SAE International

SURFACE VEHICLE RECOMMENDED PRACTICE

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Secondary Control Modifications

RATIONALE

This document is being revised to update its content to applicable current industry technology and control systems.

TABLE OF CONTENTS

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1. SCOPE

This SAE Recommended Practice establishes a uniform procedure for assuring the manufactured quality, installed utility and performance of automotive products to the relocation, alteration, replacement and/or extension of secondary controls and systems other than those provided by the vehicle manufacturer (OEM). These products are intended to provide driving capability to persons with physical disabilities. These products function as adaptive modifications to compensate for lost or reduced function in the extremities of the driver. These include, but are not limited to the following:

Cruise Control; Door Locks; Gear Selector; Hazard Flasher; Headlight Beam Selector; Heater/Vent/Air Conditioner (HVAC); Horn; Ignition/Starter; Light controls; Mirrors; Parking Brake; Power Seats; Turn Signals; Power Window Controls; and Windshield Wiper/Washer and defogger; Rear Accessories (Defogger, Wiper/Washer).

The purpose of any secondary control adaptation is to provide the effective use of the motor vehicle operating systems to a driver with a disability, so that he or she may drive and operate that motor vehicle with the same degree of safety as a non-disabled driver. Thus, the adaptive equipment must be (1) accessible to the driver with a disability for whom it is designed, (2) not susceptible to inadvertent operation which may be inconvenient or dangerous for the driver and other users of the roadway, and (3) suitable by non-disabled drivers who may have a need to operate the motor vehicle whenever possible.

For purpose of this document, the secondary controls listed previously have been classified according to the following protocols. The categorization of these controls, while different from other SAE publications, is reflective of the manner in which driver rehabilitation specialists determine appropriate vehicle modifications. These categories are arranged to assign priorities that allow the user to operate a vehicle in the most efficient manner possible.

Mode A - These controls shall be operable by the driver while the vehicle is in operating mode. They must be accessible to the driver for which they were intended while being able to maintain control of the vehicle steering, brake and accelerator functions. Included in this group are: Cruise control “Set;” Headlight Beam Selector; Horn; Turn Signals; and, Windshield Washer/Momentary Wipe.

Mode B - These controls shall be operable by the driver while maintaining control of the vehicle brake function with the vehicle not in motion, as in the case of vehicle start-up or re-start necessitated by engine stall. Included in this group are: Gear Selector and Ignition/Starter.

Mode C - These controls shall be at least operable by the driver when the vehicle is stationary, either temporarily or parked. Included in this group are: Cruise control “On” and “Off;” Door Locks; Hazard Flashers; Heater/Vent/Air Conditioner (HVAC); Light Controls; Mirrors; Parking Brake; Power Seats; Windshield Wiper; and Power Window Controls; Rear Accessories (Defogger, Wiper/Washer).

1.1 Inclusions

This document is applicable to mechanical and electrical products intended by the manufacturer to meet the following criteria.

1.1.1 Operated by a vehicle driver with a physical disability.

1.1.2 Provides an alternate location for the controls used for the OEM vehicle secondary control systems

1.1.3 Use of the device, brings about the operation of the OEM secondary controls

1.2 Exclusions

This document is not applicable to any automotive adaptive product which:

1.2.1 Do not connect with OEM secondary controls

1.2.2 Change the intended operation of the OEM secondary controls

1.2.3 Operates any primary control

1.2.4 Is intended as a special control for driver evaluation, training or research.

1.3 Purpose

The purpose of this document is to provide criteria and methods to evaluate the design, installation, operation, maintenance, and performance of Secondary Control System adaptations.

1.4 Applications

This document is intended for use in product design and evaluation by the manufacturers of the equipment referenced in this document.

1.5 Conditions

This document is concerned with the performance, safety, and reliability of the products referenced.

2. REFERENCES

2.1 Applicable Documents

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 Publications

Available from SAE International, 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 J553 Circuit Breakers

SAE J561 Electrical Terminals—Eyelet and Space Type

SAE J773 Conical Spring Washers

SAE J858 Electrical Terminals Blade Type

SAE J928 Electrical Terminals—Pin and Receptacle Type

SAE J1113-1 Electromagnetic Compatibility Measurement Procedures and Limits for Components of Vehicles, Boats (up to 15 m), and Machines (Except Aircraft) (16.6 Hz to 18 GHz)

SAE J1138 Design Criteria—Driver Hand Controls Location for Passenger Cars, Multipurpose Passenger Vehicles, and Trucks (10 000 GVW and Under)

SAE J1139 Direction-Of-Motion Stereotypes for Automotive Hand Controls

SAE J1211 Recommended Environmental Practices for Electronic Equipment Design

SAE J1213-2 Glossary of Reliability Terminology Associated with Automotive Electronics. SAE J1292

SAE J1292 Automobile, Truck, Truck-Tractor, Trailer, and Motor Coach Wiring

SAE J1292 Automobile and Motor Coach Wiring

SAE J1477 Measurement of Interior Sound Levels of Light Vehicles

2.1.2 National Highway Traffic Safety Administration Publications

Available from NHTSA, U.S. Department of Transportation, 1200 New Jersey Avenue S.E., West Building, Washington, DC 20590: Federal Motor Vehicle Safety Standards (FMVSS), Title 49, Part 571, www.nhtsa.dot.gov/cars/rules.

FMVSS 101 Passenger Cars

FMVSS 102 Transmission Shift Lever Sequence, Starter Interlock, and Transmission Braking Effect-Passenger Cars, Multipurpose Passenger Vehicles, Trucks, and Buses

FMVSS 103 Windshield Defrosting and Defogging Systems-Passenger Cars, Multipurpose Passenger Vehicles, Trucks, and Buses

FMVSS 104 Windshield Wiping and Washing Systems-Passenger Cars

FMVSS 105 Hydraulic Brake Systems-Passenger Cars, School Buses and other buses, Trucks and Multipurpose Passenger Vehicles

FMVSS 107 Reflecting Surfaces

FMVSS 108 Lamps, Reflective Devices, and Associated Equipment-Passenger Cars, Multipurpose Passenger Vehicles, Trucks, Buses, and Motorcycles

FMVSS 118 Power-Operated Window Systems-Passenger Cars and Multipurpose Passenger Vehicles, Trucks

FMVSS 201 Occupant Protection In Interior Impact—Passenger Cars, Multipurpose Passenger Vehicles, Trucks, and Buses

FMVSS 208 Occupant Crash Protection

FMVSS 302 Flammability of Interior Materials-Passenger Cars, Multipurpose Passenger Vehicles, Trucks, and Buses

2.1.3 U.S. Military Standard

Available from the Document Automation and Production Service (DAPS), Building 4D, 700 Robins Avenue, Philadelphia, PA 19111-5094.

MIL-STD-1472F Design Criteria Standard, Human Engineering

2.2 Related Publications

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

2.2.1 SAE Publications

Available from SAE International, 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 J112a Electric Windshield Wiper Switch

SAE J163 Low Tension Wiring and Cable Terminals and Splice Clips

SAE J195 Automatic Vehicle Speed Control - Motor Vehicles

SAE J234 Electric Windshield Washer Switch

SAE J235 Electric Blower Motor Switch

SAE J249 Mechanical Stop Lamp Switch

SAE J253 Headlamp Switch

SAE J259 Ignition Switch

SAE J287 Driver Hand Control Reach

SAE J564 Headlamp Beam Switching

SAE J589b Turn Signal Switch

SAE J771 Automotive Printed Circuits

SAE J910 Hazard Warning Signal Switch

SAE J915 Automatic Transmissions - Manual Control Sequence

SAE J1138 Design Criteria - Driver Hand Controls Location for Passenger Cars, Multipurpose Passenger Vehicles, and Trucks (10 000 GVW and Under)

SAE J1338 Open Field Whole - Vehicle Radiated Susceptibility 10 kHz - 18 GHz, Electric Field

SAE J2068 Combination Turn Signal Hazard Warning Signal Flashers

SAE J2094 Vehicle and Control Modifications for Drivers with Physical Disabilities Terminology

SAE J2119 Manual Controls for Mature Drivers

SAE J2217 Photometric Guidelines for Instrument Panel Displays that Accommodate Older Drivers

SAE J2223-1 Connections for On-Board Road Vehicle Electrical Wiring Harnesses - Part 1: Single-Pole Connectors - Flat Blade Terminals - Dimensional Characteristics and Specific Requirements

2.2.2 International Electrical Commission (IEC) Standards

Available from American National Standards Institute, Customer Service, 25 West 43rd Street, New York, NY 10036-8002.

IEC 801-3 Electromagnetic Compatibility for Industrial—Process Measurement and Control Equipment, Part 3: Radiated Electromagnetic Field Requirements, 1984

3. DEFINITIONS

The Definitions in this section are specific to this document. Definitions for many terms used in this document are provided in SAE J2049.

3.1 ATTACHMENTS

A mechanical addition to an existing OEM control to facilitate its operation by a disabled driver.

3.2 COMMON HAND TOOL

Hand-held device, available for purchase in consumer stores, that is used to perform common mechanical and electrical repairs.

3.3 CONTROL BOX

The control box is the component of the secondary control system which can be mounted in the driver's space or remotely and in which the switch processing hardware is located.

3.4 CONTROL HANDLE

The point of contact on the adaptive product where input motions of the operator are applied.

3.5 DRIVER'S SPACE

The volume inside the vehicle occupied by the vehicle operator and containing all primary and secondary controls.

3.6 ELECTROMAGNETIC INTERFERENCE (EMI)

A condition in which sources of electromagnetic activity interfere with the function of equipment, subsystems, and systems. Also the condition in which such equipment, subsystems, and systems interfere with or produce unwanted electromagnetic activity, or in which different sources of electromagnetic activity interact with one another with consequent degradation of performance.

3.7 EMERGENCY BACKUP

A device which can be used as a substitute for a primary system in the event of a failure of the primary system. While serving the same purpose, its design and performance may be different from that of the primary system.

3.8 EXTENSION

A mechanical addition to an existing OEM control which provides extra mechanical advantage to facilitate its operation by a disabled driver

3.9 FINAL MANUFACTURER

The company that is responsible for the design, final assembly and sale of the product to installers or consumers.

3.10 MANUFACTURER

The word manufacturer as used in this document, when not specifically being used otherwise, refers to the manufacturer of the Secondary Control System.

3.11 NON-DISABLED DRIVER

The driver for whom the vehicle was originally designed by its OEM.

3.12 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.

3.13 PHYSICAL DISABILITY

The absence or reduction of a neuromuscular or orthopedic function of the human body.

3.14 PRIMARY BACKUP SYSTEM

A device which can be used as a substitute for a primary system in the event of a failure of the primary system. It operates parallel (redundant) to the primary operating system and while its design could be significantly different, its performance is the same as the primary system.

3.15 PRIMARY OR SECONDARY CONTROLS

Controls are grouped based on the potential consequences of product failure. The groups are listed below in order of importance.

3.15.1 PRIMARY CONTROLS

Those controls, operated by the driver, which directly affect the direction and rate of the moving vehicle, including the steering, brake and accelerator controls.

3.15.2 SECONDARY CONTROLS

3.15.2.1 MODE A

Those controls which are operated by the driver while the vehicle is in operating mode. They must be accessible to the driver for which they were intended while being able to maintain control of the vehicle steering, brake and accelerator functions. Included in this group are: Cruise control “Set;” Headlight Beam Selector; Horn; Turn Signals; and, Windshield Washer/Momentary Wipe.

3.15.2.2 MODE B

Those controls operable by the driver while maintaining control of the vehicle brake function with the vehicle not in motion, as in the case of vehicle start-up or re-start necessitated by engine stall. Included in this group are: Gear Selector and Ignition/Starter.

3.15.2.3 MODE C

Those controls which are accessible by the driver when the vehicle is stationary, either temporarily or parked. Included in this group are: Cruise control “On” and “Off;” Door Locks; Hazard Flashers; Heater, Vent and Air Conditioner (HVAC) Controls; Mirrors; Parking Brake; Power seat; Rear Accessories (Defogger, Wiper/Washer); Windshield Wipers, and, Window Regulator.

3.16 PRODUCT LITERATURE

Information about a manufacturer’s product which, while it may or may not be distributed for advertising purposes, is available to consumers upon request.

3.17 RANGE OF MOTION

An imaginary volume of space whose outer shape and dimensions are described by the limits of movement of a person or a movable portion of that person's body.

3.18 REDUNDANCY

The existence of more than one means of accomplishing a given function.

3.19 RESPONSE TIME

The elapsed time between initiation of a step input on the control handle until the time when the output reaches 63% of the output associated with the selected level of steady-state input.

3.20 SERVO

A power device used to provide control of a desired operation through the use of feedback.

3.21 SHALL

Implies compliance is required; deviation is not permitted.

3.22 SHOULD

Implies compliance is recommended; deviation is permitted.

3.23 SINGLE POINT FAILURE

Any failure of a component which directly causes the system of which that component is a part, to cease function

3.24 STEP INPUT

An input into a control system in which the entire input is made at one time, rather than as a gradual increase or an increase following a specific other wave form.

3.25 UNIDIRECTIONAL

Revolving, functioning, moving, or responsive in a single direction.

3.26 VISIBLE DEFORMATION

A change in alignment, position, or shape that is apparent to a careful observer.

4. TECHNICAL REQUIREMENTS

4.1 General Design Requirements

4.1.1 A primary design consideration for secondary control system modifications shall be the driving safety of the end user and protection of the general population.

4.1.2 Design of automotive adaptive equipment shall be consistent with accepted engineering principles and with automotive design practice with regard to materials, structures, lubricants, and maintainability. Where applicable, materials shall be in compliance with FMVSS 302.

4.1.3 Any electrical or electronic component or enclosure of an secondary control system modification shall be designed, assembled, and connected in a manner suitable for the automotive operational environment: temperature extremes, flammability, vibration, mechanical shock, dust and dirt contamination, electromagnetic and electrostatic interference, salt spray, splashing with water and other chemicals, especially petroleum type hydrocarbons, and moisture, as defined in SAE J1211.

4.1.4 Any electrical component and its associated wiring including connection into or in place of the stock automotive wiring shall meet the minimum standards of SAE J1292.

4.1.5 Secondary control system modification shall not permanently deform under the stress of normal usage.

4.1.6 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:

4.1.6.1 Vibratory, electrical, and chemical environments of the vehicle interior

4.1.6.2 Long-term repetition of operating cycles

4.1.6.3 Occasional overloads due to common driving occurrences

4.1.7 4.1.7As manufactured, an automotive vehicle is expected to perform reliably, with regular maintenance for 160 000 km (100 000 miles) or 10 years of moderate use. A secondary control system modification shall perform as long and reliably as the OEM components of the vehicle for which they are intended to replace or emulate.

4.1.8 In routine use, the vehicle interior and exterior, where the secondary control system modification and components 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. The product shall be expected to withstand such conditions with no resulting degradation of performance.

4.1.9 Positioning of the product shall assure the greatest possible retention of occupant protection features provided the OEM, such as collapsible steering column assembly, knee bolsters, and supplemental restraint systems. It is preferable to modify the knee bolster than to remove it.

4.1.10 Where applicable, all installations shall be designed to be permanent, and shall use hardware, fasteners, and connectors consistent with permanent installation.

4.1.11 As a general design principle, all adaptive equipment and vehicle modifications should permit operation by an able-bodied driver and transport of an able-bodied passenger, with as little change as possible from conventional subsystems operation and function.

4.1.12 Design of automotive adaptive equipment shall be consistent with accepted engineering principles and with automotive design practice with regard to materials, structures, lubricants, and maintainability.

4.1.13 Where applicable, materials shall be in compliance with FMVSS 302.

4.1.14 Requirements for Voice Recognition Systems

4.1.14.1 Voice or speech recognition secondary control system modifications are those devices which respond to human speech to control the functioning of secondary control system modification of any mode of operation. Voice recognition logic may recognize natural speech without restriction, a restricted vocabulary, or a prescribed set of specific commands for the various functions that are implemented. Voice recognition logic may be designed to recognize only a specific voice or many be designed to respond to a wide variety of voices.

4.1.14.2 Voice recognition secondary control system modification shall have the following performance characteristics:

4.1.14.2.1 Be capable of voice recognition in the expected noise environment of a motor vehicle as defined by SAE J1477

4.1.14.2.2 Provide indication to operator if command message is not recognized

4.1.14.2.3 The voice recognition system shall not be the only method of operating the secondary controls or performing the OEM functions.

4.1.14.2.4 Provide a positive indication to the operator of voice recognition system operation status

4.1.14.2.5 Not require active connection or attachment of the microphone in a manner inconsistent with the goal of independent operation of the vehicle by the disabled user of the voice recognition device.

4.1.15 All OEM functions shall be retained.

4.1.16 Prevention of the inadvertent operation of the following shall be incorporated in the design: ignition/start; gear selector; headlights; and parking brake.

4.1.17 Special precautions for electromagnetic interference shall be taken. Any electrical or electronic component of a secondary control system modification should be designed, assembled, and connected in a manner suitable for the automotive operational environment as defined in SAE J1211and SAE J1113.

4.2 Extensions and Attachments

4.2.1 The use of attachments and extensions shall not damage the OEM controls and systems.

4.2.2 Extensions or attachments must not interfere with the use of other (OEM or adaptive) controls or systems at any point in their operation.

4.2.3 Attachments or extensions shall allow the full operational function of the OEM control.

4.2.4 Attachments or extensions shall be manufactured of materials that exhibit strength and durability equal to the OEM control or system.

4.3 Maintenance and Serviceability

4.3.1 The manufacturer of adaptive equipment shall specify in the owner's manual if there is any user/owner maintenance to be performed, provide as part of the user instructions sufficient information to permit the user/owner to perform the maintenance operations, and identify those maintenance operations (if any) which must or should be performed by the manufacturer, supplier or installer.

4.3.2 This user/owner maintenance information shall include a parts list with instructions on how to obtain spare parts or replacements.

4.3.3 This information shall include names, addresses, and telephone numbers of the manufacturer or his representative, and authorized service agencies or distributors.

4.3.4 Any hazards to service personnel or to the equipment caused by access to the consol that is provided shall be prominently identified by a prominent label when the access panel is removed.

4.4 Operations

The design of all automotive adaptive equipment shall conform to generally accepted human factors principles of operation, as well as to anthropometric and force limitations (modified as required for the client being adapted) as contained in standard human factors (ergonomic) sources such as MIL-STD-1472 and SAE J1139.

4.5 Labeling

4.5.1 Parts traceability shall be provided down to, but not including, fasteners.

4.5.2 All labels shall be designed to remain permanently affixed and legible for the design lifetime of the device or panel to which they are affixed.

4.5.3 All labels for controls, operation of equipment, or for cautionary information shall be designed to be legible at the distance at which they should be expected to be read under normal operating conditions, under ambient daytime conditions, of illumination.

4.5.4 Any dash panel controls, if relocated to a panel visible to the driver in the driver position shall be illuminated according to the requirements of FMVSS 101. Applicable displays include; speedometer, turn signal, gear position, brake failure warning, fuel, engine coolant temperature, oil, highbeam, and electrical charge.

4.5.5 Label nomenclature and symbols shall be designed to meet the standards of FMVSS 101.

4.6 Specific Components and Systems

4.6.1 Nothing in this section shall be construed to require substitution of or improvement upon OEM functions.

4.6.2 When considering the operational requirements of a control or system, it is acceptable for a function to be operated at a higher level, but not a lower level of access. For example, a Mode C function can be operated at the Mode A or B level, but a Mode B control cannot be designed to be operated at the Mode C level.

4.6.3 Mode A Controls and Systems

4.6.3.1 Cruise Control “Set”. The Cruise control “set” function shall meet the requirements for Mode A operation.

4.6.3.2 Headlight Beam Selector

4.6.3.2.1 The headlight beam selector shall meet the requirements of Mode A operation.

4.6.3.2.2 Provision shall be made to ensure that a visual high beam telltale is present.

4.6.3.3 Horn

The horn shall meet the requirements of Mode A operation.

4.6.3.4 Turn Signals

4.6.3.4.1 The turn signals shall meet the requirements of Mode A operation.

4.6.3.4.2 An automatic cancellation feature shall be maintained or provided. If a timer system is used, the signal shall remain activated for a minimum of six (6) seconds. A means of maintaining signal activation without further operator input during situations requiring a signal duration longer than six (6) seconds should be provided (i.e., at intersections).

4.6.3.4.3 Provisions shall be made for the following:

4.6.3.4.3.1 A visual telltale (indicating direction) and audible indicator.

4.6.3.4.3.2 An automatic cancellation feature

4.6.3.4.3.3 Switching from right to left signal activation or left to right activation.

4.6.3.5 Windshield Washer/Momentary Wiper. The windshield washer function shall meet the requirements of Mode A operation.

4.6.4 Mode B Controls and Systems

4.6.4.1 Gear Selector

4.6.4.1.1 The Gear Selector shall meet the requirements of Mode B operation.

4.6.4.1.2 Provision shall be made to prevent inadvertent engagement of the gear selector

4.6.4.1.3 The OEM ignition and park/neutral interlock capability shall be maintained

4.6.4.1.4 Power shifters shall have all OEM shift positions available and identified, illuminated and visible to the driver.

4.6.4.2 Ignition/Starter

4.6.4.2.1 An add-on extension to the ignition system and the engine start function shall be designed to be operable by the driver of the vehicle while he or she is in the driver's position, however, express provisions to minimize the possibility of the device activating the system without operator input shall be taken.

4.6.4.2.2 A relocated ignition switch shall incorporate the following provisions:

4.6.4.2.2.1 Inadvertent operation, particularly operation which shuts off the ignition, shall be minimized.

4.6.4.2.2.2 The ignition switch should retain provisions for theft protection.

4.6.4.2.2.3 The interlock with transmission position such that engine cranking is only possible in PARK or NEUTRAL shall be retained.

4.6.4.2.3 FMVSS 102 and MIL-STD-1472 as applicable shall be met by all relocated ignition/engine start switches separately or combined.

4.6.4.2.4 Provision shall be made to prevent the inadvertent operation of the ignition/start system.

4.6.5 Mode C Controls and Systems

4.6.5.1 Cruise Control “On“ and “Off”

The Cruise Control “ON” and “OFF” functions shall meet the requirements of Mode C Operation.