

McRAINEY

M-E-M-O-R-A-N-D-U-M

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SUBJ: Installed Performance of TPE 331 Engines

The attached tables specify the installed static (zero airspeed) take-off power setting engine performance for both the VTB and the Porter for various ambient conditions. These tables specify fuel flow and torque for take-off limit EGT and take-off RPM (100%).

The following information is supplied to assist in trouble shooting analysis of engines which do not meet the specified performance.

A. Instrumentation:

1. Fuel Flow

The Foxboro fuel flow system, used in both the VTB and the Porter, measures volume flow (gallons per hour). However, engine power output is a function of mass flow (pounds per hour). Therefore it is essential that we account for the density of the fuel when specifying desired volume fuel flow. Since fuel density is a function of fuel temperature we must account for the temperature of the fuel as it passes through the flowmeter. In both the VTB and the Porter, fuel flow is measured downstream of the fuel/oil heat exchanger and fuel temperatures at the flowmeter are approximately 5°C less than oil temperatures. For example, in a VTB with an oil temperature of 110°C, we are metering JP-4 fuel with a temperature of 105°C and a density of 5.86 pounds per gallon. When these temperature/density effects are taken into account (as they are in the attached tables) the fuel flow metering and readout system should be accurate to within  $\pm 1\%$ . Unless compressor efficiency has deteriorated, the fuel flows noted in the attached table should result in limit turbine inlet temperature and the pilot should see limit exhaust gas temperature on his cockpit EGT indicator.

2. Exhaust Gas Temperature ( $T_5$ )

In the TPE-331, we measure EGT by means of eight thermocouples situated in the tailpipe. EGT is used as an indication of turbine inlet temperature ( $T_4$ ). The purpose of specifying a take-off EGT limit is to insure that the take-off limit  $T_4$  (1811°F) is not exceeded. The  $T_4/T_5$  relationship may vary slightly from engine to engine. When engines are run in a test all this variance can be

determined. On TPE 331-25 (Porter) engines a calibration resistor is added to the EGT circuit with the result that the  $T_5$  indication is biased so that take-off limit  $T_5$  will be indicated when take-off limit  $T_4$  exists. At present the VTB installation does not use a calibration resistor. Therefore when limit EGT is indicated,  $T_4$  may be higher or lower than limit and power output will vary accordingly. It is planned to convert the VTB installation to the use of the calibration resistor.

A recent survey of the engines we are operating has indicated large errors in EGT. While the source of these errors is not definitely determined, it is suspected that even minor clogging of the fuel nozzles may shift the temperature distribution in the tailpipe and thereby induce major errors in EGT. If, due to these errors, the EGT reads low, we will "overtemp" the engine if we advance the power lever until limit EGT is indicated, or if the EGT reads high we will indicate low torque and fuel flow when limit EGT is indicated.

### 3. Torque

The torque reading in the cockpit is a measurement of differential oil pressure. For a given torque value this differential oil pressure will vary with oil temperature. Therefore it is essential that the torque sensor calibration be performed at installed operationing oil temperature. The indicated torque value decreases about 1% for every 15°C increase in oil temperature. For this reason VTB torque indicates about one to one and a half PSI low. In the future it is planned to calibrate VTB torque sensors at higher oil temperatures thus eliminating this error.

### B. Take-off Power Setting Procedures and Analysis

1. Advance the power lever until limit fuel flow or EGT is attained. Do not exceed either fuel flow or EGT limit.
2. If limit EGT is attained at a low fuel flow value, check the torque value. If torque is also low it is probable that EGT error exists due to either the EGT measuring system or fuel nozzle clogging. If the torque is correct, fuel flow instrumentation error is indicated.
3. If the fuel flow limit is reached prior to attaining limit EGT, check the torque value. If the torque is correct, EGT error due to the EGT measuring system or fuel nozzle clogging is probable. If the torque is low, either fuel flow error or engine power deterioration is indicated.

4. If EGT and fuel flow limit are attained together but the torque is low, either torque meter error or engine power deterioration is indicated.

The attached tables will be added to the VTB and Porter Flight Manuals as well as the take-off fuel flow limitation. Pending these Flight Manual changes, no pilot will exceed take-off limit EGT or fuel flow.



D. Carew

Attachment: as stated

cc: VPFO  
DFD  
VPTS via VPFO  
MMR via VPTS  
DRM via VPTS  
MFD/SGN (All VTB and PC-6C pilots)  
MFD/UDN (All VTB and PC-6C pilots)  
MFD/BKK (All VTB and PC-6C pilots)  
MFSD  
File (2)

DC/hk

TAKE-OFF POWER SETTING

DO NOT EXCEED EGT OR FUEL FLOW

VTB VOLPAR						
OAT °C	18	22	26	30	34	38
LIMIT EGT °C	573	575	577	579	582	585
ALT FT	TORQUE ( $\Delta P$ ) ~ PSI					
	JP-4 FUEL FLOW (wf) ~ Gal/Hr					
S.L.	52.5 64.4	51.2 63	50.0 61.7	48.5 60	47.2 59.1	46.2 57.8
500	51.7 63.4	50.5 62.1	49.4 60.8	47.9 59.4	46.6 58.2	45.5 56.9
1000	51 62.1	49.8 60.8	48.6 59.5	47.2 58.2	45.9 57.0	44.9 55.8
2000	49.5 59.9	48.4 58.6	47.2 57.4	45.8 56.1	44.7 55.0	43.7 53.8
3000	48 58	46.7 56.7	45.8 55.5	44.5 54.3	41.4 53.2	42.4 52.0
4000	46.5 55.7	45.5 54.5	44.5 53.4	43.3 52.2	42.2 51.1	41.2 50.0
To convert to JP-1 fuel subtract 2.0 gal/hr from JP-4 fuel flow						
H.P. = 12 (Torque ~ PSI-10)						

TAKE-OFF POWER SETTING

DO NOT EXCEED EGT OR FUEL FLOW

PC-6 PORTER						
OAT °C	18	22	26	30	34	38
LIMIT EGT °C	573	575	577	579	582	585
ALT FT	TORQUE (ΔP) ~ PSI					
	JP-4 FUEL FLOW (wf) ~ Gal/Hr					
S.L.	55.2 63	53.8 61.6	52.5 60.3	51 59	49.5 57.8	48.4 56.6
500	54.3 62	53.0 60.7	51.8 59.4	50.3 58.1	49 56.9	47.9 55.6
1000	53.5 60.8	52.2 59.4	51.0 58.2	49.5 56.9	48.2 55.8	47.2 54.7
2000	52 58.5	50.8 57.3	49.6 56.1	48.2 54.9	47.0 53.7	46 52.5
3000	50.5 56.7	49.4 55.4	48.3 54.3	46.9 53.1	45.8 52.0	44.8 50.8
4000	49.2 54.5	47.9 53.3	46.8 52.2	45.5 51.0	44.2 50.0	43.2 48.9
To convert to JP-1 fuel subtract 2.0 Gal/Hr from JP-4 fuel flow						
H.P. = (Torque ~ PSI-10)						