

Poor-man's Dyno

First of all, a dynamometer does not directly measure horsepower; it calculates horsepower from the measurement of torque and rpm. What is obtained is the actual horsepower being generated within the limits of the measurement accuracy of the torque and rpm. This resulting horsepower may then be corrected to a sea-level value by taking into account such variables as temperature and barometric pressure. Note again; the horsepower obtained on a dyno is a calculated value, not a directly measured value!

Here's a way to determine your aircraft's *installed* horsepower fairly accurately. It requires a tape measure, a calculator, an accurate tachometer, preferably electronic, two accurate scales of about 400-800 lb capacity, depending on the aircraft's weight, about 40' of 1/8" steel cable, a helper, a car or truck, and a reasonably flat test area. This method utilizes the plane's propeller as the load, the scales to determine the torque, and the tach along with the torque, to calculate hp.

Wheel the plane out to the test area, insert scales under the main wheels, and block the nose wheel or tail wheel to make the engine thrust line horizontal. To get a more accurate measurement of the distance between the wheels, put pieces of angle iron on the scales and center the tires on them. Measure the distance between the tops of the angles and record that as "d", the total center-to-center distance between the tires. Measure the height of the center of the prop above the test area and subtract the height of the top surface of the scales. Record this as "h". Attach cables to the gear legs or the airplane's tail wheel and fasten these to the tow-hooks under the bumper of the car or truck parked behind the plane. (Don't try this on an EZ!) Start the engine and allow it to warm up for several minutes to get it up to operating temperature, and see that the plane remains properly tied down and stable on the scales and the block under the nose-wheel or tail-wheel. It might be necessary to clamp the nose strut if the nose depresses under thrust.

Shut off the engine and read and record the altimeter with it set to 29.92", as well as OAT. Have the helper read the values of the scales under each wheel. Record these as WR1 and WL1. Start the engine and give it full throttle and lean it for maximum power. If the plane is equipped with a constant-speed prop, adjust the rpm for the rated value. Again read the values of the two scales. Record these as WR2 and WL2, and record the rpm and manifold pressure, if available. Shut down the engine.

Perform the following calculations:

$$r = (d^2/4 + h^2)^{1/2}$$

$$\Delta R = WR1 - WR2 \quad \Delta L = WL2 - WL1$$

$$F_R = 2 * r * \Delta R / d \quad F_L = 2 * r * \Delta L / d \quad T_R = F_R * r / 12 \quad T_L = F_L * r / 12$$

$$HP = (T_R + T_L) * rpm / 5252.12$$

Consider the following example: d = 96", h = 36", r = 60", rpm = 2700

WR1 = 282, WL1 = 357, WR2 = 307, WL2 = 332

$\Delta R = 25$ lb, $\Delta L = 25$ lb, $F_R = 31$, $F_L = 31$, $T_R = 155$, $T_L = 155$

HP = 159.4

Here are some corrections you can make to the measured horsepower to correct it to sea-level value:

$$F_T = (459^\circ + \text{OAT}) / 518^\circ \text{ using } F^\circ, \text{ or } (273^\circ + \text{OAT}) / 288^\circ \text{ using } C^\circ$$

$$P_A = 29.92 * (1 - 6.88E-6 * \text{alt})^{5.256}$$

F_M , without MAP, = $(P_A - 1.5) / 28.4$, carbureted, or $(P_A - 0.5) / 29.4$, injected

With MAP, $F_M = \text{MAP} / 28.4$, carbureted, or $\text{MAP} / 29.4$, injected

Typically, a carbureted engine will have about 1.5" drop in the carburetor and induction system, so that it's sea-level rating is based on 28.4" MAP rather than 29.92", and the injector system has about 0.5" drop. If you know your induction drop, use it instead.

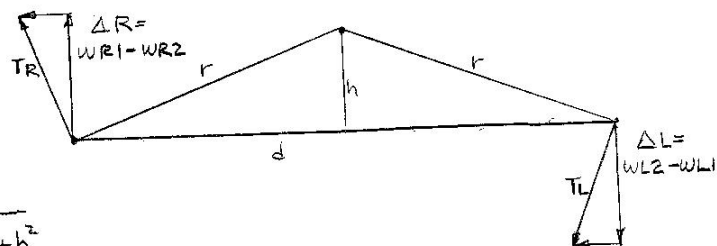
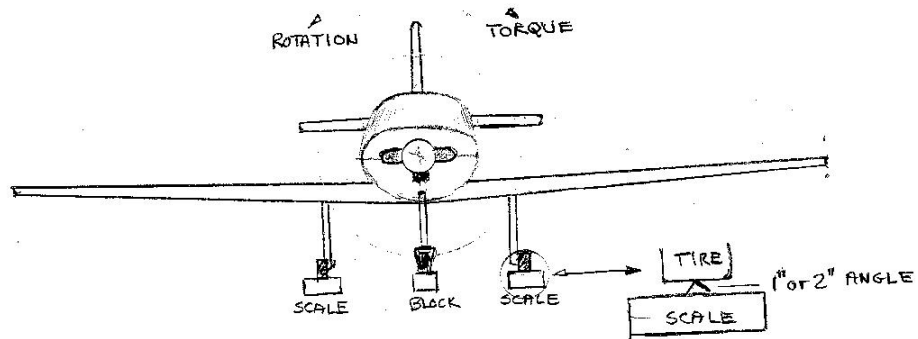
$$F_R = \text{rated rpm} / \text{measured rpm}$$

$$\text{HP, sea-level,} = \text{HP, measured,} * F_T * F_M * F_R$$

Let's say you had an OAT of 73F, pressure altitude of 1870', and, with a fixed- pitch prop you had 2370 rpm, rated rpm is 2700, and your hp measured 147.

$$F_T = 1.027, P_A = 27.95, F_M = 0.931, F_R = 1.139$$

$$\text{Sea-level corrected HP} = 160.2$$



$$r = \sqrt{\frac{d^2}{4} + h^2}$$

$$T_R = \frac{2r\Delta R}{d} \quad T_L = \frac{2r\Delta L}{d}$$

$$hp = \frac{(T_R + T_L) \text{ RPM}}{5252}$$

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