Part V

EMERGENCY HANDLING

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Part V

Emergency Handling

1 Engine failure on take-off

(*a*) If an engine fails on take-off there is little tendency to swing and the safety speed will always be below the unstick speed. The decision whether to continue or abandon the take-off will depend on the aircraft configuration and airfield conditions as determined by the Operating Data manual. Exactly the same applies if water-methanol fails to provide increased thrust on one engine, or even two engines on the same side. In the event of a water-methanol assisted take-off being continued after an *engine* failure, it should be noted that the duration of increased thrust on the remaining engines will be increased (see Part III, para. 31(*b*)(iv)), thus helping the initial climb.

(*b*) If it is necessary to abandon an assisted take-off, close the throttles and use the brakes in the normal way. The water-methanol will stop as soon as the throttles are closed, but as soon as convenient the master switch must be put off.

2 Engine failure in flight

(*a*) *Flame extinction*

If an engine flames-out in flight with no indications of mechanical failure or engine fire, close the HP cock, switch OFF the ENGINE MASTER COCK (LP fuel cock) and switch OFF the generator. At the captain's discretion one attempt may be made to relight the engine at a height below 35,000 feet and speed below 200 knots.

(*b*) *Mechanical failure*

If an engine fails in flight with indications of mechanical failure, close the HP cock, switch OFF the ENGINE MASTER COCK (LP fuel cock) and switch OFF the generator. Keep close observation for warning of engine fire. Do not attempt to re-start the engine.

(*c*) *Engine Overheat Warning or Low Oil Pressure*

If a progressive decrease of oil pressure is noted, or if pressure falls below 25 PSI in normal flight, or, post-Mod. 3094, if the engine overheat light comes on, it is an indication of possible failure of the engine rear bearing. If any of these indications are noticed check oil pressure, close the HP cock, switch OFF the ENGINE MASTER COCK and switch OFF the generator. The fire extinguisher must not be used unless the EFWL comes on; a close watch should be kept on this light. The affected engine must not be restarted and the ENGINE MASTER COCK should not be re-opened.

NOTE: Once the engine overheat warning light has come on it will remain on even though the temperature decreases.

(*d*) Following any engine failure select the CABIN AIR SUPPLY switch for the affected side to OFF, and that for the other side to ON.

3 Action in the event of fire

(*a*) *Engine fire*

Engine fire will be indicated by the red warning lights in the head of the FIRE EXTINGUISHERS push-buttons. The following action must be taken without delay:

(i) Close the HP cock.

(ii) Warn crew.

(iii) Switch OFF the ENGINE MASTER COCK.

(iv) Press the fire extinguisher button.

(v) Fuselage pumps ON, Wing pumps OFF.

(vi) Select the engine GATE VALVES for the affected side to EMERGENCY CLOSE. Select CABIN AIR SUPPLY switch for the affected side to OFF and for the other side to ON.

(vii) Switch OFF the generator.

(viii) Use the sextant to inspect the affected wing for signs of fire or smoke. DO NOT ATTEMPT TO RELIGHT THE ENGINE.

(*b*) If consistent with safe operation of the aircraft, the adjacent engine should be stopped by closing the HP cock and the ENGINE MASTER COCK, and its generator switched OFF. Switch OFF the CROSS-FEED cock and switch OFF all booster pumps on the affected side. Provided that the fire is extinguished, and that the fire was not accompanied by indications of mechanical failure, the unaffected engine may be re-lit at the captain's discretion. If essential for the safe completion of the flight the affected wing fuel may be used following a minimum period of 30 minutes after the fire has been extinguished, but after any fire the aircraft should be landed as soon as possible.

(*c*) *Fuel tank fire*

The fuel tank fire-extinguishing systems only operate through the crash switches in the event of a crash landing. There is no indication in the cabin of fire having broken out in a fuel tank bay, nor is there any means of extinguishing it.

4 Cabin over-pressurisation

(*a*) Cabin over-pressurisation may be detected by its physical effects but is more likely to be noted by reference to the cabin altimeter which should be checked at frequent intervals during flight at altitude. Post-Mod. 2490, a cabin pressure warning light, which comes on if the differential pressure rises to 9·5 PSI, it fitted (see Part I, para. 78(*d*)). If cabin over-pressurisation should occur the following drill should be put into operation at once:

(i) If flying with CRUISE selected, re-select to COMBAT. If the malfunction is due to the pressure controller this action may clear the fault. If this does not cure the fault, proceed as follows:

(ii) The 1st pilot should reduce the cabin differential at once by holding the normal/depressurise switch to DEPRESSURISE, aiming to bring the cabin altitude to 15,000 feet.

(iii) The cabin air supplies should be selected port ON, starboard OFF. The starboard bomb bay heating should be selected ON and attention should be given to the bomb bay temperature when stores are carried.

(iv) Select one of the port engine gate valves CLOSED (to reduce the mass flow of air into the cabin).

(v) Once the cabin altitude has been stabilised at approx. 15,000 feet, and all of the above actions have been completed, a steady leak rate should be set up by careful adjustment of the manual depressurising control in the rear cabin (this control will give a variable leak rate from fully open to fully closed position). The objective is to hold the cabin altitude at 15,000 feet.

(*b*) In the event of the above actions failing to bring about the desired results the aircraft altitude should be reduced to 30,000 feet and the cabin depressurised by means of the manual depressurising control in the rear cabin.

(*c*) The wire-locked knurled knob on the top of the pressure controller can be used to re-set the capsule stack to control at $3\frac{1}{2}$ PSI. Adjustment of this knob should not normally be necessary, but if the combat selection on the pressure selector switch does not bring the capsule stack to the "combat" position, then manual setting of the capsule stack should be attempted by rotation of the knurled knob.

5 Tailplane malfunction

(*a*) Modification action has considerably reduced the possibility of a runaway TPI motor, but the following drill should be applied in the unlikely event of a runaway, partial runaway or reversal of the trim motor.

(*b*) A malfunction of this nature is most likely to occur whilst attempting to retrim the aircraft, and should become apparent by a changing or worsening out-of-trim condition. In all cases the first action must be to release the trim switches immediately.

(*c*) TPI *malfunction, nose-down*

(i) The pilot at the controls should resist the nose-down pitch by use of the elevator and at the same time warn the crew.

(ii) At the earliest possible moment the 1st Pilot should make opposite selection on the 1st Pilot/2nd Pilot and the coarse/fine switches.

(iii) The other pilot will be alerted by the warning and should assist at once in resisting the nose-down pitch, on the control column.

(iv) The pilot who now has control of the TPI should attempt to retrim the aircraft.

(v) If unable to trim the aircraft the airbrakes should be extended, further acceleration avoided and the IAS reduced, if the flight conditions permit, by reduction of power.

(vi) Once the aircraft is under control, the 1st pilot should trim out the elevator load lights. If the TPI has run to the fully nose-down position, reduction of speed to 170 knots and reversion to manual control will enable the aircraft to be flown comfortably at that speed with all stick forces relieved. If speed is further reduced, elevator control effectiveness will be reduced, but control may still be maintained down to 120-130 knots. However, the change of trim associated with lowering of flap may introduce control difficulties. It is therefore recommended that before landing the AUW is reduced to 98,000 lb or below, and that only 20° of flap is lowered during the approach. After touchdown full flap may be lowered to provide increased drag during the landing run.

(*d*) TPI *malfunction, nose-up*

(i) The pilot at the controls should resist the nose-up pitch by use of the elevator and warn the crew. A turn may be commenced to assist in absorbing the out-of-trim loads, but bank angles in excess of 50° should not be used.

(ii) The other pilot will be alerted by the warning and should assist at once in resisting the nose-up pitch, on the control column.

(iii) At the earliest possible moment the 1st Pilot should make opposite selection on the 1st Pilot/2nd Pilot and the coarse/fine switches.

(iv) The pilot who now has control of the TPI should attempt to retrim the aircraft.

(v) If unable to retrim the aircraft, flap should be lowered to at least 40°. Further acceleration should be avoided, and the IAS reduced, if flight conditions permit, by reduction of power.

(vi) Once the aircraft is under control the 1st Pilot should trim out the elevator load lights.

NOTE: In either case, if the runaway cannot be rectified and prolonged flight is essential with heavy out of trim loads, revert to manual control of rudder and elevators and use the manual trimmers to restore the in trim condition.

6 Artificial feel failure

(*a*) Pilots are warned that when flying in power with the artificial feel units disengaged there are no control forces except the friction in the circuits and care must be taken to avoid overstressing the aircraft by applying excessive control deflections. With feel disengaged on any surface, speed must not exceed 220 knots.

(*b*) The artificial feel must never be disengaged in flight except in the unlikely event of a feel unit (or units) jamming. Should this occur, speed should first be reduced to 200 knots, or lower if possible, and then the appropriate power control motors must be tripped out. The affected feel unit should be disengaged by operating the lever on the control pedestal. Only the control affected should be reverted to manual, but if either the rudder or the elevator feel unit has failed it will not be possible to revert to manual on only one of these controls.

(*c*) Should it become necessary subsequently to revert to power control the following should be borne in mind:

(i) With rudder feel disengaged, the rudder should not be used if at all possible and the feet should be removed from the pedals.

(ii) With elevator feel disengaged, manoeuvres should be kept to a minimum and only initiated very gently. Constant reference should be made to the accelerometer to avoid applying excessive G. It will be necessary to restrain the control wheel from moving forward under its own weight during steady flight.

(iii) With aileron feel disengaged it will be necessary to restrain the control wheel from moving to port.

7 Failure to raise the undercarriage

(*a*) There is only one system for raising the undercarriage, and failure of this system will necessitate abandonment of the sortie. If excessive pressure is required to operate the undercarriage selector UP button, the attempt to raise the undercarriage must be abandoned. If selector fuse failure is suspected, the up control fuse (No. 16 at panel D, 10 amp) may be changed once in order to effect retraction. If the nosewheel fails to retract, and misalignment is suspected, the nosewheel steering system must not be operated in an attempt to complete retraction ; operation of the nosewheel steering system in flight may cause damage to the nosewheel strut and may result in the nose-wheel jamming in the wheel bay.

(*b*) If an attempt is made to retract the undercarriage at speeds above 195 knots, or under conditions of excess G, the clutch slip device may operate to trip the contactors, protecting the motors against overload. If it is considered that failure to retract was due to these conditions it is permissible to reset the contactors after reducing speed below 195 knots and releasing any excess G. If the contactors again trip, the undercarriage should be lowered as in (*c*) below.

(*c*) If the undercarriage fails to retract, the sortie must be abandoned and the aircraft flown at a speed below 195 knots if the undercarriage is fully down and locked, or below 170 knots if the undercarriage is not fully locked down. At the captain's discretion, 20° flap may be lowered to improve controllability. A *normal* DOWN selection should be made as soon as possible. If the undercarriage is fully locked down, weight should be reduced and a normal landing made. If the undercarriage is not fully locked down, weight should be reduced to 110,000 lb before any further action is taken, except in cases of extreme emergency. Because of the attendant fire risk if an emergency undercarriage actuator motor continues to run after the undercarriage has locked down, an EMergency DOWN selection should not be made until the aircraft is down to landing weight. If an EMergency DOWN selection is made, a normal DOWN selection must be made as soon as the undercarriage is fully locked down, and the aircraft should be landed as soon as possible.

8 Failure to lower the undercarriage

(*a*) Failure of the undercarriage to lower normally may be due to electrical failure or to a mechanical jam of the door or up-lock. The following procedure should be followed according to the circumstances.

(*b*) *Suspected electrical failure or door jammed*

Indicated by red door light remaining out and the red travel light remaining out.

(i) Select emergency down.

If the undercarriage still does not lower :

(ii) Re-select normal down.

(iii) Check that the extreme emergency circuit-breaker(s) made as required.

(iv) Operate the extreme emergency switch(es).

(v) Reset the undercarriage main contactors.

(vi) DO NOT RETRACT UNDERCARRIAGE.

(*c*) *Suspected up-lock jammed*

Indicated by red door light coming on, but red travel light staying out. In this case the contactor will automatically be tripped.

(i) Select emergency down for 10 seconds maximum.

If the undercarriage still does not lower :

(ii) After 10 seconds re-select normal down.

(iii) Check that the extreme emergency circuit-breakers are made.

(iv) Operate the extreme emergency switch(es).

(v) Reset the undercarriage main contactors.

(vi) DO NOT RETRACT UNDERCARRIAGE.

NOTE: When the extreme emergency system is used there is possibility of the undercarriage door becoming completely detached. When this system is used, therefore, it is important that the flaps are up and the aircraft in straight and level flight.

(*d*) *Contactor tripped during travel down*

Indicated by red door and travel lights remaining on, and contactor light coming on.

(i) Reset contactor, but do not hold in if it again trips.

(ii) If the undercarriage does not lower select emergency down and proceed as in sub-para. (*b*).

9 Landing with the undercarriage up

(*a*) When a " wheels up " landing is necessary it should, if possible be made on grass. If the grass surface is very bad, and likely to result in the break-up of the aircraft, the landing may be made on a runway; in this event, however, the fire risk is increased, particularly when carrying underwing tanks.

(*b*) Before joining the circuit ensure that the cabin is depressurised and that all loose articles, maps, charts, etc., are securely stowed, the ejection seats safe and the crew securely strapped in with their parachute harness locks at UNLOCK.

(*c*) The entrance door should not be jettisoned as there is some risk of debris coming into the cabin. The ditching exit and the crash landing exit on the starboard side should, however, be removed. The noise level will be somewhat higher than normal and it is therefore advisable that the captain's orders and intentions are given beforehand.

(*d*) The circuit should be made at the normal speeds and flap settings. For the final approach, the normal speed should be used, but the flaps should be restricted to 40 degrees. The engines should be fully throttled back as the runway threshold is reached and the aircraft then held off the ground for as long as possible in order to touch down at the lowest practicable speed. After touch-down the 2nd pilot should shut all high pressure and low pressure cocks and

then operate all the engine fire extinguishers. Greater deceleration will be obtained by pushing the stick fully forward after touch-down.

(*e*) As soon as the aircraft has come to rest all crew members should leave by the ditching and crash landing exits. An attempt may be made to jettison the entrance door, but it may jam due to distortion; if it does not jettison immediately no further time should be wasted. There is no object in firing the canopy explosive bolts unless the other exits are obstructed or fire makes a quick exit essential. If the bolts are fired the canopy will not leave the aircraft but will have to be lifted off by the pilots. Provided all bolts have fired this is quite straightforward, but the canopy is heavy.

10 Landing with the nosewheel up

If the undercarriage failure is such that the nose-wheel is not extended (note that the extreme emergency switches only lower the main wheels) then, time and fuel permitting, the remaining fuel should be used in an attempt to move the CG to the extreme aft limit (575·7 in. aod) and to reduce the weight as much as practical. There is little likelihood of the entrance door becoming jammed so there is no point in jettisoning it, especially as the noise level is very high with it off. However, if desired the astro-dome may be pulled in after depressurising ; no undue noise or discomfort results. The ejection seats should be made safe and all crew members should disconnect parachutes and oxygen leads, and tighten their harnesses. A normal landing should be made, on grass, if possible, and if the surface is good. After touchdown the nose should be held off for as long as possible. When the elevators start to become ineffective (at about 50 knots) the nose should be lowered gently on to the ground, and gentle braking used to stop the aircraft.

11 Failure to raise or lower flaps

(*a*) If the flaps fail to operate on the normal motor they should be operated by the emergency motor. Being a much smaller motor, this takes a considerable time to raise or lower the flaps (see Part 1, para. 57 (*j*)) and care should be taken not to exceed the limiting speed with the flaps down. If both motors fail, the flaps will remain immovable.

NOTE: The flaps will only go down 45 degrees on the emergency motor.

(*b*) It is possible that a section of the flaps might stick at any position during their travel. In the event of any flap malfunction or any abnormal change of trim during flap operation, the selection must be stopped immediately. An attempt may be made to equalise the flap setting by making an opposite selection. After this attempt no further flap selections should be made and the aircraft should be landed as soon as possible, if necessary with partial flap only.

12 Landing with no wheel brakes

If hydraulic failure makes it necessary to land with no wheel brakes, the following procedure should be adopted. It should be remembered that the nosewheel steering will also be inoperative.

1 Use the longest available runway into wind.

2 Reduce weight to a minimum.

3 Prepare the aircraft for a crash landing.

4 Cross the threshold 10 knots above the stalling speed.

5 Flame out all engines on touch-down.

6 Switch off generators, rotary transformers and inverters.

7 Keep the nosewheel off as long as possible.

8 Towards the end of the landing run directional control will be nil.

9 If the aircraft leaves the runway and major obstructions are in the way, rotate the undercarriage override and select wheels up.

13 Action in the event of partial generator failure

(*a*) *Generator resetting procedures*

(i) *Single-generator failure*

Check voltmeter

If voltmeter reads zero .	Leave ON
If voltmeter reads approx. 106 volts (undervolting) .	Leave ON
If voltmeter reads 110 volts	Switch OFF, change control fuse, Switch ON and ENGAGE

NOTE: In the first two cases the generator must be left ON until a technical investigation is made.

(ii) *Three-generator failure*

If this is caused by overvolting of the fourth generator, the three ammeters will read zero and the remaining ammeter will indicate an excessive load; the busbar voltage will be high.

Switch OFF the remaining generator.
ENGAGE the failed generators.

(iii) *Four-generator failure*

Shed loads (see para. 14).
Leave all generators ON.
Check voltages, ENGAGE any generator giving 110 volts.

(*b*) The maximum permitted rating of the generators depends on whether or not generator Mod. A.175 (PEG 11 brushes) is incorporated.

(i) *Pre-Mod. A.175*

The generators are cleared to operate at a continuous load of not more than 100 amps each at all altitudes. They are also cleared to operate up to 135 amps each for 5 hours provided that they are inspected after flight.

(ii) *Post-Mod. A.175*

The generators are cleared to operate at a continuous load of not more than 150 amps each at all altitudes.

(*c*) The *average continuous* load to be met by the generators during day or night cruising conditions is approximately:

B 1 aircraft . . .	150 to 180 amps (Excluding underwing tank pumps)
B/PR 1 aircraft in PR role	170 to 200 amps (Excluding underwing tank pumps)
B/K/PR 1 aircraft in tanker role during fuel transfer	315 to 345 amps

(*d*) In the event of generator failure, load must be reduced to within the clearance of the generators:

(i) Pre generator Mod. A.175, if one generator fails, the remaining generators may be run above the 100 amp clearance but within the 135 amp clearance. If two or three generators fail. the remaining ones should not be run above the 100 amp clearance.

(ii) Post generator Mod. A.175, generators should always be kept within the 150 amp clearance.

(*e*) The following table gives a guide to the action to be taken following generator failure (resetting action having been taken unsuccessfully), but it is emphasised that it is only a guide. The total continuous loads vary so much between aircraft and in various conditions that it is not possible to lay down a rigid drill.

Condition	*B1*	*B/PR 1 in* PR *Role*	*Tanker during transfer*	*RCM Aircraft (not WF214)*
One generator failed	No action	No action	No action	Selected, limited RCM equipments only
Two generators failed	No action	No action	Discontinue transfer. Reel in hose. Close bomb doors	Emergency RCM ON/OFF switch OFF. (No. 1 & 4 type 350 inverters and all RCM equipments OFF with this switch.) Royal Inverter OFF. No. 4 rotary transformer OFF
Three generators failed	No. 1 & 2 rotary transformers OFF. Underwing tank fuel pumps OFF. Shed NBC & H2S No. 1 type 350 inverter OFF. Power controls to ½ rate	No. 1 & 2 rotary transformers OFF. Underwing tank fuel pumps OFF. Shed NBC & H2S No. 1 type 350 inverter OFF. Power controls to ½ rate. Cameras OFF	No. 1 & 2 rotary transformers OFF. Discontinue transfer. HDU OFF. Jettison hose. Close bomb doors. Underwing tank fuel pumps OFF. Shed NBC & H2S No. 1 type 350 inverter OFF. Power controls to ½ rate.	Emergency RCM ON/OFF switch OFF. Royal Inverter OFF. No. 1, 2 & 4 rotary transformers OFF. Underwing tank fuel pumps OFF. Power controls to ½ rate.

NOTE: In the two or three generator failure condition it is recommended that the undercarriage be lowered on the emergency system to keep the temporary overload on the remaining generator as low as possible. (Attention is drawn to Part III, para. 24(*a*)(ii).

(*f*) The following tables gives an indication of the average load taken by various electrical services.

Service	*Amps*
Underwing tank pumps	40 each
Power controls	50
Night role cameras	22 (PR only)
Day role cameras	19 (PR only)
No. 1 radar inverter	45
No. 2 radar inverter	35
No. 3 radar inverter	10
Green Satin	14
H2S	10
Windscreen wipers	11
HF Trans./Rec.	15
Ration heaters	5
Fuel booster pumps	3 each

NOTE: All the above loads show the effect on the generators, not on the rotary transformers.

(*g*) Mod. 2454 introduces ammeters for the generators and rotary transformers on the radio crate. Prior to this Mod. the generator load shedding will have to be estimated.

14 Action in the event of total generator failure

(*a*) *Indication of failure*

The indications of total generator failure will be:

(i) Illumination of all four generator warning lights.

(ii) Post-Mod. 2454, all four generator ammeters reading zero.

(iii) Post-Mod. 2650, the 96-volt battery ammeters showing a discharge equivalent to the 112-volt loads.

(*b*) (i) The 96-volt battery reading *must* be carefully monitored at the moment of failure. If the battery voltage falls very rapidly, and Post-Mod. 2650 the battery ammeter shows a maximum

discharge, the fault is not a four generator failure but an earth on the 96-volt busbar. This fault is much more serious than a four generator failure. The drills set out in para. 16 will apply.

(ii) The battery ammeters fitted by Mod. 2650, although having a small scale can be used to cross check on the calculated battery loads to within ±5 amps after load shedding has been completed.

(*c*) *Immediate actions*

Reset action must be taken without delay as in Part V, para. 13. If this is unsuccessful, the following actions should be taken.

(*d*) The essential object is to conserve battery power, especially the 24-volt battery, as this battery will limit the duration of flight. The following actions should be taken as quickly as possible.

1 Immediate reversion to manual control and power control motors switched OFF.

2 Underwing tank fuel pumps and fuselage fuel pumps OFF. Use one wing fuel pump (preferably No. 2) on each side only. If fuel will gravity feed then all pumps OFF.

3 Simultaneously with 1 and 2 the AEO will switch all type 350 inverters OFF, type 153 inverter OFF, all rotary transformers OFF. (NBC OFF, H2S OFF.) (Note that oil pressure gauges and Mk. 4B compass will be inoperative.)

4 If at night use emergency lighting and switch OFF all navigation lights. (Emergency battery should last at least 3 hours.)

5 Starboard pitot head heater OFF ; port pitot head heater ON when in cloud and air temperature is below 0°C, otherwise OFF.

6 Artificial feel disengaged. Post Command Mod. Valiant 61 artificial feel unit heater switches OFF.

7 Bomb bay heating must be ON.

8 *Tanker aircraft during transfer*, additionally:

Discontinue transfer
Switch OFF HDU
Jettison hose
Close bomb doors

9 *RCM aircraft* (not WP214) additionally:

Switch emergency RCM ON/OFF switch OFF (Ensure No. 1 & 4 type 350 inverters OFF with switch)
Switch Royal inverter OFF
Ensure all RCM loads are OFF with emergency switch

(*e*) *Subsequent actions*

Subsequent actions and use of the remaining battery power will depend on the circumstances prevailing. It is not possible to provide hard and fast drills for all conditions, but the following cases are given to help pilots to make their decisions according to circumstances.

(i) *Failure within easy reach of airfields* (100 miles).

The aircraft should be landed at the nearest airfield. The following drill is given for guidance:

1 Lower the undercarriage on the emergency motor.

2 Commence descent without using airbrakes.

3 Jettison underwing fuel if carried.

4 TPI to be used only when absolutely necessary.

5 STR18 to be used for distress message then switched OFF (circuit breaker tripped).

6 If artificial horizons not required 100A inverter switched OFF by removing fuse D90. (To reselect the 100A inverter it is necessary to replace fuse D90 then remove and replace fuse D91).

7 VHF to be used for distress message and vital transmissions only ; only the required set to be switched ON, otherwise OFF.

8 Manual trimmers to be used only when absolutely necessary.

9 Flowmeters to bypass.

10 In the circuit, one fuselage fuel pump ON each side (if all have been switched OFF). Flaps may be used at the captain's discretion, bearing in mind runway length and the state of the batteries. If used they should not be lowered to more than 40° and the main motor should be used. Flaps must not be lowered until landing is certain owing to the hazard to rear crew escape (see Part V, para. 19).

NOTE 1: *The battery readings must be monitored continually*. The 24-v battery will be the limiting factor and under certain circumstances it may be possible to relieve the load of the 24-volt battery by switching ON one rotary transformer. This action will rapidly exhaust the 96-volt battery and should only be adopted when absolutely essential.

NOTE 2: If in good condition the batteries should last approximately 1 hour if the above drills are complied with. This time, however, cannot be relied on; battery voltage should constantly be checked and when 24-volt battery and 96-volt battery voltages fall to 20 and 80 respectively, operation of any service should be not relied on. The 24-volt battery life will be considerably prolonged by adopting the methods suggested in para 14 (f). Under certain flight conditions, the batteries may be switched OFF, to extend their life. If a landing can be made within the hour, depending on the state of the batteries, the ILS may be used to assist the approach.

(ii) *Failure in adverse weather conditions*

The considerations in (i) above apply also to this case, but with the added problem of the availability of the ILS and/or other navigation and landing aids. The most economical method of using the remaining electrical supplies for navigational aids is to use the VHF for " Steers." In adverse weather conditions the 100A inverter will have to be ON for the artificial horizons, this load can however be reduced by removing fuses 8 and 15 Post-Mod. 988, or fuses 41 and 44 Pre-Mod. 988, from the radar AC/DC distribution box (the removal of these fuses will switch OFF the starboard artificial horizon). Depending on the 24-volt battery state the ILS may be used for the approach. Pilots should consider abandoning the aircraft rather than risk the failure of instruments and aids at a critical phase in an instrument landing. When the battery voltage has fallen to 20v the operation of any service cannot be relied upon.

(iii) *Failure far from an airfield*

If total generator failure occurs a considerable flying time from an airfield, the problem becomes one of the CG control. Assuming that distress calls have been made, the undercarriage has *not* been lowered, and that the minimum current is being used, all available battery power will have to be used for the fuel pumps to keep the CG from moving so far as to make the aircraft uncontrollable. When battery power fails, there will be no means of controlling the CG or of trimming against it. The aircraft can be flown with the CG a considerable way outside the limits, but control for landing is marginal with the CG even a short way outside the limits. Fuel flow from the various tanks, without any pumps running, is unpredictable, but it is expected usually to result in an aft CG travel. The best thing to do in these circumstances is to keep one fuel pump only on each side running to maintain fuel supply and to control the C of G. The reserve tank cocks must be left closed and wing No. 2 pumps and transfer tank pumps selected on as necessary. This will keep the C of G well forward and allow a good period of flight after battery power fails.

(f) Conserving the batteries

(i) After all switched loads and all radio and radar loads have been shed during the initial load shedding action, certain loads remain on the 24-volt battery. These are unswitched loads and are on whenever the 24-volt battery switch and the instrument master switch are ON. The following table gives these loads and the methods of shedding them. By shedding these loads the 24-volt battery life can be appreciably extended.

Service	*Load in Amps*	*Method of removing loads from the 24-v battery*
Sextant	0·65	Remove plug
Mk 4B compass (DC supply)	0·35	Remove fuse 38 on AC/DC distribution box
Outside air temp . .	0·05	Remove fuse G51
Power control failure warning lights . . .	0·4	Remove fuses E40 to E43
Generator and rotary transformer warning lights .	0·8	Remove bulbs
Differential pressure switch (cabin pressurising) .	0·35	Remove fuse D24
TPI changeover relay .	0·15	Select TPI to 'coarse'
Instrument circuit - breaker without 100A . .	4·5	It is not recommended that this is switched OFF
100A inverter . . .	11·5	Remove fuse D90 (to switch on when required, replace fuse D90 then remove and replace fuse D91)
Intercomm . . .	1·5	Switch OFF
Artificial feel unit heaters .	6·0	See para 14 (d) 6
Unswitched and uncontrolled loads . .	0·8	Not possible to remove power
Total . .	27·05	

(ii) Various intermittent loads will be applied to the battery during the operation of manual trim actuators, fuel cocks and 96-volt service selections. These loads should not affect the battery to any great extent.

(iii) If it is possible to dispense with the 100A inverter, the battery life will be extended as this is the biggest continual load on the battery. It may be practicable to switch OFF the intercomm; the crew can then communicate by voice after helmet removal. It will normally be possible to shed most of the other loads by the methods suggested in the table, e.g. it is pointless wasting power to illuminate failure indicators in generator, rotary transformers and power control motors after they are known to have failed or have been switched OFF.

(iv) When flight conditions permit, the 24-volt battery can be switched OFF. In this condition there will be no instruments or indicators except the pressure instruments, the rpm gauges, jet pipe temperature gauges and the magnetic compass.

15 Action in the event of rotary transformer failure

(*a*) It is assumed that in the event of 1, 2 or 3 rotary transformers failing, RESET action is immediately taken without result.

(*b*) One rotary transformer failed—no action except RCM aircraft ; shed selected RCM loads where necessary.

(*c*) Two rotary transformers failed:

(i) *B1 aircraft*—no action.

(ii) *B/PR1 aircraft in PR role*—cameras OFF otherwise no action.

(iii) *Tanker aircraft during transfer*—discontinue transfer, reel in hose, close bomb doors.

(iv) *RCM aircraft* (not WP214)—RCM emergency ON/OFF switch OFF, ensure all RCM equipments OFF. Royal inverter OFF.

(*d*) Three rotary transformers failed, indicated by:

(i) Three warning lights on.

(ii) Post-Mod. 2454, rotary transformer ammeters reading zero.

(iii) Post-Mod. 2650, 24-volt battery ammeter showing a discharge equivalent to the 28-volt loads.

The 24-volt battery reading *must* be carefully monitored immediately the failure occurs. If the battery voltage falls very rapidly, and post-Mod. 2650 the battery ammeter shows a maximum discharge, the fault is not rotary transformer failure but the very much more serious 24-volt bus-bar short to earth. As soon as the rotary transformer failure is established, apply the drills as recommended in para. 14, except that one generator should be left ON and the

power control motors are only reduced to half rate. As in the case of a total generator failure, the 24-volt battery will limit the flight and the same remarks apply in regard to duration.

16 96-volt bus-bar short to earth

(*a*) The indications of a 96-volt bus-bar short to earth are:

(i) 96-volt bus-bar voltmeter showing sudden fall, post-Mod. 2454 generator ammeters showing excess current, and post-Mod. 2650 battery ammeter showing maximum discharge. Note that the generator warning lights *may not* come on.

(ii) Type 350 inverter serviceability lights out.

(iii) Power control motors and all other 112-volt services failing.

(*b*) The 24-volt battery will have to be immediately relieved of all possible loads as detailed in para 14. The aircraft will be controllable only as long as the 24-volt battery will support the manual trimmer load, the fuel will gravity feed and the C of G remains in limits. If an airfield is immediately available the aircraft is committed to a manual, wheels up, flapless landing, otherwise the aircraft must be abandoned.

17 24-volt bus-bar short to earth

(*a*) The indications of 24-volt bus-bar short to earth are:

(i) All services will fail except those switched by latched contactors, e.g. power control motors and inverters.

(ii) No rotary transformer or generator warning lights (generators will be OFF line because there will be no power to maintain main circuit-breakers closed).

(iii) 24-volt bus-bar voltmeter showing sudden fall, post-Mod. 2454 rotary transformer ammeter showing excess current, and post-Mod. 2650 battery ammeter showing maximum discharge.

(iv) No intercomm or W/T or VHF for distress calls.

(v) At night, all lights out.

(vi) Pressure instruments, JPT gauges, RPM gauges and magnetic compass only.

(*b*) The aircraft will be controllable only as long as:

(i) The 96-volt battery will support the power control motors (it is not possible to conserve power by tripping out power controls, no 24-volt power available).

(ii) The fuel will gravity feed (the fuel pumps will stop as the 24-volt power fails).

(iii) The C of G remains in limits after the power control motors have failed (the power control motors will fail in approx 15 minutes).

(*c*) No landing should be attempted, the crew should bale out as soon as the speed has been reduced.

18 Flight with the canopy and/or door removed

(*a*) Test flights have shown that flight with the canopy and/or the entrance door off with the eye-lid extended is quite practicable at speeds up to 300 knots; further tests to higher speeds will be carried out later. The handling characteristics of the aircraft are unaltered except that the stalling speed may be increased by up to 10 knots.

(*b*) The noise level in the aircraft is extremely high, making VHF communication very difficult above 170 knots and normal intercommunication very difficult above 200 knots. These conditions are alleviated slightly if crash helmets are worn.

(*c*) Airflow conditions in the cabin do not become uncomfortable, but when the canopy is off there is considerable forward flow of air between the pilots' seats, particularly when the door is off also, and this becomes turbulent with increase in speed. At 300 knots considerable buffeting behind the pilots' heads is felt which may be severe enough to cause loss of vision.

(*d*) At all speeds the ejection seat blind handles can easily be reached by the pilots and conditions in the cabin allow any movement by crew members to be made without difficulty.

(e) *Cabin altitude*

Tests indicate that a negative differential pressure exists within the cabin when flying with the door off. Relative altitudes are as follows:

Aircraft altitude	*Speed*	*Cabin altitude*
45,000 feet	0·85 M	50,000 feet
47,000 feet	160 knots	50,000 feet
35,000 feet	0·85 M	40,000 feet
38,000 feet	160 knots	40,000 feet

In view of the limitations on oxygen equipment it is recommended that, when circumstances permit, the cabin door should not be jettisoned at altitudes greater than those which give a cabin altitude of 50,000 feet. The oxygen limitations permit one minute at 50,000 feet, and a descent should be made at once. 40,000 feet (cabin altitude) should be reached within 2 minutes of the cabin pressure loss. To allow for the scatter of test results, a reduction of 2,000 feet should be made to the aircraft altitude figures quoted above.

19 Abandoning the aircraft

(a) *General*

(i) Before an attempt is made to abandon the aircraft, the cabin pressure must be reduced by operating the emergency depressurising cock above the radio crate. In addition, circumstances permitting, the 1st pilot should operate the emergency depressurising switch on the port console panel and the 2nd pilot should select the cabin pressure control to NO PRESSURE.

NOTE: As the emergency depressurising cock is above the radio crate, it is unlikely that the crew will be able to operate it above $2\frac{1}{2}$ G.

(ii) The entrance door should be jettisoned by the AEO (i.e. nearest the door) who must remain strapped in until jettisoning is complete (see Part I, para. 91). Tests indicate that the door will jettison satisfactorily at speeds up to 300 knots ; the flaps should be up.

Fig. 1 Rear crew abandoning posture

(*b*) *Abandoning—Rear crew members*

(i) The rear crew members should bale out in the following order:

1 AEO (nearest door)

2 Navigator plotter (centre seat)

3 Navigator radar (farthest from door)

NOTE 1: If the occasional seat is occupied, the occupant should bale out third, i.e. between the Nav. plotter and the Nav. radar.

NOTE 2: In aircraft fitted with ARI 5910, the occasional seat is near the door. The occupant should remain strapped in until the door has been jettisoned, and should then bale out after the AEO.

(ii) After the door has been jettisoned, each man, in the above order, should leave his seat, the first two moving their seats *fully aft* against the radio crate table and locking them there. The emergency oxygen bottle manual release must be pulled immediately before disconnecting the mask tube.

(iii) If static lines are fitted (see Part I, para. 93 (*c*)), each man, as he comes to the door to escape, should grasp one static line ring and attach it to the parachute barostat release hook. The static lines should be taken by the crew members in the order shown in Part I, Fig. 26. The behaviour of a static line after use is unpredictable, and as it might flail and present a hazard to the second and subsequent crew member it is recommended that if time permits, each line, after use, should be pulled into the cabin and stowed aft between the port seat and the side of the aircraft by the following crew member before making his escape.

(iv) Each man, in turn, should then step on to the eyelid platform, facing outward and parallel to the eyelid, and crouch down adopting as compact ("balled up") a position as possible (see Fig. 1). The head must be down, the arms around the shins, and hands grasping the surplus material of the overall legs (see (vi) 3 below), or the hands interlocked, so as to ensure maintenance of this posture when exposed to the airflow. Exit should then be made by rolling forward, and every endeavour must be made to remain "balled up" for two or three seconds until well clear of the aircraft. The last man out should tap the pilot immediately before making his escape.

(v) Tests have shown that underwing clearance is good provided that the flaps are up, and that there is little danger of striking the undercarriage if this is down. Fuselage clearance, however, is marginal, but should be adequate if the recommended compact posture is maintained. Tests were made at speeds up to 360 knots straight and level, and with maximum permissible starboard side-slip. In the latter condition there was an improvement in fuselage clearance.

(vi) The chances of avoiding injury in escape are considerably increased if the following points are observed.

1 The protective helmet must be a good fit and the chin-strap secure and *tight*.

2 The oxygen mask must be securely and tightly fastened, or, if fitted with toggle harness this must be in the emergency position.

3 The flying overalls should be worn outside the flying boots (see (iv) above).

4 The dinghy pack should be removed unless required; if retained it must be correctly and securely fitted. The type C is almost certain to be lost, but the type S, which is replacing the type C, should remain attached if correctly and securely fitted.

(vii) *Limitations*

Tests have shown that successful escape from the aircraft is possible in straight and level flight at speeds up to 360 knots, and with small amounts of starboard sideslip. However, at speeds above 270 knots there is increased possibility of injury, and of loss of the protective helmet, type S survival pack and life-jacket equipment. Every endeavour should be made to

reduce speed to below 270 knots and if possible, to the optimum speed range of 180-220 knots. The bomb-doors should be closed and the flaps should be up. If possible the undercarriage should be retracted although escape is possible with the undercarriage locked down. Whenever possible there should be no yaw, bank or applied G. The prone position cannot normally be vacated at more than $1\frac{3}{4}$G, and the rear crew seats cannot normally be vacated at more than $2\frac{1}{2}$G.

(*c*) *Abandoning aircraft at low altitude*

Should it be necessary to abandon the aircraft at low altitude (below 1,000 ft.), reduction of the time interval between the moment at which the order to abandon aircraft is given and the moment at which the parachute is deployed can be of overriding importance, and the following points should be borne in mind.

(i) Whilst it is highly desirable to connect a static line, time should not be wasted if this proves troublesome.

(ii) The static line arms the parachute barostat, which then withdraws the pack pins after a delay of 2 seconds. Therefore, irrespective of whether the static line is connected or not, the manual override should always be pulled as soon as possible after abandoning the aircraft below 1,000 feet.

(*d*) *Abandoning—Pilots*

NOTE: When seat-mounted emergency oxygen bottles are fitted, they remain with the seat after separation occurs at or below 10,000 feet.

(i) When time permits, the canopy should not be jettisoned until the rear crew members have baled out, otherwise their difficulties may be considerably increased. When the pilots are ready to eject:

1 The second pilot must operate his canopy jettison lever (this will also disconnect and throw forward the 2nd pilot's handwheel) and then fire his ejection seat, using the main firing handle if possible, or the alternative firing handle.

2 The first pilot must then operate his canopy jettison lever (to disconnect and throw forward the 1st pilot's handwheel) and then fire his ejection seat, using the main firing handle if possible, or the alternative firing handle.

WARNING: Operation of the alternative firing handle without first jettisoning the canopy will have fatal results.

(ii) *Limitations*

1 The limitations for minimum safe height for ejection are indicated on a small plate attached to each ejection seat. Without a G-stop fitted the minimum height for ejection is 100 feet. With a G-stop fitted the seats have a ground level ejection capability provided that the speed is 90 knots or above, and the flight path is parallel to the ground. If the aircraft is descending the minimum height for safe ejection must be increased.

2 The optimum speed for ejection is 200 knots, but there is no IAS limitation for ejection other than that mentioned at 1 above. However, successful canopy jettison trials have only been carried out at speeds between 150 and 300 knots.

Unless unavoidable the ejection seat should not be used when the aircraft is inverted. The canopy must always be jettisoned before ejection, as the chances of surviving an attempt to eject through it are nil. (When Mod 1018 is embodied it is not possible to eject until the canopy is off). There is also a risk of severe injury if the control hand-wheels are not disconnected and thrown forward before ejection (see Part I, para 96). If it is necessary to use the parachute manual override, the parachute should not be opened above 20,000 feet.

20 Ditching

(*a*) Although the ditching characteristics are rather poor, model tests indicate that the aircraft can be ditched safely under certain conditions.

(*b*) The behaviour of the aircraft on ditching is dependent on the position of the bomb doors, air spoilers and flaps. It is also dependent on the touch-down attitude and rate of sink. The following table shows the probable behaviour under various conditions:

Configuration	*Flaps*	*Landing attitude*
Bomb doors closed Air spoilers in	Up	Safe below 9°
	55°	Safe below 6°
Bomb doors closed Air spoilers out	0° to 55°	Safe below 10°
Bomb doors open Air spoilers in	0° to 55°	Catastrophic dive at any attitude
Bomb doors open Air spoilers out	0° to 55°	Safe below 9°

From this it will be seen that while it is advisable to have the bomb doors closed, it is really the air spoilers which have the greatest effect on the behaviour. Except in the clean condition (bomb doors closed and air spoilers in) the flaps have little or no effect. The best chance appears to be with bomb doors closed and air spoilers out. The undercarriage, of course, must be left retracted. The approach should be made at not more than nine degrees nose-up, every endeavour being made to keep the landing shock as light as possible by keeping the rate of sink low.

(*c*) An angle of yaw of up to five degrees has no effect, but the angle of roll must not exceed three degrees otherwise the lower wing-tip may bury, causing the aircraft to ground loop.

(*d*) Landing in waves, especially in a well-defined swell, should be made along the wave crests. If the landing is made across the waves there appears to be a strong likelihood of the nose burying, with consequent violent deceleration.

(*e*) Whatever the conditions, only the upper ditching hatch should be removed and stowed prior to ditching. When the aircraft has come to rest, a crew member should be ready to pull the dinghy release handle. The crew members and pilots should make their escape through the ditching exit. The entrance door and the crash landing exit on the starboard side must not be jettisoned or opened. The canopy may be jettisoned if desired, but not until the aircraft has almost come to rest. When the canopy explosive bolts have fired the canopy will not leave the aircraft owing to the absence of air flow, and it will have to be lifted off by the pilots. Provided all bolts have fired this is quite straightforward, but the canopy is heavy.

(*f*) No information is available about the flotation qualities of the aircraft, but if the ditching has been clean and no major break-up has occurred, there should be adequate time for successful escape.

21 Use of aircraft destructors

The following drill should be used for applying and firing the aircraft destructors.

(*a*) All except two of the crew members should evacuate the aircraft and take cover.

(*b*) The two remaining crew members remove the sextant dome, and one member climbs out on to top of fuselage.

(*c*) Second crew member stands on chart table, unseals and opens destructor containers, passes destructors out to other crew members and then climbs out on to top of fuselage.

(*d*) Each crew member moistens the destructor suction cup and applies the destructor in the selected position (see Part I, para. 134). Retaining a grip on the flyoff levers, the crew members remove the transit and primary safety pins and then, at a pre-arranged signal, release the fly-over levers.

(*e*) Both crew members leave the aircraft as quickly as possible and take cover. If a wing-tip is on the ground the wing can be used as a walkway ; otherwise, the pitot head can be used to help the crew swing down to the ground.

(*f*) A built-in time delay allows about 60 seconds between releasing the fly-off levers and the firing of the destructors.