SURFACE VEHICLE INFORMATION REPORT

J2672™ FEB2024

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(R) Reduced Effort Power Steering Modifications and Backup Systems (Hydraulic and/or Electric)

RATIONALE

Performance standards and testing procedures are needed to guide adaptations to the hydraulic and electric steering for drivers with physical disabilities. This document has been revised to include document lists and wording for the inclusion of the technology of electric steering.

1. SCOPE

1.1 Scope

This SAE Information Report relates to a special class of automotive adaptive equipment which consists of modifications to the power steering system provided as original equipment on personally licensed vehicles. These modifications are generically called “modified effort steering” or “reduced effort power steering.” The purpose of the modification is to alter the amount of driver effort required to steer the vehicle. Retention of reliability, ease of use for physically disabled drivers and maintainability are of primary concern. As an Information Report, the numerical values for performance measurements presented in this report and in the test procedure in the appendices, while based upon the best knowledge available at the time, have not been validated.

1.2 Classification

Steering modifications are classified as modification in which the power steering assist effort is altered. The modifications considered in this Information Report may be accomplished by electrical, hydraulic, or other means.

1.3 Limitations and Inclusions

These recommendations are limited to modifications which are designed to utilize an OEM, electrical, mechanical, and/or hydraulic steering system for steering control.

1.3.1 This Information Report does include additional auxiliary power systems (henceforth referred to as power steering backup systems) which are installed to provide needed redundancy for backup/emergency operation.

1.3.2 Although other types of auxiliary power systems are possible, this Information Report deals only with electrical, mechanical, and/or hydraulic systems.

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1.3.3 Although the recommendations are limited to changes to the electrical, mechanical, and/or hydraulic power steering system and the power steering backup system, the modifications would be tested with an OEM steering column and steering wheel or the aftermarket manufacturer's recommendations.

1.3.4 Although it is possible to combine other steering wheel and/or steering column modifications with Reduced Effort Power Steering and Power Steering Backup Systems, those modifications will not be considered as a part of this Information Report.

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 +1 724-776-4970 (outside USA), www.sae.org.

SAE J188 Power Steering Pressure Hose - High Volumetric Expansion Type

SAE J189 Power Steering Return Hose - Low Pressure

SAE J190 Power Steering Pressure Hose - Wire Braid

SAE J191 Power Steering Pressure Hose - Low Volumetric Expansion Type

SAE J771 Automotive Printed Circuits

SAE J1211 Handbook for Robustness Validation of Automotive Electrical/Electronic Modules

SAE J1292 Automobile and Motor Coach Wiring

SAE J1673 High Voltage Automotive Wiring Assembly Design

SAE J2223 Connections for On-Board Road Vehicle Electrical Wiring Harnesses-Parts 1, 2, 3

SAE J2561 Bluetooth™ Wireless Protocol for Automotive Applications

2.1.2 NHTSA Publications

Available from National Highway Traffic Safety Administration, 1200 New Jersey Avenue, SE, Washington, DC 20590, Tel: 1-888-327-4236, https://www.nhtsa.gov/.

FMVSS No. 201 Occupant Protection in Interior Impacts.

FMVSS No. 203 Steering Wheel Impact Protection.

FMVSS No. 204 Steering Wheel Rearward Displacement

Part 595 Exemptions from the Make Inoperative Prohibition; Final Rule

2.1.3 Military Publications

Available from Document Automation and Production Service (DAPS), Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, http://assist.daps.dla.mil/quicksearch/.

MIL-STD-1472 (Rev. F) Department of Defense Design Control Criteria Standard: Human Engineering.

3. DEFINITIONS

3.1 ABLE-BODIED

A person without disabilities who does not require adaptive aids to operate a personally licensed vehicle.

3.2 ACTUATOR

A transducer whose output is a force or torque and usually involves motion.

3.3 AFTERMARKET MANUFACTURER

3.4 The manufacturer of adaptive devices that is not Original Equipment (OE) in a vehicle.

3.5 AUTHORIZED DEALER, FACILITY OR REPRESENTATIVE

The manufacturer of the adaptive devices has the responsibility to designate the qualifications needed to work on the system for installation and/or service.

3.6 BACKUP

Any device which duplicates or otherwise fulfills the function of another if the latter fails or becomes inoperative.

3.7 BOOSTER

Any device for increasing power or output.

3.8 CRASHWORTHINESS

Degree to which the interior of a motor vehicle, devices installed in the passenger compartment, and the structure of the vehicle as a whole minimize injury to an occupant in the event of a crash.

3.9 dBA

Decibels, referenced to the A scale of attenuation by frequency, which approximates the human ear: a measure of sound intensity.

3.10 FEEDBACK

The recycling of a portion of the output to the input of a system. Systems employing feedback are called closed loop systems.

3.11 GEAR BOX

A transmission assembly comprising gear sets providing mechanical advantage or torque multiplier also includes rack and pinion systems. Within this document it includes both Steering Gear Box and Steering Rack and Pinion systems.

3.12 GEAR RATIO

The ratio of the angular velocity of meshed gears.

3.13 INPUT

The force exerted by the driver to the steering system to create mechanical movement to the vehicle steer wheels.

3.14 JOYSTICK

Any of a class of primary vehicle controls which substitutes a lever or tiller for the steering wheel. Some joysticks also incorporate control of throttle and brake functions as well.

3.15 LOCK-TO-LOCK

Excursion of the front wheels of a motor vehicle from full left extent of travel to full right extent of travel.

3.16 LOGIC

Components in a system which have a decision-making function, or which perform switching activities based on certain conditions or events.

3.17 LOGO

A manufacturer's name or trademark.

3.18 LOW EFFORT

An input that is less than the OE required steering force but higher than "Zero Effort."

3.19 MAJOR ASSEMBLY

Functional unit of a system, such as a pump, steering wheel, steering gearbox, or reservoir. Each major assembly is made up of several parts or components.

3.20 NOMINAL

Normal or acceptable, within acceptable limits.

3.21 ORIGINAL EQUIPMENT

See OEM.

3.22 OEM

Original Equipment Manufacturer refers to the vehicle and its systems as they are designed and produced by the automobile manufacturer.

3.23 POWER STEERING CONTROL VALVE

That part of the steering gearbox or connected to the steering gearbox which controls the admission of hydraulic fluid under pressure to the actuator which in turn moves the steering linkage of the motor vehicle. This valve is mechanically connected to the steering wheel through a feedback spring, and to the resultant output from the steering linkage.

3.24 PRIMARY

Pertaining to the system which is intended to be in operation normally or routinely.

3.25 POWER STEERING BACKUP SYSTEM

An electric, mechanical, and/or hydraulic backup system for the OEM or aftermarket provided power steering system and/or peripheral components.

3.26 PROTOCOL

A set of procedures to be followed.

3.27 REDUCED EFFORT POWER STEERING

A modified OEM power steering system with lower effort required to steer the vehicle. This term includes both “Low Effort Power Steering System” and a “Zero Effort Power Steering System.”

3.28 SHALL

The term to be used whenever the criteria for conformance with the specific recommendations requires that there be no deviation. (SAE J1159)

3.29 SHOULD

The term to be used whenever noncompliance with the specific recommendation is permissible. (SAE J1159)

3.30 SINGLE-POINT FAILURE

Any failure of a component which directly causes the system of which the failed component is a part to cease to function.

3.31 STEERING GEARBOX

A mechanism that translates the rotary input of the steering wheel into the resultant movement that controls the angle of the front wheels of a vehicle.

3.32 STEERING WHEEL

Any kind of device which controls vehicle direction by means of rotary motion.

3.33 ZERO EFFORT

Commonly reference to “NO” or “Minimum” effort input required to steer the vehicle.

4. DESIGN RECOMMENDATIONS

4.1 Conventional Use of Motor Vehicle

Reduced effort power steering and power steering backup system modifications should be designed to permit the conventional use of the steering wheel by drivers without disabilities. Driving after installation of equipment by a driver without disabilities may require training. (APPENDIX RTP 3.1)

4.2 Power Steering Back up

Altered power steering adaptation should incorporate a power steering backup system for altered power steering operation in case of primary power failure. If primary power steering failure occurs, the backup system should retain the altered steering effort.

4.3 Reduced Effort Power Steering

4.3.1 Maintenance of OEM Design Recommendations

4.3.1.1 Modifications should not introduce new single-point failures of the steering system that do not exist in the OEM system.

4.3.1.2 Whenever possible the modifications should not compromise or eliminate crashworthiness provisions provided by the vehicle manufacturer in compliance with Applicable FMVS/CMVS Standards.

4.3.2 Torque Required for Steering

The torque required for steering control should be measured at the top of the steering shaft nut with vehicle powerplant engaged at the factory recommended curb idle “park” position (for IC engine with engine warm) and environmentals such as HVAC “off.”

This torque should be reduced from OE stock effort input to as low as 15.1 lb-in for steering designated as “low effort steering” and below 15.0 lb-in for steering designated as “zero” effort steering when tested with OEM wheels and tires on a dry smooth concrete surface. (APPENDIX RTP 5.1)

4.4 Power Steering Backup Systems

4.4.1 Automatic Activation

Automatic activation of the power steering backup system is recommended as a critical safety feature in the case of primary power steering system failure.

4.4.1.1 The power steering backup system should have automatic logic which can withstand a test of 2500 cycles of operation. (APPENDIX RTP 5.3.1)

4.4.1.2 When the power steering backup system is hydraulic it should also have automatic logic such that the system comes on within one second when an appropriate sensor detects a reduction or cessation of pressure or flow. Typical causes might be:

4.4.1.2.1 Decay in flow and/or pressure (from, for instance, a fluid leak). (APPENDIX RTP 5.3.2.1)

4.4.1.2.2 Sudden loss of flow and/or pressure (from, for instance, a broken belt or pump failure). (APPENDIX RTP 5.3.2.2)

4.4.1.2.3 Cessation of flow and/or pressure (from, for instance a blockage in the line). (APPENDIX RTP 5.3.2.2.2)

4.4.1.3 The electric power steering backup system should also have automatic logic such that the system comes on within one second when an appropriate sensor detects a problem or failure due to any altered component or the altered system.

4.4.1.4 Safety features of the OEM electric power steering system shall not be altered.

4.4.2 Acceptable Backup Power Sources

The power source for the primary steering system (usually the engine and related power transmission systems such as belts or batteries) should be functionally separate from the power source for the power steering backup system. The power steering backup system is powered by some source other than the primary power (e.g., an electric motor driven pump).

4.4.3 Duty Time

The power steering backup system should provide power for steering with no support from the primary power source for a minimum of 5 minutes without serious overheating and damage. (APPENDIX RTP 6.1)

4.5 System Requirements Reduced Effort Power Steering and Power Steering Backup Systems

4.5.1 Leaks in Hydraulic Systems

Neither the reduced effort power steering nor the power steering backup system should display any significant leaks. (APPENDIX RTP 5.4)

4.5.2 Electrical Systems

Neither the reduced effort power steering nor the power steering backup system should have short circuits, abnormal current draws, or high resistance connections.

4.5.3 Operational Test

The combined reduced effort power steering system and power steering backup system should withstand a 2000 mile on-the-road test with no changes in the torque required for steering (IR 4.3.2). Hydraulic systems should not exhibit significant leakage (IR 4.5.1) or noticeable wear, fraying, or other anomalous conditions not present at the commencement of testing. Electrical systems should have equivalent or better current and voltage performance readings than at the commencement of testing.

4.5.4 Pressure Maintenance Capability on Hydraulic Systems

The pressure produced by the power steering backup system at the power steering gearbox inlet must not fall below the nominal pressure of the OEM power steering pump pressure delivery at the power steering gearbox inlet for the same steering input after 25 cycles of the steering wheel from lock-to-lock.

4.5.5 Maintenance Capability on Electric Systems

The electric power produced by the power steering backup system at the power steering motor must be equivalent or better than the nominal OEM power provided to the steering motor after 25 cycles of the steering wheel from lock-to-lock.

4.5.6 Hydraulic Fluid Cooling

4.5.6.1 Allowed Temperature Rise

The combined reduced effort power steering and power steering backup systems should be able to withstand idling for at least 20 minutes without an increase in hydraulic fluid temperature to over 150 °C or a temperature specifically approved by the manufacturer of the fluid recommended. (APPENDIX RTP 5.6.1)

4.5.6.2 Special Hydraulic Fluids

If a hydraulic fluid is used with an approved operating temperature over 150 °C, instructions to use that fluid should be permanently placed in a prominent position on the fluid reservoir, near the filler lid, as well as in the User's Manual. (APPENDIX RTP 2.2 and 3.13.5)

4.5.6.2.1 If special hydraulic fluid is required for extreme temperature operations, instructions to use that fluid should be permanently placed in a prominent position on the fluid reservoir, near the filler lid, as well as in the User's Manual.

5. MATERIALS AND COMPONENTS

5.1 Reduced Effort Power Steering

5.1.1 Power Steering Power Source Quality

Primary power for the reduced effort power steering system should be an OEM power steering pump or electric motor for that vehicle or substitute with equal or better performance documented by an independent testing laboratory. (APPENDIX RTP 3.4 OEM Power Steering Power Source Quality)

5.1.2 Power Steering Mechanism Quality

The power steering Mechanism which is modified for the reduced effort power steering system be an OEM power steering box for that vehicle or a substitute with equal or better performance documented by an independent testing laboratory. (APPENDIX RTP 3.5 OEM Power Steering Mechanism Quality)

Rationale: This recommendation is primarily to assure a minimal level of performance for the power steering box modified for the reduced effort power steering and for the power steering pump which will be used with the reduced effort power steering.

5.2 Power Steering Backup Systems

5.2.1 Backup Power Steering Power Source Quality

Backup power source for the steering system for which the backup system is being installed should be an OEM power source or substitute with equal or better performance documented by an independent testing laboratory. (APPENDIX RTP 3.3 and 3.4)

Rationale: This recommendation is primarily to assure a minimum level of performance for the power steering power source which will be backed up by the power steering backup system. It is intended to avoid substitutions of inferior components due to space or other needs. This recommendation will usually be redundant with 5.1.1 but is needed when a backup system is fitted without a reduced effort steering system (for a driver who could operate OEM power steering, but not if the pump, belt, etc., failed).

5.2.2 Electrical Components and Wiring

5.2.2.1 Applicable Standards

Electrical components and wiring should conform to the SAE International Standards or Recommended Practices as applicable. Those listed below are applicable to the wiring of the electrical control system for the power steering backup system. (APPENDIX RTP 3.6.1)

SAE J258, SAE J553 - Circuit Breakers
SAE J1292 - Automobile Wiring
SAE J561, SAE J858a, SAE J928 - Electrical Terminals
Note to check current SAE standards

Rationale: It is expected that all equipment meets other applicable SAE Standards or Recommended Practices, even if this document is an Information Report.

5.2.2.2 Packaging of Electrical Systems

All electrical systems should be designed and packaged to protect the driver or passengers against injury resulting from short circuits, electrical fires, and similar accidents. (APPENDIX RTP 3.9)

Rationale: The electrical systems have the potential to cause injury in a number of ways. Design consideration must be given to the prevention of such injuries.

5.2.2.3 Protection from Weather

Electrical components which are exposed to the environment outside the enclosed portions of the vehicle should be protected from failure due to weather and meet SAE J1211 for environmental practices. (APPENDIX RTP 3.10)

Rationale: Some of the electrical components of a power steering backup system may be exposed to the weather. They should be protected appropriately. It is expected that all equipment meets other applicable SAE Standards or Recommended Practices, even if this document is an Information Report.

5.2.3 Hydraulic Components

5.2.3.1 Applicable Standards

Hydraulic components should conform to the SAE International Standards or Recommended Practices as applicable. (APPENDIX RTP 3.6.2) Unless otherwise indicated, the latest version of these publications shall apply.

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

Rationale: It is expected that all equipment meets other applicable SAE Standards or Recommended Practices, even if this document is an Information Report.

5.2.3.2 Protection of Hydraulic Hoses

Hydraulic Hoses should be protected from rubbing on any components or bearing on high temperature vehicle components. (APPENDIX RTP 3.7)

Rationale: One frequent cause of hydraulic hose failure is improper contact with other vehicle components.

5.2.4 Electric Motors and Components

5.2.4.1 Applicable Standards

Electric motors and components should conform to the SAE International Standards or Recommended Practices as applicable. (APPENDIX RTP A3.6.1) Unless otherwise indicated, the latest version of these publications shall apply.

SAE J2980 - Consideration for ISO 26262 ASIL Hazard Classification

5.2.5 Fasteners

5.2.5.1 Applicable Standards

All fasteners used should conform to the SAE International Standards or Recommended Practices or ANSI Standards as applicable. (APPENDIX RTP 3.6.3)

ANSI/ASME/B 18.21 - Lock Washers (Supersedes SAE J489)
ANSI/ASME/B 18.2.2 - Square and Hex Nuts (Supersedes SAE J104)
ANSI/B 18.2.1 - Hex Bolts
ANSI/B 18.6.1 - Slotted and Recessed Head Screws (Supersedes SAE J478a)
ANSI/B 18.6.2 - Slotted and Recessed Head Screws (Supersedes SAE J478a)
ANSI/B 18.6.3 - Slotted and Recessed Head Screws (Supersedes SAE J478a)
ANSI/B 18.6.3 - Square and Hex Nuts (Supersedes SAE J104)
ANSI/B 18.6.4 - Slotted and Recessed Head Screws (Supersedes SAE J478a)
ANSI/B 18.22.1 - Plain Washers (Supersedes SAE J488)
SAE J58 - Flanged 12-Point Screws
SAE J78 - Steel Self-Drilling Tapping Screws
SAE J81 - Thread Rolling Screws

SAE J82 - Mechanical and Quality Requirements of Machine Screws
SAE J102 - Replaces J477 Square and Hexagonal Bolts and Nuts
SAE J103 - Replaces J477 Square and Hexagonal Bolts and Nuts
SAE J104 - Replaces J477 Square and Hexagonal Bolts and Nuts
SAE J105 - Replaces J477 Square and Hexagonal Bolts and Nuts
SAE J122a - Surface Discontinuities on Nuts
SAE J123 - Surface Discontinuities on Bolts, Screws, and Studs in Fatigue Applications
SAE J174 - Torque-Tension Test Procedure for Steel Threaded Fasteners
SAE J238 - Nut and Conical Spring Washer Assemblies
SAE J474a - Screw Threads
SAE J482 - Hexagon High Nuts
SAE J483 - Crown (Blind, Acorn) Nuts
SAE J485 - Holes in Bolt and Screw Shanks and Slots in Nuts for Cotter Pins
SAE J773b - Conical Spring Washers
SAE J891 - Spring Nuts
SAE J892a - Push-On Spring Nuts
SAE J924 - Thrust Washers - Design and Application
SAE J933 - Mechanical and Quality Requirements for Tapping Screws
SAE J995 - Mechanical and Material Requirements for Steel Nuts
SAE J1053 - Steel Stamped Nuts of One Pitch Thread Design
SAE J1199 - Mechanical and Material Requirements for Metric Externally Threaded Steel Fasteners
SAE J1216 - Test Methods for Metric Threaded Fasteners
SAE J1231 - Metric Thread Rolling Screws
SAE J1291 - Automotive Hydraulic Brake System - Metric Banjo Bolt Connections

5.2.5.2 Fastener Grade

All nuts and bolts used to secure components during manufacture or installation should be OEM equivalent, if non-OEM hardware is required, SAE grade 5, metric grade 8.8 or better should be used. (APPENDIX RTP 3.11)

5.2.5.3 Locking Fasteners

Locking nuts are the preferred method of fastening where a locking system is indicated. Nuts with lock washers are also acceptable. (APPENDIX RTP 3.12)

5.2.5.4 Operational Testing of Fasteners

Fasteners should be considered an integral part of the power steering backup system and should be tested for wear, integrity, and resistance to loosening or loss through vibration or use conditions. Such testing and inspection should be done before and after the Operational Test. (APPENDIX RTP 6.2)

Rationale: It is expected that all equipment meets other applicable SAE Standards or Recommended Practices or ANSI Standards, even if this document is an Information Report. Many of the components of the power steering backup system are subject to stress, vibration and other conditions which can lead to various forms of fastener failure. The potential for system failure subsequent to fastener failure quite high.

5.3 Peripheral Components

All labels, switches, lights, wires, hydraulic hoses, etc. (except fluids) needed for Reduced Effort Power Steering Systems and/or Power Steering Backup Systems should be furnished with the system or specified by the adaptive device manufacturer to avoid the use of inappropriate components by an installer who may not be qualified to select the proper components for this specialized application. (APPENDIX RTP 2.8 and 3.8)

Rationale: The hoses available locally to installers may not be adequate to the pressures and temperatures possible within a power steering backup system. In addition, installers may not have the equipment to make proper labels and may not be aware of the requirements for many of the labels.

6. OPERATION

6.1 Reduced Effort Power Steering

6.1.1 Labeling

A label should be prominently and permanently fixed in a prominent location on or near the instrument panel of the modified vehicle stating “WARNING - THIS VEHICLE IS EQUIPPED FOR A DRIVER WITH A DISABILITY. DO NOT OPERATE WITHOUT PROPER INSTRUCTION.” (APPENDIX RTP 3.13.6)

Rationale: Reduced effort power steering changes the way the steering of the vehicle feels. In addition to making the steering easier, the tendency for OEM steering to return to center has been reduced. Individuals who are not familiar with the vehicle, (family, mechanics, thieves, etc.) need to be warned to expect something different.

6.1.2 User’s Manual

With every reduced effort power steering the manufacturer should provide a detailed manual of instructions concerning user operation, cautions concerning use by drivers other than the intended driver, recommended maintenance (if any), and the name, mailing address, email address, web site (if any) and telephone number of the manufacturer or their representative. The user should also be made aware that repairs to the power steering system at a facility which does not specialize in modifications of vehicles for people with disabilities could result in the system being replaced with a system which does not have reduced effort steering. (APPENDIX RTP 2.1)

Rationale: The User’s Manual for the reduced effort power steering modification may be very brief since reduced effort power steering is simply the modification of an existing component for which no special care is specified in the OEM owner’s manual, but some information is needed.

6.2 Power Steering Backup Systems

6.2.1 Manual Operation (Override)

6.2.1.1 Manual Activation

There should be provision for driver (manual) actuation of the Power Steering Backup system which bypasses the automatic control circuit. (APPENDIX RTP 3.14)

6.2.1.1.1 Wiring Logic of Manual Activation

The manual activation of the Power Steering Backup System should be independent of the vehicle ignition circuit. (APPENDIX RTP 4.1.1)

6.2.1.1.2 Accessibility of the Manual Activation Switch

The manual activation (“ON”) switch should be immediately accessible to the driver leaving one hand available for steering. (Note: This requirement should be included in the installation manual, see Information Report 7.2.1.5). (APPENDIX RTP 4.1.3)

Rationale: Manual activation is needed in case of failure of the automatic activation.

6.2.1.2 Manual Shut Off

A manual shut off of the power steering backup system may be provided. This system will turn off the power steering backup system. (APPENDIX RTP 4.2.1)

6.2.1.2.1 Manual Shut-Off Wiring

The manual shut off switch, if installed, should be wired such that the Manual Shut-off System will override the Manual Activation system. (APPENDIX RTP 4.2.3)

6.2.1.2.2 Manual Shut-Off Location

If a manual shut off switch that deactivates the automatic system is provided, the switch should be located where it cannot be activated accidentally, and the location clearly identified. (APPENDIX RTP 3.15)

Rationale: The driver must have an override option in case of sensor/logic failure. It is also advantageous to allow mechanics to work on the vehicle without the backup system remaining in operation when the ignition is on but the engine is off (which, on many systems, would leave the backup running).

6.2.1.3 Warning Lights for Manual Operation

Clearly identifiable warning light(s) should be provided to indicate that the Back-up system is either activated in manual operation or not available. Light(s) are active when ignition circuit is active.

6.2.1.3.1 A red light which indicates that the Power Steering Backup System has been manually turned on and should be appropriately labeled such as: “BACK UP ACTIVATED.” (APPENDIX RTP 4.1.2)

6.2.1.3.2 The red light should also be activated if the Power Steering Backup System has been manually shut-off and not available. (APPENDIX RTP 4.2.2)

Rationale: The red lights indicate that the driver should not be operating the vehicle on a road.

6.2.1.4 Labels and Lighting

Switches for manual activation and manual shut off of the power steering backup system should be appropriately labeled such as “TURN ON STEERING BACKUP” and “TURN OFF STEERING BACKUP” and should be visible under low light conditions if the headlights have been activated (e.g., night operation). (APPENDIX RTP 3.14.2, 3.14.6, and 4.1.3)

6.2.2 Automatic Backup Activation Warning

Incorporated into the automatic activation of the backup system (IR 3.4.1), there should be a primary power system failure warning/backup system takeover indication. This indication should be a warning light and an auditory signal.

6.2.2.1 Warning Light

The indicator light can be the same light used for the activation of the manual backup. (IR 6.2.1.3) (APPENDIX RTP 3.14.2 and 5.3.3)

6.2.2.2 Audible Warning

The audible signal should be audible to a person with normal hearing in an 80 dB white noise environment.

Rationale: The driver must know that they are driving in a situation where there has been a primary system failure and that they are now relying on a backup system for an important component of vehicle control.

6.2.3 User’s Manual

With every power steering backup system, the manufacturer should provide a detailed manual of instructions concerning user operation and required or recommended maintenance to be performed by the user, owner, or dealer. The maintenance instructions should address at least the following areas:

- operation (including a description of all manual and automatic modes and proper operating procedures for manual modes),
- fluids (types, levels, and frequency of checking),
- adjustments (if any), maintenance intervals on belts and hoses,

- trouble shooting (possible failures and required corrective action),
- parts list (including specific source and part number information for replacement belts and hoses),
- components requiring special attention,
- contact information such as name, address and telephone number of the manufacturer and their representative,
- the User's Manual should include instructions on the interpretation of all warning lights or other warning indicators as well as the indications for operation of manual operation of systems. (APPENDIX RTP 2.2)

Rationale: The power steering backup system has many switches, warning lights, etc., the understanding of which is vital to the safe operation of the vehicle. Most systems do require periodic maintenance which is different from that of the OEM steering system. In addition, many of the parts which are subject to wear and are essential to the operation of the system may not be readily available from the OEM dealer or automotive parts houses.

7. METHOD OF INSTALLATION

7.1 Reduced Effort Power Steering

7.1.1 Installation Manual

The Reduced Effort Power Steering System should be furnished with an installation manual describing the installation procedure. The manual should discuss all special installation considerations for all vehicles for which the modified unit is intended. The manual should list all vehicles for which the modified unit is intended and where updated information can be obtained for newer vehicles. (APPENDIX RTP 2.3)

Rationale: In addition to the need for specific information about normal installation procedures, there are some aspects of Reduced Effort Power Steering which are very important but can only be accomplished by the installer, not the manufacturer. For these items, instructions to accomplish those specific aspects are included in the installation manual.

7.1.1.1 Counterweight

The installation manual should consider that whenever reduced effort power steering is installed on a vehicle on which an orthotic or other steering device will be attached to the steering wheel, a counterweight to the weight of the steering device and any attaching fixture might be added to balance the steering wheel. (Typically, this is a recommendation of a driver evaluator.) This counterweight should be appropriately mounted on the steering wheel in relation to the steering device. (APPENDIX RTP 2.3)

Rationale: The counterweight may be prescribed by a driver evaluator because in some cases it has been found that the weight of an adaptive steering device can exert sufficient force on the rim of the wheel to cause the steering boost to become activated. If the system remains activated for an extended period of time (idling in a parking lot) overheating of the steering hydraulic fluid can occur, eventually causing damage to the system.

7.1.1.2 Labels

The installation manual should specify that the label stating that the vehicle has been modified (required by Information Report 6.1.1), which is furnished with the Reduced Effort Power Steering System (per Information Report 5.3) should be prominently and permanently fixed on the instrument panel of the modified vehicle. The installation manual should state the preferred location for the label and the method of attachment. (APPENDIX RTP 2.3)

7.1.2 Installation by Dealer

The manufacturer should take measures to assure that only an authorized facility, officially designated representative, or an authorized dealer should accomplish all modifications and installations of modified power steering systems advertised as meeting this SAE standard and should provide written documentation to that effect. (APPENDIX RTP 2.4)

Rationale: Since it is possible to effect reduced effort power steering modifications and make up a backup system from over-the-counter parts, the intent of this paragraph is to ensure that the system and modifications offered as conforming to this Information Report are performed by a vendor who can provide accountability for a given installation. It also precludes the sale of kits to individuals or vendors who are not properly prepared to install such a system.

7.1.3 Installation of Additional Aftermarket Systems

The manufacturer should take measures to assure that common other aftermarket systems (such as remote starting systems) will not cause improper operation of the Reduced Effort Power Steering or Back-up Systems. Notations in the installation and owner's manuals should identify methods to address these issues including recommending end users contacting the installing dealer BEFORE installation of additional aftermarket systems.

7.2 Power Steering Backup Systems

7.2.1 Installation Manual

The power steering backup system should be furnished with an installation manual describing the installation procedure. The manual should discuss all special installation considerations (e.g., location of the pump or electric motor, accessibility for maintenance of OEM and power steering backup system components) for all vehicles for which the system is intended. The manual should list all vehicles for which the system is intended, where updated information can be obtained for new vehicles and all the following information. (APPENDIX RTP 2.5)

7.2.1.1 Flow Diagrams (Hydraulic Systems Only)

The installation manual should contain complete flow diagrams of the installed power steering backup system.

7.2.1.2 Electrical Diagrams

The installation manual should contain complete electrical diagrams of the installed power steering backup system.

7.2.1.3 Installation Hardware

Power steering backup systems distributed for installation should be accompanied by all installation hardware required or required hardware specifications needed for the vehicle on which the backup system is to be installed.

7.2.1.4 Parts List

The installation manual should contain a complete parts list of all components of the power steering backup system and any associated installation hardware (hoses, fasteners, labels, etc.). Components which are made up of more than one part and which should not be disassembled prior to installation of the entire component into the system should be so designated.

7.2.1.5 Switch Accessibility

Per Information Report 6.2.1, the installation manual should state that the power steering backup manual activation switch should be accessible to the driver while in the driving position.

7.2.1.6 Maintainability

Per Information Report 8.3, the installation manual should state that the installer should install the power steering backup system such that parts requiring user/dealer maintenance and OEM components of the vehicle requiring user/dealer maintenance are readily accessible without major disassembly or use of special tools.

7.2.1.7 Label Locations

The installation manual should indicate the locations of all labels for lights and switches and that labels should be identifiable for night use.

Rationale: In addition to the need for specific information about normal installation procedures, there are some aspects of Power Steering Backup Systems which are very important but can only be accomplished by the installer, not the manufacturer. For these items, all that can be required in an Information Report is that instructions to accomplish those specific aspects be included in the installation manual.

7.2.2 Installation

The manufacturer of the power steering backup system should take measures to assure that only an authorized facility, officially designated representative, or an authorized dealer should accomplish all modifications and installations of modified power steering systems advertised as meeting this SAE standard and should provide written documentation to that effect. (APPENDIX RTP 2.6)

Rationale: See Rationale for 7.1.2.

8. QUALITY CONTROL AND MAINTENANCE

8.1 Warranty

A written statement of warranty for the reduced effort power steering and/or the power steering backup system should be provided with each installation assuring the quality of materials for at least 1 year and state the length of time workmanship is covered from the date of delivery to the motor vehicle operator. The warranty should state that if defects are found during the warranty period, the faulty components will be repaired, replaced, or a refund made by the manufacturer or their authorized agent. Although certain components may have warranties from their respective manufacturers, all separate warranties are handled by the power steering manufacturer. (APPENDIX RTP 2.7)

Rationale: The 1-year warranty is typical to that issued for other consumer products, and for automobiles themselves. The prohibition of pass-through warranties ensures that a purchaser has only one supplier to deal with if an installation proves defective or unsatisfactory. In some cases, components are used in ways either not originally intended or excluded by their original manufacturers. Such use is the responsibility of the reduced effort power steering system manufacturer and installer, not the user.

8.2 Identification and Markings

Every major assembly of reduced effort power steering and/or power steering backup system should be permanently marked with the manufacturer's name, trademark (or otherwise recognizable logo) and part number. Such marks should be visible to Service personnel when working on the vehicle. Parts number should be keyed to and location identified on parts lists and/or diagrams as provided for in 7.2.1. (APPENDIX RTP 3.16)

Rationale: It is necessary for evaluation and maintenance personnel to identify (OEM) components from those changed or added by the modifier. Easy identification will facilitate maintenance and repair. Clear identification of power steering units modified for Reduced Effort Power Steering will reduce the possibility of inadvertent change out to OEM units by uninformed mechanics when working on worn power steering systems. In addition, large distributors and vehicle modifiers may offer a “custom” vehicle which combines products and modifications from or by several different manufacturers. It should remain possible for purchasers, to identify these manufacturers for accountability, particularly if standards are applicable.

8.3 Power Steering Backup System Accessibility

The manufacturer should design and fabricate their power steering backup system such that parts requiring user/dealer maintenance and OEM components of the vehicle requiring user/dealer maintenance are readily accessible without major disassembly or use of special tools. This should include instructions in the installation manual (IR 7.2.1) to preclude the negation of these design and fabrication efforts during the installation process. (APPENDIX RTP 3.17)

Rationale: The necessary combinations of pumps, reservoirs, hoses, etc., which make up power steering backup system take up a fair amount of space. This Information Report is to assure that dealers or manufacturers do not take expedient solutions to the mounting of this equipment which will later make maintenance of the system or the primary vehicle much more difficult and expensive.

9. NOTES

9.1 Revision Indicator

A change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

PREPARED BY SAE ADAPTIVE DEVICES STANDARDS COMMITTEE

APPENDIX A - RECOMMENDED TEST PROCEDURE (RTP)

A.1 GENERAL

This test procedure is for qualification testing of reduced effort power steering and power steering backup systems to assure compliance with the Information Report for these assistive devices. Reduced effort power steering systems and power steering backup systems which complete the test without failure should be considered to be in compliance with the Information Report. The following tests should be done in the sequence listed.

A.1.1 Testing Protocol

Two samples of low effort power steering systems should be submitted to the agency designated by the manufacturer to perform the testing.

A.1.1.1 Installed System

One system should be completely installed in a motor vehicle. This vehicle should be made available for continuous use during the course of testing. This vehicle should have the complete modification of reduced effort power steering and power steering backup systems as they would be delivered to the user including all labeling and manuals.

A.1.1.2 Uninstalled System

A complete uninstalled system should be supplied for bench testing and study of individual components. All parts of the original equipment steering system which are modified in any way, and all additional parts that make up the reduced effort power steering and power steering backup system installation (labels, hoses, etc.) should be supplied in this bench test system.

A.2 RECEIVING INSPECTION TEST

A receiving inspection test should be conducted and should include a detailed inspection of the unassembled system to determine that the following have been provided and meet the referenced Information Reports:

A.2.1 Reduced Effort Power Steering User's Manual

The User's Manual furnished with the vehicle with the reduced effort power steering modification should be a detailed manual of instructions concerning user operation, cautions concerning use by drivers other than the intended driver, recommended maintenance (if any), and the name, address and telephone number of the manufacturer or their representative. (IR 6.1.2)

A.2.2 Power Steering Backup System User's Manual

The User's Manual should be furnished with the vehicle with the power steering backup system modification and should provide a detailed manual of instructions concerning user operation and required or recommended maintenance to be performed by the user, owner or dealer. The User's Manual should include instructions on the interpretation of all warning lights or other warning indicators as well as the indications and procedures for the manual operation of these systems. The maintenance instructions should address the following areas where applicable:

- operation (including a description of all manual and automatic modes),
- fluids (types, levels, and frequency of checking),
- adjustments (if any),
- maintenance intervals on belts and hoses,
- trouble shooting (possible failures and required corrective action),

- battery maintenance,
- parts list (including specific source and part number information for replacement belts and hoses),
- components requiring special attention,
- contact information including name, address, and telephone number of the manufacturer and their representative. (IR 4.5.4.2 and 6.2.3)

A.2.3 Reduced Effort Power Steering Installation Manual

The installation manual furnished with the unassembled reduced effort power steering system should be a detailed manual of installation instructions and should contain specific instructions for any related procedures and labeling practices. (IR 7.1.1, 7.1.1.1, and 7.1.1.2)

A.2.4 Documentation of Reduced Effort Power Steering Installation by Dealer

Documentation furnished with the reduced effort power steering system should be examined to confirm that measures have been taken by the manufacturer to assure that only an authorized facility, an officially designated representative, or an authorized dealer should accomplish all modifications and installations of modified power steering systems advertised as meeting this SAE standard. (IR 7.1.2)

A.2.5 Power Steering Backup System Installation Manual

The installation manual furnished with the unassembled power steering backup system should be a detailed manual of installation instructions and should contain any specific instructions required for a proper installation and for any related procedures such as label and switch locations. The installation manual should also include Flow Diagrams, Electrical Diagrams, Installation Hardware, a Parts List, Switch Accessibility Information, Maintainability Information and Label Locations. (IR 7.2.1, 7.2.1.1 to 7.2.1.7)

A.2.6 Documentation of Power Steering Backup System Installation by Dealer

Documentation furnished with the unassembled power steering backup system should be examined to confirm that measures have been taken by the manufacturer to assure that only an authorized facility, an officially designated representative, or an authorized dealer should accomplish all modifications and installations of power steering backup systems advertised as meeting this SAE standard. (IR 7.2.2)

A.2.7 Warranty

A written statement of warranty for the reduced effort power steering and/or the power steering backup system should be provided with each installation assuring the quality of materials for at least 1 year and state the length of time workmanship is covered from the date of delivery to the motor vehicle operator. The warranty should state that if defects are found during the warranty period, the faulty components will be repaired, replaced, or a refund made by the manufacturer or their authorized agent. Although certain components may have warranties from their respective manufacturers, all separate warranties are handled by the power steering manufacturer. (IR 8.1)

A.2.8 Furnished Parts

All parts needed to install the Reduced Effort Power Steering System and Power Steering Backup System which must be furnished with the system per the parts lists, including those required per this Information Report (hoses, labels, etc.) should be confirmed as having been shipped. (IR 5.3)

A.3 INSPECTION OF THE INSTALLED REDUCED EFFORT POWER STEERING AND POWER STEERING BACKUP SYSTEM

A.3.1 Conventional Use of Motor Vehicles

The vehicle modified with reduced effort power steering and a power steering backup system should be examined to determine if it permits the conventional use of the steering wheel by drivers without disabilities. (IR 4.1)

A.3.2 Maintenance of OEM Design Safety Factors

The vehicle should be examined to assure that the modifications made to install the reduced effort power steering and/or the power steering backup system did not introduce any new single point failure forces to the steering system and that the modifications did not compromise or eliminate any crashworthiness provisions provided by the vehicle manufacturer in compliance with FMVSS 203 or 204 or the general provisions of FMVSS 201. (IR 4.3.1)

A.3.3 Mandatory Power Steering Backup System

The vehicle should be examined to assure that components related to a power steering backup system have been installed.

NOTE: This test is a preliminary check to assure the installation of the mandatory backup system prior to proceeding with the remainder of the tests. The test for automatic activation is in Recommended Test Procedure 5.3. (IR 4.2)

A.3.4 OEM Power Steering Power Source Quality

The vehicle should be examined to determine that the primary power for the reduced effort power steering system or used in conjunction with a power steering backup system is a standard (OEM) power steering pump or electric motor for that vehicle or substitute with equal or better performance documented by an independent testing laboratory. If it is not the standard power steering pump or electric motor for the vehicle being examined, the documentation of equal or superior performance must be presented with the vehicle. (IR 5.1.1 and 5.2.1)

A.3.5 OEM Power Steering Mechanism Quality

The vehicle should be examined to determine that the power steering mechanism which is modified for the reduced effort power steering system be an OEM power steering mechanism for that vehicle or a substitute with equal or better performance documented by an independent testing laboratory. If it is not the OEM power steering mechanism for the vehicle being examined, the documentation of equal or superior performance must be presented with the vehicle. (IR 5.1.2)

A.3.6 Applicable Standards

Each power steering backup system should be checked for conformance with the following existing standards.

A.3.6.1 Electrical

Electrical components and wiring should conform to the SAE International Standards or Recommended Practices noted in Information Report 5.2.2.1.

A.3.6.2 Hydraulic

Hydraulic components should conform to the SAE International Standards or Recommended Practices noted in Information Report 5.2.3.1.

A.3.6.3 Fasteners

All fasteners used should conform to the SAE International Standards or Recommended Practice noted in Information Report 5.2.4.1.

A.3.7 Hoses Protected from Rubbing

The hydraulic portions of the reduced effort power steering and power steering backup system should be inspected on the vehicle to assure that all hydraulic hoses are protected from rubbing on any components or bearing on any components of the exhaust system. (IR 5.2.3.2)

A.3.8 Hoses Furnished

The unassembled power steering backup system should be inspected and compared to the vehicle to assure that all hydraulic hoses needed for the power steering back up system were furnished with the system shipped from the manufacturer. (IR 5.3)

A.3.9 Electrical Wiring Harnesses Protected from Rubbing

The Electric Motor and control harness portions of the reduced effort power steering and power steering backup system should be inspected on the vehicle to assure that all harnesses are protected from rubbing on any sharp components or bearing on any components of the exhaust system. (IR 5.2.3.2)

A.3.10 Electrical System Packaging

The installation of the reduced power steering backup system should be examined to assure that all electrical systems have been designed and packaged to protect the driver or passengers against injury resulting from short circuits, electrical fires, and similar accidents. (IR 5.2.2.2)

A.3.11 Environmental Protection

The installation of the reduced power steering backup system should be examined to assure that all electrical components which are exposed to the environment outside the enclosed portions of the vehicle have been protected from failure due to weather and meet SAE standard J1211 for environmental practices. (IR 5.2.2.3)

A.3.12 Fastener Grade

The vehicle should be examined to assure that all nuts and bolts used to secure structural members during manufacture or installation are grade 5/metric grade 8.8 or better. (IR 5.2.4.2)

A.3.13 Fastener locking

The vehicle should be examined to assure that locking nuts or nuts with split lock washers are used where a locking system is indicated. (IR 5.2.4.3)

A.3.14 Labeling

The vehicle should be examined to assure that the following conditions are met.

A.3.14.1 Switches for reduced effort power steering manual override and (if included) manual shut off switches should be labeled such as “STEERING BACKUP.” (IR 6.2.1.4)

A.3.14.2 The light which has been installed on the instrument panel (or auxiliary control panel) of the vehicle to come on when the power steering backup system is manually or automatically activated should be labeled such as “BACKUP ACTIVATED.” (IR 6.2.2.1)

A.3.14.3 The light which has been installed on the instrument panel (or auxiliary control panel) of the vehicle to come on when the power steering backup system has been manually bypassed should be labeled “NO STEERING BACKUP.” (IR 6.2.1.3.2)

A.3.14.4 If the User’s Manual states a specific type of hydraulic fluid due to the fluid having an approved operating temperature over 300 °F (150 °C), an appropriate label should be placed on the Power Steering Backup System reservoir, near the filler lid, stating the specific fluid needed. (IR 4.5.4.2)