Specifying Unbalance and the Location of Tolerance Planes

Gary K. Grim
Jake Schlaegel

Balance Technology Inc • 7035 Jomar Drive, Whitmore Lake, MI 48189 • 734-769-2100 • USA
www.balancetechnology.com

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All our equipment is engineered & manufactured in the USA.

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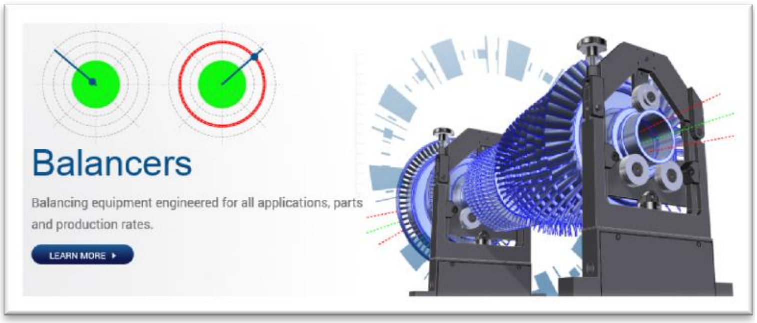
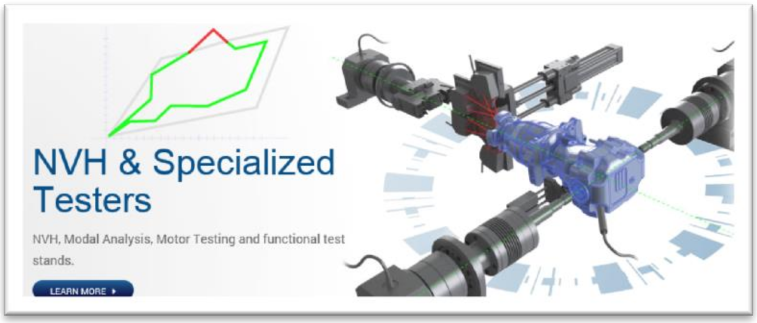
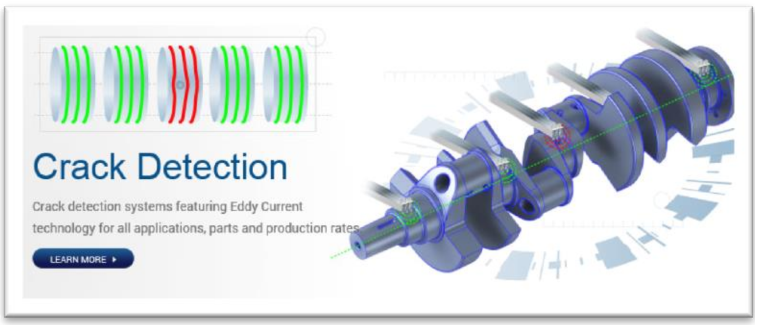
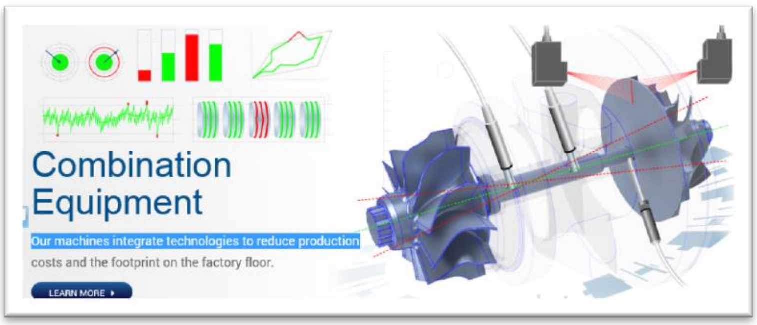








SPECIFYING UNBALANCE AND THE LOCATION OF TOLERANCE PLANES

Gary K. Grim, Bruce J. Mitchell, Jr.

Unbalance can be specified in many forms. The most common is expressed as a weight of material to be added or removed at a specified correction radius. The weight units can be any convenient units; grams (g), ounces (oz), and kilograms (kg) are common units. Occasionally Newton's (N) are specified, but for practical use must be converted to available weight scale units. Length units are often expressed in; inches (in), millimeters (mm), centimeters (cm), and meters (m). The most common combinations used to specify unbalance are ounce-inches (oz-in), gram-inches (g-in), gram-millimeters (g-mm), gram-centimeters (g-cm), and kilogram-meters (kg-m).

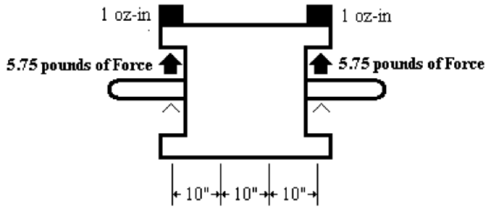
A complete specification for two-plane unbalance must include both the maximum allowable unbalance and the location of the tolerance planes. If the locations are omitted, the specification is incomplete and the locations must be assumed. If the workpiece is to be balanced dynamically, a correction method and correction location should be identified as well.

In the past, balancers could only operate in one set of planes, so it was only possible to audit unbalance at the correction planes, therefore requiring the location of the tolerance planes to coincide with the correction planes. However, modern balancers incorporating PC's allow the tolerance planes to be different than the correction planes.

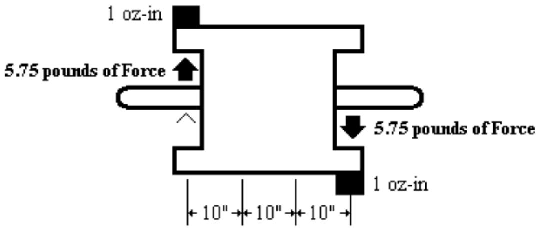
So where should the unbalance be audited? At the bearing planes! After all, the forces due to unbalance will be "felt" through the bearings. When the balance tolerance is established at the bearing planes, the force of unbalance is the same whether it be static or couple unbalance. Whereas, if the balance tolerance is established at planes narrower than the bearing planes, the force on the bearings due to couple is less than the force due to static unbalance. This is caused from the couple component being balanced unnecessary low as compared to the force unbalance. One additional thing to consider when correcting for couple unbalance; when the correction plans are as far apart as possible, a minimum amount of correction required.

Consider the following examples:

A rotor spinning at 1800 rpm with 1.0 ounce·inche of unbalance directly in-line with the bearing planes will produce 5.75 pounds of centripetal force on each bearing regardless of the angle around the workpiece or the relative angle. The following two examples show the extremes, the first is with two weights at the same angle, the second is with the two weights 180 degrees opposed.

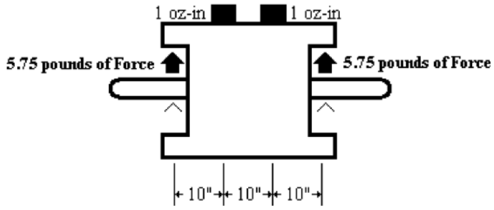


Force (single plane) unbalance is **2 oz in**
Left plane unbalance at the left bearing plane **1 oz in**
Right plane unbalance at the right bearing plane **1 oz in**
Couple unbalance at the bearings **0 oz in²**.

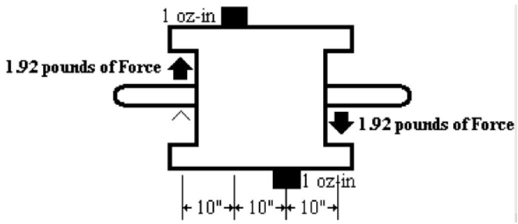


Force (single plane) unbalance is **0 oz in**
Left plane unbalance at the left bearing plane**1 oz in**
Right plane unbalance at the right bearing plane **1 oz in**
Couple unbalance at the bearings **30 oz in²**.

This is not true when the unbalances are moved to the inner set of planes. Unbalances at the same angle produce the same static unbalance whereas the unbalance placed at opposite angles on the workpiece produce a reduced amount of pure couple. The effect of the couple at the bearings produces 1/3 of the force, because the distance between weight planes is 1/3 the distance between the bearing planes. Instead of 5.75 pounds, the force on the bearings is now 1.92 pounds.



Force (single plane) unbalance is **2 oz in**
Left plane unbalance at the left bearing plane **1 oz in**
Right plane unbalance at the right bearing plane **1 oz in**
Couple unbalance at the bearings **0 oz in²**.



Force (single plane) unbalance is **0 oz in**
Left plane unbalance at the left bearing plane **.33 oz in**
Right plane unbalance at the right bearing plane **.33 oz in**
Couple unbalance at the bearings **10 oz in²**.

Equal amounts of unbalance in these planes produce a force on the bearings which varies between 5.75# and 1.92# depending on the relative angle of the unbalances. If the balance tolerance is specified at planes 10 inches apart the maximum force on the bearings is 5.75# when the unbalances are aligned. Then at all other relative angles the tolerance is too low and the balance is being reduced lower than necessary.