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TECHNICAL REPORT

Environmental conditions – Vibration and shock of electrotechnical equipment – Part 1: Process for validation of dynamic data

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FOREWORD

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IEC/TR 62131-1, 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
104/506/DTR	104/535/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.

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- withdrawn,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.

INTRODUCTION

A major reservation, identified early in the work of IEC technical committee 104 (working group 15) to collate dynamic environmental data, was the lack of fully validated data sets. In the absence of fully validated dynamic information, an essentially empirical data validation procedure has had to be adopted. The process set out in this technical report is intended to be generic in nature and is normally expected to be adopted as far as is practical within the circumstances of any particular data item.

In most cases, a fully quantified validation approach is not possible; as a consequence, the alternative approach set out in this technical report has been adopted. The approach is fundamentally an exercise in building confidence that the data were acquired and analysed in a competent manner. Such confidence is essential if the data is to form a reasonable basis for establishing trends and quantifying environmental conditions. A fundamental consequence of the absence of fully validated data sets is that no single data set can be entirely relied upon to quantify any dynamic environmental condition. As will be seen, a minimum of three independent data sets are required to complete the third phase of the verification process. All of these data sets should have met the preceding two data verification phases.

The validation process is set out in three phases. The intent is that each phase builds on the one preceding it and are normally undertaken in the order indicated. The data are firstly reviewed as individual records, then as a complete data set and lastly as compared with other similar data sets. The process set out in this technical report retains some quantitative requirements but becomes increasingly more subjective as the process proceeds.

The process, as set out, is neither novel nor innovative but is rather the logical check list that the majority of assessors of dynamical data work through prior to utilizing any measured information. The process as described below is primarily that for vibration data; the process for shock is essentially identical.

The verification process as described within this technical report is intrinsically embedded within the technical reports which assess the available measured dynamic data from various sources. In those reports the verification process is undertaken prior to the derivation of any environmental descriptions or test severity derivation. The verification process is not used to reject data but rather to categorize confidence in that data. In the assessment reports, the three phases of verification are undertaken under the headings “Data source and quality”, “Intra data source comparison” and “Inter data source comparison”. Under these headings the reports summarize how well each data source meets the criteria set out in this technical report.

ENVIRONMENTAL CONDITIONS – VIBRATION AND SHOCK OF ELECTROTECHNICAL EQUIPMENT –

Part 1: Process for validation of dynamic data

1 Scope

IEC/TR 62131-1, which is a technical report, reviews the essentially empirical data validation procedure adopted to establish confidence in the data utilized by the other Parts of IEC/TR 62131. The adoption of a validation procedure was necessary, due the lack of fully validated data sets.

This technical report is intended to be generic in nature and is normally expected to be adopted as far as is practical within the circumstances of any particular data item.

2 Normative references

None.

3 Data source and quality (undertaken on a single data item)

The purpose of this phase is to review each individual record to establish that it appears consistent. The main tools in this are the visual appearance of the data and consideration of its accompanying error assessment. It is acknowledged that few data items are accompanied by a full error assessment. However, the use of data items accompanied by no error assessment is at best questionable as they may prove to be entirely worthless. The extent of any error assessment is often a guide to the competence and care taken in the data acquisition exercise. Assessment of the data quality of each data item would normally include consideration of the following aspects.

a) title and labelling: a data item is only of use if it is possible to identify (as a minimum) the location and axis of measurement as well as the conditions in which it was made in (such as speed, event, surface type etc.). Whilst such labelling is unlikely to be entirely adequate, the data user should not be in a position of having to make significant judgements as to the conditions and locations to which the data refers. A significant problem is that frequently, at the time of the test, inadequate information is recorded;

b) appearance: the trace characteristics of many measurement and analysis faults can be identified from the appearance of the data alone. Whilst the identification of such trace characteristics may not be conclusive they are often “warning signs” of problems justifying further appraisal;

c) measurement errors: in some instances estimates of errors of the entire measurement system are quoted. More frequently a “noise” measurement is made. This may be a specific channel set up to measure background noise or it may be from an otherwise non-operating platform. When neither are available, it is sometimes possible to identify a condition which can be treated, for practical purposes, as a measure of the background noise. As a minimum, the data user must be confident that the characteristics under investigation have not been unduly modified by measurement noise and errors;

d) analysis errors: any analysis should be accompanied by information indicating the parameters adopted in undertaking the analysis. This should also include information from which the variability and errors arising from the analysis process can be established.

Most data likely to be subject to the data validation process will have been analysed digitally. In such cases the conversion from analogue measurements to digital form can introduce errors. As a consequence, some knowledge of the process adopted is required, i.e. at least sample rate and filter frequency. The data recording strategy may also have a direct interaction with the data analysis process. This is particularly true when using digital recorders which store data "intermittently" according to some defined criteria. In such instances, knowledge of the recording process and criteria is essential. It remains advantageous, in all other cases, as the recording medium frequently sets limits on frequency, noise, etc.

4 Intra data source comparison (undertaken on a data ensemble)

The purpose of this phase is to establish that the data set, as a whole, is self consistent. This usually involves verifying that any trends and characteristics are consistent across the data set. The extent to which trends exist within the data will depend upon the conditions in which the measurements were made and knowledge of the those conditions is important. For measurements intended to quantify the excitation conditions, the following questions can usually be posed;

– axes: are the variations in amplitude and characteristics between different axis sets consistent?
– location; are the variations in amplitude and characteristics between different measurement locations consistent?
– measurement conditions: are variations in amplitude and characteristics between different measurement conditions consistent?
– trends: can specific trends be identified (and quantified) within the data and are these trends consistent across the data set?

Bearing in mind that data analysis is also a data reduction process, the inherent assumptions in each analysis process should be verified. A good example is that the commonly adopted power spectral density analysis requires data stationarity (that is not time variant); establishing this should precede any analysis. Statements on verification of inherent assumptions should either be presented in an accompanying assessment or in a supporting data analysis. Generally, data from just a single data analysis process should be regarded with some reservation unless supported by other data sets or by a reasonable assessment indicating that such checks have been made.

5 Inter data source comparison (undertaken on several data sources)

The purpose of this phase is to establish that the data set is comparable with other similar data sets or, failing that, with expectations. This usually requires some knowledge of the physical meaning of the data character. In order to have confidence in any comparison, a minimum of three independent data sets are required. These should all meet the preceding two data verification phases. Two common questions of the data set can be made at this stage:

– are significant features of the results from the data analysis consistent? Almost all excitation sources exhibit some features which are consistent. Such consistency usually arises because of the physical attributes of the excitation. Some features may be a measure of the excitation source and others related to the dynamic characteristics of the platform on which the measurements are made;
– are underlying severities consistent? Most excitation sources are limited by intrinsic limitations imposed either by the laws of physics (for example the amount of energy available) or by human intervention (because of the sensitivity of the human body). Identifying the effects of such limitations on the environment can frequently allow comparison.

With a minimum number of data sets it is important to establish positive consistency across at least three of those available. In certain cases, it is easier to identify the potential reasons for differences, though this is not entirely helpful as it is difficult to prove such arguments. A number of common and documented reasons exist for differences between data sets and are worthy of consideration.

Almost all data analysis processes rely, to at least some extent, upon parameters set by the data analyst. A particular process cannot be relied upon to produce identical results for different analysts. Certain data analysis processes are more sensitive to variability in this regard than others. Intrinsic differences between data sets due to variations in processing are difficult to establish. However, statistical analysis methods (such as analysis of variance) can be useful indicators.

In some cases, the dynamic responses may be a result of several excitation sources. The significance of individual sources may differ from one exercise to another. Moreover, in some conditions an entirely different source dynamic excitation may appear. This may be due to a real phenomenon or be caused by the manner in which the measurement exercise was undertaken.

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