Part I—Description and Management of Systems

Chapter 3—Engine Controls, Instruments and Oil Systems

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1 General

(*a*) The Olympus Mk. 104 engine incorporates two independent axial compressors, each driven by a separate turbine, and a can-nular straight flow combustion system. It is controlled by a single throttle lever and a two-position TAKE-OFF/CRUISE combined RPM governor and JPT limiter selector switch. Automatic control is provided in the various fuel system components to compensate for changes in ambient conditions and airspeed.

(*b*) The engines are equipped with a jet-pipe temperature limiter which, as conditions require, reduces the engine speed to below the governor controlling speed, so that the corresponding jet-pipe temperature limit is not exceeded. The limiter is effective under normally changing conditions of power but not during very rapid changes. When switched off, manual throttling will be required.

(*c*) To improve engine handling at high altitudes, trimmers are fitted in each jet-pipe nozzle, thereby reducing the effective area of the nozzle.

(*d*) Drainage from the engine fuel system, dump valve, combustion chambers and turbine annulus is piped to collector tanks, self-emptying in flight through outlets in the centre engine doors.

2 Throttle control/HP cock controls

(*a*) The four throttle levers (B/29), which also control the HP cocks, are in a throttle quadrant marked OPEN-IDLING. The sleeves on the throttle levers must be held up to permit backward and forward movement of the levers at the IDLING gate, and forward movement from the HP cock SHUT position. A sector marked OPEN—HP COCKS—SHUTcorresponds to the HP cock settings.

(*b*) The throttle friction lever (B/28) is on the starboard side of the throttle quadrant. Forward movement of the lever increases friction.

3 Take-off/cruise selector switch

(*a*) The TAKE-OFF/CRUISE selector switch (A/43), on the throttle quadrant adjacent to the throttle levers, eliminates the need for throttle lever adjustments to maintain the engine RPM and JPT within their respective limitations under take-off and cruise conditions. This single switch simultaneously controls the RPM governors and JPT limiters on all four engines.

(*b*) An ENGINE CONTROL magnetic indicator (A/25) on the engine instrument panel shows black when the selector switch is set to TAKE-OFF and white when set to CRUISE.

4 RPM governor and JPT limiter

(*a*) RPM *governor*

(i) The fuel system of each engine incorporates a driven and a static governor which, with the throttle OPEN, control the RPM at the TAKE-OFF and CRUISE limitations respectively. With the TAKE-OFF/CRUISE selector switch set to TAKE-OFF, the static governor is by-passed and the driven governor controls the RPM within the TAKE-OFF limitation. With the switch at CRUISE, the static governor is brought into circuit and, with its lower setting, overrides the driven governor to control the RPM within the CRUISE limitation.

(ii) The governors are of the hydro-mechanical variety and maintain the selected limiting RPM regardless of variations in fuel temperature and density. However, the governor RPM may vary very slightly with altitude.

(iii) In the event of an electrical failure associated with the TAKE-OFF/CRUISE selector mechanism, the static governor is by-passed and the driven governor assumes control, thus ensuring the attainment of maximum thrust, if required.

(*b*) JPT *limiter*

(i) Signals from the jet pipe thermocouples of each engine are fed to the cockpit JPT gauge and also to the amplifier of the JPT limiter system. Hence, defects in the thermocouples or their wiring will affect the limiter and the gauge together but defects in the gauge system will not affect the limiter. Each amplifier has a TAKE-OFF datum and a CRUISE datum and the appropriate datum is selected by the TAKE-OFF/CRUISE selector switch. Any rise in JPT above the selected amplifier datum results in a signal from the amplifier to the electro-pressure control in the fuel system, which then reduces fuel-flow until the JPT falls to the datum value. Any such reduction will reduce RPM below the selected governed value. When the JPT limiter is active, the JPT should be within 5°C of the selected limitation.

When an engine is accelerated, the JPT does not rise as rapidly as the turbine temperature. The JPT limiter system incorporates an anticipator circuit which senses the rate of rise of JPT and computes the ultimate stable JPT. If this should be higher than the limitation, a signal is sent to the electro-pressure control to reduce fuel-flow by an amount sufficient to prevent turbine overheating.

(ii) The JPT limiter system is provided with an ON/OVERRIDE selector switch (A/42), adjacent to the TAKE-OFF/CRUISE selector switch, and this should normally be set to the ON position. Set to the OVERRIDE position, the JPT limiter system is rendered inoperative. This single switch controls all four JPT limiter amplifiers simultaneously.

Certain failures of the JPT limiter system are possible which could lead to excessive JPT, reduced thrust or instability. In the event of excessive JPT, manual throttling of the offending engine is necessary to maintain JPT within the appropriate limitation. In the event of reduced thrust or instability, the JPT limiter selector switch should be set to OVERRIDE and the engine operated within the appropriate limitation by manual throttle control. It is extremely unlikely that either of these latter defects would occur on more than one engine at a time. However, once the switch is set to OVERRIDE for one defective JPT limiter system, all four engines must now revert to manual throttle control.

The extreme case of reduced thrust is associated with any failure leading to a runaway of the electro-pressure control, in which event the RPM of the affected engine will reduce to about 88%

on the ground in ISA conditions and about 90½% in maximum tropical conditions. If such a failure becomes apparent prior to take-off, the JPT limiter selector switch should be set to OVERRIDE and the throttles set to obtain the RPM shown in Part III, Chapter 1, para. 6(*a*) to avoid turbine overheating.

(iii) The settings of the JPT limiter amplifier TAKE-OFF and CRUISE data are identical with the engine TAKE-OFF and CRUISE JPT limitations. However, the data settings increase with altitude to the extent of about 5°C. In practice, TAKE-OFF will rarely be needed at altitude and at CRUISE, the RPM limitation will normally be reached before the JPT limitation.

(iv) The JPT limiter selector switch can be set to OVERRIDE to check the RPM governor settings during ground test. Particular care is necesary when TAKE-OFF is selected to avoid or minimise turbine overheating during the period in which the JPT does not attain its stable value. Again, for the purposes of ground test, the JPT limiter system can be checked with the RPM governor inoperative. With the TAKE-OFF/CRUISE selector switch at CRUISE and the JPT limiter selector switch ON, the cruise governor is by-passed by holding the two RPM GOVERNOR ISOLATION switches at the top of panel No. 3P to ON. Engine RPM will rise until checked by the operation of the JPT limiter controlling at its CRUISE datum.

(v) Power supply for the JPT limiter amplifiers is obtained from No. 1 inverter in the case of outer engines and from No. 3 inverter in the case of inner engines.

5 Engine starting controls

(*a*) Each engine is started by its own electric starter motor. Power is normally supplied from the ground supply, plugged in to the external socket in the power compartment.

(*b*) The engine starting controls are grouped together at the rear of the port console and consist of ;

(i) An ENGINE STARTING rotary selector (at C/3) marked 1, 2, 3 and 4, which is used to select the engine to be started.

(ii) A guarded IGN ISOLATION ON (forward)—OFF switch (C/4) which controls the ignition of all four engines.

(iii) An ENGINE MASTER ON (forward)—OFF switch (C/33) which, when set to ON, enables an engine to be started by pressing the engine starter-button (C/31).

(*c*) The ignition isolation switch and the engine master switch must be ON before an engine can be started. With the ignition isolation switch set to OFF and the engine master switch ON, the engines may be motored over after a failure to start to clear excess fuel.

(*d*) When the engine starter-button is pressed for two seconds and released, the button will remain in until the overspeed relay operates to trip the isolating switches (approx 22 seconds), or if the light-up does not occur, for the period of the starting cycle (30 seconds). A mechanical inter-link between the engine starting rotary selector and the engine starter-button ensures that the selector is retained in the position selected until the starting cycle for that particular engine is completed.

5A Simultaneous engine starting

All engines can be started simultaneously by use of a simultaneous-start trolley. Power supplies and controls for engine starting are contained on the trolley which must be connected to sockets in the undercarriage bays. Starting is effected externally by the Crew Chief pressing each start button at one second intervals. The ignition and engine master switches in the cockpit must be OFF for simultaneous starting, as the aircraft starter panel is not used.

6 Starting from internal power supplies

One engine may be started in an emergency from the 96-volt and 24-volt batteries when no ground supply is available. The 96-volt battery provides the power to operate the starter motor and the 24-volt battery the power for the high-energy ignition.

7 Engine relighting buttons

The high-energy igniters may be used to relight an engine in flight by pressing and holding in the relight push-button (B/1) in the head of the appropriate throttle lever (B/29).

8 Engine instruments

Oil pressure gauges (B/18), engine speed indicators (B/16) and JPT gauges (B/13) are on the engine instruments panel. The JPT gauges are AC operated from the No. 1 inverter in the case of the outer engines, and from the No. 3 inverter in the case of the inner engines. Post-Mod. 1996, four oil temperature gauges are fitted at the AEO's station. Power supplies for the gauges are from the 28-volt DC system.

9 Oil systems

Each engine has its own independent integral oil system, the oil tank (oil capacity 7 gall with 3 gall air space) being integral with the engine air-intake casing. Four oil pressure gauges (B/18) are on the engine instruments panel. Post-Mod. 1996, four oil temperature gauges are fitted at the AEO's station.