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JANUARY 1959 UNCLASSIFIED CONFIDENTIAL

Preliminary

AIRCRAFT OPERATING INSTRUCTIONS - ARROW 1

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PRELIMINARY

AIRCRAFT OPERATING INSTRUCTIONS

ARROW 1

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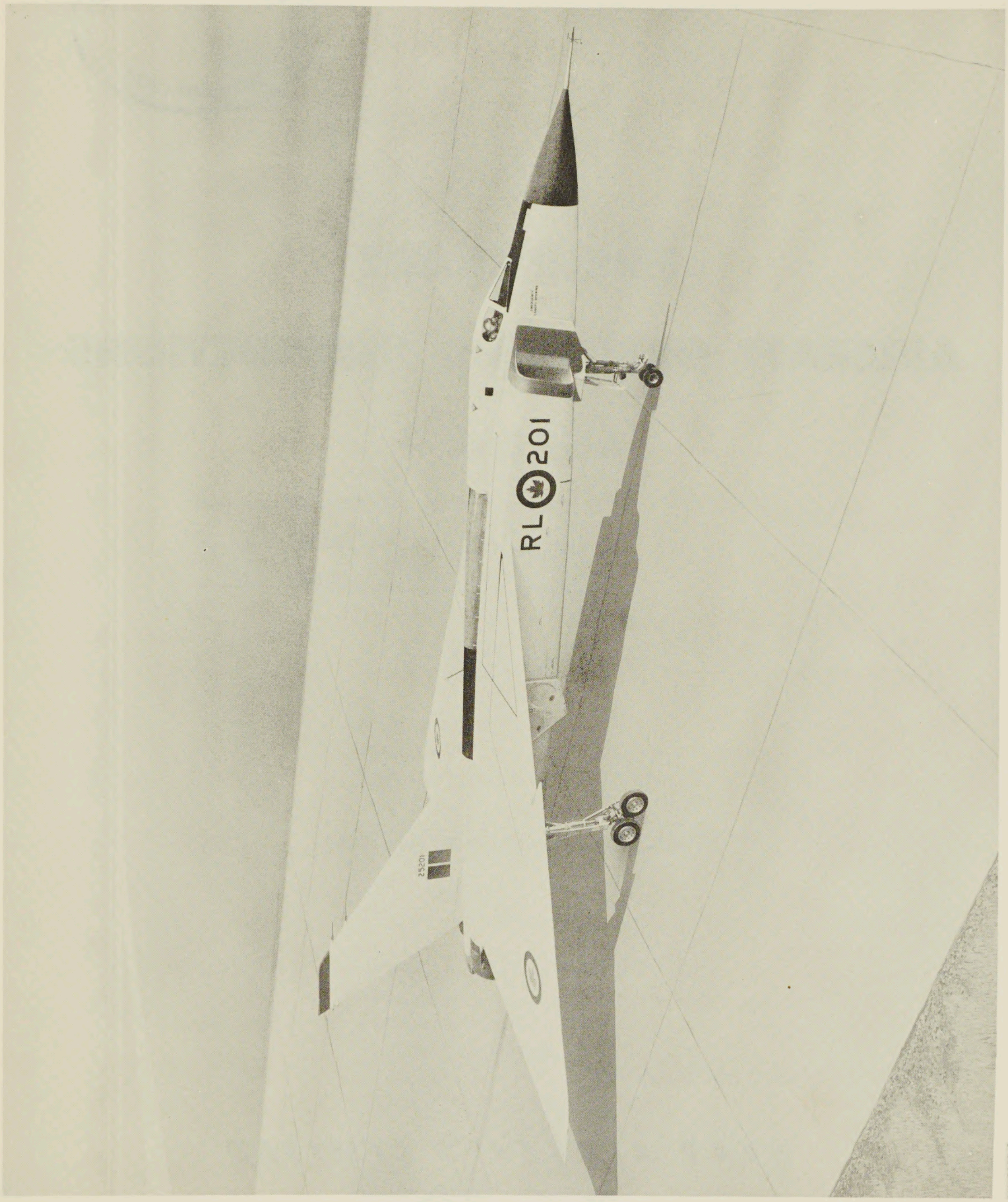

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PRELIMINARY AIRCRAFT OPERATING INSTRUCTIONS

ARROW 1

PART 1

DESCRIPTION

INTRODUCTION

General

1. The ARROW 1 is a delta wing aircraft powered by two Pratt and Whitney J75 engines. Aircraft 25201 has Series P3 engines. Aircraft 25202 and subsequent have Series P5 engines.

Airframe

2. The fuselage, wings, vertical stabilizer and control surfaces are of all metal construction. The tandem bogey main wheels and legs are attached to the inner wing and retract inboard and forward. The nose wheel is located beneath the pressurized cockpits and retracts forward. The flying control surfaces are fully powered by two independent hydraulic systems. Speed brakes are fitted below the fuselage and a brake parachute is installed in the aft end of the fuselage. Space in the radar nose and armament bay is utilized, at present, for test equipment and instrumentation.

Engines

3. The J75 P3 and P5 engines are continuous axial flow turbojets. Two tandem compressors, one low pressure and the other high pressure, with their respective turbines, form two rotor systems which are mechanically independent but related as to airflow. A hydro-mechanical fuel control establishes the power output. The engine is provided with a low pressure compressor speed limiter which reduces fuel flow when a predetermined low pressure compressor rpm is exceeded. The engine has an installed military thrust on a standard day at sea level of approximately 12,500 lb.

4. The engine incorporates an afterburner, the operation of which is automatic after it has been selected by the pilot. The afterburner increases the available engine thrust by approximately 50%, giving an installed maximum thrust on a standard day at sea level of approximately 18,500 lb.

5. An anti-icing system prevents icing on the inlet section of the engine and a de-icing system is employed on the duct intakes.

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Dimensions

6. The dimensions of the aircraft are as follows:

(a) Length - 73 ft 4 in. (To datum)
Length - 80 ft 10 in. (Including probe)

(b) Wing Span - 50 ft 0 in.

(c) Height - 21 ft 3 in. (To top of vertical stabilizer - unloaded aircraft)
Height - 14 ft 6 in. (To top of canopy)

(d) Sweepback - 61° 27' (Leading edge)
11° 12' (Trailing edge)

(e) Wheel Track - 30 ft 2-1/2 in.

FUEL SYSTEM

General

7. Fuel is carried in two rubber cell type tanks in the fuselage and six integral tanks in each wing. The forward fuselage tank and the six wing tanks in the right wing normally feed the RH engine, while the aft fuselage tank and the six wing tanks in the left wing normally feed the LH engine. The only interconnection between each sub-system is the crossfeed. One of the wing tanks in each sub-system functions as a collector tank. Each sub-system supplies fuel to its respective engine by means of a collector tank booster pump driven by a shaft from that engine. Each booster pump has sufficient capacity to supply the maximum fuel demand of its own engine and afterburner, or to supply the demand of both engines with partial after-burning. The fuel passes from the booster pumps to an oil-to-fuel heat exchanger and a low pressure fuel cock before entering the engine compartment.

Tank Capacities and Usable Fuel

8. The fuel capacities are given in Imperial gallons. Weights are for JP4 fuel, specific gravity .78.

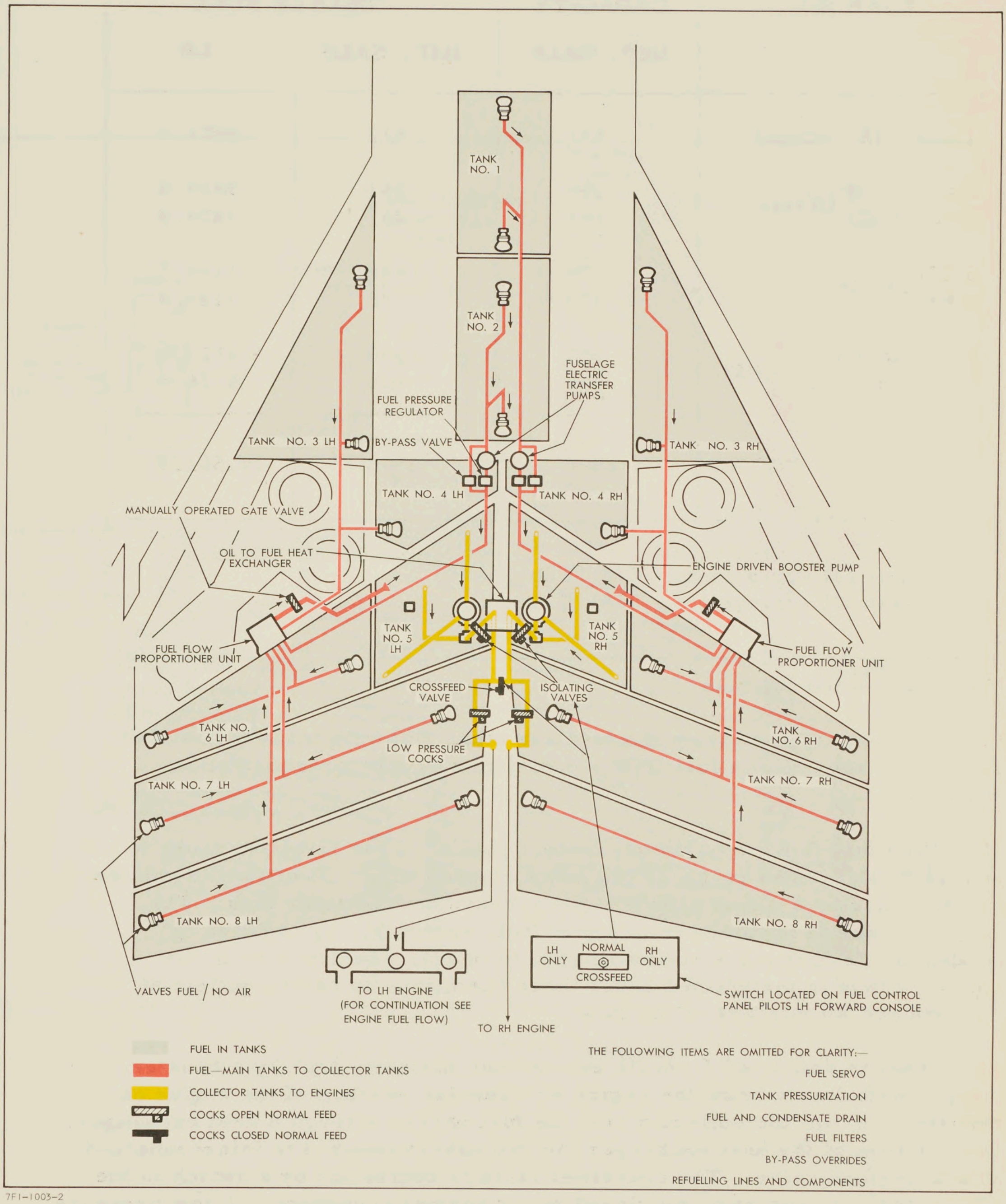

FIG 1-1 FUEL SYSTEM FEEDS (Aircraft)

TANK NO	CAPACITY IMP. GALS	USABLE FUEL IMP. GALS	LB
1 and 2 (Fuselage)	615	522	4071.6
3 and 4 LH (Wing)	266	241	1879.8
3 and 4 RH (Wing)	266	241	1879.8
5 LH (Collector)	170	146	1138.8
5 RH (Collector)	170	146	1138.8
6, 7 and 8 LH (Wing)	705	606	4726.8
6, 7 and 8 RH (Wing)	705	606	4726.8
TOTAL	2897	2508	19,562.4

Total LH sub-system - 9781.2 lb
Total RH sub-system - 9781.2 lb

Fuel Flow to the Engines

9. Fuel is supplied from the fuselage tanks and wing tanks to the respective sub-system fuel flow proportioner by tank pressurization. See para 13.

10. The fuel flow proportioner meters fuel from the tributary tanks to ensure that all tanks empty in the same elapsed time. Fuel flows from the proportioner by a single pipe into the sub-system collector tank. The collector tank is normally maintained full, except during negative 'g' conditions or during a sustained high rate of roll. Delivery from the collector tank is maintained under these conditions by having outlets at the fore and aft corners of the tank.

11. Fuel is delivered from its sub-system collector tank by a booster pump, shaft driven from the engine accessories gearbox of the engine on that side. From the collector tank the fuel passes through a heat exchanger. Downstream of the heat exchanger the two sub-systems are interconnected by a crossfeed valve. The crossfeed valve is controlled by a switch in the pilot's cockpit, and remains closed under normal conditions. A low pressure cock is fitted between the heat exchanger and the engine.

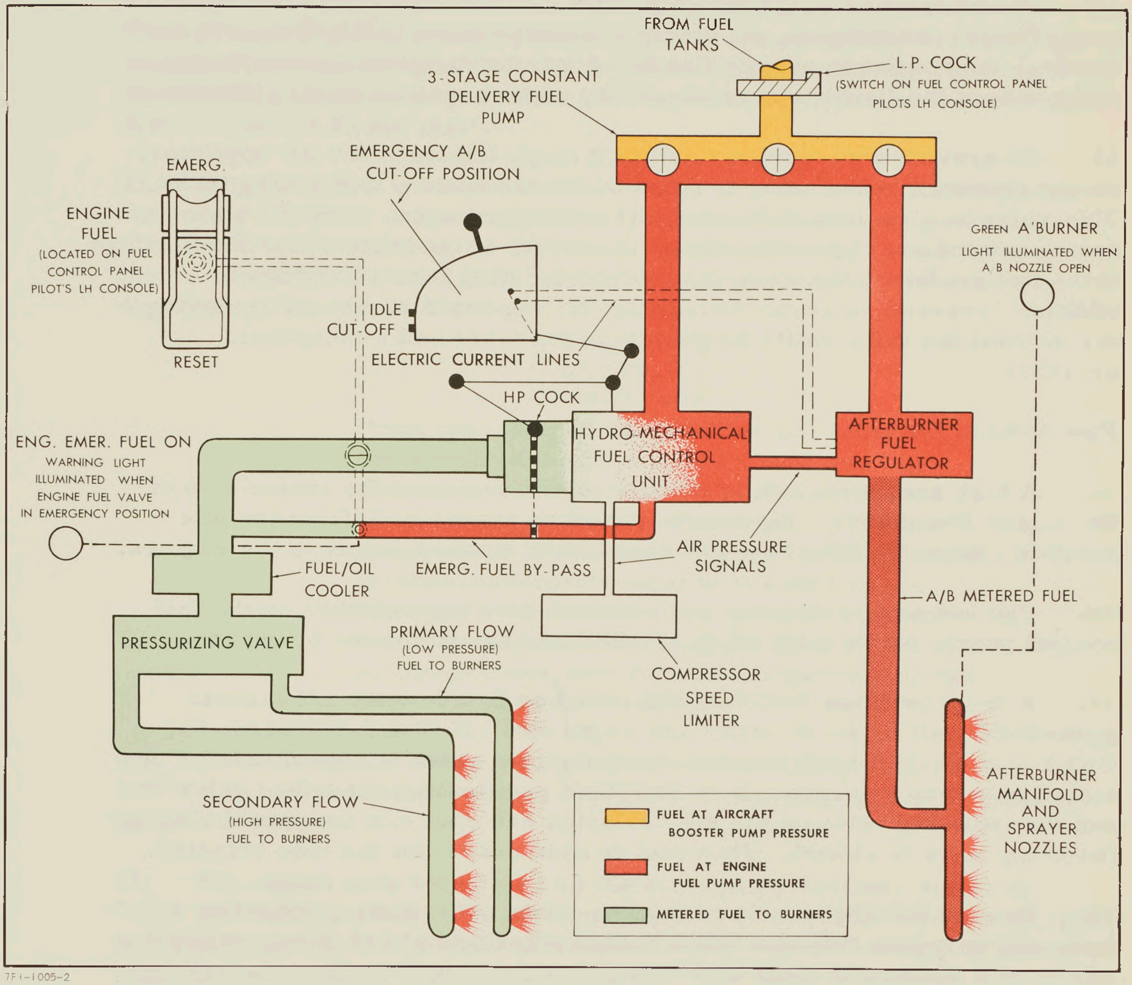

FIG 1-2 FUEL FLOW (Engine)

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Fuel Tank Pressurization

12. All fuel tanks are pressurized by engine bleed air taken from the air conditioning system downstream of the ram air heat exchanger. The purpose of this is to achieve fuel transfer and also to prevent fuel boiling.

13. Pressurization of the fuselage tanks is lower than the wing tanks due to structural limitations. An electric transfer pump is fitted at each fuselage tank outlet to ensure that fuel from the fuselage tanks and wing tanks enters the flow proportioner at the same pressure at all altitudes.

14. To prevent over-pressurization through failure of an air regulator, an air pressure relief valve is fitted in the air system to the wing tanks. This valve is also used as a means of venting pressure from the tanks during ground pressure refuelling. A similar valve is fitted for the fuselage tanks and performs the same function as the wing tank valve but, in addition, prevents over-pressurization during rapid climbs by releasing air to limit the differential between tank pressure and atmospheric pressure.

Fuel System Controls

15. A high pressure cock is fitted for each engine at the engine side of the engine fuel pumps. Moving the throttles up and back from the idle position closes the HP cocks and terminates the fuel supply to the engines.

16. The low pressure cocks are controlled by two switches on the fuel control panel, marked LP FUEL COCKS and are protected by guards.

17. A three position CROSSFEED switch is fitted on the LH console immediately aft of the throttles and is marked LH ONLY-NORMAL-RH ONLY. In the NORMAL position the crossfeed valve is closed and the two isolating valves are open. In a crossfeed position the crossfeed valve and the isolating valve on the side selected are open and the opposite side isolating valve is closed. Thus fuel is used only from the side selected.

18. On aircraft 25202 and subsequent, when crossfeeding from the inoperative engine side the FUEL PRESS warning light of the operating engine will illuminate (thus both fuel press lights will be illuminated). The light on the operating engine side illuminates because the isolating valve closes off the fuel supply from that side. Fuel is supplied to the operating engine by a combination of tank pressurization, engine pump suction and gravity.

19. During single engine flying, in order to maintain the weight of fuel on either side approximately equal, the crossfeed switch should be selected to the inoperative engine side alternately with the normal selection.

Engine Fuel System Emergencies

20. Two ENGINE FUEL toggle switches, protected by guards, are located on the fuel control panel on the LH console to allow selection of emergency fuel should failure of the flow control unit occur. The switches are of the three-position type, with EMERG and RESET positions marked. The switches are spring-loaded from RESET to the centre, normal fuel position. When the guards are closed the switches are automatically set in the normal fuel position. In this position the engines are automatically controlled by speed, temperature and pressure sensing devices to obtain and hold the thrust selected by the pilot.

21. When a guard is raised and the switch is selected to EMERG, the automatic fuel flow control unit is by-passed and fuel flow, partially compensated for altitude, is then directly controlled by power lever movement. The ENG EMERG FUEL warning light will illuminate when the emergency fuel selector valve is fully open.

CAUTION

When operating in the EMERG fuel selection, the turbine discharge temperature must be closely monitored. Power must be reduced immediately if there is any tendency for the temperature to increase beyond limits. Rapid throttle movements must be avoided as the emergency system does not provide the automatic overspeed, overtemperature, flame-out or compressor stall prevention features of the normal fuel control system.

22. The emergency sytem will provide at least 95% military thrust on a 100°F day at low altitudes and at least 80% of military thrust at altitudes up to 30,000 feet.

23. The engine may be started on the emergency system, either in flight or on the ground. The afterburner may be operated on the emergency system, in which case the throttles must be operated carefully to prevent engine overspeed and over-temperature.

24. During training or testing, and with a properly functioning fuel control system, the transfer back from EMERG to the normal system may be made. The throttle control for the affected engine should be retarded to the idle position, and the appropriate engine fuel toggle switch moved and held in RESET for five seconds. This selection will

open the selector valve to the normal position and the ENG EMERG FUEL warning light will go out. The switch, when released, will take up the centre position and the guard should then be closed.

CAUTION

> The solenoid operated fuel selector valve will not be energized if the switch is only moved back to the normal or centre postion. The solenoid is energized in the RESET position, and then de-energized when the switch is allowed to return to the centre position.

Fuel Warning Lights

25. Warning lights for the fuel system are located on the warning panel fitted to the forward RH console. The master amber warning light is located on the main panel.

26. Individual amber warning lights for the fuel system are marked and indicate as follows:

(a) FUEL LOW - Two lights are fitted to indicate low level of fuel in the LH or RH collector tanks. The illumination of a FUEL LOW light should always be accompanied by the illumination of the FUEL PROP light as the low level switch also operates the flow proportioner by-pass. If the FUEL LOW light illuminates due to failure of the fuel flow proportioner, the automatic opening of the proportioner by-pass will allow fuel to flow to the collector tank and the FUEL LOW light will then go out. If the light stays on it indicates that approximately 740 lb of usable fuel remains on that side.

(b) FUEL PROP - One light is fitted and when illuminated indicates one of three conditions, or a combination of these conditions, as follows:

(1) That a fuel flow proportioner has failed and the by-pass has opened. In this case the relevant FUEL LOW warning light will also illuminate and remain illuminated until the collector tank fuel level exceeds the low level limit. It will inform the pilot that automatic control of the fuel centre of gravity has ceased and that violent manoeuvres or sustained operation at high altitudes must be avoided.

(2) That the LH or RH fuselage tank fuel delivery pressure differential is less than 3 psi, due to a pump failure, lack of fuel in a fuselage tank, or loss of prime of a fuselage pump. The pump by-pass will automatically

open and allow fuel from the fuselage tank to flow to the proportioner, but at a decreased pressure. At high altitudes fuel from the fuselage tank may not be used in correct proportion to fuel from the other tanks.

(3) That the refuelling master switch on the master refuelling panel located adjacent to the LH speed brake is ON. (The access door of this panel will not close if the switch is ON).

(c) ENG EMER FUEL ON - One light is fitted which illuminates when either the LH or RH toggle switch marked ENGINE FUEL on the LH console is selected to EMERG. The light is extinguished when the toggle switch is held at RESET for five seconds and then allowed to return to the centre position. No master amber indication is given.

(d) ENG FUEL PRESS - A light is fitted for each engine and illuminates when the fuel pressure at the engine inlet falls below 17 - 18 psi, and indicates failure of a booster pump. The pump by-pass will automatically open and allow fuel to be delivered by a combination of tank pressurization, engine pump suction and gravity, at rates adequate to supply that engine at military power. If fuel tank pressurization fails when operating above military rating, the light will also illuminate.

Fuel Tank Contents Indicators

27 Two indicators marked FUEL QUANTITY LBS x 1000 are fitted on the pilot's main instrument panel. The left hand indicator registers the weight of fuel in the left hand tank sub-system, while the right hand indicator registers the weight of fuel in the right hand tank sub-system. The indicators register continuously while the master electrical switch is ON, and both main DC and primary AC current is available.

CAUTION

Should the electrical supply to the indicators fail, the contents pointers will remain at the position they occupied at time of failure. No power warning flag is provided.

OIL SYSTEM

General

28. The oil system on each engine is entirely self-contained and automatic. An oil tank with a usable capacity of 2.9 Imp. gals. (3.5 U.S. gals) is fitted on each engine.

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Oil Pressure Warning

29. Warning of a drop in oil pressure to below 25 psi is given by the illumination of the master amber warning light and an amber light for each engine oil system on the warning panel, marked OIL PRESS.

ELECTRICAL SYSTEM

General

30. The aircraft is equipped with two 30 KVA 120/208 volt, ram air cooled alternators. One alternator is fitted to and is driven by each engine through a constant speed unit for AC power supply. In addition to supplying the aircraft AC services, each alternator supplies a transformer rectifier unit. The TRUs operate in parallel and provide 27.5 volts DC for the DC services. A hydraulically driven emergency alternator is fitted and supplies essential AC services in case of complete electrical failure. The aircraft battery supplies essential DC services for a limited period during this emergency.

Master Electrical Switch

31. The master electrical switch is located on the forward RH console below the warning panel and is marked MASTER ELEC ON-OFF. The switch controls the complete electrics of the aircraft with the exception of the services taken from the battery bus which are as follows:

(a) Engine and hydraulic bay fire extinguishers.

(b) Canopy actuation.

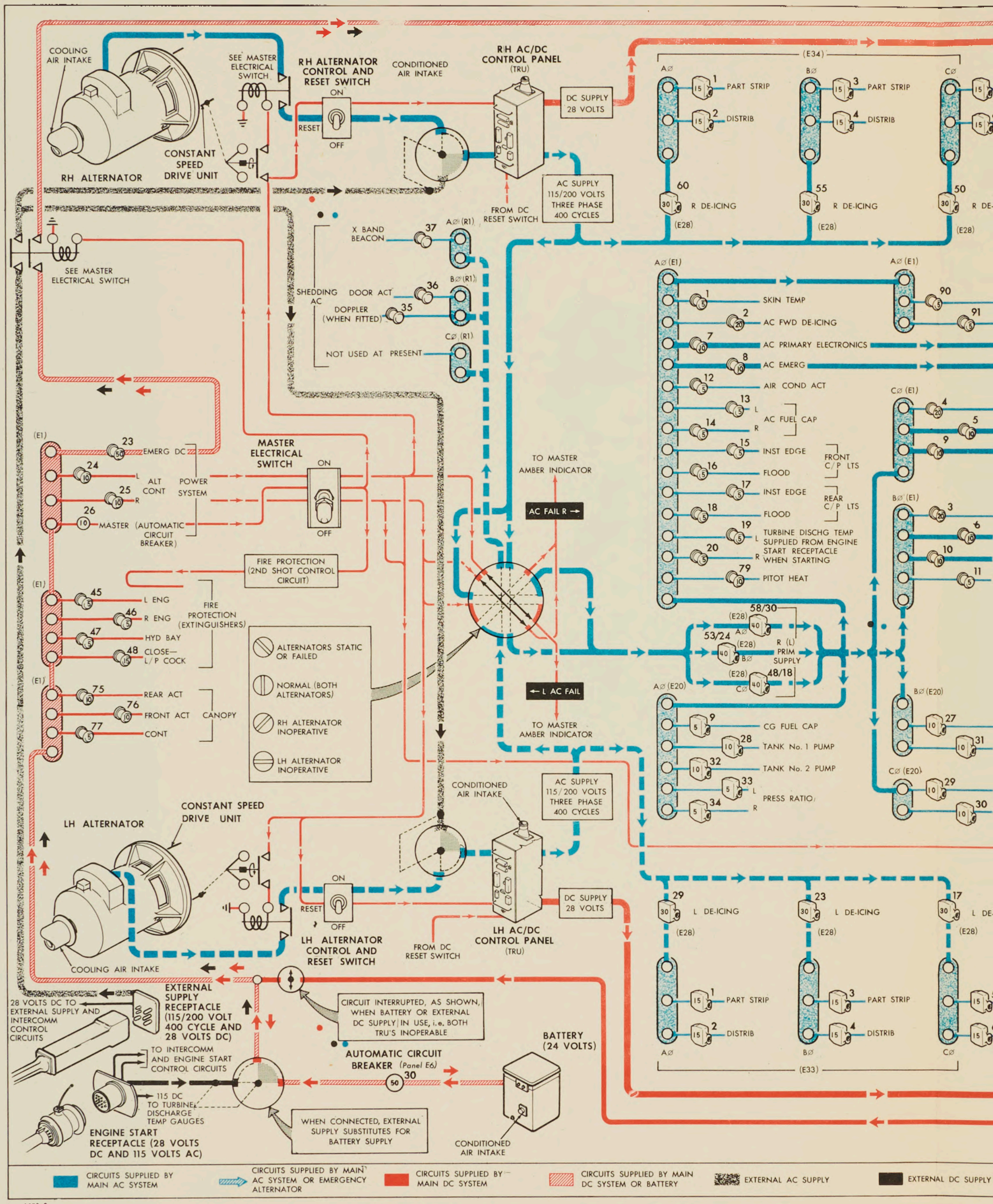
(c) LP cock operation to closed position only. (OFF).

Warning and Indicating Lights

32. The warning and indicating light system in the pilot's cockpit consists of the following:

(a) One red and one amber master warning indicator, located at the top centre of the main instrument panel. The indicators are fitted with double filament bulbs.

(b) A warning panel on the RH forward console, consisting of 26 amber lights, a master warning light PRESS-TO-RESET switch, a PRESS-TO-TEST switch and a DAY/NIGHT dimmer toggle switch.


COOLING AIR INTAKE
RH ALTERNATOR
SEE MASTER ELECTRICAL SWITCH
CONSTANT SPEED DRIVE UNIT
RH ALTERNATOR CONTROL AND RESET SWITCH
ON
RESET
OFF
CONDITIONED AIR INTAKE
RH AC/DC CONTROL PANEL (TRU)
DC SUPPLY 28 VOLTS
AC SUPPLY 115/200 VOLTS THREE PHASE 400 CYCLES
FROM DC RESET SWITCH
(E34)
PART STRIP
DISTRIB
R DE-ICING
(E28)
X BAND BEACON
SHEDDING AC
DOOR ACT
DOPPLER (WHEN FITTED)
NOT USED AT PRESENT
SKIN TEMP
AC FWD DE-ICING
AC PRIMARY ELECTRONICS
AC EMERG
AIR COND ACT
AC FUEL CAP
INST EDGE
FLOOD
FRONT C/P LTS
REAR C/P LTS
TURBINE DISCHG TEMP SUPPLIED FROM ENGINE START RECEPTACLE WHEN STARTING
PITOT HEAT
EMERG DC
ALT CONT
POWER SYSTEM
MASTER (AUTOMATIC CIRCUIT BREAKER)
MASTER ELECTRICAL SWITCH
TO MASTER AMBER INDICATOR
AC FAIL R
L AC FAIL
FIRE PROTECTION (2ND SHOT CONTROL CIRCUIT)
L ENG
R ENG
HYD BAY
CLOSE— L/P COCK
FIRE PROTECTION (EXTINGUISHERS)
ALTERNATORS STATIC OR FAILED
NORMAL (BOTH ALTERNATORS)
RH ALTERNATOR INOPERATIVE
LH ALTERNATOR INOPERATIVE
REAR ACT
FRONT ACT
CONT
CANOPY
R (L) PRIM SUPPLY
CG FUEL CAP
TANK No. 1 PUMP
TANK No. 2 PUMP
PRESS RATIO
LH ALTERNATOR
CONSTANT SPEED DRIVE UNIT
LH ALTERNATOR CONTROL AND RESET SWITCH
LH AC/DC CONTROL PANEL (TRU)
L DE-ICING
(E33)
COOLING AIR INTAKE
28 VOLTS DC TO EXTERNAL SUPPLY AND INTERCOMM CONTROL CIRCUITS
EXTERNAL SUPPLY RECEPTACLE (115/200 VOLT 400 CYCLE AND 28 VOLTS DC)
CIRCUIT INTERRUPTED, AS SHOWN, WHEN BATTERY OR EXTERNAL DC SUPPLY IN USE, i.e. BOTH TRU'S INOPERABLE
TO INTERCOMM AND ENGINE START CONTROL CIRCUITS
AUTOMATIC CIRCUIT BREAKER (Panel E6)
BATTERY (24 VOLTS)
115 DC TO TURBINE DISCHARGE TEMP GAUGES
ENGINE START RECEPTACLE (28 VOLTS DC AND 115 VOLTS AC)
WHEN CONNECTED, EXTERNAL SUPPLY SUBSTITUTES FOR BATTERY SUPPLY
CONDITIONED AIR INTAKE
CIRCUITS SUPPLIED BY MAIN AC SYSTEM
CIRCUITS SUPPLIED BY MAIN AC SYSTEM OR EMERGENCY ALTERNATOR
CIRCUITS SUPPLIED BY MAIN DC SYSTEM
CIRCUITS SUPPLIED BY MAIN DC SYSTEM OR BATTERY
EXTERNAL AC SUPPLY
EXTERNAL DC SUPPLY

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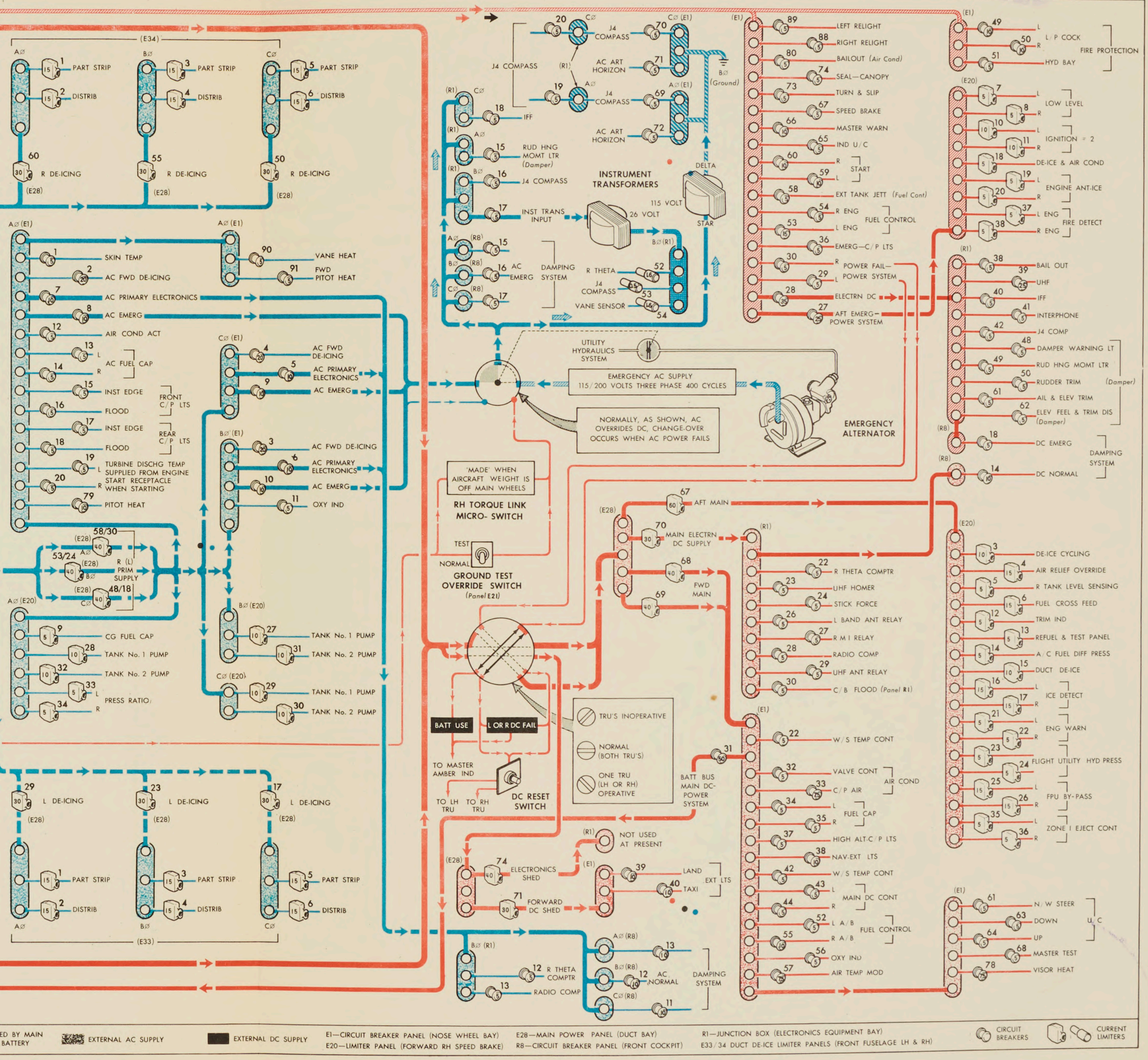

FIG 1-3 ELECTRICAL POWER SUPPLY SYSTEM

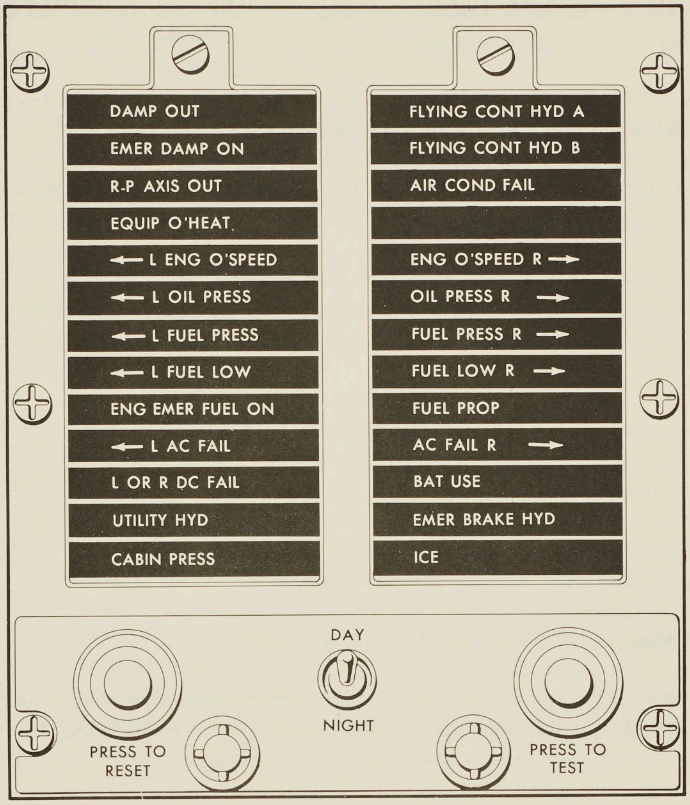

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FIG 1-4 MASTER WARNING PANEL

(c) Two red ENG BLEED warning lights located on the forward RH console.

(d) Three red fire warning lights located on the LH console, immediately below the throttle levers, marked FIRE - LH/HYD/RH.

(e) A warning light fitted in the landing gear selector lever.

(f) A green NAV BAIL OUT indicating light on the top centre of the main instrument panel.

(g) Two green indicating lights on the RH side of the main instrument panel marked A'BURNERS LEFT and RIGHT.

(h) An amber light (for aircraft with development dampers fitted) or a green light (for aircraft with test dampers fitted) for indication of L/G MODE selection.

33. The warning light system in the navigator's cockpit consists of a red BAIL OUT warning light located on the main panel, directly in front of the navigator.

NOTE

When the red BAIL OUT light is illuminated, an audio oscillator is energized, giving audible warning for bail out in addition to the visual warning.

Master Warning Lights and System Warning Lights

34. The amber master warning light illuminates in conjunction with the individual lights on the warning panel. The red master warning illuminates only in conjunction with the lights on the fire warning panel.

35. All warning light filaments may be checked by means of the PRESS TO TEST switch on the panel (this does not include the navigator's BAIL OUT light in the rear cockpit). After illumination through a fault, the master lights may be turned off by operation of the PRESS TO RESET switch. The system warning lights will remain on, however, until the fault has been cleared.

36. The warning light panel has twenty-six indicators. Each indicator contains two lamps wired in parallel. The lamps are covered by an

identification plate inscribed with the system or function served. If an indicator is handed it is shown by the letter L or R and an arrow. One indicator is not used at present.

37. The function of the lights is described under their particular system. The following describes the warning lights applicable to the electrical system.

(a) AC FAIL L and R - Indicates a phase failure in the LH or RH AC system, and will be accompanied by the illumination of the single light marked L OR R DC FAIL.

(b) L OR R DC FAIL - One light indicates for both TRUs. It will denote failure of both TRUs if the BAT USE light also illuminates. If the L or R DC FAIL light illuminates on its own, it will indicate that one TRU has failed.

(c) BAT USE - Indicates when the aircraft battery alone is supplying the DC power.

AC System

38. The engine driven alternators supplying AC power are controlled by two switches on the RH forward console, marked ALTERNATORS ON-RESET-OFF.

39. Should an alternator fail, it may be reset by moving the ALTERNATOR switch to RESET and back to ON. If the reset is successful the AC FAIL, DC FAIL and master amber lights will go out; alternatively, only the AC FAIL light may go out. In the latter case, the DC RESET button should be pressed, and a successful reset will be indicated by the DC FAIL and master amber light going out. If the fault has not cleared the AC FAIL will again illuminate, in which case the switch should be left in the OFF position.

40. Normally, the RH alternator supplies the AC power requirements. Should the RH alternator fail, the LH alternator assumes the load except that the RH intake duct de-icing will be shed (if installed). Should the LH alternator fail, no change in power supply will be apparent, except that the LH intake duct de-icing will be shed (if installed). The operating alternator will supply, through its TRU, all DC services except the landing and taxi lights.

41. An emergency alternator is fitted to provide electrical power to essential services in the event of complete electrical failure, or under a double-engine flame out condition. The alternator operates automatically

upon electrical failure by energizing a solenoid shut-off valve which diverts utility hydraulic fluid to a hydraulic motor which in turn drives the alternator. Sufficient power is supplied to operate the emergency damping system, artificial horizon, J4 compass and IFF until a relight is obtained. In case of a double engine flame out, one windmilling engine will maintain sufficient utility hydraulic pressure to drive the motor.

DC System

42. The transformer rectifier units (TRU's) are fed from their respective alternators, and the output is fed to the main DC bus.

43. Failure of a single transformer rectifier unit is indicated by the illumination of the master amber warning light and the DC L or R FAIL light on the warning panel. The operating TRU will provide all DC services except the landing and taxi light. Failure of both TRU's will be indicated by the illumination of the DC FAIL light and the BAT USE light on the warning panel. The illumination of the BAT USE light signifies that the DC supply to the emergency bus and battery bus is being taken from the aircraft battery. The main DC bus supply will be automatically shed.

44. A push button switch is fitted on the RH console in the front cockpit, marked DC RESET. If the L or R DC FAIL warning light illuminates alone, or in conjunction with the BAT USE warning light, either or both TRU's may be reset, provided the fault has been cleared, by pressing the DC RESET button.

45. The DC system maintains the battery charged, therefore if the BAT USE light illuminates, the battery is discharging. The following services will be available from the battery through the DC Emergency Flight Bus for approximately 20 minutes, depending on the battery condition and the number of services operated:

(a) Landing Gear Indication.

(b) Fire Detection.

(c) Canopy Seal.

(d) Speed Brake Actuation.

(e) Warning Light System.

(f) Emergency Cockpit Lights (Emer. Flood Light).

(g) Turn and Slip Indicator.

(h) Ignition (Relight).

(j) ARC/34 UHF.

(k) AIC/10 Intercommunication.

(m) DC Damping (Yaw).

(n) IFF (APX/6A).

(p) Hinge Moment Limiter.

(q) Engine Emergency Fuel Selection.

(r) Bail Out Indication.

NOTE

> The landing gear selector valve is operated by the main DC supply. If the BAT USE light is illuminated, the landing gear cannot be unlocked by the normal selection. However, it can be unlocked by using the emergency extension procedure. (See Part 3, Para 14).

Engine Starting Services

46. The engines may be started individually or simultaneously by means of a ground starter cart which supplies compressed air to the turbine starters, a 28 volt DC supply for ignition and a single phase AC supply. Leads from the cart to the aircraft comprise two air hoses and an electrical supply connector. Incorporated in the connector are intercommunication leads which allow the pilot to communicate with the ground control centre, the navigator, and the ground starting crew. These connections are automatically withdrawn from the aircraft by means of lanyard releases when the aircraft commences to taxi. When the aircraft is being towed, a lead from the towing vehicle to the aircraft receptacle enables intercommunication between the cockpit occupant and the driver of the towing vehicle.

47. The starting system consists essentially of an air turbine starter and an ignition system for each engine. The air supply to the air turbine starter is controlled by the ENGINE START - START/OFF/RESET switches, one for each engine, which are spring loaded to OFF. The

ignition supply is energized by a centrifugal switch operated when an engine speed of 700 rpm is attained. A second centrifugal switch is operated at 3020 rpm, to de-energize the ignition system.

48. An ENGINE START switch may be momentarily selected to RESET if it becomes necessary to interrupt the starting cycle. This de-energizes the 'locked' starting relay and resets the system for a further start. The RESET position is also used for motoring the engine without ignition.

49. An external supply socket is provided to plug in a supply of single phase AC current. This supply is available on the starting cart and is used to provide power to the turbine discharge temperature gauges during starting the engines. The supply may also be used for ground servicing checks.

FLYING CONTROL SYSTEM

General

50. The ailerons, elevators and rudder are fully power operated, utilizing hydraulic pressure supplied by two pumps on each engine. The hydraulic components are controlled electrically, or mechanically through cables and linkages; there being no direct mechanical control. Hydraulic boosters are fitted to the aileron and elevator front quadrant shafts and are actuated by the parallel servos in the normal mode, or by mechanical linkage in the emergency mode. The resultant extension or retraction of the booster rotates the front quadrant in the appropriate direction.

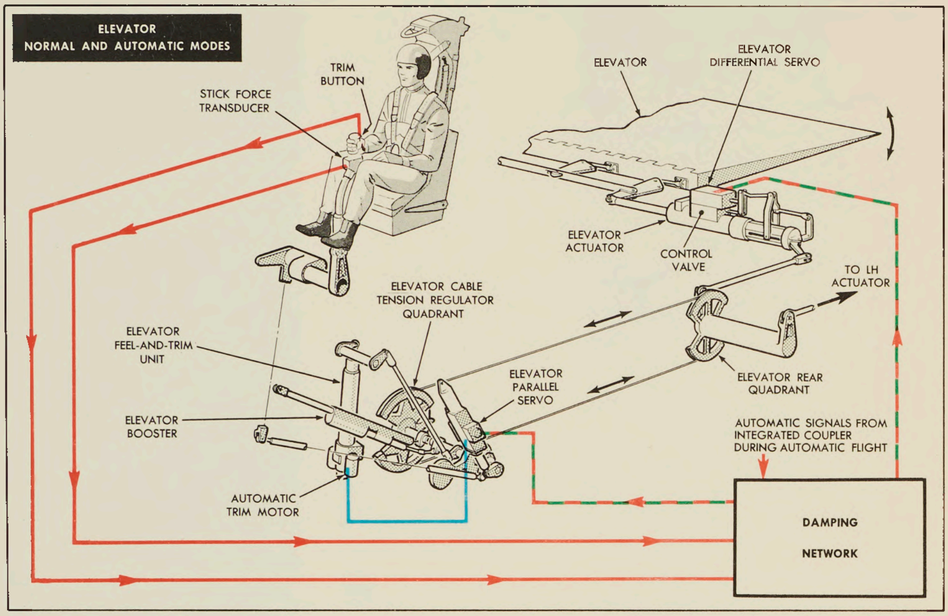
NOTE

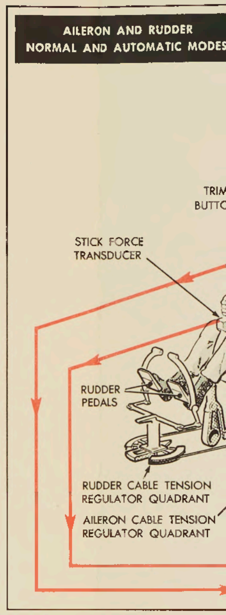
> Certain aircraft do not have the elevator booster fitted. Control behaviour of aircraft both with and without the booster fitted is described in Part 2.

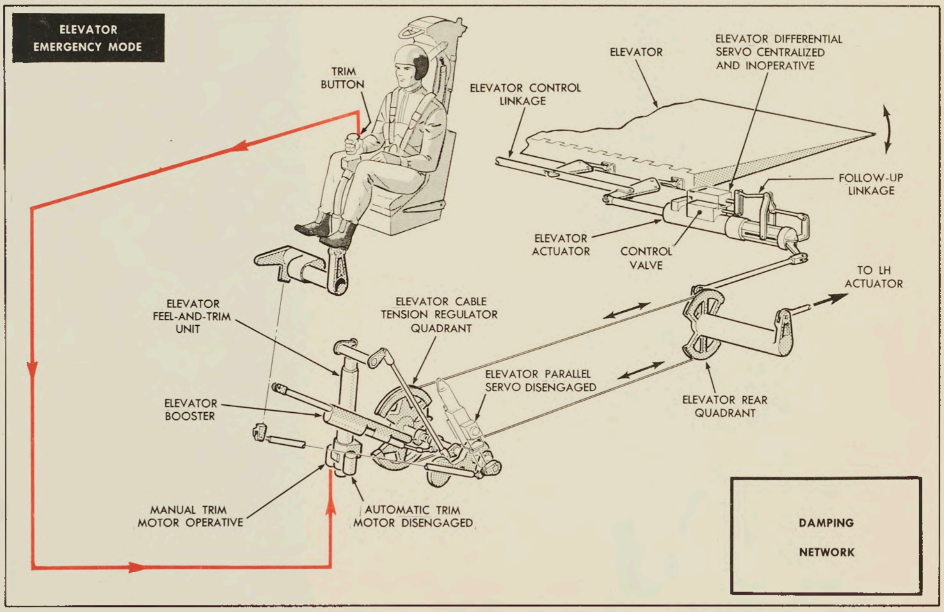
51. There are three modes of control of the aircraft in its final configuration, the normal mode, the automatic mode and the emergency mode. The automatic flight mode will not be installed in early aircraft.

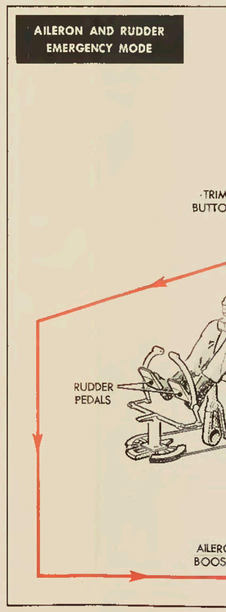
52. In the normal mode, a damping system automatically stabilizes the aircraft in all three axes and co-ordinates rudder movement with movement of the ailerons and elevators. Control in the normal mode is by means of an electrical force transducer fitted in the control column handgrip.

53. In the automatic flight mode (when fitted), the damping system is operative as in the normal mode, but aileron and elevator position is controlled by an Automatic Flight Control Sub-system (AFCS). The AFCS









COMMAND SIGNALS DAMPING AND TURN CO-ORDINATION SIGNALS COMB

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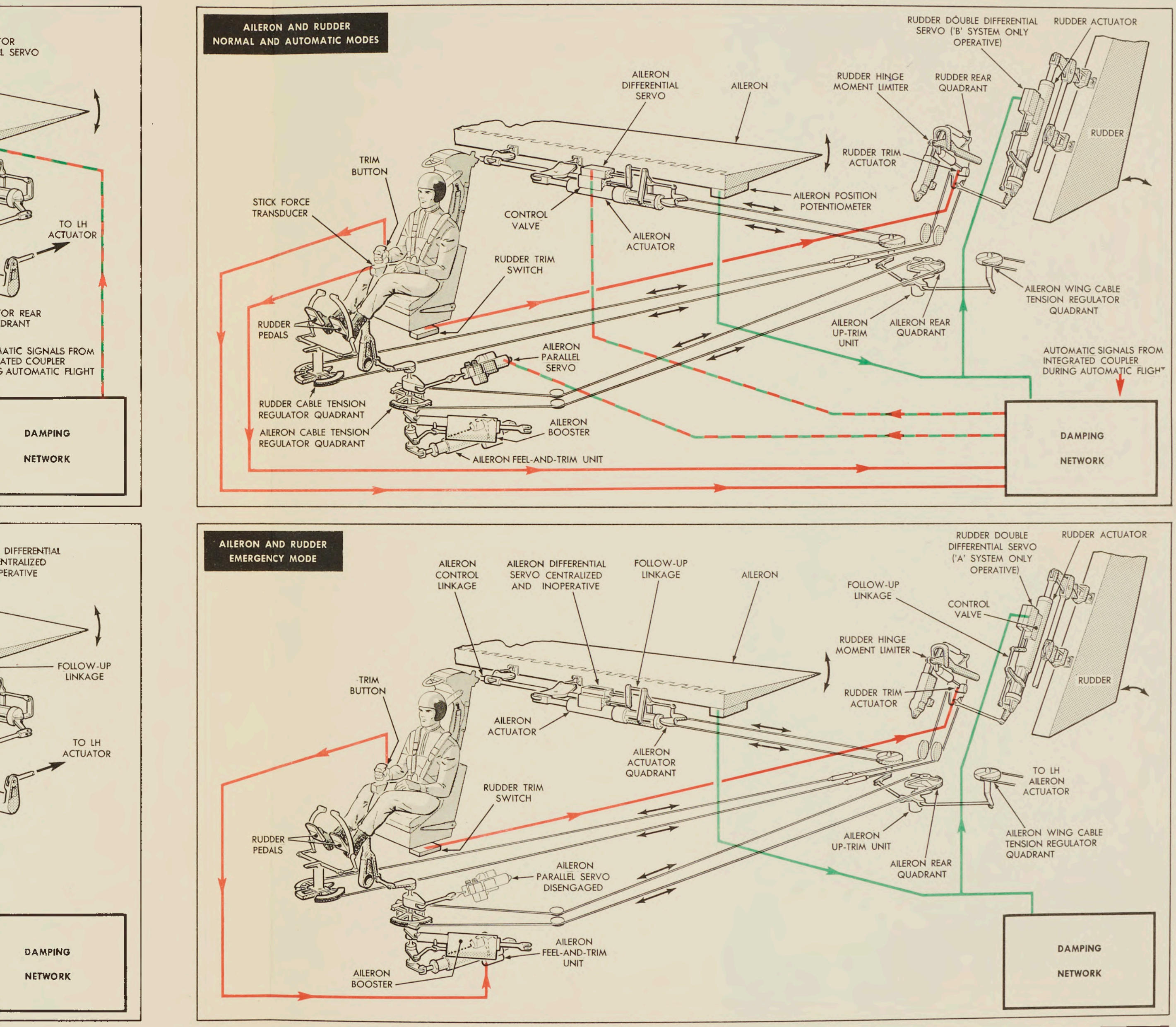

PING AND TURN CO-ORDINATION SIGNALS — COMBINATION OF COMMAND AND DAMPING SIGNALS — AUTOMATIC FEEL TRIM SIGNALS

FIG 1-5 FLYING CONTROLS DIAGRAM

allows the aircraft to be controlled from the ground for Automatic Ground Control Interception (AGCI) or for Automatic Ground Control Approach (AGCA). It also provides certain pilot assist functions by holding any set course or altitude, or it may hold any set Mach number by varying the pitch attitude. It also provides for automatic navigation by controlling the aircraft according to information fed into a dead reckoning computer by the navigator. An AFCS disconnect push button switch will be fitted on the control column handgrip. When the AFCS is disconnected by this switch, the damping system reverts to the normal mode.

54. In the emergency mode the hydraulic components for operating the ailerons and elevators are controlled mechanically. Yaw stabilization and rudder co-ordination are maintained by an emergency yaw damping system.

55. Pilot feel at the control column is provided by the damping system in the normal mode, and by spring feel in the emergency mode.

56. If certain flight limitations are exceeded in the normal damping mode, the system automatically changes over to the emergency mode.

57. Elevator and aileron trim is obtained by means of a four-way switch on the control column, while rudder trim is obtained by a toggle switch on the pilot's LH console. A control surface position indicator is fitted on the LH console and shows the amount of movement of the control surfaces in relation to the main surfaces. In later aircraft, to reduce elevator trim drag at altitude, the ailerons will be automatically deflected upwards by means of a pressure switch which will operate at approximately 45,000 feet. The switch will open when the aircraft descends to 42,000 feet and the ailerons will return to their normal position.

Hydraulic System

58. Two independent hydraulic systems are employed. One pump on each engine supplies the 'A' system while the other pump on each engine supplies the 'B' system. The supply is 4000 psi; an accumulator in each system prevents fluctuations. The lowering or loss of pressure in a system to approximately 1000 psi will illuminate the appropriate light on the warning panel, in conjunction with the master amber light. Illumination of both system warning lights, in conjunction with the master amber light will indicate loss of pressure in both systems. During single engine flight, or two engine flight with low engine rpm, the lights may illuminate momentarily if high control rates are used.

59. The warning lights are marked FLYING CONT HYD A and FLYING CONT HYD B. Both the 'A' and 'B' systems supply the flying control surface actuators. The 'B' system is the major system for supplying the damping servos in pitch, roll and yaw axis damping; while the 'A' system only supplies the damping servo for emergency yaw damping. The hydraulic boosters are supplied by both the 'A' and 'B' system during normal operation. Should one system fail, the other system will supply the boosters. (See NOTE, para 50).

60. In the event of loss of one engine or loss of one system, adequate control is still available. Rates of control movement will be slower with one engine failed. With one system failed, less 'g' is available at high speeds. With the 'B' system failed the aircraft will be in the emergency mode of flying control.

Damping System

61. The damping system provides artificial stabilization in flight. Unstable tendencies are picked up by sensors and adjustments are made to the control surfaces. As the damping in the yaw axis is of major importance in the higher speed range, duplicated electrical and hydraulic supplies are installed for the rudder control. The damping system comprises three distinct channels, the pitch channel which controls the elevators, the roll channel which controls the ailerons and the yaw channel which controls the rudder.

62. Switches for controlling the damping system are located on the pilot's LH console, and on the control column. Eight DAMPING CIRCUIT BREAKERS are fitted outboard of the DAMPER control panel. The rear group of four are in the NORMAL damping circuit, while the forward group of four are in the EMERGENCY damping circuit. The breakers are a protection against excessive current drain and will not reset if the circuit is overloaded. They also provide a secondary means of switching should the normal means of damper disengagement fail to operate. Mounted on the DAMPER panel are the following controls:

(a) A POWER ON-OFF toggle switch protected by a guard. When selected "ON" power is supplied to the damping system and AFCS.

(b) A DAMPER ENGAGE push button switch for engaging the normal mode of operation, or for re-engaging the aileron or elevator damping if they have been automatically disconnected through excessive manoeuvring. Normal mode must be selected before the emergency mode can be selected.

(c) An EMERG push button switch for selecting the emergency mode of damping (i.e. to disengage the normal mode).

63. A flight test panel is fitted in the pilots cockpit and also in the rear cockpit. The pots and switches on these panels should be set initially to values detailed by the Minneapolis-Honeywell flight test department, prior to flight.

64. The control column grip has three damping controls fitted. The missile trigger switch is wired for normal mode engagement, and performs the same function as the push button switch on the DAMPER control panel. The upper push button switch is wired for disengaging all damping. (When the AFCS is fitted, this switch will be used for disengaging the AFCS). The central (side) push button is marked EMERG DAMP and reverts the damping system to the emergency mode (i.e. it disengages the normal mode), performing the same function as the push-button switch on the DAMPER control panel.

65. When the landing gear is selected down and the L/G MODE switch is selected to DOWN, damping of all control surfaces is modified as follows:

(a) In the roll axis, sufficient damping is retained to assist in counter-acting "dutch roll", (in conjunction with the yaw axis).

(b) In the yaw axis, the modified damping allows intentional sideslip to be introduced, although any transient yaw will be corrected.

(c) In the pitch axis, damping is retained to a limited extent. Any excessive instability left uncorrected by the damper will be easily counteracted by the pilot.

(d) Pilot "feel" at the controls changes. (See para 78).

66. In the emergency mode, only rudder damping is effective.

Landing Gear Configuration and Damping

67. Two methods of damping control are available in the normal and emergency modes. One damper condition is normally in use when the landing gear is raised, while the other condition is normally in use when the landing gear is lowered. For reasons of safety the damping change-over is at present, manually controlled by the pilot.

NOTE

> The damping system and controls are in the experimental stage. Changes are constantly occurring, therefore each aircraft must be studied for its own particular system.

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Switching Arrangements

68. A toggle switch on the flight test panel (rear RH console) is marked L/G MODE UP-DOWN. A green indicating light is fitted adjacent to the landing gear position indicator, marked L/G DOWN MODE.

69. The green indicating light is illuminated whenever the L/G MODE switch is in the DOWN selection, and will go out when the switch is selected to UP. The light is positioned adjacent to the landing gear indicator so that quick reference may be made to landing gear configuration and damper condition.

70. When development dampers are fitted in place of test dampers, an amber light is installed and the green light is removed. The amber light will illuminate if at any time the landing gear configuration differs from the L/G MODE selected, and will go out when they agree.

Damping System Warning Lights

71. Malfunction of the damping system is indicated by the illumination of the master amber warning light and the system warning light or lights on the warning panel. Three lights are fitted on the warning panel for the damping system. They are marked and function as follows:

(a) EMER DAMP ON - Illuminates when emergency damping only is in operation, i.e., damping is operative on the rudder only, and can occur for the following reasons:

(1) By automatic reversion to the emergency mode by excessive yaw or lateral acceleration. (See para 88). The R/P AXIS OUT light will also illuminate.

(2) By manually selecting EMERG on the DAMPING SYSTEM panel or the EMER DAMP switch on the control column. The R/P AXIS OUT light will also illuminate.

(b) R/P-AXIS OUT - Illuminates when either the elevator and/or aileron damper is cut out automatically by excessive pitch or roll. (Provisionally 4-1/2 to 5 g in pitch and 159° per second in roll). It will also illuminate in conjunction with the EMER DAMP ON light.

NOTE

After the manoeuvre the axis or axes may be re-engaged by pressing the ENGAGE switch on the DAMPER panel.

(c) DAMP OUT - Illuminates when all damping is inoperative and can occur for the following reasons:

(1) When the master electrics switch is turned on after entering the aircraft and the DAMPER POWER switch is either OFF, or ON with no mode selected.

(2) When a change over is made to emergency mode for any reason but the 'A' hydraulic system, supplying the emergency yaw damper, is unserviceable.

(3) When the upper push button switch on the control column grip has been actuated, thus disengaging all damping.

PITCH AXIS

Pilot Command Control

72. In the normal mode, when the pilot exerts a force on the control column grip to move the elevators, a force transducer on the control column transmits an electrical signal. Similar signals are transmitted by ground control when in the AFCS mode without pilot operation of the control column. These signals are modified by an electronic network and an air data computing system and are then fed to the parallel (command) servo and differential (damping) servo which convert the signals into hydraulic power to actuate control valves. The control valves direct hydraulic pressure to the appropriate side of a hydraulic jack, resulting in elevator movement.

73. In the normal mode, the electrical output at the transducer is directly proportional to the force exerted at the grip. The break-out force (i.e. the force required to obtain initial movement of the surface) is approximately 4 lbs. The control column will move as the force is exerted, but it is not moved directly by the pilot. Movement of the control column follows the positioning of the elevators by the command circuits, but as the response of the system is nearly instantaneous, the control column will appear to be moved by the pilot.

74. In the normal (and AFCS) mode a force of approximately 75 lb at the control column will counteract the hydraulic pressure in a runaway parallel servo, until such time as the particular mode of flying control is disengaged.

75. In the emergency mode the parallel servo is disengaged. Movement of the control column does not send electrical signals from the

transducer to the parallel servo, but moves cables and a mechanical link system which operates the hydraulic actuator control valve. The actuator moves the elevators by hydraulic pressure as in the normal and AFCS modes.

Trim Control

76. In the normal and emergency modes, up and down movement of the trim button will result in movement of the elevator control surfaces. In the normal mode the control surface movement is achieved by the transmission of an electrical signal which moves the elevators in the same manner as would hand pressure on the control column.

77. In the emergency mode, a feel and trim unit provides pilot feel and trim. Two motors form part of the trim unit. One of the motors is actuated by signals from the parallel servo when in the normal mode, and provides automatic feel trim to prevent any change in stick position during changeover from the normal to the emergency mode. The other motor is controlled by the trim switch, and operates when in the emergency mode.

Pilot Feel

78. Pilot feel at the control column is provided artificially by the damping networks in the normal mode. The stick force required to move the elevators is made to feel proportional to the amount of 'g' pulled, through signals provided by an accelerometer. For a particular 'g' the stick force requirement is constant irrespective of speed or altitude. With the landing gear selected down, feel is directly proportional to the degree of displacement of the elevator control surfaces, as the accelerometer is by-passed.

79. A 'g' bob weight is fitted at the end of a lever and forms part of the elevator control system. During 'g' conditions, in the emergency mode, the weight will be felt at the control column, progressively increasing as 'g' increases. A balance spring counteracts the weight during normal flight.

G Limits

80. The stick force transducer is set to limit pilot imposed 'g' to a value of 4-1/2 to 5 g, but if through component malfunctions this value is exceeded, the normal mode of control in the pitch axis disengages automatically and control reverts to emergency mode. Upon change-over the aircraft may require to be manually re-trimmed.

81. The pitch axis will also disengage should the yaw axis monitor operate due to excessive yaw or lateral acceleration. (See para 88).

ROLL AXIS

General

82. In all modes of control, the operation of the ailerons by means of signals, or by cables, is identical to the operation of the elevators. (See para 72). Components in the system differ slightly - for instance in place of an accelerometer, the aileron system utilizes a roll rate gyro, but from the pilot's point of view, the systems operate in a similar manner.

Turn Co-ordination

83. In the normal and emergency modes, rudder movement is automatically co-ordinated with aileron movement in turns. Yaw damping during turns is also effective.

Feel and Trim

84. In the normal mode of control, lateral trim is obtained by operating the control column trim button in the appropriate direction until the ailerons have moved the desired amount. In the emergency mode of control the effect of moving the trim button is the same, although aileron movement is obtained by means of the trim actuator instead of through the command servo. Electronic feel of the ailerons is cut out during the emergency mode of control. The springs of the feel-and-trim unit are compressed when the control column is moved thus providing feel. A pressure trim circuit ensures smooth re-engagement upon change-over from emergency mode to normal mode; however, the aircraft may require to be trimmed laterally for straight and level flight in the normal mode.

Roll Rate Limits

85. To prevent overstressing the aircraft structure, the roll axis damping system disengages if the roll rate exceeds 159° per second. The system will also disengage should the yaw axis monitor operate due to excessive yaw or lateral acceleration.

YAW AXIS

General

86. The yaw damping system provides directional damping and rudder turn co-ordination when in the normal mode of control. The system is duplicated in order to provide emergency yaw damping and turn co-ordination in the event of failure of the normal system, or should control

of the aircraft be reverted to the emergency mode. Should failure of the electrical supply to the damping system occur, an emergency hydraulically driven alternator automatically supplies power for emergency yaw damping.

87. When the landing gear is selected down, the yaw damping signal is modified in order that a certain amount of intentional yaw may be applied by the pilot without opposition from the system. Although the pilot has this control if required, stability about the yaw axis is maintained.

Yaw Rate Limits

88. Automatic disengagement occurs if, due to a fault in the normal damper system, 10° of sideslip is exceeded or the aircraft exceeds a preset yaw or lateral acceleration. Control of all three axes is then in the emergency mode, i.e. only the emergency yaw damping is effective.

Rudder Feel and Hinge Moment Limitation

89. Pilot feel at the rudder bar is provided by two springs in the feel unit, and the system incorporates a hinge moment limitation linkage. The action of the system is to decrease the amount of rudder movement for a given pilot effort as the aerodynamic pressure increases, thus preventing structural damage at high speeds. This also applies to the trim circuit.

90. The system installed in Arrow 1 aircraft at present is designed to limit rudder authority according to qc (aerodynamic pressure). When the temporary retrofit scheme is fitted, the qc control will be by-passed. This temporary scheme, and the modified system which will be installed later, are described below.

NOTE

Each aircraft must be checked for its own particular system.

Temporary Retrofit Scheme

91. This system does not utilize aerodynamic pressure, but a linear actuator will extend or retract when the landing gear is raised or lowered, thus providing a "step" in the system. This actuator length determines the amount of rudder movement that may be obtained for a given pilot force on the rudder bar. When the landing gear is down, the pilot has full (30°) authority. When the landing gear is raised, rudder authority is limited to 10°. This system does not provide full protection at high speeds and care in use of rudder must be exercised under these conditions.

92. To provide for linear actuator malfunction, a guarded toggle switch is fitted. The switch is marked RUDDER FEEL and has AUTO and FULL AUTHORITY positions.

93. A malfunction of the actuator motor or system may cause the rudder movement to be limited to 10° when the landing gear is selected down. To obtain full rudder authority of 30°, the RUDDER FEEL switch must be selected to FULL AUTHORITY. This will disengage the automatic hinge moment limitation system and allow full rudder movement, if required.

Modified System

94. The incorporation of the qc (aerodynamic pressure) switch will supply a further "step" in the system, thus providing a greater degree of safety. An amber light on the warning panel marked QC FAIL, will signal a malfunction to the pilot. The linear actuator will still be operated through the landing gear selector to obtain the first "step" from full rudder authority (30°) to 12°. After the landing gear is raised the linear actuator length is controlled by qc, which will further limit rudder movement as the airspeed increases, to 4°. The limits of rudder authority are as follows:

(a) 30° from centre (full rudder movement) with landing gear down.

(b) 10° - 12° from centre with the landing gear raised and the airspeed less than 410 knots EAS at sea level (decreasing to 380 knots EAS at 30,000 feet).

(c) 4° from centre with the landing gear raised and the airspeed more than 410 knots EAS at sea level (decreasing to 380 knots EAS at 30,000 feet).

95. Should a malfunction occur and the QC FAIL warning light illuminate, a toggle switch marked RUDDER FEEL, AUTO-FULL AUTH must be selected to FULL AUTH. This will allow full rudder movement, if required. Under these conditions no protection is provided by hinge moment limitation.

Rudder Trim

96. The rudder may be trimmed by a toggle switch located on the pilot's LH console, marked RUDDER TRIM, LEFT-RIGHT. The trim unit forms part of the feel and hinge moment limitation system (see para 89) and operates within the limits of this system, except that slightly more rudder

trim may be obtained when operating at high qc than may be obtained by pilot effort at the rudder bar (6° of trim obtainable as against the 4° limit by rudder bar movement). Maximum trim movement may only be obtained at low airspeeds when the landing gear is lowered.

AUTOMATIC FLIGHT CONTROL SYSTEM (When fitted)

97. In the AFCS mode, either pilot assist functions or fully automatic functions may be selected on the selector panel.

98. The pilot assist functions are normal AFCS, mach hold and altitude hold. The automatic functions are Automatic Ground Control Intercept (AGCI), Attack, Automatic Navigation and Automatic Ground Control Approach (AGCA).

99. In the normal AFCS mode heading hold, roll attitude and pitch attitude hold are maintained, provided certain attitude limits are not exceeded. Heading will be maintained provided the aircraft is not banked at an angle in excess of 7-1/2°. A change in heading is made by movement of the control column. This action will disconnect the heading reference when the bank angle exceeds 7-1/2°. The aircraft is then levelled at the new heading and the control column is released. This new heading will be maintained. If the control column is released during a turn, the turn will be maintained provided the bank angle is less than 76°. If the bank is more than 76° only stabilization in roll is provided. In the pitch axis, an angle of climb or dive will be maintained upon release of the control column, provided the climb or dive angle is less than 55°.

100. Any malfunction occuring in the AFCS mode will call for immediate manual disengagement of the system, although in later aircraft this disengagement may be made automatic. In this case a warning that the AFCS had been automatically disengaged will be incorporated.

101. A failure of the system when the aircraft is performing a 'g' manoeuvre will, by means of the spring of the trim unit, automatically ensure that 'g' is reduced in the pitch axis to ± 1/2 'g' of 1 'g' flight, provided no force is applied to the control column.

AIR CONDITIONING SYSTEM

General

102. The air conditioning system is supplied with hot air bled from both engine compressors. A certain proportion of this hot air is cooled by means of thre components; an air to air heat exchanger which cools engine bleed

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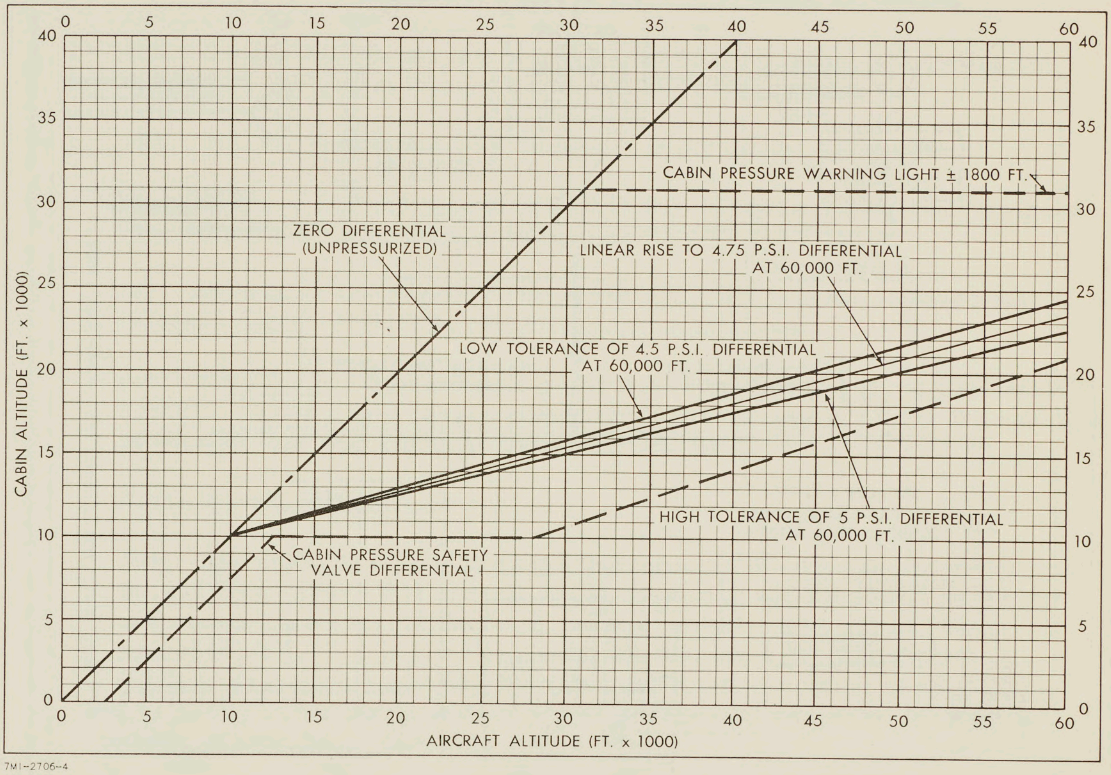

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FIG 1-6 PRESSURIZATION GRAPH

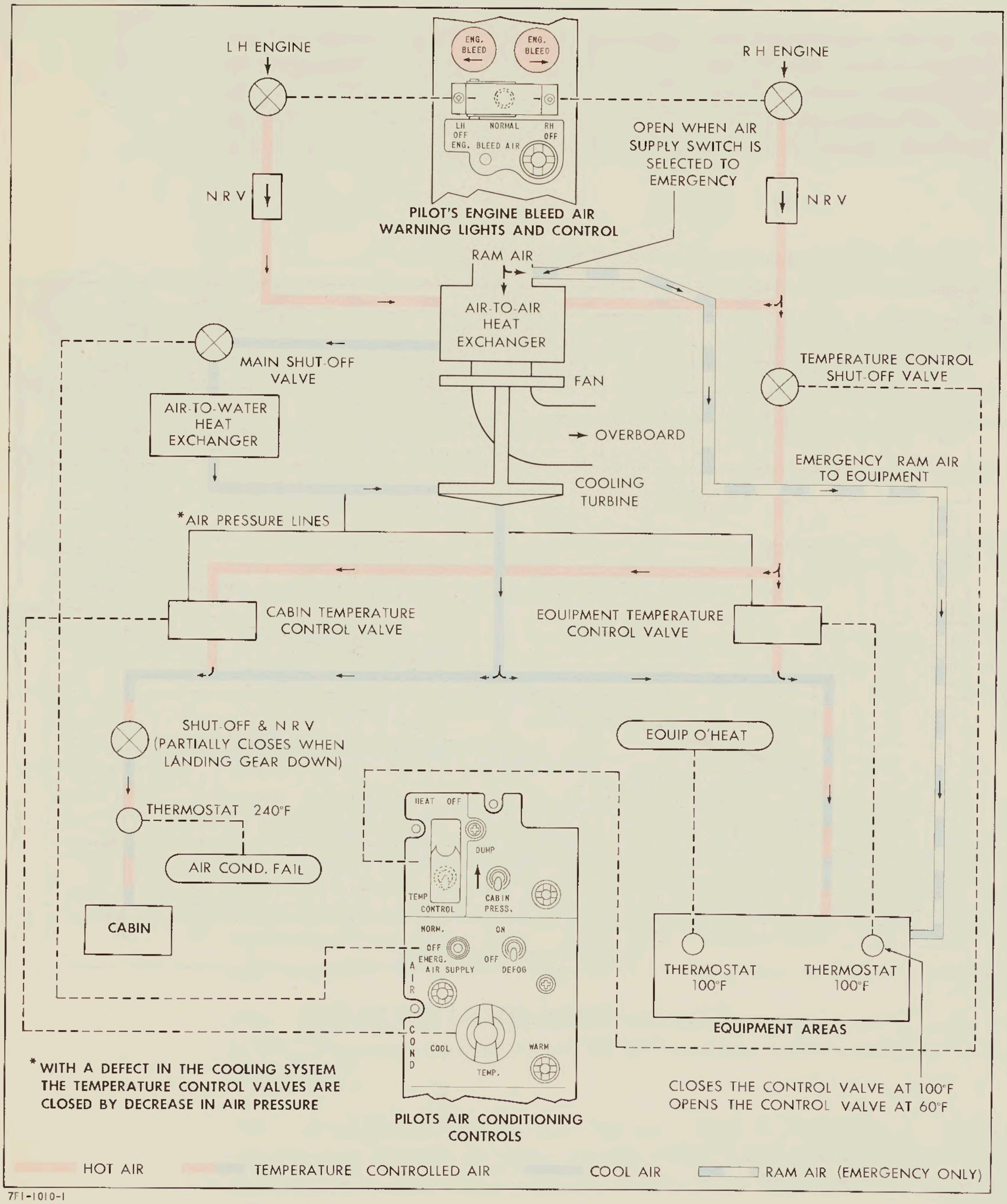

FIG 1-7 AIR CONDITIONING SYSTEM DIAGRAM

air by ram airstream, an air to water heat exchanger which cools conditioned air by heat transfer to distilled water, and a cooling turbine and fan. Various types of controllers and air valves served by thermostats and sensors are fitted which serve to maintain the selected conditions of air in the system during various airspeed and altitude conditions.

NOTE

The temperature and pressure of the engine bleed air varies according to flight conditions.

103. Ground equipment can be connected to the system for cooling the electronic equipment when the aircraft is on the ground.

104. The air conditioning system fulfills the following functions:

(a) Supplies hot and cold air to maintain cockpit pressure and temperature within the required limits.

(b) Maintains the required temperature levels in areas where heat is generated by electrical and electronic equipment.

(c) Supplies air for fuel tank pressurization, low pressure pneumatic system and the liquid oxygen converter. Discharged air from the cockpits is used to cool and scavenge the armament bay.

Cabin Pressurization

105. The cabin pressure remains the same as the outside air up to 10,000 feet. Above this altitude the differential between cabin pressure and aircraft pressure altitude increases linearly until a differential pressure of 4.5 - 5 psi is reached at 60,000 feet. A safety valve is fitted to prevent overpressurization if the normal control system fails. The safety valve limits the maximum differential pressure to 5.25 psi above 28,000 feet. See Fig. 1-6.

106. Cabin pressure altitude is shown on a gauge fitted on the RH side of the instrument panel in the pilot's cockpit and is marked CABIN PRESSURE.

107. A CABIN PRESS amber warning light is fitted on the warning panel. The master amber warning and the CABIN PRESS warning will illuminate if at any time the cabin altitude reaches 31,000 feet (± 1800 feet) or higher.

Cockpit Controls

108. The air conditioning controls are grouped together on a panel marked AIR COND at the rear of the RH console in the pilot's cockpit and comprise the following:

(a) A temperature setting rheostat switch marked TEMP/COOL-WARM. Movement of the switch from COOL to WARM will result in an increase of cabin temperature within the range of approximately 40°F - 80°F.

(b) A DEFOG switch with ON/OFF positions. In the case of fog forming in the cabin, selecting the switch to ON will rapidly raise the cabin temperature to approximately 90°F thus overriding the rheostat temperature selection.

(c) An AIR SUPPLY switch with NORM-OFF-EMERG positions which controls as follows:

(1) In the NORMAL position air is delivered to the cabin at a temperature determined by the setting of the TEMP/COOL-WARM rheostat. Outlets in the cockpits are located on either side of the seats and at floor level. During taxying and take-off the amount of air supplied to the cockpits is reduced. When the landing gear is raised after take-off a micro-switch is actuated which fully opens the cockpit air shut-off valve and allows full air supply to the cabin. Lowering the landing gear will reduce the air supply by partially closing the valve. Pressurization of the cockpits commences when the aircraft reaches an altitude of 10,000 feet. During flight, the equipment areas comprising the nose radar, alternator control, oxygen converter, fuselage electronics, fire control, dorsal electronics and the aircraft battery are maintained at a temperature of between 80° - 90°F by air from the system. The armament bay is cooled by discharged air from the cockpits. This air also scavenges the armament bay of fumes.

(2) In the OFF position the main air shut-off valve is closed, thus shutting off all air to the cockpits and equipment. When radar is fitted, a signal will also shut off the electronic equipment in the nose radar compartment. The OFF selection is used in flight to switch off the entire air conditioning system should the immediate action of selecting the TEMP CONTROL/HEAT OFF switch to HEAT OFF fail to remedy the fault. (See sub-para (e) also Part 3-Table). The speed of the aircraft must then be reduced below Mach 1.2 and the AIR SUPPLY switch selected to EMERG. (See sub-para (3) below).

(3) In the EMERG position emergency ram air valves are opened and ram air is used to cool the same equipment areas that were previously cooled under normal operation except for the nose radar equipment which

is automatically switched OFF. The cockpit air supply valve remains closed so altitude may have to be reduced as any further pressurization of the cabin will cease. Cabin pressure will fall at the natural leakage rate of the cabin.

(d) A two position switch marked CABIN PRESS and DUMP. The switch must be in the CABIN PRESS position for cabin pressurization to take place. In the DUMP position the cabin safety valve is opened and any pressure existing at the time is discharged through the valve; no further cabin pressurization will take place with the switch in this position. Air conditioning of the armament bay ceases when the DUMP selection is made.

(e) A toggle switch marked TEMP CONTROL - HEAT OFF. The TEMP CONTROL position is the normal selection for flight. The HEAT OFF position shuts off the supply of hot air to the cabin and equipment areas. Cool air will continue to flow to provide cabin pressurization and equipment cooling. The HEAT OFF selection is made if the AIR COND FAIL warning light or the EQUIP O'HEAT warning light illuminate. With certain system malfunctions, the selection of HEAT OFF may not lower the temperature sufficiently to extinguish the warning light. Under these circumstances the AIR SUPPLY switch is used. (See sub-para (c) (2).

Engine Bleed Hot Air

109. Two red warning lights are fitted above a three way toggle switch on the forward RH console. The lights are marked ENG BLEED, and arrows indicate their particular engine. The switch is marked ENG BLEED AIR, with three positions LH OFF-NORMAL-RH OFF. A particular ENG BLEED light will illuminate should a leakage of engine bleed hot air occur in the ducting to the air-to-air heat exchanger, or should the bleed air reach an excessive pressure through failure of a pressure reducing valve. Selecting the switch to the appropriate side indicated by the warning light (i.e. LH OFF or RH OFF), will close the shut-off valve in the engine bleed air supply duct on that side. If the condition is relieved, the warning light will go out.

NOTE

> Red lights are used as no master warning light illuminates.

Single Engine Flying

110. If one engine is shut down, or a drop in pressure of the engine bleed air to the heat exchanger occurs for any reason, a pressure switch is operated and a signal shuts off the electronic equipment in the nose compartment. (Aircraft with radar fitted).

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System Operation with Landing Gear Down

111. When the landing gear is lowered, a switch operated by the main door uplock is actuated. This action almost closes the cockpit air shut-off valve to conserve the air supply. The flow augmentor is also closed.

COCKPIT CANOPIES

General

112. The front and rear cockpits each have an independently operated two-piece canopy. Each canopy is normally opened or closed by electrical actuators controlled by switches, and is locked or unlocked manually by a lever which operates latches.

113. Power for canopy actuation is supplied from the battery bus so that opening or closing can be carried out when the master electrical switch is off.

NOTE

> The canopies should only be opened or closed once when using the aircraft battery. If more than one operation is required and provided the engines have not been started, a starting cart or ground supply should be used. This will prevent excessive drain on the aircraft battery.

114. Provision is made to open the canopy in an emergency by means of gas generating cartridges which may be fired either from inside or outside the aircraft. In case of seat ejection, a canopy is opened and the seat is ejected by pulling a large overhead firing handle down over the face, or by pulling the alternative firing handle on the seat pan. (See para 225).

Normal Operation

115. A switch marked CANOPY/OPEN-OFF-CLOSE is located in each cockpit on the LH console and controls the operation of the canopy for that cockpit. The switches are spring loaded to OFF and must be held in the required position until the operation is completed. The canopy locking lever must be fully back before the canopy open-close switch is operative.

116. When the canopy has been fully closed by the switch, it is locked by means of an overhead lever. Pulling down and moving the lever to the first

detent will latch or lock the two halves of the canopy together. It must then be pulled down and moved fully forward. It will engage a switch and, provided the other canopy is closed and locked, will operate the canopy seal pressurization valve and inflate the seals of both canopies. When a canopy is locked, the canopy open-close switch is de-energized and is inoperative. The lever is held in the fully forward position by a spring loaded plunger.

117. The canopy is opened when the aircraft is on the ground by pulling the overhead lever down and fully to the rear. The first rearward movement of the lever will deflate the seal of both canopies. As the lever passes the first detent position it unlocks the two halves of the canopy. When the lever is fully back the canopy open-close switch is energized and holding this switch in the open position will fully open the canopy.

Normal Operation from the Ground

118. The canopies may be opened or closed from outside the aircraft by means of two switches, one for each canopy, fitted on the canopy arch. The switches are marked CANOPIES/OPEN-OFF-CLOSE and are spring loaded to OFF.

Emergency Opening from the Ground

119. If the canopies are locked, the CANOPY OPEN-CLOSE switches outside the aircraft are inoperative. In an emergency the canopy locks can be released and the canopies opened by gas cartridge pressure.

120. An access door located on the RH side of the aircraft nose below the pilot's cockpit, marked EMERGENCY CANOPY OPENING, must be opened. Located inside is a lanyard, which is attached by cables to the front and rear cockpit canopy sears. Pulling the lanyard withdraws both sears and fires a gas generating cartridge for each canopy. The gas pressure first unlocks the canopy locking levers and then operates the emergency jacks, which open the canopies slightly more than for normal opening. A shear pin on the electrically operated jacks is sheared, allowing the extra movement. Pulling the lanyard does not move the emergency levers in the cockpits.

WARNING

If the aircraft is flown with the rear cockpit unoccupied, the safety pin must NOT be installed in the rear cockpit canopy sear. (See Part 2, para 4 (c).)

Emergency Opening in the Air

121. Each canopy may be opened individually in an emergency when in flight by operation of the emergency lever fitted on the RH side of each cockpit.

122. After an emergency canopy opening lever has been pulled, the operation of the gas generator and jacks is the same as in para 120.

NOTE

When a canopy is opened by the cartridge operated system the electrically operated jack is sheared, preventing closing of the canopy.

LIGHTING EQUIPMENT

Cockpit Lights

123. A panel, marked COCKPIT LIGHTING is located on the RH console in both front and rear cockpits. The front cockpit lighting panel has three rheostat switches and a toggle switch, while the rear cockpit lighting panel has two rheostat switches and a toggle switch, to control the lighting. An emergency flood/map light, powered from the DC emergency bus, is provided on the RH side in each cockpit and is controlled by a rheostat dimmer control incorporated with the on/off switch housing. The light may be selected red or clear by rotation of the bezel ring. The individual panel switches are as follows:

(a) A rheostat switch marked MAIN PANEL - OFF/BRIGHT, controls all lighting of the main panel. Power is taken from the main AC bus.

(b) A rheostat switch marked CONSOLE PANELS - OFF/BRIGHT, controls the red edge lights for the console panels. Power is taken from the main AC bus.

(c) A rheostat switch marked CONSOLE FLOOD-OFF/BRIGHT, controls the red console flood lights. Power is taken from the main AC bus.

(d) A toggle switch marked HIGH ALT LIGHTING-ON/OFF, controls the amber flood lights for the main instrument panel and consoles. Power is taken from the main DC bus.

124. The rear cockpit individual panel switches are as follows:

(a) A rheostat switch marked PANEL LIGHTS - OFF/BRIGHT, controls the instrument lights and console panel edge lights. Power is taken from the main AC bus.

(b) A rheostat switch marked CONSOLE FLOOD OFF/BRIGHT, controls the red console flood lights. Power is taken from the main AC bus.

(c) A toggle switch marked HIGH ALT LIGHTING ON/OFF is not connected at present.

External Lights

125. External lights comprise two landing/taxi lights, and the navigation lights. The landing lights are fitted on the nose landing gear. One is fitted on the steering portion for taxying purposes and the other is fitted on the fixed portion of the leg. A switch, fitted on the LH console in the front cockpit and marked LIGHTS, has three positions, LAND-TAXI-OFF. With the landing gear extended, selection of LAND will illuminate both lights while selection of TAXI will allow only the taxi light to illuminate. (Landing and taxi lights are not fitted at present).

126. The navigation lights consist of the right (green) and left (red) wing tip lights and two fin tip lights (white and red). They are controlled by a flasher unit through a switch located on the RH forward console in the front cockpit marked NAV LIGHTS/FLASH-OFF-STEADY. When selected to FLASH the two wing tip lights and the white fin tip light will be on together and will flash alternately with the red fin tip light. The lights will revert to 'steady' should the flasher unit fail.

ENGINE OPERATION AND CONTROLS

Engine Power Controls

127. Two conventionally operated engine throttle levers are installed on the LH console. Movement of each lever operates the fuel flow control quadrant lever at the engine via a continuous cable. The cable is automatically maintained at correct tension by a tension regulating device.

128. Each lever has "gated" stops to enable a positive selection of the cut-off and idle positions. Lifting and pulling the levers aft of the idle position shuts off the HP fuel supply to the engines. To move the levers from the cut-off to the idle position they must be moved forwards and down.

Afterburner Control

129. Each throttle lever controls non-afterburning and afterburning engine operation as follows:

(a) Progressive forward movement of the lever up to the maximum stop position selects a range of engine thrust (without afterburning) from "idle" to "military" power.

(b) Progressive forward movement from "idle" to a position marked DOWN FOR AFTERBURNER on the quadrant gives normal engine thrust. Depression of the lever within the afterburner range actuates a micro-switch and the afterburner lights. Normally the afterburner is engaged when the throttle levers are in the fully open position.

130. Two green indicating lights, located on the RH side of the main instrument panel, are marked A 'BURNERS LEFT and RIGHT. Illumination of a light will indicate that the afterburner nozzle is fully open and should be illuminated only during the time the afterburner is operating.

WARNING

Should the afterburner nozzle fail to open immediately the afterburner starts to operate, the green light will not illuminate and, in addition, there be a rapid increase in exhaust temperature and a decrease in rpm. Afterburning should be discontinued immediately should any of the above conditions exist.

131. Normally afterburning is terminated by lifting the lever to the original 'up' position within the quadrant. This relieves the pressure on the micro-switch which shuts down the afterburner.

132. If, during afterburner operation, an emergency requires a rapid reduction in engine power below the afterburner range, the levers may be pulled straight back as far as necessary. On the levers passing the DOWN FOR AFTERBURNER position a ramp will lift the levers up, de-actuate the micro-switches and shut down the afterburners. Should an electrical fault exist which prevents the afterburners being shut down by the normal method of raising the throttle levers, they may be shut down independently of the electrical system by retarding the throttle levers past the DOWN FOR AFTERBURNER position. This action cuts off the afterburner main and igniter fuel supply and closes the nozzles, by means of pressure.

Engine Starting Controls

133. The engine starting controls comprise:

(a) An ENGINE START switch with START-OFF-RESET positions, located on the RH console.

(b) A relight button on each throttle lever.

(c) An LP FUEL cock switch for each engine, located on the LH console.

(d) An HP fuel cock for each engine controlled by its respective throttle lever.

134. During the normal start procedure when the ENGINE START switch is pulsed to START and released, the following sequence of operations automatically take place:

(a) A switch which is operated in the air turbine starter motor when the engine reaches approximately 700 rpm energizes the ignition circuit for 'light-up'.

(b) A second switch in the air turbine starter motor is operated when the engine reaches approximately 3,000 rpm, and performs the following operations simultaneously:

(1) Switches off the ignition.

(2) Shuts off the air supply from the ground starter cart.

Engine Motoring

135. The engines may be motored should a wet start occur, or in the case of an internal engine fire on the ground, as follows:

(a) Move the throttle lever to the cut-off position.

(b) Check that the LP cocks are in the ON position.

(c) Check that air starting power is available from the ground starter unit.

(d) Select the ENGINE START switch to the RESET position and hold for a maxium time limit of 30 seconds. Allow the switch to return to the OFF position. The engine will motor at approximately 1,200 rpm.

NOTE

Holding the ENGINE START switch to the RESET position isolates the ignition circuit, opens the air supply valve in the ground starter unit and permits the engine to rotate. When the switch is released, the air supply valve in the ground starter unit is closed and the engine will gradually run down.

ENGINE INSTRUMENTS AND WARNING LIGHTS

Pressure Ratio Indicator

136. An Engine Pressure Ratio Indicator for each engine is fitted on the main instrument panel. Each indicator denotes the ratio of the turbine discharge total pressure to the compressor inlet total pressure and is an indication of the power being developed by the engine.

137. The ratio shown on the indicator for an engine developing military thrust at take-off will vary from day to day, according to the ambient temperature.

138. To compute the engine pressure ratio which a normally functioning engine may be expected to produce during a take-off thrust check, a curve as shown in the engine operating handbook may be used. This curve for the ARROW 1 installation will be issued later.

139. Curves may be used for determining the engine pressure ratio for a desired engine power setting, either for a climb or cruise condition, the factors involved being altitude and compressor inlet total temperature (ambient temperature corrected for ram effect). This curve will also be issued later.

140. Once the desired power condition has been set up for climb or cruise, the fuel control will maintain an approximately constant percentage of thrust output with a fixed power lever position. As engine pressure ratio varies with compressor inlet temperature, the pressure ratio will increase as temperature becomes lower at the higher altitudes.

Engine RPM Indicator

141. An rpm indicator (tachometer) graduated in percentage rpm, is fitted on the main instrument panel for each engine. On the indicator 100% rpm represents a high pressure compressor speed of 8732 rpm.

NOTE

The low pressure compressor rpm are not instrumented in the cockpit.

142. The 100% position is not the rpm at which Military Rated thrust will be developed by the engine. The rpm for military rated thrust on standard day sea level static conditions for different engines will vary, depending upon the engine trim speed which is stamped on the engine data plate. The rpm serves as an indication that compressor speed is within allowable limits. A red line on the indicator at 103.5% represents the overspeed limit.

CAUTION

Each case of rpm overspeed in excess of 103.5% should be noted in the engine log book.

143. The rpm indicators can be used for checking engine power output. In this case, temperature/rpm curves must be used and the result adjusted for the particular engine trim speed.

Turbine Outlet Temperature Gauge

144. One gauge is fitted for each engine, indicating the temperature immediately downstream from the turbine discharge and serving as a relative indication of the temperature at the turbine inlet. The instruments require AC power. Two flags are visible at windows on the face of the instrument. When electrical power is off, both flags show the word OFF. When electrical power is ON, the flags disappear. One flag is always visible in the event of the other flag being obscured by the indicating pointer.

Warning Lights

145. Two amber lights are fitted on the warning panel marked ENG O'SPEED L and R, and indicate when the LH or RH engine low pressure compressor is overspeeding. (See para 147)

146. Two amber lights are fitted on the warning panel marked OIL PRESS L and R, and indicate when the oil pressure of the particular engine is 25 psi or less.

147. On aircraft 25201, an indication is given when the engine breather pressure to the oil tank and gear box exceeds 15 psi. Wiring from a

pressure switch has been taken to the ENG O'SPEED warning light; therefore on aircraft 25201 the illumination of the ENG O'SPEED warning light will indicate either rotor overspeed or excessive engine breather pressure. In either event, the immediate action of throttling back the particular engine until the light goes out is the same. The engine should then be operated to maintain the light out.

LOW PRESSURE PNEUMATIC SYSTEM

General

148. The LP pneumatic system supplies low pressure air, tapped from the inlet side of the air conditioning cooling turbine, to the anti-g suits and the canopy seals.

Anti-g Suit Controls

149. An anti-g valve is located at the aft end of the RH console in each cockpit and controls the supply of LP air to the anti-g trousers. The valves are set to start pressurizing the trousers at 1.5 g to 1.8 g. The pressurization increases with the increase of 'g' force up to a maximum of 10 psig which would be reached at 8 g. Connection between the anti-g valve and anti-g trousers is made through the crew members composite leads disconnect. An override button on the top of the anti-g valve will, when depressed, allow the full 10 psig pressure to enter the trousers.

Canopy Seals

150. The pilot's and navigator's canopy seals are inflated by low pressure air at 18-22 psi, through a control valve. The valve is operated electrically and the seals are inflated when both canopy handles are in the "sealed" position, i.e. fully forward. If either canopy handle is not fully forward the seals will deflate and vent the pressure to atmosphere. The rear cockpit canopy locking handle may be operated from the front cockpit through an access door in the bulkhead, to enable the rear canopy to be sealed if the aircraft is flown solo.

DE-ICING AND ANTI-ICING SYSTEMS

General

151. The aircraft anti-icing and de-icing systems are entirely automatic in operation. The engine systems may be divided as follows:

(a) Ice detection.

(b) De-icing of the duct intake ramps and lips.

(c) Engine compressor inlet anti-icing.

152. The airframe systems are as follows:

(a) Windscreen and canopy anti-icing.

(b) Pitot head anti-icing.

(c) Probe vane anti-icing.

Ice Detection

153. Two identical electrically heated ice detectors are fitted; one mounted on the lip of each engine intake duct.

154. Each detector has two probes, one of which is electrically heated whenever power is ON, and the other which is only heated when ice covers the forward holes. A pressure differential switch signals the ice controller when ice forms on the normally unheated probe. The signal also causes the master amber warning light and the light on the warning panel, marked ICE, to illuminate. The automatic heating of this probe melts the ice on the probe, restores the normal pressure, and the probe is then ready to send another signal to the ice controller. The signals continue as long as icing conditions exist, at a rate proportional to the rate of icing. The rate is indicated to the pilot by the ICE warning light and the master amber light, going on and off.

Duct De-icing

155. De-icing of the engine ducts is accomplished by electrically heated rubber ice protectors which are automatically controlled. The protectors are separated by parting strips which are heated at the first ice signal from the controller (para 154). The remainder of the protectors are heated after a pre-set number of ice signals are received and will shed the ice. The icing and de-icing cycle will be repeated according to the number of signals received by the controller.

Engine Compressor Inlet Anti-icing

156. Engine anti-icing is accomplished by the use of engine bleed air. The first icing signal from the controller automatically opens air supply valves and provides hot air to the compressor inlet section of the engine. The system functions continuously during icing conditions. The valves close automatically at the same time as the duct de-icing ceases.

157. The flow of hot air is regulated according to the compressor discharge temperature. Flow will be reduced as the temperature increases.

NOTE

During descent at high airspeeds and low power settings the heat supplied may be inadequate if the ice formation is severe. Increased thrust should be applied to provide more heat. An abnormal increase in turbine discharge temperature will be noted when the throttles are advanced if ice is still accumulating in the compressor inlet.

Windscreen and Canopy Anti-icing

158. The pilot's windscreen and canopy windows are automatically heated by electrical means when the aircraft master electrical switch is on, with AC and DC supply available.

Pitot-head and Vane Anti-icing

159. A toggle switch, located at the rear of the RH console is marked FWD PITOT HEAT, ON-OFF. With this switch on, and provided the master electrical switch is on with AC and DC supplies available, the nose boom and vanes are heated by electrical means to prevent icing. Pre-production nose booms are not fitted with thermostatically controlled heaters for the vanes, therefore care must be exercised to ensure that the heat switch does not remain on when the aircraft is stationary.

160. The production nose boom vanes will be thermostatically controlled and, when fitted, the switch will be removed.

161. The fin pitot-heads are heated when the master electrical switch is on, with AC and DC supplies available.

OXYGEN SYSTEM

General

162. In the normal system, both crew members are supplied with oxygen from a single liquid oxygen converter. In the emergency system, each crew member is supplied from his individual bottle containing gaseous oxygen.

Normal System

163. The normal system is supplied from a converter containing liquid oxygen. The liquid oxygen is converted into gaseous oxygen for crew members breathing purposes and for inflation of the partial pressure suits.

164. The quantity of liquid oxygen contained in the converter is shown on two gauges in litres. One gauge is fitted on the forward RH console in the pilot's cockpit, while the other gauge is fitted on the navigator's main panel. The gauges are operated electrically and an OFF indicator flag on each gauge becomes visible when electrical power to the quantity gauging system is terminated.

165. Oxygen flows from the converter, through the composite leads disconnect, to a regulator mounted beneath the ejection seat. The regulator automatically compensates for altitude. From the regulator, oxygen flows to the composite leads disconnect from which a flexible hose delivers it to the pressure gravity valve (PGV) on the crew members pressure breathing waistcoat.

166. From the PGV oxygen is fed directly to the pressure breathing waistcoat and through flexible hoses to the crew members pressure helmet and anti-g trousers.

167. In the event of a malfunction reducing cabin pressure below a pressure equivalent to 40,000 feet or above, the oxygen regulator feeds oxygen to pressurize the pressure breathing waistcoat, anti-g trousers and pressure helmet.

168. Should the aircraft be subjected to positive 'g' load while the partial pressure suit is pressurized with oxygen, the air pressure supplied through the anti-g valve overrides the oxygen pressure in the anti-g trousers (para 166). Upon removal of the 'g' load the anti-g valve will vent the air pressure and the pressure in the trousers will reduce until it equals the pressure in the pressure breathing waistcoat and pressure helmet. The PGV will maintain this pressure.

Oxygen Regulator

169. An automatic pressure demand oxygen regulator is fitted beneath each seat pan. A PRESS-TO-TEST button is fitted on the right of the seat pan and is used to test the mask and pressure suit, prior to flight.

Emergency Oxygen Supply

170. Attached to the forward part of each seat pan is an emergency oxygen

cylinder containing gaseous oxygen at a pressure of 1800 psi when fully charged. The oxygen pressure is shown on a gauge attached to the cylinder. A fully charged cylinder provides a minimum of 20 minutes supply.

171. A combined automatic and manual trip valve is fitted to each cylinder. The automatic function operates upon seat ejection by means of a lanyard, which connects the valve to the floor of the aircraft. Should the normal oxygen supply fail, the emergency bottle supply may be used by operating the EMERGENCY OXYGEN MANUAL CONTROL located on the LH side of each seat pan. In both automatic or manual function, the trip valve connects the emergency cylinder to the regulator, and to the mask and pressure suit through the composite leads disconnect. Thus the regulator adjusts the emergency supply in the same manner as the normal supply is adjusted.

Composite Leads Disconnect

172. A composite leads disconnect fitting is located to the right of each ejection seat pan. Connections from the fitting are as follows:

(a) Oxygen to mask and pressure to suit.

(b) Telecommunications.

(c) Anti-g suit trousers.

173. The fitting is in three parts and when seat ejection takes place one part of the fitting remains with the aircraft while the other two parts are attached to the seat. This allows emergency oxygen to be used during the early part of the descent. When the occupant separates from the seat, the remaining two parts disconnect, leaving one on the seat and the other attached to the occupant.

UTILITY HYDRAULIC SYSTEM

General

174. The utility hydraulic system is separate from the flying control hydraulic system. The utility system is powered by two pumps, one mounted on each engine driven gearbox. A nominal operating pressure of 4000 psi is maintained by the pressure regulating valves. Either pump will supply the requirements of the utility hydraulic sub-systems, but the speed of operation of the system in use will be reduced.

175. A 5000 psi nitrogen charged storage bottle is provided for emergency extension of the landing gear. Two 4000 psi accumulators are included in the system for emergency braking.

176. The utility hydraulic system operates the following components:

(a) Landing gear.

(b) Wheel brakes.

(c) Nose wheel steering. (If fitted)

(d) Speed brakes.

(e) A hydraulic motor to drive the emergency alternator. Operation is automatic in case of complete electrical failure.

Landing Gear

177. The tricycle landing gear consists of a forward retracting nose gear with dual wheels, and main gears with two-wheeled bogies which retract inboard and forward into the wing.

Landing Gear Controls

178. The landing gear is operated by means of a lever which has a wheel shaped handle containing a red light, located on the landing gear selector panel on the LH forward panel.

179. The landing gear control lever cannot be selected UP when the weight of the aircraft is on the main wheels. When the weight is off the main wheels, micro-switches are operated to energize a solenoid permitting an UP selection to be made.

Emergency Lowering Landing Gear

180. In the event of failure of the normal system, the landing gear may be lowered by means of nitrogen pressure from a 5000 psi nitrogen storage bottle. To operate the system a thumb latch marked EMERGENCY EXTENSION, under the landing gear lever, is pressed down and the lever is moved fully downwards. The nitrogen pressure releases the uplocks of the doors and gears at approximately the same time, and each gear then falls in a manner similar to normal lowering.

Landing Gear Position Indicators

181. Three indicators marked GEAR POSITION are located on the LH side of the main instrument panel, and show the position of the two main gears and nose gear. In addition, a red light is fitted into the handle of the landing gear selector lever and illuminates steadily when any gear

or gear doors are between locks. The red light flashes if either throttle lever is retarded below the minimum cruise position if the landing gear selector lever is not in the down position. When the throttle of a non-operating engine is placed in the cut-off position for one engine flight, the light will go out. However, the light will illuminate again when the throttle lever of the live engine is retarded if the landing gear lever has not been selected down.

182. With electrical power switched on, the three indicators on the main panel show landing gear position as follows:

Position	Indication	Landing Gear Handle Warning Light
Landing Gear and Doors Locked Up	UP	OFF
Landing Gear or Doors Between Locks	Black and White bars	ON
Landing Gear Locked Down	Wheel symbol	OFF

Sequencing of Landing Gear and Doors

183. The nose landing gear door is electrically sequenced to open and close automatically in conjunction with a landing gear selection, so that the take off and landing may be made with the door closed. Later aircraft will, in addition to electrical nose door sequencing, be fitted with mechanical main door sequencing, so that all landing gear doors may be closed during take-off and landing.

184. A ground service guarded switch, marked N/W DOOR UP - DOWN is fitted in the nose wheel well for ground crew use; the switch is spring loaded from DOWN to the centre off position. The nose door may be opened on the ground, provided one engine is operating, by selecting the switch momentarily to DOWN and releasing.

185. The ground service switch is normally pre-selected to UP before starting the engines. With this selection when one engine is started the nose gear door will close. If the switch remains at the centre 'off' position the door will not close, except when the landing gear is raised after take-off, but it will close after the landing gear is lowered.

WARNING

All personnel must be clear of the door during the opening or closing cycle.

186. When the landing gear lever is selected up after take-off, the nose gear door will commence to open, but the nose gear indicator will show 'gear locked down' until the door is fully open. When the door is fully open the gear downlocks will be released by hydraulic pressure, the indicators will show gear unlocked, the red light in the gear lever handle will illuminate and all gears will retract. When the individual gears lock up, the doors will commence to close and when the doors are locked up the "gear locked up" symbol will show on the indicator, and the red light in the gear handle will go out.

187. The hydraulic selector valve, which is operated by electrical means whenever the landing gear lever is moved, is returned to neutral when all gears and doors are 'up', and the system pressure is reduced. A by-pass valve is provided in the circuit to by-pass the selector valve during emergency landing gear extension.

188. If one door becomes unlocked during flight and releases the micro-switch plunger, the red light will illuminate in the gear handle and the indicator will show that gear 'unsafe'. At the same time power will be applied to the UP solenoid of the selector valve, the door will retract, the indicator will show 'gear up' and the gear handle light will go out. The selector valve will again automatically return to neutral.

189. When the landing gear is selected DOWN, hydraulic pressure releases the door and gear uplocks in sequence and the gear falls by gravity aided by air loads. Its fall is restricted by a fixed orifice in the jack and is damped at the final portion of extension.

190. The red light in the gear handle will illuminate and remain illuminated until all gears are locked down. The indicators will also show unlocked until the gears are locked down. When the nose gear locks down the nose door will close but no indication is given.

Wheel Brakes

191. The normal braking system derives its pressure from the utility hydraulics main pressure line and the emergency system derives its pressure from two nitrogen charged emergency brake accumulators in the utility hydraulics circuit. The emergency accumulators are maintained at a pressure of 4000 psi by the main system. The emergency system takes over automatically from the normal system whenever the pressure in the normal system falls below 850-900 psi. (See para 197). Two brake control valves are fitted which reduce pressure to the brake units and vary this pressure depending upon the force applied to the brake pedals. The normal system pressure at the brake units is between 90 - 2500 psi, while the emergency system pressure at the brake units is between 90 - 1500 psi.

192. Toe pressure on the pilot's rudder brake pedals actuates control valves via cables and allows differential and proportional braking of the two pairs of main wheels. No anti-skid protection is provided on early aircraft, but later aircraft will be fitted with an anti-skid system which will release pressure on the brakes when a skid is imminent.

193. Brakes are applied automatically upon retraction of the landing gear to stop the wheels spinning.

Anti-skid System (When fitted)

194. Detection of an imminent skid of a wheel and immediate release of pressure to that brake to prevent actual skidding, is provided on later aircraft. To prevent excessive differential braking being used when the pressure is cut off from one side, the brake on the opposite side is also released, thus preventing a yawing effect.

195. A locked-wheel touchdown is prevented by a micro-switch which prevents brakes being used until the weight of the aircraft is on the main wheels. Detectors are also fitted which prevent use of the brakes until the wheels are rotating at the aircraft landing speed.

196. In case of failure of an anti-skid unit, selecting the ANTI-SKID switch located on the LH console to EMERG OFF disconnects all anti-skid units.

Pressure Warning Lights

197. If the pressure in the normal utility system falls below 850-900 psi, the master amber warning light and the UTIL HYD indicator light on the warning panel, will illuminate. This indicates that emergency extension of the landing gear will be necessary and that emergency brake pressure will be used for braking upon landing. Should the pressure in the emergency accumulators fall below 1600 psi, the EMERG BRAKE HYD indicator light on the warning panel will illuminate and indicate that emergency braking will be inoperative upon landing.

Parking Brake

198. A handle is fitted on the LH side of the main instrument panel and is marked PARKING. The brakes can be locked on for parking by depressing the rudder brake pedals, pulling the parking brake control and releasing the brakes. To release the parking brakes, the handle is pulled outwards and allowed to return fully inwards.

199. The emergency accumulator provides hydraulic pressure for the brakes when towing the aircraft or for parking after engine shut-down.

Nose Wheel Steering - (Trial Installation Only)

200. The nose wheels are steered hydraulically by the movement of the pilot's rudder pedals which are mechanically linked to a steering control valve. A solenoid valve is opened when the push button, located at the bottom left of the control column grip, is pressed. This allows high pressure hydraulic fluid to flow to the control valve which operates a jack and moves the nose wheel according to the pilot's rudder pedal movements. When the nose wheel reaches an angle corresponding to the position of the rudder pedals, the control valve spool returns to normal. The rudder pedal position must be synchronized with the nose wheel position when initiating steering. Normal castoring of the nose wheels is available when steering is not engaged. A micro-switch prevents turning of the nose wheels unless the weight of the aircraft is on the nose wheels.

201. The nose wheels can be steered or castored through an angle of 55° each side of the centre line, enabling the aircraft to be turned on a 21 ft radius.

Speed Brakes

202. Two speed brakes are fitted in the bottom of the fuselage immediately aft of the armament bay. They are hydraulically operated by the utilities system and are controlled by a thumb switch on the RH throttle lever. The switch opens or closes the electrical circuit to a solenoid operated hydraulic control valve. There is no indicated airspeed limitation for extending the speed brakes or for flying with them extended. However, the amount of opening, or the amount they will "blow back" if already open, is governed by the airload on the brakes.

203. The speed brake selector switch has three positions, fully forward - "OUT", central - "hold", and fully back - "IN". The switch should remain at the IN position when speed brakes are not in use and at the OUT position when using them fully down. The 'hold' position may be used to obtain intermediate selections, the speed brakes being hydraulically locked in the position existing at the time of selection.

NAVIGATION EQUIPMENT

Radio Magnetic Indicator

204. The pilot and navigator are each supplied with a RADIO MAGNETIC INDICATOR, located on their respective main instrument panels. A

selector switch, marked RMI NEEDLE - UHF HOMER/TACAN is fitted in both cockpits on the RH console. The TACAN position is not connected and is not used. When selected to UHF HOMER the single pointer of the radio magnetic indicator in that particular cockpit will show the relative bearing of the station selected on the ARC-34 receiver. The compass card of the RMI is controlled by the J4 compass and indicates the magnetic heading of the aircraft. (See para 208). The double pointer is used, in conjunction with the radio compass, to obtain a bearing of a broadcast or radio range station (see para 206).

UHF Homer

205. This navigational aid utilizes the AN/ARC-34 main receiver (see Communication Equipment). Homing facilities are provided by selecting the OFF- MAIN- BOTH-ADF switch on the COMM control panel to ADF. Provided the RMI NEEDLE selector switch on the RH console is selected to UHF HOMER, the single pointer of the RMI will indicate the relative bearing of the selected radio signal source, and enable the aircraft to "home" on the signal. Signals must be in the 225 to 400 MC range for automatic direction finding to operate. Successful operation depends upon the power of the transmitting station, the altitude and the distance between the transmitting station and the aircraft. Results will not be dependable if the horizon appears between the transmitting station and the aircraft.

Radio Compass (AN/ARN-6 L.F)

206. The ARN-6 radio compass receiver provides a bearing on broadcast or radio range stations, and the relative bearing is shown by the double pointer on the radio magnetic indicators. A RADIO COMPASS control panel is fitted on the RH console in both cockpits, but only one panel is in control at a time. The tuning dial of the control panel in use is illuminated. Control may be gained by the other crew member by turning the selector switch to CONT (control) and then back to COMP. The bearing indication is shown on the double pointers of both radio magnetic indicators simultaneously. Audio signals are received through the AN/AIC 10 interphone system, provided the mixing switch on the interphone panel marked COMP, is ON.

207. A station is tuned by means of a band selector switch and a tuning knob. Mode of operation is selected as follows:

COMP - To obtain station bearing automatically.
ANT - To operate as a communications receiver only.
LOOP - To obtain station bearing manually by means of a loop drive control on the panel.

J4 Gyrosyn Compass

208. The J4 Gyrosyn compass system can operate as a gyro stabilized magnetic compass or as a directional gyro. Magnetic heading information is sensed by a remote compass transmitter installed in the right wing. Heading information is displayed by the cards of the radio magnetic indicators and the R-Theta computer system (if fitted). A J4 compass control panel, fitted to the RH console of the pilot's cockpit, has the following controls:

(a) A function selector switch marked MAG-DG is used to select the mode of operation of the compass system. When the switch is in the MAG (magnetic) position, the system operates as a magnetic compass and can be synchronized with the remote transmitter. In the DG (directional gyro) position, the system operates as a directional gyro, which can be latitude corrected. The compass is automatically synchronized with the remote compass transmitter when the function selector is switched from DG to MAG. Automatic synchronization can be achieved at any time when in the MAG mode by switching momentarily to DG and back to MAG.

NOTE

The annunciator normally indicates a small error upon completion of the automatic synchronization. This error will usually be corrected within one or two minutes.

CAUTION

Approximately two minutes must be allowed between each automatic synchronization procedure to allow the cycle to be completed.

(b) A synchronizer knob marked SET, which is spring loaded to the SET position. The knob may be moved to the left (marked DECR-, standing for decrease heading) or to the right (marked INCR+, standing for increase heading) in order to increase or decrease the indicated heading at either a fast or slow rate; only these two speeds are available. The control may be used to help synchronize the compass in the MAG mode if the automatic synchronization fails. The annunciator pointer should line up with the centre index when synchronization is obtained; however, it may be found impossible to line up the annunciator with the index using this control. If the control is released as soon as the annunciator begins to move off the stop (using the slow slewing rate) the card will be within two or three degrees of synchronization, even though the annunciator is hard over to the other stop. This small error will be removed by the system within two or three minutes without any further action by the pilot. When the function selector is in the DG position the annunciator window is covered and the letters DG appear.

(c) The latitude correction controller, marked LAT is manually set to the flight latitude to correct the system, when in the DG mode of operation, for the apparent drift of the gyro due to the earth's rotation.

(d) A hemisphere screwadjustment marked N and S is normally set on the ground to the northern or southern hemisphere in which the gyro is operated. Setting it to "N" will effect a clockwise correction for gyro drift, while an "S" setting will effect a counter-clockwise correction; the rate of precession is determined by the setting of the latitude correction controller.

(e) An annunciator which indicates synchronization to ± 15' between the compass system and the remote transmitter when in the magnetic mode of operation. When the system is not synchronized, the annunciator indicates in which direction the synchronizer knob must be turned.

209. A J4 COMP, NORMAL-AEROBATICS switch is fitted on a panel located below the radio compass control panel on the pilot's RH console. If violent manoeuvres are to be carried out this switch should be selected to AEROBATICS to prevent erroneous readings. NORMAL should be selected after return to normal flight otherwise significant compass errors will develop with time.

COMMUNICATION EQUIPMENT

UHF Equipment (AN/ARC-34)

210. An AN/ARC-34 receiver-transmitter is installed and permits short range voice transmission and reception, air-to-air or ground, on 20 preset frequencies. Any other frquency within the operating range may be selected manually. Reception and transmission is made through the AIC/10 interphone system. The control panel, marked COMM, is located on the LH console in the pilot's cockpit and comprises:

(a) An OFF-MAIN-BOTH-ADF switch, which sets up the type of operation as follows:

OFF
MAIN - Main transmitter/receiver is operative.
BOTH - Main transmitter/receiver and the Guard receiver are both operative.
ADF - The automatic direction finder (HOMER) is operative. (See para 205).

(b) A MANUAL/PRESET/GUARD switch which selects the type of frequency control for the transmitter and main receiver. When PRESET is selected, the large central knob is rotated to bring the required frequency channel number in the centre window. The preset frequency and channel numbers are inscribed on a card at the base of the panel. When MANUAL is selected, four windows at the top of the panel open and expose digits, which may be altered to the frequency required by means of a knob located below each window. When GUARD is selected the windows are closed and the transmitter and main receiver operate on the GUARD frequency.

(c) A TONE button, which provides MCW transmission.

(d) A VOLUME control.

211. Two antennas are fitted for the UHF equipment, one in the fin and one in the equipment bay. They are known as upper and lower respectively, and may be selected at the pilot's discretion by means of a two position switch on the RH console in the front cockpit. The switch is marked UHF ANT-UPPER/OWER.

Intercommunication (AN/AIC-10)

212. Intercommunication is provided by an AN/AIC-10 set. It provides interphone between aircrew, ground crew and operations room and also affords a means of selection of the aircraft's radio facilities.

213. Identical control boxes are fitted for the pilot and the navigator and are located on their respective RH consoles. A PRESS-TO-TALK button is fitted in the RH throttle lever in the front cockpit and on the panel forward of the AIC-10 panel in the rear cockpit. The control box comprises the following switches:

(a) A series of five mixing toggle switches which allow for listening simultaneously on all channels which are selected to the ON position.

Switch 1 marked INTER - For interphone between pilot and navigator.

Switch 2 marked COMP - Radio Compass AN/ARN-6 aural reception, used to tune and identify a particular station.

Switch 3 marked COMM - Command radio, gives UHF reception with other aircraft or ground stations.

Switch 4 marked TACAN - AN/ARN-21 radio set aural reception used to tune and identify a particular station.

Switch 5 marked TEL - For telescramble information reception when the aircraft is on the ground.

(b) A six position rotary switch giving talk facilities by means of the following selections:

Position 1 - (Fully counter-clockwise) - Spare.

Position 2 - Spare.

Position 3 - Marked TEL, provides transmission facilities through the telescramble line when the aircraft is on the ground by operating the "Press to Transmit" button.

Position 4 - Marked COMM. Provides a "live" microphone for interphone without interrupting command radio listening, provided the INTER mixing switch is ON. When the "Press to Talk" button is pressed, it permits transmission on command radio.

Position 5 - Marked INTER. Provides "Press to Talk" interphone operation.

Position 6 - Marked CALL. Spring loaded in the fully clockwise position and returns to position 5 (INTER) when released. When held in the CALL position it overrides all other functions irrespective of switch positions and gives interphone without the use of the "Press to Talk" button.

214. The "Press to Talk" button is used when the selector switch is in the COMM position and it is desired to transmit on command radio or in the TEL position when transmitting on the telescramble line. When the selector switch is in the INTER position "Press to Talk" interphone facilities are available regardless of the mixing switch positions. A volume control is fitted and adjusts volume on all incoming channels.

215. A toggle switch marked NORMAL-AUX. LISTEN is wire-locked in the NORMAL position, but if reception at the station fails a quick test of the amplifier may be made by breaking the locking wire and listening with the switch on AUX. LISTEN; this cuts out the amplifier. This facility is available for emergency listening in flight, and when used, the mixing is inoperative and one channel only is available for listening, as selected by a toggle switch. If more than one switch is on, the only audible channel will be that given by the first (from the left) of the row of mixing switches that are on. If none are ON, the only audible channel will be the one to which the rotary selector switch is set.

216. Inadvertent rotation of the selector switch past the TEL position will result in interruption of the talk facility.

217. Numerous combinations of switch positions are possible. One example is given below:

(a) Mixing switches on INTER.

(b) Rotary switch on COMM.

(c) Volume control with the white line at approximately the mid position.

218. Under the above arrangement interphone, both with navigator and ground crew, is available at all times without any other operation, command radio is available for listening; and by pressing the "Press to Talk" button, transmission on command radio is available.

NOTE

The above position of the volume control will provide maximum efficiency. Movement past this position may be used for reception during abnormal atmospheric conditions or weak signal strength. The volume of the UHF and radio compass should then be adjusted individually as desired.

OPERATIONAL EQUIPMENT AND CONTROLS

IFF (AN/APX-6A)

219. The purpose of the IFF equipment is to enable the aircraft in which it is installed to identify itself when interrogated by coded transmissions from ground or airborne radar sets. The coded interrogation transmissions can be transmitted in any one of three modes classified as Modes 1, 2 and 3. Each mode of interrogation initiates the transmission of a corresponding mode of reply from the IFF transmitter-receiver (transponder). The reply is presented on the interrogators radar display adjacent to the target pip.

220. Mode 1 interrogation serves for general identification of any aircraft detected by a ground or airborne radar set. Modes 2 and 3 permit specific aircraft to be identified and distinguished from other aircraft. Normally, Modes 2 and 3 are used only when requested by radio or prior to take-off.

221. An emergency reply, which overrides the three normal modes can be selected. This reply will be transmitted when the aircraft is interrogated irrespective of the mode of interrogation.

222. The control panel is located on the LH console in the pilot's cockpit and comprises the following control switches:

(a) MASTER switch - A five position rotary switch used to control power supplies to the equipment and to select EMERGENCY operation. The switch positions are as follows:

(1) OFF: All power supplies are disconnected from the equipment, but this does not effect the lighting of the control panel.

(2) STDBY: All power supplies are switched ON, but the receiver is rendered inoperative.

(3) LOW: The receiver is ON but is sensitive only to strong interrogation signals from nearby stations.

(4) NORM: The receiver is at maximum sensitivity and the equipment responds to interrogation from distant stations.

(5) EMERGENCY: The receiver is at maximum sensitivity and the equipment responds to interrogation in any mode with the emergency reply.

NOTE

To select EMERGENCY, a spring loaded button adjacent to the rotary selector must be depressed. The button prevents accidental selection of the emergency operation.

(b) MODE 2 switch: Is a two position switch controlling operation of the equipment on MODE 2, with switch positions as follows:

(1) OUT: The equipment will respond to normal mode 1 interrogations. It will not respond to mode 2 except to transmit the emergency response if the master switch is selected to EMERGENCY.

(2) MODE 2: The equipment will respond to MODE 1 and MODE 2 interrogations.

(c) MODE 3 switch: Is a two position switch for controlling mode 3 operation, with switch positions as follows:

(1) OUT: The equipment will respond to Mode 1 interrogations. It will not respond to MODE 3 except to transmit the emergency response if the master switch is set to EMERGENCY.

(2) MODE 3: The equipment will respond to MODES 1 and MODE 3 interrogations.

(d) I/P-OUT-MIC switch is a three position switch for special operation of the system on Mode 2, with switch positions as follows:

(1) I/P: Switch position is inoperative.

(2) OUT: Will respond to interrogations normally.

(3) MIC: Will respond to Mode 2 interrogations whenever the UHF transmitter is energized.

223. For automatic operation of the IFF upon seat ejection, see para 249.

224. The IFF system shares two antennas with the TACAN system (if the TACAN system is fitted). They are the upper and lower "L" band antennas. A two position "L" band antenna transfer switch is mounted on the navigator's RH console, marked IFF UP/TACAN LOW and IFF LOW/TACAN UP. The switch allows the antennas to be connected to the systems as selected.

EJECTION SEATS

General

225. The pilot and navigator are each provided with a MK C5 automatic ejection seat. Provided the aircraft is straight and level, ejection is possible at ground level at aircraft speeds as low as 90 knots IAS. Trials have shown, however that ejection at still lower speeds may be successful. If the aircraft is descending, or nose down, more than the recommended minimum altitude will be required.

226. The ejection seats are made safe when the aircraft is at rest by installing safety pins at the following locations:

(a) The seat firing sear and the canopy cartridge firing mechanism sear. These two safety pins are attached to a common chain with a warning plate. Alternatively, the canopy sear pin of this assembly may be used to lock the overhead firing handle. In this case, the seat firing sear pin is not used.

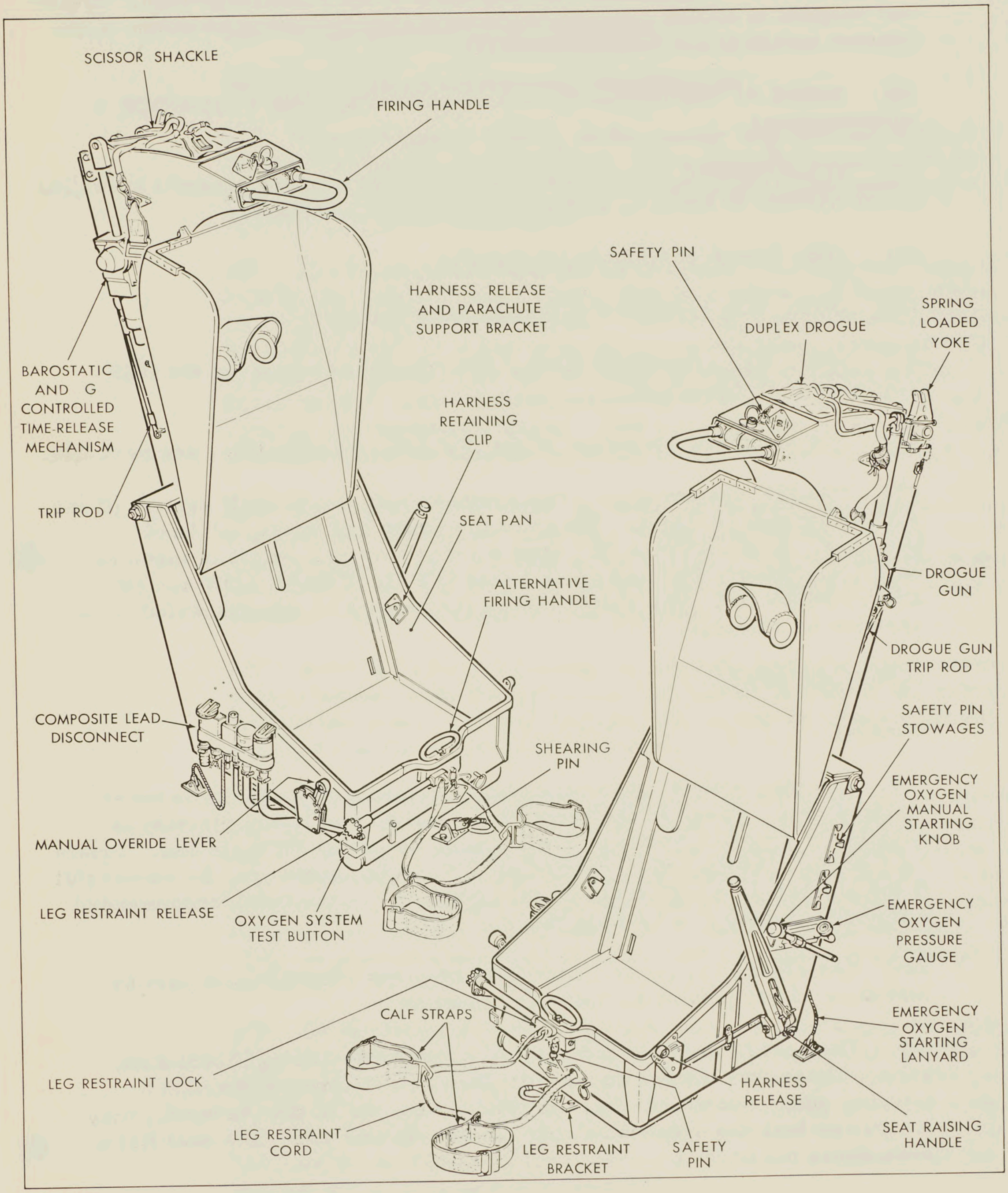

FIG 1-8 Mk C5 EJECTION SEAT

(b) The drogue gun safety lock.

(c) The alternative firing handle.

Integrated Canopy Opening and Seat Ejection

227 The emergency opening of the canopy and ejection of the seat is achieved by means of cartridges. The canopy is forced open by a single cartridge, while the seat is fired by an ejection gun containing a primary and two secondary cartridges.

228 The canopy cartridge and ejection gun cartridge are fired by pulling a large horizontal firing handle, coloured yellow and black, fitted immediately above the headrest. The firing handle is attached to a canvas face blind which is pulled over the occupants face. Alternatively, the canopy and ejection gun can be fired by pulling upwards on the alternative firing handle, also coloured yellow and black, located on the seat pan between the occupant's knees. This firing handle is for use should the seat occupant find it impossible to reach or operate the overhead firing handle.

229 The operation of either of these firing handles withdraws two sears, one sear for the canopy cartridge firing mechanism and one sear for the ejection gun. The cartridge of the canopy firing mechanism is detonated immediately but the firing of the ejection gun does not take place until the canopy is in its emergency open position.

230 When the canopy cartridge is fired the gas generated unlocks the canopy latches and, through uncovered ports, passes to the actuating mechanism jack. Through linkage, the canopy is forced open and is retained open by a spring-loaded hook.

231 During the canopy opening process the firing pin of the ejection gun is prevented from moving by a release rod, but as soon as the canopy passes its normal open position the release rod begins to withdraw from the firing pin. When the canopy has opened sufficiently to give clearance for the path of the seat, the release rod is fully withdrawn and allows the spring-loaded firing pin to detonate the primary cartridge of the ejection gun. The firing of the secondary cartridges is then caused by flame from the primary cartridge.

232 As the seat leaves the aircraft, the occupant's legs are pulled to the rear and held against the front of the seat pan by means of a leg restraint cord. They are held in this position until separation from the seat takes place. Movement of the seat also breaks the quick disconnect between the seat and the aircraft, primes the drogue gun and the time release mechanism by removing their respective sears, and operates the emergency oxygen bottle by means of a lanyard.

233. Approximately one-half second after the seat and occupant have been ejected the cartridge operated drogue gun withdraws a controller drogue from a container behind the headrest. This drogue tilts the seat into a horizontal attitude and then withdraws the main 5 foot drogue from the container. The main drogue further decelerates and steadies the seat.

234. A barostatic and 'g' controlled time-delay mechanism is fitted to the top of the RH side beam. Provided ejection takes place below 5000 metres (16,400 feet), and that the forward deceleration of the seat is less than 4 g, the time-delay mechanism will operate after 1.3 seconds. If ejection occurs at a higher altitude, a barostat attached to the time-release mechanism prevents the release from functioning until the seat and occupant have fallen to 5000 metres (16,400 feet). The barostat in the first aircraft is set to 10,000 feet.

235. When the time-delay mechanism operates it releases the parachute harness from its attachments to the seat at three points and disconnects the seat portion from the crew member portion of the composite leads disconnect. It also releases the leg restraining cords and the drogue line from the seat. The drogue line now pulls on a lifting line which extracts the parachute pack pin and withdraws the main parachute from the pack. The seat is allowed to fall free.

Manual Override Control

236. Provision is made to manually disconnect the parachute withdrawal line from the parachute static line by means of the parachute override 'D' ring. A separate lever control is fitted to manually release the parachute and parachute harness from the seat. These manually operated controls enable the seat occupant to separate himself from the seat should the seat fail to eject or, after ejection, if the automatic separation mechanism fails to function.

237. The override 'D' ring is a conventional ring partly covered by a small flap secured by press-studs. When the flap is removed and the override 'D' ring is pulled, the parachute withdrawal line is disconnected from the parachute static line. This action also uncovers the inner ripcord 'D' ring. The manual override lever is fitted on the RH side of the seat pan and is normally locked in the fully forward position by a spring catch under the head of the lever engaging in a slot of the lever quadrant. Releasing the spring catch and moving the lever fully to the rear until the catch engages in the rear slot of the quadrant will perform the following operations automatically:

(a) Release the parachute and parachute harness from the seat.

(b) Release the leg restraint cords from the seat.

(c) Release the crew member portion of the composite leads disconnect from the seat portion.

Manual Leg Restraint Release

238. A small handwheel is fitted at the front of the RH side of the seat pan. Turning the handwheel will operate the release on the front of the seat pan and free the leg restraint cords from the seat.

Harness Release

239. A lever is fitted on the forward LH side of the seat pan. Movement of the lever to the rear allows the seat occupant to lean forward against the pull of a spring-loaded harness reel. As the occupant leans back the harness will be snubbed at all positions and the lever must be operated to lean forward again.

Seat Raising Handle

240. A lever is fitted on the LH side of the seat. By depressing a spring-loaded plunger in the end of the lever, and moving the lever up or down, the seat pan will raise or lower. When the plunger is released it will engage in one of several locating holes and lock the seat pan in position.

241. Further information on the ejection seat is contained in Arrow 1 Service Data - Section 31 - Ejection Seat, Mk C5.

EMERGENCY EQUIPMENT

Engine Fire Detection and Extinguishing System

242. A system of cable type fire detectors are located in three potential fire areas. These areas are the RH engine compartment, the LH engine compartment and the hydraulic and equipment bay. The detectors sense a fire or an overheat condition existing in these areas and cause the illumination of warning lights. Two container bottles of fire extinguishing chemical are carried.

243. The fire warning and extinguishing panel marked FIRE, is mounted on the LH console in the pilot's cockpit. The panel contains three red lights marked LH, HYD, RH; the lights are provided with transparent covers. A toggle switch protected by a guard, is marked SECOND SHOT. A second toggle switch protected by a guard, is marked CRASH. There is no provision for automatic operation of the extinguishers by deceleration.

244. Fire indication is given by the illumination of the master red warning light on the main instrument panel. At the same time a red warning light will illuminate on the FIRE warning/extinguishing panel. The particular light that illuminates will indicate the location of the fire.

245. The extinguisher is operated by lifting the cover and pressing the illuminated bulb on the FIRE panel. This action will release one bottle of extinguishing chemical into the appropriate fire area. The remaining bottle of extinguishing chemical may be discharged into the same fire area if the warning light does not go out, by lifting the cover and selecting the SECOND SHOT switch. Alternatively, should a fire occur in either of the other two areas, the second bottle may be used by pressing the appropriate warning light.

CAUTION

Should a fire occur in either the LH or RH engine compartments, the appropriate HP and LP fuel cocks should be selected off before operating the fire extinguisher. (See Part 3 para 15).

246. The CRASH switch distributes the contents of the fire extinguisher bottles in the event of a crash landing. The switch should be operated after the throttles have been placed in the "cut-off" position and the LP FUEL COCKS have been switched off. Operating the switch will discharge the contents of one bottle into the hydraulic and equipment bay and the contents of the other bottle will be divided between the LH and RH engine bays.

NOTE

If the CRASH switch is operated while the aircraft is still airborne, or the engines are running, it will result in loss of extinguisher fluid through the engines.

247. Power for the fire extinguishing system is taken from the battery bus and therefore the system will operate regardless of the position of the master electrical switch.

Bail-out Signal

248. A switch, protected by a guard and marked NAV BAIL OUT is located on the LH console, aft of the power controls. Operating the switch will

illuminate a red warning light on the navigator's panel marked BAIL OUT and a signal horn will be energized to warn the navigator to eject. A green light on the pilot's main instrument panel, marked NAV BAIL OUT, will also illuminate. The green light will go out when the navigator ejects. Power is supplied from the emergency bus.

Emergency Operation of the UHF and IFF on Seat Ejection

249. Upon the ejection of either seat from the aircraft, a switch located on the seat bulkhead is actuated and causes emergency operation of the IFF. At the same time the emergency channel of the UHF set is energized and causes an MCW signal to be transmitted. Provided the IFF and UHF had previously been selected on, the signals transmitted will enable ground stations to obtain a fix on the aircraft's position.

250. A test push button switch marked PRESS-TO-TEST - UHF/IFF EMERG, is located on the pilot's RH console. Testing should be carried out according to Telecommunication Confidential Orders.

PARABRAKE

251. A brake parachute is fitted in the rear end of the fuselage and is mechanically controlled through cables by a lever which has STREAM and JETTISON positions. The lever is located in the pilot's cockpit, aft of the engine power controls. The parachute is released through two doors above the stinger by moving the lever downwards to the STREAM position. The action of the parachute when released slows the aircraft after landing. A shear pin is fitted which will shear if the parachute is released during flight. The parachute may be jettisoned after completing the landing run, or in an emergency, by moving the control lever inwards and downwards to the JETTISON position. An indicator is fitted below the tail cone and is visible when a parachute is not installed. The installation of a parachute raises the indicator flush with the skin.

FLIGHT INSTRUMENTS

Pitot-Static System

252. Three pressure heads are fitted to the aircraft and supply pitot and static air pressure to the various instruments, controllers and transducers. One pressure head is installed on the forward end of the air data probe at the aircraft nose, while two are fitted to the leading edge of the fin. The lower pressure head on the fin is used for flight test instrumentation only, while the upper is utilized by the flying control emergency damping system transducer.

253. The pitot and static pressure from the nose pressure head is transmitted to the Mach/airspeed indicator and the flying control normal damping system transducer. The static pressure, in addition, serves the altimeters, rate of climb indicator, cabin pressure regulator and safety pressure valve controllers.

Mach/Airspeed Indicator

254. The Mach/Airspeed Indicator is mounted on the pilot's main instrument panel. Indicated airspeed and mach number are displayed on a single dial, and a striped pointer provides a constant indication of the maximum allowable airspeed at any altitude. An adjustable index allows a landing speed to be pre-set. The split airspeed pointer indicates mach number on the inner scale, with the corresponding IAS on the outer scale.

Altimeter

255. An altimeter is mounted on the main instrument panel in both cockpits. The instrument has three pointers and incorporates a cut-out window. The largest pointer registers hundreds of feet, the intermediate pointer registers thousands of feet while the small pointer indicates tens of thousands of feet. A striped area is progressively covered during a climb and is uncovered again upon descending. During descent, the striped area commences to uncover at 16,700 feet, and is fully uncovered at zero feet. This warning provides an additional indication, during a rapid descent that the aircraft is approaching the lower altitudes.

Skin Temperature Indicator

256. A skin temperature indicator is mounted on the pilot's main instrument panel. During flight the instrument registers the temperature of the aircraft skin taken from the underside of the radar nose. When the aircraft is on the ground the indicator registers the outside air temperature.

Sideslip and Angle of Attack Indicators

257. A sideslip indicator and an angle of attack indicator are mounted on the pilot's main instrument panel. Vanes, fitted to the air data probe, sense any change in direction of the relative airflow to the aircraft datum, both in the lateral and vertical axes. Movement of the vanes is transmitted to the indicators and the angle of sideslip and/or the angle of attack of the aircraft are shown on the appropriate indicators in degrees.

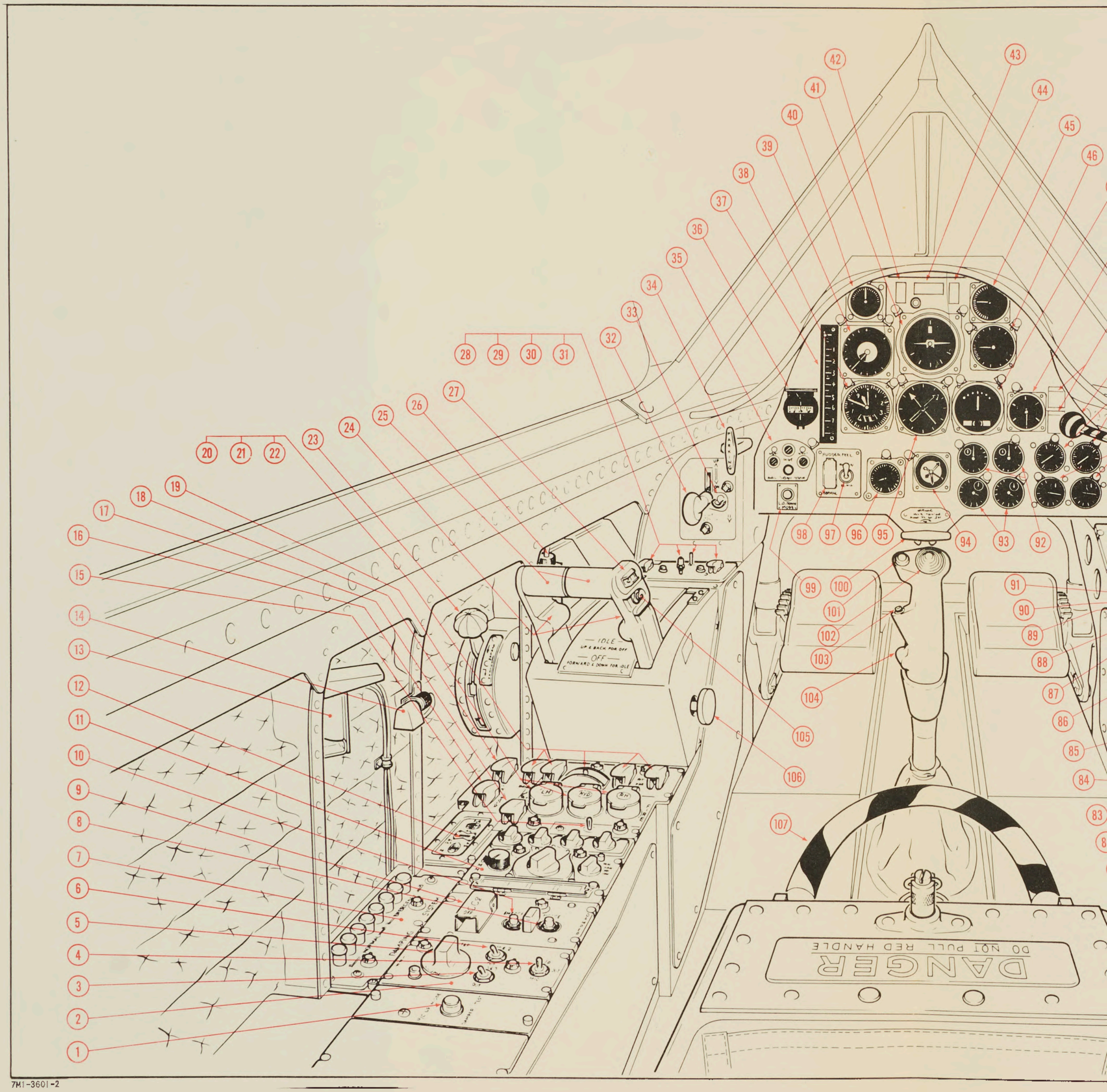

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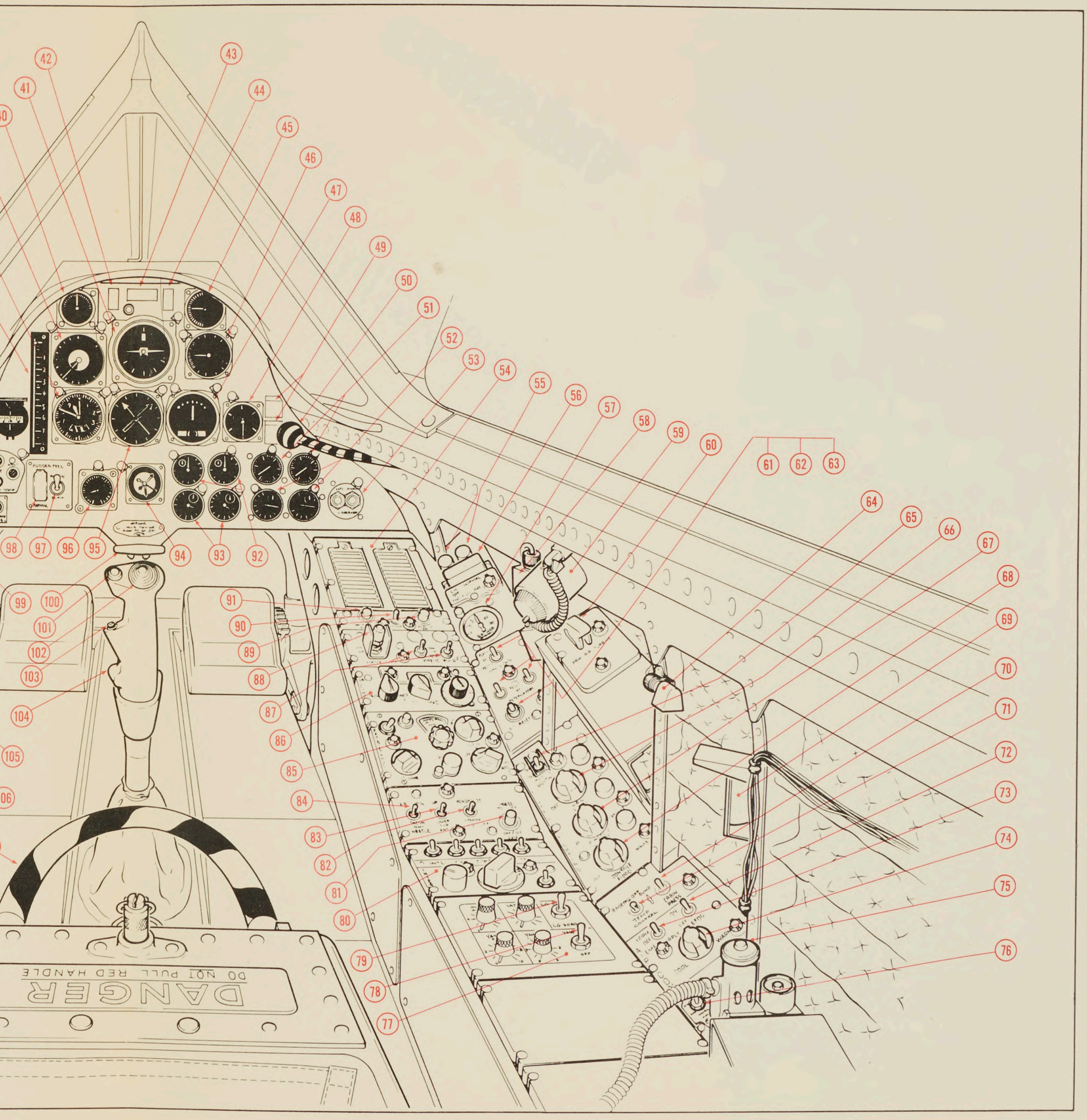
FIG 1-9 PILOT'S COCKPIT LAYOUT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DANGER
DO NOT PULL RED HANDLE

1 U/C UP MODE - DAMPER TEST Push Button
2 IFF Control Panel
3 IFF, MODE 3 - OUT Switch
4 IFF, MIC - I/P - OUT Switch
5 IFF, MASTER Selector
6 IFF, MODE 2 - OUT Switch
7 DAMPING SYSTEM Circuit Breaker Panel
8 DAMPER, ENGAGE Push Button
9 DAMPER, POWER ON-OFF Switch
10 DAMPER, EMERGENCY Push Button
11 COMM Radio Control Panel, ARC 34
12 Control Surface Response Indicator
13 High Altitude Light
14 Console Flood Light
15 RUDDER TRIM, LEFT - RIGHT Switch
16 FIRE Extinguisher, CRASH Switch
17 FIRE Extinguisher, SECOND SHOT Switch
18 NAV BAIL OUT Warning Switch
19 FIRE, Combined Warning Lights and Selector Switches LH, HYD and RH
20 LP FUEL COCKS Switches
21 CROSSFEED, LH ONLY - NORMAL - RH ONLY Switch
22 ENGINE FUEL, EMERG - NORMAL Switches
23 Parachute Brake, STREAM - JETTISON Selector Lever
24 Engine Relight Switches LH and RH
25 Throttle Levers, LH and RH
26 Console Flood Light
27 SPEED BRAKE, IN - OUT Switch
28 ANTI-SKID, NORM - EMERG OFF Switch
29 LIGHTS LAND - OFF - TAXI, Switch
30 CANOPY OPEN - OFF - CLOSE
31 ELEV TRIM DISENGAGE Switch
32 Landing Gear Control Lever, UP - DN
33 Landing Gear EMERGENCY EXTENSION Locking Latch Push Button
34 PARKING Brake Handle
35 LANDING GEAR POSITION Indicator
36 Standby Compass
37 Accelerometer
38 Altimeter
39 Mach/ASI Indicator
40 Indicator (Sideslip)
41 Artificial Horizon
42 Green NAV BAIL OUT Light
43 Red Master Warning Li
44 Amber Master Warning
45 Indicator (Angle of Atta
46 Rate of Climb Indicator
47 Turn and Slip Indicator
48 CABIN PRESSURE Gau
49 CHECK LIST LANDINC LIST TAKE OFF
50 EMERGENCY CANOPY Lever
51 Engine PRESSURE RAT LH and RH
52 FUEL QUANTITY Gaug
53 LEFT and RIGHT A'BU Indicator Green Ligh
54 Master Warning Panel
55 ENG BLEED Air Condi Warning Lights
56 ENG BLEED AIR, LH - RH OFF Switch
57 OXYGEN Quantity Gaug
58 Console Flood Light
59 Map and Emergency Li
60 RAM AIR TURBINE Sw
61 NAV LIGHTS, FLASH - Switch
62 ALTERNATORS, ON - Switches
63 DC RESET Push Button
64 Console Flood Light
65 HIGH ALT LIGHTING C
66 MAIN PANEL Lights, Selector
67 CONSOLE PANELS Lig BRIGHT Selector
68 CONSOLE FLOOD Ligh BRIGHT Selector
69 High Altitude Light
70 CABIN PRESS, DUMP
71 TEMP CONTROL, HEA

Altimeter
Mach/ASI Indicator
Indicator (Sideslip)
Artificial Horizon
Green NAV BAIL OUT Indicating Light
Red Master Warning Light
Amber Master Warning Light
Indicator (Angle of Attack)
Rate of Climb Indicator
Turn and Slip Indicator
CABIN PRESSURE Gauge
CHECK LIST LANDING and CHECK LIST TAKE OFF
EMERGENCY CANOPY OPENING Lever
Engine PRESSURE RATIO Gauges LH and RH
FUEL QUANTITY Gauges LH and RH
LEFT and RIGHT A'BURNERS Indicator Green Lights
Master Warning Panel
ENG BLEED Air Conditioning Red Warning Lights
ENG BLEED AIR, LH OFF - NORMAL - RH OFF Switch
OXYGEN Quantity Gauge
Console Flood Light
Map and Emergency Light
RAM AIR TURBINE Switch
NAV LIGHTS, FLASH - OFF - STEADY Switch
ALTERNATORS, ON - RESET - OFF Switches
DC RESET Push Button
Console Flood Light
HIGH ALT LIGHTING ON - OFF Switch
MAIN PANEL Lights, OFF - BRIGHT Selector
CONSOLE PANELS Lights, OFF - BRIGHT Selector
CONSOLE FLOOD Lights, OFF - BRIGHT Selector
High Altitude Light
CABIN PRESS, DUMP Switch
TEMP CONTROL, HEAT OFF Switch

72 DEFOG ON - OFF Switch
73 AIR SUPPLY, NORM - OFF - EMERG Switch
74 TEMP, COOL - WARM Selector
75 Anti-g Valve Manual Override Button
76 FWD PITOT HEAT, ON - OFF Switch
77 Pilots Flight Test Panel
78 YAW NORM, STEP - OFF Switch
79 L/G UP MODE - L/G DOWN MODE Switch
80 AIC 10 INTER Control Panel
81 UHF/IFF EMERG, PRESS TO TEST Button
82 J4 COMP, AEROBATICS - NORMAL Switch
83 UHF ANT, UPPER - LOWER Switch
84 RMI NEEDLE, TACAN - UHF HOMER Switch
85 RADIO COMPASS Control Panel
86 J4 COMP Control Panel
87 ENGINE START, START - OFF - RESET Switches
88 MASTER ELEC, ON - OFF Switch
89 Master Warning Panel PRESS TO TEST Button
90 Master Warning Panel DAY - NIGHT Switch
91 Master Warning Panel PRESS - TO - RESET Button
92 Engine RPM Indicators
93 EXH TEMP Gauges LH and RH
94 Clock
95 Radio Magnetic Indicator
96 SKIN TEMP Gauge
97 RUDDER FEEL, HIGH - LOW Switch
98 RUDDER FEEL, MANUAL - NORMAL Switch
99 L/G DOWN MODE Indicator Light
100 Rudder PEDAL ADJUST Handle
101 Automatic Mode Disengage Switch
102 Elevator and Aileron Trim Button
103 Emergency Damping Engage Switch
104 Nose Wheel Steering Selector Switch
105 Press to Transmit Push Button
106 Throttles Friction Damper
107 Ejection Seat Firing Handle

PILOT'S COCKPIT LAYOUT

UNCLASSIFIED

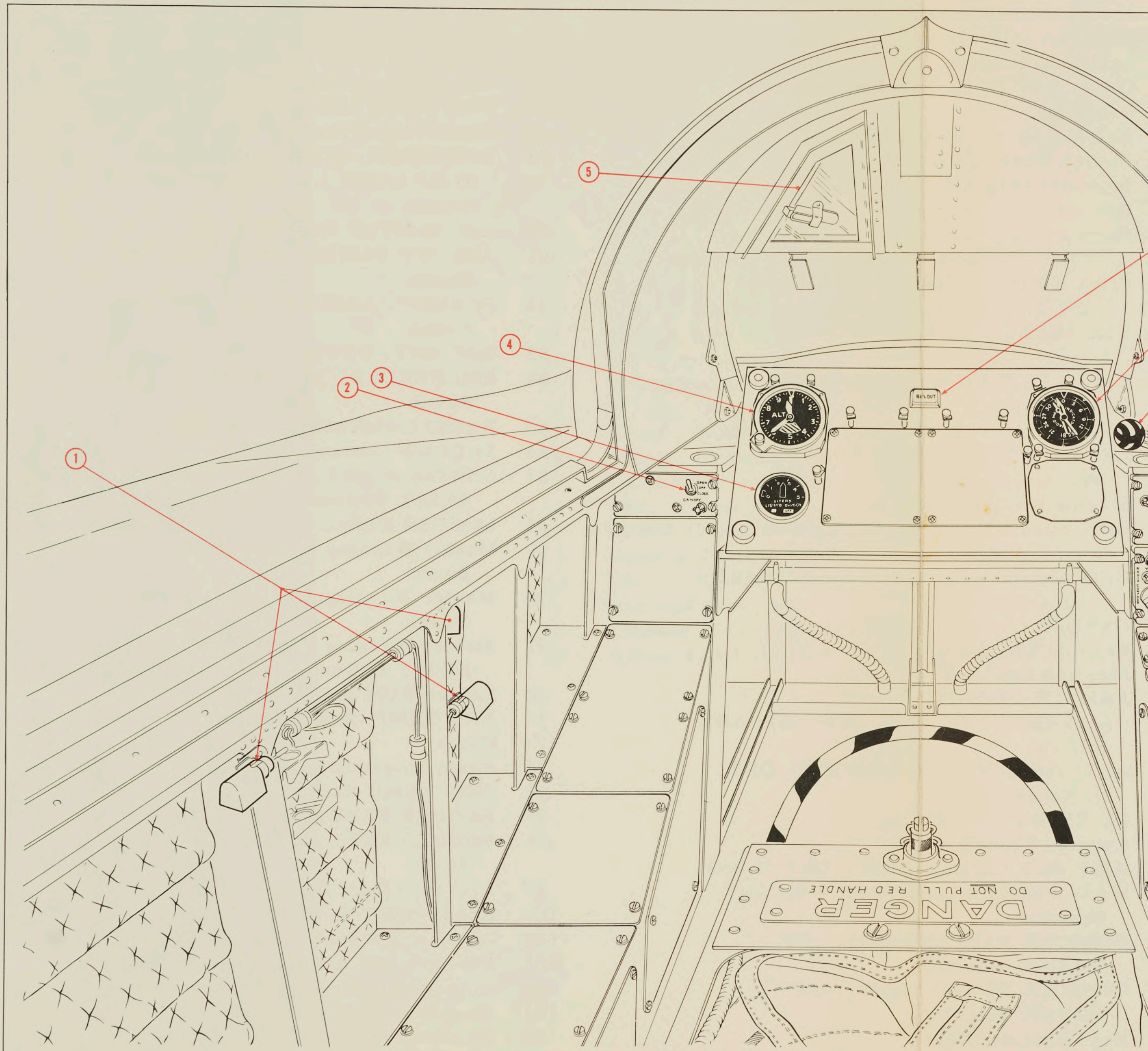

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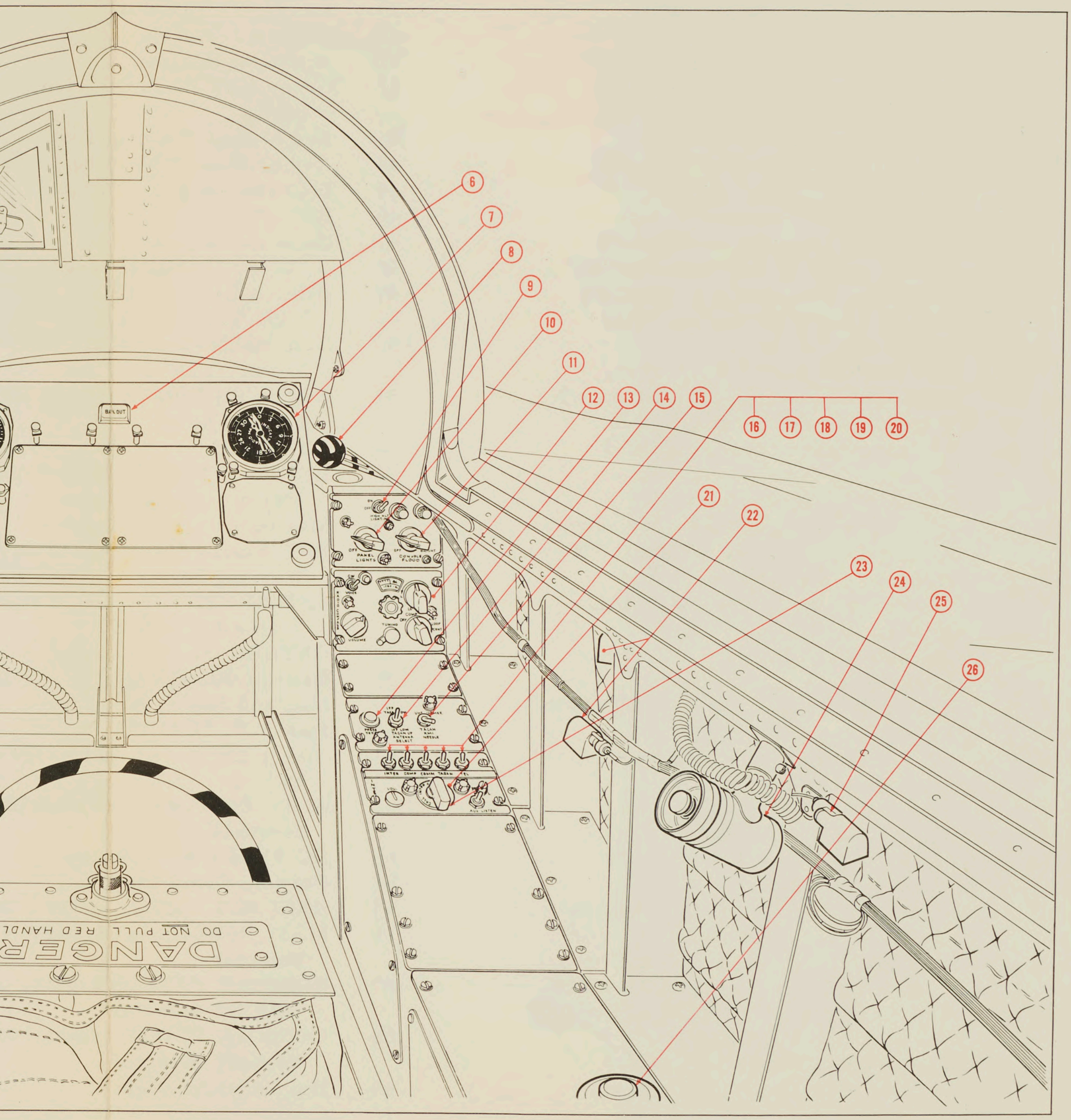
FIG 1-10 NAVIGATOR'S COCKPIT LAYOUT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NAVIGATOR'S COCKPIT

1 Console Flood Lights (3)
2 CANOPY, OPEN-OFF-CLOSE Switch
3 OXYGEN Quantity Gauge
4 Altimeter
5 Access Panel to Navigator's Canopy Locking Handle from Front Cockpit
6 Navigator's BAIL OUT Warning Light
7 RADIO MAGNETIC INDICATOR
8 EMERGENCY CANOPY OPENING Lever
9 HIGH ALT LIGHTING, ON-OFF Switch (Non-operative)
10 PANEL LIGHTS OFF-BRIGHT Selector Switch
11 CONSOLE FLOOD OFF-BRIGHT Selector Switch
12 RADIO COMPASS Control Panel ARN-6
13 PRESS TO TALK Switch
14 IFF-TACAN ANTENNA SELECT Switch
15 UHF HOMER - TACAN RMI NEEDLE Selector
16 INTER, Interphone Mixing Switch
17 COMP, Radio Compass Mixing Switch
18 COMM, Command Receiver Mixing Switch
19 TACAN Mixing Switch
20 TEL, Telescramble Mixing Switch
21 INTER Control Panel AIC-10
22 Console Flood Lights (2)
23 CALL, INTER, COMM, TEL Rotary Selector
24 Map and Emergency Light
25 Console Flood Light
26 Anti-g Suit Pressure Regulator Manual Override

PART 2

HANDLING

PRELIMINARIES

Before Entering the Aircraft

1. Check RCAF Form L14A for fuel, oil and oxygen quantities, and signatures completed throughout by tradesmen concerned. Note unserviceabilities, if any.

2. Compute engine pressure ratio for take-off.

3. Carry out the Exterior Inspection as shown on Fig. 2-1.

Solo Flying

4. If the aircraft is to be flown with the rear cockpit unoccupied, check in the rear cockpit:

(a) Harness secured.

(b) All loose articles of equipment removed or stowed.

(c) Safety pins in position in seat sear, drogue gun and alternate firing handle.

WARNING

Ensure that the canopy sear safety pin is NOT fitted. Emergency canopy opening from outside the aircraft would not be possible with the safety pin in the rear canopy sear.

(d) Rear canopy - latch in "sealed" position (fully forward).

Aircrew Flight Equipment

5. The low altitude aircrew flight equipment consists of anti-g trousers, pressure breathing waistcoat, pressure gravity valve and adaptor for the A13A oxygen mask with Pate suspension, coveralls, boots and gloves. For flights above 45,000 feet the Canadian partial pressure suit is worn.

NOSE WHEEL WELL

1 PRE-SELECT NOSE L/G DOOR SWITCH TO **CLOSE**

2 NOSE L/G DOWN LOCK PIN REMOVED—DOWN LOCK ENGAGED

3 CONDITION OF L/G LEG FAIRING—NO HYDRAULIC LEAKS

4 SHOCK ABSORBER STRUT EXTENSION NORMAL

5 TIRES—CUTS, WHEELS ALIGNED FORE AND AFT

6 LANDING AND TAXI LIGHTS UNDAMAGED

7 EMERGENCY NITROGEN—5000 PSI MIN.— **CB'S** SET

8 RADOME ACCESS DOOR SECURE (UNDERSIDE).

9 NOSE DOOR UNDAMAGED—NOSE DOOR SAFETY GROUND LOCK REMOVED

NOSE AREA

10 RADOME SECURE—LHS RADOME ACCESS DOOR SECURE

11 PROBE SECURE AND COVER REMOVED

12 RHS RADOME ACCESS DOOR SECURE

RHS

13 EMERGENCY CANOPY OPENING PANEL SECURE

14 RH ENGINE AND AIR COND. INTAKE COVERS REMOVED—DE-ICING BOOTS UNDAMAGED.

15 FORWARD ACCESS PANELS AND DOORS SECURE (UNDERSIDE).

16 ELECTRONIC EQUIPMENT **CB'S** SET (VISUAL THRO' INSPECTION PORT, UNDERSIDE).

17 RH INSTRUMENT PACK LOCKS SECURE—PACK UNDAMAGED.

18 RH INNER WING LE UNDAMAGED.

19 RH WHEEL WELL FOR SECURITY, LEAKS AND DAMAGE—MAIN L/G GROUND LOCK REMOVED, TIRES FOR CUTS, SHOCK ABSORBER EXTENSION NORMAL, RECUPERATOR PRESSURE AND OIL CONTENT CORRECT.

20 SPEED BRAKES IN AND UNDAMAGED. PRESS TO CHECK DRAG CHUTE GREEN LIGHT ON (DOORS CLOSED), ON REFUELLING TEST PANEL—SECURE DOOR.

21 ALL EQUIPMENT AND ENGINE ACCESS DOORS SECURE—CHECK FOR LEAKS.

22 UNDERSIDE OF RH WING FOR LEAKS AND DAMAGE—RH OUTER WING LEADING EDGE UNDAMAGED—NAV. LIGHTS UNDAMAGED.

REAR OF A/C

23 RH AILERON, ELEVATOR UNDAMAGED.

24 JET PIPES—COVERS REMOVED, CHECK FOR DAMAGE, FLUID ACCU TIONS, CONCENTRICITY OF NOZZLES, STINGER AND TAIL CONES SE DRAG CHUTE DOORS CLOSED—RED INDICATOR **NOT** SHOWING (INSTALLED 1 A TAIL CONE).

LHS

25 LH ELEVATOR AND AILERON UNDAMAGED.

26 LH NAV. LIGHTS UNDAMAGED—OUTER WING LE UNDAMAGED—U SIDE OF WING FOR LEAKS AND DAMAGE.

27 LH WHEEL WELLS FOR SECURITY, LEAKS AND DAMAGE—MAIN L/G GR LOCK REMOVED, TIRES FOR CUTS, SHOCK ABSORBER EXTENSION NO RECUPERATOR PRESSURE AND OIL CONTENT CORRECT.

28 LH INNER WING LE UNDAMAGED.

29 LH INSTRUMENT PACK LOCKS SECURE—PACK UNDAMAGED.

30 LH ENGINE AND AIR COND. INTAKE COVERS REMOVED—DE-ICING B UNDAMAGED.

UPPER SURFACE OF A/C

31 VISUAL INSPECTION OF ACCESS PANELS, WING SURFACES, FIN RUDDER FOR SECURITY AND DAMAGE—NAV. LIGHTS UNDAMAGE

32 FIN PITOT COVERS REMOVED—FIN UNDAMAGED—AIR COND. EX COVER REMOVED.

REAR COCKPIT FOR SOLO FLIGHT

33 HARNESS SECURED.

34 LOOSE EQUIPMENT REMOVED OR STOWED.

35 SAFETY PINS LOCATED IN SEAT SEAR, DROGUE GUN AND ALTE FIRING HANDLE.

36 **REAR CANOPY SAFETY PIN NOT INSTALLED.**

37 REAR CANOPY CLOSED—LATCH LEVER TO **SEAL INFLATE** (FULLY FO

REAR OF A/C

N, ELEVATOR UNDAMAGED.

COVERS REMOVED, CHECK FOR DAMAGE, FLUID ACCUMULA-
NCENTRICITY OF NOZZLES, STINGER AND TAIL CONES SECURE,
TE DOORS CLOSED—RED INDICATOR **NOT** SHOWING (CHUTE
A TAIL CONE).

LHS

OR AND AILERON UNDAMAGED.

GHTS UNDAMAGED—OUTER WING LE UNDAMAGED—UNDER-
VING FOR LEAKS AND DAMAGE.

VELLS FOR SECURITY, LEAKS AND DAMAGE—MAIN L/G GROUND
OVED, TIRES FOR CUTS, SHOCK ABSORBER EXTENSION NORMAL,
OR PRESSURE AND OIL CONTENT CORRECT.

VING LE UNDAMAGED.

MENT PACK LOCKS SECURE—PACK UNDAMAGED.

AND AIR COND. INTAKE COVERS REMOVED—DE-ICING BOOTS
ED.

UPPER SURFACE OF A/C

SPECTION OF ACCESS PANELS, WING SURFACES, FIN AND
OR SECURITY AND DAMAGE—NAV. LIGHTS UNDAMAGED.

COVERS REMOVED—FIN UNDAMAGED—AIR COND. EXHAUST
MOVED.

REAR COCKPIT FOR SOLO FLIGHT

SECURED.

UIPMENT REMOVED OR STOWED.

NS LOCATED IN SEAT SEAR, DROGUE GUN AND ALTERNATE
NDLE.

NOPY SAFETY PIN NOT INSTALLED.

OPY CLOSED—LATCH LEVER TO **SEAL INFLATE** (FULLY FORWARD).

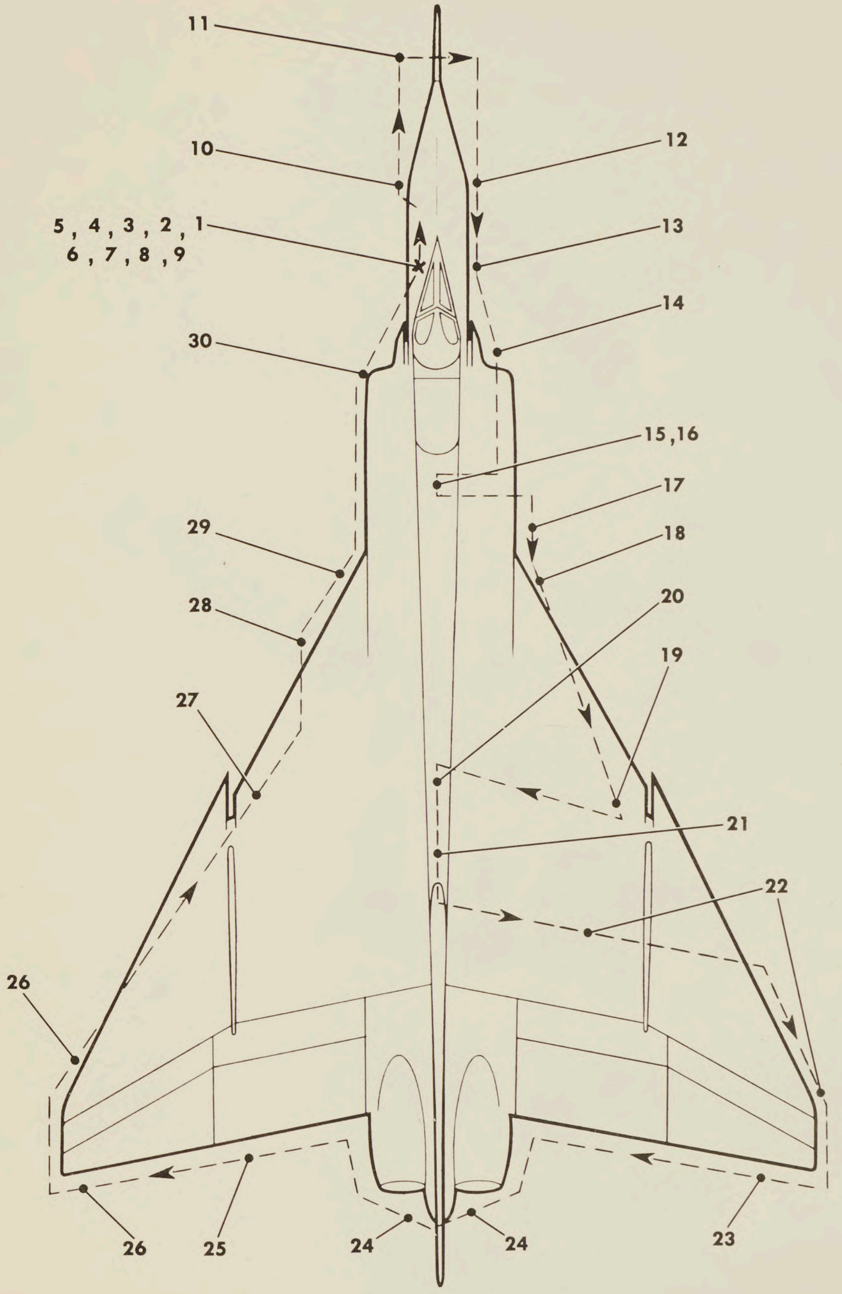

FIG 2-1 EXTERIOR INSPECTION

6. The equipment should be checked on the pressure breathing console in the safety equipment section prior to flight. The check should be carried out by the aircrew, assisted by the safety equipment technician.

On Entering the Cockpits

7. Carry out the following ejection seat checks:

(a) Check the emergency oxygen bottle pressure gauge. A fully charged cylinder registers 1800 psi. Check that the operating lanyard is attached to the aircraft structure.

(b) Check that the drogue gun shackle is securely attached to the drogue gun barrel, and that the static rod is securely attached to the bracket on the ejection gun body.

(c) Check that the drogue withdrawal line is not trapped under the link line.

(d) Check that the time-delay unit static rod is securely attached to the bracket on the ejection gun body.

(e) Check that the manual override control lever is wirelocked in the forward position.

(f) Check that the pin attaching the leg restraint cord to the floor bracket, is fitted.

(g) Check that the composite lead disconnect lanyard is attached to the aircraft structure.

Pre-Flight Checks.

8. Carry out the following actions (Front or rear cockpit as applicable).

(a) Check landing gear lever is in the DOWN position.

(b) Attach the leg restraints by passing the cord through the calf straps and locking it to the release mechanism on the front of the seat pan.

(c) Adjust the rudder pedals for reach by counting the number of notches on each side to obtain even alignment.

(d) Adjust the seat height.

(e) Connect the survival kit lanyard to the lanyard on the Mae West.

(f) Fasten and adjust the combined parachute and seat harness.

(g) Attach the thigh straps to the survival pack quick disconnect fittings and adjust.

(h) Connect the low altitude flight equipment as follows:

(1) Holding the pressure gravity valve in the hand, connect the hose from the trousers to the PG valve. The locking ring must be depressed and turned clockwise.

(2) Join the thick tube of the PG valve to the rear connector on the quick disconnect panel. The locking ring on the quick disconnect must be turned anti-clockwise. Check for security.

(3) Connect the oxygen tube to the quick disconnect panel, ensuring that the bayonet fitting is secure.

(4) Check for oxygen flow from the PG valve which should still be held in the hand.

(5) Connect the mask to the helmet on.both sides, with suspension fully extended; then check that the mask microphone is connected.

(6) Make helmet cable connection to quick disconnect fittings and check for security.

(7) Connect the PG valve to the vest; the oxygen should now fill the vest and trousers, and should flow audibly from the mask.

(8) Place the helmet on and strap the mask in place. Check the effort required to breath.

(9) Press oxygen "press-to-test" button, check for flow to the pressure breathing waistcoat and mask.

(j) Remove the safety pin from the alternative firing handle and hand it to the ground crew. Check that they also remove the safety pins from the sears of the ejection gun, drogue gun and canopy. All safety pins should be stowed by the ground crew.

(k) Signal the ground crew to connect the electrical and compressed air lines to the aircraft.

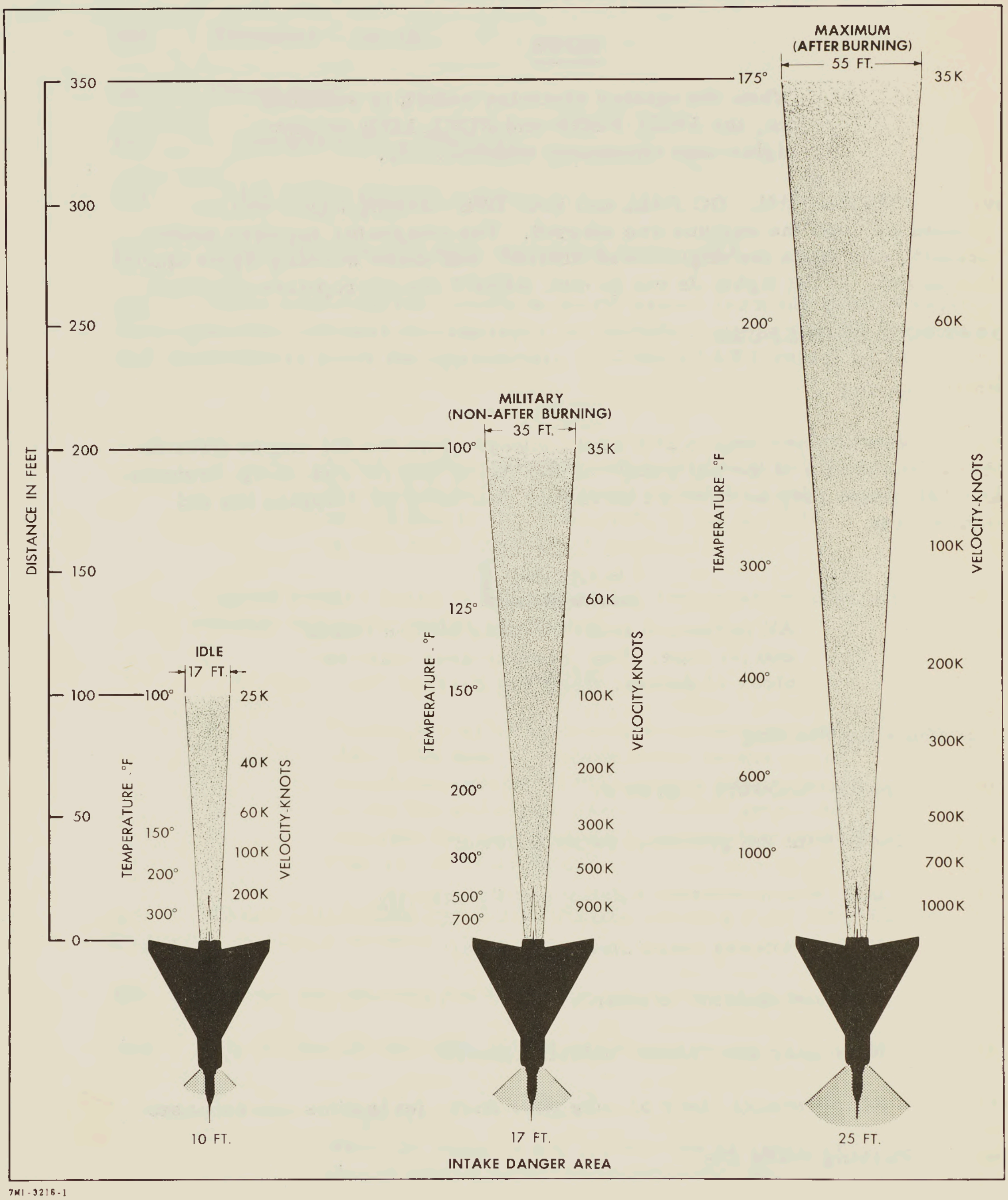

FIG 2-2 JET WAKE AND INTAKE DANGER AREAS

(m) Switch the master electrics switch ON.

NOTE

When the master electrics switch is switched on, the FUEL PROP and FUEL LOW warning lights may illuminate momentarily.

(n) The AC FAIL, DC FAIL and BAT USE warning lights will be illuminated until the engines are started. The alternator supplies power automatically when the engines are started, and these warning lights should then go out. If the lights do not go out, RESET the appropriate switches.

STARTING PROCEDURE

Preliminaries

9. If starting one engine at a time, always start the RH engine first to check functioning of the RH pumps on the flying control and utility systems. The LH pumps may be checked on engine shut down by stopping the RH engine first.

WARNING

All personnel must be clear of both intake and jet pipe. The jet wake area must be clear of debris. (See Fig 2-2).

Procedure for Starting

10. Adopt the following sequence:

(a) Check with the ground crew as follows:

(1) Intercommunication functions satisfactorily.

(2) Cockpit access stand clear of aircraft.

(3) Fire extinguisher available.

(4) Nose gear door switch selected to UP.

(5) All personnel clear of nose gear door, jet intakes and exhausts.

(b) Parking brake ON.

(c) Check that the MASTER ELECT switch is ON.

(d) Throttles - cut off.

(e) Check fuel:

(1) CROSSFEED - NORMAL.

(2) LP FUEL COCKS - ON.

(f) A'BURNER nozzle open indicating lights OFF.

(g) Upon receiving the "ready to start" signal from the ground engine start operator, advance the appropriate throttle lever to the IDLE position and immediately pulse the appropriate ENGINE START switch to START.

NOTE

Some engines may require a slight (1/2") forward throttle movement to obtain light-up. If this is the case, return the throttle to idle after light-up is obtained.

(h) Check turbine outlet temperature. A temperature rise within 10-15 seconds indicates engine "light-up".

NOTE

The engine will accelerate to approximately 57% - 58% rpm. Turbine outlet temperature should not exceed 600°C, except momentarily, during the transition period to idle rpm. At idle rpm the turbine outlet temperature should drop to 340°C or below.

(j) Check OIL PRESS and FUEL PRESS warning light out. Check hydraulic pressure warning lights out.

(k) Repeat the starting procedure for the other engine.

(m) Check that the ALTERNATOR switches are on.

NOTE

When the engines are started the alternators should supply power automatically, thus extinguishing the AC FAIL, DC FAIL and BAT USE lights. If the lights are not extinguished, RESET the circuits.

(n) Check ENGINE FUEL switches at NORMAL in conjunction with ENG EMERG FUEL ON light being off. If light is on, switches should be held in RESET, with the engines running, until the light goes out. Maintain the switches in the RESET position for three to five seconds after the light goes out.

(p) If the engines have been cold-soaked to a temperature of -35°C or below, allow the engines to idle for five minutes in order to warm up.

Engines at Idle

11. Check with the ground crew by means of the intercom that the engine overboard bleed valve is in the "open" position and that the air ejector nozzle is operating (indicated by visual overboard discharge).

Wet Start

12. If, during the normal starting sequence, no rise in temperature is observed within 20 seconds of opening the throttle lever to the idle position, a wet start has occurred and the following procedure should be carried out:

(a) Bring the throttle lever back to the cut-off position.

(b) Hold the engine start switch to RESET for a period of 30 seconds only, then release the switch and carry out the normal starting procedure.

(c) Should another wet start occur, bring the throttle lever back to the cut-off position.

(d) Switch the MASTER ELECT switch OFF.

(e) Investigate the cause of failure to light up.

Hot Start

13. If, during the normal starting sequence, the turbine discharge temperature rises above 600°C for more than five seconds, the engine must be stopped immediately by placing the throttle to cut-off. The engine start switch should be selected to RESET momentarily; this will break the ignition circuit and shut off the ground starter air supply. Investigate the cause of the hot start before attempting a relight.

NOTE

All hot starts where a temperature of 600°C is exceeded must be recorded on Form L14A.

CAUTION

A maximum of three starting runs in 10 minutes is permissible. Two of these runs may be of 30 seconds duration and run consecutively.

GENERAL COCKPIT CHECK

14. Before taxying out for flight the following checks must be carried out:

(a) Fuel Contents - registered correctly.

(b) J4 COMPASS (as required)
MAG-DG switch to MAG
NORMAL/AEROBATICS switch to NORMAL.

(c) IFF selector switch to STANDBY.

(d) AIR CONDITIONING
AIR SUPPLY switch - NORM
CABIN PRESS/DUMP switch - CABIN PRESS
DEFOG switch - as required
Cabin TEMP-COOL/WARM rheostat switch - mid position
TEMP CONTROL/HEAT OFF switch - TEMP CONTROL.

NOTE

Selections made at this time will be operative when the external air supply is disconnected, and full air supply will be available when the landing gear is raised after take-off.

(e) Operate the PRESS TO TEST switch on the warning light panel and check that the warning lights illuminate.

(f) Landing and taxi lights - check operation. Switch OFF.

(g) Set aircraft altimeters.

(h) Check ASI limiting speed pointer is set.

(j) Operate the NAV BAIL OUT switch. Check that the NAV BAIL OUT green light in the front cockpit illuminates. Check with the navigator that the red BAIL OUT light illuminates and that the warning buzzer sounds. Return the switch to off.

(k) Artificial horizon erected. If necessary press gyro ERECTION button after gyro has run up for 30 seconds. OFF flag not visible.

(m) Turn and bank indicator erected. OFF flag not visible.

(n) FWD PITOT HEAT switch ON, prior to taxying. (If fitted)

(p) UHF switched to MAIN.

(q) AIC 10 switched:

INTER mixing switch ON

COMM selected on rotary selector.

(r) Check intercomm with ground crew.

(s) IFF switched to correct mode.

(t) Front and rear cockpit canopies closed and sealed.

CAUTION

The canopy lever must be in the fully forward position, otherwise the seals will not inflate and emergency canopy opening will be inoperative. The lever is nearly horizontal when locked fully forward in the sealed position.

(u) Check DAMPING circuit breakers IN.

FLYING CONTROLS CHECK (Engines Operating)

15. Check the flying controls as follows:

(a) DAMPER POWER switch ON. DAMP OUT and R/P AXIS OUT lights will be on.

(b) Allow 1-1/2 minutes for warm-up. Press DAMPER ENGAGE button. All damper lights should be out (except R/P AXIS OUT light; this will be on if either or both ROLL AXIS or PITCH AXIS switches are at OFF).

(c) Check L/G MODE - DOWN. L/G DOWN MODE green light illuminated.

(d) Operate the control column fore and aft, left and right. Note the response on the control surface indicators. Check the co-ordination of rudder when the ailerons are moved and check that the rudder returns to neutral within five seconds, from any position, with the control column stationary. Check for freedom of movement of all controls; there should be no evidence of juddering at the control column or at the indicator.

(e) Press DAMPER EMERGENCY push button switch and repeat the test as in sub para (d); the results should be the same. EMER DAMP ON and R/P AXIS OUT lights ON.

(f) Select full trim both ways for the elevators and then ailerons. Check that the control column moves in the correct direction and that the surface indicators movement agrees. Trim all surfaces to neutral.

(g) Operate the rudder pedals and note movement of the surface indicators.

(h) Operate the rudder trim switch left and right and note corresponding pedal movement, also surface indicator movement. Trim the rudder neutral.

(j) Press damper disengage push button switch on control column (marked AFCS). Check that DAMP OUT and R/P AXIS OUT lights illuminate.

(k) Re-select DAMPER ENGAGE. Check lights out.

(m) Disengage ROLL and PITCH AXIS in turn and check the R/P AXIS OUT light illuminates. Select the roll and pitch axis switches to ON or OFF as briefed.

TAXYING PROCEDURE

General

16. The cockpit canopy should be closed before taxying. When the chocks have been removed and the brakes released, only a very small increase in engine power is necessary to start the aircraft moving. Check

the brake response after moving forwards a few yards by bringing the aircraft to a stop; then move away.

17. Use gentle but firm application of brake pedal; do not move the rudder bar. A certain amount of airframe vibration will be felt when using brake, and occasionally vibration may be noticed when brake is not being used. Taxy at a moderate speed with throttles practically closed.

18. If a long taxy run is necessary, check the rudder control without damping engaged, and note that some effect is gained down to 50 knots, particularly if the wind is favourable. Note also the rudder feel characteristics which tend to be springy and slightly heavy at the centre.

19. To turn the aircraft around on the runway button requires judgement; engine and brake must be used but care must be exercised not to lock the wheels, otherwise damage to the tires will result.

Nose Wheel Steering (Trial Installation Only)

20. Nose wheel steering is engaged by aligning the rudder pedals to the corresponding nose wheel position and depressing the nose wheel steering push button located at the bottom left of the control column hand grip. The button must be maintained depressed during steering operations. The aircraft is steered by slowly moving the rudder pedals in the required turn direction.

NOTE

> Movement of the nose wheel is governed to a maximum turning rate of 19° per second. Rapid movement of the rudder pedals or increased pressure on them will not affect the rate of turn of the nose wheel.

21. Use of brakes when nose wheel steering is in operation is still under investigation. If brakes are used at all, they must be applied carefully and at a low speed only. Steering is disengaged by releasing the button on the control column, when normal castoring action of the nose wheel will be restored.

TAKE-OFF PROCEDURE

Vital Actions Before Take-off

22. The following drill of vital actions is to be carried out before take-off:

(a) Check that the canopy is closed, handle fully forward.

(b) Set throttle tension nut.

(c) L/G MODE selected to DOWN.

(d) DAMPERS - Disengaged or selected according to briefing instructions.

(e) Check flying control movement.

(f) Check trim.

Take-off

23. For normal take-off proceed as follows:

(a) Line up on the runway by taxying forward in a straight line for approximately 20 yards. Slowly apply the brakes, until the aircraft stops without any tendency to depart from centre.

(b) Hold the aircraft with brake pedal pressure. Do not use the parking brake as it may not hold the aircraft steady in the aligned position, and any slip of the brake will necessitate realignment of the aircraft on the runway.

(c) Check the engine instruments at low power and check warning lights out.

(d) Maintain a heavy pressure on the brake pedals while opening the throttles. The brakes should hold up to 90% rpm, and may hold to 100% rpm. Decrease the pressure on the brakes sufficiently to allow the aircraft to move straight ahead, correcting any tendency to swing from centre by small applications of brake. Release the brakes fully and hold the aircraft straight by small but rapid brake applications until 80-100 knots is reached. At this speed heading should be maintained by rudder.

(e) At a speed of approximately 130 knots, ease the stick back slightly to raise the nose-wheel off the ground. Hold the aircraft attitude once the nose boom comes up to the horizon. A nose wheel bounce may be experienced just after initial elevator movement.

NOTE

On aircraft with the elevator control booster removed stick forces are higher. For this reason, after initial elevator application to raise the aircraft nose during take-off, a certain amount of anticipation is required in arresting upward movement of the nose.

(f) Maintain heading with careful use of rudder. As speed increases, greater response to rudder for the same force will be noticed.

(g) The aircraft will unstick at approximately 160-170 knots. Do not pull the aircraft off the runway.

Actions after Take-off

24. After unstick, climb slowly away; a noticeable vibration of the airframe will be felt at unstick. Check the sideslip pointer or ball indicator, and eliminate any sideslip by use of rudder.

25. Due to airframe vibration increasing with increased speed, raise the landing gear before 200 knots is reached. Maintain the speed at 200 knots by steepening the attitude after unstick or slightly throttling back prior to the "gear-up" selection. As the gear comes up, directional disturbances are noticeable and if allowed to develop without rudder corrections, rolling effects may follow. Lateral control to suppress the roll is rather heavy at this speed. After unstick it is recommended that normal damper engage be selected by the trigger. This will tend to reduce yawing tendencies. Brake is applied automatically before the wheels lock up and will cause the brake pedals to be depressed; it may cause slight rudder bar movement.

26. Airframe vibration will cease when the gear is up. If throttling back was necessary before the wheels up selection, open the throttle fully and establish climb at 300-350 knots. Trim the aircraft to fly without sideslip or any load on the stick, and then select "gear-up" on the landing gear mode switch. Sideslip elimination is good and the rudder bar may be left alone.

<u>NOTE</u>

If, after "gear-up" mode is selected a small amount of sideslip remains ($1/4^{\circ}$ - $1/2^{\circ}$), proceed with the flight, but some unbalanced rolling tendency will be experienced. Should this sideslip be more than $1/2^{\circ}$, the damper accelerometers are incorrectly set, therefore flight should be continued with due regard

to Mach number and E.A.S. limits
consistent with structural safety.

27. The view from the aircraft on the climb is good and the attitude in military thrust is not excessive. A certain amount of lag in response to both elevators and ailerons is noticeable, but this is, at present, a normal characteristic. When approaching a height of 25,000 feet, aim to hold 0.85 Mach (approximately), otherwise very slow climb performance will result, particularly if speed is allowed to fall below 0.7 Mach.

FLYING CHARACTERISTICS

Flight with Dampers Disengaged (Subsonic)

28. This aircraft, in common with most delta types, has less directional stability than "long tailed" aircraft and therefore sideslip is more easily induced. In flight without dampers engaged, any aileron movement applied to maintain level flight will produce adverse aileron yaw, which is very noticeable. The drag of the down-going aileron will yaw the aircraft to that side, or if in a turn, the yaw will be against the turn. In addition, sideslip produces a pronounced dihedral effect i.e. if the aircraft yaws to starboard the port wing will have a tendency to come up in a roll. This effect is magnified at high angles of attack, or at certain Mach numbers and altitudes. This means that sideslip, however caused, will result in a tendency to roll, which if corrected for by aileron will only tend to induce more sideslip. To maintain sideslip under control in flight without dampers engaged, rudder and aileron movements must be co-ordinated.

Flight with Yaw Damping Only

29. In the damper gear-up mode, rudder is automatically co-ordinated with aileron movement, sideslip is eliminated and control is quite straight forward. In the damper "gear-down" mode, transient directional disturbances are well damped, but in a steady turn some sideslip will be apparent (usually "slipping in" on a turn) and this must be eliminated by small rudder application, which must be removed once straight flight is achieved.

High Speed Flight - Control in the Pitch Axis

30. With an increase in speed at low altitude the feel of the aircraft becomes progressively more sensitive, particularly in the pitch axis. This oversensitivity in pitch at speeds in excess of 400 knots, is noticeably reduced on aircraft which have the elevator control booster removed, and in addition handling at high speeds has been considerably improved. Trim rate is, as yet, comparatively slow and should be used to obtain pitch trim

as closely as possible. If the aircraft is out-of-trim in pitch and an attempt is made to hold attitude by pressure on the stick, then the steadiness of flight will be lost due to the difficulty of holding an accurate force just outside the breakout force. This may lead to pilot induced oscillations which may become severe. It is recommended that the stick be left alone and the oscillation be left to damp out naturally. The aircraft should then be re-trimmed for further flight.

31. Small inaccuracies in the setting up of the feel unit could make the aircraft respond to stick movement without the pilot coming out of break-out force. This will mean minor stick movements can command response, and this undesirable characteristic should be reported after flight.

Supersonic Flight

32. It is recommended that the afterburner be used to obtain supersonic flight, although it is possible to obtain supersonic flight at certain altitudes without the afterburner.

33. The transition from subsonic to supersonic flight is characterized by a small disturbance in roll which may or may not be detected at approximately .92 I.M.N. Also, an increased sensitivity in pitch may be apparent at this stage. Supersonic penetration occurs at .95 I.M.N. and can be detected on the instruments by a large jump in height indication (approximately 1500 feet), with corresponding jumps in I.M.N. and A.S.I.

34. The control in pitch and roll show a marked improvement once the aircraft is settled in supersonic flight, due to a reduction in sensitivity. Flight is much steadier, provided the yaw damper is used. Without the damper, sideslip will be induced very easily and must be eliminated by co-ordination of controls; although in certain areas of the flight envelope utmost difficulty will be experienced in flying the aircraft without dampers. Therefore, unless specially briefed, the aircraft must not be flown without dampers engaged except in an emergency.

NOTE

On aircraft with the elevator control booster removed, the elevator feel is generally heavier, particularly at supersonic speeds. For a given manoeuvre the required stick movement will appear to be greater.

35. The acceleration in supersonic flight is rapid, and although no marked trim changes accompany this, difficulty may be experienced at first in flying

the aircraft on instruments with any degree of accuracy. This particularly refers to Mach number or A.S.I. stabilization.

36. Deceleration from high supersonic flight is rapid if the afterburner is closed. The engines should not be throttled back below 90% rpm until the speed falls off to subsonic value.

37. Up to the present little experience has been gained in rolling manoeuvres, and excessive manoevres in pitch are prohibited until trials are completed. At high Mach numbers, a limit of 1.5g is at present in force, unless specially briefed.

Descent Procedure

38. It is recommended that the engines be throttled back to 80% rpm, the airbrakes extended and the descent made at 0.8 - 0.9 Mach. During descent some intake rumble may be noticed, which manifests itself by a high frequency vibrational noise from the sides of the cockpit.

Aircraft Behaviour at Slow Speeds (At A/C Weight of 56,000 lb)

39. As speed is reduced with the landing gear up, the first indication of buffet is felt in the form of some airframe vibration at approximately 185 knots. This vibration will tend to increase in intensity as speed is reduced to 170 knots. The aircraft has been flown just after take-off at 155 knots, this representing 15° angle of attack.

40. Lateral control becomes progressively heavier as speed is reduced, which is characteristic of spring feel. Control in pitch is more sluggish, requiring more careful throttle manipulation to maintain constant altitude. Approximately 80% rpm are required at 160 knots to maintain altitude; high rates of descent will result as power is reduced.

NOTE

> On aircraft with the elevator control booster removed, stick forces are higher and at speeds below 250 knots this causes a marked phase lag between control application and aircraft response.

41. With the landing gear down vibration is felt throughout the airframe, the severity depending upon airspeed. On some aircraft vibration is severe at 250 knots, moderating at 200 knots and becoming light at 180 knots. Power must be increased to offset the additional drag with the landing gear down (approximately 90% rpm at 160 knots). With the dampers

engaged there is no problem to fly at 170 knots, but without dampers it is more difficult and careful handling is required, directed particularly towards the elimination of sideslip.

APPROACH AND LANDING

42. Enter the downwind leg at 250 knots with speed-brakes extended. Reduce speed to 200 knots and select the landing gear down; increase power immediately to maintain height. Very little trim change occurs with the lowering of the gear. Check on the gear indicator, and an additional check is to be made by the chase pilot, for gear down indications.

43. A wide circuit is recommended. Select DOWN on the L/G MODE switch before turning on the base leg, and check for green light indication. Turn onto base leg, co-ordinating the controls to eliminate sideslip. It may be necessary to use quite large rudder movements to eliminate this sideslip.

44. It will be found that once settled on a straight approach the view from the cockpit is quite limited and therefore care must be exercised. The speed should be gradually reduced to 180 knots and held at this figure, while a crosscheck should be made on the angle of attack indicator. At a landing weight of 56,000 lb and a speed of 180 knots, the angle of attack should be approximately 12° - 13°.

45. On the approach, the beginning of the runway should just be visible over the nose of the aircraft. It may be convenient to maintain the runway visible through one side of the windscreen, just to one side of the divider panel. This is recommended because some familiarization is necessary before an individual pilot can become fully accustomed to the use of the divider panel.

46. Approximately one mile from the runway, elevator and power adjustments should be made to obtain a rate of descent of approximately 1000 fpm, aiming to touch down about 500 feet in, on the runway. Approximately 88 - 90% rpm is required with gear down and speed-brakes extended. Maintain the thrust setting for the rate of descent steady, and allow the aircraft to keep sinking until a gradual check on sinking rate with the elevator is made, as the ground is approached. The attitude will increase and, as the aircraft touches the ground, the throttles should be gradually closed. Do not close the throttles too early, as the aircraft will sink very rapidly.

47. If speed is excessive at touchdown, any backward elevator movement may cause the aircraft to become airborne again and a heavy porpoise may result. Should this occur, do not "chase" the aircraft motion with the stick, but damp the porpoise by immobilizing the stick at centre.

NOTE

On aircraft with the elevator booster removed stick forces are heavier, causing a marked phase lag between control application and aircraft response, therefore greater concentration on the approach and landing is required. In addition, care must be exercised to avoid large attitude changes near the ground as the pilot can easily get out of phase with the aircraft.

48. After touch-down, allow the nose wheel to gently touch the ground and once firmly down, stream the parabrake. It is important for the pilot to be able to locate the parabrake handle instinctively and not require to look down. The parabrake is very effective, but sometimes its behaviour may be erratic causing severe swinging tendencies. Swings must be instantaneously corrected by brake application. Maintain a straight run using mainly brakes as the rudder is less effective as speed is reduced, and nose wheel steering is not, at present, fitted.

49. Jettison the parabrake when clear of the runway.

ENGINE HANDLING

Engines at Idle RPM

50. An engine should not be idled for a period in excess of thirty minutes. Extensive idling will cause "cokeing" of the combustion burners and of the burner pressure F.C.U. sensing probe. If a prolonged idling period has occurred, it is recommended that the engines be run up to military rating as a check on acceleration and engine performance.

Engine Pressure Ratio During Afterburning

51. When the afterburners are turned on, the engine pressure ratio may increase or decrease slightly. The acceptable variation will be published when available.

Low Pressure Compressor Overspeed Warning Light

52. When the afterburners are turned on, the LH and RH ROTOR O'SPEED lights may illuminate momentarily. This condition is normal and serves as an indication that the compressor overspeed light and mechanism are functioning normally.

Engine Fuel System Failure

53. When operating on the EMERG fuel system, do not return the ENGINE FUEL switch to NORMAL for the remainder of the flight. This may result in engine flame-out. If checking the system in the air, the transfer back to NORMAL must be carried out with the power lever at idle to avoid a pressure surge in the fuel system.

54. The procedure for returning the fuel system to NORMAL, after ground checks or in the air is as follows:

(a) Power lever of affected engine to IDLE.

(b) Select ENGINE FUEL switch to RESET and hold for approximately 3 to 5 seconds after the EMERG FUEL warning light goes out.

(c) Allow the switch to return to NORMAL.

Thrust Overshoot

55. When using engine pressure ratio to check engine power prior to take-off, a thrust overshoot may be noted when the throttle is advanced from idle to military thrust on a cold engine. This thrust overshoot will gradually diminish to the specified or computed value within five minutes or less. The condition is considered to be normal; however, it must not be relied upon for added performance during take-off.

END OF FLIGHT PROCEDURE

Stopping the Engines

56. Whenever the engines have been operated at high power settings for an appreciable length of time, they must be allowed to idle for up to five minutes prior to shutdown.

57. Stop the RH engine first by moving the RH power lever to the cut-off position. Operate the flying controls and check that the utility hydraulics and the flying control hydraulic warning lights do not illuminate. Stop the LH engine by moving the LH power lever to the cut-off position.

Actions Before Leaving the Aircraft

58. Proceed as follows:

(a) Master electrics switch OFF.

(b) Parking brake ON.

(c) Ensure the ejection seats and canopies are made safe. (See Part 1 para 226).

PART 3

EMERGENCY HANDLING

ASYMMETRIC FLIGHT

General

1. Flight tests relating to asymmetric flight have not yet been completed, but the following information has been obtained from certain tests that have been carried out.

2. The main control problems associated with asymmetric flight may be grouped as follows:

(a) With the landing gear down and military power on the live engine (aircraft weight of 60,000 lb approx.), the aircraft capability to maintain altitude at circuit height on a standard day is marginal. However, the aircraft will climb easily when afterburner is used.

(b) The type of yaw damping that is installed will affect control in the gear-down mode. In the unmodified gear-down mode, only transient yaw is damped and in this case the steady thrust of the live engine would have to be corrected for by the pilot with rudder. In the modified gear-down mode, 50% of lateral acceleration input is available and sideslip elimination is good but not as vigorous as in the gear-up mode. No problem arises with either system when in the gear-up mode.

(c) The rate of control is reduced by one-half, due to the reduction in the rate of hydraulic flow.

(d) On the approach the aircraft is in the vicinity of its minimum drag speed, with all the difficulties inherent in flying at or below this speed.

(e) The ambient temperature affects the thrust output considerably, giving an improved single engine performance on a cold day but resulting in an appreciably reduced performance on a hot day. However, with the afterburner available, temperature variation effects will be easily overcome.

Asymmetric Flight without Dampers or with Unmodified Yaw Damper

3. No flight tests have been carried out on the above to date, but an engine failure under these conditions would probably entail serious control problems, particularly if afterburners were in use at the time. Altitude

and Mach number will have a bearing on the severity of the control problem arising from instantaneous sideslip build-up. This sideslip must be corrected immediately. The immediate action is to throttle back the live engine and correct for yaw with rudder, taking care not to overcorrect in yaw. Only small rudder correction will be needed to keep sideslip to zero (at 200 knots, only 3^{o} to 5^{o} will be required). If the damper system is available, it should be engaged immediately (on aircraft 201, 202 and 203, by depressing the firing trigger on the stick grip).

4. Should a large sideslip occur, considerable roll effect will result. If an attempt is made to correct by ailerons alone, an increase in the existing sideslip will result. Co-ordination of rudder and aileron is the only means of correction.

Asymmetric Flight with Gear Up or Modified Gear Down Yaw Damper (Approach and Landing Case)

5. Since the aircraft capability of maintaining altitude is marginal using military thrust with the landing gear down, it is recommended that intermittent use of the afterburner be employed on the approach. In all other respects the approach should be normal. This technique will allow a flat angle of approach without excessive or rapid build-up of approach speed. With the landing gear and speed brakes extended, maintain an approach speed of 185 knots; this places the throttle of the live engine close to the afterburner operating range and will allow for good control of glide path. There is a slight nose up trim change when the afterburner is turned on.

6. Should a steep approach be attempted with the object of completing the landing on military thrust only, it is possible that difficulty will be experienced due to the high rate of descent. In addition, the final flare out and the initial placing of the aircraft in relation to the runway with only half control rates available, will also be difficult.

One Engine Failure in Flight

7. If an engine fails in flight proceed as follows:

(a) Immediately close the throttle to idle and attempt to relight the engine.

(b) If the engine will not relight after one attempt, proceed as follows:

(1) Close the relevant throttle to cut-off position.

(2) Follow the relight procedure in para 11.

(c) If relight is inadvisable, adjust the trim for asymmetric flight.

(d) Select fuel crossfeed as required to balance fuel load.

Two-Engine Failure in Flight

8. If fuel is still available and the aircraft has sufficient altitude, and if there are no apparent mechanical defects in the engines, proceed as follows:

(a) Maintain airspeed above 250 knots EAS to provide pressure for the flying control hydraulics.

(b) Carry out the relight procedure for one engine. If unsuccessful attempt to relight the other engine (See para 10 and 11).

NOTE

Do not use speed brakes unless absolutely necessary as they require pressure from the utility hydraulic system. This system is, in the above emergency, driving the emergency alternator.

EMERGENCY RELIGHT IN THE AIR

General

9. The J-75 engine will relight at any combination of airspeed and altitude which falls within the "Normal Windmilling Start Range" indicated on Fig. 3-1. The "Probable Start Range" represents those combinations of airspeed and altitude at which engine relights may frequently, but not always, be made. For best results, when operating above the maximum altitude and airspeed combinations indicated in the "Normal Windmilling Start Range", reduce either the airspeed, the altitude or both until they are within the ranges shown on the chart.

Relight Procedure

10. Relights may sometimes be obtained at very high altitudes provided the relight is accomplished before the compressor rpm has decreased appreciably. In the event of a flame out at airspeeds and altitudes above the "Probable Start Region" on the chart, the following procedure should be tried immediately a flame-out at high altitude occurs:

(a) Close the appropriate throttle to the idle position.

(b) Press the relight button for 20 seconds and watch for an increase in turbine outlet temperature which indicates a relight.

11. If the above procedure is unsuccessful proceed as follows:

(a) Throttle lever to cut-off.

(b) Windmill the engine for 20-30 seconds to dry out surplus fuel.

(c) Fuel Control Selector - NORM (EMERG if a primary fuel system failure is suspected).

(d) Adjust the IAS and altitude to within the "Normal Windmilling Start Range" (Fig. 3-1).

(e) Advance throttle lever to idle and at the same time press and hold the relight button for 20 seconds.

(f) Watch for an increase in turbine outlet temperature which indicates a relight.

(g) When turbine outlet temperature has settled down, open the throttle lever to the desired position and resume normal flight.

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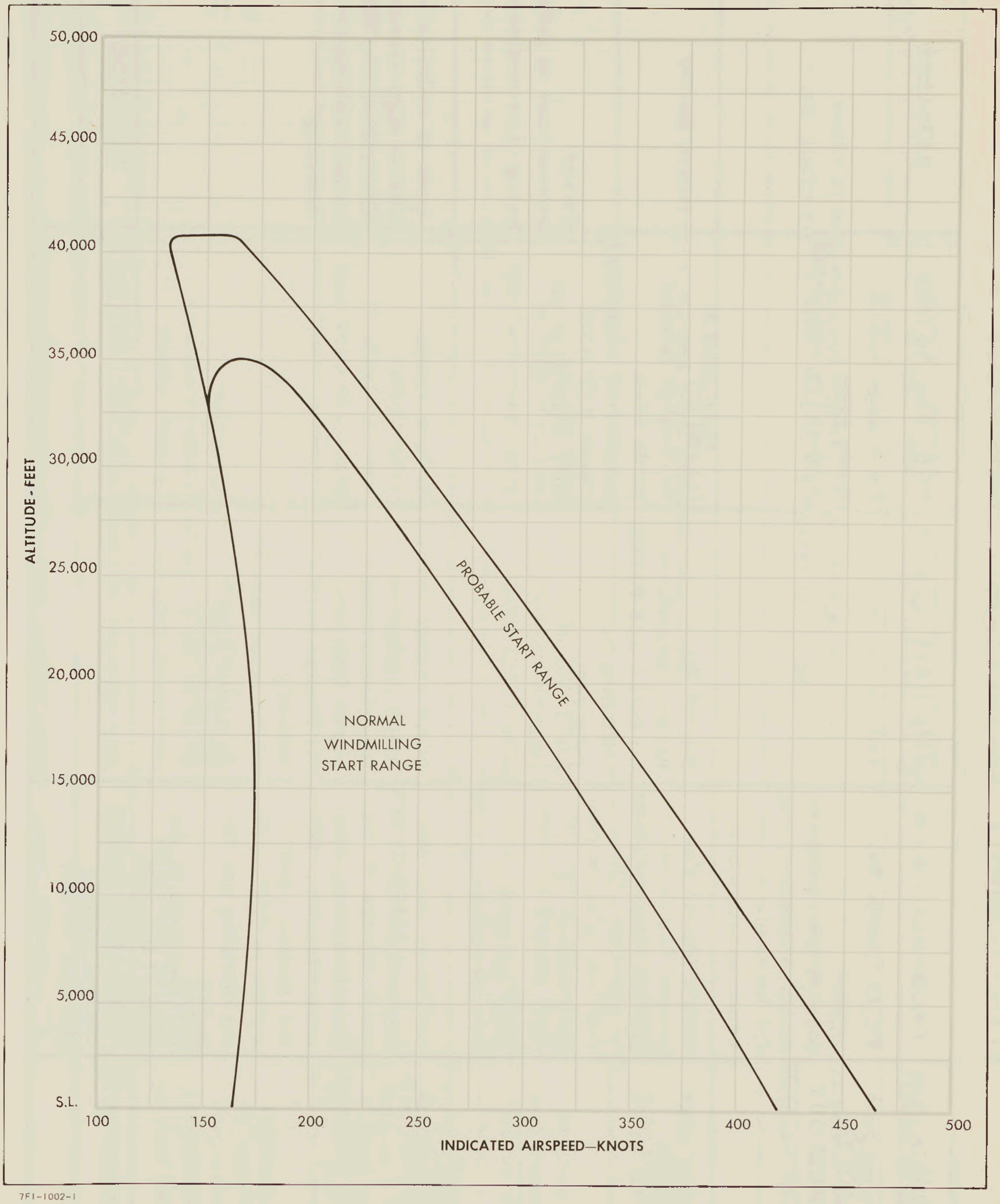

FIG 3-1 J-75 RELIGHT CHART

FLYING CONTROLS - EMERGENCY PROCEDURES (TABLE 1 of 3)

PILOT INDICATION	PROBABLE CAUSE	IMMEDIATE ACTION	FURTHER ACTION	REMARKS
Master amber plus EMER DAMP ON plus R/P AXIS OUT	Flight Limits Exceeded (a) Sideslip in excess of 10° and/or (b) Excessive transverse acceleration	Reduce manoeuvre	Re-engage normal mode when manoeuvre completed	
Master amber plus R/P AXIS OUT	Flight Limits Exceeded (a)Roll rate in excess of 159°/sec. OR (b)Pitch 'g'in excess of 4-1/2g to 5g. OR Both (a) and (b) combined. (c)ROLL and/or PITCH switching OFF	(a) and (b) Reduce manoeuvre (c) ROLL and PITCH switching as required.	(a) and (b) Re-engage normal mode when manoeuvre completed. Check R/P AXIS OUT light goes out.	
Master amber plus DAMP OUT	(a)Change over was made to EMERGENCY mode but the 'A' hydraulic system was unserviceable. OR (b) Damper power switch is OFF. OR (c) Damping not engaged. (d) Operation by the pilot of the push-button switch on the control column (Marked AFCS)	(a)Re-engage normal mode if possible. (b) Select damper power ON. (c) Engage normal damping (d)Exercise care in co-ordination of flying controls	Reduce speed.	Loss of stability in yaw at high speeds. Controllable at low speeds with no damping.

FLYING CONTROLS - EMERGENCY PROCEDURES (TABLE 2 of 3)

PILOT INDICATION	PROBABLE CAUSE	IMMEDIATE ACTION	FURTHER ACTION	REMARKS
Any unusual control column and control surface movement not commanded by the pilot in NORM mode.	Runaway Parallel servo	Overcome fault by force on stick. Select EMERG mode.	Reduce speed. Land as soon as possible.	
<u>Unmodified Aircraft:</u> Insufficient rudder movement available when landing gear is lowered (In L/G MODE-DOWN)	Hinge moment limitation system malfunction.	Select RUDDER FEEL switch to FULL AUTH	Exercise care with use of rudder at high speeds.	Avoid unco-ordinated manoeuvres at high speeds.
<u>Modified Aircraft:</u> Master Amber plus QC FAIL warning light.	Hinge moment limitation system malfunction.	Select RUDDER FEEL switch to FULL AUTH	Exercise care with use of rudder at high speeds.	Avoid unco-ordinated manoeuvres at high speeds.
<u>Aircraft with flight test dampers:</u> L/G DOWN MODE green light illuminated.	Dampers should be in landing gear down condition.	NIL - The light indicates that the L/G MODE switch is at DOWN.		
<u>Aircraft with development dampers:</u> Illumination of amber light L/G CONF	Damper condition and landing gear position differ.	NIL - At pilot's discretion, select L/G CONF UP - DOWN switch or landing gear position to agree.		
Malfunction of damping system in EMERG mode.		Press damping disengage push button on control column, (marked AFCS).	Reduce speed. Exercise care in co-ordination of flying controls.	

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FLYING CONTROLS - EMERGENCY PROCEDURES (TABLE 3 of 3)

PILOT INDICATION	PROBABLE CAUSE	IMMEDIATE ACTION	FURTHER ACTION	REMARKS
Master amber plus FLYING CONT HYD B warning light, (plus EMER DAMP ON and R/P AXIS OUT)	Loss of hydraulic pressure in 'B' system	Reduce speed	Land as soon as possible.	
Master amber plus FLYING CONT HYD A warning light.	Loss of hydraulic pressure in 'A' system	Reduce speed	Ensure mode of flying control remains in NORMAL. Land as soon as possible	
TWO ENGINE FAIL (at least one engine windmilling). Master AMBER plus FLYING CONT HYD A and B (provided airspeed is less than Mach .4 at S/L or .85@55,000') (plus EMER DAMP ON and R/P AXIS OUT).		(1)Maintain airspeed above 250 knots EAS (2)Check that the emergency alternator is operating (i.e. emerg damp system, J4 Comp., artificial horizon, IFF).	Relight one engine	

ELECTRICAL SYSTEM EMERGENCY PROCEDURES (TABLE 1 of 3)

PILOT INDICATION	PROBABLE CAUSE	IMMEDIATE ACTION	FURTHER ACTION	REMARKS
Master amber plus L or R AC FAIL warning light (L or R DC FAIL warning light will always illuminate with the above)	(1) Failure of the electrical generating system	(1)Move appropriate ALTERNATOR switch to RESET and back to ON.	(1) If AC FAIL and DC FAIL lights go out, so will the master amber light go out. - No further action required If AC FAIL light goes out and DC FAIL remains on (with master amber remaining on)press DC RESET button. If reset is accomplished, both lights will go out. If AC FAIL light does not go out - move appropriate ALTERNATOR switch OFF. PRESS TO RESET master amber.	
	(2) One-engine flame-out	(2) Carry out engine relight procedure	(2) No further action. When engine starts, the warning lights should go out.	

ELECTRICAL SYSTEM EMERGENCY PROCEDURES (TABLE 2 of 3)

PILOT INDICATION	PROBABLE CAUSE	IMMEDIATE ACTION	FURTHER ACTION	REMARKS
Master amber plus L and R AC FAIL lights. (Will be accompanied by the L or R DC FAIL light and BAT USE light.)	(1) Flame-out of both engines (2)Failure of both electrical generating systems	(1)Refer to two-engine flame-out procedure, para 3-2. (2)Move both ALTERNATOR switches to RESET and back to ON.	(2)Refer to one alternator failure above. BAT USE light will go out when DC is reset	Emergency AC power will automatically be supplied by the emergency alternator. The battery will supply emergency DC power
Master amber plus L or R DC FAIL	Failure of one TRU	Press DC RESET button	If DC FAIL light goes out (master amber will also go out) - No further action required If DC FAIL light does not go out PRESS TO RESET master amber. The other TRU will maintain the DC services less the landing and taxi lights	

ELECTRICAL SYSTEM EMERGENCY PROCEDURES (TABLE 3 of 3)

PILOT INDICATION	PROBABLE CAUSE	IMMEDIATE ACTION	FURTHER ACTION	REMARKS
Master amber plus L or R DC FAIL and BAT USE	Failure of both TRUs	Press DC RESET button	If one TRU resets, the BAT USE light will go out - PRESS TO RESET master amber. If both TRUs reset, the DC FAIL, BAT USE and master amber light will go out. If all lights remain on - PRESS TO RESET master amber. Land as soon as possible	CAUTION Limited DC loads are now taken from the aircraft battery.

FUEL SYSTEM - EMERGENCY PROCEDURES (TABLE 1 of 3)

PILOT INDICATION	PROBABLE CAUSE	IMMEDIATE ACTION	FURTHER ACTION	REMARKS
Master amber, plus L or R FUEL PRESS warning light	Relevant booster pump inoperative (Pressure has dropped below 18 psi)	NONE. Tank pressurization will maintain sufficient fuel delivery to the engine pumps to maintain military rating.	Throttle back affected engine until light goes out. PRESS-TO-RESET master amber	Excessive engine operation in this condition is detrimental to engine pumps, particularly after high speed operations, due to temperature effects. Crossfeed from the side with most fuel, when one sub-system is empty
Master amber plus FUEL PROP warning light. (In flight). (FUEL LOW light NOT on)	Inoperative fuselage transfer pump OR A transfer pump has lost its prime	Climb the aircraft above 10^{o} nose-up for 15 seconds. If it occurs on a descent, open up the engines momentarily to military rating	If the light goes out, no further action. If light remains on, avoid sustained operation at high altitudes. Fuselage tank fuel may not be used in proportion to other tanks, particularly at high altitudes. PRESS-TO-RESET master amber	Fuel quantity should be closely monitored. When fuel quantity on one side reaches approximately 2300 lb., the remaining fuselage tank contents may not be usable at the altitude of operation. However, it will be usable at sea level.

FUEL SYSTEM - EMERGENCY PROCEDURES (TABLE 2 of 3)

PILOT INDICATION	PROBABLE CAUSE	IMMEDIATE ACTION	FURTHER ACTION	REMARKS
Master amber plus FUEL PROP warning light. (L or R FUEL LOW warning light on temporarily)	Relevant fuel flow proportioner seized.	NONE Automatic control of the fuel C of G has ceased	Avoid violent manoeuvres. PRESS-TO-RESET master amber	
Master amber plus L or R FUEL LOW warning light plus FUEL PROP warning light	Aircraft fuel supply low on that side. (Light illuminates when fuel is down to 740 lb on that side). OR Stalled flow proportioner	Prepare to land at nearest airfield. Throttle back affected engine until light goes out.	(1)Cross check fuel supply with contents gauges. (2)Crossfeed when one sub-system is empty. PRESS-TO-RESET master amber	NOTE (ON GROUND) When power is first turned on, FUEL PROP and FUEL LOW lights may illuminate momentarily.
One engine failure (Engine will not relight).		Carry out engine fail procedure (See para 3-1) Throttle lever of failed engine to cut-off	Maintain fuel weight on each side approximately equal by alternating the fuel CROSSFEED between NORMAL and the failed engine side during the flight.	Adequate aileron control is available to maintain flying control with an unbalanced fuel condition. It is preferable however, to maintain the fuel quantity in each side approximately equal, due to shift in C of G which may occur

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FUEL SYSTEM - EMERGENCY PROCEDURES (TABLE 3 of 3)

PILOT INDICATION	PROBABLE CAUSE	IMMEDIATE ACTION	FURTHER ACTION	REMARKS
<u>ON GROUND</u>				
Master amber plus FUEL PROP warning light	(1)Master refuelling switch inadvertently left on. (2)A seized fuel flow proportioner (If engines are running)	Inform ground crew		

AIR CONDITIONING AND PRESSURIZATION EMERGENCY PROCEDURES (TABLE 1 of 3)

PILOT INDICATION	PROBABLE CAUSE	IMMEDIATE ACTION	FURTHER ACTION	REMARKS
Master amber plus EQUIP O'HEAT warning light.	Inlet air to equipment has exceeded 100°F	If light on for short period - NONE. If light remains on, select TEMP CONTROL/HEAT OFF switch to HEAT OFF.	If light goes out - select switch back to TEMP CONTROL. If EQUIP O'HEAT illuminates again, switch to HEAT OFF and land as soon as possible PRESS TO RESET master amber. If light does not go out, or is accompanied by the AIR COND FAIL light, select AIR SUPPLY switch to OFF. Reduce speed below Mach 1.2 and then select switch to EMERG. Reduce altitude. Land as soon as possible. PRESS TO RESET master amber.	Cooling turbine or air-to-water heat exchanger malfunction.

AIR CONDITIONING AND PRESSURIZATION EMERGENCY PROCEDURES (TABLE 2 of 3)

PILOT INDICATION	PROBABLE CAUSE	IMMEDIATE ACTION	FURTHER ACTION	REMARKS
Master amber plus CABIN PRESS warning light. (Check with cabin pressure gauge).	Cabin pressure has reached the equivalent of 31,000 feet, ± 1800 feet or higher. (1) Failure of the canopy seal. (2) Cabin pressure switch on DUMP (3) Air supply switch on EMERG or OFF. (4) Sticking open of cabin pressure safety valve or controller failed. (5) Sticking open of outflow valve or controller	(a) Throttle back engines. (b) Open speed brakes. (c) Descent to 35,000 feet or below.	PRESS TO RESET master amber	

AIR CONDITIONING AND PRESSURIZATION EMERGENCY PROCEDURES (TABLE 3 of 3)

PILOT INDICATION	PROBABLE CAUSE	IMMEDIATE ACTION	FURTHER ACTION	REMARKS
LH or RH ENG BLEED warning light. (RED) (No master warning light indication).	(1)Leaking of hot engine bleed air occurring OR (2)Failure of pressure reducing valve.	Select LH OFF or RH OFF (depending on which light illuminates) on the ENG BLEED AIR toggle switch.	Warning light will go out when condition is relieved. Switch must be maintained in the LH OFF or RH OFF position while air-borne.	
Master amber plus AIR COND FAIL warning light.	Inlet air to cockpits has exceeded 240^{o}F.	Select TEMP CONTROL/HEAT OFF switch to HEAT OFF.	If light goes out - select switch back to TEMP CONTROL. If AIR COND FAIL light illuminates again, switch to HEAT OFF and land as soon as possible. PRESS TO RESET master amber.	With a main system malfunction the EQUIP O'HEAT light would illuminate first and may then be followed by the AIR COND FAIL light. (See EQUIP O'HEAT indication under "further action").

ENGINES - EMERGENCY PROCEDURES (TABLE 1 of 3)

PILOT INDICATION	PROBABLE CAUSE	IMMEDIATE ACTION	FURTHER ACTION	REMARKS
Master amber plus L or R ENG O'SPEED warning light on momentarily.	Temporary over-speeding of a low pressure compressor.	NONE		Occurs when the afterburner is lit or shut down.
Master amber plus L or R ENG O'SPEED warning light on steadily.	Malfunction of a low pressure compressor overspeed limiter.	Reduce engine power until light goes out.	Maintain warning light out by reduced power and speed.	
Master amber plus L or R FUEL PRESS warning light.	See FUEL SYSTEM EMERGENCIES			
A'BURNER lights illuminate when the afterburners are selected on, but one or both JPT's show a decrease.	Nozzles have opened, but one or both afterburners have failed to light-up. The JPT of the engine with the unlit A/B will decrease.	Discontinue afterburning by raising the throttle levers.	Check that the A'BURNER lights go out (Nozzles closed).	Attempt a further re-light of afterburners.
One or both A'BURNER lights do not go out when afterburners are selected off.	Afterburner has not shut down OR Afterburner has shut down, but nozzle remains open. In this case the JPT will decrease.	RETARD throttle levers out of afterburner range.	Check that the afterburner shuts down and A'BURNER lights go out. JPT's normal.	

ENGINES - EMERGENCY PROCEDURES (TABLE 2 of 3)

PILOT INDICATION	PROBABLE CAUSE	IMMEDIATE ACTION	FURTHER ACTION	REMARKS
Master amber plus ICE warning light.	Ice detectors icing and de-icing	If engines are operating at relatively high thrust - no further action. If descending or engines are operating at relatively low thrust, open up engines occasionally to provide additional heat	Further action depends upon icing conditions. See EO 05-1-1 Pilot's Operating Instructions - General	(The interval between the lights going on and off will denote the severity of the icing conditions. Short interval will denote severe icing).
One engine flame-out occuring for no apparent cause	Malfunction of hydro-mechanical fuel flow control unit.	Select ENG FUEL switch to EMERG.	Carry out engine re-light procedure.	Complete the flight in EMERG fuel. Ensure turbine discharge temperature does not exceed limits
Rapid rise in turbine discharge temperature for no apparent cause	Malfunction of hydro-mechanical fuel flow control unit.	Select ENG FUEL switch to EMERG.	Check that the EMERG selection corrects the condition	Complete the flight in EMERG fuel. Ensure turbine discharge temp. does not exceed limits
Rough engine operation	Malfunction of hydro-mechanical fuel flow control unit.	Select ENG FUEL switch to EMERG	Check that the EMERG selection corrects the condition.	Complete the flight in EMERG fuel. Ensure turbine discharge temp. does not exceed limits

ENGINES - EMERGENCY PROCEDURES (TABLE 3 of 3)

PILOT INDICATION	PROBABLE CAUSE	IMMEDIATE ACTION	FURTHER ACTION	REMARKS
One engine or two engine flame out. (Possibly through excessive manoeuvring causing interrupted air flow to engine inlet)	Compressor stall.	Throttle to idle and attempt an immediate relight of one engine.		(See Part 3, para 8).
Master amber plus L or R OIL PRESS warning light.	Engine oil pressure has reduced to 25 psi or below	Shut down affected engine	Reduce speed in order to lower windmilling rpm of affected engine PRESS TO RESET Master amber.	

EMERGENCY LANDINGS

12. All emergency landings, either on prepared or unprepared surfaces, should be made with the landing gear down. The extended gear, even on reasonably rough terrain, helps to absorb the initial shock. The inherent nose high landing attitude will result in a severe "slap" into the ground if the tail section is permitted to take the initial shock of a wheels up landing.

LANDING GEAR EMERGENCY PROCEDURES

General

13. The procedure to be adopted is dependent upon the indications given by the UTIL HYD warning light and the landing gear position indicator. It should be noted that once the emergency nitrogen system has been used, the landing gear cannot be reselected up, therefore the following procedure should be carried out in the sequence given.

Normal Hydraulic Pressure

14. If the UTIL HYD warning light is not illuminated, there should be sufficient hydraulic pressure to open the doors and unlock the landing gear.

15. If, after a normal down selection the indicators show that the gear is still locked up, a fault in the selection circuit is indicated. In this case, proceed as follows:

(a) Re-select UP and DOWN a number of times.

NOTE

> If the BATT USE light is illuminated, the landing gear selector valve is inoperative. (See Part 1, para 45 NOTE). In this case the action in sub para (a) above will have no effect and is unnecessary.

(b) If this fails, push the thumb latch button and move the landing gear handle fully down to the EMERGENCY EXTENSION position.

16. If, after a normal down selection the indicators show a between-locks indication for one or more of the legs, an indicator fault or a mechanical fault is indicated. In this case, proceed as follows:

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(a) Attempt to lock the gear down by yawing to the left and right to open the doors and shake the legs down by applying positive 'g' in the pitching plane. Waggling the wings and accelerating the aircraft to 250 knots EAS may also help to lock the gear down.

(b) If this does not obtain a locked down indication, check with the control tower to see if the gear appears to be locked down.

(c) If the gear is not locked down, re-select UP and make a wheels-up landing.

Insufficient Hydraulic Pressure

17. If the UTIL HYD warning light is illuminated there will probably be insufficient hydraulic pressure to unlock the doors and landing gear locks. (See para 18). In this case use the EMERGENCY EXTENSION selection.

BRAKE EMERGENCY PROCEDURES

Emergency Operation of the Brakes

18. Two accumulators in the utility hydraulic system supply emergency brake pressure automatically upon failure of the normal supply. Indication that the normal supply has failed (pressure reduced to 1000 psi or less) is given by the illumination of the UTIL HYD warning light. (See para 17).

19. When landing after a utility system failure the brakes should be applied sparingly, pumping should be avoided, and every effort should be made to complete the landing run with as few applications of the brakes as is possible.

CAUTION

After completion of the landing run do not taxi the aircraft, even though brake pressure may still be available. Shut down the engines.

20. Should the pressure in the accumulators fall below 1600 psi, the light on the warning panel marked EMERG BRAKE HYD will illuminate. This light warns the pilot that the aircraft brakes will be ineffective upon landing.

Engine Thrust at Idle RPM

21. Engine thrust at idle rpm is comparatively high. In a case of brake failure, the engines should be stopped as soon as possible.

AIRFRAME AND ENGINE ICING

General

22. Except for a switch fitted to control nose boom anti-icing on aircraft fitted with pre-production nose booms (See Part 1 para 159), the anti-icing and de-icing systems are entirely automatic and no manual controls are provided. If the automatic functions fail during icing conditions the aircraft should be operated as laid down in Pilot's Operating Instructions - General EO 05-1-1.

Engine Anti-Icing

23. Only intermittent use of high rpm during descent under severe icing conditions is necessary. At the relatively high thrust setting used during climb or cruise, the hot air to the compressor inlet section of the engine is adequate to prevent ice formation.

ACTION IN THE EVENT OF FIRE

24. Should the master RED warning light on the instrument panel illuminate, carry out the following procedure:

(a) Check the location of the fire on the FIRE panel by means of the illuminated bulb.

(b) If an engine fire is indicated - retard the throttle lever of the appropriate engine to the cut-off position.

(c) Switch off the appropriate LP cock.

(d) Press the illuminated bulb on the FIRE panel.

(e) If the fire is extinguished, the light on the warning panel will go out.

(f) If the warning panel light does not go out, lift the guard and select the SECOND SHOT switch on.

NOTE

The toggle switch is used only to give a second shot to the same compartment. If two separate fires occur, pressing the appropriate two warning lights will provide one shot to each compartment.

ABANDONING THE AIRCRAFT

General

25. The aircraft may be abandoned by means of the ejection seats at a minimum airspeed of 90 knots IAS at ground level, provided the aircraft is straight and level.

Pilot Preliminaries

26. If it becomes necessary to abandon the aircraft, the following procedure should be adopted:

(a) Reduce the aircraft speed, if possible.

(b) Order the navigator to eject, or if intercommunication has failed, operate the NAV BAIL OUT signal switch. Check that the green NAV BAIL OUT light illuminates.

Navigator

27. After receiving the verbal order to eject, or if the BAIL OUT warning light illuminates and the signal horn sounds during inter-communication failure, proceed as follows:

(a) Acknowledge a verbal order.

(b) Ensure that the head is correctly located on the headrest, and lean fully back.

(c) Grasp the overhead firing handle with both hands, ensuring that the palms of the hands face to the rear.

(d) Maintain the head hard back against the headrest and the arms and hands close to the chest, then pull the firing handle and face screen firmly down over the face. The canopy will open immediately. Seat ejection will take place as soon as the canopy is fully open.

CAUTION

> The overhead firing handle must be pulled straight down over the face and not outwards away from the face.

NOTE

If, for any reason, the overhead firing handle cannot be operated, pull the alternate firing handle (located between the knees) fully upwards by grasping it with both hands, one hand over the other.

Pilot

28. After the navigator has left the aircraft (indicated by the green NAV BAIL OUT light being extinguished) proceed as follows:

(a) Ensure that the head is correctly located on the headrest, and lean fully back.

(b) Grasp the overhead firing handle with both hands ensuring that the palms of the hands face to the rear.

(c) Maintain the head hard back against the headrest and the arms and hands close to the chest, then pull the firing handle and face screen firmly down over the face. The canopy will open immediately. Seat ejection will take place as soon as the canopy is fully open.

CAUTION

The overhead firing handle must be pulled straight down over the face and not outwards away from the face.

NOTE

If, for any reason, the overhead firing handle cannot be operated, pull the alternative firing handle (located between the knees) fully upwards by grasping it with both hands, one hand over the other.

Manual Release

29. If, for any reason, the seat does not eject or, when ejected, the automatic parachute opening gear does not function, provision is made to disconnect the parachute and parachute harness from the seat and enable the occupant to operate the parachute manually as follows:

(a) Pull on the outer 'D' ring.

(b) Release the spring catch on the manual override lever on the RH side of the seat pan and move the lever fully to the rear.

(c) Leave the aircraft or seat.

(d) Pull the ripcord 'D' ring.

EMERGENCY CANOPY OPENING ON THE GROUND

From Inside the Cockpit

30. In the event that either canopy cannot be opened by the normal method and an emergency exists, the lever marked EMERGENCY CANOPY OPEN, located on the RH side of each cockpit, should be pulled fully back.

From Outside the Cockpit

31. In an emergency, should either crew member be unable to operate his emergency canopy opening handle, provision is made for these handles to be operated from outside the aircraft. A door, located on the RH side of the aircraft below the pilot's cockpit, is marked in red letters EMERGENCY CANOPY OPENING - PUSH TO OPEN - STAND BACK-PULL HANDLE. When the toggle handle attached to the lanyard is pulled, both canopies will be opened by cartridge firing. (For precautions when solo flying See Part 2 para 4(c)).

WARNING

The canopies will be forced open very rapidly. Therefore all personnel should stand clear of the canopies when the lanyard is pulled.

PART 4

OPERATING DATA

ENGINE LIMITATIONS

Principal Limitations

1. The principal limitations of the Pratt and Whitney J-75 P3 and P5 engines are:

OPERATING CONDITION	OPERATIONAL LIMITS: MAX. OBSERVED TURBINE DISCHARGE TEMP (°C) — P3 ENGINES	OPERATIONAL LIMITS: MAX. OBSERVED TURBINE DISCHARGE TEMP (°C) — P5 ENGINES	TIME LIMIT (MINUTES)
MAXIMUM (WITH A/B)	610	620	15
MILITARY	610	615	30
NORMAL RATED	540	555	UNRESTRICTED
CRUISE			
90% NORMAL RATED	540(MAX) 500(NORM)	555(MAX) 505(NORM)	UNRESTRICTED
80% NORMAL RATED	540(MAX) 460(NORM)	555(MAX) 475(NORM)	UNRESTRICTED
70% NORMAL RATED	540(MAX) 410(NORM)	555(MAX) 435(NORM)	UNRESTRICTED
IDLE	340	340	30
STARTING	600	600	MOMENTARY
ACCELERATION	625	620	1

FLYING LIMITATIONS

2. The following speeds and limitations apply to the ARROW 1 aircraft when fully cleared to its design specification. Until such clearance is obtained, the applicable aircraft design certificate must be studied prior to flight to obtain the overriding limitations to those given below:

(a) Maximum Permissible Speeds

Maximum Design Speed	-	700 Knots EAS or Mach 2.0 (Lowest limit to apply)
Extending or Retracting Landing Gear	-	250 Knots EAS
Extending Speed Brakes	-	No Limit
Parabrake Selection	-	185 Knots EAS (All wheels in ground contact)
Cross-wind component	-	30 Knots

(b) Crew Ejection

Maximum Speed	-	No structural limit
Minimum Speed	-	90 Knots at ground level

(c) Angle of Attack

Maximum Indicated Angle	-	15^{o} (in level flight) $1/2^{o}$ less for each incremental 'g' imposed

(d) Weights

Maximum Take-off	-	69,000 lb. (approx)
Maximum Landing	-	65,000 lb. (approx)

(e) 'G' Limits

'G' Limits are shown on Figs 4-1, 4-2 and 4-3

The maximum load factor in a rolling pull-out is two-thirds of the maximum allowable 'g' at that time.

UNCLASSIFIED

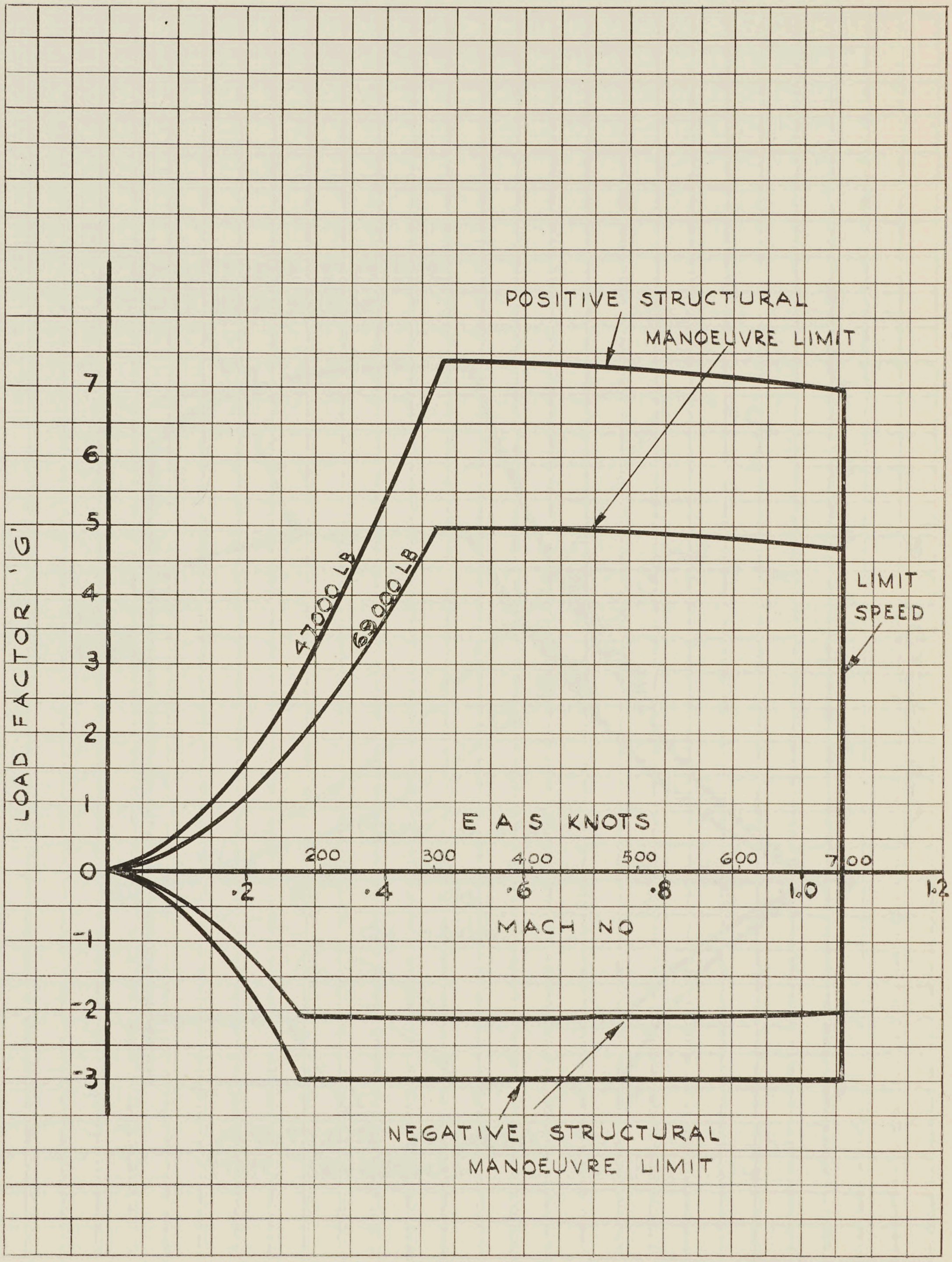

FIG 4-1 FLIGHT ENVELOPE - SEA LEVEL

UNCLASSIFIED

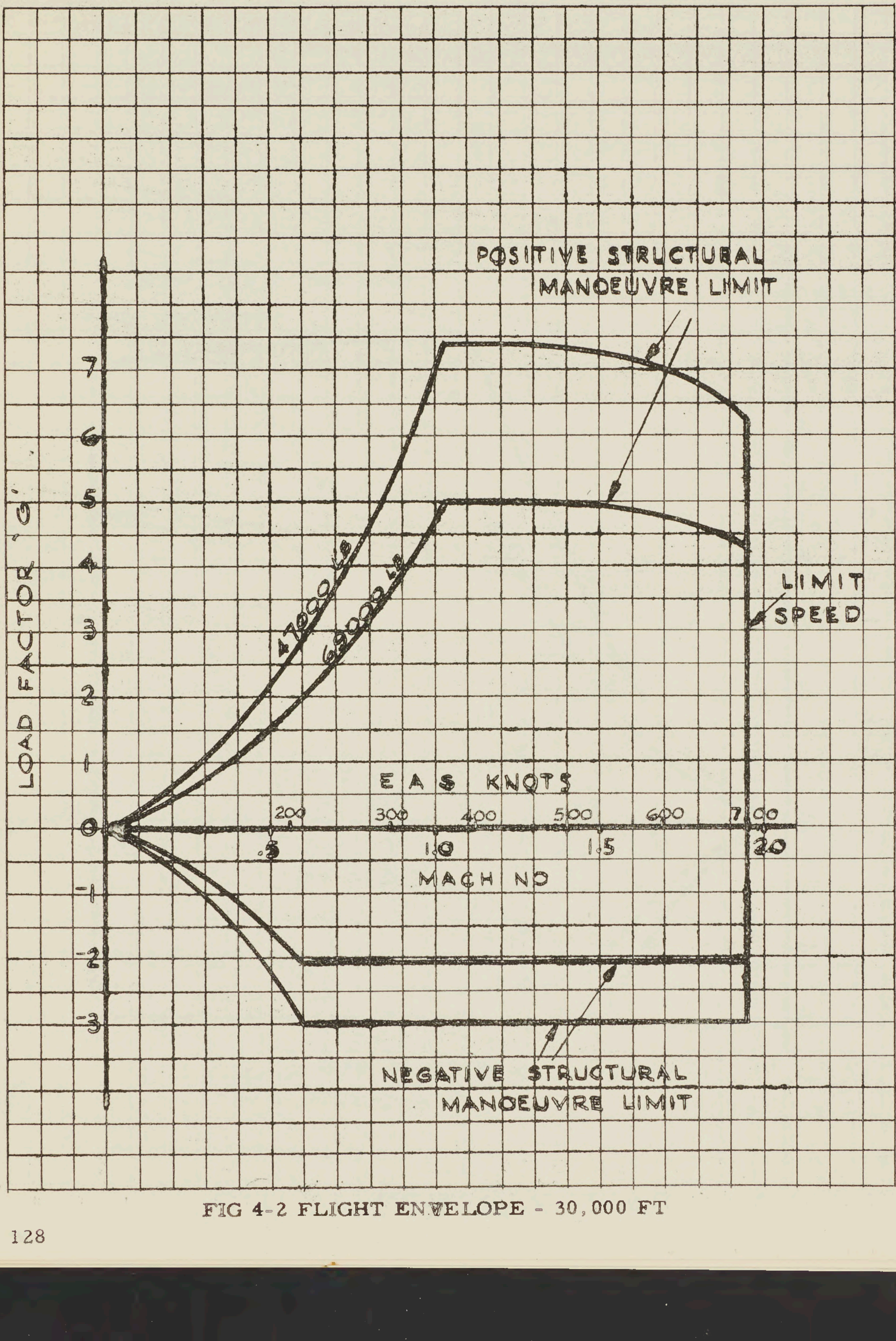

FIG 4-2 FLIGHT ENVELOPE - 30,000 FT

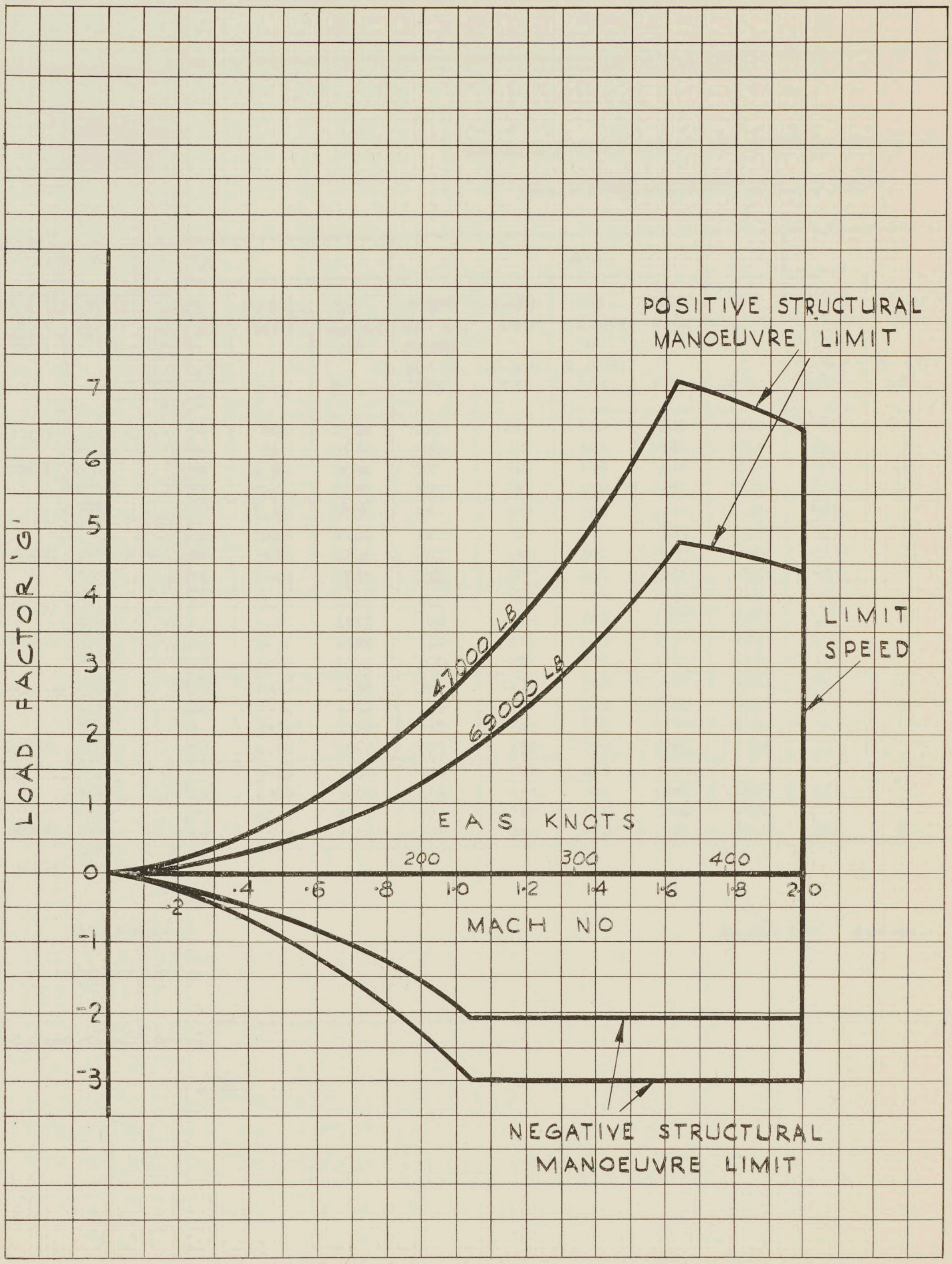

FIG 4-3 FLIGHT ENVELOPE - 50,000 FT

AIRCRAFT
ARROW 1

GROSS WT. LB.	PRESS ALT. FT.	-45°C					-25°C					
		NOSE WHEEL RAISE E.A.S. KTS.	TAKE OFF E.A.S. KTS.	TO CLEAR 50' E.A.S. KTS.	GRND. RUN FT.	TO CLEAR 50' FT.	NOSE WHEEL RAISE E.A.S. KTS.	TAKE OFF E.A.S. KTS.	TO CLEAR 50' E.A.S. KTS.	GRND. RUN FT.	TO CLEAR 50' FT.	NOSE WHEEL RAISE E.A.S. KTS.
50000	S.L.	124	138	152	1300	1850	130	145	160	1500	2130	135
	2000	130	145	159	1400	1980	134	149	164	1650	2320	140
	4000	135	150	165	1500	2110	140	156	172	1800	2510	145
	6000	141	157	172	1600	2240	145	161	177	1950	2700	150
55000	S.L.	130	145	159	1600	2280	137	152	167	1870	2700	141
	2000	135	150	165	1740	2470	141	157	173	2030	2900	147
	4000	141	157	172	1880	2660	147	163	179	2190	3100	152
	6000	147	163	180	2020	2850	152	169	186	2360	3300	158
60000	S.L.	135	150	165	1950	2800	142	158	174	2330	3280	147
	2000	141	157	172	2110	3030	148	164	180	2480	3560	153
	4000	147	163	180	2270	3260	154	171	188	2650	3840	158
	6000	154	170	186	2430	3490	159	177	195	2800	4120	165
65000	S.L.	141	157	172	2300	3400	149	165	181	2760	4010	153
	2000	147	163	180	2500	3660	154	171	188	2950	4310	159
	4000	154	170	186	2700	3930	159	177	195	3130	4610	166
	6000	158	176	194	2900	4190	166	184	202	3310	4910	171
70000	S.L.	147	163	180	2750	4080	154	171	188	3190	4780	159
	2000	154	170	186	2930	4380	159	177	195	3420	5160	166
	4000	158	176	194	3110	4680	166	184	202	3670	5540	171
	6000	165	183	201	3290	4980	171	190	209	3900	5920	178

DATA AS OF: Jan 1959 (71/PERF/29)

BASED ON : JP4 Fuel

AIRCRAFT
ARROW 1

GROSS WT. LB.	PRESS ALT. FT.	-45°C					-25°C					
		NOSE WHEEL RAISE E.A.S. KTS.	TAKE OFF E.A.S. KTS.	TO CLEAR 50' E.A.S. KTS.	GRND. RUN FT.	TO CLEAR 50' FT.	NOSE WHEEL RAISE E.A.S. KTS.	TAKE OFF E.A.S. KTS.	TO CLEAR 50' E.A.S. KTS.	GRND. RUN FT.	TO CLEAR 50' FT.	NOSE WHEEL RAISE E.A.S. KTS.
50000	S.L.	124	138	152	1300	1850	130	145	160	1500	2130	135
	2000	130	145	159	1400	1980	134	149	164	1650	2320	140
	4000	135	150	165	1500	2110	140	156	172	1800	2510	145
	6000	141	157	172	1600	2240	145	161	177	1950	2700	150
55000	S.L.	130	145	159	1600	2280	137	152	167	1870	2700	141
	2000	135	150	165	1740	2470	141	157	173	2030	2900	147
	4000	141	157	172	1880	2660	147	163	179	2190	3100	152
	6000	147	163	180	2020	2850	152	169	186	2360	3300	158
60000	S.L.	135	150	165	1950	2800	142	158	174	2330	3280	147
	2000	141	157	172	2110	3030	148	164	180	2480	3560	153
	4000	147	163	180	2270	3260	154	171	188	2650	3840	158
	6000	154	170	186	2430	3490	159	177	195	2800	4120	165
65000	S.L.	141	157	172	2300	3400	149	165	181	2760	4010	153
	2000	147	163	180	2500	3660	154	171	188	2950	4310	159
	4000	154	170	186	2700	3930	159	177	195	3130	4610	166
	6000	158	176	194	2900	4190	166	184	202	3310	4910	171
70000	S.L.	147	163	180	2750	4080	154	171	188	3190	4780	159
	2000	154	170	186	2930	4380	159	177	195	3420	5160	166
	4000	158	176	194	3110	4680	166	184	202	3670	5540	171
	6000	165	183	201	3290	4980	171	190	209	3900	5920	178

DATA AS OF: Jan 1959 (71/PERF/29)

BASED ON : JP4 Fuel

TAKE-OFF PERFORMANCE - NO AFTERBURNER

(HARD SURFACE RUNWAY - NO WIND)

-25°C			-5°C					+15°C					+35°C		
TO CLEAR 50' E.A.S. KTS.	GRND. RUN FT.	TO CLEAR 50' FT.	NOSE WHEEL RAISE E.A.S. KTS.	TAKE OFF E.A.S. KTS.	TO CLEAR 50' E.A.S. KTS.	GRND. RUN FT.	TO CLEAR 50' FT.	NOSE WHEEL RAISE E.A.S. KTS.	TAKE OFF E.A.S. KTS.	TO CLEAR 50' E.A.S. KTS.	GRND. RUN FT.	TO CLEAR 50' FT.	NOSE WHEEL RAISE E.A.S. KTS.	TAKE OFF E.A.S. KTS.	TO CLEAR 50' E.A.S. KTS.
160	1500	2130	135	150	165	1820	2640	140	155	170	2240	3300	145	161	177
164	1650	2320	140	155	170	1990	2840	145	161	177	2630	3790	150	168	184
172	1800	2510	145	161	177	2160	3040	151	168	185	3010	4350	157	174	191
177	1950	2700	150	167	184	2330	3240	157	175	192	3390	5000	164	182	200
167	1870	2700	141	157	173	2290	3300	147	164	180	2810	4200	151	168	185
173	2030	2900	147	163	179	2460	3560	151	168	185	3170	4780	157	174	191
179	2190	3100	152	169	186	2630	3840	157	175	192	3580	5480	164	182	200
186	2360	3300	158	175	193	2800	4100	165	183	201	4050	6440	171	189	209
174	2330	3280	147	164	180	2760	4030	154	171	188	3420	5240	158	174	194
180	2480	3560	153	170	187	2950	4350	157	175	192	3840	5900	164	182	200
188	2650	3840	158	176	194	3130	4670	165	183	201	4320	6940	170	189	208
195	2800	4120	165	183	201	3310	5000	171	190	209	4900	8300	176	196	216
181	2760	4010	153	170	187	3280	4920	160	178	196	4080	6450	165	182	201
188	2950	4310	159	177	195	3540	5320	165	183	201	4600	7420	170	189	208
195	3130	4610	166	184	201	3600	5720	171	190	209	5220	8840	176	196	216
202	3310	4910	171	190	209	3790	6120	178	198	218	5960	10830	184	204	224
188	3190	4780	159	177	195	3850	6020	165	184	202	4750	8000	171	189	209
195	3420	5160	166	184	202	4150	6480	171	190	209	5410	9450	176	196	216
202	3670	5540	171	190	209	4470	6860	178	198	218	6190	11400	184	204	224
209	3900	5920	178	198	218	4780	7400	185	205	222	7050	14430	191	212	233

BASED ON: Estimate, with input of some Flight Test Data.

FIG 4-4 TAKE-OFF P

UNCLASSIFIED

AFTERBURNER

NO WIND)

ENGINES
J 75 - P5

+15°C					+35°C					+38°C				
OSE HEEL AISE A.S. KTS.	TAKE OFF E.A.S. KTS.	TO CLEAR 50' E.A.S. KTS.	GRND. RUN FT.	TO CLEAR 50' FT.	NOSE WHEEL RAISE E.A.S. KTS.	TAKE OFF E.A.S. KTS.	TO CLEAR 50' E.A.S. KTS.	GRND. RUN FT.	TO CLEAR 50' FT.	NOSE WHEEL RAISE E.A.S. KTS.	TAKE OFF E.A.S. KTS.	TO CLEAR 50' E.A.S. KTS.	GRND. RUN FT.	TO CLEAR 50' FT.
140	155	170	2240	3300	145	161	177	2950	4400	146	162	178	3110	4840
145	161	177	2630	3790	150	168	184	3160	4780	151	168	185	3370	5240
151	168	185	3010	4350	157	174	191	3300	5150	158	175	193	3630	5640
157	175	192	3390	5000	164	182	200	3560	5530	165	183	201	3890	6040
147	164	180	2810	4200	151	168	185	3580	5620	151	168	185	3830	6210
151	168	185	3170	4780	157	174	191	3880	6100	158	175	193	4140	6740
157	175	192	3580	5480	164	182	200	4180	6580	165	183	201	4450	7270
165	183	201	4050	6440	171	189	209	4470	7050	172	191	210	4760	7800
154	171	188	3420	5240	158	174	194	4400	7220	158	175	193	4500	7950
157	175	192	3840	5900	164	182	200	4720	7820	165	183	201	4900	8650
165	183	201	4320	6940	170	189	208	5080	8420	172	191	210	5300	9350
171	190	209	4900	8300	176	196	216	5400	9020	178	198	218	5700	10050
160	178	196	4080	6450	165	182	201	5110	9320	165	183	201	5640	10950
165	183	201	4600	7420	170	189	208	5580	10100	172	191	210	6100	11800
171	190	209	5220	8840	176	196	216	6020	10820	178	198	218	6560	12650
178	198	218	5960	10830	184	204	224	6480	11580	186	206	226	7020	13550
165	184	202	4750	8000	171	189	209	6180	12480	172	191	210	6640	14900
171	190	209	5410	9450	176	196	216	6700	13500	178	198	218	7180	16200
178	198	218	6190	11400	184	204	224	7220	14520	186	206	226	7720	17500
185	205	222	7050	14430	191	212	233	7750	15540	192	213	234	8300	18800

N: Estimate, with input of some Flight Test Data.

FIG 4-4 TAKE-OFF PERFORMANCE CHART - (NO A/B)

UNCLASSIFIED

UNC

AIRCRAFT
ARROW 1

TAKE-OFF PERFORMA

(HARD SURFACE

GROSS WT. LB.	PRESS ALT. FT.	-45°C					-25°C					-5°C			
		NOSE WHEEL RAISE E.A.S. KTS.	TAKE OFF E.A.S. KTS.	TO CLEAR 50' E.A.S. KTS.	GRND. RUN FT.	TO CLEAR 50' FT.	NOSE WHEEL RAISE E.A.S. KTS.	TAKE OFF E.A.S. KTS.	TO CLEAR 50' E.A.S. KTS.	GRND. RUN FT.	TO CLEAR 50' FT.	NOSE WHEEL RAISE E.A.S. KTS.	TAKE OFF E.A.S. KTS.	TO CLEAR 50' E.A.S. KTS	GRN RUN FT.
50000	S.L.	124	138	166	720	1140	130	145	174	860	1370	135	150	180	1030
	2000	130	145	174	830	1340	134	149	179	990	1610	140	155	186	1220
	4000	135	150	180	940	1540	140	156	187	1120	1850	145	161	193	1410
	6000	141	157	188	1050	1740	145	161	193	1250	2090	150	167	200	1600
55000	S.L.	130	145	174	840	1420	137	152	183	1030	1700	141	157	188	1260
	2000	135	150	180	980	1660	141	157	188	1200	1980	147	163	196	1480
	4000	141	157	188	1120	1900	147	163	196	1370	2260	152	169	203	1700
	6000	147	163	196	1260	2140	152	169	203	1540	2540	158	175	210	1920
60000	S.L.	135	150	180	1040	1660	142	158	190	1230	2050	147	164	197	1520
	2000	141	157	188	1200	1950	148	164	197	1420	2370	153	170	204	1770
	4000	147	163	196	1360	2240	154	171	205	1610	2690	158	176	211	2020
	6000	154	170	204	1520	2530	159	177	212	1800	3010	165	183	220	2270
65000	S.L.	141	157	188	1200	2060	149	165	198	1450	2380	153	170	204	1770
	2000	147	163	196	1390	2380	154	170	204	1670	2780	159	177	212	2080
	4000	154	170	204	1580	2700	159	176	211	1890	3180	166	184	221	2390
	6000	158	176	211	1770	3020	166	184	221	2110	3580	171	190	228	2700
70000	S.L.	147	163	196	1400	2360	154	171	205	1660	2800	159	177	212	2080
	2000	154	170	204	1620	2750	159	177	212	1930	3300	166	184	221	2450
	4000	158	176	211	1840	3140	166	184	221	2200	3800	171	190	228	2820
	6000	165	183	220	2060	3530	171	190	228	2470	4300	178	198	238	3190

DATA AS OF: Jan 1959 (71/PERF/29)

BASED ON : JP4 Fuel

FIG 4-5 TAKE-OFF PERFORMANCE - (WITH A/B)

UNCLASSIFIED

TAKE-OFF PERFORMANCE - WITH AFTERBURNER

(HARD SURFACE RUNWAY - NO WIND)

°C			-5°C					+15°C					+35°C				
O EAR 0' .S. TS.	GRND. RUN FT.	TO CLEAR 50' FT.	NOSE WHEEL RAISE E.A.S. KTS.	TAKE OFF E.A.S. KTS.	TO CLEAR 50' E.A.S. KTS	GRND. RUN FT.	TO CLEAR 50' FT.	NOSE WHEEL RAISE E.A.S. KTS.	TAKE OFF E.A.S. KTS.	TO CLEAR 50' E.A.S. KTS.	GRND. RUN FT.	TO CLEAR 50' FT.	NOSE WHEEL RAISE E.A.S. KTS.	TAKE OFF E.A.S. KTS.	TO CLEAR 50' E.A.S. KTS.	GRND. RUN FT.	TO CLE 50 FT
74	860	1370	135	150	180	1030	1720	140	155	186	1320	2170	145	161	193	1700	2900
79	990	1610	140	155	186	1220	2020	145	161	193	1440	2370	150	168	202	1820	3120
37	1120	1850	145	161	193	1410	2320	151	168	202	1560	2570	157	174	209	1940	3340
93	1250	2090	150	167	200	1600	2620	157	175	210	1680	2770	164	182	218	2060	3560
33	1030	1700	141	157	188	1260	2120	147	164	197	1580	2670	151	168	202	2110	3610
38	1200	1980	147	163	196	1480	2500	151	168	202	1730	2900	157	174	209	2260	3880
96	1370	2260	152	169	203	1700	2880	157	175	210	1880	3130	164	182	218	2410	4150
03	1540	2540	158	175	210	1920	3260	165	183	220	2030	3360	171	189	227	2560	4420
90	1230	2050	147	164	197	1520	2580	154	171	205	1860	3250	158	174	209	2500	4410
97	1420	2370	153	170	204	1770	3030	157	175	210	2030	3530	164	182	218	2680	4760
05	1610	2690	158	176	211	2020	3480	165	183	220	2200	3810	170	189	227	2860	5110
12	1800	3010	165	183	220	2270	3930	171	190	229	2370	4090	176	196	235	3040	5460
98	1450	2380	153	170	204	1770	3020	160	178	214	2200	3910	165	182	218	3000	5390
04	1670	2780	159	177	212	2080	3590	165	183	220	2400	4240	170	189	227	3210	5790
11	1890	3180	166	184	221	2390	4160	171	190	229	2600	4570	176	196	235	3420	6190
21	2110	3580	171	190	228	2700	4730	178	198	238	2800	4880	184	204	245	3640	6590
05	1660	2800	159	177	212	2080	3600	165	184	221	2650	4710	171	189	227	3500	6470
12	1930	3300	166	184	221	2450	4270	171	190	229	2870	5090	176	196	235	3760	6960
21	2200	3800	171	190	228	2820	4940	178	198	238	3090	5470	184	204	245	4020	7450
28	2470	4300	178	198	238	3190	5610	185	205	246	3310	5850	191	212	254	4280	7940

BASED ON: Estimate, with input of some Flight Test Data

/B)

BURNER

ENGINES
J 75 - P5

+15°C				+35°C					+38°C				
AKE OFF .A.S. KTS.	TO CLEAR 50' E.A.S. KTS.	GRND. RUN FT.	TO CLEAR 50' FT.	NOSE WHEEL RAISE E.A.S. KTS.	TAKE OFF E.A.S. KTS.	TO CLEAR 50' E.A.S. KTS.	GRND. RUN FT.	TO CLEAR 50' FT.	NOSE WHEEL RAISE E.A.S. KTS.	TAKE OFF E.A.S. KTS.	TO CLEAR 50' E.A.S. KTS.	GRND. RUN FT.	TO CLEAR 50' FT.
155	186	1320	2170	145	161	193	1700	2900	146	162	194	1800	3110
161	193	1440	2370	150	168	202	1820	3120	151	168	202	1900	3320
168	202	1560	2570	157	174	209	1940	3340	158	175	210	2000	3530
175	210	1680	2770	164	182	218	2060	3560	165	183	220	2100	3740
164	197	1580	2670	151	168	202	2110	3610	151	168	202	2150	3800
168	202	1730	2900	157	174	209	2260	3880	158	175	210	2340	4110
175	210	1880	3130	164	182	218	2410	4150	165	183	220	2530	4420
183	220	2030	3360	171	189	227	2560	4420	172	191	229	2710	4730
171	205	1860	3250	158	174	209	2500	4410	158	175	210	2640	4720
175	210	2030	3530	164	182	218	2680	4760	165	183	220	2830	5070
183	220	2200	3810	170	189	227	2860	5110	172	191	229	3020	5420
190	229	2370	4090	176	196	235	3040	5460	178	198	238	3210	5770
178	214	2200	3910	165	182	218	3000	5390	165	183	220	3090	5660
183	220	2400	4240	170	189	227	3210	5790	172	191	229	3340	6110
190	229	2600	4570	176	196	235	3420	6190	178	198	238	3590	6560
198	238	2800	4880	184	204	245	3640	6590	186	206	247	3840	7010
184	221	2650	4710	171	189	227	3500	6470	172	191	229	3650	6950
190	229	2870	5090	176	196	235	3760	6960	178	198	238	3930	7440
198	238	3090	5470	184	204	245	4020	7450	186	206	247	4210	7930
205	246	3310	5850	191	212	254	4280	7940	192	213	256	4490	8420

nate, with input of some Flight Test Data

AIRCRAFT ARROW 1	CLIMB CHART (AT 527 KTS. T.A.S.) NO AFTERBURNER				ENGINES J 75 - P5
MILITARY THRUST - ENGINE START GROSS WT. - 60,000 LB.					
PRESSURE ALT.	TRUE A/S KTS.	APPROXIMATE VALUES FROM SEA LEVEL			RATE OF CLIMB (FT/MIN)
		FUEL (LB)	TIME(MIN)	DIST.(N.M.)	
S.L.	527	0	0	0	11,600
5,000	527	198	.45	3.8	10,850
10,000	527	388	.93	8.0	9,700
15,000	527	583	1.50	12.9	7,950
20,000	527	796	2.21	19.1	6,250
25,000	527	1046	3.14	27.2	4,450
30,000	527	1342	4.42	38.4	3,400
35,000	527	1713	6.27	54.7	2,000
38,000	527	2054	8.26	72.1	1,100
40,000	527	2391	10.49	101.7	650
40,900	527	2613	12.06	115.5	500
Start, Take-off and Accelerate to Climb Allowance		721	1.97	7.03	

DATA AS OF: Jan 1959 (71/PERF/29)

BASED ON : Estimated Data

BASED ON : JP-4 Fuel

FIGURES HAVE NOT BEEN FLIGHT CHECKED

FIG 4-6 CLIMB CHART (NO A/B) - 60,000 LB.

AIRCRAFT ARROW 1		CLIMB CHART (AT 527 KTS. T.A.S.) NO AFTERBURNER			ENGINES J 75 - P 5
MAXIMUM THRUST - ENGINE START GROSS WT. 68,000 LB.					
PRESSURE ALT.	TRUE A/S KTS.	APPROXIMATE VALUES FROM SEA LEVEL			RATE OF CLIMB
		FUEL (LB)	TIME(MIN)	DIST.(N.M.)	(FT/MIN)
S.L.	527	0	0	0	10,000
5,000	527	230	.52	4.5	9,400
10,000	527	452	1.09	9.4	8,200
15,000	527	680	1.75	15.2	6,850
20,000	527	930	2.58	22.4	5,300
25,000	527	1225	3.68	32.1	3,750
30,000	527	1588	5.25	45.8	2,600
35,000	527	2119	7.90	69.0	1,150
37,000	527	2525	10.21	87.3	600
37,600	527	2701	11.28	98.7	500
Start, Take-off and Accelerate to Climb Allowance		875	2.34	8.4	

DATA AS OF: Jan 1959 (71/PERF/29)

BASED ON : Estimated Data

BASED : JP-4 Fuel

FIGURES HAVE NOT BEEN FLIGHT CHECKED

FIG 4-7 CLIMB CHART (NO A/B) - 68,000 LB.

AIRCRAFT ARROW 1	CLIMB CHART WITH AFTERBURNERS									ENGINES J 75 - P 5
MAXIMUM THRUST - ENGINE START GROSS WT. -60,000 LB.										
PRESSURE ALT.	MACH NO.		APPROXIMATE VALUES FROM SEA LEVEL						RATE OF CLIMB (FT./MIN)	
	HIGH SPEED CLIMB	COMBAT CLIMB	FUEL(LB)		TIME(MIN)		DISTANCE(N.M.)			
S.L.	.92	.92	0		0		0		38,450	
5,000	.92	.92	282		.13		1.1		36,300	
10,000	.92	.92	524		.28		2.2		33,650	
15,000	.92	.92	754		.44		3.5		29,800	
20,000	.92	.92	979		.62		5.0		25,850	
25,000	.92	.92	1202		.83		6.8		21,650	
30,000	.92	.92	1413		1.08		9.0		17,450	
			.92M	1.5M	.92M	1.5M	.92M	1.5M	.92M	1.5M
30,000	-	1.5(accel)	-	2678	-	2.30	-	23.5	-	29,550
35,000	.92	1.5	1681	2878	1.46	2.47	12.2	25.8	13,300	30,300
40,000	.92	1.5	1953	3318	1.94	2.88	16.4	31.6	8,500	16,500
45,000	.92	1.5	2286	3606	2.68	3.36	22.9	36.8	5,050	10,450
47,000	.92	1.5	2469	3747	3.17	3.58	27.1	40.0	3,200	7,800
50,000	.92	1.5	2872	4022	4.37	4.08	37.7	47.1	1,800	4,200
51,000	.92	1.5	3096	4148	5.10	4.33	44.1	50.8	900	3,600
51,700	.92	-	3366	-	6.06	-	52.5	-	500	-
52,000	-	1.5	-	4320	-	4.70	-	56.1	-	1,850
53,000	-	1.5	-	4591	-	5.30	-	64.8	-	1,450
54,300	-	1.5	-	5172	-	6.68	-	84.6	-	500
Start, Take-off and Accelerate to Climb Allowance			1483		1.33		4.5			

DATA AS OF: Jan 1959 (71/PERF/29)
BASED ON : Estimated Data
BASED ON : JP 4 Fuel
FIGURES HAVE NOT BEEN FLIGHT CHECKED

FIG 4-8 CLIMB CHART (WITH A/B) - 60,000 LB.

AIRCRAFT ARROW 1			CLIMB CHART WITH AFTERBURNERS						ENGINES J 75 - P5	
MAXIMUM THRUST - ENGINE START GROSS WT. - 68,000 LB.										
PRESSURE ALT.	MACH NO.		APPROXIMATE VALUES FROM SEA LEVEL						RATE OF CLIMB (FT./MIN)	
	HIGH SPEED CLIMB	COMBAT CLIMB	FUEL (LB)		TIME (MIN)		DISTANCE (N.M.)			
S.L.	.92	.92	0		0		0		33,750	
5,000	.92	.92	321		.15		1.3		31,900	
10,000	.92	.92	596		.32		2.7		29,600	
15,000	.92	.92	858		.50		4.2		26,150	
20,000	.92	.92	1115		.70		6.0		22,600	
25,000	.92	.92	1371		.94		8.1		18,800	
30,000	.92	.92	1615		1.24		10.7		14,950	
			.92M	1.5M	.92M	1.5M	.92M	1.5M	.92M	1.5M
30,000	-	1.5(accel)	-	3098	-	2.68	-	27.7	-	25,700
35,000	.92	1.5	1888	3329	1.62	2.87	14.0	30.4	11,150	26,100
40,000	.92	1.5	2227	3607	2.22	3.16	19.2	34.5	6,450	14,200
45,000	.92	1.5	2685	3960	3.25	3.61	28.1	40.9	3,400	7,850
47,000	.92	1.5	2946	4153	3.93	3.92	34.2	45.2	2,450	5,500
49,000	.92	1.5	3405	4423	5.26	4.37	45.9	51.8	500	3,250
50,000	-	1.5	-	4629	-	4.76	-	57.3	-	2,000
51,000	-	1.5	-	4910	-	5.33	-	65.5	-	1,450
52,000	-	1.5	-	5392	-	6.35	-	83.1	-	500
Start, Take-off and Accelerate to Climb Allowance			1684		1.46		4.9			

DATA AS OF: Jan 1959 (71/PERF/29)
BASED ON : Estimated Data
BASED ON : JP 4 Fuel
FIGURES HAVE NOT BEEN FLIGHT CHECKED

FIG 4-9 CLIMB CHART (WITH A/B) - 68,000 LB.

AIRCRAFT ARROW 1	FUEL FLOW AT MACH 0.92 AND MACH 1.5 LB/MIN/ENGINE									ENGINES J 75 - P5
ALTITUDE FT.	AIRCRAFT WEIGHT LB.									
	45,000		50,000		55,000		60,000		65,000	
	MACH .92	MACH 1.5	MACH .92	MACH 1.5	MACH .92	MACH 1.5	MACH .92	MACH 1.5	MACH .92	MACH 1.5
25,000	68.7	-	69.8	-	71.5	-	74.4	-	77.3	-
30,000	59.5	-	61.8	-	64.6	-	68.7	-	73.3	-
35,000	53.4	423.3	58.2	425.0	63.9	428.7	70.1	430.5	77.4	432.3
40,000	51.5	337.1	57.4	339.9	65.4	342.7	-	345.6	-	348.4
45,000	51.2	269.6	59.3	274.2	-	278.7	-	283.1	-	289.9

DATA AS OF: Jan. 1959 (71/PERF/29)

BASED ON : Estimated Data

BASED ON : JP 4 Fuel

NOTES: (1) 45" Divergent ejector used.

(2) Fuel Flow is increased by 5%.

NOTE:
Mach .92 is with A/B Unlit
Mach 1.5 is with A/B Lit

FIGURES HAVE NOT BEEN FLIGHT CHECKED

FIG 4-10 FUEL FLOW CHART

UNCLASSIFIED

AIRCRAFT ARROW 1	LANDING DISTANCE FEET (WITH PARABRAKE AND DIVEBRAKES)				ENGINES J 75 - P5
GROSS WEIGHT (LB.)	APPROACH SPEED E.A.S. KTS.	TOUCHDOWN SPEED E.A.S. KTS.	BRAKING SPEED E.A.S. KTS.	HARD SURFACE RUNWAY NO WIND - TEMPERATURE 15°C AT SEA LEVEL	
				GROUND RUN (FT.)	CLEAR TO 50' (FT.)
50,000	180	163	147	4070	5920
55,000	189	172	157	4470	6410
60,000	197	179	163	4860	6880
65,000	205	186	170	5250	7370
70,000	213	194	178	5630	7850

ASSUMPTIONS:
- Nose Wheel Down, Parabrake Fully Streamed and Brakes Effective 4 seconds after Touchdown.
- Without Anti-skid Units
- Engines Idle at Touchdown
- Wet Runway

DATA AS OF : Jan 1959 (71/PERF/29)

BASED ON : Estimate, with Input of Some Flight Test Data

FIG 4-11 LANDING DISTANCE CHART - WITH PARABRAKE

AIRCRAFT ARROW 1	LANDING DISTANCE FEET (NO PARABRAKE, WITH DIVEBRAKES)			ENGINES J 75 - P5	
GROSS WEIGHT (LB.)	APPROACH SPEED E.A.S. KTS.	TOUCHDOWN SPEED E.A.S. KTS.	BRAKING SPEE D E.A.S. KTS.	HARD SURFACE RUNWAY NO WIND - TEMPERATURE 15°C AT SEA LEVEL	
				GROUND RUN (FT.)	CLEAR TO 50' (FT.)
50,000	180	163	147	6620	8500
55,000	189	172	157	7340	9300
60,000	197	179	163	8050	10070
65,000	205	186	170	8760	10860
70,000	213	194	178	9490	11650

ASSUMPTIONS:

- Nose Wheel Down and Brakes Effective 4 seconds after Touchdown
- Without Anti-skid Units
- Engines Idle at Touchdown
- Wet Runway

DATA AS OF : Jan 1959 (71/PERF/29)

BASED ON : Estimate, with Input of Some Flight Test Data

FIG 4-12 LANDING DISTANCE CHART - WITHOUT PARABRAKE