

PART V

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100. Engine failure and flame-out

(a) *Mechanical failure*

Engine seizure will involve both hydraulic and electric supply failure. If the engine has failed due to obvious mechanical causes do not attempt to relight. Proceed as follows:—

- (i) Close the throttle. Turn off the H.P. and L.P. cocks and switch off the booster-pumps.
- (ii) Reduce speed and glide at 210 knots.
- (iii) Switch off all unnecessary electrics, including TAIL-PLANE.
- (iv) Set tailplane incidence to $\frac{1}{2}^\circ$ nose-up. Release aileron trim safety lock and check that trim indicator is at zero (see para. 104).
- (v) The controls may be left in Power, but manual reversion must be expected.
- (vi) Carry out forced landing procedure (see para. 112) or abandon.

(b) *Sudden drop in engine speed*

If a sudden inexplicable drop in engine speed occurs, which cannot be identified as engine surge (see para. 63(c)(ii)) proceed as follows:—

Above 20,000 ft. Close the throttle fully and descend; check engine response to throttle movement during the descent.

Below 20,000 ft. If the engine fails to respond to normal throttle movements, close the throttle fully and set the H.P. pump isolating switch to ISOLATE. If the engine still fails to respond to throttle movement, leave the switch at ISOLATE and carry out relight action. Once the switch has been set to ISOLATE it must be left there for the remainder of the flight; with it thus set the B.P.C. and A.C.U. are ineffective and all throttle movements must be made with care.

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(c) *Flame-out*

- (i) If a flame-out occurs a relight may be attempted immediately, while r.p.m. are decreasing, by pressing the relight button with the H.P. cock open and the throttle at its set position. A successful relight will be indicated by the r.p.m. stabilising and then starting to rise; the likelihood of a successful relight is increased if the height and airspeed are below the recommended maxima for relighting.

- (ii) If no relight occurs within 10 seconds, release the relight button and proceed as follows:—

H.P. cock	OFF.
Throttle	Closed.
L.P. cock	Leave on.
All non-essential electrical services	OFF (see para. 67(c)).
If below 35,000 ft.	Relight at once.
If above 35,000 ft.	Switch off the booster pumps, descend to 35,000 ft. and carry out the relight drill.

- (iii) If above 35,000 ft. the decision either to descend quickly or glide at 210 knots will depend on the prevailing circumstances e.g. weather conditions, distance to travel, etc. The following should be borne in mind.

1. The likelihood of obtaining a relight increases with decrease in altitude.
2. At best gliding speed the aircraft will cover approximately 2 miles per 1,000 ft.
3. With normal services running, the battery cannot be relied on for more than approximately 10 minutes. All non-essential services including booster pumps should therefore be switched off to conserve battery power.
4. Descending rapidly at a speed above 210 knots will increase the wind-milling r.p.m. Consequently hydraulic pressure will be higher and the generators may continue to supply power (see also para. 67(c)(iii)).

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5. If a glide is to be made at 210 knots the tailplane should be set to $\frac{1}{2}^{\circ}$ nose-up.
6. If it is necessary to descend more rapidly than at normal gliding speed 15° flap may be used to increase the rate of descent, but the speed must not exceed 0.9 M and the tailplane incidence must be left at $\frac{1}{2}^{\circ}$ nose-up. Intermediate degrees of flap can only be selected while electric power is available. The pull force needed to reduce speed to 210 knots will be considerable if in Manual.

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101. Relighting

- NOTE.—1. Relights are obtained more easily at lower altitudes and with lower airspeeds. Every precaution should be taken to ensure success at the first attempt due to the loads on the battery. If the engine and its fuel system are serviceable and the drill is followed correctly, a relight should occur at the first attempt.
2. If below 20,000 feet set the HP pump isolation switch to ISOLATE before relighting and leave it at ISOLATE after relighting has been accomplished.

- (a) (i) Check and/or set:—

Maximum altitude	35,000 ft.
Maximum airspeed	200 knots above 25,000 ft. 0.80 M below 25,000 ft.
All non-essential electrics	OFF (see para. 67(c)).
Throttle	Closed.
Battery master switch	ON.
Ignition switch	ON.
Engine master switch	ON.
Booster-pumps	ON.
- (ii) Press the relight button and at the same time open the H.P. cock fully, keeping the relight button pressed until the engine lights up and r.p.m. rise by about 200. R.p.m. should start to rise almost immediately. When the r.p.m. rise to idling, increase power carefully.
- (iii) If no relight occurs within 30 seconds, release the relight button, close the H.P. cock and switch off the booster pumps. Allow, if possible, 30 seconds for the engine to dry out before the next attempt.

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(b) Emergency relighting

- (i) In circumstances where the engine cannot be relit by use of the above drill, provided that the pilot is reasonably certain that the fault lies in the relight button circuit, it may be possible to obtain a light-up using the starter pushbutton in the following way:—
- (ii) To ensure that a live cartridge is not fired, the spent cartridge with which the engine was ground-started should first be mechanically re-indexed. To do this set the starter master switch OFF and then press the starter pushbutton fully in twice, pausing for an instant between each operation to allow the button to spring fully out.
- (iii) Check and/or set:—

Maximum altitude	15,000 ft.
Maximum airspeed	0.80 M.
All non-essential electrics	OFF (see para. 67).
Throttle	Closed.
Battery master switch	ON.
Booster pumps	ON.
Starter master switch	ON.
Ignition switch	ON.
- (iv) Press the starter pushbutton again and then open the H.P. cock fully. The igniters will then function but if the reindexing drill has been correctly carried out a cartridge will not be fired. If no relight occurs within 30 seconds, set the H.P. cock OFF when the starter button comes out. The spent cartridge must be re-indexed as in (ii) above before any further attempt is made.

WARNING.—If for any reason the re-indexing drill has not been correctly carried out and a live cartridge is indexed when the starter button is finally pressed, it is probable that damage will be caused to the starter and to the aircraft. This probability may be lessened to some extent if the engine windmilling speed is low and positive G is not applied at the time of operating the pushbutton.

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(c) Failure to relight

- (i) If the engine fails to relight turn off the H.P. and L.P. cocks and switch off all non-essential electrical services (including the booster pumps).
- (ii) Set the tailplane incidence to $\frac{1}{2}^\circ$ nose-up and reduce speed to the trimmed condition.
- (iii) Release the aileron trim safety lock and check that the trim indicator is at zero.
- (iv) Carry out forced landing procedure (see para. 112) or abandon.

102. Action in the event of fire

- (a) If the engine fire warning light comes on, close the throttle immediately. If the light then goes out within 5 seconds, a hot gas leakage as distinct from a fire is indicated. It is safe to use the engine in this condition, but a landing should be made as soon as practicable. Reduced power should be used, but unless the power required is low the light will probably come on again. It is advisable, therefore, to throttle back every 5 minutes to check the light goes out in order to ensure that a fire has not started.
- (b) Should the light remain on after throttling back, a fire is indicated. Should a fire occur:—

H.P. cock	OFF.
L.P. cock	OFF.
Booster-pumps	OFF.

and quickly reduce airspeed to a practicable minimum. Then press the extinguisher pushbutton. Should the light remain on and the fire persist, the aircraft should be abandoned.
- (c) If a satisfactory extinction has occurred the warning light should go out as the circuit is broken by the cooling of the flame switches. The engine must not be restarted, due to the risk of fire with the fire-fighting resources exhausted.
- (d) Carry out forced landing procedure (see para. 112) or abandon.

103. Action in the event of hydraulic failure

- (a) (i) Complete failure will be indicated by a loss of pressure on the gauge followed by the red light coming on and by the audio warning.

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(ii) Immediate actions are:—

1. Reduce speed to 250 knots or, if above 40,000 ft., to 0.80 M.
2. Release the aileron trim safety lock and check that the trim indicator shows zero.
3. Jettison drop tanks if they contain fuel.
4. The controls may be left in Power, but when Manual reversion occurs, and in any case at a safe height before joining the circuit switch OFF elevator and aileron Power.

(iii) Lower undercarriage and flaps on the emergency systems.

(b) Partial hydraulic failure

- (i) 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.

(ii) Immediate actions are:—

1. Reduce speed to 250 knots or 0.80 M.
2. Release aileron trim safety lock and check that the trim indicator shows zero.
3. Jettison drop tanks if they contain fuel.
4. Select Manual before joining the circuit.

(c) Wheel brakes emergency operation

- (i) 1. Should the hydraulic system fail, the wheel brake accumulators provide sufficient pressure for brake operation during landing, down to a gauge reading of 750 lb./sq. in. approximately. To conserve pressure when landing without main hydraulic pressure do not operate the lever during the downwind checks.
2. Apply brake pressure in such a way that maxaretting does not occur (little pressure at high speed but increasing with decrease in speed) and avoid differential braking as much as possible. The brake lever should not be released after brakes have once been applied as this will result in a large loss of fluid.
- (ii) The H.P. cock should be put OFF on touchdown, if the brakes accumulator pressure is low and the runway short.
- (iii) The aircraft must not be taxied after the landing run has been completed.

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104. Action in the event of electrical failure

- (a) If complete generator failure occurs, switch off all non-essential electrical services to conserve the battery for as long as possible.
- (b) Set the tailplane angle to ^{to nose-up} ~~zero~~ and switch the TAILPLANE interconnection off.
- (c) Provided that the engine is running correctly and hydraulic pressure is normal the flying controls may be left in Power. The magnetic indicators will show white when the batteries are discharged although the controls will remain in Power.

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105. Emergency operation of the tailplane

If the normal tailplane motor fails or "runs away", lift the cover of the standby switch on the port shelf and use that control. If this does not stop the runaway, operate the tailplane cut-out switch (128) or trip the main actuator circuit breaker if Mod. 921 is not embodied. Control can then be regained by operation of the standby trimmer, the rate of operation of which is one-third that of the normal control. If complete electric failure occurs, control of the tailplane is impossible. It is important therefore to set the tailplane to $\frac{1}{2}^\circ$ nose-up before the batteries are fully discharged.

106. Aileron trim malfunction in Manual

- (a) When flying in Manual should the aileron trim actuator malfunction resulting in full trim being applied with subsequent inability to rectify, carry out the following actions:—

Reduce speed below 200 knots. Select elevator power ON.

If above 5,000 ft. select aileron power ON; if below 5,000 ft. leave ailerons in Manual (but see (iii) below). Land as soon as possible.

- (b) If a one-way restriction occurs when reselecting aileron power clear it in the normal way. If a both-ways restriction occurs reselect Manual immediately and remain in Manual.
- (c) A landing in Manual with full aileron trim applied is hazardous and should only be attempted if conditions are favourable.

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107. Undercarriage and flaps emergency operation

NOTE.—Both systems operate independently of their normal selectors. When operating either the flap or the undercarriage emergency selector, it must be pulled out to the full extent of the operating wire.

(a) Undercarriage

- (i) If the undercarriage fails to lock down by normal selection, when both electric and hydraulic systems are serviceable, repeated raising and lowering and the application of sideslip or G may have the desired effect.
- (ii) If all attempts to lower the undercarriage (or any unit of the undercarriage) by the normal system fail, use the emergency system.
- (iii) To raise the undercarriage on the ground in an emergency following normal selection, rotate and press the normal UP selector button. It must not be used in this way to retract the undercarriage in the air as there is a risk of the legs being retracted when not fully extended and the leg fairings may be damaged. If the UP button cannot be pressed in normally after take-off, the wheels must be left down and the aircraft landed.

(b) Flaps

If electrical or hydraulic supply failure has occurred the flaps may be lowered, fully down only, by pulling out the emergency lowering control after first pushing in the central knob.

108. Cockpit pressure failure

- (a) Pressurisation failure will be indicated by the warning light.
- (b) Failure of the canopy seal should not result in cockpit altitude exceeding aircraft altitude.
- (c) Failure or loss of the canopy in flight will result in cockpit altitude exceeding aircraft altitude. At 50,000 ft., dependent on the airspeed, cockpit altitude may increase to as high as 60,000 ft.

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- (d) If the aircraft is above 30,000 feet descend as rapidly as possible to below 30,000 feet cabin altitude.

109. Emergency use of oxygen

(a) *Toxic fumes*

If the cockpit becomes contaminated with toxic fumes, check that the air-dilution switch on the regulator is at 100% OXYGEN and deflect the EMERGENCY switch to either side, to prevent inward leaks on the mask.

(b) *Blinker failure*

(i) If the blinker mechanism ceases to operate check that the main tube is correctly connected, that the pressure on the regulator gauge is normal and that the main oxygen contents gauge is indicating that oxygen is still available.

(ii) If the above indications are satisfactory depress the regulator EMERGENCY switch when in the central position. A supply of oxygen under increased pressure indicates that the regulator is serviceable but that the blinker mechanism is defective. If the regulator is unserviceable, as indicated by no flow, descend immediately to a safe altitude and check all oxygen tube connections.

(c) *Use of emergency bottle*

(i) If it is necessary to use the emergency oxygen bottle through failure of the regulator or because of exhaustion of the main supply, pull up the emergency control on the right of the seat, and disconnect the mask tube from the main supply point.

(ii) The main supply tube is automatically released and the emergency bottle brought into use on ejection.

(iii) The duration of supply from the emergency bottle is 10 minutes only.

110. Canopy jettisoning

NOTE.—The canopy is jettisoned automatically when either primary or secondary firing handle is pulled.

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- (a) If possible, reduce speed to between 130 and 280 knots. Each occupant must lower his seat fully. Lower the head before pulling the jettison handle.
- (b) The canopy can be safely jettisoned in a spin.
- (c) If it is desired to remove the canopy on the ground without using the explosive jettison system, remove the pip-pin and then pull the adjacent red lever. The canopy can then be pushed off manually.

111. Drop tank jettisoning

Drop tank jettisoning must be carried out in straight and level flight without yaw or sideslip in the following speed range.

Drop tanks with fins 200–450 knots.

112. Forced landing procedure

NOTE.—1. All the circumstances prevailing at the time of engine, hydraulic or electrical failure cannot be predicted. Each system and the effects of failure of each system must be thoroughly understood. The following information is intended to help the pilot reach the best decision.

2. For practice forced landings, a flap setting of 23° and 5,500 r.p.m. will give a rate of descent comparable with an engine-off glide.

- (a) When a relight is not possible or practicable, glide at 210 knots. (See 100 (c) (iii) 6.) If deceleration is required to obtain the correct gliding speed, climb rather than use the airbrake. If used, the airbrake requires considerable hydraulic power and constitutes a hazard on landing should it remain out.
- (b) The recommended gliding speed for maximum range is 210 knots. In still-air conditions a distance of approximately 86 n.m. can be achieved from 40,000 ft. or about 2 n.m./1,000 ft. The average rate of descent is approximately 2,300 ft./min. These distances do not allow for the recommended overhead height of 7,000 ft. (see (e) below). The gliding speed of 210 knots should be maintained when gliding for range and/or in Power. If maximum range is not essential and a descent in Manual is being made, control is more comfortable at 175 knots.

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(c) Check and/or set the following:—

H.P. and L.P. cocks	OFF.
Booster-pumps	OFF.
Tailplane incidence	$\frac{1}{2}^{\circ}$ nose-up. Interconnection OFF.
All non-essential electrics	OFF.
Aileron trim	Safety lock off. Indicator zero.
Elevator and aileron power	Leave on temporarily, but select OFF before joining circuit.

(d) Powered controls

- (i) Engine failure may lead to either or both electrical and hydraulic failure. Experience shows that at 200 knots windmilling r.p.m. will create sufficient hydraulic pressure for limited use of the controls. Selection of any of the services may cause Manual reversion.
- (ii) When gliding at 210 knots, windmilling r.p.m. at high altitude will be sufficient to keep the generators charging, but r.p.m. will decrease gradually as height is lost. Make frequent checks on the generator warning lights, and after they come on, the batteries should not be relied on for more than 10 minutes.
- (iii) If electrical power is still available, the undercarriage and flaps may be lowered by means of the normal systems, but the service will take longer than usual to lower. If electrical power is not available, the emergency systems can be used, but the undercarriage, once locked down, cannot be retracted either in the air or on the ground in the event of overshooting, and the flaps can only be lowered to the fully-down position.

(e) Circuit procedure and landing

- (i) If a forced landing on an airfield is being made attempt to arrive overhead at approximately 7,000 ft. or above.
- (ii) **Plan a Manual approach and aim to be downwind opposite the caravan at 210 knots at a minimum of 4,000 feet A.G.L. depending on the prevailing wind conditions.**

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- (iii) **Turn across wind at 175 knots and when it is certain that the touchdown point can be reached, select full flap. The rate of descent is markedly increased with full flap lowered.**

- (iv) Maintain 175 knots on the final approach and aim to cross the threshold at 150 knots. In Manual the pull force to roundout from a glide approach is large.

(f) Undercarriage and flap lowering

- (i) Experience suggests that it is preferable to lower the undercarriage when making a forced landing on an airfield or in open country. In the down position it absorbs much if not all the initial impact, assists in retarding the aircraft, and provided that electrical power is available, and that the emergency lowering system has not been operated, it may be retracted after touch-down if necessary. With the undercarriage up, the aircraft must be lowered gently on to the ground at the normal speed; if the speed is too low a wing drop is likely to occur, and if the speed is too high the aircraft is prone to bounce, the initial impact having a damaging effect on the cockpit.
- (ii) With the undercarriage down, the rate of descent is high, and it increases rapidly as speed is reduced below 180 knots.

113. Landing with an undercarriage unit not locked down

NOTE.—Experience has shown that these techniques cause minimum damage to the aircraft and none to the pilot.

(a) Both main wheels only locked down

- (i) Use up as much fuel as is safe in order to move the C of G as far aft as possible. Unless circumstances dictate otherwise, land on a runway.
- (ii) Check harness tight and locked.
- (iii) Make a powered approach at the normal speed. On touch-down set H.P. cock OFF and maintain a moderate nose-up attitude.
- (iv) Trim the tailplane to give full nose-up trim and as the speed falls below 100 knots maintain a high nose-up attitude without actually touching the tail cone on the ground.

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(v) Lower the nose on to the runway at 80–90 knots and use the brakes gently to keep straight.

(b) *Nosewheel and one main wheel locked down*

If all attempts to lower the undercarriage satisfactorily fail and only the nosewheel and one main wheel come down, make a normal approach and landing; after touch-down hold the wings level for as long as possible by use of the ailerons. When aileron is applied and when the wing finally drops, the aircraft will swing in the direction of the unlocked wheel; this should be counteracted as much as possible by opposite brake. Experience has shown that the distance from the landing path to the point of rest averages approximately 250 yards, varying from 100 to 400 yards. A runway should be chosen which has an area about 400 yards wide available in the direction of the anticipated swing.

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(c) *Belly landing*

If it is necessary to land with the undercarriage retracted, empty drop tanks should be retained. Make a normal approach and fly the aircraft on to the runway at the normal speed.

114. Landing with a burst tyre

No special difficulty is encountered when landing with a burst tyre(s), directional control and braking being adequate.

115. Abandoning the aircraft

NOTE.—1. The second pilot should eject first followed by the captain.

2. If both seats fail to eject, the captain should remain tightly strapped in his seat until the other occupant has cleared the aircraft.

- (a) Reduce speed as much as possible.
- (b) Withdraw the feet from the rudder pedals, at the same time grasping the firing handle. The elbows must be drawn in close to the body and both hands must grasp the handle firmly, the backs of the hands facing forward.
- (c) (i) Draw the handle and face-blind firmly over the face, keeping the head pressed hard against the headrest.

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It is not necessary to jerk the handle and in no circumstances should the blind be pulled outwards away from the face as it may not then be possible to fire the cartridge. Ejection takes place 1 sec. after the canopy has jettisoned.

- (ii) If conditions prohibit the use of the primary firing handle, ejection should be initiated by pulling the secondary handle upwards. In this event no protection is given to the face. It is essential that the head is pressed firmly against the headrest to avoid spinal injury on ejection. A strong pull force is required to ensure that the secondary handle is pulled to the full extent of its travel.

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- (d) After ejection the drogue gun will fire automatically.
- (e) If ejection takes place above 10,000 ft. automatic separation will not occur until that height is reached. If ejection takes place at or below 10,000 ft. automatic separation will be immediate.
- (f) (i) Without a G-stop fitted the minimum recommended height for safe ejection in straight and level flight at speeds above 120 knots is 100 feet.
(ii) With a G-stop fitted ejection may be initiated, in straight and level flight, at any height from ground level upwards. However, runway ejections should only be made if the speed of the aircraft is above 90 knots, or the circumstances of the emergency dictate that ejection is the only reasonable solution.
- (g) Should the ejection seat fail to fire:—
 - (i) Pull the manual override D-ring to disconnect the parachute from the automatic mechanism.
 - (ii) Pull up the manual separation lever on the port side of the seat to disconnect the parachute from the seat then proceed as on aircraft not fitted with an ejection seat. Under these circumstances the parachute will not be opened automatically.

- (h) If automatic separation fails after ejection proceed as follows:—
 - (i) When forward speed is sufficiently low discard the face screen.
 - (ii) Pull the manual override D-ring to disconnect the parachute from the automatic mechanism.
 - (iii) Pull up the manual separation lever on the port side of the seat. Operation of the manual separation lever makes it necessary for the pilot to force himself out of the seat by pressing down on the seat pan. He must

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ensure that the lever has been operated to its full extent before attempting to leave the seat.

(iv) Pull the rip cord handle.

116. Ditching

- (a) Model tests of a clean aircraft indicate that a ditching in any but ideal conditions would be very hazardous.
 - (b) It is recommended, therefore, that except in calm sea and air conditions combined with good visibility, the pilot should abandon the aircraft rather than attempt a ditching.
 - (c) If ditching is inevitable:—
 - (i) Jettison the canopy, check that 100 per cent oxygen is selected and deflect the emergency toggle sideways.
 - (ii) Lower full flap and make the approach at the lowest forward speed and rate of descent compatible with good control.
 - (iii) Ditch along the swell or, if the swell is not steep, into wind.
- NOTE.—The airbrake must be retracted.

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