Part I

Chapter 4—Hydraulic System and Aircraft Controls

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Description

1 General

(*a*) Hydraulic power, supplied by two electrically-driven pumps operates the following services:

Undercarriage
Nosewheel steering
Wheelbrakes
Main flaps
Airbrakes
Nose flaps (pre-Mod. 2352)
Bomb-doors

(*b*) The hydraulic fluid is drawn from a tank, divided into two equal halves, each half of which feeds one pump. The pressure output from each pump (4000 PSI) is fed to two electrically-operated selectors, the normal master and the emergency master. With a serviceable system the normal master selector is open and supplies the individual circuits, each having its own selector.

(*c*) The emergency Master Selector is normally closed but is opened under emergency conditions and feeds pressure through pipelines independent of the normal system, to selectors for the emergency operation of

Undercarriage	DOWN
Main flaps	DOWN
Airbrakes	CLOSED
Bomb-doors	OPEN and CLOSE

(*d*) The electrical arrangement of the Master Selector is such that when an emergency selection is originated the normal Master Selector closes and the emergency master opens. If the Emergency Selection is due to an individual circuit fault the master selectors revert to their normal settings after the affected circuit has been operated, but if the emergency is due to loss of hydraulic fluid, all systems have to be operated on emergency.

2 Hydraulic reservoir

(*a*) The hydraulic tank is at the rear of the nosewheel bay together with the hydraulic pumps. The contents of the tank when at the normal level with the system fully charged are 15½ gallons. The emergency level of the tank is 9½ gallons (4¾ gallons per side).

(*b*) A float switch in each half of the tank operates when the fluid level in the respective compartment has fallen to 4¾ gallons and switches off the associated pump. Additionally warning lights at the AEO's station come on to indicate that the float switches have operated.

3 Accumulators

Accumulators are fitted in the main power circuit (one per pump) and in the wheelbrakes and nose-flap systems. Charging details are as follows:

Accumulator	*No. off*	*Location of gauges and inflation valves*	*Air charge pressure* PSI	
Power	2	Nose-wheel bay	3,000	
Wheelbrakes	4	Nose-wheel bay	2,000	
			°C OAT	± 25 PSI
Nose flaps	8	Access panels beneath nose flaps	−40	1,270
			−20	1,380
			0	1,490
			+20	1,600
			+40	1,710
			+70	1,870

Controls and Indicators

4 Hydraulic pump controls—pre-Mod. 2866

(*a*) Each of the two electrically-driven pumps draws its supply from its associated hydraulic tank compartment. Each pump is controlled by a manual switch. No. 1 pump switch is a three-position AUTO/OFF/ON type; No. 2 pump switch is a four-position GROUND TEST/AUTO/OFF/ON type. Both switches are situated in the crew compartment at the AEO's station on panel BB.

(*b*) With both switches at AUTO, during flight the pumps switch on and off according to the position of the hydraulically-operated services.

If all services are in the flight position, i.e.:

Undercarriage	UP
Nose flaps	IN and accumulators fully charged
Main flaps	UP
Airbrakes	IN
Bomb-doors	CLOSED

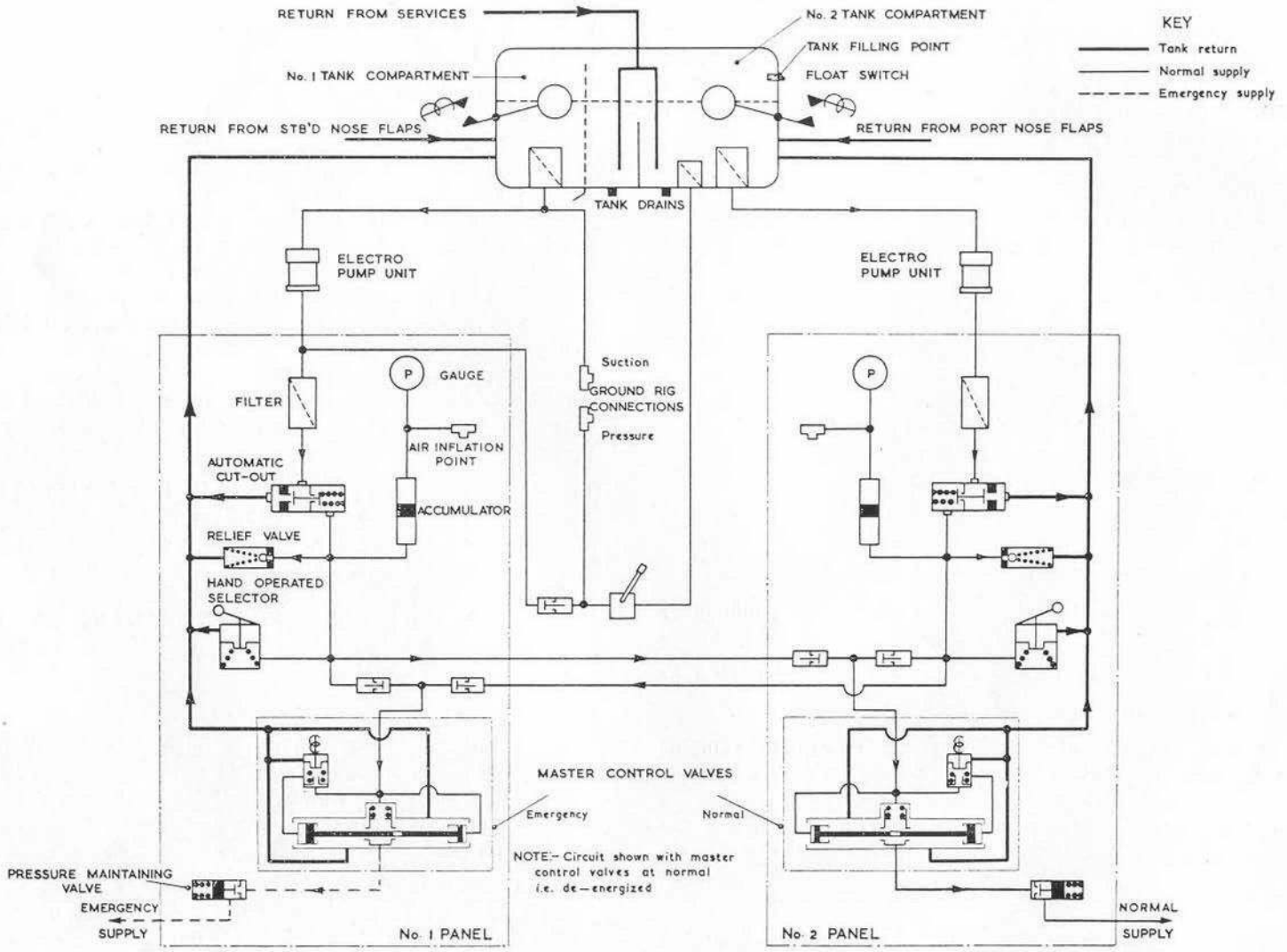

Fig. 1 Hydraulic power supplies

the pumps do not run. If any service is not in the position mentioned above both pumps run but when the pressure reaches 4,000 $\pm^{50}_{0}$ PSI the pumps are off-loaded until the pressure falls again to 3,600 $\pm^{100}_{0}$ PSI. Once all services are in the flight position again the pumps are automatically switched off.

(*c*) With both pump switches set to ON the pumps run continuously irrespective of the position of any of the services. The pumps run on and off load according to line pressure. With the switches in this position, the pumps are not switched off if the fluid level in the tanks falls.

(*d*) The GROUND TEST position permits the testing of No. 2 pump simultaneously with No. 1 pump. If this position is not selected only No. 1 pump runs when a ground servicing truck is plugged in, thus ensuring that the ground generating equipment is not overloaded. If both switches are at AUTO when the electrical supply is plugged in, both pumps run.

5 Hydraulic pump controls, post-Mod. 2866

(*a*) When Mod. 2866 is embodied the pumps run continuously when selected to ON or AUTO. The effect of loss of hydraulic fluid and emergency selections remains as detailed in para. 6(*a*).

(*b*) Essential to Mod. 2866 is Mod. 2348 which introduces an ammeter at the AEO's station, for each pump to measure the current in the pump motor earth lines. Additionally Bomber Command Mod. 28 provides, a green pump running light for each pump, on panel BB; their indication is that the pumps have been switched on and their main contactors are closed. They do not indicate that the pumps are actually running.

(*c*) The brake pressure gauges indicate the system pressure when this exceeds brake accumulator pressure.

6 Emergency operation of the system with the pumps at AUTO

(*a*) A failure causing loss of fluid from one power panel will cause the fluid level to drop in the tank compartment feeding that panel. When the level in that compartment, drops to the $4\frac{3}{4}$ gallons (emergency level), the compartment float switch will operate and stop the associated pump feeding the faulty panel. Hydraulic power supply will then be maintained by the other power panel, still feeding normal service lines via the normal power circuit selector. Services operation will, however, be at a reduced speed as only one pump is effective. If services continue to be selected with the power circuit in this condition, half of the return fluid will flow into the failed circuit compartment. This flow will cause intermittent operation of the float switch, allowing the pump to run and causing further loss of fluid. As a result, fluid level in the other compartment will drop until the $4\frac{3}{4}$ gallon emergency level is reached.

(*b*) When the other compartment fluid level reaches the $4\frac{3}{4}$ gallon level as in the above condition, associated float switch will operate and stop the remaining pump. Immediately the second float switch operates, the solenoids on the power circuit selectors are energised, closing the normal selector and opening the emergency selector. Simultaneously the EMERGENCY HYDRAULIC WARNING light on Panel AZ is illuminated. Any service selections must now be emergency selections.

(*c*) (i) On making an emergency selection with this condition, the pumps will commence running. It is possible that the failed panel will pump its remaining fluid to waste, consequently the serviceable panel only will be supplying fluid from the power circuit via the emergency selector to a selected service.

(ii) If a failure causing loss of fluid is experienced downstream of the power supply circuit, i.e. in a normal service line, the levels of both tank compartments will drop simultaneously. Consequently, both float switches will operate together, energising the power circuit selector solenoids to emergency open,

normal closed, stopping the pumps and illuminating the EMERGENCY HYDRAULIC WARNING light. Any service selections must again be emergency selections but this time, as the fault may be in a normal service line, further fluid loss may not occur.

(iii) If an emergency selection is made due to an electrical or a hydraulic fault on a service but with the power supply circuit in a normal state, then the emergency service selection will not only energise the emergency selector for that service but will also energise the power circuit selector solenoids, changing those selectors to emergency open, normal closed for the duration of operation of that service. Upon completion of operation of that service the power circuit solenoid is de-energised and the power circuit returns to normal open, emergency closed. The emergency hydraulic warning light is then extinguished.

NOTE 1: The power supply circuit will not revert to Normal after a bomb-door emergency OPEN selection. With the doors selected open, no normal selections of other services, with the exception of nose-flaps, are available until the bomb-doors have been closed using an emergency selection.

NOTE 2: When airbrakes have been closed using an emergency selection, the 1st Pilot's control lever must be brought out of the emergency gate to the normal closed position before the power supply circuit reverts to normal and the emergency hydraulic warning light goes out.

NOTE 3: The float switch will not switch OFF its associated pump when that pump is switched to ON. Mod. 2529 introduces a warning light for each float switch on panel BB.

NOTE 4: When the undercarriage is selected by emergency selection the pumps will continue to run until the normal down button is pressed.

7 Protection units

(*a*) Protection units are fitted in the normal supply lines to the selectors of the following services:

Undercarriage
Bomb-doors
Main flaps
Airbrakes

The purpose of a unit is to isolate the normal supply to the circuit and provide an alternative path for the return fluid.

(*b*) Normally pressure fluid has an unrestricted path through the protection unit to the selector, but when an emergency selection is made emergency circuit pressure is connected to the piston of the associated protection unit to close the normal supply line. Once a protection unit has been operated, normal selection of its associated service cannot be made again in flight since the units must be manually reset and are inaccessible in flight.

8 Undercarriage control

(*a*) The undercarriage is hydraulically operated and electrically selected by one of three push-buttons, UP, DOWN and EMERGENCY-DOWN, in the centre of panel A. The buttons are mechanically interlocked, so that when any one button is pressed in, the button left in by a previous selection is released. On Mk. 1 aircraft the buttons are forward on the port console, AE.

(*b*) When the aircraft is on the ground the undercarriage cannot be retracted since the UP button is electro-mechanically locked and cannot be depressed until a pitot-switch operates at 105 knots to release the lock. Although the button can then be depressed, micro-switches on the bogie mechanism prevent the completion of the selection circuit until the weight of the aircraft is off the wheels and the tip hooks are engaged.

NOTE: The electro-mechanical lock can be overridden, for servicing purposes, by *twisting the UP button 60° clockwise.*

(*c*) On Mk. 1A aircraft the brakes are automatically applied when the UP selection circuit is completed and before the retraction cycle commences. To achieve this there is a 3 second delay before fluid is allowed to pass to the undercarriage circuit ; during this three seconds the maxaret spill line is pressurised from the under carriage UP line and the units are cocked, thus applying the brakes.

(*d*) When a DOWN selection is made, the up lines pressure is relieved and the brake units are depressurised and released.

(*e*) A standard position indicator is on panel AZ.

(*f*) Pre-Mod. 2987 the 2nd pilot's ASI incorporates an undercarriage warning device. This consists of a window in the face of the instrument in which a flag marked U/C oscillates if any undercarriage unit is not locked down at speeds below 160 knots.

9 Undercarriage emergency control

(*a*) When an EMERGENCY DOWN selection is made, the pressure supply from the pumps is changed from the normal to the emergency circuit, the protection unit is closed and the emergency selector valve opens to feed fluid to the lowering jacks.

(*b*) When the undercarriage is locked down the pressure supply reverts to normal provided that the float switches have not operated, but further undercarriage selection will not be possible and nosewheel steering will not be available.

(*c*) *Independent emergency lowering nitrogen system*

(i) Mod. 3079 introduces an independent system for emergency lowering of the main and nosewheel undercarriage. The system operates from an independent nitrogen supply and caters for the case of complete hydraulic failure.

(ii) At the rear of the second pilot's seat, facing inboard, is a control unit which incorporates a pressure gauge and a charging point. When the flap at the top of the unit is lifted a lever is revealed. When the lever is pushed fully down a valve is opened which permits nitrogen, stored in a single bottle in the plenum chamber, to pass to the normal undercarriage lowering lines. Once the undercarriage is lowered in this way it cannot be raised again until the system has been ground-serviced.

(iii) The following table lists the nitrogen bottle charging pressures, which are also given on a plate on the control unit.

Temp. °C	−40	−20	0	20	40	70
PSI . .	2,380	2,590	2,800	3,000	3,200	3,510

Tolerances in pressure are ± 25 PSI

10 Wheelbrakes control

(*a*) A maxaret braking system controlled by the rudder pedals is fitted. Four hydraulic accumulators are included in the system to provide a reserve of pressure in an emergency.

(*b*) Two separate pressure supplies feed the inboard and outboard brakes respectively of the port and starboard wheel units. Depression of either pilot's rudder pedals feeds pressure to both the inboard and outboard brakes associated with the rudder pedal which is depressed.

(*c*) (i) When Mod. 2163 (*Not* B.1 aircraft) is embodied the brakes are automatically applied when an undercarriage UP selection is made before the retraction cycle commences. To achieve this there is a 3 second delay before fluid is allowed to pass to the undercarriage circuit ; during this period the maxaret spill line is pressurised from the undercarriage UP line and the units locked, thus applying the brakes.

(ii) When a DOWN selection is made, the up line pressure is relieved and the brake units depressurised and released.

(*d*) Two pressure gauges, one for the inboard brakes and one for the outboard brakes, indicate the supply pressure of 4,000 PSI to the wheelbrakes reducing valves.

(*e*) A hand-operated parking brake is fitted at the forward end of panel AE. A warning light (MK. 1A only) alongside the undercarriage selector switch on panel A comes on whenever the parking brake is applied and either main undercarriage leg is locked down.

(f) Emergency operation

With the hydraulic circuit in EMERGENCY, only accumulator pressure will be available for braking. The brake parachute must always be streamed and maxaretting and unnecessary brake application avoided. The brake pressure gauges should be carefully monitored. When the aircraft has come to rest, no further taxying should be attempted; have the aircraft towed to dispersal.

11 Nosewheel steering

(*a*) The GROUND STEERING MASTER switch and the steering control wheel are on panel AA. Hydraulic pressure to the circuit is only available after the undercarriage has been selected down on the normal system.

(*b*) Nosewheel steering is effected by two opposed steering jacks of which hydraulic pressure is electrically controlled following movement of the handwheel. The handwheel may be operated clockwise or anti-clockwise to give a steering range of approximately 45° in either direction. When the handwheel is stopped and held in any position the nosewheel is held at a similar position giving a constant turning radius.

(*c*) When the handwheel is released a centring spring returns it to neutral at which setting the nosewheel is free to caster.

(*d*) No emergency system is incorporated, i.e. no steering power is available if the undercarriage has been lowered on emergency or if both hydraulic tank float switches have operated.

(*e*) The handwheel may be pulled out from its normal position by up to 3 inches for greater pilot comfort.

(*f*) A ground test switch is on Console AE.

(*g*) Nosewheel steering is inoperative when the aircraft is being towed with an external MV supply connected and when the nosewheel is off the ground.

12 Airbrakes control

(*a*) The airbrakes, which are fitted in the tail cone, are operated by a single hydraulic jack which is electrically controlled by interconnected levers one on each pilot's throttle quadrant, inboard. Control is of the "follow-up" type and airbrake selection is infinitely variable between the OPEN and CLOSE positions. The 1st pilot's lever only has a third (gated) position—EMERGENCY IN.

(*b*) Movement of either lever causes the hydraulic jack to operate. When the selected position is reached electrical supply is terminated and the brakes are then hydraulically locked.

(*c*) Airbrakes movement is shown on an indicator on Panel AZ. A magnetic indicator below shows black with the airbrakes in and white with the airbrakes other than fully in.

13 Airbrakes emergency control

(*a*) The emergency system is for use only to close the airbrakes.

(*b*) When the 1st pilot's selector is set into the EMERGENCY IN gate, the hydraulic system operates in the emergency condition until the airbrake is fully closed. The airbrakes are then inoperative and no further selection can be made. The power circuit will remain in emergency (warning light on) and the airbrakes magnetic indicator will remain at white until the selector lever is returned to CLOSE when the selection is completed.

14 Braking parachute control

(*a*) The SAFE/STREAM switch is on the 1st Pilot's panel AE. When set to STREAM the parachute is ejected. When the switch is returned to SAFE it is jettisoned.

(*b*) Should the parachute stream inadvertently in flight it is automatically jettisoned, provided that the switch is at SAFE.

(*c*) A test switch is on the forward edge of panel AJ.

(*d*) (i) When Mod. 3248 is embodied the doors are unlocked by hydraulic pressure and opened by spring pressure. If hydraulic failure occurs an accumulator provides adequate pressure for unlocking the doors. The system is controlled by two SAFE/STREAM selector switches, one for the normal and one for emergency system, ganged together so that they operate simultaneously, fitted on the 1st pilot's panel AE. (Post Mod. 3925 panel AAP). When they are set to STREAM the parachute is ejected. When they are returned to SAFE the parachute is jettisoned.

(ii) If there is no pressure available from the aircraft's normal hydraulic system, emergency accumulator pressure will stream the parachute.

(iii) Unless there is prior knowledge of hydraulic system failure, there is no indication that the emergency accumulator pressure has been used to stream the parachute.

15 Main flaps control

The three po ition UP/TAKE-OFF/DOWN control switch is on panel A (AE, Mk. 1) together with a gated EMERGENCY Selector switch. A position indicator which indicates the positions of both main flaps, in divisions, is on panel AZ.

16 Main flaps emergency control

When the EM DOWN selector is operated after first raising the locking guard, the hydraulic system is switched to emergency and the main flaps are lowered fully down only; however intermediate positions can be obtained by reselecting OFF when the position indicator shows that the flaps have reached the required position. The flaps cannot subsequently be raised.

17 Nose flaps control

NOTE: Mod. 2352 introduces fixed droop leading edges in lieu of nose flaps to Mk. (K) 1, Mk. 1A and Mk. (K) 1A aircraft. The following paragraph applies only to B Mk. 1 aircraft.

(*a*) *Power supply circuit operation*

(i) With the hydraulic pumps at AUTO, whenever nose flaps move out, pumps commence running and remain running until the nose flaps are moved in.

(ii) A drop in any one nose flap accumulator pressure to 2900 PSI causes the pumps to run, if set to AUTO. Then they recharge that accumulator to 3500 PSI and automatically stop. (Post Mod. 2866 — continuously running pumps — this recharging is indicated by pump ammeters showing pumps working on load.)

(iii) There is no emergency supply of hydraulic fluid to the nose flaps. They are always moved out by their accumulator pressure, and moved in by normal power circuit pressure once the accumulators have been recharged.

(*b*) *Control and indications*

(i) A three position rotary switch (IN-AUTO-OUT) is provided on Panel AC.

(ii) Two magnetic indicators on Panel AZ show positions of inner and outer nose flap sections. They indicate as follows:

Black . Both sections locked in
White . Both sections out
Striped . In any position other than above and when electrical power is lacking

(iii) Two amber lights, on Panel AZ, in circuit with the CL detector system and the accumulator pressure switches.

(*c*) *Nose flaps selected to AUTO*

(i) Whenever main flaps leave the up position, nose flaps automatically move out. When main flaps return to the up position and providing all eight nose flaps accumulators are recharged, nose flaps move back in.

(ii) At speeds below 0·7M, when a high CL condition exists on either wing, all nose flap sections move out. When the CL condition disappears the nose flaps move in.

(iii) At speeds below 0·7M when the pressure in any one nose flap accumulator drops to 2800 PSI all nose flap sections move out and remain out until all accumulators are recharged.

(*d*) *Nose flaps selected to IN*

(i) Nose flaps move out automatically whenever the main flap leaves the up position. Each nose flap section moves in when main flap returns to the up position, providing one of its pair of accumulators is fully charged.

(ii) Other automatic functions of nose flap are cancelled.

(*e*) *Nose flaps selected to OUT*

An OUT selection of nose flaps moves them out providing sufficient pressure exists in the accumulators. This selection must not be made above 0·75M.

(*f*) CL *Warning Lights*

(i) *Nose flaps at AUTO.* CL warning lights illuminate whenever a high CL condition exists and the nose flaps have not moved out. At speeds below 0·7M, only a brief flicker is apparent. Above 0·7M, mach switches prevent the nose flaps moving under high CL conditions. In this case a steady amber is apparent during a a high CL condition.

(ii) *Nose flaps at IN.* A CL condition above 0·7M gives a constant amber indication. Below 0·7M however, not only does amber indicate a high CL condition but also a pressure drop in one or more nose flap accumulators. The pressure dropping to 2800 PSI in any one nose flap accumulator causes its associated CL warning light to illuminate. The forward four accumulator pressure switches are in circuit with the starboard amber, the rear four with the port amber.

(*g*) *Pre-Mod.* 214

British Messier nose flaps have identical control and indications except that there is no automatic out selection of nose flaps with a drop of any one accumulator pressure to 2800 PSI.

NOTE: Because of the pressure switch system, if the aircraft is parked with electrical power ON and nose-flaps selected AUTO, any release of pressure from one of the eight accumulators causes the nose-flaps to move out without warning.

18 Bomb-bay doors control

(*a*) The bomb-bay doors are controlled by a three-position OPEN/AUTO/CLOSE switch on panel AZ. A three-position magnetic indicator is situated adjacent, which shows black when the doors are closed, striped when they are moving or if no electric power is available and OPEN (white) when they are open.

(*b*) If the bomb-bay doors do not open within a predetermined time with the switch set to OPEN, the hydraulic system is automatically switched to emergency and the doors are opened on the emergency circuit.

(*c*) When the switch is at AUTO automatic door opening is achieved on receipt of a signal from the NBC equipment. In addition, when Mod. 930 is embodied the doors can be opened in emergency by a signal from the NBC equipment.

(*d*) The doors can be closed following an OPEN or AUTO open selection by setting the switch to CLOSE.

(*e*) Circuit breakers on panel AJ protect the supply to both the normal and emergency circuits.

19 Bomb-bay doors emergency control

(*a*) Located on panel AC are an EMERGENCY BOMB three-position JETTISON/OFF/EMERGENCY CLOSE switch and a LOWER CARRIERS JETTISON two-position JETTISON/OFF switch.

(*b*) If the EMERGENCY BOMB switch is set to JETTISON the doors are automatically opened and the stores are jettisoned. Following a JETTISON selection, the doors must be closed by an EMERGENCY CLOSE selection.

(*c*) If the bomb doors fail to close, first set the normal selector to CLOSE and then set the EMERGENCY BOMB switch to EMERGENCY CLOSE to set the hydraulic system to emergency and close the doors. If the normal selector is not set to CLOSE, the doors will re-open after 3 seconds.

(*d*) If the bombs hang up on the lower carriers, the carriers can be jettisoned by opening the bomb doors and selecting JETTISON on the LOWER CARRIERS JETTISON switch.

20 Bomb release safety lock

The bomb release safety lock prevents inadvertent weapon release. The lock is controlled by a guarded double pole switch on panel AAF marked LOCK IN/off/LOCK OUT. Two lights are fitted above the switch, one green and one amber. The amber light comes on when the safety lock is released and the green light when the lock is engaged.

Management of the System

21 Hydraulic pump management

(*a*) *Pre-flight functional checks*

Prior to starting the engines, and when an LV AND MV supply is available, check the function of both hydraulic pumps in all selector positions and of all hydraulic services, in accordance with the check list. When changing pump selections a pause of at least 5 seconds should be made at the OFF position. Check that both BRAKE-SUPPLY gauges indicate 4,000 PSI and that the pressure does not fall when both pumps are switched OFF.

(*b*) *Pump selection*

Taxy with one pump selected to AUTO (green pump running light on) and the other pump OFF. Take off with one pump ON and the other pump at AUTO (both pump running lights on). On completion of the after take-off checks, and when all hydraulically-operated controls are retracted, switch one pump (normally No. 1 pump) OFF and leave the other pump selected to AUTO. All flying, except during take-off and landing, should be carried out with one pump selected to AUTO and the other one OFF. It is recommended that the switching on and off of pump motors at altitude should be avoided except in cases of malfunction. Pre-Mod. 2866, with a pump selected to AUTO it will only run when a hydraulically operated control is not fully retracted, or when re-charging of hydraulic accumulators on the main hydraulic system is necessary. The green PUMP RUNNING light will indicate when the pump is switched on. Post-Mods. 2866 and 2348, a pump will run continuously when selected to AUTO and variations in the pump ammeter indications will indicate whether the pump is running on or off load. During the checks before landing switch both pumps to AUTO and maintain these selections throughout roller landings and overshoots. Before final landing select one pump ON and the other to AUTO.

(*c*) A pump should not be switched to ON or AUTO within 5 seconds of switching it OFF.

22 Approximate times of operation for hydraulic services

Service	*Time of Operation (seconds)*			
Undercarriage	Up to down	12–16	Down to up	12–16
Nose-flaps	In to out	0·7–1	Out to in	12–15
Main-flaps	Up to take-off	14–16	Take-off to up	14–15
	Take-off to Down	4½–5	Down to take-off	3½–4
	Up to down	18–20	Down to up	17–18
Airbrakes	Close to open	4–5	Open to close	2–3
Bomb-doors	Close to open	3–4	Open to close	6–8

NOTE 1: The above times are valid when both hydraulic pumps are in operation. When only one hydraulic pump is in operation the times may be increased by up to 100%.

NOTE 2: The undercarriage lowers and retracts in flight in approximately 7 seconds but the times stated above include the period of time for the doors to close and the jack to lock.

Malfunctioning of the System

23 Pump failure

If a hydraulic pump fails, the sortie should be abandoned except in operational conditions. If possible reduce height before switching the other pump to AUTO and lower the undercarriage and flaps as soon as possible.

24 Overloading of pump motors

If the steady indication on a pump motor ammeter exceeds 60 amps the pump should be switched OFF. Intermittent peaking up to 100 amps may normally be expected.

25 Excessive cut-in rate

If, during flight, the cut-in rate of a pump motor increases to more than once per 30 seconds switch OFF the pump and use only when required.

26 Overheating of pump motors

If a pump ammeter reading is beyond the white sector (i.e. exceeds 45 amps) when the pump is idling, overheating should be suspected. Switch OFF the pump as soon as possible.

27 Loss of hydraulic fluid (float switch operation)

(*a*) If a hydraulic leak occurs causing loss of fluid in one system, the float switch in the appropriate hydraulic tank compartment will operate when the fluid level in that compartment reaches 4.75 gallons. This will automatically switch off the associated pump motor if it is selected to AUTO, and Post-Mod. 2529, will illuminate the associated HYDRAULIC WARNING light at panel BB. If the pump motor is selected to ON it will continue to run and must be switched OFF manually. Approximately 2·5 gallons of fluid will be available in the other tank compartment to allow normal operation of services. However, during operation of services return fluid will be divided between the tank compartments allowing further loss of fluid, and when the second tank compartments contents fall to 4·75 gallons the second float switch will operate. The second pump motor will automatically be switched off (if it is selected to AUTO) and the second HYDRAULIC WARNING light at panel BB will illuminate. At the same time the EMERGENCY HYDRAULIC warning light at panel AZ will illuminate indicating that the Normal Master Selector has closed and the Emergency Master Selector has opened.

(*b*) If a hydraulic leak occurs downstream of the Normal Master Selector both tank float switches will operate and the EMERGENCY HYDRAULIC warning light and both HYDRAULIC WARNING lights (if fitted) will illuminate simultaneously.

(*c*) If the Emergency Master Selector has opened, the pump motors will only run when an Emergency service selection is made with the pump motors selected to AUTO, or if the pump motors are selected to ON. The following Emergency selections only can be made:—

Undercarriage	EMERGENCY DOWN
Main Flaps	EMERGENCY DOWN
Nose Flaps	OUT
Airbrakes	EMERGENCY CLOSE
Bomb Doors	OPEN or JETTISON, EMERGENCY CLOSE (open and close once only to avoid excessive loss of fluid)

(*d*) (i) The order of service selection will be at the captain's discretion but normally the undercarriage should be lowered as soon as possible.

(ii) Operation of the nose flaps will use the fluid in the nose flap accumulators.

(iii) Whilst the main flaps emergency selector has only NORMAL and EMERGENCY DOWN selection positions, intermediate flap positions may be obtained by selecting EMERGENCY DOWN and then cancelling the selection by selecting NORMAL when the flap position indicator shows that the required position has been reached.

(iv) If bomb door operation is necessary it is essential to check that the normal bomb selector is at CLOSE before selecting EMERGENCY CLOSE. Failure to do so will cause automatic re-cycling of the bomb doors with consequent loss of hydraulic fluid.

(v) When an Emergency selection of any service, except undercarriage EMERGENCY DOWN, is completed, the pump motors will be switched off automatically provided that they are selected to AUTO. However, following completion of an undercarriage EMERGENCY DOWN selection the pump motors will continue to run until they are selected OFF. As the undercarriage will normally be the first service to be operated in the emergency condition, the pump motors must be switched OFF on completion of each Emergency selection to avoid unnecessary loss of fluid. After the emergency retraction of airbrakes return the selector lever to NORMAL CLOSE to obtain correct indication of the magnetic indicator (see para. 13(*b*)).

(*e*) Nosewheel steering will not be available and only accumulator pressure will be available for operation of the wheelbrakes. This should provide adequate pressure for one full stop landing, but unnecessarily harsh braking causing operation of the maxaret units must be avoided. When the brake pressure gauges indicate 2,000 PSI, further brake application will cause the gauge reading to fall to zero.

28 Hydraulic service failure

(*a*) If a hydraulic service fails to operate following a normal selection and the failure is not apparently caused by a main system (e.g. float switch operation), those services which incorporate Emergency selections may be operated as described in the preceding paragraph without causing hydraulic system as a whole to operate permanently in an Emergency condition. Make the appropriate Emergency selection of the service required. During the Emergency operation the EMERGENCY HYDRAULIC warning light will illuminate indicating that the hydraulic system is in the Emergency condition. On completion of the operation the main hydraulic system will revert to its normal condition and the EMERGENCY HYDRAULIC warning light will go out. No further operation of the failed service (except the bomb doors) can then be made, but the remaining services can be operated normally.

(*b*) If the undercarriage has been lowered by selecting EMERGENCY DOWN, and the pump motors have then been stopped by selecting OFF, the pumps may only be restarted by one of the following procedures:

(i) Selecting ON at the pump control switches.

(ii) By depressing the normal undercarriage DOWN button *after* the undercarriage is indicated down and locked, and then selecting AUTO at the pump control switches.