A letter received here at the factory asked a question we have heard quite often:

"Is it a fact, or is it fiction, that engines with constant speed props should not use power settings where inches of mercury exceed RPM in hundreds? I am referring of course to non-turbocharged engines in general ."

The answer to this question is easily found in cruise power charts of the airframe Pilot's Operating Handbook. Whatever the combinations of RPM and MP listed in the charts_they have been flight tested and approved by the airframe and powerplant engineers. Therefore, if there are power settings such as 2100 RPM and 24" MP in the power chart, they are approved for use.

The confusion over so-called "squared" power settings(i. e. 2400 x 24" MP), appears to have been a carry-over from some models of the old radial engines which were vulnerable to excessive bearing wear where a MP higher than "squared" was used. More pressure on the bearings with the higher than "squared" MP was the cause of their problem. However, changes in design, metals, and lubricants permit changes in operation in the more modern flat opposed powerplants.

Let's look at the power charts in a couple of the Pilot's Operating Handbooks of two different aircraft manufacturers, but where both are using the four cylinder 200 HP Lycoming engine.

Cessna's Model 177 RAG, using the Lycoming IO-360A1B6D, in the cruise range at 6,000 feet, lists a cruise power setting range at that altitude of anywhere from 2100 RPM to 2500 RPM with variations all the way from 18" MP to 24"MP. They list a recommended power setting for 66% power at 2100 RPM at 24" MP.

The Piper Arrow, powered by the Lycoming IO-360 series engine, lists the following cruise power settings at 6,000 feet in their chart at 65% power at full throttle (about 23" MP) x 2100 RPM.

Altitude	2100 RPM	2400 RPM
SL	25.9 MP	22.9 MP
1,000	25.6 MP	22.7 MP
2,000	25.4 MP	22.5 MP
3,000	25.1 MP	22.2 MP
4,000	24.8 MP	22.0 MP
5,000	F.T. MP	21.7 MP
6,000	F.T. MP	21.5 MP

After studying the power chart, the pilot would undoubtedly then ask what combination of RPM and MP would be best to use at cruise. We recommend the pilot try the various combinations offered by the power chart over afire-minute period when flying in smooth air, and use the listed RPM and MP combination which gave the least vibration and the lowest noise level.

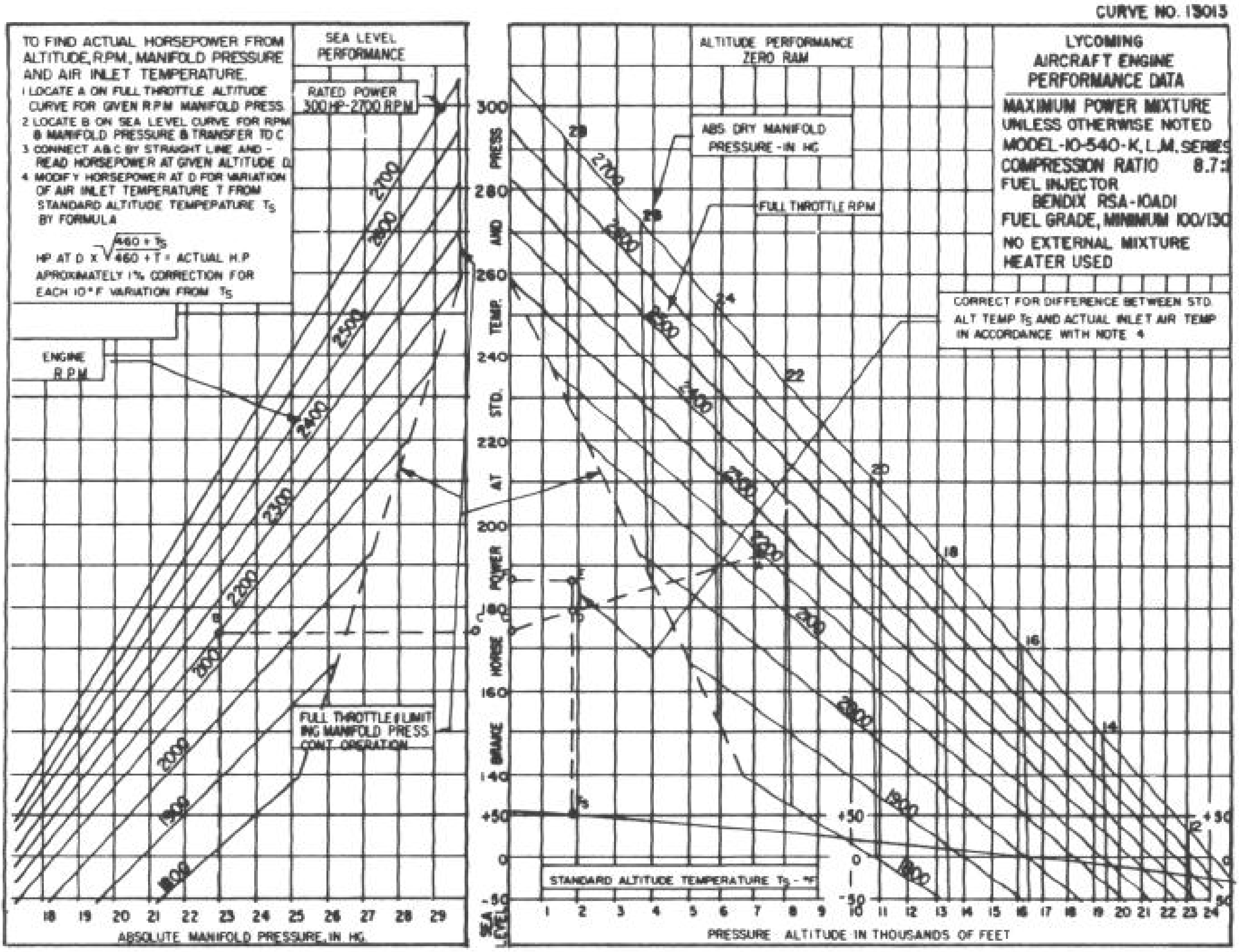
In addition to the quieter and smoother consideration, lower RPM means lower friction hp. This reduced loss of horsepower due to friction also translates to slightly improved fuel economy.

The Pilot's Operating Handbook is the basic reference for the pilot as this subject illustrates.

Considerations For Low Power Low RPM Cruise

The high price of aviation fuel is causing aircraft owners and pilots to review their operations in search of ways to keep operating costs down. Those operating aircraft with controllable propellers have been requesting information on cruise operation in the low RPM range - 1800 or 1900 RPM for example. The number of queries received indicates great deal of interest, and therefore it seems appropriate to share the information on this subject with all of our readers.

The Textron Lycoming Engine Operator's Manual has performance curves applicable to each engine series. The curve for the IO-540-K series, 300 horsepower engine imprinted here as a reference for this article. The curve does provide data on the maximum manifold pressure (MP), which may be used with any particular RPM at sea level and at altitude. The limiting manifold pressure line clearly restricts high manifold pressures with low RPM settings. There is a good reason for this; high manifold pressure and low RPM is similar to allowing your automobile to lug uphill in fourth gear. The pinging you hear in your automobile tells you that detonation is occurring and you should shift down to a lower gear. In an aircraft, detonation is not likely to be heard as damage occurs in the engine and it is then too late for preventive measures. For this reason, engine operation should be within the limitations established in the Pilot's Operating Handbook (POH).



Sea Level and Altitude Performance Curve - IO-540-K, -L, -M, -S

Although there are restrictions, it is quite apparent that operation is possible in the 1800 to 1900 RPM range. Lower RPM will result in less friction horsepower with a resultant fuel savings, but most of the fuel flow reduction experienced will be the result of a much lower power setting and therefore reduced performance. This raises a question about the amount of benefit in terms of cost savings that might actually be achieved by using the lower RPM settings for cruise.

One of the first considerations of low RPM cruise is that power settings this low should not used during the engine break-in period. During the break-in period, normal climb power as specified in the Pilots Operating Handbook should be used. To seat the piston rings in a new or overhauled engine, cruise the aircraft at 65% to 75% power for the first 50hours, or until oil consumption has stabilized. Low power for break-in may result in glazed cylinder walls and high oil consumption that can only be cured by cylinder removal andre honing.

There are some other considerations of low power cruise operation. Low manifold pressures, below an arbitrary point of perhaps 18 inches for continuous cruise, may cause excessive oil usage, and oil buildup in the valve guides which could lead to sicking valves.

Particularly during cold weather aeration low power operation may allow both the oil and cylinder head temperatures to fall below the normal range. This is detrimental to good engine health. Oil temperature in particular should be maintained between 165 deg F and 220 deg F to achieve maximum service life. At lower temperatures, the moisture which gathers as a result of combustion will not vaporized and be expelled. This can cause dilution of the oil which detracts from its lubricating properties.

The Pilot's Operating Handbook for each aircraft provides a variety of power settings that most often show 2100 or 2200 RPM as the minimum for cruise. The table shown here is for the IO-540-K series engine which was illustrated in the curve shown earlier. Using that curve, note that cruise flight at 6000 feet using 1900 RPM would be limited to approximately 55% of power with manifold pressure set at 24 inches. As shown in the curve, 24 inches of MP is very near the limiting manifold pressure line and therefore close to the maximum available.

POWER TABLE SETTING —
LYCOMING MODEL IO-540-K, -L, -M SERIES, 300 HP ENGINE

Press. Alt. Feet	Std. Temp °F	165 HP — 55% Rated RPM and MAN. Press.				195 HP — 65% Rated RPM and MAN. Press.				225 HP — 75% Rated RPM and MAN. Press.		
		2100	2200	2300	2400	2100	2200	2300	2400	2200	2300	2400
SL	59	22.5	21.8	21.2	20.7	25.6	24.7	23.8	23.2	27.6	26.6	25.8
1,000	55	22.3	21.6	21.0	20.5	25.3	24.4	23.5	22.9	27.3	26.3	25.5
2,000	52	22.1	21.4	20.7	20.2	25.1	24.2	23.3	22.7	27.1	26.1	25.2
3,000	48	21.9	21.2	20.5	20.0	24.8	23.9	23.0	22.5	26.8	25.8	24.9
4,000	45	21.7	21.0	20.3	19.8	24.6	23.7	22.8	22.2	26.5	25.6	24.6
5,000	41	21.5	20.8	20.1	19.6	24.3	23.5	22.5	22.0	—	25.3	24.4
6,000	38	21.3	20.6	19.8	19.3	24.0	23.2	22.3	21.7	—	25.0	24.1
7,000	34	21.0	20.4	19.6	19.1	23.7	22.9	22.0	21.5	—	—	23.8
8,000	31	20.8	20.2	19.4	18.9	—	22.5	21.8	21.2			
9,000	27	20.6	20.0	19.2	18.6	—	—	21.5	21.0			
10,000	23	20.4	19.8	19.0	18.4	—	—	21.2	20.7			
11,000	19	20.2	19.6	18.7	18.2	—	—	—	20.4			
12,000	16	20.0	19.4	18.5	18.0							
13,000	12	—	19.2	18.3	17.7							
14,000	9	—	—	18.0	17.3							
15,000	5	—	—	—	16.9							

To maintain constant power, correct manifold pressure approximately 0.18" Hg for each 10°F variation in induction air temperature from standard altitude temperature. Add manifold pressure for air temperature above standard; subtract for temperature below standard.

Quite frequently, someone will ask if the engine will last longer if it is run at a slower RPM setting. The answer must be qualified. Operation at the recommended cruise RPM settings should allow the engine to reach TBO if it has regular oil changes, is operated within normal temperature ranges and is well cared for by pilots and maintenance personnel. Longer engine life may be expected from most engines when the operator is willing to sacrifice maximum performance for conservative cruise operation in the 60% to 65% power range. For many engines these power settings are achieved at 2100 or 2200 RPM rather than the 1800 or 1900 RPM mentioned earlier in this discussion.

In summary, it is possible to run an engine at cruise using 1800 or 1900 RPM. A curve from the Engine Operator's Manual should be consulted to insure that manifold pressure limits are not exceeded. In reality, there commendations of the Pilot's Operating Handbook provide the best guidance for operation of an aircraft/engine combination, and therefore the recommendations and limitations of the POH should be observed.

Lest We Forget - The Engine Will Not Run Without Air

INDUCTION ICING AND OTHER OBSTRUCTIONS

Rewritten and combined with article "Induction Icing"