

	SURFACE VEHICLE STANDARD	
	SAE	J2358 SEP2010
	Issued Revised	2002-03 2010-09
Superseding J2358 MAR2002		
(R) Low Speed Vehicles		

RATIONALE

The revisions to SAE J2358 are intended to achieve consistency with other SAE standards and procedures, to make the test results more repeatable and quantitative, and to incorporate improvements in test procedures and data analysis.

The primary changes and the reasons for them are listed as follows:

a. Added the Table of Contents

Reason: To make sections easier to access

b. Revised Scope to increase maximum G.V.W. to 1361 kg (3000 lb)

Reason: To include appropriate vehicles.

c. Reviewed normative references and deleted those not used, revised references as necessary, had SAE J1718 Stabilized, and added references

Reason: To insure applicability and to include new references.

d. Revised definitions of Accelerator (3.1), Brake Pedal (3.4), Charged Battery (3.7), Fuel System (3.15), Low Speed Vehicles (3.22), and Operator or Driver (3.24), and added definition of Key (3.21).

Reason: Clarity.

e. Revised (6.2.1) General - Safety Signs to add on-vehicle and in Operator Manual information .

Reason: To insure that required information will be included.

f. Revised (6.4) Operational Controls to define Reverse Warning Indicator (6.4.4.1) and to add Theft Protection (6.4.5)

Reason: To clarify the intent of the standard.

g. Revised General Configuration (6.5) to include revised anthropometry (6.5.2), to revise seat restraint anchorage (6.5.5.2), and to detail the requirements of the Operator Protection Structure (6.5.5.3) including new Figures 1a and 1b.

Reason: To eliminate reliance on the FMVSS for timely and applicable revisions and to clarify the test procedures.

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- h. Revised the Brake Systems test conditions (6.6.4.1.1.e) and Brake System fade (6.6.4.2.1) test.

Reason: For clarity and to better define worst case conditions.

- i. Revised Park Brake test (6.6.4.4.2) to specify applied loads

Reason: To define the two loading conditions needed for testing.

- j. Revised Containment (6.7.2) by adding Impact Containment (6.7.2.1) and Roll-over Containment (6.7.2.2) test conditions, test procedure, and test acceptance.

Reason: To better define procedures and tests to allow accurate determination of test acceptance.

- k. Revised Lighting (6.8) to better align requirements of Head Lamps (6.8.1 and 6.8.2), Tail Lamps (6.8.3), Stop Lamps (6.8.4), and Turn Signals (6.8.5), and add Center High Mounted Stop Lamps (6.8.4.2).

Reason: To better align requirements with SAE Standards and FMVSS, and to also improve vehicle identification and recognition.

- l. Revised Electric Powered Vehicles (7) Grounding (7.1.1) to add (7.1.1.a, .b, and .c) and EMC (7.2.3).

Reason: To reflect current technology and safety practices, and to provide a procedure to ensure Electromagnetic Compatibility.

- m. Revised Spark and Compression Ignition Engine Powered Vehicles (8) Fuel System Installation (8.3.2.1) requirements for over engine tanks, and added EMC (8.2.4).

Reason: To reflect current technology and safety practices, and to provide a procedure to ensure Electromagnetic Compatibility.

- n. Added Hybrid Vehicles (9) requirements

Reason: To reflect current technology and safety practices.

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.

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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 not more than 40 km/h (25 mph), and a maximum gross vehicle weight of 1361 kg (3000 lb), that is intended for operating on designated roadways where permitted by law.

1.1 Purpose

The purpose of this document is to promote safety in the design, manufacture, maintenance and operation of LSVs. 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 LSVs.

2. REFERENCES

2.1 Applicable Documents

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, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

SAE/ANSI Z26.1-Feb96	Glazing Materials
SAE J114	Seat Belt Hardware Webbing Abrasion Performance Requirements
SAE J140a	Seat Belt Hardware Test Procedures
SAE J141	Seat Belt Hardware Performance Requirements
SAE J268	Rear View Mirrors - Motorcycles
SAE J272	Vehicle Identification Number Systems
SAE J339	Seat Belt Hardware Webbing Abrasion Test Procedure
SAE J377	Vehicular Traffic Sound Signaling Devices (Horns)
SAE J384	Motor Vehicle Seat Belt Anchorages 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	Sidemarkers Lamps for Use on Road Vehicles Less than 2032 mm in Overall Width
SAE J594	Reflex Reflectors
SAE J800	Motor Vehicle Seat Belt Assembly Installation

SAE J916-1992 (cancelled) Rules for SAE Use of SI (Metric) Units, Use TSB 003

SAE J1718 Measurement of Hydrogen Gas Emission from Battery-Powered Passenger Cars and Light Trucks During Battery Charging

SAE J1957 Center High Mounted Stop Lamp Standard for Vehicles Less than 2032 mm Overall Width

2.1.2 ANSI Publications

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ANSI/NFPA 30-1990 Fuel handling and storage

ANSI/NFPA 58-1992 LPG fuel handling and storage

ANSI Z535.1 -2006 Safety Colors

ANSI Z535.4 - 2007 Product Safety Signs and Labels

2.1.3 NASA Publication

Available from National Technical Information Service, U.S. Department of Commerce, Alexandria, VA 22312, Tel: 703-605-6000, www.ntis.gov.

NASA-STD-3000, Revision B, July 2003, Man-Systems Integration Standards, Volume I, Section 3, ANTHROPOMETRY AND BIOMECHANICS,

2.1.4 ISO Publication

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ISO 3864 Graphical Symbols, Safety colours and safety signs

2.1.5 EC Directive 97/24/EC

2.2 Related Publication

The following publication is provided for information purposes only and is not a required part of this SAE Technical Report.

2.2.1 SAE Publication

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

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

3. DEFINITIONS - GLOSSARY OF COMMONLY USED WORDS AND PHRASES

3.1 ACCELERATOR

A foot operated 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 or functionality.

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 foot operated pedal used by the Operator 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

Full charge is to be established using manufacturer's recommended charging procedure and appropriate equipment.

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 ENGINE 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 (if so powered/equipped)

The fuel system includes all tanks, lines, hoses, pumps, filters, canisters, connections, caps and fittings necessary to fill and carry fuel or vapor 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 KEY

A physical device or an electronic code which, when inserted into the starting system (by physical or electronic means), enables the vehicle Operator to activate the engine or motor.

3.22 LOW SPEED VEHICLE

Any powered vehicle with a minimum of 4-wheels, a maximum level ground speed of more than 32 km/h (20 mph) but not more than 40 km/h (25 mph), and a maximum gross vehicle weight of 1361 kg (3000 lb), that is intended for operating on designated roadways where permitted by law.

3.23 OCCUPANT PROTECTIVE STRUCTURE

A frame or other structural enclosure for the protection of occupants of LSVs to minimize the possibility of serious occupant injury resulting from accidental upsets.

3.24 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 Man-Systems Integration Standards, Volume I, Section 3, ANTHROPOMETRY AND BIOMECHANICS.

3.25 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.

3.26 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 INDICATOR

A 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 orientation 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.

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 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 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.

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 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 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 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 shall be properly ventilated to avoid fire hazards in accordance with applicable fire codes and ordinances.

Ventilation for internal combustion engine powered LSVs 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 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. 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 indelibly mark the vehicle identification number (VIN) that conforms to the requirements of SAE J272.

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 Z535.1 and Z535.4 or ISO 3864, 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 information shall be permanently affixed to the vehicle in the battery compartment and included within the Operator's Manual (if applicable):

- a. Danger! - High Voltage cables and terminals are contained within this compartment (this applies to vehicles with system voltage equal or greater than 60 VDC, 30 VAC)
- 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 information shall be permanently affixed to the vehicle and included within the Operator's Manual (if applicable):

- 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 Indicator

Every vehicle shall be equipped with a Reverse Warning Indicator for the Operator

- a. If sound-producing capable of 60 db(A) minimum at the Operator's ear level
- b. If a mechanical device or illuminated symbol, visible to the Operator, during normal use.

The reverse warning indicator shall function at all times when the directional control is in the reverse position and the key in the "ON" position.

6.4.5 Theft Protection

Each vehicle must have a starting system which, whenever the key is removed from the starting system prevents the normal activation of the vehicle's engine or motor.

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 Man-Systems Integration Standards, Volume I, Section 3, 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. Seat Belt assemblies (Type 1 or Type 2) shall conform to the following standards: SAE J114, SAE J140a, 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 The seat belt anchorage shall be capable of withstanding a static tensile force of 4448 N (988 lb) applied in accordance with the procedures of SAE J384. 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. Tensile forces shall be equally divided between the anchorages.

6.5.5.3 An enclosure that restricts the ability of the occupants to exit freely shall be an Occupant Protection Structure and shall meet the requirements of the following Roof Crush Resistance.

a. Requirements

A test device as described in 6.5.5.3 b shall not move more than 127 mm (5 in), measured in accordance with 6.5.5.3 c.4, when it is used to apply a force of 1.5 times the unloaded vehicle weight of the vehicle or 2268 kg (5000 lb) whichever is less, to either side of the forward edge of the vehicle's roof in accordance with the procedures of 6.5.5.3 c.3. Both the left and right front portions of the vehicle's roof structure shall be capable of meeting the requirements, but a particular vehicle need not meet further requirements after being tested at one location.

b. Test Device

The test device is a rigid unyielding block with its lower surface formed as a flat rectangle 762 mm x 1829 mm (30 in x 72 in).

c. Test Procedure

Each vehicle shall be capable of meeting the requirements when tested in accordance with the following procedure.

1. Place the chassis frame of the vehicle on a rigid horizontal surface, fix the vehicle rigidly in position, close all windows, close and lock all doors, and secure any convertible top or removable roof structure in place over the passenger compartment.

2. Orient the test device as shown in Figure 1A and 1B, so that:
 - a. its longitudinal axis is at a forward angle (side view) of 5 degrees below the horizontal, and is parallel to the vertical plane through the vehicle's longitudinal centerline;
 - b. its lateral axis is at a lateral outboard angle, in front view projection, of 25 degrees below the horizontal;
 - c. its lower surface is tangent to the surface of the vehicle; and
 - d. the initial contact point, or center of the initial contact area, is on the longitudinal centerline of the lower surface of the test device and 254 mm (10 in) from the forward-most point of that centerline.
3. Apply force in a downward direction perpendicular to the lower surface of the test device at a rate of not more than 1/2 in per second until reaching a force of 1.5 times the unloaded vehicle weight of the tested vehicle or 2268 kg (5000 lb), whichever is less. Complete the test within 120 seconds. Guide the test device so that throughout the test it moves, without rotation, in a straight line with its lower surface oriented as specified in 6.5.5.3 c.2.a) through 6.5.5.3 c.2.d).
4. Measure the distance that the test device moves, i.e., the distance between the original location of the lower surface of the test device and its location as the force level specified in 6.5.5.3 c.3 is reached.

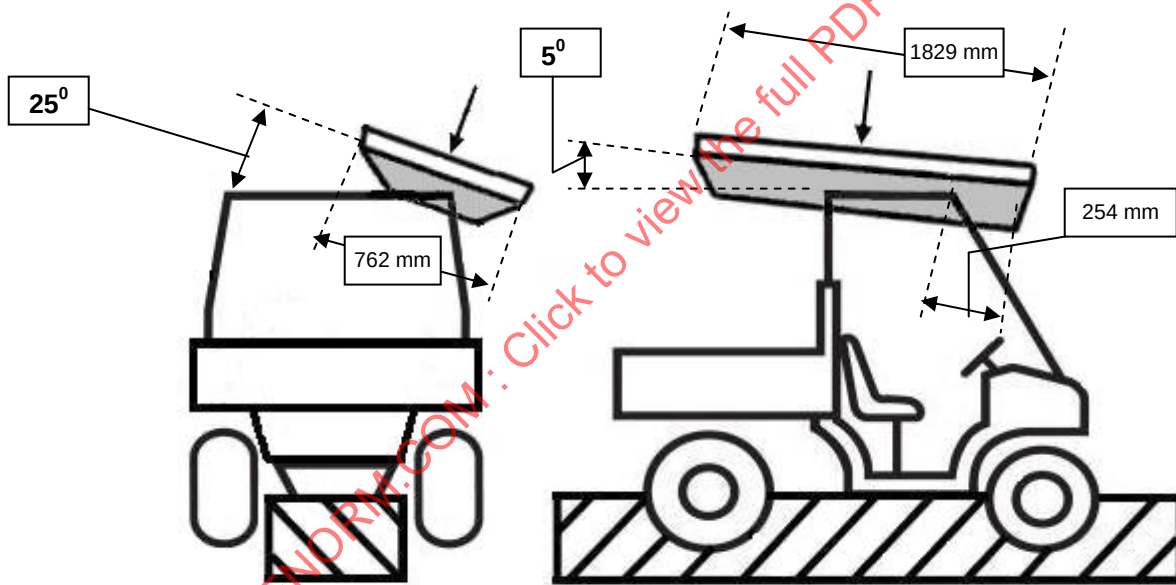


FIGURE 1A - REAR VIEW, BLOCK ON RIGHT SIDE

FIGURE 1B - RIGHT SIDE, BLOCK ON LEFT SIDE

FIGURE 1

- 6.5.5.4 Surfaces normally exposed to occupants or bystanders shall be free of sharp edges and projections.
- 6.5.5.5 All floor areas shall have a slip resistant surface.
- 6.5.5.6 Windshields shall be provided and shall comply with the requirements of SAE/ANSI Z26.1 for AS-1 or AS-4.

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, 1.0% grade (0.6 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 min), 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.

6.6.2 Maximum Vehicle Acceleration

6.6.2.1 Test Conditions

Test conditions shall be as follows:

- a. Horizontally flat surface, 1.0% grade (0.6 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 min), 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/s^2 (16 ft/s^2).

6.6.3 Static Stability

The most severe conditions for stability shall be used for each test. A Test Weight, 300 mm (12 in) cubed and weighing 90 kg (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 2). 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.

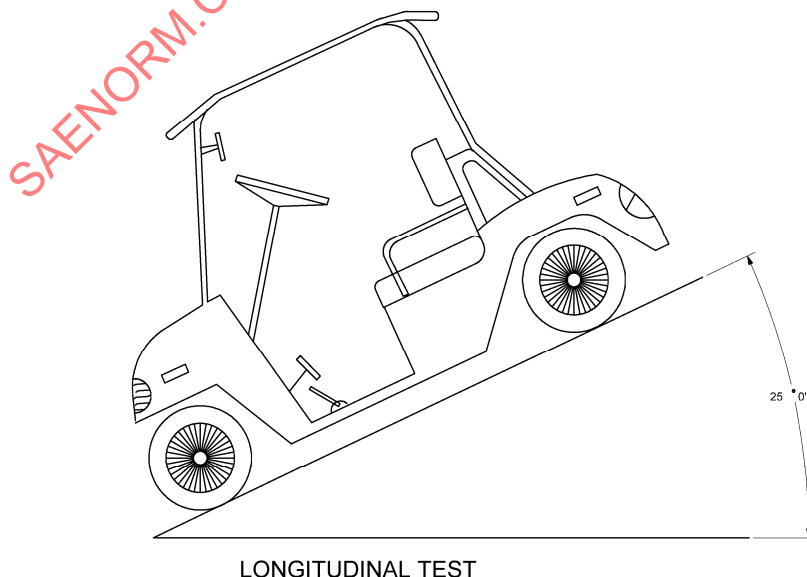


FIGURE 2 - VEHICLE PLACEMENT ON LONGITUDINAL TILTING PLATFORM

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:

- The parking brake shall maintain the position of the test vehicle on the tilting platform
- The vehicle with test loads in place shall be put on the tilting platform in accordance with Figure 3
- Test vehicles shall be positioned (Figure 3) 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
- 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
- The steerable tires on the vehicle shall be turned to be parallel to the tilting axis
- The stability of the test vehicle shall be determined directly by tilting the platform to a 40% grade (21.8 degrees)

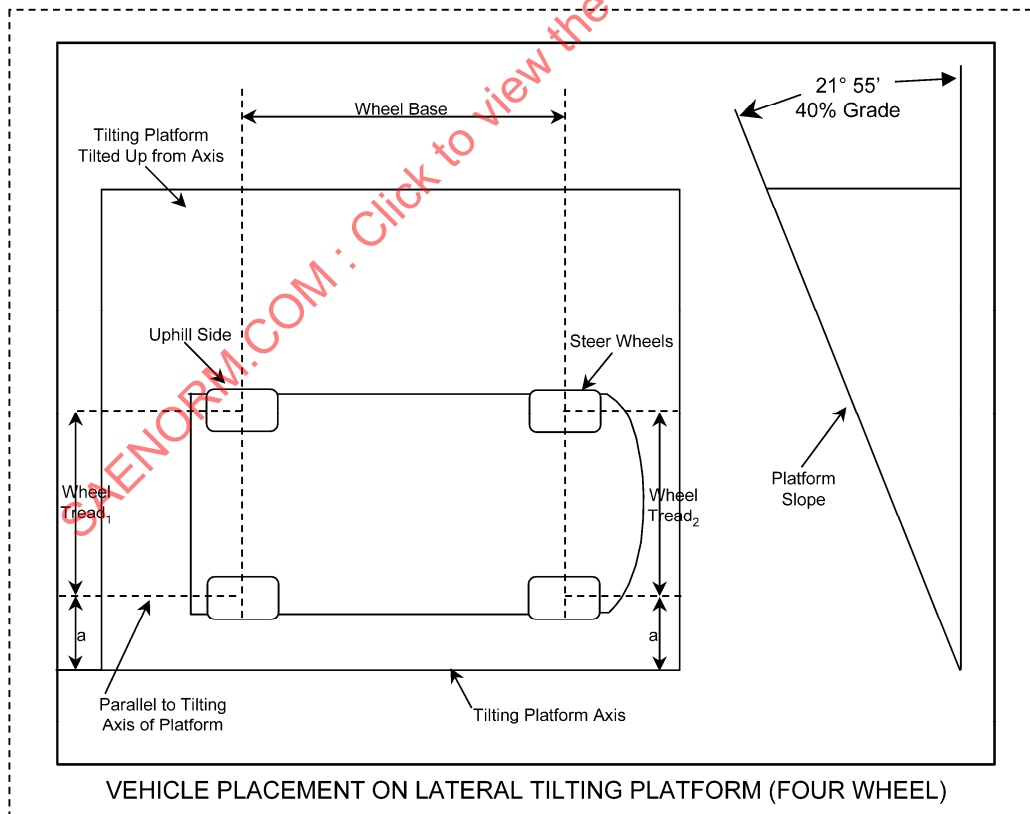


FIGURE 3 - VEHICLE PLACEMENT ON LATERAL TILTING PLATFORM

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.

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:

- Horizontally flat surface. 1.0% grade (0.6 degree) maximum
- Straight course
- 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
- Sufficient track lengths to allow the vehicle to reach maximum speed before measurements begin
- The test vehicle weight (TVW) and battery state of charge shall be such that it creates the most severe conditions for braking (see 6.6.3)
- 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 constant force of 1100 N (250 lb) shall be applied to the center of the brake pedal for a minimum of 5 min.
- 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.

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:

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

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

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.

6.6.4.2.2 Drag Load

The test vehicle shall be towed at 50% of maximum speed 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 degree slope

{This drag load shall be maintained within $\pm 15\%$ for 150 m (500 ft)}

6.6.4.2.3 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 within 1 min of completion of the drag load.

6.6.4.2.4 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:

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

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:

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

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 555 N (125 lb) force applied to the foot pedal or 400 N (90 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% (16.7 degrees) grade. Vehicle shall not move more than 76 mm (3 in) in 1 hr. 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.

6.7.2.1 Impact Containment

6.7.2.1.1 Test Conditions

Test conditions shall be as follows:

- Where applicable, remove acid from discharged lead acid batteries and rinse with potable water to minimize acid-related accidents during testing. Refill cells with potable water. If batteries other than lead acid are used, precautionary measures should be taken to minimize potential hazards.
- Horizontally flat surface, 1.0% grade (0.6 degrees) maximum;
- Straight course;
- Sufficient track length to allow test vehicles to reach maximum test speed as specified in 6.6.1.2;
- An unyielding, flat concrete or steel barrier with sufficient strength to fully resist the impact of the test vehicle at the test speed. The barrier shall be wider than the vehicle.

6.7.2.1.2 Test

A test vehicle shall be propelled into the barrier at:

- 50% of maximum speed in the forward direction;
- 50% of maximum forward speed or maximum reverse speed, whichever is less, in the reverse direction.

6.7.2.1.3 Test Acceptance

The battery or batteries shall be contained within the test vehicle and not intrude into occupant compartment. Leakage from battery or batteries is permissible but shall not intrude into occupant compartment.

6.7.2.2 Roll-Over Containment

6.7.2.2.1 Test Conditions

- Where applicable, remove acid from discharged batteries and rinse with potable water to minimize acid-related accidents during testing. Refill cells with potable water. If batteries other than lead acid are used, precautionary measures should be taken to minimize potential hazards.
- The test vehicle shall be positioned on a concrete or asphalt surface.

6.7.2.2.2 Test

The test vehicle shall be tilted by elevating each side up to the point just past the point of neutral stability and released so the test vehicle completes at least one quarter revolution (90 degrees) in both lateral directions on its own accord.

6.7.2.2.3 Test Acceptance

The battery or batteries and their contents shall be contained within the test vehicle battery compartment. Leakage from battery vent system, if present, is permissible.