant on these vehicles at this time.

Delete the displacement requirement, since only adequate horsepower and torque are required. Specifying displacement is too restrictive and limiting of advanced concept engine types. A torque requirement could ensure that any advanced concept engines are equivalent to a minimum requirement 300 cu. in. V-8. Torque is important in stop and start duty cycles.

Suggested Revised Statement. 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 100 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 120 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 100-120 HP.

#### Subsection 4.3

Original. Engine shall be furnished with a large capacity full flow oil filter easily reached and replaced without removal of any major component. An oil bath or dry type air cleaner is required.

Suggested Changes. Replaceable air cleaners are available from the vehicle manufacturer, thus simplifying maintenance and reducing the danger of fire.

Suggested Revised Statement. 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.

#### Subsection 4.4

Original. The vehicle's electrical system shall be supplied by a heavy duty generator or alternator, 60 Amps. minimum; in the case of an alternator, the battery terminals and alternator terminals, shall be clearly marked to avoid misconnection and subsequent damage of rectifier components.

Suggested Changes. Delete this section, as appropriate information should be supplied in Section 17.0 Electrical System.

## 5.0 ENGINE COMPARTMENT

Original. Engine compartment shall be insulated to prevent transmission of noise, exhaust, odor, smoke or heat to the interior of the coach. 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. 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 (grab-rails, stanchions, heater assemblies, etc.) inside the coach, except seats. Wires shall not be routed on or near manifolds or exhausts in a manner which will allow them to overheat and ignite.

Comments. A number of comments were received on this issue. However, many of them are beyond the control of the converter. It was noted that one popular vehicle make requires that the engine be removed from inside the bus. It was suggested that it should be possible to do this without removing parts of the bus added by the converter. The engine cover should be removable by one person. Apparently, this is not the case presently. It must reseal properly. Some users commented that they had problems as the vehicles aged, with the engine cover distorting so that it no longer sealed, permitting noise, heat, and fumes to leak into the interior of the bus. One user commented that 100 degrees was too hot, that it would make the driver uncomfortable. One person suggested that the bus be equipped with a light in the engine compartment to facilitate work on the engine.

Suggested Changes. Insert a requirement for a fresh air plenum chamber to insure a supply of fresh unheated air for the driver. Specify that outside engine access is required for items like oil, transmission, brake and radiator fluids. We suggest that allowing seats to be removed for engine access is too cumbersome. Finally, hoses as well as wires need protection from heat.

Suggested Revised Statement. Engine compartment shall be insulated to prevent transmission of noise, exhaust, odor, smoke or heat to the interior of the coach. 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 (grab-rails, 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

### Subsection 6.1

Original. Radiator fan shall be thermostatically controlled fluid drive type so as to be effectively power driven only above the minimum efficient engine temperature, and shall maintain engine temperature not to exceed 195<sup>0</sup>.

Comments. One user commented that overheating has been a recurrent problem on their buses to the extent that the air conditioning compressors had been removed to reduce load on the engine.

The specification says "only above the minimum efficient engine temperature." Typically such fans are designed to engage only when overheating threatens, thus we feel that "maximum" was intended instead of "minimum."

Suggested Changes. Electrically driven cooling fans are a viable option. We suggest deleting "fluid drive type" as design restrictive. Because of the severe demands placed on these cooling systems it may be best to specify "largest available" radiator. Note that a 195<sup>0</sup> thermostat attempts to maintain 195<sup>0</sup> or above. Change specification to 235<sup>0</sup> F to provide a safety margin. Finally, replace "minimum" with "maximum."

Suggested Revised Statement. 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<sup>0</sup> F with an ambient temperature of 100<sup>0</sup> F and all accessories operating.

### Subsection 6.2

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

Comments. No changes are suggested for Subsection 6.2.





## 7.0 FUEL SYSTEM

### Subsection 7.1

Original. Fuel tank shall be a minimum 35 U.S. gallon capacity, internally baffled to prevent surging and rigidly supported by at least four (4) supports, arranged for easy removal. Tank shall incorporate sump with removable drain plug. Filler pipe or inspection plate shall be removable for easy inspection.

Comments. There is no tank currently available having a sump with a removable drain plug. One user commented that they'd had poor experience with plastic gas tanks and recommended that they be explicitly prohibited. One converter, however, commented that he had found plastic gas tanks to be acceptable if they are protected by frame members. Joints in the gas line have leaked at times, causing fire hazards.

Suggested Changes. Suggest adding: "A plastic fuel tank acceptable only if installed in a manner such that it is adequately protected by structural members of the vehicle." to follow the first sentence in Section 7.1. Delete sentence "tank shall incorporate sump with removable drain plug" and replace it with "the gas line from the carburetor to the pump shall be one piece steel."

Suggested Revised Statement. Fuel tank shall be a minimum 35 U.S. gallon capacity, internally baffled to prevent surging and rigidly supported by at least four (4) 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.

### Subsection 7.2

Original. An engine mounted fuel filter is required with replaceable type elements.

Comments. A user commented that engine mounted fuel filters lead to engine fires because of leaks near the distributor.

Suggested Changes. Replace "engine mounted" with "underbody" to remove fuel filter leaks from vicinity of distributor and engine to reduce underhood fires which occasionally occur.

Suggested Revised Statement. An underbody fuel filter is required with replaceable type elements.

## 8.0 EXHAUST SYSTEM

Original. 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.

They buyer does not wish to specify muffler type and location provided that these requirements are met.

Comments. There were complaints about the exhaust system hangers and other small parts not being sufficiently rugged to withstand bus type service. Obviously, this is a manufacturing problem and if possible, the manufacturer might find a way of upgrading these parts.

Suggested Changes. There are no suggested changes.



## 9.0 TRANSMISSION

### Subsection 9.1

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

Suggested Changes. Delete "power shift, hydraulic drive type" as unnecessary and design restrictive, perhaps prohibiting new fuel efficient lock-up torque converters.

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

### Subsection 9.2

Original. Transmission shall be 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 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.

Comments. Transmissions are apparently a frequent source of trouble in bus type service. Where options are available, the specifications should require the use of the heaviest duty transmission available.

Suggested Changes. Insert "the heaviest duty available" after "Transmission shall be." We also suggest that the final line of

the first paragraph be modified to say "heat exchanger to maintain safe operating temperature at full rated loads."

Suggested Revised Statement. 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.

#### Subsection 9.3

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

Comments. No comments were received on this subsection, no changes are suggested.

## 10.0 FRONT SUSPENSION

### Original

Axle Capacity	3,300 lbs. minimum
Spring Capacity each	1,700 lbs. minimum at ground

Solid tubular or beam axle, or independent front suspension, is allowable. In the case of the later, 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 front wheel bearings shall be fitted. The heaviest available shock absorbers shall be provided, 1 3/8" diameter minimum.

Comments. There has been a great deal of trouble with front suspension components. Major frame and suspension components have often broken or distorted under this type of service. User problems have included cracking around the steering gear and shock tower, excessive linkage, idler arm, control arm, and shock wear, and alignment problems which are exacerbated by these failures. A supplier noted that the chassis structure has been upgraded recently, at least by one manufacturer, to reduce shock tower cracking and other similar problems experienced by users.

One converter states that no complaints have been received from his 3,300/1,725 lbs. front suspension setup. However, users reportedly desired a 4,000/1,900 lbs. system to reduce the front suspension problems. Reportedly, there are small cost differences between the maximum available axle/spring capacities and those in the draft specification.

It was also mentioned that there is no point in specifying parameters such as minimum shock diameters. One, because this may unnecessarily restrict the use of other materials in the future and second, because it may prohibit the use of certain chassis. A large scale user thought that air shocks might be heavier duty and more

comfortable. However, they require periodic maintenance to keep the pressure at the correct level and automatically adjustable ones would be too expensive.

There have been problems with smaller than adequate or available wheel bearings being fitted and with wheel bearing breakage.

Suggested Changes. Upgrade the axle capacities to 4,000 lbs., the spring capacity to 1,900 lbs. minimum. We suggest that the last sentence be modified as follows: "The heaviest duty available shock absorber shall be provided." The reference to shock diameter should be deleted.

Suggested Revised Statement

Axle Capacity	4,000 lbs. minimum
Spring Capacity each	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

Original. 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	5,000 lbs. minimum
Spring Capacity	2,500 lbs. minimum at ground

Comments. A converter suggested that his 5,500/2,750 package seemed adequate. A major user said use of 2,750 lb. springs led to broken spring leaves. Recent changes on the part of chassis manufacturers make it possible to upgrade the specifications. The axle capacity can now be set at 6,200 lbs. minimum, the spring capacity at 3,100 lbs. each. These values were recommended by several users.

Suggested Changes. We suggest that the capacities be upgraded as indicated above. It should also be noted that, for purposes of clarification and uniformity, the underline in the parenthetical statement be continued in the last line "as seasonal driving conditions)."

Suggested Revised Statement. 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	6,200 lbs. minimum
Spring Capacity	3,100 lbs. minimum at ground



## 12.0 PROPELLER SHAFT

Original. The propeller shaft shall be of minimum 3 1/2" O.D. heavy duty type, 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 the pavement should the front universal joint break.

Comments. It was pointed out that there is no point in specifying the sizes of items such as propeller shafts. Rather the specification should be concerned with acquiring the heaviest duty components available for a given chassis type.

Suggested Changes. Replace the statement "of minimum 3 1/2" O.D. heavy duty type" with "the heaviest duty component available."

Upon breaking, the propeller shaft should not be allowed to damage any vital vehicle components. (See inserted additional language in the suggested revised statement.)

Suggested Revised Statement. 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

### Subsection 13.1 - Steering Effort

Original. 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 seated load (150 lbs. per passenger) 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.

Suggested Changes. We suggest that the sentence which says, "the pull at the rim for a wet vehicle with a seated load," be altered to read "a full load (150 lbs. per passenger x maximum passenger capacity)."

Suggested Revised Statement. 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.

### Subsection 13.2

Original. Steering mechanism shall be constructed so as to make the wheel 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

be not less than 16 inches in diameter and the wheel ring shall be of all plastic or synthetic resin construction, molded over metal. Further, it shall be provided with puller holes in the hub so that a standard or Universal puller may be used.

Comments. No comments were received, no changes are suggested.

#### Subsection 13.3

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

Comments. No comments were received, no changes are suggested.

#### Subsection 13.4

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

Comments. No comments were received, no changes are suggested.

## 14.0 BRAKES

### Subsection 14.1

Original. A dual hydraulic brake system shall be provided.

Comments. No comments were received, no changes are suggested.

### Subsection 14.2

Original. Service brakes shall be four wheel internal expanding or disc type, power operated, capable of decelerating the vehicle to a stop within 22' from a speed of 20 m.p.h.

Comments. Brakes have given users some problems in heavy service. Complaints about over heating and glazing of the drum surfaces are common. Some users thought that it was necessary to specify brake size to get larger brakes to minimize these problems. However, Section 14.3 seems to deal with this appropriately. Other users to whom we spoke wished that disk brakes on all four wheels were available. Obviously, this is a factory matter and it simply may be that four wheel disk brakes are not available on this type of vehicle at the present time. However, it might be unwise to specify all disk brakes because of their shorter life.

Suggested Changes. We suggest changing "power operated" to "power assisted" as a more adequate description of what the brakes actually do.

Suggested Revised Statement. Service brakes shall be four wheel internal expanding or disc type, power assisted, capable of decelerating the vehicle to a stop within 22' from a speed of 20 m.p.h.

### Subsection 14.3

Original. 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.

Comments. No comments were received, no changes are suggested.

Subsection 14.4

Original. Parking brake shall be mechanical type with Orschlin type hand brake lever at left of driver activating rear wheel brakes and shall be capable of stopping vehicle at a deceleration rate equivalent to a stop within 50' from a speed of 20 m.p.h., on dry pavement with a full seated load.

Comments. This section mentions a specific type (Orschlin) hand brake lever. This type of brake is no longer available. As a matter of fact, many vehicles use a foot operated parking brake. It seems pointless to specify a hand brake.

Suggested Changes. We suggest that Subsection 14.4 be modified as shown in the suggested revised statement.

Suggested Revised Statement. Parking brake shall be mechanical type, either hand or foot operated, at left of driver, activating rear wheel brakes, and shall be capable of stopping vehicle at a deceleration rate equivalent to a stop within 50' from a speed of 20 m.p.h., on dry pavement with a full seated load.



## 15.0 WHEELS

Original. Vehicles shall be equipped with the heaviest duty available ventilated pressed steel wheels, 16.5" diameter and 6.75" width, single front and rear. All wheels are to be interchangeable. Extra heavy duty wheel bearings are required.

Comments. One user expressed a preference for rear dual wheels, stating that it would aid considerably in load carrying capability. While this may be the case, we have been advised that it is not possible to fit such a vehicle with rear dual wheels. Only by building up from the chassis with a completely different body are rear duals possible.

Suggested Changes. An option of specifying other size wheels was inserted so the purchaser may match wheel sizes with others in his fleet if he desires.

Suggested Revised Statement. Vehicles shall be equipped with the heaviest duty available ventilated pressed steel wheels, 16.5" diameter and 6.75" width (unless otherwise specified), single front and rear. All wheels are to be interchangeable. Extra heavy duty wheel bearings are required.



## 16.0 TIRES

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

Spare wheel and tire shall also be supplied with each vehicle and 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.

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

Comments. There was considerable disagreement regarding tire size. Some users and suppliers to whom we spoke felt that the 8.00 x 16.5 tire referred to in the specifications is too small. Others felt it was adequate.

One supplier pointed out that many users do not allow the driver to change a flat tire. Rather, if a flat occurs the driver is required to call in for a service truck. If this is the mode of operation of a given agency, they might consider modifying this section of the specifications to reflect the fact that while a spare tire is to be delivered with the vehicle, it should not be mounted on the vehicle.

Suggested Changes. Load range E seems necessary to all concerned parties. However, there was disagreement as to the desired tire size, so the purchaser is provided the option of changing the size to match his fleet as shown.

Suggested Revised Statement. Vehicles are to be equipped with four 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.

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

## 17.0 ELECTRICAL SYSTEM

Original. 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 of at least 60 amperes output at governed engine speed. The buyer desires that the vehicle be fitted with a single battery of 500 ampere longlife 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. Engine compartment wiring may be numbered in lieu of color code.

Comments. There have been problems with the electrical systems on vehicles, particularly those which are lift equipped. Some users thought that the lift places a considerable drain on the system and a 60 ampere alternator as specified is simply not adequate. However, a major converter said he had never heard of complaints with the 60 ampere alternator.

Dead batteries were reported to be a major winter problem in cold weather areas where a 70 ampere OEM alternator will discharge 8 amps at idle. Apparently, 60 amps are sufficient in more moderate climates. Generally speaking, maintenance free batteries of the type recently available have proven to be unsatisfactory, although deep cycle maintenance free batteries were found to be satisfactory. The use of permanently sealed maintenance free batteries is not recommended.

Users would appreciate it if a wiring schematic could be supplied with the vehicles as they have been converted.

Suggested Changes. In the first sentence of the second paragraph, "For gasoline powered vehicles..." there is a verb missing. The sentence might say "an alternator is required of at least..." We also recommend that the alternator be upgraded from a minimum of 60 amperes to at least 90 amperes output if the vehicle is used in cold weather regions or is air conditioned and/or lift equipped. (See the recommended user choice in the suggested revised statement.) We suggest that the last sentence in the second paragraph be modified as follows: "The buyer desires that the vehicle be fitted with a single battery of 250 ampere hour rating." Also, the last sentence under wiring should be replaced with "a full schematic of all OEM and conversion wiring must be included."

Suggested Revised Statement. 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<sup>0</sup> F 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 & CONTROLS

### Subsection 18.1

Original. The following instruments shall be provided:

- Speedometer, with recording odometer.
- Ammeter or voltmeter
- Low-charge warning light (Battery)
- Oil pressure gauge
- Fuel tank level gauge
- Engine temperature gauge
- Headlight on indication and headlight high beam indicator
- Directional signal and flasher action light

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.

Comments. The need for a headlamp on indicator was questioned. Also, it was mentioned that conversion to a heavy duty alternator burns out ammeters that do not have enough range to record the high current values. Other things mentioned were that items like a speedometer and odometer are already required by Federal law and a blanket phrase could cover all such Federal and State legal requirements.

Suggested Changes. If the headlamp on indication is to be left in, even though it is not OEM equipment, it should be in the form of an auditory signal, to reduce the chance of the driver leaving the bus with the headlamps on when the engine is off. Other changes to reflect the comments are contained in the suggested revised statement.

Suggested Revised Statement. The following instruments shall be provided:

- Ammeter consistent with alternator size, or voltmeter
- Low-charge warning light (Battery)
- Oil pressure gauge
- Fuel tank level gauge
- Engine temperature gauge
- 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.

#### Subsection 18.2

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

- Column mounted turn signal lever.
- Emergency flasher control facing driver and clearly visible.
- Door control (manual) 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. Switches must all be of uniform type, identical to light switches.
- Key start or push button starter switch.
- Two-speed wiper control.
- Foot operated windshield washer.
- Passenger compartment lights.
- Hand throttle for control of engine speed.

All controls shall be within driver's arm reach with seat belt fastened. All 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.

Comments. A specification for a foot operated windshield washer is not pertinent since such an option is no longer available.

We have also been advised that hand throttles cannot be installed by a manufacturer because this is construed as a violation of EPA emission requirements, since vans are not certified with hand throttles.

Other comments suggested that the door control be capable of being locked in the open position to prevent its being blown closed on passengers.

Several other comments addressed the uniformity and "identical to light switch" requirements as causing problems, especially as OEM switches would have to be changed. Labeling and illumination was also suggested for switches.

Suggested Changes. Replace the "key start or push button" starter switch provision with a less restrictive "electric" starter switch. Other changes are shown on the suggested revised statement to alleviate various problems or complaints which were mentioned. For example, foot operated windshield washer and hand throttle control provisions are deleted. Other items we suggest eliminating do not seem to be essential and may be disfunctional or out-of-date as an OEM item. For example, OEM light switches are normally push-pull types. Various temperature and air controls would be more distinguishable if they were different from light switches. Deleting requirements for similarity will allow manufacturers to propose other more advantageous designs. It is not economical to require OEM switches to be changed for the sake of uniformity. All conversion switches need to be labeled and illuminated to encourage proper operation.

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

- Column mounted turn signal lever.
- 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

### Subsection 19.1

Original. The body structure shall be built as an integral unit, adequately reinforced at all joints and corners where stress concentration may occur and shall adequately carry required loads and stand road shock.

Comments. There was some confusion with the term "integral unit." Does this mean that only a Dodge unibody is acceptable? If a General Motors frame and body combination is acceptable, for example, it might be better to delete the phrase "built as an integral unit."

Suggested Changes. Delete or explain what is meant by the term "built as an integral unit."

Suggested Revised Statement. 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.

### Subsection 19.2

Original. 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.

Comments. No comments were received and no changes are suggested.

### Subsection 19.3

Original. All exterior panels shall be riveted, welded, or bonded to body frame. No metal screws shall be permitted. Exterior seams shall be constructed in such a manner that they will shed water,

that is, the leading panel shall be lapped over the following panel and in no case shall the sealing of the panels be dependent on caulking alone. All exterior joints and seams shall be protected by the application of caulking compound of zinc chromate type, Butyl rubber tape, or approved equal. Body shall be thoroughly water tested and made tight to prevent leakage.

Comments. No comments were received and no changes are suggested.

#### Subsection 19.4

Original. Raised roof caps shall have at least one fixed, tinted safety glass window. The minimum acceptable center aisle height will be 72 inches. Roof conversions may be of steel, aluminum or fiberglass, but shall include a collapse resistant steel rollover cage.

Comments. This subsection contains reference to a minimum acceptable height of 72 inches. This precludes the possibility of lower roof conversions of approximately 62" which might be deemed preferable by some agencies for certain types of service. For example, it would seem that a conversion designed primarily for exclusive usage by the handicapped might well use a conversion with a height of about 60" or more.

Suggested Changes. Delete from subsection 19.4 the sentence, "The minimum acceptable center aisle height will be 72 inches."

Suggested Revised Statement. 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.

#### Subsection 19.5

Original. Before assembling all metal body parts shall be given a thorough multiple stage anti-corrosion treatment. Zinc chromate 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).

Comments. No comments were received, no changes are suggested.

#### Subsection 19.6

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

Suggested Changes. Add "or huck bolted" after "riveted," as this is supposedly equivalent or better in strength, according to a major converter.

Suggested Revised Statement. All nuts, bolts, clips, washers, clamps, and like fasteners shall be zinc or cadmium 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.

#### Subsection 19.7

Original. Stepwells are to be of one-piece construction, either molded fiberglass stamped aluminum or stainless 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 12" deep. Individual risers shall not exceed 8" in height, and in the case of more than one riser all shall be the same height.

Comments. It should be noted that it is simply not possible to meet this specification with current chasses, since major structural members are in the way. The maximum tread depth that can be supplied at present is 9 inches. Also, a white step edge is needed for better visibility by the elderly. An illuminated stepwell is recommended.

Suggested Changes. Modify the stepwell specifications by replacing the "12" deep" currently specified with "at least 9 inches deep with at least a 1 1/2" white front edge on both the top vertical and leading horizontal surfaces of each step." A phrase specifying an illuminated stepwell was added to the end of Section 19.7 in the suggested revised statement.

Suggested Revised Statement. Stepwells are to be on one-piece construction, either molded fiberglass, stamped aluminum or stainless 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 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.

#### Subsection 19.8

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

Comments. No comments were received and no changes are suggested.

#### Subsection 19.9

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

Comments. No comments were received and no changes are suggested.

#### Subsection 19.10

Original. The entire body-frame under structure of the vehicle is to be fully undercoated with nonflammable resin-type material, polyoleum, or equivalent, applied at time of manufacture. Automotive quality undercoating applied at a local dealer is not satisfactory.

Comments. No comments were received and no changes are suggested.



Subsection 19.11

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

Comments. No comments were received and no changes are suggested.



## 20.0 DOORS

### Subsection 20.1

Original. The vehicle shall be equipped with a single section front entrance door, located opposite the driver. The door shall be of the front hinged "sedan type" and shall be driver operated. A simple, manually operated, with overcenter linkage of self locking type is preferred. The door shall have a clear center opening width of at least 32" and a full length of at least 72" with roof conversion and 47" without roof conversion.

Comments. Doors on these vehicles have provided considerable problems for user organizations. They tend to sag with use, fit poorly, and cause operational difficulties. The front door is exposed to a special form of abuse because people tend to use the door operating mechanism, or any other available hardware in that area, as a means to pull themselves on board the bus. This is particularly a problem with older people. Because of this natural tendency on the part of the passengers, it is imperative that the door and associated hardware be made sturdy enough to be able to tolerate this sort of abuse without distortion over a period of time. This point is particularly stressed by users of sedan hinged type doors, especially where the lower reinforcement member is not used for support. It was also thought that bi-fold doors might not have this problem, would not tend to hit the curb (causing misalignment) when opened, and might provide a larger, more convenient opening. Again, the absolute requirement for 72" was questioned as was the 47" without roof conversion, which contradicts the "adult standing headroom" in paragraph 1.0.

Suggested Changes. If it is necessary to restrict from usage bi-fold doors, which may offer less protrusion and wider steps and aisles, the original paragraph may be retained. Otherwise, the paragraph provided in the suggested revised statement offering a choice of door styles should be used.

After the sentence concerning the "sedan type hinge" include the sentence "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." Replacing the word "length" with "height" may make the intention clearer in the last sentence in 20.1.

Suggested Revised Statement. 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 overcenter 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.

#### Subsection 20.2

Original. A side entrance door shall be provided even when a lift is not required. The door shall be a two section, hinged type with meeting edges that are gasketed to form a weather tight seal. There shall be provisions for tie back straps to hold the doors open.

Comments. The individuals to whom we talked did not understand the need for a side entrance door when a lift is not ordered. There seems to be no real need for this provision, and it costs seating room. It was also pointed out that, even if this section was changed to be required only when a lift was ordered, it was not an adequate specification.

Suggested Changes. Modify so that a side entrance door is provided only when a lift is required. Also, add the last two sentences from Subsection 20.3.

Suggested Revised Statement. 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 56" 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.

### Subsection 20.3

Original. 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. Vehicles to be equipped with lifts and roof conversions shall have the double side entrance doors extended at the top to give a minimum 57" clearance between the floor and top of the door opening. There shall be a minimum entry way at least 39" wide after provision has been made for lift hardware.

Suggested Changes. Take the last two sentences from 20.3, which aren't about emergency doors or exits, and incorporate this side door material into 20.2. As shown, the recommended insertion for 20.2 changes the clearance height from 57" to 56" to allow for manufacturing variation and changes the minimum entry way from 39" to 32". This latter change is proposed because a 39" entry way is currently not feasible. Most converters commented that a van side body opening of 39" is available, but only prior to lift installation. After lift installation only a 29 1/2 to 32 1/2 inch entry space is available, depending on the lift installed. Replace the last two sentences of 20.3 with the material suggested below, which is needed

to more adequately define the emergency door/doors requirement.

Suggested Revised Statement. 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 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."

## 21.0 WINDOWS

### Subsection 21.1

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

Comments. One user commented that it would be helpful if the windshield could be supplied with a full tint to help the driver with the heat load.

Suggested Changes. None.

### Subsection 21.2

Original. 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 tip or kick-out type for emergency escape in compliance with FMVSS 217.

Comments. At the end of 21.2 some users would specify "and shall be marked with instructions."

Suggested Changes. Change "tip" to "top" in the last sentence.

Suggested Revised Statement. 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 for emergency escape in compliance with FMVSS 217.

### Subsection 21.3

Original. 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.

Suggested Changes. Add "to  $\leq$  33% transmittance" to the end of the paragraph.

Suggested Revised Statement. 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

### Subsection 22.1

Original. 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.

Comments. Heater output requirements probably depend on the climate in which the vehicles operate. One converter thought that 21,000 BTU would be adequate given an OEM heavy duty heater. However, some users in cold weather areas require 35,000 BTU. Thus, 30,000 BTU seems to be a reasonable compromise. The sentence "no heater lines should be exposed" should be added to 22.1 according to several users.

Suggested Changes. Add the sentence "no heater lines shall be exposed."

Suggested Revised Statement. 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.

### Subsection 22.2

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

Comments. One user indicated that it would be better to use manually controlled switches. Several converters and users indicated that there is no practical way to meet the requirement for individually thermostatically controlled switches.

Suggested Changes. We suggest that the word "thermostatically" in the second sentence of paragraph 22.2 be deleted.

Suggested Revised Statement. 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.

### Subsection 22.3

Original. Provision shall be made for windshield defrosting, adjustable, and within easy reach of the driver. The buyer prefers that all other glass be fitted with defoggers if possible.

Comments. All other glass "fitted with defoggers" may take a bidder out of contention. It was suggested that the driver's left hand window be included instead of "all other glass."

Suggested Changes. This subsection can probably be adequately specified by deleting the second sentence and changing the first sentence to "provision shall be made for defrosting of the windshield and the driver's left hand side window. Such provision shall be adjustable and within easy reach of the driver."

Suggested Revised Statement. 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.

### Subsection 22.4

Original. 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.

Comments. No comments were received and no changes are suggested.

## Subsection 22.5

Original. 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 up to 90<sup>0</sup> F. and 100% relative humidity, and to maintain that temperature during operation with varying engine speed, and with frequent passenger door operation.

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

Suggested Changes. Insert "of 76<sup>0</sup> F at conditions of temperature and humidity" between "temperature" and "up" in Section 22.5. Also, inserting "heat exchanger" between "evaporate" and "units" would allow new, more efficient types of air conditioning to be used.

Suggested Revised Statement. 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 of 76<sup>0</sup> F. at conditions of temperature and humidity up to 90<sup>0</sup> F. and 100% relative humidity, and to maintain that temperature during operation with varying engine speed, and with frequent passenger door operation.

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

Original. 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 both front and rear bumpers. Bumpers are to be painted, not chromimum plated or bright metal. Bumper guards shall be faced with rubber pads for added shock resistance.

Comments. It was noted that it is not possible to provide OEM rear bumper guards since they are not available on most vans. They also interfere with the operation of the rear emergency doors in some cases.

Suggested Changes. The sentence which refers to bumper guard installation should delete reference to having them on the rear bumpers.

Suggested Revised Statement. 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 faced with rubber pads for added shock resistance.



## 24.0 INTERIOR LIGHTING

Original. Interior shall be illuminated so as to provide a minimum of 12 foot candles of illumination over the entire normal reading position of each two passenger cross seat. 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.

Comments. It was recommended by a user that "and rheostat controlled" be inserted after "illuminated."

Suggested Changes. Allow for adjustment of interior illumination.

Suggested Revised Statement. Interior shall be illuminated 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.





## 25.0 EXTERIOR LIGHTING

Original. All exterior lights must meet the state of ----- requirements and Federal Regulations.

Headlights of sealed beam type are required with high and low beam.

Directional signals shall meet all federal motor vehicle standards, front and rear.

Rear mounted red combination stop/tail lights shall be provided to meet all Federal Motor Vehicle Safety Standards. Amber front and red rear reflectors shall be provided on each side.

Two back-up lights and rear license plate lights shall be provided.

A circuit shall be provided for the directional signal which when on will cause them to function as traffic hazard warning signals. Four-way emergency flashers must either be wired so as to override the brake light function if both functions activate the same set of bulb filaments at rear of vehicle, plus a conspicuous pair of red or amber separate lights must be installed near the outer rear corners of the vehicle in a manner harmonious with the basic vehicle design, activated by a separate switch.

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.

Comments. The second, third, fourth, fifth, and sixth paragraphs are redundant to the first paragraph. The Federal Motor Vehicle Safety Standards require these lighting systems.

The fourth paragraph makes reference to amber front and rear reflectors. Some vehicles use lights instead of reflectors and the specification ought not to arbitrarily require only reflectors.

There appears to be a grammatical problem in the sixth paragraph. The second sentence says, "four way emergency flashers must either be" and then goes on to talk about "plus a conspicuous pair of red or amber lights." We believe it was the author's intent to allow either turn/stop combination lights or separate turn signals.

Suggested Changes. The first sentence would be simpler if it said "all exterior lights must meet requirements of the state of the purchaser and all applicable Federal regulations." The next five paragraphs should be deleted. The first sentence will still require all of the lights which were previously specified, as they are required by Federal and State laws. If for some reason these sentences aren't deleted, delete the word "combination" in the fourth sentence and add "or lights" after reflectors. In the sixth paragraph, we would then suggest that the word "either" be moved to follow "wired so as to" and replace the whole phrase "plus...switch" with "or operate the separate directional signals."

Suggested Revised Statement. All exterior lights must meet the requirements of the state of the purchaser and all applicable Federal Regulations.

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.

## 26.0 INTERIOR

### Subsection 26.1

Original. The subfloor shall be of minimum 1/2" thick, 5-ply waterproof plywood securely fastened to steel and covered from wall to wall with ACA 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 in conformance with Federal Motor Carrier regulations.

Suggested Changes. "ACA" should be "RCA."

### Subsection 26.2

Original. (OPTION) Full floor wool carpeting is to be provided of highest wear quality and shall be treated with fire retardant solution. Color shall harmonize with other vehicle colors and contrast with seat colors. In the area of the driver's compartment engine cover, entry ways and lift area, RCA transit floor or approved hard rubber equivalent shall be provided. The driver's compartment begins at a line approximately behind the driver's seat.

Comment. Both converters and users recommended against allowing this option, due to cleaning problems.

Suggested Changes. We recommend that this section be dropped as impractical for this type of vehicle and service.

### Subsection 26.3

Original. Inside walls and ceiling shall be insulated with fiberglass blankets (aluminum faced) and body areas so insulated shall be thoroughly treated with Tuff-Cote, Ziebart, Polyoleum or equivalent before application of fiberglass blankets.

Comments. We were asked: Why require aluminum faced fiberglass as opposed to other materials (e.g., spray foam) applied to give a equivalent R value for resistance to heat loss?

Suggested Changes. Replace first sentence with material as shown below. Follow this with the body areas rustproofing requirement.

Suggested Revised Statement. 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.

#### Subsection 26.4

Original. All interior panels shall be textured aluminum and/or vinyl clad sheet steel, aluminum, or melamine with colors harmonizing with other vehicle colors. Fiber, wood or vinyl covered fiber or wood panels are not acceptable.

Comments. It was suggested that "vinyl clad" materials was too restrictive. Rust resistant steel can be painted with the new polyurethane paints and will do as well.

Suggested Changes. Add provision for painted steel.

Suggested Revised Statement. All interior panels shall be textured aluminum and/or vinyl clad or rust resistant polyurethane (IMRON equivalent) painted sheet steel, aluminum, or melamine with colors harmonizing with other vehicle colors. Fiber, wood or vinyl covered fiber or wood panels are not acceptable.

### Subsection 26.5

Original. 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.

Comments. No comments were received on this subsection and no changes are recommended.

### Subsection 26.6

Original. Stanchions, 1 1/4" diameter of corrosion resistant steel tubing shall be in the entry area. Grab rails at the door shall be within reach from the ground to assist passengers both in boarding and alighting. All vertical stanchions shall be padded. Stanchions shall be provided at each wheelchair location if so equipped. A handhold device shall be provided in the lift area to enable a person standing on the lift to steady himself through the entire lift operation.

Comments. It was noted with reference to subsection 26.6 that problems have been encountered with the stanchions tearing loose. The securest possible mounting should be employed. Stanchions on some vans are set into sockets, which in turn are screwed or bolted to the floor. This arrangement in the event of a crash, can result in a stanchion being torn out, leaving the socket protruding one to two inches above the floor and down from the ceiling, a very bad situation from the point of view of harming persons being thrown about inside the vehicle. Also, grab rails are needed on both sides of the door to account for amputations and arm preference. The intent of the "person standing on the lift" needs to be clarified since some converters do not recommend someone riding up on the lift with the wheelchair occupant.

Suggested Changes. We recommend that subsection 26.6 be modified to include language stressing that stanchions will be attached as

securely as possible. In addition, stanchions shall be attached in such a way that should they be torn loose in a crash, no support, etc. shall remain on the floor or ceiling which may cause damage to a person thrown against it. Also, "both sides of" should be inserted between "grab rails at" and "the door." Clarify the intent of the last line of 26.6 by inserting between "lift" and "to" the phrase "perhaps using crutches or a walker."

Suggested Revised Statement. 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)

### Subsection 27.1

Original. Handicapped units' seats shall be identical to those in the regular units except as otherwise herein provided. Each wheelchair position shall be fitted with a recessed track 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.

Comments. The phrase "with a recessed track" was thought to be design restrictive. A major converter said his main purchaser did not really use the recessed track to obtain "quick and easy installation of regular type seats," but only to rearrange seating.

Suggested Changes. Delete "with a recessed track."

Suggested Revised Statement. 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.

### Subsection 27.2

Original. Passenger seats except at wheelchair locations shall be all forward facing, covered with commercial grade vinyl or equal of heavy duty, fully padded (4 inch) construction. Seat backs and bottoms shall be contoured for maximum comfort. Minimum seat cushion

depth 15", width 18" per passenger. Seat backs shall be between 18" and 20" high. No arm-rests attached. Seats should 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 a minimum of 14" and shall extend the length of the vehicle such that there is a clear path to the emergency back doors.

Comments. It was mentioned by a major user 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.

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.

Suggested Changes. Insert "or heavy duty woven fabric, color coded with exterior vehicle colors. Seats shall be..." after "or equal" and before "of heavy duty." Even though 17" may be normal, the 18" requirement seems justified to accommodate large persons. We recommend a 16" aisle to make it easier for the elderly (especially with canes or walkers) to move about.

Suggested Revised Statement. 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 comfort. Minimum seat cushion depth 15", width 18" per passenger. Seat backs shall be between 18" and 20" high. No arm-rests attached. Seats should 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 supports and shall extend the length of the vehicle such that there is a clear path to the emergency back doors.

#### Subsection 27.3

Original. The driver's seat shall be full foam (neoprene) construction. The back and cushion of the seat shall be perforated black vinyl and of bucket configuration. The seat shall be securely mounted so that the 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 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.

Comments. There were disagreements between suppliers and users concerning the driver's seat. One manufacturer wanted only a OEM driver's seat while a user said that OEM was not heavy duty or comfortable enough.

Suggested Changes. Insert "or upholstered in heavy duty fabric" after "black vinyl."

Suggested Revised Statement. 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 the 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 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

### Subsection 28.1

Original. 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.

Comments. No comments were received concerning this subsection, no changes are suggested.

### Subsection 28.2

Original. All metal surfaces shall be treated with zinc chromate primer prior to painting. The contractor will be provided with color chips or with Dupont (or equal) color numbers. Paint material will be acrylic enamel.

Comments. A supplier pointed out that the paint referred to should be Dupont "Imron" which is a trade name for a new "polyurethane" paint.

Suggested Changes. Insert "polyurethane equivalent to Dupont Imron" after "paint material will be."

Suggested Revised Statement. All metal surfaces shall be treated with zinc chromate primer prior to painting. The contractor will be provided with color chips or with Dupont (or equal) color numbers. Paint material will be polyurethane equivalent to Dupont Imron.

### Subsection 28.3

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

Comments. No comments were received concerning this subsection, no changes are recommended.



## 29.0 WHEELCHAIR LIFT (OPTION)

Original. 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. The doors on the right side of the vehicle shall be extended at the top to give a 57" minimum clearance between floor and top of the door opening where the vehicle has a roof conversion and a minimum entry way of at least 39" wide. 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 have a self cleaning, expanded metal, non skid platform which can be folded and unfolded by one person. 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 a 600-lb. load. The platform shall measure at least 30" wide x 44" long. A safety device shall extend the full length of the curb side edge of the platform and shall be a movable hinged surface to provide a barrier to prevent the wheelchair from rolling off the street end of the lift during operation. A 3" high barrier shall also be provided on each side of the platform to prevent wheelchairs from rolling over the edge.

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. 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 10 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.

System control valve shall be solenoid controlled and shall be externally mounted for easy maintenance.

Gravity down shall also be controllable 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 and constructed with sealed roller or sleeve bearings.

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 and hand-held control, 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.

Switches shall be completely weather proof and labeled as to function.

Comments. The entry way has been previously discussed and a recommendation made for Section 20.2. Thus, it might be desirable to add to the first sentence "as specified in Section 20.2" and delete the second sentence, since the door was previously specified and this section is suppose to deal with the lift.

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 chassis 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.

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 control 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.

Suggested Changes. Modify the first paragraph as suggested above and as shown in the revised suggested statement. We suggest that the second paragraph delete "self cleaning, expanded metal" and be modified to say, "The platform shall measure at least 42" long by at least 30" wide, and preferably 32" or wider to the maximum extent permitted by the chassis of the vehicle." Further in the same paragraph we suggest modifying the last sentence to "a 1 1/2 inch high barrier shall also be provided on each side of the platform to prevent the wheelchairs from rolling over the edge." It is also recommended that the doors to the lift shall be restricted in their opening to 90 degrees to form a positive retaining enclosure.

Changing "10" seconds to "15" in the fourth paragraph will allow for production variance and varying ambient temperature. Although a full down/up cycle time would be more appropriate.

Change the second line of the fifth paragraph to read "shall be accessible for ease of maintenance."



Change the last line of the sixth paragraph to read "free of exposed grease when in the transport position."

Change the last paragraph of Section 29.0 to read "Switches shall be deadman type, weatherproof, and labeled as to function."

Revised Suggested Statement. 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 have a non skid platform which can be folded and unfolded by one person. 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 a 600-lb. load. The platform shall measure at least 42" long by at least 30" wide, and preferably 32" 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 a 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.

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

Gravity down shall also be controllable 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 and hand-held control, 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.

Switches shall be deadman type, weather proof, and labeled as to function.

### 30.0 RAMP (OPTION)

Original. 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 600 pounds but not weigh more than 80 pounds.

#### RAMP DIMENSIONS

Overall width	27"
Channel Guide Width	5"
Stair Tred Width	15"
Minimum Track Width	16"
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

Comments. 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 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.

Suggested Changes. We recommend that Section 30.0 Ramp (OPTION) be deleted. If not, we recommend that the strength of the ramp be upgraded to a minimum of 800 pounds and that serious consideration be given to requiring an electric winch to pull wheelchairs up the ramp and lower them.

Suggested Revised Statement. 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	16"
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

## 31.0 WHEELCHAIR RESTRAINTS

Original. All vans equipped with wheelchair lifts shall have wheelchair locking devices permanently affixed to the vehicle for the wheelchair positions for which the vehicle is designed. 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 location shall be equipped with safety belts (conforming with FMVSS No. 208, 209, 210) and shall be equipped with shoulder-crossing safety belts which are anchored in the floor.

Suggested Changes. The first paragraph should be augmented by saying: "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."

Suggested Revised Statement. All vans equipped with wheelchair lifts shall have wheelchair locking devices permanently affixed to the vehicle for the 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 location shall be equipped with safety belts (conforming with FMVSS No. 208, 209 & 210) and shall be equipped with shoulder-crossing safety belts which are anchored to the floor.



## 32.0 FIRE AND FIRST AID EQUIPMENT

Original. First aid kit (16 passenger) and one five pound dry powder or CO<sub>2</sub> fire extinguisher 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.

Suggested Changes. After "five pound" insert "type 5 ABC or other dry powder or CO<sub>2</sub> fire extinguisher meeting all applicable Federal regulations."

Suggested Revised Statement. First aid kit (16 passenger) and one five pound type 5 ABC or other dry powder or CO<sub>2</sub> 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

Original. 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.

Comments. There were no comments received pertaining to this section and no changes are suggested.



## 34.0 DRIVERS ACCESSORIES

### Subsection 34.1

Original. 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 the right hand mirror.

A 4"x12" rectangular rear view mirror shall be installed for the driver's viewing of the bus interior.

Suggested Changes. We suggest that Section 34.1 be modified to state, in the last sentence of the first paragraph, "a convex insert shall be provided on both outside rearview mirrors." The next line should read "At least a 4" x 12" rectangular rear view mirror shall be installed."

Suggested Revised Statement. 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" x 12" rectangular rearview mirror shall be installed for the driver's viewing of the bus interior.

### Subsection 34.2

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

Suggested Changes. Delete "inside the coach" as some users prefer inside the engine compartment.

Suggested Revised Statement. Windshield Wipers & Washers: Two heavy duty, electric, 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.

### Subsection 34.3

Original. A drivers 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

Comments. No comments were received pertaining to this subsection, no changes are suggested.

### 35.0 TWO WAY RADIOS (OPTION)

Original. 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.

Comments. No comments were received, no modifications are suggested for this paragraph.



REPORT OF NEW TECHNOLOGY APPENDIX

No "subject inventions" were achieved during the performance of work on this contract. Modifications, which the authors believe to be improvements, were suggested for most of the sections of the draft specifications. These suggested modifications are listed on the following pages:

<u>Section</u>	<u>Page</u>
1.0	14
3.0	19
4.2	21
4.3	22
4.4	22
5.0	23
6.1	25
7.1	27
7.2	28
9.1	31
9.2	31
10.0	34
11.0	35
12.0	37
13.1	39
14.2	41
14.4	42
15.0	43
16.0	45
17.0	48
18.1	51
18.2	53
19.1	55
19.4	56
19.6	57
19.7	57



(continued)

<u>Section</u>	<u>Page</u>
20.1	61
20.2	63
20.3	63
21.2	65
21.3	65
22.1	67
22.2	68
22.3	68
22.5	69
23.0	71
24.0	73
25.0	76
26.1	77
26.2	77
26.3	78
26.4	78
26.6	79
27.1	81
27.2	82
27.3	83
28.2	85
29.0	90
30.0	93
31.0	95
32.0	97
34.1	101
34.2	102

