SURFACE VEHICLE INFORMATION REPORT

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Structural Modification for Personally Licensed Vehicles to Meet the Transportation Needs of Persons with Disabilities

RATIONALE

This technical report is being stabilized because the technical committee has determined that the using community is moving towards newer technology and would like to alert users that this new technology exists, which may want to be considered for new design.

STABILIZED NOTICE

This document has been declared “Stabilized” by the SAE Adaptive Devices Standards Committee and will no longer be subjected to periodic reviews for currency. Users are responsible for verifying references and continued suitability of technical requirements. Newer technology may exist.

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Foreword—A variety of adaptations to vehicles are necessary in order to meet the transportation needs of people with disabilities. Structural modifications allow entry of occupied wheelchairs into vans. Modifications to floors, roofs, or both can create the head clearance necessary for entry or egress, and for proper eye position to enable drivers and passengers in wheelchairs to see outside of the vehicle.

Because of this need, a specialized industry has evolved to provide these modifications for the disabled consumer. However, the industry is without the benefit of uniform standards.

This SAE Information Report provides recommended state-of-the-art practices in the vehicle modification field, and suggests minimum acceptable design requirements and performance criteria. Its goal is to promote a reasonable level of performance and vehicle reliability after modification.

With the realization that the field of vehicle structural modification is ever changing, it is intended that this document provide a general framework by which future revisions and additions can be incorporated.

The document was drafted by a working group of the Society of Automotive Engineers' (SAE's) Adaptive Devices Standards Committee, and reviewed by a committee made up of the following:

a. Individuals from companies that manufacture and/or install adaptive equipment,
b. Third party contributors to funds for adaptive equipment
c. Driver Rehabilitation Specialists
d. Researchers
e. Engineers with Original Vehicle Manufacturer experience
f. Users of adaptive devices

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1. ***Scope—***The recommendations in this SAE Information Report apply to structural integrity, performance, driveability, and serviceability of personally licensed vehicles not exceeding 10 000 lb GVWR. While many of these recommendations may have application to other vehicles, such as those used in paratransit operations, the contents of this document are not directed at these types of vehicles.

1.1 **Purpose—**The purpose of this document is to:

a. Provide engineering direction to vehicle modifiers that does not limit innovation.
b. Suggest minimum acceptable performance criteria that maintain OEM design intent, allowing consumers and third party payers the ability to obtain equipment that meets or exceeds these minimum acceptable performance criteria.
c. Provides general recommendations on the vehicle modification process and recommendations on specific vehicle modifications.

2. ***References***

2.1 **Applicable Publications—**The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of these publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE TSB 002—Preparation of SAE Technical Reports
SAE HS-13[1]—Vehicle Occupant Restraint Systems and Components, November, 1985
SAE J140a—Seat Belt Hardware Test Procedure (4.33.01)
SAE J141[1]—Seat Belt Hardware Performance Requirements (4.33.03)
SAE J201—In-service Brake Performance Test (2.22.69)
SAE J155[1]—Service Brake System Performance Requirements—Light Duty Truck
SAE J229—Brake System Structural Integrity Test (2.22.110)
SAE J299—Stopping Distance Test (2.22.133)
SAE J367—Passenger Car Door System Crush Test (4.34.227)
SAE J369—Flammability of Automotive Interior Materials Test (1.11.152)
SAE J374—Vehicle Roof Strength Test (4.34.226)
SAE J383—Seat Belt Anchorages [Design Requirements] (4.33.06)
SAE J384—Seat Belt Anchorages [Test Procedure] (4.33.08)
SAE J385[1]—Seat Belt Anchorages [Performance Requirements] (4.33.09)
SAE J398[1]—Fuel Tank Filler Conditions (3.24.415)
SAE J429[1]—Requirements for Externally Threaded Fasteners (1.4.01)
SAE J514[1]—Hydraulic Tube Fittings (2.19.51)
SAE J516[1]—Hydraulic Hose Fittings (2.19.85)
SAE J615[1]—Engine Mountings (3.24.220)
SAE J689[1]—Curb Clearance Approach, Departure, and Ramp Breakover Angles (4.32.03)
SAE J800—Motor Vehicle Seat Belt Assembly Installations
SAE J843d—Brake System Road Test (2.22.90)
SAE J937b[1]—Service Brake System Performance Requirements-Passenger Car
SAE J941[1]—Motor Vehicle Driver's Eye Range (4.34.104)
SAE J1030[1]—Maximum Sound Level for Passenger Car (3.26.17)
SAE J1047[1]—Brake System Hydraulic Tubing (2.22.139)
SAE J1050a[1]—Driver's Ellipse (4.34.157)
SAE J1100[1]—Motor Vehicle Dimensions (4.34.85)

1. Denotes performance requirements.

SAE J1827—Unibody Weld Quality Testing (4.42.22)
SAE J1828[2]—Dimensional Guidelines for Unibody Vehicles (4.42.27)
SAE J1140[2]—Filler Pipes of Automobile Fuel Tanks (3.24.412)
SAE J1147[2]—Welding, Brazing and Soldering Materials and Practices (1.9.07)
SAE J1214[2]—Tire to Body Clearance Check for Recreational Vehicles (4.35.04)
SAE J1292[2]—Wiring [Automotive] (2.20.110)
SAE J1517[2]—Driver Selected Seat Position (4.34.190)
SAE J1554—Identifying and Repairing High Strength Steel Vehicle Components
SAE J1555[2]—Design Guidelines for Optimizing Automobile Collision Damage resistance, Repairability, and Serviceability (4.42.19)
SAE J1959[2]—Corrosion Preventative Compounds [Underbody] (1.3.53)
SAE J1976[2]—Outdoor Weathering of Exterior Materials (1.11.234)

2.1.2 AWS PUBLICATIONS—Available from the American Welding Society, 2501 Northwest 7th Street, Miami, FL 33125.

AWS 1.3-81 Sheet Steel
AWS D1.1-88 Structural Welding
AWS D8.4-61 Automotive Welding Design
AWS D8.5-66 Automotive Portable Gun Resistance Spot Welding
AWS D8.7-78 Auto Weld Quality Resistance Spot Welding
AWS D8.8-79 Auto Frame Weld Quality Arc Welding Specification

2.1.3 NFPA PUBLICATIONS—Available from The National Fire Prevention Association, Battery Park, Quincy, MA 02269-9990.

NEC 2.240—Overcurrent Protection
NEC 3.300—Wiring Methods
NEC 5.551—Recreational Vehicles
NEC 6.620—Wheelchair Lifts

2.1.4 NHTSA REGULATIONS—Promulgated by the National Highway Traffic Safety Administration (NHTSA), U.S. Department of Transportation (DOT), 400 7th Street, S.W., Washington, DC 20590. Available from the Superintendent of Documents, Government Printing Office, Washington, DC 20402. Tel. (202) 783-3238.

2.1.4.1 Code of Federal Regulations (CFR), Title 49—Transportation, Part 571—Federal Motor Vehicle Safety Standards (FMVSS).

FMVS Standard No. 105—Hydraulic Brake Systems
FMVS Standard No. 106—Brake Hoses
FMVS Standard No. 116—Motor Vehicle Brake Fluids
FMVS Standard No. 204—Steering Control Rearward Displacement
FMVS Standard No. 206—Door Locks & Door Retention Components
FMVS Standard No. 207—Seating Systems
FMVS Standard No. 208—Occupant Crash Protection
FMVS Standard No. 209—Seat Belt Assembly
FMVS Standard No. 210—Seat Belt Assembly Anchorages
FMVS Standard No. 214—Side Impact Protection
FMVS Standard No. 216—Vehicle Roof Strength
FMVS Standard No. 301—Fuel System Integrity
FMVS Standard No. 302—Flammability of Interior Materials

2. Denotes performance requirements.

2.1.4.2 CFR, Title 49—Transportation, Part 567—Certification

2.1.4.3 CFR, Title 49—Transportation, Part 568—Vehicles Manufactured in Two or More Stages

2.1.4.4 CFR, Title 49, Part 581—Bumper Standard

2.1.4.5 CFR, Title 49, Part 590—Motor Vehicle Emission Inspections

2.1.5 OSHA REGULATIONS—Promulgated by the Occupational Safety and Health Administration (OSHA), U.S. Department of Labor (DOL), 200 Constitution Ave, N.W., Washington, DC 20210. Available from the Superintendent of Documents, Government Printing Office, Washington, DC 20402. Tel (202) 783-3238.

2.1.5.1 Code of Federal Regulations (CFR), Title 29—Labor, Part 1910—Occupational Safety and Health Standards (OSHS).

2.1.6 OEM MANUALS

2.1.6.1 Service Manuals

2.1.6.1.1 Ford and General Motors—Available from Helm Incorporated, P.O. Box 07130, Detroit, MI 48207. Tel (313) 865-5000, (800) 782-4356.

2.1.6.1.2 Chrysler—Available from Dyment Dist. Services, P.O. Box 360450, Strongville, Ohio 44136. Tel (216) 572-0740.

2.1.6.2 Body Builders Manuals

2.1.6.2.1 Ford Body Builder Advisory Service, Tel (800) 635-5560.

2.1.6.2.2 Dodge Truck Body Builders Manual, Tel (800) 521-0953.

2.1.6.2.3 General Motors Body Builders Manual, Tel (800) 923-2000.

3. Definitions

3.1 Aftermarket—Neither included nor available as a component, structure or system on the OEM vehicle.

3.2 Anchorage Point—The point (area) on a vehicle, wheelchair, wheelchair tiedown, or vehicle seatbase to which an anchorage is attached.

3.3 AWS—An abbreviation for American Welding Society

3.4 Certified Welder—A welder who has been certified to the appropriate AWS standards related to vehicle modifications.

3.5 Crush Zone—In the event of a collision, that portion of a vehicle body designed for transforming kinetic energy into deformation work for the purpose of reducing deceleration and deformation of the vehicle interior.

3.6 Entrance Modifications—Any alteration or substitution of the OEM door, threshold, and/or header to increase the vertical and/or horizontal dimension of the door opening, facilitating access to the vehicle.

3.7 Eyellipse—A statistical representation of the population of driver eye location in a motor vehicle used to determine field of view both outside and inside (e.g., instrument panel) of the vehicle. (modified from SAE J941)

3.8 Floor Modifications—Alteration of the OEM vehicle floor to facilitate access, vision, positioning, and/or increase headroom. This includes the following:

a. Flat Floor—A floor modification that eliminates the uneven surface in a vehicle floor to provide a smooth surface for wheelchair movement.
b. Lowered Floor—An alteration that lowers certain portions of the vehicle floor.
c. Power Pan—An elevator type device for lowering and raising certain portions of the OEM vehicle floor.
d. Wheelchair Channels—Lowered portions of the vehicle floor which align with wheels of the wheelchair.
e. Driving Pan—The lowered portion of the floor in the area of the driver's station.

3.9 FMVSS—An abbreviation for U.S. Federal Motor Vehicle Safety Standard, (Code of Federal Regulations Part 571 or Canadian equivalent).

3.10 Fuel System—The combination of fuel tank, fuel lines, pump, filter and vapor return lines, carburetor or injection components, and all fuel system vents and evaporative emission control systems or devices. (SAE J1145a)

3.11 GVWR—An Abbreviation for Gross Vehicle Weight Rating—The value specified by the manufacturer as the loaded weight. (SAE J1451)

3.12 Header—An OEM reinforcement structure located at the interior junction of the OEM roof and the remainder of the vehicle.

3.13 Integrated Body/Frame—See Unibody.

3.14 Jounce—The range of vertical motion of the vehicle suspension starting with the steady-state suspension deflection and ending with the suspension compressed to the point where the suspension bump stops are 50% compressed.

3.15 NEC—An Abbreviation for National Electric Code

3.16 New Component—Any part or mechanism installed during the vehicle alteration process which is wholly fabricated by the vehicle modifier or is a purchased aftermarket component.

3.17 Non-Integrated Body/Frame—Construction composed of vehicle body supported by a separate load-bearing chassis or frame. In this construction the body panels are not load bearing members.

3.18 Occupant Restraint Anchorage—An assembly of hardware and fittings by which loads are transferred directly from the occupant restraint to the vehicle, wheelchair tiedown, or seatbase.

3.19 Occupant Restraint—A system or device for restraining the occupant in a vehicle to prevent or minimize contact with the vehicle interior components and prevent ejection during a crash.

3.20 OEM—An abbreviation for Original Equipment Manufacturer—This refers to the vehicle, and its systems, as they are designed and produced by the automobile manufacturer.

3.21 OEM Manual—Includes but is not limited to the following:

a. Shop Manual
b. Body Manual
c. Service Manual
d. Safety Manual

or any document which is authorized by the OEM and gives guidance for alteration, installation, removal, or finishing of OEM components.

3.22 Payload—That which a vehicle carries including passengers, cargo, and fluids.

3.23 Personally Licensed Vehicle—A car, van, or light truck licensed to an individual for private use.

3.24 Power Pan—See FLOOR MODIFICATION.

3.25 Powerplant—The engine, motor, or any other device which produces mechanical kinetic energy from potential energy for the purpose of producing vehicle motion.

3.26 Raised Roof—An alteration or substitution of OEM roof to provide greater interior headroom.

3.27 Ramp—An inclined plane used to provide access between two levels.

3.28 Rebound—The range of vertical motion of the suspension starting with the steady-state suspension deflection and ending with the suspension extended to the position it would occupy when suspended from the vehicle under its own weight.

3.29 Seatbase Anchorage—An assembly of hardware and fittings by which loads are transferred directly from the seatbase to the vehicle.

3.30 Service Brake—The primary system used for retarding and stopping a vehicle. (SAE J656g.)

3.31 Should—The term to be used whenever noncompliance with the specific recommendation is permissible. (See SAE TSB 002.)

3.32 Threshold—The bottom of the entry-way under the door, which may or may not be below the vehicle floor or floor modification.

3.33 Torsional Stiffness—The extent to which a rigid body or structure exhibits rotational deformation when subjected to an external torsional moment. This is a function of the rigid body geometry and material.

3.34 Unibody—An integrated body/frame type of construction where the body panels serve as load-bearing members.

3.35 Vertical Riser—The vertical portion of the raised roof structural reinforcement, typically made of steel tubing, which is welded to the weldment-base plate.

3.36 Weatherproof—The term applied to equipment so constructed or protected that exposure to weather will cause minimal deterioration and will not interfere with successful operation. (SAE J2094.)

3.37 Weldment Base Plate—Steel plate or tubing welded in the horizontal plane between the vehicle header and exterior vehicle surface, used as an interface between the vehicle side wall/header assembly and vehicle riser or the raised roof structural reinforcement.

3.38 Wheelchair—A wheeled seat for the support and conveyance of disabled persons, comprised of a frame, seat, and wheels. (from Australian Standard AS 2492: 1987.)

3.39 Wheelchair Lift—A device which raises and lowers a wheelchair from the ground to the vehicle floor.

3.40 Wheelchair Tiedown and Occupant Restraint Systems (WTORS)—A complete restraint system for wheelchair-seated occupants comprised of a system or device for wheelchair tiedown as well as a system for restraining the occupant.

4. Vehicle Preparation and Precautions—This section provides recommended procedures intended to ensure the safety of the vehicle modifier and protect the vehicle from unnecessary damages.

4.1 Preparation for Modification

4.1.1 Consult the appropriate OEM manuals for precautions and preparation procedures.

4.1.2 Disconnect battery and isolate all electrical microprocessor components, fuel systems, air bags, and anti-lock brake systems.

NOTE—Some vehicle fuel lines maintain a large internal pressure even when the fuel system is not active.

4.1.3 Secure fuel system (seal and cap).

4.1.4 Remove and tag or label appropriate OEM equipment.

4.1.5 Protect all surfaces from the effects of alteration (i.e., glass fabric, carpet painted surfaces, etc.).

4.1.6 Initiate fire control measures.

4.1.7 Secure vehicle from movements during alteration.

4.1.8 When performing any alteration, follow all appropriate Occupational Health and Safety Standards (OSHS). Remove harmful vapors from the work area and provide ventilation.

5. General Practice—The following general practices are recommended to assure a level of vehicle performance consistent with the performance which was intended by the OEM. Specific recommendations are made in 7.1 through 7.14.

5.1 Fasteners—Any fastener used as an OEM replacement, or in a similar application, should meet or exceed the OEM performance regarding strength, corrosion resistance, material, and fastening capability.

5.2 Materials—Any material used as an OEM replacement, or in a similar application, should meet or exceed OEM performance regarding strength, corrosion resistance, and characteristic chemical compatibility.

5.3 Cutting—Prior to cutting, stabilize the structure to avoid movement or misalignment. Any cutting process that alters the material properties, such as oxy-acetylene should not be used. Distortion-free methods of cutting, such as plasma arc, nibbler, air chisel, friction saw, reciprocating saw, should be used. Remove all burrs and sharp edges from cut surfaces.

5.4 Welding—Refer to the appropriate OEM, AWS, or SAE manuals for proper welding procedures. Any welding should be done by a welder certified to perform that particular type of welding. Remove all burrs and sharp edges occurring as a result of weldment.

5.5 Sealing—Refer to the appropriate OEM manual for proper sealing procedures. Any seal or sealant used as an OEM replacement or in a similar application should meet or exceed OEM performance. No alteration should compromise the OEM barriers to moisture, fumes, and temperature.

5.6 Body Finish—Refer to the appropriate OEM manual for proper finishing procedures. All body finishes should meet or exceed the quality and performance available in professional vehicle painting facilities in the areas affected by the vehicle alteration.

5.7 Corrosion—All surface areas affected by vehicle alterations should have corrosion protection that meets or exceeds OEM quality and performance. Consideration should be given to corrosion resistance of any interface of dissimilar metals. Consideration should be given to the corrosion resistance of any area that has been exposed to extreme temperatures during a welding process.

5.8 Gross Vehicle Weight—After vehicle alterations, the vehicle and payload should not exceed OEM gross vehicle weight rating (GVWR).

5.9 Flammability—All materials in the vehicle interior should conform to FMVSS 302.

5.10 Performance—The design, fabrication, and installation of vehicle alterations should insure that the OEM structural integrity is maintained or improved. Every effort should be made to maintain every other aspect of vehicle performance. For vehicle alterations which have the effect of moving the center of gravity, adding weight, or changing the moment of inertia, degradation of performance factors such as fuel economy and vehicle dynamics should be minimized.

6. General Vehicle Modification Process

6.1 Scope

6.1.1 Each Scope section in 7.1 through 7.14 provides a description of, and/or rationale for, the specific modification being addressed.

6.1.2 Subsections 6.2 to 6.14 describe a specific aspect of the vehicle modification process. Within each subsection are general guidance and requirements which are applicable to most types of vehicle modifications within the scope of this information report. Subsections 7.1 through 7.14 utilize the headings of Section 6 as an outline for providing specific guidance and requirements for each vehicle modification.

6.2 Vehicle Preparation

6.2.1 Each Vehicle Preparation section in 7.1 through 7.14 provides specific vehicle preparation procedures.

See Section 4 for general recommendations.

6.3 Temporary Reinforcement

6.3.1 Each Temporary Reinforcement section in 7.1 through 7.14 provides guidance on temporary reinforcement and/or external fixturing used when it is necessary to maintain the geometric relationship of the structure being altered.

6.3.2 If a modification procedure involves the removal, replacement, or alteration of a vehicle body and/or frame structure, the vehicle frame and body relationships should be fixed prior to beginning the alteration.

6.4 Permanent Removal of OEM Structure, Components, or Material

6.4.1 Each Permanent Removal section in 7.1 through 7.14 provides guidance on factors to be considered when removing OEM structure, components, or material in the process of a vehicle modification.

6.4.2 When any OEM structure, component, or material is removed, considerations should be given to the structural integrity of the vehicle and/or all affected components. See the appropriate OEM manuals for proper procedures. The removal of structures or components should conform to good engineering practices.

6.4.3 See 5.3.

6.5 Modification—Altering an OEM Structure or Component

6.5.1 Each Modification section in 7.1 through 7.14 provides guidance on factors to be considered during the modification process, as well as performance requirements for the completed vehicle modification.

6.5.2 The modified vehicle structure and or components should conform to this document and all applicable FMVSS, AWS, NEC, and SAE standards. The alteration procedures should conform to good engineering practices. All welding should be done by a certified welder.

6.5.3 When any OEM structure or component is modified, the structural integrity should be maintained or improved. Where appropriate, see the OEM manual for proper procedures.

6.5.4 Any material used for an alteration should meet or exceed OEM performance regarding strength, corrosion resistance, and chemical compatibility. The performance or design intent of any vehicle component and/or subsystem should not be degraded. This includes, but is not limited to, the following: vehicle structure, air conditioning, brake, electrical, exhaust, fuel, linkages, mounts, suspension, and transmission.

6.6 Fabrication—Components Wholly Fabricated by Modifier

6.6.1 Each Fabrication section in 7.1 through 7.14 provides guidance on factors to be considered when wholly fabricating components, as well as performance requirements for wholly fabricated components.

6.6.2 Wholly fabricated component(s) should conform to this document and all applicable FMVSS, AWS, NEC, and SAE standards. Their design and fabrication should conform to good engineering practices.

6.6.3 Wholly fabricated component(s) should meet or exceed the performance of the OEM component(s) being replaced.

6.6.4 Refer to Section 5 where appropriate.

6.7 Installation of Components

6.7.1 Each Installation section in 7.1 through 7.14 provides guidance on factors to be considered when installing components during the modification process, as well as performance requirements for installed components.

6.7.2 The installation of components should conform to this document, and all applicable FMVSS, AWS, NEC, and SAE standards. The installed components should meet or exceed the performance of the OEM component(s) being replaced. The installation procedures should conform to good engineering practices.

6.7.3 Fabricated or modified components should be installed in a manner consistent with OEM methods. See the appropriate OEM manuals for proper component installation procedures. Aftermarket components purchased by the vehicle modifier should be installed according to manufacturer's instructions.

6.7.4 Refer to Section 5 where appropriate.

6.8 Removal and Reinstallation—Unaltered OEM Components

6.8.1 Each Removal and Reinstallation section in 7.1 through 7.14 provides guidance on factors to be considered when removing and/or reinstalling OEM components which have not been modified, as well as performance requirements for the reinstalled components.

6.8.2 Removal and reinstallation of unmodified OEM components should conform to this document and all applicable FMVSS, AWS, NEC, and SAE standards. The reinstalled components should meet or exceed the performance of the OEM components prior to their removal, even if relocation is necessary. The reinstallation procedures should conform to good engineering practices. Refer to the appropriate OEM manual for proper procedure.

6.9 Sealing, Finish, Corrosion Protection

6.9.1 Each Sealing, Finish, and Corrosion Protection section in 7.1 through 7.14 provides guidance and performance requirements for the sealing finish and corrosion protection of the area affected by the modification.

6.9.2 Refer to 5.5, 5.6, and/or 5.7.

6.10 Labels

6.10.1 Each Labels section in 7.1 through 7.14 provides guidance on labeling to be provided in specified areas of the modified vehicle.

6.10.2 All structurally modified vehicles should be accompanied by a permanent identification label containing the following information:

Name, address, and phone number of the modifier;
Date of alteration

6.10.3 Any OEM label that has been affected by vehicle structural modification should be replaced by a label that contains the same information and is located as close as possible to the original location.

6.11 Inspection

6.11.1 Each Inspection section in 7.1 through 7.14 provides guidance on inspection procedures to be followed after completion of the vehicle modification.

6.11.2 Each structurally modified vehicle, within the scope of this document, should be inspected. Inspections should verify the use of fasteners, materials, welding, sealing, finishing, and installation procedures as specified by this document. Inspections should also verify the adherence to good engineering practices and compliance with all applicable FMVSS, and should verify adherence to all applicable AWS, NEC, and SAE standards.

6.11.3 Inspections should be documented.

6.12 Testing

6.12.1 Each Testing section in 7.1 through 7.14 provides guidance on testing to be performed on the modified vehicle or components other than testing necessary to certify compliance with standards referenced by this document. Some of the tests listed in 7.1 through 7.14 are required to be performed on each vehicle modified. Others are only required on an example of each modification design.

6.13 Applicable Standards

6.13.1 Each Applicable Standards section in 7.1 through 7.14 provides a list of FMVSS possibly affected by the alteration. A list of AWS, NEC, and SAE standards is also provided as a guide to important considerations in performing a vehicle modification and in assessing the completed modification. The list is not necessarily all inclusive. Some of the SAE standards referenced are test procedures rather than performance standards. These are provided to assist the modifier in testing the vehicle and affected components.

6.14 Documentation—Each Documentation section in 7.1 through 7.14 provides guidance on the appropriate documentation to accompany the modified vehicle

6.14.1 OWNER'S MANUAL—All structurally modified vehicles should be furnished with an owner's manual which provides at least the following information.

a. Intended Users—This section should describe the basis for alterations with regard to the client.
b. Warnings—A list of any warnings concerning the operation, limits on performance or hazards. Particular attention should be given to alterations affecting the dynamic characteristics of the vehicle.
c. Maintenance—A description of all required periodic maintenance of any new components should be included.
d. Operating Instructions—Where applicable, a description of the guidelines for operation.
e. The modifier should provide documentation that all the requirements outlined in this document have been met.

7. Specific Vehicle Modification Process

7.1 Power Pan Well

7.1.1 SCOPE—This section addresses alterations to the OEM structure in preparation for the installation of the power pan system. It does not cover the power pan system itself.

7.1.2 VEHICLE PREPARATION

7.1.2.1 Remove gas, brake, electrical, and exhaust system components as necessary. Secure remaining fuel system from liquid and vapor leaks. Remove undercoating as required. Layout the area of the floor intended for alteration. Protect all interior components from welding, cutting, and grinding procedures.

7.1.2.2 See 6.2.

7.1.3 TEMPORARY REINFORCEMENT—See 6.3.

7.1.4 PERMANENT REMOVAL OF OEM STRUCTURE, COMPONENTS, OR MATERIAL

7.1.4.1 If temporary structural reinforcement is not used, the replacement frame structure should be installed prior to removal of any OEM frame structure or material.

7.1.4.2 See 6.4.

7.1.5 MODIFICATION—ALTERING AN OEM STRUCTURE OR COMPONENT

7.1.5.1 *Frame Alterations*—Any offset frame structure should be gussetted, triangulated, and/or braced. Any alteration required to install a power pan should not compromise the integrity of the vehicle frame including cross-members. The OEM energy-absorbing crush zones should be maintained.

7.1.5.2 *Cross-members*—Any alteration of a cross-member should not compromise the function, number, and method of attachment. All detachable cross-members should remain detachable.

7.1.5.3 *Body Mounts*—Body mounts removed or modified should be reinstalled or replaced to maintain form, fit, and function of the OEM component. Non-integrated body/frame vibration isolation should be maintained. The body should not be welded or otherwise rigidly attached to the frame at any point. If body mounts are relocated, they should be positioned as close as possible to the original location. Additional supporting structure may be required to maintain the OEM design intent. Minimum body to frame clearance should be 6.4 mm (0.25 in). Flexible and weatherproof isolating material should be placed between body and frame in appropriate locations.

7.1.5.4 *Wheel Wells*—Alteration should provide clearance for full jounce and rebound with steering position lock-to-lock.

7.1.5.5 *Engine Cover*

7.1.5.5.1 The flammability of materials used in any alteration, fabrication, or reinstallation of the OEM engine cover, should not exceed that of the OEM engine cover components. Any engine cover alteration should not compromise OEM barriers to moisture, fumes, and temperature.

7.1.5.5.2 See 5.5 and 7.4.

7.1.5.6 *Fuel System*—Fasteners should not protrude in such a way as to increase the likelihood of puncturing any component of the fuel system.

7.1.5.7 *Exhaust System*—Heat shielding should be provided both above and below the system to maintain OEM design intent and performance. The modified vehicle exhaust system should also meet or exceed the OEM performance with respect to heat dissipation. Gaseous emissions and noise level should be below the limits set by the jurisdiction in which the vehicle is registered.

7.1.5.8 See 6.5.

7.1.6 FABRICATION—COMPONENTS WHOLLY FABRICATED BY MODIFIER

7.1.6.1 *Welding Procedure*—All joints should have continuous welds. Care should be taken to minimize distortion to the vehicle.

7.1.7 INSTALLATION OF COMPONENTS—The installation should not compromise the serviceability of OEM transmission and exhaust systems. Power pan wells should be installed to power pan manufacturer's specifications.

7.1.8 REMOVAL AND REINSTALLATION—UNALTERED OEM COMPONENTS—Body mounts should not be permanently removed.

7.1.9 SEALING, FINISH, AND CORROSION PROTECTION—See 6.9.

7.1.9.1 *Sealing*—The power pan modification should not compromise the OEM barriers to moisture, fumes, and temperature.

7.1.9.2 *Finish*—The interior surface of the power pan well should be finished in a manner consistent with OEM practice.

7.1.10 LABELS—Not applicable.

7.1.11 INSPECTION—See 6.11.

7.1.12 TESTING

7.1.12.1 Each vehicle should be road tested to verify proper functioning of all affected components and/or subsystems including, but not limited to, steering, braking, electrical, fuel, exhaust, and powerplant cooling systems.

7.1.12.2 See 6.12.

7.1.13 APPLICABLE STANDARDS—The following is a list of standards which may be applicable to the modification performed. The list is not necessarily inclusive. See 6.13.

FMVSS 207, 208, 210, 301, 209

AWS 1.3-81, D1.1-88, D8.4-61, D8.5-66, D8.7-78, D8.8-79

SAE J689, J1517, J429, J1959, J140a, J141, J385, J383, J941, J1147, J1554, J1827, J1828, NEC 3.300

7.1.14 DOCUMENTATION

7.1.14.1 Any alteration of wheel well clearance should be noted in the structurally modified vehicles owner's manual. Any alteration of user replaceable fuel and/or exhaust system components should be noted in the structurally modified vehicle owner's manual.

7.1.14.2 See 6.14.

7.2 Lowered Floors

7.2.1 SCOPE—A lowered floor is an alteration that lowers portions of the original vehicle floor to accommodate a wheelchair user's needs for vehicle access and passenger/driver positioning. An important aspect of this is the driver's eye location. The driver's eyellipse is a convention defined by SAE used to describe the location of the driver's eyes for various sized drivers and is used to determine the field of vision. This section also covers driving pans (floor cut) and wheelchair channels.

7.2.2 VEHICLE PREPARATION

7.2.2.1 Remove gas, brake, electrical, and exhaust system components as required. Remove undercoating as required. Protect interior and exterior from welding, cutting, and grinding. Layout the area of the floor intended for alteration.

7.2.2.2 See 6.2.

7.2.3 TEMPORARY REINFORCEMENT—See 6.3.

7.2.4 PERMANENT REMOVAL OF OEM STRUCTURE, COMPONENTS, OR MATERIAL

7.2.4.1 If temporary structural reinforcement is not used, the replacement frame structure should be installed prior to removal of any OEM frame structure or material.

7.2.4.2 See 6.4.

7.2.5 MODIFICATION—ALTERING AN OEM STRUCTURE OR COMPONENT

7.2.5.1 *Frame Alterations*—Any offset frame structure should be gussetted, triangulated, and/or braced. Any alteration required to install a lowered floor should not compromise the integrity of the vehicle frame including cross-members. The OEM energy absorbing crush zones should be maintained.

7.2.5.2 *Cross-members*—Any alteration of a cross-member should not compromise the function, number, and method of attachment.

7.2.5.3 *Body Mounts*—Body mounts removed or modified should be reinstalled or replaced to maintain form, fit, and function of the OEM component. Non-integrated body/frame vibration isolation should be maintained. The body should not be welded or otherwise rigidly attached to the frame at any point. If body mounts are relocated, they should be positioned as close as possible to the original location. Additional supporting structure may be required to maintain the OEM design intent. Minimum body to frame clearance should be 6.4 mm (0.25 in). Flexible and weatherproof isolating material should be placed between body and frame where appropriate.

7.2.5.4 *Wheel Wells*—Any alteration should provide clearance for full jounce, rebound, and steering lock-to-lock.

7.2.5.5 *Engine Cover*

7.2.5.5.1 The flammability of materials used in any alteration, fabrication, or reinstallation of the OEM engine cover, should not exceed that of the OEM engine cover components. Any engine cover alteration should not compromise OEM barriers to moisture, fumes, and temperature.

7.2.5.5.2 See 5.5.

7.2.5.6 *Fuel System*—Fasteners should not protrude in such a way as to increase the likelihood of puncturing any component of the fuel system.

7.2.5.7 *Exhaust System*—Heat shielding should be provided both above and below the system to maintain OEM design intent and performance. The modified vehicle exhaust system should also meet or exceed the OEM performance with respect to heat dissipation. Gaseous emissions and noise level should be below the limits set by jurisdiction in which the vehicle is registered.

7.2.5.8 See 6.5.

7.2.6 FABRICATION—COMPONENTS WHOLLY FABRICATED BY MODIFIER—The lowered floor should be constructed to become an integral part of the remaining floor. The lowered floor should not deform more than an OEM floor under equivalent loading. The lowered floor should have a continuous weld. Care should be taken to minimize distortion to the vehicle. Dimensions of the lowered floor area(s) should allow for wheelchair maneuvering required by the user.

7.2.6.1 *Driver Position*—The lowered floor area in the driver's compartment should be designed so as to prevent wheelchair caster binding when entering and exiting. The lowered floor should allow for the same driver's eyellipse as the OEM vehicle design, which requires that the modifier know the seated eye location of the intended user. The lowered area should allow adequate space to maneuver into the driver's position and properly interface a wheelchair tiedown occupant restraint system. The floor should be constructed so as to allow the user to enter and exit the vehicle unassisted. Maximum transition should not exceed slopes of 1:6 for power chairs and 1:10 for manual wheelchairs.

7.2.6.2 *Passenger Position*—The floor should allow enough room to maneuver into a forward-facing passenger position and properly interface a wheelchair tiedown and occupant restraint system.

7.2.6.3 See 6.6.

7.2.7 INSTALLATION OF COMPONENTS—See 6.7.

7.2.8 REMOVAL AND REINSTALLATION—UNALTERED OEM COMPONENTS—See 6.8.

7.2.9 SEALING, FINISH, AND CORROSION PROTECTION—See 6.9.

7.2.9.1 *Finish*—The interior surface of the lowered floor should be finished in a manner consistent with OEM methods. The entire lowered floor including ramped area should be covered with a non-skid material; particularly any ramped areas.

7.2.10 LABELS—See 6.10.

7.2.11 INSPECTION—See 6.11.

7.2.12 TESTING

7.2.12.1 Flooring deflection should be tested. A three-point load totaling 272 kg (600 lb) should be applied to the flooring over the entire lowered floor. The three-point load is defined by contact areas of 193.5 mm^2 (3 in^2) at each of three vertices of a 610 mm (24 in) equilateral triangle. Deflection should not exceed that of the OEM floor subjected to these loads and should not cause permanent deformation. The previous test need not be performed on each vehicle. Only a representative design need be tested.

7.2.12.2 Each vehicle should be road tested to verify proper functioning of all affected components and/or subsystems including, but not limited to, steering, braking, electrical, fuel, exhaust, and powerplant cooling systems.

7.2.12.3 See 6.12.

7.2.13 APPLICABLE STANDARDS—The following is a list of standards which may be applicable to the modification performed. The list is not necessarily inclusive. See 6.13.

FMVSS 105, 207, 208, 209, 210, 301, 302

AWS 1.3-81, D1.1-88, D8.4-61, D8.5-66, D8.7-78, D8.8-79

SAE J229, J299, J1517, J429, J689, J1959, J140a, J141, J383, J385, J941, J1147, J1050a, J1554, J1827, J1828, NEC 3.300

7.2.14 DOCUMENTATION

7.2.14.1 The owner's manual should specify geometric limits on the driver's eyellipse as governed by the modification; and any alteration of wheel well clearance, user replaceable fuel system components, or user replaceable exhaust system components.

7.2.14.2 See 6.14.

7.3 Powerplant and Transmission Relocation

7.3.1 SCOPE—This section addresses the relocation of the vehicle powerplant and transmission units, including but not limited to the following items:

a. Cooling fan to shroud clearances
b. Oil pan to frame clearances
c. Exhaust system clearances
d. Control linkage alignment and function
e. Wiring harness routing, form, fit, and function
f. Fuel systems routing, form, fit, and function
g. Hydraulic systems routing, form, fit, and function

7.3.2 VEHICLE PREPARATION

7.3.2.1 Consideration should be given to all powerplant assembly components with regard to proper clearance, integrity, and function.

7.3.2.2 See 6.2.

7.3.3 TEMPORARY REINFORCEMENT

7.3.3.1 Install adequately designed temporary support to bear the weight of the powerplant, before removal of OEM powerplant supports.

7.3.3.2 See 6.3.

7.3.4 PERMANENT REMOVAL OF OEM STRUCTURE, COMPONENTS, OR MATERIAL—See 6.4.

7.3.5 MODIFICATION—ALTERING AN OEM STRUCTURE OR COMPONENT—See 6.5.

7.3.6 FABRICATION—COMPONENTS WHOLLY FABRICATED BY MODIFIER—See 6.6.

7.3.7 INSTALLATION OF COMPONENTS

7.3.7.1 Routing of modified, fabricated, or purchased flexible members (wires, hoses, etc.) and all clearances should be maintained to account for the full range of powerplant and transmission movement relative to the vehicle structure.

7.3.7.2 See 6.7.

7.3.8 REMOVAL AND REINSTALLATION—UNALTERED OEM COMPONENTS

7.3.8.1 Routing of all OEM flexible members (wires, hoses, etc.) and all clearances should be maintained to account for the full range of powerplant and transmission movement relative to the vehicle structure.

7.3.8.2 See 6.8.

7.3.9 SEALING, FINISH, AND CORROSION PROTECTION—See 6.9.

7.3.9.1 *Sealing*—The sealing of reinstalled systems, including, but not limited to, the cooling, fuel, hydraulic, exhaust, vacuum, air, and electrical systems, should perform in a manner consistent with the OEM method and design.

7.3.10 LABELS—See 6.10.

7.3.11 INSPECTION

7.3.11.1 Inspection should verify that user serviceability is not compromised.

7.3.11.2 See 6.11.

7.3.12 TESTING

7.3.12.1 The testing should include the following:

a. Start the powerplant and bring it to normal operating temperature. Check for any fluid or gaseous leaks or any adverse effects on routing members.
b. Start the powerplant and apply the brake. Place the transmission in drive or reverse. Increase powerplant rpm as necessary to achieve maximum powerplant rotational deflection in both drive and reverse gears. Check for proper clearances between all affected components.
c. The vehicle should be road tested to verify proper functioning of all affected components and/or subsystems including, but not limited to, steering, braking, electrical, fuel, exhaust, and powerplant cooling systems.

7.3.12.2 See 6.12.

7.3.13 APPLICABLE STANDARDS—The following is a list of standards which may be applicable to the modification performed. The list is not necessarily inclusive. See 6.13.

AWS 1.3-81, D1.1-88, D8.4-61, D8.5-66, D8.7-78, D8.8-79

SAE J615, J1147, J1554, J1827

7.3.14 DOCUMENTATION—See 6.14.

7.4 OEM Powerplant Compartment Alterations

7.4.1 SCOPE—This section addresses alteration of the enclosure that surrounds the powerplant and transmission.

7.4.2 VEHICLE PREPARATION—See 6.2.

7.4.3 TEMPORARY REINFORCEMENT—See 6.3.

7.4.4 PERMANENT REMOVAL OF OEM STRUCTURE, COMPONENTS, OR MATERIAL—See 6.4.

7.4.5 MODIFICATION—ALTERING AN OEM STRUCTURE OR COMPONENT

7.4.5.1 The compartment steady-state operating temperature should not be increased as a result of alteration. Air circulation through the compartment should not be altered in such a way as to increase the operating temperature of any powerplant component. The compartment surface temperature should not be increased as a result of alteration.

7.4.5.2 See 6.5.

7.4.6 FABRICATION—COMPONENTS WHOLLY FABRICATED BY MODIFIER—See 6.6.

7.4.7 INSTALLATION OF COMPONENTS—See 6.7.

7.4.8 REMOVAL AND REINSTALLATION—UNALTERED OEM COMPONENTS—See 6.8.

7.4.9 SEALING, FINISH, AND CORROSION PROTECTION—See 6.9.

7.4.10 LABELS—See 6.10.

7.4.11 INSPECTION—See 6.11.

7.4.12 TESTING

7.4.12.1 Testing of each vehicle should include the following:

a. Start the powerplant and bring it to normal operating temperature. Measure the air temperature in the compartment at the same location before and after the alteration to assure that it is no greater than the temperature of the OEM compartment under equivalent operating conditions.
b. Check for any leaks in the routing systems and any adverse effects on the flexible routing members.
c. Start the powerplant and apply the brake. Place the transmission in drive or reverse. Increase powerplant rpm as necessary to achieve maximum powerplant rotational deflection in both drive and reverse gears. Check for proper clearances between all affected components.
d. Each vehicle should be road tested to verify proper functioning of all affected components and/or subsystems including, but not limited to, steering, braking, electrical, fuel, exhaust, and powerplant cooling systems.

7.4.12.2 See 6.12.

7.4.13 APPLICABLE STANDARDS—The following is a list of standards which may be applicable to the modification performed. The list is not necessarily inclusive. See 6.13.

AWS 1.3-81, D1.1-88, D8.4-61, D8.5-66, D8.7-78, D8.8-79

SAE J1959, J615, J1147, J1554, J1827, J1214

7.4.14 DOCUMENTATION—See 6.14.

7.5 Driveshaft

7.5.1 SCOPE—This section addresses the OEM, modified OEM, wholly fabricated or purchased device that transfers power from the powerplant to the drive wheels.

7.5.2 VEHICLE PREPARATION—See 6.2.

7.5.3 TEMPORARY REINFORCEMENT—See 6.3.

7.5.4 PERMANENT REMOVAL OF OEM STRUCTURE, COMPONENTS, OR MATERIAL—See 6.4.

7.5.5 MODIFICATION-ALTERING AN OEM STRUCTURE OR COMPONENT

7.5.5.1 Consideration should be given to the torsional strength of the modified driveshaft. The completed assembly should be dynamically balanced to minimize vibration.

7.5.5.2 See 6.5.

7.5.6 FABRICATION-COMPONENTS WHOLLY FABRICATED BY MODIFIER

7.5.6.1 Consideration should be given to the torsional strength of the modified driveshaft. The completed assembly should be dynamically balanced to minimize vibration.

7.5.6.2 See 6.6.

7.5.7 INSTALLATION OF COMPONENTS

7.5.7.1 When installing a modified OEM, purchased or wholly fabricated driveshaft, the manufacturer's maximum driveshaft universal joint angle specifications should not be exceeded. The manufacturer's driveshaft alignment specifications should be maintained.

7.5.7.2 See 6.7.

7.5.8 REMOVAL AND REINSTALLATION—UNALTERED OEM COMPONENTS

7.5.8.1 When reinstalling an unmodified OEM driveshaft, the manufacturer's maximum driveshaft universal joint angle specifications should not be exceeded. The manufacturer's driveshaft alignment specifications should be maintained.

7.5.8.2 See 6.8.

7.5.9 SEALING, FINISH, AND CORROSION PROTECTION—See 6.9.

7.5.10 LABELS—Not applicable.

7.5.11 INSPECTION—See 6.11.

7.5.12 TESTING

7.5.12.1 Each vehicle should be road tested to verify proper functioning of all affected components and/or subsystems including, but not limited to, steering, braking, electrical, fuel, exhaust, and powerplant cooling systems.

7.5.12.2 See 6.12.

7.5.13 APPLICABLE STANDARDS—The following is a list of standards which may be applicable to the modification performed. The list is not necessarily inclusive. See 6.13.

AWS 1.3-81, D1.1-88, D8.4-61, D8.5-66, D8.7-78, D8.8-79

SAE J1554, J1827

7.5.14 DOCUMENTATION—See 6.14.

7.6 Entrance Modifications

7.6.1 SCOPE—This section addresses the extension of the OEM door, header, and/or threshold to increase the vertical and/or horizontal dimension of the door opening, facilitating access to the vehicle. Power-operated doors are not within the scope of this document.

7.6.2 VEHICLE PREPARATION—See 6.2.

7.6.3 TEMPORARY REINFORCEMENT

7.6.3.1 Add temporary reinforcement to maintain the OEM geometric relationship of the door opening to the vehicle when any OEM structure is removed.

7.6.3.2 See 6.3.

7.6.4 PERMANENT REMOVAL OF OEM STRUCTURE, COMPONENTS, OR MATERIAL—See 6.4.

7.6.5 MODIFICATION—ALTERING AN OEM STRUCTURE OR COMPONENT

7.6.5.1 When an OEM header is raised, door pillar extensions and the modified header should meet or exceed the performance of the OEM door pillars and header especially as related to structural integrity and fit with the vehicle door. Gussets or similar bracing should be installed between the door pillar extensions and the OEM header.

7.6.5.2 See 6.5.

7.6.6 FABRICATION—COMPONENTS WHOLLY FABRICATED BY MODIFIER

7.6.6.1 OEM door seal and sealing channel design should be maintained. Fabricated headers should be designed with appropriate provision for water deflection (i.e., drip rail).

7.6.6.2 See 6.6.

7.6.7 INSTALLATION OF COMPONENTS

7.6.7.1 When adding extensions to the OEM door to provide a raised entrance, the door extension(s) and method of attachment should meet or exceed the performance of the OEM door assembly especially as related to structural integrity and fit to the vehicle opening.

7.6.7.2 See 6.7.

7.6.8 REMOVAL AND REINSTALLATION—UNALTERED OEM COMPONENTS

7.6.8.1 All OEM door latches and locks should be retained.

7.6.8.2 See 6.8.

7.6.9 SEALING, FINISH, AND CORROSION PROTECTION—See 6.9.

7.6.10 LABELS—See 6.10.

7.6.11 INSPECTION—See 6.11.

7.6.12 TESTING

7.6.12.1 The vehicle should be road tested to verify proper functioning of all affected components and/or subsystems including, but not limited to, steering, braking, electrical, fuel, exhaust, and powerplant cooling systems.

7.6.12.2 See 6.12.

7.6.13 APPLICABLE STANDARDS—The following is a list of standards which may be applicable to the modification performed. The list is not necessarily inclusive. See 6.13.

FMVSS 206, 208, 214, 216

AWS 1.3-81, D1.1-88, D8.4-61, D8.5-66, D8.7-78, D8.8-79

SAE J1030, J689, J1100, J1976, J374, J1147, J1554, J1827, J1828

7.6.14 DOCUMENTATION—See 6.14.

7.7 Raised Roofs and Structural Reinforcement

7.7.1 SCOPE—Raised roofs are structural alterations that substitute an aftermarket roof for the OEM roof. Generally, this is done to provide the appropriate head clearance for the wheelchair occupant while maneuvering inside the vehicle. The term “structural reinforcement” in this section will refer to supporting structures which line the aftermarket roof to give the vehicle body appropriate rigidity and to protect the occupants in the event of a rollover.

7.7.2 PREPARATION—See 6.2.

7.7.3 TEMPORARY REINFORCEMENT—See 6.3.

7.7.4 PERMANENT REMOVAL OF OEM STRUCTURE, COMPONENTS, OR MATERIAL

7.7.4.1 See OEM incomplete vehicle manual for proper method of roof removal.

7.7.4.2 See the aftermarket roof manufacturer's guidelines on roof removal.

7.7.4.3 See 6.4.

7.7.5 MODIFICATION—ALTERING AN OEM STRUCTURE OR COMPONENT

7.7.5.1 The alteration should not result in OEM maximum recommended center of gravity height being exceeded. Consideration should be given to mass and location of material removed and added and additional equipment installed. Refer to the appropriate OEM incomplete-vehicle manual for recommended center of gravity height limits.

7.7.5.2 Any vehicle which has had the OEM roof replaced with an aftermarket roof should have structural reinforcement accompanying the installed roof. The structural reinforcement should be attached to the vehicle body.

7.7.5.3 See 6.5.

7.7.6 FABRICATION—COMPONENTS WHOLLY FABRICATED BY MODIFIER

7.7.6.1 The structural reinforcement should consist of the same number of reinforcing cross-bows and longitudinal members positioned in the same location as those removed. The design of the structural reinforcement should restore the vehicle structural integrity. The reinforcement should conform to the new roof structure to within 13 mm (0.5 in).

7.7.6.2 Raised roofs should be constructed of durable materials suitably finished to resist the effects of sunlight, moisture, snow, ice, and temperature extremes. Any fixtures mounted in an aftermarket roof should be moisture and air leak resistant. Water collection points should not be permitted.

7.7.6.3 See 6.6.

7.7.7 INSTALLATION OF COMPONENTS

7.7.7.1 A weldment base plate should be installed at the header to provide sufficient surface area and rigidity to weld the reinforcement structure to the vehicle. A minimum ratio of base plate surface area to cross-sectional area of each vertical riser of the reinforcement should be 10:1. The cross section of the vertical riser should have a minimum area of 1290 mm^2 (2 in^2). The minimum wall thickness of the riser should be 17 mm (0.125 in). See Figures 1 and 2. The inside perimeter at the roof attachment should be covered to avoid contact with any surfaces which may have sharp edges.

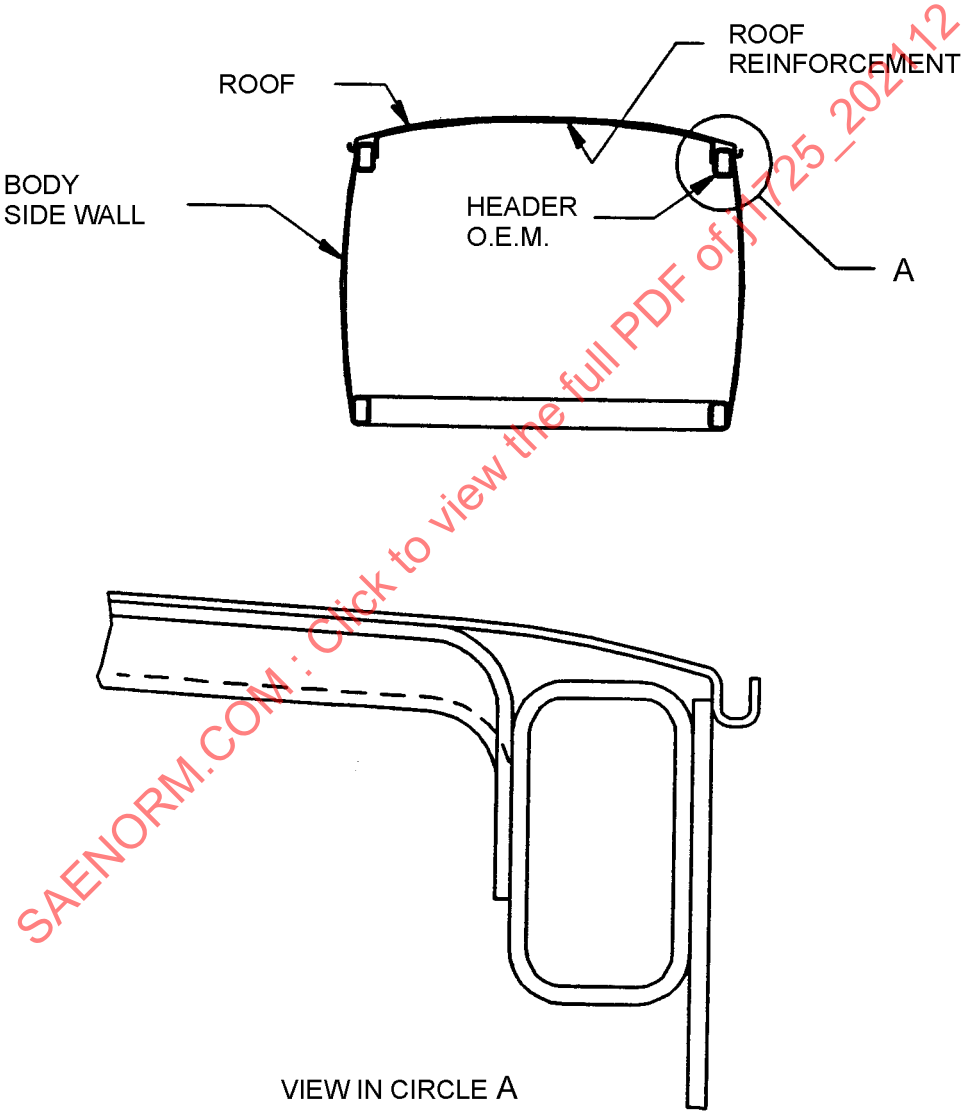

FIGURE 1—TYPICAL OEM VAN CONSTRUCTION

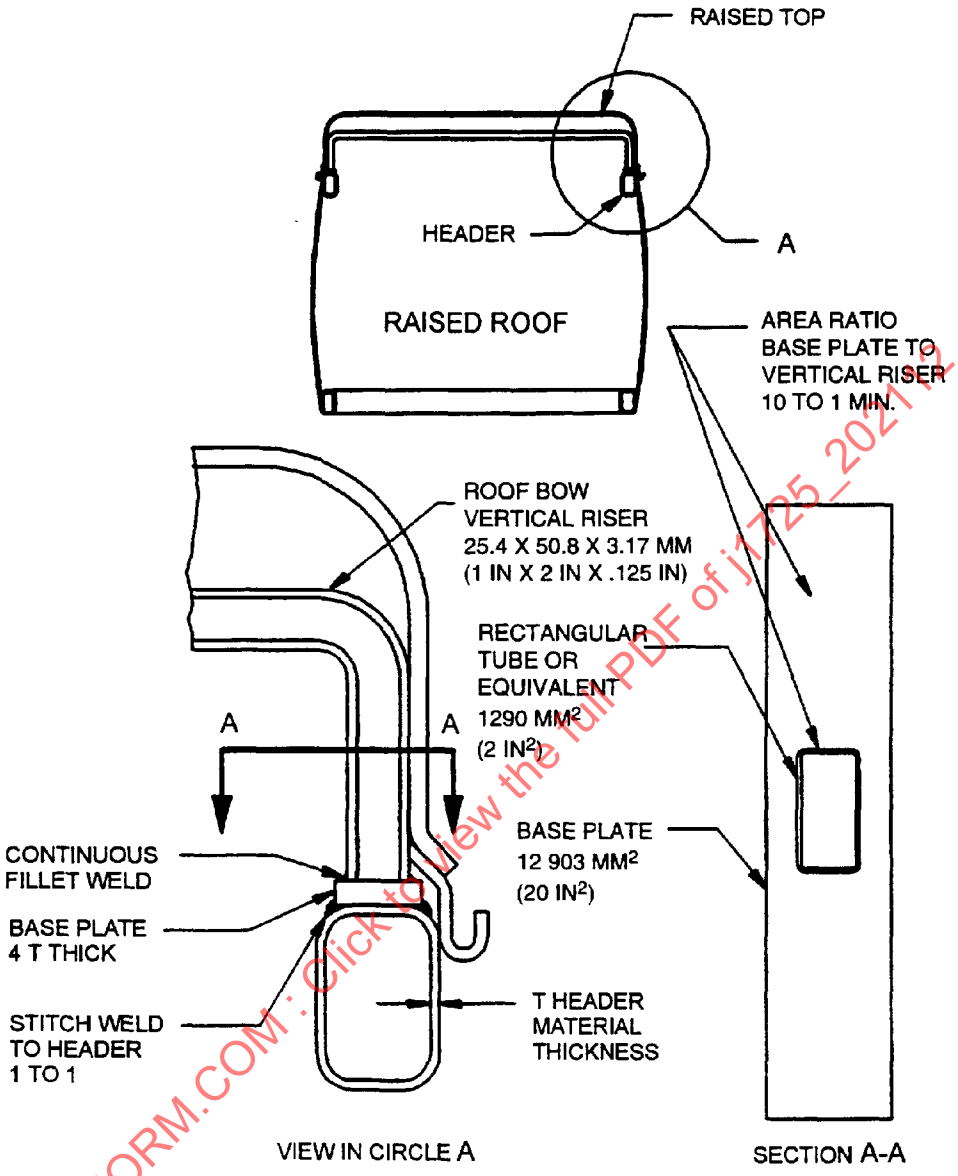

FIGURE 2—TYPICAL VAN CONSTRUCTION RAISED ROOF AND STRUCTURAL REINFORCEMENT

7.7.7.2 See 6.7.

7.7.8 REMOVAL AND REINSTALLATION—UNALTERED OEM COMPONENTS—See 6.8.

7.7.9 SEALING, FINISH, AND CORROSION PROTECTION—See 6.9.

7.7.9.1 *Sealing*—Installation of the raised roof should be accomplished with a sealant or a gasket at the seams to preclude air and water leakage. Any application of sealing material in the alteration of a roof should comply with both aftermarket roof and sealant manufacturer's guidelines.

7.7.9.2 *Finish*—See 6.2.

7.7.10 LABELS—A warning label specifying the exterior height of the modified vehicle and that vehicle handling characteristics have been altered should be in plain view of the driver.

7.7.11 INSPECTION—See 6.11.

7.7.12 TESTING

7.7.12.1 Each vehicle should be road tested to verify proper functioning of all affected components and/or subsystems including, but not limited to, steering, braking, electrical, fuel, exhaust, and powerplant cooling systems.

7.7.12.2 See 6.12.

7.7.13 APPLICABLE STANDARDS—The following is a list of standards which may be applicable to the modification performed. The list is not necessarily inclusive. See 6.13.

FMVSS 105, 216, 208, 302

AWS 1.3-81, D1.1-88, D8.4-61, D8.5-66, D8.7-78, D8.8-79

SAE J367, J1030, J1100, J1976, J374, J1147, J1554, J1827, J1828

7.7.14 DOCUMENTATION

7.7.14.1 The owner's manual should include a warning similar to those prescribed in 7.7.10.

7.7.14.2 See 6.14.

7.8 Raised Body

7.8.1 SCOPE—A lowered floor is an alteration that lowers portions of the original vehicle floor to accommodate a wheelchair user's needs for vehicle access and passenger/driver positioning. An important aspect of this is the driver's eye location. The driver's eyellipse is a convention defined by SAE used to describe the location of the driver's eyes for various sized drivers and is used to determine the field of vision. In some instances, it is necessary to lower the floor of the vehicle by an amount that causes the new floor pan to be obstructed by a structural member(s) or vehicle components. In non-integrated body/frame constructed vehicles, it may be necessary to raise the body shell vertically off of the chassis thereby allowing for a deeper lowered floor to be attached without obstruction. For integrated body/frame vehicles this is accomplished by raising the body by modifying the suspension system.

7.8.2 VEHICLE PREPARATION—For both the integrated and the non-integrated body/frame (see 6.2).

7.8.3 TEMPORARY REINFORCEMENT—Not applicable.

7.8.4 PERMANENT REMOVAL OF OEM STRUCTURE, COMPONENTS, OR MATERIAL—Not applicable.

7.8.5 MODIFICATION—ALTERING AN OEM STRUCTURE OR COMPONENT

7.8.5.1 The alteration should not result in OEM maximum recommended center-of-gravity height being exceeded. Consideration should be given to mass and location of material removed and added and additional equipment installed. Refer to the appropriate OEM incomplete-vehicle and/or body builder manuals for recommended center-of-gravity limit.

7.8.5.2 Non-integrated Body/Frame

7.8.5.2.1 If the body is being raised relative to the chassis by modifying the body mounts, the spacers should be of the same material as the OEM structure at the interface, and perform in a manner which meets or exceeds that of the OEM with respect to constrained motions, damping, corrosion resistance, and fatigue properties.

NOTE—Some body mounts virtually eliminate transverse motion of the body relative to the frame while damping the motion longitudinally.

7.8.5.2.2 All OEM interfaces and connections between body, chassis, and powertrain should not be damaged and/or compromised with regard to form, fit, and function as a result of the body raise. Items to be considered include, but may not limited to, the following: steering column, fan shroud, transmission linkage, wiring harness, brake lines, and fuel systems.

7.8.5.3 *Integrated Body/Frame*—Any component(s) used in modifying the suspension of a vehicle to attain the required height should not degrade the performance of affected systems including, but not limited to, the suspension system, brake system, and axle system.

7.8.5.4 See 6.5.

7.8.6 FABRICATION—COMPONENTS WHOLLY FABRICATED BY MODIFIER—See 6.6.

7.8.6.1 *Non-integrated Body/Frame*—The riser block should be made of a material that meets or exceeds the performance of the material of the OEM body mount. The cross-sectional dimensions should be no smaller than those of the base of the OEM body mount.

7.8.6.2 *Integrated Body/Frame*—Any component(s) fabricated for the purpose of raising the vehicle body should not degrade the performance of affected systems, but not limited to, the suspension system, brake system, and axle system.

NOTE—Replacement bolts which are longer than the OEM will have increased operating stresses. Bolts of higher grade or larger dimension should be used.

7.8.7 INSTALLATION OF COMPONENTS

7.8.7.1 Any component(s) installed for the purpose of raising the vehicle body should not degrade the performance of the affected systems including, but not limited to, the suspension system, brake system, and axle system. Spacers added in conjunction with the OEM body mounts, should have a continuous weld to the upper (body side) mount pad.

7.8.7.2 See 6.7.

7.8.8 REMOVAL AND REINSTALLATION—UNALTERED OEM COMPONENTS

7.8.8.1 Bumpers should be reattached to the OEM frame attachment points. However, the absolute height of the bumpers should comply with CFR 49 Part 581.

7.8.8.2 See 6.8.

7.8.9 SEALING, FINISH, AND CORROSION PROTECTION—See 6.9.

7.8.10 LABELS—A warning label specifying the exterior height of the modified vehicle and that vehicle handling characteristics have been altered should be in plain view of the driver.

7.8.11 INSPECTION—See 6.11.

7.8.12 TESTING

7.8.12.1 Each vehicle should be road tested to verify proper functioning of all affected components and/or subsystems including, but not limited to, steering, braking, electrical, fuel, exhaust, and powerplant cooling systems.

7.8.12.2 See 6.12.

7.8.13 APPLICABLE STANDARDS—The following is a list of standards which may be applicable to the modification performed. The list is not necessarily inclusive. See 6.13.

FMVSS 105, 208, 301

CFR 49-581

AWS 1.3-81, D1.1-88, D8.4-61, D8.5-66, D8.7-78, D8.8-79

SAE J155, J201, J229, J843d, J941, J1147, J1554, J1827, J1828

7.8.14 DOCUMENTATION

7.8.14.1 The owner's manual should include warnings identical to those described in 7.8.10.

7.8.14.2 See 6.14.

7.9 Fuel System

7.9.1 SCOPE—This section addresses the components of the fuel system which include, but are not limited to, the fuel tank, fuel pump, fuel lines, filler fittings and hoses, connectors, and anchors.

7.9.2 VEHICLE PREPARATION

7.9.2.1 Before disconnecting any component of a fuel system refer to the OEM shop or service manual. Some vehicle fuel lines maintain a large internal pressure even when the fuel system is not active. All fuel carrying and storage components should be removed prior to any structural alteration which requires any cutting, welding procedure in the vicinity of the fuel system components.

7.9.2.2 See 6.2.

7.9.3 TEMPORARY REINFORCEMENT—Not applicable.

7.9.4 PERMANENT REMOVAL OF OEM STRUCTURE, COMPONENTS, OR MATERIAL—See 6.4.

7.9.5 MODIFICATION—ALTERING AN OEM STRUCTURE OR COMPONENT—See 6.5.

7.9.6 FABRICATION—COMPONENTS WHOLLY FABRICATED BY MODIFIER—See 6.6.

7.9.7 INSTALLATION OF COMPONENTS—See 6.7.

7.9.8 REMOVAL AND REINSTALLATION—UNALTERED OEM COMPONENTS—See 6.8.

7.9.9 SEALING, FINISH, AND CORROSION PROTECTION—See 6.9.

7.9.10 LABELS—See 6.10.

7.9.11 INSPECTION—See 6.11.

7.9.12 TESTING

7.9.12.1 The vehicle should be road tested to verify proper functioning of all affected components and/or subsystems including, but not limited to, steering, braking, electrical, fuel, exhaust, and powerplant cooling systems.

7.9.12.2 See 6.12.

7.9.13 APPLICABLE STANDARDS—The following is a list of standards which may be applicable to the modification performed. The list is not necessarily inclusive. See 6.13.

FMVSS 301

AWS 1.3-81, D1.1-88, D8.4-61, D8.5-66, D8.7-78, D8.8-79

SAE J398, J1140, J1147, J1554, J1827

7.9.14 DOCUMENTATION

7.9.14.1 Any alterations to OEM fuel system should be noted in the modified vehicle owner's manual.

7.9.14.2 See 6.14.

7.10 Brake System

7.10.1 SCOPE—In the context of this document, "brake system" will refer to the OEM service and/or parking brake. None of the information presented in this section pertains to purchased or wholly fabricated brake backup systems, or brake boosters. This section describes procedures to be followed to maintain proper vehicle braking performance when vehicle structural modifications necessitate OEM brake system alteration, replacement, and/or temporary removal.

7.10.2 VEHICLE PREPARATION—See 6.2.

7.10.3 TEMPORARY REINFORCEMENT—Not applicable.

7.10.4 PERMANENT REMOVAL OF OEM STRUCTURE, COMPONENTS, OR MATERIAL—See 6.4.

7.10.5 MODIFICATION—ALTERING AN OEM STRUCTURE OR COMPONENT—See 6.5.

7.10.6 FABRICATION—COMPONENTS WHOLLY FABRICATED BY MODIFIER—See 6.6.

7.10.7 INSTALLATION OF COMPONENTS

7.10.7.1 Brake lines may be installed in a configuration that differs from OEM. However, the attachment method and installed brake system should meet or exceed the performance of the OEM system.

7.10.7.2 See 6.7.

7.10.8 REMOVAL AND REINSTALLATION—UNALTERED OEM COMPONENTS

7.10.8.1 All brake system components in the area being modified should be temporarily removed to prevent damage.

7.10.8.2 See 6.8.

7.10.9 SEALING, FINISH, AND CORROSION PROTECTION—See 6.9.

7.10.10 LABELS—See 6.10.

7.10.11 INSPECTION—See 6.11.

7.10.12 TESTING

7.10.12.1 The service brakes on each vehicle should be tested for leaks under maximum brake pressure.

7.10.12.2 Each vehicle should be road tested to verify proper functioning of all affected components and/or subsystems including, but not limited to, steering, braking, electrical, fuel, exhaust, and powerplant cooling systems.

7.10.12.3 See 6.12.

7.10.13 APPLICABLE STANDARDS—The following is a list of standards which may be applicable to the modification performed. The list is not necessarily inclusive. See 6.13.

FMVSS 105, 106, 116

SAE J155, J201, J229, J299, J514, J516, J843d, J941, J1047

7.10.14 DOCUMENTATION—See 6.14.

7.11 Exhaust System

7.11.1 SCOPE—The exhaust system components referred to in this section include, but are not limited to, piping, fasteners, connectors, manifolds, or sensors which interact with and control the flow of exhaust gases. Also included in the exhaust system is any device where a chemical transformation of exhaust gases takes place.

7.11.2 VEHICLE PREPARATION—See 6.2.

7.11.3 TEMPORARY REINFORCEMENT—Not applicable.

7.11.4 PERMANENT REMOVAL OF OEM STRUCTURE, COMPONENTS, OR MATERIAL—Not applicable.

7.11.5 MODIFICATION—ALTERING AN OEM STRUCTURE OR COMPONENT

7.11.5.1 Heat shielding should be provided above and below the system to maintain OEM design intent and performance. The modified vehicle exhaust system should also meet or exceed the OEM performance with respect to heat dissipation. Gaseous emissions and noise level should be below the limit set by the jurisdiction in which the vehicle is registered. Consideration should be given to exhaust back pressure and catalytic converter temperature and performance.

7.11.5.2 The modified exhaust system should be secured to the vehicle using the same method as the OEM design.

7.11.5.3 See 6.5.

7.11.6 FABRICATION—COMPONENTS WHOLLY FABRICATED BY MODIFIER—See 6.6.

7.11.7 INSTALLATION OF COMPONENTS

7.11.7.1 The securement of any aftermarket components should be by any method which meets or exceeds that of the OEM. Routing of any aftermarket components should maintain the design intent of the OEM. The performance of the exhaust system should not be compromised by the installation of any aftermarket components. The routing of the exhaust system and the configuration of any exhaust components should maintain the intended heat protection of all other vehicle components.

7.11.7.2 See 6.7.

7.11.8 REMOVAL AND REINSTALLATION—UNALTERED OEM COMPONENTS—See 6.8.

7.11.9 SEALING, FINISH, AND CORROSION PROTECTION—See 6.9.

7.11.9.1 *Sealing*—The exhaust system on any vehicle should not leak. Incursion of exhaust gases into the passenger compartment is prohibited.

7.11.9.2 *Corrosion Protection*—The corrosion resistance properties of the exhaust system, as designed for the OEM exhaust system, should be maintained in any alteration or installation. Consideration should be given to material composition of metal in fasteners and connectors and aftermarket components. Dissimilar metals in contact may alter the corrosion resistance of the exhaust system.

7.11.10 LABELS—See 6.10.

7.11.11 INSPECTION—See 6.11.

7.11.12 TESTING

7.11.12.1 Emissions testing is required for any exhaust system where the catalytic converter is relocated. State emissions testing is appropriate. The previous tasks need not be performed on every vehicle.

7.11.12.2 Each vehicle should be road tested to verify proper functioning of all affected components and/or subsystems including, but not limited to, steering, braking, electrical, fuel, exhaust, and powerplant cooling systems.

7.11.12.3 Testing of each exhaust system should insure that there is no incursion of exhaust gases into the passenger compartment.

7.11.12.4 See 6.12.

7.11.13 APPLICABLE STANDARDS—The following is a list of standards which may be applicable to the modification performed. The list is not necessarily inclusive. See 6.13.

CFR 49 Part 590

Local automotive emissions regulations

7.11.14 DOCUMENTATION—See 6.14.