EO 05-185A-1

CANADIAN FORCES

AIRCRAFT OPERATING INSTRUCTIONS

CF101

(This EO replaces EO 05-185A-1 dated 17 Jan 67 and all revisions issued thereto)

ISSUED ON AUTHORITY OF THE CHIEF OF THE DEFENCE STAFF

31 JAN 69

LIST OF REVISIONS

DATE	PAGE NO	DATE	PAGE NO

NOTES TO USERS

1 This publication is divided into four parts: Description, Handling, Emergency Handling, and Operating Data.

2 PART 1–DESCRIPTION of the controls and equipment with which the pilot should be acquainted.

3 PART 2–HANDLING describes the normal handling of the aircraft by the pilot.

4 PART 3–EMERGENCY HANDLING describes the emergency handling of the aircraft by the pilot.

5 PART 4–OPERATING DATA gives the flying and engine limitations and includes information on fuel consumption, range and endurance, acceleration time, and instrument errors.

6 The performance data contained in PART 4 is based on new, fully-rated J-57 engines. Care must be taken when using this data as the engines have since been derated. No revision of the original data is available and no conversion percentage has been computed.

7 These notes are complementary to EO 05-1-1 Aircraft Operating Instructions General and assume a thorough knowledge of its contents.

8 Comments and suggestions should be forwarded by UCR through the usual channels to Canadian Forces Headquarters.

TABLE OF CONTENTS

PART	TITLE	PAGE
1	INTRODUCTION	1
	GENERAL	1
	LEADING PARTICULARS	1
	AIRCRAFT DIMENSIONS	1
	AIRCRAFT GROSS WEIGHT	1
	RAMP WEIGHT	1
	ARMAMENT WEIGHTS	2
	ARMAMENT	2
	AIRFRAME	3
	GENERAL	3
	CANOPY	4
	TAIL HOOK	5
	DRAG CHUTE	6
	EXTERNAL STORES	6
	FUEL SYSTEM	11
	GENERAL	11
	FUEL GAUGING	11
	FUEL CONTROL PANEL	12
	FUEL TRANSFER	12
	FEED TANK	13
	FUEL PRESSURIZATION AND VENT SYSTEM	14
	TANK JETTISON	14
	REFUELING	14
	DEFUELING	15
	LOCK-OUT AND CHECK SWITCHES	15
	FUEL SPECIFICATIONS	15
	ENGINE	16
	GENERAL	16
	OIL SYSTEM	19
	FUEL PUMP UNIT	19
	ENGINE CONTROL	19
	AFTERBURNER CONTROL	20
	ENGINE STARTER AND IGNITION SYSTEMS	21
	ENGINE INSTRUMENTS	22
	ENGINE PRESSURE RATIO GAUGES	22
	EXHAUST GAS TEMPERATURE GAUGES	23
	FUEL FLOW METERS	23
	RPM GAUGES	23
	OIL PRESSURE GAUGES	23
	HYDRUALIC POWER SUPPLY SYSTEM	25
	GENERAL	25
	PRIMARY SYSTEM	25
	UTILITY SYSTEM	25
	HYDRAULIC PRESSURE GAUGES	25
	HYDRAULIC PRESSURE WARNING LIGHT	25
	FLIGHT CONTROL SYSTEM	25
	GENERAL	25
	STABILATOR FEEL AND TRIM	26
	AILERON FEEL AND TRIM	26
	RUDDER PEDALS	27
	RUDDER FEEL AND TRIM	27

TABLE OF CONTENTS (Cont'd)

PART	TITLE	PAGE
1	YAW DAMPER (STABILITY AUGMENTATION)	27
	TAKE-OFF TRIM BUTTON	27
	TAKE-OFF TRIM LIGHT	28
	LANDING GEAR SYSTEM	28
	GENERAL	28
	LANDING GEAR SHOCK STRUTS	28
	LANDING GEAR GROUND LOCKS	28
	LANDING GEAR HANDLE	29
	LANDING GEAR EMERGENCY HANDLE	29
	LANDING GEAR POSITION INDICATORS	29
	LANDING GEAR WARNING LIGHTS	29
	LANDING GEAR WARNING BUZZER AND SILENCER	30
	NOSE GEAR STEERING SYSTEM	30
	WHEEL BRAKE SYSTEM	30
	GENERAL	30
	WHEEL BRAKE ANTI-SKID SYSTEM	30
	ANTI-SKID SWITCH	31
	ANTI-SKID INOPERATIVE LIGHT	31
	EMERGENCY HYDRAULIC BRAKES	31
	WING FLAPS	31
	GENERAL	31
	WING FLAP LEVER	31
	WING FLAP POSITION INDICATOR	32
	SPEED BRAKES	32
	GENERAL	32
	SPEED BRAKE SWITCH	32
	EMERGENCY SPEED BRAKE SWITCH	32
	ELECTRICAL POWER SUPPLY SYSTEM	35
	GENERAL	35
	GENERATORS	35
	GENERATOR CONTROL	35
	DC POWER	35
	GENERATOR SWITCHES AND WARNING DEVICES	36
	EMERGENCY ELECTRICAL POWER	36
	EXTERNAL POWER	36
	CIRCUIT BREAKERS AND FUSES	37
	EXTERNAL LIGHTING SYSTEM	37
	LANDING AND TAXI LIGHTS	37
	POSITION AND FUSELAGE LIGHTS	37
	IDENTIFICATION LIGHT	38
	INTERIOR LIGHTING SYSTEM	38
	COCKPIT LIGHTING	38
	INDICATOR AND WARNING LIGHTS	39
	ENGINE FIRE AND OVERHEAT DETECTOR SYSTEM	39
	TELELIGHT SYSTEM	40
	PITOT/STATIC, CENTRAL AIR DATA COMPUTOR AND CENTRAL VERTICAL GYRO SYSTEMS	41
	PITOT/STATIC SYSTEM	41
	CENTRAL AIR DATA COMPUTOR	41
	CENTRAL VERTICAL GYRO	41

TABLE OF CONTENTS (Cont'd)

PART	TITLE	PAGE
1	FLIGHT INSTRUMENTS	41
	ALTIMETER	41
	VERTICAL SPEED INDICATOR	42
	AIRSPEED/MACH INDICATOR	42
	TRUE AIRSPEED INDICATOR	42
	ATTITUDE INDICATOR	42
	TURN AND SLIP INDICATOR	43
	ACCELEROMETER	43
	PITCH BOUNDARY INDICATOR	43
	COMPASS INDICATOR	43
	STANDBY COMPASS	43
	CLOCK	43
	NAVIGATION SYSTEMS	45
	AJN-3 COMPASS SYSTEM	45
	STANDBY COMPASS	46
	TACAN	46
	INSTRUMENT LANDING SYSTEM	46
	COURSE DEVIATION INDICATOR	47
	AUTOMATIC DIRECTION FINDING	47
	IFF/SIF	47
	PITCH CONTROL SYSTEM	49
	GENERAL	49
	CONTROLS AND SYSTEM WARNING DEVICES	49
	PUSHER	49
	HORN	49
	PITCH BOUNDARY INDICATOR	50
	PITCH CONTROL SYSTEM LIMITATIONS	50
	AUTOMATIC FLIGHT CONTROL SYSTEM	51
	GENERAL	51
	YAW DAMPER	51
	BASIC AFCS MODES	52
	ALTITUDE/MACH HOLD	52
	HEADING SELECT/PRE-SELECT	52
	COUPLER	52
	AFCS LIMITER	53
	MANUAL COMMAND SIGNAL LIMITER	53
	RADIO SYSTEMS	55
	INTERCOM SYSTEM	55
	UHF COMMAND RADIO	55
	DATA-LINK	56
	HEAT, VENT, AIR CONDITIONING AND PRESSURIZATION SYSTEMS	59
	GENERAL	59
	PRIMARY HEAT EXCHANGER	59
	COCKPIT AIR CONDITIONING	59
	COCKPIT PRESSURIZATION	59
	EQUIPMENT COOLING	60
	RAIN CLEARING	60
	AIR DEFROST	61
	ELECTRICAL DEFROST	61
	PITOT HEAT	61
	FACE HEAT	61

TABLE OF CONTENTS (Cont'd)

PART	TITLE	PAGE
1	ANTI "G" SYSTEM	61
	HYDRAULIC RESERVOIR PRESSURIZATION	61
	WING AND EXTERNAL TANK TRANSFER PRESSURE	62
	SAFETY EQUIPMENT SYSTEMS	63
	OXYGEN SYSTEM	63
	EJECTION SEAT	64
	CANOPY JETTISON	66
	PARACHUTE	66
	SURVIVAL KIT	67
	DUAL AIRCRAFT	72
	GENERAL	72
	FLIGHT CONTROLS AND INSTRUMENTS	72
	ENGINE CONTROLS AND INSTRUMENTS	72
	MISCELLANEOUS	72
2	VISUAL, INSTRUMENT AND NIGHT FLIGHT	73
	GENERAL	73
	INSTRUMENT TECHNIQUE	73
	FLIGHT CHARACTERISTICS	73
	GENERAL	73
	THEORY OF PITCH-UP	73
	SUPERSONIC PITCH-UP	74
	AIRSPEED BLEED PITCH-UP	74
	ACCELERATION PITCH-UP	75
	ROLL RATE PITCH-UP	75
	LEVEL FLIGHT CHARACTERISTICS	75
	LOW SPEEDS	75
	CRUISE SPEEDS	76
	HIGH SPEEDS	76
	MANOEUVERING FLIGHT CHARACTERISTICS	76
	MANOEUVERING LOADS	76
	DIVES	76
	OPTIMUM DIVE RECOVERY	76
	NOSE HIGH, LOW AIRSPEED RECOVERY	77
	FLIGHT WITH EXTERNAL TANKS	77
	FLIGHT CONTROL EFFECTIVENESS	77
	STABILATOR	77
	AILERONS	77
	RUDDER	78
	FLAPS	78
	SPEED BRAKES	78
	PREFLIGHT CHECKS	79
	BEFORE ENTERING COCKPIT	79
	PRE-EXTERNAL COCKPIT CHECK	79
	EXTERNAL INSPECTION	79
	PRE-START CHECK (FRONT COCKPIT)	79
	PRE-START CHECK (REAR COCKPIT)	83
	BEFORE STARTING ENGINES	83
	STARTING ENGINES	85
	NORMAL START	85
	BATTERY START	86
	INTERNAL AIR START	86
	PNEUMATIC START	86

TABLE OF CONTENTS (Cont'd)

PART	TITLE	PAGE
2	GROUND OPERATION	87
	BEFORE TAXIING	87
	TAXIING CHECKS	88
	PRE-TAKE-OFF CHECK	89
	TAKE-OFF CHECK	89
	TAKE-OFF	91
	NORMAL TAKE-OFF	91
	CROSSWIND TAKE-OFF	91
	AFTER TAKE-OFF	93
	AFTER BECOMING AIRBORNE	93
	CLIMB	93
	MILITARY THRUST CLIMB	93
	MAXIMUM THRUST CLIMB	93
	DURING CLIMB	93
	LEVEL-OFF	94
	DURING MISSION	94
	FUEL MONITORING	94
	FUEL SYSTEM MANAGEMENT	95
	OXYGEN CHECKS	95
	RECOVERY	97
	PRIOR TO DESCENT CHECK	97
	DESCENT CHECK	97
	HOLDING AND STACKING	97
	STRAIGHT-IN TACAN APPROACH	97
	PRE-LANDING CHECK	98
	FINAL TACAN APPROACH	98
	RADAR GROUND CONTROLLED APPROACH (GCA)	98
	INSTRUMENT LANDING SYSTEM (ILS)	99
	MISSED APPROACH	99
	VFR CIRCUIT	99
	LANDING	101
	FINAL APPROACH	101
	FLARE AND TOUCHDOWN	101
	LANDING ROLL AND DECELERATION	101
	CROSSWIND LANDING	102
	LANDING ON SLIPPERY RUNWAY	102
	OVERSHOOT	102
	POST LANDING CHECK	103
	ENGINE SHUTDOWN	103
	ADVERSE WEATHER OPERATION	107
	GENERAL	107
	HOT WEATHER	107
	PRECIPITATION AND HIGH HUMIDITY	107
	COLD WEATHER	108
	ICING	109
	TURBULENCE	109
	THUNDERSTORMS	110
	RUNWAY OVERRUN BARRIERS	111
	MA-IA (WEB-CABLE) BARRIER	111
	MODIFIED MA-IA (WEB-CABLE) BARRIER	111
	BAK-6/F-27A and BAK-9/F-27A BARRIERS	111
	BARRIER ENGAGEMENTS	111

TABLE OF CONTENTS (Cont'd)

PART	TITLE	PAGE
2	MA-IA BARRIER ENGAGEMENT	111
	MODIFIED MA-IA BARRIER ENGAGEMENT	112
	BAK-6/F-27A AND BAK-9/F-27A BARRIER ENGAGEMENT	112
	STRANGE FIELD PROCEDURES	113
	GENERAL	113
	ENGINE OIL SYSTEM	113
	FUEL SYSTEM	113
	HYDRAULIC SYSTEM RESERVOIRS	113
	HYDRAULIC SYSTEM ACCUMULATORS	114
	BATTERY	114
	LANDING GEAR TIRES	114
	ENGINE STARTER AIR BOTTLES	115
	STARTING UNITS	115
	OXYGEN SYSTEM	115
	EMERGENCY BRAKE ACCUMULATOR	115
3	EMERGENCY HANDLING	121
	GENERAL	121
	ABORTED TAKE-OFF	121
	ENGINE EMERGENCIES	122
	ENGINE FAILURE	122
	AIRSTART	124
	ENGINE FIRE OR OVERHEAT	125
	COMPRESSOR STALLS	126
	OIL SYSTEM FAILURE	126
	AFTERBURNER FAILURE	127
	AFTERBURNER NOZZLE FAILURE	128
	ELECTRICAL EMERGENCIES	129
	SINGLE GENERATOR FAILURE	129
	DOUBLE GENERATOR FAILURE	129
	TRANSFORMER RECTIFIER FAILURE	130
	ELECTRICAL FIRE	130
	FUEL SYSTEM EMERGENCIES	131
	TRANSFER PUMP FAILURE	131
	BOOST PUMP FAILURE	131
	WING VENTING	131
	ENGINE FUEL PUMP FAILURE	132
	AFTERBURNER FUEL PUMP FAILURE	132
	FUEL CONTROL UNIT FAILURE	132
	HYDRAULIC SYSTEM FAILURE	133
	GENERAL	133
	COMPLETE HYDRAULIC SYSTEM FAILURE	133
	PRIMARY HYDRAULIC SYSTEM FAILURE	133
	UTILITY HYDRAULIC SYSTEM FAILURE	133
	EMERGENCY SPEED BRAKE OPERATION	133
	LANDING GEAR EMERGENCY LOWERING	134
	ANTI-SKID SYSTEM FAILURE	134
	BRAKE SYSTEM EMERGENCY OPERATION	134
	FLIGHT CONTROL MALFUNCTION	135
	GENERAL	135
	SMOKE AND FUMES	137
	OXYGEN SYSTEM FAILURE	137

TABLE OF CONTENTS (Cont'd)

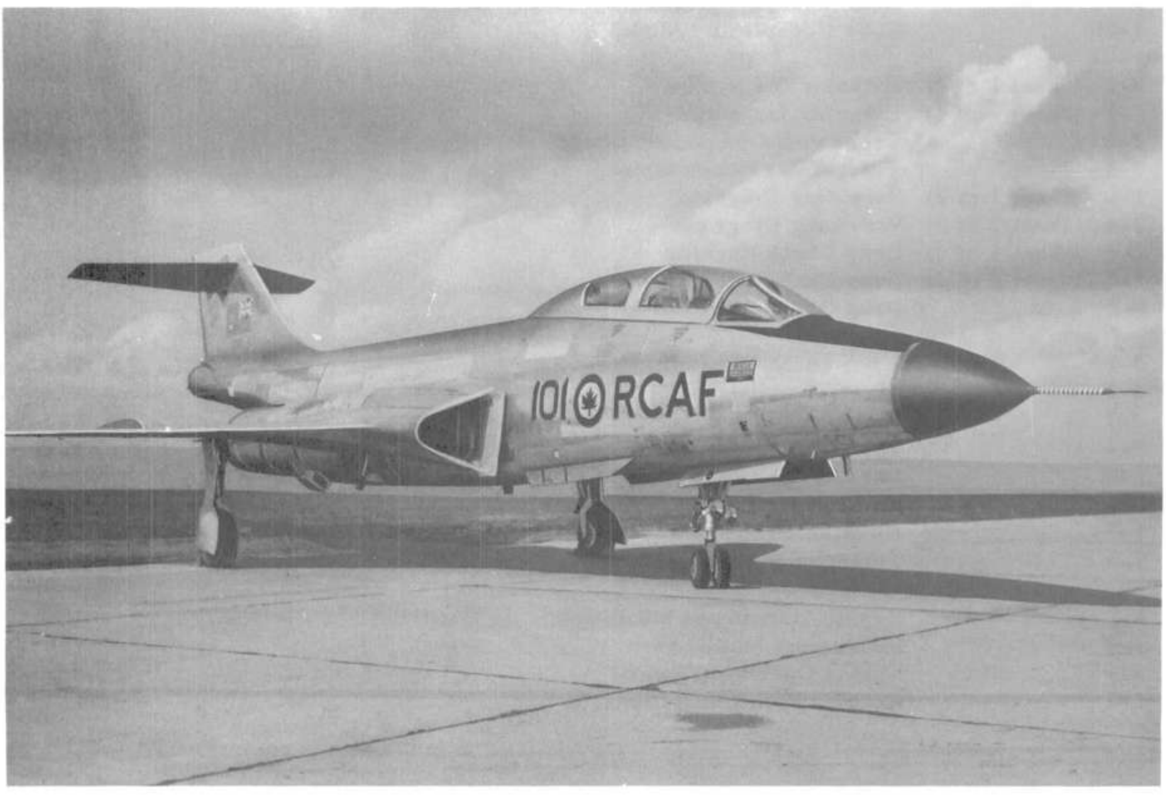
PART	TITLE	PAGE
3	EMERGENCY LANDING PROCEDURES	139
	FORCED LANDING	139
	DITCHING	139
	SINGLE ENGINE LANDING	140
	SINGLE ENGINE OVERSHOOT	140
	FLAPLESS LANDING	140
	LANDING GEAR MALFUNCTIONS	141
	BLOWN TIRE	143
	GEAR RETRACTION ON GROUND	145
	HOT BRAKES	145
	RUNWAY OVERRUN BARRIER	145
	APPROACH END BARRIER	146
	EMERGENCY ENTRANCE	150
	EMERGENCY EXIT	150
	EJECTION	153
	GENERAL	153
	LOW ALTITUDE EJECTION	153
	HIGH ALTITUDE EJECTION	154
	AFTER EJECTION	155
	EJECTION SEAT FAILURE	155
	EMERGENCY JETTISONING	157
	EXTERNAL TANKS	157
	EMERGENCY ROCKET RELEASE	157
	EMERGENCY MISSILE RELEASE	157
	MISSILE MISFIRE OR HANGFIRE	158
	AIR-2A ROCKET EJECTOR RACK MISFIRE	158
4	OPERATING DATA	161
	GENERAL	161
	ENGINE LIMITATIONS	161
	MAXIMUM THRUST	161
	MILITARY THRUST	161
	MAXIMUM CONTINUOUS THRUST	161
	ENGINE OPERATING LIMITS	162
	ENGINE OIL PRESSURE	162
	ENGINE OVERSPEED	162
	EMERGENCY FUEL	162
	ENGINE STARTER	162
	ENGINE STARTER AIR BOTTLES	162
	AIRSPEED LIMITATIONS	162
	LANDING GEAR LOWERING SPEEDS	162
	FLAP OPERATING SPEEDS	162
	CANOPY OPERATING SPEEDS	162
	DRAG CHUTE OPERATING SPEEDS	162
	RAIN CLEARING SYSTEM OPERATING SPEEDS	163
	REFUELING PROBE OPERATING SPEEDS	163
	MAXIMUM ALLOWABLE AIRSPEEDS	163
	EXTERNAL TANKS JETTISON SPEEDS	163
	PROHIBITED MANOEUVERS	163
	ACCELERATION LIMITATIONS	163
	GENERAL	163
	PITCH CONTROL SYSTEM INOPERATIVE	164

TABLE OF CONTENTS (Cont'd)

PART	TITLE	PAGE
4	CENTER OF GRAVITY LIMITATIONS	164
	MOST FORWARD C. G.	164
	MOST AFT C. G.	164
	CENTER OF GRAVITY TRAVEL	164
	WEIGHT LIMITATIONS	164
	EQUIPMENT COOLING	165
	MAGNETRON BLOWER	165
	FCS OVERHEAT	165
	CF-101 ALTITUDE LIMITATIONS	165
APPENDIX I	PERFORMANCE DATA	
APPENDIX II	FUNCTIONAL TEST FLIGHTS	1
	BEFORE-FLIGHT REQUIREMENTS	1
	INFLIGHT REQUIREMENTS	3
	AFTERFLIGHT REQUIREMENTS	9

LIST OF ILLUSTRATIONS

FIGURE		TITLE	PAGE
		Frontispiece	xii
1-1	(Sheet 1 of 2)	Voodoo Airframe	3
1-1	(Sheet 2 of 2)	Voodoo Airframe	4
1-2		Aircraft Danger Areas	7
1-3		Drag Chute Schematic	8
1-4		Canopy Schematic	9
1-5		Fuel System	10
1-6		J-57 - P-55 Engine	16
1-7		Fuel Control System	18
1-8		Hydraulic Power System	24
1-9		Control Stick	26
1-10		Electrical Power Supply	34
1-11		Lighting Panel Front Cockpit	39
1-12		Compass Indicator Control Panel	45
1-13		IFF/SIF Control Panel	48
1-14		Automatic Flight Control Panel	51
1-15		Intercom Control Panel	55
1-16		UHF Control Panel	56
1-17		Heat and Pressurization System	58
1-18		Cabin Pressure Schedule	62
1-19		Oxygen Duration Chart	63
1-20		Safety Belt	65
1-21		Parachute Layout	69
1-22		Seat Pack Layout	70
1-23		Seat Ejection Sequence	71
1-24		Front Cockpit	72A
1-25		Rear Cockpit "B" Model	72B
1-26		Rear Cockpit "F" Model	72C
2-1	(Sheet 1 of 2)	Exterior Inspection	80
2-1	(Sheet 2 of 2)	Exterior Inspection	81
2-2		Crosswind Component Chart	92
2-3		Typical Jet Penetration	96
2-4	(Sheet 1 of 2)	Servicing Diagram	105
2-4	(Sheet 2 of 2)	Servicing Diagram	106
2-5	(Sheet 1 of 2)	Drag Chute Packing	116
2-5	(Sheet 2 of 2)	Drag Chute Packing	117
2-6		Drag Chute Installation	118
3-1		Glide Distance	123
3-2		Airstart	124
3-3		Emergency Gear Operation	134
3-4		Typical Single Engine Landing Pattern	138
3-5		Barrier Limits	147
3-6		Emergency Entrance and Exit	149
3-7		Ejection Procedure	152
3-8		Emergency Tank Jettison	157
4-1		Engine Instrument Markings	159
4-2		Instrument Markings	160
4-3		Engine Operating Limits	161
4-4		Acceleration Limitations	163



Frontispiece

PART I

INTRODUCTION

GENERAL

1 The CF-101B aircraft is a two place, supersonic, all weather interceptor powered by two axial flow turbojet engines with afterburners. The aircraft features very thin, short, swept-back wings with engine intakes at the roots, and a swept back empennage with a controllable, one piece horizontal stabilator mounted high on the vertical stabilizer. The control surfaces are positioned by irreversible hydraulic actuators to provide desirable control effectiveness throughout the entire speed range. Aerodynamic pilot feel is simulated by an artificial feel system. The wing flaps are hydraulically operated and electrically controlled. Panel type speed brakes are installed on the aft portion of each side of the fuselage and may be utilized at all speeds. The fuel supply system can be serviced in flight by the probe and drogue method, and on the ground by the single point pressure system. A single canopy encloses both cockpits. A drag chute located in the empennage is deployed after landing to reduce landing roll.

2 The interceptor role is accomplished using a fire control radar, operated by the navigator in the rear cockpit, together with either manual or SAGE (data link) control. An identification light on the left side of the fuselage in the rear cockpit provides illumination of other aircraft for visual identification.

3 With dual control equipment installed, to provide secondary operation as a pilot trainer, the aircraft is designated CF-101F. This dual aircraft, however, has the same tactical capabilities as the "B" model. Differences between the two models are discussed under the heading DUAL AIRCRAFT.

LEADING PARTICULARS

AIRCRAFT DIMENSIONS

4 The approximate over-all dimensions of the aircraft are as follows:

Span	39 feet 8 inches
Length	71 feet 1 inch
Height	18 feet

5 The minimum turning radius is 47'9" with the nose gear steering deflected its maximum of 40°. With nose wheel steering disengaged the turning radius is increased by differential braking, however, care must be taken not to exceed the nose wheel deflection limit of 60°.

AIRCRAFT GROSS WEIGHT

6 The approximate empty weight of the aircraft in the armament configuration, including ungageable fuel (lines, pumps, manifolds, etc.), and two crew members, is 32,200 pounds.

RAMP WEIGHT

7 The approximate ramp gross weight of the aircraft in the armament configuration, including full internal load, pilot and crew member, is as follows:

Aircraft without external tanks	45,700 pounds
Aircraft with two full external tanks	51,950 pounds

ARMAMENT WEIGHTS

8 Approximate weights of individual aircraft armament are as follows:

AIR-2A	837.7 pounds
AIM-4D	132 pounds

ARMAMENT

9 The aircraft has provisions for launching two AIR-2A rockets and two AIM-4D missiles. The armament is carried on a rotary door, on the underside of the fuselage, aft of the nose gear well. The rotary door stores two AIR-2A rockets on the internal bay and two AIM-4D missiles externally. The armament is fired by the MG-13 Fire Control System. For additional information on the armament system, refer to EO 05-185A-1A.

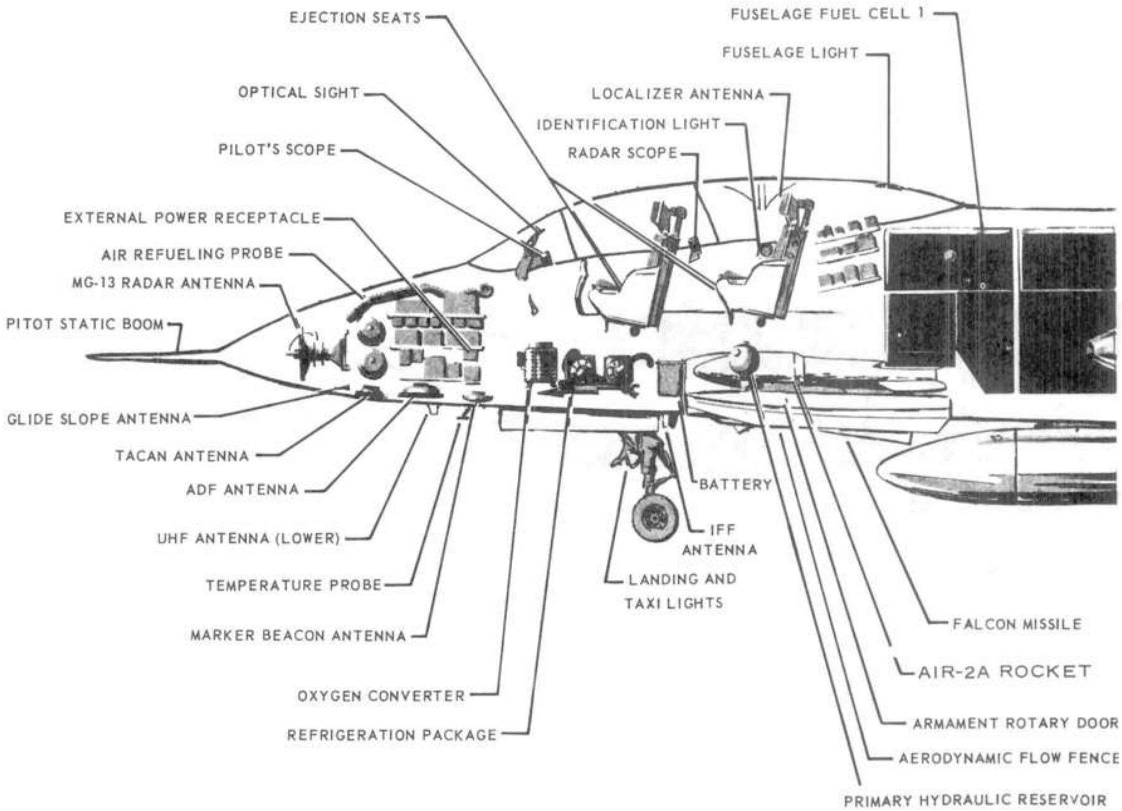


Figure 1–1 (Sheet 1 of 2) Voodoo Airframe

AIRFRAME

GENERAL

10 The fuselage of the CF-101 may be divided, for ease of reference, into four sections. The nose section houses the nose gear, inflight refueling probe, and the major portion of the radar and electronic equipment. The forward fuselage section houses the cockpit area, armament, hydraulic, refrigeration, oxygen, and additional electronic equipment. The centre fuselage section houses the fuselage fuel cells and the engines. Tunnels along each side of the fuselage in this area provide passage for flight controls, hydraulic lines, drag chute and tail hook controls, and electrical wiring. The main wings are mounted in this area. The aft fuselage section houses the hydraulic and artificial feel components associated with rudder and stabilator operation, fuselage fuel vent system components, and drag chute and tail hook components.

11 A good deal of the fuselage skin is made up of doors and removable panels. The majority of these are considered to be structural members and therefore must be secured properly before towing, hoisting, jacking, or flying. The majority of the doors and panels are numbered; identical or complimentary doors are identified by the suffix "L" or "R" to indicate on which side of the fuselage they are located. Two push-in panels are located on the engine bay doors for emergency use in event of a ground engine fire. Red lines are painted on the engine bay doors to coincide with engine turbine and starter turbine areas. These areas, plus the areas

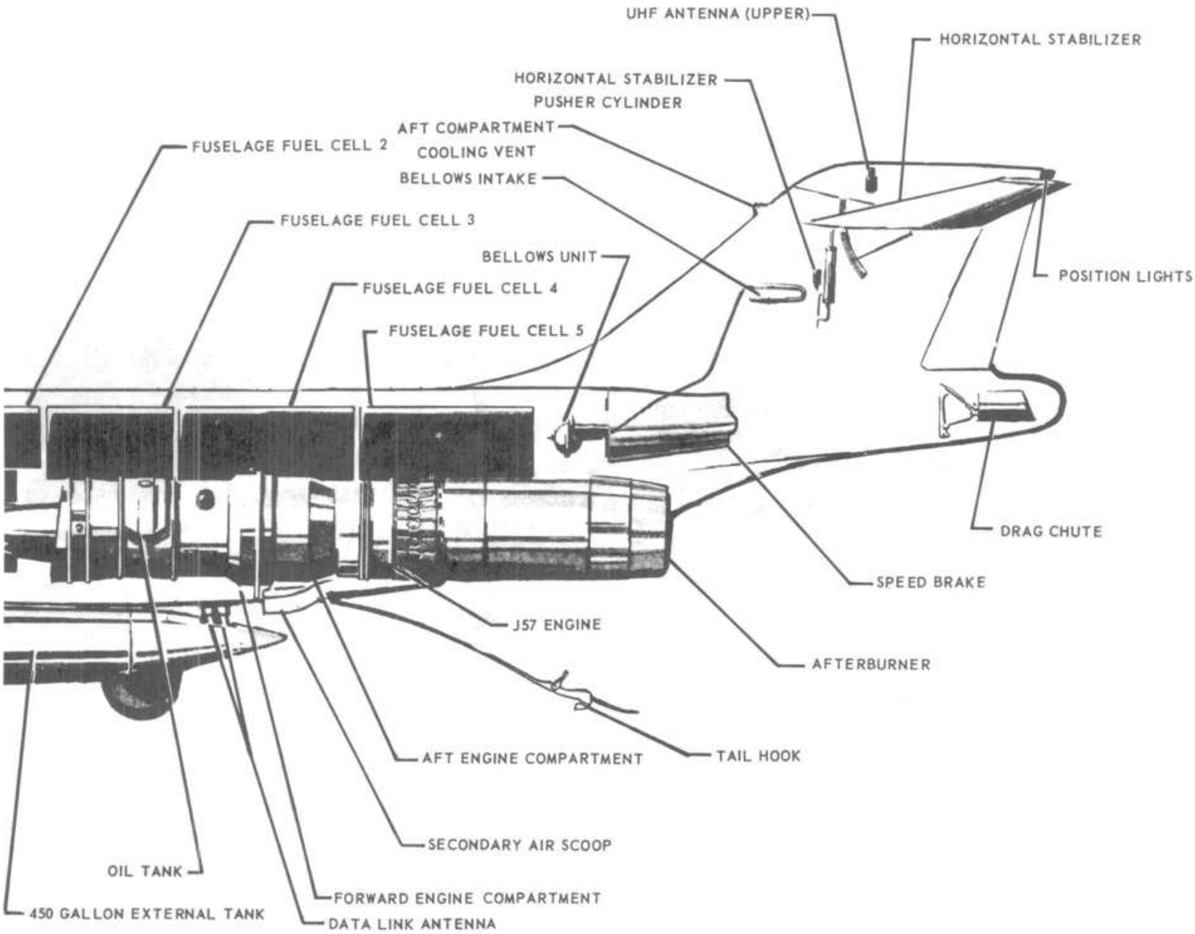


Figure 1–1 (Sheet 2 of 2) Voodoo Airframe

around the intakes and aft of the tailpipes, are to be considered danger areas during engine starts and engine operation.

12 The aircraft mainplane houses the main landing gear and, at the wing root, the engine intakes. The area above and aft of the intakes is designated a walkway and is covered with a protective finish. All flight control surfaces and the mainplane aft of the secondary spar are designated NO STEP areas. These are areas of "honey-comb" construction which, while providing a high strength to weight ratio, are not designed to accept concentrated compression loads.

CANOPY

13 The aircraft is fitted with a single, clam-shell type canopy which encloses both cockpits. It is hinged at the rear and may be opened approximately 28°. It consists of a metal frame into which two stretched acrylic plastic panels are fitted; the rear panel has a built-in ILS localizer antenna. Four studs are mounted on the canopy which, when they engage the plates mounted on the canopy rails, provide for canopy rigidity and alignment in the last stages of closure. Bumper plates mounted between the two cockpits provide canopy guidance for the last six inches of canopy closure. A rubber canopy seal runs completely around the canopy and when the canopy is closed it presses firmly against a small rail mounted on the airframe. The inside of the seal has access to cabin pressure and, although the seal does not inflate, it is so seated that differential pressure tends to tighten it. A counterbalance cylinder, mounted between the canopy and the airframe just forward of

the canopy hinge, is designed to assist in raising and to cushion the closing of the canopy. The cylinder is partially filled with oil and has an air charge of 1330 to 2300 psi depending upon temperature. A pressure gauge mounted on the bottom of the cylinder reflects this charge. The canopy may be opened and closed electrically or manually and can be jettisoned explosively – the following paragraphs cover the first two methods; explosive jettison is covered under Safety Equipment Systems.

14 A reversible 28 volt DC motor powered by the battery bus provides for electrical opening, closing, and locking of the canopy. The motor and its gear box moves up and down a toothed rack which is fixed to the airframe between the cockpits. The bottom end of the explosive canopy remover tube is mounted on this motor assembly while the top end of the canopy remover tube is connected to a crankshaft assembly on the canopy. The canopy crankshaft assembly consists of various bell-cranks, overcenter locks, gust locks, and micro switches. During the canopy closing sequence, the motor assembly moving down its rack draws the canopy down to the canopy rail; at this point the overcenter lock is tripped by an airframe mounted bolt and further motor assembly travel is converted to rotational movement by the crankshaft assembly causing rollers in the canopy to engage eight fixed hooks on the canopy rail thereby locking the canopy down. When full crankshaft travel has been achieved two micro switches are engaged cutting electrical power to the motor. The overcenter lock and the gust lock are incorporated to ensure the rollers do not attempt to engage the hooks before the canopy is in proper position. Unless it is over-ridden by a canopy switch selection, a micro switch mounted on the starboard canopy rail supplies "down power" to the motor assembly from the point where the canopy is 1/2 inch open until it is down and the locking sequence is complete. The canopy opening sequence is the reverse of the closing sequence and the motor assembly climbs the toothed rack until it engages a micro switch at the top which cuts power to the motor and applies the electrical/mechanical brake which prevents the canopy from closing by gravity. This brake also holds the canopy in any intermediate position selected. There are three, three-position switches which control power to the canopy motor – one is mounted inside a door (205) on the left-hand forward fuselage for external use, and two are mounted under the canopy rail (one in either cockpit). The three positions of the switch are UP, OFF, and DOWN and the switch is spring loaded to the OFF position. The two cockpit switches are guarded to prevent UP selection – the guard on the front switch may be moved to allow UP selection, the rear switch guard is witness wired and should not be moved unless during emergency. There is no priority on the switches but any UP selection will override any DOWN selection.

CAUTION

When the canopy is being lowered its weight creates a downdrive tendency which could cause the canopy to continue down slightly after switch release.

15 The canopy is normally opened and closed electrically, however, a manual system is available for use when electrical power is not available, when it is wished to conserve the battery charge, or when other methods have failed. Actuation of this system may be achieved by use of one of two levers; one internal, the other external – both interconnected through the canopy rail. The external handle is detachable and is normally in the stowed position in door 205. The internal handle is mounted on the left canopy frame in the front cockpit. Initial aft movement of either internal or external handle will de-clutch the canopy motor from the gear train; this also effectively releases the brake. If the canopy is locked, continued aft movement of either handle will rotate the crankshaft assembly unlocking the canopy. With the handles in the aft position the canopy may be raised or lowered by hand. When the handle is released the motor is re-clutched to the gear train and the brake is reapplied. The canopy cannot be locked by manual means, however, if battery power is available and the canopy is closed manually, the micro switch on the starboard rail will cause the canopy to be locked electrically.

TAIL HOOK

16 The Tail Hook is designed to engage any "cable across the runway" type runway barrier and is used to assist in stopping the aircraft during take-off or landing emergencies. It consists of a leafspring with a hook

mounted on the end, a solenoid, a switch, and a warning light. The hook assembly is mounted on the aft fuselage between the engine tail pipes. A solenoid type latch holds the hook in the raised position. The system is activated by pressing the tail hook switch to the down position; this activates the solenoid latch allowing the hook to drop. A warning light illuminates immediately the hook is dropped and stays on till the hook is re-positioned. The tail hook switch is located on the pilot's left vertical sub-panel immediately below the drag chute handle and is witness wired and spring loaded to the UP position. The hook switch and the latch solenoid are both powered by the battery bus and are therefore "hot" any time a serviceable battery is installed. The tail hook warning light is located on a bracket on the left side of the pilot's cockpit just out-board of the throttles. The light is powered by the 28 volt DC bus. Fatal injury may result from being struck by the tail hook when it is dropped, therefore, the area surrounding the hook must be considered a danger area. A safety pin is installed to prevent inadvertent dropping during ground operation; if the tail hook switch is activated while the pin is installed, the pin will prevent the hook from dropping, however, the latch will have been activated and the hook will drop when the pin is removed.

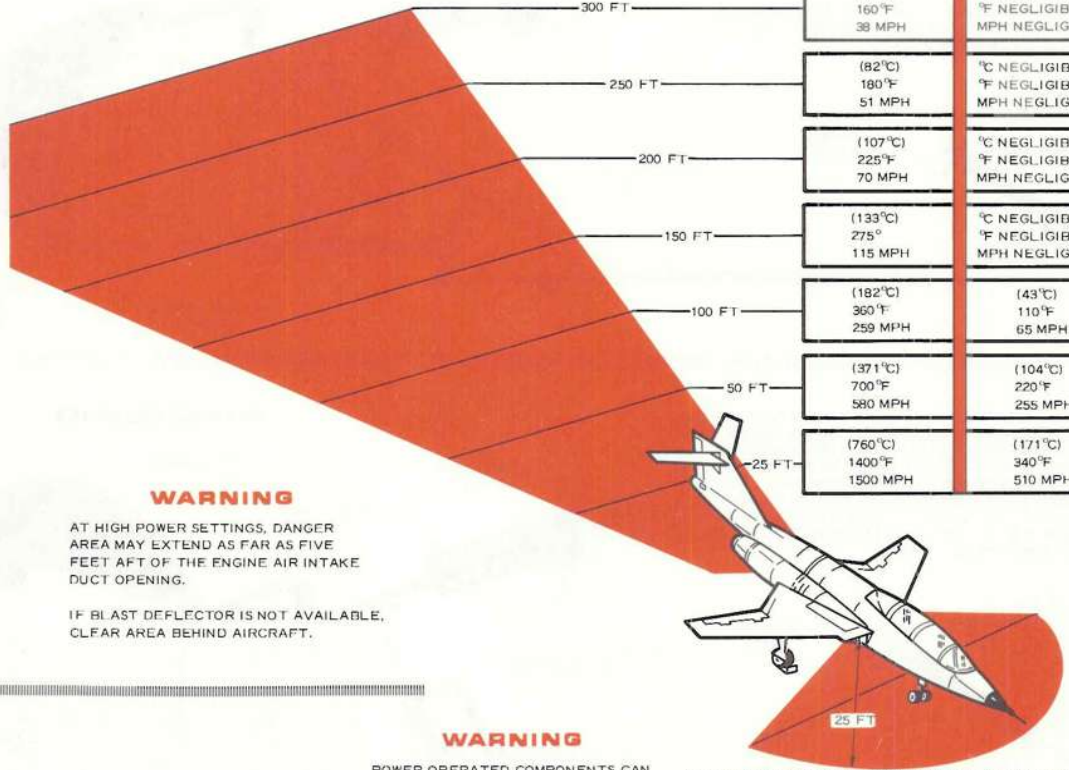
DRAG CHUTE

17 The aircraft is equipped with a 16 foot ring slot type drag chute which is deployed by the pilot after touchdown to aid in reducing the landing roll. The drag chute may also be utilized for pitch-up or spin recov-ery as outlined in the Handling and Emergency Handling parts of this EO. The chute is located in a compart-ment within the empennage at the base of the vertical stabilizer. It is pulled into the airstream by a pilot chute when the spring-loaded compartment door is released. The design of the attaching mechanism is such that should the compartment door open inadvertently, without operating the cockpit control handle, the chute will be released and fall free of the aircraft. The drag chute is locked to the airframe upon normal deployment and there is no breakaway fitting within the attaching mechanism short of structural breakage. The drag chute it-self will fail at indicated airspeeds in excess of 230-250 KIAS, therefore, a deployment at airspeeds over 200 KIAS should not be attempted. A ratchet-type drag chute handle is located on the top of the pilot's left vertical sub-panel and is mechanically connected to the drag chute mechanism in the tail. Pulling the handle approximately 3 inches serves two purposes: it locks the attaching mechanism so the chute cannot pull free, and it releases the compartment door allowing the pilot chute to spring into the airstream and pull out the main drag chute. Returning the handle to the IN position jettisons the chute, however, as an aid in preventing accidental jettisonning, it is necessary to press a lock button on the handle and turn the handle a quarter turn clockwise before it can be returned to the IN position. Although pulling the drag chute handle 3 inches should deploy the chute, it is recommended that the handle be pulled to full extension on every deployment. The drag chute is normally deployed on every landing and is therefore considered a servicing item by the ground crew.

EXTERNAL STORES

18 External fuel tanks are the only external stores ever mounted on the Canadian Voodoo aircraft. Either one or two slimline tanks may be slung from shackles immediately under the engines. These tanks restrict aircraft speeds to 500 KIAS or 1.3 mach, whichever is lower, and aircraft "G" loading to + 4 and – 2. The tanks may be dropped by three methods, all of which are covered thoroughly under Fuel System. The tanks are safetied against inadvertent dropping on the ground by long safety pins which are inserted into holes in the fuselage just above the mounting shackles.

DANGER AREAS



	MAXIMUM AFTERBURNING POWER	MILITARY POWER
300 FT	(71°C) 160°F 38 MPH	°C NEGLIGIBLE °F NEGLIGIBLE MPH NEGLIGIBLE
250 FT	(82°C) 180°F 51 MPH	°C NEGLIGIBLE °F NEGLIGIBLE MPH NEGLIGIBLE
200 FT	(107°C) 225°F 70 MPH	°C NEGLIGIBLE °F NEGLIGIBLE MPH NEGLIGIBLE
150 FT	(133°C) 275° 115 MPH	°C NEGLIGIBLE °F NEGLIGIBLE MPH NEGLIGIBLE
100 FT	(182°C) 360°F 259 MPH	(43°C) 110°F 65 MPH
50 FT	(371°C) 700°F 580 MPH	(104°C) 220°F 255 MPH
25 FT	(760°C) 1400°F 1500 MPH	(171°C) 340°F 510 MPH

WARNING

AT HIGH POWER SETTINGS, DANGER AREA MAY EXTEND AS FAR AS FIVE FEET AFT OF THE ENGINE AIR INTAKE DUCT OPENING.

IF BLAST DEFLECTOR IS NOT AVAILABLE, CLEAR AREA BEHIND AIRCRAFT.

WARNING

POWER OPERATED COMPONENTS CAN CAUSE SERIOUS INJURY AND POSSIBLE LOSS OF LIFE. CLEAR AREAS OF PERSONNEL AND EQUIPMENT BEFORE OPERATING.

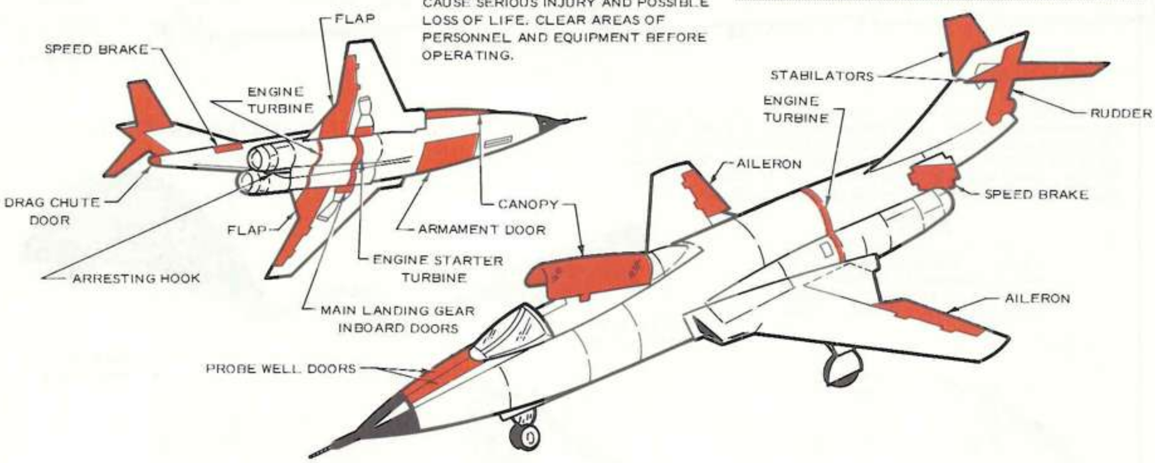


Figure 1-2 Aircraft Danger Areas

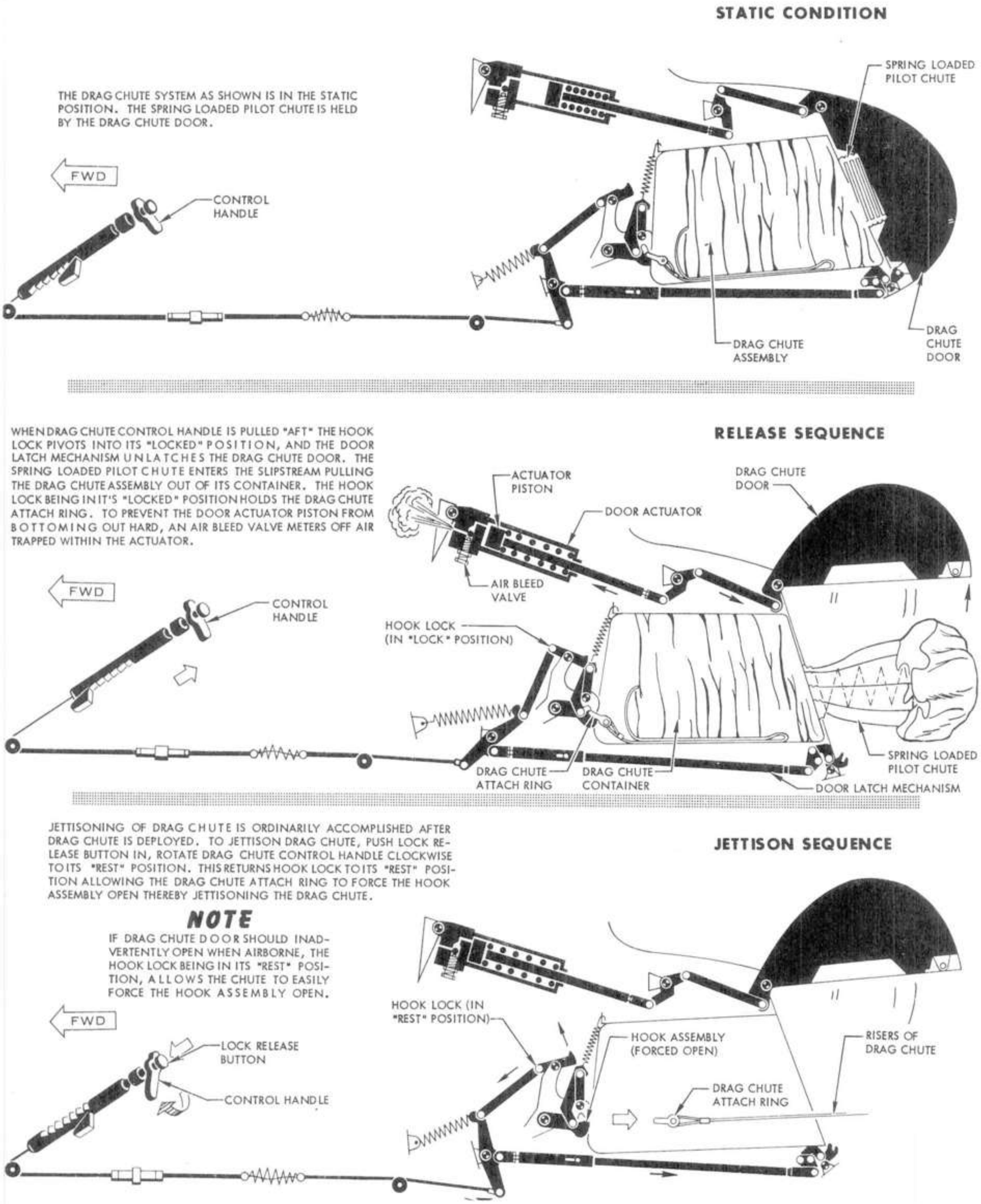


Figure 1-3 Drag Chute Schematic

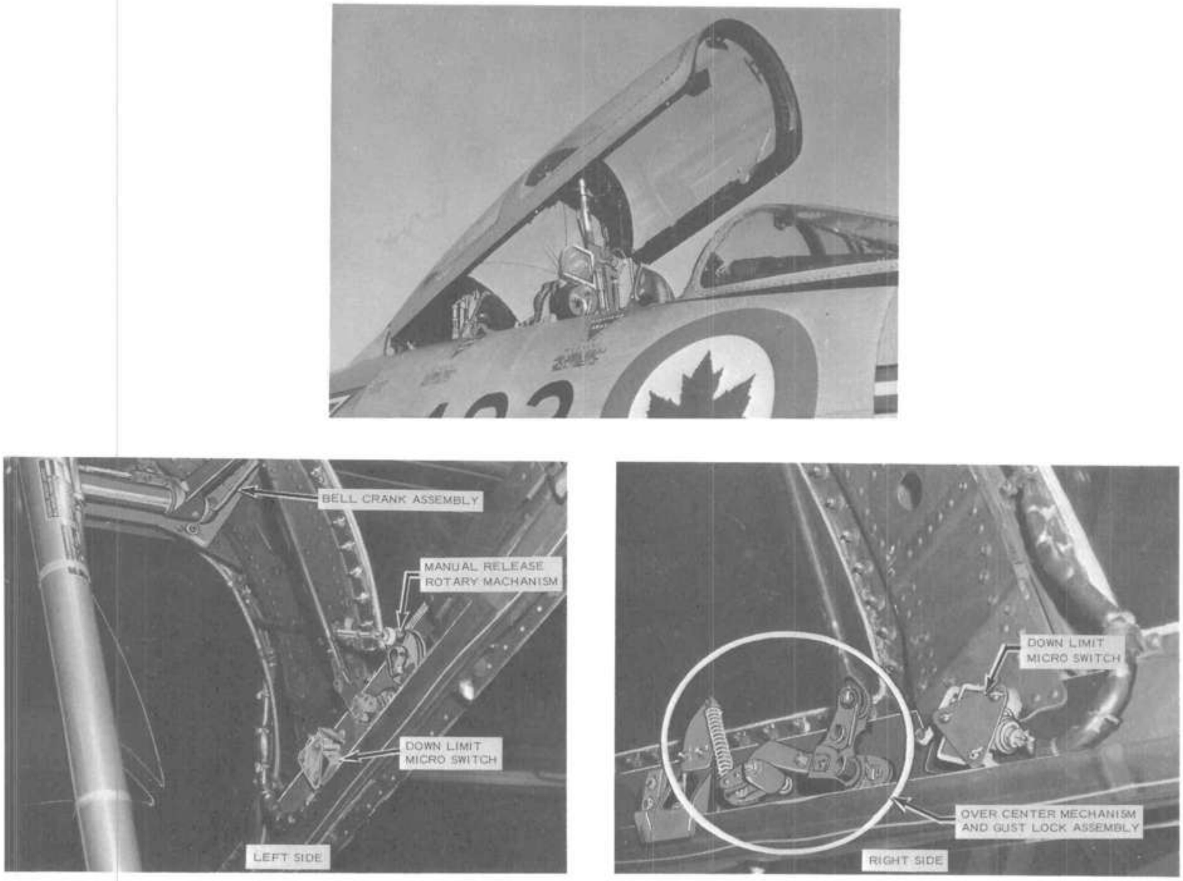
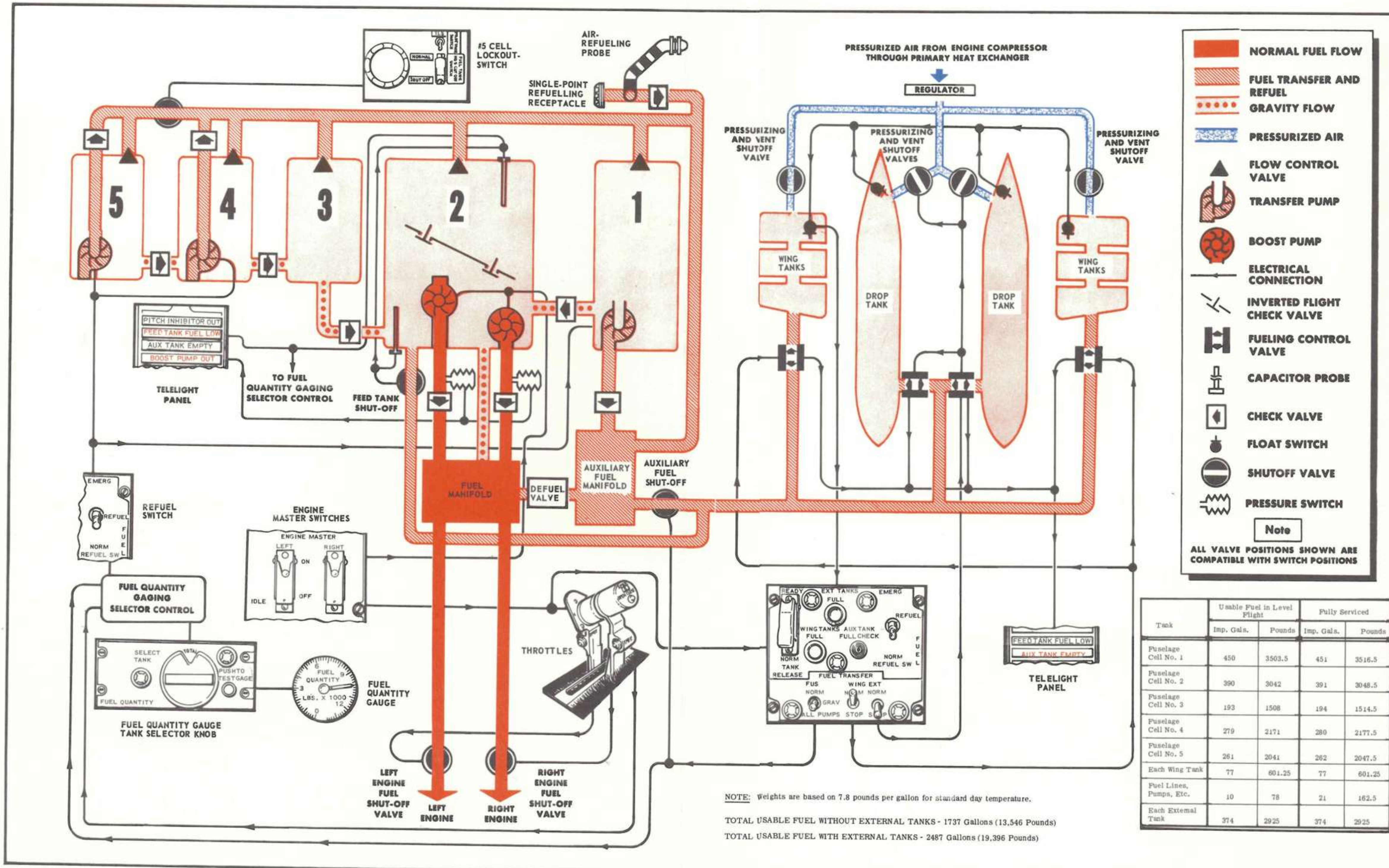


Figure 1-4 Canopy Schematic



Tank	Usable Fuel in Level Flight		Fully Serviced	
	Imp. Gals.	Pounds	Imp. Gals.	Pounds
Fuselage Cell No. 1	450	3503.5	451	3516.5
Fuselage Cell No. 2	390	3042	391	3048.5
Fuselage Cell No. 3	193	1508	194	1514.5
Fuselage Cell No. 4	279	2171	280	2177.5
Fuselage Cell No. 5	261	2041	262	2047.5
Each Wing Tank	77	601.25	77	601.25
Fuel Lines, Pumps, Etc.	10	78	21	162.5
Each External Tank	374	2925	374	2925

NOTE: Weights are based on 7.8 pounds per gallon for standard day temperature.

TOTAL USABLE FUEL WITHOUT EXTERNAL TANKS - 1737 Gallons (13,546 Pounds)

TOTAL USABLE FUEL WITH EXTERNAL TANKS - 2487 Gallons (19,396 Pounds)

Figure 1-5 Fuel System

FUEL SYSTEM

GENERAL

19 When reading the Fuel System section frequent reference should be made to the fuel system diagram (Figure 1-5) to ensure proper understanding of position and function of all components.

20 The aircraft's fuel supply is contained in five bladder-type cells within the fuselage and in a bladder-type cell in each wing. The fuselage cells are numbered 1 through 5, forward to aft-number 1 being located just aft of the rear cockpit and number 5 being located just below the leading edge of the vertical fin. Fuselage cell number 1 is actually two separate cells which are assembled as one. Each wing cell is actually three separate cells also assembled as one. In both these cases the groups of cells are referred to as one cell, i.e., "Cell number 1" and "the wing cell". The aircraft fuel supply can be increased by mounting one or two droppable, external tanks below the fuselage. The capacity of each cell and the fuel weight for standard day temperatures are listed in Figure 1-5.

21 To reach the engines, all fuel must be routed through cell number 2, which is also referred to as the FEED TANK. Large fuel lines are fitted between the fuselage cells to permit all the fuel in cells 1, 3, 4 and 5 to gravity transfer into cell 2. One-way valves are installed in each gravity line to prevent fuel, once transferred, returning. Cell 3 transfers to cell 2 by gravity alone, however, for more rapid transfer from cells 1, 4 and 5, transfer pumps have been installed – one in each of these cells. Fuel from the wing cells and the external tanks is transferred into the fuselage cells by use of high pressure air from the primary heat exchanger.

22 The fuselage cells, wing cells and the external tanks may be refilled by either single-point refueling or in-flight refueling. The external tanks have filler openings and may also be gravity filled.

FUEL GAUGING

23 The aircraft fuel supply is gauged in two ways, gauging probes and float switches. Nine fuel quantity gauging probes mounted in the five fuselage cells provide information to the Fuel Quantity Gauge located on the lower right hand corner of the pilot's instrument panel. The fuel quantity gauge gives a read-out of fuel remaining in the fuselage cells. The total reading is considered more accurate than the sum of the readings of the five cells as it eliminates the calibration errors of each individual cell. A selector knob on the pilot's left console provides for the selection of the functions of the fuel quantity gauge. It has six positions, TOTAL in the 12 o'clock position then clockwise to cells 1 through 5. The operation of the fuel quantity gauge may be tested by pressing the test button beside the selector knob. Pressing this button breaks the electrical circuit to the gauge and the gauge needle should move toward zero. When the button is released the gauge needle should return to its original position.

24 There are two problems associated with gauging fuel by weight. The first is the latitude of specific gravity allowed the fuel manufacturer. This problem is largely overcome by a compensator located in cell 2 which adjusts the gauging for changes in specific gravity. The second problem is that fuel weight will change with temperature for a given volume. In short it should be remembered that a fully fueled, clean CF-101 will always contain 1737 gallons of fuel but in cold weather the fuel weight will be greater than in hot weather. This difference can be seen on the fuel quantity gauge from day to day.

25 There are only two indications of the fuel state in the wing cells and the external tanks; "full" or "empty". The information for the full indication is provided by float switches, one in each wing cell and one in each external tank. The pilot may check for a "full" indication by pressing the Aux Tank Full Check button located on the fuel control panel. If both wing cells are full the green Wing Tanks Full light, located beside the button, will illuminate. If both external tanks are full the green Ext Tanks Full light, located forward of the button, will illuminate. There is only one check button for both the wing cells and the external tanks, and when this button is released both lights will go out. The empty indication for the wing cells and external tanks is displayed on the telelight panel as "AUX TANK EMPTY". The control valves which allow compressed air, for transfer, into the cells or tanks can also sense when air begins to move downstream in the transfer lines instead of fuel. When this air is sensed the control valves send a signal to the telelight panel lighting up the

"AUX TANK EMPTY" strip. This telelight indication is common to both the wing cells and the external tanks. With the Ext switch alone in the NORMAL position and both external tanks empty the telelight strip will illuminate. Similarly, with the wing switch alone in the NORMAL position and both wing cells empty, the telelight strip will illuminate. However, if both switches are in NORMAL, both tanks and cells must be empty to get the light.

FUEL CONTROL PANEL

26 The fuel control panel is located on the pilot's left hand console. This panel contains the Aux Tank Full Check button and the Wing Tanks and Ext Tanks Full lights which have already been mentioned. On the forward left hand corner of the panel there is a guarded Tank Release switch marked Norm and Ready. The NORM position is for normal operation, the release circuit is deactivated, and the switch cover is down and witness wired. With the witness wire broken, the switch cover up, and the switch in the READY position the release circuit is activated and, providing the landing gear handle is in the UP position, the pilot may jettison the external tanks by pressing the top red button on his control stick handgrip.

27 On the right hand side of the panel there is a Refuel Switch. This switch is for In-Flight Refueling only and should not be confused with normal ground refueling switches. This switch is a three position switch marked NORM, REFUEL, and EMERG (for Canadian operations the switch should be witness wired to NORM). In the NORM position the refuel system is completely deactivated and the fuel system is controlled by the Fuel Transfer switches alone. With the switch in the REFUEL position the refueling probe extends, the rain clearing system is turned on, and the fuel system is set up to allow refueling. The one exception to this sequence is, when the fuel level in cell 2 is below 850 pounds, all transfer pumps will activate and remain activated until the fuel level in cell 2 rises above this level. With the switch in the EMERG position the fuel system reverts to the normal mode of operation with one exception; the refueling probe remains extended. This position will only be used when the probe has been damaged and the pilot wishes to deactivate the rain clearing system and to regain full control of the fuel transfer system.

28 On the aft end of the panel there are three switches under the broad heading of Fuel Transfer. The functions of these switches are covered fully under the next heading, Fuel Transfer.

FUEL TRANSFER

29 The three transfer switches on the fuel control panel are marked FUS, WING, and EXT. The Fus switch controls the method of fuel transfer to be used within the fuselage fuel cell system. It is a three position switch marked NORM, GRAV, and ALL PUMPS. The Wing and the Ext switches are both two position marked NORM and STOP. They control the fuel transfer from the wing cells and the external tanks.

30 With the Fus switch in the NORM position an automatic fuel transfer sequencing takes place in the fuselage system. The transfer pump in cell 5 pumps fuel into cells 2 and 3 through a fuel line running above all five fuselage cells. Fuel from cell 5 is prevented from entering cells 1 and 4 by flow control valves located on the top of these tanks. Cell 5 transfer pump, like all the transfer pumps, delivers fuel at 16.5 PSI and is capable of handling 25,000 pounds per hour. When cell 5 is completely empty a thermistor in the bottom of the cell is bared shutting down the cell 5 transfer pump and allowing electrical continuity to the transfer pumps in cells 1 and 4. The transfer pumps in cells 1 and 4 then simultaneously pump fuel from their respective tanks into cells 2 and 3. Fuel is prevented from re-entering cell 5 by a flow control valve located on the top of that cell. Thermistors located on the bottom of cells 1 and 4 shut off the transfer pumps in their respective cells when the cells are empty. Interchange of fuel between cells 1 and 4 is again prevented by fuel control valves. Fuel from cell 3 then flows by gravity into cell 2. The sequence of transfer then is: 5 cell, 1 and 4 cells simultaneously. This sequencing is employed to prevent the C of G from exceeding the aft limits.

31 With the Fus switch in the NORM position and the Ext switch in the NORM position, high pressure air from the primary heat exchanger, regulated to 12.5 PSI, is allowed into the external tanks forcing fuel down transfer lines to the Feed Tank Shut-off valve located in the bottom of cell 2. If the fuel level in cell 2 is lower than 1 inch from the top, sensed by a float switch, the shut-off valve will open allowing fuel to enter

cell 2. When the fuel level in cell 2 is above 1 inch from the top, the valve closes. When all external tank fuel has been transferred, the weight of fuel in cell 2 acting on the valve will close it thereby preventing fuel returning down the transfer lines.

32 With the Fus switch in the NORM position and the Wing switch in the NORM position, the wing cell fueling control valve is opened allowing the primary heat exchanger air (12.5 PSI) acting on the wing fuel to force fuel down the transfer lines to the Feed Tank Shut-off valve. This transfer line is the same line used for external tanks transfer, so from the transfer line on, the transfer of wing fuel and that of external fuel is identical.

33 With the Fus switch in the GRAV position, all transfer pumps are inoperative and fuselage fuel is transferred to cell 2 by gravity alone. With the Wing or Ext switch in the NORM position fuel from the selected tank will feed into the bottom of cell 2 in the manner outlined in Paras 31 and 32. In addition, all the flow control valves on the tops of the fuselage cells open and the Auxiliary Fuel Shut-off valve opens allowing fuel being transferred from the wing cells or external tanks to flow into the auxiliary fuel manifold, up into the fuel transfer line above the 5 fuselage cells, through the five flow control valves and into all 5 fuselage cells.

34 With the Fus switch in the ALL PUMPS position, all transfer pumps will operate simultaneously. This switch position overrides the thermistors in cells 1, 4 and 5 and the pumps will operate whether there is fuel in the cell or not.

CAUTION

Since the transfer pumps are lubricated and cooled by fuel, the extended use of the ALL PUMPS selection should be tempered with good sense, taking into account the gravity of the situation.

In the ALL PUMPS mode of operation the transfer of fuel from wing cells and external tanks is identical to the transfer in the NORMAL mode of operation.

35 During afterburner operation where either or both throttles are placed in the afterburner position, all transfer pumps with fuel available to them will operate. The thermistors are not overridden in this case and will shut off their transfer pumps when their cells empty. Fuel transfer within the fuselage cells and from the wing cells and external tanks will be exactly the same as when the system is in the NORMAL mode of operation.

FEED TANK

36 Since all fuel must pass through cell 2 in order to reach the engines it is referred to as the Feed Tank. Fuel may enter this tank in four places: through the gravity line from cell 1, through the gravity lines from cell 3, through the Feed Tank Shut-off valve from the wing cells and external tanks, and through the flow control valve from the fuel transfer line common to all five fuselage cells. Mounted on the top of the cell is a float switch which allows the Feed Tank Shut-off valve to open if the fuel level drops lower than 1 inch from the top of the cell. There are two fuel gauging probes, one top mounted and one bottom mounted, to supply gauging information to the fuel quantity gauge. Mounted on the top gauging probe is a float switch which will cause the telelight strip "FEED TANK FUEL LOW" to illuminate any time the fuel level in cell 2 drops between 1050 to 1200 pounds. Also located on the upper probe is a thermistor which will automatically switch the transfer system to ALL PUMPS if the fuel level in cell 2 drops below 850 pounds. Located across the middle of the tank is a baffle with gravity operated one-way valves and stand-pipes to prevent fuel returning to the top of the cell once it has proceeded below the baffle. The baffle is there primarily to ensure that approximately half the cell's fuel is available to boost pumps during inverted or negative "G" flight. Located on the floor of the feed tank are two boost pumps. These pumps deliver fuel under pressure (16.5 PSI) to the fuel manifold. From the fuel Manifold a main fuel line goes to each engine's high pressure fuel pump system. In each main fuel line there is an Engine Fuel Shut-off valve. This valve may be opened by turning the Engine Master Switch ON and placing the throttle for that engine to IDLE or above. The valve may be closed by either closing the throttle or by turning the Engine Master switch OFF.

CAUTION

If, with the engine running, the Engine Master Switch is turned OFF before the throttle is placed in the CLOSED position the main fuel line may collapse due to line cavitation.

The forward boost pump is a single entry pump with the entry opening at the bottom of the cell. The aft boost pump is double entry pump one entry at the bottom of the cell and the other at the top of the pump. The double entry feature is important for inverted or negative "G" flight. Pressure switches located down-stream from the boost pumps supply warning of pump failure to the telelight panel. The illumination of the "BOOST PUMP OUT" strip indicates that either one or both boost pumps are inoperative. If both boost pumps fail, a stand-pipe will deliver fuel from cell 2 to the fuel manifold.

FUEL PRESSURIZATION AND VENT SYSTEM

37 A fuel tank pressurization and vent system is provided to maintain a positive pressure in the fuselage fuel cells during flight. Two masts are located on the tail cone of the aircraft just below the rudder. These masts are cut at different angles and are referred to as the "high scarf" and the "low scarf". The high scarf collects ram air, when the aircraft is in motion, to pressurize the fuselage cells. The low scarf vents this pressure. A pressure sensor located in cell 1 operates a shuttle valve between the high and low scarf to maintain a pressure within the cells of .5 PSI to 2.5 PSI. This pressure prevents tank collapse, minimizes fuel boil-off and evaporation at high altitudes, and aids in fuel transfer. When the aircraft is on the ground with no ram air pressure acting on the high scarf the fuselage cells are vented to atmosphere. This prevents pressure build-up due to temperature change and provides a fuel exit if a flow control valve should malfunction during refueling.

38 With power supplied to the aircraft and an engine running the wing cells are pressurized irrespective of transfer switch position. They are pressurized by primary heat exchanger air which is the same air used to transfer the wing fuel. The primary heat exchanger air is regulated to 12.5 PSI by a valve in the wing cell which vents excess pressure overboard. This valve has a dual purpose in that is also vents excess pressure which may build up in the wing cells. When the aircraft is not powered this valve opens and vents the wing cells to atmosphere.

39 The external tanks are pressurized only when the aircraft is powered, an engine is running and the external tanks transfer switch is in NORM. They are pressurized by primary heat exchanger air; the same used to transfer the fuel. A valve in each tank regulates the heat exchanger air to 12.5 PSI venting excess pressures overboard. This valve also vents excess pressures from within the tanks during high rates of descent. When the aircraft is not powered this valve opens and the tanks are vented to atmosphere.

TANK JETTISON

40 The external tanks may be jettisoned by the pilot in two ways. The first method was covered under Fuel Control Panel; turn the Jettison switch to READY and press the top red button or the control stick. In using this method it must be remembered that the landing gear handle must be in the UP position to provide electrical continuity in the jettison circuit. The second jettison method is by pressing the Emergency Jettison button or "Panic" Button. This button is powered directly by the battery bus and is therefore "hot" any time there is a serviceable battery installed in the aircraft; the landing gear handle may be in any position. Provision is also made for ground release by unscrewing a flush mounted plate under the engine intakes and pulling the attached cables. Inadvertent tank jettison while the aircraft is on the ground is prevented by inserting a long safety pin into a hole in the fuselage just above the tank mounting shackle.

REFUELING

41 The aircraft may be refueled by either Single Point Pressure refueling or by In-Flight refueling (IFR). The external tanks have filler openings and may also be gravity filled. Only battery power is required to refuel the aircraft by the Single point or the IFR method.

42 Opening door 208 (the refueling door on the forward, lower right hand side of the fuselage) sets the entire fuel system up for Single point refueling. With the refueling bowser connected to the aircraft adapter, (standard NATO) refueling can commence. The bowser delivers fuel at a rate of 500 gallons per minute at a pressure of 40-60 PSI and should refuel the fuselage cells, wing cells, and external tanks in approximately 6 minutes. During the first minute of refueling the IFR check switch (located in the refueling door) should be activated. This switch will give the system an erroneous Full indication – the bowser should stop delivering fuel automatically within 25 sec. This check is done to ensure the automatic shut-off feature is serviceable and that the aircraft will not be overfilled. When the IFR check switch is released normal refueling resumes till the aircraft is fully fueled. The bowser is then disconnected, door 24 (located on a/c belly between engines) is opened, and door 208 is closed. Opening door 24 prevents fuel from siphoning through the wing cell vents – the door is left open until an engine is started.

43 All required data on the In-Flight refueling system is covered under the Fuel Control Panel heading where it deals with the In-Flight Refueling switch. Any further data may be obtained from other technical orders.

DEFUELING

44 The aircraft fuselage cells may be defueled through the same adapter used for refueling. Note that the wing cell fuel and the external tank fuel must be transferred to the fuselage cells before they can be defueled.

LOCK-OUT AND CHECK SWITCHES

45 Located in door 208 is a switch marked Fuel Tank No 5 Cut-Off. If this switch is activated prior to refueling operations number 5 fuselage cell will not be refueled. This switch is used to prevent the fuel load placing the aircraft out of C of G limits. It is necessary only if the aircraft is not loaded with either ballast, armament, or external fuel tanks.

46 Located in the starboard wheel well are five, rubber-covered switches. With ground power connected, ground personnel may use these switches to check the fuel transfer pumps and the boost pumps.

FUEL SPECIFICATIONS

47 The recommended fuel is JP-4 (F-40) (AVTAG). The alternate fuel is JP-5 (F-44). The emergency fuel is 80/87 (F-12) (AVGAS). Emergency fuel operation is limited to one 2-3 hour trip after which the aircraft must use recommended fuel for at least one trip. Extra care must be taken that engine limitations are not exceeded when using emergency fuel.

ENGINE

GENERAL

48 Aircraft thrust is provided by two Pratt and Whitney J57-P-55 turbojet engines. The engines are equipped with afterburners and are mounted side by side in the lower portion of the center fuselage. The rated sea level static thrust of each engine is 10,700 pounds at military thrust and 16,900 pounds at maximum thrust. Thrust is transmitted to the keel of the aircraft through a single inboard mount on the inlet guide section of each engine. Two other mounts, one opposite the thrust mount and a hanger type mount over the turbine section, maintain engine position but move under varying thrust and expansion conditions, thereby absorbing vertical and side loads but transmitting no thrust.

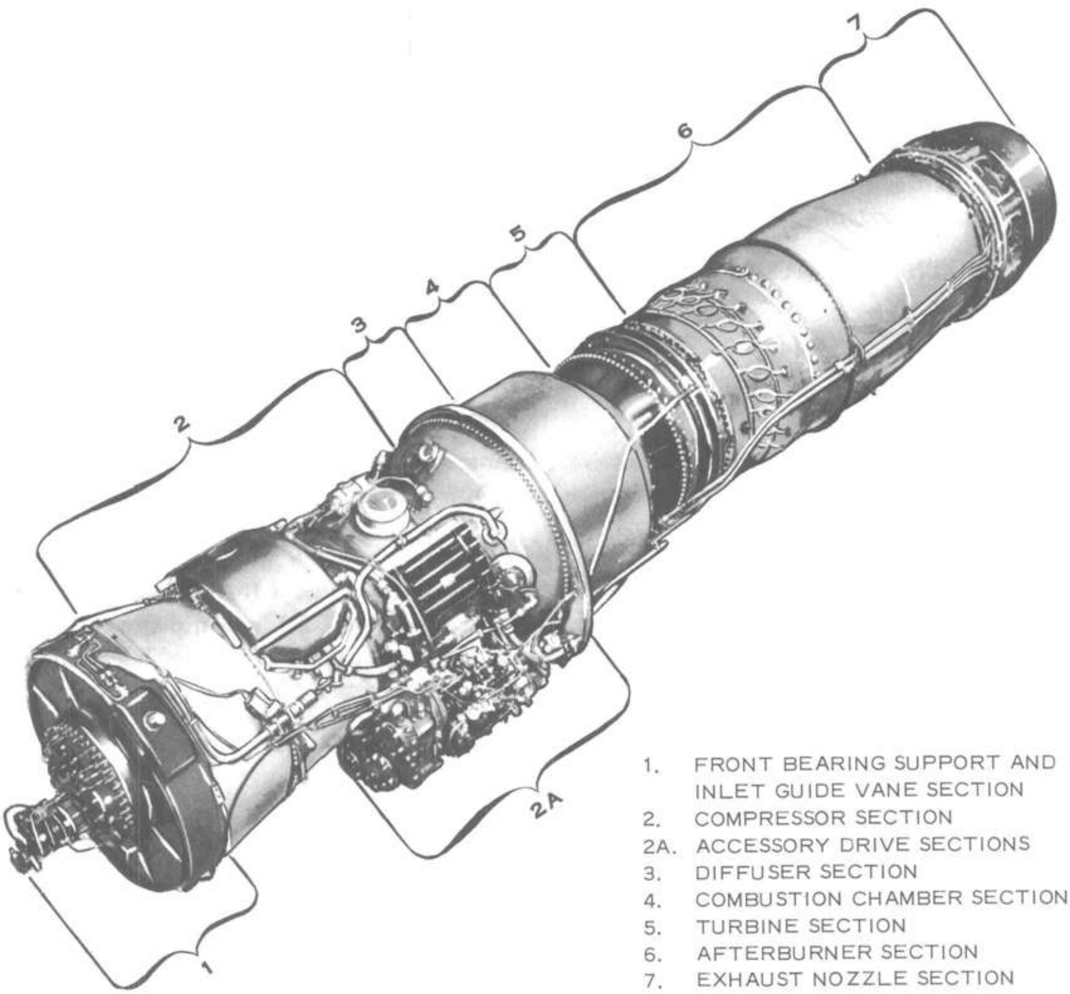


Figure 1-6 J-57–P-55 Engine

49 The engine, for ease of reference, may be divided into seven sections: forward accessory case and inlet guide vanes, compressor section and lower accessory case, diffuser casing, combustion area, turbine section, afterburner combustion area, and the exhaust nozzle.

(a) A nose cone mounted in front of and in the middle of the engine contains an air bottle which, when charged, supplied compressed air for emergency landing gear operation and for internal engine starts. Behind this bottle is a geared accessory case which is driven by the low speed compressor and drives, amongst other units, the primary hydraulic pump. Immediately behind this accessory case and nose cone is the front bearing support and the inlet guide vanes. The purpose of the guide vanes is to change the direction of the incoming air flow and guide it at the proper angle into the compressors. The guide vanes are hollow and contain the air, hydraulic, oil, and electrical lines passing to the forward components. In addition, a fully automatic engine deicing system allows hot air from the diffuser section to be ducted through the inlet guide vanes. The system operates when ice forms on a sensing probe in the left engine intake, provided an engine master switch is on, and there is a 40 MPH (or greater) wind in the intake.

(b) The engine has a dual-spool type compressor. There is a nine-stage, low speed, low pressure compressor driven by the combined second and third stages of the turbine, and a seven-stage, high speed, high pressure compressor driven by the first stage of the turbine. The two rotor assemblies are mechanically independent and revolve at different speeds so it is possible that pressures could build up between the compressors causing surging and stalling. To prevent this, a bleed valve is installed. The bleed valve resolves the differences between the compressors by bleeding the intervening pressures off. It is correctly positioned to do this by the bleed valve governor which senses and responds to the low pressure rotor speed and compressor inlet temperature and pressure. The lower accessory case has a gear train driven by the high speed compressor, and provides drives for the fuel pumps, the oil pump, the utility hydraulic pump, and the tachometer generator for the RPM gauge. In reverse, on starts, the starter drives the accessory case gear train which in turn drives the high speed compressor.

(c) The diffuser section completes the compression phase and directs the compressed air flow into the combustion section. It is from this section that air, usually referred to as 16th stage air, is tapped off for various services and systems.

(d) The combustion chamber is can-annular, i.e., a common outer case is shared by all eight combustion cans. A co-axial dual fuel manifold running around the combustion chamber directs fuel into 48 dual orifice spray nozzles, six in each combustion can. Controlling the fuel flow in the manifold is the fuel pressurization and dump valve. This valve serves two purposes – it acts as a flow divider and as a dump valve. The absence of fuel pressure at the valve (as in shut-down) allows the valve to drain unburned fuel, from the engine and fuel manifold, overboard. As fuel pressure builds up (as in starts) the valve closes and directs fuel first to the pilot (outer) manifold and then to the main (inner) manifold. The dual system is designed to give a consistent fuel spray pattern at the nozzles regardless of fuel flow. The combustion cans are numbered clockwise when viewed from the rear. Cans 4 and 5 contain electrical igniter plugs used for normal, and emergency ignition. The plug in Can 4 is used for icing ignition. The "hot streak" ignitor system for afterburner ignition is in Can 3.

(e) The turbine section is three-stage, the first stage being separate from the combined second and third stages. Immediately aft of the turbines are the eight thermocouples for the EGT gauge and six pressure sensors for the EPR gauge.

(f) The afterburner is basically a ram jet engine bolted to the rear of the jet engine. Fuel, from a manifold encircling the outside of the afterburner, is directed into 24 spray bars in the afterburner combustion area. This fuel is then ignited by the "hot streak" ignitor which shoots a tongue of flame back from the engine. Afterburner flame is held in the afterburner combustion area by a flame holder located just aft of the spray bars.

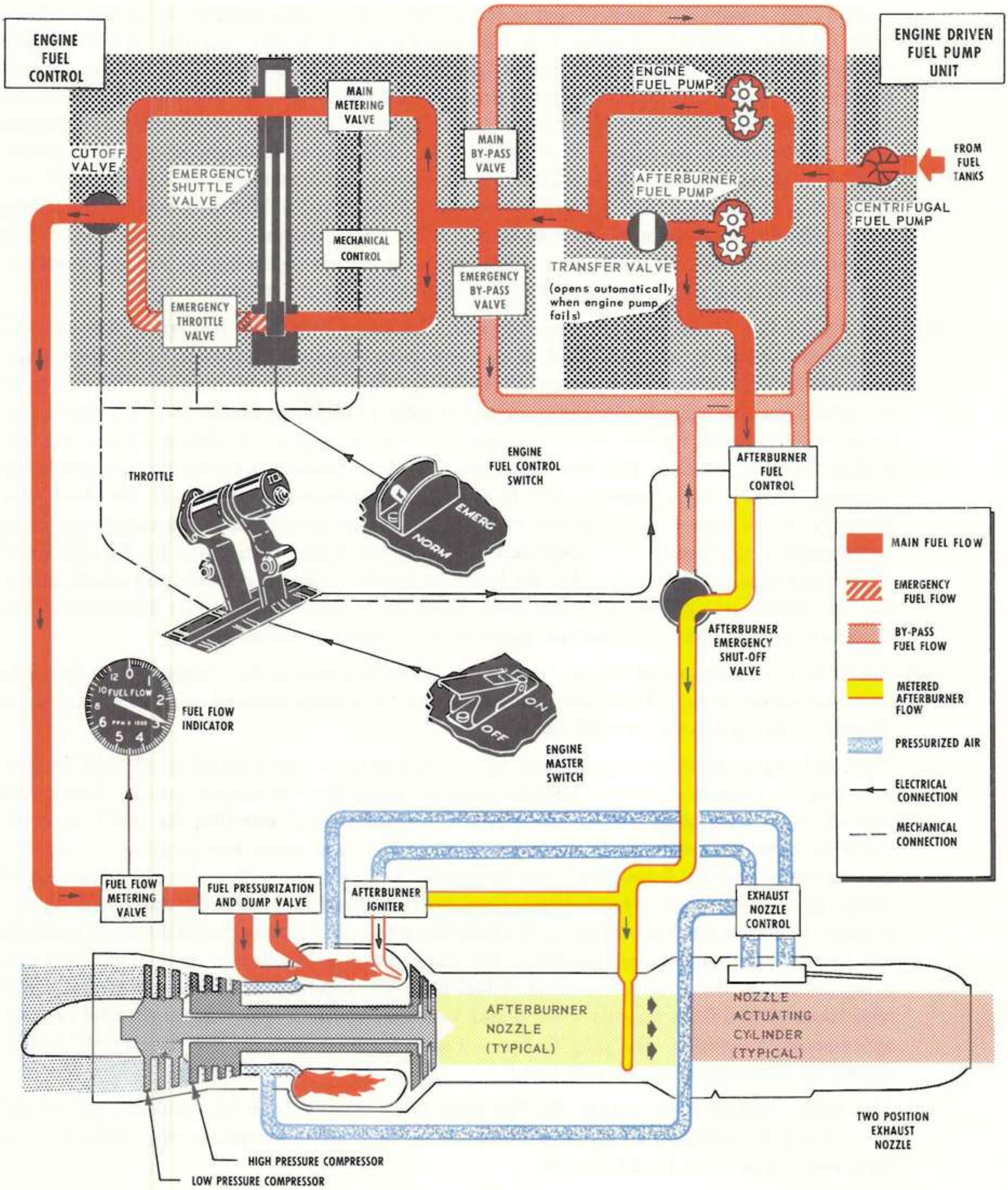


Figure 1-7 Fuel Control System

(g) The exhaust nozzle consists of eight petals or sectors which are geared at their base so they operate together. They are positioned by air operated cylinders which are located around the outside of the nozzle. There are only two nozzle positions, full open and full close. In military power, or less, the nozzle should be fully closed – in afterburner power the nozzle should be fully open. When the left landing gear strut is compressed, a micro switch is activated which will cause the nozzles to open whenever the engine RPM drops below 76%. The nozzles will close when the RPM is increased beyond 81% or when the strut extends.

NOTE

With either engine at a low power setting nozzles may cycle when gear is extended due to initial strut compression.

OIL SYSTEM

50 Each engine employs a dry-sump, pressure-type oil system. A 5.5 gallon header tank mounted on the left side of the engine supplies oil to a gear pump which is driven by the lower accessory case. This pump supplies oil under pressure to all lubrication points and to the generator constant speed drive. Since the system reaches normal pressure at idle RPM it provides adequate lubrication at all engine speeds. Oil is returned to the header tank under pressure by six scavenge pumps passing through, en route, an air-oil cooler and, if temperatures require, a fuel-oil cooler. The oil system should be serviced within 30 minutes of engine shutdown.

FUEL PUMP UNIT

51 Each engine has a fuel pump unit driven by the lower accessory case. Each unit consists of three pumps, one centrifugal and two gear-type. The centrifugal pump receives fuel from the feed tank (number 2 cell) and supplies it under pressure to the two gear pumps. One of the gear pumps supplies fuel to the engine fuel control and the other supplies fuel to the afterburner fuel control. Construction of these pumps is such that failure of any one pump leaves the others unaffected. Between the engine pump output and the afterburner pump output is a transfer valve which will open automatically should the engine pump fail. There will be no difference in engine performance with the engine pump failed and the transfer valve open. Any fuel not used by the engine, in this case, may be used for afterburner, however, at low altitudes with high engine fuel demands there will be little, if any, available. At high altitudes and low engine fuel demands there will be no noticeable loss of afterburner thrust. Failure of the afterburner pump will result in loss of afterburner. In this case the transfer valve will not open.

ENGINE CONTROL

52 Each engine is controlled by the pilot by the use of three controls: an engine master switch, a throttle, and an engine fuel control switch. The engine master switch is a two-position ON/OFF switch, guarded to prevent inadvertent movement. When in the ON position: it powers the 28 volt DC control circuit for transfer pumps and boost pumps; it supplies power to the engine anti-ice system; and it contributes to circuit continuity for the afterburner, ignition system, and fuel shut-off valve. The throttle has three main positions: CLS'D, IDLE, and OPEN. In the closed position (fully aft) the system is at rest. Moving the throttle to idle mechanically opens the cut-off valve in the fuel control unit and supplies final electrical continuity to open the fuel shut-off valve. From the idle to the open position (fully forward) the throttle can vary the engine output from idle to military thrust. The throttle must be in this range to allow electrical continuity to the emergency ignition and icing ignition circuits.

53 Each engine fuel control switch has two positions and is used to select either the NORM or the EMERG mode of operation for the engine fuel control unit. During normal fuel control operation, the throttle is the primary control of the size of a metering valve orifice which governs fuel flow. The metering orifice is further controlled automatically by a mechanical control that senses flight conditions. Thus, using throttle setting, engine speed, inlet temperature (which is a function of altitude and flight conditions), and burner pressure, the control adjusts thrust output selected by the pilot by regulated changes in the metering valve orifice. During rapid engine accelerations, the normal fuel control schedules fuel flow to protect the

engine from overspeed, overtemperature and compressor stalls. During rapid decelerations, the normal fuel control maintains a minimum fuel flow to prevent engine flameout. Any excess fuel not required by the engine is routed back to the discharge side of the centrifugal section of the fuel pump unit by the main bypass valve.

54 Emergency operation of the engine fuel control provides regulation of engine fuel flow if the normal fuel control fails. Emergency operation must be selected by the pilot. In selecting the emergency fuel control, the normal fuel control is disengaged and the fuel flow is then metered by an entirely different metering valve. This valve is directly connected to the throttle with the result that fuel flow, in effect, is manually controlled. The emergency fuel control does compensate for changes in altitude, however, the compensations are only effective up to 30,000 feet. At higher altitudes the throttle must be successively retarded to maintain a constant rpm. An emergency bypass valve routes excess fuel back to the discharge side of the centrifugal element of the fuel pump. When either engine fuel control switch is in the EMERG position the telelight "EMERG FUEL SYS ON" strip will illuminate.

NOTE

Under critical thrust conditions such as take-off, emergency fuel may be selected at any throttle position, without excessive surge, provided the aircraft is not above 10,000 feet density altitude. Above 10,000 feet density altitude, the position of the throttle must approximate the engine thrust level to avoid violent surge.

CAUTION

Since the emergency fuel control does not offer the automatic overspeed, overtemperature, flameout, and compressor stall prevention features of the normal fuel control, rapid throttle movements should be avoided during emergency fuel control operation.

55 A fuel flow metering valve is located between the fuel control unit and the fuel pressurization and dump valve. This valve measures the fuel flow to the engine and gives the pilot a visual presentation in pounds per hour on his fuel flow indicator. Afterburner fuel flow is not monitored by this valve.

AFTERBURNER CONTROL

56 Afterburner operation is initiated by moving the throttle outboard from the OPEN position. When the throttle is moved outboard, the electrically operated afterburner shutoff valve in the afterburner fuel control is opened. This action permits the flow of metered fuel to the afterburner nozzle. All fuselage transfer pumps with fuel available are energized when either throttle is placed in the afterburner detent. Afterburner augmentation should increase engine thrust approximately 57% over rated military thrust. The engine thrust can be modulated in the afterburner range and should be approximately 1-3% rpm and 0.3 epr. Afterburning can be terminated only by moving the throttle out of detent position.

CAUTION

Afterburner control operates normally when the engine fuel control switch is the EMERG position, however, throttle movement must be cautious, with due regard for engine limitations, since basic engine fuel flow is manually selected and manually controlled by the throttle.

57 Fuel is metered by the afterburner fuel control unit in direct proportion to engine output as indicated by compressor discharge pressure. This pressure surrounds a bellows that is connected to a variable orifice area metering valve. As compressor discharge pressure changes, the bellows is deflected to a new position and the metering valve is moved to provide correct fuel flow. The metered fuel is delivered to the afterburner fuel manifold.

58 The afterburner system may be shut off mechanically in the event the normal electrical control fails. The afterburner emergency shutoff valve is mechanically repositioned by the throttle when the

throttle is moved out of the afterburner detent and retarded to a position equivalent to approximately 83% rpm. The repositioned afterburner emergency shutoff valve directs fuel from the afterburner fuel control back to the engine-driven fuel pump. This terminates afterburning and causes the exhaust nozzle to close.

NOTE

Advancing the throttle past the afterburner cutoff point repositions the emergency shutoff valve and will initiate afterburning providing the failed electrical switch is still on.

59 Afterburner ignition is accomplished by means of a "hot-streak" igniter which injects a charge of fuel into number 3 combustion chamber, causing a temporary over-rich condition, which produces a flame streak through the turbine and into the afterburner fuel spray. The igniter includes an air piston, which actually "squirts" the fuel charge, and a pilot valve that triggers the air piston. When afterburning is initiated a fuel pressure signal from the afterburner fuel control shuttles the pilot valve to a position that directs high pressure air behind the air piston. This in turn forces the air piston against its spring and discharges the fuel into number 3 combustion chamber. When afterburning ceases both the air piston and the pilot valve return to their former positions and the igniter is ready for its next sequence. The igniter is a "one-shot" device only, and will not recycle until afterburner fuel pressure is shut off (afterburning terminated). Therefore, if the afterburner does not ignite (within 2 seconds at sea level, 3 to 4 seconds at altitude) it is necessary to momentarily move the throttles out of the afterburner detent before attempting to relight.

60 The operation of the exhaust nozzle is controlled by the exhaust nozzle control unit. It is essentially an air pressure operated relay valve that ports 16th stage air to either a nozzle open line or close line. The air pressure signal is generated when the afterburner fuel flow starts. When afterburning is initiated, air pressure is directed through the nozzle control unit positioning the relay valve to allow the high pressure air to be directed to the nozzle actuators through the open line, causing the exhaust nozzle to open. The close line is ported to atmosphere. When afterburning is terminated, the relay valve returns to its initial position allowing the high pressure air to enter the close line and close the nozzle. The open line is then ported to atmosphere.

ENGINE STARTER AND IGNITION SYSTEMS

61 Each engine is started with its own turbo fuel/air combustion type starter which is mounted on the lower accessory case and is geared to the engine high speed compressor. The starters may be operated in two modes, COMBUSTION and PNEUMATIC. Two, guarded, two-position switches on the aft end of the pilot's left-hand console provide the pilot the means of selecting either mode for each engine. Compressed air for either mode is obtained from an external air-cart or from the air bottles in the engine nose cones. The pilot may select either air source by a guarded, two-positioned switch on his left-hand console. OFF selects external air and ON selects internal air. In either mode of operation and with any air source, starter operation is initiated by use of the starter switches on the pilot's left-hand console. To select the starter switches to START the switch must first be lifted then it may be moved forward. The switch is held in the start position by a solenoid, and (unless the STOP/START position is selected) it will remain in the START position until the engine master switch is turned off at which time the solenoid is de-energized. Starter operation will cease when: the starter switch is placed in the STOP/START position, the starter fuel chamber is empty, or when the engine reaches approximately 35% rpm.

62 The starter is basically a small jet engine. It has a small combustion chamber and a turbine wheel with appropriate shafting and gearing to transmit the rotational force it generates to the engine. In the COMBUSTION mode, when the starter switch is selected START, air from one of the sources is allowed into the combustion chamber, fuel for a small fuel chamber is metered into the combustion chamber, and an ignitor plug begins the combustion. The expanding gases escape through the turbine and are exhausted through ports on the belly of the aircraft. Fuel for the fuel chamber is provided prior to installation and is thereafter primed from previous engine operation. Each charge will last approximately 11-13 seconds and

when it is depleted (irrespective of starter switch position) the starter control terminates air entry and ignition to the combustion chamber – the fuel chamber then recharges itself. When engine RPM reaches approximately 35% a centrifugal clutch, located in the starter shafting, will disengage and starter operation will terminate irrespective of starter switch position or time progression in the start cycle. In the PNEUMATIC mode the starter ignition and fuel injection systems are inoperative. Air from either source is allowed into the combustion chamber (when the starter switch is selected to START), escapes through the turbine, and is exhausted overboard. In this mode the centrifugal clutch is the only automatic shut-off feature, therefore, to conserve air volume in the external air-cart or the internal air bottles, the starter switch should be turned to STOP/START at 25% engine RPM.

NOTE

Internal air starts of both engines is an emergency procedure in that, at best, it is improbable that enough air exists to start both engines.

CAUTION

Simultaneous starting of the engines is prohibited unless required for tactical reasons. Low air volume to the starters and slow engine acceleration could lead to hot starts in both the starters and the engines.

63 The normal battery powered engine ignition circuits are energized when the engine start switches are moved to the START position, and are not affected by throttle position. Igniter operation is automatically terminated by a timer circuit, 15 seconds after actuation of the engine start switches.

64 The aircraft is also equipped with a continuous ignition system. This battery powered system provides a means for selecting continuous operation of the normal ignition system when icing is encountered, thereby reducing the probability of flameout due to ice ingestion. The system is controlled by the icing ignition switch located on the circuit breaker panel on the pilot's left-hand console. With the master switches ON and throttle in IDLE, placing the icing ignition system to ON completes the circuit to actuate the ignition relay and directs power to the ignition unit for both engines. Two red indicator lights (one for each engine) are located just above the icing ignition switch and will illuminate when continuous ignition is being utilized.

65 An emergency ignition button for each engine is installed on the aft face of each throttle. These buttons serve to energize the ignition circuits for air starts, independent of the starter circuits. The buttons are spring-loaded, and must be depressed with the engine master switch ON and the throttle out of the CLS'D position. An automatic timer provides continuous igniter operation for a period of 30 seconds after the button is released. Depressing the button with the engine master switch ON and the throttle in the CLS'D position will not provide ignition as the throttle cutoff limit switch will not be closed. Igniter operation cannot be terminated by the pilot after the ignition button is depressed, therefore, it is necessary to wait 30 seconds after the button is released before ignition is automatically terminated. This ignition circuit normally utilizes battery power, however, it can receive power from the emergency DC electrical system if both generators are disconnected from the AC Bus.

ENGINE INSTRUMENTS

66 The aircraft engine instruments are located in two vertical lines on the right-hand side of the pilot's instrument panel. The left line is for the left engine and the right line for the right engine. Like instruments for either engine are paired horizontally for quick comparison purposes. The pairs, from the top down are: EPR gauges, EGT gauges, fuel flow meters, RPM gauges, and oil pressure gauges. Each gauge will be dealt with individually as to purpose and function.

ENGINE PRESSURE RATIO GAUGES

67 Engine Pressure Ratio (EPR) gauges were designed as a more accurate method of assessing engine efficiency than the more conventional RPM/EGT combination. By use of various transmitters and amplifiers

the EPR system compares the engine inlet pressure, taken from the pitot/static system, and the engine output pressure, taken in the tailpipe just aft of the turbines, and presents this information in ratio form on the EPR gauge in the cockpit. The gauges are marked from 1.2 to 3.4 in increments of tenths and a conventional dial needle indicates the ratio, i.e., the needle pointing to the highest reading would indicate a ratio of 1 to 3.4.

68 Since thrust varies with ambient temperature it follows that EPR will be greater in cold temperatures than in hot. Charts in Part 4 give minimum EPR readings for take-off based on ambient temperatures. By moving the set knob on the lower left-hand side of the gauge, the minimum take-off EPR may be set in the lower window on the dial face. A pointer on the dial face edge moves to reflect this setting giving a quick visual reference to take-off EPR. If the EPR readings fail to reach these minima after the engine stabilizes at military power, take-off should be aborted. Abnormally high EPR readings at military power could mean the engine has been trimmed too high – a close watch should be kept on EGT and RPM to avoid possible overspeed and overtemperature. By pulling the set knob out and turning it, a cruise setting may be placed on the top window on the dial face. A pointer on the dial face edge moves to reflect this setting. Settings for cruise are based on in-flight ambient temperatures and altitudes and may be obtained from the cruise and range charts in Part 4.

69 Since the EPR is a pressure instrument it makes an ideal indicator to show afterburner eyelid position. If the eyelids operate correctly, initiating or terminating afterburner should not change the EPR reading other than for a momentary flick of the needle. If the eyelids open with no afterburner light-up the drop in pressure in the aft section will be reflected by a drop in EPR. If the eyelids stay shut and the afterburner lights the increase in pressure will be reflected as a soaring EPR.

70 The EPR gauges are powered by 115 volt AC. In the event of AC power failure the needles will remain where they were at the time of the failure.

EXHAUST GAS TEMPERATURE GAUGES

71 The Exhaust Gas Temperature (EGT) gauges are standard, reading from 0° to 1000°C. Eight self-generating thermocouples, located aft of the turbine, provide current to the gauge which then presents an average reading, converted to degrees, on the dial face. The system is completely independent of the aircraft power system.

FUEL FLOW METERS

72 The Fuel Flow meters indicate the rate, in pounds per hour, at which fuel is being consumed by the engine. The meters derive their information by measuring the deflection of a flap in the engine main fuel line. Fuel flow to the afterburners is not measured by these meters. The fuel flow meters operate on 28 volt AC power and if this power is lost the fuel flow indications will remain where they were at the time of the failure.

REVOLUTIONS PER MINUTE GAUGES

73 The Tachometers on RPM gauges indicate engine RPM in percentage of allowable RPM. Each gauge has two needles, one indicating 10 percent increments on the outside dial face and another indicating unit percent increments on a small dial inside the main dial. The RPM gauge receives its power from a tachometer generator connected to the engine compressor. Increase in compressor RPM causes an increase in the tachometer generator electrical output which is reflected by an increase on the RPM gauge. The system is completely independent of the aircraft power supply.

OIL PRESSURE GAUGES

74 The Oil Pressure gauges indicate in PSI the engine oil pressure. Oil pressure working on a diaphram provides the information for the gauges which operate on 28 volt AC power. If power is lost the gauge needles are spring loaded to zero. The pressure diaphram is within the oil system so in the event of its rupture no oil or actual oil pressure is lost.

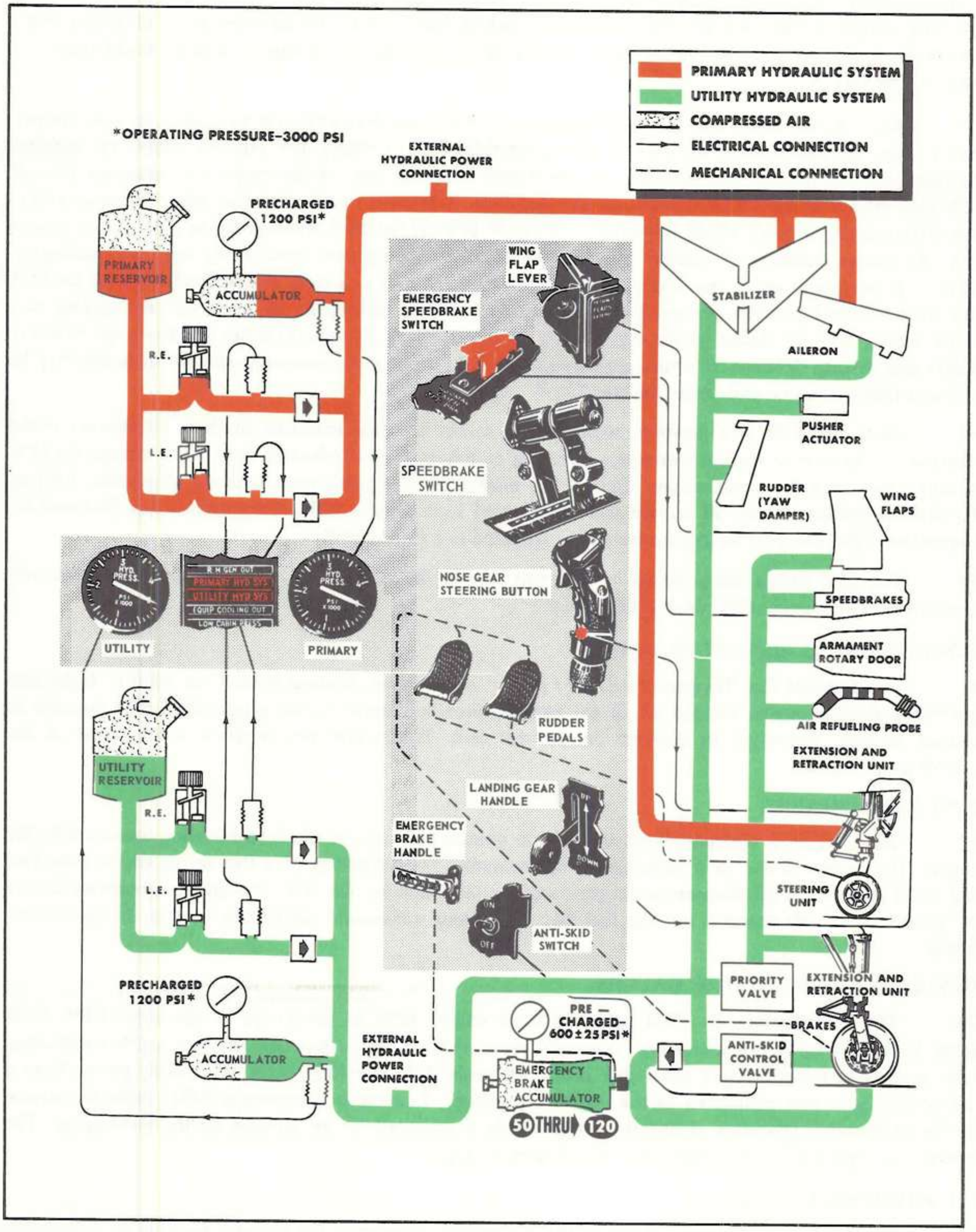


Figure 1-8 Hydraulic Power System

HYDRAULIC POWER SUPPLY SYSTEM

GENERAL

75 Hydraulic power is supplied by two completely separate systems; a primary and a utility system. Each system has two pumps, one driven by the right engine and one driven by the left engine. The loss of one pump, in either system, presents no limitations since one pump can supply fluid in adequate quantity for all normal operation. Although the normal operating pressure of each system is 3000 PSI, the pumps on the left engine have an output range 2800-3200 PSI and those on the right engine 2550-2950 PSI.

PRIMARY SYSTEM

76 The primary system is utilized to supply hydraulic pressure for operation of one section of the ailerons and horizontal stabilizer tandem power cylinders. The primary system also supplies pressure for operation of nose gear steering.

UTILITY SYSTEM

77 The utility hydraulic system supplies power to the rudder (yaw damper), pusher actuator, wheel brakes, air refueling probe, armament rotary door, flaps, landing gear, speed brakes, emergency brake accumulator, and to one section of the aileron and horizontal stabilizer tandem power cylinders. A priority valve in the utility system will deny pressure to all but the aileron, rudder, horizontal stabilizer, pusher actuator, and wheel brakes should the operating pressure drop below 1550 PSI. The valve will open when the pressure rises to 1800 PSI. The AFCS also requires utility hydraulic pressure for its operation.

HYDRAULIC PRESSURE GAUGES

78 Two pressure gauges, one for each system, are mounted side by side on the left console, just forward of the throttles. The gauges are actuated by transmitters utilizing 28 volt a-c and indicate system pressure in PSI.

HYDRAULIC PRESSURE WARNING LIGHT

79 A warning light for each system is located on the telelight panel. The lights read "Primary Hyd Sys" and "Utility Hyd Sys". If the pressure from either pump in the utility or the primary system drops below 700 PSI, the respective warning light and "Master Caution" light illuminates.

FLIGHT CONTROL SYSTEM

GENERAL

80 The control stick is mechanically connected to control valves at the aileron and horizontal stabilator power cylinders and provides a means of lateral and longitudinal control of the aircraft. Movement of the control stick mechanically positions control valves to direct hydraulic pressure to the applicable control surface power cylinder. Hydraulic pressure to the power cylinder will be blocked off automatically when desired control surface deflection is obtained. The pilot's stick grip incorporates the lateral and longitudinal trim switch, external tank release button, armament trigger, nose gear steering button, and the alternate microphone button. All of the power cylinders are irreversible in that they transmit none of the airloads back to the stick or rudder pedals. To compensate for this, and to provide the pilot with stick and rudder forces to which he has become accustomed, separate artificial feel systems are provided. The same irreversability features tend to "snub" the control surfaces, making control locks unnecessary. Each of the primary controls can be trimmed electrically. Autopilot servos are tied into all controls. Portions of the autopilot system can be used, independent of automatic flight to provide yaw damping. Provisions are made whereby the ailerons, rudder and stabilator can be simultaneously trimmed for take-off.

STABILATOR FEEL AND TRIM

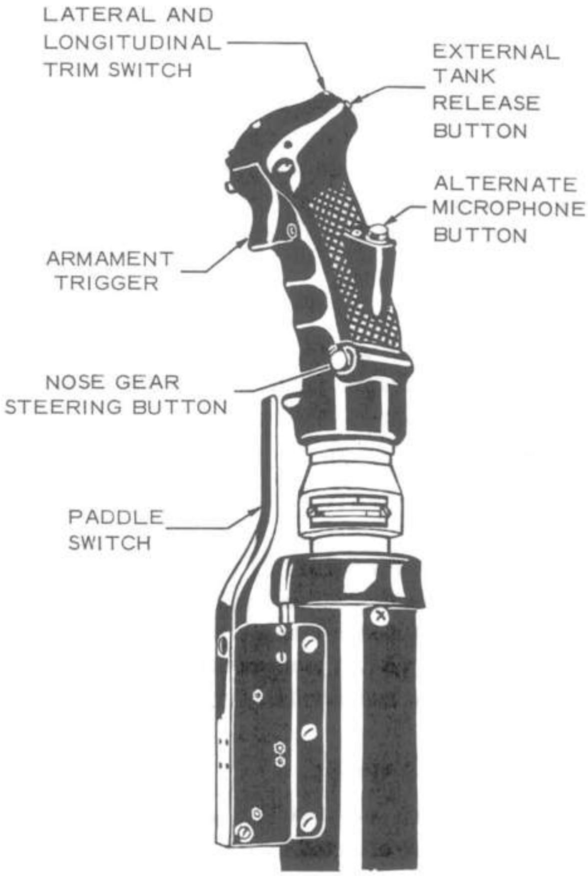


Figure 1-9 Control Stick

81 "Feel" is induced into the horizontal stabilator control system by stabilator bellows forces. The bellows assembly is located just forward of the speed brake well. Bellows forces are obtained from ram air pressure acting on a bellows (Figure 1-1), and will therefore vary with airspeed and air density. The ram air intake duct contains a molded type thermostatically controlled heater to prevent icing of the duct and subsequent loss of stabilator feel. The heater utilizes 115 volt a-c electrical power that is available to the heater whenever a-c power is supplied to the aircraft. This bellows force is supplied to a variable balance assembly which is connected to the control stick through control linkage. The control linkage is such that fore and aft stick movements cause the balance assembly to rotate. As the balance assembly rotates, control stick movements are resisted by the bellows force. The resistance, as transmitted to the stick through the linkage, is the artificial feel. The application of ram air pressure on the bellows makes possible a more accurate simulation of the stick forces encountered under varying flight conditions. Another stick force factor and aid in preventing the aircraft from being subjected to "G" loads beyond its structural capabilities, is the incorporation of a viscous damper in the feel system. This unit will provide a much greater resistance to any abrupt or sudden stick movement, either fore or aft. A bobweight is also installed on the stick which will increase stick forces with an increase in "G" load. Horizontal stabilator trim is accomplished through the use of the same mechanisms which provide artificial "feel", namely, the bellows force acting on the balance assembly. An electric actuator in the balance assembly varies the point at which the bellows force is applied to the balance assembly. The actuator is energized by the lateral and longitudinal trim switch located on the control stick grip, or by the take-off trim button on the pilot's instrument panel. Full travel of the stabilator can be obtained with the trim system.

AILERON FEEL AND TRIM

82 A spring cartridge, one end of which is attached to the aileron linkage, supplies "feel" to this system. It is designed so that movement in either direction requires compression of the spring, hence resistance to movement. Trim is provided by attaching the other end of this same cartridge to an electric actuator. When energized, the actuator moves the entire aileron linkage, thereby repositioning the neutral or no feel position. The actuator is energized by the lateral and longitudinal trim switch on the control stick or by the take-off trim button on the pilot's instrument panel.

CAUTION

The lateral and longitudinal trim switch may occasionally stick in an actuated position, resulting in application of extreme trim. If this condition occurs in flight, the trim switch must be returned manually to the center OFF position after the desired amount of trim is obtained.

RUDDER PEDALS

83 Conventional hanging-type rudder pedals, mechanically linked to hydraulic control valves at the rudder actuator, provide a means of directional control of the aircraft. Movement of the pedals mechanically positions the control valves to direct hydraulic pressure to the rudder actuator. Hydraulic pressure to the actuator will close off automatically when desired rudder deflection is proportional to rudder pedal movement. The rudder pedals are collectively adjusted fore and aft by the crank on the lower portion of the pedestal panel. Toe action of the rudder pedals applies wheel brakes. With nose gear steering system engaged, movement of the rudder pedal maintains directional control during ground operation.

RUDDER FEEL AND TRIM

84 The difference in the forces exerted on opposite sides of a piston within a hydraulic cylinder offers the resistance to rudder pedal movement necessary to produce the required "feel". This cylinder joins the rudder linkage in such a manner that control movement in either direction tends to extend the cylinder. At slower airspeeds, full hydraulic system pressure is diverted to both sides of the piston, but due to the difference in area of the two sides of the piston, some resistance to pedal movement is offered. At an airspeed of 290 (+10) knots, an airspeed switch is actuated which in turn operates a valve shutting off hydraulic pressure to the extension side of the piston. This means that full hydraulic pressure then opposes rudder control movement, greatly increasing the feel forces. Trim is accomplished by varying the neutral, or no-load position of the control linkage. This is made possible by including an electric actuator in the feel system which by extension and retraction moves the entire rudder control system proportionally. The actuator is energized by the rudder trim switch on the pilot's left console or by the take-off trim button on the pilot's instrument panel.

YAW DAMPER (STABILITY AUGMENTATION)

85 A hydraulic actuated, electrically controlled yaw damper system is used to insure turn co-ordination and improve dynamic directional characteristics. The system operates when the yaw damper switch is in the DAMPER position or when the AFCS is operating. In some aircraft the DAMPER position is marked STAB-AUG. The rudder servo is connected to the rudder pedals by a linkage assembly which permits yaw damping and auto-pilot manoeuvers without disturbing the rudder pedals.

TAKE-OFF TRIM BUTTON

86 The take-off trim button is located on the pilot's instrument panel and provides a means for the pilot to simultaneously trim all flight controls (ailerons, rudder and stabilator) to proper position for take-off. Depressing this button energizes the electric actuators to reposition the ailerons and rudder and the stabilator balance assembly to obtain the control settings for take-off. The take-off trim position of the ailerons and rudder is neutral (+2°) but the stabilator balance assembly is extended to induce a nose-down trim condition. The switch must be held depressed until illumination of the take-off trim light indicates that all flight controls are properly trimmed for take-off. Electrical power is supplied from the 28 volt d-c bus.

CAUTION

The take-off trim button should not be used in flight, as a dangerous or undesirable flight attitude may result.

TAKE-OFF TRIM LIGHT

87 A green indicator light, located adjacent to the take-off trim switch on the pilot's instrument panel, is provided to give the pilot an indication that take-off trim has been attained. With the switch held depressed, the light will illuminate when all flight controls have reached take-off trim. Releasing the take-off trim switch will cause the light to go out. If the aircraft is in an excessive nose down trim, it is possible for the stabilizer not to trim and the light not to illuminate. By manually trimming the aircraft to a nose high condition and then depressing the take-off trim button, the system will trim normally for take-off. This light utilizes 28 volt d-c power and can be dimmed and tested by the warning light test and dim button on the pilot's lighting control panel.

LANDING GEAR SYSTEM

GENERAL

88 The fully retractable tricycle landing gear consists of a dual wheel nose gear and single wheel main gear which are hydraulically operated (utility system) and electrically (28 volt d-c) controlled. The main wheels retract inboard into the wings and the nose wheel retracts forward into a compartment in the nose. When the landing gear is retracted the compartments are covered by flush doors. The doors operate automatically with the landing gear, and in the case of the main wheel doors, the operation is hydraulic; with the nose wheel doors, it is through mechanical linkage. The doors remain open when the landing gear is extended. Should they be closed, the main landing gear inboard doors will automatically open whenever hydraulic pressure and electrical power is applied, i.e., during the starting cycle (gear handle down position). The gear is mechanically locked in both the retracted and extended positions. Landing gear extension for both normal and emergency will take place in approximately 8 to 10 seconds, while retraction occurs in approximately 4 seconds. The compressed air bottles in the engine nose cones provide for emergency extension of the landing gear in the event the normal hydraulic system fails. An overrun barrier hook is mounted on the nose gear and the main gear door panels have been reinforced to improve MA–IA barrier engagement.

LANDING GEAR SHOCK STRUTS

89 The main landing gear shock struts are the conventional air-oil type but they can also be compressed when the landing gear is being retracted. The struts are compressed for stowage in the wings by relieving air pressure in an inflation chamber. Air pressure in the inflation chamber is dumped overboard as the landing gear is retracting. As the landing gear is being lowered, air pressure is metered from a high pressure storage chamber in the strut to the inflation chamber, extending the strut to its normal landing condition. The high pressure storage chamber contains enough air pressure to cycle the gear approximately 12 times. Additional landing gear cycling will cause the strut to deflate and remain in that condition. An air pressure indicating pin located on the top of the strut will extend approximately 9/16 of an inch when the storage chamber is fully serviced (3000 psi). The air pressure in the storage chamber will decrease each time the gear is cycled and consequently the pin extension will decrease proportionally.

CAUTION

> While on the ground, the gear strut may be extended even though there is no air pressure in storage (pin retracted). Consequently the pin is the only indication that the storage chamber is partially or fully serviced (pin extended).

LANDING GEAR GROUND LOCKS

90 Individual clamps for the main gear, and a pin for the nose gear, can be installed on the ground to prevent inadvertent retraction during servicing and ground handling. The locks have regulation red streamers attached and must be removed prior to flight. The landing gear ground locks should not be removed prior to starting at least one engine. Hydraulic pressure to the downside of the landing gear actuator will not be available prior to starting engines and there is the possibility that the landing gear could collapse.

LANDING GEAR HANDLE

91 Normal operation of the landing gear is accomplished by means of the landing gear handle located on the landing gear control panel. This two-position handle, which has positions marked UP and DOWN, has a wheel-shaped knob which contains a warning light. Placing the handle in either position actuates switches which in turn operate a solenoid valve to direct hydraulic pressure. When the landing gear is up and locked, limit switches disengage the solenoids relieving the system of pressure. When the landing gear is extended and locked, limit switches hold the solenoids engaged and pressure is available at all times. The system utilizes 28 volt DC electrical power which is supplied through the landing gear circuit breaker. To preclude accidental operation of the landing gear handle, limit switches enable a lever latch mechanism to hold the handle down whenever any of the landing gear struts are compressed. When the struts extend after take-off, a 28 volt DC solenoid releases the latch mechanism, permitting normal operation of the handle. The latch mechanism can be overridden by exerting a force of approximately 35 pounds on the handle. This permits emergency gear retraction on the ground when necessary.

CAUTION

With hydraulic pressure available, the landing gear will retract any time the landing gear handle is moved to UP.

LANDING GEAR EMERGENCY HANDLE

92 This handle is located outboard of the left console and is mechanically connected to a compressed air bottle discharge valve. When the handle is pulled to its full travel (approximately 3 3/4 inches) air is directed to the gear down side of the actuating cylinder, extending the gear. The handle will remain at its extended position until the trip lever directly under the handle is released and the handle returned to the normal position. Returning the handle allows the compressed air to be vented and normal gear operation restored.

CAUTION

The emergency system is actuated only upon failure of the normal system and will extend the gear pneumatically. The emergency landing gear lowering system utilizes the same source of compressed air as is used for internal air starts. Approximately 1800 psi is required, therefore, emergency gear lowering may not be available if internal air is used to make a start. The gear cannot be retracted by the emergency pneumatic system.

LANDING GEAR POSITION INDICATORS

93 Individual green indicator lights are provided to indicate a gear down and locked condition. The lights are mounted in a group on the landing gear control panel. When the landing gear handle is in the UP position the lights will not be illuminated. With the landing gear handle in the DOWN position the lights will illuminate as each individual gear is down and locked. These lights operate on 10/28 volt AC and are tested by the warning light test button and dimmed by the button on the pilot's lighting control panel.

LANDING GEAR WARNING LIGHTS

94 A red warning light on the left side of the pilot's instrument panel and a red light in the landing gear handle illuminate for any of the following reasons:

1. Gear handle position does not correspond to gear position.
2. Any gear unsafe.
3. Main gear doors unlocked.
4. Flaps down – Gear up – Either or both throttles retarded below military thrust.

The lights utilize 28 volt DC power.

LANDING GEAR WARNING BUZZER AND SILENCER

95 Co-incident with the illumination of the red warning lights, an intermittent buzzer tone will be audible in the pilot's headset. The warning buzzer will not sound as throttles are retarded when both gear and flaps are up. This signal is dependent on 28 volt DC. A push-button on the landing gear control panel silences the warning buzzer. The buzzer will remain silenced until the landing gear has been extended or retracted, the flaps have been extended or retracted, or a throttle has been advanced to military thrust and retarded. Actuation of any of these will again sound the warning buzzer. The landing gear warning light should be used as the primary warning device to determine a gear safe or unsafe condition.

NOSE GEAR STEERING SYSTEM

96 The aircraft is provided with a steerable nose gear system which allows directional control during taxiing. The system is electrically selected (28 volt DC) and hydraulically (primary system) operated. Nose gear steering is engaged by depressing the nose gear steering button on the stick grip. A holding relay is incorporated to preclude the pilot having to hold the nose gear steering button depressed. Depressing and releasing the button will engage the nose gear steering system. When the button is depressed the second time, steering will remain engaged, but will disengage when the button is released. Engaging the system electrically selects hydraulic pressure to the steering unit. This unit permits the nose gear to be steered, by rudder pedal movement, through a 40 degree arc either side of center. Further travel may be accomplished by differential braking but the steering unit is not operational beyond the 40 degree position. The system should be engaged while the rudder and nose gear are in the neutral or centered position. A safety switch prevents engagement of the steering system when the weight of the aircraft is off the nose gear (strut extended). The nose gear steering unit further serves as a shimmy damper.

WHEEL BRAKE SYSTEM

GENERAL

97 The power brake system is operated from the utility hydraulic system, and incorporates segmented rotor type brakes, which are mounted integrally with the main landing gear wheels. Multiple disks are used to increase braking efficiency, aid in heat dissipation, and prevent brake seizure due to disk war-page caused from high temperatures. The brakes are operated by toe action on the rudder pedals which meters utility hydraulic system pressure to force the brake disks together. Since the power brake valves are metering type valves, hydraulic pressure cannot be felt at the pedals. A soft, full travel pedal is characteristic of this type brake. The aircraft is not equipped with parking brakes.

WHEEL BRAKE ANTI-SKID SYSTEM

98 An electrically controlled anti-skid system is incorporated in the wheel brake system to prevent skidding and to shorten the landing roll. The system detects the start of a skid condition of the wheels and releases both brakes when this occurs. A skid detector unit mounted in each main gear senses the rate of change of wheel speeds as well as rotation of the wheel. These detectors supply electrical signals to the system control unit, which controls the anti-skid control valves in the brake lines. The control valves direct the flow of hydraulic pressure applied by the pilot to the wheel brakes or to the return line. If either wheel starts to skid after the brakes are applied the detector sends a "skid" signal to the control unit. The control unit, in response to this signal closes the anti-skid control valves to release the brakes and prevent additional pressure from reaching the brakes. As the skid condition is corrected by this automatic brake release, the anti-skid control valves open allowing metered pressure to reach the brakes. The anti-skid system maintains this automatic skid control cycling of the brakes as long as the brakes are applied and skid conditions prevail. A fail safe circuit automatically return the brake system to normal in the event the anti-skid system releases the brakes for an excessive period of time (3 seconds).

ANTI-SKID SWITCH

99 This two-position toggle switch is located on the landing gear control panel. When the switch in ON, 28 volt DC electrical power is available to the anti-skid system. The anti-skid system is shut off by placing the switch to OFF. The system can also be disengaged by holding the paddle switch depressed.

ANTI-SKID INOPERATIVE LIGHT

100 This amber light is located on the landing gear control panel. This light will illuminate when the anti-skid system is inoperative. The light utilizes 28 volt DC electrical power.

NOTE

If brakes are lost during taxiing, without loss of utility hydraulic pressure, disengage the anti-skid system by depressing the paddle switch. Normal braking will be immediately available but the anti-skid inoperative light will not illuminate for approximately 3 1/2 seconds.

CAUTION

If a system malfunction is suspected, or if the anti-skid inoperative light illuminates during the landing roll, the brakes should be released before the release lever is actuated to prevent skidding when the system is disengaged.

EMERGENCY HYDRAULIC BRAKES

101 An emergency hydraulic accumulator pre-charged to 600 ± 25 psi stores hydraulic fluid under 3000 psi pressure and can be deployed by the pilot if the normal hydraulic system fails. The emergency brake accumulator is charged with fluid from the utility hydraulic system, and in the event of utility system failure, is precautionarily isolated by a check valve. This accumulator is located in the forward wall of the nose wheel well, and is discharged by pulling the emergency brake handle, which is mounted on the pilot's left vertical sub-panel. Pulling the handle approximately 5 inches releases hydraulic pressure to two metering valves incorporated with the brake pedals. Brakes are then applied in the same manner as the normal system operation, except braking action is limited due to depletion of hydraulic pressure. Three to four full brake applications are available. Anti-skid protection is not available when the emergency brake system is employed.

CAUTION

The pilot should not attempt to taxi with normal brake system failure.

WING FLAPS

GENERAL

102 Hydraulically operated, electrically controlled, zap type flaps are located inboard of the ailerons on the trailing edge of each wing. Each flap is attached to the wing by four links which permit the flaps to move aft as well as down when extended.

WING FLAP LEVER

103 The two-position wing flap lever is located on the pilot's left console. It has positions marked RETRACT and EXTEND. In the EXTEND position, a solenoid valve is energized by 28 volts DC, directing utility hydraulic pressure to extend the flaps to the "full down", 50 degree position. The solenoids remain energized and pressure is maintained on the actuating cylinders, holding the flaps in the EXTEND position.

Placing the lever in the RETRACT position actuates solenoids to deliver utility hydraulic pressure for retraction. In the retract position the flaps are mechanically locked up and limit switches de-energize the circuit but hold a hydraulic lock. Simultaneous operation of each flap is assured by a flow divider which provides equal flow to each flap actuator. The airspeed switch that controls the rudder feel system also automatically retracts the flaps at 290 + 10 knots and prevents flap extension above this speed. If the wing flap lever is left at EXTEND, the flaps will automatically extend when the airspeed drops below approximately 290 knots.

NOTE

No intermediate flap positions are available and there are no provisions for emergency extension or retraction of the flaps. The flaps will remain down or in an intermediate position if utility hydraulic pressure is lost during or after flap operation.

CAUTION

During ground operation, repositioning the flap lever while the flaps are being extended will result in serious damage to the flaps and may prevent any subsequent flap operation. The airload will prevent this damage while airborne.

WING FLAP POSITION INDICATOR

104 An indicator on the landing gear control panel utilizes 28 volt DC power to indicate flap position. The flap position indication is obtained from the left flap and indicates flap position in percentage of travel.

SPEED BRAKES

GENERAL

105 Panel type speed brakes are installed on the aft portion of each side of the fuselage. The panels are hydraulically operated, from the utility system, and electrically controlled with 28 volt DC power. In normal operation, hydraulic pressure acts to both open and close the speed brakes.

SPEED BRAKE SWITCH

106 A serrated toggle switch located on the right throttle grip electrically positions the speed brake hydraulic control valve which passes hydraulic fluid to the actuating cylinders. This switch, powered by the 28 volt DC bus, has three fixed positions: OPEN, NEUTRAL, and CLOSE. With the switch in the OPEN position pressure is maintained on the actuating cylinder to hold the brakes open, but in the CLOSED position a limit switch returns the control valve to NEUTRAL and holds the brakes closed with a hydraulic lock. Any degree of speed brake deflection can be obtained during either the extension or retraction cycle by returning the switch to neutral when the speed brakes reach the desired position.

EMERGENCY SPEED BRAKE SWITCH

107 This switch, on the engine control panel, is guarded in the NORMAL position. Should the normal operating system fail with the speed brakes extended, placing this switch to the IN position will operate a valve relieving the hydraulic pressure and allowing the air loads to force the panels to a trail position. Power required is supplied by the 28 volt DC bus.

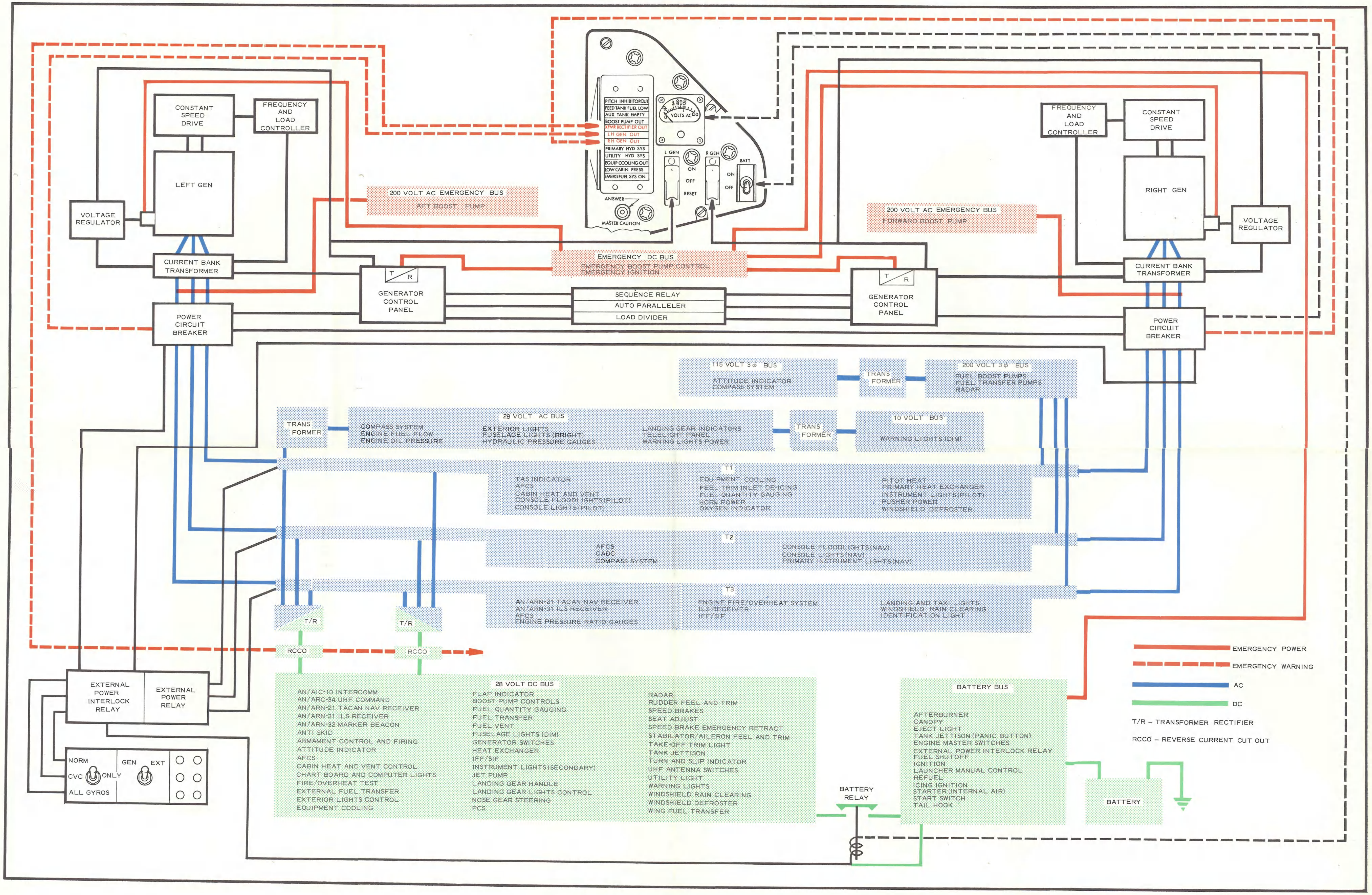


Figure 1-10 Electrical Power Supply

ELECTRICAL POWER SUPPLY SYSTEM

GENERAL

108 This section should be read with frequent reference to Figure 1-10 (Electrical Power Supply) for ease of understanding.

109 The primary electrical power for the aircraft is 200/115 volt, three-phase, 400 cycle alternating current, This current is carried on the AC Bus which is composed of three wires or strips termed: T-1, T-2, and T-3. If power is taken from all three strips to a service the resulting power is 200 volt 3 phase AC power. If power is taken from one strip through a service and is then grounded to the airframe the resulting power is 115 volt, single phase AC power. Both types of power are used for various aircraft services which are all listed in Figure 1-10. Other types of AC power, also listed, are obtained by transformer, i.e., 115 volt three phase, 28 volt single phase, and 10 volt single phase. AC power is tapped from the AC bus and sent through two Transformer/Rectifier (T/R) units which transform and rectify the AC power to 28 volt DC to power the DC Bus. The DC Bus is composed of a single wire or strip and the services powered by this bus are listed in Figure 1-10. As a suppliment to the 28 volt DC power, a 24 volt, 11 amp/hour battery is installed which directly powers the Battery Bus. The battery may be connected to the 28 volt DC Bus by turning the battery switch ON. Activating this switch applies power to a relay which then closes, connecting the two buses. The battery may be considered as a source of emergency DC power only as it is not required if generator or external power is available.

GENERATORS

110 Power is supplied to the AC Bus by two generators, each capable of delivering 30,000 volt/amperes, one driven by each engine. Either generator alone is capable of fully powering the aircraft. There is no physical connection between the engines and the generators; drive is achieved by constant speed units utilizing engine oil pressure. The constant speed drive normally regulates generator speed to 6,000 RPM, a speed which coincides with the 400 cycle frequency. Approximately 30 % engine RPM is required before the generator output reaches the criteria the generator control panel requires to allow the generator to power the AC Bus.

GENERATOR CONTROL

111 The generator is controlled in three ways: by the frequency and load controller, the voltage regulator, and the generator control panel. These three control boxes all receive a sampling of generator output from the current bank transformer. The frequency and load controller senses over/under frequency and sends a signal to the precision frequency control motor which then allows more/less oil to the constant speed drive thereby increasing/decreasing generator RPM and increasing/decreasing frequency. The voltage regulator permits full current to pass through the generator field coils until generator output reaches 90 volts, at this time it begins to vary field current to regulate generator voltage to 115 volts per phase. The generator control panel controls generator power by opening or closing the power circuit breaker. If generator output reaches certain ground set parameters the generator control panel will close the power circuit breaker allowing the generator to power the AC Bus. The auto paralleler insures that the second generator is synchronized with the one connected to the main AC Bus before allowing the second power circuit breaker to close thus connecting the second generator. The generator control panel will open the power circuit breaker if it senses over/under frequency, over/under voltage, or a short circuit within the generator. The load division relay attempts to divide the electrical load evenly between the two generators. If it cannot keep the generators output within 4 kilowatts of each other it will signal the generator control panel of the low generator to remove it from the bus. A sequence relay prevents both generators from attempting to come on the AC Bus at the same time; it will allow the left generator to come on first. Regardless of this sequence relay a generator already on the line takes priority.

DC POWER

112 The main 28 volt DC Bus is powered by two transformer/rectifiers, both of which obtain AC power from the AC Bus. If the AC Bus is not powered, DC power is available from the battery only. If one

transformer/rectifier should fail, power from the other is prevented from feeding back through the failed unit by a reverse current cut-out relay. If both transformer/rectifiers should fail, the reverse current cut-outs will open preventing the battery from discharging through the two T/R units.

113 The battery is connected directly to the battery bus so with a serviceable battery installed all services on the battery bus are "hot". The battery bus may be connected to the 28 volt DC bus by activating the battery relay. This can be done in two ways, by turning ON the battery switch or by connecting external power – the latter powers the external power interlock relay which activates the battery relay. With the battery relay activated and the DC Bus powered, current flows from the DC Bus to the battery bus to power all battery bus components and to charge the battery. If the battery relay is activated and the DC Bus is not powered the battery will power the battery bus and the DC Bus.

GENERATOR SWITCHES AND WARNING DEVICES

114 The generator switches are located on the pilot's right-hand vertical sub-panel. They are three position switches guarded to the ON position. With the switch in the ON (fully-up) position the generator control panel is allowed its automatic functions outlined in the GENERATOR CONTROL section. With the switch in the OFF (center) position the generator control panel must open the power circuit breaker taking that generator off the bus. The RESET (bottom) position is used when a generator has been automatically removed from the bus due to some malfunction. By momentarily placing the switch to RESET the voltage regulator is over-ridden and full field current is flashed through the generator field coil. Placing the switch back to ON should reconnect the generator to the bus. If, after one reset, the generator does not reconnect, place the switch to OFF and follow the emergency procedures.

115 Three telelight warning strips are devoted to the power supply; XFMR RECTIFIER OUT, LH GEN OUT, and RH GEN OUT. If AC power is available, the illumination of the XFMR RECTIFIER OUT light indicates either one or both transformer/rectifiers is inoperative. If either left-hand or right-hand generator out lights illuminate, the telelight will indicate which generator has been disconnected from the AC Bus. Unless the aircraft is on external power both "generator out lights" will not illuminate at the same time as the telelight is operated by AC power.

116 A voltmeter is located immediately above the generator switches and measures single phase voltage. Under normal conditions it should read 115 volts ± 2.

EMERGENCY ELECTRICAL POWER

117 Emergency AC and DC power is not available unless both power circuit breakers are open and the AC bus is without power. Emergency power is based on the premise that one or both generators are rotating and are therefore producing some power, although not enough to allow the generator control panels to connect them to the bus.

118 Emergency AC power is used by the fuel boost pumps only and is tapped off between the generators and the power circuit breakers. The left generator operates the aft boost pump and the right generator operates the forward boost pump.

119 Emergency DC power operates the emergency boost pump control and may be used for engine emergency ignition. This power is derived from the battery, the generator field, and transformer/rectifiers located within the generator control panels. These transformer/rectifiers must not be confused with the normal transformer/rectifiers which are completely deactivated under emergency power conditions. A control senses which emergency DC source is strongest and automatically selects, and uses, that source. With the battery switch ON the battery will power the 28 volt DC Bus, however, care should be taken to preserve battery life.

EXTERNAL POWER

120 External power is normally obtained by use of an MD-3 power cart, which supplies 200/115 volt, three-phase, 400 cycle AC, and 28 VDC power. External power is applied to the aircraft through the quick

disconnect receptable located inside door 204R on the forward right-hand side of the fuselage. A two-position switch within this door allows internal (generator) or external power to be selected. With the switch in GEN position normal generator operation is obtained. With the switch in the EXT position, 28 Volt DC power causes the external power interlock relay to close the battery relay and ensure both power circuit breakers are open. When this is complete the external power relay allows external AC power to be connected to the AC Bus. To apply external power when the power cart does not deliver 28 volts DC, the battery switch must be momentarily placed to the ON position to energize the external power interlock relay which will then allow AC power to the main AC Bus.

121 Also located inside door 204R is a three-positioned switch called the AFCS and NAV System Power switch. When the aircraft is powered externally placing this switch in the NORM position denies power to the AFCS and to all gyros, in the ALL GYROS OPERATE position all components receive power, and in the ONLY CVG OPERATE position, power is denied all components with the exception of the central vertical gyro. The primary function of this switch is ground testing and, to prevent any mistake in selection when preparing for flight, moving the power selector switch to GEN position overrides any selection on the AFCS and NAV System Power switch and all components are fully powered.

CIRCUIT BREAKERS AND FUSES

122 Most of the circuits are protected by push-pull type circuit breakers. The circuit breakers for essential circuits are located outboard of the throttles on the pilot's left-hand console and on the aft end of the navigator's left-hand console. Two fuses for the instrument lights are located on the cockpit light control panel in both cockpits. Three fuses, and a spare, for the Indicator and Warning lights are located on a control box to the left rear of the pilot's seat. The remaining circuit breakers and fuses are located on panels inaccessible during flight.

CAUTION

Circuit breakers should not be pulled or reset without a thorough understanding of all the effects and results. Pulling circuit breakers may eliminate from a system some related warning system, interlocking circuit or cancelling signal which could result in an undesirable reaction.

EXTERNAL LIGHTING SYSTEM

LANDING AND TAXI LIGHTS

123 Two 600 watt, 115 volt AC lamps are mounted on the nose wheel strut to provide illumination during landing and taxiing. The left lamp is set almost at right-angles to the strut and is used for taxiing while the right lamp is set at a much more severe angle to allow for the high angle of attack while landing. A three-position switch, located on the flap lever pedestal on the pilot's left-hand console, provides control for the lights. The TAXI (up) position turns the left-hand lamp on, the OFF (center) position deactivates both lamps, and the LDG (bottom) position turns the right-hand lamp on. A microswitch on the nose gear will turn either lamp off upon gear retraction should either lamp be inadvertently left selected.

POSITION AND FUSELAGE LIGHTS

124 Conventional position lights are mounted on each wing tip and on the top, rear of the vertical fin. A two-position switch on the external lights control panel provides for the flash/steady functions – forward for STEADY, aft for FLASH. The position lights utilize 28 volt DC power which is variable to six intensities by adjusting a rotary knob, located beside the flash/steady switch, from the OFF position clockwise through five positions to the sixth – BRIGHT.

125 Three white fuselage lights are provided to make the aircraft more visable at night. One light is located on the centerline just aft of the canopy and two are located, one on each side, just forward of the engine intakes. Each light has two bulbs, one small 28 volt DC and one large 28 volt AC. Intensity is varied by

the same rotary knob which varies the position lights. The first five positions increase the intensity of the DC bulb and the sixth position cuts off the DC bulb and turns on the bright, AC bulb.

IDENTIFICATION LIGHT

126 To aid in night intercept identification, the aircraft is equipped with an identification light flush mounted on the left side of the rear cockpit. The 600 watt, 115 volt AC lamp is mounted to project its beam perpendicular to the vertical axis and 15° forward of the lateral axis. This mounting is compatable to final positioning on VisIdent and should allow identification with a minimum of manoeuvering. The light switch is located on the bulkhead at the front of the navigator's left console; up is ON, down is OFF.

CAUTION

Care must be taken to avoid actuation of the canopy switch when reaching for the identification light switch.

CAUTION

The identification light must not be operated for more than 5 seconds when the aircraft is on the ground as heat damage will occur to the plexiglass window.

INTERIOR LIGHTING SYSTEM

COCKPIT LIGHTING

127 There are two systems available to light the cockpit. The primary system utilizes 28 volt. AC power and consists of red instrument ring lights, red submerged console lighting, red console flood lights, white thunderstorm lights, and red or white chartboard and jet computor lights. The secondary utilizes 28 volt DC power and consists of red console flood lights only and which are set at a constant intensity. The lighting selector switch is located in the middle of the pilot's cockpit lighting panel on his right-hand console – forward is PRIMARY, aft is SECONDARY.

128 The four rheostats on the pilot's cockpit lighting panel control the intensity of the instrument, console, console flood, and thunderstorm lights in that cockpit when the lighting is in the PRIMARY mode. The first three types are standard. The thunderstorm light is mounted on the pilot's right canopy rail and directs its beam onto the instrument panel. A switch marked Thunderstorm Lights located just forward and outboard of the cockpit lighting panel allows two other white lights to be controlled by the thunderstorm rheostat. These lights are mounted at the base of the canopy arch and direct a shielding white light over the windscreen and forward canopy area. A white, detachable utility light is mounted under the pilot's right-hand canopy rail. Intensity is controlled by a rheostat on the rear of the light. It is powered by 28 volt DC, independent of the primary/secondary switch. The switch for the stand-by compass light is located on the pilot's pedestal and the light's intensity is varied by the instrument light rheostat. This light is also independent of the primary/secondary switch. There are two fuses mounted on the cockpit light control panel. The one on the left protects the lights in the artificial horizon and the compass indicator; the one on the right protects the ejector racks' annunciator lights.

129 With minor deviations the navigator's cockpit lighting is the same as the pilot's. The cockpit lighting panel is on the left-hand console; it has no primary/secondary switch, and it has two additional rheostats. These rheostats control the intensity of the chartboard and jet computor lights. The chartboard light is mounted in the middle of the instrument panel on the end of a flexible cable. By turning the end of the light casing, red or white light may be selected. The jet computor light is the same type of light as the chartboard light and is mounted on the right-hand canopy rail. There is a utility light on the right-hand console similar to the pilot's. There is only one thunderstorm light and it is mounted on the left-hand canopy rail.

INDICATOR AND WARNING LIGHTS

130 There are many warning and indicator lights in the front and rear cockpits of the aircraft. With the exception of the Reduced Transmitter Power light and the Eject light in the rear cockpit and the Tail Hook and the Gyro Alignment Indicator in the front cockpit, all the bulbs in these lights may be tested by pressing the WARNING LT TEST button on the pilot's cockpit lighting panel. With the same four exceptions all these lights may be dimmed, from 28 to 10 volts AC, by pressing the WARNING LT DIMMER button on the same panel. To reset the system to bright the pilot's instrument light rheostat must be turned OFF. The Tail Hook light, the Reduced Transmitter Power light, and the Gyro Compass Alignment Indicator may be tested by the press-to-test method. The navigator's Eject light may be tested by turning the eject light switch in the front cockpit to ON. All warning and indicator lights will be covered under the systems concerned, with the exception of the Fire and Overheat Detector System and the Telelight System which will both be covered under separate headings.

ENGINE FIRE AND OVERHEAT DETECTOR SYSTEM

131 Each engine has two separate heat detection systems, one forward of the fireseal for fire detection and the other aft of of the fireseal for overheat detection. Both systems cover their respective area with heat sensitive continuous sensing elements. Both systems utilize a common, red, warning light. The forward system causes the warning light to burn steadily – the aft system causes it to flash. The warning lights for both engines are located together on the mid-upper right-hand side of the pilot's instrument panel; the left

Figure 1-11 Lighting Panel Front Cockpit

one, marked L, is for the left engine – the right one, marked R, is for the right engine. The systems require 115 volt AC, the indicator light 28 and 10 volt AC, and the test circuits 28 volt DC.

132 A three-position switch, located just below the fire warning lights, serves to test the operation of both systems. Since the test circuit establishes the same condition as the actuation of a detector, the system is tested – not just the warning light. Pressing the test switch to the spring-loaded FIRE ENG COMPT steady (UP) position causes both warning lights to burn steady – pressing the switch to the spring-loaded OVERHEAT BURNER FLASHING (DOWN) position causes both lights to flash.

TELELIGHT SYSTEM

133 A telelight panel on the pilot's right-hand vertical sub-panel provides an easily read warning of twelve different malfunctions. The illumination of a telelight strip also activates a large, amber, Master Caution light located on the upper right-hand corner of the instrument panel. The master caution light is merely installed to draw attention to the telelight panel and can be cancelled out by pressing the answer button immediately below the telelight panel, however, immediately another strip illuminates the Master Caution will again come on. Cancelling out the master caution light does not extinguish the telelight strip except in the case of the AUX TANK EMPTY strip. In all other cases the fault must be rectified before the strip will go out. Both the telelight panel and the Master Caution light are on the dimmer circuit and utilize 28 volt and 10 volt AC.

NOTE

Fuses for the 10 volt AC, 28 volt AC and 28 volt DC circuits and a spare fuse are located on a box to the left rear of the pilots seat. If warning lights malfunction check these fuses.

PITOT/STATIC, CENTRAL AIR DATA COMPUTOR AND CENTRAL VERTICAL GYRO SYSTEMS

PITOT/STATIC SYSTEM

134 The pitot/static system supplies the pitot and static pressure necessary to operate various flight instruments and system components. Pitot pressure serves the flight instruments, EPR transmitters, CADC, Mach Scheduling units, and the 290 knot switch which retracts the flaps and selects heavy/light feel for the rudders. Static pressure from the pitot boom serves the flight instruments, CADC, Mach Scheduling units, and the 290 knot switch. Static pressure obtained from the two flush-mounted ports on the bottom forward end of the aircraft nose section serves the cabin safety valve and the cabin pressure regulator. Pitot/Static anti/de-icing is supplied by a 115 volt AC heating element which is controlled by the pilot by a switch on his heat and vent panel. The same switch operates heating elements in the angle of attack vanes.

CENTRAL AIR DATA COMPUTOR

135 The Central Air Data Computor (CADC) converts information from ambient air into usable information for the Autopilot (AFCS), True Airspeed (TAS) meters, and the Radar (MG-13) and Fire Control system. The CADC collects pitot and static pressure from the pitot boom, air temperature from a probe under the aircraft nose section, and angle of attack from a vane on the starboard side of the fuselage, just below the pilot, and inserts all this information into a unit comprised of a compensator, a computor, and a converter. The CADC then converts the information into true angle of attack, mach, mach error, TAS, true altitude and altitude error and supplies this data to the user systems.

CENTRAL VERTICAL GYRO

136 The Central Vertical Gyro (CVG) is installed in the aircraft to give indication of the aircraft's attitude about the pitch and roll axes to the compass system (AJN-3), AFCS, and the MG-13. The CVG is located near the center of the fuselage and its output information is remoted to the user systems. When power is initially applied to the gyro, the gyro RPM builds and a solenoid operated pin comes out and strikes a cam on the gyro gimbal, producing erection torque and causing the gyro to "flip" over onto a stop pin. When the gyro is completely erected the solenoid operated pin is withdrawn allowing the gyro free movement. This type of erection cycle will occur any time the power source is interrupted. Normal erection is continuous and is accomplished by electric torque motors which are controlled by mercury switches. The mercury switches operate similar to the bubble of a spirit level and cause the gyro to be aligned to gravity vertical. A faster than normal erection may be accomplished by pushing in the radar adjust knob on the pilot's pedestal for as long as you wish the fast erect. This type of erection will not normally correct gross CVG errors as it merely doubles the voltage to the torque motors used for normal erection. The CVG requires both 115 volt 3 phase AC and 28 volt DC power.

CAUTION

When any type of quick erection cycle is being used it is vitally important to keep movement about all three axes at an absolute minimum. Excessive movement can sometimes prevent correct erection.

FLIGHT INSTRUMENTS

ALTIMETER

137 Both cockpits are equipped with a conventional sensitive altimeter mounted on the instrument panel. This instrument utilizes static pressure and provides the pilot and navigator with a constant indication of barometric altitude. Three pointers on the face of the instrument move over a scale graduated in 20-foot increments, with major divisions every hundred feet from zero to one thousand feet. The large pointer indicates hundreds of feet and makes one revolution for each 1000 feet of altitude. An intermediate pointer indicates thousands of feet and makes one revolution for each 10,000 feet of altitude. An additional small pointer indicating tens of thousands of feet is painted on a black disc with an extension line terminating in a triangular

section. The pointers and barometric scale can be set manually by turning the knob in the lower left-hand corner of the instrument. A striped warning indicator is also provided to prevent the pilot from misinterpreting the altimeter reading. Above 16,000 feet the striped area is covered; below that altitude however, the striped area is visible indicating to the pilot he is flying at or below 16,000 feet. The altimeter is subject to extremely large position errors when the aircraft is operating in the high sub-sonic mach number region. For position error data see Part 4.

VERTICAL SPEED INDICATOR

138 A conventional Vertical Speed Indicator (VSI), with a scale for 0 to 6000 feet per minute climb or descent, is installed on the pilot's instrument panel. The VSI utilizes static pressure only.

AIRSPEED/MACH INDICATOR

139 The airspeed indicator provides indicated airspeed (IAS), mach number, and maximum equivalent airspeed information. The airspeed and mach pointer is fixed to a rotating plate. The pointer indicates IAS between 0 and 250 KIAS, IAS and mach between 250 and 850 KIAS, and mach only above 850 KIAS. The mach scale rotates under the airspeed pointer plate and is visible through a cut-out window in the plate. The scale has a range from .5 to 2.2 mach and rotates with altitude so that the indicating pointer will show the mach number equal to the indicated airspeed for that particular flight altitude. A movable red and black limiting hand automatically shows the maximum allowable airspeed for an aircraft in the clean configuration. Changes in air density cause this hand to move giving the limiting airspeed at any altitude. The indicator is red lined at 500 KIAS as a guide for limiting IAS in a tanked aircraft. An index marker is included for referencing any desired IAS. The set knob for the marker is located on the bottom right-hand corner of the instrument.

TRUE AIRSPEED INDICATOR

140 Both cockpits are provided with a True Airspeed (TAS) indicator. TAS is displayed in four digits through a window on the indicator face. The indicator receives the TAS information from the CADC. It is powered by 115 volt AC.

ATTITUDE INDICATOR

141 An Attitude Indicator is installed on the pilot's instrument panel to give him visual indications of the aircraft's attitude about the pitch and roll axes. The attitude indicator receives its operating signals from a displacement gyro and a rate switching gyro which are located elsewhere in the aircraft. The system utilizes 115 volt AC power.

142 Changes in aircraft attitude are electrically relayed from control units to the indicator causing displacement of the indicator sphere in relation to a fixed miniature aircraft. The amount of displacement is directly proportional to the actual aircraft attitude deviation from level flight. The indicators are unlimited in roll, but will indicate pitch only up to 85 degrees in a climb or dive. Beyond 85 degree controlled precession "flips" the sphere 180 degrees in roll. Horizontal markings 5 degrees apart show accurate aircraft attitudes during climbs or dives. A horizon adjust knob is provided on the indicator for the pilot to center the horizontal bar in relation to the fixed miniature aircraft.

143 The instrument is reliable and subject to few errors. Acceleration and deceleration cause very slight pitch errors but these errors are quickly eliminated by the erection circuit when the "G" force terminates. The erection circuit automatically erects the gyros when power is initially applied. A warning flag, in the lower left corner of the indicator face, then retracts indicating erection is complete (the cycle takes about one minute). Complete failure of AC power will cause the warning flag to re-appear.

CAUTION

The Attitude Warning Flag does not indicate instrument accuracy. It only indicates that the attitude indicator is not receiving power. The absence of the flag does not necessarily mean that the attitude indicator is displaying correct information (since the flag does not indicate mechanical malfunctions). Therefore, during flight, attitude indications given by the indicator should be checked against other flight instruments, such as the directional indicator, the turn-and-slip indicator, the vertical speed indicator, and the radar horizon.

TURN AND SLIP INDICATOR

144 This conventional indicator on the instrument panel operates on 28 volt DC power and does not exhibit any noticeable error during entries into turns.

ACCELEROMETER

145 A three pointer accelerometer is located on the main instrument panel and indicates flight loads on the aircraft from -2 to 8 "G"'s. In addition to a conventional indicating pointer, this instrument incorporates two recording pointers (one for positive "G" loads and one for negative "G" loads). These recording pointers remain at the maximum travel positions reached by the indicating pointer, thereby giving a record of maximum "G" loads encountered. The recording pointers can be reset to the normal (1 "G") position by depressing the knob on the lower corner of the instrument. The accelerometer is a self-contained unit and therefore requires no external power.

PITCH BOUNDARY INDICATOR

146 During flight the Pitch Boundary Indicator (PBI) continuously measures the aircraft wing angle of attack and the horn and pusher boundaries in units of alpha. Wing angle of attack is shown by the alpha W needle while horn and pusher boundaries are displayed by the striped rectangular needle. When accurately calibrated, this instrument continuously shows the difference between current wing angle of attack and that angle of attack where the horn and pusher will be encountered. Thus, the pilot can use this instrument during high "G" symmetrical maneuvers to obtain the maximum maneuverability without encountering the horn and pusher. The PBI is powered by 28 volt DC and 28 volt, 400 cycle AC. The mechanical workings of the PBI will be discussed more fully under Pitch Control System. If the PCS horn switch is OFF the instrument is inoperative.

COMPASS INDICATOR

147 Both cockpits are equipped with Compass Indicators which receive remote information from the AJN-3 compass system located within the fuselage. The indicator has a 360° compass card which rotates under a lubber line located at the top. The indicator has two needles, center mounted, number one for the ADF function and number two for the Tacan. There is a DME read out in the center of the face and on the dial edge there is a round indicator/marker which is controlled by the set index knob on the bottom right of the indicator and which is used by the AFCS in the Heading Pre-Select mode. The AJN-3 compass system, the Tacan, and the ADF will be covered more fully under Navigation Systems. The AFCS will be covered fully under that heading.

STANDBY COMPASS

148 A conventional B-25 Standby Compass, located on the canopy arch above the pilot's instrument panel, provides direction for navigation in event of instrument or electrical malfunction. A compass correction card is located on the canopy rail.

CLOCK

149 Two clocks are installed in the aircraft, one in the front and the other in the rear cockpit. The clock is a precision timepiece and must be handled accordingly. It incorporates four hands: hour, minute, totalizer, and sweep second that move over the face of the dial. The clock is wound by a knob, which when pulled out, is used to set the hour and minute hands. The clock also incorporates an elapsed time mechanism having a

sweep second hand and a minute totalizer. The minute totalizer hand records the number of revolutions, indicating from 0 to 60 minutes, made by the sweep second hand. The mechanism is controlled by a knob located in the top right hand corner of the instrument. The knob controls the start, stop and return to 0 of both pointers by successive depressions. The 0 position is considered to be the 12 hour graduation on the dial. When properly wound the clock should operate continuously for 8 days.

NAVIGATION SYSTEMS

AJN-3 COMPASS SYSTEM

150 The AJN-3 compass system supplies heading information to the compass indicators, the tacan, the CDI, and to specific areas in the AFCS and FCS systems. It is a complicated and yet accurate system which can be used as a magnetic compass or a directional gyro. The system consists of a flux valve, a servo amplifier, a gyro package, and a control panel.

151 When the system is operating in the magnetic mode, the earth's magnetic field is picked up by a flux valve located high in the vertical stabilator, and is converted into an electrical vector. This vector is passed into the servo amplifier where it is fed into several transformers and transmitters which must align to the vector perfectly before error signals are nulled out. Heading information is passed from the servo amplifier directly to the compass indicators, the AFCS heading select wheel, and the M-1 amplifier. The M-1 amplifier boosts the signal power to supply all other user components. A gyro is installed in the system to add stability, once the system has nulled out all error signals between heading transmitters and flux valve the system is locked to the gyro. Any subsequent error signals are nulled out by electrically precessing the gyro. Any error signal between the flux valve and the heading transmitters may be seen by needle deflection in the annunciator on the compass control panel (right-hand pilot's console). Gross errors shown on the annunciator may be quickly taken out by use of the synchronization knob also located on the compass control panel. This knob, when activated either way, effectively unlocks the system from the gyro and slews the heading transmitters towards synchronization with the flux valve. When the annunciator shows zero error, the synchronization knob should be released, the gyro is again locked into the system and continuous synchronization is continued by automatically controlled gyro precession. The reason there are two synchronization methods is speed. The gyro can only be precessed at a rate of 1 to 2 degrees per minute, whereas, with the gyro unlocked from the system any error may be manually or automatically synchronized within 15 seconds. For the sake of terminology, synchronization by gyro precession may be known as normal slave, and the other method may be known as automatic/manual fast slave. Upon initial powering of the system, a timer relay holds the system in automatic fast slave for 15 seconds. Thereafter, automatic fast slave can only be achieved by interrupting electrical power or by moving the function selector switch from MAG to DG to MAG. Manual fast slave may be achieved any time by use of the synchronization knob.

Figure 1-12 Compass Indicator Control Panel

152 When the system is operating in the directional gyro mode, the flux valve does not have any inputs into the system. The heading transmitters may be slewed to any desired heading by the synchronization knob, and when the knob is released, the system locks to the gyro and further heading indication is derived from gyro movement. Apparent precession due to earth's movement is compensated for by inducing a controlled rate of gyro precession. The direction of the induced precession is controlled by the hemisphere screw (marked north and south) and the magnitude of the induced precession is controlled by the latitude knob; both controls are located on the compass control panel. There is no automatic synchronization in this mode.

153 The compass system is equipped with roll stabilization which provides for correct heading information, at any attitude, during 360° of roll, or during a turn. To do this, the directional gyro is mounted within a gimbal which allows the gyro to remain vertical through a 360° movement of the aircraft in the rolling plane. The gyro maintains the vertical by inputs from the central vertical gyro. If the roll stabilization is turned off a solenoid operated pin engages an eccentric ring on the compass gyro which centers and locks the

gimbal ring in the rolling plane. At any time the yaw rate gyro in the AFCS senses a turn in excess of .5 degrees per second, it sends a signal to the compass system which interrupts flux valve input, cuts out normal slave, and interrupts the "Gyro Comp. Align. Ind." light circuit. This light (normally called the "roll stab" light) indicates roll stabilization malfunction in that there is a misalignment in excess of 5 degrees between the roll gimbal and the gyro case. The light and the roll stab switch are located on a panel just aft of the compass control panel.

STANDBY COMPASS

154 A standby magnetic compass is installed on the pilot's canopy arch above the instrument panel. It consists of a drum type indicator in a fluid filled case. Read-out is through a glass window in the side with a lubber line etched on it. Compass adjustment is achieved by turning adjustment screws located just above the indicator face.

TACAN

155 The aircraft is fitted with an AN/ARN-21 Tacan set. Two standard control panels are installed, one on the pilot's right-hand console and one on the navigator's left-hand console. The control panels work in conjunction with Nav Control Shift panels which have a switch to either give or take control between cockpits and have a light to indicate which cockpit has control. The control panel has three controls mounted on it: a power switch, a channel selector knob, and a volume knob. The power switch has three positions: OFF, REC, and T/R. In the OFF position power to the set is shut off. In the REC position no pulse signals are transmitted so no range information is received. Bearing data only is received and is displayed on both compass indicators by use of number 2 needle. In the T/R position pulse signals are transmitted and both bearing and range information is received and displayed. The range information is displayed by DME drums in both compass indicators. The channel selector is able to select from channel 00 to channel 129, however, only channels 01 to 126 are operative. The volume knob adjusts the volume of the Tacan station identification signal which is then received through the intercom system. The set uses 115 volt AC and 28 volt DC power. An altitude switch automatically cuts off power to the set above 50,000 feet to prevent damage due to arcing.

CAUTION

Tacan is subject to errors in multiples of 40 degrees. These errors normally last less than a minute and should correct themselves if the pilot maintains heading.

INSTRUMENT LANDING SYSTEM

156 The aircraft is equipped with an AN/ARN-31 Instrument Landing System (ILS). The glide-slope and localizer receiver system provides visual guidance signals to the pilot during instrument approaches and landings. The system is composed of two receivers and displays the guidance signals on the CDI. The localizer receiver frequencies are spaced 0.2 mc apart from 108.1 mc through 111.9 mc and are selected on the ILS control panel. This receiver provides azimuth information during an instrument landing. The glide slope receiver frequencies are spaced 0.3 mc apart from 329.2 mc through 335.0 mc. The ILS frequency is selected by the frequency selector knob located on the ILS control panel. The knob is rotated until the desired localizer frequency appears in the indicator window. The glide slope receiver is automatically tuned upon selection of a localizer frequency. The knob may be rotated in either direction. A two-position switch on the ILS control panel turns the system ON or OFF. The system uses 115 volt AC and 28 volt DC power. A volume control on the control panel adjusts the volume of the ILS identification signals which then is received through the intercom system.

COURSE DEVIATION INDICATOR

157 A Course Deviation Indicator (CDI) is installed on the pilot's instrument panel to provide a display of Tacan or ILS information. The function of the CDI is determined by the position of the two-position Tacan/ ILS switch located on the pilot's center pedestal. On the face of the indicator appears a course selector knob, a course window, a TO-FROM window, a course deviation indicator (CDI), a glide slope indicator (GSI), a relative heading pointer, and a marker beacon light. The magnetic course to be flown in reference to the selected TACAN station is set in the course window by the course selector knob. The center dot represents the position of the aircraft in relation to the desired course, represented by the CDI. The CDI shows direction of deviation from the course set into the indicator. Each dot deflection represents 5° that the aircraft is off course. When the ILS-TACAN switch is in the ILS position, the CDI will indicate the location of the center of the localizer beam in relation to the aircraft. The GSI indicates the position of the glide slope in relation to the aircraft. A red warning flag appears at the end of each indicator if unreliable signals are being received, or when the ILS and TACAN are OFF.

158 The marker beacon receiver provides information of the aircraft's location by producing a signal as the aircraft flies through the signal cone of a 75 megacycle AM transmitter. The signal produced causes a relay to close which allows 28 volt DC power to illuminate the amber light on the CDI. The marker beacon receiver is energized when the 28 volt DC bus is energized. No controls are provided.

AUTOMATIC DIRECTION FINDING

159 With the UHF radio in the ADF mode the number 1 needle on the compass indicator will give magnetic bearing to any transmitter operating on the frequency selected. This mode could be used for homing or anti-ECM. This mode will be more fully explained under Radio Systems.

IFF/SIF

160 The IFF radar identification set provides automatic selective identification of the aircraft in which it is installed when properly challenged by surface or airborne radar sets. The system has provisions to identify a specific friendly aircraft within a group of friendly aircraft in which the equipment is installed. Supplementary purposes are to provide momentary identification of position upon request and to transmit a specially coded response to indicate an emergency. In operation the SIF/IFF receives coded interrogation signals and transmits coded responsive coded responsive signals to the source of the challenge, where this response is displayed, together with associated radar information (target, etc.) on the radar scope. Proper reply indicates the target is friendly. Three modes of operation are provided for interrogation or response to interrogation signals. These are known as mode 1, mode 2, and mode 3, which are used for security identification, personal identification and traffic identification respectively. The radar identification set utilizes 115 volt AC and 28 volt DC electrical power.

161 Two control panels marked SIF and IFF on the navigator's right-hand console contain the system master switch, two mode switches, two code selector switches and an I/P switch. The five-position master switch has positions marked OFF, STDBY, LOW, NORM, and EMERGENCY. In the STDBY position the system is inoperative but ready for instant use. In the LOW position the system operates in partial power and replies only in the presence of strong interrogations. In the NORM position the system operates in full sensitivity which provides maximum performance. In the EMERGENCY position the system replies to all modes of interrogation with a special coded signal to indicate an emergency. The mode 2 switch,

marked MODE 2 and OUT, is used by the pilot for personal identification. The mode 3 switch, marked MODE 3 and OUT, is used by the pilot for traffic identification. The identification of position (I/P) switch, marked I/P, OUT and MIC, is utilized by the pilot upon request, to provide 30 seconds identification of position when flicked to the I/P position. When placed in the MIC position, the identification of position signals are transmitted while the microphone button is held depressed and 30 seconds after released. Two rotary code selector switches are used to select the specified code signals to be used in Mode 1 or Mode 3 operation. The specified coded signals to be used in Mode 2 are present on the ground and cannot be changed in flight.

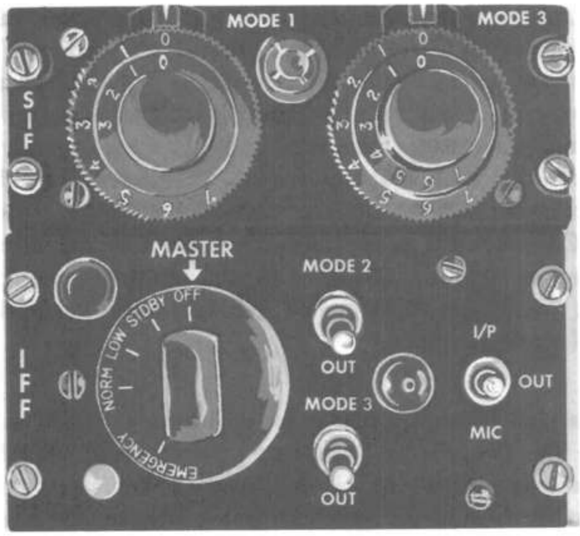


Figure 1-13 IFF/SIF Control Panel

PITCH CONTROL SYSTEM

GENERAL

162 The Pitch Control System (PCS) provides the pilot with an audible, physical, and visual warning of impending pitch-up flight conditions. A dual channel control box senses the approach of these flight conditions and sends signals to the warning devices; one channel operates the horn (audible) and the pitch boundary indicator (BI) (visual), and the other channel operates the pusher (physical). Each channel of the dual channel control box receives pitot/static pressure ratio, wing angle of attack, and stabilator rate information by its own mach scheduler, angle of attack vane, and stabilator rate sensor. This information allows the system to compute pitch-up, pusher, and horn curves at any mach, altitude, and all up weight. When aircraft wing angle of attack reaches the horn or pusher curves the appropriate control channel will trigger that warning system. If the stabilator rate sensor senses a control stick rate of travel in excess of 6° per second it will cause the control box to activate the horn and pusher earlier than normal. This feature prevents the pilot rotating the aircraft so rapidly that inertia will carry it through the horn and pusher into pitch-up area. The PCS angle of attack vanes are located on both sides of the aircraft nose section – the right vane supplies information to the horn and PBI channel and the left vane supplies information to the pusher channel.

CONTROLS AND SYSTEM WARNING DEVICES

163 Controls for the PCS system consist of a control panel and the control stick paddle switch; the system warning device is a telelight strip marked PITCH INHIBITOR OUT. The control panel is on the pilot's left-hand console and consists of two guarded, two-position switches and a test button. The horn switch, marked ON and OFF, provides for the control of 115 volt AC and 28 volt DC power to the horn and PBI. Barring malfunction in the system the horn switch should be in the ON position with the switch guard witness wired. The pusher switch, marked ON and OFF, provides for control of 115 volt AC and 28 volt DC power to the pusher. The control stick paddle switch cuts out electrical power to the pusher system when held depressed; the system reverts to normal when the switch is released.

164 The telelight PITCH INHIBITOR OUT strip will illuminate if: there is a power failure within the PCS system, either the horn or the pusher switch is in the OFF position, the comparitor which samples the output of the two mach schedulers detects a 15% output difference, the paddle switch is depressed, or the utility hydraulic pressure falls below 950 PSI ± 50 PSI.

165 The test button on the control panel provides for ground test of the horn and pusher systems. With the horn and pusher angle of attack vanes in the full up position, the horn and pusher switches on, the control stick full aft, and electrical and utility hydraulic power supplied to the aircraft – pressing the test button activates the horn and pusher systems.

PUSHER

166 The Pusher is the last warning device before aircraft pitch-up. When activated it allows hydraulic pressure to position the stabilator nose up, the control stick forward, and the aircraft nose down thereby reducing wing angle of attack to safe limits. The minimum stabilator travel for each pusher engagement is 2 1/2° in the clean configuration and 3 1/2° with speed brakes out. The pusher is deactivated if either the landing gear or flaps are down – although power is cut to the pusher in this case the PITCH INHIBITOR OUT light will not illuminate. There is a 1/2 second delay between pusher engagements. The pusher may be overpowered by a stick force not exceeding 27 1/2 pounds – 25 pounds ± 2 1/2. The pusher system may be deactivated by holding the paddle switch depressed, turning the pusher switch OFF, or lowering the the landing gear or flaps.

HORN

167 The horn provides an audible warning at slightly less angle of attack than that required to activate the pusher. When activated the audio signal reaches the pilot and navigator headsets through the mixer

amplifiers of their respective intercom sets. With either landing gear or flaps down the stabilator rate sensor input is cut out and the horn sounds at the actual horn curve valve irrespective of rotation rate. The horn system may be deactivated by turning the horn switch OFF only – it must be remembered that this switch also turns the PBI off.

PITCH BOUNDARY INDICATOR

168 The PBI provides the pilot with a continuous reference to horn and pusher boundaries and actual wing angle of attack measured in units of alpha – a synthetic value rather than actual degrees. The PBI receives its power and information through the horn system and may be deactivated by turning the horn switch OFF.

PITCH CONTROL SYSTEM LIMITATIONS

169 During "G" rolls and/or snap rolls, the local airflow at the PCS vanes may not be representative of the total airflow affecting the aircraft aerodynamically. As a result, warning systems actuation may occur too late to prevent the aircraft exceeding the critical angle of attack.

170 During high angle climbs with airspeed decreasing, the PCS system may not actuate early enough to make normal recovery to level flight. Since "G" loading (angle of attack) determines warning system trigger points, the decreased "G" in a stabalized steep climb will allow lower airspeeds to be reached before the systems actuate.

AUTOMATIC FLIGHT CONTROL SYSTEM

GENERAL

171 The Automatic Flight Control System (AFCS) is an auto pilot designed to reduce pilot fatigue, assist the pilot in the intercept role, and aid the pilot during ILS approaches. Information required for the AFCS to operate is supplied mainly by the CADC, however, it also receives inputs from various other components located throughout the aircraft. The AFCS has its own gyro package which measures the rate of movement about the pitch, roll, and yaw axes. The system requires 115 volt three-phase AC and 28 volt DC power and is ready to operate approximately one and one half minutes after this power is applied. The CVG must be erected before the AFCS is able to operate. When playing out its role the AFCS actually moves the control surfaces, however, this movement is not reflected by control stick movement except in the case of the stabilator.

172 The AFCS control panel is located on the pilot's left-hand console. Three two-position toggle switches for yaw damper, snap-up, and AFCS engage are located left to right on the forward end of the panel. Two three-position rotary switches for mach/altitude hold and attack/beam are located left and right on the aft end. In the middle of the aft end of the panel is a knurled rotary heading select wheel. All the switches are spring-loaded, held into their engaged positions by solenoids and when power to them is interrupted, by design or by malfunction, they return to NORMAL or STAND-BY.

YAW DAMPER

173 The Yaw Damper is designed to increase stability about the yaw axis. To do this it receives inputs from the AFCS roll rate and yaw rate gyros, and from transmitters on each aileron jack. During straight and level flight the yaw rate gyro causes the rudder to move to zero out any yaw deviations from a set attitude. This attitude is initially the fore and aft axis of the aircraft, however, if the yaw damper is disengaged, the rudder manually trimmed, and the yaw damper re-engaged – the yaw damper will zero out yaw deviations from the new attitude set by the trim.

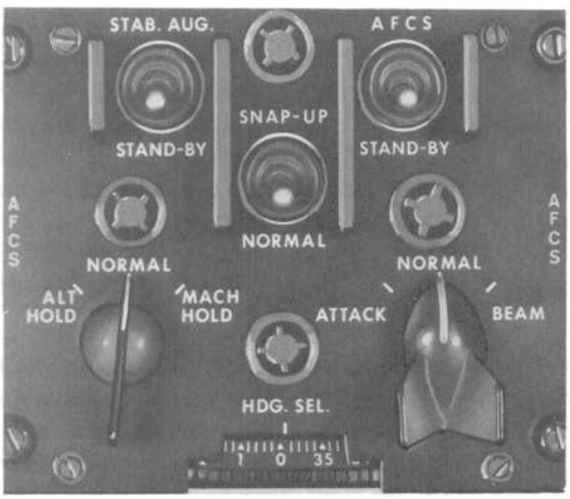


Figure 1-14 Automatic Flight Control Panel

CAUTION

If the yaw damper is not disengaged when manual trim is attempted, the set attitude of the damper is not changed resulting in manual trim and yaw damper working at cross-purposes.

174 During turns, transmitters on the ailerons detect the amount of aileron deflection and warn the yaw damper of impending induced yaw. The yaw damper then deflects the rudder in anticipation, and allows the roll rate gyro and yaw rate gyros to damp out the small errors.

175 The yaw damper is in operation any time the AFCS is engaged, irrespective of yaw damper switch position. When the AFCS is in stand-by the yaw damper may be selected independently. When the yaw damper switch is in the DAMPER or STAB AUG position the system may be disengaged by: returning the switch to STAND-BY, pulling the AFCS circuit breaker, or by depressing the paddle switch on the control stick. The paddle switch will disengage the yaw damper for as long as it is held depressed – the damper switch does not go to STAND-BY and the system re-engages when the paddle switch is released.

BASIC AFCS MODES

176 The AFCS may be engaged when the aircraft is in any attitude by moving the engage switch from STAND-BY to the AFCS position. If the pitch angle is less than ±58° the AFCS will hold the existing pitch attitude. If the bank angle is between 7 1/2° and 65° the AFCS will hold the existing bank angle. This is called the Attitude Hold mode. If the bank angle is less than 7 1/2° the AFCS will level the wings and maintain heading. This is the Heading Hold mode. If the pitch angle and bank angle exceed 58° and 65° respectively the AFCS will supply damping only in the roll and pitch planes. Irrespective of which of these modes the AFCS is in, the pilot has Control Stick Steering (CSS) available. CSS allows the pilot to change the pitch and bank angles by conventional control stick movement. When the pilot releases the control stick the AFCS reverts to whichever mode of operation the selected pitch and bank angles allow. Control Stick Steering stick forces are 2 pounds in excess of normal. The AFCS may be disengaged by moving the engage switch to STAND-BY, by pulling the circuit breaker, or by depressing the paddle switch. In the last case the AFCS switch goes to STAND-BY. This paragraph outlines the basic operation of the AFCS: subsequent paragraphs will outline what deviations from this mode of operation are available.

ALTITUDE/MACH HOLD

177 With the AFCS engaged and the altitude/mach hold switch in the ALT HOLD position, pitch CSS is denied the pilot and the AFCS will maintain the altitude at which the Altitude Hold mode was engaged. All the basic modes in the rolling plane are available. With the AFCS engaged and the altitude/mach hold switch in the MACH HOLD position, pitch CSS is denied the pilot and the AFCS will maintain the speed at which Mach Hold was selected by varying the altitude. All the basic modes in the rolling plane are available. The altitude/mach hold switch may be disengaged by moving the switch to NORMAL, disengaging the AFCS, or pulling the circuit breaker.

178 Neither Altitude nor Mach Hold may be engaged if the aircraft is outside the 58° pitch and 65° bank limitation. If the aircraft is flown past neither of these limits after mach or altitude has been engaged they will disengage automatically. To overpower either the mach or altitude hold modes requires 30 pounds forward or 60 pounds aft stick force.

HEADING SELECT/PRE-SELECT

179 The Heading Select wheel on the AFCS control panel is normally synchronized to the AJN-3 compass indicator. If, however, the AFCS is engaged and the wheel is manually selected to a heading different to that of the compass, the AFCS will turn the aircraft by the shortest route to the selected heading and roll out. A 20° bank turn is used to accomplish this and when the roll out is completed the Heading Select mode drops out and the AFCS returns to the mode of operation it was in before. The Heading Select mode may be used in conjunction with pitch CSS, altitude hold, or mach hold. If roll CSS is attempted during the Heading Select mode the Heading Select mode is overpowered by the 2 pound stick force and the system reverts to normal.

180 The actions of the AFCS in the Heading Pre-Select mode are the same as for the Heading Select mode. however, the method of mode initiation is different. To use Heading Pre-Select the round indicator/marker on the AJN-3 compass indicator must be set on the desired heading – this arms the system. To initiate the turn pull the Index Set knob out; the aircraft will turn to the selected heading using 20° of bank and roll out. At this point the Index Set knob will return to normal and the mode disengages.

COUPLER

181 The AFCS may be coupled to the ILS system to aid in the instrument approach. To attain this mode of operation the ILS and CDI must be set up as though a manual run was to be performed, the AFCS must be engaged, the attack/beam switch must be selected to BEAM, and a localizer signal must be present. The pilot must set the aircraft up to intersect the localizer at a shallow angle or the AFCS may not be able to turn the aircraft within the localizer beam. Pitch CSS, Mach Hold, or Altitude Hold may be used. When the AFCS is coupled to the ILS it will follow the localizer beam in, using 20° of bank. When the glide slope is intercepted

it will overpower whatever pitch modes are in use and follow the glide in as well. Bank angles are reduced to 10° when the aircraft is on the glide slope. Since AFCS corrections get progressively more violent the closer it comes to the signal source, it is recommended that the coupler (AFCS) be disengaged 500 feet AGL. The coupler may be disengaged by selecting the attack/beam switch to normal, disengaging the AFCS, or pulling the AFCS circuit breaker.

182 The AFCS may be coupled to the Data-Link; this is called the Automatic Ground Controlled Intercept (AGCI) mode. To engage this mode the AFCS must be engaged, no radar lock on may be present, data link signals must be present, and the attack/beam switch must be selected to ATTACK. Any pitch mode may be used: pitch CSS, altitude hold, or mach hold. The coupler will steer the aircraft in azimuth, according to data-link signals, using 30° of bank subsonic and 45° of bank supersonic. The AGCI mode may be disengaged by turning the attack/beam switch to NORMAL, disengaging the AFCS, pulling AFCS circuit breaker, or losing data-link signals. Transition to the attack mode from the AGCI mode may be accomplished by merely achieving a radar lock on.

183 The AFCS may be coupled to the attack presentation on the pilot's scope to center the dot. It can be accomplished in two-ways, by transition from the AGCI mode as outlined in the preceeding paragraph, or it can be directly coupled. To couple directly the AFCS must be engaged, a radar lock on must exist, no collision, abort or fire signals may be present, and the attack/beam switch must be in the ATTACK position. The coupler will steer the aircraft to center the dot in azimuth and elevation using up to 70° of bank and maximum available "G". If the snap-up switch is in the SNAP-UP position the coupler will steer in azimuth only till weapon's "B" time. Prior to "B" time, pitch CSS, mach or attitude hold may be used, however. when "B" time occurs the snap-up switch drops to NORMAL and the coupler steers azimuth and elevation. The coupler will drop out and only basic AFCS will remain when Abort, Fire, or Collision warning signals are generated. During coupled VisIdent runs, the coupler should be disengaged at 600 yards due to violent coupler steering when close to signal source. The coupler may be overpowered in any coupled mode by the application of 30 pounds forward, 60 pounds aft, and 15 pounds lateral stick force.

AFCS LIMITER

184 The AFCS has a Command Signal Limiter (CSL) which limits the angle of attack and "G" loading to safe values. It is in operation when the AFCS is engaged only. When CSS is in use, the CSL limits the control stick movement; in any other mode it limits the control signals. The CSL limit curve is similar to the horn and pusher curves but is set at a shallower value. The curves are set, by use of the Limiter Panel on the pilot's left-hand console (on test flights only). The AFCS "G" limits are set at + 4 and - 1/2 "G". These "G" limits are over and above the CSL limiter. When the stick is moved aft at a very rapid rate the CSL will limit angle of attack early to prevent the aircraft overshooting, by inertia, into an unsafe flight region. The CSL may be overpowered by a 30 pound forward or 60 pound aft stick force. The AFCS will automatically disengage if by malfunction it accelerates the aircraft beyond + 4 1/2 and - 1 1/2 "G", or if the pusher is encountered. With aft stick forces greater than 28 pounds, this disengage feature is by-passed and the AFCS will not be automatically disengaged as long as this force is held even though the + 4 1/2 "G" point has been exceeded.

MANUAL COMMAND SIGNAL LIMITER

185 A Manual Command Signal Limiter (MCSL) is available to limit positive angles of attack during manual flight. The MCSL uses the same limiting curve and the same aft overpower force as the CSL but at that point the similarity ends. The MCSL limits aft stick movement only, it has no set "G" limits, it has no "G" disengage value, and it will disengage when the landing gear is selected down. A panel on the pilot's pedestal contains the MCSL switch and the MCSL OUT light. The light will illuminate when the MCSL switch is OFF or when there is a malfunction in the MCSL system. When the MCSL switch is in the ON position it is held there with a solenoid – the MCSL OUT light should go out. The MCSL may be disengaged by depressing the paddle switch, turning the MCSL switch to OFF, or by pulling the AFCS circuit breaker.

The paddle switch will only disengage the MCSL for as long as it is held depressed; the MCSL switch remains ON and the system is re-engaged when the paddle switch is released.

CAUTION

With the landing gear down the light will be on regardless of switch position.

RADIO SYSTEMS

INTERCOM SYSTEM

186 The AN/AIC-10 intercom system provides voice communication between cockpits for normal operations and between cockpit and ground during maintenance operations. Ground operation is available through an intercom jack in the nose wheel well. The system also amplifies the output of the UHF system and the warning horns from the Pitch Control system and the Landing Gear Warning system. Identical control panels are provided for the pilot and the navigator for the purpose of monitoring, individually or simultaneously, signals from: Intercom, Data Link, UHF, and Navigation Identification. The pilot's control panel is located on the left-hand console and the navigator's on the right-hand vertical sub-panel. Each control panel has five monitoring switches, a rotary selector knob, a volume control, and an auxiliary listen switch.

Figure 1-15 Intercom Control Panel

187 The rotary selector knob has three positions marked COMM, INTER, and CALL. The COMM position allows HOT MIC communications between cockpits and reception and transmission on UHF. The MIC button must be depressed for UHF transmission. The INTER position allows communication between cockpits and between cockpit and ground crew – in this mode the MIC button must be depressed to talk. The CALL position spring-loaded back to INTER, is provided to interrupt all other operations and permit urgent interphone communications.

188 The five monitoring switches are marked: INTER, DA-L/COMM, NAV, BCST, and ALT COMM. The INTER position is for interphone reception. The DA-L/COMM position is for UHF and Data Link voice reception. UHF audio reception will terminate whenever data-link voice signals are being received. The NAV position is for TACAN or ILS identification signal reception. The BCST position is inoperative. The ALT COMM position is for UHF reception when data-link voice signals are being received. Reception of the Pitch Control Horn is automatic in both cockpits and reception of the Landing Gear Warning Horn is automatic and received in the front cockpit alone. The volume control knob adjusts the audio volume for all signals received in that headset.

189 The Auxiliary Listen switch is a two-position switch marked NORM and AUX LISTEN and is witness-wired to the normal position. The NORM position allows for normal intercom operation. The AUX LISTEN position is used in the event of a mixer-amplifier failure. This allows incoming signals to bypass the intercom mixer-amplifier and reach the headsets at line (unamplified) level. In this mode the volume control is inoperative and only one monitoring channel at a time can be heard. Only one monitoring channel should be selected, however, if more than one is selected precedence will be given the channel on the left, i.e., INTER over DA-L/COMM, DA-L/COMM over NAV, etc. In this mode with the Rotary Selector knob in the CALL position, you may listen only; in the INTER position you have normal operation; in the COMM position you have hot MIC intercom, you may monitor any monitoring channel but you cannot transmit on UHF. The Auxiliary Listen switch affects only the cockpit in which it has been selected.

UHF COMMAND RADIO

190 The AN/ARC-34 UHF command radio provides two-way voice communication, in the frequency range of 225.0 to 399.9 megacycles between aircraft and ground stations or between aircraft. Any of 20 frequencies may be preset. In addition to the preset frequencies, a manual means of frequency selection is available. The set uses two receivers, a main receiver and a guard receiver. Two control panels are installed,

one on the pilot's left-hand console and one on the navigator's left-hand console. Each control panel has an associated Comm Control shift panel which provides a switch which may be used to either take or give radio control and a light which indicates which cockpit has control.

191 The functions of the set are selected by a four-position control switch on the right side of the control panel. The OFF position of this switch disconnects 28 volt DC power from the set. In the MAIN position, the transmitter and main receiver are operative on the selected frequency. The BOTH position allows transmission and reception on the selected channel as well as reception on guard channel. The ADF position provides automatic direction finding, as indicated by the number one needle on the compass indicator, by use of a flush mounted ADF antenna located under the forward fuselage. A tone button, next to the control switch, provides continuous tone transmission to aid ground stations in obtaining a direction finding bearing. A channel selector knob on the center of control panel is turned to select the desired preset channel. Above the channel selector knob is a window marked MANUAL, PRESET and GUARD. A slide pointer over the window may be positioned over any of these three positions. With the slide in MANUAL, the frequency must be manually selected by the use of the four selecting knobs at the top of the panel. In PRESET position, the frequency is obtained by merely turning the channel selector knob. The channels are numbered within the above mentioned window. The GUARD position selects the fixed guard frequency for the main receiver and transmitter. A card located on the right-hand side of the canopy frame, records the frequencies that have been preset and assigned the 20 channels. There is also a card on the control box on which these frequencies may be recorded. Audio volume is adjusted by a knob on the left side of the control panel. The audio volume for both cockpits is controlled by whichever cockpit has UHF control. Two MIC buttons are available in the front cockpit, one on the right throttle the other on the control stick – the middle red button. A MIC switch and a mute switch are available in the rear cockpit, both are mounted on the floor – the MIC switch on the left and the MUTE switch on the right. The MUTE switch cuts out all audio signals except interphone.

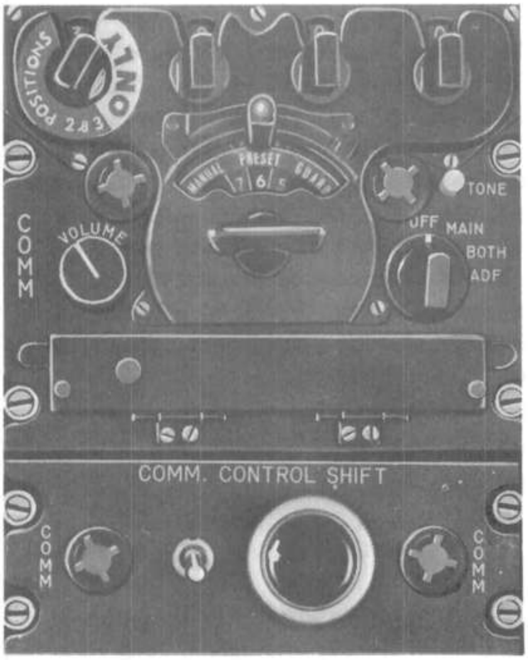


Figure 1-16 UHF Control Panel

192 A two-position antenna selector switch is mounted on the pilot's left-hand console. It has positions marked UPPER and LOWER, and allows the pilot to select the upper or lower UHF antenna for transmission and reception. Whenever ADF is selected, the upper antenna is connected to the UHF regardless of switch position.

193 A channel frequency indicator is installed on the pilot's instrument panel. The indicator provides three distinct features. When the control panel is set to MANUAL the indicator displays the frequency. When the PRESET position is selected, the indicator displays the channel number. When the GUARD position is selected the indicator displays GD.

DATA-LINK

194 For information concerning the Data-Link receiver refer to EO 05-185A-1A. Reference will be made to the data-link in the Handling and the Emergency Handling Parts of this publication, however, since data-link is classified no mention of how it operates is allowed.

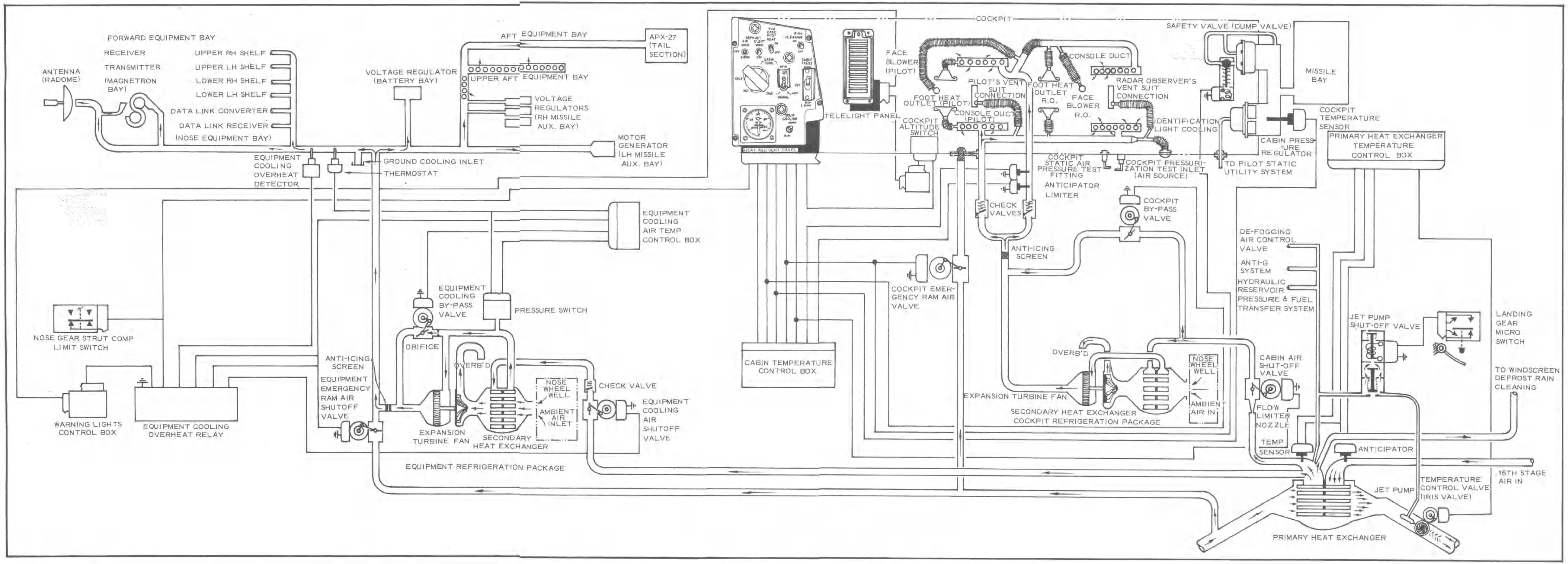


Figure 1-17 Heat and Pressurization System

HEAT, VENT, AIR CONDITIONING AND PRESSURIZATION SYSTEMS

GENERAL

195 The air conditioning and pressurization system consists of several components: a primary heat exchanger (PHE); two refrigeration packages; and various electrical controls, temperature and pressure sensing devices, and indicating units. When reading this section reference should be made to Figure 1-17 (Heat and Pressurization System).

PRIMARY HEAT EXCHANGER

196 The primary heat exchanger is located in the fuselage beside, and to the left of, the nose wheel bay. The PHE receives air from the diffuser casings (16th stage of compression) of both engines at temperatures as high as 600°F and at pressures as high as 167 PSI, reduces the temperature to between 190°F and 200°F, and ducts it to the refrigerator packages, hydraulic reservoirs, wing and external tanks, windscreen defrosters, rain clearing, anti-"G" systems, jet pump, and various other components. Cooling within the PHE is accomplished by directing ram air, from an external air scoop, through a radiator (containing the hot, engine air) then overboard. The volume of ram air flow through the PHE is controlled by a variable orifice valve (iris valve) which varies its opening to maintain the PHE air temperature between 190°F and 200°F. An anticipator in the incoming air line and a temperature sensor in the exit line provide the PHE temperature control with information for correct iris valve positioning. When the aircraft is on the ground or operating at very low airspeeds there is insufficient ram air for proper cooling in the PHE. This problem is overcome by ducting PHE air through a jet pump, located in the aft end of the PHE, which induces a ram air flow through the PHE radiator. This jet pump is in operation any time the left main gear is down and an engine is running.

COCKPIT AIR CONDITIONING

197 Air for cockpit air conditioning is a combination of PHE air at 190°F to 200°F and PHE which by ram air and expansion in the cockpit refrigeration package has been cooled to -40°F. The cockpit by-pass valve, by regulating the amount of PHE air to be mixed with the refrigeration package's output, controls the cockpit air temperature. Temperature controls are mounted on the heat and vent panel located on the forward end of the pilot's right-hand console. With the four-positioned cabin temperature switch in the AUTO (forward) position constant cabin air temperatures between 40°F and 100°F may be selected by use of the thermostat located beside the switch. In this case the cockpit by-pass valve is automatically positioned to deliver constant air temperatures. With the cabin temperature switch in the OFF (center) position the automatic system is deactivated and the pilot may open or close the cockpit by-pass valve by moving the switch into the spring-loaded HOT or COLD positions. Full travel of the by-pass valve takes 15 to 20 seconds and the temperature ranges available in this manual mode are approximately -40°F to 190°F.

198 Cockpit air is ducted around the cockpit through foot heaters, console ducts, and face blowers. The face blowers have 4 position push-pull valves varying from OFF (full in position) to FULL FLOW (full out position). Cockpit air is also ducted to the Ident light to cool it. Ducting and those connections are also available for pilot and nav pressure suits (this system is normally disconnected).

COCKPIT PRESSURIZATION

199 The cockpit pressurization system consists of five components: a three-position cabin pressure switch, an automatic cockpit altitude switch, a cabin pressure gauge, a cabin pressure regulator, and a safety (dump) valve. The cabin pressure switch is the only pressurization control available to the pilot and is located on the right-hand side of the heat and vent panel. With this switch in the NORM (forward) position the cabin pressure regulator controls the exhaust of air conditioning air to meet the pressure schedule diagrammed in Figure 1-18 (Cabin Pressure Schedule). By sensing the atmospheric pressure as compared to cockpit pressure, the cabin pressure regulator regulates cabin pressure at altitudes above 8000 feet. From 8000 feet to 23,000 feet the regulator maintains cockpit pressure at 8000 feet. Above 23,000 feet a 5 PSI differential is maintained. Cockpit altitude is displayed on the cabin pressure gauge located on the heat and

vent panel. If the cockpit altitude should ever reach 28,000 feet (4.76 PSI or less) the cockpit altitude switch will activate a telelight strip labeled LOW CABIN PRESSURE.

200 With the cabin pressure switch in the OFF (center) position the cabin air shut-off valve will close cutting off all PHE air to the cockpit air conditioning system and effectively sealing off all air to the cockpit with the exception of air from the air defrost system.

201 With the cabin pressure switch in the RAM & DUMP (aft) position the cabin air shut-off valve closes and the cockpit emergency ram air valve and the dump valve open. This cuts off all air conditioning air from the PHE and allows ram air, collected in the PHE intake, to circulate through the cockpit and exit through the dump valve.

202 The dump valve is also a safety valve which will vent excess cabin pressure if the cabin pressure regulator senses a pressure differential greater than 5.35 PSI. If atmospheric pressure should ever exceed cabin pressure the dump valve will open to equalize the pressures. Both the dump valve and the cabin pressure regulator exhaust cabin air into the armament bay to maintain, under normal conditions, a temperature of 0°F to 100°F in that area.

EQUIPMENT COOLING

203 Air for equipment cooling is a combination of air from the ram cooling stage and air from the ram and the expansion stages of the equipment refrigeration package. The equipment cooling by-pass valve in conjunction with an altitude switch ensure cooling air entering the equipment bays is 80°F below 16,000 feet and 35°F above 16,000 feet. This cooling schedule is in effect any time the equipment cooling switch on the heat and vent panel is in the NORM (forward) position. If this switch is placed in the RAM (aft) position the equipment cooling air shut-off valve closes and the equipment emergency ram air shut-off valve opens. This cuts off all air from the PHE and allows ambient, ram air to cool the equipment. Located in the cooling duct is an equipment cooling overheat detector. If this detector senses an air temperature of 140°F, or greater, it will signal the equipment cooling overheat relay which will trip sending the cooling system into the ram mode of operation and illuminating the EQUIP COOLING OUT strip in the telelight panel. To reset this relay and restore the system to normal the pilot must cycle the equipment cooling switch to RAM and back to NORM. Also located in the cooling duct is an equipment low flow sensor which measures the flow/temperature ratio of the air being delivered to the equipment bays. If this sensor detects an inadequate supply of cooling air and if the radar is selected STANDBY or ON the FCS OVERHEAT light on the navigator's instrument panel will illuminate.

CAUTION

Although not desirable the illumination of the FCS OVERHEAT light may be tolerated for 8 minutes if the tactical situation requires the radar ON or in STBY.

RAIN CLEARING

204 The rain clearing system is designed to prevent precipitation obliterating visibility through the front windscreen and left quarter panel. It is controlled by a two-position switch marked Rain Clearing on the heat and vent panel. With the switch OFF the system is deactivated. With the switch ON, air from the PHE extends nozzles in front of the windscreen and left quarter panel. Hot, high-velocity air from the PHE is then blown over these panels and prevents the majority of precipitation from contacting the windscreen. Springs retract these nozzles when the switch is returned to OFF. This system is automatically activated when the In-Flight Refueling switch is placed in the REFUEL position.

CAUTION

Do not activate the rain clearing system at speeds higher than 310 KIAS as wind pressure could damage the nozzles.

CAUTION

Do not operate the rain clearing system longer than necessary or when the engines are at high power settings when the aircraft is on the ground.

AIR DEFROST

205 The air defrost system is designed to prevent mist and frost forming on the windscreen, both quarter panels, and the forward part of the canopy. It is controlled by a three-position switch located on the heat and vent panel and marked Defrost Air. With the switch in the OFF (center) position the system is deactivated. With the switch in the NORM (forward) position air from the PHE is directed through ducts onto the inside of the windscreen and canopy. This air is regulated by a sensor on the left quarter panel and an air control valve to maintain an air temperature on the windscreen of 62°F to 68°F. A temperature limiter in the ducting will shut off all air flow if the air temperature should reach 216°F. With the defrost switch in the EMERG (aft) position unregulated PHE air is allowed to flow through the ducts and temperature is controlled only by the 216°F temperature limiter.

CAUTION

Do not operate the air defrost system in the EMERG mode longer than necessary as the resultant high temperatures could damage the windscreen and canopy plexiglass.

ELECTRICAL DEFROST

206 The electrical defrost is designed to prevent ice, frost, and mist forming on the center panel of the windscreen. It is controlled by a two-position switch, marked Defrost Elect, located on the heat and vent panel. With the switch in the OFF (aft) position the system is deactivated. With the switch in the ON (forward) position 115 volt AC power is applied to a heating element sandwiched between the layers of glass in the windscreen. This heating element covers the bottom 3/4 of the front panel only. The temperature is regulated to 62°F to 68°F by a sensor on the left-hand side.

PITOT HEAT

207 The pitot heat system is designed to prevent ice forming on and within the pitot head. It is controlled by a two-position switch located on the heat and vent panel and marked Pitot Heat. On either side of the switch is marked CADC and PCS. With the switch in the OFF (aft) position the system is deactivated. With the switch in the ON (forward) position 115 volt AC power is applied to heating elements in the pitot head and the angle of attack vanes for the CADC and PCS.

FACE HEAT

208 A helmet face-plate heater is provided for use with pressure or partial pressure suits. The rheostat controls are on the right-hand console of each cockpit and the electrical leads are located on the quick-disconnect block on the front of each ejection seat.

ANTI "G" SYSTEM

209 A system is provided for anti "G" suits. This system is deactivated in the Canadian aircraft, however, no components have been removed and the system can be re-activated at any time. The "G" suit connection is located on the quick-disconnect block on the front of each ejection seat.

HYDRAULIC RESERVOIR PRESSURIZATION

210 The hydraulic reservoirs are pressurized by air from the PHE to reduce fluid evaporation and boil-off at altitude, assist feed to hydraulic pumps, and to reduce foaming action. The PHE air pressure is reduced to 22 PSI at the reservoirs and if pressure builds within them to 24 PSI excess pressure is vented overboard.

WING AND EXTERNAL TANK TRANSFER PRESSURE

211 PHE air is ducted to the wind and external fuel tanks to pressurize the tanks and to transfer fuel. Whenever PHE air is available the wing cells are pressurized by air regulated to 12.6 PSI. To pressurize the external tanks the tank transfer switch, located on the pilot's fuel transfer panel, must be in the NORM (forward) position. The tanks are then pressurized by air regulated to 12.5 PSI.

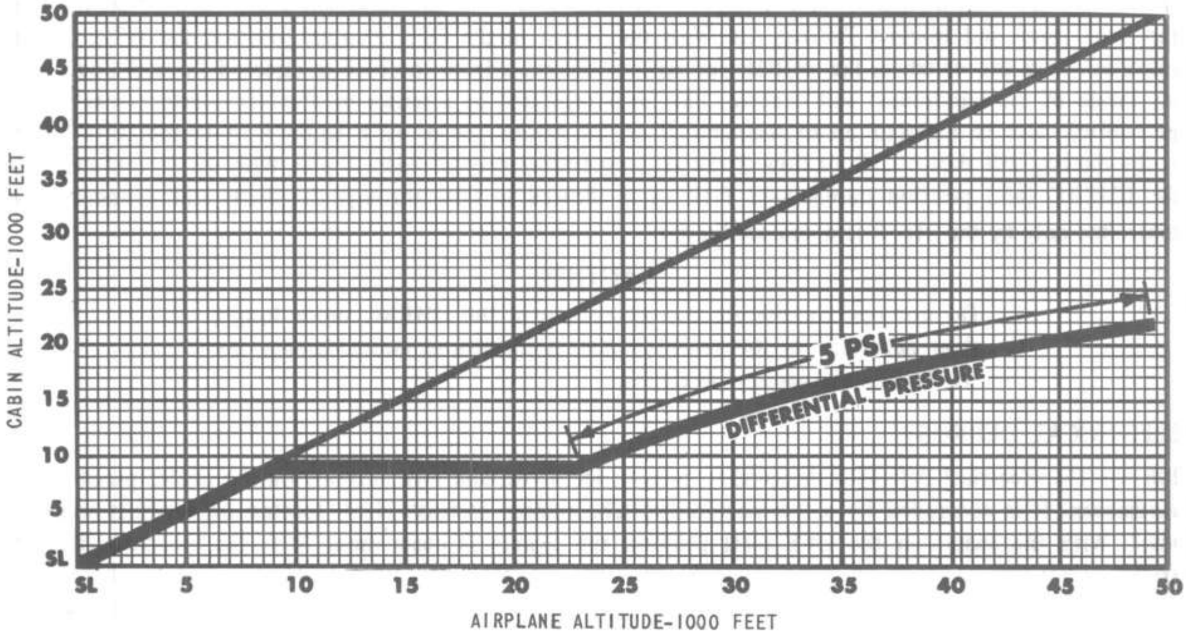


Figure 1-18 Cabin Pressure Schedule

SAFETY EQUIPMENT SYSTEMS

OXYGEN SYSTEM

212 A liquid oxygen (LOX) system is installed in the aircraft to produce breathable oxygen for crew use. The system consists of a converter, located in the left-hand forward fuselage area; two regulators, one in each cockpit; and the external controls and filler opening, located in a small door marked 253. The converter consists of a LOX supply tank, a build-up coil, an evaporator coil, and various pressure control valves. The supply tank is insulated, by the same principle as a thermos jug, and is capable of holding 10 litres of LOX.

OXYGEN DURATION - HOURS

CABIN ALTITUDE FEET	GAUGE QUANTITY - LITERS										BELOW
	10	9	8	7	6	5	4	3	2	1	1
40,000	19.4	17.4	15.5	13.5	11.6	9.7	7.7	5.8	3.9	1.9	EMERGENCY - DESCEND TO ALTITUDE NOT REQUIRING OXYGEN
and above	19.4	17.4	15.5	13.5	11.6	9.7	7.7	5.8	3.9	1.9	
35,000	13.9	12.4	11.1	9.7	8.3	6.9	5.5	4.2	2.8	1.4	
	13.9	12.4	11.1	9.7	8.3	6.9	5.5	4.2	2.8	1.4	
30,000	10.1	9.1	8.1	7.1	6.1	5.1	4.1	3.0	2.0	1.0	
	10.4	9.4	8.3	7.3	6.2	5.2	4.2	3.1	2.1	1.0	
25,000	7.8	7.0	6.2	5.4	4.7	3.9	3.1	2.3	1.5	.8	
	9.7	8.7	7.7	6.8	5.8	4.8	3.9	2.9	1.9	1.0	
20,000	6.0	5.4	4.8	4.2	3.6	3.0	2.4	1.8	1.2	.6	
	11.0	9.9	8.8	7.7	6.6	5.5	4.4	3.3	2.2	1.1	
15,000	4.8	4.3	3.8	3.3	2.9	2.4	1.9	1.4	.9	.5	
	11.4	10.3	9.1	8.0	6.8	5.7	4.5	3.4	2.3	1.1	
10,000	3.8	3.4	3.0	2.7	2.3	1.9	1.6	1.1	.8	.4	
	10.1	9.8	8.7	7.6	6.5	5.4	4.3	3.3	2.2	1.1	

UPPER FIGURES INDICATE DILUTER LEVER "100% OXYGEN"
LOWER FIGURES INDICATE DILUTER LEVER "NORMAL OXYGEN"
GAUGE PRESSURE CONSTANT 300 PSI
THE DURATION TIME IS DOUBLED WHEN ONLY ONE CREW MEMBER IS USING OXYGEN

Figure 1-19 Oxygen Duration Chart

The quantity is reflected on a gauge, on the pilot's right-hand console, marked from 0 to 10 litres and operated by 115 volt AC power. Two coils are wrapped around the supply tank, the build-up coil and the evaporator coil. The build-up coil takes a small amount of LOX from the bottom of the supply tank, evaporates it (in so doing building up pressure), and feeds the gaseous oxygen into the top of the supply tank thus pressurizing it. This pressure then forces LOX into the evaporator coil which evaporates and warms the LOX to the state where it becomes gaseous oxygen fit for human breathing. Pressure relief valves on both the build-up and evaporator coils prevent the build-up of excessive pressure within the system. A blow out patch on the LOX supply tank provides emergency relief in event that normal pressure relief should fail. A Build-Up and Vent Valve controls the pressure in the build-up coil. This valve is normally in the BUILD-UP position and the system operates as has been outlined. During refilling operations the valve is placed in the VENT position which vents the system to atmosphere. The system is then filled with LOX until it flows through the vent line. The filler cap is then secured and the valve placed to BUILD-UP. The build-up coil then operates normally and in 10 minutes the oxygen system should be ready for use.

213 Gaseous oxygen from the evaporator coil is piped to the two oxygen regulators, both identical, located on the pilot's and the navigator's right-hand consoles. From the regulators the oxygen is piped to the quick-disconnect block on the front of each ejection seat where it may be connected to the crews' oxygen masks. The regulators are the MD-1 type and consist of a blinker, pressure gauge, diluter lever, and emergency lever. The blinker is a white flag which shows in a small window during inhalation and disappears during exhalation. The pressure gauge reads from 0 to 500 PSI and should normally read between 300 and 360 PSI. The diluter lever is two-position; forward position marked 100% and aft position marked NORMAL. The NORMAL position allows the regulator to mix air and oxygen at a pre-selected schedule, dependent on cabin altitude, for delivery to the mask; the 100% position allows oxygen only to be delivered. The emergency lever is three positioned; the forward position marked EMERGENCY, the center (normal) position is unmarked, and the aft spring-loaded position marked TEST. The center position allows the regulator to follow its normal delivery schedule, the EMERGENCY position ensures continuous positive pressure of pure oxygen to the mask, and the TEST position ensures continuous positive pressure to the mask while the lever is held there. Released, the lever returns to the normal center position.

EJECTION SEAT

214 The aircraft is equipped with two Weber ejection seats. These are reliable seats, very simple and with few moving parts. There are no leg restraints or foot rests and during ejection leg flailing is restricted by ejection "G" only. Although the seats are identical, they are not interchangeable between cockpits because of the small difference that the pilot's seat height may be adjusted more than the navigator's. All other functions of the seats are identical. The seat is capable of providing safe ejection from 50 feet above ground level, providing the sink rate is zero, throughout the speed range 120 to 525 IAS. Low altitude or high mach ejections should be avoided where possible as ejection on the edge of the seat capability reduces the margin for error or malfunction. Super-sonic ejection is possible with this seat but the resultant blast and "G" forces pose the same problem as with any seat of this type.

215 The seat is raised and lowered by means of a 28 volt DC motor which operates two screw jacks located at the top of the seat. Vertical adjustment is controlled by a three-position switch which is spring-loaded to the OFF (center) position. The switch is located on the front of the right calf guard. The front seat has a greater up/down travel than the rear seat due to the difference in clearance between seat and canopy.

216 The lap belt and shoulder harness are made of a nylon webbing and incorporate quick-adjust buckles. The shoulder harness is attached to an inertia reel located on the back of the seat. The control lever for the inertia reel is located on top of the left calf guard; in the forward position it locks the shoulder harness (allows it to retract but not extend), and in the aft position it unlocks the shoulder harness. A deceleration force of 2-3 "G" will automatically lock the harness which can then only be released by cycling the control lever. Raising the seat handgrips will pull a flexible cable locking the inertia reel. The lap belt latching device

is the "lever-hook" and "eye" type. Loops on the shoulder harness and the parachute auto rip cord are threaded onto the eye portion, the hook engages the eye, and the lever locks the unit together. The lever is held in the locked position by a small ball-latch and a small strap attached to a dot fastener on the lap belt. For normal opening the lever is raised allowing the auto rip cord and shoulder harness to slide off the eye. During the ejection sequence, a gas initiator moves a small piston in the eye assembly, releasing a cam which rotates freeing the entire eye piece from the left-hand lap belt. The shoulder harness loops slide free allowing the seat occupant to separate from the seat. The auto rip cord, however, is trapped between an enlargment on, the eye piece and the latch hook and, as the seat occupant separates from the seat, the auto rip cord is pulled from the parachute.

217 The canopy may be jettisoned by either raising the hand grips or by raising the alternate canopy jettison knob. Both these methods fire the same initiator (located under the left arm rest) and use the same linkage to do so. The alternate jettison knob does not arm the seat ejection system; it will therefore be used when ejection is not immediately contemplated. To raise the alternate jettison knob, it is first necessary to push down a small latch, located immediately above the knob. The alternate jettison unit is located on the front of the left calf guard.

218 Raising the interconnected hand grips accomplishes several things. It fires the initiator to remove the canopy: exposes the ejection triggers and positions the trigger linkage so that the seat initiator may be fired (arms the seat); slides the lap belt/seat-man separator trigger aft to the armed position; and locks the inertia reel. The seat is now armed and ready to fire. A gas seat initiator cartbridge is located under each arm rest. Squeezing either or both triggers will fire one or both of these initiators and cause the seat catapult to fire. As the three-section telescoping catapult extends the seat moves up fixed guide rails. As the seat moves the lap belt/seat-man separator initiator trigger is tripped by a stop on the airframe, two quick-disconnect blocks are released by fixed lanyards, a switch causes the UHF and the IFF to transmit emergency signals, and a chaff bundle on the upper right of the seat is released by a fixed lanyard. When the seat catapult reaches full extention, the tubes separate and the seat is free of the aircraft. The lap belt/seat-man separator

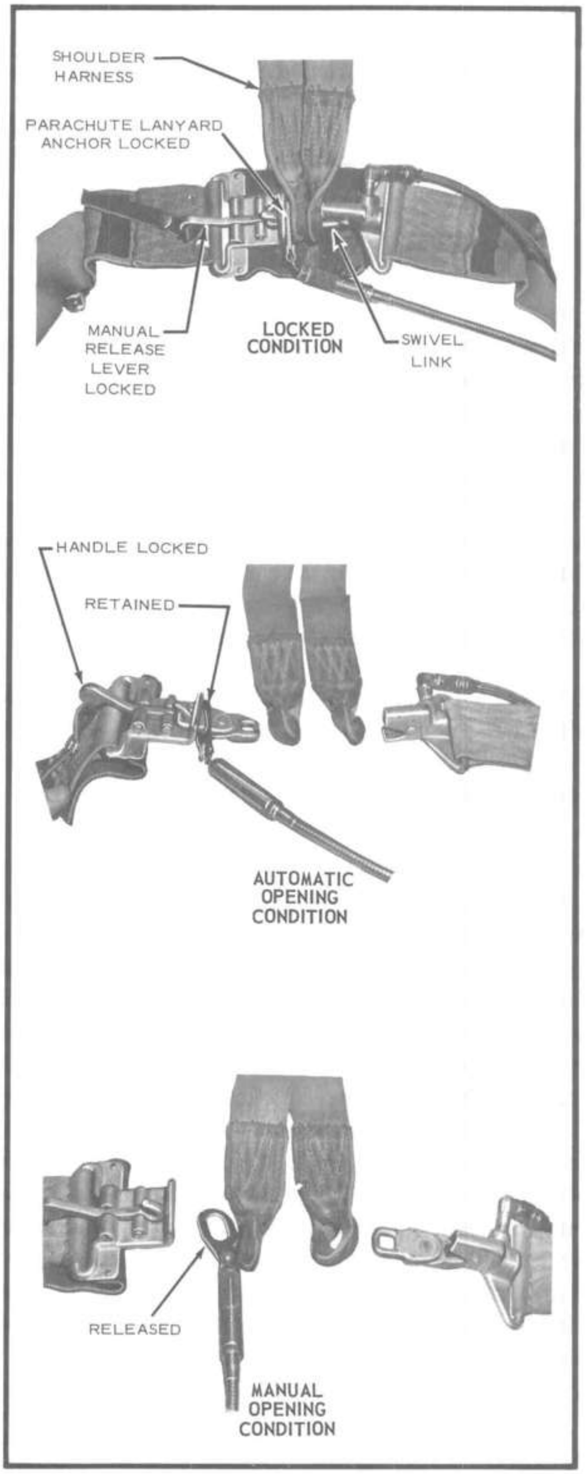


Figure 1-20 Safety Belt

initiator, which was triggered as the seat rose on the rails, fires after a 1 second delay and releases the lap belt eye. The same initiator, by rotating a rotary actuator, tightens a belt which runs between the survival kit, parachute and the seat and throws the seat occupant clear – pulling his auto rip cord en route.

CAUTION

Aircrew are to ensure that the seat-man separator straps are properly positioned under the survival kit and are flat and free of creases near the actuator. Improper strap positioning could jam the actuator.

219 In the preceding paragraph two quick-disconnect blocks and the UHF emergency transmit were mentioned. One quick-disconnect block is mounted on the front face of the seat and provides leads for oxygen, intercom, anti-g, and face heat. As the seat ejects, a lanyard attached to the cockpit floor tightens and trips a hook which holds the block together. The lower portion of the block then separates and is retained by the aircraft. The other quick-disconnect block is mounted behind the seat on the left side and provides linkage for the gas line to jettison the canopy and a wire bundle for the adjust motor. A lanyard connected to the floor unlocks and separates this block upon seat movement up the rails. Whenever either ejection seat is fired the UHF and the IFF is switched to emergency transmit. If the rear seat occupant ejects and the front seat occupant wishes to remain with the aircraft, he may regain normal control of the UHF and IFF by selecting the bailout override switch on his left-hand console from NORMAL to OVERRIDE. A spring-loaded test switch on the left-hand console in the rear seat may be used to test the system – when the test switch is released the system returns to normal operation.

220 A pip pin may be inserted into a hole in the left hand grip of each ejection seat. This pin prevents alternate canopy jettison lever movement to the jettison position, and locks the hand grips down. The pin, then, prevents canopy jettison, arming and firing of the seat, and arming of the lap belt/seat-man separator initiator. The pin must be removed prior to flight.

CANOPY JETTISON

221 The canopy may be jettisoned explosively in event of emergency. To initiate this action three M3AL gas initiators are located in the aircraft: One in door 205, and one in the left armrest of each ejection seat. The initiator in door 205 is fired by pulling the 9 foot lanyard attached, and is safetied with a pin, failure to remove this pin before flight will not effect the operation of the other two initiators. The initiators in the ejection seats located in the initiator left armrests may be fired by either raising the handgrips or by rotating the alternate canopy jettison handle located on the front of the left calf guard. When fired, gas from any initiator enters a common line, passes through two M5 gas booster initiators mounted in series, and fires the M3 canopy remover. Initial extension of the telescoped M3 canopy remover securely locks the canopy motor to its toothed rack. Further extension rotates the crankshaft assembly unlocking the canopy allowing the final extension of the M3 to jettison the canopy. As the canopy is jettisoned past 28°, the M3 inner and outer tube separate, the piston head separates from the piston rod in the canopy counterbalance cylinder, the antenna lead in and canopy jettison gas line separate, the aft end of the canopy hinge bottoms out on the airframe, shear rivets fail, the hinge assembly separates, and the canopy is free of the aircraft. Under static conditions the M3 canopy remover should jettison the canopy with sufficient force to clear the aircraft tail section.

CAUTION

Residue from fired initiators, boosters and removers is highly corrosive. If this residue comes in contact with human skin, flood the exposed skin area with water. Failure to do so will result in severe burns.

PARACHUTE

222 The parachute used for the CF-101 escape system is the B-5, which is especially designed for high speed bailouts. It may be operated automatically, by use of a barometric release system with a preset

altitude and time delay, or it may be operated manually, by use of the manual rip cord. The parachute consists of three main parts: the canopy, the pack and harness, and the automatic barometric release.

223 The canopy is constructed of high tensile strength rip-stop nylon fabric and is 28 feet in diameter. 28 rigging lines connect the nylon canopy to the parachute harness. Each rigging line extends from a connector link on the parachute harness up to the skirt of the canopy, across the canopy to the edge of the canopy skirt diametrically opposite and down to a connector link on the other side of the parachute harness. This makes each rigging line a continuous length from each connector link with the lines crossing at the canopy apex. Lateral bands of reinforced webbing completely encircle the gores at the skirt edge and the apex to strengthen the body of the canopy. A vent at the apex of the canopy is constructed of machine sewed puckers; the size of the vent is controlled by a molded rubber ring which permits the vent to open on initial opening of the chute and to close as the descent rate reaches normal. A quarter deployment bag provides a means of separately stowing 1/4 of the folded canopy and the rigging lines. The purpose of the quarter bag is to allow the orderly deployment of the rigging lines and canopy and to decrease the opening shock of the canopy. This quarter bag is lost after full canopy deployment. A coilspring loaded pilot chute is connected to the apex of the main canopy to assist in canopy deployment.

224 The pack cover houses the canopy and quarter bag when the parachute is packed. It is flexible with no reinforcement or stiffness which allows the pack to conform to the contour of the users back. A foam rubber pad is attached to the back of the pack with pull-the-dot fasteners and is for user comfort. Within the pack are two zippered pockets for the emergency bailout bottle and the auto release mechanism. A steel channel, in a zippered enclosure between the foam rubber back pad and the canopy, contains the rip cord pins. Armoured flexible tubing runs from this channel to the rip cord handle and the auto release mechanism. Opposite this steel channel on the other side of the pack is another channel, in a zippered enclosure, which houses two nylon closing tapes and a hesitator spring to withdraw the tapes when they have been released by rip cord action. The harness is permanently attached to the back of the pack cover and is constructed of light-weight flexible nylon webbing. Straps from the shoulders and the legs meet in the center of the chest and are secured with the standard quick-release box. The harness is adjustable for any size. The manual rip cord is stored in an elastic necked pocket on the left side of the chest. A pull-the-dot fastener in this area is provided to secure the auto rip cord when the parachute is stored.

225 The automatic barometric release consists of a train of gears driven by a coil spring which when released (the firing mechanism senses a pre-set criteria) pulls the rip cord free of the parachute. The pre-set criteria for the firing mechanism is: the auto-rip cord had been pulled, a time delay of 1 1/4 sec. ±1/4 sec. has expired, and the altitude is below 15,000 feet ± 500 feet. If bailout altitude is above 15,000 feet the parachute will not open automatically until that level has been reached. Upon low level bailout crew members should attempt to beat the automatic seat release and auto rip cord system. If you beat the system it is likely that the system has malfunctioned.

SURVIVAL KIT

226 The survival kit used in the CF-101 is a rigid seat pack constructed of fiberglass with metal fittings. It is connected to the sides of the parachute by standard "D" ring attachments and, in the case of the summer pack, to the mae west by a lanyard which runs from the left "D" attachment to a quick-disconnect fitting on the mae west. The kit has two compartments, a large forward compartment which contains either the summer or winter pack, and a small aft compartment which is empty. Mounted on the rear compartment is a spring parachute support to reduce parachute weight on the crew member's shoulders during normal flight. The forward compartment is covered by a lid which is attached to the kit by a hinge assembly and two hooks. A survival kit development handle on the right forward side of the kit unlatches these hooks when it is rotated aft, the hinge assembly separates and the kit bottom is free to separate from the crew member.

227 For ground evacuation a plunger device is mounted on the left side of the kit. If the plunger is held depressed, by the crew member sitting on the kit, and the deployment handle is rotated, the "D" attachment assembly will separate at the seat pack lid and the crew member will be completely free of the survival kit.

CAUTION

If a summer pack is installed the mae west lanyard must also be disconnected for ground evacuation.

228 During bailout the survival kit should be deployed after the parachute has fully deployed and oscillation has damped. In the case of the winter pack the lanyard will be attached from the left "D" ring assembly, down the lanyard approximately 10 feet will be the survival kit lid, further down will be the vacuum packed sleeping bag and at the end of the lanyard will be a vacuum packed rubber rucksack filled with the normal survival gear. In the case of the summer pack, an automatically inflated dinghy replaces the sleeping bag.

229 The survival kit development handle comes free after it is rotated to the deploy position and may be discarded. It is recommended that the survival kit be deployed on every bailout as the weight and bulk of the kit could cause severe leg injury when landing. With the summer pack, the left "D" ring should be released from the parachute and the survival gear retained by the lanyard connected to the mae west.

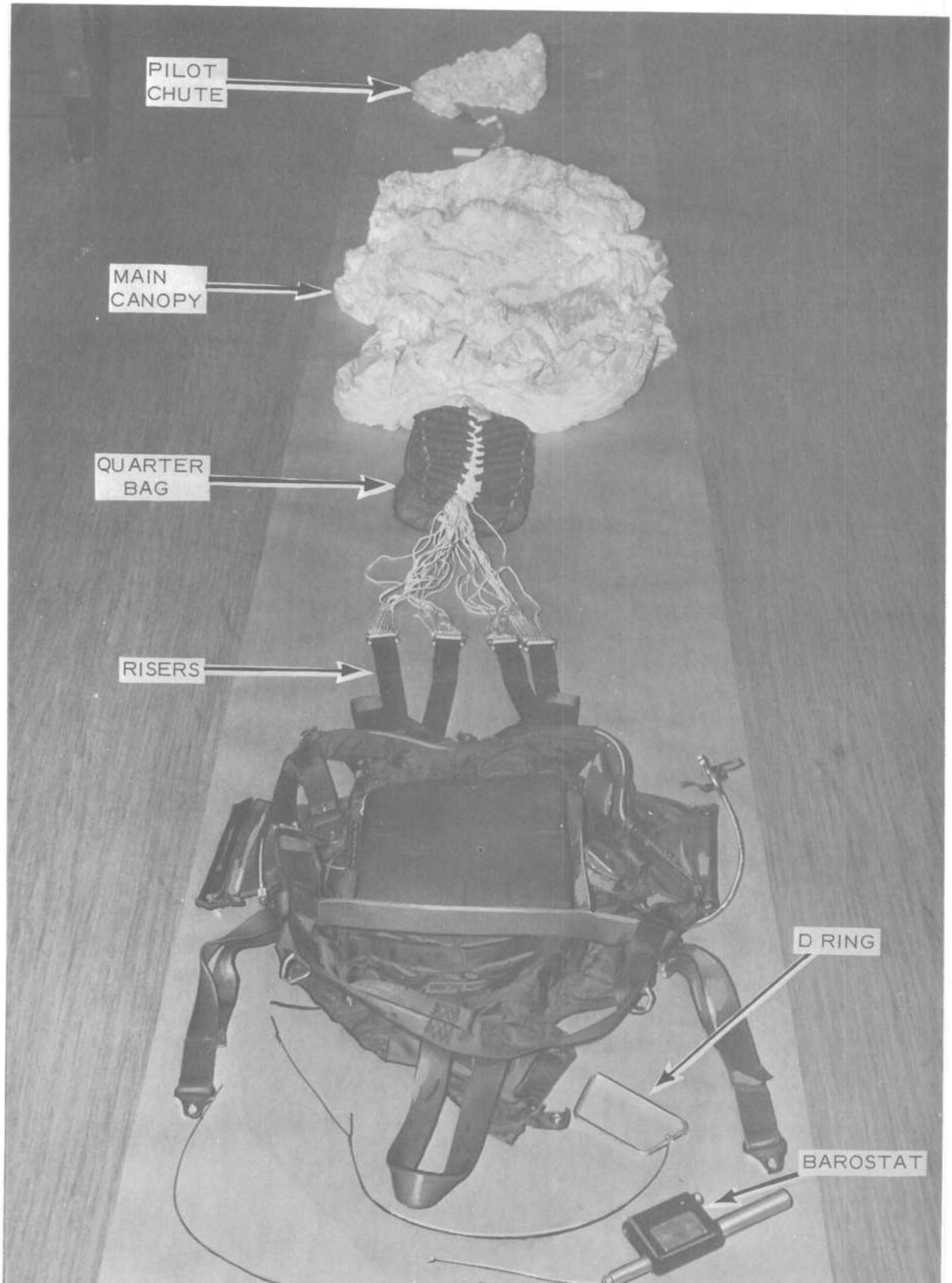


Figure 1-21 Parachute Layout

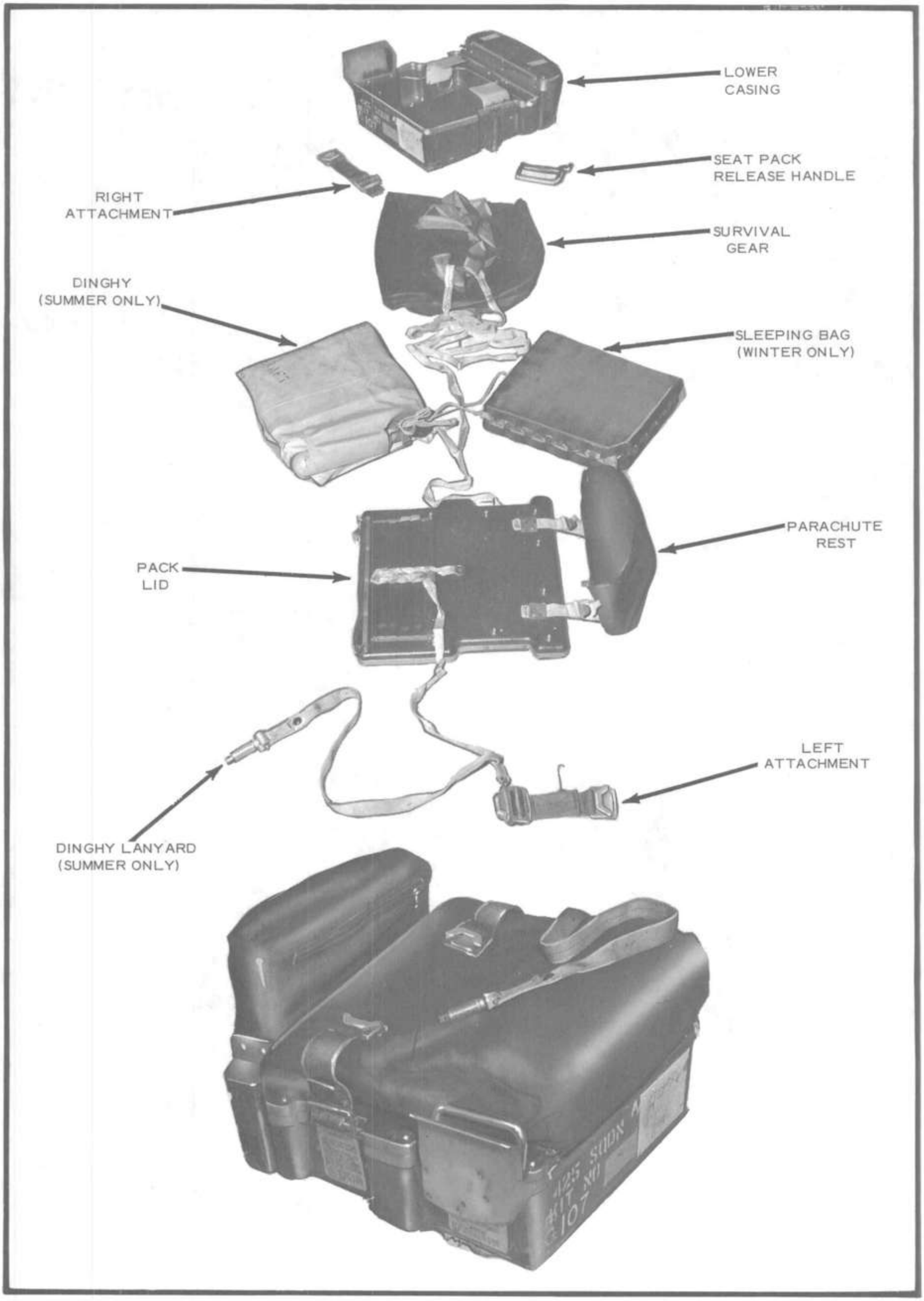


Figure 1-22 Seat Pack Layout

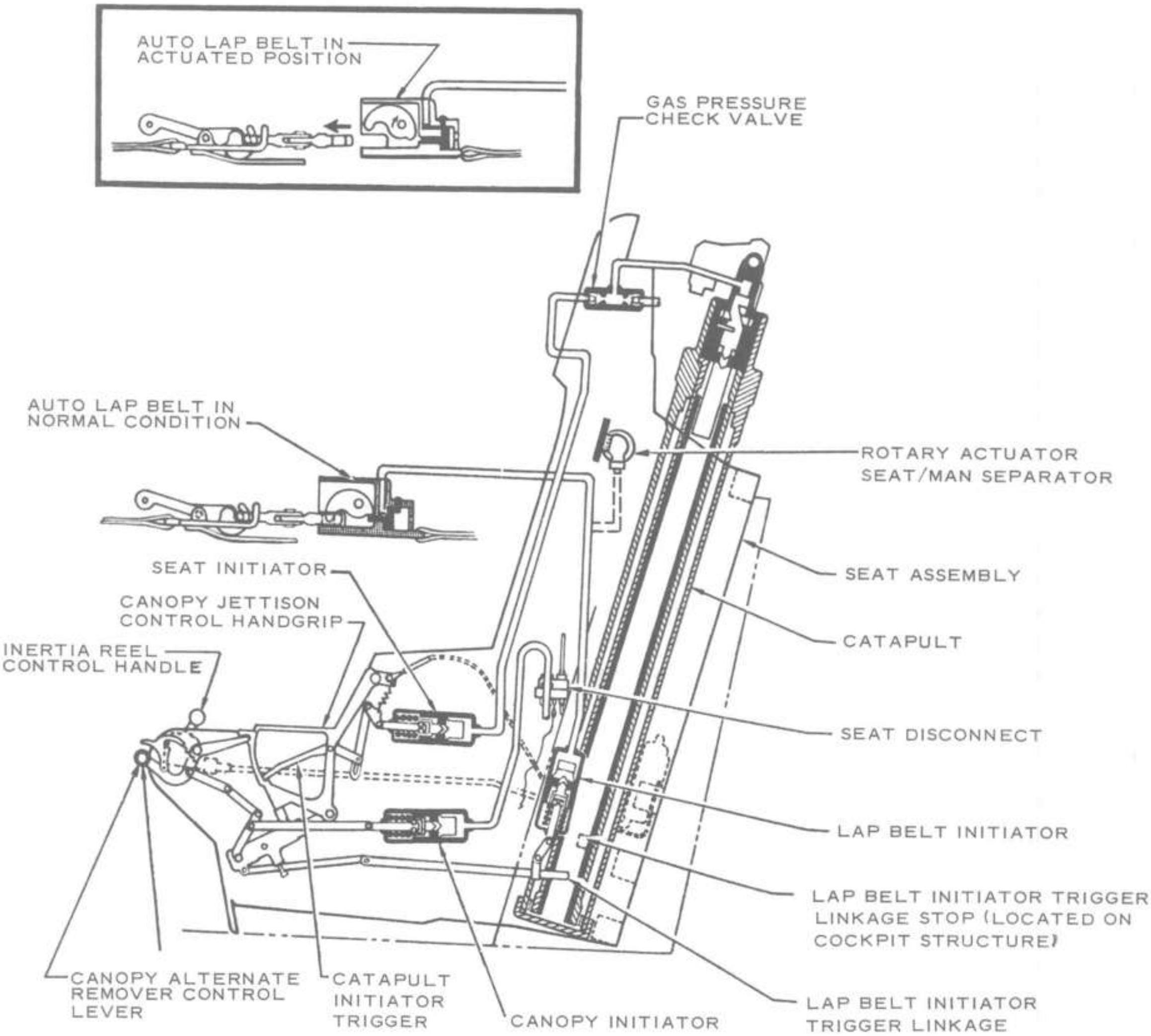


Figure 1-23 Seat Ejection Sequence

DUAL AIRCRAFT

GENERAL

230 The CF-101F is the pilot trainer model of the Voodoo aircraft. The front cockpit of the "B" and "F" models are identical, the difference being only in the controls, instrumentation and layout of the rear cockpit. The "F" model does not lose its fighter capability as all radar and fire control systems are incorporated and maintained in an operational state.

FLIGHT CONTROLS AND INSTRUMENTS

231 The rear cockpit has rudders fitted which work in parallel with the front rudders as do the toe operated brakes. The rudders are adjusted individually by moving knobs on the upper portion of the rudder bars. The control stick works in parallel with the front stick, it has a paddle switch (with functions identical to the front) and has the same handgrip as the front. The barrel of the stick, however, is smaller in diameter and does not incorporate the switches required for control stick steering in AFCS – CSS is optional from the front seat only. The trim button works normally and there is no priority over front versus rear seat operation. A rudder trim switch is located on the left-hand console. A nose wheel steering button is connected in parallel to the front seat circuit and operates the same way. Flight instruments are mounted on the left-hand instrument panel and instrument sub-panel and consist of a PBI, compass/tacan indicator, artificial horizon, CDI, VSI, airspeed/mach indicator, turn and bank indicator, and an accelerometer. The TAS meter and clock are relocated outboard of the FCS hand control. No provision is made for speed brake, flap, or landing gear operation or indication – a landing gear warning light is installed in parallel with the one in the front cockpit but the landing gear warning horn does not sound in the rear headset. An emergency brake handle is installed and is located in the same relative position as in the front.

ENGINE CONTROLS AND INSTRUMENTS

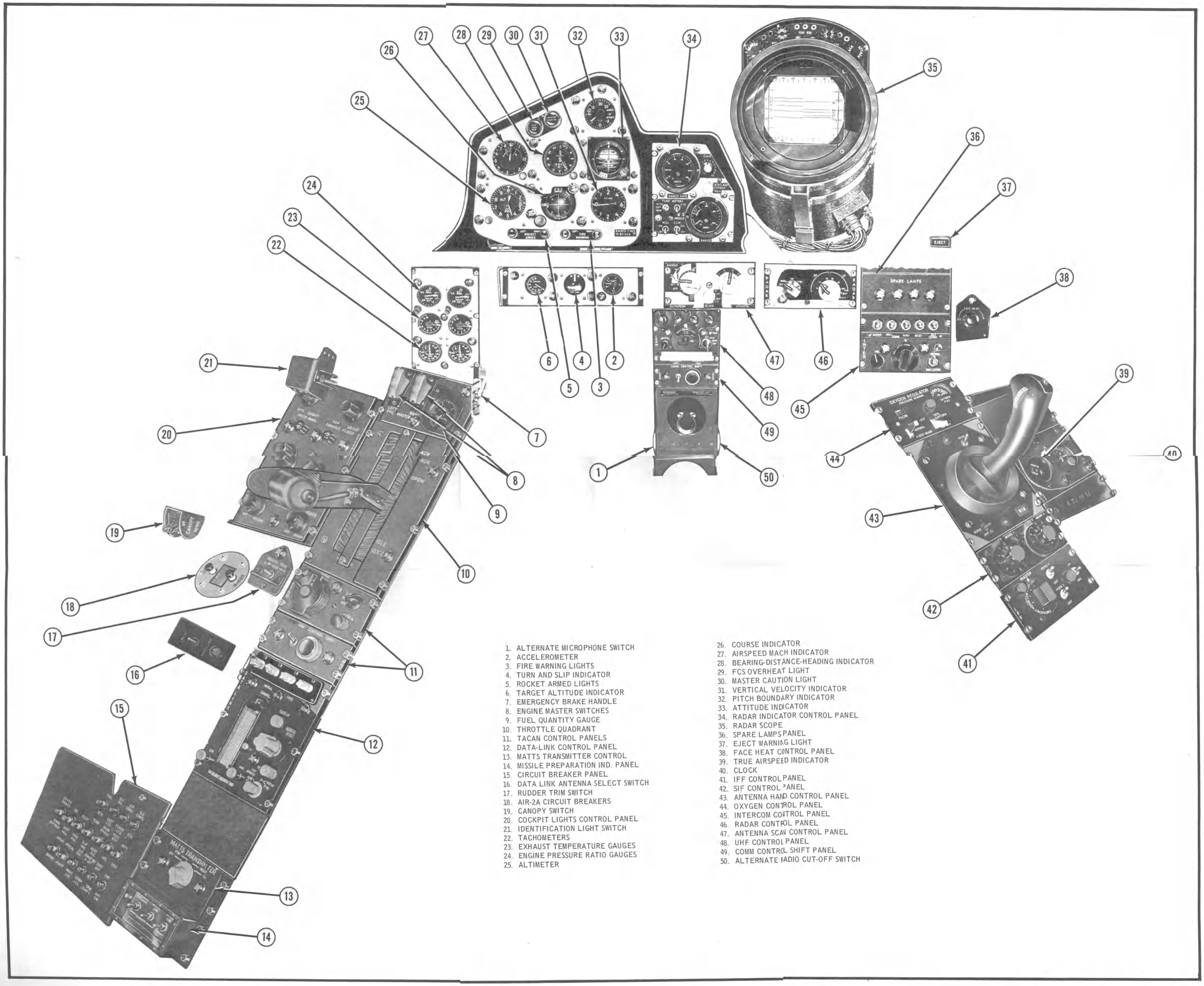
232 Two throttles are mounted on the left-hand console; operation between idle and full military power settings is identical to the front throttles, there is, however, no provision for moving the throttles to the cut-off or afterburner range. Two engine master switches are located on the left-hand console. The left-hand vertical sub-panel contains three pairs of engine instruments, the EPR's, the EGT's, and the RPM's which all work in parallel to the front seat gauges. Two fire/overheat warning lights are located on the base of the main instrument panel and they operate in parallel with the pilot's fire warning system.

MISCELLANEOUS

233 A blind flying hood is installed for practice instrument flying. The hood is stored ready for use at the rear of the canopy and may be pulled forward along elastic cords to enclose the cockpit. A pull-the-dot fastener on the bottoms of the hood may be snapped on to the male portion mounted on the canopy remover compartment. Other equipment normal to the rear cockpit may be located in different positions but their functions are unchanged. The mike and mute switches located on the floor as dimmer type buttons in the "B" model are side mounted on the center pedestal in the "F". The "F" also incorporates a mike and a mute switch on the starboard throttle.

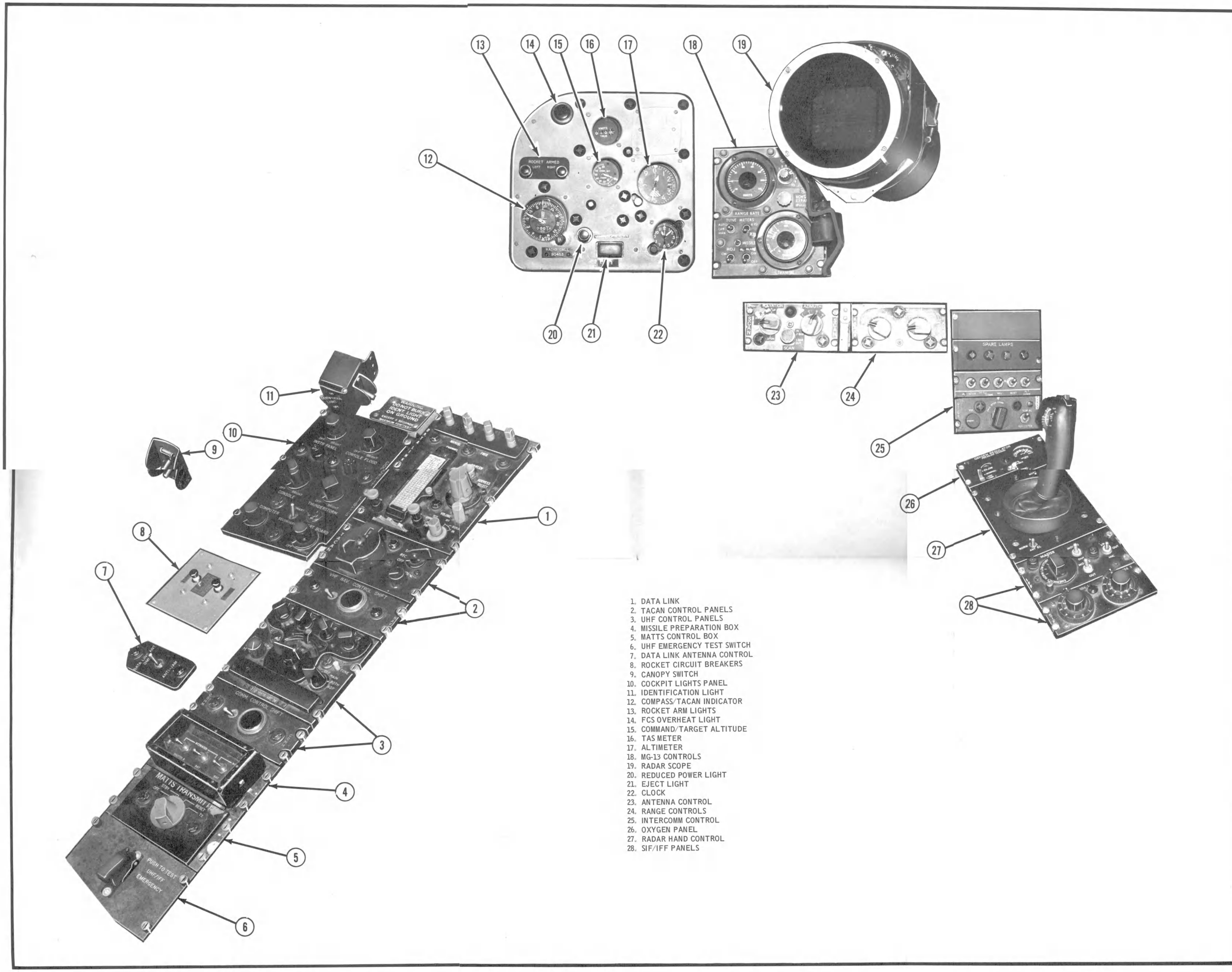
1 STANDBY COMPASS LIGHT SWITCH
2 PILOT'S SCOPE FWD. CONTROL PANEL
3 MANUAL COMMAND SIGNAL LIMITER ENGAGE SWITCH
4 MCSS OUT LIGHT
5 COURSE INDICATOR
6 BEARING-DISTANCE-HEADING INDICATOR
7 ALTIMETER
8 AIRSPEED/MACH INDICATOR
9 TARGET ALTITUDE INDICATOR
10 ARMAMENT CONTROL PANEL
11 EMERGENCY TANK JETTISON BUTTON
12 ANTI SKID CONTROLS
13 EMERGENCY BRAKE HANDLE
14 HYDRAULIC GAUGES
15 EMERGENCY SPEED BRAKE SWITCH
16 ICING IGNITION SWITCH
17 STARTER INTERNAL AIR SWITCH
18 CIRCUIT BRAKER PANEL
19 ENGINE CONTROL PANEL
20 RUDDER TRIM
21 UHF CONTROL PANELS
22 PCS CONTROL PANEL
23 INTERCOM CONTROL PANEL
24 OPTICAL SIGHT CONTROL PANEL
25 UHF EMERGENCY OVERRIDE
26 COMBUSTION, PNEUMATIC START SWITCHES
27 EJECT WARNING LIGHT SWITCH
28 FUEL CONTROL PANEL
29 FUEL QUANTITY GAUGE TANK SELECTOR PANEL
30 AUTOMATIC FLIGHT CONTROL PANEL
31 LANDING GEAR EMERGENCY HANDLE
32 WING FLAPS LEVER
33 LANDING/TAXI LIGHT SWITCH
34 CANOPY SWITCH
35 TAIL HOOK WARNING LIGHT
36 FLAP INDICATOR
37 LANDING GEAR HANDLE
38 LANDING GEAR INDICATOR LIGHTS
39 TAIL HOOK SWITCH
40 DRAG CHUTE HANDLE
41 COMMAND MACH INDICATOR
42 ACCELEROMETER
43 LANDING GEAR WARNING LIGHT
44 TURN AND SLIP INDICATOR
45 CLOCK
46 PITCH BOUNDARY INDICATOR
47 TRUE AIRSPEED INDICATOR
48 CHANNEL FREQUENCY INDICATOR
49 PILOT'S SCOPE
50 TAKE-OFF TRIM BUTTON
51 ENGINE PRESSURE RATIO GAUGES
52 EXHAUST TEMPERATURE GAUGES
53 MAGNETIC (STANDBY) COMPASS
54 MASTER CAUTION LIGHT
55 FIRE WARNING TEST PANEL
56 FUEL FLOW GAUGES
57 FUEL QUANTITY GAUGE
58 VOLTMETER
59 PILOT SCOPE CONTROLS
60 GENERATOR SWITCHES
61 BATTERY SWITCH
62 AIR CONDITIONING CONTROL PANEL
63 TACAN CONTROL PANELS
64 HEADING INDICATOR CONTROL PANELS
65 LIGHTING CONTROL PANELS
66 SPARE LAMPS PANEL
67 ANTI-COLLISION LIGHT
68 FLS CONTROL PANEL
69 OXYGEN CONTROL PANELS
70 TELELIGHT/MASTER CAUTION ANSWER BUTTON
71 TELELIGHT PANEL
72 TACHOMETERS
73 OIL PRESSURE GAUGES
74 ATTITUDE INDICATOR
75 VERTICAL VELOCITY INDICATOR
76 ILS - TACAN SWITCH
77 MB-1 EJECTOR RACKS LOCK PANEL
78 RUDDER PEDAL ADJUSTMENT CRANK

Figure 1-24 Front Cockpit



1. ALTERNATE MICROPHONE SWITCH
2. ACCELEROMETER
3. FIRE WARNING LIGHTS
4. TURN AND SLIP INDICATOR
5. ROCKET ARMED LIGHTS
6. TARGET ALTITUDE INDICATOR
7. EMERGENCY BRAKE HANDLE
8. ENGINE MASTER SWITCHES
9. FUEL QUANTITY GAUGE
10. THROTTLE QUADRANT
11. TACAN CONTROL PANELS
12. DATA-LINK CONTROL PANEL
13. MATTS TRANSMITTER CONTROL
14. MISSILE PREPARATION IND. PANEL
15. CIRCUIT BREAKER PANEL
16. DATA LINK ANTENNA SELECT SWITCH
17. RUDDER TRIM SWITCH
18. AIR-2A CIRCUIT BREAKERS
19. CANOPY SWITCH
20. COCKPIT LIGHTS CONTROL PANEL
21. IDENTIFICATION LIGHT SWITCH
22. TACHOMETERS
23. EXHAUST TEMPERATURE GAUGES
24. ENGINE PRESSURE RATIO GAUGES
25. ALTIMETER
26. COURSE INDICATOR
27. AIRSPEED MACH INDICATOR
28. BEARING-DISTANCE-HEADING INDICATOR
29. FCS OVERHEAT LIGHT
30. MASTER CAUTION LIGHT
31. VERTICAL VELOCITY INDICATOR
32. PITCH BOUNDARY INDICATOR
33. ATTITUDE INDICATOR
34. RADAR INDICATOR CONTROL PANEL
35. RADAR SCOPE
36. SPARE LAMPS PANEL
37. EJECT WARNING LIGHT
38. FACE HEAT CONTROL PANEL
39. TRUE AIRSPEED INDICATOR
40. CLOCK
41. IFF CONTROL PANEL
42. SIF CONTROL PANEL
43. ANTENNA HAND CONTROL PANEL
44. OXYGEN CONTROL PANEL
45. INTERCOM CONTROL PANEL
46. RADAR CONTROL PANEL
47. ANTENNA SCAN CONTROL PANEL
48. UHF CONTROL PANEL
49. COMM CONTROL SHIFT PANEL
50. ALTERNATE RADIO CUT-OFF SWITCH

Figure 1-25 Rear Cockpit "B" Model



1. DATA LINK
2. TACAN CONTROL PANELS
3. UHF CONTROL PANELS
4. MISSILE PREPARATION BOX
5. MATTS CONTROL BOX
6. UHF EMERGENCY TEST SWITCH
7. DATA LINK ANTENNA CONTROL
8. ROCKET CIRCUIT BREAKERS
9. CANOPY SWITCH
10. COCKPIT LIGHTS PANEL
11. IDENTIFICATION LIGHT
12. COMPASS/TACAN INDICATOR
13. ROCKET ARM LIGHTS
14. FCS OVERHEAT LIGHT
15. COMMAND/TARGET ALTITUDE
16. TAS METER
17. ALTIMETER
18. MG-13 CONTROLS
19. RADAR SCOPE
20. REDUCED POWER LIGHT
21. EJECT LIGHT
22. CLOCK
23. ANTENNA CONTROL
24. RANGE CONTROLS
25. INTERCOMM CONTROL
26. OXYGEN PANEL
27. RADAR HAND CONTROL
28. SIF/IFF PANELS

Figure 1-26 Rear Cockpit "F" Model

PART 2

VISUAL, INSTRUMENT AND NIGHT FLIGHT

GENERAL

1 In the rest of the Handling Part of the EO, no specific reference will be made to visual, instrument or night flight. The reason for this is the Voodoo does not lend itself to clear hood flying; there is too little visual reference and too much error from small variations in attitude. Visual flight and night flight must, for the sake of accuracy, be flown with almost continuous reference to the flight instruments. With very rare exceptions, the Voodoo in its normal role is always filed on an IFR flight plan. For this reason, only the primary instrument approaches and the VFR circuit are outlined in this EO. All other types of approaches may be adapted from the primary ones.

INSTRUMENT TECHNIQUE

2 The technique used for instrument flight in the Voodoo may be described, "assume an attitude and see what happens". The attitude indicator, in this technique, is the heart of the cross check with the rest of the flight instruments supporting. Attempts to fly limited panel can, and normally will, result in over-controlling. A good trimming technique would be a mixture of the trim-off-pressure and the trim-toward-the-way-you-want-to-go techniques. Whatever method is used, the rudder must be trimmed first as any yaw will induce a rolling tendency giving the false impression that the ailerons are out of trim. It is important to keep equal thrust set on the engines as asymmetric thrust produces yaw, hence roll. Although turns of 30° bank are considered standard, greater bank angles are required in some tactics. They pose no great problem and there is no limitation on them, however, in close to the ground manoeuvres such as take-off, turn out, and approach, the bank angle should not exceed 30° and the airspeed should not exceed 350 KIAS.

FLIGHT CHARACTERISTICS

GENERAL

3 The Voodoo is designed to accomplish the tactical mission throughout a wide range of altitudes and airspeeds. The most prominent airframe design features that contribute to aircraft capabilities are the thin, swept, low aspect ratio wing and the high mounted horizontal stabilator. The wing develops a minimum of parasite drag at high airspeed, which permits rapid acceleration and sustained mach numbers in the supersonic region. The high stabilator is, by position, free or airflow disturbances throughout the normal operational speed range. The aircraft is, therefore, exceptionally stable within this range. These design features, however, are responsible for an undesirable characteristic not found in earlier transonic jet aircraft. Earlier, more conventionally designed fighters have experienced stability problems in the transonic regions and in the transition to supersonic flight. They were, however, relatively stable in low speed/high "G" flight and had conventional stall characteristics. This aircraft by comparison becomes unstable at low speed and/or high "G" loading and cannot be full-stalled short of longitudinal pitch-up. Just as stall determined the performance envelope of earlier aircraft, pitch-up defines the extreme boundary of the Voodoo's performance capability. The pitch-up boundary is no more restrictive than previously known stall boundaries, and does not prohibit the aircraft from accomplishing any presently known tactical mission.

THEORY OF PITCH-UP

4 Unlike more conventional aircraft, low aspect ratio aircraft may be flown past the critical angle of attack. At angles of attack in excess of the critical, the aircraft stability becomes neutral, then longitudinal-

ly. unstable. It is in this area, as a result of the excessive angle of attack, that the aircraft will pitch-up. "G" loading, gross weight, and IAS are factors effecting angle of attack. Increasing "G" loading or gross weight, or decreasing IAS creates the requirement for more wing lift; greater angle of attack is the only method by which this required lift may be generated. If the demand for lift becomes too great the critical angle of attack will be exceeded and the aircraft will pitch-up.

5 The effects of extreme angles of attack that cause loss of longitudinal stability are wing tip stall and the downwash airflow over the horizontal stabilizer. Wing tip stall is a common aerodynamic characteristic of the thin swept wing at maximum lift (maximum angle of attack) conditions. As the stall progresses inward and forward along the swept back wing, that area still producing lift is centered forward. This forward shift of the center of lift imparts a nose-up pitching movement to the aircraft. Tip stall in effect also decreases wing span and concentrates lift distribution in the inboard wing and fuselage area. This lift concentration results in a sharp upward airflow deflection at the wing which then washes downward across the tail. As long as the stabilizer angle of attack remains positive in relation to the downwash flow direction, it is developing positive (upward) lift and will counteract nose-up rotation. Negative stabilizer angle of attack, in relation to downwash flow direction, will produce negative (downward) lift at the tail, and combined with the forward shifted center of lift, will cause a nose-up tendency. Slight forward stick can be used to prevent this initial nose-up movement even though the aircraft is flying in the negative stability envelope. If nose-up movement is allowed to continue, forward stick will become progressively less effective and pitch-up will occur. Pitch-up should never occur if the aircrew heeds the warnings and limitations imposed by the pitch control system, the command signal limiter system, airframe buffet, and the published "G" versus indicated air speed tables. However, if systems are inoperative, or limits are disregarded, pitch-up is possible throughout all performance ranges of the aircraft. Arrival at pitch-up and the ensuing gyrations will vary, dependent on the flight conditions that are responsible for exceeding the critical angle of attack.

SUPERSONIC PITCH-UP

6 Above .9 indicated mach number there is little or nô buffet warning prior to pitch-up. If the warning systems are inoperative, the aircrew will receive no mechanical or airframe indications of approach to pitch-up therefore, the following "G" indicated airspeed limitations must be strictly adhered to:

KNOTS – IAS	300	350	400	450	500
"G" LOADING	1.7	2.7	3.7	4.7	5.7

AIRSPEED BLEED PITCH-UP

7 If 1 "G" (level flight) is maintained as indicated airspeed is allowed to bleed off, pitch-up will be preceded by airframe buffet, which will become more pronounced as speed continues to decrease. Wing drop may be experienced prior to reaching critical angle of attack. As the aircraft progresses into negative stability, forward stick movement will also be required to counteract the nose-up tendency. Pitch-up from this environment will occur when forward stick travel is insufficient to maintain positive (upward) lift on the stabilizer. Under these conditions, any radical change in pitch that cannot be stopped by nose-down control must be considered pitch-up, and recovery procedures should be immediately employed.

8 Characteristics of pitch-up from less than 1 "G" flight will be generally the same as covered in the preceding paragraph. However, the warning system safety margin will be degraded for the reasons covered below. Stable flight can be maintained down to speeds in the 100 knot region, if the appropriate "G" loading is maintained. Conversely, if loading is stabilized at less than 1 "G" as in the case of a steep climb, airspeed can be decreased well below the point at which pitch-up would occur in 1 "G" flight. In this situation, airframe buffet and triggering of the PCS/CSL systems will also be delayed to lower airspeeds. This is the one extreme flight condition which may not actuate the warning systems early enough to allow sufficient airspeed margin to recover to normal flight attitudes. In high angle climbs, the minimum airspeed which will allow recovery with adequate safety margin is dependent on climb angle, gross weight, altitude, and power configuration.

ACCELERATION PITCH-UP

9 Pitch-up due to excessive "G" can occur throughout the entire speed range. Although there is less tendency to exceed critical "G" at high indicated airspeeds, pitch-up under these circumstances is possible and may result in damage to aircraft structure. For this reason it is extremely important to adhere to limits indicated in the "G" vs Airspeed table if warning systems are inoperative. In subsonic flight, increasing "G" loading to the critical point will be accompanied by airframe buffet, wing drop, and evidence of entry into the negative stability region. Adequacy of these aerodynamic warnings will vary, dependent on the rate at which "G" is built up. With a slow increase in "G", the onset and build-up of the warnings will occur at a rate that can be easily interpreted and acted on by the pilot. If the "G" is increased at a rapid rate, the warnings will be compressed into short duration and may not provide warning to unload prior to exceeding critical angle of attack. Excessive aft stick rates may cause pitch-up, even though back pressure is relieved well short of the critical point. This is due to inertial overshoot. Once the aircraft has developed a high pitching rate, it may continue unless strong counter forces (stabilator) are applied. Allowable aft stick rates will vary with angle of attack. High rates are available at low angles of attack, but must be decreased with an increase in angle of attack.

ROLL RATE PITCH-UP

10 Under flight conditions where "G" loading is at maximum, introduction of high rates of roll may induce pitch-up. Angle of attack, which is stabilized near critical at maximum "G", is caused to further increase by the aerodynamic effects of rolling. These effects are inertial or roll coupling, and a magnification of the down-wash/forward movement of the center of lift. High "G" rolls may also induce snap rolls due to complete wingstall. Snap rolls will in turn induce yaw and pitch inputs, which will in most cases result in pitch-up. Airframe buffet will provide warning in subsonic rolls; however, adequacy of warning time will depend on rate of roll. If severe airframe buffet builds up during rolling manoeuvers, the "G" loading should immediately be decreased. If a snap roll does occur, the pilot should reduce "G" loading and neutralize ailerons. This action will tend to dampen out any further adverse oscillations. Control actions to counter the snap roll will only induce oscillations that may lead to pitch-up. Snap rolls, and ensuing pitch-up, may also result from negatively stalling the aircraft. Negative stall limits are not published, but allowable negative "G" decreases proportionately with indicated airspeed. If airframe buffet is noted during negative "G" flight, immediately decrease the negative "G" to zero or a small positive value. If snap rolls occur as a result of negative stall, proceed with snap roll recovery actions outlined above.

NOTE

During high "G" rolls and/or snap rolls, the local airflow at the PCS vanes may not be representative of the total airflow affecting the aircraft aerodynamically. As a result, warning systems actuation may occur too late to prevent exceeding the critical angle of attack.

LEVEL FLIGHT CHARACTERISTICS

LOW SPEEDS

11 The recommended airspeeds for take-off, approach and landing and their relationship to gross weight, temperature, pressure altitude and wind effect contained in this manual are well above any dangerous flight attitude. Handling characteristics within the recommended speed ranges are good and control response positive. High angle of attack, usually associated with low speeds, can create undesirable rates of descent (sink). You should recognize any high rate of descent and add thrust to recover. Any attempt to pull back on the stick, further increasing angle of attack, will result in higher rates of descent. This attitude, further aggravated, may result in pitch-up. The recommended final approach airspeeds allow adjustments to your rate of descent well within safe operating flight speed ranges. You should plan to arrive at touch-down with the proper touchdown speed. Should the speed be reached while "high", do not decrease the angle of

attack to keep within the intended landing area but hold this speed, land "long" or go-around and correct your final approach on the next attempt.

CRUISE SPEEDS

12 Under cruise conditions heading and altitude are easily maintained. Under high altitude and heavy gross weight cruise conditions, a slight buffet may occur but creates no control problem. Precise lateral trimming and equalized engine thrusts are essential, otherwise counter-acting roll due to out of trim condition can be fatiguing. An automatic flight control system is provided for extended range missions.

HIGH SPEEDS

13 This aircraft is capable of very high speeds with the transition from transonic to supersonic speed being completely smooth. No adverse flight characteristics are evidenced at any speeds tested. The aircraft is capable of maintaining supersonic speeds during manoeuvering flight at constant altitudes. Stick forces will increase with an increase of airspeed.

MANOEUVERING FLIGHT CHARACTERISTICS

MANOEUVERING LOADS

14 Manoeuvering loads are incurred when the aircraft is turned, rolled, yawed, pulled out of a dive or accelerated in some manner. It is the pilot's responsibility to prevent these loads from exceeding the imposed limits of the aircraft. It should be noted that the accelerometer may mislead a pilot because it reads only accelerations in the vertical axis and is unable to detect empennage loads due to its location in the cockpit. An example will better illustrate the subject. If the aircraft is yawed or skidded during flight, the accelerometer may still indicate only 1 "G". During this manoeuver, fairly large loads are being imposed on the vertical fin of the aircraft. Actually, these steady loads may not be excessive; however, during rapid applications and/or rapid release of large control forces, very high loads can be imposed on the airframe.

DIVES

15 High mach number dives are easily entered. A slow pushover entry into a shallow dive angle (less than 40°) will develop the highest obtainable mach number.

OPTIMUM DIVE RECOVERY

16 The established optimum dive recovery technique is a constant angle-of-attack pull out at military power. By use of angle-of-attack as the prime consideration in dive recovery, the pilot is able to convert speed into best pull-up radius while keeping clear of the stall region. In a wide range of speed, the maximum safe angle-of-attack recovery will produce a "G" loading such that altitude loss will not vary appreciably with a wide range of entry airspeeds. This speed range includes any speed at which maximum safe angle-of-attack produces more than 1 "G", but less than 6 "G" (roughly 200 to 450 knots IAS). Maximum safe angle-of-attack ("G" loading) can be conservatively computed per indicated as follows:

KNOTS – IAS	300	350	400	450	500
"G" LOADING	1.7	2.7	3.7	4.7	5.7

This computation conservatively defines the horn boundary.

17 Angle-of-attack or "G" values must be recomputed as speed changes during recovery – the alternative and easier method is to recover on the horn boundary. "G" loading, up to maximum safe angle of attack, should be smoothly applied and the power simultaneously advanced to full military. The military power setting is used to prevent rapid speed bleed off with the consequent rapid reduction of available "G". At very high speed where 6 "G" is reached before the horn boundary, fly the 6 "G" limit until the airspeed bleeds off enough to obtain horn boundary. If more rapid speed reduction is required, reduce throttle and/or apply speed brakes, but restore aircraft to the low drag military power recovery condition as soon as possible. From very low airspeeds, if altitude permits, recovery should not be attempted before reaching 350 knots.

NOSE HIGH, LOW AIRSPEED RECOVERY

18 The procedure used to recover from a nose high, low airspeed position is almost identical to the tactical snap-up recovery and escape manoeuvre, however, the tactical procedure is primarily designed to clear a detonation area while the recovery outlined here is concerned only with the safe flight of the aircraft.

(a) Upon recognition of the position – UNLOAD TOWARD ZERO "G".

(b) If sufficient airspeed remains to manoeuvre – ROLL 180 DEGREES.

NOTE

These two steps are done almost simultaneously, the unload step lowers the nose and allows roll without danger of inertia coupling. The roll should be relatively slow, 4 seconds to complete the 180 degrees.

(c) When inverted – INCREASE LOADING TO MAXIMUM "G" AVAILABLE

The PBI is the best indication of what "G" is available.

(d) When the nose is 30° to 40° below the horizon, and the airspeed has increased to 300 KIAS – DECREASE LOADING TOWARD ZERO "G" AND ROLL OUT.

If afterburner power is in use, it should be terminated at this point, however, full military power should be maintained.

(e) When roll out is complete – INCREASE LOADING TO MAXIMUM "G" AVAILABLE FOR THE PULLOUT.

NOTE

Maximum "G" available changes radically throughout this manoeuvre; it will be found that the PBI is a more useful guide than the accelerometer to determine maximum available "G". Full military power should be maintained throughout the manoeuvre to reduce airspeed bleed and aid in dive recovery.

FLIGHT WITH EXTERNAL TANKS

19 Aircraft flight characteristics are essentially the same with one or two external tanks installed except for higher gross weight performance limitations. With one tank installed there is a tendency to yaw toward the tank.

FLIGHT CONTROL EFFECTIVENESS

STABILATOR

20 A single piece controllable horizontal stabilator provides highly responsive control effectiveness at both subsonic and supersonic speeds. The increased effectiveness is particularly noticeable at low altitudes and high indicated airspeeds, therefore, you should exercise caution when flying under these conditions in order to prevent excessive "G" or unintentional overshoot resulting from over controlling.

CAUTION

Igniting the afterburners in flight and subsequent acceleration may cause inadvertent aft stick movement. This acceleration should be anticipated and avoid unnecessary stick movement by relaxing your grip on the stick.

AILERONS

21 The ailerons are hydraulically powered by tandem power cylinders and they provide a good lateral control. At high speeds, rapid or extreme aileron movement can impose undesirable twisting loads to the wing.

CAUTION

Some lateral overcontrol may occur between .7 and .9 mach number below 10,000 feet due to the high roll rates and rolling accelerations available.

RUDDER

22 Rudder control becomes effective at approximately 70 knots and remains effective throughout the entire speed range. There will be a pedal force gradient increase above 290 knots airspeed. This is the feel system switchover as described in PART 1 of this EO. Inherent to swept wing design is the dihedral effect (roll due to yaw), the rudder is very effective in correcting this tendency (picking up low wing). Rudder action will normally be performed by the yaw damper which is used throughout the speed range.

FLAPS

23 Wing flaps when used for approach and landing, and in some instances in flight, improve the stability of the aircraft. The flaps act as both lift and drag devices and provide for slower touchdown speeds which shortens landing roll distances.

SPEED BRAKES

24 Two hydraulically extended panels on the empennage act as speed brakes. They are very effective and give rapid deceleration. A mild buffet will be noted when speed brakes are fully extended at high speeds. A mild nose-up trim change occurs with their extension. A good deal of yaw will occur when the speed brakes are selected when the aircraft is being operated single engine.

PREFLIGHT CHECK

BEFORE ENTERING COCKPIT

25 Check FORM L-14 for engineering status and ensure that the aircraft has been properly serviced.

PRE-EXTERNAL COCKPIT CHECK

26 (a) Ejection seat safety pin – INSTALLED
Check that the ejection seat handgrips are in the full down position and that the seat safety pin, with red warning flag attached, is properly installed through the left handgrip.
(b) Landing gear handle – DOWN
Physically check the landing gear handle in the down position.
(c) Tail hook switch – WITNESS WIRED AND LIGHT OUT
(d) Armament selector knob – VIS-IDENT
Safety detent knob should be witness wired when applicable.
(e) Master arm switch – SAFE
Switch should be witness wired and sealed in the SAFE position if armament is aboard.
(f) AIR-2A ejector racks lock switch – LOCKED
Switch should be witness wired and sealed in the locked position if an AIR-2A is aboard.
(g) Pitot heat switch – OFF
(h) Battery switch – OFF

EXTERNAL INSPECTION

27 Perform external inspection as outlined in figure 2-1.

PRE-START CHECK (Front Cockpit)

NOTE

If a battery start is to be made, certain items of this check cannot be accomplished. Those items omitted will be accomplished after the engines have been started and aircraft electrical power is available.

28 (a) Seat-man separator straps – PROPERLY POSITIONED

NOTE

Make sure the automatic-opening lap belt is properly fastened. The lap belt should be pulled tight prior to tightening the shoulder harness. Secure the auto rip cord to the safety belt.

(b) Survival kit, safety belt, and shoulder harness – FASTEN
Attach the survival kit straps to the parachute harness. Attach the shoulder harness and parachute lanyard to the safety belt.
(c) Seat and rudder pedals – ADJUST
After adjusting the seat, adjust the rudder pedals by use of the hand crank located on the pedestal panel.
(d) Optical sight control – CHECK AND SET AS DESIRED
(e) Bail-out light – CHECK
(f) Pneumatic/Combustion Start Switch – AS REQUIRED
(g) Comm control panel – CHECK
(1) Channel Selector knob – COMM
(2) Emergency listen switch – NORMAL
(h) Horn and pusher switches – ON
Check the horn switch guard is witness wired down.

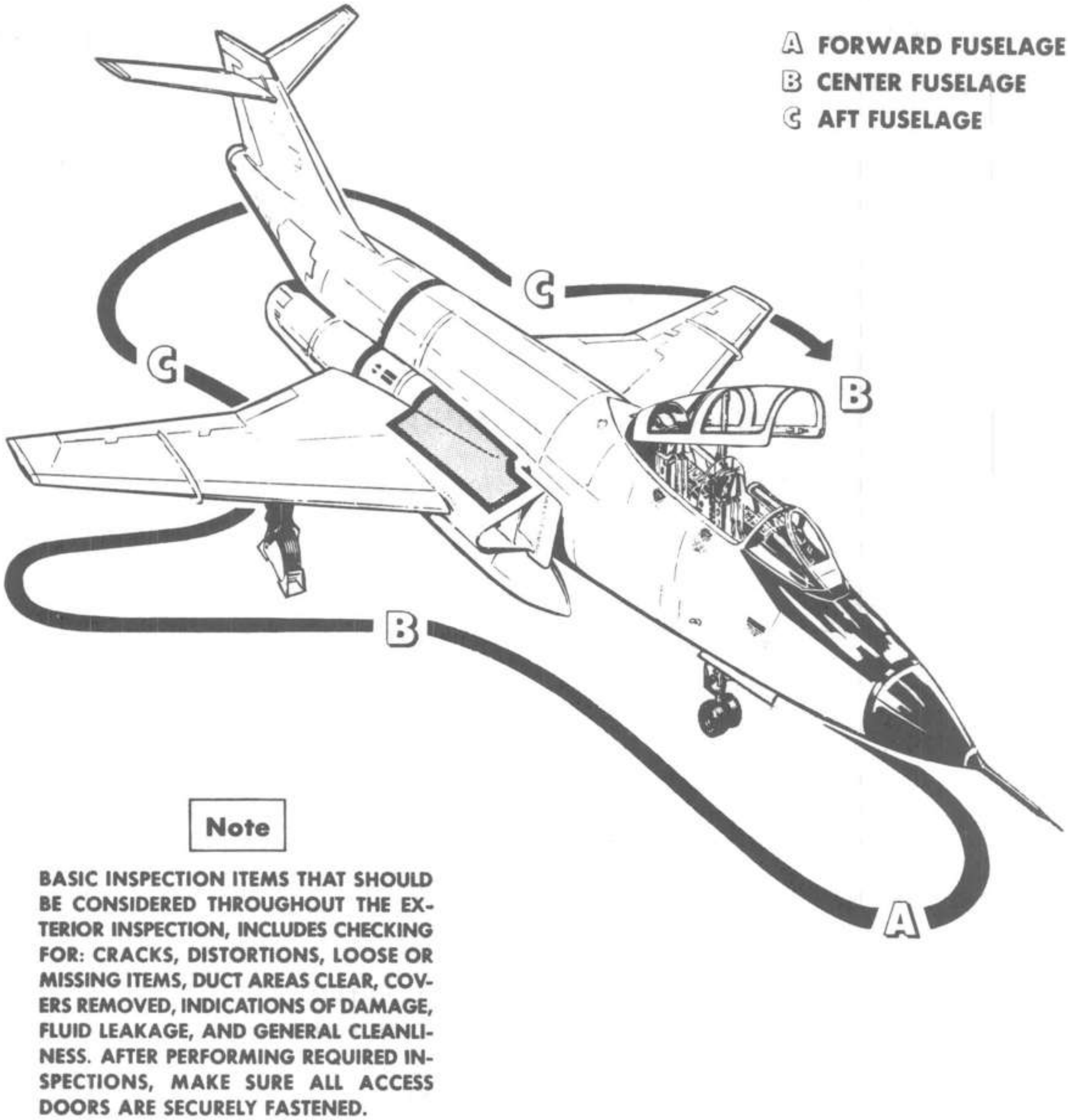
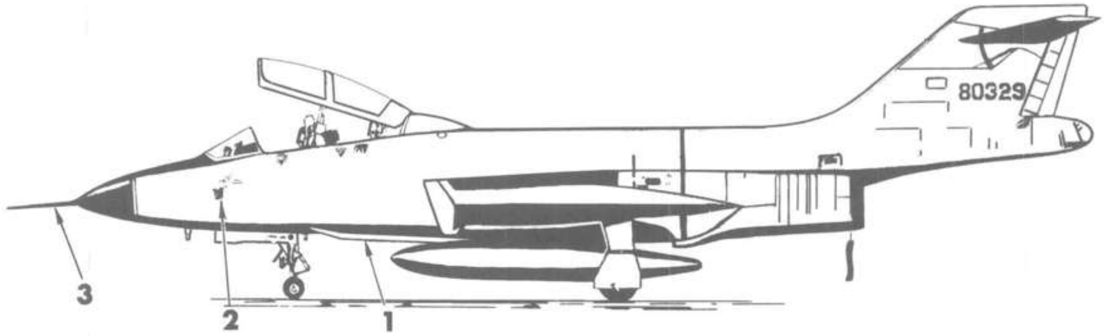
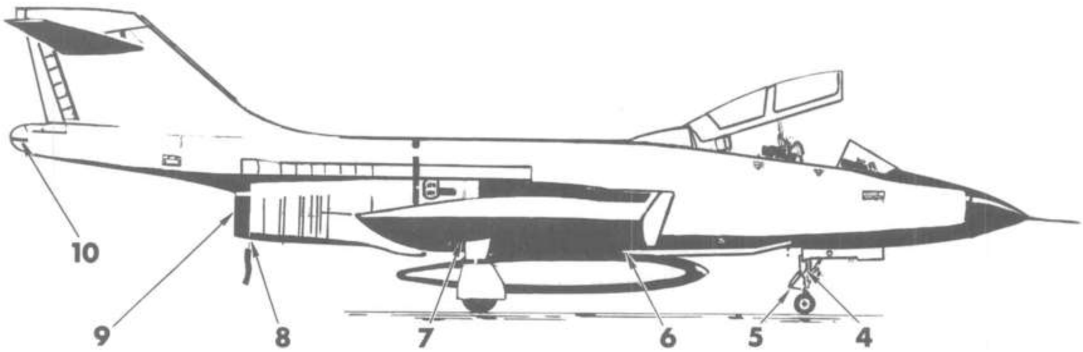


Figure 2-1 (Sheet 1 of 2) Exterior Inspection





(A) FORWARD FUSELAGE

1. ARMAMENT BAY-CHECK
   a. ARMAMENT LOAD
2. EXTERNAL CANOPY CONTROLS-CHECK
   a. OXYGEN VENT VALVE IN BUILD-UP POSITION
   b. CANOPY EMERGENCY JETTISON LANYARD IN PLACE
   c. LANYARD SAFETY PIN REMOVED
   d. CANOPY WRENCH IN PLACE
3. PITOT STATIC BOOM
4. NOSE GEAR AND WELL AREA-CHECK
   a. EMERGENCY BRAKE VALVE IN OFF POSITION
5. NOSE GEAR PIP PIN PROPERLY INSTALLED

(B) CENTER FUSELAGE AND WING AREA

6. EXTERNAL TANK-CAP SECURE AND PIN REMOVED
7. MAIN GEAR AND WELL AREA-CHECK
   a. COMPRESSION LINKAGE MOVES FREELY
   b. STORAGE CHAMBER PRESSURE INDICATOR PIN EXTENDING

WARNING

IF ANY UNUSUAL RESISTANCE IS ENCOUNTERED DO NOT PULL THE TAIL HOOK SAFETY PIN UNTIL THE TAIL HOOK IS RELATCHED.

(C) AFT FUSELAGE AREA

8. CHECK TAIL HOOK SAFETY PIN REMOVED
9. EXHAUST AREA-CHECK
10. DRAG CHUTE INSTALLED
    a. CHECK TAB SHOWING
11. CHECK LEFT SIDE SAME AS RIGHT SIDE

Figure 2-1 (Sheet 2 of 2) Exterior Inspection

(j) Fuel control panel and quantity – CHECK
  (1) Fuselage transfer switch – NORM
  (2) Wing and external tank transfer switch – STOP
  (3) Refuel switch – NORMAL
  (4) External tanks release switch – NORM
  (5) Check fuel quantity in all tanks; leave quantity selector knob on cell No. 2.

(k) UHF radio – ON

(m) Emergency landing gear handle – IN, SECURE, AND WITNESS WIRED

(n) Wing flaps – UP
  Ensure flap lever corresponds to actual flap position.

(p) Landing and taxi light switch – OFF

(q) Circuit breakers – IN

(r) Icing ignition and internal air switch – OFF

(s) Throttles – CLOSED

(t) Engine master switches – OFF

(u) Emergency fuel control switches – NORMAL

(v) UHF antenna selector switch – UPPER

(w) Emergency speed brakes switch – NORMAL

(x) Emergency brake handle – IN AND STOWED

(y) Anti-skid system – ON AND TEST
  After turning the anti-skid system ON, depress the anti-skid release paddle switch and observe the illumination of the "Anti-Skid Out" light after 3 1/2 seconds.

(z) Drag chute handle – IN AND SECURE

(aa) Landing gear and flap indicators – CHECK
  Check the three (green) landing gear indicator lights ON, and check the flap position indicator for proper indication.

(ab) Instruments – CHECK
  (1) Set airspeed index pointer
  (2) Set EPR gauge pointers
  (3) Set altimeter
  (4) Set accelerometer

NOTE

Gyro instruments will not be available unless the AFCS and NAV SYSTEM POWER is in the ALL GYRO OPERATE position.

CAUTION

It is possible to incorrectly set the altimeter by 10,000 feet, therefore, check that the altimeter 10,000 foot printer is reading correctly.

(ac) Pilot's scope – CHECK
  Ensure the pilot's scope is clean and free of cracks or damage.

(ad) Fire warning system – CHECK
  Test the steady and flashing operation of the left and right fire warning lights through use of the test switch.

(ae) Generator switches – ON

(af) Battery – OFF

(ag) Defrost switches – OFF

(ah) Pitot heat and rain clearing switches – OFF

(aj) Cabin pressure switch – RAM AND DUMP

(ak) Cabin air temperature knob – SET AS DESIRED

(am) Cabin air temperature switch – AUTO

(an) Equipment cooling switch – NORMAL
(ap) TACAN – REC
(aq) Compass function selector switch – MAG
(ar) Roll stabilization switch – ON
(as) Cockpit and exterior lights set – AS REQUIRED
Check operation of cockpit lights and set as desired. Check exterior lights for proper operation.
(at) Warning lights – TEST
(1) Instrument lights knob – ON
(2) Warning light test button – DEPRESS
All warning, caution and indicator lights will illuminate.
(3) Warning light dimmer button – DEPRESS THEN RELEASE
All warning, caution and indicator lights will dim.
(4) Instrument lights knob – OFF
All warning, caution and indicator lights will revert to bright.
(au) ILS power – As REQUIRED
(av) Oxygen control panel – CHECK
(1) Check oxygen quantity is sufficient for mission.
(2) Oxygen "Emergency" lever – TEST
(3) Check oxygen diluter lever – 100%
(4) Check oxygen supply pressure gauge – WITHIN LIMITS
(aw) TACAN/ILS switch – TACAN
(ax) Ejector racks lock switch – LOCKED
(ay) Ejector racks annunciators – LOCKED

PRE-START CHECK (Rear Cockpit)

29 All equipment duplicated in the rear cockpit will be checked in the same manner as in the front seat. In addition:

(a) Missile preparation indicators – EXT/AFT – DEACTIVATED
(b) Left and right AIR-2A Arm/Safe/Monitor power circuit breakers – CLOSE
(c) Identification light – OFF
(d) IFF/SIF – SET AS REQUIRED
(e) Engine Master Switches – ON (Dual aircraft)
Check engine master switches witness wire on.
(f) Oxygen control panel – CHECK
(1) Oxygen "Emergency" lever – TEST
(2) Check oxygen supply pressure gauge – WITHIN LIMITS (300 to 360 psi)
(3) Check oxygen diluter lever – 100% then NORMAL
Remain on Normal oxygen throughout engine start, taxi and take-off, and report any fumes to the pilot.

BEFORE STARTING ENGINES

30 Before starting engines, be sure that wheels are chocked, and the danger areas fore and aft are clear. The rotational planes of the engine and starter turbine wheels (marked by a red stripe on fuselage) should be clear of personnel.

NOTE

28 volt DC power is required to start the engines. If this power is not available from a power cart, a serviceable battery must be installed.

CAUTION

Suction at the intake duct is sufficient to kill or severely injure personnel drawn into or pulled suddenly against duct.
Danger areas aft of the aircraft are created by high exhaust temperature and velocities. The danger increases with afterburner operation.

31 Whenever practicable, start and run up engines on paved surface to minimize the possibility of foreign objects being drawn into the compressor with resultant engine damage.

STARTING ENGINES

NORMAL START

32 Either engine may be started first; however, these procedures establish starting the left (No. 1) engine first. Simultaneous starting of both J57-P-55 engines is permitted only if tactical requirements dictate.

(a) Ground power and external air – CONNECT AND SELECT
(b) Ground crew – SIGNAL FOR START
(c) Left engine master switch – ON
(d) Left engine start switch – START
(e) Left throttle – IDLE
The throttles should be advanced from CLS'D to IDLE as soon as rpm indication is obtained.

CAUTION

(1) Because of the limited burning time within the combustion starter (11 to 13 seconds), it is essential to perform steps (d) and (e) in rapid succession. To avoid a possible fire hazard, however, assure that the engine is rotating by noting a positive rpm indication before advancing the throttle to IDLE.

(2) Should the engine fail to light-off within 10 seconds, shut down the engine. The failure to light-off will be indicated by: No rise in EGT and no increase above approximately 18% rpm.

(3) To prevent the possibility of starter destruction, a second attempt after an aborted start will not be made until engine rotation has stopped and after at least one minute has elapsed since the aborted start. A third attempt will not be made until a cooling period of 45 minutes has elapsed.

(f) Fuel flow indicator – CHECK
The fuel flow will indicate approximately 800-1000 pounds per hour.

CAUTION

If the fuel flow is appreciably less than 800 pounds per hour. a false start will likely result. If the fuel flow is in excess of approximately 1300 pounds per hour, a hot start may result. It is essential that the engine be shut down immediately when an over temperature indication occurs.

(g) Exhaust gas temperature – WITHIN LIMITS
The exhaust temperature should not exceed the maximum starting temperature limits during transition to the idle range. Normal start temperatures range from 250°to 350°C; starts with temperatures rising above this temperature range should be considered potential hot starts. Throttles should be closed 75° to 100°C before maximum EGT is reached as temperature will continue to rise slightly after the engine is shut down.

(h) Oil pressure – WITHIN LIMITS
Oil pressure should indicate 35 PSI minimum, 40 to 50 PSI normally.

(j) Idle rpm – STABILIZED
Engine idle rpm should stabilize at 63% to 65%.

CAUTION

After ignition, if the engine does not accelerate to 25% rpm, shut down the engine.
After ignition, if the engine does not accelerate to idle rpm, but remains some intermediate speed, 25% rpm or above, and the exhaust tempera-

ture remains below maximum, move the engine fuel control switch to EMERG. If the rpm does not increase after switching to EMERG, slowly advance the throttle to obtain an increase in rpm. Monitor the rpm and exhaust temperature very closely. Do not exceed 1200 pph fuel flow. When the engine rpm increases beyond 45% rpm, return the fuel control switch to the NORM position. If, during this procedure, the exhaust temperature increases without an increase in rpm, shut down the engine.

(k) Power selector switch – GEN
Have the ground crew physically place the power selector switch in the GEN position as it is possible for the power selector switch to remain in the EXT PWR position when the access door is closed.

(m) External electrical power – DISCONNECT

(n) Transformer-rectifier – CHECK TELELIGHT STRIP

(p) Battery switch – ON

(q) Hydraulic pressure – WITHIN LIMITS
With one engine started, both hydraulic pressures should be within normal limits. The hydraulic pressure warning lights will remain illuminated until the other engine is started and both hydraulic systems are operating normally.

(r) Hydraulic recovery – CHECK
Reduce hydraulic pressure through control movement, and observe recovery rate for pump operation. Recovery rate with one engine operating is up to 3 seconds for the utility system and up to 5 seconds for the primary system. Recovery rate with both engines operating is up to 2 seconds for the utility system and up to 4 seconds for the primary system.

(s) Start remaining engine.
Start the right engine as indicated in the above procedures.

(t) External air – DISCONNECT

(u) Landing gear ground locks and safety pins – REMOVE
Signal the ground crew to remove the landing gear ground locks and safety pin and ensure they are removed by visual check.

BATTERY START

33 The procedures for a battery start are the same as a normal start except that fuel flow, oil pressure, and hydraulic pressure gauges will be inoperative until aircraft generator electrical power is available. The external power selector switch should be placed in EXT PWR position to prevent interruption of the start cycle when the generator underspeed switch closes. If ground crews are not available, the power selector switch may be placed to GEN position prior to engine start. With the switch in this position AC electrical power will be available when the generator comes on the line at approximately 30% rpm.

INTERNAL AIR START

34 The procedures for an internal air start are the same as a normal start except that the internal air switch must be placed to ON prior to engine start. During internal air starts, the starter should be placed to STOP/START at 25% rpm to conserve air volume. The internal air supply (3000 psi) is adequate for one (1) start on each engine. However, after an internal air start the air bottles must be checked for a minimum of 1800 psi prior to flight, to assure emergency gear extension if required. After engines are started on internal air, place the internal air switch to OFF.

PNEUMATIC START

35 The procedures for a pneumatic start are the same as a normal start except that the pilot must place the Combustion/Pneumatic start switch to Pneumatic. During pneumatic starts, the starter switch should be placed to STOP/START at 25% rpm to conserve air volume.

GROUND OPERATION

36 After satisfactory starts are accomplished, allow the engines to idle until instrument readings stabilize. No engine warm-up is necessary. As soon as the engines stabilize at idle speed with normal gauge indications, the throttles may be opened to full thrust.

BEFORE TAXIING

37 (v) Speed brakes – CHECK
Extend and retract the speed brakes. Check hydraulic recovery during the cycle.

(w) Flaps – EXTEND AND CHECK
Obtain signal from ground crew that flaps are full down. Check that flap indicators correspond to flap position.

(x) Pitot heat – CHECK AND OFF
Momentarily turn pitot heat switch ON and observe ground crew signal that pitot heat is operative.

(y) Pitch Control System – CHECK
Signal ground crew to position angle-of-attack vanes in the full up position.

CAUTION

The angle-of-attack vane heaters are energized through the pitot heat switch. Therefore, before the ground crew positions the angle-of-attack vanes, visually recheck the pitot heat switch OFF.

NOTE

In gusty or high wind conditions it may be necessary for the ground crew to hold the vanes in the desired positions

(1) Control Stick – AFT OF NEUTRAL
(2) PCS Test Button – DEPRESS
Depressing the test button will energize the warning horn and engage the pusher.
(3) Over-power the pusher force.
The pusher may be overpowered with an aft stick force of approximately 27 1/2 pounds.
(4) Paddle switch – DEPRESS
Depressing the paddle switch will disengage the pusher, however, the horn will continue until the PCS test button is released.

In addition, the following PCS checks may be performed:

(5) Angle-of-attack vanes – FULL DOWN POSITION Slowly rotate the right (horn) vane to the up position, and observe the alpha-w needle meets the boundary wand, the warning horn will sound.
(6) Control Stick – FULL FORWARD
(7) Angle-of-attack vanes – On reference mark (red line painted on fuselage)
(8) Rapidly move control stick – FULL AFT
The stabilizer rate sensor will engage the pusher and energize the the warning horn.
(9) Pusher Switch – OFF

(z) Automatic flight control system and CSL – CHECK

NOTE

A 2 minute warm-up period must be allowed prior to autopilot operation.

(1) AFCS engage switch – AFCS

(2) Yaw Damper Switch – DAMPER
(3) Control Stick – AFT OF NEUTRAL
(4) Signal ground crew to slowly rotate the CADC vane to the full up position. The CSL will engage while the CADC vane is being rotated and the control stick will move forward.
(5) Overpower AFCS
(6) Paddle switch – DEPRESS
Depressing the paddle switch will cause the AFCS engage switch to move to standby.

(aa) MCSL – CHECK
(1) AFCS engage switch – STAND-BY
(2) MCSL engage switch – ON
(3) PCS test button – DEPRESS
(4) Pull the control stick aft and signal ground crew to position the CADC vane to the full up position. The control stick will move forward.
(5) As the control stick moves forward, overpower it. Approximately 60 pounds of force will be required.
(6) Paddle switch – DEPRESS
The control stick will be free to move but the MCSL engage switch will remain ON.
(7) MCSL engage switch – OFF
(ab) Undercarriage ground locks – REMOVE
(ac) Chocks – REMOVE

CAUTION

When the chocks are pulled, have feet on the brakes since there is no parking brake on the aircraft.

(ad) Altimeter – SET
(ae) Nosegear steering – ENGAGE

TAXIING CHECKS
(af) Brakes – TEST
After initial roll, apply brakes to check operation. Use nose gear steering as much as possible to minimize use of brakes.
(1) Do not exceed 25 knots while taxiing to prevent excessive tire wear and brake heat. Be careful not to ride the brakes.
(2) Adjust canopy so that minimum side motion will occur to prevent excessive side loads from damaging canopy mechanism.
(3) The canopy should be closed (with unlocked warning light out) and adequate distance between aircraft maintained during formation taxiing. An open canopy may become damaged from jet blast.
(4) Maintain a minimum distance of 125 feet from the exhaust blast of another aircraft that is operating at Military thrust and 200 feet from the exhaust blast of an aircraft that is operating at Maximum thrust to prevent damage to the canopy.
(5) While taxiing, do not attempt turns in excess of nose gear steering limits (40° either side of center). Execute all turns with caution utilizing maximum avilable turn radius and minimum speed. Sharp turns at speeds in excess of 15 knots may result in failure of the main landing gear or its components.
(ag) Flight Intruments – CHECK OPERATION
Check all flight instruments and set the attitude indicator pitch trim knob pointer to the zero bias index. (This should place the miniature aircraft in approximately 4 degrees nose low position,

thus providing a picture of the aircraft's inflight attitude relative to level flight conditions at normal cruise airspeed.) Select appropriate navigational aids to be used for the departure and set navigational instruments and switches as required.

PRE-TAKE-OFF CHECK

(ah) Fuel switches – NORMAL, fuel quantity selector knob set to cell No. 2.
(aj) Pusher and MCSL engage switches – OFF
(ak) Seat safety pin – REMOVE

CAUTION

Do not pull up either handgrip. The seat and canopy ejection systems are fully armed when the safety pin is removed.

(am) AFCS engage switch – STAND-BY
(an) Yaw damper – ON
(ap) Flaps – DOWN
(aq) Speed brakes – CLOSED
(ar) Circuit breakers – CHECK ALL ARE IN
(as) Emergency fuel control switches – CHECK AND NORMAL

NOTE

A slight fluctuation in fuel flow at Idle position indicates that the emergency fuel control is operating.

(at) Hydraulic pressure – CHECK PRESSURE 2800-3200 PSI
(au) Anti-skid engage switch – ON
(av) Altimeter – SET
(aw) CDI – SET
(ax) Attitude gyro – 4° NOSE DOWN
(ay) Trim – CHECK GREEN LIGHT ILLUMINATES
Depress the take-off trim button until the "Trim OK for TO" light illuminates.
(az) Instrument panel – CHECK SECURITY
(ba) Generator switches – ON, 115 VOLTS
(bb) Battery – ON
(bc) Oxygen – CHECK OPERATION – Pilot 100% – Nav. normal
(bd) Cabin pressure selector switch – NORMAL
(be) Equipment cooling switch – NORMAL
(bf) IFF/SIF – SET AS REQUIRED
(bg) Manual flight control system – CHECK
Rapidly but smoothly move the control stick fore and aft. Confirm that there is no binding of the controls, and stabilizer movement corresponds to stick movement.

TAKE-OFF CHECK

(bh) Seat safety pins – REMOVED
(bj) Canopy – CLOSED; warning light – OUT
(bk) Lanyard – AUTO RIP CORD CONNECTED
(bm) Parachute quick release box – LOCKED
(bn) Seat harness and helmet chin strip – CHECK
(bp) Bailout Bottle – CHECK
Check for the position of the bailout bottle green apple and ensure it can be easily pulled.

(bq) Pitot heat and defrosters – ON

On the ground, moisture may collect in the pitot-static tube after exposure to rain or high humidity. Heat will help to eliminate the entrapped moisture.

CAUTION

Warm-up time for pitot heat is approximately one minute at 32° F. Allow sufficient heating time if taking off in freezing rain or other visible moisture with surface temperatures at or near freezing.

(br) Radar – STAND-BY OR ON

TAKE-OFF

NORMAL TAKE-OFF

38 Normal take-off, at ambient ground temperatures of 0°F and above, is made in the full afterburner power configuration. Take-offs below 0°F are done in full military power. Acceleration is rapid during either type of take-off. Directional control is achieved easily by use of nose wheel steering and the rudder which becomes effective at approximately 70 knots. Sharp crosswind conditions on a slippery runway can lead to directional problems, refer to figure 2-2 for maximum crosswind component. Uneven afterburner light up can cause momentary swerving; this normally occurs at the beginning of the take-off roll and is easily controlled by nose wheel steering. The stabilator becomes effective quite abruptly at approximately 130 knots; care must be taken that the aircraft is not overrotated to an extreme nose up attitude as it could leave the runway in a semi-stalled, out-of-control condition. Nose gear lift-off speed and take-off speed should be increased slightly with an increase in gross weight over the clean configuration – the airspeeds given in this section are for clean configuration.

(a) Brakes – APPLY

(b) Throttles – 80m RPM
Smoothly advance throttles to approximately 80m rpm and check engine instruments.

(c) Icing ignition switch – IF REQUIRED

NOTE

When large puddles are present on the runway, engine compressor stalls and afterburner blow-out is possible due to the engine's ingesting water thrown up by the nose wheel. The critical speed for this occurance is between 80 and 100 knots. When this occurance is anticipated or when icing conditions are expected during take-off and climb, turn the icing ignition switch ON prior to take-off. Icing ignition should be terminated as soon as possible to conserve igniter plug life.

(d) Warning lights – CHECK
Check that all warning lights are out.

(e) Brakes – RELEASE

(f) Throttles – FULL MILITARY
Check EPR's for correct thrust output.

(g) Afterburner – SELECT (if ambient temperature above 0°F.)
Check EPR's for proper afterburner nozzle operation.

(h) Use nose gear steering for directional control until the rudder becomes effective at approximately 70 knots IAS.

(j) Ease the nose gear off the runway at approximately 155 knots IAS, and establish a take-off attitude of approximately 5 degrees pitch.

(k) Allow the aircraft to fly off runway at take-off airspeed; approximately 175 KIAS.

CROSSWIND TAKE-OFF

39 Under crosswind conditions, the aircraft tends to "weathervane" into the wind immediately after releasing the brakes. Nose gear steering must be utilized to maintain directional control until the rudder becomes effective at approximately 70 to 90 knots, depending upon crosswind intensity. Avoid using brakes as take-off run will be increased. As take-off speed is approached and the aircraft starts to fly, it tends to "cock" into the wind and "skip" on the downwind tire until fully airbone. This tendency should be corrected through normal crosswind control procedures; wing down into wind and rudder to maintain direction.

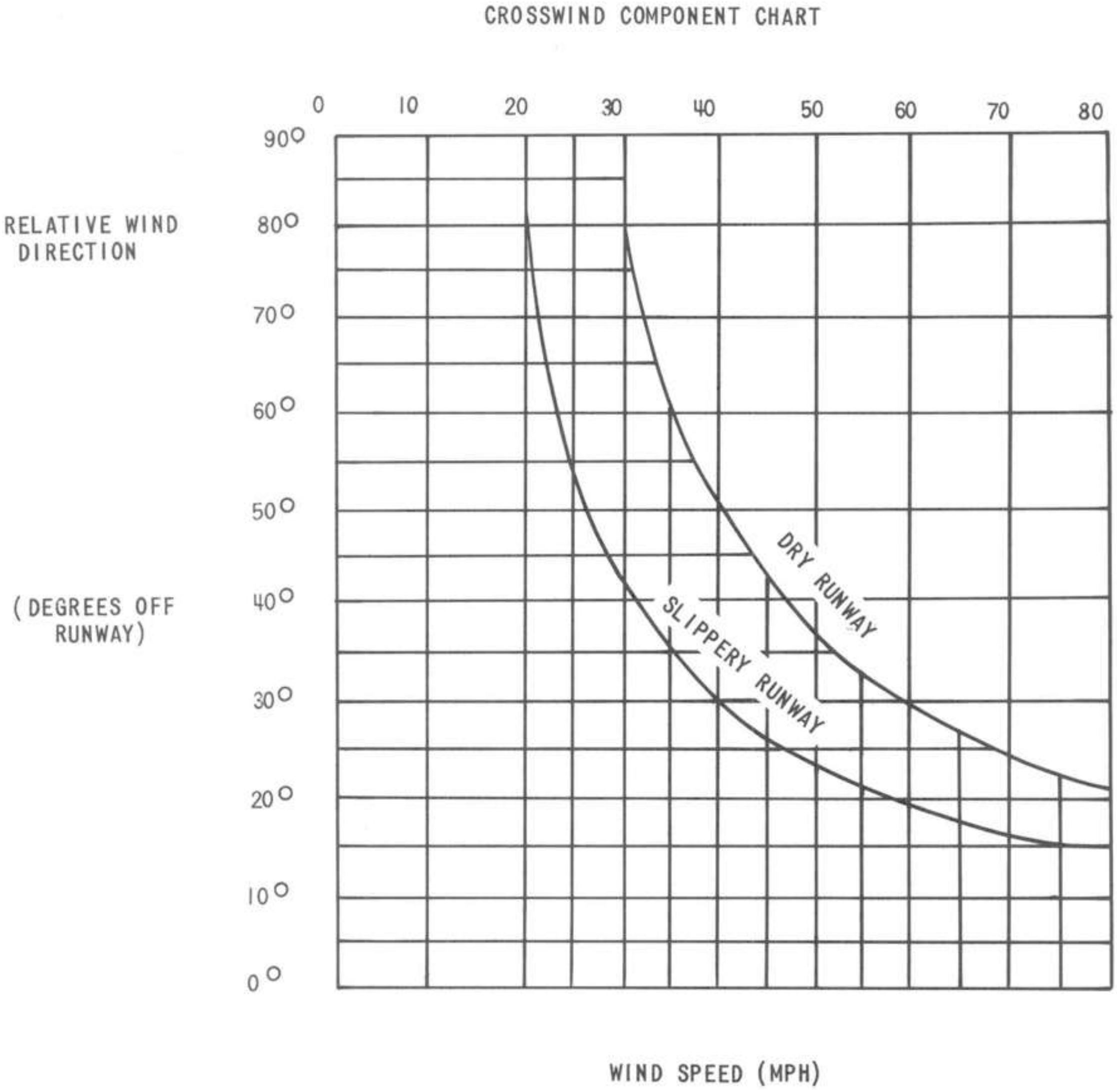


Figure 2-2 Crosswind Component Chart

AFTER TAKE-OFF

AFTER BECOMING AIRBORNE

40 (a) Landing gear – UP

Visually check the landing gear handle full UP, the gear position indicators out, and the gear handle warning light out.

NOTE

The landing gear can be up and locked without the control handle being in the full UP position. In this position the handle can be inadvertently moved to the DOWN position by vibrations or acceleration forces, causing an inadvertent landing gear extension.

CAUTION

The landing gear and gear doors should be completely up and locked before 250 KIAS is reached, otherwise excessive air loads may damage gear mechanisms and prevent subsequent operation.

(b) Flaps – RETRACT

The flaps should be up before reaching the flap limit airspeed, Check flap indicator.

(c) Throttles – AS REQUIRED

(d) Engine pressure ration gauges – CHECK

When terminating afterburner operations, engine pressure ratio should momentarily drop and then return to its original setting.

NOTE

If the engine pressure ratio should drop, and remain at a low setting, the exhaust nozzles have failed to close. Reduce thrust on the affected engine to idle of recycle the afterburner in an attempt to close the exhaust nozzles.

CLIMB

MILITARY THRUST CLIMB

41 A military thrust climb is the most efficient climb technique from a range consideration. After lift-off maintain take-off pitch attitude until the aircraft has accelerated through approximately 350 KIAS. If afterburner has been used for take-off its operation should be terminated at 250 KIAS. At 350 KIAS rotate the aircraft smoothly to approximately 10° pitch attitude, attempting to stabilize the climb at 370 KIAS. When 370 KIAS intercepts .8 mach, at approximately 20 thousand feet, maintain .8 mach until level-off. The climb schedule can be flown most accurately by selecting a pitch attitude and then analysing the result. Pitch attitude should not exceed 15° and corrections should be limited to 2° increments.

MAXIMUM THRUST CLIMB

42 An afterburner climb is the most effective climb technique if time-to-altitude is the primary consideration. After lift-off maintain take-off pitch attitude until the aircraft has accelerated through approximately 350 KIAS. At this speed smoothly rotate the aircraft to 25° pitch attitude, attempting to stabilize the climb at 400 KIAS. Do not exceed 30° pitch attitude. If 30° pitch is reached and the IAS is above 400 knots, maintain 30° pitch ignoring the IAS. When 400 KIAS intercepts .85 mach, at approximately 22 thousand feet, maintain .85 mach until level-off. Pitch corrections should not exceed 5° increments.

DURING CLIMB

43 (e) Pusher switch – ON

The pusher switch should be placed in the ON position when passing through 5000 feet terrain clearance.

(f) Oxygen diluter lever – NORMAL

CAUTION

Monitor the exhaust temperature. If the exhaust temperature increases to its maximum limit reduce thrust to maintain the exhaust temperature within allowable limits.

(g) Armament safety check – ACCOMPLISHED
(h) Ensure cell #2 is still full.

LEVEL-OFF

44 Level-off is normally accomplished by a smooth push over to level flight. To level-off from a military power climb, start push over approximately 1000 feet low. For a maximum power climb, start push over approximately 3000 feet low.

(a) Transfer external and wing fuel.
  (1) Fuel gauge – TOTAL
  (2) Fuselage transfer switch – GRAV
  (3) Follow transfer procedures as laid down under Fuel System Management.
  (4) With cruise power set each external tank will take 10-15 minutes to transfer.
  (5) With cruise power set the wings should transfer in 1 1/2 to 2 minutes and show an increase in the fuselage cells total of 800 to 1000 pounds.
(b) Oxygen – CHECK OPERATION, PRESSURE AND CONTENTS
(c) Pusher – CHECK ON
Perform rate horn and pusher check. Move the control stick rapidly fore and aft to trigger the rate horn and pusher. The magnitude of stick movement should not be sufficient to change the aircraft pitch angle.
(d) CSL – CHECK
Engage the AFCS and smoothly roll into a turn of approximately 45°of bank. Increase “G” loading smoothly until the CSL is felt. Do not exceed the PCS system limits during this check. Unload the “G” loading, roll out of the turn, and disengage AFCS
(e) MCSL – CHECK
Engage the MCSL and smoothly roll into a turn of approximately 45°of bank. Increase “G” loading until the MCSL is felt. “G” loading and PBI reading for the MCSL should be identical to the readings for the CSL. Do not exceed the PCS system limits during this check. Roll out of the turn, leave the MCSL engaged unless a malfunction was detected, and continue the flight.

CAUTION

Do not use the AFCS or MCSL if a malfunction is detected during these checks. If the AFCS does not engage do not engage the MCSL.

(f) Armament Safety Check – COMPLETE

DURING MISSION

FUEL MONITORING

45 Correct and timely fuel monitoring leads to early detection of fuel system malfunctions. Complete fuel checks should be carried out every ten minutes. This should be considered maximum time interval. During take-off and initial climb, flight under 5000 feet, and when total fuel is below 3000 pounds, cell 2 should be monitored with periodic checks on TOTAL and the other cells. During the mission, TOTAL should be monitored with frequent checks on all cells to check for proper fuel transfer.

FUEL SYSTEM MANAGEMENT

46 With one or two external tanks installed the following procedure should be followed. Fuel from external tanks should be used to keep the aircraft fully topped up internally for as long as possible in case the tactical situation requires the tanks to be jettisoned.

(a) During taxi, take-off and climb to altitude, fuselage switch – NORM, External tank switch – NORM
(b) At level-off, fuselage transfer switch – GRAV
(c) When the external tanks are empty, select wing transfer switch – NORM
(d) When the wing tanks are empty, select wing transfer switch – STOP, fuselage transfer switch – NORM
(e) The external tank transfer switch should be left in NORM until the end of the flight for tank pressurization.
(f) Barring fuel system malfunction, the fuselage transfer switch should be left in NORM for the remainder of the mission.

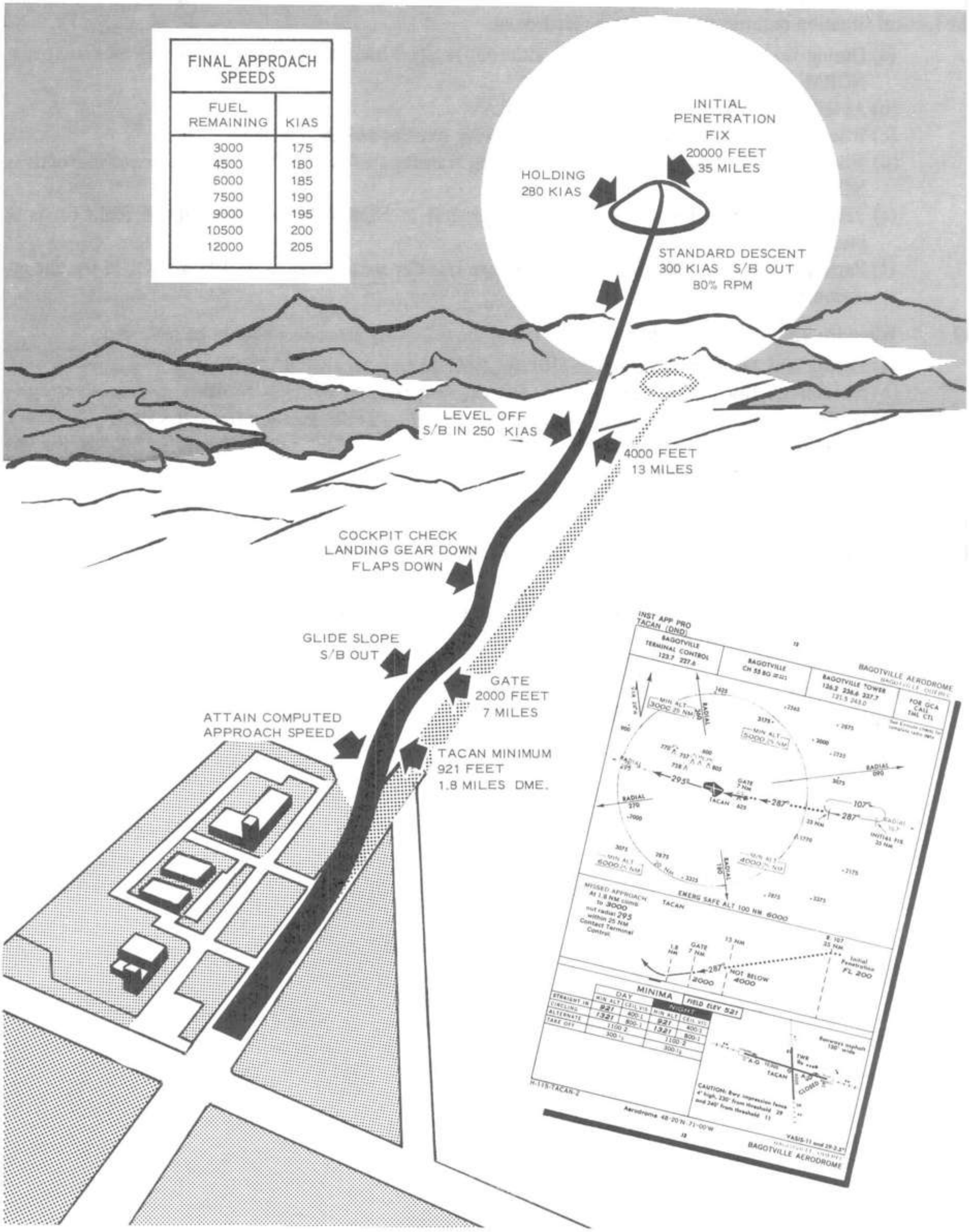
47 When the aircraft is in the clean configuration, the following procedure should be followed:

(a) During taxi, take-off and climb to altitude, fuselage transfer switch – NORM
(b) At level-off, fuselage transfer switch – GRAV, wing transfer switch – NORM
(c) When the wing tanks are empty, wing transfer switch – STOP, fuselage transfer switch – NORM
(d) Barring fuel system malfunction, the fuselage transfer switch should remain in NORM for the remainder of the mission.

OXYGEN CHECKS

48 Oxygen checks should be carried out every ten minutes at a minimum.

(a) Quantity – CHECK
Ensure quantity is greater than 1 litre. If less, descend immediately and return to base.
(b) Pressure – 300-360 PSI
(c) Blinker – CORRECT OPERATION
(d) Selection – NORMAL
(e) Hose connections – SECURE



FINAL APPROACH SPEEDS	
FUEL REMAINING	KIAS
3000	175
4500	180
6000	185
7500	190
9000	195
10500	200
12000	205

Figure 2-3 Typical Jet Penetration

RECOVERY

PRIOR TO DESCENT CHECK

49 This check should be done approximately 10 minutes before final descent is made and after the intercept mission is complete.

(a) Armament safety check – COMPLETE
(b) AIR-2 circuit breakers – OUT
(c) Pitot heat – ON
(d) Defrosters – NORM

NOTE

Both air and electrical defrost should be operated in NORM at all times. In this position the systems should preclude the formation of fog or frost on the windscreen and canopy.

(e) Circuit breakers – IN
(f) Fuel – CHECK TANK QUANTITIES, MONITOR CELL 2
It may be necessary to recheck total fuel again prior to final approach to compute final approach speed.

DESCENT CHECK

50 This check is normally done immediately before descent, but if it is delayed, it should be complete before descent through 16,000 feet ASL.

(a) Pusher and MCSL – OFF
Must be off prior to 5000 feet AGL.
(b) Hydraulics – NORMAL PRESSURE
(c) AFCS – STANDBY
Must be off prior to 500 feet AGL.
(d) Seat belt and shoulder harness – TIGHT AND LOCKED
(e) Altimeter – SET
Unless the initial approach altitude is less than 18,000 feet ASL the altimeter must not be set to station altimeter setting until final descent is initiated.

HOLDING AND STACKING

51 Holding patterns should be flown as published or directed at an IAS of 280 KIAS. This airspeed produces maximum endurance at any likely holding altitude and is high enough a speed for comfortable handling. Unless turbulence is severe there should be no necessity to increase this speed even in formation. Descent to a lower altitude within a stack should be made by use of speed brakes with care taken to maintain airspeed.

STRAIGHT-IN TACAN APPROACH

52 This approach is the only one outlined in detail; others such as tacan teardrop, random tacan, random radar, ADF, and tacan arc all use basically the same descent schedule. Enroute descents are left to the discretion of the pilot. The Tacan 2 needle on the compass indicator is normally used for point to point navigation to the initial tacan fix; during descent, however, the CDI is considered more accurate.

(a) Upon reaching initial tacan fix with clearance to the airport – BEGIN DESCENT
Ease the aircraft into a 10° dive.
(b) At 300 KIAS – SPEED BRAKES OUT AND POWER TO 80%
(c) During descent – MAINTAIN 300 KIAS
Adjust dive angle to maintain 300 KIAS.
(d) Altimeter – SET
Set altimeter, monitor during descent, and cross-check to cabin pressure etc.

(e) At published altitude – LEVEL OUT
Level out must be lead by approximately 1000 feet or it will require harsh pull out.
(f) Speed brakes – IN AT 250 KIAS
Adjust power to maintain 220-230 KIAS.

At this point the aircraft is set up to complete the approach by Tacan, GCA or ILS. Each of these final procedures are covered under separate headings as is the common Pre Landing Check.

PRE-LANDING CHECK

53 This check is common to all approaches, however, the position at which each step is carried out may be different. When this is the case it will be noted under that type of approach.

(a) At 250 KIAS, speed brakes – IN
(b) Landing gear – DOWN
(c) Flaps – DOWN
(d) Power – ADJUST TO MAINTAIN 220-230 KIAS
(e) Landing gear and flap indications – CHECK DOWN
(f) Tail hook light – OUT
(g) Landing light – ON
(h) Speed brakes – OUT WHEN REQUIRED
(j) Speed – REDUCE TO COMPUTED APPROACH SPEED

NOTE

The landing gear can be down and locked without the control handle being in the full DOWN position. In this position the handle can be inadvertently moved to the UP position by vibration or acceleration forces, causing an inadvertent landing gear retraction.

CAUTION

Do not lower landing gear in turns or pull-ups as the "G's" encountered may damage the landing gear mechanism.

FINAL TACAN APPROACH

54 During the final phases of a Tacan approach, the Tacan 2 needle may hunt and the CDI move from side to side slightly. This is due to antenna location. This movement does not create a serious problem but it may be anticipated and allowed for.

(a) Prior to 14 miles – COCKPIT CHECK COMPLETE
(b) Delay speed brakes until final descent.
(c) With CDI set on approach heading – CENTER VERTICAL BAR
(d) On final descent – SPEED BRAKES OUT
(e) Establish a 800-1000 FPM descent, gauging the descent to arrive at minimum altitude at minimum range.
(f) Fly computed approach speed.

This procedure allows the established rate of descent to continue when the runway is visable rather than leveling out early and having to re-establish a descent rate.

RADAR GROUND CONTROLLED APPROACH (GCA)

55 The aircraft is stable in the landing configuration and may be flown to normal GCA limits. During the final phases of the approach, application of small amounts of rudder may aid in more accurate heading control – this technique should not be used to excess as it could result in cross-controlling.

(a) Upon GCA direction – COCKPIT CHECK COMPLETE
(b) If GCA has not directed the cockpit check by 10 miles – COCKPIT CHECK COMPLETE

(c) Delay speed brakes until glide path.
(d) Reduce aircraft to approach speed.
(e) On glide path – SPEED BRAKES OUT
(f) Establish 800-1000 FPM descent
(g) Follow GCA directions closely
(h) Ensure an accurate approach speed by 1/2 mile.

INSTRUMENT LANDING SYSTEM (ILS)

56 A warm up period is required for the ILS set. If ILS is available at destination the power switch should be turned ON 10 minutes prior to final approach.

(a) Preparation for ILS:
(1) Power switch – ON
(2) Radar – STANDBY
(3) Localizer frequency – SET ON ILS
The glide slope frequency is automatically set when the localizer frequency is dialed. Identify ILS.
(4) Localizer beam heading – SET ON CDI
(5) ILS/TACAN switch – SET TO ILS
(b) Fly published ILS pattern.
(c) Prior to 14 miles – COCKPIT CHECK COMPLETE
(d) Delay speed brakes until glide slope.
(e) Reduce aircraft to computed approach speed.
(f) When glide slope intercepted – SPEED BRAKES OUT
(g) Establish 800-1000 FPM descent
(h) Keep vertical and glideslope bars – CENTERED
(j) Ensure an accurate approach speed as minimums are approached.

MISSED APPROACH

57 If an approach is missed due to weather and there is sufficient fuel on board, proceed to alternate. It must be remembered that on overshoot from approach minimums a certain amount of height must be lost to break the established descent. Every effort should be made to safely reduce this height loss to a minimum.

(a) When approach is aborted or missed – FULL MILITARY POWER
(b) Speed brakes – IN
(c) When climb is established – LANDING GEAR UP
(d) At 200 KIAS – FLAPS UP
(e) Establish climb at 250 KIAS with a 2000 FPM rate of ascent.
(f) Limit bank angles to 30° and do not turn out till airspeed has reached 250 KIAS.
(g) Fly missed approach pattern.

VFR CIRCUIT

58 Extensive instrument reference is used during VFR circuits to maintain accurate heading, altitude, and "G" loading control. Visual lookout, however, is particularly important due to the difference in circuit speeds of the Voodoo and of more conventional aircraft. The downwind leg and final turn are wider than normal, and the final turn is usually done with relatively high angles of bank, continuous from downwind until roll out on final – these are danger areas and a vigilant lookout must be maintained by both crew members.

(a) Fly main pattern at 350 KIAS at local circuit height.
(b) Establish initial 5 miles out.
(c) Over the approach end of the runway – ROLL INTO A 60° BANK TURN
(d) Speed brakes – OUT
(e) Increase "G" loading – 10° ALPHA ON PBI OR VERY LIGHT BUFFET
(f) Maintain circuit altitude by varying bank angle.

CAUTION

Do not increase "G" loading to the PCS horn boundary. If the horn boundary is inadvertently reached, reduce "G" loading and ease bank angle.

(g) On downwind – ROLL OUT
(h) 250 KIAS – SPEED BRAKES IN
(j) Landing gear – DOWN
Check warning light and horn, indicators, and landing gear handle position.
(k) Flaps – DOWN
(m) Tail Hook Light – OUT
(n) Begin a descending 180° turn back to the runway.
(p) Reduce speed to 220-230 KIAS during initial part of final turn.
(q) During final portion of the trun – SPEED BRAKES OUT
(r) Begin slow bleed-off to arrive at computed approach speed as the runway threshold is crossed.

LANDING

FINAL APPROACH

59 The final portion of any approach should be straight-in from 2-3 miles at an approach angle of 2 1/2° to 3° with power selected to maintain an 800 to 1000 foot per minute descent. Relatively high power settings (approximately 85% per engine) must be carried until the runway threshhold is crossed or rapid airspeed bleed and high sink rates can develop. Approach speeds are computed by using the weight of fuel remaining. With 3000 pounds or less the approach speed is 175 KIAS – with every increase of 1500 pounds over the basic 3000 pounds the airspeed is increased 5 KIAS. If the flaps are up add 15 KIAS to the weight-computed airspeed. Approach speeds must be accurately flown. If the approach speed drops below that computed, high sink rates and rapid airspeed bleed will result. If the approach speed is above that computed, the result will be a longer than normal landing roll.

FLARE AND TOUCHDOWN

60 After the runway threshhold is crossed and just before touchdown, the aircraft should be flared slightly to reduce, but not stop, the rate of descent. As the flare progresses the throttles should be eased to idle. Flaring and reducing the power to idle reduces the aircraft speed from approach to landing values (about 10 KIAS less than approach speed). Touchdown should be relatively solid with little tendency to "balloon". Velvet-smooth type landings should not be attempted as the zeroing of descent rate at the precise moment of runway contact can easily be misjudged and the attempt to re-establish a descent rate will invariably result in a hard landing. If touchdown is attempted from an approach with a high rate of descent, the flaring manoeuvre will merely rotate the aircraft leaving the rate of descent unchanged which will, in turn, result in extremely heavy touchdowns.

LANDING ROLL AND DECELERATION

61 Immediately the aircraft is on the runway and the power is at idle, proceed as follows:

(a) Drag Chute – DEPLOY

(b) Raise the aircraft nose for – MAXIMUM AERO BRAKING

NOTE

The above two steps deliver maximum deceleration at speeds in excess of 100 KIAS and should not be forfeited in favour of wheel braking.

(c) At 110 to 120 KIAS – EASE NOSE WHEEL TO THE RUNWAY

(d) Centralize rudders and – ENGAGE NOSE WHEEL STEERING

(e) Maintain direction by use of rudder/nose wheel steering.

(f) Use wheel brakes as necessary.

62 The high aerodynamic drag available from high angles of attack is extremely useful as a braking device. For maximum aero braking raise the nose 10° above the horizon. Do not exceed 13° or the PCS horn boundary as the tail pipes may scrape the runway. Begin lowering the nose between 120-110 KIAS so the nose wheel can be lowered gently – if the nose is held high till the stabilator loses effect, the nose will come in violent contact with the runway with the possible result of nose wheel tire failure, nose gear damage, radar component failure, or at least shaken aircrew.

CAUTION

Do not select nose wheel steering with large amounts of differential rudder as violent swerving will result as the nose wheels snap to the selected angle.

63 If the drag chute is deployed and maximum aero braking has been utilized, harsh braking is rarely required. The most efficient braking technique is a single, smooth application of the brakes with a constantly increasing pedal pressure with maximum braking occuring just short of anti-skid cycling. Harsh or maximum

braking should be avoided where possible as it results in excessive brake and tire wear and possibly hot brakes.

CROSSWIND LANDING

64 Carefully compensate for crosswind in the traffic pattern to guard against undershooting or overshooting the final turn. On final approach, use wing-low and crab combination to maintain course. Maintain normal approach speed aligning the aircraft with the runway just prior to flare-out and landing with a wing-low crosswind correction. After touchdown, deploy the drag chute and maintain a normal nose-high attitude (approximately + 10°) to take advantage of the high aerodynamic drag. Utilize rudder steering for directional control. Well before rudder effectiveness is lost, or at approximately 120 knots IAS (whichever occurs first), lower the nose gear to the runway and engage nose wheel steering to maintain directional control. At lower airspeed during the landing roll, the ailerons may assist in directional control.

CAUTION

(1) The nose gear steering system becomes progressively more sensitive as speeds are increased above approximately 120 knots.
(2) Caution should be used in engaging nose gear steering with rudder deflected, as swerving of the aircraft will result.
(3) The drag chute should be retained throughout the landing roll, however, if it is obvious that directional control cannot be maintained due to an extreme weather-vane effect, the drag chute should be jettisoned.

LANDING ON SLIPPERY RUNWAY

65 The technique for landing on wet or icy runways is essentially the same as that for a normal landing. Maintain aircraft alignment carefully throughout final approach, touchdown and landing roll. Use rudder for directional control prior to nose lowering speed, and nose gear steering, rudder, and aileron thereafter. If extremely slippery conditions exist, and optimum braking efficiency must be achieved; hold published airspeeds on final, slowly reduce power so as to touchdown as near the approach end as possible, deploy drag chute, and use maximum aerodynamic braking. After the nose is lowered, smoothly apply brakes to just short of the point at which anti-skid cycles. As the aircraft decelerates, tire friction will increase, and brake pressure should be increased to continue braking to the point of anti-skid cycling.

NOTE

Under extremely slippery runway conditions braking efficiency will be very low at high speeds. Initially, little if any deceleration will be noted as a result of braking, but as the aircraft slows, the effect of braking will become apparent. Do not interpret the initial lack of deceleration as a malfunctioning anti-skid system. Turning anti-skid off under these conditions will eliminate the only system that can accurately sense a skid condition.

OVERSHOOT

66 The decision to go-around should be made as early as possible. Approximately 500 pounds of fuel are consumed in a typical overshoot and closed pattern. If decision is made to overshoot, proceed as follows:

(a) Drag chute – JETTISON (if deployed)
(b) Throttles – AS REQUIRED
Advance throttles to OPEN or AFTERBURNER as required.

CAUTION

(1) If decision is made to go-around after touchdown, do not exceed normal take-off attitude.

(2) Because of excessive fuel consumption, afterburner should be used only if definitely required when fuel remaining is below 3,000 pounds.

(c) Speed brake switch – CLOSE
Simultaneously close speed brakes while advancing throttles.
(d) Landing gear – UP
Retract landing gear when definitely airborne and a rate of climb is established
(e) Flaps – UP AT 200 KIAS
(f) Clear runway as soon as practicable.

POST LANDING CHECK

67 After completing the landing roll, turn off the active runway and perform the following:

(a) Speed brakes – IN
(b) Flaps – UP
(c) Landing light – OFF
(d) Seat pin – IN
(e) Pitot heat, defrost, rain clearing – OFF
(f) Cabin pressurization – RAM AND DUMP

CAUTION

Attempting to open the canopy while the cockpit is pressurized may cause damage or loss of canopy. Prior to opening the canopy, check cabin pressure altimeter to insure that cockpit is fully depressurized.

(g) Tacan, IFF and ILS – OFF
(h) Radar – WARM
(j) Drag Chute – JETTISON

CAUTION

Taxiing at high throttle settings with the drag chute deployed will lead to reduced service life of the drag chute. Avoid taxiing over previously jettisoned drag chutes as they could become ingested into the engines or wrapped around the landing gear causing considerable damage. The drag chute should be jettisoned before taxiing downwing with tailwinds exceeding 15 to 20 knots as it could be blown forward onto the hot nozzle area or become tangled in the landing gear.

ENGINE SHUTDOWN

68 Either engine may be shutdown first, however, this procedure establishes the left engine (No. 1) first, to permit checking the right engine hydraulic system for proper operation.

(k) Brakes – APPLY
(m) Throttles – IDLE

NOTE

(1) Normally the engines will be sufficiently cooled to permit immediate shutdown. However, in instances where the engines have been operated above 85% rpm for periods exceeding one minute during the last five minutes prior to shutdown, it is recommended that they be operated below 85% rpm for 5 minutes in order to prevent seizure of the rotors.

(2) After the idle cooling period, operate the engine at 70% rpm for 30 seconds immediately before shutdown to insure complete oil scavenge.

(n) Wheels – CHOCKED
Get signal from ground crew that wheels are chocked before releasing brakes.

(p) Left throttle – CLS'D
If there have been indications of hydraulic system malfunction, DO NOT attempt an engine shutdown until landing gear ground locks have been installed and wheels are chocked.

(q) Check that port generator comes off the AC bus as engine RPM decays past approximately 30%.

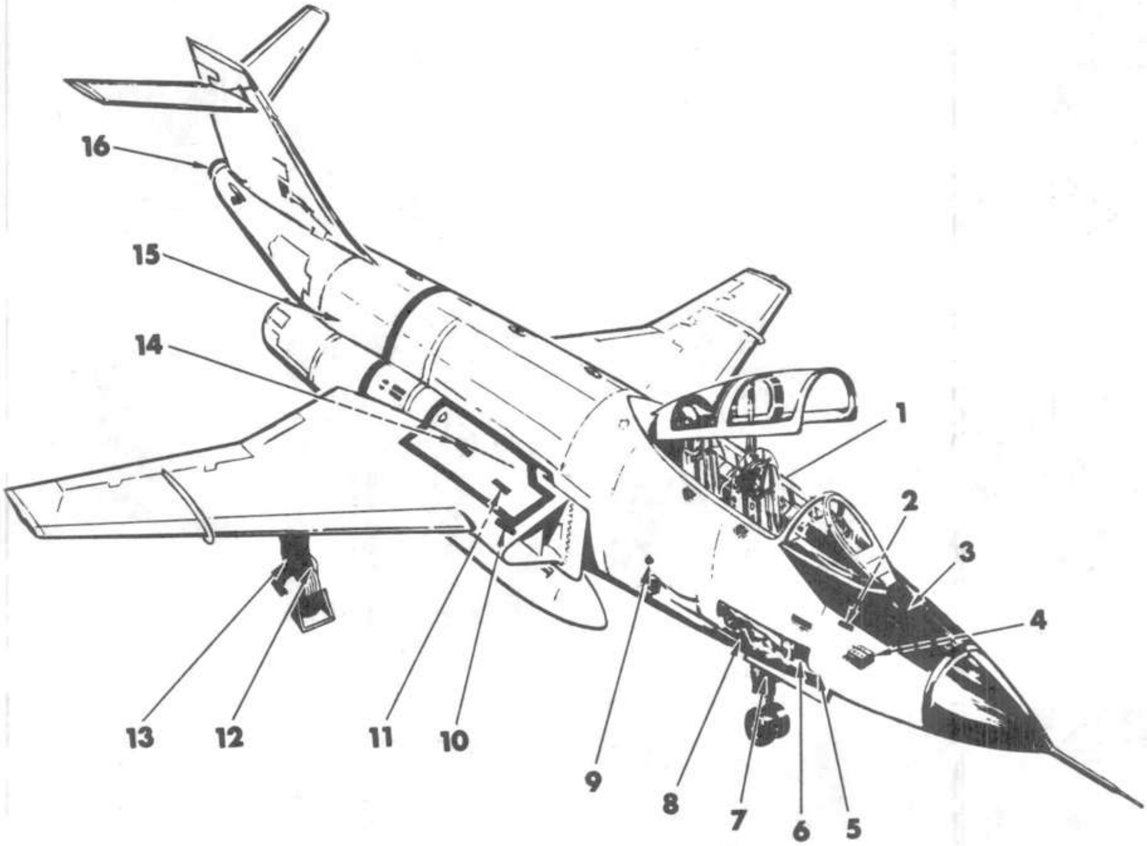
(r) Check utility and primary hydraulic lights come on as engine RPM dies. Check pressures within limits for starboard engine.

(s) When the ground crew signal that landing gear pins are in – Starboard throttle CLS'D.

(t) Check that starboard generator comes off AC bus at approximately 30%.

(u) Battery – OFF

(v) Engine master switches – OFF



HYDRAULIC FLUID MIL-O-5606 (NATO H-515).
FUEL JP-4 MILJ-5624E (NATO F-40).
ALTERNATE FUEL JP-5.
EMERGENCY FUEL-AVIATION GASOLINE MIL-G-5572,
LOWEST GRADE AVAILABLE.
COMMERCIAL FUEL-
ASTM D1655-59T, JET B
FREEZING POINT - 60° F
SINGLE POINT REFUELING MAXIMUM PRESSURE
60 PSI AT 600 GPM
OIL MIL-L-7808-I (NATO O-148).
OXYGEN MIL-O-27210A, TYPE II GRADE B.

Figure 2-4 (Sheet 1 of 2) Servicing Diagram

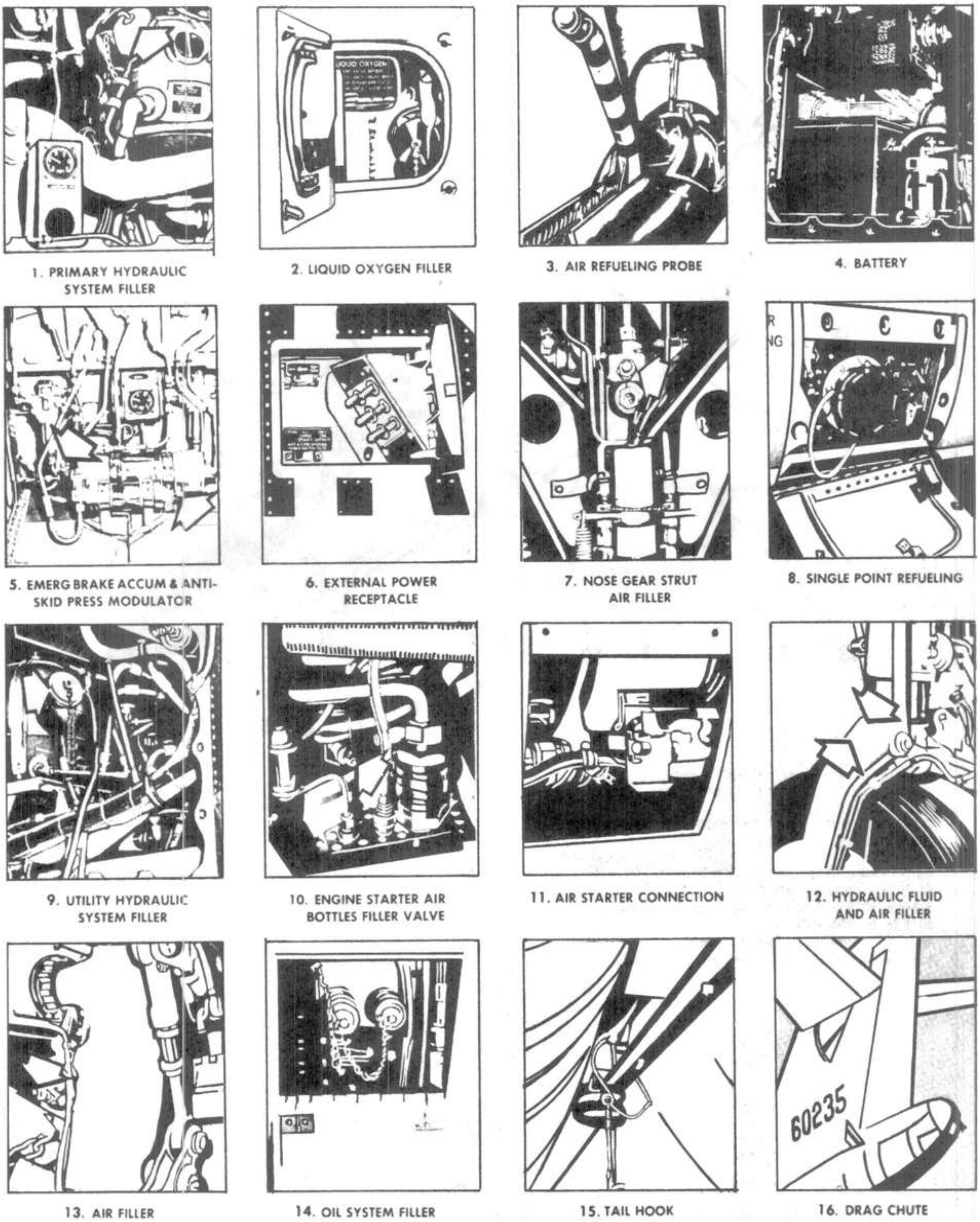


Figure 2-4 (Sheet 2 of 2) Servicing Diagram

ADVERSE WEATHER OPERATION

GENERAL

69 This section considers factors effecting flight operations which are present during seasonal or adverse weather conditions. Winter operations, although normal in Canadian latitudes, are considered adverse because of the flight safety hazard they present.

HOT WEATHER

70 Hot weather operations do not differ greatly from normal operations except that precautions must be observed to protect the aircraft from damage due to high temperatures and blowing sand, dust, etc. It must be remembered that engine performance is reduced as air temperatures rise.

(a) During external check:
  (1) Ensure all protective covers and any accumulations of sand or dust are removed.
  (2) Check oleos for cleanliness.
  (3) Inspect the tires for blisters, evidence of deteriotation, and proper inflation.
  (4) Check for hydraulic leaks as heat and moisture may cause valves and packings to swell.
  (5) If fuel caps are removed personnel should stand clear as thermally expanded fuel vapour may blow the cap off, or the fuel out of, the tank with sufficient force to cause injury.
  (6) Since it is possible to damage plexiglas in extremely hot weather, do not allow foreign objects to come in contact with the canopy and windscreen.

(b) Normal starting procedures are used in hot weather. Since the engine temperatures will probably be on the high side of the operating range, ground operation should be kept to a minimum.

(c) Since take-off distances are increased by high temperatures the charts in PART 4 should be used to compute the take-off roll and abort distances.
  (1) Avoid take-offs in air contaminated with blowing sand, dust, etc.
  (2) When taking off in warm humid conditions, place the cabin pressure switch to RAM and DUMP till 5000 feet to prevent the formation of fog in the cockpit.

(d) Landing during hot weather requires the pilot to be more cautious of gusts and wind shifts near the ground. Landing ground rolls are only slightly higher than those in normal temperatures.
  (1) Cabin temperature should be increased or RAM and DUMP selected to prevent the formation of fog in the cockpit while operating at traffic altitude.

(e) Before leaving the aircraft, protective covers should be replaced, doors and panels secured, and the canopy closed to prevent contamination by dust and sand. If the location is not subject to blowing sand and dust the canopy should be left open.

PRECIPITATION AND HIGH HUMIDITY

71 The problems encountered during operations in precipitation and high humidity are mainly vision within, and out of, the cockpit; engine operation; and slippery runway conditions.

(a) During external check, drain any accumulated water from the ailerons to prevent iced controls at altitude.

(b) Turn the defrosters on earlier than normal and increase cabin temperature, or leave the cabin pressure switch in RAM and DUMP until 5000 feet, to prevent fog in the cockpit.

(c) Out of the cockpit visibility may be improved, both on landing and take-off, by use of the rain clearing system.

(d) It is possible for the wake of the nose wheel, going through puddles, to be thrown up into the engine intakes causing engine flame out during landing or take-off. As a preventive measure, the icing ignition may be used to reduce this possibility.

(e) Flight through clouds of vertical development, with their associated high water content, is not recommended as engine flame out could result. Icing ignition should be used as a preventative measure during penetration of such clouds.

(f) Landing during, or immediately after, heavy precipitation presents the problem of slippery runways and perhaps hydro-planning. Maximum use should be made of drag chute and aerodynamic braking. Directional control should be maintained by use of rudder, and then as speed decreases, aileron and nose wheel steering. Braking should be cautious and anti-skid should be used to good advantage. The decision of whether or not to take the barrier should be made early in order to lower the tailhook well in advance of the barrier cable.

COLD WEATHER

72 Flight operations during extremely cold weather are hazardous and require increased vigilance on the part of the aircrews in the face of extreme personnal discomfort.

(a) Dress warmly – there is adequate space in the cockpit to stow headgear, heavy gloves, etc.

(b) Ensure all ice, snow, hoar frost, etc., is cleared from the airframe. Supervise to ensure the job is done correctly; at no time should ice be chipped as airframe damage could result.

(c) Ensure wheel chocks are properly installed and that the immediate area is clear in case the chocks slip.

(d) Upon entering the cockpit:

(1) Brush any snow from seat pack and cockpit consoles.

(2) Close cockpit as soon as possible for crew comfort.

(3) When checking fuel levels remember that cold fuel weights per volume are heavier than warm fuel weights. The gauging may be slow and have a tendency to stick in extreme cold.

(e) There is no difference in engine start procedure, however, engine instruments must be closely monitored.

(1) If there is no engine RPM when the starter is engaged – STOP START immediately; the compressor rotor could be ice-locked by frozen condensation. External heat should be applied to the forward end of the engine and the engine started as soon as possible after heating to prevent the moisture from re-freezing.

(2) If any unusual noise or lower than normal engine RPM is noted the start should be aborted.

(3) If the start is made at ambient temperatures of -31° F or lower, the engine must be allowed to warm up for 2 minutes at idle before running at higher speeds. Abnormal oil pressures may be experienced during this warm up period.

(4) Turn on the cockpit air conditioning, and windscreen and canopy defrosting systems immediately after engine start. Check the canopy and windscreen for cracks, paying particular attention to the areas around the mounting screws.

(5) Operate all flight controls sufficiently to ensure that control surface movement is normal.

(6) Ensure all instruments have warmed up sufficiently to operate normally.

(f) Use extreme caution when taxiing.

(1) Avoid taxiing in deep snow or drifts as steering is difficult and frozen brakes may result.

(2) Control taxi speed – increased thrust of the engines tends to accelerate the aircraft quickly – even at idle power.

(3) Increase spacing when taxiing behind other aircraft to preclude icing, jet blast damage, and collision.

(g) Take-off acceleration is extremely rapid in cold weather and care must be taken to avoid overspeeding the landing gear.

(1) Start the take-off roll at 80%RPM and when the aircraft is rolling and properly aligned with the runway, select desired take-off thrust.

(2) Asymmetric afterburner ignition could lead to directional problems – correct any yaw input smoothly but quickly.

(3) The EPR's may overshoot the maximum allowable value by as much as one tenth and for as long as 5 minutes. This overshoot may be tolerated as long as other engine limits are not exceeded.

(h) If take-off has been made from a wet snow or slush covered runway, operate the brakes several times to expel wet snow or slush. Cycle the landing gear several times to prevent it freezing in the up position.

(j) Landing in cold weather presents no specific difficulty except the chance of slippery runways is enhanced. The paragraph dealing with landing in precipitation covers this problem adequately.

(k) Prior to engine shut-down the engines should be run at idle for five minutes to ensure a more even cooling of the components. Any unusual noise on shut-down should be reported.

ICING

73 In general, icing can be divided into two specific areas: airframe icing and engine icing. Avoid icing conditions if at all possible. If flight must be made in icing conditions, plan well ahead on the best course of action.

(a) Airframe icing. It is possible to accumulate a good deal of airframe ice and be unaware of it. This is because light icing is normally dispelled from the windscreen by normal defrost methods and the greatest accumulation of wing ice is out of sight on the bottom of the wing.

(1) The accumulation of ice will disrupt the smooth flow of air over the wings and increase the weight of the aircraft to the point where flight is perilously close to the critical angle of attack. Airframe buffet and the PBI will serve as good warning devices. Increase the power setting to maintain a safe airspeed.

(2) Air-friction heat will burn off airframe ice if the indicated airspeed is above 350 to 400 KIAS.

(3) Windscreen icing will normally occur during moderate to severe icing conditions. Normal air and electrical defrost and high cabin heat should be used to prevent its build-up. If this proves inadequate, rain clearing and air defrost emergency should be judiciously used.

(b) Engine icing. Interior engine icing is normally prevented by the automatic engine de-icing system, however, there is a danger that airframe ice forming on the intake duct lips will break off and be ingested by the engine. If this occurs the engine will most probably compressor stall and flame out. Compressor damage may occur due to the impact of the ice but it is unlikely to disable the engine.

(1) The corrective action for inlet icing is – avoidance. Get out of heavy icing areas as flame out can be expected in 5 to 10 minutes.

(2) If possible fly at a speed exceeding 300 KIAS.

(3) Turn icing ignition ON.

(4) Monitor engine instruments closely and be ready to clear a compressor stall or light an engine.

(5) Attempt to maintain a high military power setting – if over-temperature occurs move the throttle slowly toward idle. If overtemperature persists, shut engine down.

(c) A third type of problem, which may be loosely termed icing, is ice crystal ingestion. Compressor stalls caused by ingesting ice crystals may be experienced at high altitudes when in, around, or under clouds or when penetrating thunderstorms. They generally occur when operating in weather above 30,000 feet. There will be a loud report or a series of loud reports from the affected engine. There will be no airframe ice accumulation preceding this type of stall. This type of icing will not normally lead to engine flame out, although the engine may have to be shut down to clear the stalls.

(1) Turn icing ignition – ON

(2) Afterburner – OFF

(3) Leave power setting relatively high to maintain level, co-ordinated flight.

(4) Clear compressor stalls in the manner outlined in Emergency Handling.

TURBULENCE

74 Intentional flight through turbulence is not recommended, although heavy turbulence may be penetrated safely at normal cruise speeds provided the yaw damper is operative. The rapid changes of angle of attack resulting from turbulence could increase the distortion of inlet airflow to the point where the

engine may surge, compressor stall, or flame out. Excessive yaw "G" loads may overstress the aircraft if the yaw damper is not operative.

(1) Penetration will be easier, and more safe, if speed is increased to 300 to 350 KIAS.
(2) If the engines surge, compressor stall, or flameout, normal recovery technique should be used.

THUNDERSTORMS

75 Intentional penetration of thunderstorms is definitely not advised. If flight must be made in close proximity to thunderstorm cells, maximum use should be made of ground and airborne radar and visual observations to avoid storm centers. All the problems associated with turbulence, precipitation, and icing have already been mentioned – hail and lightning are added thunderstorm attractions. If you must penetrate a cell, or close to a cell, proceed as follows:

(1) Set speed between 300 and 350 KIAS.
(2) Lower seats and tighten harness.
(3) Turn instrument lights full bright.
(4) Turn all thunderstorm lights – ON
(5) Turn defrosters – ON and increase cabin heat
(6) Turn icing ignition – ON
(7) Be prepared for lightning strikes, hail strikes, excessive noise, radio static, extreme turbulence, engine and airframe icing, compressor stalls and flame out.

RUNWAY OVERRUN BARRIERS

MA–1A (WEB-CABLE) BARRIER

76 The MA–1A barrier is a web-cable type barrier which consists of two across-runway cables, a series of nylon straps, and two sets of heavy link chains. The smaller "tripping" cable is suspended approximately 3 feet above the runway surface and is directly above the larger "stopping" cable. Extending between, and connected to the cables are the nylon straps. The heavy link chains, which are attached to the larger "stopping" cable, supply the required forces to stop the aircraft.

MODIFIED MA–1A (WEB-CABLE) BARRIER

77 The Modified MA–1A barrier is an MA–1A web-cable barrier with an additional across-runway cable. The additional across-runway cable is positioned 20 feet in front of the web-cable barrier and is supported approximately 3 inches above the runway surface. The additional across-runway cable and the larger "stopping" cable of the web-cable barrier are attached to heavy link chains which supply the required forces to stop the aircraft.

BAK-6/F-27A and BAK-9/F-27A BARRIERS

78 The BAK-6 tail hook barrier consists of an across-runway cable and two water-squeezer installations. The across-runway cable is supported approximately 3 inches above the runway surface. The water-squeezer installations are long, water-filled tubes. Conical plungers, which are attached to the across-runway cable, are pulled through the tubes, and the resistance of the water against the plungers produces the required forces to stop the aircraft. The BAK-9 installation utilizes the cross-runway cable, but the energy absorption device is a rotary friction mechanism or "clutch". The energy of the aircraft's mass/velocity is converted to heat as the cable rotates the friction mechanism.

BARRIER ENGAGEMENTS

79 To insure a positive engagement and a safe arrestment, barrier engagements should be made perpendicular to, and in the center of the barrier. Brakes should be released just prior to engagement. After engagement, braking may be resumed to maintain directional control and to aid in stopping the aircraft. Although off-center barrier engagements produce undesirable effects, in times of emergency, a barrier engagement should be attempted regardless of aircraft speed, gross weight, or position on the runway. The following barrier engagements have been successfully flight tested:

BAK-6/F-27A

160 knots	34,000 pounds	15 feet off-center
115 knots	34,000 pounds	75 feet off-center
145 knots	45,000 pounds	15 feet off-center
140 knots	52,000 pounds	15 feet off-center

80 Flight tests of the Modified MA-1A barrier were terminated at 90 knots, 34,000 pounds at 50 feet off-center. The MA-1A and Modifed MA-1A barriers are limited by the length of chain available. Aircraft damage can be expected from chain whipping action after all of the chain available has been utilized.

MA-1A BARRIER ENGAGEMENT

81 Engagement of the MA-1A web-cable barrier is accomplished when the nose gear of the aircraft strikes the "tripping" cable. As the aircraft continues forward, the nylon straps lift the "stopping" cable to a position suitable for main landing gear engagement. The barrier engagement is then complete when the "stopping" cable engages the main landing gear. Deceleration begins when the heavy link chains are pulled onto the runway. A positive barrier engagement can be detected by slight fore and aft "tugs" produced by the chain. External tanks should be jettisoned prior to engagement. If the external tanks are retained, the "stopping" cable will be slapped back to the runway surface, and the main landing gear tires may roll over it.

MODIFIED MA-1A BARRIER ENGAGEMENT

82 The tail hook should be lowered well in advance of barrier engagement. Engagement of the additional across-runway cable is accomplished by the tail hook, and deceleration begins when the chains are pulled onto the runway. Where a remote control capability from the tower to the web-cable (MA-1A) barrier exists, the web-cable should be lowered if preparing for a tail hook arrestment. If the additional across-runway cable is engaged by the tail hook, and the main landing gear engages the web-cable barrier, the tail hook will be "unloaded". In this case only the web-cable barrier will supply stopping forces. External tanks do not have to be jettisoned if a tail hook barrier engagement is anticipated.

BAK-6/F-27A and BAK-9/F-27A BARRIER ENGAGEMENT

83 Engagement of the across-runway cable of the BAK-6/F-27A barrier is accomplished by the tail hook, and deceleration begins as the conical plungers are pulled through the water-filled tubes. The BAK-6/F-27A barrier will normally be located 500 feet in front of the web-cable (MA-1A) barrier. If the tail hook engages the across-runway cable of the BAK-6/F-27A barrier and the main landing gear engages the web-cable (MA-1A) barrier, both barriers will supply stopping forces. External tanks do not have to be jettisoned if a tail hook barrier engagement is anticipated. Engagement of the BAK-6/F-27A across-runway cable may not be felt, however, a smooth deceleration will be noticed almost immediately. The BAK-9F-27A barrier will be engaged the same as the BAK-6/F-27A except the energy absorption device is a rotary friction mechanism or "clutch". The energy of the aircraft's mass/velocity is converted to heat as the cable rotates the friction mechanism.

STRANGE FIELD PROCEDURES

GENERAL

84 These procedures should be utilized for servicing the aircraft when applicable servicing instructions or personnel are not available. Aircrew should ensure that the landing gear downlocks, external tank safety pins, tail hook pin, and pitot head cover are properly installed. Close supervision should be given to personnel installing safety pins, especially if they are not familiar with the CF-101, as severe or fatal injury could result if the tail hook or the external tanks fell during pin installation.

ENGINE OIL SYSTEM

85 The engine oil system must be serviced within 30 minutes of engine shutdown.

(a) Servicing Instructions:

(1) Open engine oil servicing access door 74 L/R.

(2) Connect oil servicing unit and overflow hose to the oil tank fill and overflow fittings.

(3) Pump oil through the fill hose until oil drains through the overflow hose. When oil flows from the overflow hose, the oil tank is full.

(4) Allow the overflow hose to drain until the flow is reduced to a dribble.

(5) Disconnect the servicing unit and overflow hose from the oil tank fill and overflow fittings and replace the "Fill" and "Overflow" line caps..

(6) Close engine oil servicing access doors 74 L/R.

FUEL SYSTEM

86 The aircraft should be refueled with recommended (JP-4), alternate (JP-5), or if necessary emergency (80/87) fuel. A serviceable battery must be installed or ground power connected before single point refueling can commence. If the aircraft is not armed, no bar ballast is installed, or if no nose wheel well ballast is installed the number 5 cell lockout switch must be activated prior to refueling.

(a) Single point refueling:

(1) Ground the aircraft.

(2) Ground the servicing unit to the aircraft.

(3) Open access door 208 and remove the safety cap from the pressure refueling receptacle.

(4) Ground the refueling nozzle to the aircraft.

(5) Connect the refueling nozzle to the pressure adapter and commence refueling.

CAUTION

Fuel pressures should not exceed 60 PSI, at 600 GPM. Higher pressure may damage lines and fittings.

(6) During refueling place the IFR check switch in the activated position. If refueling does not stop within 25 seconds, DISCONTINUE REFUELING. If refueling does stop, release the check switch and the aircraft will stop refueling automatically when it is full.

(7) When the fuel flow stops, the tanks are full. Close and remove the refueling nozzle.

(8) Open defueling door 24.

(9) Replace the pressure refueling safety cap and close access door 208.

HYDRAULIC SYSTEM RESERVOIRS

87 To avoid overfilling of either hydraulic system, the speed brakes must be CLOSED, the landing gear DOWN, flaps UP, refuel probe RETRACTED, emergency brakes accumulator and system accumulators CHARGED, and rotary door in its NORMAL position. Failure to observe these precautions may result in the rupture of one or both hydraulic reservoirs.

(a) Cycle the flight controls to relieve the aircraft systems and accumulators of fluid pressure.

(b) Open access door 212 L/R and depress button on reservoir filler cap to relieve reservoir of pressure. Remove filler cap.

(c) Connect hydraulic power cart, type MJ-2 or MK-3 or equivalent, to filler port and fill reservoir to "full" line on reservoir sight gauge.

NOTE

Direct "pouring-in" of hydraulic fluid invites atmospheric fluid contamination and should be used only as an emergency means of servicing the hydraulic reservoirs.

(d) Disconnect the hydraulic power cart and replace the hydraulic reservoir filler cap.

HYDRAULIC SYSTEM ACCUMULATORS

88 To check the hydraulic system accumulators for the correct pre-charge:

(a) Cycle flight controls to relieve both systems of residual pressures.

(b) Open small door in upper aft corner of access door 212 L/R.

(c) Note air pressure reading on accumulator gauges. Maintain pressure for ambient temperature as follows:

100° F – 1280 + 50 PSI
70° F – 1280 + 50 PSI
40° F – 1130 + 50 PSI
0° F – 1025 + 50 PSI
-40° F – 920 + 50 PSI

89 To fill the accumulators with the correct pre-charge:

(a) Cycle flight controls to relieve both systems of residual pressures.

(b) Open access door 212 L/R.

(c) Remove valve cap from air valve and loosen 5/8 inch hex nut a maximum of two turns.

(d) Charge accumulator with clean dry air.

(e) Tighten swivel nut and cap valve.

BATTERY

90 The battery is located in the primary hydraulic compartment access door 212L. If electrolyte is low, add clear drinkable water to each cell as required. Do not exceed 3/8 inch above the battery plates. The specified battery is AN3154-1A, 24 volt, 11 ampere hour.

LANDING GEAR TIRES

91 The checking and servicing of the tires should be done with care due to the high pressures involved. If a tire fails during servicing operations severe or fatal injury could result to servicing personnel.

(a) Equipment required:

(1) Gauge kit (tire, 0 to 400 PSI, stock number 4910-506-8882).

(2) Source of clean dry air or nitrogen at a pressure of at least 300 PSI.

(b) Inflation pressures:

(1) Inflate nose wheels to 135 PSI.

(2) Inflate main gear tires according to take-off gross weight as follows:

Main gear tires 31 x 11.50

Up to 41,000 – 215 psi
41,001 to 45,600 – 250 psi
45,601 to 48,500 – 270 psi
48,501 to 51,000 – 285 psi
51,501 and up – 295 psi

Main gear tires 32 x 8.8
Up to 44,000 lb. – 260 psi
44,001 to 48,000 lb. – 280 psi
48,001 and up – 300 psi

(c) Tire specifications:
(1) Nose gear – extra high pressure, Type VII, 12 ply rating, nylon casing.
(2) Main gear – 31 x 11.50; high speed 22 ply, nylon casing; or 32 x 8.8, high speed 22 ply, nylon casing.

ENGINE STARTER AIR BOTTLES

92 The air charge in the engine starter air bottles may be read on gauges in access door 257. Pressures should never exceed 3000 PSI and should be charged according to ambient temperatures as follows:

100°F – 2970 psi
70°F – 2810 psi
40°F – 2650 psi
20°F – 2540 psi
0°F – 2440 psi
-20°F – 2340 psi
-40°F – 2225 psi

(a) The air bottles may be charged by two methods:
(1) Connect an MC-11 to the starter air quick-disconnect and the air bottles will fill automatically when pressure is applied.
(2) Apply air from any air source to the schraeder valve located by the air bottle gauges.

STARTING UNITS

93 The normal starter units are the MD-3 for electrical power and the MC-11 for compressed air. If these starting units are not available the following may be used:
(a) Any power unit producing 200/115 volt, 3 phase, 400 cycle AC.
(b) Any compressed air unit producing clean, dry air at 3000 PSI – preferably a modified MA-1 with a high flow besseler connector.

OXYGEN SYSTEM

94 The servicing connection for the oxygen system is located in access door 253. The system should be serviced by authorized personnel only. Ensure the valve is in BUILD-UP and the access door closed after servicing.

EMERGENCY BRAKE ACCUMULATOR

95 To charge the emergency brake accumulator:
(a) Remove valve cap from accumulator air valve and loosen 5/8 inch hex nut a maximum of two turns.
(b) Charge accumulator with clean dry air or nitrogen to 600 ± 25 psi.
(c) Tighten hex nut and cap valve.
(d) Reset the emergency brake valve.
(e) Connect external hydraulic power cart and adjust to 3000 psi.
(f) Disconnect external hydraulic power.

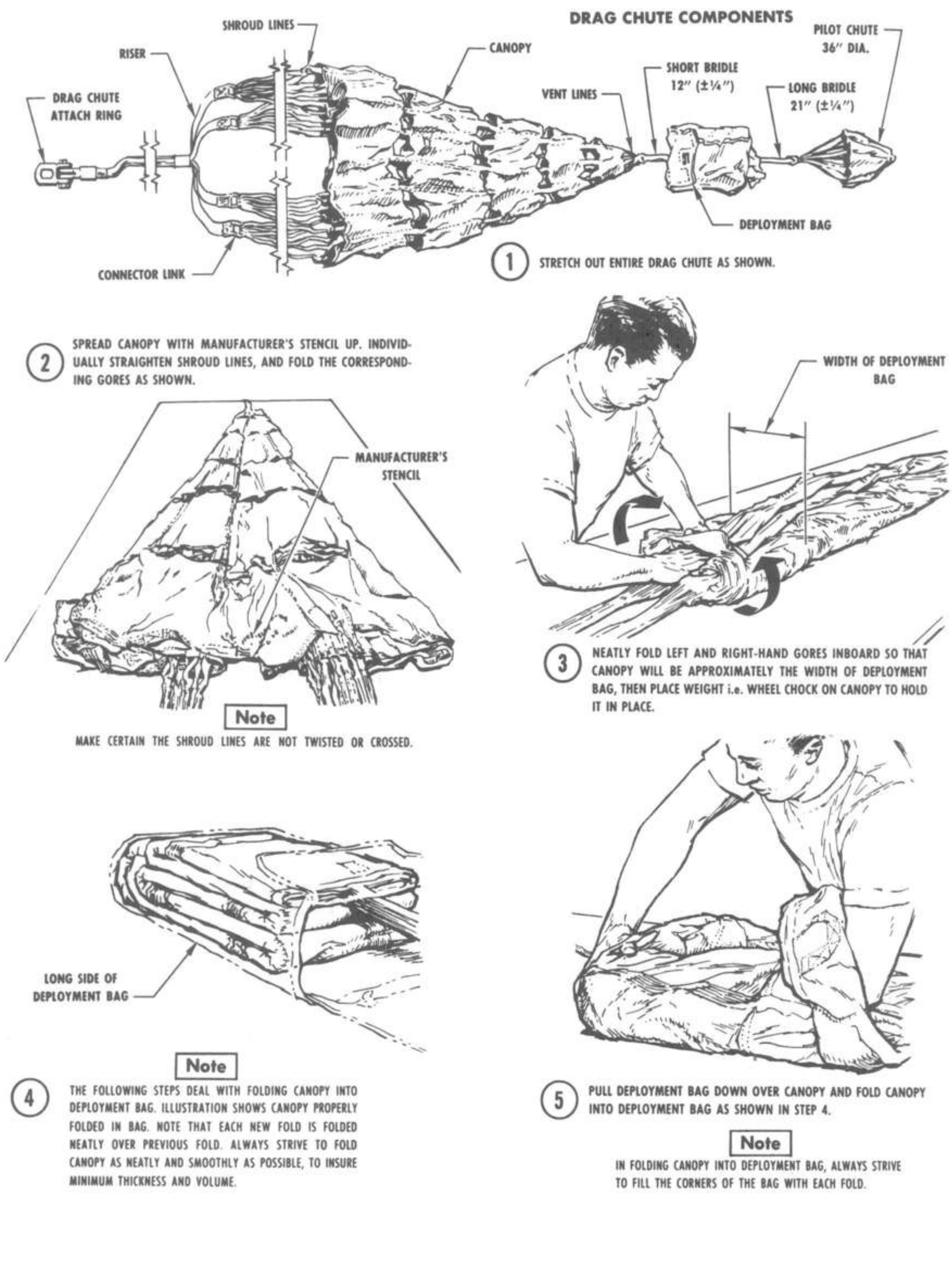
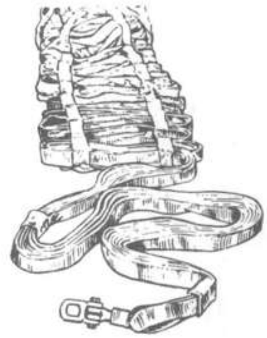


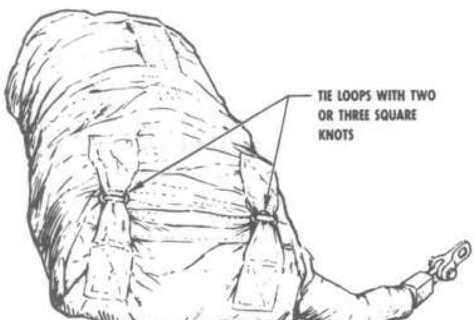
Figure 2-5 (Sheet 1 of 2) Drag Chute Packing

(6) WHEN FOLDING IS COMPLETE, PEEL BACK BAG TO EDGE OF FOLDED CHUTE COMPARTMENT AND PULL OUT FLAPS. STARTING FROM CENTER TO LEFT SIDE OF DEPLOYMENT BAG, MAKE TWO LOOPS WITH SHROUD LINES. FOLD LOWER FLAP UP AND UPPER FLAP DOWN OVER LOWER FLAP. PULL LOOPS OF LOWER FLAP THROUGH OPENINGS IN UPPER FLAP.

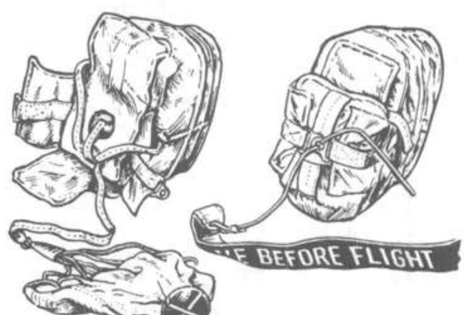


(7) WITH A HOOK OR STRONG CORD (HOOK PREFERRED) LOOP RISERS THROUGH LOOPS IN LOWER FLAP OF CANOPY COMPARTMENT AND PROCEED ALTERNATELY THROUGH LEFT AND RIGHT FLAP HOOPS. PROCEED UNTIL SHROUD LINES AND RISERS ARE STOWED ON TRAY AS SHOWN.

(8) PULL DEPLOYMENT BAG OVER SHROUD LINES AND PULL OUT FLAP. GRASP STOWAGE TRAY AND ACCORDION FOLD BACK TO CHUTE COMPARTMENT. DO NOT ROLL TRAY INTO DEPLOYMENT BAG.

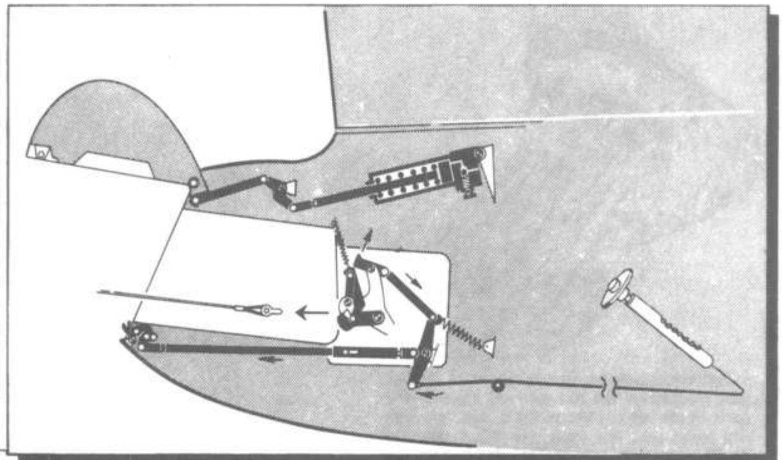


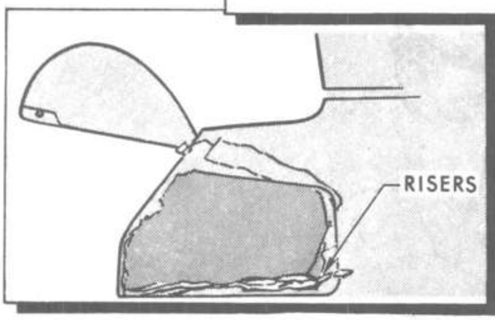
(9) FOLD SIDE FLAPS IN. LOWER UPPER FLAP AND RAISE LOWER FLAP. TIE DEPLOYMENT BAG LOOPS TOGETHER WITH 15 LB. TEST CORD.



(10) INSTALL PILOT CHUTE BY COMPRESSING THE SPRING AND FOLDING OVER THE END FLAPS. THE PILOT CHUTE CAN BE HELD IN PLACE BY INSTALLING STREAMERED STEEL WIRE OR A SIMILAR PIECE OF CABLE.

Figure 2-5 (Sheet 2 of 2) Drag Chute Packing





1. CHECK DRAG CHUTE DOOR OPEN, DRAG CHUTE HANDLE IN NORMAL POSITION.
2. HOLDING DRAG CHUTE WITH PILOT CHUTE AFT, INSERT RISER ATTACH RING THROUGH HOLE IN FRONT OF CONTAINER AND FORCE THROUGH HOOK JAWS. ATTACH RING WILL CLICK INTO PLACE. INSURE THAT IT IS SQUARE AND NOT FOULING THE HOOK MECHANISM.
3. HOLD DEPLOYMENT BAG WITH RISERS DOWN, AND PULL RISERS OUT OF BAG. LOOP RISERS NEATLY IN BOTTOM OF CONTAINER AND INSERT DRAG CHUTE, KEEPING TENSION ON PORTION OF RISER LEADING TO ATTACH RING.
4. CHECK THROUGH DOOR 58 THAT CHUTE ATTACH RING IS PROPERLY INCLOSED IN RELEASE HOOK AND THAT MECHANISM IS CLEAR.
5. POSITION CHUTE SAFETY WIRE BETWEEN DOOR HINGE AND TAIL CONE.
6. DEPRESS DOOR UNTIL NEARLY CLOSED. HOLDING DOOR WITH LEFT HAND, REACH THROUGH ACCESS DOOR 58 AND PULL RELEASE MECHANISM BELLCRANK. FINISH CLOSING DOOR AND RELEASE TENSION ON RELEASE MECHANISM BELLCRANK. SLOWLY RELEASE GRIP ON DOOR TO CHECK THAT IT IS LOCKED. IF NOT, REPEAT THIS STEP.
7. INSTALL ACCESS DOOR 58. REMOVE STREAMER AND WIRE BEFORE FLIGHT.

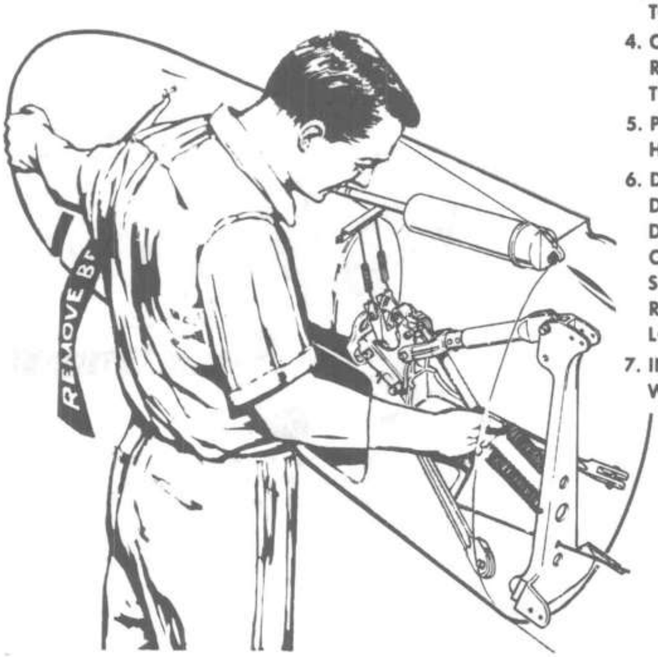


Figure 2-6 Drag Chute Installation

Pages 119/120 intentionally left blank.

PART 3

EMERGENCY HANDLING

GENERAL

1 The emergency procedures in this Part are designed to ensure maximum safety for crew and aircraft. Multiple emergencies, adverse weather and other conditions may require these procedures to be modified. It is essential, therefore, that aircrews determine the correct course of action by use of common sense and sound judgement. Within these procedures are certain steps which are considered CRITICAL. These steps must be performed immediately and without reference to written checklists. These are the steps printed in bold face type. It is considered that all other steps are non-critical in that time should be available to consult a checklist.

2 These basic steps apply to all airborne emergencies – they are CRITICAL, and should be considered included in each airborne emergency procedure.

(a) MAINTAIN AIRCRAFT CONTROL.

(b) ANALYZE THE SITUATION AND TAKE PROPER ACTION.

(c) LAND AS SOON AS PRACTICABLE.

A fourth basic step applies to all emergencies.

(d) INFORM OTHER CREW MEMBER OF THE EMERGENCY AND OF THE COURSE OF ACTION WHICH WILL BE TAKEN.

ABORTED TAKE-OFF

3 The decision to abort take-off should be made by considering the emergency, the airspeed at the time of the emergency, the length of the remaining runway, the aircraft gross weight, field elevation, ambient temperature, and runway overrun barrier availability. The first two factors should be the only ones confronting the pilot during the emergency; all the rest should have been considered prior to flight. The Critical Field Length and the Maximum Refusal Speed charts in Appendix 1 gives assisting data.

(a) THROTTLES – IDLE

(b) SPEED BRAKES – OUT

NOTE

These two steps are done simultaneously. If the emergency requires an engine to be shut down, it should be done here. If both engines are shut down, electrical and hydraulic power will be lost as the engine RPM decays.

(c) DRAG CHUTE – DEPLOY

(d) AERO BRAKING – MAXIMUM

NOTE

These two steps are done simultaneously, and immediately after the first two steps. The nose wheel should be lowered to the runway at approximately 120 KIAS.

(e) NOSE WHEEL STEERING – ENGAGE

(f) WHEEL BRAKES – AS NECESSARY

(g) TAIL HOOK – DROP (if barrier engagement is necessary)

(h) Procedures, from this point, are many and varied depending on the emergency, the pilot's success in stopping the aircraft, and whether or not the barrier was used. In general, however, if fire exists ENGINES – SHUT DOWN and ABANDON AIRCRAFT.

ENGINE EMERGENCIES

ENGINE FAILURE

4 Engine failures are often the result of malfunctions in, or incorrect utilization of the fuel system. Mechanical failure and atmospheric conditions are the other reasons for engine failures. The engine instruments will normally give warning of impending failure before it actually occurs. If the fault is correctable, air starts should be attempted, providing time and altitude permit. No aircraft system will be lost due to the failure of one engine.

(a) Before Airborne. If conditions are favorable – ABORT TAKE-OFF If flight must be continued:

(1) OPERATING ENGINE – AFTERBURNER

(2) Select dead engine out of afterburner range as soon as possible and CONTINUE TAKE-OFF.

(3) Once airborne, continue flight as is outlined in para. (b) (After Airborne).

(b) After Airborne. This is the procedure to be used if an engine failure would make speed and height critical.

(1) OPERATING ENGINE – AFTERBURNER

(2) LANDING GEAR – UP

(3) EXTERNAL TANKS – JETTISON (if height cannot be maintained)

(4) CONTINUE FLIGHT STRAIGHT AHEAD

Attempt no unnecessary manoeuvres until safe airspeed and altitude are attained.

(5) 200 KIAS – FLAPS UP

(6) 250 KIAS – ESTABLISH CLIMB

(7) Relight engine or return and land single engine, whichever the situation dictates.

(c) During Flight. This procedure will be used if an engine fails and speed and height are not critical.

(1) Determine the failed engine and, if possible, the cause of failure.

(2) If the cause is mechanical failure – shut engine down.

(3) If the cause can be rectified – attempt air start.

(4) If engine must be shut down – land as soon as practicable.

(d) Double Engine Failure at Low Altitude

(1) ZOOM-UP and JETTISON EXTERNAL TANKS

If sufficient airspeed is available, the aircraft should be pulled up to exchange airspeed for altitude. This will allow more time for airstart attempts and more altitude for ejection.

(2) ATTEMPT AIR STARTS

During zoom-up attempt airstarts one engine at a time. If sufficient altitude is available, terminate zoom-up and establish a 250 KIAS glide during which airstarts should be attempted.

(3) IF NO AIRSTART – EJECT

Eject prior to descending to minimum safe ejection altitude. If ejection is intended immediately upon zoom-up, allow the aircraft to climb as high as possible and eject while the nose is still above the horizon and before reaching stall or sink.

(e) Double Engine Failure During Flight

(1) ESTABLISH GLIDE AT 250 KIAS

This speed should ensure sufficient engine RPM to maintain electrical and hydraulic power.

(2) GLIDE TOWARD BEST EJECTION AREA

(3) ASSESS CAUSE OF FAILURE AND RECTIFY

The most likely cause would be fuel starvation. If the boost pumps have failed, relight should be possible below 30,000 feet.

(4) ATTEMPT AIRSTARTS

Attempt relights on alternate engines until an airstart is achieved or minimum ejection altitude is approached.

(5) NO RELIGHT – EJECT PRIOR TO MINIMUM EJECTION ALTITUDE.

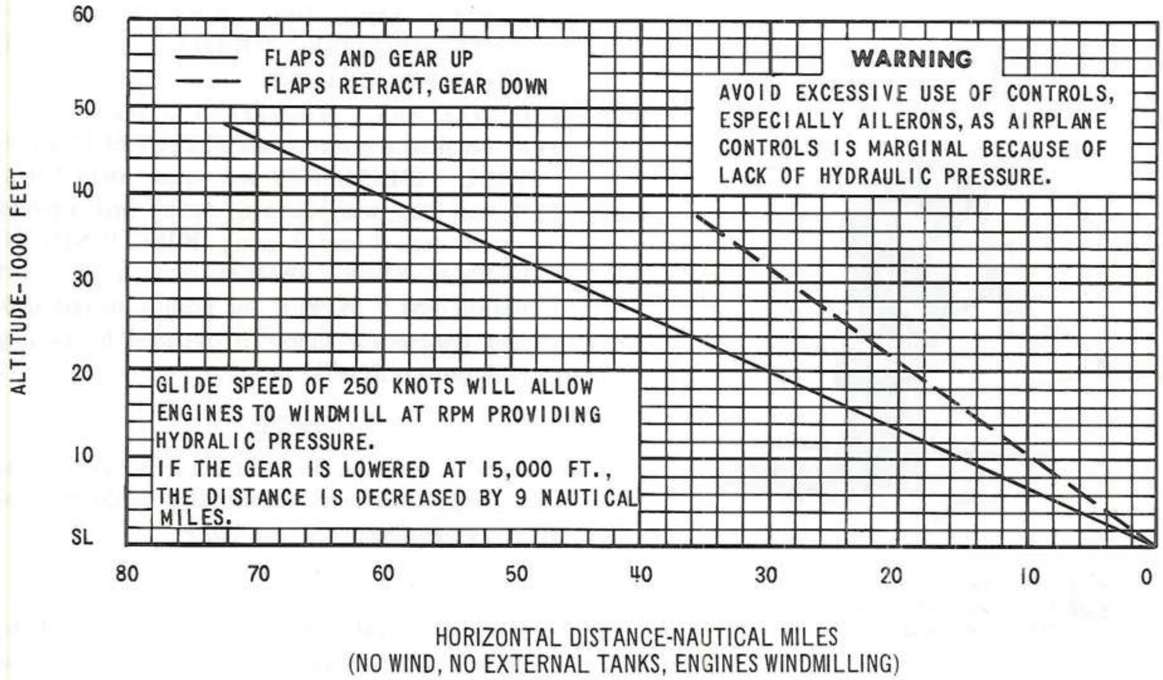


Figure 3-1 Glide Distance

AIRSTART

5 An airstart is the same as a normal ground start in that the engine must be rotating, fuel flow must be present, and ignition must be available. Failure to achieve a relight indicates the absence of one or more of these criteria. The engine instruments should indicate the problem area and subsequent airstart attempts should be changed to correct the problem. If light-off does not occur within 20 seconds, or if the engine does not accelerate to idle RPM within approximately 45 seconds, or if it will not accelerate above idle, it has been a misstart; the engine should be shut down and another airstart attempt be made. Normal relight and engine acceleration should not be expected above 30,000 feet. If, during relight, the EGT exceeds maximum limits, or if the oil pressure fails to attain 35 PSI the engine should be shut down. If the engine has cooled to sub/ zero temperatures, before the relight, it should be warmed up for 2 minutes at idle (if flight conditions permit) The following airstart procedures assume the initial cause of engine failure has been rectified.

(a) Single Engine Airstart

(1) THROTTLE (failed engine) – CLOSED

(2) DEPRESS EMERGENCY IGNITION BUTTON WHILE ADVANCING THROTTLE TO – IDLE

(3) CHECK RPM, EGT AND FUEL FLOW

(4) IF NO START – THROTTLE CLOSED

(5) If fuel flow was inadequate SELECT FUEL CONTROL – EMERGENCY and repeat steps 1 to 4.

(6) If fuel flow was adequate during first attempt repeat steps 1 and 3 using: ICING IGNITION, NORMAL START SWITCH, or as a last resort EMERGENCY POWER for normal airstart ignition (emergency power is obtained by turning both generators off).

NOTE

If airstart is made on the emergency fuel system, exhaust temperature may be controlled by throttle manipulation between CLSD and IDLE.

(b) Double Engine Airstart

(1) Maintain a GLIDE AT 250 KIAS. This should be be sufficient to hold the generators on the AC bus land to provide sufficient hydraulic pressure for control.

(2) LEFT THROTTLE – CLOSED

(3) RIGHT THROTTLE – IDLE

(4) ATTEMPT AIRSTART ON RIGHT ENGINE

(5) IF NO RELIGHT – ATTEMPT AIRSTART ON LEFT ENGINE

(6) CONTINUE AIRSTARTS ON ALTERNATE ENGINES

Airstarts should be attempted only on one engine at a time to ensure maximum fuel flow to that engine.

(7) IF NO RELIGHT – EJECT PRIOR TO MINIMUM SAFE EJECTION ALTITUDE

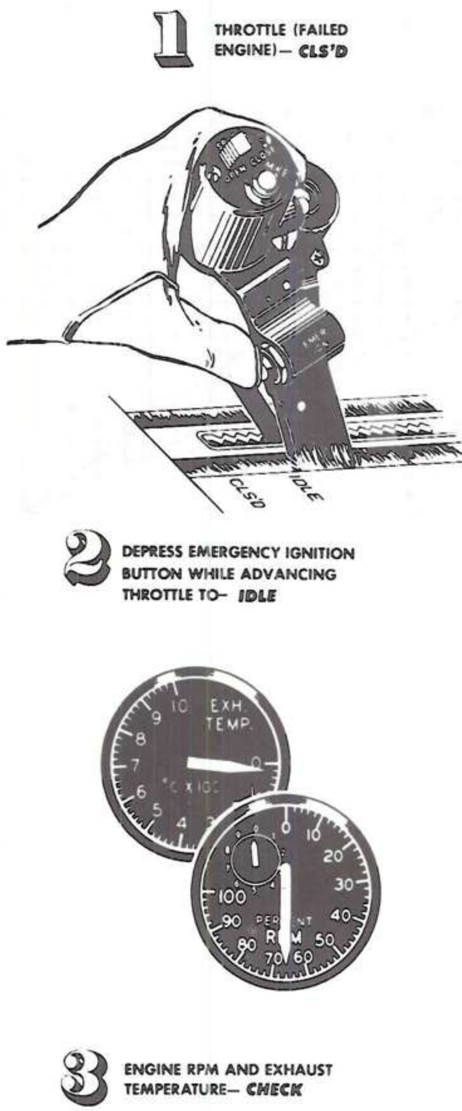


Figure 3-2 Airstart

ENGINE FIRE OR OVERHEAT

6 The engine fire and overheat lights could illuminate because of fire, overheat, or an electrical short circuit and it may be difficult to immediately determine the cause. The initial portion of these procedures should be followed immediately a fire or overheat light illuminates; the latter portion gives the options available when the cause of the light has been determined. A check for positive fire indications includes such things as trailing smoke, fumes, explosions, visual signs, engine instruments, and visual verification from an external source.

(a) Engine Fire During Starting

(1) THROTTLES – CLOSED
(2) ENGINE MASTER SWITCHES – OFF
(3) ABANDON AIRCRAFT

(b) Engine Fire or Overheat During Take-off

(1) If possible ABORT TAKE-OFF
(2) If abort is not practical CONTINUE TAKE-OFF
(3) For FIRE LIGHT – THROTTLE CLOSED
(4) For OVERHEAT LIGHT – THROTTLE IDLE
(5) Continue with appropriate After Airborne Procedure.

(c) Overheat Light After Airborne (immediately after take-off)

(1) NORMAL OPERATING ENGINE – AFTERBURNER
(2) Engine with overheat light THROTTLE – IDLE
(3) CONTINUE FLIGHT STRAIGHT AHEAD
(4) EXTERNAL TANKS – JETTISON (if height cannot be maintained)
(5) LANDING GEAR – UP
(6) 200 KIAS – FLAPS UP
(7) CHECK FOR POSITIVE INDICATIONS OF FIRE
(8) If no fire, land as soon as practicable with reduced power setting on affected engine.
(9) IF FIRE CONFIRMED – ENGINE SHUT DOWN
(10) If fire ceases, land as soon as practicable.
(11) IF FIRE CONTINUES – EJECT

(d) Fire Light After Airborne (immediately after take-off)

(1) NORMAL OPERATING ENGINE – AFTERBURNER
(2) ENGINE INDICATING FIRE – SHUT DOWN
(3) CONTINUE FLIGHT STRAIGHT AHEAD
(4) EXTERNAL TANKS – JETTISON
(5) LANDING GEAR – UP
(6) 200 KIAS – FLAPS UP
(7) CHECK FOR POSITIVE INDICATIONS OF FIRE
(8) If no fire, land as soon as possible.
(9) IF FIRE IS CONFIRMED – CLIMB TO SAFE EJECTION HEIGHT AND EJECT.

(e) Overheat Light During Flight

(1) REDUCE THRUST ON AFFECTED ENGINE
(2) CHECK FOR POSITIVE FIRE INDICATIONS
(3) If no fire and the light goes out, return to base and land as soon as practicable.
(4) If light stays on SHUT ENGINE DOWN.
(5) IF FIRE CONFIRMED – SHUT ENGINE DOWN
(6) If no fire, return to base and land as soon as possible.

(7) IF FIRE CONTINUES – EJECT

(f) Fire Light During Flight

(1) AFFECTED ENGINE – SHUT DOWN
(2) CHECK FOR POSITIVE FIRE INDICATIONS
(3) If no fire, land as soon as practicable.
(4) IF FIRE IS CONFIRMED – EJECT

(g) Engine Fire After Shutdown

(1) THROTTLES – CLOSED
(2) INTERNAL AIR SWITCH – ON
(3) ENGINE MASTER SWITCH – ON
(4) ENGINE START SWITCH – START
(5) IF FIRE CONTINUES – ALL SWITCHES OFF
(6) ABANDON AIRCRAFT

COMPRESSOR STALLS

7 Compressor stalls may occur when the engine is accelerated, decelerated, or at any other time the airflow is confused while passing through the compressor section. The stall itself will not harm the engine but the heat generated due to the lack of correct airflow in the combustion chamber will. A procedure to cover all compressor stalls is impossible due to the many and varied methods of stall entry, range of stall severity, conditions of flight at the time of stall, etc. Stalls must be understood and that part of the procedure which applies to a particular stall, be followed.

(a) Acceleration and deceleration compressor stalls.

(1) If throttle movement preceded the stall, RETURN THROTTLE TO ORIGINAL POSITION.
(2) If stall continues, follow other compressor stall procedure.

(b) Compressor Stalls

(1) NOSE DOWN IF SPEED IS LOW AND ALTITUDE PERMITS.
Nose down attitude will improve ram airflow over the compressor face. If stall occurs at high altitude, the subsequent reduction of altitude will aid in stall recovery.
(2) IF SUPERSONIC DECELERATE TO SUBSONIC SPEEDS.
(3) IF STALL CONTINUES, ACCOMPANIED BY A HIGH EGT – THROTTLE CLOSED.
(4) If no engine damage is suspected, and after the engine is stabilized – ATTEMPT AIRSTART
(5) Maintain subsonic speeds and normal co-ordinated flight attitudes for duration of mission.
(6) Report the compressor stall, its duration, and peak EGT in the Form L-14.

OIL SYSTEM FAILURE

8 An oil system failure is recognized by a decrease or a complete loss of oil pressure. If an oil system malfunction has caused prolonged oil starvation of engine bearings, the result will be a progressive bearing failure and subsequent engine seizure. This progression of bearing failure starts slowly and will normally continue at a slow rate up to a certain point at which the progression of failure accelerates rapidly to complete bearing failure. The time interval from the moment of oil starvation to complete failure depends on such factors as: condition of bearings prior to oil starvation, operating temperatures of bearings, and bearing loads. A good possibility exists that an additional 10 to 30 minutes of engine operation is available after experiencing a complete loss of lubricating oil. Bearing failure due to oil starvation is generally characterized by a rapidly increasing vibration, and when the vibration becomes moderate to heavy, complete failure is only seconds away. In order to minimize engine damage and conserve remaining operating time for possible emergencies, the affected engine should be shut down upon first recognition of oil system failure. Since the generator oil supply is taken from the engine supply tank, a generator warning light illumination could be an

early indication of engine oil starvation even before an appreciable decrease in oil pressure is indicated on the oil pressure gauge. Consequently, if a generator light illuminates, the oil pressure gauge for that engine should be monitored.

NOTE

> If the affected engine was shut down immediately after recognition of oil system failure, it may be restarted just prior to entering the traffic pattern and operated at IDLE throughout the landing phase. This will provide additional available thrust in the event of an emergency during landing.

9 These procedures are designed for oil pressure readings above and below normal operating limits.

(a) Under Critical Thrust Conditions

(1) AFFECTED ENGINE – REDUCE THRUST
(2) Avoid rapid throttle movement.
(3) EXTERNAL TANKS – JETTISON (if unable to maintain height)
(4) Avoid manoeuvres requiring excessive "G" forces.
(5) AFTER CRITICAL THRUST CONDITIONS – SHUT ENGINE DOWN

(b) Under Non-Critical Thrust Conditions

(1) AFFECTED ENGINE – SHUT DOWN

AFTERBURNER FAILURE

10 Afterburner failure should pose no problem other than on take-off since military power is adequate for all normal requirements. If, however, the burner fails and the nozzle remains open, 30 to 35% of military thrust will be lost. When afterburner fuel flow is terminated by moving the throttle inboard the nozzle should close. The three failures possible are: failure to light, blowout during operation, and failure to terminate with throttle action.

(a) Failure to Light

(1) THROTTLE OF AFFECTED ENGINE – INBOARD
(2) If afterburner thrust is required, WAIT 2-3 SECONDS AND THEN RESELECT AFTERBURNER.
(3) If failure occurs on take-off and field length is adequate – TAKE-OFF IN MILITARY POWER ON THAT ENGINE.
(4) If field length inadequate for military take-off – ABORT TAKE-OFF

(b) Afterburner Blowout

(1) Follow "Failure to Light" procedures. The problem will most likely be an afterburner fuel pump failure which will prevent any further afterburner operation. If the problem was an engine fuel pump failure, burner operation should be available at higher altitudes.

(c) Failure to Terminate

(1) In the event the afterburner fails to shut-off when the throttle is moved out of the afterburner detent, the throttle must be retarded to a position equivalent to approximately 83% rpm in order to terminate afterburning. This action mechanically terminates afterburning by opening the afterburner emergency shutoff valve and the lack of fuel pressure at the exhaust nozzle control unit will cause the exhaust nozzle to close. Subsequent advancement of the throttle past the 83% rpm position will automatically reinitiate afterburning (providing the failed electrical switch is still on).

AFTERBURNER NOZZLE FAILURE

11 The two failures which may occur to the afterburner nozzles are: failure to open when afterburner thrust is selected, and failure to close when afterburner thrust is terminated. Rarely will a nozzle fail in the intermediate position – a difficult malfunction to analyze during flight. Failure of the nozzle to open when afterburner is selected is recognized by a rapid rise in EPR and EGT. The condition may be, but not necessarily always, accompanied by compressor stall. Failure of the nozzle to close when afterburner is terminated will result in lower than normal EPR, EGT and fuel flow. There is no emergency override or manual control provided for the exhaust nozzles.

(a) Failure to Open

(1) TERMINATE AFTERBURNER ON AFFECTED ENGINE
(2) DO NOT ATTEMPT FURTHER AFTERBURNER OPERATION ON THAT ENGINE.

(b) Failure to Close

(1) If thrust is critical RESELECT AFTERBURNER.
(2) If thrust is not critical select IDLE thrust for a few seconds – the nozzle should cycle to the closed position.

ELECTRICAL EMERGENCIES

SINGLE GENERATOR FAILURE

12 Failure of one generator will be noted by illumination of one warning light. The light will indicate which generator has failed. One generator in normal operation is sufficient to support the entire electrical demand or load. Upon illumination of the warning light, immediately check the corresponding oil pressure gauge. The generator failure could have been caused by oil starvation which will also affect the engine oil system.

(a) Generator Switch – RESET then ON.
(b) If the generator fault has been corrected, the generator will be reconnected to the system and the warning light will go out.
(c) If the generator warning light remains ON, turn failed generator – OFF,
(d) Land as soon as practicable.

DOUBLE GENERATOR FAILURE

13 When both generators fail, both warning lights will be out and all AC power will be lost. The battery will provide DC power, if the battery switch is on, for a limited time only.

(a) <u>If the engines are operating:</u>

(1) BATTERY – OFF
To conserve the battery, turn battery switch OFF until non-essential electrical equipment can be turned off.
(2) All electrical switches – OFF
Turn off all electrical equipment that is not essential to flight.
(3) GENERATORS – RESET THEN ON
After placing generator switches momentarily to RESET, return to ON position ONE AT A TIME.
(4) Voltmeter – CHECK
If both generators are reconnected, voltmeter will indicate 115 volts and neither warning light will be illuminated. If both generators are still inoperative, voltmeter will indicate 0 volts and neither warning light will be illuminated. If one generator is reconnected, voltmeter will indicate 115 volts and the failed generator warning light will illuminate.
(5) If fault has not been corrected, land as soon as practicable.

NOTE

Since the battery switch is not required to be ON for the generators to come back on the line, it is recommended that the generator switches be left ON. The generators may reset automatically if the undesirable condition is corrected.

NOTE

With a double generator failure, thought must be given to conserving the battery for selective power for the gear and flaps and for vital radio transmission. With all electrical equipment off, turn battery switch ON just long enough to extend the landing gear and flaps obtaining a positive indication of gear down and locked and flap position, and to make necessary radio transmission, then turn battery switch OFF. Prior to touchdown, the battery switch may be turned ON again to select nose gear steering.

(b) If the engines are not operating:

(1) The generators may automatically disconnect due to engine underspeed or malfunction and through no fault of the generators. AC power will be available to boost pumps and emergency ignition as long as the engine rotates, however, the power will be low frequency and possibly low voltage. Air starts may be attempted providing engine failure is not attributed to mechanical reasons. With one engine restarted the other generator warning light will illuminate and normal operation will be resumed. DC power is available during emergencies providing the battery switch is ON.

TRANSFORMER RECTIFIER FAILURE

14 If XMFR OUT LIGHT illuminates, proceed as follows:

(a) Battery – OFF

(b) Press to test any DC operated light to cockpit. Failure of light to illuminate indicates both transformer rectifiers have failed.

(c) Battery – leave off to conserve battery if transformer rectifiers have both failed.

ELECTRICAL FIRE

15 Circuit breakers and fuses protect most circuits and tend to isolate an electrical fire. However, if an electrical fire occurs, perform the following, if conditions permit, and land as soon as practicable.

(a) BATTERY – OFF

(b) GENERATORS – OFF

(c) ALL ELECTRICAL EQUIPMENT – OFF

(d) Battery – ON

(e) Generators– ON

(f) Individually reposition the electrical switches ON, beginning with the most essential equipment first.

(g) Isolate affected equipment.

(h) Affected equipment – OFF

(j) Circuit breaker – PULL (if available)

(k) Land as soon as practicable.

(m) If the cause of the fire cannot be found, continue the flight with only the essential equipment in operation and land as soon as practicable.

CAUTION

If the landing is to be made with both generator switches OFF, the battery switch must be ON to provide selective power for landing gear, flaps, speed brakes and nose gear steering.

FUEL SYSTEM EMERGENCIES

TRANSFER PUMP FAILURE

16 A transfer pump failure should never become more than a routine unserviceability if proper, frequent fuel checks are carried out. Transfer pump failure is indicated by an abnormal reduction of fuel level in cells 2 and 3. If fuel consumption is high and the condition is allowed to persist the level in cell 2 could drop to the point where the "feed tank fuel low" telelight will illuminate. A failure of the transfer pump in cell 5 will preclude the operation of the transfer pumps in cells 1 and 4 (unless ALL PUMPS are selected) until cell 5 has emptied by gravity. If any transfer pump fails, proceed as follows:

(a) If high fuel consumption is required

(1) FUSELAGE TRANSFER SWITCH – ALL PUMPS
A reduction of fuel level in the affected fuel cell indicates transfer pump operation.
(2) When affected cell is empty – FUSELAGE TRANSFER SWITCH – NORMAL
(3) If the ALL PUMPS selection had no effect on the fuel level of the cell in question, the cell should be emptied by gravity after the other transfer pumps have emptied their cells.

(b) If fuel consumption requirements are more moderate, the same procedure may be used except that no transfer pump should be run in an empty cell. When any transfer pump has emptied its cell, the transfer system should be reverted to NORM or GRAV.

CAUTION

If the telelight "Feed tank fuel low" strip illuminates, immediately select ALL PUMPS.

BOOST PUMP FAILURE

17 The failure of one or both boost pumps is indicated by the illumination of the "Boost Pump Out" telelight strip. Engine operation will indicate whether both pumps are out. No difference in engine or afterburner will result from a single pump failure. If both pumps fail; both engines may flame-out above 30,000 feet; between 25,000 and 30,000 feet the engines may surge, stall or lose thrust; and the combined fuel demand for engine and afterburner thrust at any altitude may not be met.

(a) If one pump fails:

(1) Use afterburner only when required.
(2) Avoid negative "G" or inverted flight.
(3) Land as soon as practicable.

(b) If both pumps fail;

(1) Descent below 30,000 feet.
(2) Avoid use of afterburner.
(3) Avoid negative "G" and inverted flight.
(4) Land as soon as practicable.

WING VENTING

18 When the wing transfer switch is placed to STOP, the auxiliary manifold valve may fail open, permitting fuselage fuel to return to the wing tanks and vent overboard. A reduction in fuselage and total fuel at a rate faster than normal will offer the best indication. A check of the wing tank full light may confirm the malfunction.

(a) To return fuel from wings to fuselage and stop the venting, proceed as follows:

(1) Fuselage transfer switch – GRAV
(2) Wing transfer switch – NORM

(3) Upon completion of transfer return the fuselage transfer switch to NORM, leave the wing transfer switch in NORM, and cancel out telelight.

(b) The same problem does not occur to the external tanks as the transfer switch is left in the normal position after transfer.

ENGINE FUEL PUMP FAILURE

19 If the engine fuel pump fails, the afterburner fuel pump automatically takes over the engine pump's job. There will be no change in engine performance and any fuel not required by the engine may be used for the afterburner. There is no rectification procedure for this failure and the only indication that this failure has occured will be a noticeable lack of thrust from the afterburner when the engine is demanding high fuel flow.

AFTERBURNER FUEL PUMP FAILURE

20 If the afterburner fuel pump should fail there is no cut-over from the engine fuel pump so there will be no afterburner available.

FUEL CONTROL UNIT FAILURE

21 Failure within the engine fuel control unit is evidenced by abnormal increase or decrease of engine RPM, thrust, or temperature or by the inability to change RPM.

(a) <u>If failure occurs when thrust is critical;</u>

(1) THROTTLE – IDLE
(2) FUEL CONTROL SWITCH – EMERGENCY

CAUTION

If throttle setting and engine RPM are widely mismatched, flame-out could occur due to rapid reduction of fuel flow.

(b) <u>If thrust is not critical:</u>

(1) Adjust throttle to match engine RPM.
(2) Fuel control switch – EMERGENCY

CAUTION

If the throttle setting and engine RPM are seriously mismatched with throttle setting higher than engine RPM, flame-out, compressor stall, or overtemperature may result during transfer to emergency system. The pilot should be prepared to retard the throttle immediately if required.

(3) Slowly move the throttle to the desired setting.

CAUTION

The pilot must monitor all engine instruments while utilizing the emergency system. Throttle movements must be made with caution since the emergency control cannot prevent overtemperature, stall or surge reactions. If the emergency system was selected because of main system failure, DO NOT transfer back to the main system. Flame-out or engine limits could be exceeded causing damage.

HYDRAULIC SYSTEM FAILURE

GENERAL

22 The mechanical failure of one pump in either system will not affect operation in any way, however, the possibility exists that the other pump will fail due to system contamination. The illumination of the PRIMARY HYD SYS or the UTILITY HYD SYS telelight strips indicate the failure of one or both pumps in that system to maintain 700 psi output check of the appropriate hydraulic pressure will indicate a double pump failure. In the event of any hydraulic emergency land as soon as practicable.

COMPLETE HYDRAULIC SYSTEM FAILURE

23 In the event of complete hydraulic failure the aircraft will become uncontrollable. The Pilot should, upon initial detection of hydraulic power loss, note the trend of failure as to whether the pressures show a definite, steady drop, or if they fluctuate. With a steady drop indication, hydraulic power will probably not recover.

(a) DECREASE AIRSPEED
(b) ATTAIN LEVEL FLIGHT
(c) EJECT

PRIMARY HYDRAULIC SYSTEM FAILURE

24 Loss of the primary hydraulic system pressure allows the utility system to assume the full demand of the flight control dual power cylinders. Nose wheel steering will not be available.

(a) Land as soon as practicable.
(b) Consideration should be given to runway conditions as the loss of nose wheel steering could effect directional control.

UTILITY HYDRAULIC SYSTEM FAILURE

25 A priority valve in the utility system denies pressure to all units except the ailerons, stabilizer, rudder, pusher actuator and brakes if the pressure in the utility system drops below 1550 PSI. High fluctuations of the utility hydraulic pressure or loss of the utility hydraulic system, with the yaw damper or AFCS engage switches engaged, will cause yaw oscillations. Return both switches to the STANDBY position and yaw oscillations will cease. Loss of utility hydraulic system pressure allows the primary system to assume full demand of the flight control dual units. The rudder will no longer be power operated but will be manually controlled by direct rudder pedal pressure. The flaps will remain down or in an intermediate position if utility hydraulic pressure is lost during or after flap operation. The PCS pusher force will be lost in the event of a utility hydraulic system failure -- the PCS horn will still be operative. The speed brakes, landing gear, and wheel brakes have separate emergency systems which may be used when utility hydraulic power fails. These systems will be covered in subsequent paragraphs. Upon loss of utility hydraulic pressure:

(a) Land as soon as practicable.
(b) Runway and weather conditions should be carefully considered at the recovery field due to the loss of some important services.

EMERGENCY SPEED BRAKE OPERATION

26 Should the normal operating system or the utility hydraulic system fail, and the speed brakes are extended, they may be retracted by placing the emergency speed brake switch on the engine control panel to the IN position. This allows the air loads to close the panels to a trailing position.

LANDING GEAR EMERGENCY LOWERING

27 If normal gear operations fail, the gear can be lowered by utilizing the procedures in figure 3-3.

NOTE

The landing gear circuit breaker must be pulled and left in this position to prevent hydraulic reservoir rupture and fire hazard. Actuating the landing gear emergency system will cause a considerable amount of hydraulic fluid to be blown out of a fitting adjacent to the left fuel vent mast. This is normal and should not be considered as an additional malfunction by any observing aircraft.

CAUTION

Retain landing gear emergency handle in the locked (out) position. Returning the handle to its normal (stowed) position allows the compressed air from the gear down side of the actuating cylinder to be vented overboard.

ANTI-SKID SYSTEM FAILURE

28 If a system malfunction is suspected or the anti-skid inoperative light illuminates, the system can be turned off by placing the anti-skid switch OFF. In an emergency, the system can be disengaged by actuating the paddle switch. This lever must be held depressed to disengage the system. The normal braking technique, a soft but steadily increasing pedal force, should be used regardless of switch position.

CAUTION

The brakes should be released before the system is disengaged to prevent the possibility of skidding.
Do not pump the brakes when maximum braking is required since this technique only reduces the pressure available at the brakes.

Figure 3-3 Emergency Gear Operation

BRAKE SYSTEM EMERGENCY OPERATION

29 In the event of utility hydraulic system failure or loss of normal brake system, the aircraft can be stopped by using the emergency brake system.

(a) Allow aircraft to decelerate.

With drag chute deployed, utilize aerodynamic braking. Delay using wheel brakes as long as safety will permit, thus allowing the aircraft to decelerate as much as possible without wheel braking.

(b) EMERGENCY BRAKE HANDLE – PULL

After determining that an overshoot will not be made, pull the emergency brake handle.

(c) Use nose gear steering for directional control.

(d) BRAKES – APPLY

Apply the brakes evenly and simultaneously with a light steady pressure, gradually increasing the pressure to the maximum required (depending on the length of runway available). Hold this pressure until the aircraft stops.

CAUTION

The anti-skid feature of the brake system will not be available. Approximately three full brake applications will be available from the emergency brake system. Differential braking may be accomplished for maintaining directional control by slightly reducing the pressure on one brake. Releasing the brakes "dumps" emergency brake pressure and thereby decreases the number of brake applications remaining.

NOTE

If emergency braking action is exhausted, the tail hook should be lowered, or the throttles may be closed to reduce forward momentum.

FLIGHT CONTROL MALFUNCTION

GENERAL

30 Flight control malfunctions are many and varied and devising an emergency procedure against every eventuality is impractical. Complete loss of control will, of course, lead to ejection. These procedures will cover a general range of stiff or loose controls, trim failure, and inadvertent control forces.

(a) If control malfunctions occur when the AFCS is engaged:

(1) AFCS – STAND-BY
(2) AFCS CIRCUIT BREAKER – PULL
(3) HYDRAULIC PRESSURE – WITHIN LIMITS
(4) AIRSPEED – DECREASE BELOW 350 KIAS
(5) Avoid high speed manoeuvres.
(6) Avoid abrupt control movements.
(7) Descend to a lower altitude to determine if warmer air will improve control.
(8) Land as soon as practicable.

(b) If AFCS was not engaged at the time of control malfunction:

(1) AFCS – ENGAGE
(2) If this step does not improve control: AFCS – STAND-BY
(3) AFCS CIRCUIT BREAKER – PULL
(4) HYDRAULIC PRESSURE – WITHIN LIMITS
(5) AIRSPEED – DECREASE BELOW 350 KIAS
(6) Avoid high speed manoeuvres.
(7) Avoid abrupt control movements.
(8) Descend to a lower altitude to determine if warmer air will improve control.
(9) Land as soon as practicable.

(c) Failure of stabilator feel bellows:

(1) The failure of the bellows will result in a reduction of longitudinal control stick forces and a change in longitudinal trim.

(2) Dependent on the extent of bellows skirt damage, trim will tend to wander in pitch after each trim attempt.
(3) TRIM STICK FOR MINIMUM STICK FORCE.
(4) Avoid high speed flight.
(5) Avoid high rate stick movements.
(6) Land as soon as practicable – use a straight-in approach, if possible, to reduce the required pitch activity.

(d) Inadvertent Pusher Engagement

(1) PADDLE SWITCH – DEPRESS AND HOLD
(2) PUSHER SWITCH – OFF
(3) Paddle switch release.
(4) AFCS – STAND-BY
(5) AFCS CIRCUIT BREAKER – PULL
(6) Decrease airspeed, cycle speed brakes, and lower landing gear if engagement continues.

(e) Nose Down Stick Force

If the aircraft nose suddenly drives down and the reason is not immediately clear.
(1) PADDLE SWITCH – DEPRESS AND HOLD
(2) PUSHER SWITCH – OFF
(3) AFCS CIRCUIT BREAKER – PULL
(4) AFCS – STAND-BY
(5) MCSL – OFF
(6) Decrease speed and cycle speed brakes, and lower landing gear if engagement continues.
(7) Release paddle switch.

SMOKE AND FUMES

31 To eliminate smoke and fumes from the cockpit, proceed as follows:

(a) OXYGEN DILUTER LEVER – 100m

(b) OXYGEN EMERGENCY LEVER – EMERGENCY

(c) AIR DEFROST – OFF

If this step is necessary, descend to 25,000 feet or below if possible.

(d) CABIN PRESSURE SWITCH – RAM AND DUMP

If this step is necessary, descend to 25,000 feet or below if possible.

NOTE

If the above listed steps fail to clear smoke or fumes, and the situation warrants, the canopy may be jettisoned by the alternate jettison handle. Any time this step is deemed necessary the navigator should be warned to place himself as low as possible.

OXYGEN SYSTEM FAILURE

32 If any oxygen problems are noted or hypoxia is suspected proceed as follows:

(a) OXYGEN DILUTER LEVER – 100%

(b) OXYGEN EMERGENCY LEVER – EMERGENCY

(c) Check connections, pressure, contents, etc.

(d) If no pressure felt – EMERGENCY BAILOUT BOTTLE – PULL

(e) DESCEND TO CABIN ALTITUDE OF 10,000 FEET OR BELOW

(f) Land as soon as practicable.

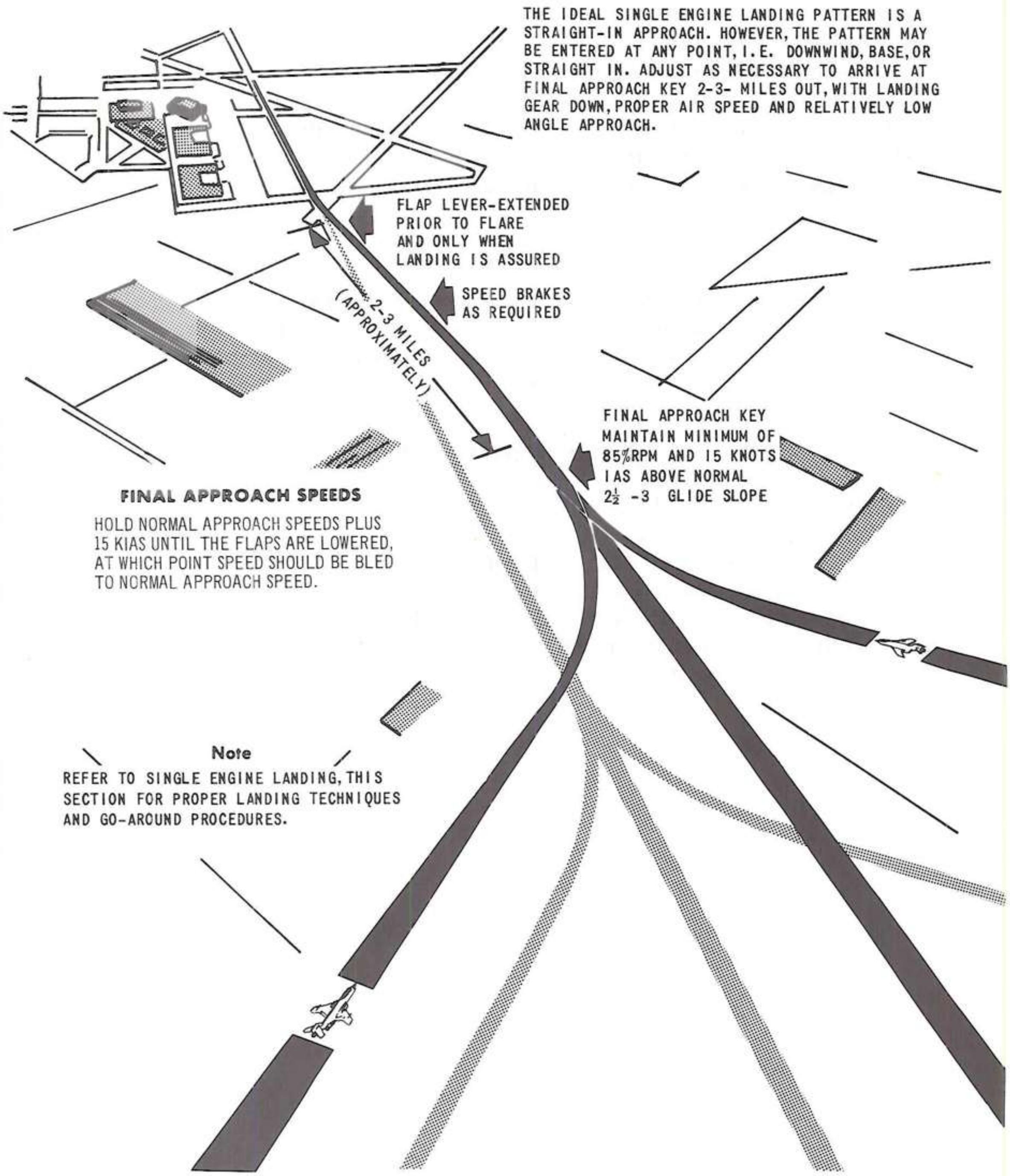


Figure 3-4 Typical Single Engine Landing Pattern

EMERGENCY LANDING PROCEDURES

FORCED LANDING

33 This procedure shall consider a forced landing to be a landing where landing gear is not available, where the landing will not be on a prepared surface, or where engine power is not available. A gear-up landing should not be attempted, the crew should eject instead. If landing gear is available it should be lowered regardless of terrain. A greater injury hazard is presented if landing gear is not lowered due to the "slap" developed from the nose high approach angle.

(a) IF POSSIBLE – EJECT
(b) If ejection is not possible proceed as follows:
- (1) EXTERNAL TANKS CONTAINING FUEL – JETTISON
  If external tanks are empty they should be retained to help absorb landing shock.
- (2) ARMAMENT – JETTISON
  Armament should be jettisoned in an authorized area.
- (3) Burn off excess fuel to lighten the aircraft.
- (4) EJECTION SEAT – SAFETY
- (5) SHOULDER HARNESS – LOCK
  All unnecessary personal leads should be disconnected to aid in speedy exit upon impact. The pilot should ensure that the locked shoulder harness does not prevent him from reaching necessary controls.
- (6) HELMET VISOR – DOWN
- (7) CANOPY – JETTISON (if necessary)
  If jettison is deemed necessary, inform navigator and jettison the canopy with the alternate handle. Jettison should be complete prior to the aircraft coming to a stop to minimize the danger of sparks from the remover starting a fire. If the canopy is retained it should be kept locked until the aircraft comes to rest.
- (8) Make normal approach and touchdown.
- (9) DRAG CHUTE – DEPLOY
- (10) ENGINES – SHUTDOWN
- (11) BATTERY AND GENERATORS – OFF
- (12) ABANDON AIRCRAFT.

DITCHING

34 Ditch the aircraft only when no alternative is available. Since all survival equipment is carried by the crew, ejection is advisable. If the altitude and situation demand a ditching, proceed as follows:

(a) EXTERNAL TANKS – JETTISON
(b) ARMAMENT – JETTISON
(c) Armament should be jettisoned in an authorized area.
(d) Disconnect all personal leads except the oxygen hose.
(e) OXYGEN – 100%
(f) LANDING GEAR – UP
(g) FLAPS – DOWN
(h) HELMET VISOR – DOWN
(j) CANOPY – JETTISON
  Warn the navigator and jettison the canopy by alternate means.
(k) SHOULDER HARNESS – LOCK
  The pilot should ensure that the locked harness does not prevent him from reaching necessary controls.
(m) Fly an approach pattern parallel to the uniform swell pattern.
(n) ENGINES – SHUTDOWN
  Shut engines down just prior to touchdown.

(p) Touchdown – if possible along a wave crest.

(q) ABANDON AIRCRAFT

NOTE

If the crew sinks with the aircraft, it is possible to survive using the oxygen equipment set at 100%. Using the bailout bottle with the mask hose disconnected will not ensure a proper amount of oxygen as water will enter the quick disconnect fitting during inhalation.

SINGLE ENGINE LANDING

35 Should it become necessary to execute a single engine landing, the primary landing pattern should be a straight in approach assisted by GCA or ILS, if available, for final approach positioning. Steep turns should be avoided during positioning for final approach.

(a) Traffic entry – 250 Knots IAS

(b) FLAPS – RETRACTED

(c) SPEED BRAKES – CLOSED

(d) LANDING GEAR – DOWN

(e) Final approach – 2-3 miles, 2 1/2°-3° GLIDE SLOPE

(f) Maintain 15 knots IAS above normal approach speed and a minimum of 85% RPM.

(g) SPEED BRAKES – AS REQUIRED THEN CLOSE

(h) FLAPS – EXTENDED (landing assured)

Extend flaps prior to flare to avoid ballooning and then only when landing is assured.

CAUTION

With one engine inoperative and landing gear and flaps down, overshoot may not be possible without the use of afterburner.

(j) Fly the aircraft down to the runway. Do not flare the aircraft or retard the throttle prior to crossing the end of the runway.

(k) SPEED BRAKES – OPEN (after touchdown)

SINGLE ENGINE OVERSHOOT

36 (a) Make decision to go-around as early as possible.

(b) THROTTLE – MILITARY POWER

NOTE

Afterburner may be required if overshoot is started after wing flaps have been extended.

(c) Continue approach until sufficient airspeed to level off is attained.

(d) LANDING GEAR – UP (after level-off)

Retract landing gear only after adequate airspeed is attained as touchdown may be necessary during overshoot.

(e) FLAPS – RETRACT

If flaps have been extended, raise wing flaps when aircraft reaches 200 knots IAS.

(f) Begin climb – 250 KNOTS IAS

(g) Maintain traffic pattern airspeed.

FLAPLESS LANDING

37 A flapless landing is basically the same as a single engine pattern except that flaps will not be available at touchdown. The increased final approach speed must therefore be maintained until flare.

(a) Fly a wide or straight-in pattern.

(b) LANDING GEAR – DOWN
(c) FLAPS – UP
(d) By 2 to 3 miles on final approach establish a 2 1/2 to 3 degree glide slope.
(e) SPEED 15 KIAS ABOVE NORMAL APPROACH SPEED
(f) SPEED BRAKES – AS REQUIRED
(g) Fly the aircraft down to the runway, do not attempt to flare the aircraft or to retard the throttles prior to crossing the end of the runway.
(h) Make normal touchdown and roll-out.

LANDING GEAR MALFUNCTIONS

38 The majority of landing gear problems are unsafe indications due to burnt out bulbs. A quick light check is available by pushing the warning lights test button on the lighting panel.

(a) Landing gear unsafe indication:

(1) Check for burnt out bulb.
(2) Check utility hydraulic pressure within limits.
(3) Slow aircraft to an airspeed below 250 KIAS.
(4) Recycle landing gear handle.
(5) Cycle speed brakes and check utility hydraulic pressure indication.
(6) Obtain visual check of gear position.
(7) If gear confirmed unsafe, utilize emergency gear lowering procedures.

(b) If landing gear appears down and locked, with normal hydraulic pressure, but unsafe indication still exists:

(1) SHOULDER HARNESS – LOCK
(2) Make normal approach and touchdown.
(3) THROTTLES – IDLE
(4) DRAG CHUTE – DEPLOY
(5) Employ normal roll-out procedures.
(6) Have landing gear ground locks installed prior to taxiing.

(c) If the nose gear remains up or in an intermediate position:

(1) Burn excess fuel, retain empty tanks. If time and conditions permit, lighten the aircraft by burning out excess fuel load. If external tanks are carried, burn out external fuel and retain tanks to absorb initial shock.
(2) ARMAMENT – JETTISON
If armament is carried, it must be jettisoned in an authorized jettison area.
(3) SHOULDER HARNESS – LOCK
(4) CANOPY – JETTISON (if necessary)
If it is necessary to jettison the canopy, alert the navigator and pull the canopy alternate jettison handle.

CAUTION

If canopy is to be jettisoned, make sure it is jettisoned before the aircraft comes to a complete stop. Otherwise, sparks from the canopy remover may cause a fire if fuel is spilled in the vicinity of the aircraft or the canopy may become jammed. If the canopy is not jettisoned, do not unlock the canopy until the aircraft stops.

(5) Make normal approach and touchdown.
(6) Land in center of runway.
(7) ENGINES – SHUTDOWN SIMULTANEOUSLY (at touchdown)
(8) DRAG CHUTE – DEPLOY
(9) Hold nose "off" runway.
(10) Fly nose to runway at 130 KIAS.

NOTE

Very little control effectiveness of the horizontal stabilizer will be available below 120 knots IAS.

(11) ALL ELECTRICAL SWITCHES – OFF
(12) ABANDON AIRCRAFT

39 In the event one or both main gear remains up or in an intermediate position, after all procedures to extend have failed, the following factors should be considered before making a final decision to land. Cross-wind effect, width and length of the runway, availability of normal and emergency systems, and ground condition. If these factors are not favourable – EJECT. It is preferable to land with both main gear up than with one only extended. The following procedures cover an attempt to retract the main gear and the actions to be taken if the attempt fails (assuming that the decision has been made to land).

(a) To raise the main landing gear and leave the nose gear extended, proceed as follows:

(1) EMERGENCY LANDING GEAR HANDLE – RESET
This will bleed emergency air from the landing gear system; failure to do this may result in the rupture of the hydraulic tank when the normal functions of the landing gear are resumed.
(2) LANDING GEAR CIRCUIT BREAKER – RESET
(3) LANDING GEAR HANDLE – DOWN
(4) Accelerate to at least 290 KIAS.

NOTE

The high speed required in this procedure may result in damage to the main gear doors. However, no damage to aircraft structure is anticipated, and this loss should not interfere with completion of the procedure.

(5) LANDING GEAR HANDLE – UP
Airloads will prevent nose gear from retracting with main gear.
(6) LANDING GEAR CIRCUIT BREAKER – PULL
Pull circuit breaker while the aircraft is at the high speed quoted.
(7) Proceed as with Both Main Gear Up or Unlocked.

(b) If both main gear are up or unlocked:

(1) Burn excess fuel, retain empty tanks. If time and conditions permit, lighten the aircraft by burning out excess fuel load. If external tanks are carried, burn out external fuel and retain to absorb initial shock.
(2) ARMAMENT – JETTISON
If armament is carried, it must be jettisoned in an authorized jettison area.
(3) SHOULDER HARNESS – LOCK
(4) CANOPY – JETTISON (if necessary)
If it is necessary to jettison the canopy, alert the navigator and pull the canopy alternate jettison handle.

CAUTION

If canopy is to be jettisoned, make sure it is jettisoned before the aircraft comes to a complete stop. Otherwise, sparks from the canopy remover may cause a fire if fuel is spilled in the vicinity of the aircraft, or the canopy may become jammed. If the canopy is not jettisoned, do not unlock the canopy until the aircraft stops.

NOTE

If a BAK-6 or BAK-9 barrier is available and located at least 1000 feet down the runway from the approach end, the possibility of lowering the tail hook while airborne and engaging the barrier on the approach end should be considered if main gear are not both up.

(5) Make normal final approach.
(6) Land on side of runway opposite failed gear.
(7) ENGINES – SHUTDOWN (at touchdown)
(8) DRAG CHUTE – DEPLOY
(9) Ease nose gear to runway immediately.
(10) Hold unsafe gear "off" as long as possible.
(11) Utilize nose gear steering for directional control.
(12) ALL ELECTRICAL SWITCHES – OFF
(13) ABANDON AIRCRAFT

NOTE

Experience has shown minimum damage is caused when landing on the tailpipes and nosewheel.

BLOWN TIRE

40 A blown tire during the take-off run presents no special problem. The decision of whether to abort the take-off or to continue should be based on the airspeed at the time of the failure and the length of runway remaining. These procedures are designed for a main wheel tire failure; if a nose wheel fails the problem is one of directional control and of airframe damage upon retraction only.

(a) If take-off is aborted. Employ normal abort techniques but keep the following in mind:

(1) ANTI-SKID – OFF
Either by turning the switch off or by holding the paddle switch depressed.
(2) MAINTAIN DIRECTIONAL CONTROL
Use rudder, nose wheel steering, and opposite brake to keep the aircraft aligned with the runway. Use brake up to and including blowing the good tire if necessary.
(3) AVOID BRAKING THE DAMAGED WHEEL
Heavy braking could cause a flat spot on the wheel which could prevent further wheel rotation and make the aircraft more difficult to control.
(4) If fire equipment is immediately available – ENGINES SHUTDOWN.

CAUTION

If possible, do not shut down engines until adequate fire fighting equipment is available. The damaged wheel may be either on fire or very hot and the fuel drained overboard, after engine shutdown, could contact the hot wheel, causing fire.

(b) If take-off is continued:

(1) LEAVE LANDING GEAR EXTENDED
This will permit cooling of the blown tire.

(2) CHECK DAMAGED TIRE CONDITION
Have condition of blown tire checked, if possible, by another aircraft. If it can be determined that the blown tire has been torn from the wheel, the landing gear may be retracted depending on mission urgency. If the tire has remained with the wheel and is severely shredded, it is recommended that the gear remain extended so as not to foul the tire on the wheel well.

(3) SPEED BRAKES – OPEN
Extend speed brakes to remain below maximum gear down airspeed and to rapidly reduce fuel load for lighter gross weight landing.

NOTE

Should conditions dictate an immediate landing, external tanks and/or armament should be jettisoned in appropriate salvo area prior to landing.

(4) Do not retract landing gear.

41 Landing with a blown tire can cause severe directional problems and heavy vibration. If landing on a known blown tire do not have the runway foamed as directional control may be lost if the good tire or the nose wheel comes in contact with the foam. If the nose wheels have blown, land normally and maintain directional control by rudder, nose wheel steering, and differential braking.

(a) If landing on a known blown tire:

(1) ANTI-SKID – OFF prior to landing
(2) HARNESS – LOCKED
(3) LAND ON SIDE OF RUNWAY OPPOSITE BLOWN TIRE
(4) Continue as in blown tire during landing roll.

(b) If tire is blown during landing roll.

(1) MAINTAIN DIRECTIONAL CONTROL
A blown tire at high speed will require immediate control action to keep the aircraft aligned with the runway. The following procedures are applicable.

(2) DRAG CHUTE – DEPLOY
Immediately after touchdown, deploy drag chute.

(3) ANTI-SKID – PADDLE OFF
Turn anti-skid off to prevent loss of braking on the good tire resulting from skid indications from blown tire.

(4) UTILIZE AERODYNAMIC BRAKING AND RUDDER STEERING FOR DIRECTIONAL CONTROL, AND LOWER NOSE GEAR TO RUNWAY BEFORE RUDDER EFFECTIVENESS IS LOST.

CAUTION

In the event the rudder fails to correct or maintain directional control, immediately lower the nose gear to the runwayaand hold nose gear steering button depressed. Hold the control stick forward to increase nose gear steering effectiveness.

(5) Use nose gear steering for directional control.

(6) Use opposite braking to slow the aircraft and maintain directional control, up to and including blowing the good tire if necessary.

CAUTION

If heavy vibration or shaking of the aircraft occurs at high speeds, lock the affected brake and complete the roll out on the sliding wheel. Evidence indicates that better control and less damage may result with locked wheel than with damaged rolling wheel. If rollout is smooth to relatively low speed, however, the brakes should not be locked. Damage will probably not result from the inevitable tire vibration at low speed.

(7) Fire equipment available, ENGINES -- SHUTDOWN

CAUTION

If possible, do not shut down engines until adequate fire fighting equipment is available. The damaged wheel may be either on fire or very hot, and fuel drained overboard after engine shutdown could contact the hot wheel, causing fire.

GEAR RETRACTION ON GROUND

42 Providing there is adequate utility hydraulic power the landing gear may be retracted on the ground at any time by merely raising the landing gear handle. The landing gear handle breakout force will be abnormally high when the aircraft weight is on the wheels, 35 pounds.

HOT BRAKES

43 The CF-101 wheel brakes and tires can become dangerously hot very easily with the resultant risk of tire explosion and/or buckling of the wheel assembly, and fire. Hot brakes can result from aborted take-offs, landing emergencies, high speed runs, a succession of low energy stops, or even very prolonged taxiing. Never more than one high speed taxi test or brake test should be conducted as subsequent runs almost invariably end up in overheated brakes, tire failures, and tire explosions. The following shall be construed as hot brake conditions demanding remedial action.

(a) Any aborted take-off where speed has reached a maximum of 80 kts.
(b) Any high speed taxi test.
    Runway braking action checks are prohibited in CF-101 A/C.
(c) Any abnormally heavy braking during the landing roll.
(d) A succession of low energy stops.
(e) Prolonged taxiing in excess of 6 miles.
(f) Any condition where wheel brake binding is suspected.

44 The above conditions will necessitate a one hour cooling period and the placing of safety cages around the tires to prevent explosion damage. If a known hot brake condition exists, pilots are to taxi immediately to the Hot Brake area and be prepared to taxi over tire deflators if necessary. Engine shut down is to be delayed until suitable fire fighting equipment is available. Should an obvious fire develop prior to the arrival of crash crews, aircrew are to use their judgement to determine whether or not to shut down the engine and vacate the aircraft. Factors to be considered in engine shutdown are, spilling fuel on hot brakes or an already existent fire, as opposed to shutting down the engine when a complete air-craft fire appears imminent.

RUNWAY OVERRUN BARRIER

45 The procedures listed below for engaging a runway overrun barrier installation involve only those steps necessary for actual engagement. It is assumed that all steps available for slowing the aircraft prior to engagement have been performed, i.e., speed brake, drag chute, aerodynamic braking, and wheel braking. For more detailed information on the runway overrun barrier systems, refer to Runway Overrun Barrier Systems in the Handling Part of this manual. Any time the aircraft cannot be stopped safely on the runway,

attempt to engage the runway overrun barrier executing as many of the following procedures as time will permit:

(a) EXTERNAL LOAD – JETTISON (if necessary)

If a tail hook arrestment is anticipated, external loads may be retained. However, if a tail hook arrestment is not possible, external loads should be jettisoned as soon as possible after the emergency is known.

CAUTION

In cases of known emergency, jettison external tanks before landing. If the external tanks are jettisoned close to the barrier, they will roll into the barrier and create a fire hazard.

(b) TAIL HOOK – DOWN

Lower the tail hook at least 2000 feet before the barrier, but not until the nose gear has been lowered to the runway.

CAUTION

If an emergency arises whereby battery power may be lost before a landing can be made the tail hook should be lowered in flight, caution must be exercised during landing to prevent the possibility of engaging the tail hook arresting gear on the approach end of the runway.

(c) CANOPY – JETTISON (if necessary)

If jettisoning the canopy is necessary, it should be jettisoned prior to the time the aircraft comes to a stop.

CAUTION

If the canopy is jettisoned after the aircraft has stopped, sparks from the canopy remover may cause a fire if fuel has spilled in the vicinity of the aircraft, or the canopy may become jammed.

NOTE

If the canopy is not jettisoned, do not unlock the canopy until the aircraft has come to a complete stop.

(d) SHOULDER HARNESS – LOCK

(e) THROTTLES – IDLE (at touchdown)

(f) Steer toward center of the barrier.

Utilizing nose gear steering and/or brakes, attempt to engage the barrier in the center and at a 90° angle. This will ensure a positive engagement and safe arrestment.

(g) BRAKES – RELEASE

Immediately prior to arrestment, release the brakes to ensure a positive barrier engagement.

(h) ENGINES – SHUTDOWN

After the aircraft has stopped, and fire equipment is available, shutdown the engines.

(j) ALL ELECTRICAL SWITCHES – OFF

(k) ABANDON AIRCRAFT

APPROACH END BARRIER

46 When it is known before landing that a main gear tire is blown or when landing with one main gear up or unlocked engagement of the BAK-6 or BAK-9 barrier at the approach end of the runway provides an effective means of stopping the aircraft. In addition, engagement of the barrier at the approach end will provide:

(a) Additional directional stability, probably enough to overcome the effects of a blown tire.

(b) A reduction in time of exposure to possible injury or damage, as rollout is confined to 1500 feet or less.

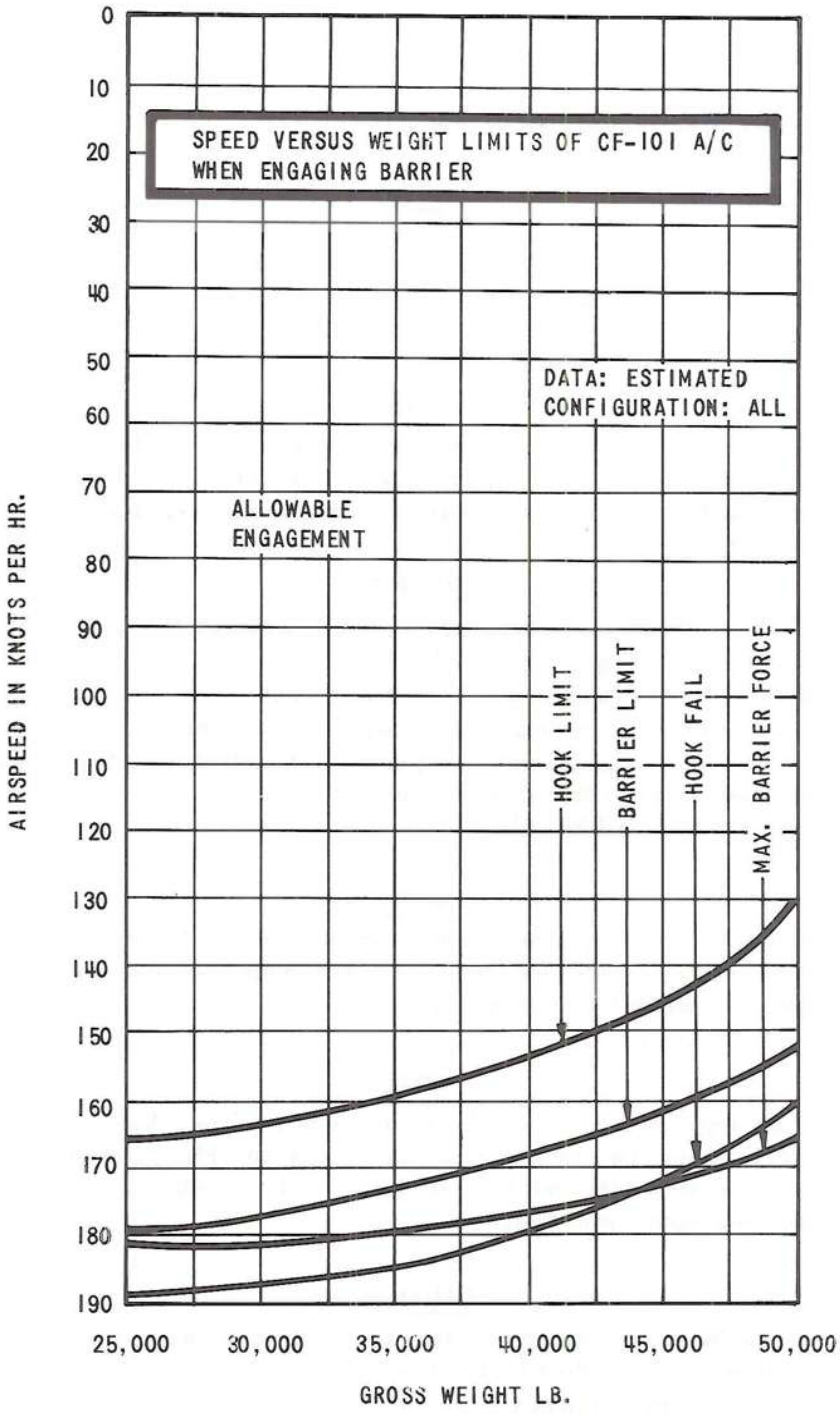


Figure 3-5 Barrier Limits

(c) A specific location at which emergency vehicles can plan to meet the aircraft.

Prior to attempting an approach end barrier engagement, the following conditions must exist:

(1) At least 500 feet of runway or suitable overrun should be available for touchdown prior to barrier engagement.

(2) Approach to the runway must be clear of obstructions.

NOTE

Where an MA-1/A barrier is located with the BAK-6 or BAK-9, the MA-1/1A must be disconnected and removed from the runway by ground personnel unless the distance between them is sufficient to allow touchdown beyond the MA-1/1A barrier.

NOTE

If time and conditioning permits, landing gross weight should be reduced. Landing with high gross weights requires landing speeds that could result in engagements that would exceed the hook yield strength.

CAUTION

Do not attempt to engage MA-1/1A type barrier on the approach end as severe damage to the aircraft will result.

(d) EXTERNAL FUEL TANKS – JETTISON (OPTIONAL)

Jettison fuel tanks if they contain fuel; otherwise, this is optional. When landing with a main gear up or unlocked, retaining empty drop thanks will cushion wing drop. This advantage would offset the relatively slight fire hazard from residual fuel.

(e) ARRESTING HOOK – EXTEND

NOTE

If the MA1/1A barrier has not been removed prior to landing, delay hook extension until past this barrier, but insure hook is extended prior to reaching BAK-6/BAK-9 cable.

(f) HARNESS – LOCKED

NOTE

Final approach should be established to assure 1 1/2 to 2 degree glide slope at minimum recommended approach speeds. Plan touchdown point at least 500 feet short of barrier cable on side of runway opposite blown tire or faulty gear.

CAUTION

If touchdown is made more than 500 feet from barrier, directional control may be lost prior to engagement.

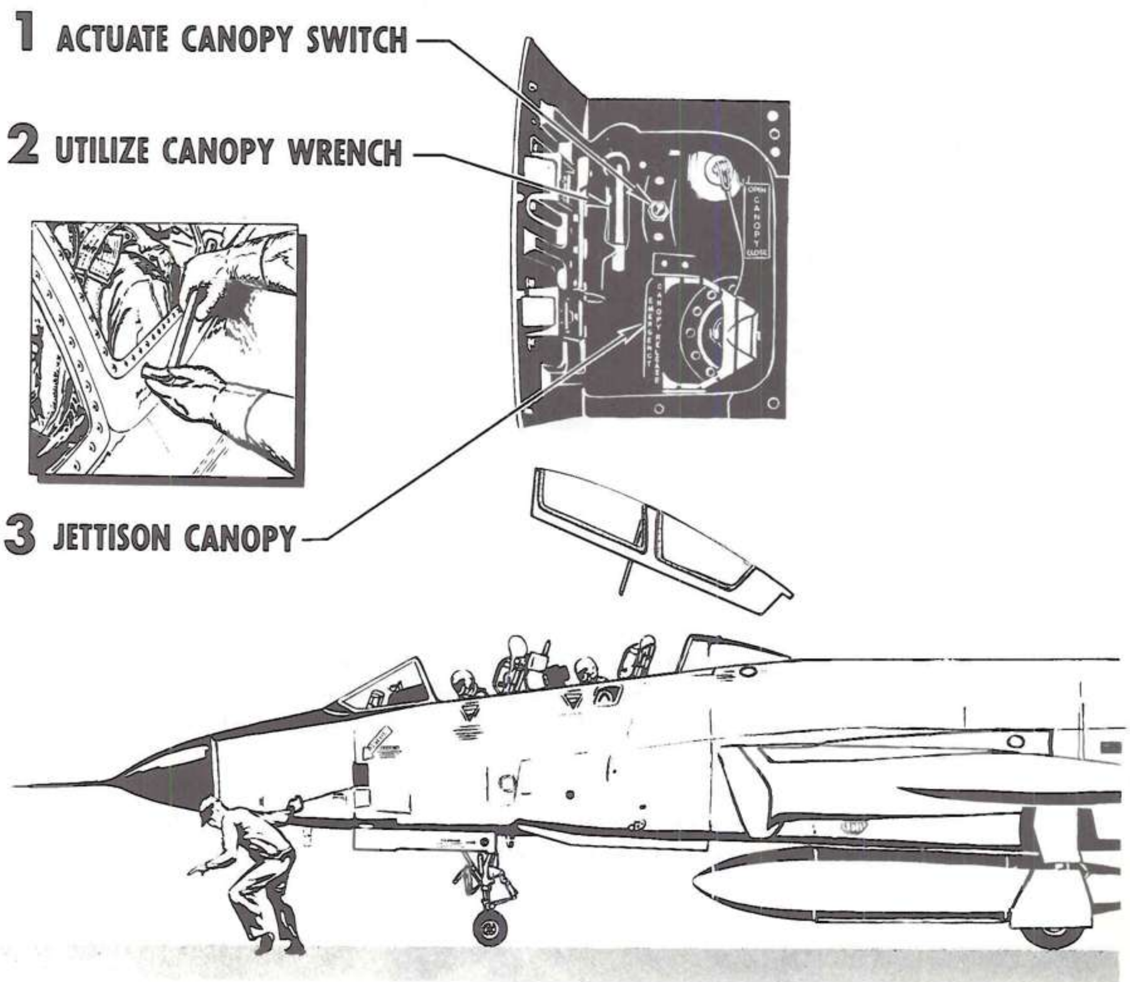
(g) Canopy – JETTISON (OPTIONAL)

The threat of a jammed canopy is minimized in this case. Retention of the canopy offers protection from flash fire; however, in the case of a missed engagement where the possibility of skidding off the runway is likely, the canopy should be jettisoned.

(h) THROTTLES – IDLE

Immediately after touchdown, place both throttles to IDLE.

(j) DRAG CHUTE – DEPLOY



CANOPY KNIFE
(BOTH COCKPITS)

LAST RESORT— BREAK THE CANOPY

IF THE CANOPY CANNOT BE OPENED, BREAK THE CANOPY WITH A SHARP POINTED INSTRUMENT SUCH AS A KNIFE OR AXE.

Note

IF THE CANOPY CANNOT BE REMOVED BY THE ABOVE PROCEDURES, THE AIRCREW CAN BREAK THROUGH THE CANOPY WITH THE CANOPY KNIFE.

Figure 3-6 Emergency Entrance and Exit

(k) NOSE WHEEL – LOWER

The nose wheel should be lowered immediately to establish a three-point attitude when hook pickup is accomplished, otherwise the nose will be rotated hard to the runway and may cause nose gear failure.

(m) NOSE WHEEL STEERING – ENGAGE

Attempt to maintain directional control for center line engagement by use of rudder, opposite brake, and nose wheel steering.

CAUTION

When landing with a blown main gear tire, do not attempt to lock the brake on affected wheel. A locked and/or ground down wheel may either snag the arresting cable and yaw the aircraft sideways or cut the cable. The wheel should be rolling when passing over the cable.

(n) Engines – SHUTDOWN

Prior to engine shutdown, ascertain from crash rescue personnel that fuel discharge during shutdown will not impose a hazard due to hot hook or brakes.

EMERGENCY ENTRANCE

47 Procedures and precautions to be observed by rescue personnel when assisting the pilot from the aircraft following a crash landing are outlined in figure 3-6.

CAUTION

If the canopy was jettisoned, the ejection seat handgrips may be up. With the handgrips up, the triggers will be exposed and any movement of either trigger may fire the seat and eject the crew member.

EMERGENCY EXIT

48 A canopy knife is mounted in each cockpit so the aircrew can break through the plexiglas in the canopy if it cannot be opened by normal or emergency procedures. In the event that no cockpit ladder or alternate device (access stand, etc.) is available, the shoulder harness may be used as "scaling ropes" for emergency exit from the cockpit.

FORWARD COCKPIT

BEFORE EJECTION

IF TIME AND CONDITIONS PERMIT...

- STOW ALL LOOSE EQUIPMENT.
- PRESSURIZATION TO RAM & DUMP (HIGH ALTITUDE).
- ACTUATE BAIL-OUT BOTTLE (HIGH ALTITUDE).

WARNING

IMMEDIATELY AFTER ACTUATING THE EMERGENCY BAILOUT BOTTLE, DISCONNECT THE SEAT OXYGEN HOSE FROM THE CONNECTOR TO PREVENT THE ESCAPE OF EMERGENCY OXYGEN THROUGH THE SEAT OXYGEN HOSE.

- SLOW AIRPLANE (ZOOM-UP MANEUVER).

1 ASSUME PROPER POSITION

- FEET ON RUDDER PEDALS.
- THIGHS BRACED ON SEAT CUSHION.
- ARMS BRACED IN ARM RESTS.
- SIT ERECT WITH CHIN IN, HEAD HARD BACK AGAINST HEAD REST.

2 EITHER HANDGRIP—PULL UP

IF CANOPY FAILS TO JETTISON...

3 CANOPY ALTERNATE JETTISON HANDLE—PULL UP (IF REQUIRED)

4 CANOPY SWITCH—HOLD OPEN (IF REQUIRED)

5 CANOPY MANUAL RELEASE LEVER—PULL (IF REQUIRED)

WARNING

MANUAL OPENING OF CANOPY MAY INFLICT SERIOUS INJURY WHEN LEVER IS NOT GRIPPED PROPERLY. CANOPY BREAKAWAY IS EXTREMELY RAPID. GRASP LEVER WITH RIGHT HAND OR LEFT HAND. WHEN GRASPING LEVER WITH EITHER HAND, MAKE SURE THUMB IS ON INSIDE OF LEVER.

- IF CANOPY DOES NOT RELEASE, PROCEED TO STEP 6, EJECTING THROUGH CANOPY.

6 EITHER TRIGGER—SQUEEZE

AFTER EJECTION

AFTER SEAT EJECTS...

- TO ASSURE IMMEDIATE SEAT SEPARATION, ATTEMPT TO "BEAT" THE AUTOMATIC FUNCTION OF THE SAFETY BELT BY MANUALLY OPENING THE BUCKLE AND KICKING FREE OF THE SEAT.

AFT COCKPIT

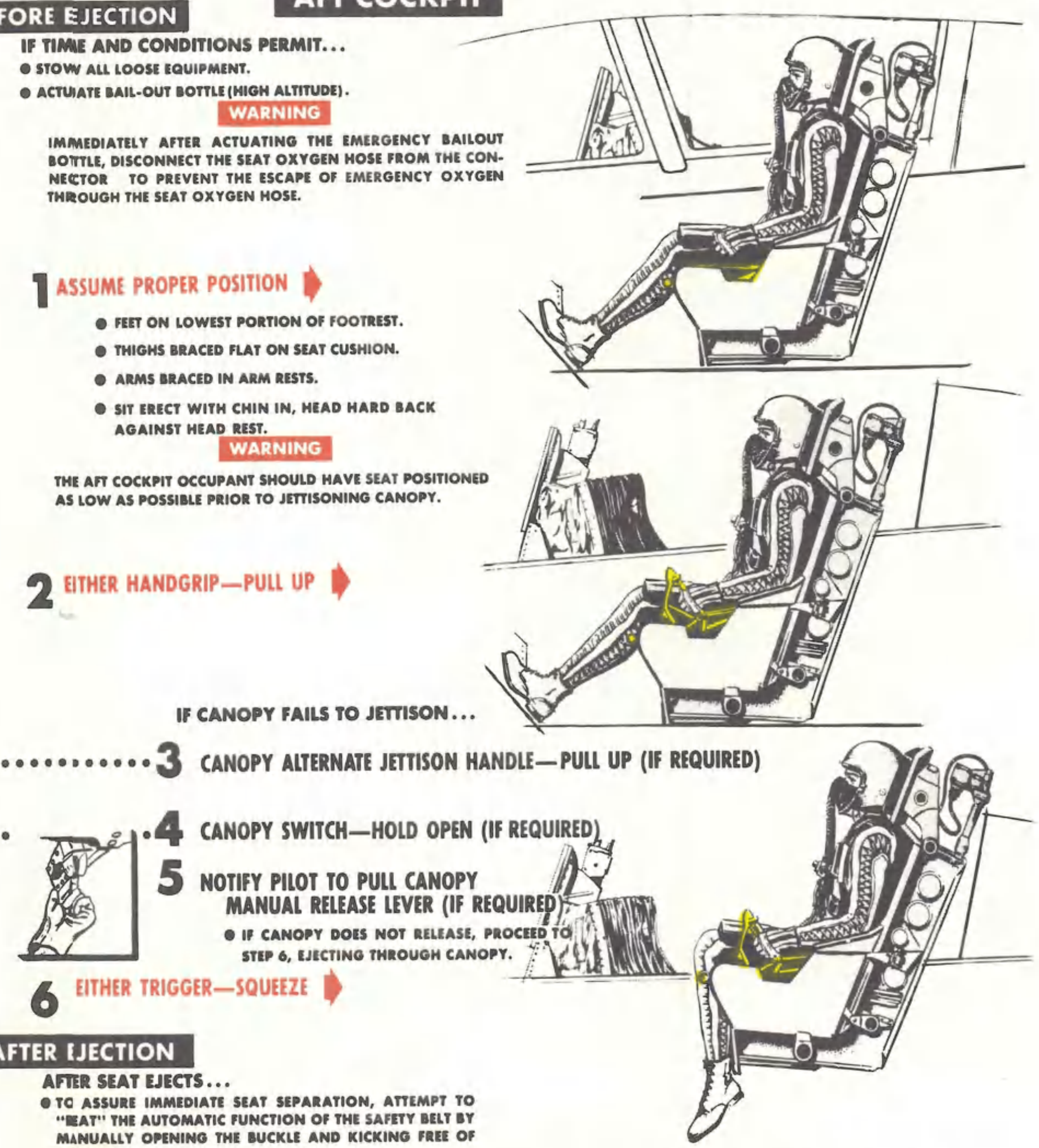
BEFORE EJECTION

IF TIME AND CONDITIONS PERMIT...

- STOW ALL LOOSE EQUIPMENT.
- ACTUATE BAIL-OUT BOTTLE (HIGH ALTITUDE).

WARNING

IMMEDIATELY AFTER ACTUATING THE EMERGENCY BAILOUT BOTTLE, DISCONNECT THE SEAT OXYGEN HOSE FROM THE CONNECTOR TO PREVENT THE ESCAPE OF EMERGENCY OXYGEN THROUGH THE SEAT OXYGEN HOSE.



1 ASSUME PROPER POSITION

- FEET ON LOWEST PORTION OF FOOTREST.
- THIGHS BRACED FLAT ON SEAT CUSHION.
- ARMS BRACED IN ARM RESTS.
- SIT ERECT WITH CHIN IN, HEAD HARD BACK AGAINST HEAD REST.

WARNING

THE AFT COCKPIT OCCUPANT SHOULD HAVE SEAT POSITIONED AS LOW AS POSSIBLE PRIOR TO JETTISONING CANOPY.

2 EITHER HANDGRIP—PULL UP

IF CANOPY FAILS TO JETTISON...

3 CANOPY ALTERNATE JETTISON HANDLE—PULL UP (IF REQUIRED)

4 CANOPY SWITCH—HOLD OPEN (IF REQUIRED)

5 NOTIFY PILOT TO PULL CANOPY MANUAL RELEASE LEVER (IF REQUIRED)

- IF CANOPY DOES NOT RELEASE, PROCEED TO STEP 6, EJECTING THROUGH CANOPY.

6 EITHER TRIGGER—SQUEEZE

AFTER EJECTION

AFTER SEAT EJECTS...

- TO ASSURE IMMEDIATE SEAT SEPARATION, ATTEMPT TO "BEAT" THE AUTOMATIC FUNCTION OF THE SAFETY BELT BY MANUALLY OPENING THE BUCKLE AND KICKING FREE OF THE SEAT.

WARNING — IMMEDIATELY AFTER LEAVING SEAT, MANUALLY PULL PARACHUTE RIPCORD HANDLE FOR ALL EJECTIONS BELOW 15,000 FEET TO OPEN PARACHUTE IMMEDIATELY.

WARNING — DO NOT RELEASE THE SURVIVAL KIT DURING DESCENT, UNTIL THE PARACHUTE IS FULLY DEPLOYED AND STABILIZED, TO PREVENT THE SURVIVAL KIT OR ATTACHING DROP LINE FROM FOULING THE PARACHUTE.

Figure 3-7 Ejection Procedure

EJECTION

GENERAL

49 Escape from the aircraft in flight should be made with the ejection seat. The basic ejection procedure is shown in figure 3-7.

NOTE

The pilot can actuate the Eject Warning Light swtich to notify aft seat occupant that he should eject.

CAUTION

Simultaneous ejection should be avoided when possible to prevent chute entanglement. If time and conditions permit, the NAV should eject first to prevent the possibility of injury to the NAV from flying debris. When practical, ejection should be staggered by one-half second or more.

The study analysis of escape techniques by means of ejection seat reveals that:

(a) Ejection at airspeeds ranging from stall speed to 525 knots IAS results in relatively minor forces being exerted on the body, thus reducing injury hazard.

(b) Appreciable forces are exerted on the body when ejection is performed at airspeed of 525 to 600 knots IAS rendering escape more hazardous.

(c) At speeds above 600 knots IAS, ejection is extremely hazardous because of excessive forces on the body.

CAUTION

Under controllable level flight conditions, ejection should be accomplished above 2000 feet terrain clearance whenever possible. Do not delay ejection below 2000 feet above the terrain in futile attempts to start the engine or for other reasons that may commit you to an unsafe ejection or a dangerous flameout landing. Accident statistics emphatically show a progressive decrease in successful ejections as altitude decreases below 2000 feet above the terrain. Under out-of-control dive conditions, ejection should be accomplished with at least 15,000 feet terrain clearance. Attempt to slow the aircraft as much as practical prior to ejection by trading airspeed for altitude.

LOW ALTITUDE EJECTION

50 During any low altitude ejection, the possibility of success can be greatly improved by zooming and ejecting while the nose of the aircraft is above the horizon and the airspeed is at least 120 knots and not more than 525 knots IAS. The zoom-up maneuver will exchange airspeed for altitude, thus providing maximum terrain clearance at time of ejection as well as reducing the airspeed to safe limits for ejection. It must be remembered that altitude and airspeed conditions alone will not insure a successful ejection. If sink rate is allowed to become high after completing the zoom climb all advantages of the increased altitude may be lost. Ejecting while the nose of the aircraft is above the horizon will result in a more nearly vertical trajectory for the seat and crew member, thus providing more altitude and time for seat separation and parachute deployment. At low altitudes, a minimum airspeed of 120 knots IAS is recommended to assure rapid deployment of the chute. A determined effort to separate from the seat must be made as soon as the belt releases to obtain maximum terrain clearance when the parachute deploys. An effort should be made to "beat" the automatic function of the seat belt.

CAUTION

> Manually opening the seat belt removes the automatic parachute deployment feature. Improper routing of personal leads may cause inadvertent opening of the lap belt manual release lever during ejection. Care must be taken to insure that flight clothing, such as sleeves, will not catch and release the lap belt during ejection.

Manually pull parachute ripcord handle immediately following seat separation for all ejections below 15,000 feet. This provides a safety factor since the parachute should deploy automatically.

51 The automatic opening safety belt should never be opened before ejection for the following reasons:

(a) If the safety belt is manually opened, the seat-man separator will still function, but the automatic opening feature will be eliminated.

(b) Manually opening the safety belt creates a hazard to survival during uncontrollable flight, since negative "G" forces may prevent the pilot from assuming the correct ejection position.

(c) Manually opening the safety belt creates a hazard to survival if the pilot decides that he has insufficient altitude for ejection and is required to proceed with a forced landing. Both hands will probably be required to control the aircraft and the pilot will not be able to fasten the the safety belt and shoulder harness.

(d) Manually opening the safety belt may cause the crew member to separate from the seat at any time during ejection. If the pilot separates from the seat immediately after the seat leaves the aircraft, severe shock loads will be imposed on the body. The automatic opening safety belt is designed to open 1 second after ejection, which is sufficient time for safe deceleration of the crew member while still in the seat.

52 The emergency minimum ejection seat limits are:

(a) 50 ft AGL.

(b) Level flight attitude.

(c) Zero sink rate.

These are emergency minimums. Ejection should be started above 2000 feet, if possible.

CAUTION

> Emergency minimum ejection altitudes quoted are based on distance above terrain on initiation of seat ejection (i.e., time seat is fired). These figures do not provide any safety factor for such matters as equipment malfunction, delays in separating from the seat, etc. These figures are quoted only to show the minimum altitude that must be achieved in the event of such low altitude emergencies as fire on take-off. They shall not be used as the basic for delaying ejection when above 2000 feet since accident statistics show a progressive decrease in successful ejections as altitude decreases below 2000 feet. Therefore, whenever possible, eject above 2000 feet. To insure survival during extremely low altitude ejections, the automatic features of the equipment must be used and depended upon.

HIGH ALTITUDE EJECTION

53 For a high altitude ejection, the basic ejection procedures are applicable. The "zoom-up" maneuver is still useful to slow the aircraft to a safer ejection speed, or provide more time and glide distance as long as an immediate ejection is not mandatory.

CAUTION

> In the event emergency oxygen is required for any reason, disconnect the seat oxygen hose from the connector immediately after actuating

the emergency bailout bottle to prevent the escape of emergency oxygen through the seat oxygen hose.

AFTER EJECTION

54 (a) Release seat ejection handles.

(b) Immediately after ejection, as a precautionary measure, in case the seat belt fails to open automatically, attempt to open the seat lap belt. Since the automatic feature is activated one second after ejection, it will be impossible to beat the automatic opening device unless it has failed.

CAUTION

Opening the belt manually eliminates the automatic feature of the parachute. The crew member must, therefore, pull the auto cord or wait till 15,000 feet and pull the manual rip cord "D" ring.

(c) Until the point of touch down the procedure for landing in water, trees or on land will be the same.

(d) If ejection takes place above 15,000 feet pull the emergency oxygen "green apple".

(e) Parachute deployment is automatic at 15,000 feet.

(f) The parachute "D" ring must not be pulled above 15,000 feet.

(g) Do not pull the survival kit deployment handle before the parachute is deployed because it it could interfere with parachute opening.

(h) Loosen oxygen mask below 10,000 feet, if time permits.

(j) Pull survival kit deployment handle between 1000 and 500 feet if time and altitude permits.

(k) If a life preserver is worn check to ensure that the survival kit lanyard is connected to the life preserver, then release the left hand quick-release fastener that attaches the survival kit to the parachute harness.

(m) If a life preserver is not worn, the survival kit contents will remain suspended on the lanyard attached to the parachute harness by the left hand survival kit quick-release fastener.

(n) If time permits during the descent blow one or two breaths of air into the life jacket.

(p) During the descent, turn the parachute harness quick-release box to the "open" position.

(q) Inflate the life preserver prior to entering the water.

(r) As you enter the water squeeze the quick release box to release the parachute harness.

EJECTION SEAT FAILURE

55 In the event that the canopy has been jettisoned but the ejection seat fails, it is recommended that both crew members proceed as follows:

CAUTION

Insure that the speed brakes are closed prior to attempting manual escape to preclude the possibility of the aircrew or parachute striking the speed brakes when evacuating the aircraft.

(a) SLOW AIRCRAFT – 275 KIAS (if time and conditions permit)

(b) SAFETY BELT AND PERSONAL LEADS – UNFASTEN

(c) BAIL-OUT BOTTLE – ACTUATE (if necessary)

(d) MAINTAIN ALTITUDE WITH FULL NOSE DOWN TRIM

(e) INVERT AIRCRAFT AND RELEASE THE STICK

(f) PUSH FREE OF SEAT

Immediately after releasing the stick, push free of the seat.

(g) PARACHUTE – DEPLOY (below 15,000 feet)

EMERGENCY JETTISONING

EXTERNAL TANKS

56 The procedures for external tank jettison are shown in figure 3-8.

CAUTION

Do not jettison external tanks containing partial fuel except in an emergency. If such action is necessary, jettison tanks in a slight dive to allow fuel to drain forward. This permits a cleaner separation and reduces the possibility of further damage to the aircraft.

Jettisoned fuel tanks sometimes fly laterally and climb rather than fall as normally expected. Therefore, pilots should warn adjacent aircraft before jettisoning tanks so that they can take a position above and forward of the jettisoning aircraft. When jettisoning tanks in formation, aircraft should line abreast at wide intervals.

Figure 3-8 Emergency Tank Jettison

EMERGENCY ROCKET RELEASE

57 To jettison the AIR-2A rocket, the following procedures must be followed:

(a) RADAR OFF
(b) MASTER ARM SWITCH – SAFE
(c) ARMAMENT SELECTOR KNOB – JETT
(d) AIR-2A EJECTOR RACKS LOCK SWITCH – UNLOCKED
(e) ARMAMENT TRIGGER – DEPRESS
When the armament trigger switch is depressed, the armament door will rotate and jettison both (unarmed) AIR-2A rockets without rocket motor ignition.

CAUTION

When the first AIR-2A rocket has been jettisoned, there will be a 5-second delay before the second rocket is jettisoned.

CAUTION

The AIR-2A rocket will not be jettisoned over friendly territory except in an authorized jettisoned area.

EMERGENCY MISSILE RELEASE

58 When conditions arise that the AIM-4D missiles must be jettisoned:

(a) ARMAMENT SELECTOR KNOB – TRIG-SALVO
(b) ARMAMENT TRIGGER SWITCH – DEPRESS (ALL THE WAY) Missile launchers extend and external missiles fire.

The missile warheads are not actuated in TRIG-SALVO therefore the missiles are unarmed and will not self-destruct. The master arm switch can be left in the SAFE position.

MISSILE MISFIRE OR HANGFIRE

59 In the event of a missile misfire or hangfire indication, perform the following:

(a) ARMAMENT TRIGGER SWITCH – RELEASE
(b) MASTER ARM SWITCH – SAFE
(c) ARMAMENT SELECTOR KNOB – VIS-IDENT
(d) Land with launchers extended.
(e) If the pilot elects to retract the launchers, Push-to-Retract button – DEPRESS
The launcher hot light will go out when the launchers retract.

CAUTION

The launchers should never be retracted if the missiles have moved on the rails as severe airframe damage may result.

CAUTION

A five minute waiting period should be observed before retracting launchers. In emergency conditions this waiting period may be shortened to 30 seconds.

AIR-2A ROCKET EJECTOR RACK MISFIRE

60 In the event that the launcher hot light illuminates on an AIR-2A attack, proceed as follows:

(a) ARMAMENT TRIGGER SWITCH – RELEASE
Immediately release the armament trigger switch on the control stick to remove the fire signal from the ejector rack.
(b) MASTER ARM SWITCH – SAFE
Place the master arm switch to the SAFE position to disarm the warhead arm-safe switch. The attack mode and rocket armed lights go OFF
(c) ARMAMENT SELECTOR KNOB – VIS-IDENT
Rotate armament selector knob to the VIS-IDENT position to de-energize the select SPL-WPN circuit.
(d) Push-to-retract button – DEPRESS
The launcher hot light will go out when the door rotates to the normal position.
(e) AIR-2A ejector racks lock switch – LOCKED

CAUTION

The AIR-2A rocket should be left in the external position for 10 minutes. The 10-minute period insures that the voltage in the thermal batteries will have dropped to a level safety below that required to ignite the rocket motor. This requirement to wait 10 minutes can be waived in event re-attack is required.

PART 4

EXHAUST TEMPERATURE

200°C-560°C	CONTINUOUS BELOW 30,000 FEET
560°C-580°C	CONTINUOUS ABOVE 30,000 FEET
620°C	MAXIMUM IN AFTERBURNER BELOW 30,000 FEET
640°C	MAXIMUM IN AFTERBURNER ABOVE 30,000 FEET

Note

610°C Maximum for Starting, Maximum in Military Thrust Below 30,000 Feet (30 Min.)
640°C Maximum in Military Thrust Above 30,000 Feet (30 Min.)
650°C Maximum for Acceleration (2 Min.)

TACHOMETER

102%	MAXIMUM OVERSPEED
85%-98%	CONTINUOUS

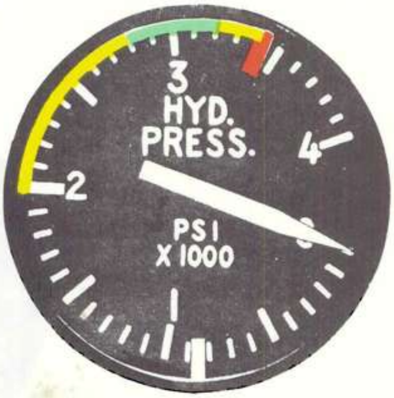
OIL PRESSURE

35 PSI	MINIMUM
35-40 PSI . .	CAUTION
40-50 PSI . .	CONTINUOUS
50 PSI	MAXIMUM

Figure 4-1 Engine Instrument Markings

AIRSPEED AND MACH

(red/yellow)	500 KNOTS MAXIMUM EXT TANKS
(yellow)	250 KNOTS MAXIMUM LANDING GEAR AND FLAPS



HYDRAULIC PRESSURE

PRIMARY-UTILITY	
2000–2800 PSI (yellow)	NORMAL WITH RAPID CONTROL MOVEMENT
	SHOWS MALFUNCTION WITH CONTROLS STATIC
2800-3200 PSI (green)	NORMAL*
3200–3400 PSI (yellow)	IF HYDRAULIC PRESSURE EXCEEDS 3200 PSI IN THE STEADY STATE AN ENTRY IN THE FORM 781 IS REQUIRED.
3400 PSI (red)	MAXIMUM

* 2550 PSI MINIMUM AND 2950 PSI MAXIMUM WHEN LEFT ENGINE IS INOPERATIVE.

ACCELEROMETER

POSITIVE LOAD FACTORS (g) LIMITS		
6.8 g	(red)	MAXIMUM CLEAN AND 8200 LB MAXIMUM FUEL
6.0 g	(red)	MAXIMUM NO EXT TANKS
4.0 g	(red/yellow)	MAXIMUM EXT TANKS (SYMMETRICAL)
NEGATIVE LOAD FACTORS (g) LIMITS		
-2.0g	(red/yellow)	MAXIMUM EXT TANKS

STARTER AIR BOTTLE PRESSURES

3000 PSI	(red)	MAXIMUM

Note

(REFER TO AMBIENT TEMPERATURE VERSUS PRESSURE TABLE SECTION II FOR MINIMUM PRESSURES AT VARIOUS TEMPERATURES).

Figure 4-2 Instrument Markings

OPERATING DATA

GENERAL

1 This part includes aircraft and engine limitations that must be observed during normal operation. Instrument markings giving various operation limitations are shown in figures 4-1, 4-2. Some markings are self evident and are not discussed in the text.

ENGINE LIMITATIONS

Operating Conditions	Maximum Observed Exhaust Temperature		Time Limit	
	Sea Level to 30,000 Feet	Above 30,000 Feet	Ground Operation	Flight Operation
Maximum	620	640	5 Minutes	15 Minutes*
Military	610	640	30 Minutes	
Maximum Conditions	560	580	Continuous	
Idle	340	–	Continuous	
Starting	610	610	Momentary	
Acceleration	650	650	2 Minutes**	

* Refer to "Maximum Thrust" this section.

** For J57-P-55 engines, the acceleration time is 2 minutes and is defined as the period between initial advancement of throttle and when the EGT begins to drop off from its peak Temperature (not to exceed 650 C). EGT indication will then show a downward trend toward a stabilized temperature for which 2 additional minutes are allowed for the EGT to reach the limiting temperature for the aircraft altitude and power setting.

Figure 4-3 Engine Operating Limits

MAXIMUM THRUST

2 Maximum thrust is defined as the thrust obtained at full afterburner and is limited to 5 minutes continuous operation on the ground and 15 minutes continuous operation in flight. Periods of afterburning up to 15 minutes should be followed by a 5 minute cooling period of non-afterburning. Due to high fuel consumption, afterburner operation should be avoided with less than 3,000 pounds of total fuel remaining.

MILITARY THRUST

3 Military thrust is defined as the thrust obtained at full throttle without afterburner and is limited at 30 minutes continuous operation.

MAXIMUM CONTINUOUS THRUST

4 This rating is the maximum stabilized thrust which may be used continuously. The rating is obtained by adjusting the throttle to obtain a predetermined engine pressure ratio. Maximum continuous thrust and all lower flight thrust selections may be used continuously.

ENGINE OPERATING LIMITS

ENGINE OIL PRESSURE

5 Normal oil pressure is 40-50 psi at all power settings. Oil pressures between 35 and 40 psi are undesirable and should be tolerated only for the completion of the flight, preferably at a reduced throttle setting. Oil pressure fluctuation is acceptable providing the fluctuation cycle remains within the normal operating range. Abnormal pressures or fluctuations not within the operating range should be reported as an unserviceability. Oil pressures below 35 psi are unsafe and require that the engine be shut down.

ENGINE OVERSPEED

6 Should the maximum permissible engine speed of 102% rpm be exceeded, the engine must be inspected for damage. Pilot should make Form L-14 entry stating maximum rpm obtained and duration of overspeed to insure inspection.

EMERGENCY FUEL

7 Aviation gasoline MIL-G-5572, lowest grade available may be used in lieu of JP-4 fuel only in emergencies. Continuous operation should not exceed one flight and such operation should be subsequently followed by operation with JP-4 prior to re- exposure to emergency fuel.

ENGINE STARTER

8 To prevent the possibility of starter destruction when a combustion start has been made or aborted, a second attempt to start will not be made until engine rotation has stopped and at least one minute has elapsed. A third attempt to start will not be made until a cooling period of 45 minutes has elapsed.

ENGINE STARTER AIR BOTTLES

9 Refer to strange field procedures Part 2 for temperature compensated air bottle pressures. A minimum of 1800 psi is required for emergency landing gear lowering.

AIRSPEED LIMITATIONS

LANDING GEAR LOWERING SPEEDS

10 Limiting airspeed for landing gear operation is 250 KIAS, due to possible damage to landing gear mechanism. During landing gear retraction, the landing gear and gear doors should be completely up and locked before gear limit airspeed is reached, otherwise excessive air loads may damage gear mechanism and prevent subsequent operation.

FLAP OPERATING SPEEDS

11 Limiting speeds for lowering or raising flaps is 250 KIAS.

CANOPY OPERATING SPEEDS

12 The canopy is not designed to be opened in flight. Any partial opening of the canopy would cause air loads to tear the canopy off the aircraft. During taxiing the canopy may be opened at speeds not in excess of 75 KIAS. The pilot should consider gust or severe surface winds as a contributing factor to the 75 knot restriction.

DRAG CHUTE OPERATING SPEEDS

13 The drag chute is designed to be deployed after landing at speeds under 200 KIAS. Should the drag chute door inadvertently open without actuation of the drag chute handle, the drag chute will fall free of the aircraft. Actuation of the handle, however, will cause a locking mechanism to hold the chute. The drag chute may be deployed in an emergency at speeds in excess of 200 KIAS but below 215 KIAS. In the event this is done, an entry in Form L-14 must be made to insure structural inspection.

RAIN CLEARING SYSTEM OPERATING SPEEDS

14 Operation of the rain clearing system is permitted during precipitation, ice clearing, and inflight refueling at speeds not above 310 KIAS.

REFUELING PROBE OPERATING SPEEDS

15 With the refueling probe extended, maximum allowable airspeed is 310 KIAS.

MAXIMUM ALLOWABLE AIRSPEEDS

16 (a) Clean Aircraft
Above 25,000 feet – 1.73 indicated Mach or 700 KIAS, whichever is lower
Below 25,000 feet – 600 KIAS
(b) With External Tanks
All altitudes – 1.3 indicated Mach or 500 KIAS, whichever is lower

EXTERNAL TANKS JETTISON SPEEDS

17 Full or empty external tanks may be jettisoned below 300 KIAS between + .5 "G" and + 3.5 "G".

PROHIBITED MANOEUVERS

18 The aircraft is restricted from the following manoeuvers:

(a) Any snap manoeuvres.
(b) Rolls continued past the 360° point.
(c) With external tanks, do not exceed 2/3 aileron travel above 300 KIAS.
(d) Intentional pitch-up and spins.
(e) Negative "G" conditions in excess of 15 seconds.
(f) Zero "G" condition in excess of 10 seconds.
(g) Aerobatic manoeuvres in the looping plane.

19 The following limitations shall be adhered to when performing snap-up manoeuvres.

(a) Fuel load, less than 10,000 pounds.
(b) Pitch attitude not to exceed 30 degrees.
(c) Recovery roll to be initiated at not less than 230 KIAS.

ACCELERATION LIMITATIONS

GENERAL

20 The following acceleration limitations are for symmetrical flight manoeuvres. Unsymmetrical flight manoeuvres limitations are 2/3 of the symmetrical limitations.

Configuration	"G" Limits	
Primary Armament Door	Armament Door Normal Position	Armament Door Attack position
With Full Internal Fuel and No External Tanks	+ 6.0 – 2.5	+ 5.33 – 1.0
With a Maximum of 8200 Pounds Internal Fuel and No External Tanks	+ 6.8 – 2.8	+ 5.33 – 1.0
With External Tanks	+ 4.0 – 2.0	+ 4.0 – 1.0

Figure 4-4 Acceleration Limits

PITCH CONTROL SYSTEM INOPERATIVE

21 (a) Below .9 indicated Mach number, do not exceed moderate buffet.

(b) Above .9 indicated Mach number, do not exceed the following load factors:

300 Knots IAS	–	1.7 "G"	400 Knots IAS	–	3.7 "G"
350 Knots IAS	–	2.7 "G"	450 Knots IAS	–	4.7 "G"

CAUTION

These factors load are based on 39,800 lbs. gross weight. Load factors may be adjusted in inverse proportion to gross weight, i.e., rolling pull-outs.

CENTER OF GRAVITY LIMITATIONS

MOST FORWARD C.G.

22 The most forward C.G. limits are 20% M.A.D. for take-off and 17% M.A.C. during flight and landing. The most forward C.G. occurs with full armament retained, external tanks full and retained, wing tanks empty, 6,175 pounds of fuselage fuel remaining and both crew members aboard.

MOST AFT C.G.

23 The most aft C.G. limits are 36% M.A.C. for take-off, and 41% M.A.C. during flight and landing. The most aft C.G. occurs with no fuel remaining, external tanks jettisoned, all armament expended, and the aft cockpit unoccupied.

24 Flight without armament and without armament replacement ballast may be made, provided both external tanks are full at take-off. Flight without armament, without armament replacement ballast and without full external tanks may be made if the aft C.G. location is maintained within limits by added ballast in the nose wheel well, as calculated from the amount of fuel consumed (-480 lbs.) during idle, taxi, and take-off, or by not fueling No. 5 cell. The aircraft has a lockout switch for the No. 5 cell which, in the CUT-OFF position, prevents fuel from entering the cell. The switch is adjacent to the refueling receptacle and is kept in the NORMAL position when not required.

CENTER OF GRAVITY TRAVEL

25 Center of gravity locations which are beyond the recommended limits may occur unless fuel is consumed in the following order: External fuel, wing fuel, internal fuselage (cells 1 thru 5). The pilot may also control the C.G. position by expending armament.

CAUTION

Partial fueling of the fuselage cells can result in an incorrect distribution of fuel which may cause the center of gravity to exceed the recommended limits. It is, therefore, recommended when fueling the fuselage cells, to fill them completely. The automatic operation of the pumps will then keep the fuel properly distributed among the fuselage cells.

WEIGHT LIMITATIONS

26 The maximum allowable take-off gross weight is 52,400 pounds. Extreme care should be taken to insure that no additional items of appreciable weight are installed or removed without a weight and balance check. There is no set maximum gross weight limit for landing.

EQUIPMENT COOLING

MAGNETRON BLOWER

27 An automatically operated magnetron blower is installed in the aircraft to aid in cooling at low engine rpm. Observe the following radar operation limitations during ground operation below 80% rpm.

WARM – Indefinite
STBY – 8 Minutes
ON – 8 Minutes

The total time in STBY and ON should not exceed 8 minutes. There is no time limit for any mode of operation when one engine is at 80% rpm or above.

FCS OVERHEAT

28 The FCS overheat warning light on the radar observer's panel will illuminate whenever the MG-13 system is receiving inadequate cooling with the radar master switch in the ON or STBY position. Operating the radar with the warning light illuminated for extended periods could affect the reliability and seriously endanger the life of the radar. The light will normally be ON during the following conditions:

(a) On the ground at engine power setting below 80% rpm.
(b) In flight any time engine power settings are below those required to maintain altitude, such as some idle letdown conditions.
(c) Decelerating flight conditions using power settings close to idle.
(d) During final approach just prior to touchdown.
(e) At any time due to failure in the equipment cooling system.

CAUTION

It is permissible to operate the radar for periods up to 8 minutes with the FCS overheat light illuminated, PROVIDING THE EQUIPMENT COOLING IS NORMAL and the engines are at taxi thrust or above.

CF-101 ALTITUDE LIMITATION

29 CF-101 aircraft may be flown up to 50,000 feet providing that both aircrew are equipped with a serviceable and properly adjusted oxygen mask that is equipped with the Pate suspension system. For flight above 50,000 feet a full pressure suit and helmet is required.

APPENDIX I

PERFORMANCE DATA

The performance data contained in this Appendix is based on new, fullyrated J-57 engines. Care must be taken when using this data as the engines have since been derated. No revision of the original data is available and no conversion percentage has been computed.

APPENDIX II

FUNCTIONAL TEST FLIGHTS

FUNCTIONAL TEST FLIGHTS

BEFORE-FLIGHT REQUIREMENTS

1 Ground Crew

(a) A complete preflight inspection shall be performed.
(b) Precision G meter will be installed in the front cockpit for all FTF. Correction card will be attached to G meter.
(c) Insure limiter control panel cover is open.
(d) Install in-flight test panel if pitch control boundaries are to be changed in-flight. If test panel is installed, helipot should be adjusted to proper placard angles and helipot readings recorded.
(e) Remove external fuel tanks if installed.

2 Pilot

(a) The following checks performed in accordance with PART 2.
(b) Weight and balance data. Check armament door proper ballast head for fuel being carried.
(c) Exterior inspection – walk-around Briefing shall be given at this time to crew chief on handling of angle-of-attack vanes and hand signals to be used for performance of PCS ground checks.
(d) Front cockpit interior.
(e) Ejection seat.
(f) Before starting engines. In addition to the procedures outlined in Part 2. After electrical power has been applied to the aircraft, check fuel quantity gauge for proper operation by use of the checkswitch. Total and individual tank readings will be recorded on the flight test card.
(g) Starting engines. Following start of left engine and prior to start of right engine, record hydraulic pressures and generator reading on flight test card. Hydraulic pressure 2800 – 3200 PSI. Generator voltage 115V plus or minus 2 volts.

(h) After both engines are started, check the PCS as follows:

(1) With the horn and pusher angle-of-attack vanes aligned with the scribed marks on the vane doors, depress pitch inhibitor test button while sharply moving the stick aft. Pusher and horn should engage on rate and pusher will push the stick forward approximately one inch before disengaging. Upon disengagement stick should be moved sharply aft again with a subsequent pusher and horn engagement subtantially aft of the original engagement point.
(2) Signal ground crew to raise horn and pusher vanes to full up position. Engage auto pilot and slowly pull stick full aft. With auto pilot engaged, depress the pitch inhibitor system test button and note horn operation and pusher engagement. As the pusher engages, the autopilot should disengage.
(3) Insure emergency disengage paddle will disengage pusher when depressed. Check that pusher force can be overpowered by approximately 27.5 pounds aft stick force.
(4) With horn vane full down, depress test button and have ground crew slowly raise horn vane to full up position. Insure Alpha W needle movement corresponds to vane movement and horn blows when Alpha W needle is within .25° of horn boundary wand.
(5) Turn off horn switch and note pitch inhibitor out light illuminates and observe power is removed from pitch boundary indicator. Turn horn switch on and check inhibitor light off.
(6) Turn pusher switch off and check pitch inhibitor out light on.

(j) Engage AFCS and yaw damper.

(1) Roll heading selector in either direction and note proper displacement of both ailerons.
(2) Move stick to one side and note that heading selector returns to corresponding heading on compass indicator.

(3) Engage altitude hold, mach hold, snap-up switch, and attack mode switches noting that switches engage and stay engaged.

(4) Disengage autopilot with paddle switch noting disengagement of all switches, except yaw damper.

(5) Re-engage autopilot and overpower by rapid fore and aft stick movement to check AFCS disengagement.

(6) Re-engage AFCS and slowly pull stick to full aft position. Signal ground crew to raise the CADC angle-of-attack vane slowly so as not to get a rate disengagement. As the CSL starts to move the stick forward, check overpower forces. (Should be 60 pounds.)

(7) Disengage autopilot and reset take-off trim.

(k) Controls

(l) Ailerons. Breakout force should be low enough to allow smooth movement of small amounts of deflection.

(2) Stabilator. Friction should be low enough to allow smooth manoeuvering.

(3) Rudder. Before take-off (with take-off trim green light on) rudder pedals should be equal fore and aft.

NOTE

All control system components must be critically inspected for forces and gradients, prior to flight check for feel, trimming, centering, and friction.

(4) Trim. Check trim centering by triming each flight control off center and return to take-off trim configuration by use of trim centering button. Time to return trim to center should be the same time used in deflecting trim from center. Caution should be used when checking stabilator trim as a green light will be given any time the trim is forward of neutral.

(5) Check that antiskid out light comes on within 3 to 5 seconds after paddle switch on stick is actuated.

(m) Taxi Check

(1) Check rain clearing.

(2) Canopy for proper operation.

(3) Brakes for proper feel and normal operation.

(4) Nose gear steering for full travel and proper centering.

(5) Check flight instruments for proper indications.

(n) Pre-take-off power check in addition to procedures outlined in Part 2.

(1) Emergency fuel system check. Emergency idle should be 54% to 64%. Emergency idle should be checked with A/B nozzles closed. Pull landing gear circuit breaker to close nozzles. Reference CF-101 Test Card for proper performance (EPR) of engine in emergency fuel control for a given temperature and atmospheric pressure.

(2) Normal fuel system check. Normal idle with pop open nozzles should be 63% to 65%. Without pop open nozzles, idle should be 59% to 61%. Throttles will be moved from idle to military in one second.

NOTE

Engine acceleration time must be 14 seconds or less and will be timed on max stop of the EPR needle. Check all engine instruments within limits for current temperature and pressure. Oil pressure 45 PSI plus or minus 5 PSI. RPM data plate speed plus 2%. Exhaust gas temperature 560° C maximum during acceleration. Hydraulic pressures 2800 to 3200 PSI.

3 Radar Observer

(a) Radar for proper operation.

(b) Indicator control panel.
  (1) If gain clockwise.
  (2) Video clockwise..
  (3) Search intensity as desired.
  (4) Scale lights clockwise.
  (5) Beacon-ground map expand switch in.
  (6) Tune switch normal.
  (7) HOJ off.
  (8) CCM off.

(c) Antenna scan control panel.
  (1) Elevation scan control knob in detent.
  (2) Azimuth scan in broad.

(d) Radar control panel.
  (1) Power switch off.
  (2) Range and mode selector switch as desired.

(e) Hand control.
  (1) Freedom of movement.
  (2) Nose/tail switch in tail.
  (3) Elevation scan vernier in detent and freedom of movement.
  (4) A-scan switch normal.

(f) Taxi.
  (1) Radar power switch in standby.
  (2) FCS overheat light on.
  (3) Position of horizon on pilots scope.
  (4) Intensity and focus of pilots scope as desired.
  (5) Equipment cooling switch off.

INFLIGHT REQUIREMENTS

4 Pilot actions during take-off.

(a) Monitor engine instruments at full military power.
  (1) Monitor engine pressure ratio and exhaust gas temperature at afterburner light-off.
  (2) Check nose wheel steering.
  (3) Flights controls and yaw damper at lift off.
  (4) Nose wheel for vibration after retraction.
  (5) Air-speed switch for proper operation at 290 plus or minus 10 knots.
  (6) Engine pressure ratio checked for proper operation when afterburner is terminated.

(b) Climb to 35,000 feet.
  (1) Check CSS during climb.
  (2) Select gravity position and total quantity on fuel control panel, turn wing tanks on, check for 800 to 1000-pound increase in total fuel quantity in an approximate time of one to three minutes.
  (3) Accomplish rate check of PCS at 260 and 310 KIAS. Accomplish by oscillating the stick fore and aft through a small arc at a rate that will not excite the aircraft in pitch. Rate should be increased until horn and pusher activate.
  (4) Air-speed system accuracy is essential for proper calibration of the PCS and the following checks are provided. At .9 IMN and 35,000 feet indicated altitude, compare IMN, IAS, and TAS. IAS should be 310 knots and TAS should be approximately 550 knots, depending on temperature. While accelerating to supersonic speeds, check air-speed indicator for mach jump at IMN (plus or minus .01).
  (5) Check afterburners for relight in a maximum of four seconds and for modulation. Check engine pressure ratio for proper eyelid operation. While maintaining military power check

and record the data from the following engine instruments being especially watchful for possible engine overtemp conditions.

a. Oil pressure 45 PSI plus or minus 5.

b. RPM data plate speed plus 2%.

c. Fuel flow.

d. EGT.

e. EPR.

(6) Accelerate to .9 IMN and perform inhibitor system check.

NOTE

Indicated mach and altitude must be maintained through proper use of power while performing a slow rate coordinated turn with increased G loading until the horn and pusher values are reached in accordance with the amount of total fuel remaining.

NOTE

Do not exceed prescribed pusher load factor at any time.

(7) New placard angles may be established in-flight by rotating individual horn and pusher knobs counter-clockwise to decrease G and clockwise to increase G until horn and pusher values. Lock adjustment dial and record readings.

(8) Check pitch boundary indicator for proper reading as horn and pusher are activated.

(9) Place automatic flight control system in on position and check command signal limiter G limiting values. If necessary, CSL values may be increased or decreased by rotating limit level knob on the in-flight adjustment panel, by small increments, clockwise to increase and counter. clockwise to decrease the Gloading at which the command signal limiter will begin limiting.

NOTE

The mach authority knob is not adjusted in-flight.

(c) Climb to 40,000 feet.

(1) Accelerate to 1.1 IMN.

(2) Repeat pitch inhibitor system and command signal limiter checks and establish values.

(3) Decelerate aircraft to subsonic speed while holding control stick against command signal limiter. Check for activation of inhibitor horn while passing through transonic region.

(d) Descend to 35,000 feet.

(1) Decelerate to .8 IMN.

(2) Repeat pitch inhibitor system and command signal limiter checks and establish values.

(e) Descend to 30,000 feet.

(1) Retard each throttle to idle and note proper idle operation without compressor stalls.

(2) Shut down each engine individually noting cabin pressure and airstart each engine at 55 rpm.

(f) The following auxiliary equipment will be checked throughout the FCF.

(1) Oxygen System.

(2) Anti-ice and defog. Normal operation of the air defrost system should not produce violent surges or abnormally high flow or noise level.

(3) IFF/SIF.

(4) Flight instruments.

(5) Flight controls.

(6) Cabin temperature and pressure.

(7) UHF. AN/ARC-34.

(8) UHF/DF.

(9) TACAN.

(10) Interphone.

(11) Fuel Sequencing.
(12) Heating and ventilation system.
(13) AJN-3 compass.
(14) Data link.
(15) Generators right and left.
(16) Trim response.
(17) Speed brakes.
(18) Fire evaluators.
(19) Electrical system.
(20) Stand-by compass.

(g) AFCS system.

(1) Yaw damper should give good damping without yaw inputs or oscillation.

(2) Engage switch. The AFCS should engage at any time without producing abrupt changes in control or altitude at any time the aircraft is being flown within the AFCS limits, i.e., plus or minus 65° bank, and plus or minus 58° pitch. No continuous short period oscillations are allowable in any axis.

(3) Heading select. New headings selected should be turned to within 18 to 22-degree bank. Small overshoots are tolerated.

(4) Altitude control. A predetermined pressure altitude should be maintained, providing aircraft is in level flight when altitude hold is selected. Tolerances up to 75 feet (at high altitude) are acceptable. At low altitudes, almost no deviation from selected altitude should be noted.

NOTE

During acceleration and deceleration with altitude hold engaged, cockpit altimeter will reflect change in static source position error.

(5) Mach hold. When mach hold is selected, existing MN should be maintained within plus or minus .01 MN.

(6) Control stick steering. If the stick is released within plus or minus 6 degrees of level flight (roll axis), the aircraft should return wings level. Aircraft should maneuver smoothly within AFCS limits with forces approximately comparable to basic aircraft control forces up to CSL limits.

(h) AFCS coupler checks. The following checks should not be attempted prior to checkout of the command signal limiter.

(l) Visual identification mode. Establish a closing rate of not greater than 100 knots on the target aircraft from the rear quarter. After radar lock-on and coupler engagement, the AFCS should fly the aircraft to center the radar steering dot and position the aircraft 200 feet to the right of the target aircraft. The coupler must provide satisfactory performance to 600 yards range.

NOTE

Uncouple before closing below 600 yards range.

(j) Missiles – Radar mode – Observe that the following maneuvering limits are not exceeded.

Roll rate – 40 degrees/second maximum.

Roll altitude – 70 degrees maximum.

Roll overshoots – 20 degrees maximum. Only slight pitch corrections sufficient to steer the pitch error to zero should be noted. Observe that the AFCS steadily flies the steering error to zero and maintains essentially zero error thereafter. There should be no sustained oscillations in any aixs and random roll activity should not exceed 10 degrees.

(k) Special weapons mode. The requirements of this mode are the same as for missiles – radar mode.

(1) Snap up maneuver. The maneuvering limits in roll are the same for missile-radar. Elevation

steering will not be available until B time. Azimuth steering will be available throughout the maneuver.

(2) Automatic ground control intercept mode. During commanded turns, the peak roll rate should not exceed 30 degrees/second and the maximum bank should be 45 degrees plus or minus 5 degrees. The AFCS shall fly the aircraft to center the dot and the maximum steady error should not exceed plus or minus 1 degree from the commanded heading. Roll out to the new heading should be smooth, with a maximum heading overshoot of 4° allowed.

(3) AGCI to auto attack. Have data link turned on with no ground signal being transmitted while on outbound leg of scissors, which is east or west. At turn in time, engage the coupler. The data link memory circuit should turn air craft north. At lock-on, coupler should automatically transition to attack. Transitions from AGCI to auto attack shall be attempted at ranges within 18 miles. The system should transition successfully from ACGI to auto attack to RLO on approximately 50 percent of the attempts without loss of RLO. If RLO is lost during the transition, the coupler will have to be re-engaged manually, after RLO.

(m) Descend to 15,000 feet.

(1) Check for G limiting of command signal limiter. After accelerating to a high IAS, . approximately 450 knots, smoothly increase aft stick force until command signal limiting is reached at approximately plus 4 G them, while guarding autopilot switch, smoothly push stick forward until negative G limiting is reached at approximately minus .5 G.

(2) Check PCS one G deceleration, using value established in CF-101 test card.

(n) Automatic Instrument Landing System.

(1) Automatic instrument landing system – prior to making an AILS pass, the pilot should set the runway heading into the ID 387 indicator and arm the system by placing the beam attack switch to beam, with an angle-of-turn to the runway heading of less than 150 degrees. The localizer beam should be intercepted at approximately 45 degrees from either side at an altitude of 1200 feet approximately 10 - 20 miles from the approach end of the runway. The localizer approach should be made using control stick steering and the altitude hold mode of the AFCS Gear and flaps should be extended before intercepting the localizer beam. The approach speed should be consistent with the standard ILS approach marker, the aircraft should be maintained to within speed for the CF-101B.

(2) Localizer – Automatic engagement of the localizer beam should occur at slightly less than 2 dots needle deflection, and the initial bank angle limit should not exceed 20 degrees, plus or minus 2.5 degrees. The initial overshoot on bracketing the beam should not exceed 3/4 dot indication. Check marker beacon for proper operation. The error at the outer marker should not exceed 1/2 dot. Random roll activity should be less than plus or minus 10 degrees. After passing the middle 1/4 dot of the beam center.

NOTE

Initial localizer signal must be received before entry on glide slope or coupler will not track ILS.

(3) Glide path – The initial overshoot, after intercepting the glide slope beam, should not produce a needle deflection greater than 2/3 of the first dot. After the initial overshoot, centering on the glide slope should be maintained to within 1/3 dot. Small, rapid stick motions may be present, but no accompanying pitch activity will be allowed. The approach should be uncoupled at an altitude of 200 feet.

(p) Landing.

(1) Drag chute for proper operation.

(2) On post-touchdown roll out, test the antiskid system by applying even brakes pressure to both brakes, with nose steering engaged at approximately 60 KIAS, the rate of brake pressure application must be increased to the point where normally the tires would skid. At this point, the anti-skid should take over and one or two cycles should be felt through the antiskid system before the aircraft comes to a stop.

NOTE

Faulty antiskid operation may result in a considerable swerve or blown tire. If, during the test, any skid, skip or swerve is felt, an anti-skid fault is likely. Release brakes immediately.

(3) Following stopcock of left engine, and prior to stopcock of right engine, record hydraulic pressure on flight test worksheet. Post-landing checklists, as outlined by Part 2 will be followed.

5 Radar Observer actions during take-off.

(a) Radar power switch on.

(b) Equipment cooling switch on.

(c) All indicator controls as desired.

6 Climb-cruise

(a) Beacon.

(1) Mode selector switch is beacon.

(2) Check for change of frequency.

(b) Ground map.

(1) Proper number of strobes.

(2) Rotate elevation scan knob to determine full limits.

(3) Ground map expand knob for proper movement of strobes.

(4) Pull expand knob for proper presentation and proper range.

(5) Jizzle band for proper width.

(6) Noise level.

(c) 200-Mile long pulse.

(1) Mode selector switch in 200-mile long pulse.

(2) Noise level.

(3) Target display.

(d) 60-Mile long pulse.

(1) Mode selector switch in 60-mile long pulse.

(2) Noise level.

(3) Altitude line for proper distance.

(4) Elevation dot level.

(5) Search intensity as desired.

(6) IF gain for proper operation.

(7) Jizzle band for proper width.

(e) 30-Mile long pulse.

(1) Code selector switch in 30-mile long pulse.

(2) Noise level.

(3) Target definition.

(4) Focus and intensity.

(5) Azimuth scan control.

(f) 30-Mile short pulse.

(1) Mode selector switch in 30-mile short pulse.

(2) Noise level.

(3) Target definition.

(4) Focus and intensity.

(5) Altitude line for proper distance.

(g) 15-Mile short pulse.

(1) Mode selector switch in 15-mile short pulse.

(2) Altitude line for proper distance.

(h) 6-Mile short pulse.
(1) Mode selector switch in 6-mile short pulse.
(2) Altitude line for proper distance.

7 Attack.

(a) Special weapons or MSR.
(b) Armament control panel as required.
(c) Proper rail rocket arm light on.
(d) Mode selector switch in 30-mile long pulse.
(e) Nose-tail switch in nose.
(f) Two bar scan switch in.
(g) Automatic search.
(1) Maximum detection distance.
(2) Normal mid-range fading.
(3) Conical scan overlap.
(h) Hand control.
(1) Limits of range gate.
(2) Elevation scan vernier limits.
(3) Spotlight target definition.
(4) Maximum lock-on distance.
(j) Tracking.
(1) Normal attack display.
(2) A-scan operation.
(3) Range gate coincidence.
(4) Steering dot motion.
(5) Antenna movement.
(6) 20-Second signal at proper distance.
(7) Door rotation at proper distance.
(8) Fire signal at proper distance.
(9) Breakaway signal at proper distance.
(10) Automatic door rotation.
(k) IR Missiles or WSEM.
(1) Armament control panel as required.
(2) Mode selector switch in 30-mile short pulse.
(3) Nose-tail switch in tail.
(4) Two-bar scan switch out.
(5) Maximum detection distance.
(6) Lock-on display.
(7) Range rate indication.
(8) Steering dot motion.
(9) 20-Second signal at proper distance.
(10) Rail extension at proper distance.
(11) Fire signal at proper distance.
(12) Breakaway signal at proper distance.
(13) Rail retraction.
(m) Vis-Ident.
(1) Radar system locked on.
(2) AFCS on.
(3) Turn left 45 degrees and check 45 degrees starboard.
(4) Turn right 90 degrees and check 45 degrees port.
(5) Nose down 15 degrees – elevation dot 15 degrees above.
(6) Nose up 30 degrees – elevation dot 15 degrees below.

(7) Position for identification.
(8) Pullout signal at proper range.

8 Recovery.

(a) Radar power switch in standby.
(b) Equipment cooling switch in ram.

AFTERFLIGHT REQUIREMENTS

9 Pilot.

(a) Engine post-test-flight operational accomplished in accordance with applicable directives.
(b) Landing gear ground safety locks installed before engine shutdown.
(c) Engines shutdown in accordance with Part 2.
(d) Discrepancies noted during test flight entered on test flight cards and aircraft form L-14.
(e) Switches positioned in accordance with Part 2 before leaving cockpit.

10 NAV.

(a) Switches positioned in accordance with Part 2 before leaving cockpit.

Functional Test Flight Card

CF-101B/F
AIRCRAFT

1. Aircraft Type, Model, Series and Serial No.	2. Date
3. Reason for Functional Check Flight	
4. Test Pilot's Signature	5. Record all Discrepancies Detected During this Flight in Form L-14.
6. Symbols Satisfactory Unsatisfactory	7.

SYM

NOTE

ITEMS PRECEDED BY AN ASTERISK (*) REQUIRE ACTUAL READING TO BE RECORDED.
*FUNCTIONAL CHECK FLIGHT NUMBER __________

PREFLIGHT

1. Form L-14
2. Exterior Inspection
3. Interior Inspection
4. Anti-Ice Ignition (30 sec.)
5. Air Start Ignition (30 sec.)
6. Fuel Quantity* Total__________

STARTING AND PRE-TAKE-OFF PREPARATION

1. Left Starter Operation
2. Hydraulic Pressure * U__________P__________
3. Left Generator *__________V
4. Right Starter Operation
5. Pitch Control System
6. Auto Pilot
7. Command Signal Limiter
8. Feel Trim System

CARD 1 OF 7

CSL LIMITS

	5000	10000	15000	20000	25000	30000
Fuel	.61MN	.61MN	.71MN	.71MN	.81MN	.81MN
11000	2.80	2.61	2.52	2.05	2.20	1.82
10000	2.88	2.65	2.59	2.11	2.27	1.87
9000	2.96	2.69	2.66	2.17	2.33	1.92
8000	3.04	2.74	2.74	2.23	2.40	1.97
7000	3.12	2.78	2.81	2.29	2.47	2.02
6000	3.19	2.83	2.89	2.35	2.54	2.07
5000	3.28	2.87	2.96	2.41	2.61	2.12
4000	3.37	2.92	3.04	2.47	2.68	2.17
3000	3.45	2.96	3.11	2.53	2.75	2.22

SYM

9. Flight Control

TAXIING

1. Brakes
2. Nose Wheel Steering
3. Flight Instruments

PRE-TAKE-OFF

1. Emergency Fuel System *
   Idle RPM (54-68) L________ R________
   Military RPM L________ R________
   Fuel Flow L________ R________
   EGT L________ R________
   EPR L________ R________
2. Normal Fuel Systems *
   Idle RPM (Eyelid open 63-65) (Eyelid Closed 59-61) L________ R________
   Generators L________ R________
   Oil Pressure (45+5) L________ R________
   Fuel Flow L________ R________
   EGT L________ R________
   Acceleration to Military (14 Sec Max) (14 Sec. Max.) L________ R________
   Oil Pressure L________ R________
   RPM (Data Plate +2%) L________ R________
   Fuel Flow L________ R________
   EGT (610) (650 2 min) L________ R________
   EPR L________ R________
   Hydraulic Pressure
   L Utility________ L Primary________
   R Utility________ R Primary________
3. NAV to Pilot Check List

CARD 2 OF 7

EMERGENCY MILITARY E. P. R.

Uncorrected Station Pressure

Temp		32" Hg	31"Hg	30" Hg
30°F	Min	2.03	2.04	2.05
	Max	2.20	2.215	2.23
40°F		2.02	2.03	2.04
		2.19	2.205	2.22
50°F		2.01	2.02	2.03
		2.18	2.195	2.21
60°F		2.00	2.01	2.02
		2.17	2.185	2.20
70°F		1.99	2.00	2.01
		2.16	2.175	2.19
80°F		1.98	1.99	2.00
		2.15	2.165	2.18
90°F		1.97	1.98	1.99
		2.14	2.155	2.17
100°F		1.96	1.97	1.98
		2.13	2.145	2.16
110°F		1.95	1.96	1.97
		2.12	2.135	2.15

SYM

TAKE OFF

1. Afterburner Operation
2. Air-Speed Switch (290K $\pm$ 10)

CLIMB TO 35,000 FEET

1. Wing Tank Operation
2. PCS Rate 250K____ 310K______
3. Air Speed
4. Afterburner Light L___R________
   Modulation L___R________
5. PCS 0. 9IMN*Fuel______ Horn______ Pusher_______
6. M/CSL 0. 9IMN*Fuel_______ CSL__________

CLIMB TO 40,000 FEET

1. Mach Jump (0. 94$\pm$0.01)
2. PCS 1. IIMN*Fuel_______Horn_______ Pusher_______
3. M/CSL 1. 1IMN*Fuel_______CSL_________
4. M/CSL Transition to Subsonic

DESCEND TO 35,000 FEET

1. PCS 0. 8IMN*Fuel_______Horn_______Pusher_______
2. M/CSL 0. 8IMN*Fuel_______CSL_________

DESCEND TO 30,000 FEET

1. Military Power *
   Oil Pressure (45$\pm$5) L____R_______
   RPM (Data Plate +2m) L____R_______
   Fuel Flow L____R_______
   EGT (640° Max.) L____R_______
   EPR L____R_______

CARD 3 OF 7

BOUNDARY TEST FLIGHT 'G' DATA

1. Transfer wing tanks before testing pitch control system or CSL.
2. Tolerance on clean configuration actuation points $\pm$4 KIAS. Tolerance on landing configuration actuation points +4, −2 KIAS.

CF-101 Fuel	35,000 Feet 0.8 Mach			35,000 Feet 0.9 Mach			40,000 Feet 1.1 Mach		
	CSL	H	P	CSL	H	P	CSL	H	P
11000	1.35	1.50	1.70	1.90	2.05	2.25	2.45	2.55	2.70
10000	1.40	1.55	1.75	1.95	2.14	2.32	2.50	2.62	2.77
9000	1.45	1.60	1.80	2.00	2.20	2.40	2.55	2.70	2.85
8000	1.47	1.65	1.85	2.05	2.25	2.45	2.62	2.77	2.92
7000	1.50	1.70	1.90	2.10	2.30	2.50	2.70	2.85	3.00
6000	1.55	1.75	1.95	2.17	2.37	2.57	2.77	2.92	3.10
5000	1.60	1.80	2.00	2.25	2.45	2.65	2.85	3.00	3.20
4000	1.65	1.85	2.05	2.32	2.52	2.72	2.92	2.07	3.30
3000	1.70	1.90	2.10	2.40	2.60	2.80	3.00	3.15	3.40

Fuel #	Clean Configuration		Landing Configuration
	Horn (KIAS)	Pusher (KIAS)	No Pusher Horn Only (KIAS)
6000	180	174	152
5500	178	173	151
5000	177	171	150
4500	175	170	148
4000	174	168	147
3500	172	167	146
3000	171	165	145
2500	169	164	143
2000	–	–	142

35,000 Feet

Mach	CSL(G)	Pusher(G)	Horn (G)
0.8	$\pm$0.10	$\pm$0.20	0.10 to 0.20 ahead of push
0.9	$\pm$0.10		0.20 to 0.30 ahead of push

40,000 Feet

Mach	CSL(G)	Pusher(G)	Horn(G)
1.10	$\pm$0.20	$\pm$0.20	0.20 to 0.40 ahead of push

SYM		
	2.	Engine Relight and Acceleration
		L________ R________
		Cabin Pressure* L________ R________
	3.	Auxiliary Systems
		Oxygen System
		Anti-Ice and De-Fog
		IFF/SIF
		Flight Instruments
		Flight Controls
		Cabin Temperature and Pressure
		UHF AN/ARC 34
		UHF/DF
		TACAN
		Fuel Sequencing
		AJN 3 Compass
		Data Link
		Generators
		Trim Response
		Speed Brakes
		FCS Evaluators
		Electrical System
		Stand-by Compass
	4.	Yaw Damper
	5.	AFCS
	6.	MG 13
		DESCEND TO 15,000 FEET
	1.	M/CSL "G" Limiter (+4-0.5 "G")
	2.	PCS Deceleration*
		Clean Horn________ Pusher________
		Landing Configuration Horn________
	3.	Gear and Flaps
	4.	Ramp and Dump

CARD 4 OF 7

SYM		
		PRE-LANDING
	1.	ILS
	2.	AILS
		AFTER LANDING
	1.	Drag Chute
	2.	Anti-Skid
	3.	Hydraulic Pressure Right Engine*________

Functional Test Flight Card

CF-101B/F
AIRCRAFT

1. Aircraft Type, Model, Series and Serial No.	2. Date
3. Reason For Functional Check Flight	
4. Radar Observer's Signature	5. Record all Discrepancies Detected During this Flight in Form L-14.
6. Symbols Satisfactory Unsatisfactory	7.

SYM

RADAR TEST FLIGHT CHECK LIST

NOTE

ITEMS PRECEDED BY AN ASTERISK (*)
REQUIRE ACTUAL READING TO BE RECORDED.

*FUNCTIONAL CHECK FLIGHT NUMBER ______________

PREFLIGHT

1. Check Radar for proper operation.
2. Radar Observer
   a. Indicator Control Panel
      (1) IF Gain – CW
      (2) Video – CW
      (3) Search Inten. – AS DESIRED
      (4) Scalelights – CW
      (5) Beacon-Ground Map Exp – IN
      (6) Tune Switch – NORMAL
      (7) HOJ – OFF
      (8) CCM – OFF
   b. Antenna Scan Control Panel
      (1) Elev. Scan Cont Knob – DETENT
      (2) Azimuth Scan – BROAD

CARD 5 OF 7

SYM

   c. Radar Control Panel
      (1) Power Switch – WARM
      (2) Range and Mode Selector Switch AS DESIRED
   d. Hand Control
      (1) Freedom of movement
      (2) Nose – Tail Switch – Tail
      (3) El-Scan Vernier – DETENT (Check freedom of movement)
      (4) A-Scan Switch – NORMAL

TAXI

A. Radar Power Switch – STANDBY
B. FCS Overheat Light – ON
C. Pilot's Scope
   1. Position of Horizon
   2. Intensity/Focus – AS DESIRED
D. Equipment Cooling Switch – OFF

TAKE-OFF-CLIMB

A. Radar Power Switch – ON
B. All indicator Controls – AS DESIRED
C. Check Voltage (115-Volt)
D. Equipment Cooling Switch – ON

CLIMB-CRUISE

A. Beacon
   1. Mode Selector Switch – BEACON
   2. Check for change of frequency
B. Ground Map
   1. Mode Selector Switch – GROUND MAP
   2. Rotate El-Scan Knob to determine full limits
   3. Ground Map Expand Knob

SYM

a. Proper movement of strobes
b. Expand Knob – PULL
(1) Expansion Range
(2) Proper Presentation
c. Jizzle Band (Proper Width)
4. Noise Level

C. 200 Mile LP
1. Mode Selector Switch – 200 MI LP
2. Check Noise Level
3. Check Target Display

D. 60 Mile LP
1. Mode Selector Switch – 60 MI LP
2. Check Noise Level
3. Altitude Line (Proper Distance)
4. El Dot – LEVEL
5. Search Intensity – AS DESIRED
6. IF Gain – DIMS AND BRIGHTNESS
7. Jizzle Band (Proper Width)

E. 30 Mile LP
1. Mode Selector Swith – 30 MI LP
2. Check Noise Level
3. Target Definition
a. Focus
b. Intensity
4. Azimuth Scan Control
a. LEFT (70°L – 15°R) L______ R______
b. CENTER (40°L – 40°R) L______ R______
c. RIGHT (15°L – 70°R) L______ R______
d. BOARD (70°L – 70°R) L______ R______

F. 30 Mile SP
1. Mode Selector Switch – 30 MI SP
2. Check Noise Level
3. Target Definition
a. Focus
b. Intensity
*4. Altitude Line (Proper Distance)*______________

CARD 6 OF 7

SYM

G. 15 Mile SP
1. Mode Selector Switch – 15 MI SP
*2. Altitude Line (Proper Distance)*______________

H. 6 Mile SP
1. Mode Selector Switch – 6 MI SP
2. Altitude Line (Proper Distance)*______________

ATTACK

A. SW (MSR)
1. Armament Control Panel - AS REQUIRED
2. AIR/2A Power Circuit Breakers – IN
3. Rocket Arm Light – ON (Proper Rail)
4. Mode Selector Switch – 30 MI LP
5. Nose Tail Switch – NOSE
6. Two-Bar Scan – IN
7. Auto Search
a. Max. Detection (_____) Distance
b. Mid Range Fading – NORMAL
c. Check Conical Scan Overlap
8. Hand Control
a. Limits of Range Gate
b. Spotlight
(1) El-Scan Vernier – LIMITS
(2) Target Definition
(3) Max. Lockon (_____) Distance
9. Tracking
a. Pilot's Attack Display – NORMAL
b. A-Scan
(1) A-Scan Switch – A-SCAN
(2) Position – RIGHT SIDE
(3) Proper Ranging Information
c. Range Gate Coincidence
d. Steering Dot Motion
e. Antenna Movement
f. 20 Sec. Signal (____) Distance
g. Door Rotation (Proper Time)*
h. Fire Signal
(1) Proper Time and Display
(2) Distance (______)

SYM

i. Break-Away Signal (Proper Time)
j. Door Rotation – AUTOMATIC

B. MISS-IR (WSEM)

1. Armament Control Panel – AS REQUIRED
2. Mode Selector Switch – 30 MI SP
3. Nose – Tail Switch –TAIL
4. Two-Bar Scan – OUT
5. Max. Detection (______) Distance
6. Lockon
   a. Pilot's Attack Display – NORMAL
   b. A-Scan Displacement – LEFT SIDE
7. Steering Dot Motion
8. 20 Sec. Signal (________) Dist/Overtake
9. Rail Extension
10. Fire Signal
   a. Proper Time and Display
   b. Distance (______)
11. Break Away (Proper Time)
12. Rail Retraction

C. VIS-IDENT (Alignment and Calibration Runs)

1. Radar System – LOCKED ON
2. AFCS – ON
3. Turn Left 45° – CHECK – 45° STBD
4. Turn Right 90° – CHECK – 45° PORT
5. Nose Down 15° – EL DOT – 15° ABV
6. Nose Up 30° – EL DOT – 15° BLW
7. Position for ID
8. Range Rate Meter
   (Proper Overtake Vs. Pilot's Scope)
9. Pullout Signal (Proper Range)

NOTE: Check for movement of AFCS and artificial horizon throughout manoeuvres.*

RECOVERY

A. Radar Power Switch – STBY
B. Equipment Cooling Switch – RAM

CARD 7 OF 7

SYM

POSTFLIGHT

A. Check Radar for Proper Recording

REMARKS

AIRCRAFT STATUS

RELEASED____NOT RELEASED____IN________OUT ____________

Radar Observer ______________________
Signature