TECHNICAL STANDARDS DOCUMENT

No. 305, Revision 2

Electrolyte Spillage and Electrical Shock Protection


Effective Date: May 21, 2011
Mandatory Compliance Date: November 21, 2011

Motor Vehicle Standards, Research and Development Branch
Road Safety and Motor Vehicle Regulation Directorate
TRANSPORT CANADA
Ottawa, Ontario
K1A 0N5
Technical Standards Document
Number 305, Revision 2

Electrolyte Spillage and Electrical Shock Protection
(Ce document est aussi disponible en français.)

Introduction

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(Original signed by)

Director, Motor Vehicle Standards, Research and Development for the Minister of Transport, Ottawa, Ontario
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ELECTROLYTE SPILLAGE AND ELECTRICAL SHOCK PROTECTION


S1. Scope

This Technical Standards Document (TSD) standard specifies requirements for limitation of electrolyte spillage, retention of electric energy storage devices, and protection from harmful electric shock during and after a crash.

S2. Purpose

The purpose of this TSD standard is to reduce deaths and injuries during and after a crash that occur because of electrolyte spillage from electric energy storage devices, intrusion of electric energy storage device components into the occupant compartment, and electrical shock.

S3. Application

[CONTENT DELETED] For applicability, please see Schedule III and subsection 305(1) of Schedule IV to the Motor Vehicle Safety Regulations.

S4. Definitions

Electrical isolation means the electrical resistance between the vehicle high voltage source and any vehicle conductive structure. (Isolation électrique)

Electric energy storage/conversion/power generating system means the components comprising, but not limited to, the vehicle's high voltage battery system, capacitor system, or fuel cell system, and rechargeable energy storage systems. These include, but are not limited to, the battery or capacitor modules, interconnects, venting systems, battery or capacitor restraint devices, and electric energy storage boxes or containers that hold the individual battery or capacitor modules. Hydrogen system components of fuel cell vehicles, such as the hydrogen tanks and hydrogen tubes, are not included in the electric energy storage/conversion system. (Dispositif d’accumulation / de conversion / de génération d’énergie électrique)
**Electric energy storage device** means a high voltage source that can store energy, such as a battery or capacitor modules. *(Dispositif d’accumulation d’énergie électrique)*

**High voltage source** means any electric component that has a working voltage greater than 30 VAC or 60 VDC. *(Source de haute tension)*

**Propulsion system** means the components or electric circuit to propel the vehicle using the energy that is supplied by a high voltage source. These include, but are not limited to, the propulsion motor, electric converter, and associated wire harnesses and connectors, and coupling systems for charging rechargeable energy storage systems. *(Système de propulsion)*

**Working voltage** means the highest root mean square voltage of the voltage source, which may occur across its terminals or between its terminals and any conductive parts in open circuit conditions or under normal operating conditions. *(Tension de fonctionnement)*

**VAC** means volts of alternating current (AC). *(VCA)*

**VDC** means volts of direct current (DC). *(VCC)*

**S5. General requirements**

Each vehicle to which this TSD standard applies, must meet the requirements in S5.1, S5.2, and S5.3 when tested according to S6 under the conditions of S7.

**S5.1 Electrolyte spillage from propulsion batteries**

Not more than 5.0 liters of electrolyte from propulsion batteries shall spill outside the passenger compartment, and no visible trace of electrolyte shall spill into the passenger compartment. Spillage is measured from the time the vehicle ceases motion after a barrier impact test until 30 minutes thereafter, and throughout any static rollover after a barrier impact test.

**S5.2 Electric energy storage/conversion system retention**

All components of the electric energy storage/conversion system must be anchored to the vehicle. All component anchorages, including any brackets or structures that transfer loads from the component to the vehicle structure, shall remain attached to the vehicle structure at all attachment locations during and after testing performed pursuant to the procedures of S6 of this TSD standard.

**S5.3 Electrical safety**

After each test, each high voltage source in a vehicle must meet the electrical isolation requirements of subparagraph (a) or the voltage level requirements of subparagraph (b).

(a) The electric isolation between each high voltage source and the vehicle chassis electricity-conducting structure must meet one of the following:

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1 Please see subsection 305(5) of Schedule IV of the Motor Vehicle Safety Regulations (MVSR) for an additional requirement.
(1) Electrical isolation must be greater than or equal to 500 ohms/volt for all DC high
voltage sources without continuous monitoring of electrical isolation during vehicle
operation and for all AC high voltage sources; or

(2) Electrical isolation must be greater than or equal to 100 ohms/volt for all DC high
voltage sources with continuous monitoring of electrical isolation, in accordance with
the requirements of S5.4, during vehicle operation.

(b) The voltage of the voltage source must be less than or equal to 30 VAC for AC
components or 60 VDC for DC components.

S5.4 Electrical isolation monitoring

For each continuously monitored DC high voltage source, the continuous monitoring of
electrical isolation during vehicle operation referred to in S5.3(a)(2) must be achieved through
an electrical isolation monitoring system that displays a warning for loss of isolation when tested
according to S8. The system must monitor its own readiness and the warning display must be
clearly visible from the driver's designated seating position.

S6. Test requirements

Each vehicle to which this TSD standard applies, under the conditions of S7, must be capable of
meeting the requirements of any applicable single barrier crash/static rollover test sequence,
without alteration of the vehicle during the test sequence. A particular vehicle need not meet
further test requirements after having been subjected to a single barrier crash/static rollover test
sequence.

S6.1 Frontal barrier crash

The vehicle must meet the requirements of S5.1, S5.2, and S5.3 when it is traveling
longitudinally forward at any speed, up to and including 48 km/h, and impacts a fixed collision
barrier that is perpendicular to the line of travel of the vehicle, or at any angle up to 30 degrees in
either direction from the perpendicular to the line of travel of the vehicle.

S6.2 Rear moving barrier impact

The vehicle must meet the requirements of S5.1, S5.2, and S5.3, when it is impacted from the
rear by a barrier that conforms to S7.3(b) of the U.S. Code of Federal Regulations (CFR),
Title 49, Part 571, Standard No. 301 (hereinafter referred to as 49 CFR 571.301) of this chapter
and that is moving at any speed up to and including 80 km/h (50 mph) with dummies in
accordance with S6.2 of 49 CFR 571.301 of this chapter.

S6.3 Side moving deformable barrier impact

The vehicle must meet the requirements of S5.1, S5.2, and S5.3 when it is impacted from the
side by a barrier that conforms to 49 CFR part 587 of this chapter that is moving at any speed up

2 Please see subsection 305(2) of Schedule IV of the Motor Vehicle Safety Regulations (MVSReg) for an additional
requirement.

3 Please see subsection 305(4) of Schedule IV of the Motor Vehicle Safety Regulations (MVSReg) for an additional
requirement.
to and including 54 km/h, with the appropriate 49 CFR part 572 test dummies specified in 49 CFR 571.214 of this chapter.

S6.4 Post-impact test static rollover

The vehicle must meet the requirements of S5.1, S5.2, and S5.3, after being rotated on its longitudinal axis to each successive increment of 90 degrees after each impact test specified in S6.1, S6.2, and S6.3.

S7. Test conditions

When the vehicle is tested according to S6, the requirements of S5.1 through S5.3 must be met under the conditions specified in S7.1 through S7.7. All measurements for calculating voltage(s) and electrical isolation are made after a minimum of 5 seconds after the vehicle comes to rest in tests specified in S6. Where a range is specified, the vehicle must be capable of meeting the requirements at all points within the range.

S7.1 Electric energy storage device state of charge

The electric energy storage device is at the state of charge specified in subparagraphs (a), (b), or (c), as appropriate:

(a) At the maximum state of charge recommended by the manufacturer, as stated in the vehicle owner’s manual or on a label that is permanently affixed to the vehicle;

(b) If the manufacturer has made no recommendation in the owner's manual or on a label permanently affixed to the vehicle, at a state of charge of not less than 95 percent of the maximum capacity of the electric energy storage device; or

(c) If the electric energy storage device(s) is/are rechargeable only by an energy source on the vehicle, at any state of charge within the normal operating voltage defined by the vehicle manufacturer.

S7.2 Vehicle conditions

The switch or device that provides power from the high voltage system to the propulsion motor(s) is in the activated position or the ready-to-drive position.

S7.2.1 The parking brake is disengaged and the transmission, if any, is in the neutral position. In a test conducted under S6.3, the parking brake is set.

S7.2.2 Tires are inflated to the manufacturer’s specifications.

S7.2.3 The vehicle, including test devices and instrumentation, is loaded as follows:

(a) A passenger car is loaded to its unloaded vehicle weight plus its rated cargo and luggage capacity weight, secured in the luggage area, plus the necessary test

4 Please see subsection 305(3) of Schedule IV of the Motor Vehicle Safety Regulations (MVSR) for an additional requirement.
S7.3 Static rollover test conditions

In addition to the conditions of S7.1 and S7.2, the conditions of S7.4 of Sec. 49 CFR 571.301 of this chapter apply to the conduct of static rollover tests specified in S6.4.

S7.4 Rear moving barrier impact test conditions

In addition to the conditions of S7.1 and S7.2, the conditions of S7.3(b) and S7.6 of 49 CFR 571.301 of this chapter apply to the conducting of the rear moving deformable barrier impact test specified in S6.2.

S7.5 Side moving deformable barrier impact test conditions

In addition to the conditions of S7.1 and S7.2, the conditions of S8.9, S8.10, and S8.11 of 49 CFR 571.214 of this chapter apply to the conduct of the side moving deformable barrier impact test specified in S6.3.

S7.6 Electrical isolation test procedure

In addition to the conditions of S7.1 and S7.2, the conditions in S7.6.1 through S7.6.7 apply to the measuring of electrical isolation specified in S5.3(a).

S7.6.1 Prior to any barrier impact test, the high voltage source is connected to the vehicle's propulsion system, and the vehicle ignition is in the “on” (propulsion system energized) position. Bypass any devices or systems that do not allow the propulsion system to be energized at the time of impact when the vehicle ignition is on and the vehicle is in neutral. For a vehicle that utilizes an automatic disconnect between the high voltage source and the traction system that is physically contained within the high voltage electric energy storage/conversion/power generating system, the electrical isolation measurement after the test is made from the traction-system side of the automatic disconnect to the vehicle chassis electricity-conducting structure. For a vehicle that utilizes an automatic disconnect that is not physically contained within the high voltage electric energy storage/conversion/power generating system, the electrical isolation measurement after the test is made from both the high voltage source side and from the traction-system side of the automatic disconnect to the vehicle chassis electricity-conducting structure.

S7.6.2 The voltmeter used in this test has an internal resistance of at least 10 MΩ.

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5 Please see subsection 305(2) of Schedule IV of the Motor Vehicle Safety Regulations (MVSR) for an additional requirement.
S7.6.3 The voltage(s) is/are measured as shown in Figure 1 and the high voltage source voltage(s) (Vb) is/are recorded. Before any vehicle impact test, Vb is equal to or greater than the nominal operating voltage as specified by the vehicle manufacturer.

S7.6.4 The voltage(s) is/are measured as shown in Figure 2, and the voltage(s) (V1) between the negative side of the high voltage source and the vehicle chassis electricity-conducting structure is/are recorded.

S7.6.5 The voltage(s) is/are measured as shown in Figure 3, and the voltage(s) (V2) between the positive side of the high voltage source and the vehicle chassis electricity-conducting structure is/are recorded.

S7.6.6 If V1 is greater than or equal to V2, insert a known resistance (Ro) between the negative side of the high voltage source and the vehicle chassis electricity-conducting structure. With the Ro installed, measure the voltage (V1’) as shown in Figure 4 between the negative side of the high voltage source and the vehicle chassis electricity-conducting structure. Calculate the electrical isolation resistance (Ri) according to the formula shown. Divide Ri (in ohms) by the working voltage of the high voltage source (in volts) to obtain the electrical isolation (in ohms/volt).

S7.6.7 If V2 is greater than V1, insert a known resistance (Ro) between the positive side of the high voltage source and the vehicle chassis electricity-conducting structure. With the Ro installed, measure the voltage (V2’) as shown in Figure 5 between the positive side of the high voltage source and the vehicle chassis electricity-conducting structure. Calculate the electrical isolation resistance (Ri) according to the formula shown. Divide Ri (in ohms) by the working voltage of the high voltage source (in volts) to obtain the electrical isolation (in ohms/volt).

S7.7 Voltage measurement.

For the purposes of determining low voltage source specified in S5.3(b), voltage is measured as shown in Figure 1. Voltage Vb is measured across the two terminals of the voltage source. Voltages V1 and V2 are measured between the source and the vehicle chassis electricity-conducting structure.

S8 Test procedure for on-board electrical isolation continuous monitoring system.

Prior to any impact test, the requirements of S5.4 for the on-board electrical isolation continuous monitoring system shall be confirmed using the following procedure.

1. The electric energy storage device is at the state of charge specified in S7.1.
2. The switch or device that provides power from the high voltage system to the propulsion motor(s) is in the activated position or the ready-to-drive position.
3. Determine the isolation resistance, Ri, of the high voltage source with the electrical isolation monitoring system using the procedure outlined in S7.6.2 through S7.6.7.
4. Insert a resistor with resistance equal to Ro=1/(1/(95 times the working voltage of the high voltage source)—1/Ri) between the positive terminal of the high voltage source and the vehicle chassis electric conducting structure.
The electrical isolation monitoring system indicator shall display a warning to the driver.

Figure 1 — S7.6.3 and S7.7 Measurement of Voltage Source Voltage
Vehicle Chassis

Power Generating Device Assembly

HV Source

Energy Storage Device Assembly

+ 

Power Generating Device

- 

Energy Storage Device

Loads

V1

Vehicle Chassis

Figure 2 — S7.6.4 Measurement for V1 Voltage between the Negative Side of the High Voltage Source and the Vehicle Chassis Electricity-Conducting Structure
Figure 3 — S7.6.5 Measurement for V2 Voltage between the Positive Side of the High Voltage Source and the Vehicle Chassis Electricity-Conducting Structure
Figure 4 — S7.6.6 Measurement for V1’ Voltage across Resistor between Negative Side of the High Voltage Source and Vehicle Chassis Electricity-Conducting Structure

R_i = R_o \left(1 + \frac{V_2}{V_1}\right) \frac{(V_1 - V_1')}{V_1'}
Figure 5 — S7.6.7 Measurement for V2' Voltage across Resistor between Positive Side of High Voltage Source and Vehicle Chassis Electricity-Conducting Structure

\[ R_l = R_o \frac{(1+V_1/V_2)((V_2-V_2')/V_2')}{V_2'} \]