BRISTOL SIDDELEY

AERO ENGINE SCHOOL

SECTION 12
GROUND HANDLING

12.1 SAFETY PRECAUTIONS

12.2 AIR CROSS-FEED STARTING

12.3 FULL GROUND RUNNING PROCEDURE

12.4 STARTING PROCEDURE (FIRST ENGINES)

12.1 SAFETY PRECAUTIONS

AIRCREW EJECTION SEATS

This equipment is a source of potential danger to personnel and of damage to the aircraft. If a firing mechanism is operated while the aircraft is on the ground, a seat will be ejected, damage will be done to the aircraft and injury could be caused to any person in, or leaning into, the cockpit.

Before any individual is allowed to enter the cabin, therefore, the N.C.O. i/c airframe servicing must ensure that the following safety precautions have been observed:-

1. The safety pins are fitted in the ejection gun sears.
2. The safety straps are in position over the firing handles of the seats.
3. The second safety pin attached to the safety pin disc is in the hole of the time delay unit on each seat
4. The safety pin is in the jettison gun sear

Jet Warning

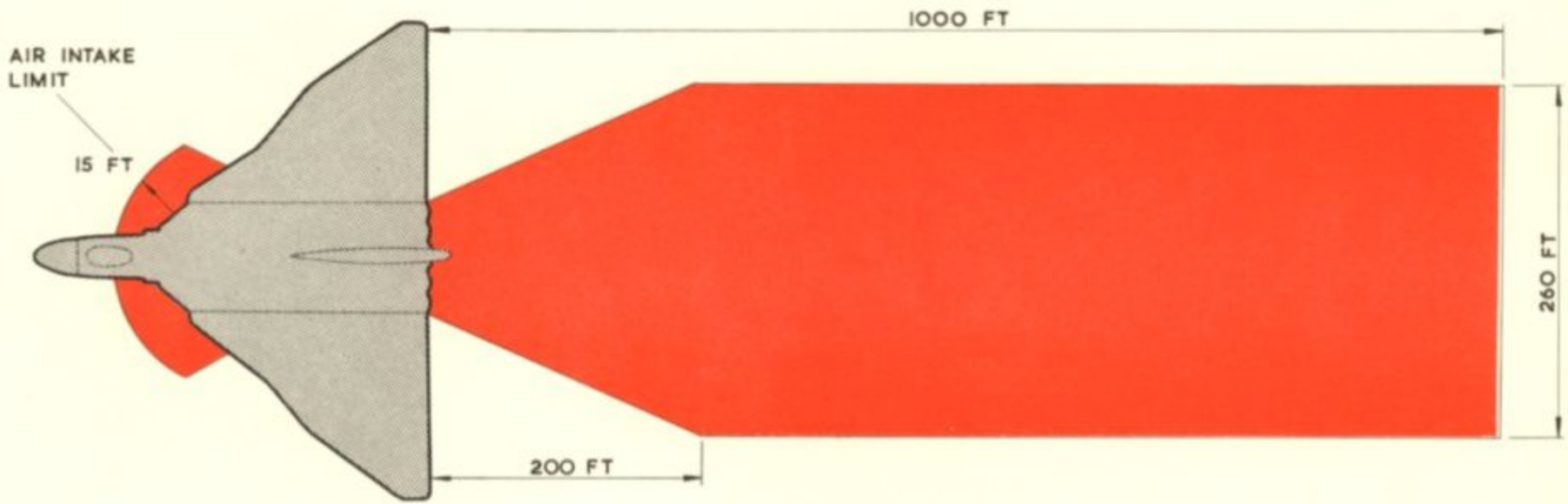
When the aircraft is being manoeuvred on the ground with the engines running, or when an engine is being run for any purpose, it is essential that personnel are given struct instructions to keep well clear of the air intakes and jet exhausts, as to remain in proximity is to hazard their safety.

Personnel and mechanical transport must not enter the shaded area when an engine, or engines are running. The rear of the aircraft must be at least 800 ft from buildings.

Personnel may walk with safety beneath the air intakes during engine running, the danger areas being confined to a 15 ft. radius in the same horizontal plane as the intakes.

See Drawing TP.4823.

PERSONNEL MUST NOT APPROACH
THE JET PIPES FROM UNDER THE
AIRCRAFT CLOSER THAN THE REAR
OF THE BOMB BAY WITHOUT PERMISSION



DANGER AREAS

TP 4823

12.2 AIR CROSS-FEED STARTING (SUBSEQUENT ENGINES)

The following procedure describes the method of starting the remaining engines, when using the cross-feed method. In each case the engine which has been started previously must be run at a minimum of 90 per cent rev/min.

Observe the precautions and set the controls of the engine(s) as described in "Starting procedure (first engine)" then proceed as follows:-

AIR SEL (Starting air selector)	NORMAL
AIR CROSS-FEED cock	Check that indicator is open.
M.SW. (engine master switch)	Move to ON.

When starting one engine:-

STARTER button	Press the appropriate button and release.

For the remainder of the operations follow the procedure described in "Starting procedure (first engine)".

When starting two or three engines:-

STARTER buttons	Press the appropriate buttons and release.

For each engine, follow the operations described in "Starting procedure (first engine)".

GROUND CHECKS

General

Before running an engine to check a suspected defect, ensure that all indicators and electrical equipment associated with the defect are serviceable.

Before commencing ground running checks on a newly-installed e.c.u., ensure that the relevant checks of all engine instruments and associated electrical systems have been made.

Switch on the engine anti-icing heat and operate the engine at maximum continuous rev/min for one minute during every ten minutes of low power running below 90 per cent rev/min under the following circumstances.

In icing conditions.

If the visibility is less than 1,000 yards due to fog and the ambient temperature is plus 3°C or lower:-

Note::

. The J.P.T. at take-off rev/min will increase by 5°C to 10°C above normal when engine anti-icing air is used, provided that the

J.P.T. has.....

J.P.T. has not reached the maximum i.e. is controlled by the J.P.T.L.

If the J.P.T.L. is controlling, the engine rev/min at take-off, will be decreased by approximately 1%.

Proportionate changes will occur when running the engine at maximum continuous rev/min with engine anti-icing in operation.

Alternator and constant speed drive cooling air inducer check

As soon as practicable after starting the engine and before running the engine above IDLING, check that cooling air is discharging from the alternator cooling air exit duct and from the constant speed drive cooling air exit duct located in zone 2A engine bay doors.

Oil Pressure Check

Throttle Lever	at IDLING (engine warm)

Check that oil pressure is registering .

Throttle Lever	Move gradually to obtain
	90 per cent rev/min

Check that the oil pressure is between 55 to 60 lb/in^2.

Note :

When the ambient temperature is high a minimum oil pressure of 50 lb/in^2 at 90 per cent rev/min is acceptable. Under these circumstances check that the oil pressure rises when the rev/min are increased.

When using engine anti-icing heat a drop of 5 lb/in^2 in the oil pressure from normal may be expected at 90% rev/min or above.

Caution :

If the oil pressure does not reach the required minimum in response to normal adjustment, (one turn of the relief valve adjuster equals approximately 5 lb/in^2 oil pressure) stop the engine immediately and investigate the cause.

Throttle lever	IDLING

Fuel Pressure check

Throttle lever	IDLING

Check that the fuel low pressure warning indicator shows black (normal).

Throttle lever	Move gradually to obtain maximum permissible J.P.T. or rev/min, whichever occurs first.
Throttle lever	IDLING

Check that the indicator remains black throughout the range.

Caution ...

Caution:

If the indicator shows white (low pressure) stop the engine and investigate.

Rev/min and jet pipe temperature check

This check ensures that the engine is functioning normally before proceeding with high power checks. Proceed as follows :-

Throttle lever	IDLING
R.P.M. GOVERNOR/J.P.T. LIMITER switch	TAKE OFF

Check that the ENGINE CONTROL indicator shows black.

J.P.T. LIMITER switch to ON.

Throttle lever	Move gradually from IDLING to obtain maximum continuous rev/min.
Jet pipe temperature	Check that the temperature is below the Ground Setting maximum Rev/min limit. Refer to Operating Limitations.
Throttle lever	IDLING

Cruise datum jet pipe temperature limiter check

With the throttle lever at the IDLING position, carry out the following operations :-

J.P.T. LIMITER switch	ON
Press the R.P.M. ISOLATOR switch (located on Panel 3P adjacent to navigator's table).	(Cruise governor inoperative).
R.P.M. GOVERNOR/J.P.T. LIMITER switch	CRUISE

Check that the ENGINE CONTROL indicator shows white.

Throttle lever	move gradually to OPEN.

The engine is now operating on the cruise datum of the jet pipe temperature limiter, the rev/min obtained will therefore vary inversely with ambient temperature. Allow the jet pipe temperature to settle for one minute, then proceed as follows :-

Check that the jet pipe temperature is at the ground setting cruise limit or not more than 4°C below.

Release the R.P.M. ISOLATOR switch

Throttle lever	IDLING

Take-off datum .....

Take-off datum jet pipe temperature limiter check

With the throttle lever at the IDLING position, carry out the following operations :

R.P.M. GOVERNOR/J.P.T. LIMITER switch	TAKE-OFF

Note :

Check that the ENGINE CONTROL indicator shows black.

Throttle lever	Move gradually to OPEN.

The engine is now operating either on the take-off datum of the jet pipe temperature limiter or on the take-off datum of the governor.

Caution :

As the take-off governor datum has not been checked at this stage, care must be taken, that the maximum permissible rev/min are not exceeded. If necessary retract the throttle lever to observe this limit.

Check that the jet pipe temperature has risen above the cruise limit

Note :

This checks the response of the jet pipe temperature electro-pressure control to the change in the selected datum.

In very cold weather it may be necessary to turn on the engine anti-icing and the cabin heating air to make the jet pipe temperature sufficiently hot.

If there is no change in jet pipe temperature, stop the engine and check the serviceability of the governor datum solenoid and its wiring. To do this make an aural check of the operation of the solenoid while the datum selector switch (ENGINE CONTROL) is operated.

Caution :

If, owing to the ambient temperature being below 20°C, it is not possible to obtain a jet pipe temperature sufficiently high to allow the operation of the jet pipe temperature limiter to be checked, warn the pilot that it may be necessary to retract the throttle lever during climbing conditions to avoid exceeding maximum permissible jet pipe temperature.

Return the throttle lever to IDLING.

Cruise governor datum check

Carry out the following operations :

R.P.M. GOVERNOR/J.P.T. LIMITER switch	TAKE-OFF
J.P.T. LIMITER switch	ON

3. Throttle ...

Throttle lever	Move gradually to OPEN.
R.P.M. GOVERNOR/J.P.T. LIMITER switch	CRUISE
J.P.T. LIMITER switch	OFF

The engine is now operating with the cruise governor datum only controlling. Proceed with the check in the following manner:-

Check rev/min stabilise without excessive fluctuation.

Check that rev/min conform to the maximum continuous limits quoted in Ground Settings of the Operating Limitations.

Note:

If necessary, adjust the governor datum as described under Fuel System Adjustments.

Return the throttle lever to IDLING

Take-off governor datum check

Check this setting in the following manner:-

J.P.T. LIMITER switch	ON
R.P.M. GOVERNOR/J.P.T. LIMITER Switch	CRUISE
Throttle lever	Move gradually to OPEN
R.P.M. GOVERNOR/J.P.T. LIMITER switch	TAKE-OFF

Allow the rev/min to stabilise for 10 to 12 secs, then check that they conform to the limit quoted in Operating Limitations - Ground Settings.

Warning:

Do not exceed the take-off jet pipe temperature limitations under any circumstances, do not therefore check the take-off governor setting with the jet pipe temperature limiter set to OFF.

Note:

Maximum permissible jet pipe temperature for take-off should be achieved when TAKE-OFF is selected without resulting in rev/min over-swing, provided that the ambient temperature is above plus 20°C, since the jet pipe temperature limiter suppressed datum will then be the governing factor.

Rev/min overswing will occur if the ambient temperature is below plus 20°C; this is permissible provided that the limit quoted in the Operating Limitations is not exceeded (this limit is of course higher than the required ground setting).

At ambient temperatures below plus 20°C the maximum jet pipe temperature obtainable will be proportionately less than the take-off setting and the rev/min will be limited by the take-off governor. If under .....

If under these circumstances the maximum rev/min are not obtained, adjust the governor as described in the "Fuel system setting and adjustments".

If the ambient temperature is 20°C or over the jet pipe temperature will rise to the take-off limit (since the limiter will be controlling), rev/min will rise to less than the take-off limit and the take-off governor setting will have to be checked in flight. Alternatively, under these circumstances, adjust the take-off governor to control at approximately cruise rev/min, note the amount of effective adjustment required, then reset the governor to give the potential take-off ground setting. In either event care must be taken that the maximum take-off rev/min is not exceeded when the ambient temperature subsequently falls below 20°C. If necessary, reset the governor as described in "Fuel system setting and adjustment".

Caution

If the take-off governor setting has not been established, the pilot must be warned that when the ambient temperature falls below 20°C, it may be necessary to retract the throttle lever from the OPEN position to avoid exceeding the maximum permissible take-off rev/min.

Acceleration check

This check should normally be made with the alternator on full load. If this is not possible, make the check with the alternator switched off. In either event ensure that the idling rev/min have been set as described in this Chapter.

R.P.M. GOVERNOR/J.P.T. LIMITER switch	TAKE-OFF
J.P.T. LIMITER switch	ON
Throttle lever	OPEN

Allow the rev/min and jet pipe temperature to stabilise then record the rev/min.

Throttle lever	IDLING
Throttle lever	Slam to OPEN

Note

Check that the engine accelerates without hesitation or surge to two per cent less than the rev/min recorded in operation (4).

Throttle lever	Position to obtain 37 per cent rev/min.
Throttle lever	Slam to OPEN

Note

Check the time taken for the engine to accelerate to two per cent less than the rev/min recorded in operation (4). This must not be more than five secs.

Throttle lever	IDLING

Throttle synchronisation check

All four engines must be running before proceeding as follows :-

Throttle levers.....

Throttle levers (all four)	Move to obtain 80 per cent rev/min on each engine.

Note

Check that the throttle levers are in reasonable alignment.

If necessary adjust the aircraft linkage; no adjustment is provided on the c.c.u.

Throttle levers (all four)	IDLING

Alternator and constant speed drive check

Throttle lever	IDLING
Appropriate ALTERNATOR Switch	ON

Note

Allow the carbon pile of the alternator to warm up for 20 mins before proceeding with this check.

Caution

The alternator may be switched on during the fore going checks, provided the preliminary voltage and frequency checks were satisfactory.

Alternator rotary selector switch	Relevant ALT Position.
Voltage indicator	Check reading 115 V.
Frequency indicator	Check reading 400 c.p.s.

Note

ENGINE CONTROL switch	TAKE-OFF
Throttle lever	Move gradually to OPEN.
Voltage indicator	Check that readings obtained in (4) and (5) remain constant
Frequency indicator	
Throttle lever	IDLING

Idling rev/min check

Throttle lever	IDLING
Appropriate alternator switch	ON

Caution

Ensure that the alternator voltage and frequency are satisfactory.

Apply full load to the alternator.

Check that the rev/min and jet pipe temperature are within the limits quoted in the Operating Limitations.

Appropriate alternator switch	OFF

Note.....

Note

If it is not possible to run the engine with full generator load applied, make the check with the alternator switched off. In this event the IDLING rev/min must be 32 per cent.

If necessary refer to "Fuel system setting and adjustments".

Note

At I.S.A. conditions the idling rev/min will increase by approximately one per cent for every 1,000 feet height increase above sea level. Therefore the rev/min/height gain obtained should be subtracted pro-rata from the rev/min observed when checking this condition at elevated aerodromes, and thus establish the relative sea-level rev/min.

Hydraulic pump pressure check

The following procedure describes the method of checking the hydraulic pressure generated by an individual engine or by a number of engines.

Throttle lever(s)	IDLING
Hydraulic pressure	3,600 to 4,000 lb/in^2
Bomb doors indicator	White

Warning

Check that personnel and ground equipment are clear of the bomb doors.

BOMB DOOR CONTROL (NORMAL) selector switch	CLOSED
Bomb doors indicator	Black

Note

Check the time taken for the bomb doors to close; the approximate time should be as follows :-

One engine running, 17 secs.

Two engines running, 12 secs.

Three engines running, 6 secs.

BOMB DOOR CONTROL (NORMAL) selector switch	OPEN
Bomb doors indicator	White

Engine anti-icing air checks

This check is made as follows :-

Throttle lever	IDLING
Appropriate ENGINE AIR switch	CLOSED
WING and ENGINE anti-icing switches	AUTO.

Note

Check that the hot air pipe entering the engine intake casing becomes hot.

WING AND ENGINE.....

WING and ENGINE anti-icing switches	OFF (central)
ENGINE AIR switch	OPEN

Relight ignition circuit check

This check is normally carried out with the engine running, but it may also be made when the engine is not running, provided, that the engine is not hot, that there is no unburnt fuel or fuel vapour in the exhaust cone and jet pipe, that the throttle is at H.P. COCK SHUT and that the precautions regarding high energy electrical equipment are observed.

LETHAL WARNING

Ensure that personnel are clear of the igniter plugs and leads.

Throttle lever	IDLING (engine running) H.P. COCK SHUT (engine static)
RELIGHT button (located at the top of the throttle lever)	Press.

Note

Check that sparking is audible on the intercom.

STOPPING PROCEDURE

Stop the engine in the following manner :-

Throttle lever	IDLING

Note

Allow the rev/min and jet pipe temperature to settle to values not exceeding those given in the Operating Limitations for this condition.

Throttle lever	H.P. COCK SHUT

Note

Flame-out will be indicated by a rapid decrease in rev/min and jet pipe temperature.

On a new installation, check that there are no unusual rubbing noises during the engine run-down.

Fuel booster pumps switch	OFF (when the compressors cease to rotate).

Note

The L.P. fuel cock is normally left switched ON. If it is desired to close the cock, first allow the compressors to cease rotating.

When the engine ceases to rotate, check that the bulkhead seals are inflated, and remain so for at least 15 mins.

EMERGENCY STOPPING PROCEDURE

To stop the engine in an emergency adopt the following procedure :-

Throttle lever ....

Throttle lever	H.P. COCK SHUT
L.P. fuel COCK	OFF
Fuel booster pump switches	OFF

Note

Before attempting to start an engine after an emergency stop, bleed the e.c.u. fuel system, then carry out the normal prestarting and starting procedure.

WET MOTORING CYCLE

A wet motoring cycle provides a check on the operation of the engine fuel pumps and drain systems and, with an engine which is newly-installed, ensures that the turbine and jet pipe joints are not leaking.

Warning 1

It is not recommended that an engine which is already running be utilised to motor an engine during a wet motoring cycle, owing to the risk of fire.

Warning 2

Do not operate the RELIGHT button (housed in top of the throttle lever) during the following motoring cycle.

Warning 3

To avoid fire risk, arrange suitable containers under the drain outlets to collect fuel which subsequently will drain from the engine and jet pipe.

DRY MOTORING CYCLE

A dry motoring cycle may be performed by utilising starting air supplied from an engine which is already running at above 90 per cent rev/min, or by the ground starting unit.

After a wet motoring cycle or an abortive attempt to start, a certain amount of fuel will have accumulated in the engine. Clear this by performing two dry motoring cycles before making any further attempt to start, otherwise high temperatures with risk of damage to the engine will result.

Warning

Do not operate the RELIGHT button (housed in the top of the throttle lever) during the following motoring cycle.

IGN. ISOLATION switch	OFF
AIR SEL (starting air selector)	NORMAL
M. SW. (engine master switch)	ON
Throttle lever	H.P. COCK SHUT
Confirm clearance to motor.	
Starter button	Press

Note

Release the button when the indicator light illuminates.

M. SW. (Engine master switch)	OFF after 30 secs (But not more than 60 secs from pressing starter button).
Starter button indicator light	Check that the light is extinguished.

If another engine was employed for this motoring cycle, retract the throttle lever of that engine to IDLING.

Note.

Allow the motored engine to stop turning before commencing another motoring cycle or before an attempt to start.

During the motoring cycle, the oil pressure should register but the rev/min will not.

12.3 FULL GROUND RUNNING PROCEDURE

Item	Check	Action	Remarks
	LETHAL WARNING:-	BEFORE PROCEDING WITH THESE TESTS ENSURE THAT THE PRECAUTIONS RELATING TO EJECTION SEATS ARE OBSERVED.	
1	Prior to starting		
	Installation proof checks	Complete the checks	
	Before starting checks	Complete the checks	
2	Starting		
	Checks before entering the cockpit	Complete the checks	
	Cockpit checks before starting	Complete the checks	
	Starting the engine	-	Observe the j.p.t.; if excessive shut down immediately.
3	After starting checks		
	Throttle lever	IDLING	-
	Rev/min	Check - 29% to 30%	Rev/min will vary with altitude. If adjustment is necessary refer to Fuel system setting and adjustment.
	Jet pipe temperature	Check - not exceeding 600°C	-
	Oil pressure	Check - pressure registering	-
	Fire warning light	Check - light extinguished	-
	Hydraulic pressure	Check - 3,600 to 4,000 lb/in^2	-
	Alternator	Check - voltage and frequency	-
			4. Alternator and constant speed.....

FULL GROUND RUNNING PROCEDURE (CONTINUED)

Item		Action	Remarks
4	Alternator and constant speed drive cooling air inducer check		
	Throttle lever	IDLING	
		Check that cooling air is discharging from the generator cooling duct and from the constant speed drive cooling duct.	This check must be made as soon as practicable after starting the engine.
5	Oil pressure check		
	Throttle lever	Obtain 90% rev/min	-
		Check - pressure between 55 to 60 lb/in	Pressure may be lower at high ambient temperature. Adjust as necessary.
6	Fuel pressure check		
	Throttle lever	Retract to IDLING	-
	-	Check - warning indicator black	-
	Throttle	Advance lever, obtain maximum permissible rev/min or jet pipe temperature (whichever is reached first).	-
		Check - warning indicator black throughout range.	-
	-	-	
	-	-	
	-	-	7. Rev/min and jet pipe.....
	-	-	

BRISTOL SIDDELEY

AERO ENGINE SCHOOL

FULL GROUND RUNNING PROCEDURE (CONTINUED)

Item	Check	Action	Remarks.
7	Rev/min and jet pipe temperature check		
	Throttle lever	IDLING	-
	R.P.M. GOVERNOR/J.P.T.LIMITER switch	TAKE-OFF	-
	ENGINE CONTROL indicator	Check - black	-
	J.P.T. LIMITER switch	ON	-
	Throttle lever	Move gradually from IDLING to obtain maximum continuous rev/min.	
	Jet pipe temperature	Check - below the Ground Setting maximum rev/min limit.	-
8	Cruise datum jet pipe temperature limiter check		
	Throttle lever	Retract to IDLING	-
	R.P.M. ISOLATOR switch	ON (indicator white)	-
	R.P.M. GOVERNOR/J.P.T.LIMITER Switch	CRUISE	Cruise governor inoperative
	ENGINE CONTROL	Indicator white	-
	Throttle lever	Move gradually to OPEN	Engine operating on cruise datum of j.p.t. limiter.
		Check j.p.t. is at cruise limit	Rev/min vary inversely with ambient temperature.
	R.P.M. ISOLATOR switch	Release	

9. Take-off datum jet .....

FULL GROUND RUNNING PROCEDURE (CONTINUED)

Item	Check	Action	Remarks
9	Take-off datum jet pipe Temperature Limiter Check		
	Throttle lever	Retract and obtain cruise rev/min.	-
	R.P.M. GOVERNOR/J.P.T. LIMITER switch	TAKE-OFF	-
	ENGINE CONTROL	Indicator (black)	-
	Throttle lever	Move gradually to OPEN Check - j.p.t. rises above cruise limit.	Engine operating either on take-off datum of j.p.t. limiter or on the take-off governor.
			Note In very cold weather turn on engine and wing anti-icing air to make j.p.t. sufficiently hot.
10	Cruise governor datum check		
	R.P.M. GOVERNOR/J.P.T. LIMITER switch	CRUISE	-
	ENGINE CONTROL	Indicator (white)	-
	J.P.T. LIMITER switch	OFF	Engine operating on cruise governor datum.
		Check - rev/min underswing without surge	-
		Check - rev/min is at cruise limit	Adjust as required (see fuel system settings and adjustments).

11. Take-off governor .....

BRISTOL SIDDELEY

AERO ENGINE SCHOOL

FULL GROUND RUNNING PROCEDURE (CONTINUED

Item	Check	Action	Remarks
11	Take-off governor datum check		
	J.P.T. LIMITER switch	ON	-
	R.P.M. GOVERNOR/J.P.T. LIMITER switch	TAKE-OFF	-
	ENGINE CONTROL	Indicator (black)	Engine operating on either take-off governor or on take-off j.p.t. limiter datum.
	Warning This check must not be made with the j.p.t. limiter switched OFF in an attempt to obtain maximum rev/min.	Check that maximum obtainable rev/min is reached without overswing.	If ambient temperature is +20°C or above j.p.t. limiter will control, check governor by flight test. If ambient temperature is below +20°C, check rev/min and adjust governor as necessary.
12	Acceleration check		
	Throttle lever	Retract to IDLING	-
	Throttle lever	Slam to OPEN	Engine must accelerate without hesitation or surge.
	Throttle lever	Retract to obtain 3%	
	Throttle lever	Slam to OPEN Check - record time taken to reach 2% rev/min less than maximum attained in item 11.	

13. Throttle synchronisation...

FULL GROUND RUNNING PROCEDURE (CONTINUED)

Item	Check	Action	Remarks
13	Throttle synchronisation check		
	Throttle levers	With all engines running advance the levers and obtain 80% rev/min.	-
		Check - throttle levers are in reasonable alignment.	Adjust as required on aircraft linkage. No adjustment is provided on the C.C.U.
14	Alternator and constant speed drive check		
	Throttle lever	IDLING	-
	Alternator switch	ON	
	Voltage and frequency selector switch	Select appropriate alternator and check voltage and frequency.	
	R.P.M. GOVERNOR/J.P.T. LIMITER switch	TAKE-OFF	-
	ENGINE CONTROL	Indicator black	-
	Throttle lever	OPEN - check that voltage and frequency remain constant	-

15. Idling rev/min check.....

BRISTOL SIDDELEY

AERO ENGINE SCHOOL

FULL GROUND RUNNING PROCEDURE (CONTINUED)

Item	Check	Action	Remarks
19	Stop the engine Throttle lever	H.P. COCK SHUT	Flame-out will be indicated by a rapid decrease in rev/min and jet pipe temperature.
		Check - that there are no unusual rubbing noises during run-down.	
20	Emergency stopping procedure		
	Throttle lever	H.P. COCK SHUT	-
	L.P. fuel cock	Switch to OFF	-
	Fuel booster pumps	Switch to OFF	Bleed e.c.u. fuel system before restarting
21	After engine has stopped		
	Fuel booster pumps switch	OFF	The L.P. fuel cocks are normally left ON, but may be switched OFF if desired.
22	Bulkhead seals check		
		Check that the seals are inflated and remain so for at least 15 mins after stopping the engine.	-

BRISTOL SIDDELEY

AERO ENGINE SCHOOL

12.4 STARTING PROCEDURE (FIRST ENGINE)

Before entering the Aircraft

Item	Action
1. Prepare the aircraft.	Observe the official precautions.
2. Fire appliances.	Check that efficient equipment is at hand.
3. Aircraft wheel chocks.	Place against nose wheel and main wheels.
4. Safety locks and jury struts	Fit them to the alighting gear.
5. Zone 2A engine bay doors.	These may be left open during engine running.
Note Before opening any other engine bay doors, position jury struts in the main wheel bays.	
6. All other doors and access panels.	Check that they are closed.
7. Intake tunnel, jet pipe nozzle and breather blanks.	Remove and position them clear of the aircraft danger areas.
8. Intake tunnels.	Inspect for cleanliness, loose rivets and screws.
9. Jet pipes.	Check that they are free from fuel. Remove any fuel with a mop or cloth. Caution Do not damage the thermocouples while doing this.

10. Oil tanks .....

STARTING PROCEDURE (Continued)

Before entering the Aircraft (Continued)

Item	Action
10. Oil tanks (engine and constant speed drive).	Check contents.
11. Fuel tanks	Check that the tanks have been replenished. Refer to Crew Chief.
12. Ground starting unit.	Position the unit so that its exhaust gases cannot impinge upon the aircraft structure; the most suitable position is forward and outboard of engine intakes. Apply the unit handbrake. Note If possible position the unit with its air intake facing into the wind; this will ensure that the unit operator is clear of exhaust fumes.
13. Cabin static vent plugs.	If cabin pressurization is to take place remove the plugs.
14. Bomb bay doors	Check that the doors are closed. Also check that the bomb bay access doors (located in the doors) are closed.

15. External electrical....

STARTING PROCEDURE (Continued)

In the Aircraft

	Control, Equipment, or Action to be taken	When using the Ground Starting Unit	When using the a.a.p.p.
15.	External electrical rig.	Instruct ground crew to plug in and start the rig.	-
16.	All electrical loads.	On, if required.	Off - make a special check of the powered flying control switches. Check that warning lights are off.
17.	115 V electrical supply.	ON	-
18.	Extra Supply switch	OFF	OFF
19.	Battery Isolation switch.	OFF.	OFF.
20.	Alternator switches.	OFF.	OFF

Note

These are located on panel 10.P.

21.	Transformer rectifier unit switches (28 V and 115V).	ON	ON

Note

1. These are located on panel 50.P.
2. These may be left on, except when failure occurs.

22. Starting unit.....

STARTING PROCEDURE (Continued)

In the Aircraft (Continued)

	Control, Equipment, or Action to be taken	When using the Ground Starting Unit	When using the a.a.p.p.
22.	Starting unit. (Ground or a.a.p.p.).	Start the unit and when the rev/min have stabilized connect the delivery hose to the aircraft, then connect the unit electrical cable.	Start the unit.
		Warning Always connect the air delivery hose before the electrical lead. Always stand at the side away from the delivery hose.	
		Cockpit Checks before starting	
23.	"Intercom" system	Make sure that clear communication can be maintained with the ground crew.	Make sure that clear communication can be maintained with the aircraft electrical engineer and with the ground crew.
24.	Ram air turbine release toggle.	NORMAL	NORMAL
25.	Direct vision windows	If cabin pressurization is to take place, lock the windows.	If cabin pressurization is to take place, lock the windows.
26.	Cockpit canopy.	If cabin pressurization is to take place, check that the canopy is locked by referring to the indicators.	If cabin pressurization is to take place, check that the canopy is locked by referring to the indicators.
			27. Main entrance door.....

STARTING PROCEDURE (Continued)

Cockpit Checks before starting (Continued)

	Control, Equipment, or Action to be taken	When using the Ground Starting Unit	When using the a.a.p.p.
27.	Main entrance door.	If cabin pressurization is to take place, check that the indicator shows CLOSED.	If cabin pressurization is to take place, check that the indicator shows CLOSED.
28.	Parking brake.	Check that it is applied. Pull out and lock.	Check that it is applied. Pull out and lock.
29.	Battery Isolation switch.	ON	COUPLE
30.	Extra Supply Switch.	-	Check a.a.p.p. voltage and frequency, (panel 10.P) oil pressure and j.p.t. (panel 70.P) if satisfactory move the Extra Supply switch to ON.
31.	Test the fire warning circuits.	Pull the appropriate test button. Check that the indicator light illuminates.	Pull the appropriate test button. Check that the indicator light illuminates.
32.	Throttle levers.	H.P. COCK SHUT	H.P. COCK SHUT
33.	M.S.W. (Engine Master Switch).	OFF	OFF
34.	IGN. (Ignition Isolation Switch).	OFF	OFF
35.	Centre floor console.	Move it to the operative position.	Move it to the operative position.

36. Fuel tanks.....

STARTING PROCEDURE (Continued)

Cockpit Checks before starting (Continued)

	Control, Equipment, or Action to be taken	When using the Ground Starting Unit	When using the a.a.p.p.
36.	Fuel tanks	Check the tank contents and record the readings.	Check the tank contents and record the readings.
37.	L.P. fuel cocks.	Check that they are SHUT.	Check that they are SHUT.
38.	Tank group fuel pump switches.	MANUAL	-
39.	Tank booster pumps.	OFF	-
40.	C of G transfer pump switches.	OFF (central)	-
41.	L.P. warning indicators.	Check that they show low pressure (white).	-
42.	Check the l.p. fuel system.		
	(1) No.1 tank booster pump (No.1 engine tanks group).	Switch ON	-
	(2) No.1 L.P. cock	Switch to OPEN Note Check that the relevant l.p. warning indicator changes to normal (black).	-

(3) Port side .....

STARTING PROCEDURE (Continued)

Cockpit Checks before starting (Continued)

	Control, Equipment or Action to be taken	When using the Ground Starting Unit	When using the a.a.p.p.
42.	Check the l.p. fuel system.		
	(3) Port side CROSS-FEED cock (between Nos. 1 and 2 engines).	Switch to OPEN	-
	(4) No.2 L.P. cock	Switch to OPEN Note Check that the relevant l.p. warning indicator changes to normal (black).	-
	(5) Aircraft CROSS-FEED cock (between the port and starboard tank groups).	Switch to OPEN	-
	(6) Starboard CROSS-FEED cock (between Nos. 3 and 4 engines).	Switch to OPEN	-
	(7) Nos. 3 and 4 L.P. cocks	Switch to OPEN Note Check that all four l.p. warning indicators are normal (black).	-

Note With one booster pump.....

STARTING PROCEDURE (Continued)

Cockpit Checks before starting (Continued)

	Control, Equipment, or Action to be taken	When using the Ground Starting Unit	When using the a.a.p.p.
42.	Note With one booster pump in operation the following points have been checked. (a) L.P. warning indicators (4) (b) L.P. cocks (4) (c) Engine and aircraft fuel tank cross-feed cocks (3)		
43.	Fuel tank CROSS-FEED cocks	Switch to OFF	Switch to OFF
44.	Tank group AUTO/MANUAL SWITCHES	Switch to AUTO	Switch to AUTO
45.	All tank booster pumps	Switch to ON	Switch to ON
46.	AIR SEL (Starting Air Selector).	Switch to NORMAL	Switch to A.A.P.P.
		Note Check that A.A.P.P. bleed vlave indicator is closed.	Note Check that A.A.P.P. bleed valve indicator changes to open.

47. Air cross-feed cock.....

STARTING PROCEDURE (Continued)

Cockpit Checks before starting (Continued)

	Control, Equipment, or Action to be taken	When using the Ground Starting Unit	When using the a.a.p.p.
47.	Air cross-feed cock.	Check that the air cross-feed indicator is OPEN.	Check that the air cross-feed indicator is CLOSED.
48.	Anti-icing air switches.	Check that they are OFF.	Check that they are OFF.
49.	CABIN AIR switches.	Check that they are SHUT.	Check that they are SHUT.
50.	TANK PRESSURISATION switch.	Check that it is OFF.	Check that it is OFF.
51.	ENGINE AIR switches.	OPEN appropriate engine switch.	OPEN No.3 or 4 switch.
52.	J.P.T. LIMITER switch.	Switch ON	Switch ON
53.	R.P.M. GOVERNOR/J.P.T. LIMITER switch.	Switch to TAKE-OFF	Switch to TAKE-OFF
54.	ENGINE CONTROL indicator.	Check that it is black.	Check that it is black.
55.	Throttle levers.	H.P. COCK - SHUT.	H.P. COCK - SHUT

Note

At these settings a motoring cycle or an engine start may be made.

Starting the engine.....

STARTING PROCEDURE (Continued)

Starting the Engine

Control, Equipment, or Action to be taken	When using the Ground Starting Unit	When using the a.a.p.p.
56. M.SW. (engine master switch).	Switch ON	Switch ON
57. IGN. (ignition isolation switch).	Switch ON Caution This switch must be ON before commencing the starting cycle. Damage to the engine may result if it is switched on after the cycle has commenced. Do not press the RELIGHT button once the starting cycle has commenced.	Switch ON
58. Clearance to start.	Check with operator that starting air is available.	Check with electrical engineer that starting air is available.
59. STARTER button.	Press the appropriate button and release. Note Check that the air delivery indicator light (housed in the starter button) illuminates. Should the light fail to illuminate, abandon the attempt to start and investigate the cause.	Press the appropriate button (Nos. 3 or 4) and release.
		60. Oil pressure.....

STARTING PROCEDURE (Continued)

Starting the Engine (Continued)

Control, Equipment, or Action to be taken	When using the Ground Starting Unit	When using the a.a.p.p.
60. Oil pressure.	Check that pressure is rising. This will denote that the engine is turning. Note Starting air is available for a period not exceeding 60 secs...	Check that pressure is rising. This will denote that the engine is turning. Note Normally, the duration of starting air is not limited. If the rev/min of the a.a.p.p. are restricted by the jet pipe temperature limiter (in high ambient temperatures) restrict the duration of starting air delivery to five consecutive mins.
61. Throttle lever.	Move to IDLING immediately after pressing the starter button.	Move to IDLING immediately after pressing the starter button.

NOTE

The rate of the throttle lever movement will depend on ambient temperature. In hot weather the movement can be rapid; in very cold weather the initial movement should be slight, followed by very slow opening.

Caution Always avoid .....

STARTING PROCEDURE (Continued)

Starting the Engine (Continued)

Control, Equipment, or Action to be taken	When using the Ground Starting Unit	When using the a.a.p.p.
61. Throttle lever.	Caution Always avoid exceeding 600°C j.p.t. during the start. If this figure is exceeded, move the throttle lever immediately to H.P. COCK-SHUT and set the M.SW. (engine master switch) to OFF. After correcting the cause carry out a dry motoring cycle then repeat the starting procedure.	
62. STARTER button light.	Check that the air delivery indicator light is extinguished. Note This indicates that the starting air supply is cut off.	Check that the air delivery indicator light is extinguished.
63. M.SW. (engine master switch).	Move to OFF	Move to OFF.
64. Throttle lever.	At IDLING	At IDLING
65. Rev/min.	29.5 to 30 per cent.	29.5 to 30 per cent.
66. J.P.T.	Not exceeding 600°C	Not exceeding 600°C
67. Oil pressure.	Registering	Registering
68. Hydraulic pressure.	2,800 to 4,000 lb/in^2	2,800 to 4,000 lb/in^2
69. Fire warning light.	Check - out	Check - out
		70. Alternator voltage.....

BRISTOL SIDDELEY

AERO ENGINE SCHOOL

Starting Procedure (Continued)

Starting the Engine (Continued)

	Control, Equipment, or Action to be Taken	When using the Ground Starting Unit	When using the a.a.p.p.
70.	Alternator voltage and frequency check.	(a) Select the appropriate engine alternator on the ALTERNATOR rotary selector switch. (b) Check voltage: 114 - 116 (c) Check frequency: 400 - 402 c.p.s. (d) If satisfactory, switch the relative ALT switch ON. (e) If unsatisfactory, switch the relative ALT switch OFF, stop the engine and investigate the cause	(a) Select the appropriate engine alternator on the ALTERNATOR rotary selector switch. (b) Check voltage: 114 - 116 (c) Check frequency: 400 - 402 c.p.s. (d) If satisfactory, switch the relative ALT switch ON. (e) If unsatisfactory, switch the relative ALT switch OFF, stop the engine and investigate the cause.
71.	Starting unit	Unless the ground starting unit is required to start the remaining engines, disconnect the delivery hose and the electrical lead.	Press the a.a.p.p. STOP switch and hold in for five secs. Set the a.a.p.p. master switch to OFF.

Starting (Using Rotax Combustion Starter System)

Multi Rapid Start (Air Selector Switch at "RAPID")

Set all throttles to a position giving approx: 50% r.p.m.

Press multi-starter button.

Check button lamp illuminates (at 2 seconds).

Check J.P.T's (initial rise at 4 to 8 secs:).

Putton lamp extinguishes at 11 to 12 seconds when J.P.T's should be 200 - 300°C. When J.P.T. on any engine has stabilized (approx: 18 secs; J.P.T's 400/500°C) wait two seconds and retract ALL throttles to the idling position. If any J.P.T. reaches 600°C immediately retract ALL throttles to the idling position. In either event the throttles, once having been retracted, can be immediately reset to give required power.

Single Engine Rapid Start

To carry out single engine starts the individual start button is pressed instead of the multi start button, and the same procedure is followed.

If any button light does not illuminate immediately attempt a re-start by pressing the appropriate individual start button. (Idling R.P.M. should then be reached in 20-28 seconds)

If any J.P.T. does not initially rise within 10 seconds, wait for the button light to extinguish, then attempt a re-start by pressing the appropriate individual start button.(Idling R.P.M. should then be reached in 24 - 28 seconds).

If any J.P.T. reaches 600°C, immediately retract all throttles to the idling position. J.P.T's will fall. Maximum J.P.T. should not exceed 700°C. Idling rev/min should be reached within 30 seconds. Once the throttles have been retracted they can be reset to give desired power. Record any J.P.T. exceeding 600°C.

In the event .....

In the event of a start being aborted and a re-start being required, proceed as follows : -

Retract the throttle fully to the shut-off position (after button light has extinguished) Wait 15 seconds after retraction then reset the throttle to approx: 50% rev/min, and press the individual start button. Idling rev/min should then be achieved within 50 seconds (If B.S. Mod. OL.1350 is incorporated in the engine, wait only seven seconds after throttle retraction) Idling rev/min should then be reached within 42 seconds.

NOTE. If the throttle has been fully retracted before the button light extinguishes (retraction under these conditions being extremely improbable) wait for the light to extinguish, then immediately reset the throttle to approx: 50% rev/min position, and press the individual start button. Idling rev/min should then be reached within 30 seconds.

Settings and Limitations

Combustion Starter Settings.

Overspeed trip signal $2100 \pm \frac{100}{0}$ H.P. rev/min

Pressure Switch 105 + 5 P.S.I.G.

Ambient Temperature Limitations

Below - 15 °C ambient temperature, do not attempt to multi-start, owing to risk of high J.P.T. Use the single start technique. The most rapid "all engines" start can then be effected by setting the started engine to 90% rev/min, and starting the other simultaneously by the "cross-feed"system.

J.P.T. Limitations

Engines should be removed and returned for inspection if J.P.T. has exceeded 700 °C during rapid starting techniques.

Restarting

Not more than two attempts at rapid starting (Combustor) on any one engine are to be made in any one 30 minute period, whether the starts were successful or not.

This does .....

This does not preclude an unlimted number of Palouste or cross-feed starts.

N.B. With the rapid start system incorporated the A.A.P.P. will not start the engines.

Rapid Start Sequence

Seconds.		Events
0	-	Throttle(s) are pre-set to approx: 50% rev/min.
0	-	Button is pressed and released.
2	-	Button light(s) illuminate, indicating combustors have lit.
4 to 8	-	J.P.T.(s) begin to rise.
11 to 12	-	Button light(s) go out, starter(s) disengage from engine(s) and begin to run down. J.P.T('s) are 200 to 300°C and rising.
16 to 19	-	J.P.T('s) peak and begin to fall. (Peaks are normal between 400 and 550°C)
18 to 22	-	Throttle(s) are retracted to the idling position, and may be used as required.
18 to 24	-	Engine(s) reach idling R.P.M.
25 to 30	-	Engine(s) reach take-off R.P.M. (The time to take off R.P.M. will have been delayed if the throttles were not immediately reset to the take-off position after retraction.