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JAPANESE INDUSTRIAL STANDARD

**Rotating machines —
Balance quality requirements
of rigid rotors**

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In the event of any doubt arising,
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Rotating machines - Balance quality
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1. Scope

This Japanese Industrial Standard specifies the methods of expressing balance qualities when rotors are balanced as rigid rotors (hereafter referred to as the "balance qualities of rotating machines") and the grades thereof, methods for determining corresponding permissible residual unbalances and allocating methods, as well as the treatments relating to the balancing of keys.

- Remarks 1. The rotors mean the rotating substances of which journals are being supported by bearings, and the rigid rotors mean the rotors of which axial loads do not exceed permissible values due to the deformations of the rotors, even though these are balanced in two planes selected arbitrarily and are rotated under the similar supporting conditions to the time of use at an arbitrary speed of not larger than the maximum speed of rotation (See JIS B 0153).
2. For rotors other than the rigid rotors, in the case where these are subjected to balancing as rigid rotors, this Standard may be applicable.
3. The equivalent International Standards to this Standard are as given in the following:
- | | |
|-----------------|---|
| ISO 1940-1:1986 | Mechanical vibration - Balance quality requirements of rigid rotors - Part 1: Determination of permissible residual unbalance |
| ISO 8821: 1989 | Mechanical vibration - Balancing - Shaft and fitment key convention |

2. Definitions

For the purpose of this Standard, the following definitions apply (See JIS B 0153).

- (1) unbalance The condition of mass distribution of a rotor which originates vibratory forces or motions in bearings as the results of centrifugal forces.

Remarks 1. This is sometimes used as the synonym of the amount of unbalance or unbalance vector.

2. The unbalance of a rigid rotor may generally result in the following types.

(a) The static unbalance or couple unbalance expressed by the three vectors on three planes defined arbitrary.

(b) The dynamic unbalance expressed by the two unbalance vectors on two planes defined arbitrary.

- (2) residual unbalance An unbalance remaining after balancing.
- (3) specific unbalance In a rigid rotor, a quotient of the static unbalance divided by the mass of the rotor. This is equal to the deviation of the center of mass of the rotor from the center line of the shaft.
- (4) balance quality A quantity indicating the degree of balance of a rigid rotor, and it is the product of the specific unbalance and a certain specified angular velocity (See 3.1).
- (5) permissible residual unbalance The amount of the permissible maximum residual unbalance. However, if it is not confusing, it may also be called the permissible unbalance.
- (6) permissible residual specific unbalance A quotient of the permissible residual unbalance divided by the mass of the rotor. However, if it is not confusing, it may also be called the permissible specific unbalance.
- (7) balancing An operation to adjust the mass distribution of a rotor, so that the vibration and force synchronous with the rotational speed which are imparted to the bearings are within the specified limits.
- (8) single-plane balancing In a rigid rotor, the balancing procedure by which the residual static unbalance is allowed to be in a certain limit by adjusting the mass distribution.
- (9) two-plane balancing In a rigid rotor, the balancing procedure by which the residual dynamic unbalance is allowed to be in a certain limit by adjusting the mass distribution.
- (10) correction plane In a rotor, a plane perpendicular to the center line of the shaft in which the correction of unbalance is performed.
- (11) full key The key to be used in the final assembling of the rotating shaft having a keyway with the part to be attached or the key equal to this, and it is the name of the key to be used corresponding to the half key, when it is used in balancing procedure.

- (12) half key The key to be used when a rotating shaft or a part to be attached having a keyway is to be balanced each in a single piece. Its unbalance is equivalent to the unbalance of the portion of the key to be used in the final assembling being inserted into the keyway of the rotating shaft or the part to be attached (See Fig. 6).

3. Balance qualities

3.1 Expression of balance quality The balance quality shall be expressed by the product (mm/s) of the amount of specific unbalance e (mm) and the maximum service angular velocity ω (rad/s) of a rotor [See formula (1)].

$$\text{Balance quality} = e\omega \quad \dots\dots\dots (1)$$

In addition, if rotational speed $n(\text{min}^{-1})$ is used instead of ω , the balance quality may also be expressed as formula (2).

$$\text{Balance quality} = \frac{en}{9.55} \quad \dots\dots\dots (2)$$

3.2 Balance quality grades The balance quality grades and the upper limit values corresponding to those shall be in accordance with Table 1.

Table 1. Balance quality grades

Unit: mm/s

Balance quality grade	G0.4	G1	G2.5	G6.3	G16	G40	G100	G250	G630	G1600	G4000
Upper limit value of balance quality	0.4	1	2.5	6.3	16	40	100	250	630	1600	4000

Remarks: Each balance quality grade G includes the range of balance qualities from the numerical value of the upper limit of the designated balance quality to zero.

3.3 Recommended values of balance qualities for various rotating machines
The recommended balance quality grades relating to various rotating machines are exemplified in Informative reference Attached Table 1.

Furthermore, this Informative reference Attached Table 1 is given for reference only, and whichever grade is to be applied to each rotor shall be as agreed between the parties concerned.

4. Determination of permissible residual unbalance

The relationship between the permissible residual specific unbalance e_{per} (μm), and the service speed of rotation $n(\text{min}^{-1})$, taking the balance quality grades as the parameter, shall be as given in Fig. 1. When the grade G of balance quality of a rotating machine and its maximum service speed of rotation n_{max} are given, the permissible residual specific unbalance can be obtained from the Fig. 1 or formula (2).

By multiplying the mass m (kg) of rotor by this permissible residual specific unbalance e_{per} , the permissible residual unbalance $U_{\text{per}} = e_{\text{per}}m$ (g·mm) can be obtained.