DEVELOPING AN ENGINE POWER CURVE FROM ROAD TEST DATA

by Ron Graves

For engine nuts who love to tinker there has always been the problem of determining whether one's tinkering is accomplishing anything in terms of horsepower. For most people, free use of a dynamometer is not available, nor is the use of a drag strip with timing equipment. Even 0-60 time runs are not good enough because the gear changes are not consistent and variations in tire spin can influence the times as much as a real change in power.

A simple method is described here that will provide a simulated engine torque curve. It involves no gear changes and requires no special equipment other than a stopwatch with the smallest divisions being 1/10 second or less. The data we want to obtain is the time-to-speed curve in second gear. Take speed readings from the tachometer since it is easier to read closely than the speedometer. I recommend using second gear because most of the tests can be run within the speed limit and the tach needle moves slowly enough during acceleration to make accurate timings.

Start by timing a full-throttle acceleration from 2000 to 5000 rpm. It is important to open the throttle at 1200-1500 rpm so you can start your timer as the tach sweeps past 2000 rpm. Stop the timer as the tach sweeps by the 5000 rpm mark and then back off the throttle. Since there is no shifting, you can probably do this solo. Do the same procedure for 3000-5000, 2000-4000, and 4000-redline. Trying to make timings on smaller rpm increments, like 2000-3000 rpm, hurts the accuracy.

Now a table can be assembled like this:

RRPM RANGE	TIME ELAPSED
2000-3000	1.8 sec*
2000-4000	3.2
2000-5000	5.1
2000-5900	6.7**

*Subtract the 3000-5000 time from the 2000-5000 time.
**Add the 2000-4000 time to the 4000-5900 tune

Using the data in the table, one can plot a curve as shown in Fig. 1. Now, to find out if you have achieved that 20 hp you expected after changing intake manifolds, you have the necessary baseline information. After making a modification, rerun the test series and plot the data again.

The approximate engine torque can be estimated as follows: Over a narrow range of engine speed, like 3000-4000 rpm, calculate a $\Delta V/\Delta T$, acceleration (see Fig. 1.). Be sure to convert engine speed to vehicle speed in ft/sec. The approximate torque over that engine speed range is then calculated from

$$\text{Torque} = \frac{M \cdot \Delta V \cdot R}{3.2 \cdot \Delta T \cdot GR}$$

(a crudely disguised F=ma...my apologies to Sir Isaac)

M-car weight in pounds
ΔV-speed change in ft/sec
ΔT-time for speed change, sec
R=rear tire radius, ft
GR=total gear ratio, about 6.2 for second gear
Using these units, torque will be in ft-lbs.

A more precise torque figure can be calculated by adding in the wind and rolling resistance forces, but it is not really necessary if you just want to keep track of performance changes. Trying

to arrive at a real engine flywheel torque is a little more complicated. At least two other factors must be estimated, (1) the drivetrain efficiency, perhaps about 94% overall (includes bearings, trans, differential, etc.), and (2) the torque absorbed by accelerating the rotational motion of the tires, gears, and axles. This latter factor is rather obscure and difficult to estimate. In a nutshell, to the engine, the car seems heavier than its weight because not only does the engine have to accelerate the tires forward, but it also expends power in accelerating their spinning motion.

I went to the trouble of calculating the aerodynamic and rolling friction and calculated a rear wheel power curve, Fig. 2. Now you ask, "Why didn't he come up with 310 hp like the Ford book says?" The possibilities are:

1. Ford was exaggerating.
2. My engine is sick.
3. The two factors mentioned earlier account for the difference.
4. All of the above.

Power calculated this way will give results similar to what you might see on a chassis dyno—but not exactly. Remember, chassis dyno power readings are taken with the wheels and other rotating parts at a constant speed, not accelerating. From what I've seen and read, though, anything over 250 hp on a chassis dyno is considered to be pretty strong for street cars.

The power curve for my vehicle indicated a couple of useful bits of information such as (1) the high rpm power is there even with a 600cfm carb and (2) there seems to be a little flatness at midrange maybe ignition timing, secondary opening at the wrong time or just some peculiarity in the manifold fluid dynamics. Another possibility is that (heaven forbid) I've made an error in timing or calculation.

It would be a great benefit to other Pantera owners if some other club members would take time to record the time-to-speed date and then describe their engine setup. That way, we can all see which combinations of equipment works best.

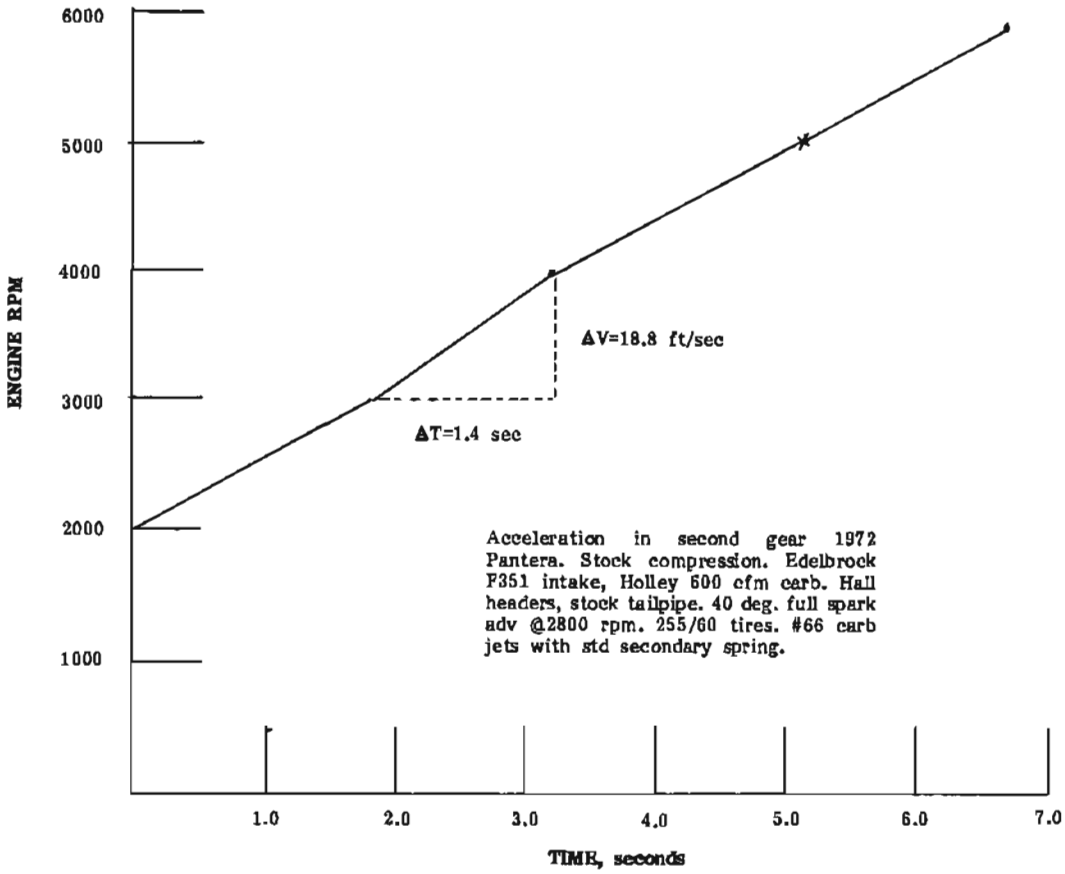

FIGURE 1

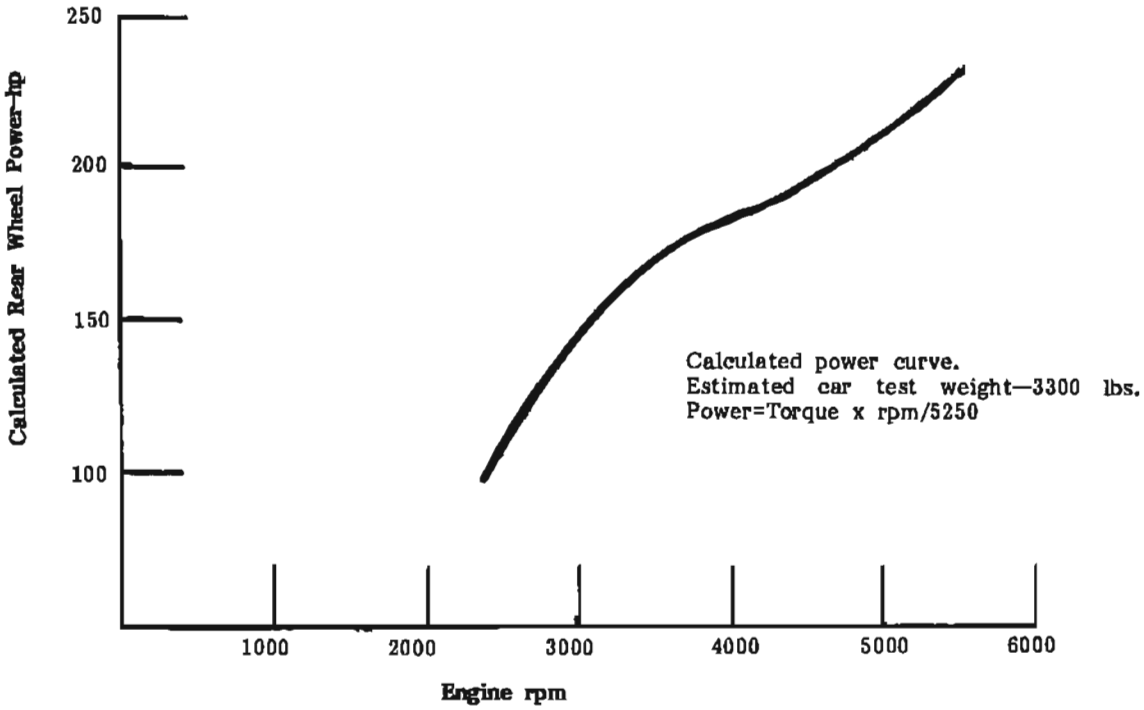

FIGURE 2