

Low Speed Vehicles

Foreword—This SAE Standard was developed to establish safety and performance requirements for the design and operation of powered Low Speed Vehicles, operated on public streets or roads where permitted by law. This document considers speed, acceleration, stability, braking systems, operational controls, lighting, electrical systems, fuel systems, and general configurations. Safety codes and standards are intended to enhance public health and safety. Standards result from consideration of factors such as technological advances, new data, and changing environmental needs.

One purpose of the document is to serve as a guide to governmental authorities having jurisdiction over subjects within the scope of the document. It is expected, however, that the document will find a major application in industry, serving as a guide to manufacturers of the vehicles.

If adopted for governmental use, references to other national standards may be changed to refer to the corresponding governmental regulations.

The use of Low Speed Vehicles is subject to certain hazards that cannot be eliminated or guarded against by mechanical means. Only the exercise of care and good judgment will minimize these hazards. It is therefore essential to have competent and careful operators, who are not physically or mentally impaired, thoroughly trained in the safe operation of Low Speed Vehicles. It is recommended that the operator be capable of obtaining a valid motor vehicle operator's license.

1. Scope—This SAE Standard defines the safety and performance requirements for Low Speed Vehicles ("LSV"). The safety specifications in this document apply to any powered vehicle with a minimum of 4-wheels, a maximum level ground speed of more than 32 km/h (20 mph) but less than 40 km/h (25 mph), a maximum rated capacity of 500 kg (1100 lb), and a maximum gross vehicle weight of 1135 Kg (2500 lb), that is intended for transporting not more than four (4) persons and operating on designated roadways where permitted by law. Personal Neighborhood Vehicles (PNVs) have the same general specifications as LSVs, but the maximum level ground speed is limited to 32 km/h (20 mph).

1.1 Purpose—The purpose of this document is to promote safety in the design, manufacture, maintenance and operation of LSV's and PNVs. Regulatory Authorities desiring to formulate safety rules and regulations may use this Standard as a guide. This document is also intended for voluntary use by others associated with manufacturing or utilizing LSV's.

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2. References

2.1 Applicable Publications—The following publications and standards contain provisions, which through reference in this text constitute provisions of this SAE Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreement based on this SAE Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. The latest issue of SAE Publications shall apply.

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

SAE/ANSI Z26.1 - Feb 96, Glazing materials
SAE J114—Seat Belt Hardware Webbing Abrasion Performance Requirements
SAE J140—Seat Belt Hardware Test Procedure
SAE J141—Seat Belt Hardware Performance Requirements
SAE J268—Rear View Mirrors—Motorcycles
SAE J272—Vehicle Identification Number Systems
SAE J273—Passenger Car Vehicle identification Number System
SAE J339—Seat Belt Hardware Webbing Abrasion Test Procedure
SAE J585—Tail Lamps (Rear Position Lamps) for Use on Motor Vehicles less Than 2032 mm in Overall Width
SAE J586—Stop Lamps for Use on Motor Vehicles Less Than 2032 mm in Overall Width
SAE J588—Turn Signal Lamps for Use on Motor Vehicles Less Than 2032 mm in Overall Width
SAE J592—Clearance, Side Marker, and Identification Lamps
SAE J594—Reflex Reflectors
SAE J800—Motor Vehicle Seat Belt Assembly Installation
SAE J916 - 1992, Rules for SAE use of SI (Metric) Units, Use TSB -003
SAE J1105—Horn—Forward Warning—Electric—Performance, Test, and Application
SAEJ1718—Measurement of Hydrogen Gas Emission from Battery-Powered Passenger cars and Light Trucks During Battery Charging

2.1.2 ANSI PUBLICATIONS—Available from ANSI, 25 West 43rd Street, New York, NY 10036-8002.

ANSI/NFPA 30 - 1990—Fuel handling and storage
ANSI/NFPA 58 - 1992—LPG fuel handling and storage
ANSI Z535.2 - 1991—Environmental and facility safety signs
ANSI Z535.4 - 1991—Safety Color Code

2.1.3 FEDERAL PUBLICATION—Available from the Superintendent of Documents, U. S. Government Printing Office, Mail Stop: SSOP, Washington, DC 20402-9320.

FMVSS 49CFR 571.216—Roof Crush Resistance

2.1.4 NASA PUBLICATION—National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22161.

NASA RP-1024 (N79-11734), Anthropomorphic Sourcebook, Vol. 1, Anthropology for Designers

2.2 Related Publication—The following publication is provided for information purposes only and is not a required part of this specification.

2.2.1 SAE PUBLICATION—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

TSB 003—Rules for SAE Use of SI (Metric) Units

3. Definitions—Glossary of Commonly Used Words and Phrases

- 3.1 Accelerator**—A floor mounted pedal used by the Operator to control the speed of the vehicle.
- 3.2 Accessory**—A LSV manufacturer approved device installed on the vehicle to enhance its usability.
- 3.3 Body Restraint**—A hand hold or combination hand hold/hip restraint anchored securely to the body or seat platform of the LSV creating a barrier to help prevent an occupant from sliding outside of the vehicle.
- 3.4 Brake Pedal**—The floor mounted pedal used to operate the braking system of the vehicle.
- 3.5 Braking System**—The system used to slow or stop the movement of the vehicle.
- 3.6 Center of Gravity of the Test Load**—The point, at which the load mass is concentrated, located horizontally in the center of the load-bearing surface and vertically by its distance above the surface.
- 3.7 Charged Battery**—A battery discharged to 1.75 volts per cell or less, then charged until a specific gravity reading as recommended by the battery manufacturer is achieved within a tolerance of ± 0.05 specific gravity with an electrolyte temperature of $26.5\text{ }^{\circ}\text{C} \pm 0.3\text{ }^{\circ}\text{C}$ ($80\text{ }^{\circ}\text{F} \pm 0.5\text{ }^{\circ}\text{F}$).
- 3.8 Closed Community**—A private residential area, resort or other private facility. The facility's ingress and egress being controlled by its owners or an association representing the owners or its members.
- 3.9 Controlling Party**—The owner, person(s) or organization(s) responsible for the conduct of the Operator and maintenance of the LSV.
- 3.10 Driver Seat**—The seat located directly behind the steering wheel.
- 3.11 Driver Side**—The left side of the LSV as viewed from the rear of the LSV.
- 3.12 Exhaust System**—The exhaust system includes all parts and their supports used to conduct exhaust gases from the engine.
- 3.13 Fire Hazard**—Any condition which presents the possibility of creating a fire by ignition of a combustible material.
- 3.14 Fire Protection Equipment**—Equipment used to prevent, control or extinguish a fire in accordance with state and local fire protection codes.
- 3.15 Fuel System**—The fuel system includes all tanks, lines, hoses, pumps, filters, connections, caps and fittings necessary to fill and carry fuel from the fuel tank to the engine.
- 3.16 Hand Hold**—A readily accessible device mounted securely to the vehicle that can be encircled by the fingers of one hand for the purpose of holding on.
- 3.17 Head Lamp**—A lighting device mounted on the front of the vehicle to provide illumination ahead of the vehicle.
- 3.18 Hill Brake**—See parking brake.
- 3.19 Horn**—An audible warning device used to signal the presence of the vehicle.
- 3.20 Insulated Tools**—Tools which are covered with a non-conducting material to prevent an inadvertent electrical short circuit and to protect the user from the dangers of electrical shock.

- 3.21 Low Speed Vehicle**—A powered, minimum 4 wheel vehicle with a maximum level ground speed of 40 km/h (25mph), maximum rated capacity of 500 kg (1100 lb), maximum gross vehicle weight of 1135 kg (2500 lb), intended for transporting not more than four persons, and operating on designated roadways where permitted by law.
- 3.22 Occupant Protective Structure**—A frame or other structural enclosure for the protection of occupants of LSVs and PNVs to minimize the possibility of serious occupant injury resulting from accidental upsets.
- 3.23 Operator or Driver**—A person authorized by the Regulatory Authority or Controlling Party to operate the LSV from the driver's seat only. This person (male or female) shall fall into the 5% to 95% male range of the appropriate measurements contained in NASA RP 1024 (N79-11734) Anthropomorphic source book, Volume 1: Anthropometry for designers.
- 3.24 Parking Brake**—The portion of the brake system used to hold one or more brakes continually in an applied position for the purpose of holding the vehicle stationary while parked.
- 3.25 Personal Neighborhood Vehicle**—A powered, minimum 4 wheel vehicle with a maximum level ground speed of 32 km/h (20 mph), maximum rated capacity of 500 kg (1100 lb), maximum gross vehicle weight of 1135 kg (2500 lb), intended for transporting not more than four persons, and operating on designated roadways where permitted by law.
- 3.26 Rated Capacity**—The total weight of material load and personnel load for a vehicle. The total personnel load for personnel vehicles.
- 3.27 Rear View Mirror**—A device having a reflecting surface used to provide a view to the rear of a vehicle.
- 3.28 Reflex Reflector**—A device used on a vehicle to indicate its presence by reflecting light.
- 3.29 Regulatory Authority**—A Closed Community or local, state, or federal governing authority, as applicable.
- 3.30 Reverse Warning Device**—An audible device installed to alert the Operator that the vehicle is in the reverse mode and is ready to proceed in a reverse or rearward direction.
- 3.31 Roll-Over**—A rotation of the vehicle 180 degrees or more in any direction from its normal upright position.
- 3.32 Service Brake**—The primary braking system of the LSV used to reduce the speed or stop the vehicle.
- 3.33 Side Marker Lamp**—A lamp used to indicate the presence and direction of a vehicle by marking its overall length.
- 3.34 Stop Lamp**—A red lamp that provides steady light to the rear of the vehicle, activated when the brake is applied, to indicate the intention of the Operator of the vehicle to diminish speed or stop.
- 3.35 Stopping Distance**—The distance traveled between the point of brake application and where the vehicle comes to rest.
- 3.36 Tail Lamp**—An energized red lamp which provides rear marking of the vehicle.
- 3.37 Test Vehicle**—Unless otherwise stated, the test vehicle shall conform to the manufacturer specifications for optimum performance. All optional and accessory items offered by the manufacturer shall be considered in performing each test, which shall be conducted with optional and accessory items installed, or not installed so as to create the most severe test conditions.
- 3.38 Turn Signal**—A flashing lamp indicating the vehicle Operator's intention to change direction.

3.39 Wiring System Assemblies—"Wiring System Assemblies" mean all wires, terminals, and connectors required to conduct electrical current to the motor, starter/generator and any other electrical functions.

4. Part I -- Safety Standard for Low Speed Vehicles

4.1 Interpretation

4.1.1 **MANDATORY AND ADVISORY RULES**—To carry out the provisions of this document, whenever the word "shall" is used, it is to be understood as mandatory, and the word "should" as recommended.

4.1.2 **TERMS**—For the purposes of this document, the term LSV shall mean Low Speed Vehicle and PNV shall mean Personal Neighborhood Vehicle.

5. Part II -- For the Controlling Party

5.1 Maintenance and Operation

5.1.1 GENERAL SAFETY PRACTICES

5.1.1.1 **Introduction**—It is recommended that Part II of this document be adopted in the vehicle manufacturer's manuals to encourage safe operation and proper maintenance. The safe operation is enhanced when LSVs and PNVs are operated within a specific set of operation instructions, safety rules, and practices established to meet actual terrain and driving conditions.

Like other machines, LSVs and PNVs can cause injury if improperly used or maintained. This section contains broad safety practices recommended for safe vehicle operation. Before operation, the Controlling Party and Operator shall become familiar with and abide by all Regulatory Authority laws, rules and ordinances, including, but not limited to, licensing requirements governing the operation of LSVs and PNVs.

The safety information contained in Part II is intended to provide the Controlling Party and Operator with basic safety information and to encourage safe operation and practices.

5.1.1.2 **General Operation**—LSV and PNV Controlling Parties and Operators shall abide by the rules of the road and equipment requirements as established by Regulatory Authorities, observe extra caution when in the proximity of larger vehicles and pedestrians, and use defensive driving techniques.

5.1.2 **VEHICLE MAINTENANCE**—LSVs and PNVs can become hazardous if maintenance is neglected or improperly performed. Therefore, the vehicle maintenance shall be performed by trained personnel and follow procedures in accordance with the manufacturer's recommendations.

5.1.2.1 **Preventive Maintenance**—A regularly scheduled inspection and preventive maintenance program in accordance with the manufacturer's recommendation should be established. Such a program will be a valuable tool in providing safe, properly operating LSVs and PNVs and will help to avoid accidents.

5.1.2.2 **Parts and Material**—Original equipment manufacturer's replacement parts and materials, or equivalent shall be used.

- 5.1.2.3 *Maintenance Safety Procedures*—The following list of recommended safety procedures are general in nature and in no way supersede the manufacturer's specific instructions.
- a. Follow manufacturer's instructions for immobilizing vehicle before beginning any maintenance
 - b. Block Chassis with jack stands before working underneath vehicle
 - c. Before performing any maintenance on the vehicle, disconnect the electrical system in accordance with the manufacturer's instruction
 - d. Use only properly insulated tools when working on electrical systems on and around batteries
 - e. Before disconnecting any part of the fuel system, turn all shut off valves, if so equipped, to the "OFF" position to prevent leakage or accumulation of flammable fuels in the work area
 - f. Avoid fire hazards and have fire protection equipment available
 - g. Brakes, steering mechanisms, warning devices, governors, safety decals and all other safety devices shall be inspected and maintained in a safe and proper operating condition and shall not be modified unless authorized by the vehicle manufacturer
 - h. After each maintenance or repair the vehicle shall be driven by qualified and trained personnel to ensure proper operation and adjustment. This check shall be performed in an area that is free of vehicular and pedestrian traffic
 - i. Record all maintenance performed in a maintenance record log and include date, name of person performing maintenance and type of maintenance
- 5.1.2.4 *Nameplates, Warnings, and Instructions*—All nameplates, warnings, and instructions, which are supplied by the manufacturer, shall be maintained in a legible condition.
- 5.1.2.5 *Modifications*—The Controlling party shall not perform, or allow to be performed, any modifications or additions which affect capacity, safe operation, maximum speed, or any change not in accordance with the Operator's Manual without the manufacturer's prior written authorization. Where authorized modifications have been made, the Controlling Party shall ensure that capacity, operation, warning, and maintenance instruction plates, tags, and decals are changed accordingly.
- 5.1.3 FUEL HANDLING AND STORAGE / BATTERY CHARGING
- 5.1.3.1 *Ventilation*—Maintenance and storage areas for LSVs and PNVs shall be properly ventilated to avoid fire hazards in accordance with applicable fire codes and ordinances.
- Ventilation for internal combustion engine powered LSVs and PNVs shall be provided to remove flammable vapors (gases), fumes and other flammable materials. Consult applicable fire codes for specific levels of ventilation.
- Ventilation for electric powered LSVs and PNVs shall be provided to remove the accumulation of flammable hydrogen gas emitted during the battery charging process. The amount of hydrogen gas emitted depends upon a number of factors such as the condition of the batteries, the output rate of the battery charger and the amount of time the batteries are on charge. Because of the highly volatile nature of hydrogen gas and its propensity to accumulate in pockets, a minimum number of air changes per hour is required during charging (1 for one vehicle and up to 5 for multiple vehicles are recommended). Consult applicable fire and safety codes for the specific ventilation levels required as well as the use of explosion proof electrical apparatus. SAE J1718 can be followed to check for hydrogen gas levels.
- 5.1.3.2 The Controlling Party shall supervise the storage and handling of fuels in accordance with ANSI/NFPA 30 requirements.
- 5.1.3.3 Storage and handling of liquefied petroleum gas fuels shall be in accordance with American Gas Association recommendations and ANSI/NFPA 58 requirements.

5.1.3.4 The Controlling Party shall require battery changing and charging facilities and procedures to be in accordance with applicable Regulatory Authority ordinances or regulations.

5.1.3.5 The Controlling Party shall periodically inspect charging and storage areas or facilities and review procedures to be certain that the procedures in 5.1.3.1 through 5.1.3.4 are being followed.

5.1.4 OPERATING SAFETY RULES AND PRACTICES

5.1.4.1 *Operator Qualifications*—It is recommended that only persons qualified and trained in proper operation of the vehicle, under the rules of the Regulatory Authority, be allowed to operate LSVs and PNVs. Qualifications may include age, valid driver's license, or other appropriate standards.

5.1.4.2 It is recommended, as with all motorized vehicles, that the warning "Do not operate vehicle when under the influence of alcohol or drugs" be strictly followed.

6. Part III - For the Manufacturer - Design and Construction Standards

6.1 General Requirements

6.1.1 VEHICLE IDENTIFICATION—On every LSV, the manufacturer shall legibly inscribe the vehicle identification number (VIN) that conforms to the requirements of SAE J272 and SAE J273.

6.2 Safety Signs

6.2.1 GENERAL

6.2.1.1 Safety signs shall be permanently affixed to the vehicle, shall be visible to the operator, shall conform to ANSI Z535, and shall convey the following minimum information:

To avoid the risk of severe personal injury or death:

- a. Only operate at maximum speed when on smooth, flat, non-congested roadways or paved pathways
- b. Do not operate the vehicle until all occupants are seated and seat belts fastened (if so equipped)
- c. Drive slowly in turns and when descending grades
- d. Set parking brake before leaving vehicle
- e. Place vehicle control in "Neutral/Park", if so equipped, and remove the ignition key when not in use
- f. Do not operate under the influence of alcohol or other drugs

6.2.1.2 The following safety warnings shall be permanently affixed to the vehicle, and shall be visible to all occupants:

- a. Remain fully seated and hold on when in motion
- b. Keep entire body inside vehicle

6.2.1.3 The following safety warnings shall be permanently affixed to the vehicle in the battery compartment (if so equipped):

- a. Danger! – High Voltage cables and terminals are contained within this compartment
- b. Danger! - battery electrolyte contains caustic substances
- c. Danger! - batteries must be connected properly, refer to the Operator's Manual

- 6.2.1.4 The following safety warnings shall be permanently affixed to the vehicle in the battery charging compartment (if so equipped):
- a. Danger! - connect battery charger to properly rated electrical receptacle with GFCI
 - b. Warning! - do not attempt to charge frozen, leaking, or damaged batteries
 - c. Warning! - do not charge batteries in a non-ventilated enclosed area or near flammable materials
- 6.2.2 DURABILITY—Safety signs shall be sufficiently durable to resist environmental stresses for the normal operational life of the vehicle.
- 6.3 Instruction Manuals**—Each manufacturer shall provide operation manuals with the following minimum information:
- 6.3.1 Complete operating instructions for the vehicle.
- 6.3.2 Instructions scheduling the required maintenance and storage to maintain the vehicle in safe operating condition.
- 6.3.3 All information contained in 5.1.3.
- 6.4 Operational Controls**—The controls shall be visible and accessible to the operator.
- 6.4.1 STEERING MECHANISM—When the vehicle is traveling in the forward direction, rotating the steering wheel in a clockwise direction shall cause the vehicle to turn to the right, and when rotated in a counter clockwise direction, the vehicle shall turn to the left, as viewed from the Operator's position.
- 6.4.2 FOOT-OPERATED CONTROLS—Foot-operated controls shall have a slip-resistant surface.
- 6.4.2.1 *Accelerator Control*—Accelerator control shall return to low idle or off position when activating force is removed from the control.
- The accelerator control shall be located for right foot operation, shall be positioned to the right of the service brake pedal, and shall be free of interference from the service brake pedal by a minimum lateral distance of 40 mm (1-1/2 in).
- 6.4.2.2 *Service Brake Control*—The service brake pedal shall be located for right foot operation.
- 6.4.3 VEHICLE PARKING BRAKE—A positive locking brake shall be provided. It shall be either a hand or foot operated type mechanism.
- 6.4.4 DIRECTIONAL CONTROL (FORWARD AND REVERSE)—The directional forward and reverse control shall be clearly marked as to its directional position.
- 6.4.4.1 *Reverse Warning Device*—Every vehicle shall be equipped with a sound-producing device capable of 60db(A) minimum at the Operator's ear level. The reverse warning device shall function at all times when the directional control is in the reverse position.
- 6.4.5 MASTER KEY LOCK—The vehicle shall be provided with a key type lock, and when the key is in the "off" position or removed, the motive power circuit shall be inoperative. The key shall be removable only in the "off" position.

6.5 General Configuration

- 6.5.1 The vehicle should be designed for convenient ingress and egress.
- 6.5.2 Operator and passenger stations shall accommodate persons falling within the 5th to 95th percentile male range of the appropriate measurements contained in NASA RP-1024 (N79-11734) Anthropomorphic source book, volume 1: Anthropometry for designers, and shall be within the plan view outline of the LSV.
- 6.5.3 The vehicle shall provide securely fastened seating arrangements, including a backrest for each intended occupant.
- 6.5.4 Body restraints securely fastened to the vehicle shall be provided for each intended occupant.
- 6.5.5 OCCUPANT PROTECTIVE SYSTEMS
- 6.5.5.1 Seat Belts and Occupant Protection Structures are required on LSVs, but Seat Belts are not recommended on PNVs unless they have Occupant Protection Structures. Seat Belt assemblies (Type 1 or Type 2) shall conform to the following standards: SAE J114, SAE 140a, SAE J141, SAE J339, and SAE J800. Where suspension seats are used, the seat belt assemblies shall be fastened to the movable portion of the seats to accommodate the ride motion of the occupants.
- 6.5.5.2 If the occupant compartment is enclosed by a structure that restricts the ability of the occupants to exit freely, the PNV shall be fitted with seat belt assemblies and the structure shall comply with 6.5.5.4.
- 6.5.5.3 The seat belt anchorage shall be capable of withstanding a static tensile force of 4448 N (988 lb) at 45degrees to the horizontal. The seat mounting shall be capable of withstanding this force, plus a force equal to four times the force of gravity, on the mass of all applicable seat components applied 45 degrees to the horizontal in a forward and upward direction. Tensile forces shall be equally divided between the anchorages.
- 6.5.5.4 An enclosure that restricts the ability of the occupants to exit freely shall be an Occupant Protection Structure and shall meet the requirements of Federal Motor Vehicle Safety Standard 49 CFR 571.216, Roof Crush Resistance.
- 6.5.5.5 Surfaces normally exposed to occupants or bystanders shall be free of sharp edges and projections.
- 6.5.5.6 All floor areas shall have a slip resistant surface.
- 6.5.5.7 Windshields shall be provided and shall comply with the requirements of SAE/ANSI Z26.1 for AS-1 (safety glass) or AS-5 (polycarbonate glass).

6.6 Mechanical Performance

6.6.1 MAXIMUM VEHICLE SPEED

6.6.1.1 Test Conditions—Test conditions shall be as follows:

- a. Horizontally flat surface, 0.5% grade (0.3 degrees) maximum
- b. Straight course
- c. Concrete or asphalt surface of sufficient track length to allow the test vehicle to reach maximum speed before measurement begins
- d. Concrete or asphalt surface that is dry and free from loose material or surface contamination with a minimum coefficient of traction of 0.8 between tire and surface

- e. The Test Vehicle shall be loaded with one Operator weighing no less than 77 kg (170 lb) or more than 82 kg (180 lb)

6.6.1.2 *Test*—The vehicle shall be operated with the directional control in forward at maximum speed under the conditions stated in 6.6.1.1. This test shall be run in one direction along the flat surface, then the opposite direction (within 30 minutes), and the results of both runs shall be averaged.

6.6.1.3 *Test Acceptance*—The average speed, from 6.6.1.2, shall not exceed 40 km/h (25 mph) for an LSV and 32km/h (20 mph) for a PNV.

6.6.2 MAXIMUM VEHICLE ACCELERATION

6.6.2.1 *Test Conditions*—Test conditions shall be as follows:

- a. Horizontally flat surface, 0.5% grade (0.3 degrees) maximum
- b. Straight course
- c. Concrete or asphalt surface of sufficient track length to allow the test vehicle to reach maximum speed
- d. Concrete or asphalt surface that is dry and free from loose material or surface contamination with a minimum coefficient of traction of 0.8 between tire and surface
- e. The Test Vehicle shall be loaded with one Operator weighing no less than 77 kg (170 lb) or more than 82 kg (180 lb)

6.6.2.2 *Test*—The test vehicle shall be accelerated at a maximum rate from stop position to maximum speed under the conditions stated in 6.6.1.1. This test shall be run in one direction along the flat surface, then the opposite direction (within 30 minutes), and the results shall be averaged.

6.6.2.3 *Test Acceptance*—The average acceleration rate for the test vehicle shall not exceed 4.9 m/s² (16 ft/s²).

6.6.3 STATIC STABILITY—The most severe conditions for stability shall be used for each test. A Test Weight, 300mm (12 in) cubed and weighing 90kg (200 lb), shall be used to represent each occupant, and additional weights shall be used and located to simulate other loads for the intended vehicle use.

6.6.3.1 *Longitudinal Stability*

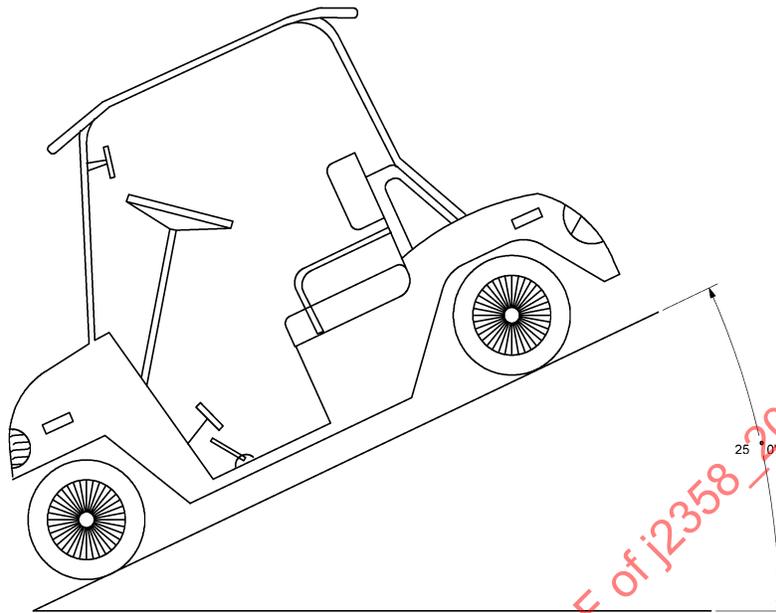
6.6.3.1.1 Test Conditions

- a. A tilting platform shall be used that is rigid, flat, and constructed to be an adjustable single plane surface.
- b. The tilting platform shall have a friction surface to achieve a coefficient of traction of one (1.0) minimum.
- c. The tilting platform surface shall be large enough to support all tires of the test vehicle.

6.6.3.1.2 *Test*—The test vehicle shall be supported by all tires with the braking wheels locked, on an adjustable inclined plane of no less than 46.6% grade (25 degrees) to the horizontal (see Figure 1). The test vehicle shall be positioned on the inclined plane with its longitudinal center line perpendicular to the intersection line of the inclined plane and the horizontal platform with its:

- a. Front end nearest the tilting axis
- b. Rear-end nearest the tilting axis

6.6.3.1.3 *Test Acceptance*—Acceptance of the longitudinal stability test shall require that the supporting tire or tires on the uphill side remain in contact with the surface or the vehicle slides. Failure shall have occurred when all of the vehicle's uphill tires lift off the platform.



LONGITUDINAL TEST

FIGURE 1—VEHICLE PLACEMENT ON LONGITUDINAL TILTING PLATFORM

6.6.3.2 *Lateral Stability*

6.6.3.2.1 Test Conditions—Test conditions shall be the same as given in 6.6.3.1.1.

6.6.3.2.2 Test —The test shall be conducted as follows:

- a. The parking brake shall maintain the position of the test vehicle on the tilting platform
- b. The vehicle with test loads in place shall be put on the tilting platform in accordance with Figure 2
- c. Test vehicles shall be positioned (Figure 2) such that a line from the center of the contact area of the lower rear tire to the center of the contact area of the lower front tire nearest to the tilting platform axis is parallel to the tilting axis of the platform
- d. The vehicle shall be positioned and tested so that: 1) the left side is nearest the tilting axis and repeated with 2) the right side nearest the tilting axis
- e. The steerable tires on the vehicle shall be turned to be parallel to the tilting axis
- f. The stability of the test vehicle shall be determined directly by tilting the platform to a 40% grade (21.8degrees)

6.6.3.2.3 Test Acceptance—Acceptance of the lateral stability test shall require that the supporting tire or tires on the uphill side remain in contact with the surface or the vehicle slides. Failure shall have occurred when all of the vehicle's uphill tires lift off the platform.

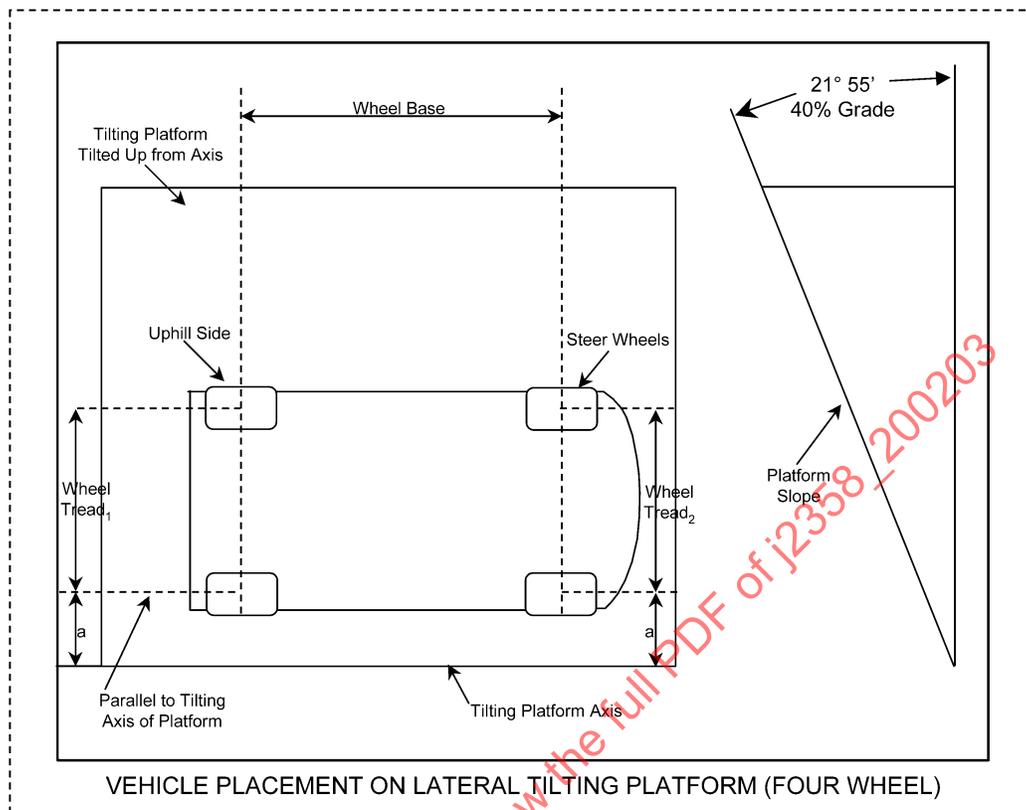


FIGURE 2—VEHICLE PLACEMENT ON LATERAL TILTING PLATFORM

6.6.4 BRAKE SYSTEMS

6.6.4.1 Service Brake Performance

6.6.4.1.1 Test Conditions—Test conditions shall be as follows:

- a. Horizontally flat surface. 0.5% grade (0.3 degree) maximum
- b. Straight course
- c. Concrete or asphalt surface that is dry and free from loose material or surface contamination with a coefficient of traction range of 0.8 to 1.1 between tires and surface
- d. Sufficient track lengths to allow the vehicle to reach maximum speed before measurements begin
- e. The test vehicle weight (TVW) shall be such that it creates the most severe conditions for braking (see 6.6.3)
- f. The same service brake components shall be used for all tests

6.6.4.1.2 Test—The test shall be conducted as follows:

- a. A constant force of 1100 N (250 lb) shall be applied to the center of the brake pedal for a minimum of five (5) minutes.
- b. After release of force on brake pedal, the test vehicle shall be run to its maximum operating speed and the brake then applied with a foot pedal force of not more than 550 N (125 lb) when applied to the center of the service brake pedal.

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6.6.4.1.3 Test Acceptance—The test vehicle shall stop in both the forward and reverse directions from the point of application of the brakes within the distances determined by Equations 1 and 2:

$$\begin{aligned} \text{Stopping Distance, forward (M)} &= 0.009V^2(V \text{ km/h}) && \text{(Eq. 1)} \\ &(\text{Ft}) = 0.070V^2(V \text{ mph}) \end{aligned}$$

$$\begin{aligned} \text{Stopping Distance, reverse (M)} &= 0.015V^2(V \text{ km/h}) && \text{(Eq. 2)} \\ &(\text{Ft}) = 0.125V^2(V \text{ mph}) \\ &(V = \text{actual maximum speed of the vehicle}) \end{aligned}$$

6.6.4.2 *Service Brake Fade*

6.6.4.2.1 Test Conditions—The Test Condition shall be the same as given in 6.6.4.1.1. The test vehicle shall be towed in the forward direction with the brake applied to produce a drag load determined by Equation 3:

$$\text{Drag Load} = TF_{fr} + (0.342) TVW \quad \text{(Eq. 3)}$$

where:

- TF_{fr} = Towing Force free rolling
- TVW = Test Vehicle Weight
- 0.342 = Downhill component of a 20 degrees slope
{This drag load shall be maintained within ±15% for 150 m (500 ft)}.

6.6.4.2.2 Test —The test shall be conducted as follows:

- a. The test vehicle shall be operated at a maximum operating speed; the brake shall be applied with a foot pedal force not to exceed 550 N (125 lb) applied to the center of the brake pedal.
- b. This test shall be performed before the brake linings have cooled more than 14 °C (25 °F) from the maximum temperature obtained during the tow period.

6.6.4.2.3 Test Acceptance—The test vehicle shall stop in the forward direction from the point of application of the brakes within the distances determined by Equation 4:

$$\begin{aligned} \text{Stopping Distance (M)} &= 0.010V^2(V \text{ km/h}) && \text{(Eq. 4)} \\ &(\text{Ft}) = 0.080V^2(V \text{ mph}) \\ &(V = \text{actual maximum speed of the vehicle}) \end{aligned}$$

6.6.4.3 *Service Brake Fade Recovery*

6.6.4.3.1 Test Conditions—The test conditions shall be the same as given in 6.6.4.1.1 and 6.6.4.2.1.

6.6.4.3.2 Test—The service brake test described in 6.6.4.1.2 shall be repeated after the brakes have cooled to ambient temperature.

6.6.4.3.3 Test Acceptance—The test vehicle shall stop in the forward direction from the point of application of the brakes within the distances determined by Equation 5:

$$\begin{aligned} \text{Stopping Distance (M)} &= 0.009V^2(V \text{ km/h}) && \text{(Eq. 5)} \\ &(\text{Ft}) = 0.070V^2(V \text{ mph}) \\ &(V = \text{actual maximum speed of the vehicle}) \end{aligned}$$

6.6.4.4 Parking Brake

6.6.4.4.1 TEST CONDITIONS—Test conditions shall be the same as in 6.6.3.1.1 and as follows:

- a. The test vehicle shall be loaded as specified in 6.6.3.
- b. The test vehicle shall be positioned on an inclined plane having a 30% grade (16.7 degrees), with its longitudinal centerline perpendicular to the intersection line of the inclined plane and the horizontal platform.

6.6.4.4.2 TEST—With a maximum 352 N (80 lb) force applied to the foot pedal or 220 N (50 lb) if hand lever and the parking brake fully engaged, the vehicle shall be positioned with its:

- a. Front end on the downhill side
- b. Rear end on the downhill side

6.6.4.4.3 TEST ACCEPTANCE—The parking brake shall hold the vehicle on the inclined plane having a 30% (16.7degrees) grade. Vehicle shall not move more than 76 mm (3 in) in one hour. Vehicle may slide off incline provided there is no rotating of wheels.

6.7 Battery Installation

6.7.1 VENTILATION—The battery or batteries shall be located to prevent accumulation of battery gases within the vehicle.

6.7.2 CONTAINMENT—Batteries shall be installed with sufficient restraint, e.g., hold down devices, to contain the batteries within the vehicle during operation.

6.8 Lighting and Marking

6.8.1 HEAD LAMPS—Two (2) headlamps shall be mounted on the front of the vehicle and disposed symmetrically about the centerline and separated as far as practicable. They shall be mounted no less than 381 mm (15 in) nor more than 1270 mm (50 in) above the ground. See Tables 1 and 2. Each lamp may be a single low beam or high/low beam and shall comply with the requirements of either Table 1 or 2. Provision may be made for the lamps to be adjusted.

**TABLE 1—LSV HEAD LAMP PHOTOMETRIC SPECIFICATION
UPPER BEAM⁽¹⁾**

TEST POINT (deg)	INTENSITY (cd)
H-V	2000 min
1/2 D-V	5000 min
1/2 D-3R-3L	3000 min
1/2 D-6R-6L	1000 min
2D-V	2500 min
3D-V	1500 min
3D-6R-6L	750 min
4D-V	5000 max

1. A tolerance of 1/4 degree shall be allowed at each test point.

**TABLE 2—LSV HEAD LAMP PHOTOMETRIC SPECIFICATION
LOWER BEAM⁽¹⁾**

TEST POINT (deg)	INTENSITY (cd)
1/2 U - and above	2000 max
2D-V	3000 min
3D-4R-4L	1500 min
3D-6R-6L	750

1. A tolerance of 1/4 degree shall be allowed at each test point.

- 6.8.2 **TAIL LAMPS**—Two (2) tail lamps shall be mounted on the rear and disposed symmetrically about the centerline of the vehicle and as far apart as practicable. They shall be mounted no less than 381 mm (15 in) nor more than 1524 mm (60 in) above the ground. Tail lamps shall be illuminated when the headlamps are energized. Each lamp shall comply with the requirements of SAE J585.
- 6.8.3 **STOP LAMPS**—Two (2) stop lamps shall be mounted on the rear of the vehicle and disposed symmetrically about the centerline of the vehicle. They shall be mounted no less than 381 mm (15 in) nor more than 1524mm (60 in) above the ground. The stop lamps shall be illuminated by activation of the vehicle service brake. A stop lamp may be combined optically with the tail lamp and shall comply with requirements of SAE J586.
- 6.8.4 **TURN SIGNALS**—Turn signal lamps shall be mounted on the vehicle, two (2) facing to the rear and two (2) facing to the front and as far from the longitudinal center line of the vehicle as practicable. They shall be mounted no less than 381 mm (15 in) or more than 1524 mm (60 in) from the ground. A turn signal lamp may be combined optically with the tail lamp and shall comply with the requirements of SAE J588.
- 6.8.5 **REFLEX REFLECTORS**—Reflex reflectors shall be mounted on the vehicle in the following manner: two (2) yellow, mounted (one on each side) as far forward as practicable; two (2) red, mounted (one on each side) as far rearward as practicable; and two (2) red, mounted on the rear, as far from the vehicle centerline as practicable. They shall also be mounted no less than 381 mm (15 in) nor more than 1524 mm (60 in) from the ground. Each reflex reflector shall comply with the requirements of SAE J594.
- 6.8.6 **SIDE MARKER LAMPS (OPTIONAL)**—Side marker lamps, when used, shall be mounted on each side of the vehicle, one (1) yellow as far forward as practicable and one (1) red, as far rearward as practicable. They shall be mounted no less than 381 mm (15 in) nor more than 1524 mm (60 in) from the ground. Each side marker lamp shall comply with the requirements of SAE J592.
- 6.9 **Horn**—A horn shall be mounted on the vehicle to give an audible signal. The activating switch for the horn shall be mounted so it can be easily activated with a minimum movement of the operator's hand or foot. The horn shall comply with the requirements of SAE J1105.
- 6.10 **Mirrors**—An exterior mirror shall be mounted on the operator's side of the vehicle, and either an exterior mirror shall be mounted on the passenger's side of the vehicle, or a mirror shall be mounted on the interior of the vehicle. The design of the mirror shall incorporate the requirements of SAE J268.

7. Electric Powered Vehicles

7.1 Wiring Systems

7.1.1 GROUNDING—Wiring System Assemblies including accessories, options and field installed items shall not be grounded to the vehicle frame.

7.1.2 ROUTING—Wiring System Assemblies shall be routed and contained within the vehicle in such a manner as to provide adequate clearance from heat generating components and to avoid obstacles or projections that the vehicle may encounter during normal operation. "Adequate clearance" defines clearance necessary to avoid breakdown of the wiring insulation due to heat from heat generating components or abrasive elements.

7.2 Heat Generating Components

7.2.1 TEST CONDITIONS—A test vehicle with fully charged batteries, shall be set up and locked in such a manner as to prevent movement of the vehicle or rotation of the vehicle traction tires when the accelerator control is set at its maximum speed position.

Tests may be conducted indoors or in a covered area protected against the direct rays of the sun. Wind velocity in the test area shall not exceed an average of 8 km/h (5 mph). The temperature of the ambient air shall not be less than 19 °C (65 °F) or more than 30 °C (86 °F), and shall not vary more than 5.5 °C (10 °F) between maximum and minimum throughout the test period.

7.2.2 HEAT TEST—Power shall be applied to the drive motor by means of the accelerator being set at the maximum speed position and held for ten (10) seconds.

7.2.2.1 Immediately afterwards, the accelerator shall be placed at the lowest speed position and held for thirty (30) minutes.

7.2.3 HEAT TEST ACCEPTANCE

7.2.3.1 There shall be no signs of fire and all electrical components shall remain contained within the vehicle.

7.2.3.2 Any heat transfer through the test vehicle shall not produce an external surface temperature accessible to persons outside or on the vehicle in excess of 60 °C (140 °F) on metal surfaces and 85 °C (185 °F) on nonmetal surfaces.

8. Gasoline Powered Vehicles

8.1 Wiring Systems

8.1.1 GROUNDING—Wiring System Assemblies may be grounded to the vehicle frame.

8.1.2 ROUTING—Wiring System Assemblies shall be routed and contained within the vehicle in such a manner as to provide adequate clearance from heat generating components and to avoid obstacles or projections that the vehicle may encounter during normal operation. "Adequate clearance" defines clearance necessary to avoid breakdown of the wiring insulation due to heat from heat generating components or abrasive elements.