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JIS B 1754 : 1998
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**Acceptance code for gears—
Part 2 : Determination of
mechanical vibrations of gear units
during acceptance testing**

ICS 17.160; 21.200

Descriptors : gear drives, acceptance inspection, vibration testing, vibration measurement

Reference number : JIS B 1754 : 1998 (E)

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Foreword

This translation has been made based on the original Japanese Industrial Standard established by the Minister of International Trade and Industry through deliberations at the Japanese Industrial Standards Committee in accordance with the Industrial Standardization Law.

In the traditional **JIS**, only the methods for determining sound levels emitted by gear units are specified, whilst the measuring of noises and vibrations, and determination of the ratings are specified as the acceptance code for gears in the International Standard. In this Standard, the methods for determining the vibrations is established according to the International Standard.

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In the event of any doubts arising as to the contents,
the original JIS is to be the final authority.

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Acceptance code for gears— Part 2 : Determination of mechanical vibrations of gear units during acceptance testing

Introduction This Japanese Industrial Standard has been prepared based on the first edition of **ISO 8579-2** *Acceptance code for gears—Part 2 : Determination of mechanical vibrations of gear units during acceptance testing* published in 1993 without modifying the technical contents.

1 Scope

1.1 This Standard specifies the **methods** for determining mechanical vibration of individually housed, enclosed, speed-increasing and speed-reducing gear units. It specifies methods for measuring housing and shaft vibrations, and the types of instrumentation, measurement methods and testing procedures for determining vibration levels. Vibration grades for acceptance are included.

It does not include torsional vibration measurements of a geared system.

This Standard applies only to a gear unit under test and operating within its design speed, load, temperature range and lubrication for acceptance testing at the manufacturer's facility. The gear unit may be tested at another location if agreed upon and operated in accordance with the manufacturer's recommendations. Other International Standards on vibration evaluation may be required for measuring gear unit vibration in field service.

This Standard does not apply to special or auxiliary drive trains, such as integrated gear-driven compressors, pumps, turbines, etc., and power take-off gears.

Note 1 Acceptance limits for tests of these types of equipment should be independently specified. However, if negotiated, this or other appropriate standards may be applied to such equipment.

1.2 Special provisions may be required for vibration measurements: the type of measurement and acceptance level should therefore be agreed between the manufacturer and purchaser at an early stage of negotiation.

2 Normative reference The following standard contains provisions which, through reference in this Standard, constitute provisions of this Standard. The most recent edition of the standard shall be applied.

JIS B 0153 *Glossary of terms used in mechanical vibration and shock*

Remarks : **ISO 2041 : 1990** *Vibration and shock—Vocabulary* is identical with the said standard.

3 Definitions For the purposes of this Standard, the definitions of the following apply. For the convenience of users of this Standard, some definitions are quoted from **ISO 2041** and **JIS B 0153 : 1985**.

3.1 non-contact transducer A transducer which converts a distance or displacement to an electrical signal that is proportional to the distance or displacement.

3.2 acceleration A vector that specifies the time-derivative of velocity. [ISO 2041, 1.3]

Note 2 See annex 1.

3.3 displacement; relative displacement A vector quantity that specifies the change of position of a body, or particle, with respect to a reference frame. [ISO 2041, 1.1]

Note 3 See annex 1.

3.4 frequency response The output signal expressed as a function of the frequency of the input signal. The frequency response is usually given graphically by curves showing the relationship of the output signal and, where applicable, phase shift or phase angle as a function of frequency. [ISO 2041, B.13]

3.5 peak-to-peak value (of a vibration) The algebraic difference between the extreme values of the vibration. [ISO 2041, 2.35]

3.6 root-mean-square value; r.m.s. value For a single-valued function $f(t)$ over an interval of time between t_1 and t_2 , the square root of the average of the squared values over the interval.

Notes 4 The r.m.s. value of a single-valued function $f(t)$ over an interval between t_1 and t_2 is

$$\text{r.m.s. value} = \left[\int_{t_1}^{t_2} f(t)^2 dt / (t_2 - t_1) \right]^{1/2}$$

5 In vibration theory, the mean value of the vibration is equal to zero. In this case, the r.m.s. value is equal to the standard deviation (σ) and the mean-square value is equal to the variance (σ^2). [ISO 2041, A.37]

3.7 transducer A device designed to convert a signal or a quantity into another of either the same or of a different kind. [JIS B 0153 : 1985]

3.8 velocity; relative velocity A vector that specifies the time-derivative of displacement. [ISO 2041, 1.2]

Note 6 See annex 1

3.9 vibration The variation with time of the magnitude of a quantity which is descriptive of the motion or position of a mechanical system, when the magnitude is alternately greater and smaller than some average value or reference. [ISO 2041, 2.1]

4 General

4.1 System considered The gear unit should be tested in such a manner as to minimize as far as possible effects of the system (see annex 2).

4.2 Effects of system Vibration levels of the gear unit in field service may be adversely affected by factors beyond the control of the gear manufacturer, as listed in annex 2. It is preferable to estimate the vibration of the whole system and to check the system effects at the initial design stage of a transmission system. The responsibility for checking should be clearly defined during this stage and all interested parties made aware of the decision.

4.3 Housing or shaft measurements The vibrations of a gear unit can be measured in two ways, i.e. on the housing or on the shafts. Housing vibration measurements are preferred for gear units operating with rolling contact bearings when the clearance in such bearings is small and little relative movement normally occurs between the shaft and housing.

Both shaft and housing vibration measurements may be made on gear units operating with plain journal bearings. Shaft vibration measurements can provide detailed information which may not be evident from housing measurements, but only over a limited frequency range (typically 0 Hz to 500 Hz). Housing vibration measurements have the advantage of having both an extended frequency range and an extended dynamic range which are essential when considering frequency of tooth contact. See the provisions of 1.2.

Care shall be taken when choosing the measurement instrument for a given gear unit and operating conditions, as each instrument has its own characteristics (see annex 3). It is often useful to combine both shaft and housing vibration measurements to obtain an absolute motion of the gear unit shaft.

When operating conditions during acceptance testing deviate considerably from field service, the differences shall be taken into account in the assessment of vibration data.

5 Instrumentation

5.1 Type Vibration shall be measured using a transducer and an instrument with a known accuracy for the measurement of velocity and displacement across a known frequency range. The instrument shall also have an electrical output signal of known accuracy related to velocity or displacement, or both. The transducer shall be used within its calibrated limits for the mounting method and for the prevailing environmental conditions such as temperature, magnetic field, surface finish, etc. The type and use of vibration instrumentation systems shall comply with the appropriate International Standards. The instrumentation should preferably include a facility for narrow-band frequency analysis with a bandwidth not exceeding one-third-octave.

5.1.1 Shaft measurement instrumentation The recommended type of transducer for measuring shaft vibration is a non-contacting transducer. The instrument shall allow a reading of peak-to-peak values of vibration displacement to be taken. However, contacting transducers are acceptable if the rotational frequency of the shaft is less than 3 000 min⁻¹, the signal frequency is less than 200 Hz, and surface rubbing velocity is less than 30 m/s.

5.1.2 Housing measurement instrumentation The recommended type of transducer for measuring housing vibration is a seismic transducer. The equipment shall include an electrical instrument with a true r.m.s. rectification characteristic giving the r.m.s. values of vibration velocity in millimetres per second. The mounting method

can affect the frequency response of the transducer; it should therefore be mounted with a screw or stud, or using bonding material. Magnetic mounting using light-weight accelerometers, may be acceptable for frequencies up to 3 000 Hz if the highest fundamental frequency of tooth meshing is less than 1 000 Hz. Hand-held contact measurements are not acceptable.

5.2 Measurement frequency range The instrument measurement frequency range shall be capable of measuring the lowest shaft rotational speed and the highest tooth mesh frequency. The shaft displacement frequency measurement range should be between 0 Hz and 500 Hz. The housing velocity frequency measurement range when using integrated acceleration measurements should preferably be between 10 Hz and 10 000 Hz or more.

5.3 Permissible error The measuring instrumentation system, including both the transducer and read-out instrumentation shall be capable of indicating the vibration level within a permissible error of 10 % of the reading over the entire operating temperature range.

5.4 Calibration The vibration read-out instrumentation shall be checked against a reference signal and any specified adjustments made immediately before and re-checked immediately after each series of gear unit vibration measurements.

Calibrations of the complete measuring equipment should be carried out at least once every 2 years.

6 Vibration measurements

6.1 Shaft measurements Vibration displacement of the shafts should preferably be measured relative to the housing. Non-contacting transducers should be used, located as near to a bearing as possible and attached to rigid housing sections. Shaft vibration shall be measured in three orthogonal directions (mutually perpendicular axes), one of which shall be parallel to the shaft axis. Only one such axial transducer per shaft is necessary. The number and location of transducers shall be agreed upon between the purchaser and manufacturer.

The mechanical and electrical run-out should preferably not exceed 25 % of the allowable vibration displacement at the shaft rotational frequency, or 6 μm , whichever is the greater. Shaft mechanical and electrical run-out at the transducer locations may be subtracted from the vibration readings to give the actual vibration levels, provided the vector and phase relationships are maintained between the run-out and the shaft vibration measurement. The permissible error in the actual vibration measurement for such subtraction shall not exceed that specified in 5.3.

6.2 Housing measurements Housing vibration shall be measured on a rigid housing section such as a bearing block. Measurements shall not be made on housing sections which do not support the bearings since they are not indicative of gear unit performance. Measurements shall be taken in three orthogonal directions, two of which lie in a plane perpendicular to the rotating axis of the gears, preferably horizontal and vertical. It is recommended that measurements be taken at each externally accessible bearing location on a gear unit. If a bearing block is inaccessible, then the nearest mounting point may be used. The number and location of transducers depend upon the rigidity of the housing and on the number of shafts and shall be agreed between the purchaser and manufacturer.