

Reciprocating internal combustion engine driven alternating current generating sets —

Part 9: Measurement and evaluation of mechanical vibrations

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Committees responsible for this British Standard

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- Agricultural Engineers Association
- British Industrial Truck Association
- Health and Safety Executive
- Society of Motor Manufacturers and Traders
- Co-opted members

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National foreword

This Part of BS 7698 has been prepared by Technical Committee MCE/14 and is identical with ISO 8528-9:1994 *Reciprocating internal combustion engine driven alternating current generating sets — Part 9: Measurement and evaluation of mechanical vibrations* published by the International Organization for Standardization (ISO). ISO 8528-9 was prepared by ISO/TC 70, Internal combustion engines.

Cross-references

International standard	Corresponding British Standard
ISO 2041:1990	BS 3015:1991 <i>Glossary of terms relating to mechanical vibration and shock</i> (Identical)
ISO 5348:1987	BS 7129:1989 <i>Recommendations for mechanical mounting of accelerometers for measuring mechanical vibration and shock</i> (Identical)
ISO 8528-5:1993	BS 7698 <i>Reciprocating internal combustion engine driven alternating current generating sets</i> Part 5:1993 <i>Specification for generating sets</i> (Identical)
IEC 34-7:1992	BS EN 60034 <i>Rotating electrical machines</i> Part 7:1993 <i>Classification of types of constructions and mounting arrangements (IM code)</i> (Identical)

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 12, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This part of ISO 8528 describes a procedure for measuring and evaluating the external mechanical vibration behaviour of generating sets at the measuring points stated in that International Standard.

It applies to RIC engine driven AC generating sets for fixed and mobile installations with rigid and/or resilient mountings. It is applicable for land and marine use, excluding generating sets used on aircraft or those used to propel land vehicles and locomotives.

For some specific applications (essential hospital supplies, high rise buildings, etc.) supplementary requirements may be necessary. The provisions of this part of ISO 8528 should be regarded as a basis.

For generating sets driven by other reciprocating-type prime movers (e.g. sewage gas engines, steam engines), the provisions of this part of ISO 8528 should be regarded as a basis.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 8528. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 8528 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 2041:1990, *Vibration and shock — Vocabulary*.

ISO 5348:1987, *Mechanical vibration and shock — Mechanical mounting of accelerometers*.

ISO 8528-5:1993, *Reciprocating internal combustion engine driven alternating current generating sets — Part 5: Generating sets*.

IEC 34-7:1992, *Rotating electrical machines — Part 7: Classification of types of constructions and mounting arrangements (IM Code)*.

3 Definitions

For the purposes of this part of ISO 8528, the definitions given in ISO 2041 and the following definition apply.

3.1 vibration severity

a generic term that designates a value or set of values, such as a maximum value, average value or rms value, or other parameter that is descriptive of the vibration

NOTE 1 It may refer to instantaneous values or average values.

NOTE 2 ISO 2041 includes two notes in the definition. These notes do not apply in this part of ISO 8528.

4 Symbols and abbreviations

For the purposes of this part of ISO 8528 the following symbols apply.

a	Acceleration
$\hat{a}$	Peak value of acceleration
f	Frequency
s	Displacement
$\hat{s}$	Peak value of displacement
t	Time
v	Velocity
$\hat{v}$	Peak value of velocity
x	Axial co-ordinate
y	Transverse co-ordinate
z	Vertical co-ordinate
ω	Angular velocity

The following subscripts are used in conjunction with the vibration quantities v , s and a .

rms	Value of vibration quantity
x	Measured value of vibration quantity in the axial direction
y	Measured value of vibration quantity in the transverse direction
z	Measured value of vibration quantity in the vertical direction
1, 2 ... n	Progressive values

The following abbreviation is used.

IMB	Type or construction and mounting arrangement of generators according to IEC 34-7
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5 Regulations and additional requirements

5.1 For a.c. generating sets used on board ships and offshore installations which have to comply with rules of a classification society, the additional requirements of the classification society shall be observed. The classification society shall be stated by the customer prior to placing the order.

For a.c. generating sets in unclassified equipment, such additional requirements are in each case subject to agreement between the manufacturer and customer.

5.2 If special requirements from regulations of any other authority, e.g. inspecting and/or legislative authorities, have to be met, the authority shall be stated by the customer prior to placing the order.

Any further additional requirements shall be subject to agreement between the manufacturer and customer.

6 Measured values

Acceleration, velocity and displacement are measured variables for the vibrations (see clause 10).

In the general case of any vibration over time interval t_1 to t_2 , the rms velocity is given by

$$v_{\text{rms}} = \sqrt{\frac{\int_{t_1}^{t_2} v^2 dt}{t_2 - t_1}} \quad \dots(1)$$

In the particular case of sinusoidal vibration the rms velocity is given by

$$v_{\text{rms}} = \frac{\hat{s}\omega}{\sqrt{2}} = \frac{\hat{v}}{\sqrt{2}} = \frac{\hat{a}}{\omega} \times \frac{1}{\sqrt{2}} \quad \dots(2)$$

If the vibration characteristics are analysed and if for angular frequencies $\omega_1, \omega_2, \dots, \omega_n$, the vibration velocities $\hat{v}_1, \hat{v}_2, \dots, \hat{v}_n$, are available, then the following relationships can be used to determine the rms velocity:

$$v_{\text{rms}} = \frac{\sqrt{\hat{v}_1^2 + \hat{v}_2^2 + \dots + \hat{v}_n^2}}{\sqrt{2}} \quad \dots(3)$$

$$v_{\text{rms}} = \sqrt{v_{\text{rms}1}^2 + v_{\text{rms}2}^2 + \dots + v_{\text{rms}n}^2} \quad \dots(4)$$

NOTE 3 For acceleration and displacement rms values are calculated in the same manner.

7 Measuring devices

The measuring system shall provide the rms values of displacement, velocity and acceleration with an accuracy of $\pm 10\%$ over the range 10 Hz to 1 000 Hz and an accuracy of $^{+10}_{-20}\%$ over the range 2 Hz to 10 Hz. These values may be obtained from a single sensor whose signal is either integrated or differentiated, depending on the outcome of the measuring device, to derive the quantities not directly measured, provided the accuracy of the measuring system is not adversely affected.

NOTE 4 The accuracy of measurement is also affected by the method of connection between the transducer and the object being measured. Both the frequency response and the measured vibration are affected by the method of attaching the transducer. It is especially important to maintain good attachment between the transducer and the point on the generating set being measured when vibration levels are high.

Refer to ISO 5348 for guidance on the mounting of accelerometers.

8 Location of measuring points and direction of measurements

Figure 1 shows the recommended points of vibration measurement in generating sets. The specifications apply as appropriate for other types of design. If possible, measurements shall be taken at these points in the three main directions, defined by x , y and z .

Figure 1 shows the approximate positions of the measuring points which have to be located on the solid engine block and on solid areas of the generator frame in order to avoid measuring local structural vibrations.

If experience with similar generating sets has shown at which points the maximum vibration severity is to be expected, not all the points given in Figure 1 need necessarily be measured.

9 Operating conditions during measurement

The measurements shall be taken with the generating set at its operating temperature and rated frequency, at both zero power and rated power. If the rated power of the generating set is not attainable, it should be tested at the maximum power that can be attained.