Wheel Balancing Fundamentals

The Need for Wheel Balancing
Out-of-balance wheels cause vibrations which are uncomfortable to a car’s occupants, may adversely affect handling and can cause premature wear on a number of under-car suspension parts. These include ball joints, shock absorbers, wheel bearings and the entire steering linkage assembly. Out-of-balance wheels can also produce abnormal tire wear as well as a ‘jumping’ effect that can dramatically reduce a vehicle’s adherence to the road. The importance of properly balanced wheels has increased in recent years due to the trend toward front wheel drive and lighter, more fuel efficient vehicles.

A wheel balancer is used to reduce this vibration source to a level which will not accelerate vehicle wear nor be perceptible to the vehicle’s occupants. The balancer accomplishes this by determining how much weight and where this weight should be placed on a wheel to offset the existing imbalance. The correct position is one directly opposite (180 degrees) from the imbalance.

Other Sources of Vibration
There are many other potential sources of vibration in a vehicle besides imbalanced wheels. These additional vibration sources must be explored if a customer complains of continued vibration after wheel balancing has been performed.

Additional Imbalanced Parts
Any vehicle part which reciprocates (pistons, connecting rods) or rotates (drive shafts, flywheels, brake rotors or engine parts) is a potential vibration source.

Wheel Runout
A balanced wheel can still be a major source of vibration if runout is present. A rim that is poorly made, is not perfectly round or has been bent will result in runout. Likewise, a tire that is improperly mounted or has tread irregularities such as flat spots due to skidding or hard spots from faulty manufacture can cause vibrations.

Runout is a significant problem. Barely visible runout of a few hundredths of an inch, such as wobble when the wheel is spinning or a rim that is not precisely round, will cause more vibration than a weight imbalance of several ounces. Wheels should always be viewed carefully during the balancing process to check for runout. If a new tire appears to have a large imbalance, check for runout. In fact, balancing a wheel with large runout may actually worsen the vibration.
**Static and Dynamic Balance**

There are basically two wheel balancing techniques: static and dynamic. Static balancing is simpler but cannot detect all the imbalance forces causing wheel vibration. Dynamic balancing does detect and measure these forces.

A ‘static balancer’ can measure one component of imbalance even when a wheel is motionless. Static balancing can be accomplished by a bubble balancer or by mounting a wheel on a freely turning shaft. In both cases, the heavy spot on the wheel comes to rest at the low point. The heavy spot on a spinning wheel produces a centrifugal force perpendicular to the road and resulting up-down vibrations.

A second component of imbalance can only be detected when the wheel is in motion. This component results from the wheel having width, with different imbalances on the two sides of the wheel. These imbalances cause sideways vibrations when the wheel is spinning and are called ‘couple imbalance’.

All wheels do exhibit, to some extent, both static and couple imbalance. When both are present, there is ‘dynamic imbalance’ which can be detected and corrected only by using a computerized dynamic balancer.
Faulty Tire Construction
During tire construction, the multiple plies of reinforcing fabric can overlap inconsistently, shift during tire molding or cause the stiffness of the tire to vary along the tire tread. Unlike tire runout, this type of defect may not be visible; however, it will cause vibration because the stiff section has the same effect as a high spot on a tire with runout.

Water in Tires
Water inside the tire will cause erratic and unreliable balancing. Two sources are excess water used as a lubricant to mount the tire and water carried in compressed air. Tires should also be checked for other internal foreign matter.

Sympathetic Vibration
Non-rotating parts can sometimes produce a ‘sympathetic vibration’, whereby road irregularities or the vibration of rotating parts cause non-rotating parts to vibrate at their resonant frequency. This type of vibration can be recognized as the vehicle speed and vibration intensity increase but the vibration frequency remains constant.

Balancing Tolerance
The goal of wheel balancing is to reduce the imbalance to a level which cannot be felt by passengers or cause accelerated wear of mechanical parts. These criteria are usually met by balancing to within 1/4 ounce (or 5 grams) on small cars, 1/2 ounce on full size cars and 1/2 to 3/4 ounce on light trucks. There are no significant benefits to balancing finer than 1/4 ounce or 5 grams and virtually no wheel weight manufacturer markets weights less than these amounts. Accu-Turn balancers round imbalances to the nearest 1/4 ounce or 5 grams in STANDARD mode and 1/10 ounce or 1 gram in FINE mode.

Remount Error
Remount error occurs whenever part of a rotating assembly is removed and reinstalled. The principal cause of balancing remount error is the slight variation in the seating of the wheel against the cone and hub which occurs each time the wheel is remounted. The largest contributors to remount error are irregularities on the rim and hub mounting surfaces (dirt, nicks, burrs or rust) and imperfections in the rim center hole.

For example, if a balanced 14” wheel weighing 35 pounds is removed and remounted on a balancer, a host of factors could cause the wheel to shift two or three thousandths of an inch, about the thickness of a human hair, and produce a ‘new’ imbalance in excess of 1/4 ounce.