SCHMITT

T.O. 1T-33A-1
NAVY AN 01-75FJC-1

USAF SERIES

T-33A

NAVY MODEL

TV-2

AIRCRAFT

FLIGHT HANDBOOK

COMMANDERS ARE RESPONSIBLE FOR BRINGING THIS TECH PUBLICATION TO THE ATTENTION OF ALL PERSONNEL CLEARED FOR OPERATION OF T-33 AIRCRAFT

PUBLISHED UNDER AUTHORITY OF THE SECRETARY OF THE AIR FORCE AND THE CHIEF OF THE BUREAU OF AERONAUTICS

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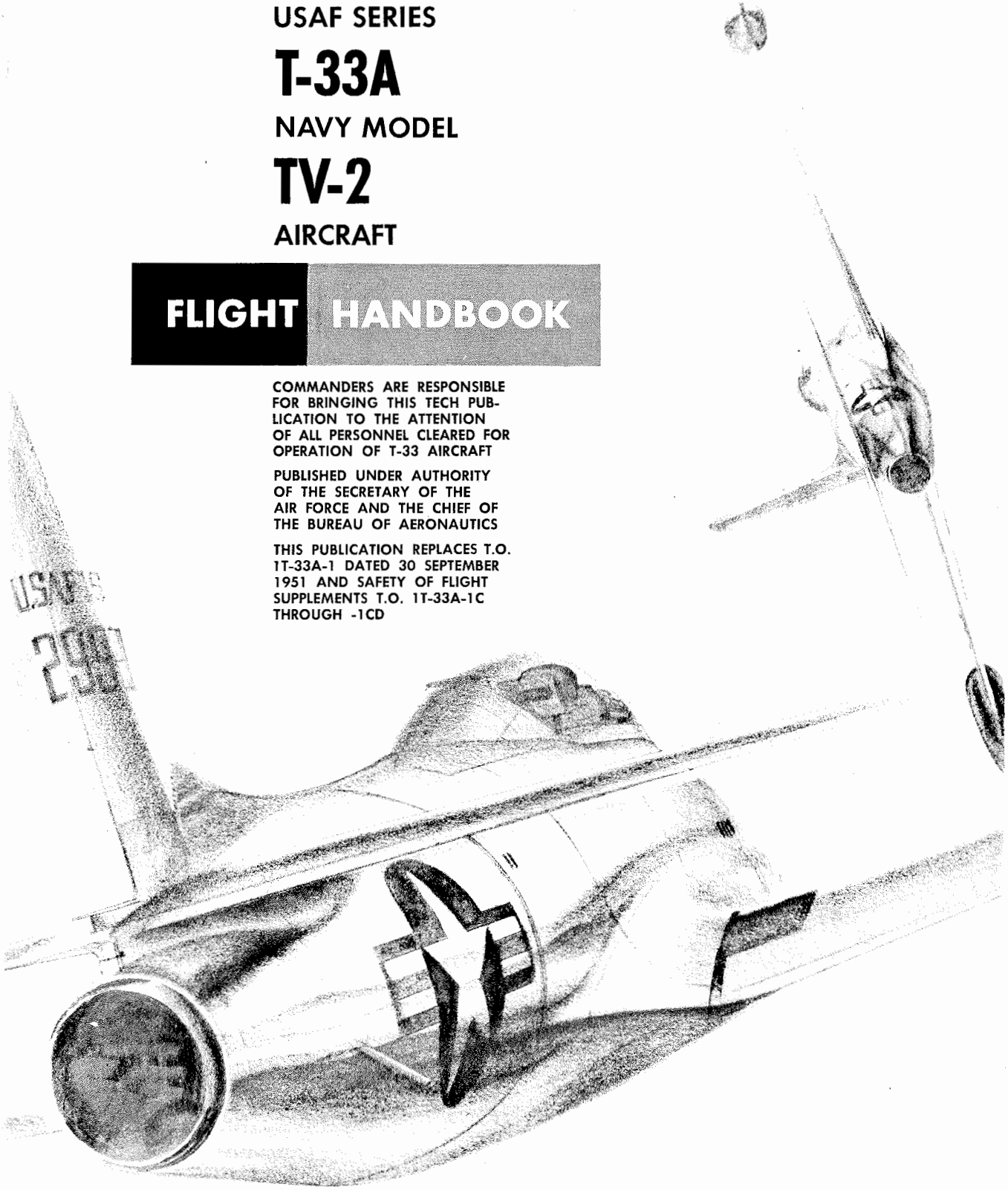

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IMPORTANT If you are to gain the maximum benefits from this handbook, it is imperative that you read this page carefully.

This handbook contains all the information necessary for safe and efficient operation of the T-33A series airplanes. These instructions do not teach basic flight principles, but are designed to provide you with a general knowledge of the airplane, its flight characteristics, and specific normal and emergency operating procedures. Your flying experience is recognized, and elementary instructions have been avoided.

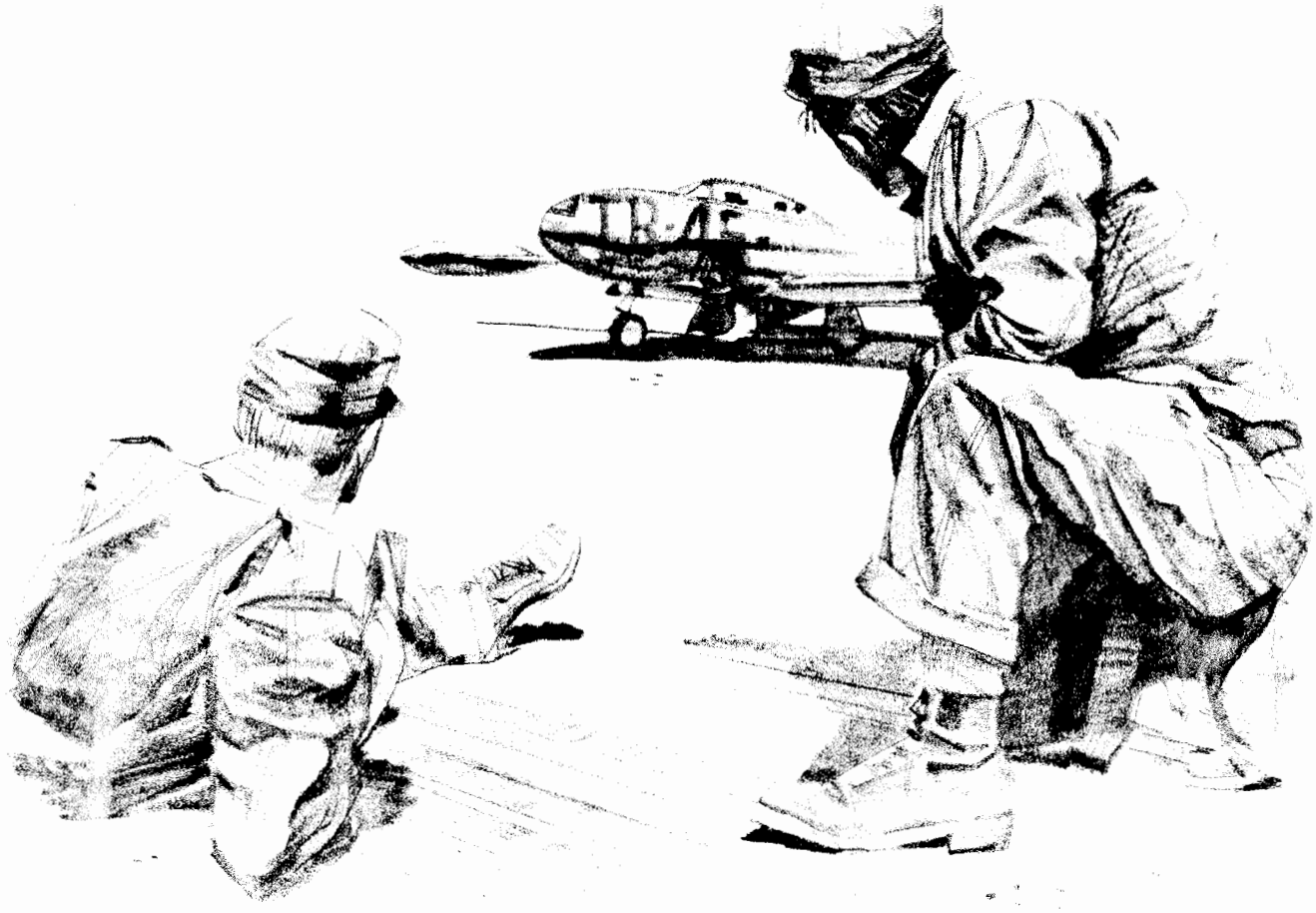
The instructions in this handbook are recommended procedures and have been established to cover average operating conditions. However, circumstances can arise where the pilot must use his best judgment to cope, for example, with compounded emergencies stemming from multiple failures, adverse weather, terrain, etc. Under these circumstances it will be the pilot's prerogative to alter the instructions contained herein as the particular situation requires.

The only source of technically accurate and constantly current operating instructions is your Flight Handbook. These instructions are based on the technical knowledge of the aircraft manufacturer and the Air Force as well as the experience of the using commands. You would never recognize these new books as your old familiar, undesirable -1 technical order. These new books have considered your specific problems and have therefore been made attractive, accurate, current, and very easy to use. Not all of the books have been prepared to the new requirements, but you can tell the old from the new very easily. The new type handbook has a full page cover illustration whereas the old book has a small "spot" illustration.

Each flight crew member (except those attached to an administrative base) is entitled to have a personal copy of the flight handbook while he is stationed at a given base. Don't let anyone tell you differently. (Air Force Regulation 5-13), issued in 1953, specifically makes that provision.

You would be surprised at how well the technical order distribution system will work if you just do your part. Order your required quantity of handbooks before they are needed instead of waiting until the need arises. If you order them early, the Air Force will print enough to cover your requirements. If you delay, you will probably be kept waiting a long time when you do order because sufficient copies may not have been originally printed to cover your request – sometimes it takes a discouragingly long time to get new printing!

The technical order system is very easy to cope with. (Technical order 00-5-2) explains, in just a few pages, the easy means by which



you can set the automatic machinery into motion. Actually, all you have to do is reflect your required quantities on the Publications Requirements Table (T.O. 0-3-1) and all the revisions, reissues, and supplements will be automatically forwarded to you in the same quantities. Talk to your base supply officer – he should know all about the system since it is his job to fulfill your technical order requests. Of course, each base must develop a system of feeding these books and related data to their flight crew members so that no one will be using an obsolete book.

One more thing – we admit it takes a long time to revise the Flight Handbook. Since the time lag is excessive for safety of flight information, a new program has been put into effect to get such information to you in a hurry. This is done by means of Safety of Flight Supplements which use the same number as your flight handbook except for the addition of a suffix letter. Supplements concerning personal safety will get to you in 48 hours; those concerning serious damage to equipment will make it in 6 days. And what do you have to do to get these supplements? Absolutely nothing! If you have ordered your flight handbook on the publications requirements table, you will automatically receive all supplements pertaining to your aircraft. Technical order 00-5-1 covers some additional information regarding these supplements.

Your comments and questions regarding any phase of the flight handbook program are invited and should be directed to the Wright Air Development Center, Attn: WCSOH.

This handbook is divided into nine sections, an appendix, and an index, as follows:

SECTION I, DESCRIPTION This section contains a description of the airplane and all of its systems, and controls which contribute to the physical act of flying the airplane. All emergency and miscellaneous equipment which is not part of the auxiliary equipment is also discussed.

SECTION II, NORMAL OPERATING PROCEDURES Complete operating instructions are given and arranged in proper sequence from the time the aircraft is approached by the flight crew until it is parked on the ramp after the completion of a non-tactical routine flight.

SECTION III, EMERGENCY OPERATING PROCEDURES This section sets forth procedures to be followed in meeting any emergency that may reasonably be expected to occur. In addition, alternate methods of operation are given for those mechanisms having emergency means of operation. Emergency operation of auxiliary equipment is described in Section IV.

SECTION IV, DESCRIPTION AND OPERATION OF AUXILIARY EQUIPMENT Descriptions, normal operating instructions, and emergency operating instructions are given in this section for all equipment that is not essential to fly the airplane to perform certain specialized functions. Additional equipment, such as armament, cockpit pressurization, heating, and ventilation is discussed.

SECTION V, OPERATING LIMITATIONS Airplane and engine operating limitations and restrictions are detailed in this section.

SECTION VI, FLIGHT CHARACTERISTICS General and specific flight characteristics are discussed in this section.

SECTION VII, SYSTEMS OPERATION The purpose of this section is to discuss any airplane system which may require special explanation. As information becomes available on special problems to be considered in operating a system, it will be included in this section.

SECTION VIII, CREW DUTIES Information covering the responsibilities of instructor pilot and student will be furnished when available.

SECTION IX, ALL WEATHER OPERATION The proper techniques and procedures to be followed under conditions of instrument flight, turbulent air, cold weather, hot weather, and desert operation are given. This section provides information supplemental to Section II.

APPENDIX, OPERATING DATA All operating data charts for efficient flight planning are contained in this appendix. Complete data are supplied for best climb and descent air speeds and necessary cruise control information with and without external loads. Take-off and landing charts for various gross weights are also included. Information contained in this section is based on and consistent with the recommended operating procedures and techniques set forth elsewhere in this handbook.

AIR FORCE AND BUAER SERIAL NUMBER CONVERSION TABLE

USAF SERIAL NUMBERS	BUAER SERIAL NUMBERS
49-934	124570
49-2758 THRU 49-2772	124571 THRU 124585
50-328	124930
50-329	124931
50-338 THRU 50-342	124932 THRU 124936
50-349 THRU 50-351	124937 THRU 124939
51-4019 THRU 51-4024	126583 THRU 126588
51-4031 THRU 51-4036	126589 THRU 126594
51-4052 THRU 51-4057	126595 THRU 126600
51-4078 THRU 51-4083	126601 THRU 126606
51-4104 THRU 51-4109	126607 THRU 126612
51-4137 THRU 51-4142	126613 THRU 126618
51-4174 THRU 51-4179	126619 THRU 126624
51-4237	126625
51-4238	126626
51-4239 THRU 51-4243	128661 THRU 128665
51-4288 THRU 51-4294	128666 THRU 128672
51-4355 THRU 51-4364	128673 THRU 128682
51-4425 THRU 51-4434	128683 THRU 128692
51-4515 THRU 51-4524	128693 THRU 128702
51-6578 THRU 51-6587	128703 THRU 128712
51-6665 THRU 51-6674	128713 THRU 128722
51-8518 THRU 51-8541	131725 THRU 131748
51-8636 THRU 51-8651	131749 THRU 131764
51-8729 THRU 51-8749	131765 THRU 131785
51-8836 THRU 51-8870	131786 THRU 131820
51-8940 THRU 51-8953	131821 THRU 131834
51-9040 THRU 51-9075	131835 THRU 131870
51-9150 THRU 51-9167	131871 THRU 131888
53-2687 THRU 53-2780	136793 THRU 136886
53-5241 THRU 53-5243	137934 THRU 137936
53-5310 THRU 53-5317	137937 THRU 137944
53-5351 THRU 53-5358	137945 THRU 137952
53-5360 THRU 53-5363	137953 THRU 137956
53-5375 THRU 53-5383	137957 THRU 137965
53-5385 THRU 53-5387	137966 THRU 137968
53-5437 THRU 53-5440	137969 THRU 137972
53-5442 THRU 53-5448	137973 THRU 137979
53-5450 THRU 53-5456	137980 THRU 137986
53-5458 THRU 53-5460	137987 THRU 137989
53-5505 THRU 53-5507	137990 THRU 137992
53-5509 THRU 53-5516	137993 THRU 138000
53-5518 THRU 53-5524	138001 THRU 138007
53-5526 THRU 53-5532	138008 THRU 138014
53-5570 THRU 53-5573	138016 THRU 138019
53-5575 THRU 53-5580	138020 THRU 138025
53-5582 THRU 53-5586	138026 THRU 138030
53-5588 THRU 53-5593	138031 THRU 138036
53-5595 THRU 53-5599	138037 THRU 138041
53-5601 THRU 53-5603	138042 THRU 138044
53-5642 THRU 53-5643	138045 THRU 138046
53-5645 THRU 53-5649	138047 THRU 138051
53-5651 THRU 53-5655	138052 THRU 138056
53-5657 THRU 53-5661	138057 THRU 138061
53-5663 THRU 53-5667	138062 THRU 138066
53-5669 THRU 53-5674	138067 THRU 138072
53-5676 THRU 53-5680	138073 THRU 138077
53-5682 THRU 53-5686	138078 THRU 138082
53-5688 THRU 53-5692	138083 THRU 138087
53-5694 THRU 53-5698	138088 THRU 138092
53-5700 THRU 53-5704	138093 THRU 138097
53-5706 THRU 53-5709	141490 THRU 141493
53-5711 THRU 53-5715	141494 THRU 141498
53-5717 THRU 53-5719	141499 THRU 141501
54-2689 THRU 54-2710	138977 THRU 138998
54-2711 THRU 54-2728	138999 THRU 139016

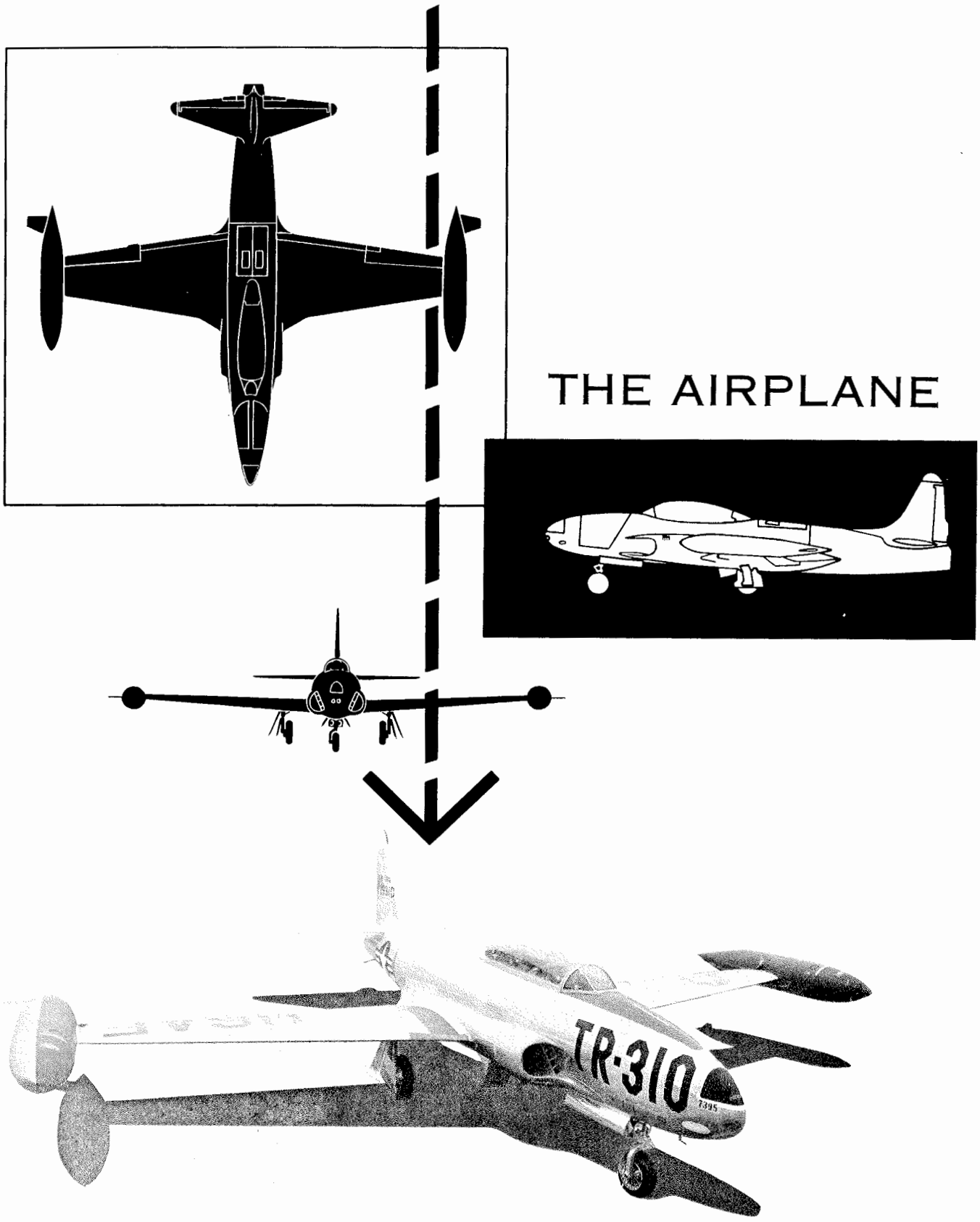


Figure 1-1

SECTION I DESCRIPTION

THE AIRPLANE.

GENERAL. The T-33A (Navy TV-2) is a tandem two-place, jet propelled fighter-trainer. Two .50 caliber machine guns or equivalent ballast are mounted in the nose. The primary mission of the airplane is jet fighter transition.

DIMENSIONS. The overall dimensions of the airplane are:

Wing span	38.9 feet
Fuselage length	37.7 feet
Height (to top of fin)	11.7 feet

GROSS WEIGHT. The gross weight with full 230 gallon tip tanks is approximately 15,500 pounds.

ENGINE.

GENERAL. The J33 is a centrifugal compressor type jet propulsion engine. Static thrust is rated at 4600 lbs. dry and 5400 lbs. with water/alcohol injection. Some early airplanes (AF Serials 48-356 thru 49-2757) are equipped with J33-A-23 engines and later airplanes (AF Serials 49-2758 and subsequent) with J33-A-35 engines. The main difference between the −23 and the −35 engines is that the latter have low pressure fuel nozzles; however, some of the −23 engines have been modified to include the low pressure nozzles.

J33-A-20. ENGINE. BuAer Serials 137934 and 137990 and subsequent are equipped with the J33-A-20 engines. The main difference between the −20 and the −35 engines is that the emergency fuel control is deleted on the −20. The engine-driven dual fuel pump is retained with both elements providing fuel pressure thru a main fuel control unit.

GENERAL ARRANGEMENT

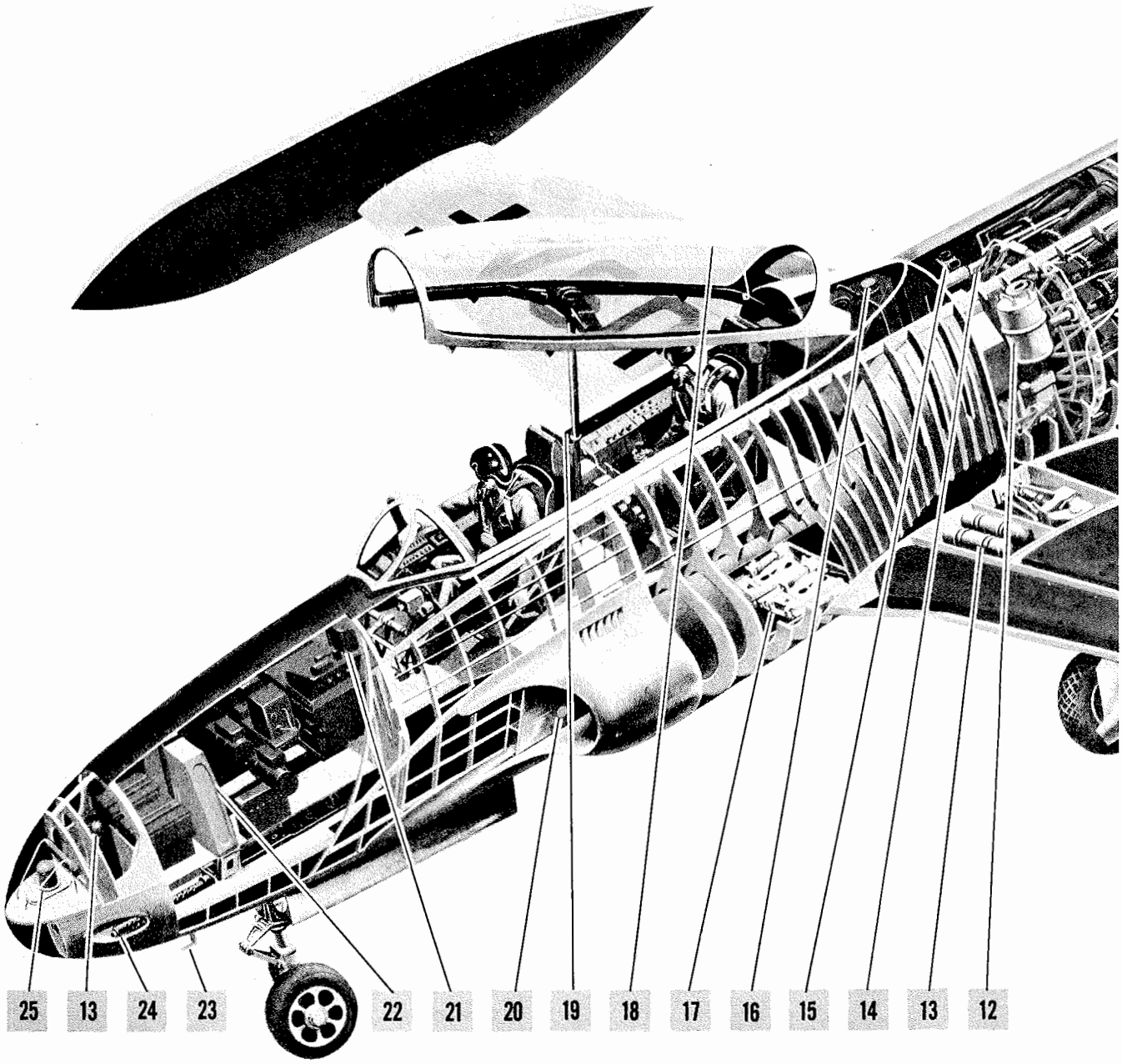
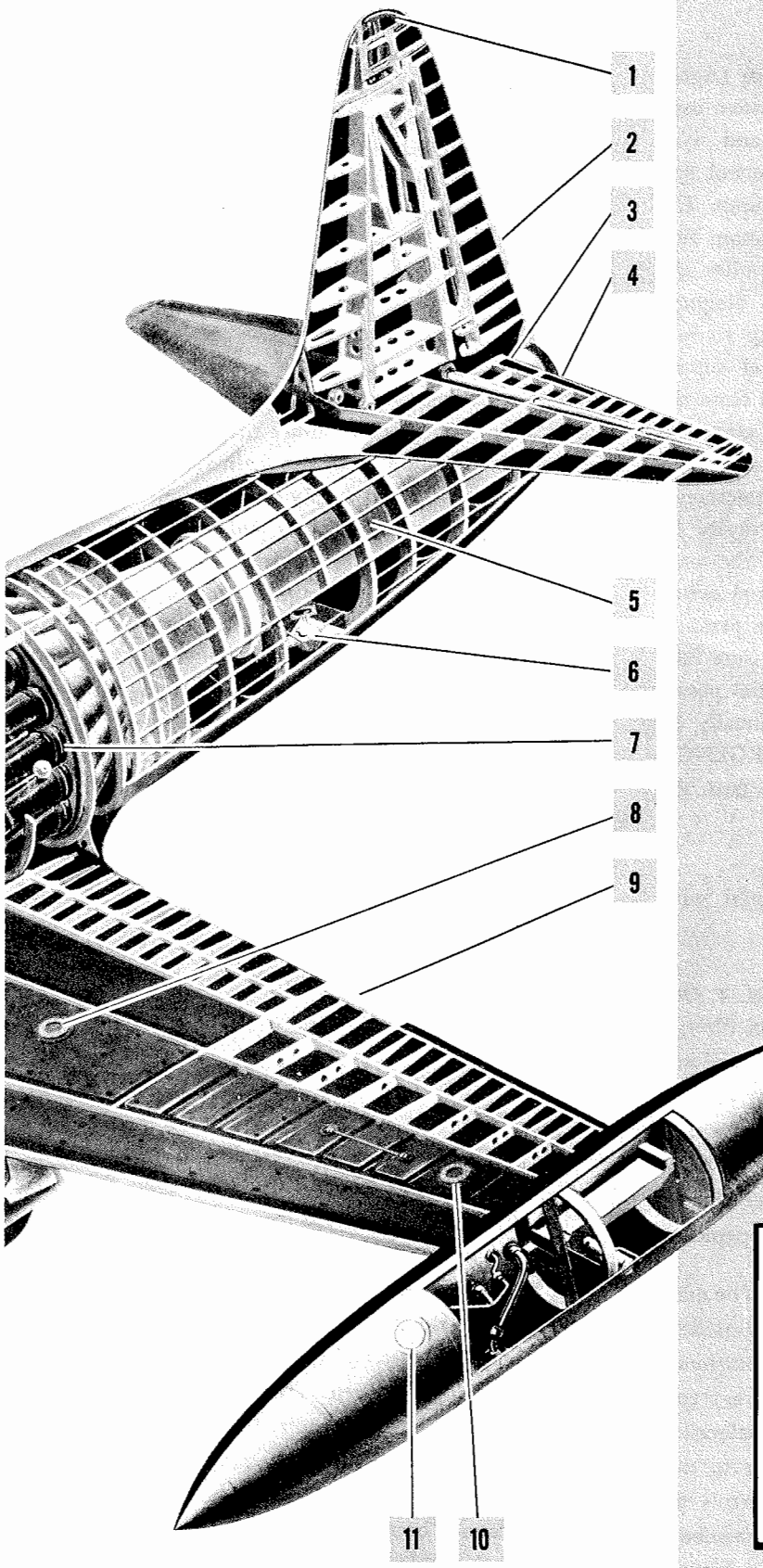


Figure 1-2 (Sheet 1 of 2)



1. COMMAND RADIO ANTENNA
2. RUDDER BEND TAB
3. ELEVATOR SPRING TABS
4. ELEVATOR TRIM TABS
5. TAILPIPE
6. REMOTE COMPASS
7. J33 ENGINE
8. WING FUEL TANKS FILLER CAP (1)
9. AILERON TRIM TAB
10. LEADING EDGE FUEL TANKS FILLER CAP (1)
11. TIP FUEL TANK FILLER CAP (1)
12. MAIN HYDRAULIC SYSTEM FLUID RESERVOIR (3)
13. OXYGEN CYLINDERS (2 PLACES)
14. ENGINE OIL FILLER CAP (2)
15. DE-ICER (4) FLUID OR WATER ALCOHOL INJECTION (5) TANK FILLER CAP
16. FUSELAGE FUEL TANK FILLER CAP (1)
17. DIVE FLAPS
18. RADIO COMPASS SENSE ANTENNA
19. EMERGENCY HYDRAULIC SYSTEM FLUID RESERVOIR (3)
20. OXYGEN FILLER
21. BRAKES FLUID RESERVOIR (3)
22. AMMUNITION BOXES
23. PITOT HEAD
24. .50 CALIBER GUNS
25. RADIO COMPASS LOOP ANTENNA

FLUID SPECIFICATIONS

(1) FUEL — SEE PARAGRAPH — FUEL SPECIFICATIONS AND GRADES

(2) ENGINE OIL — MIL-O-6081 GRADE 1010

(3) HYDRAULIC OIL — MIL-O-5606

(4) DE-ICER FLUID — MIL-A-6091

(5) WATER-ALCOHOL INJECTION FLUID — 67% DISTILLED WATER 33% AN-A-24 ALCOHOL BY VOLUME

Figure 1-2 (Sheet 2 of 2)

ENGINE FUEL SYSTEM. (Aircraft equipped with J33-A-23 and -35 engines.)

The function of the engine fuel control system (figure 1-3) is equivalent to that of the carburetor system used with reciprocating engines. The J33-A-23 and −35 engines incorporate two independent fuel control systems fed by a dual engine-driven gear-type pump. The main section of the dual pump supplies the main fuel control unit and the emergency section supplies the emergency fuel control unit. The pump is so designed that, in the event of failure of the main pump section, the emergency section can maintain the fuel supply through the emergency fuel control unit. Fuel from the emergency section of the pump is normally by-passed to the pump inlet, but is available in case of loss of main pump pressure. Changeover from main to emergency fuel control system is accomplished automatically by the action of a dc powered pressure switch in the main fuel control system, provided the emergency fuel switch is in the TAKE-OFF & LAND position. The pressure switch is set to operate when main system pressure falls below idle fuel pressure. In the event of partial power failure, changeover can be accomplished manually by placing the emergency fuel switch in the EMERGENCY position. The throttle linkage is connected to both the main and the emergency fuel control units.

ENGINE FUEL SYSTEM. (Aircraft equipped with J33-A-20 engines.)

The J33-A-20 engine fuel system consists of a dual engine-driven fuel pump, a high pressure fuel filter, a main fuel control unit, a fuel manifold and 14 individual fuel spray nozzles. The dual engine-driven pump consists of a primary and secondary element. During normal operation both elements supply pressure to the main fuel control unit. If either element fails the other element will provide adequate fuel pressure for engine operation.

MAIN FUEL CONTROL UNIT (BENDIX). The main fuel control unit is a wide range governor operated by the throttle. The unit is compensated to limit maximum engine speed, to maintain approximately constant rpm regardless of airspeed or altitude, to limit acceleration temperature, and to limit engine deceleration to that required to maintain combustion. It also controls the amount of fuel delivered to the combustion chambers, bypassing any fuel in excess of that required for the throttle setting, engine speed, altitude, and airspeed. Starting fuel control is included for automatic starting. For simplified engine starting and controlled acceleration to idling speed during starting, the starting fuel control, when first energized, directs fuel to numbers 7 and 14 burners for ignition and then to all other burners as fuel pressure builds up. This provides a more accurately controlled fuel flow during the start, reducing the possibility of a "hot start".

EMERGENCY FUEL CONTROL UNIT (ROCHESTER). Aircraft equipped with J33-A-23 and −35 engines). The emergency fuel control is mechanically linked to the throttle and the main fuel control. This unit provides manual alternate control of engine power for use in the event of failure of the main side of the engine-driven pump or of the main fuel control system. It consists of a throttle valve, an altitude-compensated relief valve (or barometric), and a solenoid-operated bypass valve (normally open). The relief valve is adjusted to provide 100% engine rpm on the ground on a 100°F day. Available full throttle rpm will vary with free air temperature and altitude. The altitude compensator attempts to maintain constant engine rpm for a given throttle setting regardless of airspeed and altitude.

CAUTION

Engine overspeeding is possible when operating on the emergency fuel control system. The throttle should be moved slowly and the tachometer checked when speed and altitude are changed.

ENGINE FUEL SYSTEM CONTROLS.

THROTTLE. The throttle (3, figure 1-6 and 15, figure 1-18) regulates the fuel pressure to the engine combustion chambers and the resulting fuel flow determines the engine speed. When the throttle is in the OFF (full aft) position, all fuel to the engine is shut off unless the starting fuel control is energized as during automatic starting. The throttle slot in the front cockpit is staggered to provide straight fore and aft motion in the operating range between IDLE and FULL while outboard and aft motion is required when moving from the IDLE to the OFF position. The slot in the rear cockpit runs straight fore and aft with no IDLE stop. The throttle cannot be closed from the rear cockpit because the front throttle must be pushed outboard to pass the IDLE detent.

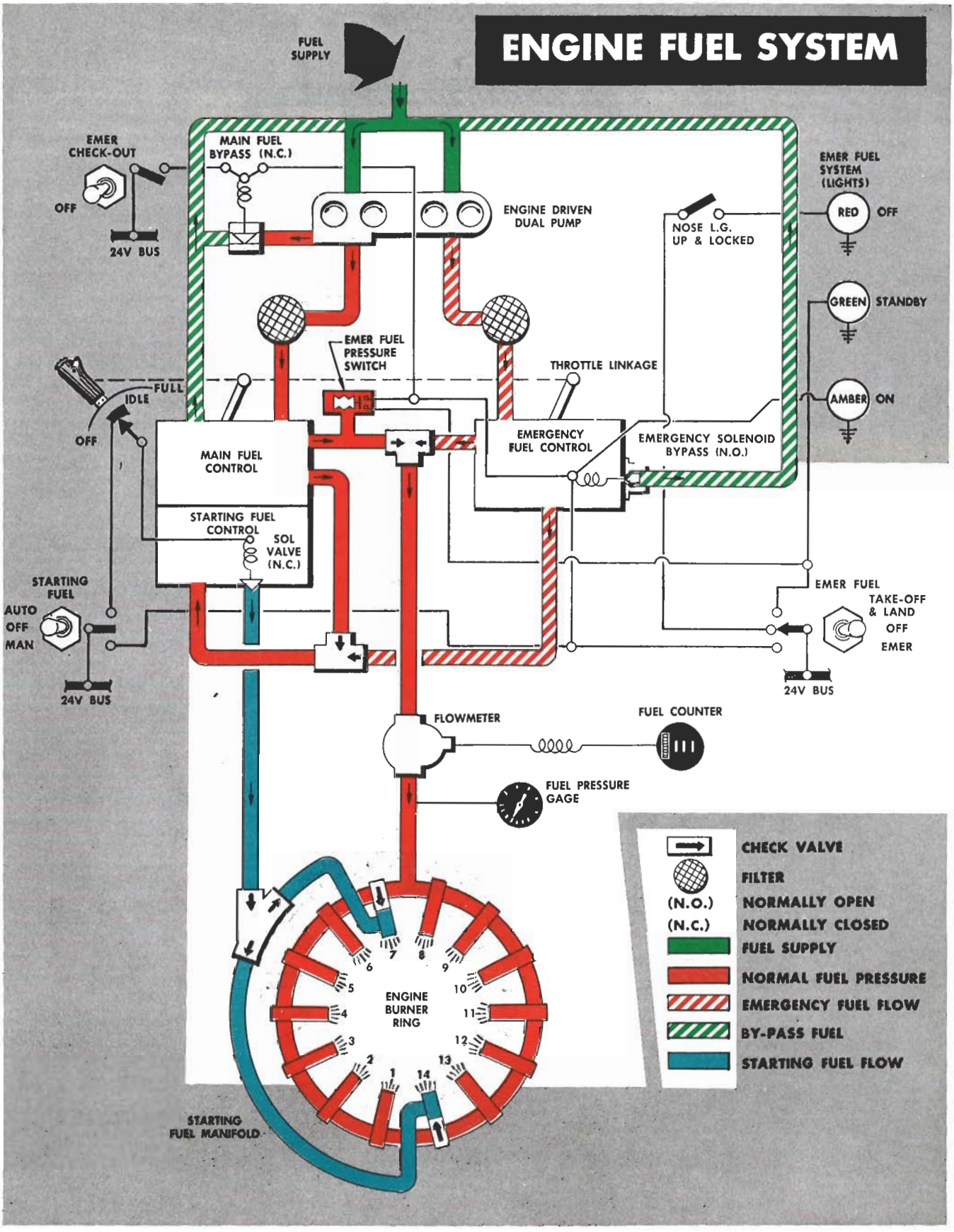


Figure 1-3 (Sheet 1 of 2)

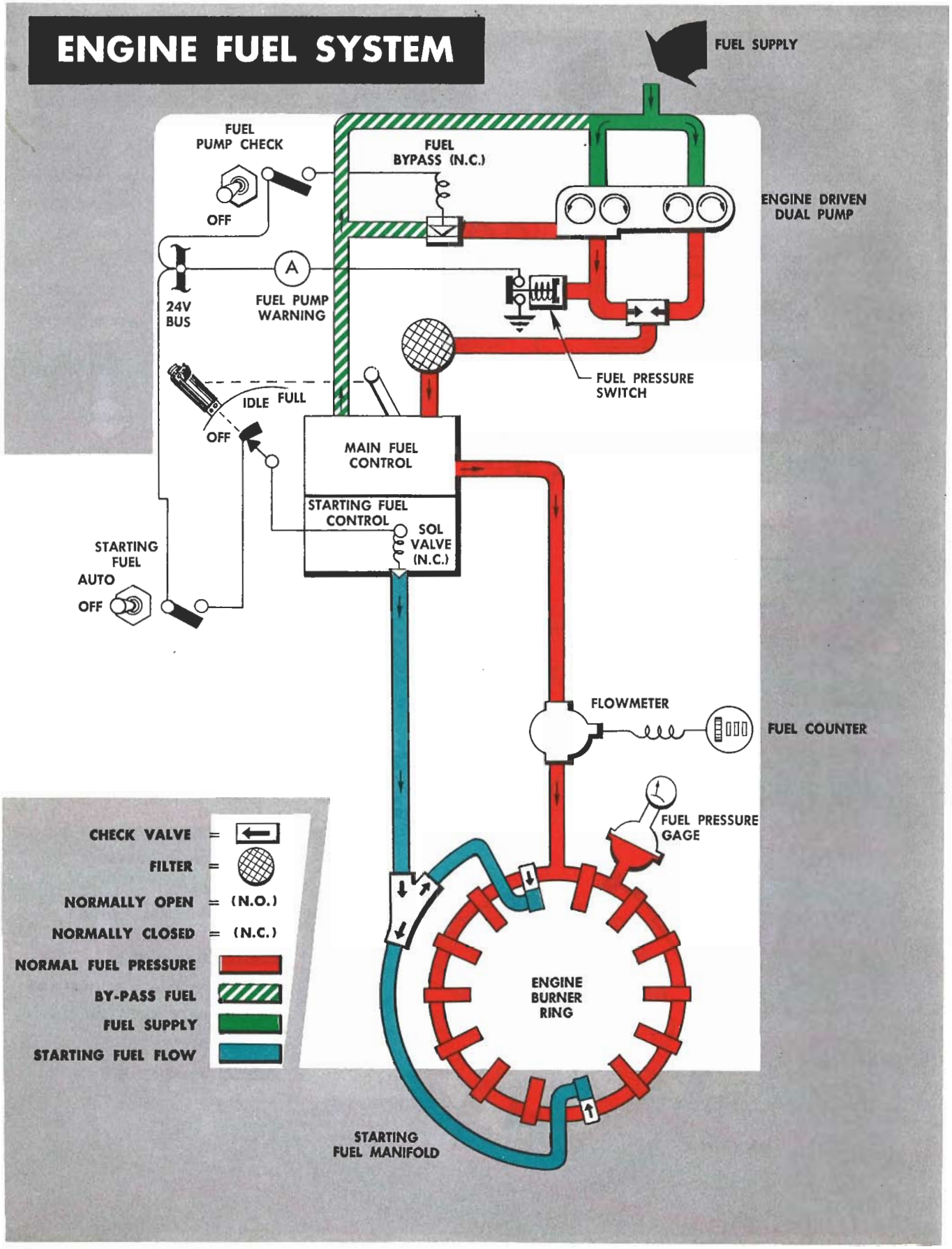


Figure 1-3 (Sheet 2 of 2)

FRONT COCKPIT

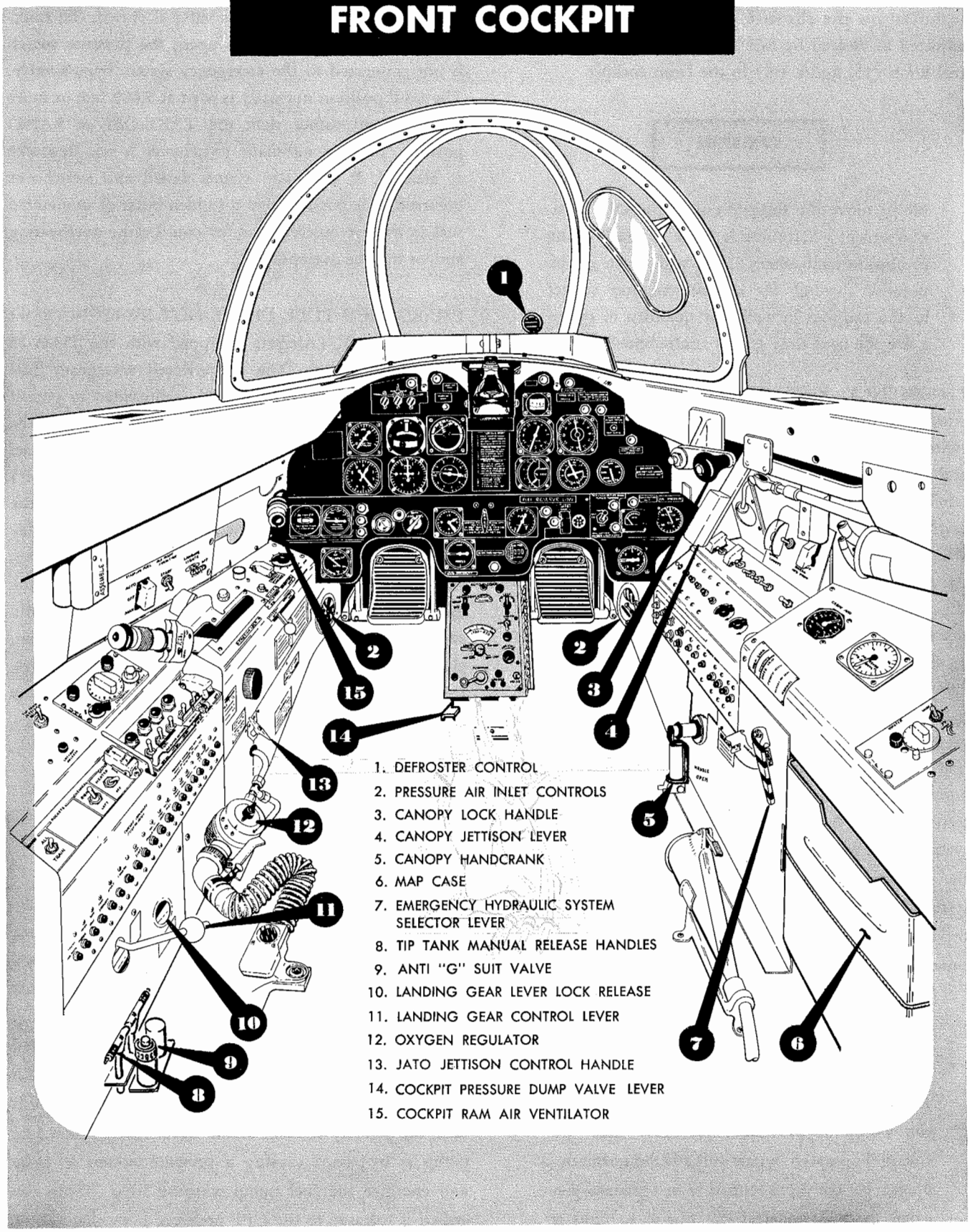


Figure 1-4

The dive flap switch and the microphone button are installed on the throttle. Throttle friction may be adjusted as desired by turning the throttle friction control knob (15, figure 1-6) in the front cockpit.

CAUTION

Never move the throttle out of the OFF position except when there is flame or spark in the combustion chambers. Fuel will drain or be pumped through the engine and may collect in the tailpipe in sufficient quantity to create a fire the next time a start is attempted.

EMERGENCY FUEL SWITCH. (Aircraft equipped with J33-A-23 and −35 engines.) This dc powered switch on the left console in each cockpit (11, figure 1-7 and 2, figure 1-18) is a three-position toggle switch labelled TAKE-OFF & LAND, EMERG, and OFF. It controls the solenoid operated (normally closed) bypass switch in the emergency system, and a pressure switch in the main system. In the TAKE-OFF & LAND position the pressure switch in the main system is energized. If pressure drops below 30-35 psi on the −35 engine or 43-49 psi on the −23 engine (approximately idle pressure) the pressure switch closes the emergency system bypass valve, allowing the emergency system fuel to feed the engine. This position is ordinarily used at all times below 5,000 feet above terrain because it gives automatic protection against flameout caused by main system failure. It gives no protection, however, against partial main system failure above the preset values of the pressure switch. In the EMERG. position the main system bypass valve is opened, the emergency system bypass valve is closed, and engine operates on the emergency system.

CAUTION

The emergency fuel control is not available in the event of electrical failure. Since the solenoid-operated bypass valve is the normally-open type, the valve returns to or remains open when there is no electrical power to hold it closed.

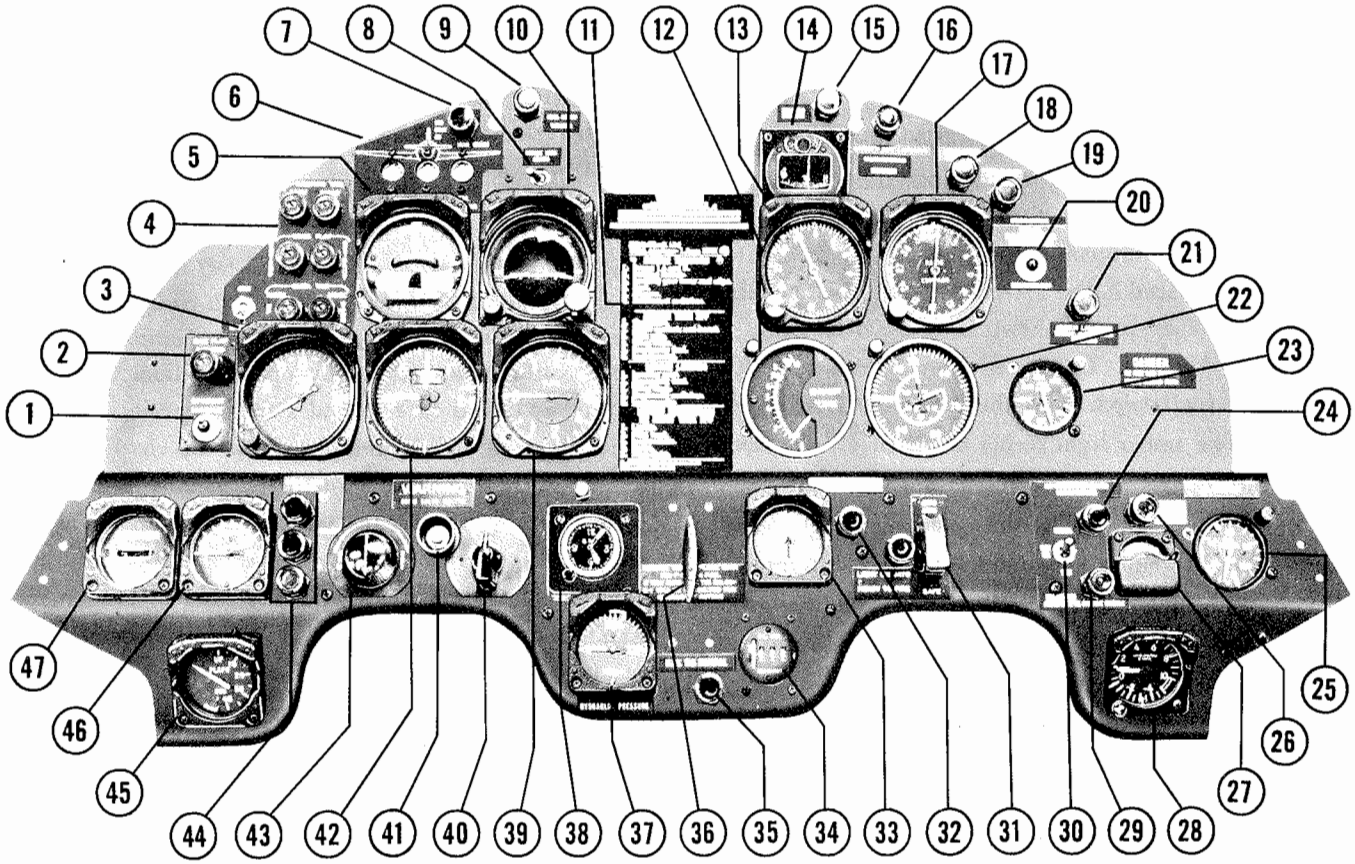
In the OFF position the switch circuit is de-energized. Thus, the main system bypass valve is closed; the emergency system bypass valve is open; the pressure switch is not connected to the emergency system bypass valve. The OFF position normally is used at 5,000 feet or more above terrain rather than the TAKE-OFF & LAND position, because automatic switchover is not desirable at altitude. If the main system failed and switchover occurred, it is possible that a sudden burst of unmetered fuel in the combustion chamber could cause overheating and/or turbine overspeeding.

EMERGENCY FUEL CHECK-OUT SWITCH (Front Cockpit Only). (Aircraft equipped with the J33-A-23 and −35 engines). The dc powered emergency fuel check-out switch, (9, figure 1-9) is provided to permit ground checking the emergency fuel system and the automatic changeover function of the emergency fuel pressure switch. It has two positions: NORMAL (off) and a spring-loaded CHECK-OUT position. When the switch is held in the CHECK-OUT position, a relay energizes the emergency fuel pressure switch and opens the main fuel bypass valve thus simulating failure of the main fuel control system. The emergency fuel pressure switch will sense the pressure drop in the main system, close the bypass valve in the emergency fuel control system, and thus automatically transfer control of engine fuel to the emergency system.

Note

The emergency fuel switch must be OFF during emergency fuel check-out because the check-out switch includes the function of the emergency fuel switch during check-out.

FUEL PUMP CHECK SWITCH. (BuAer serials 137934 and 137990 and subsequent). The fuel pump check switch replaces the Emergency Fuel Check-out Switch on the right console front cockpit only. The fuel pump check switch is a momentary type switch placarded CHECK and OFF and is spring loaded to the OFF position. When the switch is held to the CHECK position, the primary element of the engine-driven dual fuel pump is by-passed causing a pressure switch to close and energize the fuel pump warning light. When the switch is released to the OFF position, both elements of the dual fuel pump provide pressure to the engine.



INSTRUMENT PANEL, FRONT COCKPIT

1. STUDENT LOCKOUT BUTTON
2. DIVE FLAP TELL TALE INDICATOR LIGHT
3. ALTIMETER
4. TELL TALE INDICATOR LIGHT PANEL
5. TURN AND BANK INDICATOR
6. LANDING GEAR POSITION INDICATOR
7. LANDING GEAR UNSAFE WARNING LIGHT
8. FLIGHT INSTRUMENT POWER SWITCH
9. FUEL DE-ICE WARNING LIGHT
10. ATTITUDE INDICATOR
11. PILOT'S CHECK LIST
12. EXHAUST (TAILPIPE) TEMPERATURE INDICATOR
13. GYRO MAGNETIC HEADING INDICATOR
14. STANDBY MAGNETIC COMPASS
15. MARKER BEACON INDICATOR
16. CANOPY UNLATCHED WARNING LIGHT
17. RADIO COMPASS INDICATOR
18. GYRO INSTRUMENT WARNING LIGHT
19. TURN AND BANK INSTR. WARNING LIGHT
20. GYRO COMPASS FAST SLAVE BUTTON
21. STUDENT LOCKOUT WARNING LIGHT
22. ENGINE TACHOMETER
23. ENGINE FUEL PRESSURE GAGE
24. FIRE WARNING LIGHT
25. ENGINE OIL PRESSURE GAGE
26. GENERATOR OUT WARNING LIGHT
27. GENERATOR LOAD METER
28. ACCELEROMETER
29. OVERHEAT WARNING LIGHT
30. FIRE AND OVERHEAT CIRCUIT TEST SWITCH
31. JATO ARMING SWITCH AND INDICATOR LIGHT
32. FUSELAGE TANK LOW LEVEL INDICATOR
33. FUSELAGE TANK QUANTITY GAGE
34. FUEL QUANTITY COUNTER
35. ELEVATOR TAB NEUTRAL INDICATOR LIGHT
36. PARKING BRAKE HANDLE
37. HYDRAULIC SYSTEM PRESSURE GAGE
38. CLOCK
39. RATE OF CLIMB INDICATOR
40. GUNSIGHT GYRO SELECTOR
41. BOMB OR TANKS SALVO BUTTON
42. AIRSPEED INDICATOR
43. GUNSIGHT LIGHT RHEOSTAT
44. EMERGENCY FUEL SYSTEM INDICATOR LIGHTS
45. WING FLAP POSITION INDICATOR
46. OXYGEN PRESSURE GAGE
47. OXYGEN FLOW INDICATOR

Figure 1-5

EMERGENCY FUEL SYSTEM INDICATOR LIGHTS.

Red, green and amber emergency fuel system indicator lights (44, figure 1-5 and 39, figure 1-17) are located on each instrument panel. The red light is wired to glow when the nose gear is not up and locked and the emergency fuel switch is in the OFF position. This indication is intended to remind you that the emergency fuel switch has not been placed in the TAKE-OFF & LAND position (emergency fuel pressure switch energized) prior to take-off or landing. The green light glows when the emergency fuel switch is in the TAKE-OFF & LAND position. The amber light comes on whenever the emergency fuel bypass valve is closed, thus indicating that the engine is operating on the emergency fuel control system. During emergency check-out the red light will stay on, and the amber light will come on and the green light may or may not come on depending upon the type of pressure switch installed.

On BuAer serials 137934 and 137990 and subsequent the red and green emergency fuel system indicator lights are deleted. The amber light is retained and glows whenever the primary element of the dual engine pump fails or when the Fuel Pump Check Switch is held in the CHECK position.

WATER-ALCOHOL INJECTION. (AF Serials 48-356 thru 53-5085 only.)

GENERAL. This system (figure 1-10) consists of an electrically driven pump, a combination filter and shut-off valve, a pressure transmitter, a dual ring of spray nozzles, and two separate tanks located in the air intake ducts with a total capacity of 50 U.S. gallons. The fluid supply is sufficient for approximately two minutes operation. Also included is an actuating cylinder, powered by fluid injection pressure which automatically shuts off pressurizing air to the cockpit while the fluid injection system is operating. This is to prevent noxious fumes from entering the cockpit.

Use of fluid injection will give increased thrust for short periods and is especially useful for short field take-offs or emergencies in warm weather. The use of fluid injection is prohibited at ground air temperatures below 32°F, (O°C) and above 10,000 feet MSL.

Note

Part of the system is alternatively used for fuel filter de-icing (see Section IV) and when set up for de-icing, water-alcohol injection is not available.

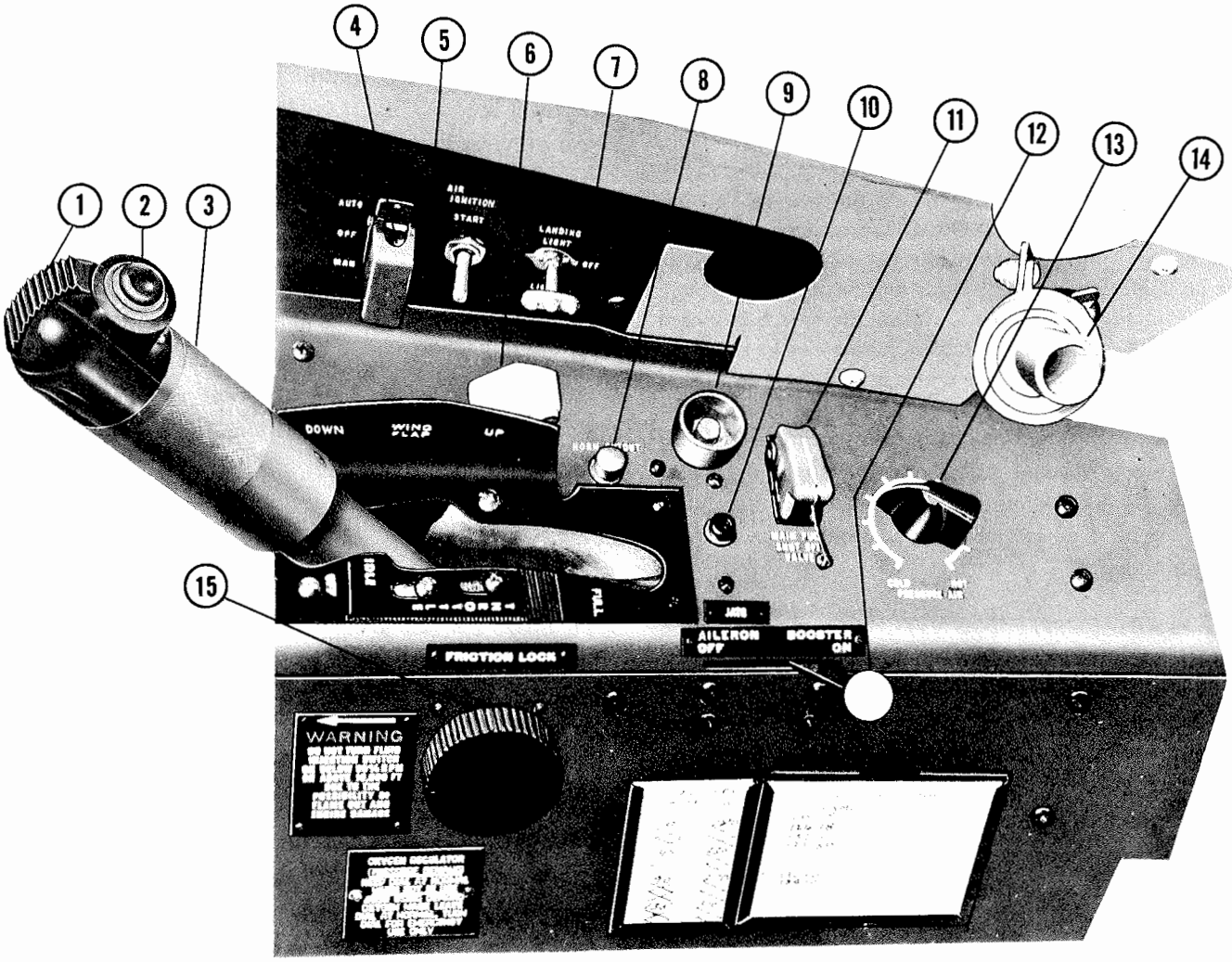
FLUID INJECTION SWITCH. Either of the dc powered fluid injection switches on the left-hand shelf (10, figure 1-7 and 17, figure 1-18) in each cockpit turns on the electrically driven fluid injection pump, provided the throttle is near the fully open position. Since the throttle is linked to a second switch in series with the fluid injection switch, completion of the circuit is prevented if the throttle is not in the vicinity of the full open position. This second switch is automatically operated and is provided to help prevent flame-outs and engine damage caused by injecting fluid at low engine rpm. It is still possible, however, to cause flame-outs by turning on fluid injection before the engine has accelerated to above 90% rpm because the throttle can be advanced at a rate faster than the engine can accelerate.

WARNING

If fluid injection is used below 90% rpm or when flying above 10,000 feet MSL, the increased water/air ratio may cause flame-out and engine damage.

IGNITION SYSTEM.

Ignition is used only for initial starting of the engine and not for sustaining combustion as in a reciprocating engine. The system consists of an ignition control unit, ignition coils and spark plugs. The spark plugs are used for initiating combustion in engine combustion chambers 7 (bottom) and 14 (top). Ignition is automatically supplied whenever the starter is energized, provided that both front and rear cockpit ignition switches are in the NORMAL position. The ignition system and starting motor are energized for the proper duration by a relay which senses starter current drain. As the engine speed increases, the starter current decreases to a value which causes the relay to disconnect the starting motor and ignition system. Ignition for air starting, independent of the starter system, is also supplied thru the Air Start switch provided both ignition switches are in the NORMAL position.



FRONT COCKPIT, LEFT FWD

1. DIVE FLAP SWITCH
2. MICROPHONE BUTTON
3. THROTTLE
4. STARTING FUEL SWITCH
5. AIR START IGNITION SWITCH
6. WING FLAP CONTROL LEVER
7. LANDING LIGHT SWITCH
8. LANDING GEAR WARNING HORN CUTOUT BUTTON
9. JATO FIRING BUTTON
10. JATO FIRING CIRCUIT BREAKER
11. MAIN FUEL SHUT-OFF
12. AILERON BOOSTER SHUT-OFF LEVER
13. CABIN TEMPERATURE SELECTOR
14. COCKPIT RAM AIR VENTILATOR
15. THROTTLE FRICTION CONTROL KNOB

Figure 1-6

IGNITION SYSTEM CONTROLS.

IGNITION SWITCH. This dc powered switch, (one in each cockpit, (3, figure 1-9, and 12, figure 1-19) has two positions, NORMAL and OFF. The switches are wired in series and while either can be used to break the circuit, both must be in the NORMAL position to provide ignition. For this reason the switch in the rear cockpit has been safety wired in the NORMAL position so that ignition can be controlled from the front cockpit. When in the NORMAL position, ignition will be supplied through a relay in the starter circuit. When the switch is placed in the OFF position, the starter motor can be operated without having automatic ignition. The engine cannot be started if this switch is OFF. During starting the ignition switch should be left in OFF until the engine is turning up to 9% rpm rather than turning it on before starting. By waiting until the engine is turning fairly rapidly, with a good airflow, a possibility of a tailpipe fire is eliminated.

AIR START IGNITION SWITCH. These switches on the left side in each cockpit (5, figure 1-6 and 4, figure 1-18) have two positions; OFF and a spring-loaded START position. When either switch is pushed to START and released, ignition will be provided for a period of 45 to 60 seconds whether or not the starter is used, provided both ignition switches are in the NORmal position.

STARTING SYSTEMS.

ENGINE STARTING SYSTEM. An external power source, capable of turning the engine at least 9% rpm should normally be used for starting. In an emergency, the airplane battery may be capable of starting the engine, depending on its state of charge, etc.

STARTER SWITCH. This dc powered switch on the right side in each cockpit (5, figure 1-9 and 11, figure 1-19) has two spring-loaded positions and a center neutral position. When the switch in either cockpit is pushed to START and held for three seconds, it energizes the starting motor and ignition system if the ignition switch is in the NORMAL position, until engine speed increases to about 15% rpm; at this point a relay opens, disconnecting both the starter and ignition system. The STOP-START position is provided to permit stopping the starting cycle immediately, if necessary, by overriding the automatic relay. You need only hold the switch in the latter position momentarily. If the STOP-START position is used, do not attempt a restart until the engine has completely stopped.

STARTING FUEL SYSTEM.

Two starting fuel control systems (automatic and manual) are provided (figure 1-3). The automatic system provides better combustion and controlled acceleration during the initial starting phase and should be used for the normal starting procedure in preference to the manual system.

On BuAer Serials 137934 and 137990 and subsequent, the MANUAL starting position has been deleted. The Starting Fuel Switch has only two positions, AUTO and OFF. There are no provisions for a manual start.

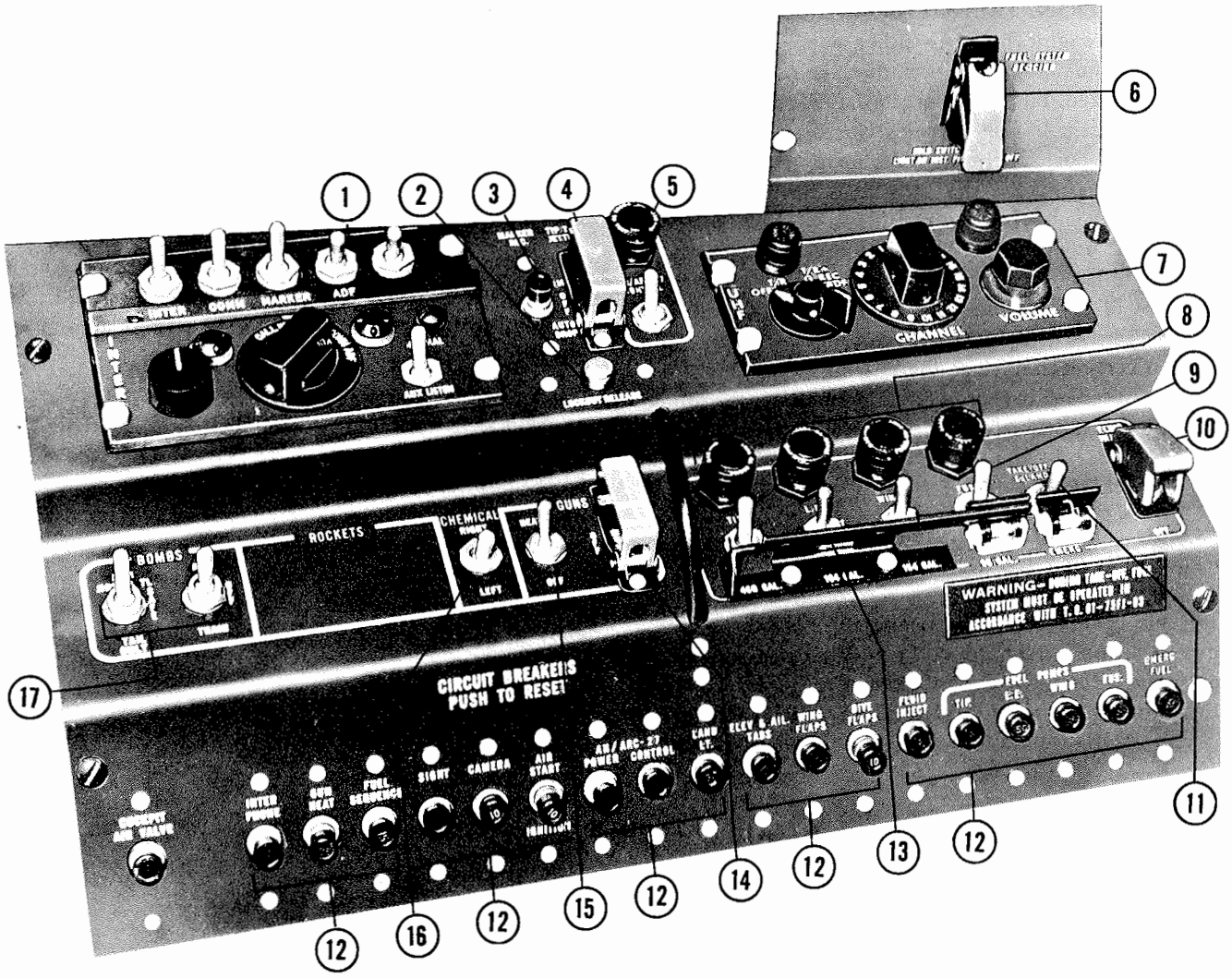
STARTING FUEL SWITCH.

This dc powered switch on the left side in each cockpit (4, figure 1-6 and 3, figure 1-18) has three positions: OFF, AUTO, and MAN. It is guarded to the OFF position and must be left there at all times except during the actual starting operation.

AUTO POSITION. When the starting fuel switch in either cockpit is placed in the AUTO position with the throttle OFF, the starting fuel control is energized and the emergency fuel control bypass valve is closed. Thus, with the engine turning both the main and emergency sections of the dual pump supply fuel thru the starting manifold to combustion chambers No. 7 and 14. As fuel pressure increases, fuel is supplied to all burners and the engine will accelerate automatically to approximately 35% rpm. The starting fuel control remains energized until the throttle is moved out of the OFF position, or the starting fuel switch is placed in the OFF position. If the starting fuel switch is left in the AUTO position, the automatic starting system will operate whenever the throttle is placed in the OFF position.

CAUTION

If the starting fuel switch is left in AUTO when there is no flame in the combustion chambers and the electrical system is energized, fuel will drain or be pumped through the engine into the tailpipe or out of the manifold drain onto the ground. This can create a fire hazard.



FRONT COCKPIT, LEFT AFT

1. AN/AIC-10 INTERPHONE PANEL
2. STUDENT LOCKOUT RELEASE BUTTON
3. MARKER BEACON CIRCUIT BREAKER
4. TIP TANK JETTISON READY SWITCH
5. AN/ARC-27 RADIO CONTROL SWITCH AND INDICATOR LIGHT
6. FUEL SYSTEM DEICER SWITCH
7. AN/ARC-27 RADIO CONTROL PANEL
8. FUEL TANK INDICATOR LIGHTS
9. FUSELAGE FUEL TANK BOOST PUMP SWITCH
10. FLUID INJECTION SWITCH
11. EMERGENCY FUEL SWITCH
12. LEFT CIRCUIT BREAKERS
13. TIP, LEADING EDGE, AND WING TANK FUEL SWITCHES
14. GUNS-CAMERA SWITCH
15. GUN-HEATER SWITCH
16. CHEMICAL TANK SELECTOR SWITCH
17. BOMB ARMING AND SELECTOR SWITCHES

Figure 1-7

MAN POSITION. (Aircraft equipped with the J33-A-23 and −35 engines). When either starting fuel switch is placed in the manual position, the starting fuel control is not energized, but the emergency fuel bypass valve is closed and main by-pass remains closed and fuel is fed to all of the burners through the main and emergency fuel controls provided the throttle is not in the OFF position. Movement of the throttle to the IDLE position has no effect on electrical sequencing because the starting fuel control is not used in manual starts. If the switch is left in the MAN. position after starting, both the normal and emergency fuel systems will continue to supply fuel. Under this condition, since there is no governor protection, overspeeding is very likely to occur; also, the idling speed will be excessively high.

ENGINE INSTRUMENTS.

Duplicate engine instruments are provided, one in each cockpit, including the tachometers (22, figure 1-5, and 20, figure 1-17) which read in percentage of maximum allowable rpm, the tailpipe temperature indicators (12, figure 1-5 and 11, figure 1-17) which read in degrees Centigrade, the fuel pressure gages (23, figure 1-5 and 21, figure 1-17) and the oil pressure gages (25, figure 1-5 and 23, figure 1-17) reading in pounds per square inch.

JATO (Jet assist take-off system).

GENERAL. Provisions are included for mounting two JATO units on the bottom of the fuselage. The JATO units add about one thousand pounds of thrust each for approximately twelve seconds duration, and will materially improve the airplane's take-off performance.

If JATO units are installed they must be used on the first take-off, or jettisoned, as they will not be safe after being subjected to low temperatures.

JATO CONTROLS. (AF Serials 50-402 and subsequent.)

JATO ARMING SWITCH. This two position dc powered switch labelled ARM and SAFE, is located on the front cockpit instrument panel (31, figure 1-5). In the ARM position it energizes the JATO firing button and the JATO READY red indicator lights on each instrument panel. When in the SAFE position, the JATO firing circuit is inoperative and the indicator lights are out.

JATO FIRING BUTTON. On the left shelf of each cockpit (9, figure 1-6 and 9, figure 1-18) is a JATO firing button. Depressing either button will fire the JATO units provided the JATO arming switch is in the ARM position.

JATO CONTROLS. (AF Serials prior to 50-402.)

In these aircraft the control stick triggers fire the JATO bottles.

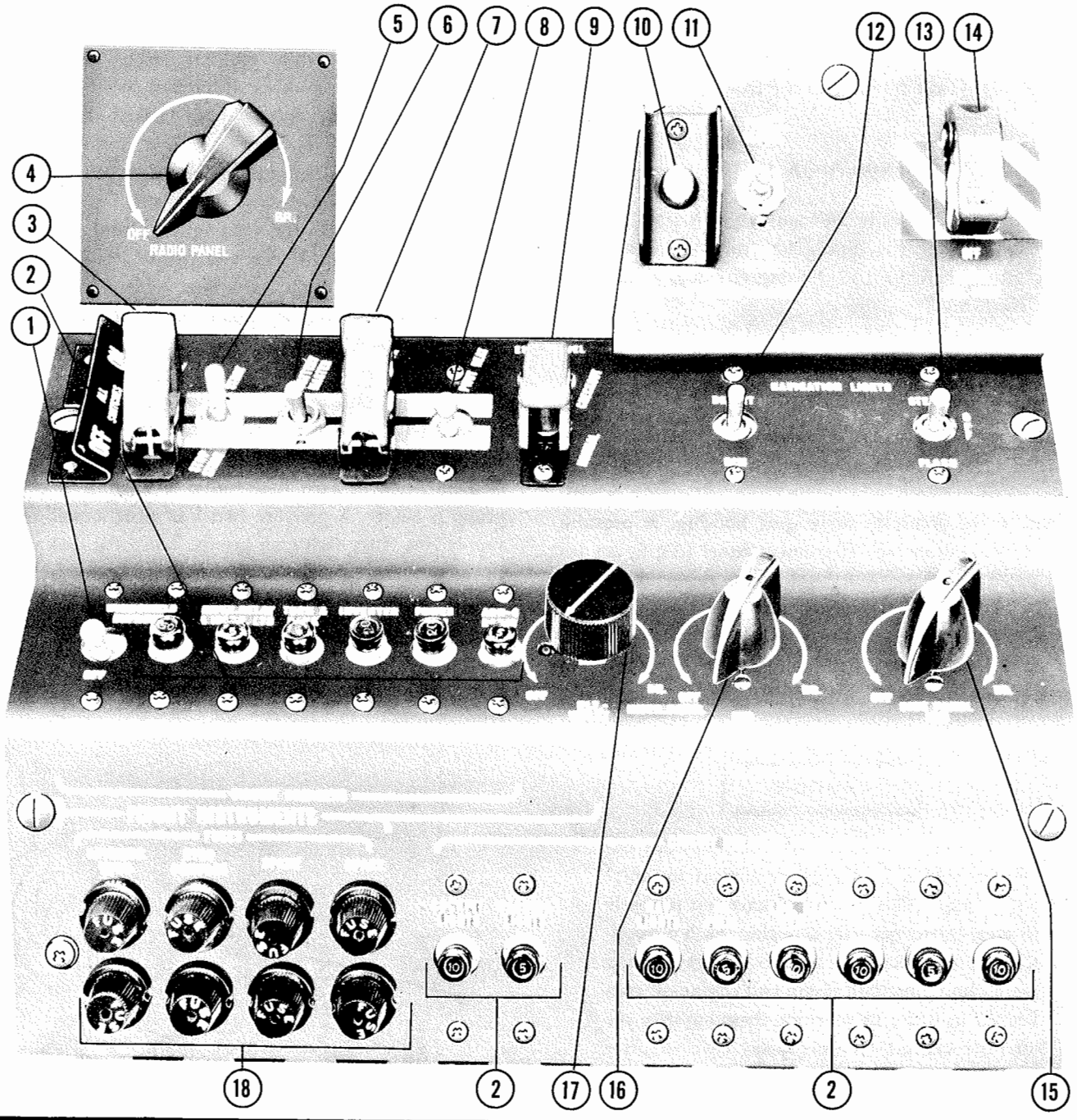
GUNS & JATO MASTER SWITCH. This dc powered switch type circuit breaker (23, figure 1-18) located on the left side of the rear cockpit has two positions ARM and SAFE. In the ARM position it energizes the control stick triggers for guns or JATO depending upon the position of the GUNS-JATO selector switch. In the SAFE position both guns and JATO circuits are inoperative.

GUNS-JATO SELECTOR SWITCH. This is a two position switch located on the front cockpit instrument panel labelled GUNS and JATO. Moving it to the JATO position connects the JATO circuit to the control stick triggers and illuminates the JATO READY red indicator light on each instrument panel, in the GUNS position it connects the gun firing circuits to the control stick triggers. Thus, its position determines whether guns or JATO will fire when you squeeze the trigger.

(AF SERIALS PRIOR TO 50-402)

GUNS-JATO SELECTOR SWITCH

Figure 1-8



FRONT COCKPIT, RIGHT SIDE

1. WINDSHIELD AUXILIARY DEFROSTER SWITCH
2. RIGHT CIRCUIT BREAKERS
3. IGNITION SWITCH
4. RADIO PANEL LIGHTS RHEOSTAT
5. STARTER SWITCH
6. BATTERY MASTER SWITCH
7. GENERATOR SWITCH
8. PITOT HEAT SWITCH
9. EMERGENCY FUEL CHECKOUT SWITCH (J33A-23,-35 ENGINES ONLY)
10. CANOPY OPEN SWITCH
11. CANOPY PART CLOSE AND FULL CLOSE SWITCH
12. NAVIGATION LIGHTS DIM-BRIGHT SWITCH
13. NAVIGATION LIGHTS STEADY-FLASH SWITCH
14. EMERGENCY HYDRAULIC PUMP SWITCH
15. SIDE PANEL RED LIGHTS RHEOSTAT
16. INSTRUMENT PANEL RED LIGHTS RHEOSTAT
17. INSTRUMENT PANEL ULTRA-VIOLET LIGHTS RHEOSTAT
18. FLIGHT INSTRUMENT FUSES

Figure 1-9

JATO JETTISON HANDLE. (All Serials). After JATO thrust is exhausted, the units may be jettisoned mechanically by pulling the manual release handle, (13, figure 1-4) on the left side in the front cockpit.

JATO "READY" INDICATOR LIGHT.

There is a JATO Ready Indicator Light located on each instrument panel, (31, figure 1-5 and 28, figure 1-17). They glow when the JATO firing circuit is armed and ready for firing.

OIL SYSTEM.

The engine oil system is automatic and requires no controls. The system is an integral wet sump type with pressure and splash lubrication. The oil supply is contained in the accessory drive gear housing. A pressure gage is located on each instrument panel (25, figure 1-5 and 23, figure 1-17). Oil level in the reservoir may be determined by a bayonet gage located on the right side of the accessory gear casing (figure 2-2). The reservoir holds 12 quarts of oil. See figure 1-2 for oil grade and specification.

CAUTION

The currently installed oil filler caps are not readily accessible. There are several instances where responsible personnel have not properly secured these caps after servicing. Such a condition has resulted in nauseous oil fumes entering the cockpit, obscured vision and engine oil starvation. In order to preclude these hazards, the oil filler cap must be physically checked prior to each flight in order to insure that the cap is definitely secured as directed on figure 2-2.

AIRPLANE FUEL SYSTEM.

GENERAL. Fuel is carried in four groups of tanks as shown on figure 1-10. Tip (droppable) tanks may be carried on attachments at the wing tips when desired. Early T-33A Airplanes may be equipped with 165 gallon underslung tanks. Later T-33A Airplanes may be equipped with 230 gallon centerline tanks. Under normal operating conditions, all fuel is transferred to the fuselage tank before being fed to the engine. Early airplanes have a by-pass system which provides for by-passing the fuselage tank as described in the following paragraph. Fuel transfer is controlled automatically by float valves within the fuselage tank when the fuel switches are ON. When the fuel level in the fuselage tank drops below any of the float valves, that valve opens, admitting fuel from the respective tank group, provided, of course, that the respective tank switch is turned on. On AF Serials 48-356 thru 53-4885 the leading edge and wing tank float valves are located one and two inches respectively below the level of the tip tank float valve. Thus the locations of these valves determine that fuel from the tip tanks will be used first, from the leading edge tanks second, and from the wing tanks last. On AF Serials 53-4886 and subsequent, the positions of the wing and leading edge tank float valves are reversed so that the leading edge tanks feed last. The fuselage tank level is maintained at each float valve level until that tank group is empty. A pressure switch is incorporated in the supply line from each tank group. When the tank group empties, the pressure drop causes a red indicator light, located above the tank switch, to glow, thus indicating that the tank switch should be turned off. However, the tip tanks switch should be left on so that the air pressure from the engine compressor will prevent the tanks from collapsing in a fast descent.

CAUTION

Tip tanks usually retain pressure for quite some time after the engine is shut down. Therefore, it is necessary to relieve pressure by slowly loosening the filler caps before removing them.

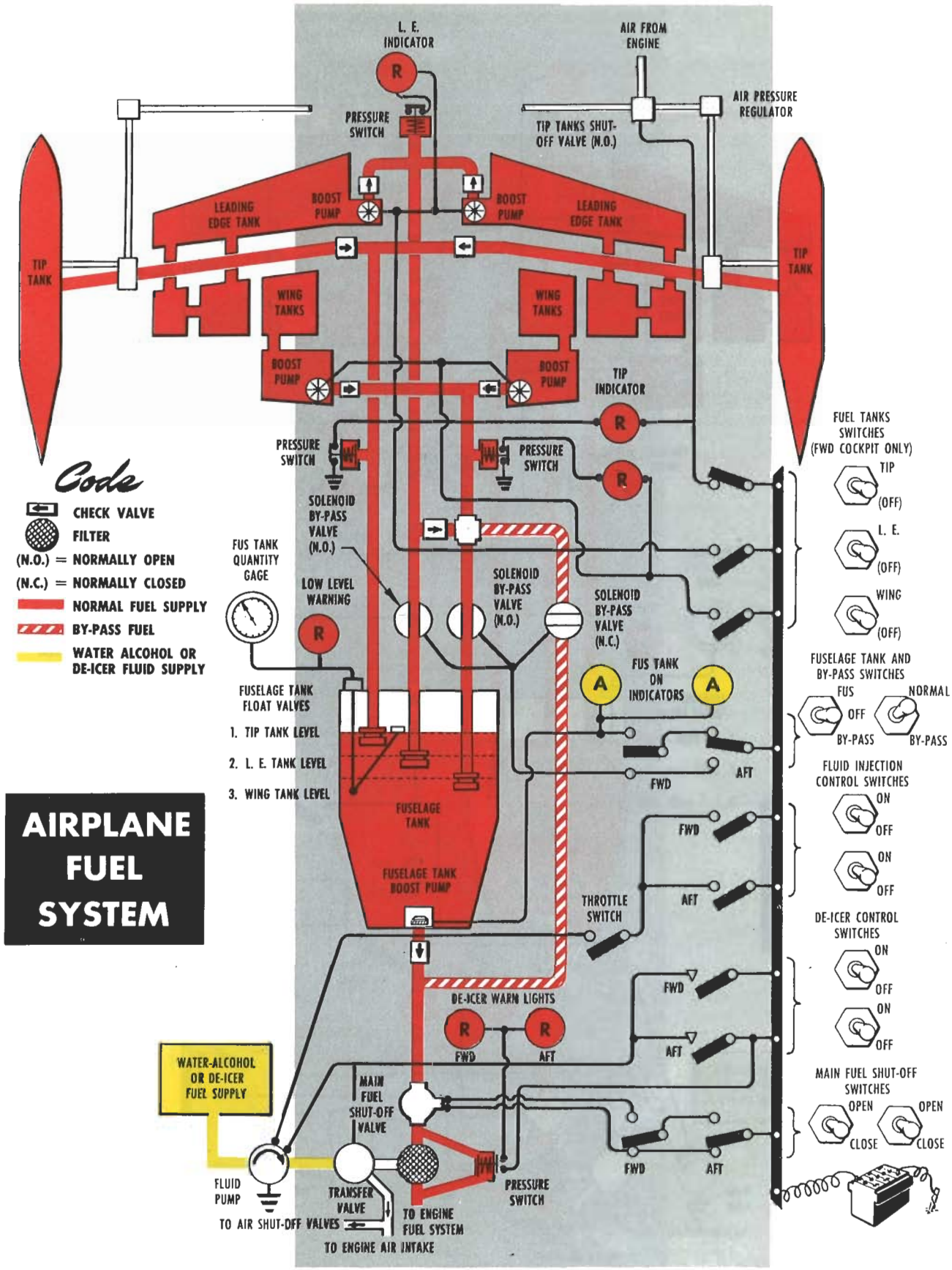


Figure 1-10 (Sheet 1 of 2). AF Serials prior to 53-4886

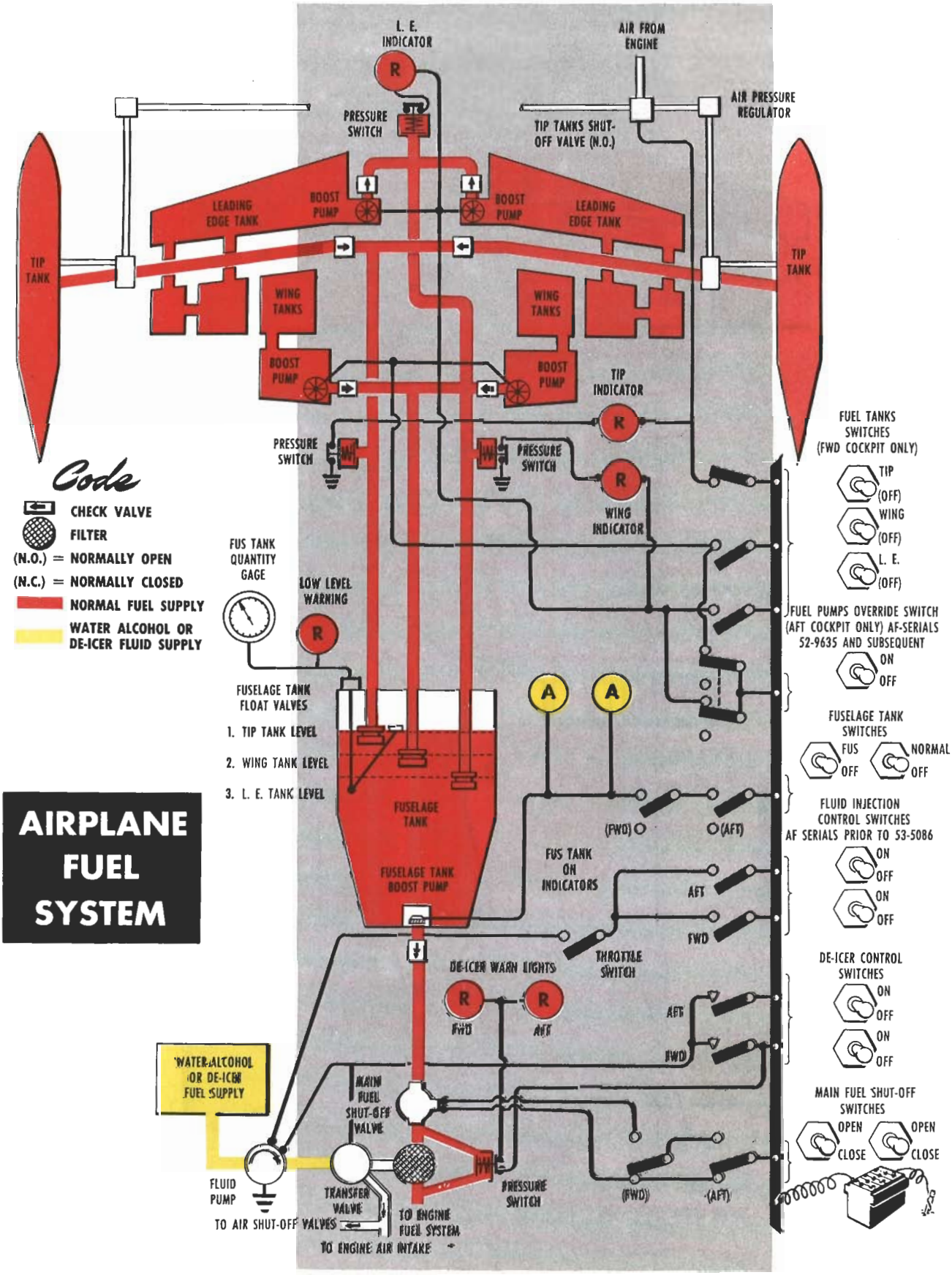


Figure 1-10 (Sheet 2 of 2). AF Serials 53-4886 and Subsequent

FUEL QUANTITY DATA—U.S. GALLONS

TANKS	NO. TANKS	USABLE FUEL (Ea.)	USABLE EXPANSION SPACE (Ea.)	TRAPPED FUEL LEVEL FLIGHT (Ea.)	TOTAL VOLUME (Ea.)
TIP (CENTERLINE)	2	230	0 (1)	0.5	(2)
TIP (UNDERSLUNG)	2	165	0 (1)	0.5	(2)
LEADING EDGE	2	52	0 (1)	(2)	(2)
WING	2	77	0 (1)	(2)	(2)
FUSELAGE	1	95	0 (1)	(2)	(2)
TOTAL AIRPLANE:	(UNDERSLUNG TANKS)	683		12.6	695.6
	(CENTERLINE TANKS)	813		12.6	825.6

(1) ALL TANKS HAVE THE USUAL EXPANSION SPACE; HOWEVER, THIS IS NOT AVAILABLE FOR "STUFFING" PURPOSES SINCE FUEL IN THIS SPACE DRAINS OVERBOARD.
(2) NOT DETERMINED FOR SEPARATE TANK GROUPS.

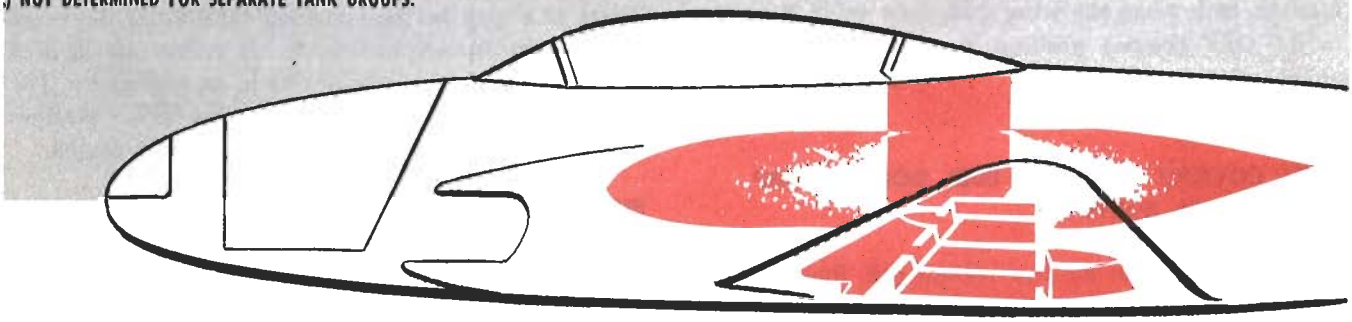


Figure 1-11

BYPASS SYSTEM. (AF Serials 48-356 thru 53-4885 only.) Under emergency conditions fuel from the wing leading edge tanks can be made to bypass the fuselage tank. Three solenoid-operated valves, actuated by the fuselage tank and bypass switch, divert the flow from these tank groups directly to the engine when the switch is placed in the BYPASS position. The fuselage tank will gravity feed even though the boost pump does not operate during BYPASS operation. In case of electrical failure the bypass valves will return to the position for normal flow.

The possibility of sucking fuel from a leading edge or wing tank with an inoperative boost pump is considered impractical because the suction would be broken by air in the connecting tank which would be emptied before the inoperative boost pump is discovered.

FUEL SPECIFICATIONS AND GRADES.

Fuels used with J33-A-20, -23, and -35 engines must conform to:

SPECIFICATION MIL-F-5624 GRADE JP-4 for all normal operation, including starting.

SPECIFICATION MIL-F-5572 GRADE 100/130 (gasoline) as an alternate fuel.

FUEL FILTER DE-ICING. Provisions are included for de-icing the low pressure fuel filter. For a description of this system, refer to Section IV.

FUEL SYSTEM CONTROLS.

TIP TANK FUEL SWITCH. (Front Cockpit Only.)

The tip tank fuel switch (13, figure 1-7) has two positions. When in the ON (up) position, the solenoid valve is de-energized and spring-loaded to the open position and admits air pressure from the engine compressor into the tip tanks. The air pressure forces fuel from the tip tanks into the fuselage tank when the tip tank float valve is open. In case of electrical failure, the solenoid valve will automatically open and fuel will be fed from the tip tanks to the fuselage tank. In the OFF (down) position this solenoid valve is energized closed.

LEADING EDGE TANK FUEL SWITCH. (Front Cockpit Only.)

The leading edge tank fuel switch (13, figure 1-7) has two positions. In the ON (up) position, it turns on a booster pump in each leading edge tank. These pumps transfer fuel into the fuselage tank when the leading edge tank float valve is open. When in the OFF (down) position, the booster pumps are inoperative.

WING TANK FUEL SWITCH. (Front Cockpit Only.)

The wing tank fuel switch (13, figure 1-7) is a two-position switch. When in the ON (up) position, a booster pump in each wing tank transfers fuel into the fuselage tank when the wing tank float valve is open. In the OFF (down) position, the booster pumps are turned off.

REAR COCKPIT FUSELAGE FUEL BOOST PUMP AND BYPASS SWITCH.

A guarded switch in the rear cockpit (18, figure 1-18) has two positions, NORMAL and BYPASS. On AF Serials 53-4886 and subsequent, the BYPASS position is replaced with an OFF position. When the rear cockpit switch is in the NORMAL position, the switch in the front cockpit controls the circuit. When the rear cockpit switch is in the BYPASS position, the fuselage tank booster pump is shut off and the electrically operated bypass valves are reset, causing fuel in the wing and leading edge tanks to bypass the fuselage tank if the boost switches in front cockpit are on. Further, when this switch is in BYPASS, the front cockpit fuselage fuel tank and bypass switch is inoperative.

FRONT COCKPIT FUSELAGE FUEL BOOST PUMP AND BYPASS SWITCH.

The fuselage fuel pump and bypass switch (9, figure 1-7) has three positions: FUS., BYPASS and OFF. On AF Serials 53-4886 and subsequent, the BYPASS position is deleted. In the FUS. position the fuselage tank booster pump is turned on to supply fuel under pressure to the engine-driven fuel pump provided the rear cockpit switch is in the NORMAL position. In the BYPASS position, the fuel system is put in the BYPASS condition and the fuselage tank booster pump is shut off. In the OFF (center) position, the fuselage tank bypass valves are set for normal operation but the fuselage tank booster pump is shut off. This switch is inoperative when the rear cockpit fuselage pump and bypass switch is in BYPASS.

FUEL PUMP OVERRIDE SWITCH. (AF Serials 52-9635 and subsequent.)

A fuel pump override switch is provided on the aft cockpit left shelf (10, figure 1-18) on later airplanes. The switch is an ON-OFF switch and permits the aft pilot to turn on wing and leading edge fuel pumps regardless of the position of the individual selector switches in the front cockpit.

MAIN FUEL SHUT-OFF SWITCH. (11, figure 1-6 and 11, figure 1-18.)

There is a guarded two-position OPEN-CLOSE emergency switch in each cockpit. Either switch may be used to shut off all fuel to the engine in an emergency. The switches in both cockpits must be in the OPEN position (guards down) in order to supply fuel to the engine.

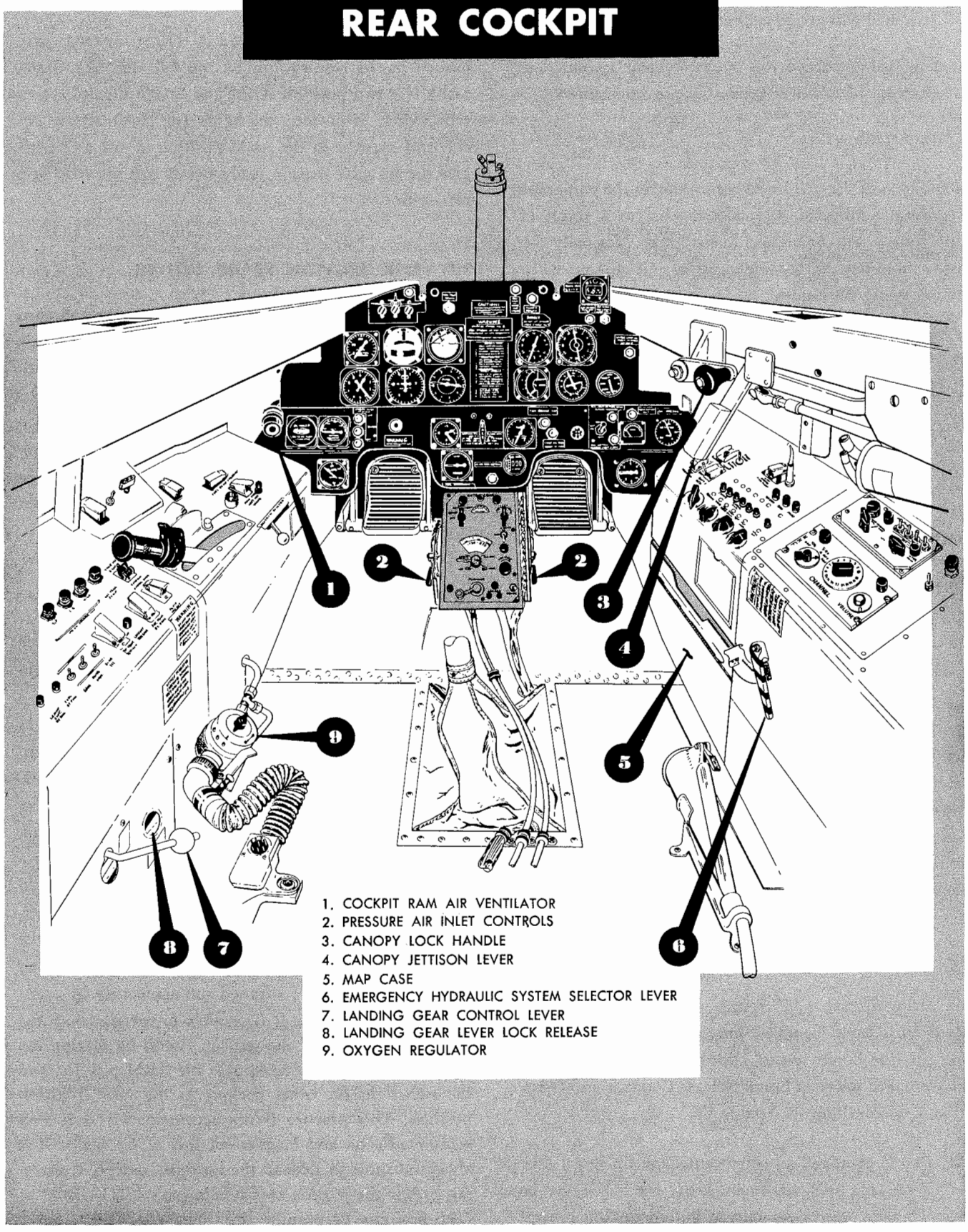
FUEL SYSTEM INDICATORS.

FUEL TANK INDICATOR LIGHTS. An indicator light (8, figure 1-7 and 1, figure 1-18) for each group of tanks is located on each fuel control panel. The tip tanks, leading edge tanks, and the wing tanks indicator lights are red and glow whenever the respective switches are ON and the fuel pressure in the lines is below 5 psi. The fuselage tank (amber) indicator light glows whenever the fuselage tank boost pump is operating.

FUEL QUANTITY INDICATORS. The float operated fuselage tank quantity gage (33, figure 1-5 and 29, figure 1-17) indicates the quantity of fuel in the fuselage tank only. A low-level warning light (32, figure 1-5 and 30, figure 1-17) glows when the quantity of fuel remaining in the fuselage tank drops to approximately 85 gallons. The low-level warning light has been relocated to the upper instrument panel on AF Serials 53-5620 and subsequent.

FUEL QUANTITY COUNTER. The fuel quantity counter (34, figure 1-5 and 31, figure 1-17) records fuel flow from a flowmeter in the engine fuel system. The counter dial must be set to read the amount of usable fuel in the airplane each time the tanks are filled. The fuel counter cannot be set after the d.c. bus is energized unless the fuel gage circuit breaker is pulled. The reading on the counter dial indicates the quantity of fuel in gallons remaining in the airplane and will be accurate except under the following conditions:

REAR COCKPIT



1. COCKPIT RAM AIR VENTILATOR
2. PRESSURE AIR INLET CONTROLS
3. CANOPY LOCK HANDLE
4. CANOPY JETTISON LEVER
5. MAP CASE
6. EMERGENCY HYDRAULIC SYSTEM SELECTOR LEVER
7. LANDING GEAR CONTROL LEVER
8. LANDING GEAR LEVER LOCK RELEASE
9. OXYGEN REGULATOR

Figure 1-12

1. Any fuel which is released when the tip tanks are jettisoned will not be counted.
2. Any fuel passing from the tank vent or fuel lines upstream of the flowmeter will not be counted.
3. Auto starting fuel.

In addition to the fuel losses mentioned in the paragraph preceding, additional fuel may be lost as a result of vaporization and/or boiling in the tanks. Normally this loss is small but can become quite large if aggravated by the following conditions:

1. Warm or hot fuel at the time of take-off.
2. High rate of climb.
3. High cruising altitude.

Each of the items listed above is a factor through which loss of fuel may result. Any one, or a combination of these factors may exist; therefore, the fuselage fuel tank quantity indicator or fuselage fuel tank low-level warning light may indicate, toward the end of a flight, that the actual fuel load is less than the indication given by the counter.

TIP TANK RELEASE.

Tip tanks may be released electrically with the Bomb Release Button on the control stick or with the Bomb or Tanks Salvo Button (figure 1-13). In case of a malfunction or failure of the electrical system the tip tanks can be released manually by pulling the Manual Release Handles (8, figure 1-4).

TIP TANK RELEASE CONTROLS.

On early aircraft (AF Serials 47-356 thru 51-4140) equipped to carry the underslung type tip tanks on bomb shackles, the bomb release controls are used to release the tip tanks. Refer to Bomb Release Controls and Operation of Bomb Controls, Section IV.

On aircraft equipped to carry centerline tip tanks (AF Serials 51-4141 and subsequent) the tip tanks may be dropped with the bomb release button on the control stick.

BOMB (OR TANKS) RELEASE MASTER SWITCH.

The dc powered bomb (or tanks) release master switch, located in the rear cockpit on the left side (21, figure 1-18) is a two position ARM and SAFE circuit breaker type switch. It protects the bomb (or tank) release circuit and must be in the ARM position in order to energize the tip tank jettison ready switch and the stick grip release button.

TIP TANK JETTISON READY SWITCH.

(AF Serials 51-4141 thru 52-9634 and 52-9876 thru 52-9905.) This switch, located on the left shelf in each cockpit (4, figure 1-7 and 20, figure 1-18) has two positions, READY and SAFE. When either switch is in the READY position, and the Bomb Release Master switch in the rear cockpit (21, figure 1-18) is in the ARM position, the circuit is armed and both tip tanks will be released simultaneously when the release button on either control stick is pressed.

TIP TANK JETTISON SWITCH.

On AF Serials 52-9635 and subsequent except 52-9876 thru 52-9905, the tip tank jettison switch has three positions: AUTO-DROP, ARM and OFF. The switch is operative only when the bomb release master switch in the aft cockpit is in the ARM position. When the jettison switch in either cockpit is placed in the AUTO-DROP position, the auto-drop circuit is energized so that if one tip tank becomes disengaged the other tank will be jettisoned automatically. This is designed to protect against sudden loss of lateral control which could result from the accidental loss of one tank during take-off. When the switch is placed in the ARM position, the release button on both control sticks is energized so that the tip tanks may be jettisoned simultaneously by pressing the release button. It is possible to energize both the auto-drop circuit and the jettison circuit by placing the jettison switch in one cockpit in the ARM position and the switch in the other cockpit in the AUTO-DROP position. This practice is not recommended as it may cause confusion and inadvertent loss of tip tanks. It is always possible to jettison the tip tanks quickly if necessary, while the jettison switch is in the AUTO-DROP or OFF position, by pushing the Bomb (or Tanks) Salvo button on the instrument panel.

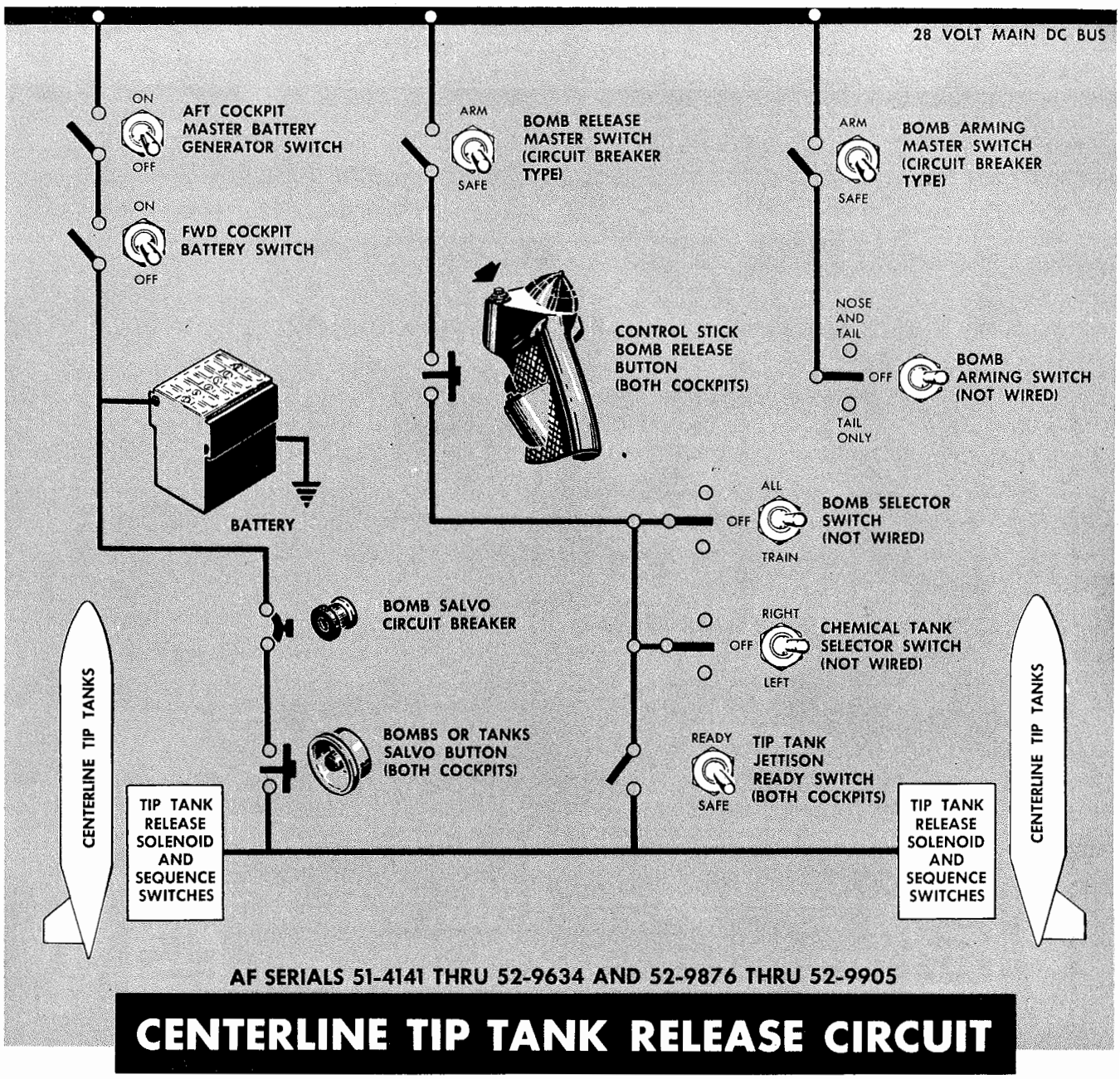


Figure 1-13 (Sheet 1 of 2)

BOMB (OR TANKS) SALVO BUTTON.

A bomb (or tanks) salvo button (41, figure 1-5 and 37, figure 1-17) located on each instrument panel is provided to permit simultaneous release of external load in an emergency. Both buttons are directly connected to the battery through a circuit breaker in the nose wheel well, and are always "hot."

Note

Some airplanes are delivered from the factory with a plastic cover over the bomb or tanks salvo switch which must be removed.

MANUAL RELEASE—TANKS OR BOMBS.

Left and right manual release handles are located on

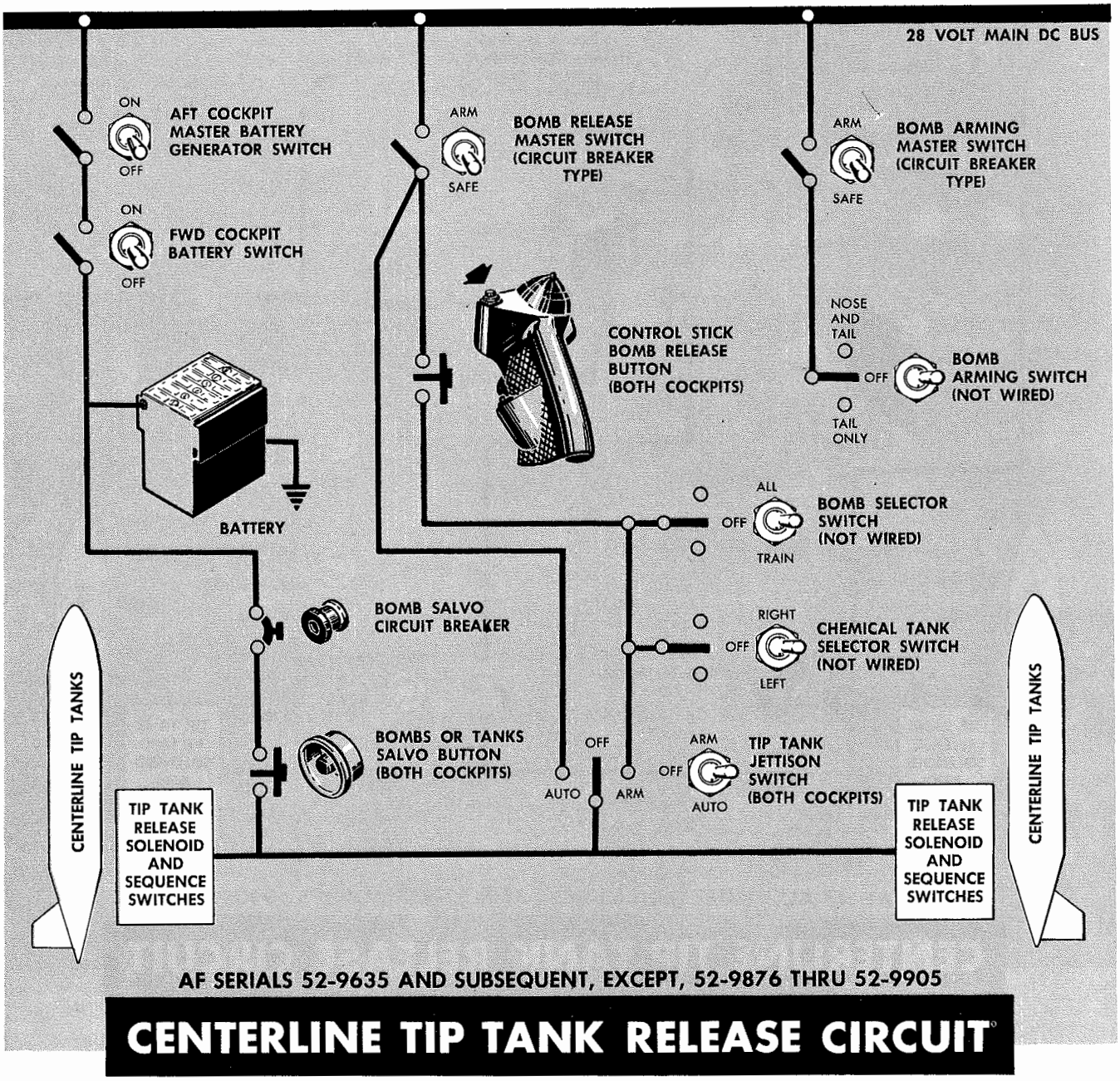


Figure 1-13 (Sheet 2 of 2)

the floor in the front cockpit at the left of the pilot's seat (8, figure 1-4). The handles are safetied with light copper wire in the off position to prevent inadvertent release of the tanks. The tanks may be released separately or together by pulling hard on either or both handles. When mid-wing pylon tanks or bombs are installed, the pylon manual release is tied into its respective tip tank release cable. Thus, when the tip tank release handle is pulled, the pylon load will also be released. This control provides an alternate method of releasing the external load in the event of an electrical failure.

TIP TANK GROUND SAFETY PINS.

(AF Serials 51-8636 and subsequent and modified Aircraft.) Red flagged ground safety pins are installed in each tip release lever (figure 2-2) to prevent accidental jettisoning while on the ground. The pins should be removed before flight and re-installed after flight.

ELECTRICAL SYSTEM.

GENERAL. The direct current electrical system is a 28-volt, single wire, grounded circuit. Power is furnished by one 300-ampere, 28-volt, engine-driven generator in parallel with two 12-volt storage batteries which are connected in series for 24-volt operation and are connected to the main bus by means of the battery relay. Alternating current is supplied by three rotary inverters that operate from the 28-volt d.c. system. The power supplied by these inverters operates the autosyn pressure instruments, gyro flight instruments, and AN/APX-6 Identification Radar. The electrical power system is shown on figure 1-14.

D.C. SYSTEM.

The 300 ampere d.c. generator is paralleled with two 12-volt batteries connected in series. A voltage regulator and a reverse current relay are used for protection and control of the system. The generator will cut in at 20 to 30% engine rpm. Higher than IDLE rpm may be required for the generator to carry equipment load and/or to compensate for low battery conditions.

EXTERNAL POWER RECEPTACLE. For ground operation, two cart receptacles are provided. These are connected in parallel for operation singly or together. No manual switching is provided in the airplane for controlling the power cart circuit. The ground cart contactor in the airplane will automatically close and connect the cart to the d.c. bus whenever a cart is plugged into either receptacle and turned on.

CAUTION

Do not turn the battery master switch ON or operate the exterior canopy control switches when a ground cart is connected to the airplane as this will place the batteries in parallel with the cart and if the cart is ON may damage the batteries. Turn off ground carts before connecting or disconnecting from airplane. This must be done to avoid burning the contact pins.

BATTERY AND GENERATOR SWITCHES. The battery and generator switches are combined into one switch in the rear cockpit (10, figure 1-19) while separate switches (6 and 7, figure 1-9) are provided in the front cockpit. The individual front cockpit battery and generator switches are in series with the rear combination battery-generator switch. Thus either circuit may be disconnected from the front cockpit but the switches in both cockpits must be ON to complete either circuit. Each switch has two positions, ON and OFF.

GENERATOR LOADMETER. Each cockpit contains a loadmeter (27, figure 1-5 and 25, figure 1-17). This instrument is an ammeter, the scale of which has been calibrated to read from −0.1 to 1.25 times the generator rated output to show generator load.

GENERATOR OUT WARNING LIGHT. (AF Serials 51-6810 and subsequent.) This amber warning light, installed on each instrument sub-panel (26, figure 1-5 and 24, figure 1-17), glows whenever the generator is inoperative and the d.c. bus is energized.

A.C. SYSTEM.

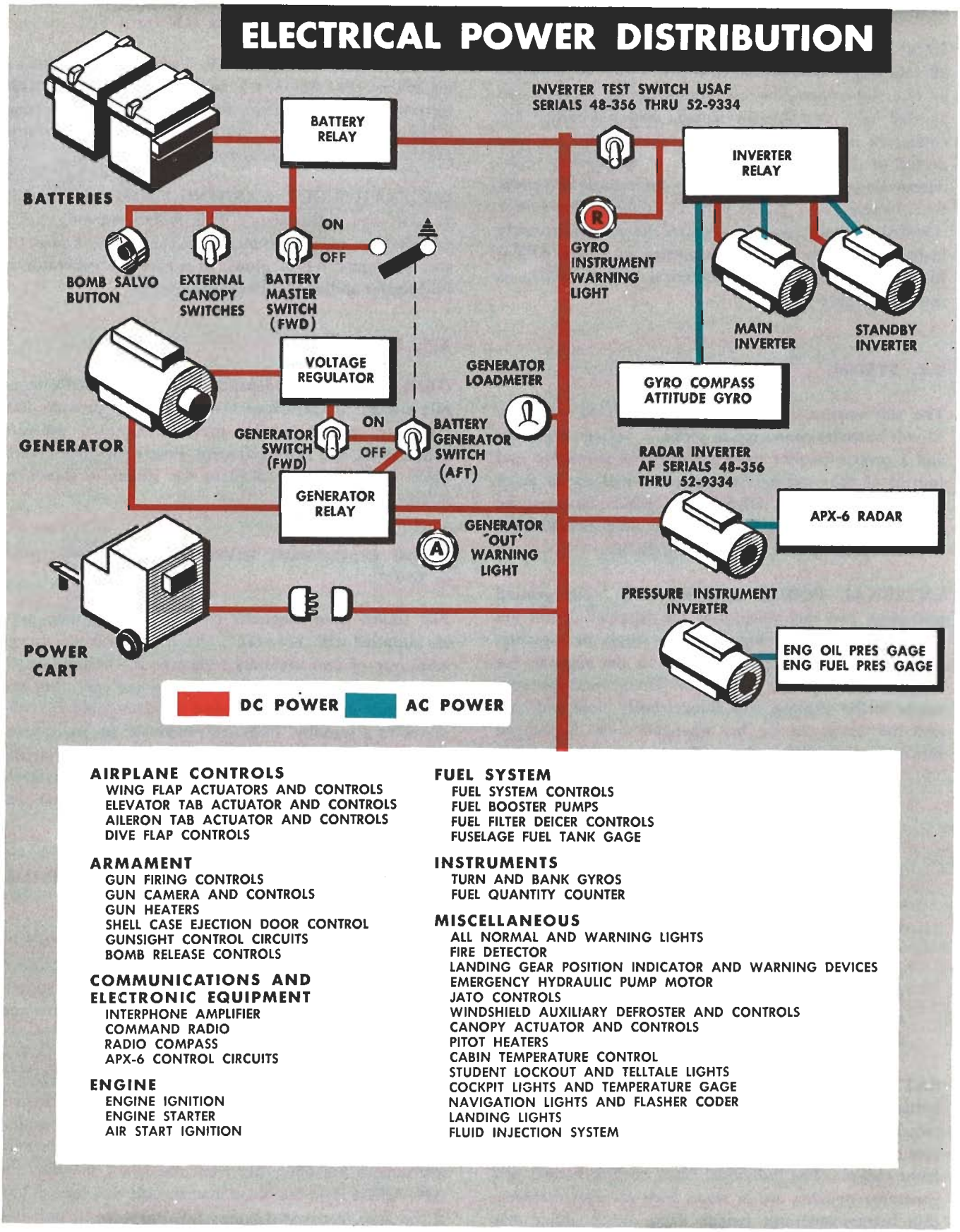
GENERAL. Three independent and functionally separate electric motor-driven inverter systems provide 400-cycle a.c. power to the gyro instruments, pressure instruments, and IFF equipment. Power for these inverters is supplied by the airplane d.c. system as shown in figure 1-14.

FLIGHT INSTRUMENT INVERTERS. (AF Serials prior to 52-9335.)

The slaved gyro magnetic compass and attitude gyro are supplied with 115-volt, 3-phase, 400-cycle a.c. power from one of two inverters whenever the battery switch is ON, or the power cart is connected and operating and the circuit breakers are pushed in. The other inverter serves as a standby. Both are controlled by an inverter relay system which automatically selects the standby inverter when the main inverter fails. If both inverters fail, the gyro instrument warning light will come on, indicating the power failure.

FLIGHT INSTRUMENT AND IFF INVERTERS SYSTEM. (AF Serials 52-9335 and subsequent.)

The gyrosyn compass and attitude gyro are powered by a 400-cycle, three phase inverter, and the AN/APX-6 identification radar is powered by a similar inverter. The circuit is arranged so that the gyro instruments and the AN/APX-6 radar may be switched from one inverter to the other by moving the manual inverter change-over switch from the No. 1 to the No. 2 position on AF Serials 52-9335 through 52-9759, or by moving the flight instrument power switch to the right ON or left ON position on AF Serials 52-9760 and subsequent. When the gyro instruments are operating from the No. 1 inverter, the AN/APX-6 is on the No. 2 inverter and vice versa. Thus, if the gyro instrument power fails they can be switched over to the other inverter, sacrificing the AN/APX-6.



AIRPLANE CONTROLS
- WING FLAP ACTUATORS AND CONTROLS
- ELEVATOR TAB ACTUATOR AND CONTROLS
- AILERON TAB ACTUATOR AND CONTROLS
- DIVE FLAP CONTROLS

ARMAMENT
- GUN FIRING CONTROLS
- GUN CAMERA AND CONTROLS
- GUN HEATERS
- SHELL CASE EJECTION DOOR CONTROL
- GUNSIGHT CONTROL CIRCUITS
- BOMB RELEASE CONTROLS

COMMUNICATIONS AND ELECTRONIC EQUIPMENT
- INTERPHONE AMPLIFIER
- COMMAND RADIO
- RADIO COMPASS
- APX-6 CONTROL CIRCUITS

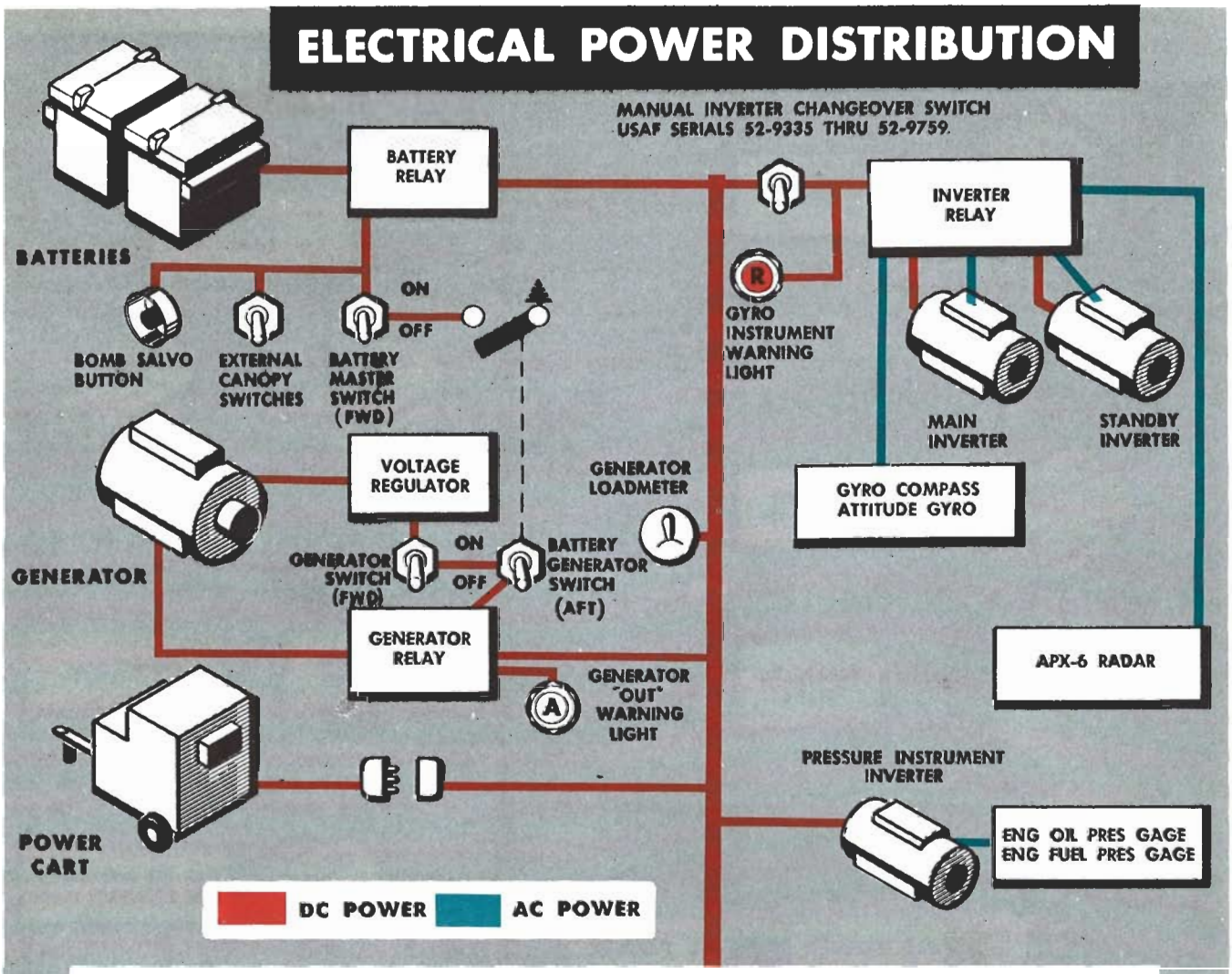
ENGINE
- ENGINE IGNITION
- ENGINE STARTER
- AIR START IGNITION

FUEL SYSTEM
- FUEL SYSTEM CONTROLS
- FUEL BOOSTER PUMPS
- FUEL FILTER DEICER CONTROLS
- FUSELAGE FUEL TANK GAGE

INSTRUMENTS
- TURN AND BANK GYROS
- FUEL QUANTITY COUNTER

MISCELLANEOUS
- ALL NORMAL AND WARNING LIGHTS
- FIRE DETECTOR
- LANDING GEAR POSITION INDICATOR AND WARNING DEVICES
- EMERGENCY HYDRAULIC PUMP MOTOR
- JATO CONTROLS
- WINDSHIELD AUXILIARY DEFROSTER AND CONTROLS
- CANOPY ACTUATOR AND CONTROLS
- PITOT HEATERS
- CABIN TEMPERATURE CONTROL
- STUDENT LOCKOUT AND TELLTALE LIGHTS
- COCKPIT LIGHTS AND TEMPERATURE GAGE
- NAVIGATION LIGHTS AND FLASHER CODER
- LANDING LIGHTS
- FLUID INJECTION SYSTEM

Figure 1-14 (Sheet 1 of 3)



AIRPLANE CONTROLS
- WING FLAP ACTUATORS AND CONTROLS
- ELEVATOR TAB ACTUATOR AND CONTROLS
- AILERON TAB ACTUATOR AND CONTROLS
- DIVE FLAP CONTROLS

ARMAMENT
- GUN FIRING CONTROLS
- GUN CAMERA AND CONTROLS
- GUN HEATERS
- SHELL CASE EJECTION DOOR CONTROL
- GUNSIGHT CONTROL CIRCUITS
- BOMB RELEASE CONTROLS

COMMUNICATIONS AND ELECTRONIC EQUIPMENT
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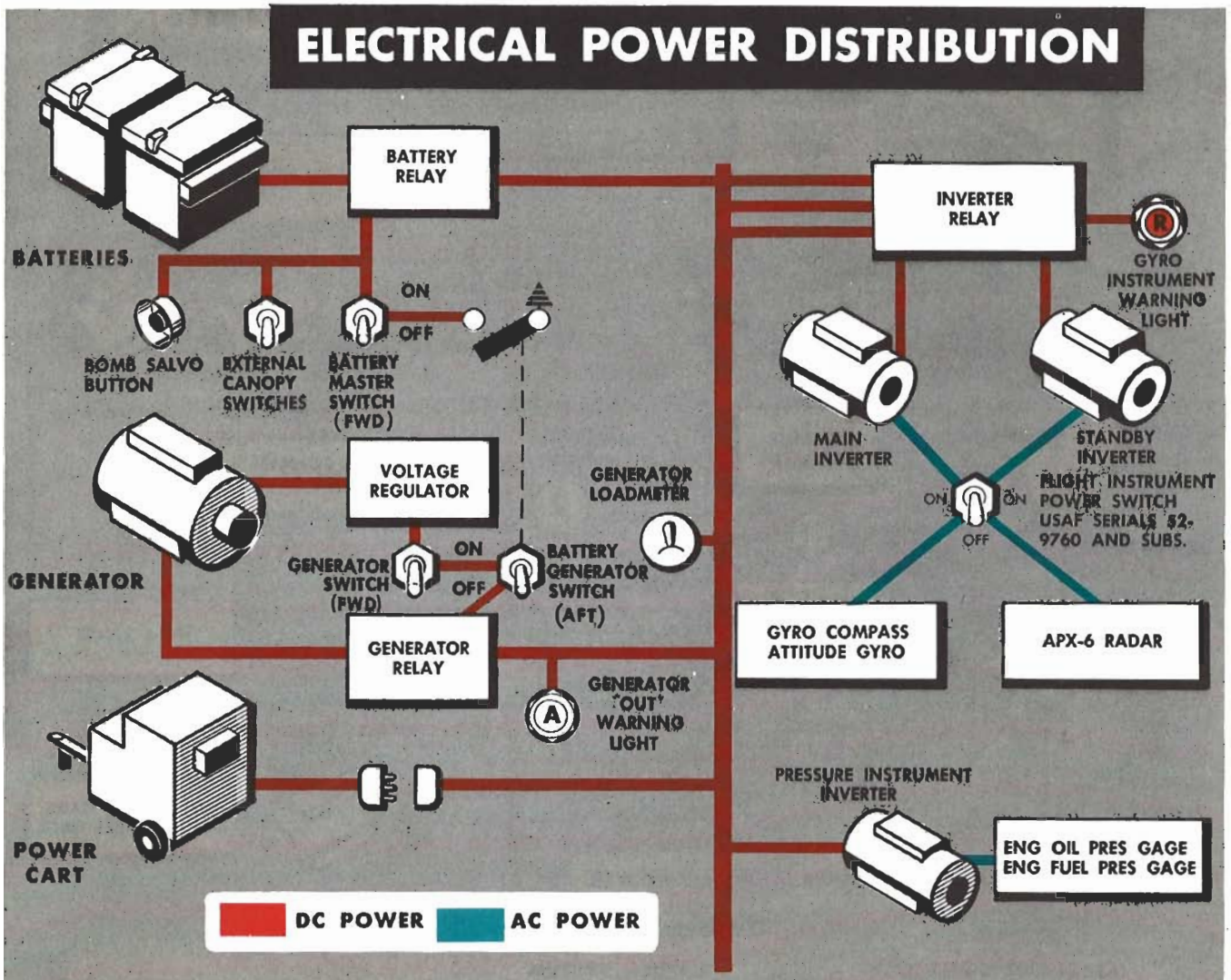
- COCKPIT LIGHTS AND TEMPERATURE GAGE
- NAVIGATION LIGHTS AND FLASHER CODER
- LANDING LIGHTS
- FLUID INJECTION SYSTEM

Figure 1-14 (Sheet 2 of 3)



AIRPLANE CONTROLS
- WING FLAP ACTUATORS AND CONTROLS
- ELEVATOR TAB ACTUATOR AND CONTROLS
- AILERON TAB ACTUATOR AND CONTROLS
- DIVE FLAP CONTROLS

ARMAMENT
- GUN FIRING CONTROLS
- GUN CAMERA AND CONTROLS
- GUN HEATERS
- SHELL CASE EJECTION DOOR CONTROL
- GUNSIGHT CONTROL CIRCUITS
- BOMB RELEASE CONTROLS

COMMUNICATIONS AND ELECTRONIC EQUIPMENT
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ENGINE
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- FUEL FILTER DEICER CONTROLS
- FUSELAGE FUEL TANK GAGE

INSTRUMENTS
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- JATO CONTROLS
- WINDSHIELD AUXILIARY DEFROSTER AND CONTROLS
- CANOPY ACTUATOR AND CONTROLS
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- COCKPIT LIGHTS AND TEMPERATURE GAGE
- NAVIGATION LIGHTS AND FLASHER CODER
- LANDING LIGHTS
- FLUID INJECTION SYSTEM

Figure 1-14 (Sheet 3 of 3)

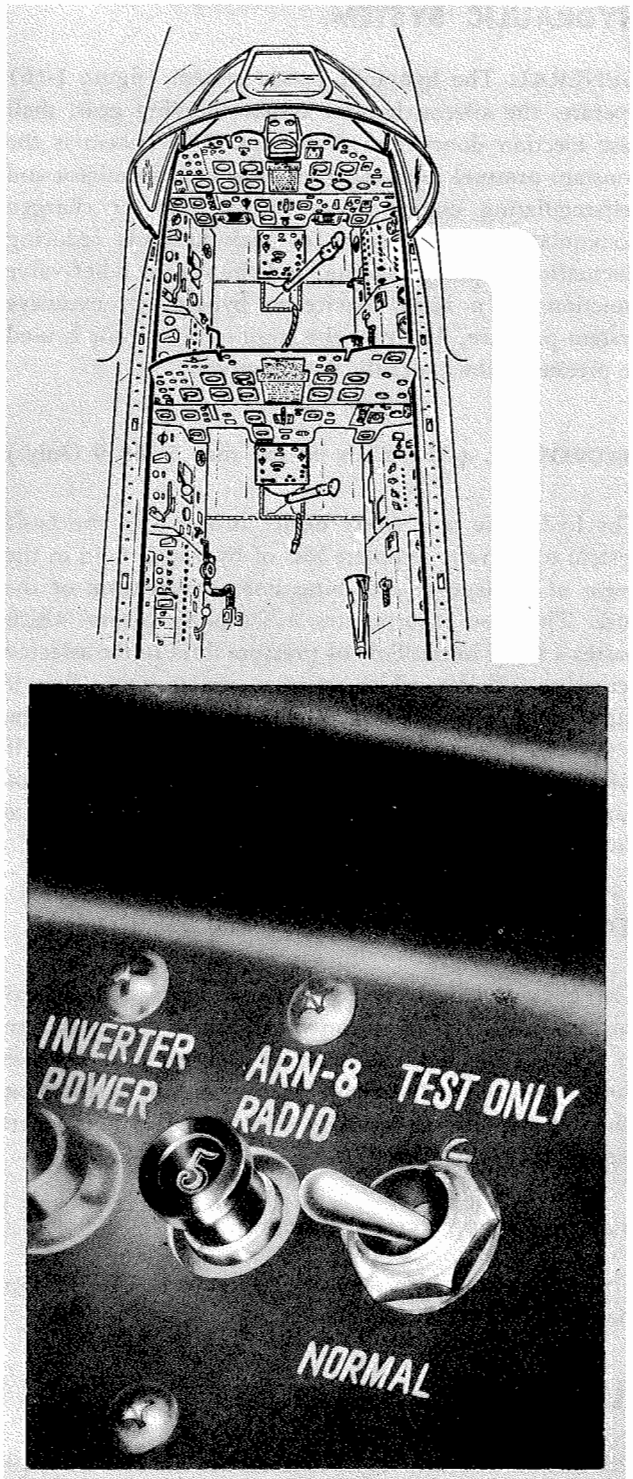


Figure 1-15. AF Serials Prior to 52-9335

GYRO INSTRUMENT WARNING LIGHT. The gyro instrument red warning light located on each instrument panel (18, figure 1-5 and 17, figure 1-17) glows to indicate gyro inverter failure.

CAUTION

- On AF Serials 52-9335 thru 52-9759 the gyro instrument warning light is inoperative. Thus, it is necessary to check the OFF flag on the instrument to detect failure.
- The inverter power and relay circuit breakers should be pulled out during APU operation because APU power surges increase slave gyro malfunction and inverter failures. On AF Serials 52-9760 and subsequent the Flight Instrument Power switch should be turned OFF instead of pulling the circuit breakers out.

INVERTER TEST SWITCH. (AF Serials prior to 52-9335.) The d.c. powered inverter test switch is located on the right shelf in the front cockpit (figure 1-15). It has two positions, NORMAL and TEST ONLY and is spring-loaded to the NORMAL position. In the TEST ONLY position it overrides the automatic relay to permit testing operation of the relay and the main and standby inverters. In the NORMAL position it connects d.c. power to the changeover relay system.

INVERTER TEST. (On unmodified aircraft, AF Serials prior to 52-9335.) Careful observation of the gyro instrument warning light is required to interpret inverter failure indication. When the test switch is pressed to TEST ONLY (after inverter has been operating for 30 seconds or more), the warning light should flick on and off briefly, indicating that the standby inverter is operating. If the light continues to glow, one of the inverters is not operating. When the test switch is released, the warning light should flick on then off, thus indicating that the main inverter is operating. If the light stays on for two or three seconds, the main inverter is not operating and the automatic relay has switched back to the standby inverter.

Continued glowing of the warning light indicates that both inverters are inoperative.

Continued blinking of the warning light indicates a short circuit in the a.c. phase and the inverter power should be cut off by pulling out the circuit breaker button.

MANUAL INVERTER CHANGEOVER SWITCH.
(AF Serials 52-9335 thru 52-9759.)

On later airplanes the automatic inverter changeover system is replaced with the manually operated changeover switch located on the right shelf in the front cockpit. The manual inverter changeover switch has two positions No. 1 and No. 2. With the switch in either position, both inverters are operating, however, when the switch is in the No. 1 position the No. 1 inverter is connected to the AN/APX-6 identification radar and the No. 2 inverter is connected to the gyrosyn compass and the attitude gyro. When the switch is in the No. 2 position the connections are reversed, that is, the No. 2 inverter is connected to the AN/APX-6 identification radar and the No. 1 inverter is connected to the gyrosyn compass and attitude gyro.

FLIGHT INSTRUMENT POWER SWITCH. (AF Serials 52-9760 and subsequent.)

The flight instrument power switch located on the front instrument panel (8, figure 1-5), replaces the manual inverter changeover switch. This switch has three positions, right ON, center OFF, and left ON. When the switch is in the right ON position the flight (gyros) instruments are connected to the No. 1 inverter. In the center OFF position the inverters are disconnected from the d.c. bus. In the left ON position the flight instruments are connected to the No. 2 inverter. Both inverters operate continuously and when the flight instruments are connected to the No. 1 inverter the APX-6 is connected to the No. 2 inverter and vice versa.

PRESSURE INSTRUMENTS INVERTER. The engine oil pressure and engine fuel pressure instruments are powered by a 26-volt single-phase 6 v.a. alternating current inverter. No control switch is provided; thus, inverter power is supplied to these instruments whenever the d.c. bus is energized.

RADAR INVERTER. (AF Serials 48-356 thru 52-9334.)

This inverter supplies 115-volt, single-phase, 400-cycle power for operation of the AN/APX-6 Identification Radar. D.C. power for operation of the inverter is supplied from the 24-volt bus when the AN/APX-6 Identification Radar is turned on. On later airplanes, the AN/APX-6 is powered by the No. 1 or No. 2 inverter, depending on the position of the Manual Inverter Changeover Switch or the Flight Instrument power switch.

HYDRAULIC SYSTEM.

GENERAL. The hydraulic power system (figure 1-16) operates the aileron booster system, landing gear, shell case ejection doors, and dive flaps. This system is the constant pressure type, incorporating an accumulator and self-regulating engine-driven pump. The air charged accumulator stores pressure for peak demands, reducing fluctuation in pump loading, and the system relief valve functions as a safety device to bypass any excessive system pressure. Air from the engine compressor is used to pressurize the hydraulic fluid reservoir.

HYDROFUSE. (AF Serials 48-356 thru 51-6819 Only.)

The hydrofuse is a safety device installed in the basic system to prevent complete loss of hydraulic fluid in the event of damage to plumbing lines downstream of the fuse. The fuse incorporates a sampling piston which passes a small initial flow of pressure fluid to the selected actuating cylinder, which causes a similar return flow if the plumbing is undamaged. This return flow holds the fuse open, permitting normal operation. However, if the return flow should fail to reach the fuse because of damaged plumbing, the fuse will shut off the pressure flow.

HYDROFUSE RESET LEVER. (Front Cockpit Only.)

The hydrofuse reset lever has a spring-loaded neutral position and a reset position which allows the hydrofuse to be manually overridden in an emergency or in case the hydrofuse malfunctions. The lever has no function when the hydrofuse is safety wired open as it is when the airplane is delivered.

HYDRAULIC PRESSURE GAGE.

This gage (37, figure 1-5 and 34, figure 1-17) indicates main hydraulic system pressure.

FLIGHT CONTROL SYSTEM.

GENERAL. Primary flight controls are the conventional stick and rudder pedals. Aileron control is augmented by a hydraulically-powered aileron booster. The elevator stick forces are reduced by means of two servo-acting spring tabs in addition to the servo action of the two trim tabs.

CONTROL STICK. The control stick grip (figure 1-21) contains the gun trigger switch, the elevator and aileron trim tab control switch and the bomb release switch.

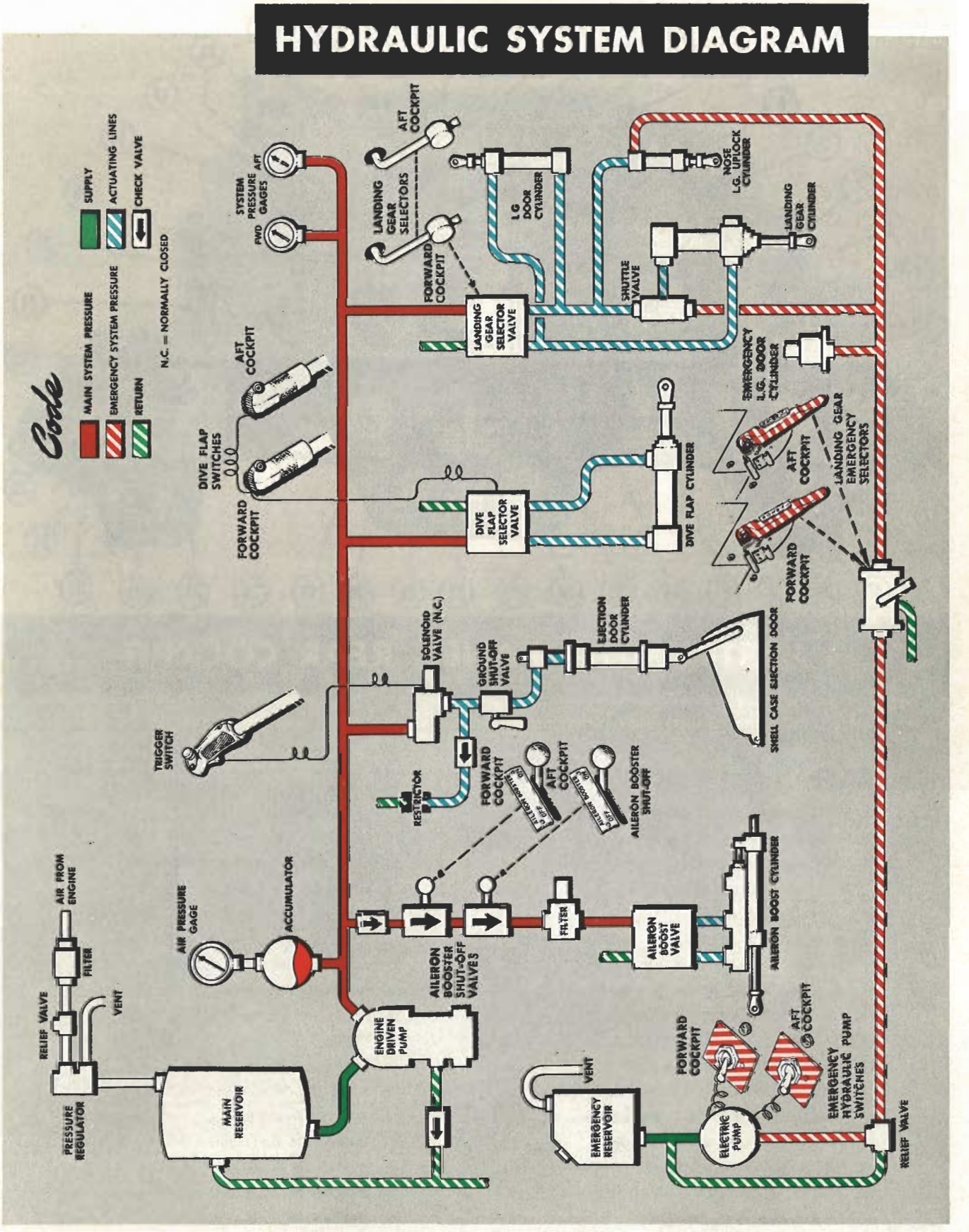
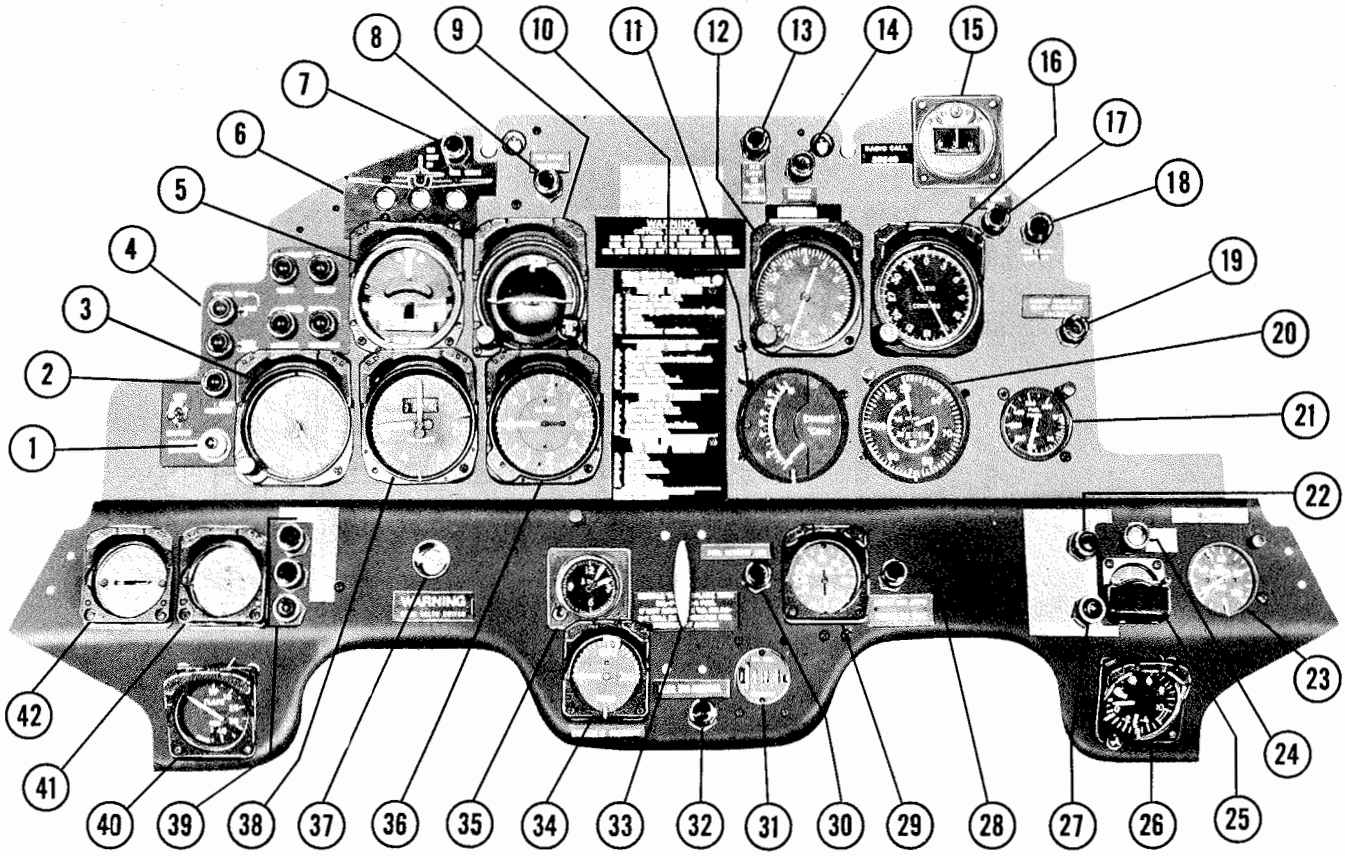

HYDRAULIC SYSTEM DIAGRAM
Code
MAIN SYSTEM PRESSURE
EMERGENCY SYSTEM PRESSURE
RETURN
SUPPLY
ACTUATING LINES
CHECK VALVE
N.C. = NORMALLY CLOSED
AIR FROM ENGINE
FILTER
RELIEF VALVE
VENT
PRESSURE REGULATOR
MAIN RESERVOIR
AIR PRESSURE GAGE
ACCUMULATOR
ENGINE DRIVEN PUMP
AILERON BOOSTER SHUT-OFF VALVES
FILTER
AILERON BOOST VALVE
AILERON BOOST CYLINDER
AILERON BOOSTER SHUT-OFF
FORWARD COCKPIT
AFT COCKPIT
RESTRICTOR
TRIGGER SWITCH
SOLENOID VALVE (N.C.)
GROUND SHUT-OFF VALVE
EJECTION DOOR CYLINDER
SHELL CASE EJECTION DOOR
DIVE FLAP SWITCHES
DIVE FLAP SELECTOR VALVE
DIVE FLAP CYLINDER
SYSTEM PRESSURE AFT
FWD
GAGES
LANDING GEAR SELECTORS
LANDING GEAR SELECTOR VALVE
LG DOOR CYLINDER
SHUTTLE VALVE
NOSE LG. UPLOCK CYLINDER
LANDING GEAR CYLINDER
EMERGENCY L.G. DOOR CYLINDER
LANDING GEAR EMERGENCY SELECTORS
EMERGENCY RESERVOIR
ELECTRIC PUMP
EMERGENCY HYDRAULIC PUMP SWITCHES
RELIEF VALVE

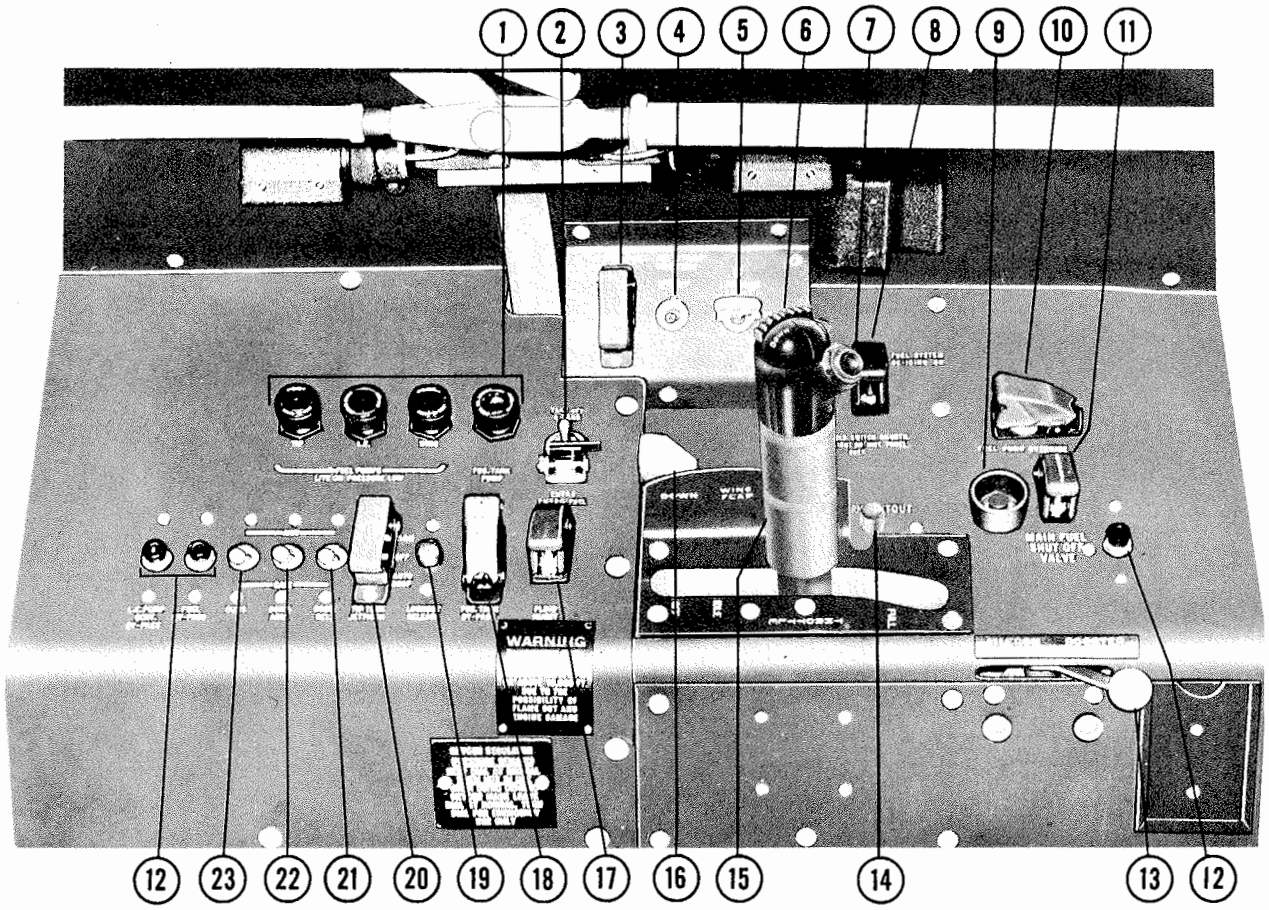
Figure 1-16



INSTRUMENT PANEL, REAR COCKPIT

1. STUDENT LOCKOUT BUTTON
2. DIVE FLAP TELL TALE INDICATOR LIGHT
3. ALTIMETER
4. TELL TALE INDICATOR LIGHT PANEL
5. TURN AND BANK INDICATOR
6. LANDING GEAR POSITION INDICATORS
7. LANDING GEAR UNSAFE WARNING LIGHT
8. FUEL DEICE WARNING LIGHT
9. ATTITUDE INDICATOR
10. PILOT'S CHECK LIST
11. EXHAUST (TAILPIPE) TEMP. INDICATOR
12. GYRO MAGNETIC HEADING INDICATOR
13. CANOPY UNLATCHED WARNING LIGHT
14. MARKER BEACON INDICATOR
15. STANDBY MAGNETIC COMPASS
16. RADIO COMPASS INDICATOR
17. GYRO INSTRUMENT WARNING LIGHT
18. TURN AND BANK WARNING LIGHT
19. STUDENT LOCKOUT WARNING LIGHT
20. ENGINE TACHOMETER
21. ENGINE FUEL PRESSURE GAGE
22. FIRE WARNING LIGHT
23. ENGINE OIL PRESSURE GAGE
24. GENERATOR OUT WARNING LIGHT
25. GENERATOR LOAD METER
26. ACCELEROMETER
27. OVERHEAT WARNING LIGHT
28. JATO READY INDICATOR LIGHT
29. FUSELAGE TANK QUANTITY GAGE
30. FUSELAGE TANK LOW LEVEL INDICATOR
31. FUEL QUANTITY COUNTER
32. ELEVATOR TAB NEUTRAL INDICATOR LIGHT
33. PARKING BRAKE HANDLE
34. HYDRAULIC SYSTEM PRESSURE GAGE
35. CLOCK
36. RATE OF CLIMB INDICATOR
37. BOMB (OR TANK) SALVO BUTTON
38. AIRSPEED INDICATOR
39. EMERGENCY FUEL SYSTEM INDICATOR LIGHTS
40. WING FLAP POSITION INDICATOR
41. OXYGEN PRESSURE GAGE
42. OXYGEN FLOW INDICATOR

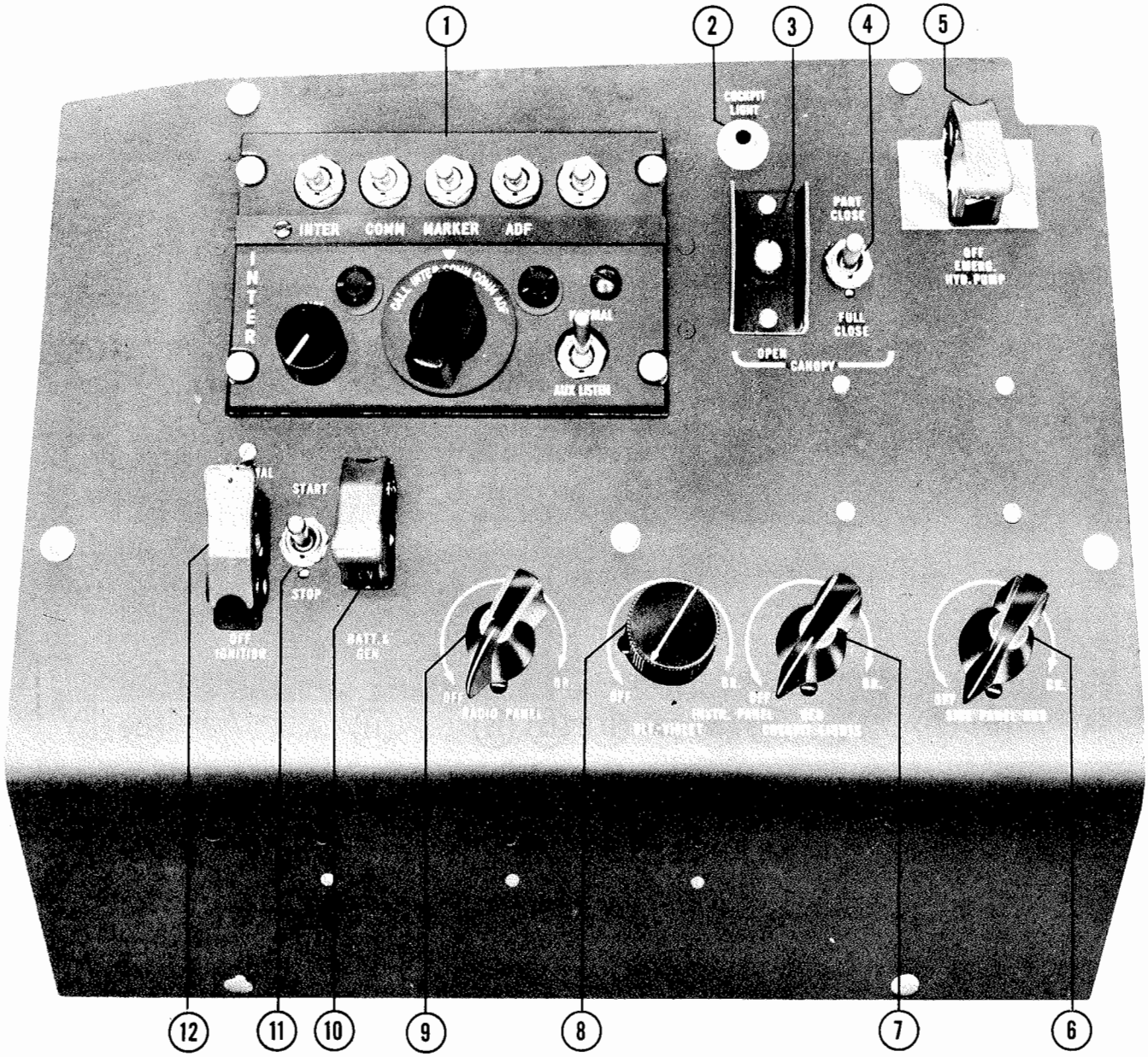
Figure 1-17



REAR COCKPIT, LEFT SIDE

1. FUEL TANKS INDICATOR LIGHTS
2. EMERGENCY FUEL SWITCH
3. STARTING FUEL SWITCH
4. AIR START IGNITION SWITCH
5. LANDING TAXI LIGHT SWITCH
6. DIVE FLAP SWITCH
7. MICROPHONE BUTTON
8. FUEL FILTER DEICER SWITCH
9. JATO FIRING BUTTON
10. FUEL PUMP OVERRIDE SWITCH
11. MAIN FUEL SHUT-OFF SWITCH
12. LEFT CIRCUIT BREAKERS
13. AILERON BOOSTER SHUT-OFF LEVER
14. LANDING GEAR WARNING HORN CUTOUT BUTTON
15. THROTTLE
16. WING FLAP CONTROL LEVER
17. FLUID INJECTION SWITCH
18. FUSELAGE FUEL TANK AND BY-PASS MASTER SWITCH
19. STUDENT LOCKOUT RELEASE BUTTON
20. TIP FUEL TANK JETTISON READY SWITCH
21. BOMBS (OR TANKS) RELEASE MASTER SWITCH
22. BOMB ARMING MASTER SWITCH
23. GUNS AND JATO MASTER SWITCH

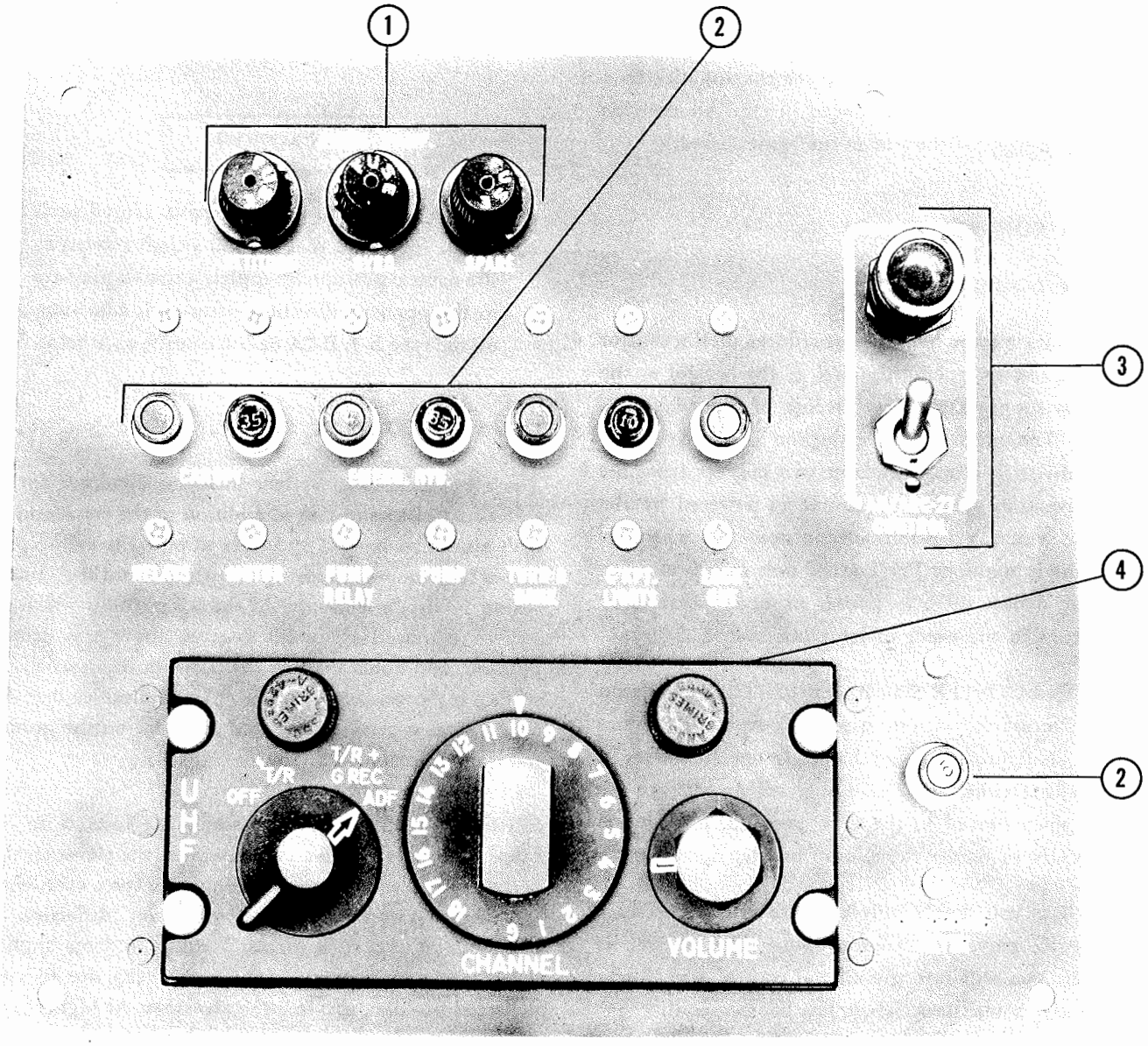
Figure 1-18



REAR COCKPIT, RIGHT FWD

1. AN/AIC-10 COMBAT INTERPHONE PANEL
2. COCKPIT LIGHT RECEPTACLE
3. CANOPY OPEN SWITCH
4. CANOPY PART CLOSE AND FULL CLOSE SWITCH
5. EMERGENCY HYDRAULIC PUMP SWITCH
6. SIDE PANEL RED LIGHTS RHEOSTAT
7. INSTRUMENT PANEL RED LIGHTS RHEOSTAT
8. INSTRUMENT PANEL ULTRA-VIOLET LIGHTS RHEOSTAT
9. RADIO PANEL LIGHTS RHEOSTAT
10. BATTERY AND GENERATOR SWITCH
11. STARTER SWITCH
12. IGNITION SWITCH

Figure 1-19



REAR COCKPIT, RIGHT AFT

1. GYRO INSTRUMENT FUSES
2. RIGHT CIRCUIT BREAKERS
3. AN/ARC-27 RADIO CONTROL SWITCH
4. AN/ARC-27 RADIO CONTROL PANEL

Figure 1-20

SURFACE CONTROL LOCK. The surface control lock consists of a tubular bracket (figure 1-22) which may be attached to the rudder pedals and the control stick by a bolt and thumbscrew. It is stowed in clips on the side panel to the right of the seat in the front cockpit.

AILERON CONTROL SYSTEM.

AILERON BOOST SYSTEM.

The hydraulic aileron booster unit reduces aileron control forces without destroying the feel of the control as the pilot must supply about one-fifteenth of the total force required. The control force reduction is effective after the control stick is moved about two degrees from the neutral position. The booster unit is powered by the hydraulic system and is normally in operation whenever the engine is running. The booster unit incorporates an automatic bypass valve to permit manual operation of the ailerons in the event of hydraulic system failure.

AILERON BOOSTER SHUT-OFF LEVER. The aileron booster shut-off levers, one in each cockpit, (12, figure 1-6 and 13, figure 1-18), mechanically operate valves in series so that either lever will shut off pressure to the booster when moved to the OFF position. Both levers must be ON to render the aileron booster operative.

Inasmuch as you supply only one-fifteenth of the force required to move the ailerons when the booster is operating, you will find the aileron control stick forces greater and some slack when the booster is shut off.

AILERON TABS.

The tab on the left aileron is operated by an electric actuator and serves to trim the airplane laterally. The tab on the right aileron is ground adjustable only.

AILERON AND ELEVATOR TRIM TABS SWITCH.

The trim tab on the left aileron and the trim tabs on the elevators are electrically operated and are controlled by the same thumb switch (figure 1-21) at the top of the control stick. The switch is spring-loaded to neutral.

Moving the switch to the left (left wing down) or to the right (right wing down) operates the aileron tab. The position of the aileron tab can be seen from the cockpit.

CAUTION

Since sticking tab switches have caused accidents, be certain that the tab switch returns to the neutral position by applying thumb pressure in the opposite direction, after each actuation, on the type B-7, B-7A or B-8 control stick grips.

ELEVATOR CONTROL SYSTEM.

The elevator control system includes a bungee spring and a pair of spring tabs in addition to the conventional trim tabs. The bungee spring is installed to tailor stick forces to pilot requirements. On the ground the bungee spring holds the elevators in the up position when the surface is raised about 20 degrees above the neutral position, and holds them in the down position when the surface is moved below neutral. You will notice that this action gives a peculiar feel to the control on the ground but is unnoticeable in flight.

SPRING TABS. These tabs, which are located on the inboard corners of the elevator, reduce the elevator stick forces. They deflect in proportion to the force exerted on the control stick until the maximum deflection is obtained. At low stick forces, there is no force applied directly to the elevators, as the spring tabs, due to their deflected position, displace the elevators. At higher stick forces, they remain fully deflected (thus reducing the forces required) and the stick force is then applied directly to the elevator through the horn assembly and torque tube.

ELEVATOR TRIM TABS.

The elevator trim tabs are located outboard of the spring tabs and are operated by an electric actuator. In addition to electric operation, automatic servo operation is incorporated to aid in reducing elevator stick forces.

AILERON AND ELEVATOR TRIM TAB SWITCH.

Pushing the tab switch forward (nose down) or aft (nose up) operates the elevator tabs.

CAUTION

Since sticking tab switches have caused accidents, be certain that the tab switch returns to the neutral position by applying thumb pressure in the opposite direction, after each actuation, on the type B-7, B-7A or B-8 control stick grips.

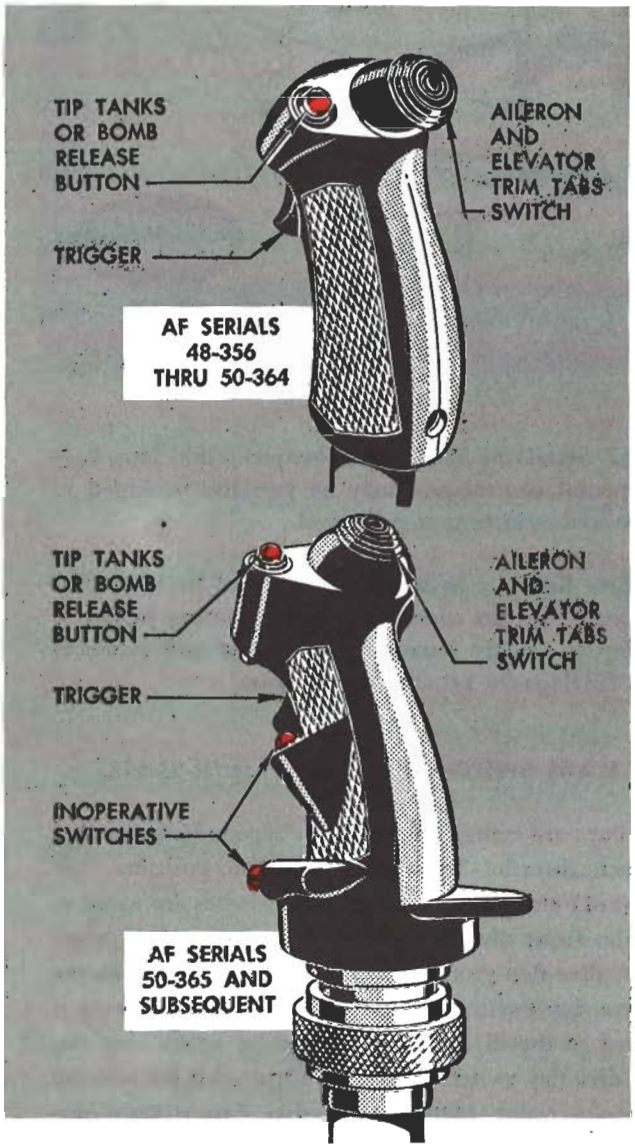


Figure 1-21

ELEVATOR TRIM OVERRIDE SWITCH.

(AF Serials 53-5466 and subsequent.) The elevator trim tab override switch located on the left shelf in the front cockpit just outboard of the throttle and on the left shelf in the rear cockpit just aft of the throttle, is provided to permit overriding the trim button on the control stick grip. When the override switch is in the OFF position, d.c. power to the trim button is disconnected. The switch is spring-loaded to the OFF position from two momentary positions NOSE UP and NOSE DOWN. When the switch is in the NORM position the d.c. circuit is completed to the aileron and elevator trim button on the control stick grip for normal operation.

ELEVATOR TABS NEUTRAL INDICATOR LIGHT.

A green light on the center instrument pedestal (35, figure 1-5 and 32, figure 1-17) glows when the elevator trim tabs are in the neutral position.

RUDDER CONTROL SYSTEM.

RUDDER. The rudder and its controls are entirely conventional.

RUDDER PEDALS. The rudder pedals may be adjusted fore and aft by releasing the adjustment lock lever on the outboard side of each pedal. When the adjustment lock levers are moved outboard spring action moves the rudder pedals toward the pilot. By holding the levers in the unlocked positions, slight foot pressure will serve to adjust the rudder pedals for the desired leg length.

RUDDER TAB. A bend tab is installed on the rudder and is ground adjustable only.

WING FLAPS.

GENERAL. The wing flaps are actuated by two electric motors mechanically inter-connected by a flexible shaft so that if one motor fails the remaining motor will actuate both flaps. Retraction and extension time will be slightly increased when only one motor is operative. There is no emergency method of operating the flaps.

WING FLAPS CONTROL.

The wing flaps are controlled by the switch, or lever (6, figure 1-6 and 16, figure 1-18), on each left shelf. It has three positions: UP, OFF (center), and DOWN. The flaps may be stopped in any intermediate position by moving the control to the OFF (center) position.

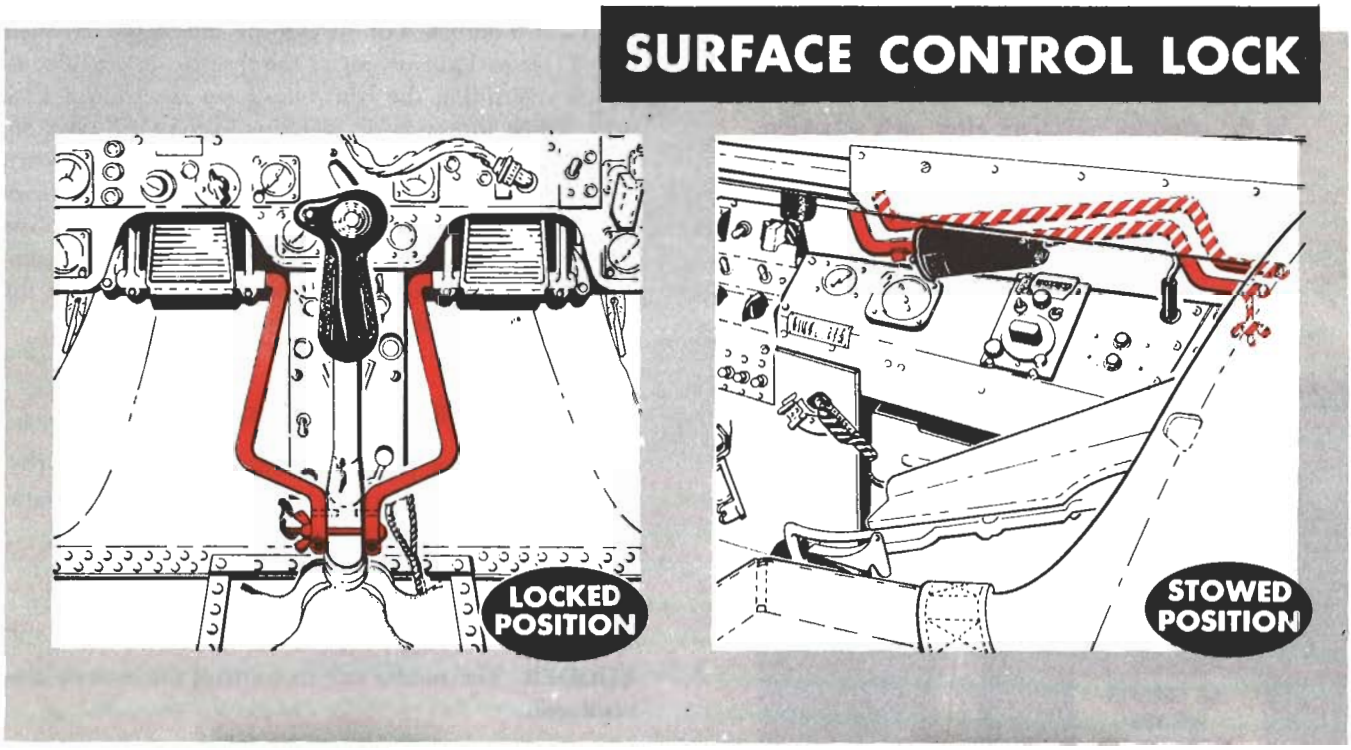


Figure 1-22

WING FLAP POSITION INDICATOR.

The wing flap position indicator is located on each left shelf (figure 1-23). (AF Serials 48-356 thru 50-384.) It shows the position of the flaps in percentage of travel from 0 to 100%. At full flap extension the instrument will indicate 100%. The wing flap position indicator on late airplanes (AF Serials 50-385 and subsequent) is located on each instrument panel (45, figure 1-5 and 40, figure 1-17) and shows flap position in degrees from zero to 45°. The instrument will indicate 45° when flaps are fully extended. Seventy percent flaps (used for take-off) is equal to 31.5°.

DIVE FLAPS (SPEED BRAKES).

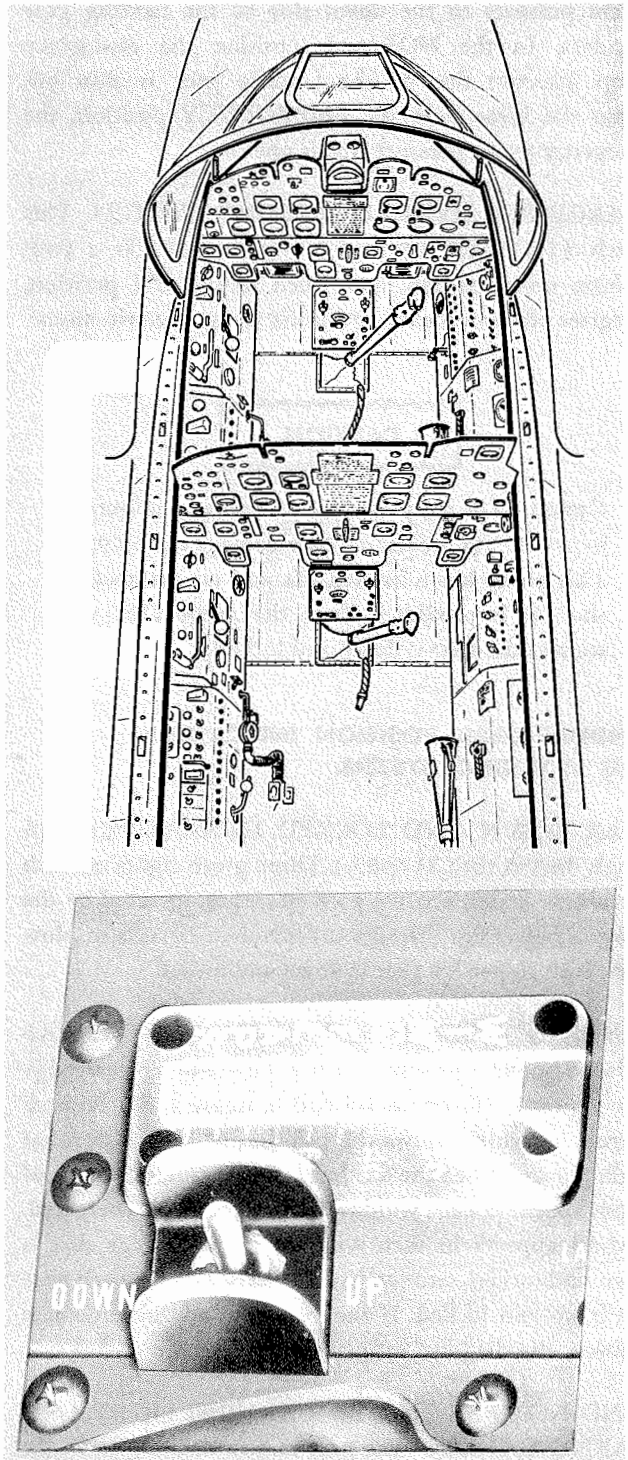
GENERAL. The dive flaps are a drag increasing device used for reducing speed in a dive or any other flight attitude where reduction of speed is desired. The dive flaps may be used at any airspeed and the direction of flap travel may be reversed at any time. On some early unmodified aircraft the dive flaps extend 45 degrees, while on later modified aircraft the extension travel is 60 degrees. Deceleration and pitch-up tendency are noticeably increased with the 60 degree extension. On AF Serials prior to 53-5286 no partial or intermediate extension of the flap is possible; they must be full up or full down.

On AF Serials 53-5286 and subsequent the flaps have incremental control and may be partially extended to any desired increment of full travel.

The dive flaps are hydraulically actuated by individual cylinders. The pin connecting each actuating piston to the flap is quickly removable to permit safe access to lower fuselage for ground maintenance.

DIVE FLAPS SWITCH. (Prior to AF Serial 53-5286.)

Dive flaps are controlled by a slide type switch mounted on each throttle. The switch has two positions, UP (forward) and DOWN (aft). The switches are wired so that the front dive flap switch is operative only when the aft dive flap switch is in the UP position. When the aft dive flap switch is in the UP position d.c. power is directed to the dive flap valve actuator motor thru the front dive flap switch. When the flaps reach the selected position a rotary switch in the dive flap actuator disconnects the power. When the aft switch is in the DOWN position power is directed to the down side of the dive flap actuator. For solo flight the aft switch must be in the UP position in order to control the dive flaps from the front cockpit.



(AF SERIALS PRIOR TO 50-385)

WING FLAP POSITION INDICATOR

Figure 1-23

DIVE FLAPS SWITCH. (AF Serials 53-5286 and subsequent.)

Later airplanes incorporating incremental dive flap control, have a three position thumb switch on top of each throttle (1, figure 1-6 and 6, figure 1-18). The switch positions are UP (forward), OFF (center), and DOWN (aft). The switches are wired so that the front cockpit has control only when the aft switch is in the UP position. When the aft switch is in the UP position, d.c. power is directed to the toggle of the front switch and the flaps travel in the direction selected by the front switch. When the aft switch is in the OFF position, power to the valve actuator solenoid is cut off and the spring-loaded hydraulic valve returns to the neutral position and flap travel is stopped. When the aft switch is in the DOWN position, power is directed to the valve actuator down solenoid and the flaps go down regardless of the position of the front switch.

LANDING GEAR.

GENERAL. The tricycle landing gear and wheel well doors are hydraulically actuated and are controlled by a lever on the left side of each cockpit. The main gears retract inboard and the nose gear retracts aft. All gears are provided with uplocks and downlocks. The nose wheel is equipped with a shimmy damper and is turned by differential main wheel braking. An electrically operated indicator and warning system is provided. Movement of the gear control lever to the UP position while the weight of the airplane is on the gear is prevented by the solenoid lever lock (figure 1-24). An emergency hydraulic system is provided to extend the gear in case of failure of the main hydraulic system.

EMERGENCY EXTENSION SYSTEM. The emergency extension system consists basically of an electrically-driven pump, a separate reservoir, a selector valve, a set of "down" lines to the gear actuating cylinders, and emergency landing gear door release cylinders. The landing gear cannot be retracted by the emergency system and because of the limited fluid supply, only one complete extension of the gear is possible.

CAUTION

The landing gear can be collapsed after an emergency extension by actuating the Landing Gear Lock Release and raising the control lever to the UP position, but fluid may be dumped in the plenum chamber causing a fire hazard if the engine is running.

LANDING GEAR SAFETY CLIPS. Clips are provided to be fastened on the downlock cartridge of each gear when the aircraft is parked. When they are installed the gear cannot be retracted by any means. Always check that the gear handle is down in the cockpit before removing the clips because it is possible to remove the clips when the gear is unsafe. If the landing gear lever is in the UP position and pressure is up, the gear will collapse. Long red streamers are attached to the clips to attract the pilot's attention during his walkaround inspection.

LANDING GEAR CONTROLS.

LANDING GEAR CONTROL LEVER.

The landing gear is controlled by the levers (11, figure 1-4 and 7, figure 1-12) located on each left side panel. The levers are mechanically interconnected so that both will be in the same positions at all times. The lever is held in either the UP or DOWN position by a spring-loaded lock which must be released before moving the lever by thumb pressure on the button at the end of the lever. This lever must be in the DOWN position before the gear can be extended by the emergency system so fluid can be returned from the UP side of the cylinders. A solenoid lock, operated by the scissors switch on the left main gear strut, prevents movement of the landing gear control lever to the UP position while the main strut is compressed.

LANDING GEAR LEVER LOCK RELEASE. The landing gear control lever solenoid lock may be released if necessary by actuating the lever lock release (figure 1-24), and raising the control lever simultaneously.

EMERGENCY HYDRAULIC SYSTEM SELECTOR LEVER. Either emergency hydraulic system selector lever (7, figure 1-4 and 6, figure 1-12) mechanically operates the valve that directs emergency hydraulic system pressure to the down side of the landing gear cylinders. In the NORMAL position the emergency pump pressure line to the landing gear is shut off. When the lever is in the EMERGENCY position, the emergency pump pressure line is open.

EMERGENCY HYDRAULIC PUMP SWITCH. This switch (14, figure 1-9 and 5, figure 1-19) is a two-position on-off switch, and when in the ON position, energizes the emergency hydraulic pump electric motor.

CAUTION

Operation of the pump for more than 3 minutes in any 20 minute period may damage the pump. This pump has a limited life and no automatic shut-off is provided. Turn the pump OFF as soon as the gear is down and locked.

LANDING GEAR POSITION INDICATORS AND WARNING SYSTEM.

GEAR DOWN AND LOCKED INDICATORS. (AF Serials 48-356 thru 51-6587.) Three green lights on each instrument panel, one for each gear, are operated by the downlock switches through independent circuits to glow when each respective gear is down and locked.

LANDING GEAR POSITION INDICATOR. (AF Serials 51-6588 and subsequent.) The landing gear position indicator (6, figure 1-5 and 6, figure 1-17) on each instrument panel, shows the position of each individual landing gear. When the d.c. bus is not energized, diagonal stripes appear in each window. When the bus is energized, a wheel appears in each window for each gear that is down and locked, and the word UP appears for each gear that is up and locked. If the gear is at any intermediate position, the diagonal stripes appear.

LANDING GEAR UNSAFE WARNING LIGHT AND WARNING HORN. The gear unsafe warning red light (7, figure 1-5 and 7, figure 1-17) glows whenever the landing gear is not down and locked or not up and locked. The warning horn sounds whenever the throttle is retarded below the position for 65% (±5%) power, and the landing gear is not down and locked. The landing gear warning horn cut-out button (8, figure 1-6 and 14, figure 1-18) is provided on each left shelf to silence the horn when desired; however, the throttle switch will be automatically reset each time the throttle is advanced.

LANDING GEAR CONTROL MECHANISM

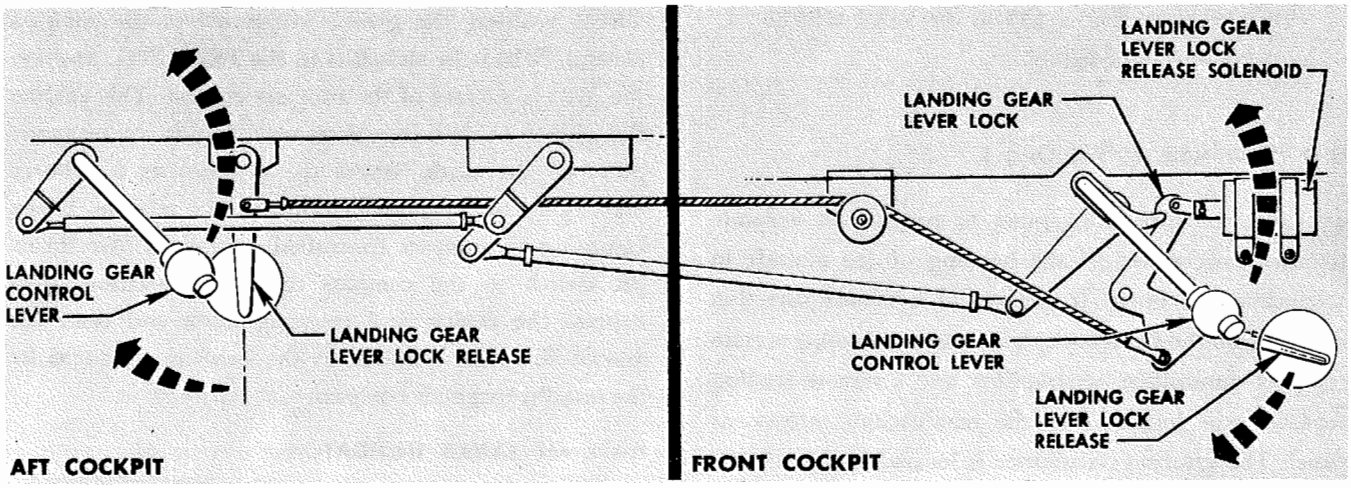


Figure 1-24

BRAKES.

GENERAL. The brake system is an independent, manually operated hydraulic system. The brakes are operated by the conventional toe pedals. No emergency braking provisions are provided.

PARKING BRAKE HANDLE.

The parking brake handle in each cockpit (36, figure 1-5 and 33, figure 1-17) is provided to set the brakes for extended periods. When applying the parking brakes it is necessary to apply toe pressure first and then pull out the handle to set the brakes. Brakes are released by applying toe pressure momentarily to both pedals and releasing.

CAUTION

If the handle is pulled out before toe pressure is applied, damage to the brake piston seal will result.

INSTRUMENTS.

SLAVED GYRO MAGNETIC HEADING INDICATOR.

The gyro compass consists fundamentally of a direction indicator (13, figure 1-5 and 12, figure 1-17) electrically connected to a transmitter which serves as a magnetic compass. The compass heading is indicated by the single needle of the indicator. The compass is powered by the inverters and is on whenever the inverters are on. Three minutes are required for the gyro to come up to speed after power is supplied.

After the gyro has attained operating speed, the indicator must be checked against the stand-by compass to see that the indicator does not show a 180° ambiguity. If a 180° ambiguity is present, the compass is not functioning properly.

GYRO COMPASS FAST SLAVING BUTTON.

(AF Serials 52-9635 and subsequent.)

The fast slaving button mounted on the front instrument panel (20, figure 1-5) provides a means of fast erection if the gyro tumbles during maneuvers. Pushing the fast slaving button momentarily interrupts d.c. power to the gyro and starts the fast slaving cycle as in initial starting.

CAUTION

- The fast slave button is placarded against using more than once in ten minutes, as more frequent use will cause damage to the erection mechanism.

- It is imperative that both airspeed and heading remain constant as long as the gyro system is in "Fast Slave." If take-off is started or turns are made while slaved gyro is in the "Fast Slave" cycle, a 20° to 40° error will be introduced immediately.

G-2 COMPASS. (TV-2 Only.)

The G-2 compass is designed to provide an accurate stabilized indication of the heading of the aircraft in azimuth at all times. It consists of a master direction indicator on the front cockpit instrument panel, a remote compass transmitter, an amplifier and a remote reading repeater type indicator on the rear cockpit instrument panel. The compass transmitter is located in the tail section where magnetic disturbances are at a minimum. It detects the magnetic heading of the aircraft and transmits it electrically to the master direction indicator. It operates from a 115-volt, 3-phase, 400-cycle, a.c. power source. A 26-volt d.c. power supply is also required.

The operation of the compass is not affected by maneuvers which the aircraft may be expected to perform. These maneuvers include banks and rolls which are beyond the limits of conventional directional gyros. The gyro should be started by turning the battery switch on at least 5 minutes before an accurate reading is required. For moderate temperatures, 3 minutes is sufficient for the gyro motor to reach full speed, but at very low temperatures up to 15 minutes may be necessary. Readings should not be taken before the motor has had sufficient time to reach full speed. For this reason it is usually desirable to start the gyro in operation prior to take-off of the aircraft. After the battery switch has been turned on for 3 minutes, the initial setting may be made. This is done by depressing the resetting knob on the face of the instrument and setting the master direction indicator dial to the heading of the aircraft as indicated by the standby magnetic compass. From this approximate heading the master direction indicator will align itself to indicate the correct magnetic heading of the aircraft. The indication will become accurately stabilized in a short period, up to 2 minutes, depending on the accuracy of the initial setting.

G-2 COMPASS CONTROL SWITCH. The G-2 compass switch (figure 1-25), located on the front cockpit instrument panel just above the master indicator has two positions. When the switch is in the COMPASS CONTROL position, the gyro is connected to the compass control. When the switch is in the FREE D.G. position the gyro is set free of the compass control. This enables the gyro to be used in regions very close to the magnetic poles of the earth, where the compass as a primary detector of the azimuth direction is not reliable. When returning to compass controlled operation, first throw the switch to the compass controlled position, then depress the caging and resetting knob and reset the master direction indicator to the heading indicated by the standby magnetic compass.

RATE OF CLIMB INDICATOR.

The rate of climb indicator located on each instrument panel (39, figure 1-5 and 36, figure 1-17) is used to indicate the vertical component of airplane speed, based on the rate of change of atmospheric pressure. The indicator is a direct reading pressure instrument requiring no electrical power for operation.

ALTIMETER.

Three altimeters are installed, one on each instrument panel (3, figure 1-5 and 3, figure 1-17) to indicate airplane altitude, and one on the right side of the front cockpit which indicates cabin pressure in terms of altitude. These instruments are direct reading pressure instruments requiring no electrical power for operation.

TURN AND BANK INDICATOR.

A turn and bank indicator is located on each instrument panel (5, figure 1-5 and 5, figure 1-17). The indicators in each cockpit are supplied with 24-volt d.c. power through independent circuits. A circuit breaker is supplied for each circuit and when either is pulled out, power to its respective turn and bank indicator will be interrupted. Red warning lights (19, figure 1-5 and 18, figure 1-17) are provided on each instrument panel to indicate power failure to the instrument.

STANDBY MAGNETIC COMPASS.

The standby magnetic compasses (14, figure 1-5 and 15, figure 1-17), located on the left side of each instrument panel, are standard type magnetic compasses to be used as a check on the operation of the gyrosyn compass system or in event of an emergency.

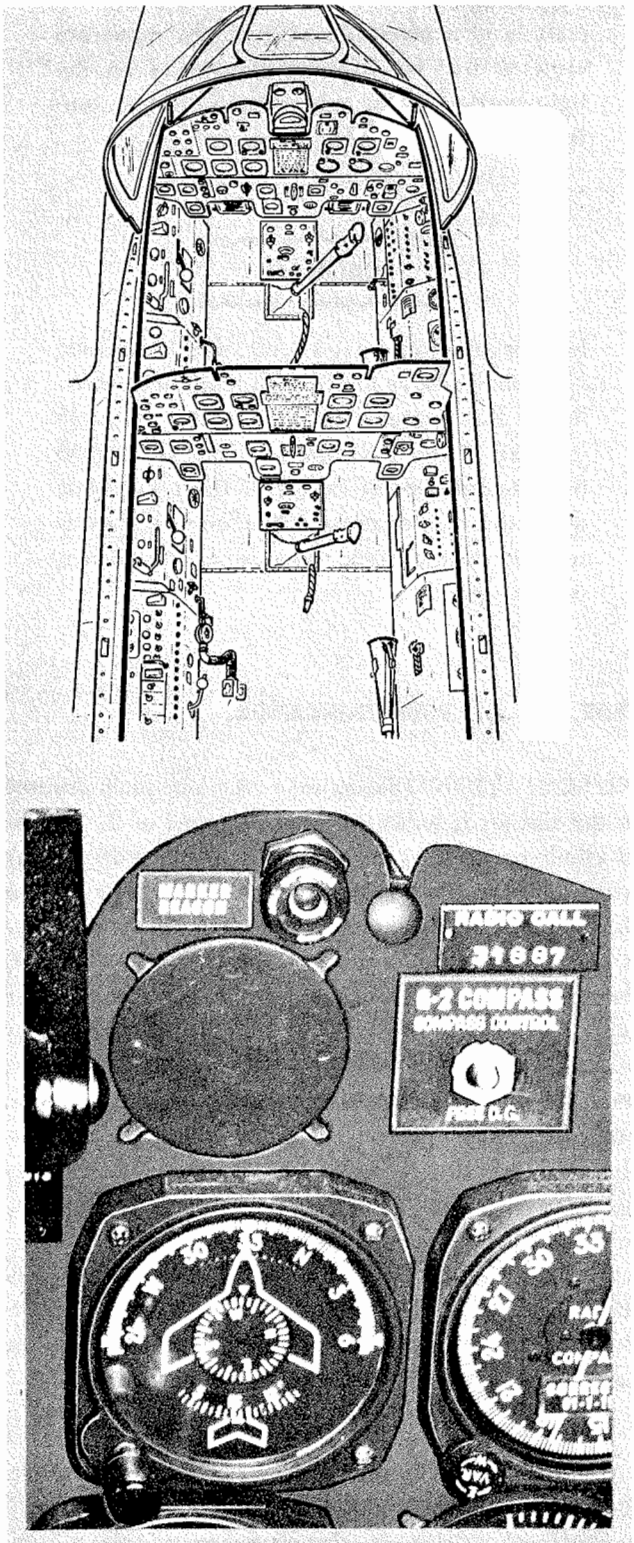


Figure 1-25

Note

The compass in the front cockpit may be as much as 10° in error when the heater blower is operating.

ATTITUDE GYRO INDICATOR.

A type J-3 attitude gyro indicator (figure 1-26) is installed in some airplanes and a type A-1 (A-2) or J-8 indicator in others. These instruments provide visual indication of any pitch and/or roll attitude. They operate on 115V 3-phase a.c. power supplied by the inverter. In these instruments the gyro is enclosed in a sphere, a portion of which is visible through the opening of the face of the instrument. The indications of these instruments may be confusing since the presentation of pitch differs. (See figure 1-26 and 1-27.)

1. A horizon bar on the A-1 and the J-8 present a conventional pitch indication with the miniature airplane appearing above the horizon bar in a climb and below the horizon bar in a dive. However, in a climb (or dive) exceeding 27 degrees of pitch, the horizon bar stops at the bottom (or top) of the instrument case and the sphere then becomes the reference.

Note

The main difference between the A-1 (A-2) and J-8 attitude indicators is that the J-8 has a manual caging control.

2. The J-3 indicator differs from conventional attitude indicators in that climb and dive are not shown in relation to a horizon bar but are read directly on a sphere. The upper hemisphere, which is dark in color, indicates a dive; the lower light hemisphere indicates a climb. Lines similar to latitude markers are painted on the sphere and indicate the amount (degrees) of pitch.

In addition, a sensitive pitch scale furnishes indications of climb or dive up to 10 degrees in one degree increments.

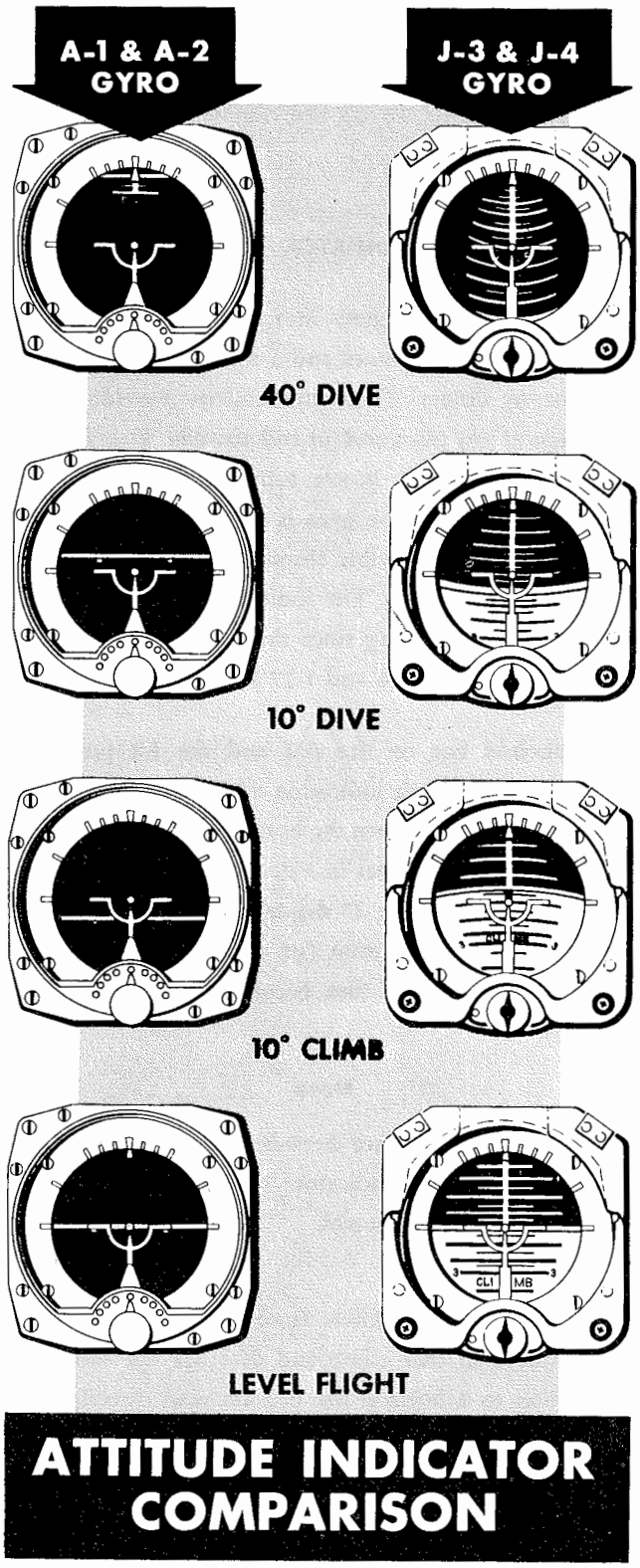


Figure 1-26

Note

The sphere is stabilized maintaining its equator parallel to the earth's surface and the aircraft (and miniature airplane) maneuvers around the stabilized sphere. Therefore, when the aircraft is in a nose-high attitude, the miniature airplane will be displaced downward on the light portion of the sphere and in a dive onto the dark portion of the sphere.

CAUTION

In some instances the A-1 (A-2) and J-3 attitude gyros may take as much as 13 minutes to erect. With the present inverter relay assembly installed in the T-33 aircraft prior to 51-9036 there is a danger of failure of the J-8 attitude gyro and J-2 compass when engine rpm is reduced below 50%, because of insufficient power supply.

TYPE J-8 ATTITUDE INDICATOR.

PRESENTATION. (See figure 1-27.) The pitch attitude of the aircraft is indicated within a range of 27 degrees in climb or dive by displacement of the horizon bar with respect to the adjustable miniature airplane. When the aircraft exceeds 27 degrees in pitch, the horizon bar is held in the extreme position and the sphere becomes the new reference. A continued increase of climb or dive angle approaching the vertical attitude is indicated by graduations on the sphere. When the aircraft approaches 90 degrees in pitch as it does during a loop, a controlled precession of 180 degrees occurs. This controlled precession should not be confused with tumbling or upsetting of the gyro. After completion of this precession, the indicator is completely operable. The attitude of the aircraft about the roll axis is shown by the angle between the miniature airplane and the horizon bar and also by the bank index relative to the degree markings on the bezel mask.

CHARACTERISTIC ERRORS. After a loop, displacement of the horizon bar in excess of five degrees in pitch and/or bank may result. This characteristic error is commonly called "sluggishness" or "lag." The J-8 indicator will immediately begin to correct these errors once true gravitational forces are sensed. If errors in excess of the aforementioned tolerance are encountered, the instrument should be replaced.

CAGING. The J-8 attitude indicator may be caged manually by means of a gyro centering device operated by pulling the cage knob. To cage the gyro, the Pull to Cage knob should be drawn smoothly away from the face of the instrument. (A violent or hard pull will damage the instrument). The force of the pull required to operate the caging knob varies sharply during travel. If caging is not done smoothly and gently, the instrument may be damaged by abrupt reactions. As soon as the knob reaches the limit of its travel, it should be released quickly.

Note

A check to determine whether the caging mechanism has completely released can be made by pushing the caging knob against the instrument case after it has been released. If further travel is evidenced and/or precession of the gyro noted, the caging mechanism is not releasing properly or the erection mechanism is malfunctioning. Failure of the caging mechanism to release completely may result in tumbling of the gyro in maneuvers.

The manual caging device on the J-8 attitude indicator serves a twofold purpose.

1. It provides a means for quickly erecting the gyro for scramble take-off. For scramble take-offs, when quick erection is necessary, allow 30 seconds after power is applied to instrument for the gyro to attain speed, then cage the instrument immediately thereafter, to prevent unnecessary torque stresses on the instrument mechanism. The caging feature eliminates the necessity of applying ground power to aircraft on alert to keep the instrument erected.

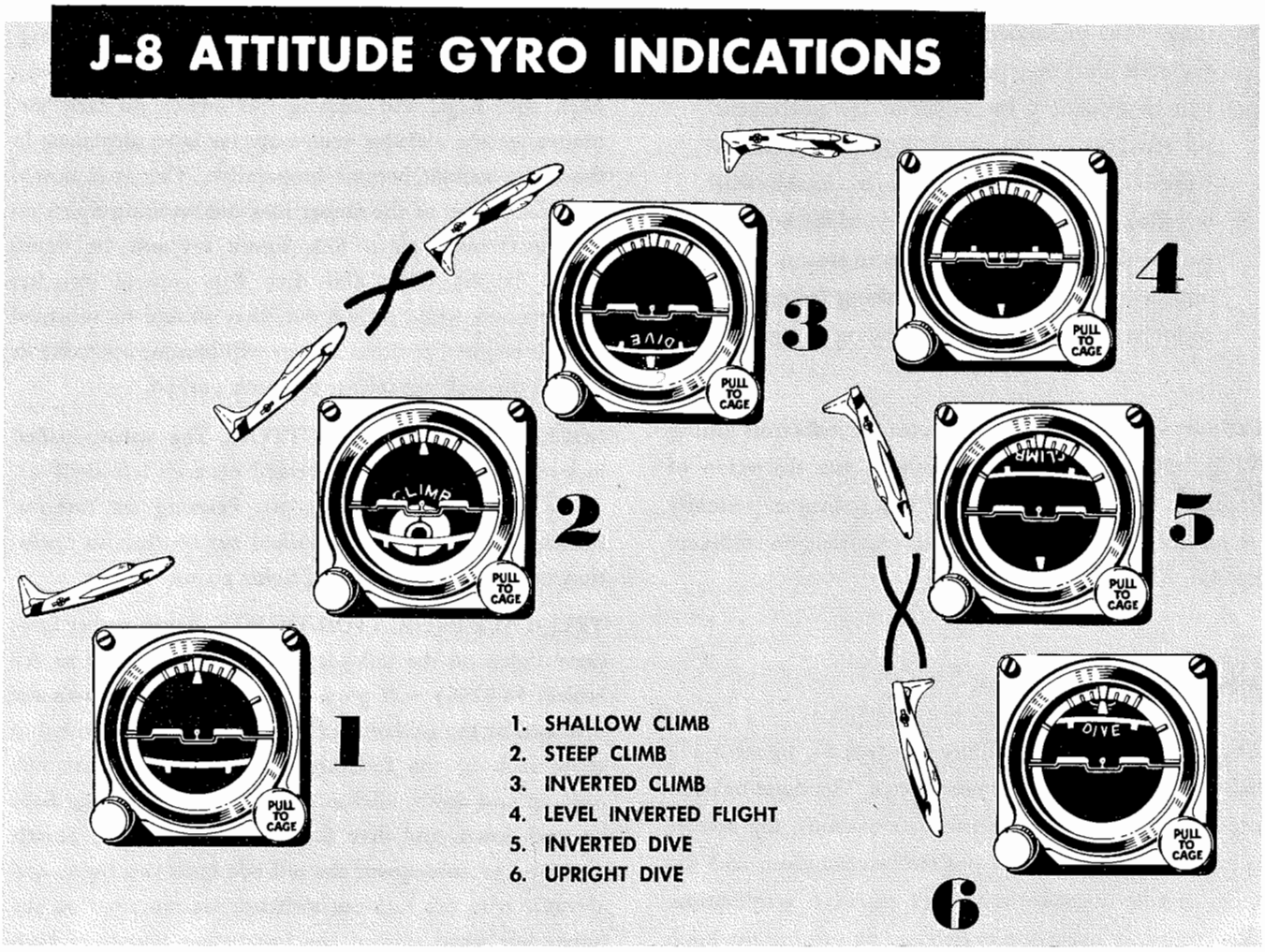


Figure 1-27

2. It provides a means for erecting the gyro when in-flight characteristic errors are induced by turns or acrobatics. In these instances, it is essential that the pilot realize that the indicator cages to the attitude of the aircraft and not to the true vertical. Therefore, the instrument should never be caged to correct in-flight errors unless the aircraft is in straight and level flight by visual reference to a true horizon.

CAUTION

Early production J-8 indicators incorporate ball bearings for engagement of the roll and pitch cams in the caging process. These bearings may break or fall off after excessively hard caging. Care is therefore required in caging the gyro. If there is any evidence of loose or broken bearings in the instrument, the indicator should be replaced immediately. Failure of these bearings will be evidenced by failure of the instrument to zero out when caged. Other deficiencies which render the instrument unserviceable will be reflected by excessive vibration of the horizon bar, by failure of the instrument to erect or level out, or by excessive errors resulting from turns or loops as outlined in the preceding paragraph.

Periodic flight checks of the J-8 attitude indicators during VFR conditions should be made at the discretion of Squadron Commanders, to insure that indicators presently in service meet the operational requirements reflected herein.

ACCELEROMETER.

The accelerometer (28, figure 1-5 and 26, figure 1-17) has three needles and a common scale. The outer or main needle indicates instantaneous accelerations, the middle needle records maximum positive acceleration, and the inner needle records maximum negative acceleration. The recording needles may be reset by turning the knob at the lower left corner of the instrument.

STUDENT LOCK-OUT CONTROL AND TELL-TALE INDICATOR LIGHT BOX.

(Prior to AF Serials 53-5286).

The lock-out control and indicator light box (figure 1-28) may be installed in either cockpit but will usually be installed in the rear cockpit. The box contains seven amber indicator lights and an electrical controls lock-out push button. On USAF Serials 53-5286 and subsequent, the control box, which the instructor could connect in either cockpit is deleted. In lieu thereof, the tell-tale indicator light system and lock-out feature of only the elevator trim tab are incorporated as permanent installations in both the forward and the aft cockpits. All other previous provisions of the control box, including lock-out of aileron trim tab, dive flaps, wing flaps and fuel sequencing circuits are eliminated.

STUDENT LOCK-OUT BUTTON. The lock-out control is located on the lock-out control box on early airplanes and on the instrument panel (1, figure 1-5 and 1, figure 1-17) on later airplanes. When the spring-loaded lock-out button is pushed, the trim tabs, wing flaps, dive flaps, and starting fuel switch on early airplanes, or the elevator trim only on later airplanes, in the other cockpit become inoperative. This is indicated by illumination of the amber lock-out warning lights on each instrument panel (21, figure 1-5 and 19, figure 1-17). If the wing and dive flap control switches are operated while locked out, they should be returned to their original position as they will become operative as soon as the lock-out release button is pushed.

LOCK-OUT RELEASE BUTTON. The spring-loaded lock-out release button is located on each left shelf (2, figure 1-7 and 19, figure 1-18). Pressing the lock-out release button restores the locked out controls to operation and the lockout warning lights go out.

TELL-TALE INDICATOR LIGHTS. Seven amber indicator lights on the tell-tale indicator box (Prior to AF Serials 53-5286) will glow when electrical controls are operated by the student. An indicator light is provided to show each of the following operations: Elevator tab nose up and down, aileron tab right and left, wing flaps up and down, and dive flaps down. On USAF Serials 53-5286 and subsequent the tell-tale indicator lights and elevator trim tab lock-out switches are mounted on the upper left hand side of the instrument panels of both cockpits.

WARNING

Check that the wing flap switches (Prior to AF Serials 53-5286) and the dive flap switches in both cockpits are in the same position and that the flaps are in the same position as the switches before pushing the lock-out release button or unexpected operation of the flaps may result.

(AF SERIALS PRIOR TO 53-5286)

TELL-TALE INDICATOR LIGHT BOX

Figure 1-28

OVERHEAT AND FIRE WARNING LIGHTS.

A tail section overheat warning light (amber) and plenum chamber fire warning light (red) (29, 24, figure 1-5, and 27, 22, figure 1-17) are located on the instrument panel. The overheat light is operated by any one of several thermoswitches located in the tail section and in the area from front engine seal to combustion cans. Normally, operation of the overheat light is an overtemperature warning which may indicate a fire, or may be just an overheat condition. A dimly blinking light or a bright light indicates a short circuit. The fire warning light is operated by thermoswitches in the plenum chamber (engine accessory section) and any overtemperature in this area would indicate a fire. Refer to Section III for procedure to be followed if the lights come on.

CAUTION

The lights may come on because of a short circuit.

CIRCUIT TEST SWITCH. The circuit test switch in the front cockpit (30, figure 1-5) is provided to permit testing the entire overheat and fire warning wiring up to, but not including, the thermoswitches. The switch has two positions: NORMAL and TEST. When pushed to the TEST position, both warning lights should come on, indicating that the wiring is operative. The light filaments are checked by the standard push-to-test procedure.

CANOPY. (Refer to figure 1-29)

A single bubble-type canopy is used to cover both stations. The canopy is hinged at the aft end and is raised or lowered by an electrically actuated jack shaft located between the seats. Upon closing, the canopy seal is inflated by engine air pressure to seal the canopy frame against the cockpit sill and windshield. An explosive catapult is provided to jettison the canopy in an emergency. While on the ground, a red-flagged safety pin (figure 2-1) is installed to prevent inadvertent firing of the catapult. On later airplanes, (AF Serials 52-9335 and subsequent), an initiator located on the right canopy sill is provided to fire the catapult. On these airplanes the red-flagged safety pin is installed in the initiator (figure 2-1). The canopy ground safety pin must be removed before flight.

CANOPY CONTROLS. Interior and exterior controls are provided to open and close the canopy electrically or mechanically and to jettison it in an emergency. An interior locking lever is provided to keep the canopy closed and locked in flight. Controls consist of an OPEN switch, a PART CLOSE and FULL CLOSE switch, a manual handcrank, a jettison lever and an interior locking handle. The jettison controls unlock the canopy when operated. There is no way of unlocking the canopy from the outside except by pulling the jettison cable which will unlock as well as jettison the canopy, providing the canopy is in the closed position.

CANOPY OPEN SWITCH. The canopy OPEN switches, (10, figure 1-9 and 3, figure 1-19) are located on the right shelf in each cockpit and in the external well (figure 1-30) on the right side of the fuselage. The switches are wired in parallel so that any switch will operate the canopy. All switches are spring loaded to the OFF position. The external switch is wired directly to the battery so that it will operate when the battery switch is OFF. Hence, when it is in the OPEN position the d.c. bus is energized, thus it has the same effect as turning the battery master switch ON.

CAUTION

If the external canopy OPEN switch is used while an external power supply is connected and ON, it will parallel the airplane batteries with the external power source and probably damage the airplane batteries.

CANOPY PART CLOSE AND FULL CLOSE SWITCH. Canopy closing switches are located next to the canopy OPEN switches (11, figure 1-9 and 4, figure 1-19) in each cockpit and in the external well (figure 1-30). Each switch has three positions: PART CLOSE, center OFF and FULL CLOSE and is spring-loaded to OFF. Canopy closing is designed to require partial closing before fully closing in order to prevent one crew member from fully closing the canopy before the other crew member is clear. After the canopy reaches the part closed position the switch is moved to the FULL CLOSE position after checking that the cockpit sills in both cockpits are clear.

CAUTION

If the external PART CLOSE and FULL CLOSE switch is used while an external power source is connected and ON, it will parallel the airplane batteries with the external power source and probably damage the airplane batteries.

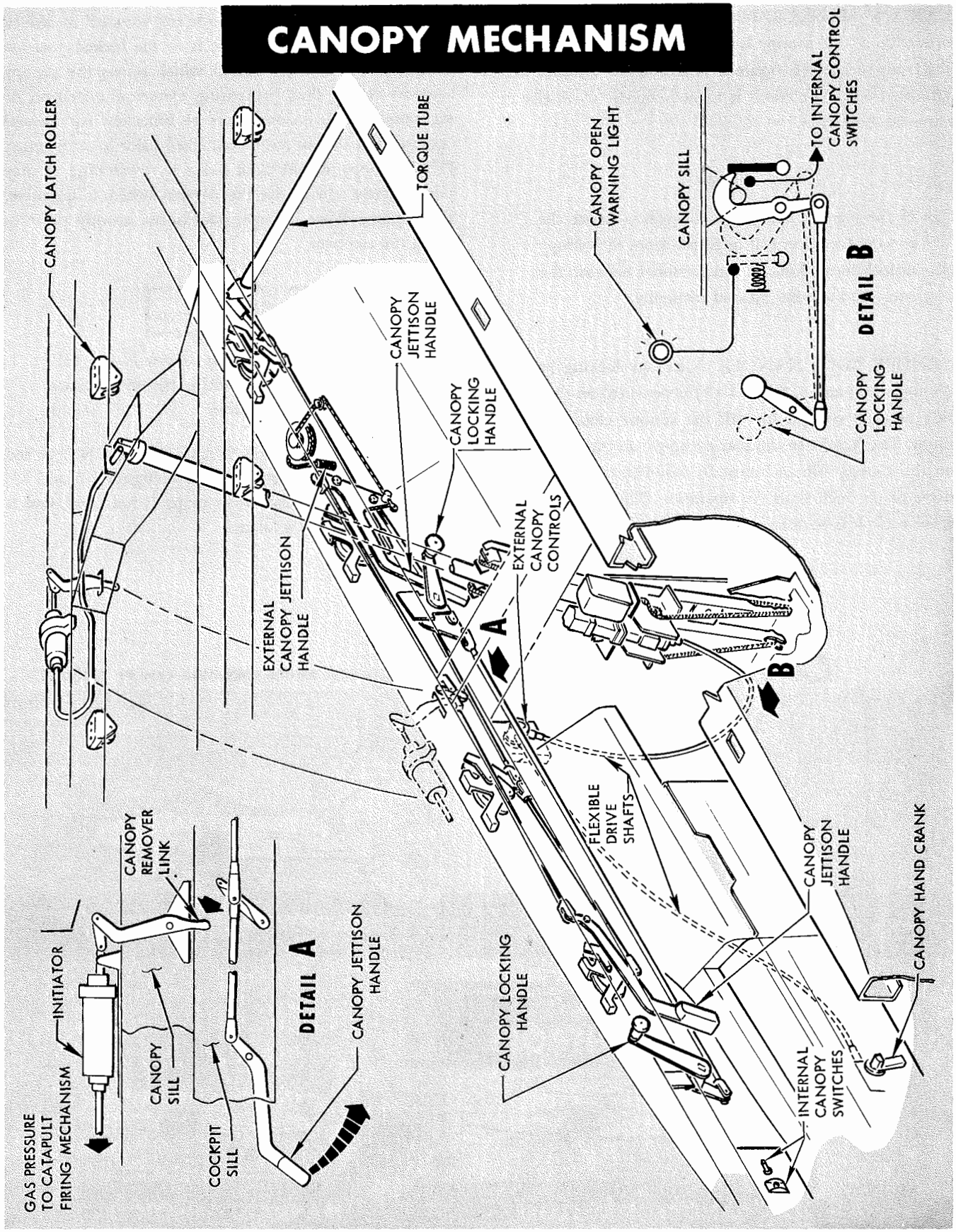

CANOPY MECHANISM
CANOPY LATCH ROLLER
TORQUE TUBE
CANOPY OPEN WARNING LIGHT
CANOPY SILL
TO INTERNAL CANOPY CONTROL SWITCHES
DETAIL B
CANOPY JETTISON HANDLE
CANOPY LOCKING HANDLE
EXTERNAL CANOPY JETTISON HANDLE
EXTERNAL CANOPY CONTROLS
A
B
FLEXIBLE DRIVE SHAFTS
CANOPY JETTISON HANDLE
CANOPY HAND CRANK
CANOPY LOCKING HANDLE
INTERNAL CANOPY SWITCHES
GAS PRESSURE TO CATAPULT FIRING MECHANISM
INITIATOR
CANOPY SILL
CANOPY REMOVER LINK
COCKPIT SILL
DETAIL A
CANOPY JETTISON HANDLE

Figure 1-29

CANOPY HANDCRANK. A handcrank for manual operation of the canopy is provided on the right side of the front cockpit (5, figure 1-4) and in the external well (figure 1-30). The crank is turned counter clockwise to close the canopy.

Note

If the canopy handcrank is used to lower the canopy from the full open position, the canopy uplock located on the crossmember between the cockpits must be released manually.

CANOPY LOCK HANDLE. A canopy locking handle (3, figure 1-4 and 3, figure 1-12) is provided on the right side of each cockpit to lock the canopy closed during flight. The handle in the rear cockpit is normally stowed on the canopy sill and must be installed on the square drive of the lock shaft for operation. The handle in the front cockpit is permanently mounted. The handle is rotated aft to lock and forward to unlock the canopy. When the handle is in the locked position it contacts an internal switch which opens the canopy actuator circuit thus preventing electrical operation of the canopy. The canopy must be unlocked for normal opening, but should not be unlocked prior to jettisoning. If the canopy is unlocked prior to jettisoning it may raise slightly and render the jettison system inoperative. The jettison lever linkage unlocks the canopy prior to firing the remover.

CAUTION

If the canopy lock handle is not in the fully unlocked position the entire canopy electrical system may be inoperative.

CANOPY UNLATCHED WARNING LIGHT. A red light on each instrument panel (16, figure 1-5 and 13, figure 1-17) glows when the canopy is unlocked, and is off when the canopy is locked.

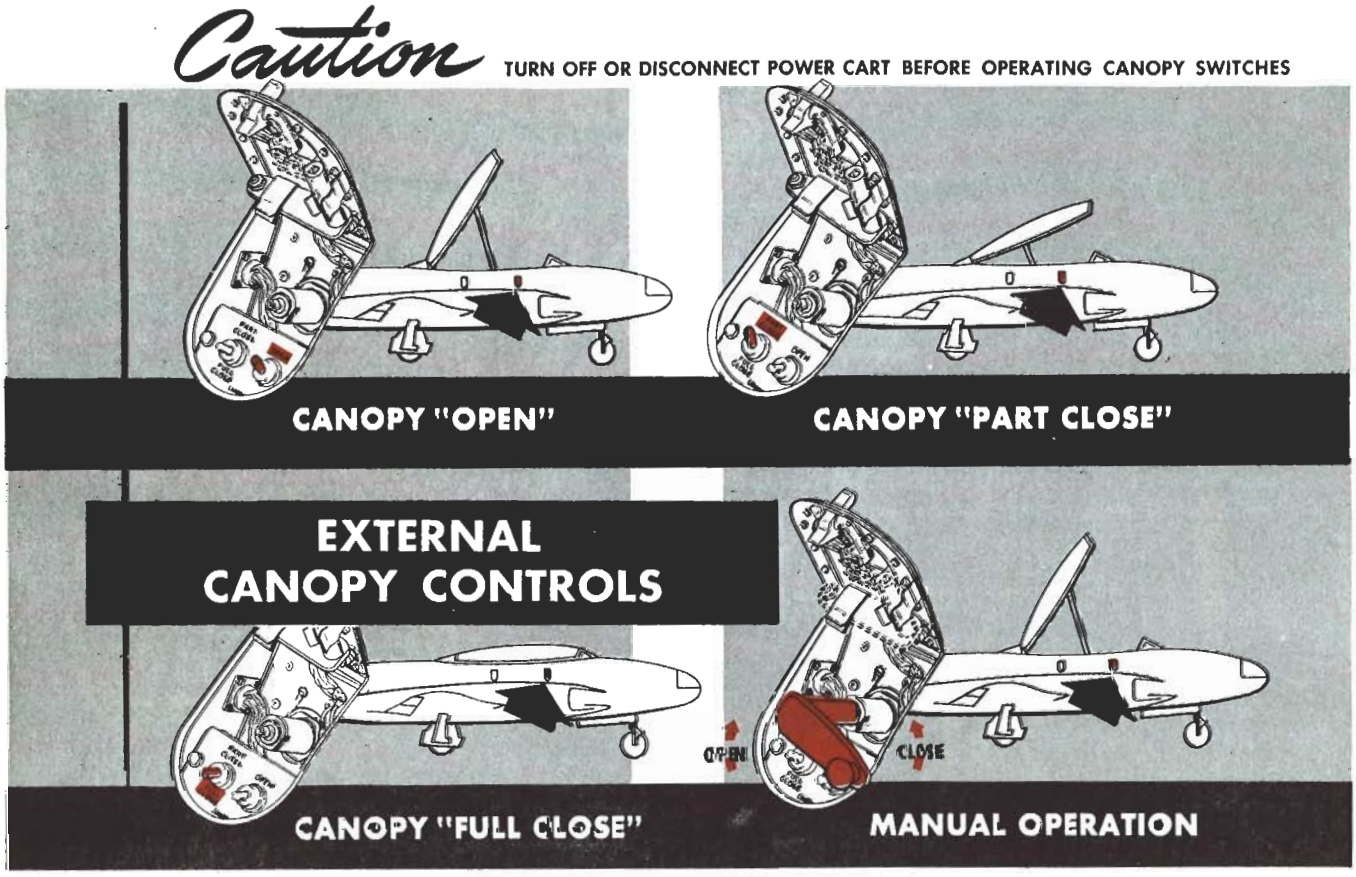


Figure 1-30

CANOPY JETTISON LEVER. Mechanically interconnected canopy jettison levers (4, figure 1-4 and 4, figure 1-12) are located on the right side of each cockpit. As either of the levers is pulled aft, a diagonal safety pin is pulled from the explosive canopy remover head, (AF Serials 51-4040 thru 51-9035), the canopy is unlatched, and the explosive canopy remover or initiator is fired. As the canopy moves from the full open to the breakaway position, a lever is tripped and cables attached to the lever pull the safety pins from the backs of the ejection seats (on early airplanes only). Normally, the canopy can only be jettisoned from the fully closed position. If no remover is installed, pulling the lever disconnects the canopy.

CAUTION

On AF Serials 52-9335 and subsequent, if the canopy jettison lever is moved from the normal stowed position, opening the canopy may result in inadvertent canopy jettison. If the jettison lever is displaced, return it completely to the stowed position before locking the canopy lock handle.

EXTERNAL JETTISON HANDLE. A handle attached to a coiled cable (figure 3-4) is stowed in the exterior well on the right side of the airplane to permit jettisoning of the canopy from the outside when the airplane is on the ground. The cable is provided to permit jettisoning from a safe distance.

BLIND FLYING HOOD. (AF Serials 53-5286 and subsequent.)

A vinyl coated nylon fabric blind-flying hood is installed over the pilots station in the rear cockpit to be used for instrument training. A plastic hoop and longitudinal cables are provided to permit sliding the hood fore and aft.

SEATS.

EJECTION SEATS. Both front and rear cockpits are equipped with ejection seats which, when actuated, will catapult the occupants clear of the tail surfaces at any speed or altitude. A catapult aft of each seat contains an explosive cartridge that supplies the propelling force for seat ejection. The seats are equipped with safety belts and inertia reel type shoulder harnesses. A multiple unit quick disconnect fitting is provided on the left side of the seats to automatically disconnect oxygen, radio and G suit lines when the seats are ejected. The seats are ejected by raising both arm rests and squeezing the trigger located on the front end of the right arm rest. When the right arm rest is raised it cocks the seat ejection trigger while raising the left arm rest locks the shoulder harness. One safety pin is installed (figure 1-31) in each seat to prevent inadvertent ejection while on the ground. These pins must be removed prior to flight. On early airplanes an interlock mechanism between the canopy and seat ejection systems is installed to prevent the seats from being ejected before the canopy has been jettisoned. On later airplanes, (AF Serials 51-9036 thru 53-5285), the seat catapult is fired by an initiator on the right side of the seat (figure 1-33) and is independent of all the canopy operation. The ejection controls and procedure are unchanged but there is no linkage between the canopy and seat remover, therefore, once the seat safety pin is removed for flight, there is no protection against inadvertently firing the seat while the canopy is in place. While on the ground the safety pin (figure 2-1) is installed in the initiator on these airplanes. It is good safety practice to get all settled in the seat before removing the safety pin and to install the pin before unfastening the seat belt and gear prior to leaving the seat.

WARNING

- It has been found possible to install the ground safety pin in the initiator in such manner that no protection is realized (figure 1-34). Since these airplanes have no interlock between the canopy and catapult, the seat safety pin is the only protection against inadvertent ejection. The safety pin engages an annular groove in the shaft when properly installed and practically no motion of the shaft is possible. However, if the shaft is pulled about 1/4 inch out of the initiator, the safety pin still can be installed with no protection gained, as the initiator can be fired with the safety pin installed in this manner.
- To avoid inadvertent ejection do not raise arm rests except for bail out.

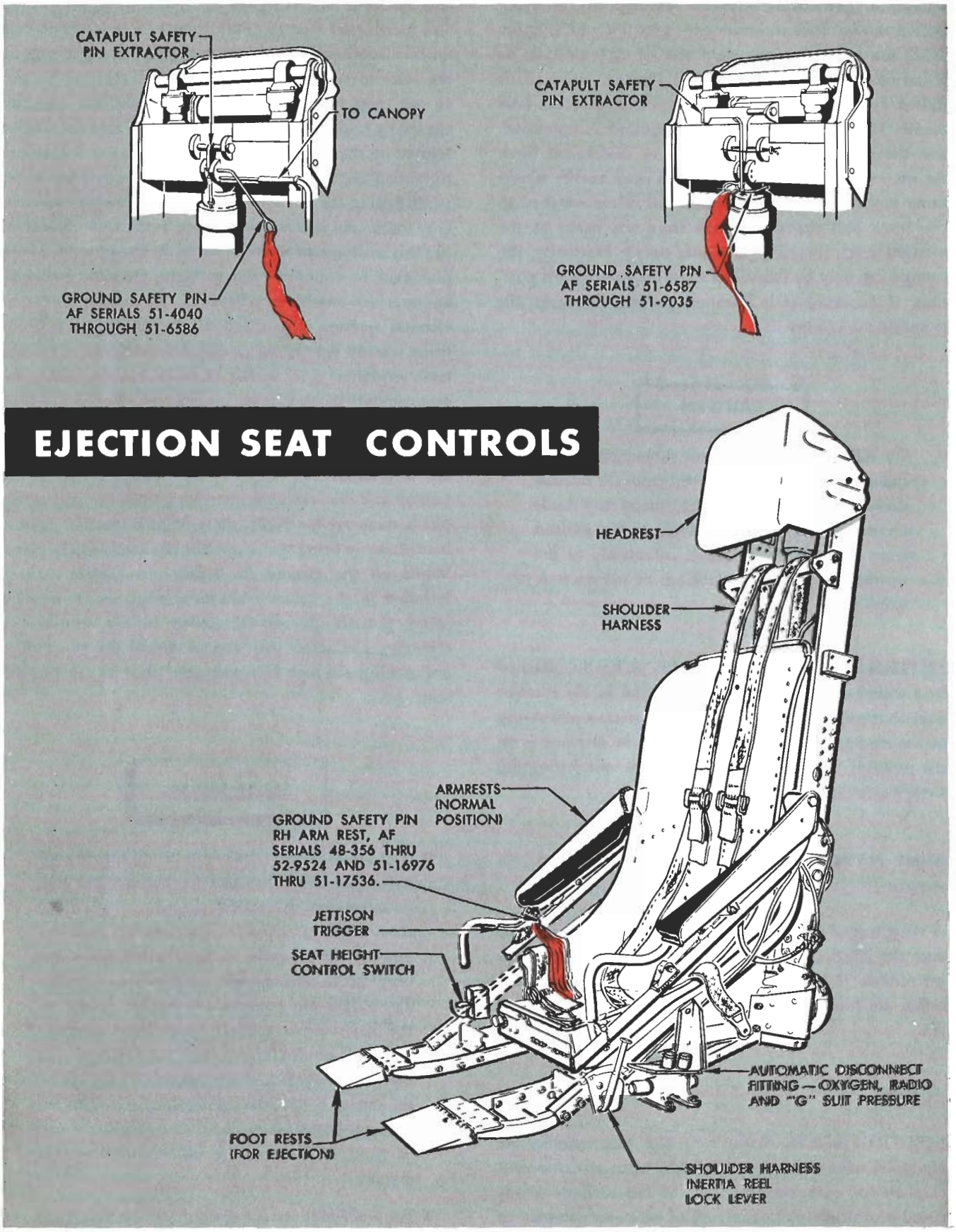


Figure 1-31. AF Serials Prior to 51-9036

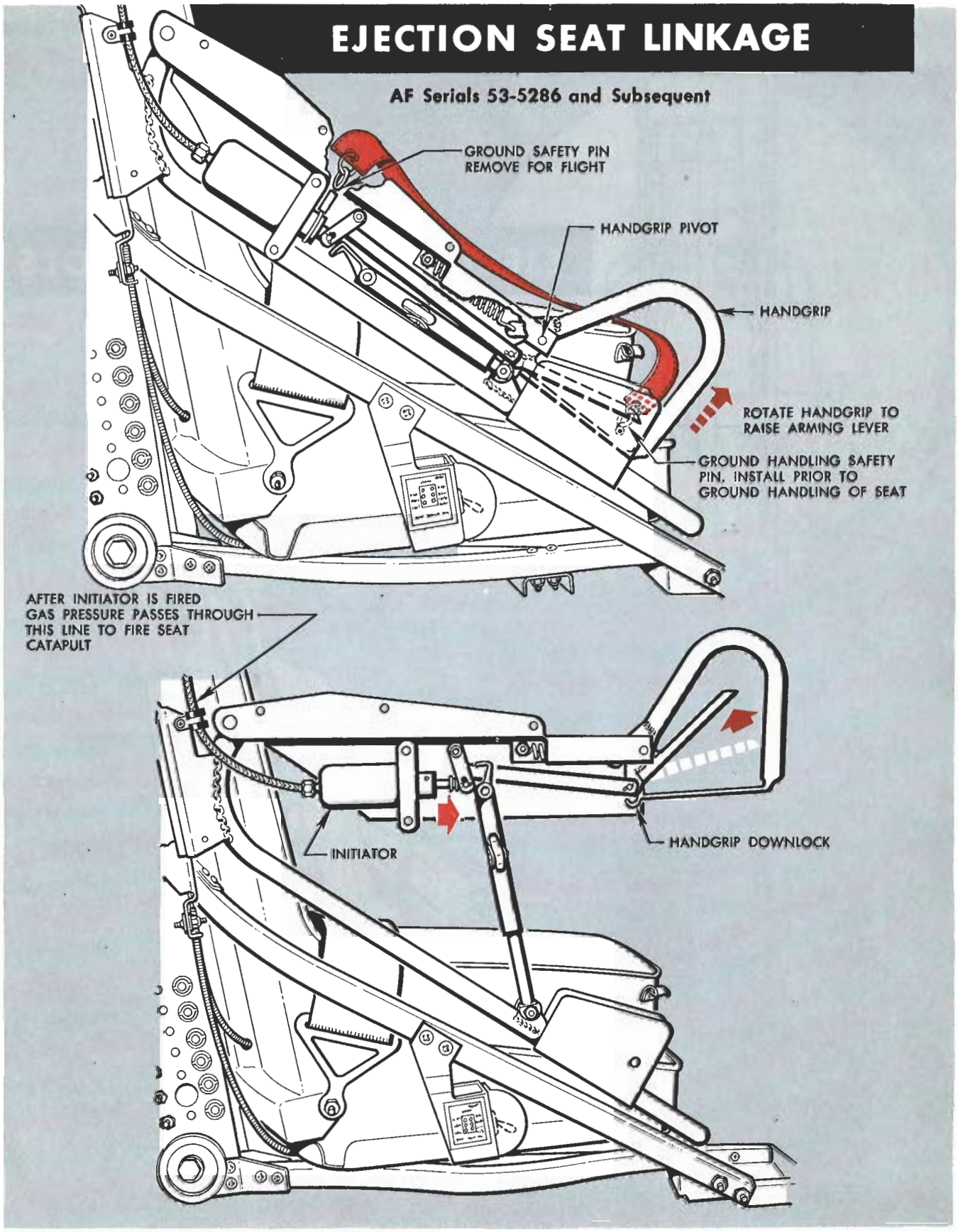

EJECTION SEAT LINKAGE
AF Serials 53-5286 and Subsequent
GROUND SAFETY PIN
REMOVE FOR FLIGHT
HANDGRIP PIVOT
HANDGRIP
ROTATE HANDGRIP TO
RAISE ARMING LEVER
GROUND HANDLING SAFETY
PIN. INSTALL PRIOR TO
GROUND HANDLING OF SEAT
AFTER INITIATOR IS FIRED
GAS PRESSURE PASSES THROUGH
THIS LINE TO FIRE SEAT
CATAPULT
INITIATOR
HANDGRIP DOWNLOCK

Figure 1-32

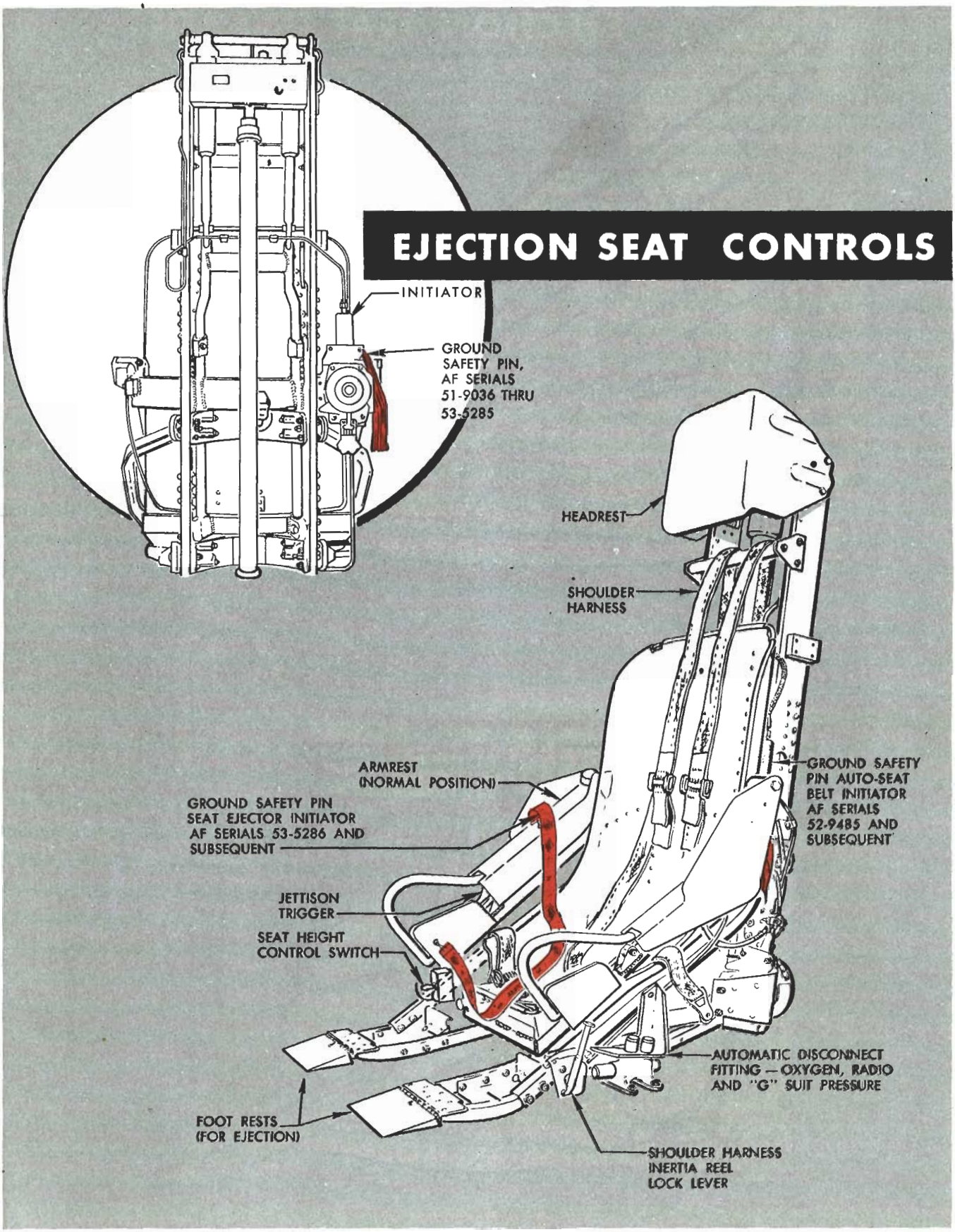


Figure 1-33. AF Serials 51-9036 and Subsequent

- If the right arm rest is raised, only a qualified maintenance specialist is authorized to return it to its normal position, and the system must be inspected before the seat is considered safe.
- The ejection seat must be given the same care in handling as a loaded gun. Always check that the safety pins are installed and be extra careful that clothing or gear does not catch on controls when entering or leaving the seat.

EJECTION SEAT CONTROLS.

RIGHT ARM REST. (AF Serials prior to 53-5286) (Figure 1-31). The right arm rest contains the jettison trigger, and is normally folded down. On modified airplanes a flagged safety pin is installed while on the ground to prevent raising the arm rest, which arms the ejection mechanism. The arm rest mounts the ejection trigger and should not be raised except for ejection.

SEAT ARMING LEVER. (AF Serials 53-5286 and subsequent). (Figure 1-32). On later airplanes the arm rests are replaced by lever assemblies. In normal flight the arming levers are depressed out of the way of the pilots' arm actions. The right hand assembly is the arming lever and trigger mechanism and is locked down by a hook which engages the bolt at the lower end of the telescoping support strut. The left hand lever is merely an arm rest for support of the pilot during ejection, and when raised locks the shoulder harness reel. The right hand arming lever is painted orange yellow and is placarded CAUTION: RAISE FOR EJECTION ONLY in red. The right hand arming lever can be unlocked and raised only by first grasping the handgrip and pulling upward with a normal natural movement and a pulling force of 30 pounds. When the arming lever is locked down, upward forces on any part of the lever other than the handgrip cannot raise the arming lever. In the lever down position, the trigger housed in the right handgrip is completely shielded by guards on both sides so that the trigger cannot be grasped until the arm rest is intentionally and deliberately elevated. The initiator is located

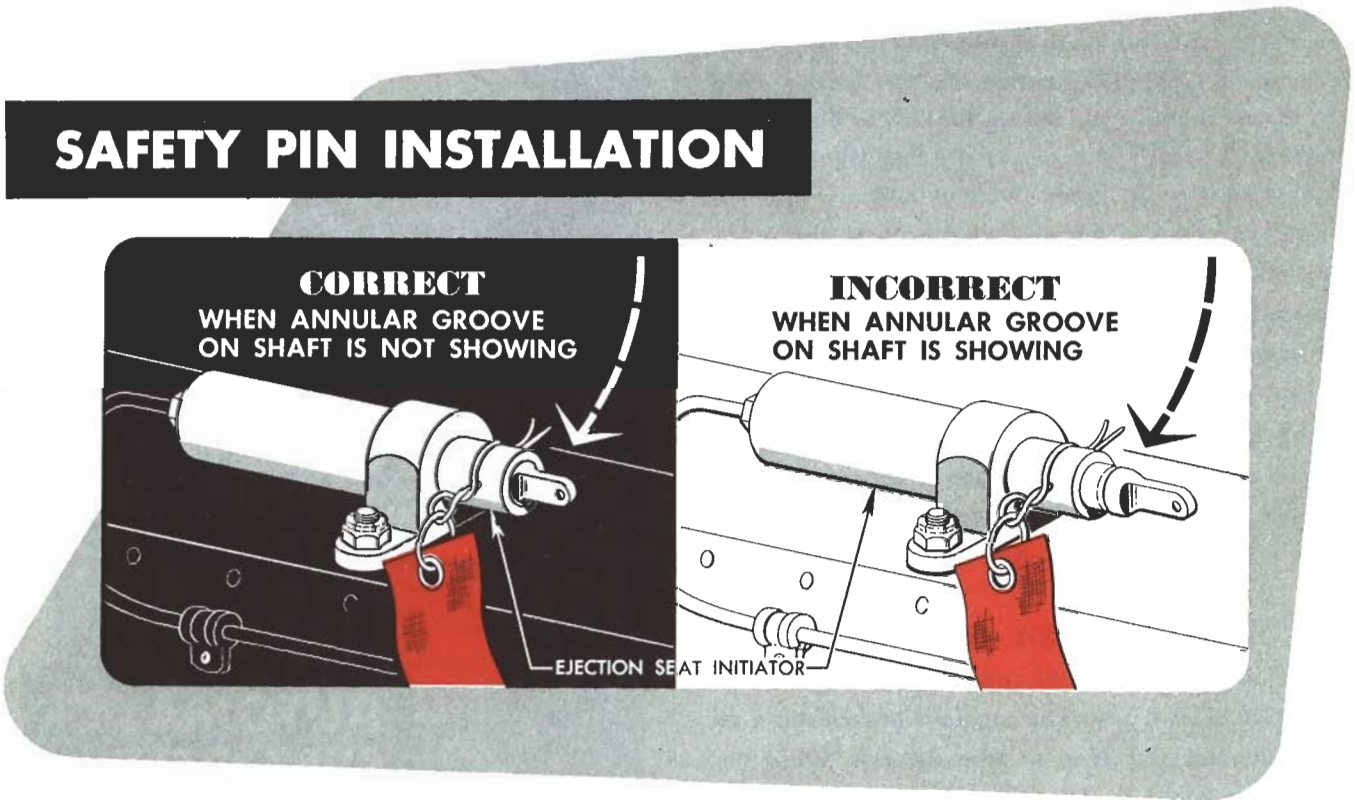


Figure 1-34

in the arming lever and the ground safety pin is inserted thru a guide hole in the top of the arming lever (figure 2-1). The safety pin flag has a straight pip pin at the opposite end for insertion thru the trigger guard when ground handling of the seat is required.

JETTISON TRIGGER. The ejection seat trigger is located on the forward end of the right arm rest. After the arm rest is raised to the horizontal position, squeezing the trigger ejects the seat, provided that the canopy has been released (on some airplanes) and the seat catapult safety pin has been removed.

LEFT ARM REST. This arm rest is normally stowed in the folded position. When it is raised to the horizontal position for ejection, it locks the shoulder harness.

SHOULDER HARNESS INERTIA REEL LOCK LEVER. The shoulder harness inertia reel lock lever (figures 1-31 and 1-33) has two positions, LOCKED and UNLOCKED and is located on the left side of each seat. A latch is provided for positively retaining the control handle at either position of the quadrant. By pressing down on the top of the control handle, the latch is released and the control handle may then be moved freely from one position to the other. When the control is in the UNLOCKED position, the reel harness cable will extend to allow you to lean forward in the cockpit; however, the reel will automatically lock when the airplane encounters an impact force of 2 to 3 G's. When the reel is locked in this manner, it will remain locked until the control handle is moved to the LOCKED position and then returned to the UNLOCKED position. When the control is in the LOCKED position, the reel harness cable is manually locked so that you are prevented from bending forward. The LOCKED position is used only when a crash landing is anticipated. This position provides an added safety precaution over and above that of the automatic safety lock.

SEAT HEIGHT CONTROL SWITCH. A seat height control switch (figures 1-31 and 1-33) is located at the right side of each seat. The toggle is pushed down to lower the seat and lifted to raise the seat. When the toggle is released it will return to the OFF (center) position. The seat may be ejected from any position.

CAUTION

To avoid jamming the seat in the up position do not operate the height control unless the seat is occupied.

AUTOMATIC SEAT BELT. (AF Serials 52-9485 and subsequent). The automatic seat belt (figure 1-35) is designed to release automatically after seat ejection. The belt may be used with an automatic type parachute or with the standard parachute. In automatic operation the belt is opened after ejection by gas pressure from the initiator located on the seat at the left arm rest. The initiator is fired by a lanyard attached to the floor, as the seat moves upward during ejection. A time delay feature

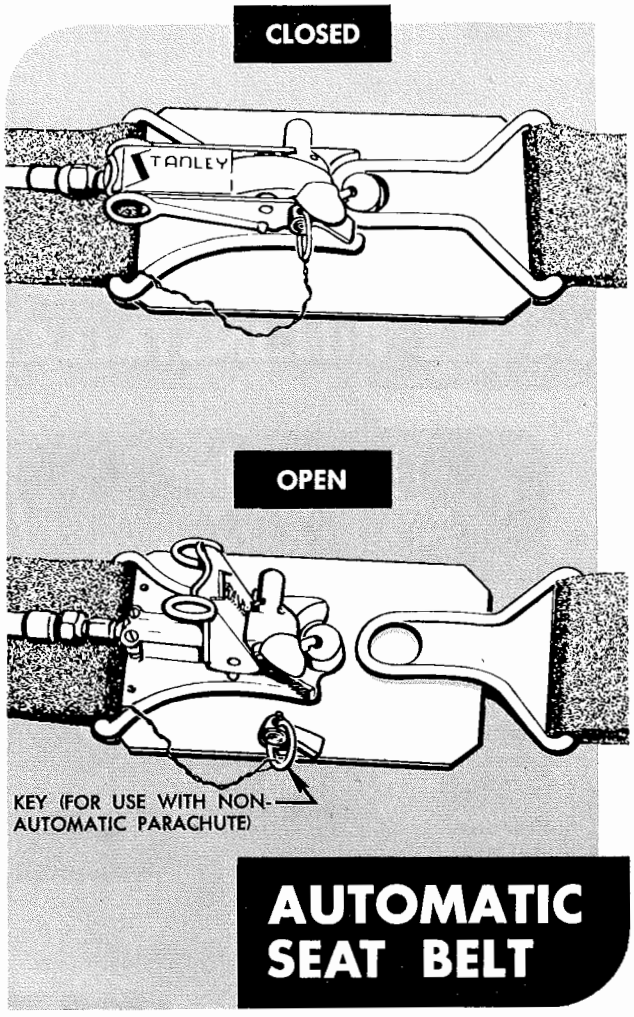
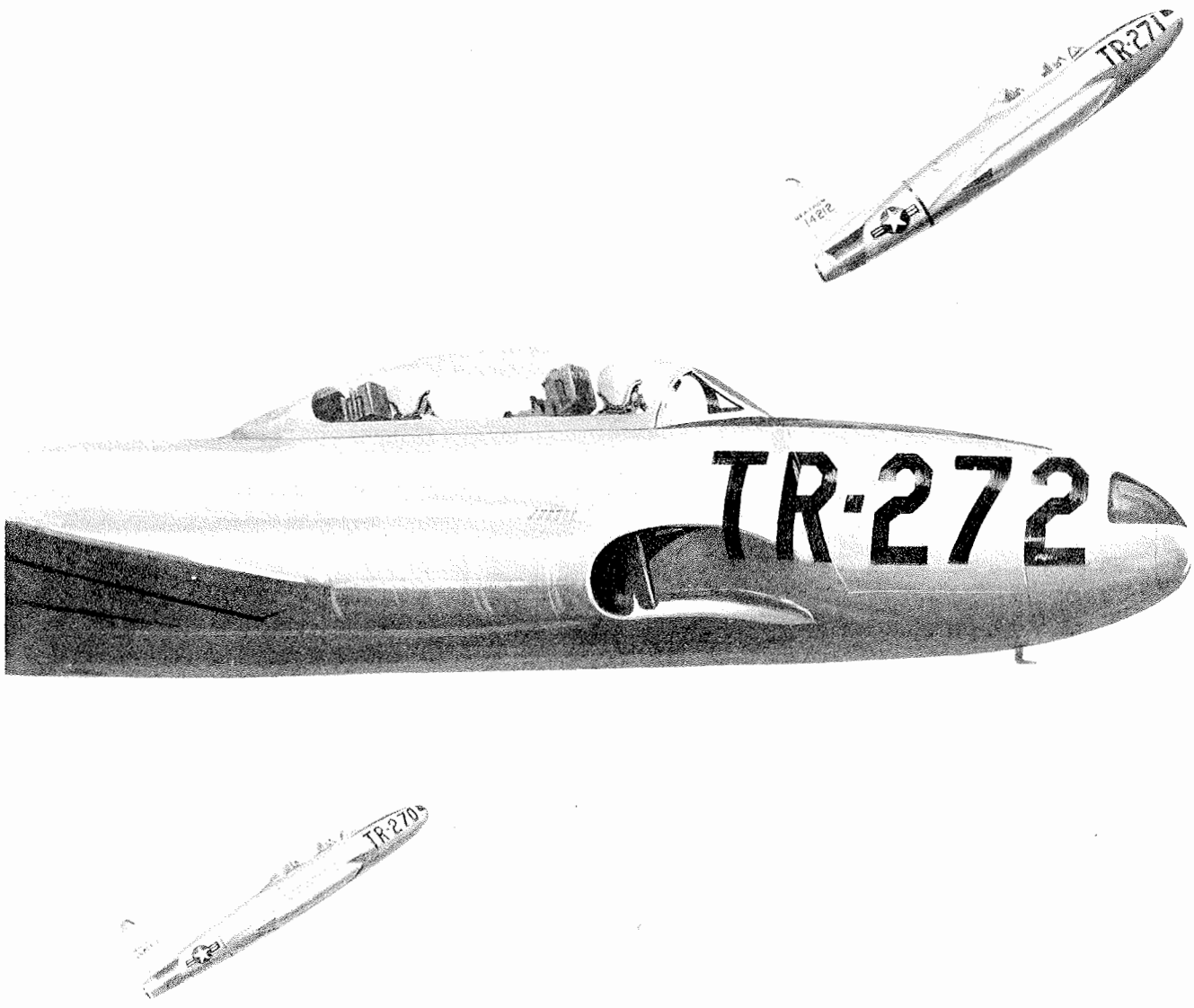


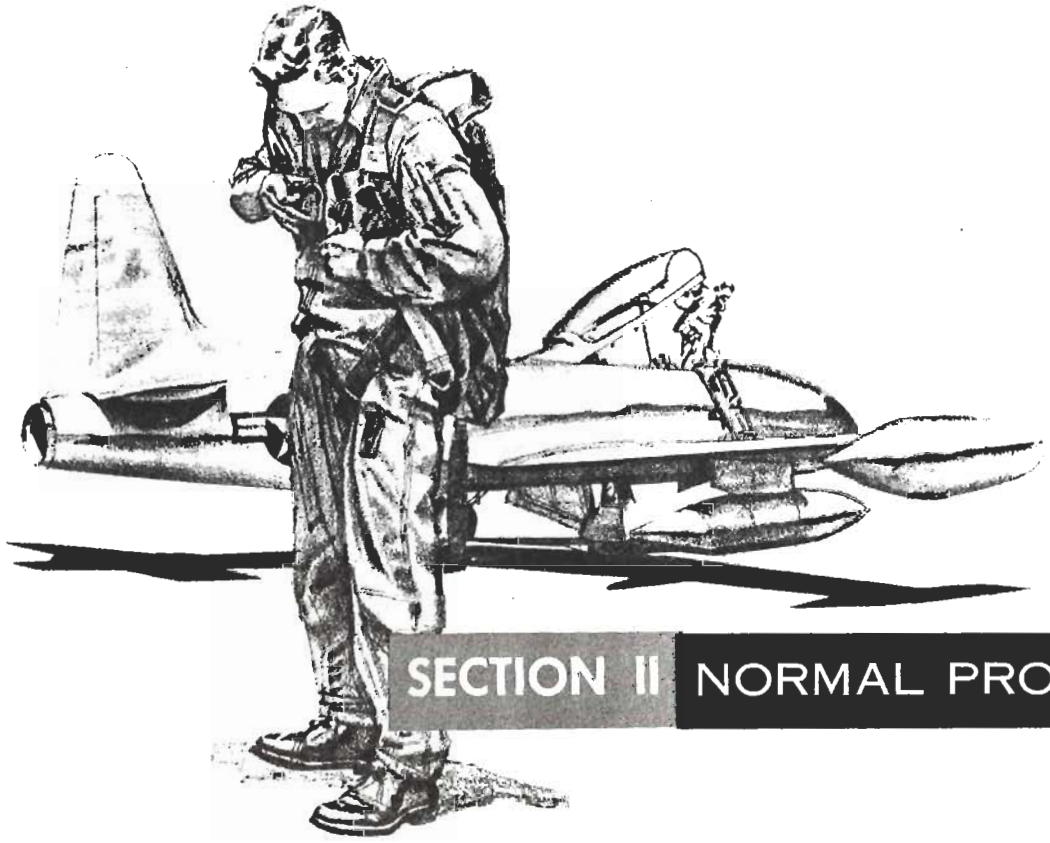
Figure 1-35

in the initiator insures that the occupant will be clear of airplane before the belt is released. The belt buckle manual operation is similar to that of the standard belt with the exception of the key which must be inserted in the buckle. This key is attached to the seat buckle for use when the standard parachute is worn. However, when the automatic type parachute is worn, a similar key, which is part of the chute, must be used in place of the key supplied with the auto safety belt. When the safety belt buckle is opened manually the key is ejected; however, when the belt is opened automatically during ejection, the key is retained and acts to operate the automatic type parachute. In order to fasten the auto seat belt, the key must be inserted in the buckle as shown. A safety pin installed in the initiator (figure 2-1) for ground safety, must be removed for flight.

AUXILIARY EQUIPMENT.

GENERAL. Auxiliary equipment, including cockpit heating and pressurization, oxygen, armament, lighting, and electronics, is described in Section IV.





SECTION II NORMAL PROCEDURES

STATUS OF THE AIRPLANE.

FLIGHT RESTRICTIONS.

Refer to Section V for all operating limitations.

FLIGHT PLAN.

Check performance data for required take-off and landing distances, cruising data, etc., as necessary to accomplish the mission.

WEIGHT AND BALANCE.

Refer to T.O. 1-1B-40 (formerly AN-01-1B-40) for weight and balance data.

ENTRANCE.

Check that external power unit (if connected) is turned off, while the canopy switch is operated to raise the canopy.

If a ladder is not available, climb onto the right wing over the leading edge.

CAUTION

A hazardous condition exists when wearing a back pack chute in the front seat of the T-33A aircraft in that some personnel (long legged) may be seriously injured during ejection due to interference of their knees with the windshield. If the forward pilot's seated thigh length measurement does not exceed 23 inches, then the type of parachute to be fitted to the pilot is optional. However, if the pilot's seated thigh length exceeds 23 inches, the pilot must be fitted with a seat type parachute in order to insure proper knee clearance upon ejection. The use of seat type parachutes will provide safe ejection clearances for pilots with seated thigh lengths up to and including 28 inches.

BEFORE EXTERIOR INSPECTION.

A complete visual inspection of the aircraft is a very important part of each mission. The pre-flight check starts before the pilot reaches the aircraft. Survey the

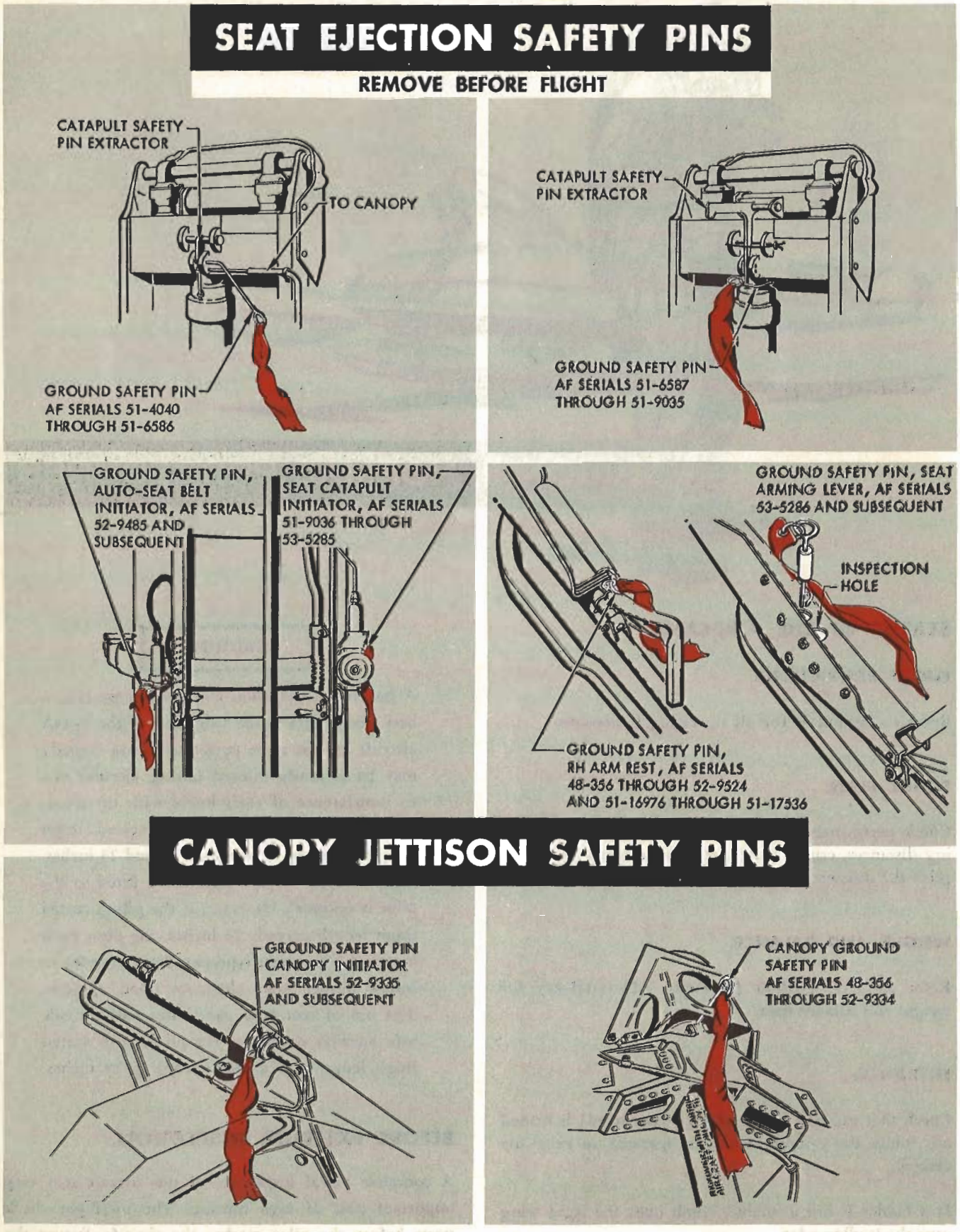

SEAT EJECTION SAFETY PINS
REMOVE BEFORE FLIGHT
CATAPULT SAFETY PIN EXTRACTOR
TO CANOPY
GROUND SAFETY PIN AF SERIALS 51-4040 THROUGH 51-6586
CATAPULT SAFETY PIN EXTRACTOR
GROUND SAFETY PIN AF SERIALS 51-6587 THROUGH 51-9035
GROUND SAFETY PIN, AUTO-SEAT BELT INITIATOR, AF SERIALS 52-9485 AND SUBSEQUENT
GROUND SAFETY PIN, SEAT CATAPULT INITIATOR, AF SERIALS 51-9036 THROUGH 53-5285
GROUND SAFETY PIN, SEAT ARMING LEVER, AF SERIALS 53-5286 AND SUBSEQUENT
INSPECTION HOLE
GROUND SAFETY PIN, RH ARM REST, AF SERIALS 48-356 THROUGH 52-9524 AND 51-16976 THROUGH 51-17536
CANOPY JETTISON SAFETY PINS
GROUND SAFETY PIN CANOPY INITIATOR AF SERIALS 52-9335 AND SUBSEQUENT
CANOPY GROUND SAFETY PIN AF SERIALS 48-356 THROUGH 52-9334

Figure 2-1

proposed taxiing routes for any possible obstruction, such as a fuel truck or tug moving about on or near the ramp, and check for stray equipment or personnel that might be harmed by the jet blast. Upon reaching the aircraft, proceed as follows:

CAUTION

When stepping on or off the wing of the T-33, do not step on the stall strip or false leading edges on the inboard wing sections. Any shift or change in contour to these modifying attachments may create undesirable stall and spin characteristics.

CANOPY JETTISON AND SEAT EJECTION SYSTEMS.

Before entering the airplane, open canopy fully and check canopy jettison initiator, ejection seat and cockpit safety pins (figure 2-1) as follows:

1. Canopy jettison levers—Full forward (check in up detent position) front cockpit lightly safetied.
2. Canopy ground safety pin installed.
3. Arm rests (both cockpits)—Down.

WARNING

If the right arm rest is raised, don't enter the airplane until the system is checked by a maintenance specialist.

4. Seat ejection safety pin (both cockpits)—Installed.
5. Canopy sear locking pin (Early Airplanes)—Diagonal safety pin—Safetied with light copper wire.
6. Seat catapult ground safety pin installed.

FRONT COCKPIT (ALL FLIGHTS).

1. AF Form 1: Check for status, exceptional release, fuel, oxygen, oil, service, and remarks pertaining to the condition of the aircraft as indicated in Parts II and III.
2. Check controls unlocked. (If controls are found locked, recheck Form 1 to insure that the engineering pre-flight and daily inspections have been performed).
3. Oxygen – 400-425 psi. Check gage pressure against Form 1 entry. If pressure has dropped, it usually indicates a leak in the system or oxygen use by ground personnel since the refilling operation.
4. Check throttle and battery switch—OFF and install seat cushion – if desired.

AFT COCKPIT (SOLO FLIGHTS).

1. Straps, belt, oxygen hose, and radio cord—secured; cushions—removed; pressure inlets – closed and rear standpipe handle—down.
2. Oxygen diluter lever—NORMAL, Landing gear handle—DOWN.
3. Bomb (or tanks) release master switch—ARM.
4. Tip tank jettison switch—OFF or SAFE.
5. Starting Fuel, Air Start Ignition, Landing Light and Fuel Override Switches—OFF; Main Fuel Shut-off Switch—OPEN (if installed).
6. Throttle—OFF; Dive Flap Switch—UP and Aileron Boost Control Lever—ON.
7. Student Lockout Box—Removed; Radio Compass Band Selector—200 to 400 KC band; Function Switch —ANT position; Volume—Full Increase.
8. Battery Generator Switch—ON; Ignition Switch—NORMAL.
9. Emergency Hydraulic Switch — OFF and safetied; Emergency Hydraulic Selector Valve — NORMAL; Circuit Breakers—IN; Cockpit Lights—OFF; Map Case—Closed and Secure.

EXTERIOR INSPECTION.

The exterior inspection should be accomplished as shown in figure 2-2.

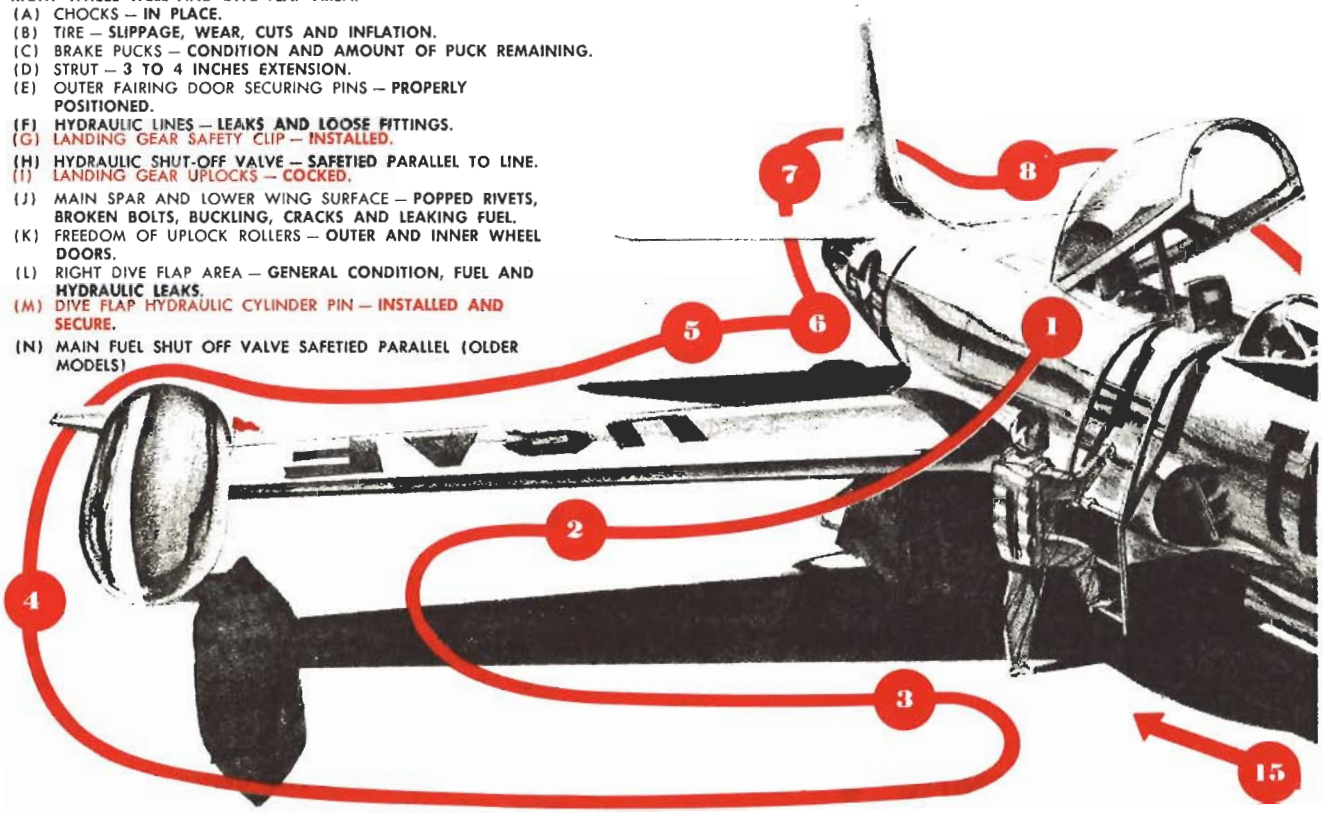
1. PLENUM CHAMBER AND FUSELAGE TANK
   (A) PLENUM CHAMBER AREA NUTS – SECURELY FASTENED.
   (B) PLENUM CHAMBER – LEAKS, FOREIGN OBJECTS, AND GENERAL CONDITION.
   (C) CIRCUIT BREAKERS (UPPER RIGHT PLENUM CHAMBER) – IN.
   (D) FUSELAGE TANK OVERFLOW VENT LINE – LEAKS AND SECURE FITTINGS.
   (E) ENGINE OIL FILTER CAP (DIPSTICK) – SECURED.
   (F) ALCOHOL TANK FILLER CAP – SECURE.
   (G) HYDRAULIC OIL RESERVOIR CAP – SECURE.
   (H) FUSELAGE TANK – FUEL QUANTITY, CAP CONDITION AND SECURITY (COMPLIANCE WITH T.O. 1T-33A-44)
   (I) FUSELAGE TANK FUEL GAGE TRANSMITTER WELL – FREE OF FUEL.

2. RIGHT MAIN WING AND LEADING EDGE FUEL TANKS – CHECK FUEL QUANTITY, CAP CONDITION AND SECURITY.

3. RIGHT WHEEL WELL AND DIVE FLAP AREA.
   (A) CHOCKS – IN PLACE.
   (B) TIRE – SLIPPAGE, WEAR, CUTS AND INFLATION.
   (C) BRAKE PUCKS – CONDITION AND AMOUNT OF PUCK REMAINING.
   (D) STRUT – 3 TO 4 INCHES EXTENSION.
   (E) OUTER FAIRING DOOR SECURING PINS – PROPERLY POSITIONED.
   (F) HYDRAULIC LINES – LEAKS AND LOOSE FITTINGS.
   (G) LANDING GEAR SAFETY CLIP – INSTALLED.
   (H) HYDRAULIC SHUT-OFF VALVE – SAFETIED PARALLEL TO LINE.
   (I) LANDING GEAR UPLOCKS – COCKED.
   (J) MAIN SPAR AND LOWER WING SURFACE – POPPED RIVETS, BROKEN BOLTS, BUCKLING, CRACKS AND LEAKING FUEL.
   (K) FREEDOM OF UPLOCK ROLLERS – OUTER AND INNER WHEEL DOORS.
   (L) RIGHT DIVE FLAP AREA – GENERAL CONDITION, FUEL AND HYDRAULIC LEAKS.
   (M) DIVE FLAP HYDRAULIC CYLINDER PIN – INSTALLED AND SECURE.
   (N) MAIN FUEL SHUT OFF VALVE SAFETIED PARALLEL (OLDER MODELS)

4. RIGHT WING LEADING EDGE AND TIP TANK
   (A) GENERAL CONDITION – DENTS, WRINKLES, POPPED RIVETS AND CRACKS.
   (B) TIP TANK – FUEL QUANTITY, CUP CONDITION AND SECURITY (LOOSEN CAP SLOWLY TO RELEASE PRESSURE).
   (C) TIP TANK SAFETY PINS – INSTALLED.
   (D) TIP TANK AND FAIRING – GENERAL CONDITION AND SECURITY OF MOUNTING.
   (E) JETTISON SPRING TORQUE INDICATOR – CORRECT POSITION.
   (F) POSITION LIGHTS – GENERAL CONDITION.

5. RIGHT WING TRAILING EDGE
   (A) WING SURFACE – POPPED RIVETS, WRINKLES AND CRACKED SKIN.
   (B) LOWER WING ACCESS PLATES – CLOSED AND SECURELY FASTENED.
   (C) PIANO HINGES ON AILERON AND FLAP – IN PLACE AND NOT BINDING.



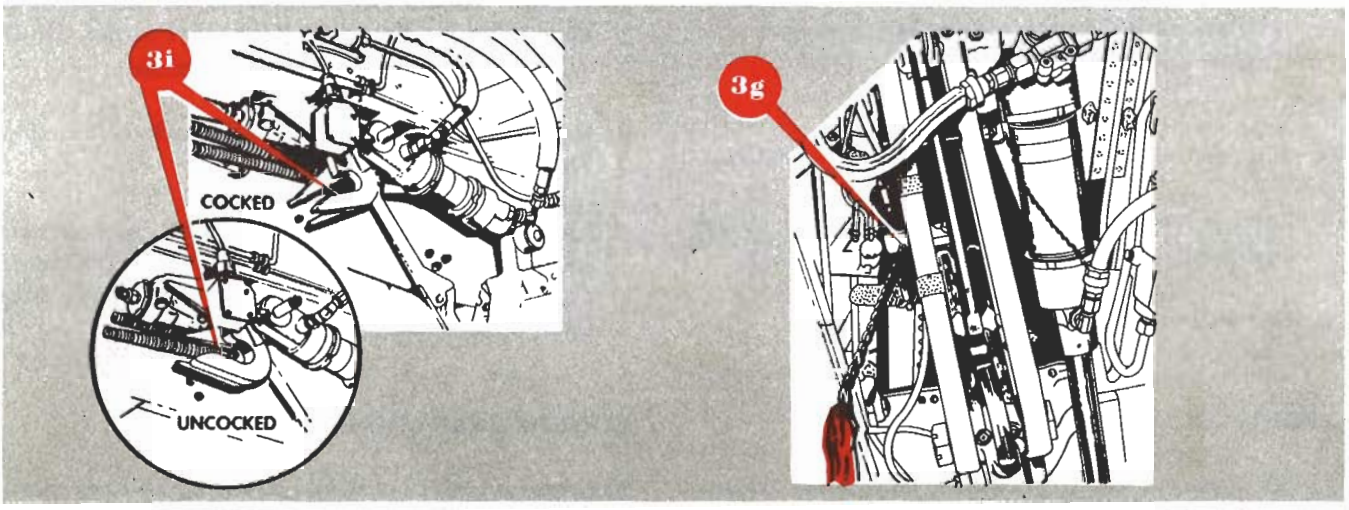


Figure 2-2 (Sheet 1 of 2)

(D) FLAP AND AILERON — **CRACKS, DENTS AND OTHER DAMAGE.**
(E) FLAPS — **EITHER FULL UP OR ALIGNED EQUALLY IF DOWN.**

6. **AFT AND LOWER FUSELAGE RIGHT SIDE**
(A) LOWER ENGINE ACCESS DOORS SECURE.
(B) INSPECTION PLATES SECURE.
(C) WRINKLED SKIN OR POPPED RIVETS.
(D) FUEL, OIL OR HYDRAULIC LEAKS.
(E) FUEL VENTS — **SECURE AND UNOBSTRUCTED.**

7. **TAIL SECTION**
(A) VERTICAL AND HORIZONTAL STABILIZERS — **GENERAL CONDITION.**
(B) ELEVATOR AND RUDDER — **FREEDOM OF MOVEMENT, CONDITION OF COUNTER WEIGHTS, NUTS AND COTTER KEYS INTACT.**
(C) TRIM AND SERVO TABS — **ALIGNMENT AND EXCESSIVE PLAY.**
(D) TAIL PIPE — **COVER REMOVED, EXPANSION CLEARANCE, CRACKS, WRINKLES, AND TURBINE BUCKETS INTACT.**
(E) TAIL SECTION DRAG SKID — **GENERAL CONDITION AND SECURITY.**

8. AFT AND LOWER FUSELAGE LEFT SIDE — **SAME AS RIGHT.**

9. LEFT WING TRAILING EDGE — **SAME AS RIGHT SIDE (PLUS — CHECK AILERON TRIM TAB SECURITY).**

10. LEFT WING LEADING EDGE AND TIP TANK — **SAME AS RIGHT SIDE.**

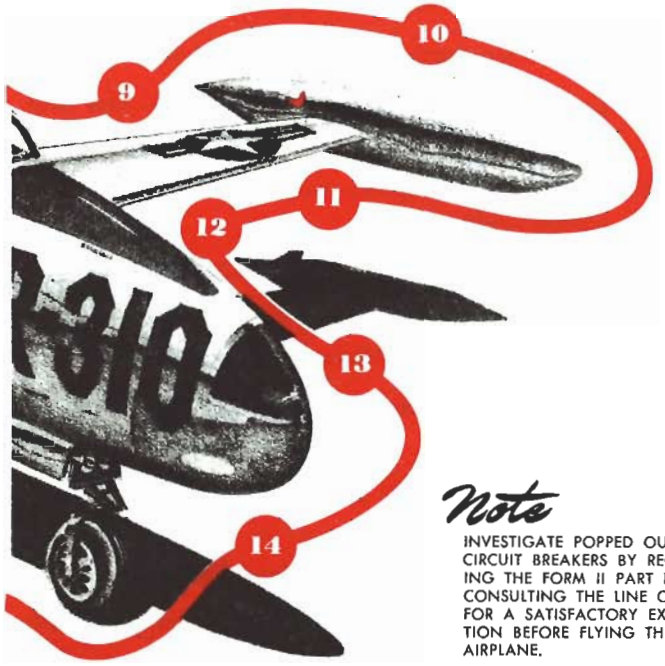
11. LEFT MAIN WING AND LEADING EDGE FUEL TANKS — **SAME AS RIGHT SIDE.**

12. LEFT WHEEL WELL AND DIVE FLAP AREA — **SAME AS RIGHT SIDE (PLUS — DIVE FLAP GROUND SAFETY HYDRAULIC VALVE — SAFETIED PARALLEL).**

13. LEFT FORWARD FUSELAGE
(A) GENERAL CONDITION — **WRINKLED SKIN OR POPPED RIVETS.**
(B) AIR INTAKE DUCT — **REMOVED AND FREE OF FOREIGN OBJECTS.**
(C) ARMAMENT COMPARTMENT — **GENERAL CONDITION, DOORS CLOSED AND SECURE.**
(D) OXYGEN FILLER ACCESS PLATE — **SECURE.**
(E) STATIC SOURCES CLEAR.

14. **NOSE WHEEL WELL**
(A) PITOT HEAD — **CONDITION AND COVER REMOVED.**
(B) NOSE WHEEL TIRE — **SLIPPAGE, WEAR, CUTS AND INFLATION.**
(C) NOSE WHEEL STRUT — **3 TO 4 INCHES EXTENSION.**
(D) LANDING LIGHT — **GENERAL CONDITION.**
(E) NOSE WHEEL SHIMMY DAMPENER — **PROPER EXTENSION OF PISTON POSITION INDICATOR.**
(F) NOSE WHEEL SAFETY CLIP — **INSTALLED.**
(G) HYDRAULIC SHUT-OFF VALVE — **SAFETIED PARALLEL TO LINE.**
(H) TIP TANK RELEASE SOLENOID CIRCUIT BREAKERS — **IN.**
(I) CIRCUIT BREAKERS AFT OF CANVAS FLAP — **IN AND REFASTEN FLAP.**
(J) NOSE WHEEL DOOR — **GENERAL CONDITION.**
(K) HYDRAULIC LINES — **LEAKS AND LOOSE FITTINGS.**

15. **RIGHT FORWARD FUSELAGE**
(A) GENERAL CONDITION, WRINKLED OR POPPED RIVETS.
(B) STATIC SOURCES — **CLEAR.**
(C) ARMAMENT COMPARTMENT — **GENERAL CONDITION, DOORS CLOSED AND SECURE.**
(D) AIR INTAKE DUCT — **COVER REMOVED, FREE OF FOREIGN OBJECTS AND GUN CAMERA DOOR SECURE.**



Note

INVESTIGATE POPPED OUT CIRCUIT BREAKERS BY RECHECKING THE FORM II PART III OR CONSULTING THE LINE CHIEF FOR A SATISFACTORY EXPLANATION BEFORE FLYING THE AIRPLANE.

EXTERIOR INSPECTION DIAGRAM

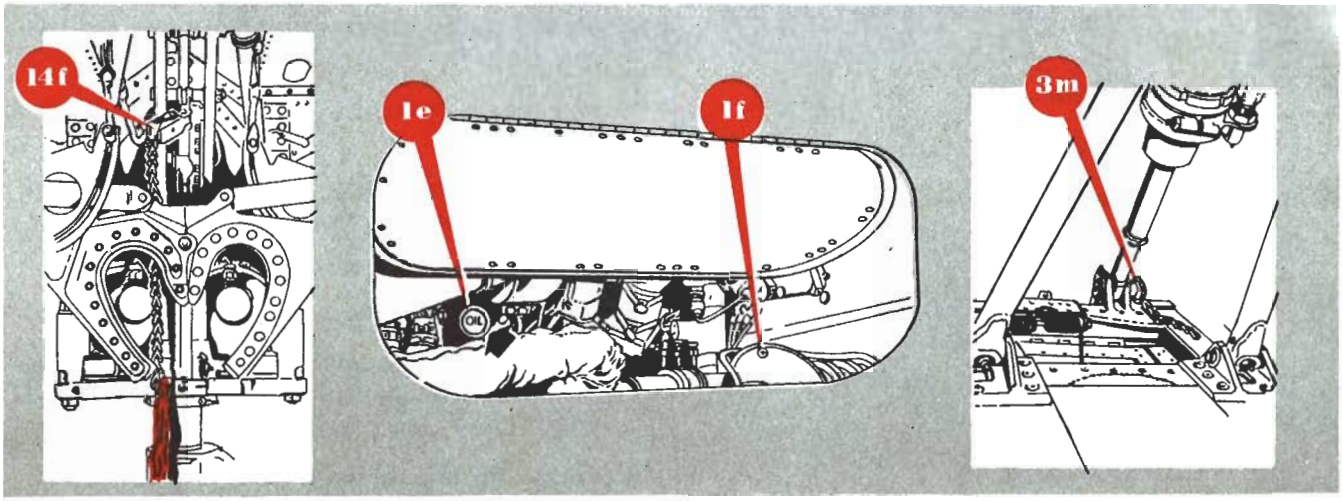


Figure 2-2 (Sheet 2 of 2)

BEFORE STARTING ENGINES.

The student lockout box on earlier aircraft may be installed in either cockpit on the center instrument panel.

FRONT COCKPIT CHECK—ALL FLIGHTS.

1. Check cockpit for—loose items, equipment, tools, etc.
2. Shoulder harness and safety belt—strap on and adjust.
3. Shoulder harness inertia reel—Unlock.
4. G-suit—connect and set—HI or LOW as desired.
5. Canopy catapult safety pin—Remove and stow.
6. Ejection seat safety pin—Remove and stow.
7. Automatic seat belt initiator safety pin—Remove and stow. (AF Serials 52-9485 and subsequent).
8. Parking brake—Set.
9. Landing gear control lever—DOWN.
10. Manual Release handles—tanks or bombs—In and safetied.
11. Left lower console circuit breakers—In.
12. Bomb arming switch—SAFE.
13. Bomb selector switch—OFF.
14. Chemical tank selector switch—OFF (center position).
15. Gun heater switch—OFF.
16. Guns camera switch—OFF.
17. Tip, wing, leading edge and fuselage tank fuel switches—OFF.
18. Emergency fuel switch—OFF.
19. Fluid injection switch—OFF (if installed).
20. AN/AIC-10 Interphone Panel—Set as desired.
21. Marker Receiver circuit breakers—In.
22. Tip tank jettison switch—AUTO DROP. (AF Serials 52-9635 and subsequent).
23. Tip tank jettison ready switch—SAFE. (AF Serials 51-4141 thru 52-9634).
24. VHF or UHF radio—OFF.
25. Fuel system de-icing switch—OFF.
26. Starting fuel switch—OFF.
27. Air start ignition switch—OFF.
28. Landing-Taxi light switch—OFF.
29. Wing flap control lever—OFF (center position).
30. Throttle—OFF (stop cocked).
31. Dive flap switch—DOWN (aft position).
32. Jato circuit breaker—as required.
33. Main fuel valve shut-off switch—OPEN (guard down and safetied).
34. Cabin temperature selector rheostat—As desired.
35. Throttle friction lock—Adjust.
36. Aileron boost—ON.
37. Manual jato jettison handle—In and safetied.
38. Canopy de-froster control valve knob—Out and Unlocked.
39. Flight instrument power switch (if installed)—OFF (center position).
40. Altimeter, clock, fuel counter and accelerometer—check for proper settings.
41. Bomb salvo button—Safety cover removed.
42. Guns-JATO selector switch—OFF. (Prior to AF Serial 50-402).
43. Jato arming switch—SAFE. (AF Serials 50-402 and subsequent).
44. AN/ARN-6 Radio compass function switch—OFF.
45. Cockpit pressurization dump valve—Out and closed.
46. Cockpit pressure air inlet ducts—Open.
47. Manual canopy handcrank handle—down and safetied.
48. Emergency hydraulic system selector lever—NORMAL.
49. Flight instrument a.c. fuses and spares—check screwed in clockwise, finger tight.
50. All other left console circuit breakers—In.
51. Auxiliary defroster switch—OFF.
52. Inverter power, inverter relay and turn and bank circuit breakers—Pull out. (AF Serials prior to 52-9760). Other circuit breakers on this panel—IN.
53. Cockpit lighting rheostats—OFF.
54. Ignition switch—OFF.

55. Starter switch—OFF (center position).
56. Battery switch—OFF.
57. Generator switch—ON.
58. Pitot heat switch—OFF.
59. Emergency fuel check-out switch—NORMAL.
60. Navigation lights switches—OFF.
61. Radio panel light rheostat—OFF.
62. Emergency hydraulic pump switch—OFF. (Guard down.)
63. Cabin altimeter—check for proper setting.
64. Forward and aft seat actuator circuit breakers—IN.
65. APX-6 IFF master selector and destructor switch—OFF.
66. Cockpit map light—OFF.
67. Map case—Closed and secure.
68. Signal ground crew to connect external power.
69. All warning and indicator lights—Push to test and set for desired brilliance.
70. Seat height—Adjust.
71. Rudder and pedal length—Adjust.
72. Oxygen system—P. McCRIPE check. (Refer to Section IV).

AFT COCKPIT CHECK—DUAL FLIGHTS.

1. Check cockpit for—Loose items, equipment, tools, etc.
2. Shoulder harness and safety belt—Strap on, lock and adjust.
3. Shoulder harness inertia reel—Unlocked.
4. G-suit—connect and set—HI or LOW as desired.
5. Check that canopy catapult safety pin has been removed and stowed.
6. Ejection seat safety pin—Remove and stow.
7. Automatic seat belt initiator safety pin—Remove and stow. (AF Serials 52-9458 and subsequent).
8. Landing gear control lever—DOWN.
9. Leading edge pump control and fuselage fuel circuit breakers—IN.
10. Guns and JATO master switch—ARM. (AF Serials 48-356 thru 50-401).
11. Bomb arming master switch—ARM.
12. Bomb release master switch—ARM.
13. Tip tank jettison switch—SAFE. (AF Serials 52-9635 and subsequent).
14. Tip tank jettison ready switch—SAFE. (AF Serials 51-4141 thru 52-9634).
15. Aft cockpit fuselage tank switch—NORMAL. (Guard down).
16. Fluid injection switch—OFF (if installed).
17. Emergency fuel switch—OFF.
18. Starting fuel switch—OFF.
19. Air start ignition switch—OFF.
20. Landing—Taxi light switch—OFF.
21. Fuel filter de-icing switch—OFF. (Guard down).
22. Wing flap lever—OFF (center position).
23. Throttle—OFF (stop-cocked).
24. Dive flap switch—UP.
25. Fuel pump override switch (if installed)—OFF. (Guard down.)
26. Main fuel valve shut-off switch—OPEN. (Guard down and safetied).
27. Main fuel shut-off circuit breaker—IN.
28. Aileron booster—ON.
29. Altimeter, clock, accelerometer and fuel counter—Check for proper setting.
30. Bomb Salvo button—Safety cover removed.
31. AN/ARN-6 Radio compass function switch—OFF.
32. Cockpit pressurization air inlet ducts—Open.
33. Map case—Closed and secure.
34. Emergency hydraulic system selector lever—NORMAL.
35. Ignition switch—NORMAL (Guard down).
36. Starter switch—OFF.
37. Battery and generator switch—ON (Guard down).
38. Cockpit lighting rheostats—OFF.
39. AN/AIC-10 Interphone control panel—As desired.
40. Emergency hydraulic pump switch—OFF.

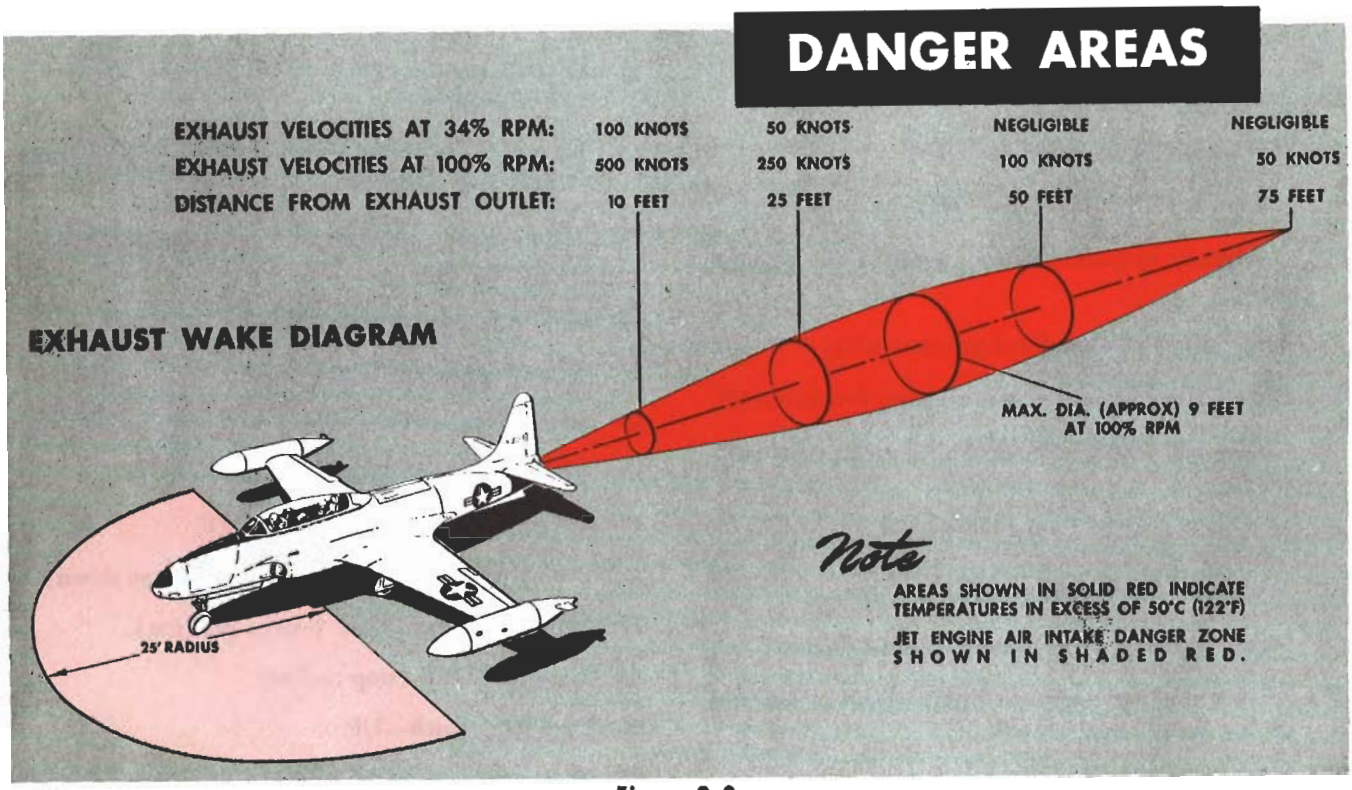


Figure 2-3

41. A.C. Fuses and spares—Check screwed in clockwise, finger tight.
42. Right console circuit breakers—IN.
43. VHF or UHF radio—OFF.
44. After external power is connected—Push to test all warning and indicator lights and set for desired brilliance.
45. Seat height—Adjust.
46. Rudder pedal length—Adjust.
47. Oxygen system—P. McCRIPE check (Refer to Section IV).

INTERIOR CHECKS (NIGHT FLIGHT).

Include the following lighting equipment checks for all night flights.

1. Landing lights and Taxi lights—Test.
2. Fluorescent lights—Test.
3. Navigation lights—Test.
4. Cockpit lights—Test.
5. Flashlight—Test.
6. Radio compass—check for control by turning function switch to LOOP and rotating azimuth needle with Right-Left Switch. Return function switch to OFF.

FUEL SYSTEM MANAGEMENT.

Refer to Section VII for fuel system management.

CARBON MONOXIDE ELIMINATION.

The presence of carbon monoxide gas in the cockpit of jet aircraft has long been suspected as the primary cause of numerous aircraft accidents. The exact source from which monoxide may enter the cockpit has not yet been determined; however, if the aircraft is to be operated under possible conditions of carbon monoxide contamination, such as, during "engine run-up," taxiing directly behind another operating jet aircraft, or during "run-up" with the tail pointed into the wind, the following procedure should be used:

GROUND STARTING SEQUENCE

REFER TO TEXT FOR GROUND STARTING PRECAUTIONS AND MALFUNCTIONS

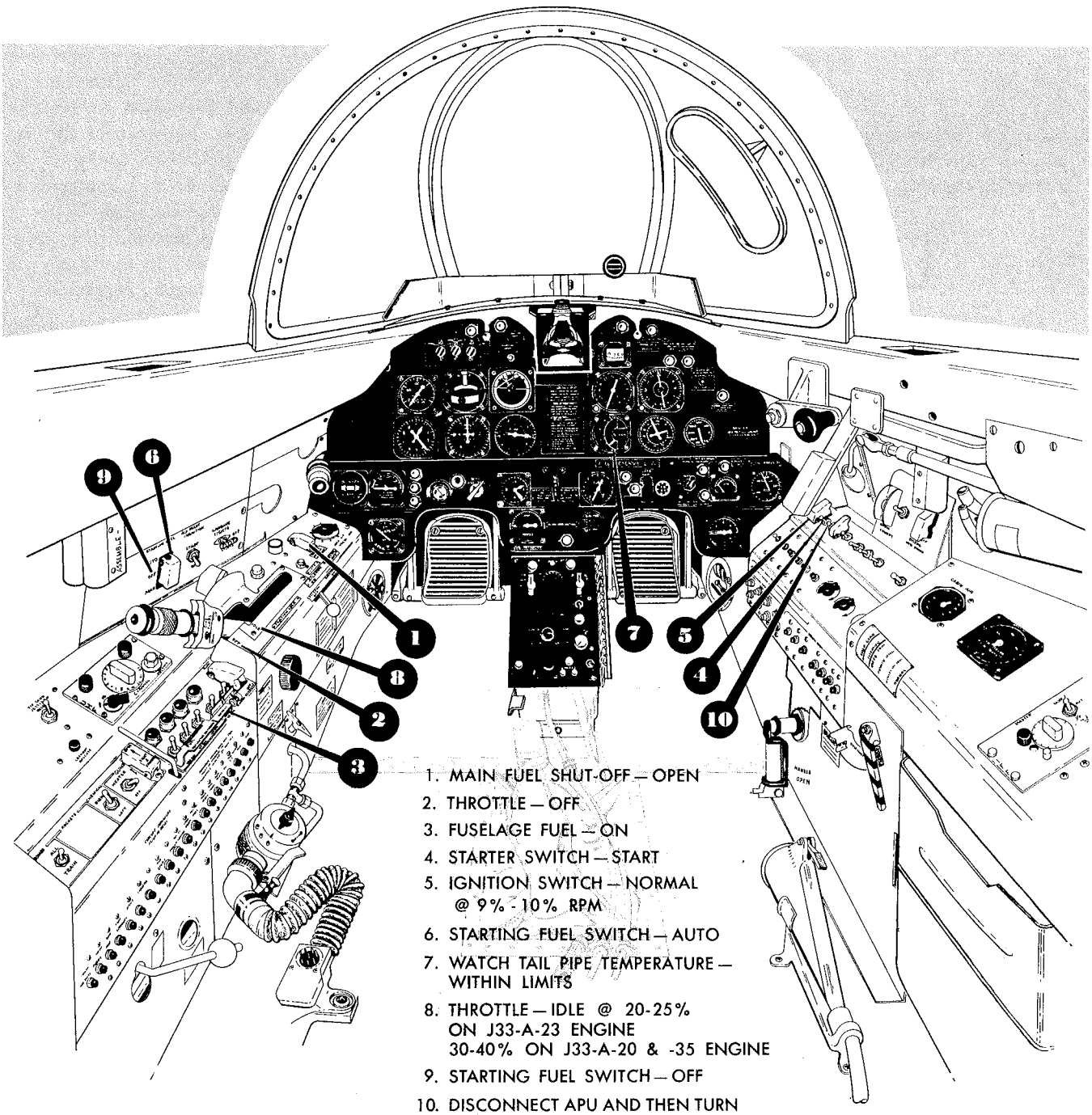


Figure 2-4

1. Before starting the engine, both crew members will don oxygen masks, connect the hoses to the regulators, and place the diluter lever in the 100% OXYGEN position.

2. Whenever carbon monoxide is suspected, 100 percent oxygen will be used during ground operation and take-off.

3. After contamination is no longer suspected, place the oxygen regulator diluter lever in the NORMAL OXYGEN position.

CAUTION

The oxygen diluter lever must be returned to the NORMAL OXYGEN position as soon as possible because the use of 100% oxygen throughout a long mission may deplete the oxygen supply before the mission is completed.

STARTING ENGINE—GROUND STARTS.

The engine may be started from either cockpit by either of two methods: The automatic start utilizing the automatic starting fuel control system or by the manual start (except on J33A-20 engines) using the normal engine operating fuel flow. It is recommended that the automatic starting method be used for all normal starts since it provides better combustion and controlled acceleration during the initial starting phase. The manual starting method is provided for use in case of an emergency or when the automatic starting system becomes inoperative. For all starts: Head the airplane into the wind whenever practicable, especially when using gasoline type fuels. Be sure that the danger areas shown in figure 2-3 are clear before starting. Make the following checks.

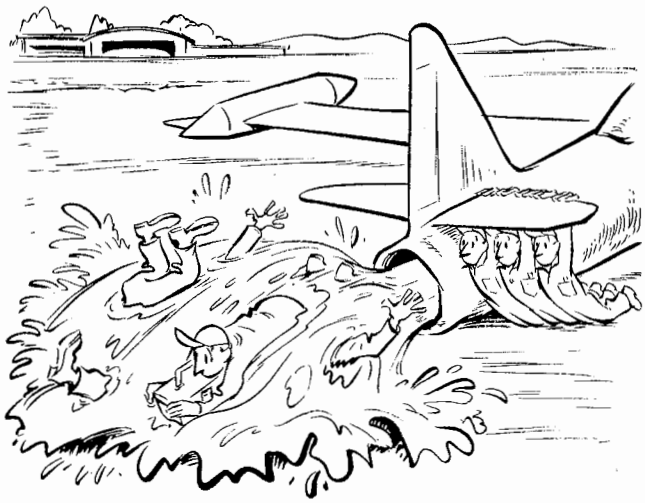
1. Throttle—OFF (stop-cocked).
2. Main fuel shut-off—OPEN (guard down).
3. Starting fuel switch—OFF.
4. Emergency fuel switch—OFF.
5. Signal ground crew to connect external power.

AUTOMATIC START—FRONT COCKPIT. (Refer to figure 2-4.)

Note

The rear cockpit master generator-battery switch must be in the ON position and the rear cockpit ignition switch must be in the NORMAL position before making a start from the front cockpit.

NORMAL PROCEDURE	IN THE EVENT OF MALFUNCTION
1. Fuselage tank switch—ON or FUS (up).	**STARTER FAILS TO PRODUCE 9 TO 10% RPM.**
2. Starter switch—Hold to start position for 3 seconds then release.	1. Starter switch—Hold momentarily to STOP-START position; allow engine to windmill to a complete stop.
Note Starter should bring engine speed to at least 10% RPM. Do not attempt to start the engine below 9% RPM, as it may cause serious damage.	2. Fuselage tank switch—OFF.
Note On aircraft equipped with the J33-A-20 engine, the amber warning pump indicator light will illuminate during starting and then go out as fuel pressure builds up. If the light does not go out, one of the elements in the dual engine-driven fuel pump has failed. The aircraft should not be flown until the condition has been corrected.	3. Secure adequate external power prior to new start attempt. If start must be made without suitable external power, the battery switch may be turned ON after external power has developed maximum possible RPM. Starts on battery power alone should be made only in an emergency.

NORMAL PROCEDURE	IN THE EVENT OF MALFUNCTION
3. Ignition switch—NORMAL after RPM has reached at least 9%.	**WARNING** It is imperative that the ignition switch be placed to the NORMAL position before turning the starting fuel switch to AUTO. If the ignition switch is turned to NORMAL after the starting switch is placed to AUTO, an explosion, followed by fire, will very likely occur.
4. Starting fuel sequence switch—AUTO at 9 to 10% or higher stabilized RPM. **Note** The engine should start immediately and accelerate to a stabilized speed of 28 to 35% RPM depending upon ambient air temperature.	FALSE START—Combustion does not occur within 5 seconds after moving starting fuel switch to AUTO. 1. Starting fuel switch—OFF. 2. Starter switch—STOP-START momentarily and wait until engine comes to a complete stop. 3. Fuselage tank switch—OFF. 4. Have ignition system checked before attempting new start. 5. Drain tailpipe by pulling it down to the ground and allowing it to drain for at least 15 to 30 seconds or until all fuel has drained out before new start.
	**WARNING** If the tailpipe has been improperly installed, fuel may leak into the area between the tailpipe and fuselage skin. Check for presence of fuel below the tailpipe joint before draining.
	HANGING START. Engine speed stabilizes at any rpm between 12 and 18% for more than 3 seconds after ignition occurs. 1. Starting fuel switch—OFF. 2. Ignition switch—OFF. 3. Fuselage tank switch—OFF. 4. Allow engine to windmill until all traces of combustion disappear. 5. External power—disconnect. 6. Make entry in Form I. 7. Do not attempt new start until aircraft has been inspected and cleared by engineering.
5. Closely monitor tailpipe temperature gage for excessive temperatures. **Note** 900°C is the maximum allowable starting acceleration temperature.	HOT STARTS—Any start in which the tailpipe temperature exceeds the limits specified in Section V shall require entry in Form I.

NORMAL PROCEDURE	IN THE EVENT OF MALFUNCTION
	1. Starting fuel switch—OFF. 2. Ignition switch—OFF. 3. Fuselage tank switch—OFF. 4. Disconnect external power after all traces of combustion disappear. 5. Wait until engine comes to a complete stop. 6. Make entry in Form I. 7. Investigate cause before attempting new start.
6. At 28 to 35% stabilized RPM—Throttle to IDLE.	If external power is disconnected before the throttle is placed to IDLE or before the generator cut in speed is reached (20 to 30% RPM) the engine fuel supply will be cut off. Proceed as follows: 1. Starting fuel switch—OFF. 2. Ignition switch—OFF. 3. Fuselage tank switch—OFF. 4. Allow engine to windmill to a complete stop before attempting a new start.
7. Starting fuel switch—OFF.	It is recommended that the starting fuel switch be turned OFF by pushing the guard down to avoid the possibility of inadvertently placing the switch in the MANUAL position (pushing the guard down will turn the switch to the OFF position from either the AUTO or MANUAL positions). The switch must be left in the OFF position at all times except during actual starting procedures. If the switch is left in the AUTO position the automatic starting system will be energized whenever the throttle is placed aft of the IDLE position. If it is left in the MANUAL position both the normal and emergency fuel systems will operate; there will be no governor protection and overspeeding will very likely occur.
8. With the throttle in the IDLE position check all engine instruments within the desired ranges. (Refer to Section V.)	
9. External power source—Disconnect.	
10. Battery switch—ON.	If the filter icing warning light comes on, hold the fuel filter de-icing switch in the ON position until the warning light goes out. If the warning light does not go out after holding the de-icer switch on for from 20 to 30 seconds, shut down the engine and have the filter checked for dirt or faulty operation.
11. Flight instrument power switch—On (right or left)—On early airplanes, inverter power, inverter relay and turn and bank circuit breakers—push in.	
12. Cage Gyro.	

AUTOMATIC START—AFT COCKPIT.

To make an automatic start from the aft cockpit, complete the following checks:

1. FRONT COCKPIT, throttle—OFF (stop-cocked).
2. FRONT COCKPIT, battery switch—ON.
3. FRONT COCKPIT, generator switch—ON.
4. FRONT COCKPIT, ignition switch—NORMAL.
5. AFT COCKPIT, Master battery-generator switch—OFF.
6. AFT COCKPIT, ignition switch—OFF.

Follow the normal procedural steps as listed for the Automatic Start—Front Cockpit.

Note

The throttle in the aft cockpit cannot be placed in the OFF position once it has been moved to IDLE.

MANUAL START. (Not applicable with J33A-20 engine.)

Refer to Section III.

AFTER START—BEFORE TAXI.

Note

No warm-up is required.

1. Radios—ON; check control in the desired cockpit by illumination of the VHF or UHF control indicator light.
2. Check the engine instruments within limits as specified in Section V.
3. Hydraulic pressure—950 to 1100 psi.
4. Loadmeter—Indicating within limits.
5. Student lockout—If indicator is glowing—push lockout release button.
6. Aileron tabs—check operation and set in neutral position.
7. Elevator trim tabs—Check operation of the elevator trim tabs with both elevator trim override switch (if installed) and the control stick trim switch. Check operation of the neutral indicator light with both controls.

Note

If the control stick trim switch sticks in any position, shut down the engine and make entry in Form I. Do not fly the aircraft.

8. Wing flaps—DOWN 30° (70%).
9. Dive flaps—UP.
10. Recheck all ground safety pins—removed and counted.
11. Inverters—Check.

EMERGENCY FUEL SYSTEM CHECK. (Not applicable to aircraft equipped with the J33-A-20 engines.) The emergency fuel system check can be made either before or during taxiing, depending upon the congestion of the parking ramp or taxi ways.

To make the check, proceed as follows:

1. Fuselage tank switch—OFF. (Reduces pressure to the engine pump and aids in simulating pump failure.)
2. Emergency fuel switch—OFF.
3. Starting fuel switch—OFF.
4. Advance throttle to between 40 and 60% rpm and allow engine speed to stabilize.
5. Move emergency fuel system checkout switch to CHECKOUT and hold. Observe the following:
   a. RPM will drop from 2 to 12%.
   b. The amber emergency fuel indicator light will come on. The red light will stay on. The green light may or may not come on depending upon the type of pressure switch installed.

CAUTION

If a flame-out occurs, continue to hold the emergency fuel checkout switch to CHECKOUT and close throttle to—OFF.

6. Release the emergency fuel system checkout switch while rapidly retarding the throttle. When the engine returns to the main fuel system the green and amber emergency fuel indicator lights will go out and the red light will stay on.
7. Fuselage tank switch—FUS or ON.

CAUTION

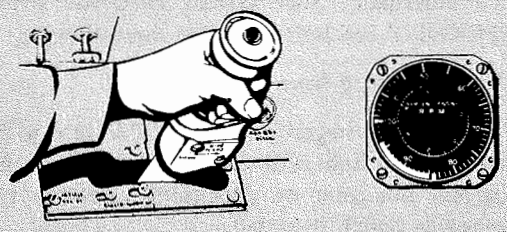
Be sure to turn the fuselage tank switch to FUS or ON after completing the check, or a partial power failure may occur during climb.

8. Emergency fuel switch—TAKE-OFF AND LAND—Note green light On; red and amber lights Off.

EMERGENCY FUEL SYSTEM POWER CHECK. If a full throttle emergency power check is desired, proceed as follows: (Refer to figure 2-5 for emergency RPM limits on Emergency Fuel System.)

1. Fuselage tank switch—FUS or ON.
2. Advance throttle to between 40 to 60% rpm and allow engine speed to stabilize.
3. Emergency fuel switch—EMERG.
4. When the amber emergency fuel indicator light comes on, retard the throttle to IDLE and note engine rpm, then advance the throttle slowly to determine the maximum engine rpm available consistent with compressor inlet (approximately the same as outside air) air temperature, as shown in the table, (figure 2-5).

ENGINE RPM LIMITS ON EMERGENCY FUEL SYSTEM



COMPRESSOR INLET TEMPERATURE °C	°F	MINIMUM RPM (PER CENT)	MAXIMUM RPM (PER CENT)
−20	−4.0	89.3	93.3
−15	5.0	90.0	94.0
−10	14.0	90.6	94.6
− 5	23.0	91.3	95.3
0	32.0	92.0	96.0
5	41.0	92.7	96.7
10	50.0	93.3	97.3
15	59.0	94.0	98.0
20	68.0	94.7	98.7
25	77.0	95.3	99.3
30	86.0	96.0	100.0
35	95.0	96.6	100.6
40	104.0	97.3	101.2
45	113.0	98.0	101.8

Figure 2-5

The tailpipe temperature must be maintained within limits by means of throttle movement since the emergency fuel control unit does not provide acceleration control.

5. Move the emergency fuel switch to OFF while rapidly retarding the throttle, to return to the main fuel system (the green and amber lights will go out).

ENGINE FUEL PUMP CHECK. (On aircraft equipped with the J33-A-20 engines.) Hold the fuel pump switch to the CHECK position at not more than 50% engine rpm and note that the amber fuel pump warning light comes on. The light should go out after the switch is released to the OFF position.

TAXI INSTRUCTIONS.

1. Check that both cockpit sills are clear and position the canopy as desired.
2. Hold brakes and signal ground crew to remove wheel chocks. (It may be necessary to pump the brakes.)
3. Advance throttle smoothly to approximately 70% rpm before releasing brakes. Allow the aircraft to gain momentum straight ahead before making turns. Throttle may then be retarded as turn is entered, to avoid blasting adjacent aircraft or equipment. Forward momentum should be maintained if on soft ground or any time turns of short radius are made, since it is difficult to start moving under those conditions. Brakes must be used for steering. Taxi time should be cut to the absolute minimum. A good rule to remember is: Every minute spent on the ground requires between 3 and 4 gallons of fuel or subtracts about 7 miles from the cruising range of the airplane.
4. For taxiing at night, place the landing-taxi light switch in the TAXI position. For landing or take-off when light is desired, place this switch in the LANDING LIGHT position. Be sure to turn the lights OFF as soon as gear is retracted for take-off.

CAUTION

The main fuel control is designed to prevent excessive acceleration with resulting flame-out or major damage to the engine. If the throttle is advanced abruptly, the tailpipe temperature

should not exceed 899°C. For normal taxi or in-flight throttle applications, the throttle should not be advanced so rapidly that 715°C tailpipe temperature is exceeded, as repeated operation above this temperature will shorten engine life. Particular care must be exercised until approximately 60-70% rpm is reached, above which speed the main fuel control is effective in maintaining temperatures below 715°C.

BEFORE TAKE-OFF.

Note

Refer to the "BEFORE TAKE-OFF" check list on the center instrument panel in each cockpit.

Make the following checks:

1. Check main wing and leading edge fuel tank boost pump operation by turning the switches on separately, observing the indicator lights and noting a positive increase on the fuselage tank fuel quantity gage (liquidometer). Return switches to off after check is complete.

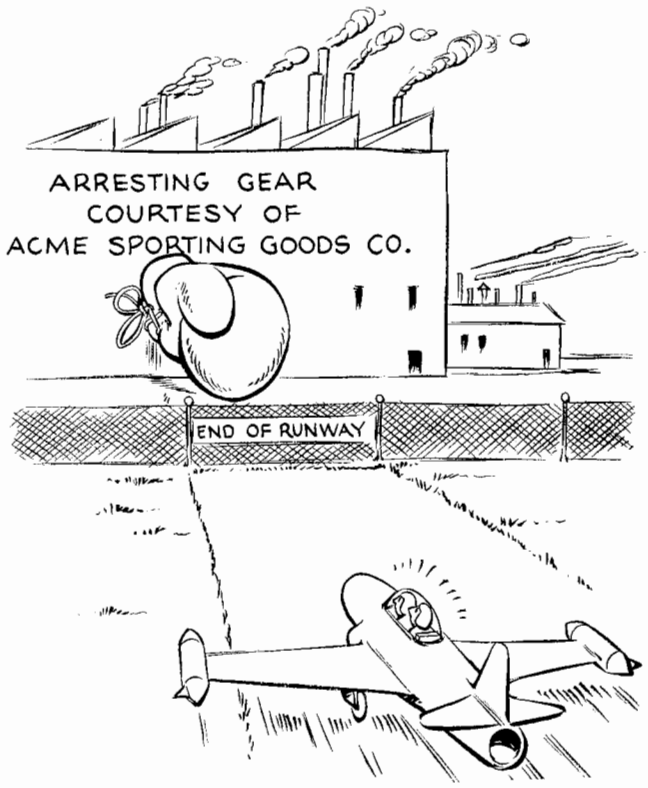
Note

Do not fill fuselage fuel tank to more than 80 gallons for take-off. A stuck float valve in the fuselage fuel tank may result in fuel being forced into the fuselage tank filler well, and from there being drawn through open plenum chamber doors into the plenum chamber. After take-off the plenum chamber doors are closed, and this will not occur.

2. Shoulder harness and safety belt—Tight. Shoulder harness inertia reel lever—UNLOCKED.
3. Recheck wing flaps—DOWN 30°. (70%)

WARNING

Never take off with the wing flaps retracted (UP) as the required take-off run and airspeed are greatly increased.



4. Recheck elevator tab—Neutral (green indicator light ON).
5. Canopy—Close and lock as follows:

CHECK THAT COCKPIT SILLS ARE CLEAR BEFORE CLOSING CANOPY!

a. Notify the other crew member that the canopy is to be closed and wait for confirmation that he is clear before closing.

b. Check both cockpit sills clear before closing.

c. Hold canopy switch to the FULL CLOSE position until the canopy comes down and stops moving.

d. After the canopy is closed, pull the canopy locking handle aft and check that the canopy unlatched red warning light goes out.

6. Surface controls—check for freedom of operation and direction of movement.

7. Align the aircraft with the runway so that the nose wheel will be centered when the brakes are released for take-off.

8. Emergency fuel switch (on aircraft equipped with the J33-A-23 and -35 engines)— TAKE-OFF & LAND, check that the emergency fuel system green indicator light comes on and that the red and amber lights are off. On aircraft equipped with the J33-A-20 engines, check that the amber fuel pump warning light is OFF.

9. Tip tank jettison switch—SAFE or OFF, on airplanes prior to AF Serial 52-9635, the Bomb Salvo button will be used if jettisoning is required. On AF Serials 52-9635 and subsequent, place the jettison switch in the AUTO-DROP position.

10. Jato arming switch—ARM or JATO (if JATO is to be used). Check that JATO READY indicator light glows.

11. Refill the fuselage tank from the wing tanks (if necessary) to between 60 and 80 gallons.

12. Tip tank fuel switch—ON.

13. Oxygen—NORMAL.

14. Throttle—advance to the fully open position.

Note

The allowable governor tolerance may permit the engine to turn up between 98.5 and 101.5% rpm with the throttle fully open. Although 100% is the normal full throttle maximum, any value between 98.5 and 101.5% is acceptable for take-off as long as the maximum tailpipe temperature (715°C) is not exceeded.

CAUTION

If the full open throttle position allows the engine to exceed either 101.5% rpm or 715°C tailpipe temperature retard the throttle as necessary. Do not attempt to take-off below 98.5% rpm.

15. Check fuel, oil and hydraulic pressure—within limits.

16. Loadmeter—Indicating, but not over 0.5.

17. Run up to 100% rpm and check that indicator light above tip tank switch goes out. If tip tanks are only partially full (100 gallons each) it may take from 2 to 5 minutes for the light to go out.

18. Take-off shall be accomplished with the fuselage and tip tank fuel switches ON (up) and the wing and leading edge fuel tank switches OFF.

Note

If operational commitments dictate, it may be considered desirable to gang load the fuel switches, to the ON position, to preclude the possibility of inadvertent fuselage tank depletion.

TAKE-OFF.

NORMAL TAKE-OFF.

For normal take-off with or without tip tanks, proceed as follows:

Note

- Refer to Appendix I for take-off distances required for the gross weight of the aircraft, pressure altitude and air temperature.
- Refer to Section III for take-off emergencies.

1. Head the aircraft straight down the runway, hold the brakes and set the throttle at 100% rpm.

2. Release the brakes and maintain directional control by differential braking until the rudder becomes effective (at approximately 50 knots).

3. At about 85 knots (100 mph) apply back pressure on the stick and raise the nose of the aircraft until the nose wheel just clears the runway. In this attitude the total drag produced is minimum and the aircraft will accelerate more rapidly.

4. At the following speeds, fly the aircraft off the ground by slightly increasing the nose up pitch attitude.

CONFIGURATION	KNOTS	MPH
Clean	110	125
165 gallon tip tanks	115	135
230 gallon tip tanks	120	140

CAUTION

Although it is possible to take off about 10 knots slower than noted above, taking off at too low an airspeed may cause the aircraft to settle back onto the ground. It must be remembered that sufficient airspeed is important when taking off in this aircraft because there is no propeller slip stream to increase the lift of the wing.

5. Landing gear lever—UP. When definitely airborne, check landing gear position indicator and that gear unsafe warning light goes out.
6. Wing flaps—UP between 140-165 knots (160-180 mph). Flaps should be completely up before reaching 175 knots (200 mph). Return the control handle to the OFF position after flaps are up.
7. Climb at about 156 knots (180 mph) to a safe altitude then accelerate to best climbing speed for the remainder of the climb.
8. Tip tank jettison switch—OFF.

5,000 FOOT CHECK (Climbing).

At 5,000 feet above the terrain (or level off altitude, if lower), make the following checks:

1. Emergency fuel switch—OFF (on aircraft equipped with the J33-A-23 and -35 engines).

WARNING

Before turning the emergency fuel switch OFF, check to see that the amber emergency fuel indicator light is off. If the amber light is on, the main fuel system has failed and the engine is running on the emergency fuel system. If such is the case, leave the switch in the TAKE-OFF & LAND position and land as soon as possible.

2. Oxygen Regulator—NORMAL.
3. Fuselage tank gage—Check for tip tank transfer.

Note

If the emergency fuel switch is left in the TAKE-OFF & LAND position and the main fuel system should fail, the emergency fuel system will take over. Since the emergency fuel system has no rpm governing control unit, engine over-speed will very likely occur at full throttle, above 15,000 feet resulting in serious damage to the engine.

CROSSWIND TAKE-OFF.

In addition to the procedures given for normal take-off the following steps are included for crosswind take-off's:

1. Increase the nose wheel lift off speed about 10 knots (12 mph) by holding the nose down a little longer during take-off run.
2. Counter-act drift when the aircraft becomes airborne by lowering the upwind wing or crabbing into the wind.

NIGHT TAKE-OFF.

Night take-off procedures are the same as for daylight take-offs, however, it is recommended that the pilot be currently proficient in instrument flying and have a thorough knowledge of the switch and light locations. The following steps should be accomplished:

1. Adjust cockpit, fluorescent and instrument lights to the desired brilliancy.
2. Check that the gyro instruments have had time to slave and are erected and adjusted properly.

SHORT FIELD TAKE-OFF.

The minimum take-off run is used whenever it is necessary to make a short field take-off or clear an obstacle in minimum distance. It is a maximum performance maneuver with the aircraft lifting off the ground at near stalling speeds. It is closely related to slow flying with the aircraft in a high angle of attack attitude, therefore, it is mandatory that the pilot be proficient in slow flying

in order to maintain a safe margin of control at near stalling speeds.

When it becomes necessary to make a take-off using the minimum take-off run, without the use of JATO or fluid injection it is recommended that the gross weight of the aircraft be decreased as much as possible by reducing the fuel and ammunition (or ballast) load to the bare minimum necessary for the flight.

The initial take-off run is the same as for normal take-off, lifting the nose wheel off at about 85 knots (100 mph). The take-off speed is about 5 to 10 knots slower than normal and the climb should be about 10 knots above the take-off speed until all obstacles are cleared.

If fluid injection is to be used, proceed as follows:

1. Oxygen regulator diluter lever—100%.
2. Throttle—Advance to 98% rpm.
3. Release brakes and start take-off roll.
4. Fluid injection switch—ON. (Note that loadmeter reading does not increase by 0.6 or more.)

CAUTION

Never turn fluid injection on below 90% rpm or when flying above 10,000 feet altitude or the increased water/air ratio may cause flame-out and engine damage.

5. Throttle—Adjust to 100% rpm.
6. After depletion of fluid—Fluid injection switch—OFF.

Note

The complete water alcohol supply must be used during take-off and initial climb if any part of the flight is to be conducted under conditions where ambient air temperatures will be below minus 12°C (10°F).

JATO TECHNIQUE.

Note

Before using JATO, check the weight and balance to make sure that the static load limits are not exceeded. Installation of the JATO bottles moves the C.G. 2.3% aft and the low thrust line of the JATO power vector shifts the "effective" C.G. further aft. Refer to T.O. 1-1B-40 for installation of ballast to get the C.G. as far forward as practical.

JATO thrust tends to raise the nose, this should be resisted during the comparatively short (12 seconds) duration period. Take-off performance will depend somewhat upon the JATO firing point. Minimum ground roll will be obtained when the units are fired shortly after the start of the take-off run. The best performance in clearing 50-foot obstacle will be obtained by firing the units later on in the take-off run so that the units will be expended at about the same time the aircraft clears the obstacle.

If JATO is to be used, proceed as follows:

AF Serials 48-356 thru 50-401.

1. GUNS-JATO master switch (aft cockpit)—ARM.
2. GUNS-JATO selector switch (front cockpit)—JATO.
3. Check illumination of the JATO READY indicator light.
4. Fire the JATO units (when ready) with the control stick trigger from either cockpit.
5. GUNS-JATO selector switch—OFF or GUNS after the JATO units are expended.

AF Serials 50-402 and subsequent.

1. JATO READY switch (front cockpit)—ARM.
2. Check illumination of the JATO READY indicator light.
3. Fire the JATO units (when ready) by pressing the JATO firing button in either cockpit.
4. JATO arming switch—SAFE after the JATO units are expended.

WARNING

If, for some reason, the JATO units are not used or misfire during the take-off run, they should be jettisoned before climbing to altitude. The units may explode if subjected to low temperatures at high altitudes.

CLIMB.

The recommended climbing speeds are given in the climb chart, Appendix I. The best rate of climb can be obtained at 100% rpm, although under some conditions it may be advantageous to climb at 96% rpm. Do not operate the engine at 100% rpm for more than 30 minutes at any one time.

FLIGHT CHARACTERISTICS.

Refer to Section VI for information concerning flight characteristics.

SYSTEMS OPERATION.

Refer to Section VII for information regarding systems operations.

DESCENT.

(Refer to the descent chart, Appendix I.) Rapid descents generally cause the most severe fogging condition on the canopy and windshield since the aircraft can descend to low altitudes where the air conditioning system will bring in humid air more rapidly than the system can raise the internal temperature. Therefore, it is necessary to have the canopy and windshield as warm as possible before descent to prevent excessive condensation. Since descents cannot always be anticipated, it is recommended that the cockpit air temperature at altitude be the maximum consistent with reasonable pilot comfort.

5,000 FOOT CHECK (DESCENDING).

At 5,000 feet above the terrain, make the following checks:

1. Emergency Fuel Switch—TAKE-OFF and LAND (on aircraft equipped with the J33-A-23 and -35 engines).
2. Radio—Proper channel.
3. Fuselage tank fuel gage—check quantity.

APPROACH.

Refer to figure 2-6 for typical landing pattern.

Keep the engine speed at 50% rpm or above during the approach so that the engine will accelerate more rapidly if power is applied. Maintain a shallow glide path during the last part of the final approach. A minimum of 20 gallons of fuel will be required for a close-in go-around pattern.

The minimum final approach speed (120 knots or 140 mph) should be increased 3 knots for each additional 100 gallons of fuel over the first 200 gallons aboard plus ½ of the velocity of the reported headwind to allow for possible gusts. The increase in speed should be obtained by application of power accompanied with a slight decrease of glide angle.

CAUTION

Do not extend the landing gear and dive flaps simultaneously while the aircraft is in a banking attitude. The drop in hydraulic pressure may cause a momentary loss of aileron boost control.

Dive flaps may be used as desired during the approach and landing. Their use will steepen the glide angle, reduce floating and decrease the length of landing roll.

LANDING.

The landing technique is similar to that of conventional tricycle landing gear airplanes, and the landing attitude is about the same; that is, main wheels first and tail slightly low. The landing pattern and airspeeds are shown in figure 2-6. The landing distances are given in Appendix I.

CAUTION

Care should be exercised to avoid extreme tail low landing attitudes which can cause the tail section to drag on the runway.

Note

Refer to Section III for landing emergencies.

If, for some reason, the flaps cannot be lowered, approach the runway approximately 15 knots (17 mph) faster than normal and allow for a much flatter gliding angle and longer landing roll. (Refer to Flight Characteristics SectionVI.)

NORMAL LANDING.

1. Emergency fuel switch—TAKE-OFF & LAND before entering traffic pattern.
2. Dive flap switch—DOWN (if desired).

3. Landing gear handle—DOWN (and Jiggle) (below 195 knots—225 mph). Check landing gear indicators and hydraulic pressure.

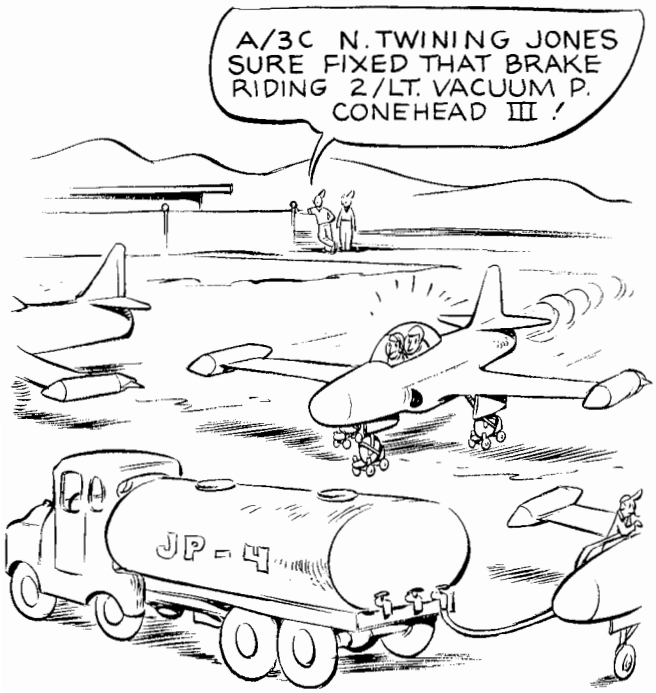
CAUTION

Do not lower landing gear and dive flaps at the same time.

4. Wing flaps switch—DOWN (100%—45°, below 175 knots—200 mph).
5. Engine speed—Not less than 50% rpm until landing is assured.

CROSSWIND LANDING.

The crosswind landing procedure is the same as for normal landings with the exception of drift correction. It is recommended that the upwind wing-low (slip) method of drift correction be used. In very strong crosswinds a combination of the wing-low and crab method for counteracting drift may be used.



SHORT FIELD LANDINGS.

CAUTION

Short field landings incorporating continuous braking action should not be practiced more often than once every 15 minutes. The heat generated by excessive braking will cause tire failure.

To make a short field landing proceed as follows:

1. Plan approach early and shoot for the end of the runway.
2. On final approach maintain 105 to 110 knots using power. If any obstacles have to be cleared, maintain 115 to 120 knots.
3. Retract flaps after flare-out or upon touchdown.

CAUTION

Do not retract flaps before or during the flare-out or above 2 feet from the runway, or the aircraft will drop in hard.

4. Get the nose wheel down as soon as possible and apply brakes smoothly and steadily to the point just short of locking the wheels.

WET RUNWAY LANDINGS.

If a landing is made on a wet runway which is marginal in length for a normal landing procedure, use the short field landing procedure.

GO-AROUND.

The ability of jet aircraft to accelerate at low speeds is inferior to that of propeller driven aircraft. The acceleration time will be accentuated if the engine rpm is less than 50% rpm. In the event that the landing cannot be completed, the decision to go-around should be made as soon as possible during the final approach.

Complete the following steps for the go-around procedure:

1. Throttle—Open to 100%.
2. Dive flaps—UP.
3. Retract landing gear only after adequate flying speed is attained, as a touchdown may be necessary during go-around.
4. Retract flaps and start climb-out as prescribed for normal take-off.

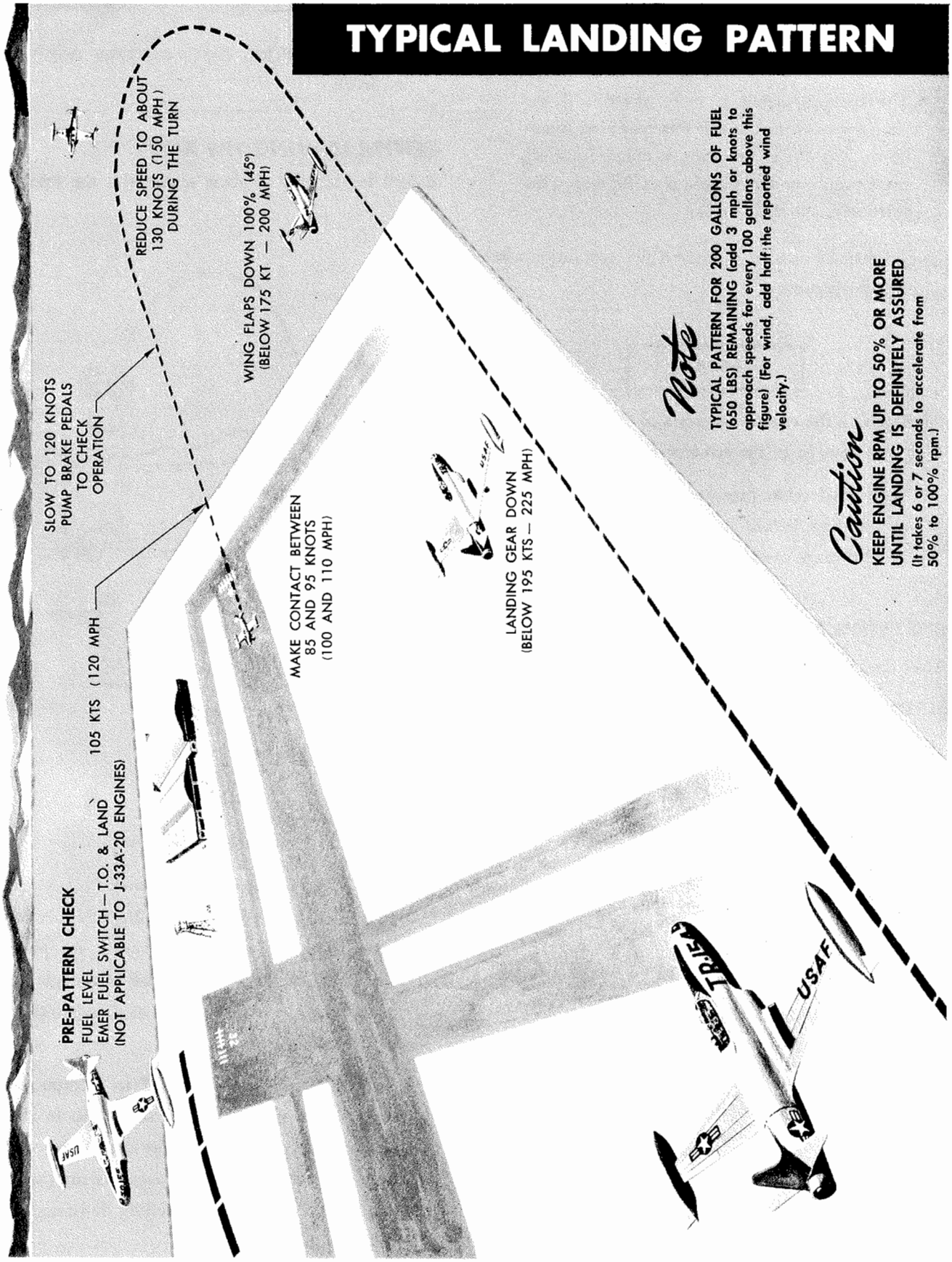

TYPICAL LANDING PATTERN
PRE-PATTERN CHECK
FUEL LEVEL
EMER FUEL SWITCH — T.O. & LAND
(NOT APPLICABLE TO J-33A-20 ENGINES)
105 KTS (120 MPH
SLOW TO 120 KNOTS
PUMP BRAKE PEDALS
TO CHECK
OPERATION
REDUCE SPEED TO ABOUT
130 KNOTS (150 MPH)
DURING THE TURN
WING FLAPS DOWN 100% (45°)
(BELOW 175 KT — 200 MPH)
MAKE CONTACT BETWEEN
85 AND 95 KNOTS
(100 AND 110 MPH)
LANDING GEAR DOWN
(BELOW 195 KTS — 225 MPH)
Note
TYPICAL PATTERN FOR 200 GALLONS OF FUEL (650 LBS) REMAINING (add 3 mph or knots to approach speeds for every 100 gallons above this figure) (For wind, add half the reported wind velocity.)
Caution
KEEP ENGINE RPM UP TO 50% OR MORE UNTIL LANDING IS DEFINITELY ASSURED
(It takes 6 or 7 seconds to accelerate from 50% to 100% rpm.)
USAF
J-35

Figure 2-6

AFTER LANDING.

Note

- The braking action is more effective if the wing flaps are immediately retracted after touchdown. The lift of the wing is reduced putting more weight on the wheels, thus improving the traction of the tires.

Canopy may be opened as desired for ventilation after turning off the runway.

CAUTION

- Opening the canopy in excess of 50 knots may cause damage to the actuator mechanism.
- Wait until cabin pressure is equal to outside air pressure before unlocking the canopy to avoid damage to canopy mechanism.

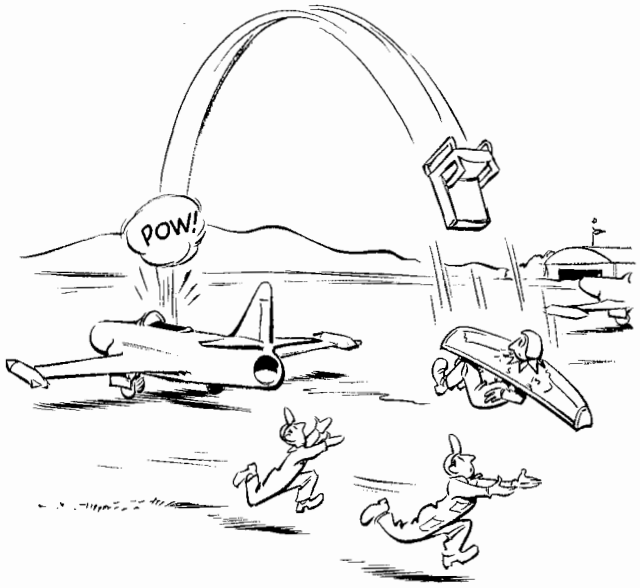
STOPPING THE ENGINE.

After the aircraft is parked, make the following checks:

1. Dive flap switch—DOWN.
2. Wing flaps—As desired.
3. Emergency fuel switch—OFF.
4. Tip Tank Jettison switch or Bomb Release switch—SAFE or OFF.
5. Radio and navigational equipment—OFF, if not needed for taxi.
6. Canopy—Full open.
7. Fuel tank switches—OFF.
8. All radio equipment—OFF.
9. Throttle—OFF.
10. Trim tabs—Neutral.
11. Ignition switch—OFF.
12. Inverter Power and Relay Circuit breakers—pulled out. On later aircraft, flight instrument power switch —OFF.
13. Battery switch—OFF.
14. All other switches, except generator switch—OFF or SAFE.

BEFORE LEAVING THE AIRPLANE.

Before leaving the airplane accomplish the following:

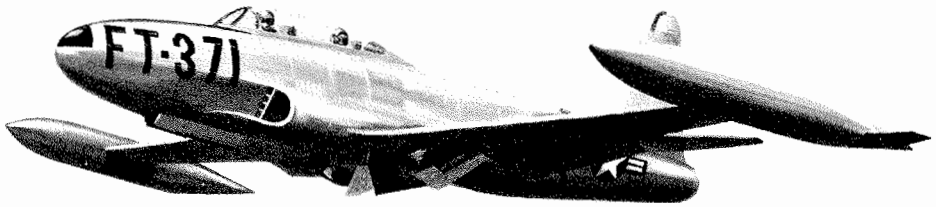


CAUTION

- In order to preclude the possibility of inadvertently firing the seat during egress, the pilot should check that the ground safety pin is installed in the armrest on all modified aircraft before raising out of the seat.
- For all aircraft not modified to incorporate the addition of the ground safety pin in the armrest, the pilot should raise out of the seat by placing his hands on the armrests and pushing himself up and not by pulling down on the canopy sill.

1. Install canopy and ejection seat ground safety pins.

2. Release the parking brake (if set) after wheel chocks are in place.
3. Lock the surface controls if necessary.
4. Complete the entries in the aircraft forms.
5. Close the canopy (if necessary).
6. Install the landing gear and tip tank ground safety pins.



SECTION III EMERGENCY PROCEDURES

ENGINE FAILURE.

GENERAL. The majority of jet engine failures are the result of improper fuel flow caused by fuel system malfunction or incorrect technique in fuel system management. Specific information of this type of engine failure is described under FUEL SYSTEM FAILURE in this section. The engine and fuel system instruments will provide indications of fuel system failure prior to and during actual engine flame-out. If engine failure is due to malfunction or mismanagement of the fuel system, and if time permits, an air start can usually be accomplished. If the engine failure is caused by obvious mechanical or material failure within the engine, an air start should not be attempted.

FLIGHT CHARACTERISTICS.

The flight characteristics of this airplane with a dead engine are normal and rapid trim revisions are not necessary. The glide speed that gives the greatest distance for the least loss of altitude is about 160 knots (185 mph) with clean configuration (landing gear, wing flaps and dive flaps up). The engine driven hydraulic pump will supply sufficient pressure to operate all services when the engine is windmilling at 10% rpm or above; however, operating time will be slightly longer. At the optimum glide speed, the engine will windmill at 10% rpm or higher. At lower airspeeds the engine windmilling rpm will decrease and the operating time for the hydraulic units will correspondingly increase. (Refer to figure 3-1 for glide distances.)

AIR-STARTS.

Before attempting an air-start, a trouble check should be made to determine the cause of the flame-out. If the flame-out was accompanied by an explosion, overheating condition, vibration, strong fuel fumes in the cockpit or fire, indicating mechanical failure within the engine, do not attempt an air-start. If it can be determined that the flame-out was caused by fuel starvation and there is fuel available in the aircraft, an air-start should be successful if the reason for the fuel starvation is remedied. (Refer to FLAME-OUT CAUSES in this section.)

Air-starts can be made either automatically or manually. It is recommended that the automatic start be tried first in all cases, except when the automatic starting fuel system becomes inoperative.

If several attempts to make an automatic start are unsuccessful, then a manual start should be attempted.

If an unsuccessful air-start results in an explosion, heavy vibration, strong fuel fumes in the cockpit or if the overheat or fire warning light comes on and stays on, cut the throttle and turn off the starting fuel switch, main fuel shut-off switch and all other fuel switches—Do not attempt another air-start.

Refer to figure 3-2 for air-start procedures.

ENGINE FAILURE DURING TAKE-OFF.

If an engine failure should occur during or following take-off run, the pilot will have to use his own discretion regarding any critical situations that may arise. Proper orientation of the physical characteristics of the take-off runways and the surrounding area, will greatly assist the pilot regarding any decisions he will have to make.

Note

In the event of an aborted take-off involving landing gear retraction, the canopy should be jettisoned before the aircraft comes to a complete stop. If the canopy is jettisoned after the aircraft comes to a complete stop and there is leaking fuel in the vicinity from ruptured fuel cells, the fuel may be ignited by the explosion of the canopy charge. If it is possible and time permits, the electrical or mechanical methods of opening the canopy should be used.

COMPLETE POWER FAILURE BEFORE LEAVING THE GROUND.

If complete power failure occurs before leaving the ground, accomplish the following:

1. Throttle—OFF immediately.
2. Use the brakes as much as possible without sliding the tires, since rolling friction is more effective than sliding friction. If necessary, release the tip tanks. The aircraft may more easily be braked to a stop if the tip tanks are released.
3. Wing flaps—UP (retracting the flaps improves braking efficiency).
4. If a crash is imminent—jettison the canopy.
5. Landing gear lever—UP, if there is insufficient runway remaining for a normal stop.

Note

- It may be necessary to depress the landing gear lever lock release while raising the lever in order to retract the landing gear.
- If the landing gear is retracted, the pilot will have to decide whether to retain or release the tip tanks. If the tanks are retained, they may rupture and spray or leak fuel creating a fire hazard. If the tanks are jettisoned, they may overtake and collide with the aircraft resulting in serious damage and fire.

6. Battery and generator switches—OFF.
7. Get out of the airplane immediately after it stops moving.

COMPLETE POWER FAILURE AFTER LEAVING THE GROUND.

If a complete power failure should occur after leaving the ground, the procedure for effecting a safe landing will depend upon the position of the aircraft relative to the runway. The airspeed, altitude, and length of remaining runway will directly affect the pilot's decisions.

If the engine failure occurs a few feet off the ground and there is sufficient runway remaining, the aircraft should be landed back on the runway and brought to a stop either with brakes or with landing gear up, depending upon the amount of runway left.

If the engine failure occurs when the aircraft is several feet in the air and there is insufficient runway remaining, the aircraft should be landed straight ahead if possible. If there is sufficient altitude and airspeed to maintain directional control, it may be possible to land the aircraft on another runway or in an adjacent field. (Refer to Crash Landings in this section.)

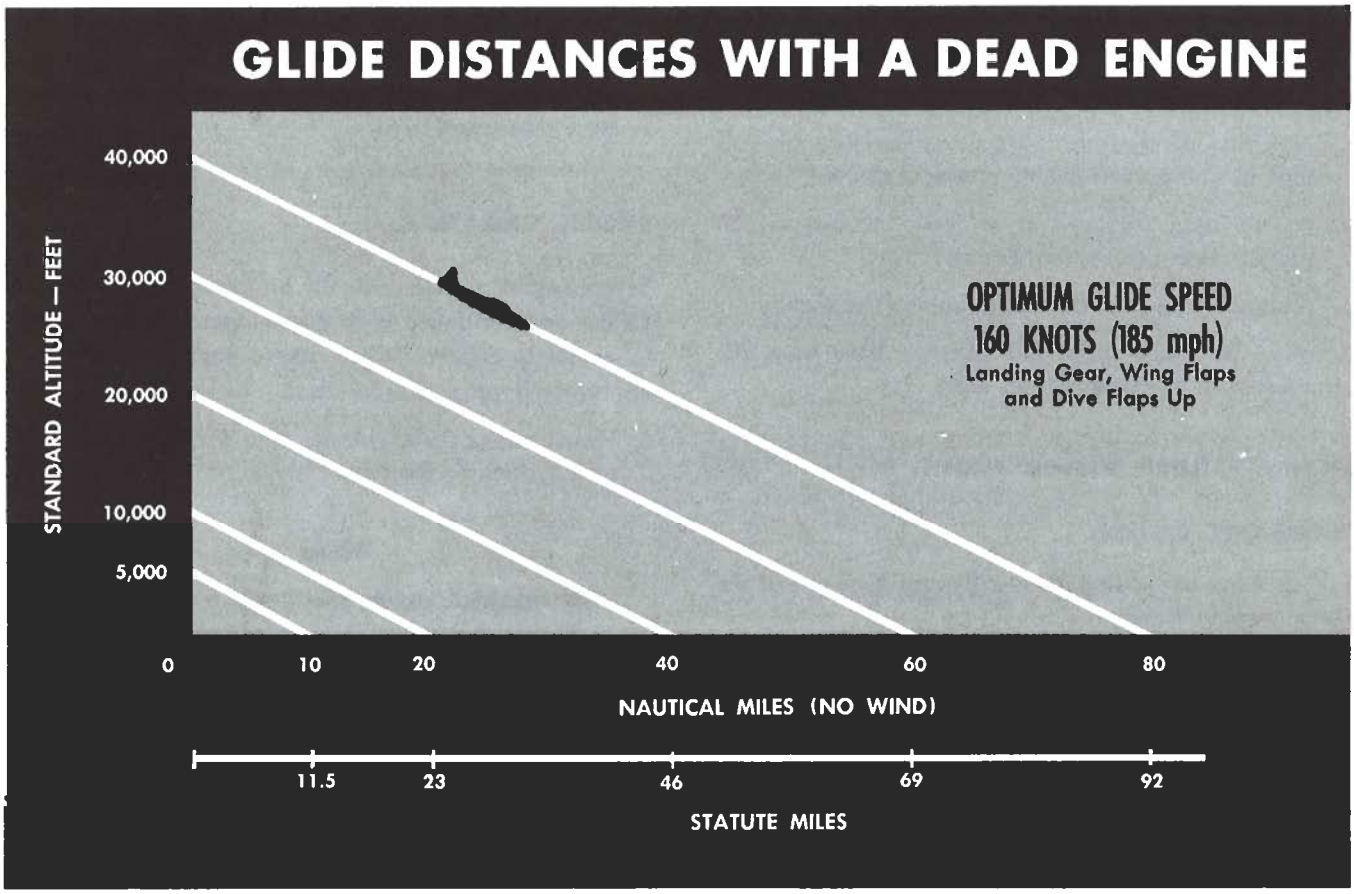


Figure 3-1

If a power failure occurs after leaving the ground, accomplish as much of the following as possible:

1. Maintain flying speed and control until contact is made.
2. Throttle—OFF.
3. The pilot will have to decide whether to retain or release the tip tanks.
4. Land straight ahead if possible.
5. Landing gear—UP if there is insufficient runway remaining or if the terrain is rough.
6. Dive flaps—Leave UP.
7. Wing flaps—Extended until touchdown is made.
8. Main fuel shut-off switch—CLOSED (guard up).
9. Jettison canopy and lock shoulder harness.

CAUTION

It is not normally advisable to jettison the canopy below a safe bail out altitude until the aircraft is within about one foot of the ground. Dirt in the cockpit may get in the pilot's eyes and the canopy does not always clear the empennage at low airspeeds.

10. Battery and generator switches—OFF before making contact with the ground.

PARTIAL POWER LOSS DURING TAKE-OFF.

The pilot must make the decision to continue or abort the take-off. If the decision is to cut off the power, proceed as described for Total Power Failure preceding. If the decision is to continue flight, release the tip tanks, if necessary, and retract the landing gear. If flight can be sustained, proceed as follows:

RPM 95% TO 80%.

1. Emergency fuel switch—EMERG. (lift guard).
2. Throttle—maintain rpm and tailpipe temperature within limits.
3. Proceed with steps 4 thru 6 following.

RPM 80% OR LOWER.

1. Throttle—retard to approximately 80% power position.
2. Emergency fuel switch—EMERG. (lift guard).
3. Throttle—advance as tailpipe temperature permits until maximum permissible power is reached.
4. Try to attain airspeed of at least 130 knots (150 mph). Lower the nose if necessary.
5. Wing flap control—UP at 130 knots (150 mph).
6. When sufficient speed and altitude have been obtained, return to the field and land.

ENGINE FAILURE DURING FLIGHT.

FLAME-OUT CAUSES.

Engine flame-out in flight is usually caused by one of the following conditions:

1. Failure of fuel to feed because of negative acceleration.
2. Fuselage tank running out of fuel.
3. Failure of one of the fuel system units.
4. Inability of the filter to pass fuel because of stoppage by ice or dust accumulation.

In the cases of flame-out given in preceding paragraphs, a restart may be accomplished. However, prior to restarting, accomplish the following as required:

1. When there is no fuel in the fuselage tank, start transferring from the wing and tip tanks if fuel is available from those sources.
2. Place fuselage fuel tank switch in the FUS position.
3. Remove the ice from the fuel filter by use of fuel filter de-icer switch.
4. On early airplanes, use the by-pass system if fuel cannot be transferred.

ENGINE VIBRATION.

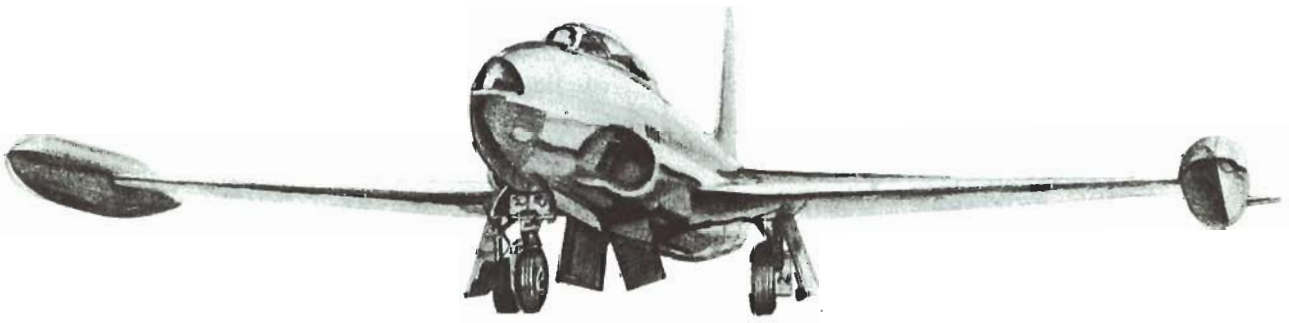
Severe engine vibration usually indicates engine materiel failure and continued high power operation may result in complete failure. When severe engine vibration is encountered, proceed as follows:

1. Slowly adjust the engine speed to a setting which will give minimum vibration.

Note

The adjusted engine speed will not eliminate vibration but will reduce its severity and may permit continued use of the engine until a landing can be made.

2. Emergency fuel switch should be placed in EMERG. after engine speed is reduced because main fuel control failures have occurred when vibration is encountered.
3. Closely watch tailpipe temperature gage. If the temperature rises above the maximum allowable in-flight temperature, shut down the engine and close the cockpit pressure inlet ducts. Check for presence of fire in the aft section.
4. A normal landing should be made as soon as possible.



MANUAL GROUND STARTS

GENERAL. It is not recommended that a manual ground start be used if the automatic starting system is available. If a manual ground start is necessary, proceed as follows:

MANUAL START—FRONT COCKPIT. (Aircraft equipped with the J-33A-20 engines have no provisions for a manual start.)

Note

The REAR COCKPIT master generator-battery switch must be in the ON position and the REAR COCKPIT ignition switch must be in the NORMAL position before making a start from the front cockpit.

NORMAL PROCEDURE	IN THE EVENT OF MALFUNCTION
1. Fuselage tank switch—FUS or ON (up).	
2. Starter switch—Hold to START position for 3 seconds, then release.	**STARTER FAILS TO PRODUCE 9 TO 10% RPM.**
Note Starter should bring engine speed to at least 10% rpm. Do not attempt to start the engine below 9% rpm as it may cause serious damage.	1. Starter switch—Hold momentarily to STOP-START position. Allow engine to windmill to a complete stop. 2. Fuselage tank switch—OFF. 3. Secure adequate external power prior to attempting new start. If start must be made without suitable external power, the battery switch may be turned ON after external power has developed maximum possible rpm. Starts on battery power alone should be made only in an emergency.
3. Ignition switch—NORMAL after rpm has reached at least 9%.	
4. Starting fuel switch—MAN at 9 to 10% or higher stabilized rpm.	
5. Emergency fuel switch—EMERG.	
6. At maximum obtainable rpm (not less than 9%)—move the throttle rapidly to the wide open position.	**FALSE START.** (Ignition does not occur within 3 seconds after throttle is opened.)
7. When fuel pressure starts to build up—retard the throttle to IDLE.	1. Throttle—OFF (stop-cocked). 2. Starter switch—STOP START. Momentarily and release. 3. Emergency fuel switch—OFF. 4. Fuselage tank switch—OFF. 5. Allow engine to windmill to a stop. 6. Have ignition checked and drain tailpipe by pulling the tailpipe down to the ground and allowing it to drain for 15 to 30 seconds or until all fuel has drained out, before attempting new start.

NORMAL PROCEDURE	IN EVENT OF MALFUNCTION
8. As soon as combustion rumble is heard and tailpipe temperature starts to rise, starting fuel switch—OFF.	**WARNING** • If the tailpipe has been improperly installed, fuel may leak into the area between the tailpipe and fuselage skin. Check for presence of fuel below the tailpipe joint before draining. • It is recommended that the starting fuel switch be turned OFF by placing the guard down to avoid the possibility of inadvertently placing the switch in the AUTO position.
9. Closely monitor tailpipe temperature gage for excessive temperatures. **Note** 900°C is the maximum allowable starting temperature.	**HOT STARTS.** Any start in which the exhaust temperature reaches 1000°C constitutes a hot start. (Refer to Section V.)
10. After engine starts—Adjust the throttle as required to keep the tailpipe temperatures below 900°C. Attempt to maintain the temperature between 800 and 900°C until engine reaches idle rpm. **Note** It may be necessary to pull the throttle back beyond the IDLE position to keep from overheating during the start.	If tailpipe temperature reaches 900°C for 5 seconds or any temperature above 900°C for any length of time: 1. Throttle—OFF (stop-cocked). 2. Starting fuel switch—OFF. 3. Emergency fuel switch—OFF. 4. Ignition switch—OFF. 5. Fuselage tank switch—OFF. 6. Disconnect external power after all traces of combustion disappear. 7. Make entry in form I. 8. Investigate cause before attempting a new start. **Note** Do not disconnect external power supply until emergency fuel switch is in the OFF position or until the generator cuts in. A sudden transfer from the emergency system to the normal system may result in a tailpipe temperature surge.
11. Advance the throttle to about 55% rpm. 12. Retard throttle rapidly and at the same time turn emergency fuel switch OFF in order to return engine to main fuel system. 13. At idling speed (28 to 35%rpm) check all engine instruments within the desired range. (Refer to Section V.) 14. External power supply—Disconnect. 15. Battery switch—ON. 16. Flight instrument power switch—ON (right or left). On early airplanes inverter power, inverter relay, and turn and bank circuit breakers—In (Push to reset). Cage gyro.	

MANUAL START—AFT COCKPIT.

To make a manual start from the aft cockpit, complete the following checks:

1. FRONT COCKPIT, throttle—OFF.
2. FRONT COCKPIT, battery switch—ON.
3. FRONT COCKPIT, generator switch—ON.
4. FRONT COCKPIT, ignition switch—ON.
5. AFT COCKPIT, master battery—generator switch—OFF.
6. AFT COCKPIT, ignition switch—OFF.

Follow the normal procedural steps as listed for the MANUAL START—FRONT COCKPIT.

Note

The throttle in the aft cockpit cannot be placed in the OFF position once it has moved to IDLE.

RESTARTING ENGINE DURING FLIGHT.

(Refer to figure 3-2.)

Note

The normal ground starting procedure may work, provided the flame-out resulted from something other than failure of the main engine-driven fuel pump or the main fuel control unit.

FIRE.

GENERAL. There is no fire extinguishing system installed in the aircraft. Illumination of the amber tail section overheat warning light is generally caused by the following:

1. Improper installation of, or defective, warning light temperature bulbs, or circuit.
2. A leaky tailpipe, tailcone or connections.
3. Very rapid advancement of the throttle and malfunction of the Bendix fuel control.
4. Parking for excessive periods in a strong tailwind, permitting heat to collect in the tail section.
5. Climbing at low airspeed and high engine rpm.
6. It may also indicate a fire.

Illumination of the red plenum chamber fire warning light is generally caused by:

1. Defective warning light temperature bulbs or circuit.
2. Hot spots in the flame tube or a broken flame tube.
3. FIRE.

PROCEDURE WHEN FIRE WARNING LIGHT COMES ON.

On take-off if sufficient runway remains:

1. Throttle—OFF.
2. Main fuel shut-off switch—CLOSE.
3. Stop as soon as possible.

If the plenum chamber fire warning light comes on too late to abort the take-off or just after becoming airborne, check the following:

1. Fluctuating fuel pressure and rpm.
2. Loss of engine rpm.
3. Smoke entering cockpit thru pressurization ducts.
4. Smoke trail behind aircraft.

If any of these additional indications are evident, a fire probably exists. If you decide you are on fire and power is not required to clear an obstacle:

1. Throttle—OFF.
2. Main fuel shut-off switch—CLOSE.
3. Drop the tip tanks, if possible.
4. Make an emergency landing or, if possible, consider pulling up and ejecting.

If no fire exists, land as soon as possible.

PROCEDURE WHEN OVERHEAT WARNING LIGHT COMES ON.

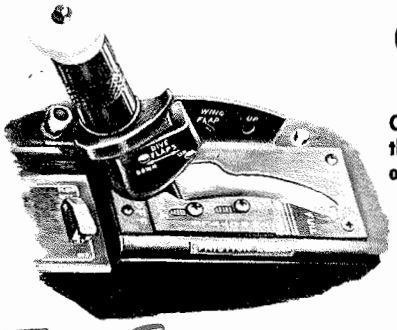
On take-off if sufficient runway remains:

1. Throttle—OFF.
2. Main fuel shut-off switch—CLOSE.
3. Stop as soon as possible.

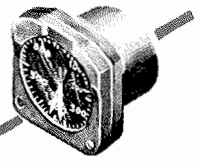
If the tail section overheat warning light comes on too late to abort the take-off or just after becoming airborne, throttle back to about 95% rpm and check the following additional indications:

AIR STARTING

PRIOR TO AIR START



Check battery, ignition master and fuel switches ON. Reduce the remaining electrical load to conserve battery power for operation of the fuel pump, ignition and starter.



3 GLIDE DOWN TO 25,000 feet. Maintain the air speed within 30 knots of the red needle during the descent.

4

1 *Warning*

As soon as flame-out occurs, MOVE THE THROTTLE TO OFF to prevent possible flooding of the engine and tailpipe with fuel.

TROUBLE CHECK — Endeavor to determine what caused the flame-out. Check fuel quantity indicator and switches for indications of fuel system malfunction. Do not attempt an air-start if the flame-out was accompanied by an explosion, overheat condition or vibration.

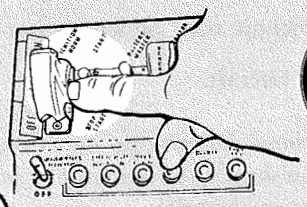
2

If time permits PULL UP SHARPLY. Hold for 5 to 10 seconds to permit drainage of fuel that has gone thru the engine between flame-out and closing the throttle. Then hold the air speed between 175 and 200 knots (200 to 230 mph) IAS for the air start.

5

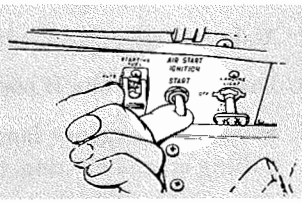
AIR-STARTING

Auto

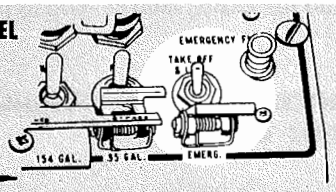


1 STARTER SWITCH— START ONLY IF RPM IS BELOW 10%.

2 AIR START IGNITION SWITCH—START (AND RELEASE). Ignition will continue for approximately 45 seconds.



3 EMERGENCY FUEL SWITCH— TAKE-OFF AND LAND.

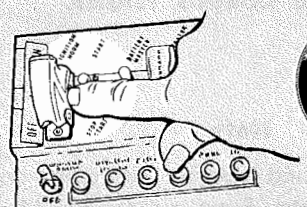


Note

The emergency fuel switch must be placed in TAKE-OFF AND LAND so the engine will start on the emergency fuel system if the main fuel system is malfunctioning.

Manual

Manual starts are not applicable to aircraft equipped with the J-33A-20 engine



1 STARTER SWITCH— START ONLY IF RPM IS BELOW 10%.

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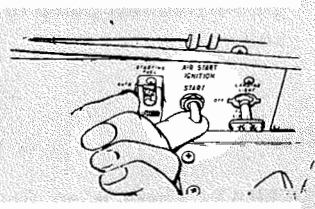
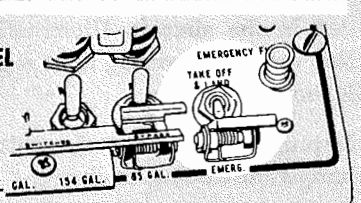


3 EMERGENCY FUEL SWITCH— EMER.



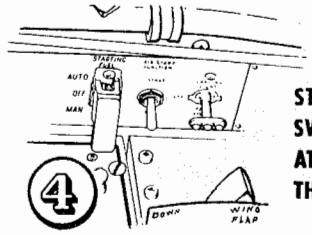
Note

Engine speed control at low rpm is more sensitive when using the emergency fuel control unit.

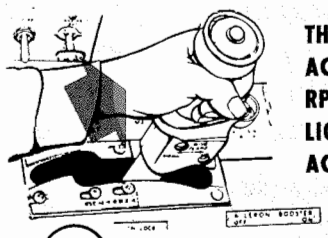
Figure 3-2 (Sheet 1 of 2)

AIR-STARTING (CONTINUED)

Auto

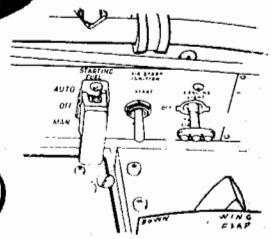


4 STARTING FUEL SWITCH—AUTO. AT NOT LESS THAN 10% RPM.

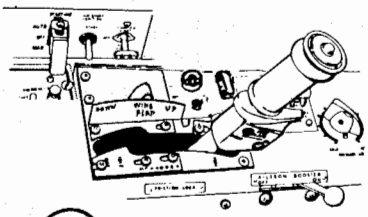


5 THROTTLE—OPEN AND ACCELERATE TO DESIRED RPM AFTER THE BURNERS LIGHT AND ENGINE HAS ACCELERATED TO 30-35%.

Manual



4 STARTING FUEL SWITCH—MAN. AT NOT LESS THAN 10% RPM.



5 THROTTLE—FULL OPEN. IMMEDIATELY AFTER BURNERS LIGHT TURN THE STARTING FUEL SWITCH OFF. Manipulate the throttle to keep the rpm and temperature within limits.

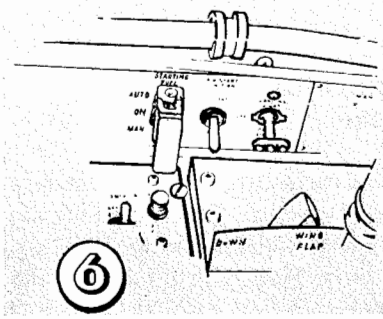
Warning

During attempted air starts either Manual or Automatic, a period of at least 5 seconds should elapse after fuel is supplied to the engine before the attempted start is abandoned. In the case of an air start where ignition and a tail pipe temperature indication is not apparent after 20 seconds, the attempted start should be abandoned and re-attempted only after the tail pipe has been drained.

If the tailpipe temperature reaches 1,000°C and stays there for more than 3 seconds, move the throttle and starting fuel switch to OFF immediately.

Warning

If the emergency fuel indicator light remains on after the throttle has been advanced, the engine will be running on the emergency system. In such an event, leave the emergency fuel switch in the TAKE-OFF & LAND position until the airplane is landed, using care to avoid engine overspeeding, since there is no governor in the emergency fuel system. If the emergency fuel indicator light is not on, the emergency fuel switch may be returned to the OFF position.



6 STARTING FUEL SWITCH—OFF

Warning

Since the engine is operating on the emergency system, use care to prevent overspeeding and excessive tailpipe temperature as there is no governor in the emergency fuel system.

Note

If engine flame-out was not caused by failure of the main engine fuel pump or main fuel control, engine operation may be returned to the main system by increasing the rpm to about 70% and then retarding the throttle (quite rapidly) and at the same time, move the emergency fuel switch to the OFF position. The foregoing procedure must be followed to assure a smooth changeover to the main fuel system.

Figure 3-2 (Sheet 2 of 2)

1. Tailpipe temperature above limits (probably 1000°C), or zero, (due to burning of wires and connections).
2. Black smoke from tail section.

If either of these indications are evident, a fire probably exists. If you decide you are on fire, follow the same procedure as given for illumination of the plenum chamber fire warning light.

If the tailpipe temperature is high, but no smoke is seen, the light is caused by an overheat condition other than fire. Continue to climb at reduced power, and retard the throttle to minimum flight settings as soon as a safe altitude is reached. Usually the light will go out at a lower power setting. Land as soon as possible.

PROCEDURE WHEN FIRE WARNING LIGHT OR OVERHEAT LIGHT COMES ON WHILE AIRBORNE.

If either light comes on during flight, check additional indications for an actual fire. If either light comes ON and remains ON or goes OFF and no other indications of fire exist, proceed at a reduced power setting and land as soon as possible. If fire is definitely indicated, proceed as follows:

1. Throttle—OFF.
2. Main fuel shut-off switch—CLOSE.
3. Decide to bail-out or crash land the aircraft. It is usually better to leave the aircraft. Prolonged fire will eventually result in loss of control of the aircraft. The elevator push rods will generally burn thru.
4. Transmit MAYDAY and give a position report, if possible.

COCKPIT FOG REMOVAL.

During certain atmospheric conditions, the air cooler will create a vapor condition in the cockpit which resembles smoke. This can usually be eliminated by temporarily moving the cabin temperature control to the full HOT position.

COCKPIT SMOKE REMOVAL.

If smoke in the cockpit is noticed during take-off, it is probably caused by oil that was spilled during the post flight or during maintenance. The smoke is generally light grey or white in color and is no cause of immediate alarm.

1. Turn oxygen regulator diluter lever to 100% position.
2. Turn OFF the battery and generator switches until it is determined that the smoke is not caused by a short in the electrical wiring.
3. Close the front and rear cabin pressurization grills and overhead inlet ducts. (The rear ducts are closed on the preflight check if the airplane is to be flown solo.)
4. Extend the dive flaps and open the dump valve. Extension of the dive flaps will facilitate cockpit smoke removal because the cockpit pressure dump valve empties into the dive flap area.
5. Open cockpit outside air vent.
6. If smoke becomes severe, jettison the canopy.

LANDING EMERGENCIES.

LANDING WITH FLAT TIRE.

When a landing in this condition is necessary, it should be made in the normal manner with the gear extended. If the nose gear tire is flat, hold the nose wheel off as long as possible. When landing with a flat main gear tire, set down on the side of the runway away from the flat. Lock shoulder harness prior to touchdown.

LANDING WITH ENGINE INOPERATIVE.

1. When the emergency occurs, head for the nearest field.
2. Set up proper glide speed (160 knots) (185 mph) IAS.
3. Airstarts should be attempted (if engine is not damaged, etc.) down to approximately 10,000 feet above terrain. It is this altitude where a decision to bail out or crash land can be more accurately made.
4. If an airport landing is to be made with known adequate runway length, the landing gear should be down and locked at sufficient altitude, if practicable, to enable you to concentrate on pattern work. If intermittent aileron boost is encountered, turn it—OFF.

FLAME-OUT AND SIMULATED FLAME-OUT PROCEDURE.

The recommended traffic pattern for a flame-out landing is the 360 degree overhead approach. The point over the touchdown end of the runway is defined as the high key point. The down wind point even with the end of the runway is the low key point and the base leg is the 270 degree point.

FLAME-OUT LANDING PATTERN

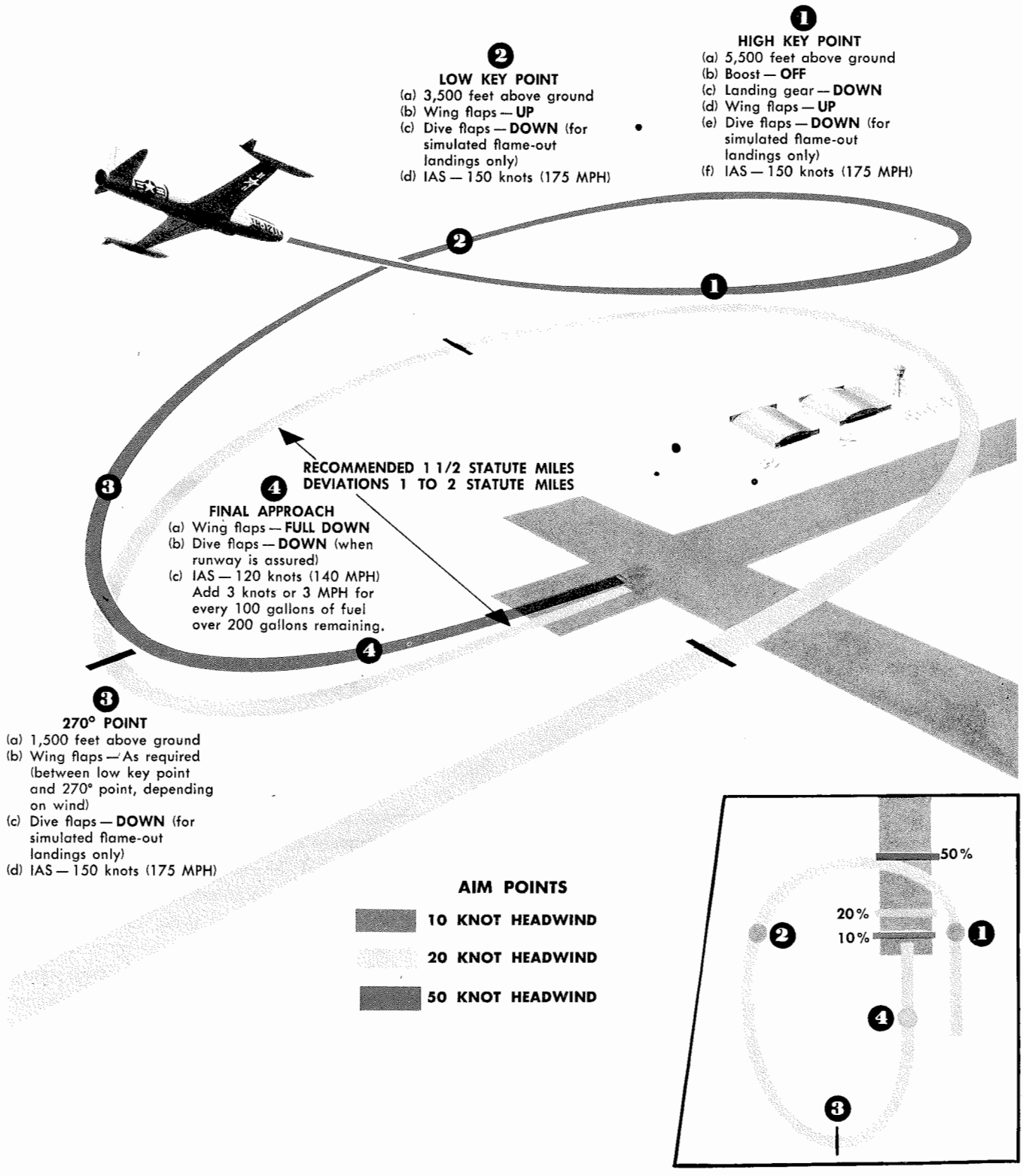


Figure 3-3

A flame-out landing may be simulated as follows: In gliding from altitudes to the field, extend the dive flaps, carry 65% rpm and maintain 160 knots (185 mph), IAS. To simulate the flame-out landing pattern: Extend the landing gear, leave the wing flaps up, and operate the engine at 55% rpm with dive flaps extended. Maintain 150 knots (175 mph) IAS. This is based on aircraft with a 60 degree dive flaps extension. On earlier aircraft with only a 45 degree dive flap extension use 50% rpm.

Refer to figure 3-3 for the flame-out landing pattern.

HIGH KEY POINT.

1. Plan arrival at the high key point at 150 knots (175 mph) and 5500 feet above the field.
2. Aileron boost—OFF.
3. Landing gear—DOWN.
4. Wing flaps—UP.
5. Dive flaps retracted (unless simulating a flame-out landing).

LOW KEY POINT.

1. Altitude 3,500 feet above the ground.
2. Airspeed 150 knots (175 mph).
3. Landing gear—DOWN.
4. Wing flaps—UP.
5. Dive flaps—retracted (unless simulating a flame-out landing).

270 DEGREE POINT.

1. Altitude 1,500 feet above the ground.
2. Airspeed 150 knots (175 mph).
3. Landing gear—DOWN.
4. Wing flaps—as required (between low key and 270° point, depending upon wind).
5. Dive flaps—retracted (unless simulating a flame-out landing).

FINAL APPROACH.

1. Start reducing airspeed and adjust final turn to make the touchdown occur on the first one third of the runway.
2. Dive flaps—DOWN (when runway is assured).
3. Extend wing flaps full down if the added drag is needed to steepen the final approach.
4. Just prior to the flare-out, the airspeed should be 120 to 130 knots depending upon the gross weight of the aircraft.
5. If the landing is simulated and is to be completed, place the throttle in IDLE during the flare-out.
6. Retract the wing flaps, either just before or after touchdown if the runway is short and excessive braking action will be required.

Flame-out landings can be made with the high key point as low as 3,000 feet above the ground, provided a tighter pattern is used. It is also practical to enter the pattern at one of the lower key points, if sufficient altitude is not available for a complete 360 degree pattern.

CRASH LANDING.

More consideration should be given by the pilots and the crew to more frequent use of the ejection seats in preference to forced landings. An ejection should be made, whenever possible, above 1500 feet. With the use of the automatic safety belt and parachute, successful ejection may be accomplished at altitudes as low as 300 feet. Whenever the terrain is unknown or unsuited for forced landings, the ejection seat should be utilized. This recommendation is made because of the increasing incidents in vertebral injuries (especially spinal compression fractures) occurring to pilots during forced landings of high performance aircraft.

If the airplane is in a position to land on a prepared runway of adequate length, the landing gear may be extended by means of the normal system if the engine is windmilling, in order to conserve battery power. If the engine is not windmilling, or main system hydraulic pressure is not otherwise available, the gear must be extended by use of the emergency system. In cases where the runway length is marginal, the landing should be made with the gear retracted. The reasoning on this is as follows:

1. In case of overshooting the desired touchdown point or coming in with excessive speed, the airplane can be forced onto the runway and will slide to a stop in a much shorter distance than if the wheels are extended.

EMERGENCY ENTRANCE

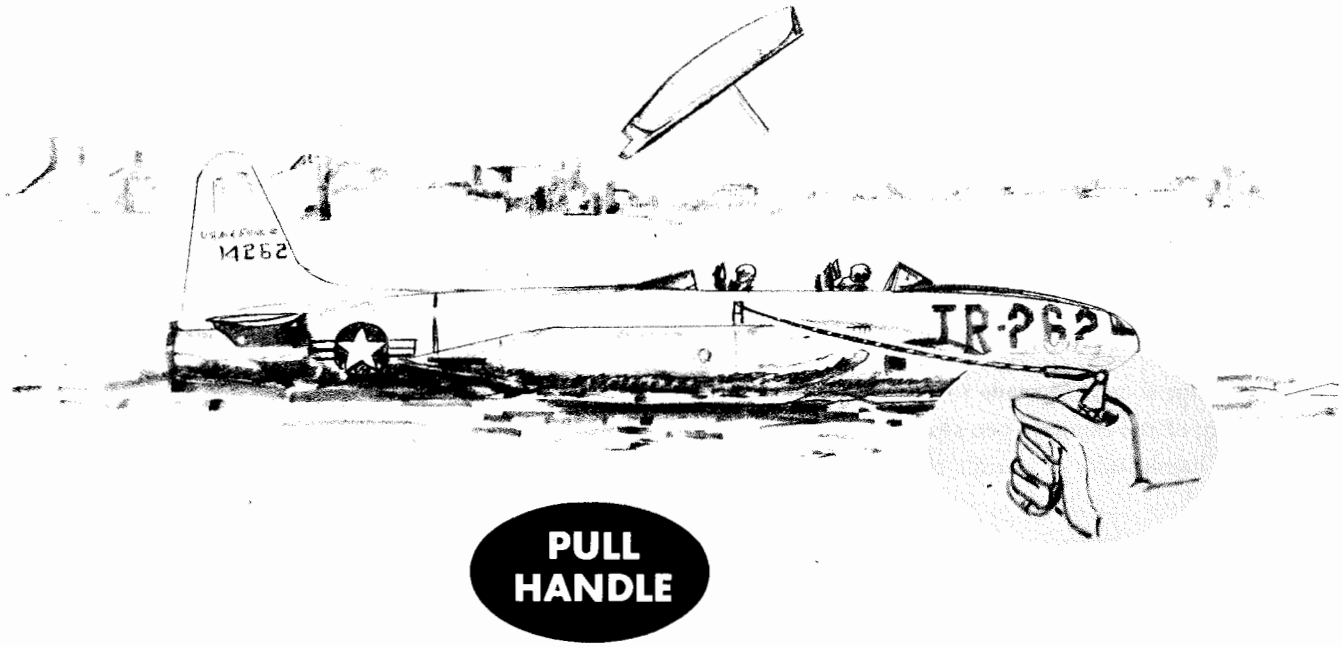


Figure 3-4

2. If the runway is undershot, the pilot may have a much better chance of survival if the landing gear is retracted.
3. If the landing is overshot or undershot, and the landing gear has been extended, it may be impossible to retract the landing gear if the need arises.

CAUTION

It is not normally advisable to jettison the canopy below "bail out" altitude until the airplane is on or within about one foot of the landing surface. Dirt in the cockpit may get in the pilot's eyes and the canopy does not always clear the empennage at low airspeeds.

BELLY LANDING PROCEDURE.

For a belly landing, notify the other occupant and ground agencies then proceed as follows:

1. TIP FUEL TANKS. When a belly landing is anticipated, if possible, drop the tip tanks if they contain fuel. If the tanks are empty, retain the tanks. They may alleviate damage to the aircraft by acting as skids. A belly landing with fuel in the tip tanks is a fire hazard and may result in an explosion.

CAUTION

In the event of a gear up landing or aborted take-off involving retraction of the landing gear, the canopy should be jettisoned before the aircraft comes to a complete stop to preclude the probability of igniting spilled fuel with the canopy jettison explosive charge.

2. Make sure the dive flaps are up before touchdown.
3. Extend the wing flaps 100% (45°). Fully extended flaps will prevent a wing tip from digging into the ground and the resulting ground loop.
4. Just before contact with the ground, jettison canopy, move the throttle to OFF, turn the main fuel shut-off switch to CLOSE, and turn the generator and battery switches OFF.

5. Make certain your parachute is unbuckled and your shoulder harness and safety belt are locked.
6. Make a normal approach and let the airplane touch the ground slightly before the stall is reached. If the engine is dead, use higher than normal (10-15 knots IAS) approaching the runway.

EMERGENCY CANOPY REMOVAL.

(Refer to figure 3-4.)

GENERAL. The canopy should be down and locked for all take-offs and, on landings, should be left locked until the landing roll is completed. This should be done so that the canopy can be jettisoned by use of the normal controls if an emergency should arise. Should an emergency arise during ground operations with the canopy partly open:

1. An attempt should be made to fully open the canopy with any of the canopy open switches or either of the canopy handcranks to permit escape of the airplane occupants.
2. Normal jettison of the canopy with the jettison controls can only be accomplished by first closing the canopy fully.

During conditions of extreme emergency an attempt to jettison the canopy while partly open can be made by either the occupants or crash or rescue crews in the following manner:

1. Aircraft equipped with M-3 gas operated canopy removers. Apply a forward force (60 to 80 pounds) on the canopy remover link safety release which protrudes from the lower right surface of the canopy frame at about the same fore and aft position as the canopy remover. (See figure 1-29.) Sufficient force on this link will actuate the initiator which, in turn, will fire the canopy remover. This link is exposed at any time the canopy is more than 2 inches open from the closed and locked position.

WARNING

The canopy remover will fire when the link is actuated and personnel should not be in the path of the canopy when jettisoned.

2. Aircraft equipped with M2A1 canopy removers. Use the same procedure as above, except that the normal canopy jettison controls, internal or external, must be actuated before a force is applied to the link.

If, for any reason, the canopy cannot be opened on the ground by the crew members from the inside of the airplane, the exterior controls may be operated by ground personnel. If the canopy is locked from the inside, the only way it can be opened from the outside is with the external jettison cable (figure 3-4). This cable is several feet long and must be pulled all the way out to actuate the canopy jettison mechanism. The extra length is to provide operation at a safe distance for the ground crew personnel in case of fire or in case the firing system should malfunction.

CANOPY REMOVAL, WITHOUT EXPLOSIVE REMOVER.

IN FLIGHT.

If the explosive remover is not installed, or fails to fire, the canopy will normally blow off after the jettison lever is pulled. However, if it fails to go, due to extreme low airspeed or some other abnormal condition, raise it into the airstream, using the canopy OPEN switch or the manual handcrank in the front cockpit.

WARNING

The occupant in the rear seat should lower his head as far as possible when the canopy is allowed to blow off, in order to avoid the possibility of the canopy striking his head.

ON THE GROUND.

If the explosive remover is not installed, there are three alternate methods of removing the canopy, available to the flight crew, as described in the following paragraphs.

ELECTRICAL OPERATION.

If there are no explosive fumes present, turn the battery switch ON, uplock the canopy and raise it by pressing the canopy OPEN switch. By pushing upward against the canopy, opening speed can be increased from the normal 6 seconds to about 4 seconds.

HANDCRANK OPERATION. (Front Cockpit Only.)

Unlock the canopy and raise it by turning the handcrank in the front cockpit counter-clockwise. The opening time of 40 seconds can be reduced to about 24 seconds by a pushing assist from the rear cockpit.

MANUAL LIFTING.

If other methods fail, or if hand cranking is too slow for the circumstances, the canopy may be lifted with the shoulders after pulling the jettison lever to disconnect the canopy hooks. The canopy weighs approximately 158 pounds. Each crew member should hold the canopy up while the other gets out.

BAIL OUT RATHER THAN ATTEMPT A WATER LANDING!

DITCHING.

GENERAL. Ditching is not recommended because deceleration may be extremely high and the airplane will sink rapidly as forward motion is lost. The fighter version of this series has been ditched successfully; however, since all the emergency equipment is carried by the crew members, there is no particular advantage in riding the airplane down. In general, bailing out is recommended in preference to ditching when the choice exists, although much will depend upon actual conditions. Remember that remaining fuel will yield much greater range at higher altitudes, therefore, if range is desired, stay at altitude as long as possible. After the fuel is exhausted, glide down below 10,000 feet and bail out.

DITCHING PROCEDURE.

If there is some reason why a safe bail-out cannot be accomplished, notify the student, then ditch as follows:

1. Turn IFF selector switch to EMERGENCY.
2. Release the tip tanks unless the sea is calm and the tanks are nearly empty.

Note

Empty or nearly empty tip tanks will hold the engine air intake ducts out of water until the initial speed is lost and will provide additional buoyancy.

3. Jettison the cockpit canopy.
4. Make sure the landing gear control lever is UP.

WARNING

Do not attempt a water landing with the landing gear extended.

5. Unbuckle the parachute harness unless the dingy is attached.
6. Make sure the shoulder harness is locked and the safety belt is fastened.
7. Throttle—OFF.
8. Dive flaps switch DOWN, wing flaps approximately 25°.

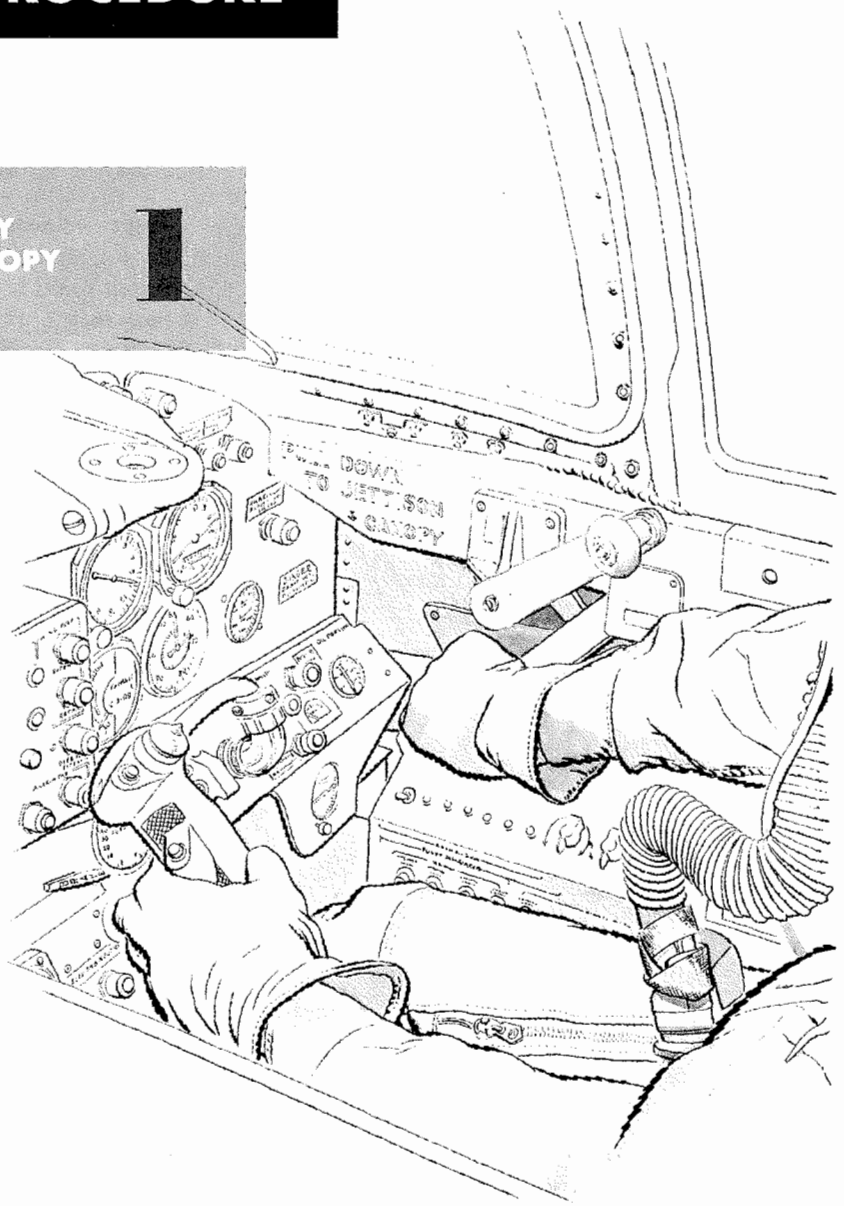
Note

The wing and dive flaps will not cause the airplane to dive. Open dive flaps will aid in keeping the engine air ducts above the water.

9. Select a heading parallel to the wave crests if possible. Aim to touch down on the down side of a crest or on the falling side of a wave, never on the rising side.
10. After the airplane comes to rest, get out of the cockpit immediately and don't forget the life raft.
11. It may be very difficult to accurately judge altitude above the water by visual reference; therefore, the pilot should monitor the vertical speed indicator and maintain a constant safe rate of descent until contact is made.

BAIL OUT PROCEDURE

JETTISON THE CANOPY BY PULLING THE CANOPY JETTISON HANDLE 1



Caution

CANOPY MAY NOT JETTISON IF IT IS UNLOCKED

Warning

RIGHT-HAND ARM REST MUST NOT BE RAISED BEFORE CANOPY IS JETTISONED. CANOPY JETTISON HANDLE IS EXTREMELY DIFFICULT TO OPERATE WHEN THE ARM REST IS IN THE RAISED POSITION.

Note

AFTER CANOPY IS JETTISONED, THERE IS A STRONG FORWARD FLOW OF AIR AROUND THE REAR COCKPIT POSITION. IN ORDER TO ASSUME THE EJECTION POSITION, THE OCCUPANT OF THE REAR COCKPIT MUST OVERCOME THE FORCE OF THIS AIRFLOW.

Warning

IF THE CANOPY DOES NOT JETTISON AN ATTEMPT SHOULD BE MADE TO RELEASE CANOPY BY PLACING THE CANOPY OPEN SWITCH IN THE OPEN POSITION OR BY USING THE MANUAL HAND CRANK. ON LATER AIRPLANES (AF SERIAL NUMBERS 51-9036 AND SUBSEQUENT), THE SEAT CAN BE EJECTED WITHOUT JETTISONING THE CANOPY; HOWEVER, THIS SHOULD BE THE LAST RESORT METHOD AND SHOULD ONLY BE ATTEMPTED AFTER THE ELECTRICAL AND MANUAL ATTEMPTS AT OPENING THE CANOPY HAVE FAILED. WHEN USING THIS LAST RESORT PROCEDURE, IT IS RECOMMENDED THAT THE SEAT BE ADJUSTED TO THE BOTTOM POSITION TO ALLOW THE GREATEST CLEARANCE BETWEEN THE TOP OF THE HEAD AND THE TOP OF THE HEAD REST.

Figure 3-5 (Sheet 1 of 2)

Warning

- WHEN RAISING RIGHT ARM REST AVOID GRASPING TRIGGER.
- BE EXTREMELY CAREFUL TO PLACE BOTH ARMS INSIDE THE ARM RESTS TO ASSURE CLEARANCE OF THE COCKPIT SILL DURING EJECTION.

2 HOOK HEELS IN FOOT RESTS, RAISE BOTH ARM RESTS, SIT ERECT WITH HEAD AND BUTTOCKS BACK AND CHIN TUCKED IN.

3 SQUEEZE THE TRIGGER FOR SEAT EJECTION

IF TRIGGER IS SQUEEZED WHILE RAISING ARMREST IT MAY NOT FIRE THE SEAT. IF THIS OCCURS RELEASE TRIGGER AND SQUEEZE AGAIN.

IF TIME PERMITS

OBSERVE THE FOLLOWING PRECAUTIONS:

1. CHECK THAT OXYGEN HOSE IS CLIPPED TO PARACHUTE HARNESS PRIOR TO EJECTION, TO PREVENT SUBSEQUENT DIFFICULTY IN LEAVING THE SEAT.
2. BEFORE EJECTION, STOW ALL LOOSE EQUIPMENT.
3. AT ALTITUDE, ACTUATE BAIL OUT BOTTLE.
4. ON AIRCRAFT WITHOUT THE AUTOMATIC SAFETY BELT, UNFASTEN THE SAFETY BELT BEFORE EJECTION AT LOW ALTITUDES, TO AID IN SEPARATING FROM THE SEAT.

●AFTER EJECTION

RELEASE SEAT BELT AND KICK AWAY FROM SEAT. DELAY OPENING PARACHUTE AS LONG AS ALTITUDE PERMITS, TO REDUCE PARACHUTE SHOCK AND ALLOW SEAT TO FALL CLEAR.

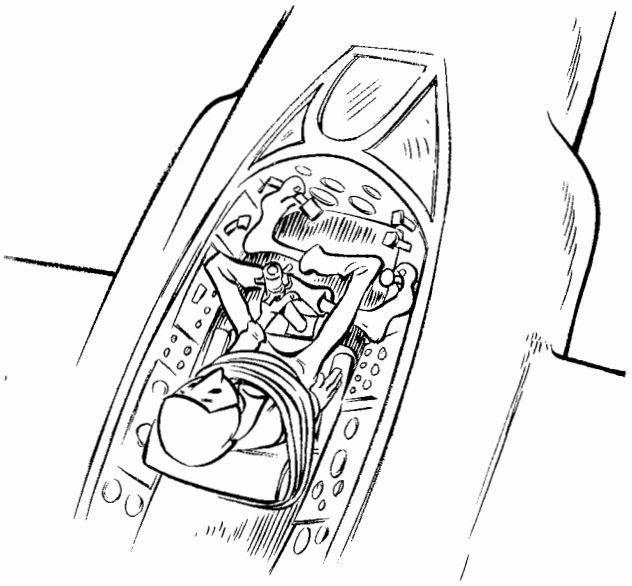
Figure 3-5 (Sheet 2 of 2)

BAIL OUT.

GENERAL. If sufficient altitude is available, it is recommended that the crew members bail out in preference to ditching or crash landing even if over open country. With good visibility in the daytime over open country a crash landing may be preferable to bailing out if a suitable field is available. The bail-out procedure is the same for both cockpits.

CAUTION

- If bail-out is made at high altitude, remain connected to the airplane oxygen system while all other preparations for leaving the airplane are being made. Just before leaving the airplane, disconnect the oxygen hose at the mask and place the type H-2 emergency oxygen cylinder into operation, by pulling the rip cord cable of the oxygen cylinder (the caution tag and pin assembly having been removed prior to take-off).



- You are restricted from bending forward when the shoulder harness is locked; therefore all switches not readily accessible should be cut before moving the lock control to the locked position.

1. Inform the other occupant as far in advance as possible that it will be necessary to bail out and check that he knows what to do.
2. If the airplane is still controllable, reduce speed to lowest speed possible to maintain straight and level flight.
3. Turn IFF selector switch to EMERGENCY.

BAIL-OUT PROCEDURE (WITH EJECTION SEATS).

HIGH ALTITUDE.

Refer to figure 3-5.

LOW ALTITUDE.

A review of statistics on ejection seat bail-outs shows a low percentage of successful bail-outs attempted below 1500 feet altitude. This is attributed to insufficient time under stress of an emergency to accomplish release from the seat and effect parachute deployment, and the natural tendency to pull the rip cord before releasing the safety belt and kicking free of the seat. Parachutes are unlikely to deploy when the rip cord is pulled while the pilot is still strapped in the seat. Therefore, on aircraft not equipped with the Automatic Seat Belt (AF Serials prior to 52-9485), the following procedure is recommended for low altitude bail-out except where negative "G" forces or violent maneuvers are applied which would force the body away from the seat.

FOR BAIL-OUTS BELOW 1500 FEET, IF PROPER POSITION ON THE SEAT CAN BE MAINTAINED FOR EJECTION, UNFASTEN THE SAFETY BELT BEFORE PROCEEDING WITH THE EJECTION SEQUENCE SHOWN ON FIGURE 3-5.

PROCEDURE WITH AUTOMATIC SEAT BELT.

Use the same procedure for bail-outs below 1500 feet without the automatic seat belt except leave the seat belt fastened.

BAIL-OUT PROCEDURE (WITHOUT EJECTION SEATS).

1. Jettison the canopy by pulling back on the jettison lever in either cockpit.
2. Release the safety belt shoulder harness and radio connection.

3. Dive over the trailing edge of the wing from either side or roll the airplane on its back, trim full nose down and push clear.

AIRCRAFT SYSTEMS.

FUEL SYSTEM FAILURE.

If the engine fails for no apparent reason, it is probable that the fuselage tank has run dry or that one of the engine fuel system units has failed. If the normal system is at fault, the engine should run on the emergency fuel system (figure 3-6) after a normal air start. If the fuselage tank has run dry, turn on wing and leading edge tank switches.

BOOSTER PUMP FAILURE.

If a wing or leading edge tank booster pump fails, fuel cannot be drawn from that tank by the engine-driven pump. However, fuel will be fed normally from the corresponding tank on the opposite side of the airplane if its booster pump is operating. Fuel may be drawn out of the fuselage tank by the engine-driven pump without the aid of the booster pump at a rate in excess of that necessary to provide 100% rpm up to an altitude of at least 8,000 feet.

FLUCTUATING FUEL PRESSURE. If fluctuating fuel pressure occurs, check position of fuselage fuel tank switch. If fuselage fuel tank switch is ON and fluctuation continues, start letdown, place emergency fuel switch to TAKE-OFF AND LAND after passing thru 15,000 feet and return to the field and land as soon as possible.

STUCK FLOAT VALVE: (OPEN).

A float valve stuck open is indicated by the fuselage fual quantity indicator reading above the "FULL" mark, and/or by fuel being pumped overboard.

In the event of a stuck float valve in the fuselage fuel tank, turn off all fuel switches except the fuselage fuel tank switch. When fuel level in the fuselage fuel tank is down to 60 gallons remaining, turn on tip, leading edge or main wing fuel tank switches until fuselage tank indicates full. Repeat this operation until tip, leading edge and main wing fuel tanks are empty.

If it can be determined by the pilot which set of tanks is malfunctioning due to a stuck float valve, the above procedure may be applied only to that set of fuel tanks.

LEAKING FUEL TANKS.

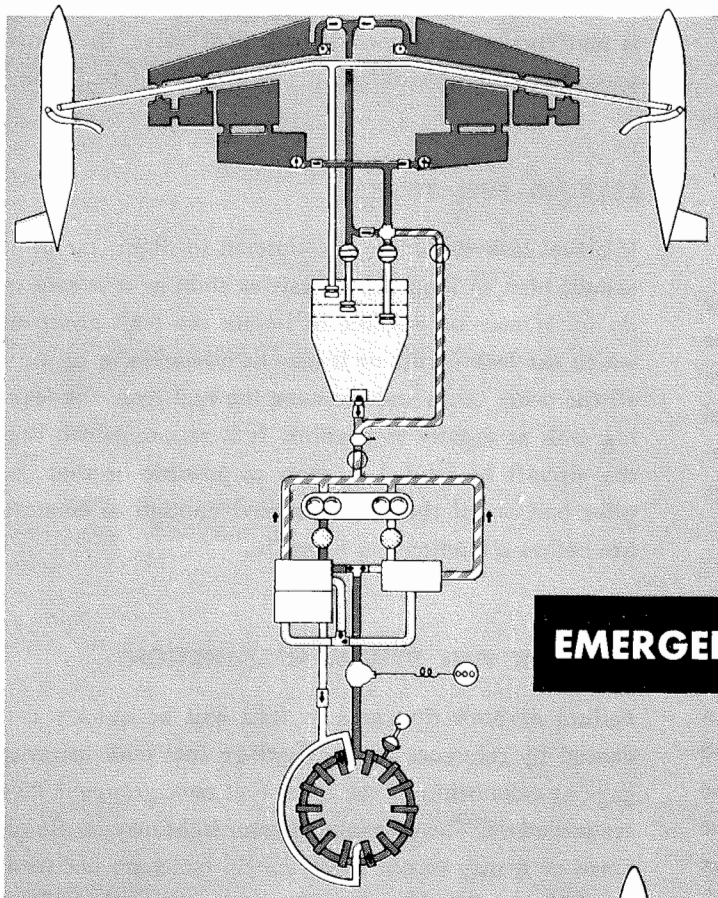
If a fuel leak should be encountered in flight, the pilot should plan to land the aircraft as soon as it is safe to do so. It may be possible to isolate the tank group in which the leak occurs or it may be advisable to turn off all the other tanks and consume the fuel from the leaking tank as rapidly as possible. It is recommended that the aircraft be landed as soon as possible or that the pilot bail out if the leak is serious enough to create a fire before a landing can be made.

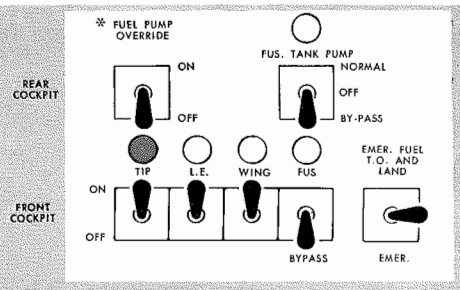
TIP TANK FUEL SYSTEM MALFUNCTION.

Failure of both tip tanks to feed will be quickly evidenced by reference to the fuselage fuel tank quantity gage or exhaustion of the other fuel tank groups if they are turned on. The tip tank indicator light may be illuminated or it may be out when the tip tanks are not feeding. If both centerline tip tanks cannot be made to feed, it is recommended that they be dropped in a safe area before a landing is attempted. If the tip tanks cannot be dropped either electrically or manually, the fuel from the main wing and leading edge tank should be consumed before a landing is made.

If one tip tank fails to feed or feeds more slowly than the other eventually full aileron trim may not hold the wings level at cruising airspeeds. Continued operation of the aileron trim tab in one direction will indicate uneven tip tank feeding and can be further checked by visual observation each time the tab is actuated. If the wings can be held level at cruising airspeeds without undue effort, the heavy tank should be retained to see if it can be made to feed. Try the following, to get the tip tank to feed:

1. Climb as rapidly as possible to 25,000 to 30,000 feet. The ambient air pressure of low altitudes will remain inside the tank and may start the tank feeding.
2. Rock the wings rapidly from side to side without exceeding a maximum bank of 45° and maintain an indicated airspeed of about 250 knots (285 mph).





FUSELAGE TANK BY-PASS OPERATION

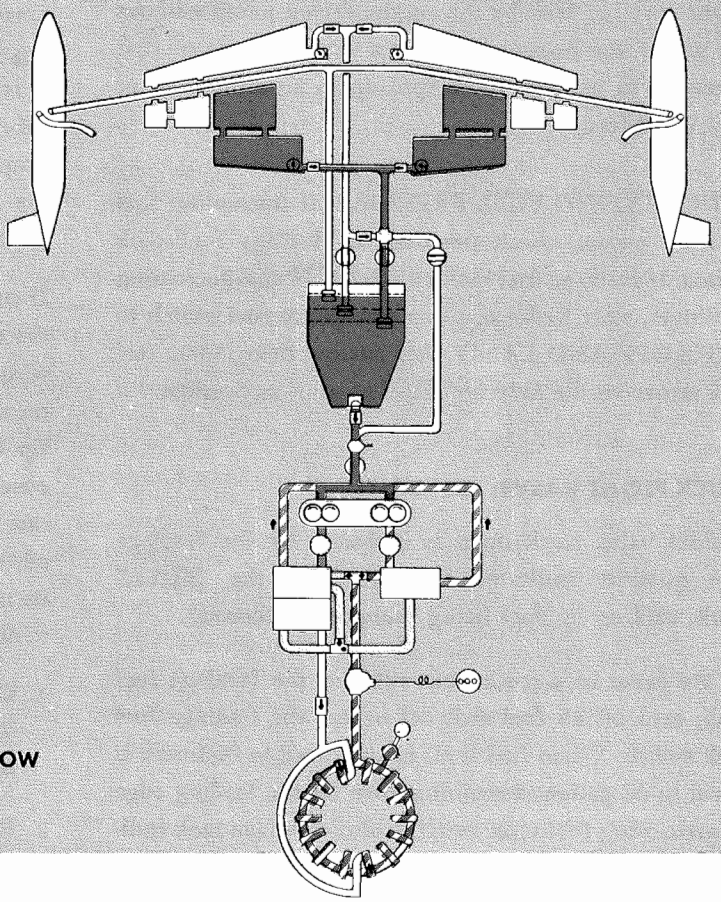
USAF SERIALS 48-356 THRU 53-4886

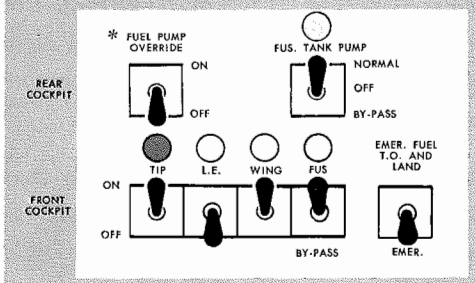
Fuel from the leading edge and wing tanks is routed to by-pass the fuselage tank with switches set as above.

NOTE

Fuselage tank will gravity feed during by-pass operation

EMERGENCY COURSES OF FUEL FLOW





EMERGENCY FUEL FLOW

J33-A-23 AND -35 ENGINES

With the emergency fuel switch in ***"EMER"*** the main fuel pump is by-passed and fuel flow is through the emergency pump and fuel control.

***USAF SERIALS 52-9635 AND SUBSEQUENT**

- NORMAL FUEL SUPPLY
- BY-PASS FUEL FLOW
- MAIN PUMP FUEL FLOW
- EMERGENCY PUMP FUEL FLOW
- STATIC FUEL

Figure 3-6 (Sheet 1 of 2)

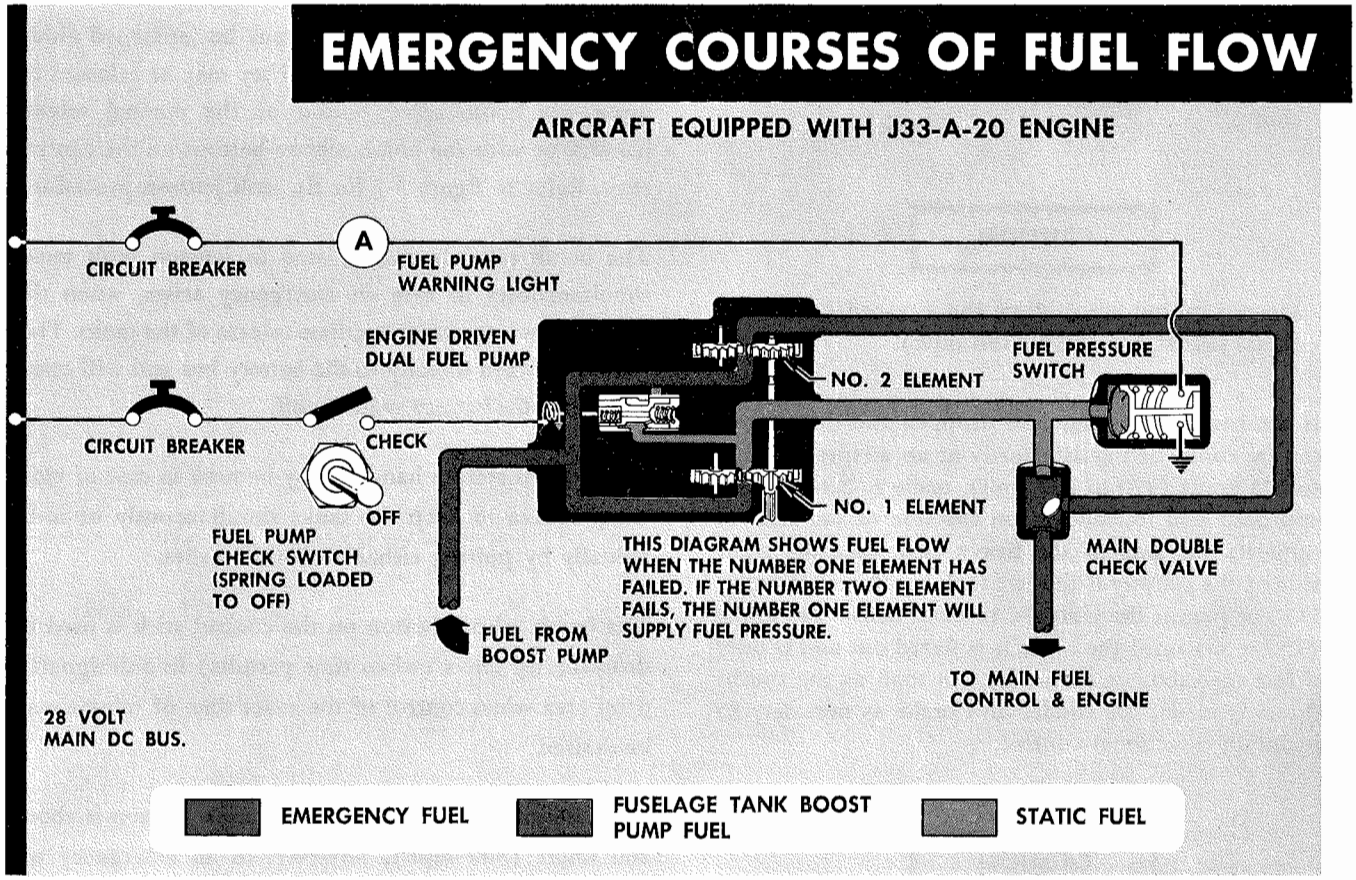
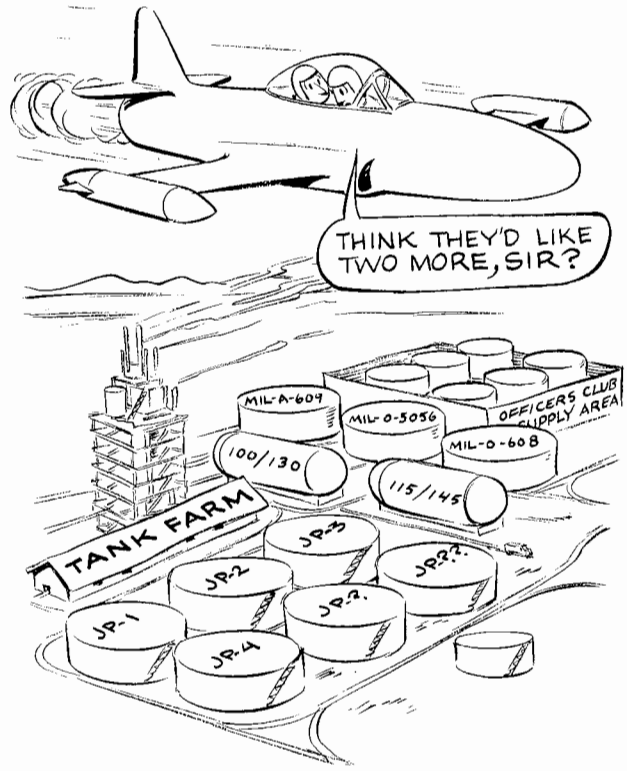


Figure 3-6 (Sheet 2 of 2)



Note

If it is determined that the heavy tank will not feed, it should be dropped in a safe area.

If a malfunction of the tip tank release mechanism precludes the dropping of the heavy tank, the aircraft should be checked to see if there will be enough aileron control to effect a safe landing. To perform this check, proceed as follows:

1. If possible, climb to 15,000 feet or more above the surrounding terrain. (Check aileron boost ON.)
2. Reduce the airspeed to 195 knots (225 mph) and make shallow turns noting the degree of aileron control.
3. Extend the landing gear and wing flaps at the proper speeds, lower the dive flaps and simulate a landing approach.
4. As the airspeed decreases, carefully note the amount of aileron pressure and degree of aileron control required to hold the wings level.

Note

If difficulty is experienced in holding the wings level, lower the nose, apply power and recover airspeed. Increased airspeed will restore aileron control.

CAUTION

Do not in any event allow the airspeed to decrease below 130 knots (150 mph).

5. If the heavy tank cannot be dropped and the aircraft can be controlled satisfactorily at an airspeed of 150 to 175 knots (170 to 200 mph), make a "Straight In" approach and touchdown on the side of the runway opposite the side of the heavy tank (use the right side of the runway if the left tank has the extra fuel). Do not permit the airspeed to drop below 150 knots (170 mph) until the aircraft is flared out and is only a few feet above the runway. As soon as the touchdown is made, use rudder and brake as necessary to maintain directional control.

CAUTION

With either the 165-gallon or the 230-gallon asymmetric configuration, a violent yawing motion is created when the gear and flaps are lowered, which will require a reversal in rudder position plus excessive control forces and higher than usual engine power requirements. In addition, in order to maintain sufficient longitudinal control, it is recommended that the gear and flaps be lowered at speeds not lower than 170 knots.

If at any time, when carrying tip tanks, lateral control and trim becomes difficult and erratic, reduce airspeed immediately. If the difficulty persists at approximately 175 knots (200 mph) IAS, jettison the wing tip tanks before further investigating the trouble. When lateral control difficulties are encountered, the aileron boost will not be turned off while the tip tanks are still on the aircraft. In the event the wing tip tanks fail to release, reduce airspeed to 160 knots (185 mph) with 230 gallon tip tanks, 130 knots (150 mph) with 165 gallon tip tanks and if satisfactory lateral control cannot be maintained, abandon the aircraft. Abandon the aircraft if satisfactory lateral control cannot be maintained after jettisoning the tip tanks.

TIP TANK JETTISON PROCEDURE.

In an emergency the tip tanks may be jettisoned either simultaneously or individually. They may be released by using the bomb salvo button or the manual release handles or with the bomb release buttons on the control stick. Refer to figure 3-7 for tip tank jettison procedure.

The bomb salvo button is used to jettison both tanks simultaneously in case an emergency arises, when the lack of time requires immediate release of the tanks. This button is wired directly to the battery bus and will operate even if the battery switch is off.

The manual release handles may be used in case of electrical failure to drop the tanks simultaneously or individually by pulling either or both handles.

The bomb release button on the control stick is used to drop the tip tanks (when time permits) in a designated drop area when control of the exact time of release may be desired.

The recommended airspeed for tip tank jettison is about 260 knots (300 mph), however, in an emergency tip tanks can be safely jettisoned at speeds up to 390 knots (450 mph).

CAUTION

Do not jettison tip tanks above 390 knots (450 mph) unless it is absolutely necessary. Possible damage to the aircraft may occur if the tanks are dropped above this speed.

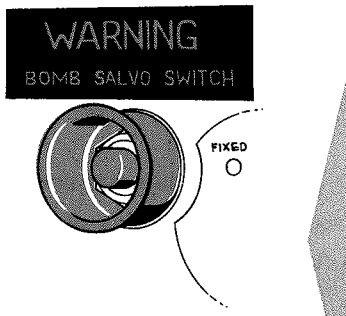
ELECTRICAL FAILURE.

HIGH LOADMETER READING. If the loadmeter shows a continuous reading above .5 proceed as follows:

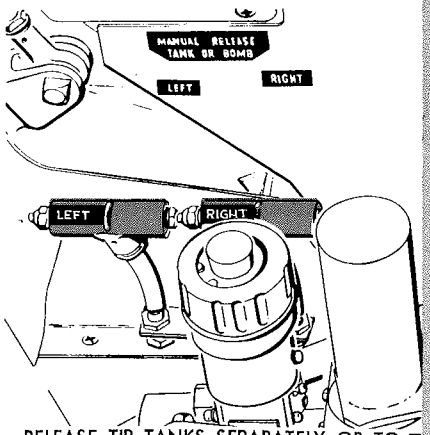
1. Check for a low charged or faulty battery by turning the battery switch in the front cockpit OFF and checking for a definite decrease or normal loadmeter reading. If the loadmeter reading returns to normal, leave the battery switch OFF and land as soon as circumstances permit.

TIP TANK JETTISON

ALL SERIALS



PRESS THE BOMB SALVO SWITCH IN EITHER COCKPIT IN CASE OF AN EMERGENCY. THE ENTIRE EXTERNAL LOAD WILL BE JETTISONED INSTANTLY REGARDLESS OF THE POSITIONS OF THE OTHER JETTISON CONTROL SWITCHES.



RELEASE TIP TANKS SEPARATELY OR TOGETHER BY PULLING HARD ON EITHER OR BOTH MANUAL RELEASE HANDLES IN FRONT COCKPIT ONLY.

CENTERLINE TIP TANKS

AF Serials 51-4141 and subsequent

PLACE BOMB OR TANKS RELEASE MASTER SWITCH IN THE REAR COCKPIT TO THE ARM POSITION.

(AF SERIALS 51-4141 THROUGH 52-9634) PLACE TIP TANK JETTISON READY SWITCH TO THE READY POSITION.

(AF SERIALS 52-9635 AND SUBSEQUENT) PLACE THE TIP TANK JETTISON SWITCH TO THE ARM POSITION.

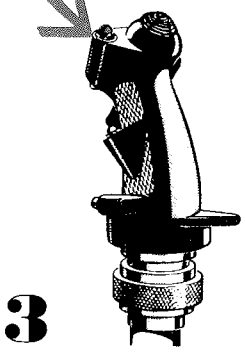
PRESS BOMB RELEASE BUTTON ON CONTROL STICK IN EITHER COCKPIT.

UNDERSLUNG TIP TANKS

AF Serials prior to 51-4141

PLACE BOMB OR TANKS RELEASE MASTER SWITCH IN THE REAR COCKPIT TO THE ARM POSITION.

PLACE THE BOMB SELECTOR SWITCH IN THE FRONT COCKPIT TO "ALL," TO JETTISON SIMULTANEOUSLY. TO JETTISON TANKS INDIVIDUALLY PLACE THE SWITCH IN "TRAIN."



PRESS BOMB RELEASE BUTTON ON CONTROL STICK IN EITHER COCKPIT.

Figure 3-7

2. If the loadmeter does not show a decrease when the battery switch in the front cockpit is turned OFF, turn the battery switch back ON and check all the electrically operated equipment such as radios, boost pumps, light switches, etc. by turning them OFF one at a time to determine whether or not any of these units is causing the trouble. If one of these units is found to be the cause of the high loadmeter reading land as soon as possible operating without it unless it is vital to the completion of the landing.

3. Usually high loadmeter reading results in battery failure, battery burning, battery explosion and/or complete electrical failure.

ZERO LOADMETER READING. During flight the loadmeter should be checked immediately after take-off and approximately every 15 minutes. On AF Serials 51-6810 and subsequent, a generator-out warning light, located on the instrument panel above the loadmeter, is provided to attract the pilot's attention when the generator fails. If this light comes on, check for a zero loadmeter reading. If the loadmeter indicates a zero reading, proceed as follows:

1. Operate an electrical device, such as the radio transmitter, to ascertain that the gage is not indicating an erroneous low reading. The loadmeter normally increases when an electrical device is placed in operation.

2. Turn the battery switch to the OFF position. If the electrical accessories continue to operate, then the loadmeter is inoperative. If the loadmeter is out, return battery switch to the ON position and continue with normal operation, and occasionally recheck.

3. If the electrical accessories become inoperable when the battery is turned OFF, then the generator or one of its control units has failed. The battery will not supply the required electrical energy to the system for any extended length of time. Conservation of battery energy is essential. Turn off all electrical equipment not needed for safe flight. Fuel should be used manually, i.e., turn on boost pump switches only long enough to refill the fuselage tank and then turn switches off. Repeat the operation as often as necessary and land as soon as possible.

COMPLETE ELECTRICAL FAILURE.

Complete electrical failure is evidenced by a zero loadmeter reading and failure of all electrically operated equipment. This condition occasionally arises because of generator failure. If the generator failure is not detected, the battery will not long support the heavy load resulting. A frequent check of loadmeter reading, especially during night flight, is good insurance.

If the generator failure has not been detected, the pilot may receive some warning of impending complete electrical failure by noting faulty operation of VHF or UHF radio, or by noting that ultra-violet cockpit lights are growing dim. If this notice is given, check for zero loadmeter, and take action required.

Complete electrical failure will render all electrical equipment inoperable. The important items to remember are:

1. All electrical instruments will fail with the pointers in operating range, except the fuselage fuel quantity gage which will fall below zero and the landing gear indicators which will indicate the barber pole.

2. Neither the aircraft lights nor any of the radios will operate.

3. Fuel will be available only from the fuselage tank and tip tanks. No leading edge or main wing fuel can be fed into the fuselage tank. If tip tanks have been emptied, note that no more than 92 gallons of fuel will be available.

4. The fuel counter and the fuselage fuel indicator (liquidometer) will be inoperative. There will be no indication when tip tanks are empty of fuel.

5. Tip tanks can be dropped only by using the Manual Release Handles.

6. The emergency fuel system cannot be used. Control of fuel from the emergency system is effected through a solenoid operated valve, and this cannot be closed without electrical equipment.

7. Gear position indicators (Selsyn windows, lights, and horn) will be inoperative.
8. The landing flaps and the dive flaps cannot be operated.
9. Attitude gyro, slaved gyro, and turn needle will be inoperative.
10. The airstart switch will be ineffective.
11. The emergency hydraulic pump will be inoperative and, therefore, landing gear may be lowered only by normal system.
12. Trim tabs will remain as set prior to electrical failure.

GENERATOR FAILURE.

If only the generator fails and battery power is still available, turn off all non-essential electrical equipment. Turn off the leading edge and wing tanks, and allow fuel to transfer from the tip tanks. When the tip tanks are empty, turn the leading edge tanks on until the fuselage tank quantity gage shows nearly full. Then turn the main wing tanks on intermittently to maintain this level until the leading edge tanks are emptied. Repeat this manual transfer from the leading edge tanks. Land as soon as possible.

RUNAWAY TRIM.

On later airplanes equipped with the elevator trim override switch the elevator trim switch can be disconnected and the elevator trim controlled by the elevator trim override switch. Runaway trim occurs more frequently with the elevator trim, although it may also occur with the aileron trim. A faulty switch may cause the trim tab motor to move the tab to the maximum limit of travel, despite efforts to halt the travel by use of the trim button. At high airspeeds, the amount of control force necessary to resist the trim effect may become great.

One common occurrence that resembles "runaway" trim results from failure to return the trim button to neutral with thumb pressure after trim is used. Check the trim switch for neutral position if trim movement does not stop after using the switch. Another cause of trim malfunctions is the student lock-out box and its cannon plug connection to the instrument panel. After runaway trim is controlled, check the plug for tight fit. If this does not remedy the condition, disconnect the plug. Along with retaining control of the aircraft, the most important objective is to reduce air speed so that the faulty trim tab loses its effectiveness. Proceed as follows:

1. For runaway elevator trim, nose up: resist stick pressure in order to keep nose from rising too high, roll into a banked attitude and reduce power with throttle as necessary.
2. For runaway elevator trim, nose down: extend dive flaps. Resist stick pressure to keep the nose up, and reduce power with throttle as necessary. As a last resort roll the aircraft upside down.
3. For runaway aileron trim: visually check the aileron trim tab. If the tab is fully deflected raise the nose to slow the aircraft, resist stick pressure to keep wings level. Check that aileron boost shut-off lever is in the ON position. Reduce power with throttle as necessary.

AILERON BOOST FAILURE.

In the event of aileron boost failure as indicated by extremely heavy or hard stick forces, turn the aileron boost shut-off lever to OFF immediately. Check the hydraulic pressure, if it reads low or below normal, do not turn the aileron boost back ON.

If any erratic roll tendencies are encountered, turn the aileron boost OFF. Do not turn it back ON at low altitudes.

WARNING

Do not diagnose a roll tendency as aileron boost trouble when the wing flaps and/or gear are extended. (Refer to Split Flap Condition,this section). First retract the flaps, then the gear to determine if that will correct the control difficulty. If it does not, then try to correct the condition by turning off the aileron boost control at an altitude of at least 10,000 feet but keep your hand on the aileron boost control so it can be turned on immediately if necessary. This condition can exist also with one empty and one full tip tank.

HYDRAULIC PRESSURE LOSS.

If the hydraulic pressure gage indicates no pressure, operate the dive flaps to determine if the gage is faulty. If the pressure is lost, follow the procedure for aileron boost failure and use the emergency procedure for extending the gear.

LANDING GEAR.

The emergency hydraulic system should be used for extension of the landing gear, only in case of failure of the normal system. After the gear has been extended by the emergency system, fluid should be removed from the main system reservoir before the gear can be retracted again. This is necessary because the fluid in the "up" sides of the cylinders is returned to the main reservoir during emergency gear extension. If fluid is not removed, the main reservoir may overflow into the plenum chamber if the gear is retracted, and cause a serious fire hazard. The gear cannot be shaken down by yawing or sharp pull-ups.

WARNING

The emergency hydraulic system is for emergency extension of the gear only, and no means of retraction is provided by the emergency system.

LANDING GEAR EMERGENCY EXTENSION. Emergency extension of the landing gear is accomplished as shown in figure 3-8. The landing gear cannot be retracted by use of the emergency system.

LANDING GEAR CONTROL LEVER MALFUNCTION. Excessive forces on the landing gear handle may shear the pin in the mechanism. This may cause the handle to swing freely, or it may jam in one position. If the pin should shear, allowing the gear handle to swing free, the landing must be made with the left hand holding the gear handle in position. The procedure is as follows:

1. Lower the landing gear at proper airspeed.
2. When on final approach, and positive of making the runway, retard throttle to IDLE.
3. Check to see that landing gear is down and the hydraulic pressure is up before touching down, horn not blowing. Land with left hand holding gear handle in DOWN position.

If the handle should stick in the DOWN position, trip the landing gear handle down-lock release. It is located forward of the landing gear handle. Try to move the handle. If this fails, return to the field and land.

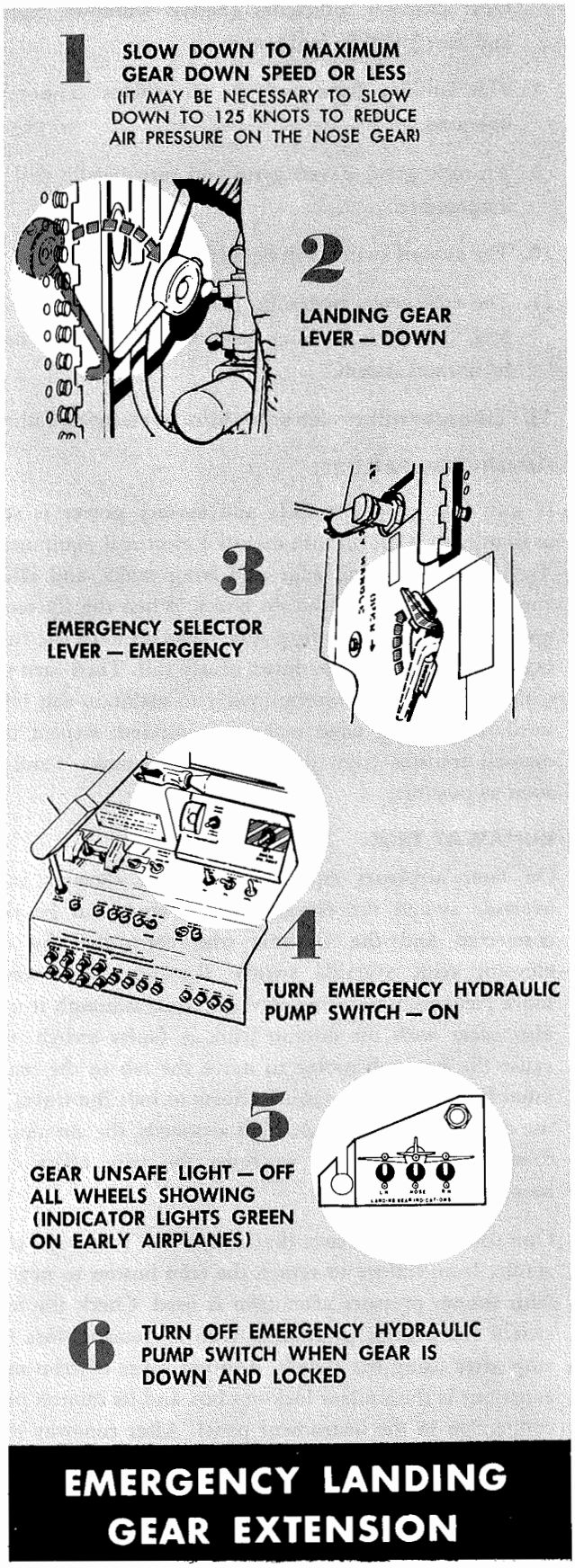


Figure 3-8

WING FLAPS.

There is no emergency method of extending the wing flaps.

In the event of split flap operation (only one flap extends), the aircraft cannot be controlled with aileron boost off. If difficulty is experienced after actuating wing flap switch to the DOWN position, check that aileron boost is on and immediately place wing flap switch or lever in the UP position.

OIL SYSTEM MALFUNCTION.

High oil pressure, or a continuing rise in oil pressure, indicates a restriction in the oil system or a false indication. If this condition exists, throttle back and return to the field and land as soon as possible. If the gage indicates a zero oil pressure reading, do not throttle back until landing is assured, as engine is less likely to "freeze".

ARMAMENT HOOD DOORS MALFUNCTION.

The armament hood doors have been known to come open in flight. Almost invariably, the reason is that they were not locked during the pre-flight inspection. If they are not locked they will usually start to come open just as the aircraft leaves the ground on take-off 120 knots (140 mph). Drop the dive flaps. The sucking action thus induced by the dive flaps being down helps to hold the doors closed. Get the airspeed above 130 knots (150 mph), as soon as possible.

The armanent hood doors normally will stay closed at airspeeds above 130 knots (150 mph), and below 215 knots (250 mph). Make all turns gentle turns, and come back in to land. Fly the final approach at 140 knots (160 mph) and bring the aircraft down very close to the ground before leveling out. Be cautious. Do not balloon or attempt to spike the aircraft on the runway.

In the event the armament hood doors come open in flight, lower airspeed immediately by dropping dive flaps, reducing power, or any other means.

T 06

SECTION IV DESCRIPTION AND OPERATION OF AUXILIARY EQUIPMENT

AIR CONDITIONING AND PRESSURIZATION SYSTEM.

GENERAL. The cabin is air conditioned and pressurized by air from the engine compressor as shown on figure 4-2. The canopy is sealed, when closed, by a pneumatic rubber seal, automatically inflated by the air system. Pressurization air enters the cabin through four pressurization inlet grilles (two in each cockpit), and the rear ducts. Cabin temperature is regulated by a mixing valve in the temperature control which diverts a portion of the hot compressor air through the turbo refrigerator for cooling before entering the cockpit. The mixing valve is controlled by the cabin temperature control in the front cockpit. Cabin pressure differential is automatically maintained by the cockpit pressure regulator. A cabin altimeter which indicates equivalent cabin altitude, and a cabin temperature gage are located on the right shelf in the front cockpit.

COCKPIT PRESSURE REGULATOR. Cabin pressure differential is automatically maintained by the cockpit pressure regulator which governs the outflow of air from the cabin at a rate designed to maintain the rate of change of cabin air and pressure differential above outside air at all altitudes (see figure 4-1). From sea level to 8,000 feet the cabin is unpressurized, between

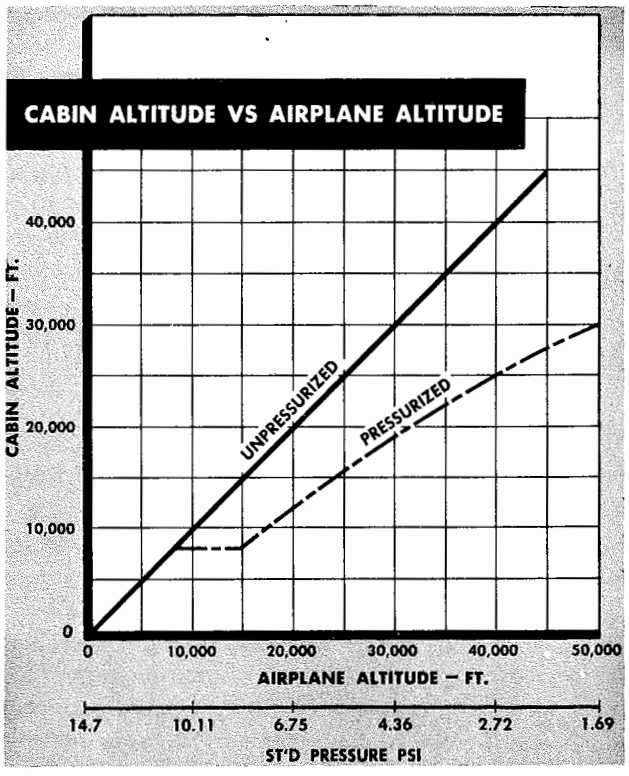


Figure 4-1

8,000 and 15,300 feet the cabin is pressurized to maintain an equivalent altitude of 8,000 feet. Above 15,300 feet, the cabin pressure differential is maintained at 2.75 psi above outside air pressure.

COCKPIT VENTILATION SYSTEM. Outside air is available to each cockpit through a scoop in the left engine air intake duct. The air enters the cockpit through a tube containing a shut-off valve and swivel fitting (14 figure 1-6) which provides directional adjustment. A check valve in the tube prevents loss of cabin pressure regardless of the position of the shut-off lever.

CONTROLS.

COCKPIT PRESSURE, VACUUM RELIEF AND DUMP VALVE. The combination cockpit pressure relief, and pressure dump valve operates automatically to relieve excessive cabin pressure in case of failure of the cockpit pressure regulator, and may be operated manually to dump cabin pressure. The toe operated cockpit pressure dump valve lever (14 figure 1-4) is located on the floor of the front cockpit. The lever is pushed down to release cabin pressure.

CABIN TEMPERATURE SELECTOR. The cabin temperature selector consists of a rheostat located on the left shelf in the front cockpit (13 figure 1-6) which controls the position of the mixing valve. The valve diverts more or less of the compressor air through the turbo-refrigerator to control cabin temperature. The cabin temperature selector control knob may be set at any position between HOT and COLD to obtain the desired cabin temperature.

PRESSURE AIR INLET CONTROLS. Pressurizing air enters the cabin through the cockpit pressurization air inlet ducts located outboard of the rudder pedals, and the rear canopy defroster ducts aft of each seat. Each inlet is provided with a shut-off control (2, figure 1-12) which may be set at any position between OPEN and SHUT.

WINDSHIELD DEFROSTING.

DESCRIPTION. Hot air for defrosting the windshield is obtained from the engine compressor (see figure 4-2) and is distributed to the windshield by a perforated tube.

SHUT-OFF CONTROL. The control knob (figure 4-2) in the defrosting tube forward of the gun sight, controls the defrosting system. To defrost, push the control knob in and turn to the right to lock it in position. Turn to the left and release to unlock and shut-off defrosting.

AUXILIARY DEFROSTER. An electrically operated windshield defroster is provided for cold weather operation or during idle descent. The control switches (1, figure 1-9) are located on the right-hand shelf of each cockpit. On AF Serials 51-4329 and subsequent, the control switch in the rear cockpit has been deleted.

FUEL FILTER DE-ICER SYSTEM.

GENERAL. This system (figure 1-10) is provided to remove ice accumulation from the low pressure fuel filter. It consists of a five gallon (five minute) alcohol supply carried in the right water-alcohol injection tank, an electrically-driven pump, a differential pressure switch, and a warning light. The tank is connected through the fluid pump and a solenoid shut-off valve to the low pressure fuel filter. When the system is set up for filter de-icing, water-alcohol injection is not available.

FUEL FILTER DE-ICER SWITCH. This toggle switch, (6, figure 1-7 and 8, figure 1-18), located on the left shelf in each cockpit, has two positions: ON and spring-loaded OFF. Holding the switch in the ON position turns on the pump and opens the solenoid valve so that alcohol is pumped into the filter. If the filter is iced, the alcohol will dissolve the ice accumulation, which reduces the pressure drop and thus extinguishes the warning light.

FUEL DE-ICE WARNING LIGHT. The red warning light, located on each left shelf on early airplanes (AF Serials 48-356 thru 51-9036), and on each instrument panel (9, figure 1-5 and 8, figure 1-17) on later airplanes (AF Serials 51-9037 and subsequent), is connected to the differential pressure switch which senses fuel pressure drop across the low pressure filter. If the pressure drop reaches approximately 2 psi, the warning light glows, indicating the possibility of icing.

WARNING

If the filter warning light comes on, hold the fuel filter de-icing switch in the ON position until the warning light goes out. If the warning light does not go out after holding the de-icer switch on for from 20 to 30 seconds, the filter may be dirty and the flight should be discontinued.

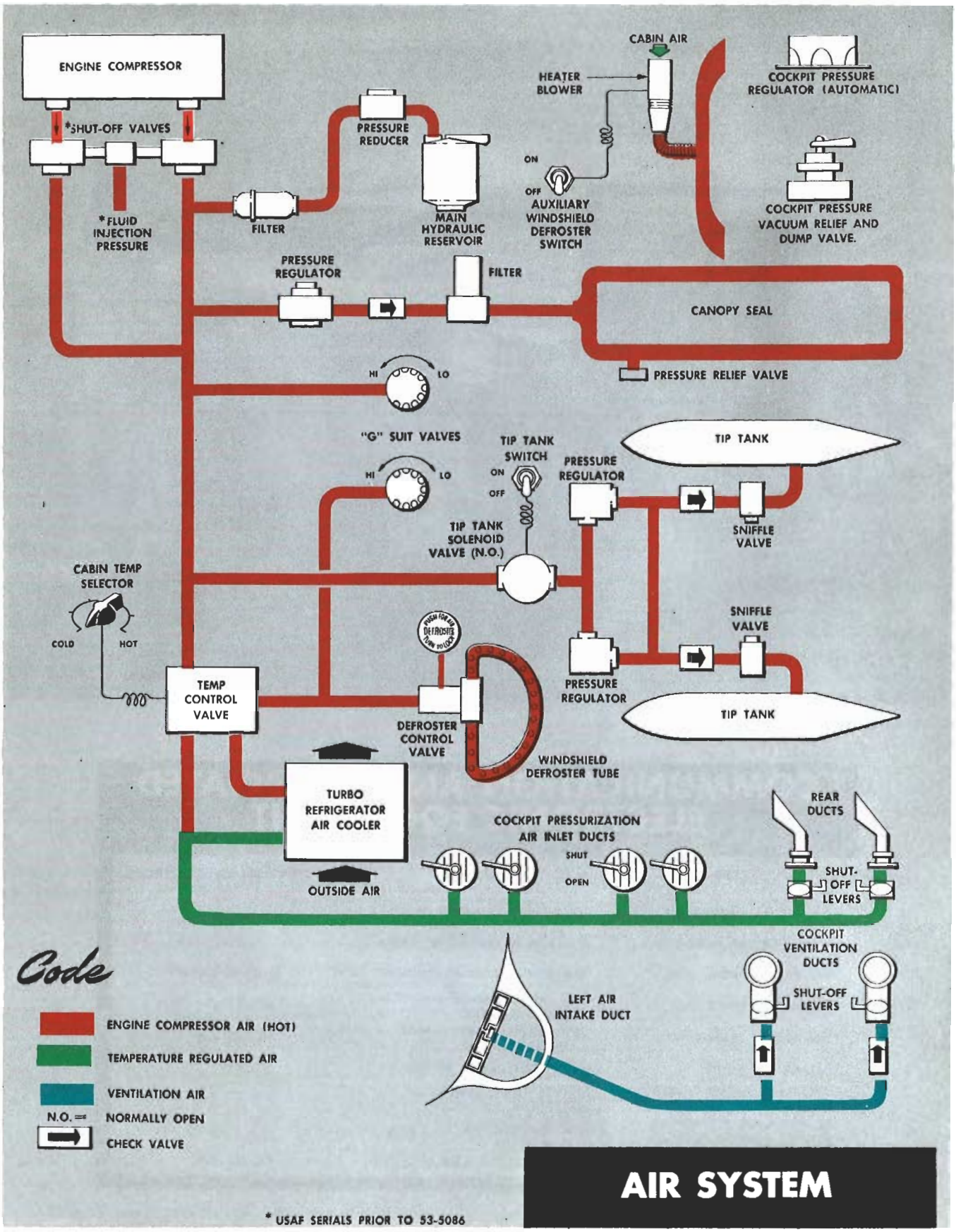
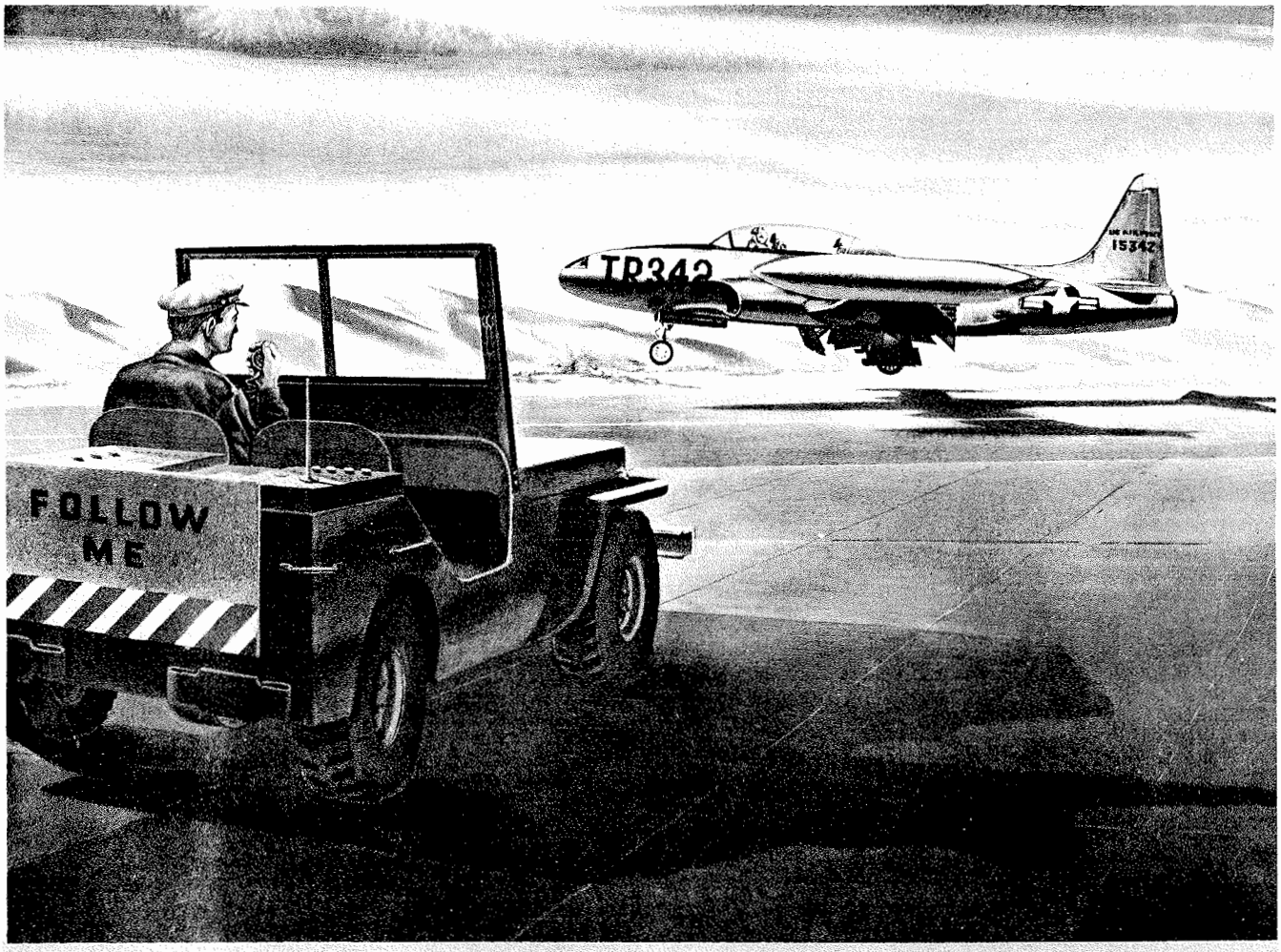

ENGINE COMPRESSOR
*SHUT-OFF VALVES
*FLUID INJECTION PRESSURE
FILTER
PRESSURE REDUCER
MAIN HYDRAULIC RESERVOIR
CABIN AIR
HEATER BLOWER
ON
OFF
AUXILIARY WINDSHIELD DEFROSTER SWITCH
COCKPIT PRESSURE REGULATOR (AUTOMATIC)
COCKPIT PRESSURE VACUUM RELIEF AND DUMP VALVE.
PRESSURE REGULATOR
FILTER
CANOPY SEAL
PRESSURE RELIEF VALVE
HI
LO
"G" SUIT VALVES
TIP TANK SWITCH
TIP TANK
PRESSURE REGULATOR
SNIFFLE VALVE
TIP TANK SOLENOID VALVE (N.O.)
CABIN TEMP SELECTOR
COLD
HOT
TEMP CONTROL VALVE
DEFROSTER CONTROL VALVE
WINDSHIELD DEFROSTER TUBE
TURBO REFRIGERATOR AIR COOLER
OUTSIDE AIR
COCKPIT PRESSURIZATION AIR INLET DUCTS
SHUT
OPEN
REAR DUCTS
SHUT-OFF LEVERS
COCKPIT VENTILATION DUCTS
LEFT AIR INTAKE DUCT
Code
ENGINE COMPRESSOR AIR (HOT)
TEMPERATURE REGULATED AIR
VENTILATION AIR
N.O. = NORMALLY OPEN
CHECK VALVE
* USAF SERIALS PRIOR TO 53-5086
AIR SYSTEM

Figure 4-2



COMMUNICATION AND ASSOCIATED ELECTRONIC EQUIPMENT

TYPE	USE	ILLUSTRATION OF CONTROLS
AN/AIC-2A INTERPHONE	INTERCREW COMMUNICATION	
USAF COMBAT INTERPHONE	INTERCREW COMMUNICATION	
AN/AIC-10 INTERPHONE	INTERCREW COMMUNICATION	FIGURE 4-4
AN/ARC-3 TRANSCEIVER	VHF SHORT RANGE 2-WAY COMMUNICATION	FIGURE 4-5
AN/ARC-27 TRANSCEIVER	UHF SHORT RANGE 2-WAY COMMUNICATION	FIGURE 4-6
AN/ARA-26 KEYER	EMER. AUTOMATIC KEYING	FIGURE 4-7
AN/ARN-6 RADIO COMPASS RECEIVER	NAVIGATION — AURAL RECEPTION	FIGURE 4-8
RC 183-A OR AN/ARN-12 MARKER BEACON RECEIVER	NAVIGATION AID	
AN/APX-6 IFF	IDENTIFICATION RADAR	FIGURE 4-9

Figure 4-3

COMMUNICATIONS AND ASSOCIATED ELECTRONIC EQUIPMENT.

AN/AIC-2A INTERPHONE. (AF Serials 48-356 thru 50-384.)

The interphone amplifier is on whenever the bus is energized. A microphone selector switch and an indicator light are located in each cockpit on early airplanes. Place the switch in the RADIO position before transmitting and in the INTERPHONE position at all other times. The indicator light glows when the switch is in the INTERPHONE position.

USAF COMBAT INTERPHONE. (AF Serials 50-385 thru 51-9235.)

The USAF Combat Interphone system includes a mixer amplifier and a control panel for each cockpit. This combination enables the operator to listen to any one or all audio channels simultaneously. The system is in operation whenever the battery switch is on and the desired channel is selected.

CONTROLS. The control panel contains a volume control, a range filter switch, four individual channel selector switches and a rotary channel selector switch. The microphone button (2, figure 1-6 and 7, figure 1-18), located on each throttle is used only for transmitting. For interphone conversation, merely speak into the microphone.

AN/AIC-10 INTERCOMMUNICATION SET.
(AF Serials 51-9236 and subsequent.)

GENERAL. This equipment provides high intelligibility of speech and signal communications at all altitudes. It provides the crew with a simplified control over the radio receivers and transmitters and permits maximum flexibility of communications facilities. It provides intercommunication within the aircraft; communication beyond the aircraft; monitoring of received radio signals including simultaneous monitoring of three radio

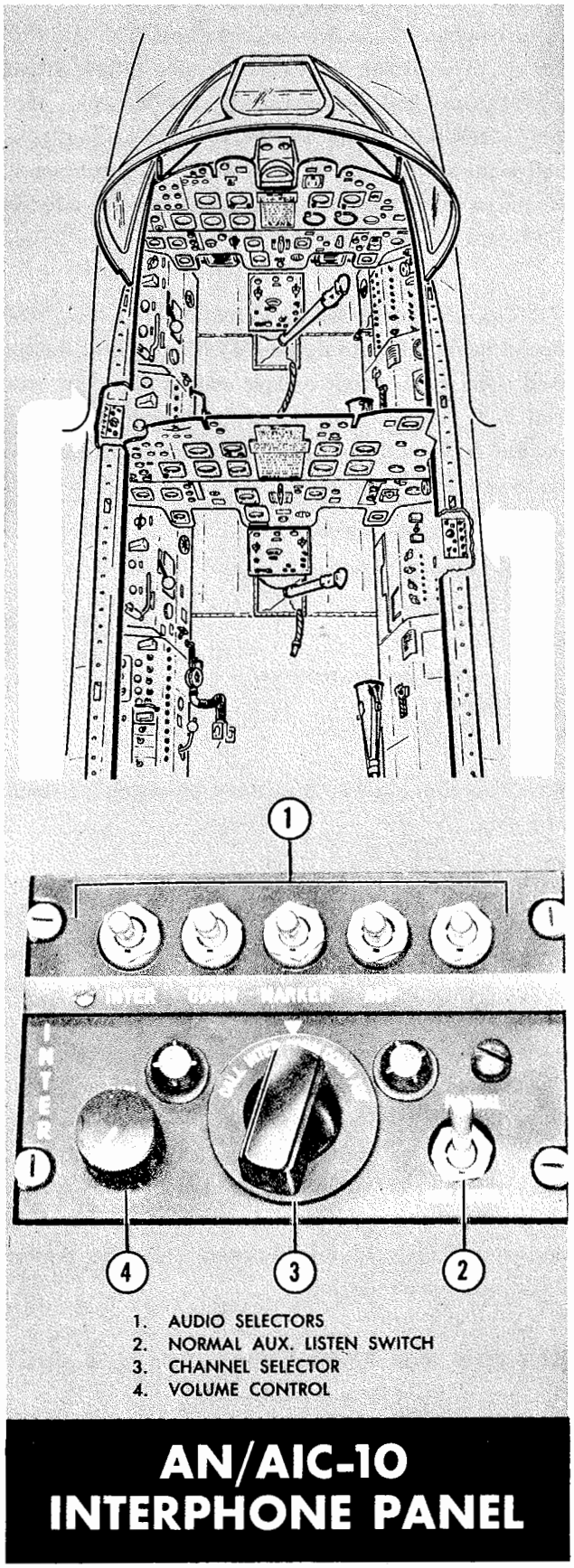


Figure 4-4

receivers; and a call facility for use in establishing interphone communication between the pilots. The set incorporates an amplifier, a dynamotor, two C-824/AIC-10 control panels and a relay assembly for "hot-mic" operation. "Hot-mic" provides operation continuously on interphone without the necessity of manual operation of the microphone button. The channel selector must be on COMM INTER or INTER.

CONTROLS. C-824/AIC-10 CONTROL PANEL. This control panel (refer to figure 4-4) is located on the left hand shelf in the front cockpit and on the right hand shelf in the rear cockpit. It acts as a master control box for the radio and intercommunication equipment and has the following controls:

1. Volume Control Knob.
2. Monitoring (mixing) Switches.
   a. Interphone.
   b. COMM.
   c. Marker beacon receiver.
   d. ADF.
   e. Spare.

These four lines can be monitored separately or simultaneously.

3. Channel Selector. This control knob has six positions: CALL — INTER — COMM — COMM INTER — ADF and a SPARE position not placarded. It permits the user to talk and listen over any of the five channels as placarded on the rotary control knob. The channel selector is connected to the monitoring switches so that the pilot can monitor lines on which he may transmit, without setting his channel selector switch to those lines.

4. Normal-Aux Listen Switch. This switch is provided to allow the pilots to receive in the event of failure of the plug-in amplifier. In this situation only one channel will be received at one time.

AN/ARC-3 VHF COMMAND RADIO. (AF Serials 48-356 thru 51-6750 and all MDAP.)

GENERAL. This set consists of a very high frequency transmitter and receiver, power for which is supplied by the direct-current bus. When the set is turned on, transmission is controlled by the microphone button on the throttle.

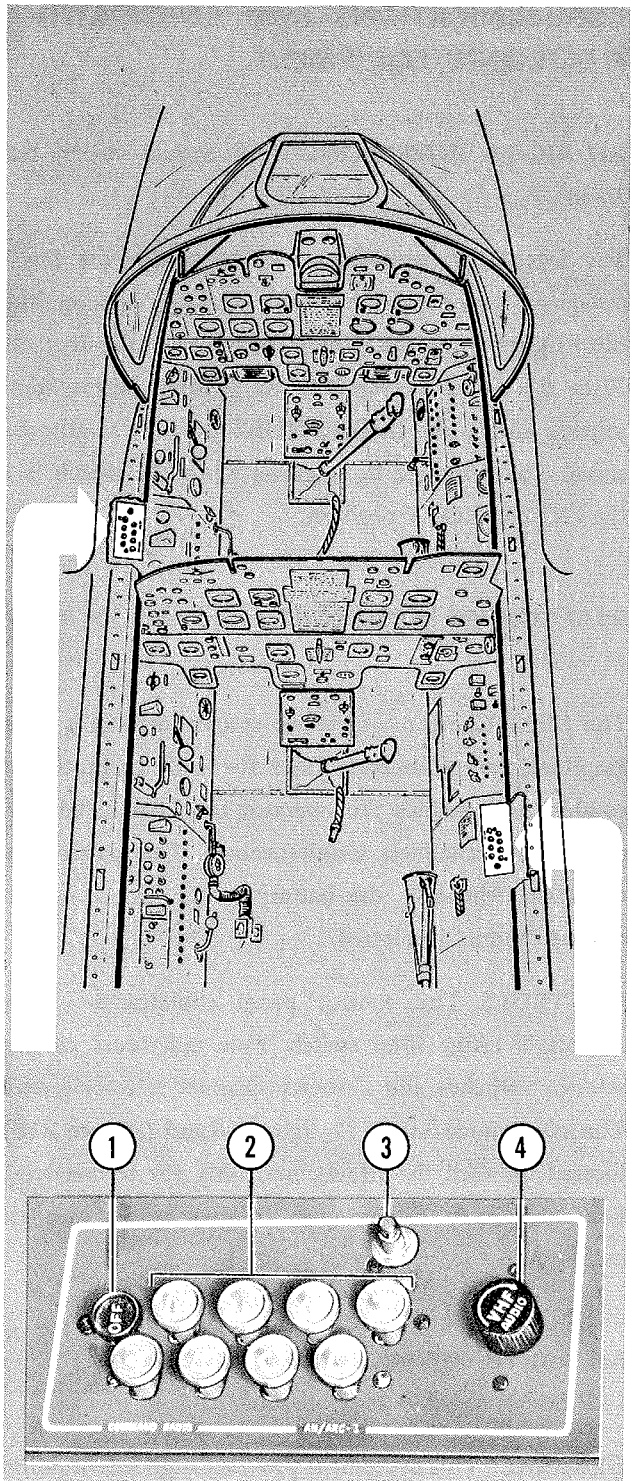


Figure 4-5

AN/ARC-3 CONTROLS.

OFF SWITCH. This switch button (1, figure 4-5) turns the set on or off. It is locked in the OFF (down) position by pressing the adjacent lock button.

CHANNEL SELECTOR BUTTONS. These buttons (2, figure 4-5) select the channel for transmission and reception. Later control panels (AF Serials 51-4094 and subsequent) have a rotary channel selector switch.

VHF AUDIO CONTROL. This control (4, figure 4-5) may be turned clockwise to increase the volume and counterclockwise to decrease volume.

D/F TONE CONTROL. By keying this control, (3, figure 4-5), code may be transmitted, and by holding it depressed, a continuous signal can be transmitted on which a fix can be obtained by a ground direction finder station.

COMMAND RADIO CONTROL SWITCH AND INDICATOR LIGHT.

The AN/ARC-3 and AN/ARC-27 Control (5, figure 1-7 and 3, figure 1-20) is a spring-loaded switch used to transfer control of the radio between cockpits. Pushing the switch transfers control of the radio to that cockpit. When the indicator light glows, you have control of the radio, provided the set is turned on. This is necessary in order to change channels.

AN/ARC-27 UHF COMMAND RADIO. (AF Serials 51-6751 and subsequent.)

CAUTION

The AN/ARC-27 radio operates in the frequency range from 225-400 Mc., and the propagation characteristics of the frequencies are very different from the VHF frequencies with which we are familiar. These frequencies are often affected by very rapid fading, resulting in broken up speech and also very erratic antenna patterns. On the T-33 there is a cone of poor reception and transmission from about 20° to 75° nose down and 30° to each side. It may be found that there will be no reception or transmission to a ground station in this area. If this occurs it will help to have the ground station abeam or aft of the airplane or the airplane may be rolled or yawed. In addition the AN/ARC-27 set itself may distort both the received and transmitted signal and the side tone level is excessively high. It should be noted that the difficulties described are not peculiar to T-33 aircraft but are common with other ARC-27 installations.

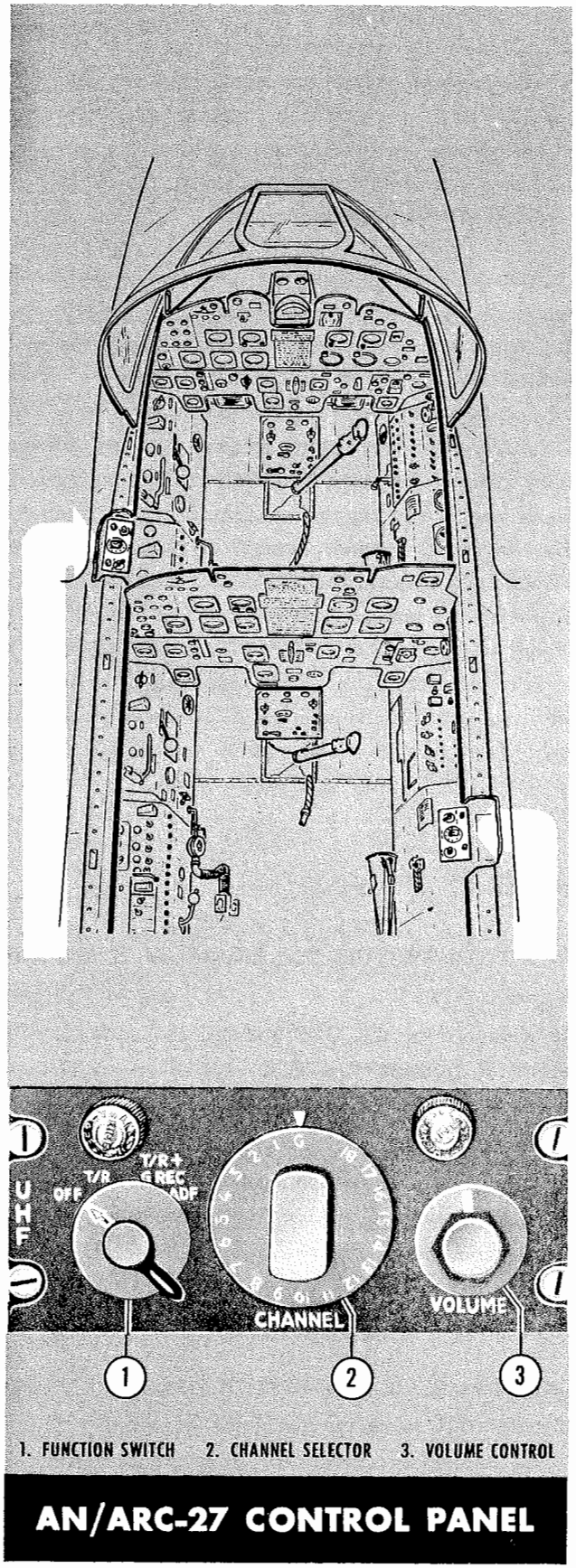
GENERAL. This equipment is operated in the same manner as the AN/ARC-3 equipment which it replaces. The equipment includes a separate guard channel receiver in addition to the main transmitter-receiver and operates in the ultra high frequency range of 225 to 400 megacycles. The guard receiver is tuned to the guard channel only and the main transmitter-receiver can be switched to any one of eighteen pre-set channels plus the guard channel. Control of channel selection is transferred between cockpits thru the command radio control switch previously described. The control panel (figure 4-6) replaces the AN/ARC-3 panel (figure 4-5) on later airplanes. The main control panel, located in the nose armament compartment, is not accessible in flight, therefore, the local remote switch must be in the REMOTE position for cockpit control.

AN/ARC-27 CONTROLS.

FUNCTION SWITCH. The function switch has four positions: OFF, T/R, T/R + G REC" and ADF. When the switch is in the OFF position the equipment is turned off. In the T/R position, transmission and reception is thru the main transmitter-receiver only and on the channel selected by the channel selector. In the T/R + G REC position conditions are the same as in the T/R position except that the guard channel is monitored simultaneously by the guard receiver. The ADF position is provided for future use with a UHF direction finder and is presently inoperative.

CHANNEL SELECTOR SWITCH. The rotary channel selector switch provides selection of any one of eighteen pre-set channels for the main transmitter-receiver, or the guard channel.

VOLUME CONTROL. The rheostat type volume control provides selection of the desired audio level.



AN/ARC-27 CONTROL PANEL

Figure 4-6

AN/ARC-27 OPERATION.

1. Rotate the function switch on the control, panel (1, figure 4-6) from OFF to T/R and allow at least one minute for warm-up.
2. Rotate channel selector switch, (2, figure 4-6), to desired frequency channel. Set is now ready to transmit and receive.
3. Rotate function switch to T/R + G REC, if simultaneous reception on guard frequency channel and another channel is desired.
4. Adjust volume controls (3, figure 4-6) as desired.
5. To transmit, press microphone button on the throttle.
6. Rotate function switch to OFF to turn set off.

AN/ARA-26 KEYER. (AF Serials 51-9236 and subsequent.)

The keyer is a motor-driven device for automatically keying distress signals through the AN/ARC-27 transmitter in an emergency. The control panel located on the right shelf in the front cockpit only, (figure 4-7) contains an on-off switch and an indicator light which glows when the keyer is operating. When the control switch is turned ON the transmitter is turned on and channeled to the distress frequency. After channeling it will transmit three SOS signals, then the last four digits of the aircraft serial number three times, followed by a series of four-second dashes spaced one second apart, six times. This series of signals will continue to be transmitted until the keyer switch is turned to the OFF position. When the keyer switch is turned OFF the transmitter is re-channeled to its original condition and the keyer will continue its cycle without transmission until the cycle is completed.

AN/ARN-6 RADIO COMPASS.

GENERAL. The AN/ARN-6 radio compass provides navigational aid as well as aural reception. The control panel (figure 4-8) is located in each cockpit below the instrument panel, and the indicator is located on each instrument panel.

AN/ARN-6 CONTROLS.

FUNCTION SWITCH. (1, figure 4-8). The function switch is used to turn the set on and select the type of operation. In the COMP position, the set functions

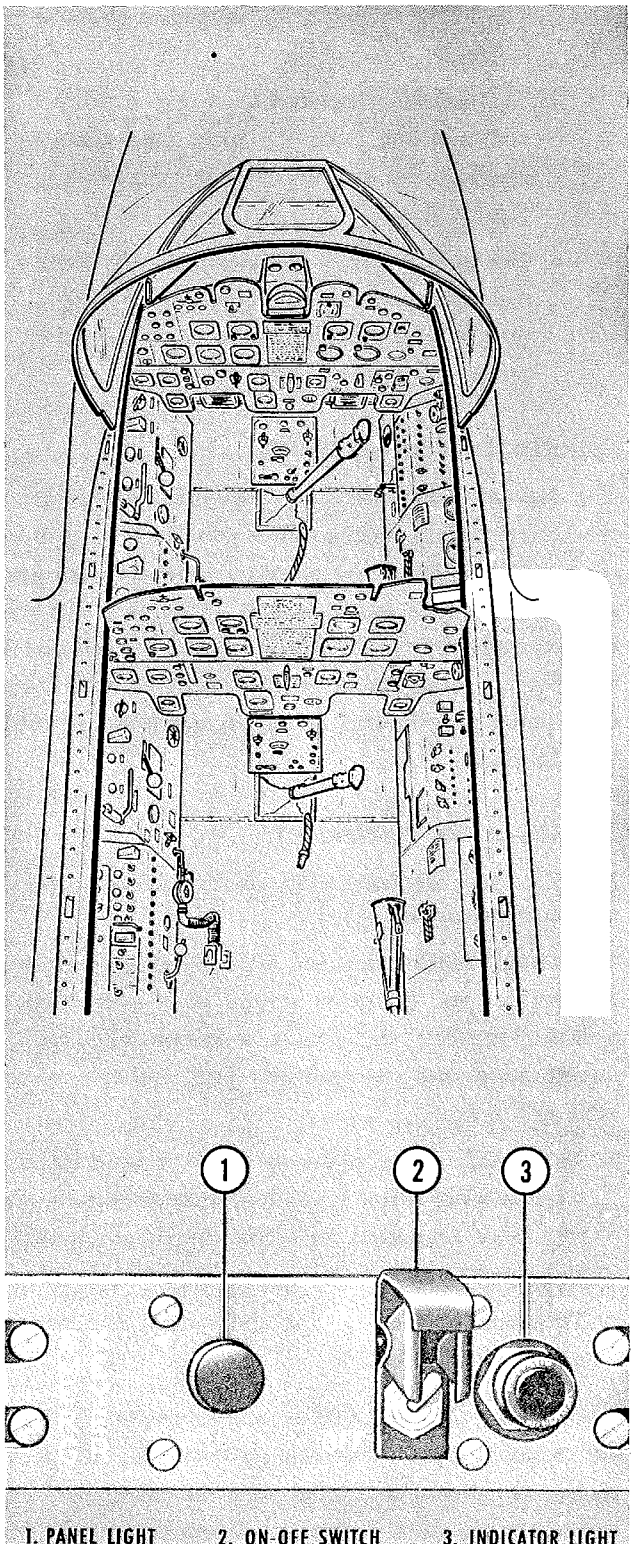


Figure 4-7

as an automatic direction finder. In the ANT position, the antenna is switched from the loop to the sense antenna. In the LOOP position, the loop can be manually rotated by the use of the loop left-right switch.

LOOP L-R SWITCH. (3, figure 4-8). This switch is provided to permit manual control of the loop when the function switch is in the LOOP position.

VOLUME CONTROL. (7, figure 4-8). This knob provides selection of the desired level of audio reception.

VOICE-CW SWITCH. (9, figure 4-8). This switch provides selection of continuous wave or voice reception.

BAND SWITCH. (6, figure 4-8). This switch provides selection of any one of four frequency bands which will be indicated on the tuning dial (4, figure 4-8) and on some airplanes contains the control button for transferring control from the other cockpit.

LIGHT SWITCH. (5, figure 4-8). This switch controls the AN/ARN-6 panel lighting and has three positions: OFF, HIGH, and LOW.

TUNING CRANK. (8, figure 4-8). The tuning crank is used to tune the desired station for maximum signal strength as indicated on the tuning meter.

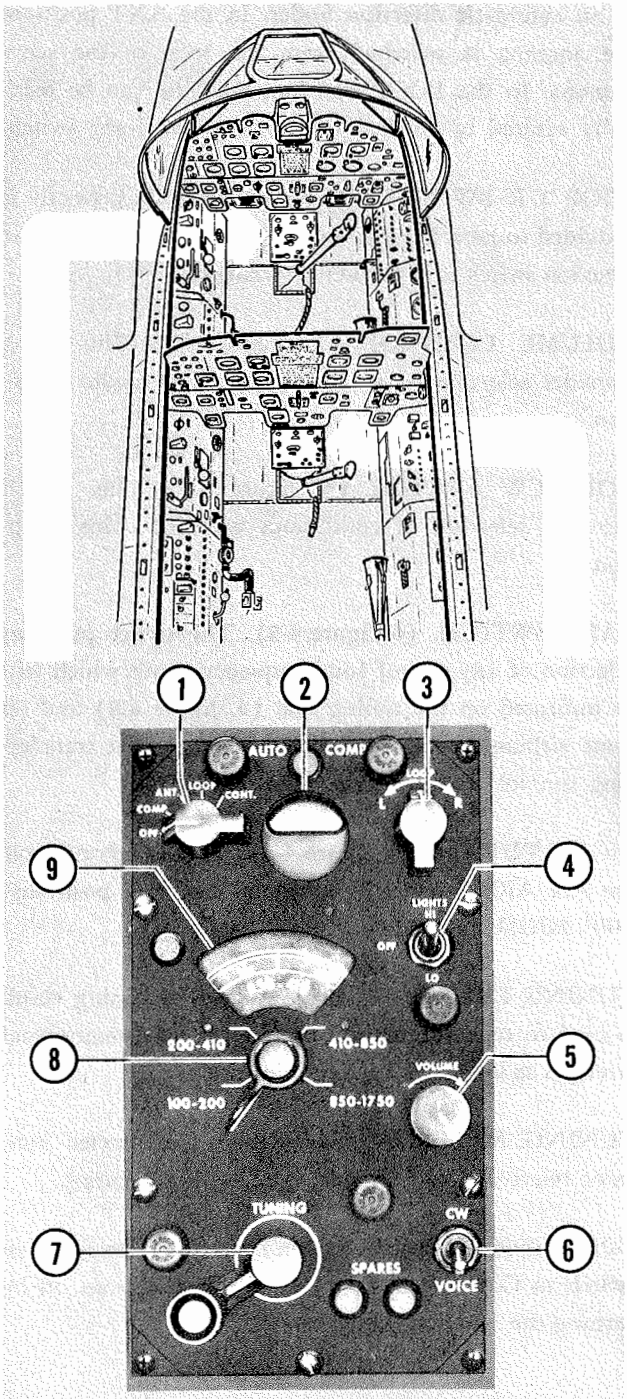
TUNING METER. (2, figure 4-8). This meter indicates relative signal strength and tuning accuracy.

OPERATION. Turn the set on by turning the function switch to COMP, ANT, or LOOP. Turn the set off by turning the function switch to OFF.

CAUTION

Erratic operation of the compass can be expected when the airplane is in a bank of 45 degrees or more as manifested by any one of the following:

1. The compass indicator may slow down so there is considerable lag between the beaming indication and the airplane heading.



1. FUNCTION SWITCH
2. TUNING METER
3. LOOP L/R SWITCH
4. LIGHT SWITCH
5. VOLUME CONTROL
6. VOICE-CW SWITCH
7. TUNING CRANK
8. BAND SWITCH
9. TUNING DIAL

AN/ARN-6 RADIO COMPASS CONTROL PANEL

Figure 4-8

2. The indicator may stop altogether or move in jerks.
3. The indicator may start moving to the direction opposite from the turn, later change direction but still lag the airplane heading considerably.
4. The indicator may oscillate violently. Since the erratic operation occurs only during a turn, it will not affect the use of the radio compass in normal flight.

MARKER BEACON RECEIVER.

The Marker Beacon receiver is in operation whenever the battery switch is ON, and is used as a navigational aid, in that a visual and an aural indication are given when the airplane passes over a 75 megacycle marker beacon transmitter. The visual signal is indicated by the glowing of an amber indicator light on each instrument panel (15, figure 1-5 and 14, figure 1-17), and by an aural tone.

AN/APX-6 IFF EQUIPMENT.

(All Air Force airplanes subsequent to AF Serial 50-401 and modified airplanes.)

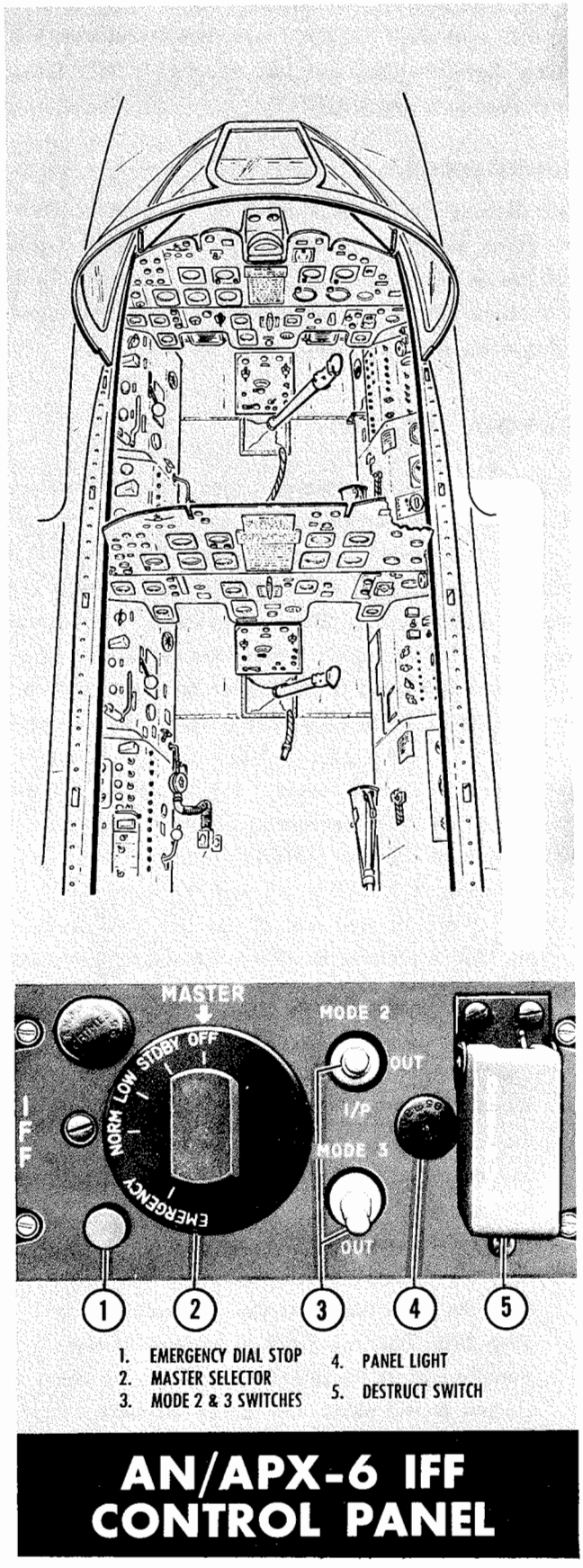
The Radar Identification Set AN/APX-6 is an airborne transpondor and is one of several units which may be operated together to provide a system of electronic identification and recognition. The purposes of the AN/APX-6 are:

1. To identify the airplane in which it is installed as friendly when correctly challenged by an interrogator-respondor associated with friendly shore, shipboard and airborne radars, and
2. To permit surface tracking and control of aircraft in which it is installed.

Functionally, the AN/APX-6 receives challenges, which are initiated by an interrogator-respondor where the replies are displayed, along with the associated radar targets, on the radar indicators. When a radar target is accompanied by a proper IFF reply, as transmitted by the AN/APX-6, that target is considered friendly.

AN/APX-6 CONTROLS.

The controls required for operation of the AN/APX-6 equipment are located on control panel (figure 4-9).



AN/APX-6 IFF CONTROL PANEL

Figure 4-9

This unit is located on the right shelf in the front cockpit.

AN/APX-6 OPERATION.

1. To turn equipment on, rotate MASTER selector (2, figure 4-9) to NORM.
2. To indicate emergency or distress, press red dial stop (1, figure 4-9) and rotate MASTER selector to EMERGENCY.
3. To maintain the equipment ready for instant use but inoperative, rotate the MASTER selector to STDBY.
4. The detent position labeled LOW on the MASTER selector should not be used except upon proper authorization.
5. The switches (3, figure 4-9) labeled MODE 2 and MODE 3 should be set to their OUT positions unless otherwise directed by proper authority.
6. With the control in the I/P position (identification position) MODE 2 operation will occur whenever the pilot operates his radio transmitter.
7. To explode destructors within the equipment, raise the switch guard labeled DESTRUCT. (5, figure 4-9) and raise the switch handle to the ON position.

WARNING

Do not fire destructors unless the AN/APX-6 is in danger of falling into enemy hands. When in doubt about the security of the area you are forced to land in, fire the destructors.

8. To secure the equipment, rotate the MASTER selector to OFF.
9. If destructors were fired during the flight, notify the responsible officer.

LIGHTING EQUIPMENT.

LANDING AND TAXI LIGHTS.

Two identical, non-adjustable landing and taxi lights are mounted on the nose gear and turn with the gear. The switch (7, figure 1-6 and 5, figure 1-18), located on each left shelf, has three positions:

LANDING LIGHTS, OFF, and TAXI LIGHT. When the switch is in the LANDING LIGHTS position, both lights are on. In the TAXI LIGHT position, only the left light is on.

COCKPIT LIGHTING.

EARLY AIRPLANES (AF Serials 48-356 thru 50-401). The panels in each cockpit are lighted by a fluorescent light on each shelf and an incandescent spot light on each left shelf. The spot light is the focusing type and is provided with a red filter. Light switches are built into each light fixture. Some airplanes (AF Serials 50-402 thru 53-5085), are provided with red floodlighting. Pairs of red floodlights, controlled by a switch type rheostat (6, 7, figure 1-19 and 15, 16 figure 1-9) on each right shelf, provide additional lighting for the instrument panel and the left and right shelves in each cockpit.

LATER AIRPLANES. (AF Serials 53-5086 and subsequent). The ultra violet lights are replaced by individual red instrument lights and shields, and a portable penlite is mounted on the right hand side of each cockpit, replacing the C-4 spotlight.

NAVIGATION LIGHTS.

Conventional navigation lights are installed on each wing tip and on the enpennage. When 230 gallon (Centerline) tip tanks are installed, navigation lights on each tip tank replace the normal lights while the tip tanks are carried. An automatic switching arrangement is provided to turn on the normal lights if the tanks are dropped, while the navigation lights are turned on. The navigation light switches (12, 13, figure 1-9) are located on the right shelf in the front cockpit. The lights are turned on or off, or connected through the flasher by the switch. When in the FLASH position, the navigation lights will flash the code character chosen by the code selector on unmodified airplanes. On modified airplanes the lights are flashed by a C-2 flasher and cannot be coded. Brilliance is controlled by the BRIGHT-DIM switch.

FUSELAGE LIGHTS.

One 6-watt fuselage light and one 100-watt signal light are installed on the top and on the bottom of the fuselage. The fuselage lights may be dimmed, but not flashed, and the signal lights may be flashed by means of the code selector. The fuselage light switch located on the right shelf in the front cockpit controls the 6-watt fuselage light and has three positions: DIM, OFF (Center), and BRIGHT.

SIGNAL LIGHTS.

The signal lights switch, located on the right shelf in the front cockpit, controls the 100-watt signal lights and has two positions: ON and OFF. The white indicator light above the switch glows with the signal lights when they are turned on or flashed.

OXYGEN SYSTEM.

GENERAL. A low pressure oxygen system consisting of four type D-2 cylinders and one type F-1 oxygen cylinder is installed in the airplane. Two type D-2 cylinders are installed in each wing, and the type F-1 cylinder is located in the fuselage nose. The system may be refilled through a single filler valve (20, figure 1-2) which is located in the engine air intake duct on the left side of the fuselage. The oxygen pressure gages (46, figure 1-5 and 41, figure 1-17) and flow indicators (47, figure 1-5 and 42, figure 1-17) are located on the lower left side of the instrument panels in each cockpit. The type A-14 pressure breathing diluter demand oxygen regulator (12, figure 1-4 and 9, figure 1-12) is located on the inboard side of the left shelf in each cockpit. Only a pressure breathing demand oxygen mask should be used.

Note

As an airplane ascends to high altitudes, where the temperature is normally quite low, the oxygen cylinders become chilled. As the cylinders grow colder, the oxygen gage pressure is reduced, sometimes rather rapidly. With a 100 degree F decrease in temperature in the cylinders the gage pressure can be expected to drop 20%. This rapid fall in pressure is occasionally a cause for unnecessary alarm. All the oxygen is still there and as the airplane descends to warmer altitudes, the pressure will tend to rise again, so that the rate of oxygen usage may appear to be slower than normal. A rapid fall in oxygen pressure while the airplane is in level flight, or while it is descend-

OXYGEN DURATION — HOURS

GAGE PRESSURE—P.S.I.

CABIN ALTITUDE FEET	400	350	300	250	200	150	100	BELOW 100
40,000	4.2 4.2	3.6 3.6	3.0 3.0	2.4 2.4	1.8 1.8	1.2 1.2	0.6 0.6	
35,000	4.2 4.2	3.6 3.6	3.0 3.0	2.4 2.4	1.8 1.8	1.2 1.2	0.6 0.6	EMERGENCY
30,000	3.2 3.2	2.7 2.7	2.2 2.2	1.8 1.8	1.4 1.4	0.9 0.9	0.5 0.5	
25,000	2.5 3.0	2.2 2.6	1.8 2.1	1.4 1.7	1.1 1.3	0.7 0.9	0.4 0.4	DESCEND TO ALTITUDE NOT REQUIRING OXYGEN
20,000	2.0 3.4	1.7 2.9	1.5 2.4	1.2 1.9	0.9 1.4	0.6 1.0	0.3 0.5	
15,000	1.6 4.1	1.4 3.5	1.1 2.9	0.9 2.3	0.7 1.8	0.5 1.2	0.2 0.6	
10,000	1.4 5.4	1.2 4.7	1.0 3.9	0.8 3.1	0.6 2.3	0.4 1.6	0.2 0.8	

RED FIGURES INDICATE DILUTER LEVER "100%" 4 TYPE D-2, 1 TYPE F1 CYLINDER
BLACK FIGURES INDICATE DILUTER LEVER "NORMAL" 2 CREW MEMBERS

Figure 4-10

ing is not ordinarily due to falling temperature of course. When this happens, leakage or loss of oxygen must be suspected.

P McCRIPE CHECK.

P—*Pressure.* 400-500 PSI.

M—*Mask.* Securely attached. Condition of rubber, proper installation of valves, arrows down on inlet valve covers.

C—*Connections at Mask.* Metal end intact, rubber gasket in place, clamps tight, 10-20 lb. pull.

C—*Connection at Regulator.* Regulator outlet elbow pointed in right direction, knurled collar tight, tubing securely clamped. Check hose for cracks, flat spots, etc.

R—*Regulator.* Each crew member will check the oxygen regulator at his station before take-off. Check the oxygen regulator with the diluter valve, first at NORMAL OXYGEN position and then at the 100% OXYGEN position as follows: Remove mask and blow gently into end of the oxygen regulator hose as during normal exhalation. If there is a resistance to blowing, the system is satisfactory. (The check valve will open at ½ pound pressure and permit some flow.) Little or no resistance to blowing indicates a faulty demand diaphragm or diluter air valve, a leaking mask-to-regulator tubing, or a faulty quick disconnect. Any of these conditions must be corrected before flight.

I—*Indicator.* Check for blink.

P—*Pressure test.* (1) Mask for exhale leaks. (2) Regulator Pressure Control Knob to 43M, hold breath, continued flow into tight mask means leaking exhalation valve. (3) Regulator Pressure back to NORMAL, exhale to check valve for sticking.

E—*Emergency Cylinder.* Red flag pin removed, 1800 PSI minimum. Connect to mask adapter.

ALL FLIGHTS ABOVE 10,000 FEET. Each pilot will check the cockpit oxygen system pressure gage before take-off, and there will NOT BE LESS THAN 400 POUNDS PER SQUARE INCH PRESSURE IN THE

SYSTEM. If there is less than 400 pounds per square inch pressure, the oxygen system will be charged to capacity prior to flight.

EMERGENCY OPERATION. With symptoms of the onset of hypoxia, set the diluter lever to 100% OXYGEN. If the oxygen regulator becomes inoperative, pull the cord of the H-2 emergency oxygen cylinder. If smoke or fuel fumes should enter the cabin, proceed as follows:

1. Set oxygen regulator diluter lever to 100% OXYGEN position.
2. If pressure is desired, set pressure dial of oxygen regulator as required by cabin altitude.

GUNNERY EQUIPMENT.

GENERAL. Two .50 caliber guns with ammunition boxes carrying up to 300 rounds each may be installed in the nose armament compartment. A gun camera mounted in the lip of the right engine air intake duct operates with the guns or separately. Provisions are included for installation of a K-14 gunsight in the front cockpit.

CONTROLS.

GUNS-CAMERA SWITCH. The guns-camera switch (14, figure 1-7), (front cockpit only) has three positions, SIGHT AND CAMERA, OFF, and GUNS. When the switch is in the SIGHT AND CAMERA position only the gunsight and the gun camera are operable. When the switch is in the GUNS position, the gunsight, gun camera and the .50 caliber machine guns are operable. The guns and camera are operated by squeezing the control stick trigger.

GUN TRIGGER SWITCHES. The gun trigger switches (figure 1-21) are located one on each control stick and are wired in parallel. They cause the guns and/or camera to operate when either one is depressed, provided the gun-camera switch is in either GUNS or SIGHT AND CAMERA position and the guns and jato master switch is in the ARM position. On early airplanes (AF Serials 48-356 thru 50-401), the trigger switches also fire the jato bottles when depressed, provided the guns-jato selector switch is in the JATO position and the guns-jato master switch in the rear cockpit is in ARM position.

BOMBING EQUIPMENT. (AF Serials prior to 51-4141 not modified for centerline tip tanks.)

WING TIP BOMBS. AF Serials prior to 51-4141 incorporate a bomb shackle on the wing tips that can carry 165 gallon underslung fuel tanks, chemical tanks or bombs. The following is a list of the type of bombs that may be carried on the wing tip bomb shackles in place of the underslung tip tanks:

1. 1,000 pound general purpose bombs, type AN-64A1, only when bomb fins are modified and M2 fin lock nuts are installed.
2. 500 pound general purpose bombs, type AN-64F1, only when bomb fins are modified and M2 fin lock nuts are installed.
3. MK47 practice bombs, only when bomb racks and aircraft are modified.

T-1 BOMB RACK ASSEMBLY. On aircraft modified to carry the T-1 bomb rack, an electrically operated bomb rack assembly is mounted on the jato hooks. It has a capacity of eight practice bombs and can be operated with either the bomb (or tank) release controls or the jato controls.

BOMB CONTROLS.

BOMB ARMING MASTER SWITCH. The bomb arming master switch located in the aft cockpit (22, figure 1-18) has two positions ARM and SAFE. This is a circuit breaker type switch that protects the bomb arming electrical circuit. It also serves as a master control switch for the bomb arming circuit and must be in the ARM position in order for the bomb arming circuit to be energized. The switch will automatically throw to the SAFE position if there is an overload or short in the bomb arming circuit.

BOMB RELEASE MASTER SWITCH. This switch has two positions ARM and SAFE and is located in the aft cockpit (21, figure 1-18). It is a circuit breaker type switch that protects the bomb or tank release electrical circuit. It also serves as a master control switch for the bomb or tank release circuit and must be in the ARM position in order to energize the circuit. The switch will automatically throw to the SAFE position if the release circuit shorts or becomes overloaded.

BOMB ARMING SWITCH. This switch located in the front cockpit (17, figure 1-7) has two positions, NOSE AND TAIL and TAIL ONLY. It is used to arm the fuse in the bomb prior to release. The position used depends upon how the bomb is fused. The chemical

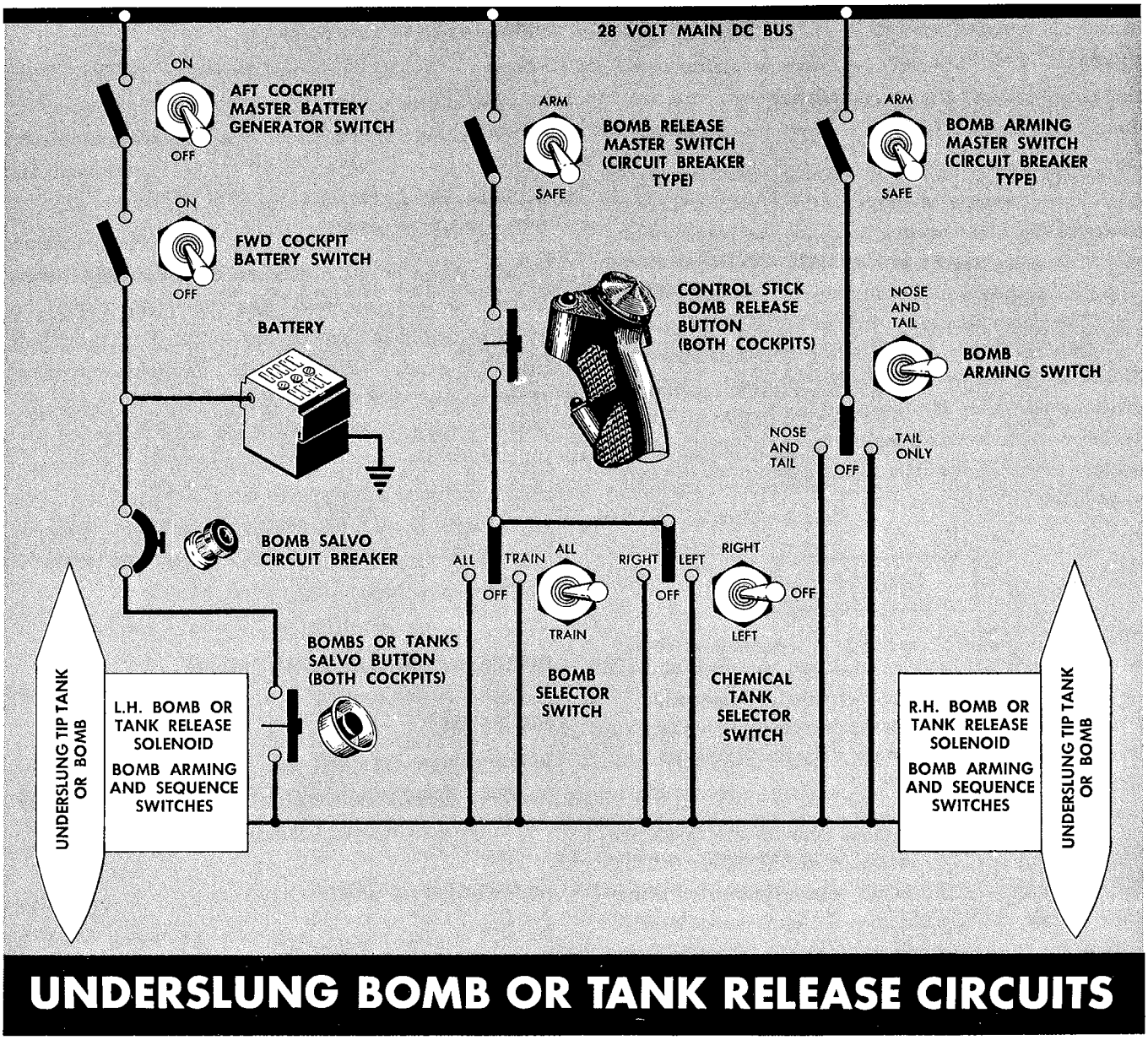


Figure 4-11

tank circuit is wired thru this switch so that when in the NOSE AND TAIL position the chemical tanks can be operated simultaneously.

BOMB SELECTOR SWITCH. The bomb selector switch located in the front cockpit (17, figure 1-7) has three positions, ALL, OFF, and TRAIN. In the ALL positions the bombs are dropped simultaneously. The TRAIN position is used to drop the bombs individually.

CHEMICAL TANK SELECTOR SWITCH. This switch is located in the front cockpit (16, figure 1-7). It has three positions, LEFT, RIGHT and center OFF, and is used to select individual chemical tank operation.

T-1 BOMB ARMING SWITCH (Modified Airplanes Only). The T-1 bomb arming switch is located in the front cockpit. It has two positions ARM and SAFE and is used to arm the T-1 bomb rack.

BOMB OR TANK SALVO SWITCH. A bomb or tanks salvo button (41, figure 1-5 and 37, figure 1-17) located on each instrument panel is provided to permit simultaneous release of external load in an emergency. Both buttons are directly connected to the battery and are always "hot."

OPERATION OF BOMB CONTROLS.

The bomb arming and release master switches in the rear cockpit must be in the ARM position before the arming and selector switches in the front cockpit will function. To arm the bombs, place the bomb arming switch (front cockpit) in the TAIL ONLY or NOSE AND TAIL position. To drop the bombs individually, place the bomb selector switch in the TRAIN position and press the bomb release button on the control stick grip. The left bomb will drop first, the right bomb will drop the next time the bomb release button is pressed. To drop both bombs simultaneously, place the bomb selector switch in the ALL position and press the bomb release button.

CAUTION

Place arming switches OFF as soon as possible following the release of bombs to preclude the possibility of the arming wire being retained in the rack, where the resultant whipping action of the wire may damage the skin of the aircraft.

To operate the chemical tanks individually, place the chemical tank selector switch in the LEFT or RIGHT position and press the bomb release button on either control stick. To operate the chemical tanks simultaneously, place the bomb arming switch (front cockpit) in the NOSE AND TAIL position and press the bomb release button on either control stick. To jettison the chemical tanks follow the same procedure given for bombs.

To drop the bombs from the T-1 bomb rack, place the bomb arming and release master switches in the aft cockpit to the ARM position, place the bomb selector and chemical tank switches in the front cockpit to the OFF position (on later aircraft place the tip tank jettison switches in both cockpits to the OFF or SAFE position), place the T-1 arming switch in the front cockpit to the ARM position and press the bomb release button on either control stick. Each time the button is pressed a bomb will drop. To release the bombs with the jato controls, follow the procedure given in Section I for operation of the jato controls. Each time the jato firing switch is pressed, one bomb will drop.

TOW TARGETS.

Either the fuselage type installation or the jato latch type installation may be used. With either type of installation a banner type A-6B or A-25B target is used.

RELEASE OF JATO LATCH TOW LINES AND TARGETS.

To accomplish release of the tow lines and target when attached to the jato latch, the tow plane should be flown at minimum safe flying speed. This procedure reduces the target drag load and facilitates operation of the manual release. In case of failure to release the target, a landing should be made at an adequate distance from the end of the runway in order that the target may clear all obstacles short of the runway. The glide angle should be planned accordingly with an increase in prescribed approach and landing speed of approximately 10 knots per hour IAS.

MISCELLANEOUS EQUIPMENT.

PITOT HEAT.

PITOT HEAT SWITCH. The pitot heater is controlled from the front cockpit only, by the switch (8, figure 1-9) located on the right side forward panel.

ANTI-G-SUIT VALVE.

GENERAL. An anti-G suit valve (9, figure 1-4,) is installed on the left side of each cockpit at floor level. The valve receives air under pressure from the engine compressor and automatically meters it to the pneumatic suit during positive G accelerations. At the high setting, suit pressurization begins at approximately 1.75 G and increases at the rate of 1.4 psi per G. At the low setting, suit pressurization begins at approximately 1.75 G and increases at the rate of one psi per G. A button on top of the valve can be manually depressed to inflate or check the suit momentarily when desired. This feature may be used to massage the body and thus lessen fatigue on a long flight. The suit is connected to the valve through a quick disconnect fitting attached to the seat.

CHECK LIST.

The pilot's check list is mounted on each instrument panel.

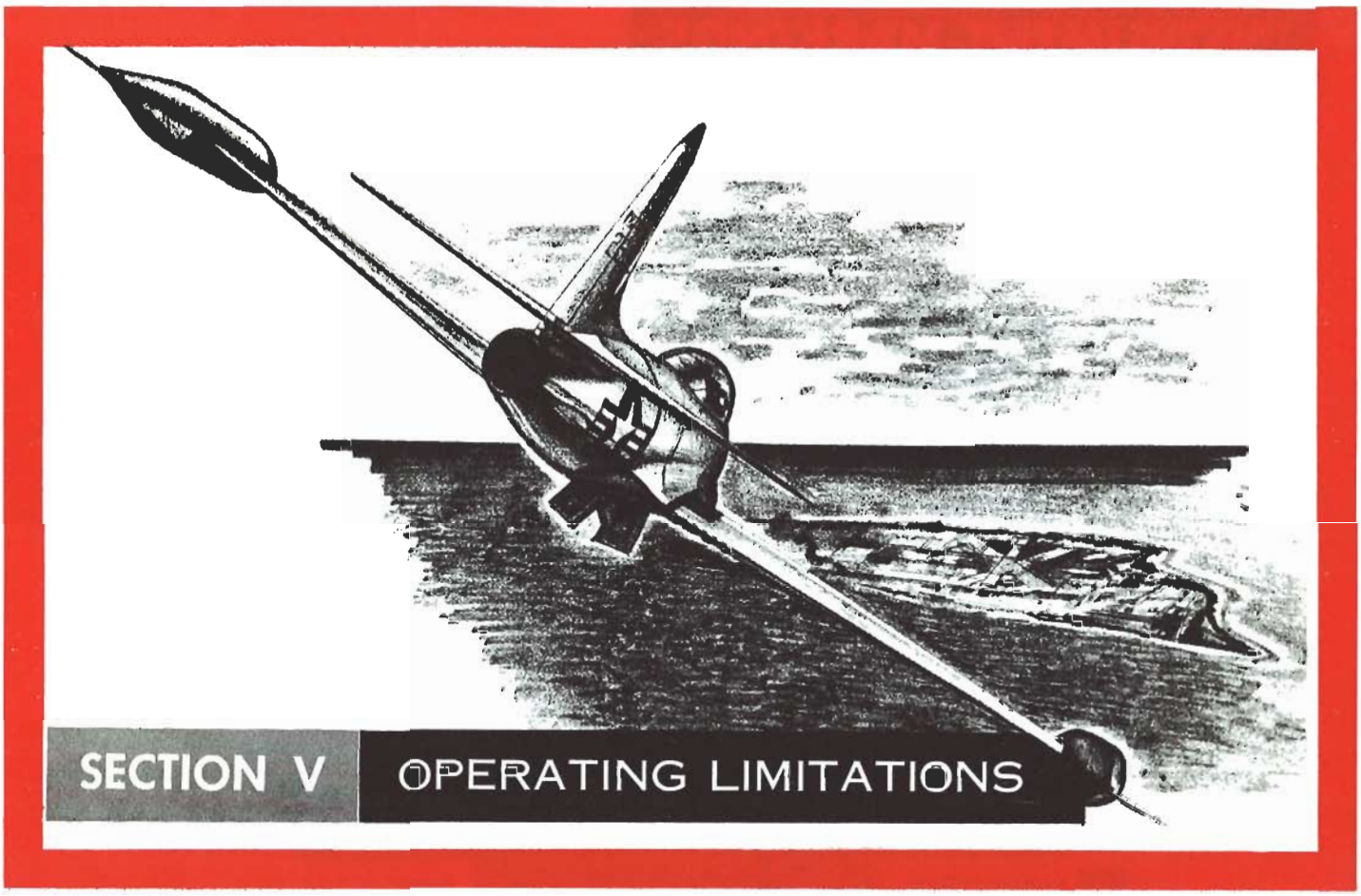
MAP CASE.

The map case (6, figure 1-4 and 5, figure 1-12) is installed in the right side panel of both cockpits. It is hinged at the bottom and is pulled out from the top. Be sure it is out of the way of canopy jettison lever.

DATA CASE.

The standard sized data case is installed in the armament compartment.

FT-363



OPERATING LIMITATIONS.

GENERAL. Operating limitations are derived from extensive flight testing and operational experience to insure your safety and to help obtain maximum utility from the equipment. The instrument dials are marked as shown on figure 5-1 as a constant reminder of airspeed and engine limitations; however, additional limitations on operational procedures, acrobatics, and airplane loading are given in the following paragraphs.

MINIMUM CREW REQUIREMENT.

The minimum crew requirement for this airplane is one pilot in the front cockpit. An additional crew member, as required, will be added at the discretion of the Commanding Officer.

INSTRUMENT MARKINGS.

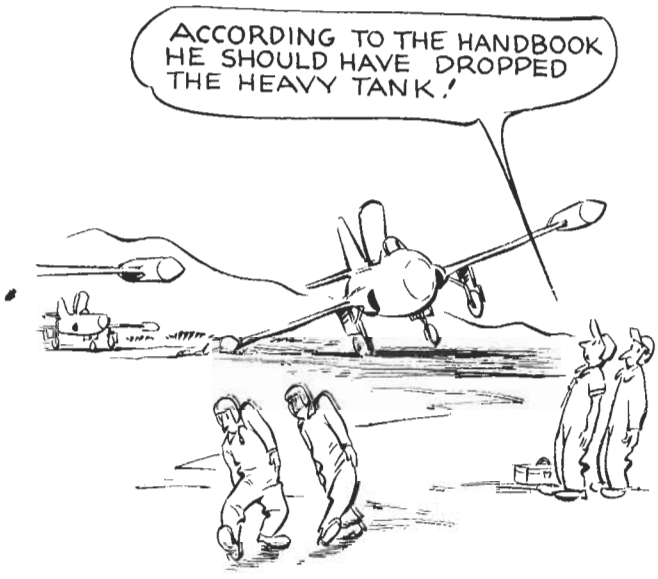
Instrument markings are shown on figure 5-1.

GENERAL FLIGHT RESTRICTIONS.

Never unlock the canopy in flight.

For solo flight, the airplane must be operated from the front cockpit, as the rear cockpit does not have complete operating controls.

Do not land with one heavy tip tank if lateral control cannot be maintained at 130 knots IAS. (Refer to Section III.)



INSTRUMENT MARKINGS

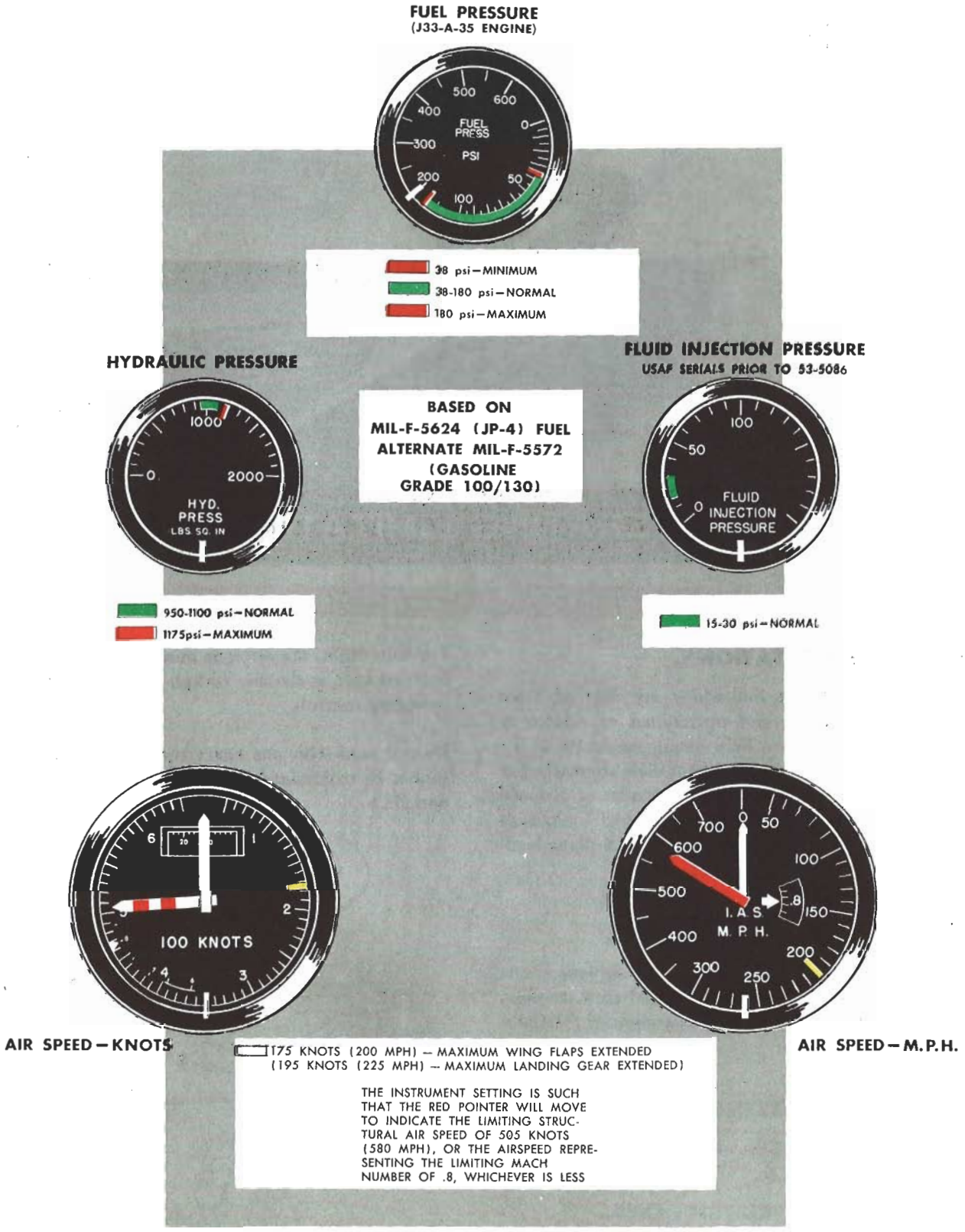


Figure 5-1 (Sheet 1 of 2)

INSTRUMENT MARKINGS

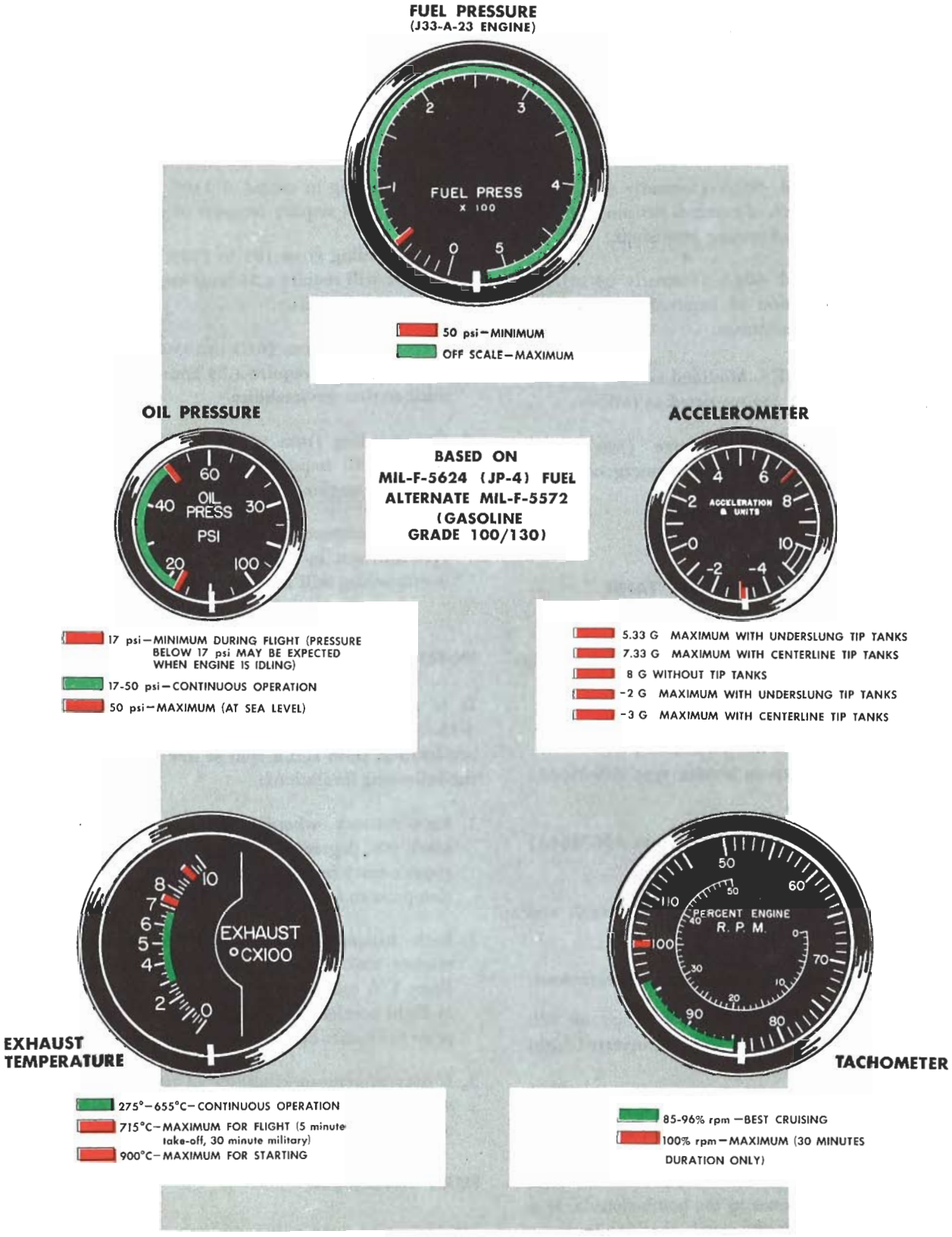


Figure 5-1 (Sheet 2 of 2)

Aircraft will be restricted from carrying 230 gallon tip tanks if the following technical orders have not been complied with:

1. T.O. 1T-33A-61 and -61A (formerly 01-75F-61 and -61A). Reinforcement of wing tip structure.
2. T.O. 1T-33A-65 and -65A (formerly 01-75F-65 and -65A). Installation of centerline tip tank ejection brackets.
3. T.O. 6J14-2-4-502 and -502A (formerly 03-10JA-50 and -50A). Modification of external jettison fuel tanks to incorporate bulkhead sealing provisions.
4. T.O. 6J14-2-4-504 and -504A (formerly 03-10JA-73 and -73A). Modification of external fuel tanks to incorporate ejector mechanism.

230 GALLON TIP TANKS. Modified aircraft with 230 gallon tip tanks installed are restricted as follows:

1. Do not jettison tip tanks above (390 knots) (450 mph) IAS except in extreme emergency.
2. Rate of roll limit—158° per second.

165 GALLON (UNDERSLUNG) TIP TANK SHACKLE LOADS.

Only the following items may be carried on the wing tip shackles:

1. 100 pound practice bombs M38A2.
2. 500 pound general purpose bombs, type AN-M64A1 modified.
3. 1,000 pound general purpose bombs, type AN-M64A1 modified.
4. MK47 practice bomb racks only when aircraft and bomb racks are modified.
5. 165 gallon tip tanks with the following restrictions:
   a. 5.33 G's will not be exceeded in pull-ups nor will −2 G's be exceeded in nose down or inverted flight maneuvers.
   b. Extreme caution will be exercised in accomplishing a rolling maneuver. The roll should be slow and not exceed a full roll in eight seconds. Rolling maneuvers induce high loads in the tank and these are multiplied five times to the bomb shackle. It is possible to overstress the bomb shackles by loads developed during fast maneuvers.

ENGINE LIMITATIONS.

ENGINE RESTRICTIONS. Operation above 100% engine rpm and/or 715°C tailpipe temperature is prohibited because of the danger of weakening the turbine wheel and causing failure.

ENGINE SPEED.

1. Overspeeding in excess of 110% rpm for *any* period of time will require removal of engine for overhaul.
2. Overspeeding from 105 to 110% rpm for *any* period of time will require a 25 hour inspection to determine engine serviceability.
3. Overspeeding from 101.5 to 105% rpm for more than 15 seconds will require a 25 hour inspection to determine engine serviceability.
4. Overspeeding from 101.5 to 105% for less than 15 seconds will require normal pre-flight inspection to determine engine serviceability.
5. When overspeeding is encountered beyond 101.5% rpm and not in excess of 110% rpm, the cause for overspeeding will be corrected prior to further flight.

IN-FLIGHT ENGINE TEMPERATURE LIMITS.

It is acceptable for the exhaust temperature of the J-33-A-35 engine to exceed 900 degrees C during in-flight acceleration from IDLE rpm at low airspeeds subject to the following limitations:

1. Each instance, wherein the exhaust temperature exceeds 900 degrees C for five seconds or more, shall require entry in the aircraft Form 1 and engine inspection prior to further operations.
2. Each instance, wherein the exhaust temperature reaches 1000°C, shall require entry in the aircraft Form 1. A total of ten high temperature starts and/or in-flight accelerations shall require engine inspection prior to further operation.
3. If overtemperature condition of 1000°C exceeds 2 seconds, the engine will be inspected prior to further operation.

FLUID INJECTION.

Never turn on fluid injection above 10,000 feet or below 90% rpm.

PROHIBITED MANEUVERS.

Inverted flying or any maneuver resulting in prolonged negative acceleration will result in engine flameout. There is no means of insuring a continuous flow of fuel or of maintaining oil pressure for more than ten seconds in this attitude. Vertical stalls are prohibited. Avoid acrobatics and maneuvers involving high rates of roll.

On AF Serials 52-9656 and subsequent and aircraft modified to incorporate revised wing leading edge and stall strips (T.O. 1T-33A-234), 20 (+2, −0) degrees maximum up elevator, and carrying guns and ammunition or equivalent ballast; the following are permitted:

1. Intentional erect spins (started at 20,000 feet or above) when tip tanks are installed and empty, and gear and flaps are retracted.
2. Practice stalls, provided the tip tanks, if installed, are empty. The landing gear may be extended or retracted.
3. Side slips without restriction in case of emergency. For practice, tip tanks must be empty, if installed.
4. All acrobatics except vertical stalls provided that tip tip tanks, if installed, are empty.

AIRCRAFT MODIFIED TO 20 (+2, −0) DEGREES MAXIMUM UP ELEVATOR TRAVEL.

Intentional acrobatics are prohibited unless the aircraft is equipped as follows:

1. Tip tanks installed and empty.
2. Guns and ammunition (or equivalent ballast) installed. (The maximum allowable forward CG limit is not to be exceeded.)

If the mission requires, practice stalls with gear and flaps extended may be accomplished if the following are observed:

1. Maneuver is completed above 15,000 feet.
2. Recovery will be initiated at first indication of stall.

EARLY UNMODIFIED AIRCRAFT.

Practice stalls below 15,000 feet.

Intentional spins are prohibited except as noted above.

On AF Serials 48-356 thru 49-967 avoid acrobatics and maneuvers involving:

1. Large yaw angles at all speeds.
2. Violent rolling pull-outs at all speeds.
3. Uncoordinated turns and steep spirals.

AIRSPEED AND ACCELERATION LIMITATIONS.

(See Figures 5-1 and 5-2.)

Airspeed is limited to 505 knots (580 mph) or .8 Mach number or aileron buzz, whichever is encountered first, and the load factors shown below:

CONFIGURATION	Symmetrical Pullout	Rolling Pullout
Without Tip Tanks	+8.0 G's −3.0 G's	+5.33 G's
230 Gallon Centerline Tip Tanks	+7.33 G's −3.0 G's	+4.9 G's
165 Gallon Underslung Tip Tanks	+5.33 G's −2.0 G's	+3.6 G's

The approximate airspeed limit will be shown by the red limit hand on the airspeed indicator. Below 4,000 feet the red needle will stop at 505 knots (580 mph); above 4,000 feet, it will show the airspeed equivalent to .8 Mach number. At Mach numbers greater than .8, compressibility effects cause aileron buzz, trim changes, and airplane buffeting. Aileron buzz can be recognized by a high frequency lateral oscillation of the control stick, and/or visual observation of the ailerons where aileron buzz is indicated by a fuzzy outline at the trailing edge of the ailerons.

The Flight Strength diagrams (figure 5-2) show the acceptable limits to which the airplane can be flown during both accelerated and unaccelerated flight. Curves are shown in the Flight Strength diagrams which indicate the number of G's that can be obtained before the airplane stalls. At the higher indicated airspeeds, the number of G's that can be obtained without stalling exceeds the limit load factors shown in the diagrams. Indicated airspeed for .8 Mach number at various altitudes and

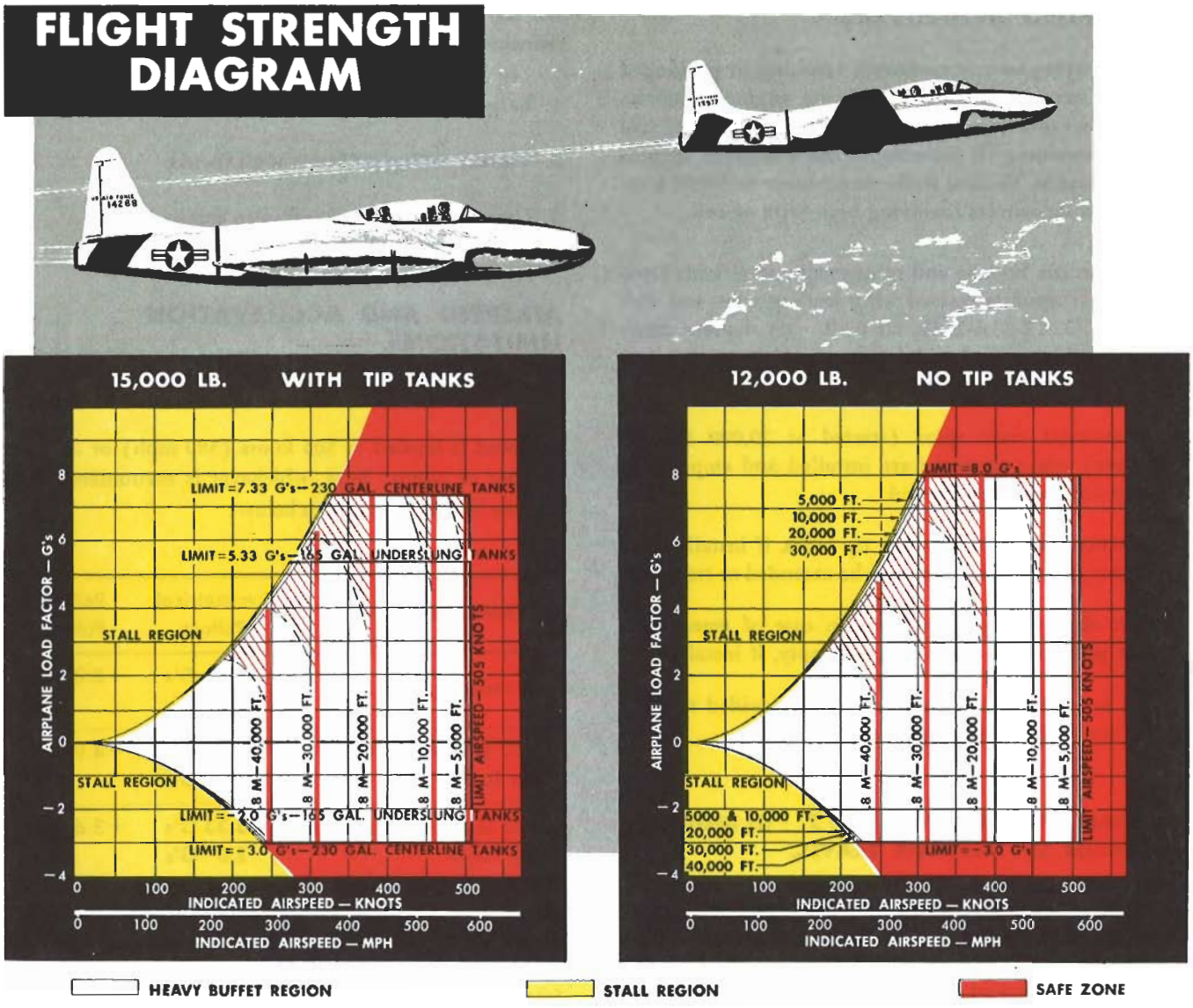


Figure 5-2

the limit structural airspeed of 505 knots (580 mph) are also shown in the diagrams. The shaded areas represent the conditions under which heavy buffet can be expected. Flight tests have shown buffeting to be tolerable, and structural loads within limits, up to the shaded areas in the diagrams. No flight tests have been made in the heavy buffet region, and operation in this region must be avoided.

Steep angle dives should not be attempted at low altitude at speeds near the red needle because compressibility buffet may prevent a successful pull-out if high G's are attempted or required. Dive flaps are very effective for reducing speed and increasing the amount of available G's.

Maximum speed for up to 50% wing flap extension is 190 knots (220 mph).

WEIGHT LIMITATIONS.

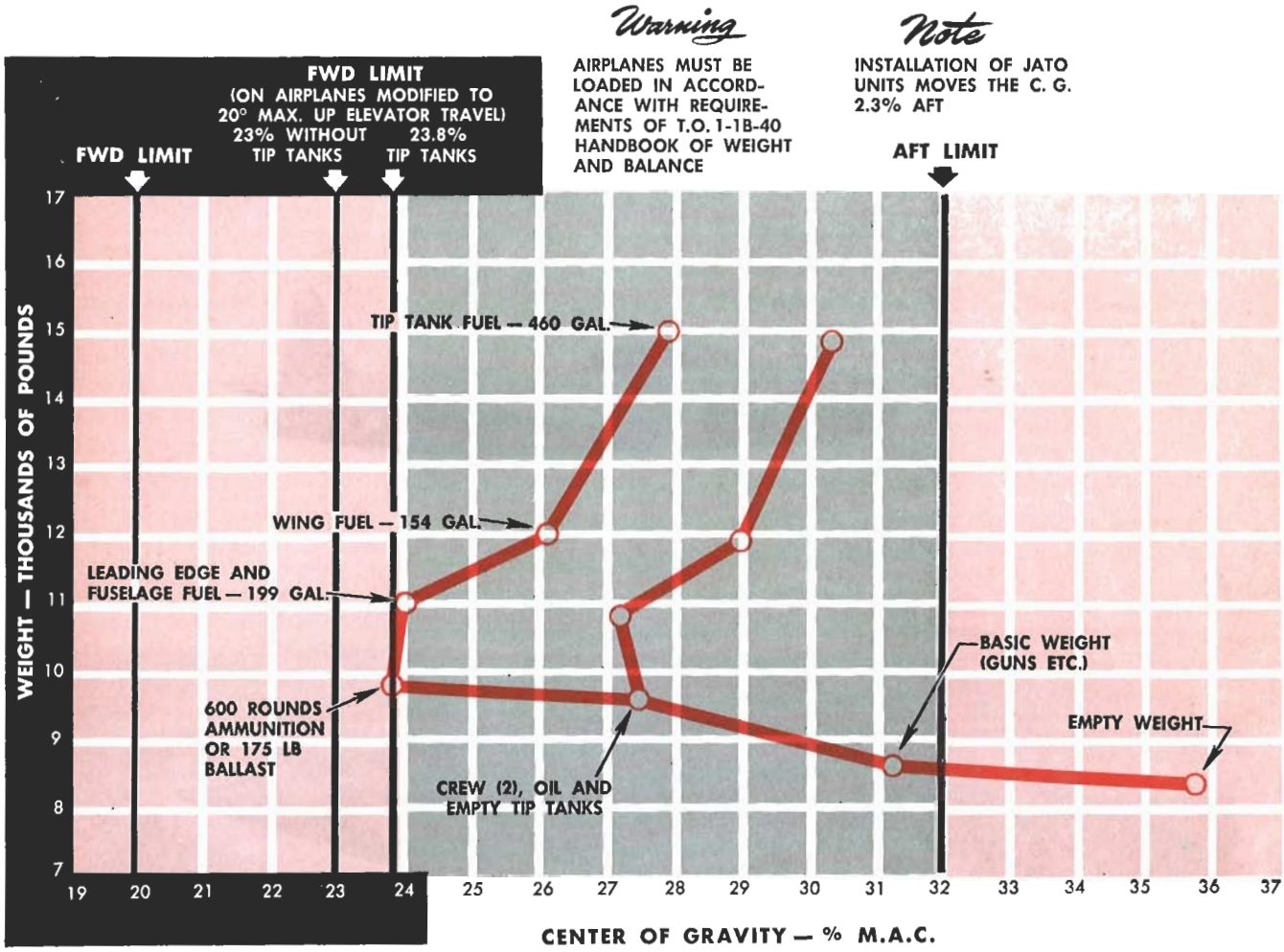
(Refer to T.O. 1-1B-40.)

The weights shown below are for general information and should not be interpreted as imposing any weight limitations on the airplane. For weight and balance information refer to T.O. 1-1B-40, Handbook of Weight and Balance Data.

WARNING

Without proper ballast, it is possible to obtain a CG position aft of the rearward limit. (See figure 5-3.)

These limitations and restrictions are subject to change and latest directives and orders must be consulted.



This curve shows the center of gravity travel and weight change as fuel and ammunition are added or consumed. Starting with the empty weight condition the c.g. moves forward with the addition of guns, crew and engine oil. With no occupant in the rear seat the c.g. moves aft about 1%. The most forward c.g. is obtained with full ammunition and no fuel, no tip tanks and two pilots. However, note that the c.g. changes very little with fuel in the fuselage tank (95 gal). The most rearward c.g. is obtained with full fuel, full tip tanks, no aft pilot and no ammunition. Extension of the landing gear or dropping the empty tip tanks has only a slight effect on c.g. location.

Figure 5-3

TR-550

TR-551
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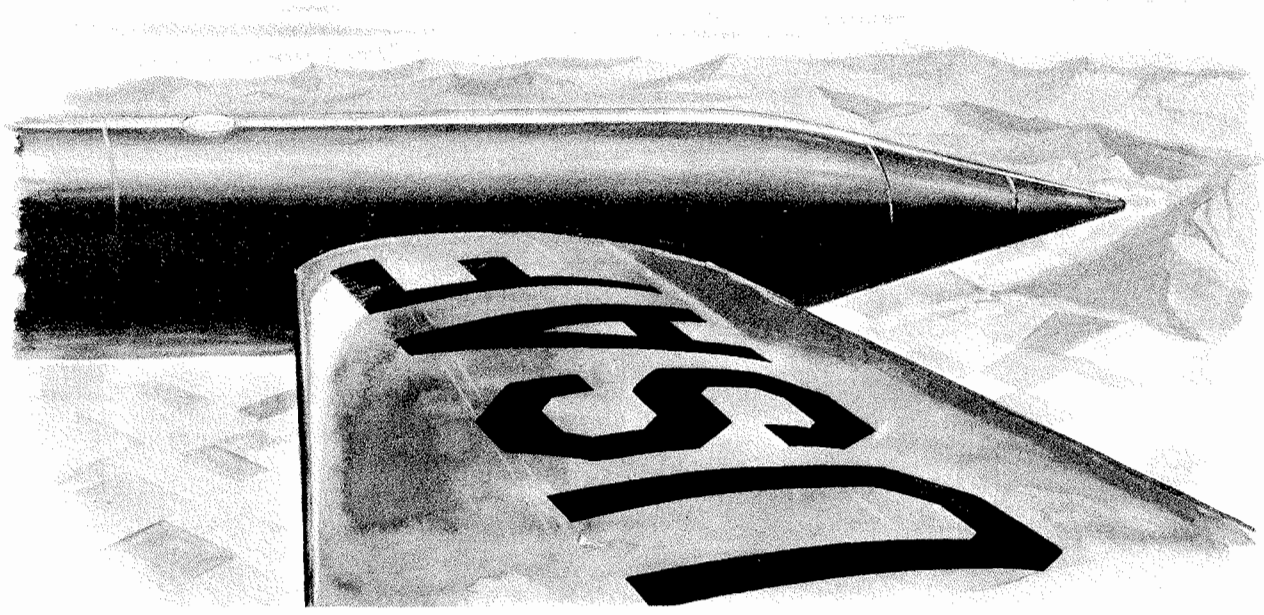
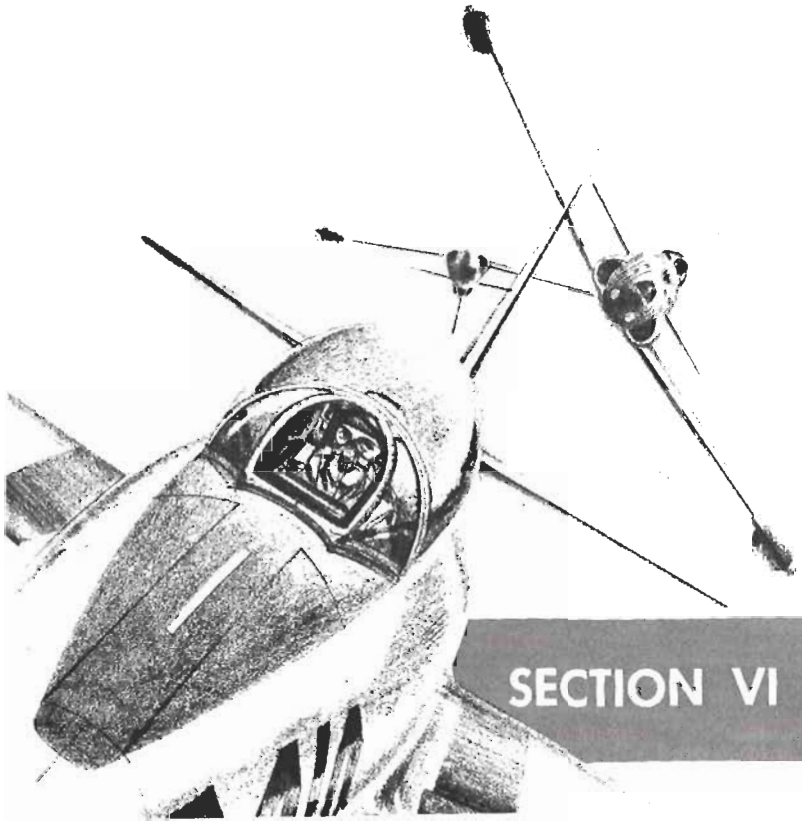




SECTION VI FLIGHT CHARACTERISTICS

FLIGHT CHARACTERISTICS.

GENERAL. The flight characteristics of jet aircraft are somewhat different from those of conventional propeller-driven aircraft. Level flight and dive speeds are higher, and climb speeds are greater, while take-off performance is inferior to that of a propeller-driven airplane. At the same time, engine controls are simplified and torque is eliminated. However, maximum overall performance and tactical value are not attained automatically in jet aircraft. In order to secure the best results, the pilot must be willing to apply techniques different from those he would use under similar circumstances in propeller-driven aircraft. He must have somewhat more training, particularly in basic theory, and he must think further ahead.

The performance characteristics peculiar to jet aircraft, i.e., high level flight speeds, high climb speeds, and inferior take-off, result from the thrust characteristics of the jet engine. At this point it is necessary to distinguish between thrust and power. Thrust is a force, and it is this force or thrust that is delivered by the engine. Power,

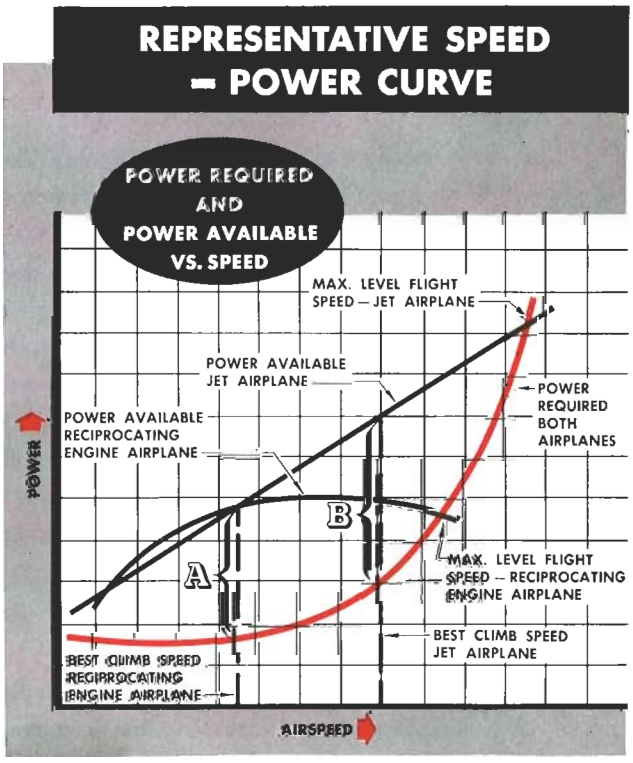


Figure 6-1

however, is the time rate of doing work. It is equal to force (or thrust) times distance divided by time. Since the distance divided by time is equivalent to speed, you can see that power is a combination of thrust AND speed. The jet engine characteristic which determines the unique flight characteristics of the jet airplane is this: At a fixed throttle setting the thrust remains approximately constant regardless of the airplane speed. Therefore, since power is the product of thrust and speed, you can see that the power available is directly proportional to speed, being low at low speed and attaining its greatest value at maximum speed. This dependence of power on speed explains the inferior take-off characteristics of jet aircraft.

Another jet aircraft flight characteristic explained by the speed-power relationship is the high climb speed. Maximum rate of climb occurs at the speed for maximum excess power, excess power being the difference between power available and power required. Figure 6-1 shows representative power available curves for a jet airplane and for a propeller-driven airplane. Also shown is a representative power required curve. Maximum excess power for the propeller-driven airplane is shown at "A." The corresponding speed is the best climb speed for the propeller-driven airplane. Since the best climb speed is comparatively low, the angle of climb will be rather high, and pilots trained in this type of aircraft instinctively tend to climb at steep angles.

The situation in the jet airplane is totally different. You can see at "B" on figure 6-1 that the speed for maximum excess power is quite high. The best climb speed for a jet airplane is correspondingly high—much higher than it is for the propeller-driven airplane—and consequently the climb angle is much lower. You should maintain the recommended speed when climbing even though you have a strong tendency to reduce air speed because, at low speed, you suffer a great loss of power and thereby sacrifice climb performance. During combat climbs it is particularly important to keep the speed up because climb performance and power must be kept at top levels if tactical advantage is to be maintained.

Another phenomenon that you may encounter while flying at cruise conditions in jet aircraft is that it appears to be possible to fly at different speeds in level flight without any change in throttle setting. This is also a result of the speed-power characteristic of the jet airplane. At some cruise conditions, particularly in the lower or middle speed range at high altitude, the power available and power required vary in such a manner that, as the speed increases (at fixed throttle), the power available also increases just about enough to keep up with the power required. This makes it advisable either to dive into the cruising altitude from a higher altitude or to increase the throttle setting until the speed builds up and then return to the cruise throttle setting.

There is another flight characteristic which should be discussed here even though it is not peculiar to jet aircraft alone. This phenomenon, which affects all airplanes, is known as flying on the "wrong" side of the speed-power curve. It is best explained by showing how total drag and power are interrelated throughout the speed range of the airplane. Total drag—the resistance to motion which must be overcome by the engine—consists of two parts—parasite drag and induced drag. Parasite (or form) drag is the resistance offered by a fluid (such as air) in the form of external viscous forces. Parasite drag varies with the airspeed, being low at low speed and becoming very high at high speed. Induced drag is a component of the backward leaning lift line. It may therefore be considered to be the drag induced by the production of lift. It is low at high speed and high at low speed.

Now refer to figure 6-1 and imagine an airplane flying at maximum level flight speed. At this point the power required and the power available are both at a maximum. The angle of attack of the wing is low, the induced drag is low, and the parasite drag is high. If the throttle is now retarded to, say, maximum cruise setting, the airplane will slow down until the power required is equivalent to the power available at the new throttle setting. Notice that the power required is less than it was at high speed. The parasite drag will be less and the induced drag will be greater, but the sum of the two will be such that the power required will be less than it was at high speed. The nose of the airplane will be up a little bit because the angle of attack has to be greater in order to provide the same lift at lower speed. This situation, i.e., less power required with lower speed, prevails until the airplane has slowed to the speed corresponding to the lowest point on the power required curve.

If the speed is reduced below that for minimum power required, the situation changes. No longer is the power required decreased because of the lower speed. On the contrary, the power must be increased if level flight is to be maintained. The reason for this is that the induced drag has now increased so much that it overbalances the effect of lower speed. The airplane is now flying on the "wrong" side of the power curve and any further reduction in speed must be accompanied by increased power.

Flying on the "wrong" side of the speed-power curve is not a stable condition. The angle of attack is high and the airplane is near the stalled condition; level flight at fixed throttle is difficult, if not impossible. The best solution is to put the nose down and sacrifice altitude to regain speed.

CLIMB.

Optimum climb performance will be attained by following the climb speeds given in the Climb Chart, Appendix I. Small variations from these recommended speeds will not seriously affect the climb performance at low altitudes; however, when above 30,000 feet, it is necessary to adhere closely to the proper climb speed in order to avoid a large reduction in rate of climb. Also, if turns are required, it is best to make these at an altitude below 25,000 feet.

CRUISE PERFORMANCE.

When setting up the cruise conditions given in the Cruise Charts, Appendix I, approach the speed condition from the high side. At high altitudes the speed must be kept up to the values given in the Cruise Charts in order to attain the ranges listed. Although the fuel economy is practically constant for a wide range of speeds at altitudes below 30,000 feet, the speed range for best fuel economy becomes quite narrow at altitudes above 30,000 feet because of compressibility and induced drag effects. At altitudes above 30,000 feet, small deviations from the recommended speeds will result in a serious reduction in range.

Best cruising performance is realized when the air is smooth. Rough air and turbulence will require more power to hold the desired airspeed. This results in increased fuel consumption and less range.

SLOW FLYING.

Slow flying is of very little value with this airplane since operation at speeds below the normal cruising range results in a waste of fuel and actually decreases the range and endurance. However, if slow flying is necessary, it should be done whenever possible in the clean configuration (gear, wing flaps and dive flaps retracted), because the engine can be accelerated faster than the airplane can be cleaned up and also because the fuel consumption will be increased with gear and flaps extended. If it is necessary to lose altitude while slow flying, the gear, wing flaps, and dive flaps should be extended to increase drag since the airplane will accelerate quite rapidly in the clean configuration when the nose is lowered.

The slow flight characteristics of this airplane are normal. All controls are effective down to the stall. Slow flight should be practiced at a safe altitude. Reduce the airspeed by retarding the throttle to IDLE and maintain altitude by holding the nose up. When the desired airspeed has been attained, it can be maintained by applying power. When descending at low airspeeds, reduce the power by retarding the throttle to IDLE and decelerate to speeds at which the landing gear and wing flaps may be extended. After the gear and wing flaps have been extended, set up the desired rate of descent by adjustment of power.

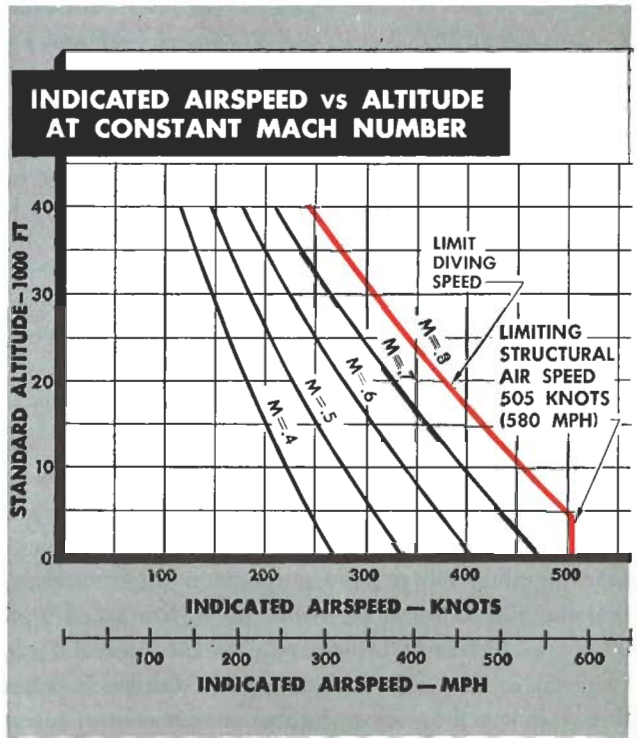


Figure 6-2

TRIM CHANGES.

Since there is no torque effect from the power plant in this airplane, the rudder trim does not change with changes in speed and power if the rudder tab has been correctly adjusted on the ground.

The elevator tab becomes fairly sensitive at high speeds. If the tab mechanism should fail, causing the tab to travel to the fully deflected position, the sudden stick force could be excessive. However, this condition can easily be overpowered if speed is reduced.

The pitch change for the extremes of flight speed is considerable in a jet airplane because of the extremely wide speed range. Since there is so much difference in cruising pitch attitudes, it is necessary to zero the attitude gyro for the cruise condition after stable flight conditions have been established.

MACH NUMBER.

Mach number represents a percentage of the speed of sound. For example, if you are flying at .50 Mach number, your speed is 50% of the speed of sound. The speed of sound, being a function of air temperature only, decreases as you climb since the air temperature decreases with altitude. For example, the speed of sound is approximately 660 knots (759 mph) at sea level, 614 knots (706 mph) at 20,000 feet, and 575 knots (661 mph) at 40,000 feet. So if you were flying at .50 Mach number, your true speed would be 330 knots (380 mph) at sea level, 307 knots (354 mph) at 20,000 feet, and 287.5 knots (331 mph) at 40,000 feet. The Mach number for any altitude and indicated airspeed condition may be found on figure 6-2.

AILERON BOOST.

While there is usually no reason for turning aileron boost off in flight, it can be turned on or off at any time. If the airplane is not trimmed and/or the stick is off center when the boost is turned on, an abrupt maneuver may occur because the airplane will react more quickly than the pilot. For practice purposes, it is recommended that the aileron boost be turned off in low speed flight to obtain first-hand information on the control forces required. In the event of boost system failure, it is best to reduce speed to obtain lighter aileron control forces, since these forces increase with airspeed. Manual aileron control may be supplemented by the use of aileron tab to obtain a fairly high rate of roll at high speed, but it is not considered good technique to depend on the tab for the fine control required, such as in formation or other precision flying.

DIVE FLAPS.

The dive flaps are effective in many ways, principally as a drag producing device to slow the airplane down. These flaps can be extended or retracted at any speed or in any flight attitude as long as hydraulic pressure is available. The extension of the flaps will be accompanied by a nose-up tendency, whereas retraction of the flaps will give the opposite effect. The force required to counteract this pitch change varies with speed, being very light at the lower airspeeds but quite high at maximum airspeed. In view of this characteristic, the pilot must be alerted to this change, particularly when retracting the flaps near the ground at high speeds. The pitching moment that accompanies operation of the flaps, however, is never strong enough to cause damage to any part of the airplane at any permissible speed, nor is it strong enough to prevent the pilot from overcoming the pitching moment without use of the elevator trim tab.

The dive flaps are effectively used in formation flying, since they have a noticeable effect upon the turning radius. This is primarily a result of slowing the airplane down. They will permit a more rapid descent without exceeding the Mach number limit and also, because of the nose-up pitching moment, they tend to counteract the "tucking under" tendency of the airplane if it is permitted to exceed this limit.

Considerable noise and roughness can be anticipated when flying at high speeds with the flaps extended. Use of the flaps below 12,000 feet will sometimes affect the pilot's ears because of the change in cabin pressure. Below 12,000 feet, the cabin pressure differential is small and the cabin air outflow valve is open. This valve is in the dive flap area, and since opening the dive flaps lowers the pressure behind them, the cabin pressure is also lowered. Above 12,000 feet, however, the cabin pressure differential is greater and the pressure regulator reacts with sufficient speed to eliminate this effect. On some early unmodified aircraft the dive flaps extend 45°, while on later modified aircraft the extension is 60°. Deceleration and pitch-up tendency are noticeably increased with the 60° extension.

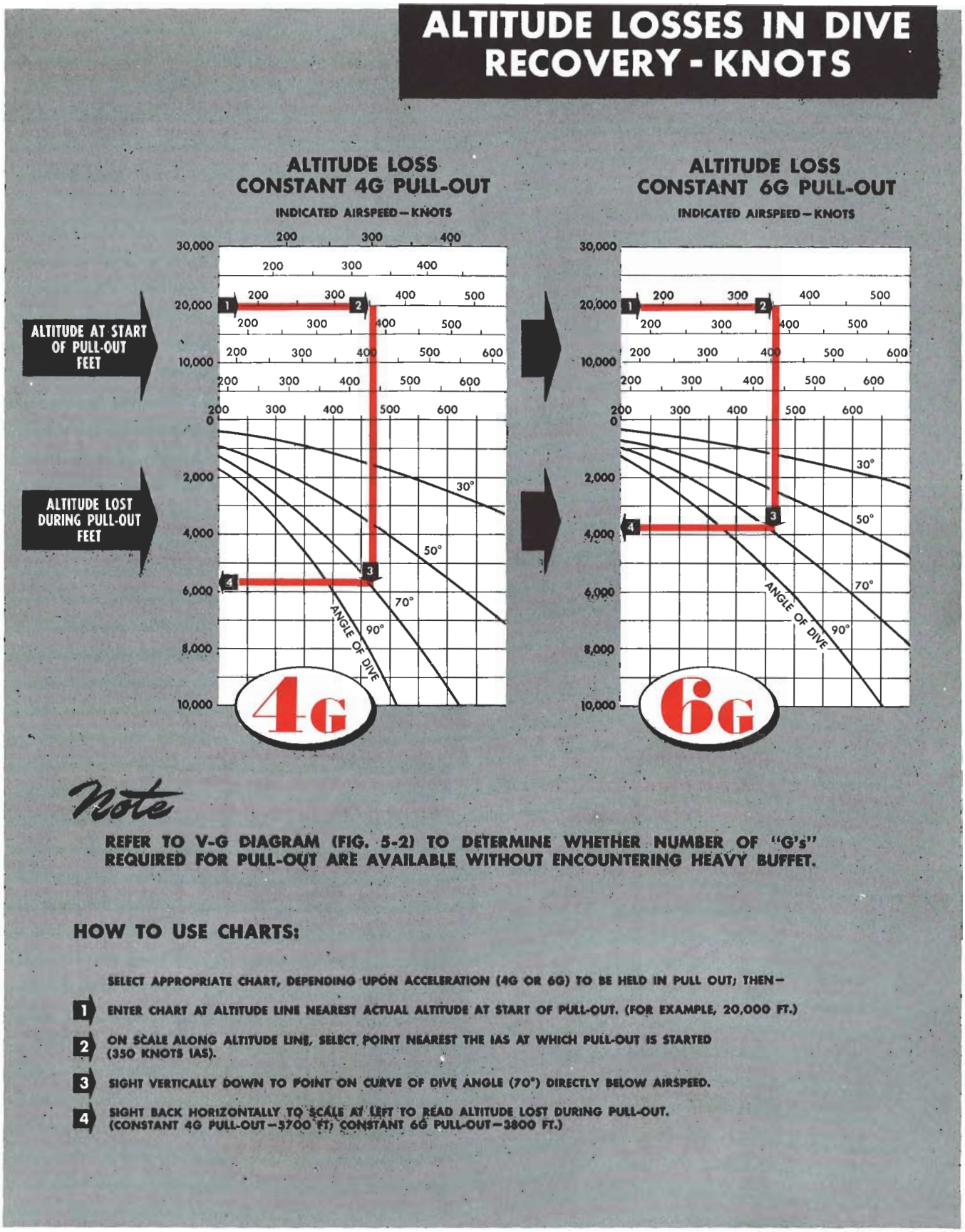


Figure 6-3 (Sheet 1 of 2)

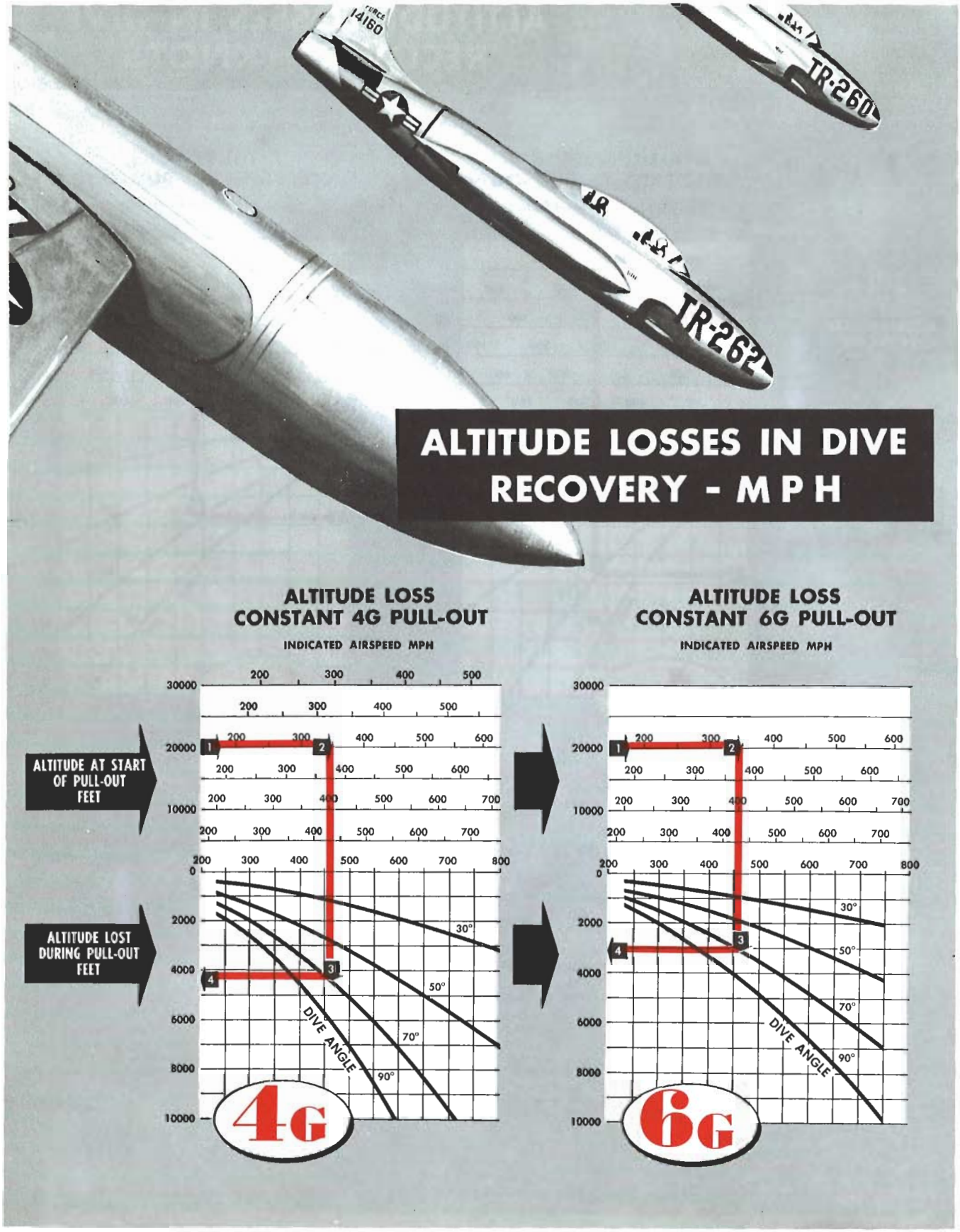


Figure 6-3 (Sheet 2 of 2)

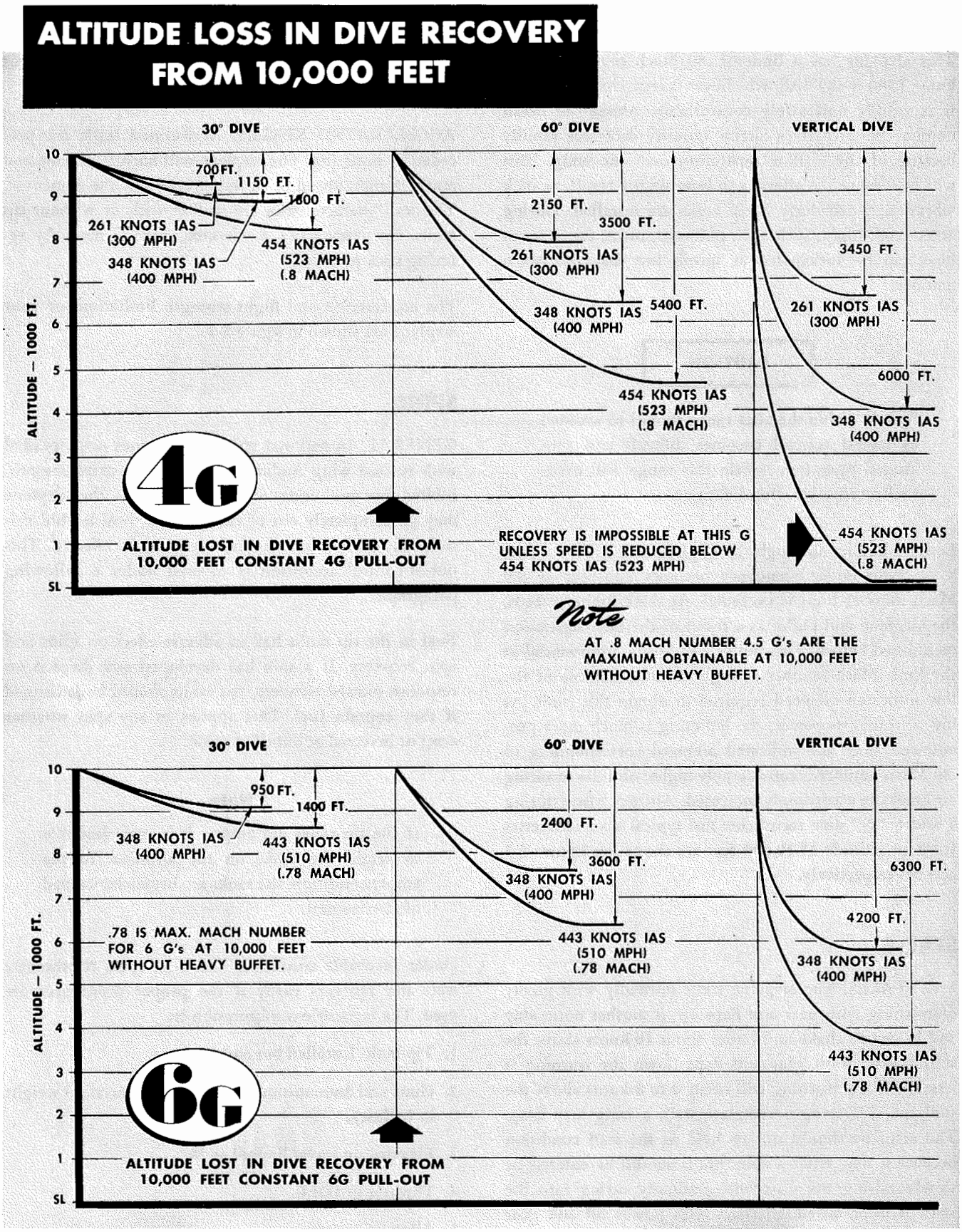

ALTITUDE LOSS IN DIVE RECOVERY FROM 10,000 FEET
30° DIVE
60° DIVE
VERTICAL DIVE
ALTITUDE — 1000 FT.
10
9
8
7
6
5
4
3
2
1
SL
700 FT.
1150 FT.
1600 FT.
261 KNOTS IAS (300 MPH)
348 KNOTS IAS (400 MPH)
454 KNOTS IAS (523 MPH) (.8 MACH)
2150 FT.
3500 FT.
261 KNOTS IAS (300 MPH)
348 KNOTS IAS (400 MPH)
5400 FT.
454 KNOTS IAS (523 MPH) (.8 MACH)
3450 FT.
261 KNOTS IAS (300 MPH)
6000 FT.
348 KNOTS IAS (400 MPH)
454 KNOTS IAS (523 MPH) (.8 MACH)
4G
ALTITUDE LOST IN DIVE RECOVERY FROM 10,000 FEET CONSTANT 4G PULL-OUT
RECOVERY IS IMPOSSIBLE AT THIS G UNLESS SPEED IS REDUCED BELOW 454 KNOTS IAS (523 MPH)
Note
AT .8 MACH NUMBER 4.5 G's ARE THE MAXIMUM OBTAINABLE AT 10,000 FEET WITHOUT HEAVY BUFFET.
30° DIVE
60° DIVE
VERTICAL DIVE
ALTITUDE — 1000 FT.
10
9
8
7
6
5
4
3
2
1
SL
950 FT.
1400 FT.
348 KNOTS IAS (400 MPH)
443 KNOTS IAS (510 MPH) (.78 MACH)
2400 FT.
3600 FT.
348 KNOTS IAS (400 MPH)
443 KNOTS IAS (510 MPH) (.78 MACH)
6300 FT.
4200 FT.
348 KNOTS IAS (400 MPH)
443 KNOTS IAS (510 MPH) (.78 MACH)
.78 IS MAX. MACH NUMBER FOR 6 G's AT 10,000 FEET WITHOUT HEAVY BUFFET.
6G
ALTITUDE LOST IN DIVE RECOVERY FROM 10,000 FEET CONSTANT 6G PULL-OUT

Figure 6-4

DIVES.

This airplane has a limit of .80 Mach number or 505 knots (580 mph) IAS, whichever is less. Up to this limit it is readily and safely controllable. Above .80 Mach number the airplane's lateral stability decreases rapidly because of the airflow separation over the wing. This will also cause the ailerons to buzz with a resultant stick vibration, particularly if tip tanks are installed. During accelerated flight, such as in pull-outs, turns, etc., aileron buzz can be anticipated at speeds less than .80 Mach number.

CAUTION

Speeds within the buzz range should be avoided as lateral control becomes difficult and prolonged operation within this range will eventually cause structural fatigue.

Longitudinally, although the airplane will still be stable, a "tucking under" tendency becomes apparent as the Mach number limit is exceeded. At these higher speeds, the airplane will buffet as a result of the flow separation mentioned before. This buffet will not be pronounced at the limit Mach number at high altitudes because of the low indicated airspeed required to obtain this limit. At low altitudes, however, the buffeting is much more pronounced since the indicated airspeed corresponding to .80 Mach number is considerably higher and the resulting air loads are accordingly increased. Altitude losses during 4 and 6 "G" dive recoveries and typical dive recoveries from an altitude of 10,000 feet are shown on figures 6-3 and 6-4 respectively.

STALLS.

1 G STALLS. The airplane stalls normally with plenty of warning with gear and flaps up; it mushes noticeably and begins to shake and buffet about 10 knots above the stall speed. With gear and flaps down the warning is less; moderate warning will occur 4 to 8 knots above the stall speed. During a complete stall, a wing may drop. The airplane should not be held in the stall condition because it may enter a spin. Stalls should be entered by slowly raising the nose and gradually easing into the stall. Abrupt nose-high stalls with power off and gear and flaps up should be avoided, especially, at rearward center-of-gravity positions because the airplane may flip over on its back. Practice stalls should be made above 15,000 feet. Stalling speeds are shown on the stalling speed chart (figure 6-5). Stall recovery is quick and easy; the ailerons are effective throughout.

ACCELERATED STALLS. Accelerated stalls are preceded by buffeting. The airplane will normally shake and mush straight ahead or in the direction of the maneuver. The stall characteristics are similar with or without tip tanks. Recovery from accelerated stalls is made by relaxing stick pressure.

The acceleration and flight strength limitations of your airplane are shown in figure 5-2.

SPINS.

GENERAL. Intentional spins in airplanes not modified with revised wing leading edge and stall strips are prohibited because under certain conditions the airplane may go completely out of control and considerable altitude may be lost before a recovery can be effected. This out-of-control condition is covered under a following paragraph.

Fuel in the tip tanks has an adverse effect on spins and spin recovery. If a spin has developed and there is no response toward recovery, the tanks should be jettisoned if they contain fuel. This applies to any spin whether erect or inverted or out-of-control.

Note

If the tip tanks are empty, it is very desirable to retain the tanks on the airplane. In the empty condition, the tanks are beneficial instead of detrimental.

Under favorable conditions the T-33 spins consistently well and recovers easily if the proper procedures are used. The favorable configuration is:

1. Tip tanks installed but empty.
2. Guns and ammunition installed (or equivalent weight in ballast).
3. Elevator up travel limited at 20°.
4. Throttle in IDLE.
5. Ailerons neutral.
6. Gear and flaps retracted.

STALL SPEED CHART

GROSS WEIGHT	APPROX. FUEL REMAINING	GEAR & FLAPS UP			GEAR & FLAPS DOWN		
		LEVEL FLIGHT	30° BANK	60° BANK	LEVEL FLIGHT	30° BANK	60° BANK
15,000 LB	800 GAL	117	126	165	104	112	147
14,000 LB	680 GAL	113	121	160	101	108	143
12,000 LB	350 GAL	105	113	149	94	101	133
10,000 LB	50 GAL	96	103	136	85	91	120

STALLING SPEEDS—IAS—KNOTS

GROSS WEIGHT	APPROX. FUEL REMAINING	GEAR & FLAPS UP			GEAR & FLAPS DOWN		
		LEVEL FLIGHT	30° BANK	60° BANK	LEVEL FLIGHT	30° BANK	60° BANK
15,000 LB	800 GAL	135	144	190	120	130	170
14,000 LB	680 GAL	130	140	184	116	125	164
12,000 LB	350 GAL	121	130	171	108	116	153
10,000 LB	50 GAL	110	118	156	98	105	139

STALLING SPEEDS—IAS—MPH

Figure 6-5

Any items which are opposite to those listed in 1 through 6 above are detrimental, such as fuel in the tip tanks, tip tanks removed, power on, ailerons deflected, etc. The adverse effects of these items increase the chances of getting the airplane out of control.

One thing to be noted and remembered is that the order of steps for recovery from erect spins, inverted spins, and out-of-control maneuvers, are the same.

RECOVERY FROM ERECT SPINS.

If you are pressing against the seat and not against the safety belt, the spin is erect. The recovery procedure for erect spins is as follows:

1. Throttle in IDLE.
2. Ailerons neutral.
3. Control stick aft.
4. Rudder against the spin until rotation has stopped.
5. Release back pressure on stick—*after* rotation has stopped.

Note

Do not pop the stick forward. Full forward stick may cause the airplane to start an inverted spin.

Each turn of the spin is accompanied by an oscillation wherein the nose swings low, then high to near the horizon. The rudder should be applied against the spin when the nose is low below the horizon, and not when

the nose is high on the oscillation. The controls are not as effective at the top of the oscillation. Recovery when the nose is low will take ½ to ¾ of a turn.

Note

If the wing flaps and landing gear are in the extended position it will help to retract these items as soon as possible.

Once the recovery is under way, time should be allowed to build up airspeed before leveling off. If the stick is pulled back too soon another spin may develop.

RECOVERY FROM INVERTED SPINS.

Inverted spins are usually caused by too much forward stick during slow speed inverted flight or by pushing the stick forward too quickly when recovering from an erect spin. In the latter case the inverted spin will start from a right-side-up attitude.

You can recognize an inverted spin by the fact that you will be pushing against the seat belt.

The recovery procedure for inverted spins is as follows:

1. Throttle in IDLE.
2. Ailerons neutral.
3. Stick aft.
4. Rudder against the spin until rotation stops.

Note

If the wing flaps and landing gear are in the extended position it will help to retract these items as soon as possible.

Recovery from the inverted spin may be started at any time. The recovery will be prompt if the airplane configuration is favorable as previously noted. When rotation has stopped, keep the stick aft until the nose is well down.

WARNING

Inverted spins in this airplane are fast, uncomfortable and confusing. Don't invite this condition.

OUT-OF-CONTROL.

If the airplane goes out-of-control the gyrations are violent and erratic, and do not follow any particular pattern. At the start of the gyrations you may have considerable difficulty keeping abreast of the changes in airplane attitude. After the airplane has fallen 2000 feet or more, the erratic nature of the gyrations should cease, or progress into an erect or inverted spin.

If the out-of-control condition is encountered you should immediately place the throttle in IDLE, hold the ailerons neutral, hold the stick aft, retract landing gear and wing flaps; in other words follow the same procedures used for the spin. When rotation has developed and the direction is apparent, use the rudder to stop rotation.

The out-of-control condition can develop from a gear and flap down stall if the stall is aggravated, such as by holding the stick aft and attempting to "walk the airplane down" by use of the rudder. (Consequently this maneuver is not recommended with gear and flaps extended.)

If the ground clearance goes below 10,000 feet it is recommended the canopy be jettisoned since this will serve as a first step toward possible bail-out and it may furthermore assist recovery. Consequently if you stay with the airplane for a few seconds after the canopy has been jettisoned, recovery may be effected.

WARNING

If a definite recovery from the spin has not been established and a pull-up initiated prior to the aircraft reaching a ground clearance of 5,000 feet—BAIL OUT.

PERMISSIBLE ACROBATICS.

All acrobatics, except vertical stalls, intentional spins (unless modified with revised wing leading edge, and stall strips) and acrobatics requiring extended negative acceleration, are permissible. During negative accelerations the engine oil pressure will drop almost immediately and a flameout will occur if the inverted condition is maintained for more than approximately 10 seconds

since fuel will not be fed to the engine. Negative acceleration greater than 1G may cause immediate flameout.

At least 10 quarts of oil are required in the engine reservoir to provide sufficient lubrication during acrobatics.

The pilot is cautioned to use extreme care in maneuvers which require a downward recovery as the loss of altitude in such a recovery is very rapid.

In general, acrobatics should not be attempted below 10,000 feet until the pilot becomes familiar with the speed at which the airplane can gain and lose altitude.

FLYING WITH EXTERNAL LOAD.

The tip tanks have very little effect on the airplane's flying characteristics. Uneven transfer of fuel from the tip tanks causes wing heaviness but this can usually be trimmed out with the aileron tab. However, if the fuel differential is more than 100 gallons, it will be difficult to make a safe landing, consequently the heavy tank should be dropped.

STABILITY.

GENERAL. The airplane is directionally and longitudinally stable at all approved center-of-gravity positions. Laterally the airplane is neutrally stable. This condition does not require any special technique other than frequent reference to the lateral attitude. The rudder is inefficient in picking up a wing, but good aileron control is maintained down to the stall.

EFFECT OF CG. The external and internal loading of the airplane affects the center of gravity. Full ammunition or equivalent ballast moves the CG forward 5 to 6½% depending on the fuel load. Tip tank fuel loading moves the CG aft about 1½%. In the aft CG range the stick forces are lighter. The airplane is quite sensitive to elevator trim at CG's aft of 29% but the stick forces and the stability remain positive.

MANEUVERING LOADS.

Maneuvering loads are incurred when an airplane 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 becoming excessive by restricting the maneuvers to the specified acceleration limits. For this purpose he relies on the accelerometer, an instrument designed to detect the acceleration loads placed upon the airplane. Although the accelerometer is generally reliable, it has limitations which can, under some circumstances, mislead the pilot into believing that he is executing a safe maneuver, whereas in reality he may be dangerously overstressing the airplane. The limitations of the accelerometer are (1) it reads only the accelerations in a vertical plane, and (2) it is located on the pilot's instrument panel and cannot accurately detect accelerations of the airplane tail assembly.

As an example, during maneuvers such as yaws and skids, the accelerometer will read approximately 1G. At the same time fairly large loads are being imposed on the vertical tail assembly of the airplane. Actually, the steady loads that are applied during these maneuvers are usually not excessive and are almost directly proportional to the rudder pedal force being applied. Of more importance is the rate of application or particularly the rate of release of these forces. During rapid application and/or rapid release of large control forces, very high loads can be imposed on the airplane structure. This is not meant to imply that the pilot should apply control forces gradually in order to avoid excessive loads; it is merely a caution that very rapid application or release of forces can, at moderate to high airspeeds, result in structural damage to the airplane.

APPROACH AND LANDING.

At approach speeds this airplane handles somewhat differently than reciprocating engine airplanes. This means that somewhat more attention is required during the approach leg. This is mostly noticeable if the nose is raised at a slow airspeed, because the drag increases very rapidly and, as a result, the airspeed will drop off unless power is applied immediately. Because of the slow acceleration of jet engines from low engine speeds, it is desirable from the standpoint of safety, to keep at least 50% rpm until you are quite close to the runway; then, if power is needed for any reason the response will be much faster. If the runway length is short enough to be marginal, the approach speed must be closely controlled; five mph too slow can mean a hard landing, possibly short of the runway. If the runway is of adequate length for high performance jet type aircraft, it will not be necessary to approach as slow as for a marginal field.

With a gliding approach, and the proper airspeed using 50% rpm, the airplane can be flared normally to touchdown. If a level power-on drag approach is made, it is necessary that more power be kept on until a few feet away from the runway. The airplane may drop suddenly if the power is pulled off too abruptly. If the speed during final approach is excessive, it should be reduced by extension of the dive flaps. Touchdown should be made in a slightly nose-high attitude on the main wheels. Avoid landing on the nose wheel.

CAUTION

With the current limitation of the elevator to 20 degrees up, the nose cannot be held high if the airplane is stalled in from several feet above the runway surface. Consequently a fully stalled attitude should be attained only if the airplane is close to the surface.

As soon as the wheels touch you can retract the wing flaps to get better braking. When landing in a crosswind, it is advisable to hold a wing down rather than crab the aircraft. The crabbed approach method however, is considered desirable only in extreme crosswind conditions and should be used in combination with the wing down method. Dead-stick landings should be made at about ten knots IAS higher because of the reduced flare with power off.

ABORTED LANDINGS OR GO-AROUNDS.

The importance of holding at least 50% rpm becomes apparent if the landing approach is short or if it is necessary for any reason to go around. The throttle should immediately be advanced to full open and the landing gear and flaps raised as soon as you are sure the airplane won't touch the runway. The gear and flaps should be retracted to eliminate their drag and thus enable the airplane to accelerate more rapidly. If the engine speed is at approximately 50% rpm, it will require only about 4 seconds for the engine to accelerate to 100% rpm; however, if the engine is operating at idling speed, it will require approximately 10 seconds to accelerate and the thrust available will be small during the first six seconds of this engine acceleration.

PORPOISING.

If, during a landing, the pilot allows the nose wheel to touch the runway first, it is possible that a porpoising oscillation may result. This oscillation results from the nose wheel bouncing off the runway and may be mild at first; however, it will probably be difficult to dampen out with the elevator because of the inertia effects. Holding the stick all the way back may help more than trying to correct the zoom. However, in all cases where the airplane hits nose wheel first, bounces, and then hits on the main wheels, it is recommended that go-around be started immediately if sufficient runway and fuel are available. If it is necessary to land with excessive speed such that the nose wheel would normally contact the runway first, the wing flaps should be retracted while the airplane is still a few feet off the runway. This will give the airplane a nose-up attitude and a normal landing can be executed.

SECTION VII SYSTEMS OPERATION

FUEL SYSTEM OPERATION.

NORMAL SEQUENCE OF FUEL TANK USE.

(See figure 7-1).

1. The fuselage tank switch shall be ON and all other fuel switches OFF for engine starting and aircraft taxi.

2. Prior to take-off, booster pump operation for the leading edge and the wing tanks shall be checked by referring to the warning lights and fuselage tank fuel gage for refilling.

3. After the aircraft check out is completed, the fuselage tank shall be refilled to the 60-80 gallon level by transferring fuel from the wing tanks. The wing tank switch shall then be turned OFF.

4. The tip tank switch shall be placed ON prior to run-up and a check made of tip tank feeding after run-up to 100% rpm.

5. Take-off shall be accomplished with the fuselage and the tip tank switches ON and the leading edge and the wing tank switches OFF.

6. After take-off the leading edge and wing tank switches will be left in the OFF position until either the tip tank warning light comes on or until the fuselage tank gage indicates that the tank is not being refilled. At this time the wing tank switch shall be placed in the ON position until either the wing tank warning light comes on or until the fuselage tank gage indicates that the tank is not being refilled. Turn on the leading edge tank switch at this time; however, turn off the wing tank switch if it is determined that the wing tanks are empty. (The wing tank switch should be left in the ON position if it is definitely known that the wing tank float valve is stuck in the closed position preventing fuel from the wing tanks to reach the fuselage tank. This procedure may eventually break open the stuck valve making available the additional fuel from the wing tanks.) Turn off the leading edge tank switch when the tanks are empty. A visual check should be made of the fuselage tank fuel gage whenever another tank is selected in order to positively determine that the fuselage tank is being refilled.

7. All fuel switches OFF when stopping engine.

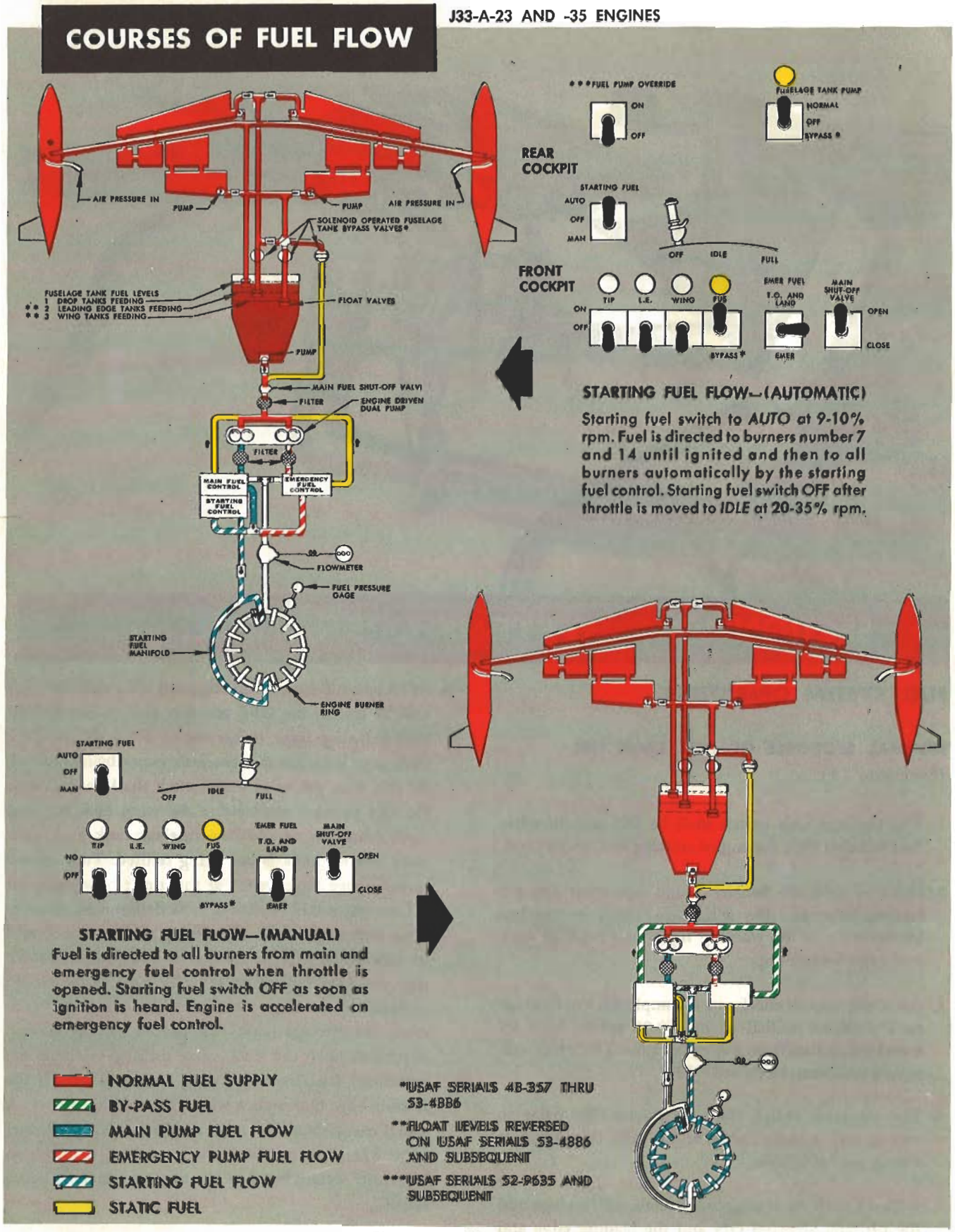


Figure 7-1 (Sheet 1 of 4)

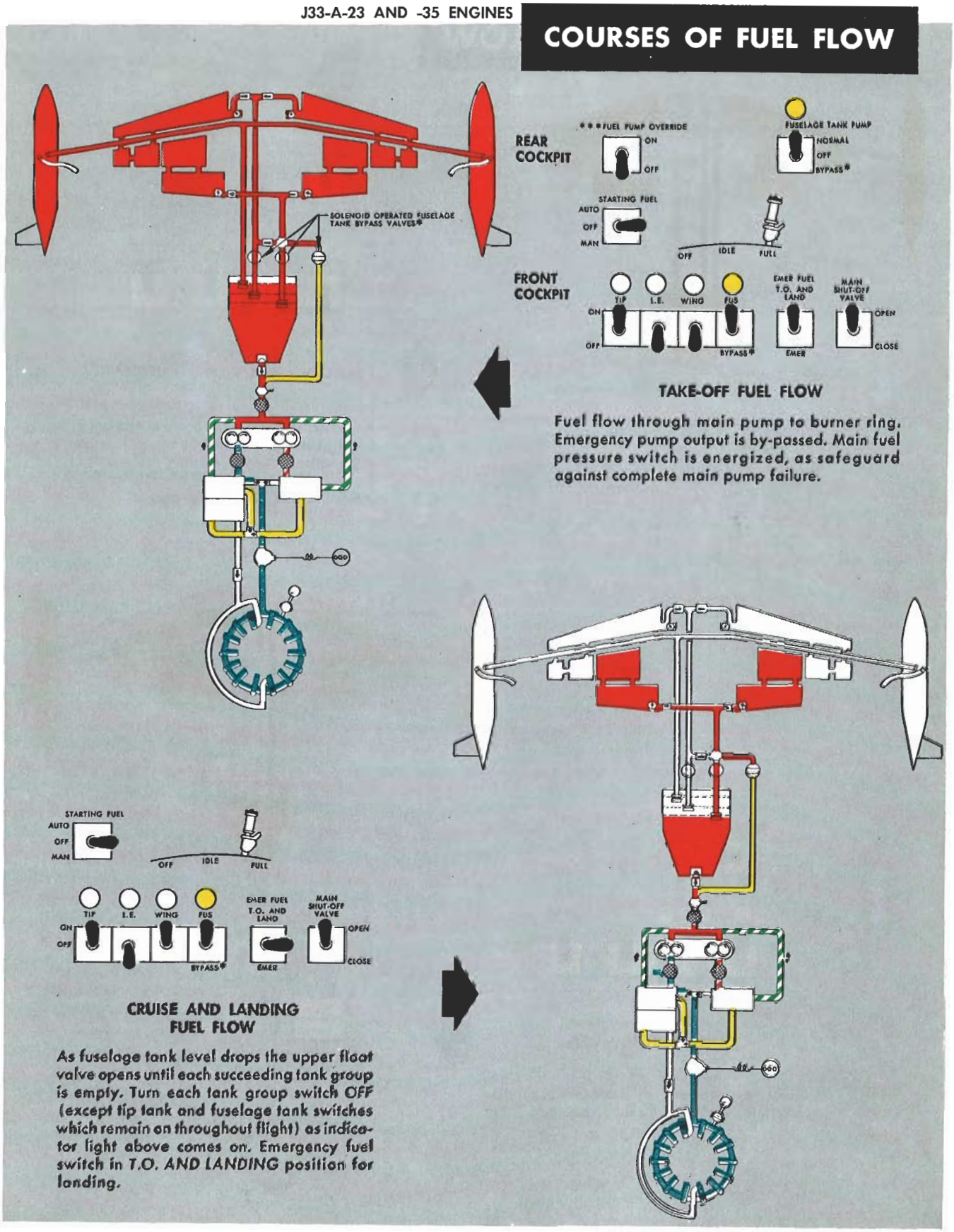
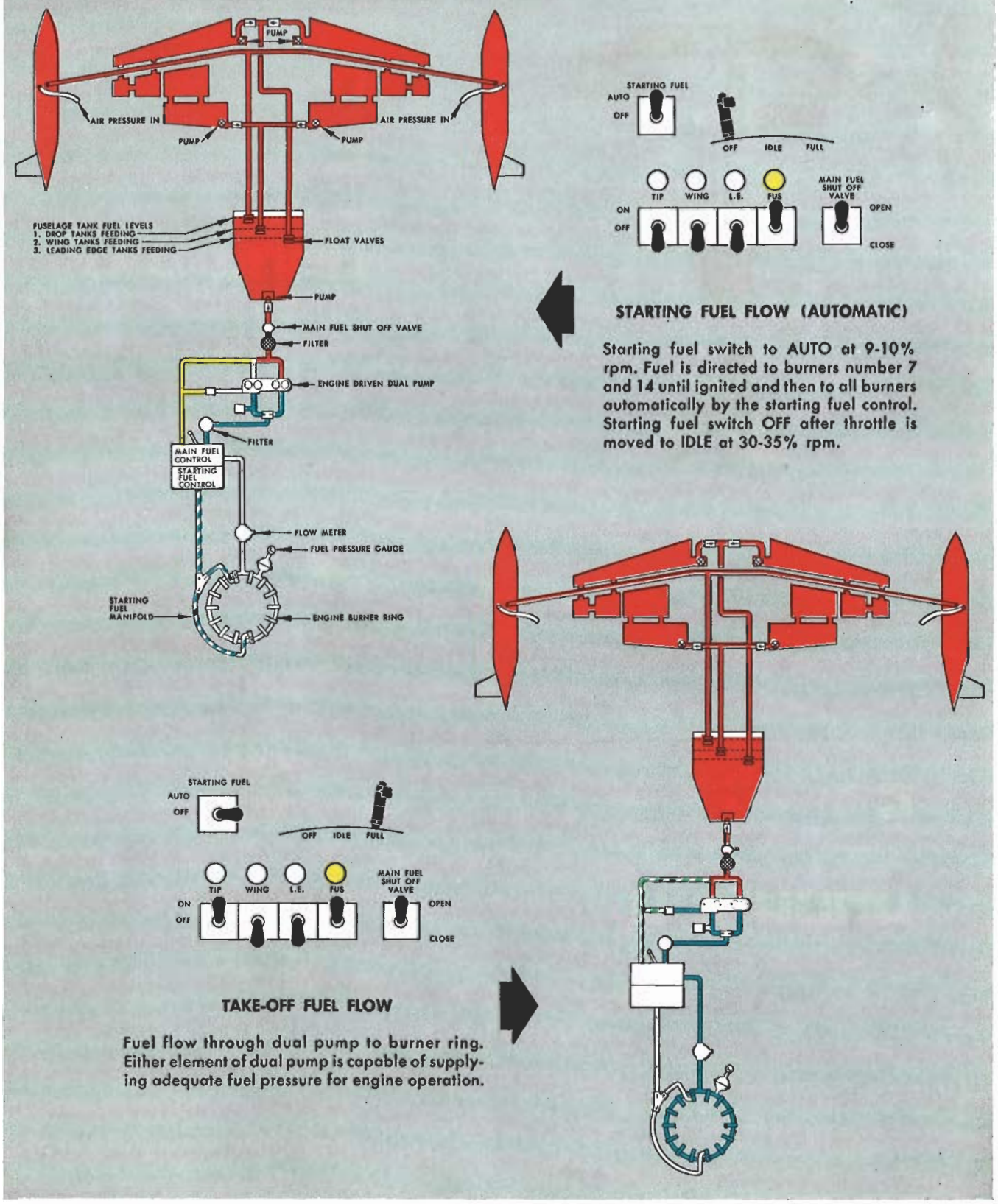


Figure 7-1 (Sheet 2 of 4)

J33-A-20 ENGINES

COURSES OF FUEL FLOW



STARTING FUEL FLOW (AUTOMATIC)

Starting fuel switch to AUTO at 9-10% rpm. Fuel is directed to burners number 7 and 14 until ignited and then to all burners automatically by the starting fuel control. Starting fuel switch OFF after throttle is moved to IDLE at 30-35% rpm.

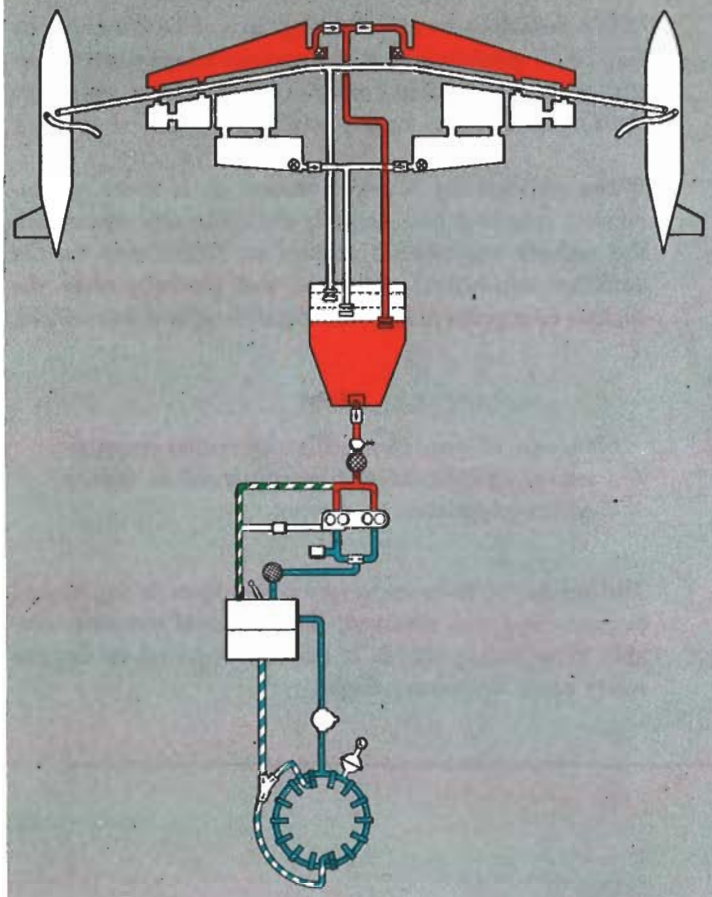
TAKE-OFF FUEL FLOW

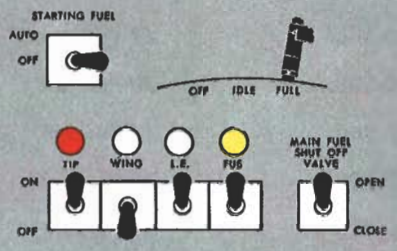
Fuel flow through dual pump to burner ring. Either element of dual pump is capable of supplying adequate fuel pressure for engine operation.

Figure 7-1 (Sheet 3 of 4)

J33-A-20 ENGINES

COURSES OF FUEL FLOW





CRUISE AND LANDING FUEL FLOW

As fuselage tank level drops the upper float valve opens until each succeeding tank group is empty. Turn each tank group switch OFF (except tip tank and fuselage tank switches which remain on throughout flight) as indicator light above comes on.

NORMAL FUEL SUPPLY

BY-PASS FUEL

ENGINE PUMP FUEL FLOW

STARTING FUEL FLOW

STATIC FUEL

Figure 7-1 (Sheet 4 of 4)

MINIMUM ENGINE SPEEDS.

The higher viscosity of JP-4 fuel as compared with JP-3 fuel affects fuel flow at low engine speeds to the extent that a partial flame-out can result. During altitude flying, the following engine speeds should be observed:

ALTITUDE—FEET	MINIMUM ENGINE SPEEDS
40,000	60 Percent
35,000	47 Percent
30,000	40 Percent
25,000	34 Percent
20,000	33 Percent
10,000	33 Percent

WINDSHIELD AND CANOPY DEFROSTING SYSTEM OPERATION.

Turn on the windshield defroster and rear ducts during all flights above 5,000 feet and adjust the cabin temperature for comfort. This will supply some heat to the transparent areas all of the time and prevent a thorough cold soak which promotes fog and/or frost.

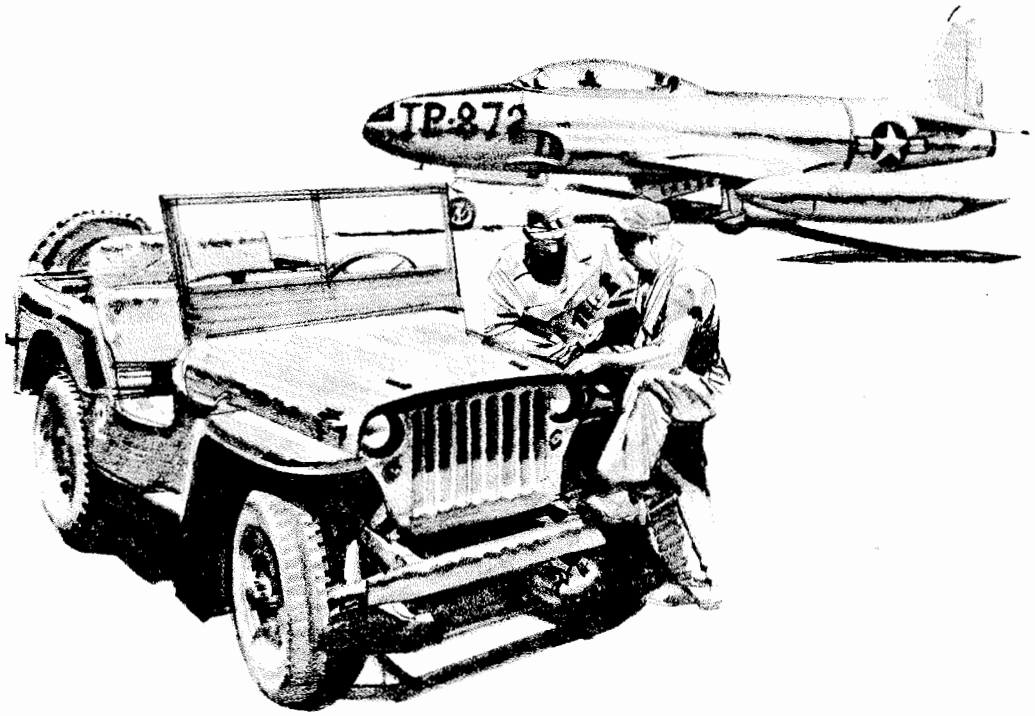
When sufficient cockpit heating cannot be obtained by full HOT positioning of the cockpit temperature selector, place the auxiliary windshield defroster switch to the ON position to supply additional heat.

When anticipating a rapid descent or a series of maneuvers resulting in constantly changing altitude, switch the cockpit temperature control to HOT, turn on the auxiliary windshield defroster, and partially close the cockpit foot grills to increase the airflow to the manifold.

Note

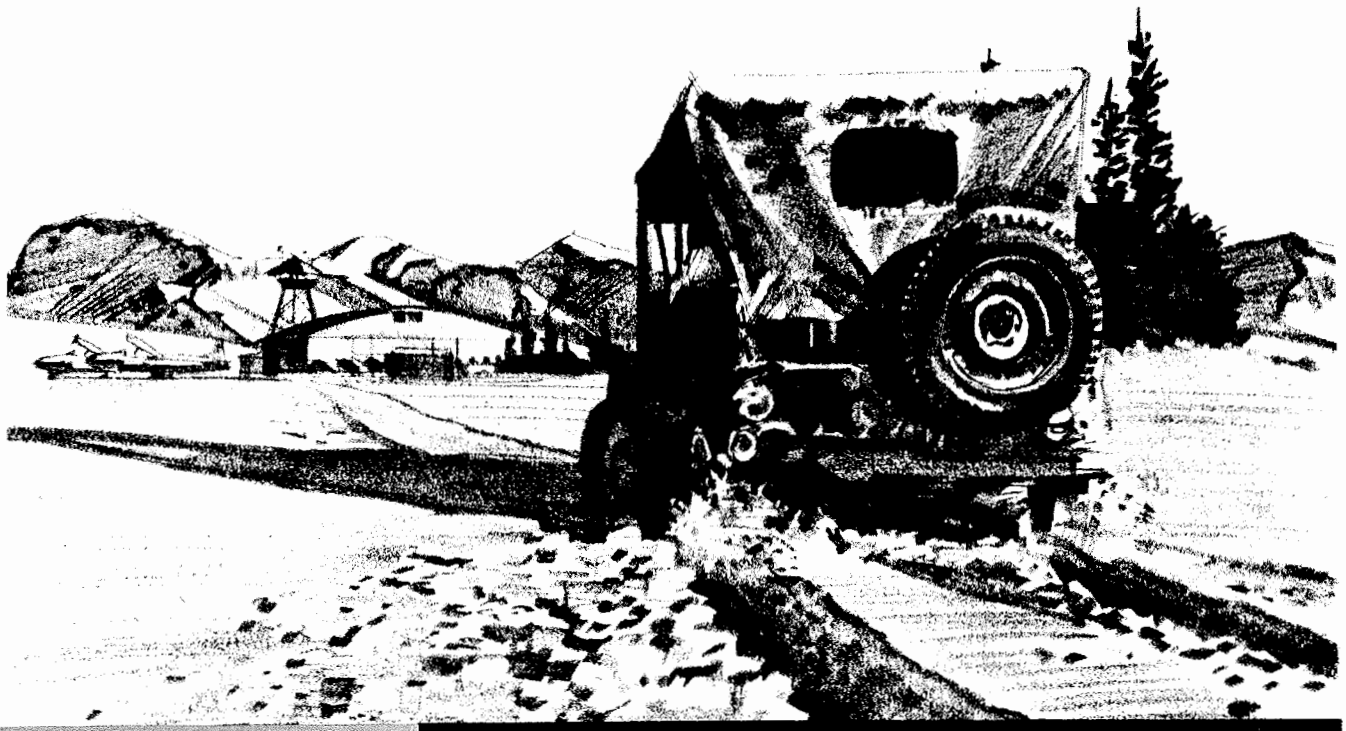
Closure of these foot grills may reduce pressurization and should not be construed as failure of the pressurization system.

The key factor to be impressed is that frost or fog should be prevented, not removed, since removal requires valuable time during which it may be required to depend solely upon instrument flight.



SECTION VIII CREW DUTIES

No information is included in this section because crew duties are more appropriately covered in connection with the discussion of the purpose of the airplane and the descriptions of the equipment installed in it.



SECTION IX ALL WEATHER OPERATION

INTRODUCTION.

Except for some repetition necessary for emphasis, or for continuity of thought, this section contains only the operating procedures necessary for instrument and/or night flying and are in addition to the normal operating instructions contained in Section II.

NIGHT FLYING.

For night flying check the lighting equipment thoroughly and be familiar with the location of all switches in the cockpit. Switch locations and lighting equipment differ in various groups of airplanes, so be familiar with the particular airplane you are going to fly and be sure to carry an adequate flashlight. For taxiing at night place the landing and taxi light switch in the TAXI position and for take-off and landing in the LANDING LIGHT position. Be sure to turn the lights off before the gear is retracted to prevent them from burning out. For prolonged flight in night weather it is recommended that the navigation lights be placed in the STEADY position to reduce eye distraction created by reflection from clouds. Use oxygen from the ground up on night flights and remember, red lighting is easiest on night vision. Don't forget your flashlight (2 cell).

INSTRUMENT FLIGHT PROCEDURES.

GENERAL: Flying the T-33 aircraft under instrument conditions, like most jet fighters, requires constant attention to indications of the flight instruments. The aircraft is sensitive to changes in control pressures. Therefore, for best results, make all changes in pitch, bank, and power slowly and smoothly and keep the aircraft properly trimmed.

The following techniques are recommended from take-off to touchdown under instrument and/or night flying conditions. These techniques are applicable when using any type of radio or radar aids to navigation and when making let-downs or landing approaches under instrument flying conditions.

PRIOR TO TAKE-OFF: In addition to the normal exterior and interior checks prescribed in Section II, the following instrument cockpit check should be completed:

1. APX-6 IFF Beacon (if installed)—ON STANDBY.
2. Radio—ON and operating (check all channels).
3. Radio Compass—ON: Check operation in COMP, ANT, and LOOP positions; check operation of left-right switch, CW switch, and the tuning meter.

4. Inverter—ON and operating (check both inverters).
5. Loadmeter—showing a proper charge with engine operating.
6. Oxygen—P. McCRIPE check.
7. Throttle—check friction lock.
8. Aileron Boost—ON and operating.
9. Turn and bank indicator—operating (check needle deflecting in the direction of the turn while taxiing—ball free in the race).
10. Attitude Indicator—set the miniature aircraft level with the 90 degree indices on the sides of the case. This should give approximately level flight indication.

CAUTION

Normal erection time for the attitude indicator is three to four minutes; however, it may take as long as thirteen minutes. In aircraft equipped with J-8 attitude indicators the caging knob may be pulled to erect the indicator if necessary.

11. Heading Indicator—
    a. Slave Gyro Type—set take-off heading under top index; check pointer for proper indication and operation while taxiing.
    b. G-2 Type Compass—set G-2 compass to magnetic heading. Prior to instrument take-off, place the compass control switch to FREE D.G. position.
12. Standby Magnetic Heading Indicator—card swings freely—bowl is full of fluid.
13. Altimeter—set to field elevation; note any variation between Kollsman reading and current field altimeter setting.
14. Airspeed Indicator—30-35 knots (wind calm).
15. Vertical Speed Indicator—set to zero.
16. Clock—running and set to correct time.
17. Engine Instruments—indicating normal.
18. Pitot Heat—operating properly.
19. Current Publications—appropriate navigational and letdown information.

CAUTION

For all night operations, the pilot should be thoroughly familiar with the location of all switches in the particular aircraft he is going to fly because switch locations and lighting equipment differ in various groups of aircraft. Remember that red lighting is easiest on night vision. Also, the following additional items should be checked:

20. Taxi and Landing Lights—taxi light ON to taxi—check operation of landing lights.
21. Navigation Lights—check in both FLASH and STEADY positions. To reduce eye distraction, use STEADY position for night weather flying.
22. Fluorescent Lights—ON and operating.
23. Cockpit Lights—ON and operating.
24. Flashlight—check operating condition.
25. Pitot Heater—ON (only if needed).
26. Heading Indicator—properly set to take-off runway heading.
27. Attitude Indicator—indicating approximately level flight attitude.

CAUTION

When lining up on the runway, some precession may occur in the slaved gyro heading indicator and the attitude indicator.

INSTRUMENT TAKE-OFF AND INITIAL CLIMB.

1. Hold brakes, run up to 90% rpm—check the oil pressure, fuel pressure, hydraulic pressure, loadmeter, and tailpipe temperature.
2. Release the brakes simultaneously.
3. Run up to 100% rpm.
4. Use the brakes to maintain directional control until the rudder becomes effective at approximately 50 knots IAS.

Note

During the take-off roll, the heading indicator is the primary directional control instrument.

5. At approximately 80 knots IAS apply back pressure to the stick to establish a take-off attitude of about 2-bar widths nose high on the attitude indicator.

Note

At this point the attitude indicator becomes primary pitch and bank control instrument and continues as such until the climb is established.

6. The aircraft will normally become airborne between 115-125 knots IAS.

7. Establish the initial climb by maintaining a wing level 2-bar width nose high attitude on the attitude indicator.

8. When the altimeter indicates a climb and the vertical speed indicates 300-500 fpm rate of climb, retract the landing gear.

9. At 140 knots IAS, retract the wing flaps (approximately 200 feet above terrain).

10. As the airspeed increases, establish a 1000 fpm rate of climb.

Note

At this point the vertical speed indicator becomes the primary pitch control instrument until the climbing airspeed is established.

11. In aircraft equipped with G-2 type compass, place compass control/free DG switch in COMPASS CONTROL position.

CLIMB.

1. Maintain 100% power.

2. Maintain a 1000 fpm rate of climb until the desired climbing airspeed is established.

Note

At this point the airspeed indicator becomes the primary pitch control instrument and continues as such for the remainder of the climb.

Note

During the climb, the miniature aircraft should not be reset from the take-off setting.

CRUISE FLIGHT.

GENERAL: This aircraft handles well on instruments at all altitudes and at all airspeeds from 10-20 knots above stalling up to within 10 knots of .8 Mach. At approximately .8 Mach, elevator control becomes less positive, and, due to external tank buffeting and slight aileron buzz, the entire aircraft vibrates to some degree.

LEVEL FLIGHT: After leveling off from the climb, establish cruising airspeed and retrim the aircraft for "hands off" flight. When the aircraft is in level flight at cruising airspeed, readjust the miniature aircraft in the attitude indicator to indicate level flight attitude.

TURNS: Whenever possible, standard rate turns (3 degrees per second) should be used; however, when the angle of bank required for standard rate turns exceeds 30 degrees, one-half standard rate turns (1-½ degrees per second) should be used. In lieu of rate turns, a constant 30 degree angle of bank may be used.

STEEP TURNS: Any angle of bank exceeding 30 degrees is considered a steep turn. When flying on instruments, the aircraft is easily controlled in steep turns up to 60 degrees of bank; however, a high airspeed is desirable at angles of bank greater than 45 degrees. During all steep turns, the attitude indicator is the primary bank control instrument.

Note

While turning, the attitude indicator will precess slightly in pitch and/or bank. This precession is at a maximum while turning at steep angles of bank and high airspeeds. After rolling out of steep turns, the attitude indicator may take several minutes to precess back to a level position. During these periods of precession, constant cross-checking of the other flight instruments will be necessary to maintain the desired attitude.

HEADINGS: When flying precise headings or constant headings for prolonged periods, rotating the dial of the heading indicator so as to place the selected heading directly under the top index of the instrument is recommended. However, this procedure is at the discretion of the pilot. (Does not apply to G-2 type compass.)

HOLDING AND STACKING.

HOLDING: To enter a holding pattern, simultaneously begin a turn to the desired heading, reduce power to the desired setting, and extend the speed brakes. Slow the aircraft to 200 knots IAS (175 knots IAS if tip tank fuel is exhausted) and retract the speed brakes. The use of dive flaps when entering a holding pattern may be avoided by reducing speed on the approach to the holding pattern.

STACKING: To descend, when holding in a stack at high altitude, reduce power to 65% rpm and maintain the holding pattern airspeed. Lead the desired level-off altitude about 100 feet by adjusting power as necessary. To descend when holding in a stack at low altitude (below 10,000 feet), reduce power to 65% rpm, extend the speed brakes, and maintain the holding pattern airspeed. Lead the desired level-off altitude about 100 feet by retracting speed brakes.

DESCENTS.

GENERAL: The following descents are applicable under all weather conditions. They may be started from any altitude, using any type of navigational aid, and can be flown by a single airplane or a formation. Prior to beginning the descent, turn on the auxiliary defroster, and when below 10,000 feet, place the emergency fuel switch in the TAKE-OFF AND LAND position. Most published instrument let-downs for jet aircraft are based on an initial penetration altitude of 20,000 feet. The following types of descents are recommended:

ENROUTE PENETRATION DESCENT: When cruising at altitudes above 20,000 feet, a descent prior to reaching the destination fix is recommended to place the airplane over the fix at 20,000 feet. For enroute penetration descent airspeeds and power settings, consult the descent charts in Appendix I.

Note

If terrain features and air traffic conditions permit, this type descent may be used to descend enroute from cruising altitude to initial approach altitude. From this point a low approach or a GCA can be completed.

CAUTION

Descents at idle rpm at airspeeds of .6 Mach, or higher, produce extremely steep pitch attitudes and very high airspeeds in the lower altitudes. Further, idle rpm may result in insufficient windshield defrosting; therefore, descents of this type are not recommended below 20,000 feet under instrument conditions.

LOW SPEED PENETRATION DESCENT: Starting at the initial penetration altitude, simultaneously extend the speed brakes and reduce power to 65% rpm. Maintain level flight until the airspeed is reduced to 195 knots IAS maximum, then extend the landing gear. After the landing gear is extended, hold the aircraft in level flight until the airspeed is reduced to 175 knots IAS maximum, then extend full wing flaps. As the wing flaps are extended, the pitch attitude of the aircraft is changed to maintain a constant indicated airspeed of 150 knots.

HIGH SPEED PENETRATION DESCENT: Starting at the initial penetration altitude, simultaneously extend the speed brakes, reduce power to 65% rpm, and lower the pitch attitude of the aircraft to an attitude that will establish and maintain a constant indicated airspeed of 250 knots.

Note

For formation penetrations, 70% rpm is recommended.

Note

During the entry into the descent, from the time the aircraft is lowered from level flight until the airspeed is established at the descending airspeed of 150 or 250 knots IAS (as applicable), the attitude indicator is the primary pitch control instrument.

PENETRATION LEVEL-OFF: To level off from a penetration, establish a clean configuration when 1000 feet above the desired level-off altitude (in a low speed penetration, retract wing flaps, landing gear, and speed brakes in that order). At the same time, change the pitch attitude to establish a 2000 fpm rate of descent and, when approximately 200 feet above the desired altitude, slowly raise the nose of the aircraft to level off at the desired altitude.

Note

After leveling off from the penetration descent, maintain a minimum power setting of 65% rpm. If necessary, add power to maintain a minimum of 175 knots IAS.

RECOVERY FROM UNUSUAL ATTITUDES.

GENERAL: An unusual attitude is any attitude of the aircraft not required for normal instrument flying. Recovery is accomplished only after proper interpretation of the airspeed indicator, altimeter, vertical speed indicator, and turn and bank indicator. During the recovery the airspeed indicator is primary for pitch and power control, the turn needle is primary for bank control, and the vertical speed indicator and altimeter are supporting pitch instruments.

CAUTION

The attitude indicator and the heading indicator should be disregarded during the initial phase of the recovery. When the aircraft is in an extreme attitude of pitch or bank, or whenever the attitude indicator is going through a controlled precession, the indications of the attitude indicator may be very confusing and cause improper recovery action to be taken.

The two general procedures used to recover from unusual attitudes are the "high airspeed recovery" and the "low airspeed recovery." The proper recovery procedure is determined by the indication and the trend of the airspeed indicator.

HIGH AIRSPEED RECOVERY: When the airspeed is higher than desirable and/or when the airspeed is increasing:

1. Power control—reduce power to approximately 65% rpm.
2. Bank control—apply control pressure to center the turn needle and level the wings.
3. Extend speed brakes after bank correction is initiated.
4. Pitch control—apply control pressure to establish a level flight attitude (when movement of the altimeter and airspeed indicator stop prior to reversing their direction of movement, the aircraft is approaching level flight).
5. As the aircraft approaches level flight, the attitude indicator may be brought into the cross-check.

CAUTION

Extending speed brakes at very high airspeeds with a high positive G loading will cause additional G forces which may result in structural damage.

LOW AIRSPEED RECOVERY: When the airspeed is lower than desirable and/or the airspeed is decreasing:

1. Power control—apply power to 100% rpm.
2. Pitch control—apply control pressure to establish a level flight attitude (when the movement of the altimeter and airspeed indicator stop prior to reversing their direction of movement, the aircraft is approaching level flight).
3. Bank control—level the wings by centering the turn needle.
4. As the aircraft approaches level flight, the attitude indicator may be brought into the cross-check.

CAUTION

Prolonged negative G forces may result in a flameout and/or fuel fumes in the cockpit.

Note

- Do not attempt to return the aircraft to the original altitude or heading until full aircraft control is regained.
- The attitude indicator may precess excessively during unusual attitudes.

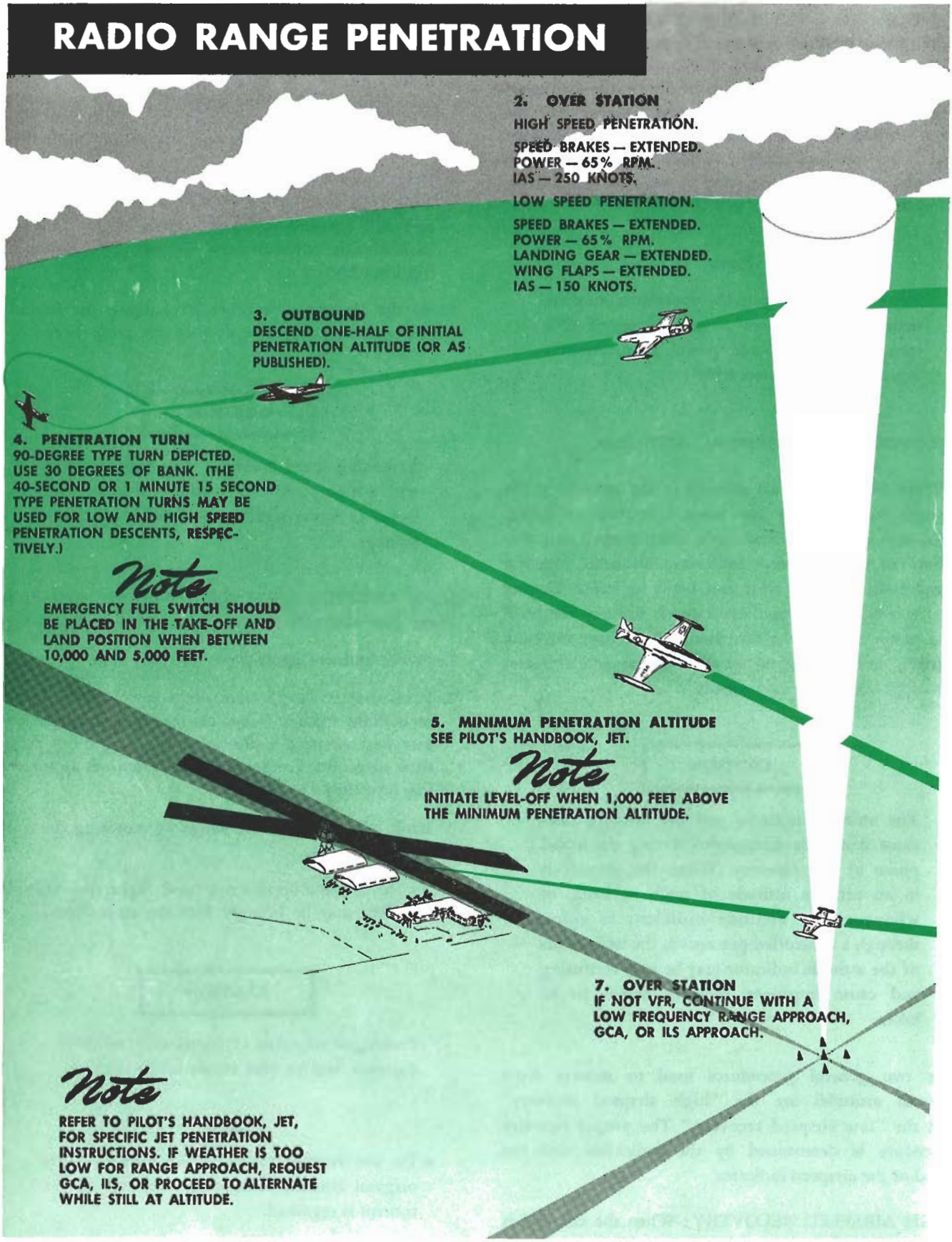


Figure 9-1 (Sheet 1 of 2)

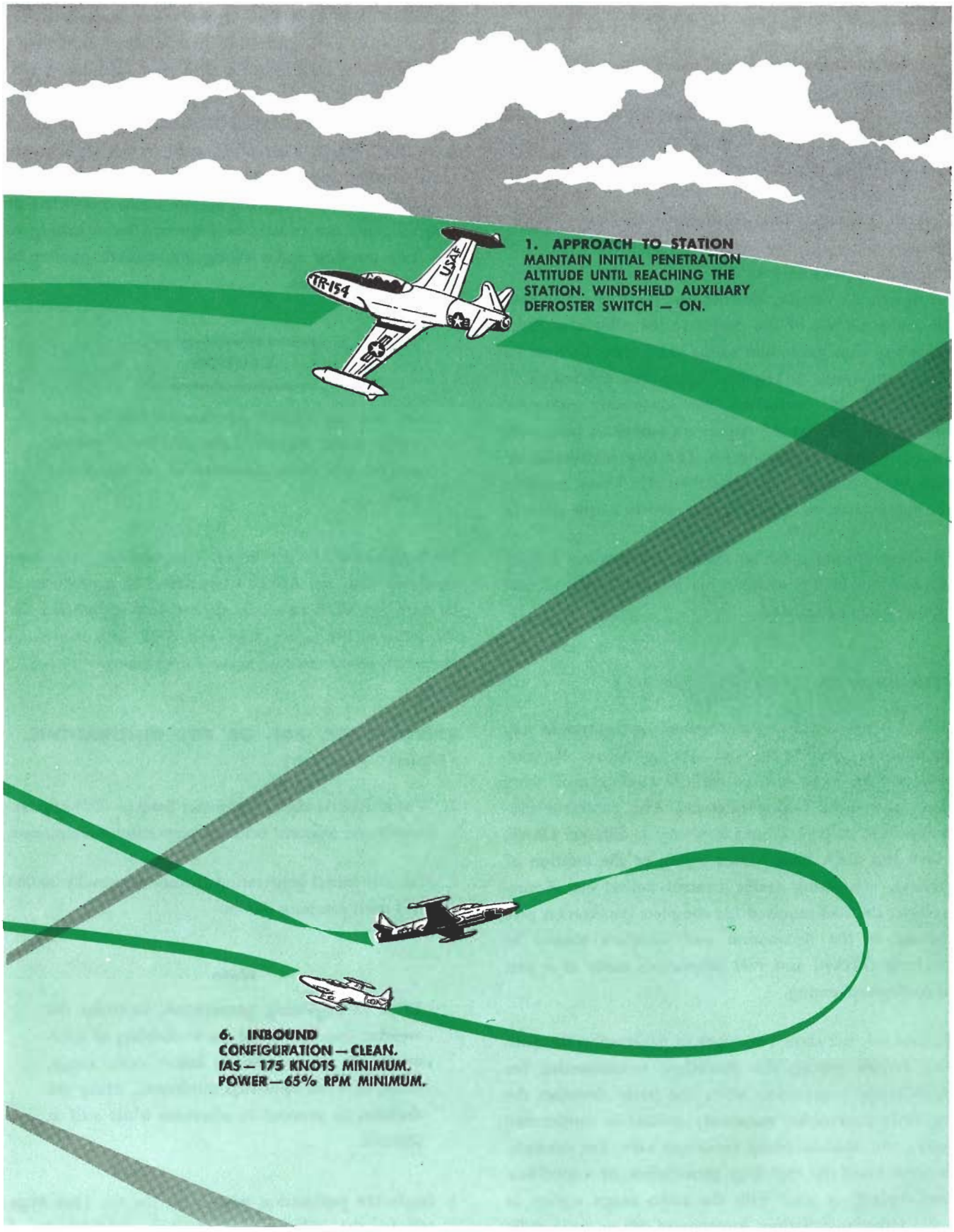


Figure 9-1 (Sheet 2 of 2)

RADAR AND VOLSCAN LETDOWNS.

GENERAL: Radar controlled penetrations to an entry gate or radar turn-on point can be made with the T-33. The pilot merely follows the verbal instructions of the radar operator. Upon reaching the entry gate he is turned over to GCA for the final approach.

Volscan, a combination of electronic tracking and computing units which are capable of automatic control of all planes approaching an airport, is a rather revolutionary device. At present, Volscan uses relay men who read the computations of the device to the pilot over voice radio and thus guide him to the entry gate. Because no special apparatus is required using this method, T-33 aircraft can be controlled. For completely automatic control the T-33 would require an automatic pilot with an automatic coupling device. (Factory installation of such equipment is not contemplated). Upon reaching the entry gates, GCA would take control of the aircraft.

By using ground radar or Volscan for recovery following missions in IFR weather, maximum economy of fuel and time can be realized.

PENETRATIONS. (Figures 9-1 and 9-2.)

FUEL REQUIREMENTS: Various configurations can be used for penetrations and low approaches. Penetrations can be made with or without landing gear, wing flaps, and speed brakes extended. The published procedures for jet penetrations may vary at different USAF, Navy and CAA installations owing to the location of airways, conflicting traffic control zones, etc. Consequently, the fuel required for complete penetration procedures at the destination and alternate should be carefully checked and fuel allowances made as a part of preflight planning.

Figures 9-1, 9-2 show two types of penetration descents. The former depicts the procedure recommended for radio range penetration while the latter describes the tear-drop penetration commonly utilized in conjunction with radio beacons. Many variations exist. For example, at some bases the tear-drop penetration, or a modification thereof, is used with the radio range station as a fix. Other installations incorporate one or more radio beacons as fixes.

RADIO COMPASS: The ARN-6 radio compass is very susceptible to static created by precipitation, particularly while flying at high airspeeds and high altitudes. Often, while flying in weather, precipitation static builds up to severe intensities and then suddenly may be discharged from the aircraft. Thereafter, radio range signals may come through very clearly. When range signals become inaudible because of precipitation static, reception of range signals can usually be improved by switching to the loop position and rotating the azimuth pointer 90 degrees to the station.

CAUTION

Do not use COMP position to receive radio range aural signals. The automatic volume control will cause distortion of the signal pattern.

VHF OMNI-RANGE: Some T-33 aircraft have been equipped with the ARN-14 receiver. The procedures to be used for VOR penetrations and low approaches are the same as for radio range and ADF with respect to airspeeds, power settings, and configurations.

RADIO RANGE, ADF, OR VOR PENETRATIONS. (Figures 9-1 and 9-2.)

1. Windshield Auxiliary Defroster Switch—ON approximately ten minutes prior to beginning penetrations.

2. Maintain initial penetration altitude (normally 20,000 feet) until reaching the fix.

Note

Prior to beginning penetration, ascertain the weather conditions and the availability of GCA or ILS if the weather is below radio range, ADF or VOR approach minimums. Make the decision to proceed to alternate while still at altitude.

3. Begin the penetration when over the fix. (See Page 160 for the techniques of the low and high speed penetration descents.)

CAUTION

The high speed penetration descent is recommended when icing and turbulent weather conditions exist. This type penetration provides a safe and comfortable airspeed in turbulence and eliminates the possibility of heavy accumulations of ice on the landing gear creating hazardous drag conditions.

Note

Although penetrations with power at IDLE can normally be safely made, 65% rpm is recommended to insure minimum tailpipe temperatures and reaching minimum penetration altitude the required number of miles from the fix. In addition, a basic power setting is established to be used throughout the penetration and part of the low approach.

4. Descend outbound on penetration course.

5. Penetration turn—Descend one-half of the difference between the initial penetration altitude and minimum penetration altitude (or as published) prior to executing penetration turn.

WARNING

Due to the high rate of descent produced in jet penetrations, the altimeter should be closely monitored throughout the penetration. AVOID MISREADING.

6. Emergency Fuel Switch—TAKE-OFF AND LAND position when between 10,000 and 5,000 feet.

7. Initiate level-off when 1,000 feet above the minimum penetration altitude.

Note

Allow airspeed to build up when leveling off. Leave power at 65% rpm. The excess speed will dissipate but will have served the useful purpose of expediting arrival at the station without high rate of fuel consumption.

8. Proceed inbound to the fix with a minimum of 175 knots IAS and/or a minimum of 65% rpm.

Note

With heavy fuel loads and/or turbulent conditions, it may be necessary to use additional power to maintain 175 knots IAS.

9. When over the fix, proceed with the low approach as published.

LOW FREQUENCY RANGE APPROACH. (Figure 9-3.)

1. When over the station at minimum penetration altitude, extend the speed brakes and descend at 175 knots IAS to procedure turn altitude. The time flown prior to starting procedure turn should normally be from 30 seconds to one minute and 30 seconds (or as published). Retract the dive flaps and level off at procedure turn altitude.

2. Procedure turn—Both the 90 degree and 40 second type procedure turns are acceptable. A double needle width turn (3 degrees per second) at a minimum of 175 knots IAS is recommended.

3. After completion of the procedure turn, extend the landing gear and descend to the published altitude, allowing the indicated airspeed to decrease to 140 knots (See Note). Apply power as needed to maintain the desired IAS and proceed inbound to the range station.

Note

Approach airspeeds should be increased 5 knots for each 100 gallons of fuel, or part thereof, in excess of 200 gallons.

4. When over the low station, begin descent to minimum approach altitude at a rate of not more than 500 fpm and an indicated airspeed of 140 knots. (See Note regarding approaching airspeeds.) Vary power settings as necessary.

5. For straight-in approach and landing, extend dive flaps and wing flaps when field is in sight. When circling or low visibility approach is required, extend dive flaps and wing flaps on base leg or final approach as desired.

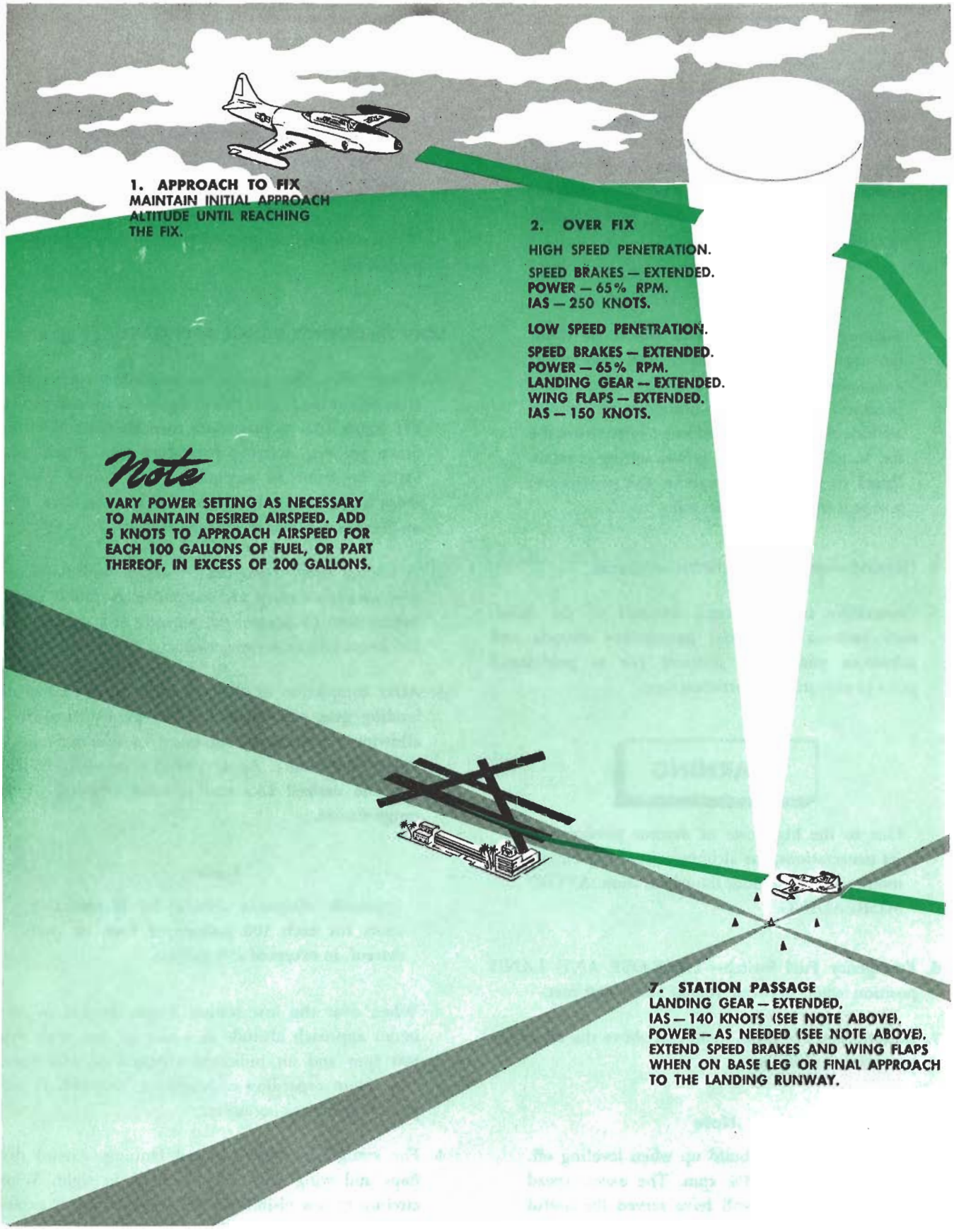
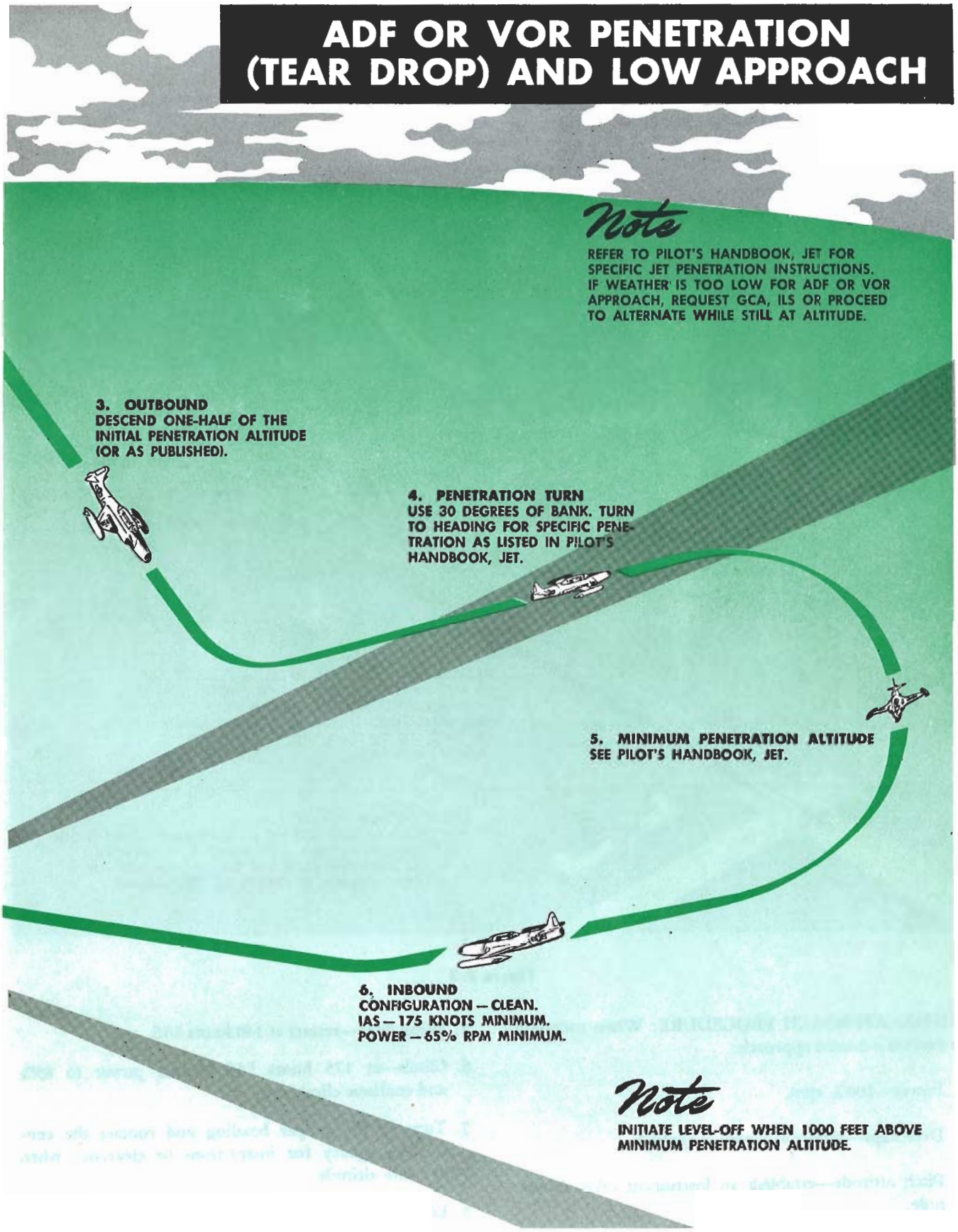


Figure 9-2 (Sheet 1 of 2)



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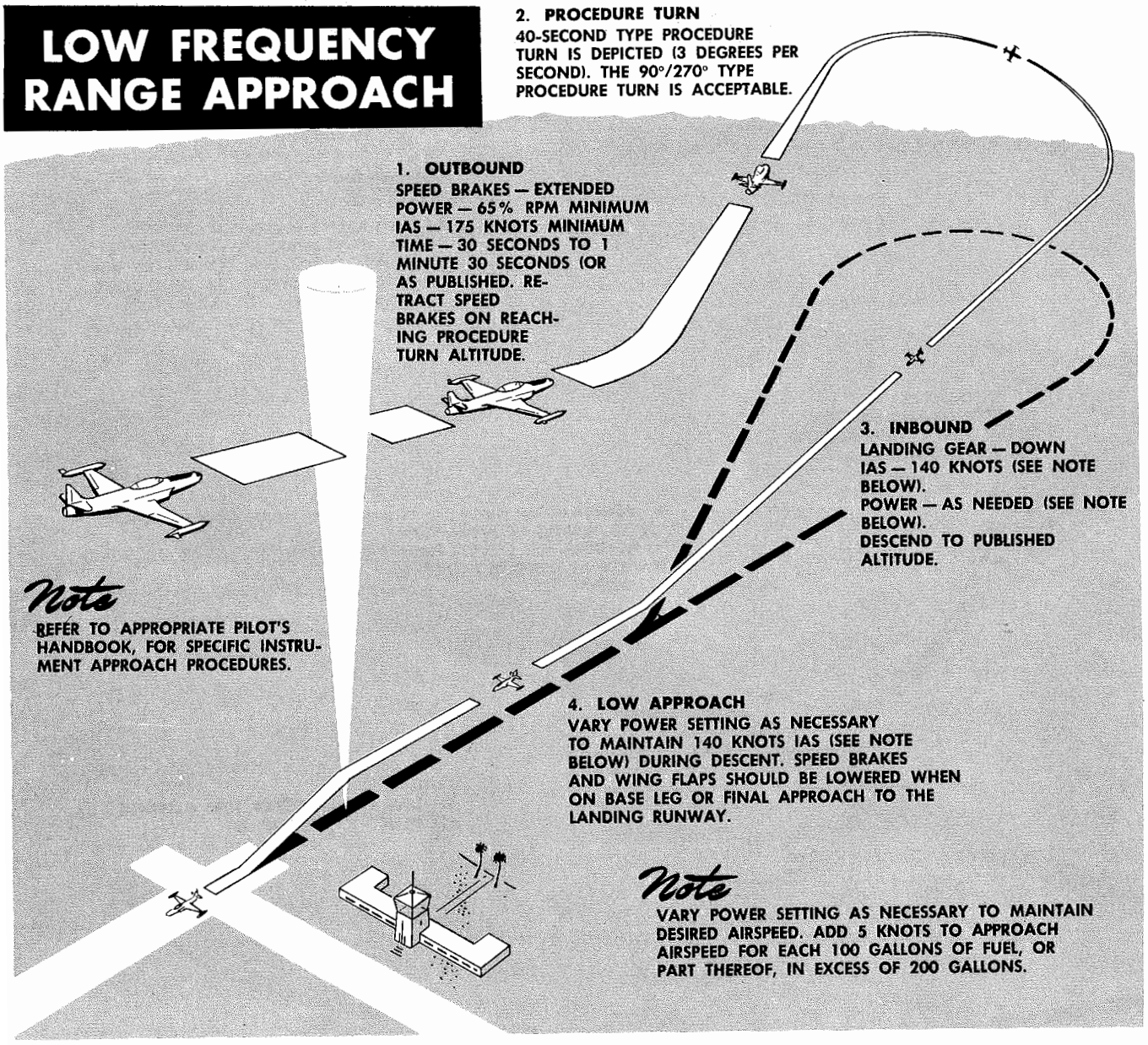


Figure 9-3

MISSED APPROACH PROCEDURE: When necessary to execute a missed approach:

1. Power—100% rpm.
2. Dive flaps—retract as power is applied.
3. Pitch attitude—establish an instrument take-off attitude.
4. Landing gear—retract when vertical speed indicator and altimeter indicate a climb.
5. Wing flaps—retract at 140 knots IAS.
6. Climb—at 175 knots IAS, reduce power to 85% and continue climbing.
7. Turn to the proper heading and contact the controlling agency for instructions or clearance when at a safe altitude.
8. Level off—when the missed approach altitude is reached, reduce power to maintain a minimum of 175 knots IAS and/or a minimum power setting of 65% rpm.

STANDARD GCA APPROACH

Note

VARY POWER SETTING AS NECESSARY TO MAINTAIN DESIRED AIRSPEED. ADD 5 KNOTS TO APPROACH AIRSPEED FOR EACH 100 GALLONS OF FUEL, OR PART THEREOF, IN EXCESS OF 200 GALLONS.

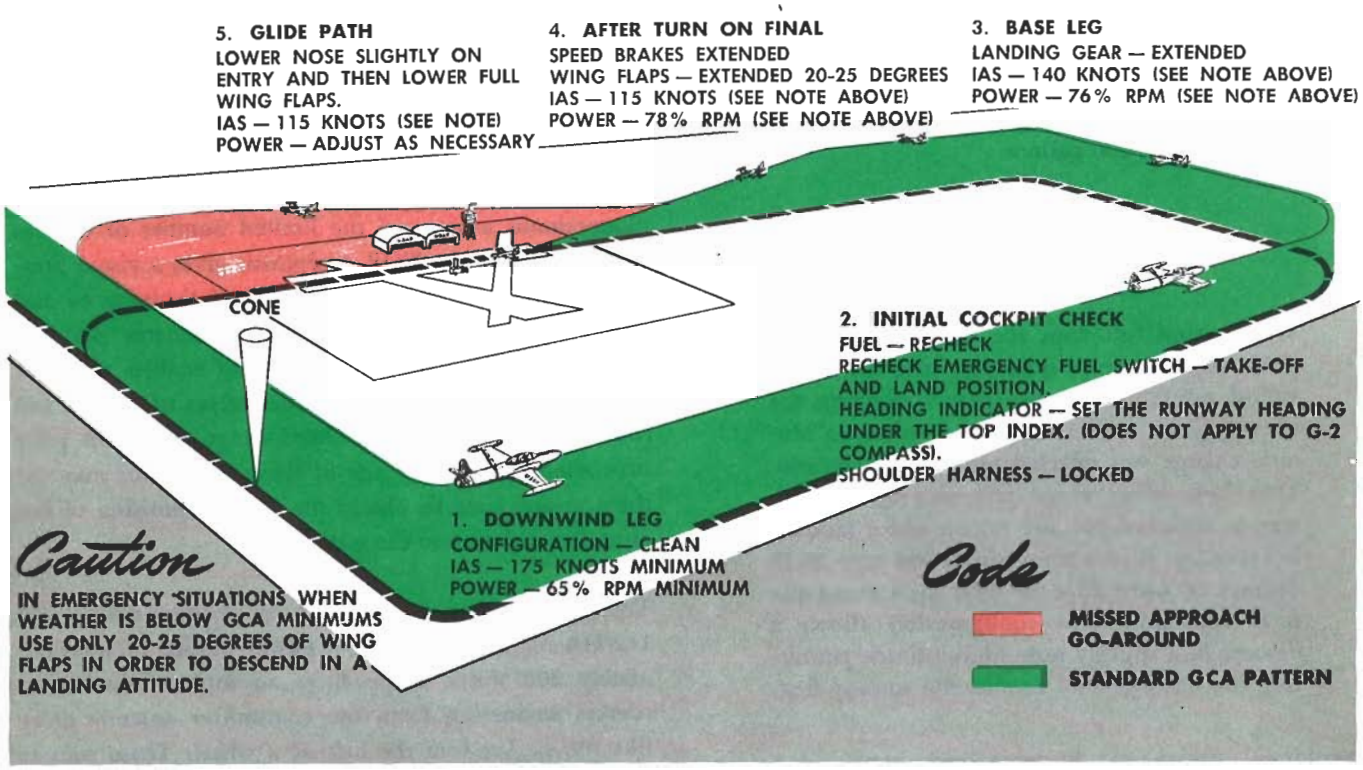


Figure 9-4

GROUND CONTROLLED APPROACH. (Figure 9-4.)

GENERAL: Ground Controlled Approaches normally consist of a rectangular pattern beginning over a fix. Some bases, ideally located in relation to radio range stations or radio beacons, employ modified versions of the basic GCA pattern. An example of this may be found in cases where the approach leg of the range station is also the final approach of the GCA pattern. Other bases have still other variations of the basic rectangular pattern. Therefore, the fuel and time required for GCA's may vary at different bases depending on the local procedure. Emergency GCA's may be made with less fuel by requesting the GCA controller to shorten the pattern.

GCA PATTERN. (Figure 9-4.)

1. Downwind leg—Maintain a clean configuration with minimum of 175 knots IAS and/or a minimum of 65% rpm.
2. Make initial cockpit check.
   a. Fuel—RECHECK.
   b. Recheck the emergency fuel switch—TAKE-OFF AND LAND position.
   c. Heading indicator—Set the heading of the landing runway under the top index. (Does not apply to G-2 compass.)
   d. Shoulder harness—LOCK.
3. Base leg—Extend landing gear after turn onto base leg. Add power as necessary (approximately 75%) to maintain 140 knots IAS.

4. After turn onto final:
   a. Dive flaps—extended.
   b. Wing flaps—20-25 degrees.
   c. IAS—115 knots minimum.
   d. Power—as needed (approximately 78% rpm).

5. Glide path—on entry, lower nose slightly and extend full wing flaps. Adjust power as needed to maintain a minimum 115 knots IAS.

Note

Add 5 knots to the base leg and final approach airspeeds for each 100 gallons of fuel, or part thereof, above 200 gallons.

CAUTION

When using full flaps for final approach the T-33 descends in a nose low attitude which would result in the nose gear contacting the runway prior to the main gear unless an attitude change was effected prior to touchdown. Therefore, when visual reference to the runway is impaired for any reason and a landing is necessary, it is recommended that only 20-25 degrees of wing flaps be used throughout the final approach. This configuration allows a descent in a slightly nose high attitude permitting the main gear to contact the runway first.

MISSED APPROACH PROCEDURE: When necessary to execute a missed approach:

1. Power—100% rpm.

2. Speed brakes—retract as power is applied.

3. Pitch attitude—establish an instrument take-off attitude.

4. Landing gear—retract when vertical speed indicator and altimeter indicate a climb.

5. Wing flaps—retract to 140 knots IAS.

6. Climb—at 175 knots IAS, reduce power to 85% and continue climbing.

7. Turn to the proper heading and contact the controlling agency for instructions or clearance when at a safe altitude.

8. Level off—when the missed approach altitude is reached, reduce power to maintain a minimum of 175 knots IAS and/or a minimum power setting of 65% rpm.

VHF OMNI-RANGE NAVIGATION.

GENERAL: The VHF Omni-Range is a navigational aid that will eliminate, to a great extent, the deficiencies most prominent when navigating by aural signals of low and medium frequency radio ranges, or by use of the radio compass.

The most outstanding of these deficiencies are: static due to atmospheric disturbances, multiple courses in mountainous areas, and the limited number of courses available. Since the VOR equipment gives a visual presentation, it eliminates the necessity of listening to and interpreting aural signals. It also eliminates the first two above mentioned deficiencies and enables the pilot and traffic controller to avail themselves of any of 360 courses TO or FROM an Omni-Range station. A pilot may select and fly any one of these courses, or may use them at any time to obtain the angular position of the aircraft in relation to the station.

The Omni-Range is designed to operate within the 112-118 mc band and has a power output of approximately 200 watts. It produces an infinite number of courses emanating from the transmitter antenna array like the spokes fom the hub of a wheel. These courses are known as radials and are identified by their magnetic direction from the station. The equipment is VHF, subject to line-of-sight restrictions, and its range varies proportionally to the altitude of the receiving equipment. Therefore, obstruction free installation sites are necessary for the most advantageous and dependable utilization of the VOR.

As VOR may, in the very near future, be our primary radio navigational aid, it is paramount that all pilots be conversant with all aspects of its operation and use.

ENROUTE PROCEDURES: Procedures contained herein have been developed for the change-over period when aircraft are using both the low frequency ranges and the omni-ranges. The developments which complemented the omni-range, such as distance measuring equipment and the course line computer, are not at present available.

These factors impose limitations on the omni-range system which will affect its efficiency. Present procedures were developed to permit the same volume of traffic to move over the omni-range system as is now moving over the low frequency range system. However, it is believed that some increase in capacity will result.

Change from one VOR facility to another shall normally be made at a mid-point between the two stations. Change points are designated on charts by a small diamond containing the mileage to each station.

With the exception of expressions peculiar to the omni-range, standard phraseology will be similar to that now used with the low frequency range system.

PENETRATION AND LOW APPROACHES: Currently, publications contain few VOR penetration and low approach procedures. When penetrating from altitude using a VOR station as a fix, the procedures, airspeeds, and configurations previously outlined for the ADF penetration and low approach may be utilized. In the interest of flying safety, close coordination with ARTC is essential.

INSTRUMENT LANDING SYSTEM.

GENERAL: The Instrument Landing System is designed to permit the execution of a safe approach and landing when low ceilings and restrictions to visibility prevail. In this respect, an instrument approach utilizing ILS is similar to a GCA. The outstanding differences between these systems are: (1) ILS is comprised of radio beams instead of radar signals; (2) the only personnel controlling the ILS approaches are tower personnel. With the advent of the Omni-Range, ILS assumes a role of increasing importance. It can be utilized readily and easily with the VOR ranges in making instrument approaches.

FLIGHT PROCEDURES: To initiate an ILS approach, the procedures are similar to those used for requesting a GCA. Advance notice and information supplied to Air Traffic Control are desirable and should be given upon reaching the reporting point preceding the holding fix at the field of intended landing.

ILS APPROACH: Select the proper ILS frequency and, when the receivers are ready for operation, turn up the receiver gain and identify the ILS station. A transition must be made from the airway to the ILS before an approach may be initiated. This transition may be made from a radio fix to the outer marker, to the non-directional radio beacon at the outer marker site, or to the localizer beam itself. A minimum altitude is specified for each transition. The transition shall be made at 175 knots IAS.

When approaching the localizer beam on initial interception, the pointer will move from its full deflection position toward the center of the cross-pointer indicator. As soon as this movement begins, a turn to the heading of the letdown course should be started. Following the localizer beam using the vertical cross-pointer is not difficult. Wind drift and compass error may be readily observed. Large and abrupt heading corrections are to be avoided.

In some cases, the transition procedure may require the pilot to intercept the localizer beam and follow it outbound to a point beyond the outer marker, then execute a procedure turn (normally within five miles of the outer marker) prior to commencing the final approach. The pilot must remember that the vertical cross-pointer always indicates the sector in which the aircraft is located. Consequently, when the aircraft is flying on the reciprocal of the landing heading, corrective turns are made in a direction opposite to the vertical cross-pointer deflection.

Tracking inbound toward the outer marker, the altitude specified for intercepting this marker must be maintained. The glide slope is intercepted at the outer marker and a letdown of approximately 500 feet per minute (depending on the approach airspeed and wind) should be commenced. From this position, both pointers on the cross-pointer indicator must be centered in order to remain on course and on glide slope.

A change in heading of more than five degrees on departing the outer marker and two degrees after departing the middle marker should be avoided. A larger correction could cause the aircraft to drift too far from the course to permit a recovery, as the localizer pointer will give a full scale deflection when the aircraft is two and one-half degrees either side of the on course. If the pointer is deflected less than one-fourth scale, the aircraft will be aligned with the runway. The glide slope is sharper than the localizer course and is extremely sensitive.

Note

Aircraft airspeeds, power settings, and configurations for ILS approaches should be the same as those previously outlined in GCA.

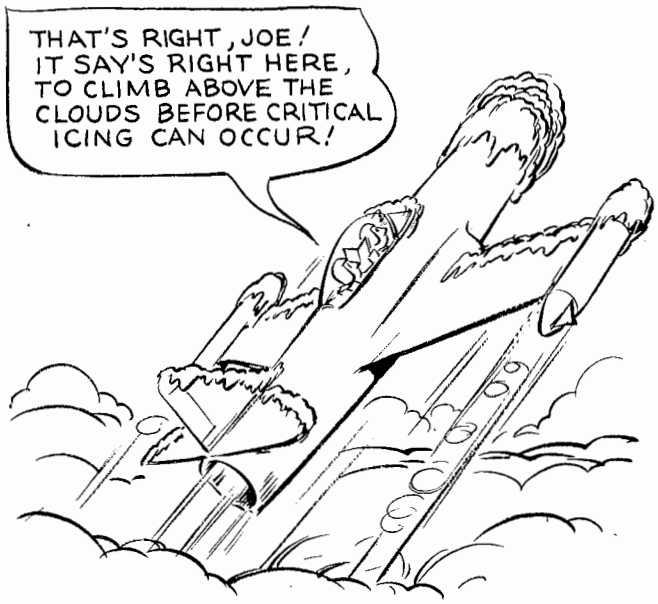
MISSED APPROACH PROCEDURE: When necessary to execute a missed approach:

1. Power—100% rpm.
2. Dive flaps—retract as power is applied.
3. Pitch attitude—establish an instrument take-off attitude.
4. Landing gear—retract when vertical speed indicator and altimeter indicate a climb.
5. Wing flaps—retract at 140 knots IAS.
6. Climb—at 175 knots IAS. Reduce power to 85% rpm and continue climb.
7. Turn to the proper heading and contact the controlling agency for instructions or clearance when at a safe altitude.
8. Level off—when the missed approach altitude is reached, reduce power to maintain a minimum of 175 knots IAS and/or a minimum power setting of 65% rpm.

ICING.

GENERAL: Thinner wing sections and higher speeds of jet aircraft can result in critical ice accumulations in relatively light icing conditions in aircraft without anti-icing systems. Icing can reduce airspeed and range of the aircraft considerably.

STRUCTURAL ICING: Ice will normally adhere to the windshield, leading edge of the wing and may extend out to approximately three inches in moderate to heavy icing conditions. Rime ice, normally associated with stratus type clouds, will usually form in horizontal ridges along the leading edge of the wing. Clear ice, normally associated with turbulent air conditions, assumes no definite pattern. Aircraft control becomes very sluggish when heavy icing accumulates on the aircraft. Up to 80 knots IAS may be lost at cruising speeds. Normally, airspeed cannot be regained with power as long as the heavy ice formations remain on the aircraft. Therefore, it is necessary to lose altitude to regain airspeed lost.



When structural icing is encountered critical accretion may be prevented by climbing to the clear air above the clouds or climbing to an altitude where the ambient temperature is low enough to preclude further ice accretion. If a climb is impractical, a descent to a temperature level above freezing is often the best solution.

WARNING

- Icing can cause the stalling speeds to increase considerably. Heavy ice may increase stall speeds in the clean configuration up to approximately 170 knots IAS. Therefore, extreme caution must be exercised when making instrument approaches and landings in icing conditions.
- During heavy icing conditions it is possible that the static pressure inlet port may ice over. Such a condition is evidenced by an abnormally high indicated airspeed in proportion to the amount of power applied. This erroneous indicated airspeed coupled with a higher stalling speed, (created by wing and structural icing), requires that extreme caution be used especially at low altitudes and during landing operations.

INDUCTION ICING: The centrifugal compressor type engine is relatively free of icing difficulties. In flight, the rotation of the air as it enters the engine effectively separates the water droplets from the air and deposits them on surfaces where icing is not considered serious. While it may be possible to ice the engine, icing conditions must be extremely severe. However, atmospheric icing conditions should be avoided whenever feasible. It is recognized that the most proficient weather service cannot always accurately predict just when or where icing may be encountered. Many areas of probable icing conditions can be avoided by careful planning and utilizing available weather information.

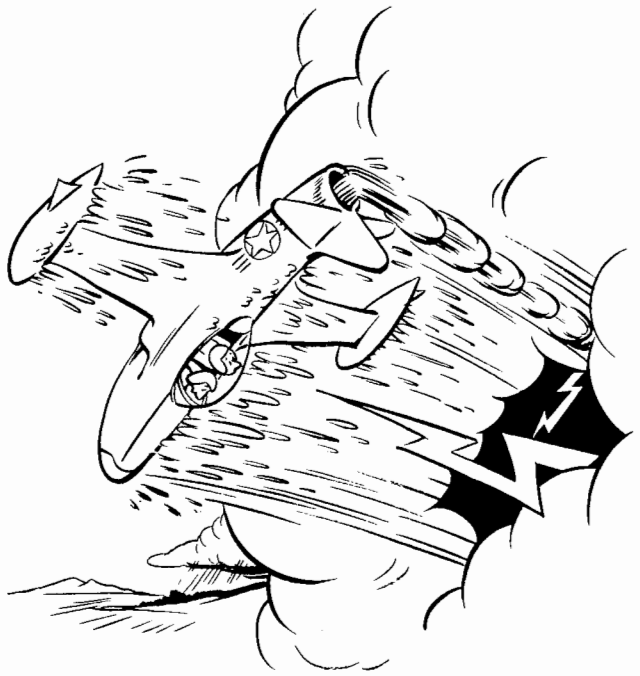
The initial indication of engine icing is increased tailpipe temperature and loss of thrust. This is usually the only indication prior to complete engine failure. When induction icing occurs, power should be immediately reduced until the tailpipe temperature is within normal operating limits. In severe cases of induction icing, it may be necessary to retard the throttle to the OFF position and descend to a lower altitude where outside air temperature is high enough to melt the ice and allow an airstart to be made.

LOW PRESSURE FUEL FILTER ICING: Icing in the fuel system is indicated by (1) a red warning light located in the cockpit, (2) fluctuating rpm and (3) the inability to obtain a higher rpm. The alcohol fuel filter de-icer system should be used as described in Section IV.

TURBULENT AIR AND THUNDERSTORM FLYING.

GENERAL: Intentional flight through thunderstorms is not recommended. This type of flight requires considerable instrument experience and may result in structural damage to the aircraft. However, thunderstorms cannot always be avoided and, with modern equipment, a pilot proficient in instrument flying can make successful penetrations.

The power setting and pitch attitude required for desired penetration airspeed should be established before entering the storm. This power setting and pitch attitude, if maintained throughout the storm, will result in approximately a constant average airspeed, regardless of any false readings of the airspeed indicator. Specific instructions for thunderstorm flying are given in the following paragraphs.



A PILOT USING MODERN EQUIPMENT AND POSSESSING A COMBINATION OF PROPER EXPERIENCE, COMMON SENSE, AND INSTRUMENT FLYING PROFICIENCY, CAN SAFELY FLY THROUGH THUNDERSTORMS.

Note

- All altitudes referred to herein are absolute (measured above the terrain).
- Altitudes between 10,000 and 25,000 feet are usually the most turbulent areas in a thunderstorm. The least turbulent areas will be below 6,000 feet and above 30,000-35,000 feet. Therefore, altitudes in excess of 30,000 feet are recommended for thunderstorm penetration. At these higher altitudes usually the size and frequency of hail is less, however, damage is possible.

BEFORE TAKE-OFF.

1. A safe and comfortable penetration speed for this aircraft at or below 30,000 feet is 250 knots IAS. Above 30,000 feet it is necessary to reduce airspeed somewhat in order to provide a comfortable and safe margin (approximately 30 knots) between cruising

airspeed and the limiting mach number of the aircraft. Example: At 40,000 feet, 210 knots IAS would be a safe and comfortable airspeed.

2. Make a thorough anaylsis of the general weather situation to determine thunderstorm areas and prepare a flight plan which will require the least possible exposure of the aircraft to regions of possible thunderstorms.

3. Be sure to check proper operation of all flight instruments, navigation equipment, pitot heater, and instrument panel lights before attempting flight into thunderstorm areas.

APPROACHING THE STORM: It is imperative that the pilot prepare the aircraft prior to entering a zone of turbulent air. If the storm cannot be seen, its proximity may often be detected by crash static. Prepare the aircraft as follows:

1. Adjust power as necessary to obtain a safe penetration speed of 250 knots.
2. Pitot heater—ON.
3. Check gyro instruments for proper settings.
4. Safety belt tight and shoulder harness locked.
5. Adjust seat to secure adequate head clearance.
6. Secure all loose equipment (publications, etc.).
7. Turn off any radio equipment rendered useless by static.
8. At night, turn cockpit lights full bright to minimize blinding effect of lighting.

CAUTION

Do not lower landing gear or wing flaps.

IN THE STORM:

1. Maintain power setting and pitch attitude throughout the storm. Hold these constant and the airspeed will remain approximately constant regardless of the indicated airspeed.
2. Devote full attention to flying the aircraft.
3. Accept turbulence, precipitation and lighting. Do not allow these conditions to cause undue concern.
4. Maintain attitude. Concentrate principally on holding a level attitude by reference to the attitude indicator.
5. Maintain original heading. Do not make turns unless absolutely necessary.
6. Do not chase the airspeed indicator; doing so could result in extreme aircraft attitudes. If a gust should be encountered while the aircraft is in a nose high attitude, a stall might easily result. A heavy rain, by partial blocking of the pitot tube pressure head, may decrease the indicated airspeed considerably.
7. Use as little elevator and aileron control as possible to maintain aircraft attitude in order to minimize the stresses imposed on the aircraft.
8. The altimeter may be unreliable in thunderstorms because of differential barometric pressure within the storm. A gain or loss of several thousand feet may be expected. Make allowance for this error in determining minimum safe altitude.

COLD WEATHER OPERATION.

GENERAL: The success of low temperature operation depends primarily upon the preparations made during the post-flight inspection, in anticipation of the requirements for operation on the following day. The procedures outlined must be followed to expedite the pre-flight inspection and to insure satisfactory operation of the airplane and its systems during the next flight.

BEFORE ENTERING THE AIRPLANE.

1. Remove all protective covers and dust plugs.
2. Check the entire airplane for freedom from frost, snow and ice. Brush off all light snow and frost. Remove all ice by a direct flow of air from a portable ground heater.

WARNING

- Care should be exercised to insure that water from melted ice is sponged so that it will not drain to some critical area and refreeze.
- Do not attempt to chip or scrape ice from the aircraft surfaces as this action may cause damage to the airplane.
- Dangerous loss of lift and treacherous stalls may result if the aircraft is not adequately cleaned of all frost, snow, and ice.

3. At temperatures below −26°C (−15°F), preheat is necessary for satisfactory closure of the cockpit canopy and should be applied to insure proper heating of the canopy seals, the cockpit, and the instrument panel. The following procedure is recommended for preheating the cockpit:
   a. Place heater duct in cockpit.
   b. Lower canopy to heater duct; insure that heater airflow is not "choked" by the canopy.
   c. Place the canopy cover over the partially closed canopy.
4. Check that the fuel tank vents, fuel filter and drain cocks are free from ice and drain condensate.
5. Check shock struts and actuating cylinders for dirt and ice; clean with a rag soaked in hydraulic fluid. Check shock struts for proper inflation.
6. No preheat or oil dilution is required to insure crankability or proper lubrication down to −54°C (−65°F); however, if a start is necessary with an inadequate power unit, preheating the accessory section and the oil sump will facilitate the start by decreasing starter loads.
7. Check that the fuel filter de-icing system has been serviced.
8. When JATO units are to be used, install units just prior to engine start to minimize cooling period before use.

ON ENTERING THE AIRPLANE.

1. Check flight controls for proper operation.
2. Insure that canopy can be closed and locked.
3. Use external power source to operate and check electrical and radio equipment.

BEFORE STARTING ENGINE.

A C-22 power unit or its equivalent is required for starting. If minimum starting rpm (9%) cannot be obtained, shut down the engine and connect an adequate power unit. Preheat through the intake ducts if a start is necessary with an inadequate power source.

STARTING ENGINE.

1. Start the engine using the normal starting procedure outlined in Section II.
2. If there is no indication of oil pressure after 30 seconds of engine operation, or if the pressure drops to zero after a few minutes of ground running, stop the engine and investigate.

Note

No warm-up is required if the oil pressure remains below 100 psi at full throttle. A temporary high oil pressure (above 100 psi) is not dangerous but take-off should be delayed until the pressure drops below 100 psi. If the oil pressure remains above 100 psi, an oil system malfunction is indicated and the airplane should not be flown.

WARM-UP AND GROUND CHECK.

1. Turn on cabin heat and windshield defrosting system, as required, immediately after engine start.
2. Check surface controls, dive flaps and aileron and trim tabs for proper operation.
3. Check wing flap and flap indicator operation. If questionable readings result, cycle flaps three to four times to correct indicator action.
4. Check the fuel filter de-icing system operation by energizing the system and checking the generator loadmeter for an increased load reading.
5. Check instruments for proper operation. Electric gyro instruments will require approximately two minutes to warm up after battery is switched on.

WARNING

Make sure all instruments have warmed up sufficiently to insure normal operation. Check for sluggish instruments during taxiing.

Note

Because of low ambient temperatures, the thrust developed at all engine speeds is noticeably greater than normal.

WARNING

Use firmly anchored wheel chocks for all engine run-ups. The aircraft should be tied down securely before attempting a full power run-up.

TAXIING INSTRUCTIONS.

1. Avoid taxiing in deep snow as taxiing and steering are extremely difficult and frozen brakes may result.
2. Use only essential electrical equipment to preserve battery life when taxiing at low engine speeds.
3. Increase the taxi interval at sub-freezing temperatures to insure safe stopping distance and to prevent icing of airplane surfaces by melted snow and ice in the jet blast of a preceding airplane.
4. Minimize taxi time to conserve fuel and to reduce the amount of ice fog generated by jet engines.

BEFORE TAKE-OFF.

1. Energize the fuel filter de-icing system for 15 seconds to preclude the possibility of engine failure during take-off.
2. Check that canopy is locked.
3. Turn gun heat switch ON.
4. Turn pitot heat switch ON.
5. Make final instrument check during the first part of the take-off roll as the brakes will not hold the airplane on snow-covered or icy runways at full throttle.

CAUTION

In case of severe cockpit fog developing, turn temperature selector to HOT. Adjust selector as necessary after becoming airborne.

Throttle—FULL. Maximum engine speed of 100% rpm will not be available at low ambient temperatures because of increased air density. However, the governor control should not be reset to 100% rpm as the rated output and design strength of the engine may be exceeded. Although take-off thrust can be obtained at less than maximum engine speed (88% rpm at −65°F), do not take off unless at least 95% rpm is available at full throttle.

AFTER TAKE-OFF.

After take-off from a wet snow or slush-covered runway, operate the landing gear and flaps through several complete cycles to prevent their freezing.

CLIMB.

Climb performance will be improved during cold weather operation at lower altitudes. Follow recommended climb speeds as given in the Climb Chart, Appendix I.

ENGINE OPERATION IN FLIGHT.

Engine operation during flight in cold weather should be governed by normal procedures (with the exception of operation of the fuel filter de-icing system as directed in paragraph following).

OPERATION OF THE AIRCRAFT SYSTEMS DURING FLIGHT.

1. Several minutes prior to the anticipated descent, adjust the cabin heat to the HOT position, engage defroster control valve, and turn on auxiliary windshield defroster, if required. This will warm the canopy and windshield and prevent the formation of fog or frost on these surfaces during rapid descents from higher altitudes.
2. Check engine operating temperatures during descents and in the landing pattern as lower temperatures are common at low altitudes because of frequent temperature inversions.

APPROACH.

1. Operate fuel filter de-icing system for 15 seconds before entering pattern.
2. Turn off all non-essential electrical equipment at least one minute before final approach to reduce battery load when generator cuts out.

3. Make normal patterns and landings but allow for a flatter glide because of increased thrust.
4. Pump brakes to check operation.

LANDING.

Landing speeds and technique are normal with the usual care being exercised in the use of the brakes on snow-covered or slippery runways. Turn pitot heat switch OFF after touchdown.

STOPPING THE ENGINE.

The engine is stopped in the normal manner.

BEFORE LEAVING AIRPLANE.

1. Release brakes after wheels are chocked.
2. Leave canopy partly open to allow circulation within the cockpit to prevent canopy cracking from contraction and to reduce windshield and canopy frosting.
3. Inspect shock struts and actuating cylinders and wipe with a rag soaked in hydraulic fluid. It is advisable to keep shock struts exceptionally clean as any scarring of the seals will result in excessive leakage.
4. Whenever possible, leave the airplane parked with full fuel tanks. Every effort should be made, during servicing, to prevent moisture from entering the fuel system.
5. Install protective covers and dust plugs.
6. Remove batteries when the aircraft is to be parked at temperatures below −29°C (—20°F) for more than four hours.

HOT WEATHER OPERATION.

BEFORE ENTERING THE AIRPLANE.

1. Make normal exterior inspection.

Note

All metal surfaces exposed to the sun are burning hot to the touch. Gloves should be worn to prevent burns. (Tape, cord or cloth muffs around the control stick, etc. are advisable.)

CAUTION

Be careful when removing fuel caps. Thermally expanded fuel vapor may blow the cap in your face.

2. Inspect tires for evidence of blisters, other deterioration, and improper inflation.
3. Check particularly for hydraulic system leaks as heat and moisture may cause valves and packings to swell.
4. Note particularly electrical wiring and equipment for evidence of corrosion.

ON ENTERING THE AIRPLANE.

Care should be exercised in allowing foreign objects to come in contact with the canopy, since it is possible to damage the plexiglas in extremely hot weather.

STARTING THE ENGINE.

Normal starting procedures are used in hot weather. Temperatures will probably be on the high side of operating ranges.

WARM-UP AND GROUND TEST.

Ground testing should be complete but accomplished as rapidly as possible.

TAXIING INSTRUCTIONS.

1. Brakes should be used as little as possible to prevent their overheating.
2. The airplane may be taxied with the canopy partially open if necessary.

BEFORE TAKE-OFF.

Be sure that take-off distances have been checked in Appendix I.

TAKE-OFF.

During take-off the airplane will accelerate slowly and ground run will be longer because the air is less dense in hot weather. Ground speed will be increased for the same indicated airspeed.

CLIMB.

Rate of climb should be held as low as practicable because of the fact that the fuel in the tanks is warm and more susceptible to vaporization losses with rapid climbs to altitude.

ENGINE OPERATION IN FLIGHT.

Engine operation in flight should not be affected at normal altitudes. At low altitudes temperatures may be in the high ranges.

DESCENT.

Warm humid air is more likely to cause canopy frosting in hot weather descents.

LANDING.

1. Hot weather operation requires the pilot to be more cautious of gusts and windshifts near the ground.
2. Landing ground rolls are only slightly longer than those in normal temperature.

BEFORE LEAVING THE AIRPLANE.

1. The canopy may be left partially open if the location is not subject to blowing sand or dust.
2. In locations with high humidity and excessive temperature changes from day to night, it is probably preferable to leave the canopy slightly open and cockpit ventilation duct shut-off levers open.

DESERT OPERATION.

GENERAL. Most hot weather procedures are also applicable to desert operation. Blowing dust and sand is the main enemy of desert operation.

BEFORE ENTERING THE AIRPLANE.

1. Inspect intake ducts and plenum chamber for evidence of sand. If excessive sand is found, do not start the engine.

TAXIING INSTRUCTIONS.

1. Taxi carefully with minimum power to minimize the blowing of dust and sand onto other aircraft.
2. Keep adequate distance from any taxiing airplanes ahead of you.

TAKE-OFF.

Be prepared for sudden gusts of wind during take-off run.

BEFORE LEAVING THE AIRPLANE.

Cover all ducts and air intakes as soon as possible to prevent the entrance of blowing sand.

APPENDIX I OPERATING DATA

INTRODUCTION.

The charts contained in this Appendix present operating data in nautical units. Examples of how to use the charts are given below.

AIRSPEED CORRECTION CHARTS.

An airspeed Installation Correction Chart is shown in figure A-6 and an Airspeed Compressibility Chart in figure A-7. By use of these charts, airspeed instrument readings can be corrected to calibrated airspeed and equivalent airspeed values.

EXAMPLE OF USE OF AIRSPEED CORRECTION CHARTS.

Flight Altitude	30,000 ft
Airspeed indicator reading (IAS)	296 knots
Correction for installation error, figure A-6	−3 knots
Calibrated airspeed (CAS)	293 knots
Correction for compressibility, figure A-7	−15 knots
Equivalent airspeed (EAS)	278 knots

TAKE-OFF CHART.

The Take-off Chart lists take-off distances for various pressure altitudes and air temperatures. Engine thrust reduces as altitude or free air temperature increases. Consequently, greater take-off distances are required at higher altitudes and on warm days. Representative performance showing the effects of altitude and air temperature are shown in figure A-1. Note that both ground roll distance and air distance are increased at higher free air temperatures and altitudes.

To use the Take-off Chart, set airplane altimeter to 29.92 and read pressure altitude. With air temperature obtained from the field weather station and pressure altitude, enter chart and determine the take-off distance that will be required when the normal take-off technique outlined in Section II is followed.

CLIMB CHART.

Standard day performance is presented in the Climb Chart, for either military thrust or maximum continuous thrust. Rate of climb, distance, time and fuel used to climb to altitude are given, based upon use of optimum climbing speed schedules shown.

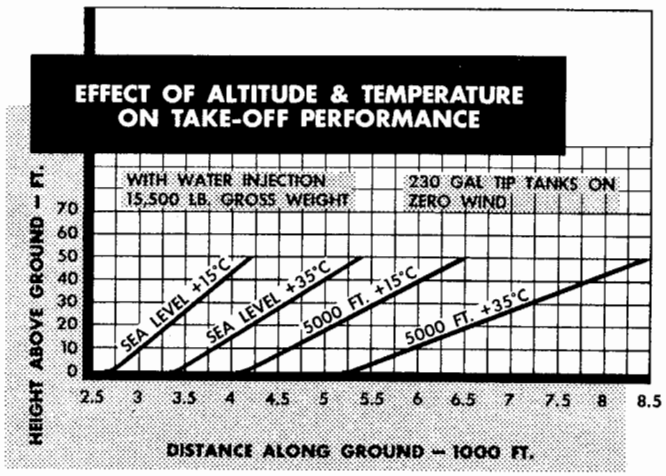


Figure A-1 — Effect of Altitude and Free Temperature on Take-off Performance

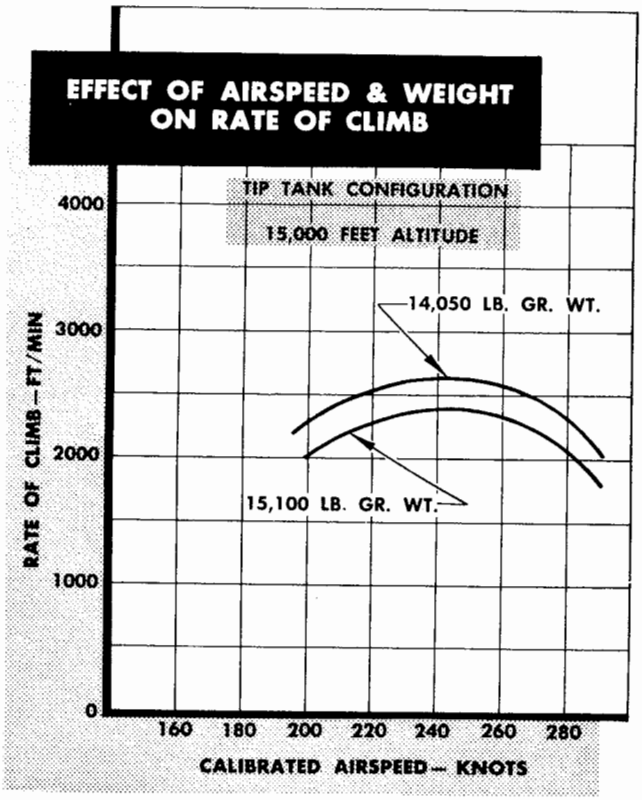


Figure A-2 — Effect of Airspeed and Weight on Rate of Climb

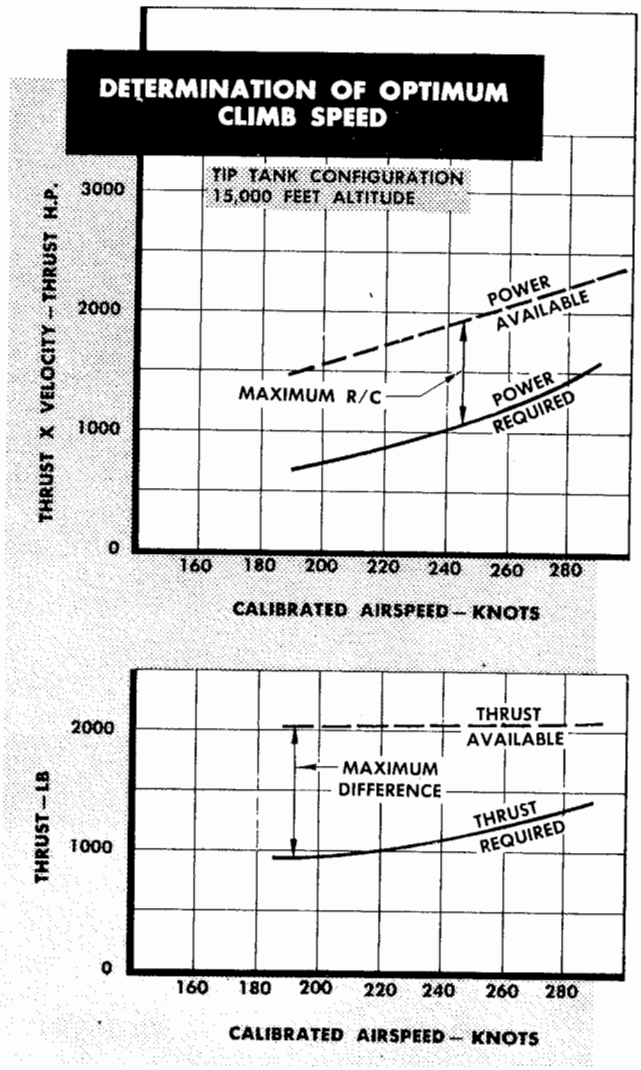


Figure A-3 — Determination of Optimum Climb Speed

Use of climb speed schedules other than shown on the Climb Chart will result in reduced rates of climb at all altitudes. Consequently, fuel used and time required to reach altitude will be greater than shown on the Climb Chart. The variation of rate of climb with airspeed and gross weight is shown in figure A-2. Rate of climb is proportional to excess thrust horsepower; therefore, the maximum rate of climb will be attained at the airspeed for which excess thrust horsepower is a maximum. Power required to maintain airspeed and power available from engine output are shown versus airspeed in the upper part of figure A-3. The difference between these two quantities is excess thrust horsepower. The speed at which the difference is a maximum is the speed for maximum rate of climb. The relationship of thrust required and thrust available is shown in the lower part of figure A-3 for comparison.

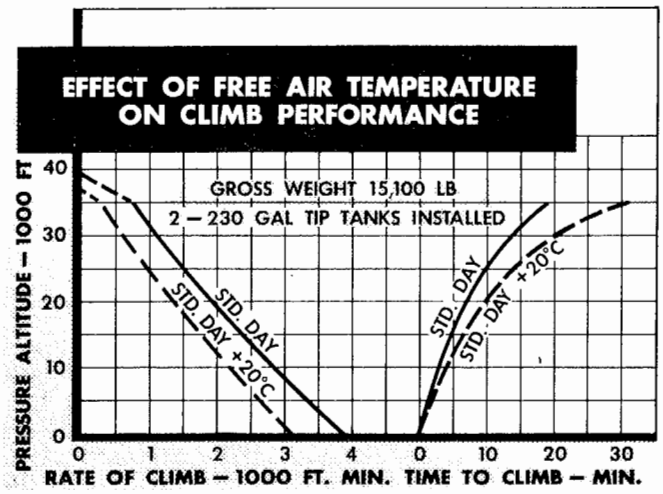


Figure A-4 — Effect of Free Air Temperature on Climb Performance

The rate of climb will be reduced on warm days due to lower engine thrust. This will result in increased time and distance required to reach altitude. These factors, in combination with the effect of temperature on fuel flow, will result in a somewhat greater quantity of fuel required to reach altitude. A typical variation of rate of climb and time to climb versus altitude is shown in figure A-4 for two days with differing free air temperatures.

DESCENT CHART.

Distance, time and fuel required to descend from altitude with idle rpm are given in the Descent Chart. These data are based upon maintaining constant 0.6 Mach number. Maximum range will be attained by following this schedule. Gear, landing flaps and dive flaps should be in the retracted position except that on some airplanes the idle rpm at altitudes above 35,000 feet may be sufficiently high that the rate of descent is quite low at 0.6 Mach number. When this occurs, the dive flaps should be used down to 35,000 feet altitude. Decreasing the airspeed below the schedule shown will decrease the rate of descent. Either change will decrease the total range of the airplane. In case of engine failure when it is necessary to extend the glide as far as possible, the airspeed shown in Section III should be used.

LANDING DISTANCE CHART.

The Landing Chart shows airplane requirements when using the normal landing technique recommended in Section II. The distances include no conservatism factor.

MAXIMUM ENDURANCE CHART.

Maximum endurance is obtained at a given altitude by flying at the condition which will give the lowest rate of fuel consumption at that altitude. This condition will be obtained by flying at the speeds shown in the Maximum Endurance Chart.

FLIGHT OPERATION INSTRUCTION CHARTS.

GENERAL. The Flight Operation Instruction Charts show the maximum range available with the fuel remaining in the airplane, and the procedure required to obtain this range. The effects of the main variables on range are shown in a manner to give the most usable and most accurate information consistent with simplicity.

The chart may be used at any point in flight or for pre-flight planning. The initial conditions are the airplane configuration and gross weight, the actual altitude of the airplane and the fuel remaining on board. In the Flight Operation Instruction Chart, the five main columns across the top are initial altitude conditions. On the line opposite fuel quantities, maximum ranges are shown for each initial altitude. In general, two range values are given for each altitude and fuel quantity, one for level flight at that altitude, and one for the maximum range obtainable by climbing to a higher altitude. Distances covered in let-down are included, and for range figures indicating a cruise at higher altitude, climb distance is included. Ranges quoted do not include any landing reserve.

In the lower half of the Flight Operation Instruction Chart the cruising instructions are given. Note that the values of rpm, fuel consumption, ground speed, range factor and let-down distance are listed as approximate. With the exception of ground speed, these items are to be varied as airplane weight reduces (within the weight limits of the particular chart) so that calibrated airspeed is maintained constant. Maximum range is attained by flying as close as possible to the recommended calibrated airspeed. Values of ground speed are based upon standard day conditions and will vary slightly when air temperature is not standard.

FUEL QUANTITIES. Fuel quantities tabulated on the chart represent fuel that is available for cruising. Allowances must be made for extra items such as combat, landing and endurance reserves. Additional allowances may have to be made for evaporation losses when using gasoline fuel under adverse conditions.

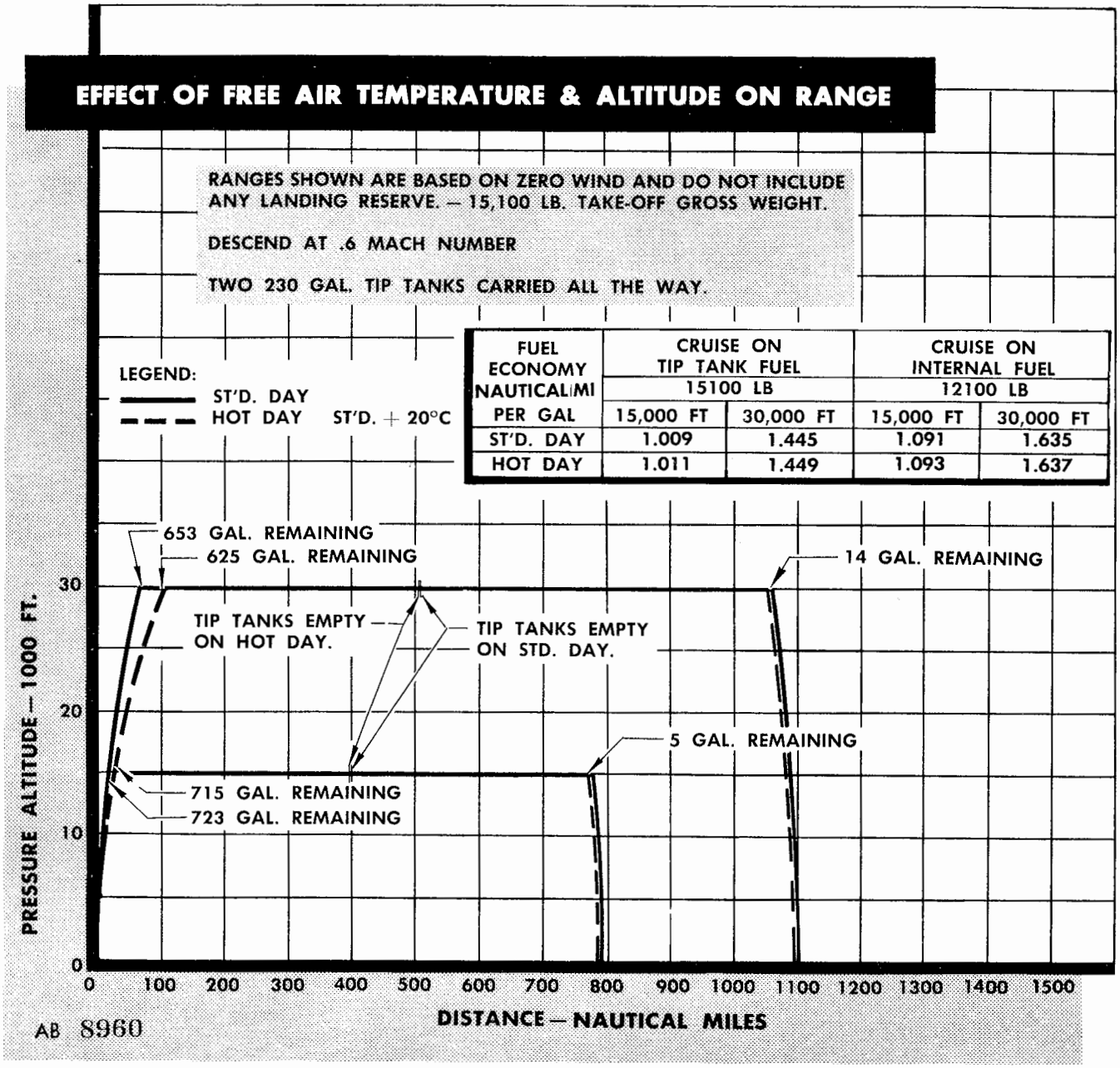


Figure A-5 — Effect of Free Air Temperature and Altitude on Range

WIND. Under different wind conditions, ranges are varied by the effect of wind on ground speed. Letdown distances are affected for the same reason. Recommended calibrated airspeed to obtain long range may also change with different headwinds in order to maintain the most favorable miles-per-gallon ratio. The lower half of the Flight Operation Instruction Chart contains operating instructions for different wind conditions. These cruising data are presented for the same altitudes that head the upper half of the chart. Since the wind may be from any direction with respect to the airplane course, some question may arise as to the method of handling winds other than direct headwinds or tailwinds. A wind at any angle to the airplane course affects the airplane's ground speed along the course. For purposes of cruise control, all winds may be expressed as effective winds. This reduces the wind to one which would have the same net effect on the airplane's ground speed as if it were a direct headwind or tailwind.

FREE AIR TEMPERATURE. All data in the Flight Operation Instruction Charts are for standard day conditions. On days when the free air temperature is other than standard, range performances will be slightly different from the values given. Climb performance is reduced but miles-per-gallon in level flight increases slightly on days hotter than standard. Typical flights on days with different free air temperatures are illustrated in figure A-5 showing the magnitude of the air temperature effects.

USE OF THE FLIGHT OPERATION INSTRUCTION CHARTS.

To use the charts in flight, refer to the upper half, and under the present altitude column read range opposite fuel quantity. For cruising at that altitude the operating instructions are listed directly below. Enter on the line according to effective wind and read the calibrated airspeed. Approximate values of cruising rpm, gallons per hour, range factor, let-down distance, and nautical ground miles per hour are given for reference. Multiplying still air range by the range factor for wind results in nautical ground miles that can be flown.

If it is desirable to increase range, enter the same altitude column as before. Under the second and third sub-headings are shown the optimum altitude to which a climb should be made to obtain best range, and the range at that optimum altitude. To obtain this range, climb immediately (according to the recommended climb procedure) to the altitude shown. For cruising instructions refer to the lower half of the chart in the column according to the new altitude. Calculation of range in a wind and cruising procedure are as described above for the level flight cruise.

Note

At any time during the flight the pilot may refer to the chart with actual conditions of altitude and fuel to obtain range remaining in the same manner as previously discussed.

EXAMPLE OF USE OF CHARTS IN PREFLIGHT PLANNING.

MAXIMUM RANGE ON INTERNAL FUEL (353 gallons). The airplane is to cruise at 35,000 feet altitude against an 80 knot headwind. The take-off weight is 11,750 pounds: (Water tanks empty).

a. From the climb chart, figure A-9, it is seen that the take-off and climb to altitude at 100% rpm will use 130 gallons of fuel. The still air range covered in climb will be about 69 nautical miles. The fuel remaining at 35,000 feet will be 223 gallons (353 — 130). By referring to the 35,000-foot section of the Flight Operation Instruction Chart, figure A-20 sheet 2, between 200 and 250 gallons, it can be seen that 460 additional still air nautical miles can be flown using straight line interpolation, including allowance for let-down. The total still air range is then 69 plus 460 or 529 nautical miles.

b. In the lower half of the chart it is seen that the range factor for an 80 knot headwind is .8. Multiplying the still air range by this factor gives about 423 nautical miles actual range.

c. Cruising at 35,000 feet with a headwind of 80 knots, according to the lower half of the Flight Operating Instruction Chart, is at a calibrated airspeed of 235 knots at approximately 92% rpm and the let-down is begun 51 nautical miles from the destination.

MAXIMUM FERRY RANGE. (230 gallon tip tanks). Take-off with tip tanks = 813 gallons. Tip tanks to be carried all the way.

Reference to figure A-16 shows that the optimum altitude is 35,000 feet.

a. The climb chart, figure A-9, shows that 189 gallons will be consumed and 103 nautical miles will be covered in taxi, take-off and climb to 35,000 feet at 100% rpm.

b. After 35,000 feet is reached, 813 — 189 = 624 gallons will be available for cruise and let-down.

c. Figure A-16 shows that the maximum range for 624 gallons at 35,000 feet is 1099 nautical miles. The operating data while cruising on the tip tank fuel are obtained from the same figure. The operating conditions are 227 knots calibrated airspeed at 35,000 feet at about 96% rpm. Figure A-16 is to be used for operating data only while cruising on tip tank fuel. When the tip tanks are empty, the operating data must be obtained from figure A-17, sheet 2. Figure A-17, sheet 2, shows that the operating conditions are 209 knots calibrated airspeed at about 91% rpm and begin letdown 54 miles from destination.

d. With the 103 nautical miles covered in climb, a total flight of 103 + 1099 = 1202 nautical miles can be made.

A small increase in range may be obtained if the tip tanks are dropped when empty. Figure A-17, sheet 2, shows that 670 nautical miles are obtained with full internal fuel (353 gallons) with tip tanks installed, whereas figure A-20 sheet 2 shows that 720 nautical miles will be traversed with full internal fuel (353 gallons) without tip tanks. Thus 50 additional miles (720 — 670) will be obtained if the tip tanks are dropped when empty. Addition of this 50 miles to the 1202 miles

range from paragraph preceding gives a maximum range of 1252 nautical miles.

Operating data to be used after the tip tanks are dropped are given in figure A-20, sheet 2. This figure shows that the maximum range calculated in paragraph preceding will be obtained by maintaining a calibrated airspeed of 228 knots as soon as the tip tanks are empty and dropped. The required rpm will be approximately 91%, which is the same as was approximately required to maintain 209 knots before the tip tanks were dropped. Let-down should be commenced 57 miles from destination.

EXAMPLE OF THE USE OF CHARTS WHILE IN FLIGHT. The airplane is at 5,000 feet altitude with 250 gallons of fuel (no tip tanks) and distance to destination is 348 nautical miles.

a. Reference to the 5,000-foot column of the Flight Operation Instruction Chart (figure A-20) opposite 250 gallons shows that by cruising at 5,000 feet the range will be only 205 nautical miles. By climbing to 35,000 feet, a flight of 400 nautical miles can be made. In order to fly 348 nautical miles it is evident that it is necessary to climb and cruise at an altitude higher than 5,000 feet, but not necessarily as high as 35,000 feet. A linear interpolation (which in all cases will be close to the actual values between the difference in range (400 — 205 = 195) and altitude (35,000 — 5,000 = 30,000) provides a quick guess that for the 143 additional nautical miles of range needed (348 — 205) = 143) an increase of at least 25,000 feet of altitude will be necessary (or a minimum cruising altitude of 30,000 feet). The 348 nautical miles are available by climbing and cruising at 30,000 feet.

b. For purposes of checking the estimate, detailed calculations are shown. A distance of 45 nautical miles will be covered with an expenditure of 77 gallons of fuel in climbing from 5,000 feet to 30,000 feet. This means that there are only 348 — 45 or 303 nautical miles to go from that point and 173 gallons are available. With these as the initial conditions, enter the Flight Operation Instruction Chart in the 30-000-foot column. The distance which can be flown at 30,000 feet with 173 gallons is 309 nautical miles. This shows that a climb to 30,000 feet will provide sufficient range to reach destination. (Cruising speed at 30,000 feet is 245 knots calibrated airspeed at approximately 90% rpm.)

AIRSPEED INSTALLATION CORRECTION TABLE

ADD CORRECTION TO CORRECTED INSTRUMENT READING (IAS)
TO OBTAIN CALIBRATED AIRSPEED

MODEL: T-33A — GEAR AND FLAPS UP

I A S — KNOTS	CORRECTION — KNOTS
150	0
200	— 1
250	— 2
300	— 3
350	— 5
400	— 6
450	— 7
500	— 7

DATA AS OF: 7-1-51
DATA BASIS: FLIGHT TEST

Figure A-6 — Airspeed Installation Correction Table

COMPRESSIBILITY CORRECTION TABLE

ADD CORRECTION TO CALIBRATED AIRSPEED TO OBTAIN
EQUIVALENT AIRSPEED

Pressure Altitude	CAS — KNOTS							
	150	200	250	300	350	400	450	500
5,000	0	0	—1	—2	—2	—3	—4	—6
10,000	0	—1	—2	—3	—5	—7	—10	
15,000	—1	—2	—3	—6	—8	—12	—16	
20,000	—1	—3	—5	—8	—12	—17		
25,000	—2	—4	—7	—11	—17			
30,000	—2	—5	—9	—15	—23			
35,000	—3	—7	—12	—20				
40,000	—4	—9	—16					

CAS — CALIBRATED AIRSPEED

Figure A-7 — Compressibility Correction Table

TAKE-OFF DISTANCES—FEET

70% (31.5°) FLAPS, HARD SURFACE RUNWAY

MODEL(S): T-33A **ENGINE(S): J33-A-23 or -35**

CONFIGURATION AND GROSS WEIGHT	PRESSURE ALTITUDE	−5 DEG. CENT.				+15 DEG. CENT.				+35 DEG. CENT.				+55 DEG. CENT.			
		ZERO WIND		30 KNOT WIND		ZERO WIND		30 KNOT WIND		ZERO WIND		30 KNOT WIND		ZERO WIND		30 KNOT WIND	
		GROUND ROLL	CLEAR 50′	GROUND ROLL	CLEAR 50′	GROUND ROLL	CLEAR 50′	GROUND ROLL	CLEAR 50′	GROUND ROLL	CLEAR 50′	GROUND ROLL	CLEAR 50′	GROUND ROLL	CLEAR 50′	GROUND ROLL	CLEAR 50′
(CLEAN) 12,100 LB. WITHOUT WATER INJECTION	5,000	2400	3500	1350	2170	3100	4525	1825	2925	4025	5900	2425	3900	5125	7550	3175	5075
	4,000	2200	3200	1250	2000	2850	4150	1650	2675	3675	5400	2200	3550	4675	6875	2850	4600
	3,000	2025	2950	1150	1825	2600	3825	1475	2425	3350	4900	1975	3200	4250	6225	2575	4150
	2,000	1875	2700	1050	1675	2400	3500	1350	2200	3050	4500	1775	2900	3875	5675	2325	3750
	1,000	1700	2500	950	1525	2175	3200	1225	1975	2800	4100	1625	2600	3525	5175	2100	3400
	S.L.	1575	2325	875	1425	2000	2950	1100	1800	2575	3750	1475	2375	3200	4725	1875	3025
(CLEAN) 12,100 LB. WITH WATER INJECTION	5,000	2025	3025	1150	1925	2625	3925	1550	2550	3375	5100	2075	3425	4300	6450	2725	4400
	4,000	1875	2800	1025	1775	2400	3600	1400	2325	3100	4650	1900	3100	3925	5875	2425	3975
	3,000	1725	2575	925	1650	2200	3325	1275	2100	2825	4250	1700	2775	3575	5375	2150	3575
	2,000	1600	2375	850	1500	2025	3050	1175	1925	2575	3900	1500	2500	3250	4900	1925	3200
	1,000	1475	2200	775	1350	1850	2800	1025	1725	2350	3550	1325	2250	2950	4475	1700	2875
	S.L.	1350	2025	700	1225	1700	2575	900	1550	2175	3275	1175	2025	2725	4100	1525	2600
(TWO 165 GAL. TIP TANKS) 14,450 LB. WITHOUT WATER INJECTION	5,000	3300	5000	1950	3250	4225	6450	2550	4275	5475	8400	3375	5650	7075	10750	4400	7350
	4,000	3050	4600	1800	2975	3875	5925	2350	3900	5000	7675	3100	5200	6450	9775	4000	6750
	3,000	2800	4250	1650	2700	3550	5450	2100	3552	4600	7050	2800	4775	5925	9000	3650	6100
	2,000	2575	3875	1500	2450	3275	5000	1900	3225	4200	6450	2550	4300	5375	8125	3275	5450
	1,000	2350	3575	1350	2225	3000	4600	1725	2925	3850	5900	2275	3850	4900	7450	2925	4900
	S.L.	2150	3300	1200	2025	2750	4250	1550	2650	3525	5400	2025	3450	4450	6800	2575	4375
(TWO 165 GAL. TIP TANKS) 14,450 LB. WITH WATER INJECTION	5,000	2725	4275	1575	2775	3450	5575	2075	3675	4450	7225	2700	4875	5675	9250	3475	6325
	4,000	2500	3925	1450	2525	3200	5125	1925	3375	4100	6600	2500	4475	5175	8425	3200	5775
	3,000	2300	3625	1325	2325	2950	4675	1750	3100	3750	6025	2300	4075	4725	7675	2900	5250
	2,000	2125	3325	1225	2125	2700	4300	1600	2850	3450	5525	2075	3700	4300	7000	2625	4725
	1,000	1950	3050	1100	1950	2475	3925	1450	2575	3150	5050	1875	3325	3925	6375	2375	4250
	S.L.	1800	2800	1000	1750	2250	3600	1300	2300	2875	4600	1675	3000	3600	5825	2100	3800

REMARKS: 1. Data were obtained with J33-A-23 engines, and are conservative for airplanes with J33-A-35 engines.
2. Take-off distances are airplane requirements when normal technique outlined in Section II is followed.

DATA AS OF: 7-1-51
DATA BASIS: FLIGHT TEST (SEE NOTE 1)

FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/GAL

Figure A-8 (Sheet 1 of 2) — Take-off Distances

TAKE-OFF DISTANCES—FEET

70% (31.5°) FLAPS, HARD SURFACE RUNWAY

MODEL(S): T-33A **ENGINE(S): J33-A-23 or -35**

CONFIGURATION AND GROSS WEIGHT	PRESSURE ALTITUDE	− 5 DEG. CENT.				+ 15 DEG. CENT.				+ 35 DEG. CENT.				+ 55 DEG. CENT.			
		ZERO WIND		30 KNOT WIND		ZERO WIND		30 KNOT WIND		ZERO WIND		30 KNOT WIND		ZERO WIND		30 KNOT WIND	
		GROUND ROLL	CLEAR 50′	GROUND ROLL	CLEAR 50′	GROUND ROLL	CLEAR 50′	GROUND ROLL	CLEAR 50′	GROUND ROLL	CLEAR 50′	GROUND ROLL	CLEAR 50′	GROUND ROLL	CLEAR 50′	GROUND ROLL	CLEAR 50′
(TWO 230 GAL. TIP TANKS) 15,500 LB. WITHOUT WATER INJECTION	5,000	3825	5825	2275	3800	4925	7500	2975	5000	6350	9750	3950	6500	8225	12500	5150	8575
	4,000	3550	5350	2100	3475	4525	6900	2725	4550	5850	8925	3600	6075	7525	11450	4650	7875
	3,000	3250	4925	1925	3150	4150	6350	2475	4150	5350	8175	3275	5575	6850	10450	4250	7125
	2,000	2975	4525	1750	2850	3810	5825	2225	3750	4900	7475	2975	5025	6250	9525	3825	6375
	1,000	2750	4150	1575	2600	3500	5350	2025	3400	4475	6850	2650	4500	5675	8675	3425	5700
	S.L.	2575	3825	1400	2375	3200	4925	1825	3100	4100	6275	2375	4025	5150	7900	3025	5125
(TWO 230 GAL. TIP TANKS) 15,500 LB. WITH WATER INJECTION	5,000	3175	4975	1850	3250	4050	6500	2425	4300	5200	8425	3175	5700	6625	10775	4075	7400
	4,000	2925	4600	1675	2950	3750	5975	2250	3950	4775	7700	2925	5225	6050	9825	3725	6750
	3,000	2700	4225	1550	2700	3425	5475	2050	3625	4400	7050	2675	4750	5500	8950	3400	6150
	2,000	2475	3875	1425	2475	3150	5000	1875	3325	4025	6425	2425	4325	5025	8150	3075	5525
	1,000	2275	3550	1300	2275	2900	4575	1675	3025	3675	5875	2200	3900	4600	7450	2775	5125
	S.L.	2100	3250	1175	2050	2650	4200	1500	2675	3350	5375	1950	3500	4200	6800	2475	4450
	5,000																
	4,000																
	3,000																
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	2,000																
	1,000																
	S.L.																

REMARKS: 1. Data were obtained with J33-A-23 engines, and are conservative for airplanes with J33-A-35 engines.
2. Take-off distances are airplane requirements when normal technique outlined in Section II is followed.

DATA AS OF: 7-1-51
DATA BASIS: FLIGHT TEST (See Note 1)

FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/GAL

Figure A-8 (Sheet 2 of 2) — Take-off Distances

CLIMB CHART FOR MAXIMUM POWER

NACA STANDARD DAY

MODEL(S): T-33A **ENGINE(S): J33-A-23 or -35**

CONFIGURATION: TWO 230 GAL. TIP TANKS
WEIGHT: 15,100 LB.

APPROXIMATE FROM SEA LEVEL			AIRSPEED KNOTS		PRESSURE ALTITUDE FEET	AIRSPEED KNOTS		APPROXIMATE FROM SEA LEVEL			RATE OF CLIMB
RATE OF CLIMB	DIST.	TIME	FUEL	IAS	CAS		IAS	CAS	FUEL	TIME	DIST.	
3850	0	0	30(1)	275	275	Sea Level	275	275	30(1)	0	0	5000
3350	6	1.4	50	265	265	5,000	265	265	45	1.1	5	4400
2850	14	3.0	70	255	255	10,000	255	255	60	2.3	11	3800
2400	23	4.8	90	245	245	15,000	245	245	75	3.7	18	3250
1950	35	7.2	111	235	235	20,000	235	235	91	5.4	27	2700
1500	50	10.0	134	225	225	25,000	225	225	107	7.4	37	2200
1100	71	13.8	160	215	215	30,000	215	215	124	9.9	51	1750
750	103	19.1	189	205	205	35,000	205	205	143	13.2	71	1350
—	—	—	—	—	—	40,000	195	195	168	18.9	106	450

CONFIGURATION: TWO 165 GAL. TIP TANKS
WEIGHT: 14,050 LB.

APPROXIMATE FROM SEA LEVEL			AIRSPEED KNOTS		PRESSURE ALTITUDE FEET	AIRSPEED KNOTS		APPROXIMATE FROM SEA LEVEL			RATE OF CLIMB
RATE OF CLIMB	DIST.	TIME	FUEL	IAS	CAS		IAS	CAS	FUEL	TIME	DIST.	
4250	0	0	30(1)	275	275	Sea Level	275	275	30(1)	0	0	5100
3700	5	1.1	48	265	265	5,000	265	265	45	1.1	5	4500
3200	12	2.5	67	255	255	10,000	255	255	59	2.2	10	3900
2700	21	4.3	85	245	245	15,000	245	245	74	3.7	17	3300
2200	32	6.5	104	235	235	20,000	235	235	89	5.3	26	2750
1750	45	9.1	124	225	225	25,000	225	225	106	7.3	37	2250
1350	63	12.3	146	215	215	30,000	215	215	122	9.8	50	1800
950	89	16.4	171	205	205	35,000	205	205	140	12.9	69	1400
150	141	25.7	212	195	195	40,000	195	195	166	18.5	103	450

CONFIGURATION: TWO 230 GAL. TIP TANKS
WEIGHT: 12,100 LB.

CONFIGURATION: TWO 165 GAL. TIP TANKS
WEIGHT: 11,900 LB.

REMARKS: (1) FUEL ALLOWANCE FOR TAXI AND TAKE-OFF
(2) CLIMB AT RECOMMENDED CAS
(3) DATA WERE OBTAINED FROM J33-A-23 ENGINES AND ARE CONSERVATIVE FOR J33-A-35 ENGINES

DATA AS OF: 7-1-51
DATA BASIS: FLIGHT TEST (See Note 3)

RATE OF CLIMB: FEET PER MINUTE
DISTANCE: NAUTICAL MILES
TIME: MINUTES
FUEL: U. S. GALLONS
CAS: CALIBRATED AIRSPEED
IAS: INDICATED AIRSPEED
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/GAL

Figure A-9 (Sheet 1 of 4) — Climb Chart

CLIMB CHART FOR MAXIMUM POWER

NACA STANDARD DAY

MODEL(S): T-33A **ENGINE(S): J33-A-23 or -35**

CONFIGURATION: CLEAN WEIGHT: 11,750 LB.	CONFIGURATION: CLEAN WEIGHT: 10,300 LB.

APPROXIMATE				AIRSPEED KNOTS		PRESSURE ALTITUDE FEET	AIRSPEED KNOTS		APPROXIMATE			
RATE OF CLIMB	FROM SEA LEVEL								FROM SEA LEVEL			RATE OF CLIMB
	DIST.	TIME	FUEL	IAS	CAS		IAS	CAS	FUEL	TIME	DIST.	
5350	0	0	20(1)	275	275	**Sea Level**	275	275	20(1)	0	0	6150
4550	5	1	35	265	265	**5,000**	265	265	32	1	4	5250
3900	10	2.2	49	255	255	**10,000**	255	255	45	2	9	4500
3300	17	3.6	64	245	245	**15,000**	245	245	58	3.1	15	3850
2750	25	5.2	79	235	235	**20,000**	235	235	71	4.5	22	3250
2250	36	7.2	95	225	225	**25,000**	225	225	84	6.2	31	2700
1750	50	9.7	112	215	215	**30,000**	215	215	98	8.2	43	2150
1350	69	12.9	130	205	205	**35,000**	205	205	113	10.8	58	1650
450	102	18.1	153	195	195	**40,000**	195	195	132	15	84	750

REMARKS: (1) FUEL ALLOWANCE FOR TAXI AND TAKE-OFF
(2) CLIMB AT RECOMMENDED CAS
(3) DATA WERE OBTAINED FROM J33-A-23 ENGINES AND ARE CONSERVATIVE FOR J33-A-35 ENGINES

DATA AS OF: 7-1-51
DATA BASIS: FLIGHT TEST (See Note 3)

RATE OF CLIMB: FEET PER MINUTE
DISTANCE: NAUTICAL MILES
TIME: MINUTES
FUEL: U. S. GALLONS
CAS: CALIBRATED AIRSPEED
IAS: INDICATED AIRSPEED
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/GAL

Figure A-9 (Sheet 2 of 4) — Climb Chart

CLIMB CHART FOR NORMAL POWER

NACA STANDARD DAY

MODEL(S): T-33A **ENGINE(S): J33-A-23 or -35**

CONFIGURATION: TWO 230 GAL. TIP TANKS
WEIGHT: 15,100 LB.

APPROXIMATE FROM SEA LEVEL			AIRSPEED KNOTS		PRESSURE ALTITUDE FEET	AIRSPEED KNOTS		APPROXIMATE FROM SEA LEVEL			RATE OF CLIMB
RATE OF CLIMB	DIST.	TIME	FUEL	IAS	CAS		IAS	CAS	FUEL	TIME	DIST.	
2950	0	0	30(1)	275	275	Sea Level	275	275	30(1)	0	0	3850
2500	8	1.8	52	265	265	5,000	265	265	46	1.4	6	3350
2150	18	4.0	73	255	255	10,000	255	255	63	3.0	14	2850
1750	31	6.5	96	245	245	15,000	245	245	80	4.9	23	2400
1350	48	9.8	120	235	235	20,000	235	235	97	7.2	36	1950
950	71	14.1	147	225	225	25,000	225	225	115	10.1	51	1500
650	105	20.2	179	215	215	30,000	215	215	136	13.9	72	1100
350	165	30.4	227	205	205	35,000	205	205	159	19.2	103	800
—	—	—	—	—	—	40,000	—	—	—	—	—	—

CONFIGURATION: TWO 165 GAL. TIP TANKS
WEIGHT: 14,050 LB.

APPROXIMATE FROM SEA LEVEL			AIRSPEED KNOTS		PRESSURE ALTITUDE FEET	AIRSPEED KNOTS		APPROXIMATE FROM SEA LEVEL			RATE OF CLIMB
RATE OF CLIMB	DIST.	TIME	FUEL	IAS	CAS		IAS	CAS	FUEL	TIME	DIST.	
3200	0	0	30(1)	275	275	Sea Level	275	275	30(1)	0	0	3900
2800	8	1.6	49	265	265	5,000	265	265	46	1.3	6	3400
2350	17	3.6	69	255	255	10,000	255	255	62	2.9	14	2950
1950	29	5.8	89	245	245	15,000	245	245	78	4.8	23	2450
1550	43	8.7	111	235	235	20,000	235	235	94	7.0	35	1950
1150	63	12.5	134	225	225	25,000	225	225	113	10.0	50	1550
800	91	17.5	162	215	215	30,000	215	215	133	13.6	71	1150
500	138	25.5	198	205	205	35,000	205	205	155	18.6	100	850
—	—	—	—	—	—	40,000	—	—	—	—	—	—

CONFIGURATION: TWO 230 GAL. TIP TANKS
WEIGHT: 12,100 LB.

CONFIGURATION: TWO 165 GAL. TIP TANKS
WEIGHT: 11,900 LB.

REMARKS: (1) FUEL ALLOWANCE FOR TAXI AND TAKE-OFF
(2) CLIMB AT RECOMMENDED CAS
(3) DATA WERE OBTAINED FROM J33-A-23 ENGINES AND ARE CONSERVATIVE FOR J33-A-35 ENGINES
(4) "NORMAL POWER" IS OBTAINED AT 96% RPM

DATA AS OF: 7-1-51
DATA BASIS: FLIGHT TEST (See Note 3)

RATE OF CLIMB: FEET PER MINUTE
DISTANCE: NAUTICAL MILES
TIME: MINUTES
FUEL: U. S. GALLONS
CAS: CALIBRATED AIRSPEED
IAS: INDICATED AIRSPEED
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/GAL

Figure A-9 (Sheet 3 of 4) — Climb Chart

CLIMB CHART FOR NORMAL POWER

NACA STANDARD DAY

MODEL(S): T-33A **ENGINE(S): J33-A-23 or -35**

CONFIGURATION: CLEAN WEIGHT: 11,750 LB.	CONFIGURATION: CLEAN WEIGHT: 10,300 LB.

APPROXIMATE				AIRSPEED KNOTS		PRESSURE ALTITUDE FEET	AIRSPEED KNOTS		APPROXIMATE			
RATE OF CLIMB	FROM SEA LEVEL			IAS	CAS		IAS	CAS	FROM SEA LEVEL			RATE OF CLIMB
	DIST.	TIME	FUEL						FUEL	TIME	DIST.	
4000	0	0	20(1)	275	275	Sea Level	275	275	20(1)	0	0	4600
3450	6	1.3	36	265	265	5,000	265	265	34	1.3	5	4000
2900	14	2.9	52	255	255	10,000	255	255	47	2.6	12	3400
2450	23	4.8	68	245	245	15,000	245	245	61	4.1	20	2850
1950	34	7.0	85	235	235	20,000	235	235	75	6.0	30	2350
1550	49	9.8	103	225	225	25,000	225	225	90	8.3	42	1900
1150	70	13.5	123	215	215	30,000	215	215	107	11.3	59	1450
750	101	18.7	146	205	205	35,000	205	205	125	15.3	82	1050
—	—	—	—	—	—	40,000	195	195	154	23.3	132	200

REMARKS: (1) FUEL ALLOWANCE FOR TAXI AND TAKE-OFF

(2) CLIMB AT RECOMMENDED CAS

(3) DATA WERE OBTAINED FROM J33-A-23 ENGINES AND ARE CONSERVATIVE FOR J33-A-35 ENGINES

(4) "NORMAL POWER" IS OBTAINED AT 96% RPM

DATA AS OF: 7-1-51

DATA BASIS: FLIGHT TEST (See Note 3)

RATE OF CLIMB: FEET PER MINUTE
DISTANCE: NAUTICAL MILES
TIME: MINUTES
FUEL: U. S. GALLONS
CAS: CALIBRATED AIRSPEED
IAS: INDICATED AIRSPEED
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/GAL

Figure A-9 (Sheet 4 of 4) — Climb Chart

DESCENT CHART

NACA STANDARD DAY

MODEL(S): T-33A **ENGINE(S): J33-A-23 or -35**

CONFIGURATION: TWO 230 GAL. TIP TANKS
WEIGHT: 10,600 LB.

APPROXIMATE				AIRSPEED KNOTS		PRESSURE ALTITUDE FEET	AIRSPEED KNOTS		APPROXIMATE			
RATE OF DESCENT	TO SEA LEVEL			IAS	CAS		IAS	CAS	TO SEA LEVEL			RATE OF DESCENT
	DIST.	TIME	FUEL						FUEL	TIME	DIST.	
1150	75	12.4	23	175	175	**40,000**	175	175	23	12.2	73	1150
1750	55	8.9.	18	200	200	**35,000**	200	200	17	8.7	53	1750
2400	40	6.4	14	225	225	**30,000**	225	225	13	6.3	38	2450
3200	30	4.7	10	250	250	**25,000**	250	250	10	4.5	28	3300
4100	21	3.4	8	275	275	**20,000**	275	275	8	3.2	20	4250
5150	14	2.2	5	305	300	**15,000**	305	300	5	2.1	14	5350
6300	9	1.4	3	340	335	**10,000**	340	335	3	1.3	8	6550
7600	4	0.6	1	370	365	**5,000**	370	365	2	0.6	4	7850
9000	0	0	0	400	395	**Sea Level**	400	395	0	0	0	9300

CONFIGURATION: TWO 165 GAL. TIP TANKS
WEIGHT: 10,200 LB.

CONFIGURATION: CLEAN
WEIGHT: 9,700 LB.

APPROXIMATE				AIRSPEED KNOTS		PRESSURE ALTITUDE FEET	AIRSPEED KNOTS		APPROXIMATE			
RATE OF DESCENT	TO SEA LEVEL			IAS	CAS		IAS	CAS	TO SEA LEVEL			RATE OF DESCENT
	DIST.	TIME	FUEL						FUEL	TIME	DIST.	
950	80	13.4	25	175	175	**40,000**						
1550	57	9.3	19	200	200	**35,000**						
2250	41	6.7	14	225	225	**30,000**						
3050	30	4.8	11	250	250	**25,000**						
3950	21	3.4	8	275	275	**20,000**						
5000	15	2.3	6	305	300	**15,000**						
6150	9	1.4	4	340	335	**10,000**						
7350	4	0.6	2	370	365	**5,000**						
8700	0	0	0	400	395	**Sea Level**						

CONFIGURATION:
WEIGHT:

REMARKS: 1. DESCEND AT 0.6 MACH NUMBER
2. USE DIVE FLAPS DOWN TO 35,000 FT. IF IDLE RPM IS TOO GREAT TO ALLOW DESCENT AT 0.6 MACH NUMBER

RATE OF CLIMB: FEET PER MINUTE
DISTANCE: NAUTICAL MILES
TIME: MINUTES
FUEL: U. S. GALLONS
CAS: CALIBRATED AIRSPEED
IAS: INDICATED AIRSPEED

DATA AS OF: 7-1-51
DATA BASIS: FLIGHT TEST (WITH J33-A-23 ENGINE)

FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/GAL

Figure A-10 — Descent Chart

AIRPLANE MODEL
T-33A

LANDING DISTANCE

FEET

ENGINE MODEL
J33-A-23
J33-A-35

NACA STANDARD DAY

GROSS WEIGHT LB.	BEST IAS FOR APPROACH		100% (45°) FLAPS — HARD SURFACE — NO WIND							
	POWER OFF	POWER ON	AT SEA LEVEL		AT 2000′		AT 4000′		AT 6000′	
	KNOTS	KNOTS	GROUND ROLL	CLEAR 50′	GROUND ROLL	CLEAR 50′	GROUND ROLL	CLEAR 50′	GROUND ROLL	CLEAR 50′
10,000	110	110	2350	3275	2500	3450	2650	3625	2800	3800
12,500	120	120	2950	3975	3125	4175	3300	4400	3500	4650
15,000	135	135	3525	4650	3725	4925	3950	5200	4200	5475

REMARKS: (1) LANDING DISTANCES ARE AIRPLANE REQUIREMENTS WHEN NORMAL LANDING TECHNIQUE OUTLINED IN SECTION II IS FOLLOWED.

LEGEND

IAS — INDICATED AIRSPEED

DATA AS OF: 7-1-51

BASED ON: FLIGHT TEST

Figure A-11 — Landing Distances

MAXIMUM ENDURANCE

NACA STANDARD DAY

MODEL(S): T-33A **ENGINE(S): J33-A-23 or -35**

CONFIGURATION: TWO 230 GAL. TIP TANKS
WEIGHT: 15,100 LB.

APPROXIMATE		AIRSPEED — KNOTS		PRESSURE ALTITUDE FEET
GAL/HR	% RPM	IAS	CAS	
346	69	160	160	**Sea Level**
301	72	160	160	**5,000**
268	76	160	160	**10,000**
238	79	160	160	**15,000**
229	83	160	160	**20,000**
222	86	160	160	**25,000**
216	89	160	160	**30,000**
218	93	160	160	**35,000**
—	—	—	—	**40,000**

CONFIGURATION: TWO 230 GAL. TIP TANKS
WEIGHT: 12,100 LB.

AIRSPEED — KNOTS		APPROXIMATE	
IAS	CAS	% RPM	GAL/HR
160	160	67	335
160	160	70	289
160	160	72	239
160	160	74	200
160	160	77	181
160	160	81	179
160	160	85	179
160	160	87	162
160	160	91	163

CONFIGURATION: TWO 165 GAL. TIP TANKS
WEIGHT: 14,050 LB.

APPROXIMATE		AIRSPEED — KNOTS		PRESSURE ALTITUDE FEET
GAL/HR	% RPM	IAS	CAS	
341	68	160	160	**Sea Level**
294	71	160	160	**5,000**
253	74	160	160	**10,000**
222	77	160	160	**15,000**
211	81	160	160	**20,000**
211	85	160	160	**25,000**
206	88	160	160	**30,000**
200	91	160	160	**35,000**
191	95	160	160	**40,000**

CONFIGURATION: TWO 165 GAL. TIP TANKS
WEIGHT: 11,900 LB.

AIRSPEED — KNOTS		APPROXIMATE	
IAS	CAS	% RPM	GAL/HR
160	160	67	335
160	160	70	289
160	160	72	239
160	160	74	200
160	160	77	181
160	160	81	179
160	160	85	179
160	160	87	162
160	160	91	163

REMARKS:

IAS — INDICATED AIRSPEED
CAS — CALIBRATED AIRSPEED
GAL/HR — FUEL CONSUMPTION

DATA AS OF: 7-1-51
DATA BASIS: FLIGHT TEST (WITH J33-A-23 ENGINE)

FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/GAL

Figure A-12 (Sheet 1 of 2) — Maximum Endurance Chart

MAXIMUM ENDURANCE

NACA STANDARD DAY

MODEL(S): T-33A **ENGINE(S): J33-A-23 or -35**

CONFIGURATION: CLEAN
WEIGHT: 11,750 LB.

CONFIGURATION:
WEIGHT:

APPROXIMATE		AIRSPEED — KNOTS		PRESSURE ALTITUDE FEET	AIRSPEED — KNOTS		APPROXIMATE	
GAL/HR	% RPM	IAS	CAS		IAS	CAS	% RPM	GAL/HR
319	64	160	160	**Seal Level**				
276	68	160	160	**5,000**				
239	72	160	160	**10,000**				
206	75	160	160	**15,000**				
187	78	160	160	**20,000**				
179	81	160	160	**25,000**				
179	85	160	160	**30,000**				
162	87	160	160	**35,000**				
163	91	160	160	**40,000**				

REMARKS:

DATA AS OF: 9-1-51
DATA BASIS: FLIGHT TEST (WITH J33-A-23 ENGINE)

IAS — INDICATED AIRSPEED
CAS — CALIBRATED AIRSPEED
GAL/HR — FUEL CONSUMPTION
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/GAL

Figure A-12 (Sheet 2 of 2) — Maximum Endurance Chart

COMBAT ALLOWANCE CHART

CLEAN CONFIGURATION
NACA STANDARD DAY

MODEL T-33A **ENGINE J33-A-23 or -35**

AT ALTITUDE FEET	FUEL REQUIRED GALLONS PER MINUTE	
	96% RPM (NORMAL POWER) MAX. CONTINUOUS	100% RPM (MILITARY POWER) 30 MINUTE LIMIT
Sea Level	13	16
5,000	11	14
10,000	9	12
15,000	8	10
20,000	7	9
25,000	6	7
30,000	5	6
35,000	4	5
40,000	3	4

REMARKS:
1. LIMIT TAILPIPE TEMP.: 700 DEG. CENTIGRADE FOR -23 ENGINES
: 720 DEG. CENTIGRADE FOR -35 ENGINES

DATA AS OF: 7-1-51
DATA BASIS: FLIGHT TEST WITH J33-A-23 ENGINE
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/GAL

Figure A-13 — Combat Allowance Chart

MAXIMUM CONTINUOUS POWER SUMMARY

MODEL(S): T-33A **ENGINE(S): J33-A-23 or -35**

CONFIGURATION: TWO 230 GAL. TIP TANKS
WEIGHT: 15,100 LB.

APPROXIMATE					PRESSURE ALTITUDE FEET	APPROXIMATE				
GAL/HR	TAS KNOTS	CAS KNOTS	IAS KNOTS	% RPM		% RPM	IAS KNOTS	CAS KNOTS	TAS KNOTS	GAL/HR
774	407	407	413	96	**Sea Level**	96	415	409	409	774
668	411	384	390	96	**5,000**	96	393	387	414	668
568	413	360	364	96	**10,000**	96	369	364	417	568
482	417	338	342	96	**15,000**	96	347	342	421	482
417	416	312	316	96	**20,000**	96	321	317	423	417
359	415	288	291	96	**25,000**	96	297	294	424	359
303	409	261	263	96	**30,000**	96	271	269	421	303
252	390	227	228	96	**35,000**	96	241	239	412	252
—	—	—	—	—	**40,000**	96	206	205	398	200

CONFIGURATION: TWO 165 GAL. TIP TANKS
WEIGHT: 14,050 LB.

APPROXIMATE					PRESSURE ALTITUDE FEET	APPROXIMATE				
GAL/HR	TAS KNOTS	CAS KNOTS	IAS KNOTS	% RPM		% RPM	IAS KNOTS	CAS KNOTS	TAS KNOTS	GAL/HR
774	408	408	414	96	**Sea Level**	96	415	409	409	774
668	412	385	391	96	**5,000**	96	393	387	414	668
568	415	362	367	96	**10,000**	96	369	364	417	568
482	418	339	343	96	**15,000**	96	347	342	421	482
417	419	315	319	96	**20,000**	96	321	317	413	417
359	419	291	294	96	**25,000**	96	297	294	424	359
303	415	265	267	96	**30,000**	96	271	269	421	303
252	399	232	234	96	**35,000**	96	241	239	412	252
200	359	184	185	96	**40,000**	96	206	205	398	200

REMARKS:

IAS — INDICATED AIRSPEED
CAS — CALIBRATED AIRSPEED
TAS — TRUE AIRSPEED
GAL/HR — FUEL CONSUMPTION

DATA AS OF: 7-1-51
DATA BASIS: FLIGHT TEST (WITH J33-A-23 ENGINE)

FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/GAL

Figure A-14 (Sheet 1 of 2) — Maximum Continous Power Summary

MAXIMUM CONTINUOUS POWER SUMMARY

MODEL(S): T-33A **ENGINE(S): J33-A-23 or -35**

CONFIGURATION: CLEAN WEIGHT: 11,750 LB.	CONFIGURATION: WEIGHT:

APPROXIMATE					ALTITUDE PRESSURE FEET	APPROXIMATE				
GAL/HR	TAS KNOTS	CAS KNOTS	IAS KNOTS	% RPM		% RPM	IAS KNOTS	CAS KNOTS	TAS KNOTS	GAL/HR
774	437	437	444	96	**Sea Level**					
668	443	414	420	96	**5,000**					
568	445	390	396	96	**10,000**					
482	448	365	370	96	**15,000**					
417	448	337	341	96	**20,000**					
359	444	309	313	96	**25,000**					
303	438	281	284	96	**30,000**					
252	432	253	255	96	**35,000**					
200	416	215	216	96	**40,000**					

REMARKS:

IAS — INDICATED AIRSPEED
CAS — CALIBRATED AIRSPEED
TAS — TRUE AIRSPEED
GAL/HR — FUEL CONSUMPTION

DATA AS OF: 7-1-51
DATA BASIS: FLIGHT TEST (WITH J33-A-23 ENGINE)

FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/GAL

Figure A-14 (Sheet 2 of 2) — Maximum Continuous Power Summary

MAXIMUM RANGE SUMMARY

NACA STANDARD DAY

MODEL(S): T-33A **ENGINE(S): J33-A-23 or -35**

CONFIGURATION: TWO 230 GAL. TIP TANKS
WEIGHT: 15,100 LB.

APPROXIMATE % RPM	APPROXIMATE MI/GAL	MACH. NO.	IAS KNOTS	CAS KNOTS	PRESSURE ALTITUDE FEET	CAS KNOTS	IAS KNOTS	MACH. NO.	APPROXIMATE MI/GAL	APPROXIMATE % RPM
84	.634	.46	307	304	**Sea Level**	275	278	.42	.673	79
85	.733	.48	294	291	**5,000**	265	267	.44	.788	80
86	.857	.51	284	281	**10,000**	254	256	.46	.930	81
87	1.009	.53	267	265	**15,000**	246	248	.49	1.090	83
90	1.134	.58	266	264	**20,000**	235	237	.52	1.256	85
91	1.281	.59	250	248	**25,000**	228	229	.54	1.427	87
93	1.442	.64	241	239	**30,000**	222	223	.60	1.625	89
96	1.548	.68	228	227	**35,000**	209	210	.63	1.832	91
—	—	—	—	—	**40,000**	195	196	.67	2.068	94

CONFIGURATION: TWO 165 GAL. TIP TANKS
WEIGHT: 14,050 LB.

APPROXIMATE % RPM	APPROXIMATE MI/GAL	MACH. NO.	IAS KNOTS	CAS KNOTS	PRESSURE ALTITUDE FEET	CAS KNOTS	IAS KNOTS	MACH. NO.	APPROXIMATE MI/GAL	APPROXIMATE % RPM
82	.642	.44	294	291	**Sea Level**	275	278	.42	.674	79
83	.747	.46	282	279	**5,000**	266	268	.44	.787	80
85	.870	.50	278	275	**10,000**	254	256	.46	.929	81
87	1.017	.53	270	268	**15,000**	247	249	.49	1.092	83
89	1.172	.57	262	260	**20,000**	235	237	.52	1.253	85
91	1.307	.60	255	253	**25,000**	228	229	.54	1.422	87
92	1.494	.63	237	235	**30,000**	222	223	.60	1.622	89
95	1.617	.68	227	226	**35,000**	209	210	.63	1.828	91
97	1.798	.67	198	197	**40,000**	195	196	.67	2.068	94

CONFIGURATION: TWO 230 GAL. TIP TANKS
WEIGHT: 12,100 LB.

CONFIGURATION: TWO 165 GAL. TIP TANKS
WEIGHT: 11,900 LB.

REMARKS:

IAS — INDICATED AIRSPEED
CAS — CALIBRATED AIRSPEED
MI/GAL — NAUTICAL MILES PER GALLON

DATA AS OF: 7-1-51
DATA BASIS: FLIGHT TEST (WITH J33-A-23 ENGINE)

FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/GAL

Figure A-15 (Sheet 1 of 2) — Maximum Range Summary

MAXIMUM RANGE SUMMARY

NACA STANDARD DAY

MODEL(S): T-33A **ENGINE(S): J33-A-23 or -35**

CONFIGURATION: CLEAN
WEIGHT: 11,750 LB.

CONFIGURATION:
WEIGHT:

APPROXIMATE					PRESSURE ALTITUDE FEET				APPROXIMATE	
% RPM	MI/GAL	MACH. NO.	IAS KNOTS	CAS KNOTS		CAS KNOTS	IAS KNOTS	MACH. NO.	MI/GAL	% RPM
79	.711	.45	298	295	**Sea Level**					
81	.810	.47	288	285	**5,000**					
83	.950	.51	282	279	**10,000**					
85	1.116	.54	276	273	**15,000**					
87	1.314	.58	270	268	**20,000**					
88	1.512	.60	256	254	**25,000**					
90	1.700	.65	247	245	**30,000**					
91	1.985	.68	229	228	**35,000**					
95	2.143	.71	211	210	**40,000**					

REMARKS:

IAS — INDICATED AIRSPEED
CAS — CALIBRATED AIRSPEED
MI/GAL — NAUTICAL MILES PER GALLON

DATA AS OF: 7-1-51
DATA BASIS: FLIGHT TEST (WITH J33-A-23 ENGINE)

FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LB/GAL

Figure A-15 (Sheet 2 of 2) — Maximum Range Summary

AIRCRAFT MODEL(S)
T-33A

ENGINE(S) J33-A-23 or -35

FLIGHT OPERATION INSTRUCTION CHART

NACA STANDARD DAY

CHART WEIGHT LIMITS 15,100 TO 12,100 POUNDS

EXTERNAL LOAD ITEMS
TWO 230 GALLON EXTERNAL TIP TANKS CARRIED ALL THE WAY

NUMBER OF ENGINES OPERATING: ONE

INSTRUCTIONS FOR USING CHART: (A) IN FLIGHT — Select figure in fuel column equal to or less than fuel available for cruise (fuel on board minus allowance for reserve, combat, navigational error, formation flight, etc.). Move horizontally right or left to section according to present altitude and read total range available (no wind) by cruising at that altitude or by climbing to another altitude of maximum range. For a flight at initial altitude, operating instructions are given directly below. For a flight at higher altitude, climb immediately to desired altitude and read cruising instructions in appropriate cruising altitude section. (B) FLIGHT PLANNING — From initial fuel on board subtract fuel for take-off and climb to desired cruising altitude and all other necessary allowances. Then use chart as for IN FLIGHT above, adding initial climb distances to range values.

NOTES: Ranges shown at optimum altitudes are maximum. In order to obtain maximum range on flights requiring more than one chart (due to external configuration or gross weight changes), it is necessary to observe the optimum cruising altitude on each chart; i.e., when changing charts a climb may be required to obtain a maximum range. All range values include allowances for descent distance and fuel. Climb distance and fuel are included where climbs are indicated.

DATA BELOW CONTAIN NO FUEL RESERVE FOR LANDING

DATA AS OF: 1-6-51

BASED ON: FLIGHT TEST WITH J33-A-23 ENGINE

LOW ALTITUDE

IF YOU ARE AT S. L.			FUEL U. S. GAL.	IF YOU ARE AT 5000′			IF YOU ARE AT 10,000′			IF YOU ARE AT 15,000′			FUEL U. S. GAL.	IF YOU ARE AT 20,000′		
RANGE IN AIRMILES				RANGE IN AIRMILES			RANGE IN AIRMILES			RANGE IN AIRMILES				RANGE IN AIRMILES		
BY CRUISING AT S. L.	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 5000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 10,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 15,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 20,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.
(RANGE FIGURES INCLUDE ALLOWANCES FOR PRESCRIBED CLIMB AND DESCENT TO SEA LEVEL) [1]																
(530)	(35)	(1235)	813	(615)	(35)	(1260)	(730)	(35)	(1285)	(860)	(35)	(1305)	813	(980)	(35)	(1325)
(520)	(35)	(1215)	800	(605)	(35)	(1240)	(720)	(35)	(1265)	(845)	(35)	(1285)	800	(965)	(35)	(1305)
490	35	1145	750	570	35	1170	(675)	(35)	(1190)	(795)	(35)	(1210)	750	(905)	(35)	(1230)
460	35	1075	700	535	35	1100	630	35	1120	745	35	1135	700	850	35	1155
425	35	1000	650	500	35	1025	590	35	1045	695	35	1065	650	795	35	1085
395	35	925	600	460	35	950	545	35	970	645	35	990	600	735	35	1005
365	35	855	550	425	35	875	505	35	895	595	35	910	550	680	35	925
330	35	780	500	390	35	800	460	35	815	545	35	840	500	625	35	850
300	35	695	450	350	35	720	420	35	740	490	35	760	450	565	35	775
265	35	615	400	315	35	635	375	35	655	440	35	680	400	510	35	700
235	35	530	350	280	35	550	330	35	575	390	35	595	350	450	35	615

CRUISING AT S.L.							EFFECTIVE WIND KNOTS	CRUISING AT 5000′							CRUISING AT 10,000′							CRUISING AT 15,000′							EFFECTIVE WIND KNOTS	CRUISING AT 20,000′						
		APPROXIMATE								APPROXIMATE							APPROXIMATE							APPROXIMATE							APPROXIMATE					
IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.
							120 HW																						120 HW	292	289	93	359	267	0.7	
							80 HW								316	313	90	437	280	0.7		293	290	90	371	280	0.7		80 HW	284	281	92	343	297	0.8	
332	328	87	328	288	0.9		40 HW	320	317	88	473	300	0.9		299	296	88	406	301	0.9		284	281	89	356	310	0.9		40 HW	276	273	91	327	326	0.9	
307	304	84	304	304	1.0		0	294	291	85	427	313	1.0		284	281	86	377	323	1.0		267	265	87	327	330	1.0		0	266	264	90	313	355	1.0	
292	289	82	289	329	1.1		40 TW	278	275	83	400	335	1.1		266	264	84	351	344	1.1		258	257	86	315	360	1.1		40 TW	257	255	89	300	383	1.1	
							80 TW								249	247	82	328	365	1.3		250	248	85	305	388	1.3		80 TW	247	245	88	287	410	1.3	
							120 TW																						120 TW	236	234	87	276	436	1.4	

Figure A-16 (Sheet 1 of 2) — Flight Operation Instruction Chart

AIRCRAFT MODEL(S) T-33A

ENGINE(S): J33-A-23 or -35

HIGH ALTITUDE

CHART WEIGHT LIMITS 15,100 TO 12,100 POUNDS

EXTERNAL LOAD
TWO 230 GALLON TIP TANKS
CARRIED ALL THE WAY

NO. OF ENGINES OPERATING: ONE

IF YOU ARE AT 25,000'			FUEL U. S. GAL.	IF YOU ARE AT 30,000'			IF YOU ARE AT 35,000'			IF YOU ARE AT 40,000'			FUEL U. S. GAL.	IF YOU ARE AT 45,000'		
RANGE IN AIRMILES				RANGE IN AIRMILES			RANGE IN AIRMILES			RANGE IN AIRMILES				RANGE IN AIRMILES		
BY CRUISING AT 25,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 30,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 35,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 40,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 45,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.
(RANGE FIGURES INCLUDE ALLOWANCES FOR PRESCRIBED CLIMB AND DESCENT TO SEA LEVEL) (1)																
(1110)	(35)	(1345)	813	(1260)	(35)	(1365)	(1385)	—	—				813			
(1090)	(35)	(1325)	800	(1240)	(35)	(1345)	(1360)	—	—				800			
(1025)	(35)	(1250)	750	(1165)	(35)	(1270)	(1285)	—	—				750			
(965)	(35)	(1175)	700	(1095)	(35)	(1190)	(1210)	—	—				700			
900	35	1100	650	1020	35	1115	(1130)	—	—				650			
835	35	1020	600	950	35	1035	1070	—	—				600			
770	35	940	550	875	35	960	975	—	—				550			
705	35	865	500	805	35	880	900	—	—				500			
645	35	790	450	730	35	805	820	—	—				450			
580	35	715	400	660	35	730	745	—	—				400			
515	35	630	350	590	35	650	665	—	—				350			

CRUISING AT 25,000'							EFFECTIVE WIND KNOTS	CRUISING AT 30,000'							CRUISING AT 35,000'							CRUISING AT 40,000'							EFFECTIVE WIND KNOTS	CRUISING AT 45,000'						
		APPROXIMATE								APPROXIMATE							APPROXIMATE							APPROXIMATE								APPROXIMATE					
IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.
276	273	94	324	275	0.7		120 HW	256	254	95	289	280	0.7		228	227	96	252	270	0.7									120 HW							
267	265	93	311	304	0.8		80 HW	256	254	95	289	320	0.8		228	227	96	252	310	0.8									80 HW							
258	256	92	295	332	0.9		40 HW	249	247	94	275	349	0.9		228	227	96	252	350	0.9									40 HW							
250	248	91	281	360	1.0		0	241	239	93	262	378	1.0		228	227	96	252	390	1.0									0							
239	237	90	268	386	1.1		40 TW	241	239	93	261	418	1.1		219	218	95	240	416	1.1									40 TW							
239	237	90	268	426	1.2		80 TW	241	239	93	261	458	1.2		219	218	95	240	456	1.2									80 TW							
239	237	90	268	465	1.4		120 TW	229	228	92	249	482	1.3		219	218	95	240	496	1.3									120 TW							

SPECIAL NOTES

1. Climb at 100% RPM.
2. Multiply nautical units by 1.15 to obtain statute units.
3. Read lower half of chart opposite effective wind only.
4. Make additional allowances for landing, navigational errors, combat, formation flight etc., as required.
5. When using JP-1 fuel for normal operation multiply the range by 1.03. When using gasoline (MIL-F-5572), normal operation multiply the range by .92.
6. Refer to Figure A-17 for letdown distances.

DATA AS OF: 1-6-51

EXAMPLE

If you are at 10,000 feet with 600 gallons of available fuel you can fly 545 nautical airmiles by holding 281 knots CAS. However, you can fly 970 nautical airmiles by immediately climbing to 35,000 feet using 100% RPM. At 35,000 feet cruise at 227 knots CAS until tip tanks are empty. When tip tanks are empty refer to Figure A-17 for cruising airspeed and letdown distance. With a 80 knot headwind the range at 35,000 feet will be 970 x 0.8 or 775 nautical airmiles. Cruise at 227 knots CAS with this wind until tip tanks are empty. When tip tanks are empty refer to Figure A-17 for cruising airspeed and letdown distance with a 80 knot headwind.

BASED ON: FLIGHT TEST WITH J33-A-23 ENGINE

LEGEND

EFFECTIVE WIND — HW, Headwind; TW, Tailwind — Knots

R.F. — Range Factor = $\frac{\text{GROUND DISTANCE (Effective Wind)}}{\text{RANGE IN AIRMILES (Zero Wind)}}$

G.S. — Ground speed in Knots
IAS — Indicated airspeed in Knots
CAS — Calibrated airspeed in Knots
GAL/HR — Fuel consumption — Gallons per hour
RANGE — Nautical miles
( ) — Possible only by inflight refueling.
BASED ON — MIL-F-5624 (Grade JP-4) Fuel.

FUEL DENSITY — 6.5 LB/GAL

Figure A-16 (Sheet 2 of 2) — Flight Operation Instruction Chart

AIRCRAFT MODEL(S)
T-33A
ENGINE(S) J33-A-23 or -35

FLIGHT OPERATION INSTRUCTION CHART

NACA STANDARD DAY

CHART WEIGHT LIMITS 12,100 TO 9,800 POUNDS

EXTERNAL LOAD ITEMS
TWO 230 GALLON EXTERNAL TIP TANKS CARRIED ALL THE WAY
NUMBER OF ENGINES OPERATING: ONE

INSTRUCTIONS FOR USING CHART: (A) IN FLIGHT — Select figure in fuel column equal to or less than fuel available for cruise (fuel on board minus allowance for reserve, combat, navigational error, formation flight, etc.). Move horizontally right or left to section according to present altitude and read total range available (no wind) by cruising at that altitude or by climbing to another altitude of maximum range. For a flight at initial altitude, operating instructions are given directly below. For a flight at higher altitude, climb immediately to desired altitude and read cruising instructions in appropriate cruising altitude section. (B) FLIGHT PLANNING — From initial fuel on board subtract fuel for take-off and climb to desired cruising altitude and all other necessary allowances. Then use chart as for IN FLIGHT above, adding initial climb distances to range values.

NOTES: Ranges shown at optimum altitudes are maximum. In order to obtain maximum range on flights requiring more than one chart (due to external configuration or gross weight changes), it is necessary to observe the optimum cruising altitude on each chart; i.e., when changing charts a climb may be required to obtain a maximum range. All range values include allowances for descent distance and fuel. Climb distance and fuel are included where climbs are indicated.

DATA BELOW CONTAIN NO FUEL RESERVE FOR LANDING

DATA AS OF: 1-6-51 BASED ON: FLIGHT TEST WITH J33-A-23 ENGINE

LOW ALTITUDE

(RANGE FIGURES INCLUDE ALLOWANCES FOR PRESCRIBED CLIMB AND DESCENT TO SEA LEVEL) [1]

IF YOU ARE AT S. L.			FUEL U. S. GAL.	IF YOU ARE AT 5000′			IF YOU ARE AT 10,000′			IF YOU ARE AT 15,000′			FUEL U. S. GAL.	IF YOU ARE AT 20,000′		
RANGE IN AIRMILES				RANGE IN AIRMILES			RANGE IN AIRMILES			RANGE IN AIRMILES				RANGE IN AIRMILES		
BY CRUISING AT S. L.	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 5000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 10,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 15,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 20,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.
240	35	540	353	280	35	560	335	35	580	395	35	600	353	455	35	620
235	35	530	350	275	35	550	330	35	575	390	35	595	350	450	35	615
200	35	445	300	240	35	465	285	35	485	335	35	505	300	390	35	520
170	35	355	250	200	35	375	240	35	390	280	35	410	250	325	35	430
135	35	270	200	160	35	285	190	35	305	225	35	325	200	265	35	340
100	35	175	150	120	35	200	145	35	215	170	35	235	150	200	35	250
65	10	85	100	80	20	115	100	25	125	115	35	145	100	140	35	165
35	—	—	50	40	—	—	55	—	—	65	—	—	50	75	—	—

CRUISING AT S.L.							EFFECTIVE WIND KNOTS	CRUISING AT 5000′							CRUISING AT 10,000′							CRUISING AT 15,000′							EFFECTIVE WIND KNOTS	CRUISING AT 20,000′						
		APPROXIMATE								APPROXIMATE							APPROXIMATE							APPROXIMATE							APPROXIMATE					
IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.
							120 HW																						120 HW	277	274	90	313	248	0.6	17
							80 HW								298	295	87	389	260	0.7	8	284	281	88	341	269	0.7	12	80 HW	268	266	89	300	277	0.7	18
297	294	82	453	255	0.8	0	40 HW	287	284	83	395	265	0.8	4	277	274	84	350	276	0.8	9	261	259	85	303	283	0.9	13	40 HW	253	251	87	275	298	0.9	20
278	275	79	409	275	1.0	0	0	267	265	80	361	285	1.0	4	256	254	81	316	294	1.0	9	248	246	83	281	307	1.0	14	0	237	235	85	253	317	1.0	21
266	264	77	386	304	1.2	0	40 TW	256	254	78	343	312	1.2	4	245	243	79	298	321	1.2	9	234	233	81	260	330	1.2	15	40 TW	220	219	83	233	335	1.1	22
							80 TW								233	232	77	277	348	1.4	11	222	221	79	238	355	1.4	17	80 TW	212	211	82	223	365	1.3	24
							120 TW																						120 TW	195	194	80	203	383	1.5	26

Figure A-17 (Sheet 1 of 2) — Flight Operation Instruction Chart

AIRCRAFT MODEL(S) T-33A

ENGINE(S) J33-A-23 or -35

HIGH ALTITUDE

CHART WEIGHT LIMITS 12,100 TO 9,800 POUNDS

EXTERNAL LOAD
TWO 230 GALLON TIP TANKS
CARRIED ALL THE WAY

NO. OF ENGINES OPERATING: ONE

IF YOU ARE AT 25,000'			FUEL	IF YOU ARE AT 30,000'			IF YOU ARE AT 35,000'			IF YOU ARE AT 40,000'			FUEL	IF YOU ARE AT 45,000'		
RANGE IN AIRMILES			U. S.	RANGE IN AIRMILES			RANGE IN AIRMILES			RANGE IN AIRMILES			U. S.	RANGE IN AIRMILES		
BY CRUISING AT 25,000'	OPT.ALT. 1000 FT.	BY CRUISING AT OPT.ALT.	GAL.	BY CRUISING AT 30,000'	OPT.ALT. 1000 FT.	BY CRUISING AT OPT.ALT.	BY CRUISING AT 35,000'	OPT.ALT. 1000 FT.	BY CRUISING AT OPT.ALT.	BY CRUISING AT 40,000'	OPT.ALT. 1000 FT.	BY CRUISING AT OPT.ALT.	GAL.	BY CRUISING AT 45,000'	OPT.ALT. 1000 FT.	BY CRUISING AT OPT.ALT.
(RANGE FIGURES INCLUDE ALLOWANCES FOR PRESCRIBED CLIMB AND DESCENT TO SEA LEVEL) (1)																
520	35	635	353	590	35	655	670	35	—	755	40	—	353			
515	35	630	350	590	35	650	660	35	—	750	40	—	350			
445	35	540	300	505	35	555	575	35	—	645	40	—	300			
370	35	445	250	425	35	465	480	35	—	545	40	—	250			
300	35	360	200	345	35	375	385	35	—	440	40	—	200			
230	35	270	150	265	35	280	295	35	—	335	40	—	150			
160	35	180	100	180	35	195	205	35	—	230	40	—	100			
85	—	—	50	100	—	—	115	35	—	130	40	—	50			

CRUISING AT 25,000'							EFFECTIVE WIND KNOTS	CRUISING AT 30,000'							CRUISING AT 35,000'							CRUISING AT 40,000'							EFFECTIVE WIND KNOTS	CRUISING AT 45,000'						
		APPROXIMATE								APPROXIMATE							APPROXIMATE							APPROXIMATE							APPROXIMATE					
IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.
264	262	91	281	260	0.6	24	120 HW	248	246	92	249	268	0.7	34	232	231	94	229	276	0.7	46	207	206	96	200	278	.7	63	120 HW							
256	254	90	267	289	0.8	27	80 HW	241	239	91	238	298	0.8	36	225	224	93	219	307	0.8	49	202	201	95	189	308	.8	67	80 HW							
239	237	88	244	306	0.9	29	40 HW	232	231	90	227	325	0.9	38	218	217	92	208	335	0.9	51	202	201	95	189	348	.9	71	40 HW							
229	228	87	234	333	1.0	30	0	223	222	89	217	352	1.0	40	210	209	91	198	363	1.0	54	196	195	94	182	377	1.0	75	0							
219	218	86	223	360	1.1	32	40 TW	223	222	89	217	392	1.1	42	210	209	91	198	403	1.1	57	196	195	94	182	417	1.1	79	40 TW							
209	208	85	212	386	1.3	35	80 TW	213	212	88	206	417	1.2	44	200	199	90	190	426	1.2	59	196	195	94	182	457	1.2	83	80 TW							
199	198	84	202	401	1.4	36	120 TW	201	200	87	195	440	1.4	48	189	188	89	180	449	1.4	65	196	195	94	182	497	1.3	87	120 TW							

SPECIAL NOTES

1. Climb at 100% RPM.
2. Multiply nautical units by 1.15 to obtain statute units.
3. Read lower half of chart opposite effective wind only.
4. Make additional allowances for landing, navigational errors, combat, formation flight, etc., as required.
5. When using JP-1 fuel, for normal operation multiply the range by 1.03. When using gasoline (AN F-48) for normal operation multiply the range by .92.

DATA AS OF: 1-6-51

EXAMPLE

If you are at 10,000 feet with 300 gallons of available fuel, you can fly 285 nautical airmiles by holding 254 knots CAS. However, you can fly 485 nautical airmiles by immediately climbing to 35,000 feet using 100% RPM. At 35,000 feet cruise at 209 knots CAS and start letdown 54 nautical airmiles from destination. With an 80 knot headwind the range at 35,000 feet will be 485 x .8 or 390 nautical airmiles. Cruise at 224 knots CAS with this wind and start letdown 49 nautical airmiles from destination.

BASED ON: FLIGHT TEST WITH J33-A-23 ENGINE

LEGEND

EFFECTIVE WIND — HW, Headwind; TW, Tailwind —

R.F. — Range Factor = $\frac{\text{GROUND DISTANCE (Effective Wind)}}{\text{RANGE IN AIRMILES (Zero Wind)}}$

G.S. — Ground speed in Knots
IAS — Indicated airspeed in Knots
CAS — Calibrated airspeed in Knots
GAL/HR — Total fuel consumption — gallons per hr.
RANGE — Nautical miles.

FUEL GRADE — MIL-F-5624 (Grade JP-4)
FUEL DENSITY — 6.5 LB/GAL

Figure A-17 (Sheet 2 of 2) — Flight Operation Instruction Chart

AIRCRAFT MODEL(S)
T-33A
ENGINE(S) J33-A-23 or -35

FLIGHT OPERATION INSTRUCTION CHART

NACA STANDARD DAY

CHART WEIGHT LIMITS 14,050 TO 11,900 POUNDS

EXTERNAL LOAD ITEMS
TWO 165 GALLON EXTERNAL TIP TANKS CARRIED ALL THE WAY
NUMBER OF ENGINES OPERATING: ONE

INSTRUCTIONS FOR USING CHART: (A) IN FLIGHT — Select figure in fuel column equal to or less than fuel available for cruise (fuel on board minus allowance for reserve, combat, navigational error, formation flight, etc.). Move horizontally right or left to section according to present altitude and read total range available (no wind) by cruising at that altitude or by climbing to another altitude of maximum range. For a flight at initial altitude, operating instructions are given directly below. For a flight at higher altitude, climb immediately to desired altitude and read cruising instructions in appropriate cruising altitude section. (B) FLIGHT PLANNING — From initial fuel on board subtract fuel for take-off and climb to desired cruising altitude and all other necessary allowances. Then use chart as for IN FLIGHT above, adding initial climb distances to range values.

NOTES: Ranges shown at optimum altitudes are maximum. In order to obtain maximum range on flights requiring more than one chart (due to external configuration or gross weight changes), it is necessary to observe the optimum cruising altitude on each chart; i.e., when changing charts a climb may be required to obtain a maximum range. All range values include allowances for descent distance and fuel. Climb distance and fuel are included where climbs are indicated.

DATA BELOW CONTAIN NO FUEL RESERVE FOR LANDING

DATA AS OF: 1-6-51

BASED ON: FLIGHT TEST WITH J33-A-23 ENGINE

LOW ALTITUDE

IF YOU ARE AT S. L.			FUEL	IF YOU ARE AT 5000′			IF YOU ARE AT 10,000′			IF YOU ARE AT 15,000′			FUEL	IF YOU ARE AT 20,000′		
RANGE IN AIRMILES			U. S.	RANGE IN AIRMILES			RANGE IN AIRMILES			RANGE IN AIRMILES			U. S.	RANGE IN AIRMILES		
BY CRUISING AT S. L.	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	GAL.	BY CRUISING AT 5000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 10,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 15,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	GAL.	BY CRUISING AT 20,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.
(RANGE FIGURES INCLUDE ALLOWANCES FOR PRESCRIBED CLIMB AND DESCENT TO SEA LEVEL) (1)																
(450)	(35)	(1065)	683	(525)	(35)	(1090)	(620)	(35)	(1110)	(730)	(35)	(1130)	683	(845)	(35)	(1150)
430	35	1010	650	(505)	(35)	(1035)	(595)	(35)	(1060)	(695)	(35)	(1080)	650	(805)	(35)	(1100)
395	35	935	600	465	35	960	550	35	980	(645)	(35)	(1000)	600	(745)	(35)	(1020)
365	35	860	550	430	35	880	505	35	900	595	35	920	550	685	35	940
335	35	780	500	390	35	800	465	35	820	545	35	845	500	630	35	855
300	35	695	450	355	35	720	420	35	740	495	35	760	450	570	35	775
270	35	615	400	315	35	635	375	35	655	440	35	680	400	510	35	700
235	35	530	350	280	35	550	330	35	575	390	35	595	350	450	35	615

CRUISING AT S.L.						EFFECTIVE WIND KNOTS	CRUISING AT 5000′							CRUISING AT 10,000′							CRUISING AT 15,000′							EFFECTIVE WIND KNOTS	CRUISING AT 20,000′						
		APPROXIMATE							APPROXIMATE							APPROXIMATE							APPROXIMATE							APPROXIMATE				
IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.
						120 HW																						120 HW	289	286	92	343	265	0.6	
						80 HW								310	307	89	421	273	0.7		288	285	89	357	273	0.7		80 HW	280	277	91	327	291	0.8	
310	307	84	482	267	0.9	40 HW	305	302	86	441	285	0.9		295	292	87	388	299	0.9		280	277	88	341	303	0.9		40 HW	271	269	90	314	320	0.9	
295	292	82	454	292	1.0	0	282	279	83	401	300	1.0		279	276	85	365	318	1.0		271	269	87	327	333	1.0		0	262	260	89	298	350	1.0	
288	285	81	440	325	1.1	40 TW	274	272	82	388	332	1.1		263	261	83	340	346	1.1		245	243	84	292	342	1.1		40 TW	253	251	88	287	377	1.1	
						80 TW								248	246	81	316	364	1.3		237	235	83	281	372	1.3		80 TW	244	242	87	275	405	1.3	
						120 TW																						120 TW	232	231	86	262	431	1.4	

Figure A-18 (Sheet 1 of 2) — Flight Operation Instruction Chart

AIRCRAFT MODEL(S) T-33A

ENGINE(S): J33-A-23 or -35

HIGH ALTITUDE

CHART WEIGHT LIMITS 14,050 TO 11,900 POUNDS

EXTERNAL LOAD
TWO 165 GALLON EXTERNAL TIP TANKS CARRIED ALL THE WAY
NO. OF ENGINES OPERATING: ONE

IF YOU ARE AT 25,000'			FUEL U. S. GAL.	IF YOU ARE AT 30,000'			IF YOU ARE AT 35,000'			IF YOU ARE AT 40,000'			FUEL U. S. GAL.	IF YOU ARE AT 45,000'		
RANGE IN AIRMILES				RANGE IN AIRMILES			RANGE IN AIRMILES			RANGE IN AIRMILES				RANGE IN AIRMILES		
BY CRUISING AT 25,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 30,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 35,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 40,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 45,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.
(RANGE FIGURES INCLUDE ALLOWANCES FOR PRESCRIBED CLIMB AND DESCENT TO SEA LEVEL) (1)																
(950)	(35)	(1170)	**683**	(1085)	(35)	(1190)	(1205)	35	—	(1350)	40	—	**683**			
(910)	(35)	(1120)	**650**	(1035)	(35)	(1135)	(1150)	35	—	(1290)	40	—	**650**			
(840)	(35)	(1035)	**600**	(960)	(35)	(1055)	(1070)	35	—	(1200)	40	—	**600**			
775	35	955	**550**	(885)	(35)	(970)	(985)	35	—	(1110)	40	—	**550**			
710	35	870	**500**	810	35	890	905	35	—	(1020)	40	—	**500**			
645	35	790	**450**	735	35	810	825	35	—	930	40	—	**450**			
580	35	715	**400**	660	35	730	745	35	—	840	40	—	**400**			
515	35	630	**350**	590	35	650	665	35	—	750	40	—	**350**			

CRUISING AT 25,000'							EFFECTIVE WIND KNOTS	CRUISING AT 30,000'							EFFECTIVE WIND KNOTS	CRUISING AT 35,000'							EFFECTIVE WIND KNOTS	CRUISING AT 40,000'							EFFECTIVE WIND KNOTS	CRUISING AT 45,000'						
		APPROXIMATE								APPROXIMATE								APPROXIMATE								APPROXIMATE								APPROXIMATE					
IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.
272	270	93	310	272	.7		**120 HW**	255	253	94	275	278	.7		**120 HW**	234	233	96	252	280	.7		**120 HW**	198	197	97	211	260	.7	SEE NOTE 6	**120 HW**							
264	262	92	296	300	.8		**80 HW**	255	253	94	275	318	.8		**80 HW**	234	233	96	252	320	.8		**80 HW**	198	197	97	211	300	.8		**80 HW**							
255	253	91	281	328	.9		**40 HW**	248	246	93	261	346	.9		**40 HW**	227	226	95	240	349	.9		**40 HW**	198	197	97	211	340	.9		**40 HW**							
255	253	91	281	368	1.0		**0**	238	236	92	249	373	1.0		**0**	227	226	95	240	389	1.0		**0**	198	197	97	211	380	1.0		**0**							
246	244	90	269	395	1.1		**40 TW**	238	236	92	249	413	1.1		**40 TW**	219	218	94	230	415	1.1		**40 TW**	185	184	96	200	420	1.1		**40 TW**							
236	234	89	255	421	1.3		**80 TW**	227	226	91	238	439	1.2		**80 TW**	219	218	94	230	455	1.2		**80 TW**	185	184	96	200	460	1.2		**80 TW**							
236	234	89	255	461	1.4		**120 TW**	227	226	91	238	479	1.3		**120 TW**	209	208	93	219	479	1.3		**120 TW**	185	184	96	200	500	1.3		**120 TW**							

SPECIAL NOTES

1. Climb at 100% RPM.
2. Multiply nautical units by 1.15 to obtain statute units.
3. Read lower half of chart opposite effective wind only.
4. Make additional allowances for landing, navigational errors, combat, formation flight, etc., as required.
5. When using JP-1 fuel for normal operation multiply the range by 1.03. When using gasoline (MIL-F-5572), for normal operation multiply the range by .92.
6. Refer to Figure A-29 for letdown distances.

DATA AS OF: 1-6-51

EXAMPLE

If you are at 10,000 feet with 600 gallons of available fuel you can fly 550 nautical airmiles by holding 276 knots CAS. However, you can fly 980 nautical airmiles by immediately climbing to 35,000 feet using 100% RPM. At 35,000 feet cruise at 226 knots CAS until tip tanks are empty. When tip tanks are empty refer to figure A-19 for cruising airspeed and letdown distance. With a 80 knot headwind the range at 35,000 feet will be 980 x 0.8 or 785 nautical airmiles. Cruise at 233 knots CAS with this wind until tip tanks are empty. When tip tanks are empty refer to figure A-19 for cruising airspeed and letdown distance with a 80 knot headwind.

BASED ON: FLIGHT TEST WITH J33-A-23 ENGINE

LEGEND

EFFECTIVE WIND — HW, Headwind; TW, Tailwind.

R.F. — Range Factor = $\frac{\text{GROUND DISTANCE (Effective Wind)}}{\text{RANGE IN AIRMILES (Zero Wind)}}$

G.S. — Ground speed in Knots

IAS — Indicated airspeed in Knots

CAS — Calibrated airspeed in Knots

GAL/HR — Fuel consumption — Gallons per hour

RANGE — Nautical miles

( ) — Possible only through use of inflight refueling

FUEL GRADE: JP-4 FUEL DENSITY: 6.5 LB/GAL

Figure A-18 (Sheet 2 of 2) — Flight Operation Instruction Chart

AIRCRAFT MODEL(S)
T-33A

ENGINE(S) J33-A-23 or -35

FLIGHT OPERATION INSTRUCTION CHART

NACA STANDARD DAY

CHART WEIGHT LIMITS 11,900 TO 9,600 POUNDS

EXTERNAL LOAD ITEMS

TWO 165 GALLON EXTERNAL TIP TANKS CARRIED ALL THE WAY

NUMBER OF ENGINES OPERATING: ONE

INSTRUCTIONS FOR USING CHART: (A) IN FLIGHT — Select figure in fuel column equal to or less than fuel available for cruise (fuel on board minus allowance for reserve, combat, navigational error, formation flight, etc.). Move horizontally right or left to section according to present altitude and read total range available (no wind) by cruising at that altitude or by climbing to another altitude of maximum range. For a flight at initial altitude, operating instructions are given directly below. For a flight at higher altitude, climb immediately to desired altitude and read cruising instructions in appropriate cruising altitude section. (B) FLIGHT PLANNING — From initial fuel on board subtract fuel for take-off and climb to desired cruising altitude and all other necessary allowances. Then use chart as for IN FLIGHT above, adding initial climb distances to range values.

NOTES: Ranges shown at optimum altitudes are maximum. In order to obtain maximum range on flights requiring more than one chart (due to external configuration or gross weight changes), it is necessary to observe the optimum cruising altitude on each chart; i.e., when changing charts a climb may be required to obtain a maximum range. All range values include allowances for descent distance and fuel. Climb distance and fuel are included where climbs are indicated.

DATA BELOW CONTAIN NO FUEL RESERVE FOR LANDING

DATA AS OF: 9-1-51

BASED ON: FLIGHT TEST WITH J33-A-23 ENGINE

LOW ALTITUDE

IF YOU ARE AT S. L.			FUEL U. S. GAL.	IF YOU ARE AT 5000′			IF YOU ARE AT 10,000′			IF YOU ARE AT 15,000′			FUEL U. S. GAL.	IF YOU ARE AT 20,000′		
RANGE IN AIRMILES				RANGE IN AIRMILES			RANGE IN AIRMILES			RANGE IN AIRMILES				RANGE IN AIRMILES		
BY CRUISING AT S. L.	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 5000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 10,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 15,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 20,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.
(RANGE FIGURES INCLUDE ALLOWANCES FOR PRESCRIBED CLIMB AND DESCENT TO SEA LEVEL) [1]																
240	35	540	353	280	35	560	335	35	580	395	35	600	353	455	35	620
235	35	530	350	275	35	550	330	35	575	390	35	595	350	450	35	615
200	35	445	300	240	35	465	285	35	485	335	35	505	300	390	35	520
170	35	355	250	200	35	375	240	35	390	280	35	410	250	325	35	430
135	35	270	200	160	35	285	190	35	305	225	35	325	200	265	35	340
100	35	175	150	120	35	200	145	35	215	170	35	235	150	200	35	250
65	10	85	100	80	20	115	100	25	125	115	35	145	100	140	35	165
35	—	—	50	40	—	—	55	—	—	65	—	—	50	75	—	—

CRUISING AT S.L.							EFFECTIVE WIND KNOTS	CRUISING AT 5000′							CRUISING AT 10,000′							CRUISING AT 15,000′							EFFECTIVE WIND KNOTS	CRUISING AT 20,000′						
		APPROXIMATE								APPROXIMATE							APPROXIMATE							APPROXIMATE							APPROXIMATE					
IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.
							120 HW																						120 HW	277	274	90	313	248	.6	17
							80 HW								298	295	87	389	260	.7	8	284	281	88	341	269	.7	12	80 HW	268	266	89	300	277	.7	18
297	294	82	453	255	.8	0	40 HW	287	284	83	395	265	.8	4	277	274	84	350	276	.8	9	261	259	85	303	283	.9	13	40 HW	253	251	87	275	298	.9	20
278	275	79	409	275	1.0	0	0	267	265	80	361	285	1.0	4	256	254	81	316	294	1.0	9	248	246	83	281	307	1.0	14	0	237	235	85	253	317	1.0	21
266	264	77	386	304	1.2	0	40 TW	256	254	78	343	312	1.2	4	245	243	79	298	321	1.2	9	234	233	81	260	330	1.2	15	40 TW	220	219	83	233	335	1.1	22
							80 TW								233	232	77	277	348	1.4	11	222	221	79	238	355	1.4	17	80 TW	212	211	82	223	365	1.3	24
							120 TW																						120 TW	195	194	80	203	383	1.5	26

Figure A-19 (Sheet 1 of 2) — Flight Operation Instruction Chart

AIRCRAFT MODEL(S) T-33A

ENGINE(S) J33-A-23 or -35

HIGH ALTITUDE

CHART WEIGHT LIMITS 11,900 TO 9,600 POUNDS

EXTERNAL LOAD
TWO 165 GALLON TIP TANKS
CARRIED ALL THE WAY

NO. OF ENGINES OPERATING: ONE

IF YOU ARE AT 25,000'			FUEL	IF YOU ARE AT 30,000'			IF YOU ARE AT 35,000'			IF YOU ARE AT 40,000'			FUEL	IF YOU ARE AT 45,000'		
RANGE IN AIRMILES			U. S. GAL.	RANGE IN AIRMILES			RANGE IN AIRMILES			RANGE IN AIRMILES			U. S. GAL.	RANGE IN AIRMILES		
BY CRUISING AT 25,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 30,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 35,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 40,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 45,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.
(RANGE FIGURES INCLUDE ALLOWANCES FOR PRESCRIBED CLIMB AND DESCENT TO SEA LEVEL) (1)																
520	35	635	353	590	35	655	670	35	—	755	40	—	353			
515	35	630	350	590	35	650	660	35	—	750	40	—	350			
445	35	540	300	505	35	555	575	35	—	645	40	—	300			
370	35	445	250	425	35	465	480	35	—	545	40	—	250			
300	35	360	200	345	35	375	395	35	—	440	40	—	200			
230	35	270	150	265	35	280	295	35	—	335	40	—	150			
160	35	180	100	180	35	195	205	35	—	230	40	—	100			
85	—	—	50	100	—	—	115	35	—	130	40	—				

CRUISING AT 25,000'							EFFECTIVE WIND KNOTS	CRUISING AT 30,000'							CRUISING AT 35,000'							CRUISING AT 40,000'							EFFECTIVE WIND KNOTS	CRUISING AT 45,000'						
		APPROXIMATE								APPROXIMATE									APPROXIMATE											APPROXIMATE					
IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.
264	262	91	281	260	.6	24	120 HW	248	246	92	249	268	.7	34	232	231	94	229	276	.7	46	207	206	96	200	278	.7	61	120 HW							
256	254	90	267	289	.8	27	80 HW	241	239	91	238	298	.8	36	225	224	93	219	307	.8	49	202	201	95	189	308	.8	65	80 HW							
239	237	88	244	306	.9	29	40 HW	232	231	90	227	325	.9	38	218	217	92	208	335	.9	51	202	201	95	189	348	.9	69	40 HW							
229	228	87	234	333	1.0	30	0	223	222	89	217	352	1.0	40	210	209	91	198	363	1.0	54	196	195	94	182	377	1.0	73	0							
219	218	86	223	360	1.1	32	40 TW	223	222	89	217	392	1.1	42	210	209	91	198	403	1.1	57	196	195	94	182	417	1.1	77	40 TW							
209	208	85	212	386	1.3	35	80 TW	213	212	88	206	417	1.2	44	200	199	90	190	426	1.2	59	196	195	94	182	457	1.2	81	80 TW							
199	198	84	202	401	1.4	36	120 TW	201	200	87	195	440	1.4	48	189	188	89	180	449	1.4	65	196	195	94	182	497	1.3	85	120 TW							

SPECIAL NOTES

1. Climb at 100% RPM.
2. Multiply nautical units by 1.15 to obtain statute units.
3. Read lower half of chart opposite effective wind only.
4. Make additional allowances for landing, navigational errors, combat, formation flight etc., as required.
5. When using JP-1 fuel, for normal operation multiply the range by 1.03. When using gasoline (MIL-F-5572), for normal operation multiply the range by .92.

DATA AS OF: 1-6-51

EXAMPLE

If you are at 10,000 feet with 300 gallons of available fuel, you can fly 285 nautical airmiles by holding 254 knots CAS. However, you can fly 485 nautical airmiles by immediately climbing to 35,000 feet using 100% RPM. At 35,000 feet cruise at 209 knots CAS and start letdown 54 nautical airmiles from destination. With a 80 knot headwind the range at 35,000 feet will be 485 x .8 or 390 nautical airmiles. Cruise at 224 knots CAS with this wind and start letdown 49 nautical airmiles from destination.

BASED ON: FLIGHT TEST WITH J33-A-23 ENGINE

LEGEND

EFFECTIVE WIND — HW, Headwind; TW, Tailwind — KNOTS

R.F. — Range Factor = $\frac{\text{GROUND DISTANCE (Effective Wind)}}{\text{RANGE IN AIRMILES (Zero Wind)}}$

G.S. — Ground speed in Knots
IAS — Indicated airspeed in Knots
CAS — Calibrated airspeed in Knots
GAL/HR — Fuel consumption — Gallons per hour
RANGE — Nautical miles
BASED ON MIL-F-5624 (Grade JP-4) FUEL

FUEL DENSITY: 6.5LB/GAL

Figure A-19 (Sheet 2 of 2) — Flight Operation Instruction Chart

AIRCRAFT MODEL(S)
T-33A

ENGINE(S) J33-A-23 or -35

FLIGHT OPERATION INSTRUCTION CHART
STANDARD DAY

CHART WEIGHT LIMITS 11,750 TO 9,450 POUNDS

EXTERNAL LOAD ITEMS
NONE

NUMBER OF ENGINES OPERATING: ONE

INSTRUCTIONS FOR USING CHART: (A) IN FLIGHT — Select figure in fuel column equal to or less than fuel available for cruise (fuel on board minus allowance for reserve, combat, navigational error, formation flight, etc.). Move horizontally right or left to section according to present altitude and read total range available (no wind) by cruising at that altitude or by climbing to another altitude of maximum range. For a flight at initial altitude, operating instructions are given directly below. For a flight at higher altitude, climb immediately to desired altitude and read cruising instructions in appropriate cruising altitude section. (B) FLIGHT PLANNING — From initial fuel on board subtract fuel for take-off and climb to desired cruising altitude and all other necessary allowances. Then use chart as for IN FLIGHT above, adding initial climb distances to range values.

NOTES: Ranges shown at optimum altitudes are maximum. In order to obtain maximum range on flights requiring more than one chart (due to external configuration or gross weight changes), it is necessary to observe the optimum cruising altitude on each chart; i.e., when changing charts a climb may be required to obtain a maximum range. All range values include allowances for descent distance and fuel. Climb distance and fuel are included where climbs are indicated.

DATA BELOW CONTAIN NO FUEL RESERVE FOR LANDING

DATA AS OF: 1-6-51

BASED ON: FLIGHT TEST WITH J33-A-23 ENGINE

LOW ALTITUDE

IF YOU ARE AT S. L.			FUEL U. S. GAL.	IF YOU ARE AT 5000′			IF YOU ARE AT 10,000′			IF YOU ARE AT 15,000′			FUEL U. S. GAL.	IF YOU ARE AT 20,000′		
RANGE IN AIRMILES				RANGE IN AIRMILES			RANGE IN AIRMILES			RANGE IN AIRMILES				RANGE IN AIRMILES		
BY CRUISING AT S. L.	OPT.ALT. 1000 FT.	BY CRUISING AT OPT.ALT.		BY CRUISING AT 5000′	OPT.ALT. 1000 FT.	BY CRUISING AT OPT.ALT.	BY CRUISING AT 10,000′	OPT.ALT. 1000 FT.	BY CRUISING AT OPT.ALT.	BY CRUISING AT 15,000′	OPT.ALT. 1000 FT.	BY CRUISING AT OPT.ALT.		BY CRUISING AT 20,000′	OPT.ALT. 1000 FT.	BY CRUISING AT OPT.ALT.
(RANGE FIGURES INCLUDE ALLOWANCES FOR PRESCRIBED CLIMB AND DESCENT TO SEA LEVEL) [1]																
(250)	(35)	(570)	353	(290)	(35)	(595)	(340)	(35)	(620)	(400)	(35)	(640)	353	(475)	(35)	(665)
(250)	(35)	(565)	350	(285)	(35)	(590)	(335)	(35)	(610)	(395)	(35)	(635)	350	(470)	(35)	(655)
215	35	475	300	245	35	495	290	35	520	(345)	(35)	(540)	300	(405)	(35)	(560)
180	35	380	250	205	35	400	240	35	420	285	35	440	250	340	35	460
140	35	285	200	165	35	305	195	35	325	230	35	345	200	275	35	365
105	30	185	150	125	35	210	145	35	225	175	35	245	150	210	35	265
70	15	95	100	85	15	105	100	20	120	120	25	140	100	140	35	175
35	—	—	50	45	—	—	55	—	—	65	—	—	50	75	—	—

CRUISING AT S.L.							EFFECTIVE WIND KNOTS	CRUISING AT 5000′							CRUISING AT 10,000′							CRUISING AT 15,000′							EFFECTIVE WIND KNOTS	CRUISING AT 20,000′						
		APPROXIMATE								APPROXIMATE							APPROXIMATE							APPROXIMATE							APPROXIMATE					
IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.
							120 HW																						120 HW	296	293	90	314	271	.7	18
							80 HW	319	316	85	428	259	.7	3	314	311	87	389	277	.7	8	310	307	89	357	300	.8	14	80 HW	288	285	89	300	301	.8	19
304	301	80	428	261	.9	0	40 HW	303	300	83	400	282	.9	4	298	295	85	364	299	.9	9	293	290	87	327	319	.9	14	40 HW	279	276	88	287	330	.9	20
298	295	79	415	295	1.0	0	0	288	285	81	378	306	1.0	4	282	279	83	339	322	1.0	9	276	273	85	303	338	1.0	15	0	270	268	87	275	360	1.0	21
292	289	78	403	329	1.1	0	40 TW	274	272	79	357	332	1.1	4	267	265	81	316	345	1.1	9	258	256	83	281	359	1.1	16	40 TW	252	250	85	252	376	1.1	22
							80 TW	256	258	77	341	357	1.3	5	251	249	79	298	368	1.3	10	232	231	80	251	368	1.3	17	80 TW	243	241	84	242	404	1.3	24
							120 TW																						120 TW	221	220	82	223	417	1.4	25

Figure A-20 (Sheet 1 of 2) — Flight Operation Instruction Chart

AIRCRAFT MODEL(S) T-33A

ENGINE(S): J33-A-23 or -35

HIGH ALTITUDE

CHART WEIGHT LIMITS 11,750 TO 9,450 POUNDS

EXTERNAL LOAD
NONE

NO. OF ENGINES OPERATING: ONE

IF YOU ARE AT 25,000'			FUEL U. S. GAL.	IF YOU ARE AT 30,000'			IF YOU ARE AT 35,000'			IF YOU ARE AT 40,000'			FUEL U. S. GAL.	IF YOU ARE AT 45,000'		
RANGE IN AIRMILES				RANGE IN AIRMILES			RANGE IN AIRMILES			RANGE IN AIRMILES				RANGE IN AIRMILES		
BY CRUISING AT 25,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 30,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 35,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 40,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 45,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.
(RANGE FIGURES INCLUDE ALLOWANCES FOR PRESCRIBED CLIMB AND DESCENT TO SEA LEVEL) [1]																
545	35	685	353	615	35	705	720	35	—	785	40	—	353			
545	35	680	350	610	35	695	715	35	—	775	40	—	350			
465	35	575	300	525	35	600	615	35	—	670	40	—	300			
390	35	480	250	440	35	500	515	35	—	560	40	—	250			
315	35	385	200	355	35	400	415	35	—	455	40	—	200			
240	35	285	150	270	35	300	315	35	—	350	40	—	150			
165	35	190	100	185	35	205	220	35	—	240	40	—	100			
90	—	—	50	100	—	—	120	35	—	135	40	—	50			

CRUISING AT 25,000'							EFFECTIVE WIND KNOTS	CRUISING AT 30,000'							CRUISING AT 35,000'							CRUISING AT 40,000'							EFFECTIVE WIND KNOTS	CRUISING AT 45,000'						
		APPROXIMATE								APPROXIMATE							APPROXIMATE							APPROXIMATE							APPROXIMATE					
IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		IAS	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.
281	278	91	281	283	.7	26	120 HW	263	261	92	249	290	.7	35	237	235	92	208	284	.7	48	217	216	96	200	296	.7	67	120 HW							
273	271	90	267	313	.8	27	80 HW	256	254	91	238	320	.8	37	237	235	92	208	324	.8	51	211	210	95	189	325	.8	71	80 HW							
265	263	89	255	342	.9	29	40 HW	256	254	91	238	360	.9	39	229	228	91	198	353	.9	54	211	210	95	189	365	.9	76	40 HW							
256	254	88	244	369	1.0	30	0	247	245	90	227	386	1.0	41	229	228	91	198	393	1.0	57	211	210	95	189	405	1.0	80	0							
246	244	87	233	396	1.1	32	40 TW	247	245	90	227	426	1.1	43	229	228	91	198	433	1.1	60	211	210	95	189	445	1.1	84	40 TW							
236	234	86	223	421	1.2	33	80 TW	247	245	90	227	466	1.2	45	219	218	90	189	456	1.2	63	211	210	95	189	485	1.2	89	80 TW							
223	222	85	212	445	1.4	36	120 TW	236	234	89	216	490	1.3	47	219	218	90	189	496	1.3	66	211	210	95	189	525	1.3	94	120 TW							

SPECIAL NOTES

1. Climb at 100% RPM.
2. Multiply nautical units by 1.15 to obtain statute units.
3. Read lower half of chart opposite effective wind only.
4. Make additional allowances for landing, navigational errors, combat, formation flight etc., as required.
5. When using JP-1 fuel for normal operation multiply the range by 1.03. When using gasoline (AN-F-48) for normal operation multiply the range by .92.

DATA AS OF: 1-6-51

EXAMPLE

If you are at 10,000 feet with 300 gallons of available fuel, you can fly 290 nautical airmiles by holding 279 knots CAS. However, you can fly 520 nautical airmiles by immediately climbing to 35,000 feet using 100% RPM. At 35,000 feet cruise at 228 knots CAS and start letdown 57 nautical airmiles from destination. With a 80 knot headwind the range at 35,000 feet will be 520 x .8 or 415 nautical airmiles. Cruise at 235 knots CAS with this wind and start letdown 51 nautical airmiles from destination.

BASED ON: FLIGHT TEST WITH J33-A-23 ENGINE

LEGEND

EFFECTIVE WIND — HW, Headwind TW, Tailwind.

R.F. — Range Factor = $\frac{\text{GROUND DISTANCE (Effective Wind)}}{\text{RANGE IN AIRMILES (Zero Wind)}}$

G.S. — Ground speed in Knots
IAS — Indicated airspeed in Knots
CAS — Calibrated airspeed in Knots
GAL/HR — Fuel consumption — Gallons per hour
RANGE — Nautical miles
( ) — Possible only if tip tanks are dropped when empty.

BASED ON — MIL-F-5624 (Grade JP-4) FUEL.
FUEL DENSITY — 6.5 LB/GAL

Figure A-20 (Sheet 2 of 2) — Flight Operation Instruction Chart

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AN 01-75FJA-1G

SAFETY OF FLIGHT SUPPLEMENT

FLIGHT HANDBOOK
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F-80A-1, -5, -10
RF-80A-5, -10, -15, -20, -25
AIRCRAFT

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★

30 SEPTEMBER 1953

1. PURPOSE.

This supplement contains information on the effect of 230-gallon tip tanks on the take-off distances and flying characteristics of the subject aircraft.

2. INSTRUCTIONS.

a. For subject aircraft using 230-gallon tip tanks, the take-off distances may be determined by multiplying the values contained in the TAKE-OFF DISTANCES chart of the Flight Handbook by a factor of 1.15.

b. The 230-gallon tip tanks have very little effect on the aircraft's flying characteristics. Uneven transfer of fuel from the tip tanks causes wing heaviness, but this can usually be trimmed out with the aileron tab. However, if the fuel differential is more than 150 gallons, the wings can not be kept level for landings and the tip tanks should be dropped. If uneven feeding of the tanks is suspected, the aircraft should be stalled (at about 15,000 feet) to determine whether or not it is safe to land. If in doubt, jettison the tip tanks.

END

SAFETY OF FLIGHT

AN 01-75FJA-1F

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10 SEPTEMBER 1953

1. PURPOSE.

This supplement outlines the procedure to be followed if a split flap is experienced i.e., one flap extended and the other in the up position.

2. INSTRUCTIONS.

In the event of split flap operation, the aircraft cannot be controlled with aileron boost off. If difficulty is experienced after actuating the flap switch to the "extend" position, insure that aileron boost is on and immediately place the flap switch in the up position.

SAFETY OF FLIGHT

SECURITY INFORMATION — RESTRICTED

AN 01-75FJA-1D

SAFETY OF FLIGHT SUPPLEMENT

FLIGHT HANDBOOK

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10 JULY 1953

1. PURPOSE.

This supplement restricts use of the ejection seat unless the canopy is separated from the aircraft.

2. GENERAL.

On aircraft with interrelated seat ejection and canopy jettison controls, no attempt should be made to eject through the canopy. Because of this interrelation of the controls, there is too great a danger that the seat will not go through the canopy or that it will go through in such a way as to injure the pilot.

3. INSTRUCTIONS.

The seat ejection control will not be operated unless the canopy has been jettisoned. If the canopy fails to separate from the aircraft, effect a bail out procedure without the actuation of the ejection seat.

SAFETY OF FLIGHT

AN 01-75FJA-1

HANDBOOK
FLIGHT OPERATING INSTRUCTIONS

USAF SERIES
F-80A-1, -5, -10
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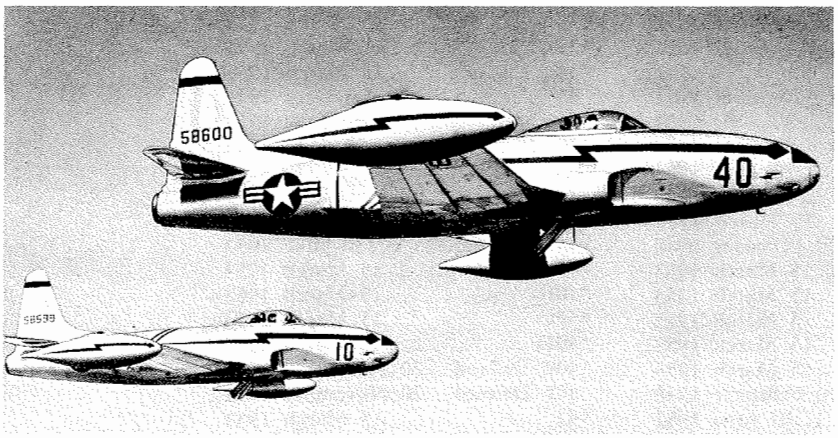

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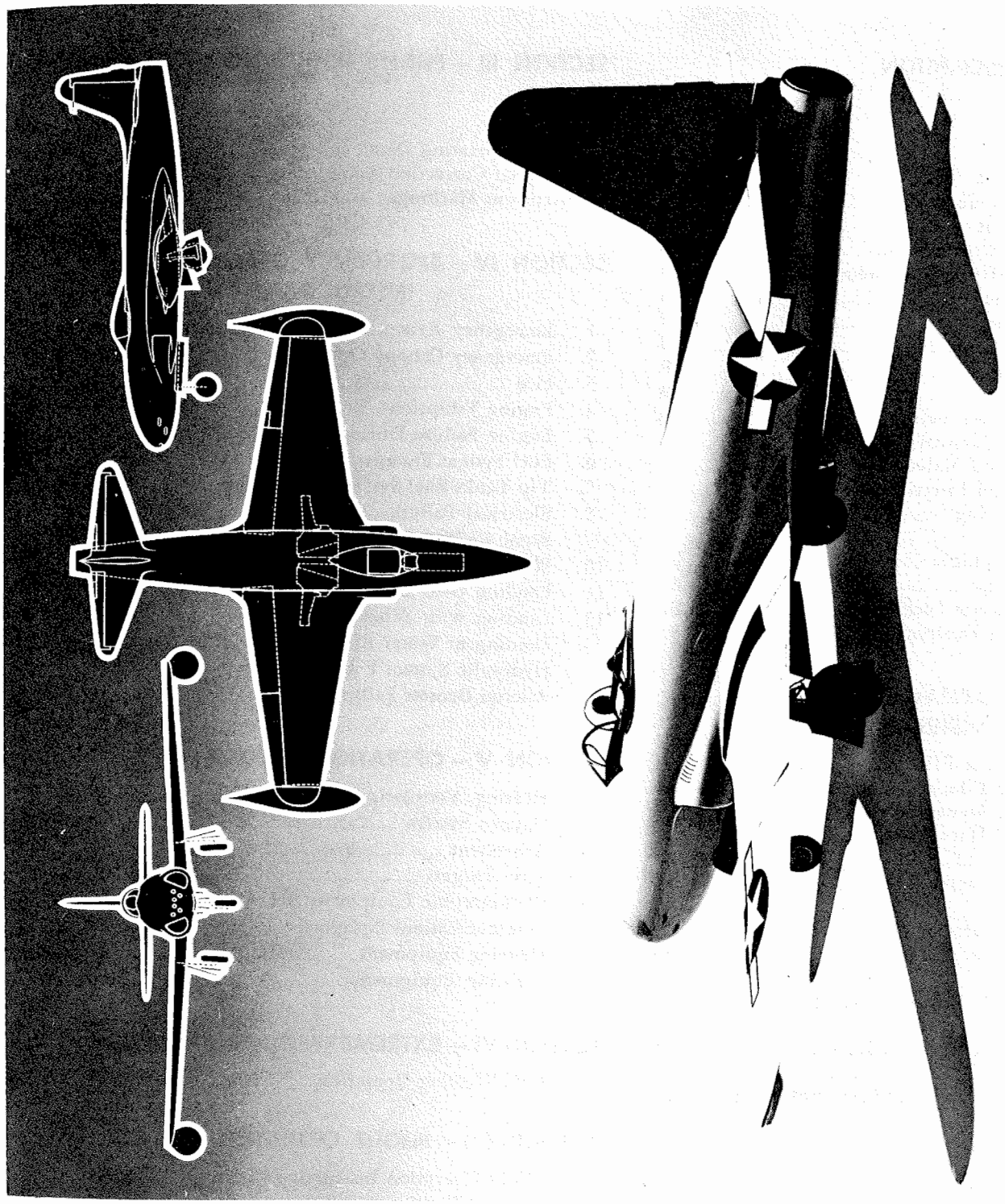


Figure 1 — The Airplane

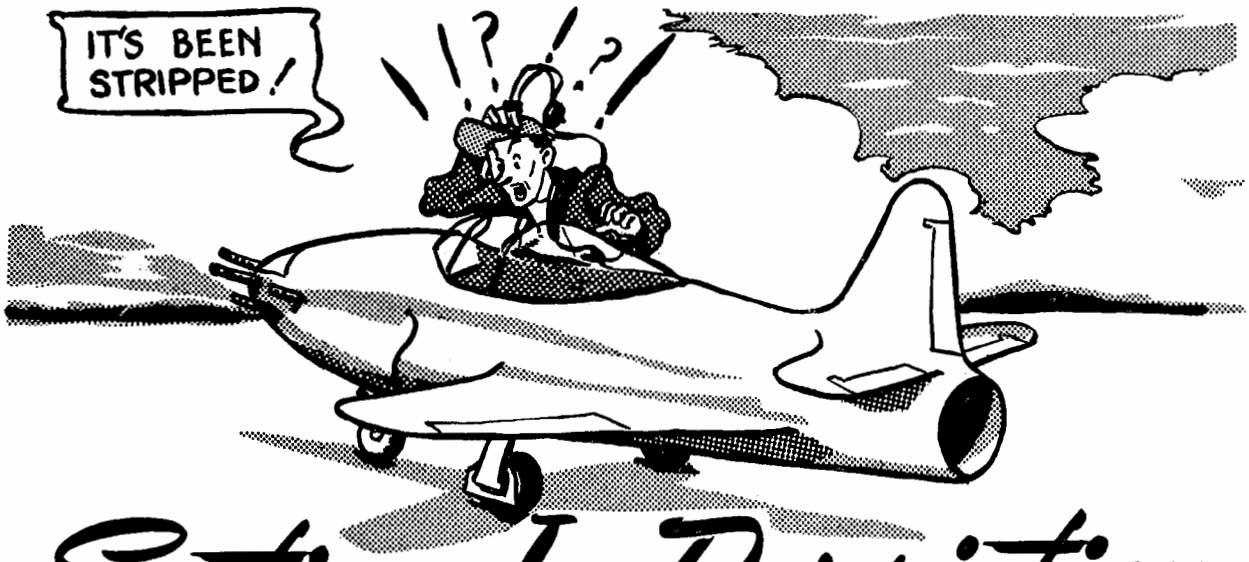
IMPORTANT

In order that you will gain maximum benefits from this handbook it is important that you read this page carefully.

This handbook contains all the information necessary for safe and efficient operation of F-80A and RF-80A series airplanes. These instructions do not teach basic flight principles, but are designed to provide you with a general knowledge of the airplane, its flight characteristics, and specific normal and emergency procedures to be used in operating the airplane and its related equipment. Your flying experience is recognized, and elementary instructions have been avoided.

Each pilot is provided with his own personal copy of the handbook, which will be his source of technically accurate and currently revised information. However, it takes a certain amount of time to get new data into the handbook. When flight or personal safety is involved, the "Immediate Attention" technical order system is employed. It is therefore essential that you arrange to be on automatic distribution for the following series of technical orders:

01-75FJ covers all F-80 models
01-75FJA covers F-80A and RF-80A aircraft only



Section I - Description

1. GENERAL.

a. TYPE.—The F-80A airplane is a single place jet propelled fighter airplane provided with six .50 calibre machine guns mounted in the nose. The RF-80A is the photographic version of the F-80A on which the entire armament nose section is replaced by a camera nose section. Airplanes referred to as "modernized" airplanes are F-80-A-1, F-80A-5, F-80A-10, RF-80A-5 or RF-08A-10 airplanes which have been modernized in accordance with applicable technical orders and directives. In addition, some F-80A airplanes have been converted for photographic use and designated RF-80A-15 and some RF-80A airplanes have been equipped with later series engines and designated RF-80A-20 and RF-80A-25.

b. MAIN DIFFERENCE TABLE

Item	*F-80A-1*	*F-80A-5* *RF-80A-5*	*F-80A-10* *RF-80A-10, -15*	*RF-80A-20* *RF-80A-25*
Engine	*J-33-A-9A *J-33-GE-11A *J-33-A-17	*J-33-A-9A *J-33-GE-11A *J-33-A-17	*J-33-A-9B *J-33-GE-11B *J-33-A-17A *J-33-A-21	J-33-A-35
Automatic Starting Sequence	No	No	No	Yes
Water Injection	No	No	Yes	Yes
Provision for Jato	No	No	Yes	Yes
Eng. Shut-off Valve Control	Yes	No	No	No
Hydraulic Fuse	No	Yes	Yes	Yes
Cabin Cooler	No	No	Yes	Yes
Aux. Windshield Defrost. Provisions	No	No	Yes	Yes
Emer. Fuel Pump Sw. Overrides Battery and Generator Switch	Yes	Yes	No	No
Radio Equipment**	Beacon Receiver BC-1206	BC-1206 or Radio Compass AN/ARN-6or-7	Radio Compass AN/ARN-6or-7	Radio Compass AN/ARN-6or-7
Radar Equipment	No	No	No	AN/APW-11 with AN/APA-90
Max. Gross Weight (Approx.)	14,500 lb.	14,500 lb.	15,300 lb.	15,300 lb.

* All these engines are interchangeable with each other. However if a water injection engine (J-33-A-9B, J-33-GE-11B, J-33-A-17A, or J-33-A-21) is installed in an F-80A-1, F-80A-5, or RF-80A-5, the water injection system is made inoperative.

**This equipment in addition to basic AN/ARC-3 (or AN/ARC-27) and SCR-695 (or AN/APX-6).

2. FLIGHT CONTROLS.

a. CONTROL SURFACES.

(1) Operation of ailerons, elevator, and rudder controls is conventional. The aileron forces are reduced by a hydraulic aileron booster unit. This control force reduction is effective about two degrees on either side of the neutral stick position. This system does not destroy the "feel" of the aileron control as it supplies only a fixed portion of the total force required. The remaining force applied by the pilot changes normally with changes in speed and rate of roll.

(*a*) A manually operated shut-off valve is provided for shutting off hydraulic pressure to the aileron booster in an emergency. The valve is controlled by a lever on the left hand shelf (24A, figure 6A). The forward position shuts off hydraulic pressure to the aileron booster system, whereas the aft position allows the aileron boost system to be operative.

(2) The elevator forces are reduced by the elevator spring tab and the elevator servo tab.

(*a*) A spring in the elevator control system acts to assist holding the elevator in either the "UP" or the "DOWN" position. This arrangement gives a peculiar feel to the control on the ground only. That is, considerable force will be required to move the elevator. After it has passed approximately the 35 degrees "UP" position, the elevator will stay "UP" of its own accord. The presence of the spring is not noticeable in flight.

(*b*) The spring-loaded elevator tab acts to assist the pilot whenever the force on the control stick exceeds approximately five pounds.

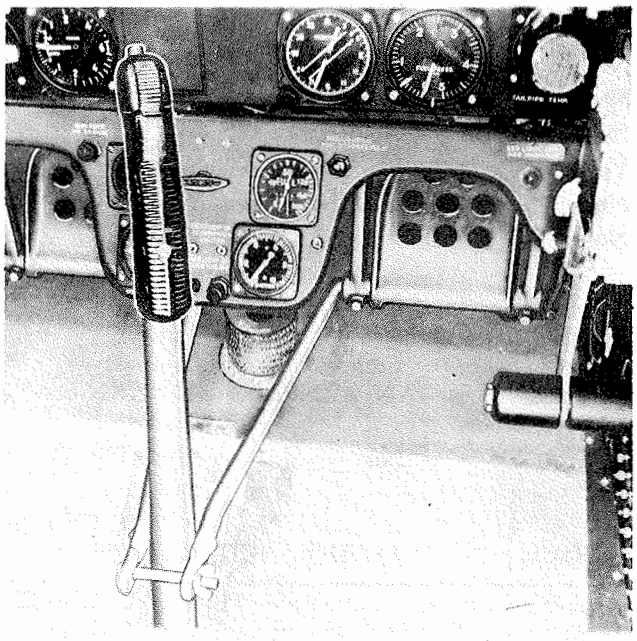
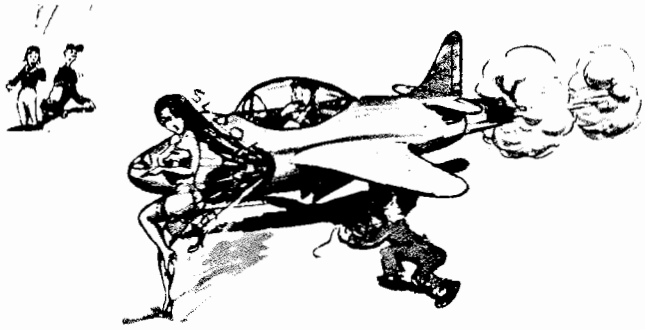


Figure 2 — Control Surface Lock



KEEP FOREIGN OBJECTS OUT OF INTAKE DUCTS

(3) The rudder is spring loaded toward the neutral position.

b. CONTROL SURFACE LOCK — The surface control lock consists of a bracket to the rudder pedals and the control stick by means of a thumbscrew (figure 2).

c. TRIM TABS.

(1) Trim tabs on the left aileron and on the elevator are electrically operated. The electric motors are controlled by switches in the cockpit.

(*a*) Aileron tab switch (2, figure 6 and 6A).

(*b*) Elevator tab switch (20, figure 7 and 30, figures 7, 7A, and 7A-1).

Note

Some airplanes have aileron and elevator trim tab controls in a combination switch on the top of the control stick.

CAUTION

Although spring loaded to the OFF position, the elevator and aileron trim tabs switch must be actuated and returned to neutral by the use of thumb pressure to insure return of switch to neutral.

(2) An indicator light (29, figures 7, 7A, and 7A-1) glows when the elevator tabs are in the neutral position.

(3) The rudder tab is not controllable from the cockpit.

Note

The tab motors and the wing flap motors coast for about 3 seconds after the switches are turned off. The lift of these motors will be increased if they are allowed to stop rotating before being reversed.

d. WING FLAPS.

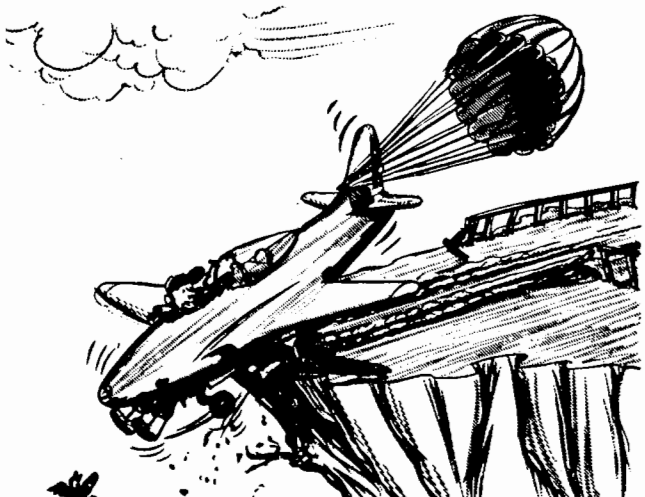
(1) The wing flaps are operated by a switch (10, figures 6 and 6A), which control two electric motors, one for each flap. The wing flap position indicator (11, figure 6 and 6A) shows the positions of the flaps at all times.

(2) The left and right wing flaps are interconnected so that either motor may operate both flaps if the other motor should fail. There is no emergency mechanical wing flap extension system on this airplane.

3. LANDING GEAR CONTROLS.

a. The landing gear is controlled by a lever (29, figures 6 and 6A) and is actuated by normal or emergency hydraulic pressure. The button on the end of the lever must be pushed in before the lever can be moved. While the airplane is resting on the landing gear an automatic downlock device prevents moving the landing gear lever out of the "DOWN" position. This downlock can be disengaged in an emergency, when it is desired, by simultaneously pushing down the release control (27, figures 6 and 6A) and moving the landing gear lever to "UP."

b. The main and nose landing gears are equipped with uplocks and downlocks. The operation of these locks is completely automatic.



THERE ARE NO EMERGENCY BRAKING PROVISIONS ON THIS AIRPLANE!

c. Two lights (26, figure 7 and 5, figures 7A and 7A-1) indicate the landing gear position. The green light is on whenever the landing gear is in "DOWN" and "LOCKED." The red light comes on and a warning horn sounds if the throttle is closed when the landing gear is *NOT* "DOWN" and "LOCKED." The horn may be silenced by pushing the switch (16, figures 6 and 6A). The switch is automatically reset when the throttle is opened.

d. A "stiff knee" clip is provided for installation, by ground personnel, on the spring cartridge located between the parallel drag struts on each leg of the landing gear to prevent accidental retraction when the airplane is on the ground.

4. BRAKE CONTROLS.

The brakes are operated by conventional toe brake pedals. A parking brake (25, figure 7, and 26, figures 7A and 7A-1) locks the brakes for extended periods. There are no emergency braking provisions on this airplane.

5. HYDRAULIC SYSTEM CONTROLS.

a. The hydraulic pump is driven by the engine.

b. Hydraulic power is used to operate the aileron booster, the landing gear, and the dive flaps.

c. A hydrofuse has been installed in the hydraulic systems of late airplanes. The purpose of this fuse is to automatically shut off hydraulic fluid to the landing gear and dive flaps in the event of a serious leak in either system. The aileron booster is not affected by the hydrofuse. A handle (35, figures 7, 7A and 7A-1) is installed to permit manual resetting of the fuse; however, it has been safety-wired to the open position.

6. EMERGENCY HYDRAULIC SYSTEM.

a. An emergency hydraulic system is provided for lowering the landing gear. The emergency system reservoir contains enough fluid for only one complete extension of the gear. Return fluid from this system is dumped into the main system making it impossible to accomplish more than one extension without refilling the reservoir.

b. A hand pump (13, figures 8 and 8A) provides pressure for the emergency system.

c. The emergency selector valve (12, figures 8 and 8A) opens and closes the line between the hand pump and the landing gear cylinders. The landing gear selector valve (12, figures 8 and 8A) must be used in conjunction with the emergency selector valve to permit the fluid trapped in the cylinders to return to the main reservoir.

7. DIVE FLAP CONTROLS.

The dive flaps are controlled by a switch (9, figures 6 and 6A) which operates an electrically actuated hydraulic valve. It is not possible to stop the dive flaps in any intermediate position; they must be either "full up" or "full down."

8. ELECTRICAL CONTROLS.

a. GENERAL.

(1) The electrical system is in operation whenever the battery switch (3, figures 8 and 8A) and the generator switch (4, figures 8 and 8A) are in the "ON" position.

Note

(Early Airplanes Only)

Operation of the emergency fuel pump automatically bypasses the generator switch and causes the generator to operate whenever the emergency fuel pump is "ON."

b. CIRCUIT BREAKERS.

(1) Each electrical circuit in the airplane is protected by a thermal circuit breaker (8, figures 6 and 6A and 16, figures 8 and 8A). The circuit breakers may be reset by pushing the button for the circuit that has failed. The generator and hydraulic pump circuit breaker is not accessible to the pilot in flight.

(2) On photographic airplanes, circuit breakers for the blinker lights, vacuum pumps, camera bays, radio compass, inverter, and VHF radio are not accessible to the pilot in flight.

c. EXTERNAL POWER SUPPLY CONNECTION. The external power supply plugs into a socket in the aft end of the right wing fuselage fillet. A double socket is provided to permit attaching two battery carts, if necessary, on some airplanes.

d. EMERGENCY BATTERY DISCONNECT. The emergency battery disconnect switch handle (figure 17) is located behind and to the right of the pilot's seat. Operation of the switch disconnects all the electric circuits from the battery. After operation, the switch cannot be reset in flight.

9. FUEL SYSTEM CONTROLS.

a. GENERAL.

(1) All the fuel is carried in four groups of tanks, the drop tanks (attached to the wing tips), the wing leading edge tanks (commonly called "leading edge tanks"), the main wing tanks (called "wing tanks"), and the fuselage tank. JP-4 fuel in accordance with MIL-F-5624 will be used for all normal operation (including starting) and gasoline in accordance with MIL-F-5572, lowest grade available gas, as an alternate in those airplanes converted for JP-4 fuel.

FUEL QUANTITY DATA (GALS.)

Tanks	No.	Usable Fuel (each)	Fully Serviced	*Expansion Space (each)	Total Volume (each)
FUSELAGE	1	207	207.5**	0	207.5
LEADING EDGE	2	44	47.0	0	47
WING	2	65	65.5	0	65.5
DROP	2	165	165.5	0	165.5
	2	230	230.5	0	230.5

* All tanks have the usual expansion space; however, this is not available for stuffing purposes since fuel in this space drains overboard.

** The unuseable fuel may increase to approximately 10 gallons during a Wave-off and to higher values during a zoom.

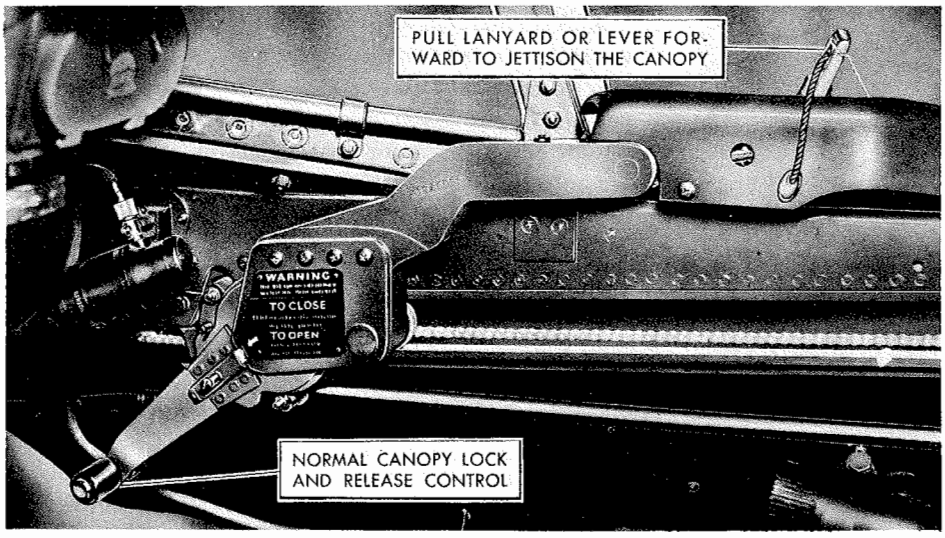


Figure 3—
Canopy Controls
(MANUAL CANOPY ONLY)

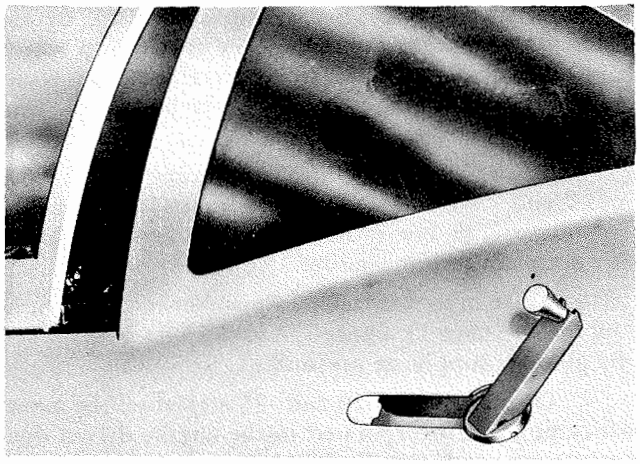


Figure 4—External Canopy Crank
(MANUAL CANOPY ONLY)

(2) Under normal operating conditions, all fuel is transferred to the fuselage tank before being fed to the engine. This fuel transfer is automatically controlled by three float valves within the fuselage tank. The leading edge tank float valve and the wing tank float valve are located one and two inches, respectively, below the drop tank float valve. Whenever the fuel level of the fuselage tank is above any of the floats, the respective tank valve will close. The fuselage tank fuel level is maintained at each float valve level until the corresponding group of tanks is empty.

CAUTION

(Except RF-80A-20 and -25)
In order to avoid damage to the transfer pumps in the leading edge tanks, the automatic operation as described above will not be used. The procedure listed in Section II will be used at all times.

(3) Under emergency operating conditions, fuel from the leading edge and wing tanks (not the drop tanks) may be made to bypass the fuselage tank. This bypass condition is controlled by a switch (30, figure 6) on some airplanes and by the fuselage tank switch on other airplanes.

(4) In case of complete electrical failure, fuel will be available only from the fuselage tank except in the case of late airplanes. On late airplanes, fuel will automatically feed from the drop tanks.

(*a*) If the fuselage tank bypass system is operating at the time electrical failure occurs, fuel will continue to be drawn through this system until one of the wing tanks (or leading edge tanks) is empty. At this time the engine driven fuel pump will probably draw air through the empty tank and engine flame-out will occur.

(*b*) On late airplanes, electrical system failure during fuselage tank bypass operation will automatically cause a change from bypass to normal operation.

(5) On winterized airplanes, the fuel system has been modified to permit the use of gasoline, Specification MIL-F-5572 (AN-F-48), in the left leading edge tank for starting purposes.

b. FUEL TANK SELECTOR SWITCHES.

(1) DROP TANKS.—The drop tank selector switch operates a valve which admits air pressure from the engine into the drop tanks. This air pressure forces fuel from the drop tanks into the fuselage tank when the drop tank float valve is open.

(2) LEADING EDGE TANKS.—The leading edge tank switch turns on a transfer pump in each leading edge tank. These pumps force fuel into the fuselage tank when the float valve is open. On winterized airplanes, a separate switch has been added to the left side of the cockpit between the oxygen regulator and the emergency fuel pump switch for the purpose of controlling the transfer pump in the left leading edge tank. The present leading edge tank switch controls the transfer pump in the right leading edge tank only and operates in the normal manner.

Note

F-80A and RF-80A aircraft, serial numbers 44-84992 thru 44-85466, which have been service modified to incorporate winterization changes, will vary from other winterized aircraft in that the gasoline starting switch will not actuate the fuel bypass control. Therefore, on these airplanes the bypass control must be placed in the bypass position for all gasoline operation.

(3) WING TANKS.—The wing tank switch turns on a transfer pump in each wing tank. These pumps force fuel into the fuselage tank when the wing tank float valve is open.

(4) FUSELAGE TANK (except RF-80A-20 and RF-80A-25).—The fuselage tank switch turns on the fuselage tank boost pump which supplies fuel pressure to the engine driven fuel pump. On late airplanes, this switch is also used to bypass the fuselage tank. On these airplanes, downward motion of the switch bypasses the fuselage tank and turns off the fuselage tank booster pump. Upward motion reverses this procedure.

(5) FUSELAGE TANK (RF-80A-20 and RF-80A-25 only).—The fuselage tank switch (20, figure 9B) has three positions. In the upward "FUS" position of the switch, the fuselage tank booster pump is turned on to supply fuel under pressure to the engine driven fuel pump. In the downward "BYPASS" position of the switch, the fuselage tank booster pump is shut off and the electrically operated bypass valves are reset, causing fuel in the wing tanks and leading edge tanks to bypass the fuselage tank. In the center "OFF" position of the switch, the fuselage tank bypass valves are set for normal operation but the fuselage tank booster pump is off.

c. FUEL TANK INDICATOR LIGHTS.

(1) An indicator light (19, figure 9B) for each group of tanks is located above the respective switch. The drop tank, leading edge tank and the wing tank indicator lights glow whenever the respective switches are "ON" and the fuel pressure in the lines is below the minimum. This drop in pressure occurs when the tank runs dry or when the source of transfer pressure fails.

(2) The fuselage tank indicator light is on whenever the fuselage tank boost pump is in operation.

(3) On winterized airplanes, an additional indicator light is located on the left side of the cockpit to indicate when the gasoline starting system is in operation and to prevent inadvertent take-off on gasoline.

d. FUEL QUANTITY INDICATORS.

(1) FUEL GAGE.—A fuel gage (23, figures 7, 7A and 7A-1) indicates the quantity of fuel in the fuselage tank only.

(2) LOW LEVEL WARNING LIGHT.—A low level light (22, figures 7, 7A and 7A-1) comes on when the fuselage tank level goes below approximately 100 U.S. gallons (83 Imperial gallons).

(3) FUEL QUANTITY COUNTER (RF-80A-20 and -25).—A fuel quanity counter (6, figure 9A) operates from a flow-meter in the main fuel line to the engine (see figure 5A). The counter dial must be set to read the total amount of fuel in the airplane each time the tanks are filled. The reading on the counter dial is in gallons of fuel remaining in the airplane.

Note

Serious error in calculating aircraft range may be made by pilots who rely on the fuel remaining counter system and are not familiar with its limitations. To enable the pilot to use the system with intelligence, the following information is given:

1. Accumulative errors in the instrument itself. These errors may assume considerable proportions.

2. The meter measures only fuel passing thru it. It does not measure fuel lost thru evaporation, leakage upstream, rapid climb, released with tip tanks, or bypassed during automatic starting or emergency operation.

3. Performance charts and the flowmeter calibration are based on JP4 fuel at standard atmospheric conditions. It is necessary to compensate for other values. Jet fuels can vary considerably in chemical makeup, temperature, and density.

4. Fuel Counters must be set to accurately reflect the fuel on board and all factors must be taken into consideration to determine range performance.

e. EMERGENCY FUEL PUMP.
(Except RF-80A-20 and -25)

The emergency fuel pump switch (5, figures 6 and 6A) turns on the emergency fuel pump which supplies operating fuel pressure directly to the throttle valve without regulation by either the barometric control or the overspeed governor.

The red indicator light (30, figures 7 and 32, figures 7 and 7A-1) burns when the pump is not supplying pressure, or not turned on, if the landing gear is down for take-off or landing.

The emergency fuel pump amber indicator light (30, figure 7 and 32, figures 7A and 7A-1) burns when the pump is supplying pressure.

On the RF-80A-20 and -25 airplanes, the emergency pump is incorporated in the engine driven dual fuel pump and supplies fuel pressure through the Rochester control. The emergency fuel system is controlled by the emergency fuel switch (see paragraph *10Cd).*

10. THROTTLE CONTROL.
(Except RF-80A-20 and -25)

a. The throttle (12, figures 6 and 6A) is the only power control on this airplane. The throttle regulates the fuel pressure to the burner fuel jets of the engine, and the resulting fuel pressure determines the rpm of the engine.

b. To obtain constant rpm engine operation at all altitudes, the burner ring fuel pressure must be decreased as the altitude is increased. A barometric control is installed in the airplane which automatically accomplishes the reduction in fuel pressure *except when the engine is operating on the emergency fuel pump.* The throttle, however, must be retarded slightly to prevent overspeeding the engine during a climb.

c. On late airplanes, the throttle lever also serves to shut off fuel to the engine burner ring. This shut-off is effective when the throttle is full aft in the position marked "OFF."

10A. STARTER SWITCH.
(Except RF-80A-20 and -25)

The starter switch (2, figures 8 and 8A) is a momentary contact switch with a center "OFF" position. Actuating the switch energizes an electric starter through a time delay circuit. The starter switch must be held in the start position until approximately 17% rpm is reached.

10B. IGNITION BOOSTER SWITCH
(Except RF-80A-20 and -25)

The ignition booster switch (1, figures 8 and 8A) has "ON," "OFF," and "NORMAL" positions. The "ON" position energizes the ignition system, as for air starting. The "OFF" position (center) permits starter operation without ignition. The "NORMAL" position provides for ignition coil operation when the starter motor is energized, as for ground starting.

10C. POWER PLANT CONTROLS.

(RF-80A-20 and -25 only)

a. GENERAL. The engine in these airplanes incorporates two separate fuel control systems, (figure 5A) with a dual engine driven fuel pump. One side of the pump supplies the normal fuel system, the other supplies the emergency fuel system. The pump is so designed that in the event one system fails, the other will continue supplying fuel to the engine. The normal fuel system control is known as the Bendix Control. The emergency system control is known as the Rochester Control. A pressure switch is installed to sense fuel pressure supplied by the normal fuel system control and a starting fuel sequence control is installed for automatic starting.

b. THROTTLE. The throttle (13, figure 9B) is the only power control on these airplanes. The throttle regulates the fuel pressure to the burner fuel jets of the engine, and the resulting fuel pressure determines the engine rpm. When the throttle is full aft in the position marked "OFF" it shuts off fuel to the engine burner ring, except that which goes thru the automatic starting fuel control.

c. The throttle is connected directly to the Bendix Control which attempts to maintain constant engine rpm for any throttle setting, regardless of altitude or airspeed. The Bendix Control is an all speed governor and a maximum throttle position stop is provided, which protects the engine from overspeeding whenever the engine is operating on the Bendix system alone. A throttle linkage is provided on the engine between the Bendix Control and the Rochester Control. The Rochester Control consists of a throttle, an altitude compensated relief valve (or Barometric), and a solenoid operated bypass valve. There is no overspeed governor in the emergency fuel system. The relief valve in the emergency fuel control is adjusted to provide approximately 100% engine rpm on a 100°F day. If the temperature is less than 100°F, less than 100% engine rpm will be available on the emergency system. On days 100°F or over, overspeeding may be possible on the ground. The altitude compensation in the emergency fuel control attempts to maintain constant engine rpm for a given throttle setting, regardless of changes in airplane altitude. However, in flight, overspeeding will generally be possible while operating on the emergency system. The solenoid operated bypass is normally open. Closing this valve puts the emergency fuel control into operation.

d. EMERGENCY FUEL SWITCH (5, figure 9B). This switch has three positions, "EMERGENCY," "OFF," and "TAKE-OFF and LAND." When this switch is placed in the "TAKE-OFF and LAND" position, the circuit is alerted so that if a *complete failure* of the main fuel system occurs, and the pressure on the normal system falls below the pressure switch setting (approximately 45 lbs.), automatic transfer to the emergency system is accomplished. This is the only condition under which automatic protection is realized. The setting of the switch is low enough so that with the throttle in the idle position, the emergency system is not actuated unless there is a definite failure in the normal system. When a *partial failure* in the normal system occurs, it may be necessary to manually position the switch to "EMERGENCY" since the pressure sensing incorporated in the system is set for pressures below idle, and consequently will not be energized until the fuel pressure drops below the idle range. Placing of the emergency fuel pressure switch in the "EMERGENCY" position will cause the emergency fuel system to override the main fuel system regardless of fuel pressure or engine speed, and it is necessary to switch to the "OFF" position to return control to the normal system. Throttle position and/or manipulation is necessary to reduce as much as possible the sudden power surge and temperature increase that will be encountered when the emergency system takes over, due to the parallel linkage between the main fuel control and the emergency control. Positioning the trottle as close as possible to the RPM indicated, will greatly reduce the power surge and temperature rise.

CAUTION

Accidental positioning of the emergency fuel pressure switch in the "EMERGENCY" position will result in reducing the life of the engine, and will possibly cause engine failure. To prevent this, a guard must be lifted in order to position the switch.

e. EMERGENCY FUEL SYSTEM INDICATOR LIGHTS (12, figure 9A). Three indicator lights are provided; one red, one green, and one amber. The red light comes on when the gear is down and the emergency fuel switch is in the "OFF" position. The green light turns on and the red light turns off when the emergency fuel switch is placed in the "TAKE-OFF and LAND" position. The amber light turns on, the green light continues to stay on, if the emergency fuel switch is in the "TAKE-OFF and LAND" position and the emergency fuel control is in operation. When the emergency fuel switch is placed in the "EMERGENCY" position, the green and amber lights come on and the red light goes out.

f. EMERGENCY FUEL CHECKOUT SWITCH (11, figure 9C). This switch, located on the right-hand shelf near the radio panel is provided to permit a complete ground check of the emergency fuel system. When this switch is actuated the main fuel pump supply is bypassed and at the same time power is supplied to operate the emergency fuel control *provided* the pressure switch closes as it should. This switch simulates a fuel system failure and demonstrates proper operation of the pressure switch. Unless the emergency fuel switch is in the "OFF" position this switch is inoperative.

g. STARTING FUEL SWITCH (2, figure 9B). These airplanes incorporate an automatic and a manual engine starting system. The automatic starting system

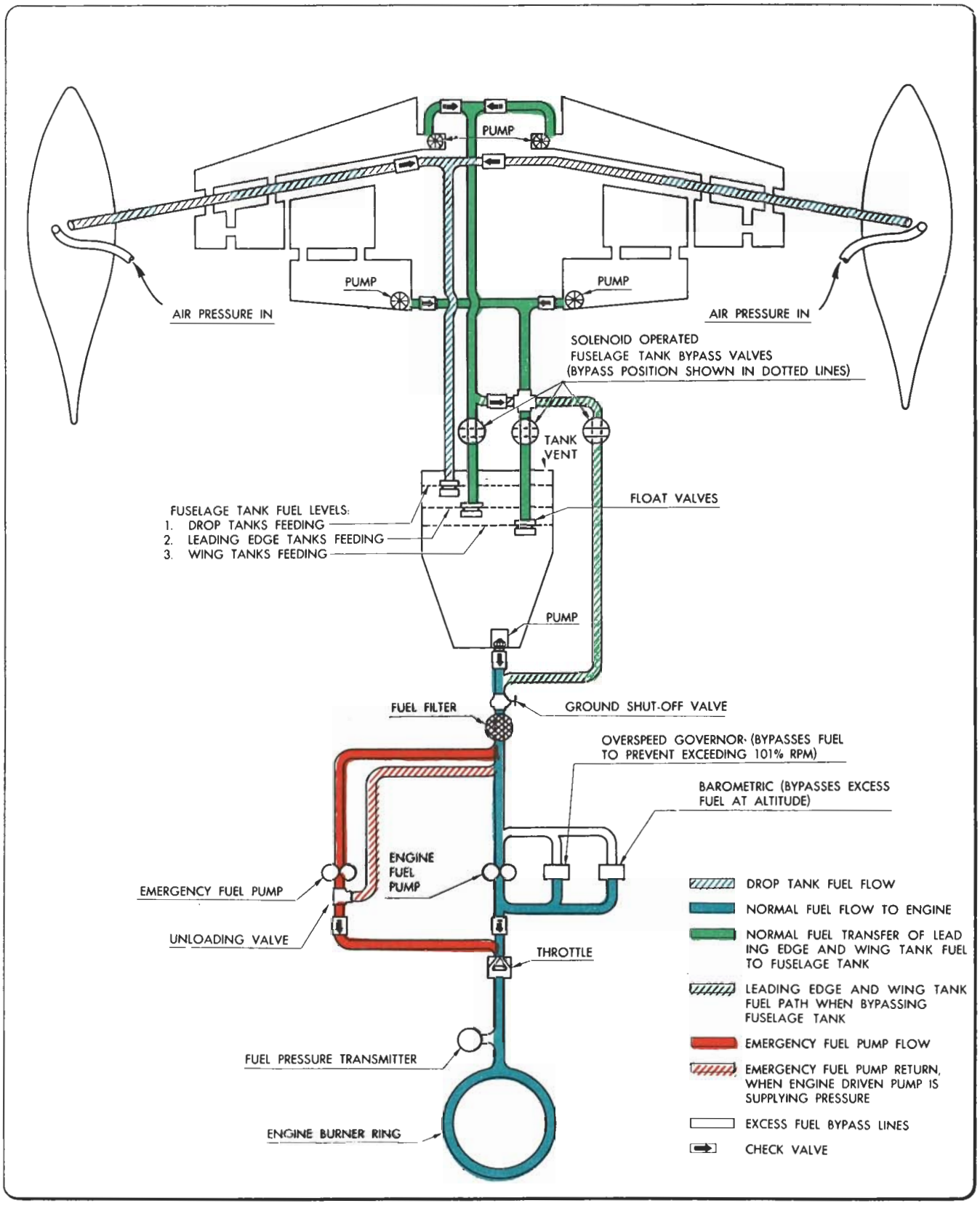


Figure 5 — Fuel Flow Diagram

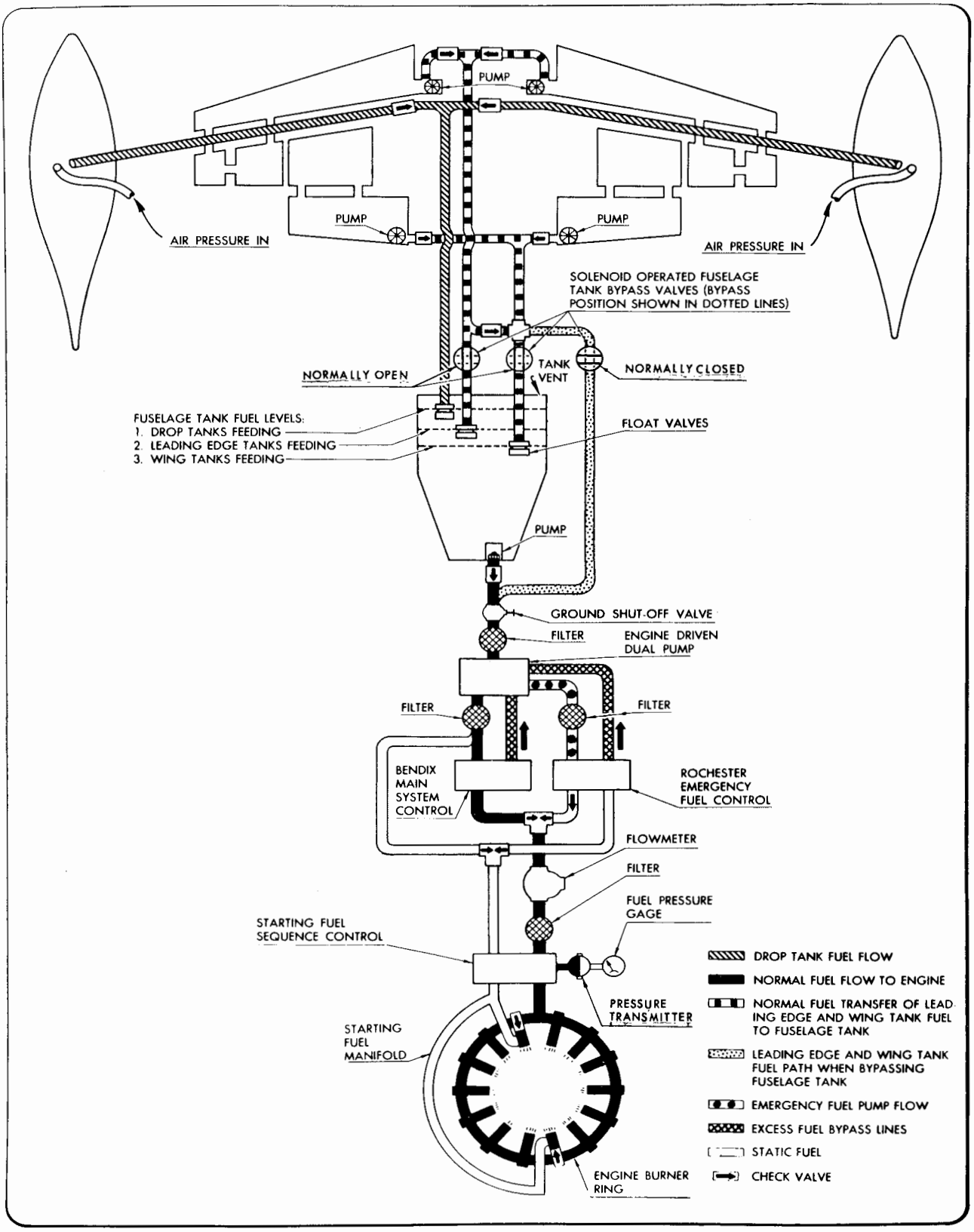


Figure 5A — Fuel Flow Diagram (RF-80A-20 and RF-80A-25)

is to be used as the normal starting procedure. When the switch is placed in the "MANUAL" position, the solenoid valve in the emergency fuel control is closed, causing the emergency fuel system to build up pressure. The bypass valve in the normal side of the main fuel pump remains closed allowing the normal system pressure to build up. When the switch is placed in "AUTO," the same changes take place as in the "MANUAL" position and in addition, the starting fuel control is energized allowing fuel to go first to the two burners which have ignitor plugs installed and then as the pressure biulds up to all other fuel nozzles. In the "OFF" position no fuel is available to the burners. It is necessary to return the switch to the "OFF" position when its function is completed.

CAUTION

If the starting fuel switch is left in "AUTO" when the engine is static or coasting and the electrical system is energized, fuel will drain or be pumped through the engine into the tailpipe or out of the manifold drain onto the ground. This can create a fire hazard.

b. AIR START IGNITION SWITCH (3, figure 9B). This switch is used to control the ignitor plugs during air starts. The ignition is turned on automatically whenever the starter is operated. In flight, ignition is accomplished by operating the air start ignition switch. Since the ignitor plug life is materially shortened by operation of the ignition, a time delay switch is incorporated to automatically limit the duration of the ignition to approximately 45 seconds. When the air start ignition switch is pushed to "START" and released, the ignition will continue for the duration of the time delay or until the guarded "NORMAL-OFF" ignition switch is turned to "OFF."

i. IGNITION "NORMAL-OFF" SWITCH (1, figure 9C). This switch is provided to permit operation of the starter without ignition and must be kept in the "NORMAL" position at all other times. When this switch is in the "OFF" position the air start ignition switch will not operate.

j. AUTOMATIC STARTER SWITCH (2, figure 9C). The starter switch operates automatically in that it does not have to be held in the "START" position but will continue to run until the engine reaches approximately 15% rpm and will then automatically shut off. If it is desired to stop the starter before it automatically cuts off, as in a false start, the switch must be pushed to the "STOP, START" position. The center position is "OFF."

11. ENGINE SHUT-OFF VALVE CONTROL.

On early airplanes, an engine shut-off valve (15, figure 6) is provided to shut off the flow of fuel to the engine burner ring.

On late airplanes, the separate shut-off control has been removed and its function has been incorporated in the throttle control.

12. WATER-ALCOHOL INJECTION AND FUEL FILTER DE-ICING.

a. WATER INJECTION SYSTEM. The system is independent and consists of two tanks of 30 U.S. gallons capacity each, an electrically driven pump, a combination filter and shut-off valve, a pressure transmitter and a ring of spray nozzles. Also included is an actuating cylinder which automatically shuts off pressurizing air to the cockpit while the water injection system is operating. This is to prevent noxious fumes from entering the cockpit.

b. Use of water injection will give increased thrust for short periods and is especially useful for short field take-offs or emergencies in warm weather. The use of fluid injection is prohibited at ground temperatures below +32°F.

CAUTION

If water injection is attempted shortly after the airplane is exposed to air temperatures colder than 10°F, the engine may become rough or the fluid may not flow at all. Therefore, complete water-alcohol supply must be used during take-off and initial climb if any part of the flight is to be conducted under that temperature.

WARNING

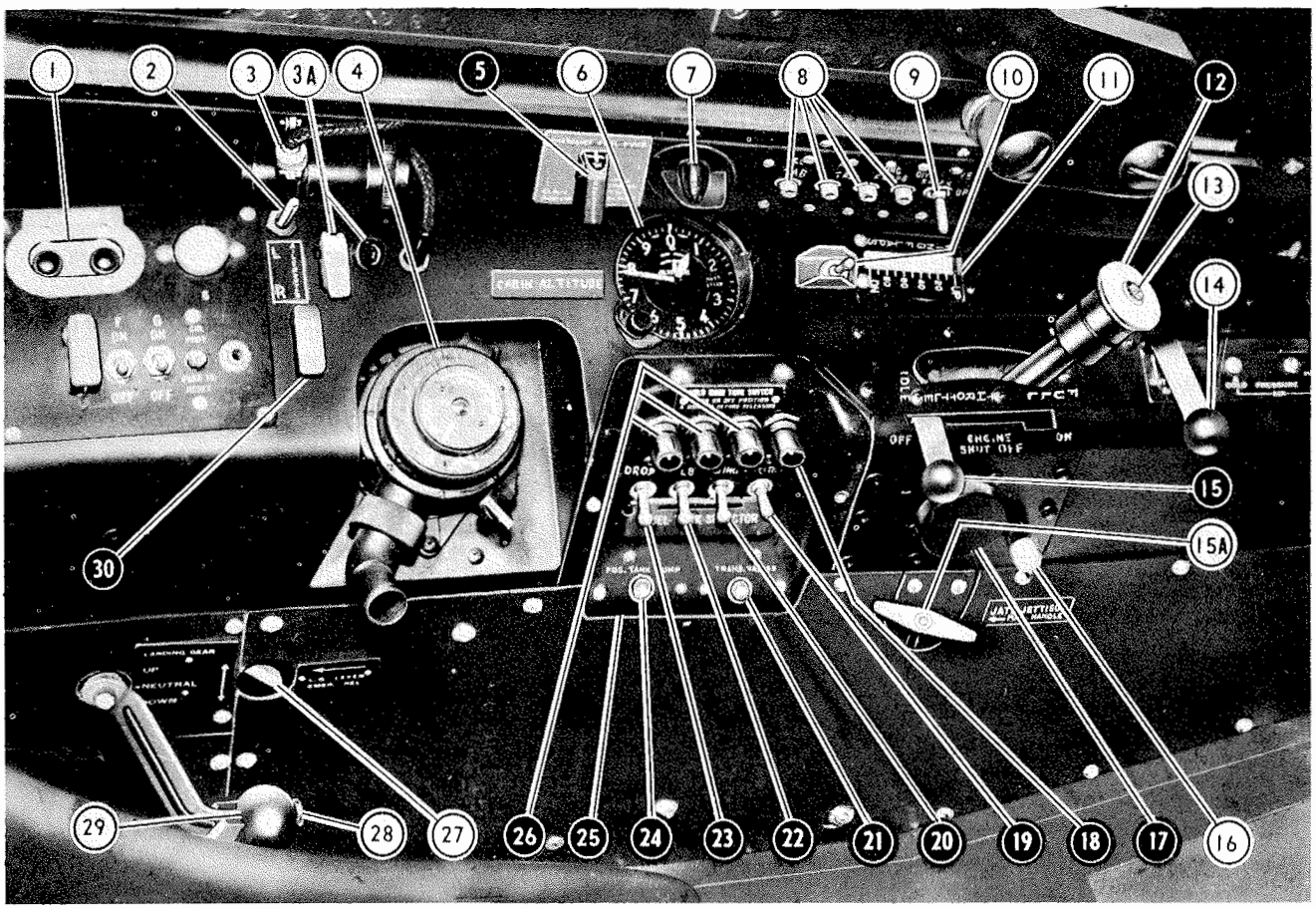
Never turn water injection switch on below 200 psi fuel pressure or above 10,000 feet altitude due to the possiblity of flame-out and engine damage.

c. WATER INJECTION SWITCH. The water injection switch on the left hand shelf (10B, figures 8 and 8A), turns on the electrically driven water injection pump, provided the throttle is almost fully advanced. The throttle is linked to another switch in series with the water injection switch which automatically opens the water pump circuit, if the trottle is retarded while water injection is in use. This second switch is provided to help prevent flame-outs caused by injecting water at low engine rpm.

d. FUEL FILTER DE-ICING. Provisions for alcohol de-icing of the low pressure fuel filter are included. The filter de-icing system utilizes components of the water injection system; therefore, if the airplane is serviced for filter de-icing, water injection will not be available and vice versa. For information on fuel filter de-icing see Section V.

13. JATO CONTROLS.

JATO CONTROLS (late airplanes)—Jato firing is controlled electrically by a "JATO-GUNS" transfer switch ("JATO-CAMERA" switch on RF-80 airplanes) on the RH Shelf. When the switch is in the "JATO" position the indicator above the switch glows and the units may be fired by pressing the gun trigger switch on



1. SCR 695 Radio control panel
2. Aileron tab switch
3. Spotlight

3A. Filter de-icing switch and indicator

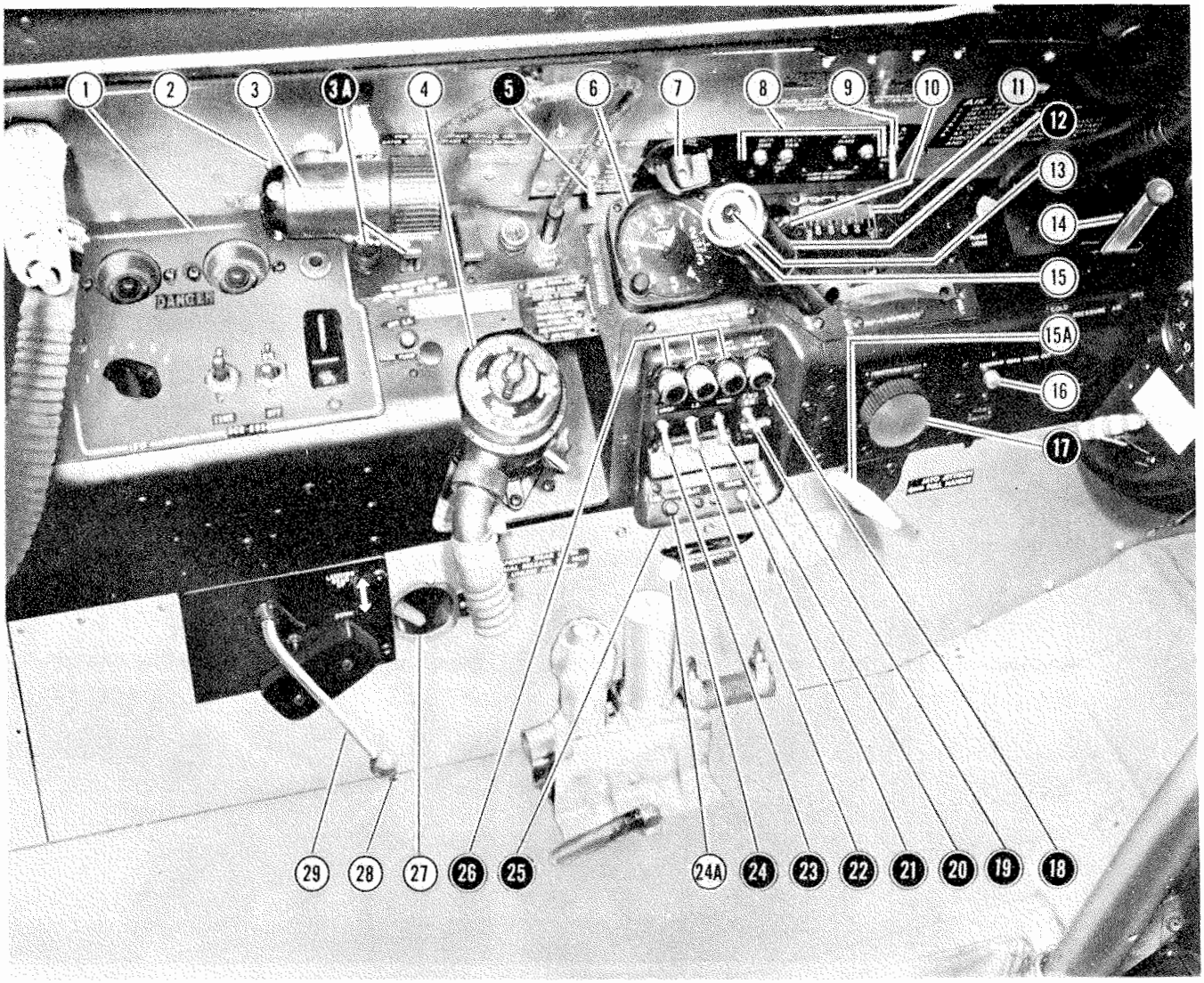
4. Oxygen regulator
5. Emergency fuel pump switch
6. Cabin altimeter
7. Fluorescent light switch
8. Circuit breaker reset buttons
9. Dive flap switch
10. Wing flap switch
11. Wing flap position indicator
12. Throttle
13. Microphone button
14. Cabin heat control
15. Engine shut-off valve control (Early Airplanes only)

15A. Jato jettison control

16. Throttle warning horn shut-off switch
17. Throttle friction control
18. Fuselage tank booster pump indicator light
19. Fuselage tank booster pump switch
20. Wing tank selector switch
21. Emergency bypass transfer valve circuit breaker reset button
22. Wing leading edge tank selector switch
23. Drop tank selector switch
24. Fuselage tank booster pump circuit reset button
25. Fuel control panel
26. Fuel tank indicator lights
27. Landing gear lever down lock release
28. Landing gear lever release button
29. Landing gear lever
30. Fuselage tank bypass switch (Early Airplanes only)

(00) Indicates power plant and fuel system controls and instruments.

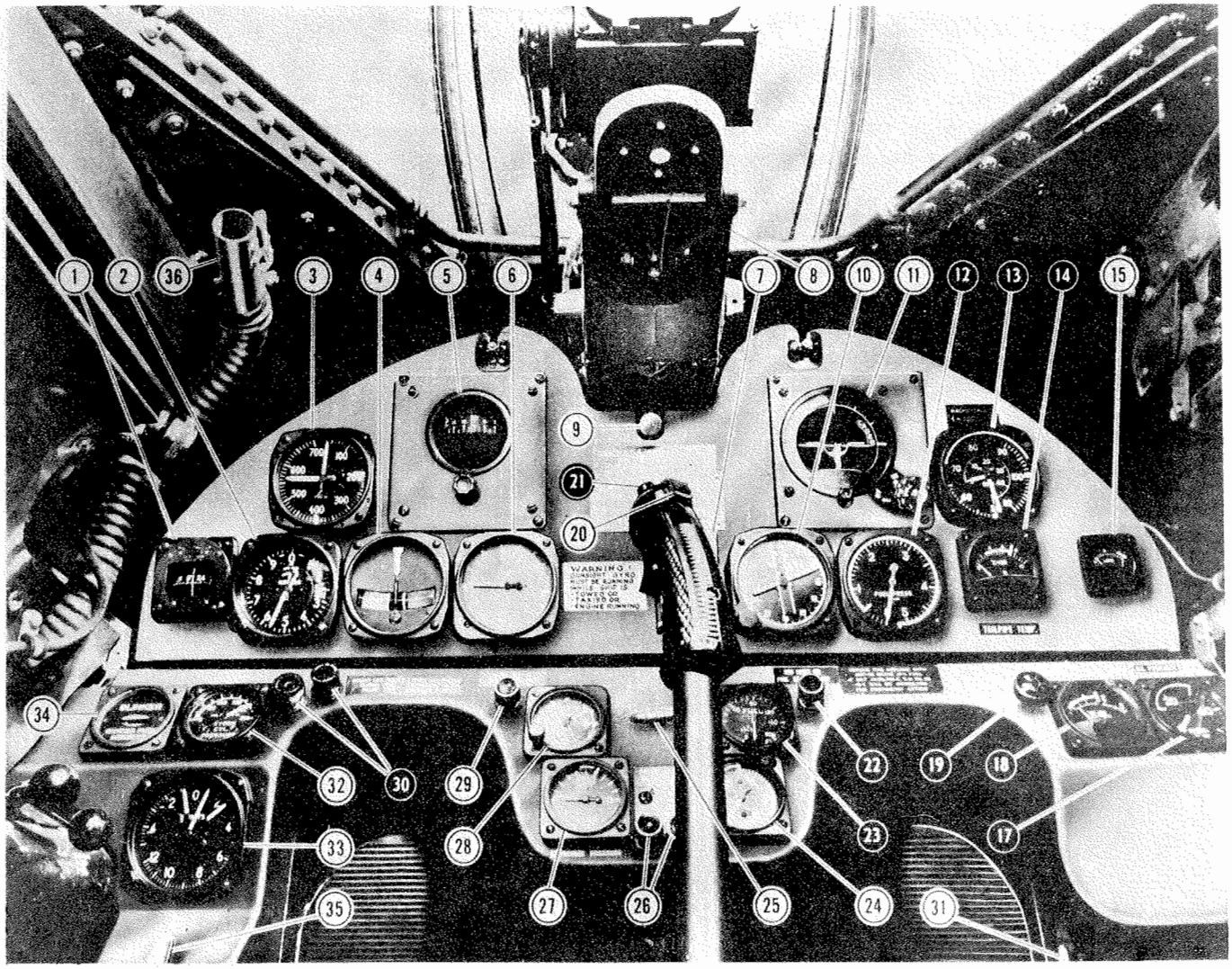
Figure 6 — Cockpit, Left-hand Side (Early Airplanes)



1. SCR 695 Radio or AN/APX-6 radar control panel
2. Aileron tab switch.
3. Spotlight.
3A. Fuel Filter De-icing Switch
4. Oxygen regulator
5. Emergency fuel pump switch
6. Cabin altimeter
7. Fluorescent light switch
8. Circuit breaker reset buttons
9. Dive flap switch
10. Wing flap switch
11. Wing flap position indicator
12. Throttle
13. Microphone button
14. Cabin heat control
15. Gunsight reset for rockets, switch
15A. Jato jettison control
16. Throttle warning horn shut-off switch
17. Throttle friction control
18. Fuselage tank booster pump indicator light
19. Fuselage tank booster pump switch
20. Wing tank selector switch
21. Emergency bypass transfer valve circuit breaker reset button
22. Wing leading edge tank selector switch
23. Drop tank selector switch
24. Fuselage tank booster pump circuit reset button
24A. Aileron boost valve lever
25. Fuel control panel
26. Fuel tank indicator lights
27. Landing gear lever down lock release
28. Landing gear lever release button
29. Landing gear lever

(00) Indicates power plant and fuel system controls and instruments.

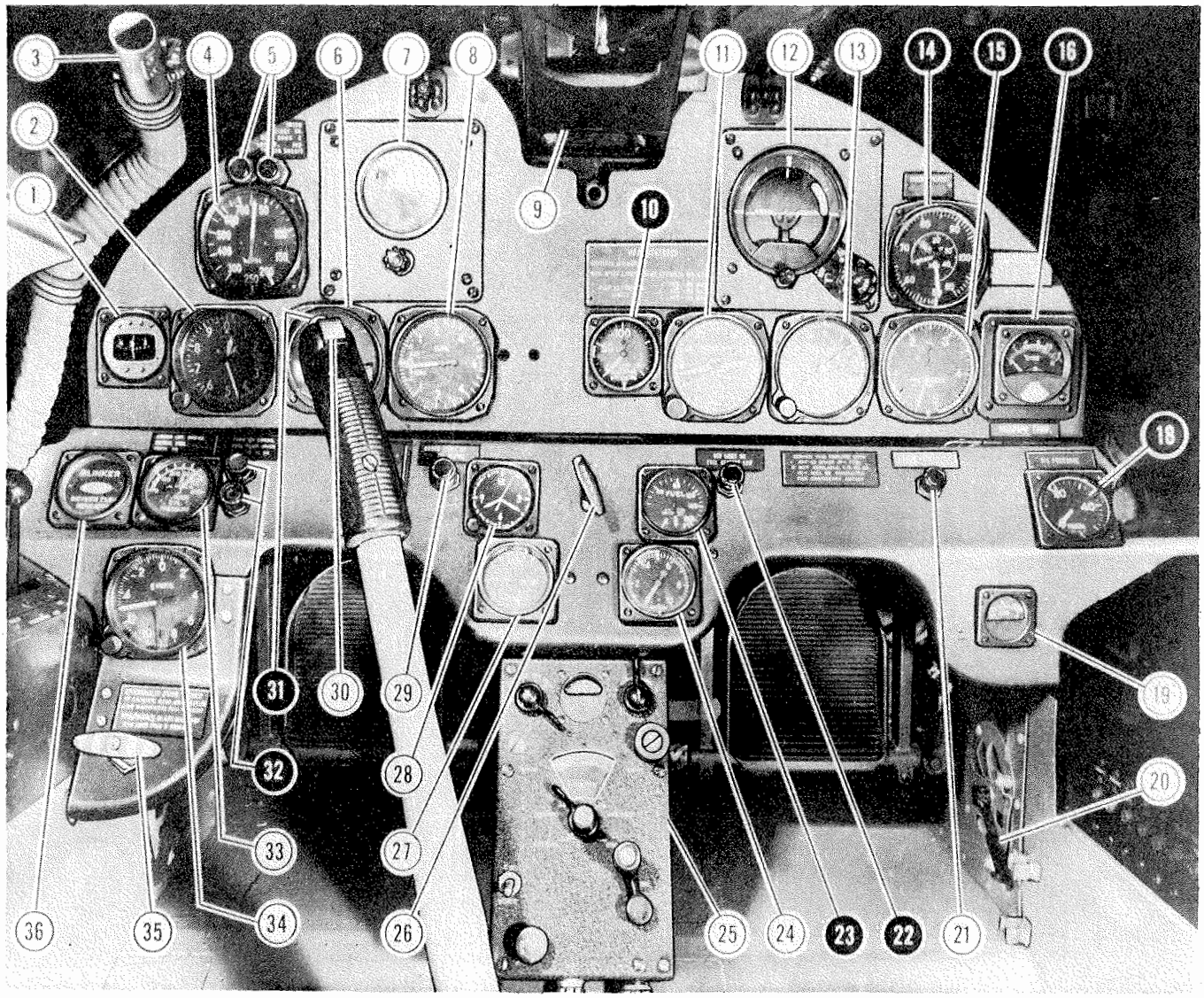
Figure 6A — Cockpit, Left-hand Side, Modernized F-80A



1. Stand-by compass
2. Altimeter
3. Air speed
4. Turn and bank
5. Directional gyro
6. Rate of climb
7. Compass correction card
8. Gun sight mount
9. Landing light position control
10. Remote compass indicator
11. Gyro-horizon
12. Burner ring fuel pressure
13. Engine tachometer
14. Tail pipe temperature
15. Ammeter
16. Deleted
17. Engine oil pressure
18. Rear bearing temperature
19. Fire warning light
20. Elevator tab switch
21. Drop tank (bomb) release
22. Fuselage tank low level warning light
23. Fuselage tank fuel quantity
24. Instrument pressure
25. Parking brake handle
26. Landing gear position lights
27. Hydraulic pressure
28. Clock
29. Elevator tab neutral light
30. Emergency fuel pump indicator lights
31. Rudder pedal ratchet release
32. Oxygen pressure gage
33. Accelerometer
34. Oxygen flow indicator
35. Hydrofuse reset handle
36. Ventilator

PP Indicates power plant and fuel system controls and instruments.

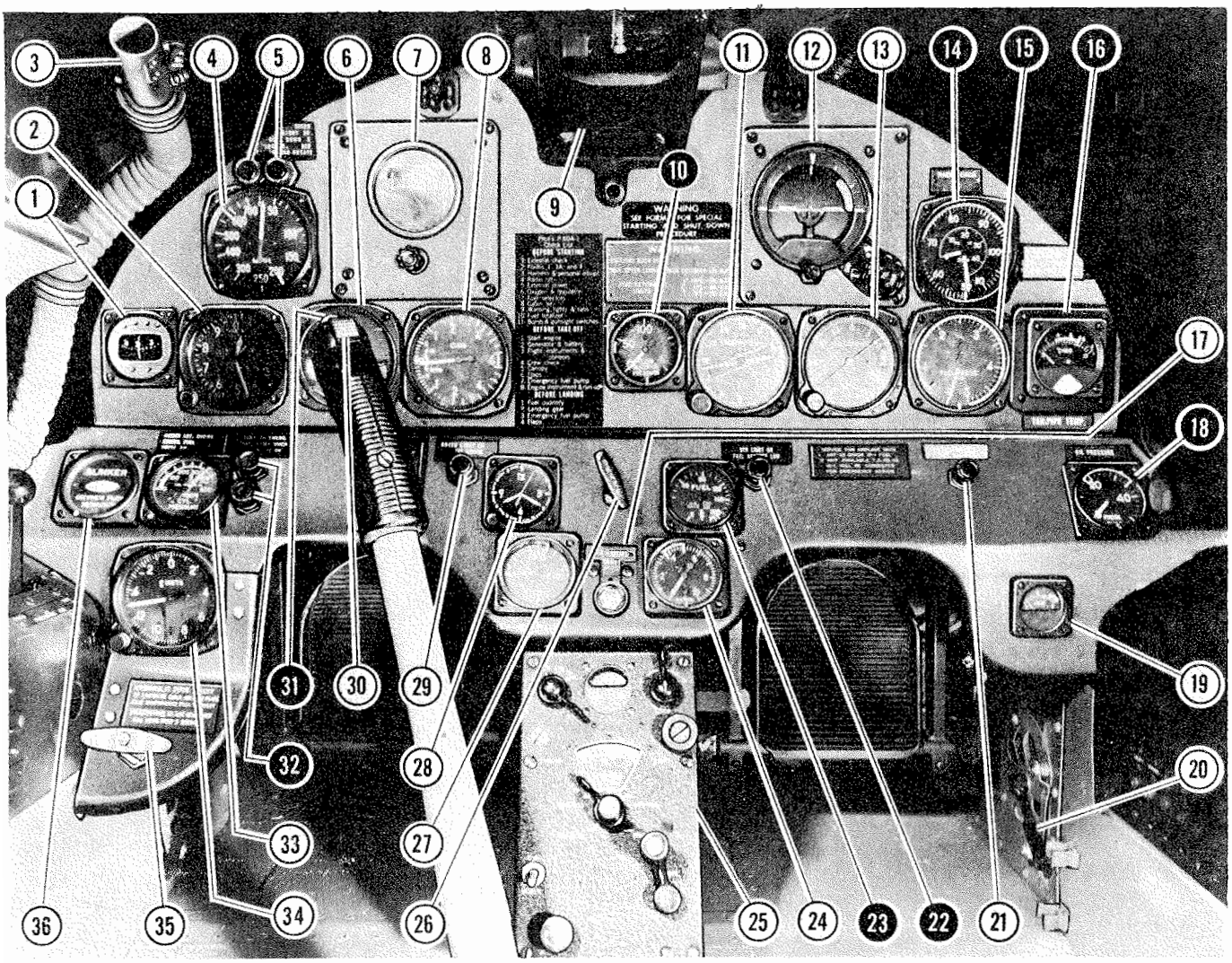
Figure 7 — Instrument Panel (Early Airplanes)



1. Standby compass
2. Altimeter
3. Ventilator
4. Airspeed indicator
5. Landing gear position lights
6. Turn and bank
7. Directional gyro
8. Rate of climb
9. Gunsight mount
10. Water injection pressure
11. Remote compass indicator
12. Gyro horizon
13. AN/ARN-6 Radio compass indicator
14. Engine tachometer
15. Burner ring fuel pressure
16. Tailpipe temperature
17. Deleted
18. Engine oil pressure
19. Ammeter
20. Pressurization grill shut-off
21. Fire warning light
22. Fuselage tank low level warning light
23. Fuselage tank fuel quantity
24. Instrument pressure
25. AN/ARN-6 Radio compass controls
26. Parking brake
27. Hydraulic pressure
28. Clock
29. Elevator tab neutral light
30. Elevator tab switch
31. Drop tank (bombs) release
32. Emergency fuel pump warning lights
33. Oxygen cylinder pressure gage
34. Accelerometer
35. Hydrofuse reset handle
36. Oxygen flow indicator

(00) Indicates power plant and fuel system controls and instruments.

Figure 7A --Instrument Panel (Late Airplanes)



1. Standby compass
2. Altimeter
3. Ventilator
4. Airspeed indicator
5. Landing gear position lights
6. Turn and bank
7. Directional gyro
8. Rate of climb
9. Gunsight mount
10. Water injection pressure
11. Remote compass indicator
12. Gyro horizon
13. AN/ARN-6 Radio compass indicator
14. Engine tachometer
15. Burner ring fuel pressure
16. Tailpipe temperature
17. Bomb salvo switch
18. Engine oil pressure
19. Ammeter
20. Pressurization grill shut-off
21. Fire warning light
22. Fuselage tank low level warning light
23. Fuselage tank fuel quantity
24. Instrument pressure
25. AN/ARN-6 Radio compass controls
26. Parking brake
27. Hydraulic pressure
28. Clock
29. Elevator tab neutral light
30. Elevator tab switch
31. Drop tank (bombs) release
32. Emergency fuel pump warning lights
33. Oxygen cylinder pressure gage
34. Accelerometer
35. Hydrofuse reset handle
36. Oxygen flow indicator

(OTC) Indicates power plant and fuel system controls and instruments.

Figure 7A-1 --Instrument Panel (Modernized Airplanes)

the control stick. After the units are fired the "JATO-GUNS" (or "JATO-CAMERA") transfer switch must be returned to the "GUNS" (or "CAMERA") position to restore the function of the gun trigger switch and the jato units jettisoned by the jettison handle (15A, figures 6 and 6A).

14. FIRE WARNING LIGHT.

The fire warning light (19, figures 7 and 21, figures 7A and 7A-1) is controlled by several thermal switches located in the engine section and in the tail pipe section of the fuselage. Operation of this light may indicate either exhaust leakage at the tail pipe, a fuel fire, or possibly a short in the warning system electrical circuit.

14A. ELECTRIC CANOPY.

a. The original manually operated canopy is being replaced with an electrically operated canopy. Provisions are made for manual operation in case of electrical power failure, and for explosive jettison in an emergency. All canopy operations can be accomplished from inside or outside of the airplane. The exterior canopy control switch operates independently of the position of the battery switch. For canopy operating instructions, refer to Section II.

b. CANOPY "OPEN-CLOSE" SWITCH. Two canopy operating switches are provided, one for interior operation (3A, figure 8), and one for exterior operation (2, figure 7C).

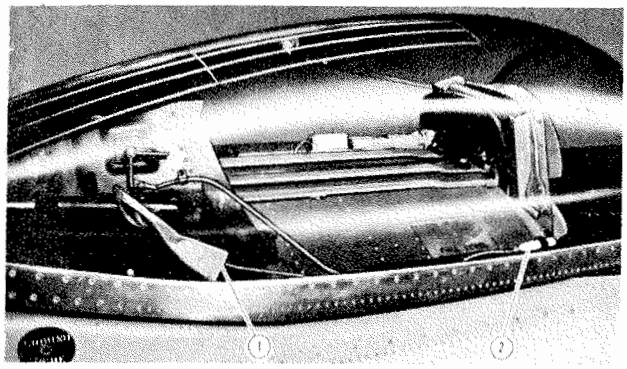
c. CANOPY MANUAL RELEASE. A manual release is provided for interior operation on the right hand canopy rail (2, figure 7B). The exterior manual release ring is flush mounted on the aft canopy cone.

d. EXPLOSIVE JETTISON CONTROL. The interior jettison control is located at the right side of the cockpit near the floor (15, figures 8A and and 15A, figure 8). The exterior jettison control is located in a well in the exterior skin (3, figure 7C).

e. GROUND SAFETY PIN. A safety pin (1, figure 7B) with red streamer attached is installed in the canopy jettison mechanism while the airplane is on the ground.

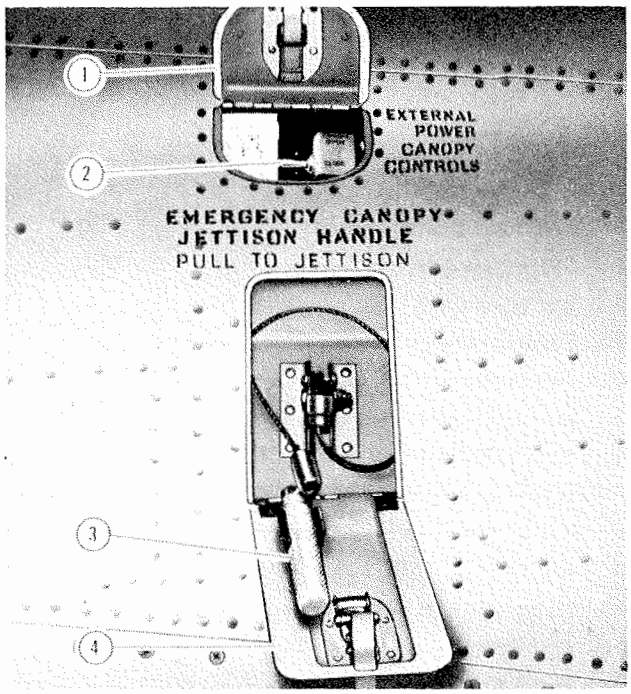
14B. SHOULDER HARNESS LOCK CONTROL.

Late airplanes are provided with an inertia reel type shoulder harness. A two position (locked-unlocked) shoulder harness inertia reel lock control is located on the left side of the pilot's seat. A latch is provided for postively retaining the control handle at either position of the quadrant. By pressing down on the top of the control handle, the latch is released and the control handle may then be moved freely from one position to another. When the control is in the unlocked position, the reel harness cable will extend to allow the pilot to lean forward in the cockpit; however, the reel harness cable will automatically lock when an impact force of 2 to 3 g's is encountered. When the reel is locked in this manner, it will remain locked until the control handle is moved to the locked and then returned to the unlocked position. When the control is in the locked position, the reel harness cable is manually locked so that the pilot is prevented from bending forward. The locked position is used only when a crash landing is anticipated. This position provides an added safety precaution over and above that of the automatic safety lock.



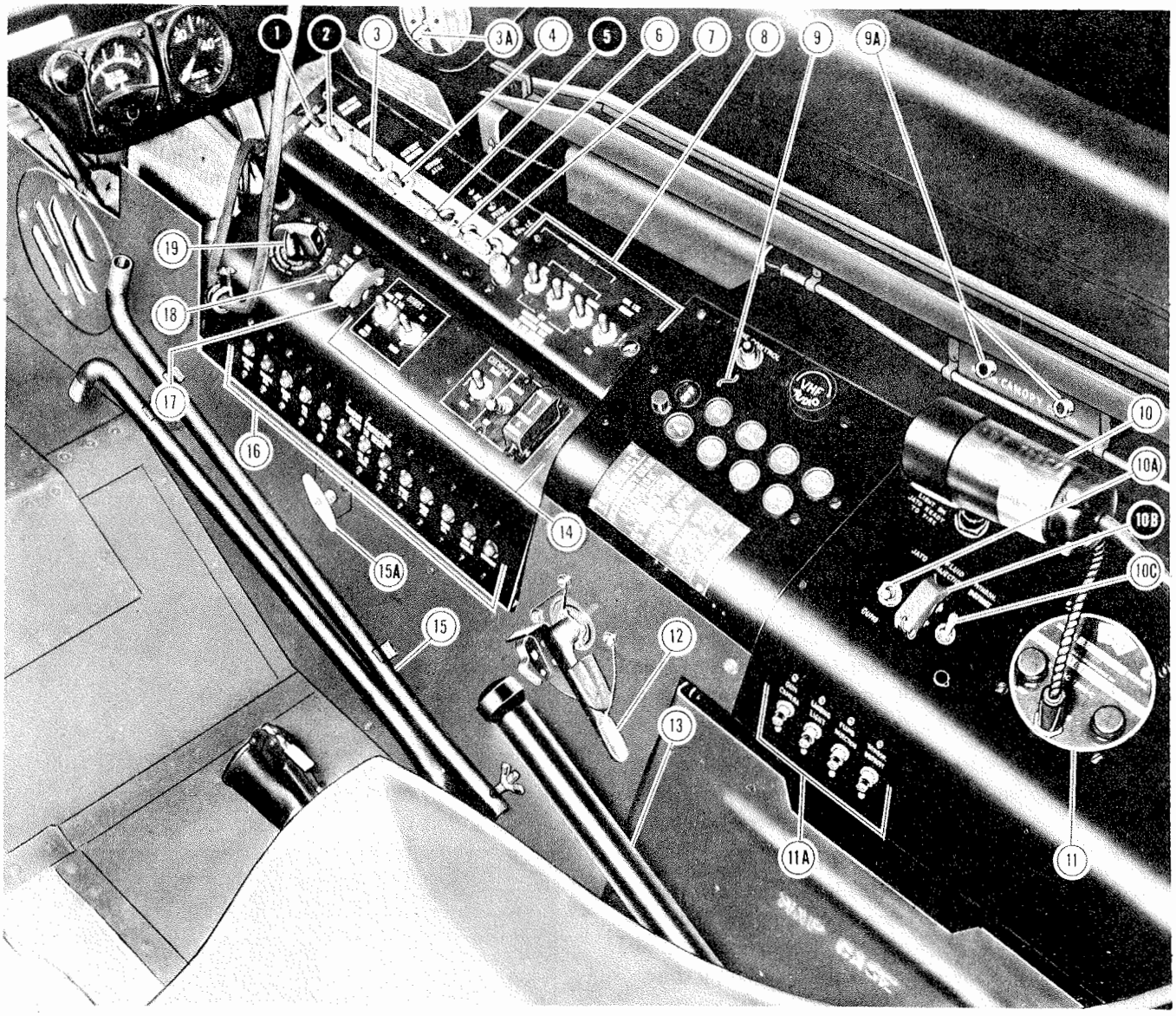
1. Canopy Ground Safety Pin
2. Canopy Manual Release

Figure 7B — Electric Canopy



1. Access Door
2. "OPEN-CLOSE" Switch
3. Explosive Jettison Control
4. Access Door

Figure 7C — External Controls — Electric Canopy



1. Ignition booster switch
2. Starter switch
3. Battery switch
3A. Electric canopy "Open-Close" switch
4. Generator switch
5. Oil heat switch (Inoperative)
6. Pitot heat switch
7. Landing light switch
8. Recognition and navigation light switches
9. AN/ARC-3 radio control panel
9A. Electric canopy circuit breakers
10. Spotlight
10A. Jato-guns transfer switch
10B. Water injection switch
10C. Auxiliary windshield defroster switch
11. Radio range receiver controls (Some airplanes)
11A. Circuit breakers
12. Landing gear emergency selector valve
13. Emergency hydraulic hand pump handle
14. Armament control panel
15. Controls lock (stowed)
15A. Electric canopy jettison control
16. Circuit breakers
17. Aileron boost shut-off switch
18. Range receiver circuit breaker
19. Fluorescent light rheostat

60 Indicates power plant and fuel system controls and instruments.

Figure 8 — Cockpit, Right-hand Side (Early Airplanes)

15. MISCELLANEOUS EQUIPMENT.

a. A free-air thermometer and a cabin-air temperature indicator have been installed as additional equipment on winterized airplanes.

b. ATTITUDE GYROS. A type J-3 attitude gyro is installed in some airplanes and a type A-1(A-2) or J-8 indicator in others. These instruments provide visual indication of any pitch and roll attitude. They operate on 115V phase AC power supplied by the inverters. In these instruments the gyro is inclosed in a sphere, a portion of which is visible through the opening of the face of the instrument.

The indications of these instruments may be confusing since the presentation of pitch differs.

(1) A horizon bar on the A-1 and the J-8 present a conventional pitch indication with the miniature airplane appearing above the horizon bar in a climb and below the horizon bar in a dive. However, in a climb (or dive) exceeding 27 degrees of pitch, the horizon bar stops at the bottom (or top) of the instrument case and the sphere then becomes the reference.

Note

The main difference between the A-1 (A-2) and J-8 attitude gyros is that the J-8 has a manual caging control.

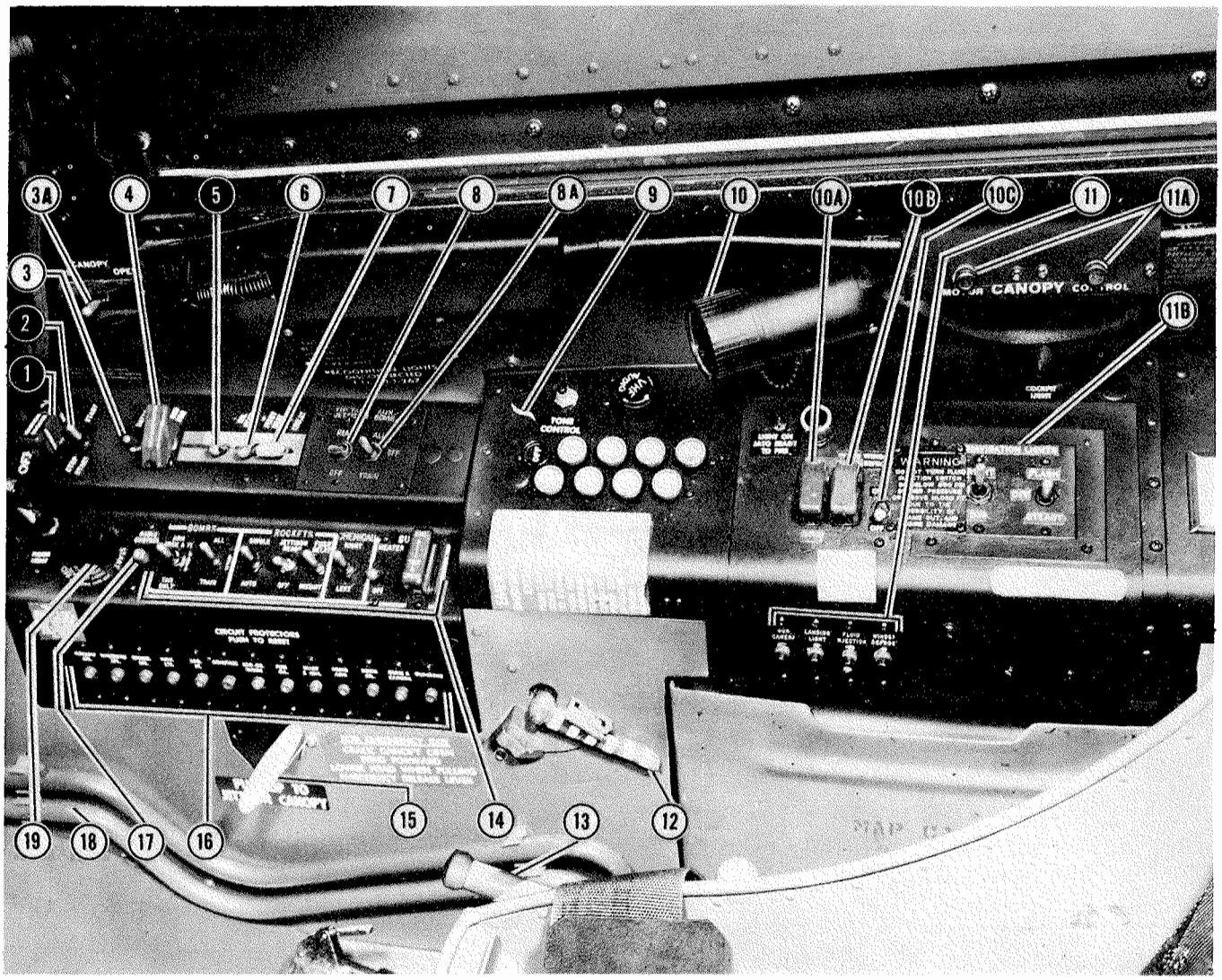
(2) The J-3 indicator differs from conventional attitude indicators in that climb and dive are not shown in relation to a horizon bar but are read directly on a sphere. The upper hemisphere, which is dark in color, indicates a dive; the lower light hemisphere indicates a climb. Lines similar to latitude markers are painted on the sphere and indicate the amount (degrees) of pitch. In addition a sensitive pitch indicator furnishes readings of climb or dive up to 10 degrees in one degree increments.

Note

The sphere is stabilized maintaining its equator parallel to the earth's surface and the aircraft (and miniature airplane) maneuvers around the stabilized sphere. Therefore when the aircraft is in a nose-high attitude, the miniature airplane will be displaced downward on the light portion of the sphere and in a dive, onto the dark portion of the sphere.

CAUTION

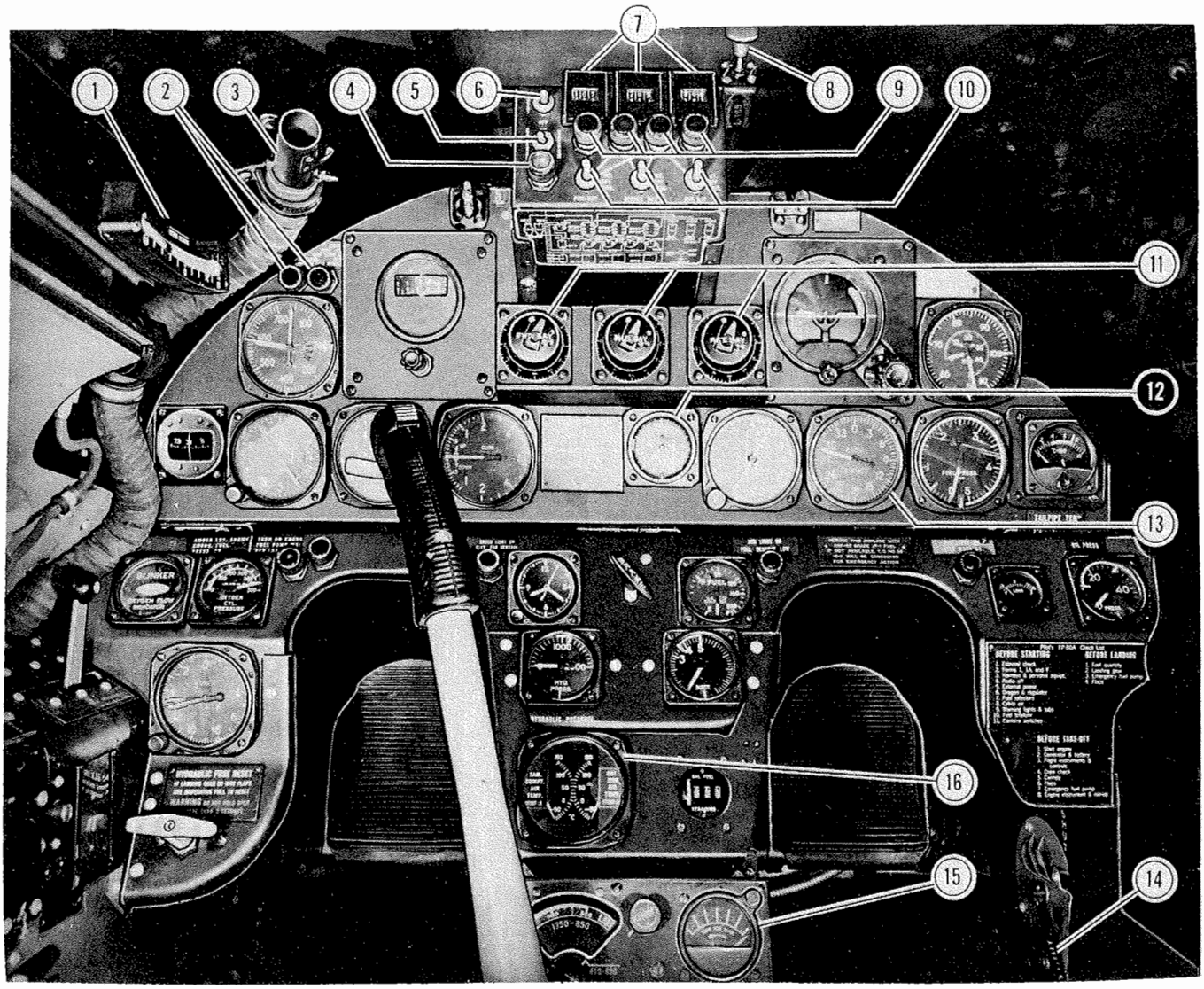
In some instances the A-1 (A-2) and J-3 attitude gyros may take as much as 13 minutes to erect itself.



1. Ignition booster switch
2. Starter switch
3. Battery switch
3A. Electric canopy "Open-Close" switch
4. Generator switch
5. Oil heat switch (Inoperative)
6. Pitot heat switch
7. Landing light switch
8. Tip tank jettison switch (airplanes with 230 gallon center line tanks)
8A. Auxiliary bomb switch (airplanes with R3 bomb shackles)
9. AN/ARC-3 Radio control panel
10. Spotlight
10A. Jato-guns transfer switch
10B. Water injection switch
10C. Auxiliary windshield defroster switch
11. Circuit breakers
11A. Electric canopy circuit breakers
11B. Navigation lights switch
12. Landing gear emergency selector
13. Emergency hydraulic hand pump handle
14. Armament control panel
15. Electric canopy jettison controls
16. Circuit breakers
17. Range receiver circuit breaker
18. Controls lock (stowed)
19. Fluorescent light rheostat

(00) Indicates power plant and fuel system controls and instruments.

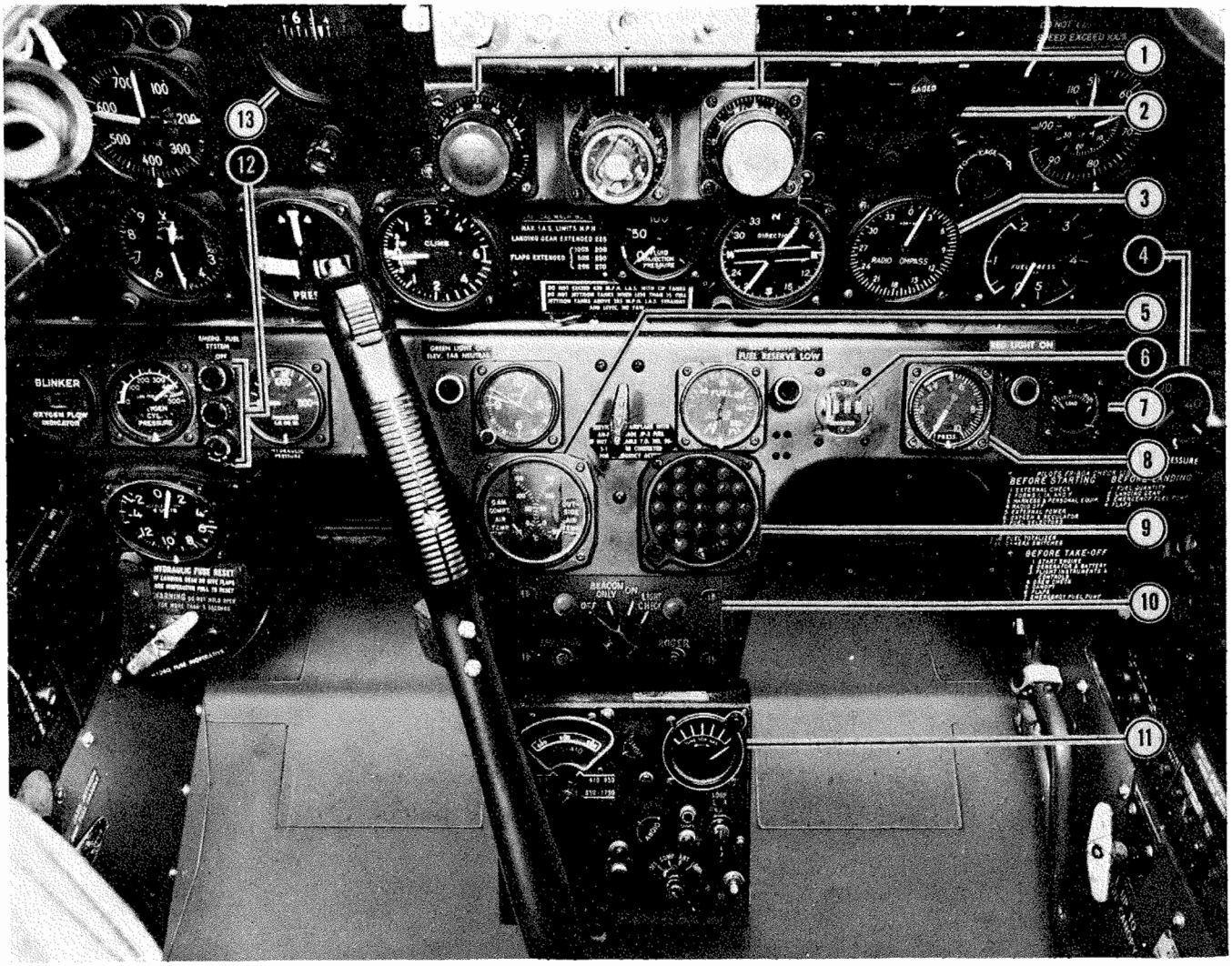
Figure 8A — Cockpit, Right-hand Side (Modernized Airplanes)



1. Pitch indicator
2. Landing gear position lights
3. Ventilator
4. Camera power indicator light
5. Camera master switch
6. Camera compartment heat switch
7. Exposure counter
8. Windshield defroster button
9. Camera blinker lights
10. Camera switches
11. Intervalometer
12. Water injection pressure (Late airplanes only)
13. AN/ARN-7 Radio compass indicator
14. Pressurization grill shut-off (Late airplanes only)
15. AN/ARN-7 Radio compass controls
16. Outside air and camera compartment temperature indicator

(00) Indicates power plant and fuel system controls and instruments.

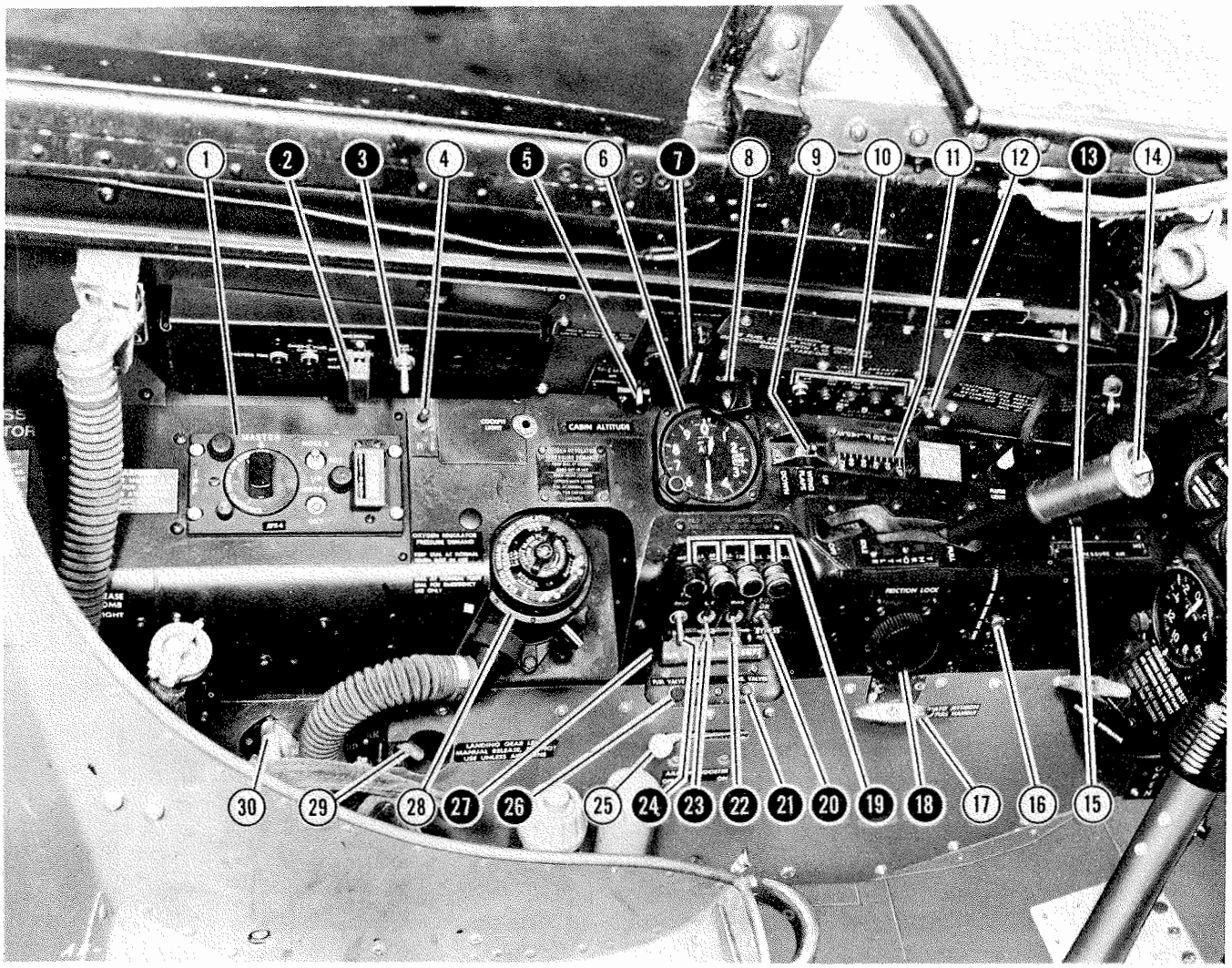
Figure 9 — Instrument Panel (FP-80A)



1. Intervalometer
2. Attitude Gyro
3. AN/ARN-6 (or AN/ARN-7) Compass Indicator
4. Oil Pressure Gage
5. Outside Air and Camera Compartment Temperature Indicator
6. Fuel Counter
7. Ammeter
8. Instrument Air Pressure
9. AN/APA-90 Indicator
10. AN/APA-90 Control Panel
11. AN/ARN-6—Radio Compass Controls (RF-80A-25)
    AN/ARN-7—Radio Compass Controls (RF-80A-20)
12. Emergency Fuel System Warning Lights
13. Directional Gyro

(00) Indicates power plant and fuel system controls and instruments.

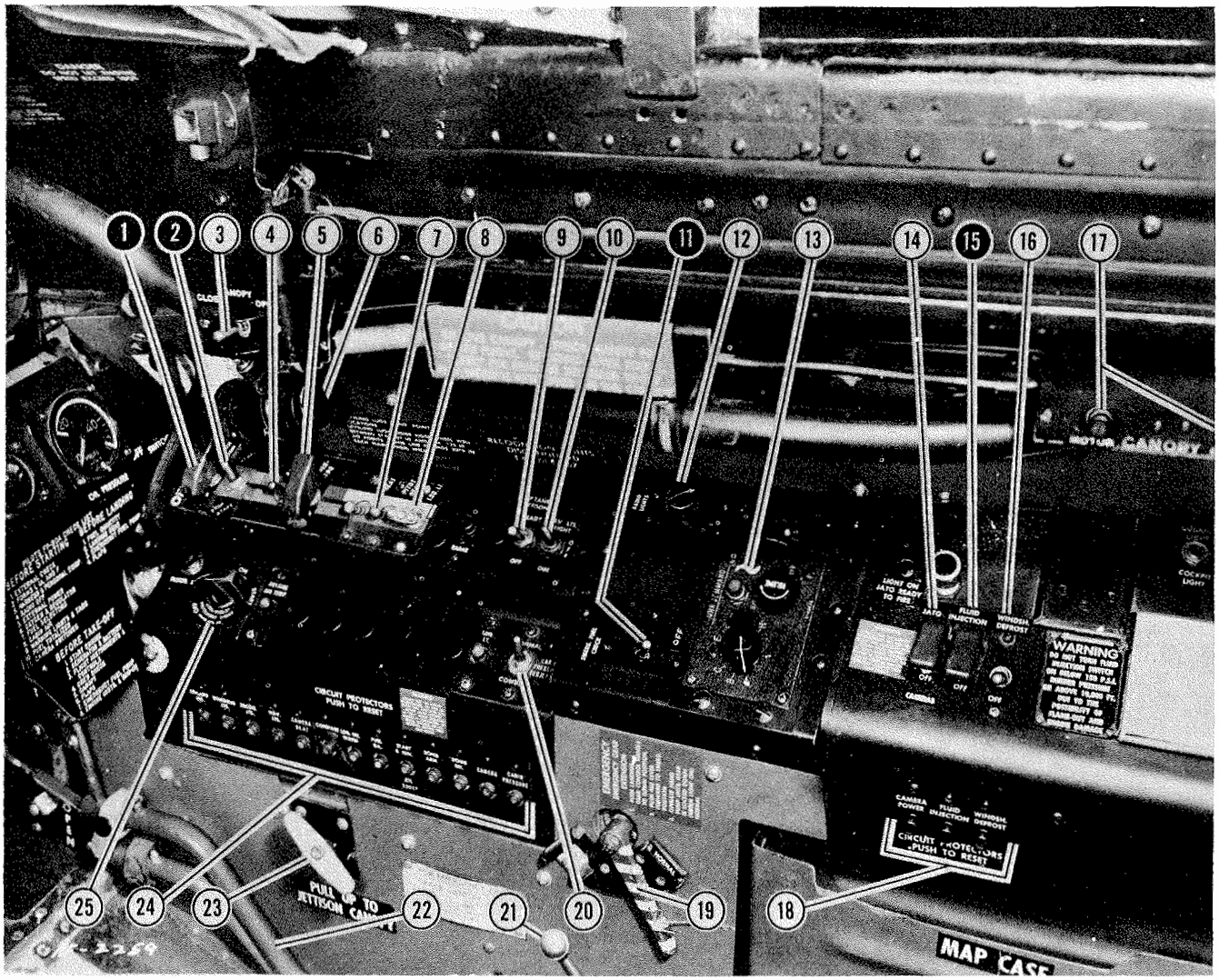
Figure 9A — Instrument Panel (RF-80A-20 and RF-80A-25)



1. SCR 695 Radio (or AN/APX-6 Radar) Control Panel
2. Starting Fuel Switch
3. Air Start Switch
4. Aileron Tab Switch
5. Emergency Fuel Switch
6. Cabin Altimeter
7. Fuel Filter De-icing Switch
8. Fluorescent Light Switch
9. Wing Flap Switch
10. Circuit Breaker Reset Buttons
11. Wing Flap Position Indicator
12. Dive Flap Switch
13. Throttle
14. Microphone Button
15. Cabin Heat Control
16. Landing Gear Horn Shut-off Switch
17. Jato-Jettison Control
18. Throttle Friction Control
19. Fuel Tank Indicator Lights
20. Fuselage Fuel Tank and By-Pass Switch
21. Emergency By-Pass Transfer Valve Circuit Breaker Reset Button
22. Wing Fuel Tank Selector Switch
23. Leading Edge Fuel Tank Selector Switch
24. Drop Tank Selector Switch
25. Aileron Boost Valve Lever
26. Fuselage Tank Pump Circuit Breaker Reset Button
27. Fuel Control Panel
28. Oxygen Regulator
29. Landing Gear Down Lock Release
30. Landing Gear Lever and Release Button

(00) Indicates power plant and fuel system controls and instruments.

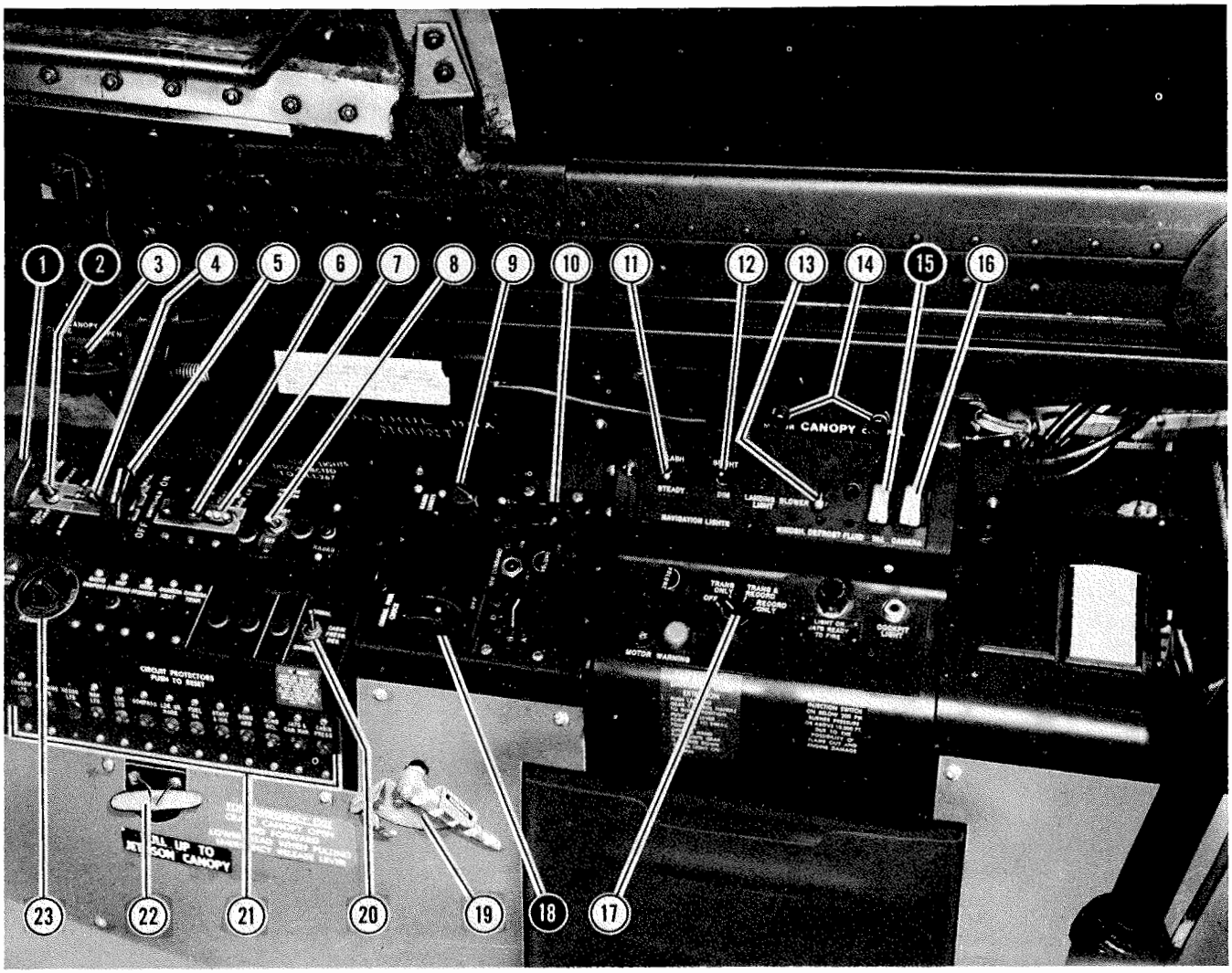
Figure 9B — Cockpit, Left-hand Side (RF-80A-20 and RF-80A-25)



1. Ignition "NORMAL-OFF" Switch
2. Automatic Starter Switch
3. Canopy "OPEN-CLOSE" Switch
4. Battery Master Switch
5. Generator Switch
6. Spotlight
7. Pitot Heat Switch
8. Landing and Taxi Light Switch
9. Drop Tank "READY" Switch
10. Navigation Lights "DIM-BRIGHT" Switch
11. Emergency Fuel Checkout Switch
12. Panel Light Control
13. AN/ARC-3 (or AN/ARC-27) Radio Control Panel
14. Jato-Camera Switch
15. Fluid Injection Switch
16. Auxiliary Windshield Defroster Switch
17. Canopy Circuit Breakers
18. Circuit Breakers
19. Landing Gear Emergency Selector
20. Cabin Pressure Selector Switch
21. Emergency Hydraulic Pump Handle
22. Controls Lock (Stowed)
23. Canopy Jettison Control
24. Circuit Breakers
25. Fluorescent Light Rheostat

(00) Indicates power plant and fuel system controls and instruments.

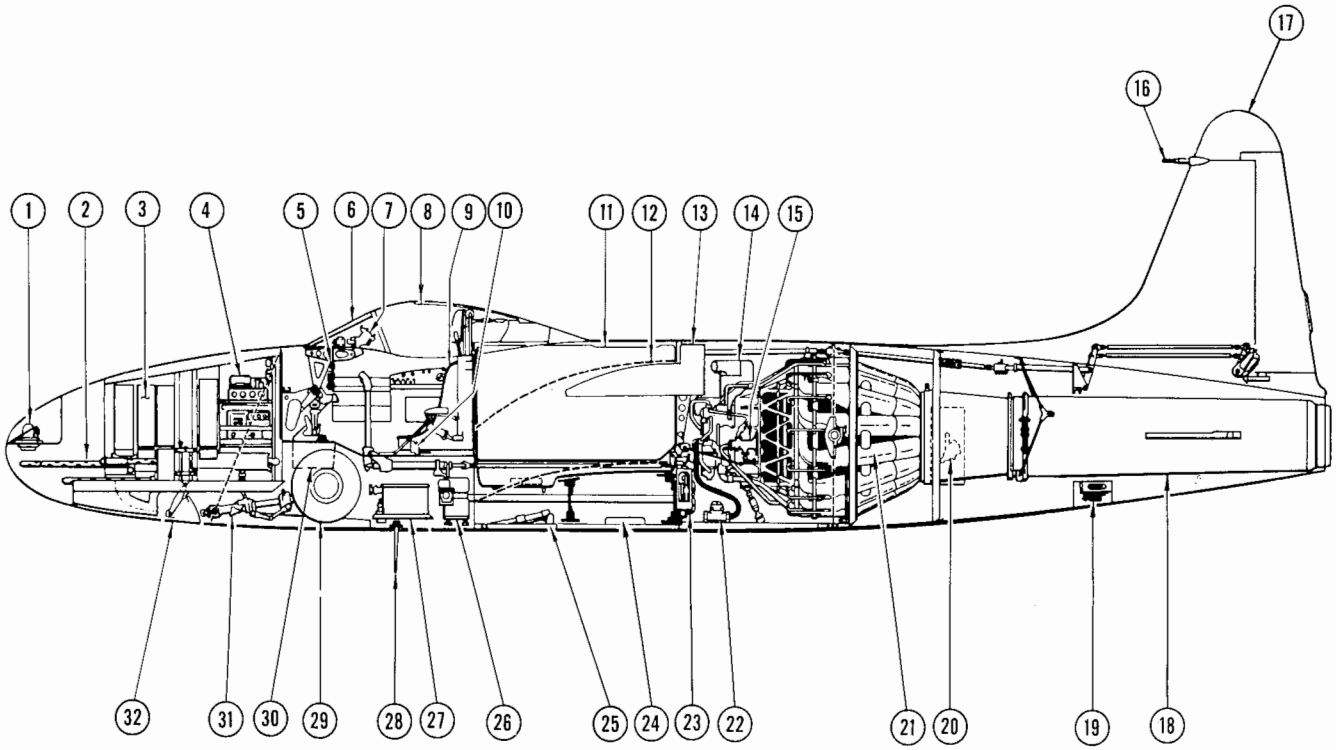
Figure 9C — Cockpit, Right-hand Side (RF-80A-20)



1. Ignition "NORMAL-OFF" Switch
2. Automatic Starter Switch
3. Canopy "OPEN-CLOSE" Switch
4. Battery Master Switch
5. Generator Switch
6. Pitot Heat Switch
7. Landing and Taxi Light Switch
8. Drop Tank "READY" Switch
9. Panel Light Control
10. AN/ARC-3 (or AN/ARC-27) Radio Control Panel
11. Navigation Lights "STEADY-FLASH" Switch
12. Navigation Lights "DIM-BRIGHT" Switch
13. Auxiliary Windshield Defroster Switch
14. Canopy Circuit Breakers
15. Fluid Injection Switch
16. Jato-Camera Switch
17. Recorder Selector Switch
18. Emergency Fuel Check-out Switch
19. Landing Gear Emergency Selector
20. Cabin Pressure Selector Switch
21. Circuit Breakers
22. Jato-Jettison Controls
23. Fluorescent Light Rheostat

(00) Indicates power plant and fuel system controls and instruments.

Figure 9D — Cockpit, Right-hand Side (RF-80A-25)



1. AN/ARN-6 Radio Compass Loop Antenna
2. 50 Calibre Machine Guns (6)
3. Ammunition Boxes (6)
4. AN/ARC-3 (or AN/ARC-27) and AN/ARN-6 Radio
5. Instrument Panel
6. Bullet Proof Windshield Panel
7. Gun Sight
8. AN/ARN-6 Radio Sense Antenna
9. Pilot's Seat
10. "G" Valve
11. Fuselage Fuel Tank
12. Intake Air Duct
13. Water Tank
14. Turbo-Refrigerator
15. Engine Control Valve (Throttle)
16. Air Speed Pitot
17. AN/ARC-3 (or AN/ARC-27) Radio Antenna
18. Tailpipe
19. Gyrosyn Compass Flux Valve
20. Elevator Tab Motor
21. Engine
22. Fuel Flowmeter
23. Aileron Booster Unit
24. AN/APX-6 Antenna (some airplanes)
25. Dive Recovery Flaps
26. SCR-695-A Radio (or AN/APX-6 Radar)
27. Battery
28. SCR-695-A Radio Antenna (some airplanes)
29. Nose Landing Gear
30. AN/APW-11 Radar
31. Landing and Taxi Lights
32. Case Ejection Door

Figure 10 — Fuselage Contents Arrangement

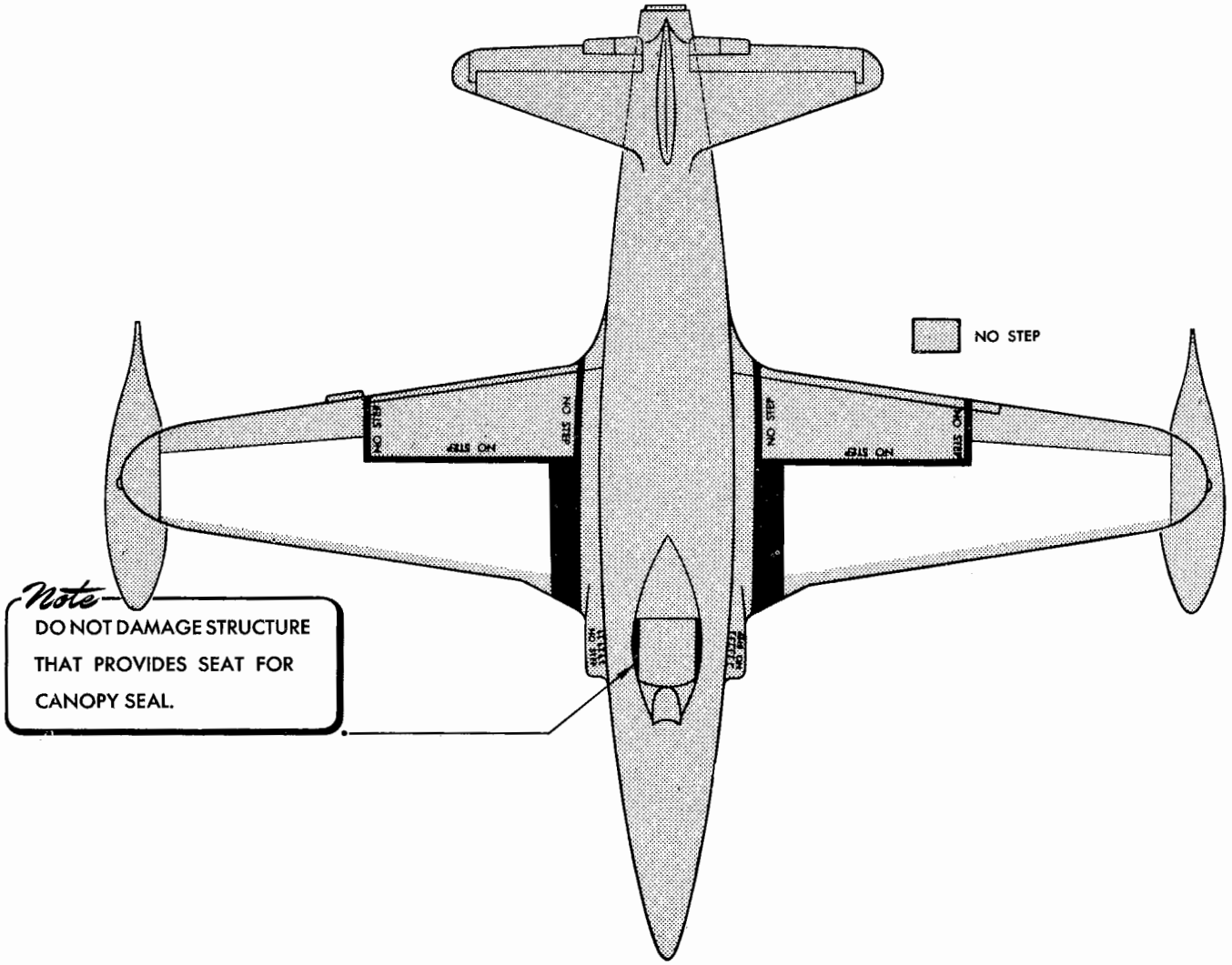
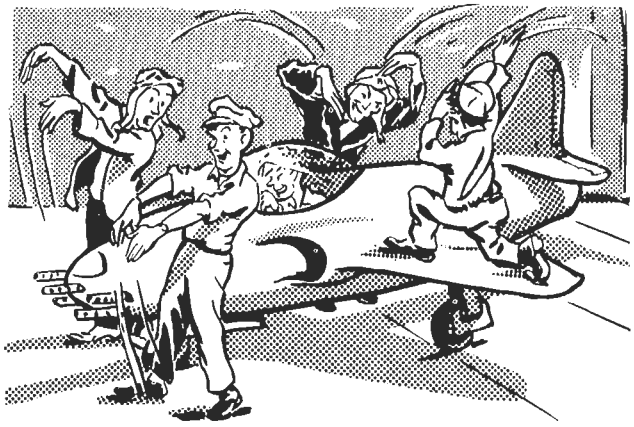
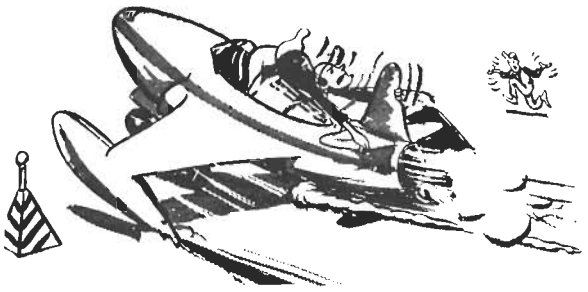


Figure 11 — No Step Diagram

Section II - Normal Operating Instructions



1. BEFORE ENTERING PILOT'S COMPARTMENT.



DON'T ATTEMPT TO TAKE OFF WITH DROPPABLE TANKS FULL, AND AMMUNITION BOXES EMPTY!

a. RESTRICTIONS.

(1) FLIGHT RESTRICTIONS.

(a) Inverted flight, vertical flight with less than 150 gallons of fuel in fuselage tank, or any maneuver resulting in extended negative acceleration, will result in probable engine burner flame-out since there is, at present, no means of insuring a continuous flow of fuel in this attitude.

Note

Whenever engine flame-out occurs, move the engine shut-off valve (throttle on late airplanes) to "OFF" immediately to avoid the danger which might result from attempting a restart with the engine and tailpipe flooded with fuel.

(b) Do not attempt to take off with full drop tanks unless there is sufficient equipment or ballast in the nose compartment.

In F-80A airplanes, ammunition or ballast (about 175 pounds or 600 rounds) will bring the C.G. far enough forward.

In RF-80A airplanes at least one camera in each camera bay (or 50 pounds of ballast in each bay) is required.

WARNING

Without proper ballast, it is possible to obtain a center of gravity position far aft of the rear limit.

(c) Vertical stalls are prohibited as recovery may require more than 10,000 feet.

(d) Do not exceed +7.3 or −3 "G."

(e) The following restrictions affect those aircraft having a non-reinforced aft fuselage section (part number 171689) installed. Avoid acrobatics and maneuvers involving:

i. Violent pull-outs at all speeds.

ii. Large yaw angles at all speeds.

iii. Uncoordinated turns and steep spirals.

iv High rates of roll.

(f) Flaps should not be used in any amount at airspeeds greater than 220 mph.

(2) TAXIING RESTRICTIONS. Brakes must be used for steering as there is no slip stream over the rudder.

(3) AIR-SPEED LIMITATIONS. *(Indicated.)*

(a) Maximum allowable air-speed —.8 Mach number or 580 mph indicated, whichever is slower.

Note

Mach number is defined as the ratio of the airplane true speed to the speed of sound in the undisturbed air through which it passes.

IF THE MACH NUMBER INDICATOR IS NOT INSTALLED OBSERVE THE FOLLOWING MAXIMUM INDICATED SPEEDS.

Altitude (feet)	*Max. Dive Speed (IAS) (mph)*
S.L.	580
5000	570
10000	520
15000	475
20000	430
25000	390
30000	350
35000	310
40000	275

Note

If aileron compressibility buzz (see section II, paragraph 14) occurs below .8 Mach number, limit speed to that at which the buzz occurs.

(b) Wing flaps extended 100%—200 mph.

(c) Wing flaps extended 50%—230 mph.

(d) Wing flaps extended 25%—270 mph.

(e) Landing gear extended—225 mph.

(3A.) OPERATIONAL LIMITATIONS WITH DROP TANKS.

(a) Do not attempt to land with one drop tank full and one empty. Drop the heavy tank at least.

(b) Aircraft with tip tanks installed will not be spun at any altitude.

(c) Aircraft with full 165 gallon tanks will not exceed 5.33 "G" in pull-ups nor —2.0 "G" in nose down or inverted maneuvers.

(d) Removal of drop tank fairings will lower "G" limitations.

(e) For aircraft with 230 gallon centerline mounted tip-tanks:

1. Aircraft will not be stalled or side slipped.

2. Do not jettison tanks when less than half full.

3. In emergencies jettison (½-full or more) above 288 mph IAS in straight and level flight (no yaw). In emergencies during or immediately after takeoff, jettison if necessary regardless of speed or altitude.

Note

The 230 gallon centerline mounted tip tank equipped with jettison spring ejection cartridge may be jettisoned at any speed up to 450 mph (IAS). Above 450 mph (IAS), tip tanks should only be jettisoned in cases of extreme emergencies. At speeds above 450 mph there is a possibility of minor damage to the wing tip and aileron during tip tank jettisoning.

4. If one tank fails to feed, jettison that tank only.

5. Do not exceed 375 mph IAS.

6. Avoid high-speed climbs or steep angles and/or zooming climbs until fuel in tip tanks is exhausted.

7. Aircraft acceleration limits are reduced to +6.0 "G."

(f) Aileron rolls are not recommended with full drop tanks. Aileron rolls, with full drop tanks, at rates faster than 45 degrees per second (one complete roll of 360 degrees in eight seconds) are prohibited.

(g) Release empty tanks one at a time, in a skid, with the tank to be released on the trailing wing (left tank first).

To release tanks individually, place the bomb switch (14, Figures 8 and 8A) to "TRAIN," then press the button on top of the control stick grip. The left tank will drop first and the right tank will drop when the button is pressed a second time.

Note

Aircraft with 230-gallon center line tanks may drop tanks individually only by manual jettison. Both tanks may be dropped at one time electrically by placing tip tank jettison switch in "READY" position and pressing the button on top of control stick grip.

(4) FUEL PRESSURE RESTRICTIONS.

WARNING

Do not allow the burner ring fuel pressure to go below 50 psi at any altitude. At pressures below 50 psi, the engine fire may go out partially, causing a gradual loss of rpm and, if corrective action is not taken, complete flame-out will occur.

(5) ENGINE RESTRICTION. (Except RF-80A-20,-25). Operation above 100% engine rpm and/or 700°C tailpipe temperature is prohibited because of danger of turbine wheel failure.

(6) OVERSPEEDING. Engine RPM in excess of 101% for -A-21 and earlier engines, and 101.5% for -35 engines, is considered overspeeding.

Overspeeding up to 105% for *not more* than 15 seconds will require normal pre-flight inspection, but overspeeding for *more* than 15 seconds will require a 25-hour inspection to determine engine serviceability.

Overspeeding from 105% to 110% for any period of time will require a 25-hour inspection to determine engine serviceability.

When overspeeding not in excess of 110% is encountered, the cause for overspeeding will be corrected prior to further flight.

Overspeeding in excess of 110% for any period of time will require removal of engine for overhaul.

b. TAKE-OFF GROSS WEIGHT AND BALANCE.

(1) On early airplanes the normal take-off gross weight is approximately 12,000 lbs. The maximum gross weight (with drop tanks on and full) is approximately 14,500 lbs. On late airplanes these weights are increased by approximately 800 lbs. See T.O. AN 01-1B-40 Handbook of Weight and Balance.

(2) The center of gravity position will be near the forward limit at take-off unless the drop tanks are on and full. That is, approximately 24% MAC without drop tanks, 27% MAC with full drop tanks, assuming that a full ammunition load is being carried. With the expenditure of ammunition, the center of gravity position moves rearward.

c. EXTERNAL CHECK.

(1) Guns.—Charged. There are no charging provisions in the cockpit.

(2) Armament Doors.—Locked.

(3) Engine Access Doors.—Fastened.

(4) L.G. Down Safety Clips.—Removed.

(5) Pitot Tube Cover.—Removed.

(6) Check the alcohol supply line is connected for fuel filter de-icing if the de-icing system is to be used.

(7) Fuselage fuel tank filler cap for security. — Check.

d. HOW TO GAIN ENTRANCE.

e. MANUAL CANOPY OPERATION.

(1) Release the external hand crank and crank the canopy open.

(2) If a ladder is not available, get on the wing over the wing leading edge and enter the cockpit from the right-hand side.

Note

Do not use the gun sight as a hand hold.

f. ELECTRIC CANOPY OPERATION.

WARNING

Remove and stow the ground safety pin before flight.

Do not open the canopy in flight above 250 mph IAS.

(1) NORMAL OPERATION. Open or close the canopy by means of the interior or exterior "OPEN-CLOSE" switch. The exterior switch will operate the canopy regardless of the position of the battery switch.

(2) CANOPY MANUAL OPERATION (Without Electrical Power).

Note

Operation of the manual release renders jettison mechanism inoperative.

CAUTION

When canopy is opened manually so that open position retainer pin is engaged, the pilot will not be able to close the canopy in flight. Any attempt to operate the canopy electrically while pin is engaged will result in damage to equipment.

(a) FROM INSIDE THE AIRPLANE — pull yellow handle release lanyard (2, figure 7B) and then pull back hard on the canopy.

(b) FROM OUTSIDE THE AIRPANE — pull ring on aft canopy cone and pull back canopy.

2. ON ENTERING THE PILOT'S COMPARTMENT.

a. CHECK FOR ALL FLIGHTS.

(1) Weight and balance Form F.—Check.

(2) Forms 1 and 1A—Check.

(3) Landing gear lever—DOWN.

(4) Parking brakes—Set.

(5) Surface control lock—Remove and stow.

(6) Diluter lever (4, figures 6 and 6A)—"NORMAL OXYGEN."

(7) Oxygen regulator altitude dial—"NORMAL."

(8) Fuel selector switches—"OFF."

(9) Fuel valve circuit breaker—Reset.

(10) Emergency fuel pump switch. (Emergency fuel switch RF-80A-20 and -25)—"OFF."

(11) Air start ignition switch (3, figure 9B) RF-80A-20 and -25—"OFF."

(12) Starting fuel switch (2, figure 9B) RF-80A-20 and -25—"OFF."

(13) Ignition Booster Switch. (Ignition "NORMAL-OFF" switch (1, figures 9C and 9D) RF-80A-20 and -25)—"OFF."

(14) Cabin pressurization control (14, figures 6 and 6A)—"OFF." (Early airplanes only.)

(15) Cabin pressure selector switch – as desired. (RF-80A only.)

(16) Oxygen pressure (32, figure 7 and 33, figures 7A and 7A-1)—400 to 450 psi.

(17) Clock and altimeter—Set.

(18) Fuel Counter (6, figure 9A) RF-80A-20 and -25—Check for proper setting.

(19) Aileron Boost Emergency Shut-off valve lever, "ON" (push forward).

(20) Battery switch (3, figures 8 and 8A)—"OFF."

(21) Generator switch (4, figures 8 and 8A) – check "ON."

(22) Pitot heat switch (6, figures 8 and 8A) – "OFF."

(23) Communication equipment—"OFF."

(24) Water injection switch (10B, figures 8 and 8A)—"OFF."

(25) Gun-camera switch (14; figures 8 and 8A)—"SIGHT AND CAMERA" (F-80A only).

(26) Circuit breaker—Reset.

(27) Camera heat switch—"OFF" (RF-80A only).

(28) Camera switch—"OFF" (RF-80A only).

(29) Cabin pressurization inlet grill and rear duct (Late airplanes)—"OFF."

WARNING

(Early Airplanes Only)
Hold the fuselage tank bypass switch to "NORMAL" for 2 seconds if seal on guard is broken.

(30) External power supply—Connected.

Note

Connect both cables from an adequate auxiliary power source to the dual connection (some airplanes) to insure that on starting at least 9% rpm will be obtained.

(31) De-icing Switch—Check.

(32) Check leading edge tank fuel booster pumps for proper operation with pump switch in "ON" (UP) position. If pumps are operating satisfactorily, the red warning light immediately above the pump switch will remain off. As an added check, ground personnel may determine whether the pump motor is operating by placing a finger on the exposed end of the armature shaft at the inboard end of the pump motor. The pump motor is accessible through the dive flap opening for this check. Return pump switch to "OFF" (DOWN) position.

b. SPECIAL CHECK FOR NIGHT FLYING.

(1) Landing light (7, figures 8 and 8A)—Test. *(Five seconds maximum.)*

(2) Fluorescent lights (7, figures 6 and 6A and 19, figures 8 and 8A)—Test.

(3) Deleted.

(4) Navigation lights (8, figure 8)—Test.

(5) Portable spotlight—Test.

3. FUEL SYSTEM MANAGEMENT

(except RF-80A-20 and -25)
(See figure 12.)

a. NORMAL SEQUENCE OF FUEL TANK USE.

(1) Fuselage tank (only for starting through completion of take-off).

(2) Drop tanks.

(3) Wing tanks.

(4) Fuselage tank to 100 gallon level.

(5) Leading edge tanks.

(6) Fuselage tank to empty.

b. The procedure for accomplishing automatic transfer of fuel from the drop tanks, the wing tanks, and the leading edge tanks, during normal operation of the system, is as follows:

(1) When starting the engine, the fuselage fuel tank switch (19, figures 6 and 6A) only will be placed in the "ON" (UP) position.

(2) After take-off is completed and the wing flaps have been returned to the "UP" position, all fuel switches with the exception of the leading edge fuel tank switch are "ON" (UP) position.

(3) The completion of the transfer of drop tank fuel will be indicated by the warning light immediately above the drop tank switch. In order to lessen the possibility of drop tanks collapsing because of differential air pressures, leave the drop tank switch "ON."

(4) Upon completion of the transfer of the wing tank fuel, as indicated by the warning light over the wing tank switch, the switch will be placed in "OFF" (DOWN) position.

(5) At this time, only the fuselage and the drop tank switches will remain in "ON" (UP) position. This switch will remain in "ON" (UP) position at all times during normal operation of the system. In the event that use of the by-pass system becomes necessary, the instructions contained in Section I, paragraph 9. *b.* (4), are applicable.

(6) When fuselage tank fuel has been consumed to a level of 100 gallons, place the leading edge tank switch in "ON" (UP) position.

(7) When all leading edge tank fuel has been transferred, as indicated by the warning light above the leading edge tank switch, place the switch in "OFF" (DOWN) position.

3A. FUEL SYSTEM MANAGEMENT

(RF-80A-20 and -25 only)
(See figure 12)

a. NORMAL SEQUENCE OF FUEL TANK USE.

(1) Fuselage tank (only for starting thru completion of take-off).

(2) After take-off, turn on all tanks (except drop tanks if not installed). Fuel will be transferred to the fuselage tank automatically in the following sequence:

(a) Drop tanks

(b) Leading edge tanks

(c) Wing tanks

4. STARTING THE ENGINE

WARNING

After any ten hot starts on the J33-A-9, -A-17, -A-21, -A-23, -A-35 and -GE-11 engines, the engines shall be inspected. A hot start is one in which the exhaust temperature exceeds 1000°C (1832°F).

The 10 hot starts constitute an inspection requirement regardless of the time between the starts and therefore all over temperature operation must be entered in Form 1A.

WARNING

When operating without blast deflectors, observe dangerous exhaust blast areas aft of the airplane. For danger zones see Figure 11A.

The suction effect at the intake duct entrances is not dangerous, but loose clothing or small articles may be drawn in if a person stands close to the entrance.

a. STARTING PROCEDURE.
(except RF-80A-20 and -25)

Note

All ground starts will be accomplished whenever possible with the aircraft *heading into* the wind.

(1) Throttle—"OFF."

(2) Engine shut-off valve (15, figure 6)—"OFF" (early airplanes only).

(3) Ignition booster switch—"OFF."

(4) Fuselage fuel tank switch (19, figures 6 and 6A) in "ON" (up) position. Leading edge, drop and wing tank switches "OFF" (down).

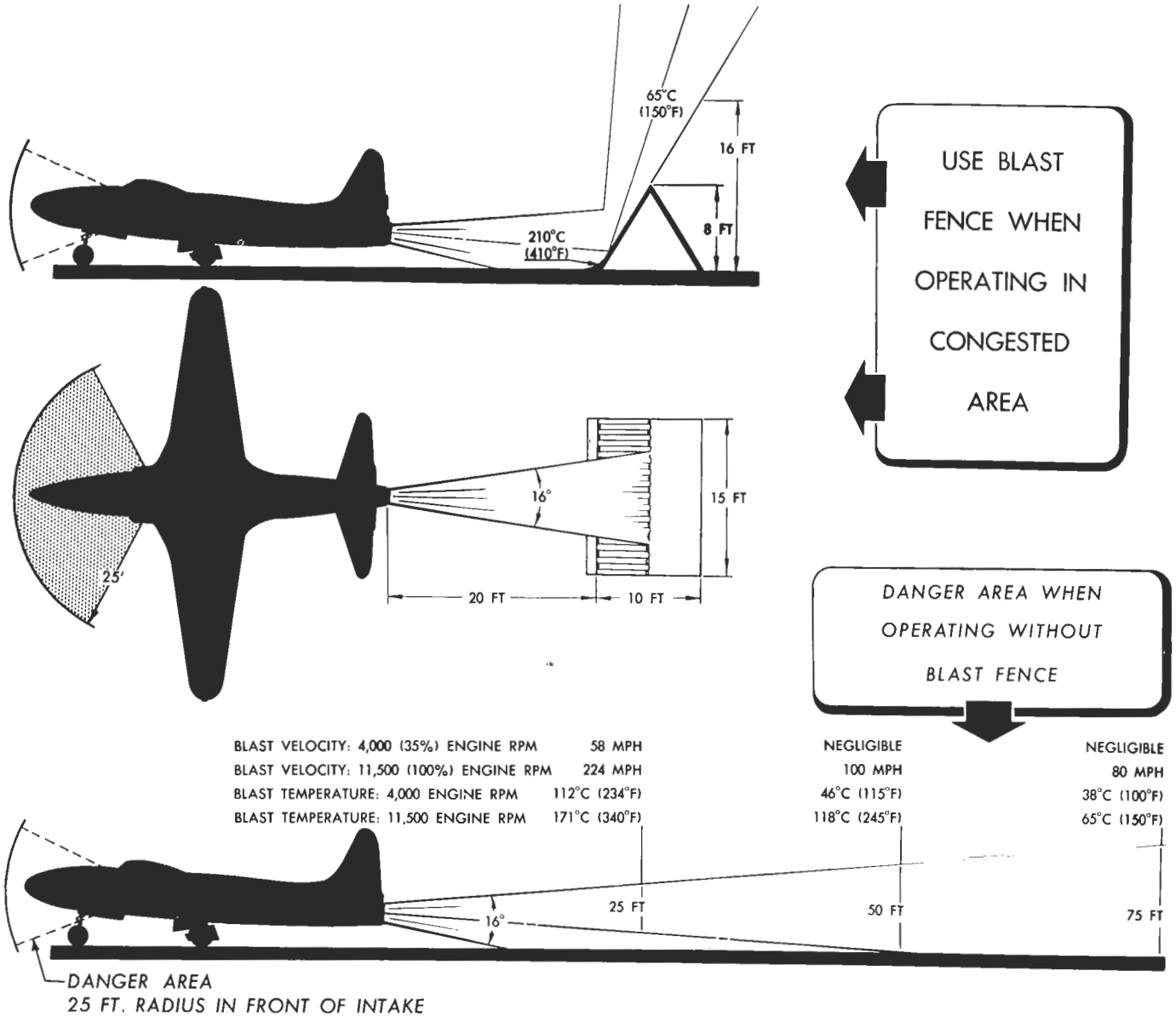
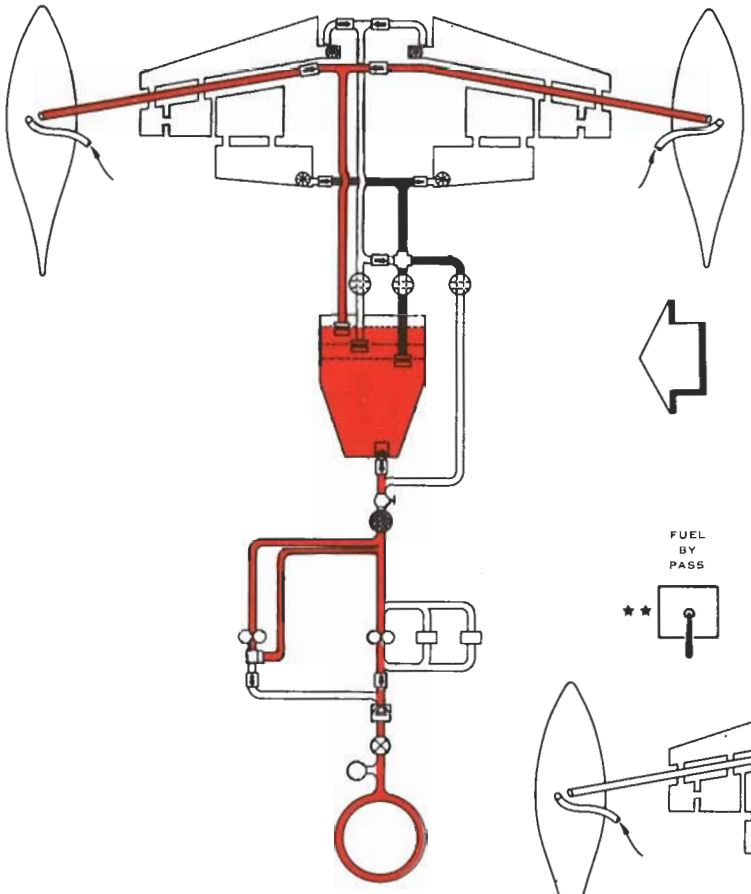


Figure 11A — Exhaust Blast Danger Areas

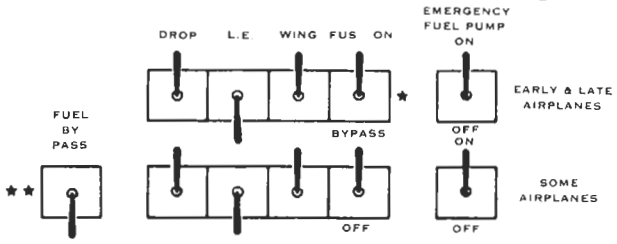


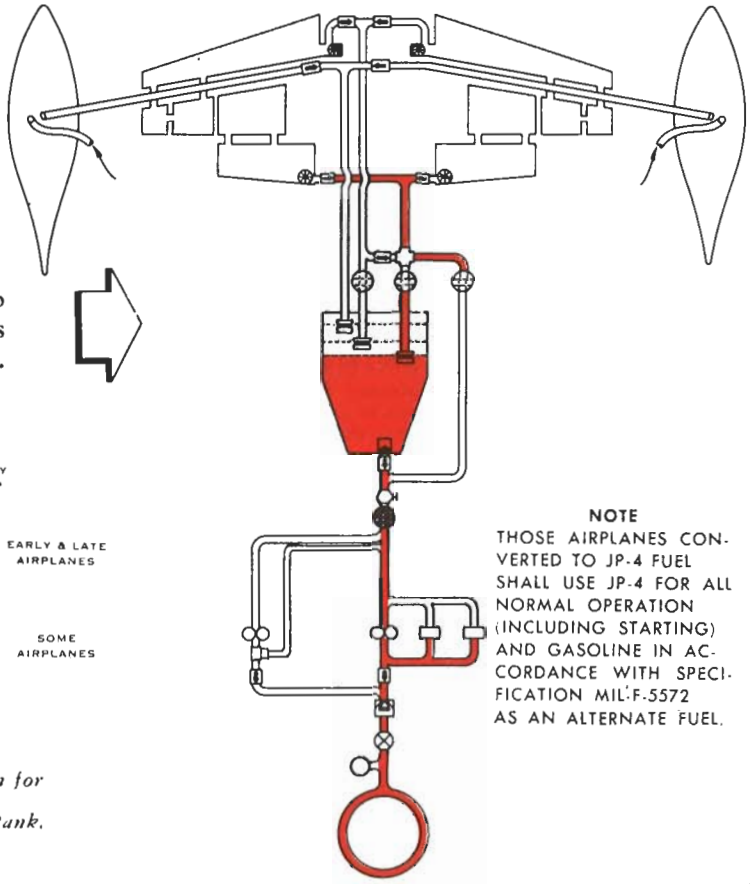
NORMAL OPERATION

Drop tanks and wing tanks full and feeding pressure to the fuselage tank. Wing leading edge and wing tank float valves closed while drop tanks supply fuel.

Emergency fuel pump *"ON"* for take-off and landing. Fuel passing through the emergency pump does not go to the engine unless the engine fuel pump pressure fails.

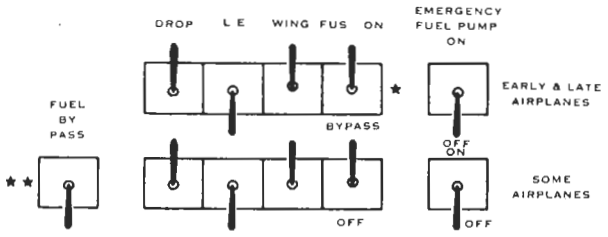
Note: Only the fuselage tank switch will be *"ON"* from the time the engine is started until take-off is completed.





NORMAL OPERATION

Turn each tank *"OFF"* (except the drop tank) as the lights over the tank switches indicate that that group of tanks is empty.

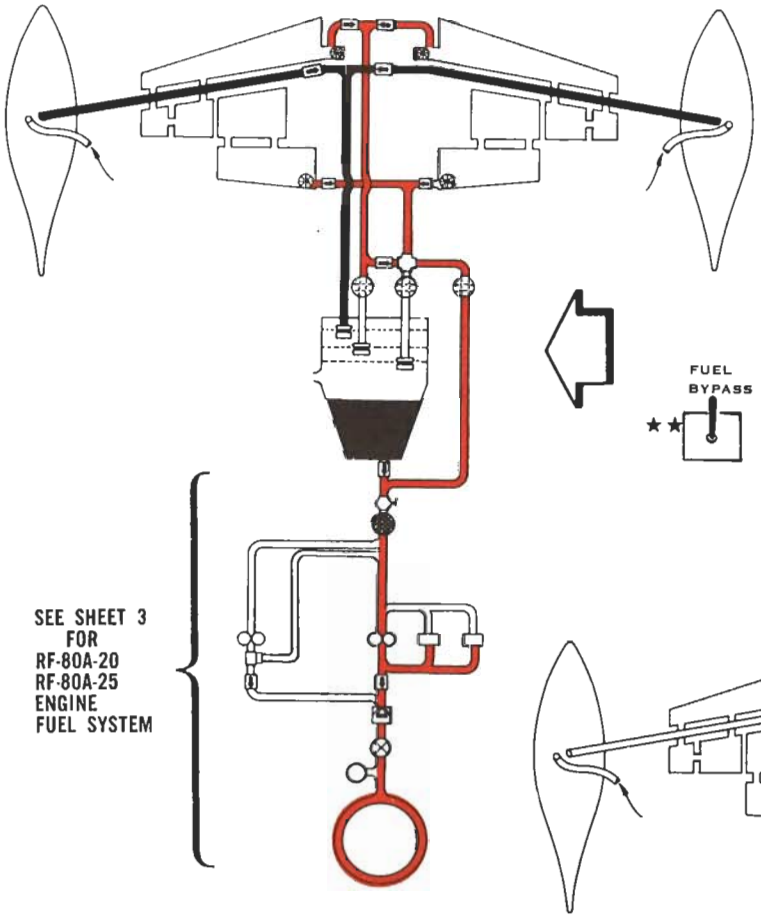


NOTE

THOSE AIRPLANES CONVERTED TO JP-4 FUEL SHALL USE JP-4 FOR ALL NORMAL OPERATION (INCLUDING STARTING) AND GASOLINE IN ACCORDANCE WITH SPECIFICATION MIL-F-5572 AS AN ALTERNATE FUEL.

★*Spring loaded switch, hold in desired position for two seconds (early airplanes only).*
★★*Spring loaded switch, to bypass fuselage fuel tank, hold in down position for two seconds.*

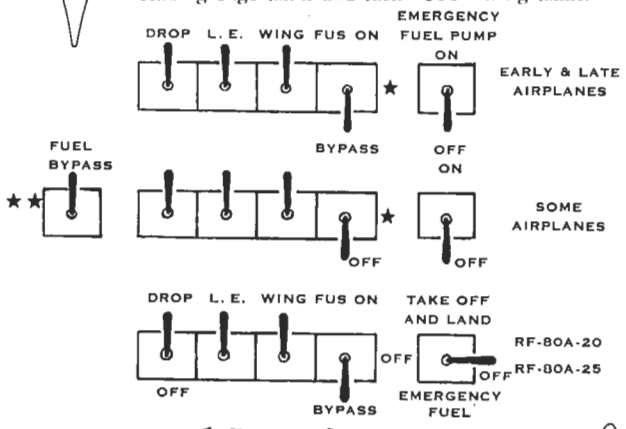
Figure 12 (Sheet 1 of 3 Sheets)—Fuel System Management

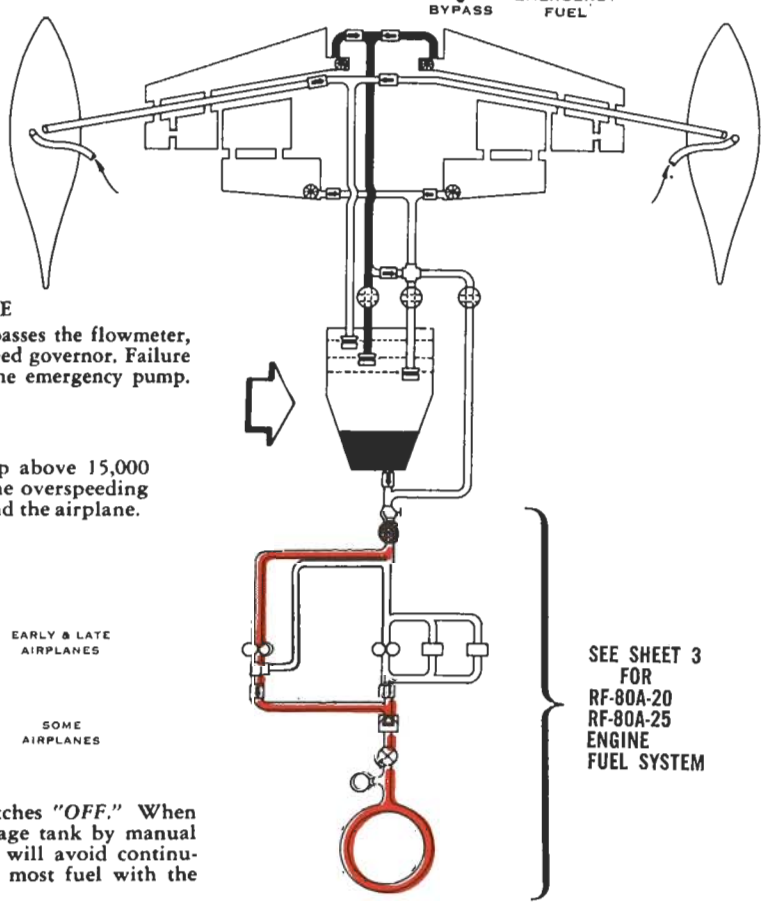


FUSELAGE TANK LEAKAGE

If fuel remains in the drop tanks, turn wing tanks *"OFF"* and maintain fuel in the fuselage tank below the level of the leak by manual operation of the drop tank switch. (See black line.)

When the drop tanks and the fuselage tank are empty, turn wing tank switches *"ON"* and turn the fuselage tank bypass switch to *"BYPASS."* Turn the fuselage tank pump switch *"OFF."* (See red lines.) After wing tanks are empty, turn *"ON"* leading edge tanks and turn *"OFF"* wing tanks.



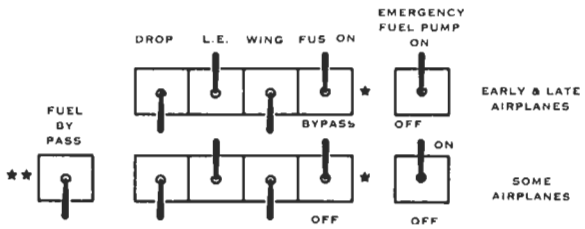


ENGINE ACCESSORY FAILURE

Turn the emergency fuel pump *"ON."* Fuel bypasses the flowmeter, the engine fuel pump, the barometric and the overspeed governor. Failure of any of these units will not affect operation of the emergency pump. (See red line.)

WARNING

When operating on the emergency fuel pump above 15,000 feet extreme care must be taken to avoid engine overspeeding which will result in destruction of the engine and the airplane.



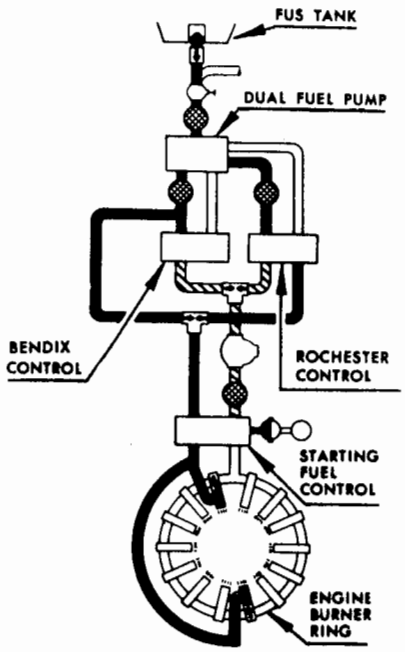
GENERATOR FAILURE

Turn wing leading edge and wing tank switches *"OFF."* When the drop tanks are empty, feed fuel into the fuselage tank by manual operation of the transfer system. This precaution will avoid continuous operation of the pumps and will transfer the most fuel with the least power. (See black line.)

When the battery power is gone, prepare to land before the fuselage tank is empty.

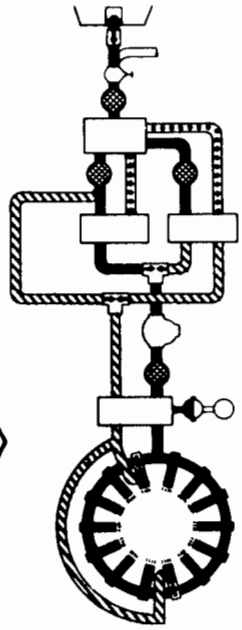
★*See footnote, Figure 12, Sheet 1 of 3.*
★★*See footnote, Figure 12, Sheet 1 of 3.*

Figure 12 (Sheet 2 of 3 Sheets) — Fuel System Management



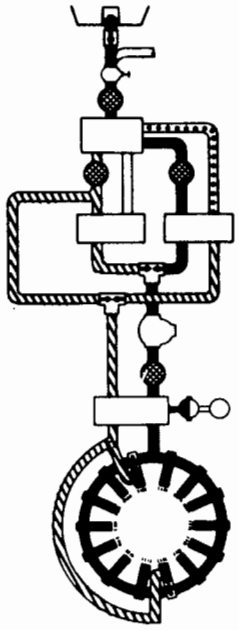
STARTING FUEL FLOW (AUTOMATIC)

Fuel is directed to burners number 7 and 14 until ignited and then to all burners automatically by the Starting Fuel Control.



NORMAL FUEL FLOW

Main fuel pump pressure is directed through the Bendix Control to main burner ring. Emergency pump pressure is bypassed.



EMERGENCY FUEL FLOW

Emergency fuel pump pressure is directed through Rochester Control to main burner ring.

WARNING

When operating on emergency fuel system use extreme care to avoid engine overspeeding.

FUEL FLOW STATIC FUEL BYPASS FUEL

Figure 12 (Sheet 3 of 3 Sheets) — Fuel System Management (RF-80A-20 and -25)

(5) Starter switch (2, figures 8 and 8A)—push to "START" and hold.

(6) At 9% rpm, place ignition switch in "NORMAL" position.

(7) Emergency fuel pump switch—"ON".

CAUTION

A defective fuel control valve will permit fuel under pressure to enter the engine. Therefore, turning on the ignition before turning on the emergency fuel pump lessens the possibility of high tail pipe temperature and excessive combustion rumble when starting.

(8) Engine shut-off valve (early airplanes) "ON," and move throttle to approximately one-half open and immediately return hand to emergency fuel pump switch.

WARNING

To avoid tail-pipe fire do not turn ignition booster switch "NORMAL" *after* moving throttle to one-half open position.

(9) At the instant combustion rumble is heard, or the instant the tail-pipe temperature starts to rise, turn the emergency fuel pump "OFF" and immediately retard the throttle to the idle position.

Note

Do not release the starter switch at this time.

(10) Adjust the throttle as required to keep the tail-pipe temperature at 700°C until the engine reaches 17% rpm. At approximately 17% rpm release the starter switch, then maintain tail-pipe temperature between 500°C and 600°C until the engine reaches idling speed (35% rpm).

Note

In the above step the reaction of each airplane will be different. With some engines, it will be necessary to pull the throttle to idle immediately to prevent the tail-pipe temperature from exceeding the starting temperature limit.

WARNING

If the tailpipe temperature reaches 1000°C, release the starter switch and close the shut-off valve immediately (on late airplanes move the throttle to "OFF"). Repeat the starting operation after pulling the tail down in order to drain all fuel from the tailpipe before restarting.

CAUTION

If the starter should be accidentally released before 17% rpm is reached, and the engine does not continue to accelerate, shut down engine. A restart will not be attempted until engine and aft section have been completely drained of any accumulated fuel.

CAUTION

When the engine shut-off valve is moved to "ON" (throttle open on late airplanes) in starting and ignition does not occur within three seconds after fuel pressure comes up, release the starter switch and pull the engine shut-off valve (or throttle on late airplanes) to "OFF." *Always release the starter switch first.*

(11) At idling speeds (about 35% rpm) check:

(a) Tailpipe temperature—600°C maximum.

(b) Fuel pressure—within limits.

(c) Oil pressure—2 to 6 psi.

(12) Disconnect external power supply and turn the battery switch "ON."

(13) Communication equipment—"ON."

b. AUTOMATIC START — RF-80A-20 and -25 ONLY.

Note

Ground starts will be accomplished whenever possible with aircraft *heading into* the wind.

(1) Throttle — "OFF."

(2) Ignition "NORMAL-OFF" switch — "OFF."

(3) Starting fuel switch — "OFF."

(4) Emergency fuel switch in "OFF" position.

(5) Automatic starter switch—push to "START" position, hold for three seconds and release.

(6) At 9 to 10% speed place ignition "Normal-Off" switch in "NORMAL" position and then place starting fuel switch in "AUTO" position. Do not attempt to start the engine below 9% speed as it will cause serious damage to the engine. In any instance that 9% speed cannot be obtained, push the automatic starter switch to "STOP-START" position and release. Then secure an adequate source of auxiliary power prior to attempting a restart of the engine.

(7) Allow the engine to stabilize at 25-35% on automatic starting control before opening throttle. This stabilized speed varies with ambient air temperature. Position fuel tank switches as required.

WARNING

If tail-pipe temperature reaches 900°C and stays there for five seconds, shut down the engine. If cause is known for the high temperature start, correct it. Repeat start. If 900°C, five second limit is exceeded shut down the engine. The engine should be checked for malfunction before any further starts.

Note

In the event a false start or flame-out is experienced, a restart will not be attempted until engine and aft section have been completely drained of any accumulated fuel.

Note

If ignition does not occur within 10 seconds after the starting fuel switch is turned to the "AUTO" position and released, push starter switch to the "STOP-START" position and then check the ignition system before attempting to make another start.

(8) Place automatic starter switch in "OFF" position after the throttle has been opened to "idle."

Note

Do not disconnect the auxiliary power source dual cables until the throttle is moved out of the "OFF" position (with the battery switch in the "OFF" position), or the engine fuel supply will be cut off. If the engine stops when the throttle is opened there is something wrong with the normal engine fuel system. Investigate the difficulty and correct.

Note

It is recommended that the starting fuel switch be turned off by pushing the guard down to avoid the possibility of turning to the "MANUAL" position instead of the "OFF" position. This switch must be in the "OFF" position at all times, except during actual starting and stopping operations. If this switch is left in the "AUTO" position the automatic starting system would be energized whenever the throttle was placed in the "OFF" position, and fuel would be supplied to the engine. If it is left in the "MANUAL" position both the normal and emergency fuel systems would be supplying fuel. Under these conditions there is no governor protection and overspeeding is very likely to occur.

(9) With the throttle in the "IDLE" position, check that instruments are in desired ranges.

(10) Disconnect the external power source and turn the battery switch "ON."

c. MANUAL START—RF-80A-20 and -25 ONLY. The engine will normally be started on the automatic system. The manual system will be used only in the event the automatic system fails to function properly.

Note

Ground starts will be accomplished whenever possible with the aircraft *heading into* the wind.

(1) Throttle—"OFF."

(2) Ignition switch in "OFF" position.

(3) Automatic starting control switch in "OFF" position.

(4) Fuselage fuel tank switch—"ON" (up) position.

(5) Emergency fuel switch — "EMERGENCY."

(6) Starter switch push to "START" and release.

(7) Turn starting fuel switch to "MANUAL."

(8) At maximum obtainable rpm (not less than 9% rpm), move the throttle rapidly to the wide open position, and as soon as the fuel pressure starts to build up, retard the throttle quickly to "IDLE." As soon as combustion rumble is heard or the tailpipe temperature starts to rise, turn the starting fuel switch "OFF."

Note

It is recommended that the starting fuel switch be turned "OFF" by pushing the guard down to avoid the possibility of accidentally turning to the "AUTO" position.

Note

If ignition does not occur within three seconds after the throttle is opened, return the throttle to "OFF" and push the starting switch to the "STOP-START" position and release.

CAUTION

A restart will not be attempted until engine and aft section have been completely drained of any accumulated fuel.

(9) After the engine starts, adjust the throttle as required to keep the tailpipe temperature below 900°C. Attempt to maintain the temperature between 800°C and 900°C until the engine reaches idle rpm.

Note

It may be necessary to pull throttle back beyond the idle position to keep from overheating during the start.

(10) Accelerate engine to about 68% rpm.

(11) Retard throttle rapidly and at the same time turn emergency fuel switch "OFF" in order to return engine to main fuel system.

CAUTION

Switching from emergency to normal fuel system at low rpm will cause an undesirable surge.

Note

Do not disconnect cart plug until emergency fuel switch is in the "OFF" position (with battery switch off) or a hot surge may occur in the changeover to the main fuel system.

(12) At idling speed (34% rpm) check that instruments are in desired ranges.

(13) Disconnect external battery cart and turn the battery switch "ON."

d. INSTRUCTIONS IN CASE OF FIRE.—There are no fire extinguishers on this airplane. If fire does occur during the starting operation,

(1) Release the starter switch.

(2) Pull the engine shut-off valve "OFF." (Throttle to "OFF" on late airplanes.)

(3) Turn all the tank selector switches "OFF."

5. GROUND TEST.

Note

No warm-up is required. If the oil pressure is up and the engine will turn up to 100% rpm, take-off may be made immediately. Gyro instruments may not be up to speed and will not give proper indications until the engine has been running five minutes. On airplanes equipped with an electrically-driven hydraulic pump, the hydraulic pump is not operative until the generator is charging, which is indicated by the ammeter.

a. Aileron tab (2, figure 6)—Check operation and set in neutral position. Left aileron only.

b. Elevator tab (20, figure 7 and 30, figures 7A and 7A-1)—Check operation and set in neutral (green light on).

Note

Late airplanes have aileron and elevator trim tab controls combined in one switch on the top of control stick.

c. Dive flap (9, figures 6 and 6A)—Check operation (be sure the ground crew is clear of the flaps) and place in "UP" position.

d. Wing flap (10, figures 6 and 6A)—Check operation.

e. Surface controls—Check for freedom.

f. Landing gear "Stiff knee" clip—Removed by ground personnel.

g. EMERGENCY FUEL SYSTEM CHECK. (RF-80A-20 and -25 only)

(1) Set engine speed at 55% while operating on main fuel system.

(2) Starting Fuel Switch—"OFF."

(3) Place emergency fuel switch in "TAKE-OFF AND LAND." Check that emergency system remains inoperative under normal conditions and return emergency fuel switch to "OFF."

(4) Push the emergency fuel check switch and hold. (When the engine changes over to the emergency fuel system, the green and amber emergency fuel indicator lights will come on. The red emergency fuel indicator light will stay on.)

Note

Engine speed will drop momentarily but should return to speed near the original setting.

Note

From this point, the pilot can return to the normal fuel system as explained in step (5) following, or advance the throttle to determine the maximum power available, if he so desires. However, the tailpipe temperature must be maintained within limits by means of the throttle as the Bendix control is not operating.

(5) Release the emergency fuel check switch while rapidly retarding the throttle. This must be done to return the engine to the normal fuel system. (When the engine returns to the normal fuel system the green and amber lights will go out, the red light will stay on.)

Note

If a flame out occurs when the emergency fuel check switch is turned on, repeat the above procedure at a different engine speed until a satisfactory change-over is accomplished.

6. TAXIING INSTRUCTIONS.

a. The airplane will start to move when the engine speed is increased to about 60% rpm. Speed should be maintained in turns of short radius. It is difficult to start moving with the nose wheel turned sharply or on soft ground. Brakes must be used for steering.

b. Taxi time should be cut to the absolute minimum. The fuel consumption while taxiing is about the same, in gallons per hour, as the fuel consumption during maximum range cruising at 35,000 feet.

Note

A good rule to remember here is: *Every minute spent on the ground taxiing requires between three and four gallons of fuel or subtracts about 7 miles from the cruising range of the airplane*

6A. JATO TECHNIQUE.

The effect of jato on airplane trim is very slight and no special technique is required. However, jato performance will depend somewhat upon the firing point. Minimum ground roll will be obtained when the jatos are fired shortly after the start of the take-off run, but the best performance in clearing a 50-foot obstacle will be obtained by firing the jatos later in the take-off run. The distances required to break ground or clear a 50-foot obstacle and the firing points are shown on the take-off chart in Appendix I.

7. TAKE-OFF.

a. BEFORE TAKE-OFF.

Note

The take-off center of gravity of this airplane, with full ammunition load, is near the forward limit unless the drop tanks are on and full. It is important that this condition be present at take-off so that the center of gravity with ammunition gone will not be too far aft for landing.

WARNING

Do not attempt to take off with full drop tanks unless there is sufficient equipment or ballast in the nose compartment. (See Section II, paragraph 1*a*.)

(1) Shoulder harness and safety belt tightened and inertia reel lock control (late airplanes) unlocked.

(2) Wing flaps (10, figures 6 and 6A) *down* 70%.

WARNING

Do not attempt take-off except at this flap setting or the speed required for take-off and the length of runway necessary will be greatly increased.

(3) Tab position during take-off is important. It is best to use neutral tab (green light on) if the drop tanks are on and full; slightly nose up if the drop tanks are off or empty.

(4) Taxi a few feet straight down the runway so that the nose wheel will be centered.

(5) Hold the brakes.

(6) Close and lock the canopy. Push the canopy forward and swing the locking handle up.

CAUTION

To preclude inadvertently jettisoning the canopy when opening or closing it, keep all foreign objects clear of the canopy jettison bar located inboard and below the canopy rail along the right side of the cockpit.

(7) Turn bomb arming switch to "SAFE" and bomb switch to "ALL."

(8) Emergency fuel switch (RF-80A-20 and -25)—"TAKE-OFF and LAND."

WARNING

Check that green emergency fuel indicator light is on and red and amber lights are out.

(9) Check fuselage tank by-pass switch "OFF" (some airplanes).

CAUTION

To avoid an excessive rpm drop, do not use the fuel filter de-icing system below 50% rpm except in an emergency.

(10) Open the throttle slowly to 100% rpm, and check:

(a) Instrument pressure (24, figures 7, 7A and 7A-1)—Check within limits.

(b) Hydraulic pressure (27, figures 7, 7A and 7A-1)—Check within limits.

(c) Ammeter (15, figures 7 and 19, figures 7A and 7A-1)—Check for charge.

(d) Oil pressure—Check within limits.

(11) Advance the throttle to full "OPEN" and check to see that the engine does not exceed 101% rpm (101.5% for -35 engines).

CAUTION

Open throttle slowly to prevent flame-out.

(12) Start emergency fuel pump. Three to four psi pressure drop will indicate normal operation of the emergency fuel system.

WARNING

Take -off is prohibited unless the fuel pressure is higher than the minimum indicated pressures listed in the chart at the bottom of this page.

b. NORMAL TAKE-OFF TECHNIQUE.

(1) Release the brakes.

(2) If using water injection for take-off, turn on the water injection switch and check cockpit air for absence of noxious fumes.

(3) Maintain directional control by a minimum use of the brakes until the rudder becomes effective. Rudder control will begin to be effective at about 75 mph indicated air speed.

(4) As elevator control becomes effective (about 80 mph) lift the nose of the airplane until the nose wheel just clears the runway. In this attitude the total drag is minimized and the acceleration will be most rapid.

(5) Pull the airplane off the ground at 125 mph with no drop tanks and at 135 mph with drop tanks (140 mph with 230 gallon drop tanks).

Note

To clear an obstacle in the minimum distance do not allow the airspeed to increase more than 10 mph above take-off airspeed.

(6) Landing gear (29, figures 6 and 6A)—"UP" only when definitely airborne.

(7) Wing flaps (10, figures 6 and 6A)—"UP" between 160 and 200 mph.

(8) Climb at about 180 mph to a safe altitude, then accelerate to best climbing speed for the remainder of the climb.

(9) Drop tank, L. E. tank, and wing tank fuel switches "ON" for RF-80A-20 and -25; drop tank and wing tank switches "ON" for other airplanes.

MINIMUM INDICATED FUEL PRESSURE AT 100% RPM
(Does not apply to aircraft with J-33-A-35 engines)

	AIR TEMPERATURE					
Altitude	17.8°C	−6.7°C	4.4°C	15.6°C	26.7°C	37.8°C
S.L.	390	370	350	330	310	290
1000′	369	349	330	309	289	269
2000′	350	330	310	290	270	250
3000′	330	310	290	270	250	230
4000′	308	288	268	248	228	208
5000′	290	270	250	230	210	190
6000′	271	251	231	211	191	171

(10) Turn the emergency fuel pump switch (5, figures 6 and 6A) "OFF."

WARNING

(Airplanes except RF-80A-20 and -25)

It is not always possible to know whether the engine is running on the main or the emergency fuel pump. Unless a fuel system malfunction is experienced, turn "OFF" the emergency fuel switch at 5000 ft. Check the fuel pressure simultaneously with turning the emergency fuel pump switch "OFF." If a drop in fuel pressure is noted, immediately turn the emergency fuel pump switch "ON." If a flame-out has occurred make a normal air start leaving the emergency fuel pump switch "ON" and land as soon as possible.

(RF-80A-20 and -25 only)

Check to see that the amber emergency fuel indicator light is out before putting the emergency fuel switch in the "OFF" position. If the amber light is on, leave the switch in the "T.O. & LAND" position and circle the field and land.

(11) Turn bomb selector switch "OFF."

(12) Gun-camera switch—"OFF" if normal. (2.75 psi) cabin pressure differential is desired.

CAUTION

Although it is possible to take off at five to ten mph slower than noted above, taking off at too low an air speed will cause the airplane to settle back on the ground. It must be remembered that sufficient airspeed is important when taking off in this airplane because there is no propeller slip stream to increase the lift of the wing. Also, failure to extend the flaps on take-off will probably cause the airplane to settle back on the ground unless the speeds recommended above are definitely increased.

8. ENGINE FAILURE DURING TAKE-OFF.

a. If the engine power should fail before leaving the ground, move the fuel shut-off valve to "OFF" (on late airplanes, move throttle to "OFF") immediately and use the brakes as required. If there is insufficient runway for braking, jettison the drop tanks and retract the landing gear.

b. If total power failure occurs soon after leaving the ground, pull the engine shut-off valve to "OFF," (on late airplanes, move throttle to "OFF), release the tanks or bombs by pushing the button on the control stick (See Section V, par. 3*b*) and land *straight ahead.* Leave the landing gear up if it is not possible to land on the runway. Leave the wing flaps extended. Pull the battery emergency disconnect switch before contact with the ground.

c. If the engine rpm should drop to about 90% at any time during a take-off, the first thing to do is to make a decision whether to go around or to stop the airplane on the ground.

Note

This sudden drop from 100% rpm to about 90% rpm usually indicates that one of the engine fuel system parts has failed. In this condition, the engine will continue to run at not less than 200 psi burner pressure (if the throttle is full "OPEN") on the emergency fuel pump alone and this power is enough to maintain flight without the drop tanks (no excessive climb).

(1) If the partial power failure occurs on the ground, stop the airplane on the runway. If the stopping distance is not sufficient, retract the landing gear and slide. *If the airplane is on the ground, it will be necessary to push down on the landing gear lever downlock release (27, figures 6 and 6A) before the gear lever can be moved.*

(2) If the airplane is already airborne:

(a) Throttle — wide open. (Not over 100% rpm.)

(b) Water injection switch—"ON" after engine has accelerated above 90% rpm (if water is available).

Note

The take-off throttle setting will usually be less than wide open, in which case increased power will be available at the wide open setting.

(c) Release the drop tanks.

(d) Landing gear—"UP."

(e) Push the nose of the airplane down as much as necessary to obtain a constant increase in air speed.

(f) Start to milk the flaps up at 135 mph.

(g) When sufficient speed and altitude have been obtained, circle the field and land.

Note

It is suggested that pilots practice flying the airplane under simulated partial power failure conditions at a safe altitude, (i.e.) gear down, flaps 80%, airspeed approximately 120 mph indicated with the drop tanks off. Set the power at 210 psi burner pressure, and check the loss of altitude which is necessary to obtain level flight. Under the above conditions, it will be possible to maintain level flight without loss of altitude. At heavier weights (with drop tanks installed) some sacrifice in altitude must be made to maintain flying speed of about 135 mph until the gear and flaps can be retracted.

9. CLIMB.

a. The speeds for best climb are given in the Take-off, Climb, and Landing charts (Appendix I).

b. The most economical climb can be obtained at 100% rpm. Do not operate at this power for more than 30 minutes at any one time.

c. Water injection switch—"OFF," after supply is consumed.

9A. OPTIONAL FUEL TRANSFER CHECK DURING FLIGHT

If the pilot desires, the following fuel availability and transfer check may be made during flight:

a. Place all switches to the "OFF" position except the fuselage and tip tank switches.

b. Make a positive check with the fuselage fuel gage and tip tank indicator light to assure fuel transfer.

c. Place the tip tank switch to the "OFF" position.

d. Place leading edge tank switch in the "ON" position and check for fuel transfer with fuselage fuel gage and leading edge tank indicator light.

e. Place leading edge tank switch to "OFF" position.

f. Place wing tank switch to "ON" and check as before with fuselage fuel gage and indicator light.

g. Place tip tank switch to "ON" and proceed with normal automatic fuel transfer.

10. GENERAL FLYING CHARACTERISTICS.

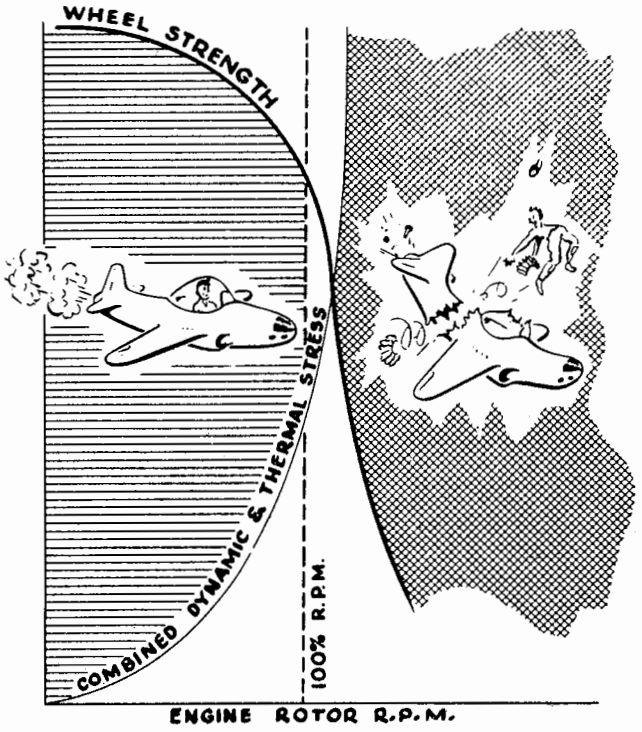
The advantage of this airplane lies in its speed. At altitude, its best climbing speed is greater than the top speed of most conventional fighters. The maximum range cruising speed at altitude is also greater than the top speed of some conventional equipment.

The disadvantage of this airplane lies in its slow acceleration from low speeds at altitude. However, once the airplane is in the air, there is ordinarily no reason to allow the speed to go below the best climbing speed or the maximum range cruising speed until approaching the field for landing. Below 300 mph, the acceleration is lower than in conventional fighters. Above this speed, the acceleration of the F-80A is greater. The zooming ability is superior above 250 mph.

The airplane has a very high rate of roll at any altitude.

WARNING

Maximum permissible engine rpm of 100% and tailpipe temperature of 700°C must not be exceeded since turbine wheel failure may result. Small increases in rpm above 100% and/or increase in tailpipe temperature above 700°C result in a large increase of turbine wheel stress and a rapid decrease of turbine wheel strength. Thus slight increases of rpm or tailpipe temperature above 100% or 700°C respectively result in a rapid increase of the possibility of turbine wheel failure.



a. STABILITY.

(1) The airplane is directionally and longitudinally stable at all approved center of gravity positions.

(2 Laterally, the airplane is neutrally stable; therefore, attention is required to hold the wings level, particularly when flying in rough air.

Note

With drop tanks installed, the airplane has a reverse rolling tendency when attempting to lift a wing with the rudder. That is, a bank cannot be corrected for by using opposite rudder, but should be corrected for by use of the ailerons.

WARNING

Avoid side-slipping the airplane with 230-gallon centerline tanks since the airplane will lose longitudinal stability in this condition.

b. TRIM CHANGES.

(1) Since there is no torque effect from the power plant of this airplane, the rudder forces are zero for all speed and power conditions if the rudder tab is properly adjusted on the ground. It may be found more convenient to fly with feet off the rudder pedals most of the time.

(2) The elevator tab should be used with caution, especially at high speeds. Failure of the tab mechanism resulting in excessive trim can be manually overcontrolled by reducing speed.

(3) The trim change due to lowering the landing gear or flaps or changing engine power is negligible.

(4) When the dive flaps are extended at high speeds, there is a tendency for the nose to come up rapidly. At low speeds, this tendency is comparatively slight.

c. CHANGING POWER IN FLIGHT.—Move the throttle forward or aft.

WARNING

Always operate the throttle as slowly as conditions will permit. If the throttle is opened too rapidly, excess fuel will be supplied to the engine which may cause flame-out or cause the tailpipe temperature to exceed the limit. If the throttle is retarded too rapidly at high altitude, flame-out may result due to rapidly diminished fuel supply and large air mass flow through engine.

d. CRUISING. (See appendix I.)

CAUTION

The oil pressure may show a tendency to increase somewhat with altitude. This is a function of the oil pressure gauge venting. If the oil pressure is questioned, it should be checked at sea level to determine if it falls within the specified limits.

e. WATER-ALCOHOL INJECTION IN FLIGHT.—Water-alcohol injection that is retained for use as thrust augmentation below 10,000 feet during flight or landing will be utilized as follows:

(1) If used when operating on the emergency fuel system, as in the case of a main fuel pump failure, advance throttle and obtain maximum rpm prior to turning on the water injection switch, then adjust the throttle to obtain 100 percent rpm.

(2) If used when operating on main fuel system, as in case of combat training, familiarization, etc., advance throttle to obtain 98 percent rpm, turn on the water injection switch, then adjust the throttle to obtain 100 percent rpm.

11. STALLS.

a. NORMAL.

(1) The stall is preceded by noticeable mushing and by buffeting which gives at least 10 mph warning. In a complete stall with power on or off, one wing may drop. If the stick is held back after the stall, the airplane will fall into a steep spiral and will probably spin.

Recovery from a stall is made by releasing the back pressure on the stick and lifting the down wing *with the ailerons.* The rudder is not effective in lifting a dropping wing.

(2) The stall will occur near the following indicated air speed at the gross weight noted but since it is improbable that a pilot will know his exact gross weight at any time and since the actual stall speed also depends upon the technique used, it is recommended that stalls be practiced so that they may be anticipated

STALLING SPEEDS

Gear and Flaps	Gross Weight (Pounds)				
	10,000	12,000	14,000	15,000	16,000
UP	110	120	130	130	135
DOWN	96	105	115	120	125

through the feel of the airplane rather than through reference to the air speed indicator alone.

CAUTION

Aircraft with 230 gallon centerline tip tanks will not be stalled.

b. ACCELERATED.

Accelerated stalls should be avoided when drop tanks are carried as high loads are imposed on the attachments at high "Gs" and because some airplanes tend to roll concurrently with the stall.

CAUTION

Abrupt rearward movement of the control stick during an accelerated stall will cause severe buffeting and must be avoided. Such abrupt stick movements during accelerated stalls may result in enough buffet loads to cause complete structural failure of the stabilizer.

11A. TURBULENT AIR AND THUNDERSTORM FLYING.

Note

Flight through a thunderstorm should be avoided if it is at all possible. However, since circumstances may force you at some time to enter a zone of severe turbulence, you should be familiar with the techniques recommended for flying the airplane under such conditions. Power setting and pitch attitude are the keys to proper flight technique in turbulent air. The power setting and pitch attitude required for the desired penetration airspeed (figure 12A) and established before entering the storm must — if maintained throughout the storm—result in a constant airspeed, regardless of any false readings of the airspeed indicator.

Specific instructions for preparing to enter a storm and flying in it are given in the following paragraphs.

a. APPROACHING THE STORM. It is imperative that you prepare the airplane prior to entering a zone of turbulent air. If the storm cannot be seen, its proximity can be detected by radio crash static. Prepare the airplane as follows:

(1) Adjust power controls as necessary to obtain safe penetration speed.

(2) Pitot heater—On.

(3) Check gyro instruments for proper settings.

(4) Safety belt tightened.

(5) Turn off any radio equipment rendered useless by static.

(6) At night, turn cockpit lights full bright or use dark glasses to minimize blinding effect of lightning.

CAUTION

Do not lower gear and flaps as they merely decrease the aerodynamic efficiency of the airplane.

b. IN THE STORM.

(1) Maintain power setting and pitch attitude (established before entering the storm) throughout the storm. Hold these constant and your airspeed will be constant—regardless of the airspeed indicator.

(2) Devote all attention to flying the airplane.

(3) Expect turbulence, precipitation, and lightning, and don't allow them to cause undue concern.

(4) Maintain attitude. Concentrate principally on holding a level attitude by reference to the artificial horizon.

(5) Don't chase the airspeed indicator, since doing so will result in extreme airplane attitudes. If a sudden gust should be encountered while airplane is in a nose high attitude, a stall might easily result. A

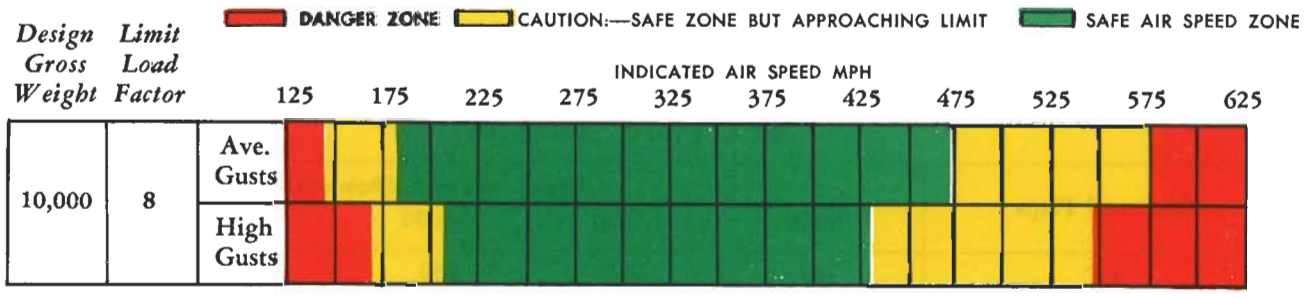


Figure 12A—Penetration Speeds

heavy rain, by partial blocking of the pitot tube pressure head, may decrease the indicated airspeed reading by as much as 70 mph.

(6) Use as little elevator control as possible to maintain your attitude in order to minimize the stresses imposed on the airplane.

(7) The altimeter is unreliable in thunderstorm flying because of differential barometric pressures within the turbulent area. A gain or loss of several thousand feet may be expected. Make allowances for this error in determining minimum safe altitude.

Note

Normally, the least turbulent area in a thunderstorm will be at an altitude of 6000 feet above the terrain. Altitudes between 10,000 feet and 20,000 feet are usually the most turbulent.

c. RECOGNITION OF ICING CONDITIONS.

(Refer to Section VI 1.)

Icing occurs because of supercooled water in fog clouds, or rain. Normally the heaviest icing takes place in clouds with strong vertical currents (cumulus clouds, projections above strato-cumulus clouds, etc.). Icing conditions as found in stratus clouds are generally light to moderate. However, severe icing conditions may occur in this type of cloud. Prolonged flights through moderate icing can build up as much ice as a short flight through severe icing conditions. The most severe type of ice formation will generally occur above —5°C (23°F).

12. SPINS.

WARNING

Do not start an intentional spin below 15,000 feet. At least 1,000 feet will be lost during each turn of the spin, and approximately 1,000 feet will be required for the recovery. As speed increases, more altitude will be required for recovery.

WARNING

Do not spin this airplane with drop tanks installed. Jettison the tanks if a spin accidentally develops.

a. DESCRIPTION.

(1) It is not probable that a spin will occur unless the stick is held full back after the stall, and full rudder is applied.

(2) The spin is erratic and rather violent and may tend to reverse direction. A definite pause occurs between each turn and each turn is made with a whipping action accompanied by considerable buffeting and snatching at the controls. The attitude of the airplane becomes steeper and the speed of rotation increases as the spin progresses.

(3) In a spin with rearward CG (32%) the control forces are lighter and the spin is less steep than in the spin with forward CG.

(4) Full rudder and up-elevator must be held in order to keep the airplane in the spin.

b. RECOVERY.

(1) CHARACTERISTICS.

(a) The spin recovery characterictics of this airplane are excellent. Recovery can be effected in from ¼ to ¾ of a turn. If recovery is started during a pause it is more rapid than if started during a turn.

(b) With rearward center of gravity (32%) approximately one full turn is required to stop rotation.

(2) PROCEDURE.

(a) For all forward and normal center of gravity positions apply full opposite rudder and push the control stick to neutral.

(b) For a rearward CG position (32%) apply full opposite rudder and push the control stick full forward. As the rotation stops, alternate left and right rudder must be applied, until the air speed increases, to prevent falling into a spin in the opposite direction.

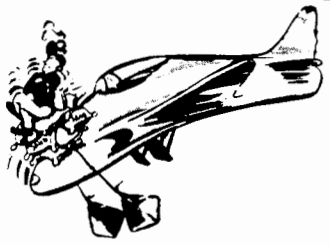
13. PERMISSIBLE ACROBATICS.

CAUTION

Cage all gyro instruments before engaging in acrobatics.

a. All acrobatics, except those requiring extended negative acceleration, are permissible. Under negative acceleration conditions, fuel will not be fed to the engine and flame-out will occur if the inverted condition is maintained for more than a few seconds.

b. The pilot is cautioned to use extreme care in maneuvers which require a downward recovery as the loss of altitude in downward recovery is very rapid. In general, acrobatics should not be attempted below 10,000



BE PREPARED FOR A DEFINITE **NOSE UP** MOMENT WHEN DIVE FLAPS ARE EXTENDED AT HIGH SPEED!

feet until the pilot becomes familiar with the speed at which the airplane can gain and lose altitude.

WARNING

Recovery from a vertical stall may require more than 10,000 feet altitude. This maneuver is not recommended at *any* altitude.

c. Ten quarts of oil are required in the engine reservoir to provide sufficient lubrication during acrobatics. Inverted flight may be maintained as long as it is possible to hold a positive accelleration. Negative accelleration will prevent fuel flow and cause almost immediate flame-out.

14. DIVING.

a. The airplane is controllable up to a Mach number of .8 and it is strongly recommended that this limit be observed.

b. At the critical Mach number, lateral control is very difficult and uncertain but longitudinal control is still good. Aileron buzz may occur slightly before, or at, the speed at which lateral instability is noticed.

If use of the trim tab is neglected, considerable push on the control stick will be required to hold the airplane in the dive. This stick force increases up to a Mach number of about .75 and will remain approximately constant between Mach numbers of .75 and .8.

c. When the dive flaps are extended at high speed, there will be a definite nose-up tendency; however the acceleration will not be excessive even with hands off. This nose-up tendency may be counteracted by applying nose down trim tab at the same time the dive flaps are started out.

Caution must be observed when retracting the dive flaps at high speed, as this creates a sudden nose-down tendency which must be resisted if flying close to the ground.

CAUTION

Aileron compressibility "buzz" is a low amplitude vibration of the ailerons which can best be detected by watching for a fuzzy outline at the trailing edge of the aileron. This buzz will occur at about .8 Mach number in "one G" flight; slower under accelerated flight conditions. Operation within the buzz region should be avoided whenever possible.

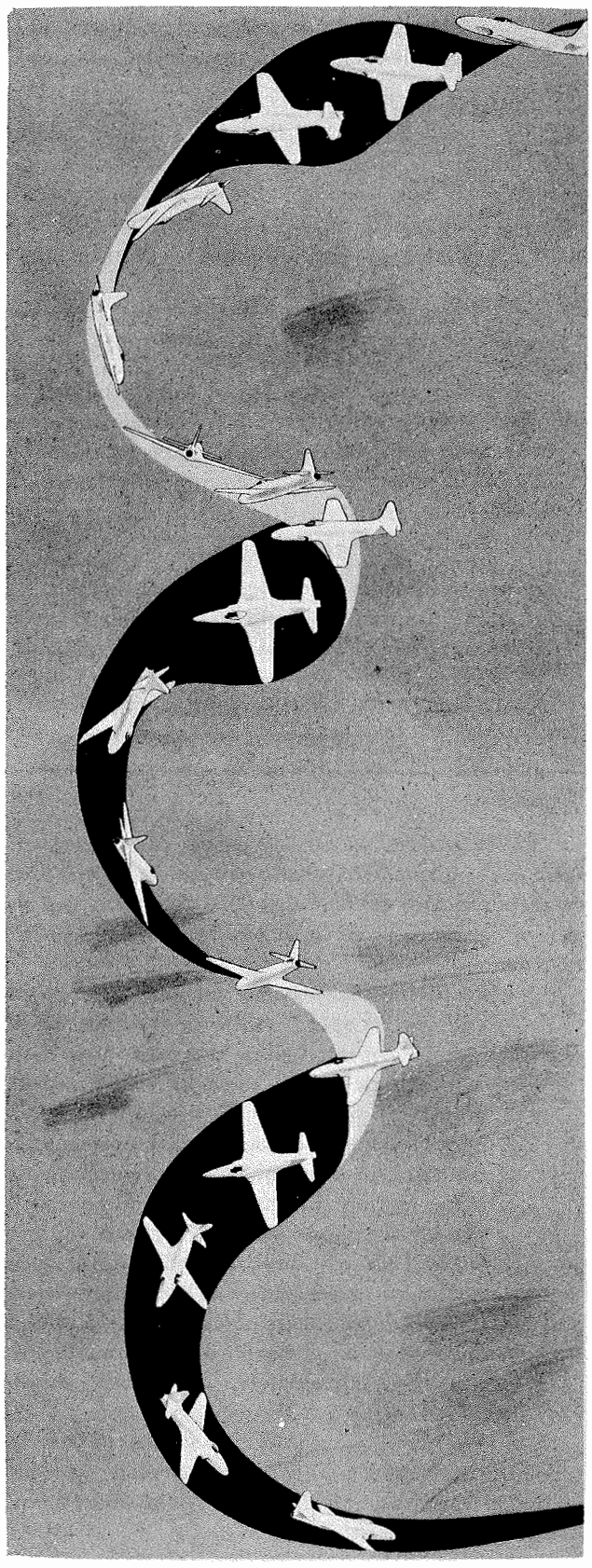


Figure 13 — Spin Pattern

d. The dive flaps may be extended at any time and at any speed. It is suggested that dives be conducted with the dive flaps up so that they will be in reserve to aid in slowing the speed when, and if, trouble is encountered.

15. NIGHT FLYING.

a. For night take-off and landing, push the landing light control (9, figure 7) in. Pull the control out for spotlight use. The landing lights on late airplanes are located on the nose gear and are not adjustable.

b. Cockpit and navigation lights are conventional.

16. APPROACH AND LANDING.

WARNING

Accumulation of mud, snow, or ice on leading edge of wing will adversely affect stall characteristics and, therefore, special precautions should be observed during landing under such conditions.

CAUTION

If wing heaviness due to uneven fuel transfer from the drop tanks should be encountered it is strongly recommended that the heavy tank be dropped before landing. The airplane has been landed with one tank full and one tank empty but full aileron was required and the airplane was very difficult to manage on the landing.

a. PORPOISING — On occasions, pilots inexperienced in the airplane have encountered difficulties with severe porpoising on landings. The following suggestions are made to avoid or minimize the effects of this condition:

(1) Porpoising may occur on fast touchdowns with excess speed and with the nose wheel making contact before the main gear. Consequently do not fly the nose wheel into the ground.

(2) If porpoising is encountered, move the control stick in a manner to counteract the airplane motion; in other words, if the nose is coming up, move the stick forward and vice versa. This will probably not stop a severe case of porpoising but will lessen the severity.

(3) If porpoising is encountered on fields of sufficient length to permit a safe go-around, elect to do this immediately.

*a*1. GENERAL.

(1) The landing technique is similar to that for conventional tricycle landing geared airplanes, and the landing attitude is about the same; that is, main wheels first, tail slightly down.

Note

When landing with flaps up, care should be exercised to avoid an extreme tail-low attitude which will cause the tail to drag on the runway.

(2) With the landing gear down and wing flaps 50% extended, start the approach at 150 mph indicated air speed. When the landing is assured, extend full flaps and start flaring off. Come over the end of the runway at 110 mph and wait for contact. If the landing is being made with an appreciable load of fuel or ammunition, the above air speeds should be increased in proportion to the load.

CAUTION

Landing with full tip tanks is permissible only in an emergency. If such a landing is necessary make a flat power-on approach in order to avoid a possible stall.

Keep the engine at 50% to 60% rpm during the approach so that power may be applied more quickly if it should become necessary to go around. Approximately 20 gallons of fuel will be required for a tight pattern on the go-around for landing.

(3) If, for some reason, the flaps cannot be lowered, land approximately 20 mph faster and allow for more flare-off and a *much flatter gliding angle.*

(4) Dive flaps may be used as desired during the approach and landing. Their use will increase the glide angle and reduce the length of roll after landing.

b. NORMAL LANDING.

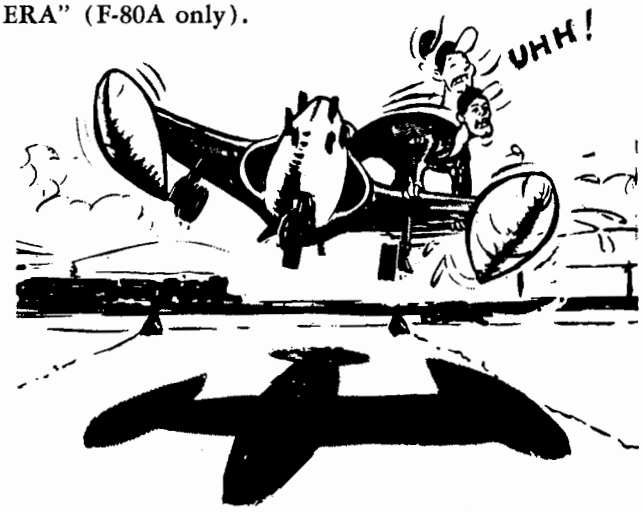
(1) Shoulder harness and safety belt tightened and inertia reel lock control (late airplanes) unlocked.

(1A) Emergency fuel pump "ON."

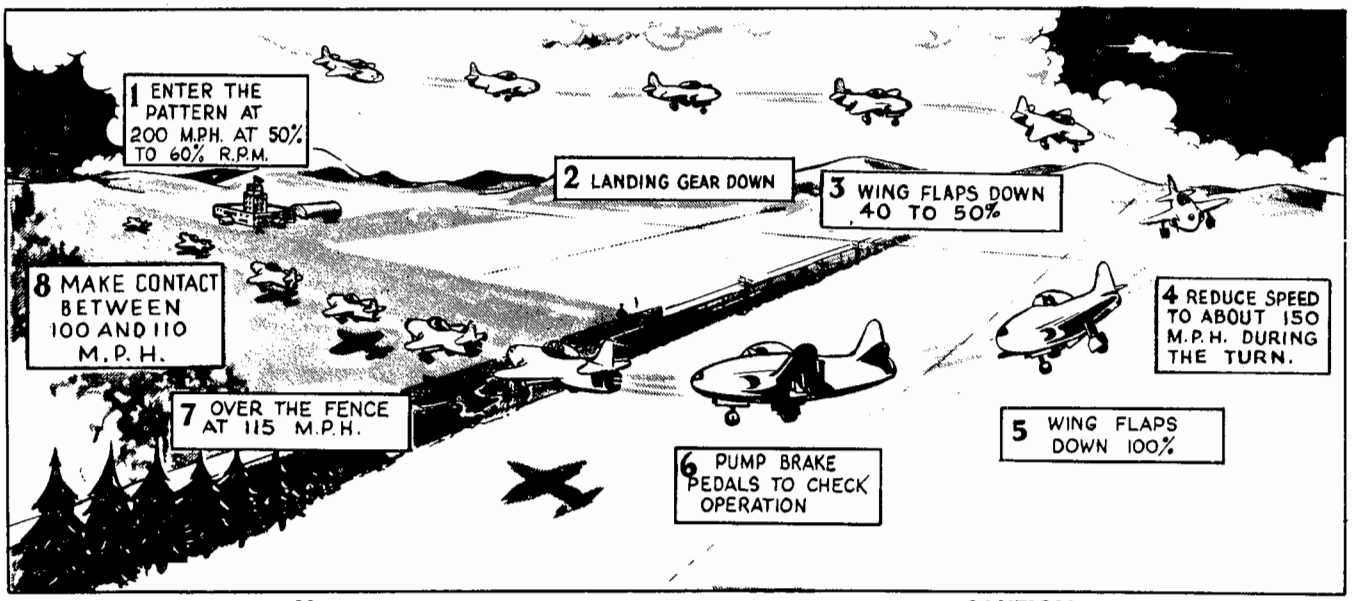
(1B) Emergency fuel switch (RF-80A-20 and -25)— "TAKE-OFF and LAND."

(2) Landing gear (29, figure 6 and 6A) *"DOWN"* (not over 225 mph).

(2A) Gun-camera switch "SIGHT AND CAMERA" (F-80A only).



IT HAS BEEN LANDED WITH ONE TANK FULL, BUT IT'S TOUGH.



Note

Side slips, fish tailing, and "S" turns may be used as desired. These maneuvers should be practiced in normal landings so that they may be used more effectively in case of an emergency "dead-stick" landing.

CAUTION

Excessive use of the brakes must be avoided. As a rule, braked landings should not be made oftener than once every 15 minutes. Heat generated by too much braking will cause tire failure.

Figure 14 — Approach Diagram

Due to the drop in hydraulic pressure while the landing gear or dive flaps are in motion, the aileron booster may not operate until their operation is completed.

Note

Particular attention should be paid to the operation of the landing gear and dive flaps on airplanes which are equipped with a hydrofuse. The fuse is apt to shut off the hydraulic pressure under certain conditions, such as low engine rpm or air in the system. When this occurs, there is no hydraulic pressure to the gear or dive flaps even though the aileron boost will remain effective. Therefore, particular note should always be made that the gear is fully extended and locked as shown by the indicator lights. If the hydrofuse does shut off hydraulic pressure, it should be re-set by pulling the re-set handle; however, handle (35, figures 7, 7A and 7A-1) has been safety-wired open so that hydrofuse cannot be reset.

(3) Wing flaps (10, figures 6and 6A) *"DOWN"* (not over 200 mph). (Dive flaps down if desired.)

(4) Engine speed—50% to 60% rpm.

c. AFTER LANDING.

(1) Wing and dive flaps "UP" before taxiing.

(2) Emergency fuel pump "OFF".
Emergency fuel switch (RF-80A-20 and -25) — "OFF."

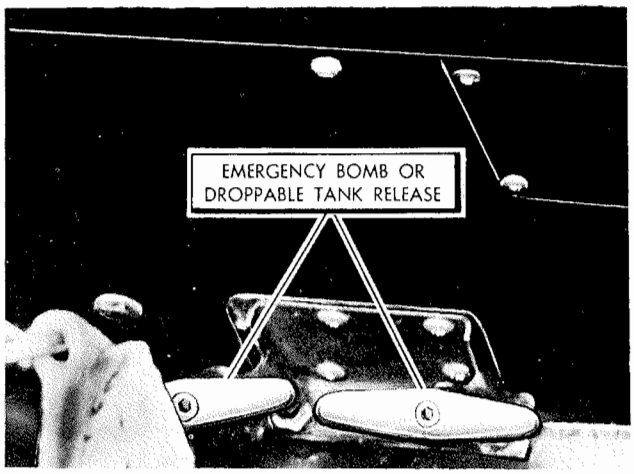


Figure 15 — Left Cockpit Floor

d. CROSS WIND LANDING.

Same as a normal landing. If the drift appears excessive, the upwind wing may be lowered until just before contact.

e. TAKE-OFF IF LANDING IS NOT COMPLETED.

The ability of this airplane to take off in the event the landing is not completed is definitely inferior to that of conventional single engine fighters. If the landing cannot be completed, the decision to go around should be made as early as possible.

Proceed as follows:

(1) Open the throttle to 100% power as slowly as circumstances will allow.

CAUTION

Open throttle slowly to prevent flame-out.

(2) Water injection switch "ON" (at not less than 90% rpm) if water—alcohol is available and ground temperature exceeds 32°F.

(3) Retract the landing gear immediately, as soon as safe flying speed is reached.

(4) Milk the flaps to 50% until the air speed indicates over 140 mph, then retract them all the way.

(5) Accelerate to approximately 165 mph before starting to climb.

17. STOPPING THE ENGINE.

a. Parking brakes—set.

b. Idle the engine between 35% and 50% rpm.

c. Pull the engine shut-off valve to "OFF." (On late airplanes, pull throttle to "OFF.")

d. Turn all switches "OFF" except generator switch.

18. BEFORE LEAVING THE PILOT'S COMPARTMENT.

a. Lock the surface controls.

b. Release parking brakes after wheels are chocked.

c. Install ground safety pin in electric canopy bungee.

SECTION III—FLIGHT OPERATING DATA

AIRPLANE MODELS
F-80A-1, -5, -10
RF-80A-5, -10, -15, -20, -25

FUEL SPEC.
MIL-F-5624—JP-4
MIL-F-5572 GASOLINE — LOWEST AVAILABLE GRADE

ENGINE MODELS
J-33-A-9A, -9B, -11A, -11B, -21, -35
J-33-GE-17, -17A

OIL SPEC.
MIL-L-6081 — GRADE 1010

ENGINE OPERATING DATA

CONDITION	R. P. M.	TIME LIMIT	*OIL PRESS. PSI	*TAIL PIPE TEMP. °C
TAKE-OFF OR MILITARY	100%	30 MINUTE LIMIT	35 (TAKE-OFF)	700
MAX. CONTINUOUS	96%	NO LIMIT	—	—
MINIMUM	—	—	2 (IDLE)	300

*Except airplanes with J-33-A-35 engine (see Fig. 16A)

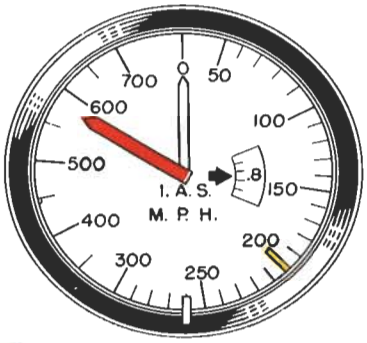
F-80A AIR SPEED CORRECTION TABLE RF-80A

INSTR. I.A.S.	CORRECT I.A.S. (gear and flaps up or down)				
	S.L.	10,000	20,000	30,000	40,000
100	98				
125	123				
150	148	148	147	146	144
175	173	172	171	170	168
200	198	197	196	194	191
225	223	221	220	217	213
250	247	245	243	240	235
275	272	270	267	263	256
300	296	294	290	285	266
325	320	317	313	306	
350	345	341	336	328	
375	369	365	358		
400	393	388	380		
425	417	411	402		
450	442	434			
475	466	457			
500	490	480			
525	515				
550	545				
575	564				

INSTR. I.A.S.	CORRECT I.A.S. (gear and flaps up or down)				
	S.L.	10,000	20,000	30,000	40,000
100	97				
125	122				
150	147	146	146	145	143
175	172	171	170	169	167
200	196	195	194	193	190
225	220	219	217	215	211
250	244	242	240	237	232
275	268	266	263	259	253
300	292	289	285	280	
325	315	312	308	302	
350	339	335	330	322	
375	363	358	352		
400	387	382	376		
425	411	405	396		
450	435	428			
475	459	450			
500	483	473			
525	507	496			
550	531				
575	555				

NOTE: Figures shown in S.L. column equal calibrated air speed (CAS).

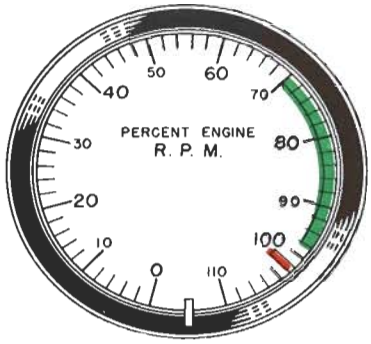
AIR SPEED



200 MPH — MAXIMUM WING FLAPS EXTENDED
(225 MPH — MAXIMUM LANDING GEAR EXTENDED)

THE INSTRUMENT SETTING IS SUCH THAT THE RED POINTER WILL MOVE TO INDICATE THE LIMITING STRUCTURAL AIR SPEED OF 580 MPH, OR THE AIR SPEED REPRESENTING THE LIMITING MACH NUMBER OF .8, WHICHEVER IS LESS.

* TACHOMETER



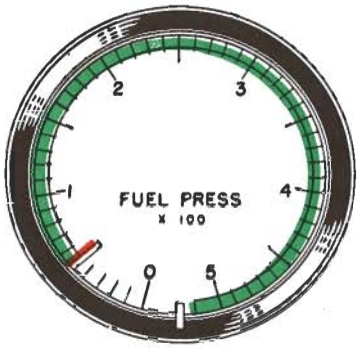
70-90% rpm — MAXIMUM ENDURANCE CRUISE

90-96% rpm — MAXIMUM RANGE CRUISE

100% rpm — MAXIMUM (30 MINUTES DURATION ONLY)

NOTE: SEE PARAGRAPH 4-SECTION II

* FUEL PRESSURE

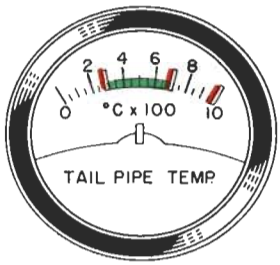


50 psi — MINIMUM

520 psi (OFF SCALE) MAXIMUM

50-250 psi — NORMAL

* TAILPIPE TEMPERATURE



300°C — MINIMUM (Except on Landing Approach)

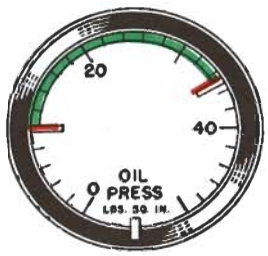
300°-700°C — CONTINUOUS OPERATION

700°C — MAXIMUM FOR FLIGHT

1000°C — MAXIMUM DURING STARTING

NOTE: SEE WARNING PARAGRAPH 4 - SECTION II

* OIL PRESSURE



10 psi — MINIMUM DURING FLIGHT (PRESSURE BELOW 10 psi MAY BE EXPECTED WHEN ENGINE IS IDLING)

10-35 psi — CONTINUOUS OPERATION

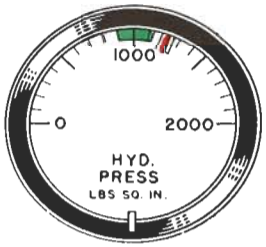
35 psi — MAXIMUM (AT SEA LEVEL)

INSTRUMENT AIR PRESSURE

5" Hg — MAXIMUM

3.5" to 5" Hg — OPERATING RANGE

* HYDRAULIC PRESSURE



900-1175 psi — NORMAL

1250psi — MAXIMUM

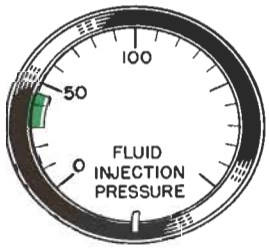
ACCELEROMETER

5.33 G MAXIMUM WITH DROP TANKS

7.33 G MAXIMUM WITHOUT DROP TANKS

-2 G MAXIMUM WITH DROP TANKS

FLUID INJECTION PRESSURE



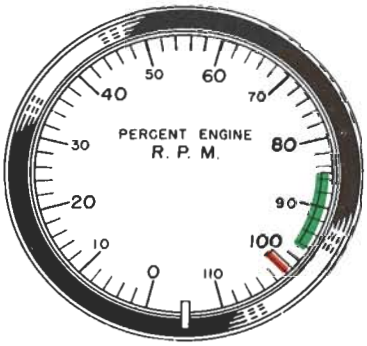
30 - 45 psi — NORMAL

FUEL GRADE — JP-4

** Except RF-80A-20, -25. (For RF-80A-20, -25 markings and limits see Figure 16A.)*

Figure 16 — Instrument Markings
F80A-1, -5, -10, and RF80A-5, -10, -15, -20, -25

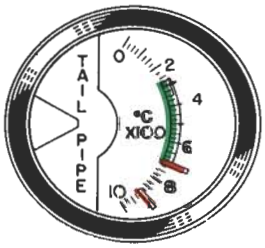
TACHOMETER



- 85-96% rpm — BEST CRUISING
- 100% rpm — MAXIMUM (30 MINUTES DURATION ONLY)

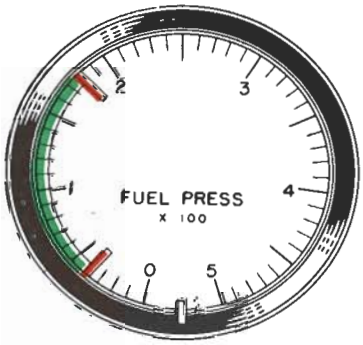
NOTE: SEE PARAGRAPH 4 - SECTION II

TAILPIPE TEMPERATURE
(J33-A-35 ENGINE)



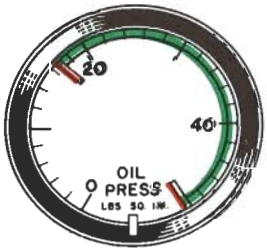
- 275°-720°C — CONTINUOUS OPERATION
- 720°C — MAXIMUM FOR FLIGHT
- 900°C — MAXIMUM FOR STARTING (5 SEC. MAX.)

FUEL PRESSURE
(J33-A-35 ENGINE)



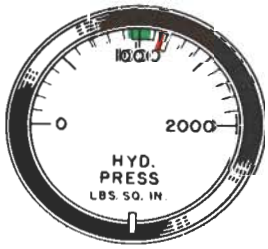
- 38 psi — MINIMUM
- 38-180 psi — NORMAL
- 180 psi — MAXIMUM

OIL PRESSURE
(J33-A-35 ENGINE)



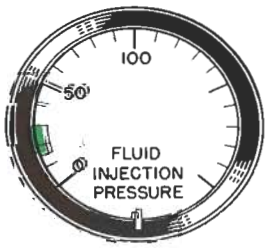
- 17 psi — MINIMUM DURING FLIGHT (PRESSURE BELOW 17 psi MAY BE EXPECTED WHEN ENGINE IS IDLING)
- 17-50 psi — CONTINUOUS OPERATION
- 50 psi — MAXIMUM (AT SEA LEVEL)

HYDRAULIC PRESSURE



- 950-1100 psi — NORMAL
- 1175psi — MAXIMUM

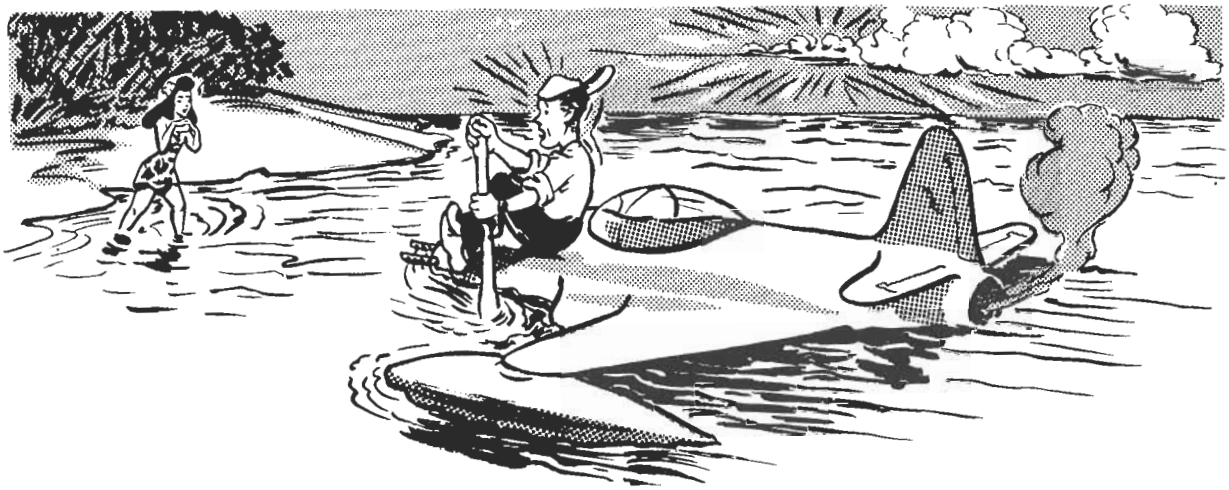
FLUID INJECTION PRESSURE



- 15-30 psi — NORMAL

FUEL GRADE JP-4

Figure 16A — Instrument Markings — RF-80A-20, -25



Section IV-Emergency Operating Instructions

1. EMERGENCY EXIT.

a. If the airplane is still controllable:

(1) Reduce air speed to less than 200 mph.

(2) Disconnect oxygen and radio equipment.

CAUTION

If bail-out is made at high altitude, remain connected to the regular airplane oxygen supply while all other preparations for leaving the airplane are being made. Just before leaving the airplane, disconnect oxygen mask from mask-to-regulator tubing and place the Type H-2 emergency oxygen cylinder in operation by pulling the rip cord cable of the oxygen cylinder (the caution tag and pin assembly having been removed prior to take-off).

(3) Jettison canopy. — With manually operated canopy, crack the canopy open about two inches before jettisoning.

(4) Roll airplane over on its back and trim to inverted climb.

(5) Clear "G" suit, oxygen and communication connections, then release safety belt and clear shoulder straps.

WARNING

Bend forward and lower the head when jettisoning the canopy to avoid injury from the released canopy.

b. If the airplane is not controllable, jettison the canopy and bail out.

2. EMERGENCY CANOPY OPERATION.

a. FROM INSIDE THE AIRPLANE. — Lower head and pull hard on jettison handle (15A, figure 8).

b. FROM OUTSIDE THE AIRPLANE.—Open jettison access door and pull yellow handle (3, figure 7C).

Note

Do not use the gun sight as a hand hold.

3. FIRE.

a. There is no fire extinguishing system on this airplane. If the fire warning light comes on, reduce power to see if the warning light will go out, especially if the engine was operating at high power.

b. If the light goes out, when power is reduced, exhaust leakage or improper positioning of the tailpipe clamp is the probable cause and flight may be continued at reduced power.

c. If the light does not go out, tailpipe temperature does not exceed maximum (700°C), and there are no external indications such as smoke, flame or blistering of the paint, continue operation at reduced power until light goes out. Even if the light goes out, it is recommended that the airplane be landed as soon as possible and thoroughly examined prior to further operation.

d. If the light does not go out, tailpipe temperature exceeds maximum (700°C) and external indications of fire are noted, shut the engine down completely and turn the fuselage tank boost pump "OFF" (on late airplanes, move the fuselage tank switch to the neutral position). If a dead stick landing is not practical, allow the engine to cool for a few seconds before restarting and operating at reduced power. Even if the light stays out after the engine is started again, it is recommended that the airplane be landed as soon as possible.

e. Make reasonably sure that fire is actually present before abandoning the airplane, as described in paragraph 1 preceding.

4. ENGINE VIBRATION.

a. In the event engine vibration is detected, reduce engine speed sufficiently to obtain lowest possible engine vibration and still maintain sufficient thrust for normal flight. Closely watch the tailpipe temperature gage. If the temperature rises above 700°C (720°C,-RF-80A-20, -25) shut down the engine and close cockpit air vents. Check for presence of fire in the aft section and land as soon as possible.

5. ENGINE FAILURE DURING FLIGHT.

a. GENERAL.—Engine flame-out in flight is usually due to one of the following causes:

(1) Fuel pressure too low at altitude.

(2) Temporary loss of fuel supply due to inverted flight or running out of fuel in the fuselage tank.

(3) Failure of one of the fuel system units.

(4) Flame-out due to too rapid opening or closing of the throttle, usually at high altitude.

(5) Wing tanks empty and fuselage tank being by-passed.

b. In the above cases, a restart may be accomplished after making sure that there is sufficient fuel in the fuselage tank and holding the fuselage tank bypass switch to "NORMAL" for at least 2 seconds (on late airplanes, turn the fuselage tank switch "ON") or, in general, making sure that fuel is available to the engine.

(1) As soon as the flame-out occurs, pull the engine shut-off valve to "OFF" (on late airplanes, move throttle to "OFF") to prevent flooding the engine and the tailpipe with fuel.

c. AIR STARTS (except RF-80A-20 and -25). Consistent restarts may be made by the following method:

(1) Correct condition causing failure, if possible.

(2) Glide down below 20,000 feet before making the first starting attempt and keep the airspeed high so that a windmill speed of over 9% will be available for starting.

(3) Throttle—one-third "OPEN" ("OFF" if engine shut-off is not installed).

(4) Pull up sharply to permit drainage of fuel from the combustion chambers and tailpipe.

(5) Reduce air speed to less than 300 mph. (Do this as quickly as possible before the windmill speed falls off excessively.)

(6) Ignition booster—"ON."

(7) Emergency fuel pump "ON" when start is made below 10,000 feet. When start is made above 10,000 feet, leave emergency fuel pump "OFF" to prevent supplying excess fuel to engine which will result in excessive tailpipe temperature.

Note

In case of an unsuccessful start above 10,000 feet, actuate the emergency fuel pump switch momentarily to build up fuel pressure.

(8) Engine shut-off valve "ON." Throttle one-third "OPEN" if shut-off is not installed.

(9) As soon as the burners light, manipulate the throttle to keep the rpm and temperature within limits.

WARNING

If the tailpipe temperature reaches 1000°C and stays there for about 4 seconds, close the shut-off valve immediately and repeat the starting operation.

DON'T GET CAUGHT AT LOW SPEED!

(10) Ignition booster—"OFF."

(11) Attempt to operate with the emergency fuel pump turned "OFF."

Note

If the engine will not start or will not accelerate from low windmill rpm, normal ground starting procedure may be used. As a rule, this should not be attempted above 9% rpm windmill speed because the starter pawls may be damaged.

WARNING

When flying on the emergency fuel system, the barometric control and the overspeed governor are not in operation. Great care must be exercised to prevent engine overspeeding as overspeeding will result in almost certain destruction of the engine and the airplane. Watch for

Figure 17—Emergency Battery Disconnect Switch

overspeeding during a climb or when starting the engine on the emergency fuel system in flight. IF THE ENGINE CANNOT BE HELD BELOW 100% rpm, SHUT IT OFF (engine shut-off "CLOSED") (or throttle "OFF") AND GLIDE TO A LOWER ALTITUDE BEFORE RESTARTING.

d. AIR START—RF-80A-20 and -25.

(1) GENERAL

(a) As soon as flame-out occurs, place throttle in "OFF" position. Immediately determine if fuselage tank contains fuel. If not, start transfer of fuel if it is available.

(b) Glide down to 25,000 feet (at higher altitudes, poor flame propagation makes air start very uncertain) before attempting an air start. If circumstances permit, keep engine windmilling speed up to 10% or more. Engine speed should stay above 10% if the air speed is maintained within about 35 mph of the red needle. If circumstances make a fast descent undesirable, the starter may be used as explained in the starting procedure.

(c) Turn off unnecessary electrical equipment to conserve battery power for starting.

(d) Air starts should be accomplished by use of the automatic fuel starting system. The manual system should be used only in case of failure of the automatic system.

Note

In case the recommended procedure has been forgotten, the normal ground start procedure will work if the flame-out was due to anything other than a failure of the normal engine pump or engine fuel control.

(2) AIR START — AUTOMATIC.

(a) Pull up for 5 to 10 seconds at 1 G to permit drainage of fuel from tailpipe and combustion chambers. Then hold air speed at about 200 to 225 mph for the start.

(b) If engine speed is below 10% rpm, push starter switch to "START" and release. If rpm is 10% or more, omit this step.

(c) Air start ignition switch—"START" (and release). Ignition will continue for approximately 45 seconds.

(d) Starting fuel sequence switch—"AUTOMATIC" at not less than 10% rpm.

(e) Emergency fuel switch — "TAKE-OFF and LAND."

(f) After burners light and engine has stabilized on the starting control, open throttle with smooth positive force to idle detent.

(g) Turn starting fuel sequence switch "OFF" immediately after setting throttle in idle. If the rpm starts to drop off, open throttle sufficiently to maintain a speed equal to the stable speed on the starting control.

WARNING

1. If the tailpipe temperature reaches 1000°C and stays there for more than three seconds, turn starting fuel switch "OFF" immediately and then move the throttle to the "OFF" position.

2. If the amber emergency fuel indicator light remains on after the throttle is opened, the engine is running on the emergency fuel system. Therefore, leave the emergency fuel switch in the "TAKE-OFF and LAND" position until the airplane is landed. Use extreme care in throttle manipulation to prevent engine overspeeding, engine blowouts, or excessively low engine idle speeds as there is no governor in the emergency fuel system. If the amber light is out, the emergency fuel switch may be returned to the "OFF" position after the throttle has been opened.

(h) Accelerate to desired rpm. Note Warning (2).

(3) AIR START — MANUAL.

(a) Pull up for 5 to 10 seconds at 1 G to permit drainage of fuel from tailpipe and combustion chambers. Then hold air speed at about 200 to 225 mph for the start.

(b) If engine speed is below 10% rpm, push starter switch to "START" and release. If rpm is 10% or more, omit this step.

(c) Air start ignition switch—"START" (and release). Ignition will continue for approximately 45 seconds.

(d) Starting fuel sequence switch—"MANUAL" at not less than 10% rpm.

(e) Emergency fuel switch—"EMERGENCY."

(f) Rapidly open throttle to approximately the three-quarters open position. As soon as the fuel manifold pressure begins to rise from zero, rapidly retard the throttle to approximately one inch below the idle detent and place hand on the starting fuel system switch.

(g) At indication of flame (sound or temperature), turn the starting fuel system switch to "OFF" and allow engine speed to stabilize.

WARNING

1. If the tailpipe temperature reaches 1000°C and stays there for more than three seconds, move the throttle into "OFF" immediately.

2. Since the engine is operating on the emergency system, use extreme care in throttle manipulation to prevent engine overspeeding, engine blowouts or excessively low engine idle speeds.

(h) After engine speed stabilizes (at approximately 25%), slowly advance throttle lever to obtain desired rpm.

(i) If engine flame-out was not due to failure of the main engine pump or main fuel control, engine operation may be returned to the main system by advancing the rpm to about 90 to 100% and then retarding the throttle (quite rapidly) at the same time the emergency fuel switch is moved to the "OFF" position.

6. FUEL SYSTEM EMERGENCY OPERATION.

a. ENGINE FAILURE.

If the engine fails for no apparent reason, it is probable that the engine fuel pump, the barometric, or the governor has failed. The engine will run on the emergency fuel pump after a normal air start.

b. LEAKING FUEL TANKS.

It is not probable that leaking tanks will be detected during flight. If a serious leak is suspected, use the fuel from the leaking tank as rapidly as possible (by turning all other tanks "OFF"). If the leak is in the fuselage tank, go on "fuselage tank by-pass" operation after the fuel in the drop tanks and the fuselage is gone.

7. TIP TANKS FUEL SYSTEM MALFUNCTION.

a. Due to malfunction of the wing tip tank fuel system, it is possible for one tip tank to be empty and one tank to remain full. If this occurs, it will result in wing heaviness which will become more apparent as airspeed is reduced and below 114 mph IAS full aileron control and trim will not hold the wing level. Therefore, whenever wing heaviness is encountered and wing tip tanks are installed observe the following instructions:

b. Retract wing flaps just to determine whether this will correct the control difficulty.

c. Jettison the tip tanks.

d. In event landing with one full and one empty tip tank becomes absolutely necessary, attain at least 10,000 feet altitude above the surrounding terrain and accomplish a simulated landing to determine the lateral control characteristics of the aircraft. Descent from altitude will be accomplished with landing gear extended and the landing will be made at least 10 mph in excess of the airspeed at which loss of lateral control was noted during the simulated landing.

e. If at any time when carrying tip tanks, lateral control and trim becomes difficult and erratic, reduce airspeed immediately. If the difficulty persists at approximately 200 mph IAS, jettison the wing tip tanks before further investigating the trouble. When lateral control difficulties are encountered, the aileron boost must not be turned off while the tip tanks are still on the aircraft. In the event the wing tip tanks fail to release, reduce the airspeed to 150 mph and if satisfactory lateral control cannot be maintained, abandon the aircraft. Also abandon the aircraft if satisfactory lateral control cannot be maintained after jettisoning the wing tip tanks and shutting off the aileron boost.

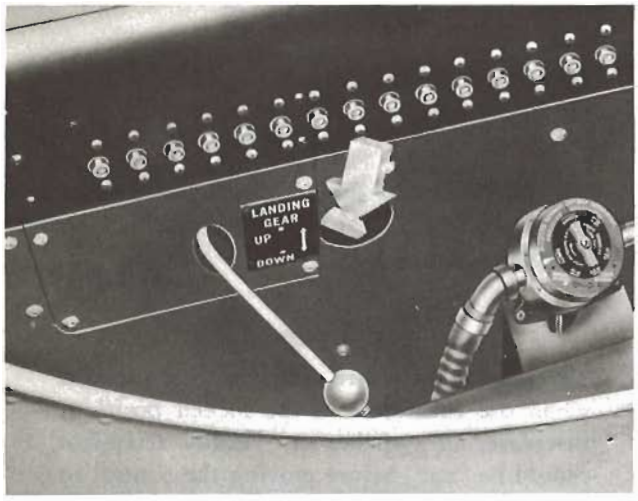
8. ELECTRICAL FAILURE.

a. GENERAL. — Complete electrical system failure results in partial fuel system failure on all airplanes. If only the generator fails, and battery power is available, the fuel system may be made to deliver its entire supply as explained in paragraph *b*(2), following. In order to conserve the battery as much as possible for manual fuel transfer, turn off all unnecessary electrical equipment, and use the necessary equipment sparingly.

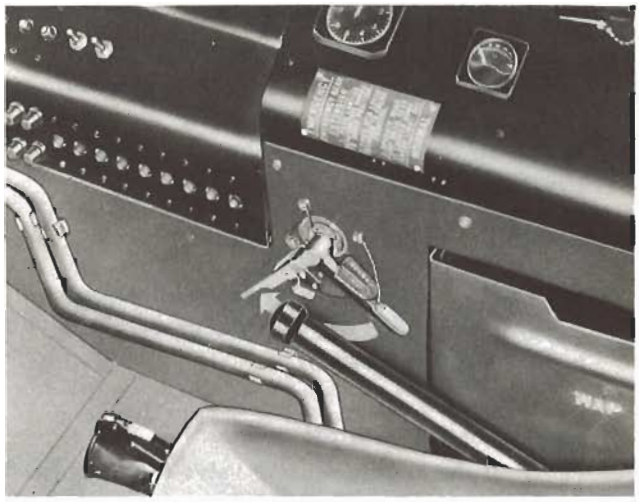
b. FUEL SYSTEM.

(1) Complete Electrical Failure. — If the electrical system should fail completely, fuel will be available only from the fuselage tank, except in the case of late airplanes. On late airplanes, fuel will also transfer from the drop tanks to the fuselage tank automatically.

(2) Partial Electrical Failure (All Airplanes). — If only the generator fails, and battery power is still available, fuel may be transferred manually from all of the tanks as follows:



NORMAL



EMERGENCY

Figure 18 — Landing Gear Controls

(a) Turn the wing leading edge and wing tanks "OFF" and allow fuel to transfer from the drop tanks.

(b) When the drop tanks are empty and the fuselage tank quantity gage reaches 160 gallons, turn "ON" the leading edge tanks intermittently to maintain this level. Repeat this manual transfer process until the leading edge tanks are emptied if maximum battery economy is desired.

(c) Transfer fuel manually, as explained in paragraph *(b)* preceding, from the wing tanks.

9. BOMB OR DROP TANK EMERGENCY RELEASE.

Two manual controls (figure 15) are connected directly to the wing tip bomb shackles. If the electric release mechanism fails, pull the manual controls out hard.

10. WING FLAP EMERGENCY OPERATION.

Either of the two wing flap motors will extend the flaps. If both motors should fail, or in case of electrical failure, the airplane must be landed with flaps up. Refer to section II, paragraph 16 *a*1(3).

11. LANDING GEAR EMERGENCY OPERATION.

a. Put the landing gear control (29, figure 6) in the "DOWN" position.

b. Break the safety wire and turn the emergency landing gear selector (12, figure 8) to "EMERGENCY."

c. Operate the hand pump (13, figure 8) until the landing gear is down and locked (approximately 60 strokes).

Note

Do not operate the hand pump until the emergency landing gear control is placed in the "EMERGENCY" position, since the fluid will only be pumped back to the emergency tank. Recheck the position of the selector lever if results are not obtained.

WARNING

If the gear has been extended using the emergency hydraulic system, it must not be retracted again except in case of an emergency. If the gear is retracted after an emergency extension, it cannot be extended again.

12. LANDING WITH WHEELS RETRACTED.

a. Release the tip tanks; bomb switch (14, figure 8) to "ALL" and depress control stick button.

Note

The decision concerning the retention of the tip tanks should be based on a consideration of whether there is fuel in the tip tanks and the type of terrain available for landing. In smooth terrain, the retention of the tip tanks will alleviate damage to the aircraft, for they act as skids and also tend to preclude cartwheeling due to a wing tip digging in.

b. Slide the cockpit canopy open, or if in any doubt, jettison.

c. Make sure that the shoulder harness and safety belt are safely secured, the inertia reel lock control (late airplanes) is locked, and the parachute is unbuckled.

CAUTION

The pilot is prevented from bending forward when the control is in the locked position; therefore, all switches not readily accessible should be "cut" before moving the control to the locked position.

CAUTION

Extend full wing flaps (full flaps will prevent wing tip from digging into the ground with resultant ground loops).

d. Before contact with the ground:

(1) Pull the engine shut-off valve to "CLOSED." (On late airplanes, throttle "OFF.")

(2) Pull the emergency battery disconnect switch to "OFF."

(3) Turn the generator switch "OFF."

(4) Move dive flap switch to "UP."

e. Make a normal approach at 10 to 15 mph above the stalling speed and let the airplane touch the ground slightly before the stall is reached.

13. LANDING IN WATER (ditching).

a. When anticipating an emergency due to lack of fuel, do not descend near the water to check conditions. The fuel remaining in the airplane will give at least 2½ times more range at 35,000 feet than it will at sea level. Stay at altitude until the fuel is gone, then glide down to a reasonable altitude and bail out.

WARNING

In all cases, it is recommended that the pilot bail out rather than attempt a water landing, if sufficient altitude is available.

b. If there is insufficient altitude for a safe bail-out, ditch as follows:

(1) Release drop tanks unless empty or nearly empty and sea is calm.

Note

Empty or nearly empty tanks will hold ducts out of water until initial speed is lost and provide additional buoyancy.

(2) Jettison the cockpit canopy.

(3) Make sure the landing gear is up.

WARNING

Do not attempt a water landing with the landing gear extended.

(4) Make sure the shoulder harness and safety belt are safely secured and that the inertia reel lock control (late airplanes) is locked.

CAUTION

The pilot is prevented from bending forward when the control is in the locked position; therefore, all switches not readily accessible should be "cut" before moving the control to the locked position.

(5) Unbuckle the parachute harness.

(6) Throttle closed.

(7) Set the dive brakes full down. Set flaps ½ to ⅔ down. (The flaps and dive brakes will not cause the airplane to dive. Extended dive brake will aid in keeping the jet intakes up.)

(8) Select heading parallel to wave crests if possible. Attempt to touch down on crest or on falling side of wave, never on rising side.

(9) After the airplane comes to rest, get out of the cockpit immediately. Don't forget the life raft.

14. HYDRAULIC SYSTEM EMERGENCY OPERATION.

Use the following emergency procedures on late airplanes equipped with hydrofuses.

a. If the hydraulic pressure on the gage drops and the aileron boost continues to operate, pull and release the hydrofuse reset lever (35, figure 7) and observe the reaction of the gage.

(1) If the pressure indication returns to normal, proceed with normal operation of the landing gear or dive flaps.

(2) If the pressure does not rise, or falls as soon as the reset handle is released, take no further action until the hydraulic system is needed.

When the hydraulic system is needed for operation of the landing gear or dive flaps, select as desired and reset the hydrofuse; however, hydrofuse handle has been safety-wired open.

If no results are obtained, use the emergency procedure for extending the gear; do not use the dive flaps unless absolutely necessary.

If the emergency extension system will not extend the gear, replace the emergency landing gear selector lever in its normal position and place the landing gear control in the down position. After these settings are made, hold the hydrofuse reset handle out until either the gear is down and locked as indicated by the green light, or until all the hydraulic fluid is pumped overboard as indicated by failure of the aileron booster.

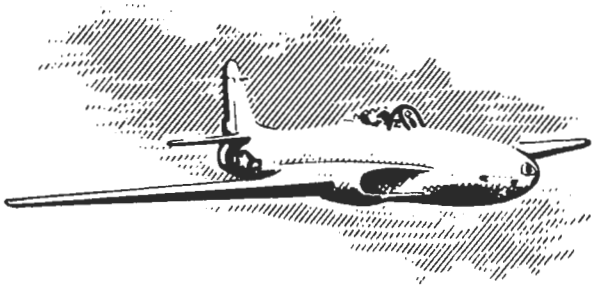
If the landing gear still fails to extend, try the emergency system again before making a belly landing or bailing out.

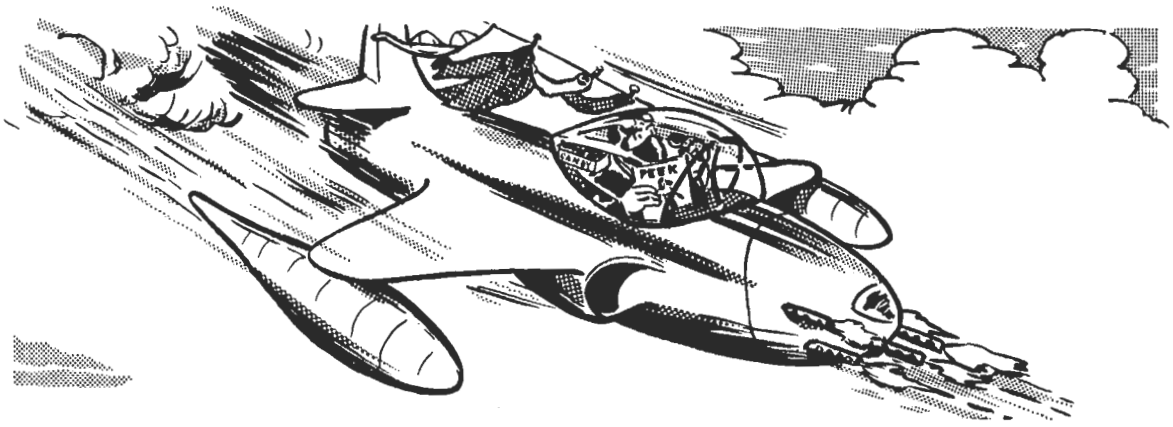
15. AILERON BOOST FAILURE.

Turn the aileron boost shut-off lever to "OFF" at altitude if necessary and at low altitude at all times.

WARNING

A roll tendency with the landing gear or landing flaps extended may not necessarily indicate aileron boost failures; therefore, do not disconnect aileron boost. First, retract gear and flaps. If this does not correct roll, and if there is an indication of an unbalanced fuel load condition, drop all external load. If the roll tendency is still felt, climb to above 12,000 feet, reduce airspeed to approximately 20% above stall speed and disconnect aileron boost.





Section V - Operational Equipment

1. HEATING, VENTILATING, AND PRESSURIZING.

a. VENTILATING.

Outside air is supplied to the cockpit through a scoop in the left engine intake duct. The air enters the cockpit through grills located near the rudder pedals when the pressurization control is in the "OUTSIDE AIR" position on early airplanes. On late airplanes, outside air enters the cockpit through a tube which directs it to the pilot's face. A butterfly shut-off valve controls the flow and a swivel fitting on the end of the tube directs the flow.

b. PRESSURIZATION AND HEATING.

(1) Air under pressure, taken from the compressor section of the engine, is used to pressurize the cockpit.

(2) On early airplanes a lever located on the forward end of the left hand shelf controls the pressurizations and heating. This lever has two usable positions ("OFF" and "COLD") and one position ("HOT") that is blocked off. When the lever is in the "OFF" position, the pressure air valve is closed and outside air is admitted through the grills. When moved to the "COLD" position, the lever opens the pressure air valve and shuts off the outside air.

(3) On late airplanes a lever on the forward end of the LH shelf controls the temperature of the pressurizing air by diverting part of it through a turbo refrigerator. The pressurizing air is turned on or off by the control levers on the grills located adjacent to the rudder pedals, and at the shut-off at the rear duct adjacent to the pilot's left shoulder.

(4) Cockpit pressure is automatically maintained by the pressure regulator at the normal differential of 2.75 psi or at the combat differential of 1.5 psi above outside air pressure. The setting of the pressure regulator is controlled by the gun camera switch or on the FP-80, by the cabin pressure selector switch. When the switch is in the "OFF" position ("NORMAL" on the FP-80) normal pressure differential is maintained. When the switch is placed in the "GUNS" or "SIGHT AND CAMERA" position ("COMBAT" on the FP-80), the regulator setting changes slowly. (to avoid the effects of rapid decompression) to the combat differential at 1.5 psi. It is recommended that operation above 38,000 feet be conducted in the combat setting to avoid the possibility of rapid decompression in event of damage by gunfire, accidental release of the canopy or any other sudden leakage.

(5) Cockpit altitude is indicated on the altimeter (6, figure 6).

(6) On FP-80A airplanes camera compartment temperature is controlled by a thermostat when the camera compartment heat switch (6, figure 9) is turned "ON." Camera compartment temperature and outside air temperature are indicated on a dual instrument (16, figure 9) on the lower center instrument panel.

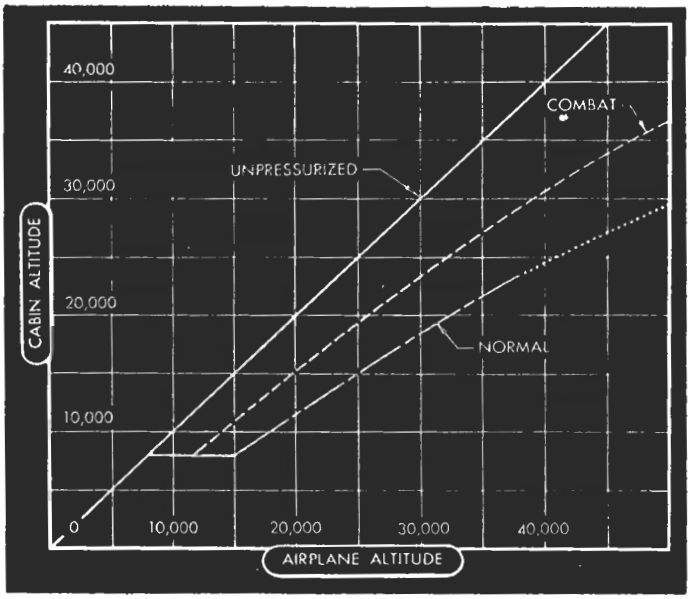


Figure 19 — Cockpit Pressurization Chart

c. DEFROSTING.

A defroster tube is located around the base of the three front windshield panels. A supply of warm air is taken from the cockpit pressurization line. To defrost, place the pressurization control lever in the "COLD" position. On late airplanes push and turn the control button to the right of the gun sight mount.

Late airplanes include provisions for an auxiliary electrically operated windshield defroster for cold weather operation and descent with low power. This defroster has a high current drain and should be used only when the normal hot air system is insufficient.

For emergency defrosting, such as may be necessary when descending with a dead engine, slide the canopy part way open and keep the air speed below 250 mph I.A.S.

PILOT OXYGEN DURATION – HOURS

Cabin Altitude Feet	Gage Pressure – P.S.I. 400	350	300	250	200	150	100	Below 100
40,000	5.7 5.7	4.9 4.9	4.1 4.1	3.2 3.2	2.4 2.4	1.6 1.6	0.8 0.8	EMERGENCY DESCEND TO ALTITUDE NOT REQUIRING OXYGEN
35,000	5.7 5.7	4.9 4.9	4.1 4.1	3.2 3.2	2.4 2.4	1.6 1.6	0.8 0.8	
30,000	4.2 4.2	3.6 3.6	3.0 3.0	2.4 2.4	1.8 1.8	1.2 1.2	0.6 0.6	
25,000	3.4 4.0	2.9 3.4	2.4 2.8	1.9 2.3	1.4 1.7	1.0 1.1	0.5 0.6	
20,000	2.7 4.5	2.3 3.9	1.9 3.2	1.5 2.6	1.2 1.9	0.8 1.3	0.4 0.6	
15,000	2.1 5.4	1.8 4.6	1.5 3.9	1.2 3.1	0.9 2.3	0.6 1.5	0.3 0.8	
10,000	1.8 7.2	1.5 6.2	1.3 5.2	1.0 4.1	0.7 3.1	0.5 2.1	0.3 1.0	

RED FIGURES INDICATE DILUTER LEVER IN "100%" POSITION.
BLACK FIGURES INDICATE DILUTER LEVER IN "NORMAL" POSITION.
CYLINDERS—4 EACH. D-2.
CREW—ONE MAN.

2. OXYGEN SYSTEM.

a. GENERAL. – A low pressure oxygen system, consisting of four Type D-2 oxygen cylinders properly check valved for combat safety, is installed in the aircraft. The four cylinders are installed in the wings (two in each wing) and may be refilled through a single filler valve which is located in a box in the nose wheel well. The oxygen pressure gage (32, figure 7 and 33, figure 7A) and flow indicator (34, figure 7 and 36, figure 7A) are installed on the lower left side of the instrument panel. A Type A-14 pressure breathing diluter demand oxygen regulator (4, figures 6 and 6A) is located on the left console. Only a pressure breathing demand oxygen mask should be used.

b. REGULATOR. – The diluter lever of the oxygen regulator should always be set at the "NORMAL OXYGEN" position except under emergency conditions. The pressure dial of the oxygen regulator should be set as follows:

(1) For cabin altitudes below 30,000 feet, leave dial at "NORMAL" position.

(2) For cabin altitudes between 30,000 feet and 40,000 feet, set the pressure dial at "SAFETY" position.

(3) For cabin altitudes above 40,000 feet, set the pressure dial to the cabin altitude.

c. EMERGENCY OPERATION. – With symptoms of the onset of anoxia, set the dilutter lever to "100% OXYGEN." If the oxygen regulator becomes inoperative, pull the cord of the H-2 emergency oxygen cylinder. If smoke or fuel fumes should enter the cabin, proceed as follows:

(1) Set the cabin pressurization lever at the ram air position.

(2) Set oxygen regulator diluter lever to "100% OXYGEN" position.

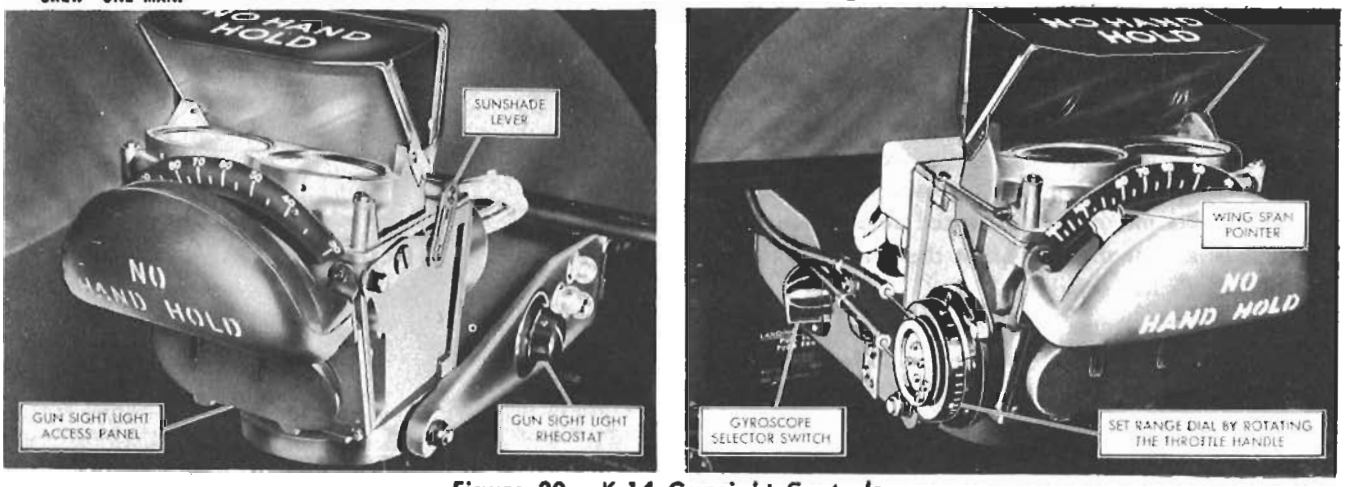


Figure 20 – K-14 Gunsight Controls

(3) Set pressure dial of oxygen regulator as required by cabin altitude. (See paragraph 2*b* above.)

3. ARMAMENT.

a. GUNNERY EQUIPMENT.

(1) The six .50 caliber guns each carry 300 rounds of ammunition when fully loaded.

(2) A gun camera, mounted in the lip of the right engine intake duct, operates with the guns or separately.

(3) To operate the guns and the camera, set the gun-camera switch (14, figure 8) to "GUNS" and operate the control stick trigger.

(4) To operate the camera alone, set the gun-camera switch to "SIGHT AND CAMERA" and operate the control stick trigger.

CAUTION

The gun sight should be in operation at full speed during take-off and landing to reduce the possibility of damage resulting from shocks.

(a) Turn the gun sight on (by turning the gun-camera switch to "GUNS" or "SIGHT AND CAMERA") before starting the engine and leave it in operation until after take-off. Turn on again before landing.

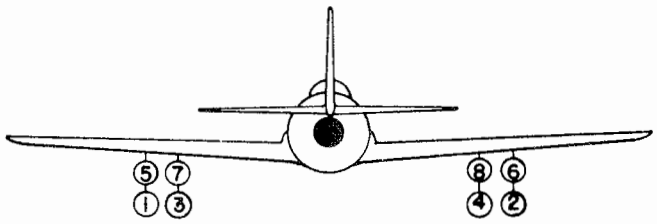
Note

Approximately 15 minutes are required for the gun sight gyro to reach its operating rpm. It must be turned on at least 15 minutes before using.

(5) On winterized airplanes, all guns are equipped with gun heaters.

b. BOMBING EQUIPMENT.

The bombs are carried on two shackles located one under each wing tip. To release the bombs individually, place the bomb switch (14, figure 8 and 8A) or auxiliary bomb switch (8A, figure 8A) to "TRAIN" and press the button on top of the control stick grip (left bomb drops first). To release the right bomb, press the button again. To release the bombs simultaneously, place the bomb switch to "ALL" and press the button on the control stick grip. A bomb salvo switch (17, figure 7A-1) is provided on some airplanes to permit release of bombs simultaneously in an emergency.



ALTERNATE ROCKET LOADING	
NO. OF ROCKETS	POSITION
2	5 and 6
4	5, 6, 7, and 8

Figure 20-A — Rocket Loading

c. CHEMICAL TANKS. — The chemical tank installation has not yet been flight tested.

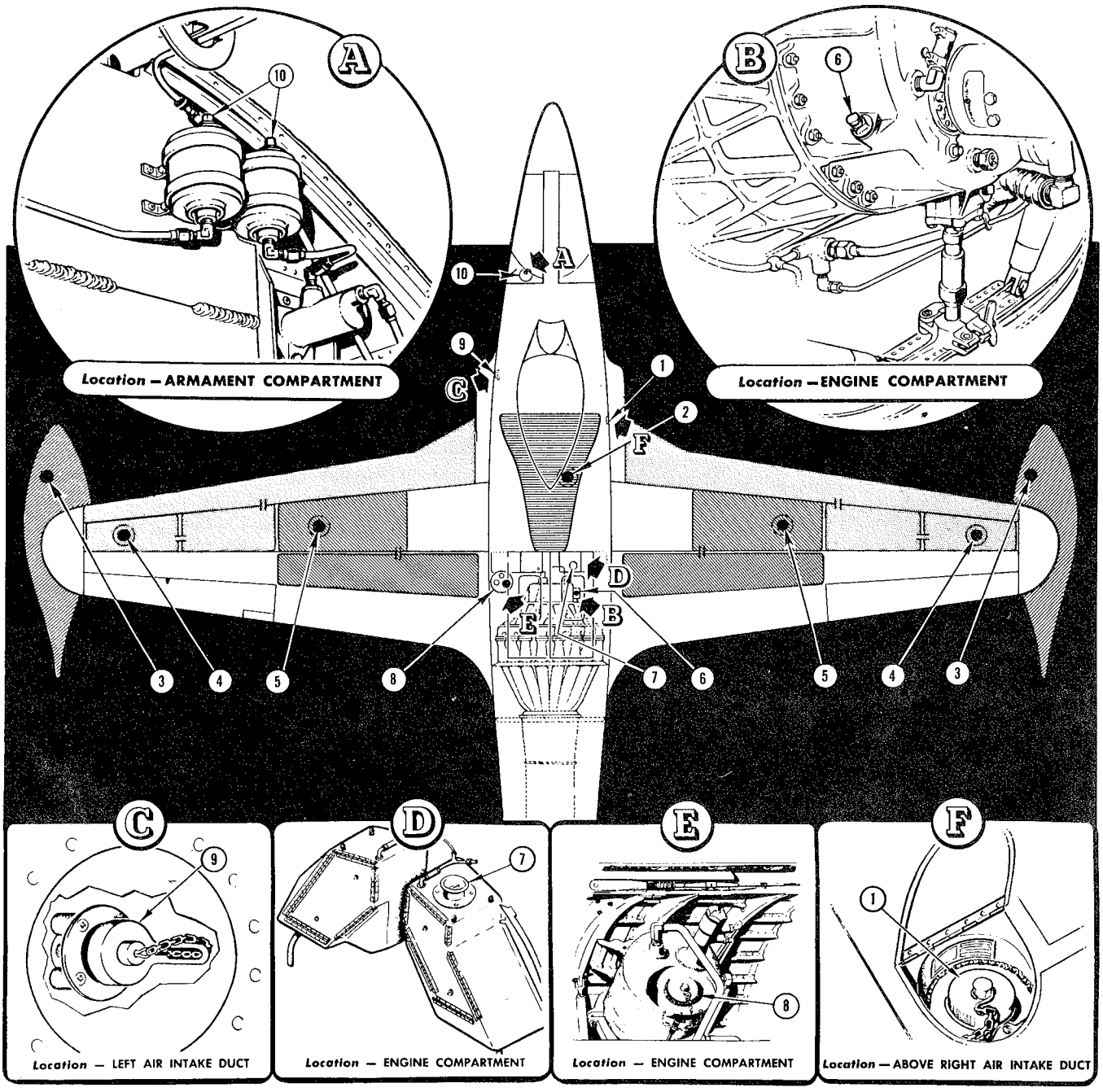
d. ROCKETS. — Some airplanes are equipped to carry up to four rockets under each wing. Rocket firing is controlled through an A-3 projector release and the rocket selector, arming and jettison switches on the right hand shelf (14, figure 8A). The rockets are fired by pressing the bomb release button on the top of the control stick. Rocket jettison circuits are energized through a scissors switch on the main gear; and therefore, will not operate unless the airplane is airborne. The gunsight is set for rocket firing by pressing the ring (15, figure 6A) on the top of the throttle.

The A-3 projector release contains a "RESET" switch and an indicator marked "RX TO BE FIRED." The reset switch selects the station number of the rocket to be fired, and the indicator shows the station selected. When the rocket selector switch is in the "SINGLE" position, only the rocket in the station selected will be fired when the bomb release switch is pressed. When the rocket selector switch is in the "AUTO" position, the rocket in the station selected and all subsequent will be fired at 1/10 second intervals as long as the bomb release button is held down. The rockets are armed by placing the arming switch in the "INSTANT" position; the "OFF" and "FUSE DELAY" positions are not wired. Rockets are jettisoned with bombs or drop tanks when the emergency bomb salvo switch is pressed, regardless of the position of the rocket jettison switch. When the rocket jettison selector switch is in the "JETTISON READY" position, rockets only, may be jettisoned by pressing the bomb release button.

CAUTION

The lower rocket must always be fired first. When it is known that the lower rocket has misfired during single round firing, the upper rocket on the same launcher must not be fired. If the upper rocket is fired with the lower rocket attached, both rockets will release with an immediate nose-over trajectory causing

(PAGE 38A DELETED.)



1.	EMERGENCY HYDRAULIC SYSTEM RESERVOIR	6.	ENGINE OIL FILLER PLUG
2.	FUSELAGE TANK FILLER CAP	7.	WATER INJECTION TANKS FILLER CAP (1)
3.	DROP TANK FILLER CAP	8.	MAIN HYDRAULIC SYSTEM RESERVOIR
4.	LEADING EDGE AND OUTBOARD WING TANK FILLER CAP	9.	OXYGEN SYSTEM FILLER CONNECTION
5.	INBOARD WING TANK FILLER CAP	10.	BRAKE RESERVOIR

Figure 21 — Replenishment Diagram

damage to the wing surface. Therefore, all the unfired rockets should be jettisoned in a safe area or returned to the base. Note that the jettisoning is not selective but that all rocket stations jettison simultaneously. If a misfire should occur during automatic firing and if the upper rocket is fired with the lower rocket still attached and if the fins are secured properly, only slight damage will occur to the airplane.

3A. TOW TARGETS.

a. Either the fuselage type installation or the jato latch type installation may be used. With either type of installation a banner type A-6B target is used.

b. RELEASE OF JATO LATCH TOW TARGETS.

(1) To accomplish release of the target when attached to the jato latch, the tow plane should be flown at minimum safe flying speed. This procedure reduces the target drag load and facilitates operation of the manual release.

(2) In case of failure to release the target, a landing should be made at an adequate distance from the end of the runway in order that the target may clear all obstacles short of the runway. The glide angle should be planned accordingly with an increase in prescribed approach and landing speed of approximately 10 miles per hour IAS.

4. PHOTOGRAPHIC EQUIPMENT (RF-80A).

a. CAMERA MASTER SWITCH.

The camera master switch (5, figure 9) energizes the entire camera electrical system.

b. INDIVIDUAL CAMERA SWITCHES.

The individual camera switches (10, figure 9) determine which cameras will be operated and whether they will operate from the intervalometer or from the manual (trigger switch) control.

c. INDICATOR LIGHTS.

The amber indicator light (4, figure 9) burns when the camera master switch is "ON."

The green blinker lights (9, figure 9) burn while film is winding for the next picture, except when Type A-5A, A-7, A-8B or A-14 film magazines are installed and the cameras are being operated manually.

d. EXPOSURE COUNTERS.

The exposure counters (7, figure 9) show the cumulative total of exposures made except when pictures are being taken "runway" Type A-5A, A-7, A-8B or A-14 magazines are installed.

e. INTERVALOMETERS.

The intervalometers are used to automatically regulate the time interval at which pictures are taken. To operate a camera on the intervalometer, set the intervalometer dial (11, figure 9) to the desired time between exposures and set the individual camera switch to "INT." To stop the intervalometer, turn the indicator through "60" to the "OFF" position.

CAUTION

Do not set an intervalometer for a shorter period than the cycling time of the equipment being used.

f. RECORDER.

A selector switch (17, figure 9D) installed on the right hand switch panel allows recorder to operate during voice transmission or separately as desired. This switch has four positions: "OFF," "TRANSMIT ONLY," "TRANSMIT & RECORD," and "RECORD ONLY."

5. COMMUNICATIONS EQUIPMENT.

a. An AN/ARC-3 (or AN/ARC-27) Radio receiver-transmitter is standard equipment in this airplane. The controls for this set are shown in figures 8 and 8A.

(1) On some airplanes the radio is turned on by pressing a frequency selector push button, on others the radio switch is closed and the selector is turned to the desired frequency. Wait about one minute for the set to warm up.

(2) To transmit, press the microphone button (13, figures 6 and 6A) and speak.

(3) To transmit code, use the tone control button as a key.

(4) To turn the equipment off, press both the off buttons simultaneously.

b. Deleted.

c. IFF is standard equipment. Early airplanes use an SCR695 radio (1, figure 6); late airplanes use an AN/APX-6 radar (1, figure 6).

d. Deleted.

e. A radio compass (AN/ARN-6 or AN/ARN-7) is installed in the RF-80A airplanes.

f. Some airplanes are equipped with AN/APW-11 Radar and AN/APA-90 controls.

6. DE-ICING EQUIPMENT.

a. FUEL FILTER DE-ICING SYSTEM. — The fuel filter de-icing system utilizes the right-hand fluid injection tank and pump. In addition a warning light and de-icing switch are located on the left-hand shelf (3A, figure 6 and 2, figure 6A). The warning light is operated by a differential pressure switch which senses the fuel pressure drop across the low pressure fuel filter. If the filter pressure drop reaches approximately 2 psi, the warning light comes on, indicating the possibility of icing. When the airplane is serviced for filter de-icing, the right-hand fluid injection tank is filled with 100% alcohol in accordance with Specification AN-A-18. In addition the tank is connected through the fluid injection pump and a solenoid shut-off valve to the low pressure fuel filter. Holding the de-icing switch in the "ON" position opens the solenoid valve and pumps alcohol into the filter. If the filter is iced, the alcohol will dissolve the ice accumulation, reducing the pressure drop, and the warning light will go out.

WARNING

If the filter icing warning light comes on, hold the de-icing switch in the "ON" position until the warning light goes out. If the warning light does not go out after holding the de-icing switch on for 20 to 30 seconds, the filter may be clogged with dirt and should therefore be inspected as soon as possible.

Note

Since the airplane may be serviced for either water injection or fuel filter de-icing, the choice will depend on ambient ground air temperatures. Operation of water-alcohol injection system is permissible only when the ambient ground air temperatures are not lower than 0°C (+32°F).

7. LIGHTING EQUIPMENT.

a. LANDING LIGHT. — The landing light located in the nose (on unmodified F-80A airplanes) normally points down at an angle suitable for landing but may also be used as a spotlight. By pulling the landing light lever (9, figure 7), the angle of the light is changed so that it points straight ahead along the flight path of the airplane. On late airplanes there are two landing lights attached to the nose landing gear shock strut. These light are not adjustable. The lights are controlled by the landing light switch (7, figures 8 and 8A) located on the right-hand cockpit shelf.

CAUTION

These lights will burn when the gear is retracted. Be sure the lights are turned off when not in use as they will burn out very rapidly.

b. RECOGNITION LIGHTS. — Red, green and amber lights for aircraft recognition are located on the bottom of the fuselage on the fuel compartment access door. The lights may be controlled individually by switches (8, figure 8) located on the right shelf, or keyed by a keying switch adjacent to the individual switches.

Some planes have recognition lights disconnected.

c. NAVIGATION LIGHTS. —A conventional navigation light system is employed, incorporating wing tip light and position lights on the vertical stabilizer. The navigation lights are controlled by the "DIM-BRIGHT" switch and the "STEADY-OFF-FLASH" switch on the right hand shelf.

d. COCKPIT LIGHTS. — Cockpit lighting is provided by two fluorescent lights and two spotlights. One fluorescent light and one spotlight are mounted on each side of the cockpit. The fluorescent lights are controlled by rheostats (7, figures 6 and 6A, and 19, figures 8 and 8A) mounted on the left and right cockpit shelves. Spotlights (3, figures 6 and 6A, and 10, figures 8 and 8A) are controlled by an integral switch.

e. FUSELAGE AND SIGNAL LIGHTS. — 6 watt and 100 watt lights are mounted in integral fixture on top and bottom of fuselage. The "DIM" position of the "DIM-BRIGHT" switch controls the 6 watt lights; the "BRIGHT" position controls the 100 watt lights.

SECTION VI
EXTREME WEATHER OPERATION

1. COLD WEATHER OPERATION.

a. GENERAL. — The success of low temperature operation depends primarily on preparations made during the engine shut-down and post-flight inspection in anticipation of the requirements for operation on the following day.The procedure outlined in"BEFORE LEAVING THE AIRPLANE" must be followed to expedite the preflight inspection and insure satisfactory operation of the aircraft and its systems during the next flight.

b. BEFORE ENTERING THE AIRPLANE.

(1) Remove all protective covers and dust plugs.

(2) Check entire aircraft for freedom from frost, snow and ice. Brush off all light snow or frost. Remove all ice by direct flow of air from a portable ground heater. Do not chip or scrape away ice as this may cause damage to the airplane. The collection of snow, frost and ice on aircraft surfaces constitutes one of the major flight hazards in low temperature operation and will result in loss of lift and treacherous stalling characteristics.

(3) Check that fuel tank vents, fuel filters and drain cocks are free from ice and drain condensate. The presence of ice in the fuel system can result in ruptured filters and collapsed screens and ultimate engine failure.

(4) Check shock strut oleos and actuating cylinders for ice and dirt and clean with a hydraulic oil-soaked rag. Check shock struts for proper inflation.

(5) No pre-heat or oil dilution is required to insure crankability down to —54°C (—65°F). Pre-heat of the accessory section and oil crankcase through the air intake ducts will decrease the starting loads, but is not necessary to accomplish starts.

(6) Check that engine fuel lines are filled with gasoline when required.

(7) Check that the fluid injection system has been serviced with alcohol for fuel filter de-icing.

(8) At temperatures below —26°C (—15°F), use pre-heat in the cockpit and on the canopy seal.

c. ON ENTERING THE AIRPLANE.

(1) Check flight controls for proper operation.

(2) Insure that canopy can be closed and locked.

(3) Use an external power source to operate and check electrical and radio equipment.

d. BEFORE STARTING ENGINE.

(1) A C-21 power unit or its equivalent is required for starting. If minimum starting rpm (9%) cannot be obtained, shut down engine and connect an "adequate" power unit. Pre-heat through the intake ducts and use the aircraft batteries as a boost if a start is necessary with an inadequate power source.

e. STARTING THE ENGINE.

Note

Ground starts will be accomplished whenever possible with aircraft *heading into* the wind.

CAUTION

Airplane serial numbers 44-84992 through 44-85466 which have been modified to incorporate winterization changes differ from other winterized aircraft in that the gasoline starting switch will not actuate the fuel by-pass control. Therefore, for these airplanes, the fuselage tank switch must be placed in the "BY-PASS" position for all starting operations.

f. WARM-UP AND GROUND CHECK.

WARNING

If there is no indication of oil pressure after 30 seconds running, or if the pressure drops to 0 after a few minutes of ground operation, stop engine and investigate.

Note

No warm-up is required if oil pressure remains below 100 psi, and 100% rpm or full throttle can be obtained. If the aircraft is equipped with the 0-50 psi gage, take-off must be delayed until the indicator has dropped below 50 psi. If the aircraft is equipped with

the later 0-100 or 0-200 psi gages, a high reading is not dangerous. However, the pressure must be allowed to drop below 100 psi before take-off. If the oil pressure reading on these higher reading gages remains at 100 psi or higher, this is an indication of an oil system malfunction and the airplane should not be flown.

(1) Turn on cabin heat and windshield defrosting system as required immediately after engine start.

(2) Check surface controls, dive flaps, and aileron and elevator trim tabs for proper operation.

(3) Check wing flap and flap indicator operation. If questionable readings result, cycle flaps three to four times to correct indicator operation.

(4) Check instruments for proper operation. Electric gyro instruments will require approximately two minutes for warm-up from the time the battery switch is turned on.

WARNING

Make sure all instruments have warmed up sufficiently to insure normal operation. Check for sluggish instruments during taxiing.

(5) Because of low ambient temperatures, the thrust developed at all engine speeds is noticeably greater than normal.

WARNING

Use firmly anchored wheel chocks for all engine run-ups. The aircraft should be tied down securely before attempting a full power run-up.

g. TAXIING INSTRUCTIONS.

(1) Avoid taxiing in deep snow as taxiing and steering are extremely difficult and frozen brakes are likely to result.

(2) Use only essential electrical equipment to preserve battery life while taxiing at low engine speeds.

(3) Increase taxi interval at subfreezing temperatures to insure safe stopping distance and to prevent icing of aircraft surfaces by melted snow and ice in the jet blast of a preceding airplane.

(4) Minimize taxi time to conserve fuel and reduce amount of ice fog generated by jet engines.

h. BEFORE TAKE-OFF.

(1) Check that fluid injection and fuel filter de-icing switches are "OFF."

(2) Check that canopy is locked.

(3) Brakes will not hold aircraft on snow covered or icy runways at full throttle. Final instrument check must be made during the first part of take-off roll.

i. TAKE-OFF.

(1) Open throttle to 100% rpm or full open position, whichever occurs first. Maximum engine speed of 100% rpm may not be available due to increased air density. However, the thrust developed at extremely low temperatures at full throttle is equal to or higher than the thrust developed at maximum rpm at normal temperatures although the available engine speed may be less than 100%. However, do not attempt to take-off if full throttle does not give at least 95% rpm.

j. AFTER TAKE-OFF.

(1) After take-off from a wet snow or slush covered field, operate the landing gear and flaps through several complete cycles to preclude their freezing.

(2) Turn on gun and gun camera heaters immediately after take-off.

k. OPERATION OF THE AIRCRAFT SYSTEMS DURING FLIGHT.

(1) Use cockpit heat and defroster as required. Adjust cockpit temperature to desired value by reference to cockpit temperature gage.

(2) Operate fuel filter de-icing system as required.

l. OPERATION UNDER ICING CONDITIONS.

(1) Aircraft which do not incorporate air intake anti-icing equipment will observe the following:

(a) Air intake icing may occur when jet aircraft are operated in areas when atmospheric conditions are such that icing is possible. Ice will form readily when air temperature and dew point are in proximity at or near freezing temperatures, due to air ram effect or the air striking solid objects. Air intake icing can occur when no visual evidence of ice can be detected on the aircraft. The effect of air intake icing on jet aircraft at a fixed throttle setting causes a reduction in air flow to the combustion chamber with a corresponding loss in thrust. This condition is not accompanied by any discernible change in fuel flow but results in a rapid increase of indicated exhaust gas temperatures.

(b) Avoid flying into known icing conditions. Under certain conditions icing can occur in the induction system which will not be observed until a reduction of air flow to the combustion chambers results.

(c) The initial symptom of engine icing is increased tail-pipe temperatures with a decrease in thrust.

(d) If icing conditions are encountered and tail-

pipe temperatures increase, the throttle will be immediately retarded and an effort made to leave the icing area. (If the throttle is not immediately retarded to maintain normal tailpipe temperatures, engine failure may result due to overheating of the turbine and exhaust system. *This may occur very rapidly.* Advance of the throttle in an effort to maintain thrust will aggravate the overheating condition and accelerate engine failure.)

(e) If, under suspected icing conditions engine overheating and "explosion" denoting turbine bucket failure occurs, with resultant engine failure, an air restart should not be attempted.

m. DESCENT.

(1) Operate auxiliary defroster to clear bullet-proof panel of frost usually formed during rapid descent from altitude.

(2) Check engine operating temperatures during descents and in the traffic pattern as low temperatures are common at low altitudes due to frequent temperature inversions.

n. APPROACH.

(1) Make normal patterns and landings but allow for flatter glide due to thrust augmentation caused by extremely low ambient temperatures.

(2) Turn off all electrical equipment possible at least one minute before final approach to reduce battery load when rpm is lowered and generator cuts out.

(3) Pump brakes to check operation.

o. BEFORE LEAVING AIRPLANE.

(1) Release brakes after wheels are chocked.

(2) Leave canopy partly open to allow circulation within the cockpit to prevent canopy cracking from differential contraction and decrease windshield and canopy frosting.

(3) Inspect and wipe shock struts and actuating cylinders with a hydraulic oil-soaked rag. It is advisable to keep shock struts exceptionally clean as any scarring of the seals will result in excessive hydraulic leakage at low temperatures.

(4) Install protective covers and dust plugs.

(5) Drain fuel pump within 30 minutes after stopping engine.

(6) Whenever possible, leave aircraft parked with full fuel tanks. Every effort should be made during servicing to prevent moisture from entering the fuel system.

(7) Remove batteries when aircraft is parked outside at temperatures below —29°C (—20°F) for more than four hours or for any extended period of time.

Pages 40E and 40F Deleted.

APPENDIX I

FLIGHT OPERATING DATA

1. FLIGHT OPERATION INSTRUCTION CHARTS.

a. The purpose of the Flight Operation Instruction Chart is to show the range remaining in the airplane and the procedure required to obtain this range. The main variables affecting range have been incorporated in an effort to give the most usable and most accurate information consistent with simplicity.

(1) The chart may be used at any point in flight or preflight planning. The initial conditions are the actual altitude of the airplane and the fuel remaining on board. In the Flight Operation Instruction Chart, the main columns across the top are initial altitude conditions. On line opposite fuel quantities, ranges are shown for each initial altitude. In general, two range values are given for each altitude and fuel quantity, one for level flight at that altitude, and one for the maximum range obtainable by climbing to a higher altitude. Distances covered in let-down are included, and for range figures indicating a cruise at higher altitude, climb distance is included.

b. Fuel quantities tabulated on the chart represent fuel that is available for cruising and landing. Allowances must be made for extra items such as combat and endurance reserves. Landing reserve allowance must also be made. Additional allowances must be made for evaporation losses when using gasoline and JP4 fuels and for fuel "slugging" losses when using JP4 fuel under adverse conditions. During fuel "slugging" large quantities of liquid fuel are carried overboard through the vent system by violent foaming of the fuel. The fuel quantities to allow for these losses cannot be simply presented as they vary from zero to considerable amounts depending upon atmospheric temperatures, fuel temperature at take-off, individual fuel shipments, the length of time since the fuel was refined (amount of weathering) and the rate of change of altitude during flight.

c. Under different wind conditions ranges are varied by the effect of wind on ground speed. Let-down distances are affected for the same reason. Recommended rpm to obtain long range may also change with different headwinds in order to maintain the most favorable miles-per-gallon ratio. The lower half of the Flight Operation Instruction Chart contains operating instructions for different wind conditions. These cruising data are presented for the same altitudes that head the upper half of chart.

(1) Since the wind may be from any direction with respect to the airplane course, some question may rise as to the method of handling winds other than straight headwinds or tailwinds. For purposes of cruise control, all winds may be expressed as effective winds. This reduces the wind to one which would have the same effect of the airplane's ground speed if it were a straight head or tailwind. In other words, it is the component of wind in the direction of the airplane heading. For example, a 100 mph wind at 45 degrees to the course will be an effective headwind of about 75 mph for an airplane whose air cruising speed is 400 mph. The ground speed along the course will be about 325 mph.

2. TAKE-OFF CHART.

a. The new type Take-Off Chart lists take-off distances for various pressure altitudes and air temperatures.

b. Set airplane altimeter to 29.92 and read pressure altitude. With air temperature in degrees Fahrenheit as obtained from the field weather station and pressure altitude, enter chart and determine required take-off distances.

c. Take-off procedures:

(1) Without tip tanks—12,000 lb.
Set flaps at 70%.
Run engine up to 100% rpm.
Release brakes.
At 80 IAS lift nose wheels slightly off runway.
Allow airplane to accelerate to 120 IAS.
Lift airplane off runway and allow airspeed to increase gradually to 130 IAS.
Hold 130 IAS until any obstacle is cleared.

(2) With tip tanks—14,500 lbs.
Set flaps at 70%.
Run engine up to 100% rpm.
Release brakes.
At 105 IAS lift nose wheel slightly off runway.
Allow airplane to accelerate to 130 IAS.
Lift airplane off runway and allow airspeed to increase gradually to 140 IAS.
Hold 140 IAS until any obstacle is cleared.

d. Take-off Charts in previous issues of the F-80A "Handbook, Flight Operating Instructions" included a 25% conservatism factor. The data listed on the Take-off Charts contains no conservatism factor and is based on an average airplane and engine with an average pilot.

3. USE OF THE FLIGHT OPERATION INSTRUCTION CHARTS.

a. To use the chart in flight, the pilot refers to the upper half, and under the present altitude column reads range opposite fuel quantity. For cruising at that altitude the operating instructions are listed directly below. Entering on the line according to effective wind, read the range factor, cruising rpm, and let-down distances. Multiplying still air range by the range factor results in ground miles that can be flown. Approximate values of indicated airspeed, gallons per hour, and ground miles per hour are given for reference.

b. If it is desirable to increase range enter the same altitude column as before. Under the second and third subheadings are shown the optimum altitude to which a climb should be made to obtain best range, and the range at that optimum altitude. To obtain this range climb immediately (according to the recommended climb procedure) to the altitude shown. For cruising instructions refer to the lower half of the chart in the column according to the new altitude. Calculation of range in a wind and cruising procedure are as described above for the level flight cruise. Note that at any time during the flight, the pilot may refer to the chart with actual conditions of altitude and fuel to obtain range remaining in the same manner as previously discussed.

4. EXAMPLES OF USE OF CHARTS.

a. Maximum range on internal fuel (420 gallons) at 35,000 feet altitude against an 80 mph headwind. Take-off weight 12,000 lb. Reserve is decided to be 40 gallons.

(1) From the climb chart (Fig. 26) it is seen that the take-off and climb to altitude will use 137 gallons of fuel. The still air range covered in climb will be about 114 miles. The fuel remaining at 35,000 feet will be 243 gallons (420 — 137 — 40).

(2) By referring to the 35,000 foot section of the Flight Operation Instruction Chart (Fig. 28 sheet 2) opposite 240 gallons, it can be seen that 555 additional still air miles can be flown, including allowances for let-down and landing. The total still air range is then 114 plus 555 or 669 miles.

(3) In the lower half of the chart it is seen that the range factor for an 80 mph headwind is .8. Multiplying the still air range by this factor gives about 535 miles actual range.

(4) Cruising at 35,000 feet with a headwind of 80 mph, according to the lower half of the Flight Operation Instruction Chart, is at 91% rpm and the let-down is begun 120 miles from the destination.

b. Illustration of the use of the chart in flight. The airplane is at 5,000 feet altitude and, after subtracting reserve, with 400 gallons of available fuel and distance to destination is 580 miles.

(1) Reference to the 5,000 column of the Flight Operation Instruction Chart (Fig. 28 sheet 1) opposite 400 gallons shows that by cruising at 5,000 feet range will be only 380 miles. By climbing to 40,000 feet a flight of 875 miles can be made. In order to fly 580 miles it is evident that it is necessary to climb and cruise at an altitude higher than 5,000 feet, but not necessarily as high as 40,000 feet. A linear interpolation (which in all cases will be close to the actual values) between the differences in range (875 — 380 = 495) and altitude (40,000 — 5,000 = 35,000)provides a quick guess that for the 200 additional miles of range needed (580 — 380 = 200) an increase of at least 15,000 feet of altitude will be necessary (or a minimum cruising altitude of 20,000 feet).

(2) Take 20,000 feet as the cruising altitude and climb to that altitude immediately, according to recommended climb procedure. A distance of 42 miles will be covered with an expenditure of 48 gallons of fuel. This means that there are only (580 — 42) or 538 miles to go from that point and 352 gallons are available. With these as the initial conditions enter the Flight Operation Instruction Chart in the 20,000 feet column. The distance which can be flown at 20,000 feet opposite 360 gallons is 545 miles. This shows that a climb to 20,000 feet will provide sufficient range (42 + 545 = 587) to reach destination. (Cruising CAS at 20,000 feet is 281 mph.) However, by climbing to 40,000 feet a flight of about 875 miles instead of 587 miles could be made with 400 gallons or with a resultant inrease in range of 288 miles.

c. ESCORT MISSION.

(1) It is desired to escort bombers at 25,000 feet, tip tanks to be carried and dropped when empty. 15 minutes' combat at 100% rpm at 25,000 feet to be included. How far can the bombers be escorted?

(2) The take-off fuel will be 750 gallons. The combat allowance chart indicates that 105 gallons (15 minutes at 7 gallons per minute) will be required for combat. 50 gallons are desired for reserve.

(a) The climb chart (Fig. 26)shows 146 gallons will be used and 100 miles will be covered in climb to altitude (Fuel for take-off included in the 146 gallons.)

(b) After 25,000 feet is reached 750 — 146 = 604 gallons will be available for level flight, combat, descent, and 50 gallons landing reserve. Subtracting the 105 gallon allowance for combat and 50 gallons landing reserve leaves 449 gallons. Reference to Fig. 30

sheet 2 shows that at 25,000 feet 775 miles can be flown with 450 gallons of fuel. With the 100 miles covered in climb 775 + 100 = 875 miles can be covered. The bombers can be escorted 435 statute miles.

(c) The operating insructions on the lower half of Fig. 30 sheet 2 shows that at 25,000 feet 268 mph CAS is required and the true airspeed or ground speed for no wind is approximately 408 mph. Fig. 28 sheet 2 (to be used after tip tanks are dropped) shows at 25,000 feet 263 mph CAS is required and the true airspeed or ground speed for no wind is approximately 400 mph.

(d) Reference to Fig. 28 sheet 2 shows that at 25,000 feet approximately 250 gallons will be required for the return trip. If a climb is made to 40,000 feet for the return trip, 595 miles can be covered with 250 gallons. This would provide a reserve of approximately 160 miles (595-435).

d. MAXIMUM FERRY RANGE

(1) Take-off fuel with tip tanks = 750 gallons. Tip tanks to be carried all the way.

(2) Reference to Fig. 29 shows that the optimum altitude for any fuel quantity over 400 gallons is 40,000 feet.

(a) The climb chart (Fig. 26) shows that 303 gallons and 335 miles will be covered in warm-up, take-off, and climb to 40,000 feet.

(b) After 40,000 feet is reached, 750 — 303 = 447 gallons will be available for level flight, let-down, landing, and reserve.

(c) For 397 gallons (447-50 gal. reserve) at 40,000 feet about 900 miles are available.

(d) With the 335 miles covered in climb a total flight of 900 + 335 = 1235 miles can be made.

(3) Reference to Fig. 30 sheet 2 (tip tanks dropped when empty) shows that at 40,000 feet 397 gallons will permit a flight of 1045 miles. With the 335 miles covered in climb the total range with a 50 gallon landing reserve is 1045 + 335 = 1370 miles.

TAKE-OFF DISTANCES

WITH TWO 1000 LB. THRUST JATO UNITS

SEA LEVEL — STANDARD DAY — ZERO WIND

AIRCRAFT MODELS
F-80A-1, -5 RF-80A-5

ENGINE MODELS
J33-A-9A, -GE-11A, -A-17

CONFIGURATION	GROSS WEIGHT POUNDS	OPTIMUM BREAK GROUND DISTANCE		OPTIMUM DISTANCE TO CLEAR 50′ OBSTACLE	
		TAKE-OFF DISTANCE FEET	JATO FIRING POINT DISTANCE FROM START	TOTAL DISTANCE OVER 50′ OBSTACLE	JATO FIRING POINT DISTANCE FROM START
Without Tip Tanks With Fluid Injection	12300	1225	50	1750	225
Without Tip Tanks Without Fluid Injection	12300	1475	300	2150	550
With Tip Tanks With Fluid Injection	14800	1850	325	2625	800
With Tip Tanks Without Fluid Injection	14800	2275	750	3350	1500

DATA AS OF: 1 Jan. 49

DATA BASED ON: Flight Test

FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LBS/GAL

Figure 22 — Take-off Distances with Jato Units (F-80A-1, -5 and RF-80A-5)

COMBAT ALLOWANCE CHART
CLEAN CONFIGURATION
STANDARD DAY

AIRCRAFT MODELS
F-80A-1, -5, -10
RF-80A-5, -10, -15, -20, -25

ENGINE MODELS
J33-A-9A, -9B, -17, -17A, -21, -35
J33-GE-11A, -11B

AT ALTITUDE FEET	FUEL REQUIRED — GALLONS PER MINUTE	
	96% RPM (NORMAL POWER) MAXIMUM CONTINUOUS	100% RPM (MILITARY POWER) 30 MINUTE LIMIT
SEA LEVEL	12 (13)	15
5,000	11 (12)	12 (14)
10,000	9 (11)	11 (13)
15,000	8	9 (10)
20,000	7	8 (9)
25,000	6	7 (8)
30,000	5	6 (7)
35,000	4	5 (6)
40,000	3	4

REMARKS
1. Fuel values in parentheses are for airplanes with J33-A-35 engines.

DATA AS OF: 1 Jan. 48 DATA BASED ON: Flight Test

FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LBS/GAL

Figure 23 — Combat Allowance Chart

LANDING DISTANCE — FEET
STANDARD DAY

AIRCRAFT MODELS
F-80A-1, -5 RF-80A-5

ENGINE MODELS
J33-A-9A, -GE-11A, -A-17

GROSS WEIGHT LBS.	BEST IAS FOR APPROACH		70% FLAPS — HARD SURFACE — NO WIND							
	POWER OFF	POWER ON	AT SEA LEVEL		AT 2000 FT.		AT 4000 FT.		AT 6000 FT.	
	MPH	MPH	GROUND ROLL	CLEAR 50′	GROUND ROLL	CLEAR 50′	GROUND ROLL	CLEAR 50′	GROUND ROLL	CLEAR 50′
8000	120	120	1400	2900	1470	3050	1540	3200	1600	3350
12000	145	145	2050	4150	2150	4350	2275	4575	2400	4800

LEGEND
IAS: INDICATED AIRSPEED
MPH: STATUTE MILES PER HOUR

DATA AS OF: 1 Dec. 47 DATA BASIS: Flight Test

FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LBS/GAL

Figure 24 — Landing Distance Chart (F-80A-1, -5 and RF-80A-5)

TAKE-OFF DISTANCES — FEET
70% FLAPS, HARD SURFACE RUNWAY

AIRCRAFT MODELS
F-80A-1, -5 RF-80A-5

ENGINE MODELS
J33-A-9A, -GE-11A, -A-17

CONFIGURATION AND GROSS WEIGHT	PRESSURE ALTITUDE FT.	60°F				80°F				100°F				120°F			
		ZERO WIND		30 KNOT WIND		ZERO WIND		30 KNOT WIND		ZERO WIND		30 KNOT WIND		ZERO WIND		30 KNOT WIND	
		GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′
CLEAN 12,000 LBS.	S. L.	2800	3350	1512	1810	3150	3675	1702	1985	3425	4125	1850	2230	3875	4575	2092	2310
	1,000	3000	3575	1620	1931	3375	3975	1822	2150	3800	4425	2000	2390	4175	4925	2255	2660
	2,000	3275	3825	1768	2065	3625	4275	1958	2310	4075	4750	2200	2564	4525	5275	2282	2850
	3,000	3500	4100	1890	2215	3900	4575	2105	2470	4350	5100	2350	2755	4850	5650	2620	3050
	4,000	3750	4425	2025	2390	4200	4925	2270	3660	4700	5500	2538	2970	5225	6025	2822	3255
	5,000	4050	4700	2190	2590	4550	5300	2458	2862	5025	5875	2715	3175	5625	6525	3040	3525
2 X 165 GALLON TIP TANKS 14,500 LBS.	S. L.	3975	4725	2285	2715	4350	5100	2500	2930	4775	5600	2745	3220	5200	6075	2990	3492
	1,000	4325	5075	2485	2917	4675	5500	2690	3160	5150	6125	2960	3520	5600	6550	3220	3765
	2,000	4625	5425	2660	3118	5050	5900	2904	3390	5525	6475	3175	3723	5625	7000	3235	4025
	3,000	5000	5825	2875	3348	5425	6325	3118	3635	5950	6925	3420	3980	6475	7500	3720	4310
	4,000	5375	6250	3090	3592	5825	6775	3350	3895	6400	7375	3680	4240	6950	8020	4000	4620
	5,000	5775	6725	3320	3870	6275	7300	3610	4190	6900	8000	3970	4600	7475	8650	4290	4970

DATA AS OF: 1 Dec. 47

DATA BASIS: Flight Test

FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LBS/GAL

Figure 25 — Take-off Distance Chart (F-80A-1, -5 and RF-80A-5)

CLIMB CHART FOR MAXIMUM POWER
HOT DAY

AIRCRAFT MODELS
F-80A-1, -5 RF-80A-5

ENGINE MODELS
J33-A-9A, -GE-11A, -A-17

CONFIGURATION: 2 X 165 GALLON TANKS
WEIGHT: 14,500 LBS.

CONFIGURATION: CLEAN
WEIGHT: 12,000 LBS.

APPROXIMATE							APPROXIMATE			
RATE OF CLIMB (3)	FROM SEA LEVEL			CAS MPH	PRESSURE ALTITUDE FEET	CAS MPH	FROM SEA LEVEL			RATE OF CLIMB (3)
	DISTANCE	TIME	FUEL				FUEL	TIME	DISTANCE	
2000	—	—	31 (2)	313	SEA LEVEL	337	21 (2)	—	—	2500
1850	14	3	52	304	5,000	328	37	2	11	2450
1650	30	6	73	294	10,000	318	52	4	24	2350
1450	49	9	99	284	15,000	309	68	6	38	2200
1250	72	13	120	276	20,000	294	85	9	53	2000
1000	100	17	146	266	25,000	280	101	11	70	1750
750	140	22	178	250	30,000	259	119	14	90	1500
400	195	30	230	236	35,000	240	137	18	114	1200
100	335	50	303	217	40,000	217	155	22	147	850

REMARKS

1. Climb at recommended CAS.
2. Taxi and take-off allowance.
3. Climb values based on hot day operation. These values will be exceeded on a standard day.

LEGEND

RATE OF CLIMB: FEET PER MINUTE
DISTANCE: STATUTE MILES
TIME: MINUTES
FUEL: U.S. GALLONS
CAS: CALIBRATED AIRSPEED
MPH: STATUTE MILES PER HOUR
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LBS/GAL

DATA AS OF: 1 Dec. 47 DATA BASIS: Flight Test

Figure 26 — Climb Chart — F-80A-1, -5 and RF-80A-5

DESCENT CHART
STANDARD DAY

AIRCRAFT MODELS
F-80A-1, -5 RF-80A-5

ENGINE MODELS
J33-A-9A, -GE-11A, -A-17

CONFIGURATION: 2 X 165 GALLON TANKS
WEIGHT: 14,500 LBS.

CONFIGURATION: CLEAN
WEIGHT: 12,000 LBS.

APPROXIMATE							APPROXIMATE			
RATE OF DESCENT	TO SEA LEVEL			CAS MPH	PRESSURE ALTITUDE FEET	CAS MPH	TO SEA LEVEL			RATE OF DESCENT
	DISTANCE	TIME	FUEL				FUEL	TIME	DISTANCE	
1200	110	18	34	187	40,000	197	66	27	175	800
1450	85	14	27	207	35,000	216	56	21	135	900
1700	70	11	22	227	30,000	235	47	16	100	1050
2000	50	9	18	245	25,000	255	40	12	70	1250
2300	40	7	14	264	20,000	275	32	8.5	50	1550
2750	30	5	9	284	15,000	294	26	5.5	35	2000
3050	15	3	6	304	10,000	312	16	3.0	20	2500
3500	5	1.5	2	323	5,000	332	7	1.5	10	3000
4000	—	—	—	342	SEA LEVEL	351	—	—	—	3600

REMARKS

1. Maintain 50-60 PSI burner pressure and recommended CAS.
2. Descend at 177 CAS for maximum range without power.

LEGEND

RATE OF DESCENT: FEET PER MINUTE
DISTANCE: STATUTE MILES
TIME: MINUTES
FUEL: U.S. GALLONS
CAS: CALIBRATED AIRSPEED
MPH: STATUTE MILES PER HOUR
FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LBS/GAL

DATA AS OF: 1 Dec. 47 DATA BASIS: Flight Test

Figure 27 — Descent Chart — F-80A-1, -5 and RF-80A-5

AIRCRAFT MODELS
F-80A-1, -5 RF-80A-5
ENGINES: J33-A-9A, -GE-11A, -A-17

FLIGHT OPERATION INSTRUCTION CHART
STANDARD DAY
CHART WEIGHT LIMITS 12,000 TO 8000 POUNDS

EXTERNAL LOAD ITEMS
NONE
NUMBER OF ENGINES OPERATING: ONE

INSTRUCTIONS FOR USING CHART: (A) IN FLIGHT — Select figure in fuel column equal to or less than fuel available for cruise (fuel on board minus allowance for reserve, combat, navigational error, formation flight, etc.). Move horizontally right or left to section according to present altitude and read total range available (no wind) by cruising at that altitude or by climbing to another altitude of maximum range. For a flight at initial altitude, operating instructions are given directly below. For a flight at higher altitude, climb immediately to desired altitude and read cruising instructions in appropriate cruising altitude section. (B) FLIGHT PLANNING — From initial fuel on board subtract fuel for take-off and climb to desired cruising altitude and all other necessary allowances. Then use chart as for IN FLIGHT above, adding initial climb distances to range values.

NOTES: Ranges shown at optimum altitudes are maximum. In order to obtain maximum range on flights requiring more than one chart (due to external configuration or gross weight changes), it is necessary to observe the optimum cruising altitude on each chart; i.e., when changing charts a climb may be required to obtain a maximum range. All range values include allowances for descent distance and fuel. Climb distance and fuel are included where climbs are indicated.

DATA BELOW CONTAIN NO FUEL RESERVE FOR LANDING

LOW ALTITUDE

IF YOU ARE AT S. L. RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 5000′ RANGE IN AIRMILES			IF YOU ARE AT 10,000′ RANGE IN AIRMILES			IF YOU ARE AT 15,000′ RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 20,000′ RANGE IN AIRMILES		
BY CRUISING AT S. L.	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 5,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 10,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 15,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 20,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.
(RANGE FIGURES INCLUDE ALLOWANCES FOR PRESCRIBED CLIMB AND DESCENT TO SEA LEVEL)																
335	40	895	420	(395)	40	(930)	(460)	40	(955)	(535)	40	(980)	420	(650)	40	(1010)
320	40	845	400	(380)	40	(875)	(440)	40	(900)	(510)	40	(925)	400	(595)	40	(955)
290	40	740	360	340	40	770	395	40	795	(460)	40	(825)	360	(545)	40	(850)
255	40	635	320	305	40	665	355	40	690	410	40	720	320	480	40	745
225	40	530	280	265	40	560	310	40	585	360	40	615	280	420	40	640
190	40	425	240	230	40	455	265	40	480	305	40	510	240	360	40	535
160	40	320	200	190	40	350	220	40	380	255	40	405	200	300	40	430
125	30	220	160	155	35	245	180	35	265	205	40	300	160	240	40	325
95	25	140	120	115	25	155	135	30	180	155	30	195	120	180	35	220
65	15	80	80	75	20	90	90	20	100	105	25	115	80	120	25	130

CRUISING AT S. L.						EFFECTIVE WIND MPH	CRUISING AT 5000′						CRUISING AT 10,000′						CRUISING AT 15,000′						EFFECTIVE WIND MPH	CRUISING AT 20,000′					
	APPROXIMATE							APPROXIMATE						APPROXIMATE						APPROXIMATE						APPROXIMATE				
CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.
						120 HW																			120 HW						
						80 HW													336	90	355	354	.8	30	80 HW	308	90	295	351	.8	46
378	87	481	348	.9	0	40 HW	361	87	428	358	.9	9	340	87	378	364	.9	18	318	88	329	370	.9	33	40 HW	295	88	280	373	.9	50
366	85	466	374	1.0	0	0	342	86	403	377	1.0	10	321	86	353	381	1.0	24	300	86	303	386	1.0	35	0	281	87	263	393	1.0	53
334	82	418	382	1.1	0	40 TW	310	82	361	382	1.1	11	294	82	319	390	1.1	26	279	83	277	398	1.1	37	40 TW	264	83	242	408	1.1	56
						80 TW													254	80	251	406	1.3	40	80 TW	244	82	221	420	1.2	59
						120 TW																			120 TW						

Figure 28 (Sheet 1 of 2 Sheets) — Flight Operation Instruction Chart (F-80A-1, -5 and RF-80A-5)

AIRCRAFT MODELS

F-80A-1, -5 RF-80A-5

ENGINES: J33-A-9A, -GE-11A, -A-17

HIGH ALTITUDE

CHART WEIGHT LIMITS 12,000 TO 8000 POUNDS

EXTERNAL LOAD ITEMS

NONE

NUMBER OF ENGINES OPERATING: ONE

IF YOU ARE AT 25,000' RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 30,000' RANGE IN AIRMILES			IF YOU ARE AT 35,000' RANGE IN AIRMILES			IF YOU ARE AT 40,000' RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 45,000' RANGE IN AIRMILES		
BY CRUISING AT 25,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 30,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 35,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 40,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 45,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.
(RANGE FIGURES INCLUDE ALLOWANCES FOR PRESCRIBED CLIMB AND DESCENT TO SEA LEVEL)																
(730)	40	(1035)	420	(850)	40	(1060)	(975)	40	(1085)	(1100)	—	—	420			
(695)	40	(980)	400	(810)	40	(1010)	(925)	40	(1030)	(1045)	—	—	400			
(625)	40	(875)	360	(725)	40	(905)	(835)	40	(925)	(940)	—	—	360			
(555)	40	(770)	320	(645)	40	(800)	(740)	40	(820)	(835)	—	—	320			
485	40	665	280	565	40	695	650	40	720	(730)	—	—	280			
415	40	560	240	485	40	590	555	40	615	630	—	—	240			
345	40	455	200	405	40	485	465	40	510	525	—	—	200			
280	40	355	160	325	40	380	370	40	405	420	—	—	160			
210	40	250	120	245	40	280	280	40	305	315	—	—	120			
140	30	150	80	165	35	175	190	35	190	210	—	—	80			

CRUISING AT 25,000'						EFFECTIVE WIND MPH	CRUISING AT 30,000'						CRUISING AT 35,000'						CRUISING AT 40,000'						EFFECTIVE WIND MPH	CRUISING AT 45,000'					
	APPROXIMATE							APPROXIMATE						APPROXIMATE						APPROXIMATE							APPROXIMATE				
CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.
293	91	272	328	.7	60	120 HW	269	91	237	328	.7	85	245	91	209	328	.7	110	233	96	193	358	.7	150	120 HW						
281	90	251	348	.8	63	80 HW	263	90	223	358	.8	90	245	91	209	368	.8	120	228	95	188	388	.8	160	80 HW						
273	88	241	376	.9	67	40 HW	253	89	213	381	.9	98	234	90	188	386	.9	128	226	94	183	424	.9	165	40 HW						
263	87	230	400	1.0	70	0	248	88	205	413	1.0	104	234	90	188	426	1.0	135	219	93	172	450	1.0	175	0						
249	86	215	418	1.1	74	40 TW	233	87	190	427	1.1	108	217	88	172	436	1.1	142	215	92	167	482	1.1	175	40 TW						
234	84	199	434	1.2	77	80 TW	220	86	178	446	1.2	114	207	87	162	458	1.2	150	207	91	162	502	1.2	185	80 TW						
215	82	188	446	1.4	84	120 TW	211	85	174	472	1.3	120	207	87	162	498	1.3	155	207	91	162	542	1.3	195	120 TW						

SPECIAL NOTES

1. Climb at 100% RPM.
2. Multiply statute units by 0.87 to obtain nautical units.
3. Read lower half of chart opposite effective wind only.
4. Make additional allowances for landing, navigational errors, combat, formation flight, etc., as required.

EXAMPLE

If you are at 25,000 ft. with 200 gallons of available fuel, you can fly 345 statute airmiles by holding 263 MPH CAS. However, you can fly 455 statute airmiles by immediately climbing to 40,000 ft. using 100% RPM. At 40,000 ft. cruise at 219 MPH CAS and start let down 175 statute miles from home. With an 80 MPH headwind the range at 40,000 ft. would be 0.80 × 455 or 364 statute miles. Cruise at 228 MPH CAS with this wind and start let down 160 statute miles from destination.

LEGEND

EFFECTIVE WIND — HW, HEADWIND, TW, TAILWIND — MPH
R.F. — RANGE FACTOR — RATIO OF GROUND DISTANCE TO AIRMILES FOR CORRESPONDING WINDS
G.S. — GROUND SPEED IN MPH
CAS — CALIBRATED AIRSPEED IN MPH
GAL/HR — FUEL CONSUMPTION — GALLONS PER HOUR
RANGE — STATUTE MILES
( ) RANGE IN PARENTHESES FOR INTERPOLATION PURPOSES ONLY

FUEL GRADE — JP-4
FUEL DENSITY — 6.5 LBS/GAL

DATA AS OF: 12-1-47 BASED ON: Flight Test

Figure 28 (Sheet 2 of 2 Sheets) — Flight Operation Instruction Chart (F-80A-1, -5 and RF-80A-5)

AIRCRAFT MODELS
F-80A-1, -5 RF-80A-5
ENGINES: J33-A-9A, -GE-11A, -A-17

FLIGHT OPERATION INSTRUCTION CHART
STANDARD DAY
CHART WEIGHT LIMITS 14,500 TO 8000 POUNDS

EXTERNAL LOAD ITEMS
2 × 165 GALLON EXTERNAL TIP TANKS
CARRIED ALL THE WAY
NUMBER OF ENGINES OPERATING: ONE

INSTRUCTIONS FOR USING CHART: (A) IN FLIGHT — Select figure in fuel column equal to or less than fuel available for cruise (fuel on board minus allowance for reserve, combat, navigational error, formation flight, etc.). Move horizontally right or left to section according to present altitude and read total range available (no wind) by cruising at that altitude or by climbing to another altitude of maximum range. For a flight at initial altitude, operating instructions are given directly below. For a flight at higher altitude, climb immediately to desired altitude and read cruising instructions in appropriate cruising altitude section. (B) FLIGHT PLANNING — From initial fuel on board subtract fuel for take-off and climb to desired cruising altitude and all other necessary allowances. Then use chart as for IN FLIGHT above, adding initial climb distances to range values.

NOTES: Ranges shown at optimum altitudes are maximum. In order to obtain maximum range on flights requiring more than one chart (due to external configuration or gross weight changes), it is necessary to observe the optimum cruising altitude on each chart; i.e., when changing charts a climb may be required to obtain a maximum range. All range values include allowances for descent distance and fuel. Climb distance and fuel are included where climbs are indicated.

DATA BELOW CONTAIN NO FUEL RESERVE FOR LANDING

LOW ALTITUDE

IF YOU ARE AT S. L. RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 5000′ RANGE IN AIRMILES			IF YOU ARE AT 10,000′ RANGE IN AIRMILES			IF YOU ARE AT 15,000′ RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 20,000′ RANGE IN AIRMILES		
BY CRUISING AT S. L.	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 5000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 10,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 15,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 20,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.
(RANGE FIGURES INCLUDE ALLOWANCES FOR PRESCRIBED CLIMB AND DESCENT TO SEA LEVEL)																
530	40	1295	700	(635)	40	(1325)	(750)	40	(1355)	(880)	40	(1395)	700	(1000)	40	(1420)
455	40	1080	600	545	40	1110	645	40	1140	755	40	1175	600	860	40	1200
380	40	865	500	455	40	895	540	40	925	635	40	960	500	720	40	985
345	40	755	450	410	40	785	485	40	815	570	40	855	450	650	40	880
305	40	650	400	365	40	680	430	40	705	510	40	745	400	580	40	770
265	40	540	350	320	40	570	380	40	600	450	40	635	350	510	40	660
230	30	445	300	275	30	465	325	40	495	390	40	530	300	440	40	555
190	30	355	250	230	30	375	270	30	395	325	30	425	250	370	40	450
150	30	265	200	185	30	290	220	30	305	265	30	335	200	300	30	350
115	25	175	150	140	30	200	165	30	220	200	30	250	150	230	30	265
75	15	110	100	95	20	125	110	20	135	140	30	160	100	160	30	175

CRUISING AT S. L.						EFFECTIVE WIND MPH	CRUISING AT 5000′						CRUISING AT 10,000′						CRUISING AT 15,000′						EFFECTIVE WIND MPH	CRUISING AT 20,000′					
	APPROXIMATE							APPROXIMATE						APPROXIMATE						APPROXIMATE						APPROXIMATE				
CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.
						120 HW																			120 HW						
						80 HW													331	91	356	346	.8	27	80 HW	313	92	329	359	.8	36
386	89	533	356	.9	0	40 HW	368	89	455	366	.9	4	344	89	397	370	.9	18	321	89	340	374	.9	28	40 HW	301	90	308	382	.9	37
369	89	497	378	1.0	0	0	348	87	424	384	1.0	5	328	87	376	390	1.0	20	309	88	329	397	1.0	30	0	288	89	294	402	1.0	40
352	85	471	400	1.1	0	40 TW	331	85	403	404	1.1	6	308	85	350	406	1.1	21	286	85	298	408	1.1	31	40 TW	271	87	272	418	1.1	41
						80 TW													266	83	277	422	1.2	34	80 TW	253	84	256	434	1.2	44
						120 TW																			120 TW						

Figure 29 (Sheet 1 of 2 Sheets) — Flight Operation Instruction Chart (F-80A-1, -5 and RF-80A-5)

AIRCRAFT MODELS

F-80A-1, -5 RF-80A-5

ENGINES: J33-A-9A, -GE-11A, -A-17

HIGH ALTITUDE

CHART WEIGHT LIMITS 14,500 TO 8000 POUNDS

EXTERNAL LOAD ITEMS

2 × 165 GALLON EXTERNAL TIP TANKS CARRIED ALL THE WAY

NUMBER OF ENGINES OPERATING: ONE

IF YOU ARE AT 25,000' RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 30,000' RANGE IN AIRMILES			IF YOU ARE AT 35,000' RANGE IN AIRMILES			IF YOU ARE AT 40,000' RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 45,000' RANGE IN AIRMILES		
BY CRUISING AT 25,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 30,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 35,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 40,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 45,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.
(RANGE FIGURES INCLUDE ALLOWANCES FOR PRESCRIBED CLIMB AND DESCENT TO SEA LEVEL)																
(1125)	40	(1445)	700	(1270)	40	(1475)	(1400)	40	(1530)	(1550)	—	—	700			
970	40	1225	600	(1095)	40	(1255)	(1205)	40	(1315)	(1330)	—	—	600			
810	40	1010	500	915	40	1040	1015	40	1100	(1115)	—	—	500			
730	40	905	450	825	40	930	915	40	990	(1010)	—	—	450			
650	40	795	400	740	40	825	815	40	880	900	—	—	400			
570	40	690	350	650	40	715	720	40	775	795	—	—	350			
495	40	580	300	560	40	610	620	40	665	685	—	—	300			
415	40	470	250	475	40	500	525	40	560	575	—	—	250			
335	30	365	200	375	40	395	425	40	450	470	—	—	200			
255	30	280	150	295	—	—	325	40	340	360	—	—	150			
175	30	195	100	210	—	—	230	—	—	255	—	—	100			

CRUISING AT 25,000'						EFFECTIVE WIND MPH	CRUISING AT 30,000'						CRUISING AT 35,000'						CRUISING AT 40,000'						EFFECTIVE WIND MPH	CRUISING AT 45,000'					
APPROXIMATE							APPROXIMATE						APPROXIMATE						APPROXIMATE							APPROXIMATE					
CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.
306	94	319	346	.7	42	120 HW	282	95	280	340	.7	57	258	96	241	334	.7	72	203	96	194	297	.7	95	120 HW						
295	93	303	372	.8	45	80 HW	269	94	266	367	.8	60	244	95	230	362	.8	76	203	96	194	337	.8	100	80 HW						
282	91	277	390	.9	47	40 HW	258	92	248	389	.9	64	234	94	219	388	.9	81	203	96	194	377	.9	105	40 HW						
268	90	262	408	1.0	50	0	248	92	235	412	1.0	67	229	93	209	417	1.0	85	203	96	194	417	1.0	110	0						
256	88	246	428	1.1	52	40 TW	240	90	225	437	1.1	70	223	92	204	446	1.1	89	203	96	194	457	1.1	115	40 TW						
241	86	235	446	1.2	55	80 TW	227	88	219	458	1.2	74	213	91	194	470	1.2	93	203	96	194	497	1.2	120	80 TW						
223	85	220	458	1.3	58	120 TW	214	87	204	477	1.3	78	206	90	188	496	1.3	98	203	96	194	537	1.3	125	120 TW						

SPECIAL NOTES

1. Climb at 100% RPM.
2. Multiply statute units by 0.87 to obtain nautical units.
3. Read lower half of chart opposite effective wind only.
4. Make additional allowances for landing, navigational errors, combat, formation flight, etc., as required.

EXAMPLE

If you are at S. L. with 600 gallons of available fuel, you can fly 455 statute airmiles by holding 369 MPH CAS. However, you can fly 1080 statute airmiles by immediately climbing to 40,000 ft. using 100% RPM. At 40,000 ft. cruise at 203 MPH CAS and start let down 110 statute miles from home. With an 80 MPH headwind the range at 40,000 ft. would be 0.80 × 1080 or 864 statute miles. Cruise at 203 MPH CAS with this wind and start let down 100 statute miles from destination.

LEGEND

EFFECTIVE WIND — HW, HEADWIND, TW, TAILWIND — MPH
R.F. — RANGE FACTOR — RATIO OF GROUND DISTANCE TO AIRMILES FOR CORRESPONDING WINDS
G.S. — GROUND SPEED IN MPH
CAS — CALIBRATED AIRSPEED IN MPH
GAL/HR — FUEL CONSUMPTION — GALLONS PER HOUR
RANGE — STATUTE MILES
( ) RANGE IN PARENTHESES FOR INTERPOLATION PURPOSES ONLY

FUEL GRADE — JP-4
FUEL DENSITY — 6.5 LBS/GAL

DATA AS OF: 12-1-47 BASED ON: Flight Test

Figure 29 (Sheet 2 of 2 Sheets) — Flight Operation Instruction Chart (F-80A-1, -5 and RF-80A-5)

AIRCRAFT MODELS
F-80A-1, -5 RF-80A-5
ENGINES: J33-A-9A, -GE-11A, -A-17

FLIGHT OPERATION INSTRUCTION CHART
STANDARD DAY
CHART WEIGHT LIMITS 14,500 TO 12,000 POUNDS

EXTERNAL LOAD ITEMS
2 × 165 GALLON TIP TANKS DROPPED WHEN EMPTY
NUMBER OF ENGINES OPERATING: ONE

INSTRUCTIONS FOR USING CHART: (A) IN FLIGHT — Select figure in fuel column equal to or less than fuel available for cruise (fuel on board minus allowance for reserve, combat, navigational error, formation flight, etc.). Move horizontally right or left to section according to present altitude and read total range available (no wind) by cruising at that altitude or by climbing to another altitude of maximum range. For a flight at initial altitude, operating instructions are given directly below. For a flight at higher altitude, climb immediately to desired altitude and read cruising instructions in appropriate cruising altitude section. (B) FLIGHT PLANNING — From initial fuel on board subtract fuel for take-off and climb to desired cruising altitude and all other necessary allowances. Then use chart as for IN FLIGHT above, adding initial climb distances to range values.

NOTES: Ranges shown at optimum altitudes are maximum. In order to obtain maximum range on flights requiring more than one chart (due to external configuration or gross weight changes), it is necessary to observe the optimum cruising altitude on each chart; i.e., when changing charts a climb may be required to obtain a maximum range. All range values include allowances for descent distance and fuel. Climb distance and fuel are included where climbs are indicated.

DATA BELOW CONTAIN NO FUEL RESERVE FOR LANDING

LOW ALTITUDE

IF YOU ARE AT S. L. RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 5000′ RANGE IN AIRMILES			IF YOU ARE AT 10,000′ RANGE IN AIRMILES			IF YOU ARE AT 15,000′ RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 20,000′ RANGE IN AIRMILES		
BY CRUISING AT S. L.	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 5,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 10,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 15,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 20,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.
(RANGE FIGURES INCLUDE ALLOWANCES FOR PRESCRIBED CLIMB AND DESCENT TO SEA LEVEL)																
550	40	1455	700	735	40	1485	760	40	1515	(880)	40	(1550)	700	(1015)	40	(1575)
510	40	1355	650	675	40	1385	705	40	1415	820	40	1445	650	945	40	1470
475	40	1255	600	615	40	1280	650	40	1310	755	40	1340	600	875	40	1370
435	40	1150	550	555	40	1180	600	40	1210	695	40	1235	550	805	40	1265
395	40	1050	500	500	40	1080	545	40	1105	635	40	1135	500	735	40	1160
360	40	950	450	440	40	975	490	40	1000	570	40	1030	450	665	40	1055
320	40	845	400	380	40	875	440	40	900	510	40	925	400	595	40	955
DROP EXTERNAL TIP TANKS WHEN EMPTY (REFER TO FIG. 28 FOR OPERATING INSTRUCTIONS)																

CRUISING AT S. L.						EFFECTIVE WIND MPH	CRUISING AT 5000′						CRUISING AT 10,000′						CRUISING AT 15,000′						EFFECTIVE WIND MPH	CRUISING AT 20,000′					
	APPROXIMATE							APPROXIMATE						APPROXIMATE						APPROXIMATE						APPROXIMATE					
CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.
					(5)	120 HW						(5)						(5)						(5)	120 HW						(5)
						80 HW													331	91	356	346	.8		80 HW	313	92	329	359	.8	
386	89	533	356	.9		40 HW	368	89	455	366	.9		344	89	397	370	.9		321	89	340	374	.9		40 HW	301	90	308	382	.9	
369	89	497	378	1.0		0	348	87	424	384	1.0		328	87	376	390	1.0		309	88	329	397	1.0		0	288	89	294	402	1.0	
352	85	471	400	1.1		40 TW	331	85	403	404	1.1		308	85	350	406	1.1		286	85	298	408	1.1		40 TW	271	87	272	418	1.1	
						80 TW													266	83	277	422	1.2		80 TW	253	84	256	434	1.2	
						120 TW																			120 TW						

Figure 30 (Sheet 1 of 2 Sheets) — Flight Operation Instruction Chart (F-80A-1, -5 and RF-80A-5)

AIRCRAFT MODELS

F-80A-1, -5 RF-80A-5

ENGINES: J33-A-9A, -GE-11A, -A-17

HIGH ALTITUDE

CHART WEIGHT LIMITS 14,500 TO 12,000 POUNDS

EXTERNAL LOAD ITEMS

2 × 165 GALLON TIP TANKS DROPPED WHEN EMPTY

NUMBER OF ENGINES OPERATING: ONE

IF YOU ARE AT 25,000' RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 30,000' RANGE IN AIRMILES			IF YOU ARE AT 35,000' RANGE IN AIRMILES			IF YOU ARE AT 40,000' RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 45,000' RANGE IN AIRMILES		
BY CRUISING AT 25,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 30,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 35,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 40,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 45,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.
(RANGE FIGURES INCLUDE ALLOWANCES FOR PRESCRIBED CLIMB AND DESCENT TO SEA LEVEL)																
(1170)	40	(1605)	700	(1345)	40	(1635)	(1520)	40	(1680)	(1700)	40	—	700			
(1090)	40	(1500)	650	(1255)	40	(1530)	(1420)	40	(1570)	(1590)	40	—	650			
1010	40	1395	600	1165	40	1425	(1320)	40	(1465)	(1480)	40	—	600			
930	40	1290	550	1075	40	1325	1220	40	1355	(1375)	40	—	550			
850	40	1190	500	990	40	1220	1125	40	1245	(1265)	40	—	500			
775	40	1085	450	900	40	1115	1025	40	1140	1155	40	—	450			
695	40	980	400	810	40	1010	925	40	1030	1045	40	—	400			
				DROP EXTERNAL TIP TANKS WHEN EMPTY (REFER TO FIG. 28 FOR OPERATING INSTRUCTIONS)												

CRUISING AT 25,000'						EFFECTIVE WIND MPH	CRUISING AT 30,000'						CRUISING AT 35,000'						CRUISING AT 40,000'						EFFECTIVE WIND MPH	CRUISING AT 45,000'					
	APPROXIMATE							APPROXIMATE						APPROXIMATE						APPROXIMATE							APPROXIMATE				
CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.
306	94	319	346	.7	(5)	120 HW	282	95	280	340	.7	(5)	258	96	241	334	.7	(5)	203	96	194	297	.7	(5)	120 HW						
295	93	303	372	.8		80 HW	269	94	266	367	.8		244	95	230	362	.8		203	96	194	337	.8		80 HW						
282	91	277	390	.9		40 HW	258	92	248	389	.9		234	94	219	388	.9		203	96	194	377	.9		40 HW						
268	90	262	408	1.0		0	248	92	235	412	1.0		229	93	209	417	1.0		203	96	194	417	1.0		0						
256	88	246	428	1.1		40 TW	240	90	225	437	1.1		223	92	204	446	1.1		203	96	194	457	1.1		40 TW						
241	86	235	446	1.2		80 TW	227	88	219	458	1.2		213	91	194	470	1.2		203	96	194	497	1.2		80 TW						
223	85	220	458	1.3		120 TW	214	87	204	477	1.3		206	90	188	496	1.3		203	96	194	537	1.3		120 TW						

SPECIAL NOTES

1. Climb at 100% RPM.
2. Multiply statute units by 0.87 to obtain nautical units.
3. Read lower half of chart opposite effective wind only.
4. Make additional allowances for landing, navigational errors, combat, formation flight, etc., as required.
5. Refer to fig. 28 for let down without external tip tanks.

DATA AS OF: 12-1-47 BASED ON: Flight Test

EXAMPLE

If you are at 15,000 ft. with 650 gallons of available fuel, you can fly 820 statute airmiles by holding 309 MPH CAS. However, you can fly 1445 statute airmiles by immediately climbing to 40,000 ft. using 100% RPM. At 40,000 ft. cruise at 203 MPH CAS and start let down 175 statute miles from home. With an 80 MPH headwind the range at 40,000 ft. would be 0.80 × 1445 or 1155 statute miles. Cruise at 203 MPH CAS with this wind and start let down 160 statute miles from destination.

LEGEND

EFFECTIVE WIND — HW, HEADWIND, TW, TAILWIND — MPH

R.F. — RANGE FACTOR — RATIO OF GROUND DISTANCE TO AIRMILES FOR CORRESPONDING WINDS

G.S. — GROUND SPEED IN MPH

CAS — CALIBRATED AIRSPEED IN MPH

GAL/HR — FUEL CONSUMPTION — GALLONS PER HOUR

RANGE — STATUTE MILES

( ) RANGE IN PARENTHESES FOR INTERPOLATION PURPOSES ONLY

FUEL GRADE — JP-4

FUEL DENSITY — 6.5 LBS/GAL

Figure 30 (Sheet 2 of 2 Sheets) — Flight Operation Instruction Chart (F-80A-1, -5 and RF-80A-5)

TAKE-OFF DISTANCES — FEET
70% FLAPS, HARD SURFACE RUNWAY

AIRCRAFT MODELS
F-80A-10 RF-80A-10, -15

ENGINE MODELS
J33A-9B, -GE-11B, -A-17A, -A-21

CONFIGURATION AND GROSS WEIGHT	PRESSURE ALTITUDE FT.	60°F				80°F				100°F				120°F			
		ZERO WIND		30 KNOT WIND		ZERO WIND		30 KNOT WIND		ZERO WIND		30 KNOT WIND		ZERO WIND		30 KNOT WIND	
		GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′	GROUND RUN	CLEAR 50′
CLEAN 12,300 LBS.	S. L.	2900	3400	1610	1888	3225	3675	1790	2040	3575	4175	1985	2320	3950	4595	2190	2550
	1,000	3125	3650	1735	2025	3475	4050	1929	2250	3850	4475	2137	2483	4250	4925	2360	2732
	2,000	3350	3925	1860	2180	3725	4350	2070	2413	4150	4825	2305	2675	4575	5400	2540	3000
	3,000	3625	4225	2010	2345	4025	4675	2233	2595	4475	5175	2483	2870	4950	5700	2747	3162
	4,000	3900	4525	2165	2510	4325	5000	2400	2775	4800	5550	2663	3080	5300	6100	2430	3382
	5,000	4210	4870	2335	2705	4675	5400	2595	3000	5200	5975	2885	3320	5725	6575	3178	3650
2 X 165 GALLON TIP TANKS 14,800 LBS.	S. L.	4150	4850	2445	2858	4525	5275	2665	3108	4925	5750	2900	3385	5350	6200	3150	3650
	1,000	4450	5200	2620	3063	4875	5650	2872	3330	5300	6150	3122	3623	5750	6650	3385	3918
	2,000	4800	5600	2825	3300	5250	6050	3090	3562	5700	6600	3357	3890	6200	7150	3650	4210
	3,000	5200	6025	3063	3550	5650	6500	3330	3830	6150	7100	3623	4180	6675	7700	3930	4540
	4,000	5575	6450	3284	3800	6075	6975	3580	4110	6600	7625	3890	4490	7175	8250	4225	4860
	5,000	6000	6925	3530	4080	6550	7525	3858	4430	7150	8200	4210	4835	7750	8875	4565	5230

DATA AS OF: 1 Jan. 48 DATA BASIS: Flight Test

FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LBS/GAL

Figure 31 — Take-off Distance — F-80A-10 and RF-80A-10, -15

LANDING DISTANCE — FEET
STANDARD DAY

AIRCRAFT MODELS
F-80A-10 RF-80A-10, -15

ENGINE MODELS
J33-A-9A, -GE-11A, -A-17

GROSS WEIGHT LBS.	BEST IAS FOR APPROACH		70% FLAPS — HARD SURFACE — NO WIND							
	POWER OFF	POWER ON	AT SEA LEVEL		AT 2000 FT.		AT 4000 FT.		AT 6000 FT.	
	MPH	MPH	GROUND ROLL	CLEAR 50′	GROUND ROLL	CLEAR 50′	GROUND ROLL	CLEAR 50′	GROUND ROLL	CLEAR 50′
10,000	130	130	1750	3550	1825	3725	1900	3900	2000	4100
12,000	145	145	2050	4150	2150	4350	2275	4550	2400	4800

LEGEND
IAS: INDICATED AIRSPEED
MPH: STATUTE MILES PER HOUR

DATA AS OF: 1 Jan. 48 DATA BASIS: Flight Test

FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LBS/GAL

Figure 32 — Landing Distance — F-80A-10 and RF-80A-10, -15

CLIMB CHART FOR MAXIMUM POWER
STANDARD DAY

AIRCRAFT MODELS
F-80A-10 RF-80A-10, -15

ENGINE MODELS
J33-A-9B, -GE-11B, -A-17A, -A-21

CONFIGURATION: 2 X 165 GALLON TANKS
WEIGHT: 15,050 LBS.

CONFIGURATION: CLEAN
WEIGHT: 12,700 LBS.

APPROXIMATE				CAS MPH	PRESSURE ALTITUDE FEET	CAS MPH	APPROXIMATE			
RATE OF CLIMB (3)	FROM SEA LEVEL						FROM SEA LEVEL			RATE OF CLIMB (3)
	DISTANCE	TIME	FUEL				FUEL	TIME	DISTANCE	
2500	—	—	31 (2)	310	SEA LEVEL	310	21 (2)	—	—	3350
2100	13	2	55	306	5,000	301	38	1.5	9	3100
1900	27	5	80	301	10,000	291	54	3.0	19	2800
1700	44	8	102	286	15,000	277	70	5	29	2500
1450	65	11	127	272	20,000	257	87	7	42	2150
1200	89	14	153	257	25,000	242	106	10	58	1800
900	119	19	179	237	30,000	223	123	13	76	1450
600	164	26	210	213	35,000	203	142	17	101	1050
200	255	40	274	193	40,000	183	173	23	137	700

REMARKS

1. Climb at recommended CAS.
2. Taxi and take-off allowance.
3. Climb values based on hot day operation. These values will be exceeded on a standard day.

LEGEND

RATE OF CLIMB: FEET PER MINUTE
DISTANCE: STATUTE MILES
TIME: MINUTES
FUEL: GALLONS
CAS: CALIBRATED AIRSPEED
MPH: STATUTE MILES PER HOUR

FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LBS/GAL

DATA AS OF: 1 Jan. 48 DATA BASIS: Flight Test

Figure 33 — Climb Chart for Maximum Power — F-80A-10 and RF-80A-10, -15

DESCENT CHART
STANDARD DAY

AIRCRAFT MODELS
F-80A-10 RF-80A-10, -15

ENGINE MODELS
J33-A-9B, -GE-11B, -A-17A, -A-21

CONFIGURATION: 2 X 165 GALLON TANKS
WEIGHT: 15,050 LBS.

CONFIGURATION: CLEAN
WEIGHT: 12,700 LBS.

APPROXIMATE				CAS MPH	PRESSURE ALTITUDE FEET	CAS MPH	APPROXIMATE			
RATE OF DESCENT	TO SEA LEVEL						TO SEA LEVEL			RATE OF DESCENT
	DISTANCE	TIME	FUEL				FUEL	TIME	DISTANCE	
1200	110	18	33	188	40,000	198	66	27	175	800
1450	85	14	27	208	35,000	218	56	21	135	900
1700	70	11	22	228	30,000	237	47	16	100	1050
2000	50	9	18	247	25,000	257	40	12	70	1250
2300	40	7	14	267	20,000	277	32	8.5	50	1550
2750	30	5	9	286	15,000	296	26	5.2	35	2000
3050	15	3	6	306	10,000	315	16	3.0	20	2500
3500	5	1.5	2	325	5,000	335	7	1.5	10	3000
4000	—	—	—	345	SEA LEVEL	355	—	—	—	3600

REMARKS

1. Maintain 50-60 PSI burner pressure and recommended CAS.
2. Descend at 180 CAS for maximum range without power.

LEGEND

RATE OF DESCENT: FEET PER MINUTE
DISTANCE: STATUTE MILES
TIME: MINUTES
FUEL: GALLONS
CAS: CALIBRATED AIRSPEED
MPH: STATUTE MILES PER HOUR

DATA AS OF: 1 Jan. 48 DATA BASIS: Flight Test

FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LBS/GAL

Figure 34 — Descent Chart — F-80A-10 and RF-80A-10, -15

AIRCRAFT MODELS
F-80A-10 . RF-80A-10, -15
ENGINES: J33-A-9B, -GE-11B, -A-17A, -A-21

FLIGHT OPERATION INSTRUCTION CHART
STANDARD DAY
CHART WEIGHT LIMITS 12,700 TO 9250 POUNDS

EXTERNAL LOAD ITEMS
NONE
NUMBER OF ENGINES OPERATING: ONE

INSTRUCTIONS FOR USING CHART: (A) IN FLIGHT — Select figure in fuel column equal to or less than fuel available for cruise (fuel on board minus allowance for reserve, combat, navigational error, formation flight, etc.). Move horizontally right or left to section according to present altitude and read total range available (no wind) by cruising at that altitude or by climbing to another altitude of maximum range. For a flight at initial altitude, operating instructions are given directly below. For a flight at higher altitude, climb immediately to desired altitude and read cruising instructions in appropriate cruising altitude section. (B) FLIGHT PLANNING — From initial fuel on board subtract fuel for take-off and climb to desired cruising altitude and all other necessary allowances. Then use chart as for IN FLIGHT above, adding initial climb distances to range values.

NOTES: Ranges shown at optimum altitudes are maximum. In order to obtain maximum range on flights requiring more than one chart (due to external configuration or gross weight changes), it is necessary to observe the optimum cruising altitude on each chart; i.e., when changing charts a climb may be required to obtain a maximum range. All range values include allowances for descent distance and fuel. Climb distance and fuel are included where climbs are indicated.

DATA BELOW CONTAIN NO FUEL RESERVE FOR LANDING

LOW ALTITUDE

IF YOU ARE AT S. L. RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 5000′ RANGE IN AIRMILES			IF YOU ARE AT 10,000′ RANGE IN AIRMILES			IF YOU ARE AT 15,000′ RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 20,000′ RANGE IN AIRMILES		
BY CRUISING AT S. L.	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 5,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 10,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 15,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 20,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.
(RANGE FIGURES INCLUDE ALLOWANCES FOR PRESCRIBED CLIMB AND DESCENT TO SEA LEVEL)																
325	40	860	420	(387)	40	(884)	(468)	40	(918)	(550)	40	(957)	420	(650)	40	(985)
311	40	808	400	368	40	832	(444)	40	(870)	(526)	40	(909)	400	(616)	40	(936)
272	40	679	350	325	40	702	392	40	731	459	40	774	350	540	40	803
234	35	526	300	277	40	574	335	40	607	392	40	645	300	464	40	674
191	35	406	250	234	35	430	277	35	468	325	40	507	250	382	40	536
153	35	296	200	186	35	316	225	35	344	263	35	373	200	306	35	402
115	25	177	150	139	25	196	167	25	225	196	35	253	150	229	35	282
76	15	96	100	96	15	110	110	20	124	129	25	143	100	148	25	167
38	—	—	50	48	—	—	53	—	—	62	—	—	50	72	—	—

CRUISING AT S. L.						EFFECTIVE WIND MPH	CRUISING AT 5000′						CRUISING AT 10,000′						CRUISING AT 15,000′						EFFECTIVE WIND MPH	CRUISING AT 20,000′					
	APPROXIMATE							APPROXIMATE						APPROXIMATE						APPROXIMATE						APPROXIMATE				
CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.
						120 HW																			120 HW	323	89	295	312	.7	43
						80 HW							365	89	398	340	.8	18	332	88	329	332	.8	30	80 HW	311	88	280	336	.8	45
400	89	549	360	.8	0	40 HW	384	89	466	372	.9	9	346	87	370	360	.9	19	322	87	314	360	.9	33	40 HW	301	87	270	364	.9	48
374	86	492	374	1.0	0	0	357	86	418	382	1.0	10	336	86	356	388	1.0	20	310	86	303	386	1.0	35	0	293	86	259	392	1.0	50
338	80	424	378	1.1	0	40 TW	323	82	366	387	1.1	11	311	83	314	398	1.2	22	290	83	267	400	1.1	37	40 TW	283	85	249	420	1.1	53
						80 TW							306	82	309	342	1.3	23	273	80	256	420	1.2	39	80 TW	274	84	240	448	1.2	55
						120 TW																			120 TW	264	83	230	476	1.3	58

Figure 35 (Sheet 1 of 2 Sheets) — Flight Operation Instruction Chart (F-80A-10 and RF-80A-10, -15)

AIRCRAFT MODELS

F-80A-10 RF-80A-10, -15

ENGINES: J33-A-9B, -GE-11B, -A-17A, -A-21

HIGH ALTITUDE

CHART WEIGHT LIMITS 12,700 TO 9250 POUNDS

EXTERNAL LOAD ITEMS

NONE

NUMBER OF ENGINES OPERATING: ONE

IF YOU ARE AT 25,000' RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 30,000' RANGE IN AIRMILES			IF YOU ARE AT 35,000' RANGE IN AIRMILES			IF YOU ARE AT 40,000' RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 45,000' RANGE IN AIRMILES		
BY CRUISING AT 25,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 30,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 35,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 40,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 45,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.
(RANGE FIGURES INCLUDE ALLOWANCES FOR PRESCRIBED CLIMB AND DESCENT TO SEA LEVEL)																
(751)	40	(1018)	420	(865)	40	(1046)	(980)	40	(1080)	(1113)	—	—	420			
(712)	40	(965)	400	(817)	40	(995)	(927)	40	(1028)	(1100)	—	—	400			
(621)	40	(832)	350	(717)	40	(865)	(813)	40	(899)	(932)	—	—	350			
536	40	703	300	617	40	731	(698)	40	(765)	(798)	—	—	300			
444	40	569	250	511	40	597	583	40	626	665	—	—	250			
354	35	430	200	411	35	459	478	40	492	531	—	—	200			
263	35	311	150	301	—	—	354	—	—	397	—	—	150			
172	35	196	100	201	—	—	234	—	—	263	—	—	100			
81	—	—	50	—	—	—	—	—	—	—	—	—	50			

CRUISING AT 25,000'						EFFECTIVE WIND MPH	CRUISING AT 30,000'						CRUISING AT 35,000'						CRUISING AT 40,000'						EFFECTIVE WIND MPH	CRUISING AT 45,000'					
	APPROXIMATE							APPROXIMATE						APPROXIMATE						APPROXIMATE							APPROXIMATE				
CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.
297	89	251	312	.7	60	120 HW	285	91	234	330	.7	85	266	92	204	338	.7	110	234	93	173	336	.7	150	120 HW						
292	88	241	344	.8	63	80 HW	279	90	224	360	.8	90	258	91	194	365	.8	120	234	93	173	376	.8	160	80 HW						
284	87	230	374	.9	67	40 HW	272	89	214	390	.9	95	258	91	194	405	.9	128	234	93	173	416	.9	165	40 HW						
275	86	220	400	1.0	70	0	263	88	205	416	1.0	100	248	90	188	430	1.0	135	229	92	167	445	1.0	175	0						
261	85	209	420	1.1	74	40 TW	253	87	197	442	1.1	105	248	90	188	470	1.1	142	220	91	157	470	1.1	185	40 TW						
249	84	204	444	1.2	77	80 TW	244	86	188	468	1.2	110	242	89	178	498	1.2	150	220	91	157	510	1.2	195	80 TW						
238	83	189	470	1.3	80	120 TW	244	86	188	508	1.3	115	233	88	173	524	1.3	155	220	91	157	550	1.3	200	120 TW						

SPECIAL NOTES

1. Climb at 100% RPM.
2. Multiply statute units by 0.87 to obtain nautical units.
3. Read lower half of chart opposite effective wind only.
4. Make additional allowances for landing, navigational errors, combat, formation flight, etc., as required.

EXAMPLE

If you are at 15,000 ft. with 350 gallons of available fuel, you can fly 459 statute airmiles by holding 310 MPH CAS. However, you can fly 774 statute airmiles by immediately climbing 40,000 ft. using 100% RPM. At 40,000 ft. cruise at 229 MPH CAS and start let down 175 statute miles from home. With an 80 MPH headwind the range at 40,000 ft. would be 0.8 × 774 or 681 statute miles. Cruise at 234 MPH CAS with this wind and start let down 160 statute miles from destination.

LEGEND

EFFECTIVE WIND — HW, HEADWIND, TW, TAILWIND — MPH
R.F. — RANGE FACTOR — RATIO OF GROUND DISTANCE TO AIRMILES FOR CORRESPONDING WINDS
G.S. — GROUND SPEED IN MPH
CAS — CALIBRATED AIRSPEED IN MPH
GAL/HR — FUEL CONSUMPTION — GALLONS PER HOUR
RANGE — STATUTE MILES
( ) RANGE IN PARENTHESES FOR INTERPOLATION PURPOSES ONLY

FUEL GRADE — JP-4
FUEL DENSITY — 6.5 LBS/GAL

DATA AS OF: 12-1-48 BASED ON: Flight Test

Figure 35 (Sheet 2 of 2 Sheets) — Flight Operation Instruction Chart (F-80A-10 and RF-80A-10, -15)

AIRCRAFT MODELS
F-80A-10 RF-80A-10, -15
ENGINES: J33-A-9B, -GE-11B, -A-17A, -A-21

FLIGHT OPERATION INSTRUCTION CHART
STANDARD DAY
CHART WEIGHT LIMITS 15,050 TO 9250 POUNDS

EXTERNAL LOAD ITEMS
2 × 165 GALLON EXTERNAL TIP TANKS
CARRIED ALL THE WAY
NUMBER OF ENGINES OPERATING: ONE

INSTRUCTIONS FOR USING CHART: (A) IN FLIGHT — Select figure in fuel column equal to or less than fuel available for cruise (fuel on board minus allowance for reserve, combat, navigational error, formation flight, etc.). Move horizontally right or left to section according to present altitude and read total range available (no wind) by cruising at that altitude or by climbing to another altitude of maximum range. For a flight at initial altitude, operating instructions are given directly below. For a flight at higher altitude, climb immediately to desired altitude and read cruising instructions in appropriate cruising altitude section. (B) FLIGHT PLANNING — From initial fuel on board subtract fuel for take-off and climb to desired cruising altitude and all other necessary allowances. Then use chart as for IN FLIGHT above, adding initial climb distances to range values.

NOTES: Ranges shown at optimum altitudes are maximum. In order to obtain maximum range on flights requiring more than one chart (due to external configuration or gross weight changes), it is necessary to observe the optimum cruising altitude on each chart; i.e., when changing charts a climb may be required to obtain a maximum range. All range values include allowances for descent distance and fuel. Climb distance and fuel are included where climbs are indicated.

DATA BELOW CONTAIN NO FUEL RESERVE FOR LANDING

LOW ALTITUDE

IF YOU ARE AT S. L. RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 5000′ RANGE IN AIRMILES			IF YOU ARE AT 10,000′ RANGE IN AIRMILES			IF YOU ARE AT 15,000′ RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 20,000′ RANGE IN AIRMILES		
BY CRUISING AT S. L.	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 5,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 10,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 15,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 20,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.
(RANGE FIGURES INCLUDE ALLOWANCES FOR PRESCRIBED CLIMB AND DESCENT TO SEA LEVEL)																
540	40	1500	750	(636)	40	(1530)	(755)	40	(1568)	(880)	40	(1610)	750	(1022)	40	(1635)
502	40	1386	700	597	40	1410	707	40	1442	(822)	40	(1491)	700	(956)	40	(1520)
468	40	1272	650	554	40	1290	660	40	1333	765	40	1377	650	889	40	1405
430	40	1147	600	511	40	1180	607	40	1220	707	40	1262	600	822	40	1285
392	40	1032	550	468	40	1060	559	40	1105	650	40	1148	550	755	40	1170
358	40	918	500	426	40	943	506	40	985	593	40	1027	500	688	40	1051
325	40	794	450	382	40	831	459	40	870	540	40	908	450	621	40	937
287	35	645	400	339	35	679	406	35	731	478	40	788	400	554	40	817
253	35	545	350	296	35	578	358	35	616	421	35	659	350	487	35	693
215	35	444	300	258	35	478	311	35	516	368	35	559	300	421	35	588
182	35	344	250	215	35	382	258	35	421	306	35	458	250	354	35	468
143	25	239	200	172	25	277	210	25	316	248	35	354	200	287	35	368
110	15	153	150	129	25	191	158	25	220	191	35	253	150	220	35	268
72	—	—	100	86	15	124	110	15	134	134	25	148	100	153	25	167
—	—	—	50	43	—	—	57	—	—	76	—	—	50	86	—	—

CRUISING AT S. L.						EFFEC-TIVE WIND MPH	CRUISING AT 5000′						CRUISING AT 10,000′						CRUISING AT 15,000′						EFFEC-TIVE WIND MPH	CRUISING AT 20,000′					
	APPROXIMATE							APPROXIMATE						APPROXIMATE						APPROXIMATE						APPROXIMATE					
CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.
						120 HW																			120 HW	320	92	341	308	.7	34
						80 HW							348	90	416	320	.8	13	326	90	361	324	.8	27	80 HW	310	91	324	334	.8	36
388	89	549	348	.9	0	40 HW	364	89	466	350	.9	4	341	89	398	352	.9	14	315	89	345	350	.9	28	40 HW	290	89	295	348	.9	38
377	88	528	377	1.0	0	0	354	88	450	379	1.0	5	330	88	385	380	1.0	15	310	88	329	385	1.0	30	0	286	89	295	385	1.0	40
351	85	481	391	1.1	0	40 TW	319	84	387	382	1.1	*6	312	86	356	400	1.1	16	290	86	303	400	1.1	31	40 TW	271	87	270	404	1.1	42
						80 TW							295	84	328	420	1.3	17	270	84	282	414	1.3	34	80 TW	255	86	260	424	1.2	44
						120 TW																			120 TW	246	85	249	452	1.4	48

Figure 36 (Sheet 1 of 2 Sheets) — Flight Operation Instruction Chart (F-80A-10 and RF-80A-10, -15)

AIRCRAFT MODELS

F-80A-10 RF-80A-10, -15

ENGINES: J33-A-9B, -GE-11B, -A-17A, -A-21

HIGH ALTITUDE

CHART WEIGHT LIMITS 15,050 TO 9250 POUNDS

EXTERNAL LOAD ITEMS

2 × 165 GALLON EXTERNAL TIP TANKS CARRIED ALL THE WAY
NUMBER OF ENGINES OPERATING: ONE

IF YOU ARE AT 25,000' RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 30,000' RANGE IN AIRMILES			IF YOU ARE AT 35,000' RANGE IN AIRMILES			IF YOU ARE AT 40,000' RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 45,000' RANGE IN AIRMILES		
BY CRUISING AT 25,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 30,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 35,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 40,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 45,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.
(RANGE FIGURES INCLUDE ALLOWANCES FOR PRESCRIBED CLIMB AND DESCENT TO SEA LEVEL)																
(1166)	40	(1663)	750	(1342)	40	(1692)	(1520)	40	(1721)	(1778)	—	—	750			
(1090)	40	(1548)	700	(1258)	40	(1578)	(1424)	40	(1606)	(1662)	—	—	700			
(1012)	40	(1432)	650	(1170)	40	(1462)	(1329)	40	(1491)	(1549)	—	—	650			
937	40	1314	600	1080	40	1344	(1223)	40	(1378)	(1433)	—	—	600			
860	40	1200	550	994	40	1223	1128	40	1262	(1315)	—	—	550			
784	40	1080	500	908	40	1108	1032	40	1142	1195	—	—	500			
707	40	965	450	823	40	994	937	40	1028	1080	—	—	450			
631	40	851	400	731	40	879	837	40	908	965	—	—	400			
554	40	731	350	645	40	760	736	40	793	846	—	—	350			
477	40	616	300	559	40	646	645	40	674	736	—	—	300			
401	35	483	250	473	35	521	545	40	564	616	—	—	250			
325	35	382	200	382	—	—	444	—	—	497	—	—	200			
248	35	287	150	301	—	—	354	—	—	382	—	—	150			
172	35	191	100	210	—	—	248	—	—	268	—	—	100			
96	—	—	50	124	—	—	153	—	—	158	—	—	50			

CRUISING AT 25,000'						EFFECTIVE WIND MPH	CRUISING AT 30,000'						CRUISING AT 35,000'						CRUISING AT 40,000'						EFFECTIVE WIND MPH	CRUISING AT 45,000'					
	APPROXIMATE							APPROXIMATE						APPROXIMATE						APPROXIMATE							APPROXIMATE				
CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.
303	93	309	320	.7	42	120 HW	279	94	267	320	.7	60	259	96	235	326	.7	72	227	96	188	320	.7	95	120 HW						
284	91	277	334	.8	45	80 HW	273	93	259	352	.8	63	253	95	230	356	.8	76	227	96	188	360	.8	100	80 HW						
272	90	262	358	.9	47	40 HW	264	92	247	378	.9	66	246	93	214	385	.9	81	227	96	188	400	.9	105	40 HW						
264	89	251	385	1.0	50	0	257	91	234	406	1.0	70	236	92	204	410	1.0	85	222	95	183	430	1.0	110	0						
254	88	241	412	1.1	52	40 TW	247	90	224	432	1.1	74	236	92	204	450	1.1	89	222	95	183	470	1.1	115	40 TW						
243	87	230	436	1.2	55	80 TW	247	90	224	472	1.2	77	236	92	204	490	1.2	93	222	95	183	510	1.2	120	80 TW						
232	86	220	460	1.3	57	120 TW	236	89	214	496	1.3	81	225	91	194	512	1.3	98	222	95	183	550	1.3	125	120 TW						

SPECIAL NOTES

1. Climb at 100% RPM.
2. Multiply statute units by 0.87 to obtain nautical units.
3. Read lower half of chart opposite effective wind only.
4. Make additional allowances for landing, navigational errors, combat, formation flight, etc., as required.

EXAMPLE

If you are at S. L. with 600 gallons of available fuel, you can fly 430 statute airmiles by holding 377 MPH CAS. However, you can fly 1147 statute airmiles by immediately climbing to 40,000 ft. using 100% RPM. At 40,000 ft. cruise at 222 MPH CAS and start let down 110 statute miles from home. With an 80 MPH headwind the range at 40,000 ft. would be 0.8 × 1147 or 917 statute miles. Cruise at 227 MPH CAS with this wind and start let down 100 statute miles from destination.

LEGEND

EFFECTIVE WIND — HW, HEADWIND, TW, TAILWIND — MPH
R.F. — RANGE FACTOR — RATIO OF GROUND DISTANCE TO AIRMILES FOR CORRESPONDING WINDS
G.S. — GROUND SPEED IN MPH
CAS — CALIBRATED AIRSPEED IN MPH
GAL/HR — FUEL CONSUMPTION — GALLONS PER HOUR
RANGE — STATUTE MILES
( ) RANGE IN PARENTHESES FOR INTERPOLATION PURPOSES ONLY

FUEL GRADE — JP-4
FUEL DENSITY — 6.5 LBS/GAL

DATA AS OF: 12-1-48 BASED ON: Flight Test

Figure 36 (Sheet 2 of 2 Sheets) — Flight Operation Instruction Chart (F-80A-10 and RF-80A-10, -15)

AIRCRAFT MODELS
F-80A-10 RF-80A-10, -15
ENGINES: J33-A-9B, -GE-11B, -A-17A, -A-21

FLIGHT OPERATION INSTRUCTION CHART
STANDARD DAY
CHART WEIGHT LIMITS 15,050 TO 12,700 POUNDS

EXTERNAL LOAD ITEMS
2 × 165 GALLON EXTERNAL TIP TANKS
DROPPED WHEN EMPTY
NUMBER OF ENGINES OPERATING: ONE

INSTRUCTIONS FOR USING CHART: (A) IN FLIGHT — Select figure in fuel column equal to or less than fuel available for cruise (fuel on board minus allowance for reserve, combat, navigational error, formation flight, etc.). Move horizontally right or left to section according to present altitude and read total range available (no wind) by cruising at that altitude or by climbing to another altitude of maximum range. For a flight at initial altitude, operating instructions are given directly below. For a flight at higher altitude, climb immediately to desired altitude and read cruising instructions in appropriate cruising altitude section. (B) FLIGHT PLANNING — From initial fuel on board subtract fuel for take-off and climb to desired cruising altitude and all other necessary allowances. Then use chart as for IN FLIGHT above, adding initial climb distances to range values.

NOTES: Ranges shown at optimum altitudes are maximum. In order to obtain maximum range on flights requiring more than one chart (due to external configuration or gross weight changes), it is necessary to observe the optimum cruising altitude on each chart; i.e., when changing charts a climb may be required to obtain a maximum range. All range values include allowances for descent distance and fuel. Climb distance and fuel are included where climbs are indicated.

DATA BELOW CONTAIN NO FUEL RESERVE FOR LANDING

LOW ALTITUDE

IF YOU ARE AT S. L. RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 5000′ RANGE IN AIRMILES			IF YOU ARE AT 10,000′ RANGE IN AIRMILES			IF YOU ARE AT 15,000′ RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 20,000′ RANGE IN AIRMILES		
BY CRUISING AT S. L.	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 5,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 10,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 15,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 20,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.
(RANGE FIGURES INCLUDE ALLOWANCES FOR PRESCRIBED CLIMB AND DESCENT TO SEA LEVEL)																
564	40	1588	750	(664)	40	(1630)	(793)	40	(1670)	(932)	40	(1701)	750	(1080)	40	(1735)
526	40	1472	700	622	40	1520	746	40	1554	(875)	40	(1592)	700	(1013)	40	(1625)
492	40	1354	650	578	40	1405	693	40	1438	818	40	1482	650	952	40	1510
454	40	1242	600	540	40	1290	645	40	1329	760	40	1368	600	884	40	1396
421	40	1100	550	497	40	1180	597	40	1213	703	40	1252	550	823	40	1281
382	40	1028	500	454	40	1071	549	40	1100	646	40	1142	500	755	40	1167
349	40	927	450	411	40	956	497	40	990	583	40	1032	450	688	40	1052
325	40	860	420	387	40	884	468	40	918	550	40	956	420	650	40	985
				DROP EXTERNAL TIP TANKS WHEN EMPTY			(REFER TO FIG. 35 FOR OPERATING INSTRUCTIONS)									

CRUISING AT S. L.						EFFECTIVE WIND MPH	CRUISING AT 5000′						CRUISING AT 10,000′						CRUISING AT 15,000′						EFFECTIVE WIND MPH	CRUISING AT 20,000′					
	APPROXIMATE							APPROXIMATE						APPROXIMATE						APPROXIMATE						APPROXIMATE				
CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.
						120 HW																			120 HW	320	92	341	308	.7	
						80 HW							348	90	416	320	.8	(5)	326	90	361	324	.8	(5)	80 HW	310	91	324	334	.8	(5)
388	89	549	348	.9	(5)	40 HW	364	89	466	350	.9	(5)	341	89	398	352	.9		315	89	345	350	.9		40 HW	290	89	295	348	.9	
377	88	528	377	1.0		0	354	88	450	379	1.0		330	88	385	380	1.0		310	88	330	385	1.0		0	286	89	295	384	1.0	
351	85	481	391	1.1		40 TW	319	84	387	382	1.1		312	86	356	400	1.1		290	86	303	400	1.1		40 TW	271	87	270	404	1.1	
						80 TW							295	84	327	420	1.3		270	84	282	414	1.3		80 TW	255	86	259	424	1.2	
						120 TW																			120 TW	246	85	249	452	1.4	

Figure 37 (Sheet 1 of 2 Sheets) — Flight Operation Instruction Chart (F-80A-10 and RF-80A-10, 15)

AIRCRAFT MODELS

F-80A-10 RF-80A-10, -15

ENGINES: J33-A-9B, -GE-11B, -A-17A, -A-21

HIGH ALTITUDE

CHART WEIGHT LIMITS 15,050 TO 12,700 POUNDS

EXTERNAL LOAD ITEMS

2 × 165 GALLON EXTERNAL TIP TANKS
DROPPED WHEN EMPTY
NUMBER OF ENGINES OPERATING: ONE

IF YOU ARE AT 25,000' RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 30,000' RANGE IN AIRMILES			IF YOU ARE AT 35,000' RANGE IN AIRMILES			IF YOU ARE AT 40,000' RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 45,000' RANGE IN AIRMILES		
BY CRUISING AT 25,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 30,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 35,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 40,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 45,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.
(RANGE FIGURES INCLUDE ALLOWANCES FOR PRESCRIBED CLIMB AND DESCENT TO SEA LEVEL)																
(1252)	40	(1769)	750	(1439)	40	(1803)	(1639)	40	(1826)	(1890)	—	—	750			
(1175)	40	(1654)	700	(1353)	40	(1688)	(1539)	40	(1718)	(1769)	—	—	700			
(1100)	40	(1540)	650	(1267)	40	(1572)	(1439)	40	(1607)	(1653)	—	—	650			
1022	40	1429	600	1176	40	1462	(1339)	40	(1492)	(1535)	—	—	600			
946	40	1315	550	1090	40	1343	1242	40	1378	(1420)	—	—	550			
870	40	1199	500	1004	40	1232	1138	40	1262	1300	—	—	500			
794	40	1090	450	918	40	1118	1037	40	1147	1185	—	—	450			
751	40	1018	420	865	40	1052	980	40	1080	1114	—	—	420			
			DROP EXTERNAL TIP TANKS WHEN EMPTY				(REFER TO FIG. 35 FOR OPERATING INSTRUCTIONS)									

CRUISING AT 25,000'						EFFECTIVE WIND MPH	CRUISING AT 30,000'						CRUISING AT 35,000'						CRUISING AT 40,000'						EFFECTIVE WIND MPH	CRUISING AT 45,000'					
	APPROXIMATE							APPROXIMATE						APPROXIMATE						APPROXIMATE							APPROXIMATE				
CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.
303	93	309	320	.7	(5)	120 HW	279	94	267	320	.7	(5)	259	96	235	326	.7	(5)	227	96	188	320	.7	(5)	120 HW						
284	91	277	334	.8		80 HW	273	93	259	352	.8		253	95	230	356	.8		227	96	188	360	.8		80 HW						
272	90	262	358	.9		40 HW	264	92	247	378	.9		246	93	214	385	.9		227	96	188	400	.9		40 HW						
264	89	251	385	1.0		0	257	91	234	406	1.0		236	92	204	410	1.0		222	95	183	430	1.0		0						
254	88	241	412	1.1		40 TW	247	90	224	432	1.1		236	92	204	450	1.1		222	95	183	470	1.1		40 TW						
243	87	230	436	1.2		80 TW	247	90	224	472	1.2		236	92	204	490	1.2		222	95	183	510	1.2		80 TW						
232	86	220	460	1.3		120 TW	236	89	214	496	1.3		225	91	194	512	1.3		222	95	183	550	1.3		120 TW						

SPECIAL NOTES

1. Climb at 100% RPM.
2. Multiply statute units by 0.87 to obtain nautical units.
3. Read lower half of chart opposite effective wind only.
4. Make additional allowances for landing, navigational errors, combat, formation flight, etc., as required.
5. Refer to fig. 35 for let down without external tip tanks.

EXAMPLE

If you are at 5000 ft. with 650 gallons of available fuel, you can fly 578 statute airmiles by holding 354 MPH CAS. However, you can fly 1405 statute airmiles by immediately climbing to 40,000 ft. using 100% RPM. At 40,000 ft. cruise at 222 MPH CAS and start let down 175 statute miles from home. With an 80 MPH headwind the range at 40,000 ft. would be 0.8 × 1405 or 1123 statute miles. Cruise at 227 MPH CAS with this wind and start let down 160 statute miles from destination.

LEGEND

EFFECTIVE WIND — HW, HEADWIND, TW, TAILWIND — MPH
R.F. — RANGE FACTOR — RATIO OF GROUND DISTANCE TO AIRMILES FOR CORRESPONDING WINDS
G.S. — GROUND SPEED IN MPH
CAS — CALIBRATED AIRSPEED IN MPH
GAL/HR — FUEL CONSUMPTION — GALLONS PER HOUR
RANGE — STATUTE MILES
( ) RANGE IN PARENTHESES FOR INTERPOLATION PURPOSES ONLY

FUEL GRADE — JP-4
FUEL DENSITY — 6.5 LBS/GAL

DATA AS OF: 12-1-48 BASED ON: Flight Test

Figure 37 (Sheet 2 of 2 Sheets) — Flight Operation Instruction Chart (F-80A-10 and RF-80A-10, 15)

TAKE-OFF DISTANCES — FEET
70% FLAPS, HARD SURFACE RUNWAY

AIRCRAFT MODELS
RF-80A-20, -25

ENGINE MODELS
J33-A-35

CONFIGURATION AND GROSS WEIGHT	PRESSURE ALTITUDE FT.	60°F				80°F				100°F				120°F			
		ZERO WIND		30 KNOT WIND		ZERO WIND		30 KNOT WIND		ZERO WIND		30 KNOT WIND		ZERO WIND		30 KNOT WIND	
		GROUND RUN	CLEAR 50'	GROUND RUN	CLEAR 50'	GROUND RUN	CLEAR 50'	GROUND RUN	CLEAR 50'	GROUND RUN	CLEAR 50'	GROUND RUN	CLEAR 50'	GROUND RUN	CLEAR 50'	GROUND RUN	CLEAR 50'
CLEAN 12,900 LBS. WITHOUT FLUID INJECTION	S. L.	2075	3025	1245	1815	2750	4025	1650	2415	3150	4600	1890	2760	3600	5300	2160	3180
	1,000	2275	3300	1365	1980	3025	4425	1815	2655	3450	5075	2070	3045	3950	5825	2370	3495
	2,000	2475	3600	1485	2160	3325	4850	1995	2910	3800	5550	2280	3330	4350	6425	2610	3855
	3,000	2675	3900	1605	2340	3625	5300	2175	3180	4150	6100	2490	3660	4750	7025	2850	4215
	4,000	2925	4250	1755	2550	3950	5800	2370	3480	4550	6675	2730	3995	5225	7750	3135	4650
	5,000	3200	4650	1920	2790	4325	6350	2595	3810	5000	7350	3000	4410	5775	8575	3465	5145
CLEAN 12,900 LBS. WITH FLUID INJECTION	S. L.	1750	2650	1050	1590	2325	3500	1395	2100	2650	3975	1590	2385	3025	4575	1815	2745
	1,000	1925	2875	1155	1725	2550	3825	1530	2295	2925	4375	1755	2625	3350	5050	2010	3030
	2,000	2075	3125	1245	1875	2775	4200	1665	2520	3200	4800	1920	2880	3675	5525	2205	3315
	3,000	2275	3400	1365	2040	3050	4575	1830	2745	3500	5250	2100	3150	4025	6050	2415	3630
	4,000	2475	3700	1485	2220	3325	5000	1995	3000	3825	5750	2295	3450	4400	6625	2640	3975
	5,000	2700	4025	1620	2415	3625	5450	2175	3270	4175	6275	2505	3765	4800	7275	2880	4365
TIP TANKS 15,350 LBS. WITHOUT FLUID INJECTION	S. L.	2800	4275	1735	2650	3700	5650	2295	3565	4225	6475	2620	4015	4800	7400	2980	4590
	1,000	3050	4650	1890	2885	4050	6175	2510	3830	4625	7100	2870	4400	5275	8100	3270	5020
	2,000	3350	5075	2078	3145	4425	6775	2745	4200	5075	7800	3145	4840	5800	8900	3595	5520
	3,000	3650	5525	2262	3425	4850	7400	3010	4590	5575	8550	3455	5300	6375	9800	3950	6075
	4,000	3950	6000	2450	3720	5300	8125	3290	5040	6100	9400	3780	5830	6975	10800	4325	6695
	5,000	4300	6550	2665	4060	5800	8850	3600	5490	6700	10275	4155	6370	7675	11875	4760	7360
TIP TANKS 15,350 LBS. WITH FLUID INJECTION	S. L.	2325	3675	1442	2280	3025	4850	1875	3010	3450	5575	2140	3455	3925	6350	2435	3940
	1,000	2525	4000	1565	2480	3325	5300	2060	3285	3800	6100	2355	3780	4300	6975	2665	4325
	2,000	2750	4350	1705	2700	3625	5825	2250	3610	4150	6700	2575	4155	4700	7675	2915	4760
	3,000	3000	4750	1860	2945	3975	6375	2465	3950	4525	7350	2805	4560	5150	8450	3195	5240
	4,000	3250	5150	2015	3195	4325	6950	2680	4300	4950	8050	3070	4990	5650	9300	3505	5765
	5,000	3525	5600	2185	3470	4700	7600	2915	4710	5375	8825	3330	5470	6175	10225	3830	6340

REMARKS

1. No conservation factor included.
2. Distances are based on normal take-off procedure. (See Paragraph 7, Sec. 11.)

DATA AS OF: 1 Jan. 49

DATA BASIS: Flight Test

FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LBS/GAL

Figure 38 — Take-off Distances — RF-80A-20, -25

LANDING DISTANCE — FEET
STANDARD DAY

AIRCRAFT MODELS
RF-80A-20, -25

ENGINE MODELS
J33-A-35

GROSS WEIGHT LBS.	BEST CAS FOR APPROACH		70% FLAPS — HARD SURFACE — NO WIND							
	POWER OFF	POWER ON	AT SEA LEVEL		AT 2000 FT.		AT 4000 FT.		AT 6000 FT.	
	MPH	MPH	GROUND ROLL	CLEAR 50′	GROUND ROLL	CLEAR 50′	GROUND ROLL	CLEAR 50′	GROUND ROLL	CLEAR 50′
10,000	125	125	2350	3275	2500	3450	2650	3625	2800	3800
12,500	140	140	2950	3950	3100	4150	3300	4400	3500	4625

REMARKS
1. No conservatism factor included.

LEGEND
CAS: CALIBRATED AIRSPEED
MPH: STATUTE MILES PER HOUR

DATA AS OF: 1 Jan. 49

DATA BASIS: Flight Test

FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LBS/GAL

Figure 39 — Landing Distance — RF-80A-20, -25

DESCENT CHART
STANDARD DAY

AIRCRAFT MODELS
RF-80A-20, -25

ENGINE MODELS
J33-A-35

CONFIGURATION: 2 X 165 GALLON TANKS
WEIGHT: 10,400 LBS.

CONFIGURATION: CLEAN
WEIGHT: 10,100 LBS.

APPROXIMATE				CAS MPH	PRESSURE ALTITUDE FEET	CAS MPH	APPROXIMATE			
RATE OF DESCENT	TO SEA LEVEL						TO SEA LEVEL			RATE OF DESCENT
	DISTANCE	TIME	FUEL				FUEL	TIME	DISTANCE	
1200	85	12.5	20	200	40,000	200	26	15.2	98	1000
1700	63	8.7	15	230	35,000	230	20	9.6	70	1500
2400	46	6.4	12	260	30,000	260	16	7.0	51	2150
3200	34	4.7	8	285	25,000	285	12	5.2	37	2850
4100	24	3.3	6	315	20,000	315	8	3.7	27	3700
5150	16	2.2	4	350	15,000	350	6	2.5	18	4650
6300	9	1.4	3	385	10,000	385	3	1.5	11	5750
7550	4	0.6	1	420	5,000	420	2	0.8	5	6850
8900	—	—	—	455	SEA LEVEL	455	—	—	—	8050

REMARKS
1. Descend at .6 mach number.
2. Use dive flaps down to 35,000 ft. Idle RPM is too great to allow descent at .6 mach number.
3. Multiply statute units by .87 for conversion to nautical units.

LEGEND
RATE OF DESCENT: FEET PER MINUTE
DISTANCE: STATUTE MILES
TIME: MINUTES
FUEL: GALLONS
CAS: CALIBRATED AIRSPEED
MPH: STATUTE MILES PER HOUR

DATA AS OF: 1 Jan. 49

DATA BASIS: Flight Test

FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LBS/GAL

Figure 40 — Descent Chart — RF-80A-20, -25

CLIMB CHART FOR MAXIMUM POWER
STANDARD DAY

AIRCRAFT MODELS
RF-80A-20, -25

ENGINE MODELS
J33-A-35

CONFIGURATION: CLEAN
WEIGHT: 12,900 LBS.

APPROXIMATE				CAS MPH	PRESSURE ALTITUDE FEET	CAS MPH	APPROXIMATE			
RATE OF CLIMB	FROM SEA LEVEL						FROM SEA LEVEL			RATE OF CLIMB
	DISTANCE	TIME	FUEL				FUEL	TIME	DISTANCE	
4950	—	—	21 (2)	310	SEA LEVEL	310	21 (2)	—	—	5900
4450	5	1	38	300	5,000	300	32	1	5	5300
3900	12	3	51	290	10,000	290	44	2	11	4700
3350	20	4	67	280	15,000	280	56	3	16	4100
2800	30	6	82	270	20,000	270	68	4	25	3500
2250	42	8	94	260	25,000	260	82	6	35	2900
1750	58	10	111	250	30,000	250	94	8	46	2300
1350	79	13	129	240	35,000	240	108	10	63	1750
650	116	19	152	230	40,000	230	123	14	89	1100

CONFIGURATION: 2 X 165 GALLON TIP TANKS
WEIGHT: 15,350 LBS.

CONFIGURATION: 2 X 165 GALLON TIP TANKS
WEIGHT: 12,350 LBS.

APPROXIMATE				CAS MPH	PRESSURE ALTITUDE FEET	CAS MPH	APPROXIMATE			
RATE OF CLIMB	FROM SEA LEVEL						FROM SEA LEVEL			RATE OF CLIMB
	DISTANCE	TIME	FUEL				FUEL	TIME	DISTANCE	
4000	—	—	31 (2)	310	SEA LEVEL	310	31 (2)	—	—	5000
3500	8	2	50	300	5,000	300	47	1	5	4400
3000	18	3	69	290	10,000	290	63	2	11	3850
2500	27	5	88	280	15,000	280	75	4	20	3250
2000	40	7	108	270	20,000	270	91	5	30	2700
1500	60	10	129	260	25,000	260	107	7	44	2150
1000	85	14	156	250	30,000	250	123	10	61	1600
600	131	20	188	240	35,000	240	145	14	88	1050
—	—	—	—	—	40,000	230	178	24	141	350

REMARKS

1. Climb at recommended CAS.
2. Taxi and take-off allowance.
3. Temp. correction — subtract 30 FPM from standard day rate of climb for each °F. above standard day temp.
4. Multiply statute units by 0.87 for conversion to nautical units.

DATA AS OF: 1 Jan. 49

DATA BASIS: Flight Test

LEGEND

RATE OF CLIMB: FEET PER MINUTE
DISTANCE: STATUTE MILES
TIME: MINUTES
FUEL: GALLONS
CAS: CALIBRATED AIRSPEED
MPH: STATUTE MILES PER HOUR

FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LBS/GAL

Figure 41 — Climb Chart — RF-80A-20, -25

MAXIMUM ENDURANCE
STANDARD DAY

AIRCRAFT MODELS
RF-80A-20, -25

ENGINE MODELS
J33-A-35

CONFIGURATION: 2 X 165 EXTERNAL TIP TANKS WEIGHT: 10,400 LBS.			CONFIGURATION: CLEAN WEIGHT: 10,100 LBS.	
APPROXIMATE FUEL FLOW GAL/MIN	**CAS MPH**	**PRESSURE ALTITUDE FEET**	**CAS MPH**	**APPROXIMATE FUEL FLOW GAL/MIN**
3	185	40,000	185	2
3	185	35,000	185	3
3	185	30,000	185	3
3	185	25,000	185	3
4	185	20,000	185	3
4	185	15,000	185	4
4	185	10,000	185	4
5	185	5,000	185	5
6	185	S. L.	185	5

LEGEND
CAS: CALIBRATED AIRSPEED
GAL/MIN: FUEL CONSUMPTION
MPH: STATUTE MILES PER HOUR

DATA AS OF: 1 Jan. 49
DATA BASIS: Flight Test

FUEL GRADE: JP-4
FUEL DENSITY: 6.5 LBS/GAL

Figure 42 — Maximum Endurance Chart — RF-80A-20, -25

AIRCRAFT MODELS	FLIGHT OPERATION INSTRUCTION CHART	EXTERNAL LOAD ITEMS
RF-80A-20, -25	**STANDARD DAY**	NONE
ENGINE: J33-A-35	CHART WEIGHT LIMITS 12,860 TO 9,000 POUNDS	NUMBER OF ENGINES OPERATING: ONE

INSTRUCTIONS FOR USING CHART: (A) IN FLIGHT — Select figure in fuel column equal to or less than fuel available for cruise (fuel on board minus allowance for reserve, combat, navigational error, formation flight, etc.). Move horizontally right or left to section according to present altitude and read total range available (no wind) by cruising at that altitude or by climbing to another altitude of maximum range. For a flight at initial altitude, operating instructions are given directly below. For a flight at higher altitude, climb immediately to desired altitude and read cruising instructions in appropriate cruising altitude section. (B) FLIGHT PLANNING — From initial fuel on board subtract fuel for take-off and climb to desired cruising altitude and all other necessary allowances. Then use chart as for IN FLIGHT above, adding initial climb distances to range values.

NOTES: Ranges shown at optimum altitudes are maximum. In order to obtain maximum range on flights requiring more than one chart (due to external configuration or gross weight changes), it is necessary to observe the optimum cruising altitude on each chart; i.e., when changing charts a climb may be required to obtain a maximum range. All range values include allowances for descent distance and fuel. Climb distance and fuel are included where climbs are indicated.

DATA BELOW CONTAIN NO FUEL RESERVE FOR LANDING

LOW ALTITUDE

IF YOU ARE AT S. L. RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 5000′ RANGE IN AIRMILES			IF YOU ARE AT 10,000′ RANGE IN AIRMILES			IF YOU ARE AT 15,000′ RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 20,000′ RANGE IN AIRMILES		
BY CRUISING AT S. L.	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 5,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 10,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 15,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 20,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.
(RANGE FIGURES INCLUDE ALLOWANCES FOR PRESCRIBED CLIMB AND DESCENT TO SEA LEVEL)																
325	40	864	425	382	40	888	435	40	912	526	40	932	425	612	40	946
306	40	808	400	358	40	832	406	40	855	497	40	874	400	574	40	888
277	40	717	360	320	40	741	368	40	764	449	40	779	360	516	40	798
244	40	621	320	287	40	650	325	40	674	397	40	688	320	463	40	707
215	40	530	280	253	40	560	288	40	583	349	40	597	280	406	40	616
182	40	440	240	215	40	468	249	40	492	301	40	506	240	349	40	526
153	40	349	200	182	40	378	205	40	397	253	40	416	200	296	40	435
124	40	258	160	143	40	287	167	40	306	205	40	325	160	239	40	344
91	30	167	120	110	35	196	124	40	215	158	40	234	120	182	40	249
62	25	91	80	76	30	115	86	30	129	110	35	143	80	129	35	158

CRUISING AT S. L.						EFFECTIVE WIND MPH	CRUISING AT 5000′						CRUISING AT 10,000′						CRUISING AT 15,000′						EFFECTIVE WIND MPH	CRUISING AT 20,000′					
	APPROXIMATE							APPROXIMATE						APPROXIMATE						APPROXIMATE						APPROXIMATE				
CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.
						120 HW							369	88	426	305	.7	9	346	88	366	309	.7	15	120 HW	325	88	314	316	.7	23
420	89	581	340	.8	0	80 HW	371	86	454	317	.8	4	356	87	409	330	.8	10	336	87	350	337	.8	16	80 HW	325	88	314	356	.8	24
396	86	520	356	.9	0	40 HW	358	85	438	344	.9	5	346	86	392	358	.9	10	327	86	335	366	.9	17	40 HW	311	87	298	377	.9	26
375	84	485	375	1.0	0	0	352	84	423	377	1.0	5	333	84	363	384	1.0	11	318	85	320	395	1.0	18	0	303	86	286	407	1.0	27
362	82	456	402	1.1	0	40 TW	348	83	409	413	1.1	5	325	83	350	412	1.1	12	308	84	307	423	1.1	19	40 TW	292	85	272	433	1.1	29
353	81	447	433	1.2	0	80 TW	338	82	398	442	1.2	6	312	82	339	440	1.2	12	297	83	298	450	1.2	20	80 TW	282	84	260	459	1.2	30
						120 TW							302	81	330	468	1.4	13	285	82	282	475	1.4	21	120 TW	267	83	249	480	1.4	32

Figure 43 (Sheet 1 of 2 Sheets) — Flight Operation Instruction Chart (RF-80A-20, -25)

AIRCRAFT MODELS
RF-80A-20, -25

ENGINE: J33-A-35

HIGH ALTITUDE
CHART WEIGHT LIMITS 12,860 TO 9,000 POUNDS

EXTERNAL LOAD ITEMS
NONE

NUMBER OF ENGINES OPERATING: ONE

IF YOU ARE AT 25,000' RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 30,000' RANGE IN AIRMILES			IF YOU ARE AT 35,000' RANGE IN AIRMILES			IF YOU ARE AT 40,000' RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 45,000' RANGE IN AIRMILES		
BY CRUISING AT 25,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 30,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 35,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 40,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 45,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.
(RANGE FIGURES INCLUDE ALLOWANCES FOR PRESCRIBED CLIMB AND DESCENT TO SEA LEVEL)																
712	40	956	425	817	40	975	927	40	994	1008	—	—	425			
669	40	903	400	764	40	917	874	40	936	951	—	—	400			
602	40	812	360	693	40	827	788	40	841	860	—	—	360			
535	40	722	320	616	40	736	702	40	750	769	—	—	320			
473	40	631	280	545	40	645	621	40	659	679	—	—	280			
406	40	540	240	468	40	550	535	40	568	588	—	—	240			
444	40	449	200	497	40	459	449	40	478	497	—	—	200			
277	40	358	160	320	40	368	368	40	387	402	—	—	160			
215	40	268	120	244	40	277	282	40	296	311	—	—	120			
148	40	172	80	172	40	186	196	40	205	220	—	—	80			

CRUISING AT 25,000'						EFFECTIVE WIND MPH	CRUISING AT 30,000'						CRUISING AT 35,000'						CRUISING AT 40,000'						EFFECTIVE WIND MPH	CRUISING AT 45,000'					
	APPROXIMATE							APPROXIMATE						APPROXIMATE						APPROXIMATE							APPROXIMATE				
CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.
312	90	295	333	.7	31	120 HW	297	91	264	348	.7	44	270	91	222	338	.7	60	216	93	193	300	.7	83	120 HW						
307	89	281	366	.8	33	80 HW	288	90	251	377	.8	46	270	91	222	378	.8	64	211	92	183	332	.8	88	80 HW						
300	88	268	396	.9	35	40 HW	281	89	241	405	.9	48	260	90	210	402	.9	67	204	91	175	360	.9	92	40 HW						
288	87	256	420	1.0	37	0	275	88	229	435	1.0	51	260	90	210	442	1.0	70	204	91	175	400	1.0	98	0						
288	87	256	460	1.1	39	40 TW	259	87	219	452	1.1	54	260	90	210	482	1.1	74	200	90	167	432	1.1	104	40 TW						
275	86	244	481	1.2	41	80 TW	259	87	219	492	1.2	56	255	89	200	514	1.2	77	200	90	167	472	1.2	109	80 TW						
263	85	232	505	1.3	43	120 TW	252	86	207	521	1.3	59	255	89	200	554	1.3	80	200	90	167	512	1.3	115	120 TW						

SPECIAL NOTES

1. Climb at 100% RPM.
2. Multiply statute units by 0.87 to obtain nautical units.
3. Read lower half of chart opposite effective wind only.
4. Make additional allowances for landing, navigational errors, combat, formation flight, etc., as required.

EXAMPLE

If you are at 15,000 ft. with 320 gallons of available fuel, you can fly 397 statute airmiles by holding 318 MPH CAS. However, you can fly 688 statute airmiles by immediately climbing to 40,000 ft. using 100% RPM. At 40,000 ft. cruise at 204 MPH CAS and start let down 98 statute miles from home. With an 80 MPH headwind the range at 40,000 ft. would be 0.8 × 688 or 550 statute miles. Cruise at 211 MPH CAS with this wind and start let down 88 statute miles from destination.

LEGEND

EFFECTIVE WIND — HW, HEADWIND, TW, TAILWIND — MPH
R.F. — RANGE FACTOR — RATIO OF GROUND DISTANCE TO AIRMILES FOR CORRESPONDING WINDS
G.S. — GROUND SPEED IN MPH
CAS — CALIBRATED AIRSPEED IN MPH
GAL/HR — FUEL CONSUMPTION — GALLONS PER HOUR
RANGE — STATUTE MILES
( ) RANGE IN PARENTHESES FOR INTERPOLATION PURPOSES ONLY

FUEL GRADE — JP-4
FUEL DENSITY — 6.5 LBS/GAL

DATA AS OF: 7-1-49 BASED ON: Flight Test

Figure 43 (Sheet 2 of 2 Sheets) — Flight Operation Instruction Chart (RF-80A-20, -25)

AIRCRAFT MODELS
RF-80A-20, -25
ENGINE: J33-A-35

FLIGHT OPERATION INSTRUCTION CHART
STANDARD DAY
CHART WEIGHT LIMITS 15,000 TO 9,250 POUNDS

EXTERNAL LOAD ITEMS
2 × 165 GALLON EXTERNAL TIP TANKS
CARRIED ALL THE WAY
NUMBER OF ENGINES OPERATING: ONE

INSTRUCTIONS FOR USING CHART: (A) IN FLIGHT — Select figure in fuel column equal to or less than fuel available for cruise (fuel on board minus allowance for reserve, combat, navigational error, formation flight, etc.). Move horizontally right or left to section according to present altitude and read total range available (no wind) by cruising at that altitude or by climbing to another altitude of maximum range. For a flight at initial altitude, operating instructions are given directly below. For a flight at higher altitude, climb immediately to desired altitude and read cruising instructions in appropriate cruising altitude section. (B) FLIGHT PLANNING — From initial fuel on board subtract fuel for take-off and climb to desired cruising altitude and all other necessary allowances. Then use chart as for IN FLIGHT above, adding initial climb distances to range values.

NOTES: Ranges shown at optimum altitudes are maximum. In order to obtain maximum range on flights requiring more than one chart (due to external configuration or gross weight changes), it is necessary to observe the optimum cruising altitude on each chart; i.e., when changing charts a climb may be required to obtain a maximum range. All range values include allowances for descent distance and fuel. Climb distance and fuel are included where climbs are indicated.

DATA BELOW CONTAIN NO FUEL RESERVE FOR LANDING

LOW ALTITUDE

IF YOU ARE AT S. L. RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 5000′ RANGE IN AIRMILES			IF YOU ARE AT 10,000′ RANGE IN AIRMILES			IF YOU ARE AT 15,000′ RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 20,000′ RANGE IN AIRMILES		
BY CRUISING AT S. L.	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 5,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 10,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 15,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 20,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.
(RANGE FIGURES INCLUDE ALLOWANCES FOR PRESCRIBED CLIMB AND DESCENT TO SEA LEVEL)																
535	35	1228	755	616	35	1242	702	35	1270	808	35	1285	755	927	35	1300
497	35	1137	700	569	35	1160	654	35	1175	750	35	1195	700	865	35	1208
425	35	965	600	487	35	989	559	35	1004	645	35	1022	600	741	35	1036
354	35	793	500	406	35	817	468	35	832	540	35	855	500	621	35	865
320	35	707	450	368	35	736	421	35	745	388	35	769	450	559	35	779
287	35	621	400	325	35	650	373	35	660	435	35	683	400	497	35	698
249	35	535	350	287	35	564	325	35	574	382	35	597	350	440	35	612
215	35	454	300	244	35	478	282	35	488	330	35	511	300	378	35	526
177	35	368	250	205	35	392	234	35	401	277	35	425	250	315	35	440
139	35	282	200	167	35	306	191	35	315	225	35	339	200	258	35	354
105	35	191	150	124	35	215	143	35	229	172	35	258	150	196	35	268
72	25	100	100	86	30	129	100	30	143	120	35	172	100	139	35	182

CRUISING AT S. L.						EFFECTIVE WIND MPH	CRUISING AT 5000′						CRUISING AT 10,000′						CRUISING AT 15,000′						EFFECTIVE WIND MPH	CRUISING AT 20,000′					
	APPROXIMATE							APPROXIMATE						APPROXIMATE						APPROXIMATE						APPROXIMATE				
CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.
						120 HW							340	90	463	271	.6	7	320	90	398	277	.7	13	120 HW	302	91	361	285	.7	20
360	87	528	280	.7	0	80 HW	340	87	471	285	.7	3	321	88	426	290	.7	8	301	88	366	294	.8	14	80 HW	287	89	327	306	.8	21
338	84	485	298	.9	0	40 HW	317	84	423	300	.9	4	306	86	392	313	.9	8	287	87	350	317	.9	15	40 HW	273	88	314	328	.9	23
317	81	447	317	1.0	0	0	286	81	385	317	1.0	4	294	84	363	340	1.0	9	273	85	320	340	1.0	16	0	261	86	286	352	1.0	24
301	78	429	341	1.1	0	40 TW	276	78	364	336	1.1	4	285	83	350	369	1.1	10	262	83	298	367	1.1	17	40 TW	251	85	272	380	1.1	26
286	76	396	366	1.3	0	80 TW	262	75	346	362	1.3	5	277	82	339	400	1.3	10	254	82	282	397	1.3	18	80 TW	243	84	260	408	1.3	27
						120 TW							271	81	330	433	1.4	11	247	81	272	429	1.4	19	120 TW	235	83	249	438	1.4	28

Figure 44 (Sheet 1 of 2 Sheets) — Flight Operation Instruction Chart (RF-80A-20, -25)

AIRCRAFT MODELS
RF-80A-20, -25

ENGINE: J33-A-35

HIGH ALTITUDE

CHART WEIGHT LIMITS 15,000 TO 9,250 POUNDS

EXTERNAL LOAD ITEMS
2 × 165 GALLON EXTERNAL TIP TANKS CARRIED ALL THE WAY
NUMBER OF ENGINES OPERATING: ONE

IF YOU ARE AT 25,000' RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 30,000' RANGE IN AIRMILES			IF YOU ARE AT 35,000' RANGE IN AIRMILES			IF YOU ARE AT 40,000' RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 45,000' RANGE IN AIRMILES		
BY CRUISING AT 25,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 30,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 35,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 40,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 45,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.
(RANGE FIGURES INCLUDE ALLOWANCES FOR PRESCRIBED CLIMB AND DESCENT TO SEA LEVEL)																
1050	35	1314	755	1205	35	1319	1324						755			
975	35	1219	700	1118	35	1228	1233						700			
841	35	1050	600	960	35	1055	1060						600			
702	35	946	500	807	35	908	889						500			
635	35	793	450	726	35	803	808						450			
569	35	708	400	650	35	717	722						400			
492	35	622	350	574	35	631	636						350			
430	35	535	300	497	35	545	550						300			
363	35	449	250	421	35	459	464						250			
296	35	368	200	339	35	373	378						200			
225	35	282	150	263	35	287	296						150			
158	35	196	100	186	35	201	210						100			

CRUISING AT 25,000'						EFFECTIVE WIND MPH	CRUISING AT 30,000'						CRUISING AT 35,000'						CRUISING AT 40,000'						EFFECTIVE WIND MPH	CRUISING AT 45,000'					
	APPROXIMATE							APPROXIMATE						APPROXIMATE						APPROXIMATE							APPROXIMATE				
CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.
288	92	324	300	.7	28	120 HW	270	95	316	308	.7	39	288	93	246	278	.7	53							120 HW						
274	90	295	320	.8	30	80 HW	265	94	302	340	.8	41	224	92	233	311	.8	56							80 HW						
262	89	281	343	.9	32	40 HW	260	93	289	374	.9	44	224	92	233	351	.9	60							40 HW						
251	88	268	368	1.0	34	0	257	92	276	409	1.0	46	216	91	222	377	1.0	63							0						
241	87	256	394	1.1	36	40 TW	254	91	264	444	1.1	48	216	91	222	417	1.1	67							40 TW						
233	86	244	422	1.3	38	80 TW	254	91	264	484	1.2	51	201	90	210	443	1.2	70							80 TW						
227	85	232	453	1.4	41	120 TW	249	90	251	517	1.3	53	201	90	210	483	1.3	74							120 TW						

SPECIAL NOTES

1. Climb at 100% RPM.
2. Multiply statute units by 0.87 to obtain nautical units.
3. Read lower half of chart opposite effective wind only.
4. Make additional allowances for landing, navigational errors, combat, formation flight, etc., as required.

EXAMPLE

If you are at S.L. with 600 gallons available fuel, you can fly 425 statute airmiles by holding 317 MPH CAS. However, you can fly 965 statute airmiles by immediately climbing to 35,000 ft. using 100% RPM. At 35,000 ft. cruise at 216 MPH CAS and start let down 63 statute miles from home. With a 40 MPH tailwind the range at 35,000 ft. would be 1.1 × 965 or 1061 statute miles. Cruise at 216 MPH CAS with this wind and start let down 67 statute miles from destination.

LEGEND

EFFECTIVE WIND — HW, HEADWIND, TW, TAILWIND — MPH
R.F. — RANGE FACTOR — RATIO OF GROUND DISTANCE TO AIRMILES FOR CORRESPONDING WINDS
G.S. — GROUND SPEED IN MPH
CAS — CALIBRATED AIRSPEED IN MPH
GAL/HR — FUEL CONSUMPTION — GALLONS PER HOUR
RANGE — STATUTE MILES
( ) RANGE IN PARENTHESES FOR INTERPOLATION PURPOSES ONLY

FUEL GRADE — JP-4
FUEL DENSITY — 6.5 LBS/GAL

DATA AS OF: 7-1-49 BASED ON: Flight Test

Figure 44 (Sheet 2 of 2 Sheets) — Flight Operation Instruction Chart (RF-80A-20, -25)

AIRCRAFT MODELS	FLIGHT OPERATION INSTRUCTION CHART	EXTERNAL LOAD ITEMS
RF-80A-20, -25	**STANDARD DAY**	2 × 165 GALLON EXTERNAL TIP TANKS DROPPED WHEN EMPTY
ENGINE: J33-A-35	CHART WEIGHT LIMITS 15,000 TO 12,860 POUNDS	NUMBER OF ENGINES OPERATING: ONE

INSTRUCTIONS FOR USING CHART: (A) IN FLIGHT — Select figure in fuel column equal to or less than fuel available for cruise (fuel on board minus allowance for reserve, combat, navigational error, formation flight, etc.). Move horizontally right or left to section according to present altitude and read total range available (no wind) by cruising at that altitude or by climbing to another altitude of maximum range. For a flight at initial altitude, operating instructions are given directly below. For a flight at higher altitude, climb immediately to desired altitude and read cruising instructions in appropriate cruising altitude section. (B) FLIGHT PLANNING — From initial fuel on board subtract fuel for take-off and climb to desired cruising altitude and all other necessary allowances. Then use chart as for IN FLIGHT above, adding initial climb distances to range values.

NOTES: Ranges shown at optimum altitudes are maximum. In order to obtain maximum range on flights requiring more than one chart (due to external configuration or gross weight changes), it is necessary to observe the optimum cruising altitude on each chart; i.e., when changing charts a climb may be required to obtain a maximum range. All range values include allowances for descent distance and fuel. Climb distance and fuel are included where climbs are indicated.

DATA BELOW CONTAIN NO FUEL RESERVE FOR LANDING

LOW ALTITUDE

IF YOU ARE AT S. L. RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 5000′ RANGE IN AIRMILES			IF YOU ARE AT 10,000′ RANGE IN AIRMILES			IF YOU ARE AT 15,000′ RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 20,000′ RANGE IN AIRMILES		
BY CRUISING AT S. L.	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 5,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 10,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 15,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 20,000′	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.
(RANGE FIGURES INCLUDE ALLOWANCES FOR PRESCRIBED CLIMB AND DESCENT TO SEA LEVEL)																
559	35	1462	**755**	650	35	1486	741	35	1505	874	35	1520	**755**	1014	35	1534
516	35	1362	**700**	602	35	1386	688	35	1405	817	35	1424	**700**	946	35	1438
483	35	1271	**650**	564	35	1295	645	35	1319	765	35	1334	**650**	884	35	1347
449	35	1180	**600**	521	35	1205	597	35	1228	712	35	1242	**600**	822	35	1257
411	35	1090	**550**	483	35	1114	550	35	1137	660	35	1156	**550**	764	35	1171
378	35	998	**500**	445	35	1023	507	35	1046	607	35	1066	**500**	702	35	1080
344	35	908	**450**	402	35	932	459	35	960	554	35	980	**450**	645	35	994
325	40	865	**425**	382	40	889	435	40	912	526	40	932	**425**	612	40	946
				DROP EXTERNAL TIP TANKS WHEN EMPTY			(REFER TO FIG. 43 FOR OPERATING INSTRUCTIONS)									

CRUISING AT S. L.						EFFEC-TIVE WIND MPH	CRUISING AT 5000′						CRUISING AT 10,000′						CRUISING AT 15,000′						EFFEC-TIVE WIND MPH	CRUISING AT 20,000′					
	APPROXIMATE							APPROXIMATE						APPROXIMATE						APPROXIMATE						APPROXIMATE					
CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.
						120 HW							340	90	463	271	.6		320	90	398	277	.7		**120 HW**	302	91	361	285	.7	
360	87	538	280	.7	(5)	**80 HW**	340	87	471	285	.7	(5)	321	88	426	290	.7	(5)	301	88	366	294	.8	(5)	**80 HW**	287	89	327	306	.8	(5)
338	84	485	298	.9		**40 HW**	317	84	423	300	.9		306	86	392	313	.9		287	87	350	317	.9		**40 HW**	273	88	314	328	.9	
317	81	447	317	1.0		**0**	286	81	385	317	1.0		294	84	363	340	1.0		273	85	320	340	1.0		**0**	261	86	286	352	1.0	
301	78	429	341	1.1		**40 TW**	276	78	364	336	1.1		285	83	350	369	1.1		262	83	298	367	1.1		**40 TW**	251	85	272	380	1.1	
286	76	396	366	1.3		**80 TW**	262	75	346	362	1.3		277	82	339	400	1.3		254	82	282	397	1.3		**80 TW**	243	84	260	408	1.3	
						120 TW							271	81	330	433	1.4		247	81	272	429	1.4		**120 TW**	235	83	249	438	1.4	

Figure 45 (Sheet 1 of 2 Sheets) — Flight Operation Instruction Chart (RF-80A-20, -25)

AIRCRAFT MODELS
RF-80A-20, -25

ENGINE: J33-A-35

HIGH ALTITUDE

CHART WEIGHT LIMITS 15,000 TO 12,860 POUNDS

EXTERNAL LOAD ITEMS
2 × 165 GALLON EXTERNAL TIP TANKS
DROPPED WHEN EMPTY
NUMBER OF ENGINES OPERATING: ONE

IF YOU ARE AT 25,000' RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 30,000' RANGE IN AIRMILES			IF YOU ARE AT 35,000' RANGE IN AIRMILES			IF YOU ARE AT 40,000' RANGE IN AIRMILES			FUEL U. S. GAL.	IF YOU ARE AT 45,000' RANGE IN AIRMILES		
BY CRUISING AT 25,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 30,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 35,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.	BY CRUISING AT 40,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.		BY CRUISING AT 45,000'	OPT. ALT. 1000 FT.	BY CRUISING AT OPT. ALT.
(RANGE FIGURES INCLUDE ALLOWANCES FOR PRESCRIBED CLIMB AND DESCENT TO SEA LEVEL)																
1161	35	1544	755	1334	35	1554	1491	35	1558				755			
1090	35	1448	700	1247	35	1457	1395	35	1462				700			
1017	35	1357	650	1166	35	1371	1309	35	1381				650			
951	35	1271	600	1089	35	1281	1228	35	1295				600			
884	35	1180	550	1013	35	1195	1142	35	1209				550			
812	35	1094	500	937	35	1108	1056	35	1123				500			
746	35	1004	450	856	35	1023	970	35	1037				450			
712	40	961	425	817	40	975	927	40	994				425			
DROP EXTERNAL TIP TANKS WHEN EMPTY				(REFER TO FIG. 43 FOR OPERATING INSTRUCTIONS)												

CRUISING AT 25,000'						EFFECTIVE WIND MPH	CRUISING AT 30,000'						CRUISING AT 35,000'						CRUISING AT 40,000'						EFFECTIVE WIND MPH	CRUISING AT 45,000'					
	APPROXIMATE							APPROXIMATE						APPROXIMATE						APPROXIMATE							APPROXIMATE					
CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.	CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.		CAS	% RPM	GAL /HR	G.S.	R.F.	Let Down Dist.
288	92	324	300	.7	(5)	120 HW	270	95	316	308	.7	(5)	228	93	246	278	.7	(5)							120 HW						
274	90	295	320	.8		80 HW	265	94	302	340	.8		224	92	233	311	.8								80 HW						
262	89	281	343	.9		40 HW	260	93	289	374	.9		224	92	233	351	.9								40 HW						
251	88	268	368	1.0		0	257	92	276	409	1.0		216	91	222	377	1.0								0						
241	87	256	394	1.1		40 TW	254	91	264	444	1.1		216	91	222	417	1.1								40 TW						
233	86	244	422	1.3		80 TW	254	91	264	484	1.2		207	90	210	443	1.2								80 TW						
227	85	232	453	1.4		120 TW	249	90	251	517	1.3		207	90	210	483	1.3								120 TW						

SPECIAL NOTES

1. Climb at 100% RPM.
2. Multiply statute units by 0.87 to obtain nautical units.
3. Read lower half of chart opposite effective wind only.
4. Make additional allowances for landing, navigational errors, combat, formation flight, etc., as required.
5. Refer to fig. 43 for letdown without external tanks.

EXAMPLE

If you are at 5,000 ft. with 650 gallons of available fuel, you can fly 564 statute airmiles by holding 286 MPH CAS. However, you can fly 1295 statute airmiles by immediately climbing to 35,000 ft. using 100% RPM. At 35,000 ft. cruise at 216 MPH CAS and start let down 70 statute miles from home. With an 120 MPH headwind the range at 35,000 ft. would be 0.7 × 1295 or 906 statute miles. Cruise at 228 MPH CAS with this wind and start let down 60 statute miles from destination.

LEGEND

EFFECTIVE WIND — HW, HEADWIND, TW, TAILWIND — MPH
R.F. — RANGE FACTOR — RATIO OF GROUND DISTANCE TO AIRMILES FOR CORRESPONDING WINDS
G.S. — GROUND SPEED IN MPH
CAS — CALIBRATED AIRSPEED IN MPH
GAL/HR — FUEL CONSUMPTION — GALLONS PER HOUR
RANGE — STATUTE MILES
( ) RANGE IN PARENTHESES FOR INTERPOLATION PURPOSES ONLY

FUEL GRADE — JP-4
FUEL DENSITY — 6.5 LBS/GAL

DATA AS OF: 7-1-49 BASED ON: Flight Test

Figure 45 (Sheet 2 of 2 Sheets) — Flight Operation Instruction Chart (RF-80A-20, -25)