

TECHNICAL REPORT



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



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TECHNICAL REPORT



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

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CONTENTS

FOREWORD.....	5
1 Scope.....	7
2 Normative references.....	7
3 Data source and quality	8
3.1 UK rail measurements	8
3.2 Association of American Railroads – Lengthways shocks	9
3.3 Association of American Railroads – Intermodal environment.....	10
3.4 Association of American Railroads – Study of the shock and vibration environment in boxcars.....	10
3.5 Association of American Railroads – Study of the railroad shock and vibration environment for railroader equipment.....	11
3.6 Supplementary data.....	11
4 Intra data source comparison.....	12
4.1 General remark	12
4.2 UK Rail measurements	12
4.3 Association of American Railroads – Lengthways shocks	13
4.4 Association of American Railroads – Intermodal environment.....	13
4.5 Association of American Railroads – Study of the shock and vibration environment in boxcars.....	14
4.6 Association of American Railroads – Study of the railroad shock and vibration environment for railroader equipment.....	14
4.7 Supplementary data.....	15
5 Inter data source comparison.....	15
6 Environmental description.....	17
7 Comparison with IEC 60721	18
8 Recommendations	20
Bibliography	49
Figure 1 – British Rail measured vertical vibration severities.....	22
Figure 2 – British Rail measured lateral vibration severities	22
Figure 3 – British Rail measurements distribution of shunting velocities	23
Figure 4 – Association of American Railroads – Lengthways shock measurements – example shock pulses	24
Figure 5 – Association of American Railroads – Lengthways shock measurements – comparison of positive peak acceleration	25
Figure 6 – Association of American Railroads – Lengthways shock measurements – comparison of negative peak acceleration	25
Figure 7 – Association of American Railroads – Lengthways shock measurements – comparison of rms acceleration.....	26
Figure 8 – Association of American Railroads – Lengthways shock measurements – comparison of crest factor	26
Figure 9 – Association of American Railroads – Lengthways shock measurements – comparison of change of velocity.....	27
Figure 10 – Association of American Railroads – Lengthways shock measurements – comparison of filtered peak acceleration.....	27
Figure 11 – Association of American Railroads – Intermodal study - amplitude probability in longitudinal axis.....	28

Figure 12 – Association of American Railroads intermodal study – amplitude probability in lateral axis	29
Figure 13 – Association of American Railroads intermodal study – amplitude probability in vertical axis	30
Figure 14 – Association of American Railroads – Intermodal study – vertical axis spectral values	32
Figure 15 – Association of American Railroads – Intermodal study – lateral axis spectral values	32
Figure 16 – Association of American Railroads – Intermodal study – longitudinal axis spectral values	33
Figure 17 – Association of American Railroads – Boxcar measurements – vertical axis spectral values	33
Figure 18 – Association of American Railroads – Boxcar measurements – lateral axis spectral values	34
Figure 19 – Association of American Railroads – Boxcar measurements – longitudinal axis spectral values	34
Figure 20 – Association of American Railroads – Cushioned boxcar measurements – middle of car	35
Figure 21 – Association of American Railroads – Cushioned boxcar measurements – end of car	35
Figure 22 – Association of American Railroads – Standard boxcar measurements – middle of car	36
Figure 23 – Association of American Railroads – Standard boxcar measurements – end of car	36
Figure 24 – Association of American Railroads – Railroader measurements – peak spectral value	37
Figure 25 – Association of American Railroads – Railroader measurements – amplitude probabilities	38
Figure 26 – Johnson – Reported measurements – spring buffers	39
Figure 27 – Johnson – Reported measurements hydraulic buffers	39
Figure 28 – Johnson – Reported measurements – probability of occurrence	40
Figure 29 – Foley – Reported measurements – frequency distribution	40
Figure 30 – Foley – Reported measurements – recurrent events	41
Figure 31 – Foley – Reported measurements – intermittent events	41
Figure 32 – GAM-EG-13 – Reported measurements – longitudinal axis	42
Figure 33 – GAM-EG-13 – Reported measurements – lateral axis	42
Figure 34 – GAM-EG-13 – Reported measurements – vertical axis	43
Figure 35 – GAM-EG-13 – Reported measurements - longitudinal shocks	43
Figure 36 – GAM-EG-13 – Reported measurements– vertical shocks	44
Figure 37 – ASTM D4728-95 – Reported measurements	44
Figure 38 – IEC 60721-3-2 (1997) – Random vibration severity	45
Figure 39 – IEC 60721-4-2 (1997) – Random vibration severity	45
Figure 40 – IEC 60721-3-2 (1997) – Sinusoidal vibration severity	46
Figure 41 – IEC 60721-4-2 (1997) – Sinusoidal vibration severity	46
Figure 42 – IEC 60721-3-2 (1997) – Shock severity	47
Figure 43 – IEC 60721-4-2 (1997) – Shock severity	47
Figure 44 – IEC 60721-4 (1997)– Recommended repeated shock severity	48

Table 1 – British Rail measurements summary of vibration measurements.....	23
Table 2 – Association of American Railroads intermodal study as it relates to Figure 11.....	28
Table 3 – Association of American Railroads – Intermodal study as it relates to Figure 12.....	29
Table 4 – Association of American Railroads – Intermodal study as it relates to Figure 13.....	30
Table 5 – Association of American Railroads intermodal study – summary of results from shock measurements	31
Table 6 – Association of American Railroads intermodal study– summary of results from vibration measurements	31
Table 7 – Association of American Railroads – Boxcar measurements – distribution of shocks	37
Table 8 – Association of American Railroads – Railroader measurements as they related to Figure 25.....	38

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ENVIRONMENTAL CONDITIONS –
VIBRATION AND SHOCK OF ELECTROTECHNICAL EQUIPMENT –****Part 3: Equipment transported in rail vehicles**

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.

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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 technical 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 technical 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.