SURFACE VEHICLE RECOMMENDED PRACTICE

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Design Considerations for Wheelchair Lifts for Entry to or Exit from a Personally Licensed Vehicle

RATIONALE

This technical report is being stabilized because the technical committee cannot find users for the technical report. It is not possible to determine with great assurance whether a technical report is being used, how often it may be used, or by whom it may be used. Stabilization is a way to alert potential users that the owning technical committee will no longer be maintaining the technical report and users should employ the technical report at their own discretion.

The compliance requirements for wheelchair lifts to assist persons with limited mobility in entering or leaving a vehicle are now mandatory in the Federal Motor Vehicle Safety Standards 49 CFR § 571.403 and 49 CFR § 571.404.

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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1. ***Scope—***This SAE Recommended Practice applies to electrically powered hydraulic or mechanically operated platform devices which permit a person seated in a manual or powered wheelchair to enter or exit a personally licensed vehicle.

The minimum performance and durability requirements are specified for satisfactory installation of wheelchair lifting devices in a personally licensed vehicle to be used by a person seated in a wheelchair to be lifted from the ground plane to the vehicle floor level in a reliable and safe manner.

1.1 SAE J2092 is the test procedure to verify compliance with this document.

2. ***References***

2.1 **Applicable Publications—**These Standards, Specifications, or Recommended Practices promulgated by the following agencies and specified herein are applicable to the design, manufacture, and/or use of wheelchair lifts. Use the current issue of each document.

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

SAE J258—Circuit Breaker—Internal Mounted—Automotive Reset
SAE J514—Hydraulic Tube Fittings
SAE J516—Hydraulic Hose Fitting
SAE J517—Hydraulic Hose
SAE J518—Hydraulic Flanged Tube, Pipe, and Hose Connections, Four-Bolt Split Flange Type
SAE J537—Storage Batteries
SAE J553—Circuit Breakers
SAE J561—Electrical Terminals—Eyelet and Spade Type
SAE J858—Electrical Terminals—Blade Type
SAE J928—Electrical Terminals—Pin and Receptacle Type
SAE J1292—Automobile, Truck, Truck-Tractor, Trailer, and Motor Coach Wiring
SAE J2092—Testing of Wheelchair Lifts for Entry to or Exit from a Personally Licensed Vehicle

2.1.2 ANSI PUBLICATIONS—Available from American National Standards Institute, 11 West 42nd Street, New York, NY 10036-8002.

ANSI A17.1—Elevators, Dumbwaiters, Escalators, and Moving Walks
ANSI A117.1—Specifications of Making Buildings and Facilities Accessible to, and Usable by Making Buildings and Facilities Accessible to, the Physically Handicapped
ANSI A120.0—Safety Requirements for Powered Platforms for Exterior Building Maintenance
ANSI B1.5—Acme Screw Threads
ANSI B1.8—Stub Acme Threads
ANSI B15.1—Safety Standard for Mechanical Power Transmission Apparatus
ANSI B29.1—Transmission, Roller Chains and Sprocket Teeth (for Standard Base Series Chain)
ANSI B30.2—Overhead and Gantry Cranes
ANSI B30.9—Safety Standards for Cranes, Derricks, Hoists, Hooks, Jacks, and Slings
ANSI B153.1—Safety Requirements for the Construction, Care, and Use of Automotive Lifts

2.1.3 ASTM PUBLICATIONS—Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM D 1005-51 (R1972)—Measurement of Dry Film Thickness of Organic Coatings
ASTM D 2200-67—Pictorial Surface Preparation Standards for Painting Steel Surfaces

2.1.4 AWS PUBLICATIONS—Available from American Welding Society, 2501 N.W. 7th Street, Miami, FL 33125.

AWS D1.1-72—Structural Welding Code
AWS D10.7-60—Recommended Practices for Gas Shielded Arc Welding of Aluminum and Aluminum Alloy Pipe

2.1.5 FMVSS PUBLICATIONS—Available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402-9371.

Federal Motor Vehicle Safety Standard No. 302, Flammability of Interior Materials

2.1.6 MILITARY SPECIFICATIONS—Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

Military Standards, 1427 C Human Engineering Design Criteria for Military Systems Equipment

2.1.7 OTHER PUBLICATIONS

Human Factors Design Handbook—Wesley E. Woodson, McGraw Hill Book Company 1981
McElroy, Frank E. (ed): Accident Prevention Manual for Industrial Operations. 6th Edition, National Safety Council, Chicago, IL, 1969, pp. 641–657
Rossnagel, W.E.: Handbook of Rigging, 3rd Edition, McGraw-Hill Book Company, New York, NY, 1964, pp. 41–83
Wire rope manufacturers' recommendations

3. Definitions

3.1 Access Path—The minimum open area between horizontal and vertical structures of the lift through which a client must pass while entering or exiting a vehicle.

3.2 Fasteners—Devices used to secure, by mechanical means, other devices or parts in place. These include but are not limited to, bolts, nuts, screws, washers, pins, rivets, and clamps.

3.3 Ground Plane—The surface (normally horizontal) on which the vehicle is resting.

3.4 Lift Electrical Components—All electrical hardware used on a wheelchair lift. These include but are not limited to, batteries, circuit breakers, motors, switches, wiring, and terminals.

3.5 Lift Controls—Devices by which an operator controls the lift operation including switches, handles, etc.

3.6 Lift Platform—That portion of a wheelchair lift device on which the wheelchair rests while being raised or lowered.

3.7 Pinch Point—A term for a hazardous location which exists when two closely spaced mechanical components move in opposite directions, or at a point of contact between belt and pulley, chain and sprocket, or similar moving parts of machinery.

3.8 Proof Load—Static test load to insure mechanical integrity at critical points.

3.9 Rated Load—Load under which a device will operate continuously.

3.10 Outer Roll Stop—A term for a device on a wheelchair lift that prevents a wheelchair from rolling off the lift platform.

3.11 Shall—The term "Shall," where used, is to be construed as mandatory.

3.12 Shear Point—A term for a hazardous location where a moving (e.g., reciprocating or sliding) part approaches or crosses another part.

3.13 Should—The term "Should," where used, shall be construed as advisory.

3.14 Vehicle Floor—The surface of the vehicle on which the wheelchair rests immediately after entering.

3.15 Weatherproof—The term applied to equipment so constructed or protected that exposure to weather will not interfere with successful operation.

3.16 Wheelchair Ground Plane—The plane that defines the surface upon which the wheelchair rests.

3.17 Wire Rope Components—A term encompassing but not limited to, wire, rope, sheaves (pulleys) clips, thimbles, end fittings, and winch hardware.

4. Design Requirements

4.1 A wheelchair lift shall be constructed to withstand the following:

4.1.1 ACCELERATED LIFE CYCLE TEST—An accelerated life shall be performed by repeating the wheelchair lift cycle 4400 times carrying a rated load of 600 lb.

4.1.2 STATIC PROOF LOAD—A static proof test at 1.5 times rated load (900 lb) at point 6 in off the ground plane with no permanent deformation.

4.1.3 STATIC ULTIMATE LOAD—A static ultimate load test at four times the rated load (2400 lb) at van floor level with no fractures.

4.2 The manufacturer shall perform a design failure mode analysis and verify that no unreasonable risk of injury exists in the event of a single point failure. Upon submission of a lift for testing to SAE J2092, the manufacturer shall provide the results of the failure mode analysis in writing. These results shall contain a listing of all identified single point failures.

4.3 Battery-powered wheelchair lifts shall operate an electrical current of less than 150 A while lifting the rated load of 600 lb at an ambient temperature between 10 °C (50 °F) and 32 °C (90 °F).

4.4 Installation of a wheelchair lift shall not require motor vehicle alterations that diminish the structural integrity of the vehicle.

4.5 The total weight of the lift and installation hardware shall not exceed 400 lb.

4.6 Hand holds, if used, should be of round cross-section and approximately 1 in outside diameter.

4.7 The lift shall clear the lateral edges of the effective door opening of the vehicles for which it is designed by a minimum of 1/4 in per side.

4.8 **Level of Lift Platform—**With the lift installed on a rigid structure and the platform horizontal, and with the rated load of 1780 N (600 lb) applied, the platform shall not slope more than 1.9 cm (0.75 in) rise in 30.48 cm (12 in) of run (3.6 degrees).

4.9 The lift shall not apply any load to the wheelchair that is contrary to the normal load characteristics of the structural design of the wheelchair.

4.10 Lift designs that employ a power-down feature, which can produce a downward force in excess of the weight of the platform components, shall provide a power cut-off at contact with the ground or obstruction.

4.11 The lift platform shall provide side barriers, the height of which shall be a minimum of 1-1/2 in above the wheelchair rolling surface.

4.12 A salt spray test shall be performed for externally mounted lifts.

5. Materials and Components

5.1 Electrical Components and Wiring

5.1.1 Electrical components and wiring shall conform to the Society of Automotive Engineers Standards or Recommended Practices as applicable. Those listed as follows are applicable to all lifts.

SAE J258, SAE J553c—Circuit Breakers
SAE J537h—Storage Batteries
SAE J1292—Automobile Wiring
SAE J561b, SAE J858a, SAE J928a—Electrical Terminals

5.1.2 All electrical systems shall be designed and packaged to protect the driver or passengers against injury resulting from short circuits, electrical fires, and similar incidents.

5.1.3 Electrical components which are exposed to the environment outside the vehicle shall be weatherproofed.

5.1.4 Externally mounted wheelchair lift controls shall be installed so that they are weatherproofed by the use of inset compartments or protective coverings. Controls shall be protected from misuse or vandalism by the use of key locks, key switches, or other security systems.

5.1.5 An automatic or self-resetting circuit breaker or other equivalent device shall be designed into the power circuit close to the vehicle battery. A solenoid or other similar device should be incorporated, per the manufacturers' instructions, into the power circuit to ensure that no voltage is applied to the main power unit until a lift operating control has been actuated.

5.2 Chain Drive Components—Chain drive components shall conform to either: ANSI B29.1 - 1963 (R1972), or other ANSI standards applicable to specialized use chains.

5.3 Hydraulic Components—Hydraulic components shall conform to the following Society of Automotive Engineers Standards or Recommended Practices as applicable.

SAE J514—Hydraulic Tube Fittings
SAE J516—Hydraulic Hose Fittings
SAE J517—Hydraulic Hose
SAE J518—Hydraulic Flanged Tube, Pipe and Hose Connections, 4-Bolt Split Flange Type

5.3.1 Hydraulic hoses shall be protected from bearing or rubbing on structural components.

5.4 Wire Rope Components—Industry Standards and specifications related to wire rope components are generally for larger, higher capacity systems other than wheelchair lifts. However, the design principles of wire rope systems in general are applicable to wheelchair lifts; therefore, the principles given in the following documents should be employed in lift design and should be certified in writing by the manufacturer upon submission of the lift for testing.

5.4.1 ANSI A120.1-1970—Safety Requirements for Powered Platforms for Exterior Building Maintenance, Section 14.8, “Drums and Sheaves,” and Section 15, “Hoisting Ropes and Rope Connections.”

5.4.2 ANSI B30.2.0-1967—Overhead and Gantry Cranes, Section 2-1.10, “Hoisting Equipment.”

5.4.3 McElroy, Frank E. (ed): Accident Prevention Manual for Industrial Operations. 6th Edition, National Safety Council, Chicago, IL, 1969, pp. 641-657.

5.4.4 Rossnagel, W.E.: Handbook of Rigging, 3rd Edition, McGraw-Hill Book Company, New York, NY, 1964, pp. 41–83.

5.4.5 Wire rope manufacturers' recommendations.

5.5 Power Screw Components—The power screw system even when disconnected from the driving source should not allow the platform loaded with 600 lb to descend at a rate greater than 12 in/s or the dropping of an occupant.

5.5.1 The lift designer should ensure that the power screw is checked for long-column conditions and that an appropriate column design formula is used.

5.5.2 Power screw components shall conform to ANSI B1.5 Acme Screw Threads, ANSI B1.8 Stub Acme Threads, and ANSI B5.4.8 as applicable.

5.6 Fasteners—All fasteners used shall conform to the Society of Automotive Engineers Standards or Recommended Practices as applicable.

5.6.1 All nuts and bolts used to secure structural members during manufacture or installation shall be grade 5 or better.

5.6.2 Self-locking fasteners are the preferred method of fastening where a Locking System is indicated. Nuts with flat washers and split lock washers are also acceptable.

5.6.3 FASTENER TESTS AND INSPECTION—Fasteners shall be considered as integral parts of the lift system and shall be tested for wear, integrity, and resistance to loosening or loss through vibration or use conditions. Such testing and inspection shall be done during the Accelerated Life Cycle Test.

5.7 Coating and Finishing

5.7.1 Corrosion of ferrous metal wheelchair lift components can be expected as a result of contact with atmospheric moisture, road deicing salt solutions, mud, and possibly other corrosive agents. All metallic materials shall be corrosion resistant or be protected from such corrosion by the application of protective coatings.

5.8 Flammability—Federal Motor Vehicle Safety Standards No. 302 shall apply to nonmetallic components such as protective coverings, housings, and padding.

6. Operation

6.1 Human Factors Standards and Specifications

6.1.1 CONTROLS STANDARD—Control selection and application shall be done in accordance with good human factors practice of location, direction of control movement, force, range, and identification. (Reference: Military Standard 1472 C and Human Factors Design Handbook.)

6.1.2 In general, all toggle-type control switches should operate in the direction in which motion is intended unless rationale is provided to justify the change.

6.2 Acceleration—With either manual or automatic operation, accelerations shall not exceed 0.3 g during any operational motion of the lift in which a weight of 1780 N (600 lb) is being raised, lowered, or moved horizontally.

6.3 Platform Access—A bridging device at floor level or lowered roll stop at ground level shall have a slope of not more than 2.54 cm (1 in) rise to 15.24 cm (6 in) of run and provided that the slope between wheelchair front and rear wheels shall not exceed 1 in in 12 in. A step over which a wheelchair must roll to enter the platform shall have a vertical dimension of not more than 15.9 mm (5/8 in) above the surface on which the platform rests.

6.4 Outer Roll Stop—The lift shall have an automatically operating device at the ground-to-platform entry/exit area, the purpose of which is to prevent the wheelchair and occupant from rolling off the lift. The device shall conform to the following:

6.4.1 If the lift has a manually operated platform, the roll stop can be manually operated.

6.4.2 If the lift has an automatically operated platform (powered folding or outboard rotating), the roll stop shall be deployed and locked any time the lift platform is more than 3 in above ground level. It shall be electrically, mechanically, or fluid interlocked so that the platform cannot rise more than 3 in additionally above the ground unless the roll stop is properly deployed and locked.

6.4.3 It shall have the same effect on a rearward moving wheelchair as a lateral, fixed step which is 7.62 cm (3 in) high and perpendicular to the wheelchair ground plane and which can resist a distributed force of 7100 N (1600 lb) applied parallel to and 2.5 in above the wheelchair ground plane. In cases where the bottom edge of the roll stop falls at or above the 2.5 in level, the roll stop shall resist the same applied force at a level as close as possible to 0.5 in above the bottom edge of the roll stop.

6.5 Limit Devices—Methods shall be employed to ensure that the platform ceases movement at the desired position as required by the design. As a minimum, the floor level position of the platform shall be positively controlled such that the wheelchair does not have to roll over a step greater than 15.9 mm (5/8 in) in height. Ground and stowage positions of the platform should be controlled as necessary to prevent equipment damage. Mechanical Bridging Systems to permit easy movement across excessive gaps and/or height differences are acceptable provided they do not exceed the slope requirements of 6.3.

6.5.1 Control circuits shall be interlocked so that no single control used by the wheelchair occupant will perform more than one function.

6.6 Platform Openings—Any openings in the platform shall reject a 19.1 mm (3/4 in) diameter metal ball.

6.7 Manual Backup System—Each lift shall include a manually operated system that will permit the lift to be folded and unfolded manually and raised and lowered with the rated load.

6.8 Threshold Warning—Each lift shall include a threshold warning system to give an audible and/or visual warning to a wheelchair passenger approaching the lift from the vehicle floor level that the lift platform is more than 1 in below floor level.

6.8.1 The audible warning should be a minimum of 80 dBA between 500 and 3000 Hz.

6.8.2 The visual warning shall be a flashing red beacon of a minimum 21 candlepower and be located such that it can be seen by a person backing onto the lift wherever the lift is installed.

6.8.3 The warning system sensor shall provide at least single redundancy for maximum reliability and shall cover the entire width of the access area not less than 18 in away from the threshold.

6.8.4 If entry onto the platform takes place wholly inside the vehicle then the lift is exempt from the threshold warning.

6.9 The wheelchair lift system shall be free of sharp edged and jagged projections. Pinch or shear points shall be minimized.

6.10 The wheelchair lift platform surface shall be provided with slip resistant type material to provide adequate tire-platform traction.

7. Method of Installation

7.1 Installation Manual Specification—Wheelchair lifts shall be accompanied by an Installation Manual that shall contain written and graphic instructions for installing the lift and shall contain specific installation information relative to the make, year, and type of van for which the lift is suited. The manual should be written at a technical level comparable to an automotive service manual.

7.1.1 A parts list of all lift and installation parts shall be included.

7.1.2 If the lift is powered by a dual battery, the vehicle shall be equipped with an isolation charging circuit that prevents one battery from depleting the other and charges both from the alternator when the engine is running. The auxiliary battery shall be comparable in size and capacity to the O.E.M. battery. If the battery is inside the vehicle, it shall be in a restrained, protective, corrosion-resistant enclosure designed for that purpose and vented to the outside of the passenger compartment and accessible for service from inside the passenger compartment. If the battery is located outside the passenger compartment, it shall be in an enclosure designed for this purpose. Any auxiliary battery installation shall be accessible for inspection and maintenance without removal of major vehicle components, the use of special tools or the necessity to raise the vehicle.

7.1.3 Instructions for the installation of the threshold warning system shall be included in the installation manual.

7.2 Installation Hardware Specification—Wheelchair lifts distributed for installation shall be accompanied by all installation hardware required for the vehicle on which the lift is to be installed. Consideration shall be given by the manufacturer to the crashworthiness of installation hardware.

7.3 Installation Training—The manufacturer shall develop and implement a written plan of a training program for installers to provide installation of the lift in accordance with recommended procedures.

8. Information Requirements

8.1 Owner Instruction Manual—With each lift, the manufacturer shall provide a detailed manual of instructions concerning user operation and required or recommended maintenance to be performed by the user, owner, or dealer. The manufacturer is urged to include annual inspections in the maintenance procedure and to encourage such inspections by proper support to distributors. The maintenance instructions shall address at least the following areas: operation, lubrication (types, location, and frequency), fluids (types, levels, and frequency of checking), adjustments (function, location, and method), calibration and alignment procedures, trouble-shooting (possible failures and required corrective action), parts lists, components requiring special attention, and name, address, and telephone number of the manufacturer or his representative.

8.2 Repair parts shall be available for purchase for a period of 5 years from the date of manufacture.

8.3 Documentation Specification—With each lift, the manufacturer shall provide to the dealer all electrical and hydraulic schematic diagrams necessary to properly maintain and repair the lift. These diagrams shall include wiring diagrams, component layout, definitions and measurements to determine excessive wear, parts list, and applicable test and calibration points.

8.3.1 The manufacturer shall include information in its literature about the minimum height and width of the access path between the members of the lift structure. Lift platform dimensions shall also be included.

8.3.2 The manufacturer shall provide on a placard on the lift the following dimensions, the minimum height and width of the access path between the structural members of the lift.

8.4 Tool Specification—The manufacturer shall design and fabricate a lift such that the tools needed for the recommended user/owner/dealer maintenance are of the standard, readily available type (e.g., adjustable, open end, and box end or socket wrenches for bolt heads equal to or less than 20 mm (3/4 in) nominal, slot-type screwdriver, phillips-type screwdriver). If special tools are required for routine maintenance or emergency operation, such special tools shall be provided by the manufacturer.

8.5 Accessibility—The manufacturer shall design and fabricate his lift such that parts requiring user/owner/installer maintenance are readily accessible without major disassembly or use of special tools.