ESTABLISHING BALANCING TOLERANCES FOR RIGID ROTORS

It is neither practical nor possible to remove all unbalance of a rotor. We must establish balancing tolerances that are economically feasible and still low enough to provide satisfactory operation. In establishing balancing tolerances, the type of equipment, operation speed, and the weight of the rotor must be considered. The ***International Standards Organization*** has proposed certain recommendations at to "The Balance Quality of Rigid Rotor Bodies", their Specification ***ISO DR1940***.

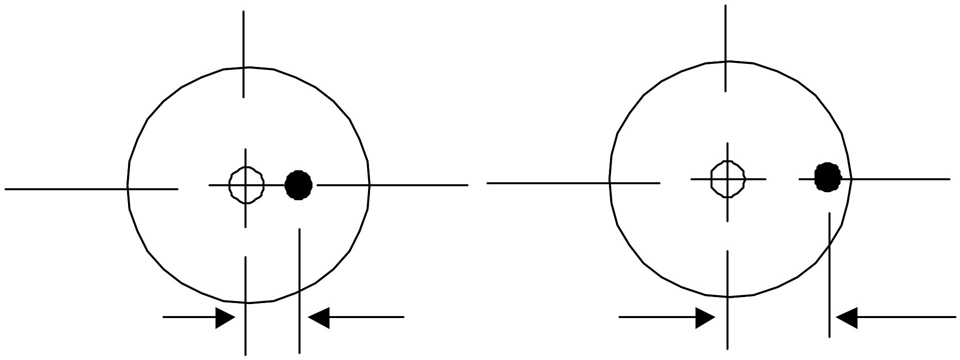
The following table gives the balancing grade for various types of rotors. To calculate the balancing tolerances, the following formula can be used.

$$\textbf{Balance Tolerance (Oz.In.)} = \frac{\textbf{0.381 X Quality Grade X Rotor Weight in Ounces}}{\textbf{RPM}}$$

In computing the balance tolerance, the maximum RPM that the rotor is to operate as is used (not the balancing speed). For single-plane correction, the balancing tolerance as calculated is used. Where two-plane balancing is required, it is normal to use one half of the balancing tolerance in each plane.

UNITS OF UNBALANCE

Balance is a zero quantity. Only amount of unbalance can be measured. Unbalance is measured in ounce-inches or gram-inches. Amount of unbalance is a mass (weight) multiplied by its distance from the rotational axis. An unbalance of 100 ounce-inches can be caused by10 ounces at 10 inch radius or 20 ounces at 5 inch radius.



20 Oz. at 5”   10 Oz. at 10”

Both of the preceding cases give the same unbalance. When you multiply the ounces by the distance to the center, the product is the same in both examples (100 ounce-inches). Since unbalance is simply the weight multiplied by the radius, it does not change with speed. This is true for all rigid rotors, rotors that do not change shape with speed. The unbalance in rigid rotors can, therefore, be measured at any convenient speed.

BALANCING GRADES FOR VARIOUS GROUPS OF REPRESENTATIVE RIGID ROTORS

Quality Grade **eW = mm/sec**	**Rotor Types – General Examples**
G 4000	Crankshaft-drives (note 3) of rigidly mounted slow marine diesel engines with uneven number of cylinders (note 4).

G 1600	Crankshaft-drives of rigidly mounted large two-cycle engines.
G 630	Crankshaft-drives of rigidly mounted large four-cycle engines. Crankshaft-drives of elastically mounted marine diesel engines (note 4).
G 250	Crankshaft-drives of rigidly mounted fast four-cylinder diesel engines (note 4).
G 100	Crankshaft-drives of fast diesel engines with six and more cylinders (note 4). Complete engines (gasoline or diesel) for cars, trucks, and locomotives (note 5).
G 40	Car wheels, wheel rims, wheel sets, drive shafts. Crankshaft-drives of elastically mounted fast four-cycle engines (gasoline or diesel) with six and more cylinders (note 4). Crankshaft-drives for engines of cars, tucks, and locomotives.
G 16	Drive shafts (propeller shafts, cardan shafts) with special requirements. Parts of crushing machinery. Parts of agricultural machinery. Individual components of engines (gasoline or diesel) for cars, trucks, and locomotives. Crankshaft-drives of engines with six and more cylinders under special requirements.
G 6.3	Parts of process plant machines. Marine main turbine gears (merchant service). Centrifuge drums. Fans. Assembled aircraft gas turbine rotors. Flywheels. Pump impellers. Machine-tool and general machinery parts. Normal electrical armatures. Individual components of engines under special requirements.
G 2.5	Gas and steam turbines, including marine main turbines (merchant service). Rigid turbo-generator rotors. Rotors. Turbo-compressors. Machine-tool

	drives. Medium and large electrical armatures with special requirements. Small electrical armatures. Turbine-driven pumps.
G 1	Tape recorder and phonograph (gramophone) drives. Grinding-machine drives. Small electrical armatures with special requirements.
G 0.4	Spindles, discs, and armature of precision grinders. Gyroscopes.

NOTES:

1. $\boldsymbol{\omega} = \mathbf{2\pi\ n / 60 \approx n / 10}$, if **n** is measured in revolutions per minute and $\boldsymbol{\omega}$ in radians per second.

2. In general, for rigid rotors with two correction planes, one-half of the recommended residual unbalance is to be taken for each plane; these values apply usually for any two arbitrarily chosen planes, but the state of unbalance may be improved upon at the bearings. Fir disc-shaped rotors, the full recommended value holds for one plane

3. A crankshaft-drive is an assembly which includes crankshaft, a flywheel, clutch, pulley, vibration damper, rotating portion of connecting rod, etc.

4. For the present purposes, slow diesel engines are those with a piston velocity of less than 9 m / s; fast diesel engines are those with a piston velocity of greater than 9 m / s.

5. In complete engines, the rotor mass comprises the sum of all masses belonging to the crankshaft-drive described in footnote 3 above.