

**SURFACE
VEHICLE
RECOMMENDED
PRACTICE**

SAE J1903

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(R) AUTOMOTIVE ADAPTIVE DRIVER CONTROLS, MANUAL

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1. Scope—This SAE Recommended Practice establishes a uniform procedure for assuring the manufactured quality, installed utility, and service performance of certain automotive adaptive products, other than those provided by the OEM, intended to provide driving capability to persons with physical disabilities. These devices function as adaptive appliances to compensate for lost or reduced performance in the arms or legs or both, of the driver. Some of the devices are designed to transfer foot functions to the hands, hand functions to the feet, or functions from one side of the body to the other.

1.1 Inclusions—This document is specifically concerned with those mechanical and electrical products that are intended by the manufacturer to:

- a. Be installed within the occupant space of the vehicle
- b. Be operated by a vehicle driver with a physical disability
- c. Be added to, or substituted for, the vehicle control pedals, wheels, levers, knobs, and switches
- d. Allow normal operation of vehicle primary controls (see 1.3.1), by a driver who is not disabled, without reconversion or special training and
- e. Rely on the operator as the only source of activating force

1.2 Exclusions—This document specifically excludes any automotive adaptive product which does not satisfy 1.1, or which, in order to be installed in the vehicle, requires the removal or alteration of a vehicle component that is normally mounted outside the occupant space (on the fire wall, chassis, or engine). Also excluded are accessory controls (see 1.3.2).

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1.3 Classification—This document establishes three control groupings, based on the potential safety consequences of product failure. The groups are listed in descending order of importance to safety.

1.3.1 PRIMARY CONTROLS—(Reference SAE Definition)

1.3.1.1 *Group A*—Those controls, operated by the driver which directly affect the direction and rate of the moving vehicle, including the steering, brake, and throttle controls. All sections of this document are applicable to Group A primary controls.

1.3.1.2 *Group B*—Those controls, operated by the driver, which are essential to the coordinated and safe operation of the vehicle in traffic situations. This includes ignition/starter switch, gear selector, parking brake, turn indicator lever, hazard flasher, horn, wiper/washer, defroster control, mirror, and headlight dimmer. All sections of this document, except 5.4, apply to Group B primary controls.

1.3.2 SECONDARY CONTROLS—Those controls not related to vehicle movement, operable by the driver or passenger, that regulate the environment of the vehicle, including heater/air conditioner, window regulator, vent, sun visor, seat positioner, radio, door lock, cigarette lighter, courtesy light, and any controls associated with wheelchair lifts, door openers, wheel chair restraints, etc. This document is not intended to be used for accessory controls, but many of the design and operating principles are applicable.

1.4 Vehicle Type—The vehicle on which adaptive controls will be installed is usually a sedan, light truck, or van-type vehicle, chosen because of spatial and functional criteria covered by other SAE Recommended Practices. In most cases, the vehicle will be equipped with such OEM options as power steering, power brakes, and automatic transmission. Other useful options can include power seat, power windows, power door locks, tilt steering wheel, remote control mirrors, and automatic speed control.

1.5 Purpose—The purpose of this document is to provide criteria and methods to evaluate control system design, installation, operation, maintenance, and performance.

1.5.1 UTILIZATION—This document may be used as a basis for product evaluation conducted by private and governmental officials engaged in the provision of such equipment for eligible beneficiaries, as well as by manufacturers of the subject equipment.

1.5.2 CONDITIONS—This document is concerned with the proper performance and reliability of the product.

2. References

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

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

SAE TSB 002—Preparation of SAE Technical Reports

2.1.2 ASTM PUBLICATION—Available from the ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM B 117-1973—Method of Salt Spray (Fog) Testing

2.1.3 AWS PUBLICATIONS—American Welding Society, 2501 Northwest 7th Street, Miami, FL 33125.

AWS D1.1-72—Structural Welding Code

AWS D10.7-60—Recommended Practice for Gas-Shielded Arc Welding of Aluminum and Aluminum Alloy Pipe

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2.1.4 U.S. FEDERAL MOTOR VEHICLE SAFETY STANDARDS—Promulgated by the National Highway Traffic Safety Administration (NHTSA), U.S. Department of Transportation, 400 7th Street, S.W., Washington, DC 20590. Available in the Code of Federal Regulations (CFR), Title 49, Part 571. Available from the Superintendent of Documents, Government Printing Office, Washington, DC 20402. Telephone (202) 512-1800.

FMVSS No. 107—Reflecting Surfaces

FMVSS No. 302—Flammability of Interior Materials

2.2 Related Publications—The following publications are provided for information purposes only and are not a required part of this document.

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

SAE J58—Flanged 12-Point Screws

SAE J78—Steel Self-Drilling Tapping Screws

SAE J81—Thread Rolling Screws

SAE J82—Mechanical and Quality Requirements for Machine Screws

SAE J174—Torque Tension Test Procedure for Steel Threaded Fasteners

SAE J349—Detection of Surface Imperfections in Ferrous Rods, Bars, Tubes, and Wires

SAE J401—Selection and Use of Steels

SAE J413—Mechanical Properties of Heat Treated Wrought Steels

SAE J429—Mechanical and Material Requirements for Externally Threaded Fasteners

SAE J430—Mechanical and Chemical Requirements for Nonthreaded Fasteners

SAE J474—Electroplating and Related Finishes

SAE J482—Hexagon High Nuts

SAE J492—Rivets and Riveting

SAE J514—Hydraulic Tube Fittings

SAE J515—Hydraulic O-Ring

SAE J516—Hydraulic Hose Fittings

SAE J517—Hydraulic Hose

SAE J554—Electric Fuses (Cartridge Type)

SAE J561—Electrical Terminals—Eyelet and Spade Type

SAE J562—Nonmetallic Loom

SAE J589—Turn Signal Switch

SAE J773—Conical Spring Washers

SAE J836—(Automotive) Metallurgical Joining

SAE J843—Brake System Road Test Code—Passenger Car and Light-Duty Truck

SAE J858—Electrical Terminals—Blade Type

SAE J891—Spring Nuts

SAE J892—Push-On Spring Nuts

SAE J924—Thrust Washers—Design and Application

SAE J928—Electrical Terminals—Pin and Receptacle Type

SAE J933—Mechanical and Quality Requirements for Tapping Screws

SAE J962—Formed Tube Ends for Hose Connections

SAE J995—Mechanical and Material Requirements for Steel Nuts

SAE J1199—Mechanical and Material Requirements for Metric Externally Threaded Steel Fasteners

SAE J1200—Blind Rivets—Break Mandrel Type

SAE J1231—Beaded Tube Hose Fittings

SAE J1273—Selection, Installation, and Maintenance of Hose and Hose Assemblies

SAE J1508—Worm Gear Hose Clamps

2.2.2 ANSI PUBLICATIONS—Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

- ANSI B18.2.1—Square and Hex Bolts and Screws (Inch Series)
- ANSI B18.2.2—Square and Hex Nuts (Inch Series)
- ANSI B18.6.1—Wood Screws (Inch Series)
- ANSI B18.6.2—Slotted Head Cap Screws, Square Head Set Screws, and Slotted Headless Set
- ANSI B18.6.3—Slotted and Recessed Head Machine Screws and Machine Screw Nuts
- ANSI B18.21.1—Lock Washers
- ANSI B18.22.1—Plain Washers

2.2.3 U.S. FEDERAL MOTOR VEHICLE SAFETY STANDARDS—Promulgated by the National Highway Traffic Safety Administration (NHTSA), U.S. Department of Transportation, 400 7th Street, S.W., Washington, DC 20590. Available in the Code of Federal Regulations (CFR), Title 49, Part 571. Available from the Superintendent of Documents, Government Printing Office, Washington, DC 20402. Telephone (202) 512-1800.

- FMVSS No. 101—Controls and Displays
- FMVSS No. 105—Hydraulic Brake Systems
- FMVSS No. 124—Accelerator Control Systems
- FMVSS No. 201—Occupant Protection in Interior Impact
- FMVSS No. 203—Impact Protection for the Driver from the Steering Control System
- FMVSS No. 204—Steering Control Rearward Displacement
- FMVSS No. 208—Occupant Crash Protection

3. Definitions

- 3.1 **ANSI**—An abbreviation for American National Standards Institute.
- 3.2 **Automotive Adaptive Product**—A piece of equipment designed to enable a person with a physical disability to operate an automotive vehicle.
- 3.3 **ASTM**—An abbreviation for American Society of Testing and Materials.
- 3.4 **AWS**—An abbreviation for American Welding Society.
- 3.5 **Common Hand Tool**—Hand-held devices, available for purchase in consumer stores, that are used to perform common mechanical and electrical repairs.
- 3.6 **Control Handle**—The point of contact on the adaptive product where input motions of the operator are applied.
- 3.7 **Driver's Space**—The volume inside the vehicle occupied by the vehicle operator and containing all primary and accessory controls.
- 3.8 **FMVSS**—An abbreviation for U.S. Federal Motor Vehicle Safety Standard (Code of Federal Regulations Part 571 or Canadian equivalent).
- 3.9 **Inertial Movement**—A change of position of the vehicle operator that results from an acceleration or deceleration of the vehicle.
- 3.10 **Nondisabled Driver**—The able-bodied driver for whom the vehicle was designed.
- 3.11 **Nonparticipating Body Parts**—Those paralyzed or otherwise limited parts of the disabled driver's body that are being compensated by the adaptive product.

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- 3.12 Occupant Space**—The volume inside the vehicle that is made available for the occupancy and comfort of the driver and any passengers. Includes driver space and passenger space.
- 3.13 OEM**—An abbreviation for Original Equipment Manufacturer. This refers to the vehicle and its systems as they are designed and produced by the automobile manufacturer.
- 3.14 Passenger Space**—The volume inside the vehicle that is made available for passenger occupancy and comfort.
- 3.15 Physical Disability**—The absence or reduction of a neuromuscular or orthopedic function of the human body as a result of disease or trauma.
- 3.16 Power(ed)**—Those systems which are operated by means of an energy source other than muscle power.
- 3.17 Power Assisted**—Those systems which are operated by means of an energy source in addition to muscle power and which remain operable when the assist is lost.
- 3.18 Range of Motion**—An imaginary volume of space whose outer shape is described by the limits of movement of a person or a movable portion of that person's body.
- 3.19 Shall**—A term used to denote “mandatory.” (SAE TSB 002 JUN92)
- 3.20 Should**—A term used to denote “advisory.” (SAE TSB 002 JUN92)
- 3.21 Uniaxial Motion**—Movement along a straight line in either or both of two opposite directions.
- 3.22 Unidirectional**—Revolving, functioning, moving, or responsive in a single direction.
- 3.23 Visible Deformation**—A change in alignment, position, or shape that is apparent to a careful observer.
- 4. Requirements**—The following criteria are considered essential for all primary control devices which attach to or substitute for the OEM control:
- 4.1 Documentation**
- 4.1.1 IDENTIFICATION**—Each control assembly, or component available for sale as a separate unit, shall bear a model number, a serial number, and the name and address of the manufacturer. The identification may be engraved directly onto a permanent structural member or placed on permanently affixed tag. The identification shall remain visible when the product has been installed in the vehicle.
- 4.1.2 QUALITY CONTROL**—The manufacturer shall employ a quality control procedure sufficient to assure a product-to-product consistency in quality of purchased components, manufactured parts, and assemblies. Evidence of quality inspection, in the form of a seal, inspection stamp, tag, or other legible identification, shall be included with every product sold. The quality control plan shall be available upon request.
- 4.1.3 WARRANTY**—The manufacturer shall provide a written statement of warranty with each product. The warranty shall state clearly the duration of the warranty period and the terms of the agreement that relate to repair, replacement, or refund of purchase price.
- 4.1.4 COMPLIANCE**—All claims of product approval by private or governmental agencies shall be specific as to the approving agency and testing protocol. Such claims shall be documentable upon request.

- 4.1.5 **INSTALLATION INSTRUCTIONS**—The manufacturer shall specify the appropriate method of installing the product and adjusting it for use. The manufacturer shall specify, when advertising or otherwise promoting the product, whether it can be installed by the purchaser or must be installed by a trained agent of the manufacturer. The product shall be accompanied, at the time of shipment from the manufacturer, by instructions written in a language suitable for the level of technical skill required for a reliable installation. The installation instructions shall include information specific to the make, year, and type of vehicle for which it was designed.
- 4.1.6 **OPERATING INSTRUCTIONS**—The manufacturer shall provide the purchaser a manual of instructions, supplemented by drawings and photographs as necessary, describing the proper use and operation of the product. The instructions shall address at least the following:
- a. General operating principles
 - b. Control movement and resulting vehicle response
 - c. User actions to be avoided and consequences
 - d. Signs of possible malfunctions
 - e. Actions to be taken in the event of product failure
 - f. Functional capabilities required of the intended user.
- 4.1.7 **MAINTENANCE PROCEDURES**—The manufacturer shall provide to the purchaser written instructions for proper maintenance of the product. They shall be included with the operating instructions. The instructions shall include at least the following:
- a. Lubrication points, lubricant type, and frequency of service
 - b. Adjustment, calibration, alignment, and measurement of wear
 - c. Tools needed for maintenance
 - d. Parts' lists and correlated assembly diagrams
 - e. Electrical and hydraulic diagrams
 - f. Name, address, and telephone number of manufacturer

4.2 Installation

- 4.2.1 **VEHICLE ALTERATIONS**—The installation of the product shall not require alterations to the motor vehicle as delivered by the OEM which diminish its structural integrity.
- 4.2.2 **OCCUPANT PROTECTION**—Positioning of the product shall assure the greatest possible retention of occupant protection features provided by the OEM, such as collapsible steering column assembly and knee bolsters. It is preferable to modify the knee bolster rather than remove it.
- 4.2.3 **FASTENERS**—All mechanical fasteners for installation shall conform in type, strength, vibration, and corrosion resistance to the SAE fastener standard that applies to the vehicle component to which the adaptive device is attached.
- 4.2.4 **CONNECTIONS**—All electrical and fluid connections to the vehicle shall conform in type, capacity, and material to the SAE Standard that applies to the vehicle electrical component to which the adaptive device is attached.
- 4.2.5 **HARDWARE**—All fasteners, terminals, couplings, lubricants, and materials required for installation shall be provided with the product at the time of shipment. A listing of all parts and components shall be included in the installation instructions.
- 4.2.6 **ADJUSTMENTS**—Adjustment of any component of the product to the intended user shall be clearly described in the installation instructions.

4.2.7 CONVENTIONAL USE—Installation of the product to the vehicle shall permit unimpeded use of the OEM vehicle controls by an able-bodied driver.

4.3 Design

4.3.1 STRUCTURAL MATERIALS—Materials used for fabrication of load-bearing components of the product shall be selected for application and manufactured according to standard engineering practice. All structural members of primary controls shall be designed to a factor of safety of at least 1.5 times the expected maximum operating load.

4.3.2 MOUNTING—The product shall be designed to mount to the vehicle at a location that will reliably bear the service load and employ a means of attachment that will remain stable during the expected service life of the product.

4.3.3 HUMAN FACTORS—The primary control design shall incorporate provisions for the following factors relating to drivers with disabilities:

- a. Throttle and brake activations require distinctly different directions of operator input movement
- b. Forward inertial movement of the operator cannot activate the throttle
- c. Passive inertial movement of nonparticipating body parts cannot impede the operation of the controls
- d. Location of the controls cannot impede the transfer of the operator to and from the driver's station

4.3.4 USE BY ABLE-BODIED DRIVERS—The product shall be designed to assure the unimpeded use of the vehicle by drivers who are not disabled.

4.3.5 NEUTRAL BALANCE—The product shall be designed such that its static mass cannot exert sufficient force to cause movement of the vehicle control to which it is attached.

4.3.6 CONTACT HAZARDS—The product shall be designed to assure that the operator is not exposed to:

- a. Specular glare from a product component in the field of view while driving
- b. Electrical shock or burn
- c. Sharp edges, pinch points, or rough surfaces
- d. Surfaces which may acquire injurious extremes of temperature
- e. Components which become dirty or greasy in routine service

4.3.7 MAINTAINABILITY—The product shall be designed to assure ease of access to parts needing replacement, lubrication, or adjustment after installation. Any component designed for adjustment shall include a means for being securely locked in the adjusted position. Service maintenance shall be described in the maintenance instructions and be performed without disassembly using common hand tools.

4.3.8 FLAMMABILITY—Any nonmetallic materials used in the product shall be as resistant to burning as the OEM materials used in the occupant space, according to FMVSS 302.

4.3.9 EFFECT ON PERFORMANCE—The product shall be designed to assure that the location and positioning of the adaptive product shall not degrade the quality, handling characteristics, visibility, reliability, and efficiency of operation of the motor vehicle. The overall weight of the adaptive product and distribution of that weight during all stages of operation shall not degrade the normal function or performance quality and shall be within the designed carrying capacity of the motor vehicle.

4.4 Selection of Components—The components of the adaptive product shall not degrade the quality nor interfere with the function of the existing product.

4.4.1 ELECTRICAL—All wiring, switches, and electrical connections shall conform to SAE Standards and Recommended Practices that apply to the vehicle component to which they are attached.

4.4.2 FASTENERS—All fasteners shall conform to SAE Standards and Recommended Practices that apply to the vehicle component to which they are attached and shall be designed or treated for resistance to loosening due to vibration.

4.4.3 COMPATIBILITY—Any stock hardware or electrical components shall be equal or equivalent in size and type to those used on surrounding OEM applications in the vehicle. Materials, component parts, finishes, and service principles used on the adaptive product should be consistent with those used by the OEM.

4.5 Manufacturing Quality

4.5.1 FINISHING OF FABRICATED PARTS—The manufacturer shall remove all sharp-edge and jagged projections which might cause injury to the user and/or damage to clothing.

4.5.2 SURFACE FINISH—The manufacturer shall prepare all ferrous metal components to resist corrosion. Parts that are in a position to reflect sunlight or glare shall comply with FMVSS 107.

4.5.3 WELDMENTS—The manufacturer shall assure that all welding which has been used to join metal components of the products conforms, as applicable, to American Welding Society Codes D.1.1072 (steel) or D10.7-60 (aluminum).

4.5.4 PACKAGING—The manufacturer shall provide packaging for shipment to the purchaser or installer that will assure the protection of the product, and its associated documentation, against shipping hazards, including vibration, impact, and moisture.

4.6 Performance Requirements

4.6.1 OPERATION AND PERFORMANCE—The adaptive control product or system, when installed and maintained according to the manufacturer's instructions, shall perform its intended function under all conditions of service, including:

- a. Vibratory, electrical, and chemical environments of the vehicle interior
- b. Long-term repetition of operating cycles
- c. Occasional overloads due to common driving occurrences

An automotive vehicle is expected to perform reliably, with regular maintenance, for 100 000 miles or 10 years of moderate use. The driver controls are an integral part of the vehicle and are expected to remain functional throughout the vehicle service life. Adaptive controls shall perform as long and reliably as the OEM components of the vehicle to which they are originally attached.

1. In routine use, the vehicle interior, where the controls are installed, will be subjected to temperature extremes, dirt, moisture, and vibration derived from the engine and the chassis' response to road conditions. This may cause components to become loosened, fatigued, or corroded.
2. Occasionally, the controls will be subjected to momentary overloads induced by the driver (panic stops, sudden hard acceleration, sudden changes of direction, loss of power assist), and by the vehicle transmitted back to the controls (curb impacts, road irregularities, and blowouts). The product shall be expected to withstand such events with no resulting degradation of strength or performance.

- 4.6.2 VIBRATION ENVIRONMENT—The product, as installed according to the manufacturer's instructions, shall continue to perform its intended function, without loosening of fasteners or adjustable components, and without loss of electrical function when subjected to the vibration test in 5.4.1.
- 4.6.3 ELECTROMECHANICAL ENVIRONMENT—When subjected to the environmental test in 5.4.2, the product shall continue to function without exhibiting degradation or loss of surface finish, mechanical resistance of moving parts, loosening of mechanical fasteners, and corrosion or dysfunction of electrical component parts.
- 4.6.4 HIGH-CYCLE DEGRADATION—After 250 000 cycles of high cycle test (5.4.3), the product shall continue to perform its intended function without signs of component deformation, mechanical loosening, wear, and loss of dimensional tolerance beyond the limits of adjustments which are prescribed in the operating instructions by the manufacturer.
- 4.6.5 SERVICE OVERLOAD—The product shall survive the service overload test described in 5.4.4. There shall be no visible deformation of the device or its mount after removal of the test load.

5. Inspection And Testing Procedures

5.1 Receiving Inspection

- 5.1.1 PACKAGING INTEGRITY—Examine the product as shipped to determine that damage has not been caused to the package contents during shipping. Look for damage incurred by materials handling equipment, indirect forces such as dropping or vibration, and exposure to weather.
- 5.1.2 PACKING DOCUMENTATION—Examine the shipping documents to determine that the product is identified by model and serial number, and manufacturer.
- 5.1.3 VERIFICATION OF CONTENTS—Open the shipping package and determine that the items contained in the package include:
- The product, identified by model number, serial number, and manufacturer's name and address, and specification of the vehicle for which it was designed
 - Quality control verification
 - Warranty information
 - Compliance documentation as required
 - Installation instruction
 - Operating instructions
 - Maintenance instructions
 - Limitations
 - Notification
- 5.1.4 WORKMANSHIP—Examine the product as received for a general, subjective impression of manufacturing quality. Look for flawed parts, presence of oil, dirt, filings, or other fabrication or warehousing by products. Note any marring of surface finish, corrosion of parts, or component deformation that might affect the results of later examination and testing.
- 5.2 Mounting—This procedure is provided to enable the inspector to assess the compliance with standards relating to installation and maintenance instructions, human factors, and quality of components. The product shall, for these purposes, be installed in a vehicle, a driver-training simulator, or onto a static mock-up of unique design. It will be necessary to have access to the specified vehicle, at least for comparison of materials and components.

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- 5.2.1 VERIFICATION OF INSTALLATION PROCEDURES—Install the product, according to the supplied instructions, using only the hardware supplied in the shipping package. Determine that the instructions are complete and sufficient and that all necessary mounting hardware has been provided (see 4.1.5).
- 5.2.2 ADJUSTMENTS—Perform any adjustments to the control that are specified by the installation instructions. Determine that the adjustable components can be securely locked in the chosen position (see 4.2.6 and 4.3.7).
- 5.2.3 COMPATIBILITY—Compare fasteners, materials, and electrical components to the intended vehicle to determine that they are of comparable size, type, and quality to the OEM parts (see 4.2.3 and 4.2.4).
- 5.2.4 HUMAN FACTORS—Observe the control movements to determine that throttle and brake movements are distinctly different and that forward inertial movement of the operator cannot activate the throttle (see 4.3.3).
- 5.2.5 CONTACT HAZARDS—Examine the product to determine that the operator is not exposed to electrical, mechanical, and thermal hazards and cannot contact dirty or greasy surfaces. In addition, determine that the operator is not exposed to glare in the field of view while driving (see 4.3.6).
- 5.2.6 MAINTAINABILITY—Perform the procedure specified by the maintenance instructions to determine that the service points are accessible (see 4.3.7).
- 5.3 Installation**—This procedure is provided to enable the inspector to determine compatibility with the vehicle and factors related to the driver's space. It can be done only in the intended vehicle or an accurate dynamic simulation of the intended vehicle. All of the procedures in 5.2 can be performed on this installation, if preferred.
- 5.3.1 VEHICLE ALTERATIONS—Examine the completed installation to determine that the vehicle's structural integrity occupant protection features and performances have remained intact (see 4.2.1).
- 5.3.2 OPERATION—Perform all the control operations described in the operating instructions. Determine that the document is complete and sufficient (see 4.1.6).
- 5.3.3 CONVENTIONAL USE—Determine that the OEM controls remain functional and accessible to an able-bodied driver (see 4.2.7).
- 5.3.4 MOUNTING—Determine that the attachment to the vehicle is secure and strong (see 4.3.2).
- 5.3.5 NEUTRAL BALANCE—Determine that the product does not activate the vehicle control by the force of its own mass. Observation shall be made while the engine is running and power-assist fluids are at operating temperature (see 4.3.5).
- 5.4 Performance Tests**—The procedures are intended to determine the structural integrity and reliable service life of the product. The following laboratory test methods are designed to accelerate the rate of product use in order to provide test results in a shorter period of time that could be obtained from on-the-road vehicle testing.

The following tests shall be performed on a single unit in the listed sequence:

- a. 5.4.1 Vibration
- b. 5.4.2 Environmental
- c. 5.4.3 High cycle test
- d. 5.4.4 Service overload

NOTE—In the test sequence, before proceeding to the next test, the product may be adjusted and serviced according to any procedures in the operating instructions. No other improvement of the product will be allowed.

- 5.4.1 VIBRATION TEST—The control assembly, mounted on a suitable rigid frame, shall be attached to a laboratory shaker of sufficient capacity. The control handle may be partially dampened to simulate the presence of the operator's hand in service. The assembled product shall be subjected to two episodes of uniaxial vibratory motion. Each episode shall be of a 2 h duration. One shall be directed lateral to the longitudinal axis of the vehicle and the other in a vertical direction. The exciting force shall be applied at a frequency of 30 Hz at a displacement of ± 1.27 mm. Inspect all fasteners and electrical components to see that they remain functional at the completion of the test, even if they have become loosened. The test shall be terminated if any component part becomes disconnected .

NOTE—Before proceeding to the next test, the product may be adjusted and serviced according to any procedures in the operating instructions. No other improvement of the condition of the product will be allowed.

- 5.4.2 ELECTROMECHANICAL ENVIRONMENTAL TEST—The control assembly, mounted in a suitable test fixture designed to hold it in an attitude simulating its normal use position, shall be subjected to a saltwater fog test, in accordance with ASTM B 117, for a period of 50 h (consisting of 2 periods of 24 h exposure each followed by 1 h of drying). After exposure, the product shall continue to operate mechanically and electrically throughout the remainder of the test sequence and shall not present any corrosion products to surfaces that can be contacted by the driver (see 4.6.3).
- 5.4.3 HIGH-CYCLE TEST—The control assembly shall be mounted into a suitable cyclic loading machine (Instron or equivalent) in such a manner that its intended operating movements, linear or torsional, or both, can be performed by the test machine. If the leverage of the control assembly can be adjusted, adjustments shall be made so that maximum forces are transmitted by the control assembly for the applied forces specified as follows. If possible, all combined functions (for example, throttle and brake) shall be loaded in one contiguous test series, alternating from one function to the other. The test load shall be applied through an appropriate fixture to the control handle in the direction of application specified in the operating instructions. A braking force of 222.4 N (50 lb) and an accelerator force of 44.5 N (10 lb) shall be applied repeatedly 250 000 times each (alternating accelerator and brake, if combined on the same control assembly). These forces must be measured at the appropriate control handle. Steering device loads shall be 35.6 N (8 lb) and shall alternate from left to right rotation at the same rate. The loading rate shall be adjusted to simulate a normal actuation, with a cyclic period not to exceed 1 s between actuations. The cyclic test shall be interrupted at intervals of 50 000 cycles to inspect for deformation or breakage and to perform routine service according to the operating instructions. No other improvement of product condition will be allowed. The test shall be terminated in the event of component breakage (see 4.6.4).
- 5.4.4 SERVICE OVERLOAD—The control assembly shall remain mounted in the cyclic loading machine, if the machine has the capability for sustained loading. If the leverage of the control assembly can be adjusted, adjustments shall be made so that maximum forces are transmitted by the control assembly for the applied forces specified. A static unidirectional load of 667 N (150 lb) shall be applied to the handle of the brake lever, in the direction of application described in the operating instructions, for a period of 30 s. A similar load of 133 N (30 lb) shall be applied to the throttle control for a period of 30 s. A 107 N (24 lb) load shall be applied to the steering device for a period of 30 s. Conduct a visual inspection for signs of deformation and breakage (see 4.6.5).