Note 2B

More on Power.

Note 2 Power (Horsepower and Accuracy) gives an overall view of how power was treated in the website.

Since then various pieces of information have been gathered about accuracy and repeatability in a wide variety of engines. This Note 2B provides a semi-organised review of this data, although no conclusions can be drawn.

In the Foreword to the website the author cautioned:-

"*Powers generally are probably not reliable to within minus 10%...some companies' figures are undoubtedly better than that (egs. Daimler-Benz, Coventry Climax, Cosworth and Honda)".*

In the section on "Grand Prix Motorcycle Engine Development, 1949-2008" introduction the author also cautioned:- "*..power data for racing engines is not given on oath!*"*.

* There is one exception to this, see the test on the Weslake WRP190 below.

Delage 1925 – 1927 Power

After a detailed examination of the evidence, Note 5 reached the Conclusion:-

"*...The power of these Delage engines should be reduced by 10% relative to the usually published figures...*".

This conclusion was validated in "CORRECTIONS & ADDITIONS" at P. 64, when works data became available to the author.

Flash power

H. N. Charles, the designer of the MG racing cars 1930-1935, gave in DASO 331 (see References below) a factual example of how flash power readings could differ from a sustained output. Relating to the prototype 'Q' engine he wrote:-

"*Bench tests of the complete engine ...with exhaust system, gearbox and other units in position have shown...a steady 110 BHP delivered to the back axle. There will also be an additional 20 BHP or so available for short periods if the fuel does not detonate when the engine warms up*".

This was + 18% , which may have been an extreme gain for a highly-supercharged (3.1 ATA) engine burning 70% alcohol fuel.

Comparative power tests

At various times firms have arranged to test other company's engines, and good data from these comparisons is available in a few cases

- Mercedes-Benz pre-WW2 bought and tested the engine of the MG 750 cc car EX127 of Bobby Kohlrausch, which had set a class record of 140 MPH in 1936 in Germany. DASO 468 reports:-
  "*On the Unterturkheim dynamometer in January 1938 the MG engine* [Q-type modified by Kohlrausch with a bronze head replacing cast-iron] *delivered 115 BHP @ 7,000 RPM...with compression ratio of 6.25 and boost pressure of 25.5 psi..*".
  Karl Ludvigsen notes this would have been with a 6'' diameter Zoller supercharger and at MG two years earlier it had shown 123 BHP @ 7,200 RPM on 31 psi boost (see "Appendix 5").
- In 1971 Weslake built an engine, WRP190, for Ford to supply to Gulf for long distance sports car races. This was 60V12 NA 75 mm/56.5 = 1.327 2,995 cc. Run in December 1971 on the same brake as a DFV it gave the same 450 HP. Some development yielded over 460 HP. However, tested over the next two years in a Brabham and a Gulf-Mirage the speeds were

disappointing. It was acknowledged afterwards that the chassis were to blame, when, after an independent test was run at Swindon Racing Engines (an approved Cosworth rebuilder), it showed 464 HP @ 10,750 RPM (DASO 1146). This settled the threat of a court case. See "Appendix 5" and "Illustrations Appendix 5(2)".

- CORRECTIONS & ADDITIONS at P. 53, expanding on P.51, describes how Jaguar tested an English owner's Ferrari 250GTO engine in ca. 1961 and found it developed 288 BHP@ 7,750 RPM. Allowing for condition this closely validated a Ferrari claim of 306 CV (302 BHP) as reported in Note 47 (the author had suggested there that the Ferrari claim was 10% optimistic).
- In Note 6 five examples were given of Maserati engines dating from 1954 to 1966 which, when tested on English beds, were found to be on average about 9% lower in power than claimed by the maker. This was believed to be because the powers were measured before the engines had reached full temperature.
  Correspondent Stephen Cansick recently has pointed out that, in two of the cases (1954 250F tested by SU and 1966 3 L V12 tested by Coventry Climax) it was acknowledged that the tests were run with "shop exhaust" systems. This is, of course, a very loose description of the arrangement but the inference is that the important contribution of an open exhaust system towards power, by reason of resonances, was smothered for reasons of health and safety. In the specific case of the 3 L the effect has been stated * to be a reduction from 336 HP to 306 (-9%). Nevertheless, 336 is still over 5% below the 355 HP (360 CV) claimed.
  *Coventry Climax Racing Engines D. Hammill Veloce 2010.
  My correspondent has noted that Alf Francis personally saw a 250F engine on test on a Heenan and Froude brake pulling load equivalent to 240 HP @ 7,250 RPM, just as Maserati claimed (DASO 158 p.216). However, Francis went on to report that, in a test with Shell fuel in place of the usual Italian, "*the engine seemed to retain its power for much longer periods*". So a drop of power *was* acknowledged.

Running loss, no loss – or gain!

- Niki Lauda, who was a very analytical driver, stated that a Cosworth DFV, which he last drove in 1983, would lose only 10 HP (say, 2%) in a race. He said that this was much less than a Ferrari 312B type , with which he was also familiar (DASO 571).
- Note 48 describes how the formation of carbon on the originally-polished surfaces of the combustion chambers of a Coventry Climax FWMV Mk2 engine reduced the power by 2.7%.
- Driven by Stirling Moss, navigated by Denis Jenkinson, the Mercedes-Benz 300SLR won the 1955 Mille Miglia at nearly 98 MPH. The engine on test afterwards gave the same power as at the start:- 296 HP (300 PS) @ 7,400 RPM (DASO 468). This ability of Mercedes engines to retain their power was a large factor in their success, which Moss acknowledged in DASO 32.
- When Prof. Dykes was developing his anti-flutter L-section piston ring, he tested an AJS 7R racing motorcycle engine, 1 cylinder NA air-cooled.348 cc. On the bench this had a plain exhaust pipe of correct length, exhausting into an expansion chamber, but no megaphone. He found that there was difficulty in determining ring modification effect because the power rose steadily during the testing. It started at 28.4 HP@ 7,000 RPM and rose to 33.4 (+17.6%)(DASO 174)!
- In DASO 838 is described how the Maserati 250F bought by the Owen organisation was tested after an early 1955 rebuild (believed to be with large – 48 mm - inlet valves) to give 255 BHP but after much running produced nearly 261 – +2.3%. The source also reported gains in power for two BRM engines (IL4 2.5 L and Flat H 16)on test.

"Super-tuning"

Enzo Ferrari dismissed "Super-tuning" by saying:- "*It gives you horses which are with you in the morning but are gone by the afternoon!*".

Nevertheless, Note 48 describes how Tony Rudd "Super-tuned" his BRM engines for the 1965 Italian GP to add 5% of power, and how the drivers kept this in hand until the last few laps, when it gave them a 1,2 finish.

"Tuning" and "Blue-printing"

- In DASO147 p.150 Alf Francis gave an example of simple "Tuning", i.e. getting the carburation right. With a 1951 Alta IL4 2 L NA engine fitted with twin double-choke Weber carburetters on Geoffrey Taylor's test-bed at Alta he was able to raise the initial 110 BHP (admittedly in late season well-worn condition – when fresh it had 130) to 125 - +13.6%
- Formula Ford was based on a Kent Cross-flow 1,599 cc engine to which no modifications were permitted. To GT specification the power was 88 BHP @ 5,400 RPM. Specialist engine builders set to work on this unit by both "Tuning" and "Blue-printing" (making sure every part of the engine was within the smallest tolerances). DASO 1233 states that the consensus of these firms in 1984 was that this produced about 104 BHP - +18%. This gain was with engines built to the average quality standard of 36 years ago. Modern production is to a higher quality and so must be less susceptible to such improvement.
- DASO 1234 describes how Roger Penske in 1971 bought a new 1970 Ferrari type 512S sports-racing car (60V12 5 L NA). He discovered that it was "*shabbily constructed*". Many chassis parts were rebuilt. "*The V12 engine was sent ...to Traco Engineering...where re-machining of the rather casual factory tolerances produced another 40 horsepower*". Ferrari claimed for the 512S 550 CV @ 8,500 RPM. Assuming that this was for a properly-built engine, the TRACO re-gain by "Blue-printing" was 40/(550-40) = about 8%.

Minor airflow development for power

Alf Francis describes in DASO 147 pp170-171 how in 1952 he spent 5 working days with the staff of Weber in Bologna in developing Peter Whitehead's IL4 2 L NA engine. The results were as follows:-

	All Tests initially with open exhausts by 12''stub pipes*-	
Specification	BHP @ 6,000 RPM	
• Original, 4 horizontal SU carburetters	117	Datum
• 2 x 2x36 mm choke Weber carburetters on new manifold	124	+6%
• Improved manifold and tuned	129.8	+11%
• Adjusted ignition timing	133.8	+14%
• 2 x 2x 38 mm choke Weber carburetters	136.8	+17%
• Longer and tapered inlet pipes	143	+22%

*Different lengths were tried with no gain.

This rapid gain of 22% was achieved without any internal changes. Probably the engine lost some power through wear while running at peak speed, so could have shown more than 143 BHP after a rebuild – which was done but without any further testing.

A cautionary tale about power quotations!

In "Formula 2" by Gregor Grant (Foulis 1953) the author reported:-

"*A few years ago, I was present at the bench test of a supercharged 1½-litre engine, which was stated by the manufacturer to produce 180 BHP at 6,000 RPM. Despite meticulous assembly, and the*

[continued on P.4]

presence of one of the most able tuners and carburation experts in Great Britain, the most that that engine could be made to give on the Heenan and Froude dynamometer, was exactly 115 BHP at the same revolutions".

The author spared shame for the maker by not naming him.

Grant was a well-respected member of the racing scene and was prepared to put this account into print. What can we make of it? The only British maker of such an engine in about 1949 would have been Geoffrey Taylor, head of Alta, and no-one has ever suggested that his products could be so down on power. Was it foreign? It is *jus*t possible that there was an error in the rev-counter gearing (which *has* been known elsewhere) and that the reading of 6,000 RPM was nothing like it. An explanation may have been published later in *Autosport* which Grant founded and edited, so a website visitor may have the answer.

*Dis*information

Jack Brabham arranged for a spare Repco 620 engine taken to the 1966 Italian GP event to have its crate stencilled "*MONZA 350 HP*" on the transport crate. Actually, it had given 298 HP! There was a comeuppance to this, however, because Brabham retired in the race (DASO 842).

Restoration engine power

DASO 1143 describes how in 2000 a Maserati 8CTF IL8 3 L PC engine was rebuilt and tested. It produced 390 BHP @ 6,400 RPM. This compares with the power of 360 BHP for the engine type when sold to the USA for Wilbur Shaw to drive to victory in the 1939 Indianapolis 500 (see "Illustrations for Appendix 5" at Fig. 17). The explanation for the increased power is that the fuel pipes had been enlarged for the methanol-based fuel. Possibly, also, the lubricating oil was to a modern standard with lower viscosity.

Effect of Con. Rod Length/Stroke (CRL/S) ratio

Note 73 Sub note E records Tony Rudd's statement (DASO 40) that on the BRM IL4 1.0 L NA engine shortening CRL/S from 1.91 to 1.7 (-11%) had raised power from 123 HP to 136 (+16%).

Corrections for atmospheric conditions

Pressure

Where there is a difference between Standard Pressure and Test Pressure (Std./Test = CP) the simple correction applied is:-

Test power (BHP) x CP = Corrected power.

The correction CP should actually be applied to Indicated power (IHP) taking into account Mechanical Efficiency (EM), where IHP = BHP/EM.

The difference between the simple and true corrections is:-

True Correction (TCP) = (CP-1+EM)/EM

Sample figures

EM =	0.8*	0.6**
CP	. TCP	.
0.95	0.9375	0.9167
0.93	0.9625	0.95
1.01	1.0125	1.0167
1.03	1.0375	1.05
1.05	1.0625	1.0833

*The SAE correction formula uses EM = 0.85 for production engines.

**See 3NA at Eg. 85 Ferrari 049 at P.4 note (iii), which justifies the value of 0.6 where RPM approaches 20.000 and Mean Piston Speed (MPS) approaches 25 m/s.

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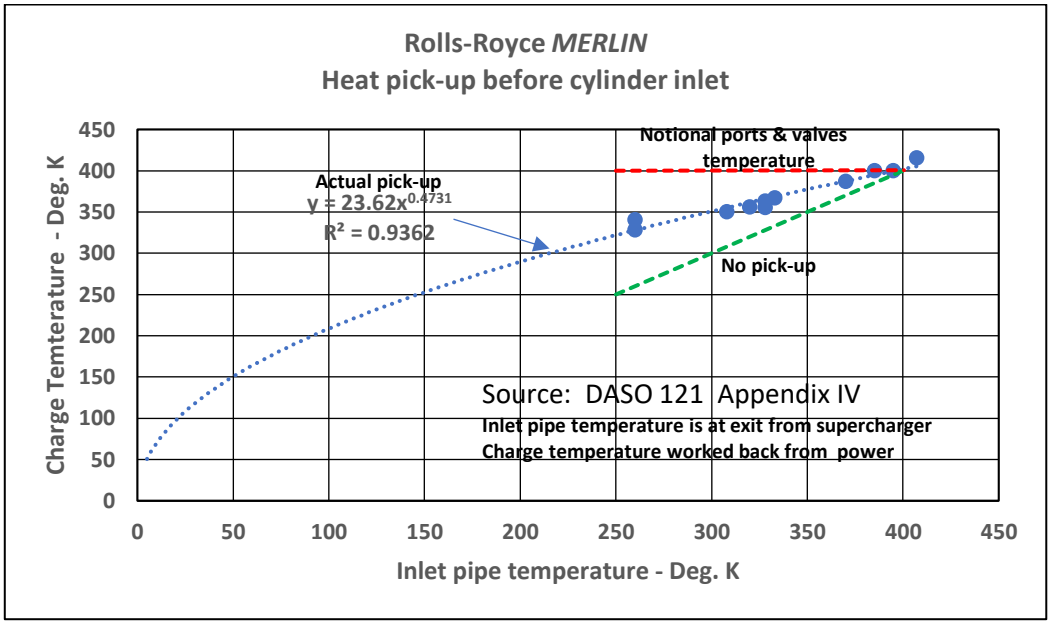
Temperature

Standard practice:-from practical tests in the '20s in variable-temperature cells it was found that a square root ratio more closely followed the observed power variation as temperature varied from STP. It is purely empirical, but arises because of pick-up of heat as the inlet charge flows through the hot ports and valves. The higher the approach temperature, the lower the heat pick-up before the charge enters the cylinder, which governs the power. So the result is a smaller rate of drop-off as approach temp. rises, compared to an ambient density change. The effect is illustrated in the chart below, derived from tests made on the Rolls-Royce *Merlin.*

The correction for temperature is therefore:-

Test power (BHP) x √(Test Temperature ^{0}K/Standard Temperature^{0}K) = Corrected power.



Humidity

In a US Bureau of Standards report No. 426 dated 1932 the results were given of tests on a Curtiss D12 NA aero engine run with varying humidity in an altitude cell. The conclusion was that the power loss was closely equal to the %age by which water vapour displaced air in the inlet charge.

The maximum humidity tested at Sea Level was 2.3% (17.7 mmHg/760), resulting in a power loss of 2.6% (427 HP from 438). It is reasonable to suppose that this was considered the highest likely at the test latitude.

In Note 73 Sub-note D a claim by John Judd was reported that Cosworth made a humidity correction on their1965 type SCA 1.0 L NA engine which he estimated raised 123 HP to the 140 published. (14%). It is now clear from reading the US report that something was awry with this estimate. The humidity in Northampton cannot possibly have been 14%! At most it might have been about 2$_{1/2}$ %, as tested in the US.

Ferrari power

See Note 70 where Denis Jenkinson, initially an "un-believer" about the power claimed for the Ferrari 65^0 V6 type 156 of 1957 did later acknowledge that the figure for the 1961 120^0 re-design "*did in fact give 178 BHP @ 9,500 RPM on its first outing*". Unfortunately, DSJ did not give his source for this.

References on P.6.

References

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