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25 October 1943

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MEMORANDUM:

To: Technical File

From: Edwin C. Walton

Subject: Estimated P-51B Mustang Performance with Improved Fuel
(160 grade)

Reference: Conference at Rolls Royce, Derby, on October 23, 1943

This conference was held to discuss tests conducted to date by Rolls Royce with 160 grade fuel in Merlin engines, and the probable performance gains to be anticipated in the P-51B with this fuel. Those present at the conference were :

Mr. Sidgreaves	Rolls Royce
Mr. Hives	" "
Mr. Lovesey	" "
Mr. Morris	" "
Lt.Col. Thomas Hitchcock	U.S. Assistant Military Air Attache
Lt. Dupell	Maintenance Division, 8th Air Force Service Command
Mr. S. D. Turner	Petroleum Attache
Mr. E. C. Walton	Aircraft Representative, Mission for Economic Affairs in London

Mr. Lovesey opened the discussion by stating that the use of 160 grade fuel (containing 2% mono methyl aniline) allows the Merlin 66 to operate at 25-lbs. boost without detonation, as compared to the 15-lb or 18-lb boost possible with 130 grade fuel. As the result of tests conducted to date by Rolls Royce on Merlin powered Spitfires, it appears that only a few very minor modifications will be necessary in the airplanes to use 160 instead of 130 grade fuel. In the Spitfire with Merlin 66 engines, the required changes are as follows :-

1. Reset the throttle to operate at 18-lbs. boost to the gate, and 25-lbs. by going through the gate (as compared to present normal setting of 15-lbs. up to the gate and 18-lbs. through the gate). This is a simple modification, and it will be easy to mark the throttles so that they may be moved back to the normal setting in a few minutes if the airplane should land at fields for refuelling where only 130 grade fuel is available.
2. Minor alterations in the spring in the boost control.
3. Strengthen one small plate in the engine mount structure

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by simply bolting on a reinforcing plate.

No change in propeller is necessary, although it is agreed that a slight additional gain might result from using a different propeller. In addition it was agreed that the propeller should not be run up to full RPM on the ground with 160 grade fuel, as it could not absorb the full static thrust. However Spitfires are now being test flown with the improved fuel, using the standard 4-blade (wood) propeller.

The cooling of the present Merlin 66 installation in the Spitfire appears satisfactory with the 160 grade fuel, at least for temperate climates. The engines themselves seem quite capable of handling the additional power, and Rolls Royce have run a total of about 800 hours on the several engines being tested at 25-lbs. boost. One of these engines has had over 150 hours. Because of the higher blower gear ratio in the Packard 1650-3 Merlin there is naturally some question as to whether the full 25-lbs. boost can be used, and it was agreed that the ultimate might be somewhere around 23-lbs. In any event the improved pistons, which are understood to be standard in all Packard 1650-3 Merlins after the first 1,300, should be used for 160 grade fuel operation.

In flight tests at Supermarine, a Spitfire IX at 25-lbs. boost and gross weight of 7,770 lbs. demonstrated a time of climb of 4.3 minutes to 20,000 feet, 5.8 minutes to 25,000 feet, and 7.8 minutes to 30,000 feet, and an increase of 1,000 feet per minute in rate of climb at sea level as compared to operation at 15-lbs. boost. In Rolls Royce flight tests at Hucknall a Spitfire VIII at 25-lbs. boost and 7,234 lbs. gross weight has demonstrated a rate of climb at sea level of 5,740 feet per minute as compared to 4,960 feet per minute at 18-lbs, and a rate of climb at 10,000 feet of 5,080 feet per minute as compared with 4,280 feet per minute at 18-lbs.

It is estimated that the Packard 1650-3 Merlin power at 3,000 RPM with 25-lbs. boost will be approximately as follows :-

2,000 HP @ 6,000 feet (low blower without ram)

1,700 HP @ 17,500 feet (high blower without ram)

On the basis of Spitfire tests it is predicted that ram will increase the critical altitude by about 5,000 feet.

The attached graph shows the Rolls Royce estimates of the probable improvement in speed in the P-51B through the use of 25-lbs. boost with the improved fuel. It should be noted especially that a maximum speed of about 450 MPH is predicted at 21,000 feet - optimum high critical altitude for use against the present FW-190 fighters.

The Rolls Royce representatives suggested that the following steps be taken to assist them in expediting their studies of P-51B Packard Merlin installations :

1. That the USAAF deliver a Packard 1650-3 Merlin to Hucknall at the earliest possible moment for bench tests, first for a further check on the boost control and carburetor adjustment at 15-lbs. and 18-lbs. boost with 130 grade fuel, and subsequently for checking engine performance at 25-lbs. boost with 160 grade fuel (replacing the present pistons with improved pistons from the supply available at Rolls Royce). Lt. Dupell is to take this up through Colonel Griffiths to General Knerr for action.
2. That they be advised whether the present P-51B engine mount, attaching fuselage structure, and Hamilton Standard propeller will stand the increased horsepower (stated above) of the Merlin 1650-3 at 25-lbs. boost. Mr. Walton is to make a preliminary check through the North American and Hamilton Standard London representatives, pending receipt of official data from the USAAF.

In conclusion, a discussion was held on the desirability of getting one or more Spitfire and P-51 squadrons into operation quickly with the improved fuel to establish a service record, and the Rolls Royce representatives estimated that somewhere around 10,000 gallons of fuel per week will be required for the operation of each Spitfire squadron (whereas total U.K. production of 160 grade fuel is now about 70,000 to 75,000 gallons per week).

As an indication of further developments to be expected it was mentioned that a 14 SM Merlin has already been operated by Rolls Royce for more than 20 hours at 2300 HP with 30-lbs. boost (using an even higher grade of fuel than 160 grade obtained by the addition of extra lead content).

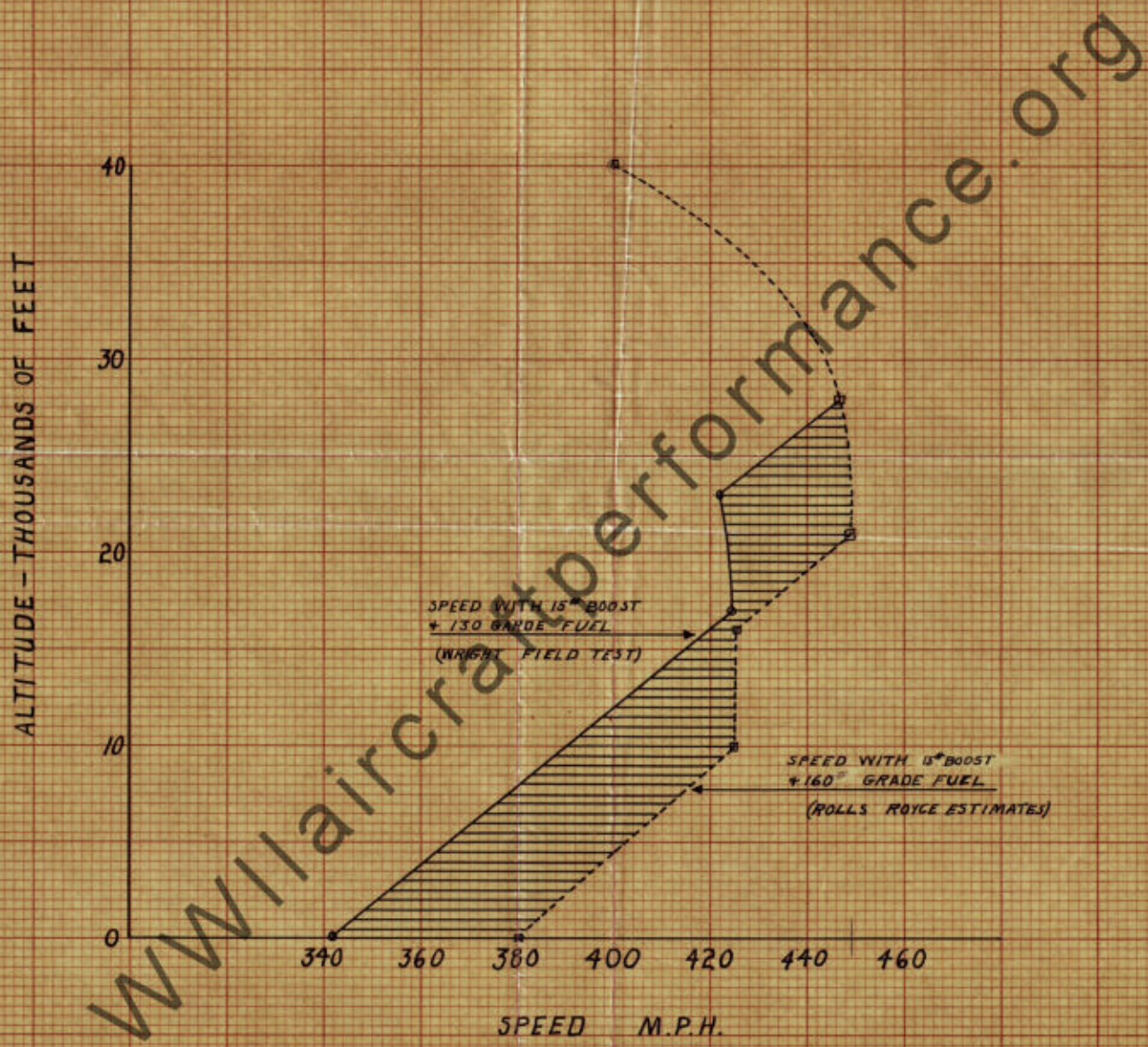
Copies to:

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Mr. S.D. Turner
Mr. Legarra
Lt. Dupell
Mr. T.P. Wright

ECW/BKC/156

P-51B FIGHTER WITH MERLIN 1650-3 ENGINE

ESTIMATED PERFORMANCE GAIN WITH IMPROVED FUEL



NOTE: WITH GROSS WEIGHT OF 8600^{lb} IT IS ESTIMATED BY R.R. THAT THE P-51B RATE OF CLIMB AT SEA LEVEL WILL INCREASE FROM 3600 FT./MIN. WITH 130 GRADE FUEL TO 4600 FT./MIN. WITH 160 GRADE FUEL.