IEC/TR 62131-3

Edition 1.0 2011-02

TECHNICAL REPORT

colour inside

Environmental conditions – Vibration and shock of electrotechnical equipment – Part 3: Equipment transported in rail vehicles

IEC/TR 62131-3:2011(E)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

PRICE CODE X

ICS 19.040

ISBN 978-2-88912-388-9

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ENVIRONMENTAL CONDITIONS – VIBRATION AND SHOCK OF ELECTROTECHNICAL EQUIPMENT –

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FOREWORD

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IEC/TR 62131-3, which is a technical report, has been prepared by IEC technical committee 104: Environmental conditions, classification and methods of test.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
104/508/DTR	104/537/RVC

Full information on the voting for the approval of this technical report can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2. A list of all the parts in the IEC 62131 series, under the general title *Environmental conditions – Vibration and shock of electrotechnical equipment*, can be found on the IEC website.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this standard may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

ENVIRONMENTAL CONDITIONS – VIBRATION AND SHOCK OF ELECTROTECHNICAL EQUIPMENT –

Part 3: Equipment transported in rail vehicles

1 Scope

IEC/TR 62131-3, which is a technical report, reviews the available dynamic data relating to electrotechnical equipment transported by rail vehicles. The intent is that from all the available data an environmental description will be generated and compared to that set out in IEC 60721.

For each of the sources identified the quality of the data is reviewed and checked for self consistency. The process used to undertake this check of data quality and that used to intrinsically categorize the various data sources is set out in IEC/TR 62131-1.

This technical report primarily addresses data extracted from a number of different sources for which reasonable confidence exist as to their quality and validity. The assessment also presents data for which the quality and validity cannot realistically be reviewed. These data are included to facilitate validation of information from other sources. The report clearly indicates when it utilizes information in this latter category.

This technical report addresses vibration and shock data from three different measurement exercises, i.e. one on the UK rail system and two on the USA rail system. Although one of these relates to a multimodal system in limited use world wide, data from it are included to facilitate validation of information from other sources. The vast majority of the rail measurements reviewed are from the USA and the remainder from Western Europe. Some of the data sources considered indicate the inclusion of some quite old vehicles. It has not been possible to identify the rail data considered in setting the existing IEC 60721 severities.

Although the majority of the measurement exercises considered in this technical report supplied both vibration and shock information, a number of measurement exercises are biased towards the shock conditions of rail transportation. The severity and incidence of shocks is mostly related to the occurrence shunting of individual wagons. The occurrence of shunting of individual wagons is in turn dependant upon the operational strategy adopted by the national rail systems. A significant number of rail systems no longer adopt methods of operation which assemble train sets when the wagons are carrying sophisticated goods (carriage of bulky raw minerals is a common exception). Other rail systems purposely utilize good quality wagons and/or procedures of operation to significantly mitigate shunting loads. These strategies are intended to minimize shock severities for sensitive equipment such as electrotechnical equipment.

Relatively little of the data reviewed have been available in electronic form. To permit comparison a quantity of the original (non-electronic) data have been manually digitized in this techical report.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60068-2 (all parts), *Environmental testing – Part 2: Tests*

IEC 60721 (all parts), *Classification of environmental conditions*

IEC 60721-3 (all parts), *Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities*

IEC 60721-3-2:1997, *Classification of environmental conditions – Part 3: Classification of groups of environmental parameters and their severities – Section 2: Transportation*

IEC/TR 60721-4-2, *Classification of environmental conditions – Part 4-2: Guidance for the correlation and transformation of environmental condition classes of IEC 60721-3 to the environmental tests of IEC 60068 – Transportation*

3 Data source and quality

3.1 UK rail measurements

The vibration data in [1][1] from the UK rail system are relatively old (1980) and were commissioned by the UK MOD to summarize existing knowledge of the shock and vibration environments experienced by goods exposed to UK rail transit. The report initially sets out the five methods of operation used at that time within the UK. However, several of these are no longer adopted.

The report indicates that the major factors creating vibration environment within a vehicle are as follows:

– vehicle running gear characteristics (suspension, wheelbase, etc.);

– track condition;

– vehicle speed;

– vehicle lading condition.

This techical report contains vibration information indicated as from “worst case” vehicles (two axle, short wheelbase, simple-suspension), intermediate suspension vehicles (longer wheelbase) and advanced suspension vehicles (long wheelbase, bogie good suspension and air brakes). The data are relatively low frequency (less than 100 Hz) but beyond the low pass filter frequency (10 Hz to 20 Hz – the report is not specific as to the actual roll-off frequency). The report admits that higher frequency content does exist but has no general information. Although it does indicate that with a rail sleeper spacing of approximately 0,7 m, a vertical component between 20 Hz and 40 Hz would be expected for speeds of 50 km/h to 100 km/h. The report does not supply any information as to the statistical errors on the measured data including the duration of measurements. Nor are any specific information supplied as to the exact location of the transducers or the specific vehicles used.

The report indicates that shocks, particularly longitudinally, can occur between two vehicles during running as a consequence of vehicle-to-vehicle interaction arising from traction, braking and gradient effects. The severity of such shocks is generally determined by the vehicle coupling arrangement and braking condition. Vehicles may be equipped with vacuum brakes, air brakes or none at all. Coupling between wagons may allow longitudinal movement (loose coupled) or none at all (tight coupled).

The report indicates that major shocks are attributed to heavy impact shunting in marshalling yards. The shocks severity is dependant upon impact speed, buffering gear characteristics and total mass of the wagon. The report explains two types of buffer are used: spring and hydraulic. The older spring buffers limit longitudinal accelerations until the springs close solid, typically at an impact speed of approximate 8 km/h, after which the acceleration levels rise rapidly. As the springs are linear energy storage systems, when the stored energy is released it can cause “shuttling” of the vehicles. As springs are linear, the impact shock is approximate to a classic half sine. Hydraulic buffers are fitted to newer wagons and are specifically intended to mitigate

[1] References in square brackets refer to the bibliography.