Technical rationale and justification

130. The purpose of this test is to verify the safety performance of the REESS under a vibration environment which the REESS would likely experience during the normal operation of the vehicle.

131. The vibration of the battery pack is caused by the random vibration of the vehicle during operation. So the actual vehicle operation data should be used to develop the vibration spectrum of the battery pack. Specifically, different types of vehicles were tested on typical road surfaces. The vibration spectrum is obtained by analyzing and normalizing the collected data.

132. In many cases, the vehicle manufacturer assesses the vehicle's durability with full vehicle simulation, either by running a rough road test track or by simulating the lifetime fatigue on a 4-poster vibration rig. These methods provide a vehicle specific assessment of the durability of all vehicle components and should be accepted in this context. Guidelines for using manufacture's profile should be given.

Vibration test for REESS or REESS subsystem(s) on vehicles of Classes M_1 and N_1

Requirement

The test shall be conducted in accordance with paragraph 6.2.2. During the test, there shall be no evidence of rupture (applicable to high voltage REESS only), electrolyte leakage, venting (for REESS other than open-type traction battery), fire or explosion.

The evidence of electrolyte leakage shall be verified by visual inspection without disassembling any part of the Tested-Device. An appropriate technique shall, if necessary, be used in order to confirm if there is any electrolyte leakage from the REESS resulting from the test. The evidence of venting shall be verified by visual inspection without disassembling any part of the Tested-Device.

For a high voltage REESS, the isolation resistance measured after the test in accordance with paragraph 6.1.1 shall not be less than 100 Ω/V.

Test procedure

6.2.2.1. Purpose.

The purpose of this test is to verify the safety performance of the REESS under a vibration environment which the REESS will likely experience during the normal operation of the vehicle.

6.2.2.2. Installations.

6.2.2.2.1. This test shall be conducted either with the complete REESS or with REESS subsystem(s). If the manufacturer chooses to test with REESS subsystem(s), the manufacturer shall demonstrate that the test result can reasonably represent the performance of the complete REESS with respect to its safety performance under the same conditions. If the electronic management control unit for the REESS is not integrated in the casing enclosing the cells, then the electronic management unit may be omitted from installation on the Tested-Device if so requested by the manufacturer.

6.2.2.2.2. The Tested-Device shall be firmly secured to the platform of the shaker table in such a manner as to ensure that the vibrations are directly transmitted to the Tested-Device.

The Test-Device should be mounted with its original mounting points and brackets as mounted in the vehicle. The brackets should be firmly secured to the vibration table in such a manner as to ensure that the vibration loads are directly transmitted to the brackets of the Tested-Device.

6.2.2.3. Procedures.

6.2.2.3.1. General test conditions.

The following conditions shall apply to the Tested-Device:

(a) The test shall be conducted at an ambient temperature of 22 ± 5 °C;

(b) At the beginning of the test, the SOC shall be adjusted in accordance with the paragraph 6.2.1.2.;

(c) At the beginning of the test, all protection devices which affect the function(s) of the Tested-Device that are relevant to the outcome of the test shall be operational.

6.2.2.3.2. Test procedures

For REESS or REESS subsystem(s) on vehicles of classes M_1 and N_1, the vibration test parameters shall be based on Table 1 and Figure 1.

Table 1 Vibration test conditions for battery packs or systems on vehicles of Classes M_1 and N_1

Random vibration			
Frequency Hz	Power spectral density (PSD) of z axis, g^2/Hz	Power spectral density (PSD) of y axis, g^2/Hz	Power spectral density (PSD) of x axis, g^2/Hz
5	0.015	0.002	0.006
10	/	0.005	/
15	0.015	/	/
20	/	0.005	/
30	/	/	0.006
65	0.001	/	/
100	0.001	/	/
200	0.0001	0.00015	0.00003
RMS	0.64g	0.45g	0.50g
Time	12h	12h	12h
Sinusoidal constant frequency vibration			
Amplitude	±1.5g	±1.0g	±1.0g
Frequency	24Hz	24Hz	24Hz
Time	1h	1h	1h

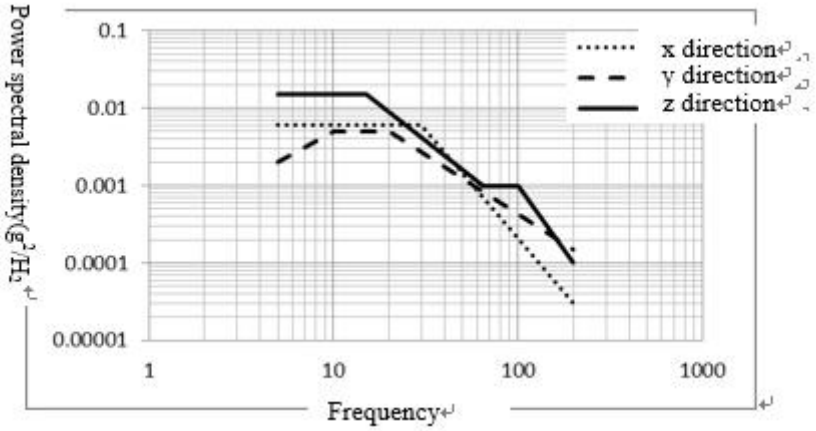

Figure 1 Random vibration test curve for battery packs or systems on vehicles of Classes M_1 and N_1

During the test, the cell voltage and temperature shall be monitored.

Note: termination condition of sharp voltage change provided by the manufacturer, where a test terminated based on using such a condition shall be treated as to fail.

If the test subject has multiple mounting directions (x/y/z), the test shall be performed in the direction with the largest RMS. For battery packs or systems mounted on the vehicle top, the test shall be performed under the vibration test parameters provided by the manufacturer (but not less than those in Table 1 and Figure 1).

At the request of the manufacturer, a higher acceleration level as well as a higher maximum frequency may be used.

At the choice of the manufacturer, a vibration test profile determined by the vehicle manufacturer verified for the vehicle application may be used as a substitute for the frequency - acceleration correlation of Table 1. The REESS certified according to this condition shall be limited to the installation for a specific vehicle type.

The test shall end with an observation period of 2 hour at the ambient temperature conditions of the test environment.

Vibration test for REESS or REESS subsystem(s) on vehicles other than Classes M_1 and N_1

Requirement

The test shall be conducted in accordance with paragraph 8.2.2. During the test, there shall be no evidence of rupture (applicable to high voltage REESS only), electrolyte leakage, venting (for REESS other than open-type traction battery), fire or explosion.

The evidence of electrolyte leakage shall be verified by visual inspection without disassembling any part of the Tested-Device. An appropriate technique shall, if necessary, be used in order to confirm if there is any electrolyte leakage from the REESS resulting from the test. The evidence of venting shall be verified by visual inspection without disassembling any part of the Tested-Device.

For a high voltage REESS, the isolation resistance measured after the test in accordance with paragraph 6.1.1. shall not be less than 100 Ω/V.

Test procedure

8.2.2.1. Purpose.

The purpose of this test is to verify the safety performance of the REESS under a vibration environment which the REESS will likely experience during the normal operation of the vehicle.

8.2.2.2. Installations.

8.2.2.2.1. This test shall be conducted either with the complete REESS or with REESS subsystem(s). If the manufacturer chooses to test with REESS subsystem(s), the manufacturer shall demonstrate that the test result can reasonably represent the performance of the complete REESS with respect to its safety performance under the same conditions. If the electronic management control unit for the REESS is not integrated in the casing enclosing the cells, then the electronic management unit may be omitted from installation on the Tested-Device if so requested by the manufacturer.

8.2.2.2.2. The Tested-Device shall be firmly secured to the platform of the vibration table in such a manner as to ensure that the vibrations are directly transmitted to the Tested-Device.

The Test-Device should be mounted with its original mounting points and brackets as mounted in the vehicle. The brackets should be firmly secured to the platform of the vibration machine in such a manner as to ensure that the vibration loads are directly transmitted to the mounting points of the Tested-Device.

8.2.2.3. Procedures.

8.2.2.3.1. General test conditions.

The following conditions shall apply to the Tested-Device:

(a) The test shall be conducted at an ambient temperature of 22 ± 5 °C;

(b) At the beginning of the test, the SOC shall be adjusted in accordance with the paragraph 6.2.1.2.;

(c) At the beginning of the test, all protection devices which affect the function(s) of the Tested-Device that are relevant to the outcome of the test shall be operational.

8.2.2.3.2. Test procedures.

For REESS or REESS subsystem(s) on vehicles other than Classes M_1 and N_1, the vibration test parameters shall be based on Table 2 and Figure 2.

Table 2 Vibration test conditions for battery packs or systems on vehicles other than Classes M_1 and N_1

Random vibration			
Frequency Hz	Power spectral density (PSD) of z axis, g^2/Hz	Power spectral density (PSD) of y axis, g^2/Hz	Power spectral density (PSD) of x axis, g^2/Hz
5	0.008	0.005	0.002
10	0.042	0.025	0.018
15	0.042	0.025	0.018
40	0.0005	/	/
60	/	0.0001	/
100	0.0005	0.0001	/
200	0.00001	0.00001	0.00001
RMS	0.73g	0.57g	0.52g
Time	12h	12h	12h
Sinusoidal constant frequency vibration			
Amplitude	±1.5g	±1.5g	±2.0g
Frequency	20Hz	20Hz	20Hz
Time	2h	2h	2h

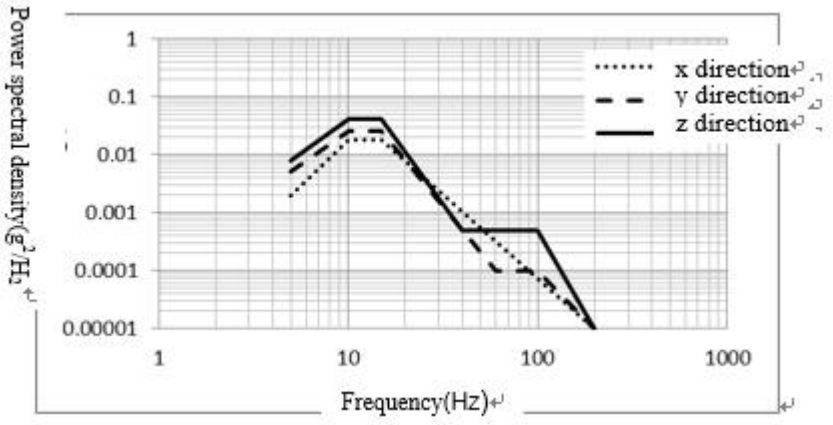

Figure 2 Random vibration test curve for battery packs or systems on vehicles other than Classes M_1 and N_1

During the test, monitor the state of the minimum monitoring unit in the test subject, such as voltage and temperature.

Note: termination condition of sharp voltage change provided by the manufacturer, where a test terminated based on using such condition shall be judged to fail.

If the test subject has multiple mounting directions (x/y/z), the test shall be performed in the direction with the largest RMS. For battery packs or systems mounted on the vehicle top, the test shall be performed under the vibration test parameters provided by the manufacturer (but not less than those in Table 2 and Figure 2).

At the request of the manufacturer, a higher acceleration level as well as a higher maximum frequency may be used.

At the choice of the manufacturer, a vibration test profile determined by the vehicle manufacturer verified for the vehicle application may be used as a substitute for the frequency - acceleration correlation of Table 2. The REESS certified according to this condition shall be limited to the installation for a specific vehicle type.

The test shall end with an observation period of 2 hour at the ambient temperature conditions of the test environment.