PART III

MANAGEMENT OF SYSTEMS AND USE OF EQUIPMENT

62. **Management of the fuel system**

(a) *Normal use*

(i) The L.P. and H.P. cocks must be ON and except for starting, and taxying after landing, the booster-pump switches should be ON at all times when the engine is running ~~except after landing~~.

(ii) Before starting, check that the pump circuit breakers are closed and that the L.P. warning light and booster-pump warning lights are on with the booster-pumps OFF.

(iii) After starting, check that with both booster-pump switches OFF the L.P. warning light is on. Then check that as each booster-pump is switched ON its associated warning light goes out and the L.P. warning light is out.

(b) *Unequal tank emptying*

Unequal emptying to the extent of 100 lb. or more will result from booster-pump failure. The contents gauges and booster-pump failure warning lights should be checked frequently to ensure that fuel balancing is being maintained. If a booster-pump fails, any resulting inequality in fuel levels cannot be corrected. Both pumps should therefore be turned OFF.

(c) *Booster-pump failure*

(i) If a booster-pump fails, indicated by a warning light coming on and the corresponding contents gauge reading high, no fuel will be used from that side if the serviceable pump is left on; in this event reduce r.p.m. to 7,200, and reduce altitude to the limits below according to the aircraft configuration.

With drop tanks	20,000 ft. max.
Without drop tanks	25,000 ft. max.

Then switch off both pumps and accept the fuel feed provided by tank pressurisation and gravity. R.p.m. must thereafter not exceed 7,200. The altitude limit may be increased in emergency by 10,000 ft. if absolute range is essential, but in this event the engine must subsequently be examined for possible damage to the fuel system.

(ii) With both booster-pumps off, negative G manoeuvres must be avoided. It is important to land while both sides still contain fuel, because the engine will not run with one side of the fuel system empty unless the booster-pump is operating on the side containing fuel. If the fuel state permits, switch the serviceable booster-pump ON prior to landing.

(d) *Transfer failure*

(i) The fuel transfer indicators should remain black throughout the flight. If one or both show white, air pressure failure has occurred and steep dives should be avoided due to the possibility of collapsing the tanks. Should an indicator show white before transfer is complete, any fuel remaining in the wing and centre tanks will be unusable and the associated contents gauge will only indicate the fuel in the front tanks (800 lb. max. per tank).

In those circumstances if the gauge registers more than the total contents of a front tank a faulty gauge should be suspected and only the front tank fuel should be relied on as available to the engine. Switch OFF the booster-pump on the side with air transfer failure until the contents gauge of the other side indicates an equal amount; then reset the switch to ON.

(ii) A fuel transfer indicator may show white when the rear and wing tanks are empty or nearly empty. This is caused by the hymatic valve freezing. If it occurs only the fuel in the front tanks will be available to the engine. Since this only occurs when all or nearly all the fuel from the wing and rear tanks has been transferred it is not serious from the fuel point of view: avoid rapid climbs and descents however, otherwise the fuel tanks may collapse.

(e) *Gauge failure*

Total or partial gauge failure will not affect fuel flow. Check that neither booster-pump nor transfer failure has occurred, leave both pumps ON and return to base.

(f) *Fuel gauge errors*

The fuel gauges have been found to give erroneous indications due to temperature effects on the electrical wiring. The magnitude of the error depends on both temperature and time. Low temperatures at high altitude give gauge under-reading; high temperatures at high speeds at low altitude, give gauge over-reading. During a descent from altitude, if the gauges are under-reading, the gauges will become progressively more accurate and may eventually tend to over-read.

(g) *Unusable fuel*

Provided that a minimum fuel state of 200 lb. per side is indicated, a further circuit may safely be attempted. Below this fuel state care must be taken to restrict excessive attitude or acceleration on overshoot, which may cause fuel in the tanks to move away from the booster-pumps resulting in possible fuel starvation.

Page 50
Para. 63
(a)
A.L.3

63. Engine handling

NOTE.—To avoid discharging the batteries engine r.p.m. during taxying are to be kept above 3,700 whenever possible and particularly during waiting periods before take-off and after landing.

(a) *Take-off*

(i) The engine is governed at 8,100 r.p.m. at which speed maximum thrust is obtained. At low air temperatures the engine may under speed on take-off to as low as 8,000 r.p.m. at full throttle whilst still maintaining maximum thrust. Below are the relevant figures.

Temp. °C.	R.p.m.
+15	8,100
0	8,085
−10	8,070
−20	8,035

It will be seen that in temperate climates the r.p.m. at take-off should not be lower than 8,020, i.e. 8,070—50 tolerance.

(ii) *Inability to achieve full take-off power*

Malfunctioning of the variable-incidence swirl vanes can result in the vanes remaining in the 40° position,

thus preventing maximum thrust being obtained. If this occurs the take-off should be abandoned. It is important to ascertain as soon as possible whether the engine is functioning correctly. Indications of incorrect swirl vane operation are:—

1. Take-off r.p.m. can be reached before the throttle is fully open.
2. At full throttle max. r.p.m. may be exceeded but with brakes on, the aircraft will not creep forward as it normally tends to do when correct take-off power is obtained. The j.p.t. will in all probability not exceed 580°C.
3. When the brakes are released, poor acceleration will at once be evident.

(iii) An acceleration effect on the r.p.m. indicator during take-off may cause the engine speed to under-read by up to 100 r.p.m. This coupled with the effect mentioned in (b) (i) below may cause the r.p.m. at the start of the climb to read as much as 150 less than the static ground figure. This effect should gradually disappear as the climb progresses.

(b) *Climb*

(i) *High airspeed at low altitude*

High forward speeds at low altitude may reduce the maximum attainable r.p.m. by as much as 100. Damage to the engine may result, if the throttle is closed too rapidly at high airspeed.

(ii) Max. r.p.m. will also be reduced if the top temperature controller comes into operation. On some engines the temperature controller reaches the limit of its control at altitudes above 40,000 ft. when climbing at full throttle. It therefore becomes necessary to close the throttle slightly to maintain j.p.t. below 690°C.

(iii) During a climb to 45,000 ft. at full throttle the governed r.p.m. may increase by up to 100. This increase may cause the j.p.t. to exceed the limitations if the t.t.c. is OFF or has reached the limit of its control unless the throttle setting is reduced.

(c) *General flying*

(i) At intermediate throttle positions different combinations of forward speed and ambient air temperature may cause r.p.m. to vary from those selected by plus 300 to minus 150.

(ii) If, when increasing to max. r.p.m. or under continuous r.p.m. conditions the engine shows any sign of excessive j.p.t. or instability, i.e. a rapid drop in r.p.m. and/or a general rumbling accompanied occasionally by a loud bang, close the throttle immediately to reduce the possibility of flame-out and dive the aircraft. Re-open the throttle slowly and smoothly, checking engine response. Repeat this drill until engine response returns to normal. Do not assume flame-out has occurred unless r.p.m. fall below 3,000 (see para. 100). This type of surge is only likely to occur at high altitudes, low airspeed and temperature conditions of less than −50°C. A surge may also occur at altitude at higher airspeed when positive G is applied.

(iii) Rapid throttle opening should be avoided at speeds below 200 knots above 30,000 ft., otherwise surging may occur.

(d) *Fuel dipping and air bleeding*

When the gun firing button is pressed the r.p.m. will drop. The amount of this r.p.m. drop is dependent upon the altitude, the length of burst, and the airspeed. The amount of fuel bled in a given time is constant and is independent of throttle position. At part throttle settings this can result in the r.p.m. dropping below flight idling; throttle response is then uncertain, particularly at low altitude and low airspeed. Provided that the engine is not in a surge condition r.p.m. may be restored by setting the H.P. pump isolating switch to ISOLATED. If the throttle is opened when firing in buffet conditions, throttle opening time must not be less than 2 seconds. R.p.m. drop will be aggravated if the gun-firing switch is held on for lengthy periods; for this reason it is important that the camera button and not the gun-firing switch is used during cine-gun practice.

64. **Management of the pressurisation and flood flow system**

(a) *Pressurisation system*

(i) Before start up, check the cockpit pressure warning light comes on by operating the cockpit pressure warning test switch to TEST. Then return the switch to NORMAL.

(ii) Switch the cockpit pressurisation ON for take-off but if, due to high humidity, misting occurs or vapour issues from the gallery pipes, switch it OFF until 5,000 feet is reached.

(b) *Flood flow system*

(i) For all normal conditions of flight the FLOOD AIR-FLOW CONTROL switch should be at AUTO. To prevent windscreen misting select MANUAL:—

1. When cruising for prolonged periods at high altitude and low engine r.p.m. e.g. more than 15 minutes above 30,000 ft. at 7,200 r.p.m. or less (see (ii) below).
2. For descents using less than 7,000 r.p.m. after high altitude cruising until misting has cleared or misting danger has passed. (See (iii) below.)

(ii) If misting occurs above 30,000 ft. when cruising at 7,200 r.p.m. or above, keep both the FLOOD AIR CONTROL and the CABIN TEMP. CONTROL switches at AUTO and select full heat on the CABIN TEMP. SELECTOR.

(iii) If descending with r.p.m. above 7,000 keep the FLOOD AIR CONTROL switch at AUTO and select HOTTER on the CABIN TEMP. CONTROL.

65. **Management of the engine anti-icing system**

NOTE.—1. The system should be regarded as a means of protection during climb and descent only and is not designed for prolonged use in level flight.

2. With the system in operation a loss of thrust and fuel economy will occur and there is usually a rise in j.p.t. of about 20°C. At full throttle it may be necessary to reduce power to keep the j.p.t. within limits if the j.p.t. controller is not switched ON; otherwise r.p.m. may fall.

3. The system may be switched OPEN or SHUT at any r.p.m. above 5,500.

Page 54 Para. 65 (contd.) A.L.2

(a) *Ground running*

In conditions of fog or mist at OAT's below + 5° C. switch ON anti-icing immediately after starting. Taxy and, if runway length permits, take-off with the system ON; otherwise run the engine at 7,000 r.p.m. for one minute immediately before take-off and then switch the system OFF. Switch the system ON again as soon as possible after take-off and leave it ON until 2 minutes clear of icing conditions.

NOTE.—Do not carry out any acceleration checks with the system ON.

(b) *Level flight*

If icing conditions are met in level flight, climb or descend out of the icing level (see (c) and (d) below).

(c) *Climbing*

Open up to not less than 7,200 r.p.m. and set the anti-icing switch to OPEN. Climb at the maximum practicable rate.

(d) *Descending*

Throttle back to not less than 5,500 r.p.m. and set the switch to OPEN. Descend at the maximum practicable rate; maximum anti-icing protection is obtained at the highest practicable r.p.m.

(e) When clear of icing conditions, set the switch to SHUT and wait for about 10 seconds before making any rapid throttle movements. If icing conditions persist down to airfield level keep the switch at OPEN and maintain engine speed above 5,500 r.p.m. until finally committed to a landing.

66. Management of the powered flying controls

Page 54 Para. 66 (a) (i) A.L.2

(a) *Ailerons and elevator*

(i) After starting switch the instructor's power control switches to POWER and, if mods. 686 and 687 are not embodied, engage the power controls by holding the three-position selector switch to POWER with the left hand and moving the control column with the right hand, laterally when engaging ailerons and fore and aft when engaging elevator, until the corresponding magnetic indicator goes black. The switch can then be released. To engage aileron power more easily it is advisable to either:—

1. Select POWER with the stick held hard over to starboard, then move it to port, or
2. Attempt the engagement immediately after light-up before hydraulic pressure builds up.

If power has not been correctly engaged the controls will revert to Manual when the switch is released.

(ii) Immediately before take-off check that the magnetic indicators are black at not less than 4,500 r.p.m. and

move the control column through full travel in both senses.

WARNING.—At any stage of a flight, if either automatic Manual reversion or any form of stick jamming occurs with Power selected ON, immediately switch Power OFF. Do not attempt to re-engage Power; return to base and land in Manual.

Page 55 Para. 66 (b) (i) A.L.2

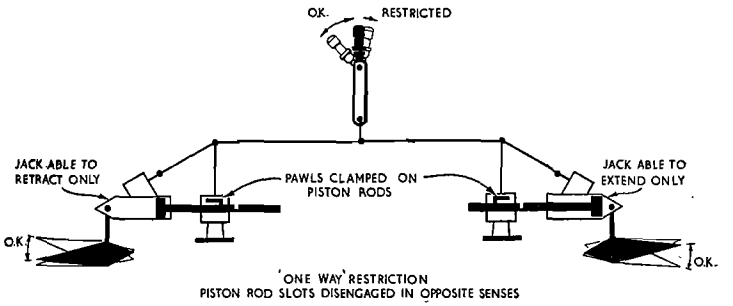
(b) *Clearing false anchorages (ailerons)*

(i) False anchorages cannot occur with mods. 686 and 687 embodied. In unmodified aircraft they can occur when re-engaging Power in the air only so long as the three position selector switch is held at POWER ON.

(ii) When a reselection to Power is made in the air, it is possible that the locking pawls will not engage in the slots on the piston rods, but merely clamp on the side of the rods giving a false anchorage; the magnetic indicators remain white. False anchorages can be caused by the pistons "creeping" to full travel during a lengthy period of manual flying or when the ailerons are deflected appreciably either by the control column or by the presence of aileron up or down float when selecting POWER ON or OFF. False anchorages can give two types of restriction. (See (c) and (d).)

(c) *One-way restriction*

(i) This usually occurs as a result of reselecting Power with the ailerons deflected, e.g. when initiating a turn. The locking pawls clamp on the side of the piston rods in opposite senses relative to the slots;



'ONE WAY' RESTRICTION
PISTON ROD SLOTS DISENGAGED IN OPPOSITE SENSES

e.g. one rod extended the other retracted. There will be apparent power-operated movement in one direction due to the clamping of the pawls on the rods. Movement of the control column in the other direction is restricted since power assistance is not available and not only has the friction clamp of both pawls to be overcome but the ailerons have to be deflected manually.

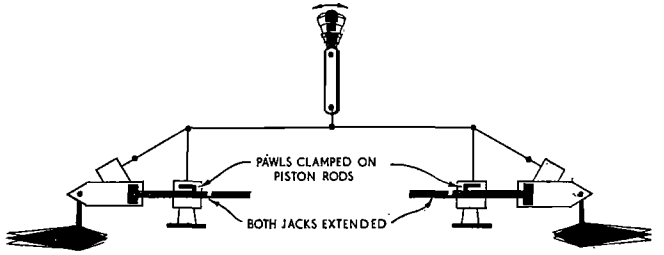
This type of restriction can also occur as a result of having one pawl correctly engaged and one pawl out of engagement. Correct engagement of the pawls can be obtained by demanding a force greater than that which can be held by pawl friction, thus causing the piston rods to slide.

(ii) If Power is reselected above 10,000 ft. and a one-way restriction occurs it may be cleared as follows:—

Hold the switch at POWER ON and then move the control column rapidly over its full movement in the direction of unrestricted travel. If the airspeed is below 250 knots, this can be done without producing excessive aircraft roll.

(d) *Both-ways restriction*

(i) This usually occurs as a result of reselecting power ON with the ailerons floating up or down, e.g. when easing out of a dive. The pawls will grip the piston rods in the same sense relative to their slots, e.g. both rods extended or both retracted, giving complete jamming of the control column in the neutral position. Movement of the control column in either direction is restricted by the friction clamp of one pawl and the ailerons having to be deflected manually.



'BOTH WAYS' RESTRICTION
PISTON ROD SLOTS DISENGAGED IN THE SAME SENSE

Page 57
A.L.2

(ii) If Power is reselected above 10,000 feet and a bothways restriction occurs it may be cleared as follows:—

Lower full flap at an airspeed of 250 knots and hold the switch at POWER ON. The aileron buffet which occurs in this configuration will probably be sufficient to enable the pawls to engage in the slots, but if necessary move the control column laterally until the magnetic indicator turns black.

(e) *Bypass hydrobooster failures*

(i) *Bypass valve fails to open—Power OFF*

(1) The aileron and elevator loads in Manual are slightly increased compared to normal Manual due to the elimination of the bypass facility. The increased loads are acceptable however.

(2) Reselecting Power ON, if this is possible, eliminates the fault but it will probably re-occur if Power OFF is again selected.

(ii) *Aileron bypass valve fails to shut—Power ON*

(1) This gives a condition of one aileron in Power and one in Manual.

(2) It is relatively easy to detect on the ground as the stick judders when moved laterally and operating loads are somewhere between normal Power and bypass Manual.

(3) In flight there is a wing-low tendency, caused by the up float of the Manual aileron, which increases with increased airspeed. The stick force to maintain lateral level does not exceed 20 lb. in level flight.

(4) Increase of G will increase the out-of-trim condition.

(5) The wing-low tendency is reduced when the flaps are lowered.

(6) Remedial action is to select Power OFF.

(f) *Follow-up tailplane*

(i) After starting, check that the tailplane switch is OFF. Note the trim position on the tailplane incidence indicator and trim to a new position at least 1° different.

Switch TAILPLANE ON. Check that the tailplane does not move from the new position. Move the stick fore and aft and check that the tailplane follows up. If the emergency switch cover is lowered after checking the emergency switch with the tailplane at a different angle from that when the cover was raised the tailplane will revert automatically to the original trim angle.

(ii) If in flight the follow-up tail malfunctions, either in its capacity as a flying control or in its trimming action, the standby trim switch cover must be lifted immediately. The standby actuator can then be used to obtain satisfactory trim. It is possible that the malfunction may not affect the main trim actuator with TAILPLANE selected OFF although it might have shown itself during either normal control movement or trimming with TAILPLANE ON. After raising the standby trim switch cover, select TAILPLANE OFF, then reselect the main actuator and check the normal trimming action. If the malfunction is still present revert to the standby actuator and return to base.

(iii) If the tailplane trim actuator runs away, lift the standby trim switch cover. If this does not stop the run away operate the tailplane cut-out switch (128) or trip the tailplane main actuator circuit breaker; control can then be regained by use of the stand-by trim switch. When Mod. 921 is embodied lifting the standby trim switch cover will trip the main circuit breaker.

(g) *Use of the autostabiliser*

Except during take off and landing the autostabiliser should be at STDBY at all times on the ground. In the air it should be ON, but if undamped directional snaking occurs, switch it to STDBY. It must be switched to STDBY during aerobatics. Only switch to OFF in an emergency such as a runaway stabiliser, or if it is essential to conserve electrical power.

67. Management of the electrical system

(a) *Testing the inverters on the ground*

(i) *Before start*	*Check*
Battery master ON	Standby inverters running
Engine master ON	Indicators STDBY
	Dolls-eye white
	Instruments functioning
(ii) *After start*	
1. Generator warning lights out	Main inverters running
	Indicators MAIN
	Dolls-eye black
2. Change-over switch to STANDBY	Inverter change-over indicators MAIN to STDBY
	Dolls-eye white
3. Change-over switch to NORMAL	Inverter change-over STDBY to MAIN
	Dolls-eye black

There is a distinct noise change when inverter changeover takes place. The above test may also be carried out in the air.

(b) *Resetting a main inverter*

On the ground or in flight, if auto-changeover of either inverter group occurs, set the appropriate NORMAL–STANDBY switch to STANDBY and then return it to NORMAL. If the associated magnetic indicator then shows MAIN, and in the case of No. 2 group, the artificial horizon magnetic indicator reverts to black, resetting has been accomplished. If the indicators still show that the standby inverter is in operation, resetting is not possible.

(c) *Electrical system failures*

(i) *Single generator failure*

If either generator fails, the output of the other is generally sufficient up to 35,000 feet. Above 35,000 feet some drain on the battery must be expected if armament loads are used, but the drain will normally be made up on subsequent flying. When the follow-up tailplane is in use a heavy electrical load is imposed; it is recommended that the interconnection should be switched OFF unless operationally necessary.

(ii) *Double generator failure*

If both generators fail, all electrical services will be supplied by the batteries. These, if fully charged, will maintain the following output before they fail (i.e. battery voltage below 16 volts).

Output—amps.	180	150	125	100	75	50
Time—Mins.	5	7	10	15	20	30

(iii) Failure to relight may involve gliding back to base, during which time all electrical loads should be reduced to minimum to conserve enough power to operate the fire-extinguisher and brake parachute. The turn and slip indicator should be operated from the emergency battery for greater reliability in the final stages and the E2B compass used as far as possible to avoid unreliability of the Mk. 4FT compass with dropping battery voltage. Engine windmilling r.p.m. will provide little or no generation.

(iv) To assist the pilot in deciding which loads should be shed, if generator failure occurs, the following table lists the major services and the current they require.

Service	Load (amps.)	Service	Load (amps.)
Radar ranging	46	R.P. firing	5
Booster pumps	30	Starter control (relighting)	5
A.C. inverters	22		
Tailplane actuator and interconnection	20	G.G.S.	4
		Autostabiliser	3
V.H.F. sets	11	Intercomm.	2.5
Gun firing	10	Fuel contents gauges	1.5
D.M.E.	7	All other electrics	14
Pressure head heater	6	Maximum flight load	187

NOTE.—The average flight load is 126 amps.

(d) *Double generator and battery failure*

Once the batteries are discharged, no electrical services may be operated, e.g. trim tab actuators, tailplane motors, electro-hydraulic selectors, etc. If the flying controls are in Power, selection of Manual will necessitate use of the

emergency selector buttons. In addition the fuel gauges, Mk. 4FT compass and electrically-operated flight instruments will become unserviceable. The fuel booster-pumps will cease operation, which will entail reduction in altitude and engine r.p.m. to ensure satisfactory engine running. (See para. 62(c) .) No relight facilities will be available when the batteries are fully discharged.

68. **Management of the hydraulic system**

(a) *After starting*

The correct functioning of the hydraulic failure warning light and audio warning may be checked by exercising the stick laterally several times and selecting full flap simultaneously to exhaust hydraulic pressure. The light should come on and the audio warning sound when pressure falls below 600 lb./sq. in. When pressure rebuilds check that the flying control magnetic indicators are still black.

(b) *Partial hydraulic failure*

Partial hydraulic failure can occur due to a type of leak which could cause complete loss of pressure during the operation of a service, but which would allow pressure to build up again when the operation is complete.

(c) *Complete hydraulic failure*

(i) Check the triple pressure gauge periodically in flight. The central needle should normally read 2,850± 150 lb./sq. in. If the reading drops substantially below this figure when no service is being operated, then hydraulic failure should be suspected.

Page 60
Para. 68
(c) (ii)
A.L.1

(ii) If the hydraulic supply pressure fails, there may be sufficient reserve in the power controls accumulators for a maximum of 3½ full reversals of aileron and elevator, the actual reserve depending on the state of charge of the respective accumulators at the time of failure. However, even if no control movement is made, accumulator pressure will not be maintained for a long period, due to normal hydraulic component seepage. When the accumulators are exhausted the controls will revert automatically to Manual. It is important, therefore, that drop tanks containing fuel are jettisoned before Manual reversion occurs (see para. 98 (b)).

(iii) A failure in the power controls hydraulic circuit, as distinct from supply failure, may lead to immediate and automatic Manual reversion.

(d) *Flaps*

When the aircraft is being flown solo, or when the pupil is in control, the instructor's selector lever must be gated beyond the UP position. If the instructor wishes to take control or to override a pupil's selection, movement of his selector lever out of the gate cuts off electrical supply to the pupil's selector. When the instructor hands back to the pupil he must first ensure that the pupil's selector is in the fully UP position otherwise the flaps will move to the position selected by that lever.

(e) *Undercarriage*

When the aircraft is being flown solo or when the pupil is in control, the instructor's PUPIL override button must be fully in and his UP and DOWN pushbuttons must both be out. If at any stage of the flight the instructor wishes to take control of the undercarriage, he presses either the UP or DOWN pushbutton to release the PUPIL pushbutton and isolate the pupil's selector buttons. Before handing back control to the pupil the instructor must first ensure that the pupil's pushbuttons are similarly selected to his own.

69. **Use of ejection seat equipment**

Each occupant must:—

(a) Check that the safety pins are in position in the primary and secondary firing handles and that the firing cables, drogue gun and time delay mechanism trip rods are correctly secured. Check that the safety pin has been removed from the emergency oxygen cylinder and that the drogue gun quick-release pin has been withdrawn from the safety lock on the drogue gun. If the aircraft is to be flown solo, check that the instructor's harness restraint apron is in position.

(b) Enter the cockpit and adjust the seat height for optimum position.

(c) Fasten the leg-restraint garters just below the knees. Connect the survival pack to the life-saving waistcoat by means of the quick-release attachments.

(d) Check that the harness box is locked and fasten the combined harness, first adjusting the lap straps, then the parachute shoulder straps and finally the harness shoulder

straps. Adjust the leg-restraining cords by means of the release buttons on the snubbing units to give comfortable leg movement.

(e) Connect the main and emergency oxygen tubes, the mic/tel plug and the anti-G connection.

(f) Check that the primary firing handle can be reached with both hands together. DO NOT PULL.

(g) Have the ejection seat pins removed and stowed.

(h) Before leaving the cockpit ensure that the primary and secondary firing handle safety pins are replaced.