

JRC comments and questions on the CN draft of the
regulatory text for the GTR EVS vibration test

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Draft proposal

Technical rationale and justification

See
note

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.

See
note

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.

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 .

CN #130-#131.

JRC Opinion (in agreement with CN #130-#131) → The vibration test within the GTR-EVS is an “in-use” test of the rechargeable electric energy storage system (REESS), which is likely to experience vibrations during its operation potentially resulting in a safety hazard. **JRC would agree to keeping a vibration test in GTR, considering it a minimum safety requirement. Nevertheless, this minimum safety requirement could be adjusted by making the vibration profile more representative of what a battery is typically exposed to in an electric vehicle (EV).**

CN #132.

JRC comment/question: What is the reason of including #132? Introduces the term “durability”; here, we are discussing the vibration test/profile in the context of “safety”. Of course [OICA spotted it too], vibration tests will anyway be conducted for reliability and durability. However, simulations cannot represent and substitute a real test.

132 contradicts 130

Suggestion: Delete 132 → it contradicts the purpose of the test as shown in 6.2.2.1

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Requirement

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 vibration machine 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 holders as mounted in the vehicle. The holders should be firmly secured to the platform of vibration machine in such a manner as to ensure that the vibrations are directly transmitted to the holders of the Tested-Device.

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6.2.2.3. Procedures

6.2.2.3.1. General test conditions

See note

The following conditions shall apply to the Tested-Device:

- (a) The test shall be conducted at an ambient temperature of $22 \pm 5^\circ \text{C}$;
- (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.

See note

6.2.2.3.2. Test procedures

For REESS or REESS subsystem(s) on vehicles of classes M1 and N1, 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 M1 and N1

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

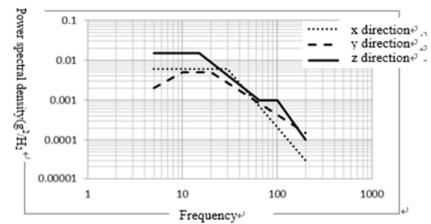


Figure 1 Random vibration test curve for battery packs or systems on vehicles of Classes M1 and N1

See CN 6.2.2.3.1

JRC Opinion (in agreement with CN 6.2.2.3.1) → Regarding the testing conditions, JRC is in favor of performing the vibration test at the maximum normal operating state of charge (SOC), whereas for the temperature, JRC is in favor of requiring test at room temperature, defined as $22^\circ\text{C} \pm 5^\circ\text{C}$ for the REESS-level tests in the current GTR No.20.

See CN 6.2.2.3.2

JRC Opinion (in agreement with CN 6.2.2.3.2) → If a random vibration test profile would be considered as an alternative to the current GTR No.20 sine wave test profile, **JRC could agree on the lower and upper frequency values, i.e., 5 Hz and 200 Hz, respectively, as proposed in both China's and OICA's proposals**

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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).

See
note

At the choice of the manufacturer, a vehicle specific vibration test profile determined by the vehicle manufacturer verified for the vehicle application may be used as a substitute for the vibration profile in Table 1 and Figure 1. The vehicle specific vibration profile determined by the vehicle manufacturer is made based on actual vehicle driving test data. The RMS value in each direction of the vehicle specific vibration profile shall be more than the value in Table 2.

Table 2 — Minimum Values for PSD in Each Direction

Items	RMS (m/s ²)
PSD value in Z-directions	2.64
PSD value in X-directions	2.34
PSD value in Y-directions	2.51

Test time is 12h or more. Shorter test time is applicable if certain rationale, such as application of time acceleration factor, is provided by the manufacturer.

JRC Opinion (in agreement with **CN 6.2.2.3.2**) → JRC would be in favor to allow for manufacturer vibration test profiles to be applied in the context of the GTR, with vibration profile based on vehicle-specific vibration inputs. In that case, manufacturer's vibration test profiles should be accompanied with the appropriate justification documentation – the corresponding necessary information and guidelines should be discussed and agreed in the GTR-EVS.

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The REESS certified according to this condition shall be limited to the installation for a specific vehicle type. In case that a vehicle specific vibration profile is applied, certain justification of the profile will be required in a documented manner. In such case, the vibration test results can also be a part of the documentation and the vibration test by the technical service may be omitted.

See
note

Confidentiality requirements requested by the manufacture regarding vibration test conditions and rationales of the vehicle specific vibration profile shall be carefully considered by the technical service.

After the vibration profile, a standard cycle as described in paragraph 6.2.1.1. shall be conducted, if not inhibited by the Tested-Device.

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

JRC comment: Documentation alone would weaken the current requirement. Technical service still needs to perform the test.

JRC Opinion → JRC would be in favor to allow for manufacturer vibration test profiles to be applied in the context of the GTR, with vibration profile based on vehicle-specific vibration inputs. **In that case, manufacturer's vibration test profiles should be accompanied with the appropriate justification documentation – the corresponding necessary information and guidelines should be discussed and agreed in the GTR-EVS.**

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6.2.2.3. Procedures

Vibration test for REESS or REESS subsystem(s) on vehicles other than Classes M1 and N1

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.

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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.

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See note 8.2.2.3.2. Test procedures

For REESS or REESS subsystem(s) on vehicles other than Classes M1 and N1, the vibration test parameters shall be based on Table 3 and Figure 2.

Table 3 Vibration test conditions for battery packs or systems on vehicles other than Classes M1 and N1

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

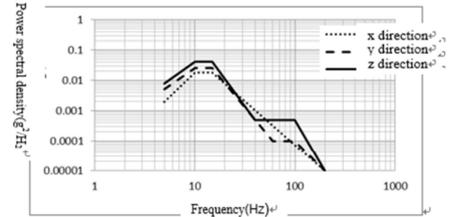


Figure 2 Random vibration test curve for battery packs or systems on vehicles other than Classes M1 and N1

JRC comment/question: Would it not be possible to be more specific defining vehicles “other than M1, N1”?

Suggestion: to specify clearly the “other than M1, N1 vehicles” term. (For less demanding applications what should happen?)

JRC Opinion → Based on the data shared by China on the vibration test parameters and profiles, JRC would be in favor of requiring different vibration test parameters for category M1, N1 vehicles as compared to vehicles of other categories. Nevertheless, JRC would welcome more data, also from other stakeholders, to demonstrate the need for such differentiation and to define the vibration test parameters for vehicles of categories other than M1, N1.

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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 3 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.

Note

Question: What is meant specifically with the term “vehicle type”? Is there any link with type approval?

JRC Opinion → JRC would be in favor to allow for manufacturer vibration test profiles to be applied in the context of the GTR, with vibration profile based on vehicle-specific vibration inputs. In that case, manufacturer’s vibration test profiles should be accompanied with the appropriate justification documentation – the corresponding necessary information and guidelines should be discussed and agreed in the GTR-EVS.